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<th>Description</th>
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<tbody>
<tr>
<td>AMR</td>
<td>automated meter reading</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
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<tr>
<td>CIP</td>
<td>Capital Improvement Program</td>
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<tr>
<td>Cu</td>
<td>copper</td>
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<tr>
<td>DBPs</td>
<td>disinfection byproducts</td>
</tr>
<tr>
<td>D/DBPR</td>
<td>Disinfectants and Disinfection Byproducts Rule</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>fps</td>
<td>feet per second</td>
</tr>
<tr>
<td>FY</td>
<td>fiscal year</td>
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<tr>
<td>GIS</td>
<td>Geographical Information Systems</td>
</tr>
<tr>
<td>gpd</td>
<td>gallons per day</td>
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<tr>
<td>HAAs</td>
<td>haloacetic acids</td>
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<tr>
<td>HPC</td>
<td>heterotrophic plate count</td>
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<tr>
<td>IDSE</td>
<td>Initial Distribution System Evaluation</td>
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<tr>
<td>ISO</td>
<td>Insurance Services Office</td>
</tr>
<tr>
<td>LCR</td>
<td>Lead and Copper Rule</td>
</tr>
<tr>
<td>LRAA</td>
<td>location-specific running annual average</td>
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<tr>
<td>MG</td>
<td>million gallons</td>
</tr>
<tr>
<td>mgd</td>
<td>million gallons per day</td>
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<tr>
<td>MCL</td>
<td>maximum contaminant level</td>
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<tr>
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<td>maximum contaminant level goals</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligrams per liter</td>
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<tr>
<td>MWCOG</td>
<td>Metropolitan Washington Council of Governments</td>
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<tr>
<td>Pb</td>
<td>lead</td>
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<tr>
<td>PRV</td>
<td>pressure reducing valve</td>
</tr>
<tr>
<td>psi</td>
<td>pounds per square inch</td>
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<tr>
<td>PSV</td>
<td>pressure sustaining valve</td>
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<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
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<tr>
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<td>Total Coliform Rule</td>
</tr>
<tr>
<td>TTHMs</td>
<td>trihalomethanes</td>
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<tr>
<td>VDH</td>
<td>Virginia Department of Health</td>
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<td>WA</td>
<td>U.S. Army Corps of Engineers, Washington Aqueduct Division</td>
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<tr>
<td>WR&amp;A</td>
<td>Whitman, Requardt &amp; Associates</td>
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<td>Arlington County Department of Environmental Services</td>
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<tr>
<td></td>
<td>Water, Sewer, Streets Bureau</td>
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<td>WTP</td>
<td>Water Treatment Plant</td>
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Executive Summary

Plan Overview
This Water Distribution System Master Plan sets forth the policy and infrastructure improvements necessary to meet anticipated growth and development and to otherwise provide adequate water supply in Arlington County. This report presents an update to the 1992 Water System Master Plan which has served as an asset management tool for the County in planning, scheduling, budgeting, and designing water system improvements as demands increase. The master plan was developed based primarily on hydraulic evaluations conducted on a computer model of the water system. The ability of the existing system to meet current and projected demands through buildout in 2040 was evaluated. While the plan projects land development for a 27-year period, it should not be used to guide County policy throughout that duration. Because unforeseen changes in community values, fiscal condition, technology, government standards, and other conditions affecting projected growth may occur, it is recommended that this water system master plan be reviewed and updated periodically to ensure that the system improvements and associated funding are being cost-effectively spent in pace with growth and development patterns.

Summary
Since its foundation in 1927, the Arlington County water system has provided a safe and reliable supply of drinking water to its customers. Regular testing and analysis of the water at its treatment source and at selected residential and commercial collection sites indicate that the water meets all federal and state quality requirements. In 2014, the first water mains constructed by the County will be reaching the age of 87 years. As the water system ages, this plan sets forth a recommended level of investment and policy guidance to maintain and improve the overall condition of this valuable asset to Arlington County. In addition, the plan sets forth recommendations that will accommodate planned growth of the County and allow for continued supply of safe and reliable drinking water.

The U. S. Army Corps of Engineers’ Dalecarlia water treatment plant, which supplies Arlington water, has adequate capacity to supply Arlington County’s present and projected future water demands. Since the 1992 master plan, population increases from development have not increased water demands for the County as a whole. It is believed that the demands have been relatively flat because of the widespread use of water-saving plumbing fixtures which have resulted in a reduction in per capita water consumption.

The Arlington County Department of Environmental Services’ Water, Sewers, and Streets Bureau (WSS) delivers water to system customers through a network of storage, pumping, and water main facilities that were constructed primarily in the 1940s and 1950s. The WSS staff monitor the system to maintain desirable water pressures; respond to emergencies such as water main breaks; undertake routine programs for water meter rehabilitation and replacement; exercise and repair valves; replace and rehabilitate mains; inspect and maintain fire hydrants, pump stations and, storage tanks; and facilitate the connection of new developments to the County water system.

Policies for the operation and extension of the Arlington water distribution system are documented in this plan, several of which are based upon water works industry standards. The evaluation of the County’s water distribution system is based upon the experience of County staff, analysis of maintenance management data, and consultant evaluations by Whitman, Requardt & Associates.

The County’s elevated storage tank and ground storage tanks are currently in good operating condition, but are in need of an ongoing inspection and improvement program to maintain their condition and continue to conform to federal and state safety regulations. The six pump stations are in good condition with one under
refurbishment and another planned for upgrade. Condition evaluations of the approximately 525 miles of County-maintained water mains are based on currently available data on age, pipe material, and history of water main breaks.

The adequacy of the existing water distribution system to satisfy current and projected average day, maximum day and peak hour water demands was evaluated. For existing and buildout land use conditions, maximum day and peak hour demands will produce low water pressures in a few locations. The system's ability to provide adequate service under main-out-of-service scenarios was also evaluated.

Water main improvement projects have been identified to address the inadequacies discussed above. Projects have been developed to provide critical backup for major transmission mains and to meet projected demand. A limited number of new mains will need to be added to the existing system in order to meet buildout water demands. Some new developments may require the installation of short lengths of new lines to provide adequate water service to the development site. Additional projects may be identified as more comprehensive evaluations of fire flow and redundancy are performed for various neighborhoods. In addition, projects will continue to be identified through improved asset management capabilities for replacement of existing lines that are of inadequate size or are in poor condition.

Planning-level cost estimates have been produced for most of the recommended projects. The higher priority projects are included in the proposed 2015-2024 Capital Improvements Program (CIP). This 10-year CIP proposes approximately $35 million in Water Distribution (expansion) and $112 million in Water Sewer Maintenance Capital (water portion of non-expansion). When projects are initially funded, an alignment study is done. Funding in later years provides for preliminary engineering, final design and construction. With each step of the process, the scope of the projects and funding needs become more defined. The CIP provides funding for constructing new and rehabilitating old water mains, valves, pump stations and storage facilities. The CIP also funds upgrades for technology enhancements such as asset management, supervisory control and data acquisition (SCADA), automated meter reading (AMR) and the utilities information billing system (UIBS).
Chapter 1
Plan Overview and Summary

Introduction
The Water Distribution System Master Plan is an element of Arlington County’s Comprehensive Plan, which is required by the Code of Virginia. Arlington County’s Comprehensive Plan was established to help the County remain a safe, healthy, convenient and prosperous community and an attractive place in which to live, work, and play with stable or expanding values for potential growth and continued economic health. The purpose of Arlington’s Comprehensive Plan is to guide the coordinated and harmonious development of the County through the provision of high standards of public services and facilities.

Arlington County’s Comprehensive Plan was established by resolution of the County Board on August 27, 1960. This resolution called for the preparation of Arlington County’s Comprehensive Plan, which originally included five elements. In later years, additional elements were added to the Comprehensive Plan and some were replaced by new elements. Arlington County’s Comprehensive Plan has been continually updated and expanded and now comprises ten elements:

- General Land Use Plan
- Master Transportation Plan
- Storm Water Master Plan
- Water Distribution System Master Plan
- Sanitary Sewer System Master Plan
- Recycling Program Implementation Plan and Map
- Chesapeake Bay Preservation Ordinance and Plan
- Public Spaces Master Plan
- Historic Preservation Master Plan
- Community Energy Plan

Goals and Objectives
The following general principles were adopted by the County Board as part of its 1960 resolution concerning the Comprehensive Plan:

- Retention of the predominantly residential character of the County, and limitation of intense development to limited and defined areas;
- Promotion of sound business, commercial and light industrial activities in designated areas appropriately related to residential neighborhoods;
- Development of governmental facilities which will promote efficiency of operation and optimum public safety and service, including the areas of health, welfare, culture and recreation;
- Provision of an adequate supply of water effectively distributed;
- Maintenance of sewage disposal standards acceptable to the immediate County area and its neighbors in the entire Washington Metropolitan Area and consistent with the program of pollution abatement of the Potomac River;
- Provision of an adequate storm water drainage system; and
• Provision of an adequate system of traffic routes which is designed to form an integral part of the highway and transportation system of the County and region, assuring a safe, convenient flow of traffic, thereby facilitating economic and social interchange in the County.

In concert with the goals and objectives of the Comprehensive Plan, Arlington County has established the following vision statement:

*Arlington will be a diverse and inclusive world-class urban community with secure, attractive residential and commercial neighborhoods where people unite to form a caring, learning, participating, sustainable community in which each person is important.*

**Water Distribution System Master Plan Update**

Arlington County’s most recent water distribution system master plan was developed in 1992. In response to changes in anticipated growth and development, Arlington County recognized a need to update the 1992 master plan. This report presents the master plan update through the following chapters:

• Chapter 2  Water System History and Description
• Chapter 3  Water Quality
• Chapter 4  Review of the 1992 Water System Study
• Chapter 5  Water Distribution Asset Management
• Chapter 6  Projected Buildout, Land Use, and Water Demand
• Chapter 7  Evaluation of the Water System for Existing and Buildout Land Uses
• Chapter 8  Capital Improvement Program and Revenue Sources
Chapter 2
Water System History and Description

Major Facilities

According to the U.S. Census, Arlington was a community of 16,040 residents in 1920 and 26,615 residents in 1930. In 1922, legislation was secured from the General Assembly of Virginia permitting the establishment of sanitary districts within the County for the purpose of constructing water and sewer systems.

