Model Report for the Revised Pesticide TMDLs for Small Tributaries in the Rock Creek and Potomac River Watersheds in the District of Columbia

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

ac	acres
ATSDR	Agency for Toxic Substances and Disease Registry
CAS	Chemical Abstract Service
CBP	Chesapeake Bay Program
CBPO	Chesapeake Bay Program Office
CCC	Criteria Continuous Concentration
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
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
DL	Detection limit
EOP	End-of-Pipe
EOS	Edge-of-Stream
EPA	U. S. Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
g	grams
GLEC	Great Lakes Environmental Center
HSPF	Hydrological Simulation Program-Fortran
IADN	Integrated Atmospheric Deposition Network
ICPRB	Interstate Commission on the Potomac River Basin
IP	Implementation Plan
l	liters
LA	Load Allocation
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

MGDS	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
NPS	Nonpoint Source
P5	Phase 5 Watershed Model
P5	Phase 5 Watershed Model
P54	Phase 5.4 Watershed Model
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PGDEP	Prince George's County Department of Environmental Protection
POP	Persistent Organic Pollutant
STPM	Small Tributary Pesticide Model
SWO	Storm Water Outfalls
TMDL	Total Maximum Daily Load
USGS	U. S. Geological Survey
WLA	Wasteload Allocation
WWTP	Wastewater Treatment Plant
yr	year

Executive Summary

This report documents the elements of the Small Tributary Pesticide Model (STPM) and its application to develop revised pesticide Total Maximum Daily Loads (TMDLs) for *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*, approved in 2004; *District of Columbia Final Total Maximum Daily Loads for Organics and Metals in Battery Kemble Creek, Foundry Branch, and Dalecarlia Tributary*, approved in 2005; and *District of Columbia Total Maximum Daily Load for Organics, Metals, and Bacteria in Oxon Run* approved in 2004. Revised TMDLs were developed for chlordane, dichloro-diphenyl-trichloroethane (DDT), dieldrin, and heptachlor epoxide for the small tributaries in the District of Columbia's (DC's) portion of the Rock Creek and Potomac River watersheds. TMDLs developed for each small tributary in which the presence of a pesticide was confirmed by instream water quality monitoring collected in 2013 (Tetra Tech, 2014). Table ES.1 shows which TMDLs were developed for each tributary.[1]

Table ES.1: Rock Creek and Potomac River Tributaries with Revised Pesticide TMDLs

Mainstem	Tributary	Dieldrin	Heptachlor Epoxide	Chlordane	DDT
Rock Creek	Broad Branch	X	X	X	
	Dumbarton Oaks	X	X	X	
	Fenwick Branch	X	X		X
	Klingle Valley Creek	X	X		
	Luzon Branch	X	X	X	
	Melvin Hazen Valley Branch	X			
	Normanstone Creek	X	X		
	Pinehurst Branch	X	X		
	Piney Branch	X	X	X	
	Portal Branch	X	X		
	Soapstone Creek	X	X	X	
Potomac	Dalecarlia Tributary	X	X		
	Oxon Run	X			

The original TMDLs were developed in 2004 – 2005, 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 pesticide TMDLs for Rock Creek and Potomac River tributaries, did not have a daily load expression established. The U.S Environmental Protection Agency

[1] Chlordane, dieldrin, heptachlor epoxide, or DDT was not detected in Battery Kemble Creek or Foundry Branch, so revised TMDLs were not developed for these tributaries at this time. See the District's 2014 Integrated Report (DOEE, 2014) for the current status of these tributaries.

(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.

DC's water quality standards for these four pesticides 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. STPM, the revised model, 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 DC MS4 monitoring data and instream monitoring data.

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.2. Piney Branch is the only tributary with combined sewer overflow (CSO) outfalls. Portions of Fenwick Branch, Pinehurst Branch, Portal Branch, and Oxon Run watersheds lie in Maryland.

Tables ES.3, ES.4, ES.5, and ES.6 give the average annual baseline loads (lbs/yr) from STPM for chlordane, dieldrin, heptachlor epoxide, and DDT, respectively, in the small tributaries over the 2001-2012 simulation period. Pesticide loads were only estimated for the small tributaries for which revised TMDLs were developed, as shown in Table ES.1.

TMDLs for the small tributaries were developed by assigning the most stringent water quality criteria, the Class D 30-day average human health criteria, as the model input concentration for both storm flow and base flow from all sources. Since all sources discharge at the human health criteria, simulated concentrations in the tributaries are held at constant values equal to the human health criteria. The human health criteria are less than either the corresponding acute or chronic aquatic life criteria, this ensures that these latter criteria are also met over their respective one-hour or four day averaging periods. The TMDLs generally require reductions greater than 90% from all sources for most constituents. 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.8 shows the reduction required under the TMDL Scenario from EOP sources and nonpoint sources.

Table ES.2: Land Use Acreage (acres) in the Rock Creek and Potomac River Watershed Tributaries

Mainstem	Tributary	MS4			Direct Drainage			CSS	Maryland			Total
		Impervious	Turf	Forest	Impervious	Turf	Forest		Impervious	Turf	Forest	
Rock Creek	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
Potomac	Dalecarlia Tributary	393	534	50	12	30	72	-	-	-	-	1,091
	Oxon Run	829	890	81	28	133	183	-	1,940	2,866	946	7,895

Sources: DOEE (MS4 and Direct Drainage); MDE (Maryland except for Oxon Run); and PGDEP (Maryland Oxon Run).

Table ES.3: Chlordane Average Annual Baseline Loads (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	6.54E-01	-	4.58E-02	-	7.00E-01
	Dumbarton Oaks	1.25E-02	-	5.03E-02	-	6.28E-02
	Luzon Branch	5.00E-01	-	1.40E-02	-	5.14E-01
	Piney Branch	2.99E-02	6.35E-02	5.25E-03	-	9.87E-02
	Soapstone Creek	3.40E-01	-	3.92E-02	-	3.79E-01

Table ES.4: Dieldrin Average Annual Baseline Loads (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	4.13E-03	-	2.73E-03	-	6.86E-03
	Dumbarton Oaks	7.91E-05	-	6.87E-04	-	7.66E-04
	Fenwick Branch	7.00E-04	-	5.93E-04	2.64E-03	3.93E-03
	Klingle Valley Creek	5.86E-04	-	4.62E-04	-	1.05E-03
	Luzon Branch	3.16E-03	-	1.06E-03	-	4.22E-03
	Melvin Hazen Valley Branch	4.87E-04	-	5.33E-04	-	1.02E-03
	Normanstone Creek	7.76E-04	-	5.33E-04	-	1.31E-03
	Pinehurst Branch	1.05E-03	-	1.42E-03	1.38E-03	3.85E-03
	Piney Branch	1.89E-04	4.01E-04	3.57E-04	-	9.48E-04
	Portal Branch	2.65E-04	-	1.51E-04	9.76E-04	1.39E-03
	Soapstone Creek	2.15E-03	-	1.14E-03	-	3.29E-03
Potomac	Dalecarlia Tributary	4.43E-03	-	2.23E-03	-	6.66E-03
	Oxon Run	1.94E-03	-	1.14E-03	9.07E-03	1.21E-02

Table ES.5: Heptachlor Epoxide Average Annual Baseline Loads (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	2.10E-03	-	2.04E-03	-	4.14E-03
	Dumbarton Oaks	4.02E-05	-	4.43E-04	-	4.84E-04
	Fenwick Branch	3.56E-04	-	4.25E-04	1.62E-03	2.41E-03
	Klingle Valley Creek	2.98E-04	-	3.32E-04	-	6.30E-04
	Luzon Branch	1.61E-03	-	8.10E-04	-	2.42E-03
	Normanstone Creek	3.94E-04	-	3.93E-04	-	7.87E-04
	Pinehurst Branch	5.36E-04	-	1.04E-03	8.86E-04	2.46E-03
	Piney Branch	9.61E-05	2.04E-04	2.60E-04	-	5.60E-04
	Portal Branch	1.35E-04	-	1.17E-04	5.54E-04	8.06E-04
	Soapstone Creek	1.09E-03	-	8.22E-04	-	1.91E-03
Potomac	Dalecarlia Tributary	2.25E-03	-	1.70E-03	-	3.95E-03

Table ES.6: DDT Average Annual Baseline Loads (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Fenwick Branch	5.71E-03	-	1.20E-03	1.38E-02	2.07E-02

Table ES.7: Percent Reductions Required to Meet Current Class D Human Health Criteria, TMDL Scenario

Mainstem	Tributary	Dieldrin		Heptachlor Epoxide		Chlordane		DDT	
		EOP	NPS	EOP	NPS	EOP	NPS	EOP	NPS
Rock Creek	Broad Branch	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Dumbarton Oaks	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Fenwick Branch	95.5%	97.8%	93.6%	98.1%			97.8%	43.6%
	Klingle Valley Creek	95.5%	97.8%	93.6%	98.1%				
	Luzon Branch	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Melvin Hazen Valley Branch	95.5%	97.8%						
	Normanstone Creek	95.5%	97.8%	93.6%	98.1%				
	Pinehurst Branch	95.5%	97.8%	93.6%	98.1%				
	Piney Branch	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Portal Branch	95.5%	97.8%	93.6%	98.1%				
	Soapstone Creek	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
Potomac	Dalecarlia Tributary	95.5%	97.8%	93.6%	98.1%				
	Oxon Run	79.2%	91.8%						

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 TMDLs are expressed as average annual loads, average daily loads, and maximum daily loads. Tables ES.8, ES.9, ES.10, and ES.11 give the average annual TMDL load allocations (lbs/yr) for chlordane, dieldrin, heptachlor epoxide, and DDT, respectively. Average daily loads are the average annual loads divided by 365. Tables ES.12, ES.13, ES.14, and ES.15 give the maximum daily load allocations (lbs/d).

Table ES.8: Chlordane Average Annual TMDL Load Allocations (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	2.79E-03	-	1.06E-03	-	3.85E-03
	Dumbarton Oaks	5.34E-05	-	3.51E-04	-	4.04E-04
	Luzon Branch	2.13E-03	-	3.86E-04	-	2.52E-03
	Piney Branch	1.28E-04	1.06E-05	1.47E-04	-	2.85E-04
	Soapstone Creek	1.45E-03	-	4.76E-04	-	1.93E-03

Table ES.9: Dieldrin Average Annual TMDL Load Allocations (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	1.86E-04	-	7.06E-05	-	2.56E-04
	Dumbarton Oaks	3.56E-06	-	2.34E-05	-	2.69E-05
	Fenwick Branch	3.15E-05	-	1.68E-05	9.61E-05	1.44E-04
	Klingle Valley Creek	2.64E-05	-	1.30E-05	-	3.94E-05

	Luzon Branch	1.42E-04	-	2.57E-05	-	1.68E-04
	Melvin Hazen Valley Branch	2.19E-05	-	1.51E-05	-	3.70E-05
	Normanstone Creek	3.49E-05	-	1.42E-05	-	4.91E-05
	Pinehurst Branch	4.75E-05	-	3.84E-05	4.71E-05	1.33E-04
	Piney Branch	8.51E-06	7.07E-07	9.78E-06	-	1.90E-05
	Portal Branch	1.19E-05	-	3.55E-06	3.92E-05	5.47E-05
	Soapstone Creek	9.67E-05	-	3.17E-05	-	1.28E-04
Potomac	Dalecarlia Tributary	2.00E-04	-	5.47E-05	-	2.54E-04
	Oxon Run	4.02E-04	-	1.14E-04	1.41E-03	1.93E-03

Table ES.10: Heptachlor Epoxide Average Annual TMDL Load Allocations (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	1.34E-04	-	5.10E-05	-	1.85E-04
	Dumbarton Oaks	2.57E-06	-	1.69E-05	-	1.95E-05
	Fenwick Branch	2.27E-05	-	1.21E-05	6.94E-05	1.04E-04
	Klingle Valley Creek	1.90E-05	-	9.39E-06	-	2.84E-05
	Luzon Branch	1.03E-04	-	1.86E-05	-	1.21E-04
	Normanstone Creek	2.52E-05	-	1.03E-05	-	3.55E-05
	Pinehurst Branch	3.43E-05	-	2.77E-05	3.40E-05	9.60E-05
	Piney Branch	6.15E-06	5.10E-07	7.06E-06	-	1.37E-05
	Portal Branch	8.60E-06	-	2.56E-06	2.83E-05	3.95E-05
	Soapstone Creek	6.98E-05	-	2.29E-05	-	9.28E-05
Potomac	Dalecarlia Tributary	1.44E-04	-	3.95E-05	-	1.84E-04

Table ES.11: DDT Average Annual TMDL Load Allocations (lbs/yr)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Fenwick Branch	1.28E-04	-	6.83E-05	3.91E-04	5.88E-04

Table ES.12: Chlordane Maximum Daily Load Allocations (lbs/d)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	5.18E-04	-	8.99E-05	-	6.08E-04
	Dumbarton Oaks	8.36E-06	-	5.43E-05	-	6.27E-05
	Luzon Branch	3.72E-04	-	2.30E-05	-	3.95E-04
	Piney Branch	2.27E-05	2.65E-05	1.77E-05	-	6.69E-05
	Soapstone Creek	2.56E-04	-	4.52E-05	-	3.01E-04

Table ES.13: Dieldrin Maximum Daily Load Allocations (lbs/d)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	3.45E-05	-	5.99E-06	-	4.05E-05
	Dumbarton Oaks	5.57E-07	-	3.62E-06	-	4.18E-06
	Fenwick Branch	5.98E-06	-	1.78E-06	9.12E-06	1.69E-05
	Klingle Valley Creek	4.69E-06	-	1.41E-06	-	6.10E-06
	Luzon Branch	2.48E-05	-	1.53E-06	-	2.63E-05
	Melvin Hazen Valley Branch	4.09E-06	-	1.63E-06	-	5.72E-06
	Normanstone Creek	6.41E-06	-	1.33E-06	-	7.73E-06
	Pinehurst Branch	9.20E-06	-	4.13E-06	3.92E-06	1.73E-05
	Piney Branch	1.51E-06	1.77E-06	1.18E-06	-	4.46E-06
	Portal Branch	2.30E-06	-	1.95E-07	4.40E-06	6.89E-06
	Soapstone Creek	1.71E-05	-	3.01E-06	-	2.01E-05
Potomac	Dalecarlia Tributary	3.71E-05	-	3.48E-06	-	4.06E-05
	Oxon Run	7.18E-05	-	9.51E-06	1.80E-04	2.61E-04

Table ES.14: Heptachlor Epoxide Maximum Daily Load Allocations (lbs/d)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Broad Branch	2.49E-05	-	4.33E-06	-	2.93E-05
	Dumbarton Oaks	4.02E-07	-	2.62E-06	-	3.02E-06
	Fenwick Branch	4.32E-06	-	1.29E-06	6.58E-06	1.22E-05
	Klingle Valley Creek	3.39E-06	-	1.02E-06	-	4.40E-06
	Luzon Branch	1.79E-05	-	1.11E-06	-	1.90E-05
	Normanstone Creek	4.63E-06	-	9.57E-07	-	5.58E-06
	Pinehurst Branch	6.65E-06	-	2.98E-06	2.83E-06	1.25E-05
	Piney Branch	1.09E-06	1.28E-06	8.53E-07	-	3.22E-06
	Portal Branch	1.66E-06	-	1.41E-07	3.18E-06	4.98E-06
	Soapstone Creek	1.23E-05	-	2.18E-06	-	1.45E-05
Potomac	Dalecarlia Tributary	2.68E-05	-	2.51E-06	-	2.93E-05

Table ES.15: DDT Maximum Daily Load Allocations (lbs/d)

Mainstem	Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Rock Creek	Fenwick Branch	2.44E-05	-	7.26E-06	3.71E-05	6.88E-05

The EPA has recommended changes to the 30-day average criteria to protect human health related to fish and shellfish consumption, and DC is considering adopting those changes in its 2016 triennial review. Table ES.16 contrasts the current and proposed 30-day average human health criteria. The TMDLs were calculated using the revised criteria expressed as average annual loads, average daily loads, and maximum daily loads.

Table ES.16: Comparison of Current and Recommended Human Health Criteria (µg/l)

Constituent	CAS Number	Class D: Fish Consumption Use Human Health (30-day average)		Percent Change
		Current	Recommended	
Chlordane	57749	0.00081	0.00032	-60%
DDT	50293	0.00022	0.000030	-86%
Dieldrin	60571	0.000054	0.0000012	-98%
Heptachlor Epoxide	1024573	0.000039	0.000032	-18%

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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 chlordane, dieldrin, heptachlor epoxide, and DDT) in eleven small tributaries to Rock Creek and four small tributaries to the Potomac River (DDOH, 2004a, 2004b, and 2004c). The TMDL reports included *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*, approved in 2004; *District of Columbia Final Total Maximum Daily Loads for Organics and Metals in Battery Kemble Creek, Foundry Branch, and Dalecarlia Tributary*, approved in 2005; and *District of Columbia Total Maximum Daily Load for Organics, Metals, and Bacteria in Oxon Run*, 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 and Potomac watersheds 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 and Potomac River 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 Polychlorinated Biphenyls (PCBs). For more information, please refer to the District's 2014 Integrated Report (DDOE, 2014).

Four pesticides were detected in Rock Creek and Potomac River tributaries: dieldrin, dichloro-diphenyl-trichloroethane (DDT), heptachlor epoxide, and chlordane. Table 1.1 shows which pesticides were detected in which tributaries. For each tributary where a pesticide was detected, DOEE will revise its

TMDLs for that pesticide and include a daily load expression. Rather than base the daily loads on the original TMDLs, EPA and DOEE decided to revise the TMDLs for these pesticides for the following reasons:

First, since the original TMDLs had been established in 2004 and 2005, the water quality standards changed for these toxic chemicals. These changes are described in more detail in Section 1.4.

Second, additional monitoring data had been collected under DC's municipal separate storm sewer system (MS4) permit in the Rock Creek and Potomac River watersheds and could be used for purposes of modeling.

Table 1.1 Rock Creek and Potomac River Tributaries with Revised Pesticide TMDLs

Mainstem	Tributary	Dieldrin	Heptachlor Epoxide	Chlordane	DDT
Rock Creek	Broad Branch	X	X	X	
	Dumbarton Oaks	X	X	X	
	Fenwick Branch	X	X		X
	Klingle Valley Creek	X	X		
	Luzon Branch	X	X	X	
	Melvin Hazen Valley Branch	X			
	Normanstone Creek	X	X		
	Pinehurst Branch	X	X		
	Piney Branch	X	X	X	
	Portal Branch	X	X		
	Soapstone Creek	X	X	X	
Potomac	Dalecarlia Tributary	X	X		
	Oxon Run	X			

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.

This report describes in detail the updated Small Tributary Pesticide Model (STPM) and its use in revising the TMDLs for the pesticides and tributaries shown in Table 1. 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.

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

1.2 Brief Overview of the Tributary Watersheds

All of the small tributary watersheds in the Rock Creek and Potomac River watersheds, except for Oxon Run, 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.

Oxon Run is in the Southeast Quadrant of DC. Figure 1.2 shows its location. Oxon Run is the largest of the tributary watersheds. More than half of the Oxon Run watershed lies in Prince George's County, MD.

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.

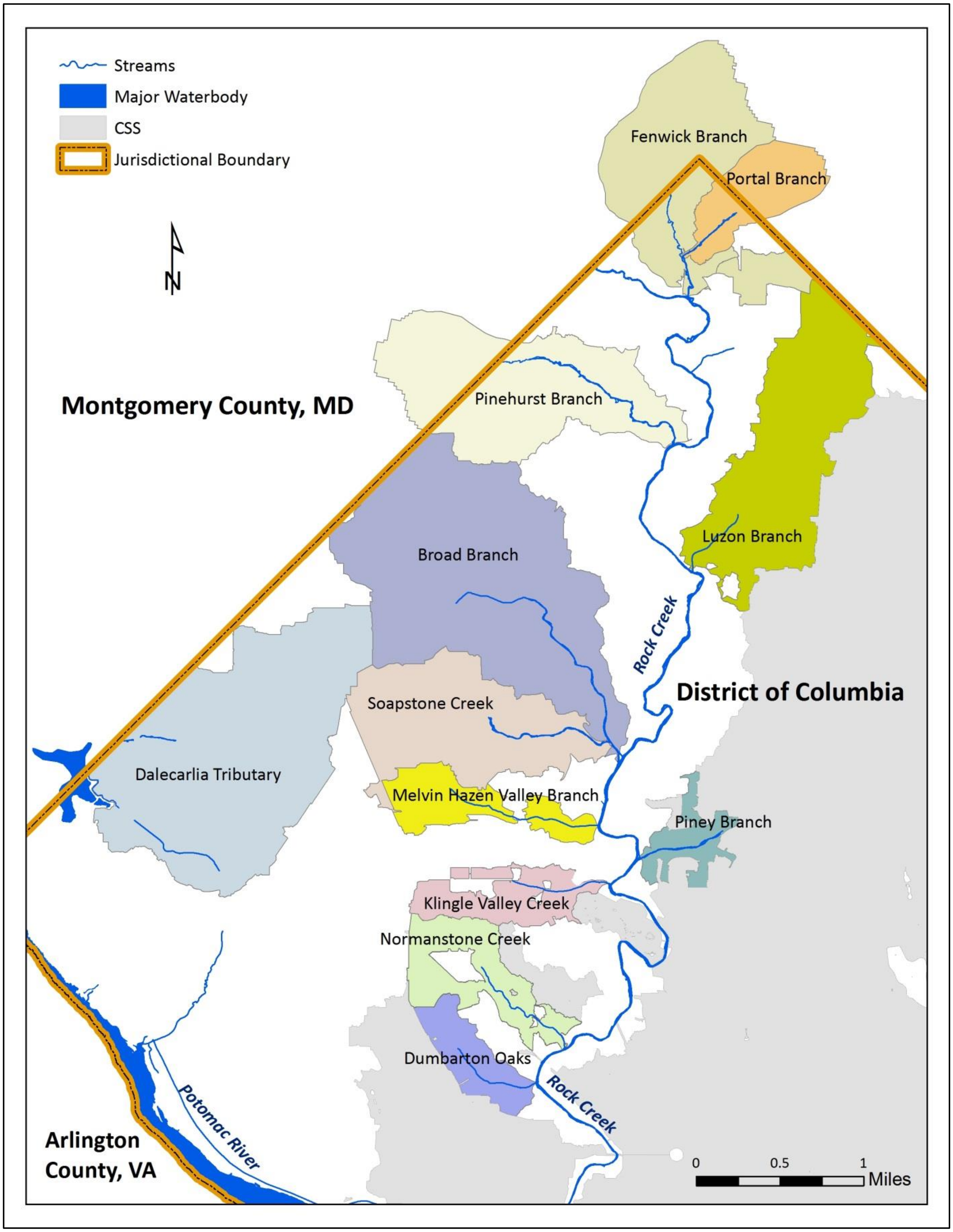

Figure 1.1: Location of Small Tributary Watersheds in Northwest District of Columbia

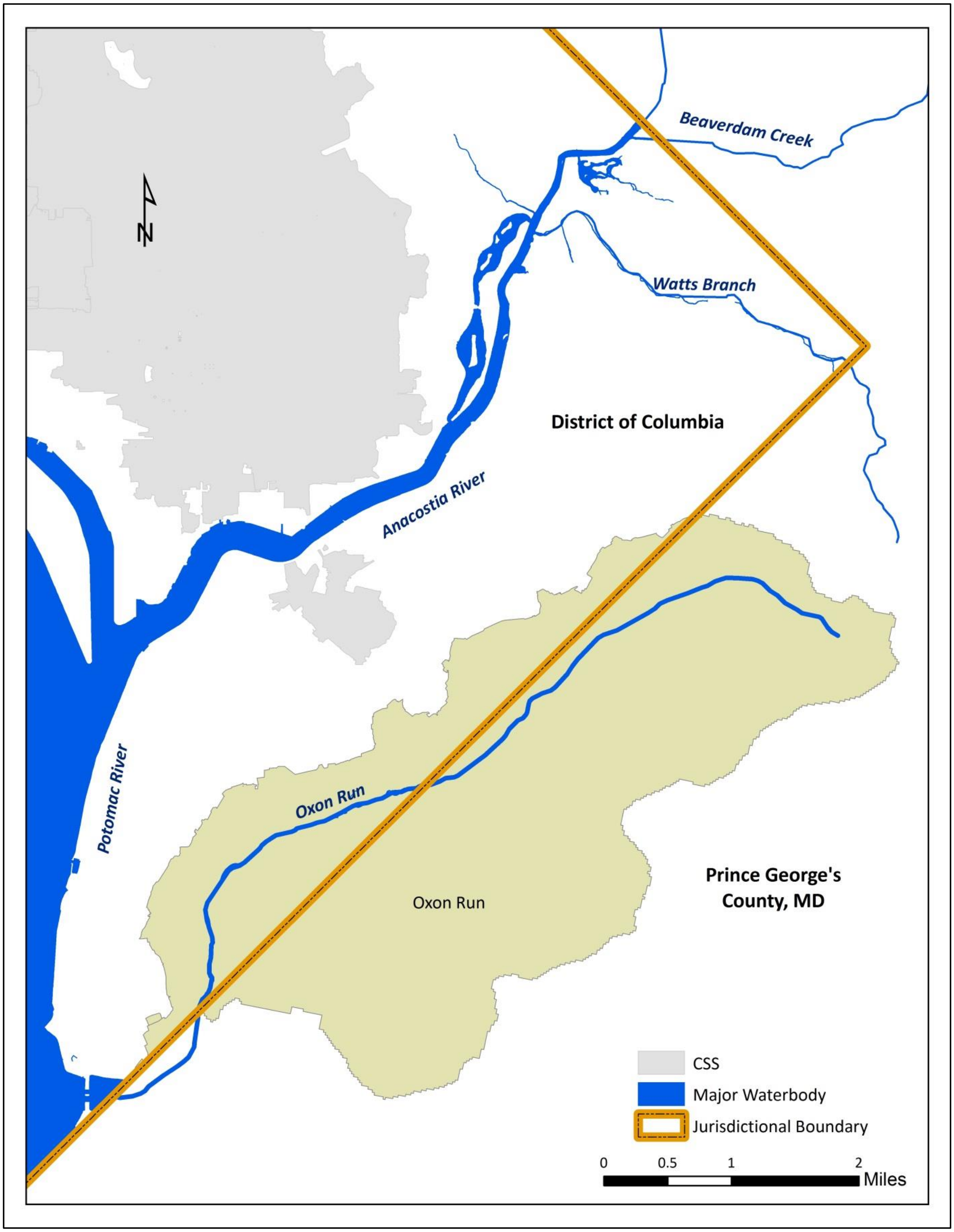

Figure 1.2: Location of Oxon Run Watershed

1.3 Overview of Organochlorine Pesticides

Chlordane, DDT, dieldrin, and heptachlor epoxide are all organochlorine insecticides or insecticide degradation products. Heptachlor epoxide is the degradation product of the pesticide heptachlor; dieldrin, while an insecticide in its own right, is also a degradation product of aldrin. Chlordane, on the other hand, was marketed as a mixture of compounds, including heptachlor. Technical chlordane (CAS no. 12789-03-6) can contain over 120 different compounds. In this report chlordane will refer to CAS no. 57-74-9, which is a mixture containing approximately 95% cis- and trans- chlordane isomers. These isomers are also known as α- and γ- chlordane, respectively (EPA, 1997). Table 1.2 shows the uses of these pesticides and the period of their use.

Organochlorine insecticides have a wide variety of harmful effects on aquatic organisms (Nowell *et al.*, 1999), which extend throughout the environment. The impacts of DDT are well-known: exposure to DDT and its degradation products was shown to be related to the thinning of egg shells and the corresponding rapid decline of populations of bald eagles and other fish-eating birds of prey (Agency for Toxic Substances and Disease Registry (ATSDR), 2002b).

ATSDR (1994, 2002a, 2002b, 2007) documents many adverse impacts on human health from exposure to these pesticides. EPA (2014 a,b,c,d) has classified chlordane, DDT, dieldrin, and heptachlor epoxide as class B2 probable human carcinogens.

EPA is authorized to license or register pesticides for specific uses under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Except for a handful of specialized uses, all uses of chlordane, DDT, dieldrin, and heptachlor epoxide have either been banned by the EPA or voluntarily withdrawn by their manufacturers. Table 1.2 shows the year in which a pesticide's registration for a use was terminated. The EPA also placed chlordane, DDT, dieldrin, and heptachlor epoxide on the Clean Water Act's Priority Pollutant List, and has recommended the adoption of water quality criteria for these chemicals to protect aquatic life and human health. Section 1.4 discusses the water quality criteria adopted by DC for these pesticides.

Table 1.2 Uses and Period of Use of Organochlorine Pesticides

Pesticide	Year Introduced	Uses	Year Use Registration Canceled
Chlordane	1948	Before 1974: 28% used on corn, citrus 35% used on termites 30% used home lawn and garden 7% used on turf and ornamentals	1974: most crops 1983: All uses except termite control 1988: termite control
DDT	1939	Control malaria and typhus Control gypsy moth and other forest pests Mothproofing and control lice Used on cotton (67-90%) but also peanuts and soybeans	1973: All uses except for public health emergencies
Aldrin Dieldrin	1948	Corn and citrus Termite control	1970: crops 1988:Termite control
Heptachlor	1952	Corn, small grain, and sorghum Termite control	1974: crops 1980: termite control Still registered for control of fire ants in underground transformers

1.3.1 Environmental Persistence

In addition to their toxicity to both people and aquatic life, organochlorine insecticides share a range of physical and chemical properties, including (Smith *et al*., 1988):

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

These properties explain the persistence of organochlorine insecticides in the environment, even after their use has been banned for decades. Their limited solubility in water prevents them from being rapidly flushed from a watershed, and their resistance to physical or biological degradation prevents them from diminishing quickly *in situ*. Chlordane can persist in soils for longer than 20 years after it is applied (ATSDR, 1994). Nevertheless, concentrations of organochloride pesticides are decreasing in sediments and in fish tissue over time. Gilliom *et al*. (2006) analyzed fish tissue data collected 1969-1986 by the U.S. Fish and Wildlife Service under the National Contaminant Biomonitoring Program and data collected by the U.S. Geological Survey 1992 -2001 under the National Water Quality Assessment (NWQA) program. They document that concentrations of DDT, dieldrin, and chlordane in fish tissue show an exponential decline since their uses were discontinued. The exponential decline can be expressed as a half-life. The half-life in fish tissue for DDT is seven years; for chlordane, 11-13 years; and for dieldrin, 30 years. Van Metre and Mahler (2005) studied sediment cores in 28 urban reservoirs and

10 natural lakes. They also found exponential declines in DDT concentrations over time, and estimated that concentrations of total DDTs in sediment had a median half-life of 14.9 years. They could not determine why the half-life is longer in sediment than in fish tissue. Van Metre et al. (1997) found similar rates of decline in concentrations of cesium, DDTs, 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.

Although the use of these organochlorine pesticides generally has been banned in other countries, they are still used abroad. Chlordane, DDT, dieldrin, and the pesticide heptachlor 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, although DDT will still be permitted to be used to control malaria.

1.3.2 Potential Sources of Organochlorine Insecticides in the Rock Creek and Potomac River Tributaries

The Rock Creek and Potomac River tributaries in DC are heavily developed watersheds and were so during the time chlordane, DDT, dieldrin, and heptachlor were in use. As Table 1.2 shows, these pesticides were used in developed areas for control of insects on lawns and gardens, and for control of termites. The legacy of these uses is the most likely source of the pesticides observed in these tributaries.

Chlordane, dieldrin, and the pesticide heptachlor were used for termite control, and were likely to be applied to soils surrounding houses and other structures. Chlordane, dieldrin, and heptachlor epoxide attached to soil can be transported in erosion and instream sediment. Nowell *et al*. (2009) developed three regression models to predict concentrations of DDT, dieldrin, and total chlordane in fish tissue. Independent variables were selected from the following categories: pesticide sources, fish taxa, watershed characteristics, and geographical regions. The DDT regression model explained 52% of the variability in fish tissue concentrations overall. Much of the variability, however, was explained by lipid content or whether the fish was a carp, and not variables which represent sources or factors controlling the fate and transport of the pesticide. Overall, the chlordane model explained 67% of the variability of the chlordane concentration in fish tissue while the dieldrin model explained 65% of the overall variability. One of the independent variables used in the dieldrin and total chlordane models was the termite-urban score, which is the product of urban land within a basin weighted by the factor corresponding to the zone of termite density. The termite-urban score explained 34% of the variability in chlordane concentrations in fish tissue and 12% of the variability in dieldrin concentrations in fish tissue. DC lies in the moderate-to-heavy termite density zone, so the use of chlordane and dieldrin for termite control is an explanatory factor in the elevated chlordane and dieldrin concentrations observed in the District's waters.

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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

Air deposition cannot be ruled out as a possible source of these pesticides, particularly DDT and chlordane. Although they generally have low volatility, because of their low solubility in water these pesticides still can volatilize. They also can be transported attached to particulates in air. Air transport of dieldrin and heptachlor epoxide is limited by photolysis (ATSDR, 2002a, 2007), but DDT and chlordane can be transported long distances through the atmosphere. Both are present in arctic food chains (ATSDR, 1994, 2002b).

The Integrated Atmospheric Deposition Network (IADN) has been collecting monitoring data to estimate air deposition, absorption, and volatilization of toxics chemicals, including DDT, chlordane, and dieldrin, as part of the Great Lakes Water Quality Agreement. Atmospheric concentrations have been measured at 15 stations since 1990. IADN (2005) documents the results of their analysis from 1990 through 2005. Deposition rates of chlordane and dieldrin have decreased over that time period, and volatilization from the Great Lakes is the dominant air-water process. DDT fluxes are approaching equilibrium, and may have been helped by Mexico's banning the use of DDT in 2000. IADN (2005) reports that wet deposition rates of all three pesticides from 2000-2005 generally are less than 1 $ng/m^2/d$. Dry deposition rates were below detection limits. Absorption of chlordane, dieldrin, and DDT was 10-20% higher in proximity to Chicago, while wet deposition of these pesticides was about 5% higher near Chicago than in rural areas. Assuming 40 inches a year of precipitation, the concentration of these pesticides in rain would be less than 0.5 ng/l. It is not clear if the deposition rates measured by IADN are applicable to the District. Poor (2002) estimated total chlordane wet deposition rates for Tampa Bay from ambient air concentrations, total rainfall, and gas/water partitioning. Her estimate of 0.4 $\mu g/m^2/yr$ is slightly higher than rates reported by IADN. She also cites Park *et al*.'s (2001) estimate of chlordane wet deposition for Galveston Bay of 0.52 $\mu g /m^2/yr$, which is larger than both the Tampa Bay and Great Lakes estimates. All three estimates, however, are the same order of magnitude, and probably indicate the order of magnitude of the contribution of air deposition to observed pesticide concentrations in the District's Rock Creek and Potomac River tributaries.

There are no wastewater treatment plants (WWTPs) in any of the Rock Creek and Potomac River tributaries, but Piney Branch does have CSO outfalls, so wastewater could be a source of pesticides in Piney Branch. EIP Associates (1997) performed a study to determine the source of organochlorine pesticides in effluent from the Palo Alto Regional Quality Control Plant. According to their semi-quantitative estimate, based on pesticide concentrations in foods, human waste and food waste could be large contributors to effluent loads of DDT, dieldrin, and heptachlor epoxide. On the other hand, the Great Lakes Environmental Center (GLEC) (2008) conducted a study for the New York-New Jersey Harbor Estuary Program. GLEC monitored WWTPs, CSOs, and storm water outfalls (SWOs). They found total organochlorine pesticide concentrations similar in CSOs and SWOs, and CSO concentrations three to four times smaller than the total concentrations found in WWTP effluent.

1.3.3 U.S. Geological Survey's Monitoring of Organochlorine Pesticides in the Rock Creek Watershed

The U. S. Geological Survey (USGS) have performed monitoring of organochlorine pesticides in the water column, instream bed sediment, and ground water in the Rock Creek watershed.

Organochlorine pesticides have been detected in bed sediment in the Rock Creek watershed. Anderson *et al*. (2002) monitored pesticides 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. The bed sediment samples were analyzed for all four organochlorine pesticides. All were detected in the sample from Portal Branch except heptachlor epoxide, while all were detected without exception in the bed sediment samples from mainstem Rock Creek.

Anderson *et al*. (2002) also collected water column samples at five stations, including one in Pinehurst Branch during a synoptic survey in the Rock Creek watershed in June 1999. Sixteen water column samples were also collected in the mainstem of Rock Creek at Joyce Road, 1999-2000. Dieldrin was detected in Pinehurst Branch but not in any other synoptic sampling site or in any sample from Joyce Road. No water column samples were analyzed for DDT, chlordane, or heptachlor epoxide.

Despite their limited solubility in water, organochlorine pesticides have been detected in shallow ground water in DC. Korterba *et al*. (2010) analyzed pesticide concentrations in samples collected from 14 wells in DC in 2005 and 13 wells in 2008. None of the wells were deeper than 100 feet. Three of the wells sampled in 2008 were in the Rock Creek watershed and one well was in the Potomac drainage in Northwest DC. The rest of the wells were in the Anacostia River watershed. Dieldrin was detected in two wells in 2005 and three wells in 2008; one of those wells was in the Rock Creek watershed. Heptachlor epoxide also was detected in two wells in 2005 and three wells in 2008; the only Rock Creek well where it was detected was the same well in which dieldrin was detected. Degradation products of DDT were detected in one well in 2005 and in three wells in 2008. None of the wells were in the Rock Creek watershed. Chlordane was detected once in 2005 but not detected in 2008.

1.4 Applicable Water Quality Standards

DC has water quality criteria for dieldrin, chlordane, DDT, and heptachlor epoxide to support both the Aquatic Life Use (Class C) and Human Health Use (Consumption of Fish and Shellfish) (Class D). All of the small tributaries are Class C and Class D waters. Table 1.3 presents the current (2016) water quality standards. There are 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. The CMC applies to a one-hour average concentration and 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 which 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 (EPA, 2014 a, b, c and d).

Table 1.3: 2016 Numerical Water Quality Criteria for Pesticides (µg/l)

Constituent	CAS Number	Class C: Aquatic Life Use		Class D: Fish and Shellfish Consumption Use
		CCC (four-day average)	CMC (one-hour average)	Human Health (30-day average)
Chlordane	57749	0.0043	2.4	0.00081
DDT	50293	0.001	1.1	0.00022
Dieldrin	60571	0.056	0.24	0.000054
Heptachlor Epoxide	1024573	0.0038	0.52	0.000039

Table 1.4 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 changed for all four pesticides; it became less stringent only in the case of chlordane. The CCC for chlordane also became less stringent. The CCC for dieldrin increased became less stringent but the CMC became more stringent. All of the other criteria remained the same.

DOEE will be undergoing it triennial review of its water quality standards in 2016 and may be considering revising its 30-day human health criteria during that review. Table 1.5 shows the proposed 30-day human health criteria that DC is considering and will take effect if DC adopts them during its triennial review of water quality standards and EPA approves them. In the event that DOEE adopts new water quality standards, TMDL allocations were calculated for both the current human health criteria and the proposed criteria.

Table 1.4: 2004 Numerical Water Quality Criteria for Pesticides (µg/l)

Constituent	CAS Number	Class C: Aquatic Life Use		Class D: Fish and Shellfish Consumption Use
		CCC (four-day average)	CMC (one-hour average)	Human Health (30-day average)
Chlordane	57749	0.004	2.4	0.00059
DDT	50293	0.001	1.1	0.00059
Dieldrin	60571	0.0019	2.5	0.00014
Heptachlor Epoxide	1024573	0.0038	0.52	0.00011

Table 1.5: Current and Recommended Human Health Criteria (µg/l)

Constituent	CAS Number	Class D: Fish Consumption Use Human Health (30-day average)		Percent Change
		Current	Recommended	
Chlordane	57749	0.00081	0.00032	-60%
DDT	50293	0.00022	0.000030	-86%
Dieldrin	60571	0.000054	0.0000012	-98%
Heptachlor Epoxide	1024573	0.000039	0.000032	-18%

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 pesticide TMDLs for the small tributaries in DC's portion of the Rock Creek and Potomac River watersheds. 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 DC MS4 monitoring data and instream monitoring data.

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 from the analysis of monitoring data.

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

Taken as a whole, the tributary watersheds span three jurisdictions: DC; Montgomery County, MD; and Prince George's County, MD. For each jurisdiction, locally-developed land use information was used to determine land use acreage. 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 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 and Potomac 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 pesticide 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[3]. 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 was 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[4]. Prince George's County Department of Environmental Protection (PGDEP) provided MDP 2010 land use data and

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[3] Martin Hurd (DOEE). 2015. Personal communication.
[4] Jeff White (MDE). 2015. Personal communication.

impervious cover data for Prince George's County[5]. For both counties, 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 (P54). This is an intermediate phase between Phase 5 and Phase 6, which is 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 water quality 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 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 in more detail.

Washington DC is represented by a single land segment in P5.4 (A11001). Montgomery County (A24031) and Prince George's County (A24033) were also represented by single land segments. P5.4

[5] Catherine Escarpeta (PGDEP). 2015. Personal communication.

(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.

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[6]. 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.

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.

[6] 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.

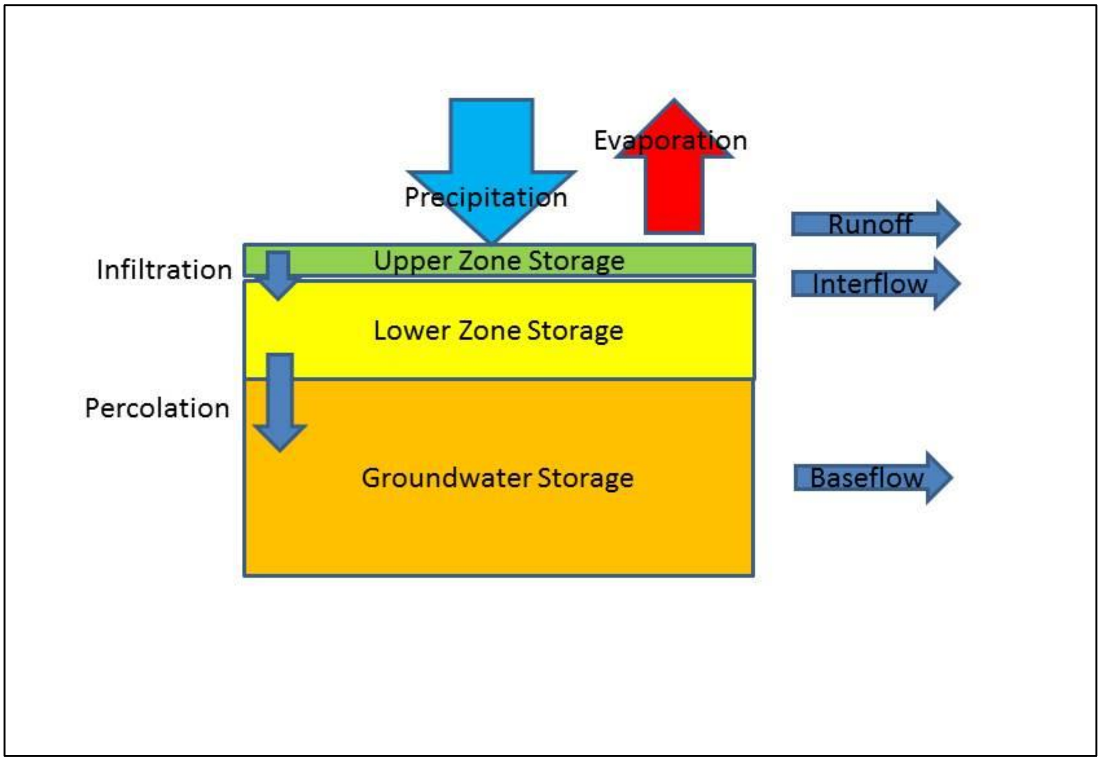

Figure 2.1: Simplified Structure of HSPF Hydrology

2.3.1 CSOs

DC Water provided simulated CSO flows from their MIKE URBAN model for the outfalls in the Piney Branch watershed[7]. 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, 1998-1990

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.

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

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

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. These input concentrations were taken from analysis of the available monitoring data. The wet-weather monitoring data collected under DC's MS4 permit was used to determine storm flow concentrations. Base flow concentrations were determined from in-stream baseflow monitoring data collected by Tetra-Tech on behalf of EPA. Results from these analyses are discussed below, following a discussion of the methods used to estimate a model input concentration from pesticide monitoring data.

2.4.1 Data Analysis Method

Figure 2.2 shows the concentration of dieldrin found in wet-weather samples collected from storm water outfalls in NW DC, 2003 -2008. Concentrations reported below the detection limit (DL) are shown at their DL. Three characteristics of the monitoring data for the pesticides of interest are apparent from Figure 2.2:

1. A large majority, 94%, of the observations are below DLs;
2. DLs changed over time due to changes in analytical techniques; and
3. Some of the DLs used were larger than the largest detected concentrations.

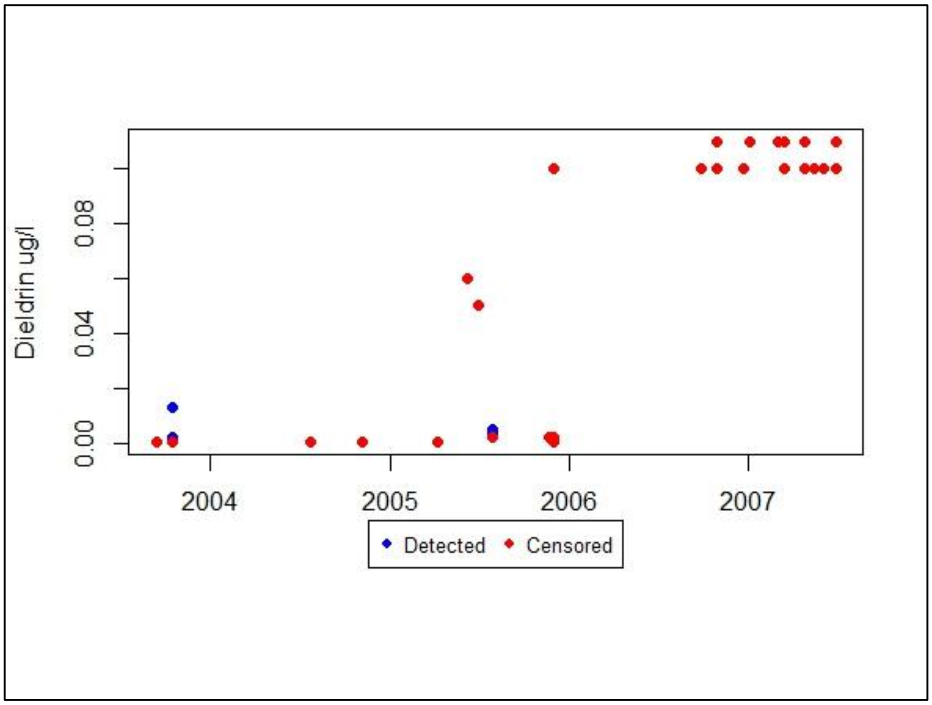

Figure 2.2: Observed Dieldrin Concentrations in Wet-Weather Monitoring Data from Storm System Outfalls in NW DC

Helsel (2012) presents a variety of statistical methods that can be used to estimate a mean or median value from monitoring data with censored values (values below the DL). Helsel recommends, however, these methods only be used if less than 80% of the data is censored. This condition is generally not met by any of the pesticides of interest in the available monitoring data. The EPA Region III guidance on handling censored data in risk assessments (Smith, 1991), recommends assigning censored data the value of half-of the DL, unless doing so would adversely impact the risk assessment. Smith notes that assigning censored data the full value of the DL produces an estimate of the mean value biased high. Assigning censored data a value of zero, however, is only justified in cases where there is reason to believe the constituent is not present. Since the pesticides of interest have been detected in the small tributaries, assigning censored data a value of zero is not justified.

Helsel (2012) asserts, however, that censored data where the DL is larger than the largest detected value contribute no information to an analysis: "A 'high nondetect' value, a censored observation whose reporting limit is higher than all uncensored values in the data set, has no information content. 'High nondetects' can be dropped from the data set without penalty (p.86)." This suggests the following procedure to determine a mean value for heavily censored data:

1. Determine the largest uncensored observation;
2. Remove from the data set any censored observations whose DL is above the largest uncensored observation;
3. Assign the remaining censored data values equal to half their DL; and

4. Average over the modified data set.

This procedure was used to determine the mean concentrations from stormwater monitoring data for use in STPM. To illustrate the procedure, Figure 2.3 shows which observations were used and which observations were excluded in the data set shown in Figure 2.2.

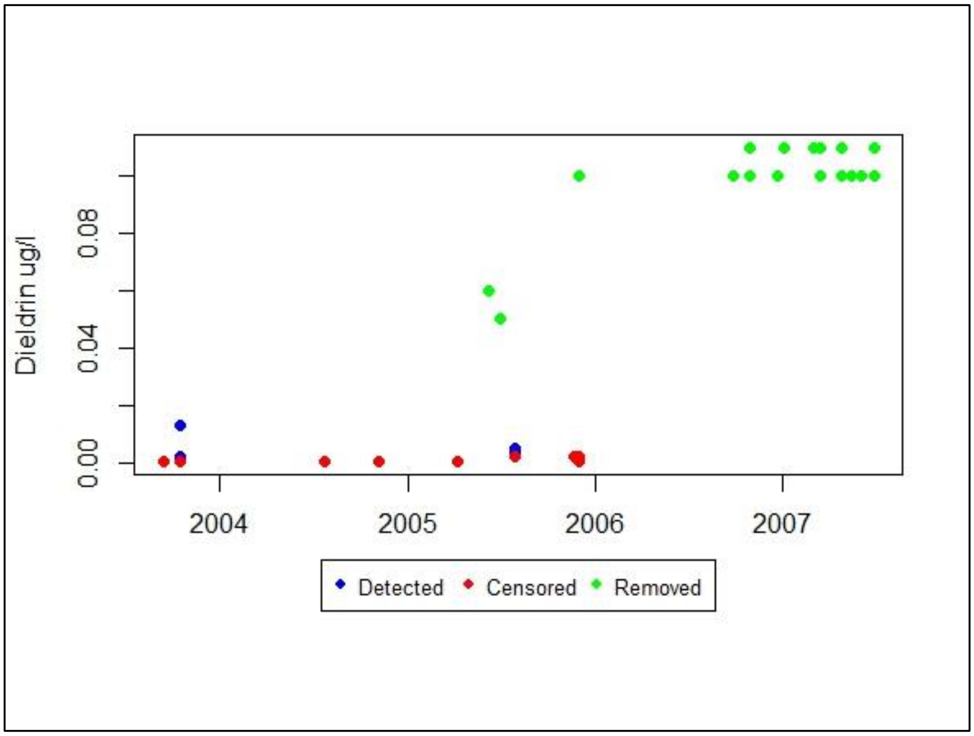

Figure 2.3: Observed Dieldrin Concentrations in Wet-Weather Monitoring Data from Storm System Outfalls in NW DC, Showing Observations Excluded from Analysis

2.4.2 Analysis of Stormwater Monitoring Data

DOEE provided a database containing all wet-weather samples collected by the DC MS4 program 2001-2013[8]. No additional wet-weather samples have been analyzed for dieldrin, chlordane, heptachlor epoxide, and DDT since 2013. Observations of dieldrin, chlordane, heptachlor epoxide, and DDT were divided into three groups geographically: (1) Piedmont Group, which includes all sampling locations in Rock Creek and the sampling locations on the Potomac tributaries in the Piedmont physiographic province; (2) Anacostia/Coastal Plain Group, including samples from Oxon Run and Anacostia River drainage primarily in the Coastal Plain; and (3) Other, which includes waterbodies that do not fit in either category, such as the Tidal Basin and the C & O Canal. Table 2.4 shows the classification of the MS4 monitoring locations.

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

Using the method described in Section 2.4.1, a mean concentration was estimated for each of the four pesticides from the monitoring data in the Piedmont Group. A mean concentration for dieldrin was also estimated from data in the Coastal Plain Group for use in the Oxon Run STPM. Table 2.5 summarizes the analysis and shows the estimated mean concentrations. These mean concentrations were used to represent the concentration of pesticides in storm water from all land uses in STPM, with the exception of forest. Since forest represents minimally disturbed conditions, the concentration of a pesticide in forest surface flow was set at the minimum of the mean storm flow concentration and mean instream concentration, discussed in the next section.

Estimated mean storm water concentrations were also used to represent concentrations in CSO flows. CSO concentrations were also taken from storm water concentrations in DCSTM (ICPRB, 2003). This approach can be justified by GLEC (2008), who found, as mentioned in Section 1.3.2, that total organochlorine pesticide concentrations were similar in CSOs and SWOs.

