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Proposal

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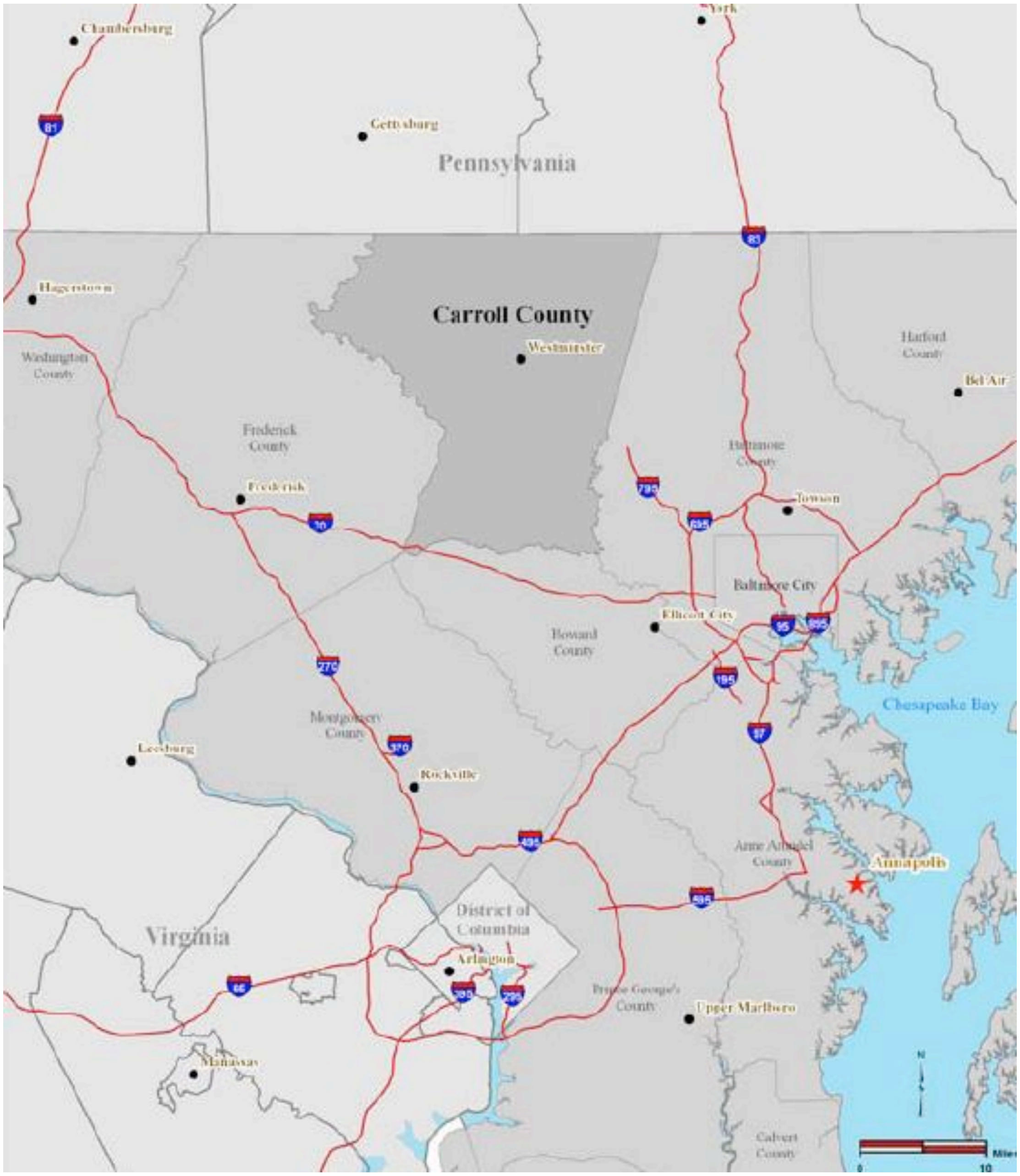
1 Statement of Purpose