In 1926, the Sixty-Ninth Congress authorized Arlington County to receive water from the U.S. Army Corps of Engineers’ Dalecarlia Water Treatment Plant (WTP) in Washington D.C. The action was prompted by Arlington's interest in centralizing its water supply and distribution system. At that time, five independently-owned distribution systems with water supplied from wells were in operation in Cherrydale, Livingstone Heights, Bon Air, Virginia Highlands, and Aurora Hills. Four of these systems were unmetered and consisted of 1 ½- to 3-inch diameter steel pipe.

In 1927, a 24-inch diameter cast iron water main was constructed from the Dalecarlia WTP to Chain Bridge. Service across the Potomac River was provided by two 8-inch diameter steel mains attached to the bridge. These two 8-inch diameter mains merged into a 24-inch diameter cast iron main on the Virginia side of the river and continued to the intersection of Glebe and Military Road. Here the 24-inch diameter main reduced to a 12-inch diameter cast iron main and continued along Glebe Road to Lynhurst Station which is now the site of the north side salt storage facility. Lynhurst Station was equipped with a pump station, a 260,000-gallon water tower, and a 1.5- million gallon reservoir. Distribution to the County through supply mains continued from Lynhurst Station. On November 3, 1927, public water supply service began in Arlington County. The event was celebrated with a long parade, a barbecue, a jousting tournament, fireworks and a dance in the bus barn in Lyon Village.

The Arlington service area is now served by a network of approximately 525 miles of water lines ranging in diameter from 4 to 48 inches. Figure 1 provides information on the age of the mains by decade. Most of the mains were constructed between 1940 and 1955. The Minor Hill pump station and the Little Falls pump station are planned to be upgraded. An elevated tank, ground, and underground storage reservoirs at Fort Barnard, Lee, and Minor Hill provide a total of 32 million gallons of water storage which are used for meeting peak demands during normal operation and for fire protection.

Arlington County Water, Sewer, Streets Bureau (WSS) staff monitor the operation of the system's major facilities 24 hours per day/7 days per week from the Water Control Center using a Supervisory Control and Data Acquisition (SCADA) system that is isolated from the internet for security purposes. Through dedicated telephone lines, the staff is able to monitor pump station operations, water levels at all storage facilities, and water pressures at selected sites in each pressure zone. Staff use the SCADA system to operate portions of the system remotely by turning selected pumps on or off. The system provides a visual display and electronic record of storage, pumping, and pressure conditions that permit quick identification and response to emerging problems.

1 Chapter 260, Acts of the Assembly of Virginia, March 15, 1922
2 69th Congress, Session I, Chapter 140, April 14, 1926, (H.R. 4505)
4 The Beginning Of Arlington County Public Water Supply by Ruth P. Rose
Figure 1. Percentage and Length of Water Main Installed per Decade (Total Length = Approximately 525 miles)
Water Supply

Virtually all of the water consumed in Arlington is produced by the U.S. Army Corps of Engineers, Washington Aqueduct Division (WA) at the Dalecarlia WTP. The plant draws raw water from the Potomac River. The redundancy and separation of the two intakes help to ensure that a malfunction or a contamination episode will not shut down the plant.

When needed, an interconnection enables the transfer of treated water between the Dalecarlia and McMillan WTPs and permits the two plants to operate together to meet regional demands. The McMillan plant is also operated by WA and is located in Washington DC. The normal capacities of the Dalecarlia and McMillan plants are 164 million gallons per day (mgd) and 125 mgd, respectively. During an average day, the plants will produce a total of 141 mgd of treated water, with recent peak demand reaching 206 mgd. The Corps of Engineers forecasts that the current plant capacities are sufficient for future area demands. The existing agreement between Arlington County and the WA places no limits on the amount of water Arlington may purchase. Additionally, the plant has more capacity than Arlington system’s needs for 2040 and beyond.

Through the Metropolitan Washington Council of Governments, a regional agreement has been produced that sets the procedures for allocating water during water supply emergencies. This agreement, titled “Low Flow Allocation Agreement”, reinforces the reliability of Arlington’s water supply. During periods of low flow in the Potomac, or when water use must be conserved to protect public health, safety, and welfare, the agreement calls for an equitable allotment of water to each of the public water suppliers that now rely upon the Potomac River as their water source. The agreement also mandates that Arlington establish water restrictions that are imposed for conserving water during periods of supply emergencies.

Pressure Zones

Arlington's water system consists of nine service areas known as pressure zones. Pressure zones are areas of relatively similar ground elevations with common transmission and service mains in which water pressures can be maintained within an acceptable range. Pressure zone boundaries are established by geographic features, county borders, and pressure regulating valves (PRVs). The County’s 14 PRVs reduce high water pressures in downhill flowing stretches of transmission mains to prevent them from operating under excessive pressure. Arlington County’s goal is to have operating pressures between 40 and 100 pounds per square inch (psi). However, it is both impractical and impossible to meet this goal in all County-owned water mains due to varying topography. To help meet this goal for customers at the point of connection to the water system, the International Plumbing Code has provisions to require a booster pump in low pressure areas and a pressure regulating valve in higher pressure areas.
Chapter 3

Water Quality

General

Arlington County, as defined by the VDH, has two water distribution systems: Arlington County (Arlington) and the Willston Area. The Arlington County system serves over 98 percent of the County’s population.

Arlington County is served by the Arlington County distribution system. The principal supplier of Arlington’s water is the U.S. Army Corps of Engineers’ Dalecarlia WTP. At the plant, the raw water from the Potomac River is physically and chemically treated prior to its conveyance to the Arlington system. Water samples required at the entry point into the Arlington County system are taken at the Dalecarlia WTP.

The Willston Area system is located on the western edge of Arlington County along Wilson Boulevard. The water provided in the Willston Area system is treated at both the Dalecarlia and McMillian WTPs, flows through the Fairfax Water system, and then into the Willston Area which is defined as a consecutive water system by VDH. Water quality samples are taken in accordance with the Environmental Protection Agency (EPA) and VDH requirements.

Monitoring of the water distribution system helps to ensure that high quality drinking water flows from the treatment plant to customers’ taps. Both distribution systems are monitored following requirements mandated in four federal regulations: Surface Water Treatment Rule, Total Coliform Rule, Lead and Copper Rule, and Disinfectant and Disinfection Byproducts Stage 2 Rule. A discussion of these regulatory requirements follows.

Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was published by the EPA in 1989. It requires monitoring and reporting of residual disinfectant concentrations in the distribution system for all systems that obtain raw water from a surface supply. The rule requires 95 percent of monthly distribution samples to have a total chlorine residual of at least 0.2 mg/L. As an alternative compliance measure, a heterotrophic plate count (HPC using Standard Plate Count agar) of ≤ 500/mL is deemed to have a detectable residual disinfectant. While HPC is monitored by Arlington County, this laboratory method is not used for compliance purposes.

Arlington monitors total chlorine in the distribution systems with grab samples at Total Coliform Rule sampling sites to determine SWTR compliance. A minimum of 120 samples per month are taken from the Arlington system and two samples per month are taken from the Willston Area system. The Arlington and Willston Area systems have consistently been in compliance with this rule.

Total Coliform Rule

EPA published the Total Coliform Rule (TCR) in 1989. The maximum contaminant level goals (MCLGs) for total coliform, fecal coliform and *E. coli* have been set at zero. Compliance with the maximum contaminant level (MCL) is therefore based on the presence or absence of total coliform in a sample.

The MCL for large systems such as Arlington is that no more than 5.0 percent of the monthly samples may have a positive total coliform result. For the Willston Area system, which is only required to collect two samples per month, the MCL is one, i.e. monthly MCL violation is triggered when more than one repeat/routine sample is total coliform positive. Samples are collected from representative sites in the distribution system, including high, medium, and low water age areas. A sampling plan must be approved by VDH. The most current plan was approved by VDH in July 2011.
All samples that are positive for total coliform must also be tested for either fecal coliform or *E. coli*. In addition, any sample that tests positive for total coliform requires sampling at that same site and sampling within five service connections both upstream and downstream of the sample site. A violation of the MCL for total coliform occurs if either the original sample is positive for fecal coliform/*E. coli* or any of the repeat samples are positive for fecal coliform/*E. coli*.

Arlington is required to collect 120 samples per month from over 90 distribution locations for compliance with the TCR. When the population of Arlington exceeds 220,000, 150 samples per month will be required. Sites are selected to cover the entire distribution system and a variety of water ages every month. Two samples per month are collected from the Willston Area system. The samples are analyzed at the WA laboratory for total coliform and *E. coli*, and the data reports are transmitted to VDH on a monthly basis for all sites.

A revision to the TCR was published by the EPA in July 2010 and finalized in February 2013. The compliance date for the revised TCR is April 1, 2016. The revised rule establishes a MCLG and MCL for *E. coli* rather than total coliform. Positive total coliform sample(s) will require an investigation into the probable cause of the coliform detection. Implementation of corrective actions and best management practices will be required. Monitoring practices will remain the same as under the original TCR (EPA 1989), with the exception of eliminated fecal coliform testing and requiring *E. coli* testing when total coliform are positive. Arlington’s samples are currently tested for *E. coli* when total coliform samples are positive. The Arlington and Willston Area distribution systems have consistently been in compliance with the TCR rule.

**Lead and Copper Rule**

The EPA Lead and Copper Rule (LCR) established in 1991 requires waterworks owners to conduct sampling at the consumers’ taps. Minor revisions to the regulation were published in 2000. Under the LCR, EPA established action levels (AL) of 0.015 mg/L for lead (Pb) and 1.3 mg/L for copper (Cu) based on the 90th percentile level of tap water samples. First draw samples must be collected by all utilities at cold water taps in Tier 1 sites (homes/buildings that are at high risk of lead/copper contamination as identified in the regulation). These sites consist of single-family structures that contain copper pipes with lead solder installed between January 1983 and April 1986 or contain lead pipes and/or are served by lead service line. Arlington does not have any known lead service lines or homes with lead pipes. However, Arlington does have some galvanized services which have a short length (~1 foot) of lead pipe to connect the service to the cast iron main. As these services are found, they are replaced with a copper service.

