Water Quality Analysis of Eutrophication for the Patuxent River Upper Watershed, Anne Arundel, Prince George's, and Howard Counties Maryland

FINAL

DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard, Suite 540
Baltimore, Maryland 21230-1718

Submitted to:

Watershed Protection Division
U.S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Submittal Date: November 28, 2006
Approval Date: February 21, 2007

Table of Contents

List of Figures i
List of Tables i
List of Abbreviations ii
EXECUTIVE SUMMARY iii
1.0 INTRODUCTION 1
2.0 GENERAL SETTING 1
3.0 WATER QUALITY CHARACTERIZATION 4
3.1 Dissolved Oxygen 5
3.2 Biochemical Oxygen Demand (BOD) 5
3.3 Chlorophyll *a* 6
3.4 Nutrients 6
4.0 CONCLUSION 8
REFERENCES 9
Appendix A: Tabular Water Quality Data A1

List of Figures

Figure 1: Patuxent River Upper Watershed Location Map and Monitoring Stations..... 2

Figure 2: Land Use Map of the Patuxent River Upper Watershed 3

Figure 3: Patuxent River Upper Water Quality Data from January 1998 through December 2004 7

List of Tables

Table 1: Locations of Water Quality Stations Monitored During 1998-2004 in Patuxent River Upper. 5

List of Abbreviations

BOD	Biochemical Oxygen Demand
COMAR	Code of Maryland Regulation
CWA	Clean Water Act
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
MBSS	Maryland Biological Stream Survey
MDP	Maryland Department of Planning
MDE	Maryland Department of the Environment
mg/l	Milligrams Per Liter
mi^2	Square miles
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
USGS	U.S. Geological Survey
WQLS	Water Quality Limited Segment
μg/l	Micrograms Per Liter

EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency (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. This list of impaired waters is commonly referred to as the "303(d) list". For each WQLS, the state is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

The Patuxent River Upper watershed (basin code 02131104) was identified on the State's 1996 list of WQLSs as impaired by nutrients (1996), sediments (1996) and impacts to biological communities (2002). In 2004, an impoundment within the watershed, Cash Lake, was listed as impaired for mercury. This document, upon EPA approval, addresses the nutrient impairment in the non-tidal portion of the Patuxent River Upper watershed. Other impairments within the basin will be addressed at a future date.

An analysis of recent monitoring data shows that the dissolved oxygen criterion and designated uses associated with nutrients are being met in Patuxent River Upper watershed. This analysis supports the conclusion that a TMDL for nutrients is not necessary to achieve water quality standards in this case. Barring the receipt of contradictory data, this report will be used to support a nutrients listing change for the Patuxent River Upper from Category 5 ("waterbodies impaired by one or more pollutants requiring a TMDL") to Category 2 ("Surface waters that are meeting some standards and have insufficient information to determine attainment of other standards"), when the Maryland Department of the Environment (MDE) proposes the revision of Maryland's 303(d) list for public review in the future. Although the waters of the Patuxent River Upper watershed do not display signs of eutrophication, the State reserves the right to require future controls in the Patuxent River Upper watershed if evidence suggests nutrients from the basin are contributing to downstream water quality problems.

1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency (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. This list of impaired waters is commonly referred to as the "303(d) list". For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

In addition to the development of a TMDL, there are four other scenarios that may be used to address an impaired waterbody: 1) more recent data indicating that the impairment no longer exists (*i.e.*, water quality standards are being met); 2) more recent and updated water quality modeling which demonstrates that the segment is now attaining standards; 3) refinements to water quality standards, or the interpretation of those standards, which result in standards being met; or 4) correction to errors made in the initial listing.

The Patuxent River Upper watershed (basin code 02131104) was identified on the State's 1996 list of WQLSs as impaired by nutrients (1996), sediments (1996) and impacts to biological communities (2002). In 2004, an impoundment within the watershed, Cash Lake, was listed as impaired for mercury. This report provides more recent information that supports the removal of the nutrients listing for Patuxent River Upper watershed when the 303(d) list is revised; therefore, the aforementioned first scenario most closely applies, with the qualification that initial listing for nutrients was suspected due to the lack of data. Other impairments within the basin will be addressed at a future date.

