Total Maximum Daily Load of Sediment
in the Upper North Branch Potomac River Watershed,
Garrett County, Maryland

FINAL

MARYLAND

DEPARTMENT OF THE ENVIRONMENT
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Submitted to:

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September 2006

EPA Submittal Date: Sept. 29, 2006
EPA Approval Date: May 15, 2007

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List of Abbreviations

BIBI	Benthic Index of Biotic Integrity
BIP	Buffer Incentive Program
BMP	Best Management Practices
CBP P5	Chesapeake Bay Program Phase V
CWA	Clean Water Act
DMR	Discharge Monitoring Report
EOF	Edge-of-Field
EOS	Edge-of-Stream
EPA	Environmental Protection Agency
EPSC	Environmental Permit Service Center
ETM	Enhanced Thematic Mapper
FIBI	Fish Index of Biologic Integrity
GIS	Geographic Information System
LA	Load Allocation
MDE	Maryland Department of the Environment
MBSS	Maryland Biological Stream Survey
MGD	Millions of Gallons per Day
mg/l	Milligrams per liter
MOS	Margin of Safety
MS4	Municipal Separate Stormwater System
NPS	Non-Point Source
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NRI	Natural Resources Inventory
PCS	Permit Compliance System
PS	Point Source
RESAC	Regional Earth Science Applications Center
S&E	Sediment & Erosion
TMDL	Total Maximum Daily Load

TSS	Total Suspended Solids
TM	Thematic Mapper
USGS	United Stated Geological Survey
WLA	Waste Load Allocation
WQIA	Water Quality Improvement Act
WQLS	Water Quality Limited Segment
WWTP	Wastewater Treatment Plant

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EXECUTIVE SUMMARY

This document, upon approval by the U.S. Environmental Protection Agency (EPA), establishes a Total Maximum Daily Load (TMDL) for sediment in the Upper North Branch Potomac River Watershed (basin number 02141005). Section 303(d) of the federal Clean Water Act (CWA) and the EPA's implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS, the State is required to either establish a TMDL of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met. (CWA, 2006)

The Maryland Department of the Environment (MDE) has identified the waters of the Upper North Branch Potomac River (basin number 02141005) on the State's 303(d) List submitted to the U.S. Environmental Protection Agency by MDE as impaired by nutrients (1996), sediments (1996), pH (1996), metals - unspecified (1996), methylmercury (2002), and portions of the basin for impacts to biological communities (2002 and 2004) (MDE, 2006a). The designated use of the Upper North Branch Potomac River is Use I-P (Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply) (COMAR, 2006a). This document proposes to establish a TMDL for sediments in the Upper North Branch Potomac River Watershed to allow for the attainment of the above mentioned designated use. The objective of the sediment TMDL established in this document is to ensure that there will be no sediment impacts affecting aquatic health, when aquatic health is evaluated based on Maryland's biocriteria (Roth et al., 2000, Roth et al., 1998 and Stribling et al., 1998), thereby establishing a sediment load that supports the Use I-P designation for the Upper North Branch Potomac River Watershed. The watershed sediment load includes the potential effects for water clarity and erosional and depositional impacts, thus accounting for all of the sediment impacts that indicate a sediment impairment per the Maryland 303(d) listing methodology (MDE, 2006b).

A data solicitation for sediments was conducted by MDE and all readily available data from the past five years have been considered. A WQA of eutrophication for the nutrient listing has been submitted to the EPA (2006). The listings for bacteria, low pH, metals, and impacts to biological communities will be addressed separately at a future date.

The computational framework chosen for the Upper North Branch Potomac River Watershed TMDL was the Chesapeake Bay Program Phase V (CBP P5) watershed model target edge-of-field (EOF) land use sediment loading rate calculations combined with sediment delivery ratio. The edge-of-stream (EOS) sediment load is calculated per land use as a product of the land use area, land use target loading rate, and loss from the EOF to the main channel. The spatial effect of sediment delivery from EOF to EOS is captured as a function of the average transport distance from individual land uses within the model segment. Therefore, each land use category will have a specific sediment delivery ratio. The spatial domain of the CBP P5 model segmentation aggregates to the Maryland 8-digit watersheds.

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Currently in Maryland, there are no specific numeric criteria that quantify the impact of sediment on the aquatic health of non-tidal stream systems. Therefore, to determine the assimilative capacity of the watershed stream system, a reference watershed approach was used and resulted in the establishment of a *sediment loading threshold* (Currey et al., 2006). This threshold is based on a detailed analysis of sediment loads from watersheds that are identified as supporting aquatic life (i.e. reference watersheds) based on Maryland's biocriteria (Roth *et al.*, 2000, Roth *et al.*, 1998, and Stribling *et al.*, 1998).

The critical condition for this TMDL is inherently addressed based on the biological monitoring data used to determine the reference watersheds. Seasonality is captured in two components. First, it is implicitly included in biological sampling, since results integrate the stress effects over the course of time. Second, the Maryland Biological Stream Survey (MBSS) sampling included benthic sampling in the spring and fish sampling in the summer.

All TMDLs must include a margin of safety (MOS) to account for any lack of knowledge and uncertainty concerning the relationship between loads and water quality (CWA, 2006). Analysis of the reference group forest normalized sediment loads indicates that approximately 75% of the reference watersheds have a value of less than 3.6, and 50% have a value of less than 3.3. The forest normalized reference sediment load (also referred to as the sediment loading threshold) was set at the median value of 3.3. This is an environmentally conservative estimate, since 50% of the reference watersheds have a load above this value, which results in an implicit margin of safety of approximately 8%.

Biological monitoring data indicated there was no impairment to aquatic health in the headwaters of the Potomac River mainstem, however, degradation related to sediment was observed in tributaries. Therefore, this TMDL was developed to meet Maryland's local water quality conditions, with upstream loads reported as baseline conditions. The total baseline sediment load from the Maryland portion of the Upper North Branch Potomac River Watershed is 6,542.0 tons per year. The total baseline sediment load from the West Virginia portion of the Upper North Branch Potomac River Watershed is 16,423.1 tons per year. The sediment TMDL for the Maryland portion of the Upper North Branch Potomac River Watershed is 4,521.4 tons per year. The load allocation (LA) is 4,141.8 tons per year and the waste load allocation (WLA) is 379.6 tons per year. This TMDL will ensure that the sediment loads and resulting effects are at a level to support the Use I-P designation for the Upper North Branch Potomac River Watershed, and more specifically at a level to support aquatic health.

Once the EPA has approved this TMDL, and it is known what measures must be taken to reduce pollution levels, implementation of best management practices (BMPs) is expected to take place. MDE intends for the required reduction to be implemented in an iterative process that first addresses those sources with the largest impact to water quality, with consideration given to ease and cost of implementation.

Maryland has several well-established programs to draw upon, including the Water Quality Improvement Act of 1998 (WQIA) and the Federal Nonpoint Source

Management Program (§ 319 of the Clean Water Act). Several potential funding sources for implementation are available, such as the Buffer Incentive Program (BIP), the State Water Quality Revolving Loan Fund, and the Stormwater Pollution Cost Share Program.

1.0 INTRODUCTION

This document, upon approval by the U.S. Environmental Protection Agency (EPA), establishes a Total Maximum Daily Load (TMDL) for sediments in the Upper North Branch Potomac River Watershed (basin number 02141005). Section 303(d)(1)(C) of the federal Clean Water Act (CWA) and EPA implementing regulations direct each State to develop a TMDL for each impaired water quality limited segment (WQLS) on the Section 303(d) List, taking into account seasonal variations and a protective margin of safety (MOS) to account for uncertainty (CWA, 2006). A TMDL reflects the total pollutant loading of an impairing substance a water body can receive and still meet water quality standards.

TMDLs are established to determine the pollutant load reductions needed to achieve and maintain water quality standards. A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, protection of aquatic life, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

The Maryland Department of the Environment (MDE) has identified the waters of the Upper North Branch Potomac River (basin number 02141005) on the State's 303(d) List submitted to the U.S. Environmental Protection Agency by MDE as impaired by nutrients (1996), sediments (1996), pH (1996), metals - unspecified (1996), methylmercury (2002), and portions of the basin for impacts to biological communities (2002 and 2004) (MDE, 2006a). The designated use of the Upper North Branch Potomac River is Use I-P (Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply) (COMAR, 2006a). This document proposes to establish a TMDL for sediments in the Upper North Branch Potomac River Watershed to allow for the attainment of the above mentioned designated use. The objective of the sediment TMDL established in this document is to ensure that there will be no sediment impacts affecting aquatic health, when aquatic health is evaluated based on Maryland's biocriteria (Roth et al., 2000, Roth et al., 1998 and Stribling et al., 1998), thereby establishing a sediment loading limit that supports the Use I-P designation for the Upper North Branch Potomac River Watershed. The watershed sediment load includes the potential effects for water clarity and erosional and depositional impacts, thus accounting for all of the sediment impacts that indicate a sediment impairment per the Maryland 303(d) listing methodology (MDE, 2006b).

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was used and resulted in the establishment of a *sediment loading threshold* (Currey et al., 2006). This threshold is based on a detailed analysis of sediment loads from watersheds that are identified as supporting aquatic life (i.e. reference watersheds) based on Maryland's biocriteria (Roth et al., 2000, Roth et al., 1998, and Stribling et al., 1998).

2.0 SETTING AND WATER QUALITY DESCRIPTION

2.1 General Setting

Location

The North Branch of the Potomac River forms the border between Maryland and West Virginia from its origin at the Fairfax Stone downstream to its confluence with the South Branch of the Potomac. The Upper North Branch of the Potomac River is defined as the reach between its headwaters in West Virginia and its confluence with the Savage River (See Figure 1). The drainage area of the Upper North Branch Potomac River Watershed is 182,200 acres. This consists of approximately 67,700 acres in Maryland and 119,500 acres in West Virginia.

Geology/Soils

The Upper North Branch Potomac River Watershed is situated within the Appalachian Plateau Province of western Maryland. The surficial geology of the Appalachian Plateau Province is characterized by gently folded shale, siltstone, and sandstone. Folding has produced elongated arches across the region, which exposes Devonian rocks at the surface. Coal bearing strata are preserved in the intervening synclinal basins of these folds. Consequently, this region has been a productive source for coal mining. The topography in the watershed is often steep and deeply carved by winding streams, with elevations ranging up to 3,200 feet (DNR, 2006a; MGS, 2006; and MDE, 2000).