Table 2.4: Classification of MS4 Monitoring Stations by Group

Group	Watershed	Station
Piedmont	Potomac	Battery Kemble Creek
Piedmont	Potomac	Dalecarlia Tributary
Piedmont	Potomac	Foundry Branch
Piedmont	Rock Creek	Broad Branch
Piedmont	Rock Creek	Ft. Stevens Drive
Piedmont	Rock Creek	Glover Archbold
Piedmont	Rock Creek	Hazen Park
Piedmont	Rock Creek	Klingle Valley Creek
Piedmont	Rock Creek	Military and Beach
Piedmont	Rock Creek	Normanstone Creek
Piedmont	Rock Creek	Oregon
Piedmont	Rock Creek	Portal and 16th St
Piedmont	Rock Creek	Soapstone Creek
Coastal Plain	Anacostia	Anacostia High School
Coastal Plain	Anacostia	East Capitol
Coastal Plain	Anacostia	Ft. Lincoln (inflow)
Coastal Plain	Anacostia	Gallatin
Coastal Plain	Anacostia	Hickey Run
Coastal Plain	Anacostia	Nash Run
Coastal Plain	Anacostia	O St. Pump Station
Coastal Plain	Anacostia	Stickfoot
Coastal Plain	Anacostia	Varnum
Coastal Plain	Potomac	Oxon Run
Other	Potomac	C&O Canal
Other	Potomac	Tidal Basin
Other	Potomac	Washington Ship Channel

Table 2.5: Summary of Analysis of MS4 Monitoring Data

Constituent	Sample Count	Number Censored Observations	Number Censored Observations >Max. Detected	Maximum Detected Concentration (µg/l)	Average Concentration (µg/l)
Chlordane	66	64	37	0.61	0.19
DDT	66	61	33	0.18	0.0098
Dieldrin (Piedmont)	67	63	37	0.013	0.0012
Dieldrin (Coastal Plain)	55	53	31	0.002	0.00026
Heptachlor Epoxide	66	65	37	0.004	0.00061

2.4.3 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 dieldrin, α- and γ-chlordane, heptachlor epoxide, and DDT, in addition to other parameters. Observations for the four pesticides of interest were classified into two groups, as shown in Table 2.6. Sampling locations in tidal waters were excluded from the analysis. Three field duplicates were included in the Piedmont Group. The method described in Section 2.4.1 was applied to estimate mean concentrations for dieldrin, heptachlor epoxide, and DDT in the Piedmont Group and for dieldrin in the Coastal Plain Group. A mean chlordane concentration was estimated in the Piedmont Group as the sum of α- and γ-chlordane.

Table 2.7 summarizes the analyses of the instream concentrations. The mean instream concentrations were used to represent baseflow concentrations from all land uses in STPM.

Table 2.6: 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 2.7: Summary of Analysis of Instream Monitoring Data

Constituent	Sample Count	Number of Censored Observations	Maximum Detected Concentration (µg/l)	Average Concentration (µg/l)
DDT	14	13	0.00081	0.00039
Dieldrin (Piedmont)	14	0	0.005	0.0025
Dieldrin (Coastal Plain)	7	5	0.0017	0.00066
Heptachlor Epoxide	14	1	0.0051	0.0020
α-Chlordane	14	10	0.0014	0.00067
γ-chlordane	14	9	0.0037	0.00096
Chlordane	14	10	0.0051	0.0016

2.4.4 Uncertainty in Concentration Estimations

The number of censored observations introduces a large element of uncertainty into the estimate of mean concentrations for use in the model. Table 2.8 contrast the mean concentrations calculated from the MS4 monitoring data in Section 2.4.3 with the mean concentrations that would be calculated (1) if zero is used in observations below the DL and (2) if the value of censored observations were set equal to the DL. Observations with DLs larger than the largest observed value have again been eliminated from the calculation. Table 2.8 also shows the range of the mean values determined by the alternative calculations, expressed as a percentage of the mean concentration calculated with censored observations set at half the DL. While none of the concentrations have an upper limit which is double of the mean calculated with half the DL, the mean concentration of chlordane could be as little as one-fifth of that mean while the mean concentration of heptachlor epoxide might be less than a quarter of that mean. Similar remarks apply to instream mean concentrations for DDT and chlordane. As shown in Table 2.9, the instream concentration of DDT might be as low as 15% of the mean calculated with half the DL. In contrast, there are no censored observations of dieldrin and only one censored observation of heptachlor epoxide from instream samples in the Piedmont, so the treatment of censored observations has little effect on the estimate of the average instream concentration of those constituents, as shown by the narrow range of estimated mean concentrations in Table 2.9.

Table 2.8: Uncertainty Results for Average Concentration from DC MS4 Monitoring Data

	Average Concentration (µg/l) Censored Observations =			**Percent Different from Average with Half MDL**	
Constituent	**½ DL**	**0**	**DL**	**Minimum**	**Maximum**
Chlordane	0.19	0.036	0.36	19%	186%
DDT	0.0098	0.0065	0.013	67%	133%
Dieldrin (Piedmont)	0.0012	0.00077	0.0016	65%	135%
Dieldrin (Coastal Plain)	0.00026	0.00017	0.00035	65%	135%
Heptachlor Epoxide	0.0006	0.0001	0.0011	23%	177%

Table 2.9: Uncertainty Results for Average Concentration from Instream Monitoring Data

	Average Concentration (µg/l) Censored Observations =			**Percent Different from Average with Half MDL**	
Constituent	**½ DL**	**0**	**DL**	**Minimum**	**Maximum**
Chlordane	0.0016	0.00100	0.00225	62%	138%
DDT	0.00039	0.000058	0.00071	15%	185%
Dieldrin (Piedmont)	0.0025	0.0025	0.0025	100%	100%
Dieldrin (Coastal Plain)	0.00066	0.00039	0.00089	58%	135%
Heptachlor Epoxide	0.00201	0.00198	0.00204	98%	102%

Overall, these analyses demonstrate that there is uncertainty in the concentration data, however that uncertainty is being lessened using the conservative assumptions of the chosen approach.

3 Application of STPM to Revise Pesticide TMDLs in Rock Creek and Potomac River Watersheds

This section discusses the application of STPM to revise the pesticide TMDLs for the small tributaries in the Rock Creek and Potomac River watersheds. 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 dieldrin, heptachlor epoxide, chlordane, and DDT. 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. Section 3.3 discusses the TMDL scenario required to meet the revised human health criteria for these pesticides. 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

Under baseline or current conditions, CMCs for dieldrin, heptachlor epoxide, chlordane and DDT are always met, reflecting the fact that that data indicates that no observed concentrations of these pesticides have exceeded the CMCs. The Class D human health criteria, on the other hand, are never met under baseline conditions. CCCs are always met for dieldrin and heptachlor epoxide, and never met for chlordane and DDT. For these four pesticides, greater reductions are required to meet the Class D criteria than the CCCs. As described in the following sections, the TMDL for each pesticide was developed to meet the Class D human health criteria which provide loads that will be also ensure that their CMCs and CCCs will be achieved.

3.1 Scoping Scenarios

Three scoping scenarios were run with the STPM: (1) equal reduction to all sources; (2) 100% reduction in EOP loads; and (3) 100% reduction in NPS loads. Since the minimum reduction in NPS loads occur 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 shows the percent reduction required to meet water quality standards when EOP and NPS loads are reduced equally. The stormflow and baseflow concentrations used in the Oxon Run dieldrin model are different than the concentrations used in the other tributaries, so the required reductions for dieldrin are different for Oxon Run; otherwise, for a given pesticide, required reductions are fairly uniform across tributaries. The minimum reduction for dieldrin is in Oxon Run (91.9%), followed by the reduction for DDT in Fenwick Branch (96.7%). The required reduction for dieldrin in the other tributaries is 97.9% and the reductions for heptachlor epoxide are 98.1%. The largest reductions are for chlordane, ranging from 99.1% to 99.4%.

Table 3.2: Percent Reductions Required to Meet Human Health Criteria, Equal Reduction Scenario

		Dieldrin		Heptachlor Epoxide		Chlordane		DDT	
Mainstem	**Tributary**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**
Rock Creek	Broad Branch	97.9%	97.9%	98.1%	98.1%	99.3%	99.3%		
	Dumbarton Oaks	97.9%	97.9%	98.1%	98.1%	99.2%	99.2%		
	Fenwick Branch	97.9%	97.9%	98.1%	98.1%			96.7%	96.7%
	Klingle Valley Creek	97.9%	97.9%	98.1%	98.1%				
	Luzon Branch	97.9%	97.9%	98.1%	98.1%	99.4%	99.4%		
	Melvin Hazen Valley Branch	97.9%	97.9%						
	Normanstone Creek	97.9%	97.9%	98.1%	98.1%				
	Pinehurst Branch	97.9%	97.9%	98.1%	98.1%				
	Piney Branch	97.9%	97.9%	98.1%	98.1%	99.1%	99.1%		
	Portal Branch	97.9%	97.9%	98.1%	98.1%				
	Soapstone Creek	97.9%	97.9%	98.1%	98.1%	99.4%	99.4%		
Potomac	Dalecarlia Tributary	97.9%	97.9%	98.1%	98.1%				
	Oxon Run	91.9%	91.9%						

Table 3-3 shows the minimum reductions required on NPS loads to meet water quality standards. For dieldrin and heptachlor epoxide, the minimum reduction on NPS is the same as the equal percent reduction. This shows that the equal percent reduction is determined by reductions on NPS loads. This occurs in the case of dieldrin and heptachlor epoxide because base flow concentrations are larger than storm flow concentrations, and during dry-weather flows reductions in storm concentration loads provide no benefit, so the reduction required on NPS loads determines the level of reduction necessary to meet water quality standards. For chlordane and DDT, water quality standards need to be met during dry-weather flows, but the minimum reduction required on NPS is less than the Equal Reduction Scenario. For chlordane and DDT, storm flow concentrations are larger than base flow concentrations, and under the Equal Reduction Scenario the level of reduction is determined by the need to reduce peak storm flow loads to meet the 30-day average criteria.

Table 3-4 shows the minimum reductions required on EOP loads to meet water quality standards. The situation is the reverse of the previous scenario. For chlordane and DDT, the required reductions under this scenario are close to the reductions required when an equal percent reduction is applied to all sources, because chlordane and DDT concentrations are higher in storm water than in base flow. On the other hand, the reductions for dieldrin and heptachlor epoxide are less than the reduction required if equal reductions are taken from all sources. The reductions required under dry weather flows have to be more stringent because the concentrations are larger in base flow than in storm flow.

Table 3.3: Percent Reductions Required to Meet Human Health Criteria, Minimum NPS Reduction Scenario

		Dieldrin		Heptachlor Epoxide		Chlordane		DDT	
Mainstem	**Tributary**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**
Rock Creek	Broad Branch	100%	97.9%	100%	98.1%	100%	90.1%		
	Dumbarton Oaks	100%	97.9%	100%	98.1%	100%	99.0%		
	Fenwick Branch	100%	97.9%	100%	98.1%			100.0%	66.0%
	Klingle Valley Creek	100%	97.9%	100%	98.1%				
	Luzon Branch	100%	97.9%	100%	98.1%	100%	87.0%		
	Melvin Hazen Valley Branch	100%	97.9%	100%	98.1%				
	Normanstone Creek	100%	97.9%						
	Pinehurst Branch	100%	97.9%	100%	98.1%				
	Piney Branch	100%	97.9%	100%	98.1%	100%	94.3%		
	Portal Branch	100%	97.9%	100%	99.0%				
	Soapstone Creek	100%	97.9%	100%	98.1%	100%	94.0%		
Potomac	Dalecarlia Tributary	100%	97.9%	100%	98.1%				
	Oxon Run	100%	91.9%						

Table 3.4: Percent Reductions Required to Meet Human Health Criteria, Minimum EOP Reduction Scenario

		Dieldrin		Heptachlor Epoxide		Chlordane		DDT	
Mainstem	**Tributary**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**
Rock Creek	Broad Branch	92.0%	100%	88.5%	100%	99.3%	100%		
	Dumbarton Oaks	54.0%	100%	35.0%	100%	95.6%	100%		
	Fenwick Branch	93.0%	100%	90.1%	100%			96.5%	100.0%
	Klingle Valley Creek	91.5%	100%	88.0%	100%				
	Luzon Branch	93.2%	100%	90.4%	100%	99.4%	100%		
	Melvin Hazen Valley Branch	90.4%	100%						
	Normanstone Creek	91.8%	100%	88.3%	100%				
	Pinehurst Branch	91.2%	100%	87.5%	100%				
	Piney Branch	89.0%	100%	84.4%	100%	99.0%	100%		
	Portal Branch	93.6%	100%	90.8%	100%				
	Soapstone Creek	92.2%	100%	88.9%	100%	99.3%	100%		
Potomac	Dalecarlia Tributary	92.8%	100%	89.7%	100%				
	Oxon Run	63.0%	100%						

To put it another way, water quality standards have to be met under extended periods of dry weather. This requires NPS load reductions approximately equal to the reductions required to reduce base flow concentrations to the Class D criteria. (The relation is only approximate because NPS loads include storm flows outside of the MS4 area.) In the case of dieldrin and heptachlor epoxide, the Equal Reduction

Scenario will therefore require average storm flow concentrations to be less than the Class D criteria, because the baseline concentrations in storm flow is less than the concentrations in base flow for those constituents. Consequently, for dieldrin and heptachlor epoxide, under the Equal Reduction Scenario, water quality standards are met under all flows if the standards are met during dry-weather periods. For chlordane and DDT, on the other hand, meeting water quality standards during dry-weather flows is not sufficient to guarantee that standards are met under all conditions, because concentrations in storm flow are higher than in baseflow. Under the Equal Reduction Scenario, in effect, baseflow concentrations are reduced to provide enough dilution to meet water quality standards during periods of frequent wet-weather flow. In other words, base flow concentrations are below the Class D criteria, while EOP sources discharge above the Class D criteria.

3.2 TMDL Scenario under Current Water Quality Standards

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. As was shown in the preceding section, however, if either EOP or NPS sources discharge above the Class D criteria, the other source 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. That uncertainty is due to the fact that the majority of observations of these four pesticides made in the Rock Creek and Potomac River watersheds are below the detection limit. Since baseline concentrations and load are uncertain, an equal percent reduction from sources may not be equitable.

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 criteria, the Class D human health criteria. This allocation was chosen as the TMDL Scenario. Table 3.5 shows the reductions necessary under the TMDL Scenario.

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

		Dieldrin		Heptachlor Epoxide		Chlordane		DDT	
Mainstem	**Tributary**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**
Rock Creek	Broad Branch	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Dumbarton Oaks	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Fenwick Branch	95.5%	97.8%	93.6%	98.1%			97.8%	43.6%
	Klingle Valley Creek	95.5%	97.8%	93.6%	98.1%				
	Luzon Branch	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Melvin Hazen Valley Branch	95.5%	97.8%						
	Normanstone Creek	95.5%	97.8%	93.6%	98.1%				
	Pinehurst Branch	95.5%	97.8%	93.6%	98.1%				
	Piney Branch	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
	Portal Branch	95.5%	97.8%	93.6%	98.1%				
	Soapstone Creek	95.5%	97.8%	93.6%	98.1%	99.6%	49%		
Potomac	Dalecarlia Tributary	95.5%	97.8%	93.6%	98.1%				
	Oxon Run	79.2%	91.8%						

The required reductions are generally greater than 90%, except for NPS reductions for chlordane and DDT, and EOP reductions for dieldrin for Oxon Run. Required NPS reductions for chlordane and DDT are less than 50%. The dramatic drop in the required reductions is due to the fact that direct drainage surface water, which is an NPS load, is discharging at the Class D criteria. Except for the NPS reductions for chlordane and DDT, in terms of reduction from baseline loads, the TMDL Scenario is not dramatically different than Equal Reduction Scenario.

For each pesticide, under the TMDL Scenario, each source discharges at the Class D human health criterion. Consequently, the concentration of the pesticide in a tributary is a constant value equal to the human health criterion. Moreover, the daily average, four-day average, and 30-day average concentrations are also constant values equal to the human health criterion. Since, for each pesticide, the 30-day average human health criterion is less than 4-day average chronic aquatic life use criterion or the one-hour average acute aquatic life criterion, those criteria will also be met under the TMDL Scenario. Figure 3.1 shows these relationships for dieldrin. 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 dieldrin 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 acute and chronic aquatic life use criteria. Figures 3.2, 3.3, and 3.4 show the same relationships for heptachlor epoxide, chlordane, and DDT, respectively.

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

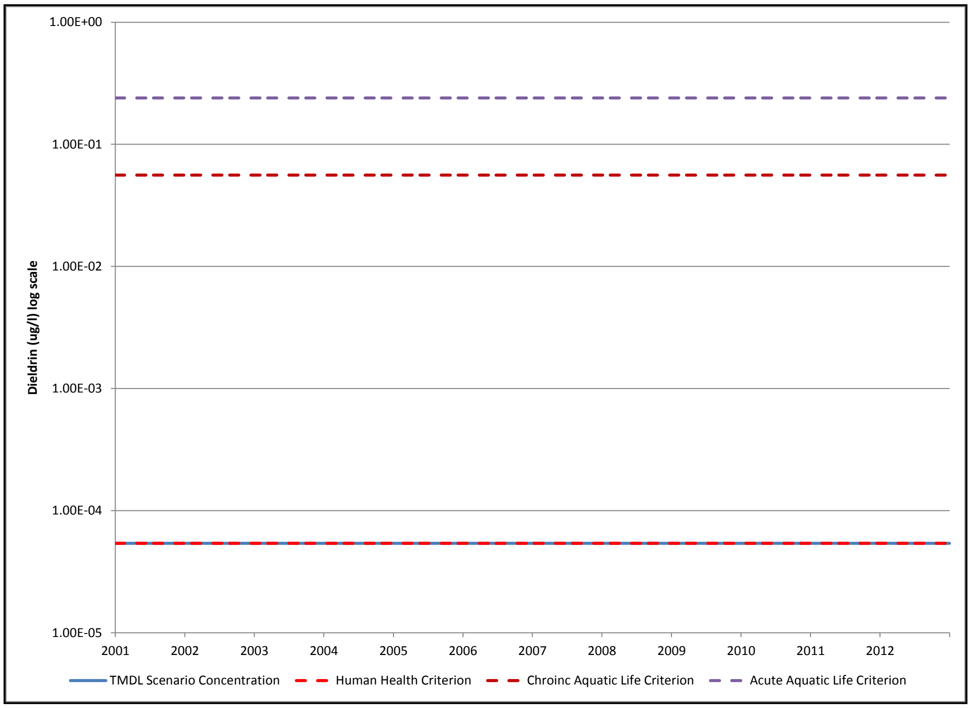

Figure 3.1: Simulated Dieldrin Concentration (µg/l), TMDL Scenario, and Dieldrin Human Health Criterion, Chronic Aquatic Life Criterion, and Acute Aquatic Life Criterion

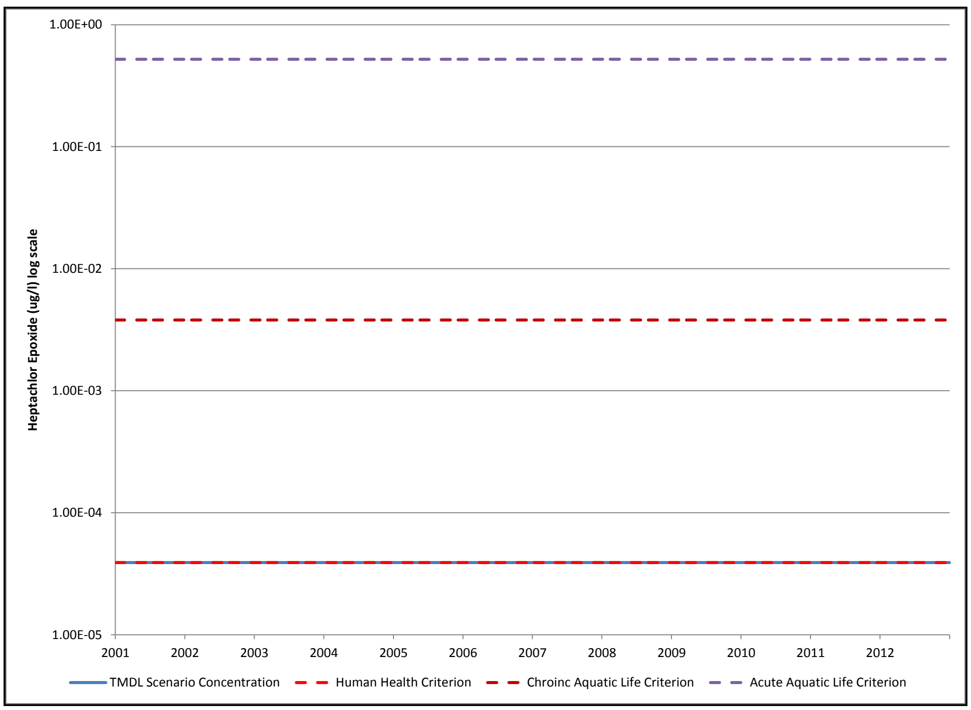

Figure 3.2: Simulated Heptachlor Epoxide Concentration (µg/l), TMDL Scenario, and Heptachlor Epoxide Human Health Criterion, Chronic Aquatic Life Criterion, and Acute Aquatic Life Criterion

Figure 3.3: Simulated Chlordane Concentration (µg/l), TMDL Scenario, and Chlordane Human Health Criterion, Chronic Aquatic Life Criterion, and Acute Aquatic Life Criterion

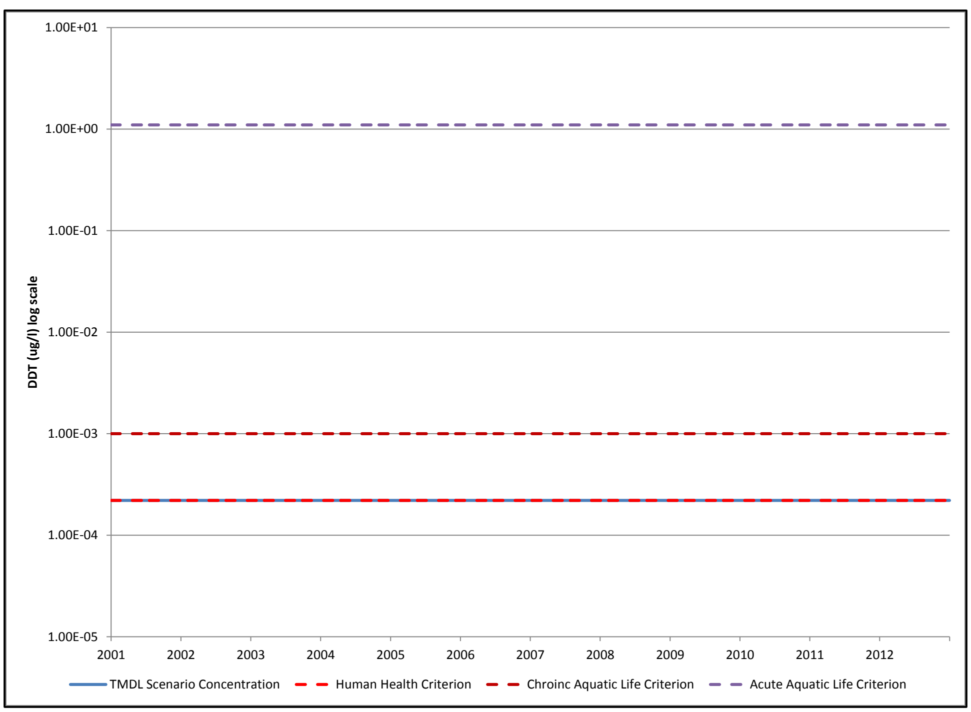

Figure 3.4: Simulated DDT Concentration (µg/l), TMDL Scenario, and DDT Human Health Criterion, Chronic Aquatic Life Criterion, and Acute Aquatic Life Criterion

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. As discussed above, the Class D criteria for dieldrin and heptachlor epoxide are most likely to be exceeded during dry weather periods, while the Class D criteria for chlordane and DDT are most likely to be exceeded during periods with frequent storm flow inputs. 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). Loading rates under these conditions are determined directly from the Class D criteria, 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. As discussed in Section 2.3, 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 pesticide TMDLs for the Rock Creek and Potomac River 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[9]. 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 pesticide TMDLs.

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

3.2.4 Allocations

Each pesticide 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 and pesticide 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.

3.3 Future TMDL Scenario under Proposed Revisions to the Class D Criteria

As discussed in Section 1.4, revisions to the Class D criteria to protect human health under the Fish Consumption Use are under consideration in 2016. Table 1.5 shows the proposed revisions. The Future TMDL Scenario would require all sources to discharge at the revised the Class D human health criteria. Table 3.6 shows the reductions required to meet proposed revisions.

Table 3.6: Percent Reductions Required to Meet Proposed Class D Human Health Criteria, Future TMDL Scenario

		Dieldrin		Heptachlor Epoxide		Chlordane		DDT	
Mainstem	**Tributary**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**
Rock Creek	Broad Branch	99.9%	99.95%	94.8%	98.4%	99.8%	80%		
	Dumbarton Oaks	99.9%	99.95%	94.8%	98.4%	99.8%	80%		
	Fenwick Branch	99.9%	99.95%	94.8%	98.4%			99.7%	92.3%
	Klingle Valley Creek	99.9%	99.95%	94.8%	98.4%				
	Luzon Branch	99.9%	99.95%	94.8%	98.4%	99.8%	80%		
	Melvin Hazen Valley Branch	99.9%	99.95%						
	Normanstone Creek	99.9%	99.95%	94.8%	98.4%				
	Pinehurst Branch	99.9%	99.95%	94.8%	98.4%				
	Piney Branch	99.9%	99.95%	94.8%	98.4%	99.8%	80%		
	Portal Branch	99.9%	99.95%	94.8%	98.4%				
	Soapstone Creek	99.9%	99.95%	94.8%	98.4%	99.8%	80%		
Potomac	Dalecarlia Tributary	99.9%	99.95%	94.8%	98.4%				
	Oxon Run	99.5%	99.82%						

The Class D dieldrin criterion is so low that all sources would be required to make reductions greater than 99%. Chlordane and DDT NPS reductions would increase to 80% and 92.3%, respectively, as compared to the percent reductions shown in Table 3.5.

4 Results for Individual Small Tributaries

In this section, the results of the application of STPM to develop pesticide 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 TDML Scenario loads for each pesticide;
- Average daily loads for baseline conditions and TMDL Scenario for each pesticide;
- Maximum daily loads for baseline conditions and TMDL Scenario for each pesticide;
- 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.

The TMDLs were calculated using current water quality standards. Appendix A contains the same tables calculated using the proposed revisions to the human health criteria.

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.

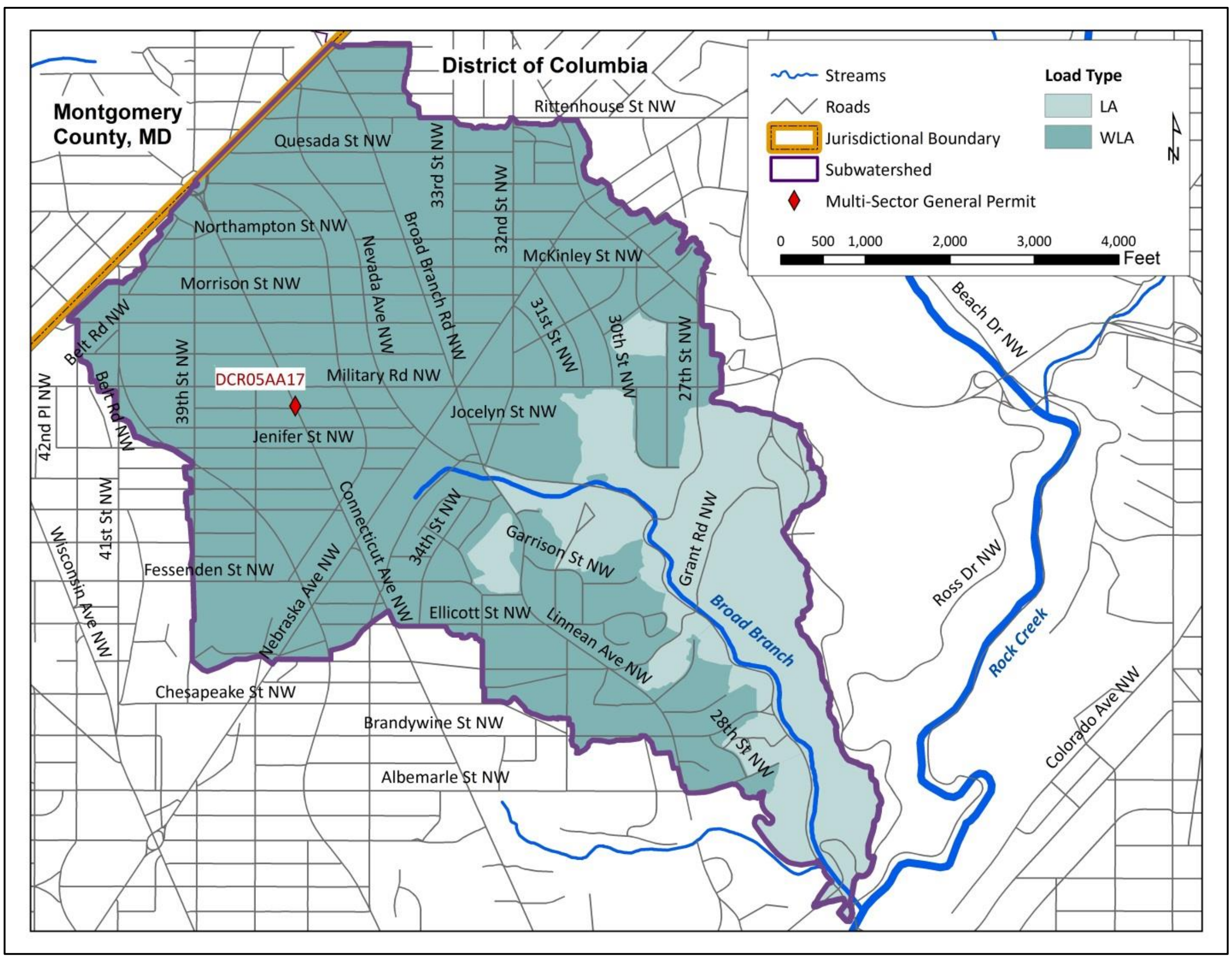

Figure 4.1: Broad Branch and its Watershed

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.

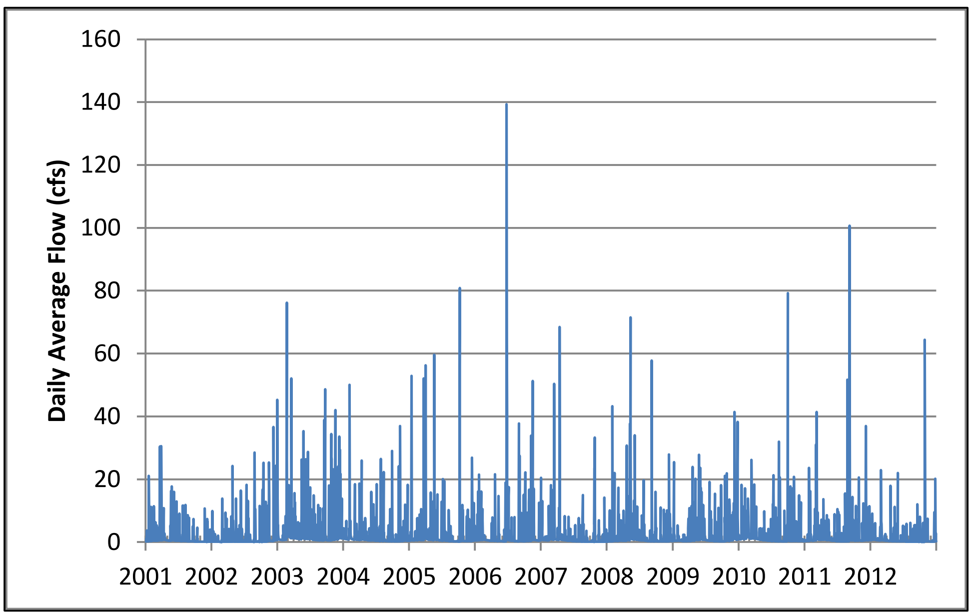

Figure 4.2: Simulated Average Daily Flow (cfs), Broad Branch

Table 4.2 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.3 presents the daily average baseline loads and TMDL allocations, and Table 4.4 presents maximum daily baseline dieldrin 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 dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.4 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.5 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.2: Average Annual Dieldrin 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	4.13E-03	1.86E-04	95.5%
	Total	4.13E-03	1.86E-04	95.5%
Load Allocation	Direct Drainage	2.73E-03	7.06E-05	97.4%
	Upstream Maryland	-	-	-
	Total	2.73E-03	7.06E-05	97.4%
Margin of Safety		-	Implicit	-
Total		6.86E-03	2.56E-04	96.3%

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

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.13E-05	5.09E-07	95.5%
	Total	1.13E-05	5.09E-07	95.5%
Load Allocation	Direct Drainage	7.47E-06	1.93E-07	97.4%
	Upstream Maryland	-	-	-
	Total	7.47E-06	1.93E-07	97.4%
Margin of Safety		-	Implicit	-
Total		1.88E-05	7.03E-07	96.3%

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

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.67E-04	3.45E-05	95.5%
	Total	7.67E-04	3.45E-05	95.5%
Load Allocation	Direct Drainage	1.35E-04	5.99E-06	95.6%
	Upstream Maryland	-	-	-
	Total	1.35E-04	5.99E-06	95.6%
Margin of Safety		-	Implicit	-
Total		9.02E-04	4.05E-05	95.5%

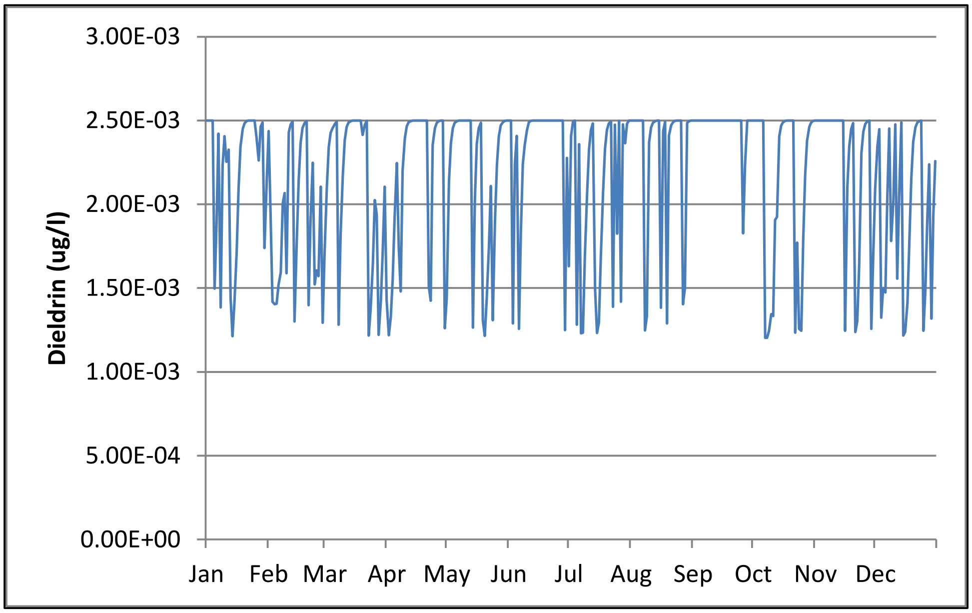

Figure 4.3: Simulated Daily Dieldrin Concentrations (μg/l), Broad Branch, Baseline Conditions, 2005

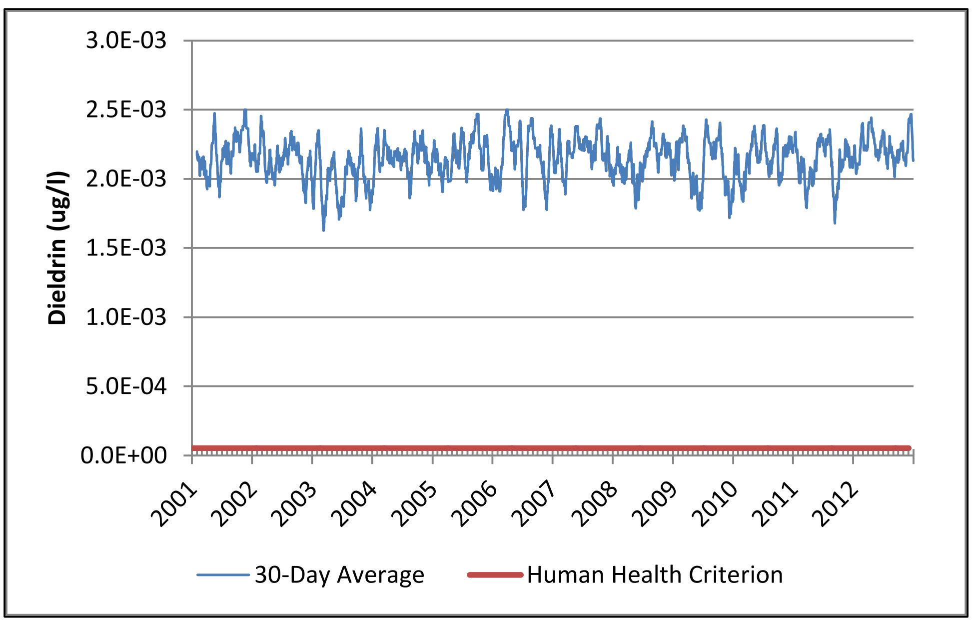

Figure 4.4: Simulated 30-Day Average Dieldrin Concentrations (μg/l), Broad Branch, Baseline Conditions

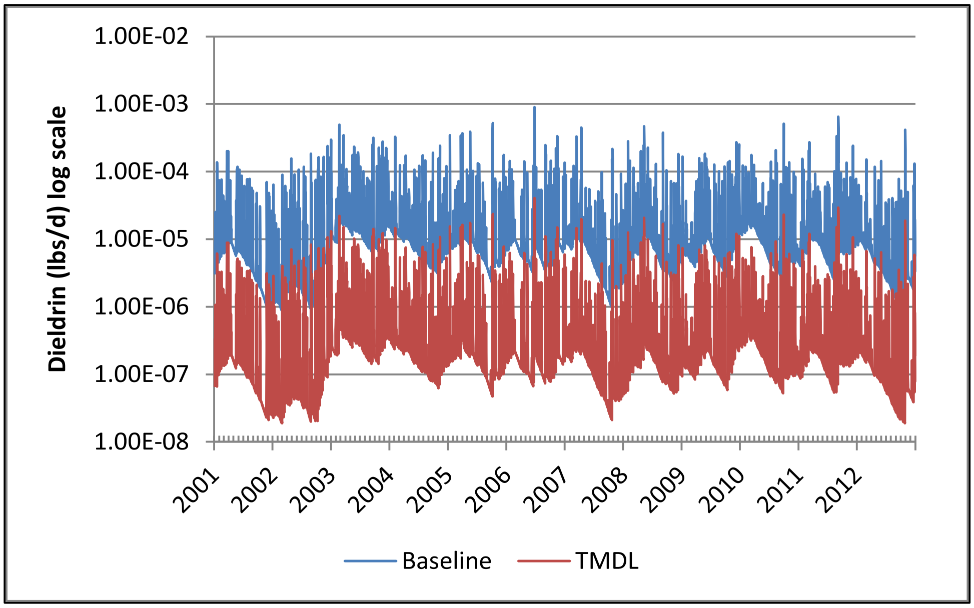

Figure 4.5: Simulated Daily Dieldrin Loads (lbs/d), Broad Branch, Baseline Conditions and TMDL Scenario

Table 4.5 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.6 presents the daily average baseline loads and TMDL allocations, and Table 4.7 presents maximum daily baseline heptachlor epoxide 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 4.6 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.7 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.8 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.5: Average Annual Heptachlor Epoxide 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	2.10E-03	1.34E-04	93.6%
	Total	2.10E-03	1.34E-04	93.6%
Load Allocation	Direct Drainage	2.04E-03	5.10E-05	97.5%
	Upstream Maryland	-	-	-
	Total	2.04E-03	5.10E-05	97.5%
Margin of Safety		-	Implicit	-
Total		4.14E-03	1.85E-04	95.5%

Table 4.6: Heptachlor Epoxide Average Daily Loads (lbs/d), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.75E-06	3.68E-07	93.6%
	Total	5.75E-06	3.68E-07	93.6%
Load Allocation	Direct Drainage	5.58E-06	1.40E-07	97.5%
	Upstream Maryland	-	-	-
	Total	5.58E-06	1.40E-07	97.5%
Margin of Safety		-	Implicit	-
Total		1.13E-05	5.07E-07	95.5%

Table 4.7: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.90E-04	2.49E-05	93.6%
	Total	3.90E-04	2.49E-05	93.6%
Load Allocation	Direct Drainage	6.97E-05	4.33E-06	93.8%
	Upstream Maryland	-	-	-
	Total	6.97E-05	4.33E-06	93.8%
Margin of Safety		-	Implicit	-
Total		4.60E-04	2.93E-05	93.6%

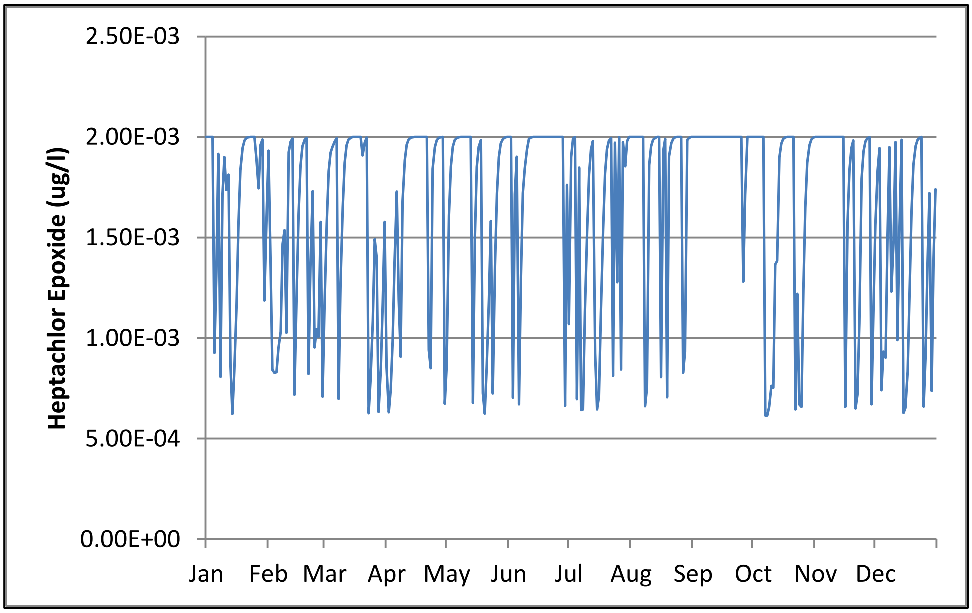

Figure 4.6: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Broad Branch, Baseline Conditions, 2005

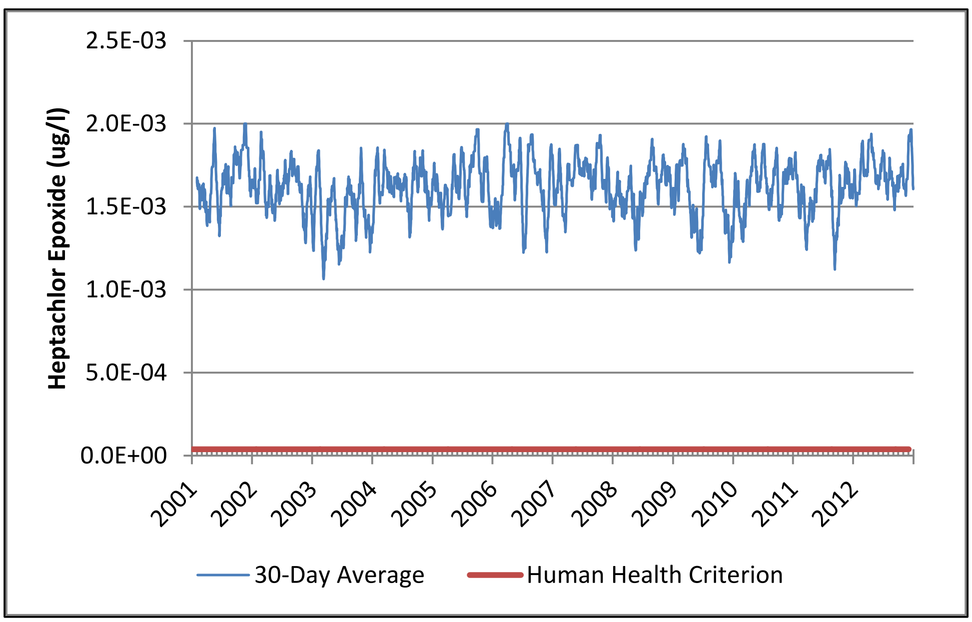

Figure 4.7: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Broad Branch, Baseline Conditions

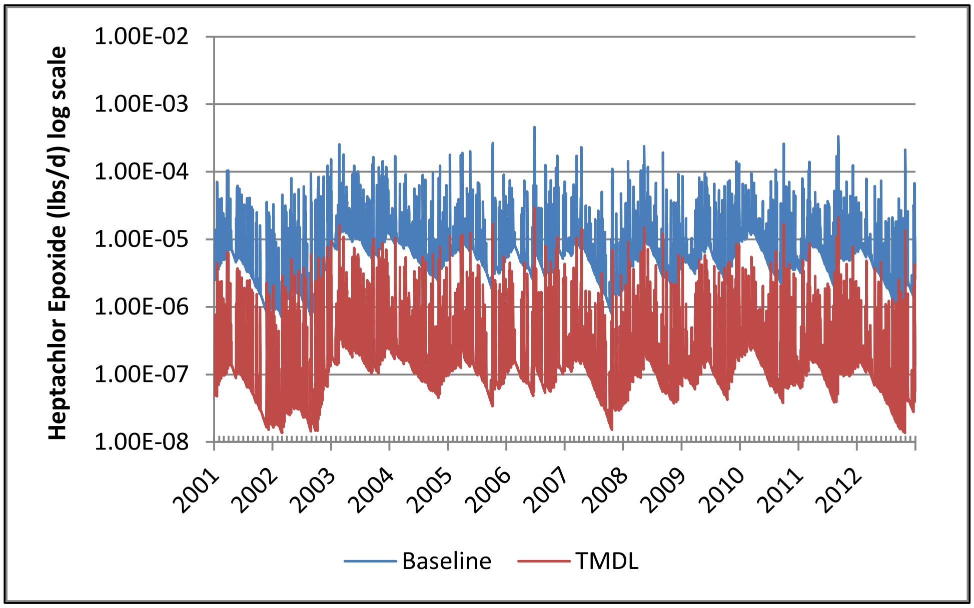

Figure 4.8: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Broad Branch, Baseline Conditions and TMDL Scenario

Table 4.8 presents the average annual baseline chlordane loads and TMDL allocations. Table 4.9 presents the daily average baseline loads and TMDL allocations, and Table 4.10 presents maximum daily baseline chlordane 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 4.9 shows simulated daily chlordane concentrations under baseline conditions in 2005. Unlike dieldrin, the concentration of chlordane in storm flow is greater than the concentration in base flow, so concentrations increase in storm events. Figure 4.10 contrasts the 30-day average chlordane concentration under baseline conditions and the current Class D human health criterion. Figure 4.11 presents simulated daily chlordane loads under baseline conditions and under the TMDL.

Table 4.8: Average Annual Chlordane 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	6.54E-01	2.79E-03	99.6%
	Total	6.54E-01	2.79E-03	99.6%
Load Allocation	Direct Drainage	4.58E-02	1.06E-03	97.7%
	Upstream Maryland	-	-	-
	Total	4.58E-02	1.06E-03	97.7%
Margin of Safety		-	Implicit	-
Total		7.00E-01	3.85E-03	99.5%

Table 4.9: Chlordane Average Daily Loads (lbs/d), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.79E-03	7.64E-06	99.6%
	Total	1.79E-03	7.64E-06	99.6%
Load Allocation	Direct Drainage	1.26E-04	2.90E-06	97.7%
	Upstream Maryland	-	-	-
	Total	1.26E-04	2.90E-06	97.7%
Margin of Safety		-	Implicit	-
Total		1.92E-03	1.05E-05	99.5%

Table 4.10: Chlordane Maximum Daily Loads (lbs/d), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.21E-01	5.18E-04	99.6%
	Total	1.21E-01	5.18E-04	99.6%
Load Allocation	Direct Drainage	9.02E-03	8.99E-05	99.0%
	Upstream Maryland	-	-	-
	Total	9.02E-03	8.99E-05	99.0%
Margin of Safety		-	Implicit	-
Total		1.30E-01	6.08E-04	99.5%

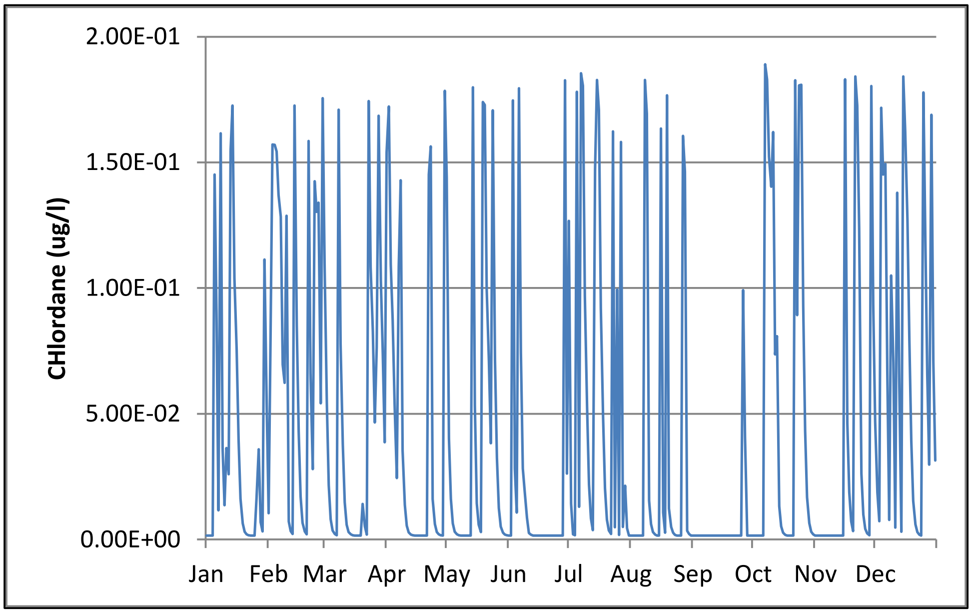

Figure 4.9: Simulated Daily Chlordane Concentrations (µg/l), Broad Branch, Baseline Conditions, 2005

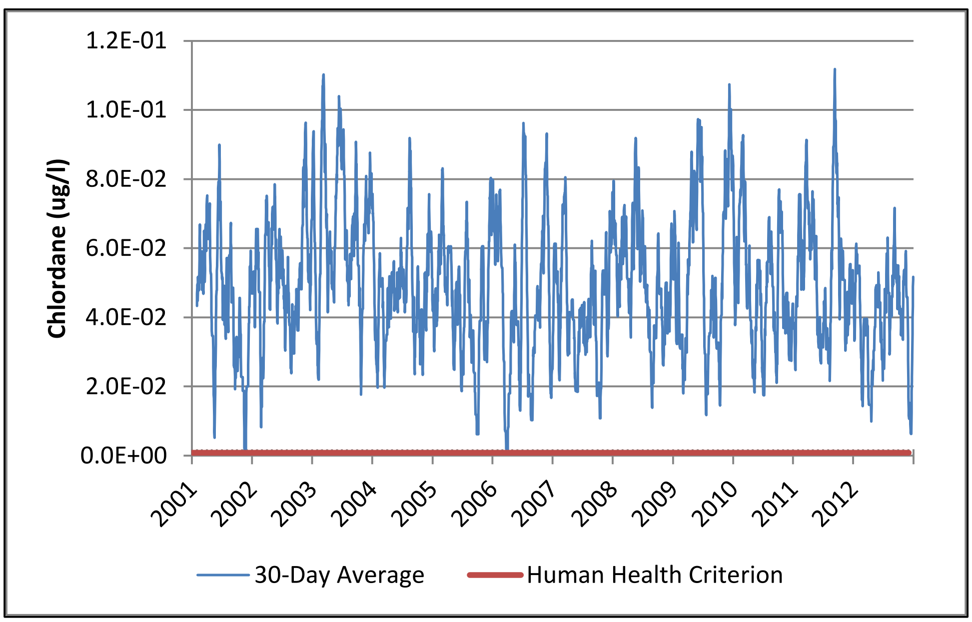

Figure 4.10: Simulated 30-Day Average Chlordane Concentrations (µg/l), Broad Branch, Baseline Conditions

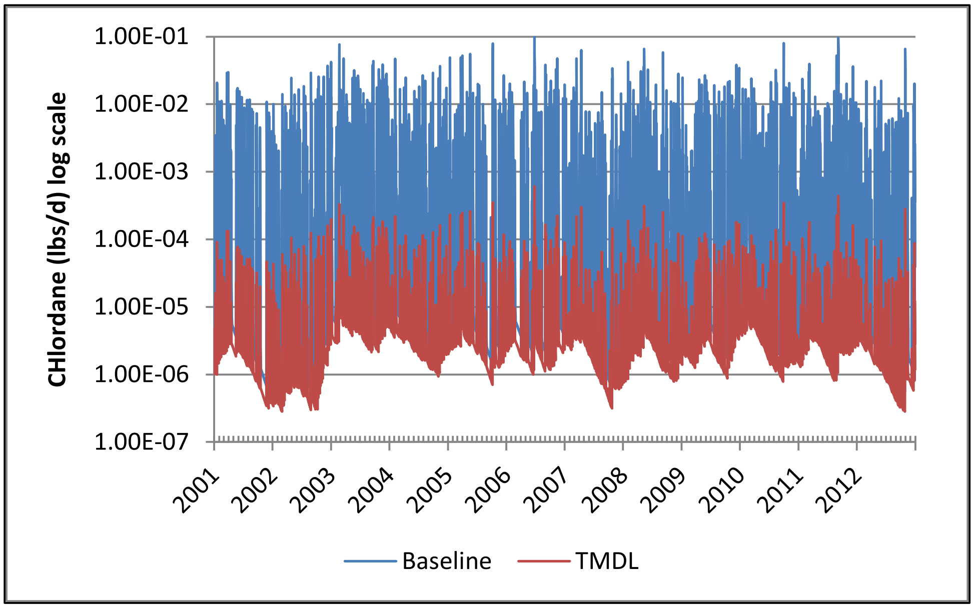

Figure 4.11: Simulated Daily Chlordane Loads (lbs/d), Broad Branch, Baseline Conditions and TMDL Scenario

4.2 Dalecarlia Tributary

Dalecarlia Tributary is a tributary of Little Falls Run in Maryland that flows to the Potomac. Figure 4.12 shows the location of Dalecarlia Tributary and its watershed. Table 4.11 gives the land use acreage in the watershed. The watershed encompasses 1,091 acres. The watershed is 37% impervious and 90% lies within the DC MS4. West of Dalecarlia Parkway, the tributary flows through sloping parkland. Most of the remainder of the watershed is suburban-style residential housing (DDOH, 2004b).