The number of sample sites required is based on system size. If corrosion control is determined to be optimized and the lead levels meet the action level, then the utility may qualify for reduced monitoring. The Arlington and Willston Area systems qualify for reduced monitoring per the following protocol:

- Based on population, Arlington is required to collect 50 samples triennially for lead and copper, with the most recent sampling period ending in September 2013.
- For the Willston Area, 10 samples must be collected triennially for lead and copper, with the most recent sampling period ending in September 2013.
- Samples must be collected between June and September, during the warmer temperatures, with reporting completed by the end of the calendar year.
- Sampling must be completed within a single year.

The water quality parameters required by the LCR are established by VDH. In addition to the lead and copper sampling performed triennially, the County is required to perform more frequent water quality
sampling on pH, alkalinity, calcium, and orthophosphate. The County monitors these water quality parameters quarterly from 10 sample sites (subset of TCR) within the distribution system. Since Arlington qualifies for reduced monitoring, only semiannual sampling is required by VDH. As of December 2010, the Willston Area was approved for reduced monitoring. Therefore, semiannual sampling will be required from two sites in the Willston Area.

Entry point lead and copper data, collected at the Dalecarlia WTP’s effluent point are sent by WA to Arlington and subsequently reported to VDH by Arlington. The Arlington and Willston Area distribution systems have consistently been in compliance with this rule.

**Disinfectants and Disinfection Byproducts Stage 2 Rule**

The EPA published the Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBPR) on January 4, 2006. The MCLs remain the same as in Stage 1 D/DBPR (0.08 mg/L for total trihalomethanes (TTHMs) and 0.06 mg/L for haloacetic acids (HAA5s)), but the compliance calculation was modified for TTHM and HAA5s. Stage 1 compliance was calculated by a running quarterly average of all of the compliance sites. Under Stage 2 D/DBPR, compliance is calculated based on a location-specific running annual average (LRAA). The rule also modified the MCLGs for the individual disinfection byproducts (DBPs).

As part of the Stage 2 Rule, utilities were required to conduct programs to determine areas of maximum TTHM and HAA5 formation in their distribution systems which correspond with higher water age (IDSE or Initial Distribution System Evaluation). The IDSE is used to develop a revised DBP monitoring plan to capture locations with the highest DBP concentrations. These sites will be used for future compliance assessments. In 2000, WA implemented chloramination in an effort to minimize DBPs in the distribution system.

As per the Stage 2 D/DBPR requirements, in 2011 Arlington County received approval for the Stage 2 Monitoring Plans for both the Arlington and Willston Area Water distribution systems. Under the Stage 2 plan, the calculations for the MCLs for TTHM and HAA5 will be based on a LRAA rather than a RAA across all monitoring locations in the distribution system. Sample points for Stage 2 were modified in the Arlington County and Willston systems with new sites added to reflect the maximum DBP formation. Since sampling under this rule began in May 2012, Arlington and Willston Area distribution systems have been in compliance.
Chapter 4
Review of the 1992 Water System Study

General

In 1992, a water system study was produced by Arlington County based on modeling and analysis performed by Camp Dresser & McKee (now CDM Smith), an engineering consulting firm. The study evaluated the adequacy of the entire County water supply, distribution, and storage system, as it existed at the time, for both 1990 and projected buildout conditions, which were expected to occur between 2040 and 2050. Over the past 20 years, the findings and recommendations of the study have guided the County’s water system planning.

During the 50-year study period, it was projected that significant growth in resident and employment populations would result in a 27-percent increase in the average day demand. This increase, along with some existing facility capacity limitations, was found to produce several localized and system-wide operating deficiencies. The consultant identified 13 system improvements that could correct the deficiencies in addition to 12 previously-programmed projects.

The 1992 study generated the following key conclusions:

- The U. S. Army Corps of Engineers’ Dalecarlia WTP plant has adequate capacity to supply Arlington County’s present and projected future water demands. Arlington County’s water demand was projected to follow its present overall trend of modest annual increases for the next several decades.

- The County’s elevated storage tank and ground storage reservoirs were found to be in good operating condition, but in need of significant work to arrest and prevent deterioration, and to conform to federal and state safety regulations.

- For both existing and buildout land use conditions, no deficiencies were forecast in the system for average day demand. However, maximum day and peak hour demands were determined to produce undesirable low water pressures in a few locations.

- CDM Smith also evaluated the system’s ability to provide adequate service under 29 fire flow and main-out-of service scenarios. Deficiencies were identified in slightly more than half of the scenarios, most of which were localized.

- Twenty-five water main improvement projects were identified by CDM Smith and County staff. Nearly all of the projects were intended to correct existing localized service deficiencies such as improving water pressures and firefighting capabilities. Some projects provided critical backup for major transmission mains. Only a few projects were identified to replace existing lines that were found to be of inadequate capacity or in poor condition. A limited number of new mains would need to be added to the existing system in order to meet buildout water demands.

1992 Proposed Projects

The 1992 Water Master Plan divided proposed projects into three subcategories: water main, pump station, and storage facility improvements. Tables 1 through 3 list the improvement projects and their current status. Improvements that have not been implemented were re-evaluated under this master plan as discussed in Chapters 7 and 8.
Table 1. 1992 Water Master Plan Proposed Water Main Projects

<table>
<thead>
<tr>
<th>1992 Project ID</th>
<th>Project</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>North Rochester Street</td>
<td>The intent of this project was met with the cleaning and lining and looping of a dead-end water main in Powhatan Street which increased the available fire flow in the area.</td>
</tr>
<tr>
<td>B</td>
<td>Williamsburg School</td>
<td>A portion of this project that consisted of a new 12-inch diameter main that runs from Little Falls Road along North Harrison Street to Williamsburg Intermediate School and on to Old Dominion Drive was completed in 2000. The portion, called the Williamsburg Supply Main, is under construction, which started in FY 13 and is planned for completion in FY14. The remaining portion called Minor Hill Yard Piping is scheduled for completion in FY 15.</td>
</tr>
<tr>
<td>C</td>
<td>Reservoir Supply</td>
<td>This project was divided into 3 parts: (1) upgrades to the Fort Ethan Allen pump station (completed in 2004), (2) a new 36-inch water main in Old Glebe Road from Ethan Allen pump station to Dittmar Road (completed in 2002), and (3) a 36-inch diameter main along Glebe Road to Williamsburg Boulevard (completed in 2013) where it connects to the remaining portion of Project B described above.</td>
</tr>
<tr>
<td>D</td>
<td>North Harrison Street</td>
<td>After further evaluation of the fire flow deficiencies, a modified version of this project has been incorporated in the current master plan as project C.</td>
</tr>
<tr>
<td>E</td>
<td>16th Street North</td>
<td>After further evaluation of the fire flow deficiencies, a modified version of this project has been incorporated in the current master plan as project C.</td>
</tr>
<tr>
<td>F</td>
<td>Donaldson Run</td>
<td>The proposed alignment for this project was along Donaldson Run, which is difficult to access and is the location of a recent stream restoration project. Therefore, an alternate alignment was selected and is incorporated in the current master plan as a portion of Project B.</td>
</tr>
<tr>
<td>G</td>
<td>North Larrimore Street</td>
<td>This project was completed in 2000 and 2001.</td>
</tr>
<tr>
<td>H</td>
<td>Virginia Square</td>
<td>This project was completed in 1998 and 1999.</td>
</tr>
<tr>
<td>I</td>
<td>Fort Myer Heights</td>
<td>After further evaluation of the fire flow deficiencies, a modified version of this project is currently under design.</td>
</tr>
<tr>
<td>I-ALT</td>
<td>Alternative</td>
<td>This project was eliminated from consideration as proposed under the 1992 master plan after further evaluation of the fire flow deficiencies.</td>
</tr>
<tr>
<td>J</td>
<td>Courthouse</td>
<td>This project was eliminated from consideration as proposed under the 1992 master plan after further evaluation of the fire flow deficiencies.</td>
</tr>
<tr>
<td>J-ALT</td>
<td>Alternative</td>
<td>This project was eliminated from consideration as proposed under the 1992 master plan after further evaluation of the fire flow deficiencies.</td>
</tr>
<tr>
<td>K</td>
<td>Claremont</td>
<td>This project was modified as proposed in the 1992 master plan after further evaluation of the fire flow deficiencies. A 12-inch water main was completed in South Columbus St. and Chesterfield Road in 2005.</td>
</tr>
<tr>
<td>1992 Project ID</td>
<td>Project</td>
<td>Current Status</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>L</td>
<td>Washington Boulevard/ Columbia Pike</td>
<td>This project was modified as proposed in the 1992 master plan after further evaluation of the fire flow deficiencies. The project was built in three phases. The first two phases consisted of a 20-inch water main between Columbia Pike and Army Navy Drive. The portion across Army Navy Country Club was completed in 1992 and the portion along South Queen Street was completed in 1997. The final phase, consisting of a 20-inch main called the Gravity 3 supply main was completed in 2009. The Gravity 3 supply main runs between the intersection of 2nd Road North and North Irving Street to Columbia Pike.</td>
</tr>
<tr>
<td>M</td>
<td>Four Mile Run / Fairlington</td>
<td>This project was modified as proposed in the 1992 master plan after further evaluation of the fire flow deficiencies. The project was broken out into multiple phases which included the construction of a water main in South Quincy by developers in 1991, construction of a 16-inch diameter main in Four Mile Drive from Walter Reed Drive to Shirlington Road in 2001, cleaning and lining of water mains in the Fairlington area in 2001, and a new 12-inch diameter main in South Stafford and South Utah Street in 2006. Several smaller projects to replace dead end water mains and provide looping were constructed between 1991 and 2006.</td>
</tr>
<tr>
<td>N</td>
<td>North Danville Street</td>
<td>Completed in 2005.</td>
</tr>
<tr>
<td>Q</td>
<td>5th Street North</td>
<td>Completed in 1998.</td>
</tr>
<tr>
<td>R</td>
<td>N. Culpeper Street</td>
<td>Completed in 1996.</td>
</tr>
<tr>
<td>S</td>
<td>Kirkwood Road</td>
<td>Completed in 2010.</td>
</tr>
<tr>
<td>U</td>
<td>North Thomas Street</td>
<td>Completed in 1993.</td>
</tr>
<tr>
<td>V</td>
<td>Old Dominion Drive</td>
<td>Under design. Construction scheduled to begin in FY15</td>
</tr>
<tr>
<td>W</td>
<td>North Edgewood Street</td>
<td>Completed in 1997.</td>
</tr>
<tr>
<td>X</td>
<td>North Quincy Street</td>
<td>Completed in 1997.</td>
</tr>
<tr>
<td>Y</td>
<td>North Piedmont Street</td>
<td>A portion of a block was completed in 1992, with the remainder to be completed as the area redevelops.</td>
</tr>
</tbody>
</table>
Table 2. 1992 Water Master Plan Proposed Pump Station Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Barnard</td>
<td>Upgrade completed in 2009</td>
</tr>
<tr>
<td>Fort Ethan Allen Pump Station – further analysis and repair of check valve slamming problem</td>
<td>Upgrade completed in 2004</td>
</tr>
<tr>
<td>Lee pump station – minor repairs</td>
<td>Upgrade completed in 2011</td>
</tr>
<tr>
<td>Little Falls pump station – add new pump equal in size to largest pump to meet buildout demand</td>
<td>Pump station to be upgraded</td>
</tr>
<tr>
<td>Minor Hill pump station – replace existing pumps with new pumps of larger capacity to meet existing demands</td>
<td>Upgrade under design</td>
</tr>
<tr>
<td>Portable pumping station</td>
<td>Purchased trailer mounted pump for use in emergency pumping situations</td>
</tr>
</tbody>
</table>

