City of Salem

ROANOKE RIVER SEDIMENT TMDL ACTION PLAN

(2013-2018 MS4 General Permit)

A Plan for Achieving Sediment Load Reductions to Meet Salem's TMDL Waste Load Allocation

June 30, 2015

This document addresses Section 1, Part B of the General Virginia Pollution Discharge Elimination System (VPDES) Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4). This document serves as a City-specific Total Maximum Daily Load (TMDL) Action Plan to identify the best management practices and other interim milestone activities to be implemented to address the sediment waste load allocation (WLA) assigned to the City's regulated MS4 area in the *"Benthic TMDL Development for the Roanoke River, Virginia"* approved by the State Water Control Board on September 7, 2006.

EXECUTIVE SUMMARY

The City of Salem is authorized to discharge stormwater from its municipal separate storm sewer system (MS4) under the Virginia Pollutant Discharge Elimination System (VPDES) General Permit for Discharge of Stormwater from Small MS4s (MS4 General Permit). To maintain permit compliance, the City implements an MS4 Program Plan that includes best management practices (BMPs) to address six minimum control measures (MCMs) and special conditions for the "*Benthic Total Maximum Daily Load (TMDL) Development for the Roanoke River, Virginia*." The Benthic TMDL for the Roanoke River, approved by the State Water Control Board on September 7, 2006, was required to be developed under the authority of the Clean Water Act (CWA) in response to the river's listing as impaired by the Department of Environmental Quality (DEQ) for not meeting water quality standards.

The Environmental Protection Agency (EPA) describes a TMDL as a "pollution diet" that identifies the maximum amount of a pollutant the waterway can receive and still meet water quality standards. In the case of the Roanoke River TMDL, sediment was identified as a pollutant of concern and MS4s within the watershed of the impaired segment of the river were assigned a waste load allocation (WLA). A WLA determines the required reduction in sediment loadings from the MS4s to meet water quality standards and is represented as a 69.5% reduction in sediment loads from urban, agricultural, and transitional land-based sources and instream erosion. The MS4 General Permit serves as the regulatory mechanism for addressing the load reductions described in the TMDL, predominantly through the requirement of a TMDL Action Plan.

Consistent with an approach taken by numerous MS4s throughout the country to achieve significant sediment load reductions, this Action Plan identifies street sweeping as the primary practice to achieve the water quality standard described in the TMDL. Although the City has performed street sweeping efforts in the past, those efforts have not been carried out under a structured program. Sediment reductions have been achieved; however, not maximized as with a targeted street sweeping program. This Action Plan addresses each of the special conditions described in the MS4 General Permit and defines scheduled steps that will be taken to achieve the sediment load reduction target through:

- A defined Street Sweeping Program that includes collected material sampling, documentation and tracking of areas swept and targeting of areas for sweeping, and
- Implementation of the City's MS4 Program Plan.

Implementation of this Action Plan is consistent with the provisions of an iterative MS4 Program, which constitutes compliance with the MS4 General Permit standard of reducing pollutants to the maximum extent practicable (MEP).

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Acronyms

BMP	Best Management Practice
CWA	Clean Water Act
DCR	Department of Conservation and Recreation
DEQ	Department of Environmental Quality
EPA	Environmental Protection Agency
ESC	Erosion and Sediment Control
GIS	Geographic Information System
GP	General Permit
HSG	Hydrological Soil Group
IDDE	Illicit Discharge Detection and Elimination
IP	Implementation Plan
LA	Load Allocation
MCM	Minimum Control Measure
MEP	Maximum Extent Practicable
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
MS4 GP	General Permit for Discharge of Stormwater from Small MS4s
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
SWCB	State Water Control Board
SWM	Stormwater Management
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
VAC	Virginia Administrative Code
VPDES	Virginia Pollutant Discharge Elimination System
VSMP	Virginia Stormwater Management Program
WLA	Wasteload Allocation
WTM	Watershed Treatment Model

1.0 INTRODUCTION AND PURPOSE

> "The Roanoke River flows through southcentral Virginia before crossing the North Carolina state line and discharging into the Albemarle Sound in North Carolina."
>
> - *Benthic TMDL Development for the Roanoke River, Virginia*

Mandated by Congress under the Clean Water Act (CWA), the National Pollutant Discharge Elimination System (NPDES) storm water program includes the Municipal Separate Storm Sewer System (MS4), Construction, and Industrial General Permits. In Virginia the NPDES Program is administered by the Department of Environmental Quality (DEQ) through the Virginia Stormwater Management Program (VSMP) and the Virginia Pollutant Discharge Elimination System (VPDES). The City of Salem, Virginia, is authorized to discharge stormwater from its MS4 under the *VPDES General Permit for Discharge of Stormwater from Small MS4s* (MS4 GP). As part of the permit authorization, Salem developed and implements an MS4 Program Plan that includes best management practices (BMPs) to address the six minimum control measures (MCMs) and special conditions for applicable total maximum daily loads (TMDLs) outlined in the MS4 GP. Implementation of these BMPs is consistent with the provisions of an iterative MS4 Program, which constitutes compliance with the standard of reducing pollutants to the "maximum extent practicable," or MEP.

