WATERFRONT PARTNERSHIP OF BALTIMORE, INC.

A Healthy Harbor Plan For Baltimore, MD

Healthy Harbor Plan
Creating a Cleaner, Greener Future
For Our Neighborhoods, Streams & Harbor

Waterfront Partnership of Baltimore, Inc.

In partnership with the Center for Watershed Protection, Inc. and Biohabitats, Inc.

Under written by:

Constellation Energy
Cleaner Greener Baltimore
Abell Foundation
Legg Mason
Rauch Foundation
Honeywell
Keith Campbell Foundation
Brown Advisory

December 2011

Healthy Harbor Plan

Table of Contents

Introduction I-1

Chapter 1. Baltimore's Water 1-1

Chapter 2. Regulatory Framework 2-1

Chapter 3. Sewage Solutions 3-1

Chapter 4. Trash Solutions 4-1

Chapter 5. Stormwater Solutions 5-1

Chapter 6. Education and Outreach 6-1

Chapter 7. Funding Strategies 7-1

Chapter 8. Implementation 8-1

Appendices:

A. Linkage of the Healthy Harbor Plan to Baltimore City's Sustainability Goals
B. Sanitary Sewage Elimination Plan
C. Case Studies
D. Documentation of Methods and Assumptions
E. Visual Glossary of Watershed Restoration BMPs
F. Recommended Green Infrastructure Practices
G. Watershed Restoration Pilot Projects and Concepts
H. Triple Bottom Line Accounting as an Approach to Restoring Baltimore Harbor

Cover photo credit: Karl Connolly

Introduction

Baltimore Harbor is the Baltimore Region's most valuable asset – the history, the location, the view, the recreation, and most of all, the water itself. A community is only as healthy as its water and our Harbor is ailing. Due to its long history of use as an industrial port and a commercially focused waterway, the water quality and habitats of the Harbor are degraded. In addition, intense urban development in the area draining to the Harbor has contributed to its pollution. Bacteria, nutrients and trash from stormwater runoff and sewage discharges flow into the Harbor. The bottom sediments have accumulated many toxicants from the industries that line the shore. The poor water quality in the Harbor is manifested in regular algal blooms, fish kills, and visible floating trash after storms. We have mistreated the Harbor for a long time. But it is not too late.

Figure I.1. Baltimore Harbor is the City of Baltimore's most valuable asset. (Source: Bryan Seipp)

In 2010, the Waterfront Partnership of Baltimore, Inc. unveiled its Healthy Harbor Initiative with a goal of making the Harbor swimmable and fishable by 2020. Included in the Initiative are pilot projects to help improve water quality and help educate the public about the Harbor's health. To reach the swimmable and fishable goal, the Waterfront Partnership initiated the development of a very specific plan of action for restoration. This plan was developed by the Center for Watershed Protection, Inc. and Biohabitats, Inc., with input from Baltimore City, Baltimore County, and Blue Water Baltimore. Although the City and County have been developing plans to protect and restore the area's waters for almost a decade, no such plan existed for the Harbor until now.

The Healthy Harbor Plan provides a roadmap for cleaning up Baltimore Harbor and its watersheds to improve the quality of life for all who live, work and play there. A clean Harbor will provide many opportunities to enjoy parks, trails, bikeways, fishing and even swimming. Greening and having trash-free neighborhoods in the Harbor watersheds will contribute to cleaner water, recreational opportunities and improved public health. A clean Harbor, clean watersheds and green neighborhoods provide ways for Baltimore City and County to grow as livable communities in this century by being

sustainable, attracting families, young professionals and businesses, and ultimately supporting a viable economy.

Goals and Vision

The goal of the Healthy Harbor Plan is to make Baltimore Harbor fishable and swimmable and the neighborhoods that drain to the Harbor more vibrant, cleaner and greener. The "fishable" and "swimmable" goals were selected because those are the broad objectives established by the Clean Water Act for all waters of the United States. The reduction of bacteria and trash are the most critical elements for making the Harbor safe for swimming and fishing and the ones that will undergo the most immediate improvement as a result of this plan. This plan will ultimately improve the health of City and County neighborhoods through an extensive greening effort that influences both water quality and quality of life for residents.

Our vision is twofold:

A Harbor and tributary streams that are safe and enjoyable for recreational activities such as boating, fishing and open water swimming by 2020. "Safe" waters are streams without eroding banks that are clear, free of noxious or foul odors and where children are safe to wade and swim. Neighborhoods are much cleaner and greener and visitors to the Harbor will enjoy trash-free open water for boating, fishing and swimming with limited health risk.

A City with clean and green neighborhoods and a Harbor and tributary streams that meet water quality goals for trash, bacteria and nutrients by 2030; Neighborhoods where runoff from roads, rooftops and parking lots is treated to the fullest extent feasible with vegetated practices and a Harbor and tributary streams that meet water quality goals for sediment by 2040. Clean and green neighborhoods contain numerous vegetated practices that store and clean runoff, provide shade, enhance property values and beautify the community. The extent of paved surfaces is reduced and the tree canopy is increased, resulting in a softer more natural feel to the previously hardened landscape. Communities are cooler in the summer, ground level ozone is reduced, and traffic is "calmer" with green street projects. Stream valley parks have more natural meanders and cascades. In the Harbor, the water is clear and supports abundant fish populations, allowing greater use for recreational fishing. Vacationers from all over the region are drawn to the Harbor each year to enjoy swimming and sunbathing at one of the local beaches.

Strategies to Achieve the Goals and Vision

Table I.1 presents the specific metrics that have been defined to measure achievement of the plan goals and vision. Each metric is described following the table, including the key strategies that are relevant to the metric and the anticipated short and long-term outcomes of implementing the strategies.

Table I.1. Metrics, Targets and Timeframe for Measuring Achievement of the Fishable and Swimmable Goal

Metric	Target	Timeframe
Eliminate dry weather sewage discharges	95%	2020
Reduce bacteria from pet waste	75%	2030
Reduce water-borne trash	75% 100%	2020 2030
Reduce nutrient loads from urban impervious cover	10% 20% 25%	2020 2030 2040
Reduce sediment loading rate from urban impervious cover	10,000 tons/year	2040
Install green infrastructure to the maximum extent practical to treat runoff from impervious cover	6% 16%	2020 2040

Eliminate dry weather sewage discharges and reduce bacteria from pet waste

Bacteria total maximum daily loads (TMDLs) have been developed for the Jones Falls and Gwynns Falls, the two major tributaries to the Harbor. A TMDL is the maximum amount of a pollutant that a particular waterbody can assimilate and still meet its intended uses. Sources of bacteria to the Harbor include wet and dry weather discharges of domestic sewage, and runoff containing waste from domestic pets, livestock and wildlife. The major controllable sources from urban areas are domestic sewage and pet waste. A large part of the effort to eliminate wet weather sewage discharges into storm drains and streams is being undertaken by the City and County through a comprehensive rehabilitation of their respective sewerage systems as required by Consent Decrees. Despite these improvements, numerous small leaks and discharges that occur during dry weather (including septic system leaks) require an additional effort that involves finding and fixing the source of the discharge.

Chapter 3 of this plan describes the following strategies that are relevant to these metrics:

1. Implement a public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste

2. Eliminate illegal connections through improved enforcement

3. Improve screening and monitoring for sewage discharges and leaking septic systems

4. Establish water quality benchmarks for stormwater outfalls

5. Increase the success rate of tracking sewage discharges to find the source

6. Increase capacity to quickly and permanently correct sewer leaks

7. Increase coordination and tracking across programs

8. Establish Harbor monitoring program and public notification system

The elimination of 95% of the dry weather sewage discharges by 2020 will make the Harbor safe for open water swimming (e.g., below the State of Maryland's standard of 104 MPN/100ml enterococci for frequent full body contact recreation) except during heavy rainfall and immediately afterwards, which can be communicated through a monitoring program and flag warning system similar to the Charles River in Boston. According to the bacteria TMDLs for Gwynns Falls and Jones Falls, the elimination of sewage discharges can help the City and County meet between 50 and 80 percent of their bacteria reduction targets depending on the tributary, and stormwater controls and public outreach programs can reduce bacteria from pet waste by up to 75 percent. This goal will be realized by 2030. The elimination of dry weather discharges can also contribute to substantial reductions in nutrients and help the City and County meet the nutrient load reduction goals established by the City and County Watershed Implementation Plans (WIPs).

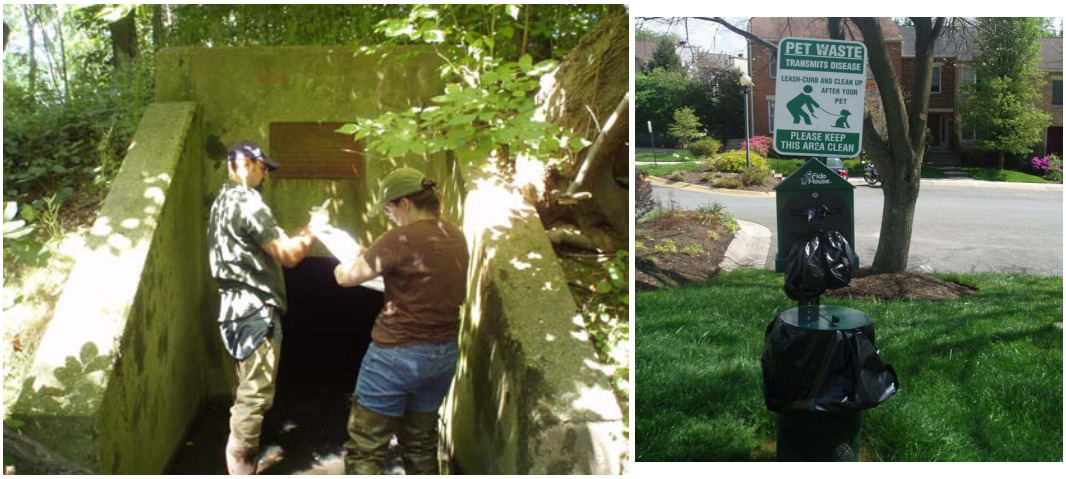

Figure I.2. Surveys of the storm drain system to find bacteria discharges and installation of pet waste pickup stations are two important strategies to reduce bacteria discharges to the Harbor (Sources: Center for Watershed Protection).

Reduce water-borne trash

Trash is a very visible problem in the Harbor. A trash TMDL is currently being developed (estimated to be completed in 2012), and the City and County will have to provide data to establish baseline conditions of trash being discharged to and from the storm drain system and develop trash reduction strategies to reduce this trash load by 100 percent. One of the key recommendations of this plan is that the City and County follow the approach taken by the City of Los Angeles in meeting their Trash TMDL by first conducting a survey to identify areas with high trash generation rates and then targeting these areas with retractable inlet grates and screen inserts, which would then be cleaned by street sweepers. The strategy developed to meet the trash TMDL for the Anacostia River in Washington, DC also recommends the use of inlet screens and street sweeping as the most cost effective approach. Anti- litter campaigns and enforcement of existing anti litter laws and trash disposal laws have a tremendous potential to

eliminate water-borne trash although there has not been enough research to date to determine the percentage of trash reduction from these actions. However, it is likely that a sustained outreach campaign will ultimately lead to changes in behavior, which could potentially reduce the maintenance costs of the inlet grates.

Chapter 4 of this plan describes the following strategies that are relevant to this metric:

1. Develop a public outreach plan to reduce trash and litter and increase enforcement of existing litter and trash disposal regulations

2. Support new legislation aimed at eliminating plastic bags and bottles

3. Conduct a trash survey to identify high trash generation areas for targeting management actions and public outreach especially for developing Clean Water Community Plans (see Chapter 6)

4. Install green infrastructure and other volume control stormwater management practices to capture trash from stormwater runoff

5. Increase implementation of practices that prevent trash from entering storm drains such as street sweepers and inlet grates

6. Increase practices that capture trash at storm drain outfalls and waterways

Figure I.3. Anti-litter campaigns and street sweeping are an effective combination of strategies to prevent littering and clean up trash before it reaches the Harbor (Sources: Center for Watershed Protection)

Half of the existing impervious area will be treated with trash collection and screening practices, requiring installation of up to 12,300 retractable grates and inserts at stormwater inlets, combined with 246 netting systems at stormwater outfalls. To maintain the inlet screening practices could require as much as a tripling of the existing street sweeping effort, which equals an additional 635,000 curb miles, swept per year. By focusing on the highest trash-generation areas, it will likely be possible to reduce trash loading by 75 percent or more by 2020 with installations that cover 50 percent of the watershed

area. The remaining 25 percent trash load reduction required by the TMDL by 2030 will be achieved through a strong outreach and enforcement campaign and trash reduction policies, which can also reduce the degree to which the inlet grates and inserts need to be maintained. The City and County will have to develop metrics to quantify the success of these respective campaigns.

Reduce nutrient and sediment loads from urban impervious cover

Excess nutrients and sediment in the Harbor reduce water clarity, contribute to algal blooms and can lead to fish kills. TMDLs for nutrients and sediment have been developed for Baltimore Harbor and for the entire Chesapeake Bay Watershed. Maryland's Phase I WIP for the Chesapeake Bay TMDL states that the City and County must reduce nutrient and sediment loads equivalent to treating runoff from 30% of untreated impervious cover by 2020. This requirement is being enforced through the City and County Municipal Separate Storm Sewer System (MS4) permits, which will likely require pollutant reductions equivalent to treatment of stormwater from 20% of untreated impervious cover in each 5-year permit cycle until the pollutant reduction goals are met.

This plan assumes that to meet the Bay TMDL goals and the MS4 permit requirements will require nutrient reductions equivalent to treatment of 40% of the total impervious cover by 2020, 80% by 2030 and 100% by 2040. This roughly equates to a 10% nutrient reduction by 2020, a 20% reduction by 2030 and a 25% reduction by 2040. For sediment, the Gwynns Falls and Jones Falls sediment TMDLs call for a total sediment reduction of 10,000 tons per year. These estimates can be refined when the final jurisdiction-wide load allocations are available later this year, and may require additional measures to meet the goals. Installation of green infrastructure practices is one way to achieve these load reductions. Green infrastructure practices use processes that are found in natural vegetated systems to reduce and treat stormwater runoff and have documented human health benefits including enhanced recreation, energy savings, and increased home values. Yet other strategies, such as redevelopment and stream restoration, can also be given credit towards these impervious cover treatment goals.

Chapter 5 of this plan describes the following strategies that are relevant to this metric:

1. Reduce stormwater pollution through redevelopment and controlling stormwater through green infrastructure

2. Utilize vacant properties to provide stormwater management as part of an offset and banking program

3. Develop plans that identify cleaning and greening actions for all City and County neighborhoods (Clean Water Community Plans)

4. Install green infrastructure practices in neighborhoods as stormwater retrofits

5. Plant trees on public and private lands

6. Implement a public education campaign for residents and businesses to encourage reduction of stormwater pollution

7. Provide incentives for retrofitting existing stormwater practices on private land

8. Implement pilot projects to demonstrate and test innovative stormwater practices

9. Restore stream channels degraded by runoff

10. Ensure proper crediting for alternative or innovative approaches to reduce urban stormwater pollution

11. Establish a tax rebate for homeowner installation of stormwater management practices on their properties

Figure I.4. Stream restoration stabilizes eroding banks and reconnects the stream to its floodplain, promoting a more natural condition, and reducing erosion and sedimentation (Source: Center for Watershed Protection).

This plan assumes that in both the City and County, an estimated one percent of land will be redeveloped each year, contributing to revitalization of these communities while reducing pollution. In addition, 53 miles of stream will be restored to a natural condition with 60 acres of riparian buffer plantings by 2020, and additional stream miles restored by 2040 to meet the sediment TMDLs. A crediting system will be in place to allow the use of the most effective practices for nutrient and sediment reduction. Various pilot projects, such as algal turf scrubbers and floating wetlands, will be installed along the waterfront to improve water quality and educate the public. The Harbor and its tributaries will meet all applicable Clean Water Act standards for nutrients by 2030 and for sediment by 2040. These pollutant reductions will improve water clarity and eliminate dissolved oxygen impairments in the Harbor, thus improving conditions for fish (but do not address fish consumption limitations). Additional, but as of yet unquantifiable, benefits will be gained from the adoption of various outreach and incentive programs to encourage landowners to install practices on their properties.

Install green infrastructure to the maximum extent practical to treat runoff from impervious cover
Increased runoff associated with urban and suburban impervious cover is a major cause of impairment to our Nation's waterways. Impervious surfaces, such as roads, buildings, parking lots, and driveways, do not allow rainwater to permeate the ground, resulting in increased runoff during storms. Stormwater runoff is associated with many detrimental effects on stream and Harbor water quality. The majority of the City and County were developed prior to adoption of requirements to manage runoff from impervious surfaces, providing an enormous opportunity to go back and "treat" these surfaces. Green infrastructure practices use processes that are found in natural vegetated systems to reduce and treat stormwater runoff and have documented human health benefits including enhanced recreation, energy savings, and increased home values. Therefore, green infrastructure plays an important role in realizing the vision of this plan. This plan recommends implementation of green infrastructure practices to treat impervious cover to the maximum extent practical, which is estimated to be 16% of impervious cover in the study area. Therefore, a significant portion of the nutrient and sediment load reductions required under the WIPs and MS4 permits will come from other practices that can be credited towards impervious cover treatment, as noted previously in this chapter.

Chapter 5 of this plan also describes the following strategies that are relevant to this metric:

1. Develop plans that identify cleaning and greening actions for all City and County neighborhoods (Clean Water Community Plans)

2. Install green infrastructure practices in neighborhoods as stormwater retrofits

3. Plant trees on public and private lands

4. Implement a public education campaign for residents and businesses to encourage reduction of stormwater pollution

Figure I.5. Urban green infrastructure includes the network of trees, open space and other natural areas that capture rainfall and reduce runoff, thereby protecting water quality. Large mature trees also provide many community benefits, such as shade and cooling, increased property values, and benefits to human health and wellness (Sources: National NEMO Network, New York City Department of Parks and Recreation, Center for Watershed Protection).

Greening plans will be developed for all 209 neighborhoods in the City, as well as for Baltimore County communities. These plans will identify locations for green infrastructure practices and tree planting and would include actions that individuals, institutions and businesses could perform (e.g., rooftop disconnection, rain gardens). At least three green infrastructure projects will be established in each City neighborhood and County planning district by 2020 to help stimulate the plan and meet regulatory goals. This will treat 1,490 acres (or 6%) of impervious cover, and by 2040, all of the feasible green infrastructure practices identified to treat impervious cover will be implemented, treating 16% of watershed impervious cover. Green infrastructure alone will not achieve the impervious cover treatment goal stated in the MS4 permits; however, other practices such as redevelopment and stream restoration can be given credit towards this goal. In addition, 135,000 trees will be planted in the City by 2020 and 405,000 trees by 2040, to reach the citywide goal of 40% canopy cover. The increased tree canopy will provide benefits such as rainfall interception, cooling, reduction of air pollutants and increased property values, at an estimated total value of more than $3 million per year. We do not know the full range of benefits that can be realized through the development and initiation of citizen actions to support the neighborhood greening plans. One of the recommendations of this plan is for the City and County to establish metrics and monitoring to document the full range of benefits of these actions, so that environmental and quality of life benefits can be determined.

Financing Alternatives

Implementation of all the strategies described in this plan will be an enormous undertaking, with estimated capital costs of implementing all recommended practices totaling $221 million by 2020 and $417 million by 2040. The bulk of this expense is related to construction of stormwater green infrastructure practices, stream restoration projects and operation and maintenance cost associated with trash control practices (e.g., street sweeping); therefore, it is important that the City and County develop a sustainable funding source for implementing these and other practices. Equally as important is to implement long-term targeted outreach and education programs, which have tremendous potential in reducing costs, especially those associated with operations and maintenance. The approach to cleaning the Harbor outlined in this plan, which involves integration of multiple programs and addresses multiple pollutants, can actually result in cost savings when one considers that it can not only achieve a swimmable, fishable Harbor but will also allow the City and County to remain in compliance with their MS4 permits and meet their TMDL goals. For instance, eliminating sewage discharges not only reduces bacteria but also has tremendous potential in reducing nutrients. Similarly, practices that capture trash can also provide significant reductions in nutrients.

Chapter 7 of this plan presents the following funding strategies:

1. Develop a stormwater offset and banking system
2. Adopt a “Triple Bottom Line” accounting approach
3. Develop stormwater utility
4. Build support for statewide bag tax
5. Develop solid waste management enterprise fund
6. Establish a Baltimore Water Fund

Development of a stormwater utility is most important, as it would provide an ongoing funding source for implementation of stormwater management practices, while measures such as a bag tax and solid waste management enterprise fund would not only reduce trash but also provide funds for cleanup and restoration projects. A Baltimore Water Fund established in cooperation with the National Fish and Wildlife Foundation would receive revenues from mitigation fees and penalties and could be used to fund a wide range of projects on a more periodic basis, while a stormwater offset and banking program would provide a means of getting stormwater management practices in the ground and also improve communities by fostering redevelopment. Lastly, a triple bottom line accounting approach, which uses a broader spectrum to evaluate the cost-effectiveness of projects, is proposed for use in prioritizing the large number of recommended projects for funding so that funding decisions can also take into account the social (e.g., enhanced recreation, improved health) and economic (e.g., increased property values, reduced energy costs) benefits of each practice.

Summary

The Waterfront Partnership of Baltimore has set a bold vision: to make the Harbor fishable and swimmable by 2020 and continue to greatly improve water quality through 2040. This is no small task. We ask you to join us in our mission – or rather your mission. Because a "healthy" Harbor can only be achieved if the neighborhoods where we live get cleaner and healthier. The trash and the pollutants that wash into the Harbor come from our yards, alleys, streets and storm drains. Each of us has the power to make our neighborhood greener, cleaner and more livable. We are all communities connected by water. We all need a healthy Harbor.

Chapter 1: Baltimore's Water

Baltimore Harbor was once teeming with crabs, fish, and other sea life. After centuries of abuse, this resource at the center of our city is fed by streams and pipes buried underground which carry trash, bacteria, and other pollutants into the Harbor from County and City watersheds. The health of the Harbor is directly connected with our own health through its use for recreation and importance to the local economy. This chapter describes Baltimore Harbor's pollution problems and primary sources and provides the watershed context for the recommendations in this plan.

Figure 1.1. The Middle Branch of Baltimore Harbor (Source: Alan Cressler, USGS)

Location

Baltimore Harbor is a large body of water that drains over 632 square miles within Baltimore City and Baltimore County. Because it is tidal and part of the Chesapeake Bay estuarine system, most of the water within the Harbor at any given point in time originates from the upper Chesapeake Bay, with an average tidal exchange rate of once per ten days. This plan focuses on the Northwest Branch and the Middle Branch (upstream from the Hanover Street bridge), shown in Figure 1.2.

Figure 1.2. Baltimore Harbor's Northwest Branch and Middle Branch are the focus of this plan.

History and Use

The City of Baltimore is the largest city in Maryland and was founded as a port city in the early 1700s for the tobacco trade and evolved into a leading port for sugar from the Caribbean. Baltimore continued to be a major manufacturing and shipping city throughout the 18th and 19th centuries. Due to the importance of the City as a center of commerce, the population grew rapidly. By the 20th century, the waterfront was an active shipping port for food with manufacturing warehouses and businesses occupying the downtown area.

The Baltimore Waterfront (Figure 1.3) is an area adjacent to the Harbor that embodies the historic, natural and cultural heritage of the region. Covering eight miles of shoreline on one of America's premier urban bodies of water, the larger Harbor shoreline connects historic communities, such as Fells Point and Federal Hill, to the modern Inner Harbor and Harbor East. Following the Inner Harbor project in the late 1970s, which reclaimed the waterfront for public use, the City of Baltimore experienced a sense of renewal and vitality, which continues to this day. The creation of a public esplanade along the waterfront has stimulated regeneration throughout all the neighborhoods adjacent to the water, from Locust Point to Canton, over the last thirty years. This portion of the Harbor is heavily occupied by residents who want to live near the water and is used by visitors for recreational purposes.

Figure 1.3. Baltimore's waterfront (Source: Waterfront Partnership of Baltimore)

Pollution Problems and Sources

Due to its long history of use as an industrial port, combined with intense urban development upstream, the water quality and habitats of Baltimore Harbor are degraded. The primary pollution problems include bacteria, trash, nutrients, sediment and toxicants. The poor water quality also contributes to a Harbor benthic community (e.g., clams, worms) that is considered "very poor" and is also completely devoid of aquatic grasses (Wicks et al., 2011).

Until recently, there were no reports that directly addressed the health of the Harbor. In 2011, EcoCheck (NOAA-UMCES Partnership) developed a baseline conditions report to evaluate a series of water quality and biotic indicators to assess ecological health, and to evaluate bacteria and trash to assess human health of the Harbor and its watershed as part of the Healthy Harbor Initiative. The full report, entitled *State of Baltimore Harbor's Human and Ecological Health 2011,* is available at http://www.waterfrontpartnership.org and the resulting scores are included below with a description of the Harbor's major pollution problems. In the future, annual "report cards" will be developed that compare the Harbor scores to these baseline condition scores.

Bacteria

Bacteria are found in the feces of animals, such as wildlife and pets, and can enter runoff during storms and ultimately make their way into the Harbor. Another major bacteria source to the Harbor is human waste that leaks from sanitary sewer systems and broken sewage lines, entering the Harbor by way of streams and storm drains.

High levels of bacteria pose a risk to swimmers, boaters and others coming into contact with bacteria-laden water. Indicator bacteria are used to determine if there are other, more harmful, pathogens in the water that put humans at risk for gastrointestinal and other health issues. Enterococci is generally accepted as the indicator of waterborne pathogens in brackish and salt water such as the Harbor. Enterococci bacteria samples were collected by the Baltimore Harbor Waterkeeper in 2009. The resulting data is presented in Figure 1.4. On average, water samples taken in the Middle Branch met the criteria (104 MPN/100 ml enterococci) for frequent water contact recreation (e.g., swimming) 71% of the time, while the Northwest Branch met these criteria only 27% of the time due to high bacteria levels (Wicks et al., 2011).

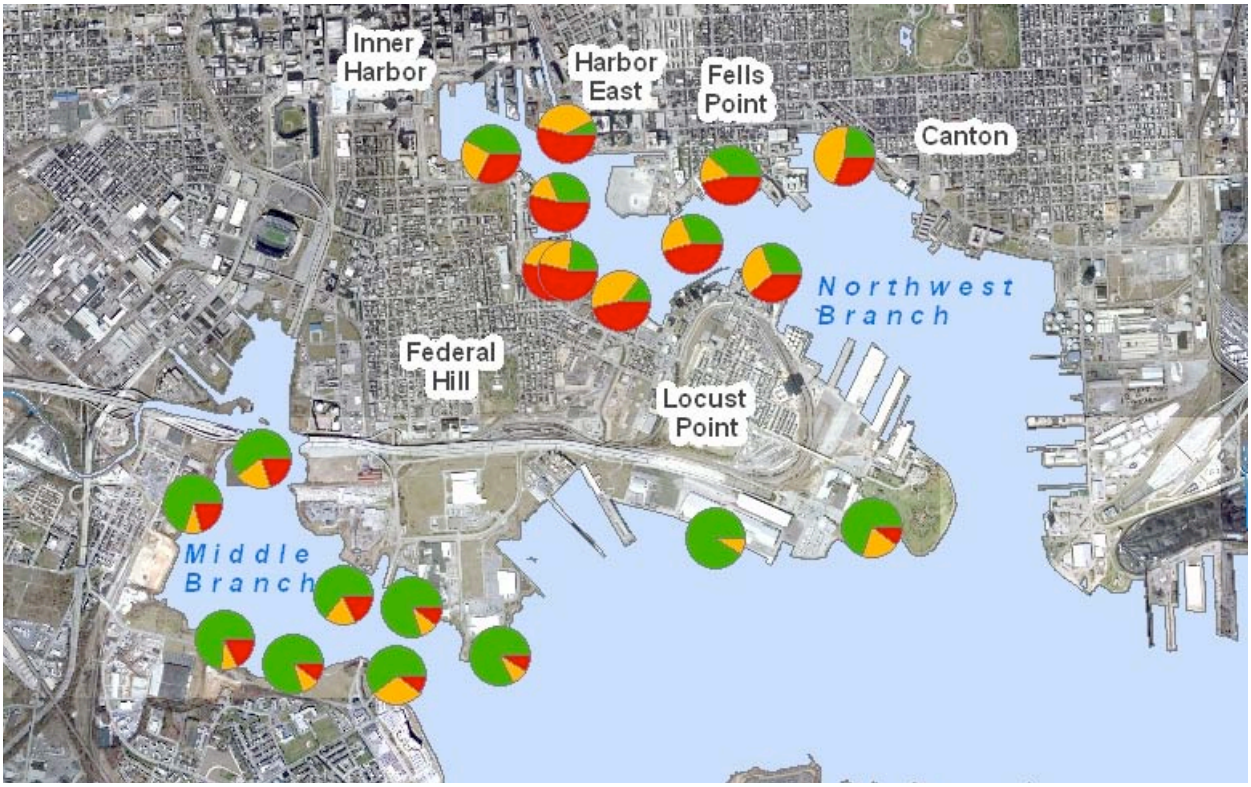

Figure 1.4. Percent of time that bacteria standards for swimming are met in the Harbor. The green pie slice is the percent of time samples were below the state limit for frequent full body contact (swimming), which is 104 MPN/100ml enterococci. The orange pie slice represents the percent of time samples exceeded the limit for swimming but met the threshold for infrequent immersion (104-500 MPN/100ml enterococci). The red pie slice represents the percent of time that the threshold for infrequent immersion was exceeded (500 MPN/100ml enterococci). Values are based on the median marine enterococci values for samples collected from May-December 2009.

Trash

Trash is a very visible indicator of poor water quality in the Harbor (Figure 1.5). Trash is a common problem in urban environments and can leach chemicals into the ecosystem, provide a breeding ground

for harmful bacteria and other pathogens, and is also aesthetically unpleasant, which influences the quality of life. The EcoCheck baseline conditions report did not provide a grade for trash in the Harbor due to limited data. However, the Harbor has been listed as impaired for trash under the federal Clean Water Act Section 303(d), which will require measuring the amount of trash reaching the Harbor to determine how much will need to be prevented from entering the waterways.

Trash makes its way into the Harbor not only from nearby land uses but from the entire watershed area. Once trash is on the ground in neighborhoods, along roads, and in parking lots, it washes into the storm sewer system and into local waterways. Each time it rains, an enormous amount of trash washes into the storm sewers and out into the Northwest Branch and along the Middle Branch.

Figure 1.5. Trash deposits in the Inner Harbor (left) and along the Middle Branch (right) (Sources: National Aquarium Waterlog, Alan Cressler, USGS)

Sediment

Excess sediment in the Harbor reduces water clarity and can also clog fish gills, suffocate fish eggs and insect larvae, and cover wildlife habitat. In addition, sediments may have other harmful pollutants attached to them, such as phosphorus, metals and organic contaminants. Sediment has an adverse impact on the shipping channels, which must be dredged annually to maintain commerce. The Ecocheck baseline conditions report assigned a grade of **C-** to the Harbor for water clarity (Wicks et al., 2011). Major sources of sediment to the Harbor include stream channel erosion and stormwater runoff from urban and agricultural lands.

Nutrients

Nutrients, such as nitrogen and phosphorus, are required for plant growth and are a necessary food source for a productive aquatic ecosystem. However, an over-abundance of nutrients can contribute to a reduction in water clarity and increased algae blooms. As the algae decompose, dissolved oxygen in the water is reduced, stressing fish and other aquatic organisms. A specific species of algae, *karlodinium venificum*, has been linked to fish kills in the Harbor.

Nutrients make their way into the Harbor from a variety of watershed sources, including fertilizers in urban and agricultural runoff, wastewater treatment plant discharges, industrial discharges, sewage leaks and overflows, and atmospheric deposition. Phosphorus, which binds strongly to sediment, is also closely linked to sediment sources such as stream channel erosion and stormwater runoff.

According to the EcoCheck baseline conditions report, the Harbor scored a **D-** for total phosphorus and an **F** for total nitrogen (Wicks et al., 2011). The baseline conditions report also summarizes data for several water quality indicators that are influenced by nutrient levels. These include dissolved oxygen, which is often low in waters with excessive nutrients due to algae blooms; chlorophyll a, which is a measure of the amount of phytoplankton biomass in the water column and is influenced by nutrient levels; and water clarity, which is influenced by the amount of sediment and nutrients in the water column. The baseline conditions report assigned the following grades to these water quality indicators (Wicks et al., 2011):

Dissolved oxygen: **D**
Chlorophyll a: **C-**
Water clarity: **C-**

Toxicants
The bottom sediments of the Harbor have accumulated many toxicants, such as heavy metals and organic contaminants, from municipal and industrial discharges (Figure 1.6). These toxicants move up the food chain as larger organisms, such as fish, feed on smaller organisms, such as benthic macroinvertebrates, that absorb small amounts of these pollutants. Bioaccumulation of toxicants is a major cause of fish and shellfish consumption advisories. Cleaning and disposing of contaminated sediments is a costly and difficult process that is made more complicated by the fact that toxicants continue to enter the Harbor sediments from polluted street and parking lot runoff and the industries located on or near the waterfront. The EcoCheck baseline conditions report rated sediment health in the Harbor as "very poor" based on a review of data from a Maryland Sea Grant 2009 study (Wicks et al., 2011).

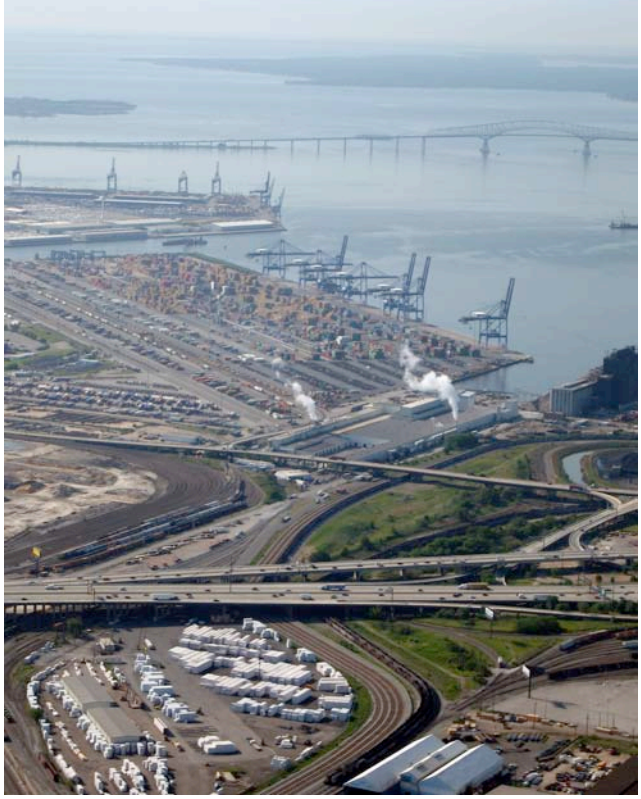

Figure 1.6. Toxicants in Baltimore Harbor sediments are a result of historic and present-day industries that line the shore as well as urban runoff (Source: Emily Nauman, IAN Image Library (ian.umces.edu/imagelibrary/)

Watershed Context

This plan focuses on reducing or eliminating pollution sources on the lands draining to the Northwest Branch and Middle Branch of the Harbor. The study area is composed of three watersheds shown in Figure 1.7. Gwynns Falls and Jones Falls drain the Gwynns Falls and Jones Falls Watersheds, and these river systems run northwest to southeast through the County and City. Gwynns Falls empties into the Middle Branch and Jones Falls drains to the Northwest Branch. The Direct Harbor drainage shown in Figure 1.7 contains no surface streams. Instead, runoff from this area is collected and conveyed directly to the Harbor through a system of curbs, gutters, inlets, pipes and outfalls. The study area is referred to as the Northwest Branch and Middle Branch Watersheds throughout this report.

