Virginia Department of Environmental Quality

TMDL Implementation Plan for Mill Creek

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April 2012

Table of Contents

1.0 Introduction 1-1
1.1 Impairment Listing 1-1
1.2 Applicable Water Quality Standard 1-3
1.2.1 Designated Uses 1-3
1.2.2 Applicable Water Quality Criteria 1-4
1.3 Nesting of Impairments 1-4

2.0 State and Federal Requirements for Implementation Plans 2-1
2.1 State Requirements 2-1
2.2 Federal Requirements 2-1
2.3 Requirements for Section 319 Funding Eligibility 2-2

3.0 Review of TMDL Development 3-1
3.1 Watershed Characterization 3-1
3.1.1 Landuse 3-1
3.1.2 Geology and Soils 3-2
3.1.3 Climate and Hydrology 3-2
3.2 Water Quality Monitoring 3-3
3.2.1 Summary of Data Analysis 3-3
3.3 Source Assessment 3-5
3.3.1 Updated VIMS Source Assessment 3-5
3.4 Water Quality Modeling 3-6
3.4.1 Selection of a TMDL End Point 3-6
3.4.2 Model Development 3-6
3.5 TMDL Allocations 3-7

4.0 Public Participation 4-1

5.0 Implementation Actions 5-1
5.1 Cost Analysis 5-3
5.2 Benefits 5-4

6.0 Measureable Goals and Milestones for Attaining Water Quality Standards 6-1
6.1 Implementation Milestones 6-1
6.2 Water Quality Milestones 6-2

7.0 Stakeholders' Roles and Responsibilities 7-1
7.1 Federal Government 7-1
7.2 State Government 7-1
7.3 Local Government 7-4
7.4 Businesses, Community Groups, and Citizens 7-5

8.0 Integration with Other Watershed Plans 8-1

9.0 Potential Funding Sources 9-1
9.1 State Funding Sources 9-1
9.2 Federal Funding Sources 9-2

10.0 References 10-1

Table of Figures

Figure 1-1: Location of the Impaired Mill Creek Watershed 1-3
Figure 3-1. Landuse of the Mill Creek Watershed 3-2
Figure 3-2. Annual Precipitation of the Mill Creek Watershed 3-3
Figure 5-1. Mill Creek Riparian Zone Coverage 5-2

Table of Tables

Table 1-1: Impairment Summary for Mill Creek (VAT- D06R-01) 1-2
Table 3-1. Landuse Categories for Mill Creek Watershed 3-1
Table 3-2: Summary of Water Quality Parameters of Mill Creek 3-4
Table 3-3. Estimated Loads and Load Reductions for TOC, TN, and TP 3-8
Table 3-4. TMDLs and Load Allocation (lb/day) 3-8
Table 5-1. Riparian Buffer Zone Quantification 5-2
Table 5-2. Mill Creek Implementation Action Overview 5-3
Table 5-3. Mill Creek Implementation Action Costs 5-3
Table 6-1. Staged Implementation Actions 6-1
Table 6-2. Water Quality Milestones for Mill Creek 6-2

1.0 Introduction

When streams fail to meet water quality standards, Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for each pollutant exceeding its standard. TMDLs represent the total pollutant loading that a waterbody can receive without violating water quality standards. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and instream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of their water resources (EPA, 2001).

As required by the Clean Water Act and Virginia's Water Quality Monitoring, Information and Restoration Act (WQMIRA), VADEQ develops and maintains a listing of all impaired waters in the state that details the pollutant(s) causing the impairments and the potential source(s) of each pollutant. This list is referred to as the 303(d) List of Impaired Waters. In addition to 303(d) List development, WQMIRA directs VADEQ to develop and implement TMDLs for listed waters (VADEQ, 2000). Once TMDLs have been developed, they are distributed for public comment and then submitted to the EPA for approval.

Once a TMDL is developed, the WQMIRA states that the "State Water and Control Board shall develop and implement a plan to achieve fully supporting status for impaired waters". The TMDL Implementation Plan (IP) describes the necessary control measures, which can include the use of better treatment technology and installation of Best Management Practices (BMPs), are implemented in a staged process.

1.1 Impairment Listing

The segment VAT-D06R_MCR01A00 of Mill Creek was first listed as aquatic life impaired on Virginia's 1998 303(d) Total Maximum Daily Load Priority List and Reports (VADEQ, 1998) due to exceedances of the state's water quality criteria for dissolved oxygen (DO) and pH. This segment was also included on subsequent Virginia 303(d)

Reports on Impaired Waters and Virginia 305(b)/303(d) Water Quality Assessment Integrated Reports (VADEQ, 2010). Mill Creek is located on the eastern shore of Virginia, within Northampton County, and empties into the Magothy Bay (USGS Cataloging Unit 02040304) (**Figure 1-1**).

The aquatic life impaired segment of Mill Creek is 2.33 miles in length, is located north of Capeville and encompasses the area at the start of Mill Creek upstream of Penn central railroad crossing and ends downstream of Rt. 600 at the beginning of the impoundment upstream of tidal waters. Based on monitoring data for the 2010 Water Quality Assessment (2007-2008), the segment was found not to be supporting its aquatic life use goal due to exceedances of the dissolved oxygen and pH criteria. **Table 1-1** summarizes the details of the impaired segment as listed in the 2010 Integrated Assessment.

Table 1-1: Impairment Summary for Mill Creek (VAT- D06R-01)

TMDL ID	Assessment Unit	Stream Name	Length (miles)	Boundaries	Listing Station ID:	Impairment for	Exceedance Rate*
VAT-D06R-01	VAT-D06R_MCR01A00	Mill Creek	2.33	Located north of Capeville. Start of Mill Creek upstream of Penn central RR crossing and ends downstream of Rt 600 at the beginning of the impoundment upstream of tidal waters.	7-MCR002.00	Dissolved Oxygen	5 violates / 9 obs.
						pH	4 violates / 9 obs

*Exceedance rate listed in Virginia's 2010 305(b)/303(d) Water Quality Integrated Assessment

