Consolidated Total Maximum Daily Load (TMDL) Implementation Plan Interim Report Scenario Analysis

Prepared for:
District Department of the Environment

Final

May 8, 2015

DISTRICT
DEPARTMENT
OF THE
ENVIRONMENT

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Executive Summary

Introduction

The District Department of Environment (DDOE) is required to develop a Consolidated Total Maximum Daily Load (TMDL) Implementation Plan (IP) as established in its Municipal Separate Storm Sewer System (MS4) permit. This Scenario Analysis Report describes a series of stormwater management scenarios that were modeled using the IP Modeling Tool. Results of these scenarios are used to develop the IP. The analysis described in this report provides the District with a framework and tools needed to develop the IP in a comprehensive and coordinated manner, with specific targets and timelines for achieving MS4 WLAs.

Overview of Scenarios

A set of scenarios were developed to explore the annual runoff and pollutant load reductions under various BMP implementation strategies. These scenarios represent both hypothetical conditions as well as implementation of stormwater controls from existing programs and budgetary resources. These scenarios include:

1. Load reductions under pre-development (100% forested) conditions.
2. Load reductions from BMP implementation projected to occur from development and redevelopment of the MS4 area and the application of the District's 2013 Stormwater Management Rule and Guidebook.
3. Load reductions from BMP implementation projected to occur from other existing drivers and programs.
4. BMP projects identified in existing watershed implementation plans.
5. Projecting current BMP implementation until all WLAs are attained.

The scenarios shown above are used to evaluate potential progress towards meeting the 206 annual WLAs that are currently modeled and evaluated using the IP Modeling Tool.

Discussion of Findings

The findings from the scenario analysis presented here are focused on the 206 annual WLAs that were evaluated with the IP Modeling Tool. Major findings include:

- 29 WLAs are already in compliance under the present conditions.
- At the current rate of BMP implementation and expected load reductions, 43 WLAs will be attained by 2040, 115 WLAs will be attained by 2127, and all 206 WLA will be attained by 2154.
- Existing BMP efficiencies may limit the ability to achieve WLAs. More than half of the annual MS4 WLAs require pollutant load reduction in excess of 70% while the typical pollutant removal efficiency for most BMPs is less than 70%.
- It also may not be feasible to retain sufficient stormwater necessary to achieve WLAs. The stormwater retention depth needed over nearly the entire MS4 area to attain all the WLAs is estimated at approximately 2 inches, which would both require a very high density of BMPs across the MS4 and BMPs with a high retention or infiltration capacity. A 2 inch retention depth means that more than 90% of all rain events would be entirely captured and treated by BMPs,

which is the level of control needed to meet the WLAs that require more than a 90% reduction in loads.

- As a point of comparison, the amount of MS4 stormwater volume that needs to be treated to meet all of the WLAs exceeds the treatment volume required of the combined sewer system.
- The results of the scenario analysis show that WLA attainment will require lengthy implementation timelines of a major subset of WLAs, and the rate of attainment is limited by the efficiencies and effectiveness of current BMPs.

Next Steps

This Scenario Analysis Report provides results for a series of stormwater management scenarios that were modeled using the IP Modeling Tool. The next step is to use the results presented herein to inform the Consolidated TMDL IP. The Consolidated TMDL IP will be finalized in May 2015.

1. Introduction

The District Department of Environment (DDOE) is required to develop a Consolidated Total Maximum Daily Load (TMDL) Implementation Plan (IP), as established in the District's Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) permit (EPA, 2011 and EPA, 2012). The IP will define and organize a multi-year process centered on reducing pollutant loads originating within the District MS4. The level of pollutant control will be based on past TMDL studies performed to protect impaired water bodies in the District. The IP will include a summary of the regulatory compliance strategy to satisfy TMDL-related permit requirements, a summary of data and methods used to develop the IP, specific prioritized recommendations for storm water control measures, a schedule for implementation and attainment of Waste Load Allocations (WLAs), and a method for tracking progress. Substantial public involvement will be sought in plan development.

This **Scenario Analysis Report** describes future management scenarios that were modeled individually over time to evaluate their potential to reduce storm water runoff and pollutant loads and meet annual WLAs. The future management scenarios consist of a combination of planned implementation strategies (e.g., the load reduction that is expected to be achieved through the stormwater regulations, as modeled through the development/redevelopment scenario), as well as potential additional implementation strategies (e.g., the implementation of projects included in the existing Watershed Implementation Plans or WIPs). While the individual strategies may be specifically planned or potentially implemented, the load reductions forecast by the IP Modeling Tool are largely conceptual but portray a possible outcome of implementation of the strategies. The scenarios evaluated in this document build upon ongoing implementation efforts and expand projected BMP implementation to specific land use activities (development and redevelopment) and control projects recommended in existing planning documents. This report presents the rate at which the 206 annual WLAs will be attained over time. Specific runoff and pollutant load reduction results, and the rate of achievement of MS4 WLAs for all scenarios over time, are established with the IP Modeling Tool.

The analysis of alternative scenarios provides a technical basis for development of the Consolidated TMDL IP. The major subjects included in this report are summarized in the following sub-sections:

1.1 Overview of Scenarios

A set of scenarios are used to explore the potential for additional structural and non-structural BMPs to reduce runoff and pollutant loads in the future. This includes scenarios that represent hypothetical conditions and scenarios that represent the implementation of stormwater controls with existing programs and budgetary resources. With the exception of one scenario (the pre-development conditions), the results of the scenario analysis are quantified at five year increments to the year 2040 and beyond. The Comprehensive Baseline Report provides an assessment of the pollutant loads and storm water volumes under the baseline (pre-BMPs) and existing (existing BMPs) conditions (DDOE, 2014). The scenarios described in this report are compared against the existing conditions to assess their effectiveness in reducing loads and ultimately attaining WLA targets. These scenarios include those described in the subsections below.

1.1.1 Pre-Development (100% forested) Conditions

The pre-development scenario represents a hypothetical historical situation wherein the entire District is covered with forest. This scenario is static and does not include any planning horizon forecasts into the future. It is included here to illustrate the challenge in attaining certain WLAs, even under pre-development conditions.

1.1.2 BMP Implementation Projected to Occur from Development and Redevelopment of the MS4 Area and the Application of the District's 2013 Stormwater Management Rule and Guidebook

This scenario examines the projected effect of District's Stormwater Management Rule and Guidebook with respect to forecasted development and redevelopment and the requirement to retain 1.2 inches of rainfall on site.

1.1.3 BMP Implementation Projected to Occur from Other Existing Drivers and Programs

This scenario examines the potential impact of projects anticipated to occur through other existing programs, such as DDOE's RiverSmart program or DDOT's green alley program.

1.1.4 BMP Projects Identified in Existing Watershed Implementation Plans

This scenario examines the implementation of potential projects that are included in the District's existing TMDL Implementation Plans and other watershed studies.

1.2 Report Organization

The research, data collection and analysis that underpin the scenarios is described and documented in each section. The discussion includes documentation of how future projections of development and redevelopment are made, and the basis of other assumptions regarding future management of stormwater. The determination of model inputs associated with each scenario is also documented. Model inputs include the amount, type, and distribution of BMPs and other stormwater management practices. The scenario results are compared and contrasted with respect to their effectiveness for runoff and pollutant removal over time. Combinations of scenarios are considered.

The Consolidated TMDL IP will draw on the analysis of the scenario results to establish the preferred Implementation Plan to guide the MS4 program.

2. Review and Summary of Baseline and Existing Conditions

2.1 Introduction

An Implementation Plan Modeling Tool was developed to track and account for pollutant load generation and load reduction across the District for all of the pollutants of interest that have MS4 WLAs. It consists of three parts:

- Runoff Module: calculates the runoff volume using the Modified Version of the Simple Method (CWP and CSN, 2008).
- Pollutant Load Module: calculates the pollutant loads using event mean concentrations (EMCs), stream bank erosion calculations, and/or trash load rates in conjunction with runoff volume from the runoff module described above.
- BMP Module: consists of the current BMP inventory and the assumed BMP pollutant load reduction efficiencies used to calculate load and runoff reductions provided by the BMPs.

Full documentation of the development of the IP Modeling Tool is provided in the Comprehensive Baseline Analysis Report (DDOE, 2014). A total of 206 annual WLAs are currently modeled and evaluated using the IP Modeling Tool.

2.2 Modeling and Projecting the Load and Storm Water Volume Reduction

The IP Modeling Tool was applied to develop baseline and current conditions, and to assess the remaining gap in load reduction that is required to attain the MS4 WLAs defined by individual TMDLs[1]. The baseline condition establishes a starting point for the evaluation of the amount, type, and distribution of BMPs and other stormwater management practices required to meet WLAs and LAs. For the purposes of this analysis, the baseline condition consists of the stormwater loads in place when the majority of TMDLs were developed (circa 2000 to 2004). Individual baseline conditions were established for each of the WLAs, as well as for the direct drainage load allocations (LA). The current condition consists of stormwater pollutant loads in the District that are influenced and reduced by existing structural and non-structural BMPs and other storm water management practices that were installed and put into operation prior to 2014.

The "gap" represents the difference between the current stormwater pollutant loads and the segment and pollutant-specific WLAs. It is expressed in terms of pollutant load reduction (e.g., lbs of pollutant) that is needed to meet the established MS4 WLA targets. Quantifying the gap in this manner documents the remaining pollutant load reduction required to meet WLAs. Major findings and implications of the gap analysis are summarized in the next section.

[1] Note: this document also refers to the nonpoint source Load Allocations (LAs) for direct drainage areas. While there is no regulatory requirement for DDOE to achieve these LAs, the IP Modeling Tool includes LAs as part of its calculations.

2.3 Results and Analysis

This section shows the gap analysis results for the 206 annual WLAs that are modeled in the IP Modeling Tool. A summary of the pollutant load reduction as a percentage reduction required to meet the annual WLAs is presented in Figure 2-1. The blue bar represents the model results for the 206 annual WLAs that were evaluated with the IP Modeling Tool. The figure also shows three additional categories:

1. "Removed from 303(d)": These represent the WLAs that are likely to be removed from the 303(d) list based on monitoring that was conducted in 2014. A sum of 136 WLAs fall within this category.
2. "Management Action": These represent the 37 WLAs that fall in three different subcategories, including:
   a. WLAs that have a non-numeric WLA
   b. WLAs that require specific source control actions and that do not require modeling to show compliance with WLA targets.
   c. WLAs that require clarification from EPA on the DC-specific WLA values.

"No Action Needed": These represent 27 WLAs, including 24 Fecal Coliform WLAs that were replaced by E.coli WLAs, 1 BOD WLA for Fort Davis that is deemed "not an impairment' according to the TMDL, and two WLAs for Kingman Lake (BOD and TSS) which "no longer require a TMDL" according to the TMDL documentation.

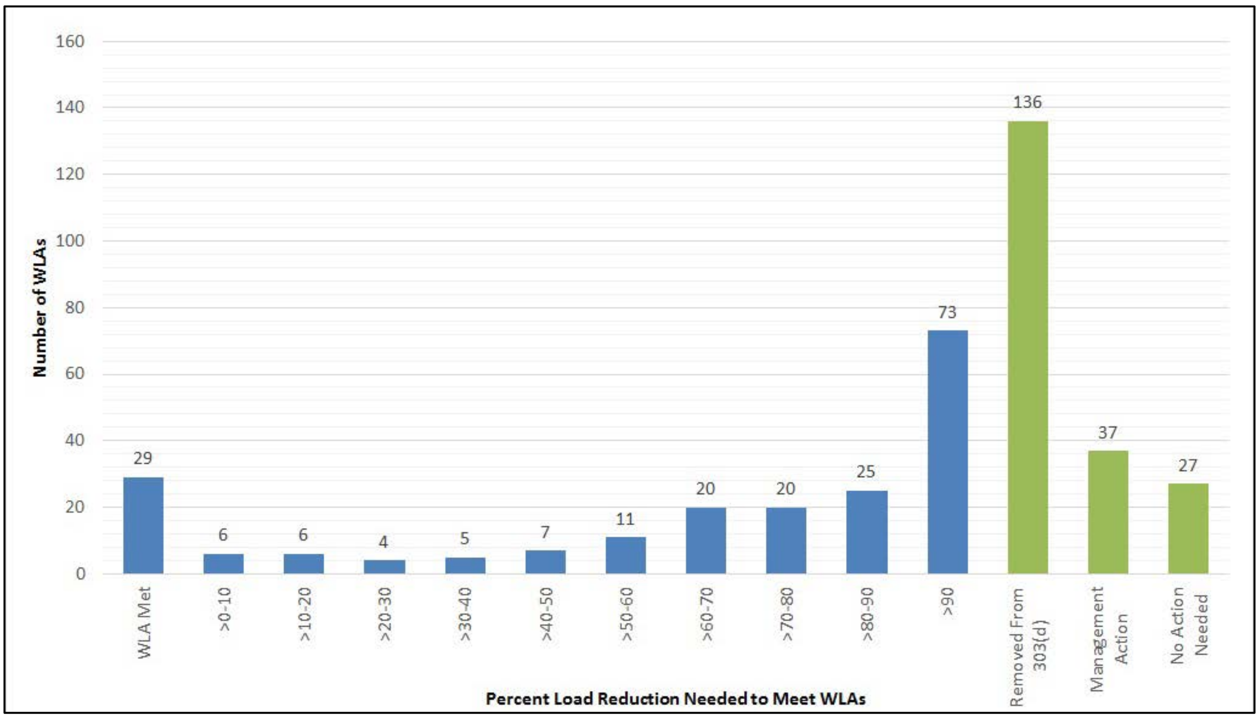

Figure 2-1: Gap Expressed as Percent Reduction Needed to Meet WLA

The gap analysis shows that 29 of the current loads meet the WLAs, 28 current loads need up to a 50% reduction to meet WLAs, 76 current loads need between 50 and 90% reduction to meet WLAs, and 73 current loads need more than a 90% reduction to meet the WLAs. The analysis confirms that a very large amount of pollutant load reduction will be needed to meet all MS4 WLA targets. The pollutant load reduction gaps for individual TMDL segments for which there are MS4 WLAs vary substantially in magnitude, and no distinctive spatial patterns in the amount of load reduction of individual pollutants required in specific watersheds were found. Bacteria and organic substances are the “controlling” pollutants in most watersheds (i.e., these pollutants require the greatest amount of stormwater control to attain WLAs relative to other pollutants in the same watershed).

Attainment of WLAs can also be expressed in terms of the BMP retention depth that must be provided over the MS4 area. The BMP retention depth describes the amount of stormwater that a particular BMP can retain and infiltrate into the ground, and therefore eliminate from the total surface stormwater runoff that discharges into any given waterbody. Calculating the BMP retention depth needed to meet WLAs is a useful and interesting exercise, especially in light of the District’s 2013 Stormwater Rule and Guidebook, which prescribes that major land disturbances from development or redevelopment activities be retrofitted with BMPs that can retain 1.2 inches of stormwater runoff. **Figure 2-2** shows that as the prescribed runoff retention depth is increased, an increasing number of individual WLAs are expected to be met. For example, if 1.2 inches of runoff (the current standard of the District’s stormwater regulations) is retained over the entire MS4 area - a scenario that would require substantial retrofitting of BMPs on most properties - a total of 113 WLAs will be met. Note that the 2 trash WLA are not included in this total because the trash WLA calculations are independent of runoff retention depth achieved. The trash WLAs are discussed in Section 5.3.

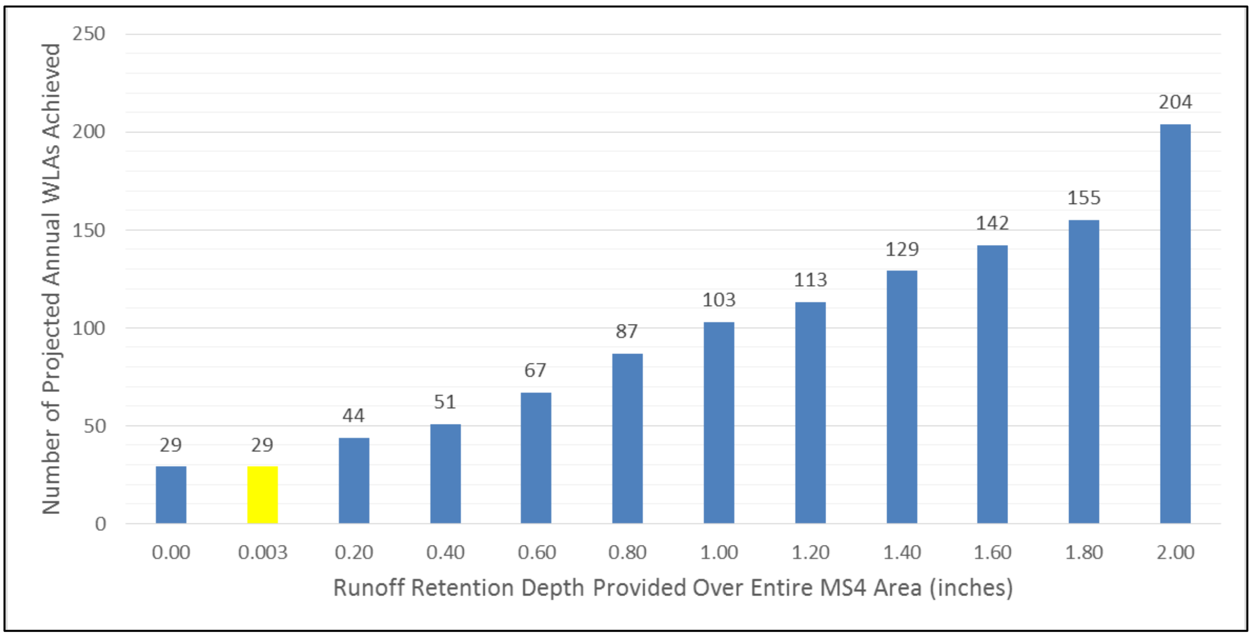

Figure 2-2: Projected WLAs Achieved with Incremental Increase in Runoff Retention Depth Provided[2]

As part of this analysis, the inventory of existing BMPs was used to show the load reduction achieved by these BMPs. As shown in the yellow bar in Figure 2-2, the existing BMPs have a very minor impact on reducing pollutant loads across the District. Overall, existing BMPs reduce loads by less than 2 percent relative to baseline, and they achieve no additional WLAs relative to that baseline. Current BMPs controlling trash are an exception, because current control programs remove roughly 60 to 85 percent of the trash load.

[2] Note that this figure shows results for 204 out of the 206 total modeled annual WLAs. The 2 trash WLAs are independent of the runoff retention depth and therefore are not included in this figure.

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In order to meet all WLAs using this method of accounting, 77% of the MS4 area must retain nearly 2 inches of rain, while the remaining 23% of the MS4 area must retain between 0.8 and 1.8. In other words,

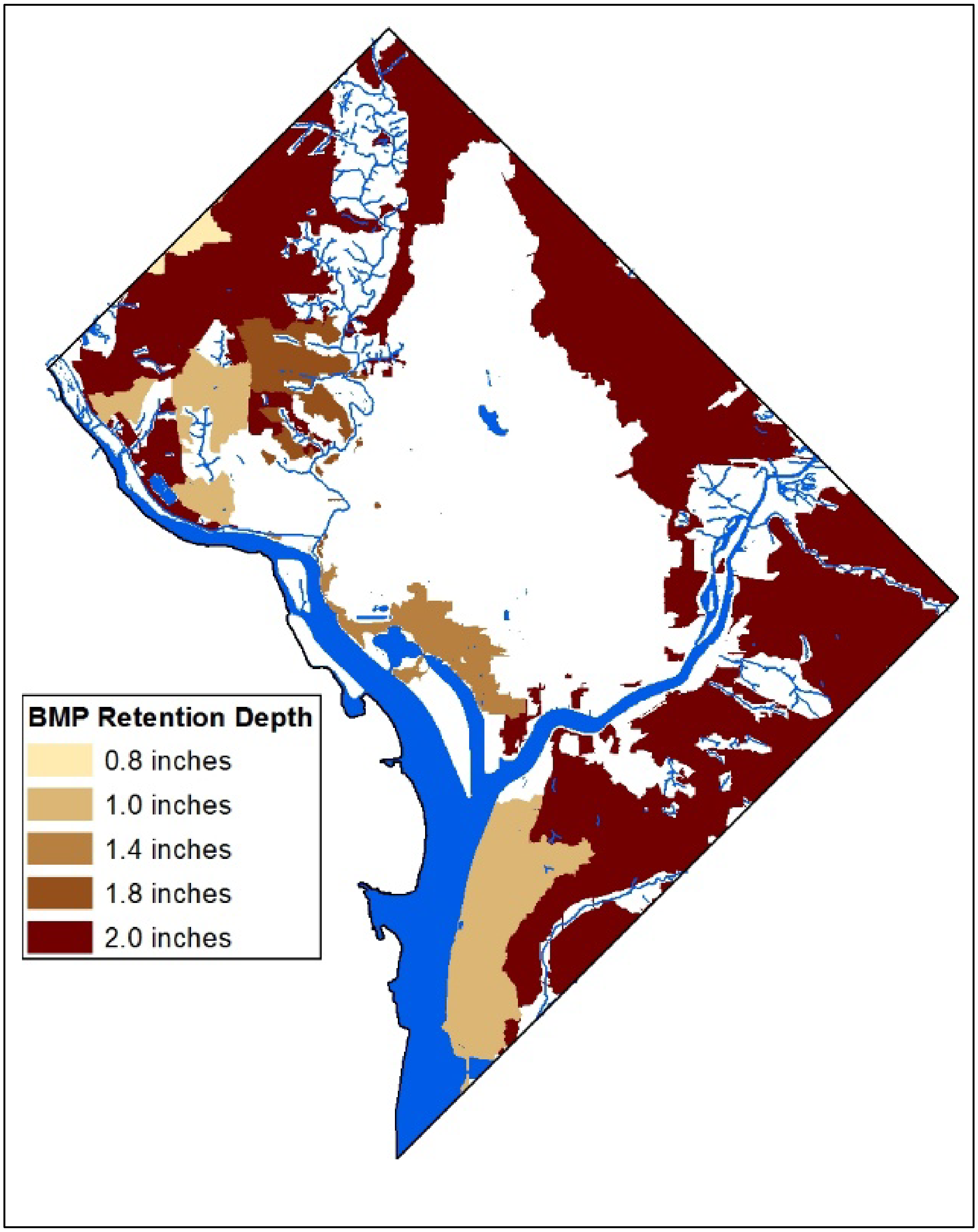

Figure 2-3: Spatial Representation of the Required BMP Retention Depth Over the MS4 to Meet All Annual MS4 WLAs.

some parts of the MS4 need more than the current standard (1.2 inches) to meet WLAs, while other parts of the MS4 can meet the WLAs within the current standard. This is because some areas of the MS4 require less pollutant load reductions to meet WLA targets, as determined by the TMDL studies. For example, the mainstem Potomac segments need less runoff reduction to meet all their WLAs than the mainstem Anacostia segments. Achieving 2 inches of runoff retention would both require a very high density of BMPs across the MS4 and BMPs with a high retention or infiltration capacity. A 2 inch retention depth means that more than 90% of all rain events would be entirely captured and treated by

BMPs, which is the amount needed to meet the WLAs that require more than a 90% reduction in current loads. The estimated runoff retention across the MS4 area is shown in Figure 2-3.

Pollutant load reduction gaps for nearly all of the MS4 TMDL WLAs are substantial. Achieving the WLAs for the majority of the pollutants will require extremely high levels of stormwater management and control. Addressing these large gaps is complicated because BMPs, which are the traditional approach to stormwater and nonpoint source control, have their own inherent limits as load reduction and volume control practices, and opportunities to successfully implement BMPs may be limited given the space constraints in highly urbanized areas such as the District MS4.

The following sections present various scenarios of BMP implementation or of hypothetical “pre-development” conditions, show how these scenarios or conditions were modeled, and provides estimates of pollutant load reductions and WLA attainment across the MS4 area.

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3. Pre-Development Conditions

3.1 Introduction

This scenario represents a hypothetical situation and assesses how many of the WLAs would be met if the entire MS4 area was converted back to pre-development conditions. For the purposes of this scenario, it is assumed that pre-development conditions equate to a completely forested landscape. This scenario is static and does not include any planning horizon forecasts into the future. The results of this scenario demonstrate that certain WLAs could not be met, even under pre-development conditions.

3.2 Modeling and Projecting the Load and Storm Water Volume Reduction

To model this scenario, it was assumed that the entire MS4 area was completely forested. Soil classifications for different areas were assigned by using the existing land use ratio of forested soil groups within a segment. That is, if 12 percent of the existing forested land in Pinehurst Branch was of soil group HSG C, then 12 percent of the total Pinehurst Branch area would be assigned to HSG C in this scenario. Subsequently, the land use runoff coefficient for forested areas with soil groups HSG A, HSG B, HSG C, and HSG D were used to calculate runoff accordingly.