The Maryland portion of the Upper North Branch Potomac River Watershed lies primarily in the Dekalb soil series. The Dekalb soil series consists of moderately deep, well drained, loamy soils that developed in material weathered in place from sandstone and some conglomerate and shale bedrock. These nearly level to very steep soils are normally found in stony, mountainous regions. Dekalb soils have rapid permeability and internal drainage (USDA – SCS, 1974).
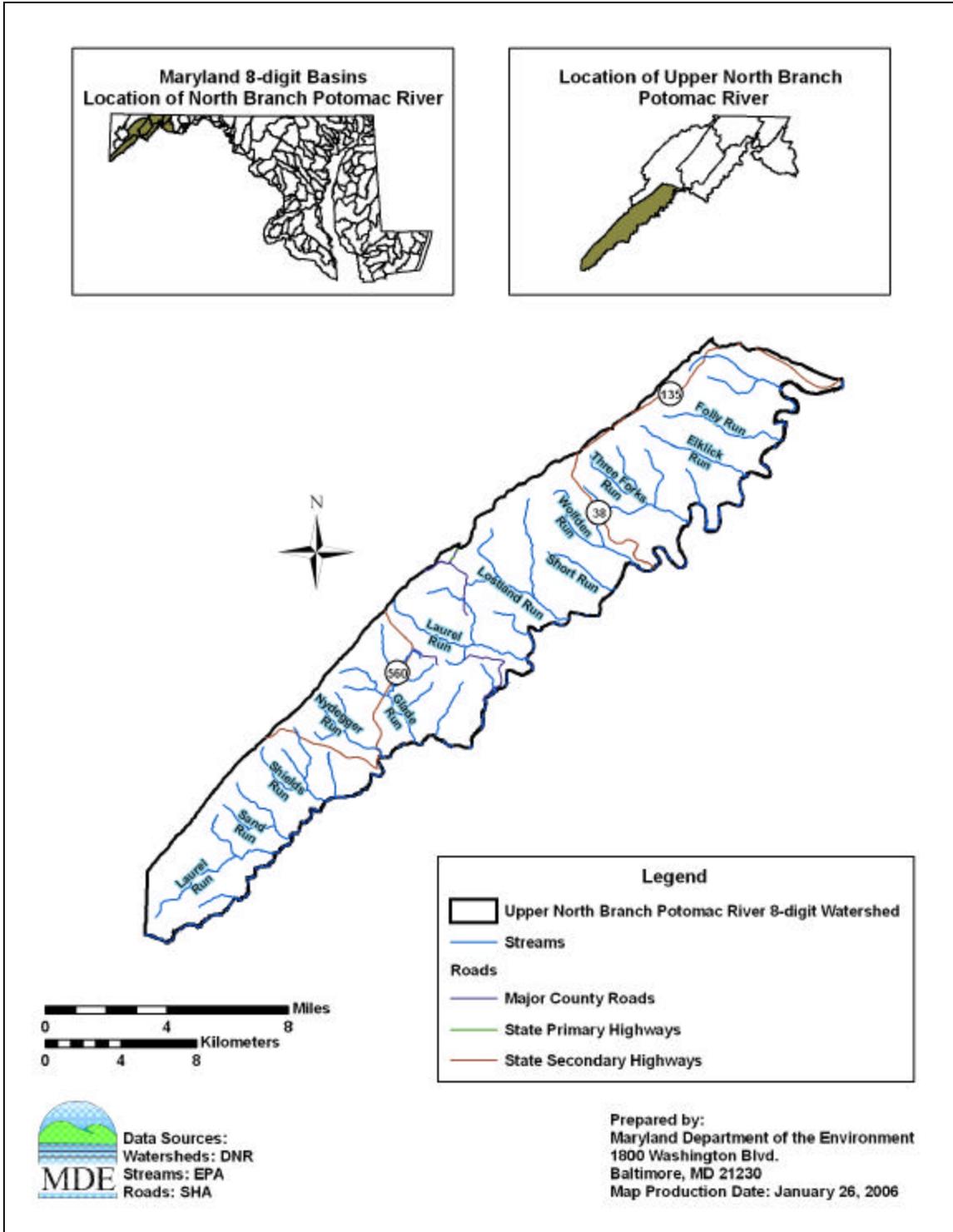
Figure 1: Location Map of the Maryland portion of the Upper North Branch Potomac River Watershed

2.1.1. Land Use

<u>Land Use Methodology</u>

The land use framework used to develop this TMDL was originally developed for the Chesapeake Bay Program Phase V (CBP P5) watershed model. [1] The CBP P5 land use Geographic Information System (GIS) framework was based on two distinct layers of development. The first GIS layer was developed by the Regional Earth Science Applications Center (RESAC) at the University of Maryland and was based on satellite imagery (Landsat 7-Enchance Thematic Mapper (ETM) and 5-Thematic Mapper (TM)) (Goetz et al., 2004). This layer did not provide the required level of accuracy that is especially important when developing agricultural land uses. In order to develop accurate agricultural land use calculations, the CBP P5 used county level U.S. Agricultural Census data as a second layer (USDA, 1982, 1987, 1992, 1997 and 2002).

Given that land use classifications based on satellite imagery are likely to be least accurate at edges (*i.e.,* boundaries between covers), the RESAC land uses bordering agricultural areas were analyzed separately. If the agricultural census data accounted for more agricultural use than the RESAC's data, appropriate acres were added to agricultural land from non-agricultural land uses. Similarly, if census agricultural land estimates were smaller than RESAC's, appropriate acres were added to non-agricultural land uses.

Adjustments were also made to the RESAC land use to determine developed land uses. RESAC land use was originally based on the United States Geological Survey (USGS) protocols used to develop the 2000 National Land Cover Database. The only difference between the RESAC and USGS approaches was that RESAC used town boundaries and road densities to determine urban land use covered by trees or grasses. This approach greatly improved the accuracy of the identified urban land uses, but led to the misclassification of some land adjacent to roads and highways as developed land. This was corrected by subsequent analysis. To ensure that the model accurately represented development over the simulation period, post-processing techniques that reflected changes in urban land use have been applied.

The result of this approach is that CBP P5 land use does not exist in a single GIS coverage; instead it is only available in a tabular format. The CBP P5 watershed model is comprised of 25 land uses. Most of these land uses are differentiated only by their nitrogen and phosphorus loading rates. The land uses are divided into 14 classes with distinct sediment erosion rates. Table 1 lists the Phase V generalized land uses and detailed land uses, which are classified by their erosion rates. Table 1 also lists the acres of each land use in the Upper North Branch Potomac River Watershed. Details of the land use development methodology have been summarized in the report entitled

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[1] The EPA Chesapeake Bay Program developed the first watershed model in 1982. There have been many upgrades since the first phase of this model. The CBP P5 was developed to estimate flow, nutrient, and sediment loads to the Bay.

"Chesapeake Bay Phase V Community Watershed Model: Tracking Nutrient and Sediment Loads on a Regional and Local Scale"(USEPA – CBP, 2006b).

Upper North Branch Potomac River Watershed Land Use Distribution

The Upper North Branch Potomac River Watershed land use was evaluated for both Maryland and West Virginia. The predominant land use in both regions is forest (78% for Maryland and 76% for West Virginia). In Maryland the remaining land use is approximately 8% urban, 6% pasture, and 6% crop. In West Virginia, the remaining land use distribution is 17% pasture, 5% crop, and 2% urban.

A land use map is provided in Figure 2 and a summary of the watershed land use areas is presented in Table 1.

Table 1: Land Use Percentage Distribution for the Upper North Branch Potomac River Watershed

| General Land Use	Detailed Land Use	Maryland			West Virginia		
		Area (Acres)	Percent	Grouped Percent of Total	Area (Acres)	Percent	Grouped Percent of Total
Crop	Animal Feeding Operations	11.2	0.0		12.7	0.0	
	Hay	2,950.4	4.4		4,900.1	4.2	
	High Till	1,045.0	1.6		353.8	0.3	
	Low Till	208.0	0.3		195.6	0.2	
	Nursery	65.2	0.1	6.4	99.9	0.1	4.8
Extractive	Extractive	806.0	1.2	1.2	634.3	0.5	0.5
Forest	Forest	51,731.7	77.6		86,865.4	75.2	
	Harvested Forest	522.5	0.8	78.3	877.4	0.8	76.0
Pasture	Natural Grass	545.5	0.8		180.7	0.2	
	Pasture	3,457.0	5.2		18,787.7	16.3	
	Trampled Pasture	18.1	0.0	6.0	98.3	0.1	16.5
Urban	Urban: Barren	22.1	0.0		36.0	0.0	
	Urban: Imp	186.4	0.3		233.0	0.2	
	Urban: perv	5,129.9	7.7	8.0	2,222.2	1.9	2.2
	Total	66,699.1	100.0	100.0	115,497.2	100.0	100.0
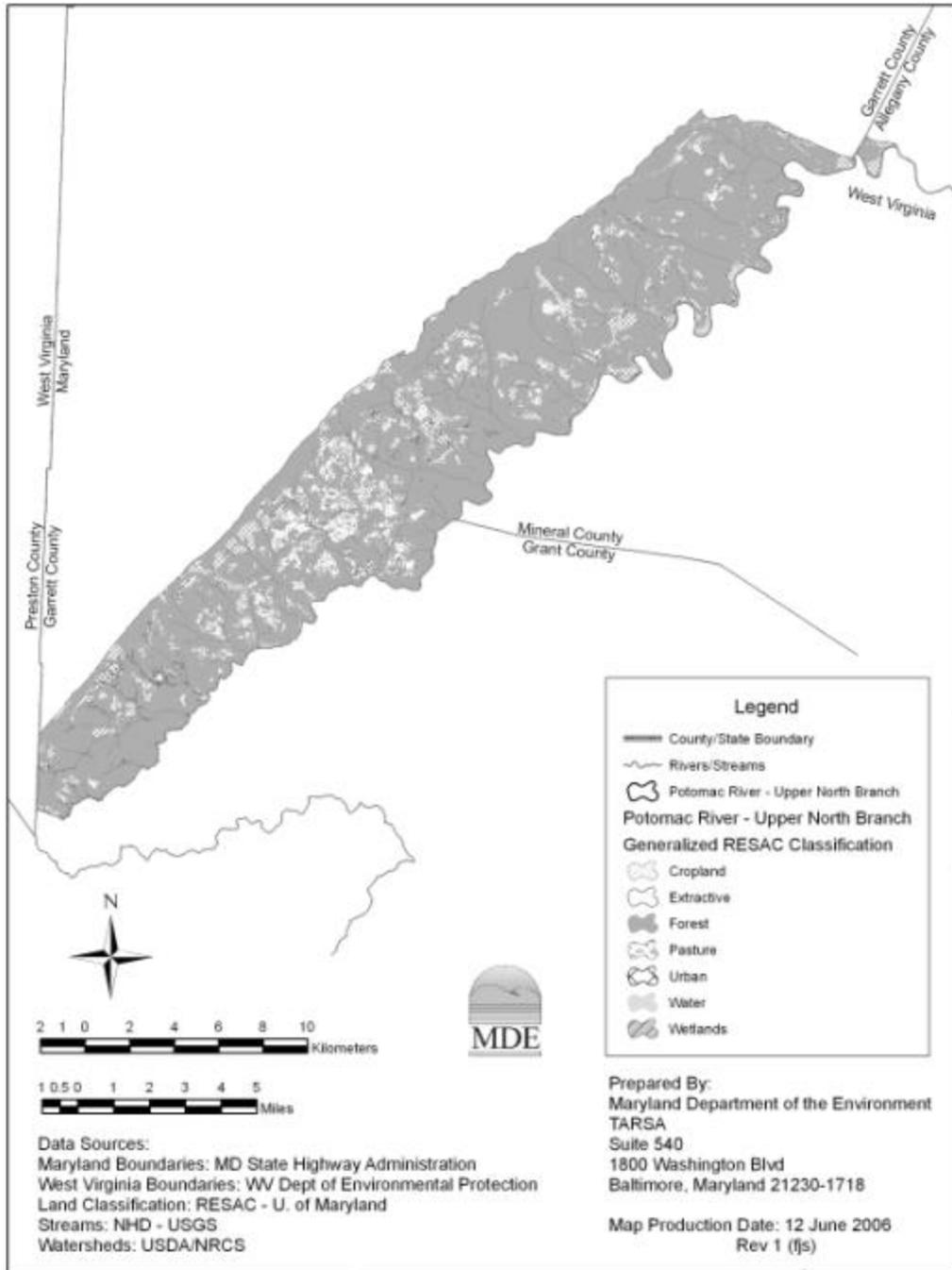
Figure 2: Land Use of the Upper North Branch Potomac River Watershed

