DISTRICT OF COLUMBIA
WATER AND SEWER AUTHORITY
Serving the Public ▪ Protecting the Environment

Sewer System Facilities Plan
Executive Summary

June 2009

Engineering Program Management Consultant-3A

GREELEY AND HANSEN

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Note to Readers

This Sewer System Facilities Plan, drafted in 2008, identifies a comprehensive program to address currently known problems in the sewer infrastructure and a proactive component for annual system renewal. It specifically addresses the needs of the District of Columbia's sewer system outside of the Blue Plains Advanced Wastewater Treatment Plant. The draft reflected consultant recommendations that were evaluated during the year by various stakeholders within DC WASA. This 2009 publication reflects the input and guidance provided by those stakeholders.

The Facilities Plan lays out a recommended 10-year program of sewer system improvements. The Facilities Plan provides a guiding framework for sewer system investments that are implemented through the 10-year Capital Improvements Program (CIP). Through the annual CIP process, projects and needs identified in the Facilities Plan are prioritized and the most important projects are budgeted. Ultimately, the CIP reflects consideration of many factors, including impact of the proposed expenditures on customer rates, spending needs for other service areas (e.g., wastewater treatment and water infrastructure), and new sewer system needs that may emerge over the course of the year. Thus, readers are cautioned that the projects and dollars specified in this Plan will be modified through each annual CIP process.

Executive Summary

1. OVERVIEW AND PURPOSE

The District of Columbia Water and Sewer Authority (WASA or Authority) provides wastewater collection and treatment for the District of Columbia, and wastewater treatment for surrounding areas including parts of suburban Virginia and Maryland at the District's Advanced Wastewater Treatment Plant (Blue Plains). In addition, WASA has certain responsibilities for maintaining the storm sewer system as part of an agreement with the District of Columbia.

The vast majority of the sewers that were constructed more than one hundred years ago are still in operation today. The effect of age on the sewer pipes is expected to deteriorate the condition and performance of the system. It is typically much more expensive and disruptive to replace an asset than to upgrade or maintain it. The sewer system service can be maintained through a reinvestment program designed to extend the performance of the sewer system. As a result, WASA conducted this study to assess the condition of the sewers to determine what improvements were necessary to maintain and renew the system. The purpose of this study is to:

- Evaluate the condition and hydraulic capacity of critical elements of the sewer system
- Develop a records system for capturing sewer inspection data electronically
- Identify rehabilitation needs based on the assessment to extend the service life of the sewer system
- Prioritize rehabilitation needs into a practical capital improvement program
- Identify operation and maintenance practices needed to improve the functioning of the system
- Develop a program of ongoing inspection and rehabilitation to maintain the performance of the system

The sewer pumping stations were assessed by others and were therefore not addressed as part of this study. Reference information is provided so the reader understands the relationship of the pumping stations and their operation to the collection of wastewater and storm water within the city.

1.1 Regulatory Requirements

WASA is required to operate the sewer system facilities in accordance with certain regulatory requirements governed by two permits and two consent decree agreements.
The contents of this report were prepared to comply with the conditions outlined in the permits and decrees listed below:

- National Pollutant Discharge Elimination System (NPDES) Permit for Blue Plains and the Combined Sewer System
- NPDES permit for the Municipal Separate Storm Sewer System
- 3-Party (Nine Minimum Controls) Consent Decree
- Long Term Control Plan Consent Decree

The sewer assessment program included the above requirement in our review of current activities. The recommended plan maintains compliance with these regulatory requirements.

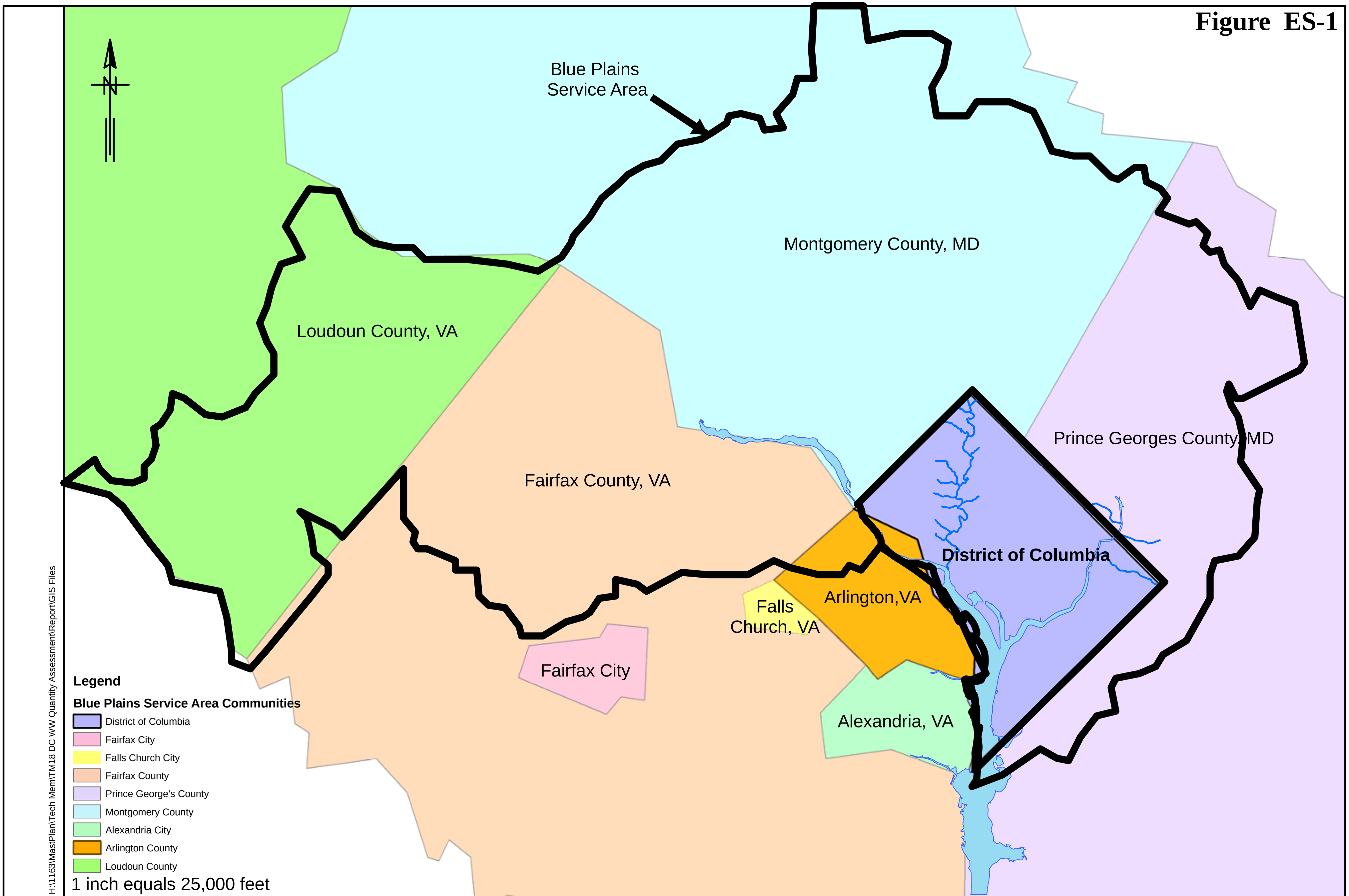
2. EXISTING SYSTEMS

WASA operates and maintains the storm, sanitary and combined sewer systems within the District of Columbia. WASA also operates and maintains the Potomac Interceptor which conveys wastewater from Maryland and Virginia to Blue Plains. The Blue Plains service area covers approximately 735 square miles. **Figure ES-1** displays the Blue Plains service area.

A schematic is presented of the major conveyance pipelines and pumping stations in the sewer system in **Figure ES-2**. It is convenient to think of the drainage areas as being divided into two subsystems - an Anacostia system and a Potomac/Rock Creek system. The Northeast Boundary, Navy Yard, Fort Stanton, and Tiber Creek drainage areas are part of the Anacostia system. The other drainage areas are part of the Potomac/Rock Creek system, with the B St/New Jersey Avenue drainage area serving as a link between the Anacostia and Potomac/Rock Creek systems. **Table ES-1** provides an inventory of the sewer system.

Table ES-1 Sewer System Inventory

Item	Estimated Quantities			
	Combined	**Separate**	**Storm**	**Total**
	Sewer Pipes (miles)			
<18-in	331	516	105	952
≥18-in to <24-in	71	37	109	217
≥24-in to <42-in	56	29	119	204
≥42-in to <72-in	46	30	53	129
≥72-in to <108-in	29	10	19	58
≥108-in	39	6	9	54
unknown	81	53	129	263
Total	**653**	**681**	**543**	**1,877**
	Structures (Each)			
Manholes	18,224	15,882	15,926	50,032
Catch basins	8,217	-	15,100	23,317