The EMC for each pollutant was also adjusted to reflect pre-developed conditions. A literature search was performed, and a median concentration observed in stormwater from forested watersheds was identified for each pollutant. A full report on the investigation of EMCs can be found in Appendix D of the Final Comprehensive Baseline Report (Technical Memorandum: Selection of Event Mean Concentrations (EMCs)). EMC values were found only for TN, TP, TSS, Fecal Coliform Bacteria, BOD, Copper, Lead, and Zinc. Arsenic can occur naturally in the environment, but a forested or natural concentration EMC value was not identified. For all anthropogenic toxics and mercury, the pre-development EMC was assumed to be zero, since these chemicals would not have existed under pre-development conditions. All nonstructural and structural best management practice load reductions were omitted from this analysis. In addition, it was assumed that there was no stream bank erosion under pre-developed conditions. Note that at the time of this analysis, the Fecal Coliform TMDLs were not yet converted to E.coli TMDLs, so only Fecal Coliform Bacteria were modeled.

3.3 Results and Analysis

The model results from this scenario show that all annual WLAs are attained under pre-development conditions except for the fecal coliform bacteria WLAs in the Anacostia tributaries. The WLAs are attained either because some pollutants, like chlordane, do not exist under pre-anthropogenic conditions, or, because the pollutants, like nitrogen, are not present in sufficient concentrations to exceed the WLA. A summary of the WLAs that are not met under pre-development conditions is shown in Table 3-1. The modeled fecal coliform pre-development loads for the Anacostia tributaries were at least four orders of magnitude larger than the WLA, which highlights a potential issue with the numeric value of these WLAs. Investigations being conducted outside of the IP process are currently re-evaluating the validity of existing bacteria WLAs in the Anacostia tributaries.

Table 3-1: WLAs that are not Attained Under Pre-development Conditions			
TMDL Segment	**Pollutant**	**Pre-Development Load (billion MPN/100 ml)**	**WLA (billion MPN/100 ml)**
Fort Chaplin Tributary	Fecal Coliform Bacteria	102	0.0027
Fort Davis Tributary	Fecal Coliform Bacteria	53	0.0012
Fort Dupont Tributary	Fecal Coliform Bacteria	45	0.0011
Fort Stanton Tributary	Fecal Coliform Bacteria	30	0.0004
Hickey Run	Fecal Coliform Bacteria	753	0.0108
Nash Run	Fecal Coliform Bacteria	304	0.0036
Pope Branch	Fecal Coliform Bacteria	117	0.0058
Texas Avenue Tributary	Fecal Coliform Bacteria	56	0.0044
Watts Branch – Upper	Fecal Coliform Bacteria	203	0.0044
Watts Branch – Lower	Fecal Coliform Bacteria	638	0.0119

4. BMP Implementation from Development and Redevelopment in the MS4 area and the Application of the District's 2013 Stormwater Management Rule

4.1 Introduction

One of the primary methods for closing gaps and meeting WLAs is implementation of the District's 2013 Stormwater Management Rule. BMP implementation is projected to occur from the planned or forecasted development and redevelopment in the MS4 area that would trigger the District's 2013 Stormwater Management Rule (DDOE, 2013). The regulations require 1.2 inches of stormwater retention for major land disturbing activities that disturb more than 5,000 square feet of land area and 0.8 inches for substantial improvement activities. This scenario, which is referred to as the "Development/ Redevelopment Scenario," forecasts the anticipated major land-disturbing activities that will be subject to the storm water regulations, which in turn establishes the acreage of MS4 area that will be treated to the 1.2" standard by BMPs over time. This information is used to estimate the corresponding load and storm water volume reductions.

The projections of the rate and extent of development and redevelopment were determined using different approaches for two different categories of land parcels. A full description of the methodology to develop the projections can be found in Section 4; a brief summary is provided below.

1. **Development/Redevelopment Projections for all Parcels except those zoned as R1-R4:** The District's Office of Planning tracks and forecasts the expected development and redevelopment in the District. OP's forecasts mainly apply to residential parcels that are zoned for 10 units or more, such as R-5 residential lots, or to commercial, industrial, and institutional parcels. OP's forecast, broadly speaking, excludes parcels zoned as R1 through R4 although some exceptions apply, as further explained in section 4.2. OP's projections were further filtered by lot size such that only development or redevelopment on parcels greater than 5,000 square feet, or a cluster of contiguous small parcels with an aggregate area of greater than 5,000 square feet were retained to identify the areas that have the potential to trigger the stormwater regulations. Planned development projects identified from the District's Office of Planning's (OP's) Expected Development database served as the main basis for the forecast. Additional parcels identified as having a high potential to develop in the future were added to this forecast through use of the Capacity/Value, and Targeted Zone methodologies (see section 4.2.2). The projections also included major roadway reconstruction projects identified by the District's Department of Transportation (DDOT) that have the potential to trigger the stormwater regulations. Interviews with agencies like DC Department of General Services, National Capital Planning Commission (NCPC), Department of Housing and Community Development (DHCD), and college campuses were conducted to determine if these organizations are planning on undertaking any major development or redevelopment projects in the near future that were not already captured by OP's forecast. The development/redevelopment projections extend out to 2040 in 5-year increments, which is the same time period and increment that OP currently uses to forecast future development or redevelopment. Projections vary in both rate and spatial distribution for each 5-year increment.

2. **Development/Redevelopment Projections for Parcels that are zoned R1-R4**
   Since OP's forecast of development and redevelopment excludes, broadly speaking, parcels that are zoned R1 through R4 (mainly single family homes), a different methodology was used to predict the projections of development or redevelopment of the R1-R4 parcels. These projections are based on DDOE's historic BMP inventory for the years 2007 through 2011. The installation of these BMPs occurred because some development or redevelopment activity on these parcels triggered the old stormwater regulations. It is assumed that if the old regulations were triggered, a similar-type project in the future would trigger the new stormwater regulations. This analysis also assumes that future development rates would be similar to past development rates for R1-R4 properties. BMPs in the historic database that are located on parcels zoned for R1 through R4 were selected for this analysis, regardless of the parcel size. Once the historic BMPs on R1-R4 parcels were identified, the total parcel area was calculated from the historic database and an average development/redevelopment rate was calculated based on this area. This rate serves as the Development/Redevelopment Projection for parcels that are zoned R1-R4. These projections do not vary in rate or spatial distribution given the limited amount of data that was available to create the projections and that OP does not project future development on R1-R4 parcels based on an industry standard.

The aggregate area of the development/redevelopment projections determined using the two approaches described above determine the rate and extent of area that will be subject to the District's 2013 Stormwater Management Rules under the "development/redevelopment scenario". The methodologies to develop the projections, and the results of the projections, are further explained in the sections below.

4.2 Development/Redevelopment Projections for all Parcels in the MS4 except those zoned as R1-R4

As explained in the previous section, the District's Office of Planning tracks and forecasts the expected development and redevelopment in the District. OP's forecasts mainly apply to parcels that are zoned R-5 residential, commercial, industrial, and institutional lots. OP's forecast typically excludes parcels zoned as R1 through R4, which are largely single family residential parcels. Therefore, the development and redevelopment projections described in this section apply to all parcels with the general exception of those zoned as R1-R4. There is one notable exception to this rule which occurs if a cluster of contiguous small R1-R4 parcels are flagged as one major development or redevelopment project, in which case these R1-R4 parcels will be included in the forecast as areas that have the potential to trigger the stormwater regulations. OP's forecast was used as the foundation to determine the extent and rate of development or redevelopment that will trigger the stormwater regulations, for all parcels except those zoned as R1-R4. Information obtained from NCPC, DDOT, DCWater, and other agencies was used to supplement these projections. The process of creating the development/redevelopment projections for non R1-R4 parcels consisted of four major steps:

1. **Identify the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities":** For the purposes of the Development/Redevelopment Scenario, the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities" represent the parcels in the MS4 area that have the potential to trigger the storm water regulations if they are developed or redeveloped in their entirety in the future. A major trigger is the size of the disturbed area, which must be larger than 5,000 square feet. Therefore, only parcels that are larger than 5,000 square feet were selected as the "Parcels Potentially Subject to the Stormwater Regulations". One caveat to this is that roadways and PROW are not associated with "parcels" per se, but they are included in the evaluation of areas that are potentially subject to the Stormwater Regulations. Further details on this step are provided in Section 4.2.1. Note

that the Stormwater Regulations also apply to "major substantial improvement" on parcels of any size, including parcels less than 5,000 square feet, if the cost of the project is equal to or greater than 50% of pre-project assessed value of the structure. However, these types of projects are currently difficult to predict because of the lack of historical tracking data, so these activities are not currently accounted for in the development/redevelopment scenario.

2. **Forecast the projected development and redevelopment areas:** The forecast uses data from the District Office of Planning (OP), the National Capital Planning Commission (NCPC), the District Department of Housing and Community Development (DHCD), the District Department of Transportation (DDOT), DC Water, and university campus master plans to determine parcels and roadways/PROW in the MS4 area that have reasonable potential to be developed or redeveloped in the next 25 years. The forecast is then developed in 5-year increments. This is further explained in Section 4.2.2.
3. **Establish the Intersection of the Parcels Potentially Subject to the Stormwater Regulations and the Forecasted Development/Redevelopment:** The results from steps 1 and 2 were intersected and the intersected area was retained and identified as the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities" that are expected to be developed/redeveloped over the next 25 years. These parcels were then sorted and a knee-of-the-curve analysis was conducted to verify, and if necessary correct, the assumption that the entire parcel area will be developed/redeveloped and be subject to the stormwater regulations. Permit plans were used to make this determination and areas were adjusted accordingly. Additionally, any partially or completely overlapping parcels were identified and deleted in order to avoid double counting those areas. The remaining parcels represent areas that are projected to be subject to the 1.2" runoff retention requirements of the new stormwater regulations over the next 25 years. This is further explained in Section 4.2.3.
4. **Project the load reductions from the Development/Redevelopment Scenario**: Use the parcels identified in step 3 and the assumption of 1.2" runoff retention to project the load and storm water volume reduction expected to occur under this scenario. This is further explained in Section 4.4.

4.2.1 Identify the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities"

Identification of the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities", defined as the parcels in the MS4 area that have the potential to trigger the storm water regulations if those parcels were developed or redeveloped, is the first step in creating the Development/Redevelopment Scenario. A major trigger is the size of the disturbed area, which must be larger than 5,000 square feet. Therefore, only parcels that are larger than 5,000 square feet were selected as the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities". One caveat to this is that roadways and PROW are not associated with "parcels" per se, but they are included in the evaluation of areas that are potentially subject to the Stormwater Regulations. The ownership and land use type for each parcel larger than 5,000 square feet were identified to better understand the types of parcels that have the potential to trigger the stormwater regulations. These data were also used as part of the assessment of the potential for each parcel to be developed or redeveloped in the future. The only types of parcels over 5,000 square feet that were excluded from the dataset were parcels that contain condominiums. Because of the management structure of condominiums, they are unlikely to be developed or redeveloped as a whole and therefore are unlikely to trigger the stormwater regulations.

Note that the Stormwater Regulations also apply to "major substantial improvement" on parcels of any size, including parcels less than 5,000 square feet, if the cost of the project is equal to or greater than 50% of pre-project assessed value of the structure. These types of projects are currently difficult to track and predict because it requires detailed information on the pre- and post-construction value of the project, which is not readily available. Therefore, these activities are not currently accounted for in the development/redevelopment scenario. Attachment 1 provides a detailed description of the processes and assumptions for identifying the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities", including the data sources used and the data processing applied.

4.2.1.a Results Summary

A few key findings about the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities" include:

- Approximately 30% of parcels in the MS4 are identified as "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities" because they have the potential to trigger the storm water regulations if those parcels are developed/redeveloped in their entirety. The aggregate area of these parcels account for approximately 87% (17,144 acres) of the total MS4 area.
- Most of the parcels identified as "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities" are either privately owned, District owned, or federally owned. A very small portion are internationally owned, owned by WMATA, or have unknown ownership.
- Roads and public right of way make up the majority of District-owned areas of the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities."

4.2.2 Forecast the Projected Development and Redevelopment Areas for All Parcels Except Those Zoned R1-R4

The second step in developing the Development and Redevelopment scenario for all parcels except those zoned R1-R4 is to forecast the development or redevelopment activity that is likely to occur between 2015 and 2040 in the MS4 area. The year 2040 represents the longest horizon at which OP projects future development. This area is called the Forecasted Development/Redevelopment Area for the purposes of this scenario. Preliminary development and redevelopment projections were developed by cross-referencing the Parcels Potentially Subject to the Stormwater Regulations with areas that were projected to be developed/redeveloped in the future. The primary source of data used to make development projections was information provided by OP, which included both information on projected development that had already been specifically identified and entered into OP's tracking system (i.e., the Expected Development Database) and information that allowed projections based on best professional judgment (BPJ) of potential development that had not been planned but had the potential to occur (i.e., projections made using the Capacity Analysis database – see below). Information on land development from local and federal agencies was used to augment the projections made from OP data. Each area that had the potential to be developed was then assigned a timeframe during which it was expected to be developed/redeveloped. The timeframe for this exercise ranged from 2015 to 2040 (the year 2040 represents the longest horizon at which OP projects future development), and each area was assigned to a 5-year increment within this timeframe (i.e., projected to be completed by the end of 2015, between 2016 and the end of 2020, between 2021 and the end of 2025, etc.).

Attachment 1 provides a more detailed description of the processes and assumptions that were applied to forecast the projected development and redevelopment of all parcels except those zoned R1-R4.

4.2.2.a Data Collection and Analysis

Data was collected from a wide variety of sources to identify the projected areas of development and redevelopment. These include:

Office of Planning Databases

OP was a key partner in providing both data and agency plans that were used for developing future projections. OP provided databases from studies that they had conducted, such as the Expected Development Database and the Capacity Analysis Database. The Expected Development Database tracks developments within the District. OP develops this database by identifying developments through a permit, zoning review, or conceptual design as filed with District government. The database also includes conceptual design projects for which a design review has been filed.[3] More information on the Expected Development Database can be found in Attachment 1. In contrast to the Expected Development Database, which tracks identified development projects, the Capacity Analysis Database provides a snapshot in time of parcel-level information that allows projection of development that is not yet planned. The Capacity Analysis Database is a parcel-level documentation of the District including any parcel with a designated floor area ratio (FAR)[4]. It contains information such as the parcel square footage, land value, improvement value, ownership, structure age, zoning labels, percent built, as well as other factors. The OP databases primarily project development on all parcels except those zoned R1-R4, but R1-R4 parcels can be included when contiguous clusters of R1-R4 parcels are a part of a single development or redevelopment project which would trigger the stormwater regulations. These data were used to determine a parcel's potential for development.

Based on OP databases, assumptions are made about the potential for development of individual parcels in order to establish a forecast. Parcels included in the Expected Development Database were already identified as expected to be developed. In addition, these parcels had data available to assign a projected date of development/redevelopment. Next, the Capacity Analysis Database was used to develop a "Capacity/Value Forecast". This forecast used the Capacity Analysis Database to identify parcels that were likely to be developed based on the "available capacity" (what was currently built on that parcel compared to what maximum zoning allows to be built) versus their "value ratio" (what the parcel is worth compared to the total value of the parcel with the structure included). Finally, a Targeted Zone Forecast was used to identify parcels that are in a "targeted zone" area that has some kind of incentive or driver for development. Examples of these "targeted zones" include a half-mile buffer around Metrorail stations, Economic Development Zones, Enterprise and Empowerment Zones, Historically Underutilized Business Zones, Neighborhood Investment Fund Zones, Supermarket Tax Credit Zones, and Main Streets Programs. Together, the parcels identified through the Expected Development Database and analysis of the Capacity Analysis Database with the Capacity/Value Forecast and the Target Zone Forecast provide a data-driven projection of development/redevelopment in the District over the next 25 years.

A number of other plans obtained from OP, including Small Area Plans, Neighborhood Investment Fund Plans, Great Streets Corridor Plans, and Gateway Plans, as well as supplemental agency plans from the DC Public Libraries and DC Public Schools, were also reviewed to determine parcels for potential development/redevelopment. While many of the parcels identified by these plans were already identified by other forecast methodologies, any parcels that were not already identified by other methodologies were included in the final forecast.

[3] Such projects were identified by OP, which followed up with other regulatory agencies to track the progress of these projects.

[4] Floor Area Ratio (FAR) is the ratio of a building's total square footage to the parcel's total square footage. This is used for zoning and planning purposes to limit the size and scale of developments.

District Department of Transportation (DDOT)

Multiple DDOT documents, including the 2014-2020 Transportation Improvement Plan (TIP), corridor studies, and moveDC (October 2014) documents were used to identify DDOT projects projected to occur between 2015 and 2040. The DDOT documents provided different information on projected transportation and roadway-related development in the District. TIPs provide detailed data on projects that are already planned to occur within the next six years. Corridor studies for Benning Road NE, Georgia Avenue NW, Minnesota Ave NE, Martin Luther King Jr Blvd SE, Nannie Helen Burroughs NE, and Pennsylvania Avenue SE were released in 2007 as part of the "Great Streets" Program. The planning horizon for these corridor studies is four years, and most of the projects included in these studies are already completed. Other corridor studies reviewed included the Wisconsin Avenue Corridor Transportation Study (released 2005, also with a 4 year planning horizon) and the 18th Street- Adams Morgan Transportation and Parking Study (2006). While many projects from the corridor studies had already been completed, any that had not yet been completed were added to the forecast.

In contrast to the TIPs and corridor studies, moveDC is more of a vision for future transportation development and funding in the District, and implementation of projects from moveDC planning is subject to available funding. Based on the relative confidence in implementation of the planning forecast in the DDOT documents, these plans were used in different ways. Specific projects from the TIP and corridor studies are included in the forecast, whereas the moveDC planning is used to inform BPJ about additional roadway construction projects to include in the forecast. In addition, BPJ is used to evaluate the information from the plans as a whole to develop the forecast of future road development. For example, these documents indicate which roads have recently been reconstructed. The assumption can be made that any roads that have been recently reconstructed will not likely need reconstruction between 2015 and 2040. Also informing BPJ about future potential road construction projects is that DDOT has identified that Federal Aid eligible roads are more likely to be reconstructed than local roads because of the availability of funding for these roads. Based on this type of information, roads such as New York Avenue NE are likely to be reconstructed in the near future because of their heavy use during construction and general need for upgrade.

While it was anticipated that DDOT plans could be used to project roadway reconstruction between 2015 and 2040, most plans did not extend out beyond 2020. In other words, most of the development or redevelopment projections for roads and public right of way, that are available through DDOT documentation, applies only to the period of 2015 and 2020. The 2015-2020 roadway projections were not extrapolated or extended to the time period of 2020 to 2040, primarily in order to maintain a degree of conservatism in the roadway reconstruction projects. However, the 2015-2020 roadway reconstruction projections were used to set rates of development/redevelopment for roads and PROW for the time period after 2040, as further explained in Section 7.

DC Water

DC Water prepares a 10-year Capital Improvement Plan to guide future utility reconstruction. These projects typically involve replacement or installation of sewer or water pipes underneath roadways. It was assumed that any major sewer rehabilitation would subsequently require DDOT to reconstruct roadways after DC Water excavates and replaces the utilities beneath it, and that this represents instances where the stormwater regulations would be enforced. Therefore, any major sewer rehabilitation projects were captured by identifying the roadway parcels that will be disturbed, including a six-foot buffer around the project to reflect disturbances in the PROW.

Department of Housing and Community Development (DHCD)

DHCD finances and oversees the development of affordable housing and community facilities. In response to an annual Request for Proposals (RFP), the agency receives loan applications from private developers that show where development is planned to occur. DHCD provided its affordable housing development dashboard database, which identifies all affordable housing projects that the agency will pursue, as well as a timeframe in which the project will be completed. This database provides real-time updates on the status of projects in the DHCD pipeline, identifying them by certain phases (in underwriting, under construction, completed, as well as leasing or on the market for purchase). The projects in the MS4 area that were identified by DHCD as under construction or in underwriting were added to the development forecast.

Department of General Services

Department of General Services develops and executes sustainability initiatives across the District, including stormwater management initiatives such as green infrastructure implementation on District owned properties. DGS is not currently anticipating additional development/redevelopment projects that are not already identified and included in OP's databases.

National Capital Planning Commission (NCPC)

The National Capital Planning Commission is tasked with coordinating, guiding, and implementing federal agency land development plans within Washington, DC. It serves as a repository of all of federal agency plans for development/redevelopment or renovation in the District. Through collaboration with the commission, the planned development/redevelopment of federal parcels within the MS4 area of the District in the next 25 years was identified.

NCPC provided a list of projects or plans associated with federal parcels, as well as a shapefile of current and proposed projects that have been approved. A master shapefile of federal projects was developed from NCPC's shapefile by adding projects to it from the planning documents provided by NCPC. Projects in the CSO area and any projects under 5,000 square feet were not included (the latter were excluded because they would not trigger the stormwater regulations for major land disturbing activity).

With respect to the timeframe during which the identified projects would occur, some of plans included project details such as project beginning and ending dates, while other plans were more vague and only discussed general development principles. Therefore, project completion dates are based on BPJ. For example, short-term projects from older planning documents are not included because they were assumed to be complete.

Campus Master Plans

Six college or university campuses were identified within the MS4 area: American University, Catholic University, George Washington University – Mt. Vernon, Georgetown University, University of District of Columbia, Howard University – Law campus, and Wesley Theological Seminary. While the Master Plans for these entities did identify potential development, most of the campuses had either already completed their development or were not expecting to complete the remaining development identified in their master plan. Thus no information from campus Master Plans is used as part of the forecasting.

4.2.2.b Synthesis of Data Collection and Analysis Efforts

In order to account for parcels that have the potential to develop or redevelop in the MS4 area, the Expected Development Database developed by OP was used in conjunction with information generated from the Capacity/Value, the Targeted Zone Analysis, and data provided by other agencies. The Expected

Development Database was first used to identify specific parcels that were expected to be developed based on specific plans filed with OP. The Capacity/Value and Targeted Zone development scenarios were then used to supplement the preliminary forecasts from the Expected Development database and were based on each parcel's zoned versus built capacity, the value, its proximity to drivers of development, and incentive programs for targeted development. Additional parcels that were expected to be developed/redeveloped that were not captured through either the Expected Development database or the Capacity/Value and Targeted Zone development scenarios were identified in plans by local and Federal agencies such as DDOT, NCPC, and DC Water. Once all potential areas of development or redevelopment were identified, a single GIS layer was created to depict the projected development and redevelopment areas in the MS4 between 2015 and 2040. Additional information on the processes and assumptions made to create this GIS layer is provided in Attachment 1.

4.2.3 Establish the Intersection of the Parcels Potentially Subject to the Stormwater Regulations and the Forecasted Development/Redevelopment:

Section 4.2.1 established the "parcels potentially Subject to the Stormwater Regulations". Section 4.2.2 established the projected areas of development and redevelopment in the MS4. These two data sets were intersected in a GIS to identify the areas where projected development and redevelopment would likely trigger the stormwater regulations. These parcels were then sorted by size and a knee-of-the-curve analysis was conducted. Parcels above the knee of the curve were examined more closely to determine if the entire or only a portion of the parcel area would be subject to the stormwater regulations. Permit plans or other supporting development/redevelopment documentation were used to make this determination and areas were adjusted accordingly. Additionally, any partially or completely overlapping parcels were identified and deleted in order to avoid double counting those parcels. Attachment 1 provides a more detailed description of the processing steps and assumptions that were applied to establish the intersected area.

The results of these processing steps are shown in Figure 4-1. The areas shown in color represent the projections of development or redevelopment for all parcels except those zoned as R1-R4, with the exception of clusters of R1-R4 parcels with a contiguous and aggregate area of larger than 5,000 square feet. Each color represents the projected area of development/redevelopment for a unique 5-year time frame. A total of approximately 132 million square feet (3,021 acres) over 25 years of development/redevelopment is expected to occur. This represents an annual average rate of approximately 5.3 million square feet (121 acres) per year. The projected areas show that expected development and redevelopment will focus primarily on major transportation corridors and areas with available, developable land, such as low density commercial areas, vacant lots, and vacant or abandoned buildings.