2.2 Source Assessment

2.2.1 Nonpoint Sources (NPS)

General load estimation methodology

Nonpoint source sediment loads in the Upper North Branch Potomac River Watershed are estimated based on the *edge-of-stream (EOS) calibration target loading rates* from the CBP P5 model. This approach is based on the fact that not all of the *edge-of-field* (EOF) sediment load is delivered to the stream or river (some of it is stored on fields down slope, at the foot of hillsides, or in smaller rivers or streams that are not represented in the model). To calculate the actual EOS loads, a *sediment delivery ratio* (the ratio of sediment reaching a basin outlet compared to the total erosion within the basin) is used. Details of the methods used to calculate sediment load will be summarized in the report entitled "Chesapeake Bay Phase V Community Watershed Model: Tracking Nutrient and Sediment Loads on a Regional and Local Scale" (USEPA – CBP, 2006b).

Edge-of-Field Target Erosion Rate Methodology

EOF target erosion rates for agricultural land uses and forested land use were based on erosion rates determined by the National Resource Inventory (NRI). NRI is a statistical survey of land use and natural resource conditions conducted by the Natural Resources Conservation Service (NRCS) (USDA – NRCS, 2006). Sampling methodology is explained by Nusser and Goebel (1997).

Estimates of average annual erosion rates for pasture and cropland are available on a county basis at five-year intervals, starting in 1982. Erosion rates for forested land uses are not available on a county basis from NRI, however for the purpose of the CBP Phase 2 watershed model, NRI calculated average annual erosion rates for forested land use on a watershed basis. These rates are still being used as targets in the Phase V model.

The average value of the 1982 and 1987 surveys was used as the basis for EOF target loads. It was thought that the erosion rates from this period do not reflect best management practices (BMPs) or other soil conservation policies introduced in the wake of the effort to restore the Chesapeake Bay.

Rates for urban pervious, urban impervious, and barren land were based on a combination of best professional judgment, literature analysis, and regression analysis. Table 2 lists erosion rates specific to the Upper North Branch Potomac River Watershed.

Table 2: Summary of EOF Erosion Rate Calculations

Land Use	Data Source	Maryland (tons/acre/year)	West Virginia (tons/acre/year)
Forest	Phase 2 NRI	0.13	0.13
Harvested Forest[1]	Average Phase 2 NRI (x 10)	3.0	3.0
Natural Grass	Average NRI Pasture (1982-1987)	1.5	1.5
Pasture	Pasture NRI (1982-1987)	0.23 – 0.57	1.87 – 2.80
Trampled pasture[2]	Pasture NRI (x 9.5)	2.19 – 5.42	17.8 – 26.8
Animal Feeding Operations[2]	Pasture NRI (x 9.5)	2.19 – 5.42	17.8 – 26.8
Hay[2]	Crop NRI (1982-1987) (x 0.32)	1.04 – 1.11	0.03 – 0.22
High Till Without Manure[2]	Crop NRI (1982-1987) (x 1.25)	4.08 – 4.34	0.14 - 0.85
High Till With manure[2]	Crop NRI (1982-1987) (x 1.25)	4.08 – 4.34	0.14 - 0.85
Low till With Manure[2]	Crop NRI (1982-1987) (x 0.75)	2.45 – 2.60	0.08 – 0.51
Pervious Urban	Intercept Regression Analysis	0.74	0.74
Extractive	Best professional judgment	10	10
Barren	Literature survey	12.5 (w/ S&E[3] Controls) 25 (w/o S&E Controls)	16.3 (w/ S&E Controls) 25 (w/o S&E Controls)
Impervious	100% Impervious Regression Analysis	5.18	5.18

Notes: 1.   Average based on Chesapeake Bay Basin NRI values.
2. NRI score data adjusted based on land use.
3. Sediment and erosion.

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Sediment Delivery Ratio: The base formula for calculating sediment delivery ratios in the CBP P5 model is the same as the formula used by the NRCS (USDA-NRCS, 1983):

$$DF = 0.417762 * A^{-0.134958} - 0.127097 \qquad \text{(Equation 2.1)}$$

where
DF (delivery factor) = sediment delivery ratio
A = drainage area in square miles.

In order to account for the differences in sediment loads due to distance traveled to the stream, the CBP P5 model uses the sediment delivery ratio. Land use specific sediment delivery ratios were calculated for each river segment using the following procedure:

> (1) Mean distance of each land use from the river reach was calculated;
>
> (2) Sediment delivery ratios for each land use were calculated (drainage area in Equation 2.1 was assumed to be equal to the area of a circle with radius equal to the mean distance between the land use and the river reach).

Edge-of-Stream Loads

EOS loads are the loads that actually enter the river reaches (*i.e.,* the mainstem of a watershed). Such loads represent not only the erosion from the land but all of the intervening processes of deposition on hillsides and sediment transport through smaller rivers and streams.

Table 3 lists the current overall solids budget for the Upper North Branch Potomac River Watershed in Maryland and West Virginia, respectively. It is broken down into nonpoint and point source loadings. In Maryland, the nonpoint source sediment load comes from three main land uses - forest, extractive, and crop– all of which contribute approximately 70% of the total sediment load. The remaining nonpoint source sediment load is divided between urban (15%) and pasture (8%). In West Virginia, the main contributor of the nonpoint source sediment load is pasture land use (69%). The remaining nonpoint sources are forest (15%), extractive (8%), and urban and crop (both 4%).

2.2.2 Point Sources (PS)

A list of 17 active permitted sources in the Upper North Branch Potomac River Watershed was compiled using MDE's Environmental Permit Service Center (EPSC) database. The types of permits identified were municipal surface discharges, industrial surface discharges, general mining, and general industrial stormwater. Permit information for municipal and industrial surface discharges was obtained from EPA's Permit Compliance System (PCS) database. Specifically, total suspended solids (TSS) permit limits and Discharge Monitoring Report (DMR) data (TSS and flow) were obtained. Permit information for general mining permits was obtained from MDE permit files. Specifically, site areas, TSS permit limits, and average flow data were obtained. The total permitted TSS load is 379.6 tons/yr (see section 4.6 for a detailed description of the calculation). Also, a detailed list of the facilities appears in Appendix B.

2.2.3 Overall Solids Budget

Table 3 presents the current overall solids budget for the Upper North Branch Potomac River Watershed.

Table 3: Current Solids[1] Budget for the Upper North Branch Potomac River Watershed

General Land Use	Description	Maryland			West Virginia		
		Load (Ton/Yr)	Percent	Grouped Percent of Total	Load (Ton/Yr)	Percent	Grouped Percent of Total
Crop	Animal Feeding Operations	10.5	0.2		45.8	0.3	
	Hay	575.9	8.8		183.7	1.3	
	High Till	796.9	12.2		53.7	0.4	
	Low Till	95.0	1.5		20.3	0.1	
	Nursery	62.0	0.9	23.5	303.2	2.1	4.1
Extractive	Extractive	1,560.1	23.8	23.8	1,117.3	7.6	7.6
Forest	Forest	1,236.9	18.9		1,810.8	12.4	
	Harvested Forest	288.3	4.4	23.3	422.1	2.9	15.3
Pasture	Natural Grass	143.9	2.2		61.7	0.4	
	Pasture	368.6	5.6		9,526.4	65.1	
	Trampled Pasture	18.3	0.3	8.1	473.8	3.2	68.8
Urban	Urban: Barren	61.3	0.9		66.0	0.5	
	Urban: Imp	251.0	3.8		224.8	1.5	
	Urban: perv	693.6	10.6	15.4	313.4	2.1	4.1
Permits	Process Load	379.6	5.8	5.8	NA	NA	NA
	Total	6,542.0	100.0	100.0	14,623.1	100.0	100.0

Note: 1. The word "solids" is used instead of "sediments" because the point source inputs are included.

2.3 Water Quality Characterization

The Upper North Branch Potomac River Watershed was originally listed on Maryland's 1996 303(d) List as impaired by elevated sediments from nonpoint sources, with supporting evidence cited in Maryland's 1996 305(b) report. The 1996 305(b) report did not directly state that elevated sediments were a concern (MDE, 2006a and DNR, 1996).

