APPENDIX D
PART I
Scenario I:
Nonpoint Source Reductions Needed for Attainment of Chlorophyll *a* Target Goal.

Introduction

This section explains one of the scenarios that was investigated when calculating the TMDLs for the Upper and Middle Chester River Watersheds. This scenario explains the reductions needed for the nonpoint source (NPS) and point source (PS) loads to achieve the dissolved oxygen (DO) criteria, and the target goal for Chlorophyll *a* (Chl*a*). The Chl*a* narrative criteria are described in Chapter 3.0 of the main TMDL document.

The main goal of this particular scenario is to calculate the necessary reductions needed to attain the 30-day rolling average targeted Chl*a* goal of less than 50 µg/l. The Chl*a* goal used in this analysis is based on guidelines set forth by Thomann and Mueller (1987), and by the EPA Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1 (1997). The recommended Chl*a* narrative criteria (COMAR 26.08.02.03-3 C (6)) states: "Chlorophyll *a* - Concentrations of chlorophyll *a* in free-floating microscopic aquatic plants (algae) shall not exceed levels that result in ecologically undesirable consequences that would render tidal waters unsuitable for designated uses". The Thomann and Mueller guidelines acknowledge that it is acceptable to maintain Chl*a* concentrations below a maximum of 100 µg/l, with a target threshold of less than 50 µg/l.
This is interpreted as maintaining peak values below 100 µg/l, and a 30-day rolling average below 50 µg/l.

Scenario Description

PS Loads
This scenario uses the same PS loads as in the TMDL scenario. Details of the flows and loads of the particular PSs can be seen in the main document in Section 4.3.3. Tables 1(a) and 1(b) summarize the flows and concentrations used in the scenario. The PS loads includes the contribution from the urban storm water loads. Although the Maryland portions of the Upper and Middle Chester River watershed do not currently have any Municipal Separate Storm Sewer Systems (MS4) permits, urban stormwater loads are included in the Waste Loads Allocation (WLA) to be consistent with previous TMDLs and allow for future permits.

PS	NPDES #	Flow	Effluent Concentration	
		MGD	TN (mg/l)	TP (mg/l)
Millington WWTP	MD0020435	0.105	18.00	3.00
Sudlersville WWTP*	MD0020559	0.09/0.075	18.00	3.00

*Flow or concentration is different in low flow period

Table 1(a): Upper Chester River Flows and Concentrations for PS

PS	NPDES #	Flow MGD	Effluent Concentration TN (mg/l)	TP (mg/l)
Worton-Butlertown WWTP*	MD0060585	0.15/0.00	18.00/0.00	3.00/0.00
Kennedyville WWTP	MD0052671	0.300	18.00	3.00
Chestertown Foods, Inc.	MD0002232	0.230	17.83	3.13
Chestertown WWTP	MD0020010	0.900	4.00	0.30

*Flow or concentration is different in low flow period

Table 1(b): Middle Chester River Flows and Concentrations for PS

NPS Loads

Compared with the TMDL scenario, further reductions were made in certain portions of the watershed that corresponded to the areas of the river that did not meet the target Chla goals. In the Upper Chester Watershed, further reductions were made to loads entering segments 40001 and 40002, which are located in the headwaters (Figure 1). In the Middle Chester River Watershed, further reductions were made to loads entering cells 43010 and 42010 (Figure 1).

