EXECUTIVE SUMMARY

This study presents an updated Water Distribution System Master Plan for the City of Rockville, Maryland. The purpose of this study was to evaluate the existing water distribution system and develop a program of recommended improvements to correct deficiencies found and meet future requirements. The scope of the study included the following:

- Analyze system demands based on the City's population and growth projections in order to determine future water requirements.
- Perform field tests to assess water loss within the system.
- Conduct a series of field tests to assess whether pipes are big enough and whether flow through pipes is being restricted due to factors such as whether closed valves or corrosion on the interior surface of the pipes.
- Convert the City's existing hydraulic computer model of the distribution system into a new, more detailed model which works with the City's geographic information system. Use the results of the demand analysis and the field testing program to develop and calibrate the new model.
- Utilize the new model to analyze water age and water tank storage volume, in order to identify causes of increased water age in the system.
- Evaluate the system using the new model and develop a program of recommended system improvements.

The following paragraphs describe the results of the field testing, modeling, and analyses and summarize the recommended program of improvements.

Evaluation of the Existing System

Average day demands for the system were estimated at 6.32 mgd in 2015 and 6.47 mgd in 2030, based on City Planning Department population and development projections. Using a maximum day factor of 1.7 calculated from historical trends, maximum day demands were then estimated at 10.74 mgd in 2015 and 11.00 mgd in 2030.

Based on the demand projections, the volume of water stored in tanks within the system was evaluated. It was determined that the total of 12 million gallons of storage within the distribution system's three water tanks will be sufficient through 2030, provided that the WSSC emergency interconnections remain in place; otherwise, a need for an additional 1.72 million gallons of storage is predicted for 2030.

The field testing program and modeling analysis found that the trunk mains (mains 12-inches in diameter or larger which distribute water throughout the system) were generally sufficient to serve the system with the exception of sections of mains along Lewis Avenue, Southlawn Lane, and Stonestreet Avenue where new pipes or larger replacement pipes were recommended. In the past, master plans typically focused on trunk mains, and the limitations of earlier generations of hydraulic computer models made it difficult to analyze all pipes within a system. Consequently, the trunk mains were the focus of the improvement program in the previous water distribution system master plan. The City has completed the majority of the recommended improvements from the previous master plan, and the results of the current study indicate that these efforts were successful in reinforcing the trunk main system.. However, the current study also analyzed the grid mains (mains 8-inches in diameter or smaller which serve individual streets and neighborhoods), and approximately 50 miles of grid mains (or 25% of the total length of pipe in the system) were found to have insufficient flow. Many of these pipes are approximately 50 years old or more. The leakage study portion of the field testing program concluded that only one area, in the northeast portion of the City where a portion of these older grid mains are located, showed significant signs of leakage. Thus, improvements to these grid mains would address both low flow and leakage issues.

While the City has only limited records as to the exact age and pipe material for these older pipes, based on the records that are available and the results of the field testing, it appears likely that a majority of the City's deteriorating water mains are unlined, cast iron pipes. Unlined, cast iron pipes are susceptible to tuberculation, in which a buildup of corrosion products on the interior wall of the pipe reduces the amount of flow that the pipe can carry. This would explain the low flows found during the field tests. These pipes tend to deteriorate with age more rapidly and continually as compared to more modern, lined pipes, which tend to deteriorate less overall, with the deterioration reaching a plateau and then stabilizing over time.

Therefore, it is expected that that the condition of the City's unlined, cast iron pipes will continue to degrade over time. The average life expectancy of pipes installed in the post-World War II era has been reported as 75 years[1]. Beyond the 50-year mark, it is not uncommon for these pipes to become hydraulically restricted and structurally more apt to break. With many water systems in the U.S. having been built in the 1930-40's, thousands of utilities like the City of Rockville are now facing for the first time the significant cost of replacing long-term assets such as these pipes.

