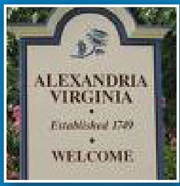
City of Alexandria

VIRGINIA SANITARY SEWER MASTER PLAN



NOVEMBER 2012

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Executive Summary

The purpose of this Sanitary Sewer Master Plan (Master Plan) is to provide the City of Alexandria (City) and its decision-makers with a plan to address future projected wastewater flows, identify when and where infrastructure upgrades or improvements will be needed to accommodate growth, and continue to serve the wastewater needs of residents and businesses. This Master Plan also addresses regulatory drivers related to sanitary sewers such as the Chesapeake Bay and Hunting Creek Total Maximum Daily Loads (TMDLs).

The Master Plan uses the growth forecasts for build-out (post year 2040) conditions to analyze the following:

- Hydraulic capacity of the City's collector (local) sanitary sewers and the Alexandria Renew Enterprises (AlexRenew) interceptor sewers.
- Treatment plant capacity at both the AlexRenew Water Resource Recovery Facility (WRRF) and the Arlington County Water Pollution Control Plant (Arlington WPCP).
- Impacts of extreme wet weather events related to sewer overflows and basement back-ups in the collector and interceptor sewers and at the wastewater treatment plants.
- Impacts of wet weather on the combined sewer system (CSS).

The results of these analyses indicate additional needs related to sanitary sewer collection system capacity, treatment plant capacity and wet weather capacity. The primary conclusions derived from this assessment are summarized below:

- A total of 19,500 feet of sanitary sewer have been identified with capacity deficiencies in the City's collection system, based on the sanitary sewer collection system model developed for build-out (post 2040) conditions.
- Capacity to support forecasted growth is available in both the Commonwealth and Potomac Interceptor sewers outside of wet weather issues. There are two sections of the lower Potomac Yard Trunk Sewer which have estimated future peaks flows that exceed capacity. Capacity along the Holmes Run Trunk Sewer is continuing to be evaluated.
- The City will have sufficient capacity at the Arlington WPCP based on current growth forecasts and its existing allocation.
- The City will exceed its annual average allocation of 21.6 mgd at the AlexRenew WRRF sometime after 2040. Based on growth projections, the flows due to build-out conditions will exceed the existing allocation by approximately 4 mgd. Alternatives identified range from $29M (hydraulic expansion of the AlexRenew WRRF) to $56M (purchase capacity at the AlexRenew WRRF from Fairfax County).
- Extreme wet weather flows have the potential to cause sanitary sewer overflows (SSOs) and basement back-ups. The occurrence of these will increase as more wastewater flows are generated due to growth. The recommended wet weather strategy identified has an estimated construction cost of $51M and an annual operating cost of $1.1M. This strategy will result in reducing basement back-ups due to surcharging and will result in eliminating SSOs at the AlexRenew WRRF. AlexRenew has also proposed an alternative site for the wet weather pumping

station which, if feasible, will likely reduce the total project costs. This site is currently under evaluation.

- Future combined sewer overflow (CSO) mitigation requirements in light of the Hunting Creek TMDL are currently unknown. The existing CSS permit has been administratively continued by the Virginia Department of Environmental Quality (VDEQ) and the City is currently negotiating the requirements of the next permit cycle with them.

There are a number of sanitary and combined sewer projects in the existing Capital Improvement Program (CIP) including the Infiltration and Inflow (I/I) remediation program, CSS separation projects, CSO mitigation, and sanitary sewer modeling and capacity analysis as shown in Table ES-1. Construction of additional capacity in the local collection system to support growth will be funded as a condition of development and/or redevelopment. The rest of the alternatives presented have been included in the FY2013 CIP as shown on Table ES-1, with the exception of increased CSO mitigation. The City sanitary sewer program, including both capital and operating expenses, is set up as an Enterprise Fund. The sanitary program is funded entirely by sewer user fees and connections fees, with the majority coming from the user fees. Sanitary sewer funding strategies are identified in this Master Plan and include the following:

- Increase connection fees, along with the consideration of additional contributions for large-scale sewer projects
- Increase user fees, along with the consideration of alternate fee structures
- Development-funded collection system improvements
- Treatment capacity reservation
- Wet weather mitigation contribution
- Combined sewer separation and mitigation contribution

The projects added to the FY2013 CIP are funded by the user fees and by the issuance of General Obligation Bonds. However, it may be more prudent to fund the AlexRenew WRRF expansion through increases in the connection fees. A Sanitary Sewer Financial Model was developed as part of this Master Plan that finances existing system needs by increases in the user fees and growth-related needs by increases in the connection fees. The Sanitary Sewer Master Plan specifically makes the following recommendations to fund identified needs:

- Increase the multi-family connection fee from 50% to 90% of the single-family connection fee, starting in FY2014. Fund the Wet Weather Management Facility and I/I remediation (existing system needs) through increases in the sanitary sewer user fee and fund the AlexRenew WRRF expansion (growth-related need) through increases in the connection fees. The Sanitary Sewer Financial Model provides the framework for how to apply these increases and when these are needed.
- Create a policy for partial credits for teardowns at 50% of the existing use. The justification for setting the credit at 50% is that the costs associated with capital investment and treating wastewater (cost per gallon) has risen substantially over the past 20-30 years, as the requirements for treated effluent have become more stringent.
- Require new development in the combined sewer service area to separate sanitary flows if there is a separate sewer system within 900 feet of the development. If there is no separate sanitary sewer within 900 feet, then the developer will be

required to contribute $300,000 per acre of the development parcel. In lieu of the $300,000 per acre contribution, the developer may do one of the following:

- Separate the sanitary sewage at the project site. If the new length of sanitary sewer exceeds 900 feet (not including the service lateral), the developer will receive a credit towards the connection fees.
- Separate an equivalent amount of wastewater flow elsewhere in the combined sewer service area. If the total length of sewer exceeds 900 feet, the developer will receive a credit towards the connection fees.

This Master Plan is intended to be updated periodically to incorporate revised growth forecasts and the resulting modifications to the necessary infrastructure improvements. Additionally, the City will be expanding and refining its sanitary sewer modeling which will likely identify additional sewers that will need to be replaced as a condition of development/redevelopment. Currently, AlexRenew, the City and Fairfax County have embarked on a project to refine and recalibrate the hydraulic model of the AlexRenew interceptor sewers, which may result in a change to the wet weather strategy. Finally, this Master Plan will need to be updated to reflect changes in both state and federal regulations related to sewage collection and treatment and water quality. Updates to this Master Plan are anticipated approximately every 3-5 years.

TABLE ES-1
SANITARY SEWER FY2013 CIP
CITY OF ALEXANDRIA, VIRGINIA SANITARY SEWER MASTER PLAN

Project	Unallocated Balance	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	TOTAL FY2013-FY2022
Commonwealth Service Chamber	*$ 370,000*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Holmes Run Trunk Sewer	*$ 6,037,000*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Reclaimed Water System via Waste-to-Energy Plant	*$ -*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Sanitary Sewer Capacity Studies	*$ 149,877*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mitigation of Combined Sewer Overflows	*$ 1,581,690*	$ 319,000	$ 335,000	$ 335,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 3,439,000
Reconstruction and Extension of Sanitary Sewers	*$ 2,373,918*	$ 322,000	$ -	$ 775,000	$ 320,000	$ 435,000	$ 540,000	$ 660,000	$ 760,000	$ 760,000	$ 845,000	$ 5,417,000
Sewer Separation Projects	*$ 600,000*	$ 500,000	$ 120,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 5,420,000
Four Mile Run Sanitary Sewer Repair	*$ 130,000*	$ 1,500,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,500,000
Holmes Run Infiltration and Inflow	*$ 4,960,000*	$ 4,360,000	$ 4,200,000	$ 3,600,000	$ 3,850,000	$ 3,850,000	$ -	$ -	$ -	$ -	$ -	$ 19,860,000
Sanitary Sewer Master Plan	*$ -*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 10,000	$ 10,000
Wet Weather Management Facility	*$ -*		$ 3,375,000	$ 1,125,000		$ 13,300,000	$ 13,700,000					$ 31,500,000
AlexRenew WRRF Expansion	*$ -*	$ 500,000	$ 500,000	$ -	$ -	$ -	$ -	$ -	$ 11,070,000	$ 11,400,000	$ 11,750,000	$ 35,220,000
Total Sanitary Sewer Projects	***$ 16,202,485***	***$ 7,501,000***	***$ 8,530,000***	***$ 6,435,000***	***$ 5,120,000***	***$ 18,535,000***	***$ 15,190,000***	***$ 1,610,000***	***$ 12,780,000***	***$ 13,110,000***	***$ 13,555,000***	***$ 102,366,000***

Chapter 1
Introduction

1.1 Background and Purpose

The City of Alexandria (City) is an independent city in the Commonwealth of Virginia located approximately 6 miles south of Washington D.C. and comprises 15.75 square miles as shown in Figure 1-1. As an independent city, Alexandria derives its governing authority from the Virginal General Assembly. The City has adopted a council-manager form of government where the City Manager is responsible for overseeing the City's administration and departments. The City's Transportation and Environmental Services (T&ES) Department is responsible for providing and maintaining various forms of infrastructure to residents, businesses and visitors. The Alexandria Sanitation Authority, created by the City Council in 1952, owns and operates the wastewater treatment plant located in the City. In April 2012, the Alexandria Sanitation Authority changed its name to Alexandria Renew Enterprises (AlexRenew). AlexRenew is independent of the City government (both administratively and financially) and oversight of AlexRenew's operations is performed via a Board of Directors, which is appointed by City Council.

Alexandria has experienced considerable growth in the past 30 years, both in terms of the increased number of residents who make Alexandria their home and the number of employees, businesses, government and non-profit organizations that are located in the City. The City is expected to continue to grow well into the future, which will impact the City's existing infrastructure. One aspect of growth is increased wastewater generation. Increased wastewater generation results in increased wastewater flow in the sanitary sewer system and at wastewater treatment plants. The purpose of this Sanitary Sewer Master Plan (Master Plan) is to provide the City and its decision-makers with a plan to address future projected wastewater flows, identify when and where infrastructure upgrades or improvements will be needed to accommodate growth, and continue to serve the wastewater needs of residents and businesses.

1.2 Master Plan Objective

This Master Plan serves multiple objectives for the City including:

- Detailed description of the existing sanitary sewer system including identification of sewersheds, how wastewater in the collection system is conveyed and how much wastewater flow is currently being sent to wastewater treatment plants
- Identification of areas of the existing system that have been studied for excessive infiltration and inflow (I/I) and summary of the work performed under existing I/I programs to date
- Status of current and planned programs related to the sanitary sewer system including upcoming I/I projects, permanent flow monitoring and sewer maintenance
- Detailed wastewater flow estimates through build-out (beyond Year 2040) conditions using demand generators provided by the City's Planning and Zoning (P&Z) Department

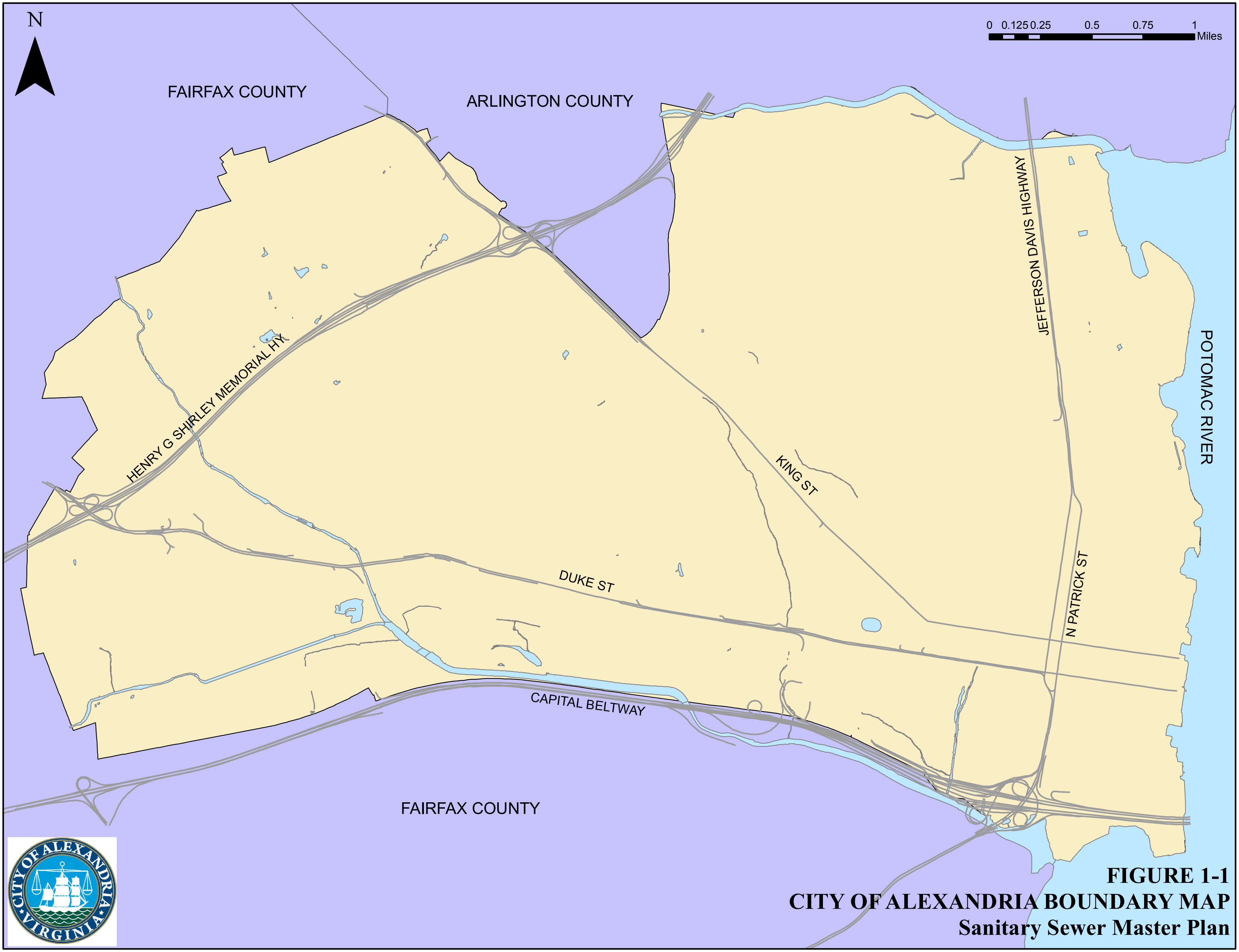


FIGURE 1-1
CITY OF ALEXANDRIA BOUNDARY MAP
Sanitary Sewer Master Plan

- Analysis of sanitary sewer hydraulic modeling. Hydraulic modeling can serve as a tool for assessment of available system capacity, improvements, and phasing
- Identification of sewer segments that have insufficient hydraulic capacity to convey future wastewater flows and identification and prioritization of system improvements needed to serve future development and growth within the service area
- Analysis of wastewater treatment plant flows at both the AlexRenew Water Resource Recovery Facility (WRRF) and the Arlington County Water Pollution Control Plant (Arlington WPCP) and determination of additional treatment needs in terms of both wastewater flows and loads
- Analysis of extreme wet weather events causing sewer overflows and basement back-ups in the collector (local) sewers, interceptor (trunk) sewers, and at the treatment plants and alternatives to mitigate wet weather impacts
- Review of existing regulations related to sanitary and combined sewer systems and review of anticipated regulatory changes and their impact(s) to the City and how it operates these systems
- Development of an overall plan for improvements on a system-wide basis, which will lead to more informed decisions on project priorities
- Development of funding options available to implement system-wide recommended improvements

1.3 Master Plan Organization

The remainder of this plan is organized into the following chapters that meet the objectives identified above:

Chapter 2 – New and Future Regulations

Chapter 3 – Sanitary Sewer Service Area Characteristics

Chapter 4 – Demand Generators

Chapter 5 – Collection System Capacity Assessment

Chapter 6 – Treatment Plant Capacity Assessment

Chapter 7 – Wet Weather Capacity Assessment

Chapter 8 – Capital Improvement Program

Chapter 9 – Financing Strategies

Chapter 2
New and Future Regulations

2.1 Introduction

The City of Alexandria's wastewater collection system is regulated by a number of federal and state regulations. In addition, although the City does not own or operate a wastewater treatment plant, its citizens still pay for the cost of treatment and therefore are impacted by regulations affecting wastewater treatment. The purpose of this chapter is to discuss the existing regulations that govern the City's collection system and treatment of its wastewater and to discuss upcoming and possible future regulations and their impact to the City. It is the City's goal to comply with both state and federal regulations and to preserve the quality of its streams, rivers and the Chesapeake Bay.

2.2 Clean Water Act

The main federal regulation governing wastewater collection and treatment is the Clean Water Act (CWA), which was enacted in 1972 by the United States Environmental Protection Agency (EPA) with several amendments thereafter.

The overall goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." Traditionally, the CWA focused on point source discharges from industrial facilities and municipal wastewater treatment plants; however, as pollutants from these sources have been monitored and controlled, regulatory interest has broadened to include nonpoint sources, such as runoff from streets, farms, and construction sites, which also can substantially contribute to water quality degradation. Currently, the regulatory climate associated with the CWA is more focused on watershed protection, both holistically and by specific sources.

Under the CWA, the National Pollutant Discharge Elimination System (NPDES) program was established. Point source discharges are regulated under the NPDES program. The following point source discharges are regulated under the NPDES program:

- Alexandria Renew Enterprises (AlexRenew) Water Resource Recovery Facility (WRRF)
- City's Combined Sewer System (CSS)

Virginia's Department of Environmental Quality (VDEQ) is the state-level NPDES issuing authority and issues discharge permits for the AlexRenew WRRF and City's CSS are issued by the Commonwealth of through its Virginia Pollutant Discharge Elimination System (VPDES) program. Permits are issued on a 5-year basis. Each permit is discussed in detail below.

2.2.1 AlexRenew WRRF VPDES Permit

The AlexRenew WRRF has a VPDES Individual Permit with an effective date of June 1, 2009 and an expiration date of May 31, 2014 for its two outfalls that discharge treated effluent into Hunting Creek Embayment. The permit establishes discharge limits for a number of water-quality constituents to ensure that treated wastewater effluent does not cause or contribute to exceedance of water-quality standards. AlexRenew submits a discharge monitoring report to VDEQ on a monthly basis to show compliance with discharge limits established by the permit. A copy of this information is also available online through AlexRenew’s website.

As part of the Chesapeake Bay Program (discussed below), AlexRenew also has a separate permit for the wasteload allocations (WLAs) for both nitrogen and phosphorous that the treatment plant can discharge. The Watershed General Permit (VAN010059) was issued January 1, 2012. AlexRenew is currently meeting the total phosphorous (TP) limits and is going through an upgrade to meet the total nitrogen (TN) limits. The new WLAs went into effect January 1, 2011. Although the AlexRenew upgrade will not be completed at this point, the plant is meeting its WLA since the current plant flow is significantly lower than its design flow.

2.2.2 City’s CSS VPDES Permit

Like many older cities, a portion of the City’s historical Old Town area is served by a combined sewer system (CSS). These systems were designed to capture and transport stormwater and wastewater in the same pipe. During dry weather and limited wet weather conditions, the CSS transports all of its flow to the wastewater treatment plant (AlexRenew WRRF). However, during periods of rainfall or snowmelt, the capacity of the CSS may be exceeded and excess flow is then discharged directly to Hunting Creek, Hooff’s Run or the Potomac River at Oronoco Bay through the City’s four permitted CSS outfalls. Figure 2-1 shows the City’s CSS boundaries, location of CSS outfalls and receiving waters.

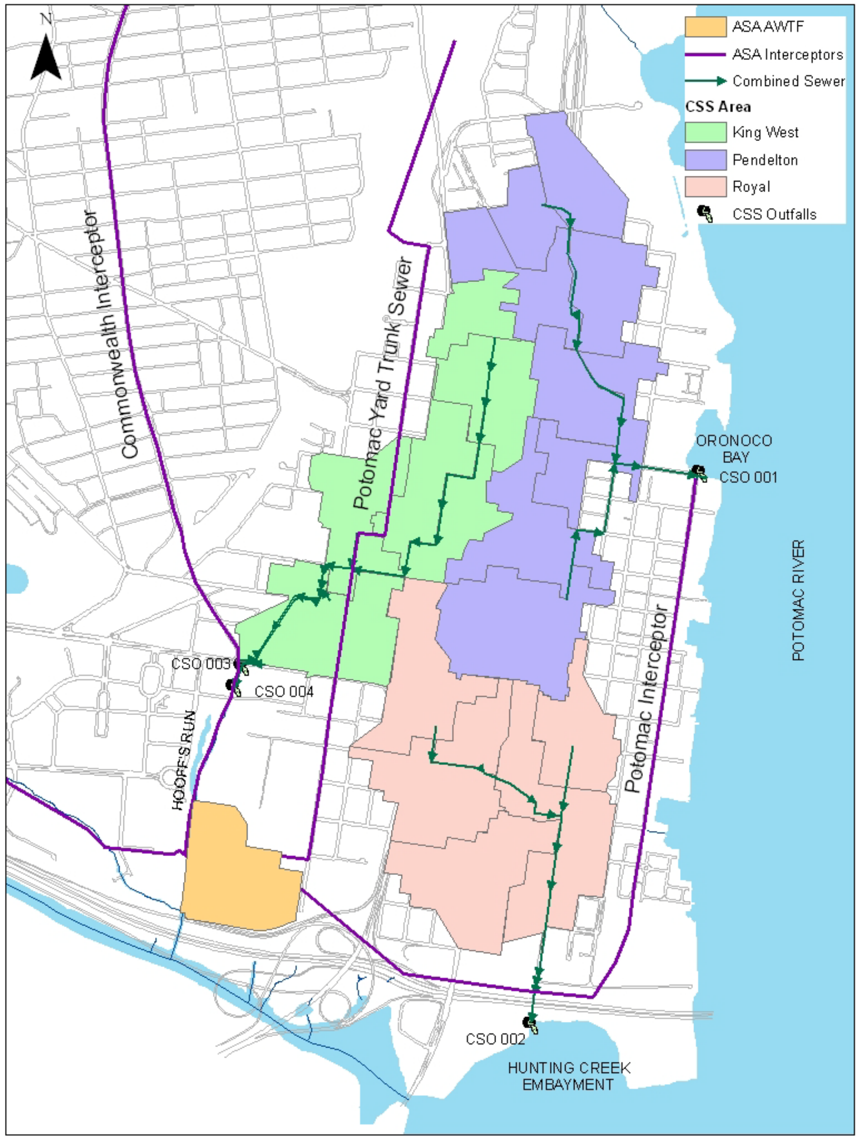
Table 2-1 summarizes each of the four permitted CSS outfalls, corresponding CSS subshed name and area, receiving waterbody, and the type of CSS regulator structure associated with each outfall structure. On average, approximately 30-40 rain events per year result in permitted combined sewer overflow (CSO) discharges from the CSS outfalls.

TABLE 2-1
SUMMARY OF CSS OUTFALLS, DIVERSION STRUCUTRES, ASSOCIATED TRUNK SEWERS, AND RECEIVING WATERS
CITY OF ALEXANDRIA, VIRGINIA SANITARY SEWER MASTER PLAN

CSS Outfall No.	CSO Outfall Name	CSS Subshed Name	CSS Subshed Area (acres)	Downstream Trunk Sewer	Receiving Waterbody	Number of Overflows per Year[1]	Description of CSS Regulator
001	Pendleton Street CSO	Pendleton	224	Potomac Interceptor	Oronoco Bay	32	Static diagonal weir along Pendleton Street; overflow through tide gates
002	Royal Street CSO	Royal	184	Potomac Interceptor	Hunting Creek Embayment	41	Float-operated mechanical gate structure and static 6-inch weir; overflow through tide gates
003	Duke Street CSO	King/West	132	Peyton Street Sewer to Commonwealth Interceptor	Hooff's Run	41	Static weir at King and West Streets, currently undergoing redesign; overflow to Hooff's Run at Duke Street
004	Hooff's Run CSO	King/West	132	Commonwealth Interceptor	Hooff's Run	36	Double siphon chamber; static weir between upstream and downstream siphon chambers; overflow through flapper gate

[1]As reported in the C*ity's Combined Sewer System Annual Report No. 16 for 2010* submitted to VDEQ in March 2011

FIGURE 2-1
CITY CSS AREA



The CSS comprises about 0.9 square miles and is generally located in the Old Town area of the City, east of U.S. Route 1. The City is authorized to discharge CSOs pursuant to VPDES Permit No. VA00887068. The City has operated its CSS through three 5-year permit cycles and is currently operating in post-monitoring status following approval of its Long Term Control Plan in 1999 by VDEQ. These VPDES permits required the City to comply with its approved Long Term Control Plan which includes the following Nine Minimum Controls related to CSO control established by the EPA:

- Conduct proper operations and regular maintenance programs
- Maximize use of collection system for storage
- Control of non-domestic discharges
- Maximize flow to the AlexRenew WRRF
- Prohibit combined sewer overflows during dry weather
- Control solid and floatable materials in CSOs
- Develop and implement pollution prevention programs
- Notify the public of CSOs
- Long Term Control Plan review
- Submit an Annual Report to VDEQ by March 31st each year

The EPA has published a document entitled "Combined Sewer Overflows: Guidance for Nine Minimum Controls" (EPA 832-B-95-003), dated May 1995, which provides CSO communities assistance with the evaluation, implementation and documentation of the Nine Minimum Controls. Pursuant to the VPDES permit, the City has developed and implemented an approved water-quality monitoring and sampling program which demonstrates that CSO discharges do not cause exceedances of Virginia water-quality standards.

The City's existing permit had an expiration date of January 15, 2012. In July 2011, the City submitted to VDEQ the permit reapplication package. VDEQ has reviewed the permit reapplication and found it to be both timely and complete. The City is currently discussing with VDEQ the details and requirements that will be included as part of the next permit cycle and VDEQ has administratively continued the current permit. Regulatory changes since the last issuance of the permit includes the Chesapeake Bay Total Maximum Daily Load (TMDL) for nutrients and sediment, and the Hunting Creek TMDL for bacteria. These TMDLs are likely to be the drivers of new permit requirements. These are discussed further in the sections below.

2.3 Chesapeake Bay Program

The City of Alexandria is fortunate to be part of the Chesapeake Bay Estuary. This unique estuary is the largest in the nation and third largest in the world. Its 64,000-square-mile watershed includes the states of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia (Bay States) and the District of Columbia. The Bay and its watershed have remarkable ecological, economic, recreational, historic, and cultural value to the region. Because of the pollution and subsequent degradation of the Bay, the Bay estuary is currently subject to several special state and federal regulations. Existing, pending and future regulations or actions are discussed in this section.

2.3.1 Chesapeake Bay Preservation Act

In 1988, Virginia's General Assembly enacted the Chesapeake Bay Preservation Act (Bay Act) to improve the water quality of the Chesapeake Bay and its tributary streams. The Bay Act is a critical element of Virginia's multifaceted response to the Chesapeake Bay Agreement (Agreement), which was originally signed in 1983. The Agreement is a signed document, including signage by Virginia's governor, that acknowledges the historical decline in the Bay's living resources and that a cooperative approach should be undertaken to restore the Bay. The Bay Act created a cooperative program between the Commonwealth of Virginia and local governments to reduce and prevent non-point source pollution and to protect and

enhance water quality through environmentally responsible land use management. The Bay Act requires the use of effective conservation planning and pollution prevention practices when using and developing environmentally sensitive lands.

The City of Alexandria has adopted an Environmental Management Ordinance to help protect the Chesapeake Bay from pollution and urban run-off. The purpose of this Ordinance is to protect the quality of water in the Chesapeake Bay and its tributaries and, to that end, to require all land uses and land development in the City to:

- Safeguard the waters of the Commonwealth from pollution;
- Prevent any increase in pollution of state waters;
- Reduce existing pollution of state waters; and,
- Promote water resource conservation.

To fulfill this policy, Article XIII of the Alexandria Zoning Ordinance was adopted to minimize potential pollution from stormwater runoff, minimize potential erosion and sedimentation, reduce the introduction of harmful nutrients and toxins into state waters, maximize rainwater infiltration while protecting groundwater, and ensure the long-term performance of the measures employed to accomplish the statutory purpose.

Resource Protection Areas (RPAs) are sensitive environmental corridors that should be preserved in a natural condition. The City adopted an RPA map in 1992 based on criteria provided in the Management Regulations. New state mandates require that all City streams with perennial flow must be protected by a 100 foot RPA buffer. Therefore, the RPA map was amended in 2004 to comply with the new state requirements. The amended RPA map and the new natural intermittent stream map were produced from information collected during Phase I of the City-wide stream classification study. Each map depicts a restrictive buffer, 100 feet for an RPA feature and 50 feet from top of stream bank for natural intermittent streams.

The Commonwealth's Department of Conservation and Recreation's (DCR) Local Implementation Section (formerly the Chesapeake Bay Local Assistance Program) addresses the impact of land use upon the water that drains into the Chesapeake Bay. The Chesapeake Bay Local Assistance Board participates in the multi-jurisdictional Chesapeake Bay Program and assists in the implementation of the Commonwealth of Virginia's Chesapeake Bay Preservation Act and the associated Regulations. They ensure that local government comprehensive plans, zoning ordinances, and subdivision ordinances are in compliance with the Chesapeake Bay Act regulations.

On January 13, 2001, the City Council adopted the Water Quality Management Supplement to the City's Overall Master Plan, thus, fulfilling the Phase II requirements of the Chesapeake Bay Program and completing a process that began in late 1996. On March 19, 2001, the Chesapeake Bay Local Assistance Board "determined that the amendments made to the City of Alexandria's Comprehensive Plan have made its Phase II program consistent" with the Chesapeake Bay Preservation Act. The City has implemented all actions consistent with Phase III activities and awaits the December 2012 final review from DCR. The City continues to provide annual data to DCR that demonstrates compliance through the Chesapeake Bay Preservation Area Annual Assessment of Activity.

2.3.2 Chesapeake Bay Agreement

Chesapeake 2000 is the third Bay Agreement written as a comprehensive guide for the actions of the multi-jurisdictional Chesapeake Bay Program. The Chesapeake Bay Program is a regional partnership including the States of Maryland, Pennsylvania, and Virginia, the District of Columbia, the Chesapeake Bay Commission, and the US Environmental Protection Agency (EPA) and their combined efforts to restore and protect the Chesapeake Bay. The first agreement, creating the Bay Program was signed in 1983. A second was signed in 1987 and amended in 1992.

The Executive Council meets annually to establish the policy direction for the restoration and protection of the Chesapeake Bay and its living resources. A series of Directives, Agreements, and Amendments signed by the Executive Council set goals and guide policy for the Bay restoration.

In the Chesapeake 2000 agreement (commonly referred to as C2K), the partners pledged to achieve over 100 specific actions designed to restore the health of the Bay and its living resources. These actions, called the Chesapeake 2000 commitments, are grouped into the Agreement's five major categories:

- Living Resource Protection and Restoration
- Vital Habitat Protection and Restoration
- Water Quality Protection and Restoration
- Sound Land Use
- Stewardship and Community Engagement

The major impact of the Chesapeake Bay Agreement on wastewater collection and treatment relates to nitrogen pollution. Both total nitrogen load and nitrogen concentrations are areas of concern for treatment plants. Although the City of Alexandria does not own and operate the wastewater treatment facility, the City’s residents and businesses contribute funding in the form of sewer rates towards plant improvements in part based on the allocation of use (currently 40 percent). The AlexRenew WRRF completed a major rehabilitation project in 2005 to meet water quality standards for nitrogen removal. As with other treatment plants in the area, additional facilities will be needed to enhance the removal of nitrogen to the limit of technology requirements. AlexRenew is addressing this requirement through their State-of-the-Art Nitrogen Upgrade Project (SANUP), which has an estimated cost of $82 million. Construction has begun and is expected to continue until 2014.

The Bay Program’s Executive Council has recently acknowledged that the 2010 restoration goals called for in the Chesapeake 2000 agreement will not be met. Among other shortfalls, current efforts to reduce nutrient and sediment pollution are not sufficient to meet the Bay’s water quality goals. In May 2009, the Executive Council set a new deadline to have all restoration measures in place no later than 2025, paced by a series of 2-year milestones.

2.3.3 Chesapeake Bay TMDL and Executive Order 13508

On December 29, 2010, EPA established the Chesapeake Bay Total Maximum Daily Load (TMDL) for nitrogen, phosphorous and sediment. A TMDL represents the maximum amount of a pollutant that a body of water may receive and still meet its water quality standards. This TMDL, the largest ever developed by EPA, sets pollution reductions across multiple sectors for the six Chesapeake Bay watershed states (including Virginia) and the District of Columbia (District). The TMDL is required under the CWA and responds to consent decrees from the late 1990s. The Bay States and the District are required to complete Watershed Implementation Plans (WIPs) to illustrate how each would meet reductions in the TMDL. According to the TMDL, these WIPs are in place to provide the proper "reasonable assurance" that water quality standards would be achieved. Final Phase I WIPs were submitted to the EPA on November 29, 2010. Currently, the Bay States and the District are in the process of completing the Phase II WIPs, due March 30, 2012.

EPA will use VDPES permits and the WIPs as tools to implement the TMDL WLAs and provide reasonable assurance that the reductions will be met. These tools, as well as other possible federal consequences, may be leveraged further if a Chesapeake Bay Watershed state or the District does not meet EPA's expectations or does not demonstrate satisfactory progress toward achieving nutrient and sediment allocations established in the TMDL. The first two elements of the accountability framework are the WIPs and the two-year milestones. The Bay states were required to complete their first set of two-year milestones by December 31, 2011.

In May 2009, President Obama issued Executive Order 13508: Chesapeake Bay Protection and Restoration that commits the broad authorities of the Federal government toward a renewed sense of urgency and commitment to restoring the Bay. Pursuant to this Executive Order, the Federal Leadership Committee (FLC) established under Section 201 and comprised of lead agencies referred to elsewhere in the order, compiled the Section 202 draft reports from the lead agencies, and published the Section 203 ordered Strategy for Protecting and Restoring the Chesapeake Bay Watershed on May 12, 2010. The FLC published the Fiscal Year 2011 Action Plan in accordance with Section 205 on September 30, 2010. The strategy begins a renewed and unparalleled effort by the federal government to restore clean water, recover habitat, sustain fish and wildlife, conserve land, increase public access, expand citizen stewardship, develop environmental markets, respond to climate change and strengthen scientific knowledge. It focuses on improving the environment in communities throughout the entire watershed and in its thousands of streams, creeks and rivers.

The key impact to City of Alexandria wastewater collection and treatment is the measurable goals for mandatory progress to reduce nutrient levels in the Chesapeake Bay watershed jurisdictions by 2025. The Bay States and the District have 15 years (since the TMDL was issued) to reduce the levels of nitrogen and phosphorous by 44 and 27 percent, respectively. Six contributing load source sectors (agriculture, urban run-off, septic systems, wastewater treatment plant discharge, forests, and air deposition) have been identified within the Bay watershed and have received WLAs as part of December 29, 2010 TMDL (Phase I). AlexRenew and the City's CSS received waste load allocations (WLA) as part of Phase I.

2.4 Hunting Creek Bacteria TMDL

A number of waterbodies in the Commonwealth of Virginia have been placed on EPA's impaired waters list per Section 303(d) of the CWA. Once a waterbody is listed as impaired for a designated use, a TMDL value must be developed for that impaired stream or stream segment to address the impairment. This has led to a number of TMDLs to be issued in the Commonwealth and the City. Most of these TMDLs focus on stormwater runoff as one of the primary pollutant sources and reductions are aimed at reducing pollutants found in runoff. Hunting Creek, which receives discharges from the AlexRenew WRRF and the City's CSS in addition to other sources, was placed on the 303(d) list due to exceedance of water-quality standards for fecal coliform bacteria in 1998, a constituent found in the intestinal tracts of warm-blooded mammals, and therefore in stormwater, wastewater treatment plant discharges and in CSOs. However, it should be noted that although Hunting Creek was listed due to exceedance of fecal coliform bacteria, the attainment of water-quality standards is now assessed using *E. coli* bacteria. VDEQ used a translator using regression analysis to convert from fecal coliform to *E. coli* bacteria in developing the TMDL.

The Holmes Run, Cameron Run and Hunting Creek TMDL was finalized on November 10, 2010 with EPA's Decision Rationale provided on November 10, 2010. The AlexRenew WRRF has a permitted discharge limit for *E. coli* and has proven to meet their discharge limits, so no reductions are required at the wastewater treatment facility. The TMDL requires wasteload reductions for *E. coli* at CSO outfalls 002, 003 and 004 of 80%, 99% and 99%, respectively, for a total wasteload reduction (from CSOs) of 86% from these three outfalls. It is possible that the City will have to update its existing Long Term Control Plan to address the wasteload reductions in the TMDL before the next permit is issued.

Currently, it is unknown what the future CSS VPDES permit requirements will be and the extent to which reductions at the three CSS outfalls will be pursued. The City is currently having discussions with VDEQ regarding these permit requirements. The possibilities for reductions range from continuing the City's existing post-construction monitoring program to elimination of the CSOs through full sewer separation over some established timeframe. It is likely that the requirements for the next permit cycle will include increased CSO mitigation and wasteload reductions within this range of possibilities.

2.5 Possible Future Regulations

There are a number of potential future regulations that could impact the collection and treatment of the City's wastewater, including the following that are discussed in this section:

- SSO Rule and CMOM component
- Water Quality Standards
- Secondary Treatment Definition
- Nutrient Numerical Criteria

2.5.1 SSO Rule and Capacity, Management, Operations, and Maintenance (CMOM)

The EPA has acknowledged, and confirmed, that sanitary sewer overflows (SSOs) cannot be completely eliminated. Sanitary sewer systems that are designed to accommodate a given design storm (frequency and duration) may experience wet-weather induced overflows as a result of rainfall conditions that exceed the design storm. These are referred to as "unavoidable" overflow events.

However, the EPA also believes that inadequate management, operation, and maintenance of wastewater collections systems are the greatest cause of SSOs across the nation. These are referred to as “avoidable” SSOs. In general, the regulatory requirements for wastewater collection systems are becoming more stringent at the state and federal level, with a trend toward a zero-tolerance policy for “avoidable” SSOs. Under the draft regulations proposed by the EPA, the nation’s sewer systems that have a National Pollution Discharge Elimination System (NPDES) permit may be required to implement a CMOM program under pending SSO regulations. The proposed CMOM regulations will require system agencies to report regularly on system efficiency. The regulations are intended to indicate the condition of a municipality's collection system and require the agency to self-audit system capacity during both dry and wet weather. Reporting would also include overall system management activities, such as mapping, maintenance tracking, training, supervision, and operational efficiency data as measured in spending and equipment performance. The premise of the CMOM program is that when a utility incorporates good business principles into its organization, its wastewater collection system will meet the intended performance standards and result in fewer SSOs. In general, the CMOM program places the burden of proof on the system owner to demonstrate that by using pipes, pumps, and infrastructure with adequate capacity, and by properly managing, operating and maintaining the system; SSOs are being prevented to the maximum extent practical. The CMOM program consists of ten components as follows:

- Authority’s Goals
- Authority’s Organization, Responsibilities, and Chain of Communications
- Legal Authority of the Authority’s CMOM Programs
- Measures and Activities
- Design and Performance Provisions
- Monitoring, Measurement, and Program Modifications
- Program Elements including an overflow emergency response plan, system evaluation and capacity assurance plan, and program audits
- Reports including immediate notification and follow-up reports, discharge monitoring reports, and annual report.
- Record Keeping
- Additional Public Notification

Currently, the City has a maintenance program related to its collection system, but does not have a CMOM program as it does not own or operate any SSOs. AlexRenew owns two SSOs, one at the treatment plant (Hooff’s Run Junction Chamber) and one at the Four Mile Run Pumping Station. Related to “unavoidable” SSOs, the EPA has not set a threshold or defined what constitutes an “unavoidable” SSO with relation to wet weather.

It should be noted that the City’s collection system is not included as part of AlexRenew’s existing NPDES permit, but it’s possible that the EPA could require individual jurisdictions that own and operate collection systems to be included as part of the NPDES permit program. If these regulations change and/or if a wet weather SSO threshold if defined, then the City may be required to develop its own CMOM program aimed at reducing the occurrence of SSOs. The City’s existing maintenance program will be incorporated into a formalized Asset Management Program, which can then later be included into a CMOM, if necessary. The development of an Asset Management Program is discussed further in Chapter 3.

2.5.2 Water-Quality Standards

Water-quality standards are the foundation of the water-quality based control program mandated under the CWA. Water-quality standards for a waterbody are set to protect the designated uses, and establish provisions to protect water quality from pollutants. A water quality standard consists of four basic elements:

- designated uses of the water body (e.g., recreation, water supply, aquatic life, agriculture),
- water-quality criteria to protect designated uses (numeric pollutant concentrations and narrative requirements),
- an antidegradation policy to maintain and protect existing uses and high quality waters, and
- General policies addressing implementation issues (e.g., low flows, variances, mixing zones).

Standards help to identify water-quality problems caused by, for example, improperly treated wastewater discharges, runoff or discharges from active or abandoned mining sites, sediment, fertilizers, and chemicals from agricultural areas, and erosion of stream banks caused by improper grazing practices. Standards also support efforts to achieve and maintain protective water quality conditions, including:

- TMDLs, which incorporates WLAs for point sources of pollution, and load allocations for non-point sources of pollution,
- Water-quality management plans which prescribe the regulatory, construction, and management activities necessary to meet the water body goals,
- NPDES water-quality based effluent limitations for point source discharges,
- Water-quality certifications under CWA Section 401 for activities that may affect water-quality and that require a federal license or permit,
- Reports, such as the reports required under CWA Section 305(b), that document current water-quality conditions, and
- CWA Section 319 management plans for the control of non point sources of pollution

The CWA requires States and authorized Indian Tribes to review their standards from time to time, but at least once every three years (called the triennial review of WQS), and revise them if appropriate. Updates to water quality standards may also be precipitated, for example, due to changing water quality conditions or water body uses or new scientific information on the effects of pollutants in the environment. Recent changes in Virginia's Water Quality Standards (effective January 20, 2011) incorporate amendments from the most recent Triennial Review (adopted March 19, 2009), and revisions to the Bay's Ambient Water Quality Criteria.

Each State and authorized Tribe has its own legal and administrative procedures for adopting water quality standards. In general, standards are adopted following a process in which draft revisions are developed (this may include a work group process or informal public meetings) and formally proposed for public comment. A public hearing is then held to receive input from the public regarding the proposal. The proposed water quality standards and supporting information are made available to the public prior to the hearing.

States and Tribes are required to prepare a summary of the public comments received and how each comment was addressed. Upon EPA approval, new or revised water quality standards become effective.

EPA may develop water-quality standards that supersede state water-quality standards in cases where new or revised State or Tribal standards are not consistent with applicable requirements of the CWA or in situations where the EPA Administrator determines that Federal criteria or standards are necessary to meet the requirements of the CWA.

Depending on what industries are present within the service area of Alexandria, and based on the revolving review policy that EPA employs to evaluate point sources, new water quality standards could be developed and enforced. While the point sources are reviewed every two years, developing new water quality standards is often a lengthy process that can take several years to implement. However, the current changes to the standards were accomplished in a very brief timeframe. Due to a need for consistency between the Chesapeake Bay Ambient Water Quality Criteria and the Bay TMDL, Virginia quickly adopted the revised Bay criteria into the State standards.

2.5.3 Secondary Treatment Definition

Under the CWA, secondary treatment standards are established by EPA for publicly owned treatment works and involve some form of biological treatment. These technology-based regulations apply to all municipal wastewater treatment plants and represent the minimum level of effluent quality attainable by secondary treatment, as reflected in terms of 5-day biochemical oxygen demand (BOD5) and total suspended solids (TSS) removal. The secondary treatment standards also provide for special considerations regarding combined sewers, industrial wastes, waste stabilization ponds, and less concentrated influent wastewater for combined and separate sewers.

The current definition of secondary treatment relates to both effluent limits (30/30 mg/L for BOD5 and total suspended solids, TSS) and the overall percent removal of BOD5 and TSS (85%). During November 2007, the National Resource Defense Council (NRDC), on behalf of several environmental organizations, petitioned EPA to expand the definition of secondary treatment to encompass the removal of nitrogen and phosphorous. The NRDC proposal offered possible nitrogen and phosphorous limits of 0.3 mg/l total phosphorus (TP) and 3.0 mg/l total nitrogen (TN). Municipal WWTP in general oppose this proposed modification to secondary treatment standards because of the increased capital costs they will incur. Also, they maintain that non point sources, such as surface water runoff contribute to the nitrogen and phosphorous input to waterbodies.

2.5.4 Nutrient Numerical Criteria

In 2008 EPA was sued by the Florida Wildlife Federation to establish National Nutrient Numerical Criteria as water quality standards for surface and marine waters in the State of Florida. Currently, the CWA has "narrative criteria" for nutrient water quality standards but does not include numerical limits. The "narrative criteria" includes items such as "no discharge of nutrient into surface water shall cause any impact of the receiving water and any damage". The state agencies are left with the task of establishing discharge limits for each WWTP based on the specific body of water, and if deemed necessary based on TMDL. The EPA entered into a consent order agreement to establish Nutrient Numerical Criteria for total phosphorus and total nitrogen on a water quality based effluent limitation basis. Final standards were established in November 2010. The rule will take effect on

March 6, 2012 to allow cities, towns, businesses and other stakeholders as well as the State of Florida a full opportunity to review the standards and develop strategies for implementation. These criteria do not apply to the Commonwealth of Virginia at this time. If Nutrient Numerical Criteria are established in the Virginia, it is possible that the effluent limits could be lower than those established by the Bay TMDL and be very costly to achieve.

Chapter 3
Sanitary Sewer Service Area Characteristics

3.1 Introduction

Alexandria's wastewater collection system dates back to the 1800s when the City constructed a system of combined sewers in the Old Town area to convey stormwater and wastewater to the Potomac River. This was typical of municipalities in the Washington, D.C. area during this time. Untreated sewage in the area waterways presented an enormous public health threat, leading to many cases of cholera, hepatitis and dysentery.

In 1952, the Alexandria City Council created the City of Alexandria Virginia Sanitation Authority, now known as Alexandria Renew Enterprises (AlexRenew) for the purpose of constructing, operating and maintaining a sewage disposal system to serve Alexandria and portions of Fairfax County. The first treatment plant went into service in 1956 and was an 18 mgd trickling filter plant. In addition, three trunk sewers and two pumping stations were constructed to convey wastewater from collector sewers (owned by the City) to the wastewater treatment plant (WWTP). The benefits of constructing the WWTP included improved water quality and reduced incidents of disease.

Since the initial treatment plant operation, a number of upgrades have been performed, including expansion to a 54 mgd design capacity. A fourth trunk sewer and another pump station were more recently constructed to serve the Potomac Yard area. The construction of the Potomac Yards Pump Station resulted in the decommissioning of the River Road Pump Station in 2010.

The City's wastewater collection system has expanded as the City has grown and currently consists of approximately 240 miles of gravity pipeline ranging in size from 6-inches in diameter to 7-feet by 6-feet. The majority of the City's wastewater flows are treated at the AlexRenew Water Resource Recovery Facility (WRRF). Wastewater flows not treated at AlexRenew are conveyed to and treated at the Arlington County Water Pollution Control Plant (WPCP). These portions of the City's wastewater collection system served by each of the wastewater treatment plants are shown in Figure 3-1.

The planning, engineering and maintenance of the gravity collector sewers is the responsibility of the City of Alexandria Department of Transportation and Environmental Services (T&ES). The operation and maintenance of the AlexRenew WRRF, trunk sewers and pump stations is the responsibility of AlexRenew. AlexRenew is governed by a board of five citizen members appointed by City Council to four-year staggered terms. It is a public body in all respects, but is independent of the City government both administratively and financially.

The AlexRenew Board hires its own staff, establishes its own operating policies, and adopts the schedule of rate fees and charges paid by the users of the system.

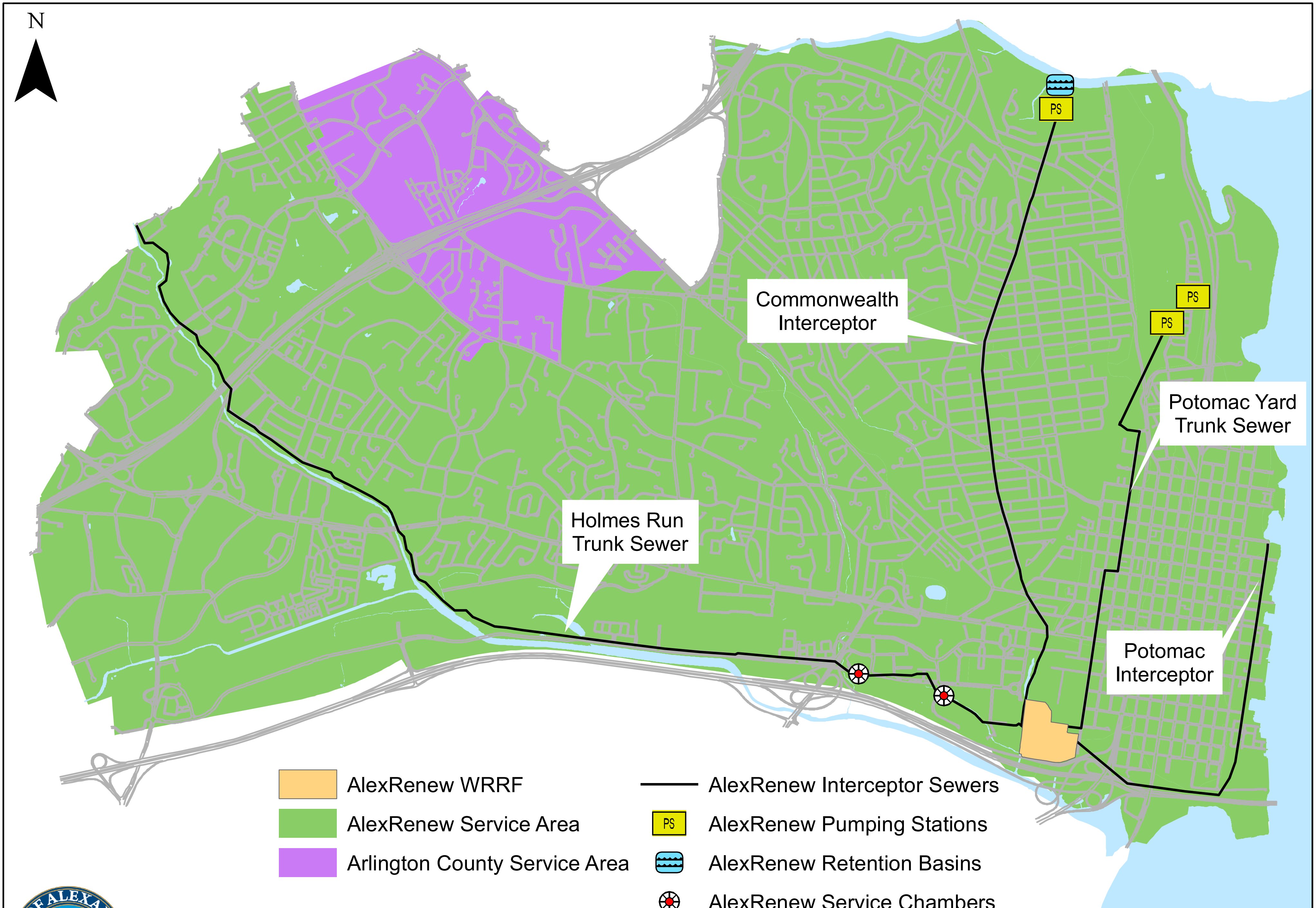


FIGURE 3-1
WWTP SERVICE AREAS AND ASSETS
Sanitary Sewer Master Plan

3.2 Sewershed Overview

The existing wastewater collection system within the City covers approximately 15.75 square miles and can be divided based on which AlexRenew interceptor sewer the wastewater flows are conveyed to, except the Arlington County WPCP sewershed. These sewersheds are delineated for the purpose of capacity planning as well as permitting issues and are shown in Figure 3-2. Information pertaining to each of the sewersheds is presented on Table 3-1.

TABLE 3-1 – CITY WASTEWATER SEWERSHED SUMMARY

Sewershed(s)	Area (sq mi)	Miles of Sanitary/ Combined Sewer	Interceptor/ Trunk Sewer	Pump Station(s)
Holmes Run	7.39	96	Holmes Run Trunk Sewer	None
Commonwealth **Four Mile Run** **King/West CSO**	4.41	90	Commonwealth Interceptor	Four Mile Run
Potomac **Pendleton CSO** **Royal CSO**	1.94	40	Potomac Interceptor	None
Potomac Yards	0.41	4	Potomac Yard Trunk Sewer	Slater's Lane Potomac Yard
Arlington County WPCP	1.18	16	None	None

The majority of the City's collection system is comprised of separate sanitary and storm sewers, where stormwater flows are discharged to receiving waters via a stormwater outfall structure. The City's stormwater sewer system is not in the scope of this Sanitary Sewer Master Plan. The City also is served by a combined sewer system (CSS) which includes both sanitary wastewater and stormwater flows. A description of the CSS is presented below.