1.1 Roanoke River TMDL

A TMDL is defined as the total amount of a given pollutant that a waterbody can assimilate and still meet water quality standards. Typically, TMDLs are represented numerically in three main components: Waste Load Allocations (WLAs), a Load Allocation (LA), and a Margin of Safety. A WLA is the allocated amount of pollutant from areas discharging through a pipe or other conveyance considered a point source. Point sources include sewage treatment plants, industrial facilities and storm sewer systems. In contrast, an LA is the amount of pollutant from existing non-point sources and natural background such as farm runoff and atmospheric deposition. An explicit margin of safety of 10% of the calculated TMDL pollutant load is used to reflect uncertainty in representative modeling computations. In this context, , MS4's are considered to be a point source discharge and are therefore assigned a WLA representing the annual loading of the pollutant of concern (POC) that can be discharged from its regulated MS4 area.

The Virginia DEQ listed segments of the Roanoke River on their biennial 303(d) list from 1996 to 2014 due to benthic impairments. Subsequent to the initial listing, the State Water Control Board (SWCB) approved a TMDL for Roanoke River, entitled *Benthic TMDL for Roanoke River, Virginia*, on September 7, 2006. This document is referred to herein as the Roanoke River TMDL. As part of the approved TMDL, Salem's permitted MS4 (VAR040010) was assigned a WLA for sediment discharge to the Roanoke River.

The Roanoke River TMDL assigns a WLA for permitted MS4s within the watershed, which represents an annual sediment load resulting from a percent reduction of the existing and projected future load from the MS4 to meet water quality standards for the watershed. The WLA represents a percent reduction from Salem's MS4 load. Specifically, the WLA requires a 69.5% reduction of sediment, the pollutant of concern, across specified land use types in the City's MS4 regulated area.

1.2 TMDL Special Conditions

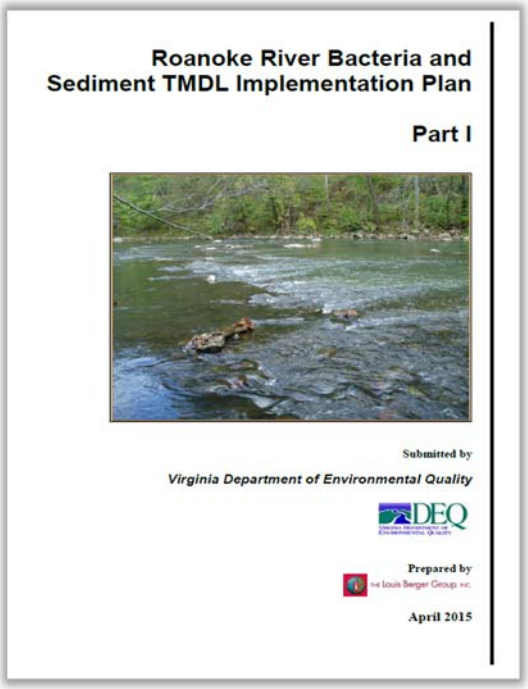
The special conditions of the MS4 GP are triggered where a permittee has been assigned a WLA under the TMDL. Since the Roanoke River TMDL assigned a WLA to Salem's MS4, the following special conditions are required to be addressed:

- ✓ Develop and maintain list of legal authorities applicable to reducing POC discharges from the MS4.
- ✓ Identify and maintain an updated list of any management practices, control techniques and system design and engineering methods, beyond those required per the MCMs, implemented as part of the MS4 program and applicable to the reduction of the POC from the MS4.
- ✓ Enhance the MS4 program's public education and outreach and employee training programs to promote methods to eliminate or reduce the discharge of the POC from the MS4.
- ✓ Conduct an assessment of facilities for significant sources of the POC.
- ✓ Develop and maintain a "TMDL Action Plan" using an adaptive iterative approach that identifies best management practices (BMPs) that reduce POC discharges from the MS4.
  - o The Action Plan may incorporate BMPs identified in the Upper Roanoke River TMDL Implementation Plan (see Section 1.3) or
  - o BMPs of equivalent design and efficiency provided that the rationale for any substituted BMP is provided, and the substituted BMP is consistent with the assumptions and requirements of the TMDL WLA.
- ✓ Develop and implement a method to assess the TMDL Action Plan for effectiveness in the reduction of the POC using water quality monitoring results or modeling tools.

