R:\Depts\Shared Data\HB 1141\WRE Document\WRE Documents Delivered to the State\Water Resources Element title page 6-14-10.doc

WATER RESOURCES ELEMENT

BALTIMORE COUNTY

MARYLAND

Draft presented to
Maryland Department of Planning
June 14, 2010

Executive Summary

Introduction

Developed in response to House Bill 1141, entitled *Land Use – Local Government Planning*, this Water Resources Element (WRE) will assist in protection and restoration of all water resources, including the Chesapeake Bay. The WRE is a thorough examination of all water resources in Baltimore County, Maryland. It includes public and private drinking water supplies, public and private wastewater disposal systems, and stormwater runoff from existing and proposed land uses. The intent of the analysis is to ensure safe and adequate supplies of drinking water, adequate facilities for wastewater disposal, protection of high quality natural resources, and a reduction *and cap* of pollutant loadings from point and non-point sources. Incorporated into the County's land use plan - *Master Plan 2020*, the WRE will inform policies and actions to be implemented over the next decade and beyond.

Growth

The population growth rate in Baltimore County is projected to slow, however, there still is an anticipated increase in the number of residents. Planning is crucial for any growth: it must be managed to protect natural resources, and assist in the restoration of degraded water bodies. Furthermore, responsible growth must be *sustainable*: the County must meet present and future needs, while preserving the environment and resources for future generations.

Drinking Water and Wastewater Disposal

Drinking water and wastewater disposal are either public or private systems. The public Baltimore Metropolitan Water Supply serves properties located "inside" the "Urban Rural Demarcation Line" (URDL), closest to Baltimore City. In a few growth-restricted areas, water and sewer is supplied due to public health issues related directly to preserving the quality of the Chesapeake Bay. The water system is supplied by 3 reservoirs located in Baltimore County, supplemented by the Susquehanna River. The public system providing wastewater treatment includes two large facilities and one smaller facility. Outside the URDL, there are private single homes, business well and septic systems, and multiple privately owned institutional, community and multi-use wastewater treatment facilities. For the most part in the rural areas, private water wells and on-site disposal systems are utilized. These public and private water supplies were examined to ensure they continue to be properly protected, and have an adequate supply to serve future populations. Pollutants discharged from all wastewater treatment facilities: public, private, community and individual systems, were analyzed to affirm they do not exceed permitted levels, accounting for the anticipated increase in the number of users.

Stormwater Runoff

The major contributor to pollution of our water bodies is how land is developed and used. Increased impervious surfaces from parking lots, driveways, houses and buildings, result in greater volumes of water runoff, eroding stream banks, and carrying nutrient-laden sediments and other contaminants. Agricultural uses, without benefit of *best management practices*, can cause similar effects, with additional contamination by inappropriate use of chemicals on crops. There is also considerable pollution from urban and suburban lawns. This Water Resources Element examines existing conditions of land uses, and determines current pollutant loadings. Based on projected population figures, and various proposed land use scenarios, future loadings are also calculated.

A Sustainable Plan

To meet the Total Maximum Daily Loads (TMDLs) required by state and federal regulations, the best future land use plan was selected from six (6) scenarios analyzed. As discussed in Chapter 5, it is demonstrated the future growth pattern allowing for the lowest pollutant loadings is a mix of high density mixed-use, revitalization of older neighborhoods with single-family homes and townhouses, including conversion of existing development to parks. Policies and actions to enable implementation of this land use pattern, preserving and protecting our high quality waters and resources in our rural areas, are proposed in this Water Resources Element. These policies and actions are further strengthened and enhanced throughout *Master Plan 2020*. The plan is based on a *sustainability framework* that will allow for appropriate development *and* redevelopment, while ensuring a brighter future for our citizens, and a cleaner, healthier natural environment. Baltimore County is strongly committed to improving the health of our local water bodies and the Chesapeake Bay.

FINAL DRAFT

Chapter 1 – Introduction

The 2006 Maryland General Assembly passed legislation (HB 1141) requiring the development of a Water Resources Element (WRE) as part of local government comprehensive plans (Master Plan). The purpose of the WRE is to compare planned growth and its impact on water resources. Specifically, three aspects of water resources are to be examined:

1. The adequacy of drinking water to support anticipated population growth,
2. The capability of waste water treatment to handle additional waste generated by the future population growth, particularly in light of discharge caps in Waste Water Treatment Plant (WWTP) permits established to meet nutrient reductions required to restore the health of the Chesapeake Bay, and
3. The impact of current and future development on stormwater runoff, especially related to the protection of high quality aquatic natural resources, and nutrient pollutant loads to local water bodies and the Chesapeake Bay.

This report provides the information needed to guide the formulation of policies and actions in a revised Master Plan that provides for adequate water and wastewater treatment for population growth, while ensuring watershed protection and restoration.

Chapter 2 contains information on anticipated population growth in Baltimore County. This chapter is supported by Technical Memo B, which gives additional detail on the calculation of population increases and its distribution in rural and urban portions and within individual watersheds in the County.

Chapter 3 assesses the adequacy of the public drinking water resources and public wastewater treatment to support the anticipated population increases over the next 25 years. Public water for Baltimore County is supplied by the Baltimore City distribution system, with the associated reservoirs located in the County. This drinking water system also delivers water to four other surrounding jurisdictions. Wastewater treatment is likewise shared with Baltimore City, which owns and manages the Back River and Patapsco WWTP's. Two other jurisdictions also depend on the Patapsco WWTP. Baltimore County owns and operates a small WWTP (Richlyn Manor). Appendices A-K support this chapter.

Chapter 4 assesses the adequacy of the individual private drinking water resources (wells) and private on-site disposal systems (OSDS) to handle future population growth. Consideration is given to the quantity and quality of the ground water as a drinking water supply, and the adequacy of OSDS.

Chapter 5 provides a comparison of the impacts of future development on urban stormwater nutrient loads and impervious surfaces utilizing three different growth scenarios. Technical Memos A-C, containing detailed information on existing water quality conditions, nutrient pollutant loads, and impervious surfaces, support this chapter.

FINAL DRAFT

Chapter 2 – Population Forecasts

Data analyses were derived from the Baltimore Metropolitan Council Round 7B population forecasts. The data was allocated to transportation analysis zones (TAZ) for two planning horizons, 2005 – 2020 and 2020 – 2035. These forecasts were compared with the most recent population changes available, 1997 – 2005. The historic population growth has reflected the County's successful Smart Growth policies to direct growth inside the Urban-Rural Demarcation Line (URDL), established in 1967. These growth management policies have proven effective: almost ninety percent (90%) of County residents live inside the URDL.

While not presented here, population forecasts were applied to the individual 8-digit watersheds to enable a more effective assessment of stormwater nutrient impacts on high quality aquatic resources. Details on the population analysis and results for individual watersheds are presented in Technical Memo B.

The table below shows information on recent population growth and forecasts, including the total and average annual changes in population.

Year	URDL	Population	Change	Annual Change
1997	Rural	72,000		
	Urban	650,000		
	Total	**722,000**		
2005	Rural	78,000	6,000	760
	Urban	711,000	61,000	7,600
	Total	**789,000**	**67,000**	**8,400**
2020	Rural	88,000	6,000	400
	Urban	759,000	51,000	3,400
	Total	**847,000**	**58,000**	**3,800**
2035	Rural	91,000	2,000	130
	Urban	775,000	15,000	1,000
	Total	**866,000**	**18,000**	**1,200**

The population growth rate in Baltimore County is projected to slow in the future. The County experienced an average annual increase of 8,400 people from 1997 to 2005. That rate is expected to decrease to 3,900 people per year in the near future, and to 1,200 per year between 2020 and 2035. This decrease, if realized, would relieve pressure on the water resources in the County. This growth needs to be managed to further protect high quality aquatic resources, and assist in the restoration of degraded water bodies.

FINAL DRAFT

Chapter 3 – Public Drinking Water and Wastewater Treatment Assessment

This documentation follows the "Water Resources Element Analytical Framework"[1] for organizing information about the public water supply and wastewater treatment facilities. This data is compiled with other point and non-point pollutant loading sources into the total pollutant loading discharging into the Chesapeake Bay attributable to Baltimore County. Using this figure, it can be determined whether the assimilative capacity of the Bay waters (as defined by State criteria) is exceeded. This confirms if the proposed land use plan (Master Plan 2020) is protective of water resources, and whether anticipated growth and planned land use patterns can be supported.

The Baltimore County Water Supply & Sewerage Plan 2007 Triennial Review[2], approved by the Maryland Department of the Environment[3] (MDE), provides the basic information for this analysis. Please refer to the description of the water supply in Chapter III of the Triennial Review. The sewer system is described in Chapter IV of the Triennial Review; however, figures concerning sewerage demand and flow are further examined in the following material. Population projections are brought up-to-date, and loading information then projected accordingly to see if the major wastewater treatment facilities are operating within the terms of their discharge permits, and will continue until 2035. The discharge permits issued to the Mayor and City Council of Baltimore for the Patapsco Wastewater Treatment Plant (WWTP)[4] and the Back River WWTP[5] specify maximum pollutant loadings at the permitted plant capacities. A separate discharge permit is issued to Baltimore County for the Richlyn Manor (WWTP)[6], and is considered a small community system separately from the major WWTP facilities, along with all other individual, community and multi-use facilities as listed in Table 10A of the 2007 Triennial Review.

The Municipal WWTP's serve other jurisdictions and must be adjusted to reflect only Baltimore County's portion of the pollutant discharge. This will be done in accordance with the governing Patapsco WWTP Memorandum of Understanding and flow figures[7] used to document billing between Baltimore County, Anne Arundel County, Howard County, and Baltimore Washington Thurgood Marshall (BWI) Airport. The Patapsco WWTP is capable of treating 73 Million Gallons per Day (MGD) [8] of wastewater under the terms of its permit. Baltimore City contributes 32% of this flow, with the remaining 68% coming from, or through[8] Baltimore

[1] See flowchart from MDP Models & Guidelines # 26
[2] See attached Triennial Review 2007 document
[3] See approval letter dated July 30, 2008
[4] State Discharge Permit Number 98-DP-0580 and NPDES Permit No. MD0021601, effective 7/1/05 and expiring 6/30/2010
[5] State Discharge Permit Number 01-DP-0581 and NPDES Permit No. MD0021555, effective 9/1/05 and expiring 8/31/2010
[6] NPDES Permit No. 0022713 (Table 10A, 2007 Triennial Review W&S Plan)
[7] See flow figures for 2004-2005, 2005-2006, 2006-2007 and 2007-2008
[8] Flow from Anne Arundel County, BWI airport and Howard County pass through Baltimore County and are received at the Patapsco WWTP.

County. The Back River WWTP is capable of treating 180[9] MGD, with the inflow of sewage evenly divided between the City and Baltimore County.

The projected sewer service is derived by multiplying the population estimates by the demand in gallons per capita per day (gpcd). Demand includes residential (90 gpcd), commercial, industrial, and infiltration/inflow estimates. The figures in the 2007 Triennial Review do not include reductions in infiltration/inflow due to system improvements resulting from the EPA consent decree[10]. Figures used in the table below were derived by the Sewer Design Section of the Department of Public Works Bureau of Engineering & Construction (BEC) and reflect the most recent flow figures[11]. In particular, the rehabilitation of the Patapsco Interceptor Sewer and the resulting reduction in infiltration & inflow are addressed. For the Back River WWTP, Table 9A of the Triennial Review of 2007 gives a figure of 165.7 gpcd, but the BEC estimates the figure as 143.5 gpcd. For the Patapsco WWTP, Table 9B gives 169.4 gpcd but the BEC estimates 137.1 gpcd, reducing to 127.8 gpcd in 2015 when the Patapsco Interceptor rehabilitation project is completed.

Although reductions in the gpcd figure due to the Patapsco Interceptor repairs are indicated above, further significant reductions are anticipated as various other sewer projects are identified and constructed under the requirements of the Consent Decree. The current studies involve extensive monitoring, flow metering and TV inspections of the sewer collection system. Once the existing conditions are evaluated, massive construction & repair projects will be completed. At present, it is not yet possible to establish the amount of reduction in gpcd each project will realize.

[9] NPDES Permit (page 4 footnote 6, 130 mgd for outfall 1; and page 6, footnote 4, 100 mgd for outfall 2, with the sum of the two outfalls not to exceed 180 mgd)
[10] See EPA consent decree document, attached.
[11] See figures for GPCD derived by Glen Keller, PE, Chief of the Sewer Design Section, DPW Bureau of Engineering and Construction, attached.

Baltimore County Population	2005	2010	2015	2020	2025	2030	2035
Total (Round 7B)[12]	788,662	815,755	833,828	846,189	856,150	861,416	864,590
Increase Factor 7B	1.000	1.034	1.057	1.073	1.086	1.092	1.096
Total (W&S Plan 2007 Triennial)[13]	793,846	820,524	832,881	841,137	841,411	848,494	850,302
Served by BCMD Public Water[14]	*648,700*	*685,900*	723,200	*762,850*	802,500	*807,436*	*810,411*
Total Public Water Demand (MGD)	*100.5*	*104.1*	107.6	*110.0*	112.3	*113.0*	*113.4*
Total Public Water Capacity[15]	113.4	113.4	113.4	113.4	113.4	113.4	113.4
Served by Patapsco WWTP	228,251	*236,012*	*241,261*	*244,913*	*247,881*	*249,250*	*250,163*
Patapsco Demand from Balto Co. MGD	Pop. x 137.1 = 31.3	Pop. x 137.1 = *32.4*	Pop. x 127.8 = *30.8*	Pop. x 127.8 = *31.3*	Pop. x 127.8 = *31.7*	Pop. x 127.8 = *31.9*	Pop. x 127.8 = *32.0*
Patapsco[16] Capacity for Balto. Co. MGD	33.9	33.9	33.9	37.8[17]	37.8	37.8	37.8
Served by Back River WWTP	421,971	*436,318*	*446,023*	*452,775*	*458,261*	*460,792*	*462,480*
Back River Demand from Balto. Co. MGD	Pop. x 143.5 = 60.6	*62.6*	*64.0*	*65.0*	*65.8*	*66.1*	*66.4*
Back River[18] Capacity for Balto. Co. MGD	50% of 180.0 = 90.0	90.0	90.0	90.0	90.0	90.0	90.0

Figures in italics are interpolated from the source document. Future projections are based on the same percentage of growth as in Round 7B figures.

Summary

Public Water Supply

[12] Provided by Balto. County Office of Planning
[13] See p. 39, Population Projections, 2007 Triennial Review
[14] Table 3, p.68, 2007 Triennial Review
[15] Proposed Fullerton Plant not included. This major treatment facility is expected to be in operation in or about 2020 and will provide an additional 120 mgd of treatment capacity to the overall water system.
[16] See Patapsco Memorandum of understanding (attached) and Bureau of Engineering and Construction notes, attached. See also Table 9B, p.115 2007 Triennial Review
[17] Capacity is expected to increase in 2020 when the ultimate permitted capacity of the Patapsco WWTP increases to 81 mgd.
[18] Table 9A, p. 114 2007 Triennial Review. Use NPDES permit capacity of 180 mgd instead of Table 9A 175 mgd

Based on population projections, reservoir capacities, and the additional source from the Susquehanna River, there will be adequate water to serve Baltimore County's citizens living within the URDL until at least 2035.

Public Sewer Service

All sewage flow figures projected out to 2035 fall within the limits of the existing NPDES permits for the wastewater treatment facilities. This maintains discharge of pollutants into the Bay within limits acceptable to the State. Discharge rates for specific pollutants allowed under the NPDES permits multiplied by the actual flow figures may be used to estimate discharge amounts of the various pollutants. These may be combined with other pollutant sources to develop overall pollutant loadings entering the Bay. As further explained in Chapter 5, analyses show that the land use plan to be selected will be capable of achieving reductions in overall pollutant loadings to the Chesapeake Bay, as determined by State and Federal requirements.

Appendices:

A WRE Flowchart
B Water Supply & Sewerage Plan Triennial Review 2007
C MDE Approval Letter for Triennial Review 2007
D Patapsco Wastewater Treatment Plant MDE/NPDES Discharge Permit
E Back River Wastewater Treatment Plant MDE/NPDES Discharge Permit
F Richlyn Manor Wastewater Treatment Plant MDE/NPDES Discharge Permit
G Patapsco Memorandum of Understanding
H Patapsco WWTP Flow Figures
I EPA Consent Decree
J EPA Consent Decree Appendix
K Sewer Design Section GPCD Demand Estimates for Patapsco and Back River

FINAL DRAFT

Chapter 4 – Private Drinking Water and Wastewater Assessment

Ground Water Supplies

Demand for groundwater by well users occurs mainly in the northern half of the county, outside the URDL. About 10% of the county's population, including approximately 30,000 households, businesses, and institutions rely on private wells for their water supplies.

Adequacy of Existing Ground Water Demands

Baltimore County consists of two physiographical provinces that are separated by the "Fall Line", which lies approximately parallel to Interstate 95 in Baltimore County. The Piedmont area is located north of the Fall Line, comprising 80% of the county. The Coastal Plain area lies to the south, and is served mainly by the Baltimore Metropolitan Water System.

Groundwater supplies in the Piedmont are generally sufficient to supply only domestic and moderate commercial demands because the yields from individual wells are relatively low, rarely exceeding 50 gallons per minute (GPM). Crystalline rocks, including schist, gneiss, gabbro (mafic rocks), granite and marble, contain the main aquifers. Groundwater generally occurs under water table conditions in the uppermost 250 feet of the rocks, and most wells and springs yield water from local recharge. The aquifers store groundwater in the more permeable zone of decomposed rock nearest to the land surface.

Well yields differ by geologic formation, and may vary substantially within localized areas. Median yields from major geologic formations were calculated from data from approximately 8,500 well records maintained by DEPRM (see Table 1.).

Table 1

Major Geologic Formations	**Well Yields**
Marble	Varies from 1- 500 GPM; median 10 GPM
Granite	Varies from 1- 100 GPM; median 10 GPM
Other Schists	Varies from 1- 100 GPM; median 8.5 GPM
Prettyboy Schist	Varies from 1-100 GPM; median 8.0 GPM
Gneiss	Varies from 1 - 100 GPM; median 8.3 GPM
Mafic and Ultramafic	Varies from 1 - 75 GPM; median 8.0 GPM
Loch Raven Schist	Varies from 1 - 100 GPM; median 4.1 GPM

Wells in the Loch Raven Schist, particularly the Chestnut Ridge and Jacksonville areas, are generally the lowest yielding wells in Baltimore County. For this reason the Loch Raven Schist (and Jones Falls Schist) are known as "Critical Water Areas", as defined in the Baltimore County Code 34-2-103(f).