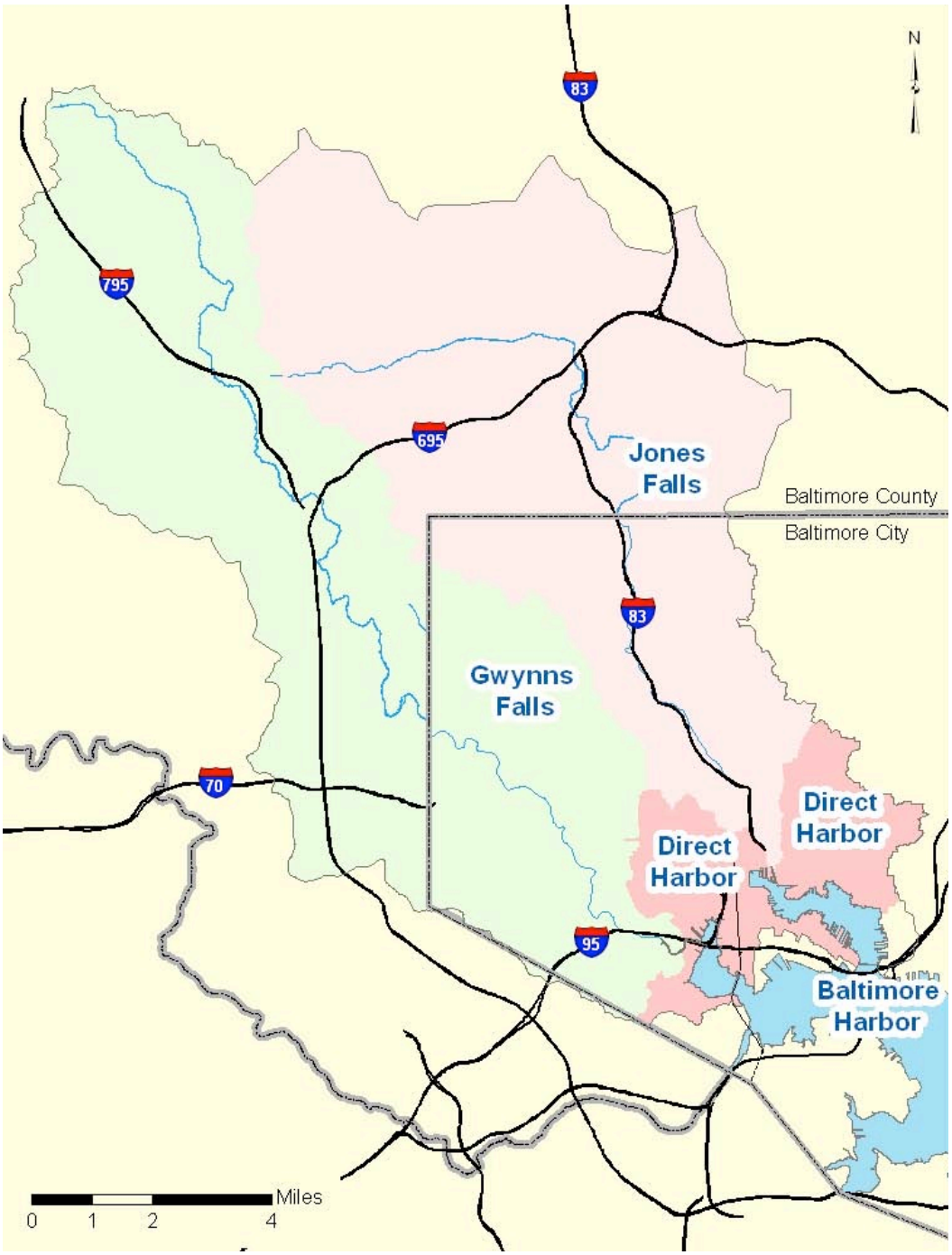

Figure 1.7. The study area for this plan includes the Gwynns Falls, Jones Falls, and Direct Harbor watersheds, which comprise the drainage area to the Middle Branch and Northwest Branch of Baltimore Harbor.

Figure 1.8. The land draining to Baltimore Harbor is a mix of urban lands with the area immediate to the Harbor having the most intensive urban character (Source: Jane Thomas, IAN Image Library, ian.umces.edu/imagelibrary/).

The watersheds that drain into the Northwest Branch and Middle Branch are highly urban, with the County portions of the Gwynns Falls and Jones Falls watershed having the most agricultural and forested land (Figure 1.8). Table 1.1 shows the breakdown of land use within the watershed.

Table 1.1 Land Use Distribution in the Watersheds Draining to the Northwest Branch and Middle Branch

Land Use (%)	Gwynns Falls	Jones Falls	Direct Harbor	Total
Agriculture	2.4	7.5	0	4.4
Forest	12.5	13.7	0	11.9
Open water/wetlands	0.2	0.4	0	0.3
Transportation rights-of-way	3.5	2.3	9.3	3.3
Institutional	7.8	8.6	18.0	8.7
Open space	8.2	8.6	9.1	8.5
Commercial	7.1	4.4	5.8	5.9
Industrial	6.3	1.7	19.1	5.3
Residential	51.6	51.7	34.8	50.5
Other (resource extraction, barren, mixed use)	0.7	1.1	3.9	1.3

The buildings, roads, parking lots, driveways and other impervious surfaces in these urban and suburban areas do not allow rain to soak into the ground, resulting in increased runoff to streams and ultimately

the Harbor. The extent of impervious surfaces in a watershed is a good measure of how urban an area is and is also a good predictor of the condition of local streams. The network of curbs, gutters, inlets, pipes and outfalls that collects runoff from these surfaces during storm events and conveys them to nearby streams, rivers, or the Harbor is called the storm sewer system. This is not to be confused with Baltimore City's and Baltimore County's separate sanitary sewer systems, which collect wastewater and transport it to either the Patapsco or Back River wastewater treatment plants for removal of pollutants before it is discharged. Table 1.2 summarizes additional data for the study area and Figure 1.9 shows the location of stormwater outfalls draining directly to the Harbor and the near-shore area.

Table 1.2 Impervious Surfaces, Drainage and Sewers in the Study Area

Characteristic	Gwynns Falls	Jones Falls	Direct Harbor	Total
Area (sq miles)	64.7	57.6	11.2	133.5
Stream miles	107.0	88.6	0	195.6
Storm sewer miles	498.1	364.5	255.3	1117.9
Sanitary sewer miles	896.2	569.4	290.6	1756.2
Impervious cover (percent)	29.3	22.7	57.4	28.8

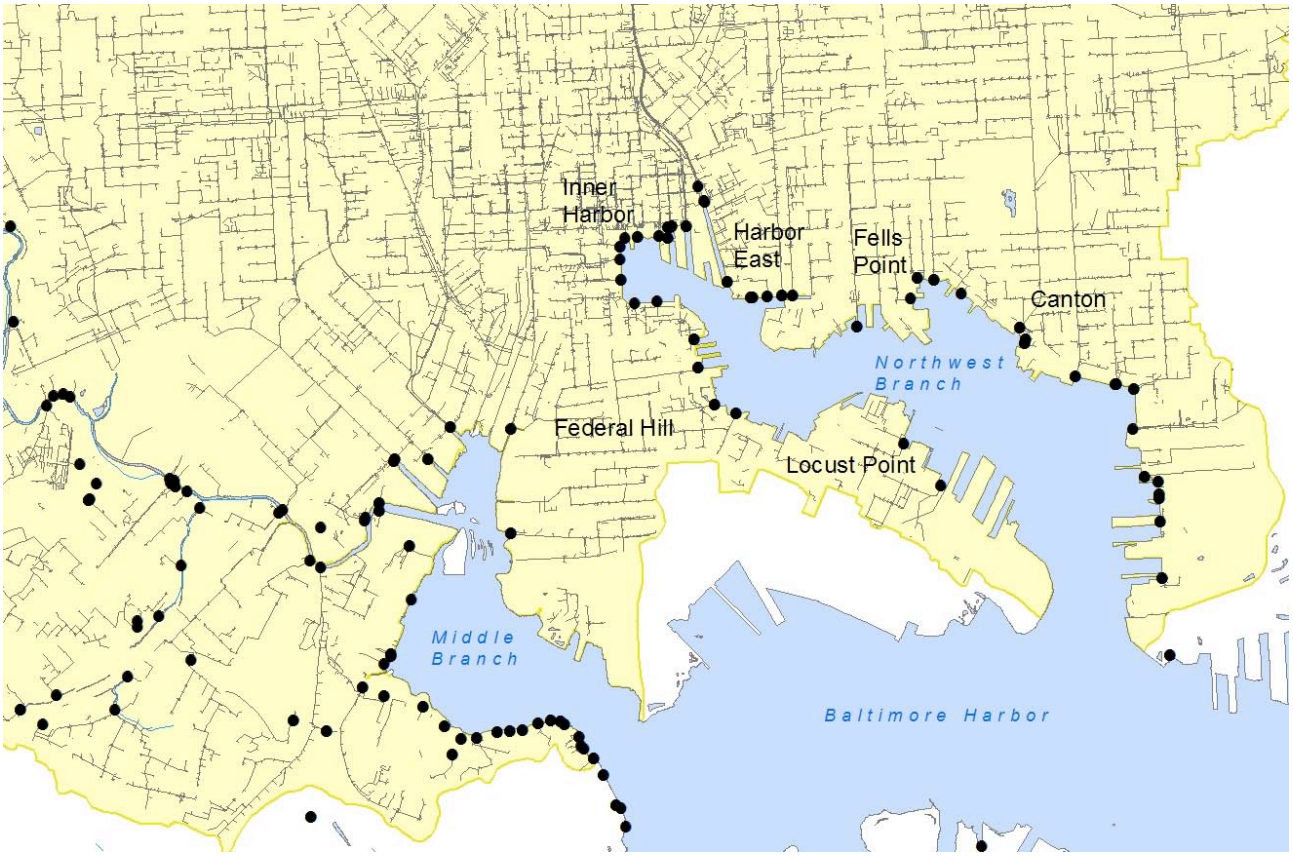

Figure 1.9. Stormwater outfalls draining to the Middle Branch and Northwest Branch of Baltimore Harbor. The land area shown in yellow is the watershed of focus in this report and the storm drain network is also depicted.

References

Wicks, E.C., Kelsey, R.H., and S. L. Powell. 2011. *State of Baltimore Harbor's Human and Ecological Health 2011.* Chesapeake EcoCheck.

Chapter 2. Regulatory Framework

Baltimore Harbor is fortunate to be governed by a number of regulatory programs, including federal and state laws. As detailed below, the years leading up to this plan have seen an unprecedented increase in the actions required by these regulations and presents a unique opportunity to ensure that the Healthy Harbor vision and goals are addressed. The complex framework of these interconnected laws and initiatives can be difficult to understand. Therefore, this section describes the myriad of tools available to achieve a "healthy" Harbor in order to provide context for the actions recommended in this plan.

Current Regulations and Initiatives to Improve Baltimore's Water

- Federal Clean Water Act Regulations
  - National Pollutant Discharge Elimination System Permits
  - Municipal Separate Storm Sewer System Permits
  - Total Maximum Daily Loads
  - Consent Decrees
- State Regulations
  - Critical Area Act
  - Water Resource Element
  - Maryland Stormwater Management Act of 2007
- Local Initiatives
  - Baltimore Watershed Agreement
  - Small Watershed Action Plans
  - Sustainability Plans
  - Urban Tree Canopy Goals

Baltimore City and County have spent considerable effort over the past two decades addressing the federal and state environmental mandates described here. This plan makes use of the results of these local initiatives, including 11 watershed assessments and Small Watershed Action Plans developed by Baltimore City and County. It is recognized that both jurisdictions ultimately have the responsibility for meeting their regulatory requirements, which apply to the entire area of Baltimore City and County and not just the area addressed by this plan.

Federal Clean Water Act Regulations

Established in 1972 and amended in 1977 and 1987, the Clean Water Act (CWA) is the primary federal law governing water pollution. The Act requires states to set clean water standards to protect uses such as swimming, fishing, and drinking, and for the regulation of pollution discharges. The major CWA regulations influencing this plan include Total Maximum Daily Loads

(TMDLs), National Pollution Discharge Elimination System (NPDES) permits, Municipal Separate Storm Sewer System (MS4) permits, and sanitary sewer overflow consent decrees.

The implementation and enforcement of the CWA is largely left up to individual states. The terms "swimmable" and "fishable" are not explicitly defined so that state governments can develop their own criteria for different water use designations. In Maryland, the designated uses define water quality standards for each waterbody, set minimum water quality goals for those uses, and enact an anti-degradation policy to assure that water quality continues to support those uses.

NPDES Permits

The CWA initially focused on addressing water quality issues caused by point sources of pollution (e.g., wastewater treatment plants and industry) by making it unlawful to discharge any pollutant into navigable waters, unless a permit was obtained under its provisions. These permits, known as NPDES permits, prevent the degradation of water quality by limiting pollution discharges to what can be safely assimilated by the environment. The Maryland Department of the Environment (MDE) is responsible for issuing NPDES permits in Maryland as well as for inspecting and monitoring the pollution discharges from permit holders to ensure that they are complying with their permits.

MS4 Permits

In 1987 the CWA was expanded to include non-point sources of urban pollution by requiring municipalities with separate storm sewer systems (referred to as "MS4s") to be permitted. This means that cities with storm sewer systems now need permits to ensure that stormwater is clear of contaminants and litter. In the early 1990s, both Baltimore City and Baltimore County were issued five-year permits requiring the control of stormwater through programs such as stormwater retrofitting, elimination of illicit discharges, public outreach, stormwater runoff control from development sites, and sediment and erosion control.

The MS4 program has evolved considerably over its 20-year history from being initially programmatic in nature to having watershed treatment goals, including restoration of impervious cover. The stormwater management component of the MS4 program has also evolved from primarily focusing on controlling large infrequent flood events at centralized facilities to using a decentralized approach focusing on smaller storms. Both Baltimore City's and Baltimore County's MS4 permits expired in 2010 and are in the process of being renewed. The current draft MS4 permits for the City and County include a requirement for the "implementation of restoration efforts" on 20% of the untreated impervious cover within the five-year permit term, and treatment of another 20% will likely be required with each additional permit cycle. The MS4 permits will also require the City and County to develop implementation plans for all of their TMDLs (as described below) within one year of the date of issuance of the permit.

TMDLs

A TMDL is a calculation of the maximum amount of a pollutant (e.g., trash, nitrogen, phosphorus) that a waterbody can receive and still meet water quality standards. EPA requires that a TMDL be developed for any waterbody that cannot meet its designated use(s) due to some form of water contamination. When a waterbody within Maryland is classified as

impaired, MDE calculates and administers TMDLs. Within the Harbor watersheds, TMDLs have been developed for the Jones Falls and Gwynns Falls for bacteria, nutrients, and sediment. Several TMDLs exist for the tributaries to the Baltimore Harbor, including sediments and nutrients. A bacteria and trash TMDL is under development specifically for Baltimore Harbor and should be released in early 2012.

The pollutant load allocations in a TMDL are met by developing implementation plans that outline required actions to reduce pollutants, and by implementing these actions over time. In recent years, the failure of state and federal governments to ensure TMDL implementation has resulted in third party lawsuits. These lawsuits have been the key drivers behind new MS4 permit requirements and the creation of stronger TMDL implementation plans.

In December 2010, the U.S. Environmental Protection Agency established a TMDL or "pollution diet" for nutrients and sediment for the entire Chesapeake Bay. In order to meet the requirements of the TMDL, each of the six states and the District of Columbia that comprise the Chesapeake Bay watershed are responsible for writing Watershed Implementation Plans (WIPs) detailing how they will meet the necessary pollution load reductions by 2025 (the Maryland goal is 2020). Phase I WIPs were completed in 2010; Phase II will be completed in 2011 and will refine the Phase I plans to include more local details about where and how pollution loads will be reduced. The City and County are currently working with MDE to develop their Phase II WIPs.

Consent Decrees

Due to the illegal discharge of untreated sewage into the Chesapeake Bay and smaller streams and rivers via sanitary sewer overflows (SSOs), the City of Baltimore and Baltimore County entered into consent decrees in 2002 and 2005, respectively, with the U.S. EPA and MDE. Overflows occur when the capacity of the sanitary sewerage conveyance system is exceeded. This happens for a variety of reasons, but most notably occurs during wet weather events when groundwater and stormwater enter the collection system through leaks and breaks, thereby reducing capacity to convey sewage.

The consent decree is a legally binding agreement stating that the City and County will fund projects to repair their SSOs or face further litigation. Project-specific programs are managed in both the City and County by the Department of Public Works. Projects include the replacement of pumping stations, the replacement and lining of sewer pipes, and other infrastructure improvements. Compliance is determined by the elimination of SSOs and progress is measured by the number of projects constructed and the implementation of other remedial measures as identified through a comprehensive planning process. The consent decree stipulates that the elimination of structural overflows has to occur by 2016 for the City and 2019 for the County. In Baltimore City, the most recent estimate is that capital projects have resulted in the elimination of 60 of an estimated 62 SSOs.

State Regulations

In addition to complying with federal clean water laws, Maryland has introduced its own set of standards and regulations to improve water quality, manage runoff, and protect and restore the

Chesapeake Bay. These include regulations established by the Critical Area Act, the Water Resource Element, and the Maryland Stormwater Act of 2007.

Critical Area Act

In 1984, the Maryland General Assembly passed the Critical Area Act and marked the first time that State and local governments jointly addressed the impacts of land development on habitat and aquatic resources. The Critical Area Act regulates and restricts land development within 1,000 feet of the mean high water line of Maryland's tidal waters. The program establishes a 100-foot buffer in which no new development is permitted unless it is associated with water dependent facilities or approved through a variance.

Implementation of the Critical Area Act is managed by a statewide Critical Area Commission, which develops criteria for local jurisdictions to use in the development of individual Critical Area Programs. The Baltimore City Critical Area Management Program includes the Harbor and consists of regulations for the redevelopment of near-Harbor brownfield sites, industrial areas, waterfront revitalization areas, resource conservation areas, and piers, barges, and new or expanded marinas. The vast majority of Baltimore City's Critical Area is intensely developed with 78.4% of critical area land categorized as industrial areas, 12.7% as revitalization areas, and the remaining 8.9% as resource conservation areas made up almost exclusively of floodplain areas and parks.

Water Resource Element

In 2006, the Maryland General Assembly enacted House Bill 1141 requiring local jurisdictions to adopt a Water Resource Element in their comprehensive plans. The Water Resource Element requires local governments to evaluate the impacts of all existing and planned development on local water resources. Water Resource Element requirements include establishing future pollution loadings in waterbodies by forecasting nutrient loads for future planned development, waste water treatment plant discharges, septic tanks, and stormwater runoff. The law further mandates that land use planning be influenced by the adequacy assessments of these forecasts.

Maryland Stormwater Management Act of 2007

The Maryland Stormwater Management Act was passed by the General Assembly in 2007 and requires that Environmental Site Design, through the use of nonstructural best management practices and other site design techniques be implemented to the maximum extent practicable for new development and redeveloped sites. New development must maintain predevelopment runoff conditions and redeveloped sites must reduce existing impervious area by 50% or provide treatment for an equivalent amount of stormwater runoff. These provisions for controlling post construction runoff are among the most progressive and protective in the Nation. Upon passage of the Act, Baltimore City and County each revised their codes to incorporate the state-mandated changes. The local stormwater management programs are administered and enforced through the MS4 Permits.

Local Initiatives

Baltimore Watershed Agreement
The Baltimore Watershed Agreement was first executed in 2002 to facilitate the integration of water quality restoration and protection across jurisdictional boundaries. Under the agreement, Baltimore City and Baltimore County agreed to improve cooperative inter-agency management of environmental resources. In December 2006, leaders from Baltimore City and Baltimore County signed the second regional watershed agreement emphasizing the value and importance of cooperation in addressing water quality and regional watershed issues while highlighting progress. A Committee of Principals was established to oversee the development of specific actions aimed at water quality improvement and five workgroups were established to develop an action strategy for each of the topic areas and to set and refine goals. The five topic areas include Development and Redevelopment, Community Greening, Stormwater, Public Health and Trash. The following goals apply to the Jones Falls, Gwynns Falls and Herring Run watersheds as well as the entire Harbor area and Back River:

- Eliminate trash-related water quality impairments by 2020
- Eliminate bacteria-related water quality impairments by 2020
- Achieve pollution reductions and stormwater controls to meet water quality standards for streams by 2020
- Ensure that development-redevelopment policies and practices are protective of natural resources and meet the objectives of the CWA
- Achieve City and County urban tree canopy and stream buffer goals to improve water quality.

The Baltimore Watershed Agreement has developed an action strategy with milestones to meet these goals.

Small Watershed Action Plans
Baltimore County and City have been systematically assessing their watersheds and developing Small Watershed Action Plans (SWAPs) in order to protect their water resources and these plans are a key tool for helping the City and County comply with their MS4 permits. Like other watershed management plans, SWAPs outline a strategy for cleaning up local streams and rivers and contributing to a healthier community. These plans are developed by assessing existing land uses, sources of pollution, and protection and restoration opportunities, then outlining actions to address the major concerns at the local level. These plans are developed collaboratively with citizens, businesses, farmers, and watershed organizations. Actions recommended in a SWAP typically include planning measures to protect pristine areas from urbanization, programs to encourage citizens to take more action, and implementation of watershed restoration practices to reduce runoff and remove pollutants.

Sustainability Plans
Both Baltimore City and Baltimore County are actively engaged in planning for sustainable futures. Baltimore City has implemented a sustainability plan and incorporated it into the City's Master Plan while Baltimore County's Department of Environmental Protection and

Sustainability works with the Commission on Environmental Quality to address environmental issues.

Published in 2009 and adopted by the Baltimore City Planning Commission, the Baltimore Sustainability Plan seeks to capitalize on the city's population density, significant public infrastructure, and large, diverse stock of existing buildings in order to integrate and market sustainability to attract and retain residents. The Plan includes the Healthy Harbor goal of restoring water quality to swimmable and fishable levels by 2020 and presents strategies that consider the watershed land of both Baltimore City and County. Appendix A presents a detailed comparison of how this plan meets the goals of the City's Sustainability Plan, which include cleanliness, pollution prevention, resource conservation, greening, transportation, education and awareness and green economy. Strategies include implementing the Baltimore Watershed Agreement, studying the creation of a stormwater utility, reducing impervious surfaces, increasing on-site stormwater treatment, and restoring stream corridors.

Baltimore County's Office of Sustainability is part of the Department of Environmental Protection and Sustainability and is responsible for managing, protecting, and enhancing the natural resources of the County. The Office of Sustainability is responsible for a number of resource management programs including forest sustainability, environmental education, and intergovernmental coordination. The Watershed Management and Monitoring Section is responsible for monitoring and protecting the County's watersheds and working with the City, via the Baltimore Watershed Agreement to protect and restore inter-jurisdictional waterways. The County has also established a Commission on Environmental Quality responsible for advising county officials on environmental matters and working with officials to develop environmentally sound and sustainable solutions to environmental issues.

Urban Tree Canopy Goals

Urban tree canopy goals and programs to meet these goals have been identified as part of the strategy for improving the health of the Chesapeake Bay. As such, the Maryland Department of Natural Resources has established voluntary urban tree canopy goals and received commitments from thirty-six communities in Maryland, including Baltimore City and County. Urban tree canopy includes the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. This canopy provides critical stormwater management by intercepting rainfall and slowing and reducing runoff. Baltimore City's urban tree canopy goal is to double the percentage of city land covered by trees from 20% to 40% by 2037. The City's TreeBaltimore Initiative calls for 750,000 new trees by 2040. To achieve the 40 percent canopy goal, Baltimore must plant and care for 25,000 new trees a year. Half of those trees will have to be planted on private property. Baltimore County recently completed its urban tree canopy assessment and is in the process of setting a goal that will be included in the Phase II WIP.

Chapter 3. Sewage Solutions

High bacteria levels in Baltimore Harbor are currently one of the primary concerns limiting its use for recreational activities such as swimming and fishing. The near-shore area of Baltimore Harbor was recently listed as impaired for bacteria based on a sampling program initiated in 2009 by the Baltimore Harbor Waterkeeper and the City's Surface Water Management Division. In addition, total maximum daily loads (TMDLs) for bacteria have been developed for the Jones Falls and Gwynns Falls, the major watersheds draining to the Harbor. Water quality testing by Maryland Department of the Environment (MDE) to define these TMDLs showed that none of the subwatersheds met the State of Maryland's water quality standards for E.coli. Bacterial source tracking studies showed that the major contributing source of bacteria in both of these watersheds is human sewage during both low and high flow conditions (in 45%-60% of the subwatersheds evaluated; MDE, 2006a). Fecal bacteria from domestic animals, wildlife and livestock (in Jones Falls only) are other contributing sources but to a much lesser extent. The TMDL recognizes that not all of the bacterial sources can be controlled but recommends that a reduction of 95% of the human sewage sources and 75% of the pet waste should be achieved through municipal programs (MDE, 2006b).

Reducing discharges of human sewage into Baltimore Harbor is one of the primary elements of this plan given that it is the single largest controllable source of bacteria to the Harbor. Sewage discharges can originate from leaks and breaks in the pipe network or clogs caused by grease or debris, such as rags, that create overflows. In some cases, sewage pipes from houses and business can be directly connected to storm drains through faulty plumbing. In Baltimore City, when a source of sewage is discovered coming from a storm drain, it is classified as a sanitary discharge of unknown origin (SDUO) until the source is identified. If the source originates from the sanitary sewer system it is classified as a sanitary sewer overflow (SSO). Sewage discharges originating from improper connections at households and businesses are referred to as illegal connections, which are one type of "illicit discharge" regulated under the National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) program (Figure 3.1). The MS4 stormwater permits and Consent Decree Programs share the responsibility for detecting and eliminating these various types of sewage discharges.

Figure 3.1. Illicit discharges are defined by EPA as any pollutant discharge to the storm drain system that is not permitted. Vegetative growth on this

The data from the Baltimore Harbor Waterkeeper's sampling program (summarized in Appendix B and Figure 1.4) show while there is substantial bacterial contamination throughout the Harbor, the contamination is not constant and in fact at some stations

the contamination is infrequent. These findings offer great hope in the ability to meet the water quality goals of this plan.

Recommended Strategies

The City and County programs to identify, track and eliminate dry weather sewage discharges have shown the technical capability and wherewithal to be very effective, but need additional resources to achieve the plan goals of eliminating 95% of dry weather sewage discharges by 2020. Most of the strategies recommended in this chapter require that additional resources be applied to these existing programs to make them more systematic and comprehensive. Appendix B contains a Sanitary Sewage Elimination Plan describing a detailed protocol for this approach. Most of the technology described in the plan is familiar to Baltimore City and County staff with some added improvements based on research and experience in communities throughout the Chesapeake Bay Watershed. Eight key strategies are identified for elimination of the "controllable" sources of bacteria from the watershed. The strategies described here are also critical to meeting the nutrient reduction goals of this plan.

Sewage Strategies

1. Implement a public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste
2. Eliminate illegal connections through improved enforcement
3. Improve screening and monitoring for sewage discharges and leaking septic systems
4. Establish water quality benchmarks for stormwater outfalls
5. Increase the success rate of tracking sewage discharges to find the source
6. Increase capacity to quickly and permanently correct sewer leaks
7. Increase coordination and tracking across programs
8. Establish Harbor monitoring program and public notification system

Implement a public education campaign to encourage proper disposal of domestic waste, proper connection of household drains, and disposal of pet waste

Approximately 14.8 million gallons of raw, untreated sewage overflowed into streams and rivers in Maryland from January 1, 2005 through October 6, 2010 due to blockages related to grease, rags, trash and other inappropriate material placed into the sanitary sewer system by citizens and businesses (MDE CSO/SSO Master database). This water quality impairment and public health concern is directly related to lack of public awareness and behavior that can be changed through concerted education and outreach efforts and programs. During the time period identified above, over 530 events occurred in

the City of Baltimore and 151 in Baltimore County, spilling nearly three million gallons of raw sewage into local watersheds and consequently the Harbor and Chesapeake Bay.

Most Chesapeake Bay jurisdictions have existing programs and regulations related to the disposal of fats, oils and grease (FOG) in the sanitary system. Some of these jurisdictions also have FOG education programs geared towards homeowners. Despite the existing programs in place, SSOs from blockages continue to be a problem as reported in the MDE database. In addition, the impact of SSOs from blockages is likely even greater than what is reported to MDE because not all SSOs are reported (e.g., if the volume is not great enough to report) and, when they are reported, the volume is based upon the time of discovery and not when the actual overflow began (a frequently unknown factor).

To address this issue, this plan recommends a joint public outreach program by the City and County in partnership with local non-profits such as Blue Water Baltimore, to increase the breadth of education on the issue by disbursing generated materials to other jurisdictions, watershed groups, and watershed stewards throughout Maryland. A key part of this effort is to conduct an analysis of where SSOs have occurred and target the outreach accordingly. For instance, areas with a high concentration of restaurants may exhibit chronic overflows related to grease. Advising homeowners how to inspect their sewerage system to assure that it is properly connected can substantially reduce the number of discharges from illegal connections. In most cases this would have to be done by a professional plumber and there would be a substantial cost ($1,000-$2,000) to make corrections. This is one of the most important actions that a private homeowner or business can do to improve water quality.

Figure 3.2. Pet waste pickup stations and educational signs can be part of an outreach campaign to encourage proper disposal of pet waste (Source: Center for Watershed Protection).

Bacteria source tracking by MDE to develop the bacteria TMDL determined that between eight and 24 percent of the bacterial load is from domestic animals depending on the watershed. The TMDL assumes the maximum practicable reduction from domestic animals (pets) is 75 percent. This is based on best engineering judgment, best management practice (BMP) efficiency studies, and estimates on the effectiveness of outreach and education programs. There have been several studies of successful social marketing campaigns around the world aimed at reducing pet waste with slogans such as *"Scoop the Poop for Cleaner Streets and Cleaner Creeks"* (Kotler et al., 2008). These campaigns typically include "scoop boxes" or disposal stations with disposable bags (Figure 3.2) and are backed by penalties and fines. This plan supports a recommendation from the Department

of Environmental Protection and Sustainability that public stewardship is the key to reducing bacteria from pet waste.

Eliminate illegal connections through improved enforcement

According to Baltimore City's Quarterly report on the Consent Decree (dated February 2, 2011), 13 of 54 sewage discharges were tracked to private sources (six sewage discharges are inconclusive). Illegal connections of sanitary pipes to the storm drain system are typically identified when the source of sewage is traced to a home or business. These discharges are periodic and generally small, making them very difficult to track from the stormwater outfall and through the storm drain system. Once the source is identified, the investigators must secure permission from the property owners to dye test their plumbing to confirm the discharge. One of the major problems is enforcing the elimination of these illegal connections when found. In Baltimore City, discharges of this nature are the responsibility of the Department of Housing and Community Development (DHCD).

DHCD staff is responsible for enforcing the disconnection of illicit discharges, which often takes several months and sometimes years to complete. Given the expected number of additional discharges that will be identified under this plan, additional staffing will likely be needed for DHCD. An alternative recommendation is to transfer enforcement responsibility to the Pollution Control Section within the Bureau of Water and Wastewater who is responsible for the monitoring and enforcement of illegal discharges into the sanitary system. Enforcement in Baltimore County is handled by Department of Environmental Protection and Sustainability (DEPS), which currently has adequate support for enforcement from within the Department. As DEPS begins expanding their monitoring and tracking program following the recommendations of this plan they will undoubtedly need to increase the level of enforcement for the removal of illegal connections.

Improve screening and monitoring for sewage discharges and leaking septic systems

The first step in controlling dry weather sewage discharges is to find the problem outfalls. A systematic, methodical and comprehensive approach for screening outfalls is recommended, particularly in large and complicated drainages such as those found in Baltimore. This can be done through a comprehensive inspection of the storm drainage network where pipe junctures that are not recorded in City and County records can be identified in a GIS system for follow-up inspection. Finding problems in a watershed involves conducting dry weather surveys of all outfalls and collecting water quality samples from flowing outfalls (Figure 3.3).

Baltimore City inspected their storm drainage network in the 1990s and suspected illegal connections were recorded and samples taken when possible. This led to the elimination of several sewage discharges. A similar program is recommended with improvements that would more accurately locate suspected connections and provide a systematic process for tracking these discharges to identify the source (see Appendix B). Analysis of water quality data collected under the Consent Decree and MS4 Permit Illicit Discharge Detection and Elimination (IDDE) Program (summarized in Appendix B) indicates most of the bacterial sources are below Lake Roland Dam. Therefore, while it is recognized that the County has responsibility for addressing local bacterial impairments in these areas, screening and monitoring efforts should focus below the dam (in Jones Falls), the entire Gwynns Falls and the Direct Harbor drainage.

In addition to an improved screening process, the methods used to isolate sewage sources must be improved or upgraded. For illicit discharge testing, a certain suite of indicator parameters is chosen that

helps to identify the source of the potentially contaminated discharge as groundwater, tap water, washwater, wastewater or an industrial source. Rapid screening methods and strategic sampling in larger drainage areas is recommended to quickly isolate contamination in the drainage system. Methods to rapidly assess ammonia concentrations (which are indicative of a sewage source) should be employed to quickly confirm a continuing problem when tracking a problem discharge and would help decrease the amount of time it takes to track a problem – particularly when the stormdrain network is complex and requires many samples to isolate the problem. Appendix B details the specific recommended rapid screening methods.