Table 3. 1992 Water Master Plan Proposed Storage Facility Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Barnard elevated storage tank – repainting</td>
<td>Tank removed in 1996</td>
</tr>
<tr>
<td>Fort Barnard ground storage tank – repainting</td>
<td>Completed in 2001</td>
</tr>
<tr>
<td>Lee elevated storage tank – repainting</td>
<td>Completed in 1995</td>
</tr>
<tr>
<td>Lee ground storage tank</td>
<td>Rehabilitation completed in 2003</td>
</tr>
<tr>
<td>Minor Hill and Lee storage facility interconnection</td>
<td>Completed in 2003</td>
</tr>
</tbody>
</table>

Operational Improvement Programs

Several operational improvement programs were either ongoing or recommended at the time of the 1992 report. Table 4 lists the proposed operational improvements and their status. Two new principles for improving and expanding the water system were suggested:

- New development should pay for or construct improvements necessary to provide the development with adequate water service.
- New projects should be ranked by an established project evaluation and ranking system to support development of the annual Capital Improvement Program (CIP). Rankings should be reviewed, and if necessary, revised annually.
### Table 4. 1992 Operational Improvement Programs

<table>
<thead>
<tr>
<th>Project or Program</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>A routine backflow prevention program that includes comprehensive inspections,</td>
<td>On-going</td>
</tr>
<tr>
<td>strict enforcement and education.</td>
<td>Currently the County replaces meters every 10 years. Efforts to reduce this</td>
</tr>
<tr>
<td>Servicing and recalibration of water meters on a seven-year cycle.</td>
<td>cycle to 7-years are on-going.</td>
</tr>
<tr>
<td>Replacement of 4-inch or smaller diameter water mains with 6- or 8-inch diameter</td>
<td>On-going</td>
</tr>
<tr>
<td>mains that meet fire flow and provide adequate transmission capacity. The 4-inch</td>
<td></td>
</tr>
<tr>
<td>diameter mains should be replaced whenever any proposed large development project</td>
<td></td>
</tr>
<tr>
<td>or street construction occurs adjacent to the line.</td>
<td></td>
</tr>
<tr>
<td>Removal of all water meters containing lead by 1994. No meters containing lead</td>
<td>Complete</td>
</tr>
<tr>
<td>would be installed or reinstalled into the system.</td>
<td>Mains are flushed annually during the spring chlorine burn. Dead-end mains and</td>
</tr>
<tr>
<td>Implement a regular main flushing program. Dead end mains and problem mains</td>
<td>problem areas are flushed on a more frequent basis.</td>
</tr>
<tr>
<td>would be flushed as frequently as needed.</td>
<td></td>
</tr>
<tr>
<td>Annual inspection and exercising of all 16-inch or larger diameter valves in the</td>
<td>Program being developed and additional resources may be required</td>
</tr>
<tr>
<td>distribution system. Valves that are not functioning properly or are inoperable</td>
<td></td>
</tr>
<tr>
<td>would be repaired or replaced promptly.</td>
<td></td>
</tr>
<tr>
<td>Pressure regulating valves would be inspected weekly.</td>
<td>PRVs are visually inspected monthly. SCADA provides on-going monitoring of the</td>
</tr>
<tr>
<td></td>
<td>water system and alerts system operators of problems.</td>
</tr>
<tr>
<td>Routine flow testing of all fire hydrants in the County.</td>
<td>All fire hydrants are inspected annually and flushed annually as part of the</td>
</tr>
<tr>
<td></td>
<td>chlorine burn.</td>
</tr>
<tr>
<td>Inspection and maintenance of all County water pump stations and storage facilities</td>
<td>On-going</td>
</tr>
<tr>
<td>in accordance with AWWA standards.</td>
<td></td>
</tr>
</tbody>
</table>

A discussion of the current and proposed operational improvement programs is presented in Chapter 5.
Chapter 5

Water Distribution Asset Management

Arlington County has established an asset management program for their water distribution system that includes operation and maintenance programs, standards, and principles to ensure that adequate water supply is provided to their customers through sound infrastructure management practices. A description of the various components of the water distribution asset management program follows.

Operation and Maintenance Programs

Water Meter Servicing and Replacement Program

Each water service customer in the County has a public water meter for billing purposes. In 2009, the County conducted a pilot study of replacing 2,000 water meters with ones capable of automated meter reading (AMR) technology. These AMR-capable meters successfully reduced the route-reading time of County staff, thereby increasing the efficiency of the data collection process. In 2011, the County began the next phase of the project to replace the remaining 30,200 residential-account meters. The AMR conversion is anticipated to be fully completed in 2014. With the new meters, the past practice of removing and servicing meters every 7 to 10 years will be evaluated and reduced or increased as appropriate.

Inspection and Exercise of Valves

Valves are a critical water system asset. They allow for control of water flow. Operability and access of valves are vital in water system emergencies. Arlington has a program of visually inspecting and exercising approximately 15,000 distribution valves in the system to identify any problems and to prevent mechanical valve parts from “freezing” in place. Arlington’s goal is to inspect small valves on a regular basis and larger transmission valves (16-inch diameter and larger) annually. The cycle for the inspection of small valves will be based on the results of a pilot valve inspection study that started in 2013.

Frequently, when valves are exercised or are to be closed due to a main repair, they are found to be inoperable. There is a program for repairing and replacing inoperable valves. Additional resources will be needed to expand the program to meet program goals.

In addition to transmission and distribution valve inspection, Arlington’s pressure reducing and altitude valves are inspected at least monthly to ensure there are no extreme pressure fluctuations or tank overflows.

Main and Hydrant Flushing Program

Industry best practice includes routine flushing of mains to reduce accumulation of minerals and sediments in the lines and to help maintain relatively low water age in the system. Higher water age or stagnant water is often associated with taste and odor concerns. Once a year in the spring, Arlington operates all fire hydrants to flush the water distribution system. The rest of the year, Arlington flushes problem areas, such as main dead ends where minerals and sediment tend to accumulate. Looped areas of the system are less susceptible to accumulating sediment and developing taste and odor issues.

Based on condition results of a pilot valve inspection study, the County will conduct a pilot study for a unidirectional flushing program within the next five years. The difference between unidirectional flushing and traditional flushing is that unidirectional flushing involves temporarily closing valves to
ensure that the main is flushed with water traveling in one direction at higher velocity. With traditional flushing, system valves are not operated and if the main is looped, the water may flow in more than one direction. While more labor intensive, less water is required for unidirectional flushing, scour velocities are higher, valves are exercised and closed valves or valves in need of repair are discovered. Hence, unidirectional flushing is an effective way of improving maintenance of the water distribution mains within the County.

Water Main Replacement and Rehabilitation

When necessary, the County will replace and rehabilitate water mains. The failure rate, which is based on excessive line leakage or main breaks due to internal and/or external corrosion, is used to justify the need for replacement or rehabilitation. Internal tuberculation (the accumulation of mineral and sediment deposits in mains) can cause low fire flow and rusty water which are also reasons for main rehabilitation.

Under the water main replacement program, the County replaces 4-inch diameter mains where fire flow is an issue and smaller diameter galvanized “temporary” lines that were installed in the 1920s, 1930s, and 1940s. These smaller lines produce occasional maintenance issues, provide poor pressure due to their size, and provide no fire flow benefit. The County plans to replace or rehabilitate all mains 4-inches or less in diameter by 2040.

Water mains 8-inches or less in diameter and installed before 1960 comprise approximately 50 percent of the system, and are generally unlined and more susceptible to interior corrosion. The County has set a goal to rehabilitate approximately 250 miles of 8-inch diameter and smaller pipe installed prior to 1960 by 2040, of which approximately 51 miles have been completed to date. The 12-inch diameter main on the South Abingdon Street bridge over I-395 was rehabilitated with a structural liner in 2011, marking the first project of this type completed in Arlington County and the region.