Salem submits reporting on the implementation of the MS4 program annually to the Virginia DEQ. The TMDL Action Plan shall be submitted with the 2015 Annual Report and in subsequent years when any significant modifications occur. Implementation and measures of effectiveness will be reported annually, as required by the City's program Plan.

1.3 Roanoke River Bacteria and Sediment TMDL Implementation Plan

Following SWCB approval of a TMDL, various stakeholders may create an Implementation Plan (IP). Although such plans are alluded to in the Federal CWA legislation, they are not a specific requirement. However, such IPs are a state requirement through Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act. The Draft *Roanoke River Bacteria and Sediment TMDL Implementation Plan*, referred to herein as the Draft IP, was developed "to reduce bacteria and sediment to the levels stated in the TMDLs and to restore the waterbodies to conditions that support the primary contact recreation use and attain the aquatic life use standard."



In regards the City of Salem, the Draft IP includes sediment reductions to be achieved through street sweeping and continued implementation of the City's stormwater management program. According to the Draft IP, the City estimated significant sediment reductions in 2013 (533 tons) and plans to expand the City's street sweeping program to address the TMDL. The Draft IP projects that the expansion to Salem's street sweeping program would amount to an annual net increase of approximately 270 tons of sediment (see Table 1).

Table 1: Estimated load reductions achieved by street sweeping programs in the TMDL watershed (from Table 5-11, Draft IP). * Estimated with ArcGIS.

Municipality	Existing Program		Proposed Program		
	Miles Swept Annually	Annual Sediment Reduction (tons)	Additional Miles Swept Annually	Annual Additional Sediment Reduction (tons)	Total Annual Sediment Reduction
City of Roanoke	10,763	9,226	2,526	2,165	11,391
City of Salem	2,115*	533	1,058*	267	800
County of Roanoke	-	-	5,092	2,824	2,824

2.0 MS4 PROGRAM ASSESSMENT


City of Salem

Municipal Separate Storm Sewer System
Program Plan & Annual Report
For
General Permit No. VAR040010
And
Annual Reporting through
July 1, 2013 through June 30, 2014

This plan and annual report is submitted in accordance with 9VAC25-890-30 and 9VAC25-890-40 as part of registration statement for permit coverage to discharge stormwater to surface waters of the Commonwealth of Virginia consistent with the VAR04 General Permit, effective July 1, 2013.

Submitted: September 30, 2014

The City maintains compliance with the MS4 GP through implementation of BMPs defined in the *City of Salem MS4 Program Plan*. A majority of the program BMPs can be considered nonstructural that, in contrast to structural BMPs such as a retention pond, capture pollutants after they have washed off the ground surface and been conveyed to the pond through stormwater runoff. Nonstructural BMPs can be considered as "source controls" whereas the pollutant is collected from the ground surface prior to exposure to precipitation that would convey the pollutant downstream. Source controls are typically performed at some defined frequency to minimize pollutant build-up and downstream wash-off during a rainfall event. Examples of nonstructural BMPs include community education programs, staff training, good housekeeping and pollution prevention procedures, catch basin cleanout and street sweeping.

There is limited data available for quantifying the pollutant removal efficiencies of nonstructural BMPs. However, the limited research indicates significant reductions are achieved with a higher degree of cost effectiveness than structural practices. Removal estimates for total suspended solids (TSS) are estimated to range from 30 – 70%.

Consistent with the special conditions described in Section 1.2, the following sub-sections characterize Salem's existing MS4 program in context of the Roanoke River TMDL pollutant of concern, sediment.

2.1 Legal Authority Applicable to Reductions of Sediment Loadings

The City's authority to reduce sediment discharges into the MS4 range from applicable ordinances in the City Code, implementation of the MS4 Program in compliance to the MS4 General Permit and enforcement of the construction general permit as a Virginia Stormwater Management Program authority. The following subsections address the following MS4 GP special condition:

- ✓ *"Develop and maintain a list of its legal authorities such as ordinances, state and other permits, orders, specific contract language, and inter-jurisdictional agreements applicable to reducing the pollutant identified in each applicable WLA."* [Section I(B)(2)(a)]

2.1.1 Applicable City Code

Specific City Codes that are applicable to the reduction of sediment discharges from the City's MS4 include:

- Part II, Chapter 106, Article IV, Section 400.3 (Final Site Plan) – As a development standard, an Erosion and Sediment Control (ESC) plan is required for land disturbance exceeding 5,000 square feet. It is noted the disturbance threshold is lower than the minimum disturbance threshold required by state laws and regulations. Implementation of ESC plans reduces sediment discharge from construction sites.
- Part II, Chapter 30, Article III (Erosion and Sediment Control) – Establishes the minimum standards for ESC plan development, implementation and enforcement consistent with consistent with the Virginia Erosion and Sediment Control Law (§62.1-44.2 et. seq.), the Virginia Erosion and Sediment Control Regulations (9VAC25-840 et. seq.), the Virginia Erosion and Sediment Control Certification Regulations (4VAC25-850 et. seq.).
- Part II, Chapter 78, Article IV, Section 601 (Flooding) – Land within a floodplain overlay district may not be developed when an increase in erosion could occur, therefore potentially reducing future sediment discharge to surface waters at these locations.
- Part II, Chapter 30, Article IV (Stormwater Management) – Establishes a local ordinance consistent with the Virginia Stormwater Management Act (§62.1-44.15:24 et. seq.), and the VSMP Permit Regulations (9VAC25-870 et. seq.). The City's threshold for requirement of a stormwater management plan is lower than the threshold established in the state's stormwater management laws and regulations. Implementation of the ordinance requires the installation of stormwater facilities for development that provide sediment reduction post-construction. The ordinance also provides for inspections and maintenance of the facilities.
- Part II, Chapter 30, Article V (Illicit Discharges) – Establishes a prohibition of non-stormwater discharges to the storm sewer.

2.1.2 MS4 General Permit Minimum Control Measures

The City maintains compliance with the MS4 GP through implementation of their MS4 Program that addresses the Minimum Control Measures (MCMs) outlined in the permit. Inherently, most are applicable to addressing reduction or elimination of sediment. Applicability is summarized as:

- ✓ MCM 1: Salem has incorporated information regarding TMDL POCs into the relevant message of the high-priority water quality issue #1 in the City's Public Education and Outreach Plan (PEOP). As such, public education and outreach incorporates sediment concerns related to water quality in outreach to the general public.
- ✓ MCM 3: Salem conducts dry-weather outfall screenings for non-stormwater discharges, including sediment, and implements written procedures for detecting and eliminating

identified discharges. Salem has also conducted a city-wide assessment to identify potential sources of sediment. Where applicable per the permit, stormwater pollution prevention plans (SWPPPs) will be developed to address potential pollutant discharges, including discharges of sediment. Salem also disseminates information to their public for the reporting of illicit discharges. A prohibition of illicit discharges in the City is established through the municipal code.

- ✓ MCM 4: Regulated land disturbance projects in the City are required to be consistent with the City's ESC and SWM Ordinances, which require approved plans that minimize sediment discharge from construction activity and post-construction. Inspections are required to be performed during construction activity and on any post-construction facilities built to address stormwater management.
- ✓ MCM5: Salem's ESC and SWM programs require regulated land disturbance projects to address post-construction water quality. The MCM also requires a long term inspection and maintenance program for stormwater management facilities to ensure functionality. Although facilities are designed to target phosphorus reductions; facilities that remove phosphorus inherently also remove sediment from passing downstream.
- ✓ MCM 6: Salem developed good housekeeping procedures that are incorporated into staff training. The potential for discharge of sediment was also included in the City's assessment to identify high priority facilities that will be targeted for site-specific SWPPPs.

2.1.3 Land Disturbance Permit and Construction General Permit

Construction and land disturbance in Salem is governed by both the City's VSMP authority and by DEQ. The City's VSMP authority requires activities involving more than 5,000 square feet of disturbance must be approved by the City Engineer, with plans prepared by a licensed professional. The *General Permit for Discharges of Stormwater from Construction Activities* (9VAC25-880) is required from DEQ for land disturbance greater than one acre. The permittee, typically the land disturbance contractor or owner, is bound by the conditions of each permit.

2.2 Additional Applicable Practices

Salem's efforts to reduce sediment loads to the Roanoke River go beyond the requirements of the MCMs in the MS4 GP. The additional efforts incorporated into the current MS4 program that are applicable to the reduction of sediment discharges from the MS4 include:

- A more stringent land disturbance area threshold for the requirement of ESC and SWM plans;
- Restrictions for development within floodplains; and
- Streets sweeping of City roads.

This section address the following MS4 GP special condition:

- ✓ *"Identify and maintain an updated list of all additional management practices, control techniques and system design and engineering methods, beyond those identified in Section II V, that have been implemented as part of the MS4 Program Plan that are applicable to reducing the pollutant identified in the WLA."* [Section I(B)(2)(b)]

2.2.1 Enhanced Public Outreach & Employee Training

Salem's MS4 program has enhanced public education and outreach and employee training programs to promote methods to eliminate or reduce the discharge of sediment from the MS4. Enhancement is described as follows:

- ✓ PEOP: The Plan incorporates information regarding TMDL POCs, including sediment, into the relevant message of the high-priority water quality issue #1. The Plan includes an annual outreach efforts the general public with information related to the Roanoke River TMDL, including methods to reduce the discharge of sediment.
- ✓ Increased Frequency of Employee Training: Salem's PEOP also identifies City staff as a target audience and requires annual training, a more frequent training schedule than the biennial training required by the MS4 General Permit. Staff training material, Salem's Good Housekeeping/Pollution Prevention Manual, includes information regarding TMDL pollutants of concern.