The Coastal Plain areas contain relatively large quantities of groundwater in artesian or semi-artesian and water-table conditions. Well yields vary from a few gallons per minute to as much

as 1,000 GPM. The average yield is 200 GPM. Deposits of sand and gravel comprise the major aquifers, and are separated by relatively impervious confining layers of clay. Approximately 6% of all wells in Baltimore County are located in the Coastal Plain.

Currently there are eight (8) community water systems and twenty (20) Multi-Use Systems that are served by ground water supply wells and are not affiliated with the Baltimore Metropolitan Water System. All of these systems are located in the Piedmont. Water Supply Capacity Management Plans (WSCMP) are required to be completed for all systems utilizing more than 20,000 gallons per day (gpd). According to the Maryland Department of the Environment, Water Supply Program, only one (1) community system in Baltimore County (Sunnybrook) has submitted a WSCMP, for which no deficiencies were noted. Based on the Water Appropriation Permit information, there are four (4) Multi-Use Systems in Baltimore County utilizing greater than 20,000 gpd that have not completed a WSCMP. These include: Glen Meadows Retirement Community; Oldfields School; Stevenson University (formerly Villa Julie College); and Woodstock Job Corps.

There are no known water capacity issues or concerns for public water supplies served by ground water wells, with the exception of Manor Shopping Center in Jacksonville. This facility reported to DEPRM in 2006 that it regularly supplements its water demand by trucking water in from other areas due to low yields of their 5 on-site wells. Manor Shopping Center is reportedly exploring efforts to minimize their water usage and incorporate on-site stormwater infiltration.

In general, residents of rural Baltimore County have little difficulty attaining adequate water supplies for domestic use. However, there are instances where existing water supplies have diminished yields or "go dry". Since the early 1990s, DEPRM has tracked the number of, and reason why private water wells are replaced by property owners. A review of that data indicates that approximately 3% of the estimated 30,000 domestic wells were replaced due to reported yield problems from 1995 to 2004. However, 70% of these domestic wells with yield problems were constructed prior to 1980 when well regulations were changed to require more stringent construction and yield testing methods. These older wells are typically shallow, and therefore, more susceptible to drought and surface contamination. Not surprisingly, over 1/3 of the nearly 1,000 wells replaced from 1995-2004 were drilled in 2002 during arguably the worst drought in 50 years.

Another theory regarding diminishing well yields is that all bedrock wells eventually fail due to the accumulation of fine particles in the fractures that transmit water to the well, thereby clogging and slowing the flow of water to the well. If this is indeed the case, then perhaps a consideration should be made for additional future drilling locations on any lot to be served by an individual water supply. There have been instances in Baltimore County where replacement water supplies could not meet the minimum setback requirements, particularly for lots less than 2 acres in size. In these cases, owners must seek variances and, in some cases, have had to acquire easements on neighboring properties to attain adequate yield and/or water quality. In a study by Wang & Koepenick (2009) [19], a statistical analysis of the well data from Baltimore County indicated that well failures were strongly correlated with initial well yield and to a lesser degree

[19] A Statistical Analysis of Well Failures in Baltimore County: Journal of Data Science, Vol. 7, No. 1, Wang, X, and Koepenick, K. W., 2009

by geology type. The relatively high percentage of well failures in certain geology types (the gneiss, serpentine and Loch Raven Schist) may be another good reason to consider a requirement for a "well reserve area" during the building/subdivision process. While certainly not a guaranteed solution for water yield or quality problems, having an area protected from encroachment of development would give property owners a better chance of resolving any future problems that might arise with their water supply.

Adequacy of Future Ground Water Demands

With few exceptions, it is anticipated that the water supply capacity in the rural areas of Baltimore County will be available and sustainable for existing and future needs, assuming that we do not experience sustained drought conditions (i.e. several consecutive years of below normal precipitation). This assertion is based on scientific knowledge on occurrence of groundwater in the Piedmont region[20] and a number of safeguards that have been put into place to regulate rural development. These safeguards include:

1. The highest density allowed for residential subdivision of land in the rural areas (RC zoning) is 1 dwelling/acre. Using the Water Balance approach (i.e., the evaluation of ground water usage vs. natural recharge from precipitation), and assuming that the average family is not utilizing more than 300 gpd, it is highly unlikely that usage will exceed recharge for residential use.
2. Prior to issuance of a building permit, state law requires that domestic supply wells must yield at least 1 gallon per minute over a six-hour period and be able to supply 500 gallons over a two-hour time period.
3. County regulations require that new domestic water supplies maintain a separation of at least 100 feet from other domestic water supplies and potential sources of contamination. This distance provision minimizes the likelihood of influences between wells.
4. County regulations require that all wells be tested for yield and basic water quality parameters prior to transfer of properties served by individual water supplies. This periodic testing provides reasonable assurance that homeowners have a safe and adequate water supply, and that problem wells are replaced prior to new ownership.
5. Prior to approval of commercial development, it must be demonstrated that the proposed development is sustainable utilizing a Water Balance approach. Projected water usage, total lot size, and total impervious surfaces must be included in this analysis.
6. All commercial /institutional development utilizing ground water wells must obtain a Water Appropriations Permit from MDE. Any proposed usage over 10,000 gpd day will require a 72-hour pump test to demonstrate that the proposed ground water use is sustainable, and the proposed well will not impact existing water supplies.

[20] Ground-Water Occurrence in the Maryland Piedmont: Maryland Geological Survey Report No. 10, Nutter, L.J., and Otton, E.G., 1969.

Ground Water Quality

In 1995, Baltimore County contracted with the Maryland Geological Survey to conduct the first comprehensive study of Piedmont groundwater quality in Baltimore County[21]. Overall, ground water in rural Baltimore County was generally found to be of excellent quality for human consumption. Comparison with federal drinking water standards indicates that approximately 5% of the water supplies tested exceeded the maximum contaminant levels (MCLs) for nitrate; 71% had pH levels below the recommended range; 30 % had iron levels exceeding the recommended level, and 14 % exceeded the recommended levels for manganese. No pesticides were detected above MCLs, and 98% of all pesticides detected were at trace levels. Trace elements with known adverse health effects (arsenic, antimony, cadmium, and cyanide) were not detected at levels of concern.

The 1995 study did find that chloride levels in drinking water wells were elevated above background levels in roughly 10% of the 100 wells tested. Since there is no natural source of sodium chloride in the region, these elevated chloride levels are presumed to be from the application of road salts for de-icing. While there are a number of anthropogenic sources of chlorides other than road salt that could be contributing to the observed trends (brine from water softening systems, septic system effluent, fertilizers, and industrial discharges), the reported volumes of road salt applied each year by the state and county are far and away the largest source to the environment. The impacts to drinking water wells from chlorides are generally localized and depend on where storm water run-off is directed and how close the well is to the roadway. Despite efforts to better manage salting operations in recent years, there are numerous indications that the impact of road salts on the counties water resources is worsening.

Once applied, road salt or sodium chloride (the predominant form of salt used in Baltimore County) is easily dissolved with precipitation and may enter the ground water system by permeating surface soils, or discharge directly into streams via storm water run-off. Studies have shown that the sodium may become bound in subsurface soils, and gradually displaces calcium, magnesium and potassium from the soil into the ground water system (Kaushal ***et. al.***) [22]. However, chlorides move through the subsurface and into groundwater relatively unaffected by chemical or biological interaction. The United States Environmental Protection Agency (US EPA) has set a secondary maximum contaminant level (SMCL) for chlorides at 250 mg/l (parts per million (ppm)) in drinking water. An SMCL is a non-enforceable water quality standard that is recommended for aesthetic qualities such as taste and odor. While chlorides are not considered a concern for human health, they can impart a bitter taste in drinking water and increase corrosion of metal pipes and fixtures. Chlorides can also inhibit plant growth, and in high concentrations cause damage to root systems. In some cases, road salting has also resulted

[21] Ground-Water Quality in the Piedmont Region of Baltimore County, Maryland: Maryland Geological Survey Report of Investigations No. 66, Bolton, D.W., 1998. and Ground-Water Quality in the Piedmont Region of Baltimore County, Maryland: Comparison of Data Collected in 2000-01 to Data Collected in 1994-96: Supplemental Report No. S2/RI66, Bolton, D.W., 2002.

[22]Kaushal, S.S., Groffman, P.M., Likens, G.E., Belt, K.T., Stack, W.P., Kelly, V.R., Band, L.E., & Fisher, G.T. (2005) *Proc. Natl. Acad. Sci. USA* 102, 13517 – 13520.

in increase levels of sodium in drinking water supplies. Elevated levels of sodium is considered a health concern for individuals with high blood pressure, and the USEPA has set a health advisory of 20 mg/l for sodium in drinking water.

Baltimore County and the City of Baltimore have monitored salt concentrations from the drinking water reservoirs and streams leading to the reservoirs during base flow conditions (i.e. during dry weather). The data show a trend of increasing sodium and chloride levels that has more than doubled over the last 30 years. The health advisory threshold of 20 mg/l for sodium has actually been exceeded in the finished water in recent years. Of most concern is that while chloride levels in streams are observed to peak during the winter months (as expected), the streams are not returning to baseline levels during the summer. The chloride levels appear to be slowly accumulating in the groundwater and reservoir system. Even if salt application were ceased today, it would take decades for the chlorides to be flushed out of the freshwater system. For an in-depth discussion of chlorides and their environmental and health impacts, please see the report completed in December 2009 by the Baltimore County Advisory Committee on Environmental Quality (CEQ) at the following website:
http://www.baltimorecountymd.gov/Agencies/ceq/index.html

Another water quality concern for certain areas of Baltimore County is naturally occurring radium in ground water. In 2005, a follow-up water quality survey of wells in the Baltimore Gneiss and Setters Gneiss formations revealed elevated levels of gross alpha particle emissions and radium (a human carcinogen) were present in roughly 10% of the wells tested, potentially affecting about 3,000 residences. The areas of concern include Monkton, northern Phoenix, Sparks, Glencoe, Butler, and Woodstock. Radioactive elements such as uranium and radium are naturally occurring in the rock. Evaluation of the well construction data indicates no particular pattern in well depth, yield or age in wells with high gross alpha or radium concentrations. The occurrence of elevated concentrations of gross alpha and radium in ground water appears to be random within the gneiss formations and localized in various “hot spots.” The County recommends (and may require) that all potentially affected wells be tested for gross alpha and/or radium to minimize exposure. Water softeners have proven to be an effective removal technique for radium. For more detailed information on this topic, refer to DEPRM’s homeowner educational booklet:
http://www.baltimorecountymd.gov/Agencies/environment/groundwatermgt/educational.html

DEPRM tracks all known contamination cases and offers assistance to residents regarding the testing and treatment options that are available for their private water supplies. In addition, county regulations require that DEPRM personnel inspect the removal of all residential underground storage tanks to determine if contamination of the ground water has occurred. Over the last 10 years, DEPRM and Maryland Department of Environment (MDE) have investigated 40-50 new cases of ground water contamination in Baltimore County each year, most of which are within the URDL in areas served by public water. The handful of contamination cases that affect domestic supply wells in the rural areas tend to be isolated to one to three wells, and result from leaking residential or commercial fuel tanks, road salting storage and application, or improper disposal of chemicals into septic systems from residential and commercial land use. The notable exception to this was the 25,000-gallon release of fuel from the Exxon station in Jacksonville in 2006. As of 2010, approximately 10 domestic wells had treatments systems

installed, and remediation of the ground water is on-going. In addition, MDE has implemented more stringent construction, monitoring, and reporting requirement for all commercial underground storage tank facilities.

Summary

Based on population growth projections, and volumes of groundwater used for residential, commercial industrial and agricultural uses, and the average annual natural recharge of the aquifers, it is anticipated Baltimore County will continue to have an adequate supply of groundwater until 2035 and beyond. Furthermore, due to the groundwater protection programs managed by DEPRM, with support from state and federal agencies, the quality of groundwater will continue to be protected far into the future.

Private On-Site Sewage Disposal Systems (OSDS)

It is estimated there are approximately 30,000 existing OSDS in Baltimore County. Most of these systems (i.e., 99 %) consist of the traditional septic system design where wastewater flows by gravity from the building to a septic tank and effluent from the tank is directed to some type of subsurface infiltration facility (i.e., seepage pit or deep trench). In recent years, there has been an increasing number of innovative and alternative (I&A) OSDS installed to resolve septic system failures. These I&A OSDS often include the use of pre-treatment units, which may significantly reduce nitrogen from the OSDS effluent. However, ensuring that these systems are properly maintained in the long-term remains a concern.

Since the 1960s, the largest concentration of known OSDS failures in Baltimore County occurred within the Chesapeake Bay Critical Area (CBCA), in areas known as the Bowleys Quarters and Back River Neck peninsulas. However, beginning in the mid-1980s, Baltimore County began to address these problems comprehensively by extending public sewerage to these "non-service" areas as part of a "Health Project." To date, over 85% of the estimated 3,000 failing septic systems in those areas have been connected to the public sewerage system. It is estimated that there are approximately 400 OSDS remaining in the CBCA in Baltimore County, 100 of which are anticipated to be within existing or planned public sewerage service.

In northern Baltimore County, several older communities continue to experience OSDS failures due to limited areas for repair (small lot sizes), poor soils, and high water tables. These areas were developed prior to current zoning and environmental protection regulations (i.e., prior to 1970). These areas include the following: the old town of Phoenix, Baldwin, Freeland, Trenton and Kingsville. Because these problems involve a relatively small number of privately owned properties that are far from the metropolitan district, there is no straightforward mechanism or procedure to accomplish community-wide septic system corrections. Efforts to organize a Rural Sanitary District to resolve these types of problems were initiated in the early 1990s, but were ultimately put on hold due to complexity of establishing such a district, and the concerns for increased development as a result. A summary of the OSDS correction and management options available to the county is summarized in the 1999 report entitled "*Water & Sewer Service in Rural Baltimore County, MD*" and can be found on the web at the following link: http://www.baltimorecountymd.gov/Agencies/environment/groundwatermgt/educational.html

The impact of nitrogen loading from OSDS to the Chesapeake Bay has been debated for years. Estimates for OSDS contributions by tributary basins range from 3 - 19%. The Bay Restoration Fund (BRF) was established in 2004 to reduce nutrient loading to the bay. A portion of this fund is reserved for the capital cost of installing nitrogen removal units on OSDS. A subsequent modification to the BRF legislation made these de-nitrification units mandatory for all new OSDS and repairs to existing OSDS in the Chesapeake Bay Critical Area (CBCA) after October 1, 2009. There has also been legislation proposed to require de-nitrification units on all OSDS throughout the state.

An evaluation of the nitrogen loading from OSDS was conducted to determine the relative impact on the Bay. As detailed in Technical Memo B, Table B-13, the 2005 nitrogen load from OSDS is estimated to be 11.8% of the total. It should be noted that nitrogen loading from OSDS was calculated using the methodology cited in the MDP guidance document, which is considered to be a conservative method.

Under Development Scenario 1, the percentage of nitrogen from OSDS is projected to increase to 12.6% of the total by 2020, and to 12.8% of the total by 2035. However, considering treatment effects of the reservoirs themselves, the nitrogen from OSDS in Baltimore County that discharge into the Prettyboy, Loch Raven and Liberty reservoirs is being reduced by 99%, 89% and 95%, respectively. This nitrogen load reduction equates to a 46% reduction of total nitrogen actually reaching the bay from OSDS.

Of the remaining 11 watersheds, OSDS nitrogen loadings are projected to decrease anywhere from 1-10% by 2035 in 7 of the watersheds as a result of existing properties currently served by OSDS being connected to public sewerage. Only four watersheds (Deer Creek, Lower Gunpowder Falls, Little Gunpowder, and Jones Falls) are expected to have an increase of OSDS nitrogen loads over the next 25 years as a result of newly installed OSDS. However, these four watersheds only contribute approximately 25% of the 2005 nitrogen load, and growth in these areas is expected to be less than 10% over the next 25 years. It is also important to note that neither the streams nor reservoirs in Baltimore County are currently exceeding TMDLs for nitrogen.

Summary

This evaluation clearly demonstrates that the nitrogen loads to the bay from OSDS in Baltimore County are relatively small. Therefore, the contribution to nitrogen loadings from most OSDS to the overall TMDL in local water bodies and the Chesapeake Bay, now and until 2035 and beyond is negligible. Moreover, it can be argued that installing de-nitrification systems on existing OSDS would not be cost effective, with the exception of the CBCA (where they are already mandated), and instances where the nitrogen loads exceeding the TMDL can be directly linked to OSDS discharges. However, the use of de-nitrification units should continue to be used to resolve OSDS failures where lot size, soils, topography, and proximity to water resources restrict conventional corrections.

FINAL DRAFT

Chapter 5 - Stormwater Assessment

Introduction

The Maryland guidance document, *The Water Resources Element: Planning for Water Supply and Wastewater and Stormwater Management*, (MDP 2007) states:

> "The Stormwater Assessment component of the WRE is intended to inform the land use planning process by evaluating suitable receiving waters and land areas to include appropriate stormwater management treatment. It is also intended to ensure that the land use planning process is used as an effective nonpoint source pollution management instrument. This, in conjunction with the management of point source pollution, will help a jurisdiction achieve and maintain its water quality standards."

To achieve this goal, Baltimore County developed three land use scenarios to determine the effects of future development on receiving waters. The first scenario assesses development as it is currently occurring in Baltimore County. The second scenario places all of the future population growth within the Urban-Rural Demarcation Line (URDL). This scenario is considered the "Smart Growth" scenario, as it limits suburban sprawl and places all growth within the Priority Funding Area. The third scenario accommodates all future population growth through redevelopment. The "redevelopment scenario" considers four separate forms of redevelopment.

The stormwater assessment is supported by four technical documents that provide additional detail:

- Technical Memo A – Existing Water Quality Conditions: a summary of existing water quality data, use designations, high quality waters (Tier II) and trout, impairment listings, and Total Maximum Daily Load (TMDL) development status.
- Technical Memo B – Pollutant Loading Analysis: an analysis of current and projected phosphorus and nitrogen pollutant loads based on estimated population increases in 25 Water Quality Planning Areas (WQPAs). Three scenarios were analyzed for effect on future pollutant loadings: Scenario 1 – Development As Is, Scenario 2 - All Development within the Urban-Rural Demarcation Line, and Scenario 3 – All Redevelopment. In addition, the cost of meeting nutrient TMDLs is addressed.
- Technical Memo C – Impervious Cover Analysis: an analysis of the changes in impervious cover as a result of future population growth.