The low flows found in many of these older mains may make it more difficult to fight fires in areas with the deteriorated pipes. The City has also experienced water quality issues such as red water complaints in areas with these older pipes. Also, breaks on these older pipes appear to be increasing based upon the City's water main break history, placing an added maintenance cost burden on the City and causing inconvenience to Rockville residents and the general public. The number of water main breaks in the City in 2007 was the highest on record, totaling 65 breaks. Thus, this is an infrastructure problem with multiple public health, safety, and welfare implications, as well as impacts on City operations and maintenance. If the City does not take a proactive approach to addressing these issues now, more and more reactive maintenance will be required in the future. Because these aging grid mains make up a significant percentage of the total length of pipe in the system and because pipe replacement is costly, the City needs to act now to begin the long-term process of replacing these pipes.

Cleaning and lining these pipes was considered as an alternative to replacement. Cleaning and lining involves a lower initial cost than replacement and is a widely used technique for rehabilitating aging cast iron mains; however, it has several disadvantages. For example, the standard technique of cleaning and then lining with cement mortar or epoxy does not improve the structural integrity of the pipe. In fact, the cleaning process may cause damage to the pipe; WSSC has experienced an increase in breaks following cleaning and lining and has chosen to discontinue its cleaning and lining program. If the structural integrity of the pipe has already been compromised due to internal corrosion, then cleaning and lining may result in a shorter service life and higher life cycle cost than replacement. Based on the

[1] National Research Council of the National Academies, Water Science and Technology Board, *Public Water Supply Distribution Systems: Assessing and Reducing Risks-First Report*, 2005.

insufficient flows and the recent increase in pipe breaks, it is probable that the structural condition of many of the City's cast iron pipes is poor. Even if cleaning and lining itself does not damage the pipes, if the average life expectancy of the City's cast iron pipes is 75 years and many of the pipes are already 50-60 years old, then only 15-25 years of service life remain. While replacement is 2-3 times the initial cost of cleaning and lining, it also offers an opportunity to replace deteriorated valves, hydrants, and connections to houses, as well as upsize mains, providing a more complete renewal of the system. Based on the advantages and disadvantages considered, City staff is recommending the replacement alternative.

Recommended Improvements

A water system infrastructure renewal program consisting of gradually replacing older cast iron mains and installing reinforcements in various areas throughout the system is recommended to address the issues found during the evaluation. The renewal program includes a total of 33 miles of pipe to be replaced or added within a 15-year timeframe, at a total cost of $53 million in 2008 dollars. Utilizing a historical annual average inflation rate of 3%, the total 15-year program cost for replacing 33 miles of pipe was projected at $63 million. In addition to the improvements identified in this study, City maintenance staff have also identified several mains that need to be replaced due to pipe size and material, leakage, and age. These projects include a 16-inch steel water main, air release valves, and several 2- and 4-inch pipes located throughout the City. The additional costs for this work total approximately $4 million, which brings the total cost of the water system infrastructure renewal program to $67 million.

The pipes included in the recommended improvement program are shown in Figure ES-1, and a list of the improvements with planning-level cost estimates is provided in Table ES-1. The improvements were divided into four groups and prioritized as discussed below.

The Group 1 improvements were developed with the goal of providing immediate improvements spread throughout the City by decreasing water main breaks, increasing fire flows, and improving water quality. In each area, an interconnected system of pipes was selected for replacement, as shown in Figure ES-1. An improvement schedule is listed in Table ES-1; however, timing of these projects may

vary according to maintenance needs, such as the frequency and magnitude of water main breaks. Barring any changes needed due to main breaks or maintenance issues, it is recommended that the projects be completed in the order shown. This order was developed to provide fire flow improvements expeditiously, minimize the number and frequency of interruptions to water service and resulting inconvenience to City residents, and group together projects that must be completed together in order to attain the overall improvement desired.

The Group 2 improvements are distributed across the City, continuing to replace old pipes and improve flows throughout the whole City. Groups 3 and 4 include the remaining pipe replacements needed to increase flows in low flow areas.

The City considered a 10-, 15-, and 20-year timeframe for the Group 1-4 improvements. A short-term rate of replacement averaging 2.2 miles of pipe per year (or a 15-year program for Groups 1-4) was selected as a level which would reduce the risks associated with further pipe deterioration while maintaining a fiscally responsible and practical approach to project implementation. Beyond the initial 15-year period, it is recommended that the City continue to periodically re-examine the condition of the system and identify additional pipes for replacement.

