Knoxville Utilities Board

Phase I: Corrective Action Plan/ Engineering Report

Revised Version Submitted to EPA on May 22, 2006

CDM

KUB

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Partners Acting for a Cleaner Environment
A 10-year Program to Improve Our Waterways

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Executive Summary

In February 2005, a Consent Decree (CD) with the Tennessee Department of Environment and Conservation, United States Environmental Protection Agency, Tennessee Clean Water Network and the City of Knoxville became effective with the goal of eliminating sanitary sewer overflows (SSOs) in the sewer collection system. As part of this CD, KUB submitted a Sanitary Sewer Overflow Evaluation Report (SSOER) dated September 2004 and an Annual Update to this report in April 2005. The SSOER contains a list of SSOs referred to as the "Long-Term List" that identifies all SSOs that occurred (including building back-ups) and the associated location, date, cause, and volume. Also, as part of this CD, KUB agreed to submit a Phase 1 Corrective Action Plan/Engineering Report (CAP/ER) to address the conditions causing reported SSOs with the goal of eliminating SSO locations on the Long-Term List of the 2001-2004 SSOER Annual Update.

The executive summary presents an overview of KUB's integrated approach to achieving CD goals, the background and purpose of the Phase 1 CAP/ER, a summary of the evaluation of alternatives, and an overview of the implementation plan.

ES.1 KUB's Integrated Approach to Achieving Consent Decree Goals

KUB has initiated implementation of several complementary programs, including the Phase 1 CAP/ER, to comply with the requirements of the CD, specifically to "address the conditions causing SSOs with the goal of eliminating the SSO locations on the Long-Term List." KUB's holistic or total basin solution for each sewershed is to:

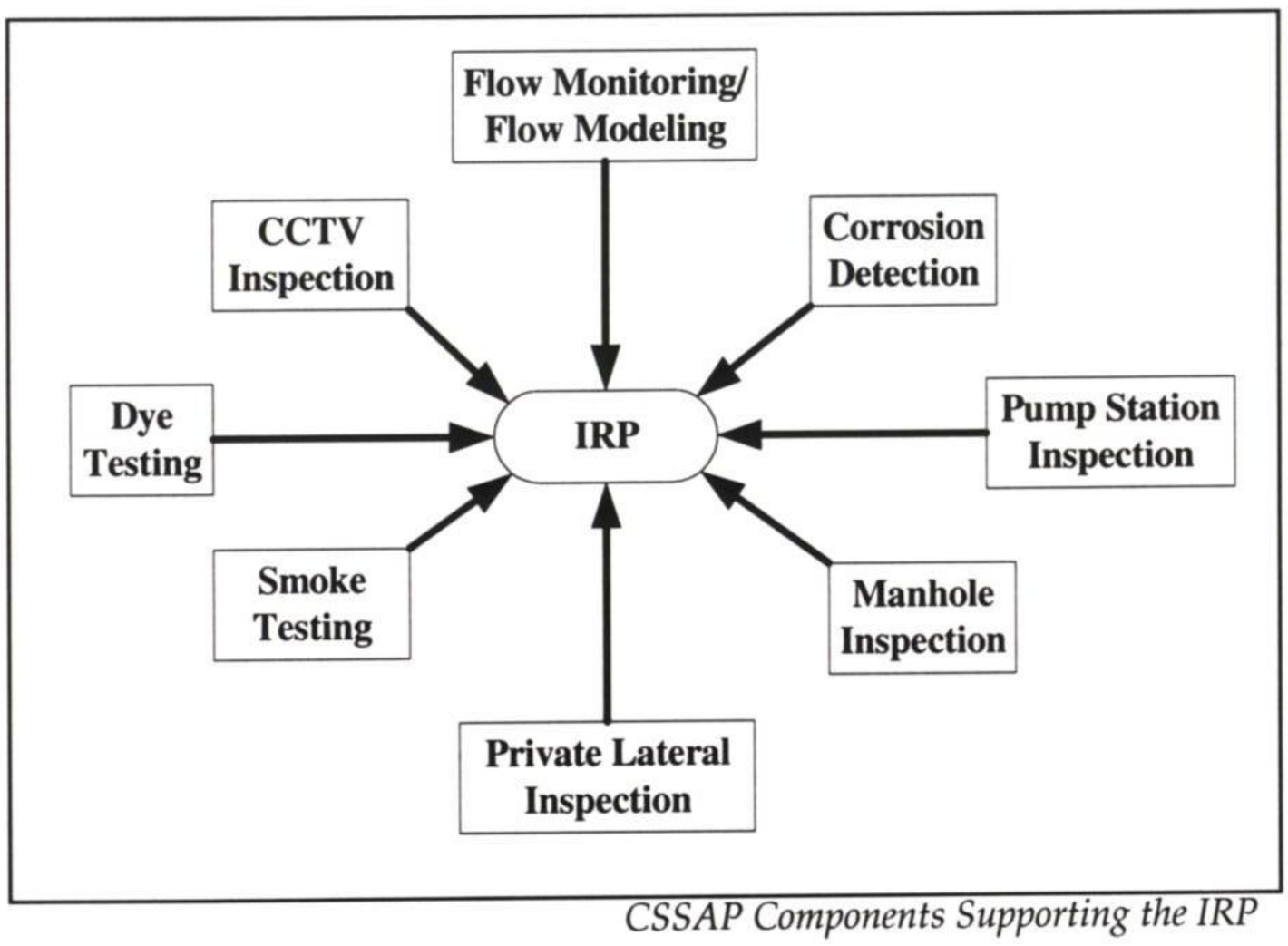
1. Implement capacity enhancement projects consistent with the CAP/ER requirements including storage facilities, relief sewers, pump station upgrades, and comprehensive rehabilitation in targeted areas with documented rainfall dependent infiltration and inflow (RDI/I) problems, and

2. Achieve capacity recovery through RDI/I removal with other complementary maintenance programs that are part of the Infrastructure Rehabilitation Program (IRP).

KUB has developed the Phase 1 CAP/ER as a conceptual design document to guide the implementation of specific projects. It is not intended to provide final design criteria, but to provide minimum criteria which will be further evaluated during preliminary and final design phases. In many cases, projects are being designed with capacities that exceed the minimum criteria established in the CAP/ER.

Other Complementary Programs Related to CAP/ER

KUB's other complementary programs that combine to comprise the IRP are supported by the Continuing Sewer System Assessment Program (CSSAP) which was previously approved. These programs address performance enhancement (removal of roots, debris, grease), asset management (condition assessment, repair and



CSSAP Components Supporting the IRP

replacement) and RDI/I removal (removal of inflow, repair of defective pipes and manholes that are the source of infiltration). Specifically, the smoke testing program addresses inflow elimination, and the lateral replacement program and sewer rehabilitation programs address infiltration reduction. It is important to note that the RDI/I reduction benefits of these programs in restoring system capacity have not been considered in developing the conceptual capacity of CAP/ER solutions. This provides an added factor of safety because the CAP/ER project facilities will be able to store and/or convey flows from increasingly larger storm events as RDI/I is removed through KUB's comprehensive IRP, which has been approved and is being aggressively implemented. KUB is in the process of analyzing permanent and temporary flow monitoring data to quantify the effectiveness of these programs.

ES.2 Background and Purpose of CAP/ER

Providing a wastewater collection system that meets the needs of KUB customers while protecting the environment is the top priority of KUB's facility planning efforts. Since 1987, KUB has performed several studies and made many improvements in a majority of the service area basins. However, there are still areas requiring capital improvements, particularly in older areas of the system where RDI/I is problematic.

RDI/I entering the sanitary sewer system during wet-weather is a major consideration in this report. All combined sanitary and storm sewers have been eliminated from the wastewater service area. However, because of sewer system defects, unintentional or illegal cross connections with the storm sewer system, or other sources, extraneous storm water flows enter the sanitary sewer system during rainfall events as RDI/I. These RDI/I flows can overload the capacity of the sanitary sewer system and result in periodic SSOs from manholes and/or building back-ups.

The objective of the Phase 1 CAP/ER is to identify facility improvements required to address reported SSOs in accordance with the CD. The SSOs listed on the Long-Term List that require improvement projects are mapped and presented in **Figure ES-1**. These SSOs include building back-ups. Some of these SSOs were caused by capacity

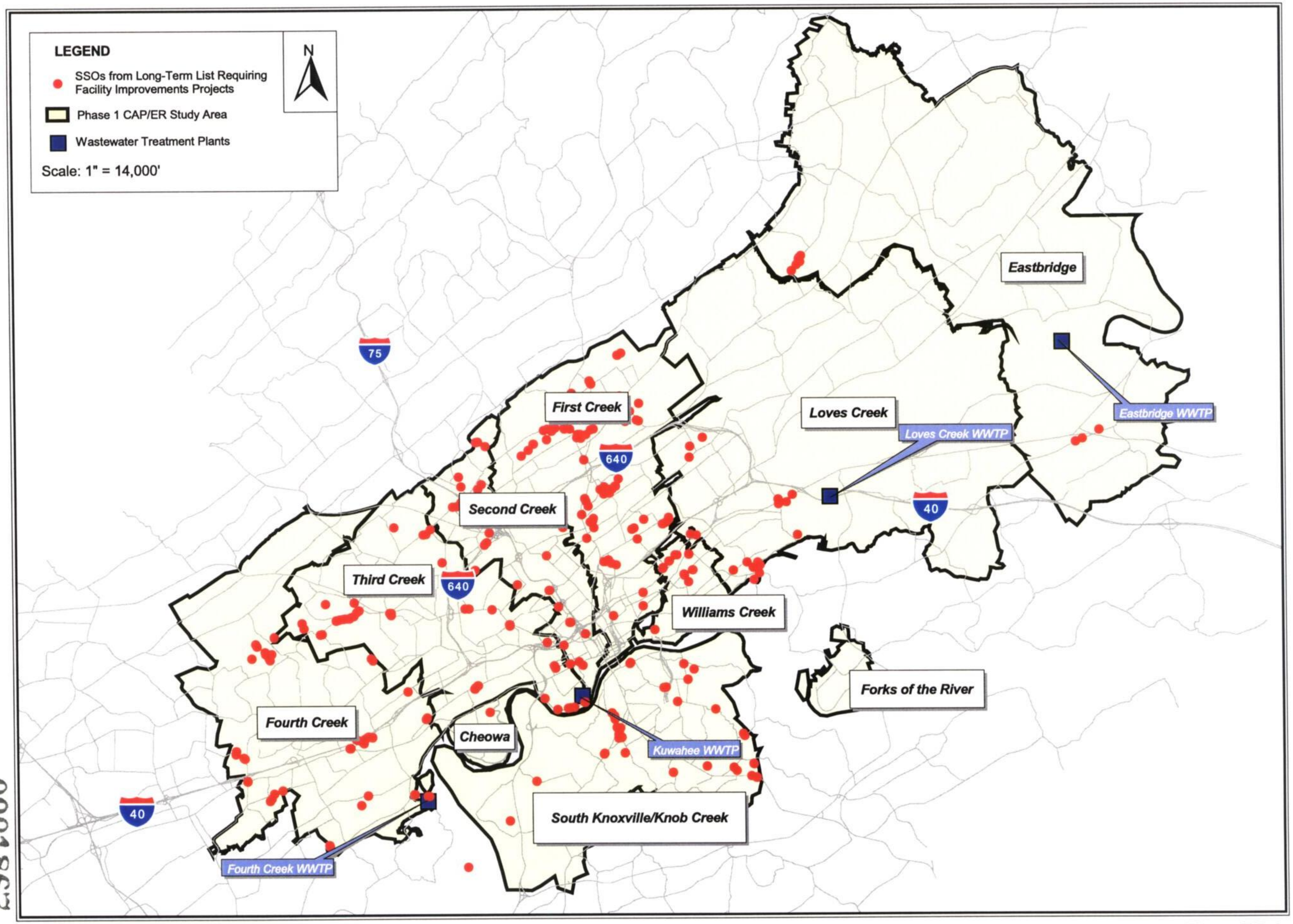


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Figure ES-1
Phase 1 CAP/ER Study Area

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issues and some were caused by non-capacity issues such as a pipe blockage caused by debris, grease, or roots.

Most capacity related SSOs were evaluated using a hydraulic modeling analysis. In keeping with KUB's goals, this hydraulic analysis consisted of first analyzing each basin using a hydraulic model and developing a total basin solution that would convey projected future flows and projected RDI/I from a representative planning storm event. The total basin solution for each basin takes into account the whole system including the effects of transporting this flow to the wastewater treatment plants. The total basin solution addresses future projected SSOs and surcharge conditions in addition to the SSOs listed in the Long-Term List.

CAP/ER Project Performance Criteria

The criteria used in evaluating wet-weather performance of the existing system and alternative capacity enhancement projects to address SSOER capacity related locations are summarized below:

1. Future base flows projected to occur at or near build-out conditions (20 years for highly developed sewersheds and 40 years for developing sewersheds) were used to represent dry-weather flows, including diurnal variations.

2. Winter/spring R values (percentage of rainfall that enters the sewers as RDI/I) were developed on the basis of extensive temporary flow monitoring program data and used to develop RDI/I influent hydrographs. The data indicate that winter/spring R values typically exceed other seasonal R values by up to 100 percent.

3. Projects selected for inclusion in the CAP/ER result in surcharging of less than 2.0 feet above top of pipe and/or no surcharging to within 3.0 feet of the manhole rim at SSOER locations during base wet-weather conditions (described below).

4. Projects selected for inclusion in the CAP/ER include sufficient downstream improvements and/or upstream comprehensive rehabilitation so that they do not result in moving overflows to downstream locations during base wet-weather conditions (described below).

5. Base wet-weather conditions consist of a synthetic rainfall event derived from a representative 24 hour event of 2.96 inches. Additional information on the synthetic rainfall event is provided in a subsequent portion of this document.

The total basin solution consists of a number of individual projects including various sewer replacement projects, storage projects, and rehabilitation projects. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution for each basin was analyzed to determine which are required to address the SSO locations on the Long-Term List. This included projects directly affecting the SSO location as well as projects required to address predicted overflows downstream, which are predicted

to occur as a result of upstream improvements. Projects that were not required to address these SSOs are not included in this report.

Some SSOs reported on the Long-Term List occurred on small collector pipes that were not included in the hydraulic model evaluation. These are also addressed by this Phase 1 CAP/ER by either collector sewer replacement projects or sewer rehabilitation projects. In addition, some SSOs reported on the Long-Term List were caused by non-capacity issues such as a pipe blockage caused by debris, grease, or roots. These SSOs have been addressed or are being addressed by KUB's CSSAP.

The primary function of the CSSAP, which has been approved by EPA, is to provide decision-support information for implementation of the Infrastructure Rehabilitation Program (IRP), along with KUB's other capital improvements to restore and maintain system hydraulic capacity, restore and maintain structural integrity of system components and reduce corrective maintenance costs. The primary objectives of the IRP are to address RDI/I and other conditions causing SSOs through:

- Capacity restoration – this objective is aimed at keeping assets functioning at their full, original capacity. Examples include removing sediment or debris from a pipeline system, reducing infiltration and inflow (I/I) in a wastewater collection system, and/or repairing system defects that would limit flow capacity through a system. In some cases, it is cost effective and/or necessary due to growth to provide increased capacity or storage to attain desired system hydraulic capacity.

- Damage repair – this objective is aimed at repairing structural damage and failures in the system that are the result of wear, corrosion, age, and/or construction-related damage to extend the useful life of the component. This function reduces the risk of system failure which could cause interruption in service which could result in impacts to the community and would increase costs as compared to scheduled maintenance and repairs.

- Maintenance reduction – this objective is aimed at repairing portions of the system that are subject to known, repeated maintenance problems that increase maintenance costs and keep crews from conducting more productive preventive maintenance. Examples in a wastewater collection system are the repair of conditions such as root intrusion, offset joints, pipe sags, improper service connections, and other system deficiencies that typically lead to recurring problems for system operators.

This CAP/ER was developed using CSSAP elements (e. g., flow monitoring, hydraulic model) and will be implemented using other CSSAP elements (e.g., dye testing/dyed water flooding, CCTV inspection, smoke testing). Therefore, for program administration purposes, KUB considers the CAP/ER and its implementation to be part of its IRP. The IRP is being submitted under separate cover for review and approval.

ES.3 Evaluation of Alternatives

The development of this Phase 1 CAP/ER included extensive flow monitoring throughout the collection system, the analysis of both existing and future wastewater flows, hydraulic modeling analysis, and the evaluation of various alternative improvement options.

Flow Monitoring

KUB initiated temporary flow monitoring programs in 1991, 2003, 2004, and 2005 as part of an ongoing capital improvements program. In addition to these temporary programs, KUB maintains 21 permanent flow monitors in the service area trunk sewer systems. The purpose of permanent and temporary flow monitoring is to collect wastewater flow data and to evaluate quantities of flow and changes in flow during dry-weather and wet-weather conditions.

The flow monitoring data is used in several ways to aid in the planning of capital improvements. First, the data is used to identify areas in the collection system that should receive the highest priority for sewer system evaluation survey (SSES) and rehabilitation based on observed response to wet-weather events. Second, the data is used to support a hydraulic analysis of the trunk sewers in each of the monitored basins where the purpose of the hydraulic analysis is to identify trunk sewers or pump stations that are over-capacity during dry- or wet-weather conditions. The flow data is used to develop the wastewater design flows and to calibrate the models. Third, the data is used to measure the relative success of sewer rehabilitation projects by quantifying the amount of I/I that is reduced as a result. Finally, the data from permanent flow meters is used for flow trending analyses.

Section 2 further discusses the flow monitoring performed.

Existing and Future Wastewater Flows

Central to the analysis of wastewater flows is an understanding of its various components and the hydrograph decomposition process, discussed in detail in Section 3. Hydrograph decomposition was performed to identify base wastewater flows and to determine the portion of the flow hydrograph attributed to RDI/I. A unit hydrograph approach that is similar to the approach used in traditional storm water hydrologic analyses is then applied to model the RDI/I in the system. Flow monitoring data is used to calibrate the unit hydrograph parameters. Once calibrated, this method may be used to predict RDI/I into the sewer system for any given rainfall event.

To evaluate the benefit of alternative sewer system improvements to reduce wet-weather overflows, it is prudent to develop one planning storm event and associated RDI/I flows. In developing a planning storm event, a rainfall frequency analysis was performed to estimate the probability that different intensities and durations of rainfall will occur in the Knoxville area. For the system capacity enhancement projects, a representative 24 hour design storm of 2.96 inches, which includes RDI/I

volumes from 97 percent of the rainfall event volumes on record, was chosen as the basis for developing a synthetic rainfall hydrograph. The unit hydrograph method was then applied to the planning storm event to simulate RDI/I flows that would occur in the system during the wet-weather planning event under winter-spring conditions when the flow monitoring studies were conducted.

The Traffic Analysis Zone (TAZ) map for Knox County, and the corresponding data provided by the Metropolitan Planning Commission (MPC), were used as a basis for the geographic distribution of current and future population and employment projections throughout the study areas. A TAZ is a transportation planning area, and each TAZ has existing and future population and employment projection data specific to that zone. TAZ population and employment projections, as well as information obtained from KUB, were used in conjunction with unit flow factors to project future dry-weather flows.

Section 3 further discusses existing and future wastewater flows.

Hydraulic Modeling Analysis

CDM developed a hydraulic model of the major trunk sewers for six of the drainage basins: First Creek, Second Creek, Third Creek, Fourth Creek, South Knoxville/Knob Creek, and Williams Creek. Hydraulic models were not developed for the Cheowa area of the Third Creek Basin, Loves Creek Basin, or Eastbridge Basin because of the limited number of overflows that have occurred in these areas, the majority of which are not capacity related. These SSOs are still addressed in this Phase 1 CAP/ER; however, a full hydraulic modeling analysis was not required to adequately address them.

The model used is the EXTRAN block of the EPA's Stormwater Management Model (SWMM). EXTRAN is a dynamic flow routing model that routes inflow hydrographs through an open channel and/or closed conduit system computing a time history of flows and heads throughout the system. The models are calibrated to both dry-weather and wet-weather conditions by comparing the output flows produced by the simulation against the flows measured by the flow meters. Modeled flows matched the measured flows within 10 percent in most sub-basins system-wide. Once calibration was complete, the capacity of the existing sewer system was compared to predicted wastewater flows for both dry- and wet-weather conditions and for both existing and future projected flows.

Section 4 further discusses the hydraulic modeling analysis performed.

Evaluation of Alternatives

Improvement alternatives that would convey projected future flows and projected RDI/I from a representative 24 hour planning storm event were developed. These alternatives take into account the whole system including the effects of transporting this flow to the wastewater treatment plant. Typically, at least four alternatives were developed with cost estimates consisting of the following options:

1) Upsize pipes and pump stations as required to meet criteria and convey flows to the WWTP.

2) Add storage units upstream to eliminate downstream pipe improvements and decrease peak flows to the WWTP.

3) Perform sewer rehabilitation in subbasins that showed high RDI/I to eliminate downstream pipe improvements and decrease peak flows to the WWTP.

4) Various combinations of 1, 2, and 3.

The recommended alternative for each basin that addressed reported and future projected SSOs and surcharge conditions in addition to the SSOs listed in the Long-Term List was developed as the total basin solution. The total basin solution consists of a number of individual projects including various sewer replacement projects, storage projects, and rehabilitation projects. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution for each basin was analyzed to determine which are required to address the SSO locations on the Long-Term List. This included projects directly affecting the SSO location as well as projects required to address predicted overflows downstream, which are predicted to occur as a result of upstream improvements. Projects that were not required to address these SSOs are not included in this report.

ES.4 Implementation Plan

The implementation plan summarizes the facility improvements required to address SSOs in accordance with the CD. The plan also lists the Fiscal Year for starting and completing all work specified in this Phase 1 CAP/ER. The implementation plan includes projects that have been completed as well as those that are planned. Sections 5 through 11 present how these projects address the SSOs in accordance with the CD and include tables of all SSOs on the Long-Term List and the associated project that addresses each.

Tables ES-1 through ES-7 present each facility improvement project including a project ID, project name, project description, start date, and end date. Start date and end date are given as fiscal year in accordance with the CD. It was assumed that the Phase 1 CAP/ER would be approved during KUB Fiscal Year 05/06 (ending June 30, 2006) and that KUB Fiscal Year 06/07 represents the first year of the seven year schedule to complete the Phase 1 CAP/ER projects. KUB prioritized projects within the seven year period based on severity and frequency of the SSO or building backup, proximity to public areas, and the complexity of the improvement project.

Table ES-1: First Creek Implementation Plan[1]

Project ID	Project Name	Project Description	Start Date	End Date
1-1	Upper First Creek Collector Project (Mini-basin 1A1, 2A2, and 3D1)	Find and fix work to identify and address cause of overflow in the vicinity of 4811 Beverly Road, 4144 Oakland Drive, and 5511 Dogwood Road.	FY 05/06	FY 06/07
1-2	Lower First Creek Collector Project (Mini-basin 8B2)	Find and fix work to identify and address cause of overflow in the vicinity of 2412, 2514, 2528, 2806, 2808, 2900, 2528, 2700, and 2808 Tecoma Drive, 3501 Whittle Springs Road, Islington Avenue, 1800 Linden Avenue, 2524 Underwood Place, and 3008 Valley View Drive.	FY 05/06	FY 07/08
1-3	First Creek Storage Tanks	Design and construction of the upper First Creek storage tank and Lower First Creek storage tank.	FY 04/05	FY 07/08
1-4	Lower Fountain City Pipe Replacement Project	Replace approximately 2,293 lf existing sewer with 36-in sewer.	FY 05/06	FY 07/08
1-5	Upper Fountain City Pipe Replacement Project	Replace approximately 1,053 lf of existing sewer with 12-in, 1,856 lf with 24-in, and 595 lf with 27-in pipe.	FY 05/06	FY 07/08
1-6	Sub-basin 08A1 Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Broadway and Powers Street, and Broadway and Ridgeway Lane	FY 04/05	FY 07/08
1-11	Fountain City Trunkline Replacement Phase IV Project	Replace approximately 724 lf of existing sewer with 15-in, 1,823 lf with 18-in, and 444 lf with 24-in pipe.		Completed 2003
1-12	Cedar Lane Area Sanitary Sewer Rehabilitation Project	Pipe rehabilitation of approximately 8,500 lf of existing sewer		Completed 2004
1-13	Fair Drive Sanitary Sewer Rehabilitation / Replacement Project	Pipe replacement and rehabilitation of approximately 8,200 lf of existing sewer.		Completed 2005
1-14	Wilderness Road Area Gravity Sewer Replacement Project - Phase II	Replace approximately 1,200 lf of existing 8-in, 340 lf 10-in, and 3,900 lf of 12-in pipe.		Completed 2003
1-15	Replace trunk sewer upstream of lower storage unit	Replace approximately 3,700 lf of existing 54-in, and 331 lf of 18-in pipe.	FY 11/12	FY 12/13
1-16	Clearview Street Sewer Project	Replace approximately 4,060 lf of existing 8-in, 227 lf 10-in, and 181 lf of 12-in pipe.		Completed 2003
1-17	Fountain Road Trunkline Sewer Improvement Project	Replace approximately 321 lf of existing 12-in, 430 lf 15-in, and 2,880 lf of 16-in pipe.		Completed 2005
1-18	Greenfield Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2333, 2352 Greenfield Lane and 2826, 2820 North Hills Boulevard		Completed 2005
1-19	Edgewood Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1620 Edgewood Avenue	FY 09/10	FY 10/11
1-20	Vine Middle School Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 214 Bertrand Street.	FY 05/06	FY 06/07
1-21	College Park Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 106 College Park Lane.	FY 10/11	FY 11/12
1-22	E. Jackson Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 400 E. Jackson Avenue.	FY 11/12	FY 12/13
1-23	Oglewood Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1307 Oglewood Avenue.	FY 11/12	FY 12/13

Table ES-1: First Creek Implementation Plan[1]

Project ID	Project Name	Project Description	Start Date	End Date
1-24	Fulton Short Line Project	Replace approximately 520 lf of existing 8-in pipe.		Completed 2003
1-25 (IAP 6)	Sub-basins 3&4 Rehabilitation Projects	Rehabilitation to reduce R to 2% in Sub-basins 03B1, 03B2, and 04B1.	FY 05/06	FY 06/07
1-26	Cherry Street Rehabilitation Project	Find and fix work to identify and address cause of overflow at 1918 Cherry Street.	FY 11/12	FY 12/13
1-27	Fair Drive Replacement Project	Find and fix work to identify and address cause of overflows at 2538, 2541, and 2544 Fair Drive.	FY 10/11	FY 11/12

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table ES-2: Second Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
2-1	Lower Second Creek Replacement/Rehabilitation at I40/I275 Junction	Replace approximately 1,300 lf of existing sewer with 30-in sewer, replace approximately 3100 lf of existing sewer with 36-in sewer, replace approximately 1200 lf of existing sewer with 42-in sewer, and rehabilitate approximately 2,400 lf of trunk line between replacement segments.	FY 06/07	FY 08/09
2-2	Lower Second Creek Replacement/Rehabilitation at Woodland	Replace approximately 2,500 lf of existing sewer with 30-in sewer and rehabilitate approximately 1,200 lf of trunk line between replacement segments.	FY 06/07	FY 07/08
2-3	Second Creek Rehabilitation of Sub-basin 23E1 Near Woodland and Central	Rehabilitation in Sub-basin 23E1 to reduce R value to 2%	FY 05/06	FY 06/07
2-4	Dutch Valley Collector Rehabilitation (Sub-basin 10B1)	Rehabilitate 10-in collection system piping in Sub-basin 10B1.	FY 05/06	FY 06/07
2-5	Rickard and Wilson Collector Rehabilitation (Sub-basin 10C1)	Rehabilitate 10-in collection system piping in Sub-basin 10C1.	FY 05/06	FY 06/07
2-6	Pilleaux Pump Station Collector Rehabilitation (Sub-basin 5A4)	Rehabilitate approximately 19,600 lf of sewer in Sub-basin 5A4.	FY 04/05	FY 05/06
2-8 (IAP 10)	Subbasin 15 Rehabilitation	Rehabilitation in Sub-basin 15D2 to reduce R value to 2%.		Completed 2005
2-9	Second Creek Trunk Sewer Improvements Phase I	Replace approximately 4,100 lf of existing sewer with 30-in sewer		Completed 2004
2-10	Second Creek Trunk Sewer Improvements Phase II	Replace approximately 3,700 lf of existing sewer with 30-in sewer, replace approximately 1,400 lf of existing sewer with 36-inch sewer.		Completed 2004
2-11	Burnside Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2523 Burnside Street.	FY 12/13	FY 12/13
2-12	Camelia Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Camelia Road and Merchant Drive and 412 Merchant Drive.	FY 10/11	FY 10/11
2-13	Cedar Heights Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5511 Cedar Heights Road and 5605 Pinecrest Road.	FY 10/11	FY 10/11
2-14	Central Avenue Pike Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5500 Central Avenue Pike.	FY 10/11	FY 10/11
2-15	1000 block Elm Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1025 Elm Street.	FY 11/12	FY 11/12
2-16	1600 block Elm Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1611 Elm Street and 801 West Oldham Avenue.	FY 11/12	FY 11/12

Table ES-2: Second Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
2-17	Shasta Drive Rehabilitaiton Project	Find and fix work to identify and address cause of overflow in the vicinity of 5108 Fennel Road and 805 Shasta Drive.	FY 11/12	FY 11/12
2-18	Nicholas Road - Clinton Highway Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4500 Nicholas Road and 4200 Clinton Highway.	FY 12/13	FY 12/13
2-19	Cumberland Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1000 Phillip Fulmer Way, 1509 Cumberland Avenue, and Seventeenth Street and White Avenue.	FY 12/13	FY 12/13
2-20	Sierra Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5609 Sierra Road.	FY 10/11	FY 10/11
2-21	Morelia Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 120 E. Morelia Avenue.	FY 11/12	FY 11/12
2-22	Dale Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 345 Dale Avenue.	FY 12/13	FY 12/13

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table ES-3: Third Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
3-2	Subbasin 11 Rehabilitation Project (approximately 25% rehabilitation)	Find and fix work to identify and address cause of overflow in the vicinity of 5815 Wooded Acres Drive, 6512 Shaftsbury Drive, and 6525 Tewksbury Drive.	FY 04/05	FY 07/08
3-3	Subbasin 9 Rehabilitation Project	Rehabilitation to reduce R to 2% in Sub-basins 09A1, 09A2, 09A4, and 09D1.	FY 04/05	FY 07/08
3-4	Upper McKamey and Third Creek Road Replacement Project	Replace approximately 3,141 lf of existing sewer with 36-in sewer and approximately 1500 lf with 15-in sewer.	FY 05/06	FY 07/08
3-5	Third Creek Storage Facility Project	Design and construction of a storage facility in Third Creek Basin (approximately 4.5 MG storage on Land Parcel # 093GB006)	FY 05/06	FY 07/08
3-6	Interstate 40 and Middlebrook Pike Trunk Replacement Project	Replace approximately 400 lf of existing sewer with 15-in sewer, 750 lf with 24-in sewer, 2,000 lf with 30-in sewer, and 7,000 lf with 36-in sewer.	FY 08/09	FY 09/10
3-7	Neyland Drive Trunk Replacement Project	Replace approximately 5,900 lf of existing sewer with 48-in sewer.	FY 08/09	FY 10/11
3-8	Third Creek Bike Trail Pipe Replacement Project	Replace approximately 1,200 lf of existing sewer with 24-in sewer.	FY 08/09	FY 10/11
3-11	Sutherland Avenue Collector Rehabilitation Project (Sub-basin 28B1)	Find and fix work to identify and address cause of overflow in the vicinity of 3110, 3204, and 3208 Sutherland Avenue, 409 North Bellemeade Avenue, Sutherland Avenue and North Bellemeade Avenue, and 5824 Stoneleigh Road.	FY 05/06	FY 07/08
3-12	Clinch and 21st Street Collector Rehabilitation Project (Sub-basin 35B3)	Find and fix work to identify and address cause of overflow in the vicinity of Twenty First Street and Twenty First Street and Laurel Avenue.	FY 10/11	FY 10/11
3-14	McKamey Road Interconnection Project	Project will involve constructing a hydraulic connection between the upper and lower McKamey Road Sewers.	FY 10/11	FY 11/12
3-15	Ball Camp Pike Improvement Project	Replace approximately 600 lf of existing sewer with 12-in sewer.	FY 10/11	FY 11/12
3-16	Painter Avenue Trunk Replacement Project	Replace approximately 2,200 lf of existing sewer with 48-in sewer and 200 lf with 54-in sewer.	FY 10/11	FY 11/12

Table ES-3: Third Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
3-17	McKamey Road Relief Sewer Project	Construct approximately 3,600 lf of 15-in sewer and 1,400 lf of 18-in sewer.		Completed 2002
3-20	Citico Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 600 and 605 Citico Street.	FY 11/12	FY 12/13
3-21	Deerfield Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4428 Deerfield Rd	FY 10/11	FY 11/12
3-22	Fountain Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4337 Fountain Drive.	FY 11/12	FY 12/13
3-23	Hillvale Circle Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of the SSO at Hillvale Circle.	FY 12/13	FY 12/13
3-24	Montgomery Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 3624 Montgomery Avenue.	FY 12/13	FY 12/13
3-25	Rolling Ridge Interconnection Project	Replace Rolling Ridge pump station with gravity sewer.	FY 10/11	FY 11/12
3-26	PCP, CPE, and CCP	Wastewater evaluation studies of the Kuwahee WWTP.	FY 05/06	FY 06/07
3-27	Montgomery Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1811 and 1816 Sterchi Street and 3608 and 3618 Montgomery Avenue.	FY 11/12	FY 12/13
3-29	Highland Hills Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 409, 411, and 419 Highland Hills Road.	FY 12/13	FY 12/13

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table ES-4: Fourth Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
4-1	Chukar Road Rehabilitation (Sub-basin 32A3) Project	Find and fix work to identify and address cause of overflow in the vicinity of 410, 2513, 2621, 2624, 2644, and 2645 Chukar Road.	FY 07/08	FY 08/09
4-2	Gleason Drive Collector Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 8013 and 8044 Gleason Drive.	FY 07/08	FY 08/09
4-3	Middlebrook Pike Rehabilitation (Sub-basin 27C3) Project	Find and fix work to identify and address cause of overflow in the vicinity of 7350, 7351, and 7424 Middlebrook Pike.	FY 07/08	FY 08/09
4-4	Northshore Drive Trunk Replacement Project	Replace approximately 3,600 lf of existing sewer with 36-in sewer (IAP 2).	FY 07/08	FY 08/09
4-6	Shadyland Drive Rehabilitation (Sub-basin 36A2) Project	Find and fix work to identify and address cause of overflow in the vicinity of 7000 Rotherwood Drive and 7112 and 7712 Shadyland Drive.	FY 07/08	FY 08/09
4-17	Storage Tank	Storage upstream of Walker Springs Pump Station.	FY 04/05	FY 06/07
4-18	Papermill Phases I, II, and III Project	Replace approximately 3,500 lf of existing sewer with 15-in sewer and approximately 1,000 lf with 36-in sewer.	FY 04/05	FY 06/07
4-19	Northshore Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5501 and 6410 Northshore Drive and Northshore Drive and Lyons Bend Road.	FY 11/12	FY 12/13
4-21	Black Bear Road Project	Find and fix work to identify and address cause of overflow in the vicinity of 2313 Black Bear Road.	FY 11/12	FY 12/13
4-22	Nightingale Lane Project	Find and fix work to identify and address cause of overflow in the vicinity of 6614 and 6617 Nightingale Lane.		Completed 2005
4-23	5205 Bent River Blvd Project	Find and fix work to identify and address cause of overflow in the vicinity of 5205 Bent River Boulevard.	FY 10/11	FY 11/12
4-24	Kerri Way Project	Find and fix work to identify and address cause of overflow in the vicinity of 7505 Kerri Way.	FY 10/11	FY 11/12
4-25	Lonas Drive Project	Find and fix work to identify and address cause of overflow in the vicinity of 4930 Lonas Drive.	FY 10/11	FY 11/12
4-26	Midpark Drive Project	Find and fix work to identify and address cause of overflow in the vicinity of 1721 Midpark and Midpark and Beard Drive.	FY 10/11	FY 11/12
4-27	Southfork Project	Find and fix work to identify and address cause of overflow in the vicinity at 2501 Miss Ellie Drive (private).	FY 11/12	FY 12/13

Table ES-4: Fourth Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
4-28	Queensridge Pump Station Upgrade Project	Upsize Queensridge Pump Station.	FY 10/11	FY 10/11
4-31	Kingston Pike @ Gallahar View Project	Find and fix work to identify and address cause of overflow in the vicinity of 8401 and 8403 Kingston Pike.	FY 11/12	FY 12/13
4-32	PCP, CPE, and CCP	Wastewater evaluation studies of the Fourth Creek WWTP.	FY 05/06	FY 06/07

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table ES-5: South Knoxville / Knob Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
S-1	Ginnbrook Pump Station Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Ginnbrook Pump Station	FY 06/07	FY 06/07
S-2	Goose Creek Trunk Sewer Replacement and Siphon Upgrade Project	Replace approximately 725 lf of existing 8-in sewer with 18-in sewer, Replace approximately 418 lf of existing 12-in sewer with 18-in sewer, Replace approximately 841 lf of existing 21-in sewer with 36-in sewer, Replace approximately 160 lf of existing 24-in sewer with 36-in sewer.	FY 06/07	FY 08/09
S-5	South Knoxville/Knob Creek Storage Facility	Design and construction of an approximately 1.7 MG storage facility	FY 05/06	FY 07/08
S-6	Sevier Avenue and Jones Street Collector Project	Rehabilitate approximately 3,100 lf of existing sewer and reroute approximately 352 lf of 8-in sewer	FY 08/09	FY 09/10
S-9	Ellis Road Rehabilitation Project	Find and fix work to rehabilitate approximately 3,940 lf of sewer in the vicinity of 6555 Chapman Highway, 6516 Jackie Lane, 212 Ellis Road, and 6528 Jackie Lane.	FY 08/09	FY 09/10
S-10	Mini-basin 41A6 Rehabilitation Project	Rehabilitate approximately 21,000 lf of sewer in Sub-basin 41A6	FY 05/06	FY 08/09
S-11	Ford Valley Pump Station Upgrade Project	Upgrade pump station	FY 08/09	FY 09/10
S-14	Stone Road Rehabilitation Project	Rehabilitation in 41B1 to reduce R value to 2%	FY 04/05	FY 05/06
S-15	Trunk Replacement in Sub-basin 40A2 Project	Replace approximately 1,932 lf of existing 12-in sewer with 24-in sewer, Replace approximately 810 lf of existing 12-in sewer with 30-in sewer, and replace approximately 1,326 lf of existing 24-in sewer with 30-in sewer.	FY 10/11	FY 11/12
S-16	Woodson Drive Trunk Replacement and Pump Station Upgrade Project	Replace approximately 260 lf of existing sewer and upgrade pump station		Completed 2004
S-17 (IAP 4)	Island Home Rehabilitation Project	Find and fix work to rehabilitate approximately 9,400 lf of existing sewer in the vicinity of 5320 McNutt and McNutt Road pump station		Completed 2004
S-18 (IAP 3)	South Haven Phases I & II Project	Relocate, rehabilitate and upsize approximately 4,700 lf		Completed 2005
S-19 (IAP 1)	Maryville Pike Pipe Replacement Project	Replace approximately 800 lf of existing sewer		Completed 2005
S-20	Avenue A Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 530 Avenue A	FY 10/11	FY 10/11
S-21	Alpine Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 3609 Alpine Avenue.	FY 11/12	FY 12/13
S-24 (IAP 5)	East Ford Valley Rehabilitation Project	Rehabilitation in Sub-basin 41A4 to reduce R value to 2%	FY 04/05	FY 05/06
S-25 (IAP 11)	South Haven Phase III Project	Rehabilitation in Sub-basin 40F1 to reduce R value to 2%	FY 04/05	FY 05/06
S-26	Trunk Sewer Replacement Project in Sub-basin 40F1	Replace 700 lf of existing sewer with 18-inch sewer	FY 10/11	FY 11/12

Table ES-5: South Knoxville / Knob Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
S-27	Trunk Sewer Replacement Project in Sub-basin 41A4	Replace approximately 175 lf of existing sewer with 12-inch sewer and 3,700 lf of existing sewer with 15-inch diameter sewer	FY 10/11	FY 11/12
S-28	Trunk Sewer Project	Replace approximately 1,464 lf of 30-in sewer with 36-in sewer.	FY 06/07	FY 08/09
S-29	4500 block Sevierville Pike Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4523 Sevierville Pike.		Completed 2003

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table ES-6: Williams Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
W-1	Sub-basin 19A2 Rehabilitation	Rehabilitation to reduce R to 2% in Sub-basin 19A2.	FY 09/10	FY 11/12
W-2 (IAP 9)	Williams Creek Trunk Line Replacement (Downstream of Golf Course)	Replace approximately 3,100 lf of existing sewer with 36-in sewer.	FY 04/05	FY 05/06
W-3	Rehabilitation of Trunk Sewer	Replace approximately 6,100 lf of existing sewer with 24-in sewer.		Completed 2003
W-4	E. Fifth Avenue Sewer Replacement Project	Find and fix work to identify and address cause of overflow in the vicinity of 2555 Fifth Avenue and 2565 E. Fifth Avenue.	FY 05/06	FY 05/06
W-5	Groner Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1114 Groner Road.	FY 11/12	FY 12/13
W-6	Selma Avenue - Harrison Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2806 Selma Avenue, 509 Harrison Street, and 515 Harrison Street.	FY 11/12	FY 12/13
W-7	Sunset Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2614 Sunset Avenue.	FY 11/12	FY 11/12
W-8	South Elmwood Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 121, 129 and 133 South Elmwood Street.	FY 11/12	FY 12/13
W-9	Williams Creek Trunk Line Replacement (Sub-basin 19A1)	Replace approximately 360 lf of existing sewer with 15-in sewer.	FY 11/12	FY 12/13

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table ES-7: Loves Creek and Eastbridge Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
L-1	Asheville Highway west of I-40 Trunk Replacement	Replace approximately 5,030 lf of existing 18-in pipe.	FY 10/11	FY 11/12
L-2	Boyds Bridge Pike and Holston Hills Trunk Replacement	Replace approximately 4,190 lf of existing 10-in, 500 lf of 12-in, and 330 lf of 15-in pipe.	FY 10/11	FY 11/12
L-3	River View Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4102, 4200, 3722, 3716, and 4014 Holston Hills Road.	FY 10/11	FY 11/12
L-4	Asheville Highway Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 5411 Asheville Highway.	FY 10/11	FY 11/12
L-5	Brentwood Shortline Repair	Find and fix work to identify and address cause of overflow in the vicinity of Brentwood Road	FY 11/12	FY 12/13
L-6	Holston Hills Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4716 Holston Hills Road.	FY 11/12	FY 12/13
L-7	Magnolia Avenue Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3301 Magnolia Avenue.	FY 11/12	FY 12/13
L-8	McDonald Drive Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3415 McDonald Drive.	FY 10/11	FY 11/12
L-9	Shelbourne Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3001 Shelbourne Road.	FY 11/12	FY 12/13
L-10	Washington Court Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4436 Washington Court.	FY 11/12	FY 12/13
EB-1	Maloneyville Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of Maloneyville Road (MH 93-1, 93-7, 93-10, and at the lift station).	FY 10/11	FY 11/12
EB-2	Strawberry Plains Pike Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 8616, 8714, and 9005 Strawberry Plains Pike.	FY 10/11	FY 11/12

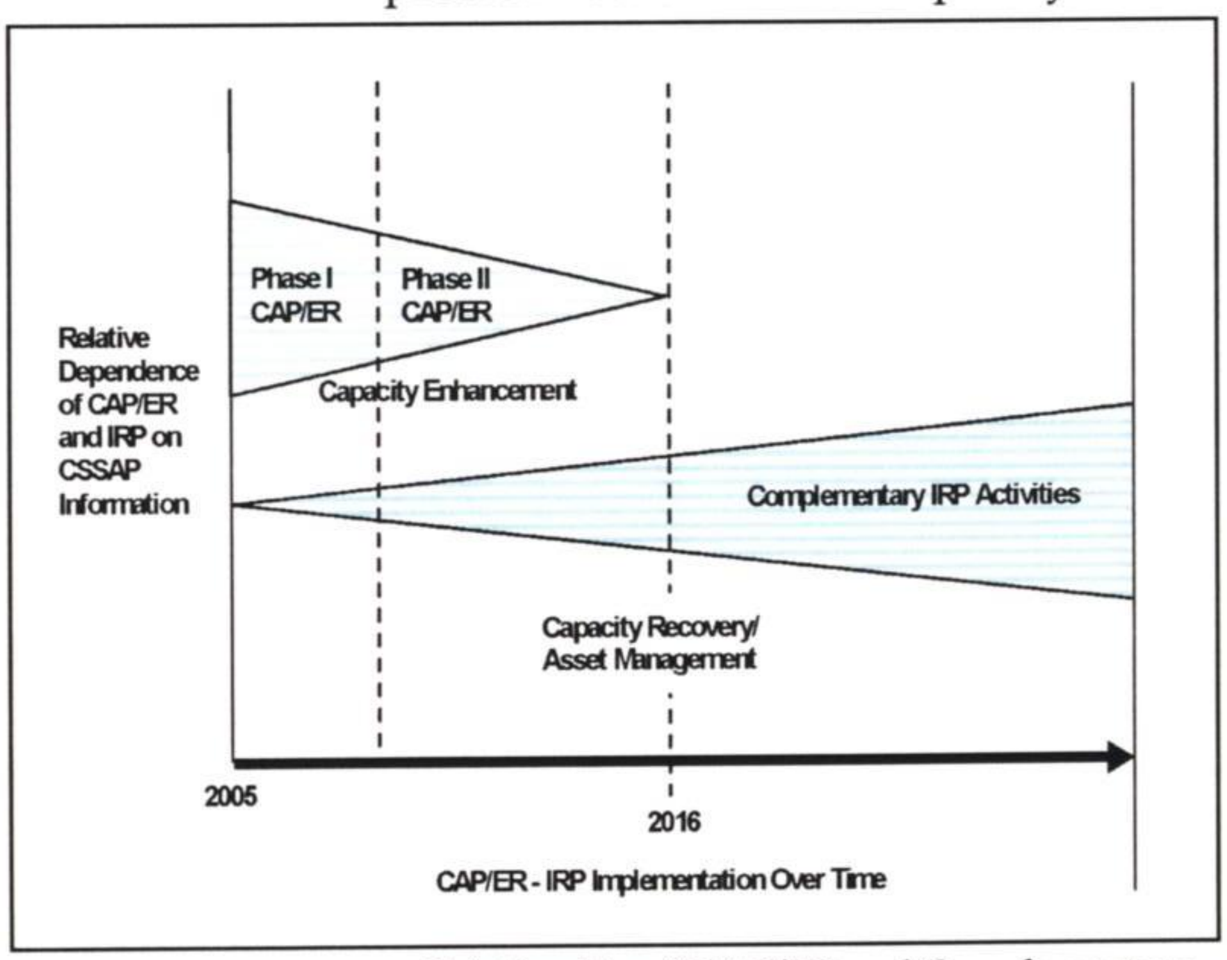
[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Approximate sizing and extents of each project are given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Figures ES-2 through ES-8 present maps of each basin showing the planned and completed facility projects to address the SSOs. Already completed pipeline improvement projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I and reducing the R value to 2% are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue. Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in Tables ES-1 through ES-7.

ES.5 Summary

KUB is aggressively implementing an integrated approach to enhancement and recovery of sewer system capacity to address conditions that cause SSOs in the system. The CAP/ER, or capacity enhancement phase relies primarily on known problem locations and temporary flow monitoring and hydraulic modeling to analyze system performance and evaluate alternative improvements. As the CSSAP matures, it will play an increasingly important role in supporting KUB's IRP to address capacity recovery and asset management goals.



Relationship of CAP/ER and Complementary IRP Activities to CSSAP

KUB is currently performing post-rehabilitation flow monitoring to determine the effectiveness of our rehabilitation efforts, and we will continue to perform these studies as we move forward with the CAP/ER and IRP. In addition, permanent flow meter data is being analyzed continuously to assess overall system performance trends. KUB is committed to adjusting our programs as necessary to meet the goals of the CD.

In Summary, this Phase 1 CAP/ER meets the objective stated in the CD: "to address the conditions causing reported SSOs with the goal of eliminating SSO locations on the Long-Term List" of the SSOER.