These three technical documents provide the framework for assessing the impact of differing development patterns on the ability of local waters to achieve and maintain water quality standards and protect natural resources.

The stormwater assessment needs to balance protecting natural resources and reducing nutrients to restore impacted receiving waters. The assessment as prescribed by the Water Resources Element takes both these factors (protecting high quality aquatic resources and reducing

nutrients) into account, but does not include other sources of impairment such as sediment, bacteria, toxics, metals, sodium, chlorides, and stream channel erosion that are often associated with urban development.

The County has a number of tools available to address the impacts of past and future development. The tools for addressing past impacts include water quality capital improvement projects, reforestation programs, public outreach programs, watershed planning, and coordination on environmental issues with environmental organizations and surrounding local jurisdictions. Future green field development, redevelopment, and revitalization development projects are subject to environmental regulations that serve to protect the County's natural resources. These regulations include stormwater management, sediment control, forest conservation, septic system and well location requirements, forest buffer regulations (protection of water quality, streams, wetlands, and floodplains), and Critical Area regulations.

The National Pollutant Discharge Elimination System – Municipal Separate Storm Sewer System (NPDES-MS4) Permit regulates the County response to stormwater issues related to urban development. The permit is issued on a 5-year cycle, with each permit more stringent than the previous one. Future permits are anticipated to include a greater emphasis on pollutant load reductions needed to meet various water quality standards, as defined in the development of Total Maximum Daily Loads (TMDLs).

This section of the Water Resources Element discusses the following:

1. The Federal and State regulatory framework,
2. Existing water quality conditions in the County's 8-digit watersheds and tidal water segments,
3. Pollutant load and impervious cover analysis results for the various land use scenarios,
4. The role of development regulations in the protection of water quality and natural resources,
5. Various tools used for the improvement of water quality as they relate to nutrients,
6. Recommendations for policies and actions related to protection of high quality natural resources,
7. And meeting water quality standards by guiding land use policies and actions in the Master Plan.

Regulatory Framework

Storm water effects must be analyzed in the context of regulatory drivers, the basis of which is the federal Clean Water Act, specifically the National Pollutant Discharge Elimination System – Municipal Separate Storm Sewer System Permit (NPDES – MS4 Permit) and Total Maximum Daily Loads (TMDLs).

NPDES – MS 4 Permit

Congress amended the Clean Water Act (CWA) in 1987 to address nonpoint source pollution. In response, the U.S. Environmental Protection Agency (US EPA) published regulations in 1990 to address discharges from municipal separate storm sewer systems. The EPA has delegated the NPDES – MS4 Permit program to the State of Maryland. Large and medium municipalities are regulated under the Phase I requirements, while smaller jurisdictions are regulated under the Phase II requirements. Baltimore County is a Phase I jurisdiction and has no smaller Phase II jurisdictions within it boundaries. The NPDES – MS4 Permit program began in 1991 with an extensive two-year application process.

The County now operates under its third permit with an expiration date of June 15, 2010. The current permit requires the development and maintenance of databases and Geographic Information System (GIS) data layers that relate to stormwater facilities, impervious surface cover, water quality monitoring, illegal discharges to the storm drain system, and grading permits. In addition, the permit requires:

1. Management Programs
    a. Stormwater Management: implement and maintain a stormwater management program.
    b. Stormwater Management Inspections: implement and maintain a stormwater management facility inspection program.
    c. Erosion and Sediment Control: implement an erosion and sediment control program and provide “responsible personnel” certification training.
    d. Illicit Discharge Detection and Elimination Program: continue to monitor storm drain outfalls and eliminate illicit discharges.
    e. County Property Management: identify County facilities that require a general industrial stormwater discharge permit, obtain the permit, and prepare pollution prevention plans.
    f. Road Maintenance: continue street sweeping and inlet cleaning programs; reduce use of roadside fertilizers and herbicides, control overuse of winter weather deicing materials.
    g. Public Education: develop a variety of education and outreach programs.
2. Watershed Assessment and Planning: Continue to develop watershed management plans with public participation and public implementation. Provide restoration for 20% of the County’s impervious area.

3. Assessment of Controls:
    h. Watershed Restoration Assessment: monitor water quality restoration within the Scotts Level Branch subwatershed.
    i. Assess the effectiveness of the Maryland 2000 Stormwater Design Manual on channel protection.

4. Provide adequate funding to comply with the conditions of the permit.

The activities associated with implementation of the permit conditions are summarized annually in a report submitted to MDE. The latest report for calendar year 2008 was submitted in June 2009. It can be found on the web at:
http://www.baltimorecountymd.gov/Agencies/environment/watersheds/epnpdesmain.html
It is anticipated that the next permit renewal will contain language requiring the development of TMDL Implementation Plans for each of the TMDLs for Baltimore County watersheds and tidal water segments.

Total Maximum Daily Loads (TMDL)

Total Maximum Daily Loads (TMDLs) must be developed for any substance that is identified as impairing a water body. The purpose of a TMDL is to establish the amount of an impairing substance or stressor that can be discharged to a water body and still maintain water quality standards. The pollution sources are identified and, through modeling, the loads are allocated among sources. The TMDL identifies how much pollutant reduction is needed to meet water quality standards.

The Maryland Department of the Environment (MDE) is responsible for determining whether water quality standards are being met. Those water bodies that do not meet water quality standards ,commonly known as the 303(d) list, ***(for more information see - http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/index.asp***) must have a TMDL developed. MDE also has the responsibility for developing the TMDLs. Each TMDL addresses a single pollutant or stressor for a water body. Impairment listings and TMDLs are typically based on the 8-digit watershed scale, tidal water segment, or an impoundment such as a reservoir. There may be multiple impairment listings and TMDLs for a single watershed, tidal segment, or impoundment.

Currently, there are no requirements regarding developing and implementing plans that address the reduction of impairing substances to meet TMDLs. As indicated above, that is anticipated to change in the next NPDES – MS4 Permit, where each individual permittee will be required to develop an Implementation Plan for each TMDL that occurs in the jurisdiction.

A TMDL is not only a reduction target, but also a cap. If future loads increase, from development or if a municipal WWTP exceeds its nutrient load allocation, then mechanisms need to be in place to offset the load increases.

Chesapeake Bay TMDL

The Chesapeake Bay TMDL is for the entire Chesapeake Bay and covers portions of six states and the District of Columbia. The Bay is impaired by nutrients and sediment that are responsible for low oxygen levels in portions of the Bay during warm weather periods, and for reducing water clarity. These two conditions in turn have a negative effect on the aquatic biological communities within the Bay.

The EPA – Chesapeake Bay Program is developing the Chesapeake Bay TMDL with an anticipated approval date of December 2010. A series of interconnected models are used to determine the nutrient and sediment loads delivered to the Bay and the effect of those pollutants. Once the models are completed, EPA will allocate the load reductions needed to meet water quality standards to each state. A preliminary allocation has been made for Maryland. The Phase 5 Watershed Model has the capability to model the nitrogen, phosphorus, and sediment sources to the 8-digit watersheds and at the county level (for more information see: http://www.chesapeakebay.net/model_phase5.aspx?menuitem=26169). Using this information, each state can decide how the needed reductions will be met and assign those reductions by source sector (point sources, agriculture, urban storm water). For those facilities that operate under a permit (municipal WWTP, industrial point sources, Confined Animal Feeding Operations (CAFOs) and NPDES – MS4 permits), the state may include reductions or discharge limitations within the permit. This has already been done for municipal WWTPs in Maryland.

Additional information and updates on the status of the Chesapeake Bay TMDL are available at: http://www.epa.gov/chesapeakebaytmdl/

Maryland Tributary Strategies

The Maryland Tributary Strategies define how the State of Maryland will meet the reductions in nutrients and sediment needed to meet water quality standards in each of ten tributary basins. The current Tributary Strategies will be superseded by two Watershed Implementation Plans being developed by the State in response to the new loading allocations from the Chesapeake Bay TMDL. The first draft Implementation Plan is due June 1, 2010 and will be based on a larger geographic scale. This plan is due to be approved with the TMDL in December 2010 after a period of public comment. The second draft Watershed Implementation Plan is due June 1, 2011 and will be based on a smaller geographic scale. The second plan may include allocations of nutrient and sediment reductions from the NPDES – MS4 jurisdictions.

In order to ensure implementation, each Watershed Implementation Plan will have two-year implementation milestones. Failure to meet the two-year milestones will result in implementation of back-up strategies and/or federal consequences. The intent of the two-year milestones is to ensure restoration progress and accountability. While the Chesapeake Bay Cabinet has identified 2025 as the target date to have all implementation in place, Maryland Governor O'Malley has committed to meeting the nutrient and sediment reductions by 2020.

Baltimore County watersheds are grouped into two of the Maryland Tributary Strategy Basins, the Upper Western Shore Basin and the Patapsco/Back River Basin. All of the Gunpowder River watersheds and Deer Creek are in the Upper Western Shore Tributary Basin, while all of the Patapsco watersheds and Back River are in the Patapsco/Back River Tributary Basin.

Water Quality in Local Streams and Tidal Waters

Baltimore County has exceptionally high value natural resources distributed mainly in the rural portion of the County, and areas with degradation of water resources. This section details the location of both good water indicators, and areas designated by the State as impaired for water quality. Technical Memo A provides additional information on the current water quality status of Baltimore County waters.

Baltimore County contains all or portions of fourteen 8-digit watersheds and portions of seven tidal water segments. These are presented in Figure 1. Because impairment listings are based on 8-digit watersheds and tidal segments, the analysis was conducted at that level. However, this summary report provides an analysis for the two Tributary Strategy Basins and for all of Baltimore County.

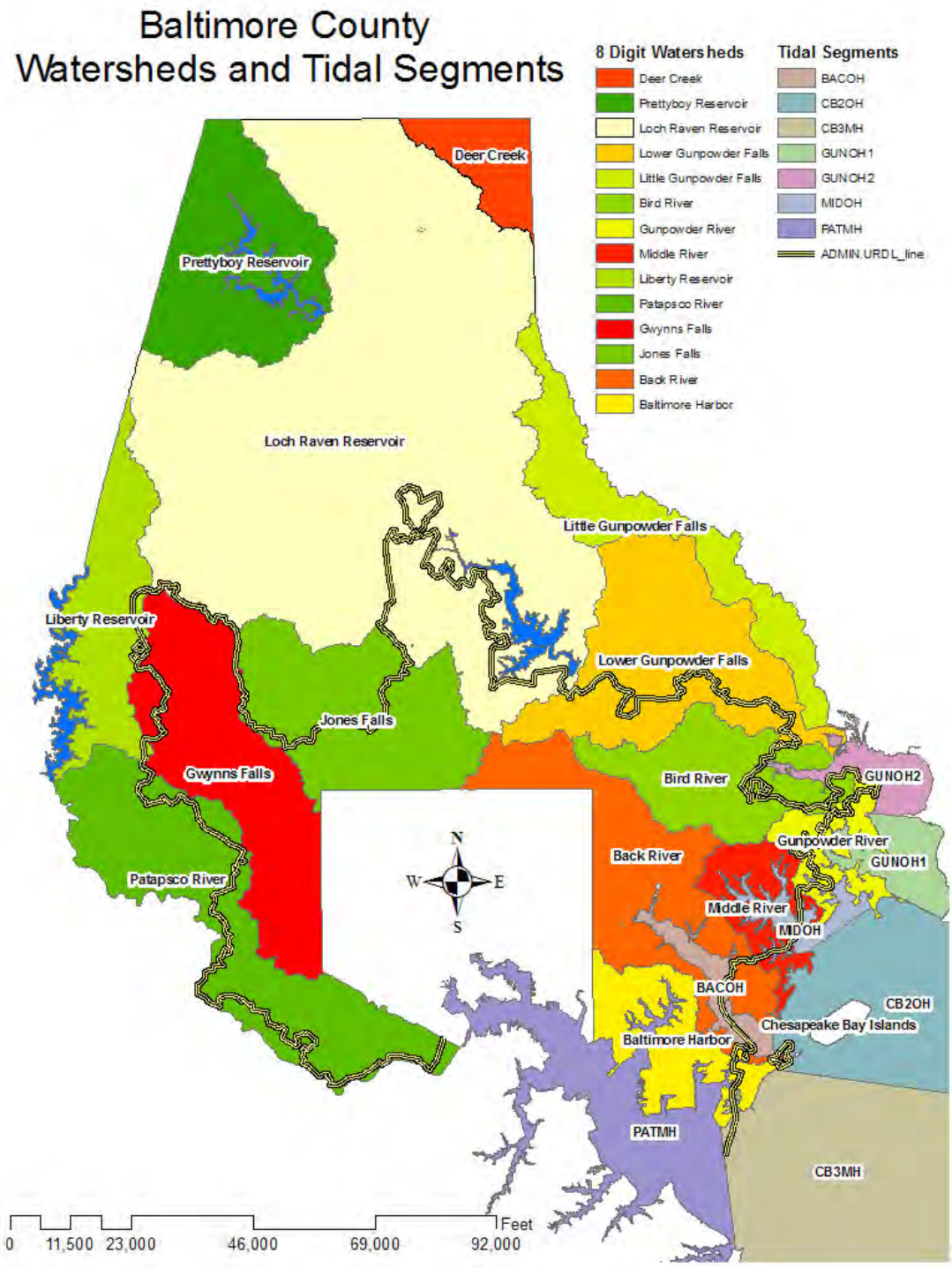


Figure 1 w imore Counw Wwersheds wnd Tidw Wwer Segmenws w

Use Class and Water Quality Standards

Water quality is regulated through three provisions:

- designated uses,
- numeric water quality standards for the designated uses, and
- antidegradation requirements.

Designated uses define an intended human and aquatic life goal for a water body. They take into account the attainable use for the water body, protection of aquatic communities and wildlife, use as a public water supply, and human uses such as recreational, agricultural, industrial, and navigation. Water quality standards have been developed to protect the Use Class designations. Waters that do not meet the water quality standards for a designated use are considered impaired and are placed on the 303(d) list of impaired waters. Total Maximum Daily Loads (TMDLs) are required to be developed for the substance that is impairing the waters.

Tier II waters are higher quality than the minimum specified for the designated use. These waters may be designated based on any water quality standard, but in current practice, they are designated based on benthic macroinvertebrate and fish community sampling conducted by Maryland Department of Natural Resources (DNR) through its Maryland Biological Stream Survey (MBSS) program. Tier II waters meet the anti-degradation requirements of the federal Clean Water Act.

Every stream, lake, reservoir, and tidal water body in Maryland has been assigned a Use designation. The Use designation is linked to specific water quality standards that will enable the Use of the water body to be met. A listing of the Use designations follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shell fish harvesting (not all subcategories apply to each tidal water segment)
    1. Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    2. Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    3. Open-water fish and shellfish subcategory (Chesapeake Bay only)
    4. Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    5. Seasonal deep-channel refuge use (Chesapeake Bay only)
    6. Shellfish harvesting subcategory
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

The letter P may follow any of the Use designations, if the surface waters are used for public water supply. There may be a mix of Use classes within a single 8-digit watershed; for example,

Gwynns Falls has Use I, Use III, and Use IV designations depending on the subwatershed. The use designations of the 8-digit watersheds and tidal segments are shown in Figure 2.

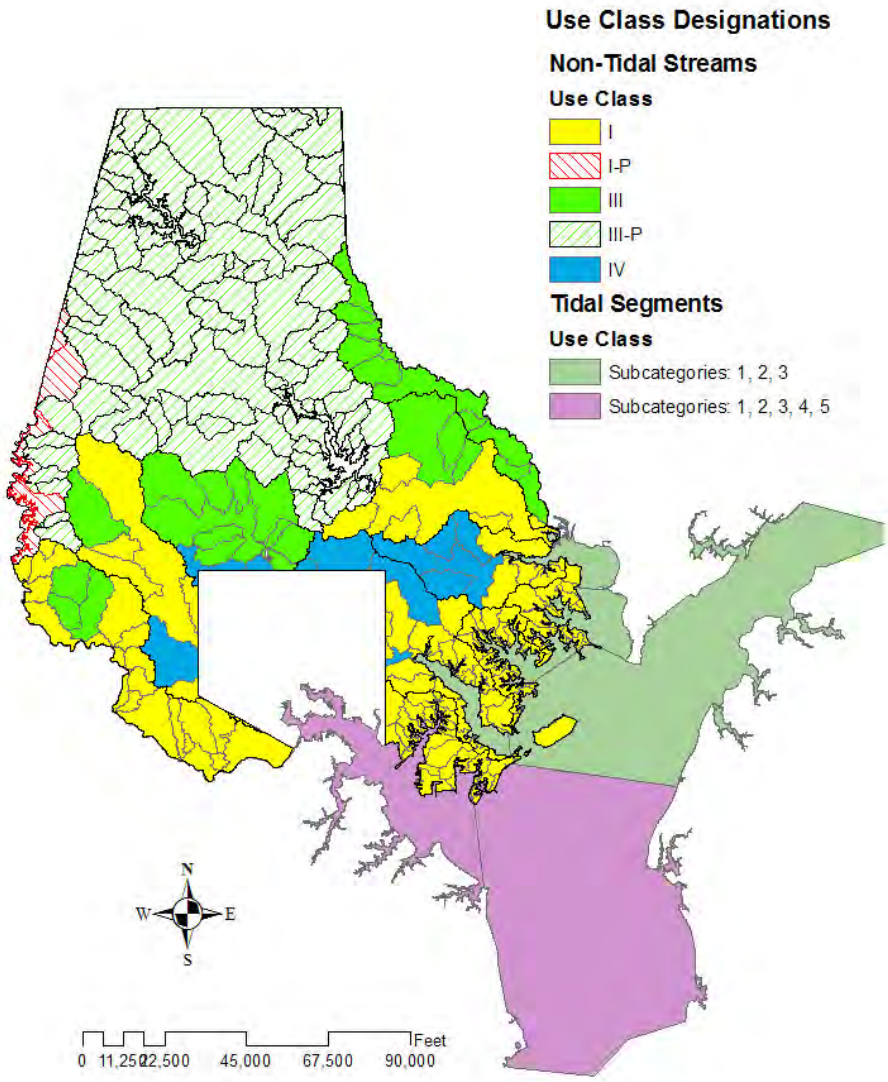


Figure 2: Use Designations for Baltimore County Watersheds and Tidal Segments

Tier II and Trout Waters

Tier II waters and trout resources indicate the presence of higher quality waters in need of extra protection. Figure 3 shows the location of designated Tier II waters, stream segments, and their drainage areas. This figure also shows the location of known trout resources.