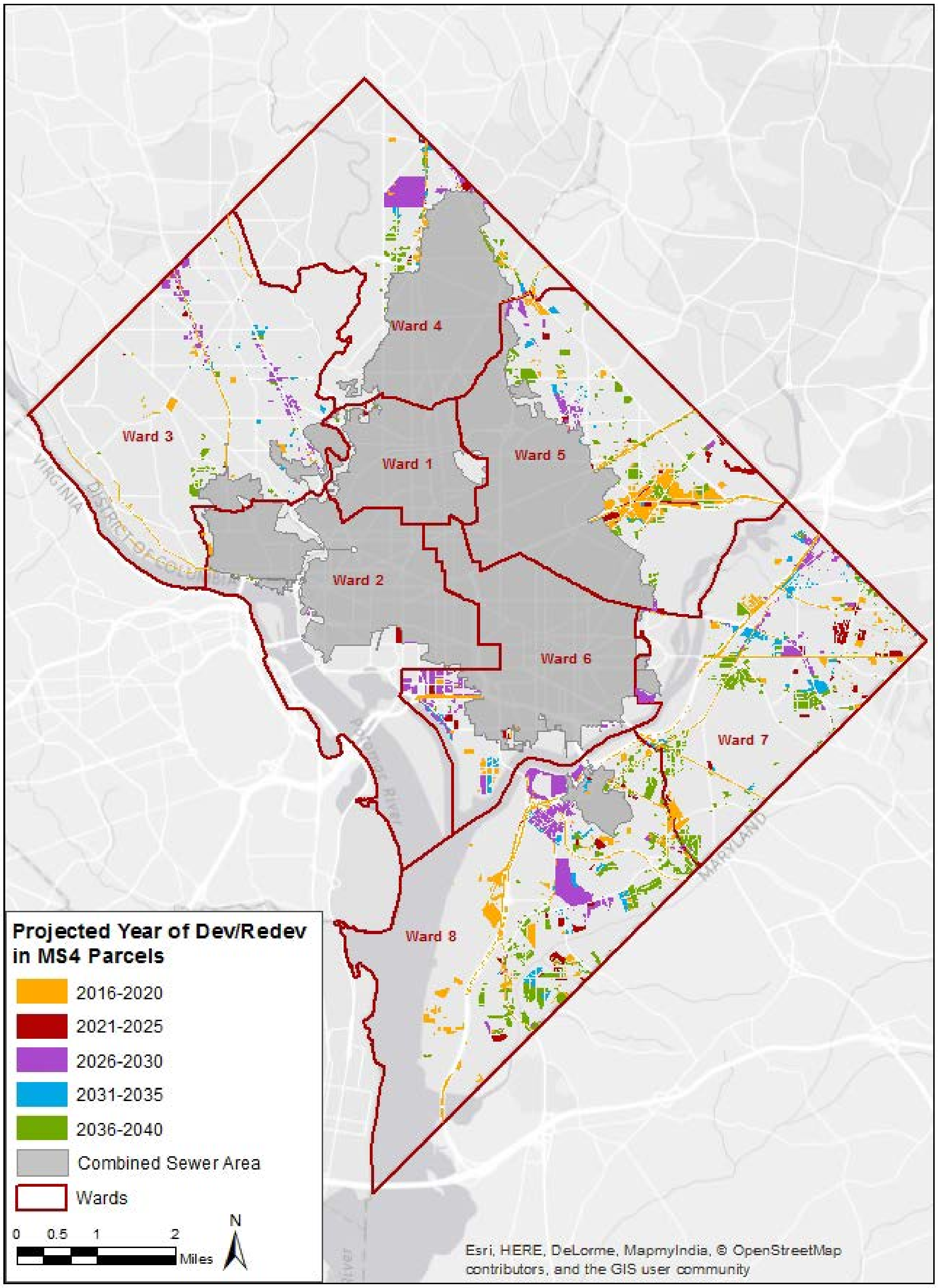

Figure 4-1: Projected Areas of Development and Redevelopment on Non R1-R4 Parcels[5]

Figure 4-2 shows the projected area of development or redevelopment in the MS4 from 2015 through 2040. The projected area varies by year, which is largely due to the assumptions that went into developing the projections. The average yearly rate of development/redevelopment, over the time period of 2015

[5] The areas shown in color represent the projections of development or redevelopment for all parcels except those zoned as R1-R4, with the exception of clusters of R1-R4 parcels with a contiguous and aggregate area of larger than 5,000 square feet.

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through 2040, is approximately 5.3 million square feet (121 acres) per year. It should be noted that the rate of development/redevelopment is noticeably lower on roads and PROW than on parcel lots. This becomes important when projecting the rates of development/redevelopment beyond 2040, as further explained in section 7.

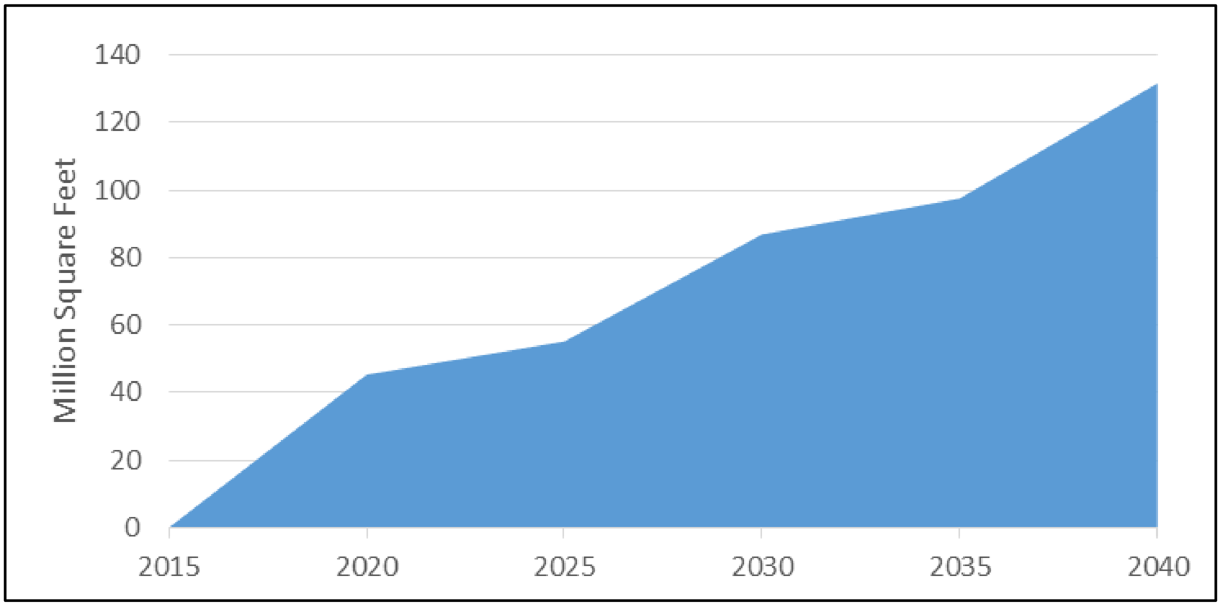

Figure 4-2 Area of Projected Development/Redevelopment in the MS4 Area on Non R1-R4 Parcels

4.3 Development/Redevelopment Projections for Parcels in the MS4 that are zoned R1-R4

The development and redevelopment projections discussed in Section 4.2 apply to all parcels except those that are zoned as residential R1-R4. A parallel effort was therefore undertaken to determine the development and redevelopment projections on the residential parcels that are zoned R1 through R4, which broadly speaking represents single family homes. These projections are based on an analysis of DDOE's historic BMP inventory for the years 2007 through 2011 as shown in Figure 4-3.

The main assumption in using this data is that the installation of these BMPs occurred because some development or redevelopment activity on these parcels triggered the old stormwater regulations. It is assumed that if the old regulations were triggered, a similar-type project in the future would trigger the new stormwater regulations. The determination of the area of development/redevelopment on R1-R4 parcels was a 3-step process:

1. Identify the R1-R4 Parcels in the MS4 area that had BMPs installed between 2007-2011
2. Use the data from step 1 to calculate the Projected Development or Redevelopment for Parcels that are zoned R1-R4
3. Determine if a spatial correlation exists between BMP installation on R1-R4 parcels and the projected development/redevelopment on non R1-R4 parcels

Each step is further explained in the following subsections below.

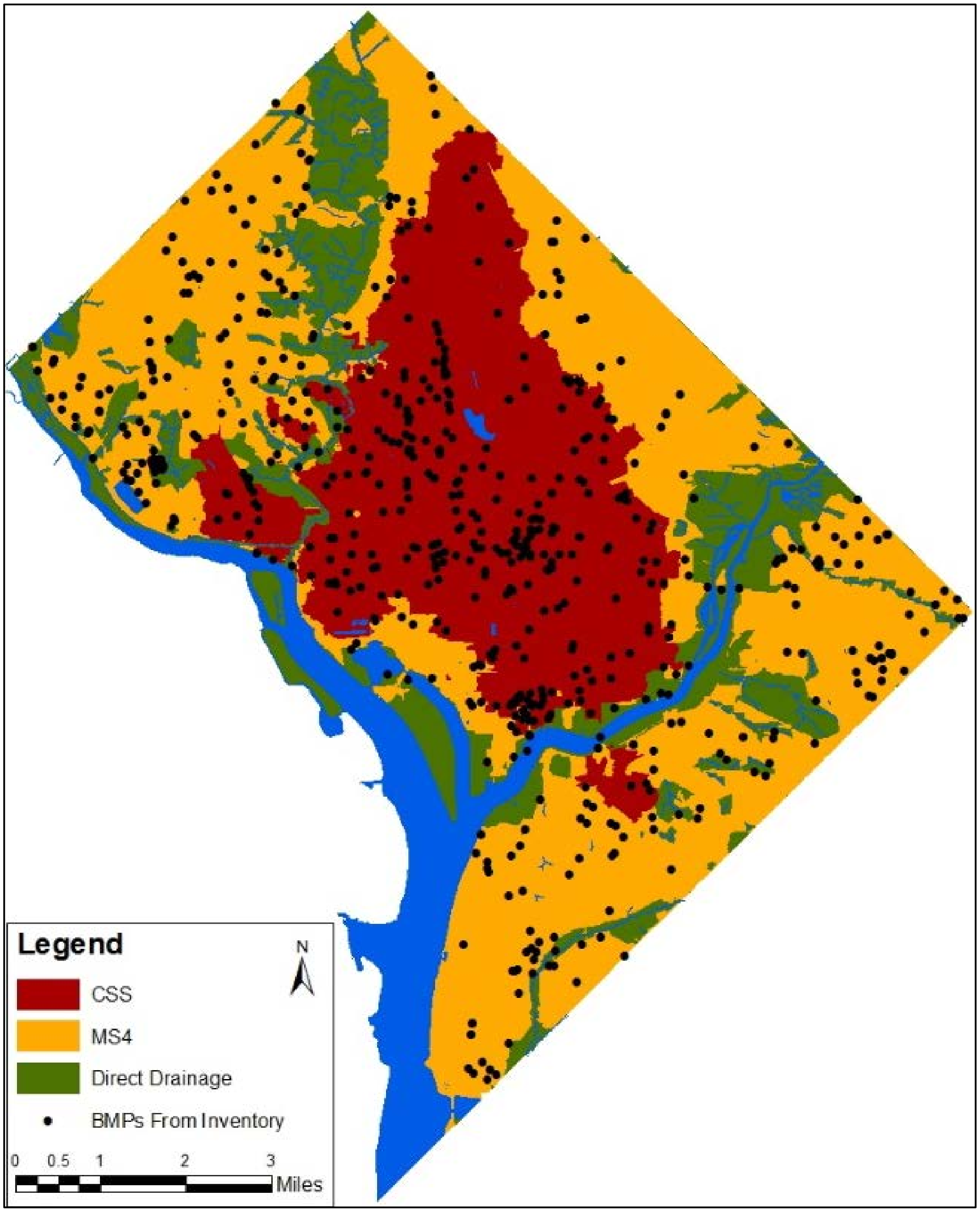

Figure 4-3: Map of the 2007-2011 BMP Inventory

4.3.1 Identify R1-R4 Parcels that had BMPs Installed between 2007-2011

Parcels zoned for R1 through R4 use were identified from the OTR parcel layer. The 2007-2011 BMP inventory was intersected with the R1-R4 parcels and only R1-R4 parcels that contain BMPs were retained for further analysis. Approximately 11% of these parcels are smaller than 5,000 square feet but were included under the assumption that these were likely developed as part of a larger development project. The total R1-R4 parcel area identified after the intersection is shown in Table 4-1. These areas are used to make projections of the area of development and redevelopment of R1-R4 parcels that will trigger the stormwater regulations in the future.

Table 4-1: Area of R1-R4 Parcels that are Managed by BMPs in the MS4

Year	Area (square feet)	Area (acres)
2007	3,881,997	89.12
2008	3,108,400	71.36
2009	1,575,849	36.18
2010	3,008,366	69.06
2011	2,747,747	63.08
Total	**14,322,359**	**328.80**

4.3.2 Forecast the Projected Development and Redevelopment for R1-R4 Parcels

Once the historic BMPs on R1-R4 parcels were identified, the total area of parcels that contain these BMPs was calculated and used to make projections of the area of development and redevelopment of R1-R4 parcels in the MS4 area that will trigger the stormwater regulations in the future. Based on the data presented in Table 4-1, the rate of development/redevelopment on R1-R4 parcels is approximately 2.8 million square feet (66 acres) per year. Based on the time period analyzed, this projection does not vary appreciably in time or in space. In other words, there did not appear to be a pattern of differential development rates over time or spatially). These projections do not vary in rate or spatial distribution given the limited amount of data that was available to create the projections.

A "correlation analysis" was undertaken to determine if the development/redevelopment projections for parcels that are not R1-R4 could be used to identify trends that would allow the R1-R4 projections to be varied in both time and space. In other words, if confirmed through the correlation analysis two possible trends might be established:

1. If there is a spatial correlation between the two data sets, then the R1-R4 projections could be projected using the same broad spatial patterns as the projections for all other parcels.
2. If there is a correlation in the implementation rate between the two data sets, then the R1-R4 projections could be projected using the same temporal variations as the projections for all other parcels.

The methodology and results of the correlation analysis are described in Attachment 2. Based on the results from the two correlation analyses, there is little, if any, evidence to justify the distribution of R1-R4 projections either spatially or temporally. It was therefore recommended that the annual historic rate of R1-R4 development be applied uniformly across the entire MS4, at a steady rate of 2.8 million square feet (66 acres) per year over time.

4.4 Aggregating the Results of the Development/Redevelopment Projections for all Parcels in the MS4

The aggregate area of the development/redevelopment projections determined using the two components described above determine the rate and extent of area that will be subject to the District's 2013 Stormwater Management Rule. Altogether, 187 acres per year are projected to be developed or redeveloped over the next 25 years. This consists of approximately 66 acres/yr. of R1 through R4 parcels and 121 acres/yr. of non R1 through R4 parcels (including roadways).

Additional observations about the total projected area of development and redevelopment in the MS4 area between 2015 and 2040 include:

- **Wards 5, 7, and 8 are forecasted to have the most development or redevelopment on non R1-R4 parcels.** The majority of the forecasted development or redevelopment area, on all parcels except those zoned as R1-R4, is within these three wards. Wards 2, 3, 4, and 6 in the MS4 are also forecasted to have pockets of development or redevelopment but to a smaller degree. As discussed above, in contrast to development/redevelopment for non R1 through R4 parcels, development or redevelopment on parcels zoned R1-R4 is assumed to occur uniformly throughout the MS4.
- **The forecasted development or redevelopment area is less than 25 percent of the total MS4 area.** The total projected development or redevelopment in the MS4 between 2015-2040 is approximately 4,665 acres out of the approximately 19,750 acres of MS4 area. This represents approximately 24 percent of the MS4 area. This includes development or redevelopment on R1-R4 parcels, non R1-R4 parcels, and roads or the public right of way.
- **The majority of predicted development or redevelopment on non R1-R4 parcels is expected to occur on privately owned parcels or on District-owned parcels.** Forecasts of development or redevelopment on non R1-R4 parcels indicate that 58% of projected development is projected to occur on privately owned parcels, 36% is projected to occur on District-owned parcels (including roads and the PROW), 4% is projected to occur on Federally-owned parcels, and the remainder is projected to occur on internationally- or WMATA-owned parcels.
- **Development or redevelopment on non R1-R4 parcels is expected to be focused along commercial properties along major transportation corridors.** Development is projected to occur primarily along the major transportation corridors in the MS4 area such as Connecticut Ave NW, New York Ave NE, and South Capitol Street SE.
- **Roads and the public right of way make up a sizeable area of development or redevelopment in the forecast.** As identified in the Transportation Improvement Plan (TIP), large sections of District roads are scheduled for reconstruction in the foreseeable future.

Figure 4-4 shows the total projected area of development or redevelopment in the MS4 from 2015 through 2040.

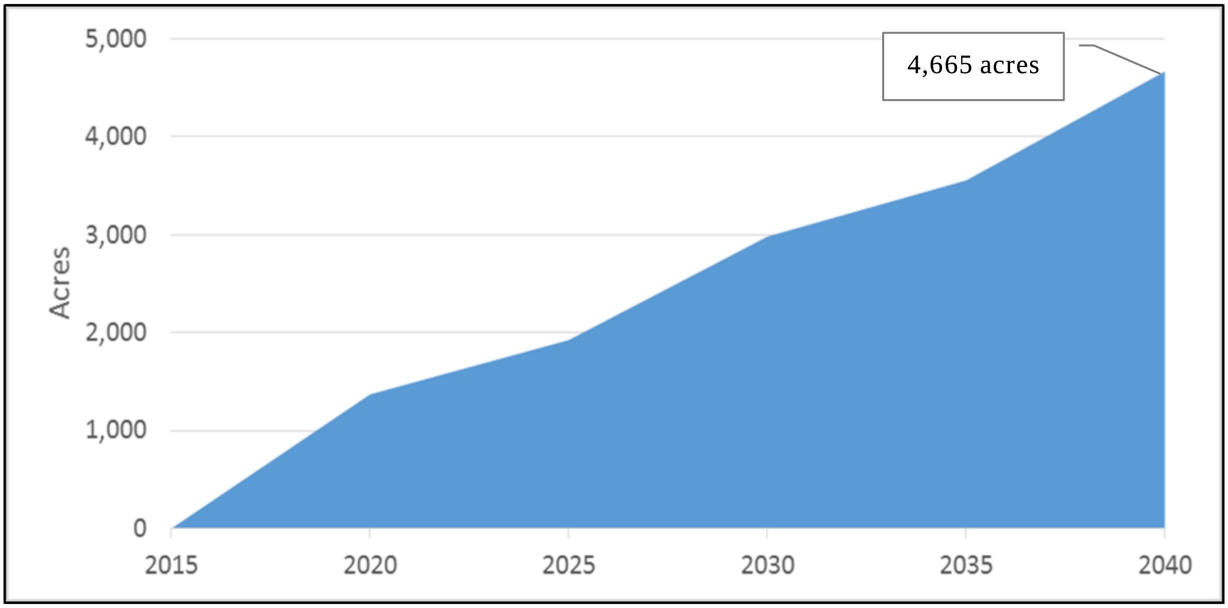

Figure 4-4. Total Projected Area of Development or Redevelopment in the MS4 from 2015 to 2040

4.5 Modeling and Projecting the Load and Storm Water Volume Reduction

The projected areas of development or redevelopment were summed for the two types of parcels (R1-R4 and non R1-R4), by TMDL segment and by 5-year increment. To model and project the load and storm water volume reduction from the Development/Redevelopment Scenario, it was assumed that all area identified under this scenario would be retrofitted by BMPs using the 1.2-inch design standard. The exact type of BMP, or combination of BMPs, that would be constructed is unknown and could be highly variable depending on the site conditions and designer. As shown in Table 4-2, the efficiencies for retention-based BMPs, at 1.2 inches of runoff retention, vary from approximately 53% (green roof) to 92% (infiltration trench).

Table 4-2: Efficiencies of Retention Based BMPs Using a 1.2 Inch Design Standard

BMP Type	Efficiency
Green Roof	53%
Standard Bioretention	60%
Enhanced Bioretention With Underdrain	83.5%
Enhanced Bioretention Without Underdrain	90%
Enhanced Permeable Pavement with Underdrain	87%
Enhanced Permeable Pavement without Underdrain	92%
Infiltration Trench	92%

The efficiency of an enhanced bioretention with underdrain is 83.5%, slightly less than the median efficiency of all the retention-based BMPs. For this reason, it was selected as the representative efficiency to model the stormwater volume reduction for the Development/Redevelopment projections.

In order to calculate the volume reduction expected from the development/redevelopment projections, the runoff volume was first calculated for these areas, and then the BMP efficiency of 83.5% was applied. This represents the volume removal provided by the future BMPs. To calculate the expected load reduction, this volume removal is then multiplied by the appropriate pollutant EMC. The runoff and pollutant load reductions were calculated for each TMDL segment and compared to the volume and load reduction requirement for each WLA. The following section provides the results from this scenario.

4.6 Results and Analysis

This scenario was modeled using the IP Modeling Tool and the projected stormwater and pollutant load reductions were calculated in 5-year increment from 2015 through 2040. The modeled load reductions were compared against the required load reduction needed to meet WLAs to determine if WLAs would be met under this scenario. Table 4-3 shows the 10 WLAs that are expected to be attained under this scenario during this period, ranked in ascending order by year of attainment.

Table 4-3: WLAs Attained Under the "Development/Redevelopment Scenario"

Segment	Pollutant	Year
Anacostia Upper	Dieldrin	2020
Lower Beaverdam Creek	BOD	2020
Texas Avenue Tributary	Arsenic	2020
Watts Branch – Upper	Dieldrin	2020
Nash Run	Lead	2030
POTTF-MD	TN	2030
Nash Run	Dieldrin	2035
Anacostia Upper	Lead	2040
ANATF_DC	TSS	2040
Fort Chaplin Tributary	Lead	2040

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5. BMP Implementation Projected to Occur from Other Existing Drivers and Programs

5.1 Introduction

This scenario, also called "Other BMP Programs" scenario, describes the ongoing and future BMP implementation that occurs through existing DC agency funding, grant programs, voluntary implementation, or regulatory drivers other than those from major land disturbances that would trigger the stormwater regulations. Examples include BMP implementation from:

- Various RiverSmart programs
- Other DDOE-funded programs (stream restoration, trash removal, other LID projects)
- University stormwater management or sustainability plans
- Federal agency stormwater management or sustainability plans
- DDOT's green alley program or sustainability plan

The following sections describe the data collection, modeling, and results and analysis from this scenario.

5.2 Data Collection

This section describes the data collection done to determine the expected future BMP implementation from other existing drivers and programs.

5.2.1 RiverSmart Programs

The RiverSmart program is the primary program intended to provide incentives for green infrastructure implementation in the District. The RiverSmart program is divided in to different sub-programs that allow assistance to be provided to a wide variety of recipients from individual homeowners to large homeowner and community associations. These RiverSmart programs include:

- RiverSmart Homes
- RiverSmart Rooftops
- RiverSmart Schools
- RiverSmart Communities

Data on the historic rate of BMP implementation through the RiverSmart program was collected for the period 2009-2013. The data included the type of BMP implemented, the year of implementation, and the BMP drainage area. These data were summarized by year, and a median projected area controlled per program per year was calculated, as shown in Table 5-1.

Table 5-1: Projected Yearly Installation of BMPs in the MS4 Area through the RiverSmart Program			
Program	**BMP Type**	**Median number installed per year**	**Median total yearly controlled area (sq.ft.)**
RiverSmart Homes	Rain gardens	-	22,400
	Rain barrels	209 rain barrels	-
	Permeable pavement	-	1,300
	Shade trees	333 new trees	-
RiverSmart Rooftops	Green roofs	-	20,499
RiverSmart Schools	None described	3 schools/year	2,500 cubic feet
RiverSmart Communities	Cistern	-	3,900
	Impervious surface removal	-	6,022
	Permeable pavement	-	1,500
	Rain gardens	-	9,439

5.2.2 DDOE-funded Stream Restoration

Stream restoration projects completed by DDOE are funded through a variety of grant programs (e.g.: NFWF). For the purposes of this scenario, it is estimated that one stream restoration project will be completed per year. This rate is expected to be sustainable over the foreseeable future based on the number of streams requiring restoration and funding sources available. Historically, stream restoration projects have been on the order of 1,000 to 2,000 feet in length per year; for modeling purposes, it was projected that 1,500 feet of stream per year would be restored.

5.2.3 DDOE-funded LID Projects

DDOE will sometimes fund low impact development (LID) projects beyond those associated with RiverSmart. For instance, the Alger Park upland LID project is one example of a future DDOE-funded LID project. DDOE-funded LID projects will typically require the involvement of multiple agencies such as DDOT or DC Water. The projects tend to be on the city-block scale and are expected to occur on an annual basis. These LID projects are typically opportunistic and it is therefore difficult to project where they will occur, how much area will be controlled, and what type of LID will be implemented. As a result, these projects were not included in the “Other BMP Programs Scenario”.