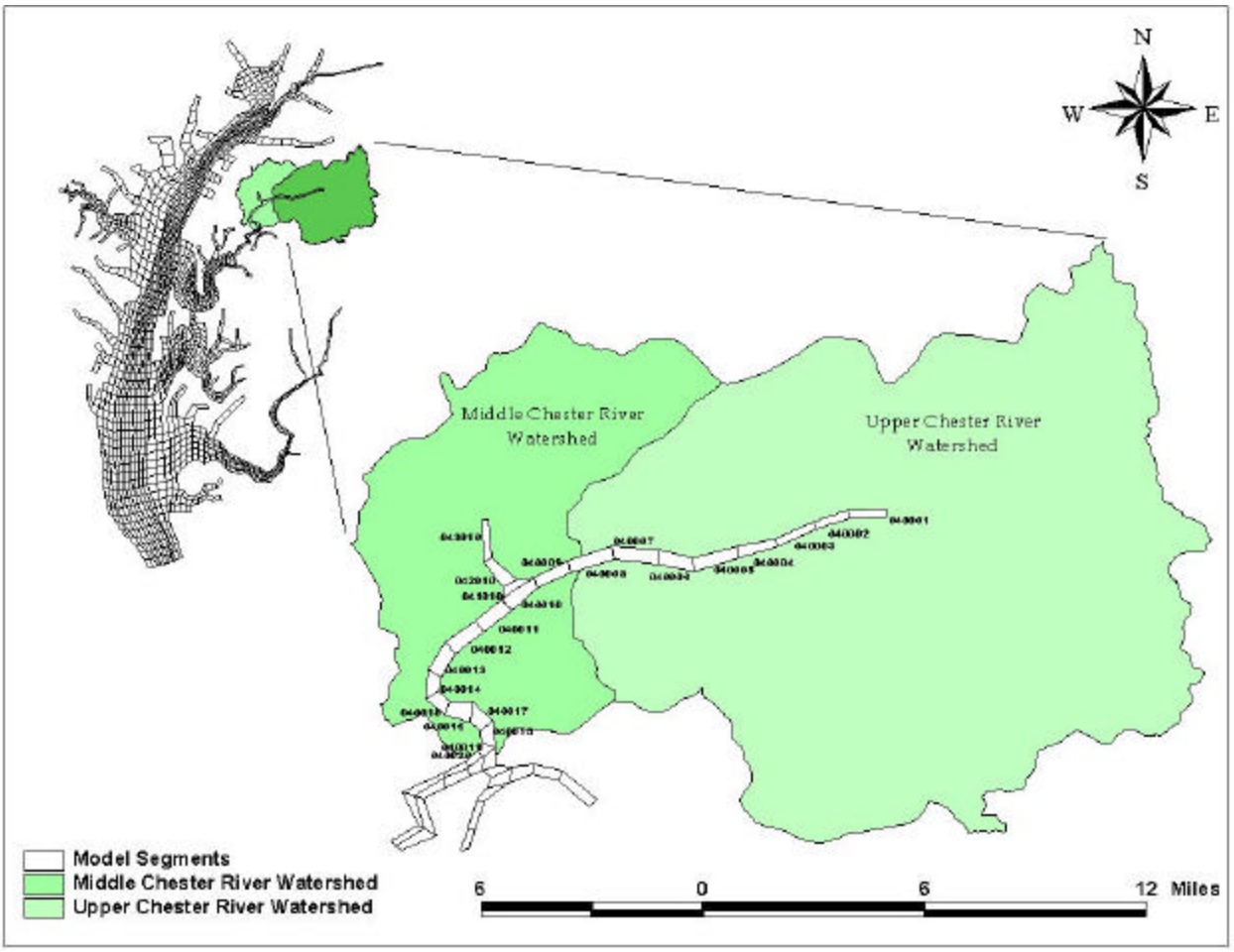

Figure 1: CE-QUAL-ICM model segments for the Upper and Middle Chester Rivers

Loading Caps and Average Annual Allocations for Scenario I

Based on the reductions made in Scenario I, the following loading caps are calculated for the Upper and Middle Chester Watersheds (Table 2). The average annual loads (calculated from Scenario I) for nitrogen and phosphorus are:

Table 2: Comparison of Loading Caps from Scenario I and the TMDL Scenario for the Upper and Middle Chester Watersheds.