Federal, state and local government have committed to restoring the Chesapeake Bay (the Bay) by 2025. In order to comply with the Clean Water Act's goal to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, the U.S. Environmental Protection Agency (EPA) establishes a total maximum daily load (TMDL) to determine the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards (EPA, 2010a). The Bay TMDL, which will establish pollution limits on the amount of suspended sediment and nutrients including nitrogen and phosphorous, is now effective. On September 24, 2010, EPA released the draft Bay TMDL for a 45-day public comment period prior to the TMDL becoming effective December 31, 2010 (EPA, 2010b). Concurrently, the Bay states are required to prepare final TMDL Phase I watershed implementation plans (WIPs), which were due to be submitted to EPA on November 29, 2010 (EPA, 2010b).

The restoration of the Bay formally began with the signing of the 1983 Chesapeake Bay Agreement by the EPA Administrator, the District of Columbia, the Commonwealths of Pennsylvania and Virginia, and the State of Maryland. In addition, EPA has initiated the development of the Bay TMDL because the water quality goals set forth in the Chesapeake 2000 Agreement will not be met by 2010, and segments of the Bay remain on the Bay states' Clean Water Act section 303(d) lists that identify impaired waterways (EPA, 2010a). Since the restoration effort began, there has been progress toward meeting water quality goals (Chesapeake Bay Program (CBP), 2010). However, with increases in development and population expected to occur within the region over the next 15 years, there is a need for a comprehensive effort to develop land in ways that incorporate sustainability principles to reduce impacts to water resources.

This paper will focus specifically on Carroll County, Maryland, which is approximately 453 square miles in land area (Water Resources Element (WRE), 2010). All of the land area within Carroll County drains to the Bay. The county is located northwest of the City of Baltimore, and currently represents the western fringe of the Baltimore-Washington metropolitan corridor. The following figure presents the location of Carroll County (p. 19, WRE, 2010).



In 2000, the population of Carroll County was 150,897 and the estimate in 2008 was 168,773 (Factfinder, 2010). The county is expected to experience increased growth in the next 15 years and beyond. Based on Carroll County's estimate of use and occupancy permits issued each year, the county projects approximately 14,550 additional households, or approximately 685 per year, between 2010 and 2030, with a total build-out population of approximately 258,200 by 2060 (WRE, 2010). The development would likely consist of the transformation from agricultural to suburban land uses, such as medium- or low-density residential and commercial. The issues faced by Carroll County, as it is transformed from primarily agricultural to largely suburban land use, serve as a microcosm for the Bay's watershed.

The purpose of this paper is to identify and evaluate cost effective opportunities to reduce pollutant loads, review sustainability principles as they relate to future stressors associated with new development and anticipated increases in population, and identify additional policy recommendations to reduce existing and/or future pollutant loads.