The inclusion of information regarding sediment sources in stormwater runoff into the PEOP and staff training materials addresses the following permit special condition:

- ✓ *"General Permit SEC I.B.2.c: Enhance [its] public education and outreach and employee training programs to also promote methods to eliminate and reduce discharges of the pollutants identified in the WLA.*

For further detail on the PEOP and employee training, Salem's MS4 Program Plan and Annual Report are available at Salem's Stormwater Webpage.

2.2.2 Facilities Assessments

Salem has performed a city-wide evaluation for the identification of areas that are a potential sources of sediment to stormwater runoff. The evaluation was consistent with the previous MS4 GP Special Condition Section I.B.6. Salem has also identified high priority areas as part of their MS4 Program consistent with Section II.B.6.b of the current MS4 GP. The facilities are considered to have a high potential to discharge pollutants and site-specific Stormwater Pollution Prevention Plans (SWPPPs) will be developed to minimize pollutant discharges. The following City-owned and operated facilities were identified as a potential significant sediment source due to include stockpiles and denuded areas:

- The City of Salem's Public Works Yard
- Mowles Spring Park

Stormwater Pollution Prevention Plans (SWPPPs) will be developed to minimize pollutant discharges consistent with the schedule requirements of the MS4 GP and the City of Salem MS4 Program Plan. The assessment and list of facilities addresses the following special condition:

- ✓ *Assess all significant sources of pollutant(s) from facilities of concern owned and operated by the MS4 operator that are not covered under a separate VPDES permit and identify all municipal facilities that may be a significant source of the identified pollutant.* [Section I(B)(2)(b)]

3.0 ROANOKE RIVER TMDL WLA

The Roanoke River TMDL wasteload allocation for MS4s is land used based and applies to all MS4s in the TMDL watershed, including Roanoke County, the City of Roanoke, the Town of Vinton, Botetourt County, the City of Salem, VDOT Roanoke and Montgomery County Urban Areas, Virginia Western Community College, the Virginia Medical Center, the Town of Blacksburg, and the Town of Christiansburg's MS4s. The TMDL directs that the WLA is achieved with a "Percent Reduction Method" that compares water quality data to applicable water quality criteria. It identifies a percent reduction of the current sediment load required to meet water quality standards for the watershed.

3.1 TMDL Model Approach

The Roanoke River TMDL describes a modeling approach that used a biomonitoring station at river mile 224.54 of the Roanoke River to develop a "reference watershed" approach to meet the water quality standard. Sediment load reduction throughout the impaired watershed, scaled up from the reference watershed location, is "expected to restore support of the aquatic life use for the Roanoke River." An area-weighted sediment load for land based sources was determined for the MS4s and WLAs for MS4s were based on an equal percent reduction (including a 10% margin of safety) across the applicable land use types. The WLA specific to the City is 428.8 tons/year, equivalent to a 69.5% reduction in the existing loads computed at the time of the TMDL development.

3.2 Draft TMDL Implementation Plan WLA Modifications

The Draft IP from April 2015 uses updated information regarding "allocation loads and reductions for bacteria impaired segments that did not have an individual established TMDL, land use changes, and corrections to the instream erosion loads". The Draft IP updated the percent reduction from 69.5% as described above to 75.1% for updated land uses depicted in Table 2. This is a 5.6% increase from the reduction rate of 69.5% across land uses in the 2006 TMDL. Having been developed in 2006 using 1992 land use data, updates to the land use distributions in the modeling scenarios were necessary for a clearer understanding of existing sediment loads. Most notably, there was a drastic increase in urban areas of the TMDL watershed with a corresponding decrease in forested and agricultural areas in the 2006 NLCD (National Land Cover Database) data. Updates were also considered due to an overestimation in the original TMDL regarding instream erosion loads in the impaired and reference watersheds.

"At the time of this Action Plan's development, the IP is in draft form. Therefore, this Action Plan will utilize reduction requirements from the approved TMDL. As an iterative MS4 program, the City of Salem will update the Action Plan as necessary to meet the reduction requirements as more refined information becomes available."

At the time of this Action Plan's development, the IP is in draft form. Therefore, this Action Plan is reliant upon the reduction requirements from the approved TMDL. As an iterative MS4 program, the City of Salem will update this Action Plan as necessary to meet the reduction requirements as more refined information becomes available.