3.2.1 COMBINED SEWER SYSTEM (CSS)

The area served by the CSS comprises about 0.9 square miles, generally located in the Old Town area of the City, east of U.S. Route 1. CSSs are common in older cities and Alexandria's CSS includes 38 miles of pipe with four permitted combined sewer overflows (CSOs). Sanitary wastewater collected in the CSS under dry weather conditions is conveyed to AlexRenew's WRRF. During periods of rainfall, the capacity of the CSS may be exceeded and excess flow, which is a mixture of stormwater and sanitary wastewater, is discharged directly to Hunting Creek, Hooff's Run or the Potomac River at Oronoco Bay through the

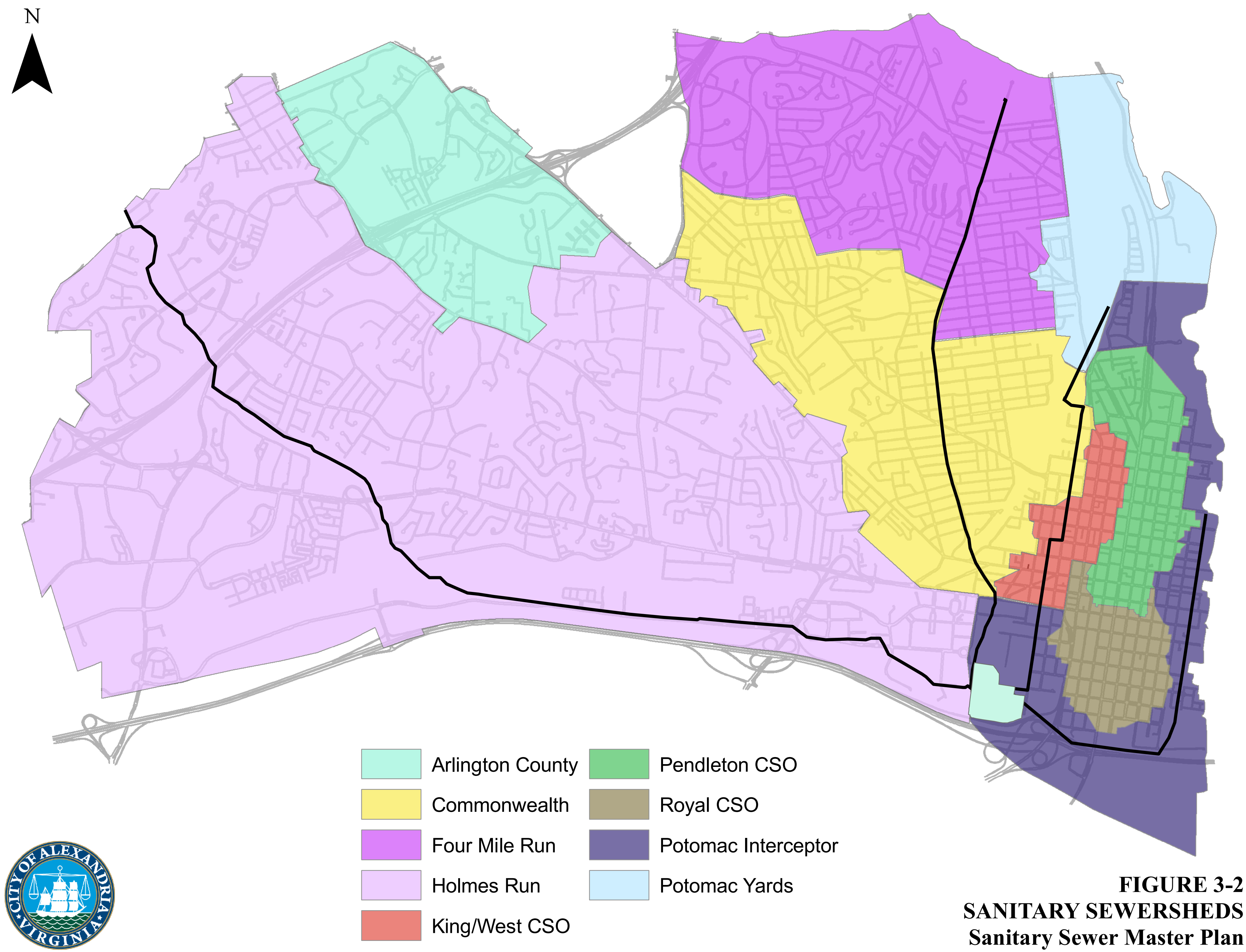


FIGURE 3-2
SANITARY SEWERSHEDS
Sanitary Sewer Master Plan

City's four permitted CSO structures. The City is authorized to discharge CSOs from the CSS under its Virginia Pollution Discharge Elimination (VPDES) Permit No. VA00887068 issued by the Commonwealth of Virginia's Department of Environmental Quality (VDEQ). The City's three CSS subsheds and the four permitted CSO outfall locations are shown on Figure 2-1.

The City is currently in its third 5-year permit cycle and is operating in post-monitoring status following approval of its Long Term Control Plan in 1999 by VDEQ. The City's VPDES permit requires the City to comply with its approved Long Term Control Plan which includes the following Nine Minimum Controls related to CSO control established by the EPA:

- Conduct proper operations and regular maintenance programs
- Maximize use of collection system for storage
- Control of non-domestic discharges
- Maximize flow to the AlexRenew WRRF
- Prohibit combined sewer overflows during dry weather
- Control solid and floatable materials in CSOs
- Develop and implement pollution prevention programs
- Notify the public of CSOs
- Long Term Control Plan review
- Submit an Annual Report to VDEQ by March 31st each year

The existing permit has an ending date of January 15, 2012. The City reapplied for renewal of the permit in July 2011. VDEQ has reviewed the permit reapplication and found it to be both timely and complete. The City is currently discussing with VDEQ the details and requirements that will be included as part of the next permit cycle and VDEQ has administratively continued the current permit.

In addition to the Nine Minimum Controls, the City is enacting other measures to reduce the occurrences and volume of CSOs. The City has separated some of the combined sewers (sanitary, storm or both) in areas of redevelopment or other projects. The City has also produced a sewer separation plan, which provides a phased approach for separation and is used as a reference tool when new development projects in the CSS arise.

3.3 Sewer Collection System Characteristics

The sewer collection system collector sewers, trunk sewers, pump stations, gravity mains, and treatment facilities are further described in this section.

3.3.1 GRAVITY MAINS

The sewer collection system gravity mains (sanitary and combined) are operated and maintained by the City's Transportation and Environmental Services (T&ES) Department as discussed in Section 3.1. The gravity mains are highlighted on Figure 3-3 and consist of approximately 240 miles of pipeline, ranging in size from 6-inches in diameter to 7-feet by 6-feet and 7,600 manholes. It should be noted that the majority of the collection sewers are less than 12 inches in diameter. The gravity collector sewers are mostly constructed of either unlined concrete pipe, vitrified clay pipe or polyvinyl chloride pipe. Most the manholes are 4 feet in diameter and constructed of either brick or concrete. Table 3-2 presents a summary of the gravity sewers based on pipe diameter and Table 3-3 presents a summary of the gravity sewers based on pipe material. These tables are based on the City's

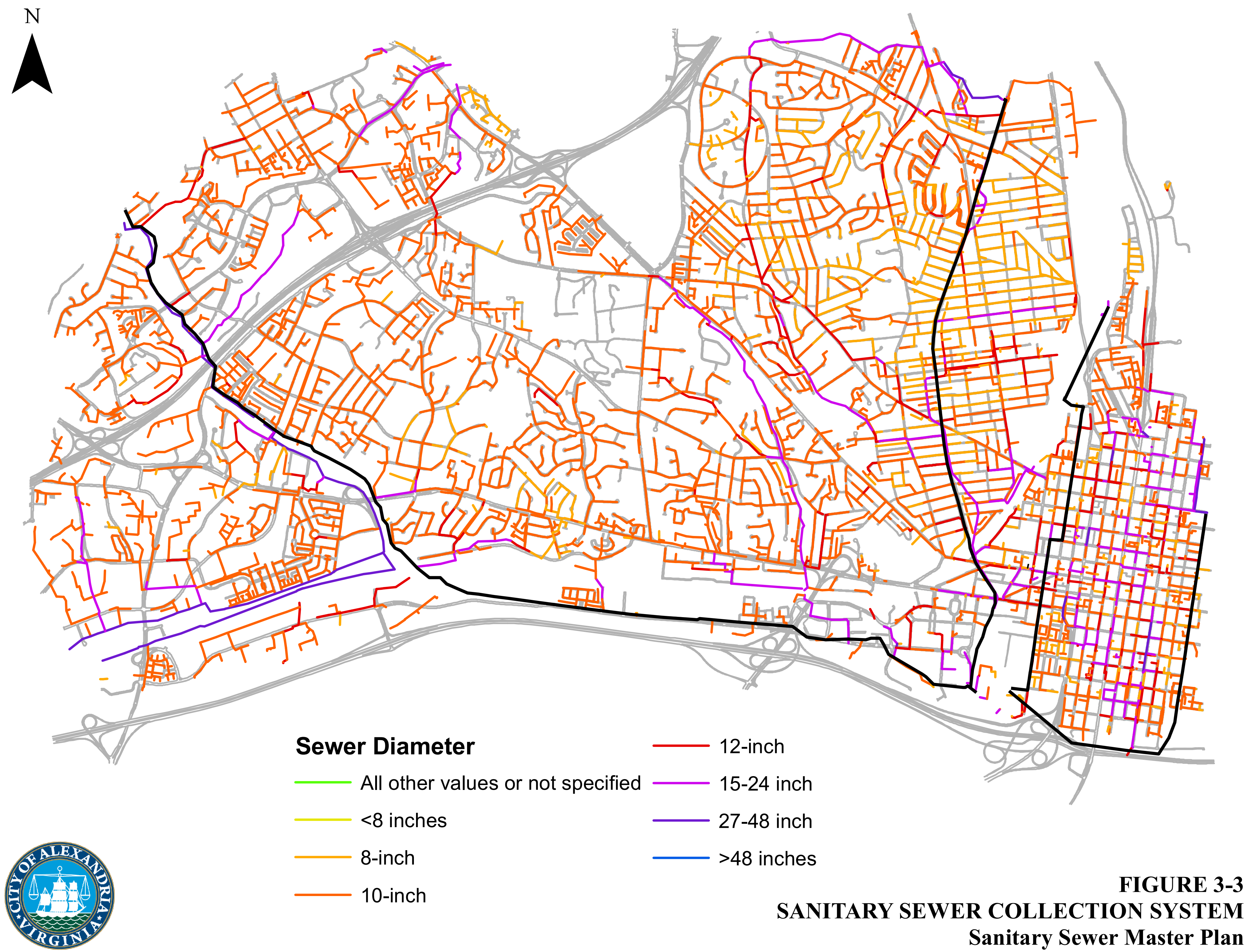


FIGURE 3-3
SANITARY SEWER COLLECTION SYSTEM
Sanitary Sewer Master Plan

Geographic Information System (GIS) of the sanitary sewer system, which is being updated on a continuous basis, based on new development or redevelopment or as a result of field investigations. It should be noted that some of these sewers have been rehabilitated (lined) or replaced as part of the City's I/I (infiltration and inflow) program. More information related to this program is presented in Section 3.4.

TABLE 3-2 – SUMMARY OF GRAVITY SEWERS BASED ON PIPE DIAMETERS

Pipe Diameter (inches)	Total Length (lineal feet)	Percent of Total System (%)
6-10	982,740	80.3
12-18	184,316	15.1
21-24	26,570	2.2
27-36	5,123	0.4
42-60	1,620	0.1
>60	347	<0.1
Box or Elliptical (width/height vary)	8,201	0.7
Unknown or Not Specified	15,168	1.2

Note: Does not include AlexRenew Interceptor sewers

TABLE 3-3 – SUMMARY OF GRAVITY SEWERS BASED ON PIPE MATERIAL

Pipe Material	Total Length (lineal feet)	Percent of Total System (%)
Concrete (RCP or Other)	781,233	63.9
PVC (Polyvinyl Chloride)	192,583	15.7
VCP (Vitrified Clay)	132,749	10.8
DIP (Ductile Iron)	57,231	4.7
Other/Not Specified/Unknown	59,455	4.9

Note: Does not include AlexRenew Interceptor sewers

3.3.2 TRUNK SEWERS AND PUMP STATIONS

Four major interceptor/trunk sewers and three pump stations are owned and operated by AlexRenew as discussed in Section 3.1. The trunk sewers and pump stations are shown on Figure 3-1. Table 3-4 provides information in relation to each of the four interceptor sewers and Table 3-5 presents information pertinent to each of the pump stations.

TABLE 3-4 – SUMMARY OF ALEXRENEW INTERCEPTOR SEWERS

Interceptor Name	Length (lineal feet)	Sewer Diameter (inches)[1]	Estimated Capacity (mgd)[2]
Commonwealth Interceptor	15,700	36 & 42	28
Holmes Run Trunk Sewer	28,100	60	60
Potomac Interceptor	10,600	42	16
Potomac Yard Trunk Sewer	8,650	30	11

[1] Sewer diameter varies throughout the length of pipe; reported diameter is basis for capacity

[2] Capacity as reported in *Wastewater Capacity and Treatment Issues Technical Memorandum of Engineering Review*, prepared by Greeley and Hansen on April 9, 2010

TABLE 3-5 - SUMMARY OF ALEXRENEW PUMP STATIONS

Pump Station Name	Firm Capacity (mgd)	Retention Basin Size (mg)	Presence of Constructed Bypass Point
Four Mile Run	9.4	1.05	Yes[1]
Potomac Yard	9.5	N/A	N/A
Slaters Lane	1.5	N/A	N/A

[1] Bypass to Four Mile Run

3.3.3 TREATMENT FACILITIES

The majority of the City's sewer collection system conveys wastewater flow to the AlexRenew WRRF as discussed above. The plant has a rated annual average capacity of 54 mgd and sits on a 30-acre site on the north bank of Hunting Creek near the Potomac River as shown on Figure 3-1. The City's allocation of the plant capacity is 21.6 mgd. Fairfax County has a separate agreement with AlexRenew of 60% of the WWTP annual average capacity, or 32.4 mgd. Figure 3-4 shows the AlexRenew sewer service areas from both the City and Fairfax County.

Existing processes at the AlexRenew WRRF include preliminary, primary, and secondary treatment followed by chemical addition (metal salt) for phosphorus removal, sedimentation, filtration, ultraviolet (UV) disinfection and post aeration. Solids processing includes gravity thickening of primary and tertiary sludges, mechanical thickening of waste activated sludge, centrifuge dewatering, and prepasteurization. Initial operation of the new Biological Nutrient Removal (BNR) system was achieved in December 2002. This system has

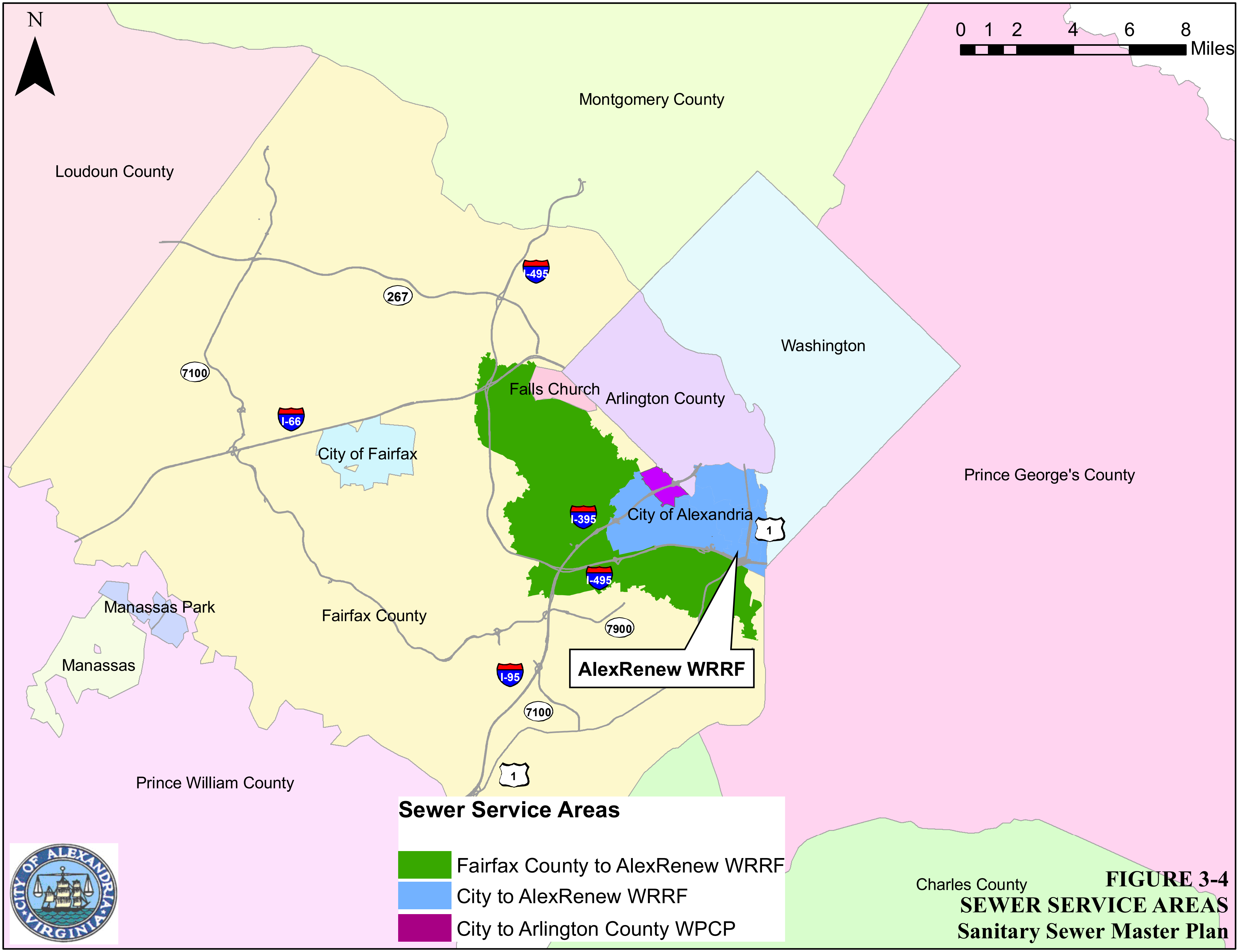


FIGURE 3-4
SEWER SERVICE AREAS
Sanitary Sewer Master Plan

reduced nitrogen discharges from the plant by approximately 80 percent. In 2006, AlexRenew completed a significant upgrade to the treatment plant to meet the water quality requirements of the Potomac Embayment Standards. Through 2015, AlexRenew will upgrade its facilities further to remove nitrogen to the limit of technology requirements. As part of the Chesapeake Bay Program, the AlexRenew WRRF received lower total nitrogen (TN) and total phosphorous (TP) wasteload allocations on January 1, 2011. Table 3-6 presents a summary of these loads. The loads are based on an annual average design flow of 54 MGD.

TABLE 3-6 – ALEXRENEW WRRF TN AND TP WASTELOAD ALLOCATIONS (WLAs)

Constituent	WLA Effective 1/1/2011 (lbs/year)
TN	493,381
TP	29,603

The City also has an allocation of 3 mgd at the Arlington County WPCP via an agreement between the City, AlexRenew and Arlington County. AlexRenew pays for a portion of the capital and operations and maintenance costs of the Arlington County treatment facility.

3.4 Sewer Collection System Condition

The City has two separate programs related to the condition of the existing sewer collection system.

- Preemptive Maintenance Program
- Infiltration and Inflow (I/I) Program

Each of these programs is discussed in detail below.

3.4.1 PREEMPTIVE MAINTENANCE PROGRAM

The preemptive maintenance needs of the system are related to roots, grease, and sags which may not cause structural failure but cost the City money in terms of the amount of maintenance required (e.g. cleaning) to maintain flow. The routine maintenance program is administered by the T&ES Maintenance Division. The Maintenance Division has developed a schedule of sewers (sanitary and combined) that are inspected and cleaned on a regular basis by City forces and contractors. The frequency of inspection varies depending on the type of sewer (gravity, siphon, etc) and maintenance issue (grease, sag, etc). Approximately 128 miles of sanitary and combined sewers are flushed and/or inspected on an annual basis via closed circuit television (CCTV). The City also has a program for operations and maintenance in the CSS that includes catch basin cleaning, diversion structure and outfall inspections, and street sweeping.

In addition to preemptive maintenance, the maintenance program also includes citizen requests for service and emergency repairs. Emergency repairs typically arise from a structural failure, such as a collapsed pipe. These may be discovered by the City or by an affected property owner if the failure results in the occurrence of a basement back-up. In addition to City forces, the City's T&ES Department has an approved list of contractors that can respond to these occurrences on short notice. On average, Maintenance Division staff typically responds to approximately 150 service requests annually related to the sewer collection system. About 60 percent of these are related to a either a maintenance condition (blockage, grease, roots, odor, etc.) or a structural condition (collapsed pipe) on City-owned sewers, whereas the remaining 40 percent are determined to be on private sewer laterals and are thus not repaired by City forces.

3.4.2 INFILTRATION AND INFLOW (I/I) REMEDIATION PROGRAM

Since the 1990s T&ES has been conducting a program to address excessive I/I into sanitary sewers. Infiltration is groundwater that enters sanitary sewers through leaks in pipes. Inflow is stormwater that is directed to the sanitary sewers through connections such as roof downspouts, driveway drains and groundwater sump pumps. During wet weather, infiltration and inflow can increase the flow to sanitary sewers to the point of overload. When this occurs, the excess water can cause sewers to overflow and release pollutants into our waterways and damage private property by creating backups into basements. Initial flow monitoring conducted citywide in the 1990s showed peak wet weather flows up to 10 times the average dry weather flow for 3 sanitary sewersheds; Four Mile Run, Commonwealth and Taylor Run during the flow monitoring period. Figure 3-5 shows the location of each of these areas. The occurrence of significant I/I in these areas led to the creation of a program to address I/I, which included conducting an I/I Study and then following up with an I/I Rehabilitation Program.

The I/I Study consisted of the following components: more intensive flow monitoring to characterize I/I across an entire sewershed, manhole inspections, CCTV inspection of the sanitary sewers, conducting drainage surveys of private property in some locations to assess direct stormwater inputs (downspouts, driveway drains, etc) into the sanitary sewer, and in some cases dye and smoke testing.

CCTV inspections of the sanitary sewer and manhole inspections were conducted to assess the condition of the sanitary sewer system. Sewers and manholes in fair to poor condition allow I/I to enter the system during rainfall events or high groundwater. The I/I studies that were conducted confirmed a number of sewers and manholes had defects that were contributing to the I/I in these sewersheds. This led to the development of sewer rehabilitation contracts in each sewershed to alleviate the defects in City-owned sewers and manholes. To date, rehabilitation has been completed in the Four Mile Run, Commonwealth and Taylor Run sewer service areas and is tabulated below in Table 3-7. The post-rehabilitation monitoring shows a decrease in the amount of wet weather I/I entering the sanitary sewer system. Flow metering and CCTV inspection of the remaining Holmes Run sewershed (see Figure 3-6) started in 2009 and rehabilitation construction is expected to commence in 2012 and continue through 2017.

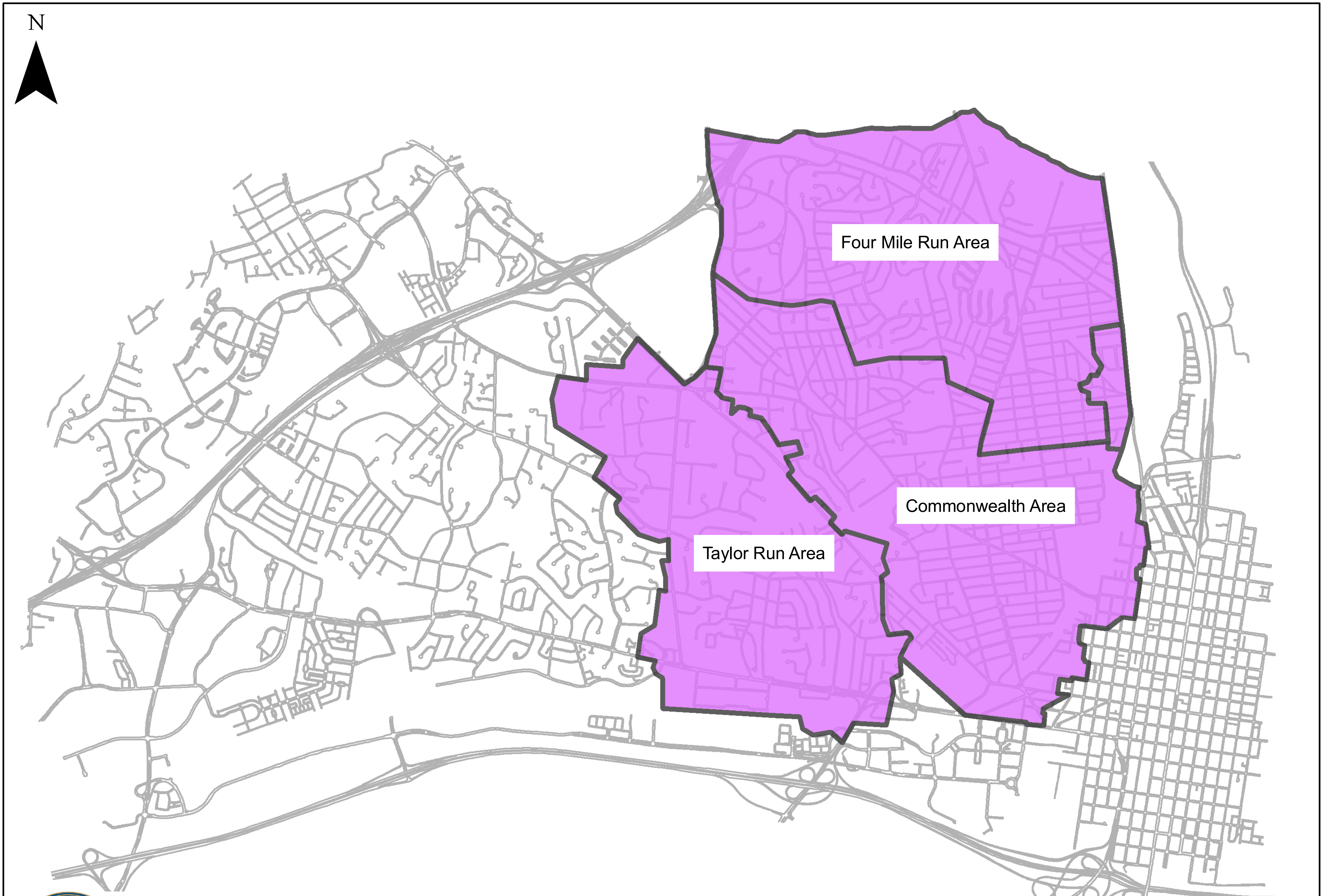


FIGURE 3-5
COMPLETED I/I REHABILITATION AREAS
Sanitary Sewer Master Plan

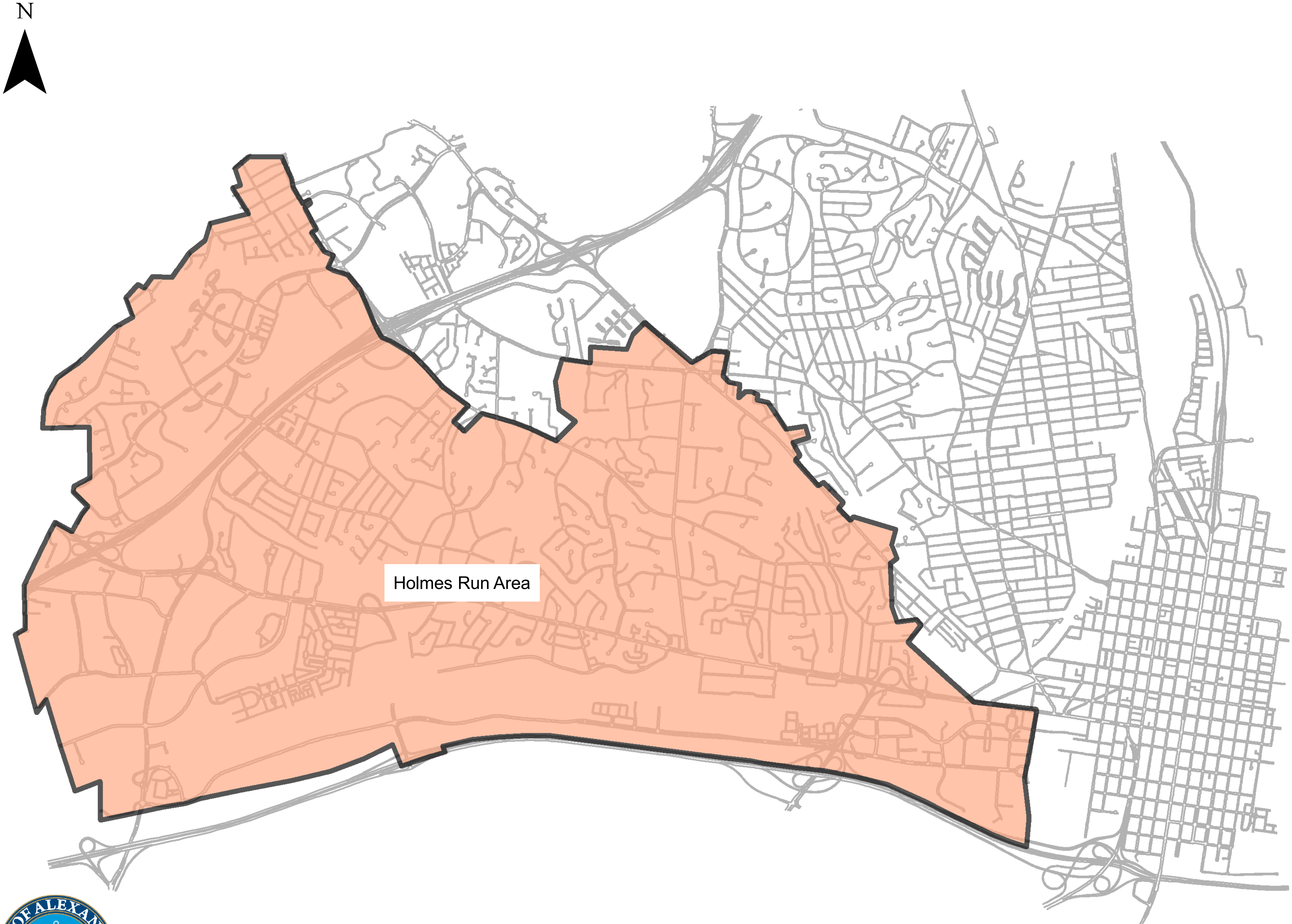


FIGURE 3-6
ONGOING I/I PROGRAM - HOLMES RUN
Sanitary Sewer Master Plan

TABLE 3-7 - SANITARY SEWER INSPECTION AND REHABILIATION			
	Four Mile Run[1]	**Commonwealth**	**Taylor Run**
Sewers inspected (ft)	158,400	204,900	128,400
Sewers repaired through lining (ft)	58,900	71,400	73,700
Sewer point repairs	111	237	170
Manholes inspected	944	1,091	696
Manholes repaired	648	855	619
Rehab completed	December 2005	March 2007	March 2010
Reduction in I&I (total volume basis)	33%[2]	22%[3]	TBD
Total Rehabilitation Contract Cost	$4.86M	$5.50M	$7.42M

[1] Includes River Road Sewershed

[2] Reduction of I/I provided in *Four Mile Run I/I Study Post-Construction Monitoring Results*, prepared by Greeley and Hansen and dated August 2006

[3] Reduction of I/I provided in *Commonwealth I/I Study Post-Construction Monitoring Results*, prepared by Greeley and Hansen and dated October 2008

3.4.3 ASSET MANAGEMENT PROGRAM

The City's T&ES Department is planning to develop an Asset Management Program for the City's sanitary sewer system. An Asset Management Program manages sewer infrastructure assets in order to minimize the cost of owning and operating them, while delivering desired customer service levels. An Asset Management Program allows the owner of a collection system to operate in a continuous planning mode and not operate in a reactive mode. Key elements include the following:

- Level of service definition
- Selection of performance goals
- Information system
- Asset identification and valuation
- Failure impact evaluation and risk management
- Condition assessment
- Rehabilitation and replacement planning
- Capacity assessment and assurance
- Maintenance analysis and planning
- Financial management
- Continuous Improvement

The City's planned Asset Management Program will pull information from the City's existing sewer programs (preemptive maintenance program, I/I remediation program) and software (CityWorks, GIS, sewer modeling) and combine it into an accessible document. The development of this program has been included in the FY2013 CIP and will be initiated in FY2014.

3.5 Sewer Collection System Existing Flows

In order to assess capacity needs in the sewer collection system, interceptor sewers and at the treatment plants, the existing sewer collection system flows must be known. Flows in the City's collection system have been computed using the following methods:

- Flow records at the treatment plants
- Flow metering
- Estimation of flows using population and employment data and application of flow factors

Each of these methods and its application is described in detail below.

3.5.1 TREATMENT PLANT FLOWS

As previously discussed, wastewater flows from the City's collection system are either conveyed to the AlexRenew WRRF or Arlington WPCP. Both treatment plants report the City's wastewater flows via quarterly reports. The City's daily wastewater flows to the AlexRenew WRRF are highly variable and are significantly influenced by the amount of rainfall, which also impact the City's average annual flows. An analysis of the wastewater flows at the AlexRenew WRRF was completed for calendar years 2003-2010 and is discussed further in Chapter 6. Table 3-8 shows the results of this analysis. The flow represents the annual average flow and includes both dry and wet weather contributions.

TABLE 3-8 - CITY ANNUAL WASTEWATER FLOWS – CALENDAR YEAR 2003-2010	
City Flow to AlexRenew WRRF (mgd)	16.30
City Flow to Arlington WPCP (mgd)	1.40
Total City Flow (mgd)	17.70

Permanent flow metering is typically performed when flows are required as part of long-range reporting purposes. For example, Fairfax County has permanent flow meters for all County sewers in the AlexRenew service area. The City flow conveyed to the AlexRenew WRRF is based on the treatment plant flow minus the flow measured at these meters.

In the fall of 2009 the City funded the installation of six permanent flow meters on the AlexRenew interceptor sewers. The meter locations were chosen by the City with the intent of gathering data to perform interceptor sewer capacity assessments, to characterize and evaluate flows within the interceptor sewersheds, further evaluate wet weather issues, and calibrate and validate the AlexRenew interceptor sewer hydraulic models. Rainfall data is also being collected in conjunction with the flow metering data. The meter locations are shown in Figure 3-7.

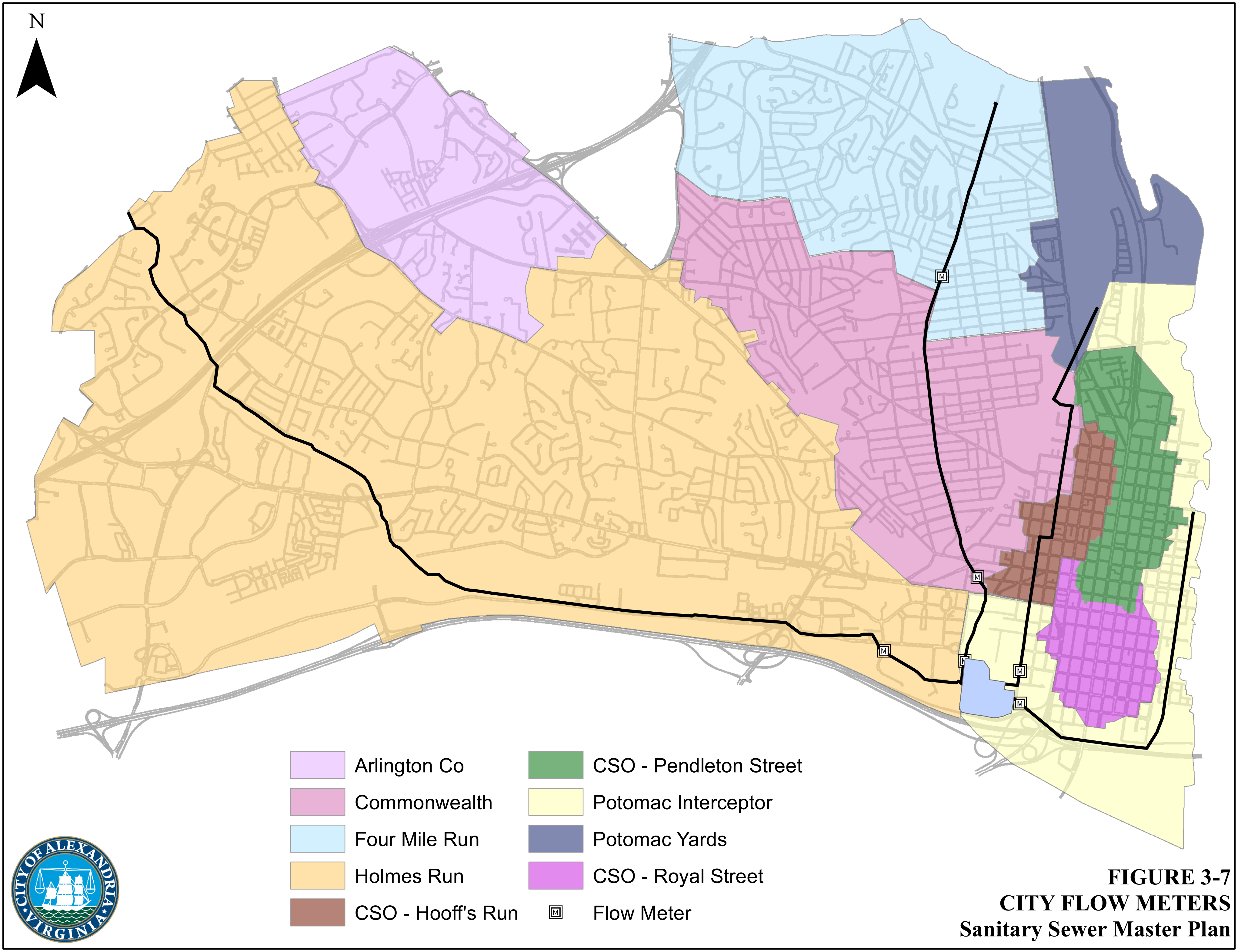


FIGURE 3-7
CITY FLOW METERS
Sanitary Sewer Master Plan

3.5.2 ESTIMATION OF FLOWS USING DEMOGRAPHIC DATA AND FLOW FACTORS

The Metropolitan Washington Council of Governments (MWCOG) provides forecasts of employment, households and population throughout the Washington D.C. Metro Area. The City's Planning and Zoning (P&Z) Department assists MWCOG with this effort and refines their forecasts as needed. Forecasts for employment, households and population are provided in relation to Traffic Analysis Zones (TAZs). Figure 3-8 shows the boundaries of each TAZ for the City. More information about MWCOG and P&Z forecasts is provided in Chapter 4.

In order to estimate existing and future wastewater flows, sanitary sewer flow factors have been developed by the City. A summary of these flow factors is presented in Table 3-9. Residential and non-residential wastewater flow factors were developed based on water consumption data reported in the Interstate Commission for the Potomac River Basin (ICPRB) 2010 report entitled *Demand and Resource Availability Forecast for the Year 2040*. Portions of the ICPRB related to specific flow factors for the City of Alexandria are provided in Appendix 3-1. The flow factor for hotels and the overall peaking factor are based on the Virginia Sewage Collection and Treatment Regulations. The base infiltration rate was developed using flow monitoring collected for the Four Mile Run, Commonwealth and Taylor Run Sewersheds following rehabilitation of City-owned sewers and manholes.

TABLE 3-9 - CITY FLOW FACTORS

Residential Unit Flow	146 gpd/unit[1]
Non-Residential Unit Flow, Except Hotels	136 gpd/1000 square feet (existing)[2]; 110 gpd/1000 square feet (future)[3]
Non-Residential Unit Flow, Hotels	130 gpd/unit
Infiltration	1600 gpd/inch diameter mile (idm)
Peak Factor	4.0

[1] Based on water consumption rate of 160 gpd (composite number including single-family and multi-family units) and a wastewater return rate of 91% as reported in the AlexRenew 1988 report entitled *Availability of Wastewater Treatment Capacity to Serve Alexandria Growth Projected to the Year 2010*

[2] Based on an employee flow rate of 42.9 gpd, 3.5 employees per 1000 square feet and 91% wastewater return rate

[3] Same as 2 including 20% reduction based on the City's required installation of WaterSense fixtures

There are two values for the non-residential flow factor (not including hotels), for existing flows and future flows. The basis of the existing flow of 136 gpd/1000 sqft comes from the ICPRB report. The future non-residential flow factor takes into account water conservation from the installation of low-flow fixtures.

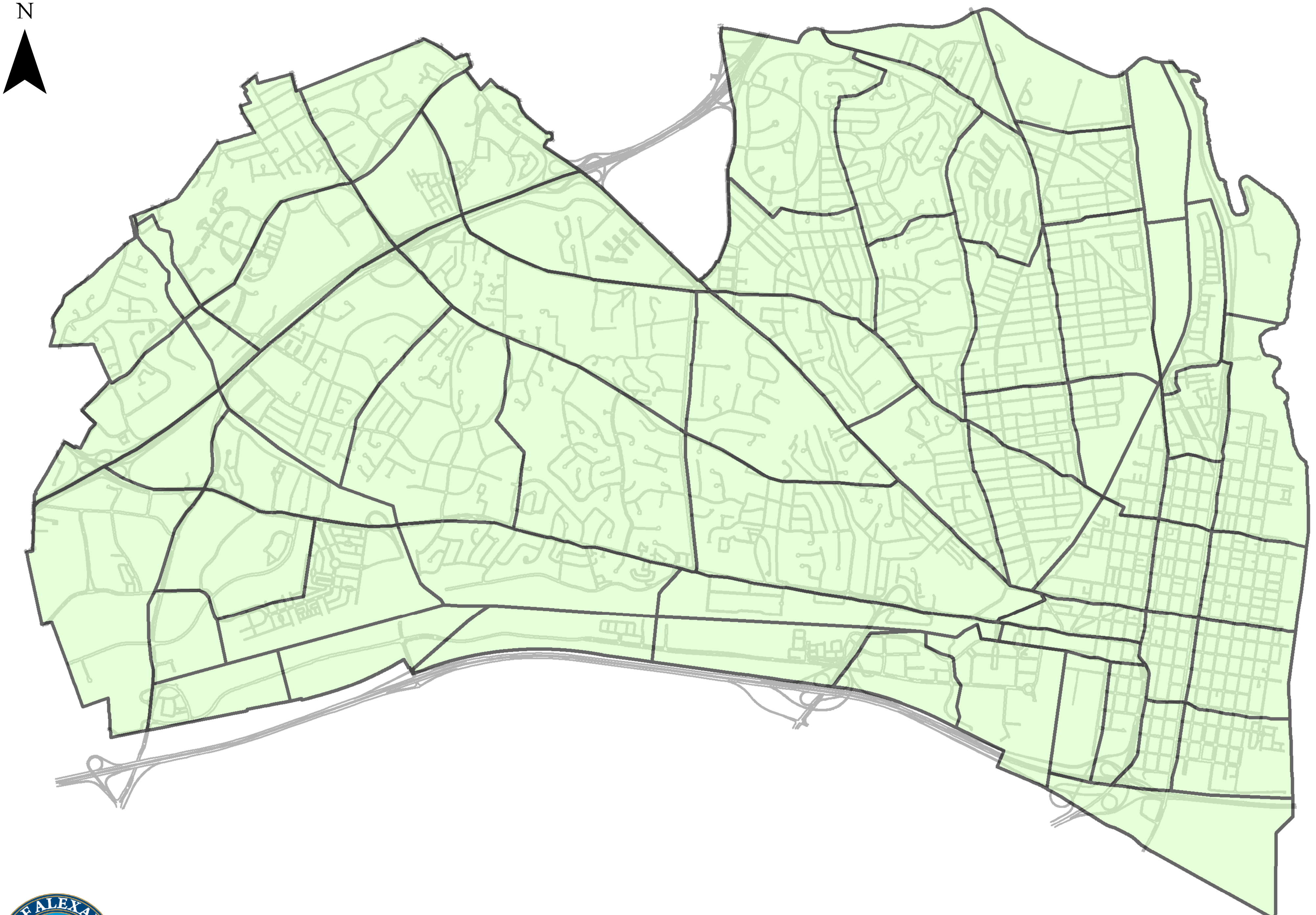


FIGURE 3-8
MWCOG TRAFFIC ANALYSIS ZONES
Sanitary Sewer Master Plan

It should be noted that these City flow factors are used for operational purposes only. A different set of flow factors has been published (Memorandum to Industry No. 02-07 dated June 1, 2007) for use by developers, architects, engineers and surveyors for determining adequacy of existing infrastructure. The residential and non-residential flow factors are higher than the flow factors reported in Table 3-9 since there is an allowance for infiltration within the flow factor, instead of a separate infiltration flow rate. In addition, the flow factors reported in the Memorandum to Industry are higher to also account for a design safety factor when estimating sewer flows and determination of adequate outfall. Appendix 3-1 provides information related to the City's and State's sewage flow factors and sanitary sewer design criteria.

3.6 Sewer Collection System Capacity

One of the primary goals of this Sanitary Sewer Master Plan is to determine instances where the capacity of the collection system is exceeded, either due to existing wastewater flows or as a result of planned development or redevelopment. As the City continues to grow, a tool is needed to assess capacity on a systemwide basis based on long-range planning. This has led to the development of a hydraulic model of the sanitary sewer collection system. More information related to the hydraulic model (model development, implementation and preliminary results) is presented in Chapter 5.

Chapter 4
Demand Generators

Demand for wastewater collection, treatment and disposal is created by the population and economic activity in a community. This chapter identifies the nature and geographic distribution of population and land uses in Alexandria today, and provides forecasts of future development consistent with regional projections. These forecasts are used to project future sanitary sewer infrastructure needs.

The table below summarizes some key components of existing conditions and projected future development used to develop forecasts of wastewater generation for the City of Alexandria. This chapter discusses how these estimates were developed and the assumptions on which they were based. The forecasts and their implications for future facilities demand will be regularly reviewed in response to changing information, in particular when this information indicates a significant change to past assumptions is in order.

TABLE 4-1 - HOUSING, POPULATION & EMPLOYMENT FORECASTS

	2005	2010	2015	2020	2025	2030	2035	2040	Post-2040[2]
Housing Units	68,406	72,204	74,110	79,614	84,841	89,367	94,301	98,431	120,800
Households	66,337[1]	66,789	68,555	73,649	78,486	82,676	87,243	91,066	111,800
Population									
In Housing Units	133,953[1]	142,910	147,387	156,493	164,810	171,542	178,838	186,674	228,600
Group Quarters	1,901	1,901	2,071	2,071	2,071	2,071	2,071	2,071	2,000
Total	135,854	144,811	149,458	158,564	166,811	173,613	180,909	188,745	230,600
Employment	105,852	108,965	117,001	125,019	137,175	144,754	156,290	164,005	241,977

[1] 2005 housing and population estimates per round MWCOG 7.2 forecasts.

[2] Post-2040 estimates for Sewer Master Plan only, see text for explanation of assumptions and method.

4.1 Demographic Projections

4.1.1 BASELINE POPULATION/EMPLOYMENT

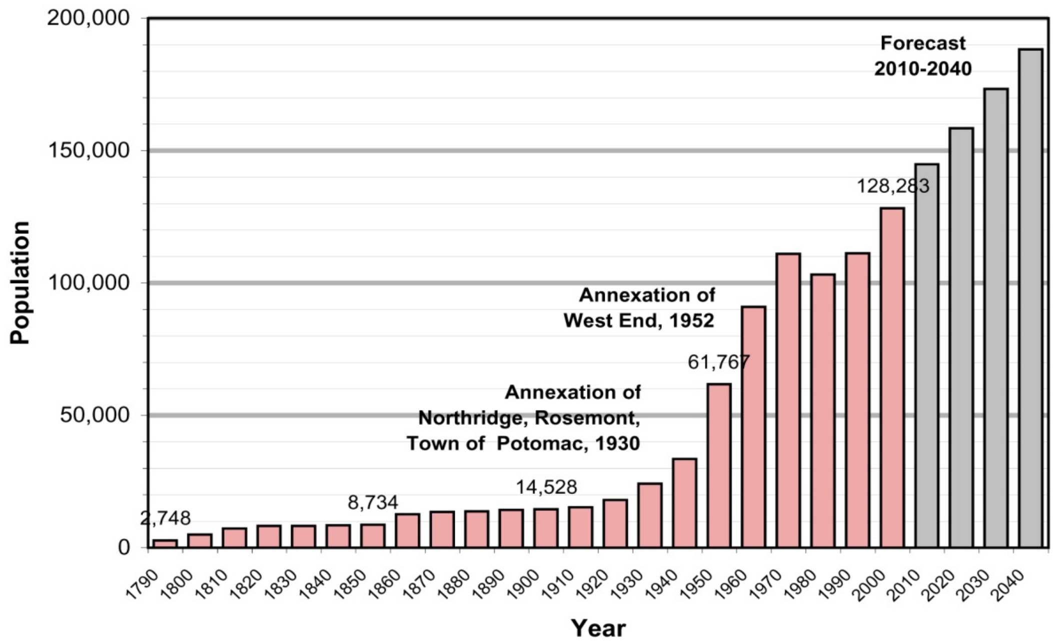
Alexandria is a medium-sized city of approximately 140,000 people. In 2000, the Washington, D.C. metropolitan region had a population of over seven million people, and was the fourth most populous metropolitan region in the country. Since it includes a relatively small portion (about 2%) of the total population and economic activity in the region, the City is very much subject to the economic fortunes of the region as a whole, but its small size also means it has some ability to set policy for what specific residential, commercial and public use markets it will serve within the wide range of possible activities in the region.

Economic activity in Alexandria includes providing day-to-day retail and service support for its resident population, as well as providing a wide range of services to the metropolitan region. Alexandria is home to a large number of national and international associations that have their headquarters in the Washington region in order to be close to the seat of national government. It provides work locations for government agencies and for contractors and consultants who support the Department of Defense and other federal agencies. Alexandria is a tourist center in its own right with a long and colorful history, and provides hospitality services to the larger visitor population attracted by Washington, D.C., Mount Vernon and other sites in the region, and those passing through on major transportation corridors. While the Port of Alexandria once hosted significant shipping and shipbuilding, the waterfront's economy is now based on serving residents, visitors and office-based businesses, and heavy industry today plays a smaller role as part of the city's economic activity.

The City's economy has a healthy balance between jobs and population with more jobs (estimated 104,366 in 2010 by the Virginia Employment Commission) than members of the civilian (non-military) labor force (98,450 per the Virginia Employment Commission), and is supported by its location along the regional Metrorail system and its close access to the national capital.

The City's area of jurisdiction has grown greatly since its founding in 1749, and it reached its current and expected permanent boundary in 1950 with the incorporation of areas of Fairfax County in the West End, with a few adjustments along the Capital Beltway in the 1970s.

FIGURE 4-1
CITY HISTORIC AND PROJECTED POPULATION 1790-2040



4.1.2 FUTURE PROJECTED POPULATION/EMPLOYMENT

Nearly all land in the City is currently developed in productive uses. Potomac Yard, formerly a major regional rail switching yard, is the last major vacant land area in the City that remains to be developed. Approximately 125 acres of land in Potomac Yard is currently being planned and will be developed over the next 20 to 30 years in a variety of urban uses, including a planned new Metrorail station. As vacant sites are developed and the development pattern shifts to redevelopment of existing active uses, the threshold of density and economic activity necessary to make development profitable increases. Because the City is near the core of the metropolitan region, the convenience of the City as a location for housing and employment means that this threshold is expected to continue to be met, and reinvestment is expected to keep the City growing with a healthy rate of internal renewal for the foreseeable future.

Although most of the City has seen its first round of development, there is active demand and development opportunity for significant infill within the existing fabric. Development demand continues even after a City has become fully developed for a number of reasons. These include national demographic changes such as changes in the distribution of population by age and family structure, movements of people internationally and within the country in search of jobs and other opportunities, changes in availability of resources and technology that change patterns of travel and residential choices, and many other factors. These changes encourage people to move, and result in the average household in the country having lived in their current home for only five years. Given this constant movement, there are constantly opportunities to provide housing of varying types and in locations that are more in current demand as desires and conditions change. Some of the key changes that are encouraging new and changing residential demand in Alexandria are the following:

- Growth in the share of single-person households. Nearly one-half of Alexandria's occupied housing units are occupied by a single person.
- Steady and increasing international migration to gateway communities like the Washington, D.C. metropolitan region.
- Movement of many households, including empty nesters, young professionals, singles, retirees, and even families with children, back to the City as a place of convenience, culture, jobs and other resources.

International, national and local changes in the nature and distribution of employment affect residential demand, and also affect the choice of firms and self-employed individuals to locate in Alexandria. Among the trends that are likely to affect future employment growth in the City are the following:

- Technological changes that are closer to realizing the full potential of telecommuting, and increasing the number of employees who telecommute for some or all of their work week.
- Desire of firms to locate headquarters or support staff near customers, such as the Department of Defense, with headquarters offices in Washington, D.C.
- New transit systems such as streetcars and bus rapid transit currently being planned for communities inside the Beltway, making commuting by transit between communities within the Beltway more convenient.

4.1.3 PROJECTED FUTURE DEVELOPMENT/LAND USE

4.1.3.1 Development Growth Zones

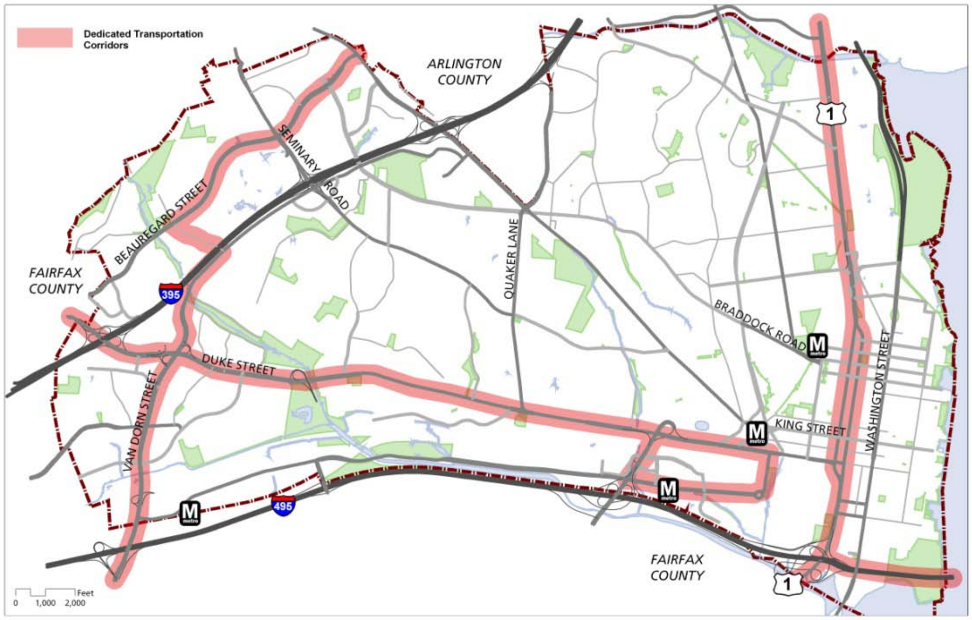
The City's single-family areas are stable residential communities that are not expected to change in the near future. Because of the scarcity of single-family homes near the center of the metropolitan area, these units are in high demand and command a high price. However, other areas of the City, particularly auto-dependent commercial and multi-family residential areas with extensive surface parking lots developed from the 1940s boom years through the 1970s show particular potential to be redeveloped. The City's plans for these areas anticipate their gradual renewal as new urban centers with more efficient pedestrian-oriented and transit-oriented mixed-use development that minimizes vehicle trips and results in a more economically and environmentally sustainable pattern of development for the long-term future.

The city has recently adopted a Transportation Master Plan that calls for a complete new layer of high-capacity transit to serve the City more intensively with frequent service in dedicated transit corridors on the arterial streets through these areas. The three transportation corridors, Route 1, Duke Street and Van Dorn/Beauregard, will serve as new centers of revitalization without disrupting the City's established residential neighborhoods. This scheme sets the pattern for growth and development in the city through the next 20 to 30 years. These corridors are shown on Figure 4-2 on the following page.

4.1.3.2 Forecasting Future Development

The forecasts of the future build on information about existing conditions. Estimates of future development are added to information about what exists in the City today to give totals for the future.

FIGURE 4-2
TRANSPORTATION MASTER PLAN TRANSIT CORRIDORS



4.1.3.3 Existing Baseline

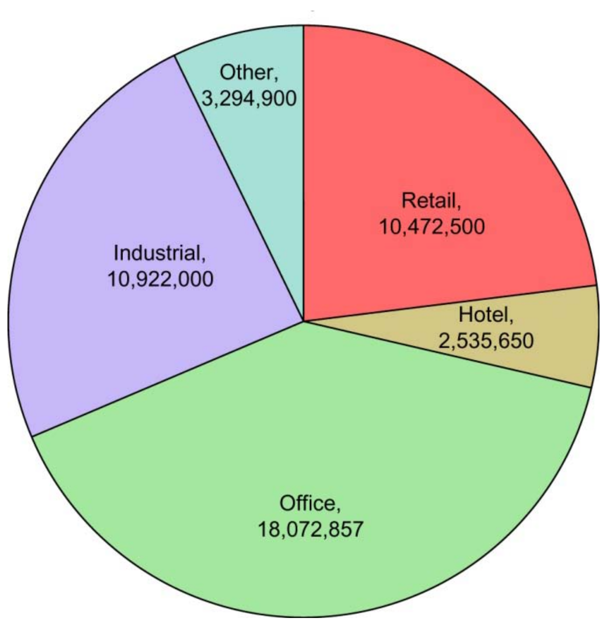
The City of Alexandria utilizes a geographic information system (GIS) to maintain a regularly updated database on each property and structure in the City. Data available includes existing land use, floor area, parcel area, and number of dwelling units. Combined with the 2000 U.S. Census of population and housing, and a survey of employment by establishment conducted in 2005 by the Metropolitan Washington Council of Governments, this data base provides a detailed picture of where people in the City live and work, and where the existing demand for wastewater collection is generated. When combined with measurements of existing flows, this data can be used to calibrate models and estimate generation rates for each type of development in the City. A summary of these data sources is provided in Table 4-2 below.