Figure 3.3. Identifying illicit discharges requires walking stream channels to evaluate each outfall (Source: Center for Watershed Protection)

Leaking septic systems in the less developed portions of the Harbor watershed are another source of bacteria to the Harbor and its tributaries during dry weather. It is recommended that Baltimore County conduct screening to detect and eliminate these sewage sources. This recommendation focuses on the Gwynns Falls since a review of Baltimore City's monitoring data collected under the MS4 program (summarized in Appendix B) found that Lake Roland mitigates the effect of sewage discharges from the Jones Falls. According to Baltimore County, there are 1,832 septic systems located in the northwestern area of the Gwynns Falls Watershed where no sewer service exists. Baltimore County plans on screening to determine how many of the septic systems in this watershed are leaking. This plan recommends that the County consider adapting the screening and monitoring techniques identified in this plan for detecting leaking septic systems.

Establish water quality benchmarks for stormwater outfalls

At the state level, water quality standards exist for contact recreation and other uses, but these apply primarily to surface waters. There are no standards for stormwater outfalls. Although outfalls are not used by the public in the traditional sense, adopting a set of water quality goals for them is important because the quality of water at the outfall will influence water quality downstream and in the Harbor. Table 3.1 presents a proposed standard for "clean" outfalls. It is recommended that the City and County

use this standard to prioritize contaminated outfalls for further investigation to identify sources, and use these standards when measuring progress towards their goals.

A two-tiered approach is recommended. First, as outfall screening is completed for a watershed, all outfalls with dry weather pollutant concentrations above the Primary Standard listed in Table 3.1 would be prioritized for drainage area investigations to track and remove pollutant sources. Once the majority (95%) of these problems are addressed, investigations would begin on outfalls with pollutant concentrations above the Secondary Standard, with problems being tracked and fixed until eventually at least 95% of all outfalls meet this standard.

Table 3.1. Proposed Water Quality Standards for Prioritizing Investigation of Contaminated Outfalls

Parameter	Primary Standard		Secondary Standard
	"High Flow" Outfalls[a]	"Low Flow" Outfalls[b]	All Outfalls
E. Coli (Freshwater) (col/100ml)	576 [c]	1,000	235[d]
Enterococci (saltwater/brackish tidal waters) (col/100ml)	500[d]	1,000	104[d]
Ammonia (mg/l)	0.1		0.05
Detergents (mg/l) OR fluorescence (fluorescence units)	0.25 OR 0.1		0.15

[a] >36 in outfall OR < 36 in outfall with flow > 0.25 cfs
[b] <36 in outfall where flow is < 0.25 cfs
[c] State of Maryland single sample maximum allowable density for infrequent full body contact recreation: http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.03-3.htm
[d] State of Maryland single sample maximum allowable density for frequent full body contact recreation: http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.03-3.htm Eventually may want to use geometric mean which is more stringent

The proposed Primary Standard for high flow outfalls is based on the State of Maryland's standard for infrequent water contact. Twice this concentration is used as the Primary Standard for low flow outfalls. The proposed Secondary Standard for is based on the State of Maryland's standard for frequent full body contact recreation. Because the flow present at the outfall is also taken into consideration with this method, this ensures that outfalls are prioritized based on the pollutant load, thereby weighting the most problematic outfalls first.

High bacteria concentrations coupled with high ammonia and/or detergents/fluorescence are the most important indicators of sewage discharges, and outfalls that also have high flow rates are likely to be significant contributors of sewage pollution to the Harbor. A number of other parameters are relevant to consider when prioritizing outfalls for tracking as well as to determine which outfalls need immediate, real-time tracking. These are further described in Appendix B.

Increase the success rate of tracking sewage discharges to find the source

Once polluted outfalls are identified, a drainage area investigation is completed to isolate the source of pollution. Baltimore County has had an Illicit Connection Program since 1997. The County is required to

screen a minimum of 150 storm drain outfalls annually for the purposes of detecting and removing unpermitted discharges to the storm drain system. The Watershed Management and Monitoring Section of DEPS are responsible for performing the outfall screenings. They also handle stream complaints and have investigated 342 cases over the last five years. Chlorine, copper, phenols, ammonia, pH and temperature are used to determine if an illicit connection is present. Currently, one full-time staff person manages this and one other program.

In Baltimore City, the Waste Water Engineering Division (WWED) estimates that isolating and tracking the problem and providing engineering assistance can cost an average of $10,200 per site based on 56 sites that have been identified by the Surface Water Management Division (SWMD). Once a storm drain outfall is identified as a suspected source, tracking occurs by moving "up-the-pipe" to systematically isolate the source of contamination (Figure 3.4). Discharges are tracked by collecting samples from manholes sequentially upstream and at lateral branches. The SWMD made significant progress in tracking and eliminating SDUOs with the additional resources given to them from the WWED. This included an inspection team comprised of wastewater engineers and a closed circuit television crew who were charged with the inspection of pipes that cannot be accessed through manholes for monitoring. However, according to the Department of Public Works (DPW)'s quarterly report to EPA ending December 2010, only 28 of 54 overflows were resolved.

Figure 3.4. Tracking the source of a sewage discharge involves sampling "up the pipe" at manholes to isolate the source of contamination.

This plan recommends the following to improve the success rate of tracking and eliminating sewage discharges:

- At least two rapid tracking teams should be available during outfall screenings to immediately track problems since oftentimes illicit discharges can have an intermittent frequency;
- Use of TV inspection capabilities for each of the tracking teams;
- Sampling branches of the stormdrain network rapidly after a problem is found
- Contamination should be quickly isolated in the drainage system; therefore, rapid screening methods and strategic sampling in larger drainage areas is needed
- Interagency meetings to track progress should occur between WWED, SWMD, DHCD and the Utility Maintenance Division of DPW. For Baltimore County, DEPS will have to work with the Bureau of Engineering and Construction and Bureau of Utilities.

Increase capacity to quickly and permanently correct sewer leaks

The City's and County's Consent Decrees by their design are project-specific programs that are managed by the WWED within the DPW in Baltimore City and the Bureau of Engineering and Construction within DPW in Baltimore County. Compliance is ultimately determined by the elimination of SSOs that discharge into the receiving waters. Progress is measured by the number of projects constructed and the implementation of other remedial measures that have been identified through a comprehensive planning process. The Consent Decree stipulates that the elimination of all overflows have to occur by 2016 for the City and 2019 for the County. The initial estimated cost for the City is $900 million (County information was not available). However, the City believes this cost will be substantially higher. This work includes the replacement of pumping stations, the replacement and lining of sewer lines and other improvements to the infrastructure (e.g., maintenance). According to the WWED's web site http://baltimorecity.gov/Government/AgenciesDepartments/PublicWorks/BureauofWaterWastewater/ConsentDecree.aspx, Baltimore City has spent $330 million thus far on capital projects, which has resulted in the elimination of 60 of an estimated 62 structural overflows.

The Consent Decree requires the elimination of all overflows including structural and system-wide overflows that occur randomly in the sewer system, the latter of which are the types of overflows that are the focus of this plan. The elimination of structural overflows can be planned and scheduled in advanced through the Capital Improvement Planning Process. To address "random" overflows, it is essential that the City and County provide enough capital in their annual budgets to cover unforeseen repairs to reduce the time between discovery of the problem and making the repair, which, as stated above, can take years. Several overflows that have been repaired before have reappeared because the "fix" was not permanent. This is because the capital needed for permanent design and construction were not included in the WWED's current budget. A solution to this is for the City and County to retain more on-call contractors that have sufficient resources and flexibility to make major repairs on short notice.

Increase coordination and tracking across programs

The City and County have been working for the past 15 years to identify and eliminate illicit sewage discharges as a programmatic requirement under their MS4 permits. The *identification* of illicit discharges has been extremely successful but their *elimination* after they have been found has been challenging because of the discontinuity between the MS4 and Consent Decree programs. Over the past two years, in an effort to better coordinate these programs at the City level, the SWMD has made substantial gains at developing a protocol for identifying and tracking these problems. However, substantially more resources and better coordination will be needed to meet the challenges of the MS4 permits.

In 2007, the City developed a SDUO action plan to report, investigate, and remediate sewage discharges of unknown origin. The SWMD has been working as a team with the City's Utility Engineering Division (UED) and Utility Maintenance Division to identify and eliminate priority problems. Investigations have shown that sources of sewage in some instances are not a SSO (as defined by the Consent Decree) but have been determined to be illegal connections directly from residences or businesses (City of Baltimore, 2010). These illicit discharges occur, or are observed, during dry weather conditions and are therefore not the direct focus or intent of the Consent Decree and once discovered are turned over to the Code Enforcement Division of the DHCD for enforcement. The results of the SDUO Program are tracked and reported quarterly to MDE and EPA.

Figure 3.5. Sewage discharges that originate from the sanitary sewer, such as this broken pipe, are classified as sanitary sewer overflows in Baltimore City and are the responsibility of the Wastewater Engineering and Maintenance Program (Source: Center for Watershed Protection).

The tracking and elimination of SDUOs is a difficult process that is hampered by the shared responsibility across different organizations within the bureaucracy. The SDUO Program requires the coordination of four different divisions across two departments. In Baltimore County, tracking and elimination of sewage discharges involves the DEPS and the Bureaus of Engineering and Construction and the Bureau of Utilities within DPW.

According to the December 2010 quarterly report of the SDUO Program, of the 54 SDUOs listed since 2007, only 30 have been resolved (City of Baltimore, 2010). Many (24%) of these SDUOs are direct discharges into the storm drainage system from homes, businesses and institutions. While these reports do an excellent job of describing progress, there is no indication of the level of effort and time necessary to resolve these problems.

This plan recommends that the City and County consider modifying their existing Illicit Discharge (under the MS4 permit) and Wastewater Engineering and Maintenance Programs (which include the Consent Decree programs) so that they are better integrated. It is recognized that the Consent Decree is a legal document resulting from months of negotiation and therefore has limitations on flexibility; however, this should not limit coordination between these programs. Increased coordination can be accomplished by establishing program outcomes and milestones for eliminating sewage discharges that are specifically related to meeting the TMDL and the fishable/swimmable goal. In addition, these programs need to improve their accountability, not just to regulators but to the public as well. The City and the County must have an open accountability system that involves the community (e.g., Waterfront Partnership, Blue Water Baltimore) with clear, trackable milestones that translate to improvements to water quality.

Tracking progress will need to be conducted quantitatively as each illicit discharge is repaired. This can be accomplished through a spreadsheet or table such as that described in Appendix B. Each storm drain outfall that exceeds Primary and Secondary Standards should have a plan of action that can be tracked with milestones, water quality data, description of the problem and corrective action. An important

component of the tracking spreadsheet will be to quantify the resulting bacterial reductions to measure progress towards the swimmable/fishable goal as well as to quantify nutrient reductions to measure progress towards TMDL goals. Quantifying pollutant reductions in this manner will require documentation of the initial discharge and concentrations of each pollutant (e.g., TN, TP, bacteria) at each outfall as well as the follow-up concentrations and discharge (if any) in order to calculate the pollutant load and reductions. These reductions should be used as the standard for measuring success.

These actions are consistent with recommendations from the Baltimore Watershed Agreement, which include:

- Evaluate watershed-based bacteria monitoring efforts.
- Determine measures of success in light of pending TMDL mandates.
- Develop consistent indicators, sampling and analytical methodology among City, County and MDE monitoring programs.
- Develop a cross-jurisdictional program for tracking, prioritizing and eliminating sources of domestic wastewater in area waterways.
- Fully coordinate with Consent Decree actions being undertaken by the City and County.

Figure 3.6. The Charles River Watershed Association conducts water quality monitoring of the River and uses a flag system to notify the public of potential risks. The red flag shown here at Union Boathouse indicates poor quality or high risk. It is recommended that a similar system be adopted for Baltimore Harbor. (Source: Charles River Watershed Association).

Establish Harbor monitoring program and public notification system

In developing a baseline conditions report for the Northwest and Middle Branches of Baltimore Harbor, EcoCheck concluded that there is little water quality data to determine the health of the Harbor (Wicks et al., 2011). There has been limited water quality monitoring in the past and only limited monitoring occurring now, which is conducted at select stormwater outfalls by Baltimore City's SWMD. The City and County have an extensive monitoring network throughout the watershed area focused mainly to gauge stream health as required under their respective MS4 permits. No such programs exist or are required for Baltimore Harbor (Baltimore County has an extensive monitoring program for the outer reaches of the Harbor that are outside of the study area). The most recent monitoring effort was a joint bacterial sampling program conducted by the Baltimore Harbor Waterkeeper and SWMD staff during the spring and summer of 2009, which led to the bacterial impairment listing for the Harbor. While this sampling program continued in 2011, a more consistent and scientifically designed program is necessary to determine progress in meeting the goals of this plan. At minimum, this would include a monitoring program for nutrients, turbidity, dissolved oxygen and trash. More detailed recommendations for a monitoring plan can be found in Wicks et al., 2011).

As the implementation of this plan progresses, the City should consider instituting a flag warning system modeled after the one developed for the Charles River in Boston (see Appendix C) and widely used by coastal cities in the United Kingdom and Australia. Such a system uses colored flags indicating water quality conditions, which are determined by weekly bacteria monitoring data. Blue indicates good conditions, yellow indicates elevated risk, and red indicates poor quality or high risk. The City should

develop a plan to identify the most suitable and practical swimming and flag locations. Initial locations may be best placed where access is feasible and water quality already meets contact criteria 75% of the time. The flagging system should be posted on line and at key locations around the Harbor in areas where contact recreation is likely.

Benefits

The elimination of 95% of the dry weather sewage discharges by 2020 should make the Harbor safe for open water swimming (e.g., below the State of Maryland's standard of 104 MPN/100ml enterococci for frequent full body contact recreation) except during heavy rainfall and immediately afterwards, which can be communicated through the monitoring program and flag warning system. This is one of the key most cost effective strategies recommended by this plan. According to the bacteria TMDLs for Gwynns Falls and Jones Falls, the elimination of sewage discharges can help the City and County meet between 50 and 80 percent of their bacteria reduction targets depending on the tributary and that public outreach programs and storm water BMPs can reduce bacteria from pet waste by up to 75 percent.

In addition to reducing bacteria, the elimination of dry weather discharges can also help to achieve the nutrient load reduction goals established by the City and County Watershed Implementation Plans more cost effectively than a plan that relies entirely on stormwater management practices. Figures 3.7 through Figure 3.10 depict the estimated nutrient reductions associated with removal of 95% of dry weather sewage discharges. As shown in these figures, nutrient reduction associated with removal of sewage discharges comprises at least one-third of the nutrient reduction estimated for implementation of all strategies in this plan.

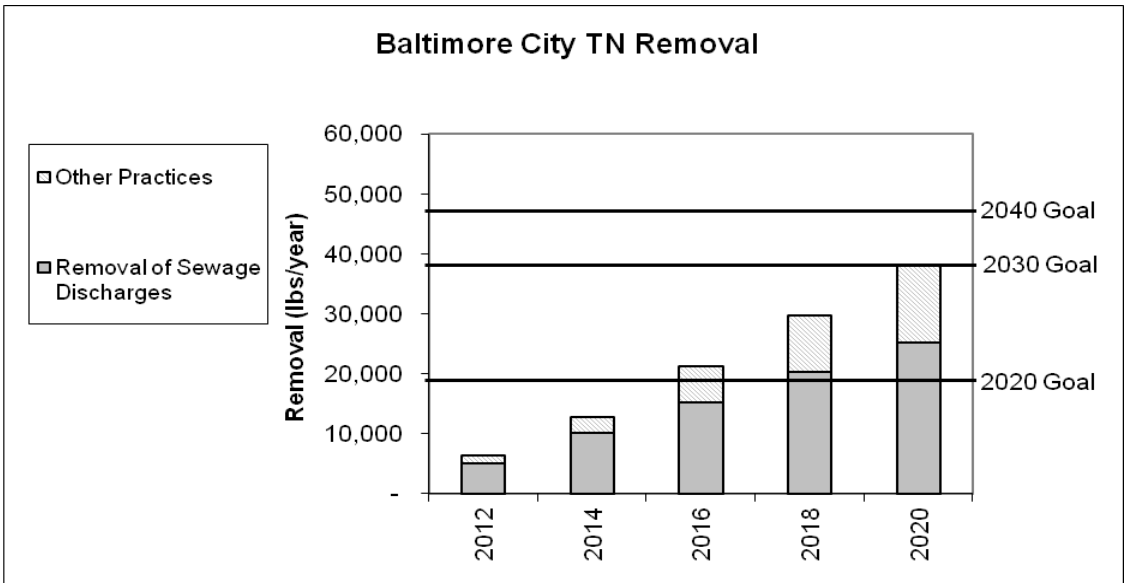

Figure 3.7. Estimated total nitrogen reduction associated with removal of sewage discharges and other practices recommended (e.g., trash collection and screening practices, green infrastructure) in this plan for Baltimore City

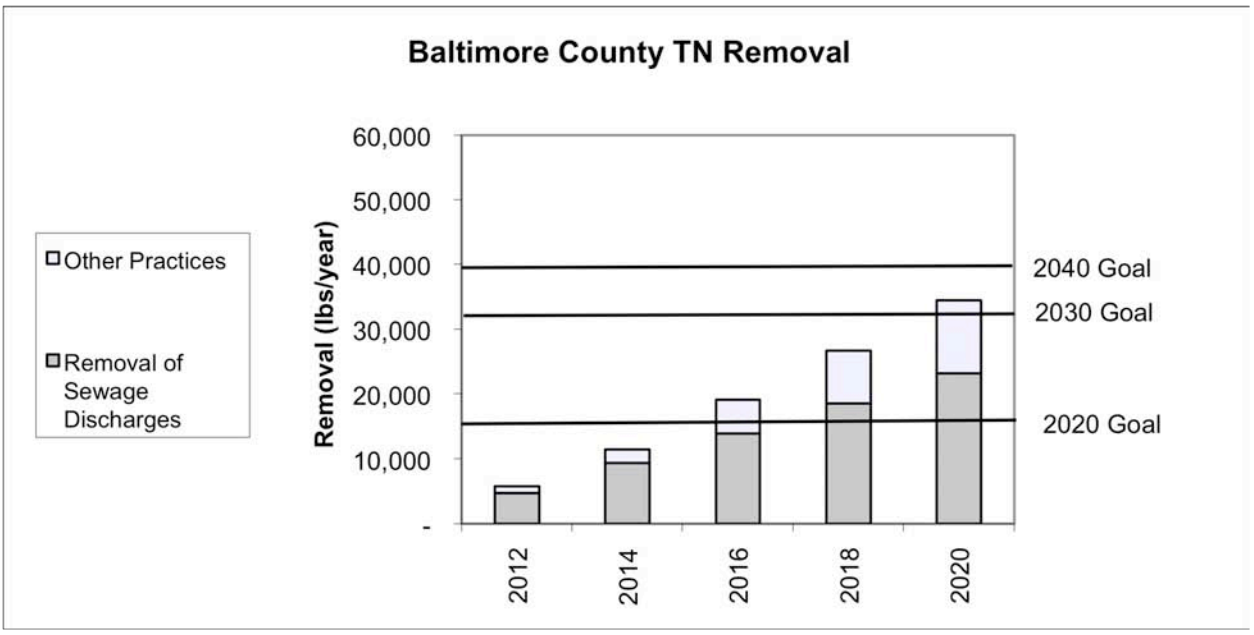

Figure 3.8. Estimated total nitrogen reduction associated with removal of sewage discharges and other practices recommended (e.g., trash collection and screening practices, green infrastructure) in this plan for Baltimore County

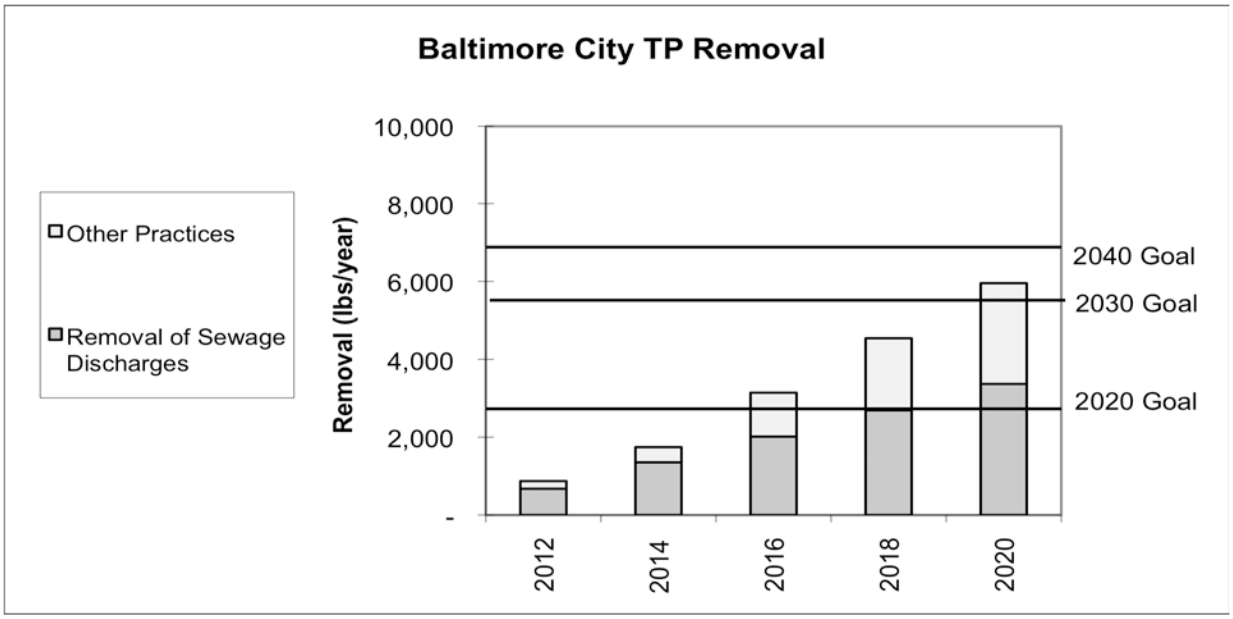

Figure 3.9. Estimated total phosphorus reduction associated with removal of sewage discharges and other practices recommended (e.g., trash collection and screening practices, green infrastructure) in this plan for Baltimore City

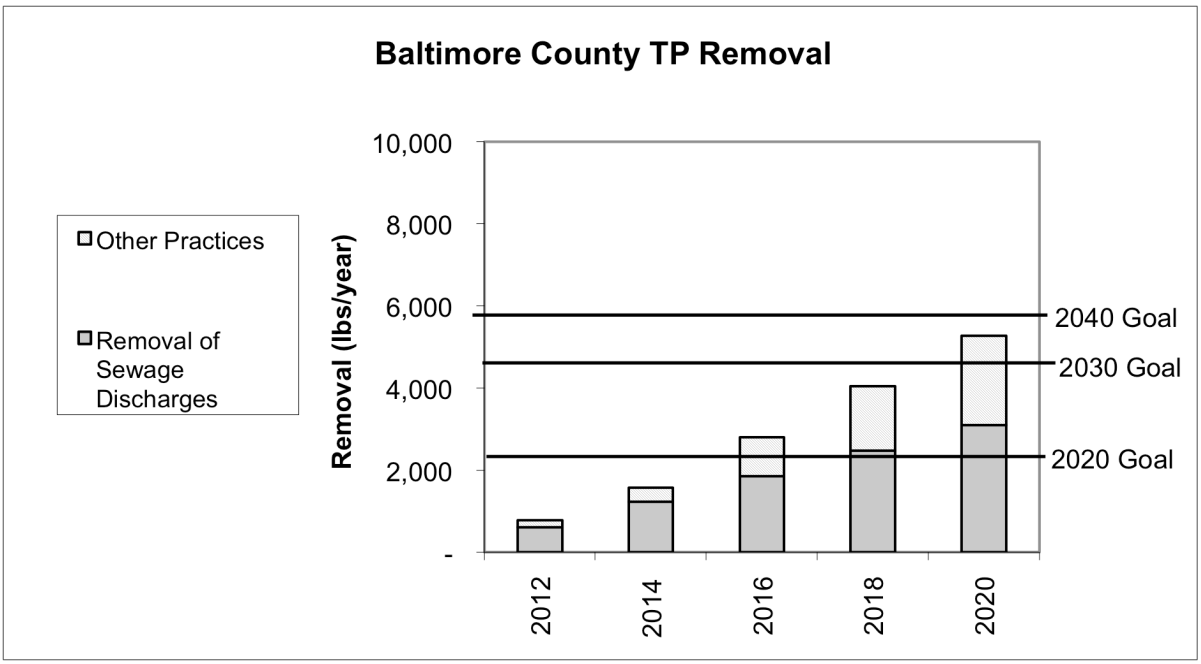

Figure 3.10. Estimated total phosphorus reduction associated with removal of sewage discharges and other practices recommended (e.g., trash collection and screening practices, green infrastructure) in this plan for Baltimore County

Costs

Staff hours required to identify dry weather sewage discharges and track them to their sources are estimated at 12,032 for the City and 7,008 for the County. Appendix B provides a more detailed breakdown of these estimates. While the resources required to track these discharges are fairly well known, the costs of making the repairs are less certain (cost data is lacking and costs are highly variable depending on the nature of the discharge), but likely represent a significant cost to both the City and County. Based on a desktop estimate, the repair costs would likely be on the order of $4 million per year in each jurisdiction, assuming 80 discharges per year, and a repair cost of approximately $50,000 per repair. It is logical that these costs should be covered under the Consent Decree, and the City and County should consider renegotiating the Consent Decrees with EPA and the Justice Department if making the repairs identified in this plan interferes with the scheduling negotiated under the Consent Decree. The City and County should also consider modifying the schedules and work planned under the Consent Decree so that these projects can be prioritized according to impacts to water quality. This could tremendously help the City and County meet bacteria and nutrient TMDLs. Figures 3.11 and 3.12 show the capital costs associated with removal of sewage discharges in the City and County.

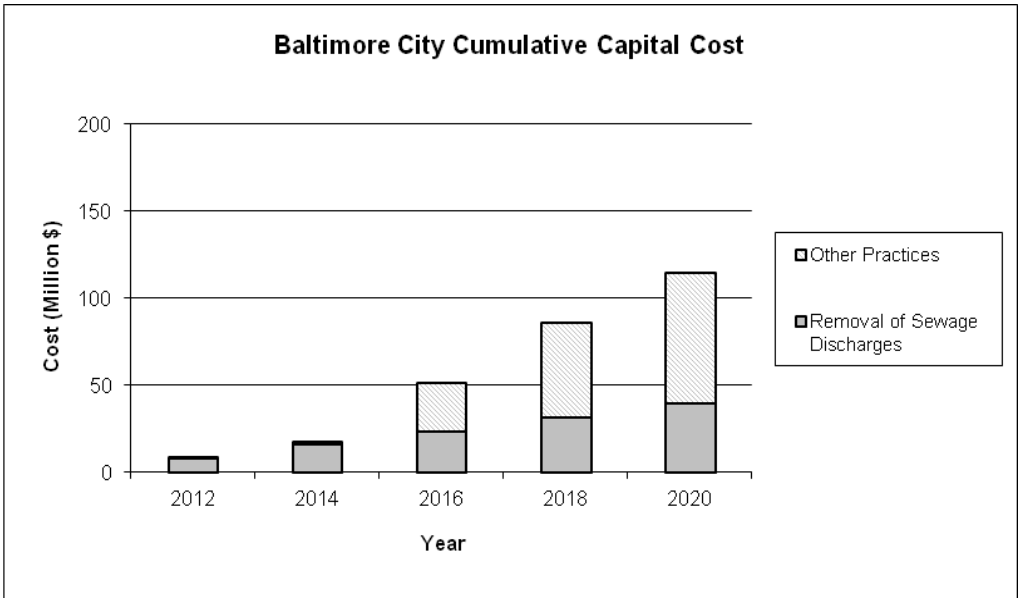

Figure 3.11. Cumulative capital cost associated with removal of sewage discharges and other practices recommended (e.g., trash collection and screening practices, green infrastructure) in this plan for Baltimore City

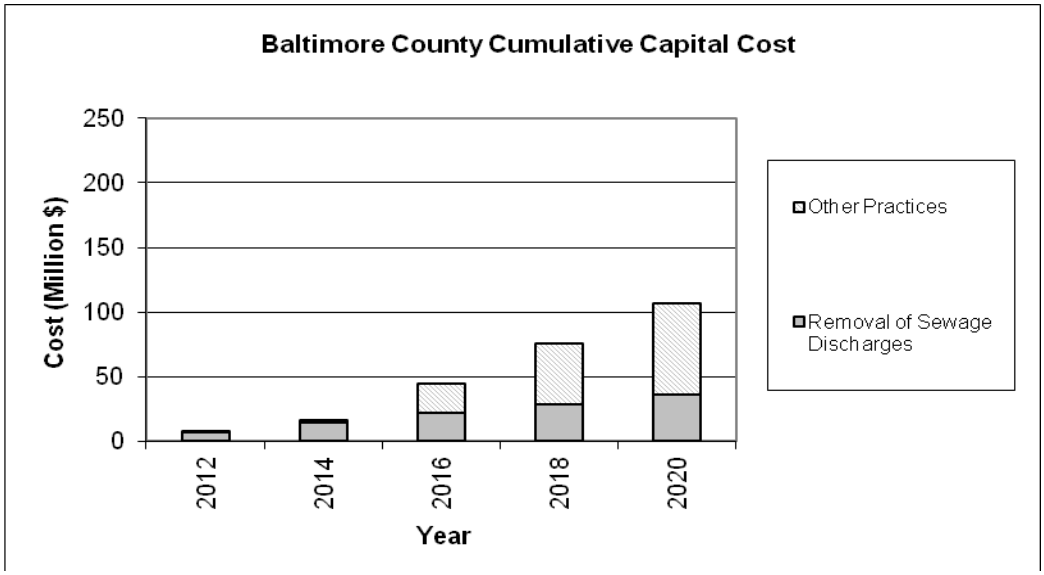

Figure 3.12. Cumulative capital cost associated with removal of sewage discharges and other practices recommended (e.g., trash collection and screening practices, green infrastructure) in this plan for Baltimore County

Schedule

A suggested schedule for implementing the strategies recommended in this chapter is presented in Table 3.2.

Table 3.2. Schedule for Implementation of Sewage Strategies	
Year	**Actions**
2012	• Solicit proposals for the development of a public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste. • Begin comprehensive screening program of all major and minor stormwater outfalls in Baltimore City following the recommended schedule in Table B.7 of Appendix B. This includes adding two dedicated tracking teams with Cable TV inspection capability. • Begin pilot screening program to determine the staffing needs in Baltimore County. • Begin integration of Healthy Harbor Plan into Baltimore Watershed Agreement.
2013	• Begin implementation of public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste. • Complete screening of all storm drain outfalls and rank based on their relative contribution to the sewage loading according to schedule in Table B.7. • Increase monitoring and tracking staffing levels according to Baltimore County pilot study. • Establish Harbor Stat in the City and County and begin tracking progress in tracking and eliminating sewage discharges. • Begin comprehensive inspection of storm drainage system using CCTV to identify illicit discharges. • Eliminate sewage discharges from 30 percent of the outfalls that do not meet the Primary Standard for "clean" outfalls identified through the screening process. • Create and fill a position dedicated to inspecting and enforcing the removal of illicit discharges within the Department of Housing and Community Development. The Alternative is to turn this responsibility over to the Pollution Control Section within the Bureau of Water and Waste Water. • Establish comprehensive Harbor Monitoring and web-based Reporting Program based on recommendations from EcoCheck to monitor improvements associated with implementation.
2014	• Continue public education campaign and begin tracking progress in the elimination of overflows and improper disposal of pet waste. • Eliminate sewage discharges from 60 percent of the outfalls that do not meet the Primary Standard for "clean" outfalls identified through the screening process. • On going monitoring and inspection of outfalls to assure standards are maintained. • Continued comprehensive Harbor Monitoring Program developing data reports for public out-reach use.
2015	• Make adjustments to public education campaign based on progress from surveys or data collection and begin to quantify cost-benefits. • Eliminate sewage discharges from 70 percent of the outfalls that do not meet the Primary Standard for "clean" outfalls identified through the screening process. • Eliminate sewage discharges from 30 percent of the outfalls that do not meet the Secondary Standard for "clean" outfalls identified through the screening process. • On going monitoring and inspection of outfalls to assure standards are maintained. • Continued comprehensive Harbor Monitoring Program.

Table 3.2. Schedule for Implementation of Sewage Strategies	
Year	**Actions**
2016	• Continue public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste and continue to update cost-effectiveness analysis. • Eliminate sewage discharges from 80 percent of the outfalls that do not meet the Primary Standard for "clean" outfalls identified through the screening process. • Eliminate sewage discharges from 40 percent of the outfalls that do not meet the Secondary Standard for "clean" outfalls identified through the screening process. • Continued comprehensive Harbor Monitoring Program.
2017	• On-going public education campaign modified based on metrics used to measure success. • Eliminate sewage discharges from 90 percent of the outfalls that do not meet the Primary Standard for "clean" outfalls identified through the screening process. • Eliminate sewage discharges from 50 percent of the outfalls that do not meet the Secondary Standard for "clean" outfalls identified through the screening process. • On going monitoring and inspection of outfalls to assure standards are maintained. • Continued comprehensive Harbor Monitoring Program.
2018	• On-going public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste. • Eliminate sewage discharges from 95 percent of the outfalls that do not meet the Primary Standard for "clean" outfalls identified through the screening process. • Eliminate sewage discharges from 75 percent of the outfalls that do not meet the Secondary Standard for "clean" outfalls identified through the screening process. • On going monitoring and inspection of outfalls to assure standards are maintained. • Continued comprehensive Harbor Monitoring Program.
2019	• On-going public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste. • Eliminate sewage discharges from 90 percent of the outfalls that do not meet the Secondary Standard for "clean" outfalls identified through the screening process. • On going monitoring and inspection of outfalls to assure standards are maintained. • Continued comprehensive Harbor Monitoring Program.
2020	• On-going public education campaign to encourage proper disposal of domestic waste, proper connection of household drains and proper disposal of pet waste. • Eliminate sewage discharges from 95 percent of the outfalls that do not meet the Secondary Standard for "clean" outfalls identified through the screening process. • Establishment of a flag-based warning system for water contact recreation similar to the Charles River using monitoring data from the Harbor and Storm drain outfall sampling programs.
2021 on	• On-going public education campaign highlighting success of campaign contributing to meeting swimmable fishable goals. • On going monitoring and inspection of outfalls to assure standards are maintained. • Continued comprehensive Harbor Monitoring Program. • Continued operation of flag-based warning system for water contact recreation using monitoring data from the Harbor and Storm drain outfall sampling programs.

To meet fishable and swimmable goals for the Harbor, an adaptive management approach will be needed to ensure that pollutant reduction goals are met. If milestones are not met at strategic points in the timeline, then it will be necessary to add more resources and manpower to reach the end goal. The process of finding contaminated outfalls and tracking them to their source should be considered iterative, and should be repeated in its entirety year after year for the study area. After the initial tracking, teams should be available for validation screening, which should be an ongoing process. Interagency meetings tracking progress should occur between DHCD, UED, SWMD, and the Utility Maintenance Division of DPW in Baltimore City. For Baltimore County, DEPS will have to work with the Bureau of Engineering and Construction and Bureau of Utilities.