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1-26
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1-3
1-2
1-22
1-20
Brookevale
Wingate
Kohls
Pilleaux Road
Emily Avenue
Pelham Road
Burlington
Jones Street
Island Home

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- First Creek Basin

Improvement Projects

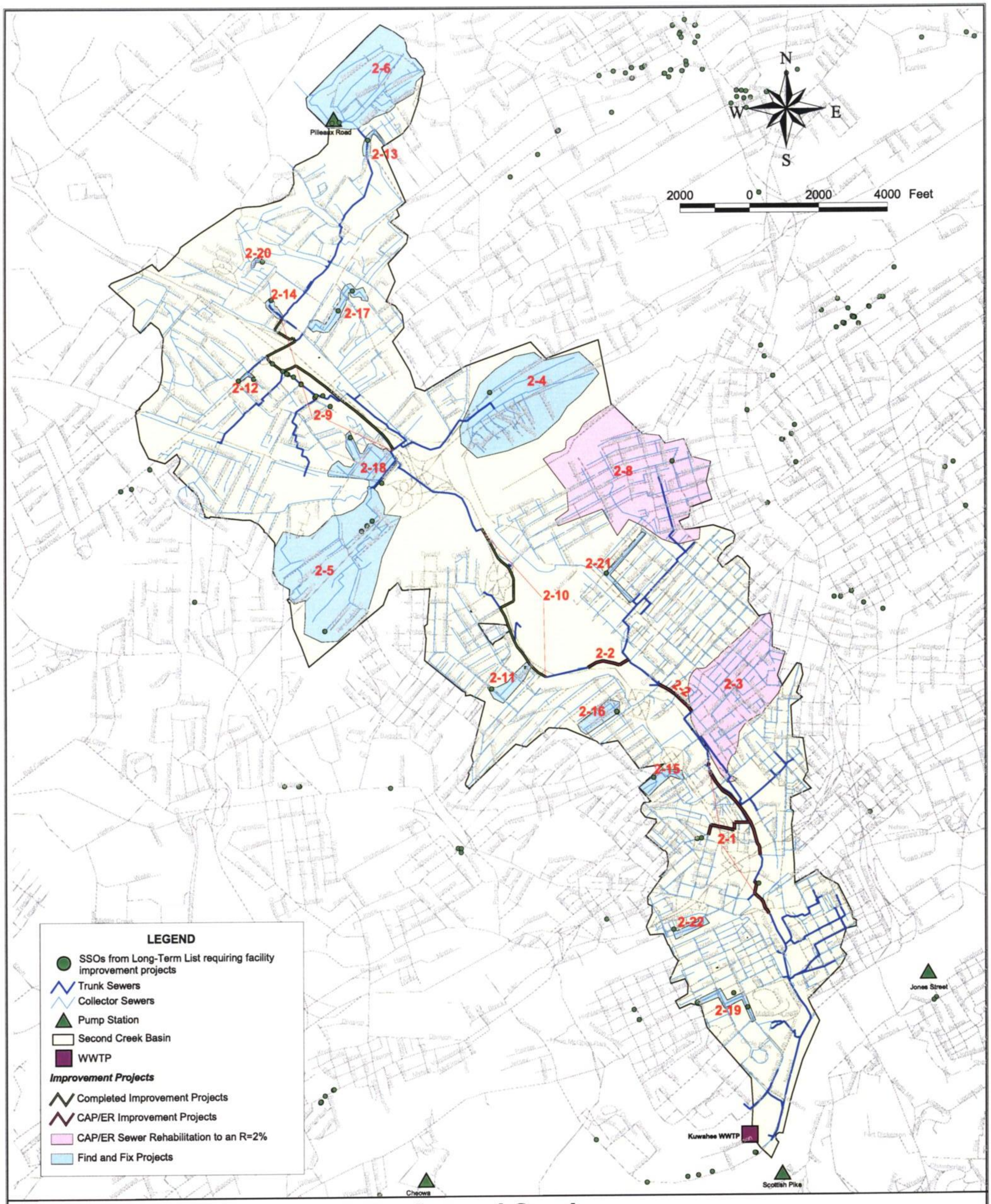
- Completed Improvement Projects
- CAP/ER Improvement Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- Find and Fix Projects
- CAP/ER Storage Facility

CDM

First Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure ES-2

0001886



CDM

Second Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure ES-3

0001887

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Pilleaux Road
Clinton Highway
Schaad Road
3-3
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3-4
3-14
3-17
3-4
3-5
3-24
3-6
3-27
3-25
3-2
Rolling Ridge
Amherst Road
3-20
3-12
3-6
3-16
3-8
3-11
Kuwahee WWTP
3-26
Scottish Pike
Cheowa
3-23
3-7
3-29
Lyons View
Vestal
Woodson

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- Third Creek Basin
- WWTP

Improvement Projects

- Completed Improvement Projects
- CAP/ER Improvement Projects
- Find and Fix Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- CAP/ER Storage Facility
- Pump Station Upgrade

CDM

Third Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure ES-4

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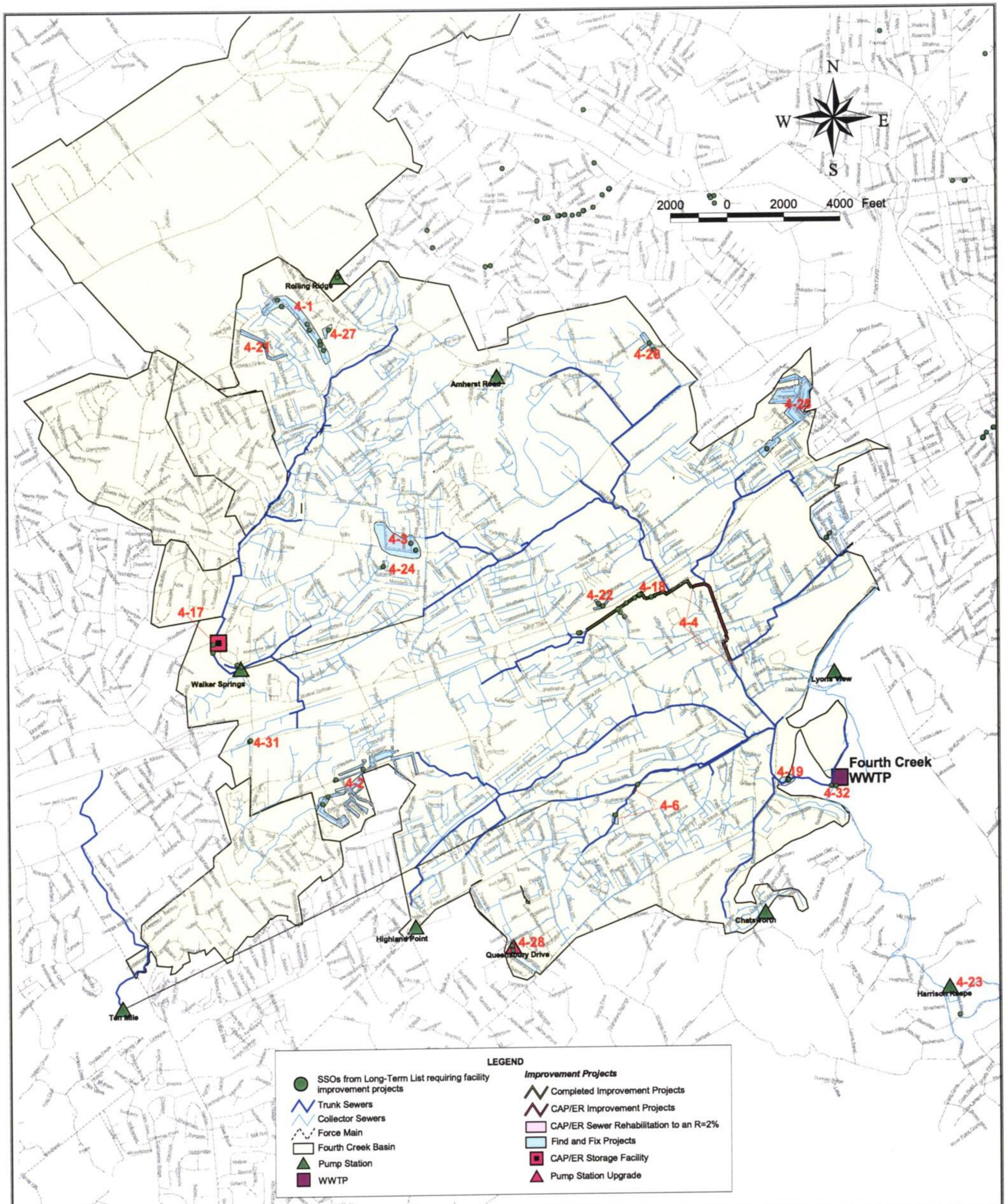

Fourth Creek
Phase 1 CAP/ER
Facility Improvement Projects

CDM

Figure ES-5

0001889

N
W E
S
2000 0 2000 4000 Feet

S-6
S-26
S-15
S-18
S-15
S-25
S-21
S-29
S-28
S-2
S-2
S-19
S-20
S-17
S-10
S-11
S-14
S-24
S-27
S-9
S-16
S-5
S-1

LEGEND
- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- South Knoxville and Knob Creek Basins
- WWTP

Improvement Projects
- Completed Improvement Projects
- CAP/ER Improvement Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- Find and Fix Projects
- Completed Rehabilitation Project
- CAP/ER Storage Facility
- Pump Station Upgrade

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South Knoxville/Knob Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure ES-6

N
W
E
S
1000 0 1000 Feet
W-1
W-2
W-3
W-4
W-5
W-6
W-7
W-8
W-9
LEGEND
SSOs from Long-Term List requiring facility improvement projects
Trunk Sewers
Collector Sewers
Pump Station
Williams Creek Basin
Improvement Projects
Completed Improvement Projects
CAP/ER Improvement Projects
CAP/ER Sewer Rehabilitation to an R=2%
Find and Fix Projects
CDM
Williams Creek
Phase 1 CAP/ER
Facility Improvement Projects
Figure ES-7
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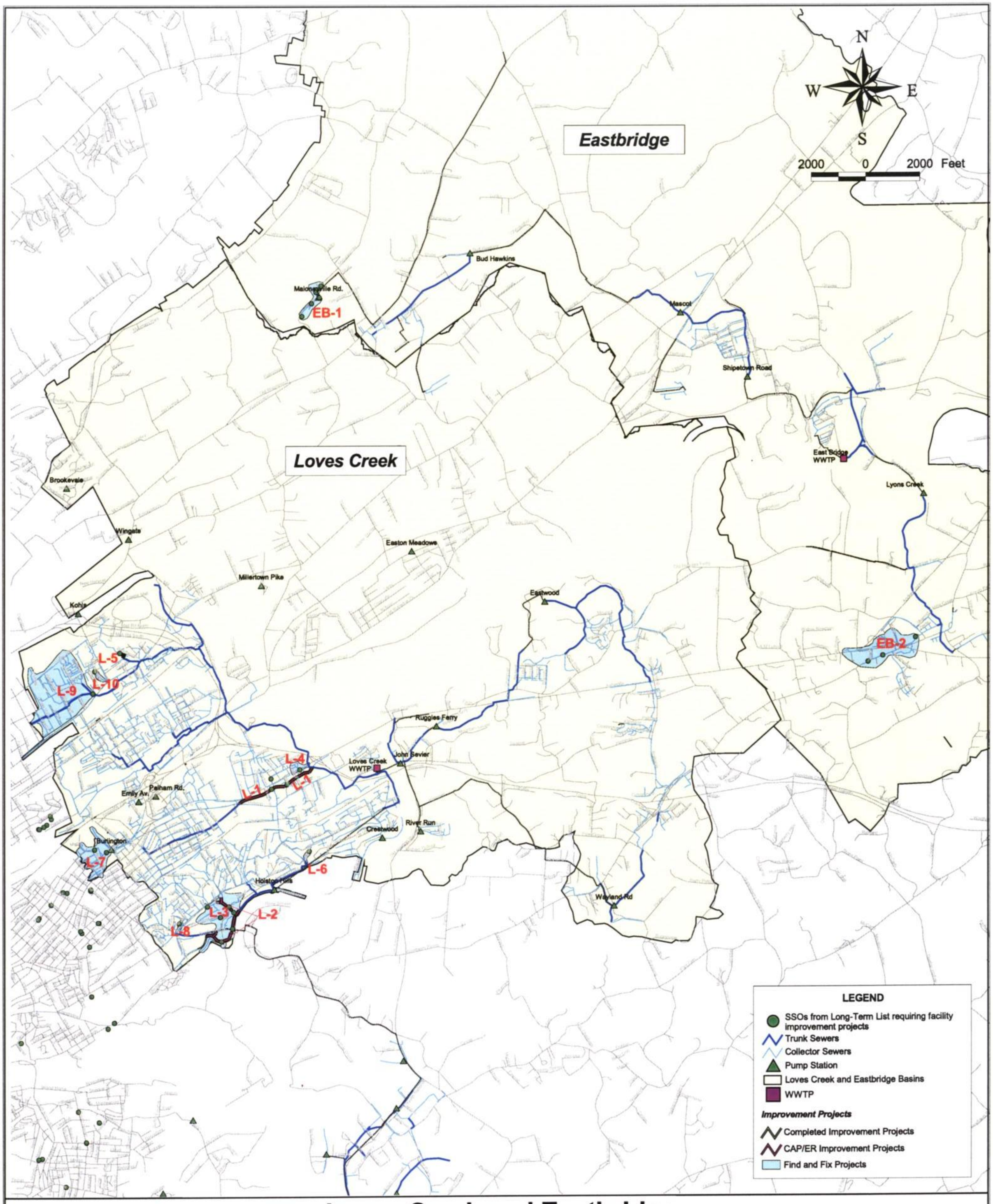

Loves Creek and Eastbridge Phase 1 CAP/ER Facility Improvement Projects

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Figure ES-8

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Section 1
Introduction

In February 2005, a CD with the Tennessee Department of Environment and Conservation, United States Environmental Protection Agency, Tennessee Clean Water Network and the City of Knoxville became effective with the goal of eliminating SSOs in the sewer collection system. As part of this CD, KUB submitted a Sanitary Sewer Overflow Evaluation Report (SSOER) dated September 2004 and an Annual Update to this report in April 2005. The SSOER contains a list of SSOs referred to as the "Long-Term List" that identifies all SSOs that occurred (including building back-ups) and the associated location, date, cause, and volume. Also, as part of this CD, KUB agreed to submit a Phase 1 CAP/ER to address the conditions causing reported SSOs with the goal of eliminating SSO locations on the Long-Term List of the 2001-2004 SSOER Annual Update.

This section describes the background and purpose of the Phase 1 CAP/ER, a description of the study area, and the organization of the report. As an introduction, an overview of KUB's integrated approach to improving sewer system performance, of which the Phase 1 CAP/ER is a major element, is presented.

1.1 KUB's Integrated Approach to Achieving Consent Decree Goals

KUB has initiated implementation of several complementary programs, including the Phase 1 CAP/ER, to comply with the requirements of the CD, specifically to "address the conditions causing SSOs with the goal of eliminating the SSO locations on the Long-Term List." KUB's holistic or total basin solution for each sewershed is to:

1. Implement capacity enhancement projects consistent with the CAP/ER requirements including storage facilities, relief sewers, pump station upgrades, and comprehensive rehabilitation in targeted areas with documented RDI/I problems, and
2. Achieve capacity recovery through RDI/I removal with other complementary maintenance programs that are part of the Infrastructure Rehabilitation Program (IRP).

KUB has developed the Phase 1 CAP/ER as a conceptual design document to guide the implementation of specific projects. It is not intended to provide final design criteria, but to provide minimum criteria which will be further evaluated during preliminary and final design phases. In many cases, projects are being designed with capacities that exceed the minimum criteria established in the CAP/ER.

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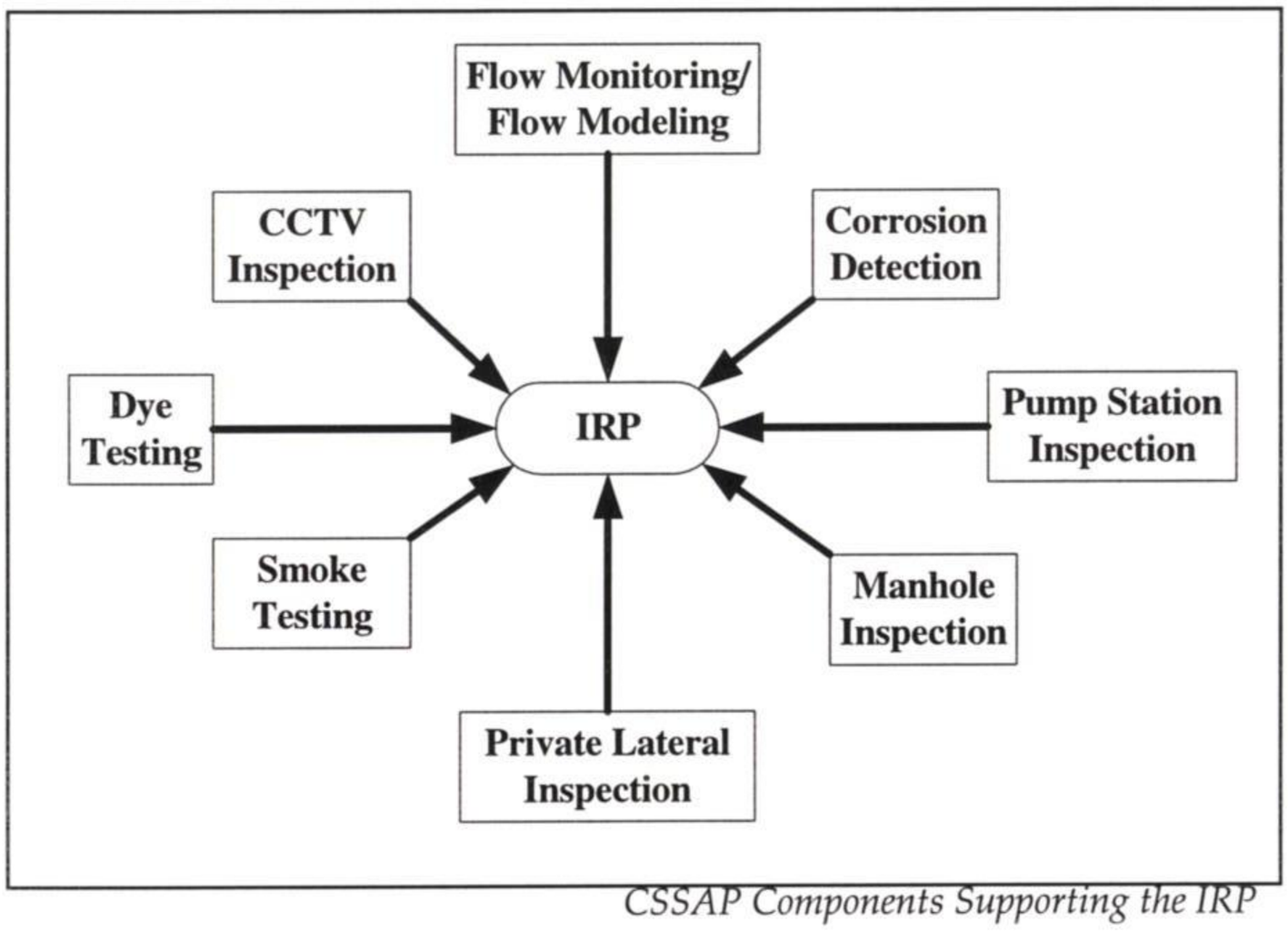
Other Complementary Programs Related to CAP/ER



CSSAP Components Supporting the IRP

KUB's other complementary programs that combine to comprise the IRP are supported by the CSSAP which was previously approved. These programs address performance enhancement (removal of roots, debris, grease), asset management (condition assessment, repair and replacement) and RDI/I removal (removal of inflow, repair of defective pipes and manholes that are the source of infiltration). Specifically, the smoke testing program addresses inflow elimination, and the lateral replacement program and sewer rehabilitation programs address infiltration reduction. It is important to note that RDI/I reduction benefits of these programs in restoring system capacity have not been considered in developing the conceptual capacity of CAP/ER solutions. This provides an added factor of safety because the CAP/ER project facilities will be able to store and/or convey flows from increasingly larger storm events as RDI/I is removed through KUB's comprehensive IRP, which has been approved and is being aggressively implemented. KUB is in the process of analyzing permanent and temporary flow monitoring data to quantify the effectiveness of these programs.

1.2 Background and Purpose of CAP/ER

Providing a wastewater collection system that meets the needs of KUB customers while protecting the environment is the top priority of KUB's facility planning efforts. Since 1987, KUB has performed several studies and made many improvements in a majority of the service area basins. However, there are still areas requiring capital improvements, particularly in older areas of the system where RDI/I is problematic.

RDI/I entering the sanitary sewer system during wet-weather is a major consideration in this report. All combined sanitary and storm sewers have been eliminated from the wastewater service area. However, because of sewer system defects, unintentional or illegal cross connections with the storm sewer system, or other sources, extraneous storm water flows enter the sanitary sewer system during rainfall events as RDI/I. These RDI/I flows can overload the capacity of the sanitary sewer system and result in periodic SSOs from manholes and/or building back-ups.

Recent attention nationally and within Environmental Protection Agency (EPA) Region IV states has been focused on SSOs. The Clean Water Act prohibits unpermitted discharges from a wastewater system (and thus prohibits SSOs); however, regulatory enforcement has been inconsistent nationally as to how much time and to what extent system operators should be given to come under compliance. EPA is in continual development of new regulations, which clarify expectations of wastewater utilities related to controlling SSOs, such as through good sewer maintenance practices and infiltration/inflow (I/I) reduction programs. These new regulations are leaning toward the requirement that rigorous sewer maintenance, evaluation, and rehabilitation programs be initiated to improve system performance and reduce SSOs.

The objective of the Phase 1 CAP/ER is to identify facility improvements required to address reported SSOs in accordance with the CD. The SSOs listed on the Long-Term List that require improvement projects are mapped and presented in **Figure 1-1**. These SSOs include building back-ups. Some of these SSOs were caused by capacity issues and some were caused by non-capacity issues such as a pipe blockage caused by debris, grease, or roots.

Most capacity related SSOs were evaluated using a hydraulic modeling analysis. In keeping with KUB's goals, this hydraulic analysis consisted of first analyzing each basin using a hydraulic model and developing a total basin solution that would convey projected future flows and projected RDI/I from a representative planning storm event. The total basin solution for each basin takes into account the whole system including the effects of transporting this flow to the wastewater treatment plants. The total basin solution addresses future projected SSOs and surcharge conditions in addition to the SSOs listed in the Long-Term List.

CAP/ER Project Performance Criteria

The criteria used in evaluating wet-weather performance of the existing system and alternative capacity enhancement projects to address SSOER capacity related locations are summarized below:

1. Future base flows projected to occur at or near build-out conditions (20 years for highly developed sewersheds and 40 years for developing sewersheds) were used to represent dry-weather flows, including diurnal variations.

2. Winter/spring R values (percentage of rainfall that enters the sewers as RDI/I) were developed on the basis of extensive temporary flow monitoring program data and used to develop RDI/I influent hydrographs. The data indicate that winter/spring R values typically exceed other seasonal R values by up to 100 percent.

3. Projects selected for inclusion in the CAP/ER result in surcharging of less than 2.0 feet above top of pipe and/or no surcharging to within 3.0 feet of the manhole rim

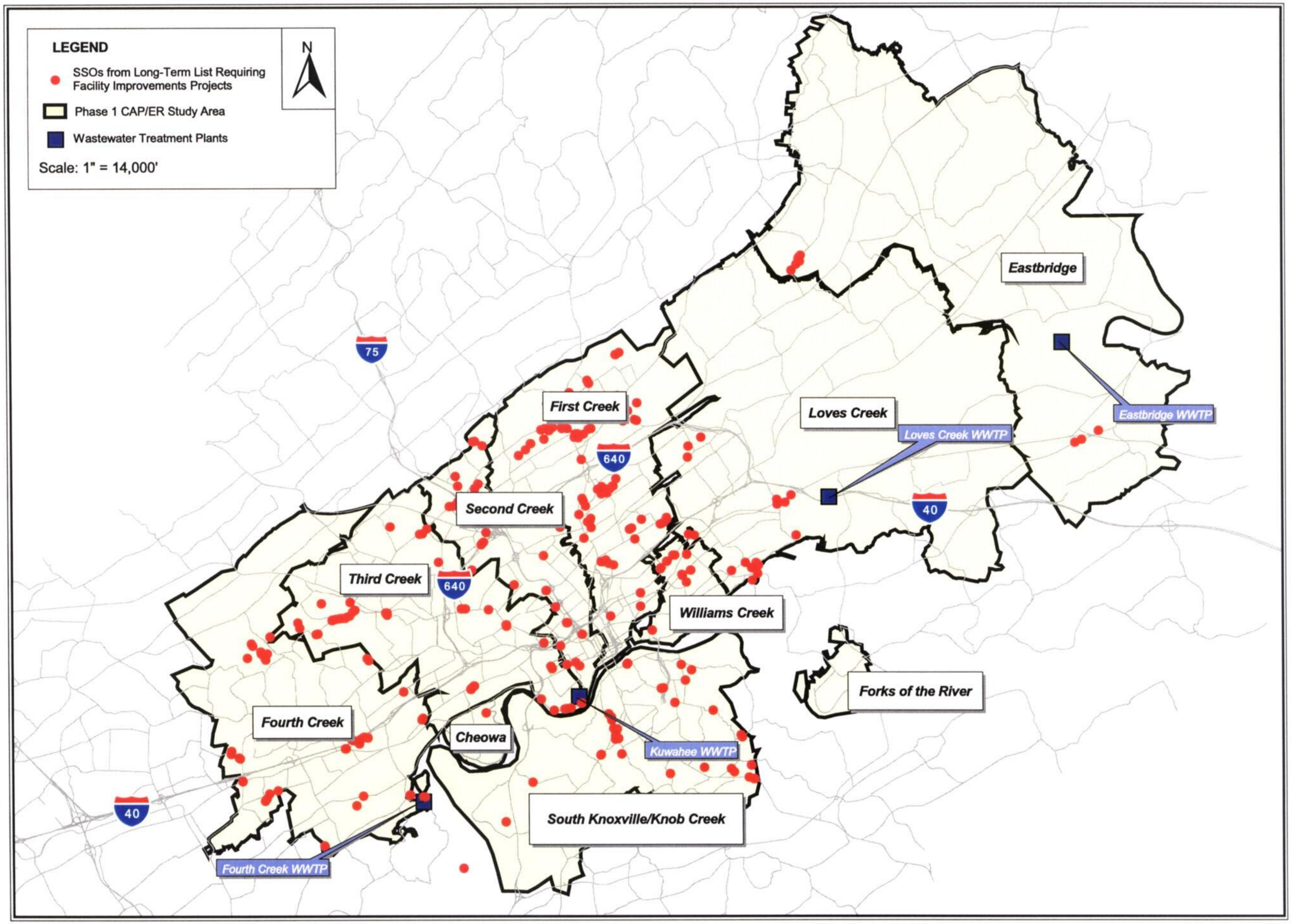


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Figure 1-1
Phase 1 CAP/ER Study Area

at SSOER locations during base wet-weather conditions (described below).

4. Projects selected for inclusion in the CAP/ER include sufficient downstream improvements and/or upstream comprehensive rehabilitation so that they do not result in moving overflows to downstream locations during base wet-weather conditions (described below).

5. Base wet-weather conditions consist of a synthetic rainfall event derived from a representative 24 hour event of 2.96 inches. Additional information on the synthetic rainfall event is provided in a subsequent portion of this document.

The total basin solution consists of a number of individual projects including various sewer replacement projects, storage projects, and rehabilitation projects. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution for each basin was analyzed to determine which are required to address the SSO locations on the Long-Term List. This included projects directly affecting the SSO location as well as projects required to address predicted overflows downstream, which are predicted to occur as a result of upstream improvements. Projects that were not required to address these SSOs are not included in this report.

Some SSOs reported on the Long-Term List occurred on small collector pipes that were not included in the hydraulic model evaluation. These are also addressed by this Phase 1 CAP/ER by either collector sewer replacement projects or sewer rehabilitation projects. In addition, some SSOs reported on the Long-Term List were caused by non-capacity issues such as a pipe blockage caused by debris, grease, or roots. These SSOs have been addressed or are being addressed by KUB's CSSAP.

The primary function of the CSSAP, which has been approved by EPA, is to provide decision-support information for implementation of the Infrastructure Rehabilitation Program (IRP), along with KUB's other capital improvements to restore and maintain system hydraulic capacity, restore and maintain structural integrity of system components and reduce corrective maintenance costs.

The primary objectives of the IRP are to address RDI/I and other conditions causing SSOs through:

- Capacity restoration – this objective is aimed at keeping assets functioning at their full, original capacity. Examples include removing sediment or debris from a pipeline system, reducing infiltration and inflow (I/I) in a wastewater collection system, and/or repairing system defects that would limit flow capacity through a system. In some cases, it is cost effective and/or necessary due to growth to provide increased capacity or storage to attain desired system hydraulic capacity.

- Damage repair – this objective is aimed at repairing structural damage and failures in the system that are the result of wear, corrosion, age, and/or construction-related damage to extend the useful life of the component. This function reduces

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the risk of system failure which could cause interruption in service which could result in impacts to the community and would increase costs as compared to scheduled maintenance and repairs.

- Maintenance reduction – this objective is aimed at repairing portions of the system that are subject to known, repeated maintenance problems that increase maintenance costs and keep crews from conducting more productive preventive maintenance. Examples in a wastewater collection system are the repair of conditions such as root intrusion, offset joints, pipe sags, improper service connections, and other system deficiencies that typically lead to recurring problems for system operators.

This CAP/ER was developed using CSSAP elements (e. g., flow monitoring, hydraulic model) and will be implemented using other CSSAP elements (e.g., dye testing/dyed water flooding, CCTV inspection, smoke testing). Therefore, for program administration purposes, KUB considers the CAP/ER and its implementation to be part of its IRP. The IRP is being submitted under separate cover for review and approval.

1.3 Implementation of CAP/ER Projects

As specific CAP/ER projects are moved from the conceptual phase described in the Phase 1 CAP/ER to implementation, KUB considers other factors in developing actual project performance criteria, including short term risks of SSOs that may occur in sensitive areas such as parks, near schools, on residential property, and other locations where public contact may be expected. This is expected to result in designs that provide enhanced capacity.

Regarding the storage facilities, the minimum required volumes were determined using a continuous hydraulic/hydrologic modeling technique based on actual rainfall data from a 54 year period of record. This analysis takes into account any volume remaining in storage from a previous wet-weather event in sizing the tank to meet the design criteria.

1.4 Description of Study Area

As shown in Figure 1-1, KUB's wastewater planning area includes the following eight basins: First Creek, Second Creek, Third Creek, Fourth Creek, South Knoxville/Knob Creek, Williams Creek, Loves Creek, and Eastbridge basins. The Cheowa service area drains to the Third Creek basin. The Forks of the River service area drains to the Williams Creek basin.

Wastewater from the First Creek, Second Creek, Third Creek, South Knoxville/Knob Creek, and Williams Creek basins flows by gravity and an intricate network of pump stations to an interceptor sewer along the Tennessee River. This interceptor sewer conveys wastewater flows to the Kuwahee Wastewater Treatment Plant (WWTP), which is the largest of three main wastewater treatment plants operated by KUB. The

Fourth Creek basin is served by a separate treatment facility, the Fourth Creek WWTP. The Loves Creek sewer basin flows by gravity and pump station to the Loves Creek WWTP. The Eastbridge basin is also served by a separate treatment facility, the Eastbridge WWTP.

Improvements associated with the treatment plants are being addressed separately by the Process Controls Program as well as the Comprehensive Performance Evaluation and Composite Correction Program. Costs for treatment of flows at the plant were taken into consideration when analyzing alternatives. Flows resulting from the improvements recommended herein are conveyed to the treatment plant and assumed to be treated at the plant as appropriate. The SSOs noted on the Long-Term List as a plant bypass are addressed separately by the Process Controls Program and/or as part of the plant improvements in the Comprehensive Performance Evaluation and Composite Correction Program.

The wastewater planning study area includes urban and suburban development and commercial/industrial land uses. The oldest and densest portions of the system are located near the Fort Loudon Reservoir in the First and Second Creek basins--with ages of some portions of the early system dating back to the mid-1920s. The system's age and density decreases as it heads out concentrically from this central location. The central portions of the area contain significant industrial and commercial development, while the northern, southern, eastern, and western portions of the planning area contain significant residential development. Like most municipalities, future residential growth and commercial developments are spreading to these outskirt areas. Model analysis of proposed improvements will consider potential build-out in both new and existing service areas.

A majority of the trunk lines in the service area are comprised of reinforced concrete. Main trunk lines range in size from 21 inches to the 72-inch diameter interceptor that conveys flow to the Kuwahee WWTP. The planning study area of the report covers roughly 65,338 KUB customers, 248 square miles, and focuses on the backbone of a sanitary sewer network that contains roughly 1,264 miles of pipe. While a majority of the system flows by gravity, KUB also operates and maintains a large network of pump stations designed to overcome the rocky, and often times steep terrain of the Knoxville metropolitan area.

1.5 Organization of Report

This Phase 1 CAP/ER report is organized into 12 sections as listed below. Sections 1 through 4 document the background, flow monitoring programs, methodologies for projecting future wastewater flows, methodologies for calibrating and using hydraulic models to analyze the system and evaluate alternatives for improvements, and a discussion of the improvement alternatives investigated. Section 5 through Section 11 describe the results of each basin analysis and present the recommended alternative to address the Phase 1 SSOs. Section 12 provides an implementation plan for completing the projects outlined in the previous sections.

Section 1 – Introduction

Section 2 – Flow Monitoring

Section 3 – Existing and Future Wastewater Flows

Section 4 – Methodology for Evaluating Sewer Infrastructure and Developing Alternatives

Section 5 – First Creek

Section 6 – Second Creek

Section 7 – Third Creek

Section 8 – Fourth Creek

Section 9 – Williams Creek

Section 10 – South Knox

Section 11 – Loves Creek and Eastbridge

Section 12 – Implementation Plan

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Section 2
Flow Monitoring

2.1 Purpose of Flow Monitoring

KUB initiated temporary flow monitoring programs in 1991, 2003, 2004, and 2005 as part of an ongoing capital improvements program. In addition to these temporary programs, KUB maintains 21 permanent flow monitors in the service area trunk sewer systems and 6 permanent rain gauges throughout the service area. The purpose of permanent and temporary flow monitoring is to collect wastewater flow data and to evaluate quantities of flow and changes in flow during dry-weather and wet-weather conditions.

The flow monitoring data is used in several ways to aid in the planning of capital improvements. First, the data is used to identify areas in the collection system that should receive the highest priority for sewer system evaluation survey (SSES) and rehabilitation based on observed response to wet-weather events. Second, the data is used to support a hydraulic analysis of the trunk sewers (including model calibration and development of design flows), where the purpose of the hydraulic analysis is to identify trunk sewers or pump stations that are over-capacity during dry- or wet-weather conditions. Third, the data is used to measure the relative success of sewer rehabilitation projects by quantifying the amount of inflow and infiltration (I/I) that is reduced. Finally, the data from permanent flow meters is used for hydraulic model calibration and for flow trending analyses.

2.2 Description of Flow Monitoring Programs

Historically, KUB has performed a series of extensive short-term flow monitoring programs throughout their system. A discussion of each program follows.

2.2.1 1991-1992 Flow Monitoring Program

KUB and ADS Environmental Services Inc. performed an extensive flow monitoring analysis in November 1991 through March 1992, during a period of high groundwater table elevation. As part of this program, data was collected from the First Creek, Second Creek, Third Creek, Fourth Creek, South Knoxville/Knob Creek, Williams Creek, and Loves Creek basins. A study was also conducted in the Cheowa basin from April to June 1992. In all, 15-minute data was collected from 241 temporary flow monitors and 20 permanent flow monitors for approximately 35 days. In addition to sewer flow monitoring data, rainfall data was gathered to assess the impact of storm events on sewer flows. Six temporary rain gauges, which recorded rainfall at 15-minute increments, were placed in the study area in 1992.

The 1992 flow data was used in several hydraulic evaluations that occurred from 1999-2003, including hydraulic models developed for the First Creek, Second Creek, Third Creek, Fourth Creek, South Knoxville/Knob Creek, Williams Creek, and Cheowa Basins.

2.2.2 2003-2005 Flow Monitoring Program

In 2003, KUB began another 3 year temporary flow monitoring program to update the flows collected over 10 years prior as part of the 1991-1992 program and to update the hydraulic models developed using the 1992 flow data. Where possible, sites for the 2003-2005 study were located in the same location as the 1991-1992 flow monitor locations to allow for easier comparison between 1991-1992 and 2003-2005 data. CDM used KUB's sewer and manhole geographic information system (GIS) data to identify 1991-1992 manholes with incoming or outgoing pipes with a steep slope, offset, or large bend. These manholes were not selected as sites for flow monitoring. In addition, a 1991-1992 site was not selected if the 1991-1992 data showed that the dry-weather flows were below the threshold that could be captured accurately by the flow monitor. Where possible, flow monitors were placed to avoid influences of downstream pump stations. At some locations, flow monitors recorded low flows at a high velocity. At these locations, flow monitors designed specifically for those types of conditions were installed.

Basins (or portions of basins) were prioritized for flow monitoring based on the implementation schedules of proposed improvements from the previous analyses. **Figure 2-1** shows the basins or portions of basins that were monitored each year of the 2003-2005 program. Each program is discussed in more detail below.

2003 Flow Monitoring Program

The 2003 program focused on collecting temporary flow monitoring data from the Upper First Creek, Upper Second Creek, and Knob Creek basins. The monitoring program began in early April 2003 and extended through the middle of July 2003. The flow monitoring data was collected by GRW Engineers, Inc. (GRW). As shown in **Figure 2-2**, GRW installed 17 flow monitors in upper First Creek and 7 monitors in upper Second Creek. **Figure 2-3** shows the additional 8 monitors installed in Knob Creek for a total of 32 flow monitors. The flow monitors measured depth, velocity, and rate of flow in 15-minute increments. The flow monitors were placed at system connection points near trunk sewers to isolate and measure wastewater flows from individual sub-basins.

Rainfall data was collected in conjunction with flow monitoring data to determine the relationship between rainfall volume and the RDI/I volume. GRW installed rain gauges at five locations within the study area during the flow monitoring period. The rain gauges recorded volumes in increments of 0.01 inches every 10 minutes.

2004 Flow Monitoring Program

The 2004 program was conducted in Lower First Creek, Upper Third Creek, Fourth Creek, and South Knoxville basins by CDM. Hydromax USA (Hydromax) installed the flow monitors and rain gauges, collected the data, and maintained the monitors

and gauges during the monitoring period. Hydromax installed 29 flow monitors in First Creek, 21 flow monitors in Third Creek, 46 flow monitors in Fourth Creek, and 36 flow monitors in South Knoxville for a total of 132 flow monitors. In addition to the temporary monitors, data from eight permanent KUB flow monitors (one in First Creek, two in Third Creek, two in Fourth Creek, and three in South Knoxville) was also collected. Wastewater flows in Lower First Creek, Upper Third Creek, and Fourth Creek were monitored from the middle of March to the beginning of June 2004. Flows in South Knoxville were monitored from the beginning of April to the beginning of June 2004. The flow monitors measured depth, velocity, and flow rate in 15-minute increments. **Figures 2-4 through 2-7** present maps of the locations of the flow monitors placed in each of these basins.

Rainfall data was collected in conjunction with flow monitoring data to determine the relationship between rainfall volume and the RDI/I volume. Rain gauge locations were selected with the goal of obtaining comprehensive coverage of rainfall throughout each monitored basin. Hydromax installed seven rain gauges in First Creek, three in Third Creek, seven in Fourth Creek, and seven in South Knoxville for a total of 24 gauges. Rainfall data from one permanent KUB rain gauge, located in South Knoxville, was also used in this study. The rain gauges recorded volumes in increments of 0.01 inches every 15 minutes.

2005 Flow Monitoring Program

The 2005 program focused on collecting updated temporary flow monitoring data from the Second Creek, Lower Third Creek, Williams Creek, and Loves Creek basins. **Figures 2-8 through 2-11** present maps of the locations of the flow monitors placed in each of these areas. Some additional meters were placed in the First Creek, Fourth Creek, and South Knoxville/Knob Creek Basins to gather additional data for the rehabilitation program as well as placed in the Eastbridge WWTP service area. The 2005 flow monitoring program included 104 temporary flow meters, 5 permanent flow meters, 68 temporary rain gauges, and 6 permanent rain gauges. Data was collected from the beginning of February until the beginning of April 2005.

A network of rain gauge locations was chosen such that an even coverage of rainfall data could be collected to coincide with the flow monitoring locations. The intent was to ensure that flow monitor response more accurately matched with rain gauge response. The rain gauge network was set up such that rain gauges were spaced in a triangular grid pattern over a basin with spacing of roughly 1 to 1.5 miles between the gauges.

2.3 Data Quality Review

After the data were collected, it was reviewed to ensure that only quality data was used in the analysis. The flow data were plotted over time to ensure that there were no unjustified changes in base wastewater flow and to ensure that the base flow was of sufficient quantity to be measured by the flow monitor. The velocity and level data recorded were used to make scatterplots. Scatterplots of level versus velocity for a

given flow monitor can be interpreted to evaluate the quality of the data and provide insight to the hydraulic conditions of the site. For example, a cluster of data that appears flat can indicate that a downstream blockage may exist. If a bottleneck occurs downstream, velocities will increase at a dramatically slower rate than during free flow conditions. In severely restricted lines, velocities will decrease as depths increase. An example scatterplot of reliable flow data is shown in **Figure 2-12**. The graph at the top of the figure shows flow recorded at the monitor in red and corresponding rainfall events in blue. The graph in the middle of the figure shows the velocity recorded at the monitor in red and the level or depth in blue. The graph at the bottom of the figure is the scatterplot of level versus velocity for this data set. The data exhibits a good correlation of velocity and depth. The velocity increases with depth similar to the relationship predicted by the Manning equation showing the sewer is operating as an open channel.

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2003 Flow Monitoring Program
2004 Flow Monitoring Program
2005 Flow Monitoring Program

Scale: 1" = 12,000'

N

75

Upper First Creek

Upper Second Creek

Loves Creek

Loves Creek WWTP

Lower First Creek

40

Upper Third Creek

Lower Second Creek

Lower Third Creek

Williams Creek

South Knoxville

Kuwahee WWTP

Fourth Creek

40

Knob Creek

Fourth Creek WWTP

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Figure 2-1
2003 - 2005 Flow Monitoring Program

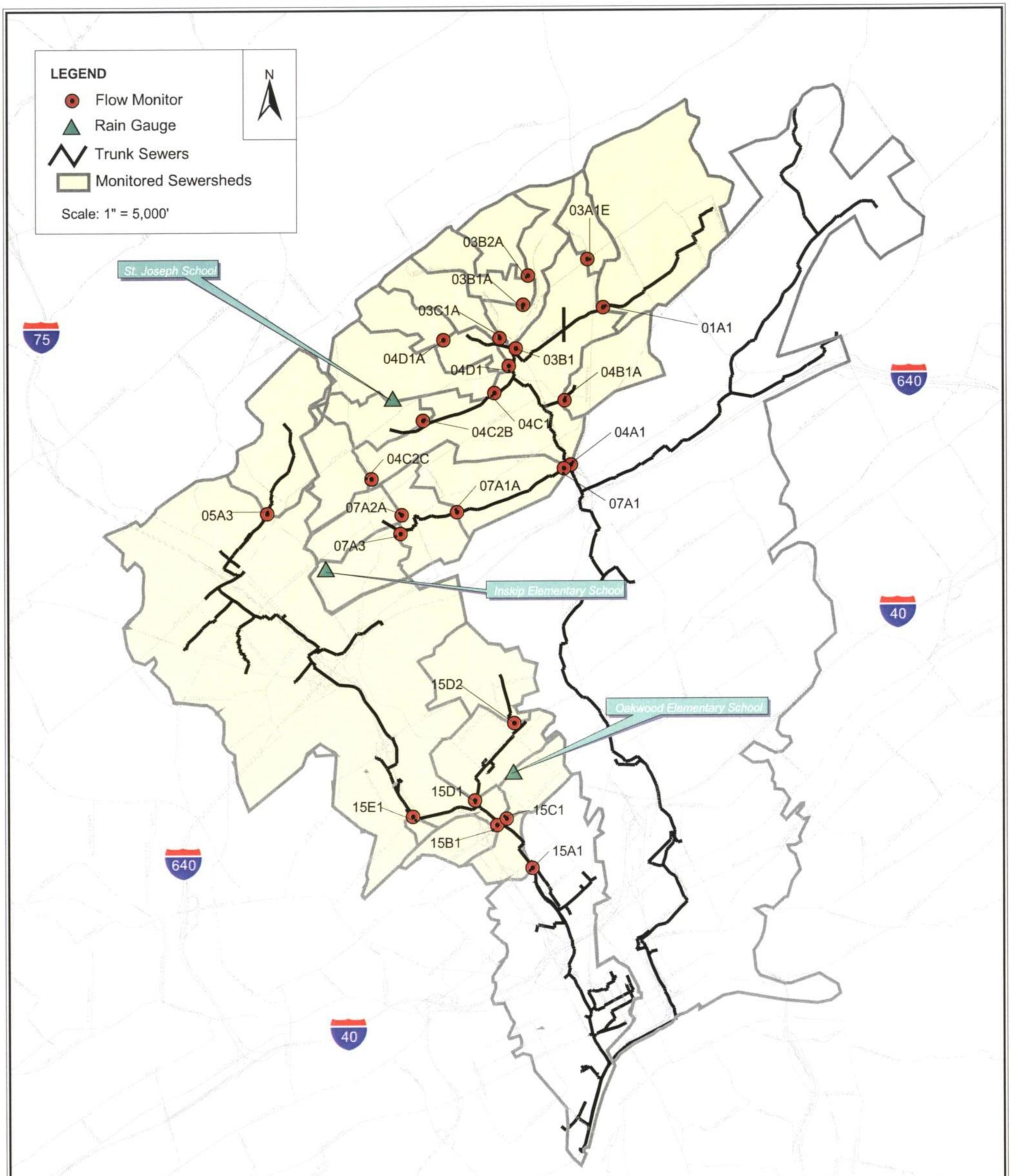

Figure 2-2
Upper First and Upper Second Creek
2003 Flow Monitor and Rain Gauge Locations

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- Pump Station
- Flow Monitor
- Rain Gauge
- Sewers
- Force Mains
- Monitored Sewersheds

Scale: 1" = 2,000'

N

Woodson Pump Station

Woodson Dr

Fitness Center

Backlot

Alcoa

Maryville

Ginnbrooke PS

Ginnbrooke

Maloney

Mount Olive Elementary School

Boy's Home PS

Power Park PS

Power Park

CHEROKEE TRL

SOUTHGATE RD

WOODSON DR

MONTLAKE DR

MOUNT OLIVE RD

MACONEY RD

BROWN RD

ALCOA HWY

RUDDER RD

Figure 2-3
Knob Creek
2003 Flow Monitor and Rain Gauge Locations

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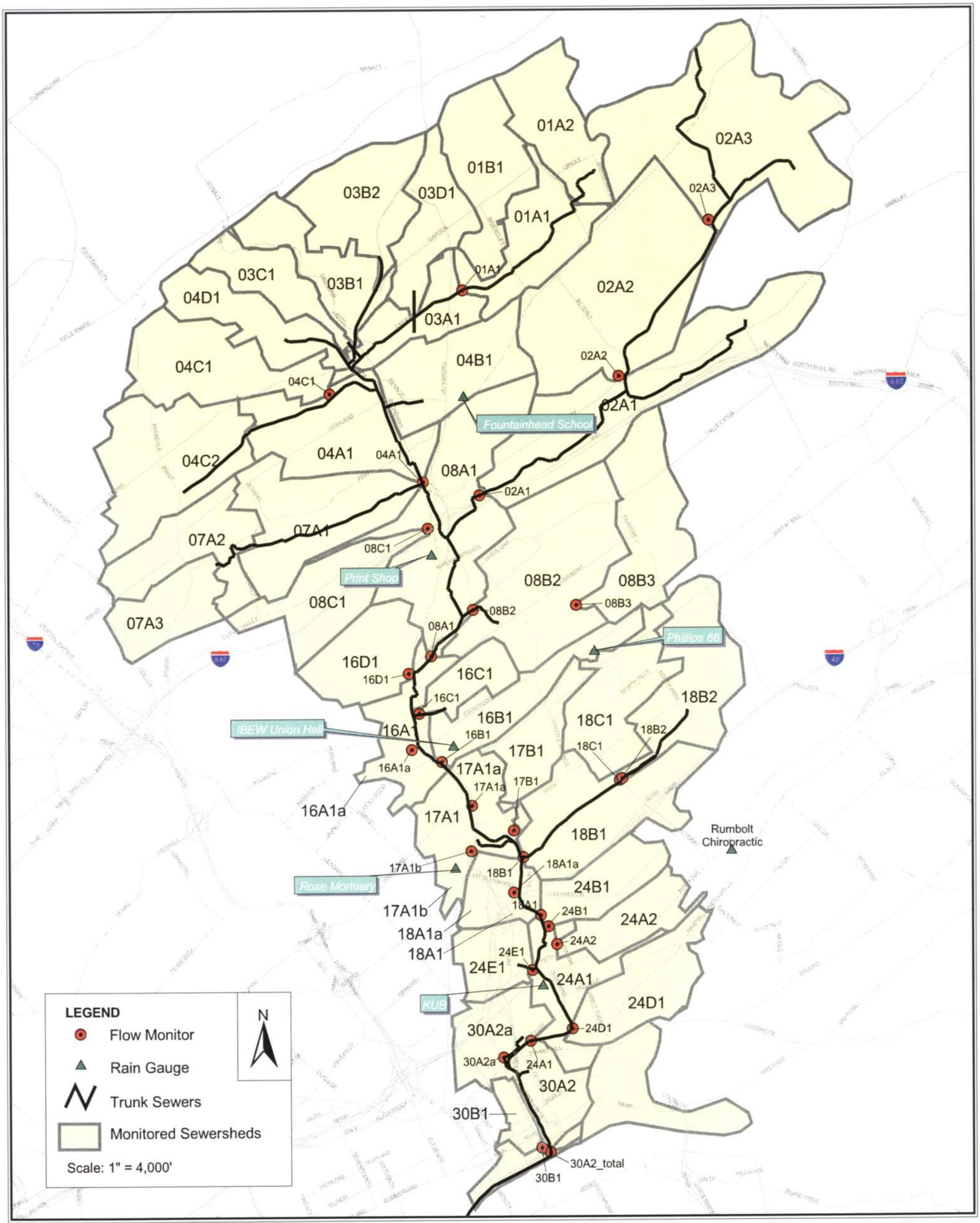

Figure 2-4
Lower First Creek
2004 Flow Monitor and Rain Gauge Locations

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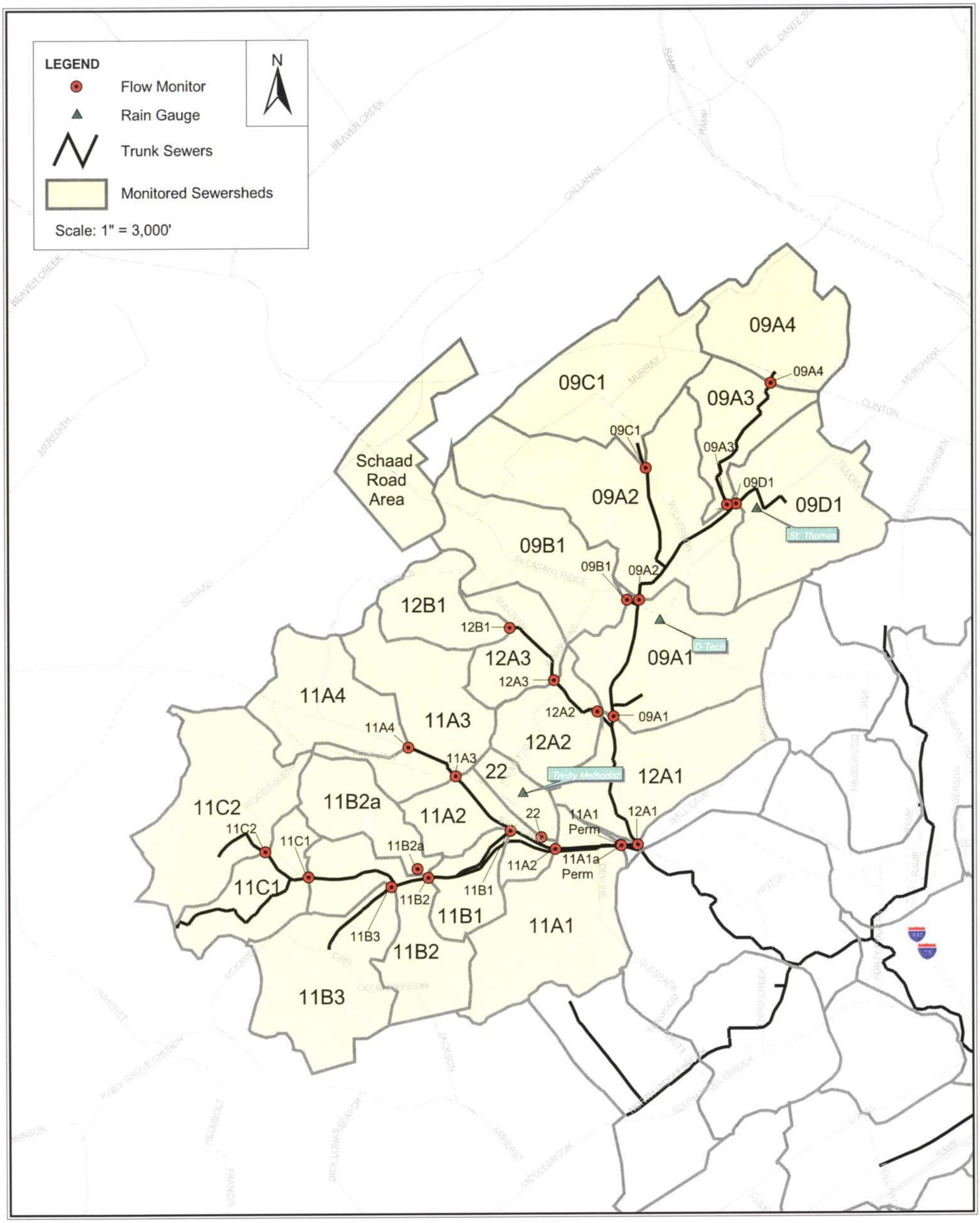