To provide a water quality characterization of the Upper North Branch Potomac River Watershed, it must first be determined how elevated sediment loads are linked to degraded stream water quality. While currently in Maryland there are no specific numeric criteria that quantify the impact of sediment on the aquatic health of non-tidal stream systems, it was outlined in the Maryland 2004 303(d) report that degraded stream water quality resulting in a sediment impairment is characterized by erosional impacts, depositional impacts, and decreased water clarity (MDE, 2006b). For this report, cumulative erosional and depositional impacts were evaluated based on two site-specific water quality parameters – embeddedness and epifaunal substrate condition. Embeddedness is the fraction of surface area of larger particles surrounded by finer sediments, and epifaunal substrate is the amount and variety of hard, stable substrates used by benthic macroinvertebrates. In general, low embeddedness and high epifaunal substrate are beneficial to the aquatic life of a stream system. The analysis was based on the data collected by the Maryland Biological Stream Survey (MBSS) program (see Table 4, Figure 3, and Appendix A). Water clarity was evaluated by instantaneous turbidity samples, also collected by the MBSS program. In addition to the characterizations outlined in the Maryland 2004 303(d) report, sediment load was also used to characterize the watershed. Sediment load is a quantitative estimate of the total sediment transported to the highest order stream draining the watershed.

Table 4: MBSS Stations in the Upper North Branch Potomac River Watershed

Site Number	Date Sampled Summer	Latitude (dec degrees)	Longitude (dec degrees)
PRUN-101-R-2001	25JUN2001	39.37884	79.28291
PRUN-102-R-2001	20AUG2001	39.27696	79.40264
PRUN-103-R-2001	16AUG2001	39.45325	79.14049
PRUN-104-R-2001	15AUG2001	39.40139	79.25945
PRUN-106-R-2001	15AUG2001	39.44353	79.16031
PRUN-107-R-2001	16AUG2001	39.45496	79.14292
PRUN-109-R-2001	06AUG2001	39.27632	79.43228
PRUN-205-R-2001	25JUN2001	39.36707	79.24819
PRUN-210-R-2001	25JUN2001	39.37077	79.25405
PRUN-211-R-2001	25JUN2001	39.41537	79.18018
PRUN-101-C-2000	25JUL2000	39.30444	79.31278
PRUN-302-C-2000	25JUL2000	39.36194	79.23334
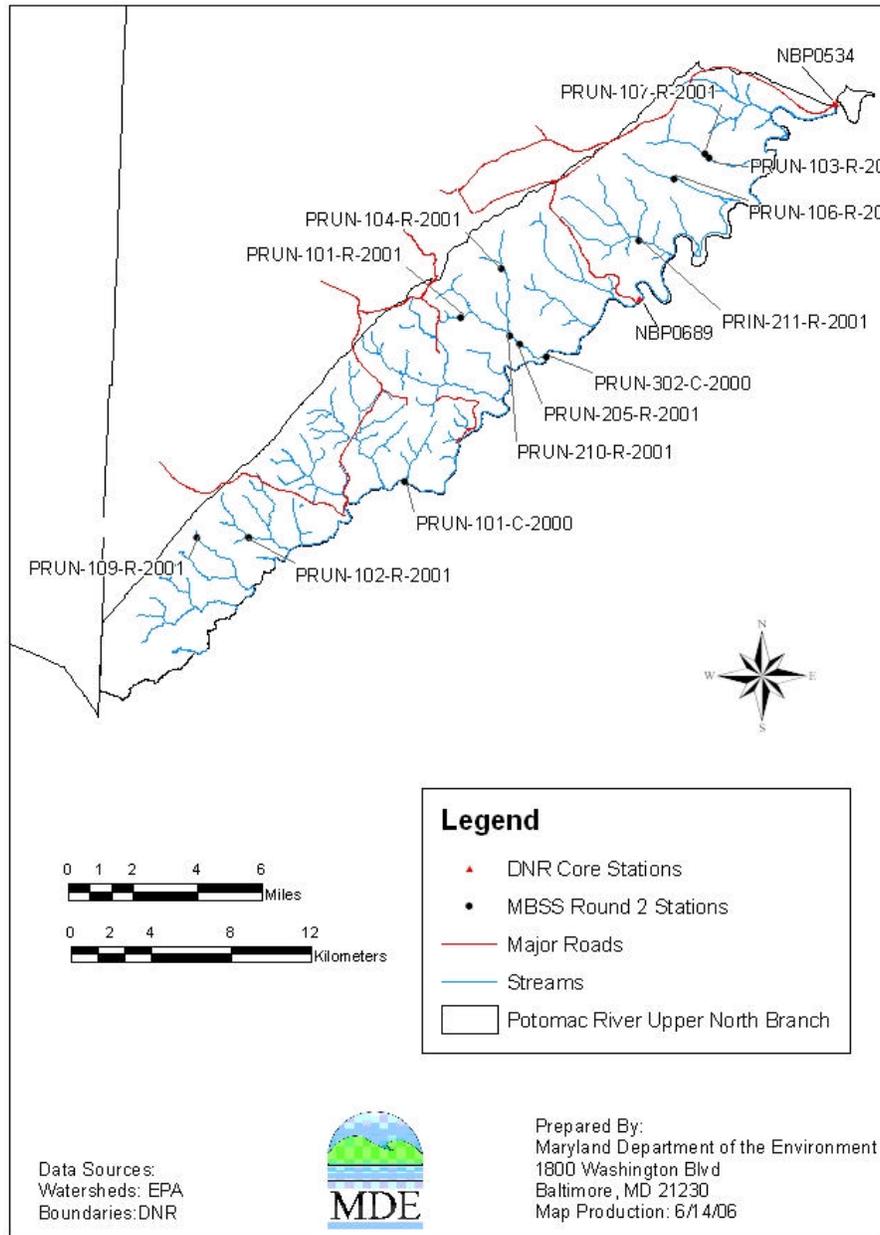
Figure 3: MBSS and DNR Core Stations in the Upper North Branch Potomac River Watershed

Increasing embeddedness and decreasing epifaunal substrate condition scores indicate possible erosional or depositional impacts from elevated sediment loads. There are no numeric criteria for embeddedness and epifaunal substrate condition. Instead, monitoring results were compared to values observed in streams identified as having a healthy benthic community (*i.e.,* reference sites). The benthic community was chosen for comparison because it is more directly impacted than are fish by the physical conditions of the streambed. Impacts or changes to the streambed could affect the benthic

community by altering food quality, covering habitat, filling interstitial space and altering water movement (Minshall, 1984).

Reference sites for comparison were selected from the non-coastal physiographic region (Highland and Piedmont) and were required to have Benthic Index of Biotic Integrity (BIBI) scores significantly greater than 3.0 (based on a scale of 1 to 5). A threshold of 3.0 was selected because this is the level indicative of satisfactory water quality in Maryland's biocriteria (Roth *et al.*, 2000, Roth *et al.*, 1998 and Stribling *et al.*, 1998.) In determining if the site score is significantly greater than 3.0, a default confidence interval was applied that is based on the coefficient of variation from replicate samples. A comparison of MBSS sampling results to reference sites is presented in the Figure 4.
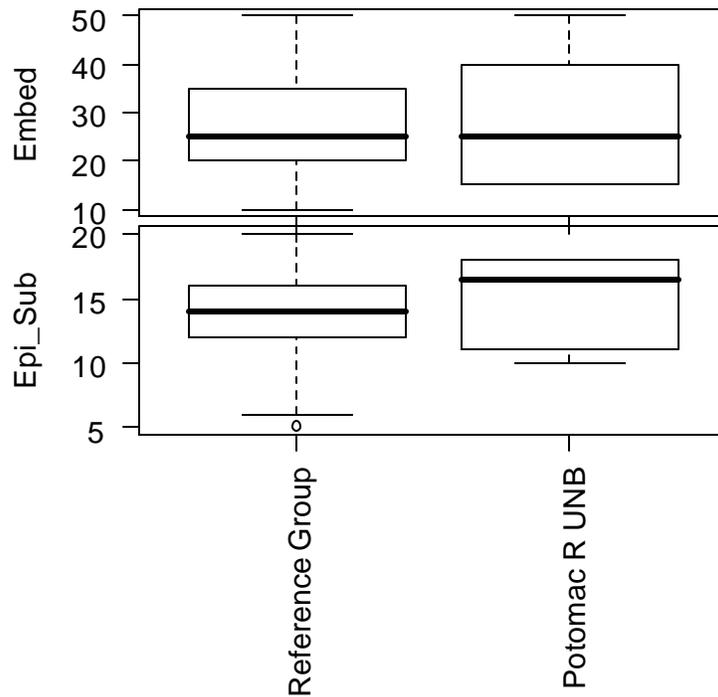
Figure 4: The Upper North Branch Potomac River Embeddedness and Epifaunal Substrate Compared to Reference Sites

MBSS sampling also includes turbidity samples, which provide an instantaneous measure for evaluating water clarity. These samples were collected during the summer low flow period and are only collected one time per site. Since the representativeness of these samples to the overall stream water quality is limited, they were not used in this analysis.

In the absence of specific numeric criteria that quantify the impact of sediment on the aquatic health of non-tidal stream systems, the average annual sediment load is the only currently available target that accounts for the potential effect of both water clarity and erosional/depositional impacts to the aquatic community. Thus, it is used in this analysis as the final determining factor for assessing if there is a sediment impact to aquatic health. In general, an elevated sediment load results from increased total suspended

solids (TSS) concentration with an effect of reduced water clarity in the water column. Sources of the increased sediment load (and TSS concentrations) are typically terrestrial and channel erosion. Increases in both sources potentially decrease water clarity and, based on stream transport capacity, increase the likelihood of depositional impacts, where an increase in the channel erosion load will result in physical alterations to the stream system. The combined effects of increased terrestrial and channel erosion are captured within the current watershed sediment load, which can be linked to the long term effects on aquatic health (i.e. water clarity, altered habitat through erosion and deposition).

The average annual watershed sediment load used in this analysis is an estimate from the CBP P5 model and provides a quantitative estimate of sediment to the highest order (largest) stream in the watershed. This sediment load is estimated for the rainfall driven sediment, which is the most significant sediment source in a non-tidal watershed. The watershed segmentation applied in the analysis is based on the CBP P5 model and results in three TMDL analysis segments for the Upper North Branch Potomac River Watershed (see Figure 5.)

Since there are no established numeric criteria for watershed sediment loads, the watershed sediment load in the Upper North Branch Potomac River Watershed was compared to loads estimated in reference watersheds. Reference watersheds were determined based on the Benthic and/or Fish Index of Biotic Integrity (BIBI/FIBI) average watershed scores being significantly greater than 3.0 (based on a scale of 1 to 5). A threshold of 3.0 was selected because this is the level indicative of satisfactory water quality per Maryland's biocriteria (Roth *et al.*, 2000; Roth *et al.*, 1998 and Stribling *et al.*, 1998). In determining if the average watershed score is significantly greater than 3.0, a 90% confidence interval was calculated for each watershed based on the individual MBSS sampling results.