Figure 4-3 summarizes information on existing nonresidential development including floor area by major category of occupancy (retail, hotel, office, industrial, and other). Industrial use includes flex space, warehousing and miscellaneous service and industrial uses, and other uses include public facilities and institutional uses other than offices.

The City is still improving the quality of its data on the amount of existing development by land use category, and expects to have a complete GIS database of existing land use by structure developed and tested in the next year or two. This estimate was developed based on a preliminary subset of that data (which is least developed in Old Town, the area with the most complex mix of uses); together with information from a variety of other sources including the Dun & Bradstreet estimate of employment by establishment.

Table 4-2 – DATA SOURCES FOR EXISTING CONDITIONS	
Existing land use (assessor's land use code), parcel area and floor area by parcel.	City GIS parcel data base, based on information collected for real estate assessment.
Structure use (assessor's land use code) and floor area by structure	City GIS, combining real estate data with analysis of structures from aerial photography and site plans.
Population – number of people, number in households	U.S. Census complete count every 10 years, small sample data annually.
Housing – number of units, occupancy, tenancy	U.S. Census – every 10 years by Census Block, small annual sample, Office of Housing annual survey of multifamily buildings over 10 units, recorded in City GIS; single-family and duplex units by parcel from GIS by assessor's land use code.
Employment by type of establishment (four-digit SIC code) and address	Metropolitan Washington Council of Governments, 2000 and 2005 surveys by Dun & Bradstreet. When combined with floor area and use codes from assessor's data, this information can confirm employment density by land use.

FIGURE 4-3
CITYWIDE TOTAL FLOOR AREA FOR NONRESIDENTIAL LAND USES



4.1.3.4 Regional and Local Forecasts

The Metropolitan Washington Council of Governments (MWCOG) is the regional organization that develops forecasts for the region for use in transportation planning, air quality planning and other regional planning efforts. These forecasts are developed through a cooperative process involving MWCOG and each of the local governments in the region. Every five years or so, MWCOG develops forecasts for regional totals of population and economic activity based on national economic trends and regional demographic factors. Local governments develop their individual forecasts, considering the regional trends, based on local knowledge of local conditions, development activity, and long-range plans. MWCOG's Cooperative Forecasting and Data Subcommittee, made up of representatives from many of the local jurisdictions, meets to reconcile the local and regional projections. The forecasts are regularly updated between major cycles by the local governments working in cooperation with MWCOG staff. Forecasts are currently made for every five years through the Year 2040. The forecasts through 2040 used in this Sewer Master Plan are based on the MWCOG Round 8 forecasts developed by the City in 2010.

As a member of MWCOG, the City regularly updates its forecasts of growth in population and employment, based on adopted plans, approved development projects, and current and expected trends in real estate and development economics. These forecasts are summarized for each of 63 Transportation Analysis Zones (TAZs) as shown in Figure 3-8 that cover the City in order to provide information for regional transportation planning. Development is distributed over future periods in a way that maintains reasonable rates of redevelopment considering the availability of development sites, an appropriate balance between retail and residential use, and the general ability of the real estate market to absorb new space for various uses over time. Totals are controlled to be consistent with overall economic projections for the region, coordinated by MWCOG.

Figure 4-4 on the following page shows locations of potential future development used in preparing the City's forecasts. Future potential developments include the following by approval status:

1. Development projects, both approved and in the approval process. These are typically projects permitted by current zoning for which there is an active or approved application for development.

2. Infill potential. These are relatively small sites that are currently underdeveloped by current zoning, but which are sufficiently large and well located that they present current development opportunities.

3. Current plans. This category includes major development sites and blocks within approved plans or plans currently being developed for which development policy is established in an adopted plan or is assumed similar to development policy in recently approved plans. Projects may require rezoning and development approvals.

4. Long-term development potential. These sites are larger areas with long-term development potential because of their current use and location. Master Plan Amendments and rezoning would typically be required for redevelopment of these sites at the assumed intensity.

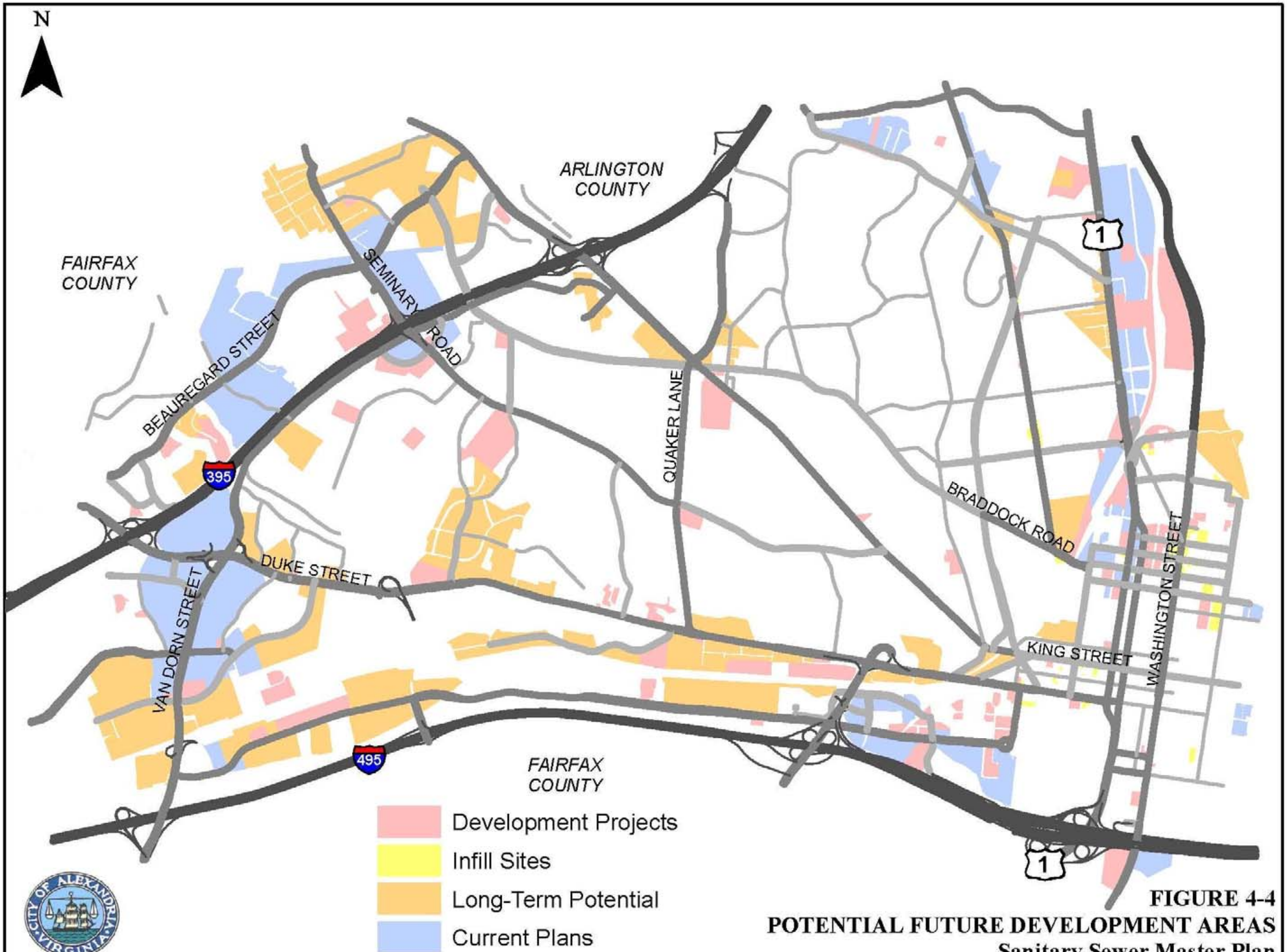


FIGURE 4-4
POTENTIAL FUTURE DEVELOPMENT AREAS
Sanitary Sewer Master Plan

4.1.3.5 Near-Term Development: Approved Projects and Projects in the Approval Process

For near-term development in the next five to 10 years, estimates are based primarily on approved projects or projects currently in the approval process. Most development approvals, with the exception of long-term conceptual plans, are assumed to be completed within 10 years after approval. Approximately 120 projects approved since 1999 were used to estimate development in this short-term period. Projects approved or in the approval process and not already occupied by 2010 include approximately 3500 dwelling units and a net increase of 3.7 million square feet of nonresidential development, nearly all of which is office development. Nearly all of this development is expected to be in place by 2020.

4.1.3.6 Near-Term and Intermediate-Term Development: Infill Sites

Infill sites are small sites scattered throughout the City, typically in commercial areas along arterial streets, that are underutilized compared to their neighbors and represent a development opportunity under current zoning and patterns of development. Infill sites are typically assumed to redevelop over the next 10 to 20 years. Identified infill sites are a small part of potential future development, with a potential for up to approximately 830 dwelling units and 350,000 square feet of office use between now and 2040, replacing existing parking lots, small retail and service facilities, and about 150,000 square feet of industrial and warehouse use.

4.1.3.7 Intermediate-Term Development: Approved Plans and Plans under Development

For the intermediate-term future, from five to 20 or 30 years, the City considers development sites or blocks that have been identified in recent corridor and area plans for areas in transition. Each of the City's major recent plans, beginning with the Arlandria and Upper Potomac West Plans adopted in 2002, has identified sites for redevelopment with policies for the type and intensity of development sought. Potential development identified in these plans on 80 sites or blocks was used to estimate development for the intermediate term. Not all of these sites or blocks were assumed to fully build out within the intermediate term. Potential development in these planning areas includes over 17,000 dwelling units and a net increase of 11,000,000 square feet of nonresidential development by 2040, with a loss of about 900,000 square feet of industrial development and increases in retail and office development. The intermediate-term development plans include the following:

- Beauregard Corridor Plan
- Braddock Road Metro Neighborhood Plan
- Eisenhower East Small Area Plan
- Landmark/Van Dorn Corridor Plan
- North Potomac Yard Plan
- Waterfront Plan

4.1.3.8 Long-Term Potential Development

In order to estimate long-term future development potential to give a reasonable guide to estimate ultimate need for wastewater collection and treatment, the City went beyond the 2040 period for which MWCOG forecasts are prepared. To develop this long-term estimate, planning staff evaluated the potential for redevelopment of most areas where current development and ownership patterns do not preclude redevelopment. In identifying these areas, existing single-family residential areas and areas in condominium ownership were in general excluded because of the City's general policy of protecting existing residential areas, and the difficulty of assembling and redeveloping areas with many individual

ownerships. Shopping centers, office areas and rental apartments with substantial surface parking not included in the near-term and medium-term forecasts were assumed to redevelop to a floor area ratio that is typical of redevelopment sites in all but the densest areas of the City near metro stations, ranging from 1.25 to 2.5 depending on access to transit and the use assumed.

Long-term development outside adopted planning areas was estimated at up to 15,000 additional dwelling units and 18 million square feet of office development, with up to 1.8 million square feet of retail use. A loss of approximately 3.9 million square feet of industrial use including flex space and warehouses would provide some of the sites for this development to take place.

If all these areas were to redevelop fully over time, the City's population would increase from approximately 140,000 today to approximately 190,000 by 2040 and 230,000 sometime after 2040, an increase of 50,000 and 90,000, or 36% and 64%, respectively. This is about the same percentage growth in population the City experienced in the 50 years from 1960 to 2010, and less than the 80% growth the City experienced in the single decade from 1940 to 1950.

4.1.3.9 Location, Density and Phasing of Forecast Development

To support the Department of Transportation and Environmental Services in preparing estimates of wastewater generation for system design, the Department of Planning and Zoning prepared tables detailing these forecasts by project for 5-year periods from 2010 through 2040, and a single estimate of potential development after 2040. These estimates are not predictions of what will happen in future years, but are a best estimate of the general distribution and amount of development distributed over future years with totals controlled by regional forecasts. They are based on professional judgment about which projects and areas are likely to develop first. Local and regional conditions and decisions by owners and developers will ultimately determine when and if these potential projects develop as anticipated.

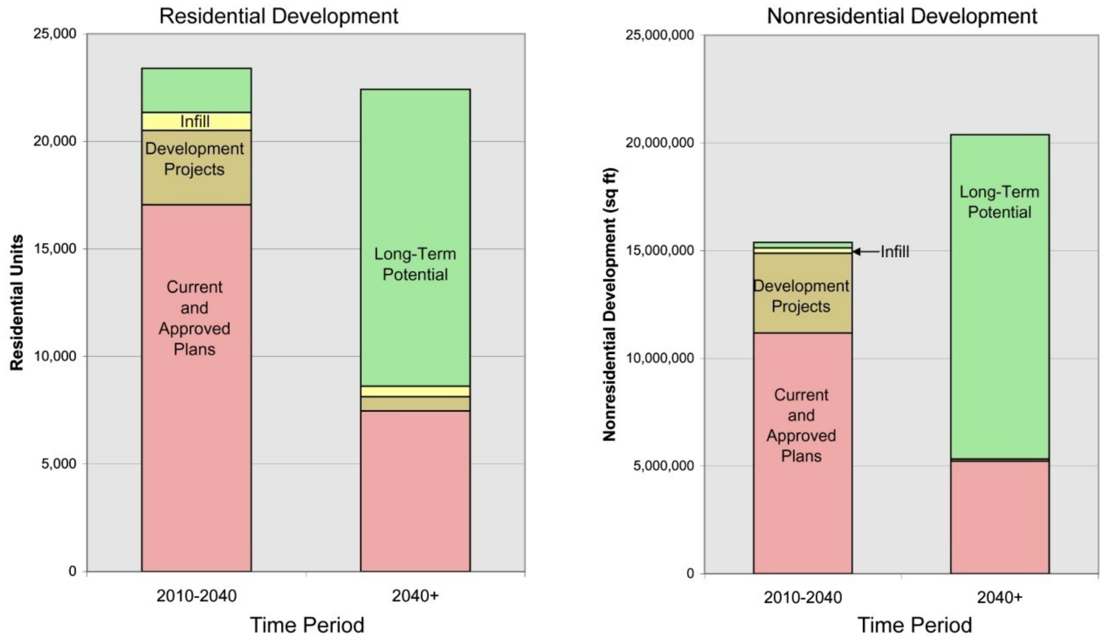
4.1.3.10 Summary of Potential Development by Approval Status

In making the forecasts for this Sewer Master Plan, the City utilized information on about 120 development projects either approved since 1999 or currently under review, 150 potential infill or long-term redevelopment opportunity sites throughout the City, and 80 potential development sites or blocks within areas identified in recently approved plans or within the Beauregard Corridor Plan, Potomac Yard Plan and Waterfront Plan planning areas for which plans are currently being developed.

As shown in Figure 4-5, development approved or in review represents about 15% of potential residential development through 2040, and about one-quarter of potential nonresidential development through 2040. Infill projects are a small portion of both residential and nonresidential development. Development in planning areas for recently approved plans and plans now being prepared represents not quite three quarters of potential residential and nonresidential development through 2040.

For potential development past 2040, long-term potential development sites are most of the potential development for both residential and nonresidential use. Nearly all of these sites would require plan amendments and rezoning before they could be developed for the assumed land use and intensity of development.

FIGURE 4-5
FORECASTED FUTURE DEVELOPMENT BY USE AND CATEGORY



4.1.3.11 Wastewater Generation from Development by Use and Category

The amount of residential and non-residential development helps to determine the level of wastewater conveyance and treatment demand. Based on the flow factors presented in Chapter 3, residential uses contribute more flow than non-residential uses.

The non-residential flow factor for future development is equal to 110 gallons/1000 square feet of non-residential use, which is based on 3.5 employees per 1000 square feet. A survey has been completed using MWCOG data for the City that shows that the employment density varies based on the type of non-residential use as indicated in Table 4-3.

TABLE 4-3 - EMPLOYMENT DENSITY FOR LAND USE CATEGORIES

Use	Employees per 1000 square feet
Retail	2.0
Office	3.75
Industrial	1.0
Other	1.5

The forecasts show a substantial decrease in industrial uses and increases in retail and office uses, with the vast majority being office uses. Thus, the existing non-residential flow factor has been deemed appropriate. The flow factor values used as part of this Sanitary Sewer Master Plan may be updated in the future to reflect the impact of increased use of water-saving devices and changes in land-use and density. It should be noted that the non-residential flow factor used in this Master Plan assumes a 20% reduction in flow based on the installation of water-saving devices.

Chapter 5
Collection System Capacity Assessment

5.1 Introduction

As discussed in Chapter 3, wastewater flows generated in the City are collected in the City's sanitary sewer collection system. Flow in the collection system sewers is then conveyed to interceptor/trunk sewers and then either to the Alexandria Renew Enterprises (AlexRenew) Water Resource Recovery Facility (WRRF) or the Arlington County Water Pollution Control Plant (WPCP). The City currently has agreements with each wastewater treatment plant regarding flow allocations.

The purpose of this chapter is to present the findings of the sewer capacity assessment in the City's sanitary collection system with regard to the City's collector (local) sewers and the AlexRenew interceptor sewers. Sanitary sewer capacity is assessed in the local sewers using a hydraulic model of the collection system. Capacity has been analyzed for future wastewater flows using the forecasts developed by the City's Planning and Zoning (P&Z) Department as presented in Chapter 4. The capacity of the interceptor sewers was evaluated based on a summation of tributary flows to each interceptor.

5.2 Local Collection System Model Development

5.2.1 MODEL DESCRIPTION

In 2009 the City began developing a hydraulic model of City local collector sewers to identify any future improvements to the local sanitary sewer collection system necessary to accommodate additional wastewater flows due to forecasted new development and redevelopment. The hydraulic analysis of the City's sewer collection system was performed using MWH Soft InfoSewer. Thirty-one individual drainage areas, comprising over 60% of the City by land area, have been modeled to date. The portion of the City's collection system that is currently modeled is shown in Figure 5-1. Characteristics of the modeled basins, computed flows and modeling results are presented in Appendix 5-1.

The 31 basins modeled represent the areas within the City where the greatest amount of future development or redevelopment is forecasted. Other areas are currently being analyzed and the modeling results will be incorporated into future updates to this Master Plan. It should be noted that significant capacity improvements are not anticipated for the remaining areas based on current growth forecasts.

MWH Soft InfoSewer modeling software is a dynamic hydraulic model that routes flows through a network of pipes and manholes. The physical information describing the collection system (pipes and manholes) was obtained from the City's sanitary sewer GIS and survey data.

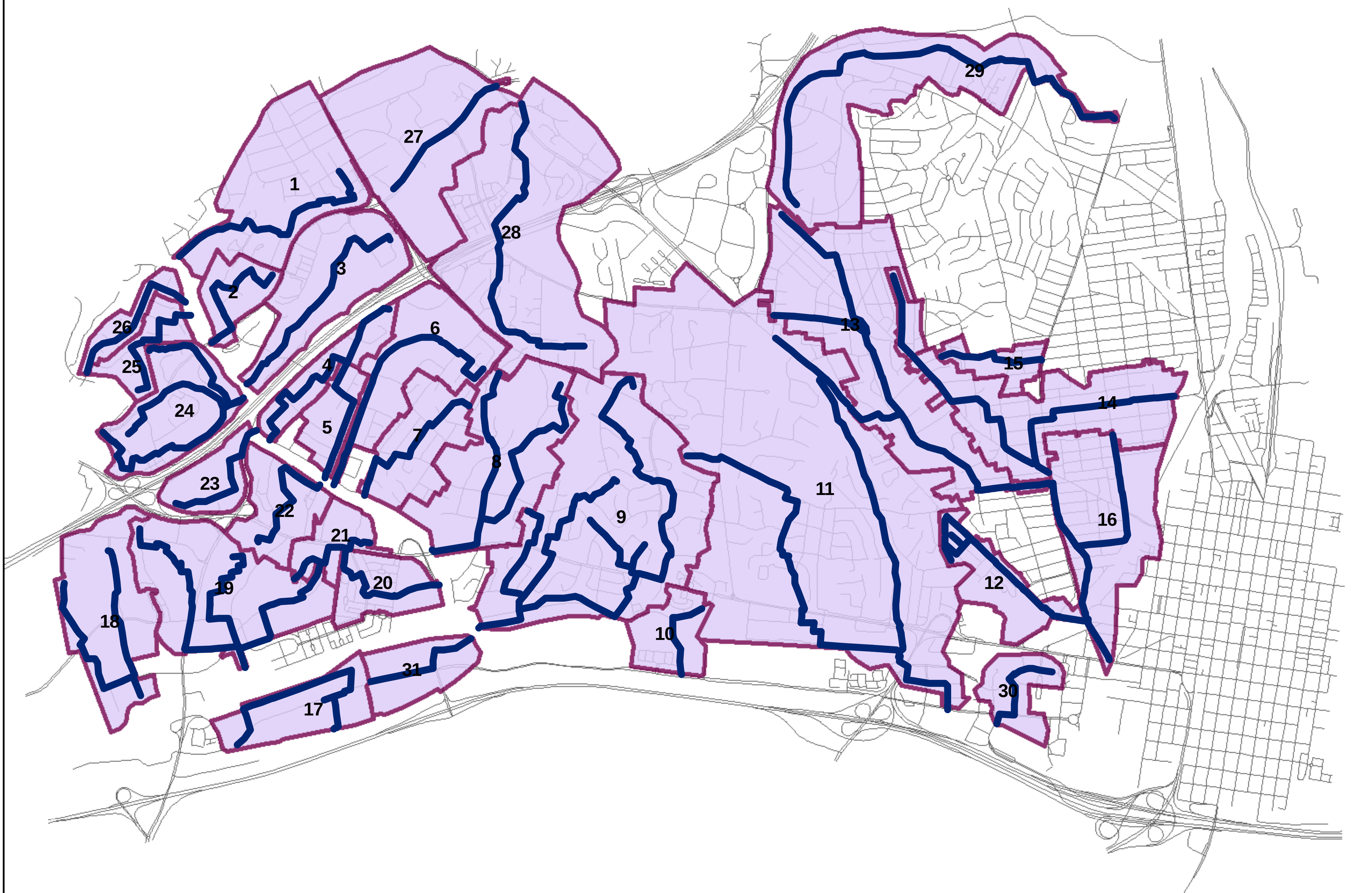


FIGURE 5-1
SANITARY SEWER CAPACITY ANALYSIS
Sanitary Sewer Master Plan

5.2.2 EXISTING WASTEWATER FLOW CALCULATIONS

5.2.2.1 Methodology

Sanitary sewer flow (outside of combined sewer systems) is comprised of three components:

- Wastewater: water that has been used for washing, flushing, manufacturing, etc. that is discharged as sewage
- Infiltration: groundwater which continuously seeps into sewer pipes and manholes; the rate of which can vary with the height of the groundwater table in relation to the sewer pipes and manholes. The groundwater table can be significantly influenced by rainfall.
- Inflow: runoff which flows directly into the sewer system during or after a rain or other type of wet weather (such as snowmelt) event. The total amount of inflow into a sanitary sewer is highly variable based on the condition of the sewer system and duration and intensity of a wet weather event.

The flow factors presented in Table 3-9 were used to compute the average dry weather flow and the peak flows for both existing conditions and build-out (post-2040) conditions. The average dry weather flow includes both the wastewater and infiltration components. Peak flow is computed by multiplying a peaking factor of 4 to the average dry weather flow in order to account for inflow into the sanitary sewer system. This peaking factor is in agreement with the requirements set forth in the Sewage Collection and Treatment (SCAT) Regulations prepared by the Commonwealth of Virginia's State Water Control Board and the City's sanitary sewer design standards.

5.2.2.2 Existing Dry Weather and Peak Flow Calculations

The existing number of residential households and total non-residential building floor area was based on analysis of the City's GIS building and parcel layers for each sanitary basin. Infiltration was computed by using the sewer diameter and total length of sewer provided in the City's GIS sanitary sewer layer.

For each sanitary basin, the existing dry weather flows were multiplied by 4 to account for inflow into the system. This peak factor is a typical inflow peaking factor applied in the design of sewer systems and consistent with state and federal regulations and guidelines. Previous flow monitoring indicates that City's I/I is variable and depends on several factors such as sewer age, incidence of defects and direct sources of inflow. For the purposes of the sewer capacity assessment, the peaking factor was universally applied to all modeled basins.

5.2.3 FUTURE WASTEWATER FLOW CALCULATIONS

5.2.3.1 Methodology and Projected Dry Weather and Peak Flow Calculations

Future projected wastewater flows were calculated from the forecasts discussed in Chapter 4 and by applying unit flow factors to the predicted households and non-residential building floor area for build-out conditions (post-2040). These flows are then added to the existing flows computed above. The number of households and non-residential building floor area for each basin was determined using building and parcel information from the City's GIS. No additional infiltration was added since it is assumed the existing sewer infrastructure will be used and that the I/I in the system is already accounted for since additional pipes, which would carry their own additional infiltration, are not being constructed. The future added

peak flow was computed by multiplying the future added dry weather flow by a peaking factor of 4. The projected additional peak flow was then added to the existing peak flow to obtain the total future peak flow. These calculations are summarized in Appendix 5-1.

5.3 Local Collection System Capacity Analysis

5.3.1 METHODOLOGY

The hydraulic model was used to evaluate wastewater flow capacity, the hydraulic grade line (HGL) and the velocity of flow in the sanitary sewers for existing and build-out conditions during periods of peak flow. Information pertaining to the existing sanitary sewers (location, pipe size, slope, etc.) used in the model originated from the City's sewer layer in GIS and survey data. The primary goal utilized when analyzing the model results was that the HGL be contained within the sewer under peak flow conditions.

This goal was chosen because it helps to ensure that conditions are not created within the sanitary sewer collection system that could lead to surcharging out of sewer manholes or create sewer back-ups into homes or businesses.

5.3.2 PIPE CAPACITY RESULTS

The hydraulic model was run for both existing and future peak flows. The results of the existing conditions model indicate that there are currently a small number of collector sewers where the HGL is not contained below the crown of the pipe. Figure 5-2 identifies these sewer mains. A total of approximately 7,800 feet of sanitary sewer is currently operating over capacity under peak flow conditions.

Approximately 3.6 percent of the existing sanitary sewer pipes modeled does not have sufficient capacity. As expected, the build-out conditions model resulted in additional sewer segments exceeding their installed capacity. These sewer segments are identified in Figure 5-3 and the model results indicate that about 19,500 feet of sanitary sewer (~9% of the pipes modeled) will not have sufficient capacity to accommodate forecasted growth.

5.3.3 DISCUSSION OF RESULTS

Based on the existing conditions results, the City will be conducting an analysis of the sewers where the model shows surcharged conditions. The analysis will focus on the potential for basement backups and manhole overflows and will help to determine if immediate repairs are needed. If the modeled surcharged sewers are in areas where basement back-ups or manhole overflows have not been reported, then flow monitoring in these areas may be warranted in order to calibrate the model. For areas where it is determined that no repairs are required, these locations will continue to be monitored for any capacity related problems.

An analysis of capacity needs based on build-out conditions resulted in a recommendation of growth related improvements. As plans for development/redevelopment that impact these sewers are submitted, further analysis will be performed and improvements, if necessary, will be required as a condition of that development. Options for improving sewer capacity are discussed below.

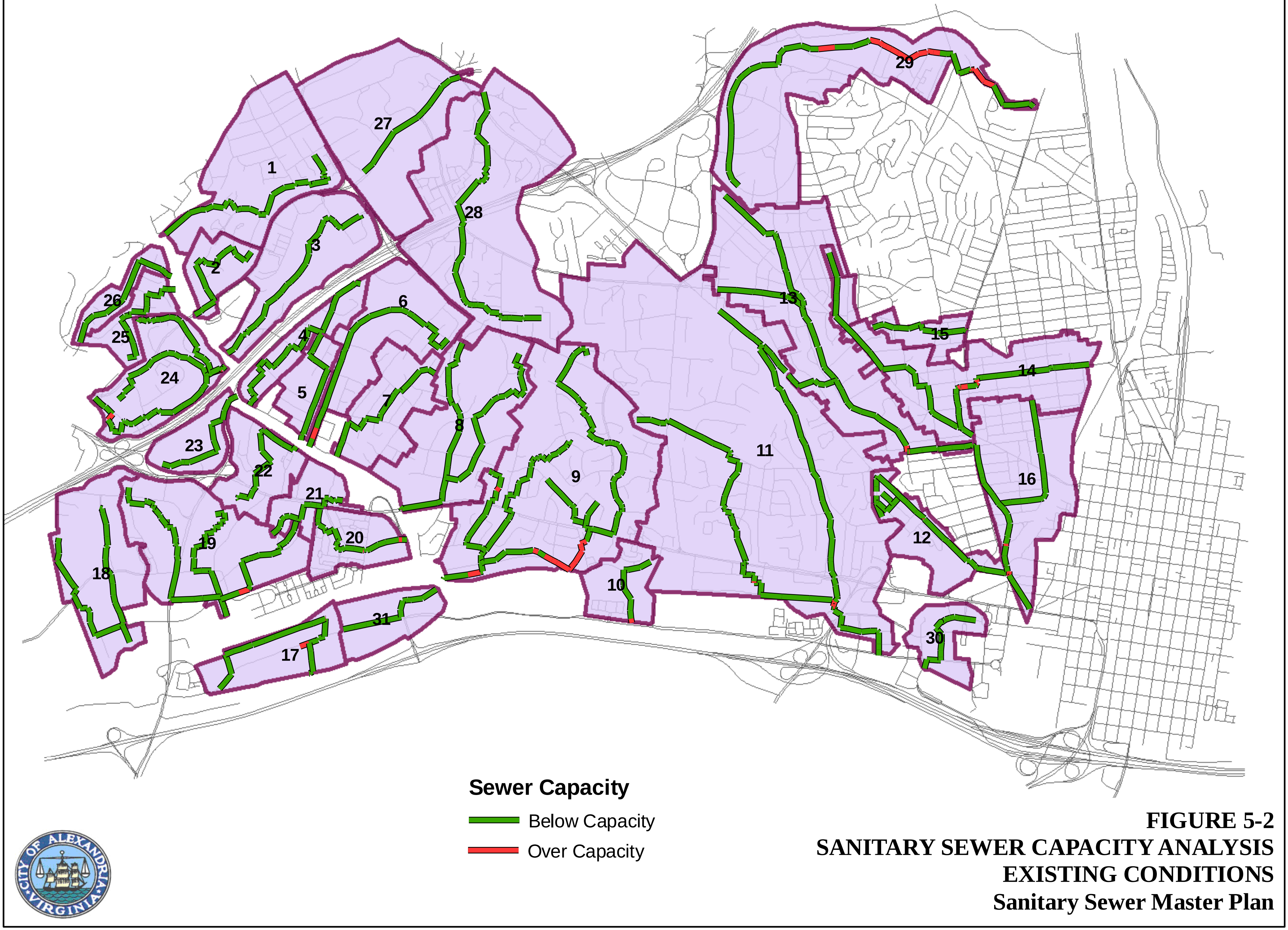


FIGURE 5-2
SANITARY SEWER CAPACITY ANALYSIS
EXISTING CONDITIONS
Sanitary Sewer Master Plan

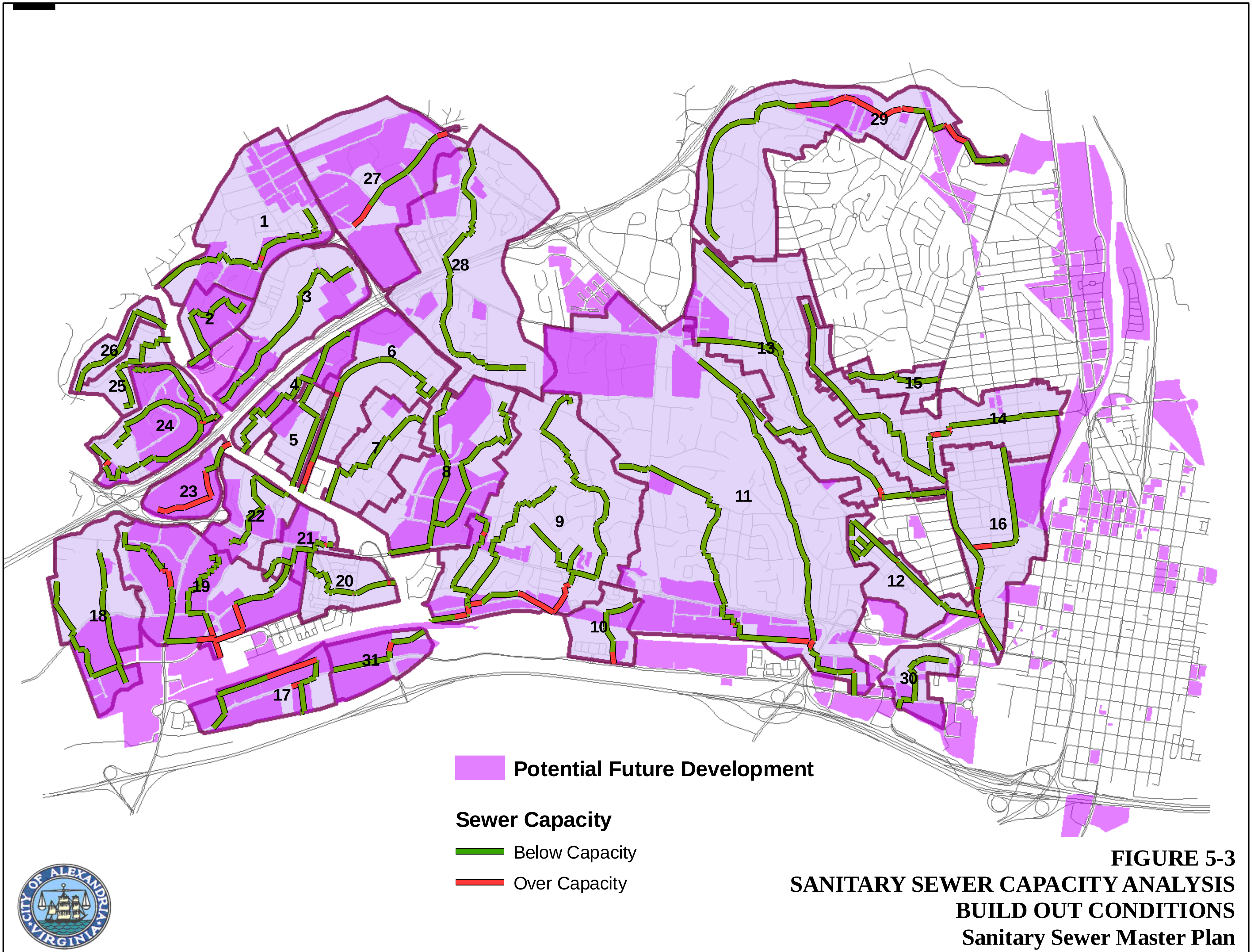


FIGURE 5-3
SANITARY SEWER CAPACITY ANALYSIS
BUILD OUT CONDITIONS
Sanitary Sewer Master Plan

5.3.4 CAPACITY IMPROVEMENTS

Several options were evaluated for increasing capacity and lowering the HGL. These options include:

- Increasing pipe diameter
- Increasing pipe slope
- New parallel sewer main (splitting flow)
- Redirecting the flow to a different sewer main

Generally, it was determined that replacing the existing pipe with a larger diameter pipe was the most efficient and cost effective means for increasing wastewater flow capacity in the collection system. The implementation and financial considerations related to these capacity improvement projects are discussed further in Chapters 8 and 9 of this Master Plan.

5.3.5 PLANNED MODELING UPDATES

As previously discussed, sanitary sewer flows are estimated using flow factors that account for wastewater, infiltration and inflow and using existing parcel information and projected growth estimates. The City plans to collect additional flow monitoring data which will be used to refine and calibrate the modeling as needed. Additional sanitary sewer service areas will be incorporated into the model over time and the model will be updated as the growth forecasts are updated It is not anticipated that a significant number of additional sewers will be identified as being over capacity since less growth is projected in these other areas of the City.

5.4 Wastewater Capacity of the AlexRenew Interceptor Sewers

Table 3-4 presented a summary of the AlexRenew interceptor sewers including the capacity of each sewer in the vicinity of the AlexRenew WRRF. Permanent flow monitoring in these interceptor sewers was initiated in the fall of 2009 to determine the existing flows in each of the interceptor sewers and the impact of projected growth on the capacity of these sewers. The purpose of this section is to provide a discussion of completed and ongoing analysis related to the capacity of each of the AlexRenew interceptor sewers. The four AlexRenew interceptor sewers are shown on Figure 3-1.

5.4.1 EXISTING AND BUILD-OUT (POST 2040) FLOWS

Table 5-1 shows the existing average dry weather flow (ADWF) in each of the interceptor sewers based on flow monitoring in each of the interceptor sewers. As discussed previously, wastewater flows were computed using the demand generators developed by the City and using the residential and non-residential flow factors presented in Chapter 3. These flows were computed through build-out (post 2040) conditions. Below in the table is the estimated additional average dry weather wastewater flow attributable to each interceptor sewer through build-out conditions.

The flows presented in the table do not account for any wet weather flows into the sanitary sewer, which are presented in more detail in Chapter 7. The sections below include a more detailed discussion of each of the interceptor sewers and some of the sewer capacity issues that are unique to each.

TABLE 5-1 - ALEXRENEW INTERCEPTOR WASTEWATER FLOWS			
Interceptor Name	Existing ADWF (mgd)[1]	Projected Additional ADWF (mgd)	Total Build-out ADWF (mgd)
Commonwealth Interceptor	5.01	1.07	6.08
Holmes Run Trunk Sewer[2]	25.81; (9.25 from City, 16.56 from County)	10.96 (6.29 from City, 4.67 from County)	36.77 (15.54 from City, 21.23 from County)
Potomac Interceptor	1.87	0.56	2.43
Potomac Yard Trunk Sewer	0.17	1.60	1.77

1 Existing ADWF as reported in Task Order 11: City of Alexandria Wastewater Capacity and Wet Weather Management Evaluation, prepared by CH2MHill and dated November 2010

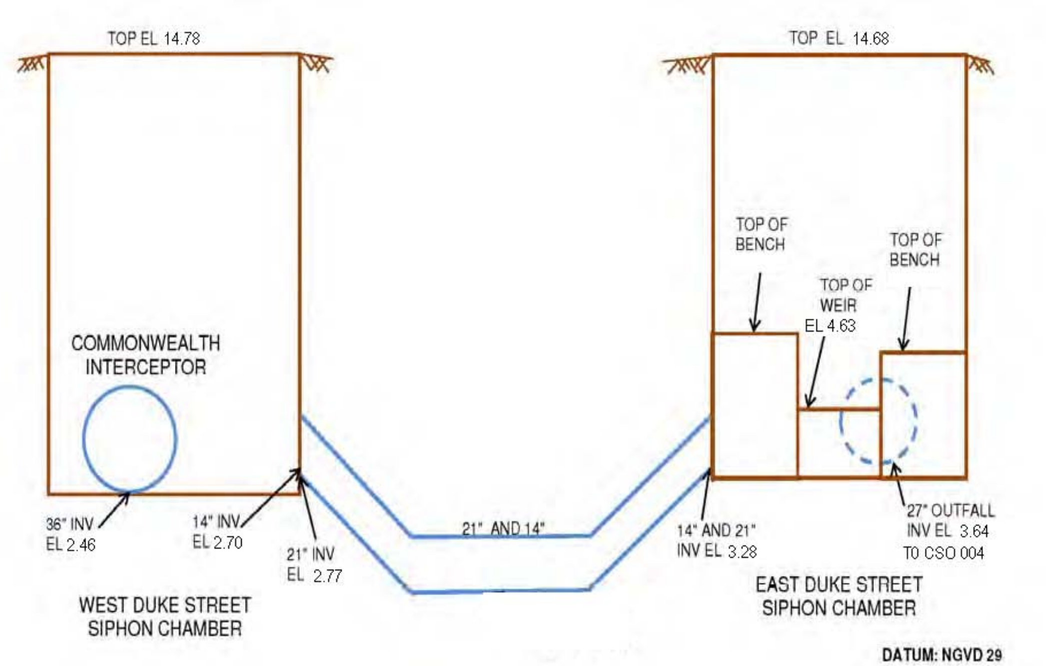
2 Holmes Run Trunk Sewer also includes Fairfax County flows from Cameron Run and Dowden Terrace Sewersheds. Projected Additional ADWF is based on forecasts from both the City and County.

5.4.2 COMMONWEALTH INTERCEPTOR

The Commonwealth Interceptor (CI) was constructed in the mid-1950s and serves the separate Four Mile Run and Commonwealth sewersheds as well as the King/West CSO sewershed as shown in Figure 3-2. The CI begins as a 24-inch force main from the Four Mile Run Pumping Station (PS) and transitions to a gravity sewer at Caton Avenue. The gravity portion from Caton Avenue to just upstream of the AlexRenew WRRF has been lined in recent years as part of an AlexRenew maintenance program. Based on the build-out forecasts presented above, the CI has sufficient capacity related to dry weather flows, as indicated in Table 3-4. Historically, capacity issues related to the CI have been due to wet weather flow during significant rain events. Flow monitoring performed in the 1990s showed that the CI has the greatest amount of wet weather I/I entering from the Four Mile Run and Commonwealth sewersheds, both of which have since been rehabilitated and reductions in wet weather I/I have been assessed (see Chapter 3). Flow metering is currently ongoing at the CI and in the Four Mile Run and Commonwealth sewersheds to determine the extent of I/I remaining in the collection system. This flow data will be incorporated as part of the joint modeling effort between the City and AlexRenew.

The King/West CSO sewershed enters the CI through a siphon chamber at Duke Street. During dry weather, sanitary flows only are discharged into the CI from the siphon chamber. During wet weather, the portion of combined sewage (mix of sanitary wastes and stormwater) that enters the CI is regulated through two CSO regulator structures at King and West Streets and at the siphon structure itself. These regulator structures ensure that capacity of the CI is not exceeded due to combined sewer flows. Figure 5-4 shows a sectional view of the Duke Street siphon chambers.

FIGURE 5-4
DUKE STREET SIPHON CHAMBERS



5.4.3 HOLMES RUN TRUNK SEWER

The Holmes Run Trunk Sewer (HRTS) was constructed in the mid-1950s to serve sanitary sewer flows from both the City and Fairfax County. Sanitary sewage from Fairfax County enters the HRTS at both the Dowden Terrace diversion chamber (no discharge during dry weather, wet weather flows only) at the upstream end of the interceptor sewer and from the parallel Fairfax County sanitary sewer which enters the HRTS at Cameron Run (during both dry and wet weather conditions). All City flows into the HRTS come from the Holmes Run sanitary sewershed (Figure 3-2 and Figure 3-3).

The Holmes Run sewershed has the greatest amount of growth forecasted citywide and includes proposed development areas such as Landmark Mall, East Eisenhower Valley and a portion of the Beauregard Corridor. This has led to concerns about the capacity of the upper portion of the HRTS (between the Dowden Terrace Diversion Chamber to Cameron Run) to convey peak flows without resulting in a surcharged condition. The City is currently working with AlexRenew to determine the impact of future development on the HRTS and developing a plan to address any capacity issues. The results of this analysis will be included in an update to this Master Plan. This update will also focus on solutions to alleviate the surcharging, including but not limited to, an upstream storage facility in the vicinity of Dowden Terrace, maximizing flows in the HRTS and the parallel Fairfax County sewer, upsizing the HRTS, and/or construction of a parallel sewer.

Analyses have already been performed to show that the lower portion of the HRTS (from Cameron Run to the Hooff's Run Junction Chamber) operates under a surcharged condition during significant wet weather events, which is discussed further in Chapter 7. The City requires service chambers to be constructed related to new development in the sewer reach identified as being prone to surcharging. Two service chambers are in operation along this reach as shown in Figure 3-1. Normal dry and wet weather flow discharge into

the HRTS by gravity (no pumping). However, during extreme wet weather, the service chambers operate by pumping flows into the HRTS. In addition, sewers and laterals that tie into the HRTS where it is surcharged must ensure that the plumbing fixtures and drains below the first floor (including parking structures) have in-structure or onsite pumped discharge into the HRTS. The pumped facilities also must be provided with a standby source of power (battery or generator).

Fairfax County currently has flow allocations in the HRTS based on their agreement with AlexRenew, but the City does not have a similar allocation in its agreement with AlexRenew. This issue will be discussed in future updates to the City's service agreement with AlexRenew.

5.4.4 POTOMAC INTERCEPTOR

The Potomac Interceptor (PI) conveys sanitary and combined sewer flows from the Pendleton and Royal CSO basins, along with the separate sanitary Potomac Interceptor basin, as shown in Figure 3-2. The regulator structure (weir) at Pendleton Street just upstream of CSO 001 determines how much flow from the combined sewer is conveyed to the PI. The regulator structure along Royal Street controls flow conveyed into the PI and how much is discharged through CSO 002.

Additionally, as development occurs in the CSS, the City requires that additional sewer flows into the CSS related to new construction be diverted to a sanitary sewer outside the limits of the CSS, that the developer remove other areas from the CSS if it is infeasible to separate at the development site, or to pay towards future sewer separation projects. Therefore, the PI has sufficient capacity to accommodate future growth without causing dry weather overflow conditions.

5.4.5 POTOMAC YARD TRUNK SEWER

The Potomac Yard Trunk Sewer (PYTS) was constructed in 2002 to convey future sanitary flows from the Potomac Yard sewershed, which has been under development since the construction of the PYTS. The PYTS is a 30-inch sanitary sewer that was designed to convey sanitary wastewater from the following areas:

- Potomac Yard sewershed based on Year 2030 flow projections (build-out post 2040 flows had not yet been developed at the time the PYTS was designed)
- Planned 4 mgd pumpover from the Four Mile Run Pumping Station to the Potomac Yard Pumping Station (just upstream of the PYTS and construction completed in 2009)
- Sanitary flows from the King/West CSO area (through sewer separation)
- Sanitary flows from the Braddock Metro Neighborhood Plan. Most of this area is located in the Commonwealth Sewershed, but flows could be diverted to the PYTS.

Following construction of the PYTS, modeling was performed to determine whether the installed PYTS has sufficient capacity to convey peak wastewater flows based on build-out conditions. The model indicated two separate sections where the HGL exceeded the crown of the pipe. It is recommended that these pipe sections be replaced in the future once capacity is exceeded or that a parallel sewer be constructed. The cost of these capacity improvements will be shared by the development projects that contribute to the surcharged condition.

5.5 Conclusions

Preliminary results from the sanitary sewer collection system hydraulic model indicates that the majority of the existing sanitary sewers modeled have adequate capacity to meet future wastewater demands based on the estimated flows. A total of approximately 19,500 lf of sewer was identified as having insufficient capacity. Capacity improvement projects are necessary to alleviate the capacity deficiencies. Typically, the most feasible means to increase capacity will be to increase the existing diameter of the sanitary sewer.

The conceptual-level cost to replace these sanitary sewers equals approximately $17.6M. These preliminary costs will be refined as part of planned future model updates. For instance, it's possible that replacement of one sewer will alleviate capacity problems in another. The model will be further refined as development occurs to determine the exact improvements needed. Chapters 8 and 9 of this Master Plan discuss options for how to implement and finance these recommended improvements.

A preliminary evaluation of the AlexRenew interceptor sewers shows that there is sufficient capacity for projected growth in both the Commonwealth and Potomac Interceptors. Two areas along the Potomac Yard Trunk Sewer have been identified as not having sufficient capacity during peak flows under build-out (post 2040) conditions. Although the analysis shows that these surcharged sections would not result in sewer back-ups, these sewers should be replaced (or a parallel sewer constructed) in order to alleviate the surcharging as a condition of development. An evaluation of the Holmes Run Trunk Sewer due to forecasted growth from the both City and Fairfax County is still ongoing and will be addressed specifically in a future update to the Sanitary Sewer Master Plan.

Chapter 6
Treatment Plant Capacity Assessment

6.1 Introduction

As discussed in Chapter 4, the City of Alexandria's Department of Planning and Zoning (P&Z) developed forecasts of predicted population, employment, and land use for Year 2015 through build-out (post 2040) conditions. This chapter discusses the evaluation of future annual average wastewater flows and capacity needs at the wastewater treatment facilities.

The purpose of this chapter is to present existing and future wastewater flow projections and to compare these flows to the City's treatment plant allocations at both the Alexandria Renew Enterprises (AlexRenew) Water Resource Recovery Facility (WRRF) and Arlington County (Arlington) Water Pollution Control Plant (WPCP). Conveyance and treatment expansions and other system improvements are discussed in this chapter with the goal of preserving the City's ability to provide for future growth. An assessment related to wet weather flows at the AlexRenew WRRF and the interceptor sewers is presented in Chapter 7.

6.2 Annual Average Flow Assessment

6.2.1 EXISTING ANNUAL AVERAGE FLOWS

The City has wastewater flow allocation agreements with AlexRenew and Arlington County based on an annual average daily flow of 21.6 mgd and 3.0 mgd, respectively. Annual average daily flow refers to the total volume of wastewater flowing into a wastewater facility during any consecutive 365 days, divided by 365 and expressed in units of million gallons per day (mgd). This differs from dry weather wastewater flows in that the annual average daily flow includes flows to the wastewater treatment plant during both dry and wet weather days. The amount of precipitation in any given year impacts the total wastewater flow volume at a wastewater treatment facility.

As discussed in Chapter 3, the City has an allocation at the AlexRenew WRRF of 21.6 mgd, which represents 40% of the permitted annual average treatment plant design capacity of 54.0 mgd. The remaining 60% is allocated to Fairfax County. The AlexRenew WRRF has a peak (instantaneous) flow capacity of 108 mgd, two times the annual average design capacity.

An analysis of dry weather, wet weather and annual average flows was performed for Years 2003 through 2010. The results of the analysis indicate annual average daily flow from the City of 16.3 mgd to the AlexRenew service area. The annual average precipitation from 2003-2010 is equal to approximately 43 inches, which is 3 inches more than the average precipitation total for the City based on rainfall records dating back to the late 1800s .

Therefore, it was determined that an annual average daily flow of 16.3 mgd is considered a representative, if not slightly conservative, estimate of the City's sanitary flow in the AlexRenew service area. A similar analysis was performed for the City's flows to the Arlington WPCP, which resulted in an annual average daily flow of 1.40 mgd. Table 6-1 below presents the existing annual average daily flows, along with the available capacity remaining and percent allocation currently utilized.

TABLE 6-1 -EXISTING CITY WASTEWATER FLOW SUMMARY

Location	Year 2003-2009 Average Flow (mgd)	Additional Available Capacity (mgd)	Percent Allocation Utilized (%)
AlexRenew WRRF	16.3	5.3	75.5
Arlington County WPCP	1.4	1.6	46.7

The flows shown above represent the existing flows to which all future flows to the AlexRenew WRRF and the Arlington WPCP are added for analysis purposes for this Sanitary Sewer Master Plan.

6.2.2 FUTURE DRY WEATHER WASTEWATER FLOWS

As discussed in Chapter 4, the City developed population, employment, and land use forecasts for every 5 years from 2010 (existing conditions) through 2040 as shown in Table 4-1. Forecasts for build-out conditions (post 2040) were also estimated. This section discusses the estimation of future wastewater flows to the treatment plants based on the application of unit flow factors. These future flows are added to the baseline flows shown in Table 6-1 and compared to the allocations at the AlexRenew WRRF and the Arlington WPCP. It is the City's goal to ensure adequate capacity at both of these treatment plants to accommodate future growth.

A brief discussion of unit flow factors was presented in Chapter 3. The residential (146 gpd per household) and non-residential (110 gpd per 1000 sqft non-hotel and 130 gpd per hotel room) flow factors were multiplied by the total number of projected additional households, square feet of non-residential building area, and number of estimated hotel rooms. These results are presented in Table 6-2 for Years 2015, 2030, 2040 and build-out conditions. It should be noted that no additional infiltration or inflow (I/I) is incorporated into these flow estimates. This is due to the fact that most proposed development or redevelopment already has sewer infrastructure in place such that there would be no additional entry points for I/I to enter into the system.

TABLE 6-2-PROJECTED FUTURE WASTEWATER FLOWS					
	Net Incremental Average Daily Wastewater Flow (mgd)				
Location	**2010-2015**	**2015-2030**	**2030-2040**	**Build-out (Post 2040)**	**Total**
AlexRenew Service Area	0.2	2.4	1.5	5.4	9.5
Arlington Service Area	0.2	0.1	0.0	0.7	1.0
Total City Flow	0.4	2.5	1.5	6.1	10.5

These flows were then added to the existing City flows presented in Table 6-1 to determine if the City's existing allocation would be exceeded and, if so, approximately when this allocation would be exceeded. This information is presented in Table 6-3.

TABLE 6-3 -PROJECTED TOTAL ANNUAL AVERAGE FLOWS					
	Cumulative Average Daily Wastewater Flow (mgd)				
Location	**2015**	**2030**	**2040**	**Build-out**	**City Allocation**
AlexRenew Service Area	16.5	18.9	20.4	25.8	21.6
Arlington Service Area	1.6	1.7	1.7	2.4	3.0
Total City Flow	18.1	20.6	22.1	28.2	----

The table above indicates that the City's annual average allocation of 21.6 mgd at the AlexRenew WRRF will be exceeded sometime following Year 2040. The total build-out flow projections exceed the annual average allocation by 4.2 mgd. The need for additional capacity at the AlexRenew WRRF has previously been identified by the City and AlexRenew and both parties are currently evaluating options to expand the treatment plant capacity to accommodate this planned future growth. Additionally, the AlexRenew WRRF will receive increased loadings (nutrients, total suspended solids (TSS), etc.) as the flows increase and it is likely that the increase in loadings will need to be addressed prior to the increase in flows.

This evaluation is ongoing, but preliminary alternatives and conceptual level costs are presented later in this chapter and in Chapter 8.

Table 6-4 indicates that the City will not require additional capacity at the Arlington WPCP to accommodate future wastewater flows for build-out conditions.

6.3 Treatment Plant Capacity Alternatives for AlexRenew Service Area

A review of the City's existing wastewater flows and growth projections indicates the need for an additional 4.2 mgd of treatment (flow and nutrients) at the AlexRenew WRRF sometime after 2040 (between 2045-2050 based on projected growth rate of 1 percent). This section identifies alternatives to obtain an additional capacity of 4 mgd at the AlexRenew WRRF and also to reduce existing wastewater flows from the City's collection system.

These alternatives can be classified into four broad categories and a discussion of each is presented in the following sections.