Figure 2-5
Upper Third Creek
2004 Flow Monitor and Rain Gauge Locations

CDM

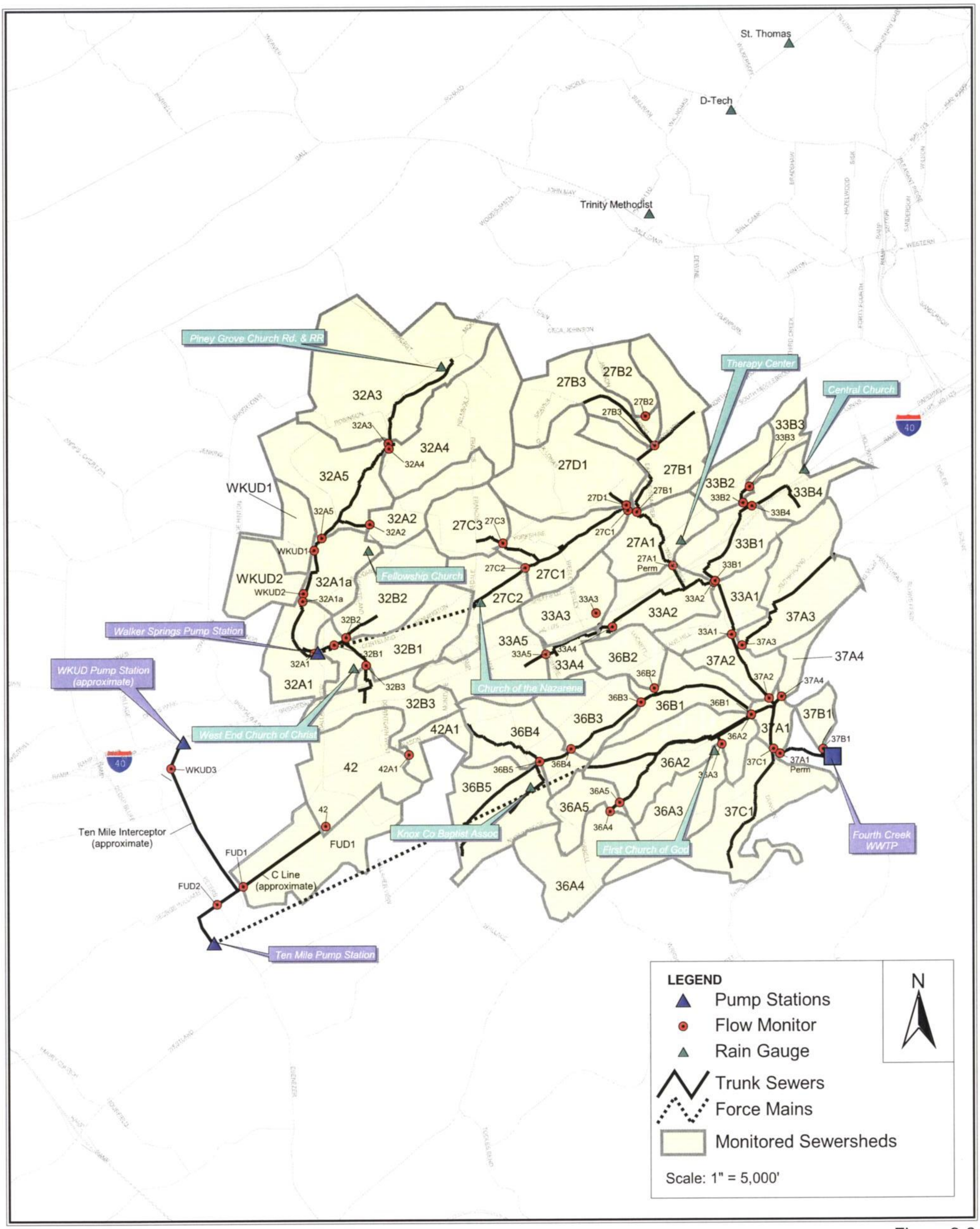

Figure 2-6
Fourth Creek
2004 Flow Monitor and Rain Gauge Locations

CDM

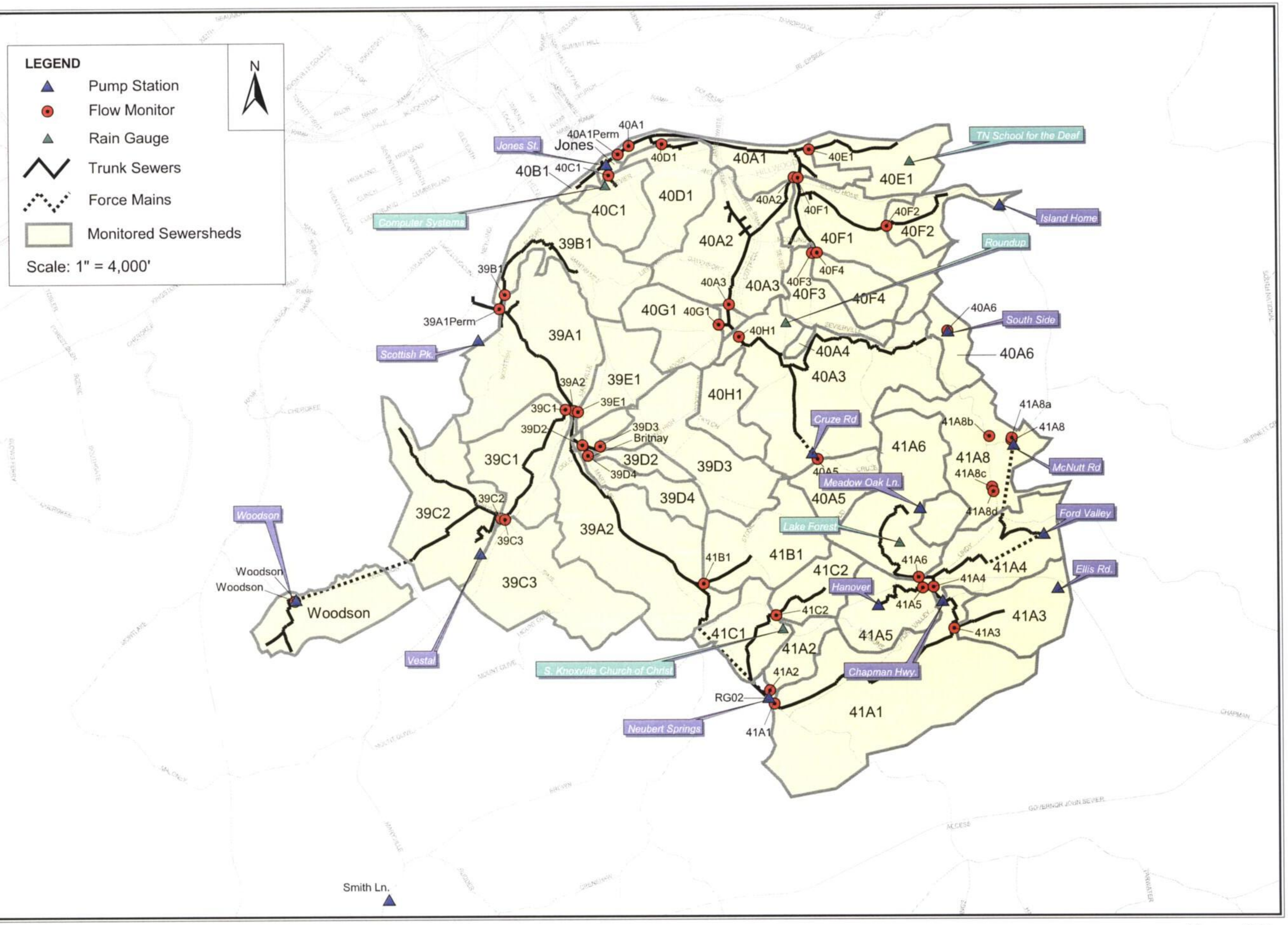

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Figure 2-7
South Knoxville
2004 Flow Monitor and Rain Gauge Locations

CDM

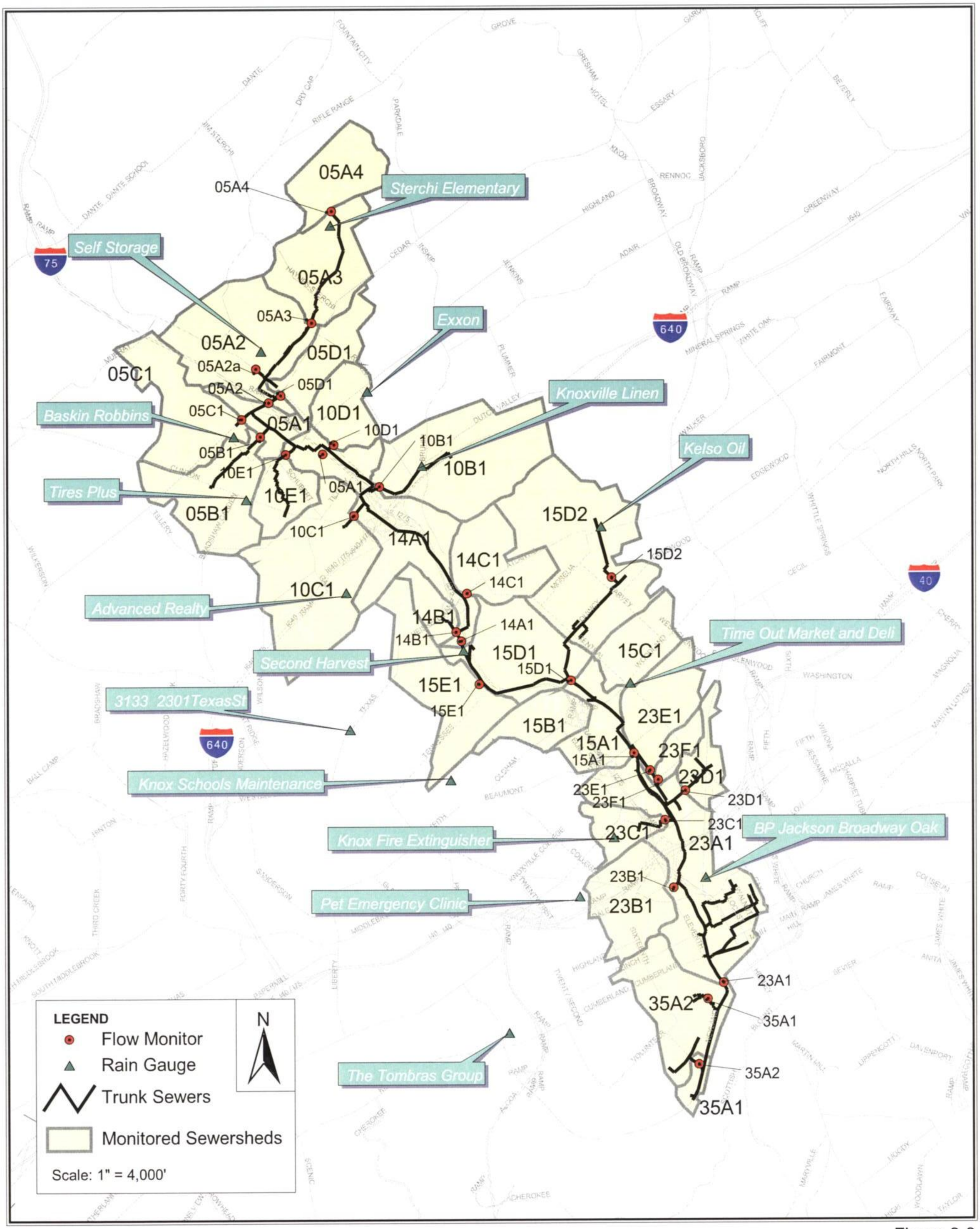

Figure 2-8
Lower Second Creek
2005 Flow Monitor and Rain Gauge Locations

CDM

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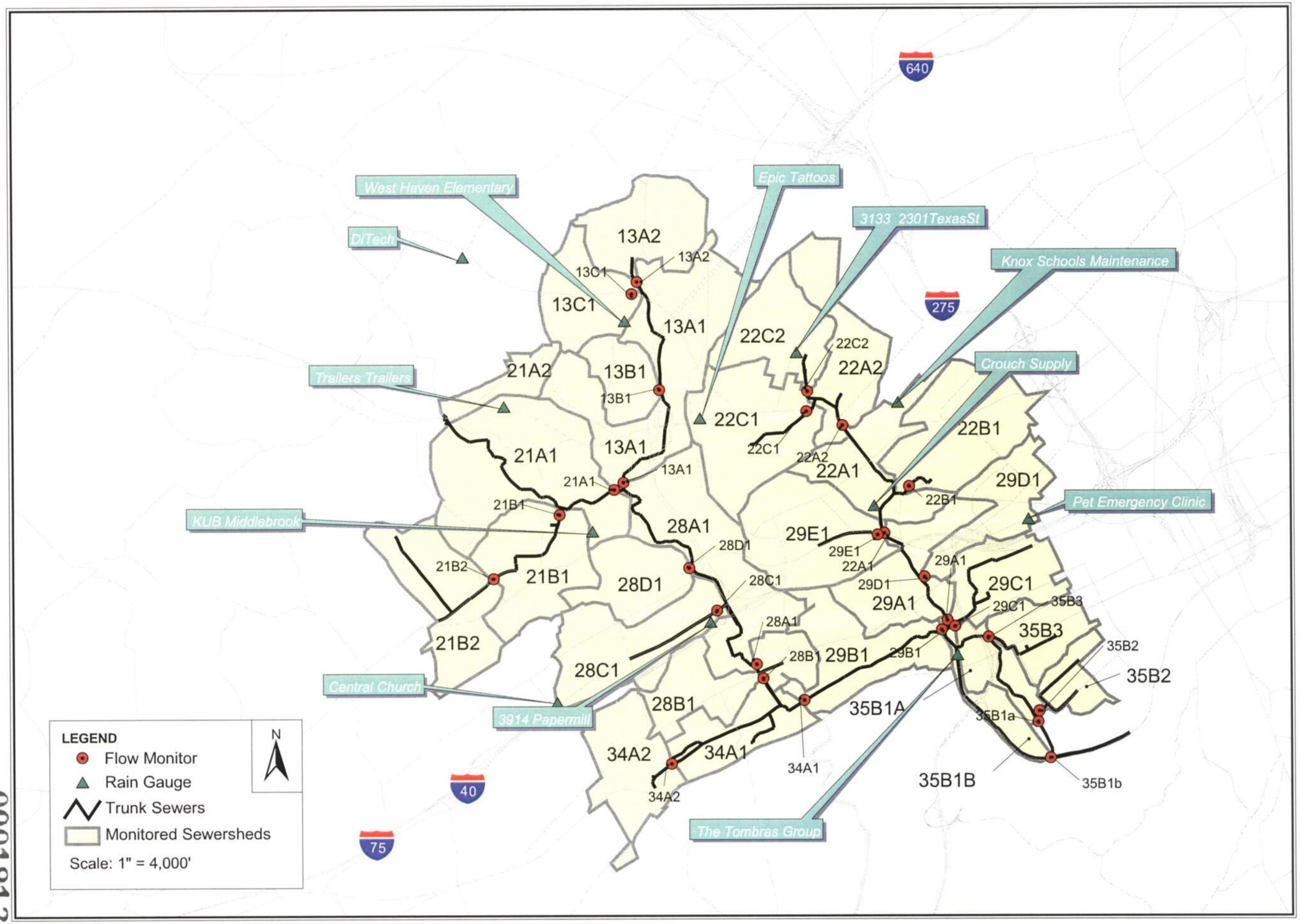

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Figure 2-9
Lower Third Creek
2005 Flow Monitor and Rain Gauge Locations

CDM

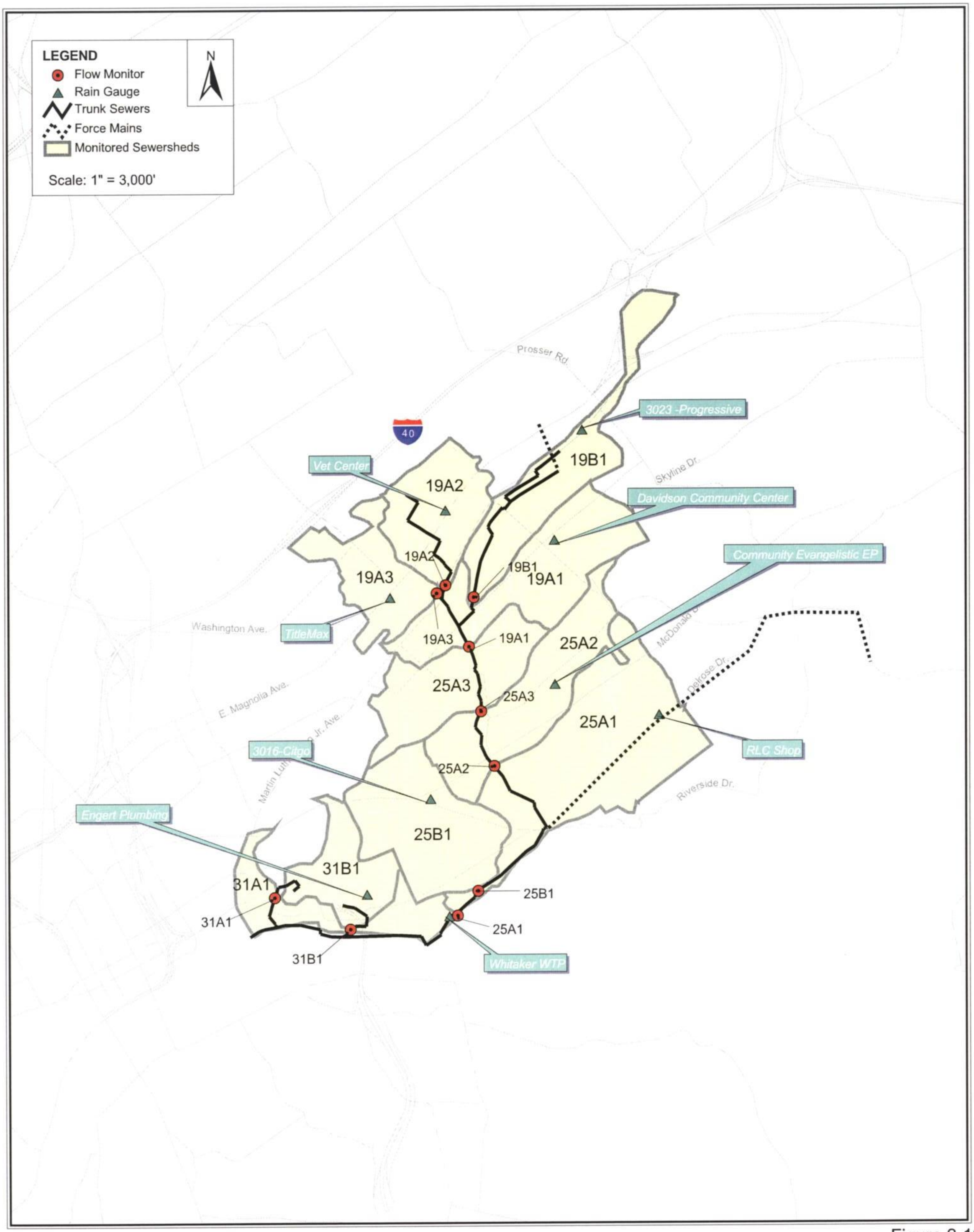

Figure 2-10
Williams Creek
2005 Flow Monitoring and Rain Gauge Locations

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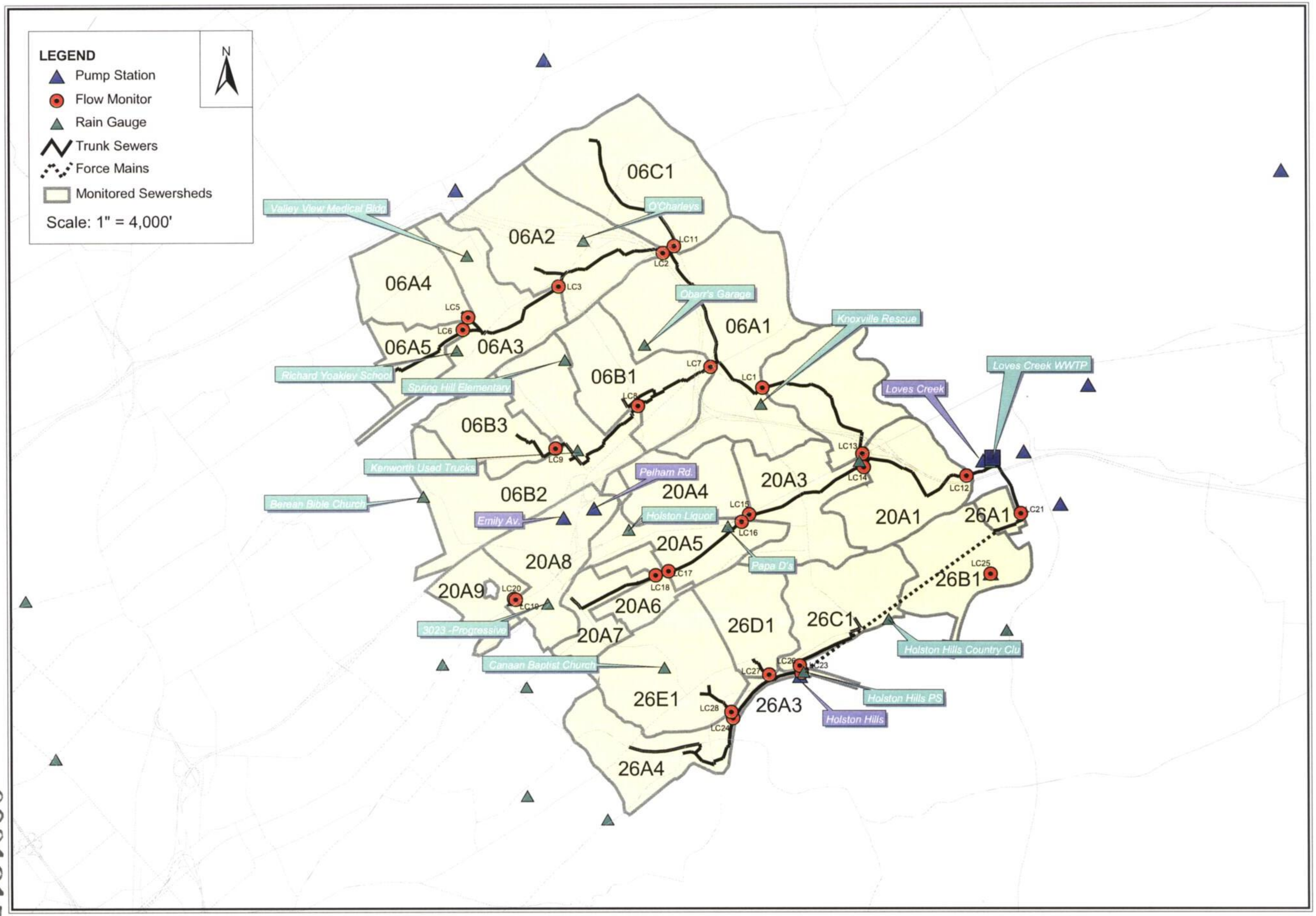

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Figure 2-11
Loves Creek
2005 Flow Monitor and Rain Gauge Locations

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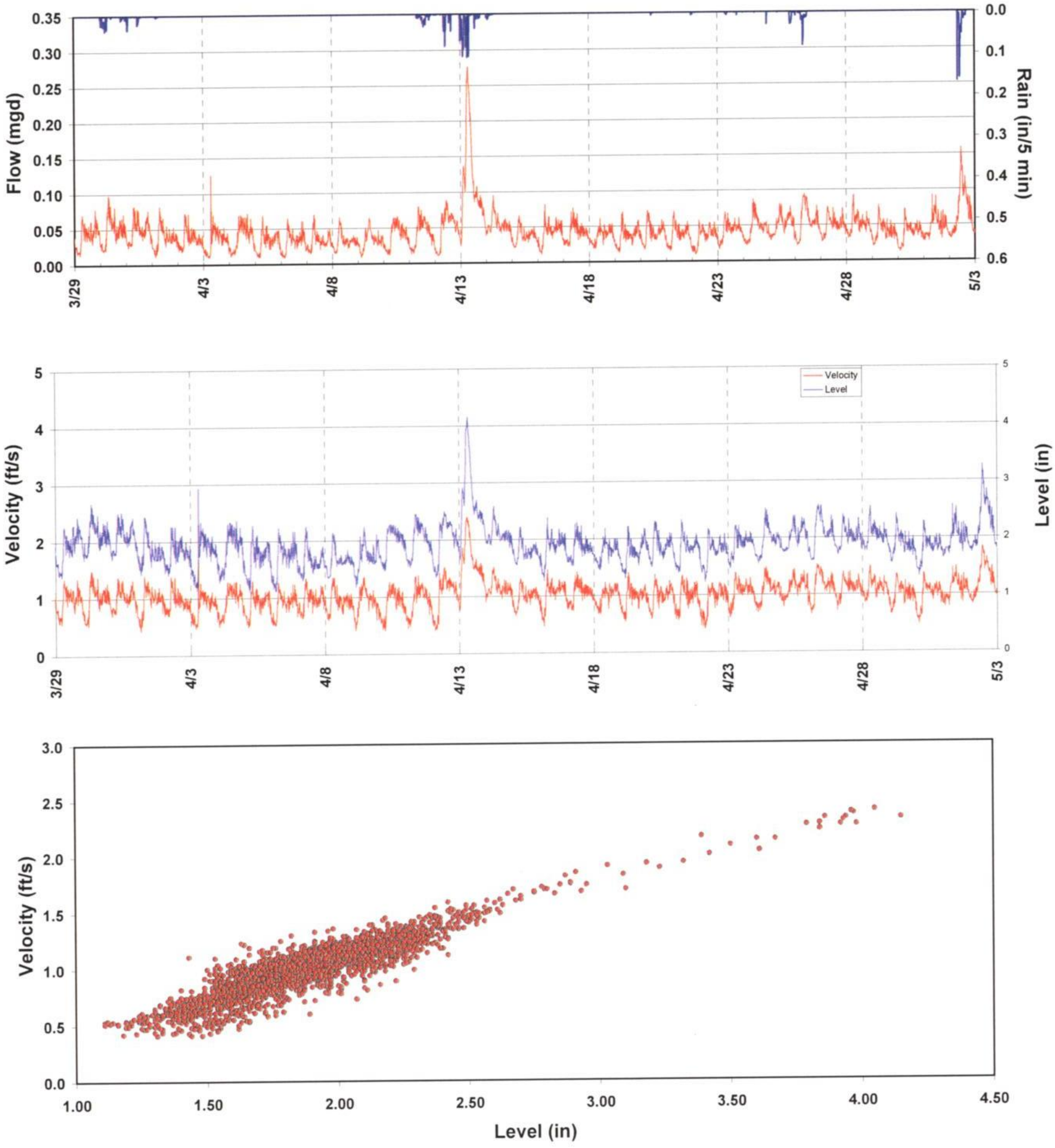

Figure 2-12
Scatterplot of Reliable Flow Monitoring Data

Section 3
Existing and Future Wastewater Flows

This section describes the calculation of existing and future wastewater flows that were used to analyze the performance of the First Creek, Second Creek, Third Creek, Fourth Creek, South Knoxville/Knob Creek, and Williams Creek trunk sewer systems and their tributaries. Central to the analysis of wastewater flow is an understanding of its various components and the decomposition process, discussed in detail in Section 3.1. The allocation and projection of future dry-weather flows is discussed in Section 3.2 followed by the analysis of wet-weather flows in Section 3.3. The final Section 3.4 presents the methodology for developing a planning storm event and predicting hydrographs from such an event.

3.1 Wastewater Flow Components

In general, wastewater flows can be divided into three components: base wastewater flow (BWWF), groundwater infiltration (GWI), and RDI/I. The wet-weather component (i.e., RDI/I) is of particular importance because it is the increased portion of flow that occurs during a rainfall event. **Figure 3-1** illustrates the flow monitoring data analysis process.

3.1.1 Base Wastewater Flow

BWWF is domestic (or sanitary) wastewater from residential, commercial, institutional (schools, churches, hospitals, etc.) sources, and industrial wastewater sources. It is affected by the population and land uses in an area and varies throughout the day in response to personal habits and business operations. BWWF is normally estimated by applying unit flow factors to land use units. For example, these unit flow factors might be expressed in terms of average gallons per day (gpd), per single-family residential unit or per acre of commercial development. Diurnal and statistical variations are normally accounted for by applying multipliers, called peaking factors, to the average BWWF.

3.1.2 Groundwater Infiltration

GWI is defined as groundwater entering the collection system through defective pipes, pipe joints, and manhole walls. The magnitude of GWI depends on the depth of the groundwater table above the pipelines, the percentage of the system that is submerged, and the physical condition of the sewer system. The variation in groundwater levels and the amount of GWI is seasonal in nature. In the Knoxville area, U.S. Geological Survey (USGS) observation wells have demonstrated that maximum groundwater levels occur in February or March, and minimum groundwater levels occur in the fall due to the impact of high summertime evapotranspiration rates. While GWI is also affected by rainfall, it responds gradually and is not directly related to any individual rainfall event. It is evidenced by a general increase in wastewater flow that persists for periods of many days or weeks. From a practical standpoint, it is often not possible to differentiate infiltration of groundwater

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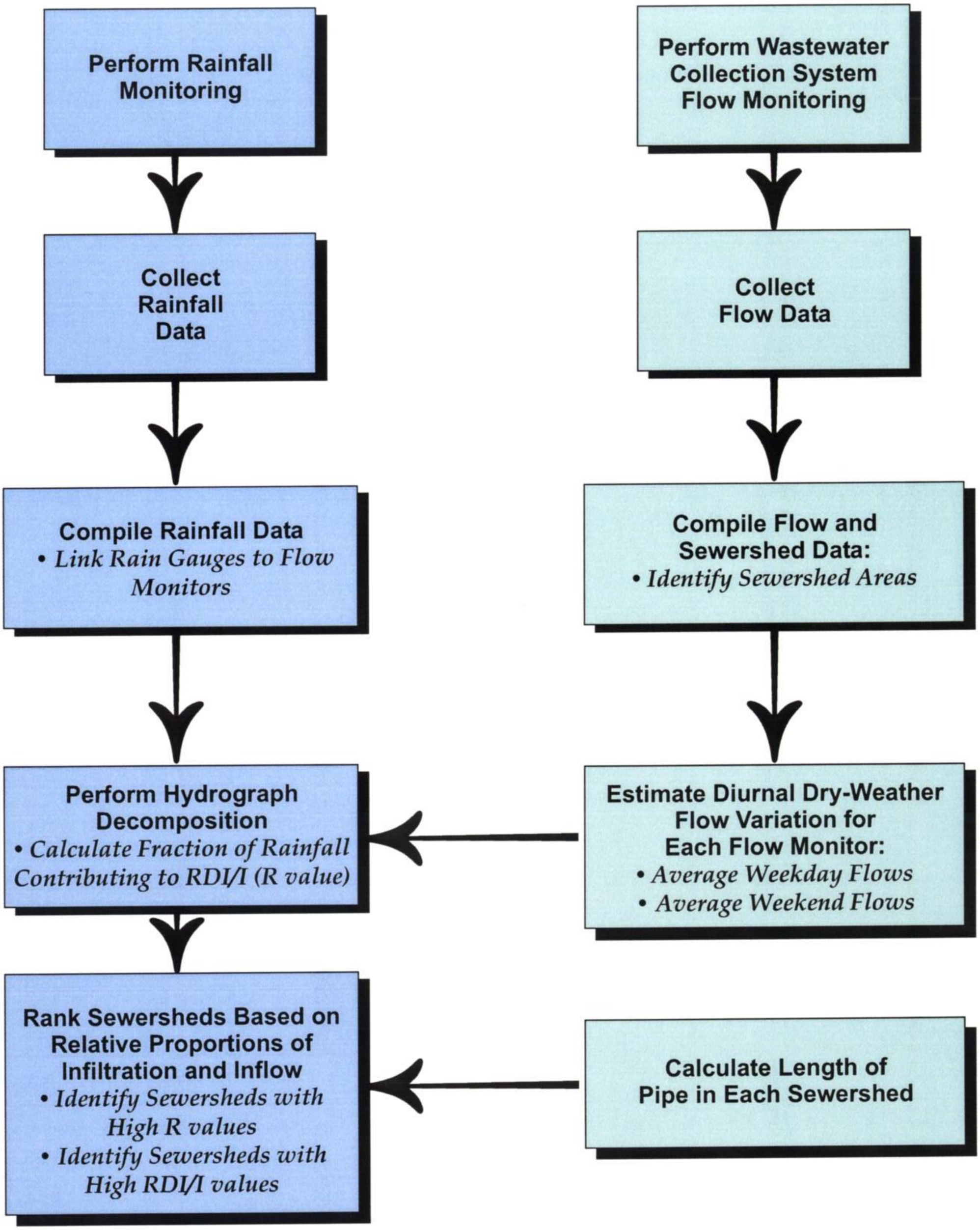

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Figure 3-1
Data Analysis Flow Chart

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(saturated zone) from infiltration due to long-term drainage of unsaturated soils, and the term GWI is used in this study to describe both types of flows.

3.1.3 Rainfall-Dependent Infiltration/Inflow

RDI/I refers to storm water that enters the collection and trunk sewer system in direct response to the intensity and duration of rainfall events. RDI/I can be further broken down into storm water inflow (SWI) and rainfall-dependent infiltration (RDI), based on the pathways through which the flow enters the sewers or manholes. SWI reaches the collection system by direct connections rather than by first percolating through the soil. SWI sources may include roof downspouts illegally connected to the sanitary sewers, yard and area drains, holes in manhole covers, cross-connections with storm drains, or catch basins. RDI includes all other rainfall-dependent flow that enters the collection system, including storm water that enters defective pipes, pipe joints, and manhole walls after percolating through the soil.

Many correction projects throughout the country that have emphasized SWI reduction have been shown to be less effective than expected. A major reason for this result was probably the assumption that any increase in wastewater flow that responded immediately to rainfall could be attributed to SWI. In fact, it has been shown that in many common situations it is possible for storm water to rapidly reach and infiltrate into defective sewers. An example is a shallow sewer bedded in granular material essentially functioning as a French drain. Thus, RDI may respond as rapidly as SWI (time to peak of less than one hour), or may respond much more gradually (time to peak of up to a day or more) depending on the depth of cover and the soil and bedding materials. In KUB the RDI response typically persists for several days and after about one week, the response is more properly considered to be a general increase in GWI. These conditions are specific to KUB, where unusually long response periods have been observed. More typical RDI response periods last up to four days. Due to complexity of the interactions between GWI and RDI, judgment is required to distinguish between the two components during data analysis.

3.1.4 Decomposition of Flow Monitoring Data

These three components (BWWF, GWI, and RDI/I) make up a total flow hydrograph that shows the quantities of wastewater over a period of time. Hydrograph decomposition was performed to identify BWWF and to determine the portion of the flow hydrograph attributed to RDI/I. Results of the hydrograph decomposition were used to evaluate existing conditions within the basins.

CDM has developed computer software to assist in separating measured wastewater flows into base flow (including groundwater infiltration) and RDI/I components. The computer program develops an average base flow hydrograph for a typical weekday and weekend day from the recorded data for dry-weather conditions. The typical base flow hydrographs are then subtracted from a wet-weather hydrograph to determine the RDI/I component. This method of hydrograph decomposition is an important step in analyzing and simulating wet-weather flows in the sewer system.

Figure 3-2 presents an example of hydrograph decomposition from the Fourth Creek Basin for flow monitor 33B4. The average dry-weather flow for 33B4 is 0.05 mgd. The peak total flow rate during the event was 0.28 mgd. The difference between the dry-weather hydrograph and the total wet-weather hydrograph gives the volume of rain that entered the collection system from sub-basin 33B4.

BWWF exhibits a diurnal variation, with peaks occurring between 6:00 a.m. and 9:00 a.m. and minimum flows occurring at night. Weekdays and weekends will typically exhibit different flow patterns; therefore, for each flow monitor, average diurnal flow patterns were developed for weekdays and weekends independently.

The GWI flow component represents the relatively constant infiltration of groundwater into the sewer system as a result of the sewer being located below the water table. It is often difficult to determine the exact groundwater infiltration component of the dry-weather flow. For this reason, Figure 3-2 shows the BWWF and GWI components together as the combined dry-weather flow to be subtracted from the total wet-weather flow to produce the RDI/I component.

Analysis of long-term flow records for the KUB system indicate that the system-wide GWI does not change significantly over the course of a few days before, during, and after a rainfall event. It does, however, show that the groundwater level changes dramatically during the course of the year. **Figure 3-3** shows the relationship between groundwater elevation, rainfall, and the average daily wastewater flow at the Kuwahee WWTP from 1993 to 1998. This shows that the groundwater level is higher during the winter months, which is common in the southeast. It is important to note that increases in wastewater flow often coincide with large rainfall events, and peaks in flow are greater if rainfall events occur during periods of high groundwater. This indicates that the greatest volume of RDI/I can be expected to occur during the winter months, when groundwater levels tend to be highest.

3.2 Dry-Weather Wastewater Flows

The first step in analyzing the flow data is to allocate dry-weather flows recorded at the flow monitors among the various sub-basins in the study areas. This is important for subsequent analysis of the amount of system capacity that is currently being used. It is also important in the estimation of per capita residential flows and per employee flows, which are required to estimate future wastewater flow rates. The basic information needed to perform the dry-weather flow analysis is monitored wastewater flows, a delineation of the upstream contributing area to a flow monitor, estimates of the residential population, and number of employees within each of the contributing areas. Dry-weather flows during the monitoring period were estimated by averaging dry-weather days from the temporary monitoring data in which there was no recorded rainfall affecting the flow.

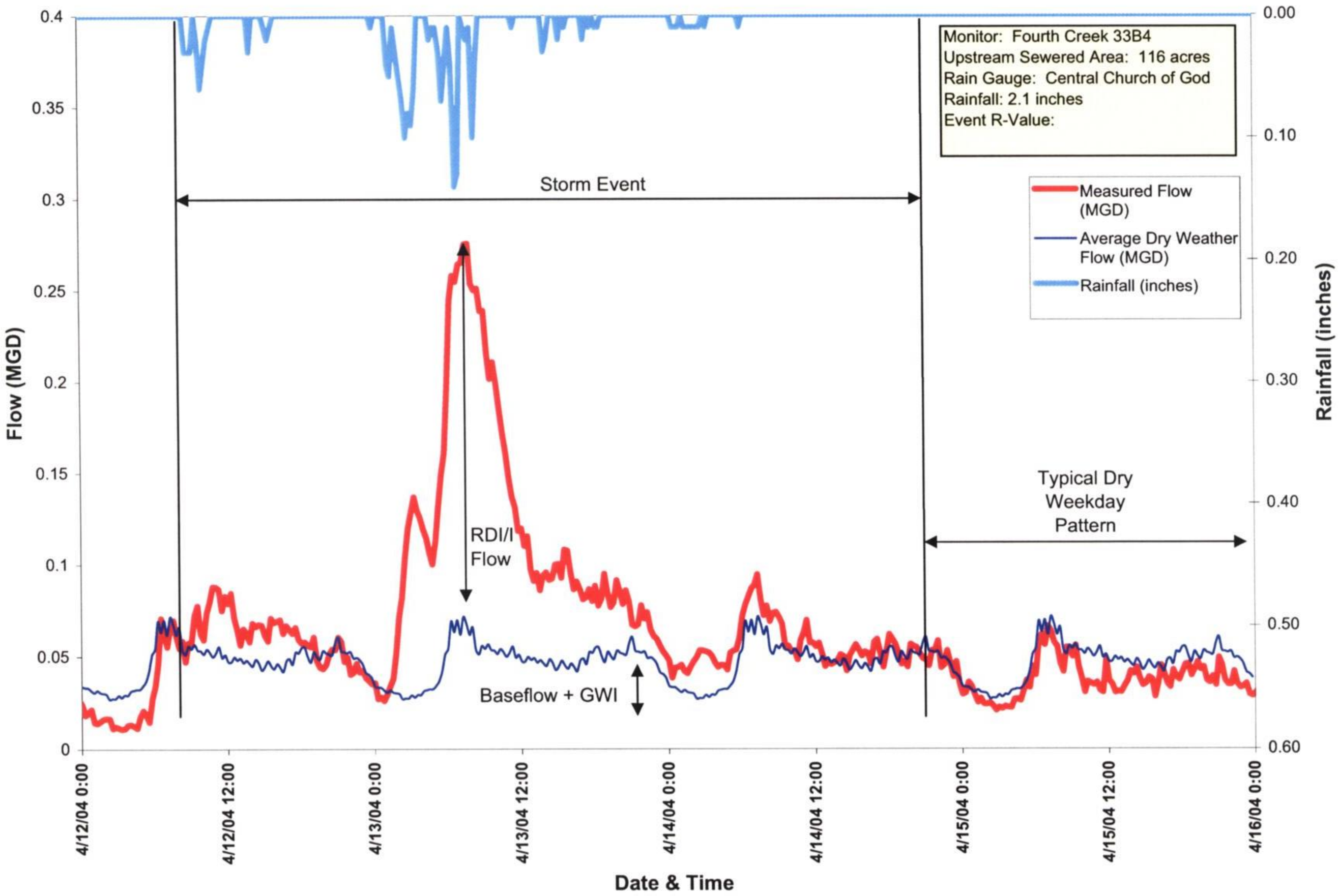

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Figure 3-2
Example Hydrograph Decomposition
Fourth Creek Flow Monitor 33B4

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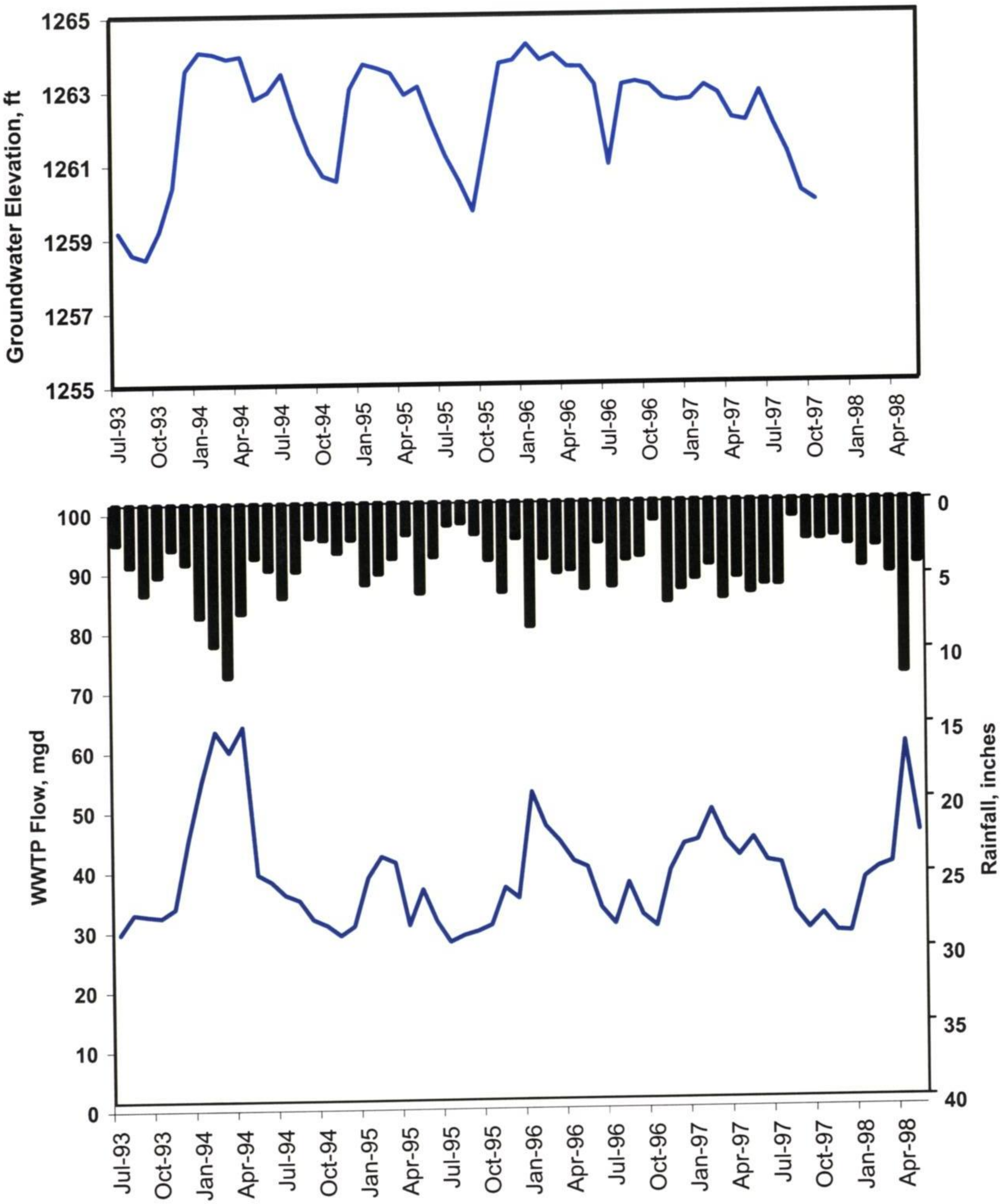

Figure 3-3
Comparison of Wastewater Flow, Groundwater Elevation, and Rainfall

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CDM used contour lines provided by KUB in Microstation format in combination with flow monitoring locations to develop sub-basins. The extent of the existing sewer service areas were estimated from sewer plans obtained from KUB, which include the most recent sewer service extensions. From these plans, CDM estimated the percentage of each sub-basin currently receiving sewered service. The majority of the basins are fully developed. In the future, sewer service could be extended to currently undeveloped central portions of Second Creek, central portions of Third Creek, northern portions of Fourth Creek, northern and southern portions of South Knoxville/Knob Creek, and southeastern portions of Williams Creek.

The Traffic Analysis Zone (TAZ) map for Knox County, and the corresponding data provided by the Metropolitan Planning Commission (MPC), were used as a basis for the geographic distribution of current and future population and employment projections throughout the study areas. A TAZ is a transportation planning area, and each TAZ has existing and future population and employment projection data specific to that zone. Using GIS, the sub-basin maps were superimposed upon the TAZ map to obtain current and projected future population and employment data for each sub-basin. Because more detailed information was not available, the population and employment numbers were assumed to be evenly distributed throughout a TAZ. With this assumption, some individual industries may be divided between two sub-basins.

As stated previously, dry-weather or base flow is comprised of GWI and BWWF. Before this data could be used to project future flows, it was necessary to divide the flows into their GWI and BWWF components and then further divide BWWF into two subcomponents: residential flow and industrial/commercial/institutional (ICI) flow. The most recent TAZ data available was used with the updated (2003-2005) flow data to calibrate these flow factors. The calibrated unit flow factors were used with the TAZ projection data to model existing conditions, and the model results were verified using permanent flow data at the downstream end of all the service areas. The methodology for calculating the population projections and average daily flow components is presented in the following paragraphs.

3.2.1 Groundwater Infiltration

There are several ways of calculating GWI at upland meters (meters on the sub-basins that receive no external inflow). One standard practice, and the method used for this CAP/ER is to estimate GWI as 50 percent of the minimum nighttime flow. This assumes that half of the nighttime dry-weather flow during the early spring conditions is the groundwater infiltration. This was used to calculate a GWI flow rate per sewered acre for each of the metered basins. GWI for the remainder of the sub-basins was calculated by applying a flow rate per sewered acre from an upland metered sub-basin. This metered sub-basin was chosen based on the proximity to the downstream sub-basin. This calculated GWI was subtracted from the observed dry-weather flow at each flow monitor to determine the BWWF for each flow monitor. A typical range of GWI is 100 to 600 gal/ac/day. A range of 13 to 1120 gal/ac/day was

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calculated for the planning area sub-basins in this study during the high groundwater months.

3.2.2 Residential Wastewater Flow

The residential flow for each sub-basin was estimated by multiplying the residential population obtained from TAZ data by a unit flow factor of 65 gpcd. The residential unit flow of 65 gpcd falls within industry standards (Metcalf & Eddy Inc., 1979) and is consistent with metered sales volumes for KUB's water system.

3.2.3 Industrial/Commercial/Institutional Flow

The industrial, commercial, and institutional (ICI) component of flow for each metered sub-basin was estimated as the flow remaining after the residential flow and GWI were subtracted from the total dry-weather flow. The upland metered sub-basins were used to calculate the ICI components. The upland metered ICI components were used as surrogate data, with ICI unit flow factors applied to the downstream sub-basins based on proximity to the upland meter and on land use. An ICI average unit flow factor was developed for each sub-basin by summing the total ICI flow for the metered sub-basins and dividing by the number of employees in the total metered sewer service area. The numbers of ICI employees within each sub-basin were estimated based on traffic analysis zone data using a GIS analysis of the overlaid TAZ boundaries on the sewer service area boundaries. Commercial/ industrial employees were assumed to be 100 percent sewered.

3.2.4 Future Dry-Weather Wastewater Flows

TAZ population and employment projections, as well as information obtained from KUB, were used in conjunction with the unit flow factors to project future dry-weather flows.

Future projections of residential wastewater flows were developed by multiplying the 65 gpcd unit flow factor by the population projection for each sub-basin. As stated previously, the TAZ population projections were evenly distributed within a given TAZ boundary and the TAZ boundaries were intersected with the sub-basins to estimate population projections for that sub-basin.

ICI flows were projected by multiplying the number of new employees given by TAZ projections in each sub-basin by the average unit flow factor derived for each respective sub-basin. The new flows were then added to the ICI flow from the previous period to give the new projected flow.

Groundwater infiltration was assumed to increase in proportion with the increase in the sewered area of each sub-basin. The GWI/acre, calculated for existing conditions, was applied to the future sewered area to calculate future GWI flows.

The TAZ projection data is based upon the most recent traffic analysis study available by the Knox County Metropolitan Planning Commission at the time the analysis was

performed. Since the analysis for some basins was performed in different years, the exact data source varies for some basins as follows:

For First Creek, the TAZ projection data is based upon the traffic analysis study performed by the Knox County Planning Commission in 1997. CDM linearly interpolated population projections for 1998, 2008, and 2018 using the years studied in the traffic analysis.

For all other basins, the TAZ projection data is based upon the traffic analysis study performed by the Knox County Planning Commission in 2004. This data projected values through 2025. The Williams Creek Basin is close to build-out so the 2025 projection was used for the future planning scenario. The Second Creek, Third Creek, Fourth Creek, South Knoxville/Knob Creek, and Loves Creek Basins used the same data; however, these basins were not close to buildout, so CDM extended the projections to 2045.

Some portions of the planning area showed a decrease in flow due to redevelopment and decreases in TAZ population and employment. In general, wastewater flows are projected to decrease over time in older portions of all the service areas because of the redevelopment of industrial areas that have had historically higher flows. In outer and some central portions of each service area, wastewater flows are projected to increase over time because of increased residential and commercial development densities within these areas.

3.3 Existing Wet-Weather Wastewater Flows

This section describes the methodology used to predict RDI/I flows in the study area during rain events. The method is based on a unit hydrograph approach that is similar to the approach used in traditional storm water hydrologic analyses. Flow monitoring data is used to calibrate the unit hydrograph parameters. Once calibrated, this method may be used to predict RDI/I into the sewer system for any given rainfall event.

To evaluate the benefit of alternative sewer system improvements to reduce wet-weather overflows, it is prudent to develop one planning storm event and associated RDI/I flows. In developing a planning storm event, a rainfall frequency analysis was performed to estimate the probability that different intensities and durations of rainfall will occur in the Knoxville area. The results of this analysis were used to develop a synthetic rainfall event that simulates rainfall, which occurs on average once every two years during the winter-spring period when flow monitoring studies were conducted.

Base wet-weather conditions were established for the purpose of determining system capacity enhancement projects (i.e., CAP/ER projects). However, it is significant to note that the ultimate system performance goal (i.e., elimination of SSOs) is based on implementation of both the capacity enhancement projects and the capacity

restoration efforts. Thus, the design storm alone is not the basis for evaluating the ultimate performance of KUB's system.

For the system capacity enhancement projects, a representative 2.96 inch, 24 hour design storm which conveys RDI/I volumes from 97 percent of the rainfall event volumes on record (total of 1,827 winter/spring events from 1948 through 2005, or approximately 32 events per year on average) was chosen as the basis for developing a synthetic rainfall hyetograph. Initially, CDM analyzed historical records for the period of 1948-2002 (December through May when R values are highest) to develop the design storm depth of 2.96 inches. The analysis was updated to include 2003 through 2005 data and there was no change in this result. The analysis used a 24 hour inter-event period (i.e., if at least 24 hours of no measurable rainfall occurred since the last hour of measurable rainfall, the next hour of measurable rainfall was considered a new event).