Comparison of watershed sediment loads to loads from reference watersheds requires that the watersheds be similar in physical and hydrological characteristics. To satisfy this requirement, reference watersheds were selected only from the Highland and Piedmont physiographic regions. This region is consistent with the non-coastal region that was identified in the 1998 development of the FIBI and subsequently used in the development of the BIBI (Roth *et al.*, 1998 and Stribling *et al.*, 1998). To control for the variability in soil type, rainfall, and topography, individual watershed sediment loads were normalized by their all forested condition sediment load. The normalization calculation divides the current watershed sediment load by the sediment load assuming an all forested condition. This resulting factor, the forest normalized sediment load, represents how many times greater the current watershed sediment load is than the all forested sediment load.
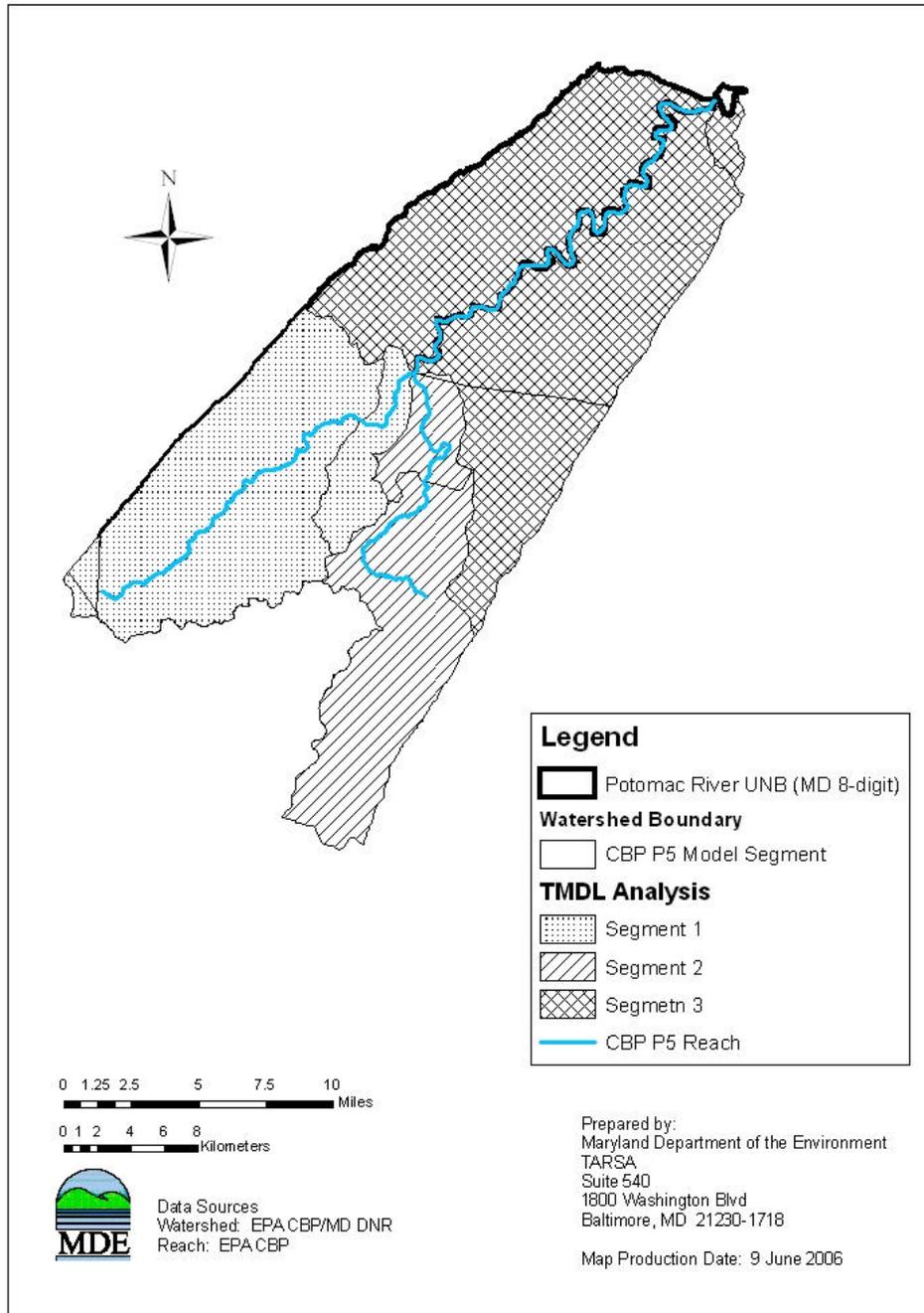
Figure 5: Upper North Branch Potomac River Watershed Characterization Segmentation

For comparison, the watershed was divided into three TMDL segments. TMDL Segment 2 lies entirely in West Virginia, and is therefore not reported. TMDL Segment 1 represents the portion of the watershed south of the town of Rawlings, approximately, and includes areas in both Maryland and West Virginia. TMDL Segment 3 represents the sediment loads transported north of the town of Rawlings, approximately. A comparison of the Upper North Branch Potomac River Watershed forest normalized sediment load (estimated as 5.2 and 4.0 times the all forested load for TMDL Segments 1 and 3, respectively) to the forest normalized reference sediment load (also referred to as the sediment loading threshold) is shown in Figure 6.

Finally, the distribution of land use for the Upper North Branch Potomac River Watershed was compared to the reference watersheds and determined to be within the ranges found in the reference watersheds. A comparison of the Upper North Branch Potomac River land use to the range of reference watersheds land use is illustrated in Figure 7.
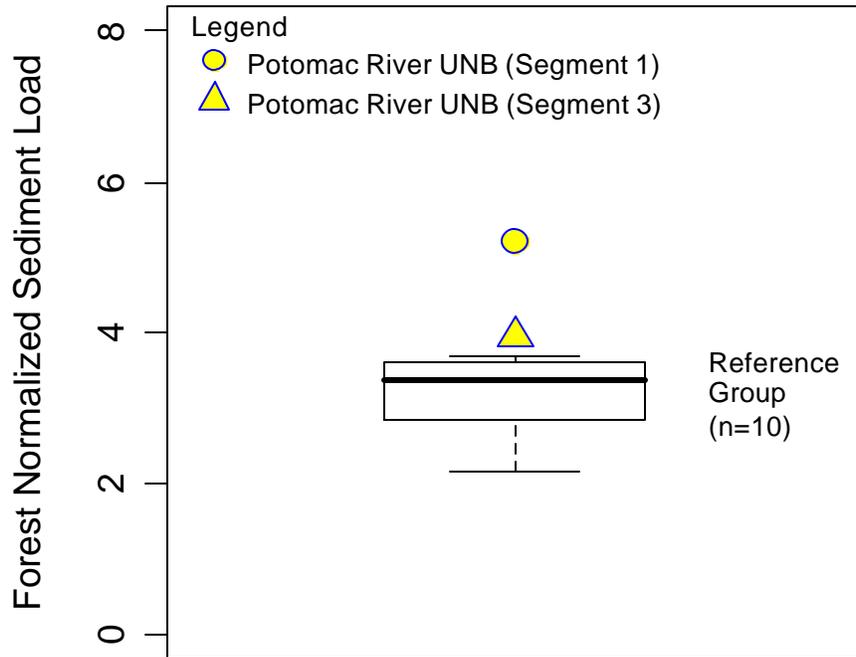
Figure 6: The Upper North Branch Potomac River Forest Normalized Sediment Load Compared to Reference Watershed Group
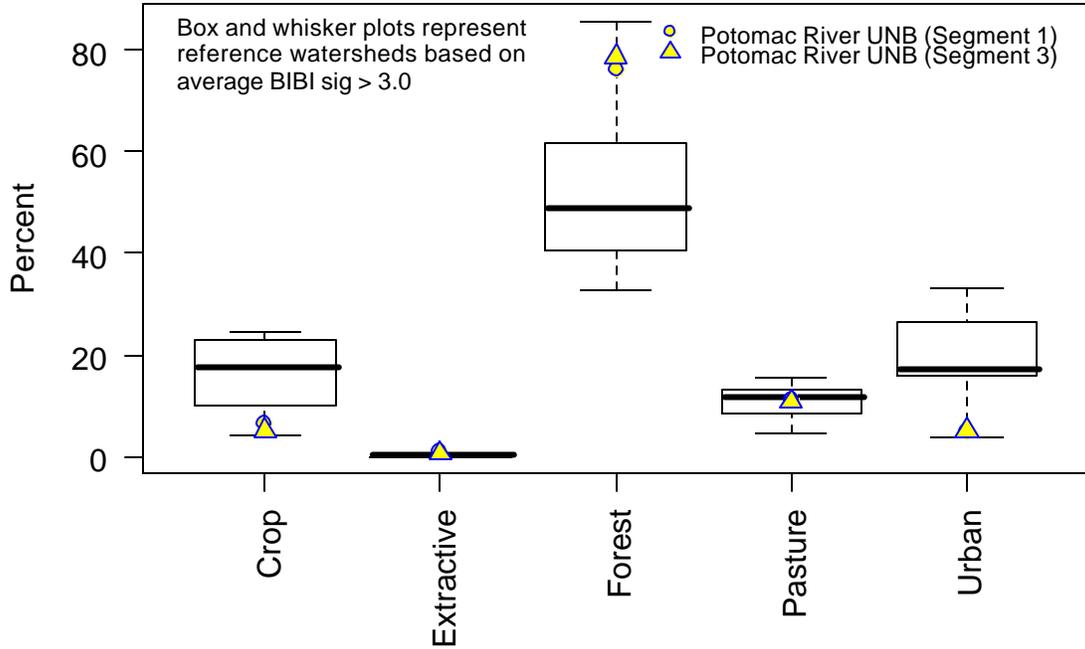
Figure 7: Upper North Branch Potomac River Land Use Compared to Reference Watershed Group

Potomac River Mainstem Stations

Maryland Department of Natural Resources has monitoring information for two stations in the mainstem of the Potomac River Upper North Branch through the Core/Trend program and two stations through the MBSS program. The Core/Trend program has one station located near Kitzmiller (NBP0689) and another is located near Bloomington (NBP0534) (see Table 5 and Figure 3). Both stations have 19 years of benthic macroinvertebrate data collected from 1977 to 2004. The MBSS program has one station on Steyer Run (PRUN-101-C-2000) and the other on Lostland Run (PRUN-302-C-2000), with one-time sampling results for both benthic macroinvertebrates and fish (see Table 4 and Figure 3).