The remainder of this report lays out the general setting of the waterbody within the Patuxent River Upper watershed, presents a discussion of the water quality characteristics in the basin, and provides conclusions with regard to the current water quality characteristics and the current standards. The data will demonstrate that the Patuxent River Upper watershed is achieving water quality standards.

2.0 GENERAL SETTING

The Patuxent River Upper, below Rocky Gorge Dam, extends from Howard County at the north, south through parts of Anne Arundel County and Prince George's County flowing into the Patuxent River Middle (Figure 1). The main transportation corridors in the watershed are Interstate 95 and Route 198 across the northern section, and Routes 301, 50, and 214 across the southern section of the watershed. Above Route 214 is the non tidal portion of the Patuxent River Upper.

The drainage area of the Patuxent River Upper watershed is 88 mi^2 or 56,351 acres. Land uses in the watershed are forest (20,475 acres or 36% of the area), mixed agriculture (6,689 acres or 12%of the area), urban (22,667 acres or 40% of the area), and water (6,520 acres or 12% of the area). Please refer to Figure 2 for a map of these land uses (MDP, 2002).

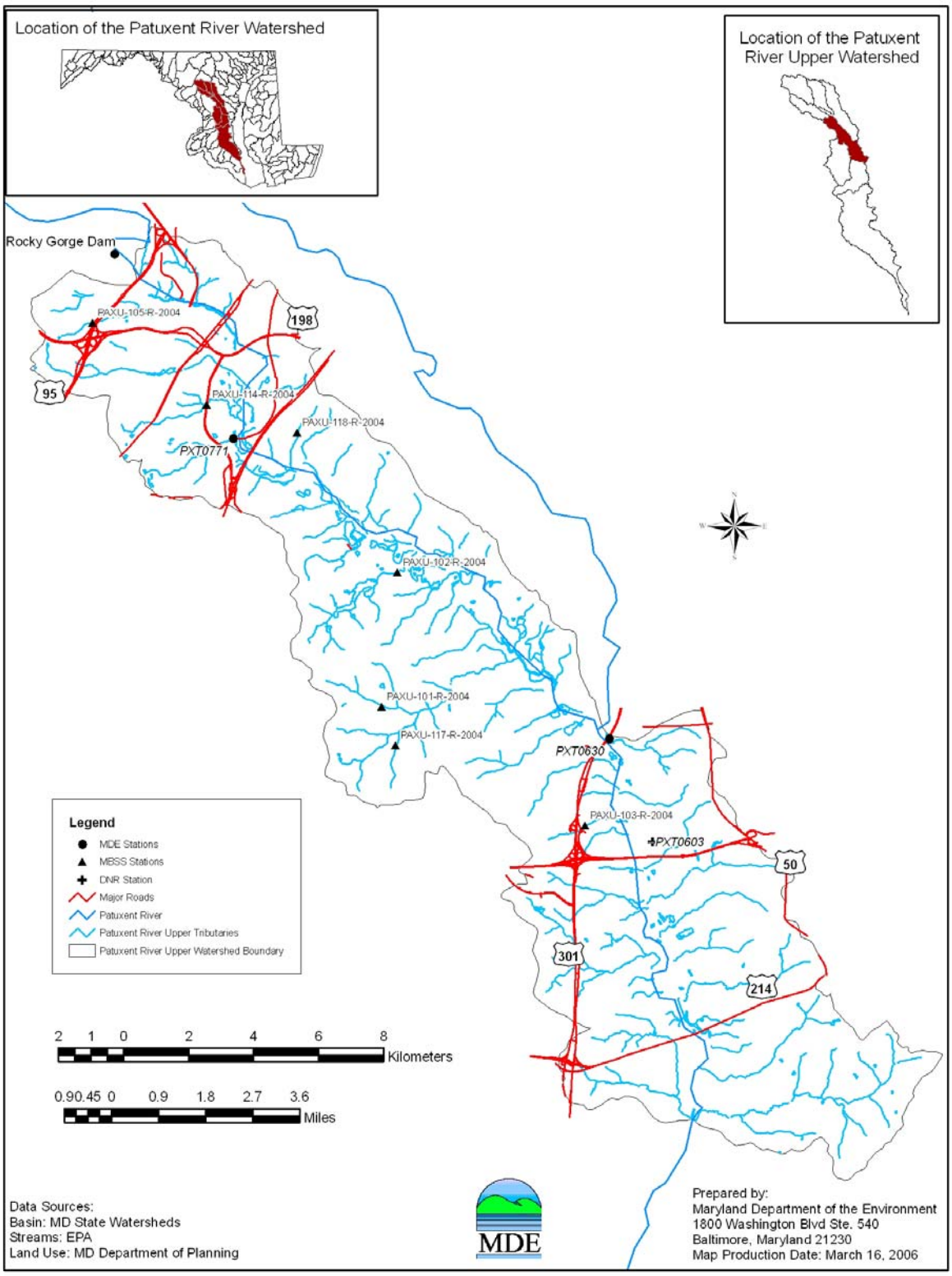

Figure 1: Patuxent River Upper Watershed Location Map and Monitoring Stations

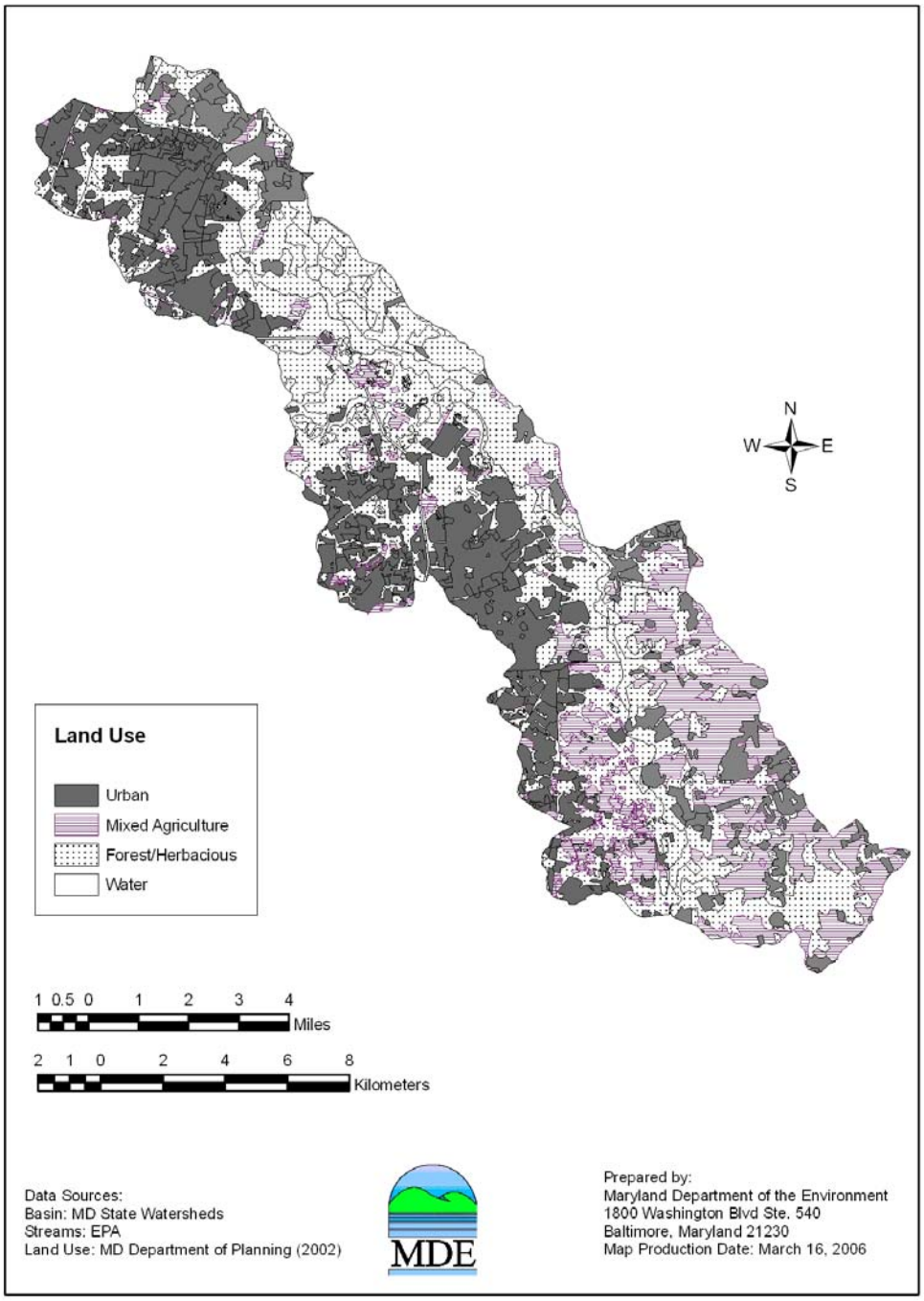

Figure 2: Land Use Map of the Patuxent River Upper Watershed

3.0 WATER QUALITY CHARACTERIZATION