The long duration storm was selected for several reasons:

1. Long duration events result in initial soil saturation which must occur prior to RDI/I rates reaching maximum levels.

2. Long duration events result in higher rainfall volumes which significantly affect storage capacity required.

3. The longer duration storms include a higher percentage of historical events.

In addition to storm volume considerations, storm intensity is also significant as it affects RDI/I rates and therefore peak sewer flows. To address this issue, the synthetic design storm features:

1. Over 1 inch of rainfall during first eleven hours to saturate soils prior to peak intensities occurring.

2. A peak intensity of 0.84 inches/hour for a 1 hour period.

Table 3-1 below provides a comparison of the peak flow intensity used to intensities for other return intervals and duration frequencies. To summarize, the peak intensity used in developing the minimum performance criteria for capacity enhancement projects (0.84 in/hr) exceeds 2 and 3 hour intensities for larger return period storms. This analysis approach provides a better understanding of how the sewer system improvements included in the Phase 1 CAP/ER will perform under a full range of storm events including both short duration, high intensity events, as well as long duration high volume events. This approach is important to establishing the right balance of capacity enhancement and capacity recovery projects to meet the CD requirements.

Duration	Return Period					
	1 year	2 year	5 year	10 year	25 year	50 year
1 hour	0.67	0.84 *	1.04	1.20	1.45	1.67
2 hour	0.48	0.58	0.69	0.79	0.94	1.08
3 hour	0.37	0.46	0.57	0.64	0.75	0.84

* *Value used for maximum 1-hour intensity in Base Wet-Weather Storm used for CAP/ER.*

Intensities exceeded by maximum intensity in Base Wet-Weather Storm used for CAP/ER.

Table 3-1
Average Rainfall Intensities for Range of Return Periods

The methodology for predicting wet-weather flows is further described in the following four sections, which present a method of predicting RDI/I volume for a given rainfall event, the unit hydrograph methodology, a rainfall frequency analysis, and a discussion of the synthetic planning storm events.

3.3.1 Calculation of RDI/I volume and "R" value

As discussed in Section 3.1, CDM analyzed the flow monitoring data with a computer program to separate the recorded flows into dry-weather flows (BWWF and GWI) and wet-weather (RDI/I) components. This method of "hydrograph decomposition" is an important step in analyzing and simulating wet-weather flows in the sewer system. Once the hydrograph decomposition is completed for each sub-basin, the volume of RDI/I is compared to the volume of rain that fell on the area contributing flow to each monitor. The ratio of RDI/I volume to rainfall volume (which is the inches of rain over the sub-basin area) is defined as the R value. In other words, the R value is the fraction of rainfall from a storm event that enters the sewer system as RDI/I. The higher the R value, the more I/I a sewer system conveys to the treatment plant. The R value can then be applied to a larger planning storm event to estimate the volume of RDI/I from such a storm event. The volume of RDI/I per linear foot of sewer can then be used to prioritize sub-basins.

R values are determined for each flow monitor for a representative rainfall event. The R value is a key parameter in the development of the hydrologic model that simulates RDI/I flows into the sewer system.

3.3.2 Unit Hydrograph Methodology

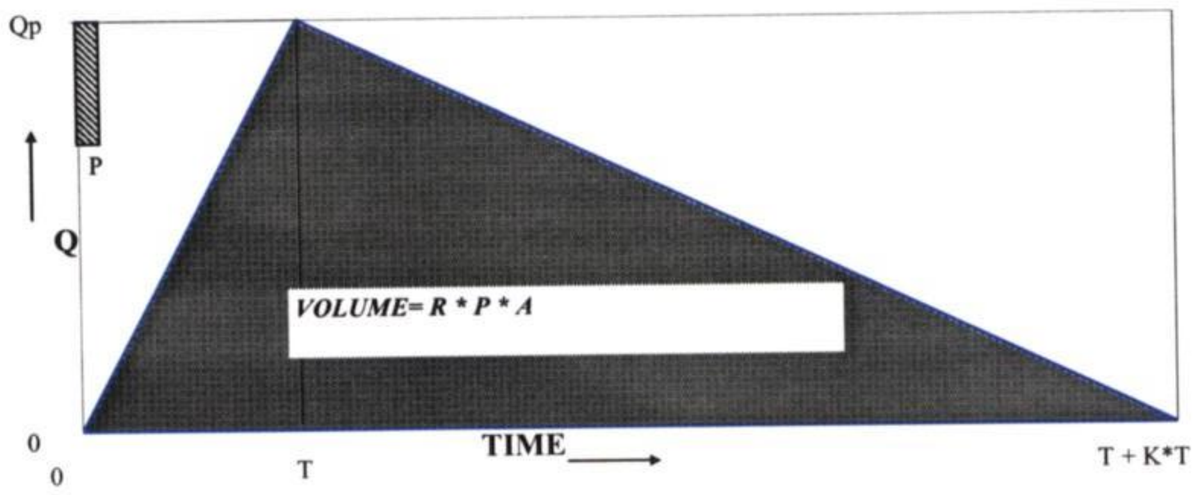
The flow monitoring periods recorded at least three significant storm events over 0.5 inches; however, none of the events approached a relatively large storm event on which the hydraulic analysis is based. Therefore, a method is needed to predict flows from such an event. Because a dynamic hydraulic model (EXTRAN) is employed for this study, the method must predict flows for the entire duration of the event, including the peak flow and the total volume of RDI/I entering the system from the event.

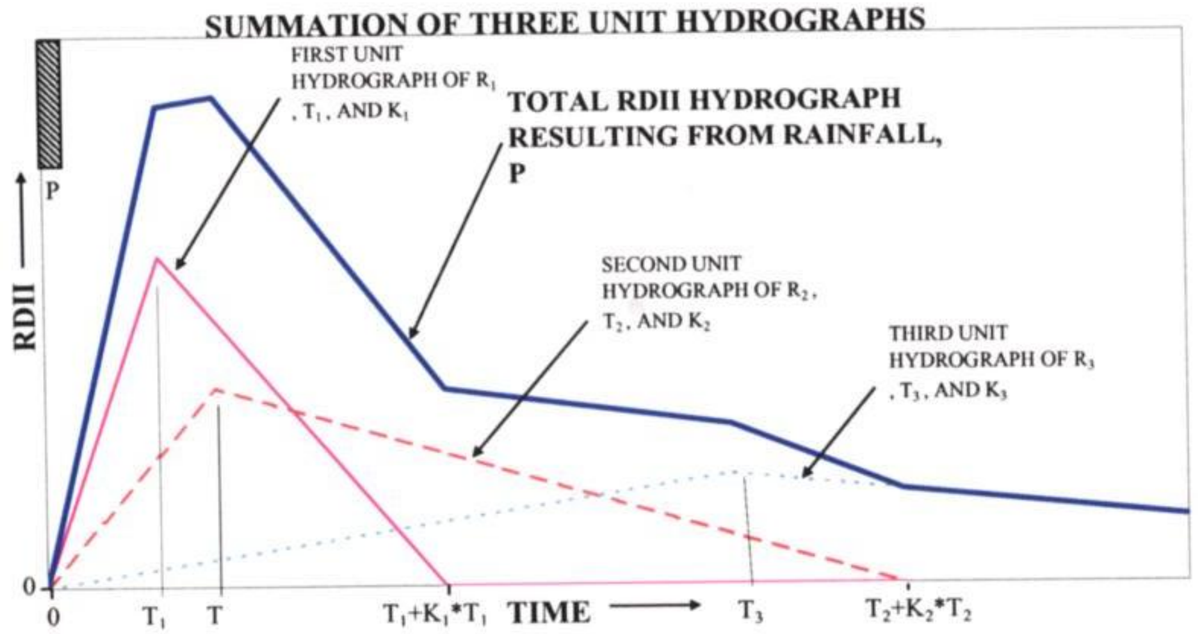
For this project, a methodology was used to simulate wet-weather RDI/I hydrographs into the sewer system that is based on a unit hydrograph technique. This method is similar to unit hydrograph methods that are commonly used to simulate flows in storm water runoff analyses. The method was developed by CDM staff members and has been used on sewer system master planning projects throughout the country since the early 1980s (Giguere and Riek, 1983).

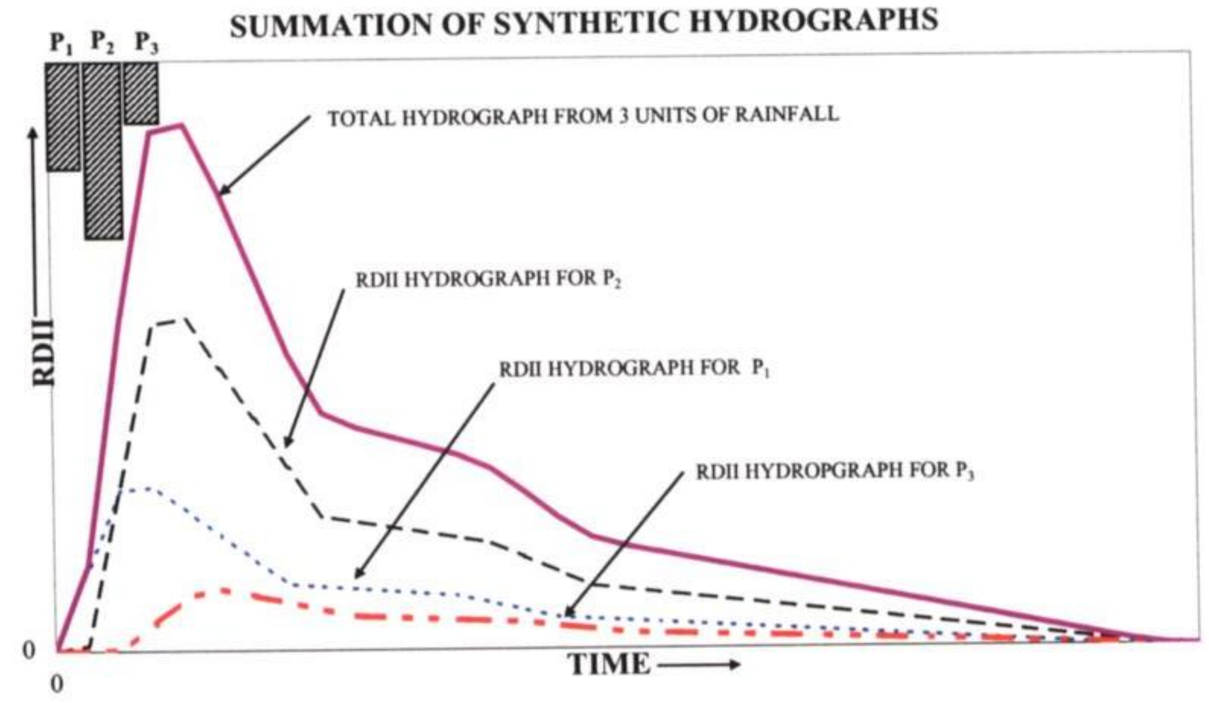
The method is based on fitting three triangular unit hydrographs to an actual RDI/I hydrograph. A unit hydrograph is defined as the flow response that results from one unit of rainfall during one unit of time. For the 2005 study, a unit of time was defined as one 5-minute time step, because the rain gauge data was provided in 5-minute increments and the unit of rainfall was one inch. This methodology has two basic steps, and is illustrated in **Figure 3-4**.

The first step is to define three parameters, R, T, and K, for each of the three triangles. R represents the fraction of rainfall entering the sewer system as RDI/I. T is the time to the peak RDI/I flow, and K is the ratio of the time of recession to the time of peak as shown in the top of Figure 3-4. The sum of the R values for each of the three unit hydrographs (R1, R2, and R3) must equal the total R value for the storm event. Three unit hydrographs are used because the shape of an RDI/I hydrograph is too complex to be well represented by a single unit hydrograph as shown in the middle of Figure 3-4. The first triangle represents the most rapidly responding flow component (including storm water inflow), and has a T of 1 to 3 hours. The second triangle includes both rainfall-dependent inflow and infiltration, and has a longer T value. The third triangle includes infiltration that may continue long after the storm event has ended and has the longest T value, ranging from approximately 5 to 30 hours for this study.

The second step of the unit hydrograph methodology is to sum all of the unit hydrographs that were developed for each unit of time to develop a total RDI/I hydrograph. The bottom of Figure 3-4 illustrates the summation of three hydrographs as an example. This would represent the hydrograph from a storm lasting 3 time steps, or 15 minutes. If a storm event has rainfall over a period of 2 hours, then the hydrograph developed by this method would be the summation of the 24 unit hydrographs that resulted from each 5-minute rainfall increment.







DEFINITION OF TERMS:

P = PRECIPITATION DEPTH OVER TIME STEP
T = TIME TO PEAK OF THE UNIT HYDROGRAPH
Qp = PEAK FLOW OF THE UNIT HYDROGRAPH
K = RECESSION COEFFICIENT
VOLUME = AREA OF SHADED REGION
VOLUME = VOLUME OF RDII IN UNIT HYDROGRAPH
R = FRACTION OF RAINFALL THAT BECOMES RDII
A = SEWERED AREA

T_1, T_2, & T_3 = TIME TO PEAK OF THE RESPECTIVE UNIT HYDROGRAPHS
K_1, K_2 & K_3 = RECESSION COEFFICIENTS OF THE RESPECTIVE UNIT HYDROGRAPHS
R_1, R_2 & R_3 = R-VALUES OF THE RESPECTIVE UNIT HYDROGRAPHS
R = FRACTION OF RAINFALL, P, THAT BECOMES RD
$R = R_1 + R_2 + R_3$

P_1, P_2, & P_3 = SUCCESSIVE RAINFALL DEPTHS OVER EACH TIME STEP
TOTAL HYDROGRAPH= SUMMATION OF SYNTHETIC HYDROGRAPHS RESULTING FROM EACH UNIT OF RAINFALL

Figure 3-4
Triangular Unit Hydrograph Definition Summation

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A computer program developed by CDM was used to find the combination of R, T, and K values for each of the three triangles that would result in a simulated hydrograph that best matched the observed RDI/I hydrographs. This process is referred to as calibrating the unit hydrographs. To calibrate the unit hydrographs, first the flow monitoring data is decomposed into the base flow and RDI/I components. The base flow component is then subtracted from the total hydrograph to leave only the RDI/I component. The best combination of the R, T, and K values for each of the three triangular unit hydrographs is determined iteratively until the predicted RDI/I hydrograph closely approximates the RDI/I hydrograph from the flow monitor.

Unit hydrographs were developed and calibrated for all "upland sub-basins" for which good flow monitoring data were available. An upland sub-basin is one that does not require subtraction of flows from an upstream monitor to determine the contributing flows of that sub-basin. Only upland sub-basins were chosen to calibrate the unit hydrographs to minimize the effect of the inherent errors in basing calculations upon multiple flow monitors. The potential error in a calculation is greater when data from more than one flow monitor are used in a calculation. For sub-basins that are not upland, unit hydrographs from representative upland sub-basins were used to estimate flows in the sub-basin.

It is noteworthy that the calibrated R values for several of the basins have a high fraction of the total R value contained within R2 and R3 components. This reflects a long response between the time of rainfall and the RDI/I response. In general, this tends to be indicative of a system where infiltration is a primary contributor to the total RDI/I flows. However, this could also be indicative of a system that operates under extreme surcharge conditions, which delays the time in which flow reaches a monitoring point.

3.4 Predicting RDI/I Hydrographs from Planning Storm Events

The ability to predict the shape of an RDI/I hydrograph from a given rainfall distribution is a key component of this study. This ability allows the flexibility of simulating RDI/I from any storm for which rainfall records are available. This method was used to simulate flows for various planning storm events. A discussion of how the RDI/I hydrographs were entered into the hydraulic model and calibrated to match downstream flow monitors is presented in Section 4.

3.4.1 Rainfall Intensity-Duration-Frequency Analysis

A frequency analysis was performed on 48 years of historical rainfall records for the Knoxville area to determine the probability that a storm of a given size or larger will occur in any given year. This analysis was used to determine the intensities and the durations of the planning storm events to be used in simulating RDI/I flow conditions in the system. Hourly rainfall data were obtained from the National

Climatic Data Center for the Knoxville Airport from September 1949 to September 1997. The results of the frequency analysis are shown on **Figure 3-5**. One of the criteria used in this analysis for defining separate events was a minimum of 24 hours with no rain between storms. The plot in Figure 3-5 shows the rainfall event depth (in inches) for a range of return periods. The return period of a storm is related to the probability that a storm of a given size or larger will occur in any given year.

Through evaluation of long-term flow monitoring data, past experience, and from discussions with KUB staff members, it was determined that surcharging and overflow conditions in the sewer system are most prevalent and severe during the winter and early spring. This is primarily the result of seasonal variations in rainfall and evapotranspiration that lead to generally higher groundwater elevations and more saturated soil conditions in the winter and early spring (presented previously in Figure 3-3). Therefore, the planning storm analysis for this study was based on groundwater conditions found in the Knoxville area during the winter and spring, and the typical rainfalls that occur during the winter and spring based on historical records. This results in a plan that addresses wet-weather problems in the KUB system during the winter and spring when the most severe surcharging and overflow conditions occur.

A rainfall intensity-duration-frequency (IDF) analysis was performed for rainfall that occurred during the months of February to April (see **Table 3-2**). Rainfall events that occur during other periods of the year typically do not cause significant surcharging and overflow problems, even if they are very large events. These data, along with the use of R values representing high groundwater conditions as described previously, will result in predicted flows from the planning events that more accurately match wet-weather flows for the simulated return period. From the frequency analysis (see Figure 3-5), a 2 year, 24 hour duration storm event (during high groundwater) has an amount of approximately 2.96 inches. This analysis was used to determine the appropriate rainfall distribution for planning conditions.

3.4.2 Planning Storm Events

Selecting Rainfall Distributions

In analyzing the capacity of the sanitary sewer system, it is important to know how frequently the simulated wet-weather flow conditions will occur. If a condition that produces overflows in a portion of the sewer system occurs frequently, perhaps more often than once per year, then it is a higher priority problem than one that will occur less frequently.

Rainfall events for the Knoxville Airport (1949-1997) were screened to identify historical rainfall events that are representative of the 2 year return period rainfall event. The return period of rainfall durations from 1 to 24 hours and total rainfall volume were determined for all events. In selecting the planning rainfall events for

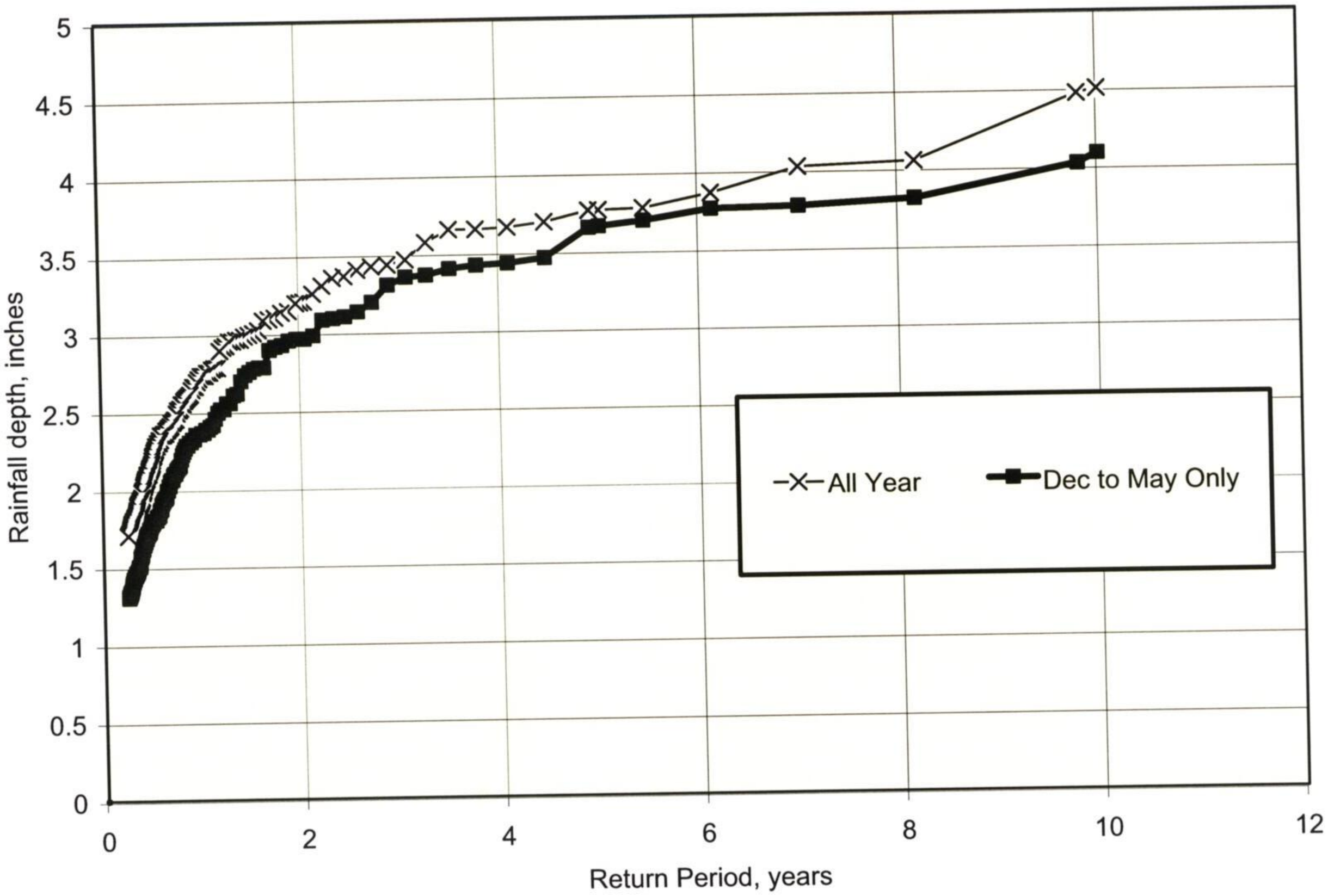

Figure 3-5
Results of Frequency Analysis of Historical Knoxville Rainfall Records

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Table 3-2: Rainfall Intensity-Duration-Frequency Relationship Including only Storms from December through May

DURATION (hours)	RETURN PERIOD									
	0.5 YEARS		1 YEAR		2 YEAR		5 YEAR		10 YEAR	
	(in/hour)	(in)	(in/hour)	(in)	(in/hour)	(in)	(in/hour)	(in)	(in/hour)	(in)
1	0.51	0.51	0.67	0.67	0.84	0.84	1.03	1.03	1.21	1.21
2	0.37	0.74	0.48	0.95	0.58	1.15	0.70	1.41	0.78	1.55
3	0.30	0.90	0.36	1.09	0.46	1.39	0.58	1.74	0.66	1.99
4	0.26	1.03	0.31	1.23	0.41	1.52	0.47	1.88	0.53	2.12
5	0.23	1.13	0.27	1.35	0.35	1.66	0.39	1.96	0.45	2.26
6	0.20	1.19	0.24	1.46	0.30	1.79	0.35	2.11	0.41	2.45
7	0.18	1.27	0.23	1.58	0.28	1.87	0.32	2.21	0.39	2.71
8	0.16	1.30	0.21	1.69	0.26	1.96	0.28	2.27	0.35	2.80
9	0.15	1.35	0.20	1.78	0.25	2.04	0.26	2.38	0.32	2.89
10	0.14	1.40	0.18	1.84	0.23	2.12	0.25	2.46	0.31	3.05
11	0.13	1.44	0.17	1.90	0.21	2.21	0.24	2.62	0.29	3.15
12	0.12	1.47	0.16	1.97	0.19	2.29	0.22	2.64	0.28	3.30
13	0.12	1.53	0.16	2.03	0.18	2.35	0.22	2.80	0.25	3.30
14	0.11	1.54	0.15	2.07	0.18	2.40	0.21	2.95	0.24	3.30
15	0.11	1.61	0.14	2.13	0.17	2.46	0.20	3.06	0.22	3.36
16	0.10	1.65	0.14	2.18	0.17	2.51	0.20	3.12	0.22	3.45
17	0.10	1.68	0.13	2.19	0.16	2.57	0.19	3.17	0.20	3.47
18	0.09	1.69	0.12	2.19	0.16	2.63	0.18	3.29	0.20	3.56
19	0.09	1.70	0.12	2.22	0.15	2.68	0.17	3.29	0.19	3.67
20	0.09	1.74	0.11	2.23	0.14	2.74	0.17	3.31	0.19	3.79
21	0.08	1.75	0.11	2.26	0.14	2.79	0.16	3.37	0.19	3.93
22	0.08	1.75	0.10	2.30	0.13	2.85	0.16	3.44	0.18	4.01
23	0.08	1.77	0.10	2.34	0.13	2.90	0.15	3.48	0.18	4.05
24	0.07	1.79	0.10	2.36	0.12	2.96	0.15	3.66	0.17	4.09

Source: Partial duration-frequency analysis of observed hourly rainfall at Knoxville Airport

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use in the evaluation of sewer system capacity using the dynamic EXTRAN model, it is critical that all durations from 1 hour through the duration of the storm have the desired return period. Short durations will be critical in the upper portions of the system, whereas longer durations may be more critical further down in the trunk system. A storm that does not have the desired return period over all durations up to the total travel time may overestimate flows in portions of the sewer system while underestimating flows in others.

No historical events could be identified that exhibited the desired return period for all rainfall durations (1 to 24 hours). An example of this is a rainfall event that occurred on January 5-6, 1962. This event had rainfall intensities approximating the 5-year event for durations of 2, 4, 5, 6, and 8 hours. However, other durations had return periods significantly greater than the 5 year event. This type of result is typical for all events in the period of record; therefore, it was necessary to construct synthetic rainfall hyetographs with the desired rainfall intensity-duration-frequency characteristics for the representative 24 hour event. Using standard hydrologic concepts, this is accomplished by imbedding the maximum 1-hour duration event within the maximum 2 hour duration event which, in turn, is imbedded in the maximum 3 hour duration event. This process is repeated to derive the entire synthetic rainfall hyetograph. The resulting rainfall hyetograph for the representative 24 hour storm event is shown on **Figure 3-6**.

After review of the rainfall frequency analysis results, the planning storm for this study was chosen to be a 2 year, 24 hour return period storm. This planning storm event is typically associated with a bank-full condition in streams. Therefore, storms that exceed this return frequency can overtop the banks of streams and cause flooding in low-lying areas. The failure of storm water drainage systems leads to flooding on streets and in sewer easements, which will likely lead to RDI/I entering the system from sources that are difficult and not practical to control.

Predicting RDI/I Hydrographs

Planning storm RDI/I flows used in the evaluation of the sanitary sewer system were generated by applying the unit hydrograph methodology described in Section 3.3.2 to the rainfall distributions of the representative 24 hour planning storm.

When combining the dry-weather and wet-weather flow hydrographs, consideration was given to how the peak wet-weather flows for the synthetic event were timed as compared to the average dry-weather flow conditions. The peak rainfall intensity in the synthetic event occurs in the twelfth hour. Typically, the model sub-basins (about 0.5 to 3 square miles in size) will have a lag time of 0.5 to 2 hours (the peak RDI/I will occur approximately 0.5 to 2 hours after the peak rainfall).

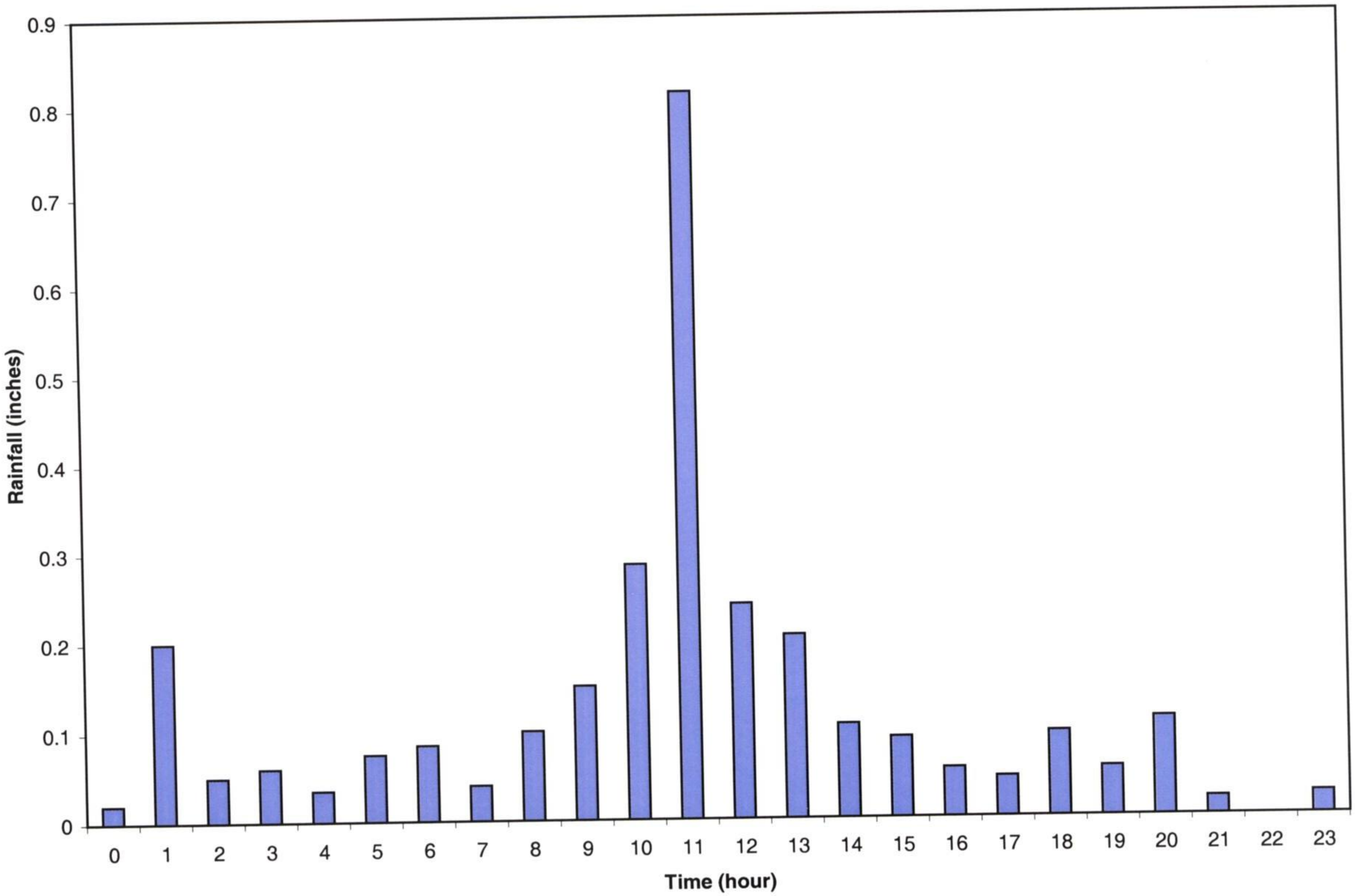

Figure 3-6
Synthetic Rainfall Hyetograph for the Representative 24 Hour Planning Event

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Therefore, peak RDI/I flows from the sub-basins into the trunk sewer system will typically occur at approximately hour 14 of the synthetic storm event. Flow during hour 14 (i.e., 2:00 pm) is typically near the average daily flow. Peak RDI/I flows would typically occur in the lower end of the trunk sewer system 0 to 8 hours later, based on a total travel time of 8 hours.

Section 4
Methodology for Evaluating Sewer Infrastructure and Developing Alternatives

This section describes the methodology for evaluating sewer infrastructure and developing alternatives for improvements. Hydraulic model development of the trunk sewer system is discussed first, followed by the methodology for calibrating and analyzing dry-weather flows and wet-weather flows, and the planning criteria used to evaluate system performance. Next the major sanitary sewer improvement options are presented, and finally, the methodology for developing the recommended alternatives.

4.1 Hydraulic Model Development

CDM developed a hydraulic model of the major trunk sewers for six drainage basins: First Creek, Second Creek, Third Creek, Fourth Creek, South Knoxville/Knob Creek, and Williams Creek. Because few capacity related SSOs have occurred in the Loves Creek Basin and no capacity related overflows have occurred in the Eastbridge Basin, a hydraulic model was not required for these basins. All SSOs on the Long-Term List are still addressed in this Phase 1 CAP/ER; however, a full hydraulic modeling analysis was not required to adequately address them.

The models were developed using the EXTRAN block of the EPA's Stormwater Management Model (SWMM). EXTRAN is a dynamic flow routing model that routes inflow hydrographs through an open channel and/or closed conduit system computing a time history of flows and heads throughout the system. It uses a link-node representation of the sewer system in an explicit difference solution of the equations of gradually varied, unsteady flow (St. Venant equations). EXTRAN requires two basic data inputs: (1) physical information describing the sanitary sewer system, and (2) inflows to the sanitary sewer system. The trunk sewer models were developed based on system data provided by KUB in a digital database. The digital database was exported from KUB's GIS system. KUB used record drawings to identify pipe invert and manhole rim elevations, pipe diameters, and pipe lengths to develop their database. KUB also provided coordinates for all manholes in the trunk sewer system to be used for display of model results and report graphics.

For all basins other than First Creek, it was necessary to write a series of database queries to determine upstream and downstream manholes in order to compile the models into a series of connected manholes and pipes. The database information was then developed into basic EXTRAN input files. Next, in each basin, the trunk sewer profiles were examined in MIKE SWMM 2001 to ensure the pipe network was properly connected. Questionable areas with negative slope or adjacent pipes with conflicting inverts were identified. Pictures of these questionable profiles were sent back to KUB staff for further investigation into pipe connectivity, direction, and invert information. Once the information was verified and appeared logical, it was entered

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back into the database as corrected information and later used in the model. This system of quality control was set in place and used to help develop the final system models and help KUB cross-check and quality control the GIS.

The type of pipe material used in the First Creek Basin is unknown, so the model assumes a Manning's n, or roughness coefficient, of 0.014 throughout, which is indicative of old but clean sewers. When the hydraulic models were developed for the other basins, more information regarding the pipe material was known. A Manning's n of 0.013 was given to concrete pipes, a value of 0.015 was given to cast iron pipes, and a value of 0.017 was given to clay pipes or brick pipes with cement mortar. These Manning's n values were based upon data found in *Fundamentals of Hydraulic Engineering Systems* by Ned H.C. Hwang and Robert J. Houghtalen.

Completed hydraulic models of the trunk sewers were used to establish the sewer dry- and wet-weather conveyance capacity, to identify hydraulic restrictions in the trunk sewer system that can result in overflows, to determine the maximum possible flow through the existing trunk sewers, and to evaluate wet-weather operating strategies to reduce overflows. Wastewater flows were loaded into the hydraulic model for each sewershed based on the flow projection methodology presented in **Section 3**.

4.2 Dry-Weather Model Analyses

4.2.1 Dry-Weather Planning Criteria

The dry-weather model analysis identified pipe segments that have or are projected to have limited capacity to convey flows under both existing and future dry-weather flow conditions. These flows are expressed as a percent of pipe capacity to facilitate identification of trunk sewer conveyance characteristics. Problems identified under this analysis will be considered for correction by trunk sewer improvements, such as sewer replacement or the addition of relief pipes. In contrast, the wet-weather analysis will focus on system problems under wet-weather conditions. Improvements to correct wet-weather problems will be based on the best mix of trunk sewer improvements, flow equalization storage, and sewer rehabilitation.

A consideration in determining the criteria for identifying undersized pipes is the allowance for wet-weather flows, or RDI/I. While an in-depth analysis of RDI/I flows is presented in the next section 4.2.2, a simplified analysis is presented here for discussion purposes. The wet-weather component of the CAP/ER addresses this issue in more detail by analyzing the sewer system response to rainfall events.

A criterion of allowing a sewer pipe to flow at 50 percent of full capacity during dry-weather would assume that the allowable RDI/I rates would be roughly equal to these dry-weather flow rates for a system in good condition. A comparison of peak dry-weather flow rates and peak wet-weather flow rates for several flow monitors indicate that peak flow rates at most meters during wet-weather were observed to be greater than twice those observed during dry-weather. Based upon this comparison,

it is likely that pipes that are at or above 50 to 75 percent capacity during dry-weather conditions will be surcharged (and possibly overflowing) under peak wet-weather flow conditions. Therefore, these pipe segments should be given consideration for relief or replacement sewers or comprehensive sewer rehabilitation.

It should be noted that standard engineering practice for the design of large-diameter trunk sewers serving new areas is to allow dry-weather flows to use 50 to 75 percent of capacity under peak daily dry-weather flow conditions (WPCA Manual of Practice No. FD-5, 1982). This corresponds to allowing the remaining 25 to 50 percent of the sewer capacity to convey wet-weather flows.

In addition to sanitary sewer capacity, modeled pump stations and force mains were also evaluated under dry- and wet-weather conditions. Pump stations are recommended for upgrade if the peak 3 hour flow exceeds the total maximum capacity of the pump station. The peak 3 hour flow was chosen as the design criteria because it is assumed that the pump stations have sufficient wet well capacity to store flows less than the peak 3 hour. It is accepted engineering practice that the maximum design should not exceed 10 fps in the force main (WPCA Manual of Practice No. FD-5, 1982). Therefore, force mains are recommended for upgrade if the maximum velocity exceeds 10 fps.

4.2.2 Analysis Methodology

Dry-weather flows in the system were determined by routing diurnal base flow hydrographs from the model sewershed through the hydraulic model of the trunk sewer system. Flow monitoring data for dry-weather flow periods were used to develop the input hydrographs for the EXTRAN model. For each sewershed, a nearby monitor was chosen to represent diurnal flow characteristics for that sewershed. As stated previously, a computer program developed by CDM was used to separate the recorded flows into dry-weather flows (BWWF and GWI) and wet-weather (RDI/I) components. The program then created an average base flow hydrograph for a typical weekday and weekend day from the recorded data.

Each flow hydrograph was subsequently divided by the average daily flow for that hydrograph, to obtain a "normalized dry-weather hydrograph" for the monitor. An example of a normalized dry-weather hydrograph for flow monitor 10B1 in the Second Creek Basin is shown in **Figure 4-1**. For each sewershed, the chosen normalized hydrograph was multiplied by the estimated average dry-weather flow (including GWI) for that sewershed for the existing and future planning horizons. By this method, an input hydrograph was obtained for each sewershed. The dry-weather hydrographs were input into the EXTRAN model and the simulation was performed. The model simulates typical winter GWI conditions, which is usually the time of the year most critical in controlling high flows in the KUB system.

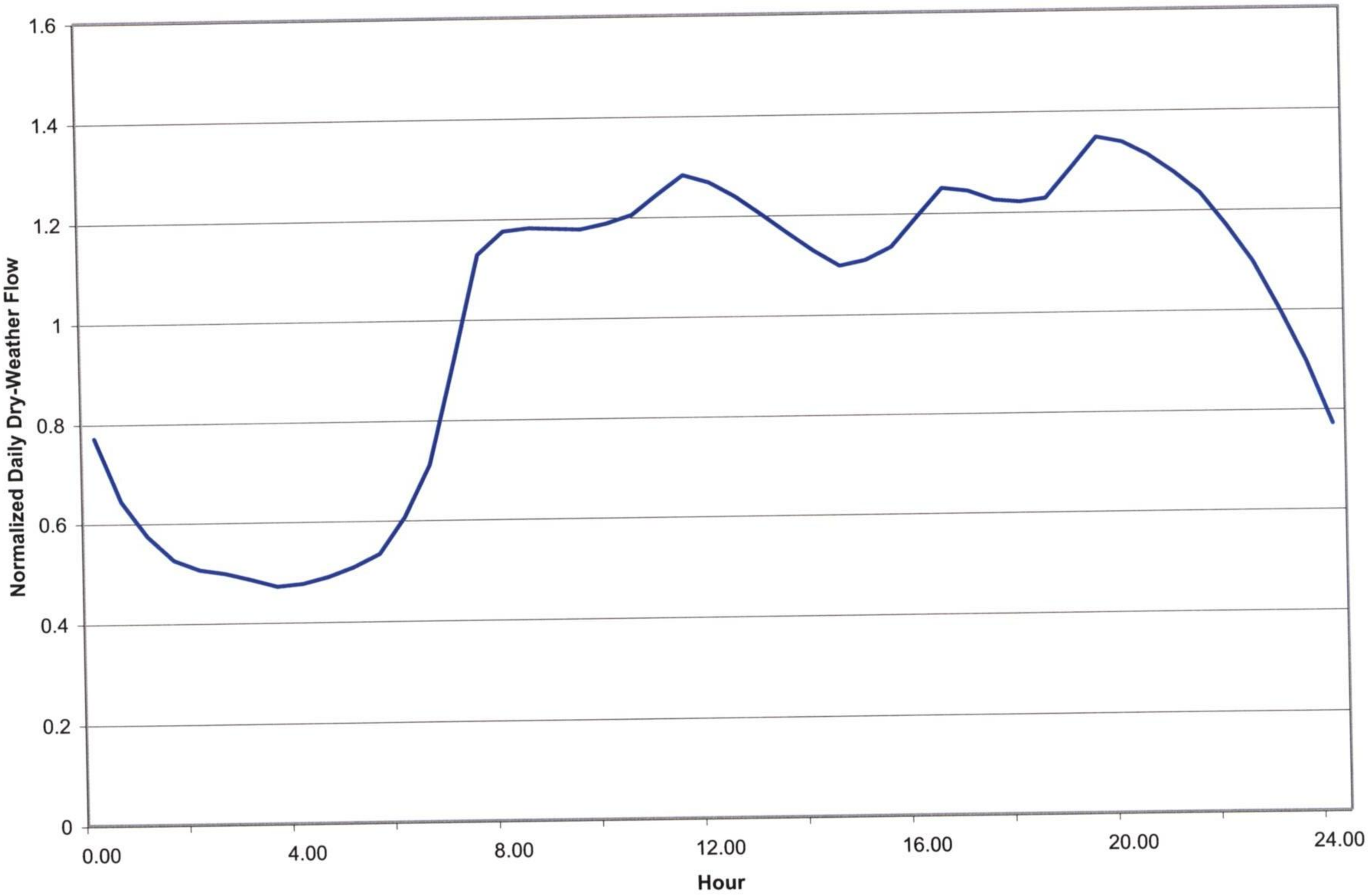

Figure 4-1
Normalized Dry-Weather Flow Hydrograph - Monitor 10B1
Second Creek Basin

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4.2.3 Dry-Weather Calibration

To calibrate the models to dry-weather conditions, the output flows produced by the simulation using existing dry-weather input hydrographs were matched against the flows measured by the meters. Where necessary, adjustments to hydrograph model load points were made so that each flow monitor reasonably matched the flow predicted at the same location in the model. The average dry-weather modeled flows matched the average dry-weather measured flows within 10 percent in most sewersheds system-wide. The calibration error of the final model was less than 10 percent throughout unless there was good reason for it be greater. For example, in some cases flow meter data was inaccurate due to low flows. In other cases, flow readings appeared to be inaccurate, so the model was calibrated to depth readings. The calibrated model dry-weather flows in each basin are discussed in Section 5 through Section 11.

4.2.4 Dry-Weather Analysis

Once calibration was complete, the capacity of the existing sewer system was compared to predicted dry-weather wastewater flows for existing and projected future flow conditions. This is computed by comparing the maximum flow in the pipe under simulation of dry-weather flow to the pipe's full capacity under gravity flow (computed from Manning's equation). If the ratio of maximum flow to capacity is over 100 percent, it indicates that the pipe is surcharged and flowing under pressure during peak dry-weather conditions.

The capacity of the modeled pump stations and force mains was also analyzed under future dry-weather flow conditions. The total maximum capacity of each modeled pump station was compared to the peak 3 hour flow entering the pump station. The total pump station capacity assumes all pumps at the station are in service and operating according to the KUB pump station data sheets.

4.3 Wet-Weather Model Analysis

4.3.1 Wet-Weather Planning Criteria

Computer hydraulic model analyses were also performed to determine potential wet-weather problem areas in the basins. The wet-weather analysis located trunk sewers in each basin that were predicted to experience surcharging and/or overflows for the representative 24 hour planning storm. Predicted RDI/I flow hydrographs for these planning storms were based on winter high groundwater periods when RDI/I responses tend to be the greatest. For the purposes of the wet-weather analysis, the RDI/I hydrographs for the base wet-weather condition were superimposed on the dry-weather base flows.

The results of this analysis were used to recommend improvements in each basin. Pipe improvements will be recommended based on the criteria of no overflows and minimal surcharging during the future planning horizon wet-weather model simulation. Pump stations were recommended for upgrade if the peak 3 hour storm

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flow exceeded the total capacity of the pump station as was done for the dry-weather analysis.

4.3.2 Analysis Methodology

For each basin, the calibrated dry-weather EXTRAN model was used as the basis for the development of the wet-weather model. The dry-weather hydrographs developed from flow-monitoring data and used to simulate diurnal variations in the base flow were also maintained in the wet-weather model. The RDI/I hydrograph for upland model sewersheds were developed using a unit hydrograph technique. Section 3 discusses the methodology for calibrating the three unit hydrograph parameters (Rs, Ts, and Ks) to a given rainfall distribution to reproduce an observed RDI/I hydrograph at a given flow monitor. Surrogate sewershed parameters were used to simulate the RDI/I response of downstream model sewersheds in which the unit hydrograph parameters could not be determined directly. Appropriate surrogate sewersheds were established through the model calibration process. The RDI/I hydrographs simulated for a particular storm event were then combined with the base flow hydrographs for each sewershed and input into the EXTRAN model.

4.3.3 Wet-Weather Calibration

The methodology for simulating the sewer collection system's response to projected wet-weather conditions is based on modeling the combination of BWWF, GWI and rainfall to simulate RDI/I response of a study area to a synthetic (i.e., planning storm event) or actual (i.e., calibration storm event) rainfall distribution. To improve the accuracy of predicted wet-weather planning conditions, the EXTRAN models were calibrated to a monitored storm event.

The models were calibrated to observed flow data by iteratively changing surrogate sewershed unit hydrograph parameters in sewersheds where the unit hydrograph parameters could not be calibrated directly. In particular, the R values were adjusted to match the observed peak storm flow. RDI/I flows were calibrated to upstream sewersheds first. Intermediate sewershed RDI/I loads were then calibrated to obtain a good match of measured total flows at all monitoring points throughout the system. This process resulted in satisfactory results with most predicted peak flows and predicted volumes within approximately 10 percent of measured flow. If the calibration was off by more than 10 percent then an analysis was performed to explain the discrepancy. In some cases flow meter data was inaccurate as shown by scatter graph data. In other cases, flow readings appeared to be inaccurate, so the model was calibrated to depth readings. The calibrated model wet-weather flows in each basin are discussed in Section 5 through Section 11.

4.3.4 Wet-Weather Analysis

The wet-weather analysis located trunk sewers in each basin that were predicted to experience surcharging and/or overflows for the representative 24 hour planning storm. The surcharging criteria established in the CD of less than 2 feet of surcharge

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was used to analyze the existing system. The results of the wet-weather analysis for each Basin are discussed in Section 5 through Section 11.

4.4 Major Sanitary Sewer Improvement Options

Collection system improvements evaluated as part of the alternatives analysis include trunk sewer system and pump station upgrades, reduction of peak wet-weather flows through flow equalization storage and sewer rehabilitation, and treatment of excess flows at the WWTP. A general discussion of each of these improvement alternatives is presented herein.

4.4.1 Trunk Sewer System Improvements

Trunk sewer system improvements can be effective in relieving existing pipelines prone to surcharging and overflows by increasing sewer capacity. These improvements also offer the benefit of providing additional dry-weather wastewater conveyance capacity to accommodate future growth in a service area. Trunk sewer improvement alternatives include (1) replacement and relief sewers, and (2) sewer "pressurization". Each of these options is described below. Because trunk sewer system improvements will result in increased downstream wet-weather peak flows, downstream sewer system improvements (additional trunk sewer capacity, pump station capacity, plant flow equalization, and other plant improvements) may be required in conjunction with upstream improvements.

4.4.1.1 Replacement and Relief Sewers

Replacement or relief sewers are typically required to convey projected dry-weather flows that exceed existing trunk sewer capacity. In addition, SSOs can be eliminated by constructing replacement or relief sewers designed with increased capacity to effectively convey peak wet-weather flows.

Relief sewers may be constructed parallel to an existing trunk sewer, or along an independent route designed to bypass areas that are hydraulically limited. Relief sewers may be designed as on-line or off-line systems. On-line relief sewers would convey both dry- and wet-weather flows. On-line relief sewers should be designed to ensure that minimum hour dry-weather flow velocities are maintained above 2.0 feet per second to prevent solids deposition and resultant odor and maintenance problems. Off-line relief sewers are only used during wet-weather conditions. Flow into off-line relief sewers can be controlled hydraulically via a fixed weir or junction box, or mechanically using a power-operated gate or similar device. In addition to providing necessary wet-weather conveyance capacity, relief sewers can increase sewer maintenance flexibility by allowing one sewer line to be removed from service (without bypass pumping).

Replacement sewers may be preferable to relief sewer construction if the existing trunk sewer is in poor condition, or if construction easement limitations and/or land acquisition requirements preclude cost-effective relief sewer construction. However,

replacement sewer material costs are typically higher than relief sewer costs, since the replacement sewers need to be sized larger to offer equivalent capacity as parallel sewers (existing and relief sewer). In addition, the need to maintain sewer flow during replacement sewer construction may necessitate special construction procedures (e.g., bypass pumping) that can significantly increase costs.

For this project, it was assumed that new or upsized sewer lines crossing roadways or railroads must be installed by a jack-and-bore or tunneling method. It was assumed that pipes 42 inches in diameter and smaller would be installed by jack-and-bore method. Pipes over 42 inches in diameter were assumed to be installed by conventional tunneling. Replacement pipes under rivers were assumed to be installed by microtunneling.

4.4.1.2 Sewer Pressurization

Sewer pressurization can increase the hydraulic and storage capacity of existing trunk sewers (and eliminate localized overflows) by increasing the hydraulic grade line in the reach until the sewer is surcharged. Typically, manholes along the reach are either sealed or raised to allow the sewer to be surcharged during peak wet-weather conditions without creating an overflow situation.

Sewer pressurization is not a conventional improvement, and potential impacts should be carefully considered on a case-by-case basis. The structural integrity and design of the sewer in question must be carefully checked to ensure that it can withstand the anticipated increase in pressure. It is equally important that the hydraulics be carefully considered to ensure that the higher water level does not cause sewage backups into homes or other connected systems, and that the backwater does not reduce upstream carrying capacity. It should be noted that if manhole inverts are formed to convey flow from one-half of the pipe depth, then pressurization may not increase hydraulic capacity because of significant entrance and exit losses. To achieve this benefit the channel must be reconstructed for conveyance of flows that will fill the pipe. If these criteria are met, sewer pressurization can be one of the most cost-effective means of eliminating localized overflows, and increasing hydraulic carrying capacity and in-line storage.

4.4.2 Pump Station Improvements

Capacity upgrades to KUB's existing pump stations or the construction of new pump stations may be required to convey future dry-weather and/or wet-weather flows and to prevent overflows upstream of the pump station. The hydraulic models contain 11 of KUB's 45 pump stations. As part of the alternatives evaluation, the cost of new pump stations assumed typical submersible pump wastewater pumping stations with standby power. Operation and maintenance costs were also considered.

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4.4.3 Flow Equalization Storage

Flow equalization facilities offer a means of reducing or eliminating wet-weather overflows by storing peak flows in excess of the sewer capacity. Flow equalization can be effective in reducing localized overflows, as well as upstream and downstream overflows (by reducing the hydraulic grade line elevation upstream, and by reducing downstream peak flow rates). Flow equalization can be constructed within the sewer system (in-system) or at pump stations and wastewater treatment plants. Flow equalization basins sited at plants can also be used for dry-weather diurnal equalization to dampen daily flow fluctuations and improve treatment performance.