- Modifications and upgrades at the AlexRenew WRRF
- Purchase of AlexRenew treatment capacity from Fairfax County
- Improvements in the City's sanitary sewer collection system and sewer service areas
- Methods aimed at reducing flows through water conservation efforts

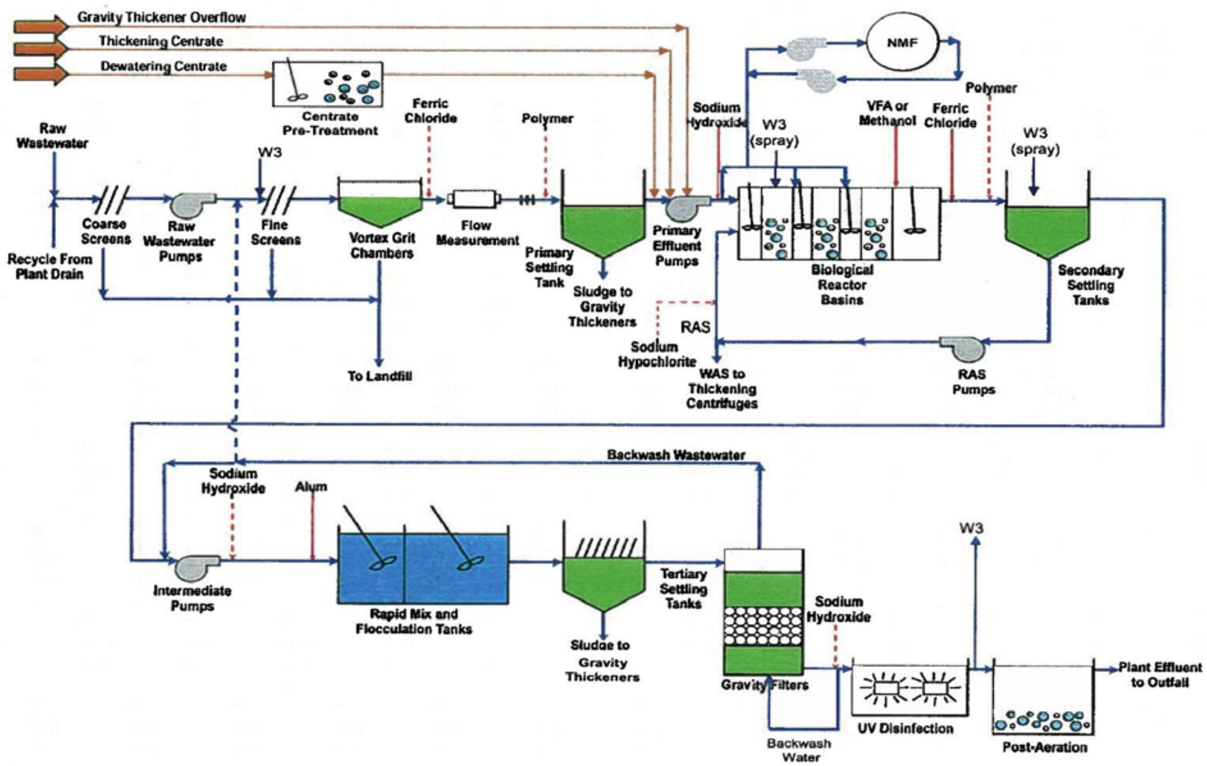
6.3.1 MODIFICATIONS AND UPGRADES AT THE ALEXRENEW WRRF

This alternative involves modifying the plant processes in order to treat an additional 4 mgd. The AlexRenew facility is scheduled to undergo planned renewals and replacements to maintain reliability related to its current annual average design capacity and peak flow capacity of 54 mgd and 108 mgd, respectively. As these renewals and replacements occur, there may be opportunities to accommodate additional flow capacity. Table 6-4 includes the costs in addition to the planned renewals and replacement costs. Table 6-4 identifies the unit processes recommended for expansion from 54 mgd to 58 mgd and the associated conceptual-level costs. These upgrades would not be required simultaneously. Figure 6-1 shows a schematic of the existing treatment plant processes, including the planned State-of-the-Art Nitrogen Upgrade Program (SANUP) which is planned to be completed in 2014.

A critical challenge related to expanding the AlexRenew WRRF will be the additional nutrient loading associated with a 4 mgd increase in flows. While the improvements shown in Table 6-4 will provide the City's necessary flow capacity to meet build-out projections, these improvements do not provide the additional capacity for nutrient discharge. AlexRenew is required to meet nutrient wasteload allocations (WLAs) as shown in Table 3-6 of this plan for total nitrogen (TN) and total phosphorous (TP) as part of their VPDES permit. AlexRenew's existing treatment processes meets the TP requirement and the treatment plant's SANUP will meet the TN requirement once constructed in 2014. It should be noted that AlexRenew meets the existing TN allocation even though SANUP is not yet complete since the wastewater flows at the treatment facility are well under the design capacity.

Figure 6-1

ALEXRENEW WRRF PROCESS SYSTEMS



The basis for these WLAs comes from the Chesapeake Bay TMDL. The additional or excess annual load associated with the treatment of an additional 4 mgd is 36,547 lbs/year and 2,193 lbs/year of TN and TP, respectively. There are a number of possible options for offsetting these loads including the following:

- Improvements in technology to allow AlexRenew to achieve higher TN and TP removal rates.
- Potential allowances in AlexRenew's VPDES permit for treating the combined sewer system flows through the AlexRenew WRRF, which will reduce loads requiring offsets.
- Point source offsets (via trading) through the Virginia Nutrient Credit Exchange Association. This is dependent on there being another discharger with sufficient nutrient credits available for purchase.
- Nonpoint source offsets which can be gained from other users (such as purchasing rural farmland) who apply and demonstrate nitrogen reduction through the implementation of best management practices (BMPs).
- Water Quality Improvement Fund which allows a discharger to purchase nutrient credits as a last resort.
- Changes to the state regulations by VDEQ would allow more reuse options for the AlexRenew WRRF effluent as irrigation water or other uses.

The total projected cost of the improvements in Table 6-4 comes to $29M (2010 dollars). It should be noted that this cost is for 4 mgd of hydraulic capacity only and does not include any costs related to the nutrient offsets or nutrient removal upgrades that would be required. Options and costs associated with the additional nutrient removal will be studied and included in future updates to this Master Plan.

6.3.2 PURCHASE ADDITIONAL WASTEWATER CAPACITY

An alternative to constructing additional capacity at the AlexRenew WRRF is purchasing wastewater capacity at the AlexRenew WRRF from Fairfax County. Currently, the AlexRenew WRRF is treating about 20.7 mgd from the County on an annual average basis. Fairfax County has indicated to the City that it may not need all of its capacity at the AlexRenew WRRF and might be willing to sell 4 mgd of its 32.4 mgd allocation. Fairfax is currently in discussions with the DC Water Blue Plains Wastewater Treatment Plant to purchase additional capacity. Acquiring capacity through DC Water benefits Fairfax County in that Fairfax is projecting high growth in areas that are already served by Blue Plains, wastewater treatment capacity is less expensive at Blue Plains and the necessary sewer infrastructure is already in place.

Fairfax County has provided a preliminary purchase cost to the City of $14 per gallon (2010 dollars), or $56M for 4 mgd. Although this option is more costly than the preliminary treatment plant expansion costs provided by AlexRenew, no nutrient offsets or regulatory approval by VDEQ would be required since the design capacity at the AlexRenew WRRF would not change. Further discussions are necessary with Fairfax to determine the timing of payment for the capacity purchase. Since the City does not require additional capacity in the near-term, this option is considered to be very costly to the City.

TABLE 6-4 - ALEXRENEW PLANT FLOW CAPACITY IMPROVEMENTS FOR 58 MGD AVERAGE ANNUAL FLOW AND 116 MGD PEAK FLOW

AlexRevew Process	Upgrade Required?	Preliminary Cost	Proposed Timeframe
Coarse screens	Yes	$2M	2021-2025
Raw pumps	No	N/A	N/A
Fine screens	Yes	$1M	2021-2025
Primary treatment	No	N/A	N/A
Primary effluent pump station	Yes	$1M	2026-2030
Nutrient management facility	No	N/A	N/A
Biological reactor basins	No	N/A	N/A
IFAS	Yes	$8M	2021-2025
Secondary settling	No	N/A	N/A
Tertiary settling	Yes	$8M	2021-2025
Filters	Yes	$8M	2021-2025
UV Disinfection	Yes	$1M	2011-2015
Chemical storage	No	N/A	N/A
Centrate pretreatment	No	N/A	N/A
Solids handling	No	N/A	N/A
TOTAL INVESTMENT		**$29M**	

6.3.3 CITYWIDE SYSTEM ALTERNATIVES

The City has conducted a number of studies aimed at identifying options for reducing wastewater flows in the sanitary collection system. A summary of some of these alternatives is presented below.

6.3.3.1 Continued I/I Program Implementation

As discussed in Chapter 3, the City has completed rehabilitation of City-owned sewers and manholes in three separate sanitary sewersheds. Rehabilitation is expected to commence in portions of the Holmes Run Sewershed in 2012. Analysis of post-construction flow monitoring has shown that there has been measured reduction in I/I volume due to the rehabilitation efforts. It is anticipated that the I/I contribution to the sanitary flows will continue to decrease as the program moves forward. Because the City’s average flows to the AlexRenew WRRF include wet weather flows, reductions in wet weather flows will decrease the annual average flow. However, this reduction in flow is not expected to be significant with regard to the 4 mgd capacity need. Additionally, this option does not result in a decrease in the nutrient loadings.

6.3.3.2 Water Conservation Programs

In April 2009, the City adopted a Green Building Policy which states that the City expects that all new development requiring a development site plan or special use permit a LEED (Leadership in Energy and Environmental Design) silver rating for non-residential development and LEED certification for residential development. LEED certification is based on the achievement of credits related to “green” building practices, including credits related to water conservation. City staff strongly encourages the inclusion of water conservation measures above and beyond those stipulated in the City’s building codes and requires WaterSense fixtures in all non-residential redevelopment. It should be noted that the implementation of water conservation measures does not result in reduced nutrient loadings.

The City is also evaluating programs that encourage water conservation in existing structures. One program under evaluation involves a rebate program where property owners are given rebates for replacing existing inefficient and/or leaky fixtures efficient fixtures such as low-flow toilets, low-flow faucets and showerheads and water-saving washing machines. Examples of communities that have enacted these types of rebate programs include the cities of Seattle, WA, San Antonio, TX and Cobb County, GA.

6.3.3.3 Combined Sewer System (CSS) Separation

The City’s CSS sends stormwater to the AlexRenew WRRF during rain events. Complete separation of the CSS into storm and sanitary sewers would result in all stormwater being discharged through storm outfalls. Separation would lower both the annual average flows and the peak wet weather flows at the treatment plant. However, construction of new storm and sanitary sewers would be costly and disruptive in the Old Town area. The City currently requires separation related to new development or redevelopment in the CSS. In addition, the City is evaluating areas within the CSS for targeted separation projects. There is currently $5.4M in the FY2013 CIP targeted towards this effort. The City has recently completed field investigations related to specific separation projects that have been identified in the King and West combined sub-basin. In addition, some of the funding in the CIP will be used to implement future green infrastructure projects in the CSS. Green

infrastructure will serve to decrease the amount of stormwater runoff entering the CSS and will result in a decrease in the volume of combined sewer discharged during an overflow event. More information related to green infrastructure is provided in Chapter 7.

Complete separation of the CSS would result in a decrease in the average daily flow to the AlexRenew WRRF by approximately 0.65 mgd based on an average rainfall year (about 40 inches). The cost to perform separation has been estimated at $250M-$350M based on the costs of previously completed small-scale separation projects in the CSS.

6.3.3.4 Reuse

There are a variety of types of reuse or reclaiming of wastewater that reduce flows to a treatment plant and reduce nutrient discharges. A few of these are described below:

- Greywater Reuse. This involves onsite treatment of greywater (from sinks, showers, laundry machines) which is then reused for toilet flushing.
- Satellite Treatment Systems. This involves treatment of wastewater flows from a particular site (remote from the treatment plant) and reusing the flow at that site.
- AlexRenew Effluent Reuse. This involves conveying treated effluent flows to a site for irrigation or other non-potable uses.

Reuse is typically only cost-effective for buildings with high wastewater flows (at least 10,000 gallons per day). Therefore, reuse is most likely to be beneficial when used in conjunction with large commercial/office developments. The Virginia Department of Environmental Quality (VDEQ) currently does not allow the use of reclaimed wastewater in residential buildings or any mixed-use building with residential units. However, a committee has been established by VDEQ, to assist the Virginia Health Department and VDEQ to identify potential opportunities, as well as impediments, to expanding water reclamation and reuse in Virginia. The City evaluates development projects on a case by case basis for possible reuse opportunities.

6.3.3.5 Summary

The City is continuing to evaluate these citywide system alternatives for reducing flows to the sanitary sewer system. However, it is unlikely that even a combination of these options will provide the necessary additional treatment capacity to meet the City's growth needs, but would help to reduce the total additional 4.22 mgd of additional capacity projected.

6.4 Conclusions

The assessment presented in this chapter indicates that the City will exceed its average annual allocation at the AlexRenew WRRF at some time after Year 2040 based on current growth forecasts. A number of alternatives have been identified that achieve or help to achieve the City's goal of being able to accommodate future growth. City staff will continue to evaluate these options. Chapter 8 presents a preliminary evaluation of scenarios, phasing, recommended improvements, and conceptual-level costs associated with these alternatives related to the AlexRenew WRRF.

Chapter 7
Wet Weather Capacity Assessment

7.1 Introduction

The previous two chapters assessed existing and future flow impacts on the City-owned collection system, Alexandria Renew Enterprises (AlexRenew's) interceptor sewers and at the AlexRenew Water Resource Recovery Facility (WRRF) and the Arlington County Water Pollution Control Plant related to forecasted growth. The purpose of this chapter is to present an analysis of wet weather flows and the impacts of these flows on the interceptor sewers and at the AlexRenew WRRF. Conveyance and treatment expansions and improvements to address wet weather are also discussed in this chapter.

7.1.1 DISCUSSION OF WET WEATHER SEWER FLOWS

As discussed in Chapter 5, sewer flows are comprised of wastewater from homes, businesses, and public facilities, as well as infiltration and inflow (I/I). Inflow comes directly from wet weather (rainfall or snowmelt). Infiltration is groundwater that is constantly entering the sewer system, but the rate of infiltration is significantly influenced by wet weather. For purposes of this chapter, I/I will be referred to only in relation to wet weather.

I/I comes from defects (cracks, voids, etc.) in sewer pipes, manholes, and private laterals; stormwater connections to the sanitary sewer (downspouts, sump pumps, etc.); and from runoff into manhole covers such as through the pick holes. It is not feasible to remove all I/I from a sanitary sewer service area, so sewers are designed based on some allowance of I/I. As the age of a sewer system increases, the level of I/I typically increases as well and can become excessive.

I/I is an important issue related to the sanitary sewer system because it is typically the cause of most sewer capacity problems. This is due to the fact that excess wet weather flow takes up valuable space in the collection system needed to convey wastewater from homes and businesses. In the City, excess wet weather in sanitary sewers has the potential to lead to the following:

- Sanitary sewer back-ups into homes and businesses, especially those located near interceptor sewers where sewer flows from the collection system are conveyed. These can cause significant damage to private property and pose a possible health risk.
- Sanitary sewer overflows (SSOs) whereby untreated sewage is discharged into the environment prior to receiving treatment such as at a WWTP. SSOs into receiving waters can have a negative impact to water quality and habitat.
- SSOs out of the manhole rims into the street or ground, which are a nuisance and pose possible health risks.

The City has been working to reduce the impacts of I/I by rehabilitating the public sanitary sewers and manholes in sewer service areas that have the highest rates of I/I. More information about the City's I/I remediation program is provided in Chapter 3.

7.2 Wet Weather Treatment Assessment

7.2.1 BACKGROUND AND GOALS

The AlexRenew WRRF has a permitted design capacity of 54 mgd on an annual average basis as defined in Section 6.2.1 and 108 mgd on a peak instantaneous basis. The peak flow capacity is equal to two times the annual average capacity. When incoming flows into the wastewater treatment plant exceed 108 mgd during significant wet weather events, there is the potential for the following two things to happen:

- Wastewater levels in the Hooff's Run Junction Chamber (HRJC) outside the AlexRenew WRRF could result in SSOs into Hooff's Run
- Extreme rainfall-induced I/I flows may back-up in the AlexRenew interceptor and City collector sewers leading to surcharged conditions and basement back-ups

There are two SSO outfalls in the AlexRenew service area. One is located just outside the treatment plant at the HRJC and the other is located adjacent to the Four Mile Run Pumping Station (PS). SSOs are not permitted under AlexRenew's Virginia Pollutant Discharge Elimination System (VPDES) permit issued by the Virginia Department of Environmental Quality (VDEQ). Each instance that a SSO occurs (due to wet weather flows or for any other reason), AlexRenew is required to report these to VDEQ. SSOs currently occur as a result of extreme wet weather.

This Sanitary Sewer Master Plan analyzes wet weather at the AlexRenew WRRF and in the interceptor sewers in order to achieve the primary goal of mitigating: Wet weather flows such that no SSOs occur for existing and future (build-out) conditions for any rain event less than or equal to the 5-year storm and to reduce basement back-up potential associated with these events.

The local collector sewers are not included in this wet weather analysis and are addressed in Chapter 5. It should be noted that the goals related to the collector sewers are different than the goals presented in this chapter. Chapter 5 addresses collection system sewer capacity related to existing flows and flows related to future anticipated development. This chapter primarily addresses SSOs and sewer back-ups.

7.2.2 BASIS FOR ANALYSIS

In 1998 AlexRenew commissioned CH2MHill to perform wet weather hydraulic modeling of the AlexRenew interceptor sewers to evaluate the relative cost effectiveness of ongoing I/I remediation programs underway in the City of Alexandria and Fairfax County versus off-line storage of projected wet weather flow bypasses. The wet weather hydraulic model analysis of the major interceptors was performed using Storm Water Management Modeling (SWMM) software (current version XP-SWMM 2009). SWMM is a dynamic model that routes flow runoff hydrographs and inflow hydrographs for the sanitary sewer system through a network of pipes, manholes, and pumps. The physical information describing the interceptors (pipes, manholes, pumps) was from as-built drawings provided by AlexRenew. The hydraulic model includes 4 major interceptors, 3 pump stations, 3 force mains, and the plant head works as shown in Figure 7-1. A Wet Weather Flow Reduction Strategy was developed using modeling results to determine the most cost-effective approach to managing wet weather flows in excess of 108 mgd, the peak hydraulic throughput to which the AlexRenew facility can treat. In 2002, 2007 and 2009 this model was updated and re-calibrated using additional flow and rainfall data.

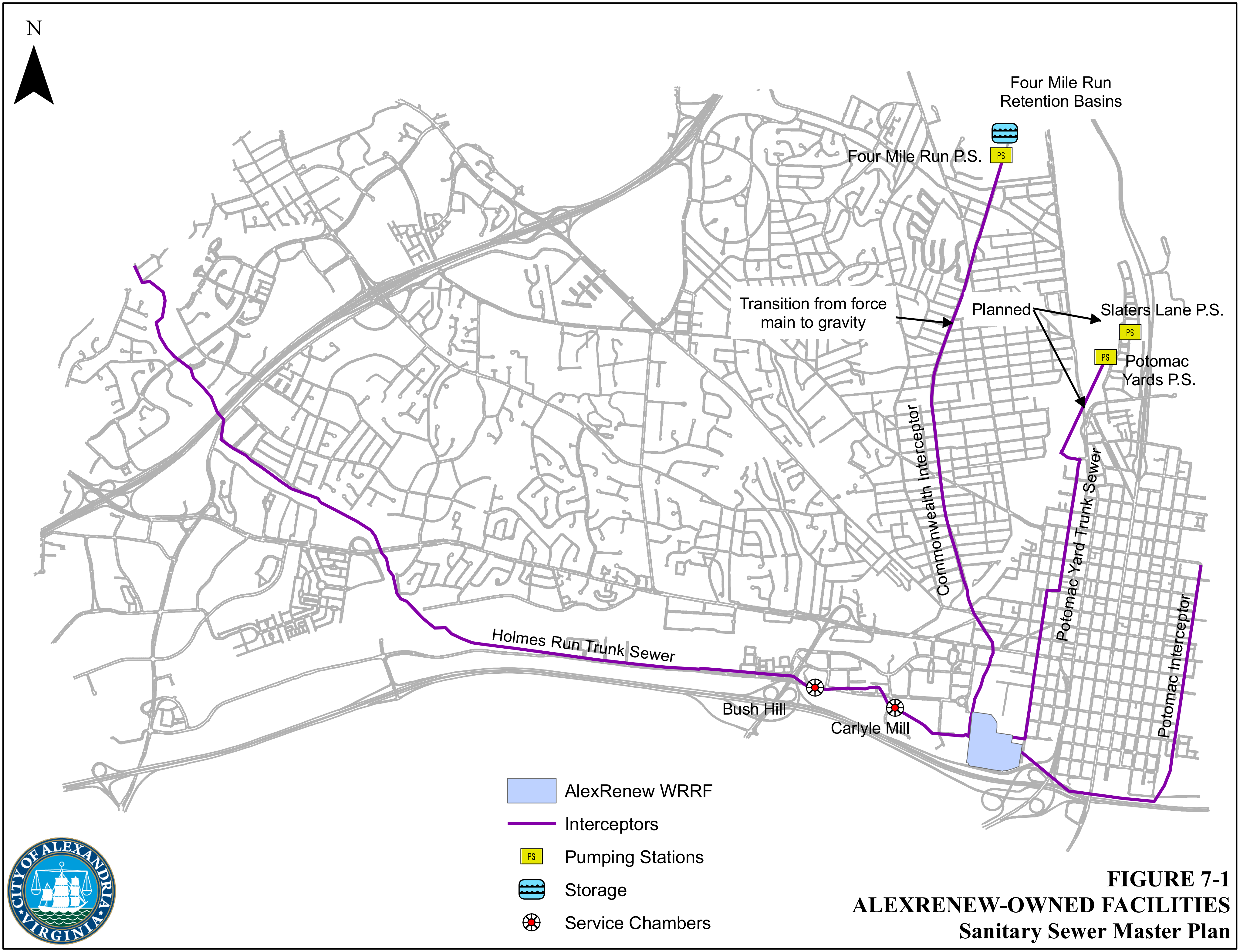


FIGURE 7-1
ALEXRENEW-OWNED FACILITIES
Sanitary Sewer Master Plan

There is a second separate SWMM hydraulic model of the City's combined sewer system (CSS). This model was developed by Limno-Tech, Inc. (LTI) on behalf of the City and is currently used to model the occurrence and volume of combined sewer overflows (CSOs). The results are provided to VDEQ as part of the City's CSS VPDES permit annual reporting requirements. Figure 7-2 shows the CSO sewersheds and subsheds, CSO outfall locations, and modeled sewers.

Both of these models are used in conjunction with one another to evaluate wastewater flows at the AlexRenew WRRF and are both updated periodically to reflect changes in the system. It should be noted that the results presented in this section are considered preliminary since updates to both models are currently underway. These results will be included in future updates to this Master Plan.

7.2.3 ANALYSIS OF EXISTING WET WEATHER FLOWS

In order to determine the impacts of existing wet weather on the interceptor sewers and at the AlexRenew WRRF, the AlexRenew interceptor model was run by adding wastewater flow and I/I from the separate sanitary areas in the City and Fairfax County and stormwater runoff from the City's CSS. The rainfall applied to the model is based on both actual measured storms and design storms developed by the Soil Conservation Service (SCS).

7.2.3.1 Past SSOs and Basement Back-ups

Table 7-1 provides a summary of SSOs, from 2005-2010 that can be attributed to wet weather. As the table shows, SSOs are generally occurring during storms that are classified as a 1-year storm event or greater based on measured storms since 2005. More recently, the data collected indicates that that the recurrence interval has increased to a 2-5 year storm interval, primarily due to the decrease in I/I from the City's I/I remediation program. AlexRenew's existing conditions hydraulic model correlates well with the historical summary in that it predicts SSOs at the HRJC at a 2-year SCS design storm interval and at the Four Mile Run PS at storms above the SCS 5-year design storm.

It should be noted that not every significant (1-year or greater) storm event results in an SSO. The largest storm that did not result in an SSO event at either the HRJC or Four Mile Run PS occurred on October 26, 2007. This storm produced a total of 4 inches in 24 hours, which is approximately equal to a 5-year storm event.

Basement back-ups can occur when there is significant I/I in the sanitary sewer so that it becomes overloaded. There have been two significant wet weather events during the last 10 years which have led to significant sanitary sewer back-ups, in February 2003 and June 2006. The February 2003 and June 2006 events are discussed below.

- February 2003 blizzard and snowmelt. From February 14-18, the Washington DC area received approximately 18 inches of snowfall, with higher totals reported in some areas. This was followed by approximately 2.5-3.0 inches of rainfall that fell on February 22-23. The combination of the rainfall and snowmelt attributed to the rain caused massive urban flooding on the morning of February 23rd. Several roads in the Washington DC area were closed, along with the Mount Vernon Square Metro Station. Due to the amount of I/I from the rainfall and subsequent snow melt that entered the system, the Commonwealth Interceptor surcharged causing numerous basement back-ups. The surcharging was so severe that a number of manhole lids along the interceptor sewer were dislodged by the rise in flow and sewage spilled out onto Commonwealth Avenue.

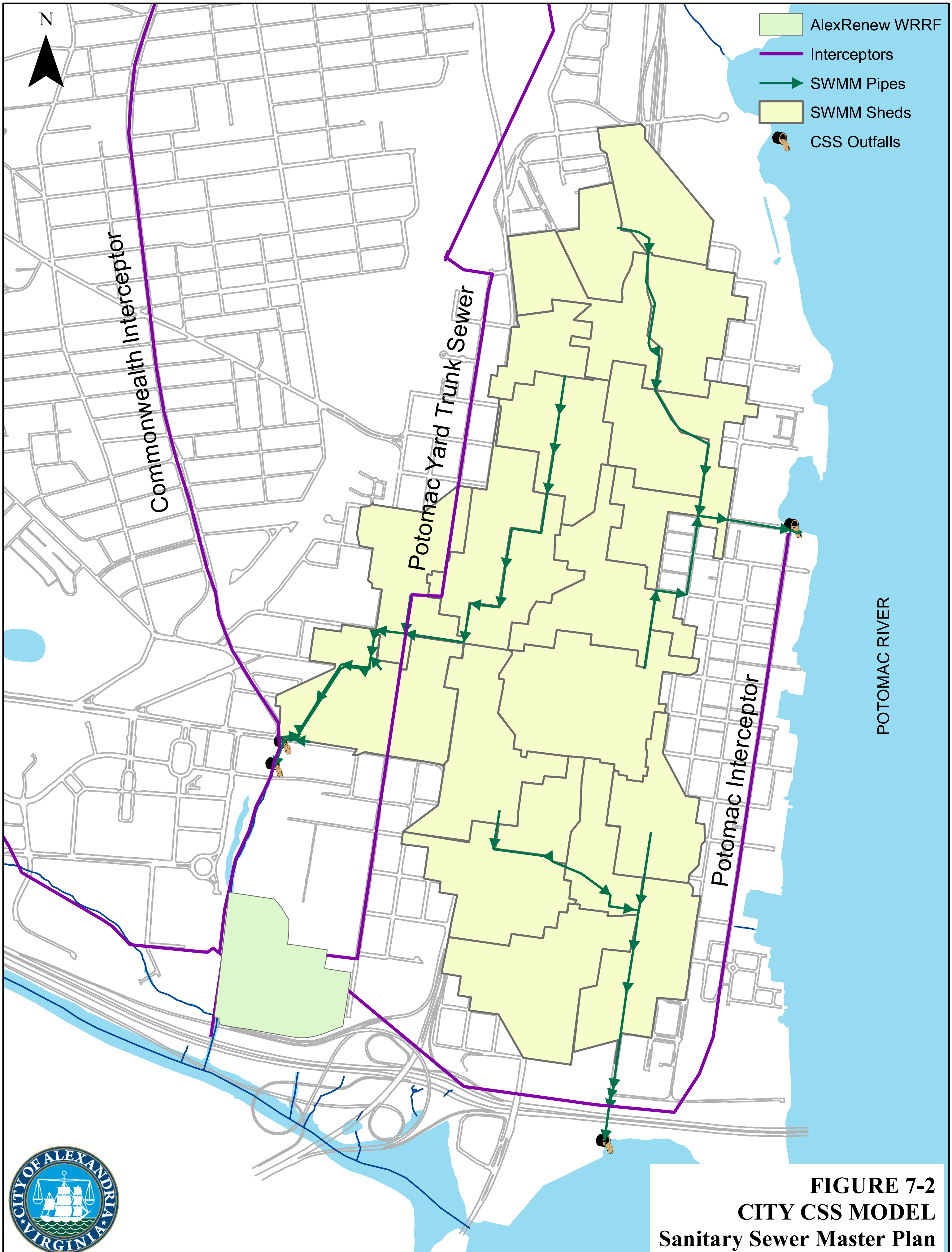


FIGURE 7-2
CITY CSS MODEL
Sanitary Sewer Master Plan

TABLE 7-1 - WET WEATHER RELATED SSOS 2005-2010			
Date	**Overflow Location**	**Total Rainfall (in)[1]**	**Storm Return Frequency[2]**
1/13/2005-1/14/2005	Hooff's Run Junction Chamber and Four Mile Run Pumping Station	2.06	~1-year
7/7/2005-7/8/2005	Four Mile Run Pumping Station	2.47	1-2 year
10/7/2005 - 10/8/2005	Hooff's Run Junction Chamber and Four Mile Run Pumping Station	7.34	25-50 year
6/24/2006 - 6/26/2006	Hooff's Run Junction Chamber and Four Mile Run Pumping Station	9.55	80-year
5/8/2008-5/9/2008	Four Mile Run Pumping Station	3.43	2-year
5/11/2008 – 5/12/2008	Hooff's Run Junction Chamber and Four Mile Run Pumping Station	3.95	~5-year
9/6/2008	Hooff's Run Junction Chamber	3.50	5-year

[1]Rainfall Data from National Airport

[2]Storm Return Frequency Based on City's Intensity-Frequency-Duration (IDF) Curves

- June 24-26 2006 storm event. A slow-moving line of thunderstorms dumped 10 inches or more rainfall over the Washington DC area and caused extensive urban flooding on the night of June 25. Analysis previously performed indicates the storm that moved through Alexandria was on the order of an 80-year storm. Numerous roadways and Metro stations were closed. There were also fast-rising floodwaters of streams, which led to evacuations in nearby neighborhoods. Basement back-ups were reported throughout the City, which were caused by surcharging of the interceptor and collector sewers and by heavy amounts of flood water entering the sanitary sewer directly through driveway drains, exterior basement area drains, and sump pumps.

Figure 7-3 shows where the back-ups were reported due to these events. Most of the back-ups in 2003 were caused by surcharging along the Commonwealth Interceptor, whereas the back-ups from the 2006 storm were widespread across the City with about one-third of the basement back-ups occurring along the Commonwealth Interceptor. This is consistent with the existing hydraulic model which shows that the Commonwealth Interceptor is the most vulnerable to surcharging conditions that would lead to basement back-ups.

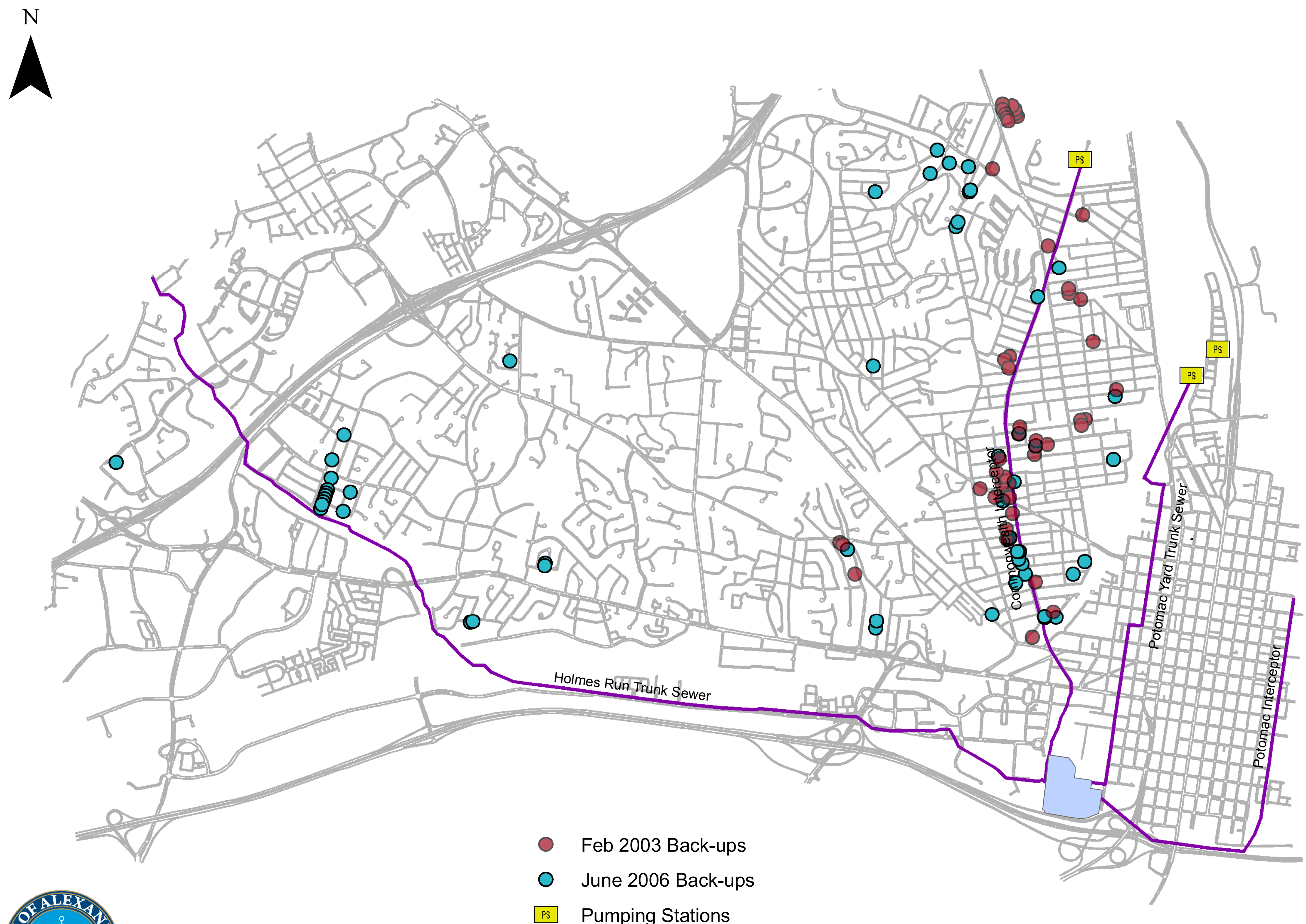


FIGURE 7-3
BASEMENT BACK-UPS IN 2003 AND 2006
Sanitary Sewer Master Plan

The Holmes Run Trunk Sewer also experiences surcharging in the reach from Mill Road to just upstream of the AlexRenew WRRF. However, this area is not prone to sewer back-ups or surcharging out of the manhole covers. Manhole covers along the surcharged reaches have been bolted down and do not have pick holes where sanitary flows can exit the system. In addition, there are two service pump chambers along the surcharged reach that pump wastewater flows from service laterals and discharge the flows to a level above the hydraulic grade line (HGL). This prevents flow from backing up into the laterals during extreme wet weather events.

7.2.3.2 Existing SSO Reduction and Basement Back-up Prevention

The City's ongoing I/I remediation program is aimed at reducing the wet weather I/I into the separate sanitary sewer system and reductions in total wet weather I/I volume have been measured and are reported in Chapter 3. Preliminary flow monitoring results from the permanent flow metering program do suggest that, during some storm events, excessive I/I still enters the sanitary collection system, which can contribute to the system becoming overloaded. The permanent flow monitoring program will help to identify those areas with the highest rates and volume of I/I such that continued I/I reduction efforts can be targeted most effectively.

Following the basement back-ups from the February 2003 rainfall and snowmelt event, the City implemented a program to install backflow preventers on sanitary laterals in the areas most vulnerable to basement back-ups. The program allowed homeowners to receive a reimbursement of up to $500 following the installation of a backflow preventer.

There were less basement back-ups along the Commonwealth Interceptor due to the June 2006 event compared to the February 2003 event, although there were more back-ups citywide due in June 2006. Based on a review of historical data, the storm event on October 7-8, 2005 was the next largest wet weather event with a return frequency of about a 25-50 year storm event. This storm did not result in a significant number of back-ups reported in the separate sanitary collection system, although it did result in an SSO. This suggests that the City's I/I program has led to a reduction in basement back-up potential in the Commonwealth Interceptor.

7.2.4 ANALYSIS OF FUTURE WET WEATHER FLOWS

A future wet weather analysis has been performed based on an annual average flow of 54 mgd, the total permitted annual average flow at the AlexRenew WRRF. Using the 54 mgd as a baseline, the following storm was modeled for the City's CSS and AlexRenew interceptor sewers:

- 5-year design storm (a total of 3.96 inches over 24 hours) to determine the impact of the storm on SSO volume at the Hooff's Run Junction Chamber and Four Mile Run Pumping Station and on the hydraulic grade line and potential for basement back-ups

The model results serve as a basis for the development of alternatives discussed in this section and evaluated in Chapter 8 to mitigate SSOs and reduce basement back-up potential.

7.2.4.1 Sanitary Sewer Overflows (SSOs)

The AlexRenew interceptor model predicts, for future conditions, an SSO through the HRJC for a 5-year design storm. No overflow is predicted at the Four Mile Run PS for a 5-year design storm, but it should be noted that modeling indicates that the retention basins, which provide 0.95 mg of storage, will be nearly full.

7.2.4.2 Basement Back-ups

The increase in annual average flows due to forecasted growth will also cause the HGL to rise in the interceptor sewers. Figure 7-4 shows locations along each of the interceptor sewers (Commonwealth Interceptor and Holmes Run Trunk Sewer) where surcharging is likely, which can lead to basement back-ups. The results of the modeling indicate that the Commonwealth Interceptor is subject to surcharging and potential basement back-ups from Caton Avenue to the HRJC. In addition, there is some potential as well for surcharging and back-ups along the Holmes Run Trunk Sewer from Mill Road to the HRJC. Basement back-ups along the Potomac Interceptor are not a concern since excess sanitary flows exit through the CSOs. Due to the significant depth of the Potomac Yard Trunk Sewer, back-ups are not a concern, even if surcharging occurs.

7.3 Wet Weather Alternatives

The analysis above indicates a need to reduce the impacts of wet weather on the sanitary sewers (collectors and interceptors) and at the AlexRenew WRRF in order to mitigate SSOs for the 5-year storm and reduce basement back-up potential. This section identifies alternatives that achieve the goals stated above. These alternatives can be classified into two broad categories:

- Modifications and upgrades at the AlexRenew WRRF and AlexRenew facilities
- Modifications and upgrades in the City's sewer system

An evaluation of these alternatives and conceptual-level costs associated with each is presented in Chapter 8.

7.3.1 POTENTIAL RECOMMENDATIONS NEAR THE ALEXRENEW WRRF

A collaborative study between the City, AlexRenew and Fairfax County to meet the wet weather goal was completed in November 2010 and is currently being updated. This study is herein referred to as the Wet Weather Management Study. This study identified and recommended the following related to wet weather flows:

- Construction of a wet weather facility at the AlexRenew WRRF that addresses wet weather through a combination of a wet weather pumping, storage and relocation of CSO 004 (located to just outside the AlexRenew WRRF) from just south of Duke Street to immediately upstream of the treatment plant. Additionally, the peak instantaneous plant capacity would be increased from 108 mgd to 116 mgd through primary treatment, with the difference being stored in the Nutrient Management Facility (part of SANUP and under design) at AlexRenew prior to secondary and tertiary treatment.

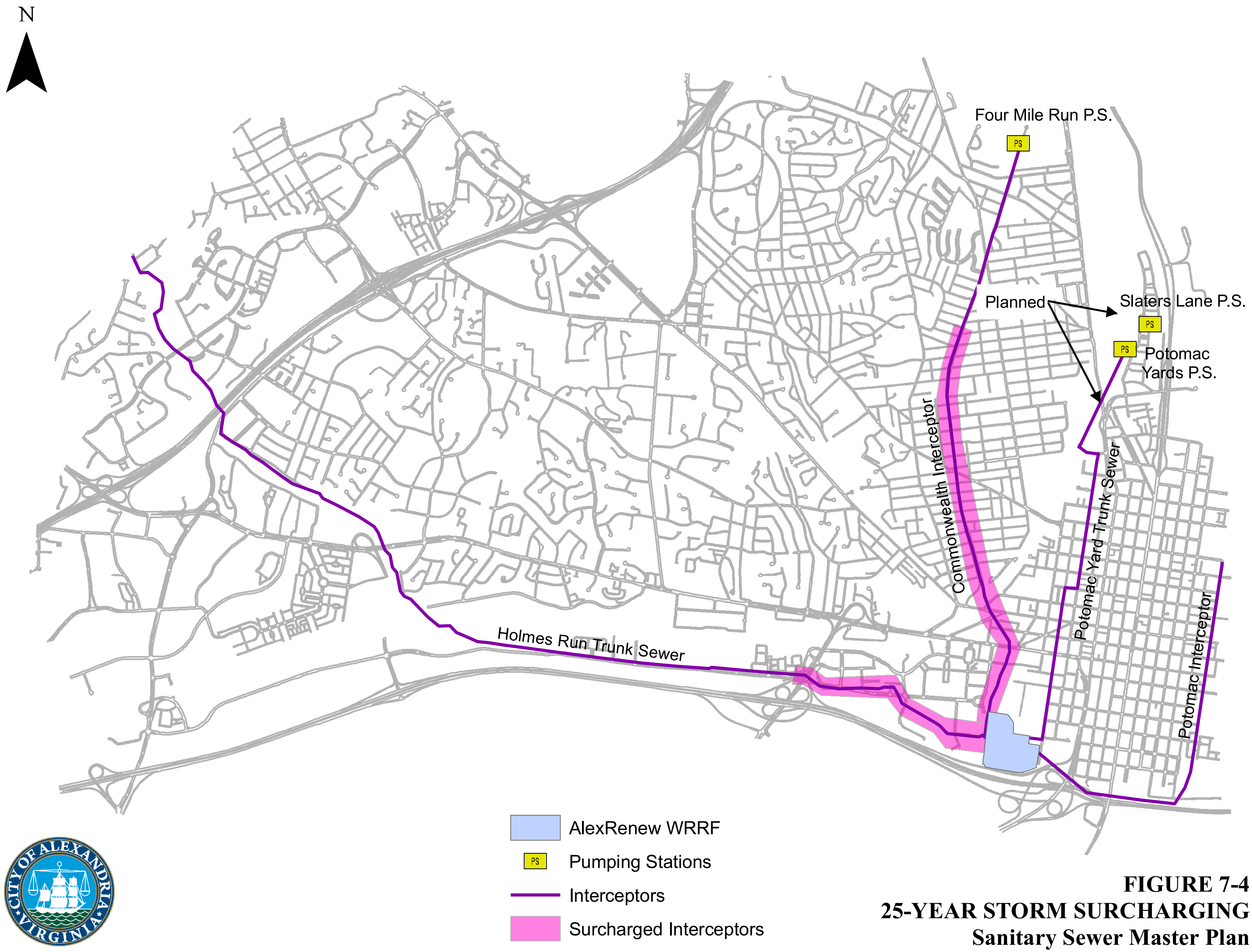


FIGURE 7-4
25-YEAR STORM SURCHARGING
Sanitary Sewer Master Plan

No additional wet weather mitigation is being proposed at the Four Mile Run PS since the modeling shows that the existing wet weather storage (0.95 mg) is sufficient to meet the 5-year storm event and for build-out conditions. The Four Mile Run PS was constructed in the mid-1950s and AlexRenew is currently in the design phase of a planned upgrade. As part of this upgrade, the existing storage will remain, along with the existing pumpover to the Potomac Yard Trunk Sewer. Construction is planned for early 2013 and is anticipated to be complete by late 2014.

7.3.1.1 Construction of a Wet Weather Facility at the AlexRenew WRRF

As part of the Wet Weather Management Study between the City, AlexRenew and Fairfax County for controlling existing excess I/I in the AlexRenew service area, an analysis was performed of the improvements needed in order to minimize the occurrence and impacts of SSOs and basement back-ups. The results indicated that minimal plant upgrades would be required in order to treat a peak flow of 116 mgd through primary treatment by using the AlexRenew Nutrient Management Facility as storage.

The analysis of a 116 mgd peak flow rate was conducted based on the peak flow being equal to two times the projected annual average flow of 58 mgd (based on the City acquiring an additional 4 mgd for growth). In this case, the plant would treat 108 mgd through the plant, 116 mgd through primary treatment, and the difference of 8 mgd would be stored in the Nutrient Management Facility until flows recede back down below 108 mgd. Once this occurs, wastewater stored in this facility could be pumped through the remaining treatment plant processes. Upgrading the AlexRenew WRRF to a peak flow of 116 mgd (primary treatment only) has a total estimated cost of $1.7M (2010 dollars).

Along with increasing plant influent flows to 116 mgd, the recommended strategy includes a series of elements that incorporate a mix of wet weather pumping, storage and the relocation of CSO 004 from just south of Duke Street to immediately upstream of the treatment plant. Figure 7-5 shows a schematic of each of these components. The objective of each of these elements is discussed in more detail below.

- Relocation of CSO 004 to a new CSO overflow structure near the HRJC. This relocation of CSO 004 would allow the AlexRenew WRRF to abandon the existing HRJC SSO structure and also reduce the number of overflows from CSO 004 and help reduce surcharging in the Commonwealth Interceptor. If this relocation is approved by VDEQ, then the SSO wet weather goal (no SSOs up to a 5-year storm) would no longer be applicable. Instead, the goal would be based on National CSO Policy. In this case, the goal would be no more than 4 overflows per year on average, as specified in EPA's CSO "presumption" approach.
- Construction of a wet weather pumping station. This pumping station would be located on the AlexRenew west plant site just north of the Nutrient Management Facility and would be designed to pump the up to the 25-year discharge overflow rate from the this structure, reducing the potential for basement back-ups on the interceptor sewers by lowering the hydraulic grade line and protecting against surcharging when the water level in Hooff's Run is high. AlexRenew has recently proposed that the wet weather pumping station could be incorporated into the design of the Nutrient Management Facility at a lower cost than a standalone facility. This option is currently under evaluation.

- Construction of wet weather storage. Along with the two elements above, a tunnel from the CSO 004 existing outfall to the new CSO 004 outfall structure is proposed. The tunnel option would be sized such that it would store the majority of wet weather flows being conveyed to the AlexRenew WRRF in excess of 116 mgd. Once the storage tunnel is filled, excess flows would overflow through CSO 004 into Hooff's Run.

The construction of the recommended wet weather mitigation facility, along with serving the goals (mitigation of SSOs and reduction of basement back-up potential) listed at the beginning of this chapter; also have the following additional benefits:

- Reduction in the number of CSOs at CSO 004. Currently, this CSO is activated approximately 35-40 times per year in an average rainfall year (about 40 inches). The construction of the wet weather facility would reduce the number of CSOs to about 4 in an average rainfall year.
- Reduction in the volume of discharges into Hooff's Run based on the construction of the storage tunnel and pumping higher flow through the treatment plant.

The above-listed benefits will result in improvements to water quality in Hooff's Run, Hunting Creek and the Potomac River. Figures 7-5 through 7-7 show the conceptual configuration of the three wet weather elements presented above. These figures show the wet weather pumping station as a standalone facility, but the final design may incorporate this pumping station into the Nutrient Management Facility.

FIGURE 7-5
CSO RELOCATION AND STORAGE

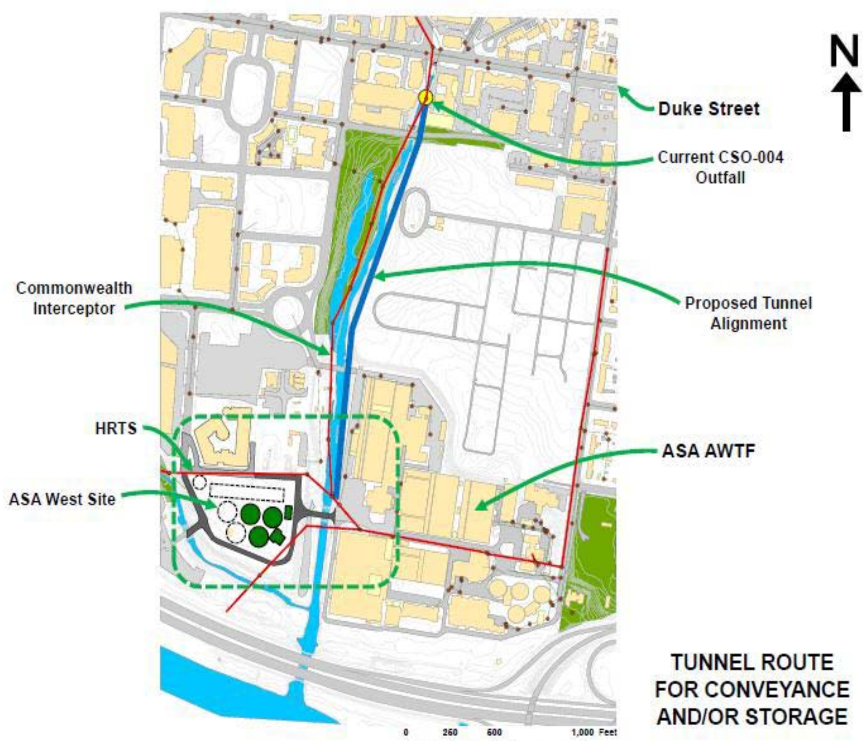


FIGURE 7-6
ELEMENTS OF WET WEATHER RECOMMENDATION

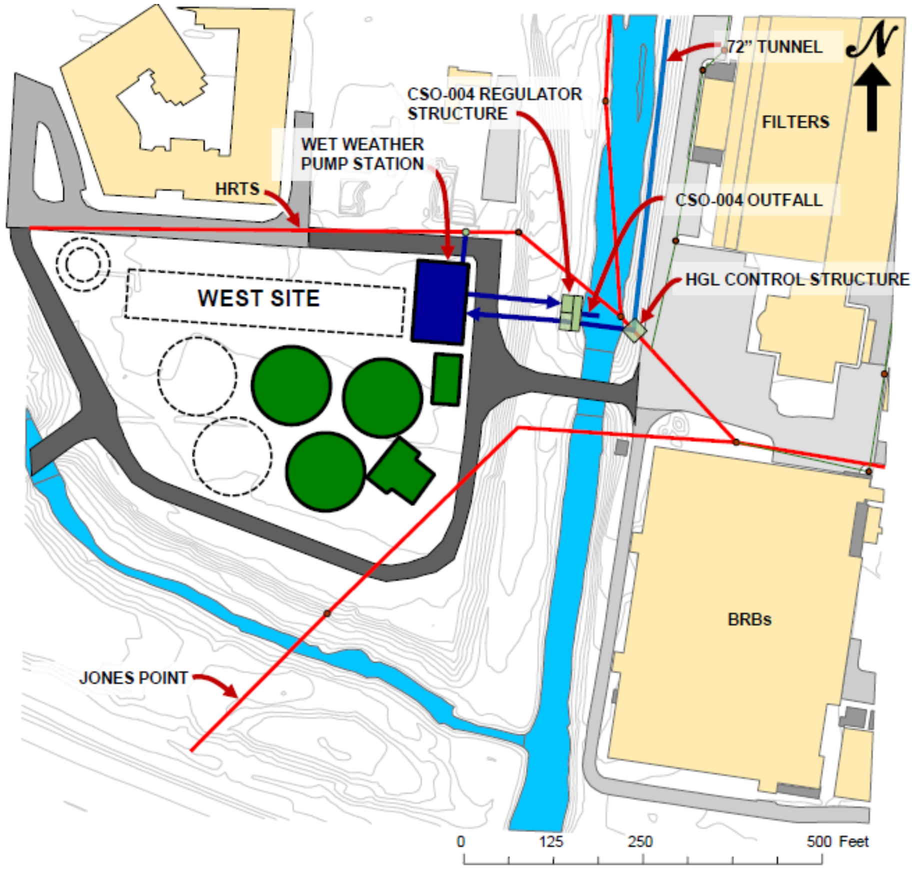


Figure 7-7
WET WEATHER RECOMMENDATION CONCEPTUAL PROFILE

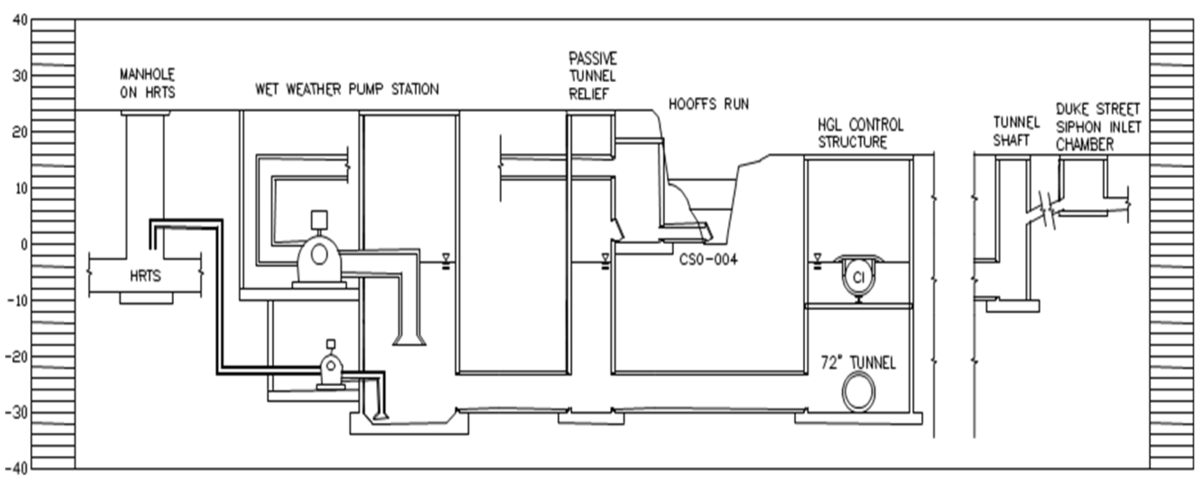


Table 7-2 presents each element of the wet weather recommendation and conceptual-level overall construction and engineering costs. The total estimated cost is $51.2M. The annual operating costs are approximately $1.1M.

TABLE 7-2 - WET WEATHER RECOMMENDATION CAPITAL COST SUMMARY (2010 DOLLARS)	
Item	**Cost ($M)**
New CSO 004 structure and hydraulic control	7.6
72-inch wet weather storage tunnel (0.5 mg)	10.0
Wet weather pump station	31.9[1]
AlexRenew improvements for 116 mgd (as presented in Section 7.3.1.1)	1.7
Total capital costs	**51.2**

1 AlexRenew has proposed an alternative site for the wet weather pump station, which if feasible, will reduce the cost of this component. Alternative site is currently under evaluation.

The recommended plan controls wet weather flows and helps to reduce basement back-ups. Additionally, the number of CSO events at CSO 004 would be reduced, along with the total volume of sewer and combined flows discharged to Hooff's Run. The recommended strategy will result in an improvement to water quality to Hooff's Run, Hunting Creek and the Potomac River. In order to be constructed, these benefits will need to be quantified and VDEQ must approve the plan.

7.3.2 OTHER POTENTIAL WET WEATHER ALTERNATIVES

The City has conducted a number of studies aimed at identifying options for continued reduction of wet weather flows in the sanitary collection system. A summary of some of these alternatives with respect to reducing peak wet weather flows is presented below.