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, 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 Surface Water Use Designation (Code of Maryland Regulations (COMAR) 26.08.02.08M) for the non-tidal portion of the Patuxent River Upper is Use I. According to Maryland's numeric criterion for DO for Use I, concentrations may not be less than 5.0 mg/l at any time (COMAR 26.08.02.03-3A(2), unless resulting from natural conditions (COMAR 26.08.02.03.A(2)). The water quality data presented in this section will show the DO concentrations meet the appropriate criteria.

Maryland's water quality standards presently do not impose a limit on the concentration of nutrients in the water column. Rather, Maryland manages nutrients indirectly by limiting their effects expressed in terms of excess algal growth and low dissolved oxygen (DO). Because biochemical oxygen demand (BOD) also consumes DO, this potentially confounding factor must be considered in the analysis if low DO is observed.

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 26.08.02.03B(2)). Excessive eutrophication, indicated by elevated levels of chlorophyll *a*, can produce nuisance levels of algae and interfere with designated uses such as fishing and swimming; therefore, an analysis to demonstrate no excessive algal growth as indicated by low chlorophyll *a* data has been established for this watershed.

A data solicitation was conducted in January 2005. All readily available water quality data from 1998 through 2004 pertaining to the Patuxent River Upper watershed were considered for this analysis. Water quality data from MDE surveys conducted at two stations in the Patuxent River Upper watershed during 2000 was used to perform this analysis. Department of Natural Resources (DNR) water quality data from one station during 1998 through 2004 were also used. Dissolved oxygen data from seven Maryland Biological Stream Survey (MBSS) stations for 2004 was also used. Other available resources, including U.S. Geological Survey (USGS) were also investigated to determine if there were other available data in the Patuxent River Upper watershed. Table 1 shows the list of stations with their geographical coordinates and descriptive location in the Patuxent River Upper watershed. Figure 3 provides graphical representation of the collected data for the parameters discussed below.

Table 1: Locations of Water Quality Stations Monitored During 1998-2004 in Patuxent River Upper.

Station Code	Latitude	Longitude	Source
PXT0630	38.99	-76.71	MDE
PXT0771	39.07	-76.84	MDE
PXT0603	38.96	-76.69	DNR
PAXU-101-R-2004	39.00	-76.79	MBSS
PAXU-102-R-2004	39.03	-76.78	MBSS
PAXU-103-R-2004	38.96	-76.71	MBSS
PAXU-105-R-2004	39.10	-76.89	MBSS
PAXU-114-R-2004	39.08	-76.85	MBSS
PAXU-117-R-2004	38.99	-76.78	MBSS
PAXU-118-R-2004	39.07	-76.82	MBSS

3.1 Dissolved Oxygen

During the January 1998 through December 2004 sampling period, DO values ranged from 5.9 mg/l to 21.0 mg/l. The data shows that none of the concentrations fell below 5 mg/l during the entire sampling period. This data is summarized in Figure 3. Tabular data is presented in Appendix A.