Flow equalization storage can be designed and operated either as on-line or off-line facilities, as discussed below. Odor control in flow equalization storage facilities is an issue that must be considered.

4.4.3.1 On-Line Flow Equalization Storage

With on-line flow equalization facilities, flow is continuously routed through the system (during both dry- and wet- weather), and storage is reserved for wet-weather events. On-line storage can be achieved by replacing a portion of an existing sewer with a larger sized conduit (pipe, tunnel, or culvert), or by constructing a parallel conduit to provide additional storage capacity. Flow into and out of the on-line storage system is by gravity, and wet-weather storage can be regulated by the downstream hydraulic grade line or by a physical control device. Alternative control devices include rate-of-flow control valves, regulators, orifices, and inflatable dams. The volume of flow equalization storage available from on-line facilities is proportional to the length of the structure; and therefore, correction of large overflows may necessitate construction of long conduits.

4.4.3.2 Off-Line Flow Equalization Storage

Typical off-line flow equalization facilities include equalization basins, tunnels, and culverts. Flow equalization basins typically consist of lagoons, storage tanks, or below-ground or above-ground tunnels and box culverts sized to store peak wet-weather flows that cannot be accommodated by the sewer system. A flow diversion chamber or pump station is required to divert peak flows from the sewer to the flow equalization tank. It is good design and operating practice to segment the tank into multiple cells and fill the tank one cell at a time. This approach minimizes the tank area to be cleaned after the wet-weather event, and can expedite tank draining by gravity. The basins can be covered and provided with odor control systems to reduce odor potential. Tank mixing systems are also frequently provided (mixers, blowers, pumps) to keep solids in suspension and minimize clean-up and odor potential.

Construction costs for new flow equalization basins were evaluated as part of the alternatives evaluation. These costs can vary significantly depending on the method of tank construction, equalization volume, and site-specific conditions. Above-ground open topped tank construction typically offers the lowest construction costs, while

below-ground covered tank construction results in the highest costs. Alternatives typically assumed an off-line flow equalization basin, including a flow diversion structure, concrete equalization basin, wastewater pumping station, and odor control facilities. Flow equalization basin operation and maintenance (O&M) requirements include inspection and clean-up of the equalization facilities after each storm event, routine testing and maintenance, wastewater pumping power requirements, blower and mixer power requirements (if applicable), and chemical costs associated with odor control (if applicable). Annual O&M costs for wet-weather flow equalization are a function of the volume and number of excess flow events that occur annually and are subject to significant variability.

4.4.4 Treatment of Increased Flows

Pump station and pipe upgrades will result in increased wastewater flows to the WWTPs. If these flows exceed the wastewater treatment plant capacity, the flows must be temporarily stored in the system until capacity is available or improvements must be made at the plant to handle the additional flows. Although treatment costs were considered when evaluating alternatives, recommendations for WWTP improvements are addressed separately by the "Comprehensive Performance Evaluation and Composite Correction Program."

4.4.5 Sewer Rehabilitation

Sewer rehabilitation and inflow source correction can be an effective means of reducing RDI/I and peak wet-weather flows that may result in sewer overflows. Three general sewer rehabilitation approaches considered for the KUB system are:

- Comprehensive rehabilitation of all sewers and service laterals located both within the public right-of-way and on private property.
- Comprehensive rehabilitation of all sewers located within public rights-of-way only.
- Repair of structural defects in pipes and manholes and removal of major identified inflow sources.

The first and second approaches encompass a "comprehensive rehabilitation" approach, with the only difference being the limits of rehabilitation. A comprehensive rehabilitation approach consists of rehabilitation of every foot of sewer to eliminate all defects that could potentially be points of entry of RDI/I. The third approach is a structural rehabilitation approach, repairing only specific defects that are identified through sewer system evaluation survey (SSES) work, and focused more on SSOs resulting from structural problems rather than RDI/I. This approach does not include rehabilitation of the laterals and thus is not an effective method of reducing overall RDI/I.

A more detailed discussion of both the structural rehabilitation and comprehensive sewer rehabilitation approaches follows.

4.4.5.1 Structural Rehabilitation Approach

Point repairs are an essential element of any sewer rehabilitation program. A point repair program will contribute to meeting the three "common" sewer rehabilitation objectives: eliminate RDI/I sources, correct structural problems, and correct alignment and maintenance problems. Defects that are identified during SSES work that can be corrected using point repairs include:

- Replacing structurally defective pipe segments
- Repairing defective lateral connections (hammer taps)
- Removing roots from joints
- Repairing offset joints
- Repairing sags in pipes or pipe joints
- Replacing and/or repairing defective manholes and manhole casings
- Removing other major inflow sources such as storm water connections

Performing point repairs will meet the rehabilitation objectives of repairing structural defects and maintenance concerns within the system. However, CDM has found that significant RDI/I reduction is often not achievable through a point repair program alone. The primary drawback to a point repair rehabilitation program is migration of RDI/I. Construction techniques using stone bedding for sewer pipe encourage migration by providing a path for groundwater to follow. Unless all defects within a reach of sewer are found, RDI/I will migrate from the location of the repaired defect to an adjacent defect. It is very difficult to find all defects within a sewer system, even if every foot of pipe is inspected by closed circuit television (CCTV). Based on past projects, CDM has found that a rehabilitation program that relies on point repairs alone can result in an RDI/I volume reduction on the order of 0 to 25 percent, and RDI/I peak reduction of 0 to 10 percent. To ensure that all defects are corrected within a reach of sewer, and to achieve higher levels of RDI/I reduction, a comprehensive rehabilitation approach must be used.

4.4.5.2 Comprehensive Sewer Rehabilitation Techniques

A comprehensive sewer rehabilitation program consists of rehabilitation of every foot of sewer within the rehabilitation project area. This type of program has been proven to be effective in other municipal systems at eliminating a large percentage of RDI/I, and is effective at reducing both the volume of RDI/I and the peak flows of RDI/I into the system. CDM has found that a comprehensive rehabilitation program of sewers in the public rights-of-way can result in RDI/I volume reductions of 50 to 80

percent (within the rehabilitated area). While comprehensive rehabilitation is typically aimed at reducing peak RDI/I flows, rehabilitation can also reduce GWI flows by 85 to 90 percent. A reduction of GWI would be beneficial during dry-weather conditions to reduce daily flows and operational costs at the wastewater treatment plant. In addition to RDI/I and GWI reduction, design of a comprehensive rehabilitation program should also typically include repairing structural defects and maintenance problems within the system.

A comprehensive sewer rehabilitation program is the most expensive type of rehabilitation program because it consists of either replacing, lining, or otherwise rehabilitating all pipe within the study area. Consequently, comprehensive sewer rehabilitation is not cost-effective for all sewer systems.

There are several issues that must be addressed in a comprehensive rehabilitation program. For example, a comprehensive rehabilitation program including all sewer mains may fail to produce desired results if a large percentage of RDI/I is entering through defective service laterals. Consequently, the need for lateral rehabilitation should be considered. Point repairs that are required prior to comprehensive sewer rehabilitation must be addressed, and will differ depending on the sewer rehabilitation technique used. Rehabilitation of manholes within the system must also be considered. A point repair program of manhole rehabilitation can be an effective method of eliminating RDI/I, repairing structural defects, and repairing maintenance problems within manholes. The ease of access to manholes makes a continued maintenance and repair program much more cost-effective in comparison to point repairs of buried pipes.

Comprehensive sewer rehabilitation techniques include pipe bursting and lining. Each of these techniques is discussed below.

Pipe Bursting

Pipe bursting involves inserting a pneumatic, hydraulic, or mechanical wedge into the pipe from an excavated insertion pit. The wedge is then expanded in the existing pipe, fracturing the walls of the pipe and pushing the pieces into the surrounding soil. A new pipe is jacked into the place directly behind the wedge. The new pipe is either high density polyethylene (HDPE) with welded joints or short-jointed and thick-walled with in-wall joints (joints with no bells), which facilitates installation of the new pipe from an existing manhole access. With pipe bursting, the hydraulic wedge is guided by the existing pipe and therefore, the new pipe will follow the grade of the existing pipe. Existing sewers that are free of sags or other hydraulic problems and have numerous relatively long and straight runs are the most appropriate for this technique. Pipe of the same or greater diameter than the existing pipe may be installed. Prior to pipe bursting, service laterals must be open excavated and disconnected at the main in order to avoid destroying them with the hydraulic wedge. Depending on the type of pipe bursting technology used, there is the potential to harm adjacent utilities, therefore, care must be exercised in the selection of

the type of equipment to be used when other utilities are located near the sewer or they may also be exposed prior to the bursting process.

Lining

CDM's broad definition of lining includes all rehabilitation techniques where a smaller diameter pipe is inserted, installed, or constructed inside of the existing sewer pipe. A wide variety of techniques fall within this category that are generally distinguished by the type of liner used. The variations in lining techniques include sliplining, cured-in-place lining, and fold-and-form lining. These techniques offer the advantage of requiring little or no excavation for installation, and are therefore most suitable for pipes where aboveground obstructions exist or where very deep excavation would be required to replace the pipe. Lining also allows minimal disruption to traffic where sewer lines are located within public roads. Sewers must be cleaned and obstructions such as roots or protruding service connections must be removed prior to insertion of the liner. If all obstructions cannot be removed with conventional cleaning and cutting equipment, then excavation is necessary at those specific locations.

- ***Sliplining*** - Sliplining involves inserting a pipe of a slightly smaller diameter into the existing pipe, usually from an excavated insertion pit. The liner pipe must be flexible and is commonly made of high-density polyethylene (HDPE), fiberglass, or polyvinyl chloride (PVC). Liner pipe joints are heat-fused or gasketed, with heat-fused joints having the advantage of allowing the liner pipe to be closer in diameter to the existing pipe. The liner pipe is inserted by excavating an insertion pit at the center of the length of existing pipe. From this pit, the liner pipe may be inserted in both directions. The liner pipes are typically pulled through the sewer pipe with the assistance of a winch assembly that is installed in the adjacent manhole. Because pulling the liner pipe often causes it to elongate, the pipe must be allowed to contract to its original length before service connections and seals to manholes are made. Alternatively, the liner can be installed by pushing the liner pipe into the old pipe, using a sling or jacking assembly to avoid damage to the liner pipe.

  CDM recommends that the void left between the existing pipe and the new pipe be filled with grout. If sliplining is used without filling voids between the liner and the existing pipe with grout, very little additional structural benefit is gained from the liner, and future loading increases to the pipe may result in failure. The annular space should be grouted in order to ensure the long-term strength of the newly lined pipe. The annular space should be at least two inches (50 mm) in order for grouting to be effective.

  Once the slipliner is in place, service connections must be made to the liner pipe. This must be performed by excavating each service connection, breaking through the outside pipe, and then making a connection to the slipliner pipe by use of sidewall heat fusion or tapping saddles.

- ***Cured-in-Place Lining*** - Cured-in-place lining (inversion lining) consists of a felt, fabric, or fiberglass lining that is impregnated with resin, and becomes rigid through thermal activation (curing). The liner typically is inserted in an inverted fashion into the existing pipe using water pressure. Once the liner is inserted, it is cured with the use of hot water or hot air that causes the liner to become rigid. The resulting liner is seamless and jointless. Service connections are made by excavation and the installation of a tapping saddle or equivalent watertight connection. Cured-in-place lining is a relatively quick method of rehabilitation and generally requires only 24 to 48 hours of bypass pumping of wastewater flows. Cured-in-place linings can be designed to handle structural loads, if necessary, where the existing pipe has structural defects or where additional loads are expected in the future.

- ***Fold and Formed Pipe Lining*** - Fold and formed pipe lining is similar to sliplining, except that the liner pipe is deformed in some manner to aid insertion into the existing pipe. Depending on the specific manufacturer, the liner pipe may be made of PVC or HDPE. One method of deforming the liner is to fold it into a "U" shape before insertion into the existing pipe. The pipe is then returned to its original circular shape using heated air or water, or using a rounded shaping device or mandrel. Ideally, there will be no void between the existing pipe and the liner pipe after expansion of the liner pipe with the shaping device. For the "U" shape liner, the resulting pipe liner is seamless and jointless.

  Most lining techniques have had very good reliability with proper installation. Sliplining and cured-in-place lining techniques have been used extensively throughout the United States, and the fold and formed technique (although newer to the U.S.) has been used throughout the country with success.

4.5 Evaluation of Alternatives

Improvement alternatives that would convey projected future flows and projected RDI/I from a 24 hour planning storm event were developed. These alternatives take into account the whole system including the effects of transporting this flow to the wastewater treatment plant. Typically, at least four alternatives were developed with cost estimates consisting of the following options:

1) Upsize pipes and pump stations as required to meet criteria and convey flows to the WWTP.

2) Add storage units upstream to eliminate downstream pipe improvements and decrease peak flows to the WWTP.

3) Perform sewer rehabilitation in subbasins that showed high RDI/I to eliminate downstream pipe improvements and decrease peak flows to the WWTP.

4) Various combinations of 1, 2, and 3.

The recommended alternative for each basin that addressed reported and future projected SSOs and surcharge conditions in addition to the SSOs listed in the Long-Term List was developed as the total basin solution. The total basin solution consists of a number of individual projects including various sewer replacement projects, storage projects, and rehabilitation projects. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution for each basin was analyzed to determine which are required to address the SSO locations on the Long-Term List. This included projects directly affecting the SSO location as well as projects required to address predicted overflows downstream, which are predicted to occur as a result of upstream improvements. Projects that were not required to address these SSOs are not included in this report.

In addition, some SSOs reported on the Long-Term List occurred on small collector pipes that were not included in the hydraulic model evaluation. This Phase 1 CAP/ER also addresses these by either collector sewer replacement projects or sewer rehabilitation projects.

Section 5
First Creek

5.1 Hydraulic Model Description

The First Creek hydraulic model contains all sewers over 10 inches in diameter in the First Creek basin and includes over 25 miles of pipes. Flows from First Creek are treated at the Kuwahee WWTP. **Figure 5-1** shows the First Creek sub-basins and modeled trunk sewers.

5.2 Existing and Future Dry-Weather Model Analysis

The First Creek basin was flow monitored in 2003 and 2004. The upper portion of First Creek was flow monitored in 2003 and the lower portion of First Creek was flow monitored in 2004 as described in Section 2. The data collected during the flow monitoring program was used to calibrate the model to dry-weather flows. The flow monitoring data was then used to project flows up to the year 2018. The procedure used to estimate future dry-weather flows is presented in Section 3.2.4. The 2018 average dry-weather flows for each sub-basin in First Creek are shown in **Table 5-1**. The total average dry-weather flow in First Creek for the year 2018 is predicted to be 11.3 mgd.

5.3 Existing and Future Wet-Weather Model Analysis

To calibrate the model to wet-weather conditions, the output flows produced by the hydraulic model simulation using a real storm event were matched against the flows measured by the meters during that storm event. Where necessary, adjustments to hydrograph model load points were made so that simulated flows at a given location reasonably matched the flow predicted at the same location in the system. The wet-weather calibration procedure is described in Section 4.3.3.

The Upper First Creek was calibrated to a storm event that was recorded in the 2003 flow monitoring program. Lower First Creek was calibrated to a storm event recorded in the 2004 flow monitoring program. R values were calculated for each of the sub-basins for the calibration storm events and are presented in **Table 5-2**. Section 3.3.1 discusses the definition of R value. In general, sub-basins with an R value greater than 5 percent are considered to have a high volume of RDI/I.

Table 5-2 also reports the volume of RDI/I per linear foot of sewer based on the calibrated R values, which were used to calculate the gallons of RDI/I entering each sub-basin for the 24 hour planning storm event. Sub-basins with high volumes of RDI/I per linear foot are good candidates for comprehensive sanitary sewer rehabilitation as the greatest amount of RDI/I can be removed per linear foot of sewer rehabilitated in these sub-basins. The 24 hour planning storm event was previously developed by CDM to size wet-weather improvements for the collection system as described in Section 3.4. The volume of RDI/I calculated for each sub-basin was divided by the length of sewer in each sub-basin to obtain the volume of infiltration

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Trunk Sewers

First Creek Sewersheds

Scale: 1" = 5,000'

N

01A2
02A3
01B1
03B2
03D1
01A1
03C1
03B1
02A2
03E1
03A1
04C1
04B1
04A1
02A1
04C2
07A1
07A2a
07A2b
08A1
08B2
08C1
07A3
16D1
16C1
18B2
16B1
18C1
16A1
17B1
18B1
17A1
24B1
18A1
24A2
24E1
24A1
24D1
30A2

75
640
40
640

Figure 5-1
First Creek
Hydraulic Model

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Table 5-1: First Creek Average Dry-Weather Flows

Sewershed	Existing Flow (mgd)	Future (2018) Predicted Flow (mgd)
01A1	0.05	0.17
01A2	0.08	0.28
01B1	0.06	0.22
02A1	0.25	0.35
02A2	0.08	0.43
02A3	0.18	0.65
03A1	0.18	0.21
03B1	0.10	0.13
03B2	0.21	0.23
03C1	0.11	0.12
03D1	0.13	0.17
03E1	0.12	0.13
04A1	0.27	0.30
04B1	0.19	0.23
04C1	0.05	0.23
04C2	0.25	0.37
07A1	0.11	0.15
07A2	0.19	0.26
07A3	0.11	0.14
08A1	0.58	0.42
08B2	0.46	0.81
08C1	0.09	0.18
16B1	0.30	0.24
16C1	0.11	0.10
16D1	0.17	0.23
16A1	0.50	0.41
17A1	0.50	0.71
17B1	0.08	0.17
18A1	0.01	0.009
18B1	0.13	0.60
18B2	0.07	0.37
18C1	0.05	0.21
24A1	0.06	0.21
24A2	0.24	0.18
24B1	0.13	0.15
24D1	0.23	0.44
24E1	0.48	0.36
30A2	1.01	0.78
Total	**7.9**	**11.3**

Table 5-2: R Values and RDI/I for First Creek Sewersheds

Sewershed	R Value %	RDII (gal/LF)[1]
01A1	11	49.4
01A2	11	46.5
01B1	11	55.1
02A1	4.3	14.7
02A2	8.17	48.8
02A3	1	4.7
03A1	11	48.8
03B1	7.1	50.8
03B2	10.2	51.4
03C1	9.1	38.5
03D1	3.8	17.0
03E1	14.3	45.3
04A1	12.4	65.0
04B1	11	54.1
04C1	15.6	60.6
04C2	5.1	21.4
07A1	5.3	25.2
07A2a	11.1	46.3
07A2b	5.3	22.7
07A3	1.3	5.9
08A1	13.4	60.9
08B2	7.8	32.3
08C1	4.9	27.0
16B1	2.3	9.5
16C1	15.5	66.4
16D1	13.4	38.6
16A1	4.9	16.6
17A1	15.5	41.1
17B1	15.5	58.8
18A1	12.9	43.4
18B1	5.55	19.3
18B2	5.55	23.9
18C1	5.55	20.9
24A1	12.9	41.4
24A2	12.9	39.6
24B1	16.3	43.0
24D1	12.9	34.0
24E1	12.9	31.1
30A2	12.9	30.8

[1] Represents predicted volume for a representative 24 hour storm.

per linear foot of pipe. This is the volume of RDI/I that might be expected to enter the sewer, if adequate capacity is available, resulting from the representative 24 hour storm event during the critical period for GWI (i.e., December to May). The representative 24 hour storm RDI/I volume is presented as a way of comparing the infiltration between sub-basins. The RDI/I per linear foot of sewer for each sub-basin is also shown in **Figure 5-2**. In general, sub-basins with an RDI/I per linear foot of sewer greater than 50 were considered good candidates for rehabilitation and RDI/I reduction. The value of 50 gallons per day per linear foot is project specific to KUB and was used to identify sub-basins where comprehensive rehabilitation was thought to reduce or eliminate a downstream capacity related improvement. Most sub-basins were predicted to have less than 50 gallons RDI/I per linear foot of sewer. Eight sub-basins were predicted to have over 50 gallons RDI/I per linear foot.

5.4 2018 Wet-Weather Storm Flows

As described in Section 3.4, a planning storm was used to predict the performance of the collection system during a representative 24 hour storm event. The planning storm and 2018 dry-weather flows were routed through the hydraulic model. The predicted pipe capacity at peak planning storm flows is shown in **Figure 5-3**. As shown in the figure, the hydraulic analysis predicts that the majority of the trunk sewers will be surcharged. Pipes were considered to be surcharged if the maximum predicted flow, Qmax, exceeded the design capacity of the sewer, Qdesign. Predicted overflow locations are also shown in Figure 5-3. Any overflow ranging from 10,000 gallons to 1,000,000 gallons is designated with a green dot. Any overflow ranging from 1 million to 2 million gallons is designated with a yellow dot. Any overflow greater than 2 million gallons is designated as a red dot. The model predicts multiple overflows primarily in the upper portion of First Creek near the main trunk sewer. The largest predicted overflows are near the intersection of Broadway and Highland Drive in upper First Creek, and near the intersection of Broadway and Cecil Avenue in Lower First Creek, which is where actual overflows have also been observed.

As explained in Sections 1.1 and 4.5, a total basin solution was developed for First Creek to address future predicted wet -weather overflows. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution was analyzed to determine which are required to address the SSO locations on the Long-Term List.

5.5 Phase 1 CAP/ER Facility Improvements

The objective of the Phase 1 CAP/ER is to address SSOs identified on the Long-Term List of the SSOER in accordance with the CD. The SSOs listed on the Long-Term List that are capacity related are addressed by facility improvement projects as outlined for the First Creek Basin in **Table 5-3**. This table lists all capacity related SSOs and a corresponding project ID, which addresses the SSO.

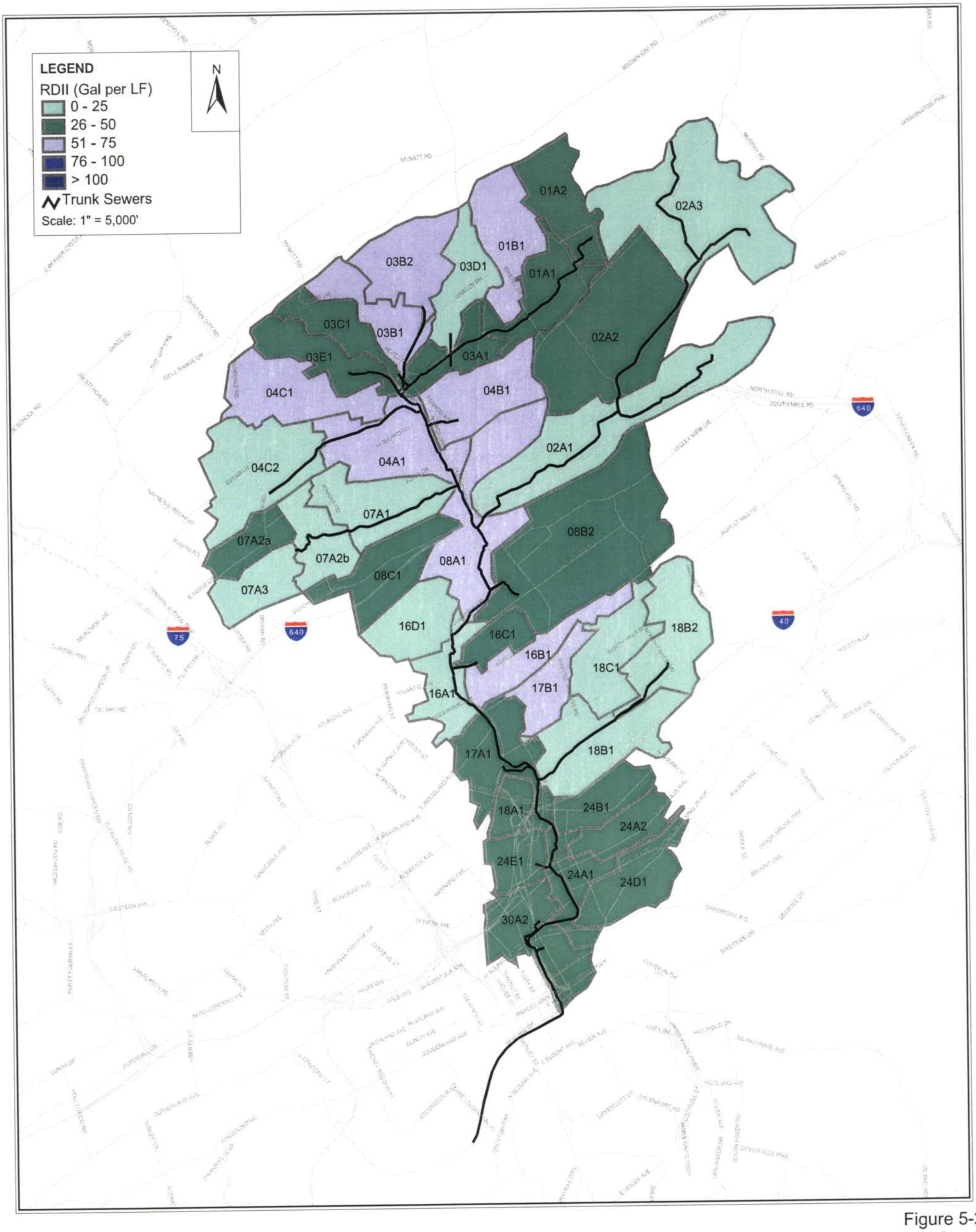

Figure 5-2
First Creek
RDI/I (Gal Per LF) By Sub-basin Predicted for 24 Hour Planning Event

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Predicted Overflow Locations
- 0.01 to 1 MG
- 1.01 to 2 MG
- Over 2 MG

Pipe Condition
- Not Surcharged (Qmax < Qdesign)
- Surcharged (Qmax> Qdesign)

First Creek Sewersheds

Scale: 1" = 5,000'

N

01A2
02A3
01B1
03B2
03D1
01A1
03C1
03B1
02A2
03E1
03A1
04C1
04B1
02A1
04C2
04A1
07A1
08B2
07A2a
07A2b
08A1
08C1
07A3
16D1
16C1
18B2
16B1
18C1
16A1
17B1
17A1
18B1
18A1
24B1
24A2
24E1
24A1
24D1
30A2

75
640
40
640

Figure 5-3
First Creek
2018 Peak Wet Weather Flow with Existing Alignment

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Table 5-3: First Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
12/9/04	106 KNOX RD	MH 16	1-3, 1-4, 1-5
12/7/04	106 KNOX RD	MH 16 & 18	1-3, 1-4, 1-5
6/25/04	1422 HOITT AVE	MH 4	1-15, 1-3
9/17/04	1422 HOITT AVE	MH 4	1-15, 1-3
11/24/04	1422 HOITT AVE	MH 4	1-15, 1-3
12/7/04	1422 HOITT AVE	MH 4	1-15, 1-3
3/6/04	1422 HOITT AVE	MH 4 & 4-9	1-15, 1-3
12/9/04	1422 HOITT AVE	MH 4, 4-9, & 4-19	1-15, 1-3
2/6/04	1500 HOITT AVE	MH 4, 4-9 & 4-19	1-15, 1-3
2/16/03	1515 GRAINGER AVE	MH 2	1-15, 1-3
2/22/03	1515 GRAINGER AVE	MH 2	1-15, 1-3
2/17/03	1620 EDGEWOOD AVE	MH 2-41	1-19
2/22/03	1620 EDGEWOOD AVE	MH 2-41	1-19
3/20/02	1703 MAPLE DR	MH 40	1-13
2/22/03	1804 CHARLES DR	MH 36	1-13
4/11/03	1804 CHARLES DR	MH 36	1-13
4/18/03	1804 CHARLES DR	MH 36	1-13
5/6/03	1804 CHARLES DR	MH 36	1-13
4/10/03	1809 LUTTRELL ST	MH 4-19	1-15, 1-3
5/8/03	1809 LUTTRELL ST	MH 4-19	1-15, 1-3
1/23/02	2100 PROSSER RD	MH 46,47,49,50,51& 52	1-14
2/20/03	2308 CEDAR LN	MH 22-33	1-5, 1-13
2/22/03	2326 CEDAR LN	Building Backup & MH 22-30	1-5, 1-13
2/17/03	2328 CEDAR LN	MH 22-30	1-5, 1-13
2/22/03	2328 CEDAR LN	MH 22-30	1-5, 1-13
2/17/03	2333 GREENFIELD LN	MH 30-35	1-18
2/22/03	2333 GREENFIELD LN	MH 30-35	1-18
3/17/02	2352 GREENFIELD LN	MH 30-67	1-18
4/10/03	2352 GREENFIELD LN	MH 30-67	1-18
5/6/03	2352 GREENFIELD LN	MH 30-67	1-18
2/15/03	2404 CEDAR LN	Building Backup & MH 22-13	1-5, 1-13
2/15/03	2406 CEDAR LN	MH 22-13	1-5, 1-13
2/15/03	2406 CEDAR LN	Building Backup & MH 22-13	1-5, 1-13
3/17/02	2412 TECOMA ST	MH 9-4	1-2
3/29/02	2424 UNDERWOOD PL	Building Backup	1-2
3/18/02	2500 CEDAR LN	MH 22-13	1-5, 1-13
2/22/03	2500 CEDAR LN	MH 22-13	1-5, 1-13
2/16/03	2500 CEDAR LN	Building Backup & MH 22-13	1-5, 1-13
2/23/03	2511 TECOMA DR	Building Backup	1-2
1/23/02	2514 TECOMA DR	Lateral	1-2
1/23/02	2514 TECOMA DR	Building Backup & Lateral	1-2
1/23/02	2524 UNDERWOOD PL	Lateral	1-2
1/23/02	2528 TECOMA DR	MH 9-6	1-2
12/9/04	2528 TECOMA DR	MH 9-34	1-2
9/25/02	2535 MAPLE DR	MH 19	1-13
2/15/03	2535 MAPLE DR	MH 19	1-13
2/22/03	2535 MAPLE DR	MH 19	1-13
4/10/03	2535 MAPLE DR	MH 19	1-13
4/17/03	2535 MAPLE DR	MH 19	1-13
5/6/03	2535 MAPLE DR	MH 19	1-13
2/15/03	2538 FAIR DR	MH 20-1	1-13
2/22/03	2538 FAIR DR	MH 20-1	1-13
4/17/03	2538 FAIR DR	MH 20-1	1-13
2/6/04	2538 FAIR DR	MH 20-1	1-13
6/24/04	2541 FAIR DR	MH 20-2	1-13
12/9/04	2541 FAIR DR	MH 20-2	1-13
3/18/02	2544 FAIR DR	MH 20-1	1-13
5/6/03	2544 FAIR DR	MH 20-2	1-13
12/22/04	2544 FAIR DR	MH 71	1-13
2/22/03	2700 TECOMA DR	Lateral	1-2
2/15/03	2700 TECOMA DR	Building Backup	1-2
2/22/03	2700 TECOMA DR	Building Backup/ Lateral	1-2

Table 5-3: First Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
1/24/02	2806 TECOMA DR	MH 9-52	1-2
1/24/02	2806 TECOMA DR	Building Backup & MH 9-52	1-2
2/15/03	2808 TECOMA DR	MH 9-52	1-2
2/22/03	2808 TECOMA DR	MH 9-52	1-2
12/9/04	2808 TECOMA DR	MH 9-52	1-2
2/16/03	2820 NORTH HILLS BLVD	MH 30-102	1-18
2/22/03	2820 NORTH HILLS BLVD	MH 30-102	1-18
1/23/02	2826 NORTH HILLS BLVD	MH 30-102	1-18
2/6/04	2827 ESSARY DR	MH 2-14	1-5, 1-7
1/19/01	2837 WOODROW DR	Building Backup	1-25
11/6/03	2837 WOODROW DR	Building Backup	1-25
9/17/04	2900 RENNOC RD	MH 13-26	1-12
11/24/04	2900 RENNOC RD	MH 13-26	1-12
1/5/04	2900 RENNOC RD	MH 13-26, 13-49 & 13-55	1-12
2/6/04	2900 RENNOC RD	MH 13-26, 13-49 & 13-55	1-12
3/6/04	2900 RENNOC RD	MH 13-26, 13-49 & 13-55	1-12
12/7/04	2900 RENNOC RD	MH 13-26, 13-49 & 13-55	1-12
12/9/04	2900 RENNOC RD	MH 13-26, 13-49 & 13-55	1-12
4/17/03	2900 RENNOC RD	MH 13-26 & 13-49	1-12
5/6/03	2900 RENNOC RD	MH 13-26 & 13-49	1-12
2/22/03	2900 RENNOC RD	MH 13-26 & 13-49 & Lateral	1-12
2/22/03	2900 RENNOC RD	Building Backup & MH13-26 & 13-49	1-25
1/23/02	2900 TECOMA DR	MH 9-34 & 9-35	1-2
6/27/04	2910 RENNOC RD	Cleanout	1-12
2/16/03	2910 RENNOC RD	MH 13-49	1-12
7/9/03	2910 RENNOC RD	MH 13-49	1-12
11/6/03	2910 RENNOC RD	MH 13-49 & 13-55	1-12
2/16/03	2910 RENNOC RD	Building Backup & MH 13-49	1-25
9/17/04	2928 RENNOC RD	MH 13-49 & 13-55	1-12
6/28/04	300 ELMWOOD DR	MH 13-112	1-25
12/9/04	300 KNOX RD	MH 79 & 18	1-3, 1-4, 1-5
1/23/02	3014 RENNOC RD	Building Backup	1-25
12/9/04	304 SEVENTH AVE	MH 15	1-15
2/6/04	304 SEVENTH AVE	MH 15	1-15
2/16/03	308 KNOX RD	Building Backup	1-5
12/9/04	308 KNOX RD	Building Backup and MH 79 & 18	1-5
2/22/03	3201 OCOEE TRL	MH 13-5	1-16
5/6/03	3201 OCOEE TRL	MH 13-5	1-16
2/16/03	3202 DEMPSTER ST	MH 13-11	1-16
2/22/03	3202 DEMPSTER ST	MH 13-11	1-16
1/19/02	3202 OCOEE TRL	MH 13-5	1-16
2/17/03	3212 WILDERNESS RD	MH 52	1-14
2/16/03	3219 GODFREY ST	MH 13-25	1-16
2/22/03	3219 GODFREY ST	MH 13-25	1-16
5/6/03	3219 GODFREY ST	MH 13-25	1-16
2/22/03	3236 WILDERNESS RD	MH 53	1-14
2/15/03	3501 WHITTLE SPRINGS RD	MH 9-35	1-2
2/22/03	3501 WHITTLE SPRINGS RD	MH 9-35	1-2
2/6/04	3501 WHITTLE SPRINGS RD	MH 9-34 & 9-35	1-2
12/9/04	3501 WHITTLE SPRINGS RD	MH 9-35	1-2
2/22/03	3616 ESSARY DR	Lateral	1-17
2/22/03	3620 ESSARY DR	Lateral	1-17
2/22/03	3701 ESSARY DR	Lateral	1-17
2/22/03	3704 ESSARY DR	Lateral	1-17
2/22/03	3716 ESSARY DR	Lateral	1-17
2/19/03	4144 OAKLAND DR	MH 39-48	1-1
2/22/03	4144 OAKLAND DR	MH 39-48	1-1
3/10/04	4144 OAKLAND DR	MH 39-4	1-1
11/30/04	4144 OAKLAND DR	MH 39-4	1-1
12/7/04	4144 OAKLAND DR	MH 39-4 & 39-44	1-1
2/6/04	4144 OAKLAND DR	MH 39-4 & 39-5	1-1
12/11/04	4144 OAKLAND DR	MH 39-4, 39-44 & 39-45	1-1

Table 5-3: First Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
3/28/03	4713 OLD BROADWAY	MH 2	1-3
2/6/04	4713 OLD BROADWAY	MH 2	1-3
3/6/04	4713 OLD BROADWAY	MH 2	1-3
6/23/04	4713 OLD BROADWAY	MH 2	1-3
9/20/04	4713 OLD BROADWAY	MH 2	1-3
11/24/04	4713 OLD BROADWAY	MH 2	1-3
12/1/04	4713 OLD BROADWAY	MH 2	1-3
12/7/04	4713 OLD BROADWAY	MH 2	1-3
12/9/04	4713 OLD BROADWAY	MH 2	1-3
1/28/04	4713 OLD BROADWAY	MH 2	1-3
11/24/04	4811 BEVERLY RD	MH 39-44 & 39-4	1-1
2/6/04	5218 N BROADWAY	MH 2-220	1-5
3/10/04	5218 N BROADWAY	MH 2-220	1-5
5/6/03	5233 N BROADWAY	Building Backup & MH 5	1-17
5/6/03	5300 & 5334 BROADWAY	MH 11 & 13	1-17
2/22/03	5300 BROADWAY	MH 10, 11, 12 & 13	1-17
2/15/03	5300 BROADWAY	MH 10, 12, 13 & 14	1-17
1/24/02	5301 FOUNTAIN RD	MH 5	1-17
12/20/02	5301 FOUNTAIN RD	MH 6	1-17
1/5/04	5301 FOUNTAIN RD	MH 4, 5, 6 & 6-1	1-17
3/6/04	5301 FOUNTAIN RD	MH 4, 5, 6 & 6-1	1-17
6/27/04	5301 FOUNTAIN RD	MH 5	1-17
2/6/04	5301 FOUNTAIN RD	MH 5 & 6	1-17
2/22/03	5319 BROADWAY	Lateral	1-17, 1-25
3/10/04	5319 N BROADWAY	Lateral	1-17, 1-25
2/17/03	5338 BROADWAY	MH 11	1-17
2/6/04	5338 N BROADWAY	MH 10, 11, 12, 13 & 14	1-17
3/6/04	5338 N BROADWAY	MH 11, 12, 13, 13-1 & 14	1-17
12/9/04	5338 N BROADWAY	MH 11, 13 & 14	1-17
1/23/02	5353 BROADWAY	MH 13-1	1-17
12/9/04	5401 FOUNTAIN RD	MH 6-1 & 6-2	1-17
2/15/03	5511 BROADWAY	MH 17	1-17
2/22/03	5511 BROADWAY	MH 17	1-17
3/17/02	5511 DOGWOOD RD	MH 2-185	1-1
3/18/02	BROADWAY & GRESHAM RD	MH 11, 13 & 14	1-17
2/22/03	BROADWAY & RIDGEWAY LN	MH 21	1-3 and 1-6
3/18/02	BROADWAY & RIDGEWOOD RD	MH 19 & 20	1-17
1/23/02	COLONIAL CIR & BROADWAY	MH 14	1-17
2/16/01	ESSARY DR & LYNNWOOD DR	MH 2-14	1-11
1/25/02	ESSARY DR & LYNNWOOD DR	MH 2-14	1-11
3/18/02	ESSARY DR & LYNNWOOD DR	MH 2-14	1-11
3/21/02	ESSARY DR & LYNNWOOD DR	MH 2-14	1-11
2/15/03	ESSARY DR & LYNNWOOD DR	MH 2-14	1-11
5/6/03	ESSARY DR & LYNNWOOD DR	MH 2-14	1-11
2/22/03	ESSARY DR & LYNNWOOD DR	MH 2-14 & 2-220	1-11
3/18/02	ESSARY DR & ROSEBAY RD	MH 2-39 & 2-40	1-11
2/16/01	ESSARY DR & ROSEBAY RD	MH 2-40	1-11
1/23/02	FOUNTAIN RD & CEDAR LN	MH 5	1-17
7/15/02	FOUNTAIN RD & CEDAR LN	MH 5	1-17
4/7/03	FOUNTAIN RD & CEDAR LN	MH 5	1-17
5/6/03	FOUNTAIN RD & CEDAR LN	MH 5	1-17
9/22/03	FOUNTAIN RD & CEDAR LN	MH 5	1-17
11/19/03	FOUNTAIN RD & CEDAR LN	MH 5	1-17
2/16/01	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
9/22/02	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
12/5/02	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
2/14/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
2/22/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
4/9/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
4/17/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
7/2/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
7/9/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17

Table 5-3: First Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
7/31/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
8/5/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
9/27/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
11/6/03	FOUNTAIN RD & CEDAR LN	MH 5 & 6	1-17
3/18/02	FOUNTAIN RD & CEDAR LN	MH 5, 6 & 6-1	1-17
1/19/01	FOUNTAIN RD & CEDAR LN	MH 6	1-17
5/6/03	FOUNTAIN RD & CEDAR LN	MH 6	1-17
2/16/01	FOUNTAIN RD & MIDLAKE DR	MH 6-1 & 6-2	1-17
2/14/03	FOUNTAIN RD & MIDLAKE DR	MH 6-1 & 6-2	1-17
2/22/03	FOUNTAIN RD & MIDLAKE DR	MH 6-1 & 6-2	1-17
4/10/03	FOUNTAIN RD & MIDLAKE DR	MH 6-1 & 6-2	1-17
5/6/03	FOUNTAIN RD & MIDLAKE DR	MH 6-1 & 6-2	1-17
1/6/04	FOURTH AVE & HOITT AVE	MH 4	1-15, 1-3
9/23/02	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
1/19/01	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
1/19/02	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
7/15/02	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
12/20/02	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
4/10/03	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
4/17/03	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
9/22/03	HOITT AVE & FOURTH AVE	MH 4	1-15, 1-3
5/6/03	HOITT AVE & FOURTH AVE	MH 4 & 4-9	1-15, 1-3
7/2/03	HOITT AVE & FOURTH AVE	MH 4 & 4-9	1-15, 1-3
7/10/03	HOITT AVE & FOURTH AVE	MH 4 & 4-9	1-15, 1-3
2/22/03	HOITT AVE & FOURTH AVE	MH 4, 4-9 & 4-14	1-15, 1-3
2/14/03	HOITT AVE & FOURTH AVE	MH 4, 4-9, 4-20 & Lateral	1-15, 1-3
3/17/02	HOITT AVE & FOURTH AVE	MH 4-8 & 4-9	1-15, 1-3
1/19/02	HOITT AVE & FOURTH AVE	MH 4-9	1-15, 1-3
1/23/02	HOITT AVE & FOURTH AVE	MH 4-9	1-15, 1-3
2/22/03	TECOMA DR & WHITTLE SPRINGS	MH 9-34	1-2
5/6/03	TECOMA DR & WHITTLE SPRINGS	MH 9-6	1-2
2/16/03	TECOMA DR & WHITTLE SPRINGS	MH 9-6 & 9-34	1-2
3/17/02	TECOMA ST & WHITTLE SPRINGS	MH 9-5 & 9	1-2

1 SSOs from Long-Term List of SSOER that are capacity related. Non-capacity related SSOs are shown in Table 5-4.
2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 5-5 and shown on Figure 5-4

The SSOs on the Long-Term List that are not capacity related are addressed by either a "find and fix" facility improvement project or KUB's CSSAP Program. Many of the SSOs on the Long-Term List that are not capacity related are the result of a blockage (debris, grease, roots, etc.) that have been addressed by KUB's CSSAP Program. These include all the SSOs on the Long-Term List that have the designation "N/A" under the "Long Term Capital Project" field. However, if the source of the blockage could not be fixed by maintenance and re-occurred after flushing or root cutting, then these SSOs were assigned a "find and fix" facility improvement project. "Find and fix" facility improvement projects will first involve further investigation into the source of the SSO through the use of smoke testing, manhole inspection, and/or CCTV inspection. Next, a determination will be made of the type and extent of the improvement required to address the SSO. In some cases, the blockage may have been only partially removed and further flushing or cutting is required to address the SSO. In other cases, replacement of sagged pipe or lining of pipe to prevent root intrusion may be required.

Table 5-4 presents all SSOs on the Long-Term List that are not capacity related. In the project ID field is either a "find and fix" project ID that addresses the SSO or the designation "has been addressed by CSSAP Program", as discussed above.

Figure 5-4 presents a map showing the locations of all SSOs on the Long-Term List from 2001-2004 in First Creek that require a facility improvement project to address the SSO. The SSOs are shown as green dots on the map. As discussed above, some SSOs on the Long-Term List were isolated cases of a blockage that have been addressed by the CSSAP Program and are not mapped on this figure.

The figure also shows the planned and completed facility projects to address the SSOs. Already completed improvement pipeline projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I and reducing the R value to 2 percent are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in the SSO Tables 5-3 and 5-4. **Table 5-5** lists all the projects on the map and a description of each project. Section 12 presents the Phase 1 CAP/ER implementation plan that provides start and end dates for each of these projects.