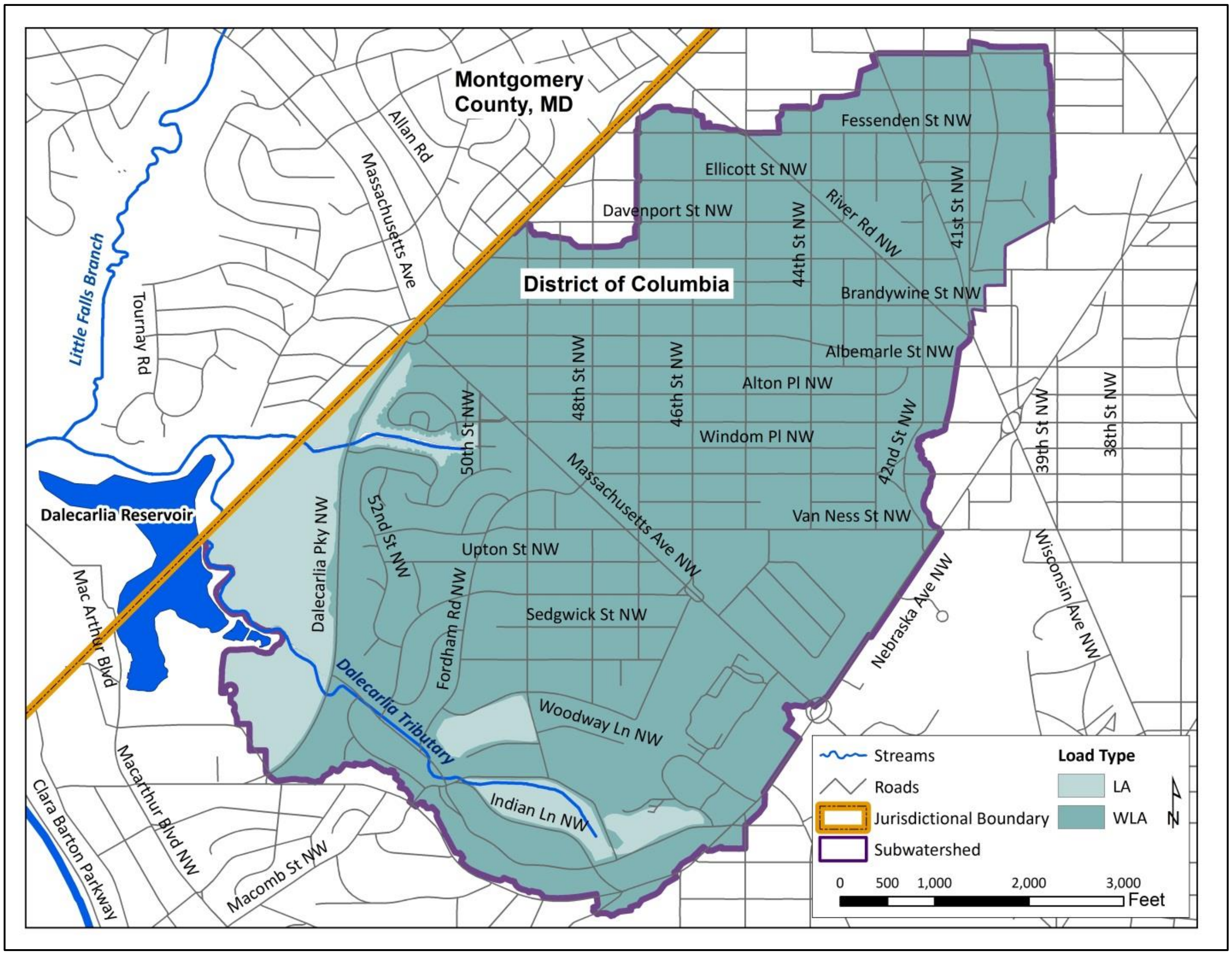

Figure 4.12: Dalecarlia Tributary and its Watershed

Table 4.11: Dalecarlia Tributary Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	393	534	50	977
DC Non-MS4	12	30	72	114
Maryland	-	-	-	-
Total	405	564	122	1,091

Figure 4.13 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.06 cfs to 141 cfs. The average daily flow is 2.4 cfs and the median flow is 0.54 cfs.

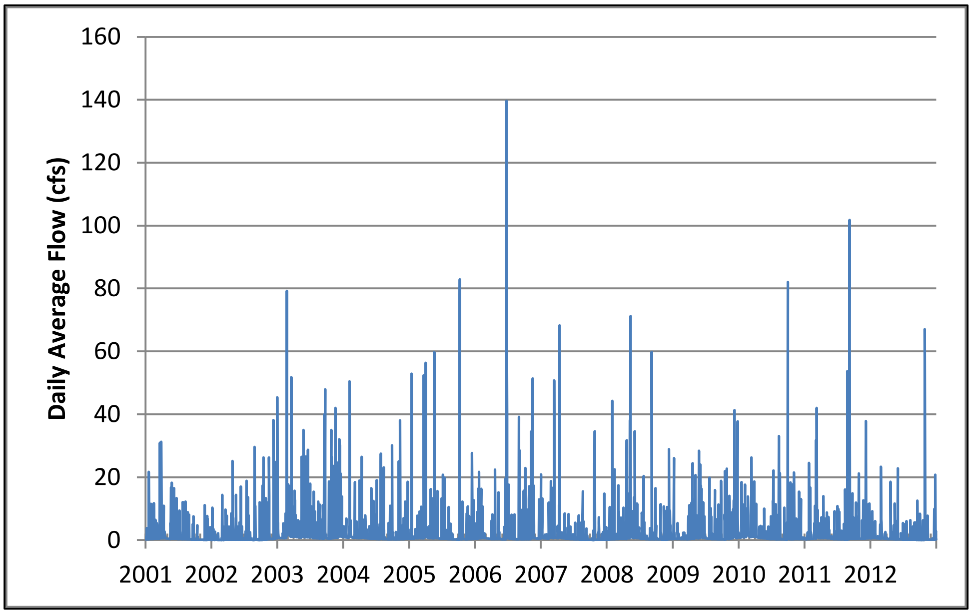

Figure 4.13: Simulated Average Daily Flow (cfs), Dalecarlia Tributary

Table 4.12 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.13 presents the daily average baseline loads and TMDL allocations, and Table 4.14 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.14 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.15 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.16 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.12: Average Annual Dieldrin Baseline Loads and TMDL Allocations (lbs/yr), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.43E-03	2.00E-04	95.5%
	Total	4.43E-03	2.00E-04	95.5%
Load Allocation	Direct Drainage	2.23E-03	5.47E-05	97.5%
	Upstream Maryland	-	-	-
	Total	2.23E-03	5.47E-05	97.5%
Margin of Safety		-	Implicit	-
Total		6.66E-03	2.54E-04	96.2%

Table 4.13: Dieldrin Average Daily Loads (lbs/d), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.21E-05	5.47E-07	95.5%
	Total	1.21E-05	5.47E-07	95.5%
Load Allocation	Direct Drainage	6.10E-06	1.50E-07	97.5%
	Upstream Maryland	-	-	-
	Total	6.10E-06	1.50E-07	97.5%
Margin of Safety		-	Implicit	-
Total		1.83E-05	6.97E-07	96.2%

Table 4.14: Dieldrin Maximum Daily Loads (lbs/d), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.24E-04	3.71E-05	95.5%
	Total	8.24E-04	3.71E-05	95.5%
Load Allocation	Direct Drainage	7.90E-05	3.48E-06	95.6%
	Upstream Maryland	-	-	-
	Total	7.90E-05	3.48E-06	95.6%
Margin of Safety		-	Implicit	-
Total		9.03E-04	4.06E-05	95.5%

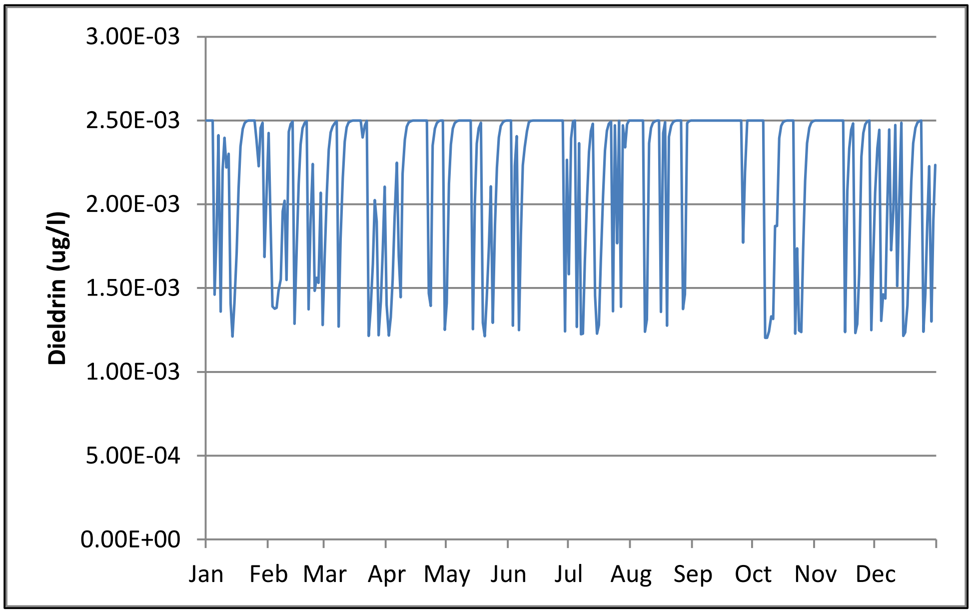

Figure 4.14: Simulated Daily Dieldrin Concentrations (µg/l), Dalecarlia Tributary, Baseline Conditions, 2005

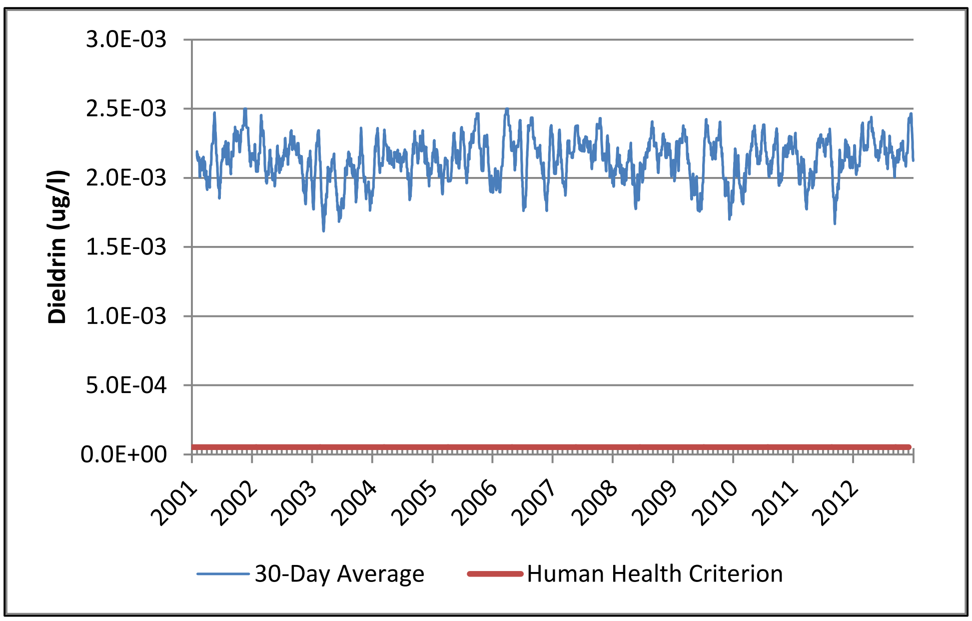

Figure 4.15: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Dalecarlia Tributary, Baseline Conditions

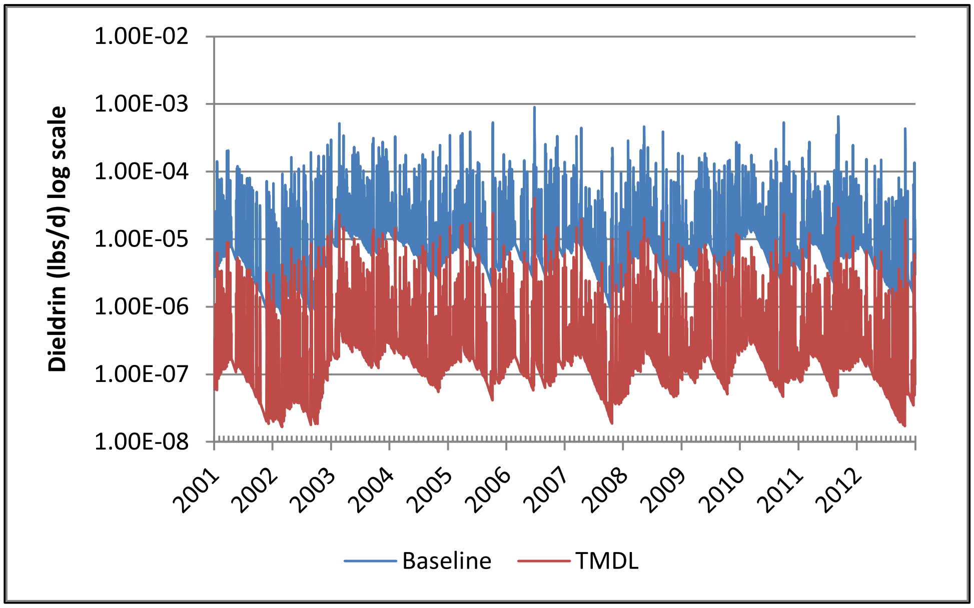

Figure 4.16: Simulated Daily Dieldrin Loads (lbs/d), Dalecarlia Tributary, Baseline Conditions and TMDL Scenario

Table 4.15 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.16 presents the daily average baseline loads and TMDL allocations, and Table 4.17 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.17 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.18 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.19 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.15: Average Annual Heptachlor Epoxide Baseline Loads and TMDL Allocations (lbs/yr), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.25E-03	1.44E-04	93.6%
	Total	2.25E-03	1.44E-04	93.6%
Load Allocation	Direct Drainage	1.70E-03	3.95E-05	97.7%
	Upstream Maryland	-	-	-
	Total	1.70E-03	3.95E-05	97.7%
Margin of Safety		-	Implicit	-
Total		3.95E-03	1.84E-04	95.4%

Table 4.16: Heptachlor Epoxide Average Daily Loads (lbs/d), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.17E-06	3.95E-07	93.6%
	Total	6.17E-06	3.95E-07	93.6%
Load Allocation	Direct Drainage	4.66E-06	1.08E-07	97.7%
	Upstream Maryland	-	-	-
	Total	4.66E-06	1.08E-07	97.7%
Margin of Safety		-	Implicit	-
Total		1.08E-05	5.03E-07	95.4%

Table 4.17: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.19E-04	2.68E-05	93.6%
	Total	4.19E-04	2.68E-05	93.6%
Load Allocation	Direct Drainage	4.11E-05	2.51E-06	93.9%
	Upstream Maryland	-	-	-
	Total	4.11E-05	2.51E-06	93.9%
Margin of Safety		-	Implicit	-
Total		4.60E-04	2.93E-05	93.6%

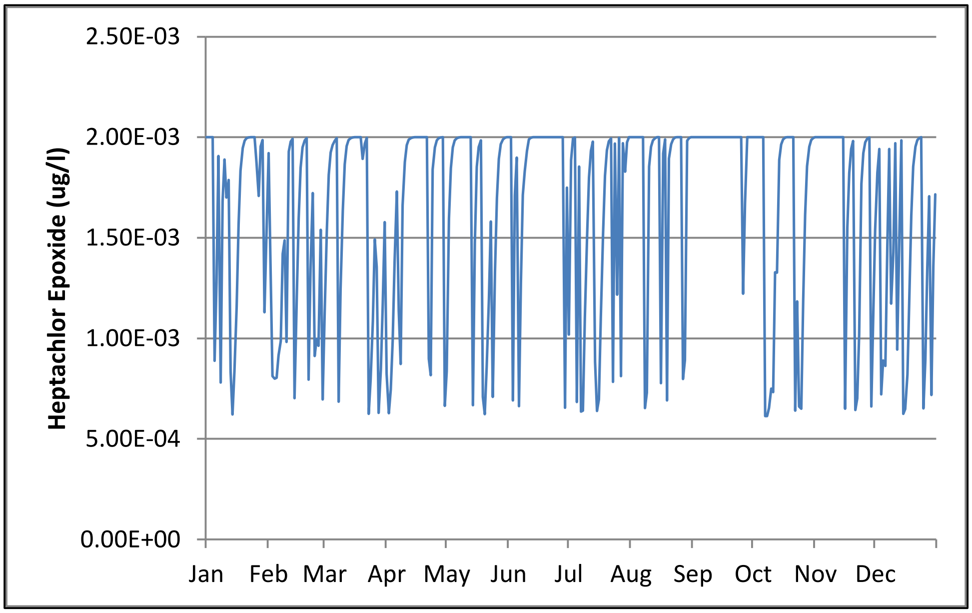

Figure 4.17: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Dalecarlia Tributary, Baseline Conditions, 2005

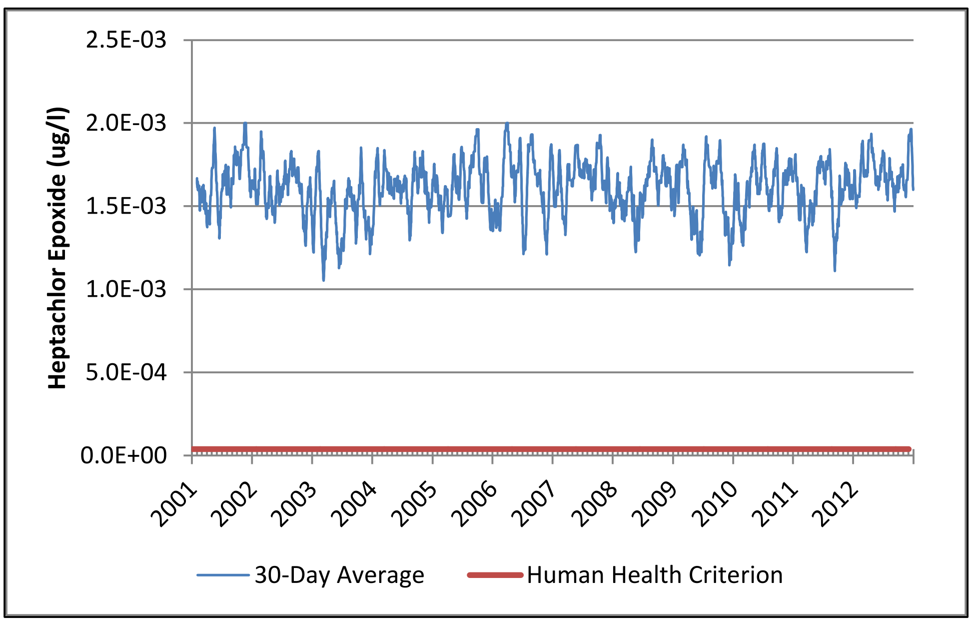

Figure 4.18: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Dalecarlia Tributary, Baseline Conditions

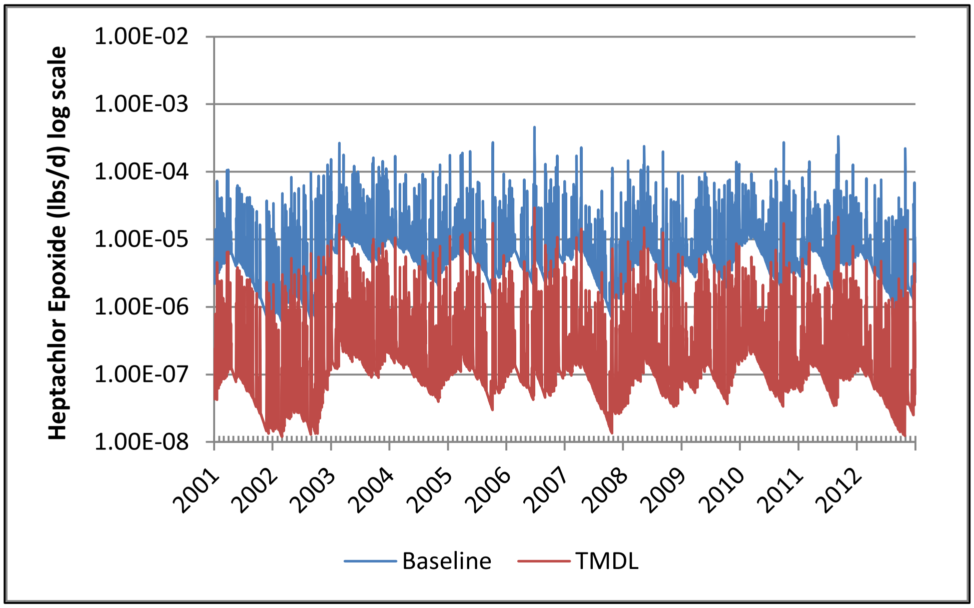

Figure 4.19: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Dalecarlia Tributary, Baseline Conditions and TMDL Scenario

4.3 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 4.20 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 4.18 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.

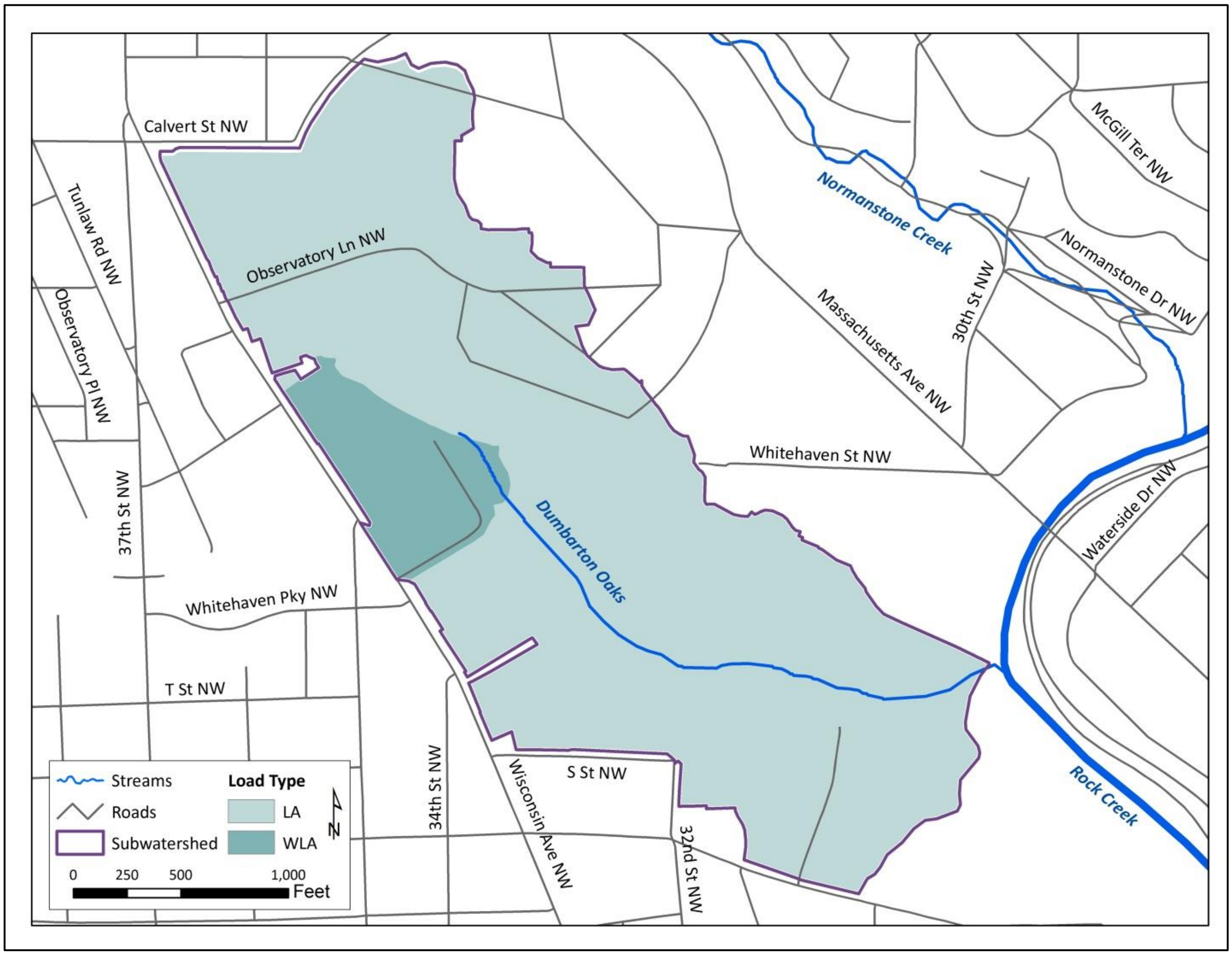

Figure 4.20: Dumbarton Oaks and its Watershed

Table 4.18: 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 4.21 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.

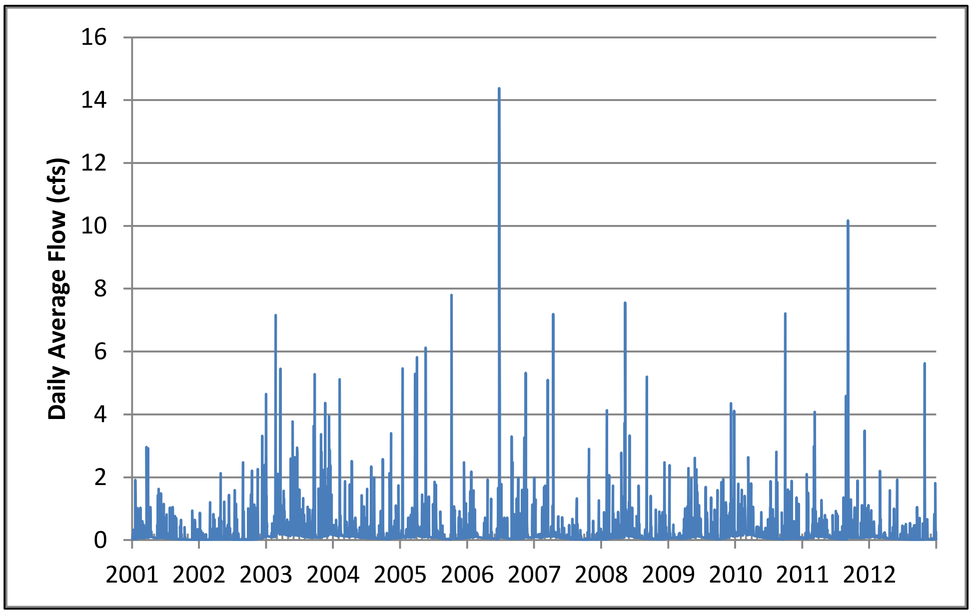

Figure 4.21: Simulated Average Daily Flow (cfs), Dumbarton Oaks

Table 4.19 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.20 presents the daily average baseline loads and TMDL allocations, and Table 4.21 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.22 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.23 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.24 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.19: Average Annual Dieldrin 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	7.91E-05	3.56E-06	95.5%
	Total	7.91E-05	3.56E-06	95.5%
Load Allocation	Direct Drainage	6.87E-04	2.34E-05	96.6%
	Upstream Maryland	-	-	-
	Total	6.87E-04	2.34E-05	96.6%
Margin of Safety		-	Implicit	-
Total		7.66E-04	2.69E-05	96.5%

Table 4.20: Dieldrin Average Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.17E-07	9.75E-09	95.5%
	Total	2.17E-07	9.75E-09	95.5%
Load Allocation	Direct Drainage	1.88E-06	6.41E-08	96.6%
	Upstream Maryland	-		
	Total	1.88E-06	6.41E-08	96.6%
Margin of Safety		-	Implicit	-
Total		2.10E-06	7.38E-08	96.5%

Table 4.21: Dieldrin Maximum Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.24E-05	5.57E-07	95.5%
	Total	1.24E-05	5.57E-07	95.5%
Load Allocation	Direct Drainage	8.08E-05	3.62E-06	95.5%
	Upstream Maryland	-	-	-
	Total	8.08E-05	3.62E-06	95.5%
Margin of Safety		-	Implicit	-
Total		9.31E-05	4.18E-06	95.5%

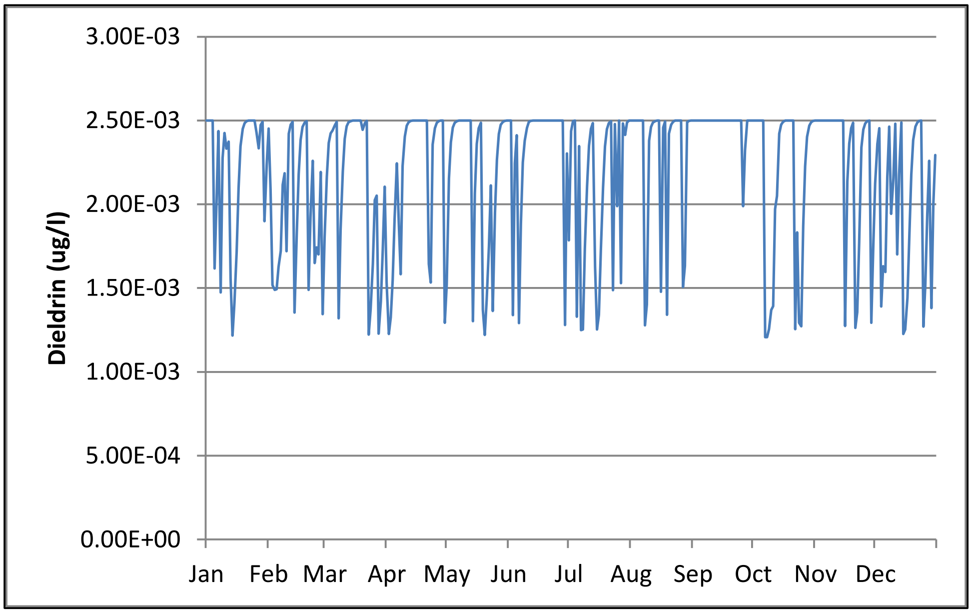

Figure 4.22: Simulated Daily Dieldrin Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions, 2005

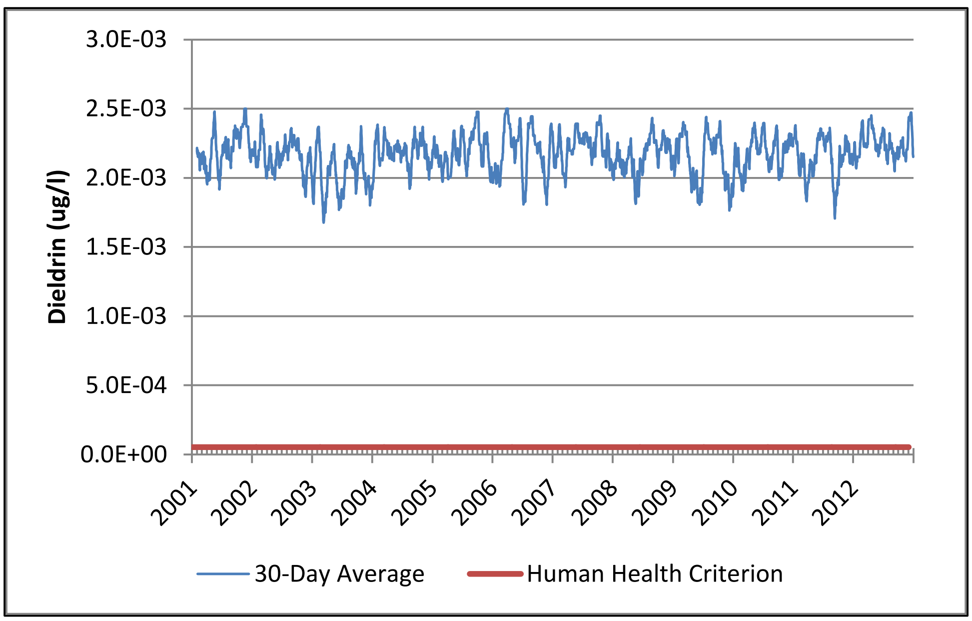

Figure 4.23: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions

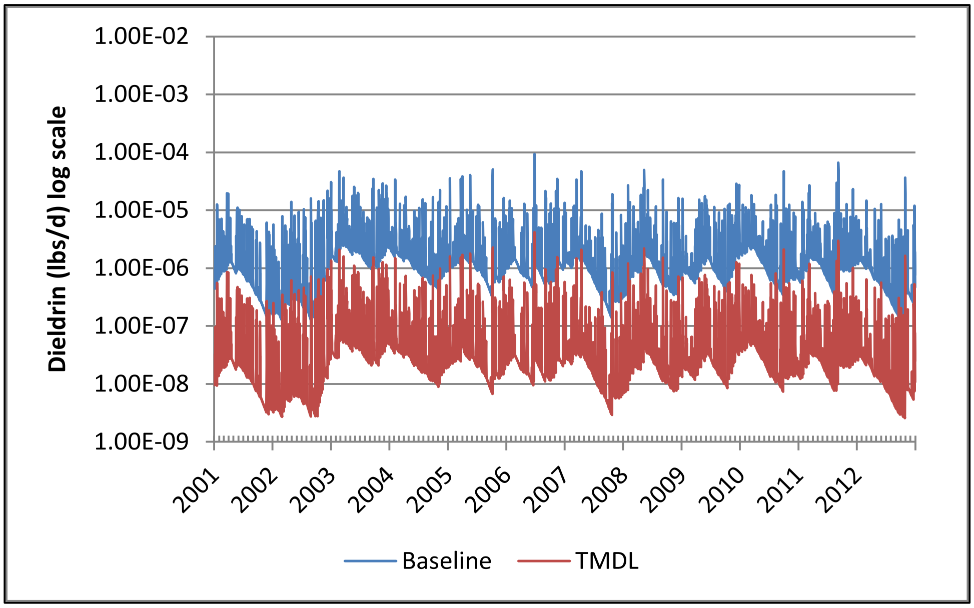

Figure 4.24: Simulated Daily Dieldrin Loads (lbs/d), Dumbarton Oaks, Baseline Conditions and TMDL Scenario

Table 4.22 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.23 presents the daily average baseline loads and TMDL allocations, and Table 4.24 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.25 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.26 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.27 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.22: Average Annual Heptachlor Epoxide 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	4.02E-05	2.57E-06	93.6%
	Total	4.02E-05	2.57E-06	93.6%
Load Allocation	Direct Drainage	4.43E-04	1.69E-05	96.2%
	Upstream Maryland	-	-	-
	Total	4.43E-04	1.69E-05	96.2%
Margin of Safety		-	Implicit	-
Total		4.84E-04	1.95E-05	96.0%

Table 4.23: Heptachlor Epoxide Average Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.10E-07	7.04E-09	93.6%
	Total	1.10E-07	7.04E-09	93.6%
Load Allocation	Direct Drainage	1.21E-06	4.63E-08	96.2%
	Upstream Maryland	-	-	-
	Total	1.21E-06	4.63E-08	96.2%
Margin of Safety		-	Implicit	-
Total		1.32E-06	5.33E-08	96.0%

Table 4.24: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.29E-06	4.02E-07	93.6%
	Total	6.29E-06	4.02E-07	93.6%
Load Allocation	Direct Drainage	4.12E-05	2.62E-06	93.7%
	Upstream Maryland	-	-	-
	Total	4.12E-05	2.62E-06	93.7%
Margin of Safety		-	Implicit	-
Total		4.75E-05	3.02E-06	93.6%

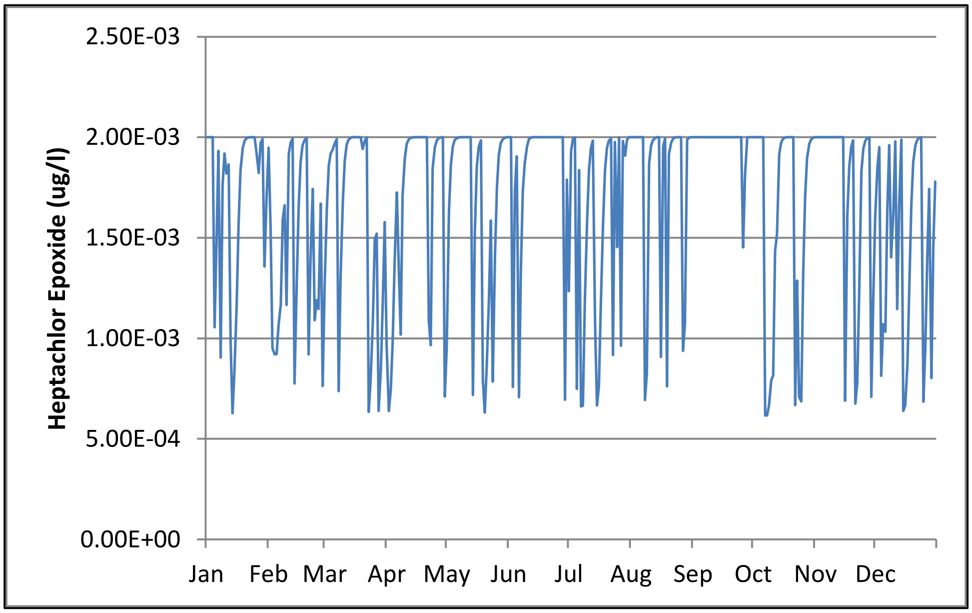

Figure 4.25: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions, 2005

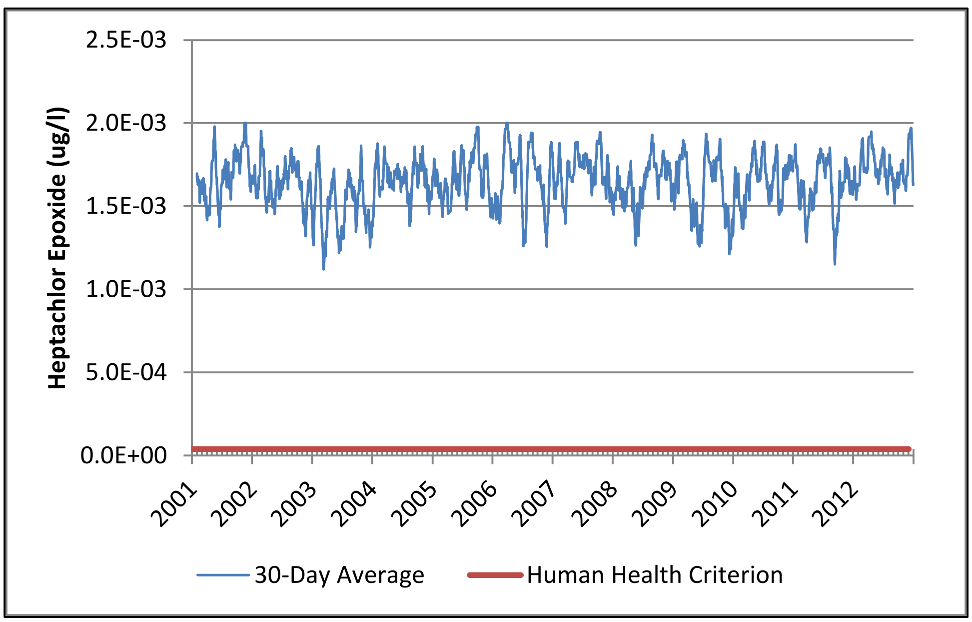

Figure 4.26: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions

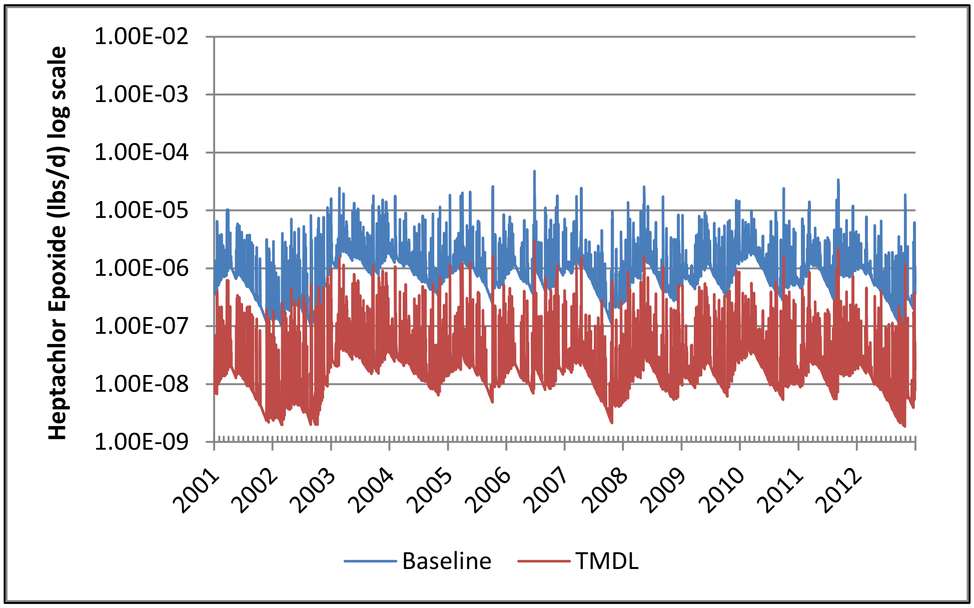

Figure 4.27: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Dumbarton Oaks, Baseline Conditions and TMDL Scenario

Table 4.25 presents the average annual baseline chlordane loads and TMDL allocations. Table 4.26 presents the daily average baseline loads and TMDL allocations, and Table 4.27 presents maximum daily baseline chlordane loads and TMDL allocations. Figure 4.28 shows simulated daily chlordane concentrations under baseline conditions in 2005. Unlike dieldrin, the concentration of chlordane in storm flow is greater than the concentration in base flow, so concentrations increase in storm events. Figure 4.29 contrasts the 30-day average chlordane concentration under baseline conditions and the current Class D human health criterion. Figure 4.30 presents simulated daily chlordane loads under baseline conditions and under the TMDL.

Table 4.25: Average Annual Chlordane 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	1.25E-02	5.34E-05	99.6%
	Total	1.25E-02	5.34E-05	99.6%
Load Allocation	Direct Drainage	5.03E-02	3.51E-04	99.3%
	Upstream Maryland	-	-	-
	Total	5.03E-02	3.51E-04	99.3%
Margin of Safety		-	Implicit	-
Total		6.28E-02	4.04E-04	99.4%

Table 4.26: Chlordane Average Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.43E-05	1.46E-07	99.6%
	Total	3.43E-05	1.46E-07	99.6%
Load Allocation	Direct Drainage	1.38E-04	9.61E-07	99.3%
	Upstream Maryland	-	-	-
	Total	1.38E-04	9.61E-07	99.3%
Margin of Safety		-	Implicit	-
Total		1.72E-04	1.11E-06	99.4%

Table 4.27: Chlordane Maximum Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.96E-03	8.36E-06	99.6%
	Total	1.96E-03	8.36E-06	99.6%
Load Allocation	Direct Drainage	1.01E-02	5.43E-05	99.5%
	Upstream Maryland	-	-	-
	Total	1.01E-02	5.43E-05	99.5%
Margin of Safety		-	Implicit	-
Total		1.20E-02	6.27E-05	99.5%

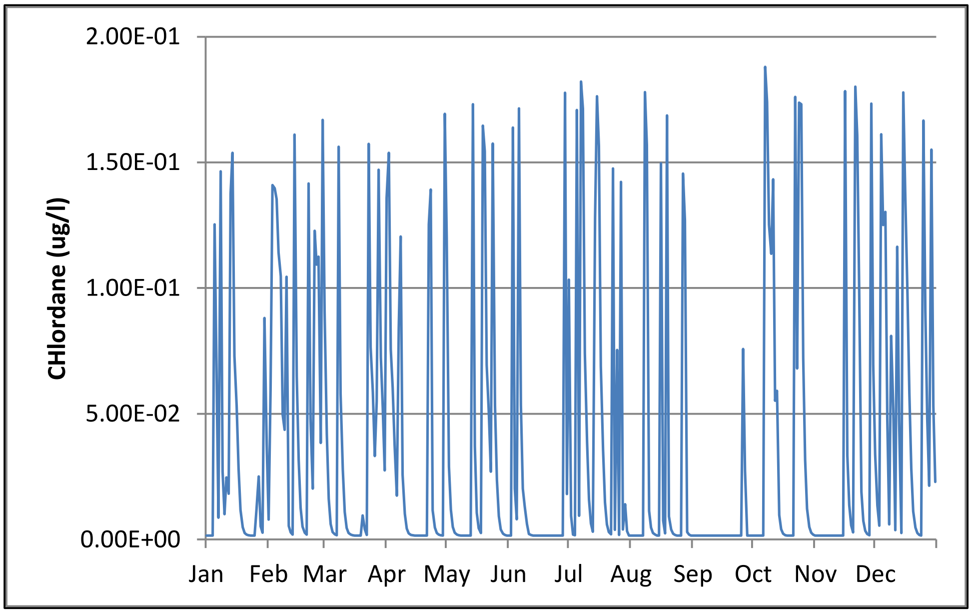

Figure 4.28: Simulated Daily Chlordane Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions, 2005

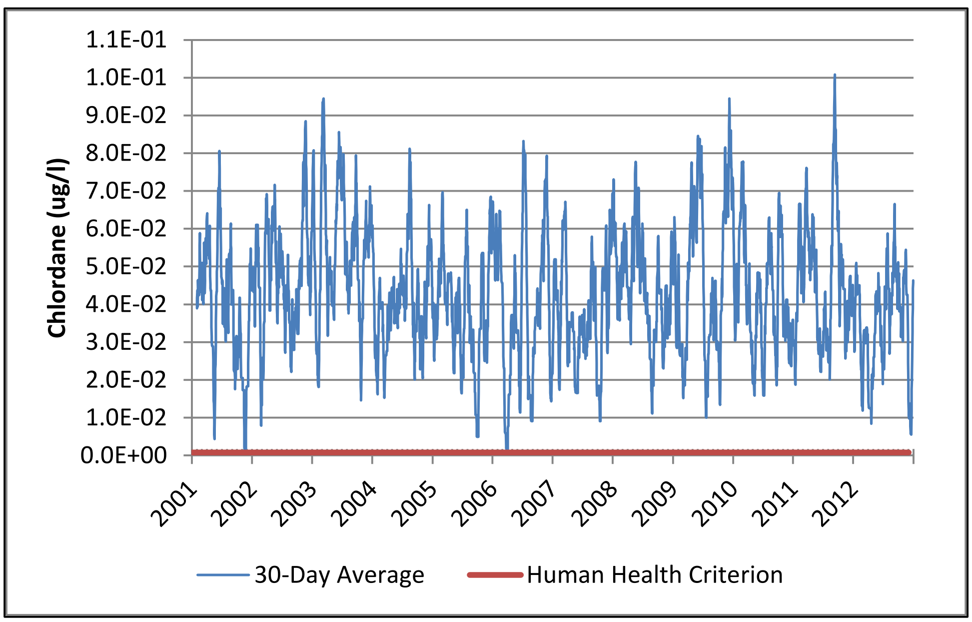

Figure 4.29: Simulated 30-Day Average Chlordane Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions

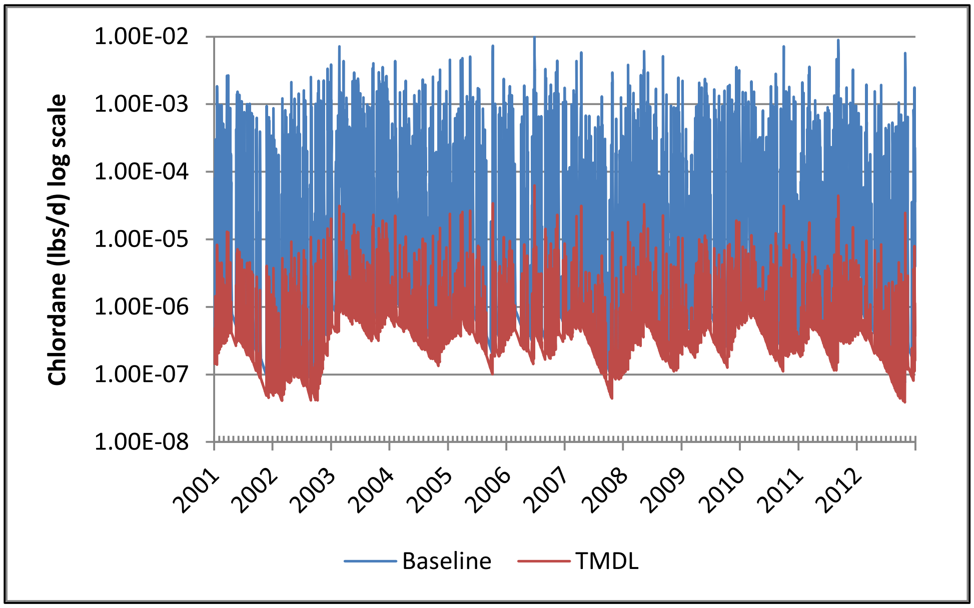

Figure 4.30: Simulated Daily Chlordane Loads (lbs/d), Dumbarton Oaks, Baseline Conditions and TMDL Scenario

4.4 Fenwick Branch

Fenwick Branch is a second-order eastern tributary of Rock Creek originating in Maryland just outside the Northeastern DC border. Figure 4.31 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 4.28 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.

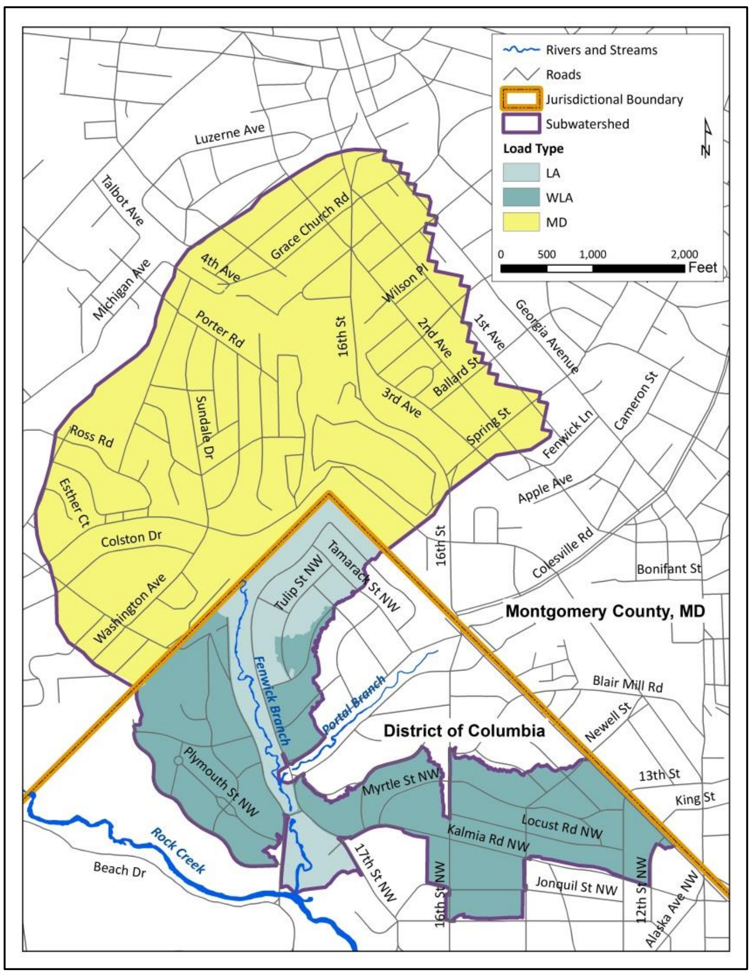

Figure 4.31: Fenwick Branch and its Watershed

Table 4.28: 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 4.32 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.