3.2 Biochemical Oxygen Demand (BOD)

Because BOD also consumes DO, this potentially confounding factor must be considered in the analysis if low DO is observed. During the 2000 sampling period, BOD concentrations ranged from 1.3 mg/l to 6.1 mg/l. Again, please refer to Figure 3 for graphical representations of this data. Data tables are presented in Appendix A. Please note that DO concentrations were always above 5 mg/l during the sampling period.

3.3 Chlorophyll *a*

Chlorophyll *a* data was collected during the entire period from January 1998 through December 2004 covering the algal growing season, when concentrations are at their peak. Observed chlorophyll *a* concentrations are low and do not reach levels higher 9.97 µg/l.

The low chlorophyll *a* concentrations found in the Patuxent River Upper watershed suggests that chlorophyll *a* photosynthesis and respiration will have no significant effect on observed DO values. Nothing out of the ordinary was observed during sampling. This data is summarized in Figure 3. Tabular data is presented in Appendix A.

3.4 Nutrients

During the January 1998 through December 2004 sampling period, total phosphorus (TP) concentrations ranged from 0.026 mg/l to 0.57 mg/l and total nitrogen (TN) concentrations ranged from 1.23 mg/l to 4.09 mg/l. Please refer to Figure 3 for graphical representations of this data; data tables are presented in Appendix A.