Table 5-4: First Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
7/18/02	DUTCH VALLEY RD	Building Backup	Addressed by CSSAP
8/24/04	100 E JACKSON AVE	Building Backup	Addressed by CSSAP
9/5/02	1000 WOODLAND AVE	MH 4-67	Addressed by CSSAP
12/26/01	1002 HIGHLAND AVE	MH 29-49	Addressed by CSSAP
3/5/01	103 FELIX ST	YARD	Addressed by CSSAP
4/26/02	106 COLLEGE PARK LN	MH 6-15	1-21
11/28/03	1060 LEDGERWOOD RD	MH 4-7	Addressed by CSSAP
12/23/04	1108 FAIRFAX AVE	MH 27-4	Addressed by CSSAP
9/17/01	112 TANSY LN	Building Backup	Addressed by CSSAP
5/7/02	1125 DUTCH VALLEY DR	MH 7-180	Addressed by CSSAP
2/17/01	1129 RALEIGH AVE	Building Backup	Addressed by CSSAP
2/16/01	115 GRESHAM RD	Building Backup	Addressed by CSSAP
10/30/04	1201 GLENOAKS DR	Underground Flow	Addressed by CSSAP
10/12/04	1209 CEDAR LN	MH 59-3	Addressed by CSSAP
11/24/04	1235 WATERCRESS DR	MH 29-9	Addressed by CSSAP
8/1/02	124 KELLER ST	MH 6-200	Addressed by CSSAP
6/9/03	125 E JACKSON AVE	Building Backup	Addressed by CSSAP
7/25/02	1301 OGLEWOOD AVE	Underground Flow	Addressed by CSSAP
11/25/01	1307 OGLEWOOD AVE	Building Backup	1-23
12/23/01	1307 OGLEWOOD AVE	Building Backup	1-23
2/23/04	1313 ADAIR DR	MH 28-1	Addressed by CSSAP
3/16/01	1317 ADAIR DR	MH 28-2	Addressed by CSSAP
3/15/01	1317 ADAIR DR	Building Backup & MH 28-2	Addressed by CSSAP
2/16/02	1325 FIELDWOOD DR	Building Backup	Addressed by CSSAP
4/16/02	1416 EDGEWOOD AVE	Building Backup	Addressed by CSSAP
5/12/03	1421 AUTUMN LN	Building Backup	Addressed by CSSAP
5/13/03	1421 AUTUMN LN	Building Backup	Addressed by CSSAP
11/28/01	1421 MAPLE DR	MH 44	1-13
5/8/02	1432 WAKE ROBIN DR	MH 7-175	Addressed by CSSAP
3/26/04	1616 EIGHTH AVE	Building Backup	Addressed by CSSAP
12/30/02	1629 LUCK AVE	MH 11-1	Addressed by CSSAP
10/22/02	1631 FAIR DR	MH 35-35	Addressed by CSSAP
4/8/02	1707 CECIL AVE	MH 11	Addressed by CSSAP
3/1/02	1707 CHARLES DR	Building Backup	Addressed by CSSAP
12/24/01	1708 E GLENWOOD AVE	Building Backup	Addressed by CSSAP
5/6/03	1726 DONINGHAM DR	MH 22-201	Addressed by CSSAP
5/1/01	1800 LINDEN AVE	MH 38-2	1-2
3/14/01	1804 CHARLES PL	MH 34	1-13
9/7/02	1805 JEFFERSON AVE	MH 25-17	Addressed by CSSAP
7/9/01	1821 EIGHTH AVE NEAR CECIL AVE	MH 8	Addressed by CSSAP
6/28/04	1903 MARTHA BERRY DR	MH 18-135	Addressed by CSSAP
11/3/03	1909 FREMONT PL	MH 4-148	Addressed by CSSAP
2/26/03	1913 WOODROW RD	Building Backup	Addressed by CSSAP
8/6/01	1914 MC CALLA AVE	Building Backup	Addressed by CSSAP
6/28/04	1915 RIDGECREST DR	MH 18-127	Addressed by CSSAP
3/7/01	1916 BROWN AV	Building Backup	Addressed by CSSAP
3/14/02	1918 CHERRY ST	Building Backup	1-25
4/18/02	1918 CHERRY ST	Building Backup	1-25
3/17/04	2027 MCCALLA AVE	Underground Flow	Addressed by CSSAP
2/27/02	2100 PROSSER RD	MH 50	1-14
6/29/02	2101 WOODBINE AVE	MH 33-12	Addressed by CSSAP
6/23/04	2110 WASHINGTON AVE	MH 25-92	Addressed by CSSAP
8/1/01	2130 FAIR DR	MH 26	1-13
7/27/04	214 BERTRAND ST	MH 6-52	1-20
12/27/03	2200 CHICAGO AVE	Building Backup	Addressed by CSSAP
8/1/02	2207 CEDAR LN	MH 22-37	Addressed by CSSAP
6/25/03	2217 ANTIETAM RD	MH 60	Addressed by CSSAP
5/19/04	2217 MARTIN LUTHER KING JR AVE	MH 6-152	Addressed by CSSAP
4/18/03	225 BELL ST	MH 6-2	Addressed by CSSAP
3/18/02	2326 CEDAR LN	Building Backup	1-5, 1-13
6/7/03	2402 CEDAR LN	Building Backup	Addressed by CSSAP

Table 5-4: First Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
3/21/04	2406 CEDAR LN	MH 22-14	Addressed by CSSAP
7/13/02	2406 CEDAR LN	Building Backup	1-13
3/17/02	2406 EMORILAND BLVD	MH 15	Addressed by CSSAP
3/18/02	2411 KANTEBURY DR	Building Backup	Addressed by CSSAP
7/30/01	2423 PARKWAY DR	Building Backup	1-12
2/17/01	2459 CECIL AV	Building Backup	Addressed by CSSAP
12/10/04	2500 CEDAR LN	MH 22-13	Addressed by CSSAP
12/11/04	2509 BROADWAY	MH 4-71	Addressed by CSSAP
12/15/02	2524 UNDERWOOD PL	Lateral	1-2
8/5/03	2532 BERNHURST DR	Building Backup	Addressed by CSSAP
12/9/04	2539 CECIL AVE	MH 30-15	Addressed by CSSAP
12/20/03	2601 EDGEWOOD AVE	Building Backup	Addressed by CSSAP
2/16/01	2837 WOODROW DR	MH 13-55	Addressed by CSSAP
3/3/03	2853 RENNOC RD	Building Backup	Addressed by CSSAP
12/10/01	2916 TAZEWELL PIKE	Lateral	Addressed by CSSAP
3/17/01	2922 RENNOC RD	MH 13-64	1-25
12/14/02	2922 RENNOC RD	MH 13-64	1-25
1/3/02	3006 BORIGHT PL	MH 32	Addressed by CSSAP
8/7/04	3008 VALLEY VIEW DR	MH 9-62	1-2
10/16/02	3010 VALLEY VIEW DR	MH 9-73	Addressed by CSSAP
3/6/02	3012 TAZEWELL PIKE	Building Backup	Addressed by CSSAP
12/29/01	3016 BORIGHT PL	MH 34	Addressed by CSSAP
12/29/01	3112 VERA DR	MH 50	Addressed by CSSAP
7/30/01	3118 KIM LN	MH 38	Addressed by CSSAP
4/8/04	3125 CARSON AVE	MH 48-5	Addressed by CSSAP
9/17/04	3144 HAGGARD RD	Building Backup	Addressed by CSSAP
12/20/02	3200 WILDERNESS RD	MH 51	1-14
3/30/03	3201 OCOEE TRL	MH 13-5	1-16
3/14/01	3207 FOUNTAIN PARK BLVD	Lateral	Addressed by CSSAP
5/27/03	3214 BORIGHT DR	Building Backup	Addressed by CSSAP
2/4/02	3215 BORIGHT DR	Building Backup	Addressed by CSSAP
3/29/03	3236 WILDERNESS RD	Building Backup	1-14
1/9/02	330 FORESTAL DR	MH 7-82	Addressed by CSSAP
12/17/02	3319 KENILWORTH LN	MH 70	Addressed by CSSAP
2/14/04	3332 BELLEVUE ST	Building Backup	Addressed by CSSAP
2/14/04	3346 BELLEVUE ST	Building Backup	Addressed by CSSAP
1/30/02	3408 BORIGHT PL	MH 42	Addressed by CSSAP
6/25/01	3409 KNOX LN	Building Backup	Addressed by CSSAP
12/9/04	3412 BORIGHT DR	MH 43 & 43-1	Addressed by CSSAP
2/9/01	3605 GARDEN DR	Building Backup	Addressed by CSSAP
4/23/01	3708 KNOX LN	Lateral	Addressed by CSSAP
4/23/01	3708 THRALL DR	Lateral	Addressed by CSSAP
6/27/03	3714 WHITTLESPRINGS RD	Building Backup	1-2
3/10/04	3814 N BROADWAY	Building Backup	Addressed by CSSAP
6/26/04	3814 POWERS ST	MH 5-9	1-6
2/19/01	3814 WOODLAKE DR	MH 5-22	Addressed by CSSAP
2/19/01	3814 WOODLAKE DR	Building Backup & MH 5-22	Addressed by CSSAP
12/19/01	3903 FAIRMONT BLVD	Building Backup	Addressed by CSSAP
6/21/01	3917 ACORN DR	MH 39-30	Addressed by CSSAP
4/29/04	3920 OAKLAND DR	MH 39-19	1-1
7/2/01	400 E JACKSON AVE	Building Backup	1-22
9/25/01	400 E JACKSON AVE	Building Backup	1-22
3/19/02	4002 TERRACE VIEW DR	MH 14-9	Addressed by CSSAP
2/24/02	4005 AUDUBON DR	MH 15-3	1-1
1/5/02	4007 GARDEN DR	MH 15-124	Addressed by CSSAP
2/16/02	4014 GARDEN DR	MH 5-49	Addressed by CSSAP
4/30/01	4024 AUDUBON DR	MH 15-4	1-1
2/1/02	404 OAK PARK DR	MH 13-123	Addressed by CSSAP
7/13/02	4040 WALKER BLVD	MH 3-1	Addressed by CSSAP
2/9/04	4040 WALKER BLVD	Building Backup	1-6
11/24/04	4040 WALKER BLVD	Building Backup	1-6

Table 5-4: First Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
7/13/02	4040 WALKER BLVD	Building Backup & MH 3-1	Addressed by CSSAP
2/1/03	4108 GARDEN DR	MH 5-51	Addressed by CSSAP
2/17/03	4116 GARDEN DR	MH 5-52	Addressed by CSSAP
10/24/01	4128 DELDEN RD	Building Backup	Addressed by CSSAP
4/13/02	4208 FULTON DR	MH 5-71	Addressed by CSSAP
5/7/02	4224 BROADWAY	MH 5-13	1-6
5/8/03	4300 GLASGOW RD	Building Backup	Addressed by CSSAP
6/10/02	4308 HIGH SCHOOL RD	MH 44-13	Addressed by CSSAP
12/1/01	4321 GLASGOW RD	Building Backup	Addressed by CSSAP
4/1/02	4321 TAZEWELL PIKE	MH 24-4	Addressed by CSSAP
6/18/02	4402 SOUTH WAHLI DR	Cleanout	Addressed by CSSAP
11/19/03	4418 MCCAMPBELL LN	MH 43-46	Addressed by CSSAP
3/18/02	4505 FULTON DR	Building Backup & MH 48	1-16
3/17/02	4505 FULTON RD	MH 48	1-16
3/18/02	4507 FULTON DR	Building Backup	1-16
9/10/02	4513 FAWNIE LN	MH 17-1	Addressed by CSSAP
9/10/02	4513 FAWNIE LN	Building Backup & MH 17-1	Addressed by CSSAP
12/12/03	4601 OLD BROADWAY	MH 7-12	Addressed by CSSAP
2/19/03	4606 UPCHURCH RD	MH 45	Addressed by CSSAP
6/13/02	4609 ORIOLE DR	MH 38-1	Addressed by CSSAP
8/29/02	4710 MURPHY RD	Residential Pump Station	Addressed by CSSAP
8/5/01	4718 UPCHURCH RD	MH 29-60	Addressed by CSSAP
9/12/01	4904 SHANNON LN	MH 43-26	1-1
1/10/02	4904 SHANNON LN	MH 43-26	1-1
12/25/03	4904 SHANNON LN	MH 43-26	1-1
1/8/04	4907 LOWE RD	Lateral	1-25
7/12/02	4963 BEVERLY RD	MH 39-48	Addressed by CSSAP
3/18/02	500 KNOX RD	MH 18-12	Addressed by CSSAP
12/11/01	5002 BEVERLY RD	MH 43-17	Addressed by CSSAP
12/11/01	5002 BEVERLY RD	Building Backup & MH 43-17	Addressed by CSSAP
5/8/04	5002 BEVERLY RD	Building Backup	Addressed by CSSAP
5/8/04	5015 JACKSBORO PIKE	MH 13-78	1-25
2/17/01	507 MIDLAKE DR	Building Backup	Addressed by CSSAP
1/24/04	5116 TAZEWELL PIKE	MH 67-20	Addressed by CSSAP
8/28/01	5205 INSKIP RD	Building Backup	Addressed by CSSAP
9/23/02	5218 BROADWAY	MH 2-220	Addressed by CSSAP
2/22/03	523 BERTRAND ST	MH 29-4	Addressed by CSSAP
2/24/03	523 BERTRAND ST	Building Backup & MH 29-4	Addressed by CSSAP
5/6/04	5301 FOUNTAIN RD	MH 4, 5 & 6	1-17, 1-25
9/27/04	5309 SHANNONDALE RD	MH 35-1	Addressed by CSSAP
3/17/03	5311 BEVERLY PARK CIR	MH 79-1	Addressed by CSSAP
2/17/01	5315 SHANNONDALE RD	MH 36	Addressed by CSSAP
12/16/03	5317 LAVESTA RD	Building Backup	Addressed by CSSAP
11/30/01	5336 JACKSBORO PIKE	Building Backup	Addressed by CSSAP
9/6/04	5367 SUMMER ROSE BLVD	Building Backup	Addressed by CSSAP
3/15/01	5406 WASSMAN RD	MH 64	Addressed by CSSAP
6/3/03	5407 LYNNDELL RD	MH 35-53	Addressed by CSSAP
6/3/03	5407 LYNNDELL RD	Building Backup & MH 35-53	Addressed by CSSAP
3/5/03	5421 CRESTWOOD RD	Building Backup	Addressed by CSSAP
5/23/03	5425 N BROADWAY	Building Backup	1-5
4/25/02	5504 JACKSBORO PIKE	MH 2-187	1-1
2/3/02	5511 DOGWOOD RD	MH 2-185	1-1
12/30/04	5600 DOGWOOD RD	MH 2-180	Addressed by CSSAP
11/15/01	5602 DOGWOOD RD	MH 2-190	Addressed by CSSAP
1/2/02	5604 BROADWAY	MH 17-9	Addressed by CSSAP
8/13/01	5759 GROVE DR	Lateral	Addressed by CSSAP
3/22/01	5824 MEDLIN HEIGHTS RD	Lateral	Addressed by CSSAP
3/19/01	6015 GLENNIFER LN	MH 26-13	Addressed by CSSAP
2/28/01	6024 MEDLIN HEIGHTS RD	MH 6-81	Addressed by CSSAP
1/6/01	606 BALSAM DR	Building Backup	Addressed by CSSAP
3/13/01	606 CEDAR LN	MH 17-77	Addressed by CSSAP

Table 5-4: First Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
11/28/03	700 HURON ST	Building Backup	Addressed by CSSAP
2/22/03	734 FOURTH AVE	MH 18-26	Addressed by CSSAP
12/19/02	746 N FIFTH AVE	MH 18-117	Addressed by CSSAP
6/11/01	905 FREEMASON ST	MH 24-36	Addressed by CSSAP
7/25/01	BELL ST & LINDEN AVE	MH 13-7	Addressed by CSSAP
10/9/01	BROADWAY & KENYON ST	MH 3-25	Addressed by CSSAP
6/24/03	BROADWAY & MCCROSKEY AVE	Seepage in Street	Addressed by CSSAP
2/15/01	BROADWAY & POWERS ST	MH 5-13	1-6
1/3/02	BROADWAY & RIDGEWOOD RD	MH 17-6	Addressed by CSSAP
1/23/01	CECIL AVE	MH 11	Addressed by CSSAP
3/23/01	ESSARY DR & GLENHAVEN RD	Lateral	1-5, 1-17
6/25/02	GAINES RD & CLAIRMONT DR	Seepage	Addressed by CSSAP
11/26/02	HILL AVE & SUMMIT HILL DR	Private MH	Addressed by CSSAP
2/2/02	ISLINGTON AVE & CRUZE ST	Underground Flow	Addressed by CSSAP
1/15/02	ISLINGTON AVENUE (200' E OF N BERTRAND ST)	MH 38-2	1-2
11/12/02	JACKSBORO PIKE & RONDO RD	MH 2-74	Addressed by CSSAP
2/27/02	KNOX RD & OCALA DR	MH 18-8	Addressed by CSSAP
2/23/01	LANGLAND ST & HENRIETTA DR	MH 6-42	Addressed by CSSAP
3/13/01	MAPLE DR & KNOX RD	MH 19	1-13
7/14/02	MARTIN LUTHER KING JR AVE & KELLER ST	MH 6-95	Addressed by CSSAP
6/6/02	MCCONNELL ST & MCCALLA AVE	Seepage	Addressed by CSSAP
3/17/02	N SIXTH AVE & GRAINGER AVE	MH 12-6	Addressed by CSSAP
1/19/01	OAKLAND DR & BEVERLY RD	MH 39-4	Addressed by CSSAP
4/30/01	SUMMIT HILL DR & CENTRAL AVENUE PIKE	MH 25	Addressed by CSSAP
3/1/02	SUMMIT HILL DR & TOWN VIEW DR	6" Stub	Addressed by CSSAP
1/8/01	TAZEWELL PIKE & OLD BROADWAY	Lateral	Addressed by CSSAP
3/29/03	TECOMA DR & WHITTLE SPRINGS RD	MH 9-34 & 9-35	1-2

1 SSOs from Long-Term List of SSOER that are non-capacity related. Capacity related SSOs are shown in Table 5-3.
2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 5-5 and shown on Figure 5-4.

N
W
E
S
2000 0 2000 4000 Feet
1-24
1-1
1-25
1-25
1-21
1-11
1-17
1-1
1-12
1-27
1-5
1-25
1-6
1-13
1-4
1-13
1-3
1-6
1-2
1-19
1-18
1-16
1-14
1-23
1-26
1-15
1-3
1-2
1-22
1-20
Brookevale
Wingate
Kohls
Pilleaux Road
Emily Avenue
Pelham Road
Burlington
Jones Street
Island Home

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- First Creek Basin

Improvement Projects

- Completed Improvement Projects
- CAP/ER Improvement Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- Find and Fix Projects
- CAP/ER Storage Facility

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First Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure 5-4

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Table 5-5: First Creek Project Descriptions

Project ID	Project Name	Project Description
1-1	Upper First Creek Collector Project (Mini-basin 1A1, 2A2, and 3D1)	Find and fix work to identify and address cause of overflow in the vicinity of 4811 Beverly Road, 4144 Oakland Drive, and 5511 Dogwood Road.
1-2	Lower First Creek Collector Project (Mini-basin 8B2)	Find and fix work to identify and address cause of overflow in the vicinity of 2412, 2514, 2528, 2806, 2808, 2900, 2528, 2700, and 2808 Tecoma Drive, 3501 Whittle Springs Road, Islington Avenue, 1800 Linden Avenue, 2524 Underwood Place, and 3008 Valley View Drive.
1-3	First Creek Storage Tanks	Design and construction of the upper First Creek storage tank and Lower First Creek storage tank.
1-4	Lower Fountain City Pipe Replacement Project	Replace approximately 2,293 lf existing sewer with 36-in sewer.
1-5	Upper Fountain City Pipe Replacement Project	Replace approximately 1,053 lf of existing sewer with 12-in, 1,856 lf with 24-in, and 595 lf with 27-in pipe.
1-6	Sub-basin 08A1 Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Broadway and Powers Street, and Broadway and Ridgeway Lane.
1-11	Fountain City Trunkline Replacement Phase IV Project	Replace approximately 724 lf of existing sewer with 15-in, 1,823 lf with 18-in, and 444 lf with 24-in pipe.
1-12	Cedar Lane Area Sanitary Sewer Rehabilitation Project	Pipe rehabilitation of approximately 8,500 lf of existing sewer.
1-13	Fair Drive Sanitary Sewer Rehabilitation / Replacement Project	Pipe replacement and rehabilitation of approximately 8,200 lf of existing sewer.
1-14	Wilderness Road Area Gravity Sewer Replacement Project - Phase II	Replace approximately 1,200 lf of existing 8-in, 340 lf 10-in, and 3,900 lf of 12-in pipe.
1-15	Replace trunk sewer upstream of lower storage unit	Replace approximately 3,700 lf of existing 54-in, and 331 lf of 18-in pipe.
1-16	Clearview Street Sewer Project	Replace approximately 4,060 lf of existing 8-in, 227 lf 10-in, and 181 lf of 12-in pipe.
1-17	Fountain Road Trunkline Sewer Improvement Project	Replace approximately 321 lf of existing 12-in, 430 lf 15-in, and 2,880 lf of 16-in pipe.
1-18	Greenfield Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2333, 2352 Greenfield Lane and 2826, 2820 North Hills Boulevard.
1-19	Edgewood Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1620 Edgewood Avenue.

Table 5-5: First Creek Project Descriptions

Project ID	Project Name	Project Description
1-20	Vine Middle School Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 214 Bertrand Street.
1-21	College Park Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 106 College Park Lane.
1-22	E. Jackson Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 400 E. Jackson Avenue.
1-23	Oglewood Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1307 Oglewood Avenue.
1-24	Fulton Short Line Project	Replace approximately 520 lf of existing 8-in pipe.
1-25 (IAP 6)	Sub-basins 3&4 Rehabilitation Projects	Rehabilitation to reduce R to 2% in Sub-basins 03B1, 03B2, and 04B1.
1-26	Cherry Street Rehabilitation Project	Find and fix work to identify and address cause of overflow at 1918 Cherry Street.
1-27	Fair Drive Replacement Project	Find and fix work to identify and address cause of overflows at 2538, 2541, and 2544 Fair Drive.

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

As Table 5-5 and Figure 5-4 detail for the First Creek Basin, several projects have already been completed and the additional facility improvements required for the Phase 1 CAP/ER include the following:

- Several trunk sewer replacement projects
- Two equalization storage tanks
- Rehabilitation to an R of 2 percent in four sub-basins
- Numerous "find and fix" sewer rehabilitation projects

Section 6
Second Creek

6.1 Hydraulic Model Description

The Second Creek model consists of approximately 18 miles of trunk sewer and includes all sewers over 10 inches in diameter. Flows from Second Creek are treated at the Kuwahee WWTP. **Figure 6-1** shows the Second Creek sub-basins and modeled trunk sewers.

6.2 Existing and Future Dry-Weather Model Analysis

Some sub-basins in Second Creek were flow monitored in 2003. The entire Second Creek basin was flow monitored again in 2005. The model is currently being updated with the 2005 flow monitoring data. This section presents the results of the hydraulic model updated with the 2003 flow monitoring data. The data collected during the 2003 flow monitoring was used to calibrate the model to dry-weather flows. A summary of the average 2003 calibrated dry-weather flows for each sub-basin is presented in **Table 6-1**. The 2003 average dry-weather flow in Second Creek is 9.9 mgd. The flow monitoring data was then used to project flows up to the year 2022. The procedure used to estimate future dry-weather flows is presented in Section 3.2.4. The 2022 average dry-weather flows for each sub-basin in Second Creek are shown in **Table 6-1**. The total average dry-weather flow in Second Creek for the year 2022 is predicted to be 11.7 mgd.

Peak dry-weather flows in 2022 were simulated based on the 2022 flow projections. The percent of pipe capacity used during peak dry-weather flow is shown in **Figure 6-2**. The figure color codes the pipe according to the capacity used. Yellow indicates that between 75 and 100 percent of the pipe capacity is used to convey the peak dry-weather flow. Red indicates that over 100 percent of the pipe capacity is required to convey the peak dry-weather flow. Any pipe in either category would be recommended for upgrading. New pipe is typically designed such that less than 50 percent of the pipe capacity is used under peak dry-weather flow conditions. In 2022, the majority of the pipes are predicted to be less than 50 percent full.

6.3 Existing and Future Wet-Weather Model Analysis

To calibrate the model to wet-weather conditions, the output flows produced by the simulation using a real storm event were matched against the flows measured by the meters during that storm event. Where necessary, adjustments to hydrograph model load points were made so that each flow monitor reasonably matched the flow predicted at the same location in the model. The wet-weather calibration procedure is described in Section 4.3.3.

The R values were calculated for each of the sub-basins for the calibration storm events and are presented in **Table 6-2**. Section 3.3.1 discusses the definition of R

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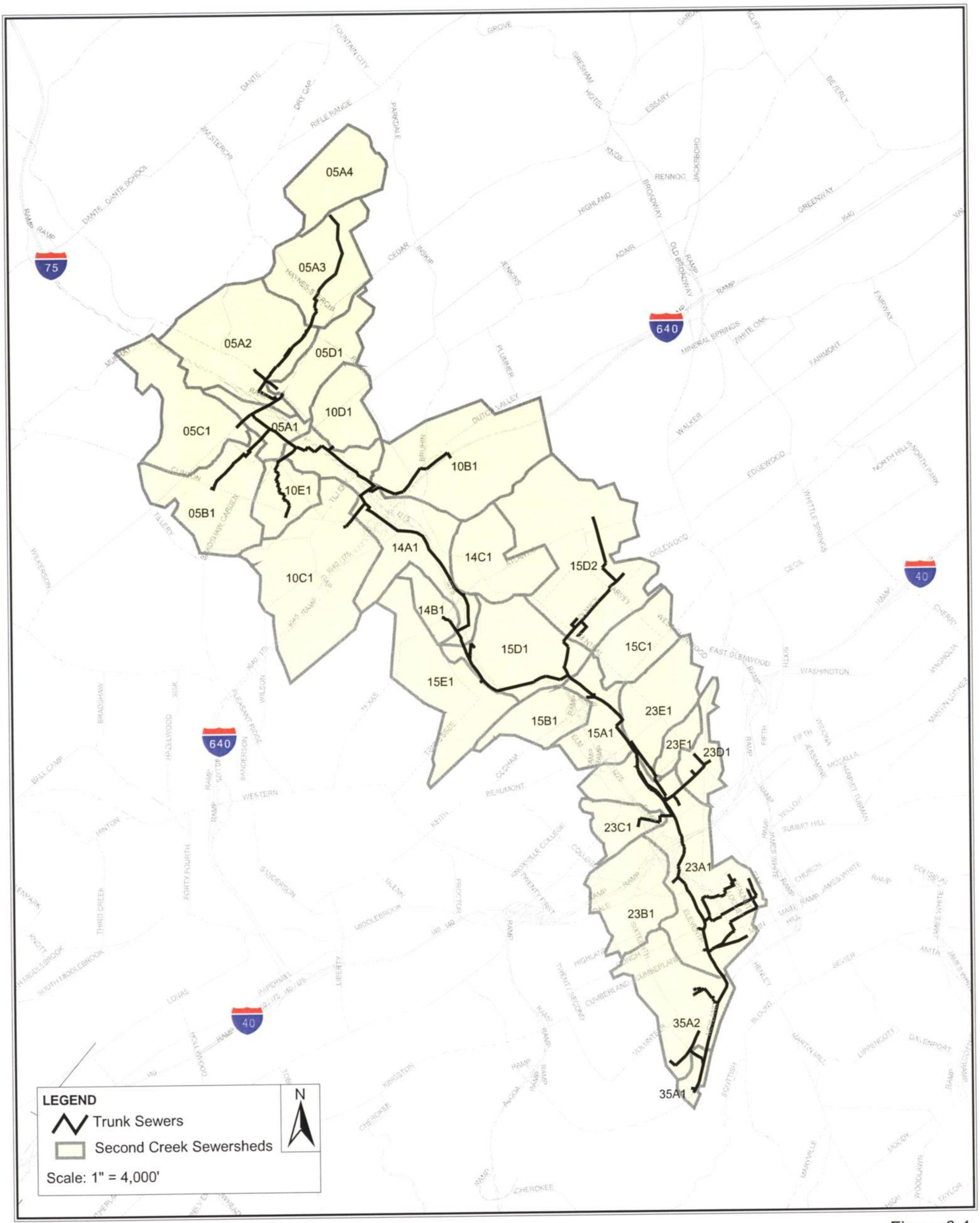

Figure 6-1
Second Creek
Location Map

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Table 6-1: Second Creek Average Dry-Weather Flows

Sewershed	2003 Average Dry Weather Flow (mgd)	2022 Average Dry Weather Flow (mgd)
05A1	0.23	0.25
05A2	1.30	1.45
05A3	0.05	0.15
05A4	0.04	0.05
05B1	0.08	0.08
05C1	0.18	0.20
05D1	0.06	0.06
10B1	0.25	0.28
10C1	0.10	0.11
10D1	0.05	0.06
10E1	0.08	0.08
14A1	0.62	0.72
14B1	0.06	0.06
14C1	0.24	0.26
15A1	0.55	0.57
15B1	0.02	0.05
15C1	0.09	0.28
15D1	0.46	0.98
15D2	0.19	0.22
15E1	0.04	0.04
23A1	1.48	1.61
23B1	0.19	0.21
23C1	0.10	0.11
23D1	0.04	0.05
23E1	0.34	0.36
23F1	0.01	0.02
35A1	1.86	2.06
35A2	1.14	1.27
35A3	0.07	0.07
Total	**9.9**	**11.7**

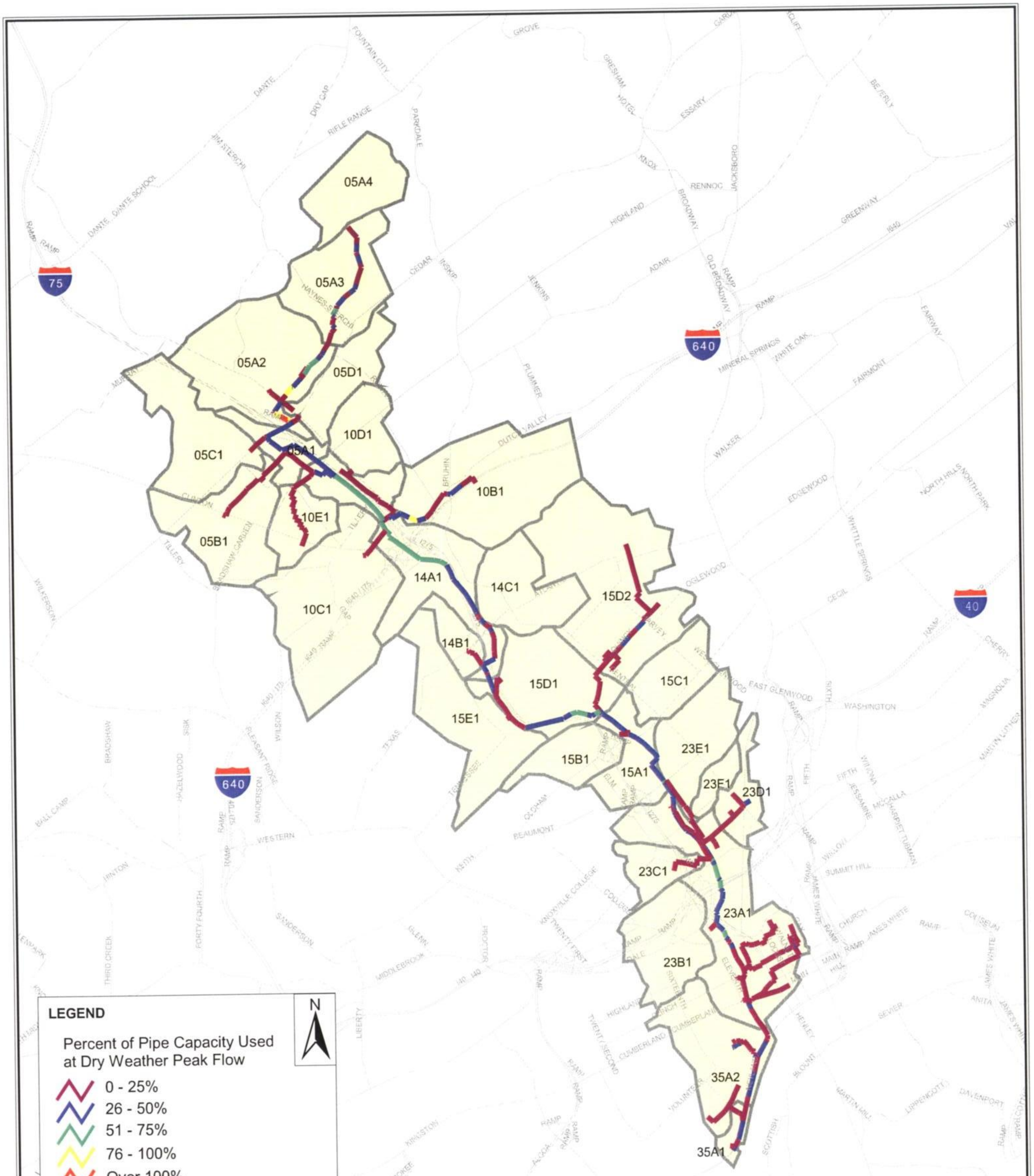

Figure 6-2
Second Creek
2022 Dry Weather Flows

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Table 6-2: R Values and RDI/I for Second Creek Sewersheds

Sewershed	R Value %	RDII (gal/LF)[1]
05A1	4.0	30.3
05A2	4.0	30.1
05A3	0.9	6.2
05A4	0.9	5.8
05B1	1.6	10.3
05C1	3.0	19.5
05D1	3.8	19.7
10B1	3.0	27.2
10C1	0.9	8.8
10D1	3.6	23.8
10E1	1.8	10.2
14A1	4.0	38.3
14B1	12.1	99.5
14C1	14.0	107.9
15A1	0.9	5.9
15B1	0.7	4.1
15C1	0.8	3.9
15D1	3.9	58.6
15D2	12.0	41.7
15E1	8.0	43.2
23A1	4.0	18.9
23B1	7.5	37.4
23C1	44.0	171.9
23D1	15.5	64.7
23E1	60.0	278.1
23F1	4.7	21.3
35A1	7.5	43.3
35A2	7.5	50.2

[1] Represents predicted volume for a representative 24 hour storm.

value. In general, sub-basins with an R value greater than 5 percent are considered to have a high volume of RDI/I.

The calibrated R values were used to calculate the gallons of RDI/I entering each sub-basin for the 24 hour planning storm event. Sub-basins with high volumes of RDI/I per linear foot are good candidates for comprehensive sanitary sewer rehabilitation as the greatest amount of RDI/I can be removed per linear foot of sewer rehabilitated in these sub-basins. The 24 hour planning storm event was previously developed by CDM to size wet-weather improvements for the collection system as described in Section 3.4. The volume of RDI/I calculated for each sub-basin was divided by the footage of sewer in each sub-basin to obtain the volume of infiltration per linear foot of pipe. These values are reported in **Table 6-2**. This is the volume of RDI/I that might be expected to enter the sewer, if adequate capacity is available, resulting from the representative 24 hour storm event during the critical period for GWI (i.e., December to May). The 2 year storm RDI/I volume is presented as a way of comparing the infiltration between sub-basins. The RDI/I per linear foot of sewer for each sub-basin is also shown in **Figure 6-3**. In general, sub-basins with an RDI/I per linear foot of sewer greater than 50 were considered good candidates for rehabilitation and RDI/I reduction. The value of 50 gallons per day per linear foot is project specific to KUB and was used to identify sub-basins where comprehensive rehabilitation was thought to reduce or eliminate a downstream capacity related improvement. Most sub-basins were predicted to have less than 50 gallons RDI/I per linear foot of sewer. Seven sub-basins were predicted to have over 50 gallons RDI/I per linear foot.

6.4 2022 Wet-Weather Storm Flows

As described in Section 3.4, a planning storm was used to predict the performance of the collection system during a representative 24 hour storm event. The planning storm and 2022 dry-weather flows were routed through the hydraulic model. The predicted pipe capacity at peak planning storm flows is shown in **Figure 6-4**. As shown in the figure, the hydraulic analysis predicts that approximately 30 percent of the trunk sewers will be surcharged. Pipes were considered to be surcharged if the maximum predicted flow, Qmax, exceeded the design capacity of the sewer, Qdesign. Predicted overflow locations are also shown in **Figure 6-4**. Any overflow ranging from 10,000 gallons to 1,000,000 gallons is designated with a green dot. Any overflow ranging from 1 million to 2 million gallons is designated with a yellow dot. Any overflow greater than 2 million is designated as a red dot. The model predicts several small overflows (less than 1 million gallons each) throughout the basin. Two overflows over 1 million gallons are predicted in Second Creek. These overflows are located near sub-basin 23E1, north of I-40.

As explained in Sections 1.1 and 4.5, a total basin solution was developed for Second Creek to address future predicted wet-weather overflows. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution was analyzed to determine which are required to address the SSO locations on the Long-Term List.

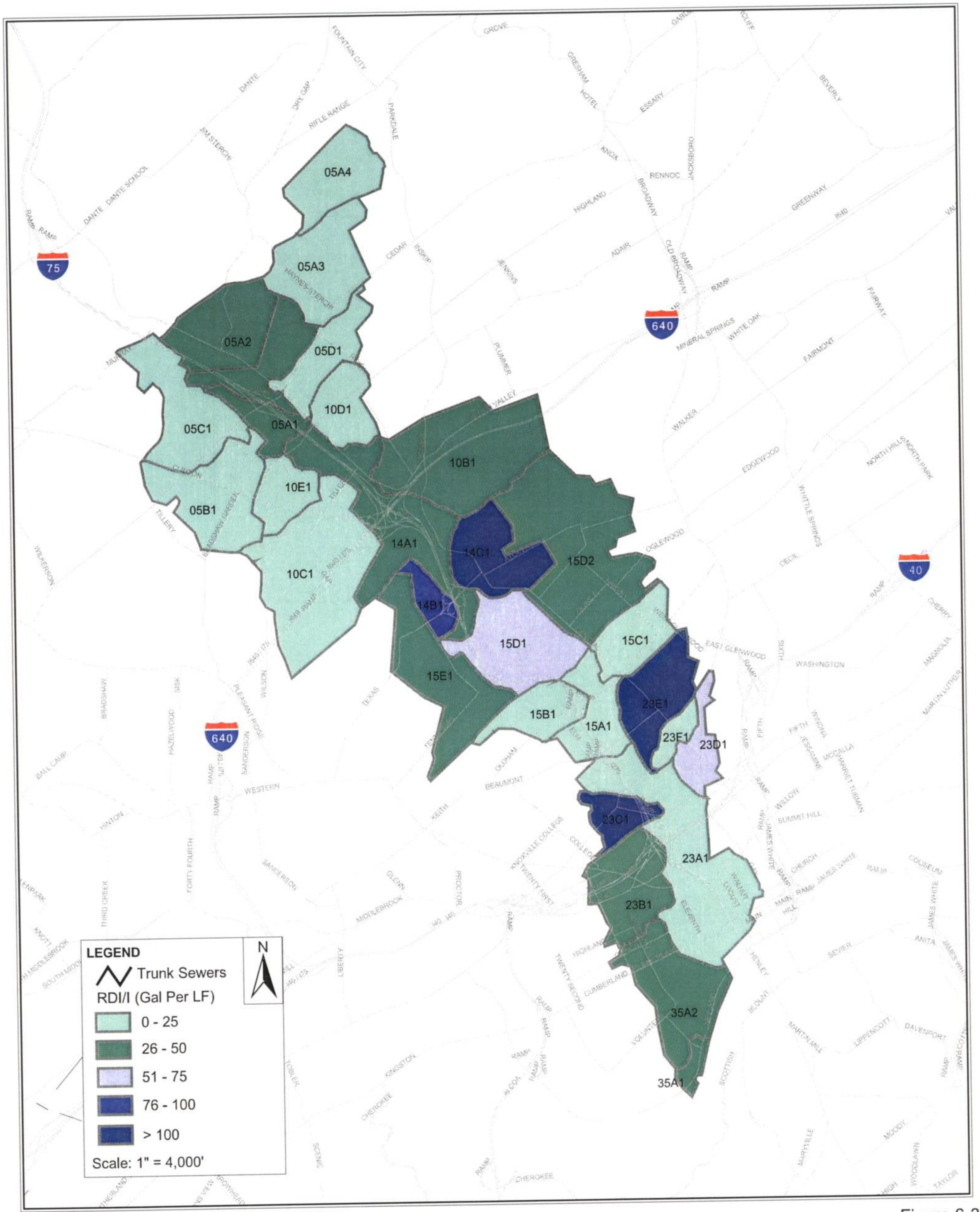

Figure 6-3
Second Creek
RDI/I (Gal Per LF) By Sub-basin Predicted for 24 Hour Planning Event

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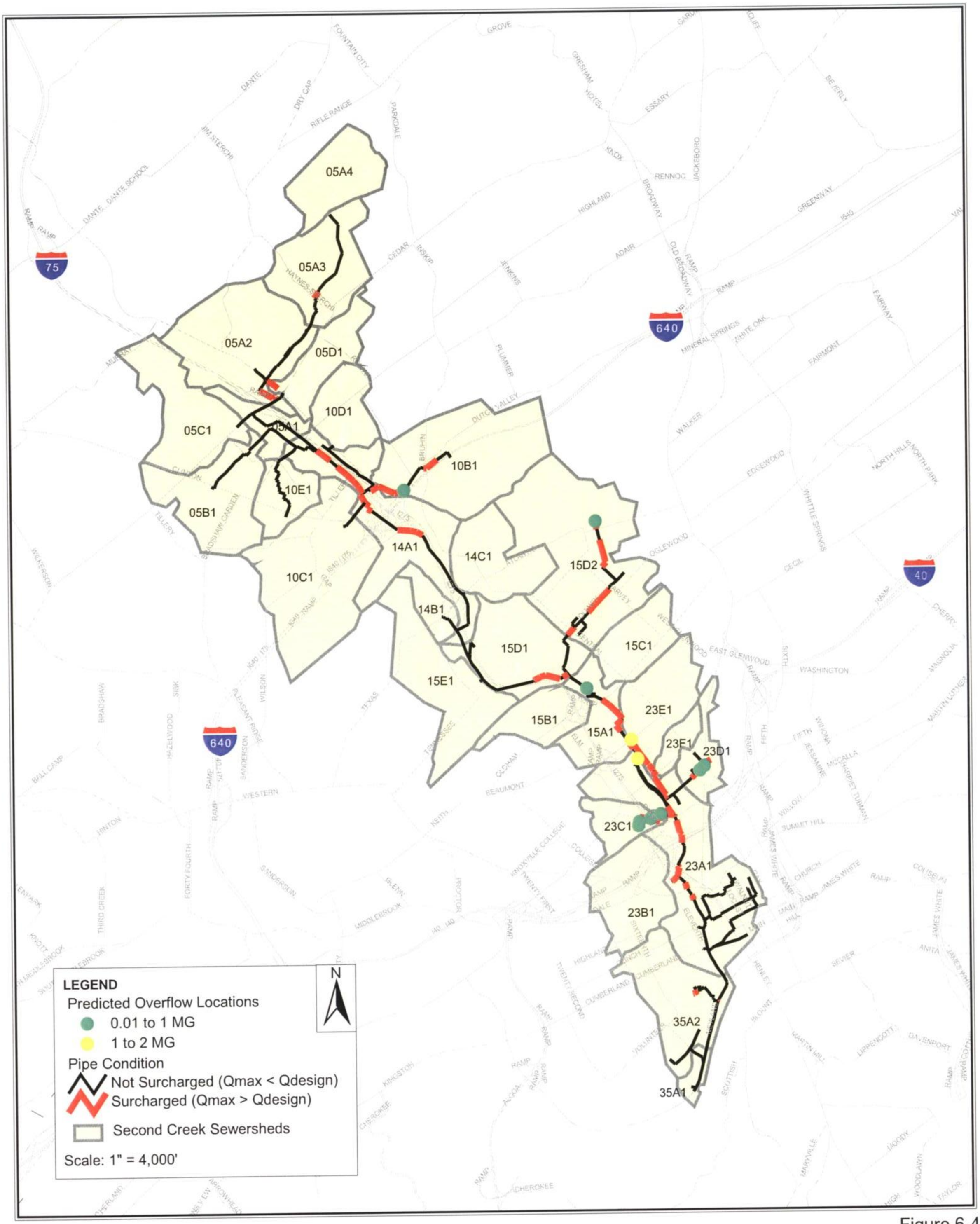

Figure 6-4
Second Creek
2022 Wet Weather Flows

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6.5 Phase 1 CAP/ER Facility Improvements

The objective of the Phase 1 CAP/ER is to address SSOs identified on the Long-Term List of the SSOER in accordance with the CD. The SSOs listed on the Long-Term List that are capacity related are addressed by facility improvement projects as outlined for the Second Creek Basin in **Table 6-3**. This table lists all capacity related SSOs and a corresponding project ID, which addresses the SSO.

The SSOs on the Long-Term List that are not capacity related are addressed by either a "find and fix" facility improvement project or KUB's CSSAP Program. Many of the SSOs on the Long-Term List that are not capacity related are the result of a blockage (debris, grease, roots, etc.) that have been addressed by KUB's CSSAP Program. These include all the SSOs on the Long-Term List that have the designation "N/A" under the "Long Term Capital Project" field. However, if the source of the blockage could not be fixed by maintenance and re-occurred after flushing or root cutting, then these SSOs were assigned a "find and fix" facility improvement project. "Find and fix" facility improvement projects will first involve further investigation into the source of the SSO through the use of smoke testing, manhole inspection, and/or CCTV inspection. Next, a determination will be made of the type and extent of the improvement required to address the SSO. In some cases, the blockage may have been only partially removed and further flushing or cutting is required to address the SSO. In other cases, replacement of sagged pipe or lining of pipe to prevent root intrusion may be required.

Table 6-4 presents all SSOs on the Long-Term List that are not capacity related. In the project ID field is either a "find and fix" project ID that addresses the SSO or the designation "has been addressed by CSSAP Program", as discussed above.

Figure 6-5 presents a map showing the locations of all SSOs on the Long-Term List from 2001-2004 in Second Creek that require a facility improvement project to address the SSO. The SSOs are shown as green dots on the map. As discussed above, some SSOs on the Long-Term List were isolated cases of a blockage that have been addressed by the CSSAP Program and are not mapped on this figure.

The figure also shows the planned and completed facility projects to address the SSOs. Already completed improvement pipeline projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I and reducing the R value to 2 percent are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in the SSO Tables **6-3 and 6-4. Table 6-5** lists all the projects on the map and a description of

Table 6-3: Second Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
2/22/2003	1204 CALLAWAY ST	MH 19-147	2-1, 2-15
2/16/2003	1305 RICKARD DR	MH 14-67	2-5
2/16/2003	1401 RICKARD DR	MH 14-69	2-5
2/22/2003	1611 ELM ST	MH 14-107	2-16
2/27/2003	212 INSKIP RD	Building Backup	2-9
2/16/2003	2523 BURNSIDE ST	MH 21-112	2-11
7/18/2003	313 JENSO DR	MH 14-69	2-5
12/11/2001	4612 CENTRAL VIEW RD	Building Backup	2-9
2/22/2003	4612 CENTRAL VIEW RD	Building Backup and MH 2, 3, & 4	2-9
2/22/2003	CALLAWAY ST & DOUGLAS AVE	MH 19-151	2-1, 2-15
11/19/2003	INSKIP BALL PARK	MH 2	2-1, 2-2, 2-3, 2-9 and 2-10
5/13/2002	INSKIP BALL PARK	MH 2 & 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
12/20/2002	INSKIP BALL PARK	MH 2 & 4	2-1, 2-2, 2-3, 2-9 and 2-10
2/22/2003	INSKIP BALL PARK	MH 2, 3, 4, 24-14 & 58	2-1, 2-2, 2-3, 2-9 and 2-10
9/22/2002	INSKIP BALL PARK	MH 2, 4 & 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
2/16/2001	INSKIP BALL PARK	MH 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
12/19/2002	INSKIP BALL PARK	MH 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
12/24/2002	INSKIP BALL PARK	MH 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
2/14/2003	INSKIP BALL PARK	MH 24-14, 2, 3, 4 & 58	2-1, 2-2, 2-3, 2-9 and 2-10
4/17/2003	INSKIP BALL PARK	MH 24-14, 2, 3, 4 & 58	2-1, 2-2, 2-3, 2-9 and 2-10
5/6/2003	INSKIP BALL PARK	MH 24-14, 2, 3, 4 & 58	2-1, 2-2, 2-3, 2-9 and 2-10
3/6/2004	INSKIP BALL PARK	MH 24-14, 58 & 4	2-1, 2-2, 2-3, 2-9 and 2-10
1/5/2004	INSKIP BALL PARK	MH 3 & 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
9/22/2003	INSKIP BALL PARK	MH 3 & 4	2-1, 2-2, 2-3, 2-9 and 2-10
4/10/2003	INSKIP BALL PARK	MH 3, 4 & 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
2/1/2002	INSKIP BALL PARK	MH 4	2-1, 2-2, 2-3, 2-9 and 2-10
12/5/2002	INSKIP BALL PARK	MH 4 & 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
7/10/2003	INSKIP BALL PARK	MH 58	2-1, 2-2, 2-3, 2-9 and 2-10
8/5/2003	INSKIP BALL PARK	MH 58	2-1, 2-2, 2-3, 2-9 and 2-10
2/1/2002	INSKIP BALL PARK	MH 6	2-1, 2-2, 2-3, 2-9 and 2-10
12/13/2002	INSKIP BALL PARK	Unidentified Manhole	2-1, 2-2, 2-3, 2-9 and 2-10
1/19/2001	INSKIP BALL PARK	MH 24-14	2-1, 2-2, 2-3, 2-9 and 2-10
5/14/2002	INSKIP BALL PARK	MH 5	2-1, 2-2, 2-3, 2-9 and 2-10
1/23/2002	PILLEAUX LIFT STATION	Wetwell	2-6
3/18/2002	PILLEAUX LIFT STATION	Wetwell	2-6

1 SSOs from Long-Term List of SSOER that are capacity related. Non-capacity related SSOs are shown in Table 6-4.
2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 6-5 and shown on Figure 6-4.

Table 6-4: Second Creek Non-Capacity Related SSOs[1]

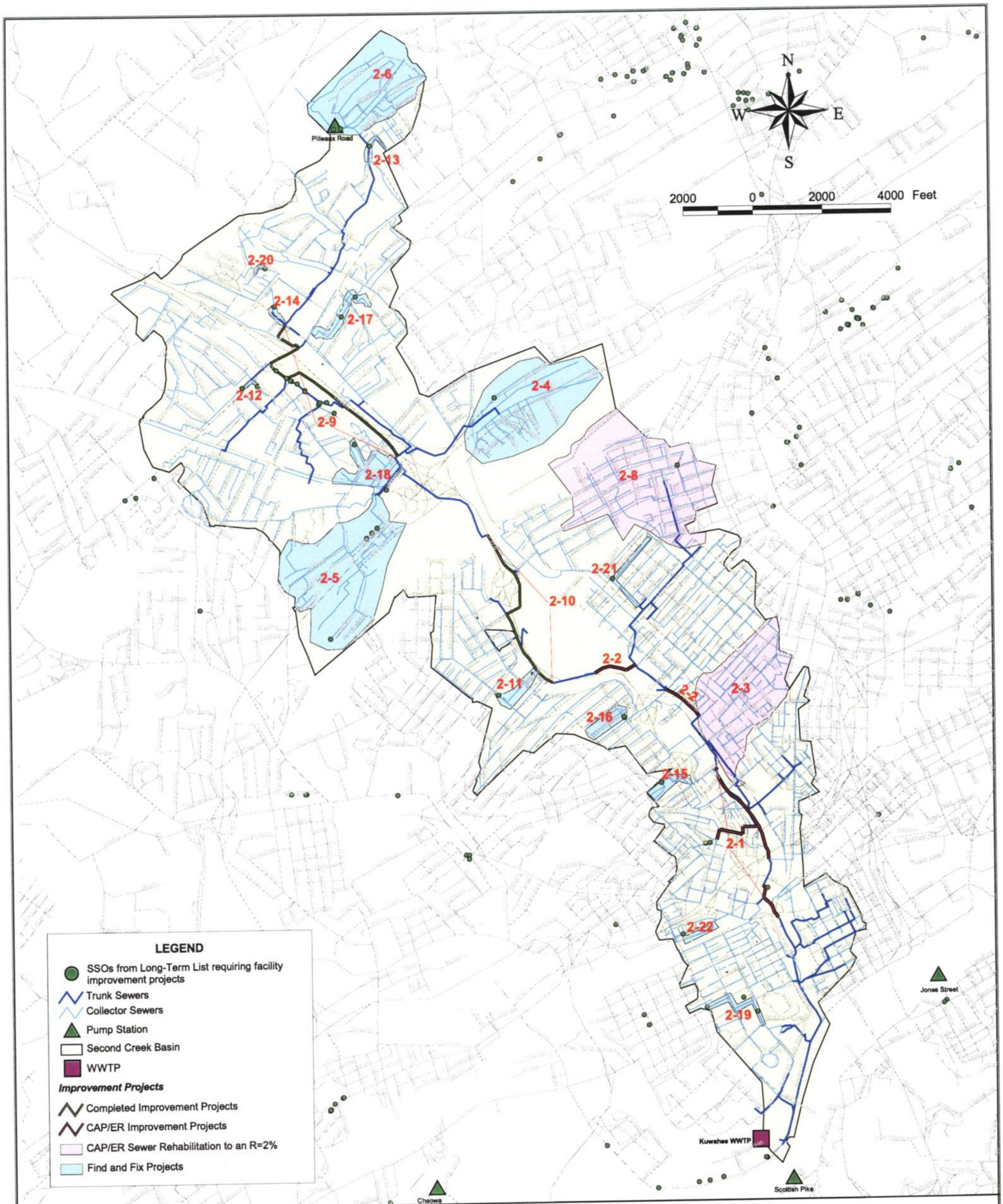
Date	Address	Overflow Location	Project ID[2]
10/15/02	1000 PHILLIP FULMER WAY	MH 21	2-19
8/14/01	1001 BUCKTHORN DR	MH 35-80	Addressed by CSSAP
7/16/02	101 WARREN AVE	Building Backup	Addressed by CSSAP
6/25/02	1012 TEXAS AVE	Building Backup	Addressed by CSSAP
7/14/03	1012 TEXAS AVE	Building Backup	Addressed by CSSAP
11/5/04	1022 ELM ST	MH 19-96	Addressed by CSSAP
8/12/03	1025 ELM ST	MH 19-99	2-15
5/8/04	105 ELYRIA DR	MH 26-1	Addressed by CSSAP
3/10/03	1106 CALLAWAY AVE	MH 19-147	Addressed by CSSAP
6/23/04	1117 BRADSHAW GARDEN DR	Building Backup	Addressed by CSSAP
9/1/01	114 TILLERY DR	MH 16-1	Addressed by CSSAP
7/8/02	119 BURWELL AVE	Building Backup	Addressed by CSSAP
8/27/02	120 COLUMBIA AVE	Seepage	Addressed by CSSAP
2/12/03	120 E MORELIA AVE	Building Backup & MH 30-25	2-21
9/4/01	120 E MORELIA ST	MH 30-25	Addressed by CSSAP
2/20/04	120 TOWER DR	MH 16-70	Addressed by CSSAP
2/21/01	1305 RICKARD DR	MH 14-67	Addressed by CSSAP
8/20/02	1311 RICKARD DR	MH 14-68	2-5
3/3/04	1311 W FOURTH AVE	Building Backup	Addressed by CSSAP
10/7/02	1440 LANTANA LN	MH 14-118	2-5
4/12/02	1505 CUMBERLAND AVE	Broken Pipe	Addressed by CSSAP
2/12/03	1509 CUMBERLAND AVE	Building Backup	2-19
2/17/01	1509 CUMBERLAND AVE	Building Backup	2-19
11/17/03	1527 WILSON RD	MH 14-89	Addressed by CSSAP
1/21/01	1640 W CLINCH AVE	Building Backup	Addressed by CSSAP
8/7/04	1712 BRANNER ST	MH 15-11	Addressed by CSSAP
10/29/01	218 E MORELIA AVE	Building Backup	Addressed by CSSAP
2/25/01	227 CANSLER ST	Building Backup	Addressed by CSSAP
3/22/01	230 BAXTER AVE	Building Backup	Addressed by CSSAP
12/23/01	2917 N CENTRAL ST	Building Backup	Addressed by CSSAP
12/3/02	345 DALE AV	Building Backup	2-22
4/23/03	350 NEYLAND DR	MH 1-24 to MH 1-25	Addressed by CSSAP
4/17/04	406 OAKCREST RD	MH 16-79	Addressed by CSSAP
8/27/01	409 BROADWAY	Leakage	Addressed by CSSAP
2/6/04	409 BROADWAY	MH 19-194	2-1
6/19/03	409 BROADWAY	MH 19-194	2-1
4/23/04	412 MERCHANT DR	MH 8-8	2-12
11/26/04	419 CALDWELL AVE	Building Backup	Addressed by CSSAP
6/14/01	420 CLINCH AVE	Building Backup	Addressed by CSSAP
7/24/02	420 W CLINCH AVE	Building Backup	Addressed by CSSAP
2/12/03	4200 CLINTON HWY	Building Backup	2-18
9/22/01	429 E MORELIA AVE	Building Backup	Addressed by CSSAP
4/14/04	4307 CLINTON HWY	MH 14-37	Addressed by CSSAP
5/20/03	432 COLUMBIA AVE	Building Backup	Addressed by CSSAP
10/29/04	4403 CLINTON HWY	Building Backup	Addressed by CSSAP
8/8/03	4500 NICHOLAS RD	Building Backup and MH 14-28	Addressed by CSSAP
7/18/02	4500 NICHOLAS RD	MH 14-28	2-18
1/22/01	4904 CENTRAL AV PIKE	Building Backup	Addressed by CSSAP

Table 6-4: Second Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
10/9/03	500 HENLEY ST	Building Backup	Addressed by CSSAP
10/2/01	501 W MAIN AVE	Building Backup	Addressed by CSSAP
11/1/02	5108 FENNEL RD	MH 17-43	2-17
2/25/04	5305 ROWAN RD	MH 25-2	Addressed by CSSAP
2/18/04	5401 HAYNES-STERCHI RD	Cleanout	Addressed by CSSAP
9/22/02	5500 CENTRAL AVENUE PIKE	MH 16-33	2-14
4/29/04	5511 CEDAR HEIGHTS RD	MH 35-32	2-13
6/18/02	5605 PINECREST RD	MH 35-32	2-13
10/20/03	5609 SIERRA RD	MH 16-64 & 16-63	2-20
11/15/04	5610 WALLWOOD DR	Building Backup	Addressed by CSSAP
8/29/03	5708 SCENICHILLS RD	MH 8-76	Addressed by CSSAP
10/16/04	5719 CENTRAL AVENUE PIKE	MH 16-50	Addressed by CSSAP
2/12/03	5823 SECOND DR	MH 8-103	Addressed by CSSAP
3/28/01	600 HENLEY ST	MH 11-25	Addressed by CSSAP
2/9/02	605 DUTCH VALLEY DR	MH 17-46	2-4
3/26/02	608 DUTCH VALLEY DR	MH 17-46	2-4
3/6/01	608 N BROADWAY	Building Backup	Addressed by CSSAP
3/28/01	635 DAMERON AVE	MH 19-78	Addressed by CSSAP
6/21/03	701 CALDWELL AVE	Underground Flow	Addressed by CSSAP
4/6/04	711 COOPER ST	MH 34-4	Addressed by CSSAP
1/19/02	712 E OAK HILL AVE	Building Backup	Addressed by CSSAP
7/31/02	718 MARTHA LN	Building Backup	Addressed by CSSAP
1/7/02	725 CHICKAMAUGA AVE	MH 52	2-8
2/22/03	733 EMERALD AVE	MH 14-108	Addressed by CSSAP
11/27/01	800 OAK HILL AVE	Building Backup	Addressed by CSSAP
9/23/02	801 WEST OLDHAM AVE	MH 14-107	2-16
7/11/04	805 SHASTA DR	MH 17-30	2-17
4/19/01	904 SNOWDEN DR	Building Backup	Addressed by CSSAP
5/24/02	904 WOODVIEW DR	Building Backup	Addressed by CSSAP
9/2/02	916 DINWIDDIE ST	Building Backup	Addressed by CSSAP
8/28/04	922 DELAWARE AVE	MH 21-165	Addressed by CSSAP
12/16/01	923 OAKLETT DR	MH 35-74	Addressed by CSSAP
5/26/02	923 OAKLETT DR	MH 35-74	2-6
1/19/01	BERNARD AVE & COOPER ST	MH 35-15	Addressed by CSSAP
1/19/02	CAMELIA RD & MERCHANT DR	MH 8-5	2-12
11/9/03	CENTRAL AVENUE PIKE & OKLAHOMA AVE	MH 53-11	Addressed by CSSAP
2/23/03	OGLEWOOD AVE & HURON ST	MH 37-5	Addressed by CSSAP
1/21/01	OGLEWOOD AVE & MCMILLAN ST	Underground Flow	Addressed by CSSAP
11/5/03	POPLAR ST & MAIN ST	MH 6-5	Addressed by CSSAP
4/15/03	SEVENTEENTH ST & WHITE AVE	MH 22-15	2-19
7/6/02	SUMMIT HILL DR & LOCUST ST	MH 15-25	Addressed by CSSAP
2/9/02	WRAY ST & BERNARD AVE	MH 35-40	Addressed by CSSAP

1 SSOs from Long-Term List of SSOER that are non-capacity related. Capacity related SSOs are shown in Table 6-3.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 6-5 and shown on Figure 6-4.