Additional recommendations include storage and pumping projects which may occur beyond the 15-year period planned for the pipe system improvements. These may address water age issues and future storage deficiencies should the City not retain its emergency interconnection agreements with WSSC. The projects are listed in Table ES-2, and include a re-pump station at the Hunting Hill Ground Storage Tank and replacement of the Carr Avenue Standpipe with an elevated tank. The total estimated cost for these projects is $11 million in 2008 dollars. Further study and water sampling is recommended in order to fully evaluate the need for these projects.

Table ES-1 – Recommended Pipe Maintenance/Replacement Projects as Identified using the Hydraulic Computer Model, FY2009 – FY2023

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
1	2009	REPLACEMENT	12	Lewis Avenue: Halpine Rd to Broadwood Dr	4,600	---	---[3]
1		REPLACEMENT	8	Crawford Drive: Broadwood Dr to Ardennes Ave	2,145	$326	$699,000
1			8	Crawford Drive: Broadwood Dr to Ardennes Ave	57	$326	$19,000
1		REPLACEMENT	8	Thornden Road: Lewis Ave to Crawford Dr	2,056	$326	$670,000
1		REPLACEMENT	8	Rockland Avenue: Lewis Ave to Thornden Rd	2,376	$326	$775,000
			8	Rockland Avenue: Lewis Ave to Thornden Rd	241	$326	$79,000
1		REPLACEMENT	8	Broadwood Drive: Lewis Ave to Veirs Mill Rd	1,730	$326	$564,000
			8	Broadwood Drive: Lewis Ave to Veirs Mill Rd	1,172	$326	$382,000
1		REPLACEMENT	8	Orchard Way S: loop south of Kersey Ln	1,619	$326	$528,000
1		REPLACEMENT	8	Kersey Lane from Falls Rd to Milboro Dr	813	$326	$265,000
						2009 Subtotal	**$3,981,000**
1	2010	REPLACEMENT	8	Vandergrift Avenue and Atlantic Avenue: Lewis Ave	4,700	$326	$1,532,000
1		REPLACEMENT	8	Broadwood Drive: Veirs Mill Rd to Baltimore Rd	2,737	$326	$892,000
1		REPLACEMENT	8	Edmonston Drive: Veirs Mill Rd to Baltimore Rd	2,019	$326	$658,000
1		REPLACEMENT	8	Lincoln Street: Horners Ln to Neal Dr	2,348	$326	$765,000
			8	Lincoln Street: Horners Ln to Neal Dr	232	$326	$76,000
1		REPLACEMENT	8	Pinewood Road: Lincoln St to Southlawn Ln	2,155	$326	$703,000
			8	Pinewood Road: Lincoln St to Southlawn Ln	299	$326	$97,000
1		REPLACEMENT	8	Lofstrand Lane and Taft Street: Pinewood Rd to 1st	1,405	$326	$458,000
1		NEW PRV	8	Southlawn PRV from WSSC	14	---	$125,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
1	2010	LOOP	8	Lofstrand Lane north of Taft St	235	$326	$76,000
1		LOOP	8	Lofstrand Lane south of Taft St	399	$326	$130,000
1		EXTENSION	12	Southlawn Lane to Lofstrand Ln	973	---	---[3]
						2010 Subtotal	**$5,512,000**
1	2011	REPLACEMENT	8	Charles Street: Crabb Ave to Baltimore Rd	1,719	$326	$560,000
1		REPLACEMENT	8	Park Road: S Horners Ln to Charles St	1,045	$326	$341,000
		NEW PIPE	8	Park Road: S Horners Ln to Charles St	80	$326	$26,000
1		REPLACEMENT	8	Crabb Avenue: Stonestreet Ave to 1st St	2,786	$326	$908,000
			8	Crabb Avenue: Stonestreet Ave to 1st St	842	$326	$274,000
1		NEW PIPE	12	Stonestreet Avenue: 16" in Park Rd to Frederick Ave	3,579	---	---[3]
1		REPLACEMENT	8	Stonestreet & Ashley Avenues: Frederick Ave to Westmore Ave	1,956	$326	$638,000
1		REPLACEMENT	8	Reading Avenue: Mapleton Rd to Grandin Ave	284	$326	$93,000
		CONNECT	8	Tie-in 6" to 16" at Grandin Ave and Reading Ave	74	$326	$24,000