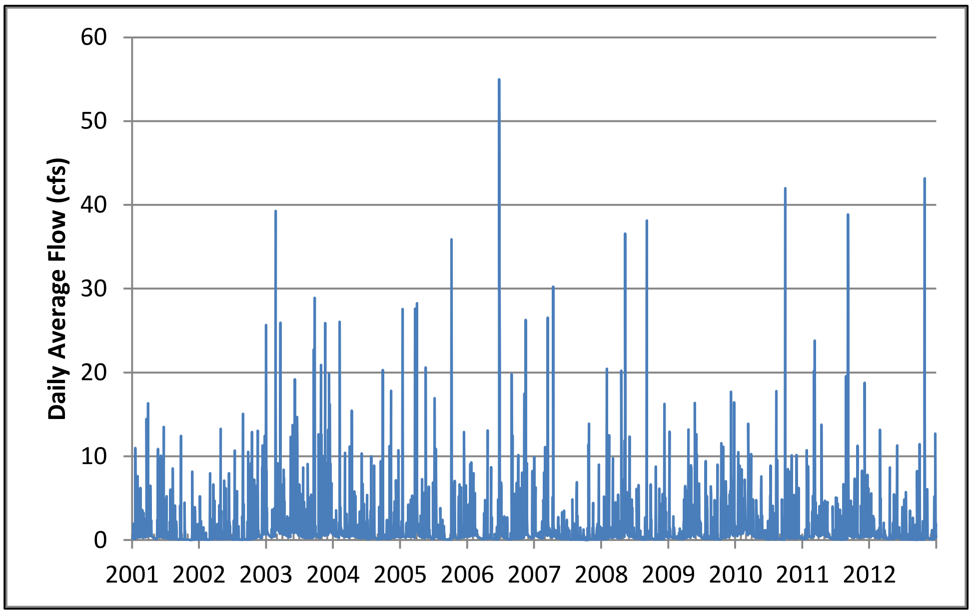

Figure 4.32: Simulated Average Daily Flow (cfs), Fenwick Branch

Table 4.29 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.30 presents the daily average baseline loads and TMDL allocations, and Table 4.31 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.33 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.34 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.35 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.29: Average Annual Dieldrin 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	7.00E-04	3.15E-05	95.5%
	Total	7.00E-04	3.15E-05	95.5%
Load Allocation	Direct Drainage	5.93E-04	1.68E-05	97.2%
	Upstream Maryland	2.64E-03	9.61E-05	96.4%
	Total	3.23E-03	1.13E-04	96.5%
Margin of Safety		-	Implicit	-
Total		3.93E-03	1.44E-04	96.3%

Table 4.30: Dieldrin Average Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.92E-06	8.62E-08	95.5%
	Total	1.92E-06	8.62E-08	95.5%
Load Allocation	Direct Drainage	1.63E-06	4.60E-08	97.2%
	Upstream Maryland	7.23E-06	2.63E-07	96.4%
	Total	8.86E-06	3.09E-07	96.5%
Margin of Safety		-	Implicit	-
Total		1.08E-05	3.95E-07	96.3%

Table 4.31: Dieldrin Maximum Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.33E-04	5.98E-06	95.5%
	Total	1.33E-04	5.98E-06	95.5%
Load Allocation	Direct Drainage	4.00E-05	1.78E-06	95.5%
	Upstream Maryland	2.03E-04	9.12E-06	95.5%
	Total	2.43E-04	1.09E-05	95.5%
Margin of Safety		-	Implicit	-
Total		3.76E-04	1.69E-05	95.5%

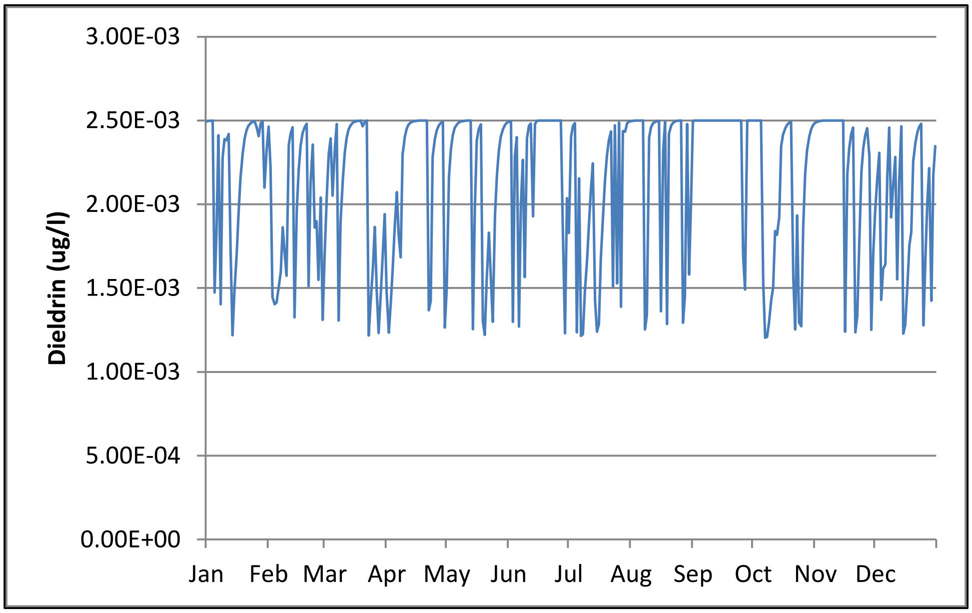

Figure 4.33: Simulated Daily Dieldrin Concentrations (µg/l), Fenwick Branch, Baseline Conditions, 2005

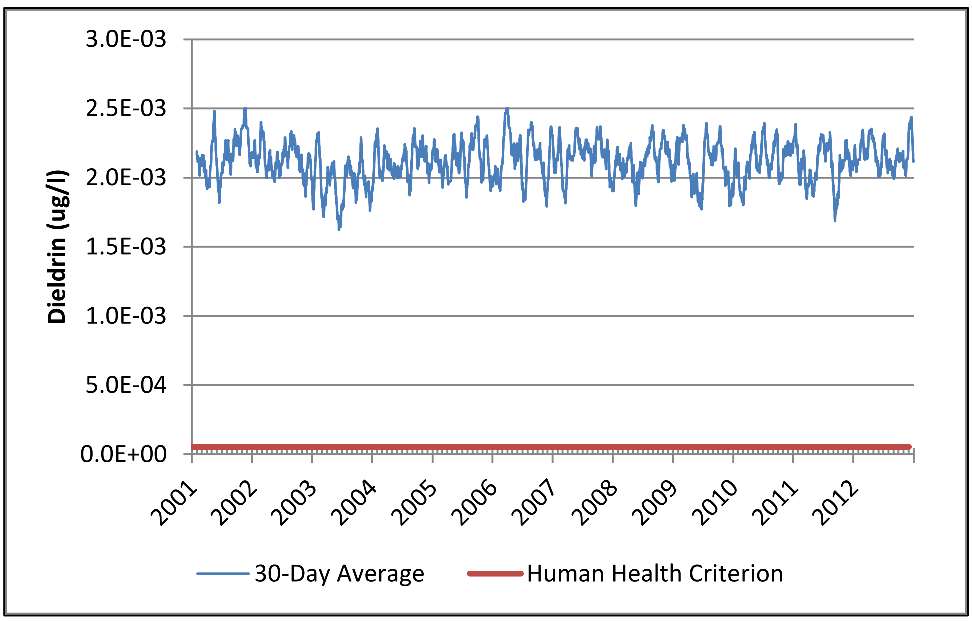

Figure 4.34: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Fenwick Branch, Baseline Conditions

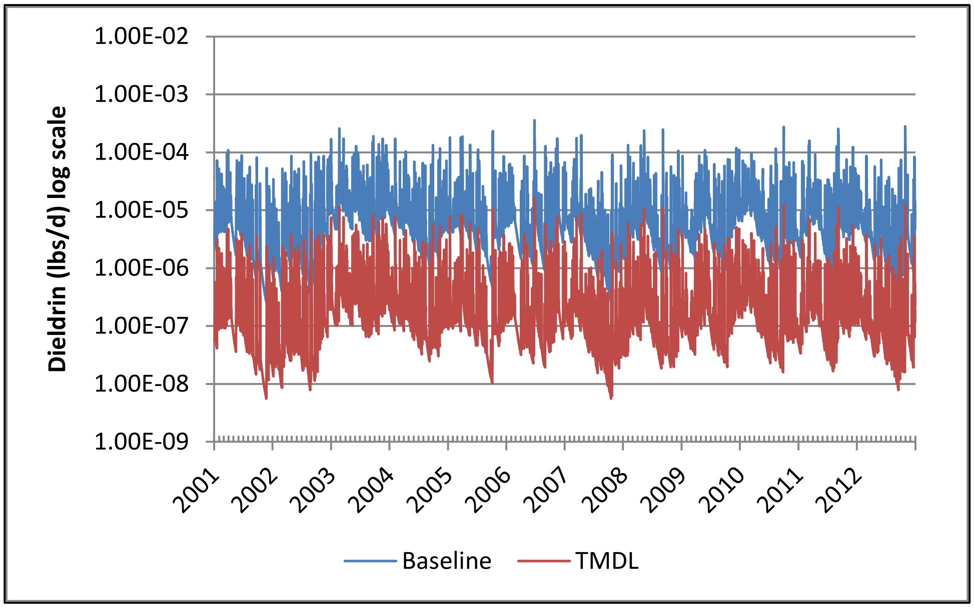

Figure 4.35: Simulated Daily Dieldrin Loads (lbs/d), Fenwick Branch, Baseline Conditions and TMDL Scenario

Table 4.32 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.33 presents the daily average baseline loads and TMDL allocations, and Table 4.34 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.36 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.37 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.38 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.32: Average Annual Heptachlor Epoxide 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	3.56E-04	2.27E-05	93.6%
	Total	3.56E-04	2.27E-05	93.6%
Load Allocation	Direct Drainage	4.25E-04	1.21E-05	97.2%
	Upstream Maryland	1.62E-03	6.94E-05	95.7%
	Total	2.05E-03	8.15E-05	96.0%
Margin of Safety		-	Implicit	-
Total		2.41E-03	1.04E-04	95.7%

Table 4.33: Heptachlor Epoxide Average Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	9.74E-07	6.23E-08	93.6%
	Total	9.74E-07	6.23E-08	93.6%
Load Allocation	Direct Drainage	1.17E-06	3.32E-08	97.2%
	Upstream Maryland	4.45E-06	1.90E-07	95.7%
	Total	5.62E-06	2.23E-07	96.0%
Margin of Safety		-	Implicit	-
Total		6.59E-06	2.86E-07	95.7%

Table 4.34: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.76E-05	4.32E-06	93.6%
	Total	6.76E-05	4.32E-06	93.6%
Load Allocation	Direct Drainage	2.05E-05	1.29E-06	93.7%
	Upstream Maryland	1.04E-04	6.58E-06	93.7%
	Total	1.24E-04	7.87E-06	93.7%
Margin of Safety		-	Implicit	-
Total		1.92E-04	1.22E-05	93.6%

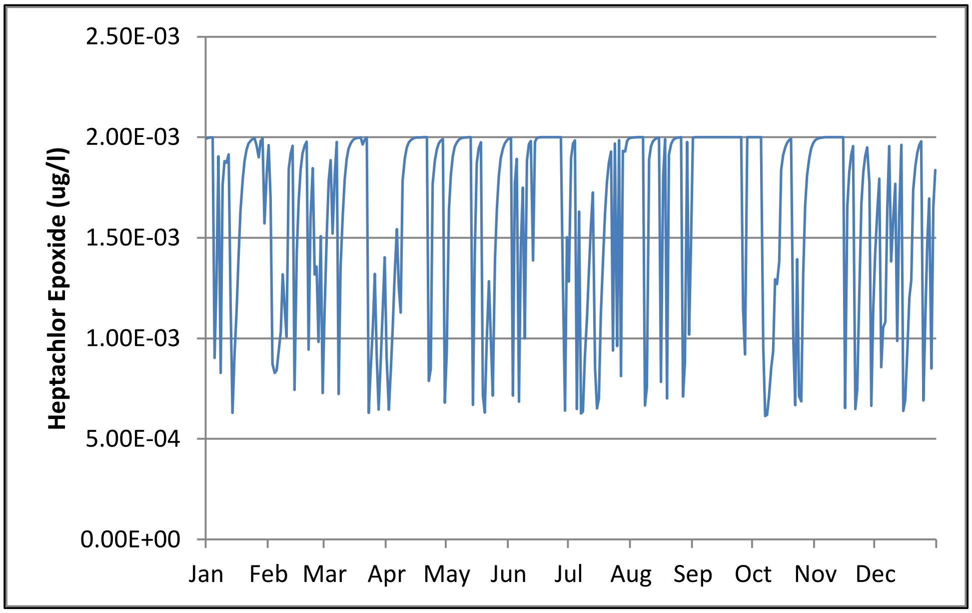

Figure 4.36: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Fenwick Branch, Baseline Conditions, 2005

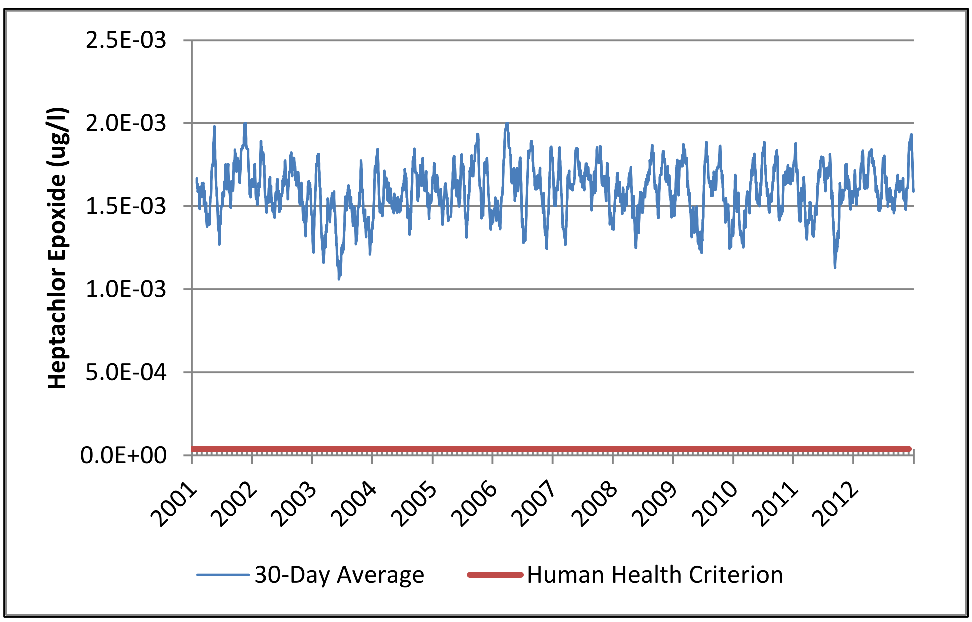

Figure 4.37: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Fenwick Branch, Baseline Conditions

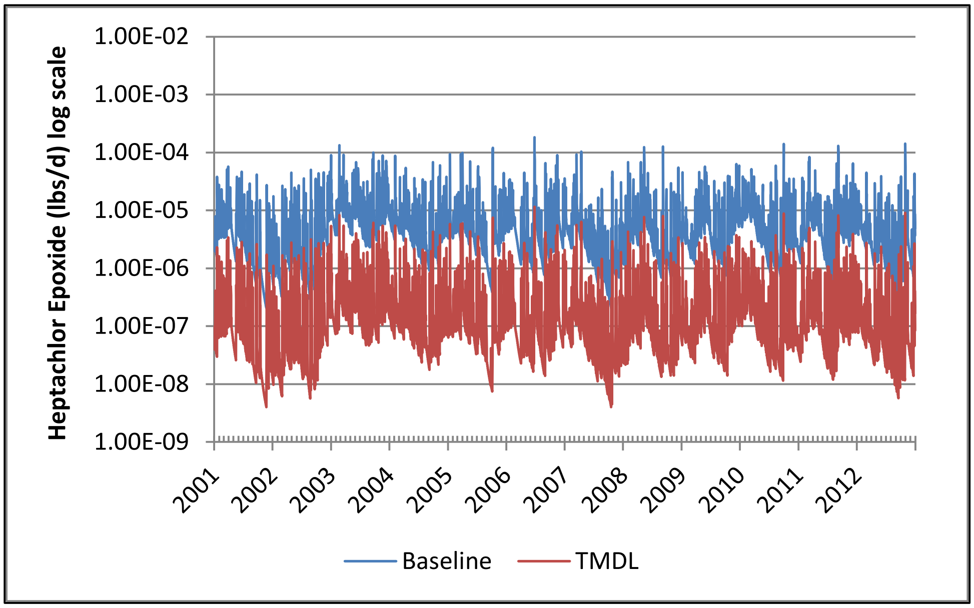

Figure 4.38: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Fenwick Branch, Baseline Conditions and TMDL Scenario

Table 4.35 presents the average annual baseline DDT loads and TMDL allocations. Table 4.36 presents the daily average baseline loads and TMDL allocations, and Table 4.37 presents maximum daily baseline DDT loads and TMDL allocations. Figure 4.39 shows simulated daily DDT concentrations under baseline conditions in 2005. Unlike dieldrin, the concentration of DDT in storm flow is greater than the concentration in base flow, so concentrations increase in storm events. Figure 4.40 contrasts the 30-day average DDT concentration under baseline conditions and the current Class D human health criterion. Figure 4.41 presents simulated daily DDT loads under baseline conditions and under the TMDL.

Table 4.35: Average Annual DDT 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	5.71E-03	1.28E-04	97.8%
	Total	5.71E-03	1.28E-04	97.8%
Load Allocation	Direct Drainage	1.20E-03	6.83E-05	94.3%
	Upstream Maryland	1.38E-02	3.91E-04	97.2%
	Total	1.50E-02	4.60E-04	96.9%
Margin of Safety		-	Implicit	-
Total		2.07E-02	5.88E-04	97.2%

Table 4.36: DDT Average Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.57E-05	3.51E-07	97.8%
	Total	1.57E-05	3.51E-07	97.8%
Load Allocation	Direct Drainage	3.29E-06	1.87E-07	94.3%
	Upstream Maryland	3.77E-05	1.07E-06	97.2%
	Total	4.10E-05	1.26E-06	96.9%
Margin of Safety		-	Implicit	-
Total		5.67E-05	1.61E-06	97.2%

Table 4.37: DDT Maximum Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.09E-03	2.44E-05	97.8%
	Total	1.09E-03	2.44E-05	97.8%
Load Allocation	Direct Drainage	2.37E-04	7.26E-06	96.9%
	Upstream Maryland	1.65E-03	3.71E-05	97.7%
	Total	1.89E-03	4.44E-05	97.6%
Margin of Safety		-	Implicit	-
Total		2.97E-03	6.88E-05	97.7%

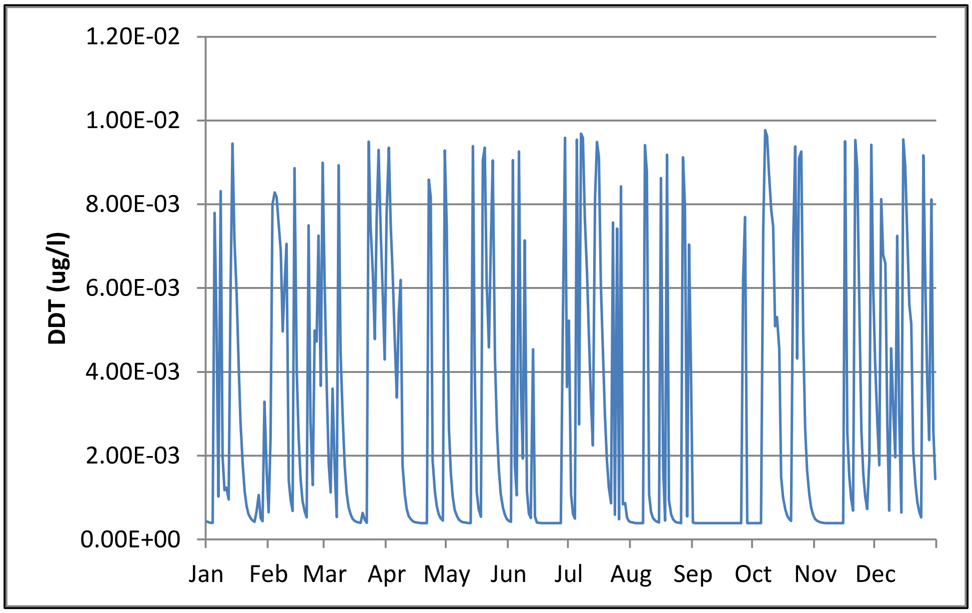

Figure 4.39: Simulated Daily DDT Concentrations (µg/l), Fenwick Branch, Baseline Conditions, 2005

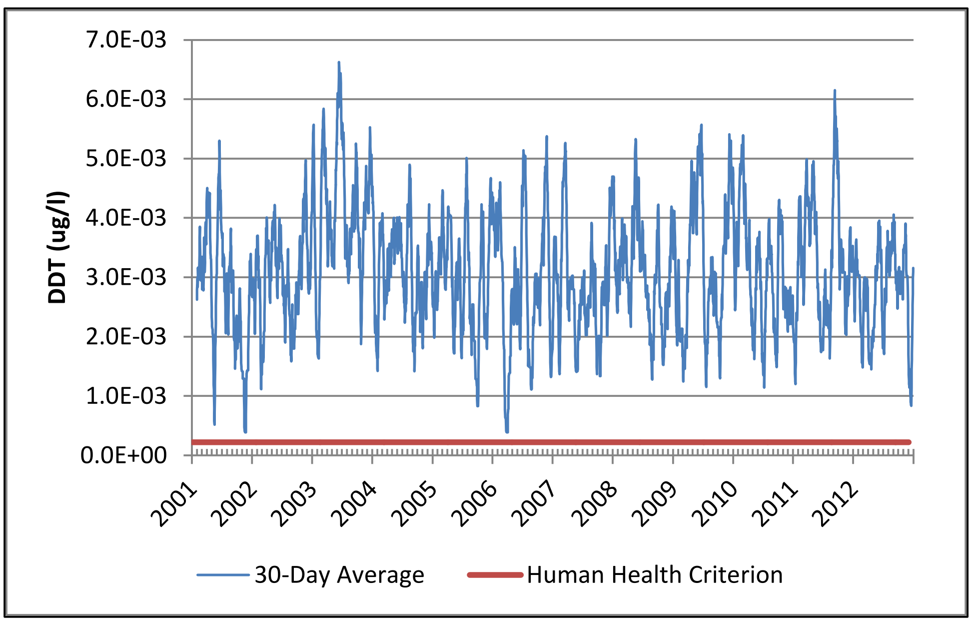

Figure 4.40: Simulated 30-Day Average DDT Concentrations (µg/l), Fenwick Branch, Baseline Conditions

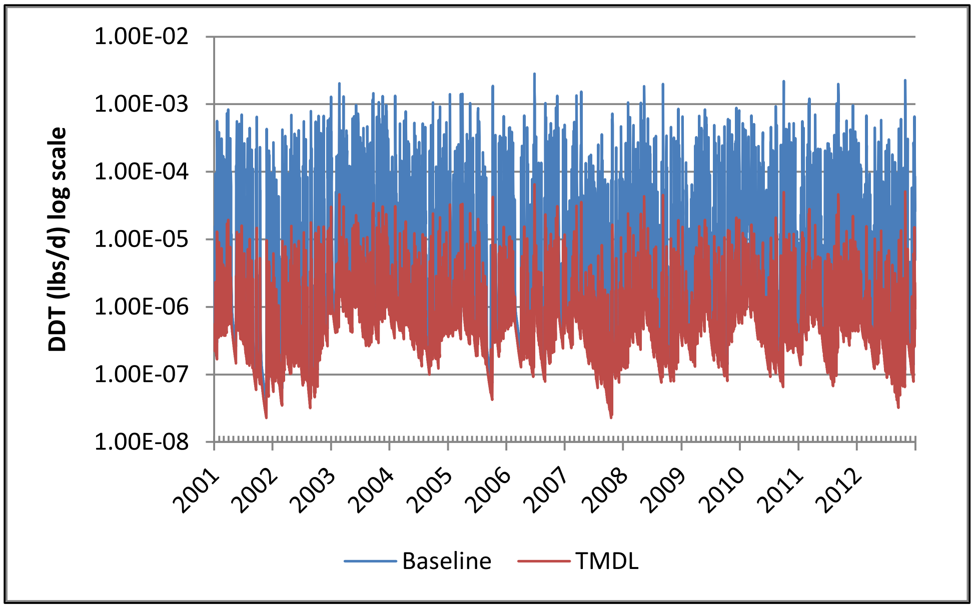

Figure 4.41: Simulated Daily DDT Loads (lbs/d), Fenwick Branch, Baseline Conditions and TMDL Scenario

4.5 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 4.42 shows the location of Klingle Valley Creek and its watershed[10]. 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 4.38 gives the land use acreage in the Klingle Valley Creek watershed. The watershed is 36% impervious and 73% lies within the DC MS4.

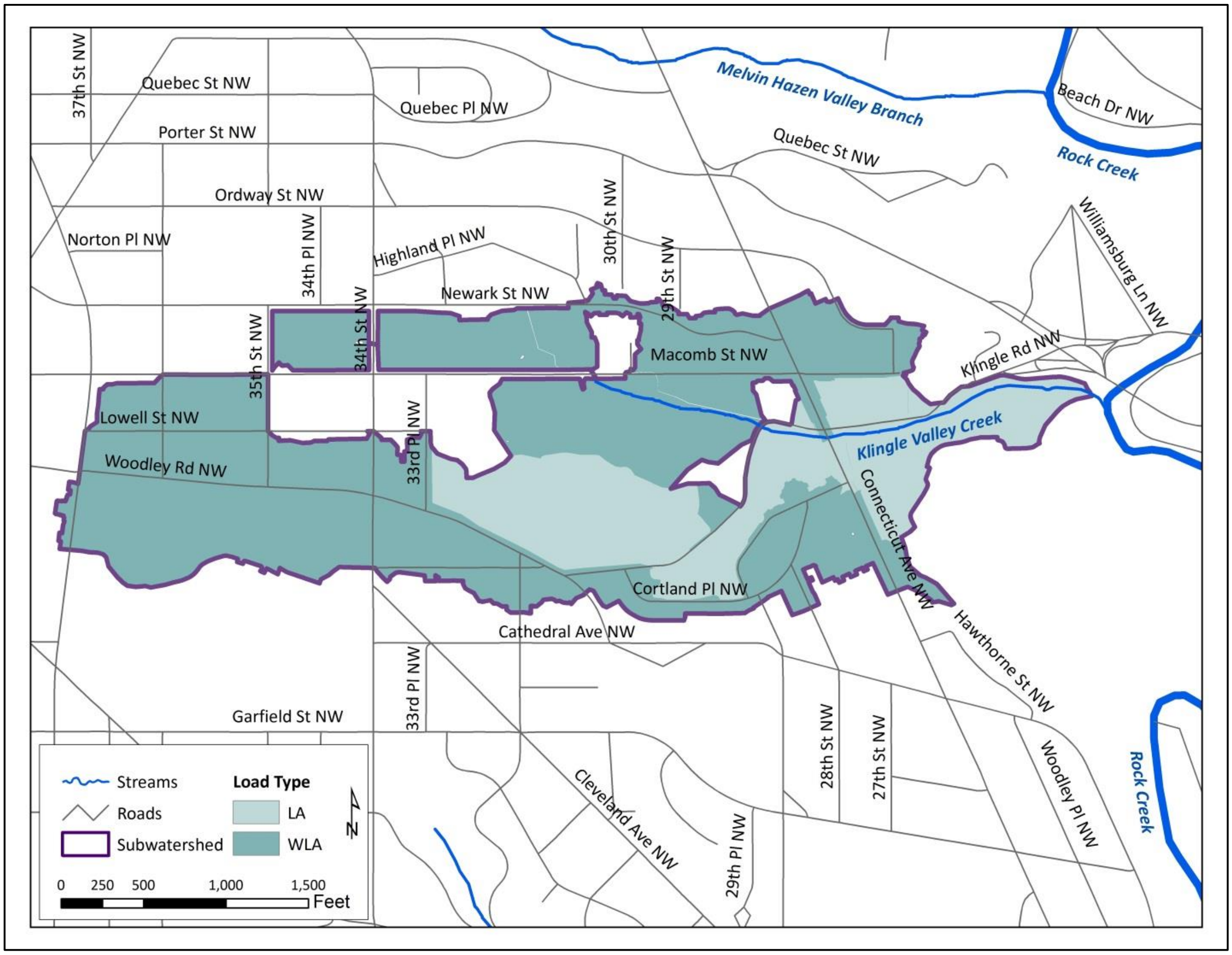

Figure 4.42: Klingle Valley Creek and its Watershed

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

Table 4.38: 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 4.43 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.

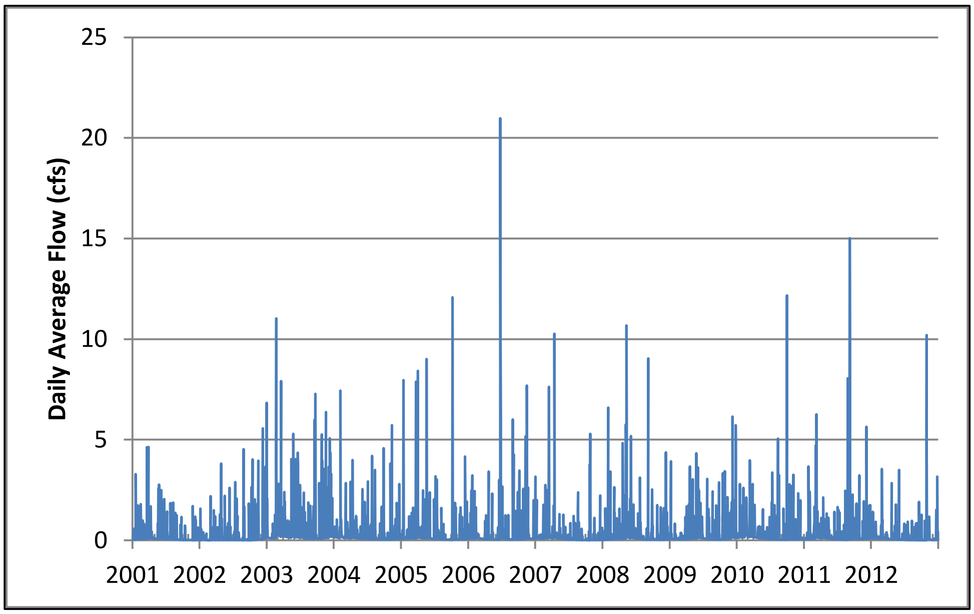

Figure 4.43: Simulated Average Daily Flow (cfs), Klingle Valley Creek

Table 4.39 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.40 presents the daily average baseline loads and TMDL allocations, and Table 4.41 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.44 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.45 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.46 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.39: Average Annual Dieldrin 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	5.86E-04	2.64E-05	95.5%
	Total	5.86E-04	2.64E-05	95.5%
Load Allocation	Direct Drainage	4.62E-04	1.30E-05	97.2%
	Upstream Maryland	-	-	-
	Total	4.62E-04	1.30E-05	97.2%
Margin of Safety		-	Implicit	-
Total		1.05E-03	3.94E-05	96.2%

Table 4.40: Dieldrin Average Daily Loads (lbs/d), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.60E-06	7.22E-08	95.5%
	Total	1.60E-06	7.22E-08	95.5%
Load Allocation	Direct Drainage	1.27E-06	3.56E-08	97.2%
	Upstream Maryland	-	-	-
	Total	1.27E-06	3.56E-08	97.2%
Margin of Safety		-	Implicit	-
Total		2.87E-06	1.08E-07	96.2%

Table 4.41: Dieldrin Maximum Daily Loads (lbs/d), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.04E-04	4.69E-06	95.5%
	Total	1.04E-04	4.69E-06	95.5%
Load Allocation	Direct Drainage	3.16E-05	1.41E-06	95.5%
	Upstream Maryland	-	-	-
	Total	3.16E-05	1.41E-06	95.5%
Margin of Safety		-	Implicit	-
Total		1.36E-04	6.10E-06	95.5%

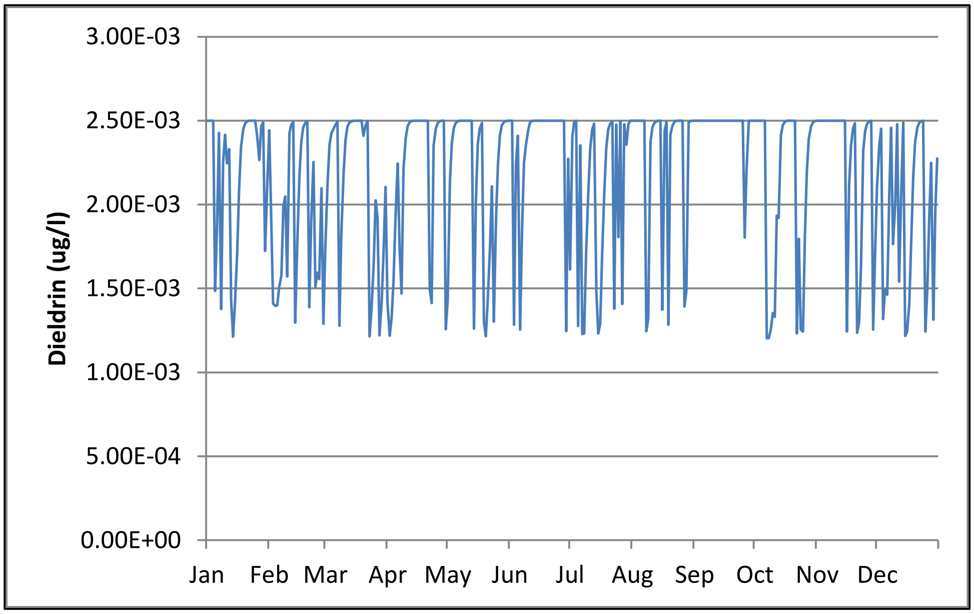

Figure 4.44: Simulated Daily Dieldrin Concentrations (µg/l), Klingle Valley Creek, Baseline Conditions, 2005

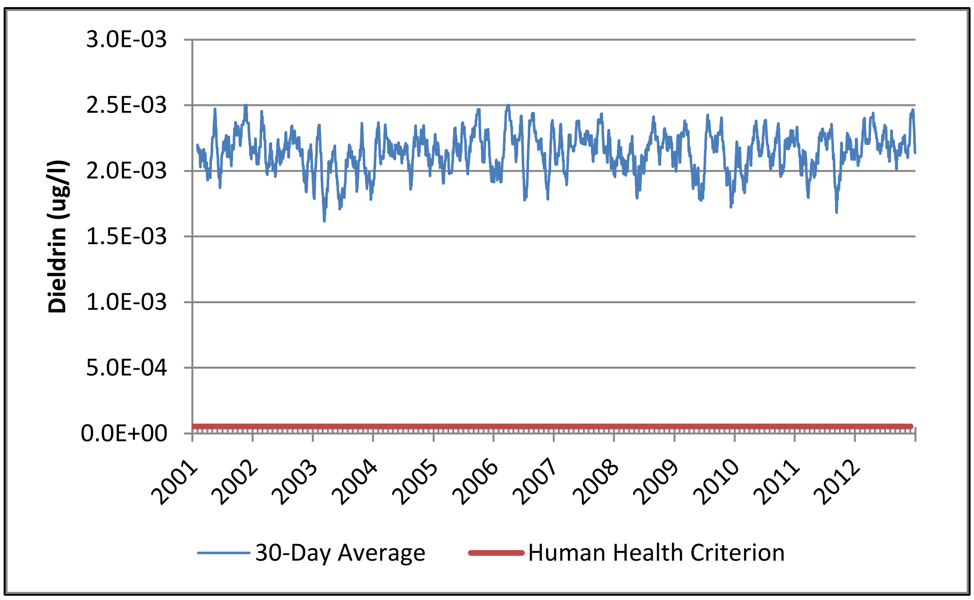

Figure 4.45: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Klingle Valley Creek, Baseline Conditions

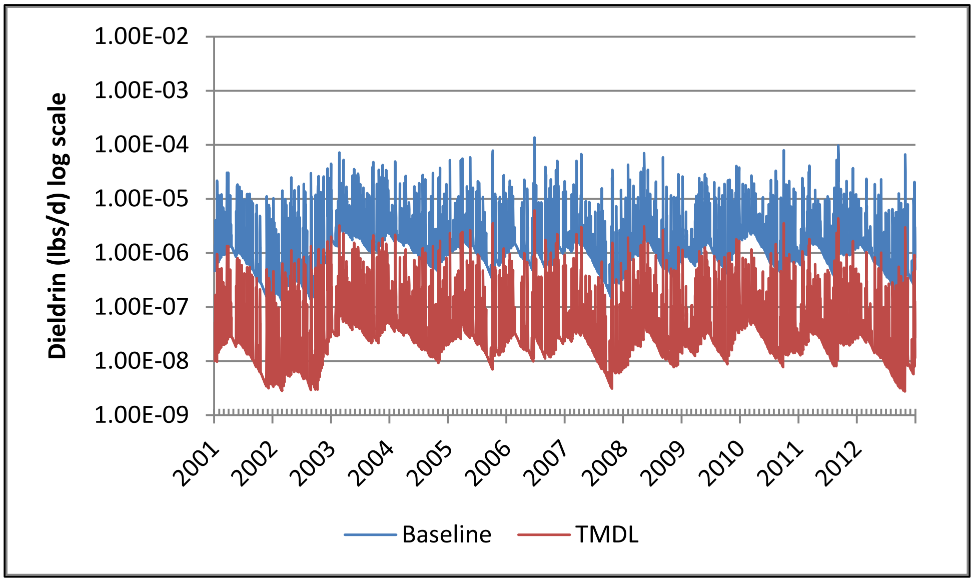

Figure 4.46: Simulated Daily Dieldrin Loads (lbs/d), Klingle Valley Creek, Baseline Conditions and TMDL Scenario

Table 4.42 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.43 presents the daily average baseline loads and TMDL allocations, and Table 4.44 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.47 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.48 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.49 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.42: Average Annual Heptachlor Epoxide 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	2.98E-04	1.90E-05	93.6%
	Total	2.98E-04	1.90E-05	93.6%
Load Allocation	Direct Drainage	3.32E-04	9.39E-06	97.2%
	Upstream Maryland	-	-	-
	Total	3.32E-04	9.39E-06	97.2%
Margin of Safety		-	Implicit	-
Total		6.30E-04	2.84E-05	95.5%

Table 4.43: Heptachlor Epoxide Average Daily Loads (lbs/d), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.16E-07	5.22E-08	93.6%
	Total	8.16E-07	5.22E-08	93.6%
Load Allocation	Direct Drainage	9.10E-07	2.57E-08	97.2%
	Upstream Maryland	-	-	-
	Total	9.10E-07	2.57E-08	97.2%
Margin of Safety		-	Implicit	-
Total		1.73E-06	7.79E-08	95.5%

Table 4.44: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.30E-05	3.39E-06	93.6%
	Total	5.30E-05	3.39E-06	93.6%
Load Allocation	Direct Drainage	1.62E-05	1.02E-06	93.7%
	Upstream Maryland	-	-	-
	Total	1.62E-05	1.02E-06	93.7%
Margin of Safety		-	Implicit	-
Total		6.92E-05	4.40E-06	93.6%

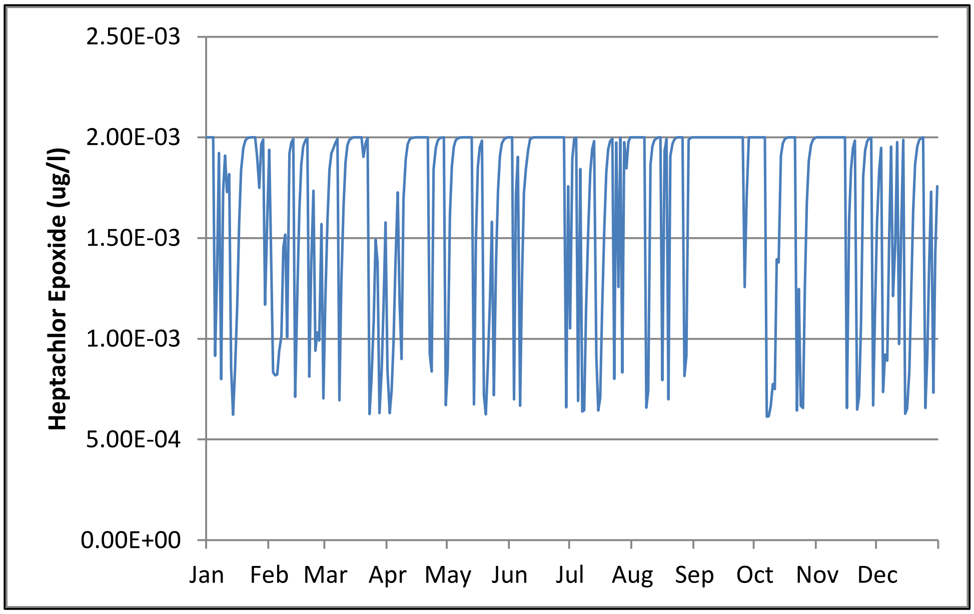

Figure 4.47: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Klingle Valley Creek, Baseline Conditions, 2005

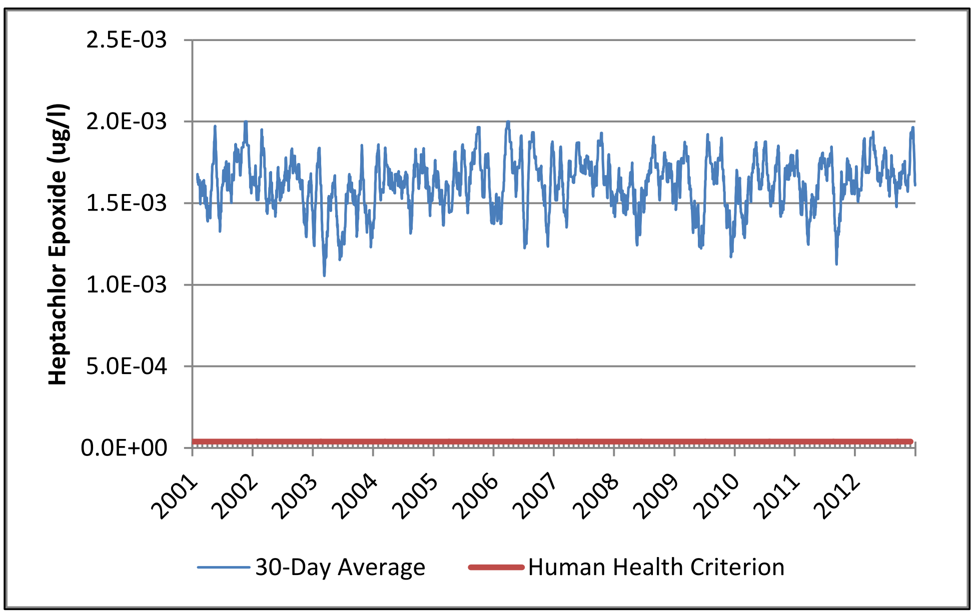

Figure 4.48: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Klingle Valley Creek, Baseline Conditions

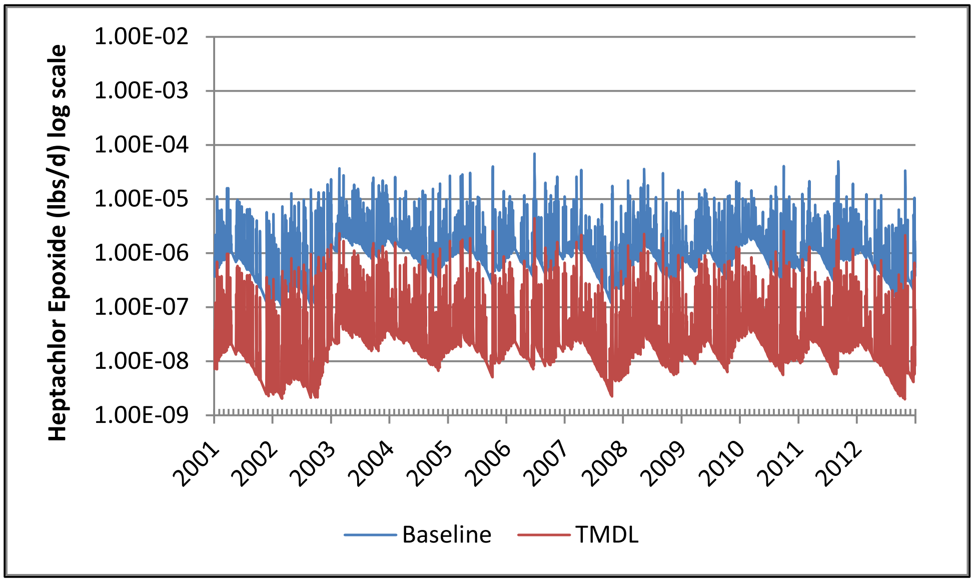

Figure 4.49: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Klingle Valley Creek, Baseline Conditions and TMDL Scenario

4.6 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 4.50 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 4.45 gives the land use acreage in the Luzon Branch watershed. The watershed is 47% impervious and 92% lies within the DC MS4.

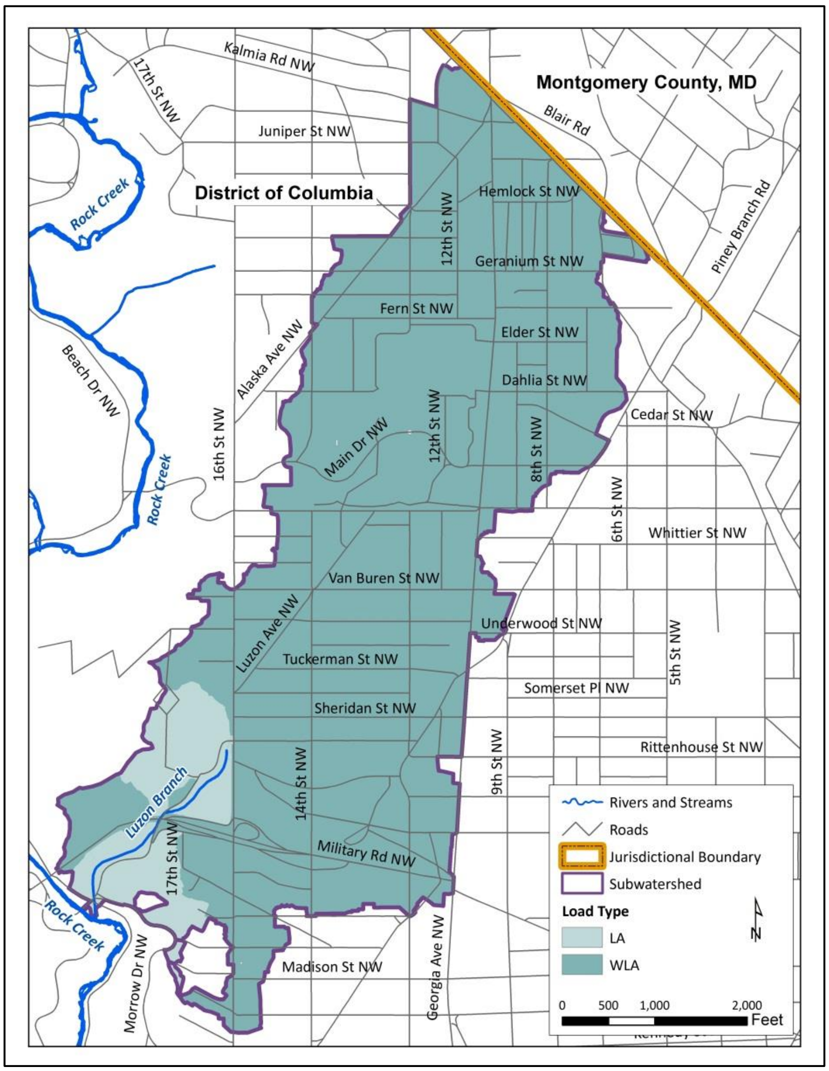

Figure 4.50: Luzon Branch and its Watershed

Table 4.45: 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 4.51 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.