Second Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure 6-5

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Table 6-5: Second Creek Project Descriptions

Project ID	Project Name	Project Description[1]
2-1	Lower Second Creek Replacement/Rehabilitation at I40/I275 Junction	Replace approximately 1,300 lf of existing sewer with 30-in sewer, replace approximately 3,100 lf of existing sewer with 36-in sewer, replace approximately 1,200 lf of existing sewer with 42-in sewer, and rehabilitate approximately 2,400 lf of trunk line between replacement segments.
2-2	Lower Second Creek Replacement/Rehabilitation at Woodland	Replace approximately 2,500 lf of existing sewer with 30-in sewer and rehabilitate approximately 1,200 lf of trunk line between replacement segments.
2-3	Second Creek Rehabilitation of Sub-basin 23E1 Near Woodland and Central	Rehabilitation in Sub-basin 23E1 to reduce R value to 2%
2-4	Dutch Valley Collector Rehabilitation (Sub-basin 10B1)	Rehabilitate 10-in collection system piping in Sub-basin 10B1.
2-5	Rickard and Wilson Collector Rehabilitation (Sub-basin 10C1)	Rehabilitate 10-in collection system piping in Sub-basin 10C1.
2-6	Pilleaux Pump Station Collector Rehabilitation (Sub-basin 5A4)	Rehabilitate approximately 19,600 LF of sewer in Sub-basin 5A4.
2-8 (IAP 10)	Subbasin 15 Rehabilitation	Rehabilitation in Sub-basin 15D2 to reduce R value to 2%.
2-9	Second Creek Trunk Sewer Improvements Phase I	Replace approximately 4,100 lf of existing sewer with 30-in sewer
2-10	Second Creek Trunk Sewer Improvements Phase II	Replace approximately 3,700 lf of existing sewer with 30-in sewer, replace approximately 1,400 lf of existing sewer with 36-inch sewer.
2-11	Burnside Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2523 Burnside Street.
2-12	Camelia Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Camelia Road and Merchant Drive and 412 Merchant Drive.
2-13	Cedar Heights Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5511 Cedar Heights Road and 5605 Pinecrest Road.
2-14	Central Avenue Pike Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5500 Central Avenue Pike.

Table 6-5: Second Creek Project Descriptions

Project ID	Project Name	Project Description[1]
2-15	1000 block Elm Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1025 Elm Street.
2-16	1600 block Elm Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1611 Elm Street and 801 West Oldham Avenue.
2-17	Shasta Drive Rehabilitaiton Project	Find and fix work to identify and address cause of overflow in the vicinity of 5108 Fennel Road and 805 Shasta Drive.
2-18	Nicholas Road - Clinton Highway Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4500 Nicholas Road and 4200 Clinton Highway.
2-19	Cumberland Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1000 Phillip Fulmer Way, 1509 Cumberland Avenue, and Seventeenth Street and White Avenue.
2-20	Sierra Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5609 Sierra Road.
2-21	Morelia Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 120 E. Morelia Avenue.
2-22	Dale Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 345 Dale Avenue.

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

each project. Section 12 presents the Phase 1 CAP/ER implementation plan that provides start and end dates for each of these projects.

As Table 6-5 and Figure 6-5 detail for the Second Creek Basin, several projects have already been completed, and the additional facility improvements required for the Phase 1 CAP/ER include the following:

- Several trunk sewer replacement projects
- Rehabilitation to an R of 2 percent in two sub-basins
- Numerous "find and fix" sewer rehabilitation projects

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Section 7
Third Creek

7.1 Hydraulic Model Description

The Third Creek hydraulic model consists of approximately 30 miles of trunk sewer and includes all major sewer pipes 10-inches in diameter or larger. In the downstream portion of the basin, flow is split through two parallel sewer lines that each flow to the Kuwahee WWTP by gravity. Third Creek receives sludge flows from the Fourth Creek WWTP. Third Creek also receives pumped flows from Cheowa basin. These flows enter the Third Creek collection system just upstream of the Kuwahee WWTP. **Figure 7-1** shows the Third Creek modeled trunk sewers and the locations where flows from the Fourth Creek WWTP and Cheowa pump station enter the trunk sewer.

7.2 Existing and Future Dry-Weather Model Analysis

To calibrate the model to dry-weather conditions, the output flows produced by the simulation using dry-weather input hydrographs were matched against the flows measured by the meters in the 2004 and 2005 flow monitoring program. As discussed in Section 2, the upper portion of Third Creek was flow monitored in 2004, and the lower portion of Third Creek was flow monitored in 2005. The dry-weather calibration procedure is described in Section 4.2.3. A summary of the calibrated dry-weather flows for each sub-basin is presented in Table 7-1. The 2004/2005 average dry-weather flow in Third Creek is 7.9 mgd. As discussed in Section 3.2.4, dry-weather flows in Third Creek were projected for year 2045. The 2045 wastewater flows for Third Creek sub-basins are also shown in **Table 7-1**. The total dry-weather Third Creek flow is predicted to increase to 11.4 mgd in 2045.

Peak dry-weather flows in 2045 were simulated based on the 2045 flow projections. The percent of pipe capacity used during peak dry-weather flow is shown in **Figure 7-2**. The figure color codes the pipe according to the capacity used. Yellow indicates that between 75 and 100 percent of the pipe capacity is used to convey the peak dry-weather flow. Red indicates that over 100 percent of the pipe capacity is required to convey the peak dry-weather flow. Any pipe in either category would be recommended for upgrading. New pipe is typically designed such that less than 50 percent of the pipe capacity is used under peak dry-weather flow conditions. In 2045, the majority of the pipes are predicted to be less than 50 percent full. There is one small segment of pipe that falls into the red category in sub-basin 29E1. This is one isolated pipe segment and is therefore not recommended for replacement.

7.3 Existing and Future Wet-Weather Model Analysis

To calibrate the model to wet-weather conditions, the output flows produced by the simulation using a real storm event were matched against the flows measured by the meters during that storm event. Where necessary, adjustments to hydrograph model load points were made so that each flow monitor reasonably matched the flow

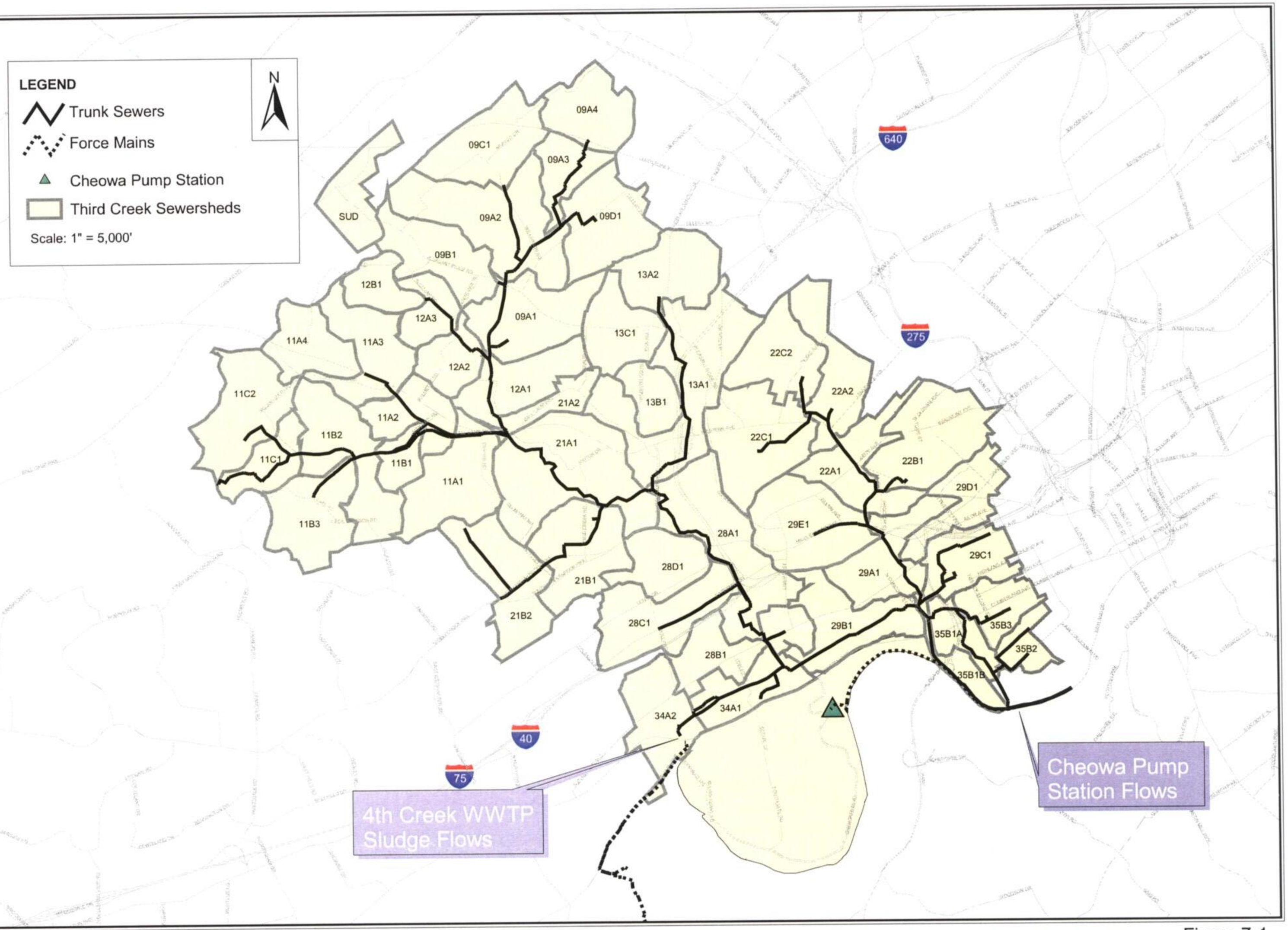

Figure 7-1
Third Creek
Location Map

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Table 7-1: Third Creek Average Dry-Weather Flow

Sewershed	2005 Average Dry Weather Flow (mgd)	2045 Average Dry Weather Flow (mgd)
09A1	0.224	0.344
09A2	0.094	0.145
09A3	0.036	0.041
09A4	0.059	0.070
09B1	0.155	0.286
09C1	0.029	0.069
09D1	0.134	0.194
11A1	0.063	0.084
11A2	0.048	0.057
11A3	0.017	0.065
11A4	0.030	0.046
11B1	0.096	0.179
11B2	0.121	0.287
11B3	0.096	0.189
11C1	0.088	0.107
11C2	0.112	0.173
12A1	0.040	0.051
12A2	0.043	0.050
12A3	0.025	0.035
12B1	0.031	0.037
13A1	0.500	0.615
13A2	0.120	0.136
13B1	0.060	0.094
13C1	0.043	0.063
21A1	0.080	0.119
21A2	0.040	0.091
21B1	0.060	0.086
21B2	0.030	0.065
22A1	0.560	1.039
22A2	0.960	1.326
22B1	0.500	0.620
22C1	0.160	0.167
22C2	0.180	0.230
28A1	0.680	1.304
28B1	0.180	0.215
28C1	0.330	0.374
28D1	0.042	0.046
29A1	0.040	0.049
29B1	0.490	0.796
29C1	0.110	0.113
29D1	0.210	0.317
29E1	0.063	0.069
34A1	0.080	0.081
34A2	0.108	0.112
35B1A	0.060	0.067
35B1B	0.070	0.078
35B2	0.260	0.270
35B3	0.32	0.351
Total	7.876	11.401

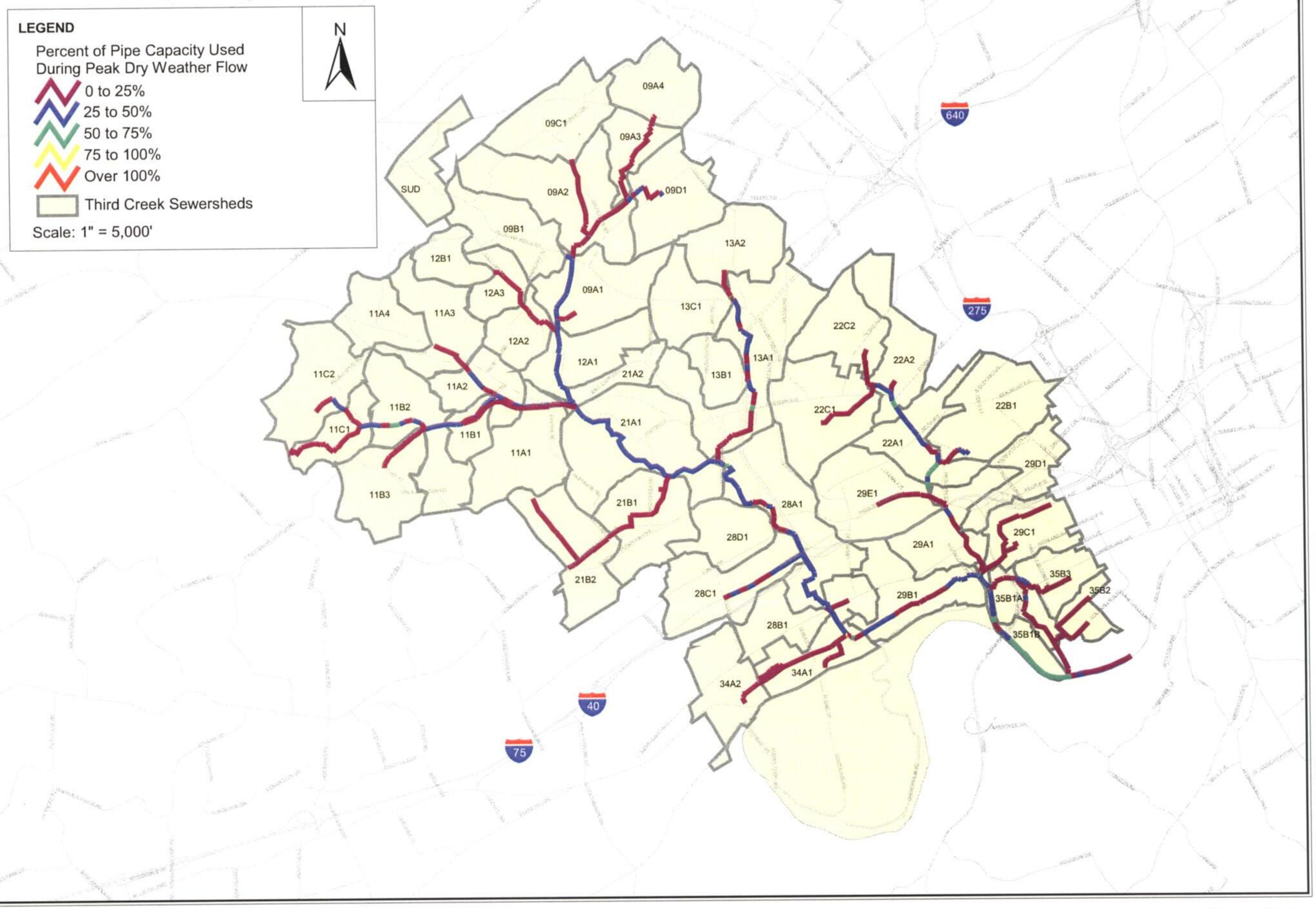

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Figure 7-2
Third Creek
2045 Peak Dry Weather Flow

predicted at the same location in the model. The wet-weather calibration procedure is described in Section 4.3.3.

Upper Third Creek was calibrated to a storm event that was recorded in the 2004 flow monitoring program while the lower portion of Third Creek was calibrated to a storm event recorded in the 2005 flow monitoring program. R values were calculated for each of the sub-basins for the calibration storm events and are presented in **Table 7-2**. Section 3.3.1 discusses the definition of R value. In general, sub-basins with an R value greater than 5 percent are considered to have a high volume of RDI/I.

The calibrated R values were used to calculate the gallons of RDI/I entering each sub-basin for the representative 24 hour planning storm event. Sub-basins with high volumes of RDI/I per linear foot are good candidates for comprehensive sanitary sewer rehabilitation as the greatest amount of RDI/I can be removed per linear foot of sewer rehabilitated in these sub-basins. The 24 hour planning storm event was previously developed by CDM to size wet-weather improvements for the collection system as described in Section 3.4. The volume of RDI/I calculated for each sub-basin was divided by the footage of sewer in each sub-basin to obtain the volume of infiltration per linear foot of pipe. These values are reported in Table 7-2. This is the volume of RDI/I that might be expected to enter the sewer, if adequate capacity is available, resulting from the representative 24 hour storm event during the critical period for GWI (i.e., December to May). The 24 hour storm RDI/I volume is presented as a way of comparing the infiltration between sub-basins. The RDI/I per linear foot of sewer for each sub-basin is also shown in **Figure 7-3**. In general, sub-basins with an RDI/I per linear foot of sewer greater than 50 were considered good candidates for rehabilitation and RDI/I reduction. The value of 50 gallons per day per linear foot is project specific to KUB and was used to identify sub-basins where comprehensive rehabilitation was thought to reduce or eliminate a downstream capacity related improvement. Most sub-basins were predicted to have less than 50 gallons RDI/I per linear foot of sewer. Sub-basins in the northeast portion of upper Third Creek have the highest values of RDI/I per linear foot of sewer. The values for sub-basins 09A4 and 09A1 are greater than 100 gallons per linear foot.

7.4 2045 Wet-Weather Storm Flows

As described in Section 3.4, a planning storm was used to predict the performance of the collection system during a representative 24 hour storm event. The planning storm and 2045 average dry-weather flows were routed through the hydraulic model. The predicted pipe capacity at peak planning storm flows is shown in **Figure 7-4**. Predicted overflow locations are also shown in Figure 7-4. Any overflow ranging from 10,000 gallons to 1,000,000 gallons is designated with a green dot. Any overflow ranging from 1 million to 2 million gallons is designated with a yellow dot. The largest overflow predicted by the model occurs just upstream of where the trunk line crosses from Upper to Lower Third Creek. This overflow is predicted to be

Table 7-2: R Values and RDI/I for Third Creek Sewersheds

Sewershed	R Value (%)	RDII (gal/LF)[1]
09A1	14.9	53.8
09A2	17.9	39.2
09A3	5.3	12.7
09A4	14.5	49.9
09B1	3.9	21.1
09C1	7.99	26.2
09D1	11.7	35.8
11A1	10	36.8
11A2	3.9	21.8
11A3	4.4	10.8
11A4	9.4	27.2
11B1	9.8	19.7
11B2	9.8	42.1
11B3	5.9	16.1
11C1	9.8	18.1
11C2	8.3	19.5
12A1	14.9	40.8
12A2	4.0	8.7
12A3	8.1	19.8
12B1	8.1	57.2
13A1	6.16	37.7
13A2	5.6	28.4
13C1	2.6	13.6
21A1	7.47	43.6
21A2	5.6	65.9
21B1	1.2	11.5
21B2	1.5	10.5
22A1	12.6	57.7
22A2	6.48	31.0
22B1	3.7	20.4
22C1	6.7	41.2
22C2	12.6	74.2
28A1	0.96	5.6
28B1	8.3	37.7
28C1	4.1	30.9
28D1	0.7	4.1
29A1	8.3	50.6
29B1	8.3	49.8
29C1	2.1	10.4
29D1	8.1	24.9
29E1	1.4	7.9
34A1	4.7	24.1
34A2	11.4	65.3
35B1A	4.1	27.2
35B1B	4.1	29.7
35B2	10.0	38.0
35B3	1.5	5.4

[1] Represents predicted volume for a representative 24 hour storm.

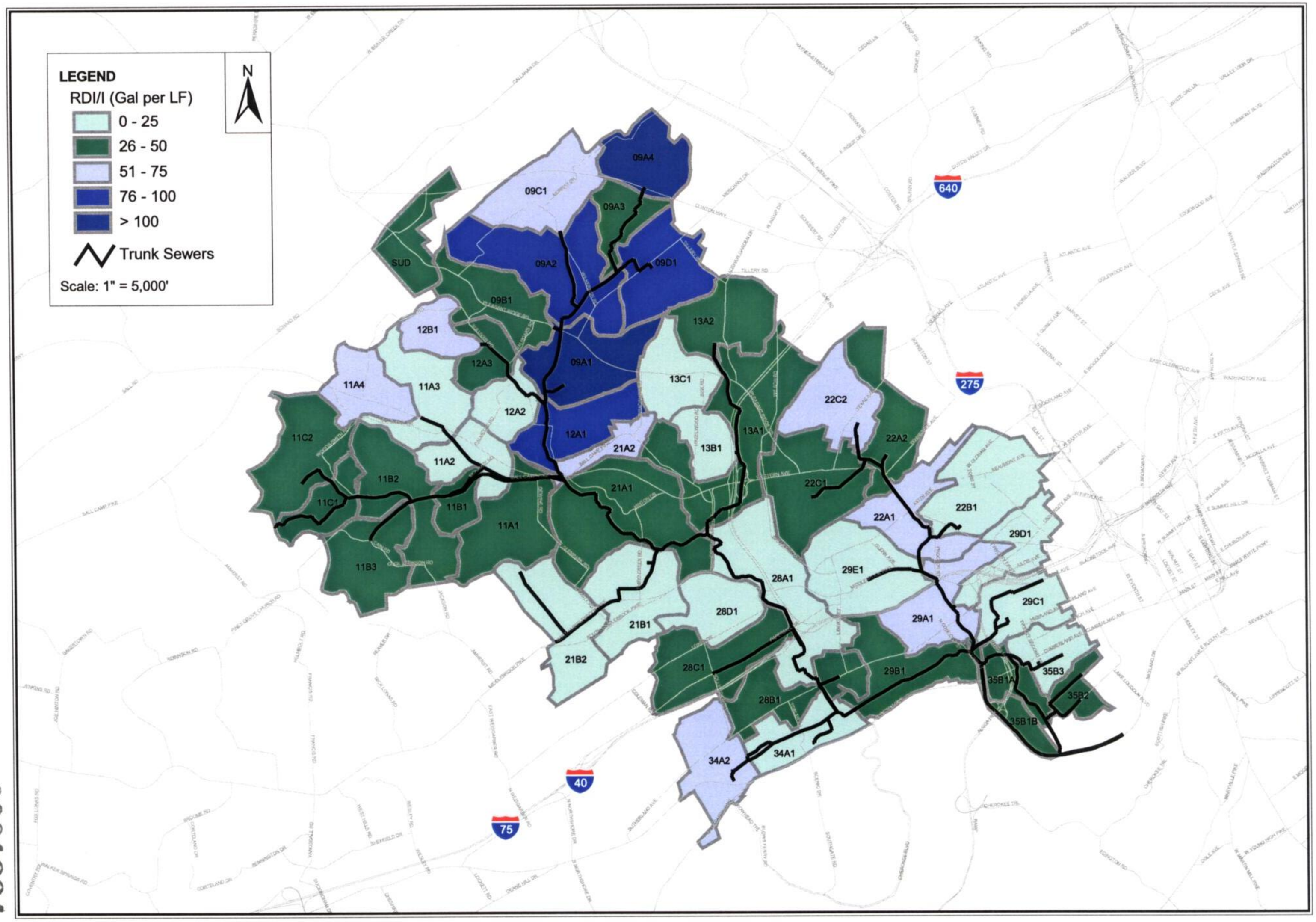

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Figure 7-3
Third Creek
RDI/I (Gal Per LF) By Sub-basin Predicted for 24 Hour Planning Event

LEGEND

Predicted Overflow Locations

- 0.01 to 1 MG
- 1 to 2 MG

Pipe Condition

- Not Surcharged (Qmax < Qdesign)
- Surcharged (Qmax > Qdesign)
- Third Creek Sewersheds

Scale: 1" = 5,000'

N

09A4, 09C1, 09A3, SUD, 09A2, 09D1, 09B1, 12B1, 13A2, 09A1, 12A3, 11A4, 11A3, 12A2, 13C1, 22C2, 12A1, 21A2, 13B1, 13A1, 22A2, 11C2, 11A2, 11B2, 22C1, 22B1, 21A1, 11C1, 11B1, 11A1, 22A1, 29D1, 11B3, 28A1, 29E1, 21B1, 28D1, 29A1, 29C1, 35B3, 21B2, 28C1, 29B1, 35B1A, 35B2, 28B1, 35B1B, 34A2, 34A1

640, 275, 40, 75

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Figure 7-4
Third Creek
2045 Peak 24 Hour Design Storm Flow

approximately 1.8 million gallons during the planning storm event. There are also several smaller overflows throughout the collection system.

As explained in Sections 1.1 and 4.5, a total basin solution was developed for Third Creek to address future predicted wet-weather overflows. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution was analyzed to determine which are required to address the SSO locations on the Long-Term List.

7.5 Phase 1 CAP/ER Facility Improvements

The objective of the Phase 1 CAP/ER is to address SSOs identified on the Long-Term List of the SSOER in accordance with the CD. The SSOs listed on the Long-Term List that are capacity related are addressed by facility improvement projects as outlined for the Third Creek Basin in **Table 7-3**. This table lists all capacity related SSOs and a corresponding project ID, which addresses the SSO.

The SSOs on the Long-Term List that are not capacity related are addressed by either a "find and fix" facility improvement project or KUB's CSSAP Program. Many of the SSOs on the Long-Term List that are not capacity related are the result of a blockage (debris, grease, roots, etc.) that have been addressed by KUB's CSSAP Program. These include all the SSOs on the Long-Term List that have the designation "N/A" under the "Long Term Capital Project" field. However, if the source of the blockage could not be fixed by maintenance and re-occurred after flushing or root cutting, then these SSOs were assigned a "find and fix" facility improvement project. "Find and fix" facility improvement projects will first involve further investigation into the source of the SSO through the use of smoke testing, manhole inspection, and/or CCTV inspection. Next, a determination will be made of the type and extent of the improvement required to address the SSO. In some cases, the blockage may have been only partially removed and further flushing or cutting is required to address the SSO. In other cases, replacement of sagged pipe or lining of pipe to prevent root intrusion may be required.

Table 7-4 presents all SSOs on the Long-Term List that are not capacity related. In the project ID field is either a "find and fix" project ID that addresses the SSO or the designation "has been addressed by CSSAP Program", as discussed above.

Figure 7-5 presents a map showing the locations of all SSOs on the Long-Term List from 2001-2004 in Third Creek that require a facility improvement project to address the SSO. The SSOs are shown as green dots on the map. As discussed above, some SSOs on the Long-Term List were isolated cases of a blockage that have been addressed by the CSSAP Program and are not mapped on this figure.

The figure also shows the planned and completed facility projects to address the SSOs. Already completed improvement pipeline projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I

Table 7-3: Third Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
2/15/03	1811 STERCHI ST	MH 11-48	3-27
2/22/03	1816 STERCHI ST	MH 11-47	3-27
12/9/04	2015 NEYLAND DR (KUWAHEE)	Influent Structure	3-3 and 3-5
11/24/04	2612 WESTERN AVE	MH 18-83	3-4 and 3-5
9/17/04	3110 SUTHERLAND AVE	MH 3-49	3-8 and 3-11
9/26/02	3204 SUTHERLAND AVE	MH 3-53	3-11
2/15/03	3204 SUTHERLAND AVE	Unnumbered	3-11
2/22/03	3208 SUTHERLAND AVE	MH 3-53	3-11
7/10/03	3208 SUTHERLAND AVE	MH 3-49 & 3-53	3-11
2/14/03	3301 MCKAMEY RD	MH 13	3-14
5/6/03	3305 MCKAMEY RD	MH 13	3-14
7/29/01	3305 MCKAMEY RD	MH 13	3-17
2/14/03	3307 MCKAMEY RD	MH 14	3-14
1/23/02	3307 MCKAMEY RD	MH 13	3-17
4/17/03	3540 & 3305 MCKAMEY RD	MH 21 & 13	3-4 and 3-14
2/15/03	3540 MCKAMEY RD	MH 21	3-4 and 3-14
1/23/02	3540 MCKAMEY RD	MH 18 & 19	3-4 and 3-17
1/23/02	3540 MCKAMEY RD	MH 21 & 23	3-4 and 3-17
2/22/03	409 HIGHLAND HILLS RD	MH 62	3-29
9/24/04	409 NORTH BELLEMEADE AVE	MH 3-53	3-11
12/9/04	409 NORTH BELLEMEADE AVE	MH 3-53	3-11
7/15/02	411 HIGHLAND HILLS RD	MH 62	3-29
2/15/03	411 HIGHLAND HILLS RD	MH 62	3-29
3/6/04	411 HIGHLAND HILLS RD	MH 62	3-29
6/17/04	411 HIGHLAND HILLS RD	MH 62	3-29
6/27/04	411 HIGHLAND HILLS RD	MH 62	3-29
5/5/03	421 HIGHLAND HILLS DR	Building Backup & MH 62	3-29
2/15/03	4428 DEERFIELD RD	MH 11-158	3-21
2/22/03	4428 DEERFIELD RD	MH 11-158	3-21
2/8/04	4812 WESTERN AVE	MH 33-2	3-4 and 3-5
2/6/04	5000 WESTERN AVE	MH 33-1	3-4 and 3-5
3/6/04	5000 WESTERN AVE	MH 33-1	3-4 and 3-5
10/12/04	5000 WESTERN AVE	MH 1	3-4 and 3-5
12/7/04	5000 WESTERN AVE	MH 33-1	3-4 and 3-5
12/9/04	5000 WESTERN AVE	MH 33-1	3-4 and 3-5
2/16/01	5659 MATLOCK DR	MH 18	3-14
2/16/01	5659 MATLOCK DR	MH 19	3-14
2/16/03	5715 BALL CAMP PIKE	MH 11-17	3-15
2/28/03	HILLVALE CIR	MH 1-27, 1-33 & 1-115	3-23
9/25/02	MCKAMEY RD	MH 16,16-1,20 & 26	3-4 and 3-14
2/22/03	MCKAMEY RD & BALL CAMP PIKE	MH 13 & 14	3-4 and 3-14
2/16/01	MCKAMEY RD & HOLIDAY BLVD	MH 20	3-4 and 3-17
2/16/01	MCKAMEY RD & LARIMER ST	MH 22	3-4 and 3-17
2/16/01	MCKAMEY RD & LARIMER ST	MH 23	3-4 and 3-17
2/15/03	MCKAMEY RD & LARIMER ST	MH 23	3-14 and 3-17
2/22/03	MCKAMEY RD & LARIMER ST	MH 21 & 23	3-14 and 3-17
4/10/03	MCKAMEY RD & MATLOCK DR	MH 17 & 21	3-4 and 3-14
2/14/03	MCKAMEY RD & MATLOCK DR	MH 18 & 19	3-4 and 3-14
2/22/03	MCKAMEY RD & MATLOCK DR	MH 17, 18 & 20	3-4 and 3-14
5/6/03	MCKAMEY RD & MATLOCK DR	MH 18, 19, 21, 24 & 25	3-4 and 3-14
1/19/01	MCKAMEY RD & MATLOCK DR	MH 21	3-4 and 3-17
2/22/03	MCKAMEY RD & PUEBLO PL	MH 24, 25 & 26	3-4 and 3-14
2/16/01	MCKAMEY RD & PUEBLO PL	MH 25	3-4 and 3-17

Table 7-3: Third Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
2/16/01	MCKAMEY RD & PUEBLO PL	MH 26	3-4 and 3-17
2/16/01	MCKAMEY RD & SAINT LUCIA LN	MH 21	3-4 and 3-17
2/16/03	MCKAMEY RD & WOOD-SMITH RD	MH 27	3-4 and 3-14
2/22/03	MCKAMEY RD & WOOD-SMITH RD	MH 27 & Unnumbered	3-4 and 3-14
1/23/02	MCKAMEY RD & WOODS-SMITH RD	MH 27	3-4 and 3-17
2/22/03	NEYLAND DR & CENTER DR	MH 4-16	3-7
5/6/03	NEYLAND DR & JACOB DR	MH 4-6 & 4-37	3-7
12/10/04	ROLLING RIDGE LIFT STATION	MH 39-122	3-25
1/23/02	SUTHERLAND AVE & NORTH BELLEME	MH 3-49	3-11
5/7/03	SUTHERLAND AVE & NORTH BELLEME	MH 3-53	3-8 and 3-11
2/15/03	WESTERN AVE & THIRD CREEK RD	MH 33	3-4 and 3-5

1 SSOs from Long-Term List of SSOER that are capacity related. Non-capacity related SSOs are shown in Table 7-4.
2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 7-5 and shown on Figure 7-4.

Table 7-4: Third Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
5/30/01	1310 HOLLYWOOD RD	MH 30-3 & 30-4	Addressed by CSSAP
1/23/02	1504 PROCTOR ST	MH 8-9	Addressed by CSSAP
11/21/03	1504 RAMBLING RD	MH 48-22	Addressed by CSSAP
7/26/04	1600 RAMBLING DR	Building Backup	Addressed by CSSAP
1/17/03	1600 UNIVERSITY AVE	MH 42	Addressed by CSSAP
4/22/03	1605 RAMBLING RD	MH 52	Addressed by CSSAP
6/11/04	1627 UNIVERSITY AVE	MH 42	Addressed by CSSAP
4/23/04	1637 UNIVERSITY AVE	MH 41	Addressed by CSSAP
4/23/03	1709 PAWNEE RD	Building Backup	Addressed by CSSAP
6/9/03	1710 MERCHANT DR	MH 24-48	3-3
11/22/01	1725 KIM WATT DR	MH 16-112	Addressed by CSSAP
10/23/02	1727 GRAND AVE	Building Backup	Addressed by CSSAP
3/4/04	1743 MOSES AVE	MH 41-40	Addressed by CSSAP
4/12/01	1801 AILOR AVE	MH 32-18 & 32-07	Addressed by CSSAP
1/23/02	1801 THIRD CREEK RD	MH 14	Addressed by CSSAP
1/24/03	1801 WESTERN AVE	Private MH	Addressed by CSSAP
2/27/03	1816 STERCHI ST	MH 11-40	3-27
6/23/04	1848 FRATERNITY PARK DR	Building Backup	Addressed by CSSAP
11/23/01	1901 CUMBERLAND AVE	Building Backup	Addressed by CSSAP
9/25/03	1901 CUMBERLAND AVE	Building Backup	Addressed by CSSAP
11/13/04	1901 CUMBERLAND AVE	Building Backup	Addressed by CSSAP
6/9/03	1902 MERCHANTS DR	Building Backup	3-3
9/16/02	1914 ANDY HOLT AVE	MH 12-18	Addressed by CSSAP
6/23/01	1924 CONNECTICUT AVE	Building Backup	Addressed by CSSAP
3/7/04	2000 MIDDLEBROOK PIKE	MH 34 & 35	Addressed by CSSAP
2/5/02	2016 HYDE PARK LN	Building Backup	Addressed by CSSAP
2/5/02	2025 HYDE PARK LN	Building Backup	Addressed by CSSAP
8/28/02	2108 WOODS-SMITH RD	Underground Flow	Addressed by CSSAP
4/10/03	211 DOUGLAS AVE	MH 43-2	Addressed by CSSAP
4/10/03	211 DOUGLAS AVE	Building Backup	Addressed by CSSAP
7/20/04	2124 OHIO AVE	Building Backup	Addressed by CSSAP
12/9/04	2125 MIDDLEBROOK PIKE	MH 55 & 29	Addressed by CSSAP
1/1/01	2218 LAUREL AVE	Broken Lateral	Addressed by CSSAP
1/25/02	2227 SANDUSKY RD	MH 35-2	Addressed by CSSAP
4/29/03	2241 MISSISSIPPI AVE	Broken Lateral	Addressed by CSSAP
11/11/02	2301 CLINCH AVE	MH 23-5	Addressed by CSSAP
4/24/04	2437 KEITH AVE	Building Backup	Addressed by CSSAP
3/17/02	2606 PIEDMONT ST	Building Backup	Addressed by CSSAP
12/31/04	2620 LESA LN	MH 12-26 & 12-31	Addressed by CSSAP
6/23/01	2701 SUTHERLAND AVE	Building Backup	Addressed by CSSAP
9/1/02	2720 DAYTON ST	Building Backup	Addressed by CSSAP
12/14/01	2809 WAVERLY ST	Lateral	Addressed by CSSAP
12/14/01	2809 WAVERLY ST	Building Backup & Lateral	Addressed by CSSAP
9/17/04	3000 WALRIDGE RD	MH 12-1	Addressed by CSSAP
9/17/04	3000 WALRIDGE RD	Building Backup & MH 12-1	Addressed by CSSAP
1/10/03	3005 LAFAYETTE RD	Cleanout	Addressed by CSSAP
10/23/01	3015 CHERRYWOOD RD	MH 13-9	Addressed by CSSAP
6/2/03	3039 KINGSTON PIKE	Private Lateral	Addressed by CSSAP
7/16/04	3106 KINGSTON PIKE	MH 3-12	Addressed by CSSAP
12/27/04	3106 KINGSTON PIKE	MH 3-12	Addressed by CSSAP
10/19/04	3110 SUTHERLAND AVE	MH 3-49	3-8 and 3-11
5/10/04	3128 KINGSTON PIKE	Broken Pipe	Addressed by CSSAP
6/18/02	3204 SUTHERLAND AVE	Leakage	3-11
2/4/02	3208 SUTHERLAND AVE	MH 3-53	3-11
11/8/02	330 KINGSTON CT	Building Backup	Addressed by CSSAP
9/4/02	3526 MONTGOMERY AVE	Building Backup	Addressed by CSSAP
9/10/02	3526 MONTGOMERY AVE	Building Backup & MH 18-155	Addressed by CSSAP
9/1/02	3550 PLEASANT RIDGE RD	Building Backup	Addressed by CSSAP
9/10/02	3608 MONTGOMERY AVE	Building Backup & MH 18-155	3-27
9/5/02	3608 MONTGOMERY AVE	Building Backup	3-27
3/14/03	3618 MONTGOMERY AVE	Building Backup	3-27
9/10/02	3624 MONTGOMERY AVE	MH 18-155	3-24

Table 7-4: Third Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
3/8/02	3716 VIENNA DR	MH 18-3	Addressed by CSSAP
9/22/03	3801 REAGAN AVE	MH 3-35	Addressed by CSSAP
8/20/03	3811 GLENFIELD DR	Building Backup	Addressed by CSSAP
3/18/02	3909 PAPERMILL RD	MH 21 & 22	Addressed by CSSAP
1/7/03	3918 WINDSOR AVE	MH 3-55	Addressed by CSSAP
12/16/02	3918 WINDSOR AVE	MH 3-55	Addressed by CSSAP
9/10/04	409 NORTH BELLEMEADE AVE	MH 3-53	3-11
10/19/04	409 NORTH BELLEMEADE AVE	Underground Flow	3-11
5/9/02	4127 APEX DR	MH 3-91	Addressed by CSSAP
2/4/03	415 PRESTWICK RIDGE WAY	MH 3-74	Addressed by CSSAP
1/22/02	4321 MCKAMEY RD	MH 27-104	3-17
12/10/03	4337 FOUNTAIN DR	MH 41	3-22
11/3/03	4404 ROYALVIEW AVE	MH 11-150	Addressed by CSSAP
2/2/01	4421 ROYALVIEW RD	Cleanout	Addressed by CSSAP
3/18/02	4428 DEERFIELD RD	MH 11-158	Addressed by CSSAP
12/9/04	4428 DEERFIELD RD	MH 11-158	Addressed by CSSAP
3/18/02	4428 DEERFIELD RD	Building Backup & MH 11-158	Addressed by CSSAP
9/10/02	4501 PLEASANT RIDGE RD	MH 34-4	Addressed by CSSAP
11/25/01	4501 PLEASANT RIDGE RD	MH 34-5	Addressed by CSSAP
3/17/02	4700 SPRINGBROOK DR	Building Backup & MH 11-205	Addressed by CSSAP
3/17/02	4700 SPRINGBROOK RD	MH 11-205	Addressed by CSSAP
12/7/04	4705 ROHAR RD	MH 29-1	Addressed by CSSAP
5/29/01	4711 KINGSTON PIKE	MH 16-14 to MH 16-27	Addressed by CSSAP
1/21/02	4715 MIDDLEBROOK PIKE	MH 10-6	Addressed by CSSAP
11/26/01	4728 BALL CAMP PIKE	Building Backup	Addressed by CSSAP
11/18/01	4741 BRIERLY RD	Building Backup	Addressed by CSSAP
9/19/04	4800 WILKSHIRE DR	MH 37	Addressed by CSSAP
4/30/04	4815 KINGSTON PK	Building Backup	Addressed by CSSAP
5/24/03	4816 KINGSTON PIKE	Private MH	Addressed by CSSAP
2/15/02	5104 FLEETWOOD CIR	MH 5-11	Addressed by CSSAP
3/10/04	5265 TILLERY RD	MH 24-49	Addressed by CSSAP
2/4/03	5278 AVERY WOODS LN	Building Backup	Addressed by CSSAP
7/26/02	5308 YOSEMITE TRL	MH 10-95	Addressed by CSSAP
10/18/02	5401 WIL-LOYD RD	Cleanout	Addressed by CSSAP
10/25/01	5409 TILLERY RD	MH 5-53	3-3
7/25/01	5409 TILLERY RD	MH 24-51	Addressed by CSSAP
9/16/04	5420 TIFFANY RD	MH 24-18	Addressed by CSSAP
8/2/02	558 NOELTON DR	Building Backup	Addressed by CSSAP
12/23/01	5601 NICKLE RD	Building Backup	Addressed by CSSAP
2/22/03	5609 CLIFFWOOD RD	MH 11-191	Addressed by CSSAP
1/13/01	5617 RIDGETOP RD	Building Backup	Addressed by CSSAP
7/2/04	5712 MATLOCK RD	Building Backup	Addressed by CSSAP
5/17/04	5717 WIL-LOYD DR	Building Backup	Addressed by CSSAP
2/18/01	5804 WEXFORD LN	Building Backup	Addressed by CSSAP
1/15/01	5813 ROCKWOOD LN	MH 23-77	3-2
2/26/01	5815 WOODED ACRES DR	MH 17-57	3-3
10/11/03	5824 STONELEIGH RD	MH 33-20	Addressed by CSSAP
11/14/01	5914 BLOSSOM RD	MH 33-23	Addressed by CSSAP
5/22/02	5914 BLOSSOM RD	MH 32-8	3-20
9/23/03	600 CITICO ST	MH 12-36 & 12-37	Addressed by CSSAP
6/27/04	6036 PLEASANT RIDGE RD	MH 32-8	3-20
9/13/03	605 CITICO ST	MH 32-8	3-20
11/19/03	605 CITICO ST	MH 32-8	3-20
12/10/03	605 CITICO ST	MH 17-244	Addressed by CSSAP
2/8/01	6100 EMERALD HILLS LN	MH 17-119	Addressed by CSSAP
3/2/01	6100 WADE LN	MH 17-194	Addressed by CSSAP
9/14/01	6107 EMERALD HILLS LN	MH 12-47 & 12-48	Addressed by CSSAP
11/18/03	6150 PLEASANT RIDGE RD	MH 48 & 49	Addressed by CSSAP
4/17/02	6226 ELLESMERE DR	Broken Pipe	Addressed by CSSAP
9/16/04	6304 ELLESMERE DR	Building Backup	Addressed by CSSAP
11/10/01	6404 SHREWSBURY DR	Building Backup	Addressed by CSSAP
1/8/04	6504 SHREWSBURY DR		

Table 7-4: Third Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
11/10/02	6508 CADBURY DR	Building Backup	Addressed by CSSAP
1/24/01	6512 SHAFTSBURY DR	Building Backup	3-2
12/22/01	6520 SHREWSBURY DR	Building Backup	Addressed by CSSAP
11/12/01	6521 TEWKSBURY DR	Building Backup	Addressed by CSSAP
8/17/02	6525 TEWKSBURY DR	MH 39-31	3-2
12/23/01	6613 CADBURY DR	Building Backup	Addressed by CSSAP
9/23/03	711 NINETEENTH ST	Underground Flow	Addressed by CSSAP
11/29/02	714 WASHBURN RD	Building Backup	Addressed by CSSAP
11/21/03	955 KNOXVILLE COLLEGE DR	MH 6-79	Addressed by CSSAP
4/14/01	CAIN RD & EVERHART LN	MH 27-28	Addressed by CSSAP
11/12/02	CLINCH AVE & TWENTY FIRST ST	MH 23-15	Addressed by CSSAP
7/16/03	FOREST AVE & TWENTY SECOND ST	MH 9-28	Addressed by CSSAP
5/10/01	KINGSTON PIKE & ALCOA HWY	MH 18-3	Addressed by CSSAP
3/17/02	KUWAHEE INFLUENT BYPASS	Influent Structure	3-26
9/21/02	KUWAHEE INFLUENT BYPASS	Influent Structure	3-26
9/22/02	KUWAHEE INFLUENT BYPASS	Influent Structure	3-26
9/22/02	KUWAHEE INFLUENT BYPASS	Influent Structure	3-26
6/6/02	KUWAHEE INFLUENT BYPASS	Influent Structure	3-26
7/30/02	KUWAHEE INFLUENT BYPASS	Influent Structure	3-26
8/21/03	KUWAHEE PRIMARIES # 1-3 INFLUENT BOXES	Primaries # 1-3 Influent Boxes	Addressed by CSSAP
3/2/01	KUWAHEE SEPTAGE UNLOADING SITE	Septage Unloading Site	(3)
7/7/01	KUWAHEE SEPTAGE UNLOADING SITE	Septage Unloading Site	(3)
8/17/01	KUWAHEE SEPTAGE UNLOADING SITE	Septage Unloading Site	(3)
4/2/03	KUWAHEE SEPTAGE UNLOADING SITE	Septage Unloading Site	(3)
11/14/01	KUWAHEE SEPTAGE UNLOADING SITE	Septage Unloading Site	(3)
8/25/03	KUWAHEE SEPTAGE UNLOADING SITE	Septage Unloading Site	(3)
2/14/03	KUWAHEE WWTP	Influent Structure	3-26
2/15/03	KUWAHEE WWTP	Influent Structure	3-26
2/16/03	KUWAHEE WWTP	Influent Structure	3-26
2/17/03	KUWAHEE WWTP	Influent Structure	3-26
2/21/03	KUWAHEE WWTP	Influent Structure	3-26
2/22/03	KUWAHEE WWTP	Influent Structure	3-26
4/10/03	KUWAHEE WWTP	Influent Structure	3-26
5/5/03	KUWAHEE WWTP	Influent Structure	3-26
5/6/03	KUWAHEE WWTP	Influent Structure	3-26
5/7/03	KUWAHEE WWTP	Influent Structure	3-26
11/6/03	KUWAHEE WWTP	Influent Structure	3-26
3/14/03	LAUREL AVE & TWENTIETH ST	MH 9-105	Addressed by CSSAP
2/5/02	MCKAMEY RD & CAIN RD	Underground Flow	3-17
3/18/02	MIDDLEBROOK PIKE & I-40	MH 15-7	Addressed by CSSAP
3/18/02	MIDDLEBROOK PIKE & TWENTY FIRST ST	MH 29	Addressed by CSSAP
3/19/04	ROLLING RIDGE LIFT STATION	MH 39-91	3-25
4/10/03	ROLLING RIDGE LIFT STATION	Wetwell	Addressed by CSSAP
2/22/03	ROLLING RIDGE LIFT STATION	Wetwell	Addressed by CSSAP
12/14/01	ROLLING RIDGE LIFT STATION	Wetwell	Addressed by CSSAP
1/24/02	SECONDARY JUNCTION BOX @ KUWAHEE WWTP	Secondary Junction Box	3-26
1/25/02	SECONDARY JUNCTION BOX @ KUWAHEE WWTP	Secondary Junction Box	3-26
3/17/02	SECONDARY JUNCTION BOX @ KUWAHEE WWTP	Secondary Junction Box	3-26
3/18/02	SECONDARY JUNCTION BOX @ KUWAHEE WWTP	Secondary Junction Box	3-26
9/21/02	SECONDARY JUNCTION BOX @ KUWAHEE WWTP	Secondary Junction Box	3-26
2/14/03	SECONDARY JUNCTION BOX @ KUWAHEE WWTP	Secondary Junction Box	3-26
9/22/02	SUTHERLAND AVE	MH 3-50	Addressed by CSSAP
3/18/03	TWENTIETH ST & LAUREL AVE	MH 9-105	Addressed by CSSAP
6/8/01	TWENTIETH ST & LAUREL AVE	MH 9-105	Addressed by CSSAP
10/14/02	TWENTY FIRST ST	MH 23-14	3-12
10/31/02	TWENTY FIRST ST & LAUREL AVE	MH 23-17	3-12
8/29/01	UNIVERSITY AVE & WESTERN AVE	MH 41	Addressed by CSSAP

1 SSOs from Long-Term List of SSOER that are non-capacity related. Capacity related SSOs are shown in Table 7-3.
2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 7-5 and shown on Figure 7-4.
3 Addressed by KWWTP operational improvements and on-site parallel sewer installation.