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Blue Plains Service Area

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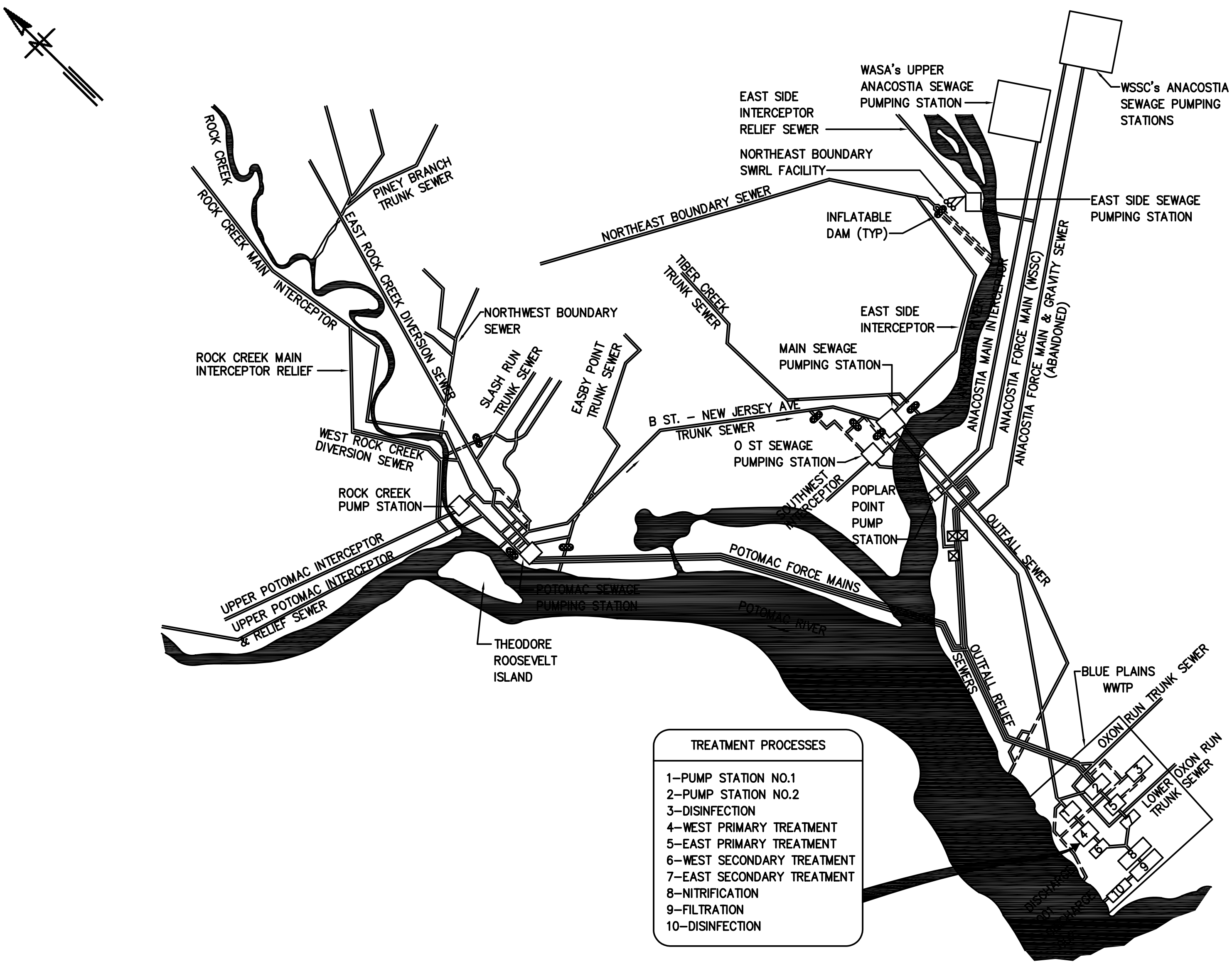
Figure ES-2



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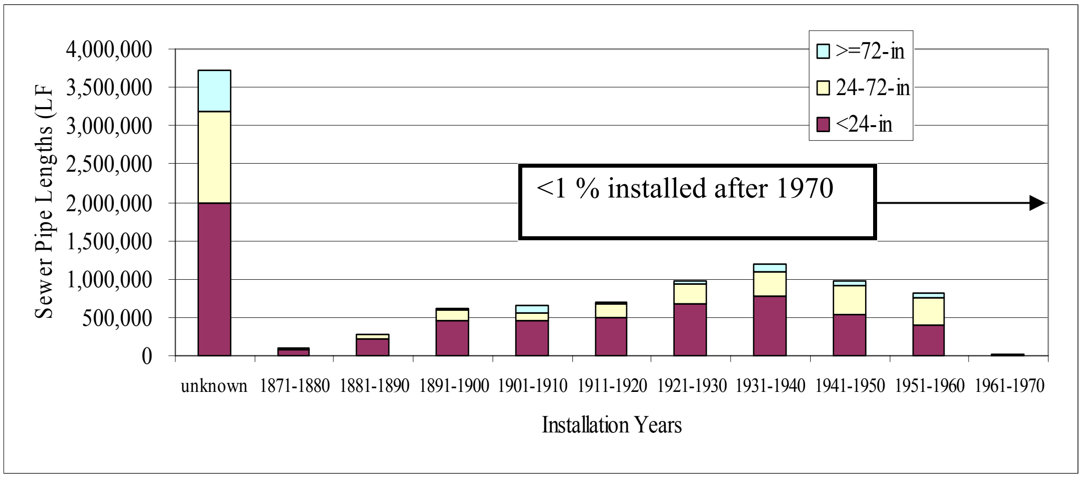
Sewer System Schematic

D.C. WATER AND SEWER AUTHORITY

Figure ES-3 shows the size distribution of sewers for various installation years expressed in 10-year increments. The pipe ages are unknown for a large inventory of pipes. However, the curve below demonstrates that the city infrastructure expanded significantly between the 1920's and 1960s. We assumed a similar distribution pattern for the pipe of unknown installation dates and concluded that most of the sewer system inventory is likely older than 50 to 75 years.

Figure ES-3 Pipe Size Distribution by Installed Date



3. DATABASE DEVELOPMENT

The purpose of the sewer database development program was to adopt an information tool that would help to organize the large amount of historical records and provide a platform where new information could be stored and easily referenced.

At the start of the program, WASA's sewer information was compiled on approximately 550 sewer counter maps. The counter maps were at scales of 1"=100' or 1"=200' and showed a plan view of the sewer system. Pipe sizes, inverts, and record drawing numbers were annotated on the plans and the background on the maps shows the street layout as it existed when the maps were originally prepared.

In order to effectively conduct the sewer assessment program, improvements to the mapping, data management and storage of information were required. The near-term program needs were to develop:

- An electronic base mapping system
- A unique numbering system for sewer facilities
- A method to perform geo-statistical analyses
- A method of storing inspection data

The method for organizing the large amount of data gathered during the Sewer Assessment Program would also need to consider WASA long-term program needs as identified below:

- On-going Inspections; A regular and systematic inspection and rehabilitation of the sewer system. A method was selected that would help identify inspection priorities, keep track of and manage data, and to produce meaningful summary reports for management.
- Maintenance Management and Work Order System; A system for storing, tracking and organizing maintenance on the system and for administering work orders to crews performing the work. WASA is currently using a computerized maintenance system which can be linked to the inspection database through MAXIMO software.
- Asset Management System; The database development system will help keep an inventory and accounting of all major capital assets. These techniques are not only limited to assets such as sewers, but also major facilities and equipment such as treatment plants, pump stations, and vehicles.

An application oriented project database was prepared, which gives:

1. Capability to interactively and graphically access, query and manipulate the data stored
2. Tools to extract reports, create projects, identify problem areas and visualize the sewer system of interest
3. Options to select and prioritize rehabilitation needs based on structural and maintenance defects statistical values
4. Cost options for selected rehabilitation and maintenance techniques

A graphical information system (GIS) of the sewer system was also developed to serve as the base mapping for the program. The GIS was developed using WASA's sewer counter maps and the D.C Governments GIS base mapping. A scanned image of the paper counter maps was overlaid on the DC GIS base mapping. The scanned counter map was "rubber-sheeted" so that it matched the background GIS mapping.

The collected data is systematically organized using GIS based database management system. This system allows users to (1) sort/query data that satisfies specific needs, (2) identify trends of data on maps with age, material, location or other attribute, (3) view attribute data, maps and image data all at the same time, and (4) summarize results in various formats and transfer or print them.

The customized geo-database uses various software to acquire, store and manipulate data. Links to digital photos and video clips are maintained by queries in the database and they are assigned proper names on the server. The design of the database allowed the sewer system information to be readily referenced, queried, updated and manipulated. Sewer inspection data acquisition and management system consist of ArcGIS and Access databases.

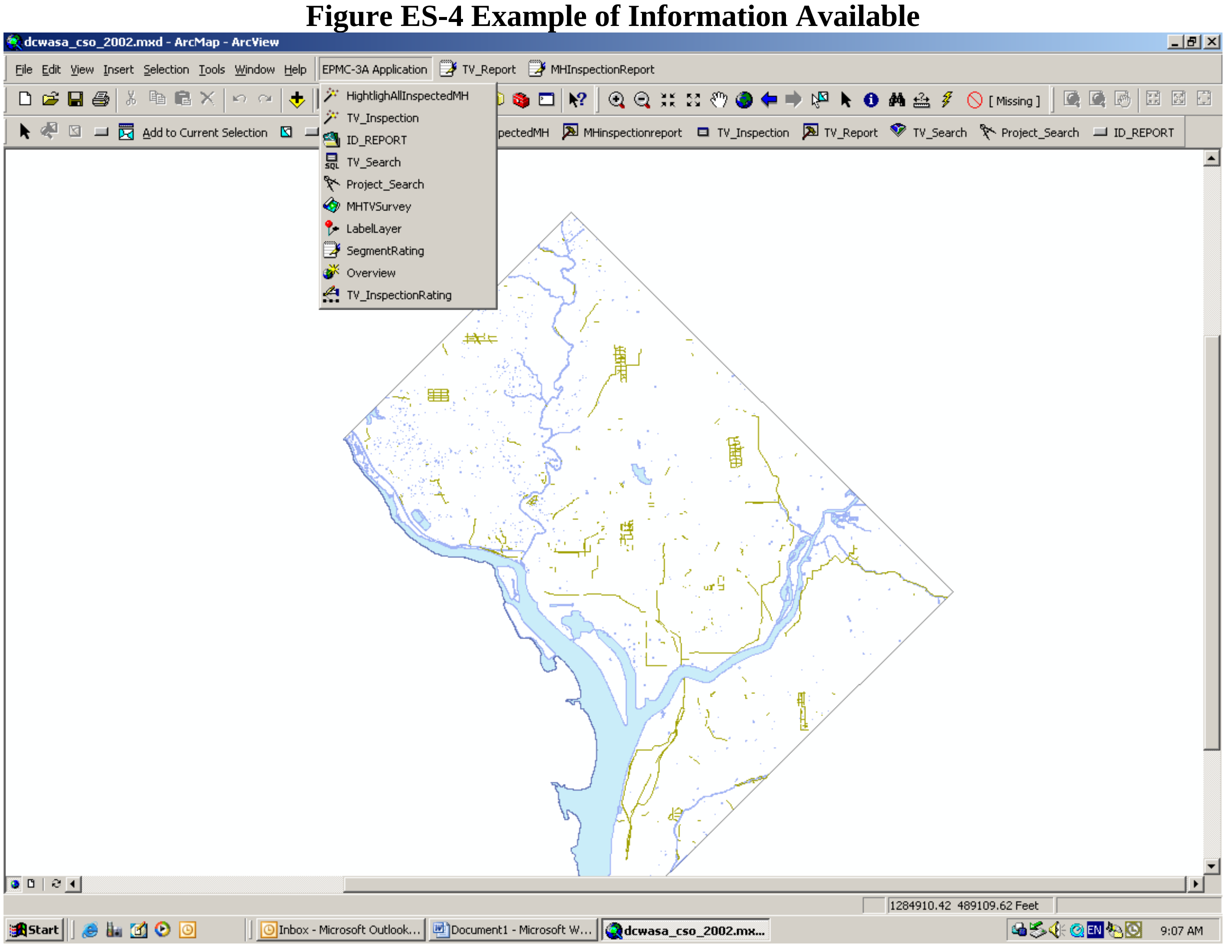
In order to let users easily operate ArcGIS, several customer built application functions were installed in GIS program including the following:

- Manhole Inspection - all inspected manholes on the GIS manhole layer can be highlighted

- Pipe Inspections – all inspected pipe segments on the sewer layer can be highlighted
- ID Report – A search form allows users to search manholes or pipe inspection reports based on Object ID or Survey ID
- TV Search – A search form allows users to search pipe inspection records based on criteria defined by the user.
- Segment Rating – pipe segments can be highlighted based on their structure condition rating
- TV Inspection Rating -pipe segments on the sewer layer can be grouped by their structure conditions.

All these functions can be displayed in GIS. After clicking on a function name or icon, GIS will automatically run a subroutine that directs the Access database to retrieve and process the related data, and then present the results in the GIS. **Figure ES-4** shows a drop down menu that a user can activate so the inspection data and report information is readily available.

Figure ES-4 Example of Information Available



4. SEWER INSPECTION RESULTS

A sewer inspection plan was prepared to identify the sewers proposed to be inspected. The sewer system inventory consists of approximately 1,860 miles or about 10 million feet of sewers. Sufficient information of the sewer system inventory was needed so that WASA could gain an understanding of the overall condition of the system. Due to limitations related to time, funding, and practicality, it was not feasible to inspect the whole sewer system. Six priority levels were established and critical sewers were grouped into the priority levels identified below:

- Priority 1 – sewers with suspected problems or with a significant potential for problems based on their nature or location. These include sewers responsible for flooding, siphons, sewers under buildings, stream crossings, and sewers identified by staff with suspected problems.
- Priority 2 - the outfall sewers, between the pumping stations and Blue Plains.
- Priority 3 - major trunk sewers in the combined, sanitary and storm sewers service areas.
- Priority 4 - geographically representative combined, separate sanitary and storm sewers.
- Priority 5 - force mains
- Priority 6 - high profile areas

The sewer condition assessment was prepared using an inspection defect coding system based on the National Association of Sewer Service Companies' (NASSCO) system. The rating system was available through their Pipeline Assessment Certification Program (PACP). This rating system is well accepted in the industry and was adopted to provide a means for repeatable assessment inspection based on a national standard.

The inspection form for PACP inspections provides an area for the inspector to include comments or remarks. If the inspector observes a defect or additional valuable information that does not fall into one of the standardized codes, a comment can be added at that station (length of sewer from starting point). The grades for the structural ratings used the numeric coding system below:

1 – Excellent; Minor defects
2 – Good; Defects that have not begun to deteriorate
3 – Fair; Moderate defects that will continue to deteriorate
4 – Poor; Severe defects that will become Grade 5 defects within the foreseeable future
5 – Attention required; Defects requiring a high priority for repair or attention

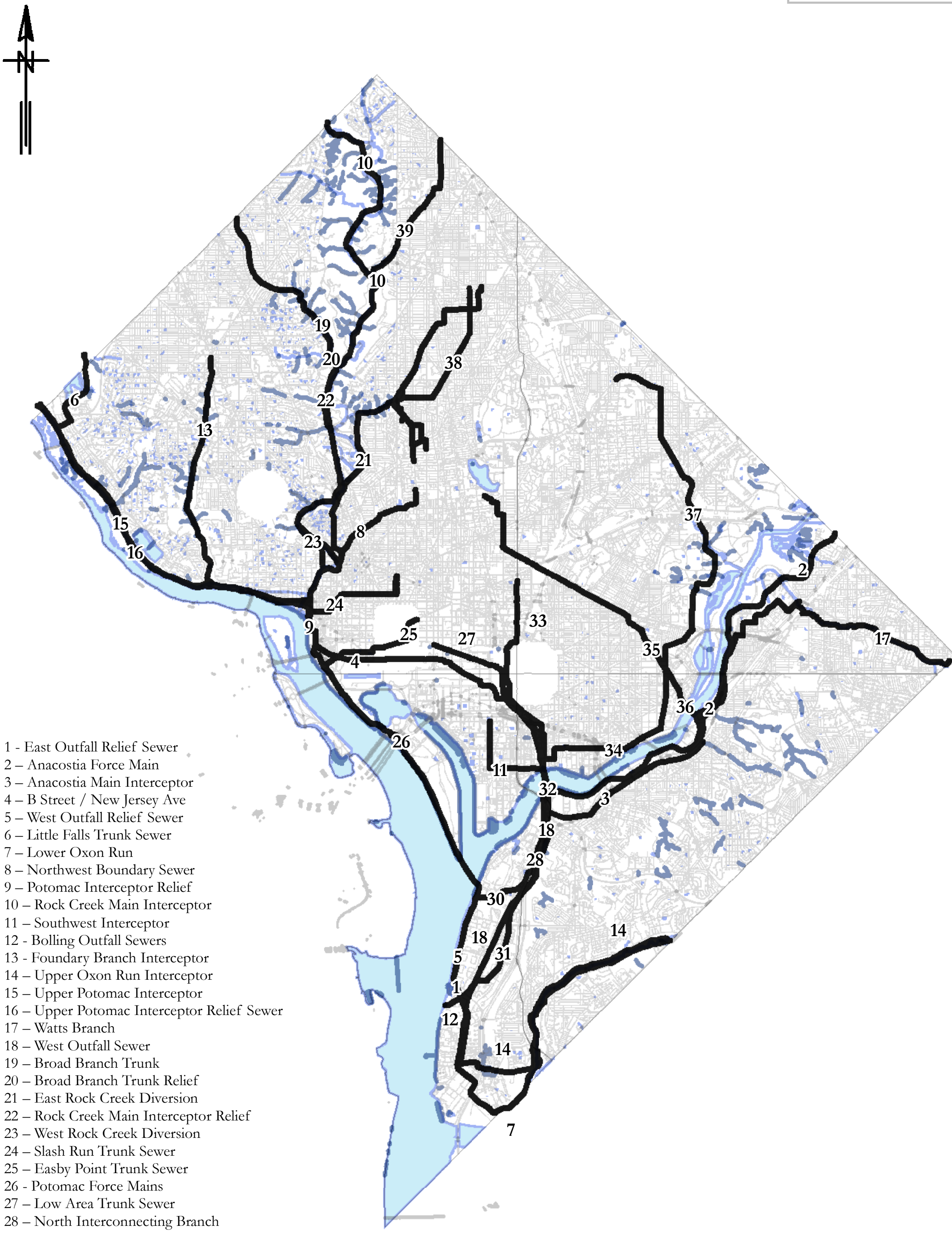
The WASA client based system followed the same structural rating system as described in the PACP system with additional revisions to highlight the frequency of defects along a pipe segment utilizing a "normalizing" feature. The normalizing features were added to the average structural rating to produce a Total Structural Segment Rating (SSR) which can be used to prioritize the inspection data.

A special priority was developed to rate the visual inspection data gathered to assess sewers in stream valleys. Visual inspections of the exposed sewers and structures were not considered as part of the PACP Rating System. A rating system was developed for this portion of the assessment based on the judgment of the survey team that included a professional engineer.

The sewer assessment program evaluated the condition of the most critical sewers within the District. As a result of the inspection activity, some early action items where taken by WASA as either a capital program or a maintenance activity. When serious sewer system defects were identified, the matter was brought to the attention of the Department of Sewer Services and immediate action was taken.

Figure ES-5 shows the location of the major wastewater sewer systems in the District of Columbia, while **Figure ES-6** shows the results of the structural segment ratings.