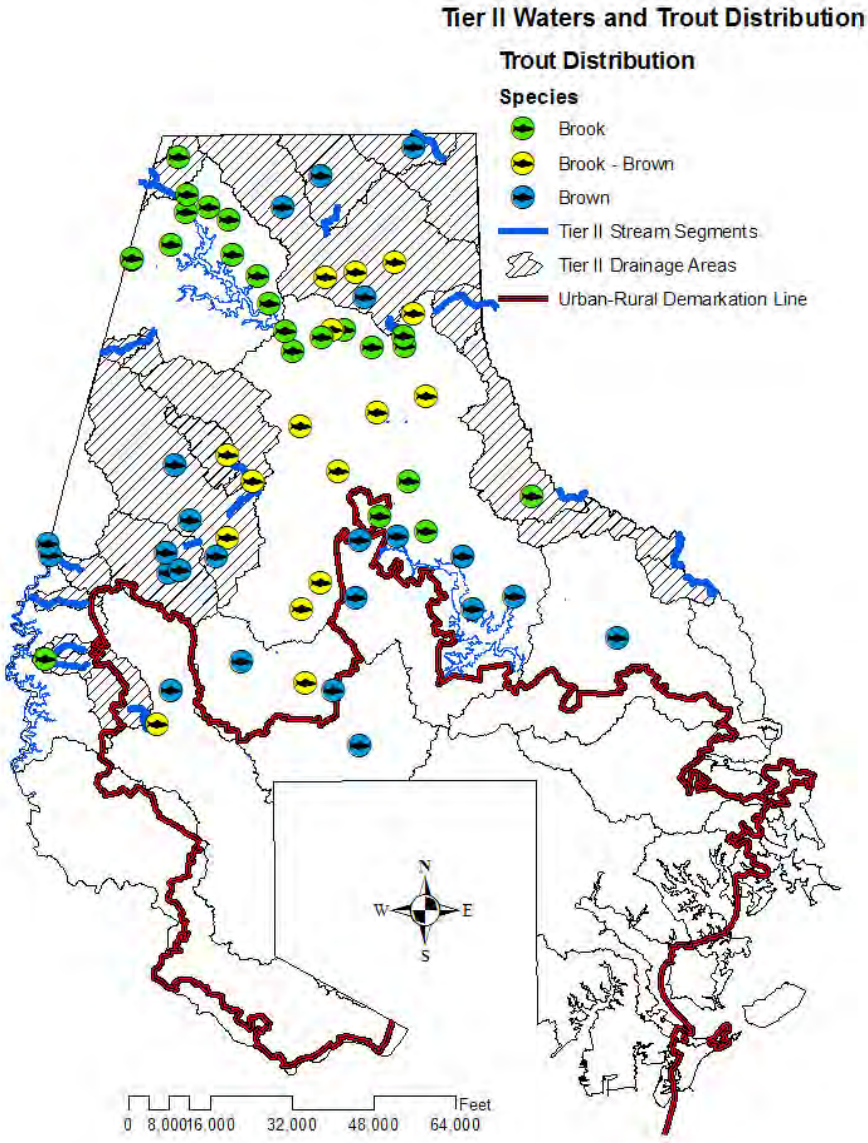


Figure 3: Tier II Waters and Known Trout Populations in Baltimore County

Overall, approximately 23% of Baltimore County drains to designated Tier II waters, where anti-degradation requirements apply. Trout are especially sensitive to impacts resulting from impervious cover, with few brook trout found in subwatersheds with greater than 3% impervious cover, and brown trout disappearing from subwatersheds with greater than 10% impervious

cover. The trout resources in Baltimore County are more widely dispersed than Tier II waters and may indicate that future monitoring by the MBSS program will result in additional designation of Tier II waters.

It is notable that the majority of Tier II waters and the location of trout resources occur outside the URDL; reflecting the lower impacts to the stream biological community that result from less urbanization. The one exception is Red Run in the Gwynns Falls watershed. This subwatershed is located in the Owings Mills designated growth area and has experienced considerable development in the past two decades. However, all of that development was subject to environmental regulations requiring considerable forest buffers associated with streams and stormwater management, which was located outside of the buffers. This suggests that it is possible to have development while maintaining the integrity of the aquatic ecosystem.

Water Quality Impairments

Impaired waters are listed in category 5 of the 303(d) list. The latest listing of impaired waters is found in *2008 Integrated Report of Surface Water Quality in Maryland* (MDE 2008). To view the report see: http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/2008_Final_303d_list.asp. These impaired waters require the development of a Total Maximum Daily Load (TMDL). A TMDL is the maximum amount of a pollutant that can be discharged to a water body while maintaining water quality standards. Table 1 indicates the impairment status of the Baltimore County 8-digit watersheds and tidal segments for five categories of impairments. Figure 4 presents the impairment status for four of the impairment categories (toxics mapping has been excluded).

The Water Resources Element requires consideration of the potential effects of nutrients from stormwater on impaired water bodies. Stream biological communities are generally not impaired by nutrients, at least until a stream reaches the size where phytoplankton are supported. Typically, the impairment occurs in the receiving water body (reservoirs, tidal waters). Thus, in recent years, many of the 8-digit watersheds previously listed as impaired by nutrients have been de-listed through Water Quality Analyses. The second column in Table 1 indicates the status of nutrient impairments of the 8-digit watersheds and tidal water bodies in Baltimore County. Each of the three reservoirs (Prettyboy, Loch Raven, and Liberty) is listed as impaired, with Prettyboy and Loch Raven having TMDLs developed for phosphorus (P) (nitrogen (N) was not an impairing substance). Five 8-digit watersheds are listed as having a TMDL for nutrients. These TMDLs are actually related to the tidal water bodies to which they drain. Thus, the TMDLs for the Patapsco River, Gwynns Falls, Jones Falls, and Baltimore Harbor watersheds are related to the necessary nitrogen and phosphorus reductions needed to meet water quality standards in the Baltimore Harbor tidal segment (PATMH), while the Back River TMDL is related to the Back River tidal segment (BACOH). The tidal segment nutrient and sediment impairments will be addressed by the Chesapeake Bay TMDL, currently being developed by the U.S. Environmental Protection Agency – Chesapeake Bay Program Office.

Twenty-one TMDLs have been developed for watersheds within Baltimore County. Two watersheds, Deer Creek and Little Gunpowder Falls, have no impairments. These two watersheds also have a high percentage of their drainage area designated as Tier II waters.

Table 1: Watershed and Tidal Segment Impairment Listings and TMDLs Completed

Watershed / Tidal Segment	Nutrients	Bacteria	Sediment	Biological Community	Toxics
Deer Creek	Not Impaired	Not Impaired	Not Impaired	Not Impaired	Not Impaired
Prettyboy Reservoir	TMDL – P	TMDL	Not Impaired	Not Impaired	TMDL - Mercury
Loch Raven Reservoir	TMDL – P	TMDL	TMDL	Impaired	TMDL - Mercury
Lower Gunpowder Falls	Impaired	Not Impaired	Not Impaired	Impaired	Not Impaired
Little Gunpowder Falls	Not Impaired*	Not Impaired	Not Impaired	Not Impaired	Not Impaired
Bird River	Not Impaired	Not Impaired	Not Impaired	Insufficient Information	Not Impaired
Gunpowder River	Not Impaired	Not Impaired	Not Impaired	Insufficient Information	Not Impaired
Middle River	Not Impaired	Not Impaired	Not Impaired	Insufficient Information	Not Impaired
Liberty Reservoir	Impaired (reservoir)	TMDL	Impaired	Impaired	TMDL – Mercury – Pending
Patapsco River	TMDL – P, N#	TMDL	TMDL – Pending	Impaired	Impaired – PCBs
Gwynns Falls	TMDL – P, N#	TMDL	TMDL – Pending	Impaired	Not Impaired
Jones Falls	TMDL – P, N#	TMDL	TMDL	Impaired	TMDL – Chlordane – Lake Roland Impaired - PCBs
Back River	TMDL – P, N#	TMDL – Herring Run	Not Impaired	Impaired	Not Impaired
Baltimore Harbor	TMDL – P, N#	Not Impaired	Not Impaired	Impaired	Not Impaired
GUNOH2	Impaired	Not Impaired	Not Impaired	Not Impaired	Impaired – PCBs
GUNOH1	Impaired	Not Impaired	Not Impaired	Not Impaired	Impaired – PCBs
MIDOH	Impaired	Not Impaired	Impaired	Not Impaired	Impaired – PCBs
CB2OH	Impaired	Not Impaired	Not Impaired	Not Impaired	Not Impaired
BACOH	TMDL – P, N	Not Impaired	Impaired	Insufficient Information	TMDL – Chlordane Impaired – PCBs
PATMH	TMDL – P, N	Not Impaired	Impaired	Impaired	TMDL – Chlordane Impaired – PCBs
CB3MH	Impaired	Not Impaired	Impaired	Impaired	Not Impaired

* A Water Quality Analysis (WQA) for nutrients in Little Gunpowder Falls was submitted to EPA in January 2009: acceptance pending.

\# The TMDL for nutrients is based on the receiving tidal water body. WQAs have been submitted for nutrients for Patapsco River, Gwynns Falls, and Jones Falls

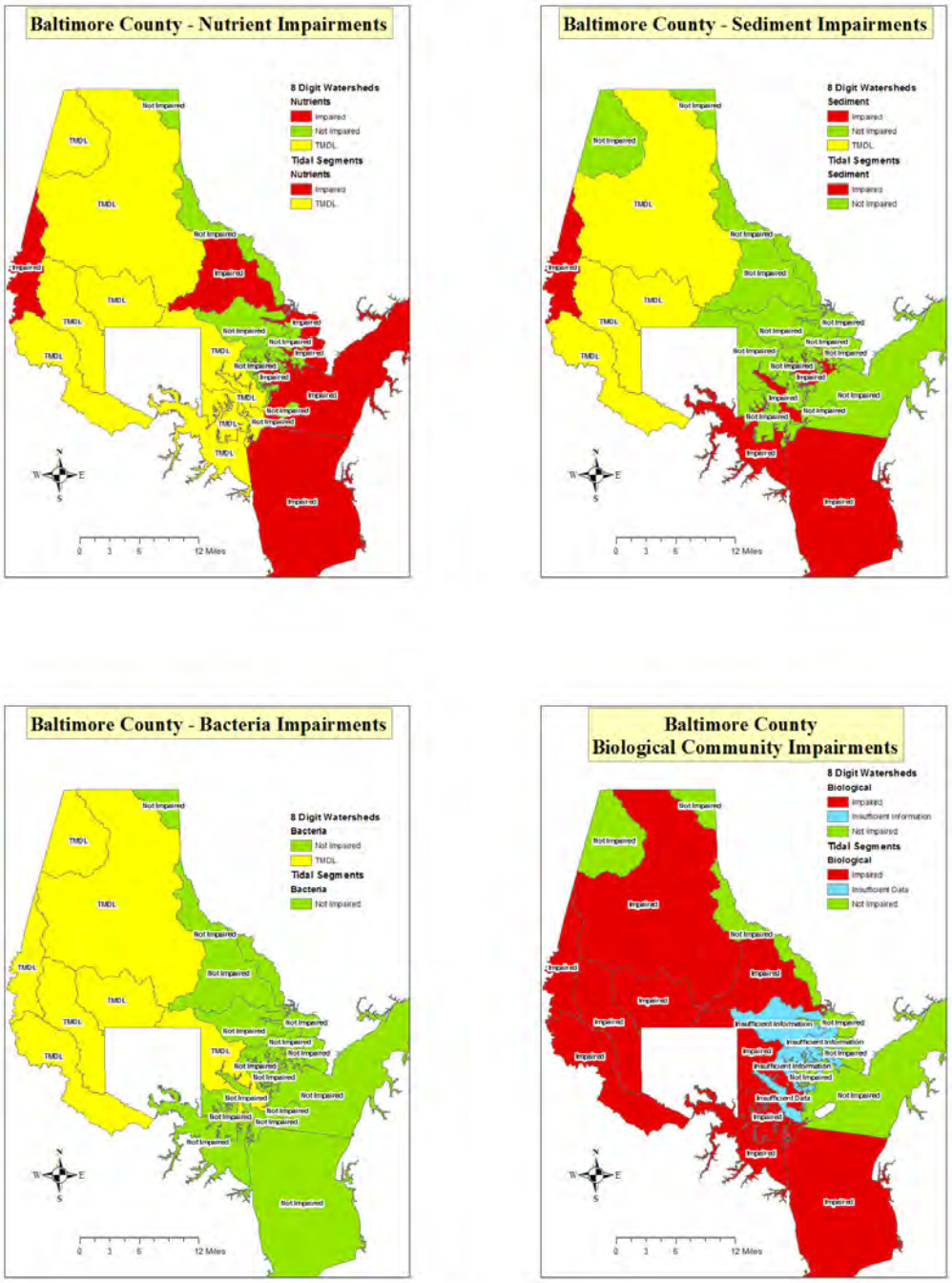


Figure 4: Watershed and Tidal Segment Impairments for Nutrients, Sediments, Biology and Biological Community

The analysis of future development and its relationship to the land use plan takes into account both nutrient impairments and protection of high quality natural resources.

Land Use Scenarios and Future Nutrient Loads and Impervious Cover

To assess the impact of future development on nitrogen and phosphorus loads and changes in impervious cover, six different land use scenarios were analyzed:

- Scenario 1: Future development patterns continue based on past development patterns with Environmental Site Design applied.
- Scenario 2: Future development is directed entirely to areas within the URDL with Environmental Site Design applied.
- Scenario 3: Future development is directed entirely to redevelopment sites. There are four subcategories of redevelopment:
    - a) Future redevelopment follows the recent pattern of redevelopment with some sites gaining residential units and some sites losing residential units. This subcategory is designated as "high" due to the need for a larger amount of land to accommodate the projected population increase.
    - b) Future redevelopment follows the pattern of higher density development, with only those recent sites resulting in an increase in residential units used in the analysis. This subcategory is designated as "low" due to the need for a smaller amount of land to accommodate the projected population increase.
    - c) Future redevelopment follows the recent pattern of redevelopment and includes parks as part of the redevelopment scenario. The parks can be used to address urban water quality through the incorporation of retrofits in the park design. This subcategory is designated as "high/park".
    - d) Future redevelopment results in higher density residential units and includes parks as part of the redevelopment scenario, as above. This subcategory is designated as "low/park".

The ultimate objective of the analysis is to find the land use growth-pattern that results in a "no net increase" in pollutant loads and, if possible, to develop a land use growth pattern that results in water quality improvement. The detailed methodology and results for the nutrient analysis is presented in Technical Memo D. The results of the impervious cover analysis are detailed in Technical Memo C.

Nutrient Loading Analysis

The nutrient loading analysis has two primary goals: to assess the change in nutrient loads for different land use development scenarios, and to assess those load changes relative to existing and anticipated nutrient Total Maximum Daily Loads. The existing nutrient TMDLs require a 15% reduction of phosphorus and nitrogen from urban land uses for five watersheds. Two watersheds will require a 50% phosphorus reduction, but the implementation scenario has a 15% reduction for urban land uses. Therefore, the 15% urban nutrient reduction was used as a

measure Countywide. The Chesapeake Bay TMDL for nutrients has not yet indicated the urban nutrient reduction, but the document produced by the U.S. EPA in response to President Obama's Chesapeake Bay Executive Order (May 12, 2009), indicates that the reduction may be as high as 36% (EPA, November 2009, page 24, Table 2). Both of these reduction targets were used in the analysis. See http://executiveorder.chesapeakebay.net/ for more detail on the Executive Order and the resulting documents.

The details of the methodology to determine the pollutant load changes resulting from the differing future development scenarios are presented in Technical Memo B. A brief overview is presented here. The analysis used the development pattern from 1997 – 2005 to estimate future changes in land use based on the projected population growth between 2005 and 2020, and between 2020 and 2035. For greater detail, the analysis was conducted at the 8-digit watershed scale, and for areas inside and outside the URDL. This resulted in an analysis of loads for 25 separate Water Quality Planning Areas (WQPAs) shown in Figure 5.

The methodology also takes into account existing water quality restoration efforts, and projects those efforts forward to determine whether nitrogen and phosphorus reductions will be adequate to meet the 15% and 36% load reductions by 2020. To assess the additional financial resources necessary, the cost per pound of removal was determined using the cost of the restoration projects completed to date and the pounds of nitrogen and phosphorus removed. The results of this analysis are presented for the Tributary Strategy Basins and for Baltimore County as a whole. Results for the individual watersheds are presented in Technical Memo B, and Appendix A, and watershed profiles and specific issues for each watershed are presented -in Technical Memo D.