References

City of Baltimore, 2010. City of Baltimore Sanitary Sewer Overflow Consent Decree Civil Action No. JFM-02-1524 Calendar Quarterly Report No. 31 for Calendar Quarter ending June 30, 2010-Submitted: July 28, 2010

Kotler, P, Lee, N.R., and Lee, N. 2008. Social Marketing. Influencing Behavior for Good. Sage Publications.

MDE, 2006a. Total Maximum Daily Loads of Fecal Bacteria for the Non-Tidal Jones Falls Basin in Baltimore City and Baltimore County, Maryland FINAL DEPARTMENT OF THE ENVIRONMENT. Submitted to: Water Protection Division U.S. Environmental Protection Agency, Region III 1650 Arch Street Philadelphia, PA 19103-2029 September 2006

MDE, 2006b. Total Maximum Daily Loads of Fecal Bacteria for the Non-Tidal Gwynns Falls Basin in Baltimore City and Baltimore County, Maryland FINAL DEPARTMENT OF THE ENVIRONMENT. Submitted to: Water Protection Division U.S. Environmental Protection Agency, Region III 1650 Arch Street Philadelphia, PA 19103-2029 September 2006.

Wicks, E.C., Kelsey, R.H., and S. L. Powell. 2011. *State of Baltimore Harbor's Human and Ecological Health 2011.* Chesapeake EcoCheck.

Chapter 4. Trash Solutions

Trash is a major contributor to poor water quality and degrading habitats in Baltimore Harbor and the Chesapeake Bay. During storms, trash (e.g., plastic, Styrofoam, metal, glass) and associated pollutants deposited in the urban landscape are washed off of impervious surfaces into storm drains, streams and the Harbor (Figure 4.1).

Figure 4.1. Trash deposits in the Middle Branch of Baltimore Harbor (Source: Alan Cressler, USGS)

To address the trash problem in the Harbor, the Maryland Department of the Environment (MDE) is developing a total maximum daily load (TMDL) for trash, which will be completed in 2012. The draft municipal separate storm sewer system (MS4) permits require Baltimore City and Baltimore County to develop a trash reduction strategy and the City and County are currently collecting data to determine the pollutant load baseline and the required reduction using best management practices (BMPs). Because the monitoring studies from the City and County are not complete, the assumptions used in this chapter regarding trash loading rates and efficiencies of BMPs to control trash were derived from data obtained from the City of Los Angeles and the District of Columbia. Both of these municipalities have trash TMDLs and implementation plans.

Other pollutants that are commonly associated with trash include “gross stormwater solids,” which are larger particles from soils, building materials and other sources and organic debris from decaying leaves, twigs and grass clippings. Research shows that this organic debris may be a significant nutrient source to urban streams as the natural capacity of watersheds to process these nutrients is lost when streamside forests and wetlands, which have the ability to transform and cycle pollutants, are replaced

with storm drains. Because gross stormwater solids are commonly attached to trash and can be captured using trash capture BMPs, many of the strategies in this chapter will reduce nutrients and sediment as well as trash.

Recommended Strategies

The major goal addressed in this chapter is to reduce trash loading by 75% by 2020 and by 100% by 2030. A secondary goal addressed is to reduce nutrient and sediment loads by the amounts required by the City and County MS4 permits. The following strategies are proposed to meet this goal:

Trash Strategies

1. Develop a public outreach plan to reduce trash and litter and increase enforcement of existing litter and trash disposal regulations
2. Support new legislation aimed at eliminating plastic bags and bottles
3. Conduct a trash survey to identify high trash generation areas for targeting management actions and public outreach especially for developing Clean Water Community Plans (see Chapter 5)
4. Install green infrastructure and other volume control stormwater management practices to capture trash from stormwater runoff
5. Increase implementation of practices that prevent trash from entering storm drains such as street sweeping and inlet grates
6. Increase practices that capture trash at storm drain outfalls and waterways

Develop a public outreach plan to reduce trash and litter and increase enforcement of existing litter and trash disposal regulations

This strategy has multiple parts that are inter-related. Anti-littering campaigns can be extremely effective in changing behaviors and reducing litter. A study of anti-litter advertising programs from five jurisdictions have been shown to reduce litter an average of 27 percent with an average cost of $0.38 per capita (Gershman et al., 2004). More comprehensive statewide programs that include voluntary clean-ups, outreach and education, litter hotlines, increased enforcement, and beautification projects can be even more effective and have reported total litter reductions to average 75 percent (Gershman et al., 2004). However, the programs that have reported these success rates had been in place for several years.

The City of Los Angeles has used trash surveys to understand littering behavior and target a multi-media outreach campaign towards businesses in communities that have the highest trash generation rates. Their surveys also identified demographics associated with increased littering behaviors (e.g., teens) and locations (e.g., fast food establishments) to assist in targeting the campaigns. The City focused its efforts

on billboards, bus advertisements, bus benches and print advertisements in community papers in the high trash generating areas. The campaign has not been in effect long enough to measure benefits in reducing trash loadings.

It is recommended that the City and County initiate a sustained public-outreach campaign that has multiple messages targeting the high trash generation areas. Working with the residents in stressed neighborhoods will accomplish two goals. First, the neighborhoods will be trash free and second, the quality of life will be improved. Developing a joint campaign was one of the Action Items of the Baltimore Watershed Agreement. The messaging of these campaigns should focus on the positive aspects of "clean streets and neighborhoods" but should also clearly describe the proposed action, sanitation codes and laws, and consequences of violating these codes, which include penalties and fines (Figure 4.2). These campaigns should be integrated into the Clean Water Community Plans that are described in Chapter 5.

Figure 4.2. Truck billboard created as part of Baltimore City's anti-litter campaign (Source: Planit)

Studies have shown limited success with increased enforcement of litter laws (KAB, 2007) because of the relatively low fines, overcrowded court dockets and uninformed judges presiding over the cases. Other major problems with enforcement are that the public is not always aware of the laws and sanitation codes because it includes a broad range of activities such as recycling, street sweeping, and litter enforcement that are housed under different agencies such as solid waste management, public works or transportation departments and police. The public outreach campaign recommended here can help to make enforcement more effective by educating people about the consequences of littering. Another way to improve enforcement is to evaluate municipal programs to identify ways to streamline, consolidate and improve trash reduction or collection and litter enforcement. A review of existing programs involved with trash reduction will allow a comprehensive look at what is currently being done across departments and how much is begin spent on trash reduction or collection. The results can be used to evaluate the ability of current program staff to implement any new trash reduction polices being considered and determine if consolidation or integration is needed to make more efficient use of resources and/or make department staff more aware of their role in trash reduction.

Support new legislation aimed at eliminating plastic bags and bottles

Bottle bills (also known as container deposit laws) require a refundable deposit on water and beverage containers. The refund value of the container (usually 5 or 10 cents) provides a monetary incentive to return the container for recycling. The City and County should consider taking action to support a statewide bottle bill in 2012. Previous efforts to pass bottle bills in Maryland have not been successful and, in recent years, have focused on development of a task force to study required deposits on containers (www.bottlebill.org). Because bottle bills are most effective when applied on a statewide level, pursuit of a local bill is not recommended at this time. Proponents of a statewide bottle bill are looking to get high profile national groups involved (e.g., Sierra Club) in addition to working with lobbyists, and hope that Baltimore's upcoming trash TMDL will garner more support for the bill.

Figure 5.3. Bottles and bags comprise a visible portion of trash deposited on the shore of the Middle Branch (Source: Alan Cressler, USGS)

The Anacostia Trash Reduction Plan for the District of Columbia (Anacostia Watershed Society, 2007) identifies political action as one of their most important trash reduction strategies. Using trash and litter surveys has helped them determine the potential effectiveness of different legislative actions. For instance, the single largest component of trash in the Anacostia is plastic bags. Therefore, based on their survey, they have estimated that legislation requiring plastic bags to be biodegradable will effectively remove 47 percent of the trash from the tributaries and 21 percent from the main stem of the river. Legislation that would eliminate the use of Styrofoam for food containers has the potential for eliminating 5 percent in the tributaries and 11 percent in the main stem, while a bottle bill will remove about 25 percent of the total trash from the tributaries and main stem (Anacostia Watershed Society, 2007). Data collected from a watershed-wide trash survey (see page 5-5) should demonstrate the potential trash reductions possible from a bottle bill, which can help to increase political support.

With a bag tax, consumers are charged a tax for every paper or plastic bag they use in any store with a food license (grocery stores, pharmacies, department stores). Of the tax amount, the retailer keeps a portion and the rest goes into a fund designated for trash cleanup or other water quality restoration activities. The Alice Ferguson Foundation and the Trash Free Maryland Alliance are working to have a statewide bag tax introduced into the Maryland Legislature in 2012. The City and County elected

officials should take action to support a statewide bag tax in 2012. In the event the statewide legislation is not passed, the City and County should consider pursuing a local bag tax modeled after the District of Columbia (DC), described below.

The Anacostia River Clean Up and Protection Act (i.e., DC's "Bag Law") requires all DC businesses selling food or alcohol charge five cents for each disposable paper or plastic carryout bag. The business keeps 1 cent (or 2 cents if it offers a rebate when customers bring their own bag) and the remaining 3 or 4 cents goes to the new Anacostia River Protection Fund. Almost immediately after implementation of the bag law in early 2010, businesses began seeing a drastic reduction in bag usage and environmental clean-up groups witnessed fewer bags polluting DC waterways (an estimated 70% reduction in plastic bag litter from 2009 to 2011). This law is the first of its kind in the U.S. One lesson learned from DC is that a fee works better than a ban because it provides an economic incentive to change behavior. One hurdle with this tax is psychological (for consumers), but it actually provides an incentive for retailers. The tax should be coupled with free reusable bag giveaways so that it is not perceived as a regressive tax.

Baltimore City currently has a plastic bag reduction program that requires all stores with a Food Service License from the City Health Department to register in the program and maintain records. Dealers may not distribute single use plastic bags unless a customer specifically requests one and, if requested, a plastic bag given by a food dealer must say in words visible to the consumer "please return to a participating store for recycling." The program is based on punitive measures as opposed to incentives to reduce trash, and so far, only a small proportion of stores have registered. In addition, there are no City resources available to enforce the program. It is recommended that the effectiveness of this program be tracked for one year and the results used to determine whether to pursue a local bag tax modeled after DC in lieu of this program.

Conduct a trash survey to identify high trash generation areas for targeting management actions and public outreach

Litter surveys can be used to determine the factors influencing littering behavior (e.g., the relevance of age or other demographic), as well as the spatial distribution of litter across the landscape. Litter surveys typically involve stratified random sampling to count items of litter above a certain size for different land use categories and use GIS to extrapolate the data region wide. The approach is similar to surveys conducted by foresters to identify the population distribution of tree species in a forest. If it is expected that other factors besides land use are more important in trash generation (e.g., property ownership) the survey can be adjusted accordingly. The City of Los Angeles conducted surveys to identify hotspots

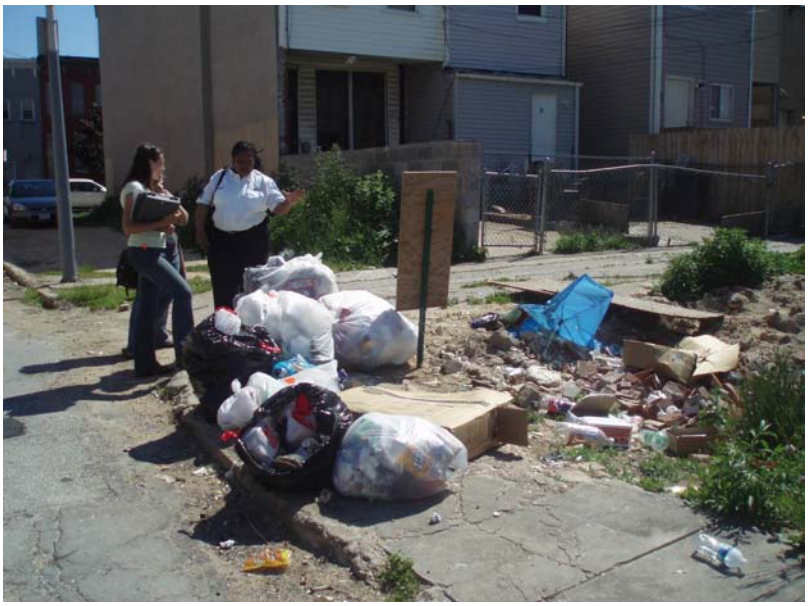

Figure 5.4. Trash hotspot survey being conducted in the Harris Creek watershed in Baltimore City Source: Center for Watershed Protection)

for targeting trash management practices as well as to inform messaging for outreach campaigns to address the Los Angeles and Ballona Creek Trash TMDL (see case study).

Case Study: Los Angeles Trash TMDL
Due to excessive amounts of trash in Ballona Creek and the Los Angeles River, the Environmental Protection Agency developed a Trash Total Maximum Daily Load (TMDL) in 2001 and revised it in 2007. The TMDL requires cities within the river's watershed to reduce their trash contribution by ten percent each year with a goal of 100 percent trash reduction in the river by 2016. The City of Los Angeles's strategy for compliance combines institutional measures like public outreach, street sweeping, and enforcement with structural measures like trash screens across storm drain inlets.

The City conducted surveys to identify hotspots for targeting trash management practices as well as to inform messaging for outreach campaigns to address the Los Angeles and Ballona Creek Trash TMDL. Los Angeles found from their surveys that 30 percent of the area generated over 60 percent of the trash. The litter surveys divided the city into three categories (low, medium, and high) based on trash generation rates and the results have been used to target management practices (LA County, 2009). To date, Los Angeles has installed over 32,000 inlet screens and 13 netting systems in high trash generation areas and has achieved a 60 percent reduction in their baseline trash load based on this prioritization method (LA County, 2009). They have also launched an outreach program targeting businesses (e.g., fast food) that have been identified as likely sources.

In 2009, the CWP surveyed four areas of the Harris Creek watershed to determine the types and distribution of litter (Figure 4.4) for Baltimore City DPW. This survey can be used and expanded watershed-wide. Alternatively, Keep America Beautiful Inc. conducted a comprehensive review of litter survey protocols adopted by other communities (KAB, 2007) which can be used. This plan recommends that the City and County conduct a bi-annual litter survey to identify the spatial distribution of litter to identify the high trash generation areas for the installation of retractable inlet grates, street sweeping and netting systems. In addition, these surveys can provide critical information about the source areas (e.g., fast foods) and collection areas (e.g., bus stops) for targeted outreach.

Install green infrastructure and other volume control stormwater management practices to capture trash from stormwater runoff
Keep America Beautiful (KAB) is a national non-profit that was established in 1953 and is dedicated to reducing trash and litter throughout the nation. In 2007, KAB funded a comprehensive study to measure public attitudes regarding littering behavior (KAB, 2007). The study found that community clean-ups are typically short-lived. However, one of the findings is that communities that make a beautification effort through landscaping and cleanliness have a positive effect in reducing littering behavior. An attractive neighborhood promotes a sense of personal responsibility not to litter.

The installation of green infrastructure practices and other measures identified in neighborhood greening plans (see Chapter 5) could dramatically improve the look and feel of neighborhoods, which can positively influence littering behavior. Furthermore, green infrastructure practices that capture and temporarily store stormwater runoff, as well as conventional stormwater practices such as extended detention ponds, are ideally suited to capture and retain trash. This plan recommends implementation of 3,645 green infrastructure practices to reduce stormwater runoff, sediment, and nutrients (see Chapter 5). If properly maintained, these practices will capture and retain all of the trash from the

contributing drainage area. Using an assumed trash load, and an estimated capture rate (depending on the specific practice), it is estimated that these practices, combined with practices implemented as redevelopment occurs, will capture about 5% of the trash load by 2030.

Increase implementation of practices that prevent trash from entering storm drains

This strategy focuses on preventing trash from entering the storm sewer system through stormwater inlets (also called catch basins). This will be a huge undertaking however, it is likely that the maintenance cost can be greatly reduced as a result of litter reduction through the outreach strategy identified earlier. The first part of this strategy is to increase the number of trash receptacles in high trash generation areas, as determined by the trash survey described above. The exact number of receptacles and frequency of emptying cannot be determined until a comprehensive trash survey is completed. The Institute for Applied Research found that trash receptacles placed in areas with high trash generation rates (commercial areas, play grounds, bus stops) can have a positive effect in reducing litter to the nearby area (Gershman et al. 2004). The study, which took place in the In the 1970s and early 1980s in six states and two cities, found that, in general, the receptacles averaged 40 percent effectiveness in reducing litter.

There are approximately 31,250 storm drain inlets within the study area of Baltimore City (comparable to Los Angeles, which has 35,000). These inlets should be categorized according to whether the trash generation rate of the upstream area is low, medium or high based on criteria developed from the litter survey. This strategy assumes that all storm drain inlets (excluding street grates) within the highest trash generation areas will be fitted with inlet screens. Inlet screens are typically a perforated metallic plate placed at the opening of the inlet to prevent trash and other large debris from entering the storm drain system. While there are many varieties of inlet screens, this strategy recommends a retractable configuration (Figure 4.5) so that it can open to allow large storm flows to enter unimpeded, thereby preventing excessive ponding or flooding. Typically, these screens remain in the closed position by means of magnetic anchors that release when runoff from large or intense storms build up to a predetermined percentage (e.g., 60 percent) of the curb height. Once the flow recedes, the screens close and lock by means of the magnet anchors. The screens are designed to keep trash and debris greater than one inch in diameter from entering the inlet chamber. Besides curb inlets, there are inlet grates that are flush with the street surface that will require a fixed screen, which will require additional maintenance.

Figure 4.5. Retractable inlet screens and street sweeping are two key strategies recommended to reduce trash (Sources: City of Los Angeles Stormwater Program http://www.lastormwater.org/siteorg/program/poll_abate/cbscreens.htm and Center for Watershed Protection).

Implementation will involve conducting initial pilot studies to determine performance and maintenance frequency; installing the inlet screens; and, depending on progress in meeting the TMDL through institutional and other programs (e.g., net capture devices), installing the inserts. Depending on the success of the pilot study, retractable inlet screens would be attached to the insides of 6,700 stormwater inlets in Baltimore City and 5,600 inlets in Baltimore County. This will control trash from 50 percent of the impervious surfaces in highest trash generation areas.

The key to making this strategy work is to remove the trash that accumulates on or adjacent to the screens before each major storm event. Los Angeles has a much drier and warmer (above freezing) climate (approximately 15 inches per year) than the Baltimore area (40 inches per year), as well as a clearly defined rainy season, which reduces the need for continuous street sweeping. Alternatively, the City will have to clean the streets adjacent to the screened inlets at least weekly (preferably biweekly) with street sweepers or road crews (Figure 4.5). This is the recommended strategy that is being proposed by the District of Columbia's Department of the Environment to meet the trash load reductions for the Anacostia River TMDL, where they found retractable screens in combination with street sweepers to be the most cost effective trash BMP compared to larger and more complicated trash capture and filtering devices.

Using the estimates from DC, the City would have to purchase an additional 66 regenerative air street sweepers (113 in the County) as well as supporting staff to achieve the trash reduction goal. This will result in an estimated 240,000 additional curb miles swept each year in Baltimore City and 395,000 in Baltimore County (current curb miles swept in Baltimore City average 80,000 per year[1]). Working with community organizations to keep the inlets and curbside clean could also be a cost effective alternative. Communities could be paid or a jobs program developed (e.g., students, work release prisoners) from the revenue that the City would otherwise have to invest in keeping the screens cleaned.

In addition to the retractable inlet screens, this strategy includes the addition of inserts in the inlet chamber below the screens (see Figure 4.6). There are dozens of proprietary storm inlet or catch basin inserts that can be inserted into storm drain inlets for removing trash or filtering pollutants. Most of these are prefabricated devices that typically incorporate filters or fabric and are placed within the curb opening. However, one of the simplest varieties includes metal screens placed horizontally or vertically within a catch basin. This will especially be useful for inlet grates that are flush with the road surface and cannot be fitted with retractable grates.

1 Baltimore County estimates are based on the average miles swept per sweeper for Baltimore City.

Figure 4.6. Catch basin inserts can remove 100 percent of trash from contributing drainage areas (Source: City of Los Angeles Stormwater Program http://www.lastormwater.org/siteorg/program/poll_abate/cbscreens.htm)

The City of Los Angeles has installed 7,400 of these in high trash generation areas and prefers this design because most of the available storage volume inside of the inlet chamber is used and large flows are allowed to pass through without clogging. These inserts are considered to be "full capture trash removal devices," which means that, if maintained properly, they are considered to remove 100 percent of the trash from the contributing drainage area. Maintenance of these devices typically requires access through a manhole and cleaning using a vacuum truck. The cleaning frequency can be reduced considerably when used in series with the retractable inlet grate attached to the inlet opening, as is recommended here.

Increase practices that capture trash at storm drain outfalls and waterways

While preventing trash and debris from entering the storm sewer system is a very important component of efforts to reduce trash in the Harbor, in some cases, it may be most appropriate to employ structural controls to ensure that trash and debris entering the storm drain system is captured before it can reach the Harbor. In these cases, end-of-pipe trash interception devices can be a cost effective option. This strategy recommends that the City install 134 nets and the County install 112 nets on stormwater outfalls associated with 50% of the highest trash generation areas.

There are numerous manufacturers of proprietary end-of-pipe devices, and each one has its benefits and drawbacks. In general, these devices consist of a net, screen, or basket secured to the end of a stormwater outfall pipe or culvert, with an overflow mechanism included to bypass high flows if the device gets clogged (Figure 4.7). Design variations address structural work necessary to install the device on an existing culvert, the type of overflow mechanism, and the use of disposable or reusable net or screening systems. Baltimore City

Figure 4.7. Outfall netting devices capture trash from the storm drain system before reaching local waterways (Source: Kristar, Inc.)

installed several netting systems and found that net systems work best when they are underground and off-line where storm flows can bypass the nets if they get clogged. These devices tend to have a very high trash capture efficiency, with many studies indicating removal rates of over 90%, and are generally considered full capture devices. However, maintenance requirements can be burdensome, particularly where trash generation rates are high, and frequent clean out of the devices will be necessary.

Given the range of products available, and the range of outfall types that exist in the Harbor watershed, it is likely that several different manufacturers or product types would be required to meet the needs of in the watershed. Nettech, from Kristar Enterprises, Inc. is one option that seems well suited for conditions in the Harbor watershed. Talbot County Government recently installed one on an elliptical pipe and plans on installing three more as part of a study to measure the effectiveness of this practice in capturing trash and removing nutrients and other contaminants.

Nettech is a re-usable net system that attaches directly to the outfall pipe. When full, the weight of the trash or the force of the water coming through the pipe releases the net from the end of the pipe, thereby avoiding flooding problems that could be caused by a clogged net. A tether attached to the net pulls the net closed and holds it in place. The net can be removed by a truck- or boat-mounted crane and emptied. This design will provide three important benefits for the Harbor watershed: 1) trash will not be re-introduced into the water through tidal action or once the net is full, as the net will be either attached directly to the outfall or released on the tether and cinched shut; 2) water backups and flooding will not be caused by the net between maintenance visits; and 3) design and installation costs are reduced, as additional infrastructure does not need to be constructed to accommodate the netting systems because they attach directly to the outfall.

Devices such as Nettech can be installed on nearly any outfall pipe that discharges to either streams or the Harbor itself (sizes range from 12 inches to 70 inches in diameter, and custom sizes are also available). The key factor in scalability of the devices is the available access to a given outfall. Since maintenance activities will likely need to occur frequently, and require a truck- or boat-mounted crane, the most feasible sites are those, which allow very close vehicular access. Determining this will generally require individual site inspections. Given the relatively high installation and maintenance costs associated with end-pipe devices, it is recommended that their installation be focused on the largest outfalls where trash and debris are most problematic.

The installation of inlet grates, inserts and netting systems as well as increased street sweeping can never be 100 percent effective. Therefore, this strategy includes installation of a “continuous removal” trash and debris capture device similar to the Water Wheel that use to be located at the mouth of the Jones Falls and later Harris Creek (Figure 4.8). A study on the effectiveness of the Water Wheel is forthcoming from Baltimore City Department of Public Works. However, the basic concept of a “catch-all” continuous trash removal device should be a major component of the City and County’s trash reduction strategy specifically located where major tributaries enter the Harbor (e.g., Jones Falls, Gwynns Falls). The basic components of this type of system include trash booms to funnel the trash to a continuously moving conveyor belt. The conveyor belt then lifts the trash to a container or “roll-off.” The process is similar to the mechanical screens installed in the influent of waste treatment plants to remove floatable materials. Not only does this type of practice provide “back up” to watershed control efforts, but the installation of these practices also allows the City and County to claim immediate trash load reductions, thereby allowing time to test and install the watershed-based (e.g., retractable grates) controls upstream.

Figure 4.8. The Water Wheel formerly located at mouth of Jones Falls in Baltimore City funnels trash onto a conveyor belt (Sources: Baltimore City Department of Public Works, Talbot County Department of Public Works)

Benefits

Since the Harbor trash TMDL is still under development, data from the Anacostia River Basin TMDL (Anacostia Watershed Society, 2010) were used to characterize trash-loading rates (Appendix D) for Baltimore City based on a trash generation study that associated land cover with trash generation. Two findings from the Anacostia study were utilized for this report. First, we assumed an average trash-loading rate of 5 lbs/acre (for all land uses). Second, we assumed that the associated organic debris was equivalent to 20 times the trash-loading rate. In addition, we assumed that 75% trash capture can be achieved by concentrating on the outfalls with the greatest trash load potential. This percentage will have to be verified by the trash survey.

The practices described in this chapter not only capture trash but other debris that are referred to as gross stormwater solids. These solids carry a significant amount of nutrients and other contaminants that are not reflected in urban runoff values used by water quality models. This is because these larger particles are filtered from most water samples used in chemical analysis of runoff. The organic debris from decayed plant material (e.g. lawn clippings and trees) is extremely rich in nutrients and other contaminants. The Anacostia study estimated that as much as 95 percent of the debris collected by trash capture devices is organic debris from plant material (Anacostia Watershed Society, 2007). This was also one of the key findings of a street sweeping effectiveness study initiated under the City of Baltimore's MS4 program, which found that street dirt is extremely "rich" in nutrients and other contaminants (City of Baltimore, 2004). Figure 4.9 through Figure 4.12 show the estimated nutrient reductions attributed to installation of trash removal practices recommended in this chapter. (See Appendix D for details on the methodology).

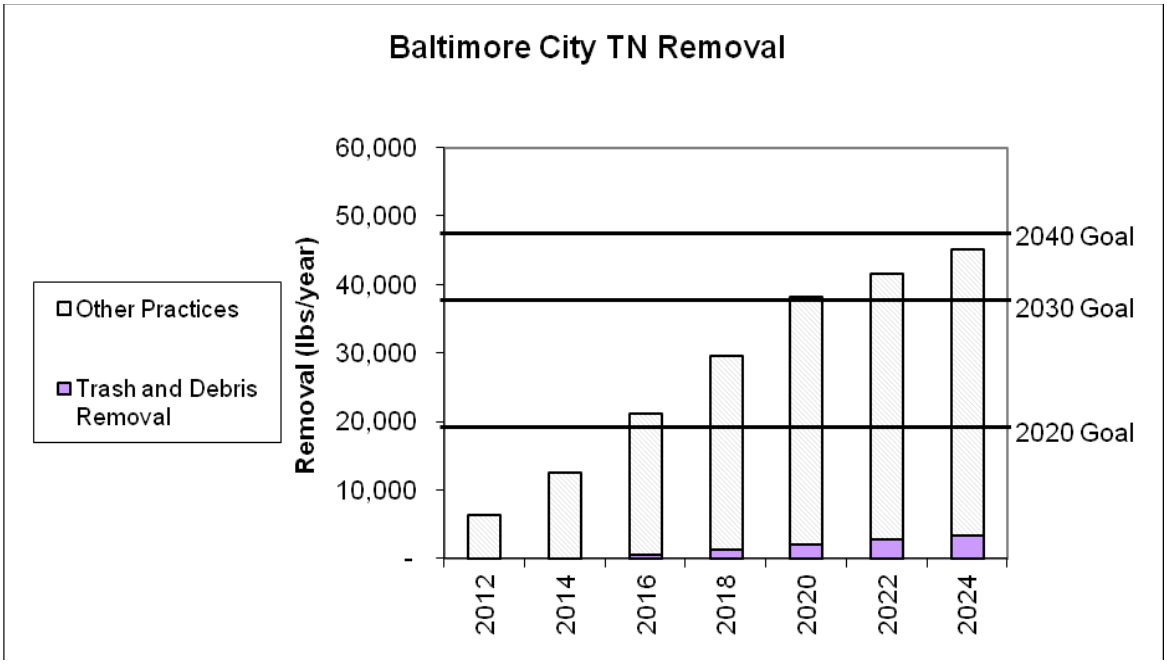

Figure 4.9. Estimated total nitrogen removal associated with installation of trash and debris removal practices recommended in this plan for Baltimore City. Nutrient reductions associated with other practices are also shown for comparison.

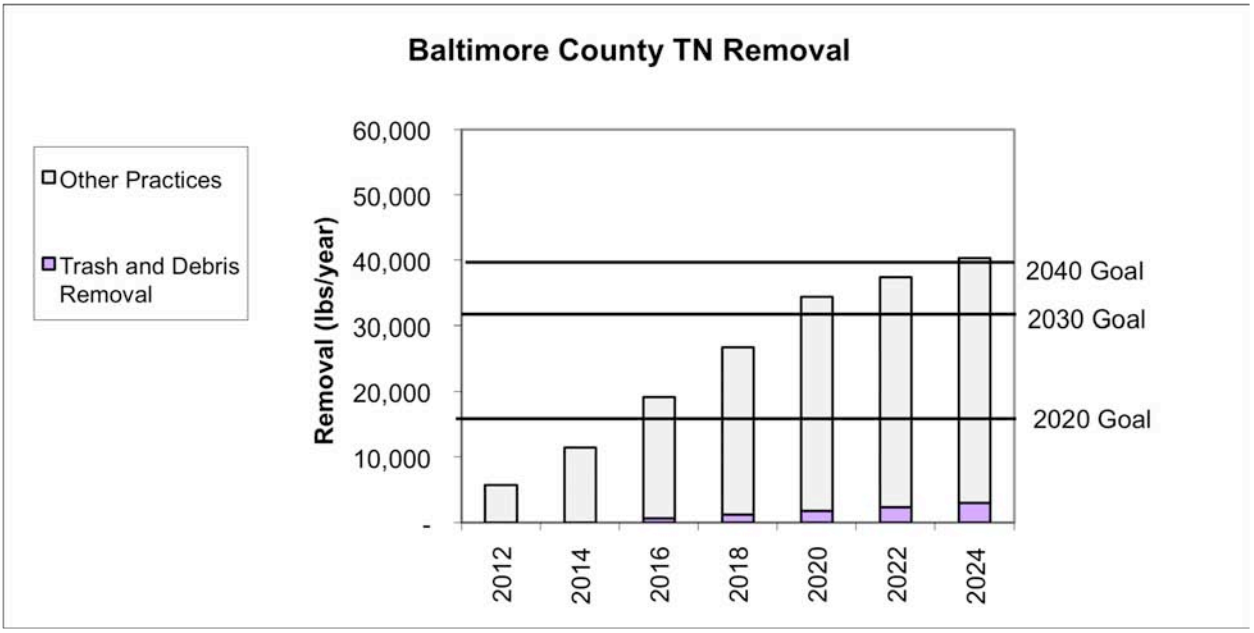

Figure 4.10. Estimated total nitrogen removal associated with installation of trash and debris removal practices recommended in this plan for Baltimore County. Nutrient reductions associated with other practices are also shown for comparison.

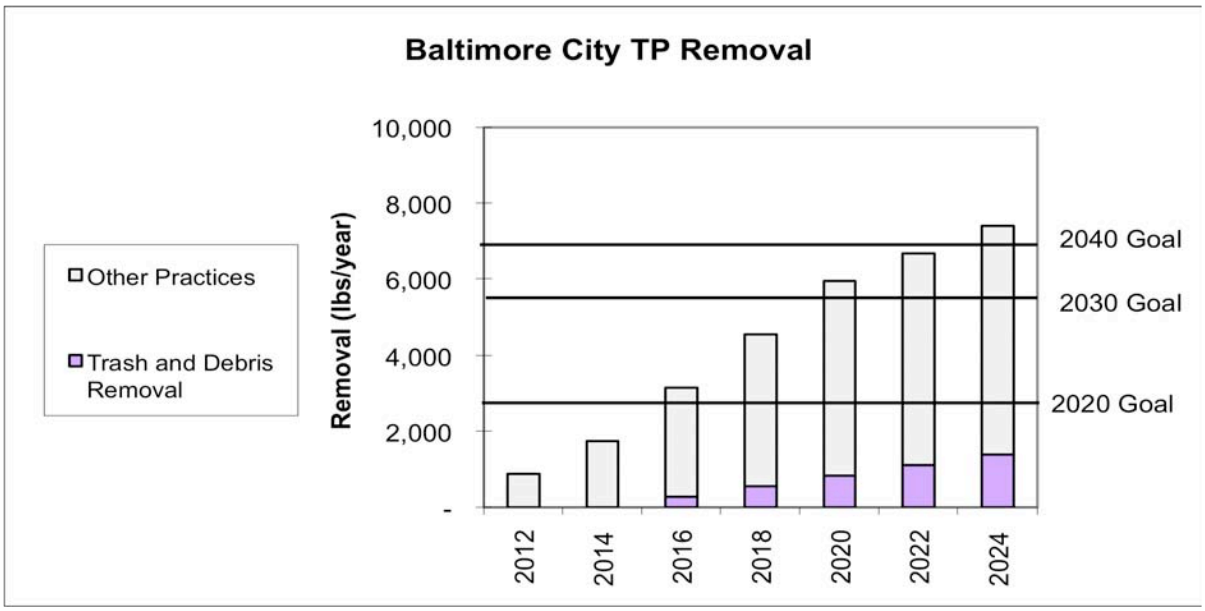

Figure 4.11. Estimated total phosphorus removal associated with installation of trash and debris removal practices recommended in this plan for Baltimore City. Nutrient reductions associated with other practices are also shown for comparison.