1		REPLACEMENT	8	Mt Vernon Place: Rockville Pike to Colonist Ct	2,293	$326	$748,000
1		CONNECT	12	Research Blvd & Research Pl	28	$344	$10,000
1		CONNECT	12	Research Blvd & Research Ct	48	$344	$17,000
1		REPLACEMENT	8	Wood Lane: Adams St to Washington St	122	$326	$40,000
		REPLACEMENT	8	Wood Lane: Adams St to Washington St	453	$326	$148,000
1		REPLACEMENT	8	Washington Street: North St to Rockville Pike	1,068	$326	$348,000
1		REPLACEMENT	8	Martins Lane: Washington St to Bickford Ave	1,063	$326	$347,000
1		REPLACEMENT	8	Bickford Avenue: heading north from Martins Ln	485	$326	$158,000
1		REPLACEMENT	8	Van Buren Street: Beall Ave to North St	603	$326	$197,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
			8	Van Buren Street: Beall Ave to North St	686	$326	$224,000
1		REPLACEMENT	8	Beall Ave & Adams St: connect 8" to 16"	15	$326	$5,000
1		CONNECT	8	Beall Ave & Van Buren: connect 8" to 16"	30	$326	$10,000
						2011 Subtotal	**$5,116,000**
1	2012	NEW PIPE	8	Blanford Street: Mt Vernon Pl to Argyle St	245	$326	$80,000
1		REPLACEMENT	8	Blanford Street: Cabin John Pky to Argyle St	911	$326	$297,000
1		REPLACEMENT	8	Harrington Road: Edmonston Dr to Mercer Rd	1,485	$326	$484,000
1		REPLACEMENT	8	Mercer Road: Harrington Rd to Mt Vernon Pl	679	$326	$221,000
1		REPLACEMENT	8	Bowie Road: Harrington Rd to Brice Rd	1,294	$326	$422,000
1		REPLACEMENT	8	Key West Avenue: 8" pipe sections	1,690	$326	$551,000
1		REPLACEMENT	8	Orchard Way N: loop north of Kersey Ln	2,591	$326	$845,000
1		REPLACEMENT	8	Stratton Drive: Lancanshire Dr to Dunster Ln	2,367	$326	$772,000
1		REPLACEMENT	8	Mannakee Street: Montgomery Ave to Carr Ave	1,263	$326	$412,000
1		PARALLEL	12	Lewis Avenue: Edmonston Dr to Broadwood Dr	1,140	---	---[3]
1		PARALLEL	16	Lewis Avenue: Edmonston Dr to 1st St	2,191	---	---[3]
1		NEW PRV	12	PRV at Lewis Avenue and Broadwood Dr	28	---	$143,000
						2012 Subtotal	**$4,227,000**
2	2013	REPLACEMENT	8	Anderson Avenue: Nelson St to Lynch St	2,730	$326	$890,000
2		REPLACEMENT	8	Wade Avenue: Simmons Dr to Veirs Mill Rd	1,308	$326	$426,000
2		NEW PIPE	8	Falls Road: Dunster Rd to Kersey Ln	1,453	$326	$474,000
2		REPLACEMENT	8	Stanley Avenue: Thornden Rd to Rockland Ave	2,168	$326	$707,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
2		REPLACEMENT	8	RidgeWay Avenue: Rockland Ave to Ardennes Ave	1,171	$326	$382,000
2		REPLACEMENT	8	Lemay Road: Holland Rd to Ardennes Ave	2,472	$326	$806,000
						2013 Subtotal	$3,685,000
2	2014	REPLACEMENT	8	Wainright Avenue: Ridgeway Ave to Atlantic Ave	1,675	$326	$546,000
2		REPLACEMENT	8	Midway Avenue: Stillwell Rd to Aleutian Ave	863	$326	$281,000
2		REPLACEMENT	8	Crawford Drive: Ardennes Rd to Atlantic Ave	1,452	$326	$473,000
2		REPLACEMENT	8	Matthews Drive: Lewis Ave to Rockland Ave	696	$326	$227,000
			8	Matthews Drive: Lewis Ave to Rockland Ave	306	$326	$100,000
2		REPLACEMENT	8	Parrish Drive: Lewis Ave to Crawford Dr	1,913	$326	$624,000
2		REPLACEMENT	8	Burris Road: Broadwood Dr to Coral Sea Ave	736	$326	$240,000
2		CONNECT	8	Coral Sea Avenue: Burris Rd to Okinawa Ave	114	$326	$37,000
2		REPLACEMENT	8	Langbrook Place: Burris Rd to Coral Sea Ave	347	$326	$113,000
						2014 Subtotal	**$2,641,000**
2	2015	REPLACEMENT	8	Henry Road: Broadwood Dr to Parrish Dr	865	$326	$282,000