The County is planning on updating the water main rehabilitation and replacement program to more fully leverage Asset Management best practices using existing data and available resources including items such as the following:

- Prioritization of assets based on both probability of failure and consequence of failure, with the highest risk assets prioritized first.
- Consideration of factors other than age and material for funding and planning purposes such as data on breaks and operating pressures, as well as hydraulic criticality (how many customers and/or critical customers impacted if pipe goes out of service), transportation impact, coordination with other County capital projects (like street repaving), difficulty of emergency repair (crossing a bridge, under water), etc.
- Evaluation of replacement footage and funding per year so that post-1960 development boom pipes can be replaced over time and not all come “due” at the same time.

The rehabilitation goal of pre- and post-1960 pipe replacement/rehabilitation will be modified based on the results of the above analyses. This effort ties into the current prioritization criteria as well as the County-wide asset management software.

Inspection and Testing of Fire Hydrants

To ensure that adequate fire protection exists throughout the County, each of the approximately 3,700 fire hydrants in the system is inspected annually. During the inspection, the static pressure at
each hydrant may be measured and recorded. The recorded pressures are reviewed, and when problems are identified, further investigation is conducted. County staff periodically measure and track hydrant flow rates and check hydrant valves.

**Inspection and Testing of Pump Stations and Storage Facilities**

Water Distribution staff inspect the five County pump stations daily. Three of the five pump stations have been renovated in the last ten years. The remaining two stations (Little Falls and Minor Hill) will be rehabilitated in the next two to five years. All storage facilities have been inspected within the last three years as a part of a routine inspection and preventative maintenance program. Minor repairs and enhancements have been made as needed. As needs are identified, projects are programmed into the Capital Improvement Program.

**Backflow Prevention Program**

Arlington County has a program to reduce the possibility of contamination of water after it has been delivered to the residential and commercial customers. Currently, County staff inspect the plumbing of commercial and multi-family residential buildings to identify where wastewater or other hazards could potentially flow back into a building’s potable water line. The staff are developing a more aggressive backflow prevention ordinance which would require building owners to correct any backflow problems that have been identified. In addition, inspections will soon be offered to single-family residential homeowners, and a more substantial backflow prevention education program is being developed.

**Technology Enhancements**

The County plans to upgrade its current asset management system and acquire software that will be fully integrated with Geographical Information Systems (GIS) technology. The system would have the ability to handle asset management and work orders for all of the WSS Bureau’s public assets and could potentially be expanded to other County-owned assets (infrastructure, transportation, facilities, fleet, and natural resources (e.g. parks, trees, streams, etc.).

Other systems such as Supervisory Control and Data Acquisition (SCADA) and Automated Meter Reading (AMR) are being looked at for future enhancements under this funding category.

**Asset Operation Standards**

Arlington bases its standards for operation of the water system on guidelines established by the American Water Works Association (AWWA). For example, a primary goal calls for the maintenance of water pressures to all customers at levels between 40 and 100 psi. During main breaks, large fire flows and other emergency conditions, the minimum pressure in the affected area should not drop below 20 psi. Other standards governing the distribution system, such as those affecting water quality, are mandated by the federal and state government.

In its commitment to provide high quality drinking water, Arlington has established a water distribution goal to join AWWA’s new Partnership Distribution System Optimization Program. The Washington Sanitary Suburban Commission (WSSC) and the City of Virginia Beach are members of this program. The program offers self-assessment and optimization programs and tools to assist utilities in improving performance of the water distribution system.
Asset Operation Principles

The following principles have been developed to govern the current and future operation of the County water distribution system. The principles have been placed into two categories, “ongoing” and “new” to distinguish those that represent additions or significant changes in County policy. New projects are those proposed for future implementation and are not funded and need to be established unless otherwise noted.

New:

- A unidirectional flushing program involving the exercising of valves should be established. The County will conduct a pilot study to assess the resources required for this program.
- All 16-inch diameter and larger valves should be inspected and exercised at least annually.
- All small valves (12-inch diameter and smaller) shall be inspected and exercised based on the results of the valve exercising study that began in 2013.

On-going:

- A routine backflow prevention program that includes comprehensive inspections, strict enforcement and educational outreach to affected customers is managed by the Inspection Services Division of CPHD.
- Water meters are serviced and recalibrated on a 10-year cycle.
- County flushes water mains annually during the spring when the treatment plant switches between chloramines and chlorine to help flush biofilm from distribution piping (known as the chlorine burn).
- Pressure regulating valves are inspected monthly. SCADA provides on-going monitoring of the water system and alerts system operators of problems. Regulator valves that are not functioning properly or are inoperable are repaired or replaced.
- All County water and pump stations and storage facilities are inspected and maintained in accordance with AWWA standards.
- All fire hydrants are inspected annually. Any inoperable or improperly functioning hydrants are repaired or replaced.
- Water mains are rehabilitated or replaced when internal tuberculation causes water quality problems, low flow or low water pressure. Mains with extensive internal and/or external corrosion conditions that cause leakage and main breaks are also replaced. Relatively few 4-inch diameter water mains are in operation within Arlington. These mains are replaced whenever any proposed project or street construction occurs adjacent to the main.
- It is a goal that under normal conditions, all water customers should receive their water at a pressure between 40 and 100 psi. During main breaks, large fire flows and other emergency conditions, a minimum pressure of at least 20 psi should be maintained.
- Pump stations should maintain sufficient capacity to meet peak hour demands with their largest pump out of service.
• Ethan Allen, Lee, and Minor Hill pump stations are equipped with emergency standby power. Other pump stations have connections for temporary generators planned or installed.

• Storage facilities should maintain adequate system-wide capacity to provide 50 percent of the daily water demand plus 20 percent of the peak hour flow and sufficient water to fight most extreme fire for their service areas.

• Water delivered to the consumers should continue to meet all Virginia and EPA quality requirements.

• Water prices are set and reviewed annually and revised as necessary so that expected revenue from County water sales, infrastructure availability fees and other fees will be sufficient to offset all costs of operating the system and to fund all non-expansion capital improvements.

Renewal and Expansion of System Assets

Renewal and expansion of the Arlington water distribution system are initiated by both the County and by private developers. The County constructs new mains and upgrades facilities to keep up with increased demands, to correct service deficiencies, improve redundancy, and replace or rehabilitate aging infrastructure. While Arlington is almost entirely developed, redevelopment and infill development in existing neighborhoods create the need for new connections as well as extensions and upgrades of existing lines. Future expansion may also occur if National Airport or the Federal properties in Arlington County that are not now part of the Arlington system request to be added to the system.

System Connections and Improvements for New Developments

The County and private developers are jointly involved in ensuring that adequate water service is provided to new development. The physical connection from the water system to a new development is constructed by the County. A connection fee is charged to the developer for this service. Most often, the connection can be made to an existing main in the street adjacent to the new building. However, where no nearby main exists or the nearest existing main is not adequate to serve the development, the County may require the developer to extend or upgrade an existing main. The developer is responsible for extending or upgrading the main to the limits of the area being developed.

Infrastructure Availability Fees

The County charges new developments an infrastructure availability fee for each new drainage fixture unit installed as defined by the Plumbing Code. These fees are utilized by the County to pay for the construction of new, extended or replacements of water and sewer mains, pump station upgrades, system maintenance or replacement, and other improvements that expand or enhance the capability of the existing system. The fund is divided between the water, sewer, and sewage treatment systems based upon asset management risk prioritization processes.

Criteria to Determine New Project Priorities

To determine overall system facility improvement priorities, County staff have developed a system for informally evaluating and ranking planned renewal and expansion projects. These criteria may result
in a water project to line the main with cement or replace it. A project is evaluated initially based upon the following five criteria which are considered critical to the water system’s function:

- **Failure Rate** - This criterion examines the number of breaks a given line segment has experienced. Evidence of excessive tuberculation may also result in a water project to either line the main with cement or replace it if the main has had a history of breaks.

- **Water Quality** - This factor considers the quality of the water that is delivered to the customers for their drinking and personal use. The primary concerns are to minimize water age, minimize water discoloration due to iron oxide (rust) releases into solution, and eliminate potential sources of water contamination.

- **System Static Pressure** - This criterion considers the pressure at which water is delivered to businesses and residences throughout the County. Projects are reviewed on their ability to raise or sustain water pressure to at least the desired level.

- **Fire Protection** - Key issues are the quantity of flow (gallons per minute) to fight a fire and the maintenance of adequate water pressures in the areas surrounding a fire.

- **Redundancy** - This factor considers the ability of the system to perform in the event of a water main break or other situation which requires the shutdown of key water mains as well as the age of the water main.

Before establishing the final project priorities, County staff considers unique conditions associated with each project. The projects are again evaluated for each of the following five conditional factors:

- **Investment Loss** - This factor considers the expected pace and scale of system deterioration that would occur from delays in implementing the project.

- **Associated Projects** - Potential cost savings or other benefits that could be realized from undertaking the project along with nearby water, street or other projects are considered.

- **Population Affected** - The relative number of residences and businesses that will benefit from the proposed project and their degree of benefit are considered.

- **Related Development** - Consideration is given as to the development potential of an area. A higher score is given where a project may be needed to accommodate planned development.

- **Infrastructure Renewal** - Arlington strives to maintain an average water main age of less than one hundred years. To meet this goal, when there are major street improvements which will result in overhauling the street and the existing main is greater than fifty years old, replacement of the water main prior to rebuilding the road is considered.

### Capital Improvement Program (CIP)

A CIP is produced with a 10-year schedule of the significant capital projects that the Department of Environmental Services has planned. The CIP is intended to plan and establish the County’s short- and long-term capital needs, and to quantify the fiscal demands of funding capital projects.

Each project is described by its objectives, physical extent, and expected cost. The department determines where in the schedule a project should be placed based upon its priorities, circumstances associated with the project, and fiscal considerations. The project prioritization in the schedule is
reviewed periodically and can be modified as circumstances and fiscal conditions change. The final CIP is also shaped by citizen input and the Arlington County Board’s review and approval.