Table 2: TMDL Load allocation for Salem.

Consolidated Source Category Land Use	TMDL Wasteload Allocation (% reduction)	Draft IP Wasteload Allocation (% reduction)
Agriculture (pasture/hay/row crop)	69.5%	75.1%
Residential (high/low intensity)*	69.5%	75.1%
Commercial/Industrial/Mining*	69.5%	75.1%
Transitional*	69.5%	75.1%
Urban/Recreational Grasses*	69.5%	75.1%
Instream Erosion	69.5%	75.1%

* Applicable for potential discharge to the City's MS4.

As indicated in Table 2, sediment from agriculture and instream erosion would not be applicable to the City's MS4 since sediment from stream bank erosion would not be likely to enter the storm sewer and agricultural land use within the city is less than 3% of the total land area. Table 3 provides an updated land use summary for the City using the 2011 NLCD data.

Table 3: Land use summary for the City of Salem based on NLCD 2011. Total area is 9,030 acres.

Land Use	Area (Acres)	% of Total Area	Sediment Source Characteristics	Significant Sediment Source to the MS4?
Developed, High Intensity	822	9	Reduced vegetation and developed exposes soils	yes
Developed, Low Intensity	3,183	35		
Developed, Med. Intensity	2,009	22		
Developed, Open Space	1,729	19		
Evergreen Forest	63	1	Loads from forest are natural condition	no
Mixed Forest	27	0		
Deciduous Forest	947	10		
Hay/Pasture	227	3	Small contributing area	no
Herbaceous Grassland	11	0		
Cultivated Crops	8	0		
Open Water	2	0	Not a sediment source	no

3.3 Quantification of Required Reductions

To determine the sediment load reduction required to achieve the WLA of 428.8 tons/year, the required percentage reduction of 69.5% is simply used as:

$$Existing\ TMDL\ Load\ from\ Salem's\ MS4\ = \frac{428.8\ \frac{tons}{year}}{(1-0.695)} = 1{,}405\ \frac{tons}{year}$$

The existing load was computed since it was not explicitly provided in the TMDL. The resulting required reduction in sediment is computed as:

$$Required\ Sediment\ Reduction\ from\ Salem's\ MS4 = 1{,}405\ \frac{tons}{year} -\ 428.8\ \frac{tons}{year}\ = 976.2\ \frac{tons}{year}$$

The required load reduction computation is based on the explicit WLA in the TMDL. It is understood that the TMDL incorporated potential sources such as instream erosion that would not contribute to Salem's regulated MS4 area; therefore, the computed existing load may be inaccurate. The resulting calculated loadings likely exceeds the actual sediment contribution from the City's MS4. The City reserves the right to modify the characterization of sediment loadings from its MS4 in the future and modify this Action Plan. Any modifications will be based on refined data inputs and the measures of effectiveness obtained by the means and methods to achieve the WLA, as described in Section 4.

4.0 METHODS TO ACHIEVE THE WLA

The City has served as an active participant in efforts to address the impairments described in the Roanoke River TMDL through maintained compliance with the MS4 GP and with implementation of the BMPs described in the Draft IP. In addition to the practices described in Section 2.2 that are beyond those required by the MCMs, the City will develop an enhanced street sweeping program to maximize and verify sediment reduction.

4.1 Enhanced Street Sweeping

Source controls remove sediment from the land surface prior to its conveyance downstream. A source control such as street sweeping can be more cost-effective at a watershed scale than structural controls, such as a detention pond, since larger surface (drainage) areas can be addressed. As discussed in previous sections of this Action Plan and the Draft IP, the City currently performs street sweeping. However the sweeping is not targeted to maximize sediment reductions.

4.2 Quantification of Street Sweeping Sediment Reduction

The Draft IP reports that Salem removed 533 tons of sediment in 2013 as a result of street sweeping and predicts 800 tons/year of removal as lane miles of sweeping are increased by 33%. Based on the data provided in the Draft IP, street sweeping has provided significant progress towards achieving the TMDL and further progress is anticipated (see Table 4).

Table 4: Salem's progress from street sweeping towards achieving the WLA according to the Draft IP.

Required Reduction (tons/year)	Removed in 2013 (tons/year)	% of Required Reductions (2013)	Predicted removal with increased lane mileage (tons/year)	% of Required Reductions (Future)
976.2	533	55	800	82

Although promising, the 2013 estimate of 533 tons of sediment removed from the Draft IP is lacking quantifiable supporting data. Further, basing future reductions of 800 tons/year on standard "reduction per lane miles swept" does not provide an accurate representation of the actual sediment removed by the City's efforts. Therefore, the City proposes to utilize the so-called "Mass Loading Approach" described in the "*Chesapeake Bay TMDL Special Condition Guidance*" (Guidance) provided by DEQ and dated May 18, 2015 for computing total suspended solid load reductions, or sediment for the purposes of this Action Plan. This method is based on actual measurement of collected material from street sweeping. The method provides conversion factors to translate the material collected to sediment by converting the total weight of material collected to a dry weight using a multiplier of 0.7. The dry weight is then translated to sediment with a multiplier of 0.3. This results in a sediment load reduction of 21% of the total weight of the collected material.