			8	Henry Road: Broadwood Dr to Parrish Dr	187	$326	$61,000
		NEW PIPE	8	Henry Road: Parrish Dr to Thorden Rd	350	$326	$114,000
2		REPLACEMENT	8	Highwood Road: Lewis Ave to Henry Rd	682	$326	$222,000
2		REPLACEMENT	8	Halsey Road: Henry Rd to Ardennes Ave	1,506	$326	$491,000
2		REPLACEMENT	8	Denfield Road: Midway Ave to Atlantic Ave	1,134	$326	$370,000
2		REPLACEMENT	8	Twinbrook Parkway: Rockville Pike to Rollins Ave	1,097	$326	$358,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
2		REPLACEMENT	8	Chapman Avenue: Thompson Ave to Twinbrook Pkwy	635	$326	$207,000
			12	Chapman Avenue: Thompson Ave to Twinbrook Pkwy	18	$344	$6,000
						2015 Subtotal	**$2,111,000**
2	2016	REPLACEMENT	8	Martha Terrace: loop off Rollins Ave	1,602	$326	$522,000
2		REPLACEMENT	8	Rollins Avenue: Evelyn Dr to easement east of Evelyn Dr	239	$326	$78,000
2		REPLACEMENT	8	Evelyn Drive: Rollins Ave to Muriel St	324	$326	$106,000
2		REPLACEMENT	8	Congressional Lane: Rollins Ave to Muriel St	64	$326	$21,000
			8	Congressional Lane: Rollins Ave to Muriel St	175	$326	$57,000
2		REPLACEMENT	8	Muriel Street: Evelyn Dr to Congressional Ln	1,105	$326	$360,000
2		REPLACEMENT	8	Lorraine Drive: Congressional Ln to Jefferson St	1,010	$326	$329,000
			8	Lorraine Drive: Congressional Ln to Jefferson St	14	$326	$5,000
2		REPLACEMENT	8	Wilmart Street-Nina Place: Muriel St to Lorre Dr	838	$326	$273,000
2		REPLACEMENT	8	Lorre Drive: Nina Pl to Lorraine Dr	605	$326	$197,000
3		REPLACEMENT	8	Paul Drive: Gail Ave to Wade Ave	922	$326	$301,000
3		REPLACEMENT	8	Grandin Avenue: Norbeck Rd to Nimitz Ave	4,324	$326	$1,410,000
			8	Grandin Avenue: Norbeck Rd to Nimitz Ave	1,070	$326	$349,000
						2016 Subtotal	**$4,008,000**
3	2017	REPLACEMENT	8	Maple Avenue and Clagett Drive: Norbeck Rd to Veirs Mill Rd	3,976	$326	$1,296,000
3		REPLACEMENT	8	Woodburn Road: Grandin Ave to Baltimore Rd	1,536	$326	$501,000
3		REPLACEMENT	8	Scott Avenue: Woodburn Rd to Gilbert Pl	1,497	$326	$488,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
3		REPLACEMENT	8	Gilbert Road and Place: Woodburn Rd to Scott Ave	1,673	$326	$545,000
3		REPLACEMENT	8	Dean Drive: Grandin Ave to Bradley Ave	1,565	$326	$510,000
			8	Dean Drive: Grandin Ave to Bradley Ave	24	$326	$8,000
						2017 Subtotal	**$3,348,000**
3	2018	REPLACEMENT	8	Gladstone Drive: Baltimore Rd to Dean Dr	1,839	$326	$600,000
			8	Gladstone Drive: Baltimore Rd to Dean Dr	417	$326	$136,000
3		REPLACEMENT	8	Cedar Lane: Veirs Mill Rd to Marshall Ave	1,334	$326	$435,000
3		REPLACEMENT	8	McAuliffe Drive: Cedar Ln to Bradley Ave	1,176	$326	$383,000
3		REPLACEMENT	8	Gruenther Avenue: Broadwood Dr to Linthicum St	1,553	$326	$506,000
3		REPLACEMENT	8	Marshall Avenue: Broadwood Dr to Gruenther Ave	1,678	$326	$547,000
3		REPLACEMENT	8	Mapleton Road: Reading Ave to Joseph St	696	$326	$227,000
3		REPLACEMENT	8	Stonestreet Avenue: Park Rd to Highland Ave	547	$326	$178,000
			8	Stonestreet Avenue: Park Rd to Highland Ave	28	$326	$9,000
						2018 Subtotal	**$3,021,000**
3	2019	REPLACEMENT	8	Woodland Road and MacArthur Drive: Stonestreet Ave to Charles St	2,500	$326	$815,000
3		REPLACEMENT	8	Grandin Avenue: Crabb Ave to England Ter	795	$326	$259,000
3		REPLACEMENT	8	Virginia Avenue: Crabb Ave to England Ter	799	$326	$260,000