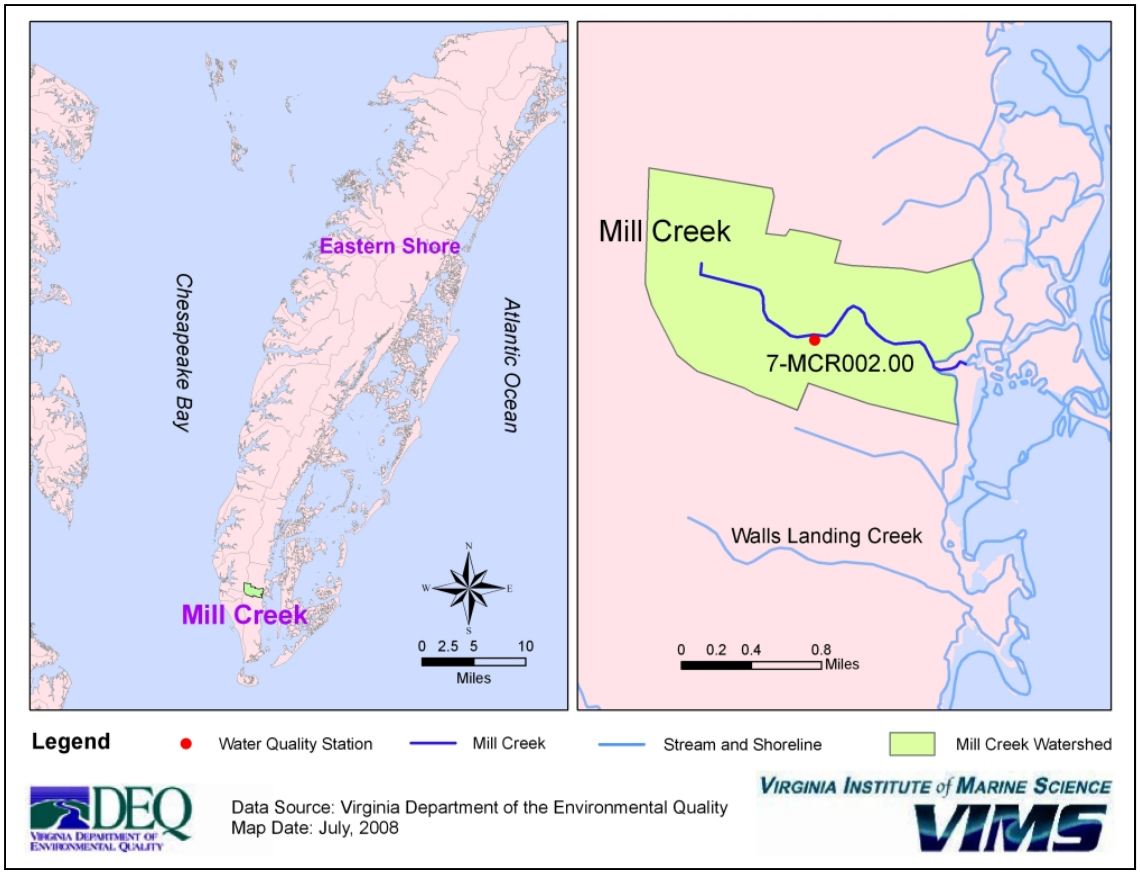

Figure 1-1: Location of the Impaired Mill Creek Watershed

1.2 Applicable Water Quality Standard

Water quality standards include designated uses for a waterbody and water quality criteria necessary to support those designated uses. According to Virginia Water Quality Standards (9 VAC 25-260-5), the term *water quality standards* "means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect public health or welfare, enhance the quality of water, and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."

1.2.1 Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10):

> *"all state waters, including wetlands, are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might*

be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish).”

1.2.2 Applicable Water Quality Criteria

VA DEQ has water quality standards for both dissolved oxygen and pH. DO is a basic requirement for any healthy aquatic ecosystem. According to 9VAC25-260-50, the numerical criterion for DO for Class III waters is a minimum of 4.0 mg/L and a daily average of 5.0 mg/L. VADEQ sets a range of 6.0 to 9.0 for the pH standard in all classes of water.

The assessments conducted on Mill Creek indicate that some pollutant(s) are interfering with attainment of the above standards.

1.3 Nesting of Impairments

The pH impairment will be nested with the DO TMDL because the causes of low DO in Mill Creek are quite similar to the causes of the pH impairment (excessive nutrients/carbon, algal productivity). The implementation action identified will improve the DO levels in Mill Creek as well as the pH levels.

2.0 State and Federal Requirements for Implementation Plans

There are a number of state and federal requirements and recommendations for TMDL IPs. The goal of this chapter is to clearly define these and explicitly state if the elements are a required component of an approvable IP or are merely a recommended topic that should be covered in a thorough IP. This chapter has three sections that discuss the a) requirements outlined by the Water Quality Monitoring, Information, and Restoration Act (WQMIRA) that must be met in order to produce an IP that is acceptable and approvable by the Commonwealth, b) EPA recommended elements of IPs, and c) required components of an IP in accordance to Section 319 guidance.

2.1 State Requirements

The TMDL IP is a requirement of Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act (§62.1-44.19:4 through 19:8 of the Code of Virginia), or WQMIRA. WQMIRA directs Virginia Department of Environmental Quality (DEQ) to "develop and implement a plan to achieve fully supporting status for impaired waters." In order for IPs to be approved by the Commonwealth, they must meet the requirements as outlined by WQMIRA. To meet the requirements of WQMIRA, IPs must include the following:

- Date of expected achievement of water quality objectives
- Measureable goals
- Necessary corrective actions
- Associated costs, benefits, and environmental impact of addressing the impairment.

2.2 Federal Requirements

Section 303(d) of the CWA and current EPA regulations do not require the development of implementation strategies. EPA does, however, outline the minimum elements of an approvable IP in its 1999 "Guidance for Water Quality-Based Decisions: The TMDL Process". The listed elements include:

- a description of the implementation actions and management measures,

- a time line for implementing these measures,
- legal or regulatory controls,
- the time required to attain water quality standards, and
- a monitoring plan and milestones for attaining water quality standards.

2.3 Requirements for Section 319 Funding Eligibility

EPA develops guidelines that describe the process and criteria to be used to award Clean Water Act (CWA) Section 319 nonpoint source grants to States. Congress amended the CWA in 1987 to establish the 319 Nonpoint Source Management Program. Under Section 319, States, Territories, and Indian Tribes receive grant money, which supports a wide variety of activities, including the restoration of impaired waters. The guidance is subject to revision and the most recent version should be considered for IP development. The "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003" identifies the following nine elements that must be included in the IP to meet the 319 requirements:

1. Identify the causes and sources of groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan;
2. Estimate the load reductions expected to achieve water quality standards;
3. Describe the NPS management measures that will need to be implemented to achieve the identified load reductions;
4. Estimate the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan.
5. Provide an information/education component that will be used to enhance public understanding of the project and encourage the public's participation in selecting, designing, and implementing NPS management measures;
6. Provide a schedule for implementing the NPS management measures identified in the watershed based plan;
7. Describe interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented;

8. Identify a set of criteria for determining if loading reductions are being achieved and progress is being made towards attaining water quality standards, and if not, the criteria for determining if the watershed-based plan needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation efforts.

For more information on the requirements for Section 319-fund eligibility, refer to http://www.epa.gov/owow/nps/cwact.html or http://www.dcr.state.va.us/sw/ss319.htm.

3.0 Review of TMDL Development

The Mill Creek DO TMDL was completed by the Virginia Marine Institute of Science (VIMS) in April 2009, approved by EPA in June 2009, and the Virginia State Water Control Board in December 2010. The following section reviews the watershed characterization, water quality monitoring, source assessment, primary cause of impairment, water quality modeling, and the allocations for the Mill Creek watershed.

3.1 Watershed Characterization

3.1.1 Landuse

The Mill Creek watershed is located in Northampton County of the Eastern Shore of Virginia. **Table 3-1** lists the landuse percentages of the watershed. It can be seen that the watershed is dominated by agriculture (63.4%, including row crops and pasture/hay) and forest (27.9%, including deciduous, evergreen, and mixed forest). A map displaying the landuse in the Mill Creek area is shown in **Figure 3-1**.