5.2.4 DDOE-funded Trash Removal

DDOE currently uses a combination of end-of-pipe BMPs placed at as many MS4 hotspot outfalls (defined as sewersheds determined to have greater than average annual trash loads) as is possible, plus a variety of structural and non-structural controls where outfall retrofit is not feasible because of issues such as access and stability of the outfall. The list of additional BMPs to be employed to remove trash includes:

- In-stream and end-of-pipe best management practices (e.g., trash traps)
- Skimmer boat activities
- Stream and river cleanup activities
- Roadway and block cleanup activities
- Street sweeping of environmental hotspots

- Education and outreach
- Regulatory approaches (e.g., Bag Law, Styrofoam ban)

A detailed list of these BMPs and their individual trash removal capacities can be found in Appendix F, Technical Memorandum: BMPs and BMP Implementation, of the Final Comprehensive Baseline Analysis Report (DDOE, 2015). As required by the permit, the District intends to achieve the MS4 WLAs for trash in the Anacostia River by 2017 through implementation of the BMPs discussed above and quantifying the expected load reduction through the methodologies described in the table. These BMPs are expected to achieve the MS4 WLAs of 83,868 lbs/yr removed from the Upper Anacostia and 24,480 lbs/yr from the Lower Anacostia, as well as the combined MS4 WLA of 108,347 total lbs/yr of trash from the entire watershed, according to the TMDL. The current trash removal strategies remove 75,820 lbs/year in the Upper Anacostia and 15,651 lbs/year in the Lower Anacostia, for a sum of 91,471 lbs/year. The difference between current conditions and the WLAs is 16,876 lbs for the entire Anacostia, which will be achieved through implementation of additional trash reduction strategies, including a combination of additional trash traps, quantifying the benefit of outreach and education, and implementation of additional litter cans throughout the MS4.

The District will track and report implementation annually, and DDOE will report on new practices along with their respective load reduction calculation methodologies as they are implemented. DDOE will continue to collect empirical data on all end-of-pipe BMPS and adjust efficiencies for future TMDL tracking purposes as necessary and appropriate.

5.2.5 DDOT BMP Projects

The District Department of Transportation provided an inventory of the current BMPs that they had completed or funded in the right of way. Additionally, DDOT documents such as the Green Infrastructure Standards Handbook, the LID Action Plan, the Action Agenda Progress Report of 2010, and DDOT's Sustainability Plan, were reviewed to identify future BMP projects or specific BMP targets. These documents identified projects under one of the four primary programs under which DDOT implements BMPs, including:

- Green Alleyways
- RiverSmart
- LID Retrofits
- Urban Forestry Agency Pavement Removal

These programs implement a range of different BMP projects in different parts of the city. DDOT provided an inventory of all DDOT BMPs that were installed between 2007 and 2014. These projects are typically described by an address or general location, the BMP type or combination of BMPs, the drainage area, the completion date, and a short description of the funding source. Because the inventory sometimes lists multiple BMPs for a single drainage area, the projected DDOT BMP implementation were summarized by total area controlled rather than area controlled by BMP. Moreover, there seems to be some overlap between the DDOT programs and other agency programs like DDOE or DGS. For example, some BMP implementation undertaken by DDOT might be funded through DDOE's RiverSmart Program. This made it difficult to parse out the BMP projects that are solely funded and driven by DDOT. Despite these potentially confounding issues, the DDOT inventory was used to estimate an annual rate of BMP implementation in the MS4 of approximately 100,108 square feet per year outside of any DDOT participation in the RiverSmart program.

5.2.6 NCPC Projects

NCPC provided project plans for planned work on federal properties. These plans included current and future stormwater BMP implementation. These plans typically describe several aspects of the proposed project, including its address, the proposed BMP type, and a short description of the project, but they do not always provide an expected area that will be treated by the BMPs, or an expected completion date. As a result, these projects were not included in the “Other BMP Programs Scenario.”

5.2.7 University Campus Master Plans

Universities are some of the largest property landowners in the District. Campuses in the MS4 area include George Washington University (Mount Vernon Campus), Georgetown, American University, and the University of the District of Columbia. Where available, campus Master Plans were reviewed for proposed new construction and future BMP implementation. In addition, interviews were conducted with George Washington and American Universities to try to supplement existing information. However, the end result of this data collection was that no universities have committed to implementing additional stormwater BMPs in the near future, so no university projects were included in the “Other BMP Programs Scenario.”

5.3 Modeling and Projecting the Load and Storm Water Volume Reduction

The data collected through the methods and analyses described in the previous sections were reviewed and compiled into a single table with projected rates of implementation by BMP type. Table 5-2 shows the projected annual rate of implementation in the MS4 area, by BMP type, that resulted from this analysis. These implementation rates were used in the scenario modeling.

Table 5-2: Projected Annual Rate of BMP Implementation in the MS4 Area

BMP Type	Projected Annual Rate of Implementation	Units
Permeable Pavement	2,800	Square Feet
Rain Barrel[6]	667	Count
Standard Bioretention	31,799	Square Feet
Cistern	3,900	Square Feet
Impervious Surface Removal	10,367	Square Feet
Green Roofs	20,499	Square Feet
New Trees	4,150	Count
Undefined (DDOT)	100,108	Square Feet
Schools	3 schools/year @2,500 cubic feet treated	-
Stream Restoration	1,500	Feet

Note that the data collection did not provide the necessary granularity or prioritization to determine the exact location of future BMPs. It is therefore assumed that these BMPs will be installed uniformly across the MS4. It is also further assumed that the retention-based BMPs will be designed to the 1.2 inch standard. Non-retention BMPs will perform at the efficiencies as shown and explained in Appendix F of the Comprehensive Baseline Analysis Report (DDOE, 2015). The total equivalent area controlled from

[6] Based on page F-57 of DDOE’s FY 2015 Proposed Budget and Financial Plan, accessible at http://cfo.dc.gov/node/806572

BMP implementation through these programs is projected to be approximately 21 acres/year. Attachment 1 describes how this acreage is calculated.

Trash removal actions are modeled differently. As required by the District's permit, the District intends to achieve the MS4 WLAs for trash in the Anacostia River by 2017, following implementation of the BMPs shown in Section 5.2.4, and quantifying the expected load reduction from each. The current trash removal BMPs remove approximately 60% of the trash load in the Lower Anacostia and 85% of the trash load in the Upper Anacostia. It is expected that with full implementation of all BMPs, that the remaining load reductions will occur by 2017. Therefore, in the IPMT, the remaining load reductions are applied as a lump sum reduction that occurs in 2017 and attainment of WLAs will be achieved.

5.4 Results and Analysis

This scenario was modeled using the IP Modeling Tool and the projected pollutant load and storm water volume reductions were calculated by 5-year increment from 2015 through 2040. The modeled load reductions were compared against the required load reduction needed to meet WLAs to determine if WLAs would be met under this scenario. Table 5-3 shows the 4 WLAs that are expected to be attained under this scenario during this period, ranked in ascending order by year of attainment.

Table 5-3. WLAs Attained Under the "Existing Drivers Scenario"

Segment	Pollutant	Year
Watts Branch – Upper	Dieldrin	2035
Texas Avenue Tributary	Arsenic	2040
Upper Anacostia	Trash	2017
Lower Anacostia	Trash	2017

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6. BMP Projects Identified in Existing Watershed Implementation Plans

6.1 Introduction

This scenario was developed to evaluate the load reduction that could be achieved through implementation of previously developed Watershed Implementation Plans (WIPs) and TMDL IPs. Multiple WIPs and TMDL IPs have been developed over the years for several watersheds in the District, including the Anacostia, Rock Creek, and Oxon Run. These WIPs and TMDL IPs were developed to address previous MS4 permit requirements to develop implementation plans for specific TMDLs as well as other watershed planning requirements. The WIPs and TMDL IPs include discussions of the pollutants of concern in the watershed and potential pollutant sources. They also include various proposed implementation activities, including ongoing programmatic activities (such as street sweeping, public education and outreach, pollution prevention, and other activities) and specific proposed structural BMPs and green infrastructure projects. Information on the proposed structural BMPs and green infrastructure projects was collected from the WIPs and run through the IP Modeling Tool to evaluate the load reduction that could be achieved through implementation of these projects.

6.2 Data Collection

The following documents were reviewed for this scenario:

- Anacostia TMDL WLA Implementation Plan (DDOE 2005)
- Anacostia River Watershed Restoration Plan (USACE 2010)
- Anacostia River WIP (DDOE 2012)
- Rock Creek TMDL WLA Implementation Plan (DDOE 2005)
- Rock Creek WIP (DDOE 2010)
- Oxon Run WIP (DDOE 2010)

In each case, the document was reviewed to identify structural BMPs and green infrastructure projects that were proposed for implementation as part of the plan. While all documents were reviewed, proposed project data from the 2005 Anacostia TMDL WLA Implementation Plan and the 2005 Rock Creek TMDL WLA Implementation Plan were not included in this analysis, as it was assumed that the projects included in the more recent documents for these watersheds superseded the planning done in the previous document. In the case of the 2010 Anacostia River Watershed Restoration Plan and the 2012 Anacostia River WIP, the 2012 WIP document indicates that it builds on the 2010 Watershed Restoration Plan, so projects from both documents were included.

Specific data were collected for each project in order to allow that project to be modeled for load reduction with the IP Modeling Tool. These data included:

- Project name
- Location
- BMP type

- Drainage area, including total drainage area and impervious drainage area
- Proposed schedule/priority information

Project data was available in multiple formats depending on the specific WIP/IP. For the most part, projects were summarized in tables in the written documents, but in some cases, GIS data was available as well. These GIS data proved useful when data necessary for modeling the projects was missing from the tables.

After review of each WIP/IP, information on the proposed structural BMPs and green infrastructure projects was extracted and put into a geodatabase (note that proposed programmatic/non-structural BMPs from the WIPs/IPs were not included in this exercise. It was assumed that proposed programmatic/non-structural BMPs are already being implemented and would continue to be implemented in the future, and thus that there is no extra load reduction that would be achieved from implementing the programmatic activities in the WIPs/IPs). This ensured that the proposed project data was in the correct format for use in the IP Modeling Tool.

In some cases, not all of the required data was available from the summary tables in the WIP/IP documents. In these cases, GIS data was used to develop the missing data. For example, for Oxon Run, no drainage area data was included in the project tables in the WIP, so drainage and impervious areas for the projects were determined in GIS. For the Rock Creek WIP, project drainage areas were included in WIP, but impervious areas were not, so these were determined in GIS. All necessary data for the Anacostia projects was included in the data tables from the WIP.

6.3 Modeling and Projecting the Load and Storm Water Volume Reduction

Several assumptions were made regarding the project data in order to run the implementation scenario. First, it was assumed that project development would begin after 2015 and that all projects would be implemented by 2040. This timeframe aligned with the other scenarios being developed for this exercise. Second, in the cases where a single project included multiple different BMP types but only one aggregate drainage area (e.g., a project may include a bioretention area and a green roof, but the project describes the total area controlled, and does not break out the area controlled by the bioretention area vs. green roof), then the drainage area was split evenly among all BMPs in the project. Also, in some cases, the drainage areas for proposed projects were very large, and it seemed unlikely that the project would treat the entire drainage area. Therefore, for any projects with drainage areas over 10,000 sq. ft., it was assumed that the project would treat only the impervious area. As discussed above, the impervious areas were either provided in the project tables or could be calculated from GIS, so these values were included in the modeling.

The other major assumptions regarding implementation of the WIP/IP projects were the timeline for proposed implementation. As discussed above, all projects in the WIP scenario were assumed to be completed between 2015 and 2040. This allowed for a direct comparison between the effectiveness of the WIP scenario and other scenarios, which were also assumed to occur between 2015 and 2040.

The WIPs/IPs did not necessarily have specific proposed timelines for project information, and thus assumptions were made about the timeframe for implementation of specific projects. For the Anacostia River Watershed Restoration Plan, projects were divided by watershed, and the Plan included information on when the projects in each watershed were expected to be completed. For example, projects in the Nash Run subwatershed were proposed to be completed within 5-10 years of implementation of the plan, and projects in Hickey Run subwatershed were proposed to be completed within 15-20 years of implementation of the plan. These timeframes were maintained in the scenario modeling. For each subwatershed, projects were assumed to begin in 2015, and implementation was assumed to take place at a constant rate until all projects in the entire subwatershed were completed.

For Oxon Run projects, a prioritization scheme was included in the WIP, but this prioritization scheme consisted only of identifying projects as proposed for the near-, medium-, or long-term. There were a few projects proposed for the near-term, and a few proposed for the long-term, but the vast majority of projects were proposed for the medium-term. This did not provide much useful information for developing an implementation schedule over the proposed time period of 2015 through 2040. Therefore, it was assumed that project implementation would take place at constant rate until all BMPs were completed in 2040.

For the Rock Creek WIP, there is only a short-term schedule that contains very few projects. The WIP states that the schedule for the majority of the proposed projects will be fleshed out in the future and based on project priority, but it does not provide further information on proposed schedules. Therefore, as with Oxon Run, it was assumed that 100% of the acreage of restoration projects will be completed by 2040 using a straightline implementation rate with a baseline of 2015. Because restoration projects have not been broken out by subwatershed, the acreage of restoration within each Rock Creek subwatershed was based on the percentage of each subwatershed relative to the Rock Creek watershed as a whole. Thus, if subwatershed 1 is 3% of the total area of the Rock Creek watershed, and 50 acres of bioretention will be completed in the Rock Creek watershed within 5 years, then 1.5 acres (50 acres * 3%) of bioretention would be assigned to subwatershed 1 for completion within 5 years.

6.4 Results and Analysis

This scenario was modeled using the IP Modeling Tool and the projected pollutant load and storm water volume reductions were calculated by 5-year increment from 2015 through 2040. The modeled load reductions were compared against the required load reduction needed to meet WLAs to determine if WLAs would be met under this scenario. One WLA is expected to be attained under this scenario during this time period, as shown in Table 6-1.

Table 6-1: WLA Attained Under the "WIP Scenario"

Segment	Pollutant	Year
Texas Avenue Tributary	Arsenic	2030

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7. Projecting Current BMP Implementation Until all WLAs are Attained

7.1 Introduction

Current BMP implementation consists of three components, including:

- Continued BMP implementation through the implementation of the existing stormwater regulations, which will reduce loads as development and redevelopment occurs and new BMPs are put in place to retain runoff in compliance with the regulations;
- Ongoing BMP implementation not associated with the stormwater regulations. This includes targeted construction of new structural BMPs and/or stream restoration projects; and
- Ongoing programmatic and source control efforts, such as street sweeping and the coal tar ban.

Sections 4 and 5 show that this level of implementation, projected to 2040, will not be sufficient to attain all WLAs. This section examines how long it would take to meet all the MS4 WLAs if implementation rates continue as modeled in Sections 4 and 5.

7.2 Methodology

Each of the components described above were evaluated in the IP Modeling Tool to determine the amount of stormwater volume and pollutant load reductions achieved over time. Section 5 describes the methodology used to define the area of the MS4 that is forecasted to be controlled by BMPs through each of these components. The three components are expected to continue into the future assuming that the current level of funding for BMP implementation and stormwater management remains unchanged. Several assumptions were made to model and project the load and storm water volume reductions resulting from these implementation measures, including:

- For the load reductions associated with the development and redevelopment of the MS4, it was assumed that all area required to be retrofitted to comply with the stormwater regulations would be retrofitted by BMPs using the 1.2-inch design standard. The exact type of BMP, or combination of BMPs, that would be constructed is unknown and could be highly variable depending on the site conditions and designer. Therefore, it was not possible to be specific about BMP implementation at each site, and a representative BMP was used. The efficiency of an enhanced bioretention with underdrain (which, at 83.5 percent removal efficiency, is slightly less than the median efficiency of all the retention-based BMPs) was chosen as the representative efficiency to model the stormwater volume reduction. To calculate the volume reduction expected from the development and redevelopment projections, the runoff volume was first calculated for the projected development and redevelopment areas, and the BMP efficiency of 83.5 percent was applied. This represents the volume removal provided by the future BMPs. To calculate the expected load reduction, this volume removal is then multiplied by the appropriate pollutant EMC. The total projected BMP area expected to occur from the implementation of the stormwater regulations is approximately 187 acres/year until 2040. Note that this acreage changes over time after 2040. The two reasons for this change include (1) a change to the projected rate of PROW re-development to a number more reflective of the expected long-term average value; and (2) changes to the amount of each land use type re-developed over time as the different land use types become completely retrofitted.

- For the load reductions associated with BMP implementation from other programs and drivers (as described in Table 5-2), it was assumed that the retention-based BMPs would be designed to the 1.2 inch standard. The BMP efficiencies were selected according to the BMP type, which can range from 53 percent for a green roof to 92 percent for an infiltration trench (based on 1.2inches of retention). Non-retention BMPs would perform at the efficiencies as shown and explained in Appendix F of the Final Comprehensive Baseline Analysis Report document (DDOE, 2015). The rate of implementation is expected to, at a minimum, remain constant over time, until the available area or land for each BMP type becomes completely retrofitted. Because there was no data available to project spatial trends in BMP implementation, it is assumed that these BMPs will be installed uniformly across the MS4. The total equivalent area controlled from BMP implementation through these programs is projected to be approximately 21 acres/year until 2040, as further explained in Attachment 3. Note that this acreage changes over time after 2040 as the different land use types become completely retrofitted.
- For the load reductions associated with source control and programmatic activities, only street sweeping, phosphorus fertilizer control, and coal tar sealant removal could be quantified in the model using the available data. The pollutant load removal provided by each of these activities is explained in Appendix F, Technical Memorandum: BMPs and BMP Implementation, of the Final Comprehensive Baseline Analysis Report (DDOE, 2015). Note that the reductions from these source control methods are accounted for in the calculation of the current load reductions. No increases in the amount of street sweeping or coal tar sealant removal are anticipated for the future. For the phosphorus fertilizer ban, the District can currently take credit for a 21.2 percent load reduction in phosphorus from pervious open land. This reduction is accounted for in the calculation of the current load reductions. After the Chesapeake Bay Program Urban Stormwater Workgroup reviews and approves the District's Anacostia River Clean Up and Protection Fertilizer Amendment Act of 2012, the District can take credit for a 24.7 percent load reduction in phosphorus from pervious open land, and this will be reflected in the projected future load reductions. While DDOE will continue to explore ways to quantify other programmatic and source control activities so that additional progress can be tracked, the fact that these activities are continuing to occur makes the current load reduction projections from these programs conservative, and indicates that more progress is being made towards improving the District's water quality than is currently being captured in this plan.

Three different time periods were used to model the load reductions and WLA achievement dates.

1. **Load reductions and WLA attainment between 2016 and 2040.** The load reductions and WLA attainment dates from this time period are based on projections of expected development or redevelopment and associated BMP implementation to comply with the stormwater regulations, as well as projections of ongoing BMP implementation, and source and programmatic controls, based on historical trends. The load reductions and WLA achievements for this timeframe can be projected with a relatively good degree of confidence because they are based in large part on the development and redevelopment forecasts prepared by the Office of Planning, and they have a high degree of spatial resolution. The results from this time period are shown in Sections 4 and 5.
2. **Load reductions and WLA attainment between 2040 and 2127.** The spatial location of the development and redevelopment beyond 2040 depends on market and regulatory forces that are not predictable, and thus the impact of this implementation component was distributed evenly across the MS4 for the 2040 to 2127 timeframe. Similarly, the BMP implementation from other programs and drivers is also assumed to be uniform across the MS4. Load reduction projections occurring after 2040 assume that the entire MS4 area will gradually be retrofitted with BMPs, at the same rate as calculated for the period of 2015 through 2040. To better project the area that will be controlled by

BMPs beyond the year 2040, a rate of BMP implementation was calculated for three different land categories including (1) Roads and the PROW, (2) R1-R4 parcels, (3) all other parcels. The reason for using three different rates of implementation is that the data shows that these three types of land categories experience different rates of development/redevelopment or BMP implementation. These three rates were developed as follows:

a. **Rate for roads and the PROW:** Development/redevelopment or BMP implementation on roads and PROW occurs at a slower rate than on property parcels and was therefore broken out as a separate BMP implementation rate. Data described in sections 4.2.2.a and 5.2 that specifically defines the development/redevelopment or BMP implementation on roads and in the PROW was used to calculate the average annual rate of area controlled by BMPs on this type of land. This rate is based on the sum of the annual average rate of retrofitted area on roads or PROW based on the BMP implementation resulting from road reconstruction that will trigger the stormwater regulations, from DDOT-led BMP installation (through, for example, the green alley program), and from tree planting that is expected to occur in the PROW (approximately half of the tree planting projected in the modeling is projected to be done in the PROW). The rate applied to each land use type is assumed to be constant after 2040, and is also assumed to occur uniformly across that land use type in the MS4 (note that while the rate of development/re-development applied to each land use type is constant after 2040, the amount of available land of each land use type declines over time as more land is retrofitted. Once all land of that land use type is projected to be retrofitted, no additional BMP implementation on that land use type is modeled. See Table 7-1 for the date by which different land use types are completely retrofitted.).

b. **Rate for parcels that are zoned R1-R4**: Data described in section 0 and 5.2 that define BMP implementation from the development/redevelopment rates or from other programs and drivers on R1-R4 parcels, but excluding any road or PROW areas, was used to calculate the average annual rate of area controlled by BMPs on this type of land. The rate is assumed to be constant after 2040, and is also assumed to occur uniformly across the MS4 (note that while the rate of BMP implementation for R1-R4 parcels is constant after 2040, the amount of available R1-R4 parcels declines over time as more land is retrofitted. Once all R1-R4 parcels are projected to be retrofitted, no additional BMP implementation on R1-R4 parcels is modeled. See Table 7-1 for the date by which different R1-R4 parcels are completely retrofitted.). This rate also assumes that half of all tree planting projected in the modeling will occur on R1-R4 parcels.

c. **Rate for all other parcels**: Data described in Section 4.2.2.a that define BMP implementation from the development/redevelopment or from other programs and drivers, but excluding any road, PROW, or R1-R4 parcels, was used to calculate the average annual rate of area controlled by BMPs on this type of land. This rate is assumed to apply to parcels zoned R-5, commercial, institutional, industrial, and several other zoning categories. The rate is assumed to be constant after 2040 (note that while the rate of BMP implementation for these parcels is constant after 2040, the amount of available parcels declines over time as more land is retrofitted. Once these all of parcels are projected to be retrofitted, no additional BMP implementation on these is modeled. See Table 7-1 for the date by which different land use types are completely retrofitted.), and is also assumed to occur uniformly across the MS4.

Table 7-1 shows the expected rate of implementation beyond 2040 for the three categories.

Table 7-1: Projected BMP Implementation Rates Beyond 2040			
	Roads and PROW	**R1-R4**	**All Other Parcels**
Target area	Road and PROW	Parcels zoned R1-R4 and excluding roads and PROW	Parcels not zoned R1-R4 and excluding roads and PROW
Retrofit rate	56 acres/year	77 acres/year	104 acres/year
Available area to retrofit after 2040	4,880 acres	5,122 acres	4,547 acres
Date by which land use type is completely retrofitted	2127	2107	2084

The rates in Table 7-1 were applied to the appropriate "remaining available area" in the MS4 to continue projecting stormwater volume and load reductions beyond 2040, and to determine the timeline necessary to meet each WLA. The "remaining available area" represents areas of the MS4 that have not yet been retrofitted by BMPs as of 2040. It is further assumed that these retrofitted areas will be treated by enhanced bioretention with underdrain, designed to the 1.2 inch standard. Because this implementation rate is based on extrapolation of existing trends, projections of BMP implementation, and subsequent load removal and WLA achievement, are made with a lower level of confidence. Using these implementation rates, it is expected that the entire MS4 area will be retrofitted by the year 2127.

3. **Load reductions and WLA attainment beyond 2127**.