Table 5: DNR Core stations in the Upper North Branch Potomac River Watershed

Site Number	Site Name	Latitude (dec degrees)	Longitude (dec degrees)
NBP0534	Bloomington	39.47926	79.0681
NBP0689	Kitzmiller	39.38926	79.1795

Statistical analysis of the long term Core/Trend data indicates that since 1977, both stations have shown significant improvement in taxa (groups of organisms) and percent EPT (Ephemeroptera, Plecoptera and Tricoptera). Using percent EPT, taxa number, biotic index, and diversity index, both sites were reported to have water quality in the

good range with an improving trend (DNR, 2006b). In addition, both stations also have a decreasing trend in average TSS concentration (DNR, 2006c).

The MBSS data are collected using an assessment methodology that is consistent with Maryland's biocriteria (Roth *et al.*, 2000; Roth *et al.*, 1998 and Stribling *et al.*, 1998). Analysis of both stations indicates that the water quality is meeting Maryland biocriteria requirements for acceptable water quality (i.e. IBI>3.0).

2.4 Water Quality Impairment

The Maryland water quality standards Surface Water Use Designation for the Upper North Branch Potomac River Watershed is Use I-P (Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply) (COMAR, 2006a). The water quality impairment of the Upper North Branch Potomac River Watershed addressed by this TMDL consists of an elevated sediment load beyond a level compatible with the support of aquatic life. The sediment loading threshold was estimated using reference watersheds, where the assimilative capacity is determined to be approximately 3.3 times the sediment load assuming an all forested condition. This value is representative of watersheds in the Highland and Piedmont physiographic regions with land use distributions within the range of the reference watersheds. Further details can be found in Tables A-1 for reference watersheds and A-4 for the Upper North Branch Potomac River.

The Upper North Branch Potomac River mainstem is the divide between Maryland and West Virginia. Because the mainstem divides the states, the watershed was first evaluated using biological information from the mainstem stations collected by the MD DNR Core/Trend program and the MBSS program. This analysis was used to determine if the mainstem was impaired. In the second stage of the evaluation, three TMDL watershed segments, which include loads from both Maryland and West Virginia, were used to determine if there was a local water quality impairment in the smaller order streams.

Biological results from both the DNR Core/Trend and MBSS stations indicate the water quality can be classified as fair to good. Moreover, the MBSS stations both have fish and benthic IBI's greater than 3.0 and thus meet the narrative water quality standard. It is therefore concluded that the Potomac River Mainstem is not impaired by elevated sediment, and therefore sediment loads from West Virginia are not adversely impacting water quality in the Potomac River mainstem.

The reference watershed approach is used to determine if there is an impairment to Maryland's local water quality in the lower order (smaller) streams. The forest normalized sediment loads from TMDL Segments 1 and 3 are approximately 5.2 and 4.0, respectively. The boundary of TMDL Segment 2 (see Figure 5) is entirely in West Virginia and is therefore not assessed further. Maryland's general water quality criteria prohibit pollution of waters of the State by any material in amounts sufficient to create nuisance or interfere with designated uses (COMAR, 2006b). This analysis indicates that in TMDL Segments 1 and 3, sediment loads exceed levels that support aquatic health,

and confirms that Maryland's local water quality in the Upper North Branch Potomac River Watershed is impaired by elevated sediment loads to the stream system.

In summary, biological monitoring results from MD DNR Core/Trend and MBSS programs were used to conclude that the mainstem of the Upper North Branch Potomac River Watershed meets the narrative water quality standard and thus supports the designated use. Using a reference watershed approach and MBSS data from the mainstem and its smaller order tributaries, however, it was determined that watershed sediment loads exceed levels that support aquatic health and thus violate Maryland local water quality standards in the lower order tributaries. As a result, this TMDL will determine sediment loads and reductions to Maryland watersheds that will meet local water quality in lower order (smaller) streams.

3.0 TARGETED WATER QUALITY GOAL

The objective of the sediment TMDL established in this document is to ensure that the sediment loads and resulting effects are at a level to support the Use I-P designation for the Upper North Branch Potomac River Watershed, and more specifically at a level to support aquatic health.

4.0 TOTAL MAXIMUM DAILY LOADS AND SOURCE ALLOCATION

4.1 Overview

This section describes how the sediment TMDL and load allocations were developed for the Upper North Branch Potomac River Watershed. Section 4.2 describes the analysis framework for estimating sediment loading rates and the assimilative capacity of the watershed stream system. Section 4.3 summarizes the scenarios that were used in the analysis and the results. Section 4.4 discusses critical conditions and seasonality. Section 4.5 explains the calculations of TMDL loading caps. Section 4.6 details the load allocations between point and nonpoint sources, and Section 4.7 explains the rationale for the margin of safety. Finally, Section 4.8 summarizes the TMDL.

As discussed in Section 2.4, it was concluded that upstream sediment loads from West Virginia were not causing a water quality impairment on the Potomac River mainstem. Therefore, this analysis focused on reductions for Maryland loads only and reports upstream loads as baseline conditions.

4.2 Analysis Framework

The computational framework chosen for the Upper North Branch Potomac River TMDL was the CBP P5 watershed model. The EOS sediment load is calculated for each land use as a product of the land use area, land use target loading rate, and loss from the edge-of-field (EOF) to the main channel. The sediment delivery ratio is used because not all of the EOF sediment load is delivered to the stream or river. Some of it is stored on fields down slope, at the foot of hillsides, or in smaller rivers or streams that are not represented in the model. The sediment delivery ratio is the ratio of the sediment load reaching a basin outlet to the total erosion within the basin.

The spatial domain of the watershed model segmentation aggregates to the Maryland 8-digit watersheds. TMDL segment 1 and Segment 3 (see Figure 5) of the Upper North Branch Potomac River watershed are each represented by multiple CBP P5 model segments. The proximity of specific land use to that of the main channel is captured through the sediment delivery ratio. Details of the data sources for the unit loading rates can be found in Section 2.2 of this report, and complete details of the modeling approach will be included in the report entitled "Chesapeake Bay Phase V Community Watershed Model: Tracking Nutrient and Sediment Loads on a Regional and Local Scale" (USEPA - CBP, 2006b). Predicted sediment loads are based on CBP P5 2002 land use, and represent a long-term average loading rate.

To reduce the variability when comparing watersheds within and across regions, the watershed sediment load is normalized by a constant background condition. A similar approach was used by EPA Region 9 in sediment TMDLs in California (Navarro River, Trinity River), where the loading capacity was based on an analysis of the amount of human-caused sediment delivery that can occur in addition to natural sediment delivery,

without causing adverse impacts to aquatic life. The forest normalized sediment load for this TMDL is calculated as the current watershed sediment load divided by the all forested sediment load. This new term, defined as the forest normalized sediment load (Y_n), represents how many times greater the current watershed sediment load is than the all forested sediment load. The equation is as follows:

$$Y_n = \frac{y_{ws}}{y_{for}}$$

(Equation 4.1)

where
Y_n = forest normalized sediment load
y_{ws} = current watershed sediment load (Ton/Yr)
Y_{for} = all forested sediment load (Ton/Yr)

4.3 Scenario Descriptions and Results

The following analyses allow a comparison of baseline conditions (under which water quality problems exist) to future conditions, which calculate the maximum average annual sediment load that supports the stream's designated use. The analyses are grouped according to *baseline conditions* and *future conditions* associated with TMDLs.

Baseline Conditions

The baseline conditions are intended to provide a point of reference by which to compare the future scenario that simulates conditions of a TMDL. The baseline conditions typically reflect an approximation of nonpoint source loads during the monitoring time frame, as well as estimated point source loads based on discharge data for the same period.

The Upper North Branch Potomac River Watershed baseline sediment loads are estimated using the CBP P5 target EOS land use sediment loading rates with the CBP 2002 land use. Watershed loading calculations based on the CBP P5 segmentation scheme are represented by multiple CBP P5 model segments in the Upper North Branch Potomac River Watershed. The sediment loads from the permitted sources are estimated using the permit information. Details of these loading source estimates can be found in Section 2.2, Section 4.6, and Appendix B of this report.

The total sediment load from the Upper North Branch Potomac River Watershed is approximately 21,165.1 tons/yr with 6,542.0 tons/year from Maryland and 14,623.1 tons/yr from West Virginia.

Future (TMDL) Conditions

This scenario represents the future conditions of maximum allowable sediment loads that will support a healthy biological community. In the TMDL calculation, the allowable load for the impaired watershed is calculated as the product of the normalized sediment loading threshold (determined from watersheds with a healthy benthic community) and the Upper North Branch Potomac River all forested sediment load (for details see Section

2.3). This load is considered the maximum allowable load the watershed can assimilate and still attain water quality standards.

The TMDL loading and associated reductions are averaged at the Maryland 8-digit watershed scale, which is consistent with the original listing scale.   It is important to recognize that in reality some subwatersheds may require higher reductions than others, depending on the distribution of the land use.

The formula for estimating the TMDL is as follows:

$$TMDL = \sum_{i=1}^{n} Yn_{ref} \cdot y_{forest_i}$$ (Equation 4.2)

where
TMDL = allowable load for impaired watershed (Ton/Yr)
Yn_{ref} = sediment loading threshold = forest normalized reference sediment load (3.3)
y_{forest_i} = all forested sediment load for segment i (Ton /Yr)
i = CBP P5 model segment
n = number of CBP P5 model segments in watershed

4.4 Critical Condition and Seasonality

EPA's regulations require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters (CFR, 2006). The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when it is most vulnerable. The biological monitoring data used to determine the reference watersheds integrates the stress effects over the course of time and thus inherently addresses critical conditions.   Seasonality is captured in two respects. First, it is implicitly included in biological sampling since results integrate the stress effects over the course of time. Second, the MBSS sampling included benthic sampling collected in the spring and fish sampling collected in the summer. While fish results were not directly applied in the final analysis, Currey *et al* (2006) reported that there was minimal difference in the forest normalized sediment loads for the reference group watersheds using benthic scores only and the group using both fish and benthic scores. Thus, this analysis has captured both spring and summer flow conditions.

4.5 TMDL Loading Caps

This section presents the TMDL of TSS for the Maryland portion of the Upper North Branch Potomac River Watershed. This load is considered the maximum allowable load the watershed can receive and still meet water quality standards. This load is a long-term average.

The sediment TMDL for the Maryland Portion of the Upper North Branch Potomac River Watershed, based on Equation 4.2, is as follows:

$$TMDL = 4,521.4 \text{ Ton/Yr}$$

4.6 Load Allocations Between Point and Nonpoint Sources

The allocations described in this section demonstrate how the TMDL of TSS can be implemented to meet the water quality criteria in the Upper North Branch Potomac River watershed. The State reserves the right to revise these allocations provided the revisions are consistent with achieving water quality standards.