Table 3-1: Landuse Categories for Mill Creek Watershed

Landuse	Acres	Percentage
Open Water	0.2	0.02%
Low Intensity Residential	6	0.55%
Commercial/Industrial/Transportation	9.6	0.87%
Deciduous Forest	45.4	4.15%
Evergreen Forest	228.4	20.89%
Mixed Forest	31.1	2.85%
Pasture/Hay	239.7	21.92%
Row Crops	453.5	41.47%
Woody Wetlands	28.2	2.58%
Emergent Herbaceous Wetlands	51.4	4.70%
Totals	**1,093.5**	**100.00%**

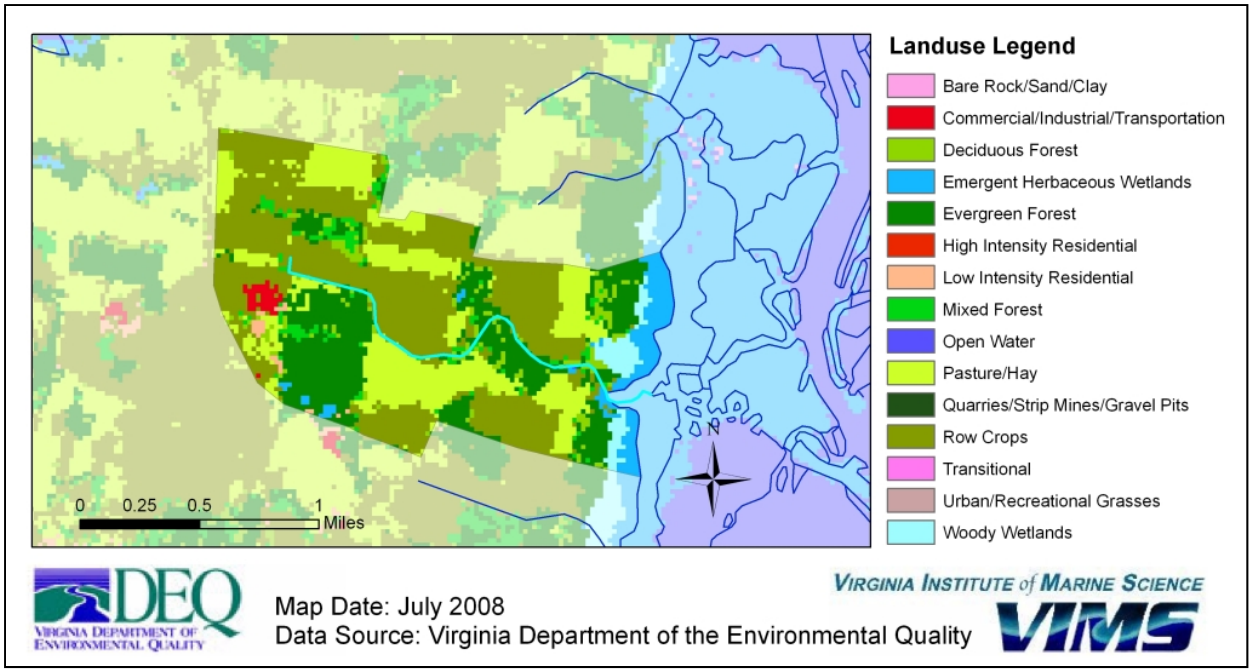

Figure 3-1: Landuse of the Mill Creek Watershed

3.1.2 Geology and Soils

Located at Virginia's Eastern Shore, the Mill Creek watershed is in the Lowland sub-province of the Coastal Plain province. Latest Tertiary and Quaternary sand, silt, and clay, which cover much of the Coastal Plain, were deposited during interglacial highstands of the sea under conditions similar to those that exist in the modern Chesapeake Bay and its tidal tributaries.

(http://www.wm.edu/geology/virginia/provinces/coastalplain/coastal_plain.html)

3.1.3 Climate and Hydrology

As part of the Tidewater Climate Region, the Mill Creek watershed experiences average January temperatures of 35-48° F and average July temperatures of 71-85° F. Annual precipitation is 41.32 inches. High precipitation occurs in late summer and March (**Figure 3.2**). Mill Creek is non-tidal and it is also influenced by stream discharge, groundwater seepage, and surface runoff.

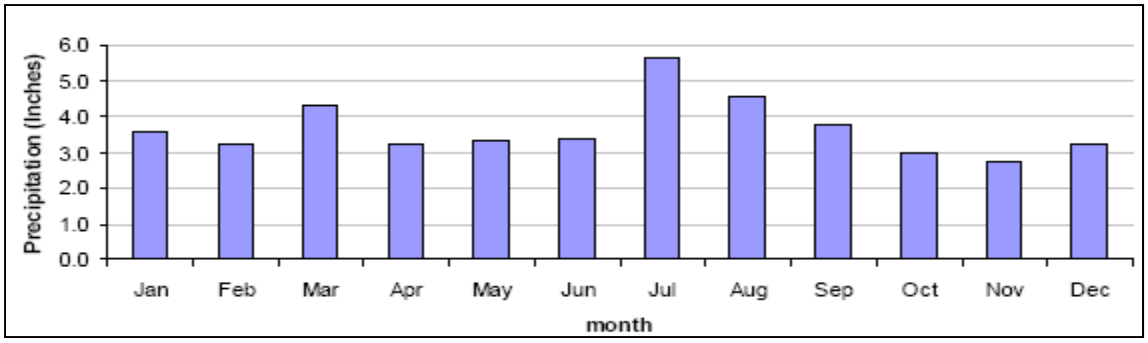

Figure 3-2: Annual Precipitation of the Mill Creek Watershed

3.2 Water Quality Monitoring

Oxygen concentrations in a water column fluctuate under hydrological conditions. Severe oxygen depletion may result from activities that introduce large quantities of organic carbon (OC) and nutrients into surface waters. Excessive nutrient input promotes the growth of algae and macroalgae, which introduce organic materials to both water column and the bottom sediment. The bacteria decomposition process consumes large quantities of oxygen, which can result in a net decline in DO concentrations in the water. Other factors (such as temperature) influence the amount of oxygen dissolved in water as well. The process of nutrient enrichment in aquatic ecosystems is called eutrophication. Human activities can greatly accelerate eutrophication by increasing the rate at which nutrients and organic substances enter aquatic ecosystems from their surrounding watersheds. Agricultural runoff, urban runoff, leaking septic systems, sewage discharges, eroded stream banks, and similar sources can increase the flow of nutrients and organic substances into aquatic systems.

3.2.1 Summary of Data Analysis

Mill Creek is a very narrow freshwater stream. It is surrounded by forest and agricultural land with a large wetland area adjacent to the stream. Runoff from adjacent farmlands can discharge to the stream through the drainage ditches connected to it. There is no point source facility with permitted nutrient levels that directly discharges to Mill Creek. The creek is characterized by low flows and minimal re-aeration under normal hydrological conditions. The flow is very low during dry season, and sometimes the creek can be completely dry for a couple of days. Large amount of carbon transported from upstream, as well as adjacent farmlands and wetlands, will be deposited inside the creek. The

vegetation on the bank often covers a large portion of the stream during summer time, resulting in low re-aeration and low light in the creek. A large quantity of decaying vegetation with high concentrations of organic acids (tannins, humic, and fulvic substances) can accumulate there. The averaged pH value was around 6.2 and 38% of the time the measured pH values were below 6. The level of acidity, as registered by pH in the waterbody, indicates the decay of vegetative material and buffering capacity. Very high nitrate concentrations were observed, and possibly most of them were discharged into the creek through ground water. The decay of OC and oxidization of ammonia in the subsurface also contribute to the DO consumption. These results indicate that low DO in the stream is caused by high inflow of nitrogen and OC, which also subsequently resulted in deposition of organic matters in the bottom. High temperature, low re-aeration, decay of organic materials and nitrogen oxidation, and the high SOD due to accumulated deposition of organic matters, are dominant causes of low DO.