Figure **2-2** in Section 2.3 shows that even if the entire MS4 area is retrofitted by BMPs designed to retain 1.2 inches of runoff, not all WLAs will be met. This is because this level of control is insufficient to meet the more stringent WLAs. Load reductions are therefore extrapolated beyond the date at which the entire MS4 area will be retrofitted with BMPs. It is assumed that some combination of new technologies, improved BMP efficiencies, or BMP treatment trains will allow load reduction to continue or increase until all WLAs are met. The load reductions after 2127 are calculated based on the average annual reduction observed from 2015-2127, for each TMDL segment and pollutant. The reduction rate is calculated and unique for each WLA. A few hypothetical examples are provided in Table 7-2. The rate of load reduction is calculated as follows:

$$Rate\ of\ Load\ Reduction\ \left(\frac{lbs}{yr}\right) = \frac{2014\ gap - 2127\ gap}{2127 - 2014}$$

The annual average rate of load reduction is applied indefinitely until all WLAs are attained. The date of WLA can be calculated as follows:

$$Date\ of\ WLA\ Attainment = \frac{2127\ gap}{rate\ of\ load\ reduction} + 2127$$

The projections of WLA attainment date are made with very low level of confidence because the load reduction rates are based on further extrapolation of existing trends and assumptions regarding future BMPs and efficiencies.

Table 7-2: Example of Calculation of Average Annual Load Reduction to Determine Date of WLA Attainment				
TMDL Segment	**2014 Gap (lbs of pollutant X)**	**2127 Gap (lbs of pollutant X)**	**Rate of Load Reduction (lbs/yr)**	**Date of WLA Attainment**
Segment A	1,200	200	8.8	2150
Segment C	50	1.5	0.4	2131

Based on the load reduction projections described in this section, the last WLAs will be achieved by 2154. Additional information on methodology and assumptions used to determine the WLA achievement dates can be found in Attachment 3.

7.3 Results

Figure 7-1 shows the cumulative stormwater volume reduction projected to be achieved by the current rate of BMP implementation in each of the three major watersheds (Anacostia, Potomac, and Rock Creek) from 2015 through 2154. While continued BMP implementation through the implementation of the existing stormwater regulations, other BMP implementation not associated with the stormwater regulations, and ongoing programmatic and source control efforts all contribute to load reductions over time, the impact of the stormwater regulations is by far the largest contributor to volume reduction. Overall, stormwater volume reductions from the BMP implementation expected from development and redevelopment activities (the dotted lines in Figure 7-1) make up almost 90 percent of the total stormwater volume reduction achieved through the IP.

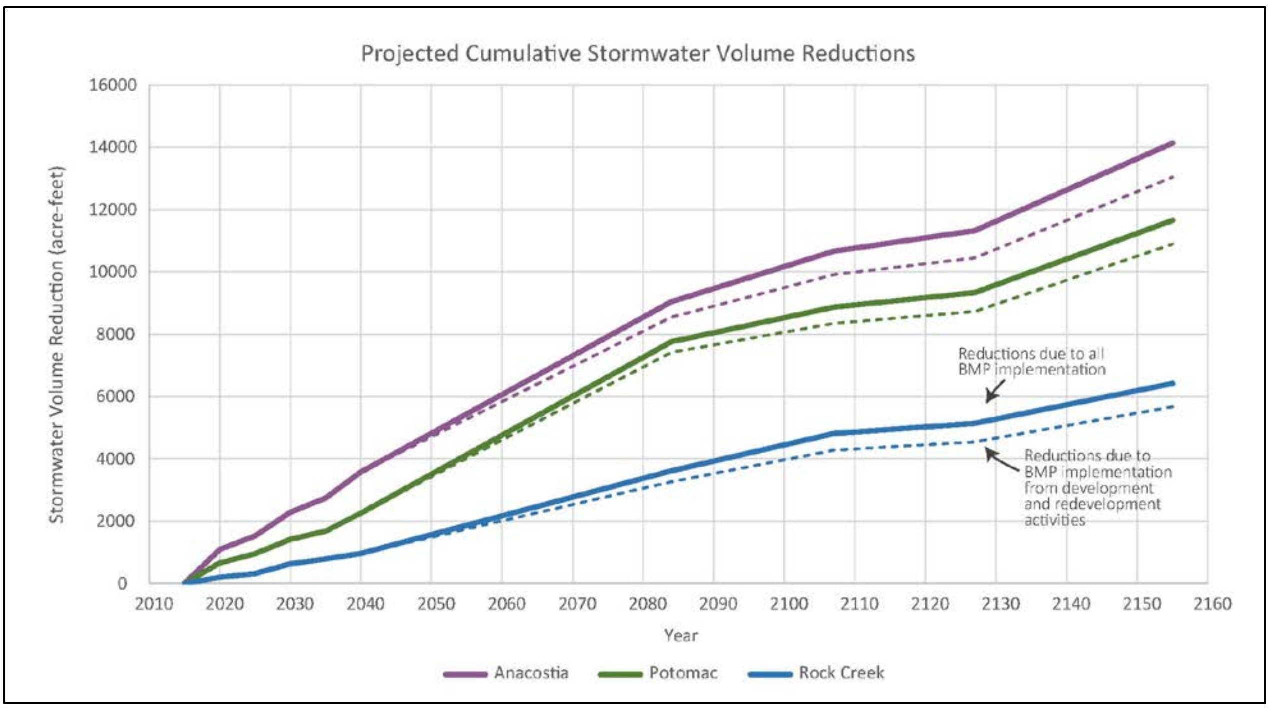

Figure 7-1: Projected Stormwater Volume Reduction Over Time by Major Watershed

Load reductions achieved through implementation of the stormwater regulations can be modeled by multiplying the projected stormwater volume reduction by the EMC for each pollutant type. The load reductions are different for each pollutant and TMDL water body. However, an example of the load reduction expected for TSS in the three major watersheds, over time, is shown in Figure 7-2.

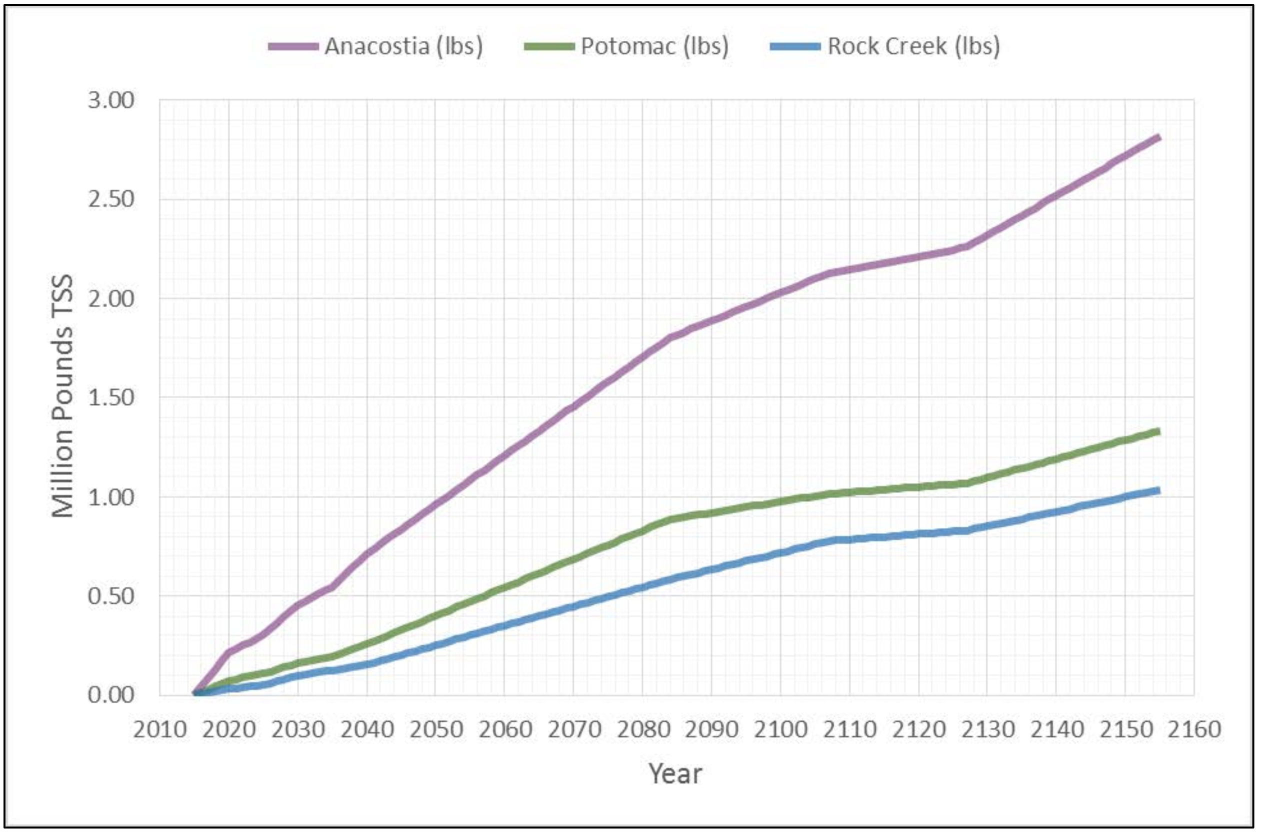

Figure 7-2. Projected TSS Load Reduction (lbs) Over Time by Major Watershed

Figure 7-3 shows the increasing number of WLAs projected to be attained over time. This figure shows that 29 WLAs are currently attained, and that additional WLAs will be achieved over time as BMP implementation is increased. The results are shown for the three different time periods that were modeled and can be summarized as follows:

- During the time period of 2015 through 2040, it is predicted that an additional 14 WLAs will be attained for a total of 43 WLAs achieved by 2040. These projections on WLA achievement are made with a relatively good degree of confidence.
- During the time period of 2040 through 2127, an additional 74 WLAs will be attained, for a total of 115 WLAs. These projections on WLA achievement are made with a lower level of confidence.
- During the time period of 2127 through 2154, all remaining WLAs will be achieved for a total of 206 WLAs. These projections are made with a very low level of confidence.

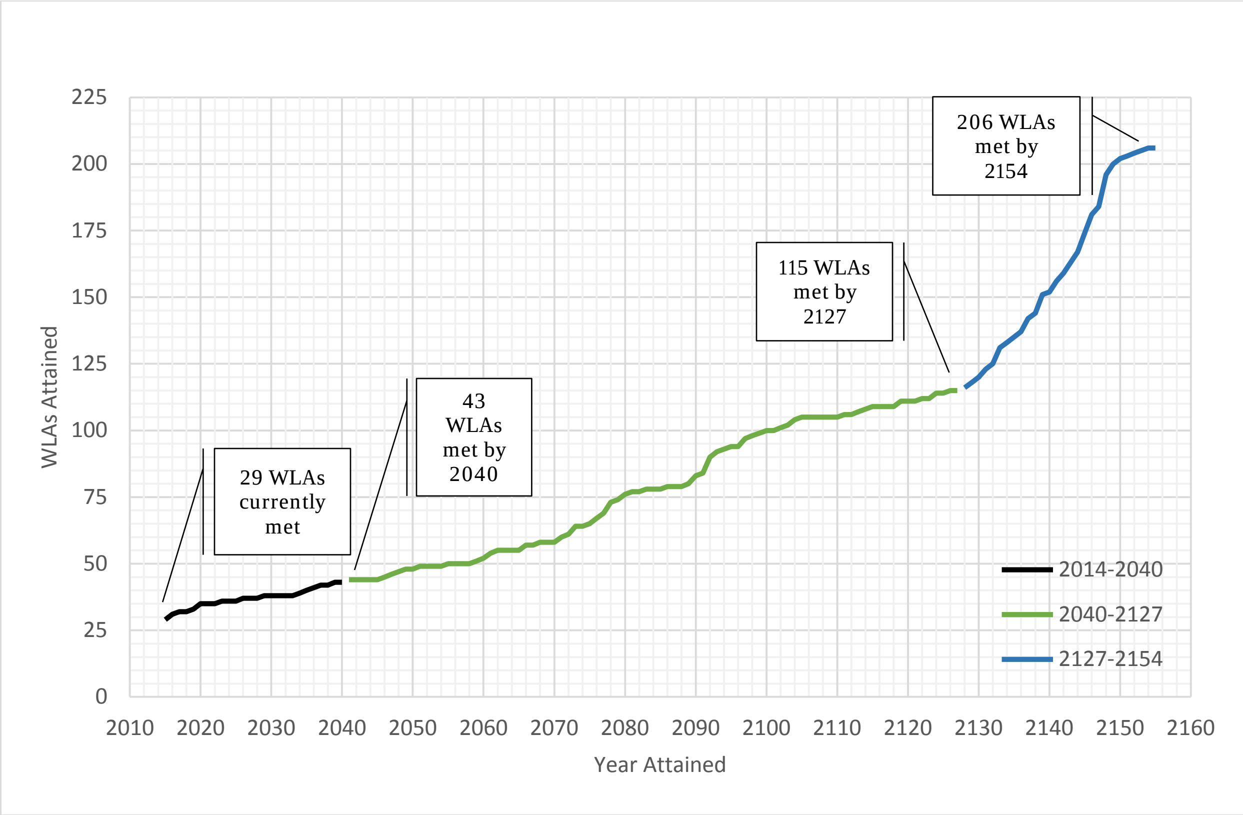

Figure 7-3: WLA Attainment Projections Over Time

Tables showing the attainment date for each individual WLA can be found in Attachment 5.

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8. Discussion of Findings

8.1 Summary of Results

Findings from the gap analysis and the scenario runs are summarized as follows:

- The BMP implementation expected to occur from development and redevelopment activities that will trigger the stormwater regulations will retrofit approximately 28% of the MS4 with BMPs by the year 2040.
- The BMP implementation expected to occur from other existing drivers and programs will retrofit approximately 3% of the MS4 with BMPs by the year 2040 (not including stream restoration projects).
- 29 WLAs are already in compliance under the present conditions. At the current rate of BMP implementation and expected load reductions, 43 WLAs will be attained by 2040, 115 WLAs will be attained by 2127, and all WLA will be attained by 2154.
- With respect to BMP efficiency and the ability of BMPs to achieve the necessary pollutant load reductions to meet targets, more than half of the annual MS4 WLAs require pollutant load reduction in excess of 70% while the typical pollutant removal efficiency for most BMPs is less than 70%.
- With respect to BMP retention capacity and the ability of BMPs to achieve the necessary pollutant load reductions through infiltration, the stormwater retention depth needed over the nearly the entire MS4 area to attain all the WLAs is estimated at approximately 2 inches, which would both require a very high density of BMPs across the MS4 and BMPs with a high retention or infiltration capacity. A 2 inch retention depth means that more than 90% of all rain events would be entirely captured and treated by BMPs, which would be needed to meet the WLAs that require more than a 90% reduction in loads.
- As a point of comparison, the amount of MS4 stormwater volume that needs to be treated to meet all of the WLAs exceeds the treatment volume required of the combined sewer system.
- WLA attainment will require lengthy implementation timelines, and is limited by the efficiencies and effectiveness of current BMPs.

8.2 Uncertainty

It should be noted that these forecasts of when WLAs will be achieved are potentially subject to both conservative and non-conservative biases, and that they may change as additional data on implementation and load reduction is collected in the future. Assumptions that may potentially make the forecasts too conservative include the fact that several ongoing source control and programmatic efforts to reduce pollutant loadings are not currently quantified through modeling. In addition, the so-called "first flush" effect is not captured in the modeling. The first flush effect theory states that pollutant loads are concentrated in the initial volume of stormwater, which means that running this initial volume through BMPs may reduce many of the pollutants. On the other hand, these forecasts may not be conservative enough relative to other factors. For example, it is assumed that when a development project triggers the stormwater regulations, the entire parcel area will be controlled by BMPs rather than a portion of the parcel. In reality, new BMPs may be designed to control only a portion of a given parcel, and not the entire parcel. Another example is that the average BMP efficiency used to model load reductions in the forecast is 83 percent, which is higher than the average efficiency of some BMPs. It is difficult to predict the aggregate effect of these assumptions on the actual load reductions that will be achieved in the future. Therefore, the forecasts contain some level of uncertainty

Data collected through ongoing monitoring should help reduce the uncertainty related to some of the model inputs, and increase the confidence in the model results. Similarly, data collected on additional, different, or newer BMPS can also be added to the model to quantify additional load reductions. With each iteration of model input refinements, the IP Modeling Tool can be rerun to calculate revised current pollutant loads, as well as future load reduction and ultimate WLA attainment date. With each revision, confidence in the model results and projections will increase.

9. Next Steps

This Scenario Analysis Report provides evaluations of:

- WLA attainment under pre-development conditions.
- The predicted BMP implementation projected to occur from development and redevelopment in the MS4 area and the application of the District's 2013 Stormwater Management Rule.
- The predicted BMP implementation projected to occur from other BMP Programs.
- The BMP implementation that could occur from implementing projects identified in existing watershed implementation plans.
- WLA attainment in the near and far future under current BMP implementation rates.

This Final Scenario Analysis Report provides results for a series of stormwater management scenarios that were modeled using the IP Modeling Tool. The next step is to use the results presented herein to inform the Consolidated TMDL IP. The Consolidated TMDL IP will be finalized in May 2015.

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References

CWP and CSN. 2008. Technical Support for the Baywide Runoff Reduction Method. Baltimore, MD www.chesapeakestormwater.net

DDOE. 2013. District Department of the Environment NOTICE OF FINAL RULEMAKING; Stormwater Management, and Soil Erosion and Sediment *Control*; ddoe.dc.gov/sites/.../dc/.../2013%20SW%20Rule.pdf

DDOE, 2014. *Consolidated Total Maximum Daily Load (TMDL); Implementation Plan Interim Report; Final Comprehensive Baseline Analysis*

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Attachments

Attachment 1: Supporting Documentation for the Development/Redevelopment Projections for all Parcels Except those Zoned R1-R4

Attachment 2: Development and Redevelopment Projections for Parcels that are zoned R1-R4: Correlation Analysis

Attachment 3: Determining the Equivalent Area of BMP Implementation from Other Existing Drivers and Programs

Attachment 4: Methodology for Load Reduction Projections Beyond 2040

Attachment 5: Summary Tables for Baseline and Current Loads, Gaps, and WLA Achievement by TMDL Watershed

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Attachment 1: Supporting Documentation for the Development/Redevelopment Projections for all Parcels Except those Zoned R1-R4

1. Additional Information on the District's 2013 Stormwater Management Rule

The development/redevelopment scenario identifies the BMP implementation projected to occur from the planned or forecasted development and redevelopment in the MS4 area that would trigger the District's 2013 Stormwater Management Rule[7]. The regulations require up to 1.2 inches of onsite stormwater retention for major land disturbing activities and 0.8 inches of retention for major substantial improvement activities, either on site or through a combination of on-site and off-site retention. Major land disturbing activities is defined as:

> *"Activity that disturbs, or is part of a common plan of development that disturbs, five thousand square feet (5,000 ft^2) or greater of land area, except that multiple distinct areas that each disturb less than 5,000 ft^2 of land and that are in separate, non-adjacent sites do not constitute a major land-disturbing activity."*

The disturbance of 5,000 square feet of land has been the trigger under the stormwater management regulations established in 1988.

Major substantial improvement activities is defined as:

> *"Renovations of existing structures that have a combined 5,000 square foot footprint and for which the project cost exceeds 50% of the pre-project value of the structure"*

Note that major substantial improvement is a new trigger for the District, and these activities are currently difficult to track and predict because it requires detailed information on the pre- and post-construction value of the project, which is not readily available. Therefore, these activities are currently not accounted for in the development/redevelopment.

A regulated site, whether it is a major land disturbance or a major substantial improvement, must achieve at least 50% of its required retention volume on site, and then has the option to achieve the remainder either on site or off site. There is currently not enough historical information available to determine whether the average regulated site manages its required retention volume on-site or off-site. Therefore, for the purpose of modeling the development/redevelopment scenario, it is assumed that all regulated sites retain all required retention volume on-site.

2. Flow Chart of the Development/Redevelopment Projections for all Parcels in the MS4 except those zoned as R1-R4

The flow chart below shows the sequential steps taken to create the development/redevelopment projections for all parcels in the MS4 except those zoned as R1-R4. The subsequent sections provide more information on each step.

[7] District Department of the Environment NOTICE OF FINAL RULEMAKING; Stormwater Management, and Soil Erosion and Sediment Control; ddoe.dc.gov/sites/.../dc/.../2013%20SW%20Rule.pdf

Collect Data

- DDOE: TMDL segment delineation GIS file
- DC OP: Expected Development Database, Capacity/Value Analysis Database, Targeted Zone Database, Small Area Plans, Neighborhood Investment Fund Plans, Great Streets Corridor Plans, and Gateway Plans
- DDOT: CIP, TIP
- DC Water: CIP
- DC OTR: Parcel Ownership GIS Layer
- Other: development/redevelopment plans from NCPC, university campuses, DHCD, DGS

Identify "parcels potentially subject to the stormwater regulations"

- Using OTR's Parcel Ownership GIS layer, eliminate all parcels under 5,000 square feet and exclude parcels that belong to a condo association. Keep parcels that are PROW and roadways. Use the clip function in GIS to only retain the parcels that are located in the MS4. The remaining areas represent the parcels that are potentially subject to the stormwater regulations in the MS4. If missing, assign ownership and landuse subclass to each parcel.

Use OP's data to identify parcels subject to projected dev/redev

- Retain all identified parcels in the Expected Development Database : these are expected to be developed based on specific plans filed with OP.
- Use the Capacity Analysis Database to identify parcels that are underutilized or undervalued. Use 40% and 70% as the threshold for capacity and value, respectively.
- Using the Targeted Zone Forecast, intersect the parcels from OP's Capacity Analysis Database with the Targeted Zone Forecast, and retain the intersect as additional parcels that are likely to develop.
- Use OP's additional plans (e.g.: small area plans, gateway plans, etc) to identify any additional targeted areas for development.

Use other sources to identify parcels subject to projected dev/redev

- Use DC DHCD plans to identify future construction of affordable housing projects.
- Use DDOT's CIP and TIPs to identify roads slated for major reconstruction. Assign a 6 foot buffer around these roads to identify the disturbed area.
- USE DC Water's CIP to identify major sewer reconstruction projects. Assign a 6 foot buffer around these roads to identify the disturbed area.
- Use information from NCPC, university campuses, and DGS to identify parcels that will be developed/redeveloped in the near future and will trigger the SW regulations.

Create a GIS layer of the projected dev/redev MS4 parcels

- Combine all the dev/redev parcels into a single GIS layer (Forecasted Development / Redevelopment Parcels). Assign or estimate year of projected completion based on the information provided or using best professional judgement. These represent
- Intersect the "Parcels Potentially Subject to the Stormwater Regulations" and the "Forecasted Development/ Redevelopment Parcels". The intersected areas represent the "Development/Redevelopment Projections for all Parcels in the MS4 except those zoned as R1-R4 "

QA/QC the identified parcels

- Conduct a knee-of-the-curve analysis. Any parcels above the knee of the curve were investigated more closely, and areas were adjusted according to the desciptions provided in the permit application
- Overlapping parcel areas were eliminated to avoid double counting areas. Parcels with a later projection date were retained if conflicting projection dates existed in overlaps.

2.1 Collect Data

The following table shows the data used to create the development/redevelopment projections for all parcels in the MS4 except those zoned as R1-R4.

Table A1-1: Data used to create the development/redevelopment projections for all parcels in the MS4 except those zoned as R1-R4

Data name	Description	Agency	Website / point of contact
"TMDL_IP_Segments_25 Mar2015"	GIS layer of the TMDL IP segments and of the MS4 area	DDOE	Martin Hurd
- OP Expected Development Database **- OP Capacity/Value Analysis Database** **- OP Targeted Zone Database**	Databases that contain information on the forecasted development and redevelopment projects in DC	DC Office of Planning	Art Rodgers, Senior Housing Planner art.rodgers@dc.gov 202-442-8801 Chris Dickersin-Prokopp chris.dickersin-prokopp@dc.gov
DDOT CIP, TIP, and CLRP	These are the long- and short-term transportation planning documents for DC	DDOT	http://ddot.dc.gov/page/transportation-capital-budget-plans
DC Water CIP	DC Water's Capital Improvement Program. These are PDFs showing the budgeted sewer improvements for the next 10 years.	DC Water	http://www.dcwater.com/about/cip/
Parcel Ownership GIS Layer	GIS layer containing the locations and attributes of owner polygons, created as part of the DC GIS for the DC OCTO and participating DC government agencies	DC OTR	http://dcatlas.dcgis.dc.gov/metadata/OwnerPly.html
Development or redevelopment plans from university campuses	Individually developed master plans or sustainability plans showing potential development or redevelopment projects	GWU Georgetown AU UDC	Check with each school's planning, facilities or sustainability department
Development or redevelopment plans from DHCD	Individually developed master plans or sustainability plans showing potential development or redevelopment projects	DHCD	https://octo.quickbase.com/db/bit4kvfmq?a=Mobile_Dashboard

Table A1-1: Data used to create the development/redevelopment projections for all parcels in the MS4 except those zoned as R1-R4			
Data name	**Description**	**Agency**	**Website / point of contact**
Development or redevelopment plans from DGS	Individually developed master plans or sustainability plans showing potential development or redevelopment projects	DGS	Stephen Campbell, Senior Planner, Planning Office, DGS 202-671-2319 Stephen.Campbell@dc.gov
Development or redevelopment plans from NCPC	Individually developed master plans or sustainability plans showing potential development or redevelopment projects	NCPC	Shane Dettman, Planner at National Capital Area Planning Commission. See also NCPC CIP website: http://www.ncpc.gov/ncpc/Main(T2)/Planning(Tr2)/CapitalImprovements.html

2.2 Identify Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities

Identification of the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities," defined as the parcels in the MS4 area that have the potential to trigger the storm water regulations if those parcels were developed or redeveloped, is the first step in creating the Development/Redevelopment Scenario. A major trigger is the size of the disturbed area, which must be larger than 5,000 square feet. Therefore, only parcels that are larger than 5,000 square feet were selected as the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities". One caveat to this is that roadways and PROW are not associated with "parcels" per se, but they are included in the evaluation of areas that are potentially subject to the Stormwater Regulations.