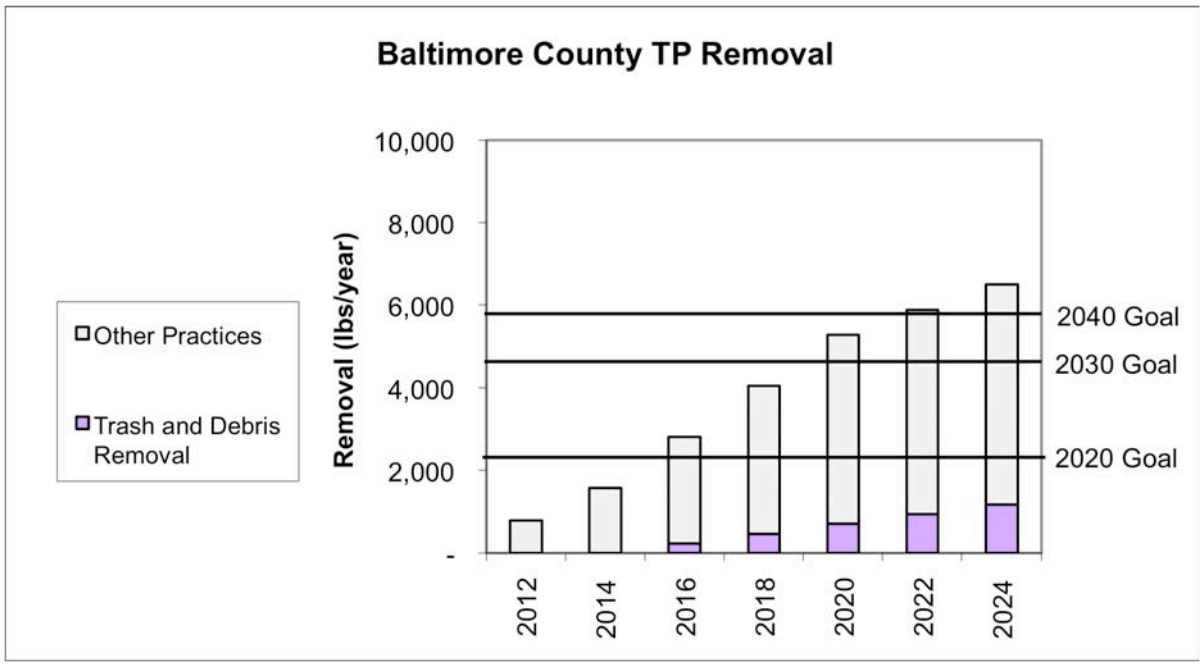

Figure 4.12. Estimated total phosphorus removal associated with installation of trash and debris removal practices recommended in this plan for Baltimore County. Nutrient reductions associated with other practices are also shown for comparison.

Los Angeles found the effectiveness of the inlet screens in preventing trash from entering the inlet varies between 58 to 79 percent. Baltimore City and County will have to conduct monitoring to determine the trash removal effectiveness of these practices, as they are likely to differ from Los Angeles based on climatic differences. For this plan, it was assumed that the target (i.e., 75 percent

capture) could be achieved by capturing 50 percent of the impervious cover (12,300 acres), with the assumption that a sustained and targeted public outreach plan can achieve the remaining trash reductions by 2030 (if not sooner). The number of grates and nets required to achieve this were determined based on the following assumptions:

- 50 percent of the area is captured by each practice (6,150 acres each)
- Inlet screens capture 0.5 acres of impervious cover (so 12,300 screens are required)
- Nets capture 25 acres of impervious cover (so 246 nets are required)
- The nets and screens are located in high trash generation areas

The total trash removal (in lbs/year) is estimated using the assumed watershed-wide loading rate of 5 lbs/acre, for a total loading rate of 427,130 lbs/year of trash. Therefore, removing 75% of the trash resulted in a reduction of 320,350 lbs of trash/year. This trash capture will also achieve an associated organic debris capture, resulting in a significant nutrient reduction (Figures 4.13 and 4.14).

Figure 4.13. Estimated trash reductions achieved through the anti-litter public education program and trash collection and screening practices recommended in this chapter and the stormwater green infrastructure practices recommended in Chapter 5 for Baltimore City.

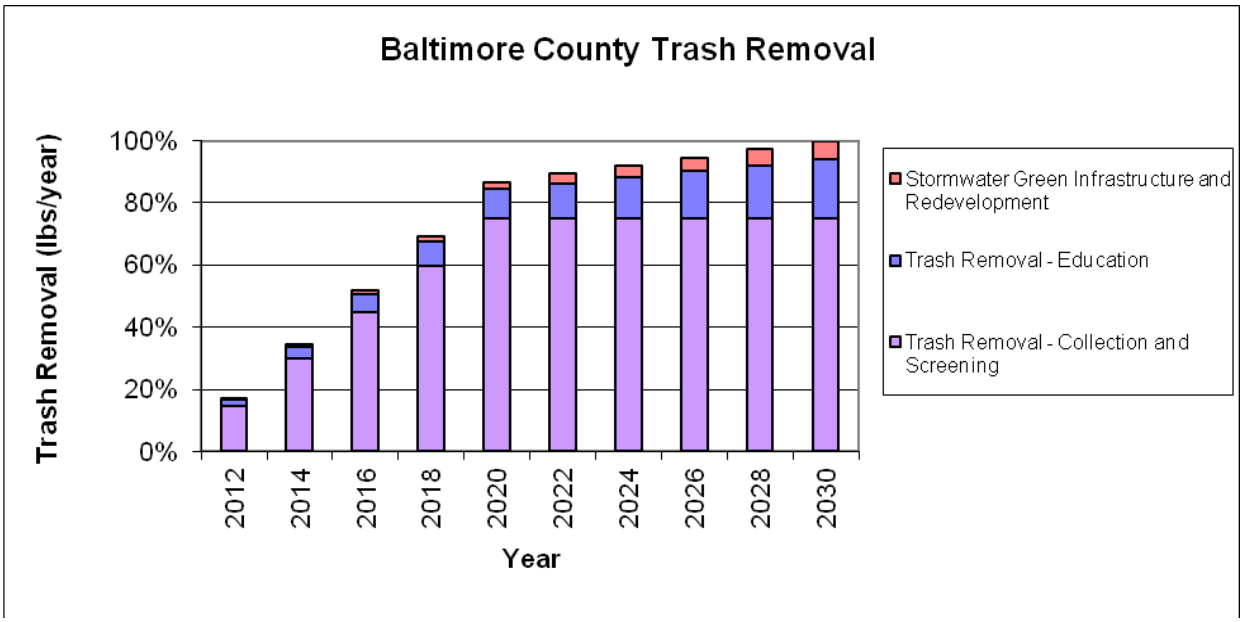

Figure 4.14. Estimated trash reductions achieved through the anti-litter public education program and trash collection and screening practices recommended in this chapter and the stormwater green infrastructure practices recommended in Chapter 5 for Baltimore County.

Costs

Estimated costs for the major strategies described in this chapter are provided below and shown in Figures 4.15 through 4.18.

Public Outreach: Having a sustained and targeted public outreach plan is one of the key strategies of this plan. Typical costs for public outreach plans can average $0.38 per capita, which for the Baltimore region would cost approximately $600,000 per year.

Inlet screens and inserts: According to the City of Los Angeles, the price for retractable inlet screens is $1,500 per inlet (City of Los Angeles, 2002). Installation costs can range between $200-$500 and annual maintenance costs averaged $4,000 per year per inlet. The Anacostia Watershed Trash Strategy estimated the costs of installing inlet screens and street sweeping to meet the TMDL for the District of Columbia. Their annualized estimate for installation and maintenance with street sweepers is $800 per impervious acre, which is almost three times the entire FY2010 street sweeping budget for the City of Baltimore (County data not available).

According a report prepared for the California Coastal Commission and Algalita Marine Research Foundation (Gordon and Zamist, 2007), the costs for inlet or catch basin inserts can range from $400 to $10,000. The cost for a stainless steel insert ranges from $1,600 to $2,400 with a nominal installation expense. In this plan, it is assumed that the majority of this cost is the operation and maintenance of the additional street sweepers and vacuum trucks.

Netting Systems: The cost of a typical netting system is estimated to be $15,000 for a 70-inch culvert and $31,000 for a 12' x 4' box culvert. Estimates are preliminary numbers based on proposed similar size installations in Talbot County, Maryland. These figures are a fraction of the cost for the netting systems installed by Baltimore City at Harris Creek and Gwynns Run and the one that is being designed underground at Bush Street, which can be explained by the difference in drainage area to the system (the Baltimore netting systems drain watersheds that are at least ten times the size of those targeted in Talbot County). Installing larger netting systems where possible has advantages from the standpoint of maintenance costs but the opportunities of finding suitable locations are limited.

Figure 4.15. Cumulative capital costs of implementing trash removal practices in Baltimore City.

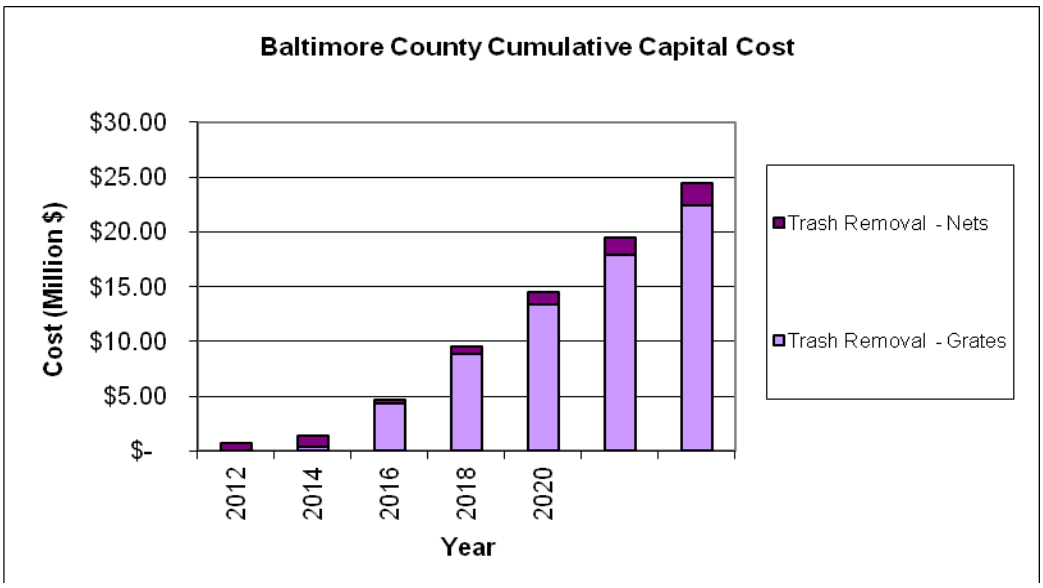

Figure 4.16. Cumulative capital costs of implementing trash removal practices in Baltimore County.

Figure 4.17. Annual maintenance costs associated with implementing trash removal practices in Baltimore City.

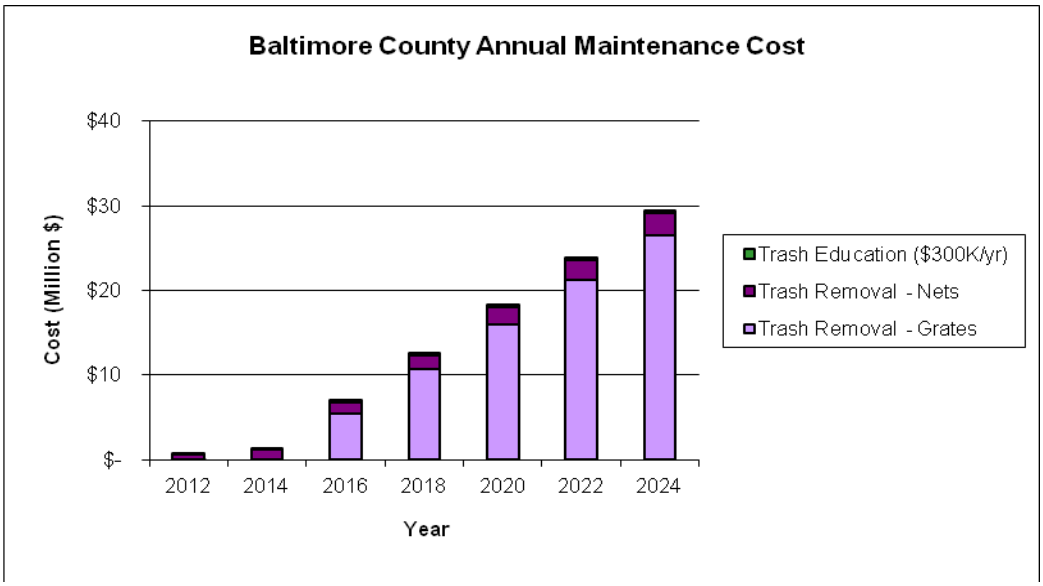

Figure 4.18. Annual maintenance costs associated with implementing trash removal practices in Baltimore County.

Schedule

A suggested schedule for implementing the strategies recommended in this chapter is presented in Table 4.1.

Table 4.1. Schedule for Implementation of Trash Strategies	
Year	Actions
2012	• Contact City and County state legislative delegation and City and County Council as well as Montgomery and Prince Georges County delegations to develop a strategy for lobbying for Bag and Bottle Bills at the state level. Work with NGOs who support Bag and Bottle Bills (e.g. and Alice Ferguson Foundation, Anacostia Watershed Society). • Begin comprehensive Trash Survey to determine high trash generation areas as well as types (e.g., plastic bags) and sources of trash (e.g., proximity to fast food establishments). • Develop multi-media public outreach plan using results of trash survey to target messages to audiences. • Begin installation of retractable inlet screens and inserts at 20-30 pilot areas in City and County. Target other areas for implementation of additional trash receptacles. • Purchase additional street sweeper dedicated to keeping inlets and adjacent streets clean • Conduct feasibility assessment and begin design of storm drain netting systems at 10 – 20 pilot areas in City and County. • Purchase or repair system similar to the Trash Paddle Boat at the Jones Falls channel to the Harbor.
2013	• Continue to develop and implement a strategy for lobbying for Bag and Bottle Bills at the state level. • Complete comprehensive Trash Survey to determine high trash generation areas and prioritize storm drain inlets and outfalls for implementation. • Continue multi-media public outreach plan using results of trash survey to target messages to audiences. • Begin implementation of storm drain netting systems at pilot locations 10 – 20 pilot areas in City and County. • Purchase additional street sweepers to maintain inlet screens (10 per year by the City and 16 per year in the County)
2014	• Assuming Bag and Bottle Bill is passed begin implementation. • Continue multi-media public outreach plan using results of trash survey to target messages to audiences. Use survey results to adjust messaging as appropriate. • Continue trash survey in pilot areas to determine effectiveness and make modifications. • Begin full-scale installation of retractable inlet screens and inserts. To meet the goal, this will require the installation of 765 screens per year. • Purchase additional street sweepers to maintain inlet screens (10 per year by the City and 16 per year in the County) • Begin large-scale design of storm drain netting systems at high trash generation outfalls.
2015	• Continue implementation of Bag and Bottle Bill. Conduct follow-up trash surveys to document program improvements. • Continue multi-media public outreach plan using results of trash survey to target messages to audiences. • Increase installation of retractable inlet screens and inserts in target areas. • Purchase additional street sweepers to maintain inlet screens increasing miles swept by 3500 per additional street sweeper. • Begin large-scale implementation of storm drain netting systems at high trash generation outfalls (This will be approximately 14 per year).

Table 4.1. Schedule for Implementation of Trash Strategies	
Year	Actions
2016 through 2030	• Repeat actions under 2015

References

City of Baltimore. 2004. Annual Report on the MS4 Permit program.

City of Los Angeles. 2006a. Watershed Protection Division Department of Public Works Bureau of Sanitation. Technical Report: Assessment of catch basin opening screen covers. June 2006

City of Los Angeles. 2006b. Watershed Protection Division Department of Public Works Bureau of Sanitation. Technical Report: Assessment of catch basin inserts June 2006

City of Los Angeles. 2002, High Trash-generation Areas and Control Measures. Department of Public Works, Watershed Protection Division.

Anacostia Watershed Society. 2008. Anacostia watershed trash reduction plan. prepared for: District of Columbia Department of the Environment

Gershman, Bricker and Bratton Inc. with Institute for Applied Research. January 2005. New Jersey Litter Survey: 2004, A Baseline Survey of Litter at 94 street and Highway Locations

Gordon, M. and Zamist, R. *Municipal Best Management Practices for Controlling Trash and Debris in Stormwater and Urban Runoff*. California Coastal Commission and Algalita Marine Research Foundation.

Keep America Beautiful. 2007. Literature Review- Litter. A Review of Litter Studies, Attitude Surveys and Other Litter-Related Literature. Final Report. By RW Beck.

Los Angeles (LA) County. 2009. Los Angeles County 2008-2009 Stormwater Monitoring Report. http://dpw.lacounty.gov/wmd/NPDES/2008-09tc.cfm

Chapter 5. Stormwater Solutions

Stormwater runoff is one of the biggest sources of pollution to the Harbor. Almost 30% of the watershed area draining to the Harbor is covered by impervious surfaces, such as roads, rooftops, and parking lots, which do not allow rainwater to permeate the ground, resulting in increased runoff during storms. Increased runoff associated with urban and suburban impervious cover is a major cause of impairment to our Nation's waterways. As impervious cover increases in a watershed, so does the runoff volume delivered to the stream, the frequency and size of flood events, and the number and amount of pollutants found in local streams (CWP, 2003; Figure 5.1). The increased volume and velocity of runoff contribute to erosion of stream banks and sediment is transported downstream to the Harbor. Stream and estuarine biological communities also decline in response to increased impervious cover upstream (McMahon et al., in press).

Figure 5.1. Stormwater runoff from the highly urban watersheds that drain to the Harbor is a major source of pollution, and negatively impacts local streams and properties. (Source: Alan Cressler, USGS).

Watershed managers have been using percent impervious cover in a watershed as a predictor of stream health since the National Urban Runoff Project in the early 1980s (U.S. Environmental Protection Agency, 1983). Now it is similarly being used as a metric for watershed restoration. The majority of Baltimore City and Baltimore County was developed prior to establishment of stormwater management regulations, providing an enormous opportunity to go back and make improvements. The Maryland

Phase I Watershed Implementation Plan (WIP) to meet the Chesapeake Bay total maximum daily load (TMDL) requires restoration of impervious cover in order to reduce the pollutant load from urban lands. The specific requirements are to (MDE, 2010):

> *"Renew permits to require Nutrient and Sediment reductions equivalent to stormwater treatment on 30% of the impervious surface that does not have adequate stormwater controls for MD's largest counties subject to Phase I Municipal Separate Storm Sewer System (MS4) Permits."*

"Treatment" of impervious surfaces can include removal of impervious cover, disconnection of impervious cover or installation of practices to treat runoff from impervious cover (Figure 5.2). In order to compute the percent treatment acreage, the City and County will have to identify land that is considered under effective treatment and subtract this acreage from the total impervious cover. The draft MS4 permits require 20% of the untreated impervious cover to be treated within the permit timeframe, with an additional 20% or more treated in subsequent permit cycles if the WIP goals are not met. Since it may be impossible to treat all of the impervious cover, MDE allows for the implementation of other practices such as street sweeping and has determined equivalency ratios (e.g. sweeping 2 acres of roadway = control of 0.14 acres of impervious cover). See Appendix E for a glossary of watershed management practices to treat impervious cover. An assumption of this plan is that, in total, nutrient reductions equivalent to 40% impervious cover treatment by 2020 and 100% by 2040 will be required.

Figure 5.2. Stormwater management practices to capture and remove pollutants from stormwater runoff (clockwise, from top left): street bioretention, permeable pavement, vegetated filter, green roof (Source for permeable pavement and green roof is Nonpoint Education for Municipal Officials)

Recommended Strategies

This chapter presents several options to address stormwater runoff pollution to the Harbor. Much of the plan is focused on the regulatory obligations the City and the County must adhere to under the Clean Water Act, but the plan also seeks to enlist the people living in the watershed. A "healthy" Harbor can only be achieved if the neighborhoods where we live get cleaner and healthier because the trash and pollutants that wash into the Harbor come from City and County yards, alleys, streets and storm drains. The major goals addressed in this chapter are to reduce nutrient and sediment loads and treat impervious cover using green infrastructure practices. The strategies described here also contribute to meeting the goals of reducing bacteria and trash. Eleven proposed stormwater strategies are described below.

Stormwater Strategies

1. Reduce stormwater pollution through redevelopment and implementation of green infrastructure
2. Utilize vacant properties to provide stormwater management as part of an offset and banking program
3. Develop plans that identify cleaning and greening actions for all City and County neighborhoods (Clean Water Community Plans)
4. Install green infrastructure practices in neighborhoods as stormwater retrofits
5. Plant trees on public and private lands
6. Implement a public education campaign for residents and businesses to encourage reduction of stormwater pollution
7. Provide incentives for retrofitting existing stormwater practices on private land
8. Implement pilot projects to demonstrate and test innovative stormwater practices
9. Restore stream channels degraded by runoff
10. Ensure proper crediting for alternative or innovative approaches to reduce urban stormwater pollution
11. Establish a tax rebate for homeowner installation of stormwater management practices on their properties

Reduce stormwater pollution through redevelopment and implementation of green infrastructure
Perhaps one of the most cost-effective strategies to reduce stormwater pollution to the Harbor and its tributary streams is to gradually make improvements on lands within the watershed by redeveloping them to a higher stormwater standard. Providing stormwater management through the redevelopment process has been shown through Baltimore City's Water Resources Element (see Chapter 2) to be one of the most cost effective ways to meet nutrient load reductions (City of Baltimore, 2009a). This is particularly important in older urban areas such as Baltimore City and County because most properties were developed prior to adoption of stormwater regulations. The Stormwater Management Act of 2007 (see Chapter 2) requires redevelopment sites to reduce stormwater runoff or provide treatment for 50 percent of the site's impervious area. Since many of these highly urban sites are 100% impervious with no prior stormwater treatment, redeveloping them to these types of standards actually reduces runoff and pollutants from these sites and can also increase community amenities such as green space. Because the requirements are so difficult to implement in an ultra-urban setting due to space limitations and poor soils it is important to have incentives in place to encourage redevelopment over new development. These can include: density bonuses, expedited permitting, reduction in impact fees, reducing or eliminating parking requirements, providing tax incentives, and grants and loans.

In Baltimore City, members of the development community have identified contiguous blocks of vacant houses that have development potential and have suggested that they would be willing to provide stormwater controls for more than what would be required under the new stormwater management regulations. A key to making this happen is for the Department of Housing and Community Development (DHCD) to sell the properties at a nominal cost. The advantage to DHCD would be the elimination of the maintenance burden and increase in tax revenues from the new properties. The value of providing the additional stormwater controls is not necessarily to DHCD but to the Department of Public Works (DPW). DHCD, DPW, Office of Sustainability and Finance Department and the development community should form a task force to examine the details of how this program could work and explore additional strategies to encourage redevelopment. The pollution reductions associated with redevelopment that are shown in Figures 6-9 through 6-19 assume a minimum of one percent of land in the City will be redeveloped each year (City of Baltimore, 2009a). The County is currently working on estimates as part of their Phase II WIP development.

Utilize vacant properties to provide stormwater management as part of an offset and banking program
Baltimore City has an estimated 30,000 vacant or abandoned lots (Figure 5.3), and roughly one third of these have been titled to the Baltimore Mayor and City Council (Baltimore City Office of Sustainability, 2009). The maintenance of these properties creates a huge financial burden on the City. The cost to maintain just the vacant lots owned by the City has been estimated at $9.5 million annually (Baltimore City Office of Sustainability, 2009). The potential for these lots to be used for the construction of stormwater management practices was evaluated in developing the stormwater offset and banking program recommendation described in Chapter 7. It is estimated that about 20-30 percent of these lots are suitable for construction of stormwater management practices.

An offset-banking system will allow developers flexibility in meeting their stormwater management requirements and will aid in promoting redevelopment. An offset-banking system would provide a means by which developers or other third parties can construct stormwater management practices and bank them for future needs or sell them to developers who cannot meet existing on-site stormwater management requirements. An important element of such a program is an available inventory of sites in the City where stormwater practices can be installed to offset the reduced treatment provided at

redevelopment sites. In addition to the City's abundant supply of vacant lots, other sites identified in this plan could also be candidates for offsets.

Figure 5.3. Vacant lots in Baltimore City (Source: Center for Watershed Protection)

Develop plans that identify cleaning and greening actions for all City and County neighborhoods (Clean Water Community Plans)

In Baltimore City, neighborhood master plans are being developed through a grass-roots effort led by community groups with assistance from non-profit organizations such as the Neighborhood Design Center and Parks and People Foundation and support from Baltimore City Departments of Planning and Public Works. One of the goals of these plans is to guide future public and private improvements (e.g., road improvements) in an effort to preserve the historical character of the neighborhood. As part of these plans, stakeholders propose streetscape improvements including the integration of diagonal parking, traffic calming devices, and green techniques. It is envisioned that a similar process can be used to develop "Clean Water Community Plans" for cleaning up and greening the neighborhoods throughout the City and County. It is expected that going through the planning and visioning process and having a visual of what the neighborhoods could look like can provide impetus for action and lead directly to implementation of community improvements. The Butcher's Hill Master Plan provides a model for how communities can develop a greening vision and plan for their neighborhood (see case study).

Based on the success of the Butcher's Hill plan and the importance of clean and green neighborhoods to a "healthy" Harbor, it is recommended that greening plans be developed for all City and County neighborhoods to identify actions to clean up and green neighborhoods while also helping to meet the regulatory goals of impervious cover restoration. The plans can be developed by neighborhood associations in coordination with the City or County and with help from non-profit organizations such as the Blue Water Baltimore, Parks and People Foundation, Baltimore Community Foundation and Neighborhood Design Center. Schools and businesses in the neighborhoods can also be involved, using an "adopt-a-neighborhood" approach where these entities commit to or sponsor specific greening actions.

Greening plans would identify locations to install green infrastructure practices focused in the street right-of-way, such as curb bioretention. Other elements of the greening plans would include identifying locations for street tree plantings, foundation plantings, plantings on private property, and vacant lot greening, identifying locations for trash receptacles and pet waste pickup stations, and identifying specific behaviors or practices that residents can implement on their properties to reduce stormwater pollution (e.g., install rain barrels, properly dispose of pet waste).

Case Study: Butcher's Hill Master Plan

In October 2008, the Baltimore neighborhood of Butchers Hill partnered with the Neighborhood Design Center to publish its Master Plan & Design Guidelines. The Plan includes significant goals for greening neighborhood streets, mitigating stormwater runoff, and established a model for implementing greener streetscapes throughout Butchers Hill and other City neighborhoods. The plan proposes several design practices for slowing and capturing urban runoff including curb bump-outs designed to provide traffic calming and reduce impervious surfaces; planting strips to absorb rain water and provide a buffer between traffic and pedestrians; and stormwater capture basins with plantings that slow rain water and beautify the streetscape.

To bring their plan to fruition, Butchers Hill partnered with Blue Water Baltimore, a local watershed association, as part of their Blue Alleys program. The Blue Alleys program received $608,000 in funding from the National Fish and Wildlife Foundation and the City of Baltimore to retrofit crumbling alleys with pervious surfaces designed to capture runoff and allow it to infiltrate into the ground. In Butchers Hill the project will include four alley retrofits and up to four curb bump-outs with bioretention facilities. At least two of the retrofits will be selected from a City list of deteriorated alleys located outside of Butchers Hill in order to encourage the transferability of the designs to other areas. The project is anticipated to remove 36 lbs of nitrogen, 10 lbs of phosphorus, and 1.3 tons of sediment.

Install green infrastructure practices in neighborhoods as stormwater retrofits

Green infrastructure practices use processes that are found in natural vegetated systems to reduce and treat stormwater runoff. Because these practices increase tree canopy and vegetation, they are associated with numerous quality of life benefits such as: increased opportunities for recreation, aesthetics, reduced crime, traffic calming, lower frequency of certain health problems and faster patient recovery rates, increased property values and creation of green jobs (http://www.naturewithin.info/urban.html). When installed as retrofits, these practices can also be counted towards the City and County's MS4 permit requirements. Therefore, green infrastructure plays an important role in meeting the goals of this plan.

Existing watershed plans and mapping data were reviewed for the study area in order to identify potential locations to install green infrastructure practices. Table 5.1 shows the types of practices considered for five land use types that are prevalent in the study area watershed and/or have high potential for implementation of green infrastructure practices due to factors such as available space and ownership. Appendix D provides detailed methods for how these opportunities were identified.

For the new sites, a total of 8,957 potential green infrastructure retrofit locations were identified through this process. Of these, it is estimated that 3,645 will be feasible for implementing retrofits. In addition, 464 sites were identified in existing plans. To aid in ranking this large suite of projects for implementation, a multi criteria screening tool was used to identify priorities based on triple bottom line principles. This approach, which is being used by cities such as Philadelphia, New York and Cincinnati (see case study in Chapter 7), evaluates the benefits of management practices according to financial, ecological and social screening criteria. The screening tool was used to rank retrofit opportunities for each land use type based on the following factors: water quality benefits, cost, implementability, and quality of life benefits. Top-ranking land use practices included vacant lots, institutions, and public rights-of-way.

Within these priority land use types, the following additional criteria were used to identify recommended projects:

- Opportunities from existing watershed plans should be pursued first because these projects have already been pre-screened and field-evaluated.
- Opportunities to treat large drainage areas with high impervious cover by a single practice were prioritized over practices treating small drainage areas.
- A goal was to ensure that each City neighborhood and County planning district would have at least three practices installed.

Table 5.1. Land Use Types Evaluated for Green Infrastructure Implementation Potential

Land Use/Location	Description	Applicable Green Infrastructure Practices
Public rights-of-way	Streets, alleys, catch basins and inlets	Bioretention, permeable paving, filters
Institutions/ open space	Churches, schools, hospitals, police/fire stations, libraries, parks, golf courses, open space	Bioretention, infiltration, permeable paving, rooftop disconnection, soil amendments, tree planting, rainwater harvesting, ponds, wetlands, green roofs, vegetated filters.
Commercial and industrial land	Retail/office and industrial uses	Bioretention, infiltration, permeable paving, rooftop disconnection, soil amendments, rainwater harvesting, filters
Vacant lands	Parcels without a structure	Bioretention, infiltration, permeable paving, ponds, wetlands, soil amendments, reforestation and tree planting
Residential neighborhoods	Residential neighborhoods with lots of 1/8 to ¼ acres	Rooftop disconnection, soil amendments

Figure 5.4 shows the locations of the 464 green infrastructure retrofit sites identified in local watershed plans. To meet the short-term goals of this plan, it is recommended that the top-ranked sites be implemented by 2020, which equates to at least three green infrastructure practices in each City neighborhood and County planning district. Appendix F provides a list of these recommended practices and locations. To meet the long-term (2040) goal, it is recommended that additional practices from the list be implemented to the maximum extent possible.

Because this planning-level analysis is unable to account for certain implementation constraints such as property owner willingness and site-specific conditions, it was assumed that only a portion of these sites would actually be feasible for implementation. A more rigorous feasibility assessment will have to be conducted for the potential restoration opportunities described in this chapter that involves field screening as part of the next step towards implementation. Appendix D provides methods for conducting such an assessment and detailed assumptions regarding feasibility.

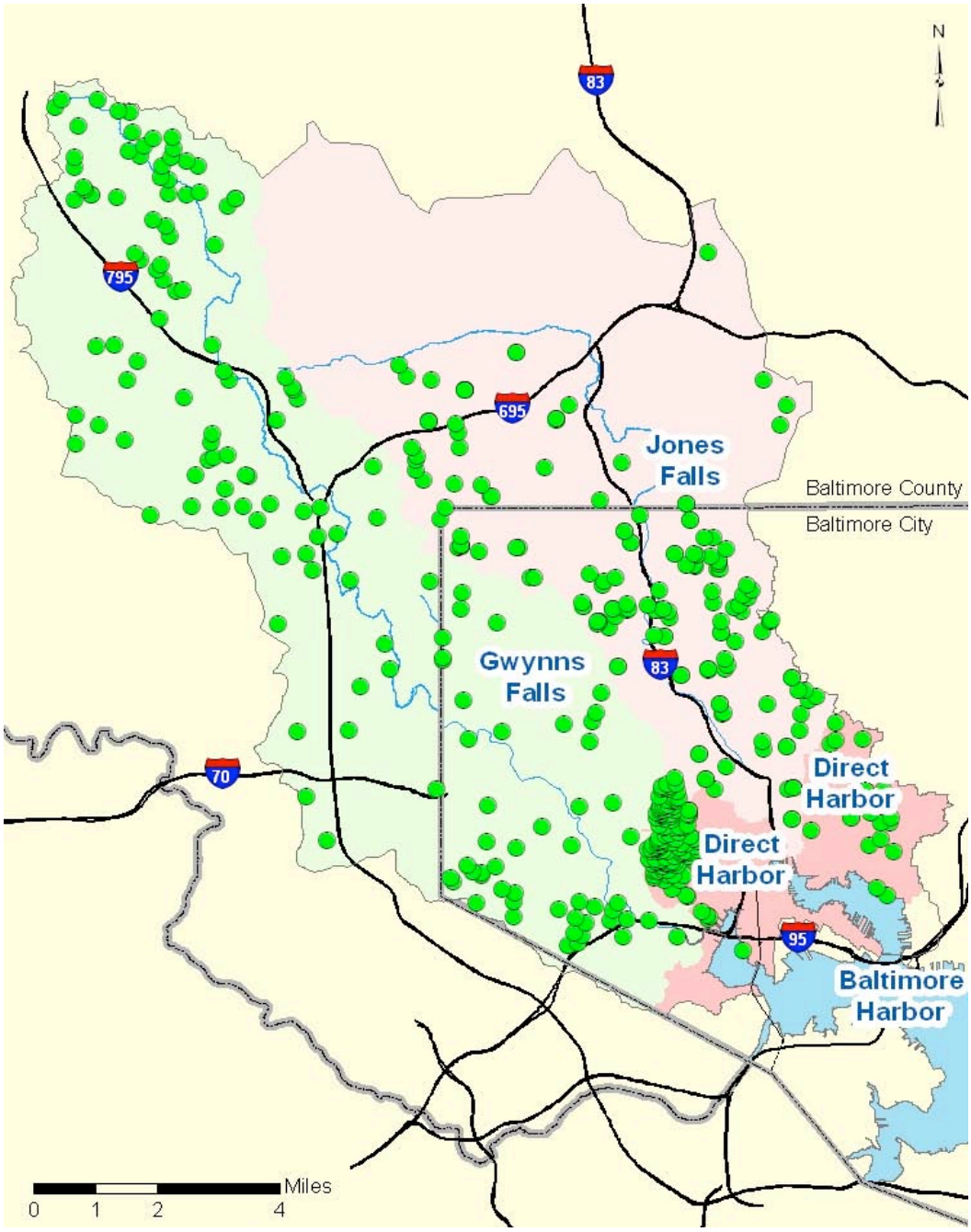

Figure 5.4. Locations of stormwater green infrastructure retrofits compiled from eleven watershed plans

Plant trees on public and private lands

The City of Baltimore has evaluated its urban tree canopy and set a goal to increase tree canopy from 25 percent to 40 percent by 2037. To create a sustainable, greener economy, the Baltimore Tree Trust is educating the public and promoting trees as green infrastructure essential to public health, cleaner air, economic development (including green jobs), energy savings, stormwater mitigation, wildlife habitat, and a more beautiful, bikeable, walkable region. Every $1 spent on trees yields $5 to $6 in these benefits (http://www.baltimoretreetrust.org/). As neighborhoods and business districts long bereft of trees become green, the richer, lusher canopy will visibly improve the quality and health of daily life. Baltimore County has also conducted an urban tree canopy assessment and is currently in the process of setting a goal. To meet the short-term goals of this plan, it is recommended that 135,000 trees be planted in the City by 2020, based on a planting rate of 15,000 trees per year estimated by Baltimore Tree Trust. By 2040, the goal of 40% will be achieved by planting 405,000 trees City-wide, at least half on private property. A review of urban tree canopy data for Baltimore's 209 neighborhoods shows that percent canopy cover varies greatly (the average is 24 percent but the range is 0 percent to 83.6 percent), as does planting potential. For instance, some neighborhoods have no canopy cover and are highly impervious, meaning efforts to increase canopy would require impervious cover removal or alternative designs such as structural soils that allow tree roots to grow underneath pavement. It is envisioned that the Clean Water Community Plans will provide more specificity in terms of potential locations for tree planting, while additional opportunities on public lands would also be pursued. In addition, large shade trees are promoted where space is available, to provide the maximum benefits in terms of canopy cover, rainfall interception and shade.