7.3.2.1 Continued I/I Program Implementation

As discussed in Chapter 3, the City has completed rehabilitation of City-owned sewers and manholes in three separate sanitary sewersheds and is continuing its rehabilitation program in the Holmes Run Sewershed. Along with I/I from City-owned sewers, I/I may be generated from private sources as well. Research conducted by the Water Environment Research Foundation has estimated that private sources of I/I are often a significant contributor to the total I/I (40% on average, but highly variable). This has resulted in a number of communities addressing I/I from a variety of private sources including:

- Direct stormwater inflow sources (downspouts, driveway drains, basement area drains) that discharge to a private lateral
- Sump pumps and foundation drains that discharge to a private lateral
- Private laterals with defects in the pipe that contribute to I/I

The City is evaluating the feasibility of removing private sources of I/I as a means to reduce both average and wet weather sanitary flows. There are several mechanisms the City may consider to conduct I/I removal on private property such as:

- Enact an ordinance which requires private sewer laterals with defects or stormwater connections to the sanitary sewer be repaired or replaced (laterals) or disconnected (stormwater connections)
- Point-of-sale program where laterals must be rehabilitated and/or illicit stormwater connections removed as a condition to the sale of a home. The legal authority to enact such a program would need to be evaluated prior to implementing.
- Voluntary program that provides a rebate (either partial or full depending on how the program is structured) to property owners who repair or replace deteriorated laterals and/or remove stormwater connections

It should be noted that the City is not proposing to expand its I/I remediation program to include I/I from private property at this juncture.

7.3.2.2 Combined Sewer System (CSS) Separation

The City's CSS sends sanitary flows mixed with stormwater to the AlexRenew WRRF during rain events of a certain intensity and duration. Complete separation of the CSS into storm and sanitary sewers would result in all stormwater discharging through storm outfalls. Separation would lower both the annual average flows and peak wet weather flows at the treatment plant. However, construction of new storm and sanitary sewers will be prohibitively costly and disruptive to the Old Town area. Additionally, this option would not significantly reduce SSOs or reduce interceptor sewer surcharging. However, the City is actively moving forward with separating the combined sewers as a condition of development and through the existing Capital Improvement Program (CIP).

7.3.2.3 CSS Real-Time Control

Real-time control refers to the ability to divert flow during a storm event from one portion of the collection system to another. This type of diversion control allows for full use of the available capacity in the collection system. Real-time control typically consists of CSS diversion structures with variable control settings that open and closes in response to flow levels within the system and typically operates under the following conditions:

- During small storm events, where there is more capacity available at the treatment plant, more flow is conveyed from the CSS to the treatment plant which reduces the occurrence and volume of CSOs
- During large storm events, where there is less capacity available at the treatment plant, more flow is conveyed from the CSS to the treatment plant until the total flow reaches a certain level, at which the amount of flow from the CSS to the treatment plant is decreased and potentially shut off from the rest of the collection system

Real-time control can minimize SSOs by diverting all CSS flow through the permitted CSO outfalls during a large storm event in order to reduce flows at the treatment plant. Although the results is an increase in CSO volume during large storm event, this increase can be countered by the decrease in CSO volume by treating more CSS flow during smaller, more frequent storm events. Along with reducing SSO volumes, the implementation of real-time

control would result in an overall decrease in the number of CSO occurrences and total CSO volume discharged on an annual basis.

7.3.2.4 Green Infrastructure

There are a number of "green" technologies or low-impact technologies that exist, primarily in relation to reducing stormwater runoff from impervious surfaces. The City is currently examining implementing these technologies in the CSS and possibly in other areas including, but not limited to, the following:

- Rainwater Harvesting. Rainwater harvesting is the gathering, or accumulating and storing, of rainwater for other uses. The rainwater is captured either into a storage tank or pond and can then be used for other purposes. Examples include rain barrels to collect rainwater from the roofs of individual properties to be later used for irrigation purposes and storage tanks (cisterns) can be used to collect rainwater from roofs or other impervious areas from larger residential, industrial or commercial facilities. Currently, water from these larger facilities can then be used for irrigation purposes, heating or cooling or facility cleaner, and toilet or urinal flushing (non-residential properties only).
- Green Roofs. Green roofs are vegetated roof covers, with growing media and plants in place of shingles or tiles, gravel ballast or a bare membrane. In addition, a waterproof membrane (or membranes) and drainage system must be installed to collect and transport rainwater not captured by the vegetative cover. Due to the additional structural design requirements, green roofs are typically more costly to install as part of a retrofit project and, if used, should be incorporated as part of new development during the design phase.
- Bioretention Curb Extensions and Sidewalk Planters. Bioretention is a versatile green street strategy. These features can be tree boxes taking runoff from the street, or can be attractive attention grabbing planter boxes or curb extensions. Many natural processes occur within bioretention cells: infiltration and storage reduces runoff volumes and attenuates peak flows; biological and chemical reactions occur in the mulch, soil matrix, and root zone; and stormwater is filtered through vegetation and soil. Amended soils with higher permeability rates may be required in areas with naturally occurring low infiltration rates.
- Permeable Pavement. Permeable pavement comes in four forms: permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers. Permeable concrete and asphalt are similar to their impervious counterparts but are open graded or have reduced fines and typically have a special binder added. Methods for pouring, setting, and curing these permeable pavements also differ from the impervious versions. The concrete and grid pavers are modular systems. Concrete pavers are installed with gaps between them that allow water to pass through to the base. Grid pavers are typically a durable plastic matrix that can be filled with gravel or vegetation. All of the permeable pavement systems have an aggregate base in common which provides structural support, runoff storage, and pollutant removal through filtering and adsorption. Aside from a rougher unfinished surface, permeable concrete and asphalt look very similar to their impervious versions. Permeable concrete and asphalt and certain permeable concrete pavers are ADA compliant.

- Water Conservation and Low-Flow Fixtures. Water conservation and low-flow fixtures implementation requires a change in behavior for those residents and businesses located in the CSS. Incentive programs and public outreach to educate residents and businesses are key to implement these practices.

These technologies can serve to reduce the direct stormwater runoff into the sanitary or combined sewer. Many green infrastructure or low-impact technologies typically capture or mitigate only the first half-inch of rainfall, which contains the first-flush of pollutants from impervious surfaces, while harvesting and reuse can assist in reducing greater volumes of stormwater through distributed storage for later use following the wet weather event. While these options would help to reduce the impact of wet weather, especially related to CSOs, they provide limited benefit during extreme wet weather that has the potential to lead to SSOs and sewer back-ups.

7.3.2.5 Summary

A study performed in August 2008 analyzed the impact that some of these options would have on reducing SSO volumes produced by the 5-year storm event. The 2008 study found that none of the above alternatives alone provided complete mitigation of the 5-year SSO volume at the HRJC. Once the City implements its I/I remediation program in the Holmes Run Sewershed, post-construction monitoring will be performed and the AlexRenew interceptor model will be updated to determine the impact of rehabilitation of City-owned sanitary sewers and manholes on predicted SSO volumes. Updates to these estimates will be provided in subsequent updates to this Master Plan.

7.4 Conclusions

The assessment presented in this chapter indicates the potential for SSOs and basement back-ups during wet weather events based on existing and future (build-out, post 2040) conditions. A number of alternatives have been identified in this chapter that achieve or help to achieve the City's goals. The recommendation provided in the Wet Weather Management Study, which includes the relocation of CSO 004, storage and a wet weather pumping station, meets the 5-year SSO goal and significantly reduces the surcharging in the interceptor sewers. Chapters 8 and 9 present a discussion of including the recommended wet weather alternative as part of the CIP and funding strategies related to this alternative.

Chapter 8
Capital Improvement Program

8.1 Introduction

Chapters 5 through 7 present an assessment of existing and forecasted wastewater flows and wet weather flows and the impacts to the City's wastewater collection system, Alexandria Renew Enterprises (AlexRenew) interceptor sewers and at the AlexRenew Water Resource Recovery Facility (WRRF) and Arlington Water Pollution Control Plant (WPCP). These flows were presented for existing conditions through build-out (post 2040) conditions. The primary conclusions derived from this assessment are summarized below:

- A total of 19,500 feet of sanitary sewer have been identified with capacity deficiencies in the City's collection system, based on the sanitary sewer collection system model developed for build-out (post 2040) conditions.
- Capacity to support forecasted growth is available in both the Commonwealth and Potomac Interceptor (CI and PI) sewers outside of wet weather issues. There are two sections of the lower Potomac Yard Trunk Sewer where projected peak flows will exceed capacity due to build-out conditions. Capacity along the Holmes Run Trunk Sewer is continuing to be evaluated.
- The City will exceed its annual average allocation of 21.6 mgd at the AlexRenew WRRF sometime after 2040. Based on growth forecasts, the flows from the build-out conditions will exceed the existing allocation by approximately 4 mgd.
- The City will have sufficient capacity at the Arlington WPCP based on current growth forecasts and its existing allocation.
- Extreme wet weather flows have the potential to cause SSOs and basement back-ups. The occurrence of these will increase as wastewater flows to the AlexRenew WRRF increase as part of growth.

The purpose of this chapter is to outline the capital needs and costs to accommodate future growth and development and continue to effectively serve the wastewater needs of the City's residents and businesses. Financing options for sustaining the City's sanitary sewer program, including large-scale future wastewater capacity and collection system projects are discussed in Chapter 9.

8.2 FY2013 Capital Improvement Program

This section presents a summary of the City's FY2013 10-year Capital Improvement Program (CIP) related to both the City's sanitary sewer and combined sewer systems. A copy of the FY2013 CIP related to sanitary sewers is included in Appendix 8-1. Sanitary sewer projects are funded through the sanitary sewer connection fees and maintenance fees discussed in more detail in Chapter 9. Stormwater projects are funded through different funding sources and are not discussed in this Sanitary Sewer Master Plan.

Table 8-1 shows a summary of all sewer (sanitary and combined) projects in the FY2013 10-year CIP. The total estimated cost for these projects over 10 years is $102M and includes the wet weather management facility and expansion of the AlexRenew WRRF hydraulically by 4 mgd. The CIP projects are discussed in more detail below.

8.2.1 SANITARY SEWER COLLECTION SYSTEM PROJECTS

Prior to the FY2013 CIP, most of the Sanitary Sewer CIP funding has been associated with remediation of the sanitary sewer collection system. As shown on Table 8-1, the Holmes Run Sewershed Infiltration and Inflow (I/I) project is funded at $19.9M over ten years. As discussed in Chapter 7, this project includes necessary rehabilitation of City-owned sanitary sewers and manholes for the area shown on Figure 3-6. Sewer and manhole rehabilitation will be prioritized based on the level of I/I estimated in individual basins within the Holmes Run Sewershed.

In addition to the rehabilitation of sanitary sewers and manholes associated with I/I, the Reconstruction and Extension of Sanitary Sewers project addresses repair and replacement of existing sanitary sewers for maintenance related improvements. This project includes an ongoing program to replace all 6-inch diameter City-owned sewers with larger diameter (typically 10-inch) sanitary sewers. These 6-inch sewers have been inspected and were found to be in deteriorating condition. These smaller sewers are the source of frequent blockages and require significant maintenance. This project also includes replacing any existing sewers operating over capacity that have the potential to lead to basement back-ups. The current CIP contains $5.4 million in funding.

Another collection system improvement project in the FY2013 CIP is Four Mile Run Sanitary Sewer Repair. This project has $1.5M budgeted to rehabilitate a 36-inch diameter sewer that runs through Four Mile Run Park and connects directly to the AlexRenew's Four Mile Run Pumping Station (PS). This work will be coordinated with AlexRenew's project to upgrade the Four Mile Run PS.

8.2.2 COMBINED SEWER SYSTEM (CSS) PROJECTS

There are two CSS-related projects funded in the FY2013 CIP: Mitigation of CSOs and CSS Sewer Separation projects. Mitigation of CSOs consists of conducting the activities as specified in the City's current CSS VPDES permit. These activities include monitoring and sampling of the CSOs and receiving waters and preparation of the annual report to VDEQ that summarizes this information. This also funds operations and maintenance activities related to the EPA's Nine Minimum Controls (outlined in Chapters 2 and 3). The FY2013 CIP includes $3.4M for this project over 10 years.

The CSS Sewer Separation Project is related to separating portions of the combined sewer system, either by construction of new sanitary sewers, storm sewers or both where feasible. Based on previous estimates, the cost of total sewer separation in the CSS comes to $250-350M and the FY2013 CIP has a total budget of $5.4M. City staff is currently working on a plan to separate portions of the combined sewers in the King and West CSO area (approximately 5 acres) by redirecting the sanitary flow to the Potomac Yard Trunk Sewer. Additionally, a portion of the CSS CIP monies will include implementation of green infrastructure techniques to decrease the volume of the stormwater component in the combined flow, and therefore decrease CSO impacts by decreasing the number of overflows and total volume discharged.

TABLE 8-1
SANITARY SEWER FY2013 CIP
CITY OF ALEXANDRIA, VIRGINIA SANITARY SEWER MASTER PLAN

Project	Unallocated Balance	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	TOTAL FY2013-FY2022
Commonwealth Service Chamber	*$ 370,000*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Holmes Run Trunk Sewer	*$ 6,037,000*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Reclaimed Water System via Waste-to-Energy Plant	*$ -*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Sanitary Sewer Capacity Studies	*$ 149,877*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mitigation of Combined Sewer Overflows	*$ 1,581,690*	$ 319,000	$ 335,000	$ 335,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 3,439,000
Reconstruction and Extension of Sanitary Sewers	*$ 2,373,918*	$ 322,000	$ -	$ 775,000	$ 320,000	$ 435,000	$ 540,000	$ 660,000	$ 760,000	$ 760,000	$ 845,000	$ 5,417,000
Sewer Separation Projects	*$ 600,000*	$ 500,000	$ 120,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 5,420,000
Four Mile Run Sanitary Sewer Repair	*$ 130,000*	$ 1,500,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,500,000
Holmes Run Infiltration and Inflow	*$ 4,960,000*	$ 4,360,000	$ 4,200,000	$ 3,600,000	$ 3,850,000	$ 3,850,000	$ -	$ -	$ -	$ -	$ -	$ 19,860,000
Sanitary Sewer Master Plan	*$ -*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 10,000	$ 10,000
Wet Weather Management Facility	*$ -*		$ 3,375,000	$ 1,125,000		$ 13,300,000	$ 13,700,000					$ 31,500,000
AlexRenew WRRF Expansion	*$ -*	$ 500,000	$ 500,000	$ -	$ -	$ -	$ -	$ -	$ 11,070,000	$ 11,400,000	$ 11,750,000	$ 35,220,000
Total Sanitary Sewer Projects	***$ 16,202,485***	***$ 7,501,000***	***$ 8,530,000***	***$ 6,435,000***	***$ 5,120,000***	***$ 18,535,000***	***$ 15,190,000***	***$ 1,610,000***	***$ 12,780,000***	***$ 13,110,000***	***$ 13,555,000***	***$ 102,366,000***

8.2.3 PRIOR CIP FUNDING

Several sanitary sewer capital projects are underway with funding from prior fiscal years:

- Commonwealth Service Chamber: This study is evaluating the effectiveness of a service pumping chamber along the Commonwealth Interceptor to prevent basement back-ups during extreme wet weather events. This option is being evaluated in coordination with the Wet Weather Management Study described in Chapter 7. Based on implementing the recommended strategy in the study, the construction of a service chamber along the Commonwealth Interceptor may no longer be necessary.
- Holmes Run Trunk Sewer: Prior year funding in the amount of $6.0M is budgeted to increase capacity in the Holmes Run Trunk Sewer. As discussed in Chapter 5, the City, AlexRenew and Fairfax County are currently studying the capacity needs in this sewer. The results of this study will be included in an update to the Master Plan.
- Reclaimed Water System via the Waste-To-Energy Facility: The City and AlexRenew have completed a feasibility study for providing reclaimed water to the Waste-to-Energy facility for use in its industrial processes. This study has found that the project is not cost effective at this time. However, the City is working with AlexRenew to evaluate the viability of other reuse projects closer to the treatment plant.
- Sanitary Sewer Capacity Studies: This project funds the local collection system modeling that is being done in support of this Master Plan. Funding in the amount of $150,000 remains to support this modeling effort.

8.3 Growth Related Needs

This section summarizes the City's sanitary sewer needs in relation to the growth forecasts presented in Chapter 4 and analysis of the impact on the following:

- Local sanitary sewer collection system
- AlexRenew Interceptor sewers
- Treatment plant capacity

Specific project recommendations are summarized in this section. A timeframe for implementing these recommendations is also provided along with conceptual-level costs. Funding considerations and strategies are discussed in Chapter 9.

There are a number of recommendations that should be considered preliminary at this juncture as additional study and evaluations continue. A discussion of the factors that remain under analysis is presented along with the recommendations.

8.3.1 LOCAL SANITARY SEWER COLLECTION SYSTEM

The local sanitary sewer collection system model demonstrated that, in the modeled areas (see Figure 5-1); approximately 19,500 feet of sewers exceed 100% of pipe capacity during peak flow conditions as a result of projected build-out (post 2040) growth. A number of alternatives were reviewed for increasing capacity, but due to various constraints, increasing the pipe diameter will likely be the most feasible alternative for increasing

capacity and meeting future flow requirements. The total conceptual-level cost for replacement of sewers in the collection system is $17.6M and includes construction and other costs (engineering, survey and administration costs).

The majority of these local sanitary sewer collection system improvements are necessary due to new development or redevelopment in localized areas. The timing of with these projects will be coordinated with proposed development and redevelopment projects. It is anticipated that the improvements will be constructed by the developers or that funding for construction will be provided to the City as part of the development process. Therefore, these sewer replacement projects are not likely to be included as part of the CIP.

For existing sewers operating over capacity, these sewers are currently being evaluated to determine the extent of surcharging and whether or not basement back-ups will be caused due to the surcharging. If the potential for a back-up or overflow condition is determined, these sewers will be replaced as part of the existing Reconstruction and Extension of Sanitary Sewers project. Future additional funding for this project may be required.

8.3.2 ALEXRENEW INTERCEPTOR SEWERS

Chapter 5 presented the estimated average daily flows in each of the AlexRenew interceptor sewers due to build-out (post 2040) projected growth and a discussion of potential capacity issues associated with each sewer. As discussed in Section 5.4, the Commonwealth and Potomac Interceptor sewers are not expected to exceed their existing capacities under current growth forecasts.

The Potomac Yard Trunk Sewer is projected to exceed its capacity in two pipe sections, based on build-out growth forecasts. The cost of this upgrade, estimated at $1.2M, will be apportioned to the development projects that are contributing to the projected flow and developer contributions will be made as these projects are constructed. The flow in this interceptor will be monitored as development occurs over time. The City will add this project to the CIP at the appropriate time to ensure that the construction will occur before the capacity is exceeded. The Holmes Run Trunk Sewer (HRTS) shed has the greatest amount of growth forecasted citywide. The City is currently working with AlexRenew to determine the impact of future development on the HRTS and developing a plan to address any capacity issues. As discussed in Section 8.2.4, prior year funding in the amount of $6.0M is available to address capacity needs in this interceptor sewer. Upon completion of the capacity evaluation, the CIP will be adjusted to accommodate specific recommended improvements.

8.3.3 ALEXRENEW TREATMENT PLANT CAPACITY

Chapter 6 presented an assessment of the City's treatment plant capacity (based on an average annual year basis) at the AlexRenew WRRF through build-out (post 2040) conditions. It is estimated that the City will require an additional capacity of 4 mgd at the AlexRenew WRRF and that the current allocation of 21.6 mgd would be reached sometime following Year 2040. A number of alternatives were presented in order for the City to allow for future growth and to preserve sufficient treatment capacity:

- Expand the AlexRenew WRRF to increase its annual average design capacity of 54 mgd to 58 mgd (preliminarily estimated at $29M)
- Purchase 4 mgd of annual average treatment capacity at the AlexRenew WRRF from Fairfax County (preliminarily estimated at $56M)

Each of these alternatives was presented in Chapter 6 and conceptual-level costs were provided. A comparison of these two options is shown in Table 8-2. The acquisition of an additional 4 mgd of wastewater treatment capacity via expansion of the AlexRenew WRRF has been included in the FY2013 CIP. Financial considerations related to these alternatives are discussed in Chapter 9.

8.3.4 ARLINGTON TREATMENT PLANT CAPACITY

Chapter 6 presented the results of the growth forecasts and resultant projected sanitary flows at the Arlington WPCP. Forecasts indicate that the existing allocation of 3 mgd wastewater capacity will be sufficient to meet forecasted growth for build-out conditions. It should be noted that these forecasts may change based on the proposed Beauregard Corridor Plan. Additionally, the Northern Virginia Community College has expressed interest in transitioning to a 4-year college, complete with student housing and other facilities. Therefore, it is possible that future forecasts will result in increased wastewater flows in the Arlington Sanitary Sewer Service Area. These forecasts will continue to be assessed and updates to the Master Plan made as warranted.

8.4 Wet Weather Needs

Chapter 7 presents an assessment related to wet weather in the AlexRenew interceptor sewers and at the AlexRenew WRRF with the goals of SSO mitigation and prevention of basement back-ups for build-out (post 2040) conditions. The analysis presented in Chapter 7 is based on the hydraulic modeling results from the AlexRenew interceptor model and the City CSS model. The analysis indicates that improvements are necessary to meet the stated goals for both existing and build-out conditions. The recommendations presented include:

- Wet weather mitigation at the AlexRenew WRRF
  - Increase the plant’s peak capacity from 108 mgd to 116 mgd through primary treatment
  - Address wet weather through a combination of pumping, storage and relocation of CSO 004 from just south of Duke Street to just upstream of the treatment plant

It was determined that wet weather mitigation at the AlexRenew WRRF is required to meet the City’s wet weather goals. The joint modeling effort between AlexRenew, the City and Fairfax County has recently been refined to incorporate data from the permanent flow meters installed on the AlexRenew interceptors and post-construction flow monitoring following the I/I rehabilitation in the Four Mile Run, Commonwealth and Taylor Run sewersheds. As stated in Chapter 7, the recommended strategy of relocating CSO 004 would require approval from the Virginia Department of Environmental Quality (VDEQ). These discussions between the City, AlexRenew, Fairfax County and VDEQ will be initiated following an agreement between the parties as to the schedule and cost sharing of this facility.

The total conceptual-level cost for the wet weather mitigation at the AlexRenew WRRF is $51.2M as shown on Table 7-3. The cost distribution between the City, AlexRenew and Fairfax County has not yet been determined. This wet weather management facility has been included in the proposed FY2013 and assumes approximately 50% of the cost to be funded by the City.

TABLE 8-2
COMPARISON OF TREATMENT PLANT CAPACITY ALTERNATIVES
CITY OF ALEXANDRIA, VIRGINIA SANITARY SEWER MASTER PLAN

Alternative	Cost	Advantages	Disadvantages	Timeline
Expand the AlexRenew WRRF from 54 to 58 mgd	$29M + possible nutrient offset/removal costs	- Meets build-out (post 2040) growth projections - May be significantly less costly - Can pay for later	- Possible additional unknown costs - Subject to regulatory approval	- $1M: 2011-2015 - Majority of cost 2021-2025 or later
Purchase 4 mgd of AlexRenew WRRF capacity from Fairfax County	$56M	- No regulatory approval required - No unknown costs - Can be negotiated now	- Start paying for now - May be significantly more costly	- Start paying for now, specifics to be negotiated

Recently, AlexRenew has proposed that the wet weather pumping station be incorporated into their Nutrient Management Facility (currently under design) as opposed to a standalone facility. Preliminary cost estimates have been provided by AlexRenew which show a total reduction in project cost from $51.2M to $33.6M. The feasibility of incorporating the wet weather pumping station into this facility is currently ongoing.

Financial considerations for both wet weather management facility options are presented in Chapter 9.

8.5 Unfunded Potential Combined Sewer System Needs

The Hunting Creek Bacteria TMDL establishes wasteload allocations (WLAs) for *E. coli* that result in a reduction in the existing CSO volume discharged from CSO 002 (80%), 003 (99%) and 004 (99%), with an overall volume reduction of 86%. To date, no deadline is established for when these reductions must be achieved, but discussions with VDEQ indicate that the timeline for complying with the TMDL will be over the next 15-25 years. In addition, the TMDL also calls for reductions from other sources, including stormwater and wildlife. WLAs for nitrogen, phosphorous and sediment related to the Chesapeake Bay TMDL were also established for the CSS. The WLAs are based on the existing CSS modeling and no reductions in CSO volume are required.

The City reapplied for its VPDES permit in July 2011 and the WLAs established by the Hunting Creek TMDL will have to be addressed as part of the permit re-issuance. The City is currently engaged in discussions with VDEQ regarding requirements of the next permit cycle. Based on current discussions, the City will likely be required to update its Long Term Control Plan, evaluate CSO control options and recommend to VDEQ a strategy for meeting the TMDL. An Alternatives Analysis will be conducted to study options to achieve the necessary CSO controls. These alternatives will consider effectiveness, cost and construction impacts to the community, including short term and long term impacts to the historic nature of Old Town Alexandria.

In order to comply with the Hunting Creek Bacterial TMDL, the additional CSO controls required could entail relatively costly sewer separation as a condition of redevelopment that would be borne by the developer, and control of stormwater volume onsite through infiltration and reuse practices. CSO controls may also include very costly City-led implementation of CSO control technologies such as full-scale sewer separation, storage and treatment of CSOs, or expanding treatment facilities to accommodate wet weather flows. Green infrastructure would likely be a component of any CSO mitigation program.

Preliminary cost estimates to achieve these required controls range from $75M – $350M. Future updates to the Sanitary Sewer Master Plan will incorporate new regulatory requirements associated with the City's CSS.

Chapter 9
Financing Strategies

9.1 Introduction

This Sanitary Sewer Master Plan provides recommendations to meet the City's growth needs and wet weather needs. Current and future capital needs are outlined in Chapter 8. Table 8-1 summarizes these needs.

This chapter discusses the City's current program for funding sewer projects in the Capital Improvement Program (CIP) and options for generating additional revenue to fund these future needs.

9.2 Current Sewer Fee Structure

The City's sanitary sewer program, including both capital and operating expenses, is set up as an Enterprise Fund. The sanitary program is funded entirely by sewer user fees and connections fees. The current fee structure is as follows:

- User fee: $1.25/1000 gallons of metered water, billed on a quarterly cycle (City Code 5-6-26 and provided in Appendix 9-1)
- Connection fees for new development or redevelopment (City Code 5-6-25.1):
  - Single-family home = $8,404
  - Multi-family home = $4,201 per dwelling unit (50% of single-family)
  - Connection fees for non-residential property based on water meter size as shown in Table 9-1.

Generally, 85% of the City's existing sewer revenue comes from user fees, with the remaining 15% from connection fees. During periods of significant growth, the contribution from connection fees may reach 30%. The Enterprise Fund is used to fund the following:

- Capital sanitary sewer or combined sewer improvement projects
- Operating expenses (personnel and non-personnel)

It is not used to fund:

- Improvements related to development projects
- Alexandria Renew Enterprises (AlexRenew) projects

The City also leverages sanitary sewer funds through the issuance of General Obligation Bonds, with the debt service covered by sewer revenues. General Obligation Bonds financed 100 percent by sanitary sewer fees are not counted by the bond rating agencies in municipal debt ratios.

TABLE 9-1 – FY2013 NON-RESIDENTIAL CONNECTION FEES BASED ON METER SIZE

Meter Size (inches)	Max. Capacity (GPM)	3/4" Meter Equiv.	Fee
3/4 or smaller	30	1.00	$8,404
1	50	1.67	$14,034
1 1/2	100	3.33	$27,985
2	160	5.33	$44,793
3	320	10.76	$90,425
4	500	16.67	$140,092
6	1000	33.33	$280,101
8	1600	53.33	$448,178
10	2300	76.67	$644,323

AlexRenew generates its own revenue from customers in the City by applying a user fee of $6.36 per 1000 gallons (for FY2013) of metered water. Sewer usage is established for the year based on the usage in the winter quarter. For the remaining three quarters, the bill is calculated at this level or is calculated based on the actual usage for the quarter, whichever is lower. AlexRenew also leverages a Chesapeake Bay Protection Charge, which varies based on the water meter size, and an Account Service Charge. The Chesapeake Bay Protection Charge helps to recover expenses needed to upgrade AlexRenew's infrastructure in order to meet the requirements of the Chesapeake Bay Total Maximum Daily Load (TMDL).

9.3 Financing Alternatives

A number of financing alternatives have been considered for funding the large-scale sewer projects identified in Chapter 8. These alternatives are described in this section and include the following:

- Increase connection fees
- Increase user fees
- Development-funded collection system improvements
- Treatment capacity reservation
- Combined sewer separation and mitigation

9.3.1 INCREASE CONNECTION FEES

Sanitary sewer connection fees are charged to new projects that connect to a City sewer. Increasing the sanitary sewer connection fee results in generating additional revenue from growth related projects that can be used to fund large-scale sewer projects. Any increase in connection fees will need to be undertaken with knowledge of neighboring jurisdictions' fees as well as the knowledge that any needed sanitary sewer capacity funds not collected through the connection fee may be covered by the existing rate payers' sanitary sewer user fee. Table 9-2 shows the connection fees imposed by surrounding jurisdictions for single-family homes.

TABLE 9-2 – FY2013 CONNECTION FEE SUMMARY: SINGLE-FAMILY HOME

Jurisdiction	Single-Family Connection Fee
City of Alexandria	$8,404
Arlington County	$110 per drainage fixture unit[1]
Fairfax County	$7,750
Prince William County	$10,800
Washington Suburban Sanitation Commission (WSSC)	$3,500 (unimproved area); $10,750 (improved area)

[1] Total number of drainage fixture units varies. For a typical single-family home, connection fee is approximately $3,080 (28 drainage fixture units).

An examination of the connection fees revealed that the City's multi-family connection fee is generally lower than the other jurisdictions. The City's multi-family connection fee is 50% of the single-family connection fee, whereas most other neighboring jurisdictions' multi-family connection fees are 80-100% of the single-family connection fee as shown in Table 9-3.

Additionally, it should be noted that the water usage for multi-family homes in the City is approximately 87% of the usage that is generated from single-family homes, as reported by the Interstate Commission for the Potomac River Basin (ICPRB) in May 2010. Therefore, it may be appropriate to increase the multi-family connection fee to more accurately reflect the water usage and to coincide with surrounding jurisdictions.

TABLE 9-3 – FY2013 CONNECTION FEE SUMMARY: MULTI-FAMILY HOME		
Jurisdiction	Multi-Family Connection Fee	% of Single-Family Connection Fee Cost
City of Alexandria	$4,201	50
Arlington County	Varies based on # of drainage fixture units	Varies
Fairfax County	$6,200	80
Prince William County	$8,640	80
WSSC	$3,500 (unimproved area); $10,750 (improved area)	100

9.3.2 INCREASE USER FEES

The sanitary sewer usage fee is charged to existing customers on the quarterly bill from AlexRenew. One option to increase sanitary sewer funding is to increase the sanitary user fees that the City charges to all households and businesses. This fee could be used to support operating, cash capital and debt service expenditures. Table 9-4 shows additional annual revenues that could be realized based on a range of increases to the existing user fees assuming existing annual revenues of $6.5M (per FY2013 CIP).

Existing customers also pay a sewer treatment fee on their sewer bill, which is charged by AlexRenew. Most other surrounding jurisdictions own and operate both the wastewater treatment facility and the collection system. Therefore, in order to compare the usage fees to neighboring areas, both the existing City and AlexRenew usage fees have been combined below. Table 9-5 shows a summary of these fees. Most of these jurisdictions have planned increases (including AlexRenew) either through the usage fee or other separate charges to meet future treatment requirements from the Chesapeake Bay TMDL.

TABLE 9-4 – POTENTIAL USER FEE INCREASE SUMMARY		
User Fee Increase (per 1000 gal)	Percent Increase	Estimated Total Added Yearly Revenue
$0.05	4%	$260,000
$0.10	8%	$520,000
$0.25	20%	$1,300,000
$0.50	40%	$2,600,000
$1.00	80%	$5,200,000

TABLE 9-5 – FY2013 SEWER USAGE FEE SUMMARY	
Jurisdiction	Usage Fee per 1000 Gallons Metered Water
City of Alexandria and AlexRenew	$1.25 (City), $6.36 (AlexRenew), $7.61 (Total)
Arlington County	$8.63
District of Columbia (DC Water)	$5.64
Fairfax County	$6.85
Prince William County	$6.55 (residential); $7.15 (commercial)
Washington Suburban Sanitation Commission (WSSC)	$3.64-$9.24 (based on usage, ~$5.73 for single-family based on 160 gallons per day)

9.3.3 DEVELOPMENT-FUNDED COLLECTION SYSTEM IMPROVEMENTS

The City currently requires developers to ensure adequate sewer capacity for developments generating a peak flow of at least 10,000 gpd, which equates to development of approximately 7-10 households based on the Memo to Industry No. 02-07 flow factors (presented in Appendix 3-1). Therefore, the local sanitary collection system capacity improvement projects discussed in Chapters 5 and 8 are anticipated to be funded by the development projects that generate the need for the additional capacity. The necessary capacity improvements in the Potomac Yard Trunk Sewer are expected to be funded in the same way.

In some cases, more than one development project may contribute to the need for upgrading a particular sewer. The local collection system needs identified in Chapter 5 are based on build-out conditions, since incremental improvements to the same sewer are not practical or cost effective. However, improvements to the sewer would be required when the cumulative amount of development exceeds the existing capacity in the pipe. A number of options are available for distributing shared costs for collection system upgrades between multiple development projects. Some examples are:

- Developer pays for entire cost for build-out conditions if the flows from that development exceed the existing capacity. If the full build out conditions requires a larger sewer than needed to serve that development, the developer would receive a credit (to be used against the connection fee) for this additional capacity.
- Developer pays entire cost of the upgrade and receives reimbursement from other developers in the future. After some timeframe, the City may pay the balance back to the developer for costs not yet reimbursed. The City then can recover this cost as development continues.
- Developer pays a portion of the cost to upgrade based on percentage of flows that contribute to build-out projections; City funds remaining portion and acquires these funds from future development projects as they occur.

These options are currently being evaluated. Individual projects may be evaluated to determine the most equitable funding solution, given the specific needs and details of the project and development area.

9.3.4 COMBINED SEWER SEPARATION AND MITIGATION

As discussed in Chapter 7, the City is working to separate certain portions of the Combined Sewer System (CSS). The City currently requires all development and redevelopment in the combined sewer area to connect its sanitary sewer flows to a separate sanitary sewer (or to contribute funds towards separation based on the project site size if separation is not feasible) and has developed more specified criteria outlining the required contributions for CSS separation. Proposed criteria are summarized in the Recommendations section (Section 9.6) of this chapter.

The proposed policy states in the event that a separate sanitary sewer is not available within 900 feet, the project is required to contribute funding toward future separation projects in an amount equal to $300,000 per acre of the development site. Staff encourages development projects to construct separation of the combined sewer, even if the project is greater than 900 feet from a separate sanitary sewer. In the case where a project constructs sewer improvements beyond those required, credits against the sewer connection free can be given to offset the additional costs. In addition, if additional sanitary sewer is constructed, the developer will connect all of the sanitary laterals along the alignment of the new sewer. These additional costs will also be credited against the sewer connection fee.

9.4 FY2013 Major Funding

A number of needs have been identified and conceptual-level costs developed, including the acquisition of 4 mgd at the AlexRenew WRRF, construction of a wet weather management facility to mitigate SSOs and reduce the potential for sewer back-ups along the interceptor sewers, and increased funding for the City's I/I remediation program in the Holmes Run Sewershed. These have been included in the FY2013 CIP (see Appendix 8-1). The FY2013 CIP does not address future regulatory requirements related to CSOs.

The FY2013 CIP proposes increasing the sewer user fees and issuing additional General Obligation Bonds to cover the costs associated with these projects. Increases in the user fees would begin in FY2015 and increase to $2.29 per 1000 gallons by the end of the 10-year CIP. No change in the connection fee is currently proposed, other than increases based on inflationary factors, which is the current practice.

The projects related to wet weather issues (I/I remediation and the wet weather management facility) are related to existing system needs. However, the growth related need of additional wastewater treatment plant capacity at the AlexRenew WRRF is based on future wastewater flows from forecasted growth. Additionally, it is not anticipated that the City will exceed its existing allocation at the AlexRenew WRRF until sometime after 2040. Additional financial modeling efforts have attempted to direct growth-related funding, such as connection fees, toward growth-related expenses, such as additional wastewater treatment capacity. These efforts have also focused existing customer revenue (user fees) toward existing system needs. A financial model was developed as part of this Master Plan that evaluates funding the AlexRenew WRRF expansion from the connection fees and funding the current wet weather needs through the user fees. The model also assumes the issuance of General Obligation Bonds.

9.5 Sanitary Sewer Financial Model

A financial model (referred to herein as the Sanitary Sewer Financial Model) has been developed that addresses recommendations included in this Master Plan for known needs, using current planning level cost estimates. This includes obtaining additional capacity at the AlexRenew WRRF (through hydraulic expansion), the proposed wet weather mitigation facility and additional funds for I/I remediation. Replacement of local collector sewers due to capacity exceedance is not included since the majority of these will be developer-funded. This model also does not include combined sewer overflow (CSO) mitigation funding beyond what is budgeted in the current FY2013 CIP nor does it include capacity improvements in the Holmes Run Trunk Sewer.

9.5.1 MODEL ASSUMPTIONS

The Sanitary Sewer Financial Model developed as part of this Master Plan assumes the following:

- Existing system needs to be funded via the sanitary sewer user fee (I/I remediation and the wet weather management facility)
- Needs due to growth (AlexRenew WRRF expansion) to be funded by the sewer connection fees

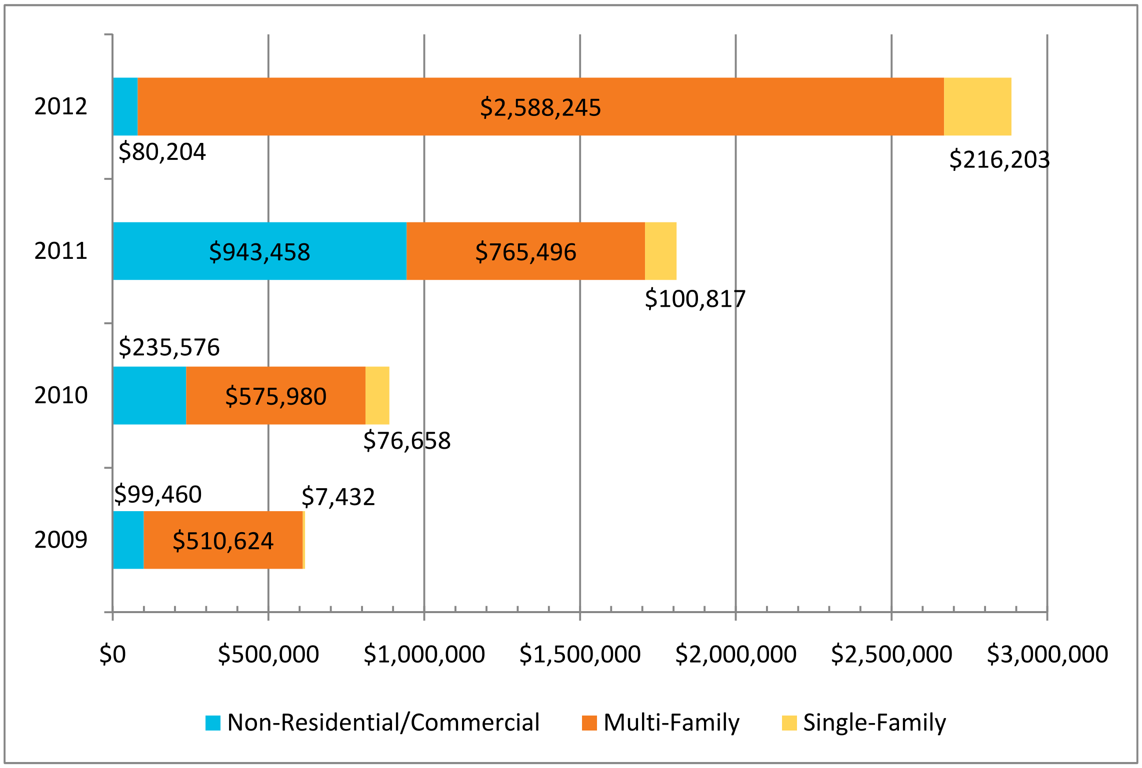
This differs from the FY2013 CIP in that the CIP assumes the costs of the recommended projects be funded through the sanitary sewer user fees. Additional model assumptions include:

- Sanitary user fees collected at a growth rate of 0.75% per year (assumes some reduction in water usage due to installation of low-flow fixtures for new development)
- Sewer connection fees are adjusted 3% annually for inflation
- Multi-family connection fee to be increased from 50% to 90% of the single-family fee in FY2014.
- Approximately $1M in connection fee revenue and $6.5M in sanitary sewer user fee revenue collected in FY2013 (this assumption is consistent with the FY2013 CIP)
- Sewer connections fees and sanitary sewer user fees are increased such that revenues exceed expenditures each year.
- Increases are made to the user fee to support increased expenditures related to the existing system
- Increases are made to the connection fee to support expenses related to growth

9.5.1.1 Rate of Growth and Connection Fee Revenue

The Sanitary Sewer Financial Model assumes a forecasted rate of growth of 1% per year. This impacts both the connection fee and sewer user fee revenue collected. The rate of growth comes from the forecasts provided by the City's Department of Planning and Zoning and is consistent with forecasted growth in other areas in the Washington, D.C. region. This rate of growth is averaged over the long-term, but can be highly variable from year to year. The impact on the sewer user fee revenues is not as significant since the majority of the revenue comes from existing customers as opposed to new customers. However, this has a significant impact on connection fee revenue since these revenues are based on new customers alone. Connection fee revenues collected from FY2009 through FY2012 were reviewed as part of this Master Plan. Figure 9-1 presents a summary of these revenues.

FIGURE 9-1
FY2009 THROUGH FY2012 SEWER CONNECTION FEE REVENUES



On average, about $1.6M has been collected in connection fee revenue over the past 4 years. Approximately 72% of this revenue has come from multi-family development. It should be noted that there were two single-family developments (James Bland, Potomac Yards Landbay I&J, Partial L East) that received a credit towards the connection fees. The City's existing connection fee credits are discussed in Section 9.5.3.1.

9.5.2 MODEL RESULTS

Table 9-6 shows the model results for FY2013 through FY2022. Table 9-7 presents a comparison of the sanitary sewer user fees between the FY2013 CIP and the model.

TABLE 9-6
SANITARY SEWER FINANCIAL MODEL SUMMARY
CITY OF ALEXANDRIA, VIRGINIA SANITARY SEWER MASTER PLAN

Sewer Connection Fee	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Base Connection Fee (Single-Family)	$ 8,404	$ 8,404	$ 8,656	$ 8,916	$ 9,183	$ 9,459	$ 9,743	$ 11,038	$ 12,506	$ 14,170
Annual Inflation Increase (% increase)	0.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Proposed Arenew Expansion Increase (% increase)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	10.0%	10.0%	10.0%
New Base Connection Fee (Single-Family)	**$ 8,404**	**$ 8,656**	**$ 8,916**	**$ 9,183**	**$ 9,459**	**$ 9,743**	**$ 11,038**	**$ 12,506**	**$ 14,170**	**$ 16,054**
Multi-Family To Single-Family Fee Ratio (%)	50.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
New Multi-Family Connection Fee	**$ 4,202**	**$ 7,791**	**$ 8,024**	**$ 8,265**	**$ 8,513**	**$ 8,768**	**$ 9,934**	**$ 11,256**	**$ 12,753**	**$ 14,449**

Sanitary Sewer Rate ($ per 1,000 gallons)	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Base Sanitary Sewer Rate ($ per 1,000 gallons)	$1.25	$1.25	$1.25	$1.25	$1.25	$1.36	$1.64	$1.88	$1.90	$1.99
Proposed Rate Increase (% increase)	0.0%	0.0%	0.0%	0.0%	9.0%	20.0%	15.0%	1.0%	5.0%	8.0%
New Sanitary Sewer Rate ($ per 1,000 gallons)	**$1.25**	**$1.25**	**$1.25**	**$1.25**	**$1.36**	**$1.64**	**$1.88**	**$1.90**	**$1.99**	**$2.15**

Sanitary Sewer Module Funding Sources	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**
Sewer Line Maintenance Fee	$6,500,000	$6,548,750	$6,597,866	$6,647,350	$7,299,953	$8,825,643	$10,225,611	$10,405,326	$11,007,534	$11,977,298
Sewer Connection Fee	$1,007,632	$1,557,228	$1,603,945	$1,652,063	$1,701,625	$1,752,674	$1,985,780	$2,249,888	$2,549,124	$2,888,157
Debt Issuance	$4,850,000	$6,905,000	$4,875,000	$3,850,000	$17,150,000	$13,700,000	$0	$11,070,000	$11,400,000	$11,750,000
Reprogrammed Prior Year Funding	$246,556	$225,000	$0	$0	$0	$0	$0	$0	$0	$0
Fund Balance Carryover	$0	$77,066	$852,684	$974,797	$883,173	$779,867	$702,820	$506,901	$470,024	$353,031
Total Funding Sources	**$12,604,188**	**$15,313,044**	**$13,929,494**	**$13,124,210**	**$27,034,751**	**$25,058,185**	**$12,914,210**	**$24,232,115**	**$25,426,682**	**$26,968,486**

Category/Project	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**
[1] ***Category 1***										
Mitigation of Combined Sewer Overflows	$319,000	$335,000	$335,000	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000
Reconstructions & Exts. of Sanitary Sewers	322,000	0	775,000	320,000	435,000	540,000	660,000	760,000	760,000	845,000
Sewer Separation Projects	500,000	120,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000
Subtotal Category 1	*1,141,000*	*455,000*	*1,710,000*	*1,270,000*	*1,385,000*	*1,490,000*	*1,610,000*	*1,710,000*	*1,710,000*	*1,795,000*
[2] ***Category 2***										
Four Mile Run Sanitary Sewer Repair	1,500,000	0	0	0	0	0	0	0	0	0
Arenew Wastewater Treatment Plant Expansion	500,000	500,000	0	0	0	0	0	11,070,000	11,400,000	11,750,000
Holmes Run Sewershed Infiltration & Inflow	4,360,000	4,200,000	3,600,000	3,850,000	3,850,000	0	0	0	0	0
Subtotal Category 2	*6,360,000*	*4,700,000*	*3,600,000*	*3,850,000*	*3,850,000*	*0*	*0*	*11,070,000*	*11,400,000*	*11,750,000*
[3] ***Category 3***										
Wet Weather Management Facility	0	3,375,000	1,125,000	0	13,300,000	13,700,000	0	0	0	0
Sanitary Sewer Master Plan	0	0	0	0	0	0	0	0	0	10,000
Subtotal Category 3	*0*	*3,375,000*	*1,125,000*	*0*	*13,300,000*	*13,700,000*	*0*	*0*	*0*	*10,000*
Subtotal Capital Expenditures	**$7,501,000**	**$8,530,000**	**$6,435,000**	**$5,120,000**	**$18,535,000**	**$15,190,000**	**$1,610,000**	**$12,780,000**	**$13,110,000**	**$13,555,000**

Sanitary Sewer Module Operating Costs	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**
Personnel	$2,437,551	$2,510,678	$2,585,998	$2,663,578	$2,743,485	$2,825,790	$2,910,563	$2,997,880	$3,087,817	$3,180,451
Non-Personnel	803,335	1,077,435	852,258	877,826	904,161	931,285	959,224	988,001	1,017,641	1,048,170
Additional Operating - Wet Weather Facility	0	0	0	0	0	0	654,000	673,620	693,829	714,643
Debt Service	1,785,236	2,342,248	3,081,441	3,579,634	4,072,238	5,408,290	6,273,522	6,322,590	7,164,365	8,011,087
Total Operating Expenditures	$5,026,122	$5,930,361	$6,519,697	$7,121,038	$7,719,884	$9,165,365	$10,797,309	$10,982,091	$11,963,651	$12,954,352

Total Sanitary Sewer Expenditures	**$12,527,122**	**$14,460,361**	**$12,954,697**	**$12,241,038**	**$26,254,884**	**$24,355,365**	**$12,407,309**	**$23,762,091**	**$25,073,651**	**$26,499,352**
Year-End Fund Balance	**$77,066**	**$852,684**	**$974,797**	**$883,173**	**$779,867**	**$702,820**	**$506,901**	**$470,024**	**$353,031**	**$459,135**

Notes:

[1] *Other Category 1 projects include Sanitary Sewer Capacity Studies, which includes $99,877 unallocated. This project is being moved into Non-Personnel Operating.*

[2] *Other Category 2 projects include the Commonwealth Service Chamber ($370,000 unallocated) and Holmes Run Trunk Sewer ($6,037,000 unallocated). No additional funding in 10-year CIP.*

[3] *Other Category 3 projects include the Reclaimed Water System via WTE Plant. The project balance of $146,566 and unallocated balance of $100,000 has been reprogrammed and the project will be closed out.*

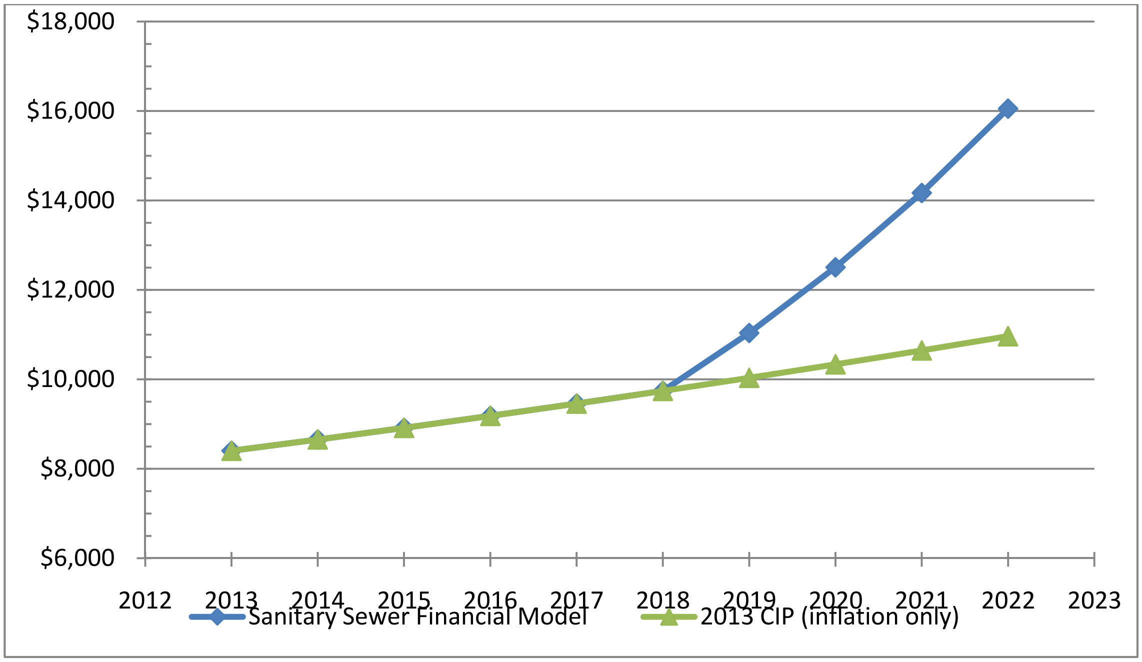
Table 9-7 – Comparison of Sanitary Sewer User Fees ($/1000 Gallons)		
Fiscal Year	**FY2013 CIP**	**Sanitary Sewer Financial Model**
2013	$1.25	$1.25
2014	$1.25	$1.25
2015	$1.38	$1.25
2016	$1.38	$1.25
2017	$1.47	$1.36
2018	$1.77	$1.64
2019	$2.05	$1.88
2020	$2.05	$1.90
2021	$2.29	$1.99
2022	$2.29	$2.15

A summary of the increases to the sewer connection fees is presented below:

- 3% per year assumed for inflation
- FY2014: Multi-family connection fee increases from 50% to 90% of the single-family connection fee
- FY2019 – FY2022: 10% increase to all fees (single-family, multi-family and commercial) each year (in addition to applied inflation costs)

As discussed in Section 9.3.1, the increase in the multi-family connection fee is being proposed based on actual water usage in the City. The increases to the connection fees starting in FY2019 are specific to funding the AlexRenew WRRF expansion. Figure 9-2 shows a comparison of the single-family connection fee between the FY2013 CIP (no increases other than inflation) and the Sanitary Sewer Financial Model.

FIGURE 9-2
Comparison of Single Family Connection Fees



9.5.3 MODEL DISCUSSION

There are additional factors that have been considered regarding the Sanitary Sewer Financial Model and connection fees including:

- Existing sewer connection fee credits
- Teardown credits

Each of these factors and the impact on the model is presented in more detail.

9.5.3.1 Existing Sewer Connection Fee Credits

There are a number of instances where the City applies a credit against the sewer connection fee as provided for in the City Code Section 5-6-25.1 (see Appendix 9-1). Specific instances where credits have been provided include the following:

- Improvements beyond what is required for the development. There are instances where the Director of T&ES will require additional improvements. Examples include constructing a larger diameter sanitary sewer pipe than what is needed in order to meet future anticipated growth or providing additional sewer separation in the combined sewer service area.
- Potomac Yard Trunk Sewer (PYTS) Construction. The PYTS was constructed in 2002 to serve the wastewater needs of the future Potomac Yard development and was paid for by the owners of Potomac Yard. Therefore, credits have been applied towards the connection fees as outlined in the Code. These credits will continue to be applied until the issuance of credits expires. The date of credit issuance is based on the date of issuance of the first building permit.
- Alexandria Redevelopment and Housing Authority (ARHA). Residential units set aside as ARHA public housing are exempt from the sewer connection fees. This exemption does not apply to affordable housing units not owned by ARHA.

- Alexandria City Schools. Per the City Code, public schools are exempt from the sewer connection fees. This exemption does not apply to private schools.

These sewer credits are accounted for in the Sanitary Sewer Financial Model. However, other types of credits, such as credits for teardowns of existing structures are not.

9.5.3.2 Teardown Credits

Currently, when a development project consists of tearing down an existing structure and building a new structure, the developer does not receive a credit for wastewater flows generated from the existing structure. A survey of other jurisdictions regarding their policy towards credits for teardowns has been undertaken. The survey results, as shown on Table 9-8, indicate policies where full credits (one-to-one), partial credits, or no credits are applied.

Table 9-8 – Credit for Teardowns

Jurisdiction	Teardown Credit (None, Partial, Full)
City of Alexandria	None
Arlington County	Partial[1]
Fairfax County	Full
Prince William County	Full
Washington Suburban Sanitary Commission	None

[1] A fixed number of drainage fixture units are applied for each single-family unit, multi-family unit, and to commercial structures (based on square footage). For a single-family unit, the credit for the existing structure represents about 40-50% of the number of drainage fixture units for a new structure.

For FY2012, $2.9M was collected in connection fees. Assuming partial teardown credits at 50% had been applied, an estimated $185,000 less would have been collected in connection fee revenue. Based on this minimal change in revenue, partial credits for teardowns should be considered. If the loss of revenue due to these credits becomes significant as development takes place, the connection fees will need to be increased further than what is presented in the Sanitary Sewer Financial Model to offset the credit.

9.6 Alternative Future Funding Strategies

Several funding strategies have been evaluated that are not being recommended. These strategies may be considered in the future if warranted by changes in sanitary sewer infrastructure needs. Currently, all customers in the City pay the same sewer user fee. In the future, the City may consider alternate billing structures related to the sewer user fees. Some options are presented below:

- The structure could be amended to create an “existing customer” fee rate as well as a “new customer” fee rate. Such a differentiation would be one way to allocate development-related improvements to new customers living or working in a new development.