Note that the Stormwater Regulations also apply to "major substantial improvement" on parcels of any size, including parcels less than 5,000 square feet, if the cost of the project is equal to or greater than 50% of pre-project assessed value of the structure. These types of projects are currently difficult to track and predict because it requires detailed information on the pre- and post-construction value of the project, which is not readily available. Therefore, these activities are currently not accounted for in the development/redevelopment scenario and no parcels under 5,000 square feet were included to identify the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities".

Data Collection, Processing, and Analysis

Data on the existing parcels in the MS4 area from DC OTR's "OwnerPly" GIS layer were used to identify the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities". In general, the 2013 Stormwater Rule regulates projects that disturb more than 5,000 square feet of land. Therefore, all parcels of more than 5,000 square feet (with one exception – see the next paragraph) were retained as part of the "Parcels Potentially Subject to the Stormwater Regulations for Major Land Disturbing Activities", while parcels less than 5,000 square feet were excluded from the data set. In addition, all area identified as roadways and PROW were included in the data set. The only types of parcels over 5,000 square feet that were excluded from the dataset were parcels that contain condominiums. Because of the management structure of condominiums, they are unlikely to be developed or redeveloped as a whole and therefore are unlikely to trigger the stormwater regulations.

Once these parcels were identified, the clip function in GIS was used to clip these parcels to the MS4 area (as defined by the GIs layer: "TMDL_IP_Segments_25Mar2015") to only retain the parcels that are located in the MS4. The remaining areas represent the parcels that are potentially subject to the stormwater regulations in the MS4.

Assigning Ownership and Subclasses of Landuse Type to Parcels

As described in Section **Error! Reference source not found.**, the ownership and land use type for each parcel were identified to better understand the types of parcels that have the potential to trigger the stormwater regulations. These data were also used as part of the assessment of the potential for each parcel to be developed or redeveloped in the future. For example, some types of federally owned land such as parks are unlikely to be developed. Identifying ownership can also be useful to identify parcels that are owned by the District or by the Federal Government, as they may present opportunities to implement BMPs that go beyond the basic requirements of the stormwater regulations.

The Office of Tax and Revenue (OTR) parcel ownership database was used to assign general categories of ownership to each parcel. Table A1-2 shows the ownership classifications used and provides a description and example of each owner type. Several parcels indicated partial or shared ownership between the District and another entity, and were classified as "DC/Private" or "DC/Federal," as appropriate.

Table A1-2: Ownership Classification

OWNER TYPE	DESCRIPTION	EXAMPLES
Private	Parcels owned by a private citizen, group of citizens, organization, institution, or business.	Residential housing, commercial businesses, private schools and universities.
District of Columbia	Parcels that are directly owned by a District agency.	Public schools, parks, office buildings, public housing, and other lots affiliated with DC governmental agencies.
Federal	Parcels that are directly owned and/or controlled by the United States government.	National parks, museums, and federal offices.
International	Parcels that are under the control and considered the domicile of other countries.	Embassies, chanceries, and housing for diplomats.
WMATA	Parcels owned by or under the control of the Washington Metropolitan Area Transit Authority (WMATA).	Metrorail tracks, Metrorail stations, Metrorail air vents, and other WMATA transportation facilities.

After classifying parcel ownership, subclasses were created to identify the land use. Parcels were classified by their use code as described in OTR's ownership database. Because OTR's ownership database was focused on the ownership of parcels containing buildings, it included use codes of "vacant" or "unimproved" for parcels that did not contain buildings, but may not be considered vacant land. Therefore, records from the OTR ownership database that used these codes were cross-referenced with OTR's Computer Assisted Mass Appraisal (CAMA) database and OP's Existing Land Use Layer to determine if other land use sub-classifications (e.g., parkland) were more appropriate for the parcel. In some cases, Google Earth was used to determine the land use sub-classification. Table A1-3 shows the ownership sub-classifications used.

Table A1-3: Ownership Sub-Classification	
Sub-Classification	**Description**
Cemetery	Burial grounds.
Commercial	Properties used by and for business purposes. These include retail, restaurants, office spaces, and other non-residential purposes.
Community / Recreation Center	Parcels not designated as parks, but intended for recreation, viewing of sporting events, or community use.
Educational	Educational facilities such as schools, colleges, universities, and other school grounds.
Embassy / Consulate	Land and facilities owned by international entities or governments for use by diplomats and their staff.
Hotel	Parcels used for sites of hotels, motels, or other short-term or limited stay housing.
Industrial	Land used for manufacturing, industrial, or construction staging purposes.
Institutional	Land containing cultural, historical, or other pseudo-educational facilities. These include museums, historic sites, monuments, and research facilities.
Medical	Parcels containing medical or health care facilities.
Military	Land owned by the federal government and designated as a military base or site.
Mixed Use	Parcels housing a mix of uses including residential and commercial.
Parks and Open Space	Land designated as a park or open space by the District of Columbia, the federal government, or a private institution.
Paved/Impervious	Parcels in which the majority is paved or impervious surfaces including parking lots and public plazas.
Place of Worship	Land owned by religious institutions including places of worship and their grounds.
Public Housing	Parcels owned by a public entity (the District or the federal government) or partial ownership thereof.
Public Right of Way	Area adjacent to roads in the public space, such as sidewalks.
Residential	Parcels primarily intended to serve as owner-occupied or rental private housing for District Residents.
Reservation	Land owned by the federal government transferred to the District or managed by a federal entity such as the National Park Service.
Transportation Utilities	Rail and bus facilities including rail right of way, tracks, and Metrorail entrances.
Utilities	Power stations, power substations, transformers, reservoirs, water pumping stations, water treatment centers, and other uses which provide power, water, or other utility service, monitoring, and maintenance.
Vacant Land	Land that has a permit or zoning attached, but does not have a structure nor designation as parkland.

2.3 Use OP's data to identify parcels subject to projected development or redevelopment

Data received from the Office of Planning (OP) was used to identify future development/redevelopment projects in the MS4. Three major sets of data were used for this purpose, including the Expected Development Database, the Capacity Analysis Database, and the Targeted Zone Forecast. All parcels included in OP's Expected Development Database were retained as these are expected to be developed based on specific plans filed with OP. The Capacity Analysis Database was used to identify parcels that are underutilized or undervalued, using 40% and 70% as the threshold for capacity and value, respectively. Lastly, the Targeted Zone Forecast was used to retain additional parcels that are likely to develop. Lastly, OP's small area plans were reviewed to determine if there were any additional targeted areas for development.

Description of OP's Expected Development Database

As explained in Section 4.2.2.a, OP was a key partner in providing both data and agency plans that were used for creating the projections of development and redevelopment in the MS4 area. One of the key pieces of information provided by OP is the Expected Development Database. The Expected Development Database tracks development within the District. OP develops this database by identifying projected development through a permit, zoning review, or conceptual design as filed with District government. The database also includes projects documented on local business journal sources with conceptual designs for which a design review had been filed. These developments are documented according to the development name, timing expected, developers, and other factors, which influence their potential for moving forward. In the MS4 area, expected developments are only available through 2025. The limitations of this dataset are that it does not track residential developments under 10 units, nor does it track low-density residential development because of the unpredictability of the housing market and the impact of the Neighborhood Conservation Zones. The database does, however, have the potential to contain parcels that are zoned R1-R4. This can occur when clusters of contiguous R1-R4 parcels are part of a single development. The projects in the database are tracked and projected based on the Status ID, which details the status of the projects from conceptual design to completion.

Description of the Capacity/Value and Targeted Zone Analysis

OP provided the Capacity Analysis Database, which was used in the "Capacity/Value" Analysis. The Capacity Analysis Database is a parcel-level documentation of the District including any parcel with a designated floor area ratio (FAR). It allows for examination of a parcel's current build out versus its zoned capacity. For example, if a parcel contains a two-story townhome, but is zoned to allow a four-story townhome on that parcel, it is considered to have additional capacity. This database includes information such as the parcel square footage, the land value, the improvement value, ownership, zoning labels, percent built, as well as other factors which were used to determine a parcel's potential for development. OP identifies a few factors in having higher potential for development, which include parcels built to less than 30% of their capacity and those that have a value ratio (land value/total value) of greater than 70%. There are over-built properties within the database which are parcels built over what their zoning capacity dictates. These properties were usually large buildings built before zoning regulations were put in place or buildings that were renovated and were grandfathered into the zoning code as variance or exceptions. Depending on the structure's age and condition, over-built parcels have the potential to redevelop. The Capacity/Value analysis uses the Capacity Analysis Database to identify parcels that are likely to be developed based on the "available capacity" (what was currently built on that parcel compared to what maximum zoning allows to be built) versus their "value" (what the land was potentially worth if it was built to capacity).

A Targeted Zone Analysis was used to identify parcels that are located in a "targeted zone" that has a specific incentive or driver for development and thus is likely to be developed or redeveloped. Examples of these "targeted zones" include a half-mile buffer around Metrorail stations, Economic Development Zones, Enterprise and Empowerment Zones, Historically Underutilized Business Zones, Neighborhood Investment Fund Zones, Supermarket Tax Credit Zones, and Main Streets Programs. Any parcels from OP's Capacity Analysis Database that lie within any of the Targeted Zones were identified as areas that are likely to be developed or redevelopment over the next 25 years.

Capacity/Value and Targeted Zone Analysis databases have the potential to contain parcels that are zoned R1-R4. This can occur when clusters of contiguous R1-R4 parcels are part of a single development.

More information on the Capacity/Value and Targeted Zone analysis is provided in Section 2.5 below.

2.4 Use other sources to identify parcels subject to projected development or redevelopment

Interviews with agencies like District's Department of Transportation (DDOT), DC Water, DC Department of General Services, National Capital Planning Commission (NCPC), DC Department of Housing and Community Development (DHCD), and DC college campuses were conducted to determine if these organizations are planning on undertaking any major development or redevelopment projects in the near future that are not already captured by OP's forecast and that have the potential to trigger the stormwater regulations. Summaries of the data provided by each agency are provided below.

District Department of Transportation (DDOT)

Multiple DDOT documents, including the 2014-2020 Transportation Improvement Plan (TIP), corridor studies, and moveDC (October 2014) documents were used to identify DDOT projects projected to occur between 2015 and 2040. The DDOT documents provided different information on projected transportation and roadway-related development in the District. TIPs provide detailed data on projects that are already planned to occur within the next six years. Corridor studies for Benning Road NE, Georgia Avenue NW, Minnesota Ave NE, Martin Luther King Jr Blvd SE, Nannie Helen Burroughs NE, and Pennsylvania Avenue SE were released in 2007 as part of the "Great Streets" Program. The planning horizon for these corridor studies is four years, and most of the projects included in these studies are already completed. Other corridor studies reviewed included the Wisconsin Avenue Corridor Transportation Study (released 2005, also with a 4 year planning horizon) and the 18th Street- Adams Morgan Transportation and Parking Study (2006). While many projects from the corridor studies had already been completed, any that had not yet been completed were added to the forecast.

In contrast to the TIPs and corridor studies, moveDC is more of a vision for future transportation development and funding in the District, and implementation of projects from moveDC planning is subject to available funding. Based on the relative confidence in implementation of the planning forecast in the DDOT documents, these plans were used in different ways. Specific projects from the TIP and corridor studies are included in the forecast, whereas the moveDC planning is used to inform BPJ about additional roadway construction projects to include in the forecast. In addition, BPJ is used to evaluate the information from the plans as a whole to develop the forecast of future road development. For example, these documents indicate which roads have recently been reconstructed. The assumption can be made that any roads that have been recently reconstructed will not likely need reconstruction between 2015 and 2040. Also informing BPJ about future potential road construction projects is that DDOT has identified that Federal Aid eligible roads are more likely to be reconstructed than local roads because of the availability of funding for these roads. Based on this type of information, roads such as New York Avenue NE are likely to be reconstructed in the near future because of their heavy use during construction and general need for upgrade.

DC Water

DC Water prepares a 10-year Capital Improvement Plan to guide future utility reconstruction. These projects typically involve replacement or installation of sewer or water pipes underneath roadways. Consequently, they typically require DDOT to reconstruct roadways after DC Water excavates and replaces the utilities beneath the roads. DC Water projects were captured by identifying the roadway that they will disturb during their projects, including a six-foot buffer around the roadway to reflect any disturbance in the PROW.

DC Department of General Services

Department of General Services develops and executes sustainability initiatives across the District, including stormwater management initiatives such as green infrastructure implementation on District owned properties. DGS is not currently anticipating additional development/redevelopment projects that are not already identified and included in OP's databases.

Department of Housing and Community Development (DHCD)

DHCD finances and oversees the development of affordable housing and community facilities. In response to an annual Request for Proposals (RFP), the agency receives loan applications from private developers that show where development is planned to occur. DHCD provided its affordable housing development dashboard database, which identifies all affordable housing projects that the agency will pursue, as well as a timeframe in which the project will be completed. This database provides real-time updates on the status of projects in the DHCD pipeline, identifying them by certain phases (in underwriting, under construction, completed, as well as leasing or on the market for purchase). The projects in the MS4 area that were identified by DHCD as under construction or in underwriting were added to the development forecast.

National Capital Planning Commission (NCPC)

The National Capital Planning Commission is tasked with coordinating, guiding, and implementing federal agency land development plans within Washington, DC. It serves as a repository of all of federal agency plans for development/redevelopment or renovation in the District. Through collaboration with the commission, the planned development/redevelopment of federal parcels within the MS4 area of the District in the next 25 years was identified.

NCPC provided a list of projects or plans associated with federal parcels, as well as a shapefile of current and proposed projects that have been approved. A master shapefile of federal projects was developed from NCPC's shapefile by adding projects to it from the planning documents provided by NCPC. Projects in the CSO area and any projects under 5,000 square feet were not included (the latter were excluded because they would not trigger the stormwater regulations for major land disturbing activity).

With respect to the timeframe during which the identified projects would occur, some of plans included project details such as project beginning and ending dates, while other plans were more vague and only discussed general development principles. Therefore, project completion dates are based on BPJ. For example, short-term projects from older planning documents are not included because they were assumed to be complete.

Campus Master Plans

Six college or university campuses were identified within the MS4 area: American University, Catholic University, George Washington University – Mt. Vernon, Georgetown University, University of District of Columbia, Howard University – Law campus, and Wesley Theological Seminary. While the Master Plans for these entities did identify potential development, most of the campuses had either already completed their development or were not expecting to complete the remaining development identified in their master plan. Thus no information from campus Master Plans is used as part of the forecasting.

2.5 Development of a GIS layer to depict the development and redevelopment areas of parcels not zoned R1-R4 in the MS4 area

A GIS layer was created to depict the projected areas of development or redevelopment on parcels not zoned R1-R4 in the MS4 area between 2015 and 2040. The starting point for creating this GIS layer is OP's Expected Development Database. The relevant information provided in this database was used to build the GIS layer as follows:

1. Using the database field "Status ID", identify parcels that will be included in the GIS layer and assign a date of completion to each parcel. Note that while it is possible that some of the identified projects may develop in phases, for the purpose of the development/redevelopment scenario, it was assumed that all projects will be developed in one phase.
    a. Parcels designated as "Completed" were excluded since these projects are expected to be completed by 2010 and the development/redevelopment scenario only considers projects that will be completed after 2015. However, "Completed" parcels were retained in the GIS layer for historical reference.
    b. Parcels designated as "Under Construction" are assumed to be completed by 2015, and therefore were also excluded in the development and redevelopment scenario since the development and redevelopment scenario only considers projects that will be completed after 2015. As with the "Completed" parcels, "Under Construction" parcels were retained in the GIS layer for historical reference.
    c. Parcels designated as "Planned" parcels are assumed to be completed by 2020.
    d. Parcels designated as "Conceptual" parcels are assumed to be completed by 2025.
    e. Parcels designated as "New Neighborhoods" are assumed to be completed by 2030.
2. Add additional parcels using the Capacity/Value and Targeted Zone analysis. The Capacity/Value analysis identifies potential parcels that are likely to be developed/redeveloped based on the parcel's "available capacity" (what was currently built on that parcel compared to what maximum zoning allows to be built) versus the parcel's "value" (what the land was potentially worth if it was built to capacity). The less built out a parcel is compared to its value, the higher the potential for it to be developed/redeveloped. This analysis uses parcels included in OP's Capacity Analysis Database and is also largely based on assumptions identified by OP. For example, OP identifies parcels built at or below 30% of their capacity, and having a value ratio of 70% or more, as parcels with the highest development potential. For the purpose of the projections for the TMDL Implementation Plan and based on best professional judgement, a capacity threshold of 40% was chosen instead of OP's 30% and the OP value ratio threshold of 70% was maintained. The "Targeted Zone" analysis identifies potential parcels from OP's Capacity Analysis Database that are located in an area that has a specific incentive or driver for development, and thus are likely to be developed or redeveloped. Examples of specific incentive or drivers for development include underutilized parcels within a ½ mile of a metro station, or parcels located in an Economic Development Zone.
    a. Adding parcels through the Capacity/Value analysis.
        i. The Capacity/Value analysis selected parcels from OP's Capacity Analysis Database that were built to 40% or less than their current zoned capacity and had

a value ratio of 70% or more. Parcels built to less than 40% of their capacity were chosen based on best professional judgment that these parcels have a great potential to develop. In addition a value ratio of 70% means the land is more valuable than the structure on the property. Parcels that were developed prior to 2014 were excluded from this analysis, as were those that were built over their current capacity. All new parcels identified through this analysis were added to the GIS layer of the projected areas of development/redevelopment. Note that, as a policy, OP does not attempt to project parcels that are low density residential (i.e. single family homes), historic, or National Park land, and therefore none of these types of parcels were included in this analysis.

b. Adding parcels through the Targeted Zone Forecast:

   i. Identify the Targeted Zones in the MS4 area. These zones included a half-mile buffer of Metrorail stations, Economic Development Zones, Enterprise and Empowerment Zones, Historically Underutilized Business Zones, Neighborhood Investment Fund Zones, Supermarket Tax Credit Zones, and Main Streets Programs. Streetcar Corridor Zones were not included because of the uncertainty of program's funding (beyond the H-Benning Line), and therefore it cannot be assumed that it will be a driver of development in the foreseeable future.[8] These zones were aggregated into one shapefile.

   ii. Identify parcels from OP's Capacity Analysis Database that lie within the Targeted Zones. These are the parcels that are likely to develop. Parcels that are currently designated as "over built" were included in the data layer, since these still parcels still present an opportunity to be substantially improved or redeveloped. All new parcels identified through this analysis were added to the GIS layer of the projected areas of development/redevelopment.

3. Add additional parcels using other OP Plans. Other OP plans include the Small Area Plans. Only development expected to occur after 2015 was included. Many of the Small Area Plans were written between 2008 and 2010 and much of the development that was identified to occur has already begun or has been completed. Nevertheless, a few areas were still identified through this program:

   a. Parcels flagged for development or redevelopment were included even if the plans were approved prior to 2010, as long as they had not been constructed or planned yet by 2014. If the parcels were already developed or under construction at the time of this analysis, then it was not included in the analysis.

   b. MS4 parcels flagged in the Small Area Plans that were less than 5,000 ft^2 were included in the analysis because many of these parcels were identified for consolidation as part of a larger revitalization effort.

   c. Abandoned or decommissioned rail lines were excluded from the forecasts because of their limited width and lack of infrastructure needed to support a residential or commercial building.

4. Add additional parcels using DDOT Plans. Roadways scheduled for reconstruction according to DDOT's plans were included based in CIP and TIP documentation.

[8] http://www.washingtonpost.com/local/dc-politics/dc-council-votes-to-override-mayor-vincent-grays-budget-veto/2014/07/14/c908f36c-0b5a-11e4-8c9a-923ecc0c7d23_story.html

   a. The CIP and TIPs were used to identify roads slated for reconstruction. The TIPs provide the best information on road reconstruction because they represent DDOT's short-range planning and it is presumed that these projects have allocated funding. The reconstruction projects were assumed to be scheduled for completion by 2020.
   b. Any roads identified in the TIPs but that were reconstructed in the past 10 years were excluded from the analysis. It is assumed that any roads that were reconstructed in the past 10 years are unlikely to be reconstructed between 2015 and 2040.
   c. Roads are given a 6-foot buffer on each side to represent disturbed area in the PROW
   d. If a large number of parcels are set to redevelop along a particular roadway, it is likely that DDOT will reconstruct that roadway. Based on OP's projections from the Expected Development Database, Capacity/Value analysis, and Targeted Zone analysis, New York Avenue was identified as a roadway with high potential of reconstruction by 2020.
   e. No projects from moveDC plans were included in the forecast because there is no guaranteed funding for projects included in moveDC plans.
5. Add additional parcels using DC DHCD Plans. Future construction of affordable housing projects was identified using the Development Finance Division's (DFD's) Pipeline Public Dashboard.
   a. The underwriting and construction pipeline databases were downloaded and reviewed.
   b. Only projects that are located in the MS4 area were retained for further analysis.
   c. Projects in the MS4 area were cross-referenced with OP's Capacity Analysis Database to identify parcels on which affordable housing projects would be implemented.
   d. Projects that are shown to be in the "construction" phase were assumed to be completed by 2020.
   e. Projects that are shown to be in the "underwriting" were as assumed to be completed by 2025.
6. Add additional parcels using DC Water Plans. DC Water prepares a 10-year Capital Improvement Plan to guide future utility reconstruction. These projects typically involve replacement or installation of sewer or water pipes underneath roadways. Consequently, they typically require DDOT to reconstruct roadways after DC Water excavates and replaces the utilities beneath it.
   a. DC Water projects were identified from DC Water's CIP documentation. Only major reconstruction projects are included. It is assumed that trenches for simple repairs would not trigger the stormwater regulations.
   b. Only projects located in the MS4 were retained for this analysis.
   c. The roadway parcels that would be disturbed for each project was identified in GIS. These parcels also include a six-foot buffer to reflect any disturbance in the PROW.
7. Add additional parcels using NCPC Plans. The National Capital Planning Commission is tasked with coordinating, guiding, and implementing federal agency land development plans within Washington, DC. Through collaboration with the commission, the planned development/redevelopment of federal parcels within the MS4 area of the District in the next 25 years was identified.
   a. NCPC provided a list of projects or plans associated with federal parcels, as well as a shapefile of current and proposed projects that have been approved. A master shapefile of federal projects was developed from NCPC's shapefile by adding projects to it from the

planning documents provided by NCPC. Projects in the CSO area and any projects under 5,000 ft2 were not included (the latter were excluded because they would not trigger the stormwater regulations for major land disturbing activity).

b. With respect to the timeframe during which the identified projects would occur, some plans included completion dates while other plans were vague and only discussed general development principles. Therefore, some project completion dates were based on BPJ. For example, short-term projects from older planning documents are not included because they were assumed to be completed.

c. Federal properties that were identified in the long-range plans, such as the Southwest Ecodistrict and the Maryland Avenue Plan, were included in the forecast.

2.6 QA/QC of the parcels included in the GIS layer

The GIS file created in the step above underwent two specific QA/QC checks. The first check was to determine if the largest identified parcels are likely to be developed or redeveloped in their entirety or if only a portion of those parcels would be developed or redeveloped. This check was incorporated to verify, and if necessary correct, the assumption that the entire parcel area will be developed/redeveloped and be subject to the stormwater regulations. In order to make this determination, the parcels were sorted and ranked by size to create a knee-of-the-curve figure as shown in Figure A1-1. The knee-of-the-curve is the inflection point of the curve, or the point on the x axis where the y axis starts increasing significantly. The points above the knee-of-the-curve were examined more closely because these parcels, while they only constitute 2% of all the identified parcels, may carry the most potential error for over-estimating the potential area of development/redevelopment because their individual areas are much larger than the median area of all the identified parcels. It therefore seemed judicious to examine these large parcels more closely using permit plans or other supporting development/redevelopment documentation. If necessary, areas of the parcels above the knee-of-the-curve were adjusted accordingly. For example, a permit plan might indicated that only one specific building is slated for redevelopment on a large parcel that contains multiple buildings, in which case only the specific building footprint from the permit was retained as the area that will undergo development or redevelopment.