There are two broad types of National Pollutant Discharge Elimination System (NPDES) permits considered in this analysis, individual and general.

In this TSS TMDL, the rationale for determining whether the permitted source is assigned to the LA or WLA is based on explicitly specified TSS permit limits, data availability, and scale. In the Upper North Branch Potomac River Watershed, permits with specific TSS limits, and corresponding flow information, are assigned to the WLA. In this case detailed information is available to accurately estimate the WLA. If specific TSS limits are not explicitly stated in the permit, then TSS loads are expected to be either (1) *de minimis* or (2) rainfall-driven and thus highly variable. If loads are *de minimis*, then they pose little or no risk to the aquatic environment and are not a significant source. Rainfall driven loads are difficult to quantify due to high variability in precipitation events and, in some cases, lack of available site-specific outfall information. Rainfall-driven loads will be assigned to the WLA at an appropriate scale.

The Department has decided to apply EPA's criterion for MS4 permitting requirements (population>100,000) as the appropriate scale for assigning rainfall-driven permitted TSS loads to the WLA.   The justification is that as the areal extent of the permitted source increases relative to the total watershed size, the TSS load estimate will be more significant compared to the total watershed load and as a result will become more reliable in its estimate. Therefore, when a watershed includes a Municipal Separate Stormwater System (MS4) permitted jurisdiction, all rainfall driven permitted TSS sources within the MS4 permitted area, without explicit TSS limits, will be included in the WLA of the TMDL as one lumped allocation. At this scale, the TSS load is expected to be more significant compared to the total watershed load and more reliable in its estimate. It is also important to point out that discharges associated with industrial activity, whether in

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the WLA or LA of a TMDL, already include a specific set of best management practices (BMPs) as per the permit requirements.

There are no MS4 permits in the Upper North Branch Potomac River watershed. Therefore, all rainfall-driven TSS loads will be allocated to the LA. These include loads from agricultural land, extractive land, forested land, and developed land. There are 16 permitted sources with explicit TSS limits (see Table B-2). The estimated TSS loads from these sources are assigned to the WLA using the current permit limits. For more information, see Table B-1 located in Appendix B, which lists the resulting allocation decision for the 17 permitted sources in the Upper North Branch Potomac River watershed.

Reductions

Reductions are estimated for the predominant controllable sources (i.e., significant contributors of sediment to the stream system). If only these predominant (generally the largest) sources are controlled, water quality standards can be achieved in the most effective and efficient manner. Predominant sources include urban land, high till crops, low till crops, hay, pasture, and harvested forest, but additional sources can be added and controlled until the water quality standard is attained.

A reduction of 30.9% from current estimated loads will be required to meet TMDL allocation and attain water quality standards. Table 6 summarizes the TMDL scenario results based on applying the 30.9% reduction equally to the predominant controllable sediment sources. The reductions in Table 6 are based on multiple sources (e.g. high till, low till, hay, animal feeding operations, and nursery all equal a crop source) and reflect that reductions were only applied to the predominant source categories (e.g. high till).

In this watershed, forest is the only non-controllable source, as it represents the most natural condition in the watershed. No reductions were applied to permitted sources because at 5.8% of the total load, such controls would produce no discernable water quality benefit.

Table 6: Point Source and Nonpoint Source Load Allocations (Maryland)

Source	Baseline Load (Ton/Yr)	TMDL Scenario Load (Ton/Yr)	Reduction
Crop	1,540.4	919.0	40.3%
Extractive	1,560.1	847.0	45.7%
Forest	1,525.3	1,407.6	7.7%
Pasture	530.8	330.1	37.8%
Urban	1,005.8	638.2	36.6%
Permitted[1]	379.6	379.6	
Total	6,542.0	4,521.4	30.9%

Note: 1. Based on permit limits.

4.7 Margin of Safety

All TMDLs must include a margin of safety (MOS) to account for any lack of knowledge and uncertainty concerning the relationship between loads and water quality (CFR, 2006). It is proposed that the estimated variability around the reference watershed group used in this analysis already accounts for such uncertainty. Analysis of the reference group forest normalized sediment loads indicates that approximately 75% of the reference watersheds have a value of less than 3.6, while 50% have a value of less than 3.3. Based on this analysis, the forest normalized reference sediment load (also referred to as the sediment loading threshold) was set at the median value of 3.3. This is considered an environmentally conservative estimate, since 50% of the reference watersheds have a load above this value, which results in an implicit margin of safety of approximately 8%.

4.8 Summary of Total Maximum Daily Loads

The long-term average annual TMDL allocation for the Maryland 8-digit Upper North Branch Potomac River is summarized in Table 7.

Table 7: Annual TMDL Allocation Summary

	TMDL (Ton/yr)	LA	WLA	MOS
Maryland	4,521.4	4,141.8	379.6	Implicit

Note: Upstream sediment loads were not included in this TMDL analysis. Baseline upstream loads are 14,623.1 ton/yr.

5.0 ASSURANCE OF IMPLEMENTATION

This section provides the basis for reasonable assurances that the sediment TMDL will be achieved and maintained. Section 303(d) of the Clean Water Act and current EPA regulations require reasonable assurance that the TMDL load and wasteload allocations can and will be implemented. Maryland has several well-established programs to draw upon, including the Water Quality Improvement Act of 1998 (WQIA) and the Federal Nonpoint Source Management Program (§ 319 of the Clean Water Act).

Potential funding sources for implementation include the Buffer Incentive Program (BIP) and the Maryland Agriculture water quality cost share program (MACS). Other funding available for local governments include the State Water Quality Revolving Loan Fund and the Stormwater Pollution Cost Share Program. Details of these programs and additional funding sources can be found at http://www.dnr.state.md.us/bay/services/summaries.html.

Potential best management practices for reducing sediment loads and resulting impacts can be grouped into three general categories. The first is directed toward agricultural lands, the second to urban (developed) land, and the third applies to all land uses.

In agricultural areas, comprehensive soil conservation plans can be developed that meet criteria of the USDA-NRCS Field Office Technical Guide (USDA – NRCS, 1983). Soil conservation plans help control erosion by modifying cultural practices or structural practices. Cultural practices may change from year to year, and include changes to crop rotations, tillage practices, or use of cover crops. Structural practices are longer-term measures that include, but are not limited to, the installation of grass waterways (in areas with concentrated flow), terraces, diversions, sediment basins or drop structures. The reduction percentage attributed to cultural practices is determined based on changes in land use, while structural practices have a reduction percentage up to 25%.   In addition, livestock can be controlled via stream fencing and rotational grazing. Sediment reduction efficiencies of methods applicable to pasture land use range from about 40% to 75% (USEPA-CBP, 2004).

Sediment from urban areas can be reduced by stormwater retrofits, impervious surface reduction, and stream restoration. Stormwater retrofits include modification of existing stormwater structural practices to address water quality. Reductions range from as low as 10% for dry detention to approximately 80% for wet ponds, wetlands, infiltration practices, and filtering practices. Impervious surface reduction results in a change in hydrology that could reduce stream erosion (USEPA – CBP, 2003).

All non-forested land uses can benefit from improved riparian buffer systems. A riparian buffer reduces the effects of upland sediment sources through trapping and filtering. Riparian buffer efficiencies vary depending on type (grass or forested), land use (urban or agriculture), and physiographic region. The CBP estimates riparian buffer sediment reduction efficiencies in the Upper North Branch Potomac River region to be approximately 50% (USEPA - CBP, 2006a).

In summary, through the use of the aforementioned funding mechanisms and best management practices, there is reasonable assurance that this TMDL can be implemented.

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APPENDIX A

Table A-1: Reference Watersheds

MD 8-digit Name [1]	MD 8-digit	FIBI n	BIBI n	FIBI	BIBI	Forest Normalized [2] Sediment Load
Deer Creek	2120202	28	28	Ind.	Pass	3.63
Broad Creek	2120205	10	10	Ind.	Pass	3.67
Little Gunpowder Falls	2130804	19	20	Ind.	Pass	3.26
Prettyboy Reservoir	2130806	11	11	Pass	Pass	2.87
Liberty Reservoir	2130907	31	31	Pass	Pass	3.28
S Branch Patapsco	2130908	10	10	Pass	Pass	3.57
Rocky Gorge Dam	2131107	10	10	Pass	Pass	3.43
Brighton Dam	2131108	11	11	Ind.	Pass	3.61
Town Creek	2140512	16	20	Ind.	Pass	2.17
Savage River	2141006	13	14	Pass	Pass	2.48
Median [3]						3.3
75th Percentile						3.6

Notes: 1. Potomac River Lower North Branch determined to be an outlier through statistical analysis and best professional judgment; Fifteen Mile Creek Watershed removed because the majority of the watershed is in Pennsylvania.
2. Forest normalized sediment load based on Maryland watershed area only (Consistent with MBSS random monitoring data).
3. Median rounded down (3.36 to 3.3) as conservative estimate.
4. Ind.= Indeterminate.

Table A-2: Reference Watersheds Land Use

MD 8-digit Name	MD 8-digit	Crop	Extractive	Forest	Pasture	Urban
Deer Creek	2120202	23	0	50	11	16
Broad Creek	2120205	24	0	48	10	17
Little Gunpowder Falls	2130804	15	0	45	16	23
Prettyboy Reservoir	2130806	20	0	50	14	16
Liberty Reservoir	2130907	22	0	38	10	30
S Branch Patapsco	2130908	23	0	33	11	33
Rocky Gorge Dam	2131107	15	0	40	12	33
Brighton Dam	2131108	17	0	41	25	17
Town Creek	2140512	5	0	84	7	4
Savage River	2141006	5	0	86	4	5

Note: 1. All values have been rounded to nearest whole number percentage.