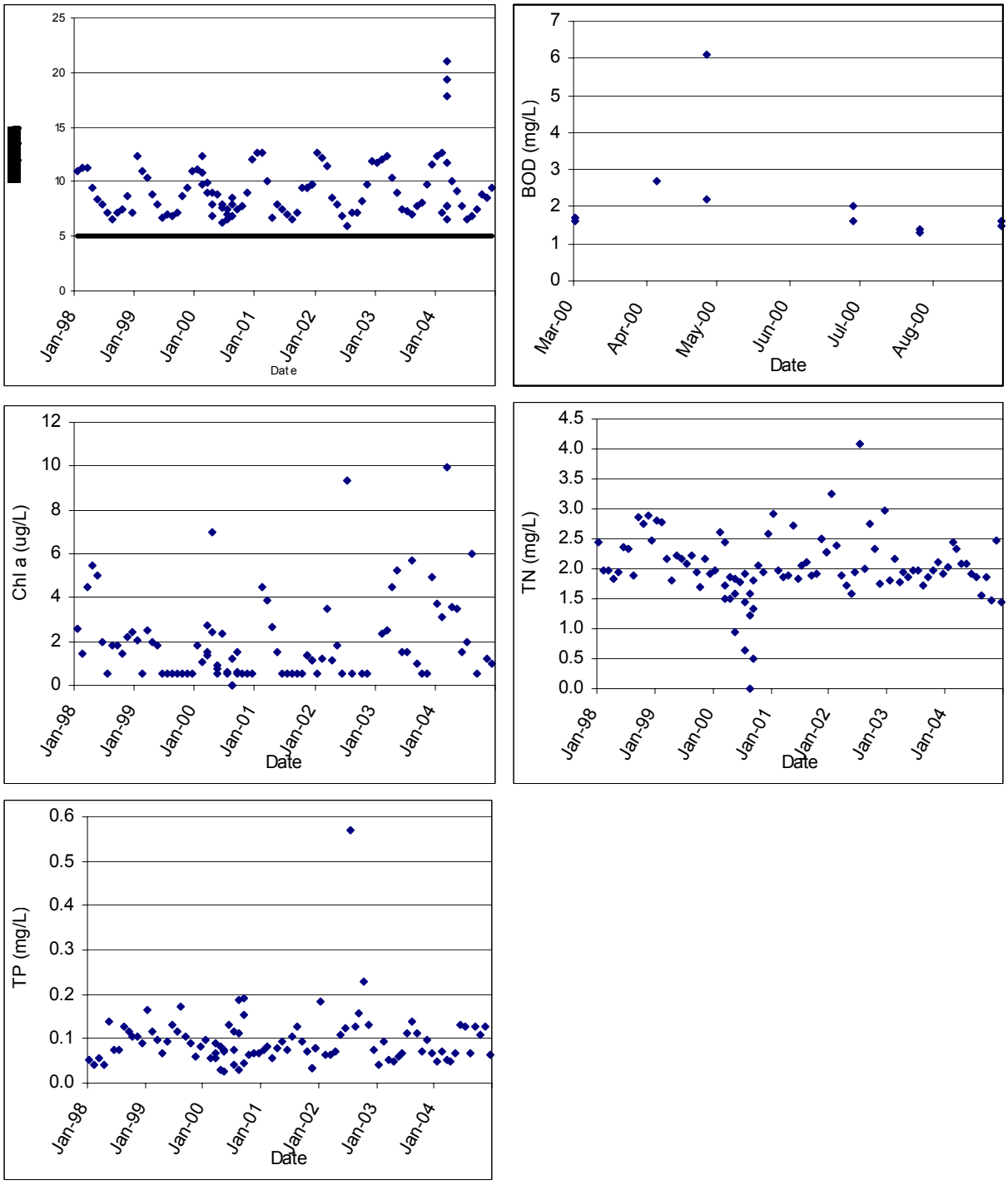

Figure 3: Patuxent River Upper Water Quality Data from January 1998 through December 2004

4.0 CONCLUSION

The data presented above clearly demonstrates that excessive algal growth does not exist in the Patuxent River Upper watershed, as indicated by low chlorophyll *a*. Similarly, DO concentrations are well above the criterion of 5.0 mg/l. Based on the synoptic surveys conducted during 1998-2004, the water quality data indicates that the Patuxent River Upper has no eutrophication-related water quality impairments. Barring the receipt of contradictory data, this report will be used to support a nutrients listing change for the Patuxent River Upper from Category 5 ("waterbodies impaired by one or more pollutants requiring a TMDL") to Category 2 ("Surface waters that are meeting some standards and have insufficient information to determine attainment of other standards"), when the Maryland Department of the Environment (MDE) proposes the revision of Maryland's 303(d) list for public review in the future. Although the waters of the Patuxent River Upper watershed do not display signs of eutrophication, the State reserves the right to require future controls in the Patuxent River Upper watershed if evidence suggests nutrients from the basin are contributing to downstream water quality problems.

REFERENCES

Code of Maryland Regulations, 26.08.02.08M, 26.08.02.03-3A(2), 26.08.02.03A(2), 26.08.02.03B(2)

Maryland Department of the Environment, 2004 FINAL List of Impaired Surface Waters [303(d) List] and Integrated Assessment of Water Quality in Maryland.

Maryland Department of Planning, 2002 Land Use, Land Cover Map Series. 2002.