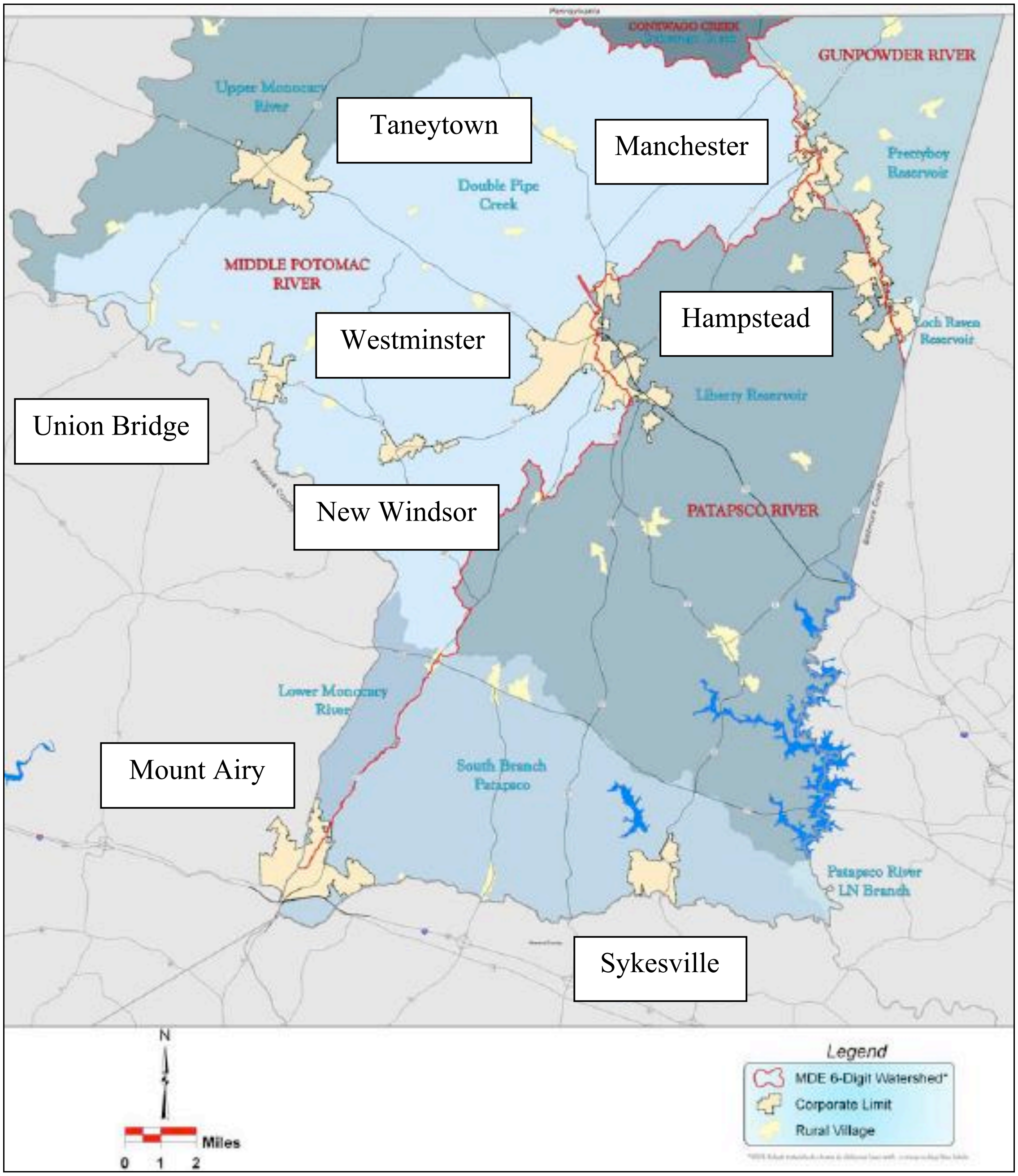
Specifically, the paper will evaluate and address the following points of interest:

1. Point source discharge (nutrient) pollutant reduction opportunities, specifically wastewater treatment plant (WWTP) operations.
2. Non-point source pollutant reduction opportunities.
3. Cost-effective pollutant reduction measures per sector (i.e, urban, agriculture, septic, and WWTPs) to determine which sector Carroll County should allocate its resources for implementation as part of the Bay TMDL restoration effort.
4. Innovative financing options to fund implementation of pollutant reduction measures.
5. Carroll County's policy towards sustainable development and potential impacts on water resources.

2 Background

The primary land uses in Carroll County are agriculture (46-percent), forest (25-percent), and low-density residential (22-percent) (WRE, 2010). Development within the county is concentrated in or near eight small but expanding municipalities: Hampstead, Manchester, Mount Airy, New Windsor, Sykesville, Taneytown, Union Bridge, and Westminster. Carroll County has identified designated growth areas (DGAs) concentrated around the eight municipalities, where development is planned to occur. Developments occurring within the DGAs are likely to be annexed into the eight municipalities (WRE, 2010).

Some streams in Carroll County drain to the Monacacy River and eventually to the Potomac River, and others drain to the Patapsco and Gunpowder Rivers (WRE, 2010). A small area in the northeastern portion of the county drains to the Susquehanna River watershed (WRE, 2010). Three reservoirs in Carroll County serve the Baltimore metropolitan area: Loch Raven, Prettyboy, and Liberty Reservoirs. The following figure presents the primary watersheds within Carroll County (p. 21, WRE, 2010).