A summary statistics of nutrients, BOD_5, and algae are listed in **Table 3.2**. In general, the average nitrate concentration was about 5.26 mg/L. The averaged total nitrogen (TN) and TP were 5.87 and 0.10 mg/L, and the former was 487% higher than the screening level of water quality assessment guideline for Class VII, Swamp Water. The TN and TP levels were 727% and 233% higher than the EPA recommended levels, respectively.

Table 3-2: Summary of Water Quality Parameters of Mill Creek

Parameter	Duration	Count	Mean	Standard Deviation	[1]Background Value for Natural Condition	Values EPA Recommended
DO (mg/L)	1997-2003	34	4.98	2.16		
TN (mg/L)	1997-2003	37	5.87	3.01	<1.0	0.71
NH_4^+ (mg/L)	1997-2003	38	0.06	0.07		
NO_3^- (mg/L)	1997-2003	38	5.26	3.15	<0.6	
TP (mg/L)	1997-2003	37	0.10	0.18	<0.1	0.03
BOD_5 (mg/L)	1997-2001	30	1.70	0.64		
Chl *a* (µg/L)	2001-2003	7	5.42	7.50		
pH	1997-2003	34	6.22	0.41	<6	

[1]Water Quality Assessment Guidance Manual, VA-DEQ, 2008, http://www.deq.virginia.gov/waterguidance/wqam.html

3.3 Source Assessment

3.3.1 Updated VIMS Source Assessment

VIMS identified total nitrogen and carbon as the primary cause of the DO impairment in Mill Creek. Based on stakeholder input, the sources of nitrogen and carbon have been updated. VIMS estimated 69 septic units, while the Northampton County Planning Office has reported 35 septic systems. This cuts the estimated number of failing septic systems from eight to four. VIMS estimated five cows and one swine within the watershed while the USDA-NRCS reported no livestock. While VIMS estimated 44 lbs/acre/year of lawn fertilizer applied, the Eastern Shore SWCD estimated no lawn fertilizer application in the watershed. The Eastern Shore SWCD confirmed the N-fertilizer application to cropland was reasonable.

The nutrient loads contributed from wildlife were estimated based on nutrient productions per animal per day. The nutrient production rates were estimated based on the animal rates that have similar sizes. The contributions from failure of septic systems were estimated based on nutrient concentrations and typical septic overcharge flow rate per person. A value of 70 gal/day/person was assumed and the concentrations for TN, TP, and BOD were 60, 23.5, and 240 mg/L, respectively.

For OC, which is both naturally-produced on land and a potential pollutant in the stream, the accumulation rates were estimated based on empirical information (Cerco and Noel, 2004) and the ratio of C/N was obtained from storm water sampling monitoring instead of directly surveyed field data in the Eastern Shore watershed. Due to the absence of subsurface water quality measurements, pollutant concentrations for interflow and groundwater were derived from the reference data of Cherrystone Inlet (Reay, 1996). The total loads for TN, TP, and OC were estimated based on landuse distribution. Load contributions from manure/litter/fertilizer applications were applied to agricultural land uses, those from atmospheric deposition were distributed to all the land uses categories, those from wildlife were distributed to all the land uses accept urban, and those from failure of septic systems to low-intensity residential landuse.

3.4 Water Quality Modeling

3.4.1 Selection of a TMDL End Point

Based on data analysis and field survey, as well as model sensitivity test, it is evident that the low DO occurring in Mill Creek is caused by a combination of natural condition and human impact. High temperature, low re-aeration, and decay of organic materials and nitrogen oxidation, together with the high SOD due to accumulated deposition of organic matters, are dominant causes of low DO. Reducing nutrients and OC discharge to the Creek will improve the DO condition. To evaluate the amount of nutrients and OC to be reduced, the DO water quality criteria of a minimum of 4.0 mg/L and a daily average of 5.0 mg/L were set as the endpoints to determine the allowable loadings.

3.4.2 Model Development

The watershed model Loading Simulation Program in C++ (LSPC) was selected to simulate the watershed hydrology and nutrient loads to the receiving waterbody of Mill Creek. The Environmental Fluid Dynamics Code (EFDC) was used to simulate the water quality of the receiving water. The LSPC model is driven by hourly precipitation and was used to simulate the freshwater flow and its associated nonpoint source pollutants. The simulated freshwater flow and pollutant (nitrogen, phosphorus, and OC) loadings from each sub-watershed were fed into the adjacent water quality model segments. The EFDC simulates the transport of pollutants and eutrophication processes in the Creek. In order to predict primary production and DO, a large suite of model state variables representing nutrient and DO dynamics were simulated in the model, including:

1. Algae (green)
2. OC (particulates and dissolved)
3. Organic phosphorus (particulates and dissolved)
4. Phosphate
5. Organic nitrogen (particulates and dissolved)
6. Inorganic nitrogen (ammonium and nitrate)
7. DO

The water column processes is coupled to the sediment diagenesis (DiToro and Fitzpatrick, 1993), which is a group of chemical processes in sediment causing mineralization of organic matters after they have been deposited. The sediment diagenesis model component simulates the changes of particulate organic matter

deposited from the overlying water column and the resulting fluxes of inorganic substances (ammonium, nitrate, phosphate, and sulfite), and the SOD back to the water column.

The flow simulated by the watershed model was calibrated using USGS gauging data at Gage 01484800 in Guy Creek near Nassawadox, VA. The gage is located approximately 33 km north of the Mill Creek watershed and is the only station located in the Eastern Shore. The flow simulation was further verified with the local flow data collected by VA-DEQ in the Onancock Creek watershed (Wang, 2005).

3.5 TMDL Allocations

A TMDL is the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, incorporating natural background levels. The TMDL must, either implicitly or explicitly, include a MOS that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody, and in the scientific and technical understanding of water quality in natural systems. In addition, when applicable, the TMDL may include a future allocation (FA) when necessary. This definition is denoted by the following equation:

$$\text{TMDL} = \text{WLAs} + \text{LAs} + \text{MOS} + (\text{FA, where applicable})$$

According to the DO criteria, the allowable nutrients to the Creek to meet the water quality standards can be computed. The allowable loads for organic carbon, total nitrogen and phosphorus were calculated using the DO water quality criteria of a minimum of 4.0 mg/L and a daily average of 5.0 mg/L. The load reductions needed for the attainment of the criteria was determined as follows:

$$\textbf{Load Reduction} = \frac{\textbf{Current Load} - \textbf{Allowable Load}}{\textbf{Current Load}} \times 100\,\%$$

The calculated results are listed in **Table 3-3**.