Appendix A: Tabular Water Quality Data

Source	Station	Date	DO (mg/L)	BOD (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Active Chlorophyll a (µg/L)
MDE	PXT0630	3/27/2000	9.8	1.6	1.837	0.068	1.50
MDE	PXT0630	5/16/2000	8.0	6.1	1.876	0.074	0.93
MDE	PXT0630	7/18/2000	7.6	2	1.494	0.075	0.64
MDE	PXT0630	8/15/2000	7.4	1.3	1.942	0.187	0.00
MDE	PXT0630	9/19/2000	7.9	1.5	2.154	0.152	0.50
MDE	PXT0771	3/20/2000	10.8	1.7	1.731	0.056	2.74
MDE	PXT0771	4/24/2000	9.0	2.7	1.848	0.031	6.98
MDE	PXT0771	5/15/2000	6.9	2.2	1.595	0.026	0.75
MDE	PXT0771	7/17/2000	6.2	1.6	1.433	0.041	0.50
MDE	PXT0771	8/14/2000	6.6	1.4	1.230	0.028	0.00
MDE	PXT0771	9/18/2000	8.6	1.6	1.334	0.043	0.64
DNR	PXT0603	1/5/1998	10.9		2.458	0.053	2.57
DNR	PXT0603	2/9/1998	11.3		1.978	0.043	1.47
DNR	PXT0603	3/16/1998	11.3		1.964	0.056	4.47
DNR	PXT0603	4/13/1998	9.5		1.845	0.040	5.44
DNR	PXT0603	5/12/1998	8.4		1.947	0.139	4.99
DNR	PXT0603	6/10/1998	7.9		2.367	0.076	1.99
DNR	PXT0603	7/15/1998	7.2		2.333	0.074	0.50
DNR	PXT0603	8/12/1998	6.6		1.902	0.128	1.84
DNR	PXT0603	9/9/1998	7.2		2.850	0.118	1.80
DNR	PXT0603	10/7/1998	7.5		2.762	0.106	1.42
DNR	PXT0603	11/12/1998	8.7		2.890	0.104	2.18
DNR	PXT0603	12/2/1998	7.1		2.467	0.091	2.40
DNR	PXT0603	1/6/1999	12.3		2.815	0.165	2.06
DNR	PXT0603	2/2/1999	11.0		2.770	0.115	0.50
DNR	PXT0603	3/9/1999	10.4		2.163	0.096	2.54
DNR	PXT0603	4/7/1999	8.8		1.814	0.067	1.94
DNR	PXT0603	5/5/1999	7.9		2.227	0.092	1.79
DNR	PXT0603	6/2/1999	6.7		2.153	0.133	0.50
DNR	PXT0603	7/14/1999	7.0		2.077	0.117	0.50
DNR	PXT0603	8/11/1999	6.8		2.235	0.171	0.50
DNR	PXT0603	9/15/1999	7.1		1.951	0.105	0.50
DNR	PXT0603	10/13/1999	8.7		1.689	0.090	0.50
DNR	PXT0603	11/9/1999	9.5		2.172	0.061	0.50
DNR	PXT0603	12/1/1999	11.0		1.914	0.084	0.50
DNR	PXT0603	1/12/2000	11.2		1.963	0.097	1.79
DNR	PXT0603	2/9/2000	12.4		2.598	0.056	1.05
DNR	PXT0603	3/8/2000	9.9		2.434	0.089	1.35
DNR	PXT0603	4/5/2000	9.0		1.503	0.081	2.43
DNR	PXT0603	5/3/2000	8.9		1.845	0.071	0.50
DNR	PXT0603	6/7/2000	8.0		1.786	0.130	2.39
DNR	PXT0603	7/6/2000	7.0		1.926	0.117	