3 Methodology

3.1 Bay TMDL Pollutant Reduction Goals

The Bay TMDL will be reviewed along with existing TMDLs for waterways within Carroll County. Watersheds within Carroll County, Maryland drain to major tributaries of the Chesapeake Bay, including the Patapsco, Potomac, and Susquehanna Rivers. The following

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table presents the Bay watershed nutrient and sediment TMDL draft allocations for Maryland by major river basin (Table ES-1, EPA, 2010c):

Jurisdiction	Basin	Nitrogen draft allocations (million lbs/year)	Phosphorous draft allocations (million lbs/year)	Sediment draft allocations (million lbs/year)
Maryland	Susquehanna	1.08	0.05	62.94
	Western Shore*	9.74	0.46	170.38
	Potomac	15.70	0.90	682.33
*Western Shore includes Gunpowder and Patapsco River (including reservoir) basins				

The Bay TMDL pollutant loads have been divided among the signatory states, and EPA has delegated the responsibility to the states to determine the appropriate geographic allocation and source sector for implementation (Maryland Department of the Environment (MDE), 2010a). In order to respond to the regulatory requirement imposed by EPA and the Bay TMDL, MDE has developed a WIP. The WIP is a detailed plan that describes the process to achieve the TMDL. MDE submitted the final Phase I WIP to EPA on December 3, 2010, and made it available to the public December 31, 2010.

The Maryland WIP includes pollution reduction goals for the state of Maryland by sector (e.g., urban regulated, urban unregulated, agriculture, WWTP, etc.). Since Carroll County could be considered a microcosm of the Bay watershed, consisting of urban/suburban, agriculture, and forest land cover, the percent reduction by various sectors by the year 2020 will be used as the goals for the reduction in pollutant loads for Carroll County. The following table presents the pollution reduction percentage goals (p. ES 6-7, MDE, 2010a)

Sector	Nitrogen % Reduction	Phosphorous % Reduction	TSS % Reduction
Urban Regulated	18	34	37
Urban Unregulated	19	39	49
Agriculture	23	12	11
CAFO	12	31	66
Septic	39	n/a	n/a
Forest	0	0	0
Air	1	2	n/a
WWTP and CSO	26	21	-889
Total	21	18	12

Each Maryland county will develop its own WIP to outline the plan to achieve the pollution reduction goals set forth by MDE. The Carroll County WRE identifies strategies where the County could potentially achieve pollution reduction. This paper is intended to complement the next step in the process, or WIP Phase II, which is to refine the details of the Phase I WIP by providing more geographic specificity regarding target loads (MDE, 2010a).

This paper will identify candidate opportunities to achieve reductions in pollution as well as to compute the results, albeit at a conceptual level (i.e., detailed hydrologic, hydraulic and routing modeling exercises will not be completed). Furthermore, as part of this effort, only those sectors where Carroll County could realistically provide measurable reductions will be evaluated as part of this paper. Those sectors include the following: urban regulated, urban unregulated, agriculture, confined animal feeding operation (CAFO), septic, and WWTP. If each Maryland county achieves the pollutant reduction goals identified in the State of Maryland WIP, then the Bay TMDL will be achieved. Therefore, the percentage of pollutant reductions presented in the State of Maryland WIP will be used as the goals for pollutant reduction in Carroll County, and this paper will strive to identify the opportunities necessary to achieve those goals. Discussion on the appropriateness of these goals applied to Carroll County (i.e., perhaps a higher percent reduction goals should be applied to the agriculture sector compared to urban unregulated sector) will be discussed in the paper. Finally, since Maryland has chosen to accelerate its goals to be achieved by 2020 as opposed to 2025 as required by EPA, the timeframe used for this paper to achieve the pollutant reduction goals will be the year 2020 (p.1-1 footnote, MDE, 2010a).