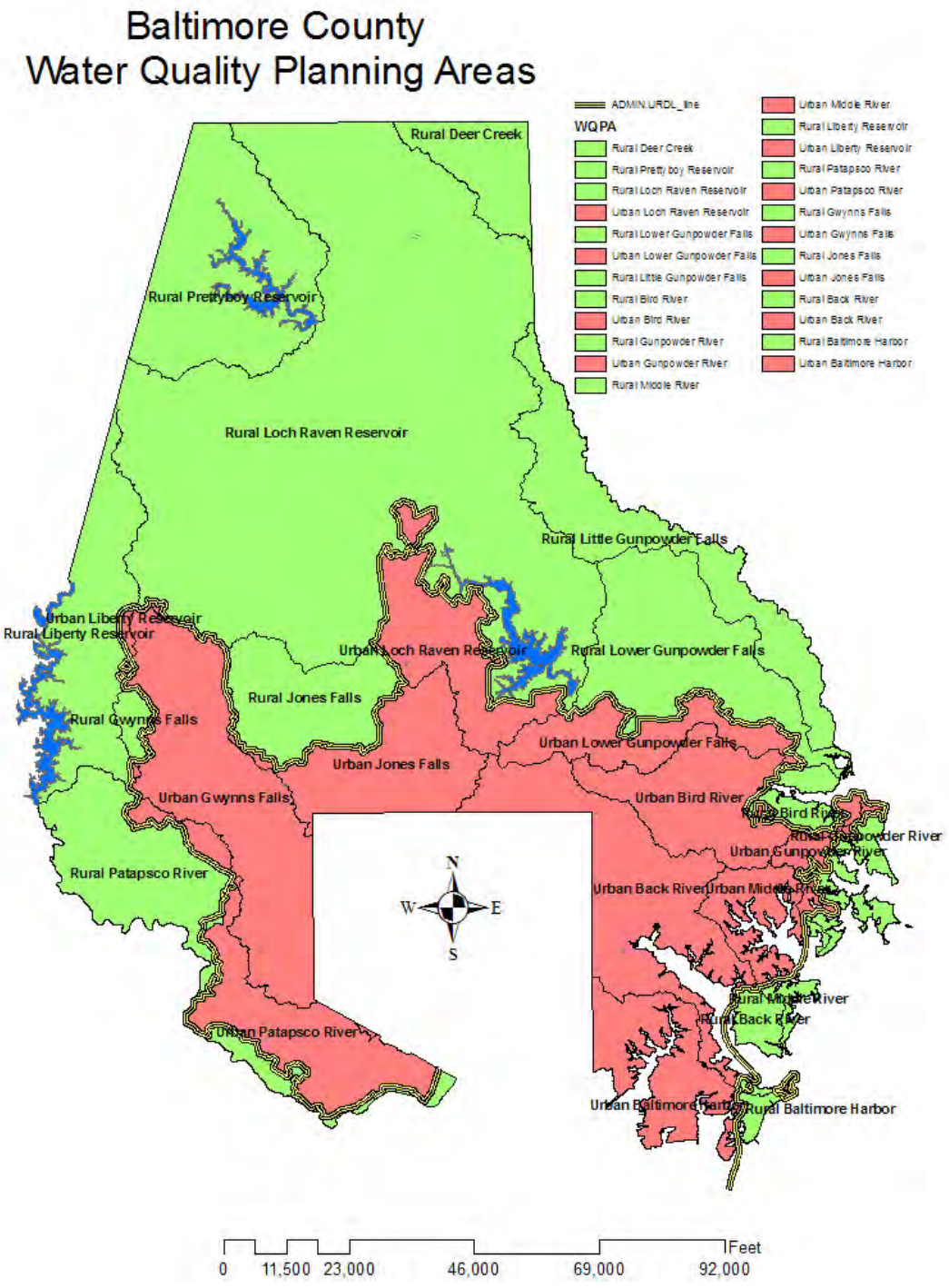


Figure 5w Wwer Qu i y Rv nning Arews (WQPAs) w

Scenario Land Use Changes

Table 2 presents the results of the analysis of the population and land use changes between 1997 and 2005. This information is based on Countywide changes in population and associated land uses.

Table 2: Per Capita Effects of Adding New Residents in Rural Areas Compared to Urban Areas

Impervious Acres	0.233	0.059	4:1
Pervious Acres	1.57	0.06	26:1
Pounds of Phosphorus*	1.14	0.18	6:1
Pounds of Nitrogen*	14.2	1.4	10:1

* Does not account for land use change effects

Table 2 demonstrates the effect of sprawl development, with higher land consumption, impervious area creation, and nutrient load generation per new resident for rural development compared to development within the URDL. The ratios in the last column clearly indicate that regardless of category, development in rural areas has more adverse effect than development in urban areas. The analysis above, however, does not take into account the land use change that results from new development.

In order to predict future land use change in response to anticipated population growth, the 1997 –2005 data were used to calculate land use change per new resident within each WQPA. This calculation included not only the increase in urban pervious and impervious areas, but also the change in agricultural and forestland uses.

Land Use Change

Scenario 1: The land use change expected if current development patterns continue is shown in Table 3.

Table 3: Scenario 1 - Land Use Change in Acres, 2005 – 2020 and 2020 – 2035

	5,110	17,379	22,489	1,492	4,935	6,427
	5,770	2,226	7,996	1,674	614	2,288
	-7,228	-547	-7,775	-2,109	-123	-2,232
	1,482	-1,669	-187	441	-496	-55
	1,444	34,221	35,665	529	11,396	11,925
	3,188	3,770	6,958	1,302	1,444	2,746
	-2,072	-1,206	-3,278	-771	-126	-897
	-1,053	-2,322	-3,375	-506	-1,292	-1,798
	All of Baltimore County					
Population Increase	6,554	51,600	58,154	2,021	16,331	18,352
Urban	8,958	5,996	14,954	2,976	2,058	5,034
Agriculture	-9,300	-1,753	-11,053	-2,879	-249	-3,128
Forest	429	-3,991	-3,562	-65	-1,788	-1,853

On a Countywide basis, an additional 11,000 acres of agricultural land and an additional 3,600 acres of forest would be lost by 2020. The majority of the forest loss would occur within the URDL. Agriculture exhibits the reverse pattern, with more loss in the rural areas than the urban areas. This is a result of little agricultural land remaining within the urban area, so new development would necessarily impact the remaining forest. There is also a difference in pattern between the two Tributary Strategy Basins, with the Patapsco/Back River experiencing forest loss in the rural area, while the Upper Western Shore may experience a gain in forest.

Scenario 2: For Scenario 2, population growth is accommodated inside the URDL, resulting in no future land use change in the rural areas. Table 4 presents the land use change resulting from this scenario.

Table 4: Scenario 2 - Land Use Change in Acres, 2005 – 2020 and 2020 – 2035

	0	22,489	22,489	0	6,427	6,427
	0	2,714	2,714	0	755	755
	0	-577	-577	0	-133	-133
	0	-2,142	-2,142	0	-635	-635
	0	35,665	35,665	0	11,925	11,925
	0	3,904	3,904	0	1,498	1,498
	0	-1,265	-1,265	0	-126	-126
	0	-2,390	-2,390	0	-1,348	-1,348
	All of Baltimore County					
Population Increase	0	58,154	58,154	0	18,352	18,352
Urban	0	6,618	6,618	0	2,253	2,253
Agriculture	0	-1,842	-1,842	0	-259	-259
Forest	0	-4,533	-4,533	0	-1,983	-1,983

In Scenario 2, much less agricultural land would be lost (1,800 acres versus 11,000 acres), but more forestland would be lost (4,500 acres versus 3,600 acres). In addition, many fewer acres of developed land (6,600 acres versus 15,000 acres) would be required to accommodate the same population increase. From a land use perspective, the main draw back would be the potential loss of additional forest.

Scenario 3: As described above, the redevelopment scenario is actually four separate scenarios. Table 5 summarizes the differences between the redevelopment scenarios. However, the land use effect is the same regardless of redevelopment scenario, in that there would be no land use changes in either the rural or urban areas of the county. Each of the redevelopment scenarios would utilize existing urban land to accommodate the population growth. Thus, redevelopment would be the most desirable approach for maintaining both agricultural and forest resources.

Table 5: Description of the Redevelopment Scenarios

Redevelopment Scenario #	Type of Redevelopment
3a	Future redevelopment would consist of a mix of high-density mixed use development and revitalization projects of older neighborhoods with single family homes and townhouses.
3b	Future redevelopment would consist of only high-density mixed use projects.
3c	Future redevelopment would consist of a mix of high-density mixed use development and revitalization projects of older neighborhoods with single family homes and townhouses and the inclusion of projects that convert existing development to parks where additional water quality can be obtained.
3d	Future redevelopment would consist of only high-density mixed use projects and the inclusion projects that convert existing development to parks where additional water quality can be obtained.

Each redevelopment sub-scenario would require differing amounts of redevelopment acreage to accommodate the anticipated population growth. Table 6 presents the acreage needed for each redevelopment scenario and the percentage of urban land within the URDL that would need to be redeveloped.

Table 6: Scenario 3 – Acres of Redevelopment Needed to Accommodate Population Growth - 2005 – 2020 and 2020 – 2035 for Each Redevelopment Scenario

	22,489		6,427	
	2,631	9.2	752	2.6
	270	0.9	77	0.3
	3,036	10.7	868	3.0
	472	1.7	135	0.5
	35,665		11,925	
	4,173	5.8	1,395	2.0
	428	0.6	143	0.2
	4,815	6.7	1,610	2.3
	749	1.0	250	0.3
	All of Baltimore County			
Population Increase	58,154		18,352	
3a	6,804	6.8	2,147	2.1
3b	698	0.7	220	0.2
3c	7,851	7.9	2,478	2.5
3d	1,221	1.2	385	0.4

Pollutant Load Analysis

The pollutant analysis for Scenarios 1 and 2 was based on the anticipated land use changes resulting from population growth. The per acre pollutant loading used for nitrogen and phosphorus was based on two sources. For the urban land uses, the Chesapeake Bay Watershed Model – Phase 5.2 was used, while the pollutant loading for the balance of the land uses was based on the guidance provided by MDE specifically for the WRE analysis. The MDE pollutant loading rates assume implementation of the Tributary Strategies. The Chesapeake Bay Watershed Model pollutant loading rates do not include the reduction effects of stormwater management facilities or restoration efforts. This allowed Baltimore County to use local data on stormwater management and restoration efforts to anticipate future nutrient pollutant loads with the implementation of the new Environmental Site Design (ESD) requirements effective May 4, 2010. It also allowed Baltimore County to assess its restoration efforts in light of nutrient

TMDLs and the anticipated Chesapeake Bay TMDL, and the ability of those restoration efforts to meet the TMDL reduction requirements.

For the redevelopment scenarios, recent projects were used to assess both the ability to absorb population growth and the nutrient reduction achieved through those redevelopment projects. Technical Memo B provides further details on the nutrient loading calculations.

For each scenario, the analysis was conducted by WQPA. Other than Scenario 1, there were no changes in nutrient pollutant loads in the rural sector of the County. After calculation of the change in pollutant loads due to the land use changes associated with Scenario 1 and 2, the nutrient load reduction due to implementation of ESD storm water management was calculated using the Chesapeake Bay Program ESD reduction factors for phosphorus and nitrogen. The reduction factor for phosphorus is 60% and for nitrogen is 50%. For the redevelopment scenarios, nitrogen and phosphorus reductions were based on recent redevelopment projects in Baltimore County. For phosphorus, the reduction factor was 23% for redevelopment Scenarios 3a and 3b, and 55% for redevelopment Scenarios 3c and 3d. For nitrogen, the reduction factor for redevelopment Scenarios 3a and 3b was 25%, and for 3c and 3d the reduction factor was 59%. See matrix below:

Redevelopment Scenario	Percent Nitrogen Reduction	Percent Phosphorus Reduction
3a	25%	23%
3b	25%	23%
3c	59%	55%
3d	59%	55%

The average annual nitrogen and phosphorus reductions due to capital restoration projects were estimated based on County projects completed between 1997 and 2005. This average annual rate was then projected forward to 2020 and 2035. The average annual nutrient reduction was also estimated for reforestation using data from the County's Community Reforestation Program, and also projected forward to 2020 and 2035. Pollutant removal due to street sweeping and watershed association restoration activities was estimated using data from the Baltimore County 2009 NPDES Annual Report. (http://www.baltimorecountymd.gov/Agencies/environment/watersheds/epnpdesmain.html). The overall nutrient reduction from these restoration efforts was then subtracted from the pollutant load.

The resulting final load for phosphorus is shown in Table 7 for each scenario. The final loads for nitrogen are shown in Table 8. The tables show rural, urban, and total loads for the Upper Western Shore Tributary Strategy Basin, the Patapsco/Back River Tributary Basin, and all of Baltimore County. In each table, the lowest loads in 2020 and 2035 are highlighted to indicate the scenario that provides the greatest benefit in terms of reductions in nutrient pollutant loads.

Table 7: Calculated Total Phosphorus Loads for 2020 and 2035 Based on the Scenario Analysis

Scenario	2020			2035		
	Rural	Urban	Total	Rural	Urban	Total
	Upper Western Shore					
1	78,085	24,209	102,294	76,900	20,591	97,492
2	82,003	24,489	106,491	81,976	20,954	102,930
3a	82,003	22,528	104,531	81,976	18,415	100,391
3b	82,003	23,191	105,194	81,976	19,267	101,243
3c	82,003	21,230	103,232	81,976	16,745	98,721
3d	82,003	22,950	104,953	81,976	18,957	100,933
	Patapsco/Back River					
1	17,691	63,189	80,879	17,410	58,401	75,811
2	18,446	63,199	81,645	18,426	58,434	76,860
3a	18,446	60,703	79,149	18,426	54,717	73,142
3b	18,446	61,754	80,200	18,426	56,119	74,544
3c	18,446	58,643	77,089	18,426	51,968	70,394
3d	18,446	61,371	79,817	18,426	55,608	74,034
	All Baltimore County					
1	95,776	87,397	183,173	94,311	78,992	173,302
2	100,449	87,687	188,136	100,402	79,388	179,789
3a	100,449	83,231	183,680	100,402	73,131	173,533
3b	100,449	84,945	185,394	100,402	75,386	175,787
3c	100,449	79,873	180,322	100,402	68,713	169,114
3d	100,449	84,321	184,770	100,402	74,565	174,967

In the case of phosphorus, redevelopment Scenario 3c provides the most benefit in Patapsco/Back River Tributary Strategy Basin and Baltimore County as a whole. While for the Upper Western Shore Tributary Strategy Basin, Scenario 1 (development as we are current doing it) provides most benefit for phosphorus reduction. This result is primarily due to the conversion of agricultural land with higher phosphorus loading rates to developed urban land with lower phosphorus loading rates. The Upper Western Shore Tributary Basin also had a smaller projected loss of forest than the Patapsco/Back River Tributary Basin.

Scenario 2 (directing all future development inside the URDL) is the worst scenario for phosphorus reduction. This is due primarily to the loss of forest resulting from projected future development. There is little agricultural land remaining within the URDL. In order to accommodate the future population growth, additional forest would be converted to developed land.

Table 8: Calculated Total Nitrogen Loads for 2020 and 2035 Based on the Scenario Analysis

Scenario	2020			2035		
	Rural	Urban	Total	Rural	Urban	Total
	Upper Western Shore					
1	1,676,583	291,365	1,967,949	1,644,709	246,192	1,890,900
2	1,778,046	292,666	2,070,712	1,777,663	247,892	2,025,555
3a	1,778,046	274,466	2,052,513	1,777,663	227,920	2,005,583
3b	1,778,046	280,488	2,058,534	1,777,663	235,662	2,013,326
3c	1,778,046	262,905	2,040,951	1,777,663	213,055	1,990,718
3d	1,778,046	278,334	2,056,380	1,777,663	232,893	2,010,556
	Patapsco/Back River					
1	375,496	710,635	1,086,131	369,511	681,469	1,050,981
2	391,958	710,293	1,102,251	391,665	681,140	1,072,805
3a	391,958	689,032	1,080,990	391,665	653,604	1,045,269
3b	391,958	698,581	1,090,539	391,665	666,346	1,058,011
3c	391,958	670,697	1,062,655	391,665	629,139	1,020,804
3d	391,958	695,165	1,087,123	391,665	661,788	1,053,453
	All Baltimore County					
1	2,052,079	1,002,001	3,054,079	2,014,220	927,661	2,941,881
2	2,170,004	1,002,959	3,172,963	2,169,328	929,032	3,098,360
3a	2,170,004	963,498	3,133,502	2,169,328	881,524	3,050,852
3b	2,170,004	979,069	3,149,073	2,169,328	902,009	3,071,337
3c	2,170,004	933,602	3,103,606	2,169,328	842,194	3,011,522
3d	2,170,004	973,499	3,143,503	2,169,328	894,681	3,064,009

For nitrogen load reduction, Scenario 1 provides the most reduction for the Upper Western Shore Tributary Basin and for Baltimore County as a whole, in both the 2020 and 2035 time frames. Redevelopment Scenario 3c performs the best for nitrogen reduction in the Patapsco/Back River Tributary Basin, and is second best for the other tributary basin and Baltimore County as a whole. The factors affecting this outcome are the same as with phosphorus. Scenario 1 has a greater conversion of high nitrogen load agricultural land uses to lower nitrogen load developed land use. This is true even with the septic system nitrogen loads included in the developed land nitrogen load.

Meeting Nutrient TMDLs and Costs

In assessing the ability of the various scenarios to meet nutrient TMDLs, only the urban stormwater component was considered. Maryland has a schedule for point source improvements in meeting nutrient TMDLs. The analysis included full implementation of Tributary Strategies for nutrient reduction of agricultural loads. The target load reductions used in the assessment were a 15% reduction and a 36% reduction for both nitrogen and phosphorus. The 15% reduction is based on existing nutrient TMDLs for local waters in Baltimore County that call for that level of restoration from urban stormwater sources within the "assurances of implementation" section of each TMDL. The 36% reduction is based on the potential for the

Chesapeake Bay nutrient TMDL to require that level of reduction effort for urban stormwater. The 36% is uncertain, and may be lower depending on local contributing factors. For example, the tidal water segments in the Upper Western Shore Tributary Basin are almost meeting water quality standards, while the Patapsco/Back River Tributary Basin is far from the standards. The final determination of the nutrient load allocations for Baltimore County will be made by the State, and are not expected until the end of 2010 or early 2011.

The target date selected for meeting the TMDL reductions was 2020. This is based on a commitment by the State of Maryland to meet the Chesapeake Bay TMDL by 2020. This should provide an aggressive estimate of potential additional funding needed to meet the TMDL reduction requirements for urban stormwater nutrient loads.

The 1997 nitrogen and phosphorus urban loads were used to determine the amount of nutrient reduction needed. This is the baseline for the local TMDLs that have been developed to date.

The cost analysis was based on the Baltimore County Waterway Improvement Program restoration actions. For this analysis, it was assumed that future restoration actions would incorporate the same types of restoration activities (shoreline enhancement, water quality retrofits, stream restoration) and in the same relative proportion as has occurred to date. The nitrogen and phosphorus reductions were calculated, along with the cost of the restoration. From this data, the costs per pound of removal for nitrogen and phosphorus were derived. The capital costs for the removal of a pound of phosphorus is $8,889 and for a pound of nitrogen $1,108. This analysis does not include the salaries of staff for project oversight or the expenses of future inspection, maintenance, and land acquisition.

Figure 6 shows the progress made in phosphorus reduction relative to the two TMDL reduction targets, while Figure 7 displays the same information for nitrogen.