Figure ES-5



1 - East Outfall Relief Sewer
2 – Anacostia Force Main
3 – Anacostia Main Interceptor
4 – B Street / New Jersey Ave
5 – West Outfall Relief Sewer
6 – Little Falls Trunk Sewer
7 – Lower Oxon Run
8 – Northwest Boundary Sewer
9 – Potomac Interceptor Relief
10 – Rock Creek Main Interceptor
11 – Southwest Interceptor
12 - Bolling Outfall Sewers
13 - Foundary Branch Interceptor
14 – Upper Oxon Run Interceptor
15 – Upper Potomac Interceptor
16 – Upper Potomac Interceptor Relief Sewer
17 – Watts Branch
18 – West Outfall Sewer
19 – Broad Branch Trunk
20 – Broad Branch Trunk Relief
21 – East Rock Creek Diversion
22 – Rock Creek Main Interceptor Relief
23 – West Rock Creek Diversion
24 – Slash Run Trunk Sewer
25 – Easby Point Trunk Sewer
26 - Potomac Force Mains
27 – Low Area Trunk Sewer
28 – North Interconnecting Branch
30 – South Interconnecting Branch
31 – East Outfall Sewer
32 – Anacostia Siphons
33 – Tiber Creek
34 – Lower East Side Interceptor
35 – Northeast Boundary Sewer
36 – East Side Force Main
37 – Upper East Side Interceptor
38 – Piney Branch Trunk Sewer System
39 – Luzon Trunk Sewer

0 1.5 3 Miles

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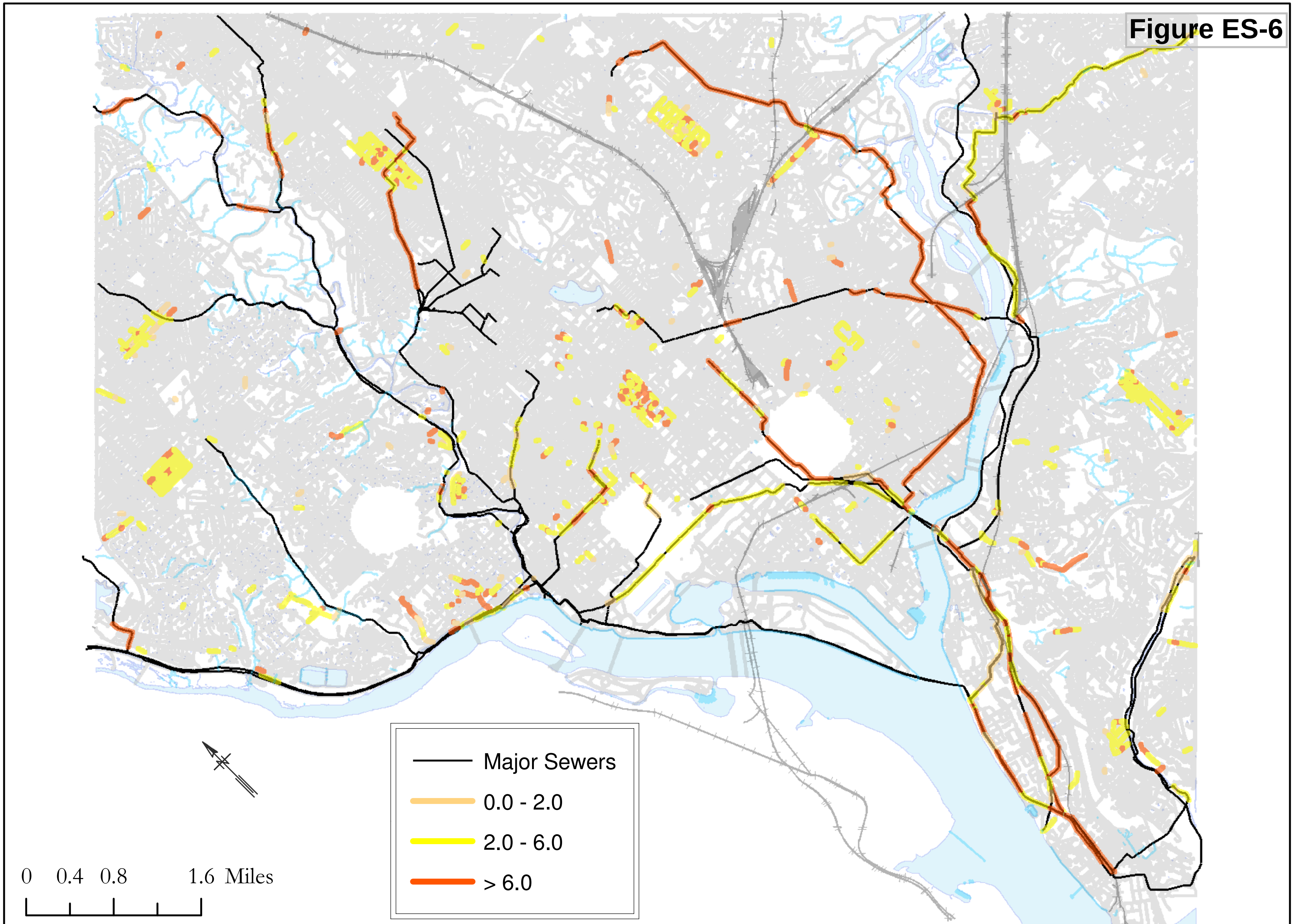
Major Sewers

DC WASA



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Major Sewers SSR Map

DC WASA

The sewer condition assessment was performed using a standardized rating system for both the video sewer inspection data and observations of existing field conditions. The data was converted into an electronic database that was then integrated with the GIS of the sewer system. The information provided using these techniques helped to prioritize areas of the sewer infrastructure that needed repair or rehabilitation.

The following summary items were noted during the sewer condition assessment survey:

- The GIS database integration with the sewer inspection data provided a platform to help organize the large amount of sewer inspection data and was used to organize and access the inspection results
- A methodology for rating the sewer condition was established so comparisons can be made between sewers and to compare assessment results over time
- Material build up in siphons and gently sloped sewers caused poor system performance and resulted in significant expense to clean
- WASA sewer system has approximately 4 % of the system inventory under existing buildings
- Sewers near streams need protection from stream bank erosion. Access to these areas was limited due to restrictions imposed by the park authorities.
- The Outfall Sewers show significant concrete corrosion requiring near term repair for approximately 20,000 feet of pipeline.
- Several major sewers also showed signs of concrete corrosion and cracking. These sewers were generally in the central core of the sewer system. The pipe defects noted during the inspections were identified throughout each priority of the critical sewers and were not limited by sewer location, age or material alone.
- There were a limited number of emergency repairs required as a result of the condition assessment inspection. Generally, the pipes maintained their original shapes and were not deformed due to the structural defects.
- Sewer blockages due to tree roots were limited to separate sewer areas
- The Anacostia No. 2 force main is made from Pre-stressed Concrete Cylinder Pipe (PCCP). This pipe material has a history of poor performance in the industry. The original Anacostia force main and gravity sewer that served as a redundant system for the Anacostia Pumping Station was isolated in the 1990's due to structural corrosion problems.
- Areas of high infiltration rates were identified in the Rock Creek, Northeast Boundary, and Oxon Run Drainage areas. High I/I can weaken a pipeline structural support and cause structural damage.

4.1 Sewer Condition Analysis

Analyses of the inspection results were performed to determine if there were relationships between sewer condition and size, age, use, material and location. If such correlations exist, they could be used to guide future inspections and rehabilitations. Defects were grouped under either structural or maintenance (O&M) categories. Analysis of these categories was performed using pipe age, material, size, use and location.

<u>Structural Pipe Defects</u>

- Sewers deteriorate with age and the deterioration rate depends on quality of sewer materials, construction techniques, and the environment in which the sewer was located. As a result, two sewers built at the same time may have significantly different useful lives, or certain portions of a sewer may deteriorate more rapidly than others. This was apparent in our investigations. Sewer pipes of similar age and materials in good condition were regularly found adjacent to a structurally deteriorated pipe section.
- Reinforced concrete pipe (RCP), brick sewers, and concrete pipe (CP) show higher number of normalized structural defect counts than other sewer materials.
- It was determined that small to medium pipe sizes experienced more structural defects than relatively larger sewers.
- The majority of inspected sewers were either combined sewers or sanitary sewers. Structural defects were observed mainly in combined sewers. These observations could be a reflection of the location of combined sewers. Since combined sewers were located in the older parts of the city, they were likely subjected to loads and disturbances from various infrastructure development activities over the years. It should be noted that combined areas were the first to be built and hence age and changes to the sewer system has had an impact on the existing condition of sewers.
- Storm sewers accounted for only 10% of the total inspected sewers. The structural inspection defects for storm water use were less representative than the other sewer uses.
- Inspected sewers crossing various critical locations were also studied to see if there is any defect peculiar to that location. The critical locations are sewers crossing streams, rail roads, parks, under buildings, under bridges and tunnels, freeways and high profile areas.

<u>Operation and Maintenance Defects</u>

The defects in this category contribute to high O&M activity to keep the collection system operational. These defects include sediment and grease build up, encrustation, infiltration, roots and defective service connections. Maintenance defects have been analyzed for pipe age, material, size and use.

- The number of maintenance defects increased with age of sewers
- O&M defects were observed mainly in small to medium size sewers.
- O&M defect counts were most common in sewers with materials brick sewers, concrete pipe (CP) and vitrified clay pipe (VCP).
- O&M defects were more common in sanitary sewers. This is most likely because sanitary sewers lack the advantage of seasonal flushing enjoyed by combined and storm water sewers.
- Leakage, roots and various forms of deposits including obstruction were maintenance defects. Leakage and deposits/obstructions are observed in all locations but roots were more frequent in sewers crossing streams and running under or near buildings.