Watershed	Scenario I		TMDL Scenario	
	TN	TP	TN	TP
Upper Chester Avg. Annual	478,472	27,345	614,612	34,354
Middle Chester Avg. Annual	153,286	11,681	275,437	16,709
Upper Chester Growing Season	191,060	1,147	246,717	8,572
Middle Chester Growing Season	63,327	3,671	116,149	5,048

Table 3: Average Annual Allocations for the Upper Chester River Using Scenario I

	Total Nitrogen *(lbs/yr)*	**Total Phosphorus *(lbs/yr)***
Nonpoint Source[1]	431,927	22,353
PS[2]	26,866	3,879
MOS[3]	19,679	1,112
Total	478,472	27,345

1. Excluding urban stormwater loads.
2. Including urban stormwater loads.
3. Representing 5% of agricultural loads.

Table 4: Average Annual Allocations for the Middle Chester River Using Scenario I

	Total Nitrogen *(lbs/yr)*	**Total Phosphorus *(lbs/yr)***
Nonpoint Source[1]	97,452	4,615
PS[2]	51,726	6,878
MOS[3]	4,108	188
Total	153,286	11,681

1. Excluding urban stormwater loads.
2. Including urban stormwater loads.
3. Representing 5% of agricultural loads.

Table 5: Growing Season Allocations for the Upper Chester River Using Scenario I

	Total Nitrogen *(lbs/month)*	**Total Phosphorus *(lbs/month)***
Nonpoint Source[1]	171,503	5,266
PS[2]	11,913	1,366
MOS[3]	7,644	250
Total	191,060	6,881

1. Excluding urban stormwater loads.
2. Including urban stormwater loads.
3. Representing 5% of agricultural loads.

Table 6: Growing Season Allocations for the Middle Chester River Using Scenario I

	Total Nitrogen *(lbs/month)*	**Total Phosphorus *(lbs/month)***
Nonpoint Source[1]	42,353	1,342
PS[2]	19,275	2,286
MOS[3]	1,699	44
Total	63,327	3,671

1. Excluding urban stormwater loads.
2. Including urban stormwater loads.
3. Representing 5% of agricultural loads.

The reductions to the NPS total nitrogen and total phosphorus loads are made only through the agricultural land use. In order to achieve these loads impractical reductions in the range of 62% to 84% are needed to the agricultural loads. Table 7 compares the reductions that are needed to the agricultural loads in Scenario I and the TMDL scenario.

Table 7: Reductions to Agricultural Loads in Scenario I

Watershed	Scenario I		TMDL Scenario	
	TN	TP	TN	TP
Upper Chester	67 %	62 %	54%	49%
Middle Chester	83 %	84 %	56%	59%

Results

The results of this scenario show that the target Chl*a* goals of less than 50 µg/l throughout the Upper and Middle portions of the Chester River are met. The model output for this scenario also shows that the DO criteria are met.

Summary and Conclusions

The TN and TP load reductions made in this scenario are able to bring down the 30-day rolling average Chl*a* levels to below 50µg/l. It can be seen that in order to make these reductions to the NPS loads, large reductions would need to be made to the agricultural loads in the Upper and Middle Chester River watersheds. The loads in the Middle Chester Watershed consider the reductions that would be made to sediment and TP from the TMDL issued for Urieville Community Lake in 1999. The Urieville Community Lake TMDL calls for reduction of 42% and 85% to sediment and TP respectively. Considering the watersheds currently have functioning Best Management Practices (BMPs) and the rate of reductions that can be obtained through these BMPs (Perkins, 2004), it can be seen that the reductions assumed under Scenario I are impractically high, i.e., beyond what current technology can achieve. The reductions required would not be possible even with stringent point source controls and the existing technology under a voluntary program for non point sources.

References

Perkins, Russ. “Agricultural BMP Descriptions As Defined for the Chesapeake Bay Program Watershed Model”, Chesapeake Bay Nutrient Subcommittee, Agricultural Nutrient Reduction Workgroup, 2004.

Thomann, Robert V., John A. Mueller “Principles of Surface Water Quality Modeling and Control.” HarperCollins Publisher Inc., New York, 1987.