Expansion Standards

Standards governing the design and construction of additions and connections to the County water system have been established and are codified in the *Arlington County Department of Environmental Services Construction Standards and Specifications*. Specific details provide a consistency in design and construction which helps to ensure high quality construction, proper system operation, and easier maintenance and repair. These standards apply to work conducted by County crews, contractors to the County, and private developers. EPA, VDH, and AWWA also have issued standards that the County follows in designing and operating the system. The County also follows guidelines produced by the Insurance Services Office (ISO), an independent organization which rates the County’s water system and fire department for insurance purposes.

The County has Local Review Authority delegated to it from VDH, which allows for review of water plans up to 20-inch diameter. This authority allows the County to review and approve water main plans by developers instead of the State. This streamlines the development review process. Quarterly reports are sent to VDH. Larger diameter water main installations are reviewed and approved by VDH.

Expansion Principles

Improvement and expansion of the existing water distribution system should be in accordance with the following principles:

- New development should pay for or construct improvements necessary to provide the development with adequate water service.
- Capacity expansions and improvements should be made to ensure that increased water demands from new development do not exceed the ability of the system to provide adequate domestic and fire-fighting service.
- In commercial districts, the minimum size for new mains should be 8-inch diameter. Where a main is not going to be interconnected with other large mains, a minimum 12-inch diameter main should be used.
- In residential districts, the minimum size for new mains is 6-inch diameter for interconnected lines and 8-inch diameter for independent lines or those greater than 600 feet in length. When serving a fire hydrant, 8-inch diameter mains are required.
- Fire hydrants should be installed no further than 300 feet apart in commercial districts and 500 feet apart in residential districts.
- Infrastructure Availability Fees are required to support necessary facility improvements.
Chapter 6
Projected Buildout, Land Use, and Water Demand

System Demands

Figure 2 shows the historical annual demand trend as well as projected demand trends from the 1980 Montgomery Engineers and 1991 CDM Smith studies. Over the 1970 to 1990 period, when there was a rapid pace of high-density development in the County, there was only a modest increase in water demand. Currently, the average day demand is approximately 23 mgd which is a 5-percent reduction from the 1992 average day demand. Demand normally fluctuates upward by about 10 to 20 percent during the summer months and declines by an equal amount during the winter.

Figure 2. Annual Demand Trend

The daily system demand includes both billed water consumption and unaccounted-for water use. The unaccounted-for water is volume lost in main breaks and leaks, fire flows, malfunctioning (under-registering) meters, or any other unmetered water use. Table 5 summarizes water supply data from 2007 to 2012. The supply data for each year (water supplied by the Washington Aqueduct to Arlington County) along with the billed volume (captured by meters) and resulting unaccounted-for water is provided. A review of recent year’s County billing records indicates that approximately 14 percent of the water is unaccounted. While the occurrence of fires and main breaks affects unaccounted-for water, weather and economic conditions can cause actual fluctuations in billed water quantities. To provide a conservative measure of unbilled water use, a 20 percent unaccounted-for water rate was used for planning purposes.
Table 5. Water Supply Data

<table>
<thead>
<tr>
<th>Year</th>
<th>Supply (mgd)</th>
<th>Billed (mgd)</th>
<th>Unaccounted-for Water (mgd)</th>
<th>Unaccounted-for Water %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>24.81</td>
<td>20.66</td>
<td>4.15</td>
<td>16.7</td>
</tr>
<tr>
<td>2008</td>
<td>23.15</td>
<td>20.04</td>
<td>3.11</td>
<td>13.4</td>
</tr>
<tr>
<td>2009</td>
<td>23.20</td>
<td>20.04</td>
<td>3.16</td>
<td>13.6</td>
</tr>
<tr>
<td>2010</td>
<td>23.78</td>
<td>20.54</td>
<td>3.24</td>
<td>13.6</td>
</tr>
<tr>
<td>2011</td>
<td>22.46</td>
<td>19.78</td>
<td>2.68</td>
<td>11.9</td>
</tr>
<tr>
<td>2012</td>
<td>22.76</td>
<td>19.41</td>
<td>3.35</td>
<td>14.7</td>
</tr>
</tbody>
</table>

The 1992 Water Master Plan discussed the possible impact of the Energy Policy Act of 1992 which mandated the minimum water efficiency standards at the federal level for plumbing fixtures. These standards became effective in 1994 for residential and commercial plumbing fixtures. Due to conservation measures, Arlington’s current demands are lower than both the 1980 and 1991 projections and average day demand in 2012 is lower than in 1992.

Development of Water Demand Projections

Water demand projections for this plan were developed by Whitman, Requardt and Associates (WR&A). Per-capita unit demands were estimated using billing data from 2007 to 2010, population and employment estimates from 2005 and 2010, and monthly water supply data from the Dalecarlia WTP. Based on the billing data, the average consumption for residential and commercial sectors was approximately 20 mgd during 2007 through 2010.

In developing the overall system demand, it was determined that the water consumption by the portion of Arlington fed by the Falls Church water system (Willston zone) is essentially cancelled out by the parts outside Arlington’s border that are fed by the Arlington system, and was therefore excluded from the study. Also omitted were the locations served by the Federally-owned water system (Pentagon and Arlington Cemetery). While the Federal system supplies National Airport, historically, the County has had to serve the airport for extended periods of time, and a demand of 1.0 mgd was applied to account for this possibility in the development of the average and maximum day demands.

Consumption on a per-capita basis is projected to remain at current levels due to the use of water-saving appliances, low-flow fixtures, and other conservation methods. Based on projected population growth and taking into account the 20-percent unaccounted-for water, the 2040 average day water demand is estimated to be 35.66 mgd, excluding the 1.0 mgd assumption for National Airport.

Table 6 provides water demands based on the projected population increase in five-year intervals until buildout in 2040.
Table 6. Average Day Water Demand Projections*

<table>
<thead>
<tr>
<th>Year</th>
<th>Population Projection</th>
<th>Population Demand (MGD)</th>
<th>Employment Projection</th>
<th>Employment Demand (MGD)</th>
<th>Total Demand (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>222,900</td>
<td>16.94</td>
<td>215,500</td>
<td>11.42</td>
<td>28.36</td>
</tr>
<tr>
<td>2020</td>
<td>236,100</td>
<td>17.95</td>
<td>244,300</td>
<td>12.94</td>
<td>30.89</td>
</tr>
<tr>
<td>2025</td>
<td>248,700</td>
<td>18.91</td>
<td>260,100</td>
<td>13.78</td>
<td>32.69</td>
</tr>
<tr>
<td>2030</td>
<td>258,800</td>
<td>19.76</td>
<td>271,100</td>
<td>14.36</td>
<td>34.04</td>
</tr>
<tr>
<td>2035</td>
<td>266,400</td>
<td>20.25</td>
<td>274,000</td>
<td>14.52</td>
<td>34.77</td>
</tr>
<tr>
<td>2040</td>
<td>276,100</td>
<td>20.99</td>
<td>276,900</td>
<td>14.67</td>
<td>35.66</td>
</tr>
</tbody>
</table>

*Excluding National Airport

Buildout Land Use

For the purposes of the water system study, Arlington County staff with the assistance of WR&A estimated the maximum expected land use development in the County. This development estimate, termed "buildout", determined the land use types and densities that could be expected to ultimately exist on each census block in the County in 2040.

Historical population information was obtained from census records.Projected population and employment growth estimates were derived from the Metropolitan Washington Council of Governments (MWCOG) Round 8.2 forecasts. A majority of the overall population increase and employment growth in the County are forecasted to be along the Metro corridors and Columbia Pike. The population and employment growth areas are identified on Figures 3 and 4, respectively.

Using rates for Arlington County population and job growth derived from the MWCOG Round 8.2 forecasts, estimated demand was calculated for 2040 (assumed ‘buildout’ for the purposes of this plan). Development is not expected to occur at the same pace throughout the County. It is anticipated that certain areas of the County will reach buildout prior to the overall County buildout.

Maximum Day Demand

Developing a maximum day demand peaking factor is critical for modeling future infrastructure needs to ensure adequate pressures are maintained throughout the system under a variety of scenarios. The standard method of calculating a peaking factor is to determine the ratio of the maximum day demand to the average day demand. Historical peaking factors ranged from 1.30 to 1.55 from 1998 to 2010. Following industry standard practices, a value of 1.5 was selected for use as the peaking factor.

The maximum day demand was developed from the average day demand projection and the peaking factor described above. Based on this, the projected maximum day for 2040 is 55.0 mgd. Table 7 provides average and maximum day demands in five-year intervals until buildout. National Airport adds 1.0 mgd to the average day demands over the values shown in Table 6.
Figure 3
Population Growth within COG 8.2 Traffic Analysis Zones from 2010-2040
Figure 4
Employment Growth within COG 8.2 Traffic Analysis Zones from 2010-2040
Table 7. Average and Maximum Day Demand Forecast*

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Day Demand (mgd)</th>
<th>Maximum Day Demand (mgd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>29.4</td>
<td>44.0</td>
</tr>
<tr>
<td>2020</td>
<td>31.9</td>
<td>47.8</td>
</tr>
<tr>
<td>2025</td>
<td>33.7</td>
<td>50.5</td>
</tr>
<tr>
<td>2030</td>
<td>35.0</td>
<td>52.6</td>
</tr>
<tr>
<td>2035</td>
<td>35.8</td>
<td>53.7</td>
</tr>
<tr>
<td>2040</td>
<td>36.7</td>
<td>55.0</td>
</tr>
</tbody>
</table>

*Including National Airport

Peak Hour Demand

Peak hour demand is the highest rate of water consumption to occur during any one-hour period during a given year. The peak hour demand is the most strenuous, instantaneous water demand exerted on the distribution system under normal circumstances (i.e. no fire flow or system failures). The peaking hour factor is often expressed as the ratio of peak hour demand to average day demand.

A distribution system’s storage facilities are typically sized to provide equalization, fire protection, and emergency storage. Equalization storage is used to supplement the flow from the water treatment plants during peak demand periods.

The diurnal demand curve which represents the hourly demand variation in the Arlington water system over 24 hours is shown on Figure 5. The highest point on the diurnal curve reflects the peak hour demand. The ability of the system to meet the peak hour demand is evaluated by applying the diurnal demand curve to the model simulations.