<u>Summary</u>

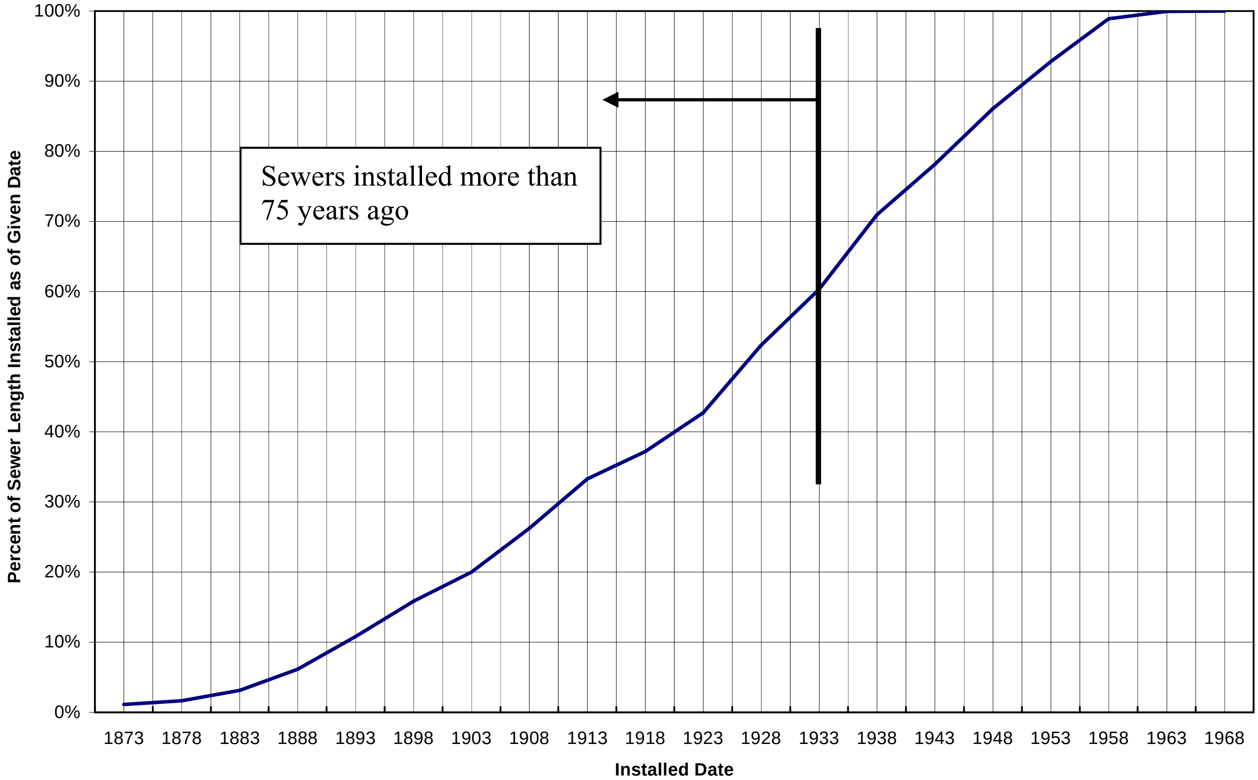
The sewer assessment study and sewer defect analyses were made based on the inspection surveys and can be summarized as follows:

- There are about 1,900 miles of sewer system in the City.
- 35% of these sewers are combined and serve older parts of the City.
- 90% of sewer materials in the sewer database are vitrified clay pipes, concrete pipes, brick pipes & reinforced concrete pipes.
- 60% of existing sewers are estimated to be more than 75 years old.
- About 70% of existing sewers are under 24 in and man-entry sewers (size ≥72 in) amount to less than 10% of the existing sewer system.
- 88% of inspected sewers had some defects. 60% of these sewers could be addressed using localized repair and the remaining require mainly lining.
- There is an increase in number of defects with sewer pipe age, but old pipes aren't necessarily in poor condition.
- Major sewer materials are vitrified clay pipes (30% of all inspected pipes), reinforced concrete pipes (27%), brick sewers (25%) and concrete pipes (7%). Of these, reinforced concrete pipes, concrete pipes and bricks showed most of the observed defects.
- Small to medium size pipes (< 72 inch) showed the majority of structural and O&M defects.
- The majority of defects observed in the three uses of sewers are either in combined sewers or in sanitary sewers. These observations could be a reflection of the location and age of combined sewers (combined sewers are located in the older parts of the city) and the size and waste water quality in sanitary sewers (sanitary sewers are smaller in size and carry separate sanitary sewage with high sulfide content).
- There are about 50,000 manholes in the sewer database.
- About 3% of these manholes have been inspected.
- 94% of the inspected manholes have one or more defects.
- Defective manhole structures, which include defects on channel, bench, cone/riser and walls account for about 40% of all manhole defects observed in our investigations.

Our inspection data indicates an increase in the number of defects as pipes get more than 75 years old. That doesn't mean that pipes have reached the end of their useful life or that they all need to be rehabilitated at that age. Some sewers in Europe have been in operation for over 200 years. However, it is a good indicator of when we need to start looking at pipes to evaluate their condition. Based on their condition, it could then be determined what is needed to extend their useful life at the least cost.

The approximate cumulative distribution of the sewer system in Washington, DC with age is given in **Figure ES-7**.

Figure ES-7 Cumulative System Lengths by Age



4.2 Sewer Hydraulic Capacity Assessment

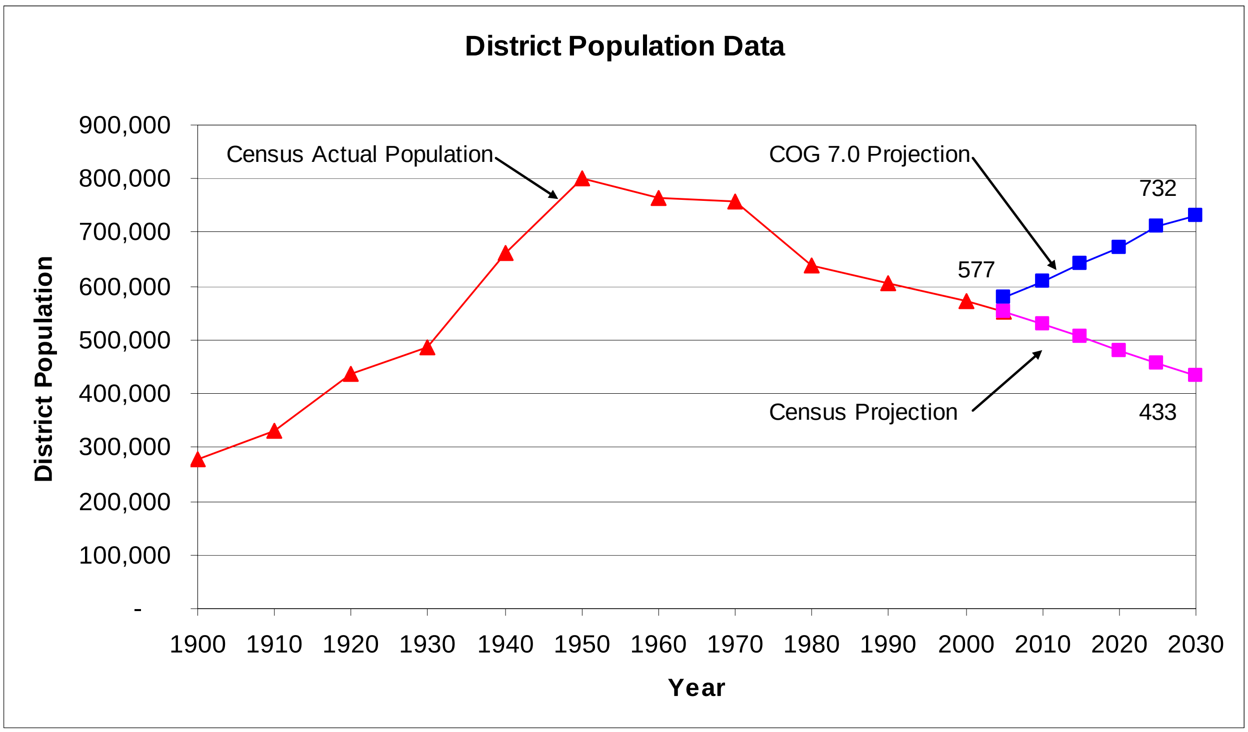
4.2.1 Model Development

The sewer system hydraulic model was expanded and improved upon from the model developed for the Long Term Control Plan (LTCP). The following data was used to estimate the various components of the District's flow:

- Sewer flow data – 75 meters and four rain gages were installed between August 2003 and November 2004 to obtain data at various points in the sewer system. Data from an additional 15 flow monitors was available from other programs and data from pumping stations and Blue Plains was also used to obtain information on sewer flows.
- Water meter data – water meter consumption data from the Authority was overlaid on each of the District's sewer sheds in order to determine the potable water used by sewer shed.
- Groundwater pumpage data - portions of the District, particularly in the Federal Triangle area, have buildings with sump pumps that discharge groundwater to the sewer system. There is very little reliable data on the location, quantity and frequency of discharge from these pumps. Estimates of groundwater pumpage were made by compiling available data on properties with sump pumps and by estimating groundwater elevations and the number of buildings with basements below the groundwater table. Due to the lack of reliable and consistent data, groundwater pumpage estimates are the least reliable data source used in the assessment.

- Inflow and captured combined sewage - A detailed hydrologic and hydraulic model of the combined sewer system, including a runoff model, was prepared as part of the preparation of the LTCP. Results from that work were used in this evaluation to quantify runoff in the combined sewer area and the amount of runoff captured in the combined sewer system under alternative CSO control scenarios.
- Demographic projections – the Metropolitan Washington Council of Governments (MWCOG) demographic projections were referenced in this assessment. The projections are based on D.C. Office of Planning data, which estimated a large increase in population and employment by the 2030 planning period. In addition, the US Census population projects were referenced for comparison as shown in **Figure ES-8**. The actual population growth will likely be somewhere in between.

Figure ES -8 DC Population Projects to 2030



We considered the potential growth patterns and the impacts on the existing infrastructure so that the sewer infrastructure could be planned to accommodate future sewer needs. Currently, the District of Columbia is undergoing major redevelopment projects throughout the city. These new redevelopments, however, are not expected to exceed the sewer system dry weather hydraulic capacity because the system was oversized to handle storm flows and because the city's previously served an active population base of 800,000 residents in the 1950's. The most optimistic population projects show the service population to be under 800,000 throughout the 2030 planning period.