Table 3-3: Estimated Loads and Load Reductions for TOC, TN, and TP			
Pollutant	**Current Load (lb/day)**	**Allowable Load (lb/day)**	**Required Reduction (%)**
TOC	76.34	30.53	60%
TN	25.18	10.07	60%
TP	0.77	0.77	0%

As there are no industrial or wastewater treatment facilities that are permitted to discharge nutrients in the watershed of Mill Creek, the loads were allocated to the LA. For consideration of future growth in this watershed, 1% of the total load is allocated to the future growth. The TMDLs are summarized in **Table 3-4**.

Table 3-4: TMDLs and Load Allocation (lb/day)									
Nutrient	**TMDL**	**=**	**LA**	**+**	**WLA**	**+**	**FA**	**+**	**MOS**
TOC	30.53	=	28.69	+	N/A	+	0.31	+	1.53
TN	10.07	=	9.47	+	N/A	+	0.10	+	0.50

Where:

TMDL = Total Maximum Daily Load
LA = Load Allocation (Nonpoint Sources)
WLA = Wasteload Allocation (Point Sources)
FA = Future Allocation
MOS = Margin of Safety

4.0 Public Participation

Public participation is an important part in developing the implementation plan for any watershed. Watershed residents and officials who work in the area have an intimate knowledge of the attitude of the citizens, what is possible to implement and what is not possible. For this implementation plan the public participated in two public meetings and one steering committee meeting was held to properly identify the control measures needed to reduce nutrient levels in Mill Creek watershed.

A technical advisory committee meeting was held on August 11th, 2011 at the Northampton County Administrative Office. Attendee's included representatives from DEQ, The Louis Berger Group, the Eastern Shore Soil and Water Conservation District, DCR, The Northampton County Health Department, and the Northampton County Planning Office. In this meeting the relationship between the dissolved oxygen impairment and the pH impairment was discussed as well as the nesting approach for the pH impairment. The de-listing of the bacteria impairment was discussed. The participants were solicited for any updates in the source assessment and the general approach to implementation was reviewed.

The first implementation plan public meeting was held in on September 26th, 2011. Attendee's included representatives from DEQ, The Louis Berger Group, the Eastern Shore Soil and Water Conservation District, DCR, and the Northampton County Planning Office. In this meeting the TMDL was reviewed and the source assessment was updated with new figures from the participants (new septic numbers, reduction in amount of fertilizer applied, etc.). The general approach for implementation actions in Mill Creek was discussed. Information about the nutrient management plans was discussed, as well as the typical farming practices in the area.

The first steering committee meeting was held on February 13th 2012. Attendee's included representatives from DEQ, The Louis Berger Group, the Eastern Shore Soil and Water Conservation District, DCR, and the Northampton County Planning Office. In this meeting the TMDL was briefly reviewed, implementation actions were suggested

and discussed, and suggestions for further implementation actions, such as septic system pump outs, were made. The general consensus was that the implementation actions suggested were feasible and water quality goals were attainable for the watershed.

The final implementation plan public meeting was held on March 12th, 2012. Attendee's included local citizens, representatives from DEQ, The Louis Berger Group, the Eastern Shore Soil and Water Conservation District, DCR, and the Northampton County Planning Office. The TMDL was reviewed; and implementation actions, measureable goals and milestones, funding sources were presented and discussed.

5.0 Implementation Actions

As presented in Chapter 3, The Mill Creek watershed is approximately 1,096 acres in size with agricultural and forested land representing 63.4% and 27.9% of the watershed respectively. The Mill Creek dissolved oxygen impairment is primarily caused by excessive nutrient and organic matter from agricultural runoff and to a lesser extent from failing septic systems. Agricultural lands consist of row crops and pasture/hay within 4 farming operations ranging in size from 11.6 to 521.2 acres with a total of 846.2 acres within the Mill Creek Watershed. There are approximately 35 septic systems in the Mill Creek watershed and the estimated number of failed systems is approximately four (4). A total of 834 agricultural acres (98.5% of the agricultural land) have a Nutrient Management Plan that is required for participation in the Virginia Cost-Share program. A farm nutrient management plan, such as the one in place in Mill Creek, is a strategy for obtaining the maximum return from the fertilizer applications in a manner that protects the quality of nearby water resources.

An assessment of the existing nutrient management plans along with the field observations made during the site visits identified riparian buffer as one category of practices that is expected to have significant impact on the water quality improvement in Mill Creek. Riparian buffer zones are an integral part of any stream ecosystem and also are a natural barrier for nutrients delivered to the stream. A riparian buffer is a forested or herbaceous area between a stream and the adjacent land that acts as a filter and maintains the water quality and ecological health of stream channels and shorelines.

A GIS analysis was performed to determine the existing riparian zone coverage around Mill Creek. It was estimated that 30% of Mill Creek's non-tidal portion has no riparian buffer zone, 23% has half a riparian buffer zone (indicating, one of the sides of the stream has a buffer zone) and 47% has a full riparian buffer zone. **Figure 5-1** illustrates the analysis of the existing riparian buffers in the Mill Creek watershed.