3		REPLACEMENT	8	England Terrace & Grandin Ave: Stonestreet Ave to Highland Ave	1,509	$326	$492,000
			8	England Terrace & Grandin Ave: Stonestreet Ave to Highland Ave	33	$326	$11,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
3		REPLACEMENT	8	Baltimore Road: Stonestreet Ave to Charles St	1,391	$326	$453,000
3		REPLACEMENT	8	Taylor Avenue: Baltimore Rd to MacArthur Dr	1,093	$326	$356,000
3		REPLACEMENT	8	Robert Road: Taylor Ave to 1st St	482	$326	$157,000
3		REPLACEMENT	8	Lawrence Drive & Court: Taylor Ave to Robert Rd	1,055	$326	$344,000
						2019 Subtotal	**$3,147,000**
3	2020	REPLACEMENT	8	Avery Road: Baltimore Rd to Lyon Pl	1,497	$326	$488,000
3		REPLACEMENT	8	Neal Drive: Lincoln St to dead-end-north	949	$326	$309,000
3		REPLACEMENT	8	Wesley Road and Wesley Court	976	$326	$318,000
3		REPLACEMENT	8	Woodston Road: Burgundy Dr to Longwood Dr	869	$326	$283,000
3		REPLACEMENT	8	Croydon Avenue: Park Rd to MacArthur Dr	292	$326	$95,000
3		REPLACEMENT	8	Howard Avenue: Stonestreet Ave to Horners Ln	1,544	$326	$503,000
3		REPLACEMENT	8	Spring Avenue: Stonestreet Ave to Douglas Ave	788	$326	$257,000
3		REPLACEMENT	8	Lenmore Avenue: Spring Ave to Frederick Ave	521	$326	$170,000
3		REPLACEMENT	8	Douglas Avenue: from Frederick Ave to Lincoln Ave	1,066	$326	$348,000
3		REPLACEMENT	8	Elizabeth Avenue: Stonestreet Ave to Westmore Ave	951	$326	$310,000
3		REPLACEMENT	8	Westmore Avenue: Frederick Ave to Ashley Ave	892	$326	$291,000
3		REPLACEMENT	8	Moore Drive: Frederick Ave to Westmore Ave	874	$326	$285,000
						2020 Subtotal	**$3,657,000**
4	2021	REPLACEMENT	8	North Street: Washington St to McLane Ct	1,492	$326	$486,000
4		REPLACEMENT	8	Dawson Avenue: Van Buren St to Washington St	714	$326	$233,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
4		REPLACEMENT	8	Forest and Dawson Avenues: Carr Ave to Van Buren St	1,015	$326	$331,000
4		REPLACEMENT	8	Beall Avenue: Owens St to Lynch St	2,961	$326	$965,000
4		REPLACEMENT	8	Balmoral Drive: Dundee Rd to Glenmore Ter	737	$326	$240,000
4		REPLACEMENT	8	Glenmore Terrace: Glenmore Ln to dead-end east of Balmoral Dr	1,355	$326	$442,000
						2021 Subtotal	**$2,697,000**
4	2022	REPLACEMENT	8	Dunster Lane: Stratton Dr to Canterbury Way	1,638	$326	$534,000
4		REPLACEMENT	8	Canterbury Way: Stratton Dr to Dunster Ln	861	$326	$281,000
4		REPLACEMENT	8	Selwothy Road: Dunster Ln to Stratton Dr	874	$326	$285,000
4		REPLACEMENT	8	Monroe Street: Cabin John Pkwy to Jefferson St	2,470	$326	$805,000
4		REPLACEMENT	8	Lynfield Drive and Argyle Street: Cabin John Pkwy to Blandford St	1,299	$326	$423,000
4		REPLACEMENT	8	Waddington easement: Waddington Ln to Cabin John Pkwy	1,317	$326	$429,000
4		REPLACEMENT	8	Cabin John Parkway: Leverton Rd to Edmonston Dr	1,026	$326	$334,000
			8	Cabin John Parkway: Leverton Rd to Edmonston Dr	40	$326	$13,000
4		REPLACEMENT	8	Leverton Road: Cabin John Pkwy to Carter Rd	624	$326	$203,000
4		REPLACEMENT	8	Carter Road: Leverton Rd to Edmonston Dr	910	$326	$297,000
4		REPLACEMENT	8	Harrington Road: Leverton Rd to Edmonston Dr	922	$326	$301,000
						2022 Subtotal	**$3,905,000**
4		REPLACEMENT	8	Brice Road: Mercer Rd to Julian Pl	2,420	$326	$789,000
4		REPLACEMENT	8	Gail Avenue: Paul Dr to Veirs Mill Rd	612	$326	$200,000