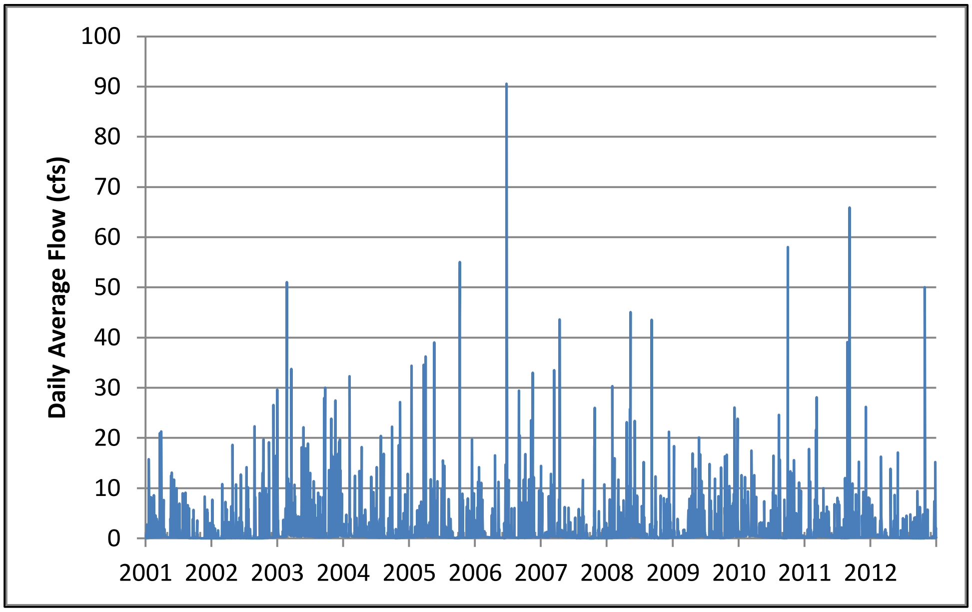

Figure 4.51: Simulated Average Daily Flow (cfs), Luzon Branch

Table 4.46 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.47 presents the daily average baseline loads and TMDL allocations, and Table 4.48 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.52 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.53 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.54 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.46: Average Annual Dieldrin 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	3.16E-03	1.42E-04	95.5%
	Total	3.16E-03	1.42E-04	95.5%
Load Allocation	Direct Drainage	1.06E-03	2.57E-05	97.6%
	Upstream Maryland	-	-	
	Total	1.06E-03	2.57E-05	97.6%
Margin of Safety		-	Implicit	-
Total		4.22E-03	1.68E-04	96.0%

Table 4.47: Dieldrin Average Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.66E-06	3.90E-07	95.5%
	Total	8.66E-06	3.90E-07	95.5%
Load Allocation	Direct Drainage	2.90E-06	7.05E-08	97.6%
	Upstream Maryland	-	-	-
	Total	2.90E-06	7.05E-08	97.6%
Margin of Safety		-	Implicit	-
Total		1.16E-05	4.60E-07	96.0%

Table 4.48: Dieldrin Maximum Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.51E-04	2.48E-05	95.5%
	Total	5.51E-04	2.48E-05	95.5%
Load Allocation	Direct Drainage	3.49E-05	1.53E-06	95.6%
	Upstream Maryland	-	-	-
	Total	3.49E-05	1.53E-06	95.6%
Margin of Safety		-	Implicit	-
Total		5.86E-04	2.63E-05	95.5%

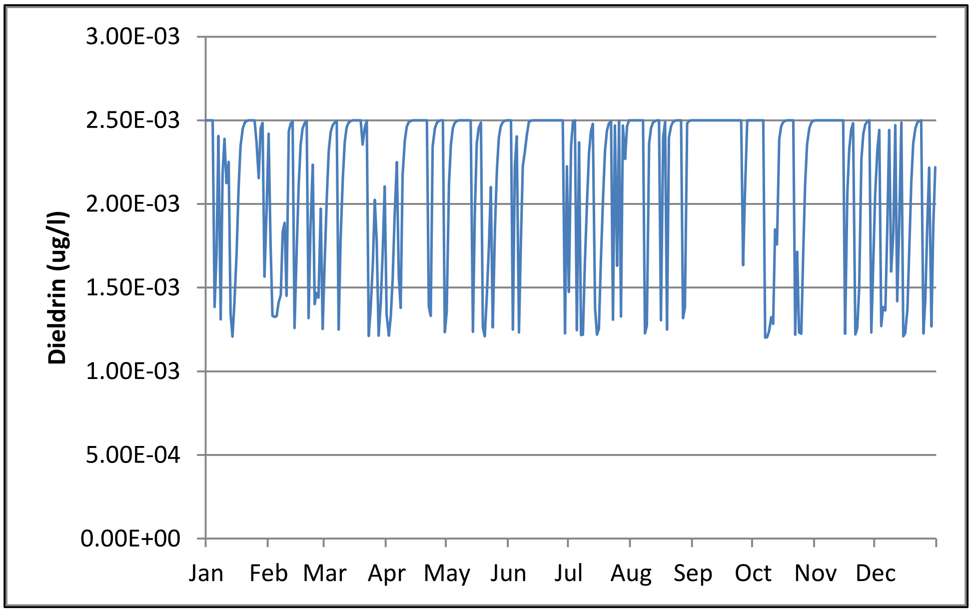

Figure 4.52: Simulated Daily Dieldrin Concentrations (µg/l), Luzon Branch, Baseline Conditions, 2005

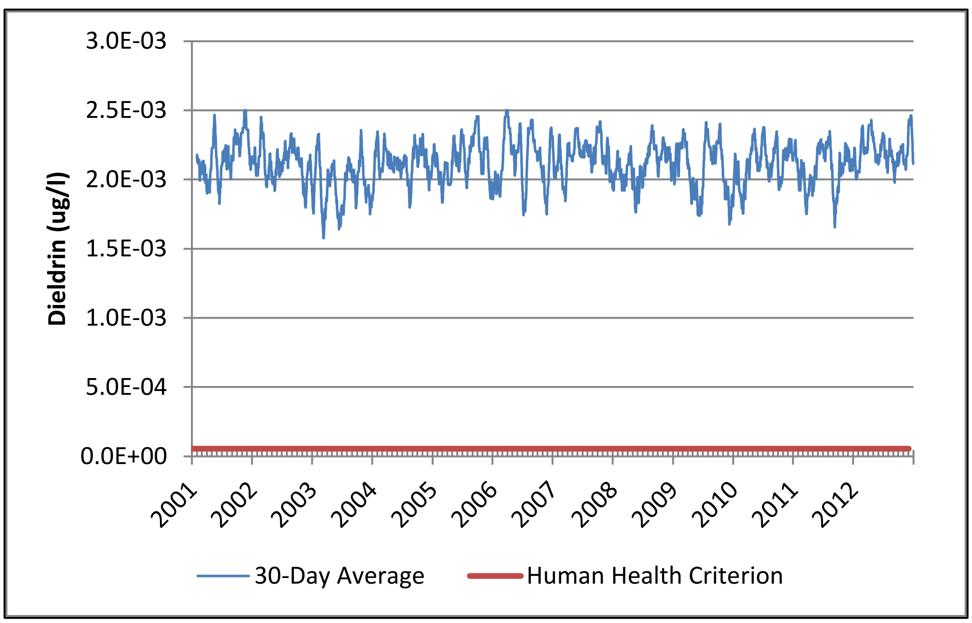

Figure 4.53: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Luzon Branch, Baseline Conditions

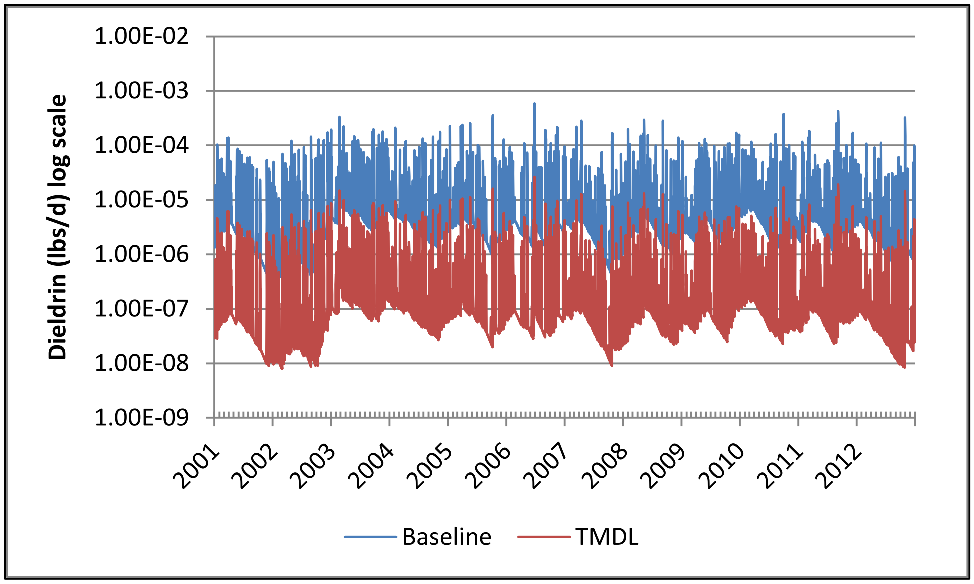

Figure 4.54: Simulated Daily Dieldrin Loads (lbs/d), Luzon Branch, Baseline Conditions and TMDL Scenario

Table 4.49 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.50 presents the daily average baseline loads and TMDL allocations, and Table 4.51 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.55 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.56 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.57 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.49: Average Annual Heptachlor Epoxide 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	1.61E-03	1.03E-04	93.6%
	Total	1.61E-03	1.03E-04	93.6%
Load Allocation	Direct Drainage	8.10E-04	1.86E-05	97.7%
	Upstream Maryland	-	-	-
	Total	8.10E-04	1.86E-05	97.7%
Margin of Safety		-	Implicit	-
Total		2.42E-03	1.21E-04	95.0%

Table 4.50: Heptachlor Epoxide Average Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.40E-06	2.81E-07	93.6%
	Total	4.40E-06	2.81E-07	93.6%
Load Allocation	Direct Drainage	2.22E-06	5.09E-08	97.7%
	Upstream Maryland	-	-	-
	Total	2.22E-06	5.09E-08	97.7%
Margin of Safety		-	Implicit	-
Total		6.62E-06	3.32E-07	95.0%

Table 4.51: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.80E-04	1.79E-05	93.6%
	Total	2.80E-04	1.79E-05	93.6%
Load Allocation	Direct Drainage	1.82E-05	1.11E-06	93.9%
	Upstream Maryland	-	-	-
	Total	1.82E-05	1.11E-06	93.9%
Margin of Safety		-	Implicit	-
Total		2.98E-04	1.90E-05	93.6%

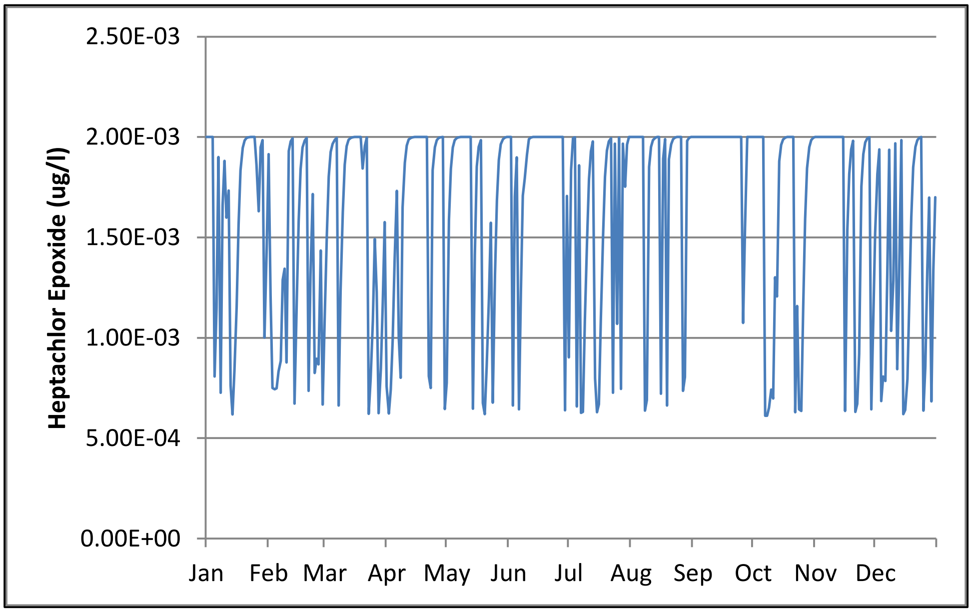

Figure 4.55: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Luzon Branch, Baseline Conditions, 2005

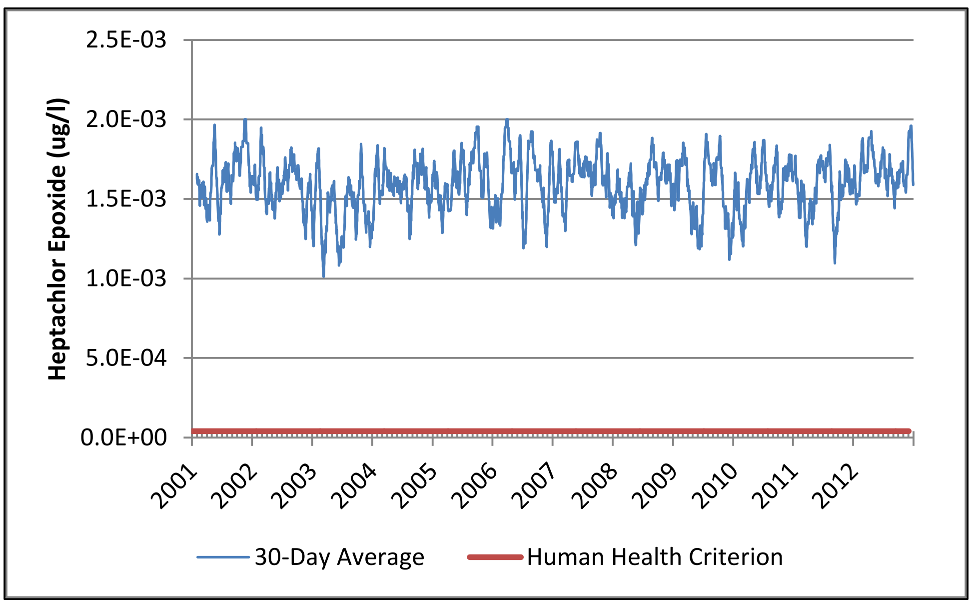

Figure 4.56: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Luzon Branch, Baseline Conditions

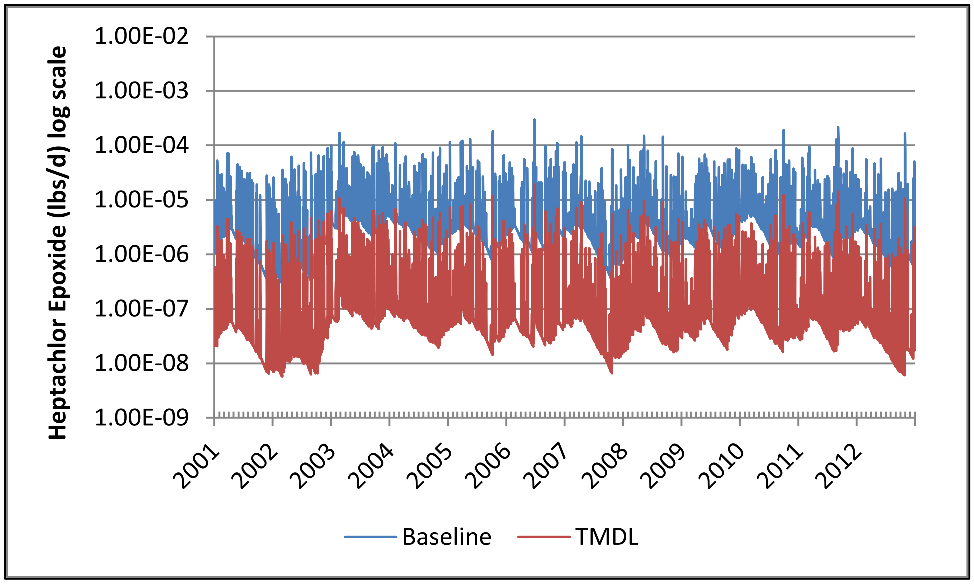

Figure 4.57: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Luzon Branch, Baseline Conditions and TMDL Scenario

Table 4.52 presents the average annual baseline chlordane loads and TMDL allocations. Table 4.53 presents the daily average baseline loads and TMDL allocations, and Table 4.54 presents maximum daily baseline chlordane loads and TMDL allocations. Figure 4.58 shows simulated daily chlordane concentrations under baseline conditions in 2005. Unlike dieldrin, the concentration of chlordane in storm flow is greater than the concentration in base flow, so concentrations increase in storm events. Figure 4.59 contrasts the 30-day average chlordane concentration under baseline conditions and the current Class D human health criterion. Figure 4.60 presents simulated daily chlordane loads under baseline conditions and under the TMDL.

Table 4.52: Average Annual Chlordane 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	5.00E-01	2.13E-03	99.6%
	Total	5.00E-01	2.13E-03	99.6%
Load Allocation	Direct Drainage	1.40E-02	3.86E-04	97.2%
	Upstream Maryland	-	-	-
	Total	1.40E-02	3.86E-04	97.2%
Margin of Safety		-	Implicit	-
Total		5.14E-01	2.52E-03	99.5%

Table 4.53: Chlordane Average Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.37E-03	5.84E-06	99.6%
	Total	1.37E-03	5.84E-06	99.6%
Load Allocation	Direct Drainage	3.84E-05	1.06E-06	97.2%
	Upstream Maryland	-	-	-
	Total	3.84E-05	1.06E-06	97.2%
Margin of Safety		-	Implicit	-
Total		1.41E-03	6.90E-06	99.5%

Table 4.54: Chlordane Maximum Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.72E-02	3.72E-04	99.6%
	Total	8.72E-02	3.72E-04	99.6%
Load Allocation	Direct Drainage	3.19E-03	2.30E-05	99.3%
	Upstream Maryland	-	-	-
	Total	3.19E-03	2.30E-05	99.3%
Margin of Safety		-	Implicit	-
Total		9.04E-02	3.95E-04	99.6%

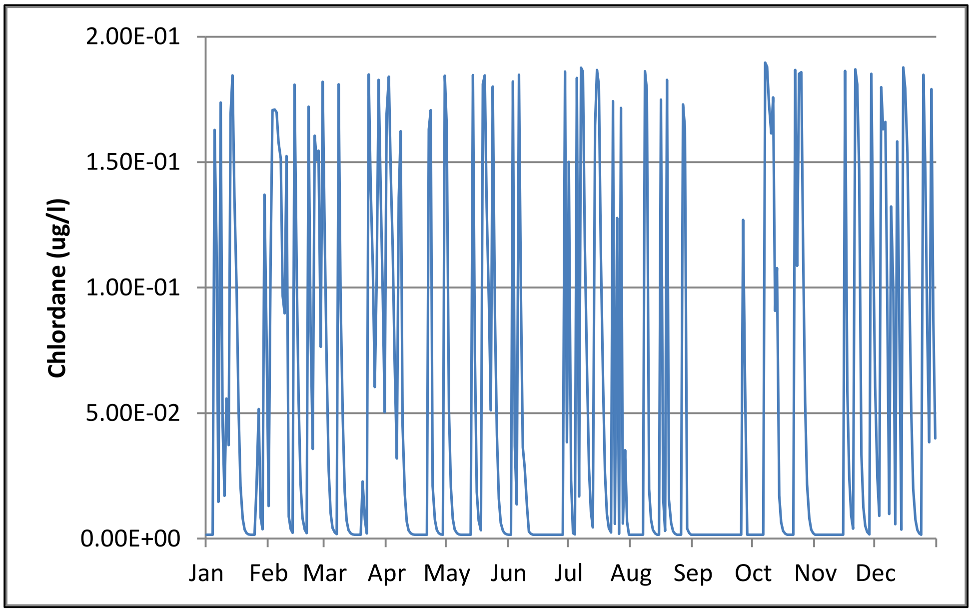

Figure 4.58: Simulated Daily Chlordane Concentrations (µg/l), Luzon Branch, Baseline Conditions, 2005

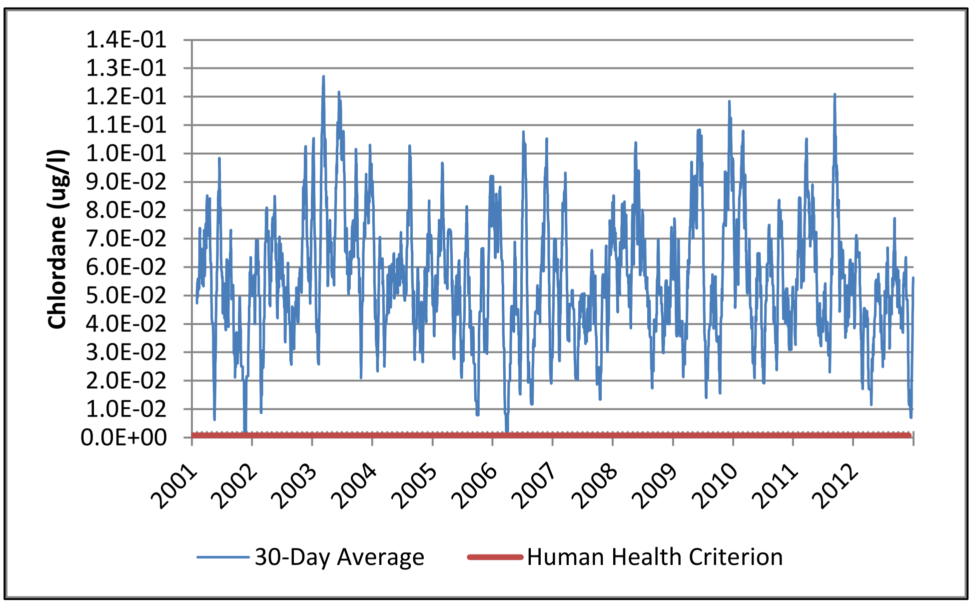

Figure 4.59: Simulated 30-Day Average Chlordane Concentrations (µg/l), Luzon Branch, Baseline Conditions

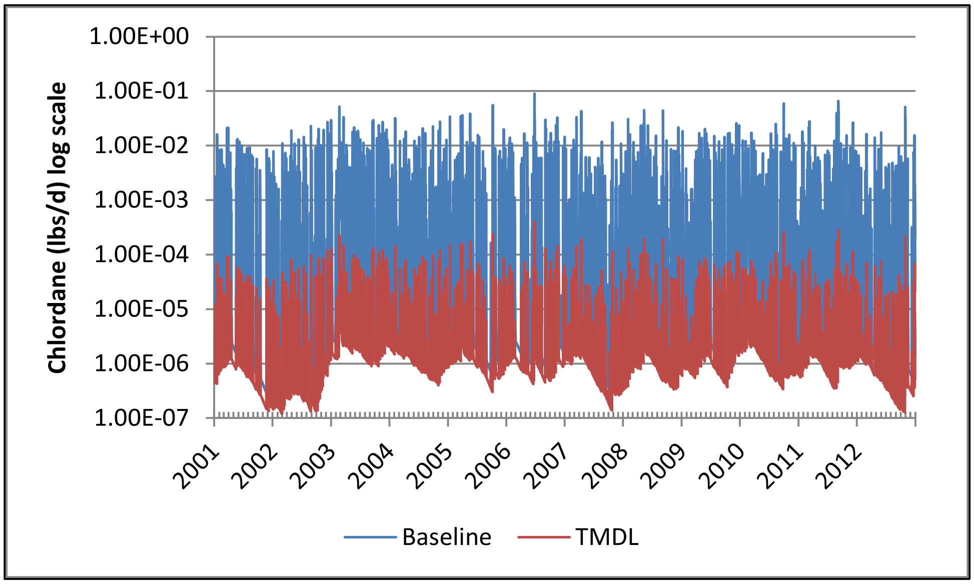

Figure 4.60: Simulated Daily Chlordane Loads (lbs/d), Luzon Branch, Baseline Conditions and TMDL Scenario

4.7 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 4.61 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[11]. 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 4.55 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 4.61. This permit is aggregated under the MS4 WLA.

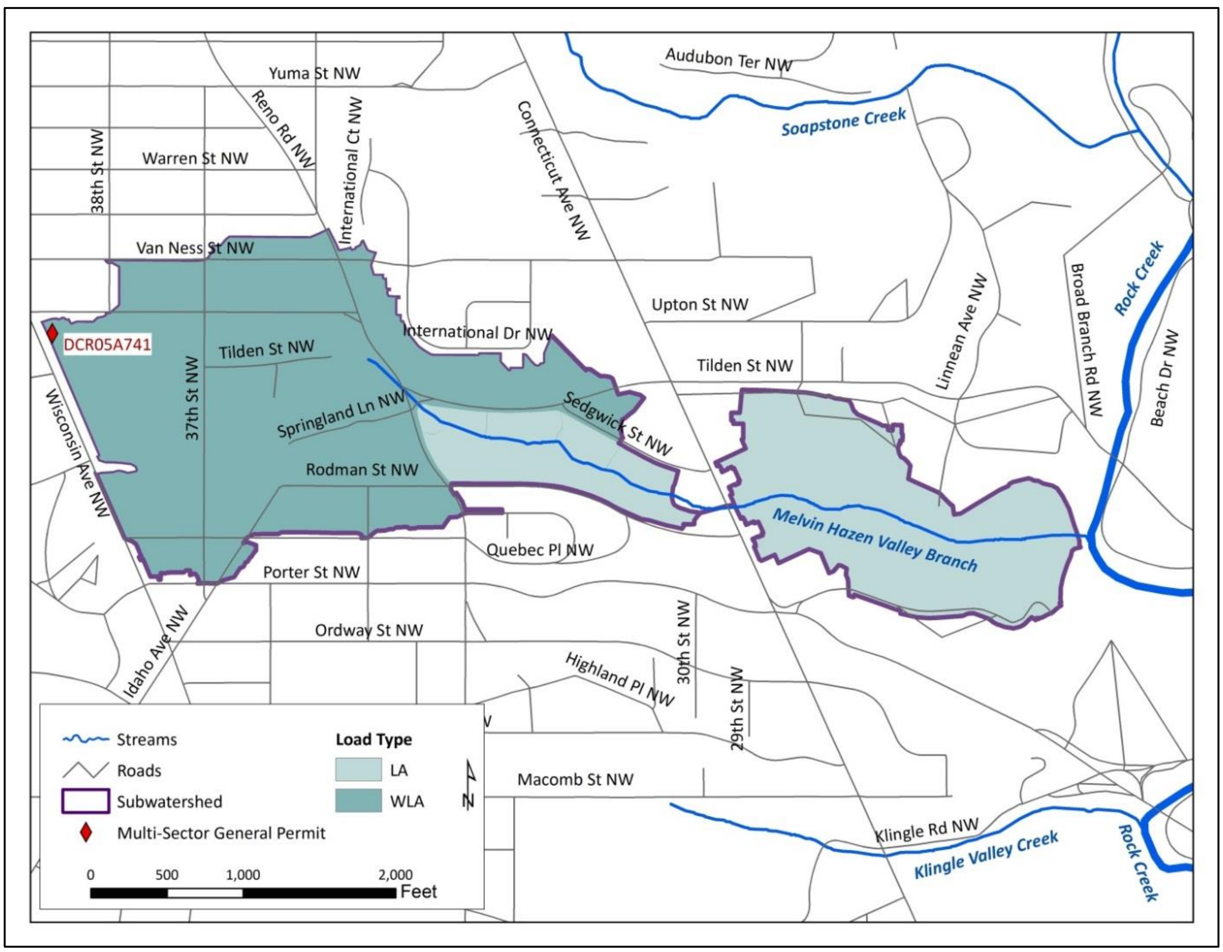

Figure 4.61: Melvin Hazen Valley Branch and its Watershed

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

Table 4.55: 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 4.62 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.

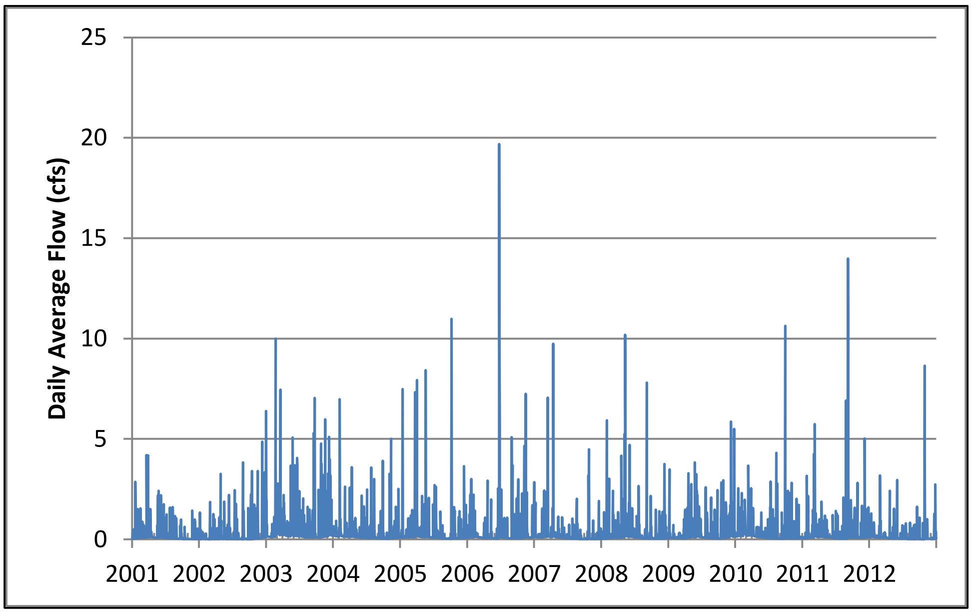

Figure 4.62: Simulated Average Daily Flow (cfs), Melvin Hazen Valley Branch

Table 4.56 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.57 presents the daily average baseline loads and TMDL allocations, and Table 4.58 presents maximum daily baseline dieldrin 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 4.63 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.64 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.65 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.56: Average Annual Dieldrin 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	4.87E-04	2.19E-05	95.5%
	Total	4.87E-04	2.19E-05	95.5%
Load Allocation	Direct Drainage	5.33E-04	1.51E-05	97.2%
	Upstream Maryland	-	-	-
	Total	5.33E-04	1.51E-05	97.2%
Margin of Safety		-	Implicit	-
Total		1.02E-03	3.70E-05	96.4%

Table 4.57: Dieldrin 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	1.33E-06	6.00E-08	95.5%
	Total	1.33E-06	6.00E-08	95.5%
Load Allocation	Direct Drainage	1.46E-06	4.14E-08	97.2%
	Upstream Maryland	-	-	-
	Total	1.46E-06	4.14E-08	97.2%
Margin of Safety		-	Implicit	-
Total		2.79E-06	1.01E-07	96.4%

Table 4.58: Dieldrin 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	9.10E-05	4.09E-06	95.5%
	Total	9.10E-05	4.09E-06	95.5%
Load Allocation	Direct Drainage	3.65E-05	1.63E-06	95.5%
	Upstream Maryland	-	-	-
	Total	3.65E-05	1.63E-06	95.5%
Margin of Safety		-	Implicit	-
Total		1.27E-04	5.72E-06	95.5%

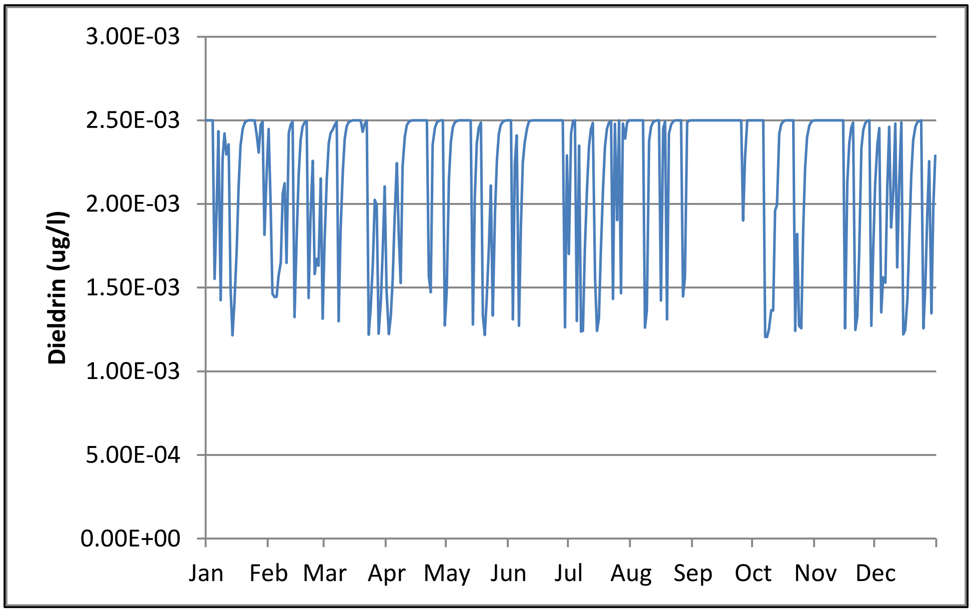

Figure 4.63: Simulated Daily Dieldrin Concentrations (µg/l), Melvin Hazen Valley Branch, Baseline Conditions, 2005

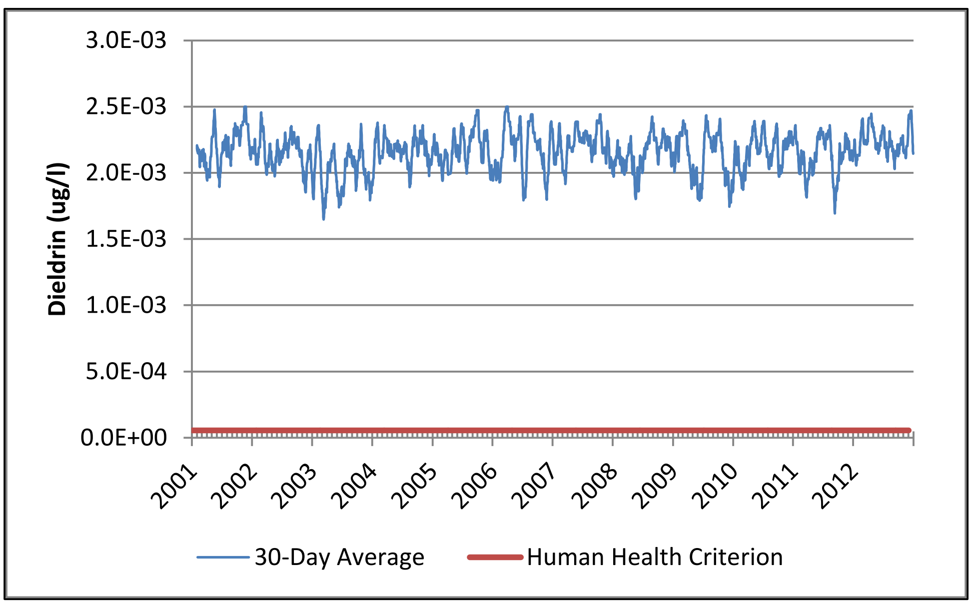

Figure 4.64: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Melvin Hazen Valley Branch, Baseline Conditions

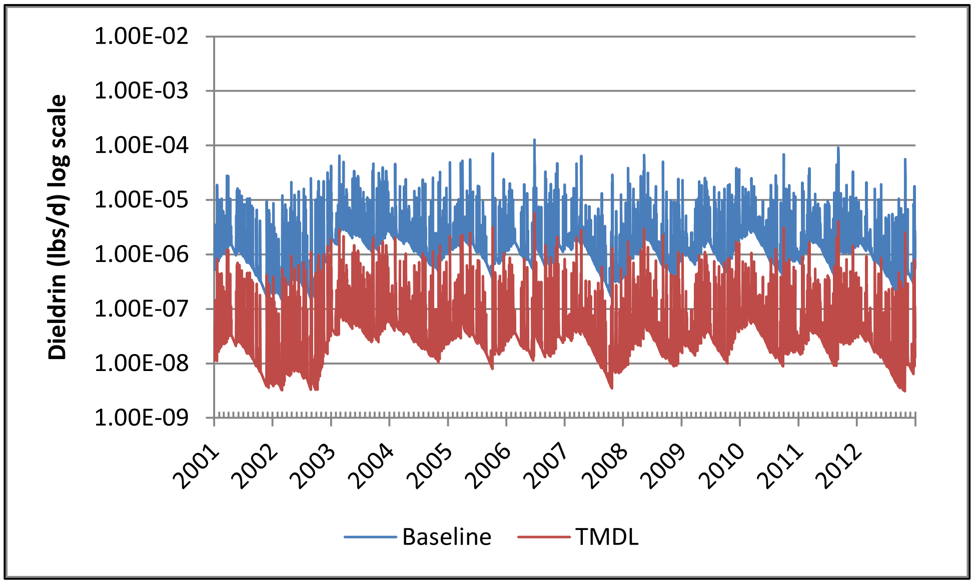

Figure 4.65: Simulated Daily Dieldrin Loads (lbs/d), Melvin Hazen Valley Branch, Baseline Conditions and TMDL Scenario

4.8 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 4.66 shows the location of Normanstone Creek and its watershed[12]. 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 4.59 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.

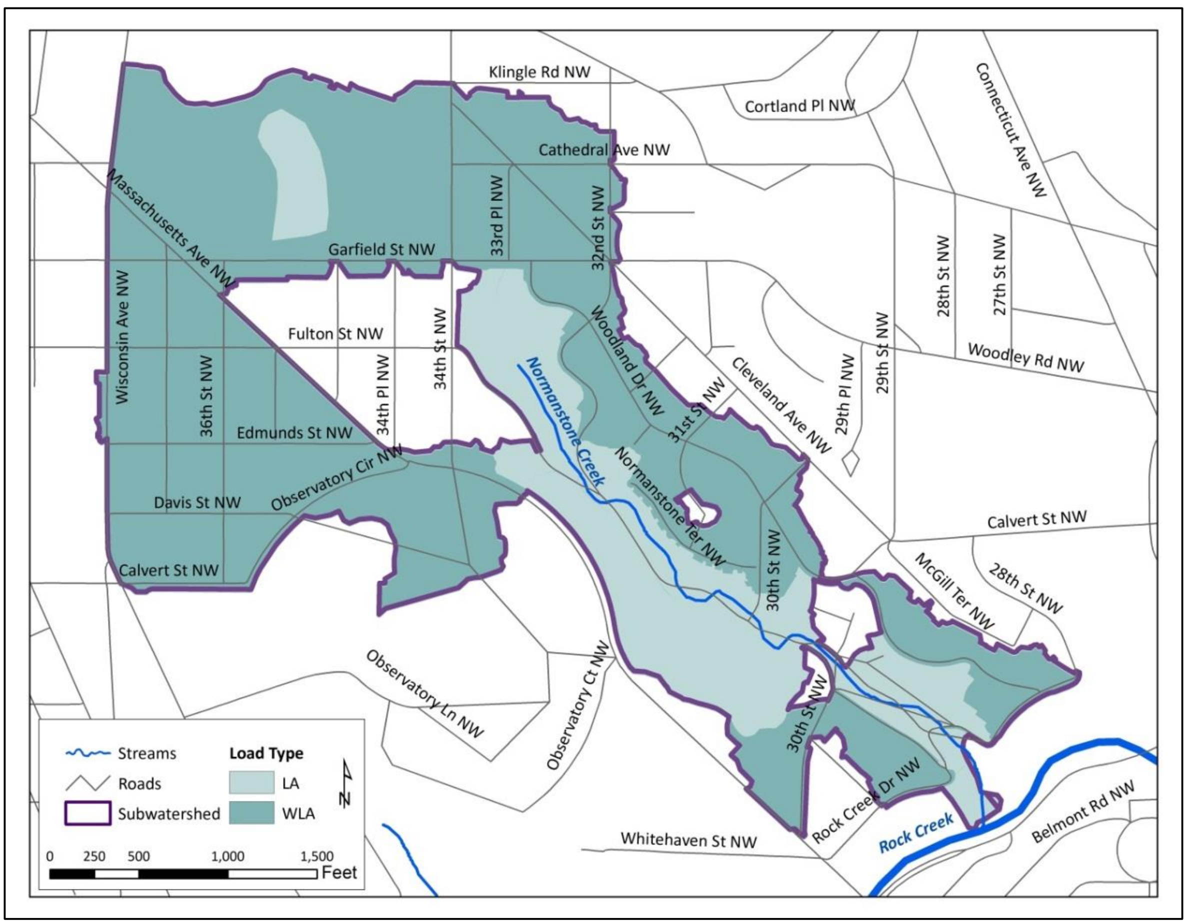

Figure 4.66: Normanstone Creek and its Watershed

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

Table 4.59: 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 4.67 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.

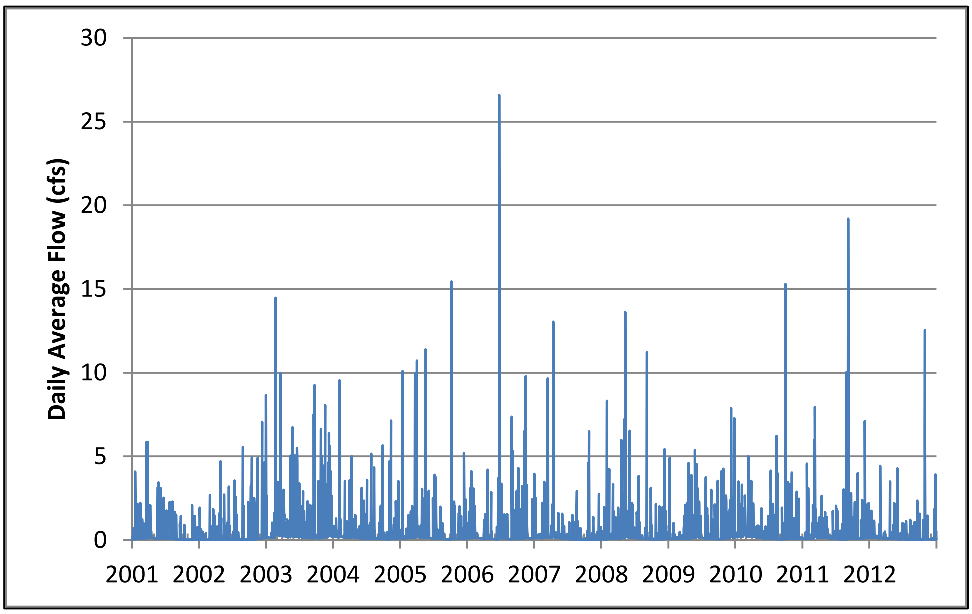

Figure 4.67: Simulated Average Daily Flow (cfs), Normanstone Creek

Table 4.60 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.61 presents the daily average baseline loads and TMDL allocations, and Table 4.62 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.68 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.69 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.70 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.60: Average Annual Dieldrin 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	7.76E-04	3.49E-05	95.5%
	Total	7.76E-04	3.49E-05	95.5%
Load Allocation	Direct Drainage	5.33E-04	1.42E-05	97.3%
	Upstream Maryland	-	-	-
	Total	5.33E-04	1.42E-05	97.3%
Margin of Safety		-	Implicit	-
Total		1.31E-03	4.91E-05	96.2%

Table 4.61: Dieldrin Average Daily Loads (lbs/d), Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.13E-06	9.57E-08	95.5%
	Total	2.13E-06	9.57E-08	95.5%
Load Allocation	Direct Drainage	1.46E-06	3.90E-08	97.3%
	Upstream Maryland	-	-	-
	Total	1.46E-06	3.90E-08	97.3%
Margin of Safety		-	Implicit	-
Total		3.59E-06	1.35E-07	96.2%

Table 4.62: Dieldrin Maximum Daily Loads (lbs/d), Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.42E-04	6.41E-06	95.5%
	Total	1.42E-04	6.41E-06	95.5%
Load Allocation	Direct Drainage	2.98E-05	1.33E-06	95.6%
	Upstream Maryland	-	-	-
	Total	2.98E-05	1.33E-06	95.6%
Margin of Safety		-	Implicit	-
Total		1.72E-04	7.73E-06	95.5%

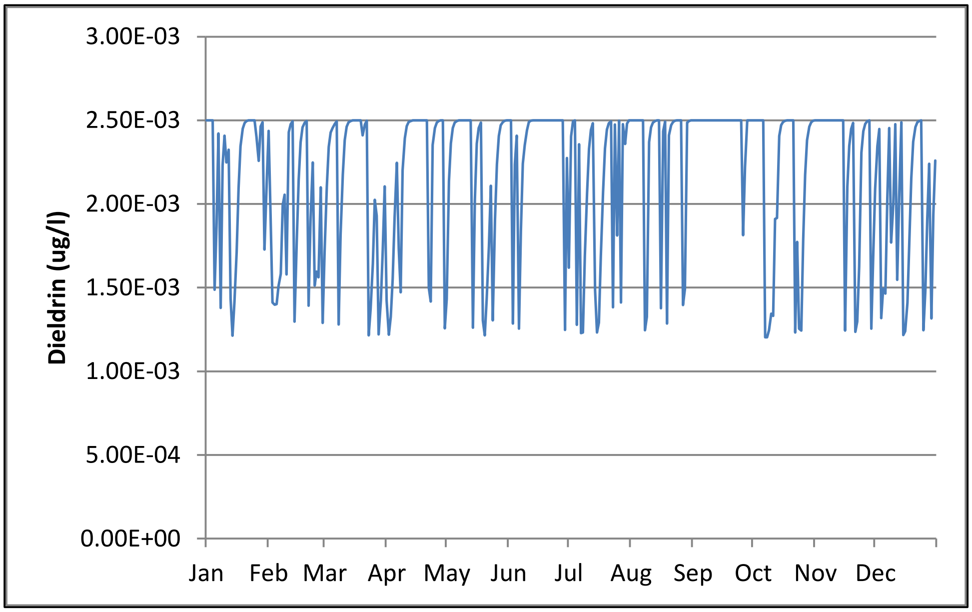

Figure 4.68: Simulated Daily Dieldrin Concentrations (µg/l), Normanstone Creek, Baseline Conditions, 2005

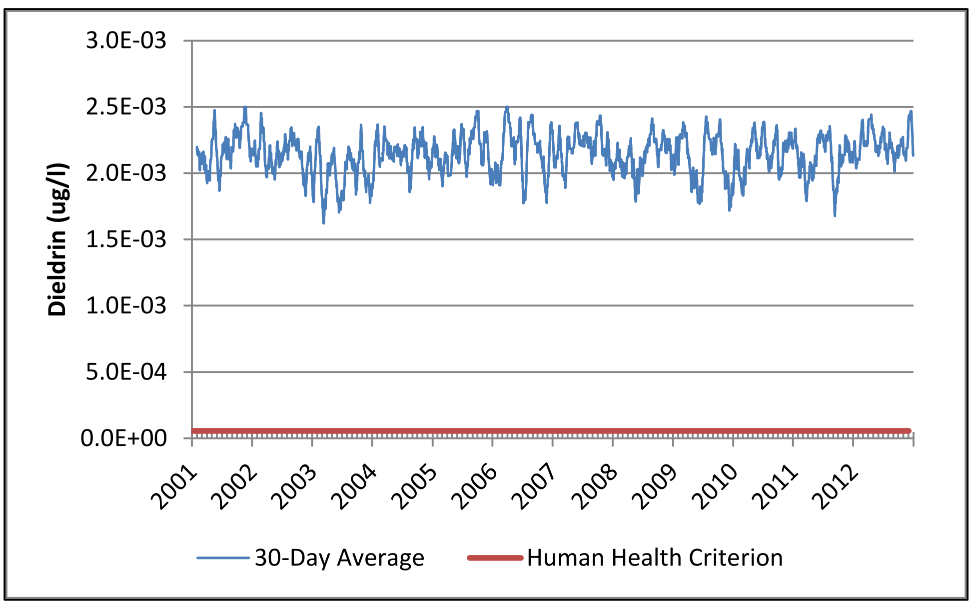

Figure 4.69: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Normanstone Creek, Baseline Conditions

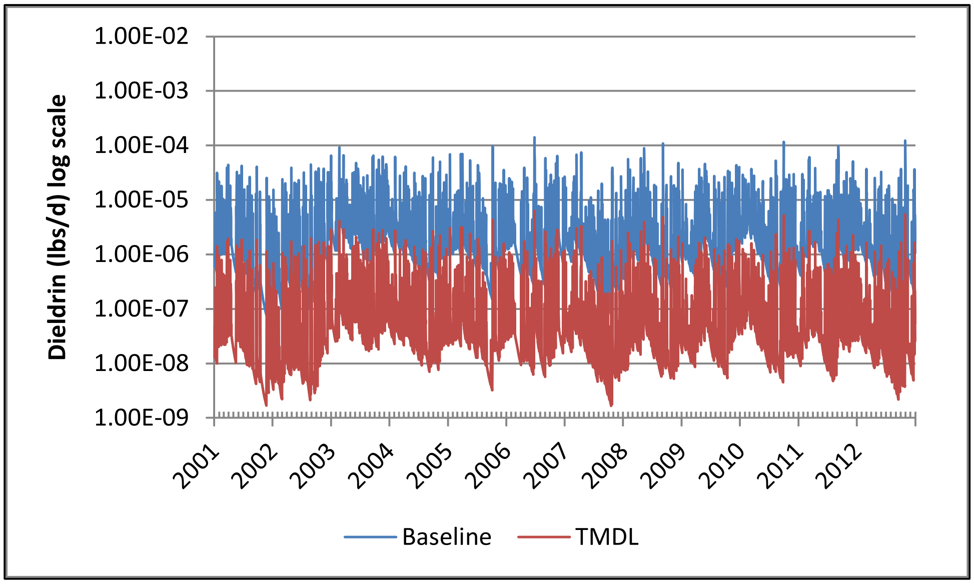

Figure 4.70: Simulated Daily Dieldrin Loads (lbs/d), Normanstone Creek, Baseline Conditions and TMDL Scenario

Table 4.63 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.64 presents the daily average baseline loads and TMDL allocations, and Table 4.65 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.71 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.72 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.73 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.63: Average Annual Heptachlor Epoxide 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	3.94E-04	2.52E-05	93.6%
	Total	3.94E-04	2.52E-05	93.6%
Load Allocation	Direct Drainage	3.93E-04	1.03E-05	97.4%
	Upstream Maryland	-	-	-
	Total	3.93E-04	1.03E-05	97.4%
Margin of Safety		-	Implicit	-
Total		7.87E-04	3.55E-05	95.5%

Table 4.64: Heptachlor Epoxide Average Daily Loads (lbs/d), Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.08E-06	6.91E-08	93.6%
	Total	1.08E-06	6.91E-08	93.6%
Load Allocation	Direct Drainage	1.08E-06	2.82E-08	97.4%
	Upstream Maryland	-	-	-
	Total	1.08E-06	2.82E-08	97.4%
Margin of Safety		-	Implicit	-
Total		2.16E-06	9.73E-08	95.5%

Table 4.65: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.24E-05	4.63E-06	93.6%
	Total	7.24E-05	4.63E-06	93.6%
Load Allocation	Direct Drainage	1.53E-05	9.57E-07	93.8%
	Upstream Maryland	-	-	-
	Total	1.53E-05	9.57E-07	93.8%
Margin of Safety		-	Implicit	-
Total		8.77E-05	5.58E-06	93.6%

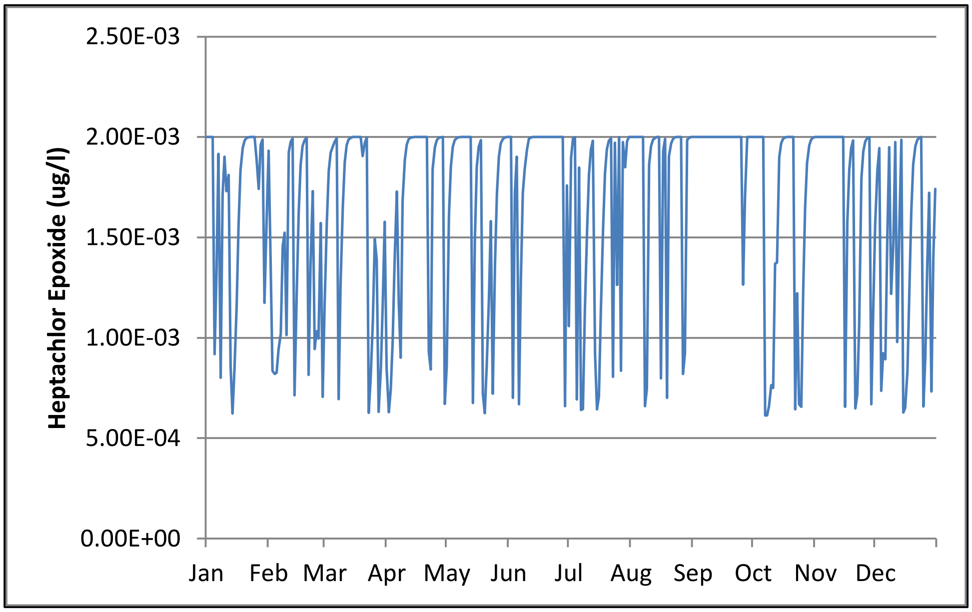

Figure 4.71: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Normanstone Creek, Baseline Conditions, 2005

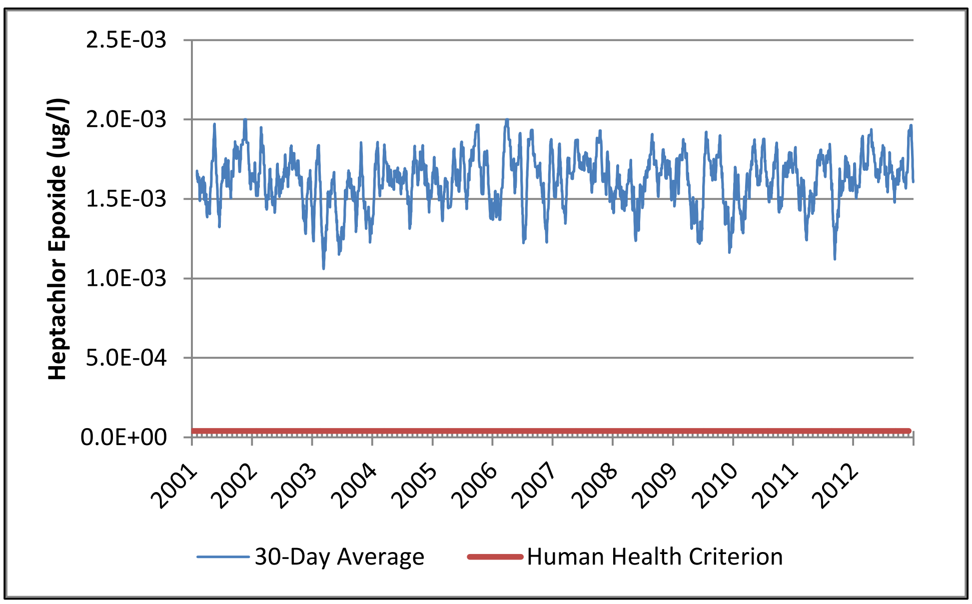

Figure 4.72: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Normanstone Creek, Baseline Conditions

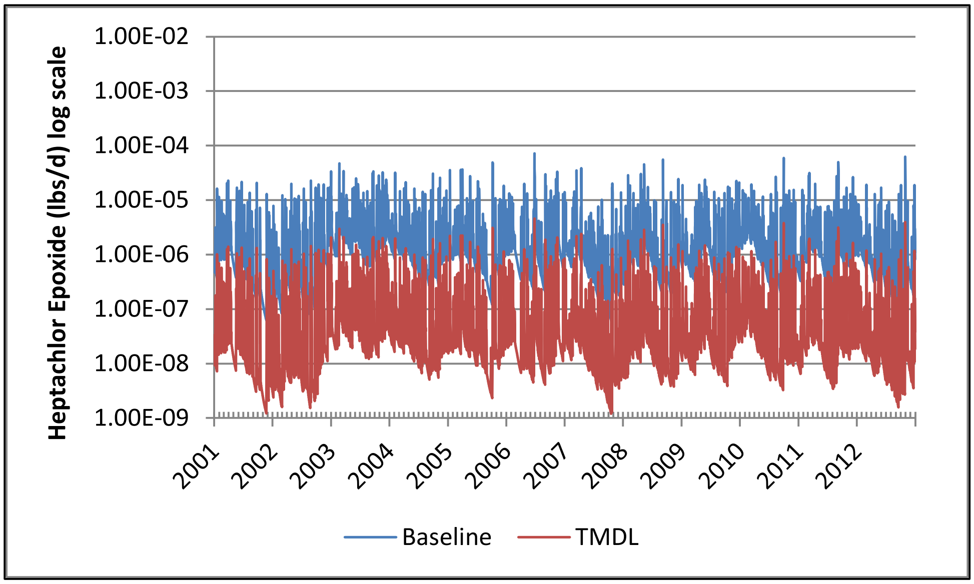

Figure 4.73: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Normanstone Creek, Baseline Conditions and TMDL Scenario

4.9 Oxon Run

Oxon Run is a tributary to the Potomac River. Figure 4.74 shows the location of Oxon Run and its watershed. The headwaters of Oxon Run originate in Prince George's County, MD. Oxon Run then flows into the southeastern section of the District before crossing back over the MD state line, then discharging into the Potomac River. The length of the mainstem of Oxon Run is approximately 6.8 miles from its headwaters in Prince George's County downstream to where it re-enters MD from DC. The length of Oxon Run in DC is approximately 2.9 miles. Most of the Oxon Run segment in DC is a concrete-lined trapezoidal channel approximately 50 feet wide and 112 feet deep with the exception of two reaches in which the natural streambed has remained intact (DDOH, 2004c).

Table 4.66 gives the land use acreage in the Oxon Run watershed. The watershed is 7,895 acres or 12.3 square miles. Seventy-three percent of the watershed is in MD. The DC portion of the watershed is 40% impervious and 84% of the DC portion lies within the DC MS4.

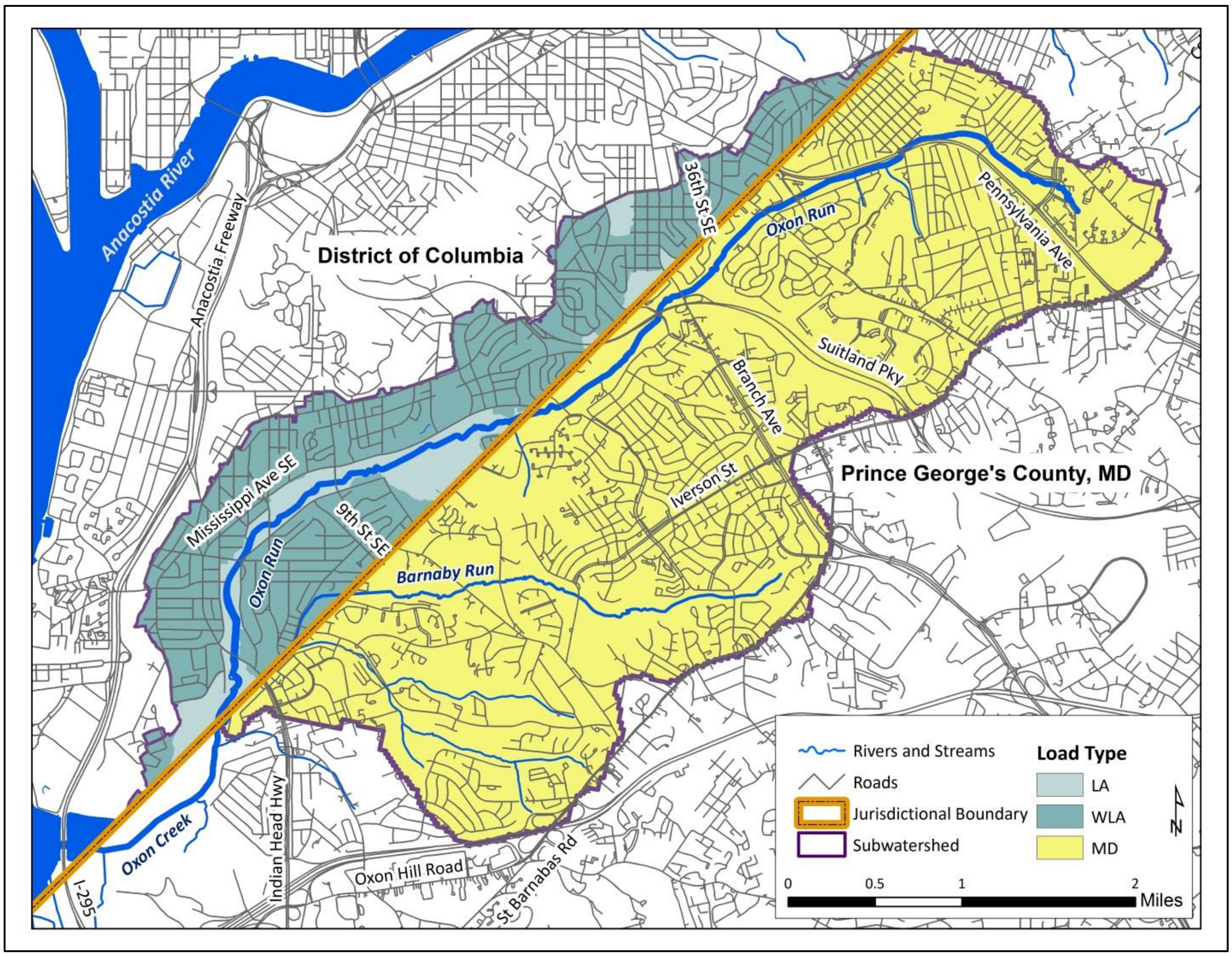

Figure 4.74: Oxon Run and its Watershed

Table 4.66: Oxon Run Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	829	890	81	1,800
DC Non-MS4	28	133	183	344
Maryland	1,940	2,866	946	5,751
Total	2,797	3,888	1,210	7,895

Figure 4.75 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.13 cfs to 821 cfs. The average daily flow is 18.1 cfs and the median flow is 4.6 cfs.