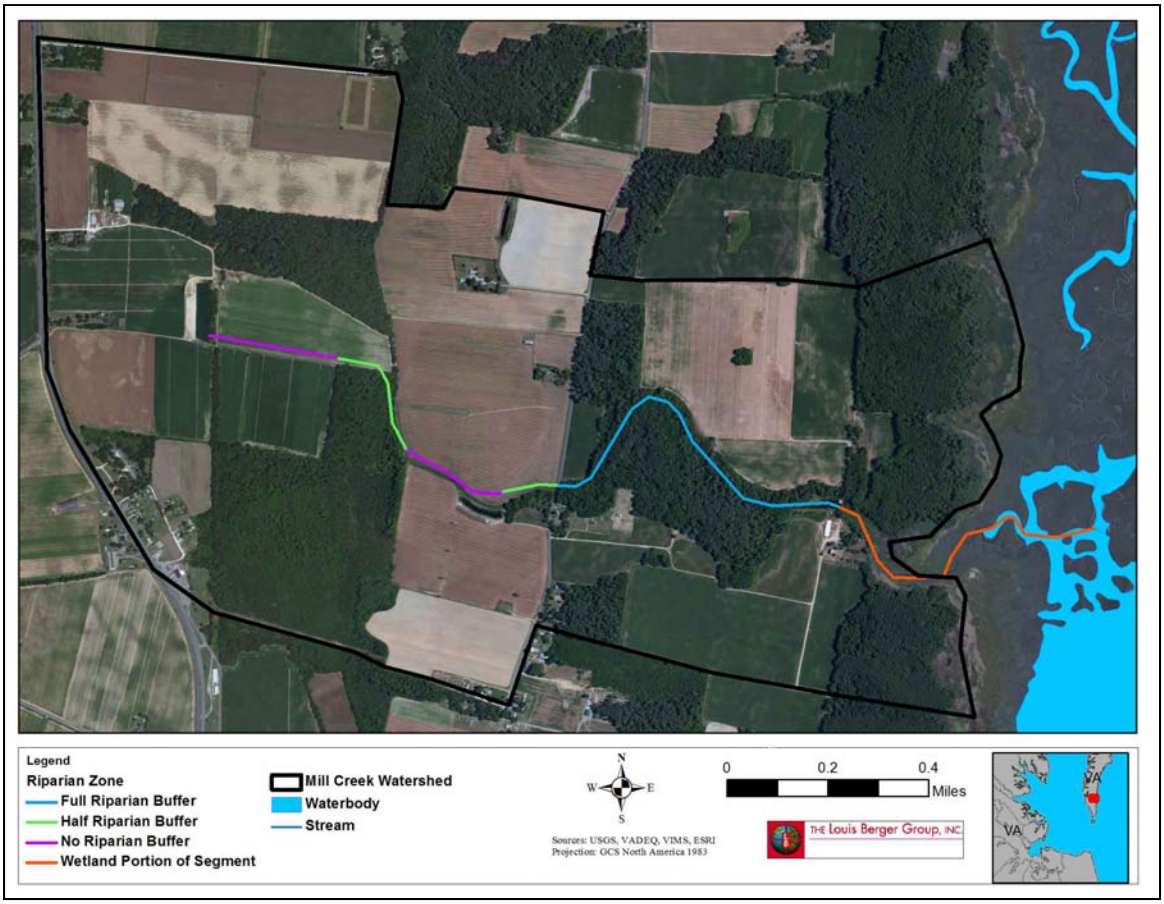

Figure 5-1: Mill Creek Riparian Zone Coverage

The effectiveness of riparian buffer in removing nitrogen is well documented with a reported nitrogen removal efficiency varying from 50% to 75% (EPA 2005, DCR 2003). The riparian buffer width is a key factor controlling nitrogen removal effectiveness and published values estimate that a 3 meter buffer (10 feet) will provide a 50 % removal and a 28 meter (92 ft) buffer will results in a 75 % nitrogen removal (EPA 2005). For the Mill Creek TMDL implementation plan, it is estimated that a 60 ft buffer along the entire length of Mill Creek (30 ft on each side the creek) will provide the necessary nitrogen control levels identified by the TMDL which are estimated at 60% nitrogen removal. **Table 5-1** quantifies the riparian buffers necessary for a full riparian buffer along Mill Creek.

Table 5-1: Riparian Buffer Zone Quantification

Riparian Zone	Length (feet)	Width of Necessary Buffer (feet)	Area of Buffer Necessary (acre)
Half Riparian Buffer	1,966	30	1.35
No Riparian Buffer	2,481	60	3.41
Total	**4,447**		**4.76**

Therefore and as shown in **Figure 5-1**, implementing a forested riparian buffer to the portions of Mill Creek which only have half a buffer or no buffer will drastically reduce the amount of nutrients delivered to Mill Creek from the adjacent agricultural lands.

In addition and as identified in the TMDL document, the existing failing septic systems need to be identified and repaired, as well as pump outs for all septic systems. **Table 5-2** summarizes the implementation actions proposed for the Mill Creek Implementation Plan.

Table 5-2: Mill Creek Implementation Action Overview

Control Measures	Unit Needed
Riparian Stream Buffer (acres)	**4.76**
Septic System Pump Out	**35**
Septic System Replacement	**4**

In order to meet the TMDL requirements, the BMPs in Table 5-2 must be implemented; however, a staged approach to implementation is described in Chapter 6 of this document. In summary, much of the needed nitrogen reductions in Mill Creek can be achieved without overly intensive actions.

5.1 Cost Analysis

As stated earlier, the Mill Creek dissolved oxygen TMDL requires reductions to the land-based agricultural loads and urban load from the failing septic systems. **Table 5-3** summarizes the implementation actions, the number of required units, the cost per unit, and the total implementation cost. Section 6.5 outlines the staged implementation of all these actions in addition to the cost at each stage, and the expected nutrient reductions.

Table 5-1: Mill Creek Implementation Action Costs

Control Measures	Unit	Units Needed	Cost per unit ($)	Total
Riparian Stream Buffer	acres	4.76	$547	$2,605
Septic System Pump-out	system	35	$300	$10,500
Septic System Replacement	system	4	$8,000	$32,000
			Total Cost of Implementation	**$45,105**

5.2 Benefits

The primary benefit of implementation is cleaner waters in Virginia, where nutrient levels will be reduced to meet the dissolved oxygen water quality standards in Mill Creek. The measures outlined in Section 5.1 have the potential to be extremely effective in preventing any nitrogen from entering Mill Creek. The key mitigation measure recommend by this plan is the full implementation of a riparian buffer along the banks of Mill Creek. The specific benefit of a riparian buffer is to keep the nutrients on the field and for for use by crops, not by the aquatic weeds in the creek. Additional benefits from a riparian buffer are the minimization of erosion and the lowering of costs associated with bank stabilization and the loss of land. In addition to and as a result of reducing the amount of nitrogen, stakeholders can anticipate benefits within their watersheds which may include an improved aquatic life.

The main objective of the IP is restoring water quality in our streams with additional benefits that may include continued economic vitality and strength. Healthy waters can improve economic opportunities for Virginians, and a healthy economic base can provide the resources and funding necessary to pursue restoration and enhancement activities. The residential and urban implementation actions recommended in the IP will often provide economic benefits to the landowner, along with the expected environmental benefits. Additionally, money spent by landowners, government agencies, and non-profit organizations in the process of implementing the IP will stimulate the local economy. An ancillary benefit is enhanced real estate values for homes and businesses located near water bodies with good water quality.

Cleaner waters in Virginia will result in improved public health, conservation of natural resources, improved aquatic habitat, and greater economic opportunities for Virginians. These benefits add up to a better quality of life in the Commonwealth of Virginia; the recognition of these effects and their applicability in watersheds will help to ensure a successful implementation.

6.0 Measureable Goals and Milestones for Attaining Water Quality Standards

The primary goals of the Mill Creek Implementation Plan are to restore water quality in the impaired segment and subsequently de-list the Mill Creek impaired segment from the Virginia 303(d) List of Impaired Waters for DO and pH issues. This section will outline specific implementation milestones, water quality milestones, the link between implementation and water quality improvement, provide a timeline for implementation, and describe additional tracking and monitoring to measure implementation achievements.

6.1 Implementation Milestones

Expected progress in implementation is established with two types of milestones: *implementation milestones* and *water quality milestones*. Implementation milestones establish the amount of control measures installed within certain timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met. Because of the relatively small size of the watershed and the targeted implementation actions it is expected to achieve full implementation within 5 years leaving 5 years to assess water quality for delisting. In other words, it is expected that the full implementation will be completed at the five-year mark and delisting at the ten-year mark.

Table 6-1 details the implementation actions, the two distinct stages, and how many units will be implemented per stage. **Table 6-2** outlines the cost of each implementation action in each stage.

Table 6-1. Staged Implementation Actions

Milestone	Specific IP Actions	Unit	Stage I Year 1 to Year 5	Stage II Year 6 to Year 10
Implementation of Actions	Riparian Stream Buffer (acres)	acres	5.4	-
	Septic System Pump Out	system	35	
	Septic System Replacement	system	4	-
Water Quality Monitoring	VADEQ Follow up monitoring	-	-	Bi monthly

6.2 Water Quality Milestones

As mentioned in Section 5, the effectiveness of riparian buffer in removing nitrogen is well documented with a reported nitrogen removal efficiency varying from 50% to 75% (EPA 2005, DCR 2003). The necessary nitrogen reductions derived during the TMDL development are estimated at 60% nitrogen removal. Therefore, the installation of riparian buffer in Mill Creek will be sufficient to address the DO impairment and bring the dissolved oxygen exceedance rate at zero. **Table 6-2** shows the water quality milestones for Mill Creek.