Figure 5. Diurnal Demand Curve
Chapter 7
Evaluation of the Water System for Existing and Buildout Land Uses

Introduction

The adequacy of the Arlington water system to handle existing and projected demands was evaluated by WR&A to determine if there were any deficiencies in the current system, and what additional stresses buildout conditions would cause. A computer model of the water system was used to conduct the evaluation. Where weaknesses were found, system improvements are recommended as described in Chapter 8. Where necessary, these system improvements have been selected to achieve the following goals:

- To accommodate anticipated system growth over time by planning for adequate capacity in the water transmission system, storage tanks, and pump stations.
- To provide sufficient water storage capacity to satisfy peak system demands, satisfy fire flow needs, provide surge protection, and provide for contingency storage in emergencies.
- To provide sufficient fire flow to all areas.
- To enhance redundancy in the transmission system to mitigate impacts from a temporary transmission main service disruption.
- To provide more consistent pressures throughout the system.

Evaluation Methodology and Criteria

To identify necessary system improvements, a hydraulic evaluation was conducted using a computer model of the water system. The model was developed with the software, WaterCAD V8i, and consists primarily of 12-inch and larger diameter pipes. Smaller diameter pipes were added for connectivity and to evaluate specific areas of concern. The model was calibrated with water system flow testing to better represent existing system flows and pressures.

Evaluation criteria were established based on AWWA recommendations, VDH requirements, and Arlington County Standards. The following criteria were used for the evaluation:

- System pressure requirements
  - Absolute minimum pressure = 30 psi at peak hour demand and 20 psi for main breaks, large fire flows and other emergency conditions
  - Desired minimum pressure = 40 psi during non-fire flow conditions
  - Desired distribution system maximum pressure = 100 psi

- Transmission flow – Transmission mains provide adequate capacity for peak hour demands or maximum day plus fire flow demands, whichever is greater.

- Pump station flow – Pump stations deliver, at a minimum, the maximum day demand or the flow required to refill the storage facilities after a maximum day demand, whichever is greater.

- Headloss – Transmission main headloss is within the AWWA design standard of 2 to 5 feet/1,000 feet for 12-inch to 20-inch diameter mains and 1 to 3 feet/1,000 feet for 24-inch diameter and larger mains under peak flow conditions.

- Pipe velocities - Velocity in transmission mains is below 8 feet per second (fps) at peak conditions and below 5 fps under normal conditions.
• Storage volume – System storage volume is equal to \( \frac{1}{2} \) the maximum day demand, per VDH requirements. This is consistent with the AWWA Manual M31 on Distribution System Requirements for Fire Protection, which considers minimum effective storage as 20 percent of the maximum day demand plus the maximum fire flow storage volume required plus a 25 percent contingency for a given pressure zone.

• Water storage tank cycling – Retention time in the tank is less than 72 hours, based on discussions with VDH.

• System pressure fluctuation – Variation between the high and low water levels within a storage facility should not exceed 30 feet, per VDH.

• Tank refill capacity - Water storage tanks must have the ability to recover from the previous day’s demand to provide the necessary storage for the next maximum day.

• System redundancy - Future transmission mains should help provide redundancy if a planned or unplanned outage were to occur in the transmission system.

Various water demand scenarios were simulated with the model and their effects on the system observed. Alternative scenarios were ranked based on their ability to convey the average and maximum day demands in a cost-effective and reliable manner. New mains were also identified to improve or maintain system reliability and performance.

### Water Storage

The existing and future water demands were evaluated with respect to minimum effective storage volumes required by VDH and fire flow criteria. VDH specifies a minimum storage volume of 50 percent of the average day demand during the max (non-rolling) month, which results in a calculated minimum storage volume of 60 percent of the average day demand. The fire flow criteria vary depending on the service level demand.

A summary of the VDH storage requirements is presented in Table 8. Using the VDH minimum criteria, the storage requirement will increase from 15.5 million gallons to 21.4 million gallons in 2040 to meet the system demands. Given the current system storage of 32 million gallons, the current amount of storage is adequate for projected demands.

#### Table 8. Storage Requirements

<table>
<thead>
<tr>
<th>Design Year</th>
<th>Storage Requirements – VDH method</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>17.0</td>
</tr>
<tr>
<td>2020</td>
<td>18.5</td>
</tr>
<tr>
<td>2025</td>
<td>19.6</td>
</tr>
<tr>
<td>2030</td>
<td>20.4</td>
</tr>
<tr>
<td>2035</td>
<td>20.9</td>
</tr>
<tr>
<td>2040</td>
<td>21.4</td>
</tr>
</tbody>
</table>

The storage requirement was calculated in the 1992 water system master plan as the sum of:

• 50% of the average day demand for emergency reserve
20% of the maximum day demand for handling peaks above the max day

- A fire demand of 7500 gpm for 7 hours

This more conservative means of developing storage requirements resulted in a storage volume need of 31.7 million gallons (MG), but it shows that either method arrives at the conclusion that storage will remain adequate for the foreseeable future.
CHAPTER 8
Capital Improvement Program and Revenue Sources

Water Distribution Asset Improvements

Water distribution asset improvements are the basis for the Capital Improvement Program (CIP). These improvements to the water distribution system were developed based on the hydraulic evaluation and asset management repair and replacement criteria established by the County. Specifically, the hydraulic model identified components of the transmission system that will require upgrade to provide the desired system capacity and reliability. Segments identified by the County as having a maintenance or operational problem were reviewed to determine system criticality and potential replacement sizes. Based on these analyses, the following sections describe projects planned to enhance the water system.

Water Main Improvements

The recommended water main improvements are identified in Table 12 to correct current and anticipated system deficiencies in firefighting capacity and main backup. More comprehensive analyses of potential main-out-of-service and fire flow scenarios will likely identify the need for additional main projects. While future water demands will create system-wide stresses, the majority of the projects identified are proposed to correct existing problems in localized areas. The projects listed in Table 12 are classified as expansion and non-expansion projects. Expansion projects primarily expand the current system's capabilities by providing additional links that improve flow through the system and that serve to backup critical mains. Non-expansion projects will be supplementing existing lines rather than taking their place. However, a few projects will replace inadequate small mains with higher capacity larger pipes. Projects that were previously identified in the 1992 Water System Master Plan and determined still necessary are included in this table.

For master planning purposes, the recommended projects are intended to focus on transmission capacity, size and length requirements and do not reflect a detailed alignment review.

A description of the general improvement projects follows.

Water Main Replacement/Cleaning & Lining Program

The County has developed a program for non-expansion projects involving replacement of small diameter water mains that require less engineering and/or timelier implementation than more traditional CIP projects. The County has budgeted for the replacement/rehabilitation and cement lining of approximately 250 miles of older, unlined, cast iron mains in areas that are unlikely to develop significantly in the future. The criteria for water mains that need to be replaced were discussed in Chapter 5. In general, the projects focus on replacement of 4-, 6- and 8-inch diameter mains where fire flow is a concern and replacement of 1-1/2- to 2-inch diameter galvanized lines installed in the 1920s to 1940s. Approximately 51 miles have already been cleaned and relined. Based on asset data available at this time, and the goal is to complete the project by 2040. Over the implementation period of this master plan the rate may be adjusted as more data is collected. The CIP allocates funds for these two programs throughout the ten year CIP and beyond.
**Table 9. Recommended Water Main Improvements**

<table>
<thead>
<tr>
<th>2014 Project ID</th>
<th>Description</th>
<th>Expansion vs. Non-Expansion</th>
<th>CIP Funding Period</th>
<th>Estimated* Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Reservoir Supply/Minor Hill Yard Piping (Formerly known as Williamsburg School and Reservoir Supply)</td>
<td>Expansion</td>
<td>Funded in prior CIP</td>
<td>$2,300,000</td>
</tr>
<tr>
<td>B</td>
<td>Gravity One Supply Main (Formerly known as Donaldson Run)</td>
<td>Expansion</td>
<td>Funded in prior CIP and proposed in FY15 to FY24 CIP</td>
<td>$2,500,000</td>
</tr>
<tr>
<td>C</td>
<td>North Harrison Street (Formerly known as North Harrison St and 16th St N)</td>
<td>Expansion</td>
<td>Funding proposed in FY15 to FY 24 CIP</td>
<td>TBD</td>
</tr>
<tr>
<td>D</td>
<td>Edison St/Carlin Springs</td>
<td>Expansion</td>
<td>Funding proposed in FY15 to FY24 CIP and beyond</td>
<td>TBD</td>
</tr>
<tr>
<td>E</td>
<td>West Reservoir/Gravity Two Supply Main</td>
<td>Expansion</td>
<td>Funding beyond FY 24</td>
<td>TBD</td>
</tr>
<tr>
<td>F</td>
<td>Columbia Pike – Taylor to Oakland</td>
<td>Expansion</td>
<td>Funded in prior CIP and proposed in FY15 to FY24 CIP</td>
<td>$650,000</td>
</tr>
<tr>
<td>G</td>
<td>Army Navy Drive at South Joyce Street</td>
<td>Expansion</td>
<td>Funded in prior CIP</td>
<td>$700,000</td>
</tr>
<tr>
<td>H</td>
<td>Army Navy County Club access road to 23rd Street South</td>
<td>Expansion</td>
<td>Funded in prior CIP and proposed in FY15 to 24 CIP</td>
<td>$1,700,000</td>
</tr>
<tr>
<td>I</td>
<td>Columbia Pike from South Orme Street to Army Navy Drive</td>
<td>Expansion</td>
<td>Funding proposed in FY15 to FY24 CIP and beyond</td>
<td>TBD</td>
</tr>
<tr>
<td>J</td>
<td>Ballston Pond to Glebe Road</td>
<td>Expansion</td>
<td>Funding proposed in FY15 to FY24 CIP</td>
<td>TBD</td>
</tr>
<tr>
<td>K</td>
<td>Fort Barnard Supply Main</td>
<td>Expansion</td>
<td>Funded in prior CIP</td>
<td>$1,600,000</td>
</tr>
<tr>
<td>L</td>
<td>Fort Myer Heights</td>
<td>Expansion</td>
<td>Funded in prior CIP</td>
<td>TBD</td>
</tr>
<tr>
<td>M</td>
<td>Potomac River Crossing</td>
<td>Expansion</td>
<td>Funding beyond FY 24</td>
<td>TBD</td>
</tr>
<tr>
<td>N</td>
<td>300 Block of 10th Street South and Crystal Drive</td>
<td>Expansion</td>
<td>Funded in prior CIP</td>
<td>TBD</td>
</tr>
<tr>
<td>O</td>
<td>Glebe Road – Old Glebe Road to Little Falls Road</td>
<td>Non-Expansion</td>
<td>Funded in prior CIP and proposed in FY15 to 24 CIP</td>
<td>TBD</td>
</tr>
<tr>
<td>N/A</td>
<td>Water Main Replacement/Cleaning &amp; Lining Program</td>
<td>Non-Expansion</td>
<td>Funded in prior CIP, proposed in FY15 to FY24 CIP and beyond</td>
<td>$5,800,000 per year</td>
</tr>
<tr>
<td>N/A</td>
<td>Improvements for Development</td>
<td>Expansion</td>
<td>Funded in prior CIP, proposed in FY15 to 24 CIP and beyond</td>
<td>TBD</td>
</tr>
<tr>
<td>N/A</td>
<td>Old Dominion Drive – North Thomas Street to Lorcom</td>
<td>Expansion</td>
<td>Funded in prior CIP, and currently in final design</td>
<td>$450,000</td>
</tr>
<tr>
<td>N/A</td>
<td>South Glebe Road- Long Branch to Arlington Ridge Rd</td>
<td></td>
<td>Funded in prior CIP</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>N/A</td>
<td>Large Diameter Water Main and Valve Rehabilitation Programs</td>
<td>Non-Expansion</td>
<td>Funded in prior CIP, proposed in FY15 to 24 CIP and beyond</td>
<td>TBD</td>
</tr>
<tr>
<td>N/A</td>
<td>Surge Protection</td>
<td>Non-Expansion</td>
<td>Funded in prior CIP, proposed in FY15 to FY24 CIP and beyond</td>
<td>TBD</td>
</tr>
</tbody>
</table>