3.2 Pollutant Loads in Carroll County

The modeling effort to compute the Bay TMDL modeling effort was a detailed simulation model, which included a hydrologic routing component. Since this paper will not include a detailed modeling effort to relate reductions in pollutant loads back to the Bay TMDL, a surrogate analysis must be completed.

As part of Carroll County's WRE, MDE, Maryland Department of Planning, and Carroll County calculated existing nitrogen and phosphorous loads for all 6- and 8-digit watersheds using a spreadsheet model. The spreadsheet methodology calculated pollutant loads based on imperviousness per land use/land cover, residential septic systems, and non-residential septic systems.

Four separate scenarios were modeled (WRE, 2010):

1. Current Condition – Estimates of loads based on 2007 Land Use/Land Cover (LULC) data, while using best management practices (BMPs) in place as of 2007.
2. Baseline Condition – Estimate loads using 2007 LULC and assumes that the Tributary Strategies have been fully implemented (excluding denitrifying septic systems) in all watersheds.
3. Future Scenario 1 – Estimates of future loads using buildout based on Carroll County and municipal zoning (prescribed permitted use in the zoning regulations) in place at the time. Carroll County's medium-range buildable land inventory (BLI) estimates were used to calculate future septic systems.
4. Future Scenario 2 – Estimates of future loads using Carroll County land use designations, adopted in the 2000 Carroll County Master Plan and community comprehensive plans. Carroll County's medium-range BLI estimates were used to calculate future septic systems.

The following table summarizes the pollutant loads for the 6-digit watersheds within Carroll County:

6-Digit Watershed	2007 LULC, 2007 BMPs		2007 LULC, Trib Strat BMPs		Existing Zoning Trib Strat BMPs		Existing Land Use Trib Strat BMPs	
	N (lbs/yr)	P (lbs/yr)	N (lbs/yr)	P (lbs/yr)	N (lbs/yr)	P (lbs/yr)	N (lbs/yr)	P (lbs/yr)
Potomac	1,752,941	134,334	1,338,077	118,026	1,349,018	113,082	1,345,119	112,742
Western Shore	214,262	13,068	177,388	10,421	181,306	10,722	178,958	10,650
Patapsco/Back River*	1,142,504	75,553	980,940	57,866	1,002,936	60,647	996,732	60,483
Susquehanna	24,746	1,886	17,907	1,756	18,666	1,721	18,659	1,721
Countywide	3,134,453	224,841	2,514,312	188,069	2,551,926	186,172	2,539,438	185,596
*Included in Bay TMDL Western Shore								

The pollutant loads computed as part of the spreadsheet analysis will be used as the baseline conditions from which potential reductions from various treatment practices could be measured. These reductions will ultimately be compared to the percent reduction goals identified in the State of Maryland WIP as discussed in Section 3.1.

3.3 Identify and Evaluate Pollutant Reduction Opportunities

3.3.1 Point Source Pollution (WWTPs)

As part of the Bay TMDL effort, a consolidated list of point discharges was compiled and presented in the draft Phase 5.3 Watershed Model, Section 7: Point Sources, Water Withdrawals, and On-Site Waste Disposal Systems (CBP, 2010; Chesapeake Community Modeling, 2010). This information will be reviewed and compared to anticipated increases in capacity necessary to accommodate an increase in population in order to identify possible upgrades to improve nutrient reduction efficiencies. Nutrient reduction technologies will be reviewed to determine a cost estimate for WWTP upgrades.

3.3.2 Non-Point Source Pollution

Atmospheric deposition notwithstanding, non-point source pollution is primarily attributed to stormwater runoff. Carroll County has several categories of land use contributing pollutant loads, including impervious surfaces in urban/suburban areas, agriculture, and CAFOs. As mentioned in Section 3.1, MDE has identified the necessary percent reductions in pollutant loads attributed to the different land use categories. This paper will identify and evaluate opportunities and calculate reductions in pollutant loads based on planning or conceptual assumptions.