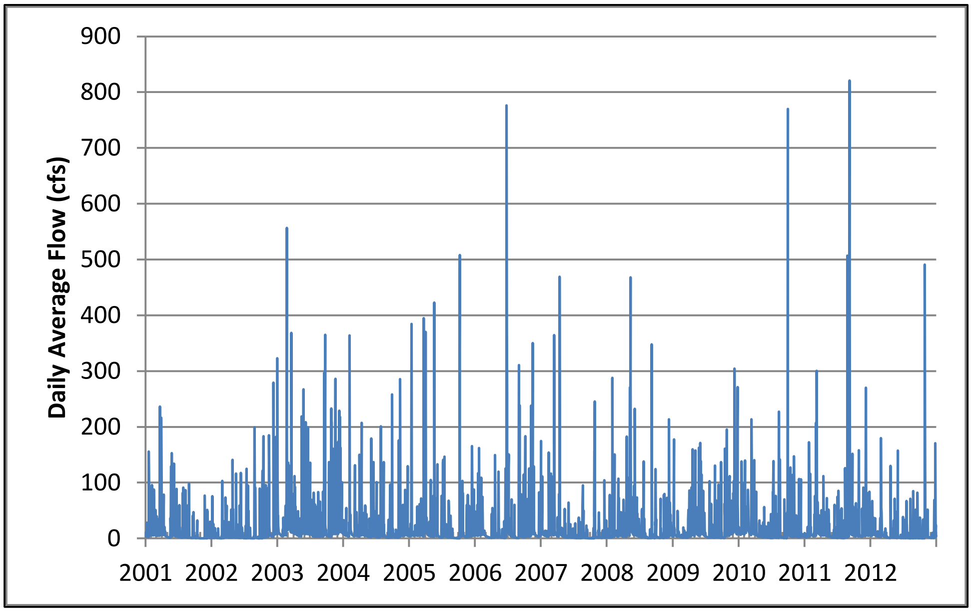

Figure 4.75: Simulated Average Daily Flow (cfs), Oxon Run

Table 4.67 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.68 presents the daily average baseline loads and TMDL allocations, and Table 4.69 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.76 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.77 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.78 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.67: Average Annual Dieldrin Baseline Loads and TMDL Allocations (lbs/yr), Oxon Run

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.94E-03	4.02E-04	79.2%
	Total	1.94E-03	4.02E-04	79.2%
Load Allocation	Direct Drainage	1.14E-03	1.14E-04	90.0%
	Upstream Maryland	9.07E-03	1.41E-03	84.5%
	Total	1.02E-02	1.52E-03	85.1%
Margin of Safety		-	Implicit	-
Total		1.21E-02	1.93E-03	84.1%

Table 4.68: Dieldrin Average Daily Loads (lbs/d), Oxon Run

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.31E-06	1.10E-06	79.2%
	Total	5.31E-06	1.10E-06	79.2%
Load Allocation	Direct Drainage	3.11E-06	3.11E-07	90.0%
	Upstream Maryland	2.49E-05	3.86E-06	84.5%
	Total	2.80E-05	4.17E-06	85.1%
Margin of Safety		-	Implicit	-
Total		3.33E-05	5.28E-06	84.1%

Table 4.69: Dieldrin Maximum Daily Loads (lbs/d), Oxon Run

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.46E-04	7.18E-05	79.2%
	Total	3.46E-04	7.18E-05	79.2%
Load Allocation	Direct Drainage	4.67E-05	9.51E-06	79.7%
	Upstream Maryland	8.78E-04	1.80E-04	79.6%
	Total	9.25E-04	1.89E-04	79.6%
Margin of Safety		-	Implicit	-
Total		1.27E-03	2.61E-04	79.5%

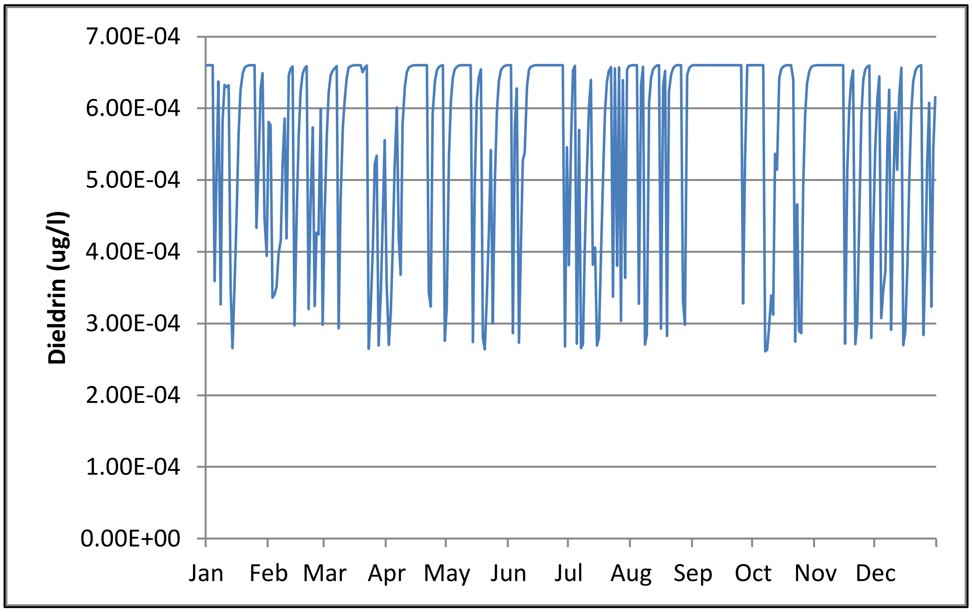

Figure 4.76: Simulated Daily Dieldrin Concentrations (µg/l), Oxon Run, Baseline Conditions, 2005

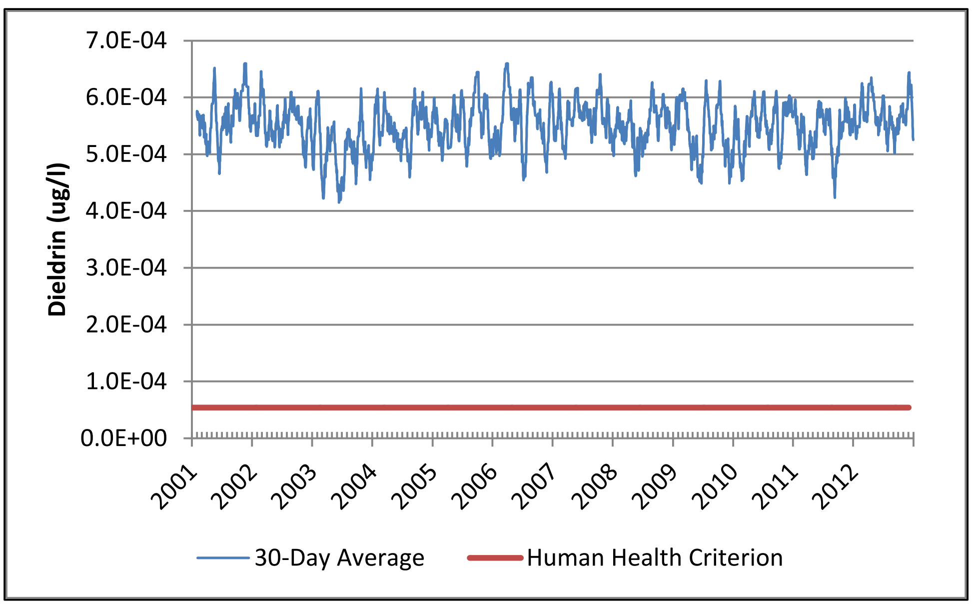

Figure 4.77: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Oxon Run, Baseline Conditions

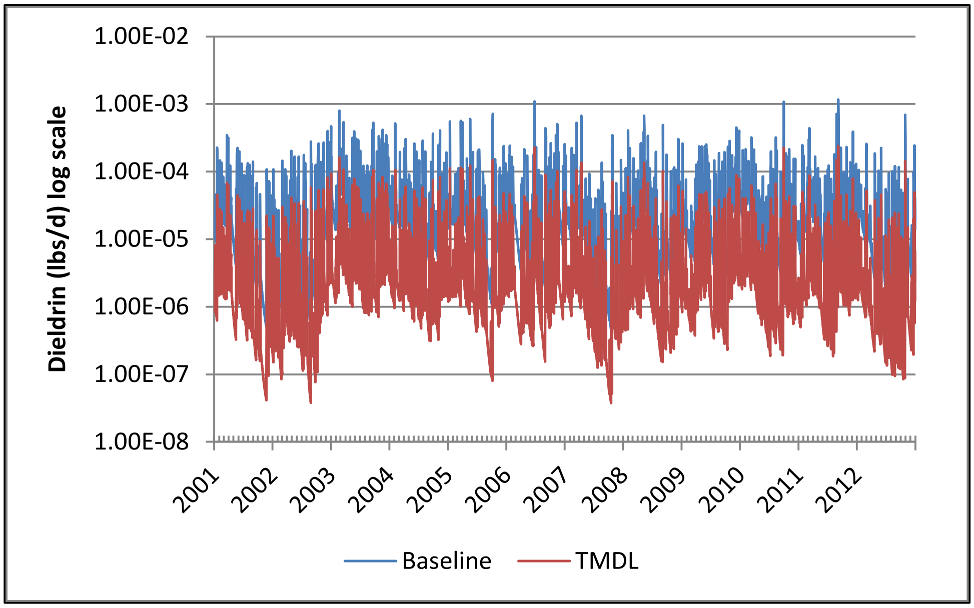

Figure 4.78: Simulated Daily Dieldrin Loads (lbs/d), Oxon Run, Baseline Conditions and TMDL Scenario

4.10 Pinehurst Branch

Pinehurst Branch originates at the DC / MD state line in Chevy Chase Manor, Maryland. Figure 4.79 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 4.70 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).

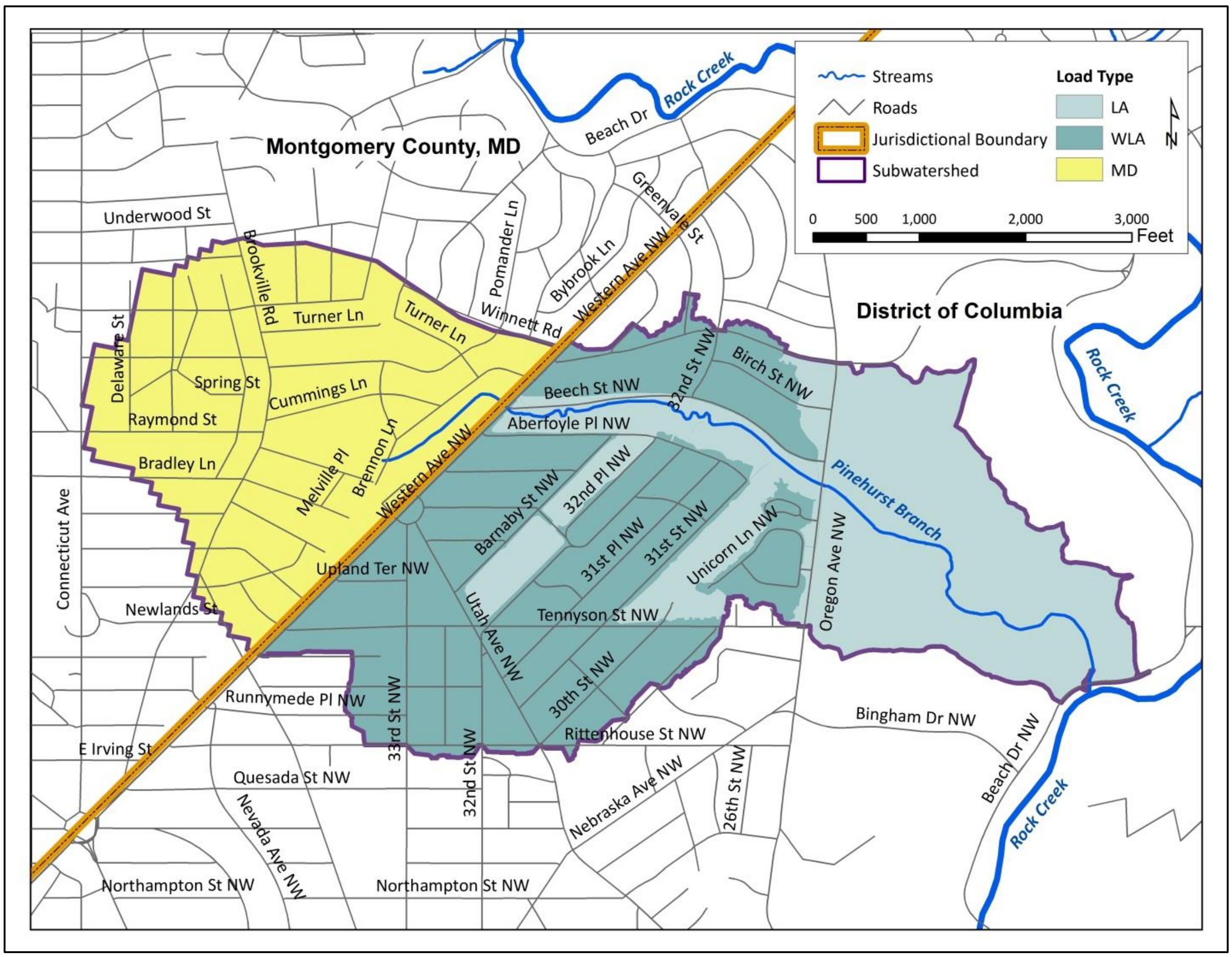

Figure 4.79: Pinehurst Branch and its Watershed

Table 4.70: 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 4.80 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.

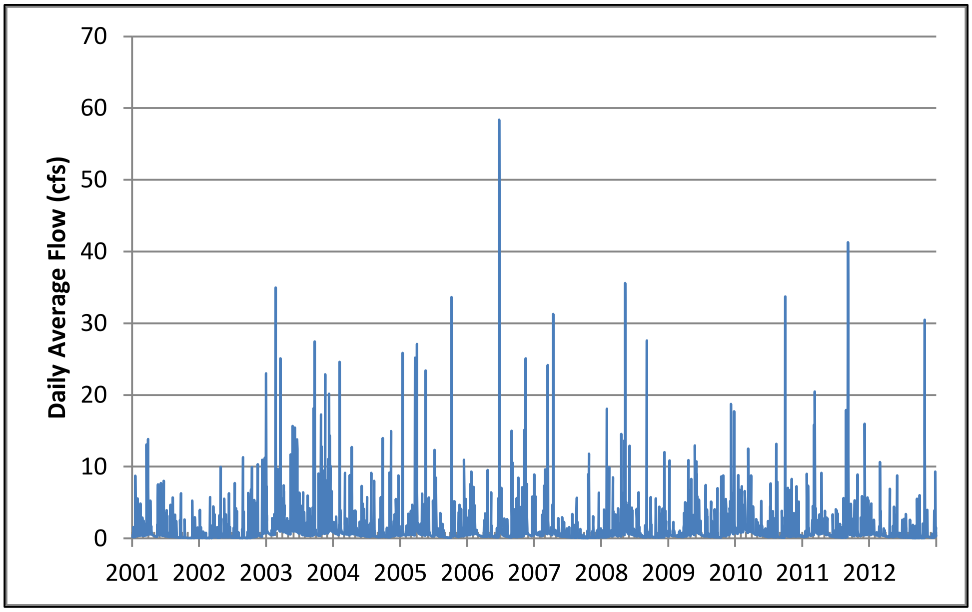

Figure 4.80: Simulated Average Daily Flow (cfs), Pinehurst Branch

Table 4.71 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.72 presents the daily average baseline loads and TMDL allocations, and Table 4.73 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.81 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.82 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.83 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.71: Average Annual Dieldrin 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	1.05E-03	4.75E-05	95.5%
	Total	1.05E-03	4.75E-05	95.5%
Load Allocation	Direct Drainage	1.42E-03	3.84E-05	97.3%
	Upstream Maryland	1.38E-03	4.71E-05	96.6%
	Total	2.80E-03	8.55E-05	96.9%
Margin of Safety		-	Implicit	-
Total		3.85E-03	1.33E-04	96.5%

Table 4.72: Dieldrin Average Daily Loads (lbs/d), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.89E-06	1.30E-07	95.5%
	Total	2.89E-06	1.30E-07	95.5%
Load Allocation	Direct Drainage	3.89E-06	1.05E-07	97.3%
	Upstream Maryland	3.77E-06	1.29E-07	96.6%
	Total	7.67E-06	2.34E-07	96.9%
Margin of Safety		-	Implicit	-
Total		1.06E-05	3.64E-07	96.5%

Table 4.73: Dieldrin Maximum Daily Loads (lbs/d), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.05E-04	9.20E-06	95.5%
	Total	2.05E-04	9.20E-06	95.5%
Load Allocation	Direct Drainage	9.27E-05	4.13E-06	95.5%
	Upstream Maryland	8.76E-05	3.92E-06	95.5%
	Total	1.80E-04	8.05E-06	95.5%
Margin of Safety		-	Implicit	-
Total		3.85E-04	1.73E-05	95.5%

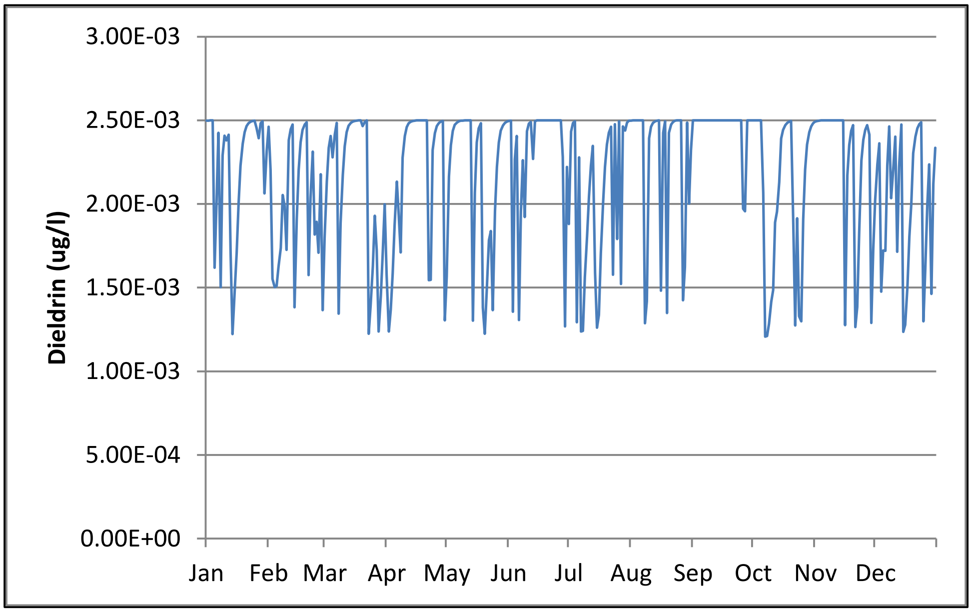

Figure 4.81: Simulated Daily Dieldrin Concentrations (µg/l), Pinehurst Branch, Baseline Conditions, 2005

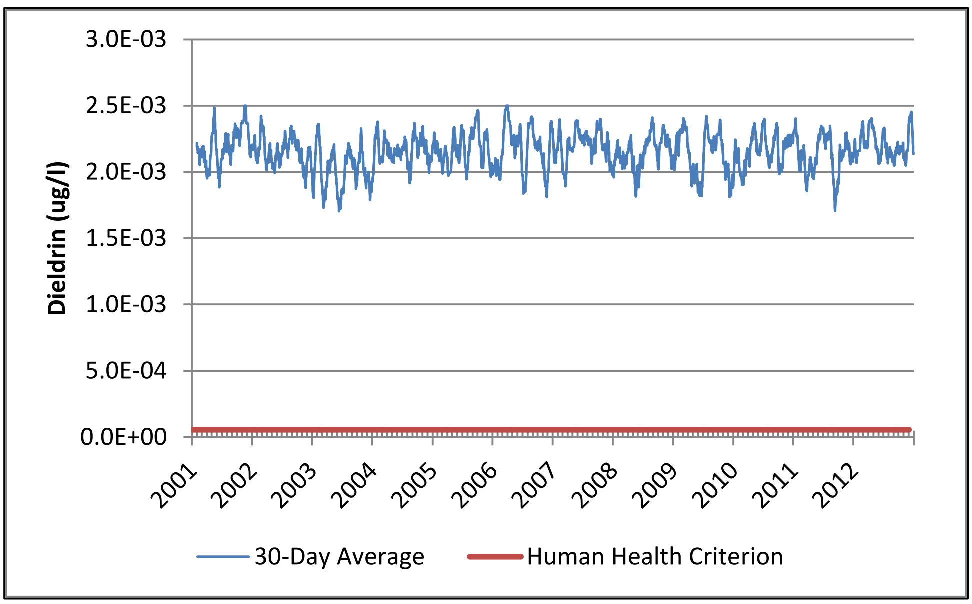

Figure 4.82: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Pinehurst Branch, Baseline Conditions

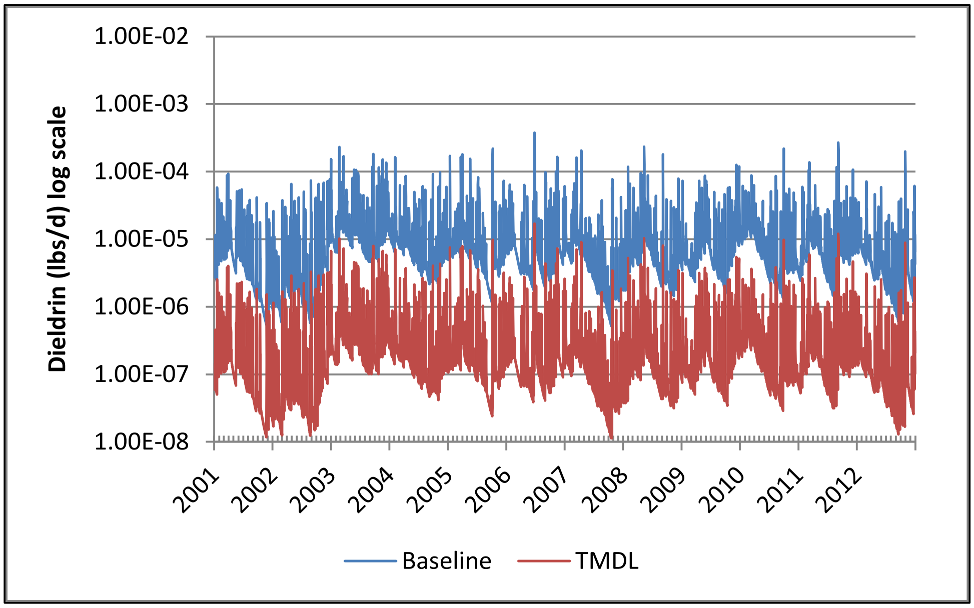

Figure 4.83: Simulated Daily Dieldrin Loads (lbs/d), Pinehurst Branch, Baseline Conditions and TMDL Scenario

Table 4.74 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.75 presents the daily average baseline loads and TMDL allocations, and Table 4.76 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.84 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.85 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.86 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.74: Average Annual Heptachlor Epoxide 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	5.36E-04	3.43E-05	93.6%
	Total	5.36E-04	3.43E-05	93.6%
Load Allocation	Direct Drainage	1.04E-03	2.77E-05	97.3%
	Upstream Maryland	8.86E-04	3.40E-05	96.2%
	Total	1.93E-03	6.18E-05	96.8%
Margin of Safety		-	Implicit	-
Total		2.46E-03	9.60E-05	96.1%

Table 4.75: Heptachlor Epoxide Average Daily Loads (lbs/d), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.47E-06	9.39E-08	93.6%
	Total	1.47E-06	9.39E-08	93.6%
Load Allocation	Direct Drainage	2.85E-06	7.60E-08	97.3%
	Upstream Maryland	2.43E-06	9.32E-08	96.2%
	Total	5.28E-06	1.69E-07	96.8%
Margin of Safety		-	Implicit	-
Total		6.75E-06	2.63E-07	96.1%

Table 4.76: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.04E-04	6.65E-06	93.6%
	Total	1.04E-04	6.65E-06	93.6%
Load Allocation	Direct Drainage	4.76E-05	2.98E-06	93.7%
	Upstream Maryland	4.48E-05	2.83E-06	93.7%
	Total	9.25E-05	5.81E-06	93.7%
Margin of Safety		-	Implicit	-
Total		1.96E-04	1.25E-05	93.7%

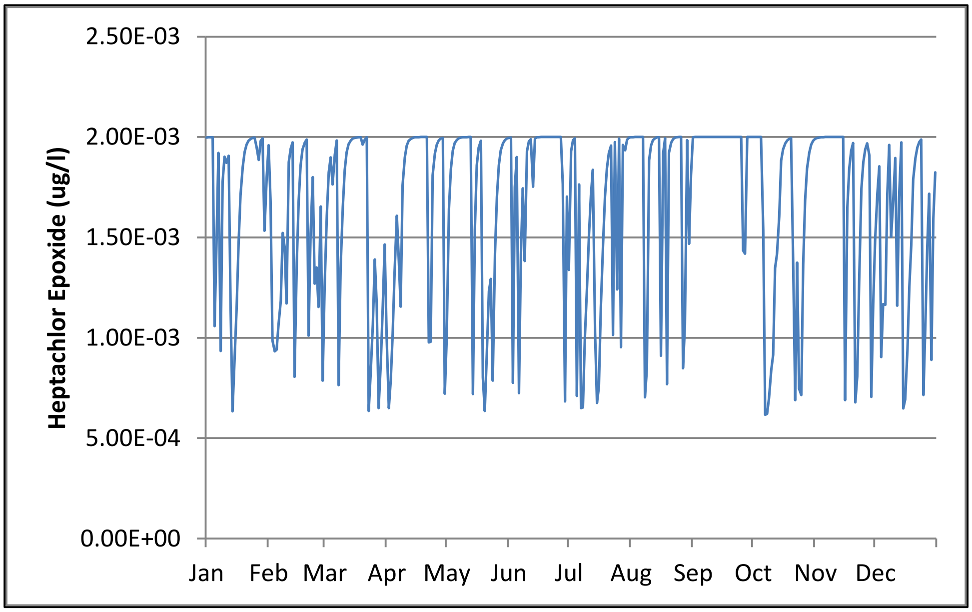

Figure 4.84: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Pinehurst Branch, Baseline Conditions, 2005

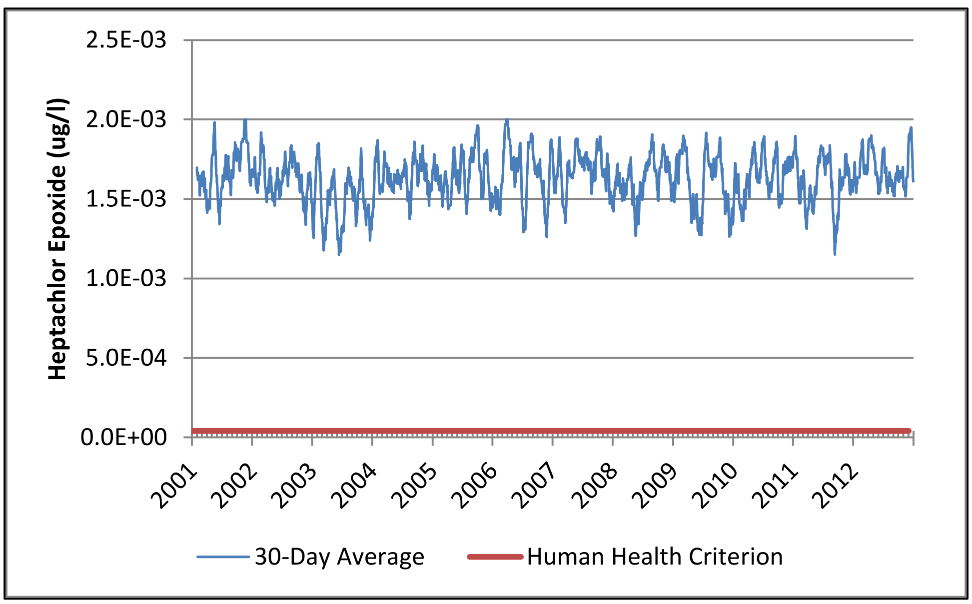

Figure 4.85: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Pinehurst Branch, Baseline Conditions

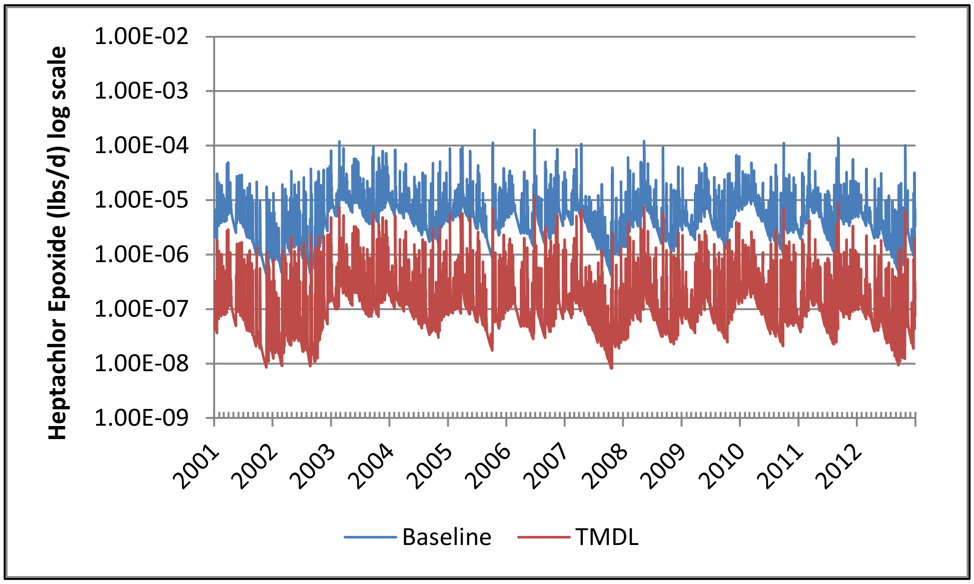

Figure 4.86: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Pinehurst Branch, Baseline Conditions and TMDL Scenario

4.11 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 4.87 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 4.77 gives the land use acreage in the Piney Branch watershed. Figure 4.88 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 4.77: 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

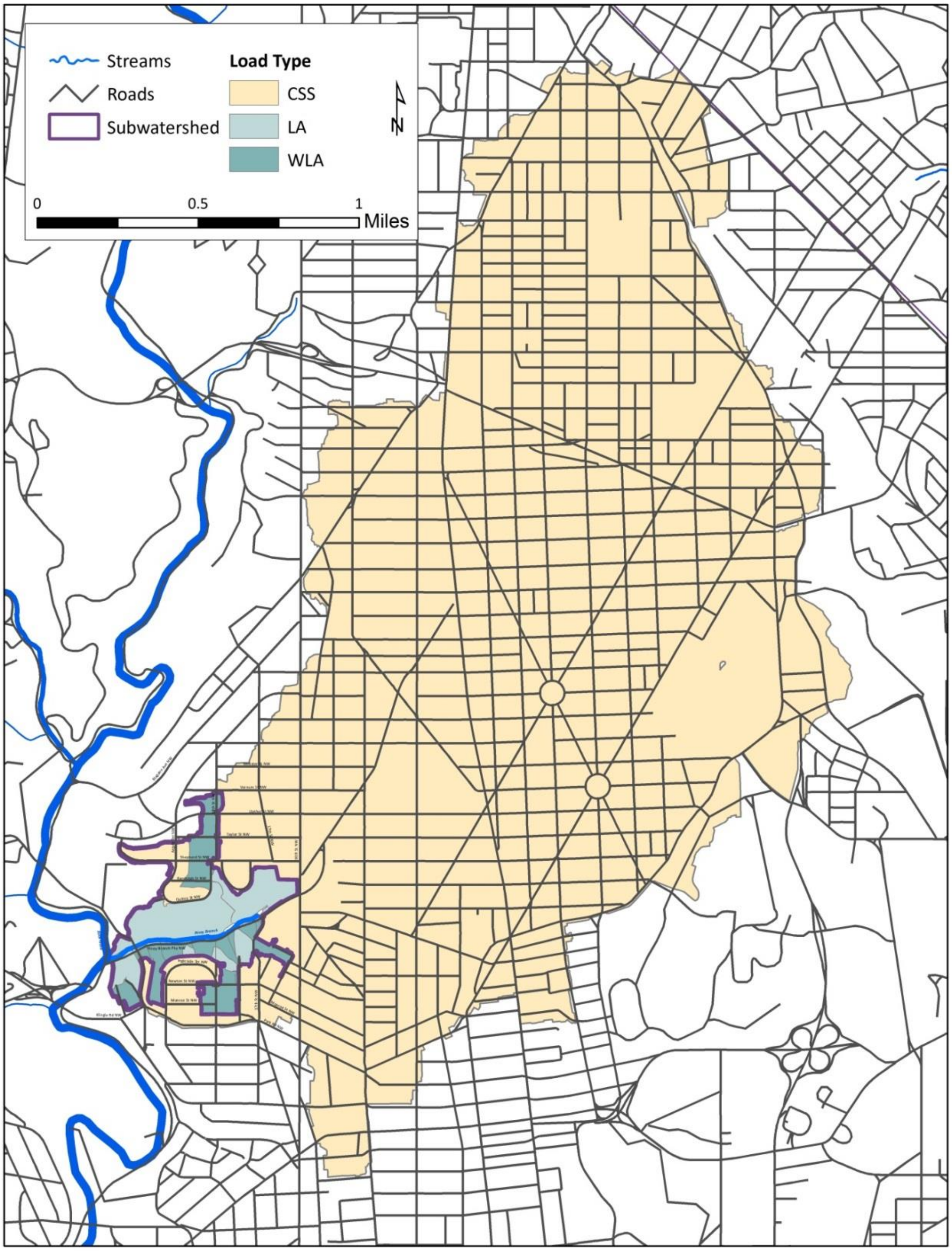

Figure 4.87: Piney Branch and its Watershed

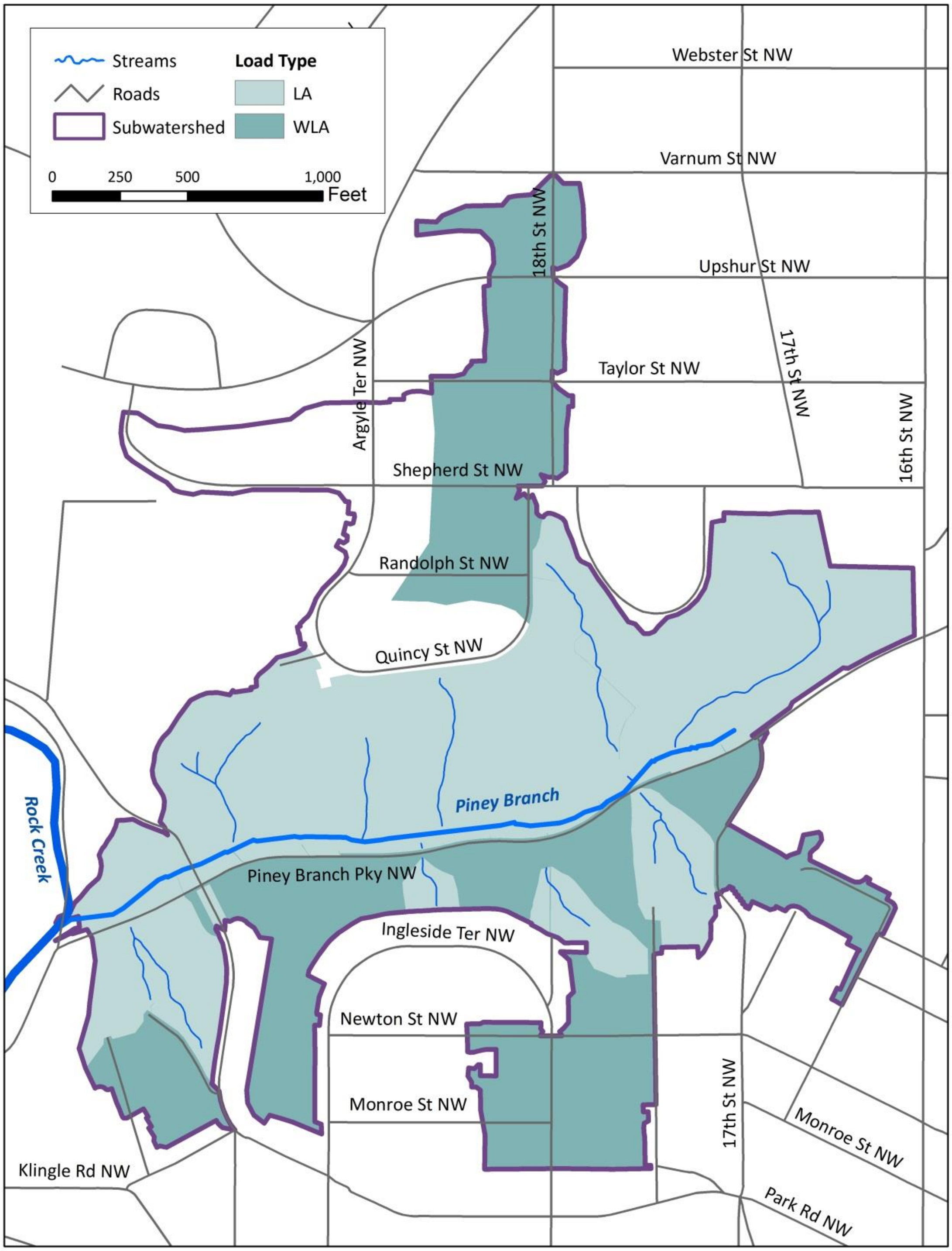

Figure 4.8**8**: Piney Branch and its Watershed, Excluding CSS Area

Figure 4.89 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.

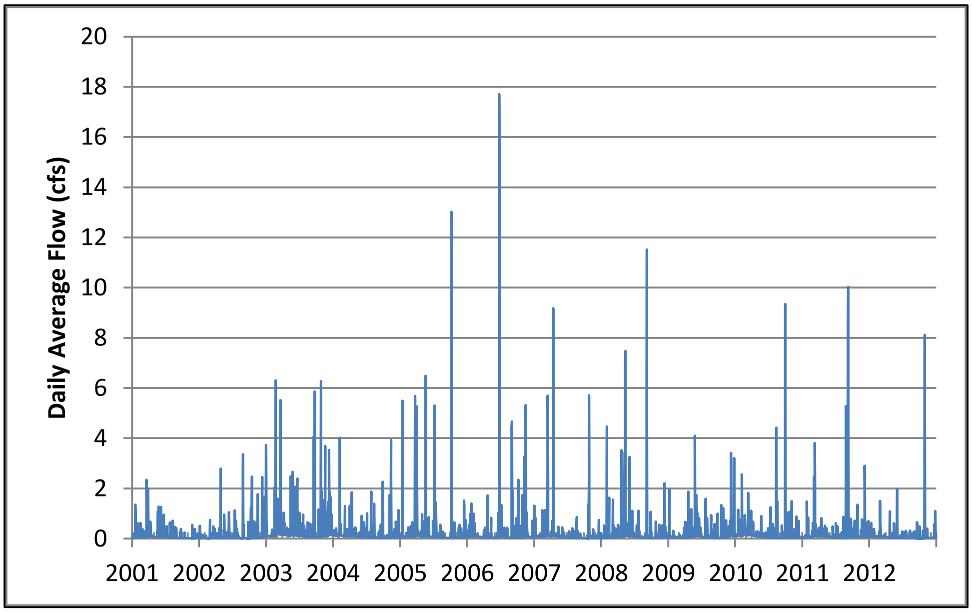

Figure 4.89: Simulated Average Daily Flow (cfs), Piney Branch

Table 4.78 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.79 presents the daily average baseline loads and TMDL allocations, and Table 4.80 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.90 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.91 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.92 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.78: Average Annual Dieldrin 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	1.89E-04	8.51E-06	95.5%
	DC Combined Sewer System	4.01E-04	7.07E-07	99.8%
	Total	5.90E-04	9.22E-06	98.4%
Load Allocation	Direct Drainage	3.57E-04	9.78E-06	97.3%
	Upstream Maryland	-	-	-
	Total	3.57E-04	9.78E-06	97.3%
Margin of Safety		-	Implicit	-
Total		9.48E-04	1.90E-05	98.0%

Table 4.79: Dieldrin Average Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.18E-07	2.33E-08	95.5%
	DC Combined Sewer System	1.10E-06	1.94E-09	99.8%
	Total	1.62E-06	2.53E-08	98.4%
Load Allocation	Direct Drainage	9.79E-07	2.68E-08	97.3%
	Upstream Maryland	-	-	-
	Total	9.79E-07	2.68E-08	97.3%
Margin of Safety		-	Implicit	-
Total		2.60E-06	5.20E-08	98.0%

Table 4.80: Dieldrin Maximum Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.36E-05	1.51E-06	95.5%
	DC Combined Sewer System	1.57E-04	1.77E-06	98.9%
	Total	1.91E-04	3.28E-06	98.3%
Load Allocation	Direct Drainage	2.65E-05	1.18E-06	95.5%
	Upstream Maryland	-	-	-
	Total	2.65E-05	1.18E-06	95.5%
Margin of Safety		-	Implicit	-
Total		2.17E-04	4.46E-06	97.9%

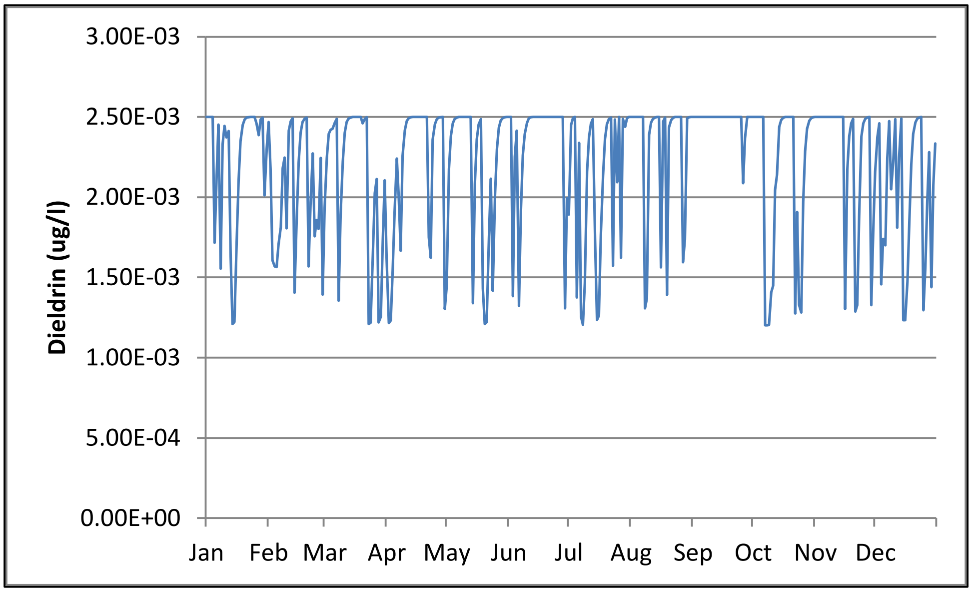

Figure 4.90: Simulated Daily Dieldrin Concentrations (μg/l), Piney Branch, Baseline Conditions, 2005

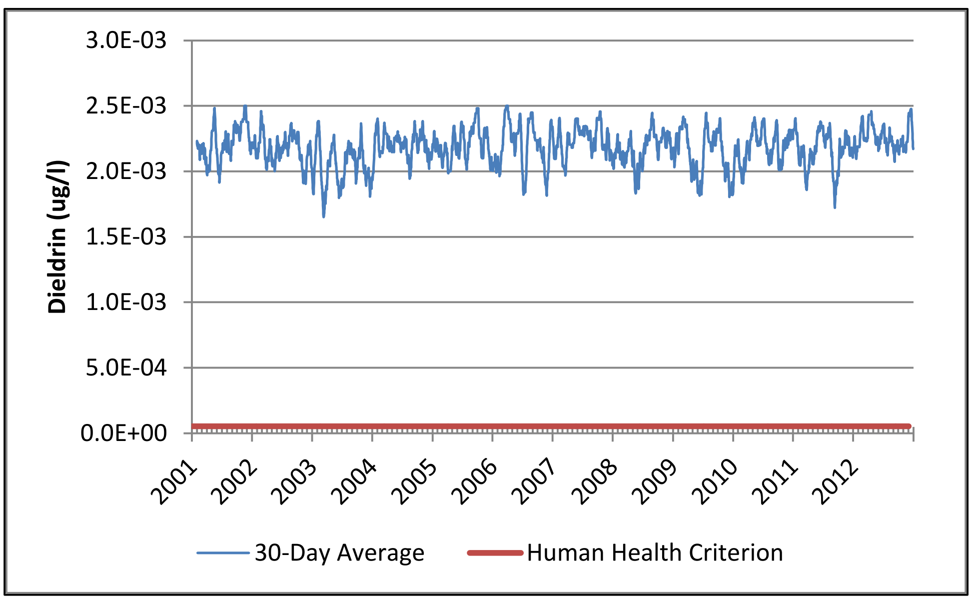

Figure 4.91: Simulated 30-Day Average Dieldrin Concentrations (μg/l), Piney Branch, Baseline Conditions

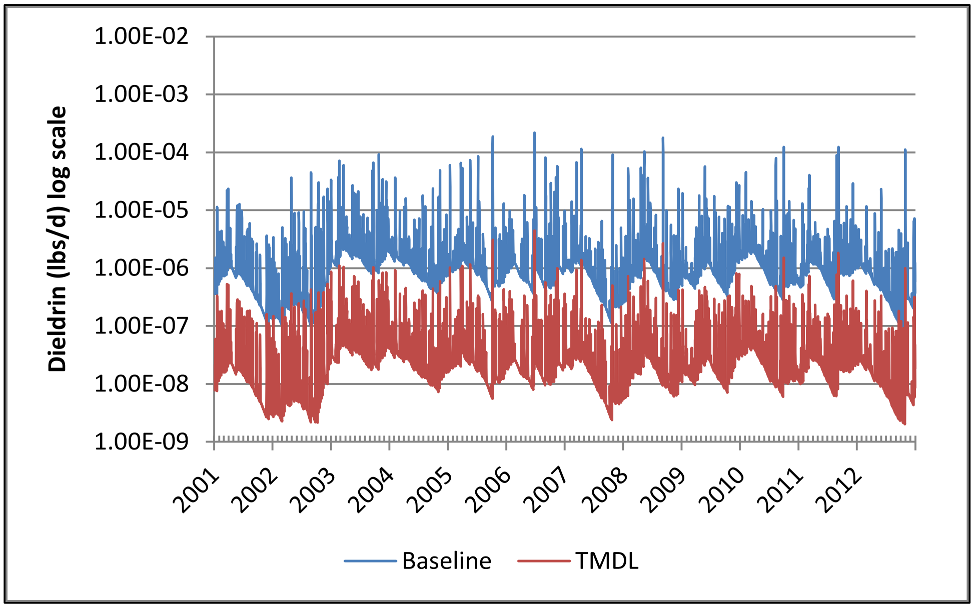

Figure 4.92: Simulated Daily Dieldrin Loads (lbs/d), Piney Branch, Baseline Conditions and TMDL Scenario

Table 4.81 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.82 presents the daily average baseline loads and TMDL allocations, and Table 4.83 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.93 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.94 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.95 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.81: Average Annual Heptachlor Epoxide 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	9.61E-05	6.15E-06	93.6%
	DC Combined Sewer System	2.04E-04	5.10E-07	99.7%
	Total	3.00E-04	6.66E-06	97.8%
Load Allocation	Direct Drainage	2.60E-04	7.06E-06	97.3%
	Upstream Maryland	-	-	-
	Total	2.60E-04	7.06E-06	97.3%
Margin of Safety		-	Implicit	-
Total		5.60E-04	1.37E-05	97.6%

Table 4.82: Heptachlor Epoxide Average Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.63E-07	1.68E-08	93.6%
	DC Combined Sewer System	5.59E-07	1.40E-09	99.7%
	Total	8.22E-07	1.82E-08	97.8%
Load Allocation	Direct Drainage	7.13E-07	1.93E-08	97.3%
	Upstream Maryland	-	-	-
	Total	7.13E-07	1.93E-08	97.3%
Margin of Safety		-	Implicit	-
Total		1.54E-06	3.76E-08	97.6%

Table 4.83: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.71E-05	1.09E-06	93.6%
	DC Combined Sewer System	7.98E-05	1.28E-06	98.4%
	Total	9.69E-05	2.37E-06	97.6%
Load Allocation	Direct Drainage	1.36E-05	8.53E-07	93.7%
	Upstream Maryland	-	-	-
	Total	1.36E-05	8.53E-07	93.7%
Margin of Safety		-	Implicit	-
Total		1.11E-04	3.22E-06	97.1%

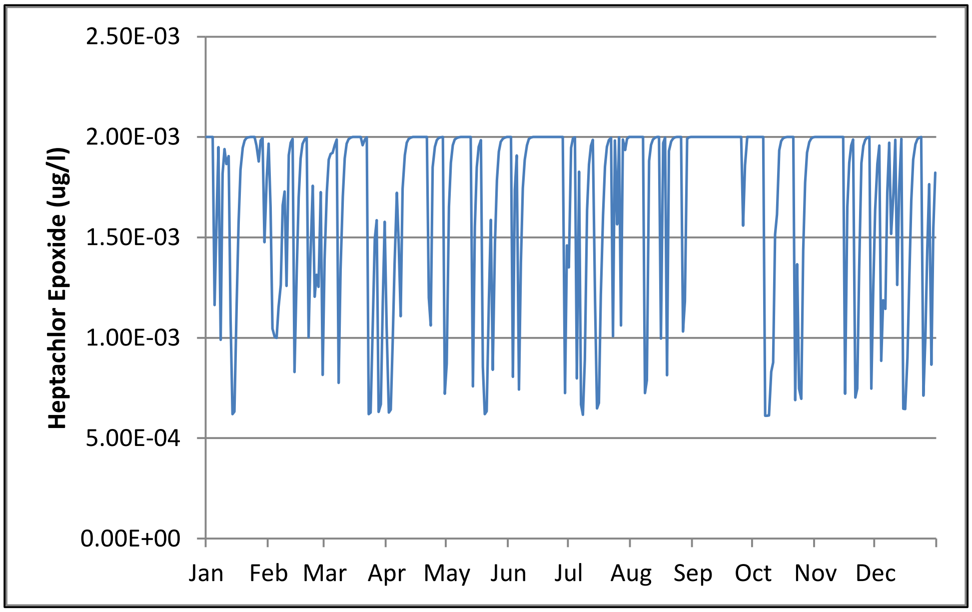

Figure 4.93: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Piney Branch, Baseline Conditions, 2005

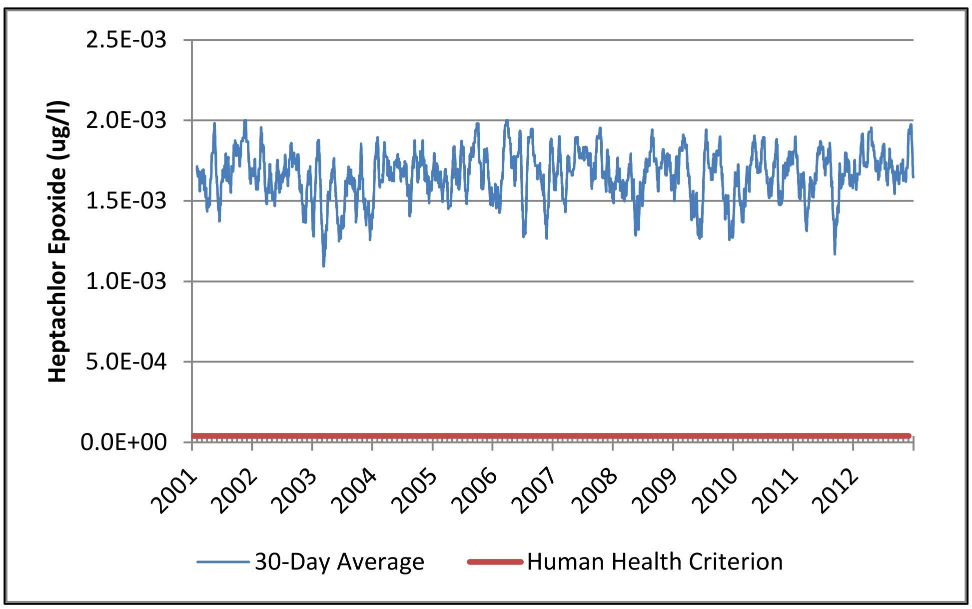

Figure 4.94: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Piney Branch, Baseline Conditions

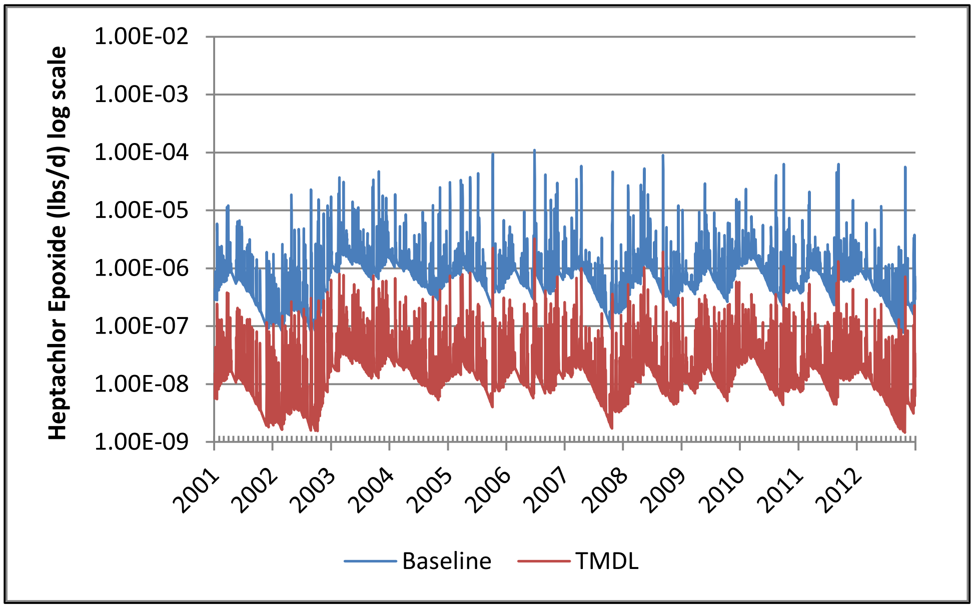

Figure 4.95: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Piney Branch, Baseline Conditions and TMDL Scenario

Table 4.84 presents the average annual baseline chlordane loads and TMDL allocations. Table 4.85 presents the daily average baseline loads and TMDL allocations, and Table 4.86 presents maximum daily baseline chlordane loads and TMDL allocations. Figure 4.96 shows simulated daily chlordane concentrations under baseline conditions in 2005. Unlike dieldrin, the concentration of chlordane in storm flow is greater than the concentration in base flow, so concentrations increase in storm events. Figure 4.97 contrasts the 30-day average chlordane concentration under baseline conditions and the current Class D human health criterion. Figure 4.98 presents simulated daily chlordane loads under baseline conditions and under the TMDL.