Consistent with an iterative Program, the City seeks to verify previous estimates of sediment reduction and establish reliable methods for predicting reduction based on future enhancements of the street sweeping program. In the interim, the City recognizes the reductions from the Draft IP, and as summarized in Table 4, as significant progress towards achieving the WLA. However, improved quantification of the program's effectiveness is expected, as described in the means and methods listed in Section 5.

4.3 Implementation of MS4 Program

Consistent with the intent of the TMDL and Draft IP, the City also intends to achieve reductions with implementation of the City's MS4 program Plan. Quantification of sediment reduction resulting from implementation of a stormwater program is difficult; however peer-reviewed literature indicates significant reductions can be achieved. Ports (2009) campaigns for the importance of source controls as a cost-effective approach to improve water quality, specifically discussing reductions achieved from urban forestry controls (i.e. urban leaf removal), pet waste management and lawn management. Nonstructural practices may also include day to day activities of public works staff or educational efforts to change the behavior of the public. Riggs (2010) recognizes the need to reduce pollutant loads from existing developed lands, citing load reductions resulting from a social marketing approach to educate and excite land owners into participating in efforts, specifically water conservation. Research conducted within Florida MS4s by Raje (2013) analyzed particulate matter from street sweeping, catch basin cleanout, and structural BMPs finding pollutant removal is significantly more economical (by several orders of magnitude) than the use and maintenance of structural BMPs ($/pound removed). Research applying quantification of reductions is summarized as:

- Murphy and Lokey (1999) developed a spreadsheet model using a Monte Carlo style simulation module to accommodate the uncertainty in published removal efficiencies and other solicited efficiency data for the 36 nonstructural BMPs included the City of Phoenix's MS4 program. The spreadsheet sums the cumulative effect of the BMPs. Removal efficiency is further estimated based on both a physical and implementation factor. Results found the cumulative load reductions of the MS4 Program BMPs to fall between 30 – 51% of a baseline estimate.
- Taylor (2002) reports that city-wide urban stormwater quality management programs are thought to range from roughly 25 – 40% in their cumulative pollutant removal efficiency. Monitoring for the City of Tulsa Oklahoma before and after implementing a stormwater quality management program resulted in reductions of 13% for sediment, 17% for phosphorus, and 18% for nitrogen.
- Taylor and Wong (2002) reference preliminary results from a monitoring based study by Smith and Simmons (2002a, 2002b, and 2000) to estimate the following removal

efficiencies for good housekeeping on an industrial site: 8% for TSS (sediment), 40% for N, and 49% for P. With the inclusion of a pollution prevention plan, removal efficiencies are increased to: 60% for TSS, 43% for TN, and 56% for TP.

The literature indicates that the implementation of the City's MS4 Program Plan results in significant reduction in pollutant discharges, including sediment. The City will continue to review the literature to attempt to quantify sediment reductions, as necessary in context to the TMDL. An initial conservative estimate of the reductions achieved by the MS4 program is based on the cited research and provided in Table 5.

Table 5: Summary of cited data and estimated reductions from implementation of the City's Program.

Reference	Median (%)	Additional Reduction (tons/year)
Murphy and Lokey (1999)	40*	562
Taylor (2002)	13**	183
Taylor and Wong (2002)	60***	605

* General reduction, specific pollutant not specified

** Specific sediment reduction based on monitoring for implementation of an overall program

*** Specific sediment reduction from site with SWPPP

Table 5 gives insight into the potential sediment reduction from implementation of nonstructural BMPs. As a conservative estimate, this Plan considers Taylor (2002) to predict reductions for sediment from implementation of the City's MS4 program as:

$$1{,}405\ \frac{tons}{year} \times 0.13 = 183\ \frac{tons}{year}$$

Adding the programmatic reductions to those predicted by street sweeping, we find:

$$800\ \frac{tons}{year} + 183\frac{tons}{year} = 983\ \frac{tons}{year}$$

Implementation of the enhanced street sweeping program and continued implementation of the MS4 Program Plan exceed the 976.2 tons/year required reduction to achieve the WLA as demonstrated in Section 3.3.

5.0 ACTION PLAN

Based on the literature review and predicted reductions from street sweeping, the City concludes the WLA can be achieved with street sweeping and implementation of the MS4 Program, consistent with the Draft IP. Verification of this conclusion will be evaluated with the implementation of the Action Plan described in the following subsections.