Group	Year	Type of Work	Size (in.)	LOCATION	Length (LF)	Unit Cost ($/LF)[1,2]	Project Cost ($)[1]
4		REPLACEMENT	8	Crawford Drive: Gail Ave to Wade Ave	872	$326	$284,000
4		REPLACEMENT	8	Debeck Drive: Lewis Ave to Wade Ave	1,446	$326	$471,000
4		REPLACEMENT	8	Clagett Drive: Lewis Ave to Veirs Mill Rd	2,284	$326	$745,000
						2023 Subtotal	**$2,489,000**
				TOTAL	**163,459**		**$53,545,000**

[1]Unit costs are based on recent bids for similar projects and represent project costs, including design, construction, and construction administration/inspection.
[2]Costs shown are in 2008 dollars.
[3]Cost for this project has already been incorporated into the City's CIP and is therefore not included here.

Table ES-2 – Recommended Storage and Pumping Improvements

Type of Work	Location	Project Cost ($)[1,2]
New Pump Station	Re-Pump Station at Hunting Hill Ground Storage Tank	$6,000,000
Tank Replacement	Demolish Carr Avenue Standpipe and Replace with 2 MG Carr Avenue Elevated Tank	$5,000,000
	TOTAL	**$11,000,000**

[1]Project cost, including design, construction, and construction administration/inspection.
[2]Costs shown are in 2008 dollars.