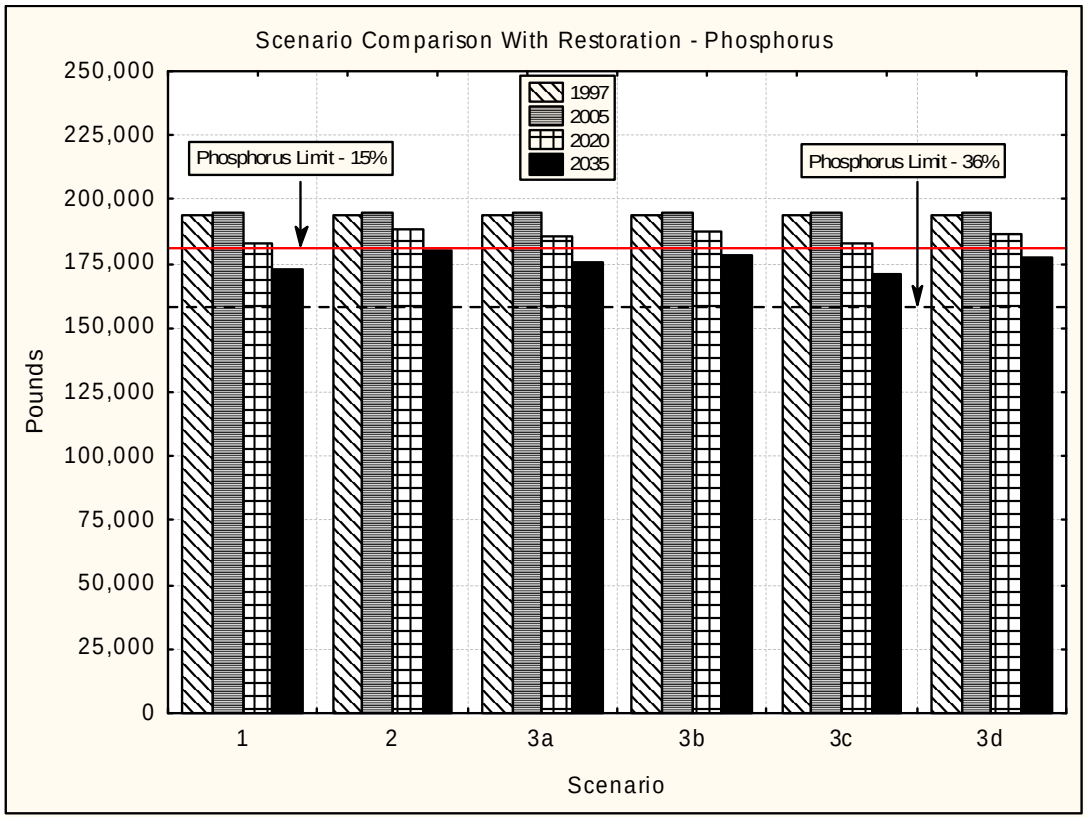


Figure 6 Phosphorus Loads Relative to TMDL Reduction Targets

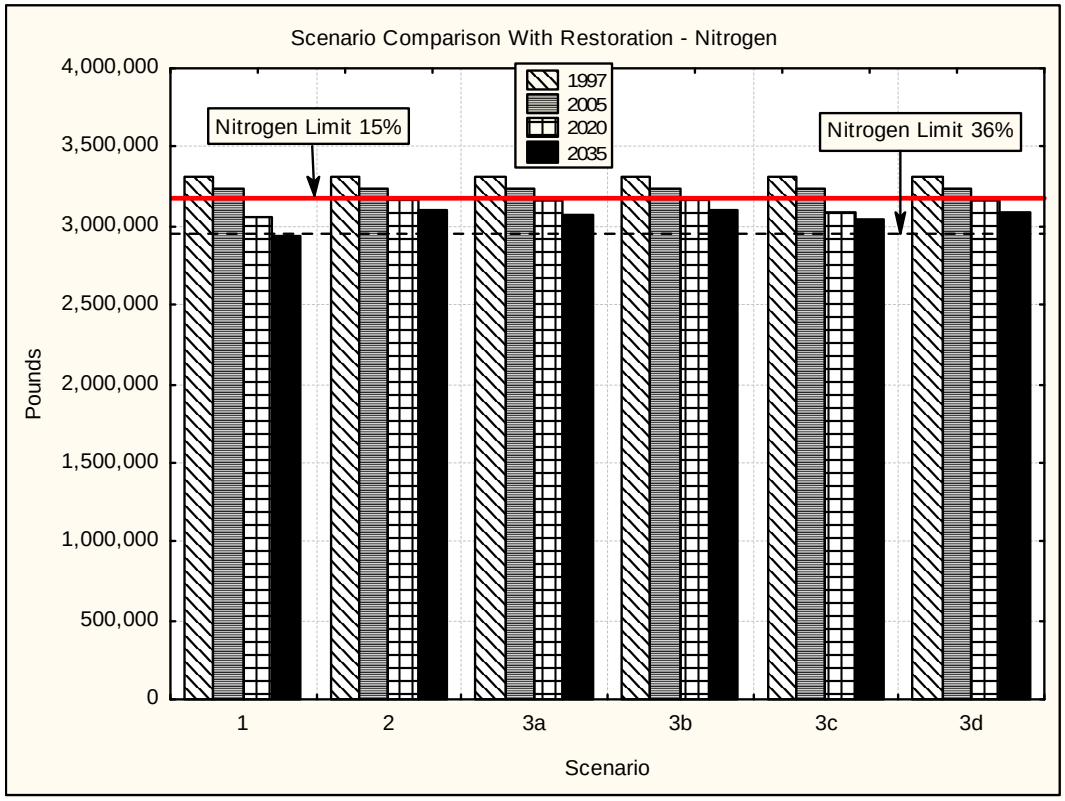


Figure 7 Nitrogen Loads Relative to TMDL Reduction Targets

Figure 6 indicates that only Scenario 3c would come close to meeting the phosphorus reduction target for a 15% reduction by 2020. All of the scenarios would meet the 15% reduction target by 2035. The 36% phosphorus reduction target cannot be met by any of the scenarios for either the 2020 or 2035 time frames without additional funding for capital restoration.

Figure 7 indicates that the 15% nitrogen reduction target could be met by implementing any of the land development scenarios within the 2020 time frame. The 36% nitrogen reduction target cannot be met by any of the scenarios by 2020, but Scenario 1 would result in meeting the 36% reduction target by 2035.

The analysis of additional capital cost needed to meet the phosphorus and nitrogen reduction targets is presented in Tables 9 and 10, respectively. The lowest additional capital needs are highlighted in each table for both the 15% and the 36% reduction.

Table 9: 2020 Progress in Meeting Phosphorus TMDL Reduction and Additional Capital Funding Needed (Pounds)

Scenario	Reduction		Target Load		2020 Load	Difference		Costs (x 1,000)	
	15%	36%	15%	36%		15%	36%	15%	36%
1	16,020	38,448	180,652	158,224	183,173	2,521	24,949	$22,409	$221,772
2	16,020	38,448	180,652	158,224	188,136	7,484	29,912	$66,525	$265,888
3a	16,020	38,448	180,652	158,224	183,680	3,028	25,812	$26,918	$226,279
3b	16,020	38,448	180,652	158,224	185,394	4,742	27,525	$42,148	$241,509
3c	16,020	38,448	180,652	158,224	180,322	-330	22,453	$0	$196,423
3d	16,020	38,448	180,652	158,224	184,770	4,118	26,902	$36,605	$235,965

Table 10: 2020 Progress in Meeting Nitrogen TMDL Reduction and Additional Capital Funding Needed (Pounds x 1,000)

Scenario	Reduction		Target Load		2020 Load	Difference		Costs (x 1,000)	
	15%	36%	15%	36%		15%	36%	15%	36%
1	161.5	387,6	3,180.6	2,954.5	3,054.1	-126.5	99.6	$0	$110,357
2	161.5	387,6	3,180.6	2,954.5	3,173.0	-7.6	218.5	$0	$242,098
3a	161.5	387,6	3,180.6	2,954.5	3,133.5	-47.1	179.0	$0	$198,321
3b	161.5	387,6	3,180.6	2,954.5	3,149.1	-31.5	194.6	$0	$215,573
3c	161.5	387,6	3,180.6	2,954.5	3,070.8	-77.0	149.1	$0	$165,196
3d	161.5	387,6	3,180.6	2,954.5	3,138.4	-37.1	189.0	$0	$209,402

For meeting the phosphorus reduction targets, redevelopment Scenario 3c would result in the least amount of additional funding needed. The 15% reduction target can be met with only an additional $222,000. An additional $200 million would be needed over a 10-year period ($20 million/year) to meet a 36% phosphorus reduction using redevelopment Scenario 3c. Nitrogen will require no additional funding to meet the 15% reduction target regardless of which land development scenario is considered. However, to meet a 36% nitrogen reduction, an additional $110 million would be required if development continues as it has in the past (Scenario 1). For Scenario 3c, the cost would be an additional $128 million. Since the Scenario 3c costs for meeting the 36% nitrogen reduction target is less than the cost to meet the phosphorus 36% reduction target, Scenario 3c would also meet the nitrogen reduction requirements while addressing phosphorus.

Summary

The most effective future development scenario in terms of protection for the high value resources, and reducing nutrient pollution, is the redevelopment Scenario 3c. This scenario provides the most cost effective means of meeting nutrient TMDL reductions overall. However, this scenario requires the most amount of land for redevelopment, requiring redevelopment of approximately 8% of urban land use within the URDL by 2020. In order to fully assess the applicability of Scenario 3c or any of the other redevelopment scenarios, additional analyses must be conducted to determine the barriers to redevelopment versus greenfield development, and what can be done to overcome those barriers. This assessment should be conducted through the development of a countywide redevelopment plan that includes most of the county agencies. This would assure that all issues related to redevelopment on a regional basis are addressed.

Impervious Cover Analysis

Technical Memo C includes a full discussion on the effects of impervious cover on habitat, aquatic biological communities, and water chemistry. In general, impervious surfaces have been found to be detrimental to the aquatic ecosystem, causing stream bank erosion and changing hydrologic regime, increasing concentrations of metals and other pollutants, increasing temperature, and contributing to the loss of trout populations.

Baltimore County has developed two GIS data layers for impervious surface coverage based on aerial photography from two different time periods. The initial data layer was based on orthophotography taken in the 1995-1997 timeframe, while the second data layer was based on orthophotography taken in 2005. These data layers do not include sidewalks, or driveways less than 200 feet in length.

Using the Water Quality Planning Areas (WQPAs), the impervious surface for each of the 25 planning areas was determined by overlays for the 1997 and the 2005 timeframes. This permitted a separate analysis for changes in the rural areas of watersheds versus changes in the urban areas. Typically, the rural areas contain the majority of Tier II waters (Red Run in Gwynns Falls is an exception) and the majority of known trout populations.

In order to estimate future impervious cover based on predicted population growth, the change in impervious cover during the 1997 – 2005 timeframe was divided by the change in population during the same time period for each of the WQPAs. The result was an impervious cover acreage change per person added to the population. In cases where there was negative population growth, the average for the basin and the appropriate area (rural or urban) was substituted.

As detailed in Technical Memo B, the future population growth was determined for each WQPA and for two time periods, 2005 - 2020 and 2020 - 2035. This projected growth was multiplied by the acres of impervious surface per person to determine the increase in impervious cover for each WQPA. This analysis was conducted for both Scenario 1 where future development will occur throughout the County in the same way as in the past, and Scenario 2 where future development will all be directed inside the URDL. The redevelopment scenarios were not considered in the

impervious cover analysis, as they will be located on already developed sites, where an overall change in impervious cover may not occur. The results of the analysis are displayed in Table 11 and Figure 8.

By forcing the population growth inside the URDL, there would be ~1,660 acres less impervious cover in the rural areas in 2020, and ~2,275 acres less in 2035. Conversely, the urban WQPAs would have ~350 acres more impervious cover in 2020 and ~450 acres more in 2035. Overall, with the same population growth, Scenario 2 – All Future Development Within the URDL, would result in ~1,300 acres less impervious countywide in 2020 and ~1,700 acres less impervious cover in 2035. Scenario 3 – Redevelopment Scenario, would result in little change in impervious cover, and therefore, would have ~4,500 impervious cover acres less than Scenario 2, and ~6,250 impervious cover acres less than Scenario 1.

Table 11: Scenario 1 and Scenario 2 – Changes in Impervious Cover

	2020			2035		
	Rural	**Urban**	**Total**	**Rural**	**Urban**	**Total**
	Upper Western Shore					
	Scenario 1 – Development As Is					
Acres	7,850	10,492	18,342	8,197	10,864	19,061
Percent	3.8%	24.5%	7.4%	4.0%	25.3%	7.7%
	Scenario 2 – All Development Inside the URDL					
Acres	6,667	10,790	17,456	6,667	11,428	17,915
Percent	3.3%	25.1%	7.0%	3.3%	26.2%	7.2%
	Scenario 2 minus Scenario 1					
Acres	-1,183	298	-885	-1,531	385	-1,146
	Patapsco Back River					
	Scenario 1 – Development As Is					
Acres	2,661	24,630	27,291	2,826	25,295	28,120
Percent	5.1%	28.1%	19.5%	5.4%	28.8%	20.1%
	Scenario 2 – All Development Inside the URDL					
Acres	2,183	24,683	26,865	2,183	25,366	27,549
Percent	4.2%	28.1%	19.2%	4.2%	28.9%	19.7%
	Scenario 2 minus Scenario 1					
Acres	-478	52	-426	-643	71	-572
	All Baltimore County					
	Scenario 1 – Development As Is					
Acres	11,142	34,942	46,084	11,788	35,865	47,653
Percent	4.3%	26.7%	11.9%	4.6%	27.4%	12.3%
	Scenario 2 – All Development Inside the URDL					
Acres	8,849	35,526	44,375	8,849	36,614	45,463
Percent	3.4%	27.2%	11.4%	3.4%	28.0%	11.7%
	Scenario 2 minus Scenario 1					
Acres	-2,293	584	-1,709	-2,939	749	-2,190

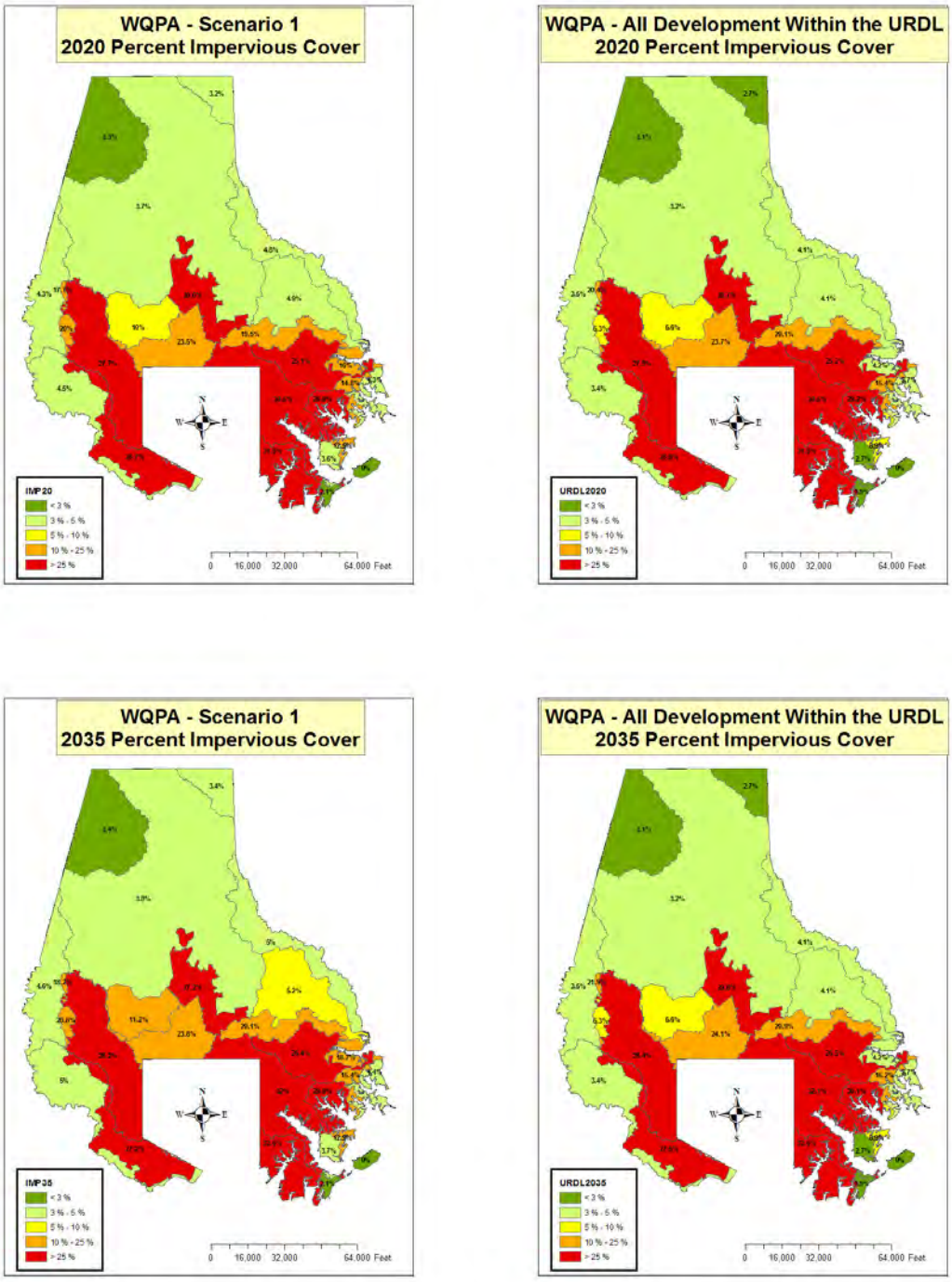


Figure 8w Impervious Cover Chwnges – Compwrison of Scenwrio 1 wnd Scenwrio 2 w

To preserve our high quality waters, represented by our Tier II waters and the locations of trout resources (Technical Memo A, Section A.2), impervious surfaces should be limited in the rural areas outside the URDL. All of the Tier II waters, excluding Red Run, are outside the URDL. Aside from three sites (again Red Run is an exception) all of the locations found to support trout

resources are outside the URDL. Both Scenario 2 – All Future Development Inside the URDL, and all of the Scenario 3 – Redevelopment subcategories would limit impervious surface growth in the rural area.

Development Regulations to Protect Water Resources

Baltimore County is a leader in protecting the environment through rigorously enforced environmental regulation related to new development and redevelopment. A brief summary of the applicable regulations is provided below.

Stormwater Management

Since the mid 1970's, Baltimore County has been a statewide leader in recognizing the impact of stormwater as a result of land use changes caused by land development. Baltimore County Stormwater Engineering in DEPRM enforces federal, state and county storm water laws and regulations ensuring that the citizens of Baltimore County experience economic growth and still protect its valuable water resources.

However, Baltimore County waterways have been damaged by years of land development and agricultural activities, mainly because 80% of the County was developed prior to the advent of storm water management regulations. As the County's Renaissance progresses and older urban and suburban areas are redeveloped, state-of-the-art storm water practices will be constructed and land areas will become greener.