Table 4.84: Average Annual Chlordane 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	2.99E-02	1.28E-04	99.6%
	DC Combined Sewer System	6.35E-02	1.06E-05	100.0%
	Total	9.35E-02	1.38E-04	99.9%
Load Allocation	Direct Drainage	5.25E-03	1.47E-04	97.2%
	Upstream Maryland	-	-	-
	Total	5.25E-03	1.47E-04	97.2%
Margin of Safety		-	Implicit	-
Total		9.87E-02	2.85E-04	99.7%

Table 4.85: Chlordane Average Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.20E-05	3.50E-07	99.6%
	DC Combined Sewer System	1.74E-04	2.90E-08	100.0%
	Total	2.56E-04	3.79E-07	99.9%
Load Allocation	Direct Drainage	1.44E-05	4.02E-07	97.2%
	Upstream Maryland	-	-	-
	Total	1.44E-05	4.02E-07	97.2%
Margin of Safety		-	Implicit	-
Total		2.71E-04	7.81E-07	99.7%

Table 4.86: Chlordane Maximum Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.32E-03	2.27E-05	99.6%
	DC Combined Sewer System	2.49E-02	2.65E-05	99.9%
	Total	3.02E-02	4.92E-05	99.8%
Load Allocation	Direct Drainage	1.11E-03	1.77E-05	98.4%
	Upstream Maryland	-	-	-
	Total	1.11E-03	1.77E-05	98.4%
Margin of Safety		-	Implicit	-
Total		3.13E-02	6.69E-05	99.8%

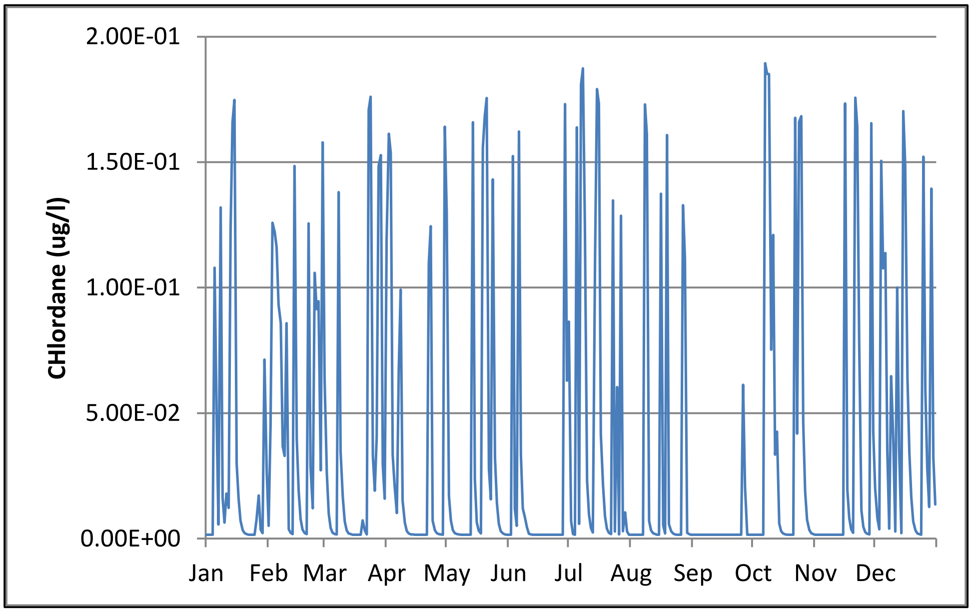

Figure 4.96: Simulated Daily Chlordane Concentrations (µg/l), Piney Branch, Baseline Conditions, 2005

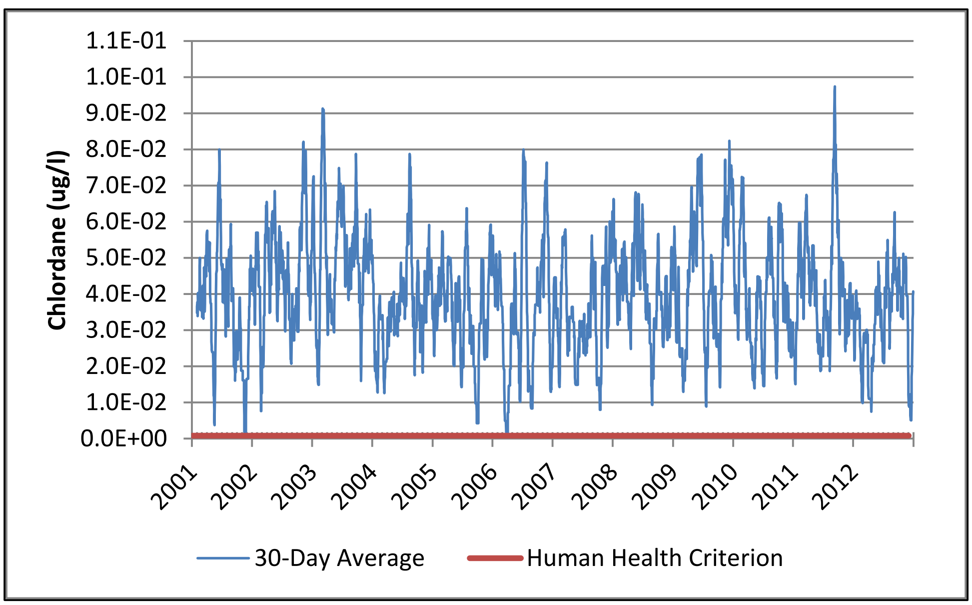

Figure 4.97: Simulated 30-Day Average Chlordane Concentrations (µg/l), Piney Branch, Baseline Conditions

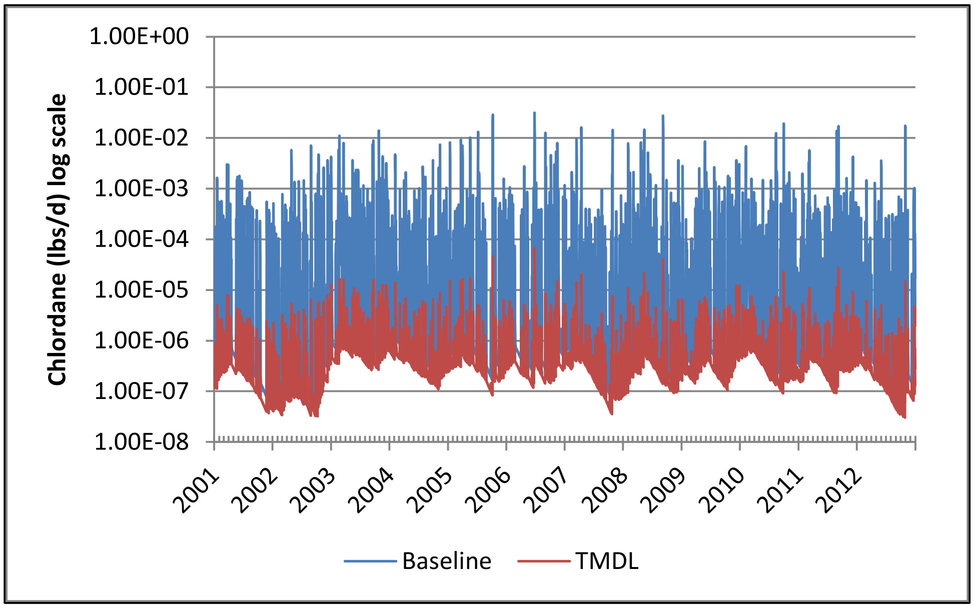

Figure 4.98: Simulated Daily Chlordane Loads (lbs/d), Piney Branch, Baseline Conditions and TMDL Scenario

4.12 Portal Branch

Portal Branch is an eastern tributary of Rock Creek near the northern corner of DC, and joins Fenwick Branch about 120 ft. 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 4.99 shows the location of Portal Branch and its watershed. Table 4.87 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.

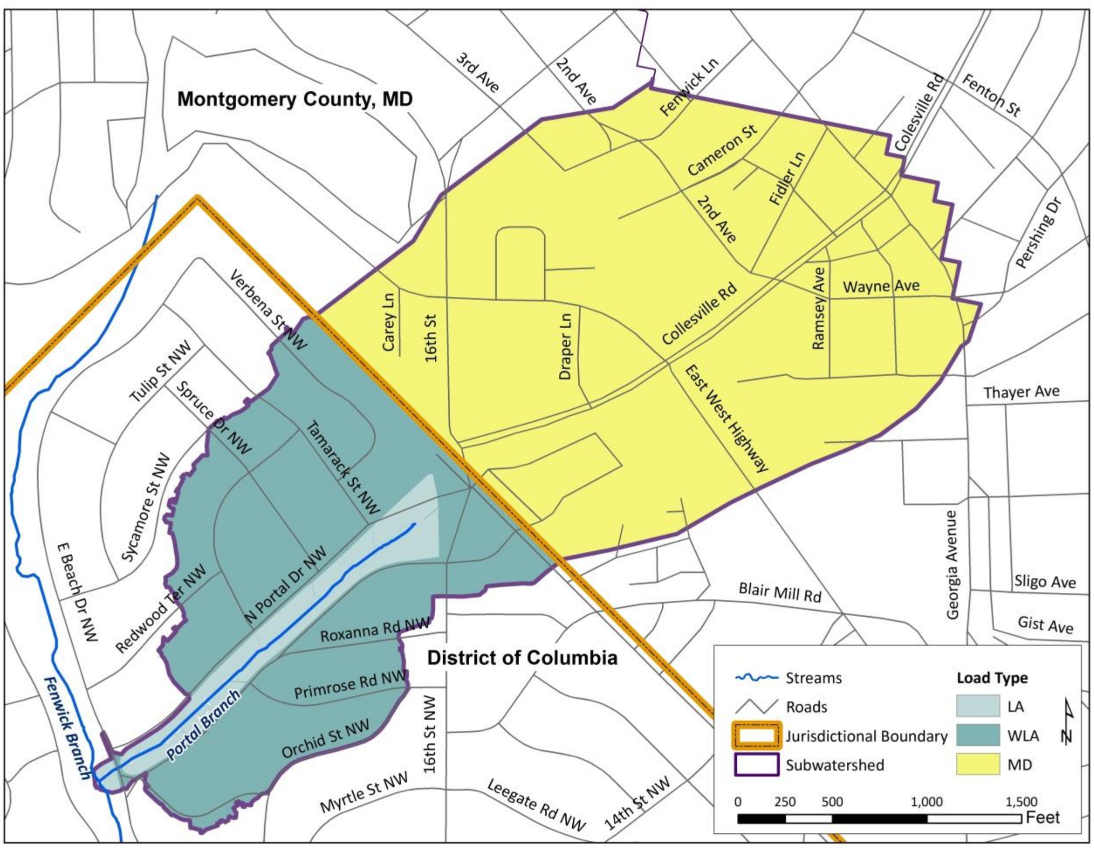

Figure 4.99: Portal Branch and its Watershed

Table 4.87: 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 4.100 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.

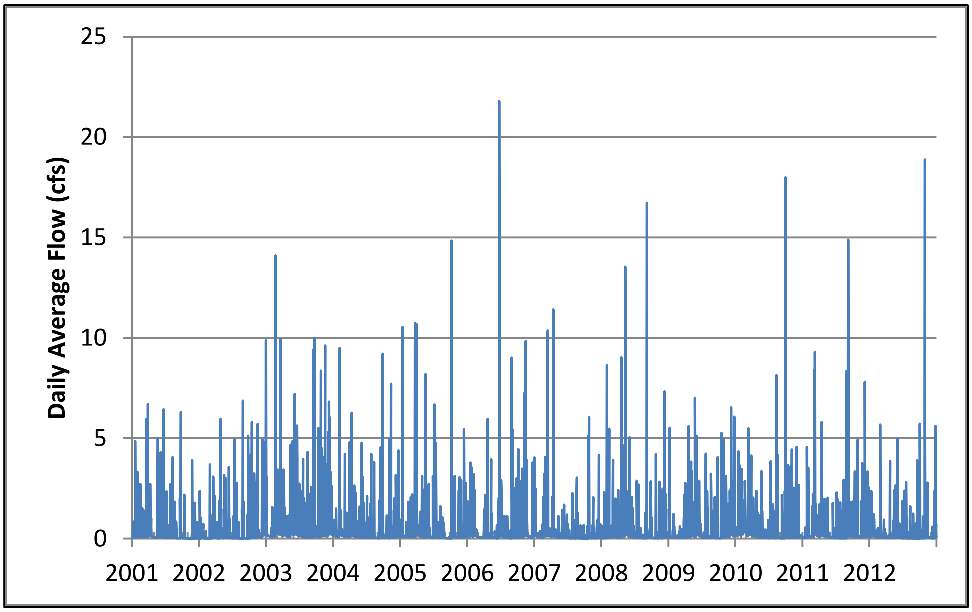

Figure 4.100: Simulated Average Daily Flow (cfs), Portal Branch

Table 4.88 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.89 presents the daily average baseline loads and TMDL allocations, and Table 4.90 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.101 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.102 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.103 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.88: Average Annual Dieldrin 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	2.65E-04	1.19E-05	95.5%
	Total	2.65E-04	1.19E-05	95.5%
Load Allocation	Direct Drainage	1.51E-04	3.55E-06	97.6%
	Upstream Maryland	9.76E-04	3.92E-05	96.0%
	Total	1.13E-03	4.28E-05	96.2%
Margin of Safety		-	Implicit	-
Total		1.39E-03	5.47E-05	96.1%

Table 4.89: Dieldrin Average Daily Loads (lbs/d), Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.25E-07	3.26E-08	95.5%
	Total	7.25E-07	3.26E-08	95.5%
Load Allocation	Direct Drainage	4.13E-07	9.71E-09	97.6%
	Upstream Maryland	2.67E-06	1.08E-07	96.0%
	Total	3.09E-06	1.17E-07	96.2%
Margin of Safety		-	Implicit	-
Total		3.81E-06	1.50E-07	96.1%

Table 4.90: Dieldrin Maximum Daily Loads (lbs/d), Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.11E-05	2.30E-06	95.5%
	Total	5.11E-05	2.30E-06	95.5%
Load Allocation	Direct Drainage	4.46E-06	1.95E-07	95.6%
	Upstream Maryland	9.79E-05	4.40E-06	95.5%
	Total	1.02E-04	4.59E-06	95.5%
Margin of Safety		-	Implicit	-
Total		1.53E-04	6.89E-06	95.5%

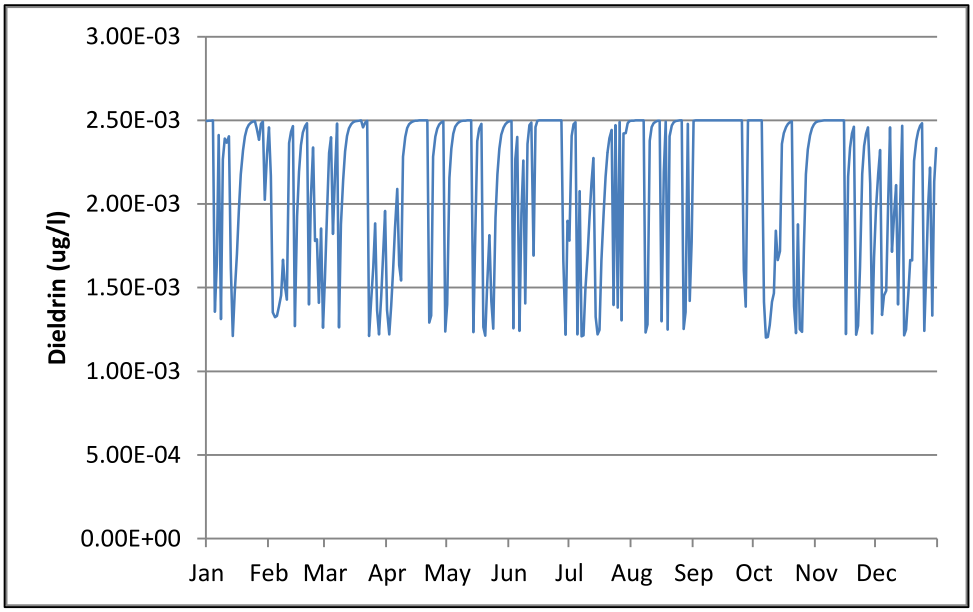

Figure 4.101: Simulated Daily Dieldrin Concentrations (µg/l), Portal Branch, Baseline Conditions, 2005

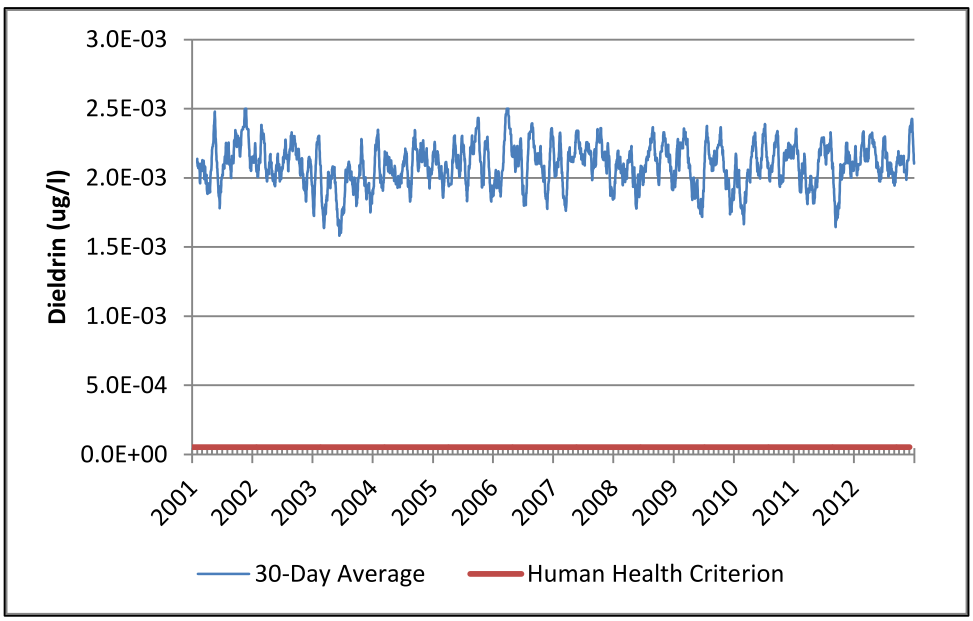

Figure 4.102: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Portal Branch, Baseline Conditions

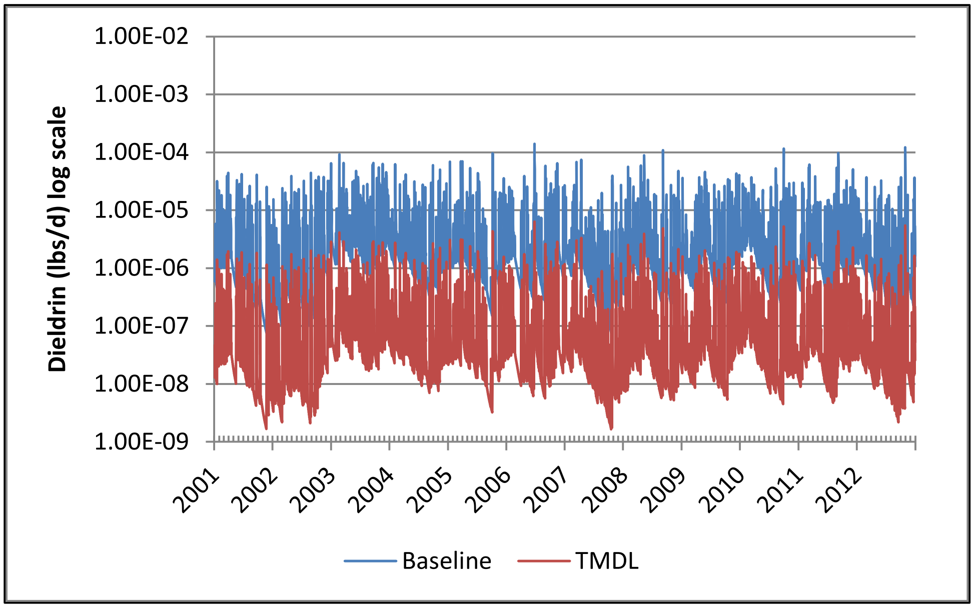

Figure 4.103: Simulated Daily Dieldrin Loads (lbs/d), Portal Branch, Baseline Conditions and TMDL Scenario

Table 4.91 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.92 presents the daily average baseline loads and TMDL allocations, and Table 4.93 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.104 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.105 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.106 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.91: Average Annual Heptachlor Epoxide 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	1.35E-04	8.60E-06	93.6%
	Total	1.35E-04	8.60E-06	93.6%
Load Allocation	Direct Drainage	1.17E-04	2.56E-06	97.8%
	Upstream Maryland	5.54E-04	2.83E-05	94.9%
	Total	6.71E-04	3.09E-05	95.4%
Margin of Safety		-	Implicit	-
Total		8.06E-04	3.95E-05	95.1%

Table 4.92: Heptachlor Epoxide Average Daily Loads (lbs/d), Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.69E-07	2.36E-08	93.6%
	Total	3.69E-07	2.36E-08	93.6%
Load Allocation	Direct Drainage	3.20E-07	7.02E-09	97.8%
	Upstream Maryland	1.52E-06	7.77E-08	94.9%
	Total	1.84E-06	8.47E-08	95.4%
Margin of Safety		-	Implicit	-
Total		2.21E-06	1.08E-07	95.1%

Table 4.93: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.60E-05	1.66E-06	93.6%
	Total	2.60E-05	1.66E-06	93.6%
Load Allocation	Direct Drainage	2.33E-06	1.41E-07	93.9%
	Upstream Maryland	4.99E-05	3.18E-06	93.6%
	Total	5.22E-05	3.32E-06	93.6%
Margin of Safety		-	Implicit	-
Total		7.82E-05	4.98E-06	93.6%

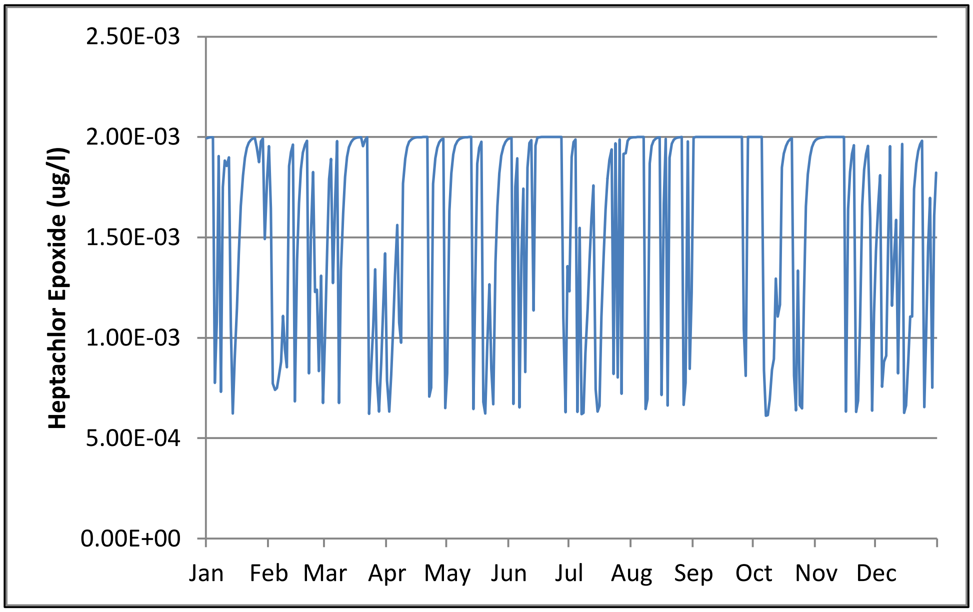

Figure 4.104: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Portal Branch, Baseline Conditions, 2005

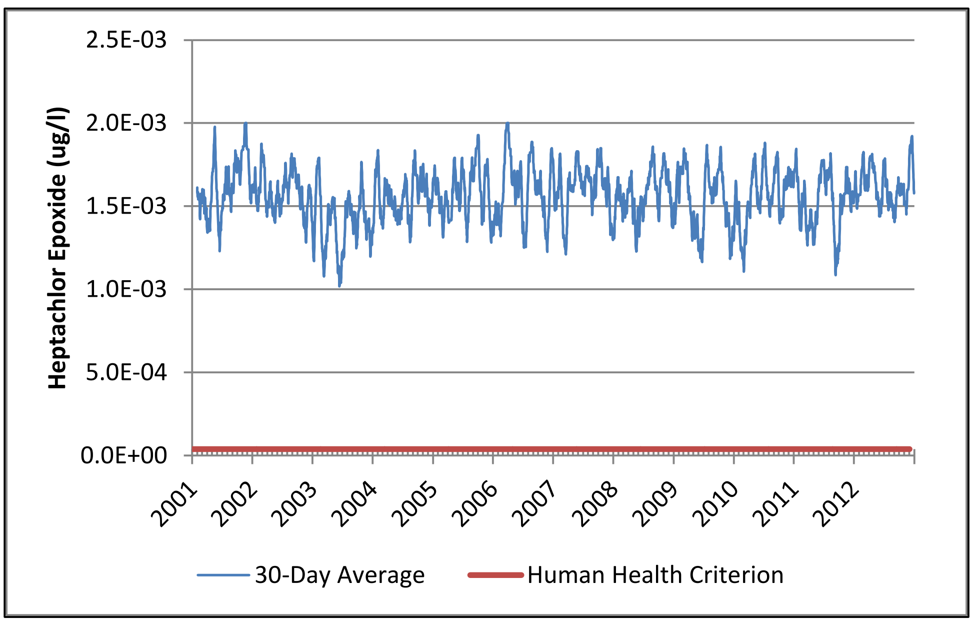

Figure 4.105: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Portal Branch, Baseline Conditions

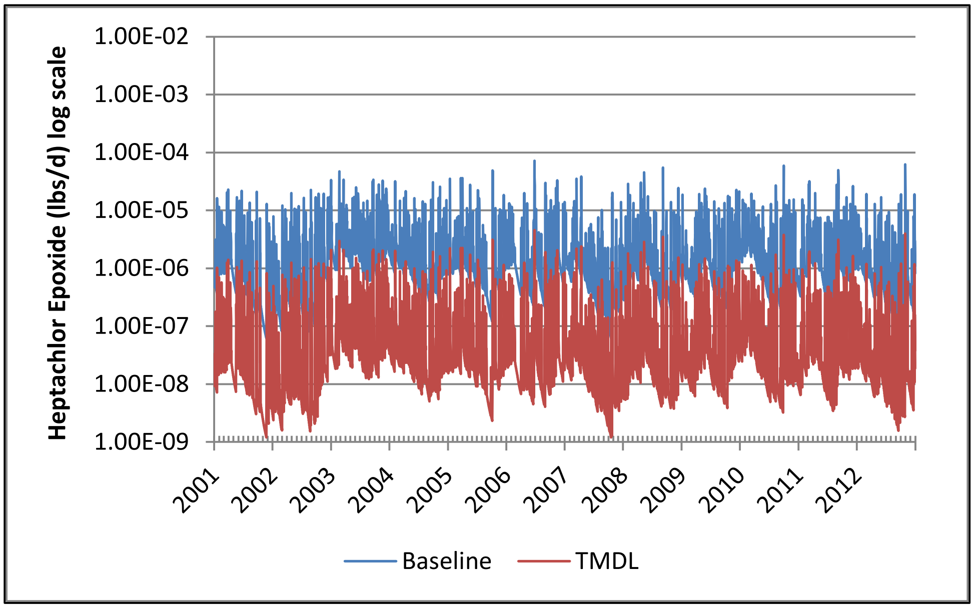

Figure 4.106: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Portal Branch, Baseline Conditions and TMDL Scenario

4.13 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 4.107 shows the location of Soapstone Creek and its watershed (DDOH, 2004a).

Table 4.94 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.

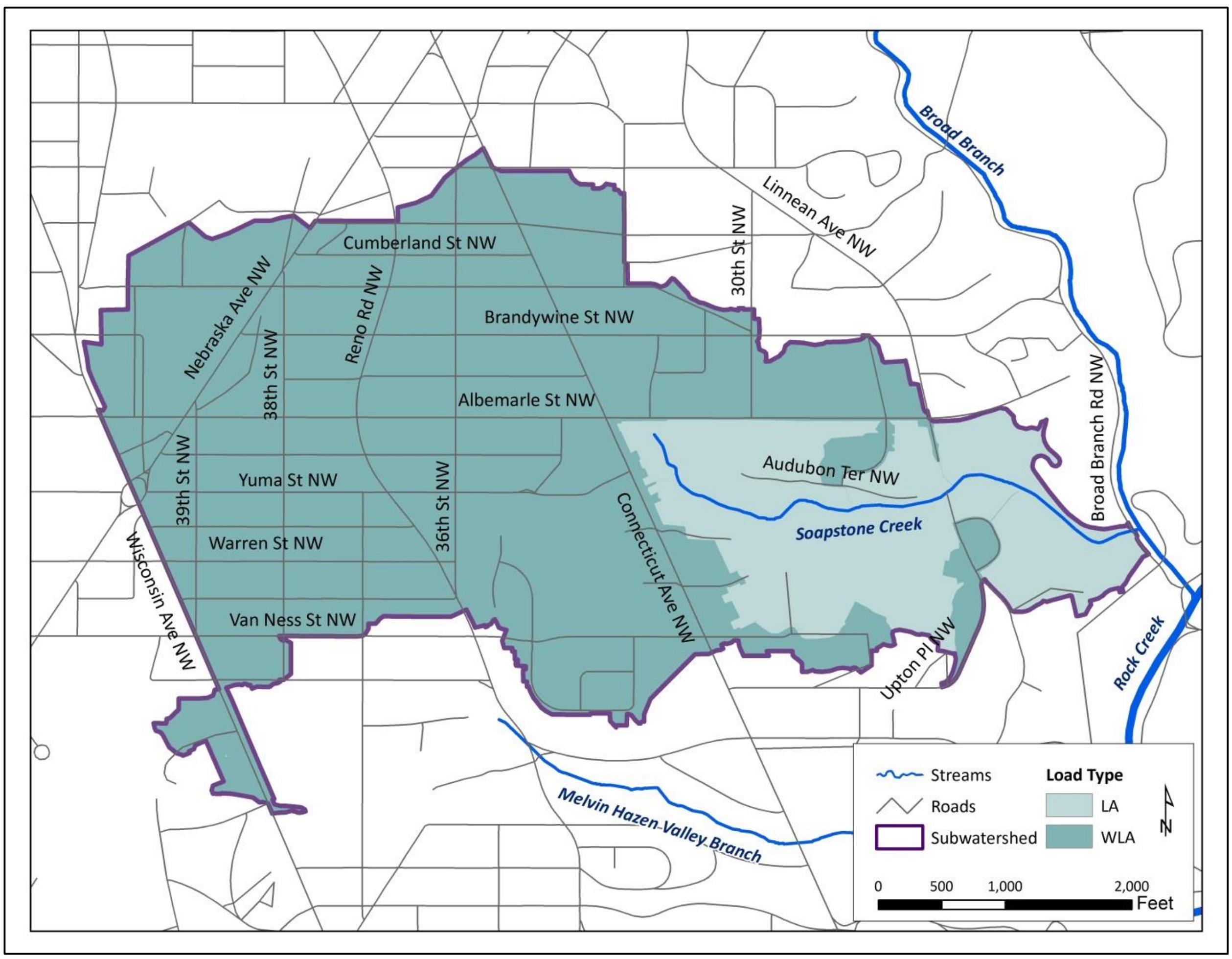

Figure 4.107: Soapstone Creek and its Watershed

Table 4.94: 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 4.108 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.

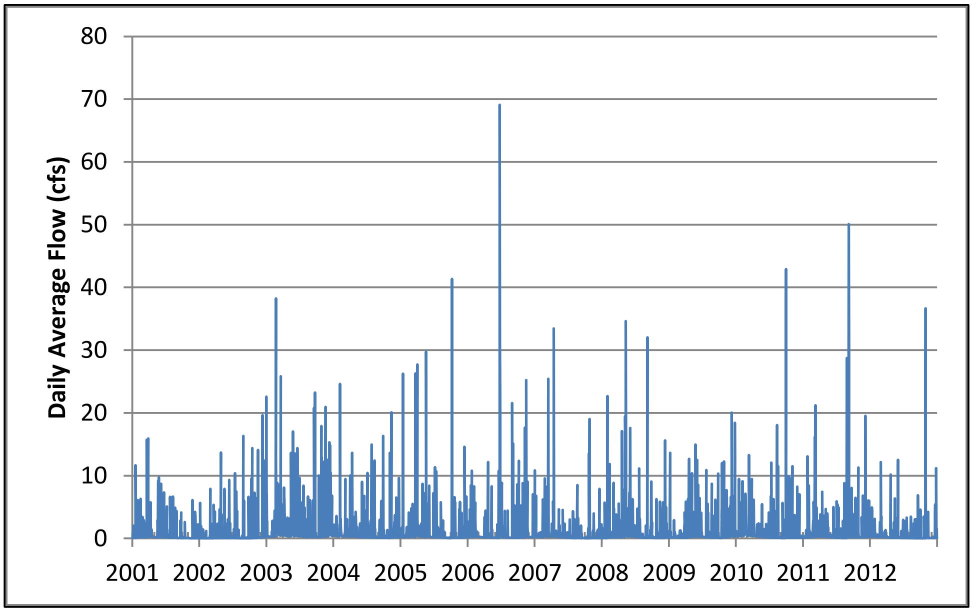

Figure 4.108: Simulated Average Daily Flow (cfs), Soapstone Creek

Table 4.95 presents the average annual baseline dieldrin loads and TMDL allocations. Table 4.96 presents the daily average baseline loads and TMDL allocations, and Table 4.97 presents maximum daily baseline dieldrin loads and TMDL allocations. Figure 4.109 shows simulated daily dieldrin concentrations under baseline conditions in 2005. Since the concentration of dieldrin in storm flow is less than the concentration in base flow, concentrations decrease in storm events. Figure 4.110 contrasts the 30-day average dieldrin concentration under baseline conditions and the current Class D human health criterion. Figure 4.111 presents simulated daily dieldrin loads under baseline conditions and under the TMDL.

Table 4.95: Average Annual Dieldrin 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	2.15E-03	9.67E-05	95.5%
	Total	2.15E-03	9.67E-05	95.5%
Load Allocation	Direct Drainage	1.14E-03	3.17E-05	97.2%
	Upstream Maryland	-	-	-
	Total	1.14E-03	3.17E-05	97.2%
Margin of Safety		-	Implicit	-
Total		3.29E-03	1.28E-04	96.1%

Table 4.96: Dieldrin Average Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.89E-06	2.65E-07	95.5%
	Total	5.89E-06	2.65E-07	95.5%
Load Allocation	Direct Drainage	3.12E-06	8.69E-08	97.2%
	Upstream Maryland	-	-	-
	Total	3.12E-06	8.69E-08	97.2%
Margin of Safety		-	Implicit	-
Total		9.01E-06	3.52E-07	96.1%

Table 4.97: Dieldrin Maximum Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.80E-04	1.71E-05	95.5%
	Total	3.80E-04	1.71E-05	95.5%
Load Allocation	Direct Drainage	6.76E-05	3.01E-06	95.5%
	Upstream Maryland	-	-	-
	Total	6.76E-05	3.01E-06	95.5%
Margin of Safety		-	Implicit	-
Total		4.47E-04	2.01E-05	95.5%

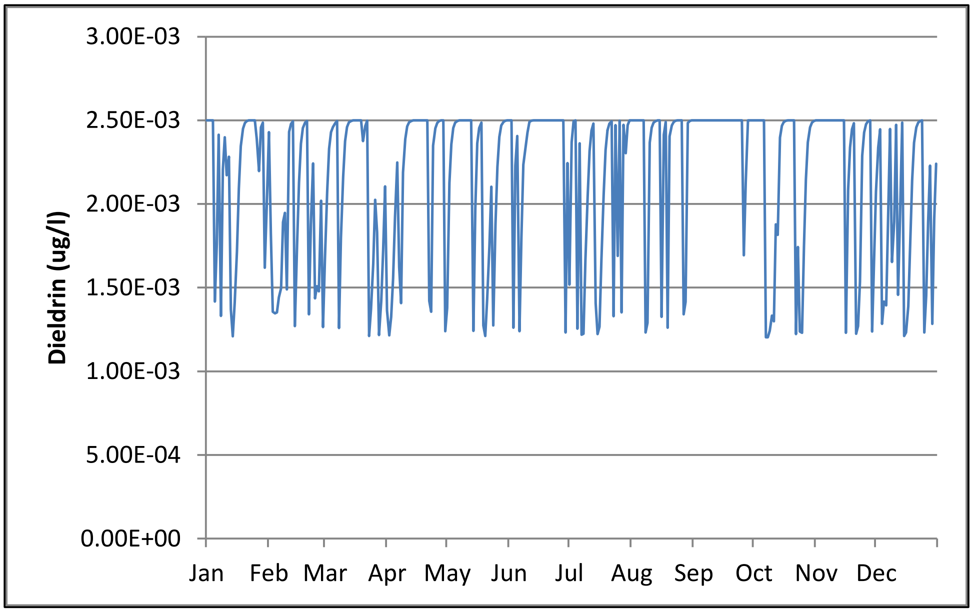

Figure 4.109: Simulated Daily Dieldrin Concentrations (µg/l), Soapstone Creek, Baseline Conditions, 2005

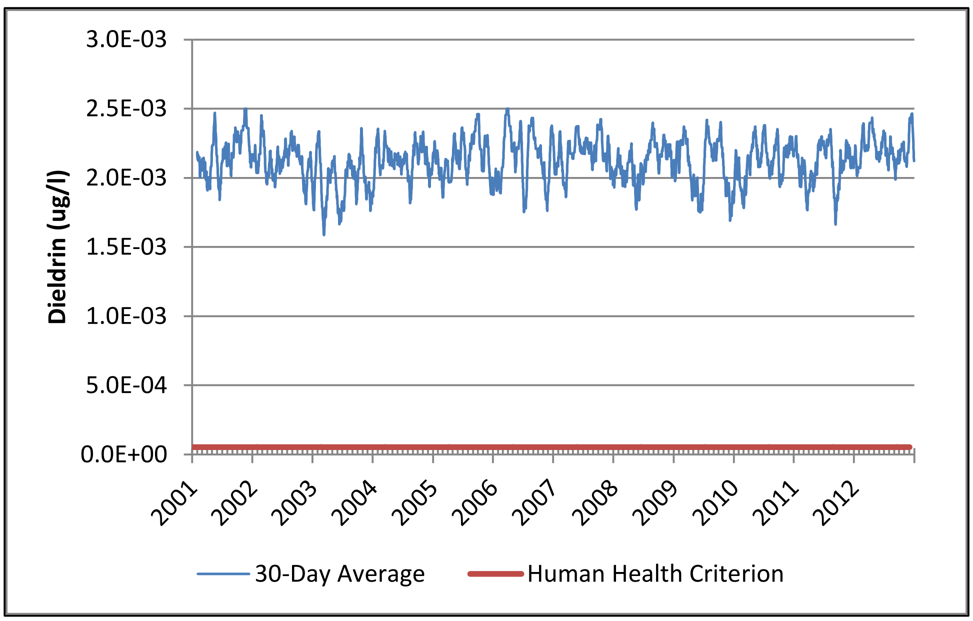

Figure 4.110: Simulated 30-Day Average Dieldrin Concentrations (µg/l), Soapstone Creek, Baseline Conditions

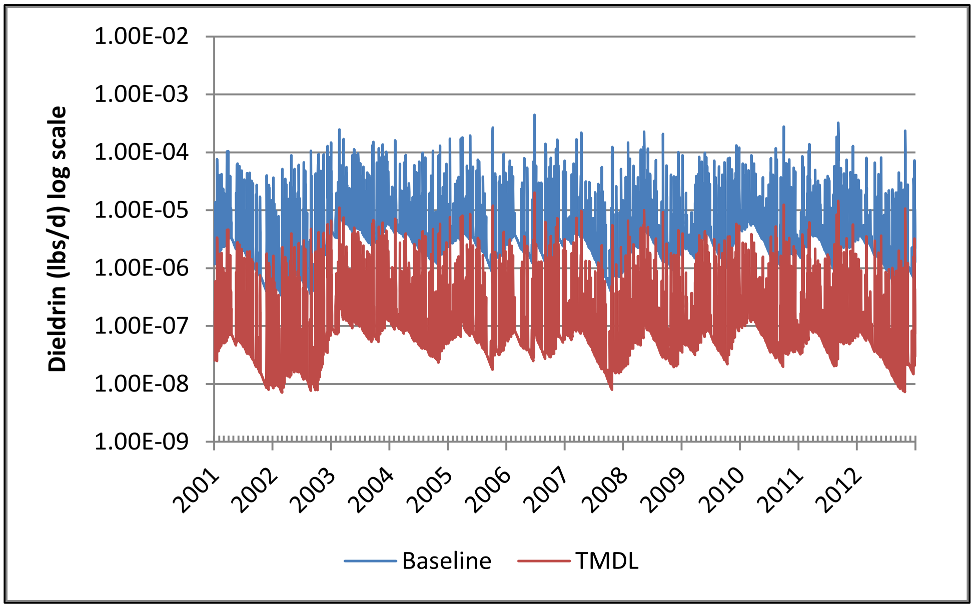

Figure 4.111: Simulated Daily Dieldrin Loads (lbs/d), Soapstone Creek, Baseline Conditions and TMDL Scenario

Table 4.98 presents the average annual baseline heptachlor epoxide loads and TMDL allocations. Table 4.99 presents the daily average baseline loads and TMDL allocations, and Table 4.100 presents maximum daily baseline heptachlor epoxide loads and TMDL allocations. Figure 4.112 shows simulated daily heptachlor epoxide concentrations under baseline conditions in 2005. Like dieldrin, the concentration of heptachlor epoxide in storm flow is less than the concentration in base flow, so concentrations decrease in storm events. Figure 4.113 contrasts the 30-day average heptachlor epoxide concentration under baseline conditions and the current Class D human health criterion. Figure 4.114 presents simulated daily heptachlor epoxide loads under baseline conditions and under the TMDL.

Table 4.98: Average Annual Heptachlor Epoxide 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	1.09E-03	6.98E-05	93.6%
	Total	1.09E-03	6.98E-05	93.6%
Load Allocation	Direct Drainage	8.22E-04	2.29E-05	97.2%
	Upstream Maryland	-	-	-
	Total	8.22E-04	2.29E-05	97.2%
Margin of Safety		-	Implicit	-
Total		1.91E-03	9.28E-05	95.2%

Table 4.99: Heptachlor Epoxide Average Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.99E-06	1.91E-07	93.6%
	Total	2.99E-06	1.91E-07	93.6%
Load Allocation	Direct Drainage	2.25E-06	6.28E-08	97.2%
	Upstream Maryland	-	-	-
	Total	2.25E-06	6.28E-08	97.2%
Margin of Safety		-	Implicit	-
Total		5.24E-06	2.54E-07	95.2%

Table 4.100: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.93E-04	1.23E-05	93.6%
	Total	1.93E-04	1.23E-05	93.6%
Load Allocation	Direct Drainage	3.48E-05	2.18E-06	93.7%
	Upstream Maryland	-	-	-
	Total	3.48E-05	2.18E-06	93.7%
Margin of Safety		-	Implicit	-
Total		2.28E-04	1.45E-05	93.6%

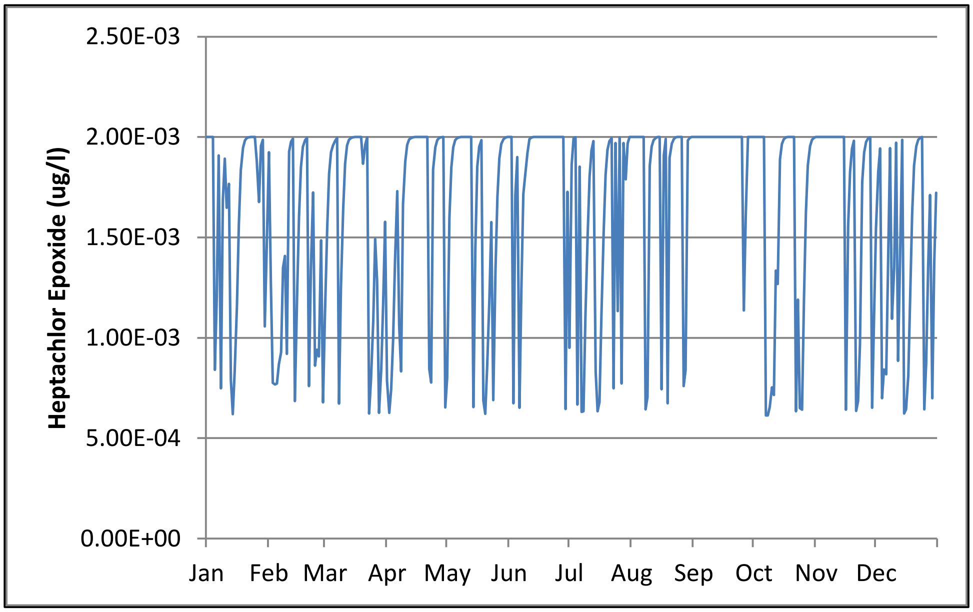

Figure 4.112: Simulated Daily Heptachlor Epoxide Concentrations (µg/l), Soapstone Creek, Baseline Conditions, 2005

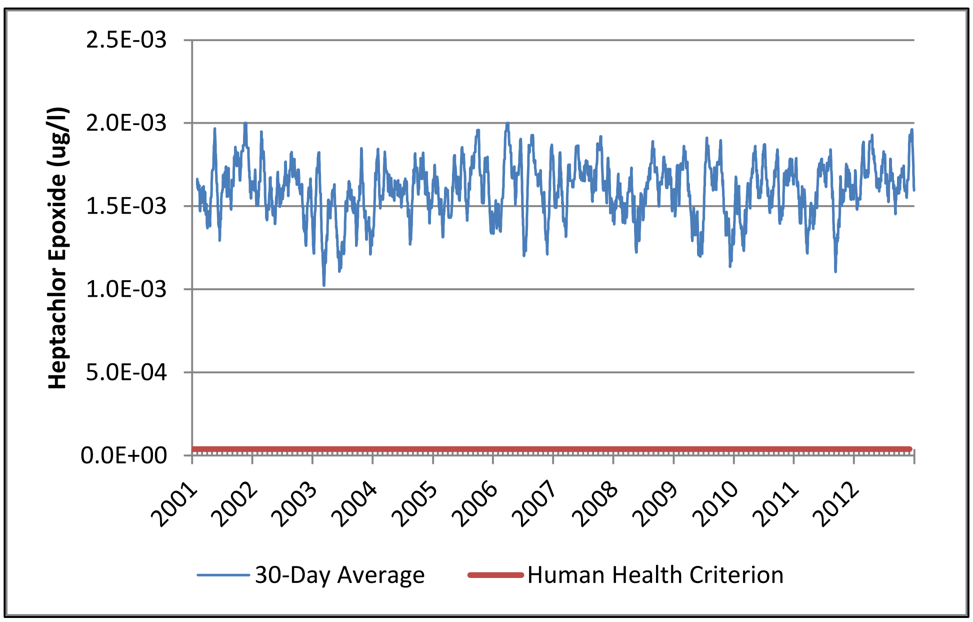

Figure 4.113: Simulated 30-Day Average Heptachlor Epoxide Concentrations (µg/l), Soapstone Creek, Baseline Conditions

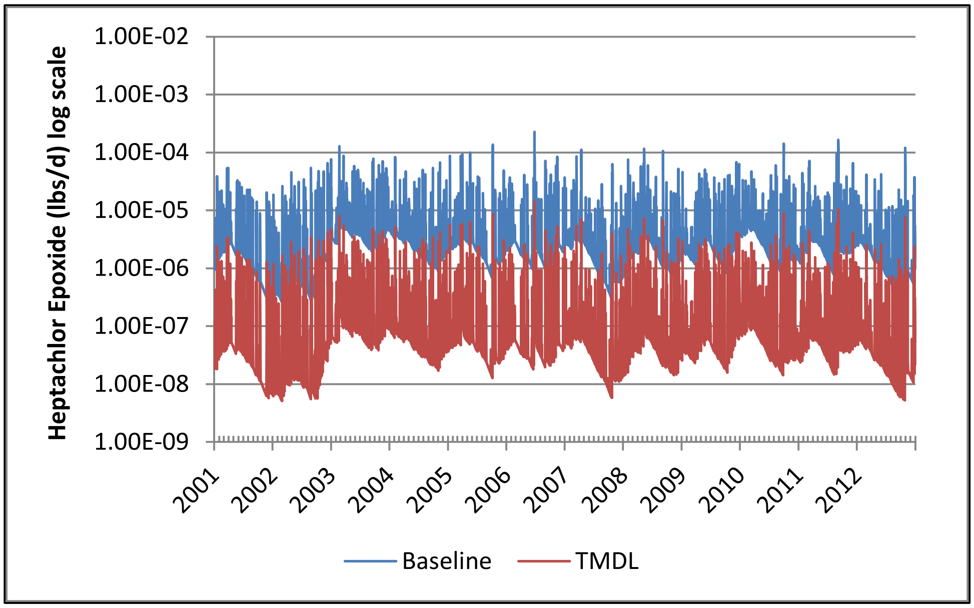

Figure 4.114: Simulated Daily Heptachlor Epoxide Loads (lbs/d), Soapstone Creek, Baseline Conditions and TMDL Scenario

Table 4.101 presents the average annual baseline chlordane loads and TMDL allocations. Table 4.102 presents the daily average baseline loads and TMDL allocations, and Table 4.103 presents maximum daily baseline chlordane loads and TMDL allocations. Figure 4.115 shows simulated daily chlordane concentrations under baseline conditions in 2005. Unlike dieldrin, the concentration of chlordane in storm flow is greater than the concentration in base flow, so concentrations increase in storm events. Figure 4.116 contrasts the 30-day average chlordane concentration under baseline conditions and the current Class D human health criterion. Figure 4.117 presents simulated daily chlordane loads under baseline conditions and under the TMDL.