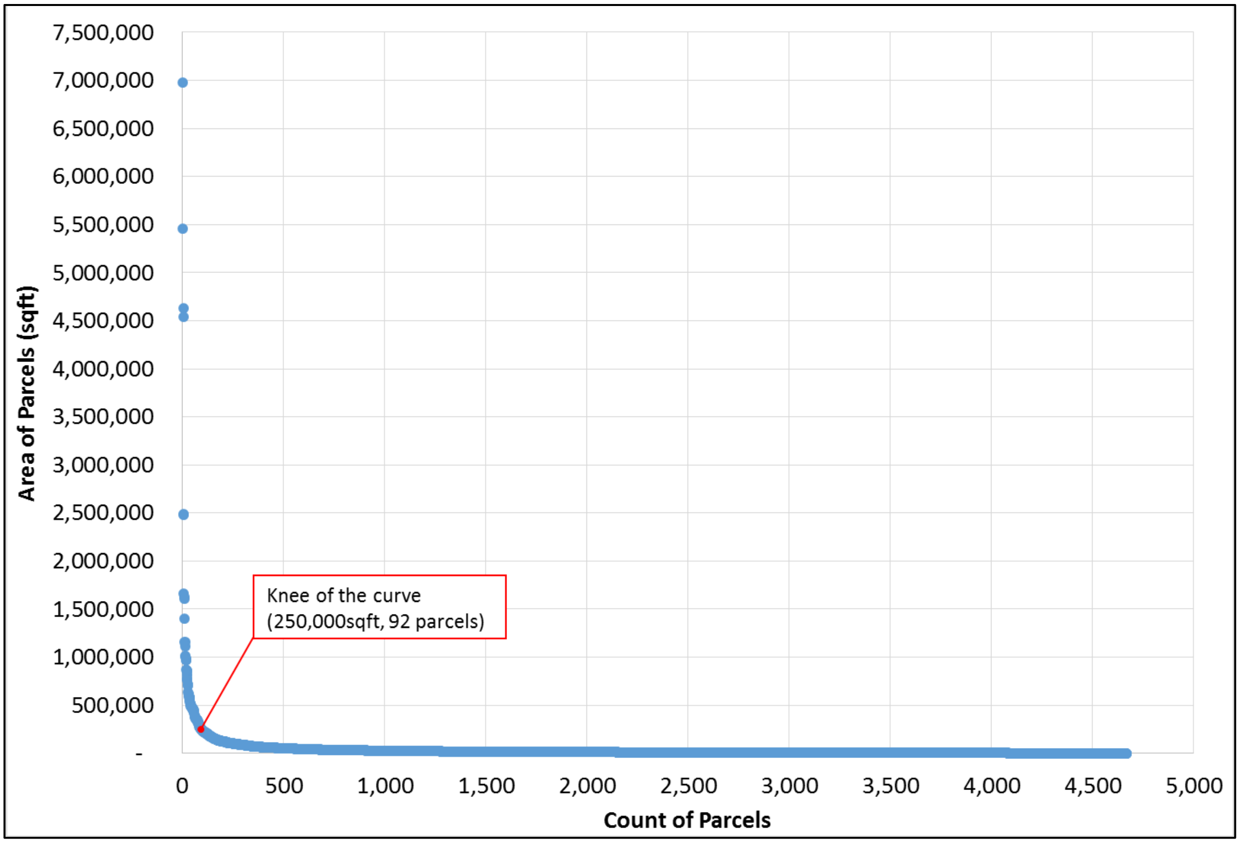

Figure A1-1: Knee of the curve analysis for parcels that were retained to represent the projected development and redevelopment of parcels in the MS4 except those zoned as R1-R4

The second QA/QC check was to check for overlapping parcels in order to avoid double counting those overlapping parcel areas. These overlapping parcels occurred either in the raw data received from OP or in the parcel data from OTR, and are a by-product of either uncertain parcel ownership or delineation or overlapping phases of parcel development/redevelopment. To eliminate these overlapping areas, the following rules were applied.

- An overlapping area can only be counted once
- If the overlapping areas had conflicting projection years assigned, then the latter date was used.
- If the overlapping areas had conflicting zoning categories (NonR1-R4 or R1-R4), it was assumed to be NonR1-R4.
- If the overlapping areas included roadways, it was assumed to be NonR1-R4 or R1-R4 rather than roadway.

Attachment 2: Development and Redevelopment Projections for Parcels that are zoned R1-R4: Correlation Analysis

1. Background

The projections of the rate of development and redevelopment were determined using two sets of data:

1. **Development/Redevelopment Projections for all Parcels except those zoned as R1-R4:** The District's Office of Planning tracks and forecasts the expected development and redevelopment in the District. OP's forecasts mainly apply to residential parcels that are zoned for 10 units or more, such as R-5 residential lots, or to commercial, industrial, and institutional parcels. OP's forecast, broadly speaking, excludes parcels zoned as R1 through R4 (some exceptions apply, as further explained in section 4.2). OP's projections were further filtered by lot size such that only development or redevelopment on parcels greater than 5,000 square feet, or a cluster of contiguous small parcels with an aggregate area of greater than 5,000 sf were retained to identify the areas that have the potential to trigger the stormwater regulations. Planned development projects identified from the District's Office of Planning's (OP's) Expected Development database served as the main basis for the forecast. Additional parcels identified as having a high potential to develop in the future were added to this forecast through use of the Capacity/Value, and Targeted Zone methodologies (see section 4.2.2). The projections also included major roadway reconstruction projects identified by the District's Department of Transportation (DDOT) that have the potential to trigger the stormwater regulations. The projections extend out to 2040 in 5-year increments, which is the same time period and increment that OP currently uses to forecast future development or redevelopment. Projections vary in both rate and spatial distribution for each 5-year increment.
2. **Development/Redevelopment Projections for Parcels that are zoned R1-R4**
Since OP's forecast of development and redevelopment excludes, broadly speaking, parcels that are zoned R1 through R4 (mainly single family homes), a different methodology was used to predict the projections of development or redevelopment of the R1-R4 parcels. These projections are based on DDOE's historic BMP inventory for the years 2007 through 2011. The installation of these BMPs occurred because some development or redevelopment activity on these parcels triggered the old stormwater regulations. It is assumed that if the old regulations were triggered, a similar-type project in the future would trigger the new stormwater regulations. This analysis also assumes that future development patterns would be similar to past development patterns for R1-R4 properties. BMPs in the historic database that are located on parcels zoned for R1 through R4 were selected for this analysis, regardless of the parcel size. Once the historic BMPs on R1-R4 parcels were identified, the total parcel area was calculated from the historic database and an average development/redevelopment rate was calculated based on this area. This rate serves as the Development/Redevelopment Projection for parcels that are zoned R1-R4. These projections do not vary in rate or spatial distribution given the limited amount of data that was available to create the projections.

2. Objective

The development/redevelopment projections for all parcels except those zoned as R1-R4 vary both in time and in space. The development/redevelopment projections for parcels that are zoned as R1-R4 are based on a snapshot in time and, based on the short time frame of the data set (2007-2011), do not vary appreciably in time or in space. A “correlation analysis” between the two projections was done to evaluate the existence of any trends that would allow the R1-R4 projections to be varied in both time and space. In other words, if confirmed through the correlation analysis, two possible trends might be established:

1. If there is a spatial correlation between the two data sets, then the R1-R4 projections could be projected using the same broad spatial patterns as the non R1-R4 projections.
2. If there is a correlation in the implementation rate between the two data sets, then the R1-R4 projections could be projected using the same temporal variations as non R1-R4 projections.

3. Approach

The first step consisted of identifying and mapping the parcels from the two datasets for comparable years. A visual check was undertaken to see if any spatial patterns were noticeable. The second step consisted of calculating the distance between each parcel from the R1-R4 dataset and the nearest non R1-R4 dataset. These distances were sorted and ranked to determine if there was a correlation based on distance. In order to test the accuracy of this test, a random set of R1 through R4 parcels were generated and the same correlation test based on distance to non R1-R4 parcels was applied. The third step consisted of comparing the total annual parcel area of the R1-R4 dataset with the non R1-R4 dataset to see if there was a correlation between the annual development rates of the two datasets. Each step is further explained below.

Step 1: Identify and Map Parcels From the non R1-R4 and the R1-R4 Datasets

Parcel Identification and Mapping Based on the R1-R4 Inventory

The DDOE BMP inventory for 2007-2011 was used to identify R1 through R4 parcels that have one or more BMPs located within the parcel polygon. For each of those parcels, both the parcel area and the BMP drainage area were identified. These parcels were displayed in a GIS map. Note that the DDOE BMP inventory registers BMPs at the beginning of the construction cycle (in other words, this is a pre-construction BMP inventory).

Parcel Identification and Mapping Based on the non R1-R4 Inventory of Recorded Development/Redevelopment

The OP R1-R4 development/redevelopment data for 2008-2012 was used to identify parcels that were developed during that time period. Only parcels that are greater than 5,000 square feet and that include a few other restrictions as explained in item #1 in the background section were included. These parcels were also displayed in a GIS map. Note that these projects are typically registered at the end of the construction cycle. It was assumed that there would be a 1-year lag between when a BMP was recorded in the DDOE inventory and when that same parcel would be recorded by OP.

Maps

The parcels identified using the DDOE R1-R4 inventory and the OP non R1-R4 inventory were mapped to determine if any visual trends exist. The map did not reveal any noticeable spatial patterns between the two datasets, as shown in Figure A2-1.

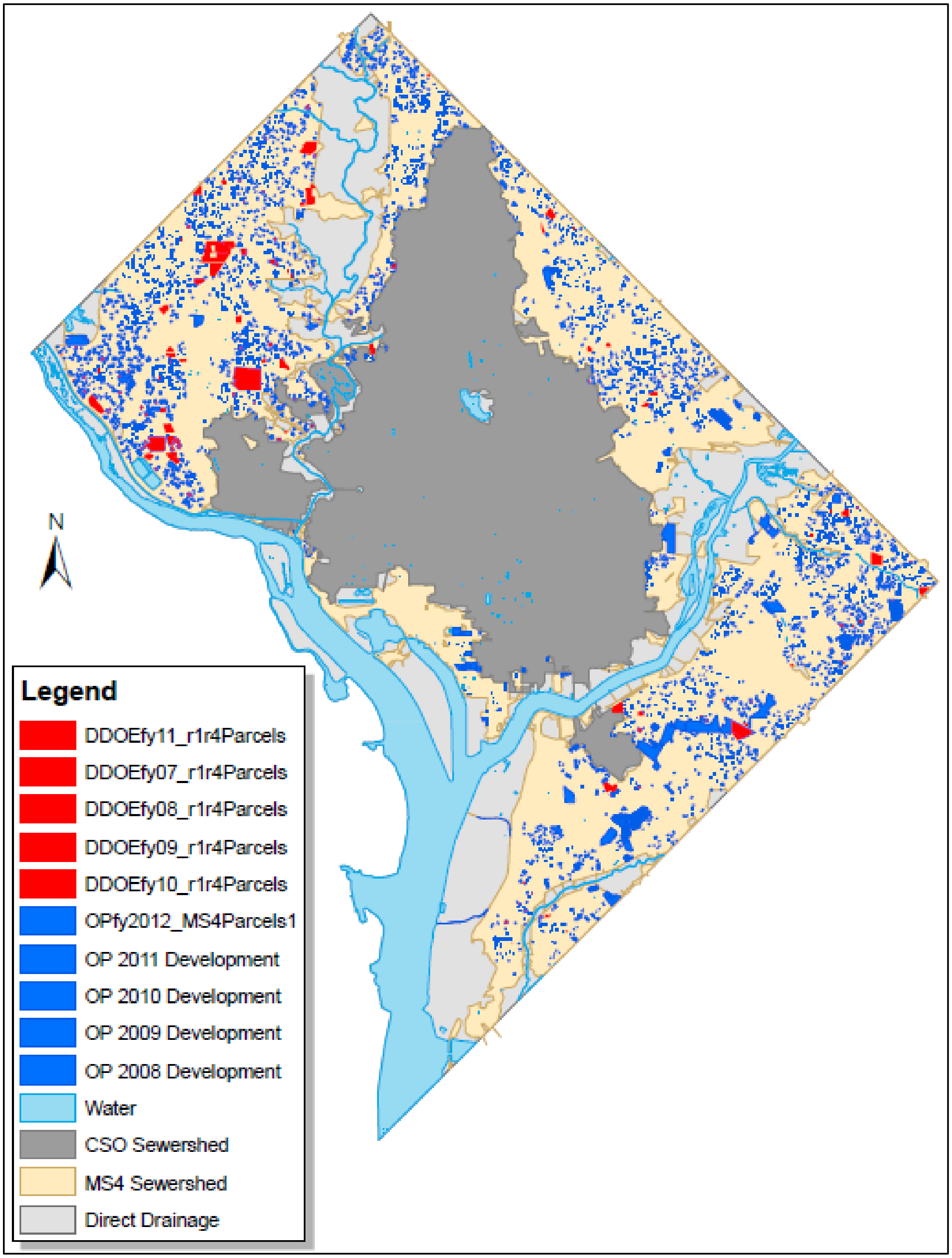

Figure A2-1: Correlation Map of DDOE and OP Inventory of Development/Redevelopment

Step 2: Correlation Analysis Based on Distance

The "near" function was used in ArcGIS to calculate the distance between the DDOE R1-R4 parcels and the nearest OP non R1-R4 parcel. These distances were sorted and ranked to determine if there is a trend in spatial location using a distance correlation. In order to test the accuracy of this test, a random set of R1 through R4 parcels was generated using the Generalized Random Tessellation Stratified (GRTS) sampling technique. In short, parcels were randomly selected while preserving spatial balance across the MS4 area. The same correlation test based on distance was applied to this dataset.

The results from this correlation analysis are shown in figure A2-2 below. The a priori metric to gauge whether a proximity correlation between the DDOE and OP projections existed was based on the fraction of DDOE projects that were located within a 0.5 mile distance of an OP project. If more than 90% of DDOE projects met this criteria, a proximity correlation would have been plausible. This metric was not met. Furthermore, it is apparent that the actual (DDOE) and random projections follow similar 'nearness' trends. That is, the random assignment of spatially uniform R1-R4 development locations resulted in distances from OP parcel development projects that were very similar to the distances calculated for the actual projects. This too signifies that there is no correlation between the development on R1-R4 parcels and the OP projected development.

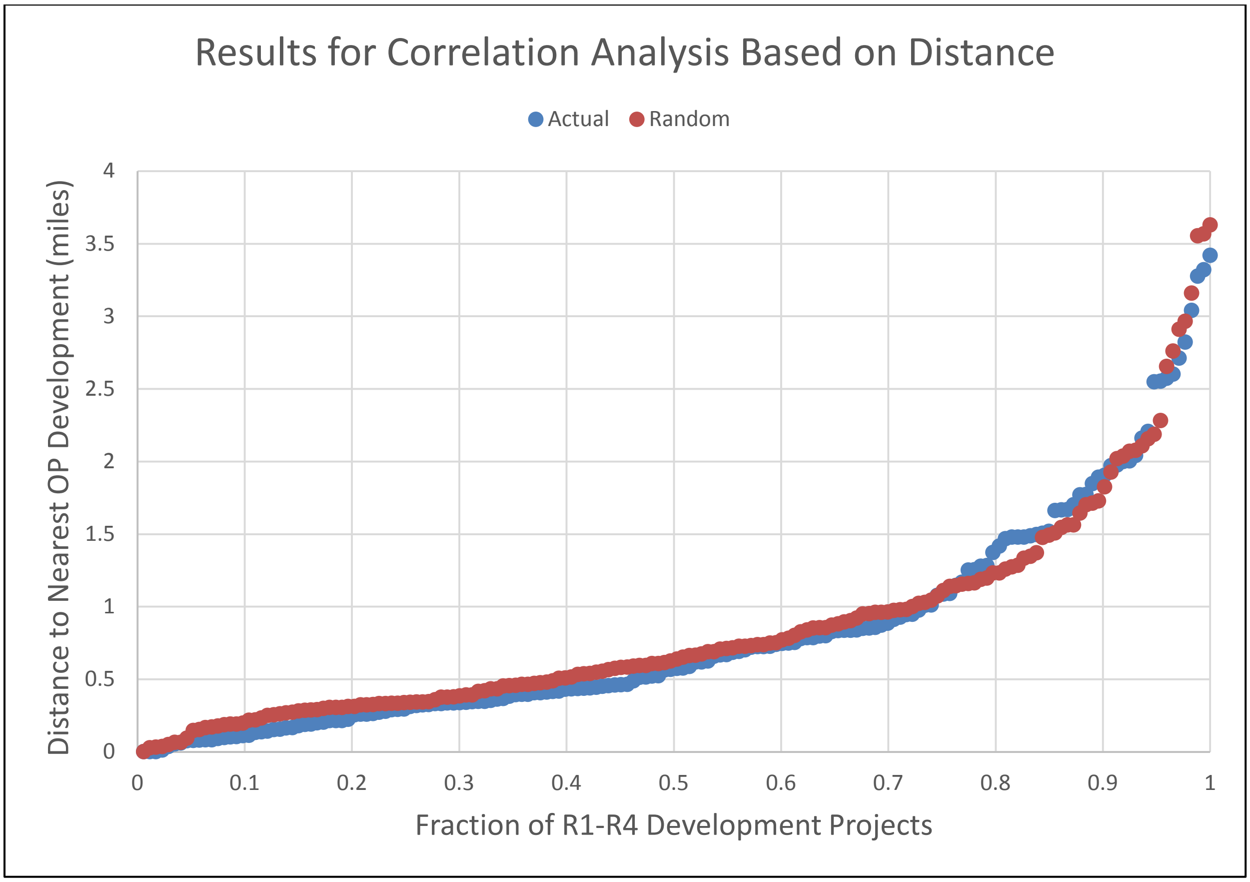

Figure A2-2: Results for Correlation Analysis Based on Distance

Step 3: Correlation Based on Rate of Implementation

The correlation between the annual area of development of the DDOE R1-R4 projections and the OP projections was explored by calculating the annual areas of development (Table A2-1). Note that the DDOE R1-R4 projections can be based both on the BMP drainage area or the parcel area. To avoid making an incorrect assumption on which area is the most accurate representation of the "developed" area, both the drainage area and the parcel area for the R1-R4 projections were tested for correlation with the OP-predicted areas.

Table A2-1: Annual Area of Development				
DDOE R1-R4 Projection			OP Non R1-R4 Projection	
Year	Drainage Area (sq. ft.)	Parcel Area (sq. ft.)	Year	Parcel Area (sq. ft.)
2007	1,722,965	4,662,413	**2008**	2,040,589
2008	5,513,171	4,494,639	**2009**	1,109,955
2009	957,551	1,646,784	**2010**	2,610,947
2010	1,709,112	4,064,941	**2011**	1,358,218
2011	1,125,038	2,591,315	**2012**	1,006,136

Pearson's correlation coefficient between the two dataset was determined for the two types of areas (R1-R4 drainage area vs. non R1-R4 parcel area; and R1-R4 parcel area vs. non R1-R4 parcel area). In both cases, the correlation was negative but not significant (Table A2-2).

Table A2-2: Correlation Summary			
Comparison	Pearson Correlation	p value	Notes
R1-R4 Drainage Area vs non R1-R4 Parcel Area	-0.45	0.201351	correlation not significant
R1-R4 Parcel Area vs non R1-R4 Parcel Area	-0.40	0.234245	correlation not significant

4. Conclusions

Based on the results from the two correlation analyses, there is little, if any, evidence to justify in using OP's future (2015-2040) development projections for non R1-R4 parcels to distribute DDOE's R1-R4 historic projections either spatially or temporally. It is therefore recommended that the annual historic rate of R1-R4 development be applied uniformly across the entire MS4, at a steady rate over time.

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Attachment 3: Determining the Equivalent Area of BMP Implementation from Other Existing Drivers and Programs

This scenario describes the ongoing and future BMP implementation that occurs through existing DC agency funding, grant programs, voluntary implementation, or regulatory drivers other than those from major land disturbances that would trigger the stormwater regulations. Examples include BMP implementation from:

- Various RiverSmart programs
- Other DDOE-funded programs (stream restoration, trash removal, other LID projects)
- University stormwater management or sustainability plans
- Federal agency stormwater management or sustainability plans
- DDOT's green alley program or sustainability plan

The data collected from these programs were reviewed and compiled into a single table with projected rates of implementation by BMP type. Table 5-21 shows the projected annual rate of implementation in the MS4 area, by BMP type, that resulted from this analysis.

Table A3-1: Projected Annual Rate of BMP Implementation in the MS4 Area

BMP Type	Projected Annual Rate of Implementation	Units
Permeable Pavement	2,800	Square Feet
Rain Barrel[9]	667	Count
Standard Bioretention	31,799	Square Feet
Cistern	3,900	Square Feet
Impervious Surface Removal	10,367	Square Feet
Green Roofs	20,499	Square Feet
New Trees	4,150	Count
Undefined (DDOT)	100,108	Square Feet
Schools	3 schools/year @2,500 cubic feet treated	-
Stream Restoration	1,500	Feet

Note that the data collection did not provide the necessary granularity or prioritization to determine the exact location of future BMPs. It is therefore assumed that these BMPs will be installed uniformly across the MS4. It is also further assumed that the retention-based BMPs will be designed to the 1.2 inch standard. Because trees, rain barrels, and schools are expressed as a number of units that retain a pre-determined annual volume of stormwater rather than using an annual projected area of implementation, an equivalent area was calculated for each of these BMPs. This equivalent area was calculated by

[9] Based on page F-57 of DDOE's FY 2015 Proposed Budget and Financial Plan, accessible at http://cfo.dc.gov/node/806572

converting the annual stormwater volume retention provided by rainbarrels, trees, and schools using the following equation.

$$Equivalent\ Drainage\ Area\ (acres) = \#\ Units\ x\ \frac{Retention\ Volume\ Provided\ (acre-ft)}{Unit}\ x\ \frac{1}{EBRU\ \%\ Efficiency}\ x\ \left(\frac{1}{0.9}\ x\ \frac{1}{Runoff\ Coefficient}\ x\ \frac{1}{Precipitation\ (inches)}\ x\ \frac{12\ inches}{foot}\right)$$

Table A3-2 shows the results of the calculation for each individual BMP, and also shows how the aggregate equivalent area is 21 acres/year, assuming that this area provides 1.2 inches retention at 83.5% retention efficiency. This rate was applied to project current BMP implementation into the future.

Table A3-2: Equivalent Area of BMP Implementation From Other Existing Drivers and Programs

BMP Type	Projected Annual Rate of Implementation	Retention Volume Provided (acre-feet)	EBRU efficiency	Average Precipitation (inches)	Average Runoff Coefficient (Rv)	Equivalent Drainage Area (acres/yr)
Permeable Pavement	2,800 square feet/yr	-	-	-	-	0.1
Rain Barrel	667 per year	0.002	0.835	40	0.5203	1.0
Standard Bioretention	31,799 square feet/yr	-	-	-	-	0.7
Cistern	3,900 square feet/yr	-	-	-	-	0.1
Impervious Surface Removal	10,367 square feet/yr	-	-	-	-	0.2
Green Roofs	20,499 square feet/yr	-	-	-	-	0.5
New Trees	4,150 per year	0.005	0.835	40	0.5203	15.9
Undefined (DDOT)	100,108 square feet/yr	-	-	-	-	2.3
Schools	3 schools per year @2,500 cubic feet treated	0.0574	0.835	40	0.5203	0.1
Stream Restoration	1,500 feet/yr	-	-	-	-	-
TOTAL						**21**

Non-retention BMPs will perform at the efficiencies as shown and explained in Appendix F of the Comprehensive Baseline Analysis Report (DDOE, 2015).

Attachment 4: Methodology for Load Reduction Projections Beyond 2040

The load reduction projections can be broken into three timeframes, where each time frame has similar but unique modeling assumptions:

1. 2015-2040 reductions from current BMP implementation (Projected Development and Existing Drivers management).
2. 2041-2127 reductions from continuing BMP implementation until the entire MS4 is projected to be retrofitted.
3. 2128-2154 reductions from the extension of annual average reduction rates projected for 2015-2127 until all WLA are met. Reductions reflect projections of future improvements in stormwater management techniques and technologies.