- Charging separate rates for residential versus commercial customers. Variable usage fee based on average daily water usage similar to WSSC. This could encourage users to invest in water-saving devices and conservation techniques resulting in lower sewer flows to the treatment plant.

The City may also wish to consider a separate fee, in addition to the user fee, to fund large-scale sewer projects. This would be similar to a "benefit assessment fee" where a property owner or multiple owners in a specific geographic area would pay a flat fee (similar to the AlexRenew Bay Protection Charge), which would be targeted towards funding a specific project of benefit to that property or properties. Once the debt service (through the issuance of General Obligation Bonds) is paid off, this fee would be removed from the water and sewer bill. These alternate fee structure options above can also be used in combination. However, the City considers needs associated with the combined sewer system to be a citywide issue. Because the anticipated improvements are needed to meet environmental permit requirements that will benefit the entire City, it would not be reasonable for property owners in this area to be subject to a separate fee structure.

As discussed in Chapter 7, the City currently experiences sanitary sewer overflows (SSOs) and basement backups as a result of excessive wet weather in the collection system. Chapter 7 also identified mitigation projects to address this. The cost for these wet weather improvements will be shared between the City, Fairfax County and AlexRenew, but the details of the cost sharing have not yet been determined.

While deficiencies in the City's existing collection system contribute to the wet weather challenges, continued development will contribute to increases in overall flows, potentially leading to additional SSOs and backups if mitigation efforts are not constructed. One means to finance the recommended wet weather facility would be to establish a wet weather mitigation contribution as a development requirement. This contribution could be based on the computed peak flow being added to the existing sewer system and AlexRenew Water Resource Recovery Facility (WRRF).

9.7 Recommendations

This chapter presents various options that have been considered for financing the large-scale sanitary sewer projects that have been recommended as part of this Master Plan. Based on the desire to have development fund growth-related needs, the results of the Sanitary Sewer Financial Model, and information provided in this chapter regarding other jurisdictions' rates and policies, the following is proposed:

- Increase the multi-family connection fee from 50% to 90% of the single-family connection fee in FY2014. Fund the Wet Weather Management Facility and I/I remediation (existing system needs) through increases in the sanitary sewer user fee and fund the AlexRenew WRRF expansion (growth-related need) through increases in the connection fees. The Sanitary Sewer Financial Model provides the framework for how to apply these increases and when these are needed.
- Create a policy for partial credits for teardowns at 50% of the existing use. The justification for setting the credit at 50% is that the costs associated with capital investment and treating wastewater (cost per gallon) has risen substantially over the past 20-30 years, as the requirements for treated effluent have become more stringent.

- Require new development in the combined sewer service area to separate sanitary flows if there is a separate sewer system within 900 feet of the development. If there is no separate sanitary sewer within 900 feet, then the developer will be required to contribute $300,000 per acre of the development parcel. In lieu of the $300,000 per acre contribution, the developer may do one of the following:
  - Separate the sanitary sewage at the project site. If the new length of sanitary sewer exceeds 900 feet (not including the service lateral), the developer will receive a credit towards the connection fees.
  - Separate an equivalent amount of wastewater flow elsewhere in the combined sewer service area. If the total length of sewer exceeds 900 feet, the developer will receive a credit towards the connection fees.

Following the adoption of this Master Plan, staff will be preparing specific guidelines and requirements related to development in the combined sewer system and will bring forth to City Council for consideration.

With respect to developer-funded collection system improvements, a number of options have been presented for distributing the costs for multiple forecasted development projects that contribute to sanitary sewer capacity exceedance. For the time being, it is recommended that these be reviewed on a case by case basis.

9.7.1 FINANCIAL MODELING UPDATES

As discussed in this Master Plan, future regulatory requirements, especially with respect to CSOs, will likely result in significant increased monetary investments over the next 15-25 years. The City is currently engaged in discussions with VDEQ to determine the requirements of the next VPDES permit. Following the issuance of the permit, staff will analyze future added monetary commitments on sanitary sewer user rates, as well as explore other methods of funding. The ongoing study related to the capacity of the Holmes Run Trunk Sewer is expected to be completed in by the end of 2013 and may result in recommended infrastructure improvements needed to serve future development. Finally, the assumptions that comprise the Sanitary Sewer Financial Model will be reviewed on an annual basis and the model will be updated accordingly and presented in Master Plan updates.

Acronyms and Abbreviations

AC	Acres
ADWF	Average Dry Weather Flow
ALEXRENEW	Alexandria Renew Enterprises
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CCTV	Closed Circuit Television
CI	Commonwealth Interceptor
CIP	Capital Improvement Program
CMOM	Capacity, Management, Operations and Maintenance
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
CSS ARP	Combined Sewer System Area Reduction Plan
CWA	Clean Water Act
DCR	Department of Conservation and Recreation
DCWATER	District of Columbia Water and Sewer Authority
EPA	Environmental Protection Agency
EQUIV	Equivalent
FT	Feet or Foot
FY	Fiscal Year
GAL	Gallon
GIS	Geographic Information System
GPD	Gallons per Day
GPM	Gallons per Minute
HGL	Hydraulic Grade Line
HRJC	Hooff's Run Junction Chamber
HRTS	Holmes Run Trunk Sewer

I/I	Infiltration and Inflow
IDM	Inch Diameter Mile
IFAS	Integrated Fixed-film Activated Sludge
IN	Inch(es)
LBS	Pounds
LEED	Leadership in Energy and Environmental Design
LF	Lineal Feet
MG	Million Gallon
MGD	Million Gallons per Day
MWCOG	Metropolitan Washington Council of Governments
NPDES	National Pollutant Discharge Elimination System
NRDC	National Resource Defense Council
OEQ	Office of Environmental Quality
P&Z	Planning and Zoning
PI	Potomac Interceptor
PS	Pumping Station
PYTS	Potomac Yard Trunk Sewer
RDII	Rainfall Derived Infiltration and Inflow
RPA	Resource Protection Area
SANUP	State-of-the-Art Nitrogen Upgrade Program
SCAT	Sewage Collection and Treatment
SCS	Soil Conservation Service
SQ FT	Square Feet
SQ MI	Square Mile
SSO	Sanitary Sewer Overflow

TAZ	Traffic Analysis Zones
T&ES	Transportation and Environmental Services
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
UV	Ultraviolet
VDEQ	Virginia Department of Environmental Quality
VPDES	Virginia Pollutant Discharge Elimination System
WIP	Watershed Implementation Plan
WLA	Wasteload Allocation
WPCP	Water Pollution Control Plant
WQS	Water Quality Standards
WRRF	Water Resource Recovery Facility
WWTP	Wastewater Treatment Plant

Appendix 3-1

City of Alexandria, Virginia

MEMORANDUM

MEMORANDUM TO INDUSTRY NO. 02-07

DATE: JUNE 1, 2007

TO: DEVELOPERS, ARCHITECTS, ENGINEERS & SURVEYORS

FROM: EMILY A. BAKER, P.E., DEPUTY DIRECTOR/ENGINEERING
TRANSPORTATION AND ENVIRONMENTAL SERVICES

SUBJECT: NEW SANITARY SEWER CONNECTION AND ADEQUATE OUTFALL ANALYSIS

The City of Alexandria has been experiencing rapid growth with large new development and/or redevelopment of previously developed areas resulting in increased building and population densities. The City has instituted sanitary sewer studies to address the issue of increased sanitary flow received in various interceptor sewers serving the City. On the basis of the results of these studies, the applicants for new development and/or redevelopment shall provide the sanitary sewer improvements, information, and analyses, as described below, to the satisfaction of the Director of Transportation and Environmental Services (T&ES), if the estimated additional flow exceeds 10,000 gallons per day (0.01 MGD) or 0.0155 cfs. The following information shall be depicted on the First Final Site Plan and addressed to the satisfaction of the Director of T&ES.

1. The applicant shall provide adequate sanitary sewer outfall analysis, as generally described below, sufficient to determine existing and future flows in the sewers to be used by the applicant that are tributary to the City of Alexandria's sanitary interceptor sewer system. The sanitary sewer adequate outfall analysis shall be completed up to the

trunk sewer downstream of the proposed development. The minimum diameter of such a trunk sewer shall be 24".

2. The applicant shall provide an estimate of the average day and peak hour wastewater flow discharged upstream of the development site under existing conditions and the current contribution of sanitary flow from the development site to the Trunk Sewer using the factors described below:
   a. The sewer connection shall be designed for the ultimate build-out conditions.
   b. Recommended average design flows*:

i.	Residence general	100 gpcd
ii.	Single Family Home	350 gpd/unit
iii.	Townhouse	350 gpd/unit
iv.	Garden Apartment	300 gpd/unit
v.	High Rise Residential	300 gpd/unit
vi.	Office / Commercial	200 gpd/1000 sq. ft.

* It is assumed that the recommended average day design flows include the dry / wet weather infiltration and inflow (I/I) contribution.

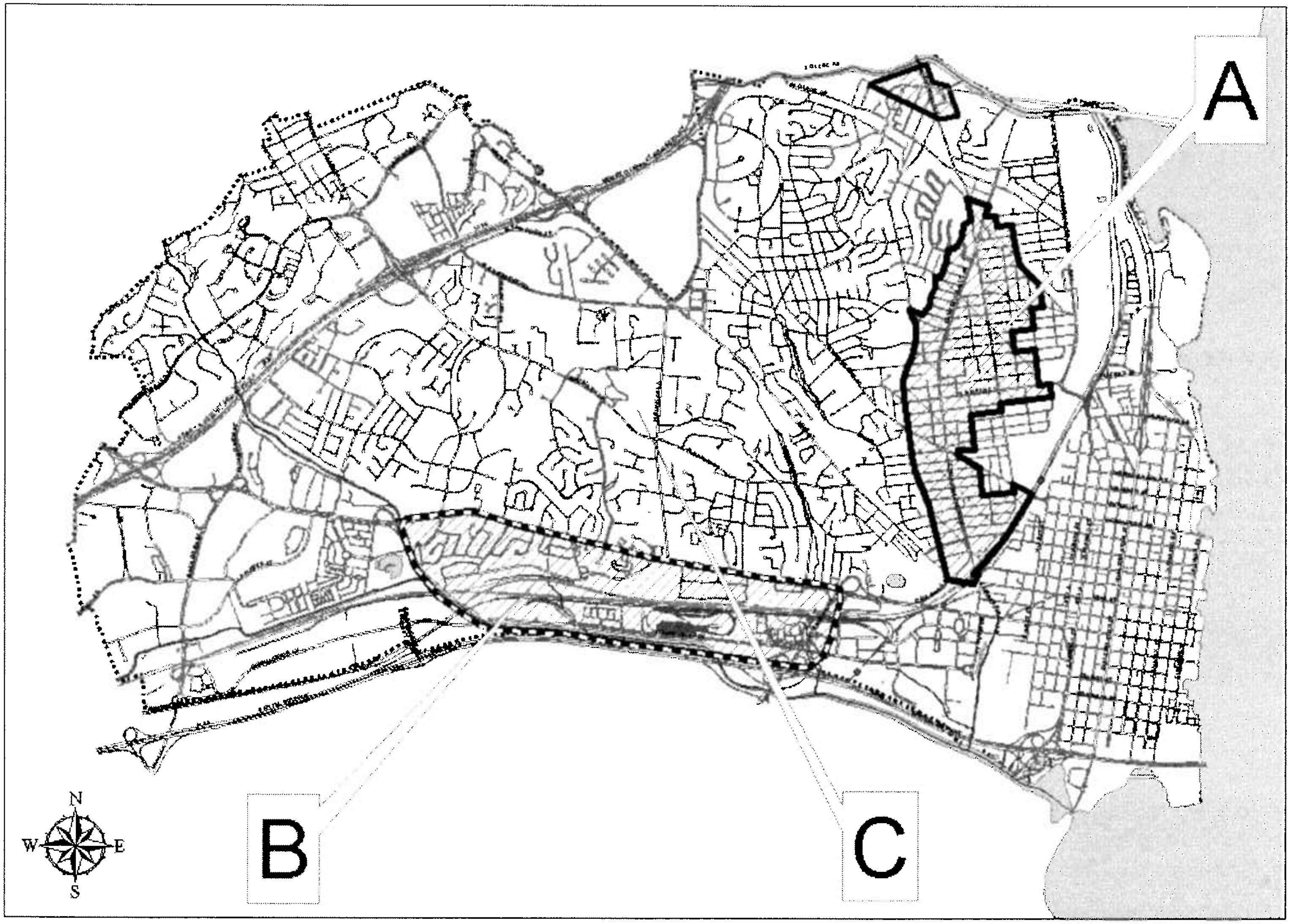
For any other type of development not covered above; the applicant may obtain contributing sanitary flow from the Commonwealth of Virginia, State Water Control Board, Sewage Collection and Treatment (SCAT) Regulations or propose the criteria to be used for estimation of sanitary flows to the satisfaction of the Director of T&ES.

   c. The sanitary sewers shall be designed for maximum hour flow.
   d. A peak factor of 4.0 shall be used for laterals and sub-mains. A peak factor of 3.0 may be used for mains.

3. In lieu of the estimation of the average day and peak hour wastewater flow, the Director of T&ES at his discretion may request the applicant to measure the sanitary flow upstream and downstream of the proposed development site to determine the current sanitary flow discharged into the trunk sewer upstream of the development site and the current contribution of the sanitary flow to the Trunk Sewer from the development site under existing conditions.
4. The applicant shall estimate additional average day and peak hour wastewater flow to be discharged into the trunk sewer from the proposed development site under proposed conditions using the factors described above.
5. The sanitary sewer adequate outfall analysis shall account for the existing and future needs.
6. The City of Alexandria, at its discretion, will provide the applicant with any readily available data to assist in completion of the adequate outfall analysis. The additional parameters required to complete the analysis shall be field measured (i.e., length, pipe diameter, material of construction, and slope, etc.) and/or estimated (i.e., Manning's roughness coefficient) by the applicant. The applicant shall use the criteria established by the Engineers and Surveyors (ESI) Institute, as shown on the ESI Check List, where applicable.
7. The applicant shall provide all the measured and/or estimated data and calculations on the adequate sanitary sewer outfall analysis on the plans for review by the City staff.
8. The increased peak flow will be placed in the City of Alexandria wastewater flow capacity registry to determine that the City has sufficient treatment capacity available in the Alexandria Sanitation Authority (ASA) Advanced Wastewater Treatment Plant (AWWTP) and in various interceptor sewers in the City of Alexandria.

9. Sanitary sewer systems that serve over 400 people require the approval of the Virginia Department of Environmental Quality (VDEQ). Therefore, the applicant shall comply with all the regulatory requirements of the State of Virginia.
10. The installation of plumbing fixtures throughout the City shall be governed by location. In the areas A and B shown in the attached map, the sanitary sewer plumbing fixtures and drains located below the first floor (including parking structures) shall have in-structure or on-site pumped discharge to the City's gravity collection system.
11. The pumped facilities shall be provided with a standby source of power (i.e., battery or generator).
12. The property Owner shall be responsible for the perpetual ownership, capital, and maintenance and operation of the pumps and appurtenances.
13. No foundation drain, basement drain, or stairwell basement access drain shall be connected to the City or ASA sanitary sewer.

If you have any questions, please contact Maurice Daly or Dr. S.P. Singh at (703) 838-4328.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SECTION 4: SANITARY SEWER DESIGN

4.1 The following criteria are to be established as minimum requirements, and the basis for expeditious review.

4.2 The following desired maximums and minimums are not to be changed except by approval of the Director of Transportation and Environmental Services.

4.3 Plans are to be prepared by a Professional engineer or surveyor duly authorized by the Commonwealth of Virginia to prepare the same.

4.3.1 The City currently lacks the authority to approve gravity fed sanitary systems which serve more than 400 persons. City approval of these sanitary sewer systems is contingent upon the concurrent approval by VDH and VADEQ.

4.4 DESIGN FLOWS

4.4.1 Sewer is to be designed for the estimated ultimate sewershed population.

4.4.2 Recommended average design flows.

Residential - General	100g/c/d
SFD	350gpd/unit
Townhouse	350gpd/unit
Garden Apartment	300gpd/unit
Highrise	300gpd/unit
Office	200gpd/1000 net sq. ft.

4.4.3 Contributing sewage flow for other types of developments may be obtained from SCAT regulations.

4.4.4 Sanitary sewers shall be designed for maximum hourly flows.

4.4.5 A peak factor of 4.0 shall be used for the design of laterals and sub-mains. A peak factor of 3.0 shall be used for mains.

4.4.6 Adequacy of sanitary sewer outfall must be determined, and all relevant calculations provided before a plan can be approved.

4.5 HORIZONTAL/VERTICAL SEPARATONS FROM WATERLINE

4.5.1 Horizontal and vertical separation between sanitary sewers and water lines

4.5.1.1 Water line must be located 10’ (edge to edge) from sanitary sewer.

4.5.1.2 When horizontal separation cannot be achieved, sanitary sewer may be laid closer, provided the water main is in a separate trench, and the bottom of the water main is a minimum of 18” above the top of the sewer. When this vertical separation cannot be obtained, use pressure tested DIP (AWWA approved water pipe).

4.5.1.3 Sanitary sewers shall cross water mains such that the top of the sewer pipe is at least 18” below the bottom of the water main. When this clearance cannot be provided, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to acceptance.

4.5.1.4 Sewers crossing over water mains shall have a separation of 18” between the bottom of sewer and top of water main. Sewers will be constructed of AWWA approved water pipe, and have adequate structural support (encasement) to prevent damage to the water main. Sewer joints shall be placed equidistant, and as far as is possible away from the water main.

4.5.1.5 No water main pipe shall pass through, or come in contact with, any part of a sanitary sewer manhole. Manholes shall be placed a minimum of 10 feet horizontally from the water main where possible. When conditions prohibit this horizontal separation, the sanitary manhole shall be of watertight construction, and tested in place.

4.5.1.6 Sanitary sewers under creeks and/or storm sewer pipe crossings with less than 6” clearance, shall be encased in concrete.

4.6 MANHOLE LOCATIONS

4.6.1 Manholes for access shall be provided:

At all points of change in alignment.
At all changes in grade.
At the terminal end of a line.
Where laterals greater than over 6” in diameter meet pubic sewers.

4.6.2 Distance between manhole structures may be a maximum of 300 feet.

4.7 PIPES LAYOUT/SIZES

4.7.1 Minimum pipe diameter for public gravity sewer is 10”.

4.7.2 Sewers shall be designed to give a mean velocity, when flowing full (minimum scour velocity) of 2.5 fps.

4.7.3 Maximum permissible velocity at average flow (before applying peak factor) is 10fps.

4.7.4 Minimum slope for 10” pipe diameter shall be 0.5%. Maximum slope for 10” pipe shall be 10%. Minimum slope for terminal run of 10” pipe shall be 1%.

4.7.5 Outside drop connections are to be constructed where lateral, or sewer pipe drops are in excess of 24”.

4.7.6 Minimum cover requirement for sanitary sewer is 3.5 feet.

4.7.7 A minimum drop of 5” within the manhole is required between the Invert In and Invert Out whenever sewers are at 90 degrees.

4.7.8 Where smaller sewers join a larger ones, arrange the relative inverts of the sewers to maintain approximately the same energy gradient.

4.7.9 Minimum fall between gravity floor drains and the top of the sewer serving the drain shall be 3 feet assuming a maximum of 50 feet lateral length. For longer lengths, add 2% gradient.

4.7.10 Sanitary sewers (concrete) within trenches where the pipe is in new or proposed fill, shall employ a concrete cradle.

4.8 PIPES/MATERIAL

4.8.1 Permitted materials, and “n” factors:

PVC (SDR 35)	n=0.012
RCP Class IV (18” or greater)	n=0.015
Ductile Iron Pipe (Class 51)	n=0.012
Cast Iron (Class 22)	n=0.013

4.8.2 Laterals shall enter the sanitary main through a manufactured “wye” or “tee” or approved sewer saddle.

4.8.3 Where laterals are to be connected to existing Terracota pipes, replace the complete section of main, and provide a manufactured “wye” or “tee” connection. Otherwise provide a manhole for lateral connection.

4.9 EASEMENTS

4.9.1 Following are general minimum easement width requirements:

10”-15” pipe	10’ easement
18”-24” pipe	15’ easement

Larger easements may be required based on depth or diameter of the sewers.

4.10 MINIMUM INFORMATION REQUIRED ON THE PLANS FOR REVIEW

4.10.1 A general layout shall be included, showing streets, lots and sanitary sewer locations, onsite and offsite. Use a scale to be used which will allow all information to be shown on one sheet.

4.10.2 Sanitary sewer design computations. Specify the design parameters.

4.10.3U Use a standard format.

4.10.4 Plan and profile for each run of sanitary sewer shall be shown on the same sheet.

4.10.5 Sewer sizes, manhole numbers, and stationing shall be shown on plan, and repeated the on profile.

4.10.6 Proposed location of sewers with flow arrows.

4.10.7 Length of pipe, pipe diameter, slope, and pipe material for each pipe run.

4.10.8 Indicate on the profile areas of minimum cover.

4.10.9 Label invert *I*n and invert Out at each manhole.

4.10.10 Show sanitary sewer easements.

4.10.11 All sanitary sewer easements are to be recorded prior to approval of the plan.

4.10.12 Specify the type of connection being employed when connecting to existing sewer.

Note: Construction sheets (Cutsheets) shall be prepared and submitted to T&ES for approval prior to construction. These construction sheets are to be prepared by a Professional surveyor or engineer authorized by the state to prepare the same.

	equal to or less than 0.1 MGD	(B) Breakpoint Chlorination (C) Carbon Adsorption (D) Chemical Coagulation, Flocculation, Precipitation (E) Filtration (F) Demineralization (Ion Exchange, Reverse Osmosis, Electrodialysis)	8 8 8 8 8	8 8 8 8 8
IV	Greater than 0.001 MGD but equal to or less than 0.04 MGD	Biological Mechanical Methods [4]	4 [5]	4 [5]
IV	Greater than 0.001 MGD but equal to or less than 1.00 MGD	Natural Treatment Methods [4]	4 [5]	4 [5]

Notes:

(1) Specific requirements for the number of licensed operators and the number and qualifications of the operating staff specified in accordance with this chapter and in consultation with and concurrence by the commissioner are to be evaluated on a case-by-case basis in accordance with operational reliability and permit compliance data. Such requirements are to be included in the Operation and Maintenance Manual.

(2) If a particular treatment unit or units are discontinued or not in use for a significant period of time and the remaining treatment processes result in a lower classification for the treatment works, the licensed operator and operating staff requirements during that period may be reduced to that required for the type and classification of treatment process remaining in service, after concurrence by the commissioner.

(3) If more than one sewage treatment process is used, the more stringent requirements among the processes will apply. In some cases, complexity of operation for several AWT processes in sequence may require more than the minimum coverage.

(4) Mechanical treatment processes are defined as those containing aerated and mixed flows using electrical or outside energy sources.

(5) An operator is not required unless the facility is designated as a wastewater treatment works by DEQ.

Statutory Authority
§62.1-44.19 of the Code of Virginia.
Historical Notes
Former 12VAC5-581-360 derived from Virginia Register Volume 18, Issue 10, eff. February 27, 2002; amended and adopted as 9VAC25-790-300, Virginia Register Volume 20, Issue 9, eff. February 12, 2004.

Part III
Manual Of Practice For Sewerage Systems And Treatment Works

Article 1
Collection and Conveyance Sewers

9VAC25-790-310. Design factors.

A. Sewage collection systems shall be designed and constructed to achieve total containment of the predicted sewage flows contributed from the established service area and population. New combined sewers receiving direct storm water drainage shall not be approved. Interceptor sewers for existing combined sewers shall be designed and constructed to prevent the discharge of inadequately treated wastes. Overflows from intercepting sewers shall be managed in accordance with the issued certificate or permit.

B. Basis. In general, sewer systems should be designed for the estimated ultimate tributary population with an upper limit consisting of the 50-year population growth projection, except when considering parts of the systems that can be readily increased in capacity. Consideration shall be given to land use plans and to other planning documents and to the maximum anticipated capacity of institutions, industrial parks, apartment developments, etc.

C. Factors. In determining the required capacities of sanitary sewers, the following factors shall be considered:

a. Maximum hourly sewage flow.

b. Additional maximum sewage or wastewater flows from industrial sources.

c. Ground water infiltration.

d. Topography of area.

e. Location of sewage treatment works.

f. Depth of excavation.

g. Pumping requirements.

h. Occupancy rates.

D. Capacity. New sewer system capacity shall be designed on the basis of an average daily per capita flow of sewage of not less than that set forth in Table 3 (9VAC25-790-460) of this chapter. These figures are assumed to include infiltration but do not address inflow. When deviations from the foregoing per capita rates and established peak flow factors are proposed, a description of the procedure used to establish those design flows shall be included with the submission for the purpose of this chapter, the following list defines the various collection system components that are to be designed to transmit peak flow rates:

1. "Lateral" means a sewer that has no other common sewers discharging into it.

2. "Submain" means a sewer that receives flow from one or more lateral sewers.

3. "Main or trunk" means a sewer that receives sewage flow from one or more submain sewers.

4. "Interceptor" means a sewer that receives sewage flow from a number of gravity mains, trunk sewers, sewage force mains, etc.

The minimum peak design capacity for lateral and submain sewers should be 400% of the average design flow.

Minimum peak design capacity of main, and trunk, sewers should be 250% of the average design flow.

Minimum peak design for interceptor sewers shall be 200% of the average design flow.

Statutory Authority
§62.1-44.19 of the Code of Virginia.
Historical Notes
Former 12VAC5-581-370 derived from Virginia Register Volume 18, Issue 10, eff. February 27, 2002; amended and adopted as 9VAC25-790-310, Virginia Register Volume 20, Issue 9, eff. February 12, 2004.

9VAC25-790-320. Design details.

A. Sizing. For the purpose of this chapter the gravity sewer design details as described herein represent the best available standards of practice. Hydraulic computations and other design data should clearly establish the capacity of proposed sewers that do not conform to the minimum standards included in this section.

1. Sewer size shall not be less than eight inches in diameter, except under the following conditions:

a. Laterals serving six connections or fewer on cul de sacs or as sidewalk collector lines may be six inches in diameter.

b. Sewer lines carrying settled sewage, such as septic tank effluent, may be as small as 1-1/2 inches in diameter.

2. Engineering calculations and justifications indicating that reduced line sizes are adequate shall be included with the submission.

B. Placement. Gravity sewers shall be of suitable material and placed such that their design capacity is maintained and leakage into and out of the pipelines is within allowable values.

1. Sewers shall be installed at a sufficient depth to prevent ice formation due to cooling of the wastewater flows, resulting in blockage of the flow channel. Sewers carrying nonsettled sewage and sewers carrying settled sewage shall be designed and constructed to give mean velocities, when flowing full, of not less than two feet per second and 1.3 feet per second, respectively, based on Manning's formula using a pipe material roughness coefficient ("n") value of 0.014. Use of other "n" values and slopes less than those specified herein shall be justified on the basis of pipe material specifications, research, or field data, presented with the submission for approval.

2. The following list represents the minimum slopes, which should be provided for gravity sewers; however, slopes greater than those listed are desirable:

Sewer Size	Minimum Slope in Feet per 100 Feet	
	Nonsettled Sewage	Settled Sewage
3 inch	Not Allowed	0.53
4 inch	Not Allowed	0.47
6 inch	0.49	0.21
8 inch	0.40	0.15
10 inch	0.28	0.12
12 inch	0.22	0.086
14 inch	0.17	0.068
15 inch	0.15	0.063
16 inch	0.14	0.058
18 inch	0.12	0.050
21 inch	0.10	0.040
24 inch	0.08	0.034
27 inch	0.067	0.029
30 inch	0.058	0.025
36 inch	0.046	0.020

3. Decreased slopes may be provided where the depth of flow will be 0.3 of the diameter or greater for design average flow. Whenever such decreased slopes are selected, design consultants must furnish, with their report, computations of the depth of flow in such pipes at minimum, average, and peak daily or hourly rates of flow. Otherwise, it must be recognized that decreased slopes may require available resources for additional sewer maintenance.

4. Sewers shall be installed with uniform slope between manholes.

5. Sewers constructed on 20% slope or greater shall be anchored securely with concrete anchors or equal. Suggested minimum anchorage is as follows:

a. Not over 36 feet center-to-center on grades 20% and up to 35%.

b. Not over 24 feet center-to-center on grades 35% and up to 50%.

c. Not over 16 feet center-to-center on grades 50% and over.

6. Gravity sewers shall normally be installed with a straight alignment between manholes. Curved sewers should be installed only on curved streets, where the curve of the street and the curve of the sewer are concentric. The use of curved alignment for sewers may be considered, with the following restrictions:

a. Justification shall be provided by the design consultant to verify that the curved alignment is more advantageous for that installation.

b. The use of curved sewers shall be limited to conveyance of settled sewage unless the owners can document that the specialized equipment necessary to clean the sewers will be obtained and used as necessary.

c. The minimum radius of the curve shall be based on the maximum allowable joint deflection in accordance with the appropriate ASTM standard or other appropriate standard.

d. The sewers shall be installed with smooth radius curves.

7. Gravity sewer size shall normally remain constant between manholes. Where a smaller sewer joins a larger one, the relative elevations of the inverts of the sewers shall be arranged to maintain approximately the same energy gradient. An approximate method for securing these results, which may be used, is to align the 80% capacity flow level, or to align the internal pipe crown or top invert, of both sewers, at the same elevation.

8. Where velocities greater than 15 feet per second are expected, special provisions shall be made to protect against internal erosion by high velocity. The pipe shall conform to applicable ASTM, AWWA, ANSI, or other appropriate standards or specifications, which provide protection against internal erosion.

9. Any generally accepted material for sewers will be given consideration, but the material selected shall be adapted to local conditions such as character of industrial waste, possibility of septicity, soil characteristics, exceptionally heavy internal-external loadings, abrasions, and similar problems. The pipe material shall conform to applicable ASTM, AWWA, ANSI, or other appropriate standards and the pipe is to be marked with an approved identification such as the specifications standard.

10. All sewers shall be designed to prevent damage from superimposed loads. Proper allowance shall be made for loads on the sewer as a result of the width and depth of the trench.

Statutory Authority
§62.1-44.19 of the Code of Virginia.
Historical Notes
Former 12VAC5-581-380 derived from Virginia Register Volume 18, Issue 10, eff. February 27, 2002; amended and adopted as 9VAC25-790-320, Virginia Register Volume 20, Issue 9, eff. February 12, 2004; Errata 20:12 VA.R. 1526 February 23, 2004.

9VAC25-790-330. Construction details.

A. Pipe joints. The method of joining pipe and the material used shall be included in the design specifications in accordance with ASTM or other nationally recognized standards and the joint material and joint testing shall conform to the appropriate standards and specifications.

1. Sewer joints shall be designed to prevent infiltration and to prevent the entrance of roots.

2. When clay sewer pipe is used, the joints shall be compression joints, made in conformance with the appropriate ASTM specification.

3. When concrete pipe is used, single rubber ring gasket joints shall conform to the appropriate ASTM specification.

4. When asbestos cement pipe, truss pipe, or ductile iron pipe is used, joints using couplings and gaskets shall be made in conformance with the requirements of the appropriate ASTM specification.

5. Joints for plastic material pipe may be of compression gaskets, chemical welded sleeves, or chemical fusion joints per manufacturers' recommendations.

Heat fusion joints may be used for high density polyethylene pipe.

B. Leakage. An acceptance test shall be specified for all gravity sewer lines. The test may be either a hydrostatic test or an air test.

1. Where hydrostatic testing is specified (infiltration or exfiltration), the leakage outward or inward shall not exceed 100 gallons per inch of nominal pipe diameter per mile per day (2,400 gpd/mi maximum) for any section of the system. Manholes should be tested prior to pipeline testing. Where the exfiltration test is employed, the line shall be subjected to a minimum of four feet of head, or up to the head to the top of the previously tested manhole, whichever is the lesser, above the crown of the pipe at the upstream manhole of the section being tested.

2. The infiltration test shall be allowed only when it can be shown that the hydrostatic head outside the pipe is a minimum of four feet or exceeds the upstream manhole depth, whichever is the lesser, above the crown of the pipe for the entire length of the pipe being tested.

3. Where air testing is specified, test methods and acceptability criteria shall be in accordance with the appropriate ASTM specification. Air testing shall generally be acceptable for all types of pipe materials. If air testing is employed, the manholes shall be tested by exfiltration.

4. Manhole leaking standards as specified in 9VAC25-790-350 shall be obtained.

C. Building sewers. Sewerage service lines from buildings (sewers) shall be constructed in accordance with either the Uniform Statewide Building Code of Virginia or this chapter and standards contained in this chapter, depending on jurisdictional considerations as outlined in Part IV (9VAC25-790-940 et seq.) of this chapter. An interceptor, or separation basins, may be required under the provisions of state or local building codes or standards and the provisions of this chapter.

1. Connections shall be made to sewers by replacing a length of pipe with branch fittings, or a clean opening cut with tapping equipment and a "y" type of connection completed and sealed. In some instances a tee-saddle or tee-insert may be attached to the sewer submain to provide a connection.

2. All connections to sewers and manholes shall be made so as to prevent structural damage and infiltration. To meet future needs, stubs, wyes, and tees may be installed if plugged tightly.

D. Trench construction. Class A, B, or C bedding (American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice—No. 36, 1974, Water Pollution Control Federation (WPCF) Manual of Practice—No. 9, 1970, and American Waterworks Association (AWWA) for Installation of Ductile-Iron Water Mains and their Appurtenances (ANSI/AWWA C600-82), 1982, bedding class shall be provided for rigid pipe, and appropriate installation shall be provided for flexible pipe material in accordance with recognized standards and manufacturers' recommendations.

1. Trenches shall be carefully backfilled with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than one inch in diameter, deposited in six inch layers, and thoroughly and carefully tamped until the pipe has a cover of not less than one foot.

2. The remainder of the backfill shall be placed in the trench in layers not exceeding two feet and thoroughly tamped. No stone or rock larger than five inches in its greatest dimension shall be used in backfilling.

3. Trenches in public roadways shall be excavated, backfilled and compacted in accordance with the standards specified in the Virginia Department of Transportation's Road and Bridge Specifications or other acceptable criteria.

Statutory Authority
§62.1-44.19 of the Code of Virginia.
Historical Notes
Former 12VAC5-581-390 derived from Virginia Register Volume 18, Issue 10, eff. February 27, 2002; amended and adopted as 9VAC25-790-330, Virginia Register Volume 20, Issue 9, eff. February 12, 2004.

9VAC25-790-340. Vacuum sewage system.

A. Features. Vacuum sewer systems consisting of small diameter pipes that collect sewage delivered through multiple service connection values and deliver that flow under negative pressure to one or more receiving stations will be considered on a case-by-case basis. The design shall include, but not be limited to, the following criteria:

1. Minimum pipe diameter shall be three inches for nonsettled sewage and 1-1/2 inches for settled sewage.

2. Shut-off valves shall be provided at branch connections with lines exceeding 300 feet and at intervals no greater than 2000 feet on main vacuum lines. Valves shall not obstruct the flow path when fully opened for operation. Gate valves and butterfly valves may not be acceptable if the flow path is obstructed during system operation.

3. Access points equal to the vacuum line diameter shall be provided at the end of main and branch lines and at intervals or locations suitable for operation and maintenance of the system. Access or inspection points shall be provided so that a suitable means for shut off of lines can be readily inserted.

4. Provisions for vacuum testing the piping system shall be described and made available to the department.

B. Connection valves. The minimum diameter of vacuum valves for nonsettled sewage shall be such that a sphere of 2-1/2 inches can pass through. For settled sewage a 1-1/2 inches sphere shall pass through the vacuum valve. Vacuum valves shall be capable of operation under severe climatic conditions such as submerged under water or ice conditions. Air vents shall extend above ground to a level up to the 100-year flood elevation, if practical. Air vent design should provide protection against both freezing and physical damage, where possible. Access to valve pits shall be such that valves may be easily removed and replaced. A holding tank of sufficient volume up to 25% or more of the design daily flow shall be provided upstream of the vacuum valve when the location of the vacuum valve alone does not permit proper system operation.

C. Receiving station. A minimum of two sewage and vacuum pumping units shall be provided for receiving stations. The system shall be capable of handling peak sewage and air flow conditions with one unit out of service. In the overall design, consideration shall be given to pump cooling requirements and features required for pumping moist air containing sewer gases. Provisions for odor control such as exhaust air oxidation or deodorization shall be considered in the system design. The design of the pump station should minimize the discharge of air along with the sewage. The capacity of the collecting tanks shall be sufficient to limit the start frequency of all pumps to less than 12 per hour. The number of collection tanks shall be established to account for system reliability and operability.

1. Provisions shall be made to isolate the receiving vacuum collection tank, vacuum pumps, raw sewage influent line, and raw sewage discharge pumps.

2. The raw sewage pumps shall meet all applicable requirements of this chapter. The negative head created by the vacuum pumps shall be considered in calculating Net Positive Suction Head (NPSH).

D. Service. Adequate service arrangements shall be provided for routine and emergency maintenance and operation. The arrangements shall include:

1. Right of access.

2. Adequate spare valves, spare parts, and service tools.

3. Monitoring, alarm system to locate vacuum loss or valve failure.

E. Operability. The vacuum collection system is to be operated in a manner to prevent the discharge of raw sewage to any waters and to protect public health and welfare by preventing back-up of sewage and subsequent discharge to basements, streets, and other public and private property.

1. Provisions for maintaining interim household service and preventing sewage overflows during system malfunction shall be described and submitted with design information in accordance with this chapter.

2. An alarm system shall be provided capable of alerting maintenance personnel of operational and safety problems in case of malfunction in the collection system.

Statutory Authority
§62.1-44.19 of the Code of Virginia.
Historical Notes
Former 12VAC5-581-400 derived from Virginia Register Volume 18, Issue 10, eff. February 27, 2002; amended and adopted as 9VAC25-790-340, Virginia Register Volume 20, Issue 9, eff. February 12, 2004.

9VAC25-790-350. Manholes.

A. Location. Manholes shall be installed at the end of each line of eight-inch diameter or greater; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet for sewers 15 inches or less in diameter and 500 feet for sewers 18 inches to 30 inches in diameter, except that distances up to 600 feet may be adequate in cases where adequate modern cleaning equipment for such spacing is provided.

1. Slightly greater spacing may be utilized in larger sewers.

2. Terminal cleanouts may be acceptable in place of manholes, on lines eight inches in diameter or less, on a case-by-case basis. Cleanouts may be used in lieu of manholes for collection of settled sewage. Manholes are required where four or more sewers intersect, or where two or more sewers intersect at depths greater than eight feet. Cleanouts shall be installed at distances not greater than 400 feet for settled sewage systems.

B. Materials. Manholes shall be constructed of materials that will maintain structural integrity throughout the design life of the sewer. Manhole wall and bottom construction shall be such as to ensure water tightness and the Virginia Department of Labor and Industry, Occupational Safety and Health Administration (VOSH) requirements may also specify design requirements. Confined space entry restrictions are to be met. For those manholes and vertical sections of pipe tees used for maintenance access, safety slabs or platform benches should be provided at depth intervals of 10 feet or less as required unless adequate access lifting devices are provided in accordance with VOSH or other recognized standards. The use of sections of reinforcing bars as access steps is not recommended for safety considerations.

C. Features. The base inside diameter of manholes and vertical pipe tees used for maintenance access shall be a minimum of 42 inches. The clear opening in the manhole frame shall be a minimum of 24 inches. Larger base diameters are preferred.

1. The manhole foundation shall be adequately designed to support the manhole and any superimposed loads that may occur.

2. The flow channel through manholes shall be of such shape and slope to provide smooth transition between inlet and outlet sewers and to reduce turbulence. Benches shall be sloped to the channel to prevent accumulation of solids.

3. When the flow direction or horizontal deflection of a sewer line varies significantly, elevation changes may be necessary to provide for head losses. The minimum vertical change in elevation from upstream to downstream should provide for a head loss of up to 3 inches or more, when ninety degrees of deflection is specified.

4. Watertight manhole covers or watertight manhole inserts shall be used whenever the manhole tops may be flooded for several hours or more. As a minimum, watertight manhole covers or watertight manhole inserts shall be used when the manhole top is below the elevation of the 100-year flood/wave action.

5. Masonry manholes of brick or segmented block and the nongasketed joints of precast manholes shall be waterproofed on the exterior with suitable coatings (e.g., cement supplemented with bituminous).

6. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place without destroying the watertight integrity of the line connections.

7. Ventilation of gravity sewer systems shall be provided where continuous watertight sections greater than 1,000 feet in length are incurred.

8. In accordance with this chapter and standards contained in this chapter, frames, and covers shall be of suitable material and designed to accommodate prevailing site conditions. Ventilation, safety lines, hoist arrangements and other requirements, as necessary for material maintenance access, should be provided in accordance with VOSH requirements.

9. A drop pipe should be provided for an upstream sewer entering a manhole at an elevation of 24 inches or more above the manhole invert unless sewer pipe crowns match elevations, or as may otherwise be required to conform to the use of standard fittings in the drop pipe construction. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert shall be filleted to prevent solids deposition. A drop pipe shall be used when the upstream to downstream invert difference exceeds 24 inches and the sewer deflects horizontally at a manhole. The drop through the manhole should be a maximum of four inches for a 90° horizontal deflection.

D. Leakage testing. Manholes may be tested for leakage at the same time that gravity sewer lines are being hydrostatically tested for leakage. For manholes greater than four feet in depth whose entire depth was not included in the hydrostatic testing of the sewer line, the manholes shall be tested by exfiltration. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The manhole shall be filled with water to the top of the rim. A maximum 12-hour soak shall be allowed. Leakage shall not exceed 0.25 gallon per hour (gph) per foot of depth.

1. If air testing of sewer lines is employed, the manholes shall normally be tested by exfiltration. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The stoppers shall be positioned in the lines far enough from the manhole to ensure testing of the untested portions of the lines. The manhole shall then be filled with water to the top of the rim. A maximum 12-hour soak shall be allowed. Leakage shall not exceed 0.25 gph per foot.

2. Air testing or vacuum testing of manholes for leakage may be considered on a case-by-case basis. It is important that the entire manhole from the invert to the top of the rim be tested.

Statutory Authority
§62.1-44.19 of the Code of Virginia.
Historical Notes
Former 12VAC5-581-410 derived from Virginia Register Volume 18, Issue 10, eff. February 27, 2002; amended and adopted as 9VAC25-790-350, Virginia Register Volume 20, Issue 9, eff. February 12, 2004.

9VAC25-790-360. Water quality and public health and welfare protection.

A. Design integrity. The tops of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. In general, one foot of suitable cover shall be provided where the stream is located in rock and three feet of suitable cover in other material. Less cover will be considered if the proposed sewer crossing is encased in concrete and will not interfere with future improvements to the stream channel. Reasons for requesting less cover shall be given in the application. Below paved channels, the crown of the sewer lines should be placed under the channel pavement. Sewers shall remain fully operational during the 25-year flood/wave action. Sewers and their appurtenances located along streams shall be protected against the normal range of high and low water conditions, including the 100-year flood/wave action. Sewers located along streams shall be located outside of the streambed wherever possible and should be sufficiently removed therefrom to provide for future possible channel widening. Reasons for requesting sewer lines to be located within streambeds shall be given in the application.

1. Sewers entering or crossing streams shall be constructed of watertight pipe. The pipe and joints shall be tested in place and shall exhibit zero infiltration. Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. Such sewers on piers shall be constructed in accordance with the requirements for sewers entering or crossing under streams. Construction methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade due to anticipated hydraulic and physical loads, erosion, and impact.

2. Depressed sewers or siphons shall have not less than two barrels, with a minimum pipe size of six inches and shall be provided with necessary appurtenances for convenient flushing and maintenance; the inlet and outlet chambers shall be designed to facilitate cleaning; and, in general, sufficient head shall be

provided and pipe sizes selected to secure velocities of at least three feet per second for average flows. The inlet and outlet details shall be arranged so that normal flow is diverted to one barrel and so that either barrel may be removed for service or cleaning.

B. Water supplies. No general requirement can be made to cover all conditions. Sewers shall meet the requirements of the appropriate reviewing agency with respect to minimum distances to structures and pipelines utilized for drinking water supplies. There shall be no cross connection between a drinking water supply and a sewer, or appurtenance thereto.

1. The requirements of the Virginia Waterworks Regulations (12VAC5-590) shall be satisfied.

2. The requirements of the Virginia Sewage Handling and Disposal Regulations (12VAC5-610) shall be satisfied.

3. No sewer line shall pass within 50 feet of a drinking water supply well, source, or structure unless special construction and pipe materials are used to obtain adequate protection. The proposed design shall identify and adequately address the protection of all drinking water supply wells, sources, and structures up to a distance of 100 feet of the sewer line installation.

4. Sewers shall be laid at least 10 feet horizontally from a water main. The distance shall be measured edge-to-edge. When local conditions prohibit this horizontal separation, the sewer may be laid closer provided that the water main is in a separate trench or an undisturbed earth shelf located on one side of the sewer and the bottom of the water main is at least 18 inches above the top of the sewer. Where this vertical separation cannot be obtained, the sewer shall be constructed of water pipe material in accordance with AWWA specifications and pressure tested in place without leakage prior to backfilling. The hydrostatic test shall be conducted in accordance with the most recent edition of the AWWA standard (ANSI/AWWA C600-82) for the pipe material, with a minimum test pressure of 30 psi.

5. Sewers shall cross under water mains such that the top of the sewer is at least 18 inches below the bottom of the water main. When local conditions prohibit this vertical separation, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to backfilling, in accordance with the provisions of this chapter. Sewers crossing over water mains shall:

a. Be laid to provide a separation of at least 18 inches between the bottom of the sewer and the top of the water main.

b. Be constructed of AWWA approved water pipe and pressure tested in place without leakage prior to backfilling, in accordance with the provisions of this chapter.

c. Have adequate structural support to prevent damage to the water main.

d. Have the sewer joints placed equidistant and as far as possible from the water main joints.

6. No water pipe shall pass through or come into contact with any part of a sewer manhole. Manholes shall be placed at least 10 feet horizontally from a water main whenever possible. The distance shall be measured edge-to-edge of the pipes or structures. When local conditions prohibit this horizontal separation, the manhole shall be of watertight construction and tested in place.

Statutory Authority
§62.1-44.19 of the Code of Virginia.
Historical Notes
Former 12VAC5-581-420 derived from Virginia Register Volume 18, Issue 10, eff. February 27, 2002; amended and adopted as 9VAC25-790-360, Virginia Register Volume 20, Issue 9, eff. February 12, 2004.

9VAC25-790-370. System access.

Sewer location should be within streets, alleys, and utility rights-of-way. Approvals shall be obtained from the appropriate jurisdictions for placement of sewers within these boundaries.

TABLE 3
CONTRIBUTING SEWAGE FLOW ESTIMATES TO BE USED AS A DESIGN BASIS FOR NEW SEWAGE WORKS.

Discharge facility (1)	Contributing Design Units	Flow gpd	BOD_5 #day (3)	S.S.#day	Flow duration, hours
Dwellings	Per person	100 (2)	0.2	0.2	24
Schools w/showers and cafeteria	Per person	16	0.04	0.04	8
Schools w/o showers w/cafeteria	Per person	10	0.025	0.025	8
Boarding Schools	Per person	75	0.2	0.2	16
Motels @ 65 gal. per person (rooms only)	Per room	130	0.26	0.26	24
Trailer courts @ 3 persons/trailer	Per trailer	300	0.6	0.6	24
Restaurants	Per seat	50	.02	0.2	16
Interstate or through highway restaurants	Per seat	180	0.7	0.7	16
Interstate rest areas	Per person	5	0.01	0.01	24
Service Stations	Per vehicle serviced	10	0.01	0.01	16
Factories	Per person/per 8-hr. shift	15-35	0.03-0.07	0.03-0.07	Oper. Per.
Shopping centers	Per 1,000 square foot of ultimate floor space	200-300	0.1	0.1	12
Hospitals	Per bed	300	0.6	0.6	24
Nursing Homes	Per bed	200	0.3	0.3	24
Doctor's offices in medical centers	Per 1000 square foot	500	0.1	0.1	12
Laundromats, 9-12 machines	Per machine	500	0.3	0.3	16
Community colleges	Per student & faculty	15	0.03	0.03	12
Swimming pools	Per swimmer	10	0.001	0.001	12
Theaters (drive-in type)	Per car	5	0.01	0.01	4
Theaters (auditorium type)	Per seat	5	0.01	0.01	12
Picnic areas	Per person	5	0.01	0.01	12
Camps, resort day & night w/limited plumbing	Per camp site	50	0.05	0.05	24
Luxury camps w/flush toilets	Per camp site	100	0.1	0.1	24

Notes:

(1) Colleges, universities and boarding institutions of special nature to be determined in accordance with subdivision B 2 of this section.

ALEXANDRIA SANITATION AUTHORITY

AVAILABILITY OF WASTEWATER TREATMENT CAPACITY TO SERVE ALEXANDRIA GROWTH PROJECTED TO THE YEAR 2010

The Alexandria Sanitation Authority is responsible for the treatment and disposal of wastewater received at its treatment plant from the sanitary sewer system of the City. The City owns, operates and maintains the collector sewer systems. The Authority owns, operates and maintains the treatment plant and certain interceptor sewers which connect the collector system to the plant.

The Authority treatment plant is located on a 33 acre site located at 835 South Payne Street ~~and~~ bounded by cemeteries on the north, Hooff's Run on the west, the Beltway on the south and Payne Street on the east. The plant site is not expandable in any horizontal direction.

The original plant was built in 1954-56 with a capacity of 18 million gallons per day (MGD) to serve the City and the Cameron Run watershed of Fairfax County. Under a 1954 service agreement between the Authority and the County, the County contracted for approximately 30% of the capacity of the plant and contributed a like share of the capital costs. Over the period 1974-1985 the plant was expanded and up-graded to its present 54 MGD capacity, of which 40%, or 21.6 MGD, is reserved for the City and 60%, or 32.4 MGD was purchased by Fairfax County under a revised 1973 service agreement.

The Washington Metropolitan Council of Governments currently projects an increase in resident population in the range of 4000 and an increase in jobs in the range of 75,000 for the City of Alexandria over the next 20 years. The City of Alexandria Department of Planning and Community Development projects a total of 8,000 new housing units (single and multi-family) and 28 million square feet of additional commercial development by the year 2010. Neither agency predicts any appreciable industrial growth in this time span.

The wastewater arriving at the treatment ~~plnat~~ plant is made up of two basic components: (1) water supplied to each consumer and discharged to the sewer system after use, and (2) ground water infiltration and storm water inflow (I/I). The I/I component is a function of the physical condition of the City sewer system and the area served by combined sanitary/storm sewers, and bears no relationship to water consumption. The I/I component, which presently averages about 25% of the total flow received, or 3.7 MGD, is not expected to increase in the future and could be decreased by separating the combined sewer system in Old Town.

There is no practical way to meter wastewater discharged from individual properties to the sewer system. However, water consumption, which is metered, is an acceptable measure of wastewater production.

The Virginia American Water Company estimates residental water consumption at 202 gallons per account per day. The Authority estimates that on a city wide annual average basis, 91% of residential water consumption reaches the sewer system. Over the past several years residential water consumption has declined, probably due to declining household sizes, improved plumbing fixtures and conservation encouraged by rising water and sewer charges. The Water Company does not expect a material departure from the present demand of 202 gallons/day/account over the next 15-20 years. Wastewater production, therefore, is estimated at 91% or 184 gallons/account/day. Using the City's current residential occupancy estimate of 2.15 persons per unit, the average per capita wastewater contribution is 86 gallons per day.

Commercial water consumption and wastewater production is more conveniently expressed in volume per unit floor area rather than in terms of people or jobs. The Authority has surveyed the water accounts of 163 commercial properties representing 9.1 million square feet of net floor area and found that the average water consumption is 72 gallons per 1000 square feet per day. The Planning and Community Development Department estimates that the occupational density of commercial office space in the City averages 3.6 employees/1000 square feet which produces an average water consumption of 20 gallons/employee/day. For the purposes of this study, it is assumed that 100% of commercial water consumption reaches the sewer system.

The above factors applied to the COG and City forecasts, respectively, produce the following treatment plant loadings:

COG

Residential:	4000 persons @ 86 g/c/d =	0.34 MGD
Commercial:	75,000 jobs @ 20 g/e/d =	1.50 MGD
	TOTAL	1.84 MGD

City

Residential:	8000 units @ 184 g/u/d =	1.47 MGD
Commercial:	28,000,000 sq.ft. @ 72 g/msf/d =	2.02 MGD
	TOTAL	3.49 MGD

As previously stated, 5.8 MGD of unused capacity in the Authority treatment plant and 1.7 MGD in the Arlington plant are available to the City for future growth. The City forecast, which is greater than the COG forecast (and therefore the more conservative for the purpose of impact assessment) is broken down between the two service areas as follows:

	ASA	Arlington
Additional housing units	6000	2000
Additional commercial space, sq.ft.	25.3 million	2.7 million

The breakdown of projected wastewater increases in each area is as follows:

	ASA	Arlington
Residential @ 184 g/u/d	1.10 MGD	0.37 MGD
Commericial @ 72 g/msf/d	1.82 MGD	0.20 MGD
Total Additional wastewater	2.92 MGD	0.57 MGD

The total projected wastewater flows to the respective treatment plants in the year 2010, compared with the available existing plant capacities are, therefore, as follows:

	To ASA TP	To Arlington TP
Current (1988) City flow	15.80 MGD	1.30 MGD
Projected increase, 1988-2010	2.92 MGD	0.57 MGD
Total flow, year 2010	18.72 MGD	1.87 MGD
Present plant capacity	21.6 MGD	3.0 MGD

Conclusion

There appears to be sufficient capacity available to the City in the Authority and Arlington treatment plants to accomodate the development projected over the next twenty years if the ground water infiltration/storm water inflow component does not increase over the present level. The City should continue its program of repair and rehabilitation of old sewers and, where possible, separation of combined sewers. Reduction of I/I will provide additional capacity in both the sewer system and the treatment plants to serve future growth and is a worthwhile goal for the City to consider.

2010 Washington Metropolitan Area Water Supply Reliability Study

Part 1: Demand and Resource Availability Forecast for the Year 2040

Prepared by

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May 2010

The Section for Cooperative Water Supply Operations on the Potomac

Interstate Commission on the Potomac River Basin
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ICPRB Report No. 10-01

Copies of this report are available at the ICPRB website, at www.potomacriver.org, under "Publications". To receive printed copies of this report, please write to ICPRB at the address given above, or call 301-984-1908.

Table 3-1: Dwelling unit ratios for each jurisdiction served by a WMA water supplier (portions of the jurisdictions not served by Fairfax Water, WSSC, Washington Aqueduct, or one of their wholesale customers are excluded from this analysis).