Table 6-2. Water Quality Milestones for Mill Creek

Current Exceedance Rate of Dissolved Oxygen Standard	38
Stage I (Y1-Y5) Exceedance Rate	0
Stage II (Y6-Y10) Exceedance Rate	0

Additional water quality monitoring throughout the implementation plan will validate the water quality improvement gained through the implementation of the riparian buffer proposed in this plan. VADEQ currently monitors Mill Creek at one station (7-MCR002.00). DEQ will monitor as part of the watershed rotation scheme which includes monitoring at the station bi-monthly for 2 years and then off for 4 years. However, if BMP actions have been put into place during an off year, DEQ will consider returning to the station to monitor for improvements made due to such actions.

7.0 Stakeholders' Roles and Responsibilities

Stakeholders are individuals who live or have land management responsibilities in the watershed, including government agencies, businesses, private individuals and special interest groups. Stakeholder participation and support is essential for achieving the goals of this TMDL effort, in other words, improving water quality and removing streams from the impaired waters list. The purpose of this chapter is to identify and define the roles of the stakeholders who will work together to develop the IP. The roles and responsibilities of the major stakeholders are described below.

7.1 Federal Government

The U.S. Environmental Protection Agency (EPA) has the responsibility of overseeing the various programs necessary for the success of the Clean Water Act. However, administration and enforcement of such programs falls largely to the states.

The Natural Resources Conservation Service (NRCS), part of The U.S. Department of Agriculture, is the federal agency that works hand-in-hand with the American people to conserve natural resources on private lands. NRCS assists private landowners with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on the expertise on NRCS staff. NRCS is also a major funding stakeholder for impaired water bodies through the Conservation Reserve Enhancement Program (CREP) and the Environmental Quality Incentive Program (EQIP). For more information on NRCS, visit http://www.nrcs.usda.gov/.

7.2 State Government

In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions. Currently, there are six state agencies responsible for regulating and/or overseeing statewide activities that impact water quality in Virginia. These agencies include: DEQ, DCR, Virginia Department of Agriculture and Consumer Services (VDACS), VDH, the Virginia Department of Forestry (DOF), and VCE.

DEQ: The State Water Control Law authorizes the State Water Control Board to control and plan for the reduction of pollutants impacting the chemical and biological quality of the State's waters resulting in the degradation of the swimming, fishing, shell fishing, aquatic life, and drinking water uses. For many years the focus of DEQ's pollution reduction efforts was the treated effluent discharged into Virginia's waters via the VPDES permit process. The TMDL process has expanded the focus of DEQ's pollution reduction efforts from the effluent of wastewater treatment plants to the pollutants causing impairments of the streams, lakes, and estuaries. The reduction tools are being expanded beyond the permit process to include a variety of voluntary strategies and BMPs.

DEQ is the lead agency in the TMDL process. The Code of Virginia directs DEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop IPs for the TMDLs. DEQ administers the TMDL process, including the public participation component, and formally submits the TMDLs to EPA and the State Water Control Board for approval. DEQ is also responsible for implementing point source WLAs, assessing water quality across the state, and conducting water quality standard related actions.

DCR: DCR is authorized to administer Virginia's NPS pollution reduction programs in accordance with §10.1-104.1 of the Code of Virginia and §319 of the Clean Water Act. EPA is requiring that much of the §319 grant monies be used for the development of TMDLs.

Because of the magnitude of the NPS component in the TMDL process, DCR is a major participant the TMDL process. DCR has a lead role in the development of IPs to address correction of NPSs contributing to water quality impairments. DCR also provides available funding and technical support for the implementation of NPS components of IPs. The staff resources in DCR's TMDL program focus primarily on providing technical assistance and funding to stakeholders to develop and carry out IPs, and support to DEQ in TMDL development related to NPS impacts. DCR staff will also be working with other state agencies, Soil and Water Conservation Districts, and watershed groups to

gather support and to improve the implementation of TMDL plans through utilization of existing authorities and resources.

VDACS: The VDACS Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis (Pugh, 2001). If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken, which may include civil penalties. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, *etc*. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures.

VDH: The VDH is responsible for maintaining safe drinking water measured by standards set by the EPA. Their duties also include septic system regulation and regulation of biosolids land application. Like VDACS, VDH is complaint driven. Complaints can range from a vent pipe odor that is not an actual sewage violation and takes very little time to investigate, to a large discharge violation that may take many weeks or longer to effect compliance. For TMDLs, VDH has the responsibility of enforcing actions to correct failed septic systems and/or eliminate straight pipes (Sewage Handling and Disposal Regulations, 12 VAC 5-610-10 *et seq*.).

DOF: The DOF has prepared a manual to inform and educate forest landowners and the professional forest community on proper BMPs and technical specifications for installation of these practices in forested areas (http://www.dof.state.va.us/wq/wq-bmp-guide.htm). Forestry BMPs are directed primarily to control erosion. For example, streamside forest buffers provide nutrient uptake and soil stabilization, which can benefit water quality by reducing the amount of nutrients and sediments that enter local streams.

Although the DOF's BMP program is intended to be voluntary, it becomes mandatory for any silvicultural operation occurring within a Chesapeake Bay Preservation Area (Chesapeake Bay Preservation Area Designation and Management Regulations,

9VAC10-20 et seq.). For more information on this regulation, visit http://www.dof.state.va.us/resources/wq-BMP-Chapter-10.pdf.

VCE: VCE is an educational outreach program of Virginia's land grant universities (Virginia Tech and Virginia State University), and a part of the national Cooperative State Research, Education, and Extension Service, an agency of the United States Department of Agriculture. VCE is a product of cooperation among local, state, and federal governments in partnership with citizens. VCE offers educational programs and technical resources for topics such as crops, grains, livestock, poultry, dairy, natural resources, and environmental management. VCE has published several publications that deal specifically with TMDLs. For more information on these publications and to find the location of county extension offices, visit www.ext.vt.edu.

7.3 Local Government

Local government groups work closely with state and federal agencies throughout the TMDL process; these groups possess insights about their community that may help to ensure the success of TMDL implementation. These stakeholders have knowledge about a community's priorities, how decisions are made locally, and how the watershed's residents interact. Some local government groups and their roles in the TMDL process are listed below.

Soil and Water Conservation Districts (SWCDs): SWCDs are local units of government responsible for the soil and water conservation work within their boundaries. The districts' role is to increase voluntary conservation practices among farmers, ranchers and other land users. District staff work closely with watershed residents and have valuable knowledge of local watershed practices.

Planning District Commissions (PDCs): PDCs were organized to promote the efficient development of the environment by assisting and encouraging local governmental agencies to plan for the future. PDCs focus much of their efforts on water quality planning, which is complementary to the TMDL process. TMDL development and implementation projects are often contracted through PDCs. For more information on the PDCs located in Virginia, please visit http://www.institute.virginia.edu/vapdc/.

County/City Government Departments: City and county government staff work closely with PDCs and state agencies to develop and implement TMDLs. They may also help to promote education and outreach to citizens, businesses and developers to introduce the importance of the TMDL process.

7.4 Businesses, Community Groups, and Citizens

While successful implementation depends on stakeholders taking responsibility for their role in the process, the primary role falls on the local groups that are most affected; that is, businesses, community watershed groups, and citizens.