Figure 5.5. Street tree plantings in the Baltimore neighborhood of Butcher's Hill (Source: Center for

Implement a public education campaign for residents and businesses to encourage reduction of stormwater pollution

The culture of the City must change. A "healthy" Harbor can only be achieved if the neighborhoods where people live get cleaner and healthier because the trash and pollutants that wash into the Harbor come from City and County yards, alleys, streets and storm drains. Everyone has the power to make their neighborhood greener, cleaner and more livable. Planting trees, converting lawns or concrete pads into native flower beds, picking up litter or a pet's droppings are small actions that keep people physically active, improve health and help residents get to know their neighbors. These small actions demonstrate a sense of pride in community and in time make a community a more pleasant place to live. In addition, these small actions collectively improve the waters of the Harbor.

The City and County recognize that collective action by individual landowners can make a difference, and each is initiating public education campaigns aimed at reducing pollution. These programs targeting citizen action will play a large role in helping the City and County meet the long-term goals of this plan and also meet MS4 and WIP requirements. Additional partners for this recommendation include Blue Water Baltimore, Parks and People Foundation, Neighborhood Design Center and the Baltimore Community Foundation.

Specific actions to promote through such a campaign include proper disposal of pet waste, recycling, proper disposal of household hazardous waste, tree planting, reduction of fertilizer and chemical use on lawns, and installation of on-lot storm water management practices such as rain barrels. Several important steps are necessary to develop an effective outreach program, including identifying the target audience based on needs, interests and/or behavioral patterns, conducting an audience assessment to identify perceived barriers to adopting the proposed behavior, message creation, selection of the delivery medium for the education campaign, pilot testing the campaign and implementation. In addition, there should be a way to track changes in behavior as a result of the program. The community-based process for developing Clean Water Community Plans described earlier in this chapter may be an effective platform for identifying the potential opportunities in each neighborhood as well as the current resident practices, perceived barriers to behavior change, and preferred methods of receiving information that can help to guide the education campaign.

Provide incentives for retrofitting existing stormwater practices on private land

Private developers have installed thousands of stormwater management practices in Baltimore City and County since the state of Maryland first initiated stormwater management requirements in 1982. Most of these were stormwater detention facilities that were installed to address flooding and stream bank erosion and therefore, with relatively minor modifications, have extra capacity to provide treatment for the smaller storms associated with water quality improvement (Figure 5.6). In the mid 1980s, Baltimore City worked with Baltimore and Carroll County to modify (i.e., retrofit) at least two dozen stormwater basins for water quality control as part of the Reservoir Watershed Management Action Strategy. Baltimore County conducts retrofit assessments of existing stormwater management ponds as part of its routine procedure for developing Small Watershed Action Plans. In Baltimore County there are over 102 private facilities draining 2,242 acres and 91 public facilities draining 2,242 acres within the watershed area. Baltimore City has not kept track of the stormwater practices since the inception of the state's program, but there are at least 350 privately-owned practices, which could have tremendous retrofit potential (City of Baltimore, 2009b). The City is making a concerted effort to find and inspect these stormwater management practices. It is recommended that the City continue these inspections but also collect enough information to determine the retrofit potential (e.g., pipe sizes and storage volume) of these stormwater practices.

One of the issues in retrofitting these practices is that they are owned and maintained by the landowner, development company, or other private entity. While the City has the authority to enforce maintenance of these stormwater management practices, they cannot enforce their modification to improve water quality treatment. Retrofitting these practices will be much less expensive than constructing new ones. Therefore, it is recommended that the City pay for this cost or offer an incentive for the owner to deed the facility to the City, who will then assume complete maintenance responsibility. The latter is similar to what Baltimore County currently does for all their stormwater practices.

Figure 5.6. This pond could be retrofitted with relatively minor modifications to provide water quality treatment for small storms (Source: Center for Watershed Protection)

Implement pilot projects to demonstrate and test innovative stormwater practices

In developing this plan, site investigations were conducted to identify opportunities to implement pilot projects to demonstrate and test innovative stormwater management practices. These include practices such as floating wetlands (Figure 5.7), algal turf scrubbers, and regenerative stormwater conveyance, as well as practices that are not typically used in this region of the country, such as retractable inlet grates and certain types of trash netting systems. The goal of this recommendation is to push the envelope on new technology so that potentially more cost-effective approaches are not overlooked. Conceptual designs for these practices were developed and are included in Appendix G. These pilot projects may be some of the first practices implemented under this plan, and the concepts outline the next steps towards putting them in the ground. Pilot projects can be implemented by the City and County, or by groups such as Blue Water Baltimore. The Waterfront Partnership has already taken the lead in installing pilot projects such as floating wetlands because of their enormous public education value.

Figure 5.7. Floating wetland cells filter pollutants from the water while providing habitat and public education value (Source:

Restore stream channels degraded by runoff

One of the major sources of sediment to the Harbor is eroding stream channels from increased urban runoff. In fact, 78% of the sediment loading for the Gwynns Falls and 64% of the sediment loading for Jones Falls is estimated to originate from stream channel erosion (MDE, 2009a; MDE, 2009b). These

estimates are based on the assumption that, as the amount of impervious surfaces increase in a watershed (especially ones that are directly connected to the storm drain system or stream), flow increases, as does the portion of the sediment load that is attributed to stream bank erosion (Figure 5.8).

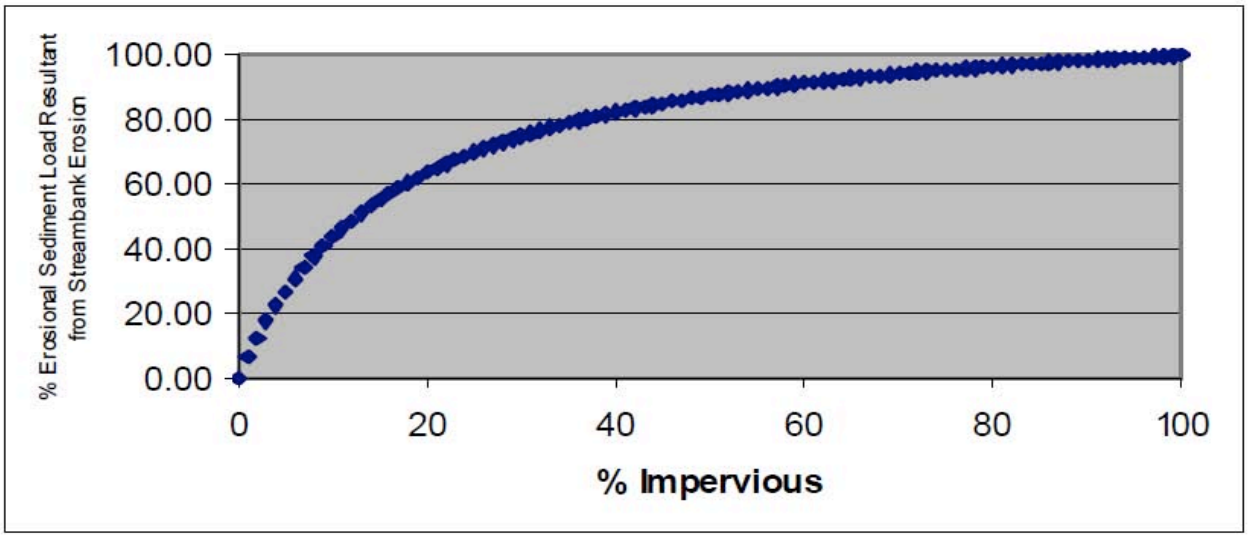

Figure 5.8. Percent impervious cover in the watershed versus percent sediment load resulting from stream bank erosion (Source: MDE, 2009b)

The City of Baltimore (2006) has determined from monitoring studies that stabilizing eroding stream channels is more effective than any other method (e.g., bioretention) to reduce sediment, as well as the associated phosphorus (which binds strongly to sediment particles), to the Harbor (City of Baltimore, 2006). In addition, stream restoration protects water and wastewater infrastructure (City of Baltimore, 2008). Therefore, stream restoration opportunities identified in local watershed plans are also considered priorities for watershed restoration.

The existing watershed plans for the study area identified 53.5 miles of recommended stream stabilization projects and 59.6 acres of riparian buffer plantings. It is recommended that all these projects be implemented by 2020 to address sediment and phosphorus reduction goals. In addition, the County and City should evaluate their remaining streams to identify further opportunities to reduce sediment through stream restoration.

The TMDLs for the Gwynns Falls and Jones Falls watersheds collectively require a reduction in the annual sediment loading rate of 10,000 tons/year. After accounting for sediment reductions from the practices in this plan (including installation of all feasible stormwater BMPs and implementation of the 53.5 miles of identified stream stabilization projects), a reduction of 8,000 tons/year would still be required to meet the TMDL goals. This is because the value used to estimate sediment reduction associated with stream restoration is 2.25 lbs/linear foot, taken from the Chesapeake Bay Program (CBP). Using this rate, meeting these sediment goals through stream restoration alone would require restoration of approximately 1,400 miles of stream. Sediment reduction from stream restoration estimated by the City of Baltimore (2006) is several factors greater than the CBP estimate, which could make achieving this goal much more realistic. In fact, the 53.5 miles of stream restoration currently identified in the plan

would quickly close the gap by using the City's 310 lb/ft credit. This is an example of one of the BMPs that need to be discussed with the CBP to assure proper "crediting" (described below).

Ensure proper crediting for alternative or innovative approaches to reduce urban stormwater pollution

Throughout the Chesapeake Bay Watershed, widely varying pollutant removal efficiencies are being reported by different states and municipalities. For example, Baltimore County assigns nutrient reduction credits for stream restoration that are 10-fold lower than what Baltimore City uses. The City and County's efficiencies are based on their respective monitoring studies, which need to be reconciled with each other. To address these types of inconsistencies, the CBP has developed a rigorous peer-review process for evaluating the effectiveness of management practices and programs for meeting the Chesapeake Bay TMDL (EPA, 2010). MDE published a guidance document (MDE, 2011) that summarizes the acceptable nutrient and reduction efficiencies for urban BMPs based on the CBP's protocols (MDE, 2011). The guidance document and CBP recognize the data limitations for certain BMPs and suggest that local governments collect data to provide better efficiency estimates, especially for practices such as stream restoration. The City and County should work together to determine how their collective monitoring efforts can improve the efficiency estimates to ensure that the best practices to reduce urban pollution are accurately and fully accounted for in the CBP's watershed model.

Some of the strategies recommended in this plan, such as public education and especially the elimination of sewage discharges, have not been formally approved by the CBP. This means they are either not credited at all or not given sufficient credit to provide an incentive for their use. This is a major obstacle to their implementation. Yet these practices can save the City and County millions of dollars (see Chapter 7) due to the relatively low cost of implementation compared to other types of structural BMPs. Therefore, the City and County should not limit their selection of strategies to those that have been accepted by the CBP. The City and County staff should work together with the CBP to assure that the best available data is used to properly credit BMPs and to work together to resolve data gaps. It is likely that enough data has been collected by the City and County to build a case for efficiency estimates for these practices. If additional data is warranted, it is in the City and County's best interest to collect it. This is especially true for some of the more innovative practices such as floating wetlands.

Establish a tax rebate for homeowner installation of stormwater management practices on their properties

More than 50% of the land in the Harbor watersheds is under residential ownership. Reaching the goal of a swimmable, fishable Harbor could be accelerated by developing a program to incentivize homeowner implementation of stormwater management practices on their properties. For example, the River Smart Home program in Washington, DC offers residents a substantial discount on approved practices, including rain barrels, rain gardens and native landscaping. Installation of the practices is performed by trained and certified River Smart contractors. Residents contribute a small co-pay directly to the contractor, who is reimbursed for the work by the City. Audits of the installed practices are performed following installation.

A similar program is recommended for the City and County. Given the disparities in tax base between the two municipalities, the only way a program such as this could work is after the development of a stormwater utility. Stormwater utilities typically discount utility fees or offer rebates to homeowners that have implemented practices such as those described above. A possible modification might be to offer a tax rebate that would free the City or County from capitalizing the projects upfront. The tax program might resemble the incentives given to historic renovations. The program could also be used

to jumpstart a green jobs program. Workshops could be offered to train individuals within communities to become certified "Healthy Harbor" contractors to install approved practices that treat or eliminate a proportion of a residence's impervious surfaces. Ultimately, tax revenues might be recaptured as neighborhoods improve and property values increase due to the greening efforts.

Benefits

Pollutant reductions attributed to redevelopment, implementation of stormwater green infrastructure, and stream restoration are presented in Figures 5.9 through 5.14. Figures 5.15 and 5.16 show how much impervious cover treatment can be achieved as a result of ongoing redevelopment and implementation of the green infrastructure practices recommended in this chapter. Data to estimate benefits of the other strategies in this chapter (which are mostly programmatic) were not available.

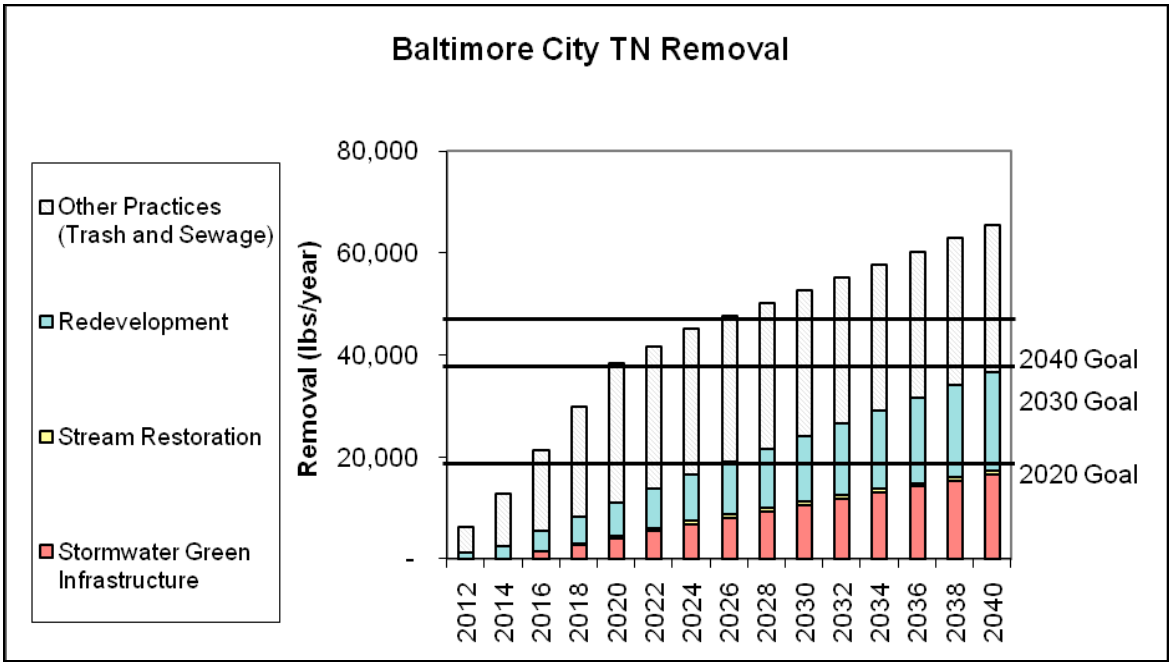

Figure 5.9. Estimated total nitrogen reductions in achieved through the redevelopment, stream restoration and stormwater green infrastructure recommendation of this plan in Baltimore City. Reductions from trash removal practices and reduction of sewage discharges are also presented for comparison.

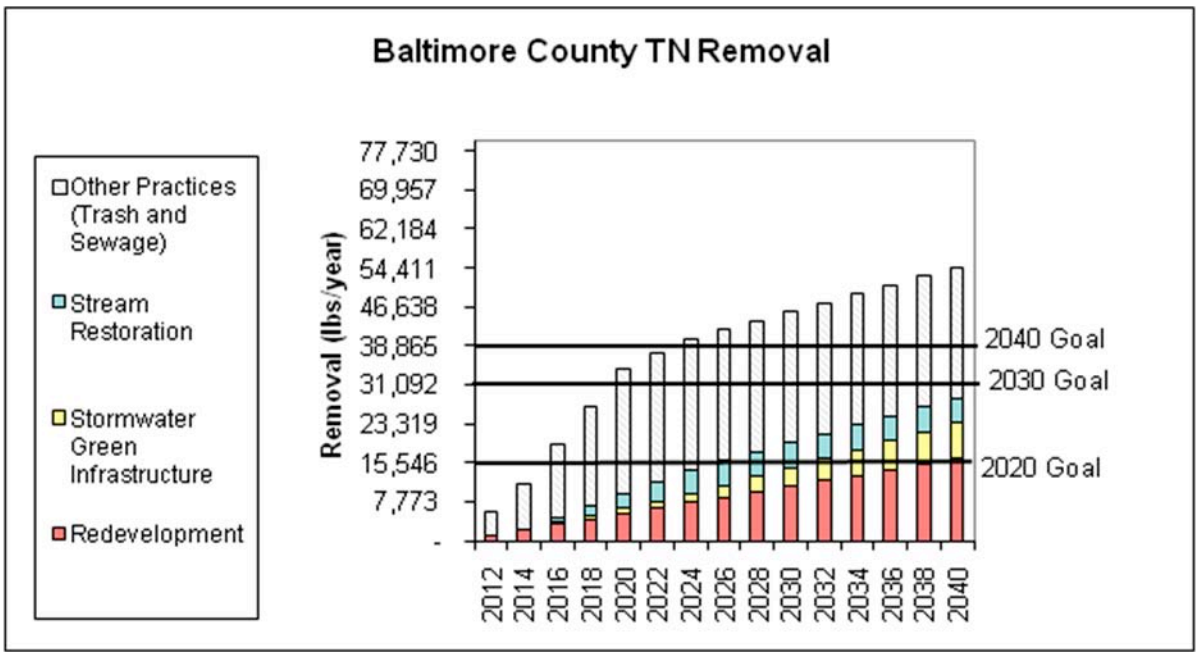

Figure 5.10. Estimated total nitrogen reductions in achieved through the redevelopment, stream restoration and stormwater green infrastructure recommendation of this plan in Baltimore County. Reductions from trash removal practices and reduction of sewage discharges are also presented for comparison.

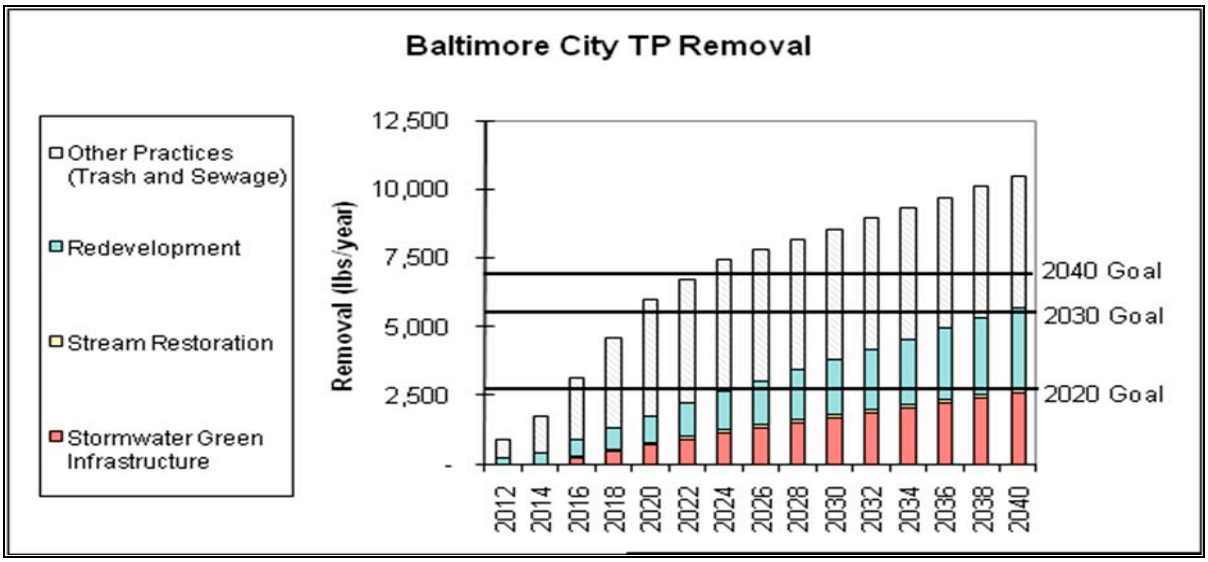

Figure 5.11. Estimated total phosphorus reductions in achieved through the redevelopment, stream restoration and stormwater green infrastructure recommendation of this plan in Baltimore City. Reductions from trash removal practices and reduction of sewage discharges are also presented for comparison.

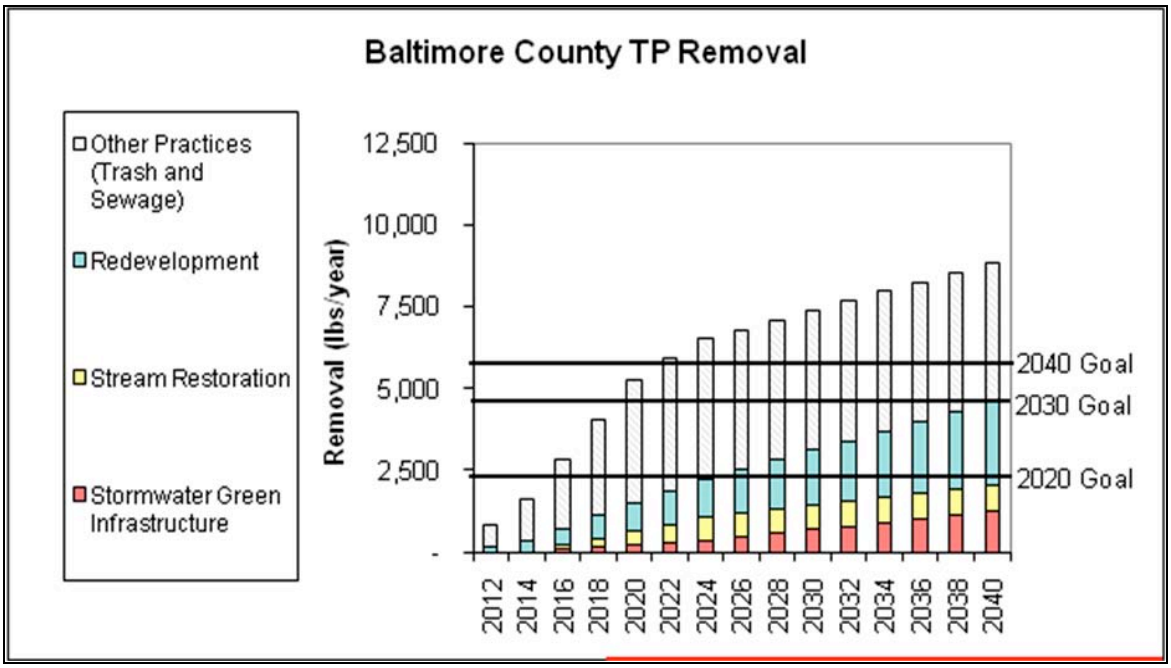

Figure 5.12. Estimated total phosphorus reductions in achieved through the redevelopment, stream restoration and stormwater green infrastructure recommendation of this plan in Baltimore County. Reductions from trash removal practices and reduction of sewage discharges are also presented for comparison.

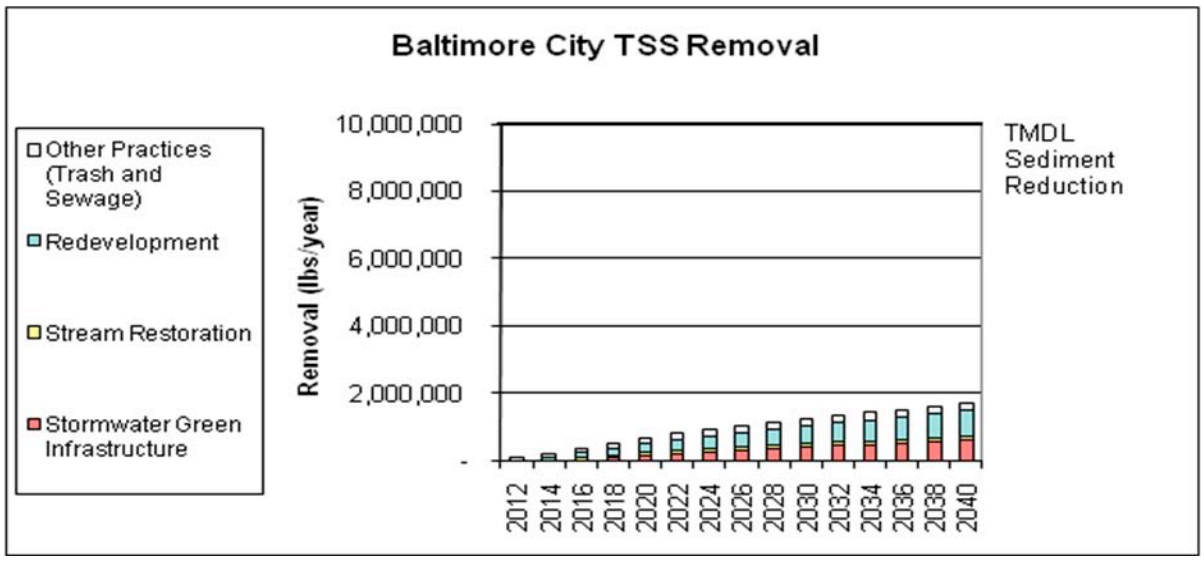

Figure 5.13. Estimated total suspended solids removal in Baltimore City with implementation of the redevelopment, stream restoration and stormwater green infrastructure practices recommended in this plan.

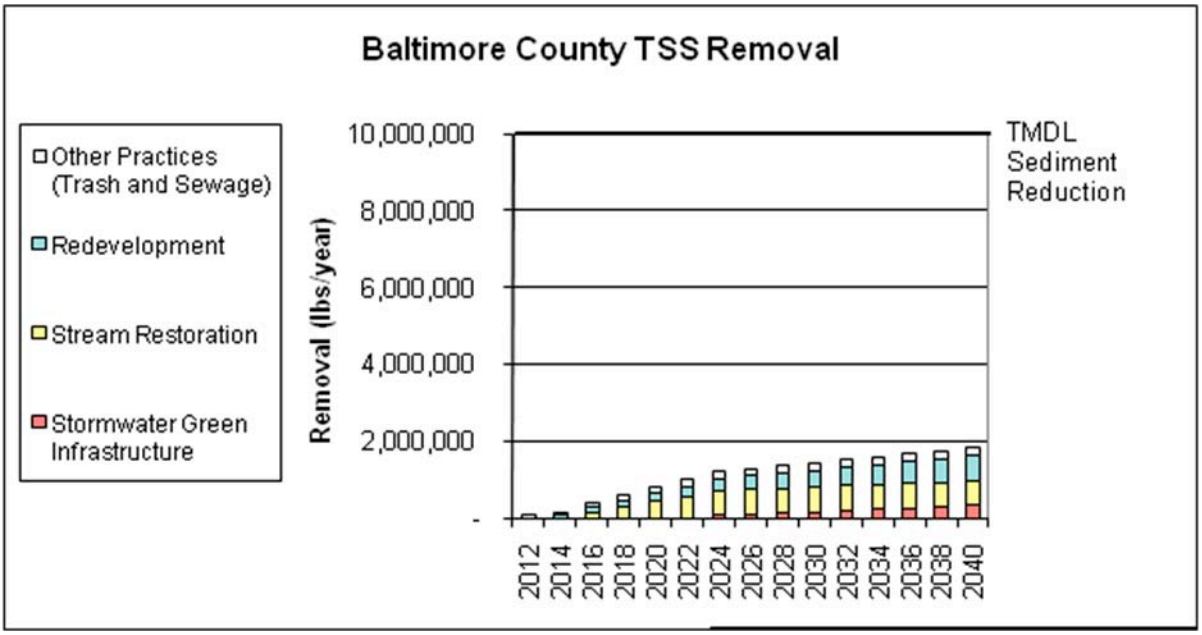

Figure 5.14. Estimated total suspended solids removal in Baltimore County with implementation of the redevelopment, stream restoration and stormwater green infrastructure practices recommended in this plan.

While it is recommended that the City and County implement additional stream restoration projects to achieve the 2040 TMDL goal shown in Figure 5.13 and Figure 5.14, the exact mileage that would need to be restored has not been calculated due to the discrepancy between the CBP and City's estimated sediment reduction rates described previously. Therefore, the sediment reduction associated with implementing these additional practices is not shown in Figure 5.13 and Figure 5.14, although it is assumed that some combination of additional stream restoration practices and acceptance by CBP of the documented higher removal rates for this practice will result in achievement of the goal.

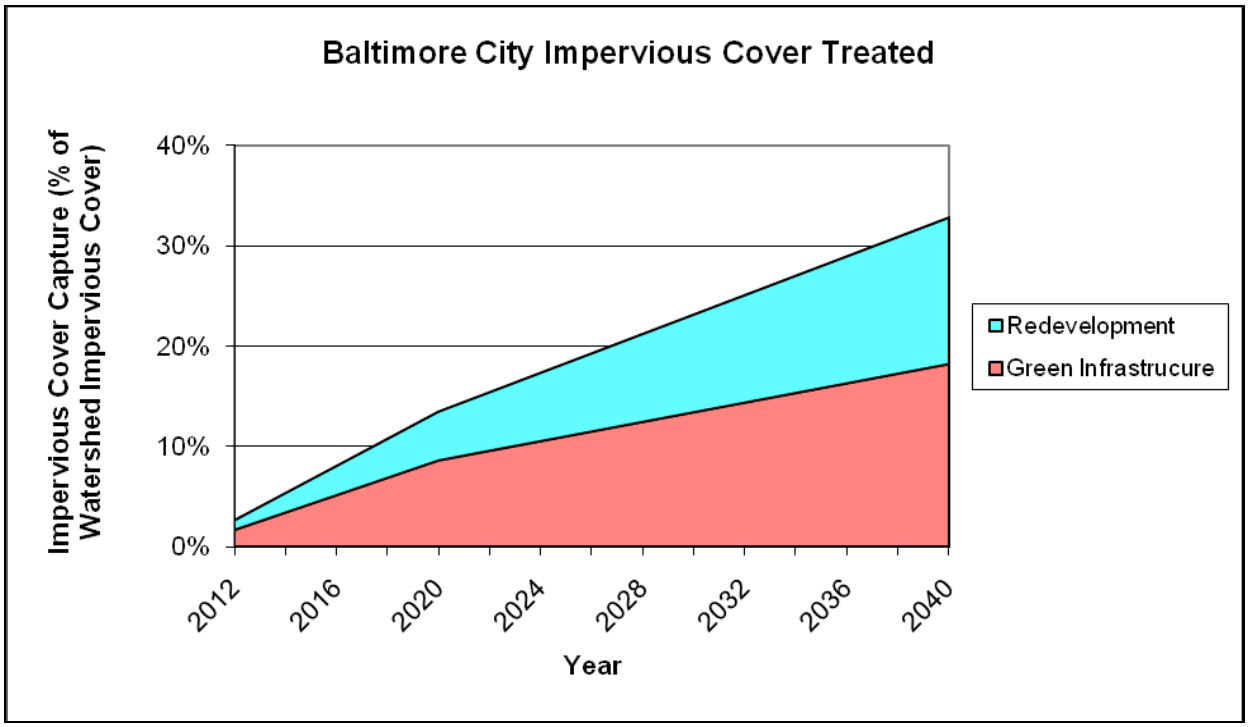

Figure 5.15. Cumulative watershed impervious cover (percent) treated through implementation of stormwater green infrastructure practices recommended in this chapter, and redevelopment of one percent of land per year in Baltimore City.

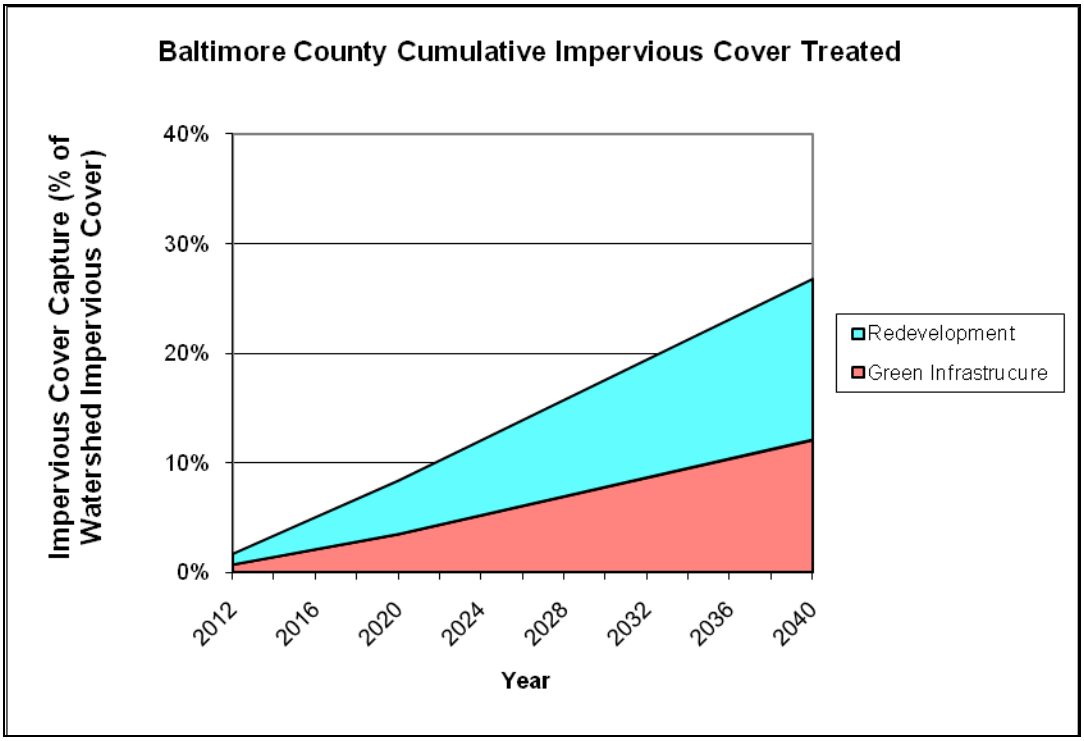

Figure 5.16. Cumulative watershed impervious cover (percent) treated through implementation of stormwater green infrastructure practices recommended in this chapter, and redevelopment of one percent of land per year in Baltimore County.