	2005	2008	2010	2015	2020	2025	2030	2035	2040
Arlington County[1]	0.67	0.60	0.59	0.52	0.47	0.46	0.44	0.44	0.44
City of Alexandria[2]	0.47	0.46	0.45	0.43	0.41	0.39	0.37	0.36	0.35
City of Rockville[3]	1.90	1.69	1.59	1.23	1.09	1.03	1.02	0.87	0.80
Dale City	3.14	2.80	2.60	1.67	1.29	1.13	0.98	0.89	0.84
District of Columbia[4]	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Fairfax County[5]	2.93	2.89	2.83	2.62	2.42	2.26	2.15	2.08	1.88
Falls Church	1.90	1.92	1.88	1.70	1.69	1.67	1.65	1.64	1.56
Loudoun County[6]	5.21	5.28	5.17	4.40	3.55	3.18	2.91	2.73	2.55
Montgomery County	2.07	1.83	1.99	1.77	1.61	1.49	1.39	1.33	1.29
Prince George's County	1.98	2.04	2.00	2.00	1.95	1.89	1.84	1.81	1.79
Prince William County	4.03	3.94	3.82	2.68	2.07	1.73	1.54	1.42	1.36
Vienna[7]	12.03	11.64	11.65	11.31	10.63	10.00	9.56	9.28	8.78
Town of Herndon[8]	2.09	2.07	2.06	1.90	1.72	1.71	1.67	1.60	1.53

[1]Data was provided by housing unit (all houses, including those not occupied). The county vacancy rate was applied to these numbers to calculate the number of occupied households.

[2]2005, 2008, 2035, and 2040 were extrapolated from the provided data.

[3]Rockville's household projections for 2006 through 2030 were provided as the annual change in the number of households from a baseline number from the 2000 Census. Household figures for 2035 and 2040 were extrapolated.

[4]The District of Columbia does not track the number of single family or multi-family households. U.S. Census data from 2007 was used to derive the dwelling unit ratio. This value was assumed for all years, as has been done in previous reports.

[5]The number of housing units was provided for 2008, 2009, 2010-2035, 2037 by TAZ. The vacancy rate was applied by TAZ to calculate the number of single and multi-family occupied households. 2005 and 2040 values were extrapolated.

[6]The number of single family and multi-family households by TAZ was not available for 2008. The 2008 value was interpolated for the areas of Loudoun County served by Loudoun Water.

[7] The area served by Vienna extends beyond the town's boundaries; therefore, the demographic figures for within the area and the town are not necessarily the same.

[8]The number of 2008 single family and multi-family housing units were provided, along with estimates for the total number of units in 2010, 2020, and 2030. An estimate of the number of single family units in 2030 was also provided. 2020 values were assumed to be half way between 2010 and 2030 values. The others values were extrapolated.

3.5 MWCOG Cooperative Forecast

Estimates of population, households, and employees in the WMA for 2005 through 2040 are based on the Metropolitan Washington Council of Governments' (MWCOG) Round 7.2 Cooperative Forecast (MWCOG, 2009). This forecast is developed through a cooperative process involving MWCOG and local government agencies. The Cooperative Forecasting Program, established in 1975 and administered by MWCOG, allows for coordinated local and regional planning using common assumptions about future growth and development. The forecast available at the beginning of this study, Round 7.2, for the period between 2005 and 2040, was completed in fall 2008, and approved by the MWCOG Board of Directors in July 2009.

The development of the MWCOG forecast uses both a regional econometric model and bottom-up approach undertaken by local planning agencies. The econometric model is based on national and local economic and demographic trends, while the local planning agencies rely more on development and transportation plans, in addition to local economic and demographic trends. After these two forecasts have been independently completed, they are reconciled through MWCOG's Cooperative Forecasting and Data Subcommittee and approved by MWCOG's Board of Directors. The final product is an estimate of population, employees, and households as distributed by traffic analysis zone (TAZ). Each county has several hundred TAZs, which allows for a forecast of water demand at the TAZ level by areas served by each water supplier. In the WMA there are currently 1,972 TAZs of varying size. TAZs tend to be smaller closer to the urban core (*i.e.* D.C. has the most TAZs of all jurisdictions in the area). More information on the development of this forecast can be found at MWCOG's website*: www.mwcog.org.*

MWCOG provided ICPRB with the Round 7.2 dataset by county. Data was extracted from the county datasets in order to determine the population, number of households, and number of employees in a given area served by a WMA water supplier. To do this, GIS ArcMap™ (ESRI) was used to estimate a ratio of the area within a TAZ served by a water supplier. For the TAZs that were not completely within an area served by one of the WMA water suppliers, it was assumed that the number of units (households, employees, or population) was allocated based on the area ratio. For example, if 50 percent of the area in a TAZ was within the area served by WSSC, then 50 percent of its households, employees, and population were assumed to be customers of WSSC. In order to verify this assumption and to make corrections when needed, footprints of areas served were exported to Google Earth and overlaid on satellite imagery in order to survey area boundaries. For example, if a TAZ was only partially within an area boundary, the satellite image was used to estimate the percentage of households within the TAZ that were actually within the area. This was done for WSSC, Fairfax Water, Loudoun Water, Prince William County Service Authority, Falls Church DEP, and Rockville DPW. Finally, the data associated with each TAZ were multiplied by the percentage of supplier coverage in the given TAZ. While most TAZs were covered 100 percent by the areas, perimeter TAZs ranged in coverage. This second step followed similar imaging techniques adopted by ICPRB during the 2005 WMA water supply study, and allowed for more precise demographic estimates.

Once this process was complete, the population, household, and employee data for each area were extracted from the county data (Table 3-2). Overall, Round 7.2 indicates continued growth throughout the area served by the WMA suppliers and their wholesale customers (Table 3-3). Fairfax Water is predicted to experience the most growth of all the suppliers over the next 30 years. The largest expected gain is in the number of employees, which is predicted to grow by 54 percent by 2040. Overall, the WMA forecast indicates an increase in the number of households by 29 percent, population by 24 percent, and employment by 38 percent.

Table 3-2: Projected MWCOG Round 7.2 figures for households, population, and employees by WMA water supplier.

	2010			2040		
Areas Served	**Households**	**Population**	**Employees**	**Households**	**Population**	**Employees**
Fairfax Water - Dulles International Airport	23	57	16,268	23	57	20,844
Fairfax Water - Fort Belvoir	504	1,309	17,892	665	1,804	21,279
Fairfax Water - Town of Herndon	7,580	22,972	24,733	8,400	25,405	27,334
Fairfax Water - Loudoun Water	67,750	192,356	115,309	109,621	296,052	225,145
Fairfax Water - Prince William County Service Authority	95,114	276,820	85,743	154,651	418,105	185,262
Fairfax Water - Current retail area	307,256	834,922	456,687	386,624	1,037,719	620,677
Fairfax Water/Virginia American - City of Alexandria	70,434	142,420	109,109	93,006	178,128	164,844
Fairfax Water/Virginia American - Dale City	21,903	66,166	9,950	23,871	71,008	18,484
Fairfax Water subtotal	570,564	1,537,022	835,691	776,861	2,028,278	1,283,869
Aqueduct - Arlington County DES	99,581	208,808	212,380	122,107	245,048	278,972
Aqueduct - City of Falls Church DES	52,050	129,794	140,469	67,203	164,728	180,417
Aqueduct - Vienna PWD[1]	9,662	26,832	14,105	11,306	31,408	15,079
Aqueduct - D.C. Water and Sewer Authority	275,963	610,732	788,162	359,378	789,456	957,162
Aqueduct - D.C. WASA - Fort Meyer	305	2,594	2,121	305	2,594	1,782
Aqueduct subtotal	437,561	978,760	1,157,237	560,299	1,233,234	1,433,412
WSSC - Prince George's County	307,034	841,431	353,588	364,280	951,971	507,534
WSSC – Montgomery County	331,130	881,436	437,556	414,864	1,057,213	615,761
WSSC subtotal[2]	638,164	1,722,867	791,144	779,144	2,009,184	1,123,295
Fairfax Water, Aqueduct, WSSC total	1,646,289	4,238,649	2,784,072	2,116,304	5,270,696	3,840,576
City of Rockville DPW	17,880	46,014	64,893	26,282	63,045	87,180
Fairfax Water, Aqueduct, WSSC, Rockville total	1,664,169	4,284,663	2,848,965	2,142,586	5,333,741	3,927,756

[1] The area served by Vienna extends beyond the town's boundaries; therefore, the demographic figures for the area served and the town are not necessarily the same.

[2] These numbers reflect the expansion in the area served that is anticipated for WSSC.

Table 3-7: Round 7.2a figures for Prince George's and Montgomery counties, reflecting the development of a rapid transit line in the region.

	Montgomery County			Prince George's County		
	Households	**Population**	**Employee**	**Households**	**Population**	**Employee**
2005	347,000	929,100	500,000	306,014	849,333	347,885
2010	362,000	966,000	510,000	317,881	872,014	362,886
2015	386,000	1,025,000	547,000	331,243	899,192	379,393
2020	408,000	1,075,000	590,000	344,789	924,788	399,211
2025	425,200	1,113,500	631,500	356,841	945,710	424,429
2030	440,400	1,142,000	673,000	367,834	966,852	454,932
2035	451,400	1,161,000	703,000	375,627	985,064	488,946
2040	460,000	1,174,000	723,000	380,375	995,372	524,292

3.7 Calculation of Unit Use Values

The average daily water consumption by single family household (SFH), multi-family household (MFH), and employee (EMP) users was calculated in terms of gallons per unit (household or employee) per day for each of the four years (2005, 2006, 2007, 2008) for which data were available for this study (Table 3-8). The unit use values were calculated based on the aforementioned dwelling unit ratios, MWCOG housing and employment data, and water consumption as billed by the WMA water suppliers. Current unit use factors are a primary input for the long-term water demand forecasts presented in Chapter 4.

Billing data from the regional water suppliers was requested in terms of single family households, multi-family households, and commercial categories. The availability of such disaggregated data was dependent on the individual water suppliers' billing system. Instances where these data were not available are noted in Appendix B. The total amount of water consumed by each category was divided by the number of single or multi-family households or the number of employees. In addition, unmetered water was calculated. This is the difference between the water produced (or purchased at the wholesale level) and the water billed to customers. When each water suppliers' total demand was calculated, if the amount of unmetered water was less than 10 percent, it was assumed to be 10 percent to allow for a conservative estimate of demand. These values are also included in each water supplier summary in Appendix B.

Table 3-8: Unit use values by area served by water supplier (gallons per unit per day). (A detailed description of unit use calculations can be found in Appendix B.)

	2005			2006			2007			2008		
Area Served	**SFH**	**MFH**	**EMP**	**SFH**	**MFH**	**EMP**	**SFH**	**MFH**	**EMP**	**SFH**	**MFH**	**EMP**
Fairfax Water - Dulles International Airport[1]	(206.4)	(170.0)	61.5	(211.2)	(167.5)	55.7	(227.6)	(167.8)	49.5	(199.9)	(165.6)	43.8
Fairfax Water - Fort Belvoir[1]	(206.4)	(170.0)	85.1	(211.2)	(167.5)	108.4	(227.6)	(167.8)	99.9	(199.9)	(165.6)	73.3
Fairfax Water - Town of Herndon[2]	157.5		43.7	157.9		42.6	157.0		42.0	[157.5]		[42.8]
Fairfax Water - Loudoun Water	216.9	173.8	47.6	236.2	188.9	52.1	254.3	203.0	54.5	220.6	176.2	45.3
Fairfax Water - Prince William County Service Authority[1,2]	270.8	(173.8)	(47.6)	277.3	(188.9)	(52.1)	290.0	(203.0)	(54.5)	[279.4]	[188.6]	[51.4]
Fairfax Water - Area currently served by retail	206.4	170.0	41.8	211.2	167.5	42.3	227.6	167.8	44.4	199.9	165.6	40.0
Fairfax Water/Virginia American - City of Alexandria[1,2]	164.7	167.8	(41.8)	177.0	148.4	(42.3)	183.4	143.8	(44.4)	[175.0]	[153.3]	[42.9]
Fairfax Water/Virginia American - Dale City[1,2]	245.2	172.6	(41.8)	275.5	274.0	(42.3)	255.9	233.4	(44.4)	[258.9]	[226.7]	[42.9]
Aqueduct - Arlington County DES	164.7	103.3	42.5	168.0	100.4	41.3	170.4	96.6	42.0	158.8	93.3	39.7
Aqueduct - City of Falls Church DES	136.6	118.0	18.6	221.8	159.8	35.0	220.0	157.1	34.3	199.9	163.3	30.4
Aqueduct - Vienna PWD	207.7	148.6	29.7	197.7	133.7	28.0	204.6	132.3	27.0	196.8	130.9	26.0
Aqueduct - D.C. Water and Sewer Authority	177.5	140.4	58.6	174.7	137.9	61.5	169.9	132.9	60.2	161.9	122.5	58.9
Aqueduct - D.C. WASA - Fort Meyer[1]	(206.4)	(170.0)	92.1	(211.2)	(167.5)	107.8	(227.6)	(167.8)	129.3	(199.9)	(165.6)	115.2
WSSC - Montgomery County and Prince George's County	179.6	162.6	49.0	185.7	154.2	44.0	186.9	152.2	42.5	189.3	142.0	40.8
City of Rockville DPW	154.6	139.1	16.6	183.7	165.3	22.3	186.9	168.2	24.2	161.1	145.0	23.8
Weighted Average (WSSC, Fairfax Water retail, and D.C. WASA only)	**187.5**	**156.0**	**51.2**	**191.9**	**150.8**	**50.5**	**196.8**	**148.1**	**49.8**	**188.5**	**139.2**	**47.8**

Note: SFH = single family home; MFH = multi-family home; EMP = employees

[1] Values in parenthesis are assumed, based on values from another utility.

[2] Values in brackets are averages of the previous years' values.

Table 4-1: Forecast of average annual water demand for the WMA from 2010 to 2040 (mgd).

Areas Served	2010	2015	2020	2025	2030	2035	2040
Fairfax Water - Area currently served by Retail	90.0	93.6	96.9	100.6	103.4	105.5	107.1
Fairfax Water - Dulles	0.8	0.8	0.9	0.9	1.0	1.0	1.0
Fairfax Water - Fort Belvoir	1.6	1.8	1.8	1.8	1.8	1.8	1.8
Fairfax Water - Herndon	2.6	2.7	2.7	2.7	2.7	2.7	2.7
Fairfax Water - Loudon Water	23.3	26.5	31.1	34.1	35.5	36.4	37.2
Fairfax Water - Prince William Co. Service Authority	32.1	35.5	38.9	41.9	44.6	46.7	48.7
Fairfax Water/Virginia American - City of Alexandria	18.2	19.0	20.1	21.1	22.1	22.6	23.2
Fairfax Water/Virginia American - Dale City	6.7	6.9	7.0	7.0	7.0	7.1	7.1
Total Fairfax Water (Scenario 1[1])	**175.2**	**186.9**	**199.4**	**210.2**	**218.2**	**223.8**	**228.9**
Potential demand from "special growth areas"	12	13	15	19	23	28	32
Added demand assuming constant SFH[2] unit use	-	1.9	3.4	5.0	6.1	7.2	8.2
TOTAL Fairfax Water (Scenario 2[3])	**187.2**	**201.7**	**217.8**	**234.2**	**247.3**	**259.0**	**269.1**
Aqueduct - Arlington County DES	25.0	26.7	28.2	28.5	28.6	28.7	28.6
Aqueduct - District of Columbia WASA	107.4	111.3	116.4	119.6	122.6	124.2	127.5
Aqueduct - Falls Church DES	15.6	16.8	17.3	17.8	18.2	18.5	18.7
Aqueduct - Fort Meyer	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Aqueduct - Vienna PWD	2.5	2.5	2.6	2.6	2.6	2.6	2.7
TOTAL Washington Aqueduct (Scenario 1)	**150.9**	**157.7**	**164.8**	**168.7**	**172.2**	**174.2**	**177.8**
Added demand assuming constant SFH unit use	-	1.0	1.8	2.6	3.3	3.9	4.6
TOTAL Washington Aqueduct (Scenario 2)	**150.9**	**158.6**	**166.6**	**171.4**	**175.5**	**178.1**	**182.4**
WSSC – Served by Retail	168.7	174.3	180.3	185.2	190.7	194.7	197.4
WSSC – Howard County[4]	2.5	2.5	5.0	5.0	5.0	5.0	5.0
WSSC – Charles County	0.7	0.7	1.4	1.4	1.4	1.4	1.4
WSSC (Scenario 1)	**171.9**	**177.5**	**186.7**	**191.6**	**197.1**	**201.1**	**203.8**
Added demand assuming constant SFH unit use	-	2.0	3.7	5.3	6.4	7.6	8.7
WSSC (Scenario 2)	**171.9**	**179.6**	**190.4**	**196.9**	**203.5**	**208.7**	**212.5**
WMA Suppliers Subtotal (Scenario 1)	**497.9**	**522.1**	**551.0**	**570.6**	**587.5**	**599.1**	**610.5**
Potential demand from "special growth areas"	12	13	15	19	23	28	32
Added demand assuming constant SFH unit use	0.0	4.9	8.8	12.9	15.8	18.7	21.5
WMA Suppliers Subtotal (Scenario 2)	**509.9**	**540.0**	**574.8**	**602.5**	**626.3**	**645.7**	**664.0**
City of Rockville DPW (Scenario 1)	4.8	5.0	5.3	5.6	5.8	6.1	6.3
Added demand assuming constant SFH unit use	0.0	0.0	0.1	0.1	0.2	0.2	0.2
City of Rockville DPW (Scenario 2)	4.8	5.0	5.4	5.7	6.0	6.3	6.5
WMA TOTAL plus Rockville (Scenario 1)	**502.7**	**527.1**	**556.3**	**576.2**	**593.3**	**605.1**	**616.8**
Potential demand from "special growth areas"	12	13	15	19	23	28	32
Added demand assuming constant SFH unit use	0.0	4.9	8.9	13.0	16.0	18.9	21.7
WMA TOTAL plus Rockville (Scenario 2)	**514.7**	**545.0**	**580.2**	**608.2**	**632.3**	**652.0**	**670.5**

[1]Scenario 1 predictions are based on calculations of demand that account for reductions due to the Energy Policy Act being applied to both single family and multi-family households, starting in 2015.

[2]SFH = single family households

[3]Scenario 2 predictions are based on calculations of demand that account for reductions due to the Energy Policy Act being applied to multi-family households only, starting in 2015. The values for single family household unit use are assumed to be constant from 2010 on. In the case of Fairfax Water, the Scenario 2 prediction also accounts for estimated additional demand from special growth areas.

[4]2010-2040 wholesale figures are based on total allowable amounts sold to Howard and Charles counties by WSSC. They are assumed to use half of the allowable amount until 2020, after which the full amount is assumed to be used (personal communication, Roland Steiner, 3/25/09).

Appendix B Calculation of Unit Use Factors for Each Supplier

B1 Introduction

This section provides detailed documentation of the calculation of the unit use factors. Unit use factors were determined for single family and multi-family households and for employees, which contains commercial, municipal, and any other use of water, for each of the region's water suppliers. This section also includes information on data sources and summaries of billing records, as well as the method used for calculating unmetered water use. Other relevant notes are included as needed in regard to data availability and calculations.

Due to limited data availability, some unit use figures are assumed for specific utility customer classes using professional judgment. These instances are noted for each occurrence below. These estimates are a result of limited disaggregation of water use data by service providers and therefore could not be avoided.

B2 Data Sources

The study authors thank all those who helped to provide data for this report. Many of those who provided data are mentioned below. We thank these individuals as well as those who we may have neglected to mention. Without the support of many, this report would not have been possible.

B2.1 Water Data

The following employees of the water providers were invaluable to the data collection process by which the unit use factors were calculated:

Arlington Department of Environmental Services: Dave Hundelt, Barbara Forbes, Elizabeth Craig

DCWASA: Charles Kiely, Syed Khalil

Fairfax Water: Greg Prelewicz

Falls Church: Mary Ann Burke, Rodney Collins

Loudoun Water: Thomas Lipinski, Thomas Bonacquisti

Prince William County Service Authority: Beau Caire

City of Rockville DPW: Susan Strauss, Ilene Lish

City of Rockville Finance Department: Jason Zimmerman

Town of Herndon: Salah Jaro

Vienna: Marion Serfass

Virginia American: Jim Downs, Michael Youshock

WSSC: Tim Hirrel, Roland Steiner

B2.2 Demographic and Service Area Mapping Data

The following persons were invaluable to the data collection process by which the service areas were compiled:

Arlington County, Department of Community Planning, Housing & Development: Angie de la Barrera, Elizabeth Rodgers

City of Alexandria, Department of Planning and Zoning: Ralph Rosenbaum

City of Rockville, Community Planning and Development Services: Mayra Bayonet, Manisha Tewari

District of Columbia: Kimberly Driggins, Joy Phillips, Art Rodgers

Fairfax County: Fatima Khaja (Dept.of Planning & Zoning), Sterling Wheeler

Fairfax Water: Greg Prelewicz, Traci Kammer Goldberg

Falls Church Planning Division: Rodney Collins

Town of Herndon, Department of Community Development: Dana Heiberg

Loudoun County, Department of Management and Financial Services: Jill Allmon

Loudoun Water: Thomas Lipinski, Craig Lees

Maryland National Capital Park and Planning Commission: Wayne Koempel (Montgomery County, Research & Technology Center), Patrick Callahan (Prince George's County), Jacquelin Philson (Prince George's County), Joseph Valenza (Prince George's County)

Metropolitan Washington Council of Governments: Paul DesJardin, Greg Goodwin

Prince William County: Frank Hunt (Planning Office), David McGettigan

Prince William County Service Authority: Beau Caire

Town of Herndon: Salah Jaro

Town of Vienna, Planning and Zoning Department: Julie Morris

WSSC: Pedro Flores, Roland Steiner

B3 Fairfax Water

B3.1 Service Area

The current areas served map provided by Fairfax Water is the extent of the water main under current conditions. According to Fairfax Water, the general boundaries of the area served may grow only modestly at the margin and are not anticipated to change in a way that would materially impact the twenty-year water demand forecast for the WMA. In particular, Fairfax Water does not anticipate significant demand growth in areas that are not currently served by public water systems (Traci Goldberg, personal communication, February 10, 2009). This assumption was verified by Fairfax County, which indicated the areas served in the county were not likely to expand because they plan to remain low density and are not on a sewer system (Sterling Wheeler, personal communication, May 26, 2009).

B3.2 Billing Records

Fairfax Water provided billing records for both its retail and wholesale customers by year for 2005 through 2008 (Table B-1). Retail billing categories are disaggregated into single family households, townhouses, apartments, commercial, municipal, and hydrants. For this study's purposes, the single family households and townhouses were combined for the single family use category and commercial and municipal categories were combined for the employee use category. The water in the hydrant category was not combined into another use category, but was accounted for in the unmetered use calculation. In addition to its retail customers, Fairfax Water supplies water to a number of wholesale customers, including Prince William County Service Authority, Virginia American (serving the City of Alexandria and Dale City), Loudoun Water, Town of Herndon, Fort Belvoir, and MWAA Dulles International Airport. An analysis of their water use follows this section.

Table B-1: Consumption (millions of gallons per day) by customer category for Fairfax Water – retail customers.

	Single Family	Multi-Family	Employee	Total
2005	46	13	17	76
2006	47	13	18	78
2007	51	13	19	83
2008	45	13	18	76

B3.3 Unmetered Water Use

According to Fairfax Water billing records it billed approximately 76 mgd to retail customers in 2008. The amount of water sold to all wholesale customers was on average 62 mgd in 2008, for a total of 138 mgd sold to retail and wholesale customers. Fairfax Water also sells and purchases a small amount of water from other suppliers in the area to satisfy interchange agreements. In 2008, Fairfax Water produced on average 145 mgd at the Occoquan and Corbalis water treatment plants. The difference between water produced and billed water consumption is calculated as unmetered water use. In 2008, this difference was 7 mgd or 5 percent of the water produced (Table B-2).

Table B-2: Summary of water purchased and billed (millions of gallons per day) for Fairfax Water – retail and wholesale customers.

	Produced	Purchased	Billed – Retail, Wholesale, Other	Unmetered	Percent Unmetered
2005	152.372	0.216	144.850	8	6%
2006	158.508	0.062	147.339	12	7%
2007	166.524	0.150	155.214	11	7%
2008	144.685	0.279	139.514	7	5%

B3.4 Determination of Single and Multi-family Unit Use Factors

In 2008, Fairfax Water billed approximately 45 mgd to the single family household water use category (this includes the townhouse category) and 13 mgd to the multi-family household category. The number of 2008 households in the Fairfax Water's retail area served was 303,604 as based on the ICPRB analysis using a GIS overlay of Fairfax Water's retail area served with household data by traffic analysis zone, extracting the 2005 and 2010 household data and interpolating for 2008. Applying the 2008 dwelling unit ratio in Fairfax Water's service area of 2.89 (number of single family residences divided by number of multi-family residences) to the total number of households in the areas served by Fairfax Water yields 225,563 single family households and 78,041 multi-family households. Therefore, the unit use factor for single family households was 199.9 gallons per day (45 mgd divided by 303,604 single family households) and 165.6 gallons per day for multi-family households (13 mgd divided by 78,041 multi-family households in 2008) (Table B-3).

B3.5 Determination of Employee Unit Use Factors

Fairfax Water reports that approximately 18 mgd of water was consumed by employee category (commercial and municipal) in 2008. The number of 2008 employees in the Fairfax Water area served is 439,043 as based on the ICPRB analysis using a GIS overlay of Fairfax Water's area served with employment information by traffic analysis zone, extracting the 2005 and 2010 data and interpolating for 2008. The per employee daily water use is thus calculated as 40.0 gallons per day (Table B-3).

Table B-3: Dwelling unit ratio and unit use (gallons per day) by customer category for Fairfax Water - retail.

	2005	2006	2007	2008
Households	298,126	299,952	301,778	303,604
Dwelling unit ratio	2.93	2.92	2.90	2.89
Single family	222,349	223,434	224,399	225,563
Multi-family	75,777	76,518	77,379	78,041
Employment	412,577	421,399	430,221	439,043
Unit use (gpd)				
Single family	206.4	211.2	227.6	199.9
Multi-family	170.0	167.5	167.8	165.6
Employee	41.8	42.3	44.4	40.0

B4 Fairfax Water - Prince William County Service Authority (PWCSA)

B4.1 Service Area

According to PWCSA, growth in Prince William County will occur mainly in the Haymarket, Gainesville-Wellington, Lake Ridge, Hoadly, and Oak Ridge areas (Beau Caire, personal communication, April 2, 2009). Redevelopment of Woodbridge and Dumfries-Triangle is also expected. Prince William County is promoting mixed use areas to concentrate development in specified areas.

B4.2 Billing Records

PWCSA provided information on water pumped or conveyed through metering stations from January 2002 through August 2008 (Table B-4). This information was used as a proxy for customer billing information which was not available. A categorical breakdown of water use by customer category was, likewise, not available. Figures for 2007 are reported here and were used in the analysis, as they constitute the last complete year of data. While these numbers are a good approximation of consumption, they also include water used for system flushing and fire use (Beau Caire, personal communication, February 19, 2009).

B4.3 Unmetered Water Use

PWCSA relies on water from Fairfax Water and the City of Manassas, in addition to some water drawn from wells to meet its demands (Beau Caire, personal communication, February 19, 2009). Purchasing records available from Fairfax Water indicate that on average in 2007, PWSCA purchased 23.64 mgd. Typically, PWSCA purchases between 2 and 5 mgd from the City of Manassas each year as well (Beau Caire, personal communication, February 19, 2009). In 2007, 2.99 mgd were purchased on average. PWCSA has 5 mgd capacity rights with the City of Manassas, but usage depends on water quality during the summer months (Beau Caire, personal communication, February 19, 2009). In 2007, the last complete year of data, PWCSA reported that 28.03 mgd was conveyed to customers and that a total of 26.63 mgd was purchased from Fairfax Water and the City of Manassas. These numbers indicate that more water is being sent to customers than is purchased or is pumped from wells. This discrepancy could be due to inaccuracies at pumping station and purchasing meters (Beau Caire, personal communication, April 2, 2009).

Table B-4: Summary of water purchased and billed (millions of gallons per day) for PWCSA.

	Purchased	Pumped	Unmetered	Percent Unmetered
2004	20.27	20.29	-0.02	-0.10%
2005	23.72	24.09	-0.37	-1.56%
2006	23.77	25.91	-2.14	-9.00%
2007	26.63	28.03	-1.4	-5.26%

B4.4 Determination of Single and Multi-family Unit Use Factors

The number of 2007 households in the area served by PWCSA is 86,649, as based on the ICPRB analysis using a GIS overlay of PWCSA's area served with household data by traffic analysis zone, extracting the 2005 and 2010 household data and interpolating for 2007. Applying the dwelling unit ratio of 3.97 in the area served (number of single family residences divided by number of multi-family residences) to the number of 2007 households yields 69,215 single family households and 17,434 multi-family households.

The unit use factor for PWCSA's multi-family households was assumed to be equal to that of Loudoun Water's, 203.0 gallons per day. Applying Loudoun Water's multi-family unit use factor to the number of multi-family households yields a total water use of 3.539 mgd. The single family unit use factor was calculated by subtracting the total amount used by multi-family households and employees from the total pumped in 2007, divided by the number of employees. This yields a single family unit use factor of 290.0 gallons per day (Table B-5).

B4.5 Determination of Employee Unit Use Factors

Loudoun Water's employee unit use factor (54.5 gpd) was assumed for PWCSA. The number of 2007 employees in the PWSCA service area was 81,100 as based on the ICPRB analysis using a GIS overlay of PWCSA's service area with employment data by traffic analysis zone, extracting the 2005 and 2010 data and interpolating for 2007. Assuming per employee daily water use is 54.5 gallons, the daily demand for PWCSA employees in 2007 was 3.54 mgd.

Table B-5: Dwelling unit ratio and unit use (gallons per day) by customer category for PWCSA.

	2005	2006	2007
Households	81,006	83,828	86,649
Dwelling unit ratio	4.03	4.00	3.97
Single family	64,901	67,062	69,215
Multi-family	16,105	16,766	17,434
Employment	78,005	79,553	81,100
Unit use (gpd)			
Single family	270.8	277.3	290.0
Multi-family	173.8	188.9	203.0
Employee	47.6	52.1	54.5

B5 Fairfax Water - Virginia American – City of Alexandria

B5.1 Service Area

Virginia American does not have a map of the area they serve in the City of Alexandria; it is assumed that the entire city receives water from them.

B5.2 Billing Records

Billing data were available by calendar year from 2005 to 2007 (Table B-6). Values for 2007 are reported here. Virginia American uses residential, commercial, industrial, fire/special, and other for its water use billing categories. Virginia American's residential water use category includes single family homes and duplexes with one meter per occupant (Jim Downs, personal communication, February 13, 2009). This category was used for this study's single family use category. The commercial category includes apartment buildings, businesses, and other commercial water uses. This category usually covers units with two meters per structure (Jim Downs, personal communication, February 13, 2009). The industrial category encompasses high-volume production facilities with multiple water feeds. Virginia American's "other" category includes water sold to municipal government facilities. Given the structure of the billing categories, separate multi-family household and employee figures could not be parsed out.

Table B-6: Consumption (millions of gallons per day) by customer category for City of Alexandria.

	Single Family	Multi-family/Employee	Total
2005	3.49	11.99	15.48
2006	3.75	11.33	15.08
2007	3.93	11.45	15.38

B5.3 Unmetered Water Use

In 2007, Virginia American purchased on average 16.71 mgd from Fairfax Water. In the same year, Virginia American billed 15.38 mgd to customers in the City of Alexandria. The resultant unmetered water in 2007 was 1.33 mgd or approximately 7.95 percent (Table B-7).

Table B-7: Summary of water purchased and billed (millions of gallons per day) for City of Alexandria.

	Purchased	Billed	Unmetered	Percent Unmetered
2005	18.15	15.48	2.66	14.68%
2006	18.21	15.08	3.13	17.19%
2007	16.71	15.38	1.33	7.95%

B5.4 Determination of Single Family Unit Use Factor

During 2007, 3.93 mgd were billed to single family households. The number of 2007 households in the area served by Virginia American in Alexandria is 67,976 as based on the ICPRB analysis using a GIS overlay of the area they serve with household data by traffic analysis zone, extracting the 2005 and 2010 data and interpolating for 2007. Applying the dwelling unit ratio in the city of 0.46 (number of single family residences divided by number of multi-family residences) to the number of 2007 households in the Virginia American service area yields 21,417 single family households and 46,559 multi-family households. The single-family water use factor was thus 183.4 gpd (Table B-8).

B5.5 Determination of Multi-family and Employee Unit Use Factor

Given Virginia American's billing categories, the amount of water billed to multi-family households and to employees could not be broken out in the same way as done for other utilities. A total of 11.45 mgd was billed to the commercial, industrial, and "other" categories in 2007. In order to calculate an approximate daily use amount for both multi-family and employee use, Fairfax Water's unit use factor for employee demand was assumed. The Fairfax Water's 2007 employee unit use factor was 44.4 GPD. The number of 2007 employees in the Alexandria service area was 107,136 as based on the ICPRB analysis using a GIS overlay of Alexandria's service area with employment data by traffic analysis zone. Applying the Fairfax Water employee unit use factor to the number of employees yields a total water use of 4.760 mgd. Subtracting this approximation of employee water use from Alexandria's total annual commercial, industrial, and "other" use, yields 6.694 mgd assumed for the multi-family category. Given 46,559 multi-family households in the area served by Virginia American as calculated above, a multi-family unit use factor of 143.8 gallons per household per day was derived (Table B-8).

Appendix 5-1

Sanitary Sewer Hydraulic Model Update: Revised Unit Flow Assumptions
Technical Memorandum
March 2, 2012

Background

A comprehensive hydraulic model has been developed to simulate existing and future flow conditions in the City of Alexandria sanitary sewer collection system. The model is a collection of 31 basin models developed using Innovyze InfoSewer hydraulic modeling software. The individual drainage areas discharge to larger trunk sewers owned by Fairfax County, Alexandria Sanitation Authority and Arlington County which are not modeled. The models have been developed and refined over a two year period, with regular reviews and updates to system data and flow assumptions.

System Data

The current model is based on invert elevations and system connectivity as indicated in the City's GIS database provided on January 11, 2012. The City has continued to update the GIS database with field survey data and review by field staff. The model development process is documented in prior memoranda which outline assumptions regarding sub-basin delineation and invert data.

System flow data is calculated using unit flow factors, land use information and an allowance for infiltration. A peaking factor of 4.0 is applied to all base flows to calculate the design flow. The flow parameters are updated for this review as listed;

Residential flow factor	146 gpd/household (existing and future)
Non-residential flow factor	136 gpd/1000 sqft (existing)
Non-residential flow factor	110 gpd/1000 sqft (future)
Base infiltration	1600 gpd/inch-diameter-mile
Peaking factor	4.0 (include base infiltration and wastewater flows)

WR&A also received the existing building database on January 11, 2012 which is maintained by the City planning department. The building database includes the number of units for residential dwellings, the number of hotel rooms and building square feet for commercial buildings. Calculated flows were then allocated to manholes in the associated sub-basins. Infiltration loading was calculated for all the gravity mains in each sub-basin, including un-modeled mains, and allocated to the associated manholes.

Future redevelopment build-out flows were provided by the City on January 11, 2012 as the net increase in flow for a designated development area. WR&A converted the total flow to a flow per sub-basin area and allocated loads to appropriate manholes.

Model Scenarios

The model scenarios include an evaluation of the gravity collection system for both existing and future loading conditions for all 31 basins. The outlet discharge conditions are assumed to have a partially submerged outlet at 80% of the pipe diameter. The modeled scenarios are as listed.

1. Existing System – Existing Flows
2. Existing System – Build-out Flows

Model Evaluation Criteria

The hydraulic model was used to evaluate remaining flow capacity as determined by the hydraulic grade line under existing and build-out design flows. The calculated model data includes the depth of flow adjusted for backwater conditions, the velocity, and the potential full flow capacity of each segment. The flow depth reported is an average of the depth at the upstream and downstream inverts, and will be equal to the diameter if both upstream and downstream manholes are surcharged.

The goal of the modeling is to identify all sewer mains operating in surcharged condition under design flow (peak) rates. The hydraulic grade should not exceed the invert plus pipe diameter at any point. The existing sewer mains are not expected to meet the same criteria as new construction for minimum slope or cover and this was not reviewed. Profile data tables (attached) do include velocity and slope which may provide insight for additional evaluation and analysis.

Model Evaluation Assumptions

Under the broad planning scope of this project, certain assumptions have been made to develop the model. The assumptions follow existing City standards, DEQ standards and commonly accepted engineering practice.

- Sewer mains all have a common "n" factor of 0.013
- Sewer mains are clean, straight runs
- Design flows represent field conditions
- GIS data matches field conditions
- Peak Factor is 4.0 throughout

Model Calculations

The loading allocation for each basin is calculated based on the unit flow values, infiltration rates and peaking factor. The calculated flows are listed in **Table 1**. The existing flows in each basin vary greatly and the additional build-out flows also vary greatly from zero additional flow to nearly 3,000 gpm additional flow at peak conditions. In all cases it is assumed the infiltration rate does not change and the peaking factor remains 4.0.

Table 1
Existing Flow Calculations

Basin	Residential Units per GIS bldg	Hotel Units per GIS bldg data	Area (sf) per GIS bldg data	Pipe Length (mi) All Pipe in Basin	Infiltration (gpm) 1600gpd/idm	Hotel Flow (gpm) Units*130 gpd	Residential Flow (gpm) Units*146gpd	Commercial Flow (gpm) Area*136gpd/1000sf	Base Flow (gpm) (I + R + C)	Existing Design Flow (gpm) (I+R+C)*4	Additional Buildout Flows (gpm)	Buildout Deisgn Flow (gpm)
1	989	0	507,039	5.80	69	0	100	48	217	**867**	252	**1,875**
2	818	0	88,578	1.04	12	0	83	8	103	**412**	136	**957**
3	1,125	496	1,190,392	2.18	30	45	114	112	301	**1,206**	210	**2,044**
4	1,181	0	3,950	2.42	29	0	120	0	149	**597**	27	**707**
5	321	0	0	1.61	18	0	33	0	50	**200**	17	**267**
6	1,048	0	304,803	3.49	38	0	106	29	173	**693**	73	**986**
7	291	0	3,100	3.14	35	0	30	0	64	**257**	0	**258**
8	2,592	0	253,458	4.87	53	0	263	24	340	**1,359**	125	**1,857**
9	1,735	0	705,025	12.96	146	0	176	67	389	**1,555**	137	**2,105**
10	465	130	545,997	1.66	19	12	47	52	130	**519**	35	**659**
11	2,993	0	2,368,319	23.40	283	0	303	224	810	**3,241**	409	**4,876**
12	219	0	0	1.90	21	0	22	0	43	**172**	0	**172**
13	1,193	0	477,789	12.65	142	0	121	45	308	**1,233**	42	**1,399**
14	1,506	0	332,862	9.25	108	0	153	31	293	**1,170**	6	**1,195**
15	120	0	23,214	1.26	13	0	12	2	27	**108**	0	**108**
16	1,543	409	946,445	8.23	119	37	156	89	401	**1,606**	32	**1,735**
17	662	0	1,469,166	1.84	21	0	67	139	227	**906**	168	**1,578**
18	4,388	0	718,735	3.86	53	0	445	68	565	**2,261**	170	**2,940**
19	3,227	0	1,485,018	4.96	56	0	327	140	523	**2,094**	749	**5,088**
20	900	0	2,218	2.58	29	0	91	0	120	**480**	0	**480**
21	1,054	0	187,044	1.25	14	0	107	18	138	**554**	47	**741**
22	2,994	219	42,467	1.88	22	20	304	4	349	**1,398**	23	**1,492**
23	0	185	1,258,143	0.75	8	17	0	119	144	**575**	392	**2,144**
24	2,878	104	63,518	4.11	46	9	292	6	353	**1,413**	43	**1,586**
25	115	0	0	1.32	14	0	12	0	26	**105**	0	**105**
26	87	0	0	0.91	10	0	9	0	19	**76**	0	**76**
27	4,118	0	497,844	4.34	51	0	418	47	516	**2,064**	449	**3,860**
28	5,464	203	333,544	8.26	91	18	554	32	695	**2,779**	116	**3,244**
29	3,970	0	138,223	7.29	100	0	403	13	516	**2,063**	74	**2,360**
30	611	500	2,813,150	0.93	14	45	62	266	386	**1,546**	65	**1,807**
31	0	0	655,629	0.75	9	0	0	62	71	**284**	168	**956**

Model Evaluation Results

The model evaluation is based on the calculated flow depth and hydraulic grade line. Flow profiles, data tables and mapping for each of the 31 basins are attached. The mapping includes color coded sewer mains to identify the drainage basins and the mains which are submerged or surcharging. Multiple profiles are shown for each modeled sewer basin, and printed at a suitable scale to allow a visual review of the results. The hydraulic grade line (HGL) and water surface are shown on the flow profiles and a measure of the submerged depth is calculated at each manhole. The HGL is a red line which is visible above the water surface when the pipe is submerged or under a pressurized situation. The submerged depth is shown as SD and listed over the manhole. For a submerged manhole the value will be positive.

The total length of pipe in each basin which has a flow depth greater than the diameter is listed in **Table 2**. The total length of pipe modeled included in the model is approximately 217,000 lineal feet or over 37 miles. The modeling indicates about 4% of the system may surcharge under existing peak flow conditions and 9% under build-out flow conditions. The amount of surcharge is not quantified and may be as small as 0.1 feet or may fill the manhole.

Table 2
Length of Pipe Over Capacity

	Existing Flows: Length of Pipe Over Capacity (ft)	Build-out Flows: Length of Pipe Over Capacity (ft)
Basin 1	0	131
Basin 2	0	0
Basin 3	0	0
Basin 4	0	0
Basin 5	0	0
Basin 6	285	757
Basin 7	0	0
Basin 8	0	0
Basin 9	2,181	2,880
Basin 10	102	301
Basin 11	270	1,008
Basin 12	16	16
Basin 13	174	296
Basin 14	359	359
Basin 15	0	0
Basin 16	184	714
Basin 17	252	1,589

	Existing Flows: Length of Pipe Over Capacity (ft)	Build-out Flows: Length of Pipe Over Capacity (ft)
Basin 18	0	0
Basin 19	260	3,394
Basin 20	125	125
Basin 21	0	75
Basin 22	0	0
Basin 23	0	2,406
Basin 24	461	623
Basin 25	0	0
Basin 26	0	0
Basin 27	0	958
Basin 28	0	0
Basin 29	3,113	3,571
Basin 30	0	0
Basin 31	0	250
TOTAL	**7,781**	**19,452**

Conclusions

The model provides an easily viewed set of results based on the assumed flow rates and peaking factors. The collection system has documented capacity issues as identified in Table 2 and on the mapping and profiles. In a few locations the invert data appears to be suspect (as shown on the basin profiles where the upstream invert is lower than downstream invert), however this does not significantly impact the modeling results.

The existing basins with considerable surcharging include Basins 9 and 29. Under build-out conditions Basins 9, 11, 19, 23 and 29 show signs of surcharging at or above the manhole rim elevation, indicating a potential overflow condition. The modeling does not account for basin by basin variability in peaking factor, base flow, infiltration and diurnal patterns. Therefore the model should be calibrated for specific basins under review and field conditions investigated prior to designing capital improvments.

Attachments (pdf format)

Existing Basin Maps – Contains map for each basin, color coded to represent capacity (depth)
Existing PD – Contains profile and data table for each basin
Buildout Basin Maps – Contains map for each basin, color coded to represent capacity (depth)
Build-out PD– Contains profile and data table for each basin

Appendix 8-1

SEWERS

Including the Sanitary Sewer Fund and Stormwater Management Fund

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Sewers

Sanitary Sewers Subsection/Project	*Unallocated Balance (01/12)*	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY 13-22
Sanitary Sewers												
Commonwealth Service Chamber	*$370,000*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Holmes Run Trunk Sewer	*6,037,000*	0	0	0	0	0	0	0	0	0	0	0
Sanitary Sewer Capacity Studies	*149,877*	0	0	0	0	0	0	0	0	0	0	0
Four Mile Run Sanitary Sewer Repair	*130,000*	1,500,000	0	0	0	0	0	0	0	0	0	1,500,000
Holmes Run Sewershed Infiltration & Inflow	*4,960,000*	4,360,000	4,200,000	3,600,000	3,850,000	3,850,000	0	0	0	0	0	19,860,000
Mitigation of Combined Sewer Overflows	*1,581,690*	319,000	335,000	335,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	3,439,000
Reconstructions & Exts. of Sanitary Sewers	*2,373,918*	322,000	0	775,000	320,000	435,000	540,000	660,000	760,000	760,000	845,000	5,417,000
Sewer Separation Projects	*600,000*	500,000	120,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	5,420,000
ASA Wastewater Treatment Plant Expansion	*0*	500,000	500,000	0	0	0	0	0	11,070,000	11,400,000	11,750,000	35,220,000
Wet Weather Management Facility	*0*	0	3,375,000	1,125,000	0	13,300,000	13,700,000	0	0	0	0	31,500,000
Sanitary Sewer Master Plan	*0*	0	0	0	0	0	0	0	0	0	10,000	10,000
Sanitary Sewers Total	*$16,202,485*	$7,501,000	$8,530,000	$6,435,000	$5,120,000	$18,535,000	$15,190,000	$1,610,000	$12,780,000	$13,110,000	$13,555,000	$102,366,000
Less Total Non-City Revenue	*$0*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Net City Costs	*$16,202,485*	$7,501,000	$8,530,000	$6,435,000	$5,120,000	$18,535,000	$15,190,000	$1,610,000	$12,780,000	$13,110,000	$13,555,000	$102,366,000

Stormwater Management Subsection/Project	*Unallocated Balance (01/12)*	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY 13-22
Stormwater Management												
Taylor Run at Janney's Lane	*$551,250*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NPDES / MS4 Permit	*134,000*	0	0	0	0	0	0	0	0	0	0	0
Four Mile Run Channel Maintenance	*600,000*	1,010,000	0	0	0	600,000	0	0	0	0	0	1,610,000
Ft. Ward Stormwater	*85,000*	500,000	0	0	0	0	0	0	0	0	0	500,000
Storm Sewer Capacity Analysis	*1,088,500*	350,000	400,000	0	0	0	0	0	0	0	0	750,000
Stream & Channel Maintenance and Rest.	*170,750*	1,198,000	1,198,000	0	0	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	9,596,000
Miscellaneous Storm Sewer Repairs	*3,314,113*	0	525,000	775,000	535,000	825,000	925,000	285,000	395,000	670,000	300,000	5,235,000
Storm/Combined Sewer Assessment and Renov.	*450,000*	0	0	380,000	900,000	900,000	900,000	900,000	900,000	0	0	4,880,000
Key Drive Flood Mitigation	*0*	0	0	1,000,000	800,000	0	0	0	0	0	0	1,800,000
Braddock Rd. & West St. Storm Sewer	*0*	0	0	0	0	0	0	750,000	750,000	1,500,000	2,000,000	5,000,000
Stormwater Management Total	*$6,393,613*	$3,058,000	$2,123,000	$2,155,000	$2,235,000	$3,525,000	$3,025,000	$3,135,000	$3,245,000	$3,370,000	$3,500,000	$29,371,000
Less Total Non-City Revenue	*$0*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Net City Costs	*$6,393,613*	$3,058,000	$2,123,000	$2,155,000	$2,235,000	$3,525,000	$3,025,000	$3,135,000	$3,245,000	$3,370,000	$3,500,000	$29,371,000

SANITARY SEWER FUND

Overview: The Proposed FY 2013 – 2022 Sanitary Sewer Fund totals $189.3 million over ten years, including $86.9 million of operating expenditure and debt services payment for General Obligation Bonds and $102.4 million for sanitary sewer capital improvement projects for reducing stormwater inflow and infiltration and expanding system capacity in order to prevent sanitary sewer backups while minimizing the environmental impacts of sanitary sewer discharge. These improvements are provided as part of the City's compliance with Commonwealth of Virginia environmental permitting regulations.

A Sanitary Sewer Master Plan currently under development has defined two significant capital investments which are included as part of the Proposed FY 2013 – 2022 CIP. These projects are the Alexandria Sanitation Authority (ASA) Wastewater Treatment Plant expansion ($35.2 million) and a Wet Weather Treatment Facility ($31.5 million). Projects are proposed to be funded with a combination of increases to the current Sewer Maintenance Fee (currently $1.25/1,000 gallons) and possible increases to the Sewer Line Connection Fees (paid by developers).

Revenue Generation: The Sanitary Sewer Fund is funded by a combination of Sewer Connection Fees charged to developers for tying new structures in to the system and Sanitary Sewer Line Maintenance Fees charged to existing property owners on the quarterly water bill based on gallons consumed. The Sewer Connection Fees are adjusted annually according to the CPI-U. The sewer usage fee was increased to $1.25/1,000 gallons in FY 2011, is proposed to stay the same for FY 2013. The current rate costs the typical household approximately $87.50 annually, or $21.88 per quarter.

Reflecting the Proposed FY 2013 – 2022 Sanitary Sewer Fund budget, rate increases to the Sewer Line Maintenance Fee are projected beginning FY 2015. The rate increases appear necessary to fund large one-time capital projects including the Wet Weather Treatment Facility, ASA Wastewater Treatment Plant Expansion, and completion of funding for the Holmes Run Sewer Shed Infiltration and Inflow project. The following table is an estimate of proposed rate increases in the ten-year plan. The City will also explore the possibility of eventually increasing the Sewer Line Connection Fees charged to developers. Actual rate increases would be aligned with project timing and financing needs as the scope of each project becomes clearer, and the rate increases below are estimated. Rate increases and increases to the base Sewer Line Connection Fees would be approved by City Council on an annual basis.

	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Beginning FY Rate	$1.25	$1.25	$1.25	$1.38	$1.38	$1.47	$1.77	$2.05	$2.05	$2.27
Proposed % Increase	0.0%	0.0%	10.0%	0.0%	7.0%	20.0%	16.0%	0.0%	12.0%	0.0%
New Rate	$1.25	$1.25	$1.38	$1.38	$1.47	$1.77	$2.05	$2.05	$2.27	$2.27

Each of the projects listed in the previous paragraph are assumed to be bond financed, and the resulting rate increase will be used to pay debt service associated with the projects. This is a pay-as-you-use system of finance which is an appropriate model for a utility such as a sanitary sewer system. The FY 2013 - 2022 CIP calls for the leveraging of $85.6 million in General Obligation Bonds over the ten year plan, with the debt service paid from dedicated Sanitary Sewer Fund revenues. General Obligation Bonds paid by sewer fee revenue are considered "double barreled" bonds by the rating agencies and do not count towards a jurisdictions debt ratios.

Planned Projects: The projects included in the FY 2013 – FY 2022 Proposed Sanitary Sewer Fund plan address maintenance-related issues necessary at current levels of development in the City. Additionally, the plan includes capacity-related projects stemming from projected development and population growth in the City. As the Sanitary Sewer Master Plan is fully developed, additional projects are likely to be added to future ten year plans.

Additional operating costs for the Wet Weather Management Facility are also factored into the ten year plan, with an estimated cost of $654,000 in FY 2019 once construction of the facility is completed.

FY 2013 - 2022 PROPOSED CIP: SANITARY SEWER FUND
SOURCES AND USES

Sanitary Sewer Rate ($ per 1,000 gallons)		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	
Sanitary Sewer Rate ($ per 1,000 gallons)		$1.25	$1.25	$1.25	$1.38	$1.38	$1.47	$1.77	$2.05	$2.05	$2.27	
Proposed Rate Increase (% increase)		0.0%	0.0%	10.0%	0.0%	7.0%	20.0%	16.0%	0.0%	12.0%	0.0%	
New Sanitary Sewer Rate ($ per 1,000 gallons)		$1.25	$1.25	$1.38	$1.38	$1.47	$1.77	$2.05	$2.05	$2.27	$2.27	

Sanitary Sewer Module Funding Sources		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY13-FY22
Sewer Line Maintenance Fee		$6,500,000	$6,548,750	$7,257,652	$7,312,085	$7,882,610	$9,530,075	$11,137,799	$11,221,333	$12,662,152	$12,757,118	$92,809,574
Sewer Connection Fee		1,000,000	1,050,000	1,102,500	1,157,625	1,215,506	1,276,282	1,340,096	1,407,100	1,477,455	1,551,328	12,577,893
New Debt Issuance		4,850,000	3,530,000	3,750,000	0	0	0	0	0	0	0	12,130,000
New Debt Issuance (with New Projects)		0	3,375,000	1,125,000	3,850,000	17,150,000	13,700,000	0	11,070,000	11,400,000	11,750,000	73,420,000
Reprogrammed Prior Year Funding		246,556	225,000	0	0	0	0	0	0	0	0	471,556
Fund Balance Carryover		0	168	8,392	135,681	132,623	45,868	118,237	184,422	114,775	572,714	0
Total Funding Sources		$12,596,556	$14,728,918	$13,243,545	$12,455,390	$26,380,739	$24,552,225	$12,596,132	$23,882,856	$25,654,382	$26,631,160	$191,409,022

Category/Project	*Unallocated (12/2011)*	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY13-FY22
Category 1												
Mitigation of Combined Sewer Overflows	*$1,581,690*	$319,000	$335,000	$335,000	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000	$3,439,000
Reconstructions & Exts. of Sanitary Sewers	*2,373,918*	322,000	0	775,000	320,000	435,000	540,000	660,000	760,000	760,000	845,000	5,417,000
Sanitary Sewer Capacity Studies	*149,877*	0	0	0	0	0	0	0	0	0	0	0
Sewer Separation Projects	*600,000*	500,000	120,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	5,420,000
Subtotal Category 1	*4,705,485*	1,141,000	455,000	1,710,000	1,270,000	1,385,000	1,490,000	1,610,000	1,710,000	1,710,000	1,795,000	14,276,000
Category 2												
Commonwealth Service Chamber	*370,000*	0	0	0	0	0	0	0	0	0	0	0
Holmes Run Trunk Sewer	*6,037,000*	0	0	0	0	0	0	0	0	0	0	0
Four Mile Run Sanitary Sewer Repair	*130,000*	1,500,000	0	0	0	0	0	0	0	0	0	1,500,000
ASA Wastewater Treatment Plant Expansion	*0*	500,000	500,000	0	0	0	0	0	11,070,000	11,400,000	11,750,000	35,220,000
Holmes Run Sewershed Infiltration & Inflow	*4,960,000*	4,360,000	4,200,000	3,600,000	3,850,000	3,850,000	0	0	0	0	0	19,860,000
Subtotal Category 2	*11,497,000*	6,360,000	4,700,000	3,600,000	3,850,000	3,850,000	0	0	11,070,000	11,400,000	11,750,000	56,580,000
Category 3												
[1]Reclaimed Water System via WTE Plant	*0*	0	0	0	0	0	0	0	0	0	0	0
Wet Weather Management Facility	*0*	0	3,375,000	1,125,000	0	13,300,000	13,700,000	0	0	0	0	31,500,000
Sanitary Sewer Master Plan	*0*	0	0	0	0	0	0	0	0	0	10,000	10,000
Subtotal Category 3	*0*	0	3,375,000	1,125,000	0	13,300,000	13,700,000	0	0	0	10,000	31,510,000
Subtotal Capital Expenditures	*$16,202,485*	$7,501,000	$8,530,000	$6,435,000	$5,120,000	$18,535,000	$15,190,000	$1,610,000	$12,780,000	$13,110,000	$13,555,000	$102,366,000

[1] Project balance of $146,566 and unallocated balance of $100,000 proposed to be reprogrammed in FY 2013, and project closed out.