Community Watershed Groups: Local watershed groups offer a meeting place for river groups to share ideas and coordinate preservation efforts and are also a showcase site for citizen action. Watershed groups also have a valuable knowledge of the local watershed and river habitat that is important to the implementation process.

Citizens and Businesses: The primary role of citizens and businesses is simply to get involved in the TMDL process. This may include participating in public meetings (Section 5.1), assisting with public outreach, providing input about the local watershed history, and/or implementing best management practices to help restore water quality.

Community Civic Groups: Community civic groups take on a wide range of community service including environmental projects. Such groups include Ruritan, Farm Clubs, Homeowner Associations and youth organizations such as 4-H and Future Farmers of America. These groups offer a resource to assist in the public participation process, educational outreach, and assisting with implementation activities in local watersheds.

Animal Clubs/Associations: Clubs and associations for various animal groups (*e.g.*, beef, equine, poultry, swine, and canine) provide a resource to assist and promote conservation practices among farmers and other land owners, not only in rural areas, but in urban areas as well, where pet waste has been identified as a source of bacteria in water bodies.

Virginia's approach to correcting non-point source pollution problems continues to be encouragement of participation through education and financial incentives; that is, outside of the regulatory framework. If, however, voluntary approaches prove to be ineffective, it is likely that implementation will become less voluntary and more regulatory.

The benefits of involving the public in the implementation process are potentially very rewarding, but the process of doing so can be incredibly challenging. It is, therefore, the primary responsibility of these stakeholder groups to work with the various state agencies to encourage public participation and assure broad representation and objectivity throughout the IP development process.

8.0 Integration with Other Watershed Plans

Current on-going watershed projects or programs within Northampton County/Eastern Shore to be integrated with the Mill Creek TMDL IP include:

- Northampton County Comprehensive Plan
- Northampton County Septic Tank Pump-Out and Inspection
- Accomack-Northampton Planning District Commission (A-NPDC) Septic System Pump-Out Assistance Program
- Department of Environmental Quality No-Discharge Zone
- Eastern Shore of Virginia Groundwater Committee
- Eastern Shore Soil and Water Conservation District Agricultural Cost Share Program

9.0 Potential Funding Sources

9.1 Federal Funding Sources

EPA 319 Funds – EPA develops guidelines that describe the process and criteria to be used to award Clean Water Act Section 319 NPS grants to states. States may use up to 20% of the Section 319 incremental funds to develop NPS TMDLs as well as to develop watershed-based plans for Section 303(d) listed waters. The balance of funding can be used for implementing watershed-based plans for waters that have completed TMDLs. Implementation of both agricultural and residential BMPs is eligible. http://www.epa.gov/owow/nps/319/319stateguide-revised.pdf

Conservation Reserve Enhancement Program (CREP) – In Virginia, this is a partnership program between the USDA and the Commonwealth of Virginia, with the DCR being the lead state agency. The program uses financial incentives to encourage farmers to enroll in contracts of 10 to 15 years or perpetual easements to remove lands from agricultural production.
http://www.dcr.state.va.us/sw/crep.htm

Conservation Reserve Program (CRP) – The program offers annual rental payments, incentive payments for certain activities, and cost-share assistance to establish approved cover on cropland. Contract duration is between 10 and 15 years, and cost-share assistance is provided up to 50% of costs. http://www.nrcs.usda.gov/programs/crp/

Environmental Quality Incentives Program (EQIP) - The purposes of the program are achieved through the implementation of an EQIP plan of operation, which includes structural and land management practices on eligible lands. Contracts up to ten years are written with eligible producers. Cost-share is made available to implement one or more eligible conservation practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more management practices, such as nutrient management, pest management, and grazing land management.

http://www.nrcs.usda.gov/programs/eqip/

Forestry Incentives Program (FIP) – The purpose of this program is to encourage development, management, and protection of private forestland. http://www.nrcs.usda.gov/programs/fip/

Small Watershed Program and Flood Prevention Program (Public Law 83-566) – The purpose of this program is to assist federal, state, local agencies, local government sponsors, tribal governments, and program participants to protect watersheds from damage caused by erosion, floodwater, and sediment, to conserve and develop water and land resources; and to solve natural resource and related economic problems on a watershed basis. The program empowers local people or decision makers, builds partnerships, and requires local and state funding contributions. Both technical and financial assistance is available for watersheds not exceeding 250,000 acres.
http://www.nrcs.usda.gov/programs/watershed/index.html

Wetlands Reserve Program (WRP) – The program provides an opportunity for landowners to receive financial incentives to enhance wetlands in exchange for retiring marginal lands from agriculture. The program offers three enrollment options: permanent easements, 30-year easement, and restoration cost-share agreement (10-year agreement where USDA pays 75% of the restoration
costs). http://www.nrcs.usda.gov/programs/wrp/

Wildlife Habitat Incentives Program (WHIP) - USDA and the participant enter into a five to ten year cost-share agreement for wildlife habitat development. Cost-share up to 75% is available for the cost of installing practices. http://www.nrcs.usda.gov/programs/whip/

U.S. Fish and Wildlife Service Private Stewardship Program – Funds individuals or groups engaged in local, private, and voluntary conservation efforts to benefit federally listed, proposed, or candidate species, or other at risk species.
http://endangered.fws.gov/grants/private_stewardship.html

U.S. Fish and Wildlife Service Conservation Grants – Funds states to implement conservation projects to protect federally listed threatened or endangered species and species at risk.

9.2 State Funding Sources

Virginia Agricultural Best Management Practices Cost-Share Program – The Program is administered by DCR to improve water quality in the state's streams, rivers and the Chesapeake Bay. The basis of the program is to encourage the voluntary installation of agricultural best management practices to meet Virginia's NPS pollution water quality objectives. This program is funded by the state Water Quality Improvement Fund and the federal Chesapeake Bay Program Implementation Grant monies through local SWCDs.
http://www.dcr.state.va.us/sw/docs/bmpsbro2.pdf

Virginia Agricultural Best Management Practices Tax Credit Program – The program provides a tax credit for approved agricultural BMPs that are installed to improve water quality in accordance with a conservation plan approved by the local SWCD. The goal of this program is to encourage voluntary installation of BMPs that will address Virginia's NPS pollution water quality objectives.
http://www.dcr.state.va.us/sw/docs/bmpsbro2.pdf

Virginia Agricultural Best Management Practices Loan Program – The program offers a source of low interest financing to encourage the use of specific BMPs to reduce or eliminate the impact of agricultural NPS pollution on Virginia's waters. The minimum allowable loan amount is $5,000 and the repayment periods may range from one to ten years. DEQ administers this program.
http://www.deq.state.va.us/cap/aghome.html

Virginia Forest Stewardship Program - The program is administered by the DOF to protect soil, water, and wildlife and to provide sustainable forest products and recreation.
http://www.vdof.org/resources/f127_po.pdf

Virginia Small Business Environmental Compliance Assistance Fund – The program provides financial assistance to small businesses by providing loans for the installation of agricultural BMPs certified as eligible by DCR. Interest rates are fixed at 3%, and the maximum loan available is $100,000.

http://www.dba.state.va.us/financing/programs/small.asp

10.0 References

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