While increasing the urban tree canopy through tree planting is widely recognized for its potential to improve water quality, it can be difficult to quantify these benefits as well as the other community and health benefits that trees provide. The U.S. Forest Service recently developed a Tree Benefits Calculator that estimates the benefits and values of trees based on the available research. Using the Tree Benefits Calculator, the following benefits are estimated as a result of planting 405,000 trees in the City as recommended in this chapter:

- Interception of 33,259,267 gallons of rainfall each year
- Conservation of 1,924,201 kilowatt/hours of electricity for cooling and reduce consumption of oil or natural gas by 123,370 therm(s)
- Reduction of atmospheric carbon by 9,588,375 pounds each year
- Reduction of air pollutants, such as ozone, nitrogen dioxide and sulfur dioxide, through leaves and intercept particulate patter such as ash, dust and smoke

The total estimated value of these tree benefits is $3,045,561 per year. Figure 5.17 shows a breakdown of these values for each benefit. These estimated benefits will continue to increase as the trees grow and increase their canopy size.

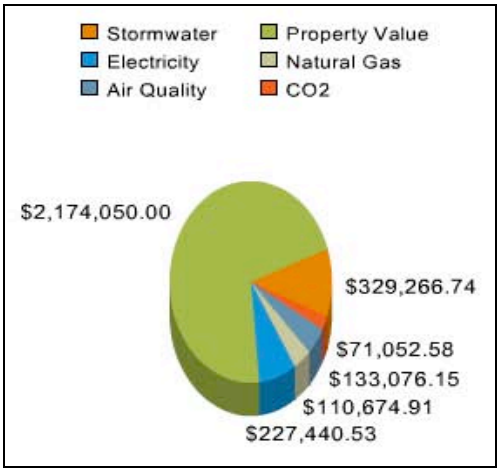

Figure 5.17. Estimated value of benefits provided by 405,000 trees planted in Baltimore City. ***Assumptions used in the Tree Benefits Calculator include: zip code 21217; 50,625 of each the following species would be planted: red maple, pin oak, willow oak, Japanese zelkova, goldenrain tree, Eastern redbud, downy serviceberry, common crapemyrtle; tree size at planting is 2" diameter at breast height; 101,250 trees will be planted on commercial or industrial***

Costs

Estimated costs for implementation of stormwater green infrastructure and stream restoration are shown in Figures 5.18 through 5.21. The total estimated cost for these practices is $164 million for the City and $120 million for the County. Costs for green infrastructure practices are based on typical costs per cubic foot treated, as outlined in Appendix D. For stream restoration, an assumed cost of $350/linear foot is assumed. Due to the discrepancy between the CBP and City's estimated sediment reduction rates described previously, the cost to implement additional stream restoration practices beyond the 53.5 miles already identified in watershed plans is not included in Figures 5.18 through 5.21.

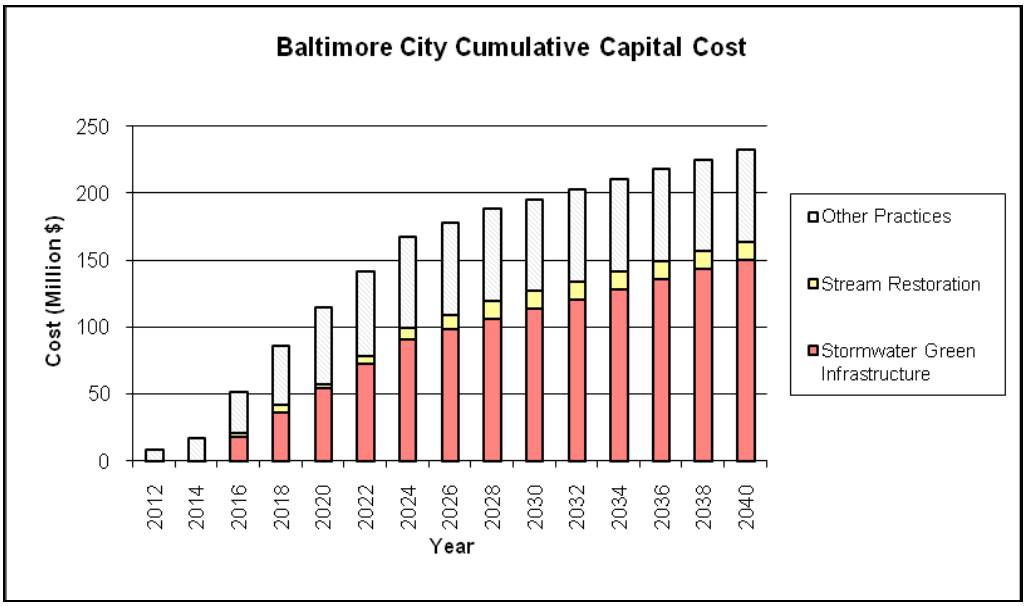

Figure 5.18. Cumulative capital costs of implementing recommended stream restoration and stormwater green infrastructure practices in Baltimore City. Costs for other practices (e.g., trash removal) are shown for comparison.

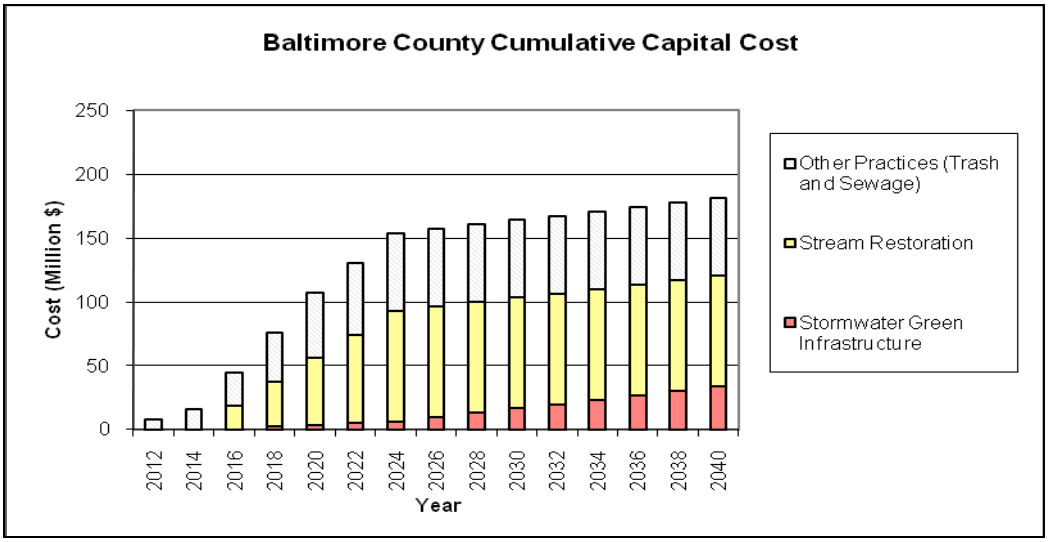

Figure 5.19. Cumulative capital costs of implementing recommended stream restoration and stormwater green infrastructure practices in Baltimore County. Costs for other practices (e.g., trash removal) are shown for comparison.

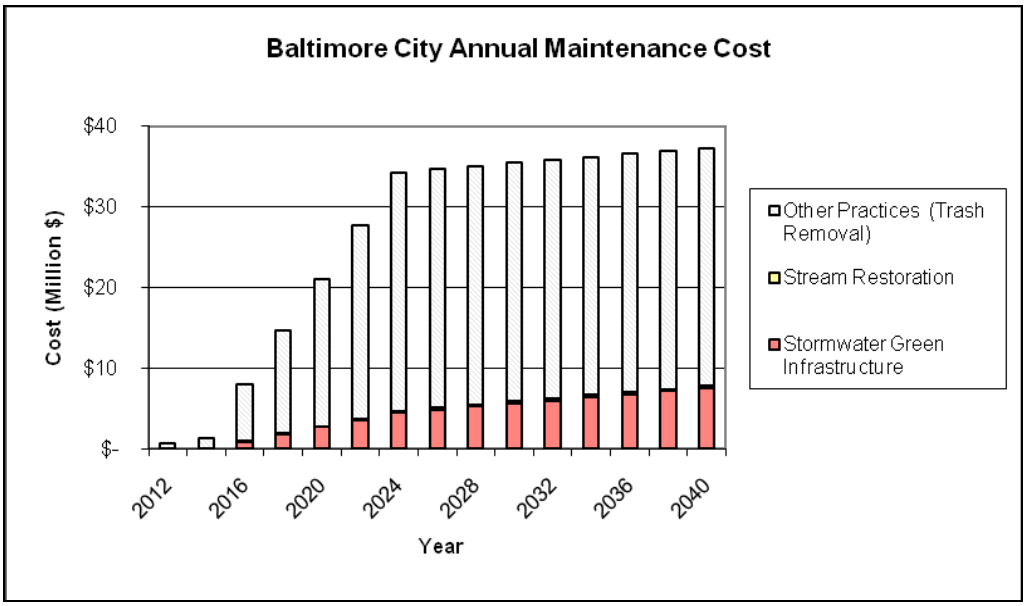

Figure 5.20. Annual cost of maintaining recommended stream restoration and stormwater green infrastructure practices in Baltimore City. Costs for other practices (e.g., trash removal) are shown for comparison.

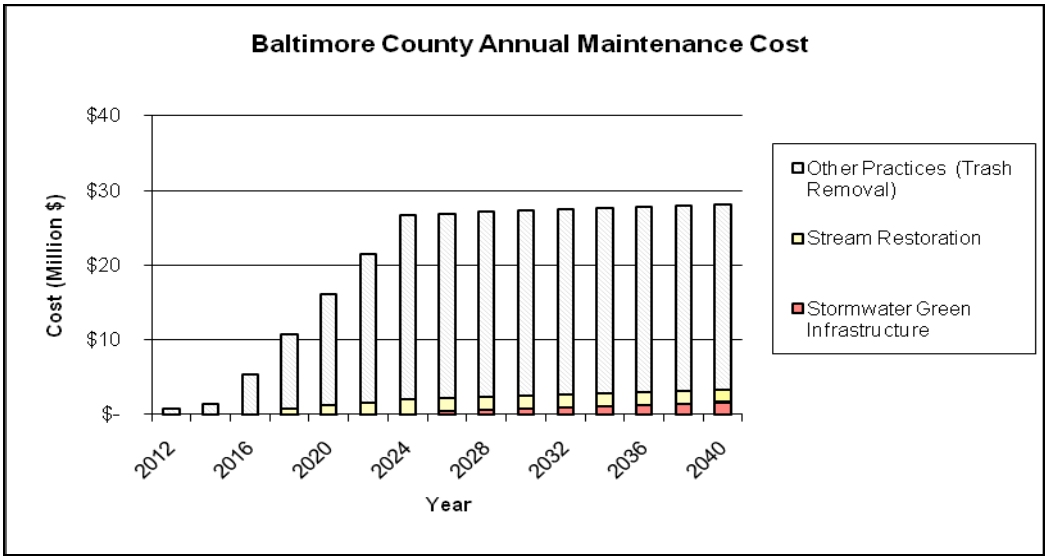

Figure 5.21. Annual cost of maintaining recommended stream restoration and stormwater green infrastructure practices in Baltimore County. Costs for other practices (e.g., trash removal) are shown for comparison

Schedule

A suggested schedule for implementing the strategies recommended in this chapter is presented in Table 5.2. Full-scale implementation of stormwater management and stream restoration practices will begin in 2014 to allow time for the City and County to "ramp up" their personnel and funding solutions.

Table 5.2. Schedule for Implementation of Stormwater Strategies

Year	Actions
2012	• Begin development of Stormwater Banking and Offset System Study utilizing vacant properties that includes providing incentives for retrofitting practices on private land. • Establish a multi-agency Work Group with the development community to determine how to incentivize redevelopment • Develop a sponsorship program among NGOs (e.g., Neighborhood Design Center, Blue Water Baltimore) and businesses for the development of neighborhood cleaning and greening plans. Set a target goal of 30 neighborhoods per year in year in the initial phases. This program will coordinate with the Urban Tree Canopy programs to use assessment results to help identify tree planting locations and count planting efforts towards achievement of the canopy goal. It will also involve site assessments to develop conceptual designs for green infrastructure practices • Conduct a capacity analysis to determine the number of staffing and consultants necessary to meet the implementation goals of the MS4 permit, WIPs and Healthy Harbor Plan • Work with Baltimore City and County to integrate strategies under this plan into the next Baltimore Watershed Agreement that is due to be resigned in 2012 • Establish meeting with the Urban Stormwater Work Group of the Chesapeake Bay Program to determine the process for adding or revising the credits for stream restoration, illicit discharge detection and elimination and street sweeping practices towards meeting Chesapeake Bay TMDL • Begin hiring additional staffing and consultant selection to meet schedule set by the MS4 permits, WIPs and Healthy Harbor Plan and begin designs to meet sediment nutrient, bacteria and trash reductions of this plan, the MS4 permit and WIPs
2013	• Implement a public education campaign for residents and businesses to encourage reduction of stormwater pollution in cooperation with the Baltimore Watershed Agreement which also has identified this as an action item • Complete the development of Stormwater Banking and Offset System utilizing vacant properties that includes providing incentives for retrofitting practices on private land • Continue work group with the development community and establish goals to incentivize redevelopment • Continue recruiting sponsorship program among NGOs and businesses for the development of neighborhood cleaning and greening programs with the goal of developing 30 neighborhood plans per year • Follow through on the Chesapeake Bay Program process for getting practices approved for meeting Chesapeake Bay TMDL • Begin developing designs for practices identified in this plan according to the nutrient, sediment, trash and bacteria goals • Implement 5 pilot projects and begin monitoring to document their performance

Table 5.2. Schedule for Implementation of Stormwater Strategies	
Year	**Actions**
2014	• Continue the implementation of a public education campaign and begin analyzing metrics to determine effectiveness • Implement at least one of the workgroup-recommended strategies to incentivize redevelopment • Continue to meet with the Urban Stormwater Work Group of the Chesapeake Bay Program to determine the process for approving additional practices (e.g., floating wetlands), as needed, for meeting Chesapeake Bay TMDL • Continue operation of the Stormwater Banking and Offset System • Begin to develop 30 neighborhood plans per year • Begin implementation of completed Clean Water Community Plans. To achieve the 2020 goal, the implementation rate will be treatment of 248 impervious acres each year with green infrastructure and planting 16,875 trees each year • Begin implementation of stream restoration projects, at a rate of 8.9 miles restored each year to meet the 2020 goal
2015	• Continue the implementation of a public education campaign and make adjustments based on monitoring results • Continue operation of the Stormwater Banking and Offset System • Continue development of 30 neighborhood plans per year • Continue implementation of completed Clean Water Community Plans to achieve treatment of 248 impervious acres each year with green infrastructure and planting 16,875 trees each year • Continue implementation of stream restoration projects at 8.9 miles per year
2016	• Continue the implementation of a public education campaign • Establish a tax rebate for homeowner installation of stormwater management practices on their properties • Continue operation of the Stormwater Banking and Offset System • Continue development of 30 neighborhood plans per year • Continue implementation of completed Clean Water Community Plans to achieve treatment of 248 impervious acres each year with green infrastructure and planting 16,875 trees each year • Continue implementation of stream restoration projects at 8.9 miles per year. • Implement additional workgroup-recommended strategies to incentivize redevelopment.
2017	• Continue the implementation of a public education campaign. • Continue development of 30 neighborhood plans per year • Continue operation of the Stormwater Banking and Offset System • Continue implementation of completed Clean Water Community Plans to achieve treatment of 248 impervious acres each year with green infrastructure and planting 16,875 trees each year • Implement 5 pilot projects • Continue implementation of stream restoration projects at 8.9 miles per year

Table 5.2. Schedule for Implementation of Stormwater Strategies	
Year	**Actions**
2018-2020	• Continue the implementation of a public education campaign • Continue operation of the Stormwater Banking and Offset System • Continue implementation of completed Clean Water Community Plans to achieve treatment of 248 impervious acres each year with green infrastructure and planting 16,875 trees each year • Continue implementation of stream restoration projects at 8.9 miles per year
2021-2040	• Implement additional workgroup-recommended strategies to incentivize redevelopment • Continue the implementation of a public education campaign • Continue to meet with the Urban Stormwater Work Group of the Chesapeake Bay Program to determine the process for approving additional practices (e.g., floating wetlands), as needed, for meeting Chesapeake Bay TMDL • Continue implementation of green infrastructure so that all feasible practices are installed by 2040 • Continue tree planting to achieve the 40% canopy goal by 2040 • Continue to implement stream restoration projects to achieve the 2040 sediment reduction goals • Continue operation of the Stormwater Banking and Offset System

References

Center for Watershed Protection (CWP). 2003. *Impacts of Impervious Cover on Aquatic Systems.* Center for Watershed Protection. Ellicott City, MD.

City of Baltimore. 2006. 2005 NPDES Stormwater Permit Annual Report. City of Baltimore Water Quality Management Section.

City of Baltimore, 2008. "Utility Impact-Stream Erosion Study. Final Report For Powder Mill Run, East Stony Run & Western Run Stream Restoration Projects" Revised: June 30, 2008. Submitted by: Rummel, Klepper & Kahl, LLP. 81 Mosher Street, Baltimore, Maryland 21217.

City of Baltimore. 2009a Water Resources Element

City of Baltimore. 2009b. 2008 NPDES Stormwater Permit Annual Report. City of Baltimore Water Quality Management Section.

Evans, C. January 2011. Personal Communication.

Maryland Department of the Environment (MDE). 2009a. Total Maximum Daily Load of Sediment in the Gwynns Falls Watershed, Baltimore City and Baltimore County, Maryland. FINAL

Maryland Department of the Environment (MDE). 2009b. Total Maximum Daily Load of Sediment in the Jones Falls Watershed, Baltimore City and Baltimore County, Maryland. REVIEW DRAFT

Maryland Department of the Environment (MDE). 2010. Maryland's Phase I Watershed Implementation Plan for the Chesapeake Bay Total Maximum Daily Load. Submitted Final Report, 12/03/2010. http://www.mde.state.md.us/programs/Water/TMDL/Documents/www.mde.state.md.us/assets/document/MD_Phase_I_Plan_12_03_2010_Submitted_Final.pdf

McMahon, G., Bell, A.H., Brown, L.R., Bryant, W.L., Cappiella, K., Coles, J.F., Cuffney, T.F., Fitzpatrick, F.A., Fraley-McNeal, L., Scudder Eikenberry, B.C., Stack, W.P., and Woodside, W.D. In press. Effects of Urban Development on Stream Ecosystems in Nine Metropolitan Areas across the U.S. U.S. Geological Survey Circular.

Maryland Department of the Environment (MDE). 2010. Accounting For Stormwater Wasteload Allocations and Impervious Acres Treated. Guidance for the NPDES Stormwater Permits. June (Draft) 2011.

Chapter 6. Education and Outreach

Public Perception

While trash, sewage, and stormwater runoff are the major sources of pollution in the Harbor and its tributary streams, the lack of public awareness about these issues is itself a major obstacle to improving water quality. A 2008 survey found that while the public is aware of dirty water, most citizens do not know how it happened or what to do about it. Most blame industry and overdevelopment, but few understand the flushing effect that a large storm event has on the landscape. There is very little awareness of the problems of trash, sediment, nutrients, and other contaminants washing off lawns, parking lots, rooftops, and driveways (Raabe, 2008).

In a statewide survey done for the Chesapeake Bay Trust, 73% of residents answered "no" when asked, "do you live in a watershed?" (Raabe, 2009). Very few could define a watershed, let alone name the watershed in which they live (Raabe, 2008). Over two-thirds of Baltimore residents surveyed either wrongly believe that stormwater is sent to a treatment plant or are unsure of what happens to it. Only 26% know that stormwater is not treated (Baltimore, 2010). Similarly, three-quarters of Baltimore residents surveyed were unsure whether trash is filtered out of the storm drain system before it reaches the Harbor (Raabe, 2008).

Despite this lack of information, 9 out of 10 people believe that the problem can be fixed and a large majority said that individuals could be a meaningful part of the solution (Raabe, 2008). The public is aware that the Harbor is not safe for swimming or fishing and surveys show they strongly support the fishable, swimmable goals of this plan. Though they cannot visualize a Healthy Harbor and only see it as a long-term goal, the concept is compelling to them and 70% say it is a goal the city should work towards (Raabe, 2009).

Opportunities for Education and Outreach

Creating a Healthy Harbor is everybody's responsibility, not just the government's. The survey results indicate both a great need and a great potential for conservation outreach and public education throughout the Baltimore Harbor watershed. A majority of people are ready and willing to change their behaviors in order to improve water quality, but they need to be told what actions to take and be reassured that their actions will have a meaningful impact. Studies show that connecting water quality to family health concerns is extremely motivating. 92% of all residents are very bothered by the thought of contaminated drinking water and 88% feel very bothered by floating trash and contaminated seafood (Raabe, 2008). A collection of public outreach and education programs are needed to help people connect these fears to the effects of stormwater runoff and neighborhood storm drains. Trash and pet waste are excellent gateway issues for targeted outreach because they are visible and easy to understand. Once people feel personally connected to their local storm drains, they will be ready to hear more complex messages about less visible contaminants such as nutrients and sediment.

Chapters 3, 4, and 5 recommend strategies for reducing and eliminating sewage, trash, and stormwater runoff. Each chapter includes a recommendation for City and County governments to develop public outreach campaigns relating to these goals. In addition to traditional

government-led public outreach campaigns, non-traditional outreach programs should be led by the business and non-profit sectors. It is also important to support and implement environmental education programs that work directly with students to improve their understanding of water quality issues.

Currently, Baltimore City and County have a number of excellent environmental education programs provided through partnerships with non-profit organizations such as the Parks and People Foundation, the Living Classroom Foundation, the National Aquarium, and the Maryland Science Center, among others. City and County governments also have a history of implementing successful public outreach programs that have helped improve water quality such as Cleaner Greener Baltimore, Living Shorelines, and the City's single-stream recycling program. Both the City and County also participate in the Maryland Green Schools program. These ongoing efforts should continue to be supported, even as new programs are developed. This plan seeks to provide guidance that will align the objectives of new and existing education and outreach programs in order to meet the Healthy Harbor objectives.

Education and Outreach Strategies

Education Strategies

Support Maryland's environmental literacy requirement

Create partnerships to fund and implement stormwater restoration activities on school grounds

Partner with science-based institutions to teach students the science behind water quality issues and give them hands-on lab experience

Partner with schools and local organizations to fund field experiences that teach students as well as teachers and principals about water quality issues in local ecosystems

Outreach Strategies

Regularly inform the public about completed and ongoing restoration activities

Create a branded awareness campaign to increase awareness about litter, pet waste, and stormwater runoff

Help neighborhoods create Clean Water Community plans with incentives for cleaning and greening

Provide households with a method for calculating their stormwater footprints

Recommended Strategies

The following recommendations are provided to help create focused and consistent environmental education and public outreach programs. They should be viewed as guiding principles and do not include the level of technical analysis found elsewhere in this report.

Support Maryland's environmental literacy requirement
In 2011 Maryland became the first state to enact a requirement that high school seniors be "environmentally literate" in order to graduate. The water quality issues addressed in this plan should be an important piece of the environmental education needed to meet this requirement. Partnerships should be formed between the Maryland Department of Education, city and county schools, and non-profit organizations to craft water quality lesson plans. These lessons should provide teachers with current and relevant environmental information about the state of the Inner Harbor, while giving them the tools they need to inform their students. Educating students about water quality issues has the potential to change their behavior, as well as the behavior of parents and community members that students interact with.

Create partnerships to fund stormwater restoration activities on school grounds
School grounds are an ideal location for removing impervious cover like pavement and parking lots and replacing it with pervious pavement or green infrastructure. Schoolyard greening programs have already successfully removed acres of pavement from Baltimore City schools and replaced it with grass, trees, and gardens that provide an urban oasis for students while also allowing stormwater runoff to infiltrate naturally into the ground. These programs not only improve the Health of our waterways, they also provide a unique opportunity to teach by doing. Students can contribute to rain garden planting, tree planting, and other associated tasks while learning about stormwater and its impact on their neighborhood waterways.

The Maryland Port Administration funds a schoolyard greening program as a way of mitigating the environmental impacts of their commercial operations. The Port Administration expects to continue these projects with one or two schools on an annual basis (Schoolyard, 2010).

Partner with science-based institutions to teach students the science behind water quality issues and give them hands-on lab experience
The Baltimore region has a number of institutions capable of providing science-based learning opportunities. The National Aquarium, the Maryland Science Center, the Maryland Zoo, and Masonville Environmental Education Center are just some examples of organizations already providing these services. Programs offered by these organizations provide students with hands-on learning experiences typically outside of the classroom using scientific tools they may not otherwise have access to. These institutions should create Healthy Harbor programs that focus on the science of water quality and ecosystems of Baltimore's Harbor and tributary streams.

Partner with schools and local organizations to fund field experiences that teach students as well as principal and teachers about water quality issues in the local ecosystem
It is not enough to teach students about water quality issues and solutions. Programs focusing on informing principals and teachers must also be implemented. Field experiences are an effective way of educating both teachers and students because they offer people a chance to interact with real world environments and connect what they learn or teach in the classroom to

what they see outside. A 2008 survey found that Baltimore residents are more likely to eat seafood than to actually experience the water, despite living so close to it. Only about one-third of city residents swim outdoors, only 12% sail or power boat, and only 10% canoe or kayak (Raabe, 2008).

Taking a boat out onto the Chesapeake Bay can be a life changing experience for students who have never been on the water, but there are also simpler ways of getting students out of the classroom. Because the Baltimore Harbor watershed is all around us, streams and stormwater infrastructure are never far away. In some neighborhoods a walk around the block may be all it takes to see problems like pet waste, litter, and stormwater runoff as well as solutions like dog waste bag dispensers, rain gardens, and recycling bins.

Inform the Public about ongoing and completed restoration activities.
The City and County are spending millions of dollars on fixing sewer pipes and restoring stream channels. Many of these projects are highly visible during the construction phase as they typically involve road closures and the use of heavy machinery. Projects like stream restoration may also take place near public parks and walkways and therefore remain highly visible after construction is complete. In order to help the public understand the purpose of these projects, informational signage should be used, as appropriate, during the construction phase and after a project is completed. Educational signage will help the public understand the water quality issues being addressed by the City and County as well as keep the public informed about what specific actions are being taken. Mass media and social networking tools should also be utilized to inform the public about work that is ongoing and to celebrate completed projects.

Create a branded awareness campaign to increase awareness about litter, pet waste, and stormwater runoff.
In order to change behavior people have to know what's in it for them. A branded awareness campaign should be created to tell people why they should care about clean water and about the consequences of not caring. The City and County should partner with businesses and non-profits to create campaigns to remove trash, eliminate bacteria, and manage stormwater in the Harbor watershed.

The Back River Restoration Committee has successfully implemented a community-based social marketing campaign. Social marketing campaigns are different from traditional information-based campaigns. Numerous studies have documented that these traditional campaigns often do little to change behaviors (McKenzie-Mohr, 2011). While information plays a critical role in changing attitudes, traditional marketing campaigns often fail to address the barriers that prevent people from changing. However, a well-executed and sustained public outreach campaign based on community-based social marketing can be extremely effective so long as it is carefully targeted to maximize its impact (McKenzie-Mohr, 2011).

Community-based social marketing methods, such as the McKenzie-Mohr model, have proven to be more successful than traditional information-intensive campaigns. "It's effectiveness is due to its pragmatic approach," writes author Doug McKenzie-Mohr, "This approach involves: carefully selecting the behavior to be promoted; identifying the barriers and benefits; piloting the strategy with a small segment of a community; and, finally; evaluating the impact of the program once it has been implemented broadly" (McKenzie-Mohr, 2011). This type of

marketing campaign has recently been executed by the Back River Restoration Committee as part of their trash cleanup strategy in Baltimore County.

Help neighborhoods create Clean Water Community plans with incentives for cleaning and greening.

The restoration of Baltimore Harbor will require the cleaning and greening of communities throughout the watershed and, in order to catalyze the necessary change, programs must include incentives to encourage apprehensive community leaders. This plan recommends the creation of Clean Water Community plans in which neighborhoods develop their own plans for cleaning and greening by identifying their needs and assets. To incentivise these activities small grants should be made available for initial low-cost projects such as vacant lot restoration, tree plantings, rain garden construction, neighborhood cleanups, storm drain painting, and other activities identified by neighborhoods. These projects will bring people together and educate them about how their neighborhoods are connected to the health of the Harbor and the importance of proper stormwater management. These Clean Water Community plans will ultimately be integrated into a larger neighborhood greening plan. The Baltimore neighborhood of Butchers Hill has integrated community greening into their 2008 Master Plan.

Provide households with a method for calculating their stormwater footprints

Individual households that want to reduce their contribution to stormwater runoff can start by calculating their stormwater footprint. A stormwater footprint is defined as the amount of runoff and pollutants a property contributes to the watershed. Determining the size of a sotrmwater footprint involves calculating the volume of rain a property receives, the amount of impervious surface on a property, and the amount of fertilizer applied to the property lawn and other vegetation. Once property owners understand their stormwater footprint, they can choose what best management practices will provide the greatest reduction in runoff and what practices will fit on their property.

In 2011, the New Hampshire Department of Environmental Services released a do-it-yourself guide to stormwater management. Based on a runoff reduction method designed by the Center for Watershed Protection, it takes homeowners step-by-step through the process of estimating their stormwater footprint, stormwater capture target, and soil type. It then recommends locations for stormwater management practices based on the size and slope of the property and the homeowner's desired runoff reduction. Recommended stormwater practices include infiltration trenches, dry wells, rain gardens, pervious walkways, vegetated swales, infiltration steps, rain barrels, and water bars (McCarthy, 2011). It is recommended that a similar guide be created for Maryland homeowners to help them determine the best way to address stormwater runoff from their own property.

Environmental Education Strategies

Strategy	Pollutants Addressed	Lead Organization or Entity	Timeframe
Support Maryland's environmental literacy requirement.	Trash, bacteria, nutrients, various others	City/County schools State – MSDE City – DPW, Sustainability County – DEPS Local non-profits	Short and long term
Create partnerships to fund stormwater restoration activities on school grounds.	Trash, bacteria, nutrients, various others	City/County schools City – DPW, Sustainability County – DEPS Local non-profits Corporate sponsors	Short and long term
Partner with science-based institutions to teach students the science behind water quality issues and give them hands-on lab experience.	Bacteria, nutrients, various others	City/County schools State – MSDE Local non-profits Corporate sponsors	Short and long term
Partner with schools and local organizations to fund field experiences that teach students as well as principal and teachers about water quality issues in the local ecosystem	Trash, bacteria, nutrients, various others	City/County schools Local non-profits Corporate sponsors	Short and long term

Public Outreach Strategies

Strategy	Pollutants Addressed	Lead Organization or Entity	Timeframe
Inform the Public about ongoing and completed restoration activities.	Trash, bacteria, nutrients, various others	City – DPW, sustainability, County – DEPS Local non-profits Corporate sponsors	Long term
Create community-based social marketing campaigns to spread awareness about litter, pet waste, and stormwater runoff.	Trash, bacteria, nutrients, various others	City – DPW, sustainability, County – DEPS Local non-profits Corporate sponsors	Long term
Help neighborhoods create Clean Water Community plans with incentives for cleaning and greening.	Trash, bacteria, nutrients, various others	City and County neighborhood organizations Local non-profits Corporate sponsors	Short and long term
Provide households with a method for calculating their stormwater footprint.	Nutrients, various others	State – DNR City – DPW County – DEPS Local non-profits Corporate Sponsors	Short and long term

References

Baltimore City Survey. 2010. Available online at http://resources.baltimorecountymd.gov/ Documents/ Environment/Watersheds/bwaopinionworks.pdf.

McCarthy, Jillian. 2011. *New Hampshire Homeowner's Guide to Stormwater Management*. New Hampshire Department of Environmental Services.

McKenzie-Mohr, Doug. 2011. *Fostering Sustainable Behavior*. New Society Publishers. PO Box 189, Gabriola Island, BC VoR 1X0, Canada.

Raabe, Steve. 2008. *Upstream, Downstream: From Good Intentions to Cleaner Waters*. Herring Run Watershed Association and OpinionWorks. Available online at http:// www.opinionworks.com/ StormwaterStudy_v3.pdf.

Raabe, Steve. 2009. *Marylanders and the Environment*. Chesapeake Bay Trust and OpinionWorks. Available online at http://www.cbtrust.org.

Schoolyard Greening Program, The. 2010. Maryland Port Administration Available online at http://www.mpasafepassage.org/projectFiles/school.pdf.

Chapter 7: Funding Strategies

Implementation of all the strategies described in this plan will be a huge undertaking, but the City and County have already demonstrated their abilities to tackle a challenge of this magnitude through their work under their Consent Decrees. The cumulative capital cost of all recommended practices by the year 2040 will be $236 million in Baltimore City (Figure 7.1) and $181 million in Baltimore County (Figure 7.2), implemented gradually over time. The resulting annual maintenance cost will increase over time, as more practices are installed, with the total maintenance cost ranging from $7.2 million/year in 2012 to $37 million/year in 2040 in Baltimore City (Figure 7.3) and from $5.7 million in2012 to $28 million in 2040 in Baltimore County (Figure 7.4). There is a tremendous potential to substantially reduce these costs through sustained public education and outreach. In any case, the City and County will have to develop a sustainable funding source to implement stormwater management practices to remain in compliance with their MS4 permits. Perhaps one of the key selling points is to identify the societal benefits of program implementation using a triple bottom line analysis (see Strategy 2). For example, in Philadelphia's triple bottom line analysis, replacing 4000 acres of impervious cover with green infrastructure would increase property values 2-5% and reduce energy costs by $33 million (based on a 40-year planning period).

One of the major findings of this plan is the savings realized through the integration of programs in addressing the TMDLs. For instance, Chapter 4 shows the tremendous potential in reducing nutrients as well as bacteria through the elimination of sewage discharges. Similarly, Chapter 5 shows the tremendous reductions in nutrients that can result through the elimination of trash. Implementation of all the strategies described in this plan will certainly be costly, but the value of a Harbor and tributary streams that are safe and enjoyable for recreational activities, as well as clean and green neighborhoods, cannot be overstated.