Water meter data was used to estimate sewage flow from homes and businesses in each sewer shed. During dry weather, the difference between the sewer flow meter data and water meter data was considered to represent the sum of groundwater pumpage and infiltration. Groundwater pumpage was estimated from records of sump pumps and estimates of the number of buildings with sump pumps. Infiltration was then estimated by subtracting the calculated groundwater pumpage from the sum of infiltration and groundwater pumpage. Inflow and captured combined sewage were estimated using the sewer system model developed for the Long Term Control Plan.

Table ES-2 shows wastewater quantities projected for the District. The table also shows the actual quantities measured during the assessment period from May 2003 to May 2004. These values where used in conjunction with model for the collection system and historical data to estimate wastewater quantities for year 2005 for dry, wet and average years. In addition, a projection was made for 2030 using demographic projections provided by the District Office of Planning and MWCOG.

WASA is in the process of implementing the LTCP. The table identifies the amount of captured CSO that will be treated by Blue Plains at the following stages of implementation of the plan:

- Sewer Collection System without the Inflatable Dams and Pumping Stations not Rehabilitated - This was the configuration of the system prior to implementation of the Phase I CSO controls in the early 1980's. Since many of the inflatable dams failed after installation due to a manufacturing defect, this scenario is also an approximation of the system up to 2004, when the inflatable dams were replaced.

- Inflatable Dams and Pumping Stations Rehabilitated – This is the configuration of the system expected by the end of 2009. Inflatable dams were replaced in 2004. The rehabilitation of the pumping stations is expected to be complete by 2009.

- Complete LTCP in Place –This is the configuration of the system after the entire LTCP is in place, including rehabilitation of the pumping stations and inflatable dams, construction of 193 million gallons of tunnel storage, targeted sewer separation, low impact development at WASA facilities and consolidation of selected outfalls. This is scheduled for completion in 2025.

Table ES-2 Projected District Wastewater Quantities (All flows in mgd)

Category	Assessment Period (5/03 to 5/04)	Year 2005			Year 2030[1]		
		Dry Year	Avg Year	Wet Year	Dry Year	Avg Year	Wet Year
Rainfall (inches/year)	*53.69"*	*31.74" (1988)*	*40.84" (avg '88-90)*	*50.32" (1989)*	*31.74" (1988)*	*40.84" (avg '88-90)*	*50.32" (1989)*
Wastewater							
Domestic	63.1	63.1	63.1	63.1	75.0	75.0	75.0
Employment	27.3	27.3	27.3	27.3	30.2	30.2	30.2
Visitors	5.2	5.2	5.2	5.2	5.4	5.4	5.4
Wastewater Subtotal	**95.6**	**95.6**	**95.6**	**95.6**	**111**	**111**	**111**
Infiltration & Groundwater Pumpage							
Infiltration	58	37	41	51	37	41	51
Groundwater Pumpage	16	10	11	14	10	11	14
Infiltration/GW Subtotal	**74**	**47**	**52**	**64**	**47**	**52**	**64**
Inflow	2.6	1.5	2	2.5	1.5	2	2.5
All Flows Except Captured Combined Sewage	**172**	**144**	**150**	**162**	**159**	**165**	**177**
Captured Combined Sewage							
No Inflatable Dams, No P.S. Rehab.	13	10	12	13	10	12	13
Total w/this CSO Scenario	**185**	**155**	**162**	**176**	**170**	**177**	**191**
With Inflatable Dams and P.S. Rehabilitated (scheduled for 2009)	N/A	13	16	18	13	16	18
Total w/this CSO Scenario		**158**	**166**	**181**	**173**	**181**	**196**
Complete LTCP in Place (scheduled for 2025)	N/A	16	21	25	16	21	25
Total w/this CSO Scenario		**161**	**171**	**187**	**176**	**186**	**202**

A comparison of the District's IMA allocation to projected flows in an average year of rainfall is shown in **Table ES-3**. If captured combined sewage flows are excluded, the District is very close to its 148 mgd allocation in 2005. However, the District is projected to exceed its allocation by 17 mgd in 2030 if population growth occurs as projected by the Office of Planning and MWCOG. If captured combined sewage flows are included in the calculation, the District is projected to exceed its allocation by 14 mgd in 2005 and 38 mgd in 2030. Note that the projections for 2030 assume that

[1] Assumes DC (COG Round 7.0) Population Projects.

the aggressive growth in population and employment anticipated by the Office of Planning and MWCOG occur.

Table ES-3
Flow Reductions to Meet Current IMA
(All flows in mgd)

Parameter	*Average Year Rainfall of 40.84" (avg '88-90)*	
	Year 2005	*Year 2030*
Excluding Captured Combined Sewage		
IMA Allocation	148	148
Projected Flow Excluding Captured Combined Sewage	150	165
Flow Reduction Needed	**2**	**17**
Including Captured Combined Sewage		
IMA Allocation	148	148
Projected Flow Including Captured Combined Sewage	162	186
Flow Reduction Needed	**14**	**38**

The IMA is currently under review for updating and possible redistribution of flow allocations. The outcome of these negotiations is not known. For purposes of this study, we based our recommended plan on flow allocations of 148 mgd currently assigned to the District of Columbia excluding any captured combined flow.

4.2.2 Hydraulic Capacity

The current sewer design standard requires a sewer to convey a 15 year storm flow. The major sewer systems performances were assessed for15 and 100 years storm events. Software developed by the Danish Hydraulic Institute, MIKE VIEW was utilized to view the sewer networks performance when conveying flows during selected storm events. The level of the Hydraulic Grade Line (HGL) was noted. From this analysis a rating scale was established to prioritize the systems based on the level of the HGL to the ground level. Each system was assigned a rating of 1, 3, or 5. The rating scale defined below is followed by **Table ES-4** which illustrates the ratings for each major sewer system:

1 – HGL is within the pipe or stays 7 feet from the ground surface
3 – HGL comes within 7 feet of the ground surface
5 – HGL is above the ground surface

Table ES-4
Hydraulic Ratings for Major Sewers located in Metropolitan Washington, DC

Sewer System	Hydraulic Rating	
	15 year storm	100 year storm
Anacostia Main Interceptor	5	5
B Street/New Jersey	3	5
Easby Point	5	5
East Oxen Run	1	1
Lower East Side Interceptor	3	3
Luzon Valley	1	1
Northeast Boundary	5	5
Northwest Boundary	1	3
Piney Branch	3	5
Rock Creek Main Interceptor	3	5
Slash Run	1	1
Tiber Creek	1	3
Upper East Side Interceptor	1	3
Upper Potomac Interceptor	5	5
Upper Potomac Interceptor Relief Sewer	3[1]	5
Watts Branch	5	5
West Oxon Run	1	1

[1]A portion of the Upper Potomac Interceptor Relief Sewer was design to operate under pressure where the HGL is shown above the man-hole rim elevation. See **Appendix B** UPIR Sewer 15 year storm.

The hydraulic improvement projects developed to address the surcharged condition where the HGL was near grade were along the Anacostia Main Interceptor, Upper Potomac Interceptor Relief Sewer, and Easby Point Sewer. These projects are described in the Recommended Plan. The existing CIP assigned projects to rehabilitate portions of the UPI and PI Relief Sewer. The LTCP includes elements to address the most serious capacity issues along the Northeast Boundary Sewer.

5. PROJECT INDENTIFICATION

Defective pipe segments were assessed for rehabilitation using various rehabilitation technologies. In support of this process, a data quality control program was used to review and correct the accuracy of sewer and manhole inspection data collected as part of the planning process. The data was then uploaded into the sewer system database so queries could be made to identify the most seriously defective sewer pipes.

The selection of appropriate rehabilitation technologies was performed using the following steps:

1. Identify all pipe segments with Structural Segment Ratings (SSR) of 2 and above from the computer database
2. Analyze identified sewer segments in Step 1 to determine defect type, frequency, continuity and severity.
3. Group defective sewer segments under appropriate rehabilitation methods and categories
4. Estimate capitol costs for each proposed project

The proposed projects were divided into six project categories, as shown in **Table ES-5,** to assist with project identification and organization.

Table ES-5 Project Classification

Category		Description	Number of Projects
I	Major Sewers	Projects on outfalls, interceptors, force mains and trunk sewers. This category has been divided into two parts: • Category 1A – major sewers which were inspected and proposed to be rehabilitated • Category 1B - major sewers which have not been inspected during the study period. But, because of their importance, should be inspected.	1A - 29 projects IB - 16 projects
II	Local Sewers	Rehabilitation of local sewers with identified defects	5
III	Projects to Facilitate O & M	Projects intended to improve the ability to operate and maintain the system such as improving access, adding manholes, installing stop logs, etc.	13
IV	Permit & Consent Decree	Projects required by the NPDES Permit or Consent Decrees, such as cleaning and inspection of Anacostia Siphons and Eastside Interceptor	3
V	Hydraulic Improvements	Projects designed to improve hydraulic performance of the system	3
VI	Creek Bed Sewer Rehabilitation	Projects intended to rehabilitate sewers in creeks and stream crossing to address problems such as erosion, joint failure, physical damage, and infiltration / inflow	26

Costs were estimated based on historical construction costs for similar projects in the District of Columbia and other cities, published data and vendor quotes. Since these estimates are made without detailed design, they are useful for planning purposes only. The estimated total project costs include:

- Construction cost = Raw construction cost plus 35% contingency
- Capital Cost = construction cost x 1.4 for program management, design, construction management and others.

6. RECOMMENDATIONS

6.1 Capital Improvement Plan

The total estimated cost of all capital improvement plan (CIP) projects identified for the planning period ending in year 2030 is approximately $537 million (2008 dollars). **Table ES-6** provides a summary of all projects and the 10-year recommended plan.