Table 4.101: Average Annual Chlordane 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	3.40E-01	1.45E-03	99.6%
	Total	3.40E-01	1.45E-03	99.6%
Load Allocation	Direct Drainage	3.92E-02	4.76E-04	98.8%
	Upstream Maryland	-	-	-
	Total	3.92E-02	4.76E-04	98.8%
Margin of Safety		-	Implicit	-
Total		3.79E-01	1.93E-03	99.5%

Table 4.102: Chlordane Average Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	9.32E-04	3.97E-06	99.6%
	Total	9.32E-04	3.97E-06	99.6%
Load Allocation	Direct Drainage	1.07E-04	1.30E-06	98.8%
	Upstream Maryland	-	-	-
	Total	1.07E-04	1.30E-06	98.8%
Margin of Safety		-	Implicit	-
Total		1.04E-03	5.28E-06	99.5%

Table 4.103: Chlordane Maximum Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.01E-02	2.56E-04	99.6%
	Total	6.01E-02	2.56E-04	99.6%
Load Allocation	Direct Drainage	7.23E-03	4.52E-05	99.4%
	Upstream Maryland	-	-	-
	Total	7.23E-03	4.52E-05	99.4%
Margin of Safety		-	Implicit	-
Total		6.73E-02	3.01E-04	99.6%

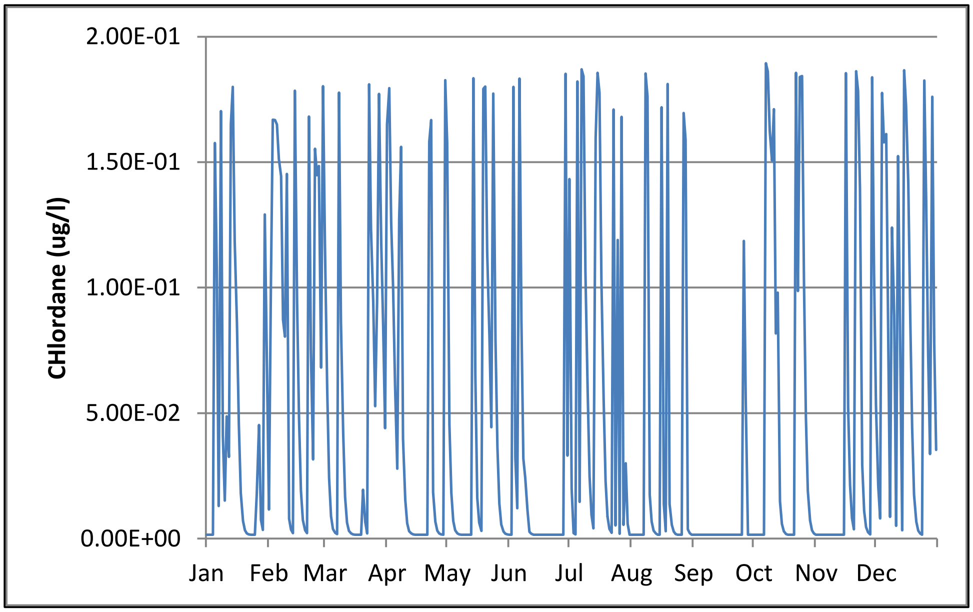

Figure 4.115: Simulated Daily Chlordane Concentrations (µg/l), Soapstone Creek, Baseline Conditions, 2005

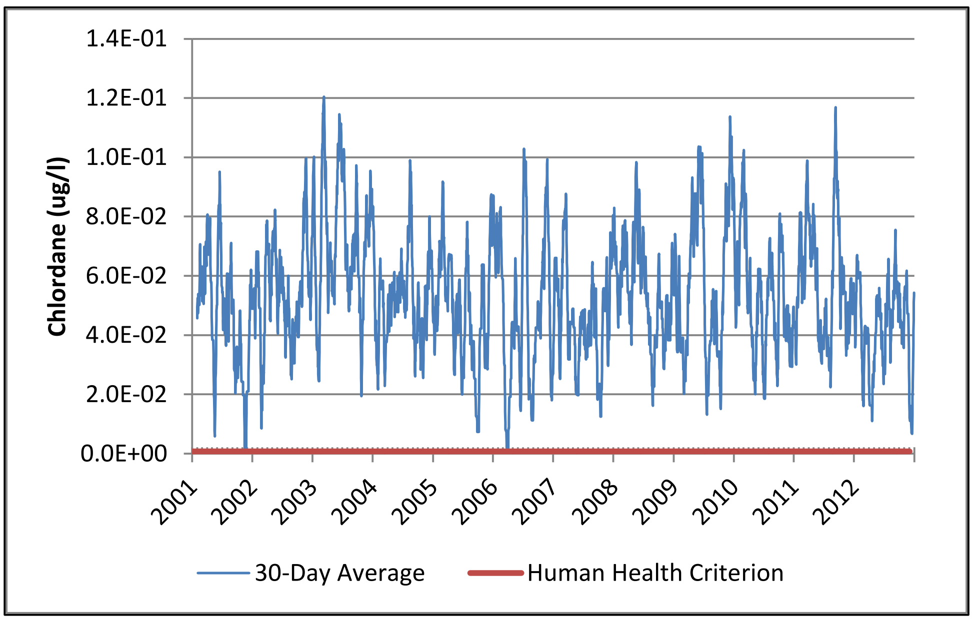

Figure 4.116: Simulated 30-Day Average Chlordane Concentrations (µg/l), Soapstone Creek, Baseline Conditions

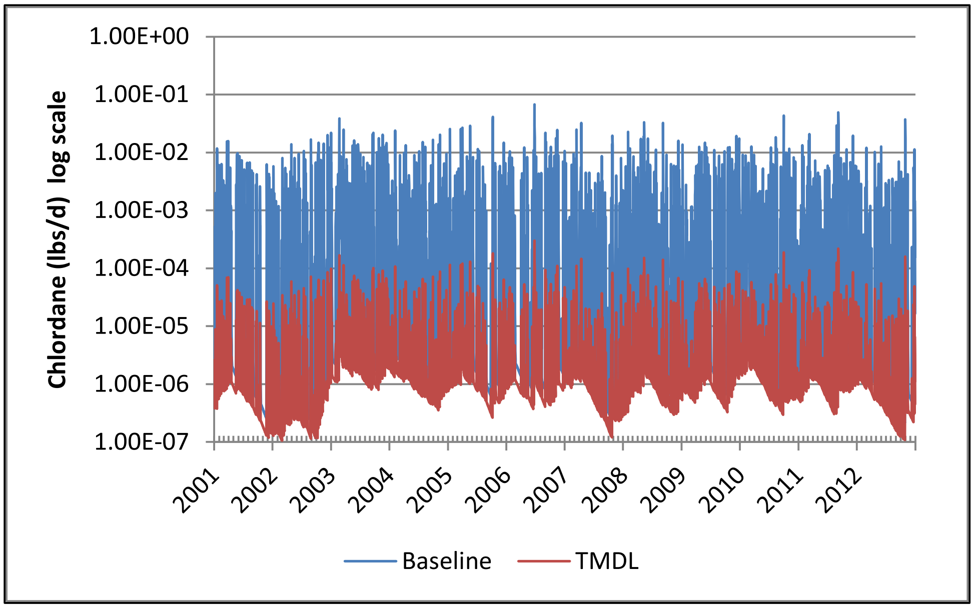

Figure 4.117: Simulated Daily Chlordane Loads (lbs/d), Soapstone Creek, Baseline Conditions and TMDL Scenario

5 Conclusion

A simple computer simulation model, the Small Tributary Pesticide Model (STPM), has been developed and used to revise 30 pesticide TMDLs for small tributaries in DC's portion of the Rock Creek and Potomac River watersheds. 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
- Storm water and instream pesticide monitoring data.

TMDLs were established based on all sources meeting the District's acute and chronic aquatic life criteria for pesticides 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.*

Table 5.1 shows the total average annual TMDLs for chlordane under the original TMDLs and the current TMDLs. The District is considering adopting EPA's recommended changes to the 30-day average criteria to protect human health related to fish and shellfish consumption during its 2016 triennial review, and Table 5.1 also shows the potential TMDLs based on the potential revision to the health criterion under consideration. Tables 5.2, 5.3, and 5.4 show the same information for dieldrin, heptachlor epoxide, and DDT, respectively. The tables also show the percent difference between the original TMDL, on the one hand, and the current TMDL and the TMDL based on revised human health criteria, on the other. With the exception of the chlordane TMDLs for Broad Branch and Piney Branch, the revised TMDLs under the current criteria are more stringent than the original TMDLs, while for all pesticides, the potential TMDLs under the proposed criteria are more stringent than either the revised or original TMDLs.

Generally, with the exception of the chlordane TMDLs, the overall differences in the TMDLs are primarily due to the changes in criteria, while the variability in the differences is due to differences in simulated hydrology and the methods used to set the allocations under the original TMDLs. Table 5.5 gives the 2004, current, and proposed 30-day human health criteria for dieldrin, heptachlor epoxide, and DDT, as well as percent difference between the 2004 criteria, on the one hand, and current and proposed criteria, on the other. The current human health criterion for chlordane is less strict than the criterion in effect at the time the original TMDLs were developed; the human health criteria for dieldrin, heptachlor epoxide, and DDT are currently stricter than the criteria in place for the original TMDLs. The average percent differences between the original TMDLs and the current TMDLs are -44%, -55%, and -63%, for dieldrin, heptachlor epoxide, and DDT, respectively, while the corresponding differences in the human health criteria are -63%, -61%, and -65%. Under the revised human health criteria which the District is considering for adoption, all human health criteria for pesticides would be more stringent than either the current criteria or the criteria in place when the original TMDLs were developed. The average percent differences between the original TMDL and the TMDL based on the proposed criteria are -65%, -99%, -63%, and -95%, for chlordane, dieldrin, heptachlor epoxide, and DDT, respectively, while the corresponding differences in the human health criteria are -46%, -95%, -99%, and -71%, respectively. The potential TMDLs under the revised criteria under consideration would be stricter than either the original TMDLs or the revised TMDLs based on current criteria.

Table 5.1: Chlordane Average Annual TMDL Load Allocations (lbs/yr)

			Current TMDL		Potential Future TMDL	
Mainstem	Tributary	Original TMDL	Load	Percent Difference From Original	Load	Percent Difference From Original
Rock Creek	Broad Branch	3.677E-03	3.85E-03	4.7%	1.52E-03	-58.7%
	Dumbarton Oaks	7.254E-04	4.04E-04	-44.3%	1.60E-04	-77.9%
	Luzon Branch	2.618E-03	2.52E-03	-3.7%	9.95E-04	-62.0%
	Piney Branch	2.749E-04	2.85E-04	3.7%	1.13E-04	-58.9%
	Soapstone Creek	2.359E-03	1.93E-03	-18.2%	7.61E-04	-67.7%

Table 5.2: Dieldrin Average Annual TMDL Load Allocations (lbs/yr)

			Current TMDL		Potential Future TMDL	
Mainstem	Tributary	Original TMDL	Load	Percent Difference From Original	Load	Percent Difference From Original
Rock Creek	Broad Branch	4.43E-04	2.56E-04	-42.2%	5.70E-06	-98.7%
	Dumbarton Oaks	6.60E-05	2.69E-05	-59.2%	5.99E-07	-99.1%
	Fenwick Branch	2.40E-04	1.44E-04	-40.0%	3.21E-06	-98.7%
	Klingle Valley Creek	1.39E-04	3.94E-05	-71.7%	8.75E-07	-99.4%
	Luzon Branch	2.55E-04	1.68E-04	-34.1%	3.73E-06	-98.5%
	Melvin Hazen Valley Branch	7.23E-05	3.70E-05	-48.8%	8.22E-07	-98.9%
	Normanstone Creek	9.79E-05	4.91E-05	-49.8%	1.09E-06	-98.9%
	Piney Branch	2.75E-05	1.90E-05	-30.9%	4.22E-07	-98.5%
	Pinehurst Branch	2.43E-04	1.33E-04	-45.3%	2.95E-06	-98.8%
	Portal Branch	8.35E-05	5.47E-05	-34.5%	1.22E-06	-98.5%
	Soapstone Creek	2.04E-04	1.28E-04	-37.3%	2.85E-06	-98.6%
Potomac	Dalecarlia Tributary	4.36E-04	2.54E-04	-41.7%	5.65E-06	-98.7%
	Oxon Run	3.26E-03	1.93E-03	-40.9%	9.68E-06	-99.7%

Table 5.3: Heptachlor Epoxide Average Annual TMDL Load Allocations (lbs/yr)

Mainstem	Tributary	Original TMDL	Current TMDL		Potential Future TMDL	
			Load	Percent Difference From Original	Load	Percent Difference From Original
Rock Creek	Broad Branch	3.72E-04	1.85E-04	-50.3%	1.52E-04	-59.1%
	Dumbarton Oaks	6.38E-05	1.95E-05	-69.4%	1.60E-05	-74.9%
	Fenwick Branch	1.89E-04	1.04E-04	-45.0%	8.55E-05	-54.8%
	Klingle Valley Creek	1.32E-04	2.84E-05	-78.5%	2.33E-05	-82.3%
	Luzon Branch	2.38E-04	1.21E-04	-49.2%	9.95E-05	-58.2%
	Normanstone Creek	8.87E-05	3.55E-05	-60.0%	2.91E-05	-67.2%
	Piney Branch	3.58E-05	1.37E-05	-61.7%	1.13E-05	-68.4%
	Pinehurst Branch	1.84E-04	9.60E-05	-47.8%	7.88E-05	-57.2%
	Portal Branch	6.57E-05	3.95E-05	-39.9%	3.24E-05	-50.7%
	Soapstone Creek	2.03E-04	9.28E-05	-54.3%	7.61E-05	-62.5%
Potomac	Dalecarlia Tributary	3.79E-04	1.84E-04	-51.5%	1.51E-04	-60.2%

Table 5.4: DDT Average Annual TMDL Load Allocations (lbs/yr)

Mainstem	Tributary	Original TMDL	Current TMDL		Potential Future TMDL	
			Load	Percent Difference From Original	Load	Percent Difference From Original
Rock Creek	Fenwick Branch	1.58E-03	5.88E-04	-62.8%	8.02E-05	-94.9%

Table 5.5: Changes in Class D 30-Day Human Health Criteria (µg/l)

Pesticide	2004 Criteria	Current TMDL		Potential Future TMDL	
		Criteria	Percent Difference From 2004 Criteria	Criteria	Percent Difference From 2004 Criteria
Chlordane	0.00059	0.00081	37.3%	0.00032	-45.8%
Dieldrin	0.00059	0.00022	-62.7%	0.00003	-94.9%
Heptachlor Epoxide	0.00014	0.000054	-61.4%	1.2E-06	-99.1%
DDT	0.00011	0.000039	-64.5%	0.000032	-70.9%

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Appendix A: Future TMDL Allocations under Proposed Class D Human Health Criteria

Appendix A presents baseline loads and allocations for all small tributaries and pesticides under the Future TMDL Scenario. Under the Future TMDL Scenario, as explained in Section 3.3, allocations are calculated using the proposed Class D human health criteria that DOEE may adopt during its next triennial review. The TMDLs are expressed as average annual loads, daily average loads, and maximum daily loads, and were calculated as they were presented in Section 4.

Table A.1: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.13E-03	4.13E-06	99.9%
	Total	4.13E-03	4.13E-06	99.9%
Load Allocation	Direct Drainage	2.73E-03	1.57E-06	99.9%
	Upstream Maryland	-	-	-
	Total	2.73E-03	1.57E-06	99.9%
Margin of Safety		-	Implicit	-
Total		6.86E-03	5.70E-06	99.9%

Table A.2: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Broad Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.13E-05	1.13E-08	99.9%
	Total	1.13E-05	1.13E-08	99.9%
Load Allocation	Direct Drainage	7.47E-06	4.30E-09	99.9%
	Upstream Maryland	-	-	-
	Total	7.47E-06	4.30E-09	99.9%
Margin of Safety		-	Implicit	-
Total		1.88E-05	1.56E-08	99.9%

Table A.3: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Broad Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.67E-04	7.67E-07	99.9%
	Total	7.67E-04	7.67E-07	99.9%
Load Allocation	Direct Drainage	1.35E-04	1.33E-07	99.9%
	Upstream Maryland	-	-	-
	Total	1.35E-04	1.33E-07	99.9%
Margin of Safety		-	Implicit	-
Total		9.02E-04	9.00E-07	99.9%

Table A.4: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.10E-03	1.10E-04	94.8%
	Total	2.10E-03	1.10E-04	94.8%
Load Allocation	Direct Drainage	2.04E-03	4.18E-05	97.9%
	Upstream Maryland	-	-	-
	Total	2.04E-03	4.18E-05	97.9%
Margin of Safety		-	Implicit	-
Total		4.14E-03	1.52E-04	96.3%

Table A.5: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Broad Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.75E-06	3.02E-07	94.8%
	Total	5.75E-06	3.02E-07	94.8%
Load Allocation	Direct Drainage	5.58E-06	1.15E-07	97.9%
	Upstream Maryland	-	-	-
	Total	5.58E-06	1.15E-07	97.9%
Margin of Safety		-	Implicit	-
Total		1.13E-05	4.16E-07	96.3%

Table A.6: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Broad Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.90E-04	2.04E-05	94.8%
	Total	3.90E-04	2.04E-05	94.8%
Load Allocation	Direct Drainage	6.97E-05	3.55E-06	94.9%
	Upstream Maryland	-	-	-
	Total	6.97E-05	3.55E-06	94.9%
Margin of Safety		-	Implicit	-
Total		4.60E-04	2.40E-05	94.8%

Table A.7: Average Annual Chlordane Baseline Loads and Future TMDL Allocations (lbs/yr), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.54E-01	1.10E-03	99.8%
	Total	6.54E-01	1.10E-03	99.8%
Load Allocation	Direct Drainage	4.58E-02	4.18E-04	99.1%
	Upstream Maryland	-	-	-
	Total	4.58E-02	4.18E-04	99.1%
Margin of Safety		-	Implicit	-
Total		7.00E-01	1.52E-03	99.8%

Table A.8: Chlordane Average Daily Loads (lbs/d), Future TMDL Scenario, Broad Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.79E-03	3.02E-06	99.8%
	Total	1.79E-03	3.02E-06	99.8%
Load Allocation	Direct Drainage	1.26E-04	1.15E-06	99.1%
	Upstream Maryland	-	-	-
	Total	1.26E-04	1.15E-06	99.1%
Margin of Safety		-	Implicit	-
Total		1.92E-03	4.16E-06	99.8%

Table A.9: Chlordane Maximum Daily Loads (lbs/d), Future TMDL Scenario, Broad Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.21E-01	2.04E-04	99.8%
	Total	1.21E-01	2.04E-04	99.8%
Load Allocation	Direct Drainage	9.02E-03	3.55E-05	99.6%
	Upstream Maryland	-	-	-
	Total	9.02E-03	3.55E-05	99.6%
Margin of Safety		-	Implicit	-
Total		1.30E-01	2.40E-04	99.8%

Table A.10: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.43E-03	4.43E-06	99.9%
	Total	4.43E-03	4.43E-06	99.9%
Load Allocation	Direct Drainage	2.23E-03	1.22E-06	99.9%
	Upstream Maryland	-	-	-
	Total	2.23E-03	1.22E-06	99.9%
Margin of Safety		-	Implicit	-
Total		6.66E-03	5.65E-06	99.9%

Table A.11: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.21E-05	1.21E-08	99.9%
	Total	1.21E-05	1.21E-08	99.9%
Load Allocation	Direct Drainage	6.10E-06	3.33E-09	99.9%
	Upstream Maryland	-	-	-
	Total	6.10E-06	3.33E-09	99.9%
Margin of Safety		-	Implicit	-
Total		1.83E-05	1.55E-08	99.9%

Table A.12: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.24E-04	8.24E-07	99.9%
	Total	8.24E-04	8.24E-07	99.9%
Load Allocation	Direct Drainage	7.90E-05	7.73E-08	99.9%
	Upstream Maryland	-	-	-
	Total	7.90E-05	7.73E-08	99.9%
Margin of Safety		-	Implicit	-
Total		9.03E-04	9.02E-07	99.9%

Table A.13: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.25E-03	1.18E-04	94.8%
	Total	2.25E-03	1.18E-04	94.8%
Load Allocation	Direct Drainage	1.70E-03	3.24E-05	98.1%
	Upstream Maryland	-	-	-
	Total	1.70E-03	3.24E-05	98.1%
Margin of Safety		-	Implicit	-
Total		3.95E-03	1.51E-04	96.2%

Table A.14: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.17E-06	3.24E-07	94.8%
	Total	6.17E-06	3.24E-07	94.8%
Load Allocation	Direct Drainage	4.66E-06	8.88E-08	98.1%
	Upstream Maryland	-	-	-
	Total	4.66E-06	8.88E-08	98.1%
Margin of Safety		-	Implicit	-
Total		1.08E-05	4.13E-07	96.2%

Table A.15: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Dalecarlia Tributary

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.19E-04	2.20E-05	94.8%
	Total	4.19E-04	2.20E-05	94.8%
Load Allocation	Direct Drainage	4.11E-05	2.06E-06	95.0%
	Upstream Maryland	-	-	-
	Total	4.11E-05	2.06E-06	95.0%
Margin of Safety		-	Implicit	-
Total		4.60E-04	2.40E-05	94.8%

Table A.16: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.91E-05	7.91E-08	99.9%
	Total	7.91E-05	7.91E-08	99.9%
Load Allocation	Direct Drainage	6.87E-04	5.20E-07	99.9%
	Upstream Maryland	-	-	-
	Total	6.87E-04	5.20E-07	99.9%
Margin of Safety		-	Implicit	-
Total		7.66E-04	5.99E-07	99.9%

Table A.17: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/ d)	TMDL (lbs/ d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.17E-07	2.17E-10	99.9%
	Total	2.17E-07	2.17E-10	99.9%
Load Allocation	Direct Drainage	1.88E-06	1.42E-09	99.9%
	Upstream Maryland	-	-	-
	Total	1.88E-06	1.42E-09	99.9%
Margin of Safety		-	Implicit	-
Total		2.10E-06	1.64E-09	99.9%

Table A.18: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/ d)	TMDL (lbs/ d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.24E-05	1.24E-08	99.9%
	Total	1.24E-05	1.24E-08	99.9%
Load Allocation	Direct Drainage	8.08E-05	8.05E-08	99.9%
	Upstream Maryland	-	-	-
	Total	8.08E-05	8.05E-08	99.9%
Margin of Safety		-	Implicit	-
Total		9.31E-05	9.29E-08	99.9%

Table A.19: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.02E-05	2.11E-06	94.8%
	Total	4.02E-05	2.11E-06	94.8%
Load Allocation	Direct Drainage	4.43E-04	1.39E-05	96.9%
	Upstream Maryland	-	-	-
	Total	4.43E-04	1.39E-05	96.9%
Margin of Safety		-	Implicit	-
Total		4.84E-04	1.60E-05	96.7%

Table A.20: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.10E-07	5.78E-09	94.8%
	Total	1.10E-07	5.78E-09	94.8%
Load Allocation	Direct Drainage	1.21E-06	3.80E-08	96.9%
	Upstream Maryland	-	-	-
	Total	1.21E-06	3.80E-08	96.9%
Margin of Safety		-	Implicit	-
Total		1.32E-06	4.37E-08	96.7%

Table A.21: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.29E-06	3.30E-07	94.8%
	Total	6.29E-06	3.30E-07	94.8%
Load Allocation	Direct Drainage	4.12E-05	2.15E-06	94.8%
	Upstream Maryland	-	-	-
	Total	4.12E-05	2.15E-06	94.8%
Margin of Safety		-	Implicit	-
Total		4.75E-05	2.48E-06	94.8%

Table A.22: Average Annual Chlordane Baseline Loads and Future TMDL Allocations (lbs/yr), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.25E-02	2.11E-05	99.8%
	Total	1.25E-02	2.11E-05	99.8%
Load Allocation	Direct Drainage	5.03E-02	1.39E-04	99.7%
	Upstream Maryland	-	-	-
	Total	5.03E-02	1.39E-04	99.7%
Margin of Safety		-	Implicit	-
Total		6.28E-02	1.60E-04	99.7%

Table A.23: Chlordane Average Daily Loads (lbs/d), Future TMDL Scenario, Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.43E-05	5.78E-08	99.8%
	Total	3.43E-05	5.78E-08	99.8%
Load Allocation	Direct Drainage	1.38E-04	3.80E-07	99.7%
	Upstream Maryland	-	-	-
	Total	1.38E-04	3.80E-07	99.7%
Margin of Safety		-	Implicit	-
Total		1.72E-04	4.37E-07	99.7%

Table A.24: Chlordane Maximum Daily Loads (lbs/d), Future TMDL Scenario, Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.96E-03	3.30E-06	99.8%
	Total	1.96E-03	3.30E-06	99.8%
Load Allocation	Direct Drainage	1.01E-02	2.15E-05	99.8%
	Upstream Maryland	-	-	-
	Total	1.01E-02	2.15E-05	99.8%
Margin of Safety		-	Implicit	-
Total		1.20E-02	2.48E-05	99.8%

Table A.25: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Fenwick Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.00E-04	7.00E-07	99.9%
	Total	7.00E-04	7.00E-07	99.9%
Load Allocation	Direct Drainage	5.93E-04	3.73E-07	99.9%
	Upstream Maryland	2.64E-03	2.13E-06	99.9%
	Total	3.23E-03	2.51E-06	99.9%
Margin of Safety		-	Implicit	-
Total		3.93E-03	3.21E-06	99.9%

Table A.26: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.92E-06	1.92E-09	99.9%
	Total	1.92E-06	1.92E-09	99.9%
Load Allocation	Direct Drainage	1.63E-06	1.02E-09	99.9%
	Upstream Maryland	7.23E-06	5.85E-09	99.9%
	Total	8.86E-06	6.87E-09	99.9%
Margin of Safety		-	Implicit	-
Total		1.08E-05	8.79E-09	99.9%

Table A.27: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.33E-04	1.33E-07	99.9%
	Total	1.33E-04	1.33E-07	99.9%
Load Allocation	Direct Drainage	4.00E-05	3.96E-08	99.9%
	Upstream Maryland	2.03E-04	2.03E-07	99.9%
	Total	2.43E-04	2.42E-07	99.9%
Margin of Safety		-	Implicit	-
Total		3.76E-04	3.75E-07	99.9%

Table A.28: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Fenwick Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.56E-04	1.87E-05	94.8%
	Total	3.56E-04	1.87E-05	94.8%
Load Allocation	Direct Drainage	4.25E-04	9.94E-06	97.7%
	Upstream Maryland	1.62E-03	5.69E-05	96.5%
	Total	2.05E-03	6.69E-05	96.7%
Margin of Safety		-	Implicit	-
Total		2.41E-03	8.55E-05	96.4%

Table A.29: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	9.74E-07	5.11E-08	94.8%
	Total	9.74E-07	5.11E-08	94.8%
Load Allocation	Direct Drainage	1.17E-06	2.72E-08	97.7%
	Upstream Maryland	4.45E-06	1.56E-07	96.5%
	Total	5.62E-06	1.83E-07	96.7%
Margin of Safety		-	Implicit	-
Total		6.59E-06	2.34E-07	96.4%

Table A.30: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.76E-05	3.55E-06	94.8%
	Total	6.76E-05	3.55E-06	94.8%
Load Allocation	Direct Drainage	2.05E-05	1.06E-06	94.9%
	Upstream Maryland	1.04E-04	5.40E-06	94.8%
	Total	1.24E-04	6.46E-06	94.8%
Margin of Safety		-	Implicit	-
Total		1.92E-04	1.00E-05	94.8%

Table A.31: Average Annual DDT Baseline Loads and Future TMDL Allocations (lbs/yr), Fenwick Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.71E-03	1.75E-05	99.7%
	Total	5.71E-03	1.75E-05	99.7%
Load Allocation	Direct Drainage	1.20E-03	9.32E-06	99.2%
	Upstream Maryland	1.38E-02	5.34E-05	99.6%
	Total	1.50E-02	6.27E-05	99.6%
Margin of Safety		-	Implicit	-
Total		2.07E-02	8.02E-05	99.6%

Table A.32: DDT Average Daily Loads (lbs/d), Future TMDL Scenario, Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.57E-05	4.79E-08	99.7%
	Total	1.57E-05	4.79E-08	99.7%
Load Allocation	Direct Drainage	3.29E-06	2.55E-08	99.2%
	Upstream Maryland	3.77E-05	1.46E-07	99.6%
	Total	4.10E-05	1.72E-07	99.6%
Margin of Safety		-	Implicit	-
Total		5.67E-05	2.20E-07	99.6%

Table A.33: DDT Maximum Daily Loads (lbs/d), Future TMDL Scenario, Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.09E-03	3.32E-06	99.7%
	Total	1.09E-03	3.32E-06	99.7%
Load Allocation	Direct Drainage	2.37E-04	9.90E-07	99.6%
	Upstream Maryland	1.65E-03	5.06E-06	99.7%
	Total	1.89E-03	6.05E-06	99.7%
Margin of Safety		-	Implicit	-
Total		2.97E-03	9.38E-06	99.7%

Table A.34: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.86E-04	5.86E-07	99.9%
	Total	5.86E-04	5.86E-07	99.9%
Load Allocation	Direct Drainage	4.62E-04	2.89E-07	99.9%
	Upstream Maryland	-	-	-
	Total	4.62E-04	2.89E-07	99.9%
Margin of Safety		-	Implicit	-
Total		1.05E-03	8.75E-07	99.9%

Table A.35: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.60E-06	1.60E-09	99.9%
	Total	1.60E-06	1.60E-09	99.9%
Load Allocation	Direct Drainage	1.27E-06	7.91E-10	99.9%
	Upstream Maryland	-	-	-
	Total	1.27E-06	7.91E-10	99.9%
Margin of Safety		-	Implicit	-
Total		2.87E-06	2.40E-09	99.9%

Table A.36: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.04E-04	1.04E-07	99.9%
	Total	1.04E-04	1.04E-07	99.9%
Load Allocation	Direct Drainage	3.16E-05	3.13E-08	99.9%
	Upstream Maryland	-	-	-
	Total	3.16E-05	3.13E-08	99.9%
Margin of Safety		-	Implicit	-
Total		1.36E-04	1.36E-07	99.9%

Table A.37: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.98E-04	1.56E-05	94.8%
	Total	2.98E-04	1.56E-05	94.8%
Load Allocation	Direct Drainage	3.32E-04	7.70E-06	97.7%
	Upstream Maryland	-	-	-
	Total	3.32E-04	7.70E-06	97.7%
Margin of Safety		-	Implicit	-
Total		6.30E-04	2.33E-05	96.3%

Table A.38: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.16E-07	4.28E-08	94.8%
	Total	8.16E-07	4.28E-08	94.8%
Load Allocation	Direct Drainage	9.10E-07	2.11E-08	97.7%
	Upstream Maryland	-	-	-
	Total	9.10E-07	2.11E-08	97.7%
Margin of Safety		-	Implicit	-
Total		1.73E-06	6.39E-08	96.3%

Table A.39: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.30E-05	2.78E-06	94.8%
	Total	5.30E-05	2.78E-06	94.8%
Load Allocation	Direct Drainage	1.62E-05	8.35E-07	94.9%
	Upstream Maryland	-	-	-
	Total	1.62E-05	8.35E-07	94.9%
Margin of Safety		-	Implicit	-
Total		6.92E-05	3.61E-06	94.8%

Table A.40: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Luzon Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.16E-03	3.16E-06	99.9%
	Total	3.16E-03	3.16E-06	99.9%
Load Allocation	Direct Drainage	1.06E-03	5.72E-07	99.9%
	Upstream Maryland	-	-	-
	Total	1.06E-03	5.72E-07	99.9%
Margin of Safety		-	Implicit	-
Total		4.22E-03	3.73E-06	99.9%

Table A.41: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.66E-06	8.66E-09	99.9%
	Total	8.66E-06	8.66E-09	99.9%
Load Allocation	Direct Drainage	2.90E-06	1.57E-09	99.9%
	Upstream Maryland	-	-	-
	Total	2.90E-06	1.57E-09	99.9%
Margin of Safety		-	Implicit	-
Total		1.16E-05	1.02E-08	99.9%

Table A.42: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.51E-04	5.51E-07	99.9%
	Total	5.51E-04	5.51E-07	99.9%
Load Allocation	Direct Drainage	3.49E-05	3.41E-08	99.9%
	Upstream Maryland	-	-	-
	Total	3.49E-05	3.41E-08	99.9%
Margin of Safety		-	Implicit	-
Total		5.86E-04	5.85E-07	99.9%

Table A.43: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Luzon Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.61E-03	8.43E-05	94.8%
	Total	1.61E-03	8.43E-05	94.8%
Load Allocation	Direct Drainage	8.10E-04	1.53E-05	98.1%
	Upstream Maryland	-	-	-
	Total	8.10E-04	1.53E-05	98.1%
Margin of Safety		-	Implicit	-
Total		2.42E-03	9.95E-05	95.9%

Table A.44: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.40E-06	2.31E-07	94.8%
	Total	4.40E-06	2.31E-07	94.8%
Load Allocation	Direct Drainage	2.22E-06	4.18E-08	98.1%
	Upstream Maryland	-	-	-
	Total	2.22E-06	4.18E-08	98.1%
Margin of Safety		-	Implicit	-
Total		6.62E-06	2.73E-07	95.9%

Table A.45: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.80E-04	1.47E-05	94.8%
	Total	2.80E-04	1.47E-05	94.8%
Load Allocation	Direct Drainage	1.82E-05	9.09E-07	95.0%
	Upstream Maryland	-	-	-
	Total	1.82E-05	9.09E-07	95.0%
Margin of Safety		-	Implicit	-
Total		2.98E-04	1.56E-05	94.8%

Table A.46: Average Annual Chlordane Baseline Loads and Future TMDL Allocations (lbs/yr), Luzon Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.00E-01	8.43E-04	99.8%
	Total	5.00E-01	8.43E-04	99.8%
Load Allocation	Direct Drainage	1.40E-02	1.53E-04	98.9%
	Upstream Maryland	-	-	-
	Total	1.40E-02	1.53E-04	98.9%
Margin of Safety		-	Implicit	-
Total		5.14E-01	9.95E-04	99.8%

Table A.47: Chlordane Average Daily Loads (lbs/d), Future TMDL Scenario, Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.37E-03	2.31E-06	99.8%
	Total	1.37E-03	2.31E-06	99.8%
Load Allocation	Direct Drainage	3.84E-05	4.18E-07	98.9%
	Upstream Maryland	-	-	-
	Total	3.84E-05	4.18E-07	98.9%
Margin of Safety		-	Implicit	-
Total		1.41E-03	2.73E-06	99.8%

Table A.48: Chlordane Maximum Daily Loads (lbs/d), Future TMDL Scenario, Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.72E-02	1.47E-04	99.8%
	Total	8.72E-02	1.47E-04	99.8%
Load Allocation	Direct Drainage	3.19E-03	9.09E-06	99.7%
	Upstream Maryland	-	-	-
	Total	3.19E-03	9.09E-06	99.7%
Margin of Safety		-	Implicit	-
Total		9.04E-02	1.56E-04	99.8%

Table A.49: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Melvin Hazen Valley Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.87E-04	4.87E-07	99.9%
	Total	4.87E-04	4.87E-07	99.9%
Load Allocation	Direct Drainage	5.33E-04	3.35E-07	99.9%
	Upstream Maryland	-	-	-
	Total	5.33E-04	3.35E-07	99.9%
Margin of Safety		-	Implicit	-
Total		1.02E-03	8.22E-07	99.9%

Table A.50: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Melvin Hazen Valley Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.33E-06	1.33E-09	99.9%
	Total	1.33E-06	1.33E-09	99.9%
Load Allocation	Direct Drainage	1.46E-06	9.19E-10	99.9%
	Upstream Maryland	-	-	-
	Total	1.46E-06	9.19E-10	99.9%
Margin of Safety		-	Implicit	-
Total		2.79E-06	2.25E-09	99.9%

Table A.51: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Melvin Hazen Valley Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	9.10E-05	9.10E-08	99.9%
	Total	9.10E-05	9.10E-08	99.9%
Load Allocation	Direct Drainage	3.65E-05	3.62E-08	99.9%
	Upstream Maryland	-	-	-
	Total	3.65E-05	3.62E-08	99.9%
Margin of Safety		-	Implicit	-
Total		1.27E-04	1.27E-07	99.9%

Table A.52: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Normanstone Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.76E-04	7.76E-07	99.9%
	Total	7.76E-04	7.76E-07	99.9%
Load Allocation	Direct Drainage	5.33E-04	3.16E-07	99.9%
	Upstream Maryland	-	-	-
	Total	5.33E-04	3.16E-07	99.9%
Margin of Safety		-	Implicit	-
Total		1.31E-03	1.09E-06	99.9%

Table A.53: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.13E-06	2.13E-09	99.9%
	Total	2.13E-06	2.13E-09	99.9%
Load Allocation	Direct Drainage	1.46E-06	8.66E-10	99.9%
	Upstream Maryland	-	-	-
	Total	1.46E-06	8.66E-10	99.9%
Margin of Safety		-	Implicit	-
Total		3.59E-06	2.99E-09	99.9%

Table A.54: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.42E-04	1.42E-07	99.9%
	Total	1.42E-04	1.42E-07	99.9%
Load Allocation	Direct Drainage	2.98E-05	2.94E-08	99.9%
	Upstream Maryland	-	-	-
	Total	2.98E-05	2.94E-08	99.9%
Margin of Safety		-	Implicit	-
Total		1.72E-04	1.72E-07	99.9%

Table A.55: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Normanstone Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.94E-04	2.07E-05	94.8%
	Total	3.94E-04	2.07E-05	94.8%
Load Allocation	Direct Drainage	3.93E-04	8.43E-06	97.9%
	Upstream Maryland	-	-	-
	Total	3.93E-04	8.43E-06	97.9%
Margin of Safety		-	Implicit	-
Total		7.87E-04	2.91E-05	96.3%

Table A.56: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.08E-06	5.67E-08	94.8%
	Total	1.08E-06	5.67E-08	94.8%
Load Allocation	Direct Drainage	1.08E-06	2.31E-08	97.9%
	Upstream Maryland	-	-	-
	Total	1.08E-06	2.31E-08	97.9%
Margin of Safety		-	Implicit	-
Total		2.16E-06	7.98E-08	96.3%

Table A.57: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.24E-05	3.80E-06	94.8%
	Total	7.24E-05	3.80E-06	94.8%
Load Allocation	Direct Drainage	1.53E-05	7.85E-07	94.9%
	Upstream Maryland	-	-	-
	Total	1.53E-05	7.85E-07	94.9%
Margin of Safety		-	Implicit	-
Total		8.77E-05	4.58E-06	94.8%

Table A.58: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Oxon Run

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.94E-03	1.94E-06	99.9%
	Total	1.94E-03	1.94E-06	99.9%
Load Allocation	Direct Drainage	1.14E-03	6.30E-07	99.9%
	Upstream Maryland	9.07E-03	7.11E-06	-
	Total	1.02E-02	7.74E-06	99.9%
Margin of Safety		-	Implicit	-
Total		1.21E-02	9.68E-06	99.9%

Table A.59: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Oxon Run

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.31E-06	5.31E-09	99.9%
	Total	5.31E-06	5.31E-09	99.9%
Load Allocation	Direct Drainage	3.11E-06	1.73E-09	99.9%
	Upstream Maryland	2.49E-05	1.95E-08	
	Total	2.80E-05	2.12E-08	99.9%
Margin of Safety		-	Implicit	-
Total		3.33E-05	2.65E-08	99.9%

Table A.60: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Oxon Run

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.46E-04	3.46E-07	99.9%
	Total	3.46E-04	3.46E-07	99.9%
Load Allocation	Direct Drainage	4.67E-05	4.59E-08	99.9%
	Upstream Maryland	8.78E-04	8.66E-07	
	Total	9.25E-04	9.12E-07	99.9%
Margin of Safety		-	Implicit	-
Total		1.27E-03	1.26E-06	99.9%

Table A.61: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.05E-03	1.05E-06	99.9%
	Total	1.05E-03	1.05E-06	99.9%
Load Allocation	Direct Drainage	1.42E-03	8.54E-07	99.9%
	Upstream Maryland	1.38E-03	1.05E-06	99.9%
	Total	2.80E-03	1.90E-06	99.9%
Margin of Safety		-	Implicit	-
Total		3.85E-03	2.95E-06	99.9%

Table A.62: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.89E-06	2.89E-09	99.9%
	Total	2.89E-06	2.89E-09	99.9%
Load Allocation	Direct Drainage	3.89E-06	2.34E-09	99.9%
	Upstream Maryland	3.77E-06	2.87E-09	99.9%
	Total	7.67E-06	5.21E-09	99.9%
Margin of Safety		-	Implicit	-
Total		1.06E-05	8.09E-09	99.9%

Table A.63: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.05E-04	2.05E-07	99.9%
	Total	2.05E-04	2.05E-07	99.9%
Load Allocation	Direct Drainage	9.27E-05	9.18E-08	99.9%
	Upstream Maryland	8.76E-05	8.70E-08	99.9%
	Total	1.80E-04	1.79E-07	99.9%
Margin of Safety		-	Implicit	-
Total		3.85E-04	3.83E-07	99.9%

Table A.64: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.36E-04	2.81E-05	94.8%
	Total	5.36E-04	2.81E-05	94.8%
Load Allocation	Direct Drainage	1.04E-03	2.28E-05	97.8%
	Upstream Maryland	8.86E-04	2.79E-05	96.9%
	Total	1.93E-03	5.07E-05	97.4%
Margin of Safety		-	Implicit	-
Total		2.46E-03	7.88E-05	96.8%

Table A.65: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.47E-06	7.70E-08	94.8%
	Total	1.47E-06	7.70E-08	94.8%
Load Allocation	Direct Drainage	2.85E-06	6.24E-08	97.8%
	Upstream Maryland	2.43E-06	7.64E-08	96.9%
	Total	5.28E-06	1.39E-07	97.4%
Margin of Safety		-	Implicit	-
Total		6.75E-06	2.16E-07	96.8%

Table A.66: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.04E-04	5.45E-06	94.8%
	Total	1.04E-04	5.45E-06	94.8%
Load Allocation	Direct Drainage	4.76E-05	2.45E-06	94.9%
	Upstream Maryland	4.48E-05	2.32E-06	94.8%
	Total	9.25E-05	4.77E-06	94.8%
Margin of Safety		-	Implicit	-
Total		1.96E-04	1.02E-05	94.8%

Table 4.67: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Piney Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.89E-04	1.89E-07	99.9%
	DC Combined Sewer System	4.01E-04	1.57E-08	100.0%
	Total	5.90E-04	2.05E-07	99.9%
Load Allocation	Direct Drainage	3.57E-04	2.17E-07	99.9%
	Upstream Maryland	-	-	-
	Total	3.57E-04	2.17E-07	99.9%
Margin of Safety		-	Implicit	-
Total		9.48E-04	4.22E-07	100.0%

Table 4.68: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.18E-07	5.18E-10	99.9%
	DC Combined Sewer System	1.10E-06	4.30E-11	100.0%
	Total	1.62E-06	5.61E-10	99.9%
Load Allocation	Direct Drainage	9.79E-07	5.95E-10	99.9%
	Upstream Maryland	-	-	-
	Total	9.79E-07	5.95E-10	99.9%
Margin of Safety		-	Implicit	-
Total		2.60E-06	1.16E-09	100.0%

Table 4.69: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.36E-05	3.36E-08	99.9%
	DC Combined Sewer System	1.57E-04	3.93E-08	100.0%
	Total	1.91E-04	7.29E-08	99.9%
Load Allocation	Direct Drainage	2.65E-05	2.63E-08	99.9%
	Upstream Maryland	-	-	-
	Total	2.65E-05	2.63E-08	99.9%
Margin of Safety		-	Implicit	-
Total		2.17E-04	9.91E-08	100.0%

Table A.70: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Piney Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	9.61E-05	5.04E-06	94.8%
	DC Combined Sewer System	2.04E-04	4.19E-07	99.8%
	Total	3.00E-04	5.46E-06	94.8%
Load Allocation	Direct Drainage	2.60E-04	5.79E-06	97.8%
	Upstream Maryland	-	-	-
	Total	2.60E-04	5.79E-06	97.8%
Margin of Safety		-	Implicit	-
Total		5.60E-04	1.13E-05	98.0%

Table A.71: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.63E-07	1.38E-08	94.8%
	DC Combined Sewer System	5.59E-07	1.15E-09	99.8%
	Total	8.22E-07	1.50E-08	94.8%
Load Allocation	Direct Drainage	7.13E-07	1.59E-08	97.8%
	Upstream Maryland	-	-	-
	Total	7.13E-07	1.59E-08	97.8%
Margin of Safety		-	Implicit	-
Total		1.54E-06	3.08E-08	98.0%

Table A.72: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.71E-05	8.96E-07	94.8%
	DC Combined Sewer System	7.98E-05	1.05E-06	98.7%
	Total	9.69E-05	1.94E-06	94.8%
Load Allocation	Direct Drainage	1.36E-05	7.00E-07	94.8%
	Upstream Maryland	-	-	-
	Total	1.36E-05	7.00E-07	94.8%
Margin of Safety		-	Implicit	-
Total		1.11E-04	2.64E-06	97.6%

Table A.73: Average Annual Chlordane Baseline Loads and Future TMDL Allocations (lbs/yr), Piney Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.99E-02	5.04E-05	99.8%
	DC Combined Sewer System	6.35E-02	4.19E-06	100.0%
	Total	9.35E-02	5.46E-05	99.8%
Load Allocation	Direct Drainage	5.25E-03	5.79E-05	98.9%
	Upstream Maryland	-	-	-
	Total	5.25E-03	5.79E-05	98.9%
Margin of Safety		-	Implicit	-
Total		9.87E-02	1.13E-04	99.9%

Table A.74: Chlordane Average Daily Loads (lbs/d), Future TMDL Scenario, Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.20E-05	1.38E-07	99.8%
	DC Combined Sewer System	1.74E-04	1.15E-08	100.0%
	Total	2.56E-04	1.50E-07	99.8%
Load Allocation	Direct Drainage	1.44E-05	1.59E-07	98.9%
	Upstream Maryland	-	-	-
	Total	1.44E-05	1.59E-07	98.9%
Margin of Safety		-	Implicit	-
Total		2.71E-04	3.08E-07	99.9%

Table A.75: Chlordane Maximum Daily Loads (lbs/d), Future TMDL Scenario, Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.32E-03	8.96E-06	99.8%
	DC Combined Sewer System	2.49E-02	1.05E-05	100.0%
	Total	3.02E-02	1.94E-05	99.8%
Load Allocation	Direct Drainage	1.11E-03	7.00E-06	99.4%
	Upstream Maryland	-	-	-
	Total	1.11E-03	7.00E-06	99.4%
Margin of Safety		-	Implicit	-
Total		3.13E-02	2.64E-05	99.9%

Table A.76: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Portal Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.65E-04	2.65E-07	99.9%
	Total	2.65E-04	2.65E-07	99.9%
Load Allocation	Direct Drainage	1.51E-04	7.88E-08	99.9%
	Upstream Maryland	9.76E-04	8.72E-07	99.9%
	Total	1.13E-03	9.51E-07	99.9%
Margin of Safety		-	Implicit	-
Total		1.39E-03	1.22E-06	99.9%

Table A.77: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.25E-07	7.25E-10	99.9%
	Total	7.25E-07	7.25E-10	99.9%
Load Allocation	Direct Drainage	4.13E-07	2.16E-10	99.9%
	Upstream Maryland	2.67E-06	2.39E-09	99.9%
	Total	3.09E-06	2.61E-09	99.9%
Margin of Safety		-	Implicit	-
Total		3.81E-06	3.33E-09	99.9%

Table A.78: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.11E-05	5.11E-08	99.9%
	Total	5.11E-05	5.11E-08	99.9%
Load Allocation	Direct Drainage	4.46E-06	4.34E-09	99.9%
	Upstream Maryland	9.79E-05	9.77E-08	99.9%
	Total	1.02E-04	1.02E-07	99.9%
Margin of Safety		-	Implicit	-
Total		1.53E-04	1.53E-07	99.9%

Table A.79: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Portal Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.35E-04	7.06E-06	94.8%
	Total	1.35E-04	7.06E-06	94.8%
Load Allocation	Direct Drainage	1.17E-04	2.10E-06	98.2%
	Upstream Maryland	5.54E-04	2.33E-05	95.8%
	Total	6.71E-04	2.54E-05	96.2%
Margin of Safety		-	Implicit	-
Total		8.06E-04	3.24E-05	96.0%

Table A.80: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.69E-07	1.93E-08	94.8%
	Total	3.69E-07	1.93E-08	94.8%
Load Allocation	Direct Drainage	3.20E-07	5.76E-09	98.2%
	Upstream Maryland	1.52E-06	6.37E-08	95.8%
	Total	1.84E-06	6.95E-08	96.2%
Margin of Safety		-	Implicit	-
Total		2.21E-06	8.88E-08	96.0%

Table A.81: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.60E-05	1.36E-06	94.8%
	Total	2.60E-05	1.36E-06	94.8%
Load Allocation	Direct Drainage	2.33E-06	1.16E-07	95.0%
	Upstream Maryland	4.99E-05	2.61E-06	94.8%
	Total	5.22E-05	2.72E-06	94.8%
Margin of Safety		-	Implicit	-
Total		7.82E-05	4.09E-06	94.8%

Table A.82: Average Annual Dieldrin Baseline Loads and Future TMDL Allocations (lbs/yr), Soapstone Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.15E-03	2.15E-06	99.9%
	Total	2.15E-03	2.15E-06	99.9%
Load Allocation	Direct Drainage	1.14E-03	7.05E-07	99.9%
	Upstream Maryland	-	-	-
	Total	1.14E-03	7.05E-07	99.9%
Margin of Safety		-	Implicit	-
Total		3.29E-03	2.85E-06	99.9%

Table A.83: Dieldrin Average Daily Loads (lbs/d), Future TMDL Scenario, Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.89E-06	5.89E-09	99.9%
	Total	5.89E-06	5.89E-09	99.9%
Load Allocation	Direct Drainage	3.12E-06	1.93E-09	99.9%
	Upstream Maryland	-	-	-
	Total	3.12E-06	1.93E-09	99.9%
Margin of Safety		-	Implicit	-
Total		9.01E-06	7.82E-09	99.9%

Table A.84: Dieldrin Maximum Daily Loads (lbs/d), Future TMDL Scenario, Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.80E-04	3.80E-07	99.9%
	Total	3.80E-04	3.80E-07	99.9%
Load Allocation	Direct Drainage	6.76E-05	6.69E-08	99.9%
	Upstream Maryland	-	-	-
	Total	6.76E-05	6.69E-08	99.9%
Margin of Safety		-	Implicit	-
Total		4.47E-04	4.46E-07	99.9%

Table A.85: Average Annual Heptachlor Epoxide Baseline Loads and Future TMDL Allocations (lbs/yr), Soapstone Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.09E-03	5.73E-05	94.8%
	Total	1.09E-03	5.73E-05	94.8%
Load Allocation	Direct Drainage	8.22E-04	1.88E-05	97.7%
	Upstream Maryland	-	-	-
	Total	8.22E-04	1.88E-05	97.7%
Margin of Safety		-	Implicit	-
Total		1.91E-03	7.61E-05	96.0%

Table A.86: Heptachlor Epoxide Average Daily Loads (lbs/d), Future TMDL Scenario, Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.99E-06	1.57E-07	94.8%
	Total	2.99E-06	1.57E-07	94.8%
Load Allocation	Direct Drainage	2.25E-06	5.15E-08	97.7%
	Upstream Maryland	-	-	-
	Total	2.25E-06	5.15E-08	97.7%
Margin of Safety		-	Implicit	-
Total		5.24E-06	2.09E-07	96.0%

Table A.87: Heptachlor Epoxide Maximum Daily Loads (lbs/d), Future TMDL Scenario, Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.93E-04	1.01E-05	94.8%
	Total	1.93E-04	1.01E-05	94.8%
Load Allocation	Direct Drainage	3.48E-05	1.78E-06	94.9%
	Upstream Maryland	-	-	-
	Total	3.48E-05	1.78E-06	94.9%
Margin of Safety		-	Implicit	-
Total		2.28E-04	1.19E-05	94.8%

Table A.88: Average Annual Chlordane Baseline Loads and Future TMDL Allocations (lbs/yr), Soapstone Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.40E-01	5.73E-04	99.8%
	Total	3.40E-01	5.73E-04	99.8%
Load Allocation	Direct Drainage	3.92E-02	1.88E-04	99.5%
	Upstream Maryland	-	-	-
	Total	3.92E-02	1.88E-04	99.5%
Margin of Safety		-	Implicit	-
Total		3.79E-01	7.61E-04	99.8%

Table A.89: Chlordane Average Daily Loads (lbs/d), Future TMDL Scenario, Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	9.32E-04	1.57E-06	99.8%
	Total	9.32E-04	1.57E-06	99.8%
Load Allocation	Direct Drainage	1.07E-04	5.15E-07	99.5%
	Upstream Maryland	-	-	-
	Total	1.07E-04	5.15E-07	99.5%
Margin of Safety		-	Implicit	-
Total		1.04E-03	2.09E-06	99.8%

Table A.90: Chlordane Maximum Daily Loads (lbs/d), Future TMDL Scenario, Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.01E-02	1.01E-04	99.8%
	Total	6.01E-02	1.01E-04	99.8%
Load Allocation	Direct Drainage	7.23E-03	1.78E-05	99.8%
	Upstream Maryland	-	-	-
	Total	7.23E-03	1.78E-05	99.8%
Margin of Safety		-	Implicit	-
Total		6.73E-02	1.19E-04	99.8%