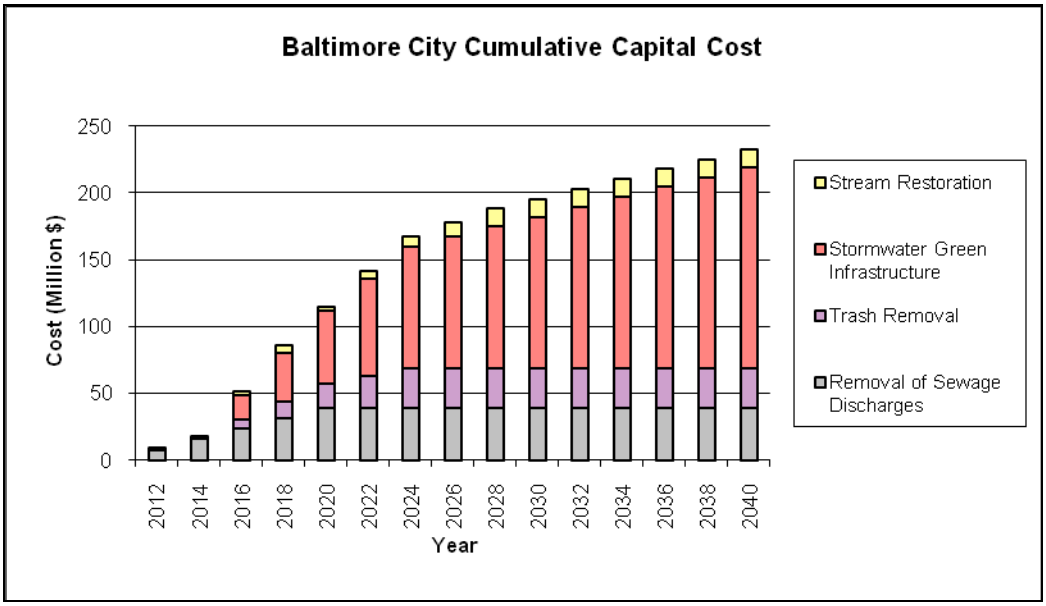

Figure 7.1. Cumulative capital costs of implementing recommended stream restoration, stormwater green infrastructure and trash removal practices and removal of 95% of sewage discharges in Baltimore City.

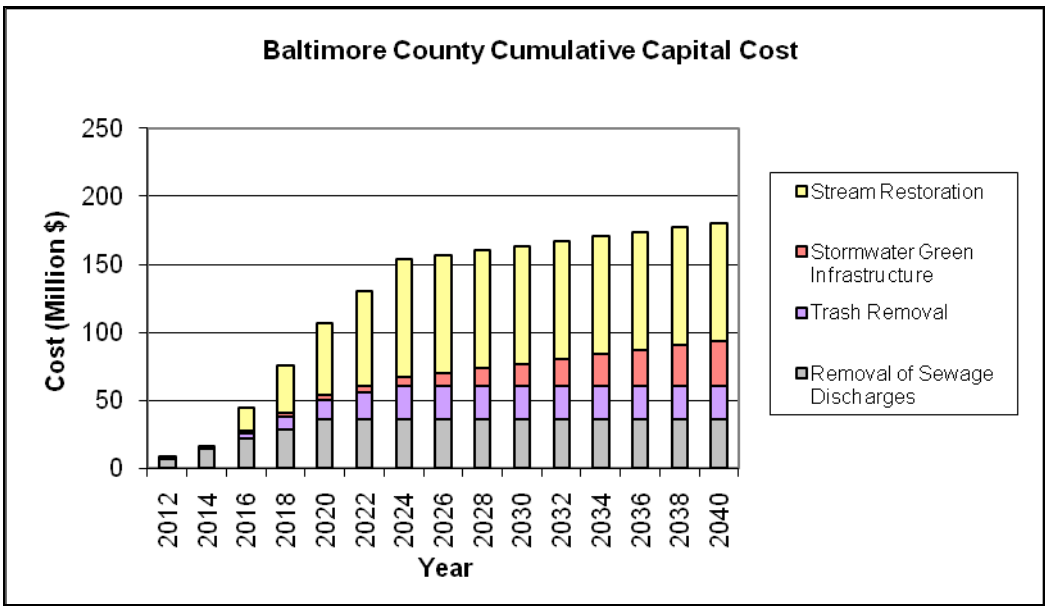

Figure 7.2. Cumulative capital costs of implementing recommended stream restoration, stormwater green infrastructure and trash removal practices and removal of 95% of sewage discharges in Baltimore County.

Figure 7.3. Annual cost of maintaining recommended stream restoration, stormwater green infrastructure and trash removal practices in Baltimore City.

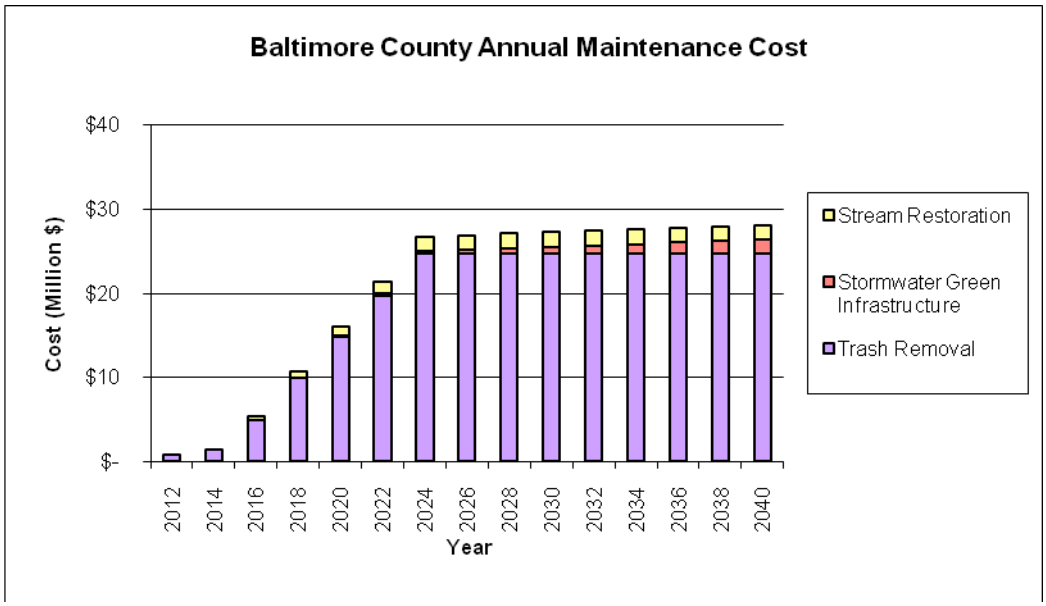

Figure 7.4. Annual cost of maintaining recommended stream restoration, stormwater green infrastructure and trash removal practices in Baltimore County.

Recommended Strategies

The following strategies are proposed for funding the implementation of this plan:

Funding Strategies

1. Develop a stormwater offset and banking system
2. Adopt a "Triple Bottom Line" accounting approach
3. Develop stormwater utility
4. Build support for statewide bag tax
5. Develop solid waste management enterprise fund
6. Establish a Baltimore Water Fund

Develop a stormwater offset and banking system
The City and County should develop a stormwater offset and banking system using comparable methodologies. An offset-banking system will allow developers flexibility in meeting their stormwater management requirements and will aid in promoting redevelopment. An offset-banking system would

provide a means by which developers or other third parties can construct stormwater BMPs and bank them for future needs or sell them to developers who cannot meet existing on-site stormwater management requirements. This could be tremendously helpful in funding mitigation and stormwater projects for major construction efforts such as the Red Line. An important element of such a program is an available inventory of sites in the City where stormwater practices can be installed to offset the reduced treatment provided at redevelopment sites. Baltimore City has an abundant supply of vacant properties (Figure 7.5) that are proposed for use in this offset and banking program (see Chapter 6). Other sites identified in this plan could also be candidates for offsets. The offset-banking system will include a method to track and credit stormwater offsets that is directly translatable to nutrient load reductions. This will allow stormwater offsets to be integrated into the total maximum daily load (TMDL) implementation plans that are being required under the new municipal separate storm sewer system (MS4) permits. While this program itself would not generate funds, it is a way to get storm water management practices in the ground, which can result in substantial cost savings to the City and County in meeting the new regulatory mandates.

There is no existing banking system in the City or County; however there are existing stormwater offset programs that use a fee-in-lieu of system, which is determined by the estimated costs of providing on-site stormwater management. The fees are placed in a fund that is used to construct stormwater-related projects. In the City, these projects are generally not tracked and are not equated to "offsetting" the stormwater impacts from the sites that are paying into the fund. The currency of exchange for the offset should be the water quality volume requirement. This is the basic approach that is being developed by the District of Columbia's District Department of the Environment. Focusing on stormwater retention rather than a single nutrient (e.g., phosphorus) is a preferred approach since local nutrient and the Chesapeake Bay TMDL is based on nitrogen and phosphorus. Therefore, an offset program using stormwater retention is directly transferrable to nutrient reductions.

Figure 7.5. Vacant lots in Baltimore City (Source: Center for Watershed Protection)

Adopt a "Triple Bottom Line" accounting approach

Green infrastructure includes decentralized stormwater best management practices with multiple benefits such as stormwater filtration, urban heat island reduction, air quality improvement and wildlife habitat. This plan recommends the widespread use of green infrastructure to meet the fishable swimmable goals as well as the goals of the MS4 permits and watershed implementation plans (WIPs), which will cost the City and County millions of dollars over the next decade. These mandates could pressure the City and County to favor conventional practices (e.g., detention basins) over green

infrastructure because they have been studied more and appear to be more cost effective in delivering nutrient and sediment reductions. However, it is advisable for the City and County to have a multi-criteria process that evaluates the full societal benefits of green infrastructure in order to make decisions on the practices necessary to meet these mandates.

Recognizing the full range of benefits provided by green infrastructure will require the City and County to shift how they measure costs and benefits. Over the past ten years, a new paradigm has emerged that encourages municipalities to consider the social and ecological impacts of projects in addition to economic costs. Using what is known as Triple Bottom Line accounting, cities like New York and Philadelphia have identified millions of dollars in annual benefits that would have been lost had they chosen to continue to invest in only traditional gray infrastructure (see case study). Benefits like enhanced recreation, energy savings, increased home values, and a cleaner environment would be missed under a traditional cost-benefit analysis.

Case Study: Philadelphia's Triple Bottom Line Analysis

Philadelphia's Green City, Clean Waters plan has been hailed as a national model for cleaning up urban waterways. The plan proposes to meet water quality goals by implementing green infrastructure, such as green roofs, pervious pavement, and rain gardens, instead of traditional gray infrastructure, like pipelines and treatment plants. In June 2011, the EPA and Pennsylvania Department of Environmental Protection approved the $2 billion plan acknowledging that the best way to control stormwater is at its source.

Unlike Baltimore, Philadelphia has a combined storm and sanitary sewer system, meaning that stormwater and wastewater are both conveyed to wastewater treatment plants. During heavy rain events, the capacity of plants can be exceeded, resulting in overflows of untreated stormwater/wastewater to local waterways. One way to reduce these combined sewer overflows is to reduce the amount of runoff that flows to the sewer system. While the use of green infrastructure in Baltimore will not reduce its sanitary sewer overflows, there are numerous water quality benefits to be gained from this approach. Philadelphia's analysis also explains that green infrastructure provides additional benefits to the community, meaning that each dollar spent on new green projects brings more value to the city than conventional pipes in the ground

To justify the Green City, Clean Waters Plan, Philadelphia used a triple bottom line analysis to value the costs and benefits of multiple alternatives. By looking at the financial, social, and ecological impacts for each of nine criteria (recreation, property values, heat reduction, water quality, wetland enhancement, poverty reduction, energy savings, air quality, and maintenance) and establishing a dollar value for each, the analysis concluded that a 50% green infrastructure option, in which 50% of runoff is managed through green infrastructure, would bring greater benefits in all categories than traditional gray infrastructure. The city valued green infrastructure benefits at $2.85 billion over 40 years, compared to just $122 million in benefits from gray infrastructure.

Given the tremendous cost of meeting MS4 and WIP requirements and the need to make informed decisions on what implementation strategies to fund, it is essential that Baltimore City and County recognize the multiple long-term benefits that green infrastructure can provide. Triple Bottom Line accounting is a decision framework that separates the analysis of costs and benefits into three value

categories: financial, social, and ecological. Criteria are then selected for evaluating management options under each category. Triple Bottom Line accounting can be supported by methods for quantifying costs and benefits in each value category. A Triple Bottom Line assessment can help the City and County in prioritizing programs and projects for funding and would lend itself to the Outcome Budgeting Process that Baltimore City uses where project outcomes are considered for funding based on how well their outcomes supports multiple goals established by the Administration. See Appendix H for a more detailed description of the Triple Bottom Line accounting process.

Develop stormwater utility

This plan supports the City's goal to develop a stormwater utility to pay for the millions of dollars in management practices and programs necessary to comply with the MS4 permits and WIPs. It is also recommended that Baltimore County consider the same. Stormwater utilities are similar in structure to water and wastewater utilities but instead of properties being assessed on the amount of water consumed, they are assessed based on the amount of stormwater runoff they generate. Hundreds of municipalities throughout the nation have adopted stormwater utilities because it is the most equitable way to pay for costs associated with stormwater management. Richmond is the most recent city to adopt a stormwater utility in the Chesapeake Bay region. Philadelphia just adopted a stormwater utility to fund their green infrastructure plans (see case study) and have used a Triple Bottom Line accounting approach to demonstrate the broader societal benefits of the projects and programs funded by the utility. One of the major values of a utility is that incentives (i.e., credits) can be given to businesses and homeowners who can demonstrate actions to reduce stormwater runoff (e.g., rain barrels).

Case Study: Philadelphia's Stormwater Utility

On July 1, 2010, the Philadelphia Water Department began to collect a monthly stormwater management service charge from all properties within the city. The Water Department does not define the utility fee as a new or additional charge, but as an alternate and more equitable method for calculating the rate customers have previously been billed for stormwater collection and treatment. The charge was previously included in the sewer service fee and based on the size of a property's water meter. The new method is based on the amount of stormwater that a property delivers to the sewer system via stormwater runoff and therefore varies by the size and impervious cover of each lot.

The new billing methodology will be phased in over a four-year period and provides a 25% discount for senior citizens. Properties with low amounts of impervious cover as well as small residential lots will see relatively small rate increases on monthly water bills. Properties with large impervious surfaces such as parking lots and warehouses will likely see substantial increases. The charge is designed to be revenue neutral and based on the fair cost of servicing the storm sewer system. As property owners implement best management practices to reduce runoff, their stormwater rates will go down. Condominium associations and non-residential properties are encouraged to implement best management practices through a system of stormwater credits; however, credits are not currently available to individual residential property owners.

Despite these changes and a scheduled rate increase, Philadelphia water and sewer rates remain among the lowest in the region, in some cases half as much as neighboring investor-owned utilities. For those wanting to confirm the City's impervious cover calculations, the Philadelphia Water Department website hosts an interactive impervious surface map complete with satellite images and a measuring tool for double-checking the City's assessments.

One of the major obstacles to a stormwater utility is having citizens pay a new fee on top of the already high tax rate in Baltimore City in the current economic climate. Developing a stormwater utility is a long and involved process and the City has already invested considerable time in developing a rate structure and cost of services assessment. Baltimore County should follow suit, in part to avoid worsening the disparity between the taxes and fees paid by City versus County residents. The fees can initially be kept low so as not to be a drain on the economy. In addition, the initial revenues will largely go towards the design of projects, which is much less expensive than construction. The utility can also be used to issue bonds, which can also keep initial costs lower.

Both the City and County should work through organizations such as the Maryland Municipal League and Maryland Association of Counties to support legislation that would require all municipalities with MS4 permits to implement a utility. Similar legislation has been proposed during the last three legislative sessions and was put on hold this year because of the economy.

Build support for statewide bag tax

The Alice Ferguson Foundation and the Trash Free Maryland Alliance are working to have a statewide bag tax introduced into the Maryland legislature in 2012. With a bag tax, consumers are charged a tax for every paper or plastic bag (Figure 7.6) they use in any store with a food license (grocery stores, pharmacies, department stores). Of the tax amount, the retailer keeps a portion, and the rest goes into a fund designated for trash cleanup or other water quality restoration activities. The City and County elected officials should take action to support a statewide bag tax in 2012.

Figure 7.6. Plastic bags comprise a significant proportion of trash in our cities and landfills, as depicted in this image. (Source: IAN Image Library ian.umces.edu/imagelibrary/)

If a statewide bag tax is not successful, the City and County should pursue institution of a local bag tax that is modeled after the one adopted by the District of Columbia (DC). The Anacostia River Clean Up

and Protection Act (i.e., DC's "Bag Law") requires all DC businesses selling food or alcohol charge five cents for each disposable paper or plastic carryout bag. The business keeps 1 cent (or 2 cents if it offers a rebate when customers bring their own bag), and the remaining 3 or 4 cents goes to the new Anacostia River Protection Fund. Almost immediately after implementation of the bag law in early 2010, businesses began seeing a drastic reduction in bag usage, and environmental clean-up groups witnessed fewer bags polluting DC waterways. This law is the first of its kind in the U.S. One lesson learned from DC is that a fee works better than a ban because it provides an economic incentive to change behavior. One hurdle with this tax is psychological (for consumers), but it actually provides an incentive for retailers. The tax should be coupled with free reusable bag giveaways so that it is not perceived as a regressive tax.

Baltimore City currently has a plastic bag reduction program that requires all stores with a Food Service License from the City Health Department to register in the program and maintain records. Dealers may not distribute single use plastic bags unless a customer specifically requests one, and, if requested, a plastic bag given by a food dealer must say in words visible to the consumer "please return to a participating store for recycling." The program is based on punitive measures as opposed to incentives to reduce trash, and so far, only a small proportion of stores have registered. In addition, there are no City resources available to enforce the program. It is recommended that the effectiveness of this program be tracked through Harbor Stat (see Chapter 8) for one year, and the results used to determine whether to pursue a bag tax modeled after DC in lieu of this program.

Develop a solid waste management enterprise fund

Solid waste management in Baltimore City is currently paid for through the General Fund, which pays for salaries and benefits of employees, landfill tipping fees, fuel and other supplies, depreciation of assets, and funding for stormwater retrofits and maintenance to prevent trash from entering the city's storm drain network. Although the total cost for solid waste management represents just a small portion of the General Fund, the impeding trash TMDL is expected to increase this cost substantially. Baltimore City should establish a solid waste management enterprise fund that receives revenue from garbage collection charges to customers, special trash pickup fees, and sales of recyclables. There are several benefits to the City if it chooses to establish a separate enterprise fund:

1. A separate fund enables the City to <u>see the revenues and expenses of providing solid waste and recycling services apart from other activities</u> of the General Fund.
2. A separate fund allows for the <u>budgeting and financing of equipment needed to perform solid waste and recycling functions without these needs competing with other demands</u> on the General Fund.
3. Enterprise funds <u>eliminate unintentional subsides</u> for services provided to non-residents and those occupying tax-exempt properties.
4. Charging users directly results in <u>a more equitable distribution of services</u> as households that produce more trash pay more than households that produce less.
5. Charging a direct fee for trash collection results in <u>less trash being produced and an increase in recycling rates</u>.
6. Reliance on an enterprise fund may help <u>reduce future tax rate increases</u> on income, sales, or property values.

Establishing a solid waste management enterprise fund will provide a revenue source for meeting EPA's impending trash TMDL while addressing imbalances in the way City services are provided and paid for.

For example, a 2002 study by the Johns Hopkins Institute for Policy Studies analyzed 44 U.S. cities and found that Baltimore received only 1.1% of its general revenue from solid waste management, compared to an average of 3.7% received by other cities (Schachtel et al., 2002). It also showed Baltimore recouped 28% of solid waste management costs from user fees, compared to 42.1% in Indianapolis, 44.5% in Jacksonville, and 94.7% in Seattle (94.7%) (Schachtel et al., 2002). Charging users directly for City trash services would not only help clean up the Harbor, but would bring Baltimore's solid waste management revenue in line with the revenues being generated by other major U.S. cities. A portion of the current budgets for solid waste management or other functions may need to be retained to provide a subsidy for low-income residents.

Establish a Baltimore Water Fund

The City and County should explore the establishment of a Baltimore Water Fund as part of the National Fish and Wildlife Foundation (NFWF)'s Impact-Directed Environmental Account (IDEA) program to capture funds from penalties and fines to be used for projects that benefit water quality. The IDEA program receives, manages, and disburses funds that originate from court orders, settlements of legal cases, regulatory permits, licenses, and restoration and mitigation plans. IDEA funds can also arise from voluntary activities focused on preventative conservation.

Through the IDEA program, NFWF acts as a neutral third-party fiduciary to manage funds for the benefit of government and private sector stakeholders. NFWF works collaboratively with these partners to invest and grow designated monies while at the same time helping to ensure that the funds are applied to the most effective conservation and restoration projects. NFWF provides account management services, plus assistance with project solicitation and selection, negotiation and administration of contracts and grant agreements, identification of leveraging opportunities, and evaluation of project outcomes.

Some advantages to the City and County of participating in the IDEA program versus separately collecting and applying these funds include:

- Tax-free growth of funds invested in IDEA accounts, conferring an important financial advantage that can increase the amount of funds ultimately available for conservation
- Access to financial management expertise, focused on optimizing investment income according to the liquidity needs and acceptable risk levels of stakeholders
- Maximum transparency, via financial statements and other reporting mechanisms detailing account activity
- Ability to leverage NFWF's existing grant programs, such that funds in IDEA accounts may potentially be "matched" with other funds to create synergistic effects
- Access to an expansive portfolio of conservation and restoration projects, allowing partners to quickly and efficiently apply their funds to targeted projects across virtually the entire spectrum of conservation initiatives
- Availability of NFWF's technical and program management expertise, including scientific evaluation of project options and outcomes
- Efficiencies gained from NFWF's streamlined operations, which have been specifically honed for the implementation of conservation and restoration projects
- Credibility from partnering with a trusted third party and recognized practice leader in the conservation arena, with a proven track record – established over a quarter century – of accountability, efficiency, and effectiveness

References

Schachtel, M.R.B., Glazer, A.M., and M.E. Bell. 2002. Alternative Revenue Sources and Structures for Baltimore City. Johns Hopkins Institute for Policy Studies.

Montgomery County. 2011. "Montgomery County Coordinated Implementation Strategy. Prepared for Montgomery County. Department of Environmental Protection. Draft February 16, 2011

Chapter 8. Implementation

This chapter summarizes the recommended strategies from Chapters 4, 5, and 6 that address sewage discharges, trash and pollutants in stormwater runoff. Table 7.1 presents each recommendation, the major pollutants targeted, lead entity and timeframe. Strategies with a short-term timeframe are associated with a 2020 milestone, while long-term strategies are linked to 2030 or 2040 milestones. Some strategies will be implemented immediately and are ongoing – these are noted as short and long-term in Table 8.1. As described in Chapters 5 and 6, to allow for the City and County to "ramp-up" their personnel and funding solutions there is a two-year delay for implementation of the major operating and capital programs. Therefore, full-scale implementation of trash reduction and stormwater management practices will not begin until 2014.

Table 8.1. Summary of Strategies to Make Baltimore Harbor Fishable and Swimmable

Strategy		Pollutants Addressed	Lead Organization or Entity	Timeframe
Chapter 3. Sewage Solutions	Implement a public education campaign to encourage proper disposal of domestic waste, proper connection of household drains, and disposal of pet waste	Bacteria, nutrients, various others	City- Department of Public Works (DPW), County -Department of Environmental Protection and Sustainability (DEPS)/Waterfront Partnership/Local non-profits	Short and long term
	Eliminate illegal connections through improved enforcement	Bacteria, nutrients	City- DPW, Department of Housing and Community Development (HCD) County – DEPS and Department of Public Works (DPW)	Short term
	Improve screening and monitoring for sewage discharges and leaking septic systems	Bacteria, nutrients	City – DPW County – DEPS, DPW	Short term
	Establish water quality benchmarks for stormwater outfalls	Bacteria, nutrients	City – DPW County – DEPS, DPW	Short term
	Increase the success rate of tracking sewage discharges to find the source	Bacteria, nutrients	City – DPW County – DEPS, DPW	Short term
	Increase capacity to quickly and permanently correct sewer leaks	Bacteria, nutrients	City – DPW County – DEPS, DPW	Short term
	Increase coordination	Bacteria,	City – DPW	Short and

Table 8.1. Summary of Strategies to Make Baltimore Harbor Fishable and Swimmable				
Strategy		**Pollutants Addressed**	**Lead Organization or Entity**	**Timeframe**
	and tracking across programs	nutrients	County – DEPS, DPW	long term
	Establish Harbor monitoring and public notification systems	Bacteria	City – DPW, Health Department County – DEPS Local non-profits	Short term
Chapter 4. Trash Solutions	Develop a public outreach plan to reduce trash and litter and increase enforcement of existing litter and trash disposal regulations	Trash, nutrients	City – DPW (Solid Waste, Surface Water) County – DEPS, DPW (Solid Waste) Waterfront Partnership Local non-profits	Short and long term
	Support new legislation aimed at eliminating plastic bags and bottles	Trash	City – Mayors Office, DPW, Sustainability County – Executive Office, DEPS Waterfront Partnership Local non-profits	Short term
	Conduct a trash survey to identify high trash generation areas for targeting management actions and outreach	Trash, nutrients	City – DPW (Solid Waste and Surface Water) County – DEPS, DPW (Solid Waste)	Short term
	Install green infrastructure and other volume control stormwater management practices to capture trash from stormwater runoff	Trash, nutrients, bacteria, various others	City – DPW County - DEPS	Short and long term
	Increase implementation of practices that prevent trash from entering storm drains	Trash, nutrients	City – DPW County - DEPS	Short and long term
	Increase practices that capture trash at storm drain outfalls and waterways	Trash, nutrients	City – DPW County - DEPS	Short term
m w	Reduce stormwater	Nutrients	City – DPW, Planning, Sustainability	Long term

Table 8.1. Summary of Strategies to Make Baltimore Harbor Fishable and Swimmable				
Strategy		**Pollutants Addressed**	**Lead Organization or Entity**	**Timeframe**
	pollution through redevelopment	sediment, trash, bacteria, various others	HCD County – DEPS, Planning	
	Utilize vacant properties to provide stormwater management as part of an offset and banking program	Nutrients, sediment, trash, bacteria, various others	City –DPW, Planning, Sustainability, HCD County – DEPS, Planning	Long term
	Develop plans that identify cleaning and greening actions for all City and County neighborhoods	Nutrients, sediment, trash, bacteria, various others	Neighborhoods/City/County/Local non-profits, Corporate and other sponsors	Short term
	Install green infrastructure practices in neighborhoods as stormwater retrofits	Nutrients, sediment, trash, bacteria, various others	City – DPW, Department of Transportation County - DEPS , Department of Transportation	Short and long term
	Plant trees on public and private lands	Nutrients, sediment	City – DPW, Recreation and Parks County – DEPS, Recreation and Parks Local non-profits, community organizations, citizens	Short and long term
	Implement a public education campaign for residents and businesses to encourage reduction of stormwater pollution	Nutrients, sediment, trash, bacteria, various others	City – DPW, Sustainability County - DEPS Local non-profits Corporate sponsors	Long term
	Provide incentives for retrofitting existing stormwater practices on private land	Nutrients, sediment, trash, bacteria, various others	City - DPW County - DEPS	Long term
	Implement pilot projects to demonstrate and test innovative stormwater practices	Nutrients, sediment, trash, bacteria, various others	City -DPW County – DEPS Waterfront Partnership/Corporate sponsors/Local non-profits	Short term
	Restore stream channels degraded by runoff	Sediment, nutrients	City - DPW County -DEPS	Short term
	Ensure proper crediting	Nutrients,	City -DPW	Short term

Table 8.1. Summary of Strategies to Make Baltimore Harbor Fishable and Swimmable				
Strategy		**Pollutants Addressed**	**Lead Organization or Entity**	**Timeframe**
	for alternative or innovative approaches to reduce urban stormwater pollution	sediment, trash, bacteria, various others	County - DEPS State - MDE EPA - Chesapeake Bay Program	
	Establish a tax rebate for homeowner installation of stormwater management practices on their properties	Nutrients, sediment, trash, bacteria, various others	City – DPW, Department of Finance County – DEPS, Department of Finance	Long term

Chapter 7 presented six alternatives for funding implementation of this plan. The City and County can evaluate these alternatives to determine the most appropriate mix of strategies to pursue in the near term and long term given the recommended implementation schedule. For example, a stormwater utility is the most viable option for funding implementation of green infrastructure practices; but it may not be realistic to get a utility established for at least a few years. Therefore, other funding sources such as establishing a solid waste management enterprise fund may be needed to fund trash reduction strategies until more resources are available to devote to addressing stormwater programs. In addition to the funding strategies described in Chapter 7, various grants and loans are available (e.g., federal grants, private foundation funds), especially for the actions where non-profits play a key role.

Table 8.2 summarizes the estimated pollutant reductions achieved with implementation of this plan. Appendix D describes the assumptions used to develop these estimates.

Table 8.2 Estimated Pollutant Reductions Associated with Plan Implementation	
Pollutant	**Pounds Reduced (City and County total)**
Total Nitrogen	120,000
Total Phosphorus	19,300
Total Suspended Solids	3,510,000
Trash	427,000

Tracking Progress of Plan Implementation

This plan outlines a strategy for making the Harbor fishable and swimmable and the resulting strategies will be implemented by various departments within the City and County or by local non-profits. To keep track of this complex web of actions over its almost 30-year timeframe will require a system for accountability. Three additional recommendations are described below that relate to tracking progress of plan implementation.

Integrate plan into Baltimore Watershed Agreement
The Baltimore Watershed Agreement (BWA, see Chapter 3 for background) would be a perfect "home" for the implementation phase of the Healthy Harbor Plan especially given that the BWA will be renewed in 2012. The new agreement will have new commitments and appointees to the Committee of Principals. Given the higher standards of accountability expected of the municipal separate storm sewer permits (MS4) permits and watershed implementation plans (WIPs), care will have to be taken to assure that the Committee of Principals is actively engaged and that the milestones of the BWA are tracked as part of an open process which would lend itself to a forum such as Harbor Stat (see below). Given the commitment of the Waterfront Partnership to developing this plan, it is recommended that they have a representative appointed to the Committee of Principals. In addition, it is recommended the leadership of the Baltimore Watershed Agreement be strengthened so that it acts more like a regional planning authority. This would include the establishment of an oversight committee that would coordinate between the City and County Consent Decrees for the elimination of sanitary sewer overflows (SSOs).

Create Harbor Stat to track quarterly progress
The City and County should develop an open process where project milestones can be tracked and adjustments made to assure that the goals of this plan as well as the MS4 permits and WIPs are met. Quarterly meetings are probably sufficient. The City has been very successful in tracking departmental projects and programs through City-Stat. The State of Maryland used this approach to develop Bay Stat, which would be a good model to follow. Having quarterly meetings with invited stakeholders will help to assure interagency coordination. Because of the enormity of the task, the City should also track day-to-day milestones through the existing monthly City-Stat process. Baltimore County should consider a similar tracking and accountability process.

One of the first steps in developing Harbor Stat is to establish trackable indicators. Potential indicators to be tracked include the programs and projects described in Table 8.1. The City and County may have other programs that need to be tracked as required by the MS4 permits. The design and construction phases of projects are complicated, involving dozens of steps (e.g., permitting, surveying, easements). To be mired down at this level of detail would defeat the purpose of Harbor Stat. Instead, basic tracking metrics could include the list of projects, key milestones (e.g., 90 percent design, permitting), schedule and estimated benefits. Harbor Stat should track these metrics for the following elements:

- projects
- programs (e.g., stormwater utility)
- elimination of illicit discharges and SSOs

Ultimately, water quality data should be tracked as part of this process; however, it is probably sufficient to track this annually or bi-annually.

Develop phase II Harbor Restoration Plan
The Healthy Harbor Plan limited its scope to the entire Northwest Branch and part of the Middle Branch upstream from the Hanover Street Bridge. The plan is also limited to addressing bacteria, trash, sediment and nutrients. It is not intended to address fish advisories, toxic sediments and other related issues.

The Harbor "proper" is a much larger body of water that extends to Key Bridge and with a watershed area that includes part of Carroll, Anne Arundel County, and Howard County. All four counties (and Baltimore City) will have to address sediment and nutrient total maximum daily loads (TMDLs) under the WIPs. However, the narrow focus of the WIPs does not address all of the issues identified by the stakeholder community. The MS4 permits will address some of these issues over time, but the current regulatory drivers necessitate that the City and County will concentrate their resources on eliminating trash, bacteria and sediment impairments. The City and County and other stakeholders should engage the public and identify the issues not being addressed by the MS4 permits and WIPs. It is likely that there may be synergies between the actions recommended by this plan and the broader Harbor issues. A Phase II Harbor Restoration Plan should be developed under the Baltimore Watershed Agreement and could be a new commitment when the agreement is renewed in 2012.

Conclusion

Local governments across the Chesapeake Bay Watershed are asking how meeting their local TMDLs and other requirements will help them to meet the Chesapeake Bay TMDL. They are trying to get a handle on how much, if any, additional effort will be needed, but the differences in scale, pollutants of interest, and pollutant removal efficiencies used to calculate reductions make it challenging to answer this question. The Healthy Harbor Plan takes a unique approach to cleaning up the Harbor in that it integrates these and other regulatory requirements and channels the ongoing efforts to meet these requirements towards a common and recognizable end goal: a swimmable, fishable Harbor. The process used here can be adopted by other communities.

The Healthy Harbor Plan provides a roadmap for cleaning up Baltimore Harbor and its watersheds to improve the quality of life for all who live, work and play there. Implementation of all the strategies described in this plan will certainly be costly, but the approach, which involves integration of multiple programs and addresses multiple pollutants, will not only result in a swimmable, fishable Harbor but will also allow the City and County to meet their MS4 and TMDL requirements and improve their communities. The value of a Harbor and tributary streams that are safe and enjoyable for recreational activities, as well as clean and green neighborhoods, cannot be overstated. In addition, there is great potential for tremendous cost savings through behavioral change and actions by individuals.

Baltimore City and Baltimore County have spent considerable effort over the past two decades addressing the environmental mandates of the Clean Water Act, and the Healthy Harbor Plan makes use of this data. While this plan does not replace the need for each jurisdiction to develop WIPs and implement MS4 permits, which apply to land outside of the Harbor drainage, the groundwork and path for restoration of the Harbor have been established. The City and County can now lead the way for other Chesapeake Bay communities by showing their commitment to cleaning the Harbor and by fostering the necessary support from residents, businesses and other stakeholders to do their part so that each and every resident and visitor has the opportunity to fully enjoy and use the Harbor and its tributary streams.