The major approach and assumptions for each of these categories is described below

2016-2040 Projections

The load reductions are modeled in two separate scenarios which are aggregated to form a load reduction projection for each WLA. The first scenario is the ““Development/ Redevelopment Scenario” and is based on:

1. The Office of Planning (OP) projections (mostly affects non R1-R4 parcels)
2. Projected plans from organizations including DDOT and DC Water (mostly affects the PROW).
3. A historic rate of development estimated by DDOE (for R1-R4 parcels).

The second scenario is the “Other BMP Programs” scenario, which is based on the projection of BMP implementation based on the recent historical rate of voluntary BMP implementation by DDOE and other District agencies (like RiverSmart, Casey Trees tree planting, etc.).

In addition to the reductions credited from the scenarios, a Phosphorus fertilizer legislation ban is expected to begin in 2015, and appropriate reductions from this legislation are counted in the load projections.

The rates of area controlled by BMPs, from 2016 through 2040 in the MS4, are shown in Table A4-1.

Table A4-1: Rates of MS4 Area Controlled by BMPs from 2016 through 2040			
Components	**Description**	**2016-2040 Rate (acre/year)**	**Notes**
Development/ Redevelopment on NonR1-R4 Parcels	High density/large parcel development	104	Approximately 19 acres/yr actually occurs on R1-R4 parcels because permit application sometimes includes multiple R1-R4 parcels. So while this rate is called 'NonR1-R4', there is actually a small R1-R4 component. This is inconsequential for the load reduction projections occurring through 2040, but is necessary in order to distinguish availability of different parcel types after 2040.
Development/ Redevelopment on R1-R4 Parcels	Low density/small parcel development	66	Historic rate of development estimated by DDOE.
Development/ Redevelopment on PROW	Roads and public right of way	16	This rate includes major road reconstruction estimates based on both DCWater and DDOT CIP plans. Note that DDOT's projections of major road reconstruction only extend out to 2020 but the annual rate shown here is based on the time period of 2016-2040. This is inconsequential for the load reduction projections occurring through 2040, but is necessary to understand in order to calculate the PROW rate for the time period after 2040.
Other BMP Programs on R1-R4 Parcels	Low density/small parcel development	11	Consists of 50% tree plantings and all other BMP implementation. It was assumed that the majority of this implementation targets R1-R4 parcels.
Other BMP Programs on PROW	High density/large parcel development	10	Consists of 100% of DDOT voluntary BMP implementation and 50% of tree plantings.
TOTAL		207	

2041-2127 Load Reduction Projections

The rates listed in Table A-9 above were aggregated according to three major categories, including:

1. Non R1-R4
2. R1-R4
3. PROW

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These rates are shown in Table 2 and apply after the year 2040. Any alterations in the rate as compared to the rates shown in Table A4-1 are described in the notes column of Table A4-2.

Table A4-2: Rates of MS4 Area Controlled by BMPs After 2040

Components	2041-beyond Rate (acre/year)	Notes
NonR1-R4	104	Same rate as rate of Development/ Redevelopment on NonR1-R4 Parcels in Table 1 above
R1-R4	77	Sum of the Development/ Redevelopment on R1-R4 Parcels and Other BMP Programs on R1-R4 Parcels rates shown in Table 1 above.
PROW	56	The DDOT roadway reconstruction forecasted to occur between 2016 and 2020 comprises 38% of all high density/large parcel PD development in 2020. Therefore, a revised long-term rate was established based on 38% of the high density/large parcel PD development projections from 2016-2040 (104+16), which equates to an annual average of 46 acres/year. Add to that the 10 acres from Other BMP Programs on PROW shown in Table 1.
TOTAL	236	~30 acres more than 2016-2040 projections because of the PROW projections.

No spatial information was available beyond 2040, thus, it was deemed most appropriate to apply the rates uniformly and without making any geographic assumptions. Each rate is applied to its respective land use category (uniformly across the MS4) until that land use group is completely retrofitted (date of complete retrofit). These dates are projected to be 2084, 2107, and 2127 for NonR1-R4, R1-R4, and PROW, respectively as shown in Table A4-3.

Table A4-3: Summary of MS4 BMP Retrofit Rates from 2016 through 2127

Components	**Area Available in 2016 (acres)**	**Area retrofitted between 2016-2040 (acres)**	**Area Available in 2040 (acres)**	**2040 and beyond Projected Rate of BMP implementation (acre/yr)**	**Date at which area is exhausted (year)**
NonR1-R4	6,692	2,145	4,547	104	2084
R1-R4	7,500	2,378	5,122	77	2107
PROW	5,547	667	4,880	56	2127
TOTAL	19,739	5,190	14549	237	-

2128-2154 Load Reduction Projections

The load reductions in this final segment are calculated based on the average annual reduction observed from 2015-2127. The modeling approach shifts slightly in this time period because the IPMT projects that the entire MS4 will be completely retrofitted in 2127. The MS4 permit language requires that all WLAs

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must have a projected attainment date, thus LimnoTech chose to extend the average annual rate to reflect the assumed technology and management improvements that will be in effect by 2127. The reduction rate is calculated and unique for each WLA.

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Attachment 5: Summary Tables for Baseline and Current Loads, Gaps, and WLA Achievement by TMDL Watershed

1. Anacostia Watershed

Table A5- 1. Anacostia							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	916059	905097	230000	675097	74.59%	2097	

Table A5- 2. Anacostia Lower							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Arsenic	9.7	9.4	3.4	6.0	63.75%	2068	
Chlordane	6.2E-02	6.1E-02	7.8E-03	5.3E-02	87.25%	2130	
DDD	1.9E-02	1.8E-02	8.7E-03	9.5E-03	52.29%	2055	
DDE	8.4E-02	8.0E-02	2.1E-02	5.9E-02	73.75%	2078	
DDT	0.22	0.21	5.7E-02	1.5E-01	72.49%	2077	
Dieldrin	1.8E-03	1.8E-03	3.5E-03	0	-	2014	
Heptachlor Epoxide	6.1E-03	6.0E-03	2.0E-03	4.0E-03	66.73%	2073	
Lead	101	96	219	0	-	2014	
PAH1	4.2	4.1	0.11	4.0	97.44%	2145	
PAH2	26	26	0.64	25	97.51%	2143	
PAH3	17	16	0.41	16	97.46%	2139	
Zinc	765	732	1339	0	-	2014	
TSS	463963	439179	92800	346379	78.87%	2083	
BOD	227331	225614	98435	127179	56.37%	2061	
TN	21006	20457	5172	15285	74.72%	2080	

Table A5- 2. Anacostia Lower

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
TP	2404	2205	509	1696	76.92%	2077	
Trash	24480	8829	24480	8829	36.06%	2017	WLA expressed as lbs to be removed. Percent Reduction Required expressed as % of baseline.

Table A5- 3. Anacostia Upper

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Arsenic	47	47	1.4	45	96.92%	2145	
Chlordane	0.30	0.30	1.4E-02	2.8E-01	95.28%	2143	
DDD	9.1E-02	9.1E-02	5.2E-03	8.6E-02	94.28%	2141	
DDE	0.41	0.40	1.3E-02	3.9E-01	96.85%	2145	
DDT	1.0	1.0	3.4E-02	1.0	96.72%	2145	
Dieldrin	8.8E-03	8.8E-03	8.2E-03	6.1E-04	6.93%	2019	
Heptachlor Epoxide	2.9E-02	2.9E-02	4.1E-03	2.5E-02	85.76%	2129	
Lead	486	483	388	95	19.75%	2036	
PAH1	20	20	0.19	20	99.03%	2148	
PAH2	127	126	1.1	125	99.09%	2148	
PAH3	82	81	0.73	80	99.10%	2148	
Zinc	3685	3665	2385	1279	34.91%	2051	
TSS	2234484	2220940	169200	2051740	92.38%	2139	
BOD	1094845	1090988	181841	909147	83.33%	2124	
TN	101166	100662	10493	90169	89.58%	2135	
TP	11579	11017	966	10051	91.23%	2131	

Table A5- 3. Anacostia Upper							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Trash	83868	8048	83868	8048	9.06%	2017	WLA expressed as lbs to be removed. Percent Reduction Required expressed as % of baseline.

Table A5- 4. Chesapeake Bay TMDL Segment ANATF_DC							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
TN	101285	100692	41517	59175	58.77%	2071	
TP	11597	11014	6498	4516	41.00%	2049	
TSS	2248361	2209237	1682470	526767	23.84%	2035	

Table A5- 5. Chesapeake Bay TMDL Segment ANATF_MD							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
TN	33706	33676	10424	23252	69.05%	2092	
TP	3858	3675	1444	2231	60.70%	2078	
TSS	744473	743461	314421	429040	57.71%	2078	

Table A5- 6. Fort Chaplin Tributary							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	13082	12981	1.3E-03	12981	99.99999%	2149	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly
Arsenic	0.81	0.80	0.38	0.42	52.69%	2081	
Copper	28	28	18	9.3	33.67%	2062	
Lead	8.4	8.3	7.7	0.64	7.73%	2034	
Zinc	64	63	135	0	-	2014	

Table A5- 7. Fort Davis Tributary							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	6254	6194	8.2E-04	6194	99.99%	2148	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly
Arsenic	0.39	0.38	0.10	0.28	73.92%	2103	
Copper	13	13	4.7	8.4	64.06%	2092	
Lead	4.0	4.0	2.0	2.0	50.82%	2078	

Table A5- 7. Fort Davis Tributary							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Zinc	30	30	42	0	-	2014	

Table A5- 8. Fort Dupont Tributary							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	5276	5265	2.3E-03	5265	99.99%	2151	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly.
Arsenic	0.33	0.33	0.17	0.16	47.81%	2073	
Lead	3.4	3.4	3.6	0	-	2014	

Table A5- 9. Fort Stanton Tributary

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
E. coli	3811	3791	0	3791	99.99%	2152	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly
Arsenic	0.24	0.23	0.05	0.18	78.69%	2114	
Chlordane	1.5E-03	1.5E-03	2.0E-04	1.3E-03	86.66%	2133	
Copper	8.1	8.1	2.5	5.6	69.21%	2093	
DDD	4.6E-04	4.6E-04	9.0E-05	3.7E-04	80.31%	2119	
DDE	2.0E-03	2.0E-03	1.0E-04	1.9E-03	95.06%	2145	
DDT	5.2E-03	5.2E-03	1.5E-04	5.1E-03	97.12%	2148	
Dieldrin	4.4E-05	4.4E-05	2.3E-05	2.1E-05	48.00%	2066	
Heptachlor Epoxide	1.5E-04	1.4E-04	2.0E-05	1.2E-04	86.03%	2130	
Lead	2.4	2.4	1.1	1.4	56.74%	2076	
PAH1	0.10	0.10	0.08	2.2E-02	22.34%	2039	
PAH2	0.64	0.63	9.0E-03	0.63	98.58%	2150	
PAH3	0.41	0.41	6.0E-03	0.40	98.53%	2149	
Zinc	19	18	91	0	-	2014	

Table A5- 10. Hickey Run							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	99979	99697	0	99697	99.99%	2150	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly
Chlordane	3.9E-02	3.9E-02	1.4E-02	2.5E-02	63.96%	2073	
DDE	0.05	0.05	0.0	4.6E-02	87.05%	2132	
PAH1	2.6	2.6	3.9	0	-	2014	
PAH2	16.7	16.6	0.47	16.2	97.18%	2146	
PAH3	10.8	10.7	0.30	10.4	97.20%	2146	

Table A5- 11. Kingman Lake							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Arsenic	2.2	2.2	4.0E-02	2.2	98.20%	2147	
Chlordane	1.4E-02	1.4E-02	1.8E-04	1.4E-02	98.74%	2148	
DDT	4.9E-02	4.9E-02	7.8E-03	4.1E-02	84.13%	2128	
Lead	23	23	4.9	18	78.65%	2093	
PAH1	0.95	0.95	0.12	0.83	87.33%	2133	
PAH2	6.0	6.0	7.1	0	-	2014	
PAH3	3.9	3.8	0.45	3.4	88.27%	2133	

Table A5- 12. Lower Beaverdam Creek							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
TSS	959	943	1200	0	-	2014	
BOD	470	462	403	59	12.75%	2016	
TN	43	43	45	0	-	2014	
TP	5.0	4.8	6.0	0	-	2014	

Table A5- 13. Nash Run							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Arsenic	2.1	2.1	0.9	1.2	58.87%	2079	
Chlordane	1.3E-02	1.3E-02	3.2E-03	1.0E-02	76.06%	2104	
Dieldrin	4.0E-04	3.9E-04	3.3E-04	6.6E-05	16.62%	2029	
Heptachlor Epoxide	1.3E-03	1.3E-03	3.1E-04	9.9E-04	76.19%	2104	
Lead	22	22	20	2.0	9.11%	2026	
PAH1	0.90	0.90	1.6	0	-	2014	
PAH2	5.7	5.7	0.19	5.5	96.60%	2145	
PAH3	3.7	3.6	0.12	3.5	96.62%	2145	

Table A5- 14. Northwest Branch							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
TSS	585312	582673	52400	530273	91.01%	2137	
BOD	286790	285817	14421	271396	94.95%	2142	
TN	26500	26394	1955	24439	92.59%	2139	

Table A5- 14. Northwest Branch

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
TP	3033	2880	162	2718	94.38%	2134	

Table A5- 15. Pope Branch

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
E. coli	14984	14892	1.7E-03	14892	99.99%	2149	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly
Chlordane	5.9E-03	5.9E-03	1.7E-03	4.2E-03	71.13%	2098	
DDE	8.0E-03	8.0E-03	1.6E-03	6.4E-03	79.89%	2113	
Heptachlor Epoxide	5.8E-04	5.7E-04	1.9E-04	3.8E-04	66.67%	2092	
Lead	9.6	9.5	10.8	0	-	2014	
PAH1	0.40	0.39	0.80	0	-	2014	
PAH2	2.5	2.5	0.09	2.40	96.27%	2144	
PAH3	1.6	1.6	0.06	1.54	96.32%	2144	

Table A5- 16. Texas Avenue Tributary							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	6684	6620	1.4E-03	6620	99.99%	2149	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly
Arsenic	0.41	0.41	0.40	9.9E-03	2.42%	2016	
Chlordane	2.6E-03	2.6E-03	1.3E-03	1.3E-03	50.40%	2072	
Copper	14	14	20	0	-	2014	
DDD	8.1E-04	8.0E-04	7.0E-03	0	-	2014	
DDE	3.6E-03	3.5E-03	1.2E-03	2.3E-03	66.07%	2090	
DDT	9.2E-03	9.1E-03	4.0E-02	0	-	2014	
Dieldrin	7.8E-05	7.7E-05	1.7E-04	0	-	2014	
Heptachlor Epoxide	2.6E-04	2.5E-04	1.4E-04	1.1E-04	44.78%	2066	
Lead	4.3	4.2	8.3	0	-	2014	
PAH1	0.18	0.18	0.61	0	-	2014	
PAH2	1.1	1.1	7.1E-02	1.0	93.59%	2141	
PAH3	0.72	0.71	4.5E-02	0.67	93.69%	2141	
Zinc	32	32	138	0	-	2014	

Table A5- 17. Watts Branch							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
TSS	333496	330338	48200	282138	85.41%	2129	
BOD	163405	162865	14252	148613	91.25%	2137	
TN	15099	15004	1731	13273	88.46%	2133	

Table A5- 17. Watts Branch							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
TP	1728	1635	248	1387	84.83%	2111	

Table A5- 18. Watts Branch - Lower							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Chlordane	1.1E-02	1.1E-02	3.7E-03	7.3E-03	66.50%	2076	
Dieldrin	3.3E-04	3.3E-04	3.7E-04	0	-	2014	
TSS	82517	82340	11200	71140	86.40%	2131	

Table A5- 19. Watts Branch - Upper							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Chlordane	3.4E-02	3.3E-02	9.6E-03	2.4E-02	71.32%	2091	
Dieldrin	9.9E-04	9.9E-04	9.5E-04	4.4E-05	4.48%	2017	
TSS	250979	247998	29600	218398	88.06%	2122	

2. Potomac Watershed

Table A5- 20. Potomac Lower

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
E. coli	383104	381680	265000	116680	30.57%	2046	

Table A5- 21. Potomac Middle

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
E. coli	102822	102508	12400	90108	87.90%	2133	

Table A5- 22. Potomac Upper

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
E. coli	268779	267273	235000	32273	12.08%	2037	

Table A5- 23. Chesapeake Bay TMDL Segment POTTF_DC

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
TN	127818	127345	39427	87918	69.04%	2090	
TP	14709	13933	2975	10958	78.65%	2099	
TSS	2153124	1968592	3843848	0	-	2014	

Table A5- 24. Chesapeake Bay TMDL Segment POTTF_MD

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
TN	15716	15700	15019	681	4.34%	2023	
TP	1811	1728	536	1192	68.98%	2092	
TSS	228866	228558	363762	0	-	2014	

Table A5- 25. Battery Kemble Creek

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
E. coli	8410	8377	70	8306	99.16%	2148	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly.
Lead	5.4	5.4	3.6	1.7	32.21%	2059	

Table A5- 26. C&O Canal

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
E. coli	43788	43434	96	43338	99.78%	2148	E. coli translation appears to be done incorrectly.

Table A5- 27. Dalecarlia Tributary							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Dieldrin	1.1E-03	1.1E-03	4.0E-04	7.4E-04	65.07%	2092	
E. coli	98187	97675	401	97274	99.59%	2148	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly.
Heptachlor Epoxide	3.8E-03	3.8E-03	3.5E-04	3.4E-03	90.80%	2137	

Table A5- 28. Foundry Branch							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Arsenic	0.69	0.68	0.17	0.52	75.51%	2097	
Copper	24	23	10	13	55.98%	2071	
E. Coli	11089	11048	69	10979	99.38%	2148	Original fecal coliform WLA appears to be calculated incorrectly. E. coli translation appears to be done incorrectly.
Lead	7.1	7.1	3.8	3.2	45.86%	2061	
Zinc	45	45	77	0	-	2014	

Table A5- 29. Oxon Run							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Dieldrin	2.3E-03	2.3E-03	7.3E-04	1.6E-03	68.39%	2090	
E. coli	198920	197668	9520	188148	95.18%	2146	E. coli translation appears to be done incorrectly.
Lead	127	127	23	104	82.06%	2126	

Table A5- 30. Tidal Basin							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	25703	25669	55300	0	-	2014	

Table A5- 31. Washington Ship Channel							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
E. coli	65337	65070	183000	0	-	2014	
TP	997	971	977	0	-	2014	

3. Rock Creek Watershed

Table A5- 32. Rock Creek Lower

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Copper	226	225	142	83	36.75%	2060	
Lead	68	68	9	59	86.43%	2131	
Mercury	0.81	0.81	0.05	0.76	93.44%	2140	
Zinc	435	432	334	99	22.85%	2047	
E. coli	106419	105811	10100	95711	90.45%	2136	

Table A5- 33. Rock Creek Upper

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Copper	657	654	148	506	77.39%	2105	
Lead	198	197	10	187	95.15%	2143	
Mercury	2.4	2.3	0.05	2.3	97.74%	2146	
Zinc	1263	1257	347	911	72.42%	2100	
E. coli	309154	307668	28700	278968	90.67%	2137	

Table A5- 34. Broad Branch

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Chlordane	3.6E-02	3.6E-02	2.8E-03	3.3E-02	92.23%	2139	
DDD	1.1E-02	1.1E-02	1.4E-03	9.7E-03	87.51%	2132	
DDE	4.9E-02	4.9E-02	2.4E-03	4.7E-02	95.05%	2142	
DDT	0.13	0.13	2.5E-03	0.12	98.05%	2146	
Dieldrin	1.1E-03	1.1E-03	3.4E-04	7.3E-04	68.29%	2097	

Table A5- 34. Broad Branch							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Heptachlor Epoxide	3.5E-03	3.5E-03	2.8E-04	3.2E-03	91.93%	2138	
PAH1	2.4	2.4	1.3	1.1	46.86%	2075	
PAH2	15.4	15.3	0.15	15.2	99.01%	2148	
PAH3	9.9	9.9	0.1	9.8	99.02%	2148	

Table A5- 35. Dumbarton Oaks							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Chlordane	6.9E-04	6.9E-04	6.2E-05	6.3E-04	91.04%	2153	
Dieldrin	2.0E-05	2.0E-05	5.7E-06	1.5E-05	72.38%	2115	
Heptachlor Epoxide	6.8E-05	6.8E-05	5.5E-06	6.2E-05	91.91%	2154	

Table A5- 36. Fenwick Branch							
Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
DDT	2.1E-02	2.1E-02	4.5E-04	2.1E-02	97.88%	2144	
Dieldrin	1.8E-04	1.8E-04	6.8E-05	1.1E-04	62.23%	2089	
Heptachlor Epoxide	6.0E-04	5.9E-04	5.4E-05	5.4E-04	90.96%	2135	

Table A5- 37. Klingle Valley Run							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Dieldrin	1.5E-04	1.5E-04	1.3E-04	2.2E-05	14.32%	2041	
Heptachlor Epoxide	5.0E-04	5.0E-04	1.2E-04	3.8E-04	75.42%	2102	

Table A5- 38. Luzon Branch							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Chlordane	2.8E-02	2.8E-02	4.8E-04	2.7E-02	98.26%	2147	
Dieldrin	8.2E-04	8.1E-04	4.7E-05	7.7E-04	94.27%	2142	
Heptachlor Epoxide	2.7E-03	2.7E-03	4.3E-05	2.6E-03	98.37%	2147	

Table A5- 39. Melvin Hazen Valley Branch							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Dieldrin	1.2E-04	1.2E-04	5.2E-05	7.1E-05	57.90%	2080	

Table A5- 40. Normanstone Creek

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Chlordane	6.8E-03	6.8E-03	7.8E-04	6.0E-03	88.54%	2133	
DDD	2.1E-03	2.1E-03	3.3E-04	1.7E-03	83.87%	2124	
DDE	9.2E-03	9.1E-03	6.5E-04	8.5E-03	92.94%	2139	
DDT	2.4E-02	2.4E-02	6.5E-04	2.3E-02	97.24%	2144	
Dieldrin	2.0E-04	2.0E-04	8.0E-05	1.2E-04	60.00%	2086	
Heptachlor Epoxide	6.6E-04	6.6E-04	7.3E-05	5.9E-04	89.02%	2134	
PAH1	0.46	0.45	0.35	0.10	22.06%	2048	
PAH2	2.9	2.9	4.2E-02	2.82	98.52%	2146	
PAH3	1.9	1.8	2.7E-02	1.82	98.53%	2146	

Table A5- 41. Pinehurst Branch

Pollutant	Baseline Load (lbs/yr; E. coli in billion MPN/yr)	Current Load (lbs/yr; E. coli in billion MPN/yr)	WLA (lbs/yr; E. coli in billion MPN/yr)	Gap (lbs/yr; E. coli in billion MPN/yr)	Percent Reduction Required	Projected WLA Attainment Date	Notes
Dieldrin	2.8E-04	2.8E-04	1.0E-04	1.8E-04	64.35%	2094	
Heptachlor Epoxide	9.2E-04	9.2E-04	7.6E-05	8.5E-04	91.79%	2138	

Table A5- 42. Piney Branch							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Chlordane	1.7E-03	1.7E-03	5.4E-05	1.6E-03	96.80%	2143	
Dieldrin	5.0E-05	5.0E-05	8.2E-06	4.2E-05	83.63%	2119	
Heptachlor Epoxide	1.6E-04	1.6E-04	8.3E-06	1.6E-04	94.92%	2141	
Lead	2.7	2.7	0.2	2.57	93.81%	2139	

Table A5- 43. Portal Branch							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	Notes
Dieldrin	6.9E-05	6.8E-05	2.5E-05	4.3E-05	62.89%	2092	
Heptachlor Epoxide	2.3E-04	2.3E-04	2.0E-05	2.1E-04	91.15%	2139	

Table A5- 44. Soapstone Creek							
Pollutant	**Baseline Load (lbs/yr; E. coli in billion MPN/yr)**	**Current Load (lbs/yr; E. coli in billion MPN/yr)**	**WLA (lbs/yr; E. coli in billion MPN/yr)**	**Gap (lbs/yr; E. coli in billion MPN/yr)**	**Percent Reduction Required**	**Projected WLA Attainment Date**	**Notes**
Chlordane	1.9E-02	1.9E-02	2.0E-03	1.7E-02	89.54%	2136	
Dieldrin	5.6E-04	5.5E-04	1.7E-04	3.8E-04	69.29%	2095	
Heptachlor Epoxide	1.8E-03	1.8E-03	1.7E-04	1.7E-03	90.76%	2137	