Table ES-6 Summary of Proposed CIP Projects and Ten Year Funding Needs

Category	All Projects		Proposed 10-yr CIP		
	No.	Capital Cost ($2008M)	No.	Capital Cost (2008$M)	Capital Cost ($M, Escalated @ 5% per year)
Major Sewer Rehab	29	444.1	14 (+/-)	173.2	249.8
Major Sewer Critical Inspection	16	6.5	16	6.5	7.8
Local Sewer Rehab	5	23.7	5	23.7	33.8
Operation & Maintenance Projects	13	8.0	13	8.0	10.7
Permit and Consent Decree Projects (includes recurring costs during the planning period)	3	4.9	3	2.0	2.5
Hydraulic Improvements	3	1.0	3	1.0	1.1
Creek Bed Sewer Rehab	26	48.3	26	45.6	67.7
Total	**95**	**536.5**	**80**	**260.0**	**373.4**

We recommend implementing 80 of the 95 projects during the first 10 years. Approximately $260 million (2008 dollars) would be needed during the period. The projects were prioritized using a selection process based upon the ranking criteria discussed below:

- Projects grouped under Permits & Consent Decree (Category IV) were not ranked because they were required by Consent Decree.
- Projects grouped under O & M Improvement (Category III) and Hydraulic Improvement (Category V) have not been ranked, since they constitute less than 2.5 % of the total estimated capital cost of the recommended projects and the projects address immediate operational needs.
- Projects grouped under the remaining three categories were ranked within their own category
  - Major and Local Sewers were prioritized based on weighted values for Structural Defects, Impacts on Sewer Operation and Maintenance, Sewer System Redundancy, and Hydraulic Impacts
  - Sewers Rehabilitation near Creek Beds; Two criteria were evaluated. Weighted values for replacement versus rehabilitation projects. Higher value was given to replacement projects due to the severity of the pipe condition. The other criteria considered were the scope of the projects. Larger scope projects were given a higher priority due to the expected benefit from the project.

It is recommended that the project priorities ranking for project categories be reviewed annually to incorporated current system knowledge. **Table ES-7** lists the projects using the ranking system described above.

Table ES-7 List of Projects

Project ID	Project Title	Total Project Cost, 2008 $M
Category IA Major Sewer Rehab		
SS-1-20	Rehabilitation of Lower East Side Interceptor	12.6
SS-1-26	Rehabilitation of Piney Branch Trunk Sewer from Madison St, NW to Structure no 70	21.3
SS-1-21	Rehabilitation of Northeast Boundary Trunk Sewer	43.1
SS-1-11	Rehabilitation of the Upper Part of Rock Creek Main Interceptor	12.4
SS-1-18	Lining of Part of Tiber Creek Trunk Sewer	37.3
SS-1-02	Construction of backup Force Main for existing AFM	102.9
SS-1-03	Assessment and Rehabilitation of existing AFM	64.1
SS-1-19	Local repairs on Tiber Creek Trunk Sewer	6.5
SS-1-08	Rehabilitation of Little Falls Trunk Sewer	5.5
SS-1-17	Cleaning and Inspection of Potomac Force Main	1.3
SS-1-04	Rehabilitation of Anacostia Main Interceptor between Benning Rd and East Capitol St, NE	4.2
SS-1-13	Rehabilitation of Watts Branch between Gault Rd and Minnesota Ave, NE	0.9
SS-1-01	Rehabilitation of East Outfall Relief Sewer	45.3
SS-1-15	Rehabilitation of West Outfall Sewer	22.1
SS-1-22	Rehabilitation of Upper East Side Interceptor at Rhode Island Road	4.6
SS-1-23	Rehabilitation of Upper East Side Interceptor at Arboretum	6.2
SS-1-24	Rehabilitation of Lower Part of Upper East Side Interceptor	5.7
SS-1-16	Rehabilitation of Slash Run Overflow Sewer	2.8
SS-1-28	Rehabilitation of Sheridan Rd Strom Sewer	3.4
SS-1-25	Rehabilitation of Upper Middle Part of Upper East Side Interceptor	5.3
SS-1-29	Rehabilitation of Storm Sewer on New York Avenue at Hickey Run	1.7
SS-1-05	Rehabilitation of Anacostia Main Interceptor between Grant St and Benning Rd, NE	0.6
SS-1-06	Rehabilitation of Anacostia Main Interceptor between East Capitol St and Fairlawn Ave, NE	1.8
SS-1-14	Localized repair on Watts Branch from manhole M-49636 to manhole M-40076	0.6
SS-1-07	Rehabilitation of West Outfall Relief Sewer	27.6
SS-1-10	Rehabilitation of Northwest Boundary Trunk Sewer (NWBT)	1.7
SS-1-27	Rehabilitation of Luzon Trunk Sewer	0.6

Project ID	Project Title	Total Project Cost, 2008 $M
SS-1-12	Rehabilitation of Southwest Interceptor	0.3
SS-1-09	Rehabilitation of Lower Oxon Run Interceptor (LOX)	1.7
	Subtotal	**444.1**
Category IB Major Sewer-Critical Inspection		
SS-1-41	Cleaning and Inspection of Northeast Boundary Trunk Sewer Between McMillan Reservoir and intersection of Maryland Ave & Florida Ave, NE	1.1
SS-1-34	Cleaning and CCTV Inspection of Upper Potomac Interceptor Relief Sewer	1.0
SS-1-37	Cleaning and Inspection of East Rock Creek Diversion Sewer	1.4
SS-1-30	Cleaning and inspection of AMI from Anacostia Dr, SE, (M-44023) to Popular Point Pumping Station	0.3
SS-1-43	Cleaning and Inspection of Piney Branch Trunk Sewer from Structure N-36725 to Structure no 70	0.6
SS-1-33	Cleaning and CCTV Inspection of Upper Potomac Interceptor	0.5
SS-1-45	Cleaning and Inspection of Part of Piney Branch Trunk Sewers located between 5th St, NW and 16th St, NW	0.2
SS-1-42	Cleaning and Inspection of East Side Force Main	0.1
SS-1-44	Cleaning and Inspection of Piney Branch Trunk Sewer located Southeast of Structure no 70	0.2
SS-1-39	Cleaning and Inspection of West Rock Creek Diversion Sewer	0.1
SS-1-31	Cleaning and CCTV Inspection of Potomac Interceptor Relief Sewer	0.3
SS-1-40	Cleaning and Inspection of Slash Run Trunk Sewer Between 14th St, NW and Scott Circle, NW	0.1
SS-1-32	Cleaning and CCTV Inspection of Foundry Branch Interceptor	0.2
SS-1-35	Cleaning and Inspection of Broad Branch Trunk Sewer	0.2
SS-1-36	Cleaning and Inspection of Broad Branch Trunk Relief Sewer	0.1
SS-1-38	Cleaning and Inspection of Rock Creek Main Interceptor Relief Sewer	0.1
	Subtotal	**6.5**
Category II Local Sewer Rehabilitation		
SS-2-01	Cleaning and Inspection of Local Representative Sewers	0.2
SS-2-02	Lining of Local Representative Sewers	13.5
SS-2-04	Rehabilitation of Local Sewers in the Vicinity of Georgetown	6.7
SS-2-03	Point Repair of Local Representative Sewers	1.5
SS-2-05	Rehabilitation of Structures 51, 57, 68 & 78	1.8
	Subtotal	**23.7**
Category III O & M Projects		
SS-3-01	Rehabilitation of Structure 35B (Reopen water gate diversion)	0.2
SS-3-02	Supply and install Sewer Flow Meters	2.1

Project ID	Project Title	Total Project Cost, 2008 $M
SS-3-03	Access Improvement to Str 24 and 34 and manhole Construction	0.8
SS-3-04	Access improvement to NPDES CSO 061	0.6
SS-3-05	Rehabilitation of gates at structures 5A, 5B, 5C and at Poplar Point pumping station	1.8
SS-3-06	Installation of additional MH to East Outfall Sewer	0.3
SS-3-07	Installation of Sluice Gates at main Siphon Chamber (Structure 5A) and rehabilitation of historic building at Anacostia river	0.2
SS-3-08	Rehabilitation of structures 24 a,b,c and d and construction of access road	0.7
SS-3-09	Prepare operation and maintenance manual for all siphons in Washington, DC	0.1
SS-3-10	Modification of Structure 38	0.2
SS-3-11	Rehabilitation of Structure 81	0.2
SS-3-12	Modify Str 56	0.2
SS-3-13	Locate all buried MH in all Major Interceptors	0.6
	Subtotal	**8.0**
Category IV Permits & CD Projects		
SS-4-01	East Side Interceptor Inspection (every 5 years)	0.9
SS-4-02	Supply and Install rain gauges	0.050
SS-4-03	Anacostia Siphons (every 10 years)	0.1
	Subtotal	1.1
	Subtotal for 2030	**4.9**
Category V Hydraulic Improvement Projects		
SS-5-01	AMI & Watts Branch Manhole Reinforcement	0.5
SS-5-02	Easby Point Manhole Reinforcements	0.2
SS-5-03	UPIRS Manhole Reinforcements	0.3
	Subtotal	**1.0**
Category VI Creek Bed Sewer Rehabilitation		
SS-6-23	Sewer Lining & Manhole Rehabilitation around Glover Archibald Park between Massachusetts Avenue & Davis Place	5.0