FY 2013 - 2022 PROPOSED CIP: SANITARY SEWER FUND
SOURCES AND USES

Sanitary Sewer Module Operating Costs	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY13-FY22
Personnel	$2,437,551	$2,510,678	$2,585,998	$2,663,578	$2,743,485	$2,825,790	$2,910,563	$2,997,880	$3,087,817	$3,180,451	$27,943,790
[2]Non-Personnel	803,335	1,077,435	852,258	877,826	904,161	931,285	959,224	988,001	1,017,641	1,048,170	9,459,335
Additional Operating - Wet Weather Facility	0	0	0	0	0	0	654,000	673,620	693,829	714,643	2,736,092
Debt Service - Pre-FY 2013	1,708,727	1,773,909	1,856,576	1,897,309	1,816,622	1,738,762	1,663,572	1,599,332	1,557,806	1,513,098	17,125,713
Debt Service - FY 2013-2022	145,775	828,504	1,378,032	1,764,055	2,335,603	3,748,151	4,614,350	4,729,248	5,614,576	6,507,534	31,665,828
Total Operating Expenditures	$5,095,388	$6,190,526	$6,672,864	$7,202,768	$7,799,871	$9,243,988	$10,801,709	$10,988,081	$11,971,668	$12,963,897	$88,930,759
Total Sanitary Sewer Expenditures	$12,596,388	$14,720,526	$13,107,864	$12,322,768	$26,334,871	$24,433,988	$12,411,709	$23,768,081	$25,081,668	$26,518,897	$191,296,759

[2] Includes $250,000 for an Asset Management System in FY 2014

Commonwealth Service Chamber

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2
Estimated Useful Life of Improvement: 40 years
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: Hoof's Run South of Duke Street

Project Summary: This project will fund the construction of a service chamber on the Commonwealth Interceptor. The service chamber will act to prevent sewer backups during wet weather flows from the combined sewer area when the combined sewer outfall at Hooff's Run is submerged. The service chamber may be similar to two located on the Holmes Run Trunk Sewer that protect the low lying developed areas in the Eisenhower Valley. A study initiated in FY 2010, and is still underway using the remaining unallocated project balance of $370,000. Construction costs and schedule will be determined at the completion of the study, and have not been factored in the FY 2013 – FY 2022 CIP.

Changes from Prior Year: No changes from prior year.

Operating Impact: No additional operating impact.

Commonwealth Service Chamber	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	370,000	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	370,000	0	0	0	0	0

Commonwealth Service Chamber	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	0

Holmes Run Trunk Sewer

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: 40 years
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: ASA Plant to the City/Fairfax Border

Project Summary: This project provides for an increase in capacity in the Holmes Run trunk sewer line, required to support development occurring in the Eisenhower Valley, as well as future development and redevelopment in the West End. Engineering studies indicated that lining the existing sewer with specialized materials would provide the needed capacity increase with minimal environmental disruption. Relining will increase the capacity in the western portion of the sewer from Van Dorn Street to Eisenhower Avenue at Cameron Run. A total of $6.037 million in unallocated project balance from prior fiscal years will be combined with a project balance of $621,000 to complete this phase of the project. Alexandria Sanitary Authority (ASA) maintains this trunk sewer.

Changes from Prior Year: No changes from prior year.

Project History: Phase I of this project included relining the western portion of the trunk sewer, completed in summer 2008. Additional engineering and analysis has determined that pipe lining alone will not increase capacity sufficiently in the Phase II – East Eisenhower section. Additional engineering analysis is underway to evaluate other capacity relief options, including constructing a relief sewer from Eisenhower Avenue to the Alexandria Sanitation Authority plant, and potential wet weather sewer storage and treatment in the Holmes Run Service Area. City staff is still studying the project, and the construction schedule is unknown at this time.

Operating Impact: This project does not have an impact on the City's operating budget, as it is maintained by the Alexandria Sanitation Authority.

Holmes Run Trunk Sewer	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	6,037,000	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	6,037,000	0	0	0	0	0

Holmes Run Trunk Sewer	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	0

Sanitary Sewer Capacity Studies

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 1

Estimated Useful Life of Improvement: 40 years
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Citywide

Project Summary: This project provides for an ongoing sanitary sewer capacity study to assess the sanitary sewer's systems ability to support existing flows and on-going development.

Changes from Prior Year: Future funding was been moved to the Sanitary Sewers operating budget beginning FY 2012. An unallocated balance of $149,877 remains to complete studies as part of the CIP. Once all funding is expended, the project will be removed from the CIP.

Operating Impact: No additional operating impact from the remainder of the study.

Sanitary Sewer Capacity Studies	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	149,877	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	149,877	0	0	0	0	0

Sanitary Sewer Capacity Studies	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	0

Four Mile Run Sanitary Sewer Repair

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: 40 years
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: End of Commonwealth Ave to Bruce Street

Project Summary: This project will fund the rehabilitation of the Four Mile Run sanitary sewer. During field inspections of the Four Mile Run Inflow and Infiltration project in FY 2001, surcharged manholes with significant solids were encountered along the 36-inch diameter truck sewer upstream of the Four Mile Run pump station. Efforts to clean the trunk sewer were unsuccessful due to the heavy solids volume and compaction in the sewer. In FY 2008, a specialty contractor successfully removed the solids and an inspection and condition assessment was completed. Based on the condition assessment of the trunk sewer following the removal of the solids, rehabilitation is necessary. $1.8 million is budgeted for this project with $300,000 approved for design in FY 2012 and $1.5 million for construction in FY 2013. ASA will be upgrading the existing 4-Mile Run Pump station and the City is coordinating the trunk sewer rehabilitation with ASA's improvements. The project is currently in the design phase, and construction must be coordinated with ASA improvements.

Changes from Prior Year: No change from prior year.

Operating Impact: No additional operating impact.

Four Mile Run Sanitary Sewer Repair	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	130,000	1,500,000	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	130,000	1,500,000	0	0	0	0

Four Mile Run Sanitary Sewer Repair	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	1,500,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	1,500,000

Holmes Run Sewershed Inflow and Infiltration and Rehabilitation

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: 40 years
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: Holmes Run Sewer Shed

Project Summary: This project provides for the evaluation and remediation of infiltration/inflow and sewer rehabilitation conditions for the sanitary sewer system in the Holmes Run sewershed. Many of the sewers and manholes are old and deteriorated, and require rehabilitation. During wet weather, infiltration and inflow into the sanitary sewers have created overload conditions causing basement backups. The field work and monitoring is being performed by dividing the 4,600 acre sewer shed into sections and proceeding through each section sequentially. Leaking sewers and connections (which allow excessive infiltration/inflow to enter sewers), and deteriorated sewers requiring remediation, will be identified via street by street closed circuit television inspection of sewers. The results of this field are being be evaluated to develop remediation projects that are expected to include the relining of sewers and manhole repairs. The sewers in the Holmes Run sewershed, although originally constructed more recently than the newly rehabilitated Commonweatlth and Four Mile Run sewer sheds, will most likely require a higher percentage of remediation than that of the older sewer sheds.

Changes from Prior Year: Funding in the amount of $3.85 million in FY 2016 and FY 2017 to fully fund this project. Project funding/completion is contingent on eventually increasing current Sewer Line Maintenance Fees and Sewer Connection Fees.

Project History: During FY 2010, flow metering at 23 locations was completed and closed circuit television field inspections were completed for 10 sub-basins. This provided information to prioritize capital improvements. Design of remediation measures started in summer 2010 for two sub-basins and construction is anticipated to begin in FY 2013.

Operating Impact: No additional operating impact.

Holmes Run I & I	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	4,960,000	4,360,000	4,200,000	3,600,000	3,850,000	3,850,000
Less Revenues	0	0	0	0	0	0
Net City Share	4,960,000	4,360,000	4,200,000	3,600,000	3,850,000	3,850,000

Holmes Run I & I	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	19,860,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	19,860,000

Mitigation of Combined Sewer Overflows (CSOs)

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 1

Estimated Useful Life of Improvement: 40 years
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Citywide

Project Summary: This project category funds the mitigation projects related to combined sewer overflows (CSOs). The City's combined storm and sanitary sewer system is comprised of areas east of the railroad corridor (primarily Old Town), which includes an area of approximately 560 acres. Combined sewer outfalls (discharge points for wet weather overflows) are located at the foot of Pendleton and Royal Streets and under Duke Street at Hooff's Run. An unallocated balance of $1.6 million and total of $3.4 million over ten years is planned to continue the implementation of permit conditions through FY 2022. A total mitigation of the CSO system would require significantly more funds than planned in this CIP.

Changes from Prior Year: Funding in the amount of $350,000 is added for FY 2022.

Project History: The City began engineering studies in the early 1990's to seek alternative approaches to control combined sewer overflows and in 1995 submitted a Long Term Control Plan (LTCP) to the Virginia Department of Environmental Quality (VADEQ). The VADEQ first issued the City a permit for its combined sewer system in 1995. Based on the City's studies, the permit calls for the City to operate and maintain the combined sewer system according to the United States Environmental Protection Agency's (USEPA) technology-based best management practices. The practices are known as the Nine Minimum Controls (NMCs) and are part of the National CSO Control Policy. The NMCs that the City implemented for controlling CSO discharges comprise the following:

1. Proper operation and regular maintenance programs for the sewer system and the combined sewer overflows;
2. Maximum use of the collection system for storage;
3. Review and modification of the pretreatment program to assure CSO impacts are minimized;
4. Maximization of flow to the publicly owned and treated works (POTW) for treatment;
5. Prohibition of CSOs during dry weather;
6. Control of solid and floatable materials in CSOs;
7. Pollution prevention programs that focus on containment reduction activities;
8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts; and
9. Monitoring and reporting to effectively characterize CSO impacts and the efficacy of CSO controls.

Currently, TMDLs (Total Maximum Daily Loads) for various pollutants are being developed by USEPA and VA Department of Environmental Quality (DEQ) for the receiving waters. Bacteria TMDL for Hunting Creek approved by VA Department of Environmental Quality and EPA provides load allocations for the Combined Sewer System that requires drastic reductions in the permitted overflows. Depending on the conditions of the future permits, the City may be required to revise its LTCP, and implement expensive controls which may include full or partial separation, detention, or end of pipe technologies. Implementation of an "Area Reduction Plan" study identifies areas within the combined system shed that can be potentially separated as part of new development or re-developments can also become part of permit requirements. The City's current permit was re-issued in January 2007 and expires was to January 2012. The permit was continued by DEQ while negotiations the City over a new permit continue. An application for permit re-issuance has been submitted to the Virginia Department of Environmental Quality, and depending of the conditions of the new permits, it is possible that substantially more CIP funds may be required for FY 2014 and beyond.

Operating Impact: No additional operating impact.

Mitigation of CSOs	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	1,581,690	319,000	335,000	335,000	350,000	350,000
Less Revenues	0	0	0	0	0	0
Net City Share	1,581,690	319,000	335,000	335,000	350,000	350,000

Mitigation of CSOs	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	350,000	350,000	350,000	350,000	350,000	3,439,000
Less Revenues	0	0	0	0	0	0
Net City Share	350,000	350,000	350,000	350,000	350,000	3,439,000

Reconstructions & Extensions of Sanitary Sewers

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 1

Estimated Useful Life of Improvement: 40 years
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Citywide

Project Summary: This project provides for the construction of new sewer mains and the replacement and rehabilitation of old lines as needed. The project also includes funds for the City's share of the cost of sewer extensions required for development. This is an essential infrastructure project. A total of $5.42 million is planned over ten years. This project also funds repairs to City streets disturbed by sewer line construction. Projects to be funded with the current allocated balance of $1.25 million an unallocated balance of $2.37 million as listed in the table below.

Project/Description	Estimated Costs
Sewer line in alley between Monroe & Nelson	$100,000
Groves Avenue sewer replacement	$400,000
W. Uhler Avenue sewer replacement	$600,000
Sycamore Street sewer replacement	$450,000
Paxton Street crossing replacement	$920,000
Taylor Run – replace exposed sewer line (near Tuckahoe and King)	$100,000
Hoof's Run sewer relocation (Chapman to Maple)	$600,000
Taylor Run at Janney's Lane – siphon replacement	$400,000
Total	$3,570,000

Changes from Prior Year: Total project funding reduced from $9.7 million in the Approved FY 2012 – 2021 CIP to $5.42 million based on revised project completion schedule and available fund revenues. Funding in the amount of $845,000 is added for FY 2022.

Project History: In FY 1987, the City initiated an on-going program to reline existing leaking sewers in the City. Projects completed in the last several years include West Caton Avenue between Commonwealth Avenue and Sanford Street; Diagonal Road, Hickory Street; and Forrest Street. Projects under design include Sycamore Street, between Mt. Ida Street and Kennedy Street; Groves Avenue, W. Uhler Avenue, Hoof's Run from E. Chapman to E. Maple Streets; elimination of a sewer siphon at Taylor Run @ Janney's Lane; and a sewer located in the alley between East Monroe Avenue and East Nelson Avenue. The City's share of the Four Mile Run Force Main is also paid out of this project.

Operating Impact: No additional operating impact.

Recon. and Extentions of San Sewers	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	2,373,918	322,000	0	775,000	320,000	435,000
Less Revenues	0	0	0	0	0	0
Net City Share	2,373,918	322,000	0	775,000	320,000	435,000

Recon. and Extentions of San Sewers	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	540,000	660,000	760,000	760,000	845,000	5,417,000
Less Revenues	0	0	0	0		0
Net City Share	540,000	660,000	760,000	760,000	845,000	5,417,000

Sewer Separation Projects

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s):
Project Category: 1

Estimated Useful Life of Improvement: 40 years
Priority: Essential
Strategic Plan Goal: 2 - Health & Environment
Location: Citywide

Project Summary: This project provides for small projects to separate areas of combined sewers. Areas of opportunity exist for separation of combined sewer systems where construction of additional sewers in a few blocks due to new development may result in completing the separation of a larger area. Opportunities may also arise in conjunction with redevelopment in the combined sewer area. In 2011 City Staff identified portions of the King and West CSO sewershed where separation may be achieved by disconnecting sanitary sewers from the combined sewer system and reconnecting to the Potomac Yards Trunk Sewer, which was designed to accommodate separated sanitary flow from this area. Field investigations were conducted in the fall of 2011 to collect survey data, confirm sewer connectivity, and to provide sewer separation recommendations and planning level design and construction costs. The City is planning on moving towards design of small-scale sewer separation projections in 2012.

Changes from Prior Year: Funding in the amount of $600,000 is added for FY 2022.

Project History: $600,000 has been added to FY 2021 to address future sewer separation projects.

Operating Impact: No additional operating impact.

Sewer Separation Projects	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	600,000	500,000	120,000	600,000	600,000	600,000
Less Revenues	0	0	0	0	0	0
Net City Share	600,000	500,000	120,000	600,000	600,000	600,000

Sewer Separation Projects	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	600,000	600,000	600,000	600,000	600,000	5,420,000
Less Revenues	0	0	0	0	0	0
Net City Share	600,000	600,000	600,000	600,000	600,000	5,420,000

ASA AWTF Expansion

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 3

Estimated Useful Life of Improvement: 40 years
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Eisenhower Valley

Project Summary: The City's has developed growth forecasts for build-out conditions in the City of Alexandria (post year 2040). Based on these forecasts, the City is projected to need additional wastewater allocation at the Alexandria Sanitation Authority (ASA) Advanced Wastewater Treatment Facility (AWTF) of approximately 4 million gallons per day (mgd) sometime after 2040. ASA has indicated that their facility can be expanded/upgraded to treat this additional 4 MGD at a total capital cost of $35.2 million (adjusted for inflation). This cost is based on hydraulically expanding the plant at the same time as other anticipated upgrades are needed (as existing process equipment reaches the end of its useful life). Thus, although the need for an additional 4 mgd is not anticipated until after 2040, it would be more cost-effective to perform the hydraulic expansion while other upgrades are occurring based on the timeline provided by ASA. It should be noted that the costs provided are for an additional 4 MGD of flow and does not include any additional nutrient (phosphorous and nitrogen) loads associated with these flows. Options for addressing these added nutrient loadings have been identified (including an additional wet weather allocation, improvements in technology, point and nonpoint source offsets, purchase of nutrient credits) and will continue to be evaluated. The City is not expected to reach its nutrient limits until sometime after 2040 (when the existing flow allocation is forecasted to be reached), so the need to address this is not included as part of the ten-year CIP. Finally, with the hydraulic expansion, the agreement between the City and ASA and ASA and Fairfax County would have to be renegotiated.

Another option for an additional 4 mgd identified in the Sanitary Sewer Master Plan is to purchase 4 mgd of wastewater treatment capacity from Fairfax County. The budget cost for this purchase could be the cost to Fairfax County for the construction of 4 MGD capacity at the ASA plant, and is estimated to be approximately $56.0 million (2011 dollars). This option would not require any offset of nutrient loadings since the design flow at the ASA facility will not change, but the City may be expected to finance the entire $56.0 million now, even though this additional capacity is currently not needed. Additionally, this option is contingent on Fairfax County acquiring additional treatment plant capacity at DC Water's Blue Plains Wastewater Treatment facility. The City will be continuing discussions with Fairfax County concerning this option.

Changes from Prior Year: This is a new project for inclusion in the Proposed FY 2013 – 2022 CIP. Project funding/completion is contingent on eventually increasing current Sewer Line Maintenance Fees and Sewer Connection Fees.

Operating Impact: This project will have no impact on the operating budget.

ASA Wastewater Treatement Plant Expansion	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	0	500,000	500,000	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	500,000	500,000	0	0	0

ASA Wastewater Treatement Plant Expansion	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	11,070,000	11,400,000	11,750,000	35,220,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	11,070,000	11,400,000	11,750,000	35,220,000

Wet Weather Management Facility

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department: N/A
Project Category: 3

Estimated Useful Life of Improvement: 40 years
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Eisenhower Valley

Project Summary: During periods of extreme wet weather, stormwater enters the City's sanitary sewer collection system. This has the potential to lead to sewer back-ups in homes and businesses throughout the City. Past sewer back-ups have been recorded and many of them occur in the vicinity of the ASA interceptor sewers, especially the Commonwealth Interceptor. In addition, wet weather flows in the sewer can cause sanitary sewer overflows (SSOs), where raw sewage is discharged to receiving waters before being treated. There are two SSO locations in the City - at the Four Mile Run Pumping Station and at the Alexandria Sanitation Authority wastewater treatment facility. SSOs are not permitted by the State. Due to forecasted growth in the City (and Fairfax County), there is concern that this growth will lead to increased SSOs in the future and create an additional potential for sewer back-ups.

A study was completed in 2010 which recommended a wet weather management facility to mitigate SSOs and basement back-ups for up to the 5-year storm event. The facility also would reduce the occurrence of combined sewer overflows (CSOs) from Outfall 004. The wet weather management facility includes the following components: increasing the flow at the ASA plant from 108 to 116 MGD (through primary treatment), relocation of CSO 004 from Duke Street to the ASA plant, construction of a 500,000 gallon storage tunnel, and a wet weather pumping station to reduce the surcharging in the interceptor sewers to prevent back-ups. The total project cost is estimated to be $63.0 million (adjusted for inflation), and it is anticipated that the costs for this facility would be shared equally between Fairfax County and the City.

Design of the wet weather management facility is planned for FY2014 and construction scheduled to begin in FY2017.

Changes from Prior Year: This is a new project for inclusion in the Proposed FY 2013 – 2022 CIP. Project funding/completion is contingent on eventually increasing current Sewer Line Maintenance Fees and Sewer Connection Fees.

Operating Impact: Annual operating impacts of $654,000 annually are factored into the Sanitary Sewer Fund beginning FY 2019.

Wet Weather Management Facility	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	0	0	3,375,000	1,125,000	0	13,300,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	3,375,000	1,125,000	0	13,300,000

Wet Weather Management Facility	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	13,700,000	0	0	0	0	31,500,000
Less Revenues	0	0	0	0	0	0
Net City Share	13,700,000	0	0	0	0	31,500,000

Sanitary Sewer Master Plan

Subsection: Sanitary Sewers
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 3

Estimated Useful Life of Improvement: N/A
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Citywide

Project Summary: The City of Alexandria is currently developing a comprehensive Sanitary Sewer Master Plan. Projects identified in the master plan include the Alexandria Sanitation Authority (ASA) Advanced Wastewater Treatment Facility (AWTF) Expansion, and the Wet Weather Management Facility. Both of these projects have been included in the Proposed FY 2013-2022 CIP. Projects identified but not included in the FY 2013 CIP are undersized sewers that require upgrading because of projected growth, and an accelerated schedule for Combined Sewer Separation or Storage that may be required by the Virginia Department of Environmental Quality (VDEQ) as part of the City Combined Sewer Overflow (CSO) permit reauthorization.

Changes from Prior Year: No changes from prior year.

Operating Impact: Additional operating impact is unknown at this time.

Sanitary Sewer Master Plan	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	0	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	0

Sanitary Sewer Master Plan	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	10,000	10,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	10,000	10,000

STORMWATER MANAGEMENT FUND

Overview: The Stormwater Management Fund will includes funding from three separate sources and encompasses both capital and operating costs associated with the storm sewer system. In keeping with City Council guidance restricting the use of a Stormwater Utility to supplant existing operating and capital levels of effort, the Fund collects an annual transfer in of $0.95 million from the City's General Fund for operating maintenance and $1.0 million from the Capital Fund for capital maintenance. These funding sources maintain the previous level of effort in these areas (prior to the creation of the Stormwater Management Fund as a part of the FY 2011 budget process) and establish a baseline moving into the future.

Beginning in FY 2013, two projects previously included in the Community Development section of the CIP(Four Mile Run Channel Maintenance and Stream and Channel Maintenance are moved to the Stormwater Management Fund, along with the associated CIP funding. Moving these projects provides an additional $5.21 million dollars in base CIP funding to the Stormwater Management Fund.

Additionally, this Fund will gather revenues from 0.5 cents dedicated from the City's real estate tax rate, estimated at $1.7 million in FY 2013 and growing each year as projected property assessments increase. The revenues from the dedicated tax would be used primarily for capital projects. An average of $2.1 million of annual funding over the ten year period is planned to come from this dedicated portion (0.5 cents) of the real estate tax rate. This will provide a reliable on-going source of funding for maintaining and improving the City's stormwater infrastructure.

Proposed Uses: The FY 2013 - 2022 CIP includes an average of $2.9 million per year for stormwater improvement projects necessary to reduce flooding and the environmental impacts of stormwater pollutants entering streams and rivers. The total ten-year spending for this Fund is projected to be $46.1 million ($29.4 million capital and $16.7 million operating).

Projects scheduled to be initiated in the first few years of the Stormwater will address street, property, and/or basement flooding problems. A description of planned projects can be found on the following pages of the Stormwater Management section. Details of individual projects specifically attached to the new revenue source are currently included under the Miscellaneous Storm Sewers CIP Project.

FY 2013 -2022 PROPOSED CIP: STORMWATER MANAGEMENT SOURCES AND USES

Storwater Management Revenue Sources		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY13-FY 22
Transfer from General Fund (Current Operating)		$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$9,500,000
Transfer from Capital Fund (Base Capital)		2,010,000	1,000,000	1,000,000	1,000,000	2,200,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	15,210,000
Stormwater Management Tax Revenues		1,699,040	1,758,506	1,828,846	1,920,288	2,035,506	2,157,636	2,287,094	2,424,320	2,569,779	2,723,966	21,404,981
Fund Balance Carryovers		0	19,321	4,156	7,811	2,803	2,304	2,604	393	2,778	2,315	
Total Funding Sources		$4,659,040	$3,727,826	$3,783,002	$3,878,100	$5,188,309	$4,709,940	$4,839,699	$4,974,713	$5,122,557	$5,276,280	$46,114,981

Category/Project	*Unallocated (01-12)*	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY13-FY 22
Category 1												
Miscellaneous Storm Sewer Projects	*$3,314,113*	$0	$525,000	$775,000	$535,000	$825,000	$925,000	$285,000	$395,000	$670,000	$300,000	$5,235,000
Storm & Combined Assessment	*450,000*	0	0	380,000	900,000	900,000	900,000	900,000	900,000	0	0	$4,880,000
Stream & Channel Maintenance	*170,750*	1,198,000	1,198,000	0	0	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	$9,596,000
Subtotal Category 1	*3,934,863*	1,198,000	1,723,000	1,155,000	1,435,000	2,925,000	3,025,000	2,385,000	2,495,000	1,870,000	1,500,000	19,711,000
Category 2												
Taylor's Run at Janney's Lane	*551,250*	0	0	0	0	0	0	0	0	0	0	0
NPDES / MS4 Permit	*134,000*	0	0	0	0	0	0	0	0	0	0	0
Four Mile Run Channel Maintenance	*600,000*	1,010,000	0	0	0	600,000	0	0	0	0	0	1,610,000
Ft. Ward Stormwater	*85,000*	500,000	0	0	0	0	0	0	0	0	0	500,000
Storm Sewer Capacity Analysis	*1,088,500*	350,000	400,000	0	0	0	0	0	0	0	0	750,000
Key Drive Flood Mitigation	*0*	0	0	1,000,000	800,000	0	0	0	0	0	0	1,800,000
Braddock Rd. & West St. Storm Sewer	*0*	0	0	0	0	0	0	750,000	750,000	1,500,000	2,000,000	5,000,000
Subtotal Category 2	*$2,458,750*	$1,860,000	$400,000	$1,000,000	$800,000	$600,000	$0	$750,000	$750,000	$1,500,000	$2,000,000	$9,660,000
Subtotal Capital Expenditures	*$6,393,613*	$3,058,000	$2,123,000	$2,155,000	$2,235,000	$3,525,000	$3,025,000	$3,135,000	$3,245,000	$3,370,000	$3,500,000	$29,371,000
Operating Expenditures												
Current Operating Support (From General Fund)		$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$9,500,000
Expanded Operating Support (Through Dedicated Tax)		631,719	650,671	670,191	690,296	711,005	732,335	754,306	776,935	800,243	824,250	7,241,950
Total Operating Expenditures		$1,581,719	$1,600,671	$1,620,191	$1,640,296	$1,661,005	$1,682,335	$1,704,306	$1,726,935	$1,750,243	$1,774,250	$16,741,950
Total Stormwater Management Expenditures		$4,639,719	$3,723,671	$3,775,191	$3,875,296	$5,186,005	$4,707,335	$4,839,306	$4,971,935	$5,120,243	$5,274,250	$46,112,950

Taylor Run at Janney's Lane

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: 25 years
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: Taylor Run Parkway at Janney's Lane

Project Summary: This project provides for the rehabilitation of a deteriorating culvert at Taylor Run and Janney's Lane and other improvements to the existing storm sewer in the area. A total of $551,250 in prior year unallocated funds will fund the construction.

Changes from Prior Year: No changes from prior year.

Project History: Project is currently in the design phase, with construction schedule to be determined.

Operating Impact: No additional operating impact.

Taylor Run at Janney's Lane	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	551,250	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	551,250	0	0	0	0	0

Taylor Run at Janney's Lane	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	0

NPDES / Municipal Separate Storm Sewer System (MS4) Permit Program

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: 5 years
Priority: Essential
Strategic Plan Goal: 2 - Health & Environment
Location: Citywide

Project Summary: This project provides for the data collection, reporting activities, public education, outreach, involvement and citizen participation associated with implementation of any program changes of the programs required by the National Pollution Discharge Elimination System (NPDES) Permit. A total of $134,000 in prior year unallocated monies remains for this purpose.

Changes from Prior Year: No changes from prior year.

Project History: The Federal Water Quality Act of 1987 required that small municipalities obtain storm water discharge permits for their municipal separate storm sewer system (MS4) under Phase II of the National Storm Water Program. The City submitted an application for a MS4 permit to the Virginia Department of Environmental Quality (VDEQ) and received its first permit effective July 8, 2003. The permit required that the City develop, implement, and enforce a storm water management program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable (MEP), protect the water quality and satisfy the appropriate water quality requirements of the Clean Water Act. The permit required the City to develop and implement the Stormwater Management program The City was issued the new MS4 permit effective July 9, 2008 and subsequently has successfully negotiated a Program Plan with the Virginia DCR. The permit has extensive regulatory requirements that require more intensive monitoring and sampling. The MS4 Permit has numerous requirements including an illicit discharge detection and elimination program and associated concept designs; preliminary concept designs of structural and non-structural floatable controls; and best management practices. It includes requirements related to TMDL (Total Maximum Daily Loads) requirements related to PCB s for Potomac River and Bacteria for the Four Mile Run watershed.

The City is now facing decisions on complying with an additional TMDL for Bacteria in Hunting Creek. The Virginia Watershed Implementation Plan, which implements the standards set by the Chesapeake Bay Nutrient and Sediment TMDL (approved in January of 2011 setting measurable effluent limits and outlines penalties for non-compliance), delineates mechanisms to achieve compliance. Implementation will largely be through actions/programs incorporated into the MS4 permit. These new effluent limits are exceedingly stringent and would require an effort termed E3 ("everything, everywhere, by everybody") to achieve compliance. While the City's next permit is reappraised in July of 2013, the City must have practices in place to meet 60% of the load reductions required by 2017. Additionally TMDL's are currently being developed for various other pollutants by USEPA and VA Department of Environmental Quality for the receiving waters. Four Mile Run has recently been declared impaired for Chlordane and a TMDL will be forthcoming. The Chesapeake Bay TMDL requires more explicit reduction allocations resulting in new requirements ranging from additional monitoring and evaluation to improvements in infrastructure that may require significant capital expenditures. Allocated funding in this project is not the total cost of compliance, which staff anticipates will be much higher depending on the permit requirements of future MS4 permits.

Operating Impact: Additional operating impact is unknown at this time and depends on requirements of future MS4 permits.

NPDES / NS4 Permit	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	134,000	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	134,000	0	0	0	0	0

NPDES / NS4 Permit	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	0

Four Mile Run Channel Maintenance

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: N/A
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: Four Mile Run

Project Summary: This project reflects the City's share of the Four Mile Run Channel Maintenance agreement with Arlington County as required by the U.S. Army Corp of Engineers. The U.S. Army Corps of Engineers annually inspects Four Mile Run and dictates the extent of the channel maintenance activities that are to be completed. The latest inspection by USACE (2009) identified a number of deficiencies, and gave the overall levee system an unacceptable rating. The City hired a consultant to perform a detailed inspection of the flood control system, and to develop recommendations for corrections. Staff is working with the Corps to determine exactly what improvements the City needs to do to bring the rating up to acceptable. Total City funding for the current phase of the project is $1.61 million, with $0.6 million in unallocated balance from prior years and $1.01 million planned in FY 2013. City funding for the project will be combined with funds (not shown in the budget) from Arlington County for the sediment removal portion of the project totaling $2.8 million ($1.4 million City of Alexandria / $1.4 million Arlington County).

Additional projects funded with City dollars (not shared with Arlington County) that are required to obtain levee certification on the Alexandria side of Four Mile Run include clearing non-woody brush ($10,000); clearing woody brush and trees ($50,000); and levee repairs including rip rap, geotextile, concrete outlet repairs, and floodwall joint repair ($150,000). An additional $600,000 is planned in FY 2017 for future channel maintenance costs. Improvements to the channel beyond routine maintenance are funded by the Four Mile Run Stream restoration project (part of the Community Development section of the CIP).

Changes from Prior Year: This project was moved from the Community Development section of the CIP to the Stormwater Management section. No changes in total funding, funding sources or project timeline.

Project History: The valley of Four Mile Run is a historically high flood risk area, and experienced considerable damage during Hurricane Agnes in 1972. The U.S. Army Corps of Engineers (USACE), in cooperation with the City, and Arlington County completed a flood control project in the early 1980's. This project consists of a trapezoidal, gabion lined channel, along with limited stretches of levees and floodwalls. Local governments have the responsibility for maintaining these systems, and are subject to annual inspection by USACE. In FY 2006, maintenance activities were conducted in Four Mile Run primarily involving the removal of sediment near bridges and vegetation within the floodway. The work was completed in partnership with Arlington County and the cost was split 50/50 between the City and the County.

Operating Impact: No additional operating impact.

Four Mile Run Channel Maintenance	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	600,000	1,010,000	0	0	0	600,000
Less Revenues	0	0	0	0	0	0
Net City Share	600,000	1,010,000	0	0	0	600,000

Four Mile Run Channel Maintenance	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	1,610,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	1,610,000

Ft. Ward Stormwater

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): Office of Historic Alexandria/RPCA
Project Category: 2

Estimated Useful Life of Improvement: 25 years
Priority: Highly Desirable
Strategic Plan Goal: 2 - Health & Environment
Location: Ft. Ward

Project Summary: Fort Ward Park is the best preserved of the system of Union forts and batteries built to protect Washington, DC during the American Civil War (1861-1865). This site receives drainage from the adjacent Marlboro Estates subdivision built in the late 1970's, Episcopal High School property and from the Braddock Road area. Over time, due to changes in grading and overland drainage patterns, erosion has occurred in the park and in the adjacent Oakland Baptist Church cemetery. Additionally, the stream in the park is showing signs of erosion and degradation. Property owners at the bottom of the park are experiencing flooding. The proposed project will include overland flow improvements, erosion protection, stream restoration and flood prevention.

In FY 2012, $85,000 was budgeted to develop a stormwater and drainage master plan, along with associated drainage improvements. The first phase of the master plan is scheduled to be completed in calendar year 2012, and includes the area between the Park Loop Road and Marlboro Estates. FY 2013 funding in the amount of $500,000 is planned for improvements identified in the stormwater and drainage master plan.

Changes from Prior Year: FY 2013 funding ($500,000) was included as part of the Miscellaneous Storm Sewer projects in the Approved FY 2012 – 2021. Funding was moved to this stand-alone project for the Proposed FY 2012 – 2021 CIP.

Project History: In calendar year 2011, an interim drainage system was installed to protect the Oakland Baptist Church Cemetery from further soil erosion and flooding due to overland flow and erosion.

Operating Impact: No additional operating impact.

Ft. Ward Stormwater	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	85,000	500,000	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	85,000	500,000	0	0	0	0

Ft. Ward Stormwater	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	500,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	500,000

Storm Sewer Capacity Analysis & Modeling

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: N/A
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: Citywide

Project Summary: This project provides for a multi-year City-wide storm sewer analysis and flow modeling to determine the storm water system's capacity. Flow modeling, field verification of invert elevations and manhole locations and metering to verify computations will be part of this project, which will be completed over a four year timeframe.

A total of $2.55 million has been allocated to date. An unallocated balance of $1.09 million will be combined with planned funding in FY 2013-2014 of $0.75 million for total project funding of $4.39 million. Work will be coordinated with the-Storm / Combined Sewer Assessment and Renovation project.

Changes from Prior Year: Funding in the amount of $350,000 in FY 2013 and $400,000 in FY 2014 was added to provide for additional capacity analysis and modeling projects.

Project History: This study is budgeted as a response to several large magnitude storms in 2003 and 2006 that caused flooding in low-lying areas of the City. Staff continues to study the system's capacity to develop a comprehensive plan for improvements to the existing storm sewer system.

Operating Impact: No additional operating impact.

Storm Sewer Capacity Analysis	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	1,088,500	350,000	400,000	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	1,088,500	350,000	400,000	0	0	0

Storm Sewer Capacity Analysis	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	750,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	750,000

Stream / Channel Maintenance and Restoration

Subsection: Stormwater Management.
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 1

Estimated Useful Life of Improvement: Varies
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Citywide

Project Summary: This subtask includes an annual capital maintenance budget for routine maintenance of various streams and channels throughout the City to preserve their capacity to carry a 100-year floodwater, and for repairs to erosion damage, stream corridor degradation, grade control structures, storm sewer discharge points, and stream stabilization/restoration.

Changes from Prior Year: This project was moved from the Community Development section of the CIP to the Stormwater Management section. Funding in the amount of $1.198 million in FY 2013 and FY 2014 was added from Stormwater Management funds to provide funding for sediment removal in Holmes Run and Backlick Run caused by flooding events in September 2011 by Tropical Storm Lee.

Beginning in FY 2017, $0.6 million in base CIP funding is combined with $0.6 million in Stormwater Management funding to provide an annual funding stream of $1.2 million for stream restoration and sediment removal in Backlick Run, Holmes Run, Lucky Run and Taylor Run, as well as other yet to be identified projects. Some portion of funds may be reimbursed from FEMA and/or insurance for those items damaged by flooding events.

Project History: Stream maintenance activities occurred in FY 2002 in Cameron Run and in FY 2003 and 2004 in Holmes Run. More recently, additional maintenance was performed in early FY 2007 in Cameron Run and Backlick Run as a result of the flooding that occurred in June/July of 2006. Work completed in FY 2011 and FY 2012 included removing large sandbars obstructing flow from the Cameron Run Stream Channel immediately upstream from Cameron Run Beltway crossing near Bluestone Road; in Holmes Run near Pendleton Street, and immediately upstream of the Cameron Run Beltway crossing. Weedy vegetation was removed along the banks of Cameron Run and Holmes Run.

Operating Impact: No additional operating impact.

Stream & Channel Maintenance and Restoration	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	170,750	1,198,000	1,198,000	0	0	1,200,000
Less Revenues	0	0	0	0	0	0
Net City Share	170,750	1,198,000	1,198,000	0	0	1,200,000

Stream & Channel Maintenance and Restoration	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	9,596,000
Less Revenues	0	0	0	0	0	0
Net City Share	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	9,596,000

Miscellaneous Extension and Replacement of Storm Sewers

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 1

Estimated Useful Life of Improvement: 25 years
Priority: Essential
Strategic Plan Goal: 2 – Health & Environment
Location: Citywide

Project Summary: This project provides funding for essential infrastructure maintenance on the City's storm sewer system. Total funding of $5.235 million in Stormwater Management dedicated tax revenue is planned over ten years.

These projects are identified as reconstruction projects due to deterioration or needed additional capacity to reduce flooding. Including current allocated and unallocated balances of approximately $3.7 million, and proposed FY 2014 funding of $0.5 million, a total of $4.2 million will be available for these projects from through FY 2014. Current estimated costs exceed available funding for that time period. Once project costs are fully developed, projects may accelerated or delayed based on available funding. A summary of the individual projects prioritized under this project category is provided in the table below.

Project	Description	Estimated Costs
Monroe / Nelson Alley Improvements	Alley re-grading and storm sewer improvements to alleviate flooding on adjacent properties in the vicinity of Alexandria and Wayne Streets.	$85,000
Bishop Ln. Drainage Improvements	Installation of storm sewer improvements to alleviate ponding and drainage onto adjacent properties from the public right-of-way.	$100,000
Bruce St. Repetitive Loss Analysis	Conduct a study of the causes of flooding in the Bruce Street area and identify of possible mitigation measures.	$100,000
Hooff's Run Park Drainage Improvements	Improvements to drainage in the park to eliminate flooding onto adjacent properties.	$200,000
W. Alexandria Ave. at Timber Branch	Drainage improvements along West Alexandria Ave. An existing culvert and existing inlet currently experience flooding in large storm events. The capacity of both will be analyzed and necessary improvements constructed.	$60,000
N. Henry St. / Montgomery St.	Drainage improvements and sanitary sewer separation along N. Henry and Montgomery Streets.	$90,000
N. Rosser St. / Calhoun Ave. / Colfax Ave. / Dawes Ave. Drainage System	Storm sewer evaluation and possible improvements including extension of existing storm sewers in roadside ditches to alleviate nuisance flooding and ponding water. Design is scheduled for FY 2012, construction in FY 2013.	$975,000
N. Frazier Ave. / N. Frost Ave. / Lawrence Ave. Drainage System	Storm improvements along North Frazier, North Frost, and Lawrence Avenue. The existing drainage ditch has limited capacity and frequent ponding occurs. Design is scheduled for FY 2012, construction in FY 2013.	$975,000
Pegram / Paxton	This area was identified during the flood of June 2006 as a problem area. This is the next shed to be investigated by the Storm Sewer Capacity Analysis Project. Design is scheduled for FY 2012, construction in FY 2013.	$600,000
DASH Facility Stormwater Outfall	This project includes storm sewer design and construction of a new storm sewer outfall through CSX railroad property which will provide an adequate outfall to the DASH facility to eliminate frequent flooding. Design and permitting are scheduled for FY 2012, construction in FY 2013.	$1,100,000
Timber Branch Stream Erosion	Stream bank stabilization to protect the street and sewer line near Oakland Terrace from stream erosion damage.	$50,000
Total		$4,335,000

Changes from Prior Year: Projects costs and timing were adjusted based on estimated construction schedules.

(Miscellaneous Extension and Replacement of Storm Sewers)

Project History: Recently completed projects include East Maple Street Storm Sewer reconstruction, replacement of the Edsall Road storm sewer near Cameron Station; and George Mason School and Park drainage system. Other completed projects include replacement of the Edsall Road storm sewer near Cameron Station; George Mason school and park drainage system; 800 block of St. Asaph St; Templeton Place ponding; Commonwealth Avenue and Glebe Road (Auburn Village Phase 1); Dash facility(Phase 1); 600 block of S. Pickett Street; and the City Wide Digital Flood Insurance Rate Maps have been updated. Projects under construction in FY 2012 include Hoof's Run culvert repair between E. Maple and E. Walnut Streets, Bishop Lane; Hooff's Run Park; W. Alexandria Avenue at Timber Branch; and Monroe / Nelson Alley.

Operating Impact: No additional operating impact.

Miscellaneous Stormwater	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	3,314,113	0	525,000	775,000	535,000	825,000
Less Revenues	0	0	0	0	0	0
Net City Share	3,314,113	0	525,000	775,000	535,000	825,000

Miscellaneous Stormwater	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	925,000	285,000	395,000	670,000	300,000	5,235,000
Less Revenues	0	0	0	0	0	0
Net City Share	925,000	285,000	395,000	670,000	300,000	5,235,000

Storm/Combined Sewer Assessment and Remediation

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 1

Estimated Useful Life of Improvement: 40 years
Priority: Essential
Strategic Plan Goal: 2 – Health & Education
Location: Citywide

Project Summary: This project provides for the City-wide condition assessment of the existing 14 miles of combined sewers and 185 miles of storm sewers. The City will perform condition assessments including cleaning and televising of the lines; assessing information to determine condition of lines; and determining if rehabilitation is needed. Field work will be performed by dividing the City into sewer sheds and proceeding through each section sequentially. Structurally deficient sewers will be identified and the results of the field work will be evaluated to develop remediation projects, which are expected to include the relining of sewers and manhole repairs. Work will be coordinated with the Storm Sewer Capacity Analysis & Modeling project. Evaluation and design are approximately 30% of the annual costs, while construction comprises the remaining 70% of annual funding.

Changes from Prior Year: Funding is reduced from $8.55 million in the Approved FY 2012 – 2021 CIP to $4.88 million in the Proposed FY 2013 – 2022 CIP due to available resources within the Stormwater Management Fund.

Operating Impact: No additional operating impact.

Storm and Combined Syst. Assess. & Remed.	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	450,000	0	0	380,000	900,000	900,000
Less Revenues	0	0	0	0	0	0
Net City Share	450,000	0	0	380,000	900,000	900,000

Storm and Combined Syst. Assess. & Remed.	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	900,000	900,000	900,000	0	0	4,880,000
Less Revenues	0	0	0	0	0	0
Net City Share	900,000	900,000	900,000	0	0	4,880,000

Key Drive Flood Mitigation

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: 25 years
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: Key Drive

Project Summary: This project provides for the design and construction of a storm sewer bypass to alleviate drainage problems on Key Drive and Francis Hammond Parkway and to prevent flooding in residential areas with lower elevations.

Changes from Prior Year: No changes from prior year.

Project History: $1.0 million has been allocated to date for this project, and design is currently underway.

Operating Impact: No additional operating impact.

Key Drive Flood Mitigation	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	0	0	0	1,000,000	800,000	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	1,000,000	800,000	0

Key Drive Flood Mitigation	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2013-FY2022
Expenditures	0	0	0	0	0	1,800,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	1,800,000

Braddock Rd. and West St. Storm Sewer Drainage Improvements

Subsection: Stormwater Management
Managing Department: T & ES
Supporting Department(s): N/A
Project Category: 2

Estimated Useful Life of Improvement: 40 years
Priority: Highly Desirable
Strategic Plan Goal: 2 – Health & Environment
Location: Braddock Metro Area

Project Summary: This project addresses flooding at the intersection of Braddock Road and West Street, adjacent to the Braddock Road Metro Station. The adjacent properties and streets drain to the intersection, which is a low point (sump condition). Stormwater is collected at the low points and conveyed beneath the rail corridor to the Hooff's Run storm culvert adjacent to Commonwealth Avenue. The conveyance system is inadequate to convey the stormwater in a timely fashion, resulting in flooding of the intersection. The City hired a consultant to investigate various alternatives to alleviate the problem. A cost benefit analysis of the project will be prepared to determine the most feasible solution to this flooding problem. A total of $5.0 million has been programmed in the FY 2013 – 2022 CIP.

Changes from Prior Year: Funding has been delayed until FY 2019 as City staff continues to explore less costly alternatives to alleviate the flooding issues.

Project History: Based on a drainage study completed in FY 2004, the storm sewers at the intersection of Braddock Road and West Street were found to be inadequate to relieve the frequent flooding of this critical rail crossing. A feasibility study was completed in fall 2008 with engineering alternatives ranging from $18.0 million to $64.0 million. Several alternatives will be further evaluated during the preliminary design to address constructability issues and further refine construction costs, as well as to undertake a thorough cost-benefit analysis. Alternatives would include incoroporation of a full/partial solution into a Braddock Road Metrorail site redevelopment plan. The total cost reflects the feasibility study's cost estimates to collect and convey the storm water to the Potomac River by means of a large (approximately five foot diameter) storm sewer pipe down Wythe Street through Oronoco Park.

Operating Impact: No additional operating impact.

Braddock and West	Unallocated Balance	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Expenditures	0	0	0	0	0	0
Less Revenues	0	0	0	0	0	0
Net City Share	0	0	0	0	0	0

Braddock and West	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total FY2012-FY2021
Expenditures	0	750,000	750,000	1,500,000	2,000,000	5,000,000
Less Revenues	0	0	0	0	0	0
Net City Share	0	750,000	750,000	1,500,000	2,000,000	5,000,000

Appendix 9-1

Sec. 5-6-25.1 - Sewer connection permits and service fees; construction costs; constructing sewers by owners rather than city; additional connections.

(a) Any person who is required, or who desires, to provide a connection for sewer service from his property, through any sewer constructed by or belonging to the city or any sewer serving the area annexed to the city in 1952, but belonging to a county, by direct connection at a city sewer main, trunk or lateral, shall, before starting to make such connection, apply to the director for a permit to make the connection, and the director shall issue a permit for the sewer connection when and after the person shall have paid to the department of finance the sum hereinafter provided.

(1) For each single family dwelling, townhouse dwelling, or townhouse type dwelling irrespective of classification for other purposes, or for each dwelling unit in a two-family dwelling, the amount of $7,432.

(2) For each multifamily dwelling, an amount equal to the product of the number of dwelling units in the multifamily dwelling, multiplied by $3,716.

(3) For each nonresidential property, an amount determined in accordance with the following fee schedule based on the size of each water meter which serves such nonresidential property:

Meter Size (inches)	Max. Capacity (GPM)	¾" Meter Equiv.	Fee
¾ or smaller	30	1.00	$7,432
1	50	1.67	$12,411
1½	100	3.33	$24,749
2	160	5.33	$39,613
3	320	10.76	$79,968
4	500	16.67	$123,891
6	1000	33.33	$247,709
8	1600	53.33	$396,349
10	2300	76.67	$569,811

(4) For each mixed use property, where such property includes both residential and nonresidential uses, an amount equal to the sum of the fee determined for the residential portion of such property, in accordance with this section, plus the fee determined for the nonresidential portion of such property, in accordance with this section; provided, however, if the residential portion and nonresidential portion of such property are served by a single water meter, the fee shall be an amount determined by the director in his reasonable discretion.

(5) The chart set forth in section (3) above reflects the fees for fiscal year 2009. Those fees were adjusted upward at the rate of inflation as determined by the annual CPI-U for the Washington-Baltimore-Northern Virginia, DC-MD-VA-WVA Combined Statistical Area on July 1 of each of fiscal years 2010 and 2011. For fiscal year 2012 and going forward, the foregoing fees

shall increase each year at the rate of inflation as determined by the annual CPI-U for the Washington-Baltimore-Northern Virginia, DC-MD-VA-WVA Combined Statistical Area. The fees applicable to each fiscal year after FY 2011 are subject to annual review by city council.

(b) Extension of service; credits.

(1) A person required or desiring to provide extension of sewer service to his property shall construct or have constructed such extension at his own expense. The person shall execute a satisfactory agreement with the city, as prescribed by the city manager, agreeing to construct such sewer or sewers in accordance with plans and specifications approved by the director and the person shall in addition furnish such guarantee of performance and maintenance to the city as the city manager may require. Such sewers shall become the property of the city upon completion and acceptance of the work.

(2) If, pursuant to a written requirement of the director, the person constructs such extension in a manner that exceeds the requirements to provide service to the property of such person, a credit shall be available to be applied to the fees otherwise due under this section, in an amount equal to the difference between the cost of such extension, constructed in accordance with the written requirement of the director, and the cost of such extension, constructed as originally proposed by the person, such amount to be determined by the director. The amount of the credit shall be estimated by the director prior to commencement of construction, and an interim fee shall be paid by the person in an amount equal to the fees otherwise due under this section minus the estimated credit; provided, the minimum interim fee shall be for each single family dwelling, townhouse dwelling or dwelling unit in a two-family dwelling residential unit, $100, for each dwelling unit in a multifamily dwelling, $100, and for each floor of a nonresidential property, $100 or $0.08 per square foot of floor space, whichever is greater.

(3) Upon satisfactory completion of the work, the actual amount of the credit shall be determined by the director based on certified bills submitted to and approved by him. The final fee to the person shall be an amount equal to the fees otherwise due under this section minus the amount of the actual credit; provided, the minimum final fee shall be for each single family dwelling, townhouse dwelling or dwelling unit in a two-family dwelling residential unit, $100, for each dwelling unit in a multifamily dwelling, $100, and for each floor of a nonresidential property, $100 or $0.08 per square foot of floor space, whichever is greater. Any difference between the interim fee and the final fee shall immediately be paid to or refunded by the department of finance.

(4) If the amount of the credit estimated under subsection (b)(2) above exceeds the amount of the fees otherwise due under this section without regard to the minimum fee calculated under subsection (b)(2) of this section, prior to the commencement of construction, the city shall agree to pay the person an amount equal to such excess or shall withdraw the written requirement of the director for construction of such extension in a manner that exceeds the requirements to provide service to the property of such person.

(c) Exclusions and exemptions.

(1) Notwithstanding anything to the contrary contained in this section, no fee shall be charged to connect a sewer system or sewage disposal system which serves exclusively a fire sprinkler system, installed pursuant to section 906.0 of the Virginia Uniform Statewide Building Code, as amended, a fire standpipe system, installed pursuant to section 915.0 of the Virginia Uniform Statewide Building Code, as amended, or a yard hydrant, installed pursuant to section 917.0 of the Virginia Uniform Statewide Building Code, as amended.

(2) Notwithstanding anything to the contrary contained in this section, no fee shall be charged to

connect a sewer system or sewage disposal system which serves property owned by the Alexandria City Public Schools, the Alexandria Redevelopment and Housing Authority, or an entity in which the Alexandria Redevelopment and Housing Authority holds an ownership interest and the purpose of such entity is to develop property using federal low income tax housing credits.

(3) The fees established and imposed by this section shall not apply to a connection where (i) such connection is within the limits of a coordinated development district approved by city council, (ii) the main or trunk line to which such connection will be made extends from such coordinated development district directly to the publicly owned treatment works of the Alexandria Sanitation Authority, without connection at the time of its construction to any city sewer, unless such a connection is made pursuant to a written requirement of the director and exceeds the requirements to provide service to the coordinated development district, (iii) such main or trunk line was constructed totally at private expense, and (iv) the application for such connection is submitted within 22 years of the date of issuance of the first building permit subsequent to April 1, 2002, within such coordinated development district. Upon satisfaction of the foregoing criteria, a permit for the sewer connection shall be issued upon payment of a fee for each single family dwelling, townhouse dwelling or dwelling unit in a two-family dwelling residential unit, of $100, for each dwelling unit in a multifamily dwelling, of $100, and for each floor of a nonresidential property, of $100 or $0.08 per square foot of floor space, whichever is greater; provided, however, in the event construction of the improvements to be served by such permitted connection has not substantially commenced within 23 years of the date of issuance of the first building permit subsequent to April 1, 2002, within such coordinated development district, the permit for the sewer connection issued shall expire and thereafter the fees established and imposed generally by this section shall apply.

(d) If the city manager finds that construction of an extension by a person would constitute a hardship on such person, by reason of his inability to secure a satisfactory contract, or otherwise, the city manager may direct that the construction be done by or for the city; provided, however, that the cost to the city shall not exceed the fees paid by such person less for each single family dwelling, townhouse dwelling or dwelling unit in a two-family dwelling residential unit, $100, for each dwelling unit in a multifamily dwelling, $100, and for each floor of a nonresidential property, $100 or $0.08 per square foot of floor space, whichever is greater. Costs in excess of such fees shall be paid by the person prior to making any connection to such sewer.

(e) The total sum to be paid to the department of finance for sewer service at the city sewer main, trunk or lateral for any property in the city, the sewage of which will be transported from such property through sewers constructed previously by private parties into sewers constructed or belonging to the city, except for such sewers as may have been constructed by private parties under the control or supervision of the city or other public authority, shall be as provided generally in this section for each such property so connected.

(f) Any person desiring additional sewer service connection to any property shall make application to the director for permission to construct such connection and shall pay to the department of finance the sum as provided generally in this section for each additional connection prior to the issuance of the permit for the sewer connection.

(g) Nothing in this chapter shall be construed to prevent the city sanitation authority from making a service charge for collecting and treating sewage. (Ord. No. 4257, 6/15/02, Sec. 1; Ord. No. 4394, 5/2/05, Sec. 1; Ord. No. 4536, 5/5/08, Sec. 1; Ord. No. 4682, 10/16/10, Sec. 1; Ord. No. 4730, 6/25/11, Sec. 1)

Editor's note— It should be noted that § 2 of Ord. No. 4257 provides, "That the provisions of section 5-6-25.1 shall become effective on July 1, 2002, and shall apply to all applications for permits for sewer connections which may be filed after such date; provided, however, that: (a) With respect to any property for which a preliminary site plan was filed with the city and determined by the Director of Planning and Zoning to be complete prior to April 1, 2002, the applicable fee shall be determined in accordance with section 5-6-25, with the exception of any credit, which shall be determined not in accordance with subsection (e) of section 5-6-25, but in accordance with subsection (b) of section 5-6-25.1; provided, however, in the event construction of the improvements to be served by such permitted connection has not substantially commenced prior to April 1, 2004, the permit for the sewer connection issued shall expire and thereafter the fees established and imposed by section 5-6-25.1 shall apply, without any adjustment.

(b) With respect to any property for which a preliminary site plan is filed and determined by the Director of Planning and Zoning to be complete from April 1, 2002, until September 30, 2002, the fee shall be the product of the fee determined in accordance with section 5-6-25.1, multiplied by fifty percent (50%); provided, however, in the event construction of the improvements to be served by such permitted connection has not substantially commenced prior to April 1, 2004, the permit for the sewer connection issued shall expire and thereafter the fees established and imposed by section 5-6-25.1 shall apply, without any adjustment.

(c) With respect to any property for which a preliminary site plan is filed or determined by the Director of Planning and Zoning to be complete from and after October 1, 2002, the fee shall be as provided in section 5-6-25.1, without any adjustment." See the Code Comparative Table.

It should be noted that § 2 of Ord. No. 4536 provides that "this ordinance shall become effective on the date and at the time of final passage, and shall apply to all applications for permits for sewer connections which may be filed after such effective date; provided, however, that with respect to any property for which the first final site plan was filed with the city on or before April 1, 2008, the applicable fee shall be determined in accordance with Section 5-6-25.1 prior to amendment."


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