5.1 Enhanced Street Sweeping Program

Street sweeping is anticipated to achieve the bulk of the reductions necessary to achieve the WLA, specifically with the planned implementation of the City's Enhanced Street Sweeping Program. Street sweeping efforts will be enhanced with the following action steps, each aimed to increase reduction of sediment loads:

1. Develop improved documentation for tracking areas swept, type of sweeper used, man hours employed, and other information determined relevant for characterization of collected materials. Documentation may include mapping for incorporation of a GIS database.
2. Conduct sampling of collected street sweeping materials to correlate dry weight and sediment fraction to verify computational methods for determining sediment reductions from collected street sweeping material. Sampling will be based on technically defensible analytical methods and be based on environmental and technical variables.
3. Assess the City's current street sweepers to determine their sediment removal efficiencies and cost effectiveness. The assessment will consider alternatives to the current sweeping equipment.
4. Conduct an assessment to identify target areas and optimal frequency of sweeping based on areas swept that produce the largest yield of sediment collected per acre and variables identified as the result of implementation of Step 2. The assessment will consider types of locations swept, time span between sweeping and weather conditions at the time of sweeping.
5. Concentrate sweeping in areas identified as target areas from implementation of Step 4 at the optimal frequencies identified in the evaluation. Additional areas for sweeping will be identified, if necessary.

The action steps identified above are intended to serve as a defined method that inherently aids as an adaptive iterative approach to achieve the WLA.

5.2 Continued MS4 Program Plan Implementation

The City will continue to implement its MS4 Program Plan and update the literature provided in Section 4.3. If necessary after quantification of street sweeping reductions, the City will attempt to quantify reductions achieved by programmatic reductions based on research and other methods as additional information becomes available.

5.3 Progress Reporting and Measure of Effectiveness

Effectiveness will be measured through explicit accounting of sediment reductions using the "Mass Loading Approach" to convert total material collected into sediment reductions. As the steps in Section 5.1 are implemented, the measure of effectiveness will be dependent on the annual average increase in the sum of sediment collection from street sweeping until the WLA is achieved. In the case that reductions decrease in a given year, the difference will be made up in subsequent years. The difference may also be addressed with quantification of reductions achieved with the implementation of the City's MS4 Program Plan. The "Sediment Reduction Tracking Form" provided in Appendix A will serve as the annual documentation for tracking effectiveness. It is anticipated that sediment reduction will increase as the Action Plan steps are implemented. The City's plan addresses the following MS4 General Permit special condition:

- ✓ *"Develop and implement a method to assess TMDL Action Plans for their effectiveness in reducing the pollutants identified in the WLAs."* [Section I(B)(2)(e)]

5.4 Street Sweeping Schedule

Since the approval of the Roanoke River Sediment TMDL, the City has made significant progress in the reduction of sediment loads from its MS4. These reductions are demonstrated qualitatively in the MS4 Program assessment described in Section 2 and with the estimated reductions from street sweeping described in the Draft IP. Additional reductions will be quantified from street sweeping efforts as described in Section 5.1. Appendix B summarizes the schedule for completion of the Action Plan's Enhanced Street Sweeping Program steps described in Section 5.1. At the time that three consecutive annual reports find reductions necessary to achieve the WLA have been accomplished, the sweeping schedule in place at that time will be maintained and completion of all of the steps presented may be ceased.

6.0 REFERENCES

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Appendix A: Sediment Reduction Tracking Summary

(To be provided with data collected from implementation of Action Plan)

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Appendix B: Enhanced Street Sweeping Program Schedule

Table 6: Schedule for City's TMDL Action Plan Street Sweeping Program.*

Step	General Description	Measurable Goal	Completion Date
1	Improve tracking and information on areas swept	Written report and supporting materials for tracking documentation; completed tracking documentation beginning after completion date	July 2016
2	Begin annual training for staff identified in the Written Program	Training materials and documentation of training implementation	July 2016
3	Conduct collected material sampling and analysis	Written report incorporating a summary of relevant sampling data and analysis for computing sediment fraction	Oct. 2016
4	Target area identification and sediment reduction assessment	Written reporting building on field collected data from Steps 1 and 3 to target areas for sweeping to maximize sediment reduction	July 2017
5	Sweeper evaluation	Written report assessing the effectiveness and appropriateness of the City's sweepers. The assessment will be utilized in the consideration of future sweeper purchases.	Jan. 2018
6	Implementation of targeted areas for sweeping	Implementation of the identified target areas resulting from Step 4 and remaining reductions necessary to achieve the WLA.	Annually, begin July 2018

* As necessary to achieve the WLA.