Recently, increased attention has been directed to the impact of storm water management on stream systems. Developed initially to protect downstream areas from flooding as a result of upstream runoff, storm water management can also erode stream channels when the stored runoff volume is discharged at a sustained level. Responses to this problem include: (1) state-of-the-art stormwater management regulations requiring Environmental Site Design techniques for new and redevelopment projects which mimic natural runoff characteristics and minimize impact to water resources; and (2) re-incorporation of the natural flood function into stream restoration projects where access to floodplains for the river are possible, and where no downstream areas are susceptible to flooding damage.

Forest Conservation

Baltimore County's Forest Conservation Act of 1992 (FCA) was passed pursuant to requirements of the Maryland Forest Conservation Act of 1991, the nation's first statewide forest protection measure. Forest protection measures prior to this time were limited to the Chesapeake Critical Area, as required by Chesapeake Bay Critical Area Law of 1984, and Baltimore County's Critical Area Law of 1988. Through these laws, developers are required to preserve or reestablish forests on development sites, or provide mitigation through either off-site plantings or by payment of fees to the county. Establishment of areas for mitigation of forest losses may be another alternative for meeting forest retention requirements.

From 1993 through 2006, more than 1,100 development projects in Baltimore County were subject to the Forest Conservation Act. Cumulatively, >6,500 acres (67%) of existing forests on development sites were protected. About 3,200 acres (33%) of forests were cleared, averaging about 245 acres per year. Some of the forest loss from land development is required to be mitigated, while additional losses are incurred from activities exempt from the FCA regulations. The percentage of forests on sites that are cleared rose slightly in recent years.

Forest Buffer, Wetland, and Floodplains

In 1990, Baltimore County passed regulations to protect water quality, streams, wetlands, floodplains, forests, and steep or highly erodible slopes from land development impacts. These regulations were implemented for the two years prior to 1990 through an Executive Order. The regulations establish a minimum 75-foot forest buffer from Use I streams, and a minimum 100-foot buffer from Use III or Use IV streams. They also establish a 25-foot buffer from wetlands and 100-year floodplains. The buffer may be expanded, based on a Steep Slope Erodible Soil Analysis. In all cases, the greater buffer applies. In addition to the buffer, a setback of 35 feet for residential buildings and 25 feet for commercial/industrial buildings is required.

Critical Area Regulations

Land development proposals are reviewed for compliance with the Chesapeake Bay Critical Area Program. Baltimore County's program was enacted in 1988, following the passage of the Maryland Chesapeake Bay Critical Area Act in 1984, and the publishing of the regulations in 1986. Several updates to State and local Critical Area programs to improve regulatory efficiency and effectiveness were made over the last two decades. This program generally encompasses all of the land within 1,000 feet of tidal waters and all of the southeastern peninsulas. Redevelopment of properties within the Critical Area is limited by the amount of impervious surface lot coverage on the site, the amount of trees and forest, the location of wetlands, buffers, and significant plant and wildlife habitat areas, and the controls on stormwater runoff. Tidal and non-tidal wetlands, shorelines and streams are required to maintain and establish naturally vegetated buffers, which filter the sediments and nutrients in runoff. A Buffer Management Program adopted by the county for waterfront properties with historically disturbed buffers allows the continuation of maintenance activities and limited improvements within the buffer. This program has relieved homeowners and business owners of the burden of obtaining variances from the critical area criteria for many small improvements on their properties.

Erosion and Sediment Control

Since 1968, Baltimore County has recognized the negative impacts associated with soil erosion and sediment damage. Soil erosion from construction activity may exceed 100 to 400 times that obtained from an adjacent undeveloped land or woodland in an equivalent period of time. Federal, state and county laws exist to prevent and reduce sediment pollution regulate land-disturbing activity in Baltimore County.

Minimizing soil erosion and off-site sedimentation will reduce damage to public and private property and assist in the attainment and maintenance of water quality standards. The erosion

and sediment control standards and specifications are currently being modified by MDE to provide greater protection for water quality. DEPRM has a staff of inspectors that routinely inspects permitted construction activity and investigates citizen complaints associated with construction runoff. Staff interaction with on-site construction operators, and regulatory enforcement obtain compliance.

Watershed Planning, Preservation, Restoration, and Cooperative Efforts

Multiple efforts are needed to protect existing high quality aquatic resources and to restore degraded water bodies. While restoration, preservation, and protection efforts are underway, an analysis framework is needed to identify where protection is needed, and how much restoration is required to meet TMDL reduction targets. Baltimore County has identified a process called Small Watershed Action Plans (SWAP) to provide the analysis framework. The SWAP process is detailed below. The county has a strong preservation program that limits impacts to water quality through preserving agriculture and forestland, and thereby limiting rural development. The county has an existing Waterway Improvement Program and a Reforestation Program. Each of these programs provides restoration that improves water quality and will result in meeting pollutant load reductions. In order to be truly effective in restoration, cooperative efforts need to be enlisted, including other local jurisdictions, state offices, local watershed associations, and citizens. Baltimore County participates in many cooperative efforts; the three most prominent (Reservoir Protection Strategy, Baltimore Watershed Agreement, and cooperative efforts with our local watershed associations) are discussed below.

Small Watershed Action Plans

Small Watershed Action Plans are being developed for all of Baltimore County (Figure 9) with all areas to be completed by 2015.

A SWAP is a document prepared through community collaboration with the County to set protection and restoration goals for small watersheds in the county. It will outline specific actions to be taken by the County and residents in each of the watersheds to achieve protection and restoration goals. The plan will build on the technical assessments done over the past 8-10 years by consultants that identified important resources and problems in each watershed. These "watershed plans" provide a useful starting point for defining conditions in each watershed and suggesting remedial actions. The action plan process is intended to help prioritize and facilitate restoration projects for the watershed.

The SWAP planning process is also meant to bring together the many mandates that the County is charged to meet in each individual watershed. For example, Baltimore County, along with the other local jurisdictions in Maryland, has committed to achieve the goals in Chesapeake 2000, the current Chesapeake Bay Agreement. The County is a partner in the state's "tributary strategy" program, which sets targets for nutrient reduction in order to achieve a clean bay. The County also must meet mandates known as TMDLs (Total Maximum Daily Loads) for impaired streams and receiving waters, and has an NPDES (National Pollution Discharge Elimination System) permit that requires certain water quality goals to be met. The SWAP planning process

is designed to bring all these individual mandates together at a watershed level that will help residents understand the intent of each program, how to most efficiently meet the goals, and define the roles of the partners.

Stakeholders are urged to participate in the action planning process for a number of reasons:

- They may be aware of conditions and circumstances at the small watershed level that could affect the County's ability to accomplish desired actions.
- They represent citizens whose support is essential to make changes favorable to the watershed.
- They can become local experts on the watershed functions and be part of the outreach effort to other residents, businesses, and organizations.
- They can participate in watershed improvements by actions they take on their own property, whether it is via lawn care, septic system maintenance, parking lot management, reduction of impervious surfaces, planting of buffers, community education and many other practices.

To date, five SWAPs have been completed:

- Prettyboy Reservoir Watershed Restoration Action Strategy
- Deer Creek Watershed Restoration Action Strategy
- Lower Jones Falls Small Watershed Action Plan
- Upper Back River Small Watershed Action Plan
- Tidal Back River Small Watershed Action Plan.

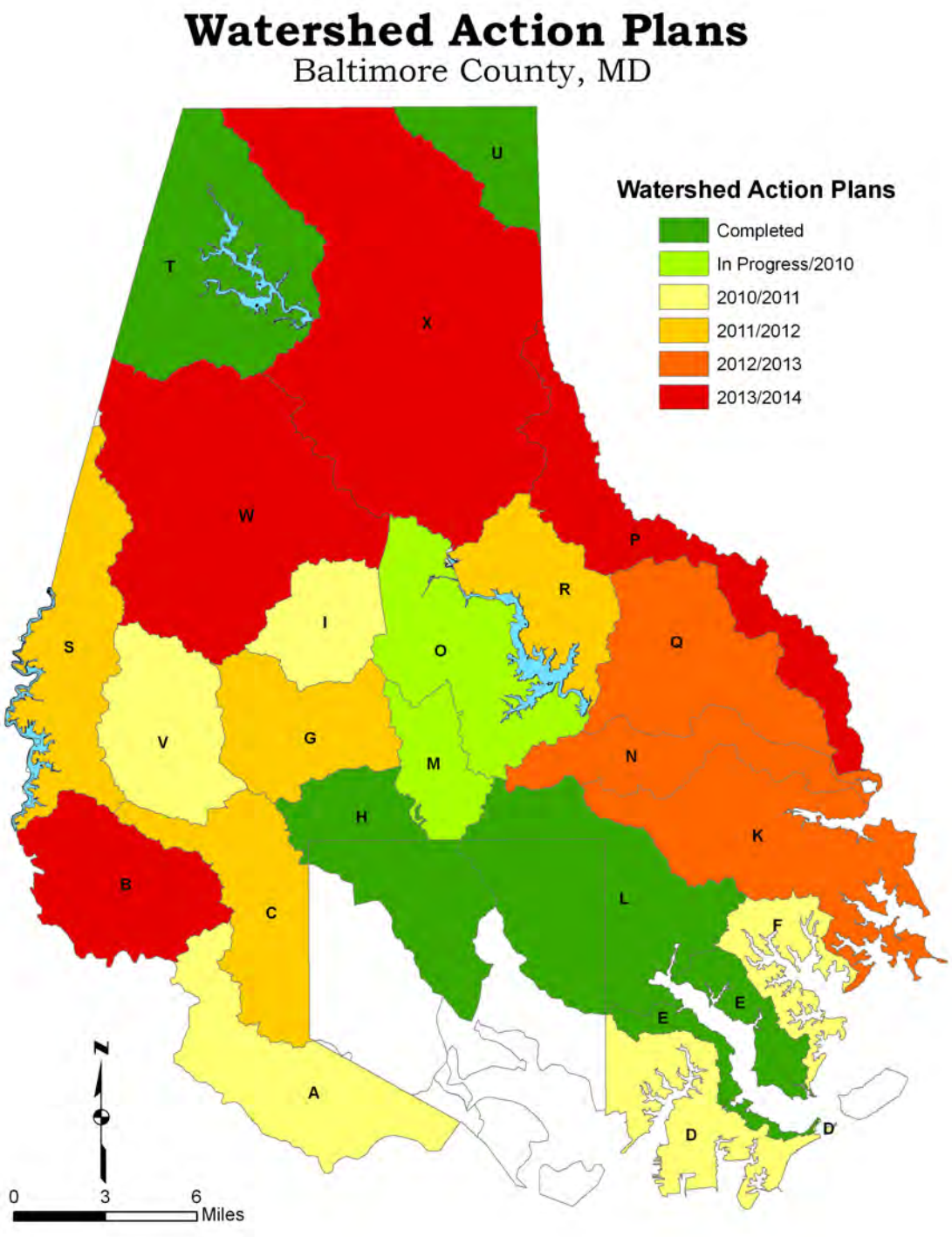


Figure 9w Smw Wwershed Ac ion Pv n (SWAP) Schedu e w

Preservation

The award winning "Plan for the Valleys" prepared in the 1960's called for the protection of rural lands for the benefit of natural resources and water quality through planning, zoning and land preservation easements. Since 1974, when the first private citizen took the lead in protecting their natural resources through the Maryland Environmental Trust, Baltimore County has been in the forefront of land preservation. Today through its many preservation programs Baltimore County has more than 55,000 acres in perpetual easements. The County is well over halfway to the goal of permanently protecting at least 80,000 acres.

The focus of the preservation effort is in the rural two-thirds of the County and has been on protection of agricultural, scenic, and environmentally sensitive lands. Fortunately for water quality protection, this area includes not just the reservoirs, but also the majority of the first and second order streams that are the supply source for the Metropolitan District Water System. Over 40% of the lands protected are in forest cover. The lands in agricultural production are required to implement best management practices to reduce soil runoff and protect water quality.

In addition to the critically important use of the surface waters for the public drinking water system of the Region, the wetlands, streams, rivers, and ponds of the Rural Areas provide important wildlife and fisheries habitat. For example, the Gunpowder Falls is considered a premier cold-water fishery in the region. The protection of these rural lands results in the maintenance of high quality waters such as those designated as Tier II waters and waters that have trout resources. The protection of these waters is a requirement of the Clean Water Act.

The pace of resource protection through land preservation has increased slowly with the funding of its various programs, and landowners ability to donate easements. Over a quarter of the preserved land has been through the donation of easements to the Maryland Environmental Trust and local land trusts. The remainder of preservation has been through the purchase of development rights using Federal, State and County funds through various programs.

In 1997, the Maryland General Assembly adopted the Rural Legacy Program to focus preservation to protect large contiguous blocks of rural resource lands. The State recognized that not only were significant resources being lost, but also what remained was fragmented by development, thus reducing its economic and environmental values. Baltimore County was well positioned to take advantage of this new State program. The County had designated preservation areas in the 1989 Master Plan and thus already established blocks of protected lands. Of equal or greater importance, with the assistance of the Maryland Environmental Trust, five active land trusts are operating in the County. The Rural Legacy Program provided State funding to land trusts acting as sponsors for areas designated for preservation.

The County and its Land Trusts have received designation and funding for the five Rural Legacy Areas that include the Coastal, Gunpowder River, Long Green Valley, Manor and Piney Run. Significant preservation has occurred in all of these areas as a result of the additional State and County funding. In particular, the goal of preserving contiguous blocks of land has been achieved in the Piney Run Rural Legacy Area where over 12,000 acres of land surrounding

McGill Run and Piney Run (both tributaries to Loch Raven Reservoir) have been connected through the Rural Legacy Program.

Continued implementation of the land preservation program will provide additional protection of the natural resources, including Tier II waters and trout resources, in the rural areas of the county.

Restoration

Restoration activities have evolved over time as tools are added. Baltimore County addresses restoration through two programs, the Capital Improvement Program and the Community Reforestation Program. In addition, the county is working cooperatively with the surrounding jurisdictions and the local watershed associations to promote restoration activities.

Capital Improvement Program

Baltimore County contains more than 2,100 miles of non-tidal streams and rivers, including more than 1,000 miles of streams that drain to the three drinking water reservoirs. The County faces a challenge common to most areas experiencing urban growth: how to keep its waterways stable and healthy for the sake of its ecosystem and residents. In 1987, the Baltimore County Department of Environmental Protection and Resource Management (DEPRM) initiated a capital environmental restoration program to assess and identify water quality problems and implement design and construction of watershed restoration projects. In addition to stream restoration, DEPRM's efforts to improve and protect waterways include storm water retrofit projects, waterway dredging, and shoreline erosion control measures. The program is based on the County's fourteen (14) major watersheds in order to provide a comprehensive framework of protection and restoration of the County's water resources.

The County's stream restoration program integrates state-of-the-art techniques with an environmentally sensitive approach to stabilize streams and reduce sediment loads, in turn enhancing stream morphology, ecological function, water quality, and aquatic habitat. DEPRM addresses these issues in the context of how one impaired stream (or reach) affects the safety and function of all waterways, residents, and habitats downstream. DEPRM has been nationally recognized for it's stream restoration projects and with the completion of numerous projects has been successful in meeting its objectives to restore watershed health. This program requires a watershed approach—an understanding of how waterways are directly linked to one another, the land, and the Chesapeake Bay.

In addition to stream restoration projects, DEPRM implements stormwater management facility conversions and retrofits to improve water quality. Many of the older stormwater management facilities did not provide water quality. These older facilities provide an opportunity to improve water quality through conversion to water quality facilities, while still maintaining the water quantity control functions of the original facility. In some situations it is possible to construct new stormwater management facilities to address areas that were developed prior to the existing environmental regulations.

Baltimore County continues to implement the Waterway Improvement Program, an initiative to enhance the resource quality of the shoreline communities. One component is a dredging program for the maintenance of existing boat channels in creeks and boat access "spurs" from these channels to individual waterfront properties. As part of the federal and state dredging permit requirements, Baltimore County surveys the submerged aquatic vegetation (SAV) in the channels to be dredged to assure that these resources are not impacted. The dredging permits also require that the county implement controls to help prevent future runoff of sediment and nutrients to the dredged waterways.

DEPRM's Waterway Improvement Program also includes shore erosion control and restoration projects which have stabilized thousands of feet of steep, eroding shoreline with vegetated beaches and structural protection such as offshore, gapped breakwaters to control erosive wave energy. With the use of natural vegetation for stabilization, the county is introducing citizens to alternative living shoreline protection approaches. These techniques are self-maintaining and therefore provide a much longer-term solution. Shore erosion control projects have been completed for many of the county's waterfront parks, and an updated project needs inventory has been completed to prioritize additional areas for restoration.

Community Reforestation Program

The Community Reforestation Program (CRP) was established by DEPRM to provide a dedicated workforce for planting, monitoring, and maintaining forest mitigation projects. The program is funded through fees-in-lieu of mitigation for forests removed as a result of public and private land development, as required by the implementation of the County's Forest Conservation Act and Chesapeake Bay Critical Areas Regulations. The CRP is the only full-time countywide reforestation mitigation program among Maryland's counties.

The CRP includes a four-person reforestation crew that carries out year-round reforestation operations. The crew is based at a 1-acre site in eastern Baltimore County provided by the Department of Recreation and Parks. This home base houses a growing out nursery for 10,000 tree seedlings; equipment and machinery needed for planting, monitoring, and maintaining the reforestation projects; and office space for the reforestation team.

Occasionally, the CRP will undertake special grant-funded projects to improve water quality and groundwater recharge, as well as wildlife habitat. The most recent example is the expansion of forest buffers and the reforestation of fields on private rural properties.
To date, the CRP has reforested over 155 acres in 32 projects in urban and rural areas of Baltimore County. Despite weather fluctuations, ever-present deer and vole predation, and other natural and human stressors, the program has maintained a strategy of flexibility in matching species selection, planting techniques, tree protection equipment, and maintenance efforts to site characteristics. As a result, the program has experienced a steady increase in tree survival to the present 85+% in recent projects.

Cooperative Efforts

Reservoir Protection Strategy

The regional reservoir system, including the Prettyboy, Liberty, and Loch Raven Reservoirs, provides a large and dependable drinking water supply for 1.8 million people in the Baltimore metropolitan region.

Although Baltimore City owns and maintains the reservoirs and drinking water system, Baltimore County has a special responsibility for the protection of the water supply. Baltimore City manages 17,200 acres of land surrounding the reservoirs, but this land comprises only 6% of the total reservoir watershed. Careful management of the entire watershed area for the three reservoirs is important for maintaining the water quality of the reservoirs.