The land within DGAs are expected to develop from rural to suburban land use in the next few decades, impervious surfaces must be evaluated for potential pollutant reductions. Existing stormwater management facilities (i.e., urban regulated land use sector) will be identified for potential retrofit opportunities by using geographic information systems (GIS) data provided by Carroll County Department of Planning, including aerial photos, public land layer, road layer, existing stormwater management facilities database, building footprints, and imperviousness raster data (data received November 8, 2010). In addition, public lands will be targeted for stormwater management retrofit opportunities as part of the county's capital improvement program (i.e., urban unregulated land use sector). The purpose of this exercise is to ensure a high probability of successful implementation of retrofit projects because of possible fatal flaws associated with unwilling private land owners. However, since privately-owned land, specifically commercial or retail land uses, likely comprises a significant portion of impervious surface, stormwater management retrofit opportunities would be identified for areas of impervious surfaces on those parcels greater than five acres in size. Upon further investigation, this criterion may be adjusted to identify additional opportunities for further consideration as appropriate. Finally, although stormwater treatment practices also provide water quantity and hydrological benefits, the potential benefits will not be computed as part of this paper and will be discussed in a qualitative fashion.

Two GIS shapefiles will be created as part of stormwater management BMP analysis: one point shapefile identifying the location of each proposed BMP, and one polygon shapefile to determine the approximate drainage area for each proposed BMP. The point shapefile will contain numerous attributes related to the spatial location of the proposed BMP. The following attributes will be included in the shapefile: numerical identification, BMP type, BMP description, watershed location, land use sector, latitude and longitude, approximate drainage area, and approximate impervious area treated. Other attributes may be included once the analysis is underway. A GIS application will be used to compute the geometric area in acres for the polygon features. The approximate drainage area, approximate impervious area treated, and land use sector is criteria necessary for pollutant reduction computations discussed in Section 3.4.

CAFOs, though considered to be a point source discharge, will be evaluated similar to the regulated and unregulated land use sectors. A search for CAFOs within Carroll County will be completed. A literature search to determine efficiencies associated with proposed BMPs will be completed.

The pollutant reductions associated with the agricultural land use sector will be more challenging to assess and evaluate. Pollutant loads to receiving waters would vary considerably based on fertilizing and land use practices. In addition, the crops planted would also affect pollutant loads based on their nutrient uptake ability as well as their ability to detain stormwater runoff via precipitation interception. Agricultural land uses will be assessed by computing the using GIS and the land use sector shapefile, and completing an analysis to evaluate different scenarios of treatment practices, such as non-structural BMPs, crop rotation, and fertilizing practices. A literature review to determine potential pollutant reduction efficiencies will be completed.

The septic pollutant loading sector will also be challenging to compute potential reductions. A literature review will be completed to determine technology available to reduce nutrient pollutant loadings for septic systems. The total number of septic systems identified through research, or derived using other information. An analysis to determine the percent reduction in pollutant loadings will be completed.

3.4 Compute Pollutant Reductions Associated with Non-Point Source Opportunities

Using MDE's publicly-available non-point source spreadsheet, the pollutant reduction associated with the proposed BMPs as discussed in Section 3.3.2 will be calculated. The spreadsheet utilizes the Simple Method calculation to compute reductions in pollutant loads for each treatment type (MDE, 2010b).

The proposed BMPs described in Section 3.3.2 will be identified based on the specific treatment practices included in the spreadsheet. The treatment practices include the following: detention facilities, extended detention facilities with micro pool, wet ponds/wetland systems, infiltration practices, filtration practices, and open channel systems. The spreadsheet computes pollutant reductions based on the treatment practice and treatment practice pollutant reduction efficiency applied to the land area (acres) of the corresponding land use category and imperviousness.

3.5 Identify innovative financing options to implement water resource projects

In addition to the effort to identify opportunities to reduce pollutant loads as described in Section 3.3, an analysis to determine estimated costs to implement those opportunities and strategies will be completed. The estimated costs will be determined using unit costs, which will be derived from examples of similar strategies included in literature or other sources of information. For example, information on WWTP upgrades is available online or other government sources of information. Using the WWTP treatment capacity along with the total cost to complete an upgrade, a unit cost would be derived. For other BMPs, cost estimates will be computed by the cost per acre treated.