Source	Station	Date	DO (mg/L)	BOD (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Active Chlorophyll a (µg/L)
DNR	PXT0603	8/2/2000	6.8		1.580	0.114	1.20
DNR	PXT0603	9/6/2000	7.5		1.810	0.192	1.50
DNR	PXT0603	10/4/2000	7.7		2.056	0.063	0.50
DNR	PXT0603	11/1/2000	9.0		1.943	0.069	0.50
DNR	PXT0603	12/6/2000	12.1		2.593	0.066	0.50
DNR	PXT0603	1/3/2001	12.7		2.904	0.076	
DNR	PXT0603	2/7/2001	12.6		1.984	0.084	4.49
DNR	PXT0603	3/14/2001	10.0		1.849	0.055	3.89
DNR	PXT0603	4/11/2001	6.7		1.897	0.078	2.69
DNR	PXT0603	5/2/2001	8.0		2.736	0.092	1.50
DNR	PXT0603	6/6/2001	7.5		1.830	0.074	0.50
DNR	PXT0603	7/18/2001	7.0		2.060	0.106	0.50
DNR	PXT0603	8/8/2001	6.5		2.120	0.129	0.50
DNR	PXT0603	9/5/2001	7.1		1.880	0.092	0.50
DNR	PXT0603	10/10/2001	9.4		1.910	0.072	0.50
DNR	PXT0603	11/7/2001	9.4		2.510	0.034	1.40
DNR	PXT0603	11/7/2001	9.4		2.510	0.034	1.40
DNR	PXT0603	12/5/2001	9.7		2.270	0.078	1.12
DNR	PXT0603	12/5/2001	9.7		2.270	0.078	1.12
DNR	PXT0603	1/2/2002	12.6		3.250	0.182	0.50
DNR	PXT0603	2/6/2002	12.2		2.380	0.063	1.20
DNR	PXT0603	3/6/2002	11.4		1.900	0.064	3.49
DNR	PXT0603	4/3/2002	8.5		1.710	0.070	1.12
DNR	PXT0603	5/1/2002	7.9		1.590	0.108	1.79
DNR	PXT0603	6/12/2002	6.8		1.940	0.125	0.50
DNR	PXT0603	7/10/2002	5.9		4.090	0.570	9.34
DNR	PXT0603	8/7/2002	7.1		2.000	0.126	0.50
DNR	PXT0603	9/11/2002	7.1		2.740	0.158	
DNR	PXT0603	10/9/2002	8.2		2.320	0.230	0.50
DNR	PXT0603	11/6/2002	9.7		1.750	0.131	0.50
DNR	PXT0603	12/4/2002	11.9		2.978	0.074	
DNR	PXT0603	1/8/2003	11.8		1.802	0.042	
DNR	PXT0603	2/5/2003	12.0		2.170	0.093	2.39
DNR	PXT0603	3/5/2003	12.3		1.780	0.051	2.49
DNR	PXT0603	4/2/2003	10.3		1.950	0.048	4.49
DNR	PXT0603	5/1/2003	9.0		1.870	0.059	5.23
DNR	PXT0603	6/1/2003	7.5		1.960	0.069	1.50
DNR	PXT0603	7/2/2003	7.3		1.960	0.114	1.50
DNR	PXT0603	8/13/2003	7.0		1.735	0.137	5.68
DNR	PXT0603	9/10/2003	7.7		1.867	0.111	1.00
DNR	PXT0603	10/1/2003	8.1		1.968	0.071	0.50
DNR	PXT0603	11/12/2003	9.8		2.114	0.099	0.50
DNR	PXT0603	12/10/2003	11.6		1.903	0.066	4.93
DNR	PXT0603	1/7/2004	12.3		2.041	0.048	3.74
DNR	PXT0603	2/11/2004	12.7		2.438	0.071	3.14

Source	Station	Date	DO (mg/L)	BOD (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Active Chlorophyll a (µg/L)
DNR	PXT0603	3/10/2004	11.8		2.347	0.053	9.97
DNR	PXT0603	4/7/2004	10.1		2.091	0.048	3.55
DNR	PXT0603	5/5/2004	9.2		2.084	0.069	3.49
DNR	PXT0603	6/2/2004	7.7		1.915	0.130	1.50
DNR	PXT0603	7/14/2004	6.6		1.856	0.127	1.99
DNR	PXT0603	8/4/2004	6.9		1.556	0.069	5.98
DNR	PXT0603	9/15/2004	7.4		1.871	0.128	0.50
DNR	PXT0603	10/6/2004	8.9		1.473	0.108	
DNR	PXT0603	11/4/2004	8.6		2.479	0.126	1.20
DNR	PXT0603	12/1/2004	9.5		1.442	0.064	1.00

Source	Station	Date	DO (mg/L)
MBSS	PAXU-101-R-2004	3/9/2004	7.1
MBSS	PAXU-102-R-2004	3/8/2004	21.0
MBSS	PAXU-103-R-2004	3/9/2004	17.8
MBSS	PAXU-105-R-2004	3/9/2004	7.8
MBSS	PAXU-114-R-2004	3/9/2004	7.7
MBSS	PAXU-117-R-2004	3/9/2004	6.5
MBSS	PAXU-118-R-2004	3/8/2004	19.4