The continuing water quality-monitoring program conducted by the City of Baltimore since 1985 indicates that the reservoirs continue to be impacted by nutrient over-enrichment. In particular, phosphorus from sewage treatment plants, agriculture, and urban development is contributing to the excessive growth of nuisance algae. The reservoirs are also experiencing increasing levels of chlorides and sodium, thought to be the result of applying deicing compounds on the increasing mileage of roadways in the watersheds. Currently, the finished water supplied by the City of Baltimore contains 20 mg/l of sodium, which is near the limit recommended for individuals on sodium-restricted diets.

The Reservoir Watershed Management Agreement was first signed in 1979, strengthened in 1984, and resigned in 2005. Among the signatories are Baltimore and Carroll Counties, Baltimore City, Baltimore County Soil Conservation District, Carroll Soil Conservation District, the Maryland Departments of Agriculture, and Environment, and the Baltimore Metropolitan Council. The agreement establishes a Reservoir Watershed Protection Committee to provide program oversight, and a Reservoir Technical Group to coordinate program work efforts, review technical work and prepare the Action Strategy to improve and maintain water quality in the reservoirs. The Reservoir Action Strategy can be found at:
http://www.baltometro.org/RWP/RWPActionStrategy2005.pdf

Baltimore Watershed Agreement

Baltimore County and Baltimore City share four 8-digit watersheds (Gwynns Falls, Jones Falls, Back River, and Baltimore Harbor). In recognition of this fact, the Baltimore Watershed Agreement between the County and the City was signed in October 2002. The purpose of the agreement is to ensure better management of shared water resources including coordinated monitoring, compliance with environmental regulations, reservoir management, implementation of tributary strategies, collaboration with watershed organizations, and annual reporting on restoration progress to the citizens of the region. The agreement was resigned in December 2006 and committed the County and the City to specific tasks, including: the creation of a Committee of Principals (heads of City and County agencies), development of goals and action strategies in five specific areas (stormwater, community greening, development and redevelopment, public

health, and trash), the hosting of a biennial meeting to review accomplishments, and continuing to work with watershed organizations and specifically involving them in the development and implementation of the action strategies.

Goals for each of the five areas of interest, and a Phase I Action Strategy were developed through collaborative efforts of Baltimore County, Baltimore City, watershed associations, and interested citizens. The action strategy indicates the preliminary actions needed to meet the goals by 2020. Details of the Baltimore Watershed Agreement and the Phase I Action Plan can be found at:
http://www.baltimorecountymd.gov/Agencies/environment/watershedagreement/index.html

Watershed Associations

Baltimore County has several very active volunteer organizations whose mission is focused on enhancement of environmental resources. In an effort to expand their ability to organize and conduct restoration activities, DEPRM developed a grant program entitled, *Watershed Association Restoration Planning and Implementation Grant* program. This grant program was developed to keep permanent staff with the county's local watershed associations. The groups continue to implement restoration projects and educational activities, and also participate in County restoration planning and support of the Stream Watch program (a citizen based stream monitoring program) . The money can be used to leverage additional grant funding. The county keeps an accounting of the groups' efforts and adds these restoration activities into the County's totals for meeting nutrient reduction goals. Annual funding for each group is limited up to $30,000 with a minimum of 1000 hours of staff time to be expended each year.

Policy and Actions

The intent of the Water Resources Element Stormwater Assessment is to link the results to the County Comprehensive Plan so that future land development considers both protection and preservation of high quality waters and addresses nutrient impairments. The 2020 Master Plan is under development and is taking a sustainability focus. The policies and actions detailed here are tailored to meet both the protection goal and the reduction of nutrient impairment goal. Many of the policies and actions in the existing 2010 Master Plan are applicable to the Water Resources Element. Existing policies and actions are listed in normal font, new or revised policies and actions are in **bold**. In addition, the policies and actions are organized in three main groupings:

1. Policies associated with the promotion of redevelopment and the inclusion of water quality considerations in community planning.
2. Policies and actions associated with protecting high quality waters.
3. Policies and actions associated with restoring aquatic natural resources and meeting TMDL reduction requirements.

1. Policies and actions associated with promotion of redevelopment and community planning.

Policy: Promote redevelopment and revitalization inside the URDL

Actions:

1. **Develop a Countywide redevelopment plan by 2012 to accommodate population growth, provide maximum pollutant reduction, protect high quality waters, promote economic vitality, and maintain a high quality of life for Baltimore County residents.**
2. **Identify and implement incentives that will promote private redevelopment in the appropriate locations.**
3. Include environmental policies and goals in community plans for the preservation and enhancement of functional open spaces such as greenways and wildlife habitat; the reduction of water, air, and toxic pollution and solid wastes; and the promotion of neighborhood environmental stewardship.
4. Facilitate the redevelopment of underused industrial properties to support the Port of Baltimore.
5. Steer redevelopment efforts along the waterfront into historically disturbed buffer areas in order to maximize water quality protection.
6. Provide flexibility to developers in redevelopment sites so they can implement innovative solutions to stormwater management.

2. Policies and actions associated with protecting high quality waters

Policy: Provide additional protection to Baltimore County's Tier II waters and waters with known trout resources.

Actions:

1. Continue to down zone properties outside the URDL to relieve development pressure on natural resources, especially Tier II waters and waters with known trout resources.
2. Continue to identify and protect the remaining high value natural resources in watersheds in order to preserve their beneficial functions for clean water, clean air, and habitat.
3. **Investigate the development of overlay zones for Tier II waters and waters with known trout resources, and provide additional protection through development regulations.**
4. Establish and maintain cooperative relationships with other jurisdictions to protect shared watersheds.
5. Ensure inclusion of stream protection policies in all community plans. Continue to assist citizen efforts for stream clean-ups, stream surveys, watershed surveys, and other projects that improve stream quality.

Policy: Protect natural resources from impacts due to development

Actions:

1. Continue to protect streams, wetlands, floodplains, and woodlands from impacts of new development and redevelopment as required by development regulations.
2. Identify and protect high value natural resources in watersheds in order to preserve their beneficial functions for clean water, clean air, and habitat.
3. Continue commitments to restrict development in the reservoir watersheds, and expand this restriction of development to all rural areas outside the URDL.
4. Review permits for construction of shoreline structures, and only allow structural measures where a nonstructural alternative does not exist.
5. Improve implementation procedures of the Chesapeake Bay Critical Area Program while maintaining a high level of water quality and habitat standards.
6. Limit growth and control density along the waterfront.
7. Maintain land use and development standards essential for the protection of the Chesapeake Bay's biological integrity.
8. Enhance the image of the waterfront, while at the same time protecting water quality and significant plant and wildlife habitats.
9. Preserve the unique rural character of the waterfront residential communities, and improve the quality of new development and redevelopment; provide effective buffers between development projects and adjoining rural areas, and implement cluster principles and environmental site design techniques to maintain forests and open space.
10. Steer growth allocations involving conversions to Intensely Developed Areas into priority funding areas.
11. Implement environmental site design (ESD) practices in accordance with Baltimore County and state stormwater regulations, including design process and planning techniques that will protect natural areas, minimize impervious surfaces, and use available landscaping areas for ESD practices.
12. Ensure that stormwater practices are sustainable in that they utilize natural processes to treat stormwater runoff and minimize environmental impacts.

3. Policies and actions associated with restoring aquatic natural resources and meeting TMDL reduction requirements.

Policy: Restore degraded waterways to meet water quality standards and enhance enjoyment and quality of life for Baltimore County residents and visitors

Actions:

1. **Continue to prepare small watershed action plans and participate in studies to identify needs and opportunities for stream restoration, wetland creation or restoration, and stormwater management.**

2. **Investigate the feasibility of an offset program that results in a no net increase in pollutant loads from new development.**
3. Continue the design and construction of stream restoration projects, based on natural channel stability concepts.
4. Reduce pollution through a reduction in impervious surface, improved management of urban runoff, and implementation of source-based controls.
5. Coordinate management of inter-jurisdictional watersheds with surrounding jurisdictions.
6. Encourage and actively participate in partnerships among agencies, organizations, and communities to address environmental issues.
7. Continue to implement the 2006 Baltimore Watershed Agreement with the City of Baltimore for improved and coordinated efforts for public health, trash, stormwater management, community greening, and redevelopment.
8. Continue efforts to protect shorelines from erosion and improve the water quality and habitat value of tidal wetlands; use nonstructural measures for shoreline stabilization, where physically feasible, and enhance tidal wetlands by increasing the number of native species.
9. Continue to monitor and control upland sources of sediment and other water pollutants carried to waterways as storm water runoff.
10. Explore beneficial uses of dredge spoil disposal including shoreline stabilization projects and tidal marsh creation.
11. Educate property owners about the benefits of living shorelines.
12. Develop an aggressive public education campaign to inform and promote behaviors that will improve water quality.
13. Evaluate existing private septic systems in the CBCA; make loans or grants to encourage and/or require septic system upgrades or public sewerage connection, as needed.
14. Encourage the implementation of clean marina best management practices.
15. Identify opportunities for the creation of wetlands as mitigation for County capital projects and other land development impacts.
16. Continue environmental education programs for schools, businesses, and homeowners for the reduction of water pollution and toxic and solid wastes.
17. Continue to implement environmental inspection and maintenance programs such as storm drain inlet cleaning, **street sweeping,** and maintenance of stormwater management facilities.
18. Continue to implement and expand the stream biological monitoring program in order to measure the long-term trends in stream quality.

Policy: Baltimore County will continue cooperative efforts to protect the quantity and quality of source water in its three reservoir watersheds

Actions:

1. Continue to participate with other area jurisdictions in the cooperative regional Reservoir Watershed Management Program, including participation in the Reservoir Technical

Group for coordination of program implementation under the adopted Action Strategies and preparation of progress reports.

2. Continue commitments to restrict development in the reservoir watersheds.
3. Continue to implement non-point pollution control, stream restoration projects, and sewerage improvements.
4. Continue to prioritize implementation of projects to establish riparian forest buffers along stream systems in the reservoir watersheds in cooperation with private organizations and other public agencies.
5. In cooperation with citizen organizations, continue to implement the ambient biological stream monitoring program in order to provide information about the impacts of land use activities on reservoir stream quality, and to assist in the evaluation and implementation of management programs.

Maryland Department of Planning

Martin O'Malley
Governor
Anthony G. Brown
Lt. Governor

Richard Eberhart Hall
Secretary
Matthew J. Power
Deputy Secretary

Mr. Arnold F. 'Pat' Keller, III
Director
Baltimore County Office of Planning
105 West Chesapeake Avenue, Suite 101
Towson, Maryland 21204

August 27, 2010

Dear Mr. Keller: Pat

The Maryland Department of Planning has completed the coordinated review of the draft Water Resources Element for Baltimore County dated June 14, 2010. The draft element was sent to the Maryland Departments of Transportation, Environment, Natural Resources, Business and Economic Development, Housing and Community Development, and Agriculture. Comments received after the date of this letter will be forwarded to you upon receipt.

In addition to the requirements of HB 1141, our planning staff has reviewed the elements for consistency with the Planning Act of 1992, the Smart Growth Areas Act of 1997 and other State growth management principles and policies. Our review comments are attached for your consideration.

If you have any questions please feel free to contact me at (410) 767- 4500 or Steve Allan at (410) 767-4572 with any questions or concerns.

The Maryland Department of Planning looks forward to continued planning coordination with Baltimore County.

Sincerely,

Peter Conrad, AICP
Director, Local Government Assistance

Enclosure: Review comments

cc: Jason Dubow, Planner, WRE Coordinator
Steve Allan, Regional Planner
Rich Josephson, Director, Planning Services
Rita Elliot, MDP Clearinghouse

301 West Preston Street • Suite 1101 • Baltimore, Maryland 21201-2305
Telephone: 410.767.4500 • Fax: 410.767.4480 • Toll Free: 1.877.767.6272 • TTY Users: Maryland Relay
Internet: www.MDP.state.md.us

Maryland Department of Planning
Review Comments
Baltimore County Water Resources Element
August 27, 2010

The WRE is very close to completion, but would meet the requirements of HB1141 with recommended comments. The most important comments to include are in **bold**. The WRE does not yet effectively address the following purposes of the law and/or State guidance, as follows:

- For each watershed, identify current WWTP discharge locations and loads (MDP M&G 26, p. 12).
- Does the WRE make findings that address estimated changes in both point and nonpoint nutrient loads (MDP M&G 26, pp. 39-40).

Overall WRE comments:

- The Master Plan indicates that the WRE is incorporated as part of the Master Plan (Master Plan 2020, p. 24). The WRE (and not just the WRE executive summary) should be adopted as part of the Master Plan.
- The County should be commended for:
    - including a WRE that examines multiple possible land use scenarios (p. 27) and a Master Plan that chooses the least impactful land use plan examined by the WRE with regard to both nutrient loading and impervious surface (Master Plan 2020, p. 24).
    - recognizing in its WRE that all new development impacts must be offset (pp. 17, 27) and including a policy to investigate the feasibility of an offset program (p. 55).
    - using the WRE as a preliminary assessment to determine whether local and Chesapeake Bay TMDL allocations can be met, in part through the proposed land use plan (pp. 27-28, 39).
- **The County should include a forecast on how future water and sewer demand would change given the WRE's recommendation of a land use plan that focuses on redevelopment within the URDL.** The water and sewer demand forecast (p. 5) appears to be based on the County's current land use plan. An alternative land use plan that focuses on redevelopment likely will increase demand for public water and sewer above current forecasts. If the County believes that the water and sewer demand forecast provided in the WRE adequately captures expected demand under the alternative land use scenario (i.e., redevelopment within the URDL), then the WRE should clarify that this is the case.
- The County should review its Land Preservation, Parks, and Recreation Plan and identify measures that will implement the Water Resources Element strategies. Referral of these relevant sections within the Land Preservation, Parks and Recreation Plan should be cited within the Water Resources Element.
- SB276, passed in the 2009 Maryland legislative session, sets a statewide land use goal of increasing the current percentage of growth in Priority Funding Areas (PFAs) and decreasing the current percentage of growth outside of PFAs. SB276 also requires local governments to develop

a percentage goal towards achieving the statewide goal. Although the new annual report requirements (including the local land use goal) under SB276 will not be filed until July 1, 2011, Baltimore County should consider (and discuss) whether its estimates of the percentage of growth to be served by public water and sewer will be sufficient to achieve the statewide land use goal. Statewide in Maryland, the current (as of 2006) percentage of growth in PFAs (not including "comment areas") is 68% http://www.mdp.state.md.us/msdc/PFA/Resid_Growth/by_County/PFA_cnty_index.htm.

- Please consider the following edits to add clarity:
    - There is a possible typo (p. 2) where the text refers to the county's population rate as decreasing to "3,900 people per year in the near future." To add clarity the text could use the 3,800 figure found in the chart for 2020 annual change in population.
    - The list of appendices (p. 6) is confusing because it does not refer to the appendices within the WRE. The WRE should clarify where these documents are located and/or assign them a letter not already used in the current appendix. For example, Appendix A is listed as the WRE Flowchart. However, Appendix A in the WRE is actually a technical memo on existing water quality conditions.

Comments on source water protection:

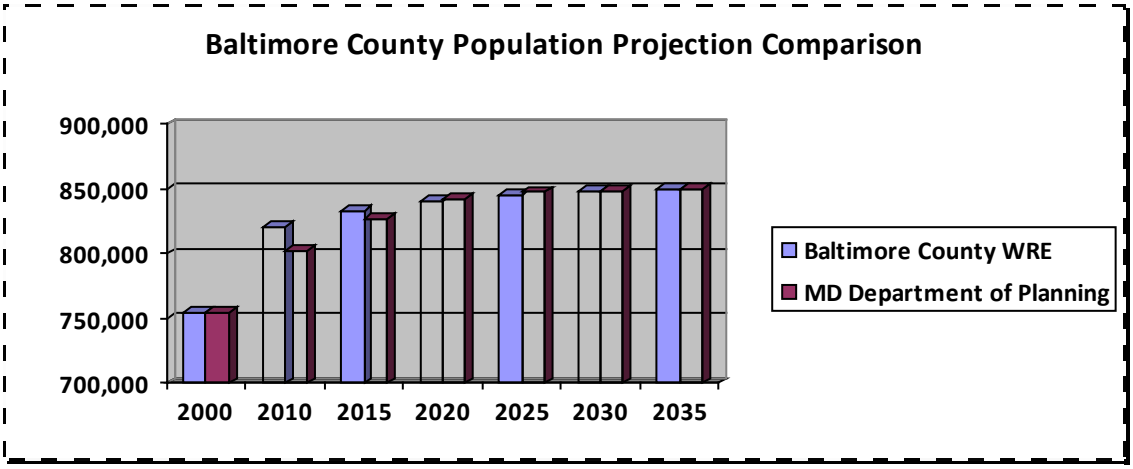
- The WRE could also include a few sentences regarding regional efforts to protect the Susquehanna River as a drinking water source since the County relies on the river in part for its drinking water needs.

Comments on identifying suitable receiving waters:

- **The WRE should provide a point source loading forecast for and indicate the discharge locations of the Patapsco WWTP, Back River WWTP and Richlyn Manor WWTP.**
- **The WRE should list the Maryland Tributary Strategy point source caps for the County's WWTPs.**
- **The WRE also should provide a combined point and nonpoint source loading forecast.**

Comments on population projections:

The population projections in the WRE are suitable for planning purposes. The long range (2020 through 2035) population projections presented in the WRE are consistent with county level population projections prepared by the Maryland Department of Planning (MDP) for Baltimore County (See Chart 1).



The short range (2010 and 2015) population projections presented in the Baltimore County Water Resources Element are slightly high relative to Maryland Department of Planning population projections. This difference is due to our incorporating the slowdown in population growth over the last several years as documented by the U. S. Bureau of the Census' population estimates through July 1, 2009.

The time period displaying the highest difference is 2010 where the WRE projection is 18,774 persons above the MDP projection. This difference shrinks in 2015 with the WRE population projection higher by 6,888 persons. Both short term projections presented in the WRE represent a less than three-percent difference compared to the MDP population projections for the same years.

Other Comments on methodology:

The population forecasts provided in the Draft of the Baltimore County WRE are generally found to be in-line with MDP's historical and projected total population estimates for Baltimore County, last updated in December 2008.

The methodologies used to determine the household population distribution from TAZ and Census Tracts to WQPA's, the modification of 2002 MDP Land Use data to 2005 Land Use data, low density residential modifications and the population change analyses are thoroughly explained and generally well executed, thanks in-part to the concise diagrams and thorough discussions found throughout the WRE Technical Memo B.