*When projects are initially funded, an alignment study is done. Funding in later years provides for preliminary engineering, final design and construction. With each step of the process the scope of the projects and funding needs become more defined. Project funding is shown as TBD when project information is too preliminary to provide a funding range.
**Improvements for Development**

The County has allocated funding for continuing a water main beyond the limits constructed by a developer. These projects may also include work to upsize or abandon existing mains and complete loops in areas already developed. When hydraulic evaluations indicate a need for larger mains, but the development generating the increase in demand is by-right, this funding may be used to do entire projects. These projects may be funded by infrastructure availability fees, Paygo or Bonds.

**Large Diameter Water Main and Large Valve Rehabilitation Programs**

The County has a program to rehabilitate large diameter (20- to 36-inch) mains with internal joint seals, re-lining or other innovative technologies to prolong the life of these assets. Due to the high cost of doing comprehensive rehabilitation of large diameter water mains, replacement may be a more cost effective option.

The Large Valve Rehabilitation Program replaces inoperable large valves and addresses PRV issues. This work requires extensive planning and coordination on critical asset infrastructure. This work is important because it allows staff to more effectively isolate large mains when they need repair or replacement. The CIP allocates funds for these two programs every year throughout the ten-year CIP.

**Surge Protection**

The County will be conducting a study to incorporate surge protection that mitigates pressure fluctuations within the pressure zones that do not have water storage tanks. Funding will be programmed under non-expansion.

**Storage Improvements**

The evaluation results indicate that the existing storage volume exceeds the required volume based on the County criteria and state regulations. While additional volume provides security in an emergency, excess volume can be detrimental to water quality due to increased water age.

At the Minor Hill Reservoir site, to help mitigate water age issues, free standing mixers were installed in each of the four reservoirs in 2010. In addition, piping in the vicinity of the four Minor Hill cells will be updated in conjunction with the Williamsburg transmission main project. The changes will improve the circulation patterns through the reservoir site.

Water quality at all of the tanks is monitored for disinfectant levels. In the future, to mitigate tank stratification and water age concerns, the need for mixers will be evaluated for the Lee ground storage and Fort Barnard reservoirs. The County has available land at the Lee reservoir site and could accommodate up to another 6 MG of ground storage or an elevated storage tank which would lessen the peak pumping requirements for the zone. Although the County has adequate storage based on the forecasted demands and existing firm pumping capacity, it is recommended that the County retain this area in the event that future water storage is needed for capacity, redundancy, or replacement of a deteriorating facility.

Since the 1992 Water System Master Plan, County staff has been regularly inspecting and upgrading water storage facilities. Improvements to these facilities are included in the 10-year CIP. As future needs arise based on inspections, the CIP will be revised to incorporate needed projects.

The County has allocated funding for the maintenance and rehabilitation of the storage tanks at Minor Hill, Lee, and Fort Barnard. The CIP allocates funds for this program throughout the ten year CIP and beyond.

**Pump Station Improvements**

All pump stations, with the exception of Little Falls, have been upgraded or are in design. Therefore, no major upgrade or new pump station project is anticipated beyond what is in the 10-year CIP for the 2040 water system configuration. Capital costs for pump stations will be routine maintenance or upgrades to
electrical controls and SCADA systems. However, as with the other existing facilities, the stations should be regularly evaluated to determine if upgrades are necessary.

**Miscellaneous Improvements**

**Technology Enhancements**

The County plans to upgrade its current asset management system and acquire software that will be fully integrated with Geographical Information Systems (GIS) technology. The system would have the ability to handle asset management and work orders for all of the WSS Bureau’s public assets and could potentially be expanded to other County-owned assets (infrastructure, transportation, facilities, fleet, and natural resources (e.g. parks, trees, streams, etc.).

Other systems such as Supervisory Control and Data Acquisition (SCADA) and Automated Meter Reading (AMR) are being looked at for future enhancements under this funding category.

**Utilities Information Billing System**

This project replaces the Utilities Information Billing System (UIBS), which was implemented in 1996. This system bills customers for water, sewer, and refuse. As UIBS bills for refuse, which is not within the scope of Utilities, a non-Utilities funding source will contribute toward the project cost.

**Washington Aqueduct Capital Program**

The Washington Aqueduct Capital Program provides the County’s share of funding for capital improvements to the water treatment plant managed by the U.S. Army Corps of Engineers’ Washington Aqueduct Division. The Aqueduct’s capital budget is approved by its three customers (DC Water, Fairfax Water, and Arlington County) during the annual budget process. The CIP allocates funds for this program throughout the ten year CIP and beyond.

**Cost Estimates**

Based on the system improvements, County staff have identified existing and projected future capital needs for the County water distribution system. Table 9 includes planning-level cost estimates for larger capital projects and identifies whether the funding is in place or proposed in future CIP’s. The majority of the projects are directed towards the correction of existing deficiencies in the water system. Preliminary engineering and final design for each project will refine details and routing of the projects, and their scopes and construction costs estimates will change. Analysis of additional emergency scenarios is likely to identify additional deficiencies and projects.

In fiscal year (FY) 2013, Arlington County began programming its capital expenditures for a ten-year period in its annual CIP. Utilizing needs assessments and cost estimates prepared by County staff and WR&A, a proposed FY 2015 to 2024 CIP for the water system is provided and will be put forward for approval by the County Board.

Over the 10-year period, funding will be needed to repair and replace critical assets determined through routine asset management practice, including water main construction, storage facility repair, and pump station upgrade. The CIP is included to provide guidance in planning future facility improvements. Actual funding allocations will be determined annually based upon County priorities and fiscal conditions.

**Revenue Sources**

In Arlington, investments in capital facilities for water projects are generally funded by four sources: "pay as you go" capital funds (Utility Fund), bond issues, the Utilities Fund, and Infrastructure Availability Fees. Each
funding source will vary in the quantity of money that it can provide and the restrictions placed on expenditures.

**Pay As You Go (Utility Fund)**

The "pay as you go" funds are specific item appropriations from the County's annual budget. They have the fewest use restrictions of any financing method. However, with the County required to balance its annual budget, funding for capital projects must compete against other utility funding needs, particularly during periods of high fiscal stress.

The Utilities Fund was created as a self-sustaining, fee-based enterprise under state code to support and maintain development of the County's water and sewer infrastructure. The County's Utilities Fund is an enterprise fund which allows municipal service providers to charge a fee in exchange for goods or services. Under enterprise accounting, the revenues generated from services provided are managed separately from the revenues and expenses of other government activities. CIP development may receive funding from the Utilities Fund based on the conclusions drawn from the following considerations:

- Master Plans
- Permits and Regulatory Requirements
- Current Fund Balances
- Revenue projections (Infrastructure Availability Fee revenue)
- Impact on Water/Sewer Rate
- Technology
- Future Regulations

**Bonds**

Bonds are often used to pay for public infrastructure improvements that are expected to have a long service life. Their long payback period spreads the costs across many years and fluctuations in economic conditions. Unlike "pay as you go" financing, bond issues require approval by the Arlington voters. Bond funds are restricted to the specific uses and programs determined by the voters. Historically, Arlington bond issue votes have been proposed only in the even-numbered years.

**Infrastructure Availability Fee**

Infrastructure Availability Fee revenues are collected from new developments that are connecting to the Arlington water and sanitary sewer systems. These fees are assessed to developers and builders to join the water and sewer system based on the cost of capacity (volume) of the systems for the customers in the new development. These funds are programmed during the annual budget process and can be used only for utilities projects. The amount of funds collected depends upon the pace of development in the County, and tends to follow local economic conditions. During periods when the economy is weak and there is little new development, Infrastructure Availability Fees drop.

**Summary**

It is recommended that the water system improvements implementation plan summarized in this master plan be reviewed and updated periodically to ensure that the system improvements and associated funding are being cost-effectively spent in pace with growth and development patterns. Local factors such as right-of-way acquisitions and street paving or road repair construction may also affect the implementation schedule and should be considered in updating the implementation plan.