Project ID	Project Title	Total Project Cost, 2008 $M
SS-6-14	Sewer Lining & Replacement and Manhole Rehabilitation around Rock Creek, Audoban Terrace & 29th St	3.9
SS-6-22	Sewer & Manhole Replacement & Rehabilitation around Foundry Branch, 39th Street between Upton & Newark	3.8
SS-6-17	Sewer Lining & Manhole Rehabilitation around Klingle Valley, Connecticutt Ave & Klingle Rd	3.3
SS-6-20	Sewer & Manhole Replacement around Normanstone Park, Rock Creek Drive & Normanstone Drive	2.8
SS-6-12	Sewer Lining & Manhole Rehabilitation around Broad Branch, Broad Branch Rd & Linnean Ave	1.6
SS-6-09	Sewer Replacement & Rehabilitation and Structure Rehabilitation around Pinehurst Branch, Aberfoyle Place & 32nd St	1.6
SS-6-21	Sewer Lining & Manhole Replacement and Rehabilitation around Dumbarton Oaks, between S St & 32nd St	1.5
SS-6-24	Sewer & Manhole Rehabilitation and Replacement around Palisades Park, Nebraska Avenue & MacArthur Blvd	1.2
SS-6-25	Sewer Lining & Manhole Rehabilitation around For Stanton Park, Irving St & Suitland Parkway	0.9
SS-6-08	Sewer & Manhole Rehabilitation around Rock Creek, Sherill Drive & Beach Drive	0.5
SS-6-01	Sewer & Manhole Replacement around Fenwick Branch, E Beach Dr & Red Bud Lane	0.4
SS-6-19	Sewer Lining & Manhole Rehabilitation around Rock Creek, Calvert St & Beach Drive	4.3
SS-6-26	Sewer Lining & Manhole Rehabilitation around Oxon Run, S Capital St & 1st Street	3.6
SS-6-06	Sewer Lining & Manhole Rehabilitation around Rock Creek, Beach Drive north of Sherrill Drive	1.8
SS-6-07	Sewer Lining & Manhole Rehabilitation around Pinehurst Branch, at Oregon Knolls Drive	1.7
SS-6-04	Sewer Lining & Manhole Rehabilitation around Rock Creek, Beach Drive @ MD Border (Western Ave extended)	1.6
SS-6-16	Sewer Lining & Manhole Rehabilitation around Rock Creek, Tilden St & Shoemaker St	1.6
SS-6-05	Sewer Lining & Manhole Rehabilitation around Rock Creek, Wise Rd & Beach Drive	1.5
SS-6-10	Sewer Lining & Manhole Rehabilitation around Rock Creek, Beach Drive north of Military Rd	1.4
SS-6-18	Sewer Lining & Manhole Rehabilitation around National Zoo, Beach Drive & Harvard St	1.0

Project ID	Project Title	Total Project Cost, 2008 $M
SS-6-03	Sewer Lining & Manhole Rehabilitation around Rock Creek, Kalmia Rd & W Beach Drive	1.0
SS-6-02	Sewer Lining & Manhole Rehabilitation around Rock Creek, N Portal Drive & Spruce Drive	0.4
SS-6-11	Sewer Lining & Manhole Rehabilitation around Rock Creek, Joyce Rd & 16th St	0.4
SS-6-15	Sewer Lining & Manhole Rehabilitation around Rock Creek, Blagden Rd & Beach Drive	0.3
SS-6-13	Manhole Rehabilitation around Broad Branch, between 27th St & Brandywine St	1.2
	Subtotal	**48.3**
	Total	**536.5**

6.2 Service Life Improvements

Prior to the formation of the DCWASA in 1996, capital expenditures for sewer needs were kept low due to frozen sewer rates that lasted for 10 years. In addition, other agency programs needed funding at a higher priority than the sewer infrastructure program. The Authority should now invest in a program to repair and maintain the sewer collection systems in order to assure reliable sewer service into the future.

Repairing and maintaining a collection system is critical to its reliability and performance. These activities include inspecting, cleaning, repairing and lining sewer pipes and maintaining an integrated computer database system for safe records keeping. Within the Department of Sewer Services (DSS) four branches are responsible for maintaining the collection system, the Pumping Branch, the Inspection and Maintenance (I&M) Branch, Construction and Repair Branch and Potomac Interceptor Branch. These Branches have been actively engaged in maintaining the sewer service availability for the users of the system.

It was determined that two intervention mechanisms were needed in order to preserve the sewer system and extend the period of service. These were fixing problems identified prior to loss of service or loss of shape of the sewer pipe and adopting a regular sewer inspection and rehabilitation program designed to provide advanced planning for scheduling the work.

Inspection programs should maintain a regular schedule in order to identify and solve problems before users are impacted. An inspection program can typically include closed circuit television, sonar imaging, smoke testing, dye testing, manhole inspection, and flow monitoring. When performing inspections, it is crucial to maintain consistency and effectiveness by employing a standard inspection method. Many cities such as Chicago, Milwaukee, Indianapolis and San Diego employ some variation of a standard set sewer defect codes updated by NASSCO for remote and manual CCTV and sonar inspections. The standard operating procedures should also include information on the frequency of inspection. This frequency varies by utility depending on the conditions present within the collection system.

Presented in **Table ES-8** are the recommended inspection frequencies compliant with the NPDES permit and extended to other system components based on engineering judgment. Once the procedures are established and followed and data is collected, WASA managers can make informed decisions as to where and when resources should be applied. This can include necessary cleaning, root control, repairs, and an ongoing re-lining of the existing sewers.

Table ES-8: Inspection Frequency Annual Cost

Sewer Type	Inspect. Freq.	Length of sewer	Size Range	Avg Sewer Size	Inspect. Length per Year	Total Cost
	Years	LF	in	in	LF	2008 $K
Required by NPDES permit						
Major Sewers						
Major Combined Sewers	25	445,620	18-288	84	18,000	373.8
Outfall Sewers	25	69,140	60-165	120	3,000	62.3
Force Main	10	75,120	48-108	96	8,000	166.1
Subtotal		**589,880**			**29,000**	**602.2**
Local Sewers						
Siphon	10	9,800	12-108	60	1,000	20.8
Sewers Under Buildings	15	140,700	8-288	24	9,000	72.4
All Other Sewers						
Sanitary Sewers	25	3,564,170	8-96	18	143,000	1,149.9
Other combined & storm sewers	25	5,489,240	8-288	18	220,000	1,769.1
Subtotal		**9,203,910**			**373,000**	**3,012.2**
Total		**9,793,790**			**402,000**	**3,614.4**

Currently, the DSS cleans segments to restore customer service and on as needed basis which has resulted in a backlog of sewer segments requiring cleaning. To clean the sewer system the DSS currently has one (1) four-person bucket machine crew and two (2), two-person jet-vactor crews performing sewer cleaning. Crews operate during weekdays and are mobilized as needed for emergencies after hours and on weekends/holidays. In order to decrease the cleaning backlog dedicating one or more crews to this effort is critical. Undertaking an aggressive heavy cleaning program followed by a routine cleaning program with dedicated crews is recommended to expel existing accumulation and prevent significant accumulation within the system.

The recommended annual program for cleaning the sewer system was based on the percentage of pipelines needing cleaning found during the sewer assessment program and is estimated in **Table ES-9**.

Table ES-9 Cleaning Frequency Annual Cost

Sewer Component	Inspection Frequency	Length of sewer	Size Range	Average Sewer Size	Cleaning Length per Year	Total Cost
	Years	LF	in	in	LF	2008, $K
Major Sewers						
Major Combined Sewers	25	445,620	18-288	84	7,200	225.4
Outfall Sewers	25	69,140	60-165	120	1,200	61.0
Force Main	10	75,120	48-108	96	3,200	120.1
Subtotal		**589,880**			**11,600**	**406.5**
Local Sewers						
Siphons	10	9,800	12-108	60	1,000	22.4
Sewers Under Buildings	15	140,700	8-288	24	3,600	56.3
Sanitary Sewers	25	3,564,170	6-33	15	57,200	796.8
Other combined & storm sewers	25	5,489,240	6-33	15	110,000	1,532.2
Subtotal		**9,203,910**			**171,800**	**2,407.7**
Total		**9,793,790**			**183,400**	**2,814.2**

The Sewer Assessment Program (SAP) was used to determine the condition of selected storm, sanitary and combined sewer segments. A continuous asset assessment program is recommended above to help avoid service disruptions and also to provide an engineering basis for needed improvements. An inspection goal of 76 miles per year of various sewer types has been set based on the frequency above. An assessment of the condition and of the necessary work should be identified to determine which pipes require cleaning, repair, lining, or replacement.

A regular rehabilitation program is recommended to address problems associated with local sewers (size <36-in) and service connections. Estimated rehabilitation cost includes fixing observed defects during inspection programs, pre- and post- CCTV, cleaning and other factors as site and pipe condition dictates. For planning purposes, it has been assumed that 60% of inspected local sewers require either point repair or lining. This is based on inspection results obtained during this study. About 79,500 LF of sewers are proposed to be repaired every year at estimated cost of about $17.6M.

Manhole rehabilitation is also needed to eliminate sources of both infiltration and inflow directly into the manhole structure and to re-establish the manhole's structural integrity. Coating and grouting (of inside wall of manhole and cracks in manhole frame and cover) are the preferred manhole rehabilitation methods for reducing I/I. Other methods include replacing manhole cover, raising the rim elevation and removing manhole steps.

The proposed manhole rehabilitation program is arranged such that one cycle of manhole rehabilitation is done every 25 years.

Inspections results of major sewers, force mains and outfalls are expected to result in additional rehabilitation projects. For this reason, an allowance in the amount of $10M a year has been allocated. **Table ES-10** summarizes the proposed service life improvement program.

Table ES-10 Service Life Improvement Program

Program	Approx Quantity	Frequency	Annual Cost (2008, $M)
Major Sewers			
Inspection	29,000 LF/year	Approx 20 yr cycle	0.6
Cleaning	11,600 LF/year	Approx 50 yr cycle	0.4
Allowance for rehabilitation			10.0
Subtotal			**11.0**
Local Sewers			
Inspection of sewer pipes	373,000 LF/year	Approx 25 yr cycle	3.0[1]
Cleaning of sewers	171,800 LF/year	Approx 55 yr cycle	2.4
Rehabilitation of local sewers	79,500 LF/year	Approx 85 yr cycle	17.65
MH rehabilitation	2,400 (#/year)	Approx 25 yr cycle	3.2
Subtotal			**26.1**
Total Cost			**37.1**

[1]$2.0M in current approved 10 year CIP.

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