Table A-3: MBSS Data for Sites with BIBI Significantly > 3

MBSS Site	Epifaunal Substrate	Embeddedness
PRMO-110-R-2002	14	30
PRMO-115-R-2002	16	25
PRMO-202-R-2002	13	35
PRMO-304-R-2002	13	25
SENE-104-R-2001	10	25
UMON-119-R-2000	18	25
UMON-221-R-2000	16	30
UMON-230-R-2000	20	20
UMON-304-R-2000	16	30
DOUB-116-R-2002	16	20
DOUB-119-R-2002	12	35
DOUB-221-R-2002	14	35
DOUB-407-R-2002	8	45
CATO-104-R-2003	14	15
CATO-106-R-2003	14	30
CATO-214-R-2003	12	40
PRWA-103-R-2000	10	30
PRWA-122-R-2000	12	20
PRWA-124-R-2002	11	35
ANTI-113-R-2003	14	35
ANTI-208-R-2003	9	30
LCON-119-R-2004	15	25
LIKG-103-R-2004	18	20
LIKG-113-R-2004	16	25
LIKG-115-R-2004	8	42
LIKG-211-R-2004	16	30
PRAL-107-R-2001	14	15
PRAL-208-R-2001	16	10
SIDE-402-R-2001	16	15
SIDE-410-R-2001	16	20
FIMI-106-R-2000	12	10
FIMI-109-R-2000	17	10
FIMI-110-R-2000	14	10
FIMI-202-R-2000	14	10
FIMI-401-R-2000	17	10
FIMI-407-R-2000	18	10
TOWN-101-R-2000	11	25
TOWN-102-R-2000	10	10
TOWN-108-R-2002	15	20
TOWN-110-R-2000	15	10
TOWN-113-R-2000	11	15
TOWN-116-R-2002	12	40
TOWN-205-R-2002	14	20
TOWN-408-R-2000	17	15
TOWN-409-R-2000	16	15

MBSS Site	Epifaunal Substrate	Embeddedness
TOWN-412-R-2000	18	10
TOWN-417-R-2002	18	20
TOWN-419-R-2002	17	20
TOWN-420-R-2002	16	20
PRLN-104-R-2003	11	35
PRLN-107-R-2003	8	35
PRLN-108-R-2003	11	35
PRLN-109-R-2003	19	15
PRLN-113-R-2003	19	15
PRLN-115-R-2003	16	20
PRLN-119-R-2003	13	25
PRLN-122-R-2003	17	30
PRLN-201-R-2003	11	35
PRLN-306-R-2003	13	25
PRLN-316-R-2003	12	35
PRLN-318-R-2003	17	20
PRLN-321-R-2003	13	40
EVIT-102-R-2004	6	30
EVIT-110-R-2004	9	35
WILL-105-R-2004	10	35
WILL-109-R-2004	10	35
WILL-115-R-2004	15	30
WILL-120-R-2004	14	30
WILL-404-R-2004	10	25
GEOR-103-R-2003	16	45
GEOR-106-R-2003	13	35
GEOR-107-R-2003	12	35
GEOR-114-R-2003	12	35
GEOR-211-R-2003	12	30
PRUN-102-R-2001	14	45
PRUN-107-R-2001	17	15
PRUN-205-R-2001	18	15
SAVA-103-R-2002	12	30
SAVA-104-R-2002	19	15
SAVA-105-R-2002	13	35
SAVA-116-R-2002	15	25
SAVA-117-R-2002	12	20
SAVA-119-R-2002	18	15
SAVA-120-R-2002	17	15
SAVA-206-R-2002	12	20
SAVA-308-R-2002	18	20
SAVA-312-R-2002	18	15
SAVA-401-R-2002	18	20
SAVA-410-R-2002	17	25
SAVA-414-R-2002	18	20
YOUG-101-R-2001	13	20
YOUG-106-R-2001	16	15
YOUG-107-R-2001	15	38

MBSS Site	Epifaunal Substrate	Embeddedness
YOUG-117-R-2001	11	35
YOUG-123-R-2001	14	20
YOUG-208-R-2001	16	25
YOUG-221-R-2001	18	35
YOUG-320-R-2001	13	25
LYOU-110-R-2004	5	50
LYOU-118-R-2004	9	50
LYOU-219-R-2004	8	50
DCRL-109-R-2004	6	40
CASS-104-R-2000	17	15
CASS-106-R-2000	12	35
CASS-307-R-2000	14	25

Table A-4: MBSS data for the Upper North Branch Potomac River Watershed

Site	Date Sampled Summer	Date Sampled Spring	FIBI	BIBI	Epifaunal Substrate	Percent Embeddedness
PRUN-101-R-2001	25JUN2001	02APR2001	4.00	3.00	10	35
PRUN-102-R-2001	20AUG2001	02APR2001	2.00	4.25	14	45
PRUN-103-R-2001	16AUG2001	28MAR2001	3.00	3.00	17	15
PRUN-104-R-2001	15AUG2001	02APR2001	2.00	2.25	18	25
PRUN-106-R-2001	15AUG2001	28MAR2001	2.00	2.00	16	25
PRUN-107-R-2001	16AUG2001	28MAR2001	3.00	3.50	17	15
PRUN-109-R-2001	06AUG2001	02APR2001	2.00	2.00	11	40
PRUN-205-R-2001	25JUN2001	02APR2001	1.67	4.50	18	15
PRUN-210-R-2001	25JUN2001	02APR2001	1.67	3.00	18	15
PRUN-211-R-2001	25JUN2001	02APR2001	1.00	1.25	11	50
Average			2.23 ± 0.35	2.88 ± 0.42		

Notes: 1. Summer sampling includes FIBI, epifaunal substrate, and embeddedness.
2. Spring sampling includes BIBI.

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APPENDIX B

Table B-1: Upper North Branch Potomac River Permit Summary

Permit #	NPDES #	County	Facility	City	Type	TMDL
01DP3384	MD0068811	GARRETT	BACKBONE MOUNTAIN, LLC - MINE #1	OAKLAND	Industrial	WLA
03DP1422	MD0055182	GARRETT	METTIKI COAL, LLC	OAKLAND	Industrial – Major	WLA
02DP2175	MD0060933	GARRETT	BLOOMINGTON WWTP	BLOOMINGTON	Municipal	WLA
03DP2176	MD0060941	GARRETT	KITZMILLER WWTP	KITZMILLER	Municipal	WLA
03DP2177	MD0060950	GARRETT	GORMAN WWTP	GORMAN	Municipal	WLA
00CM1716A	MDG851716a	GARRETT	G & S COAL COMPANY - SNAKE HILL MINE	SWANTON	General – Mining	WLA
00CM1722	MDG851722	GARRETT	BUFFALO COAL COMPANY - KEMPTON JOB	OAKLAND	General – Mining	WLA
00CM2173	MDG852173	GARRETT	ANKER WEST VIRGINIA MINING - STEYER DEEP MINE	GORMAN	General – Mining	WLA
00CM2343	MDG852343	GARRETT	ANKER WEST VIRGINIA MINING - SUGAR III	MT. LAKE PARK	General – Mining	WLA
00CM2905A	MDG852905A	GARRETT	G & S COAL COMPANY - MANOR HILL MINE	SWANTON	General - Mining	WLA
00CM9602	MDG859602	GARRETT	METTIKI COAL CORP. - SM-97-428	OAKLAND	General – Mining	WLA
00CM9605	MDG859605	GARRETT	PATRIOT MINING COMPANY	SWANTON	General – Mining	WLA
00CM9609A	MDG859609A	GARRETT	G & S COAL COMPANY - PEE WEE HILL MINE	KITZMILLER	General – Mining	WLA
00CM9611	MDG859611	GARRETT	MILLENNIUM RESOURCES, LLC - WILDMAN MINE	BLOOMINGTON	General – Mining	WLA
00CM9613	MDG859613	GARRETT	VINDEX ENERGY CORPORATION - ISLAND TRACT MINE	KITZMILLER	General - Mining	WLA
00CM9615	MDG859615	GARRETT	LAOC CORPORATION - PAUGH TRACT MINE	DEER PARK	General - Mining	WLA
02SW1340	02SW1340	GARRETT	SHA - OAKLAND SHOP	OAKLAND	General - Industrial Stormwater	LA

Note: 1. TMDL column identifies how the permit was considered in the TMDL allocation.

Table B-2: Municipal Permits

Permit #	NPDES	Facility	Observed flow (MGD)	Observed TSS (mg/l)	Observed TSS Load (ton/yr)	Design flow (MGD)	Permit TSS (mg/l)	Permit TSS Load (ton/yr)
02DP2175	MD0060933	BLOOMINGTON WWTP	0.04	4.28	0.261	0.05	30	2.283
03DP2177	MD0060950	GORMAN WWTP	0.0004	1.27	0.001	0.0085	30	0.388
03DP2176	MD0060941	KITZMILLER WWTP	0.02	4.29	0.131	0.04	30	1.826
		Total	0.06		0.392	0.0985		4.581

Notes: 1. All values in table are from PCS. All values agree with those in the permit files.
No DMR data in permit files.

Table B-3: Industrial Permits

Permit #	NPDES	Facility	Design flow (MGD)	Permit TSS (mg/l)	Permit TSS Load (ton/yr)
01DP3384	MD0068811	BACKBONE MOUNTAIN, LLC - MINE #1	0.0045	30	0.205
03DP1422	MD0055182	METTIKI COAL, LLC	8.2	30	374.424

Notes: 1. Permit for Backbone Mountain, LLC is not in PCS. Data from permit file.
2. Values for Mettiki Coal, LLC in table are the sum of all outfalls. Also, PCS indicates design flow of 80 MGD, but permit indicates 8.2 MGD, which is comparable to observed data.

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Table B-5: General Mine Permits

NPDES	Facility	Current Acres	Total Acres	Average flow, gpd (per permit)	Notes
MDG852173	ANKER WEST VIRGINIA MINING - STEYER DEEP MINE	0	52	0	permit indicates mine inactive as of 2003
MDG852343	ANKER WEST VIRGINIA MINING - SUGAR III	***	20	***	1 outfall, avg flow reported was 0
MDG851722	BUFFALO COAL COMPANY - KEMPTON JOB	20	62	3000	3 outfalls, 1000 gpd each
MDG852905A	G & S COAL COMPANY - MANOR HILL MINE	60	245	800	4 outfalls, 200 gpd each
MDG859609A	G & S COAL COMPANY - PEE WEE HILL MINE	65	260	1100	12 outfalls, 50 - 200 each
MDG851716a	G & S COAL COMPANY - SNAKE HILL MINE	1.5	303	100	1 outfall, avg flow reported was 0
MDG859615	LAOC CORPORATION - PAUGH TRACT MINE	0	0	0	proposed mine, not opened yet
MDG859602	METTIKI COAL CORP. - SM-97-428	***	***	< 1000	1 outfall
MDG859611	MILLENNIUM RESOURCES, LLC - WILDMAN MINE	14	174	100	3 outfalls
MDG859605	PATRIOT MINING COMPANY	9	14	100	1 outfall
MDG859613	VINDEX ENERGY CORPORATION - ISLAND TRACT MINE	55	304	75	4 outfalls, 2 of them proposed (0 flow)

Note: *** Data not included in permit file.