It is likely the cost to implement WWTP upgrades, retrofit existing stormwater management facilities, and retrofit existing impervious surfaces, particularly roads and parking lots, will be in the tens of millions of dollars, and could reach into the hundreds of millions. Carroll County may be required by EPA to identify sources of funding to implement projects to comply with the Bay TMDL. Funding opportunities, such as EPA's Section 319 funding, state grants, or other sources of revenue, along with other innovative opportunities being implemented in other parts of the United States will be discussed and presented for further consideration by Carroll County.

3.6 Review and discuss Carroll County's strategic plan to address planned development and how to mitigate, minimize, and/or prevent future stressors associated with stormwater runoff and protection of natural stream systems

Policy changes will afford Carroll County the ability to prevent or at least reduce the impact of future stressors on water resources associated with new development. As new developments are planned, sustainability and low impact development principles should be considered and enforced. For example, in 2004, Carroll County adopted revisions to seven major environmental regulations to strengthen stormwater management and environmental protection (WRE, 2010).

In addition to stormwater runoff, septic systems in Carroll County contribute a significant portion of the nutrient load. According to the existing pollutant loading calculations completed for the WRE, nitrogen loads from septic systems in Carroll County account for approximately 13-percent of the current condition scenario, and approximately 16-percent of the baseline condition scenario (WRE, 2010).

Using a literature review of effective policies implemented in other areas of the United States, recommendations to improve Carroll County's current policy on future development and land use changes, and opportunities to reduce nitrogen loads associated with septic systems, will be explored and presented for further consideration by Carroll County.

4 Anticipated Results

Carroll County's effort to reduce pollutant loads to meet the Bay TMDL regulatory requirement will have to focus on those opportunities that provide the greatest pollutant load reduction at the lowest cost to taxpayers. The results of this paper will provide information for decision-makers to identify which sector (i.e., urban, agriculture, septic, and WWTPs) to allocate financial resources in order to make measurable progress towards achieving the pollutant reduction goals by the year 2020.

The State of Maryland WIP identifies the various sectors that are contributing pollutant loads to the Bay, which will require reductions within each sector in order to show measurable results. This paper will identify opportunities to reduce pollutant loads for each sector as discussed in Section 3.1. Of all the opportunities and strategies identified as described in Section 3.3, I anticipate WWTP upgrades would be the most cost-effective strategy to reduce pollutant loads, specifically nutrients including nitrogen and phosphorous. Although the upgrades would likely be the most costly to implement, they would likely provide the greatest reduction of nutrients per dollar. A cost-effectiveness analysis will be completed to compare the results of pollutant reductions per sector to the estimated cost to implement.

5 Schedule

1. Student submits draft proposal to Chair (December 15, 2010)
2. Field advisor prepares letter of support (January 2011)
3. Student submits final proposal and field advisor's letter of support to Chair (January 15, 2011)
4. Student completes review of TMDL and other pertinent information and writes corresponding section of paper (February 6, 2011)
5. Student prepares a pilot investigation to field advisor for review and comment (February 16, 2011)

6. Student completes identification and evaluation of pollutant reduction opportunities and writes corresponding section of paper (February 27, 2011)
7. Field advisor monitors student's progress (student provides status updates to mentor end-February)
8. Student completes pollutant reduction computations associated with stormwater management BMPs and writes corresponding section of paper (March 6, 2011)
9. Field advisor monitors student's progress (student provides status updates to mentor mid-March)
10. Student completes review of Carroll County's strategic plan and writes corresponding section of paper (March 13, 2011)
11. Student completes discussion of innovative financing opportunities and writes corresponding section of paper (March 27, 2011)
12. Field advisor monitors student's progress (student provides status updates to mentor April 1, 2011)
13. Draft report submitted to field advisor and Chair (April 15, 2011)
14. Field advisor and Chair submit comments to student (April 29, 2011)
15. Student submits final report to field advisor and Chair (May 7, 2011)

6 References

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