N
W
E
S
2000 0 2000 4000 Feet
Pilleaux Road
Clinton Highway
Schaad Road
3-3
3-3
3-3
3-3
3-22
3-21
3-15
3-4
3-14
3-17
3-4
3-5
3-24
3-6
3-27
3-2
3-25
Rolling Ridge
Amherst Road
3-20
3-12
3-8
3-16
3-8
3-11
Kuwahee WWTP
3-26
Scottish Pike
Cheowa
3-23
3-7
3-29
Lyons View
Vestal
Woodson
LEGEND
SSOs from Long-Term List requiring facility improvement projects
Trunk Sewers
Collector Sewers
Pump Station
Third Creek Basin
WWTP
Improvement Projects
Completed Improvement Projects
CAP/ER Improvement Projects
Find and Fix Projects
CAP/ER Sewer Rehabilitation to an R=2%
CAP/ER Storage Facility
Pump Station Upgrade
CDM
Third Creek
Phase 1 CAP/ER
Facility Improvement Projects
Figure 7-5
0002002

and reducing the R value to 2 percent are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in the SSO Tables 7-3 and 7-4. **Table 7-5** lists all the projects on the map and a description of each project. Section 12 presents the Phase 1 CAP/ER implementation plan that provides start and end dates for each of these projects.

As Table 7-5 and Figure 7-5 detail for the Third Creek Basin, several projects have already been completed, and the additional facility improvements required for the Phase 1 CAP/ER include the following:

- Several trunk sewer replacement projects
- An equalization storage tank
- Rehabilitation to an R of 2 percent in four sub-basins
- Numerous "find and fix" sewer rehabilitation projects

Table 7-5: Third Creek Project Descriptions

Project ID	Project Name	Project Description[1]
3-2	Subbasin 11 Rehabilitation Project (approximately 25% rehabilitation)	Find and fix work to identify and address cause of overflow in the vicinity of 5815 Wooded Acres Drive, 6512 Shaftsbury Drive, and 6525 Tewksbury Drive.
3-3	Subbasin 9 Rehabilitation Project	Rehabilitation to reduce R to 2% in Sub-basins 09A1, 09A2, 09A4, and 09D1.
3-4	Upper McKamey and Third Creek Road Replacement Project	Replace approximately 3,141 lf of existing sewer with 36-in sewer and approximately 1,500 lf with 15-in sewer.
3-5	Third Creek Storage Facility Project	Design and construction of a storage facility in Third Creek Basin (approximately 4.5 MG storage on Land Parcel # 093GB006)
3-6	Interstate 40 and Middlebrook Pike Trunk Replacement Project	Replace approximately 400 lf of existing sewer with 15-in sewer, 750 lf with 24-in sewer, 2,000 lf with 30-in sewer, and 7,000 lf with 36-in sewer.
3-7	Neyland Drive Trunk Replacement Project	Replace approximately 5,900 lf of existing sewer with 48-in sewer.
3-8	Third Creek Bike Trail Pipe Replacement Project	Replace approximately 1,200 lf of existing sewer with 24-in sewer.
3-11	Sutherland Avenue Collector Rehabilitation Project (Sub-basin 28B1)	Find and fix work to identify and address cause of overflow in the vicinity of 3110, 3204, and 3208 Sutherland Avenue, 409 North Bellemeade Avenue, Sutherland Avenue and North Bellemeade Avenue, and 5824 Stoneleigh Road.
3-12	Clinch and 21st Street Collector Rehabilitation Project (Sub-basin 35B3)	Find and fix work to identify and address cause of overflow in the vicinity of Twenty First Street and Twenty First Street and Laurel Avenue.

Table 7-5: Third Creek Project Descriptions

Project ID	Project Name	Project Description[1]
3-14	McKamey Road Interconnection Project	Project will involve constructing a hydraulic connection between the upper and lower McKamey Road Sewers.
3-15	Ball Camp Pike Improvement Project	Replace approximately 600 lf of existing sewer with 12-in sewer.
3-16	Painter Avenue Trunk Replacement Project	Replace approximately 2,200 lf of existing sewer with 48-in sewer and 200 lf with 54-in sewer.
3-17	McKamey Road Relief Sewer Project	Construct approximately 3,600 lf of 15-in sewer and 1,400 lf of 18-in sewer.
3-20	Citico Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 600 and 605 Citico Street.
3-21	Deerfield Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4428 Deerfield Rd.
3-22	Fountain Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4337 Fountain Drive.
3-23	Hillvale Circle Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of the SSO at Hillvale Circle.
3-24	Montgomery Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 3624 Montgomery Avenue.
3-25	Rolling Ridge Interconnection Project	Replace Rolling Ridge pump station with gravity sewer.
3-26	PCP, CPE, and CCP	Wastewater evaluation studies of the Kuwahee WWTP.
3-27	Montgomery Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1811 and 1816 Sterchi Street and 3608 and 3618 Montgomery Avenue.
3-29	Highland Hills Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 409, 411, and 419 Highland Hills Road.

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Section 8
Fourth Creek

8.1 Hydraulic Model Description

The Fourth Creek hydraulic model consists of approximately 30 miles of trunk sewer and includes all major sewer pipes 10-inches in diameter or larger. The Walker Springs and Ten Mile pump stations are both included in the hydraulic model. Fourth Creek receives flow from the Ball Road Development, West Knoxville Utility District (WKUD), and First Utility District (FUD). All flows are treated at the Fourth Creek WWTP. **Figure 8-1** shows the location of the Fourth Creek trunk sewer, pump stations, Ball Road, WKUD, and FUD areas that contribute flow to Fourth Creek.

8.2 Existing and Future Dry-Weather Model Analysis

To calibrate the model to dry-weather conditions, the output flows produced by the simulation using dry-weather input hydrographs were matched against the flows measured by the meters in the 2004 flow monitoring program. The dry-weather calibration procedure is described in Section 4.2.3. A summary of the calibrated dry-weather flows for each sub-basin is presented in **Table 8-1**. The 2004 average dry-weather flow in Fourth Creek is 4.7 mgd. As discussed in Section 3.2.4, dry-weather flows in Fourth Creek were projected for year 2045. The 2045 wastewater flows for Fourth Creek sub-basins are also shown in **Table 8-1**. The total dry-weather Fourth Creek flow is predicted to increase to 5.7 mgd.

Peak dry-weather flows in 2045 were simulated based on the 2045 flow projections. The percent of pipe capacity used during peak dry-weather flow is shown in **Figure 8-2**. The figure color codes the pipe according to the capacity used. Yellow indicates that between 75 and 100 percent of the pipe capacity is used to convey the peak dry-weather flow. Red indicates that over 100 percent of the pipe capacity is required to convey the peak dry-weather flow. Any pipe in either category would be recommended for upgrading. New pipe is typically designed such that less than 50 percent of the pipe capacity is used under peak dry-weather flow conditions. In 2045, the majority of the pipes are predicted to be less than 50 percent full. There are some pipe segments that fall into the red category (over 100 percent full) near Papermill Drive. The capacity of these pipes is currently being improved by trunk sewer replacement projects on Papermill Drive.

8.3 Existing and Future Wet-Weather Model Analysis

To calibrate the model to wet-weather conditions, the output flows produced by the simulation using a real storm event were matched against the flows measured by the meters during that storm event. Where necessary, adjustments to hydrograph model load points were made so that each flow monitor reasonably matched the flow predicted at the same location in the model. The wet-weather calibration procedure is described in Section 4.3.3.

LEGEND

Pump Stations

Trunk Sewers

Force Mains

Fourth Creek Sewersheds

Scale: 1" = 5,000'

N

Ball Road Area

32A3

32A4

35A5

WKUD1

32A5

32A2

32A1a

WKUD2

32B2

32B1

32B3

27C3

27C2

27D1

27B3

27B2

27B1

27C1

27A1

33B3

33B2

33B4

33B1

33A1

33A2

33A3

37A3

37A4

37A2

33A4

33A5

36B2

36B1

36B3

36B4

36B5

36A5

36A4

36A3

37C1

37B1

37A1

42

42A1

FUD2

Walker Springs

WKUD

Ten Mile

Fourth Creek WWTP

Harrison Keepe

Figure 8-1
Fourth Creek
Hydraulic Model

CDM

0002007

Table 8-1: Fourth Creek Average Dry-Weather Flow

Sewershed	2004 Average Dry Weather Flow (mgd)	2045 Average Dry Weather Flow (mgd)
27A1	0.075	0.086
27B1	0.394	0.322
27B2	0.119	0.144
27B3	0.143	0.186
27C1	0.077	0.094
27C2	0.108	0.126
27C3	0.062	0.079
27D1	0.130	0.171
32A1	0.060	0.074
32A1A	0.063	0.075
32A2	0.095	0.130
32A3	0.235	0.299
32A4	0.118	0.151
32A5	0.128	0.175
32B1	0.058	0.070
32B2	0.060	0.072
32B3	0.186	0.225
33A1	0.137	0.152
33A2	0.077	0.079
33A3	0.027	0.032
33A4	0.125	0.151
33A5	0.182	0.233
33B1	0.070	0.070
33B2	0.081	0.047
33B3	0.038	0.028
33B4	0.047	0.051
36A2	0.060	0.072
36A3	0.049	0.059
36A4	0.067	0.081
36A5	0.077	0.090
36B1	0.076	0.091
36B2	0.020	0.031
36B3	0.136	0.176
36B4	0.136	0.177
36B5	0.023	0.028
37A1	0.022	0.026
37A2	0.055	0.066
37A3	0.094	0.108
37A4	0.053	0.058
37B1	0.034	0.028
37C1	0.035	0.044
42A1	0.064	0.086
42	0.150	0.239
WKUD1	0.227	0.361
WKUD2	0.053	0.061
FUD	0.354	0.504
Total	4.677	5.712

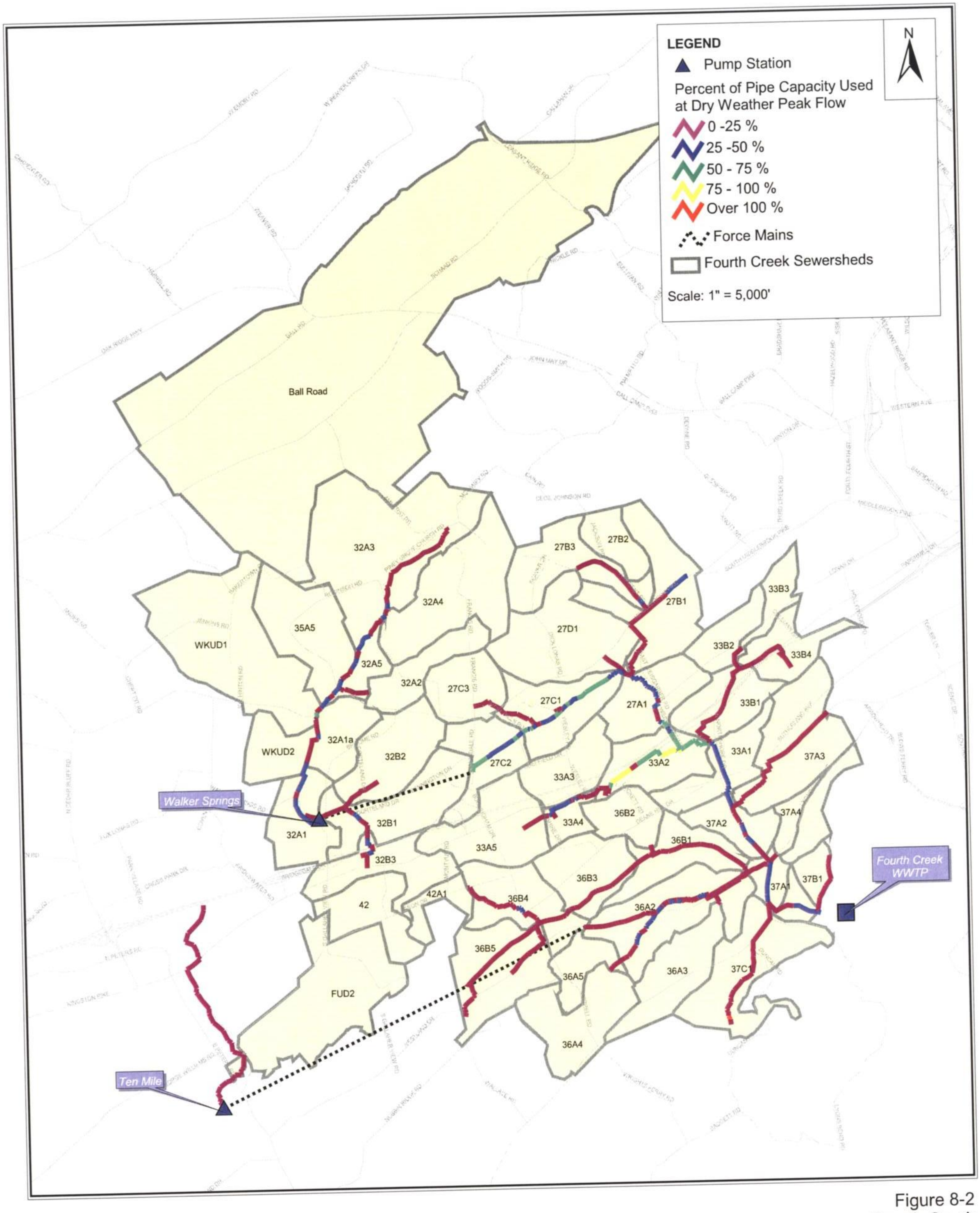


Figure 8-2
Fourth Creek
2045 Dry Weather Flow

CDM

0002009

Fourth Creek was calibrated to the April 12, 2004 storm event. This event produced the highest peak wet-weather flows for the monitoring period. R values were calculated for each of the sub-basins for the calibration storm event and are presented in **Table 8-2**. Section 3.3.1 discusses the definition of R value. In general, sub-basins with an R value greater than 5 percent are considered to have a high volume of RDI/I.

The calibrated R values were used to calculate the gallons of RDI/I entering each sub-basin for the representative 24 hour planning storm event. Sub-basins with high volumes of RDI/I per linear foot are good candidates for comprehensive sanitary sewer rehabilitation as the greatest amount of RDI/I can be removed per linear foot of sewer rehabilitated in these sub-basins. The 24 hour planning storm event was previously developed by CDM to size wet-weather improvements for the collection system as described in Section 3.4. The volume of RDI/I calculated for each sub-basin was divided by the footage of sewer in each sub-basin to obtain the volume of infiltration per linear foot of pipe. These values are reported in Table 8-2. This is the volume of RDI/I that might be expected to enter the sewer, if adequate capacity is available, resulting from the representative 24 hour storm event during the critical period for GWI (i.e., December to May). The 24 hour storm RDI/I volume is presented as a way of comparing the infiltration between sub-basins. The RDI/I per linear foot of sewer for each sub-basin is also shown in **Figure 8-3**. In general, sub-basins with an RDI/I per linear foot of sewer greater than 50 were considered good candidates for rehabilitation and RDI/I reduction. The value of 50 gallons per day per linear foot is project specific to KUB and was used to identify sub-basins where comprehensive rehabilitation was thought to reduce or eliminate a downstream capacity related improvement. Most sub-basins were predicted to have less than 25 gallons RDI/I per linear foot of sewer. One sub-basin, 36A4, has 51 to 75 gallons RDI/I per linear foot of sewer. Another sub-basin, 32A4, has between 76 and 100 gallons RDI/I per linear foot of sewer.

8.4 2045 Wet-Weather Storm Flows

As described in Section 3.4, a planning storm was used to predict the performance of the collection system during a representative 24 hour storm event. The planning storm and 2045 dry-weather flows were routed through the hydraulic model. The predicted pipe capacity at peak design storm flows is shown in **Figure 8-4**. Pipes were considered to be surcharged if the maximum predicted flow, Qmax, exceeded the design capacity of the sewer, Qdesign. Predicted overflow locations are also shown in **Figure 8-4**. Any overflow ranging from 10,000 gallons to 1,000,000 gallons is designated with a green dot. Any overflow ranging from 1 million to 2 million gallons is designated with a yellow dot. Predicted overflows in 2045 occur upstream of Walker Springs pump station and on Papermill Drive. SSOs have been reported in these areas. The model also predicts some other overflows in the collection system in the year 2045 during the 24 hour planning storm event.

Table 8-2: R Values and RDI/I for Fourth Creek Sewersheds

Sewershed	R Value (%)	RDII (gal/LF)[1]
27B1	0.7	6.4
27B2	4.0	35.7
27B3	0.6	4.7
27C1	3.2	14.6
27C2	3.5	21.3
27C3	1.0	7.4
27D1	4.4	36.3
32A1	1.9	18.2
32A1a	1.9	11.3
32A2	3.3	20.0
32A3	2.0	15.7
32A4	11.9	85.9
32A5	1.2	5.1
32B1	3.7	22.1
32B2	3.1	19.6
32B3	2.8	24.1
33A1	2.5	13.8
33A2	2.3	21.0
33A3	0.6	4.4
33A4	0.1	0.3
33A5	0.9	7.4
33B1	3.1	20.2
33B2	2.1	12.1
33B3	2.6	15.8
33B4	1.5	7.7
36A2	3.8	21.3
36A3	1.0	7.3
36A4	6.5	58.4
36A5	7.4	40.7
36B1	0.2	1.8
36B2	1.6	11.1
36B3	1.3	7.2
36B4	3.4	21.6
36B5	1.1	6.5
37A1	3.8	31.8
37A2	1.9	12.9
37A3	4.0	24.1
37A4	0.9	9.1
37B1	4.7	23.7
37C1	0.7	5.1
42	3.8	46.7
42A1	3.8	19.8
FUD2	3.8	29.9
WKUD1	1.4	10.9
WKUD2	0.4	2.9

[1] Represents predicted volume for a representative 24 hour storm.

LEGEND

- Pump Stations
- Trunk Sewers
- Force Mains

RDI/I (Gal Per LF)

- 0 - 25
- 26 - 50
- 51 - 75
- 76 - 100
- > 100

Scale: 1" = 5,000'

N

Walker Springs

WKUD

Ten Mile

Fourth Creek WWTP

Figure 8-3
Fourth Creek
RDI/I (Gal Per LF) By Sub-basin Predicted for 24 Hour Planning Event

CDM

LEGEND

- Pump Stations

Predicted Overflow Locations

- Less than 1 MG
- 1 - 2 MG

Pipe Condition

- Not Surcharged (Qmax < Qdesign)
- Surcharged (Qmax > Qdesign)
- Force Mains
- Fourth Creek Sewersheds

Scale: 1" = 5,000'

N

Ball Road Area

WKUD1
WKUD2
FUD2
35A5
32A1
32A1a
32A2
32A3
32A4
32A5
32B1
32B2
32B3
27A1
27B1
27B2
27B3
27C1
27C2
27C3
27D1
33A1
33A2
33A3
33A4
33A5
33B1
33B2
33B3
33B4
36A2
36A3
36A4
36A5
36B1
36B2
36B3
36B4
36B5
37A1
37A2
37A3
37A4
37B1
37C1
42
42A1

Walker Springs

Ten Mile

Fourth Creek WWTP

Figure 8-4
Fourth Creek
2045 24 Hour Storm

CDM

0002013

As explained in Sections 1.1 and 4.5, a total basin solution was developed for Fourth Creek to address future predicted wet-weather overflows. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution was analyzed to determine which are required to address the SSO locations on the Long-Term List.

8.5 Phase 1 CAP/ER Facility Improvements

The objective of the Phase 1 CAP/ER is to address SSOs identified on the Long-Term List of the SSOER in accordance with the CD. The SSOs listed on the Long-Term List that are capacity related are addressed by facility improvement projects as outlined for the Fourth Creek Basin in **Table 8-3**. This table lists all capacity related SSOs and a corresponding project ID, which addresses the SSO.

The SSOs on the Long-Term List that are not capacity related are addressed by either a "find and fix" facility improvement project or KUB's CSSAP Program. Many of the SSOs on the Long-Term List that are not capacity related are the result of a blockage (debris, grease, roots, etc.) that have been addressed by KUB's CSSAP Program. These include all the SSOs on the Long-Term List that have the designation "N/A" under the "Long Term Capital Project" field. However, if the source of the blockage could not be fixed by maintenance and re-occurred after flushing or root cutting, then these SSOs were assigned a "find and fix" facility improvement project. "Find and fix" facility improvement projects will first involve further investigation into the source of the SSO through the use of smoke testing, manhole inspection, and/or CCTV inspection. Next, a determination will be made of the type and extent of the improvement required to address the SSO. In some cases, the blockage may have been only partially removed and further flushing or cutting is required to address the SSO. In other cases, replacement of sagged pipe or lining of pipe to prevent root intrusion may be required.

Table 8-4 presents all SSOs on the Long-Term List that are not capacity related. In the project ID field is either a "find and fix" project ID that addresses the SSO or the designation "has been addressed by CSSAP Program", as discussed above.

Figure 8-5 presents a map showing the locations of all SSOs on the Long-Term List from 2001-2004 in Fourth Creek that require a facility improvement project to address the SSO. The SSOs are shown as green dots on the map. As discussed above, some SSOs on the Long-Term List were isolated cases of a blockage that have been addressed by the CSSAP Program and are not mapped on this figure.

The figure also shows the planned and completed facility projects to address the SSOs. Already completed improvement pipeline projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I and reducing the R value to 2 percent are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

0002014

Table 8-3: Fourth Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
5/6/03	1300 WOODRIDGE DR	MH 1	4-28
12/9/04	1300 WOODRIDGE DR	MH 2-1	4-28
12/9/04	1500 LYONS BEND RD (4TH CREEK)	Influent Structure	4-32
3/17/02	2621 CHUKAR RD	Building Backup	4-1
3/17/02	2645 CHUKAR RD	MH 69	4-1
2/25/03	309 BROOME RD	MH 2-1	4-17
9/22/02	310 WESTFIELD DR	Building Backup & MH 28	4-18, 4-4
6/17/04	310 WESTFIELD DR	Building Backup & MH 28-1	4-18, 4-4
9/22/02	310 WESTFIELD RD	MH 28	4-18, 4-4
6/17/04	310 WESTFIELD RD	MH 28 & 28-1	4-18, 4-4
2/6/04	310 WESTFIELD RD	MH 28-1	4-18, 4-4
1/23/02	4930 LONAS DR	MH 89	4-25
2/22/03	5501 NORTHSHORE DR	MH 6 & 7	4-19
2/6/04	600 N GALLAHER VIEW RD	MH 77	4-17
3/6/04	600 N GALLAHER VIEW RD	MH 77	4-17
6/27/04	600 N GALLAHER VIEW RD	MH 77	4-17
9/17/04	600 N GALLAHER VIEW RD	MH 77	4-17
11/24/04	600 N GALLAHER VIEW RD	MH 77	4-17
12/1/04	600 N GALLAHER VIEW RD	MH 77	4-17
12/7/04	600 N GALLAHER VIEW RD	MH 77	4-17
12/9/04	600 N GALLAHER VIEW RD	MH 77	4-17
2/16/03	6410 NORTHSHORE DR	MH 6 & 7	4-19
5/6/03	6410 NORTHSHORE DR	MH 7 & 8	4-19
11/24/04	6410 PAPERMILL DR	MH 22 & 23	4-18, 4-4
11/30/04	6410 PAPERMILL DR	MH 22 & 23	4-18, 4-4
12/7/04	6410 PAPERMILL DR	MH 22 & 23	4-18, 4-4
12/9/04	6410 PAPERMILL DR	MH 22 & 23	4-18, 4-4
3/13/03	6430 PAPERMILL DR	Lateral	4-18, 4-4
12/7/04	6500 PAPERMILL DR	MH 28	4-18, 4-4
6/25/04	6500 PAPERMILL DR	MH 28 & 28-1	4-18, 4-4
7/8/04	6500 PAPERMILL DR	MH 28, 28-1 & 29	4-18, 4-4
2/22/03	6500 PAPERMILL RD	MH 28	4-18, 4-4
9/22/02	6913 KINGSTON PIKE	Building Backup	4-18
9/21/02	NORTHSHORE DR & LYONS BEND RD	MH 7	4-19
5/6/03	PAPERMILL RD	MH 26, 27, 28 & 28-1	4-18
12/9/04	QUEENSBURY LIFT STATION	MH 1	4-28
3/18/02	WALKER SPRINGS RD & BROOME RD	MH 1-2A	4-17
1/27/02	WALKER SPRINGS RD & MARS HILL	Unidentified Manhole	4-17
2/27/03	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 77	4-17
5/6/03	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 77	4-17
7/2/03	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 77	4-17
11/6/03	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 77	4-17
11/19/03	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 77	4-17
2/16/03	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 78	4-17
2/22/03	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 78	4-17
10/3/02	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 77	4-17
12/5/02	WALKER SPRINGS RD & N GALLAHER VIEW RD	MH 77	4-17

1 SSOs from Long-Term List of SSOER that are capacity related. Non-capacity related SSOs are shown in Table 8-4.
2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 8-5 and shown on Figure 8-4.

Table 8-4: Fourth Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
3/9/02	109 GOLF CLUB RD	Building Backup	Addressed by CSSAP
12/31/03	1128 BURTON RD	Building Backup	Addressed by CSSAP
5/22/04	1215 ROCKY HILL RD	MH 55	Addressed by CSSAP
4/3/03	1215 ROCKY HILL RD	MH 55	Addressed by CSSAP
9/7/02	1304 KNOLLWOOD CIR	Cleanout	Addressed by CSSAP
2/1/02	1325 PARK GLEN RD	Building Backup	Addressed by CSSAP
6/4/01	1341 FRANCIS RD	Lateral	Addressed by CSSAP
1/31/01	1410 WRIGHTS FERRY RD at NORTHSHORE	Private MH	Addressed by CSSAP
1/3/03	1424 MARCONI DR	MH 49-11	Addressed by CSSAP
9/26/01	1476 LYONS BEND RD	MH 9-90	Addressed by CSSAP
6/17/04	1500 LYONS BEND RD (4TH CREEK)	PRIM. CLARS. 3, 4, 5 & 6	Addressed by CSSAP
9/22/04	1500 LYONS BEND RD (4TH CREEK)	Influent Structure	Addressed by CSSAP
11/24/04	1500 LYONS BEND RD (4TH CREEK)	Influent Structure	4-17
12/9/04	1500 LYONS BEND RD (4TH CREEK)	Tank Overflow	4-17
5/6/01	1713 WILSHIRE RD	MH 12-82	Addressed by CSSAP
6/25/02	1721 MIDPARK RD	MH 22-182	4-26
5/26/03	1732 POLKWRIGHT LN	Grinder Pump	Addressed by CSSAP
5/24/02	1805 JACKSON RD	MH 22-88	Addressed by CSSAP
3/12/03	1815 DOWNTOWN WEST BLVD	MH 9-29	Addressed by CSSAP
7/6/04	1900 LYONS BEND RD	Broken Force Main	Addressed by CSSAP
12/4/01	2010 COUNTRY HILL LN	Building Backup	Addressed by CSSAP
5/1/03	2039 PINEY GROVE CHURCH RD	MH 57-2	Addressed by CSSAP
5/10/02	2139 WILLOW CREEK LN	MH 65	Addressed by CSSAP
3/21/01	2313 BLACK BEAR RD	MH 57-64	4-21
3/15/01	2313 BLACK BEAR RD	MH 57-64	4-21
12/23/04	2405 CHIMNEY RIDGE RD	MH 69-21	Addressed by CSSAP
2/4/03	2408 ROBINSON RD	Building Backup	Addressed by CSSAP
2/11/03	2501 MISS ELLIE DR	MH 71	4-27
8/13/03	2501 MISS ELLIE DR	MH 71	4-27
1/16/03	2501 MISS ELLIE DR	MH 71	4-27
8/7/03	2501 MISS ELLIE DR	MH 71	4-27
10/14/01	2513 CHUKAR RD	MH 69-10	4-1
1/7/03	2624 CHUKAR RD	MH 69-30	4-1
1/8/03	2644 CHUKAR RD	MH 66	4-1
1/6/03	2644 CHUKAR RD	MH 67	4-1
10/31/02	309 BROOME RD	MH 2-1	Addressed by CSSAP
10/22/03	310 WESTFIELD DR	Building Backup	4-18, 4-4
5/16/04	3300 BRANCH HILL LN	MH 14 & 18	Addressed by CSSAP
5/13/04	3301 BRANCH HILL LN	MH 16 & 17	Addressed by CSSAP
9/12/01	410 CHUKAR RD	MH 67	4-1
10/17/01	4724 SANTALA DRIVE	Cleanout	Addressed by CSSAP
4/3/02	4920 JONQUIL DR	Building Backup	Addressed by CSSAP
3/25/02	4930 LONAS DR	MH 89	4-25
9/19/03	5103 KINGSTON PIKE	MH 58	Addressed by CSSAP
2/11/03	5113 PAPERMILL RD	Private MH	Addressed by CSSAP
10/21/02	5118 EVELYN DR	MH 83-80	Addressed by CSSAP
3/3/02	5121 PAPERMILL RD	MH 79-16	Addressed by CSSAP
6/21/01	519 MORRELL RD	Unidentified Manhole	Addressed by CSSAP
9/12/04	5205 BENT RIVER BLVD	Grinder Pump	4-23
9/10/04	5205 BENT RIVER BLVD	Grinder Pump	4-23
9/11/04	5205 BENT RIVER BLVD	Grinder Pump	4-23
9/13/03	5241 BENT RIVER BLVD	Grinder Pump	Addressed by CSSAP
9/9/03	5246 BENT RIVER BLVD	Grinder Pump	Addressed by CSSAP
11/30/04	5246 BENT RIVER BLVD	Grinder Pump	Addressed by CSSAP
7/20/03	5247 BENT RIVER BLVD	Grinder Pump	Addressed by CSSAP
9/21/03	5315 BENT RIVER BLVD	Grinder Pump	Addressed by CSSAP
12/20/01	5316 BENT RIVER BLVD	Broken Force Main	Addressed by CSSAP
9/29/04	5363 BENT RIVER BLVD	Grinder Pump	Addressed by CSSAP
7/29/01	5501 MIDDLEBROOK PK	Building Backup	Addressed by CSSAP
2/9/01	5507 PINELLAS DR	Building Backup	Addressed by CSSAP
2/1/02	5514 MIDDLEBROOK PK	Building Backup	Addressed by CSSAP
2/18/02	5601 MIDDLEBROOK PIKE	MH 22-192	Addressed by CSSAP
3/17/02	5612 NORTH CENTURY CT	Building Backup	Addressed by CSSAP

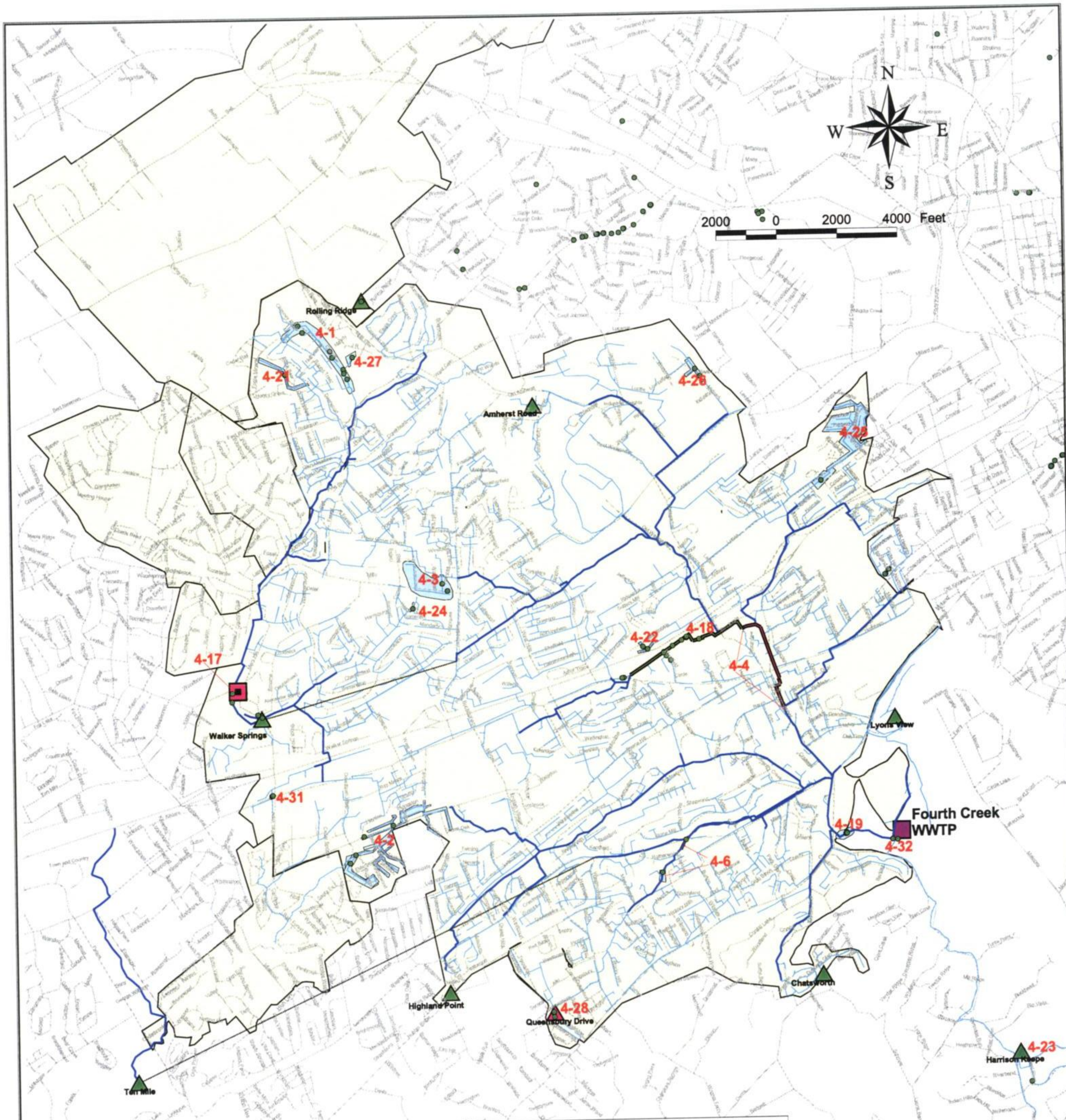
Table 8-4: Fourth Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
5/6/03	5909 WESTMERE DR	Lateral	Addressed by CSSAP
2/13/02	5912 WESTMERE DR	Cleanout	Addressed by CSSAP
7/13/04	5929 WESTOVER DR	MH 63-48	Addressed by CSSAP
7/8/03	6031 GRACE LN	MH 21-1	Addressed by CSSAP
11/25/04	606 VANOSDALE RD	MH 64-1	Addressed by CSSAP
7/8/04	6207 JANMER LN	MH 65-15	Addressed by CSSAP
5/6/04	6408 PAPERMILL DR	Broken Pipe	4-18, 4-4
10/29/03	6410 PAPERMILL DR	MH 23 & 24	4-18, 4-4
10/29/03	6410 PAPERMILL DR	Building Backup & MH 23 & 24	4-18, 4-4
6/21/02	6410 PAPERMILL RD	Broken Sewer	Addressed by CSSAP
10/5/04	6500 PAPERMILL DR	Underground Flow	4-18, 4-4
5/2/03	6500 PAPERMILL RD	MH 28	4-18, 4-4
6/26/02	6536 CREEKHEAD DR	MH 49-5	Addressed by CSSAP
11/11/03	6606 HOLT LN	Building Backup	Addressed by CSSAP
7/23/01	6613 WOODCOCK CR	Building Backup	4-1
12/3/04	6614 NIGHTINGALE LN	MH 19-19 & 19-21	4-22
12/6/04	6617 NIGHTINGALE LN	MH 19-21	4-22
12/21/04	6700 PAPERMILL DR	Broken Force Main	Addressed by CSSAP
12/21/04	6725 PAPERMILL RD	Building Backup	Addressed by CSSAP
5/10/02	6907 KINGSTON PIKE	Lateral	Addressed by CSSAP
5/10/02	6907 KINGSTON PIKE	Building Backup & Broken Lateral	4-18
5/10/02	6913 KINGSTON PIKE	Building Backup	4-18
11/18/04	7000 ROTHERWOOD DR	MH 30 & Lateral	4-6
11/14/02	7004 ROTHERWOOD DR	MH 30	Addressed by CSSAP
2/23/02	7011 ROCKINGHAM DR	Building Backup	Addressed by CSSAP
1/12/04	7020 GAINSBOROUGH DR	MH 32-77	Addressed by CSSAP
1/14/01	7023 ROCKINGHAM DR	Building Backup & MH 51-20	Addressed by CSSAP
9/21/01	7100 TRADITIONAL DR	MH 32-77	Addressed by CSSAP
4/22/01	7107 NORTHSHORE DR	Lateral	Addressed by CSSAP
3/9/03	7112 SHADYLAND DR	MH 36	4-6
11/13/02	7112 SHADYLAND DR	MH 36	4-6
4/7/02	7130 CHESHIRE DR	MH 3-157	Addressed by CSSAP
9/30/03	7316 DEANNE HILL RD	Building Backup	Addressed by CSSAP
3/19/01	7324 TOXAWAY DR	MH 49-87	Addressed by CSSAP
4/8/01	7350 MIDDLEBROOK PIKE	MH 49-98	4-3
9/24/02	7351 MIDDLEBROOK PIKE	Private MH	Addressed by CSSAP
9/22/03	7351 MIDDLEBROOK PK	Building Backup	4-3
2/16/04	7414 DEANE HILL DR	MH 3-81	Addressed by CSSAP
3/22/01	7424 MIDDLEBROOK PIKE	MH 49-98	4-3
6/29/02	7505 KERRI WAY	MH 4-115	4-24
11/5/02	7505 KERRI WAY	MH 4-115	4-24
6/9/01	7509 CHATHAM CIR	MH 49-68	Addressed by CSSAP
6/9/01	7509 CHATHAM CR	Building Backup & MH 49-68	Addressed by CSSAP
11/4/01	7545 CHATHAM CR	Broken Lateral	Addressed by CSSAP
12/30/04	7671 NORTHSHORE DR	MH 61-2	Addressed by CSSAP
12/22/04	7695 KINGSTON PIKE	Private MH	Addressed by CSSAP
9/5/02	7712 SHADYLAND DR	MH 36	4-6
11/22/03	7804 LUSCUMBE DR	Building Backup	Addressed by CSSAP
11/8/02	7924 HAYDEN DR	Building Backup	Addressed by CSSAP
7/18/01	801 MARLBORO RD	MH 4-62	Addressed by CSSAP
12/19/01	8013 GLEASON DR	Building Backup	4-2
4/12/01	8020 BENNINGTON DR	Building Backup	Addressed by CSSAP
7/21/01	8044 GLEASON DR	MH 14-2	4-2
7/15/02	8044 GLEASON DR	MH 15	4-2
7/21/01	8044 GLEASON RD	Broken Lateral & MH 14-2	4-2
11/25/02	8079 KINGSTON PIKE	MH 9-10	Addressed by CSSAP
8/15/04	8140 HAYDEN DR	MH 26-7	Addressed by CSSAP
5/12/01	8145 HAYDEN DR	Building Backup	Addressed by CSSAP
3/25/04	817 CRESWELL CT	MH 3-4	Addressed by CSSAP
7/22/04	8373 KINGSTON PIKE	Broken Pipe	Addressed by CSSAP
12/26/02	8401 KINGSTON PIKE	Cleanout	Addressed by CSSAP
4/3/01	8401 KINGSTON PIKE	Building Backup	4-31
12/26/02	8401 KINGSTON PIKE	2 Building Backup	4-31

Table 8-4: Fourth Creek Non-Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
2/14/01	8403 KINGSTON PIKE	Building Backup	4-31
3/28/01	900 PINEY GROVE CHURCH RD	Lateral	Addressed by CSSAP
7/6/01	BAUM DR & WEISGARBER	MH 25-7	Addressed by CSSAP
3/17/02	FOURTH CREEK WWTP	Influent Structure	Addressed by CSSAP
4/19/02	FOURTH CREEK WWTP	Influent Structure	Addressed by CSSAP
12/11/03	FOURTH CREEK WWTP	Influent Structure	4-32
2/15/03	FOURTH CREEK WWTP	Influent Structure	4-32
2/16/03	FOURTH CREEK WWTP	Influent Structure	4-32
5/6/03	FOURTH CREEK WWTP	Influent Structure	4-32
3/18/02	FOURTH CREEK WWTP	Influent Structure	4-32
5/15/03	FOURTH CREEK WWTP	Influent Structure	4-32
7/9/03	FOURTH CREEK WWTP	Influent Structure	4-32
2/6/01	HARRISON KEEPE LIFT STATION FORCE MAIN	Broken Force Main	Addressed by CSSAP
4/30/02	MIDPARK RD & BEARD DR	MH 22-181	4-26
1/27/02	NUBBIN RIDGE DR & SHADYLAND DRIVE	MH 39-3	Addressed by CSSAP
1/14/01	ROCKINGHAM DR & WEST HILLS	MH 51-20	Addressed by CSSAP
2/20/01	WALKER SPRINGS LIFT STATION	Wetwell	Addressed by CSSAP
9/17/01	WALKER SPRINGS RD & N GALLAHER VIEW RD	Broken Sewer	Addressed by CSSAP

1 SSOs from Long-Term List of SSOER that are non-capacity related. Capacity related SSOs are shown in Table 8-3.
2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 8-5 and shown on Figure 8-4.



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Fourth Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure 8-5

0002019

Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in the SSO Tables 8-3 and 8-4. **Table 8-5** lists all the projects on the map and a description of each project. Section 12 presents the Phase 1 CAP/ER implementation plan that provides start and end dates for each of these projects.

As Table 8-5 and Figure 8-4 detail for the Fourth Creek Basin, several projects have already been completed, and the additional facility improvements required for the Phase 1 CAP/ER include the following:

- Several trunk sewer replacement projects
- An equalization storage tank
- Pump station upgrade
- Several "find and fix" sewer rehabilitation projects

0002020

Table 8-5: Fourth Creek Project Descriptions

Project ID	Project Name	Project Description[1]
4-1	Chukar Road Rehabilitation (Sub-basin 32A3) Project	Find and fix work to identify and address cause of overflow in the vicinity of 410, 2513, 2621, 2624, 2644, and 2645 Chukar Road.
4-2	Gleason Drive Collector Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 8013 and 8044 Gleason Drive.
4-3	Middlebrook Pike Rehabilitation (Sub-basin 27C3) Project	Find and fix work to identify and address cause of overflow in the vicinity of 7350, 7351, and 7424 Middlebrook Pike.
4-4	Northshore Drive Trunk Replacement Project	Replace approximately 3,600 lf of existing sewer with 36-in sewer (IAP 2).
4-6	Shadyland Drive Rehabilitation (Sub-basin 36A2) Project	Find and fix work to identify and address cause of overflow in the vicinity of 7000 Rotherwood Drive and 7112 and 7712 Shadyland Drive.
4-17	Storage Tank	Storage upstream of Walker Springs Pump Station.
4-18	Papermill Phases I, II, and III Project	Replace approximately 3,500 lf of existing sewer with 15-in sewer and approximately 1,000 lf with 36-in sewer.
4-19	Northshore Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5501 and 6410 Northshore Drive and Northshore Drive and Lyons Bend Road.
4-21	Black Bear Road Project	Find and fix work to identify and address cause of overflow in the vicinity of 2313 Black Bear Road.
4-22	Nightingale Lane Project	Find and fix work to identify and address cause of overflow in the vicinity of 6614 and 6617 Nightingale Lane.
4-23	5205 Bent River Blvd Project	Find and fix work to identify and address cause of overflow in the vicinity of 5205 Bent River Boulevard.
4-24	Kerri Way Project	Find and fix work to identify and address cause of overflow in the vicinity of 7505 Kerri Way.
4-25	Lonas Drive Project	Find and fix work to identify and address cause of overflow in the vicinity of 4930 Lonas Drive.

Table 8-5: Fourth Creek Project Descriptions

Project ID	Project Name	Project Description[1]
4-26	Midpark Drive Project	Find and fix work to identify and address cause of overflow in the vicinity of 1721 Midpark and Midpark and Beard Drive.
4-27	Southfork Project	Find and fix work to identify and address cause of overflow in the vicinity at 2501 Miss Ellie Drive (private).
4-28	Queensridge Pump Station Upgrade Project	Upsize Queensridge Pump Station.
4-31	Kingston Pike @ Gallahar View Project	Find and fix work to identify and address cause of overflow in the vicinity of 8401 and 8403 Kingston Pike.
4-32	PCP, CPE, and CCP	Wastewater evaluation studies of the Fourth Creek WWTP.

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Section 9
South Knoxville/Knob Creek

9.1 Hydraulic Model Description

The South Knoxville/Knob Creek model consists of just over 30 miles of trunk sewer and includes all major sewer pipes 10-inches in diameter or larger as shown in **Figure 9-1**. Sewers in the southwest portion of the basin upstream of the Woodson pump station are not modeled since the pipes in this area are smaller than 10-inches in diameter. The South Knoxville/Knob Creek model includes eight modeled pump stations: Woodson, Neubert Springs, Jones, Chapman Highway, Cruze Road, McNutt, Power Park, and Ford Valley. The McNutt pump station pumps into the trunk sewer upstream of Ford Valley pump station. Ford Valley pump station pumps flow to Chapman Highway pump station. The Chapman Highway pump station conveys flow to the Neubert Springs pump station. The Neubert Springs pump station pumps to the sewer along West Martin Mill Pike. The Woodson pump station conveys flow from the southwestern portion of Knob Creek to the trunk sewer along Edington Road. The Cruze Road pump station pumps to the gravity system upstream of the Jones Street pump station. The Jones Street pump station pumps flow to the river interceptor at the base of Second Creek before eventually flowing onward to Kuwahee WWTP. The Power Park pump station conveys flow to the sewer upstream of the Woodson pump station. The South Knoxville/Knob Creek hydraulic model also includes a double barrel siphon under the Tennessee River feeding in upstream of the Kuwahee WWTP. All South Knoxville flows are treated at the Kuwahee WWTP.

9.2 Existing and Future Dry-Weather Model Analysis

To calibrate the model to dry-weather conditions, the output flows produced by the simulation using 2004 dry-weather input hydrographs were matched against the flows measured by the meters in the 2004 flow monitoring program. The 2004 flow monitoring program is discussed in Section 2. The dry-weather calibration procedure is described in Section 4.2.3. A summary of the average 2004 calibrated dry-weather flows for each sub-basin is presented in **Table 9-1**. The 2004 average dry-weather flow in South Knoxville/Knob Creek is 5.1 mgd. As discussed in Section 3.2.4, dry-weather flows in South Knoxville/Knob Creek were projected for year 2045. The 2045 wastewater flow components for South Knoxville/Knob Creek sub-basins are also shown in **Table 9-1**. The total dry-weather South Knoxville/Knob Creek flow is predicted to increase to 6.1 mgd in 2045.

Peak dry-weather flows in 2045 were simulated based on the 2045 flow projections. The percent of pipe capacity used during peak dry-weather flow is shown in **Figure 9-2**. The figure color codes the pipe according to the capacity used. Yellow indicates that between 75 and 100 percent of the pipe capacity is used to convey the peak dry-weather flow. Red indicates that over 100 percent of the pipe capacity is required to

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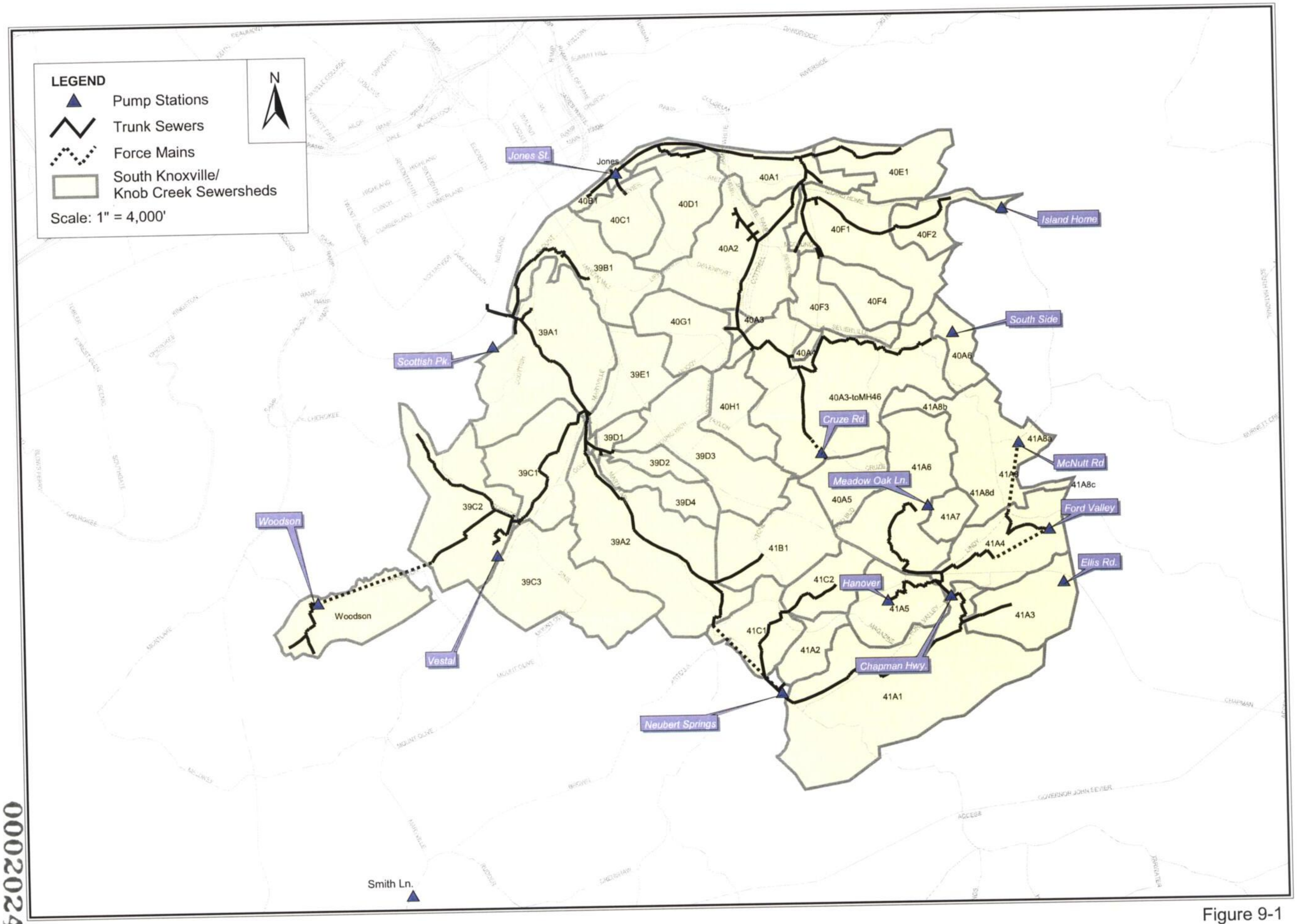

Figure 9-1
South Knoxville/Knob Creek
Hydraulic Model

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Table 9-1: South Knoxville/Knob Creek Average Dry-Weather Flows

Sewershed	2004 Dry-Weather Flow (mgd)	2045 Dry-Weather Flow (mgd)
39A1	0.56	0.68
39A2	0.06	0.07
39B1	0.21	0.23
39C1	0.31	0.37
39C2	0.10	0.26
39C3	0.34	0.38
39D1	0.01	0.01
39D2	0.09	0.10
39D3	0.07	0.08
39D4	0.09	0.10
39E1	0.16	0.18
40A1	0.05	0.06
40A2	0.38	0.45
40A3	0.24	0.27
40A4	0.002	0.00
40A5	0.02	0.02
40B1	0.01	0.01
40C1	0.20	0.20
40D1	0.02	0.03
40E1	0.06	0.07
40F1	0.56	0.66
40F2	0.04	0.04
40F3	0.07	0.08
40F4	0.12	0.14
40G1	0.15	0.17
40H1	0.05	0.06
41A1	0.11	0.08
41A2	0.02	0.02
41A3	0.05	0.05
41A4	0.16	0.20
41A5	0.08	0.10
41A6	0.37	0.52
41A8	0.13	0.11
41B1	0.05	0.06
41C1	0.08	0.09
41C2	0.04	0.05
Woodson	0.06	0.06
Total	**5.1**	**6.1**

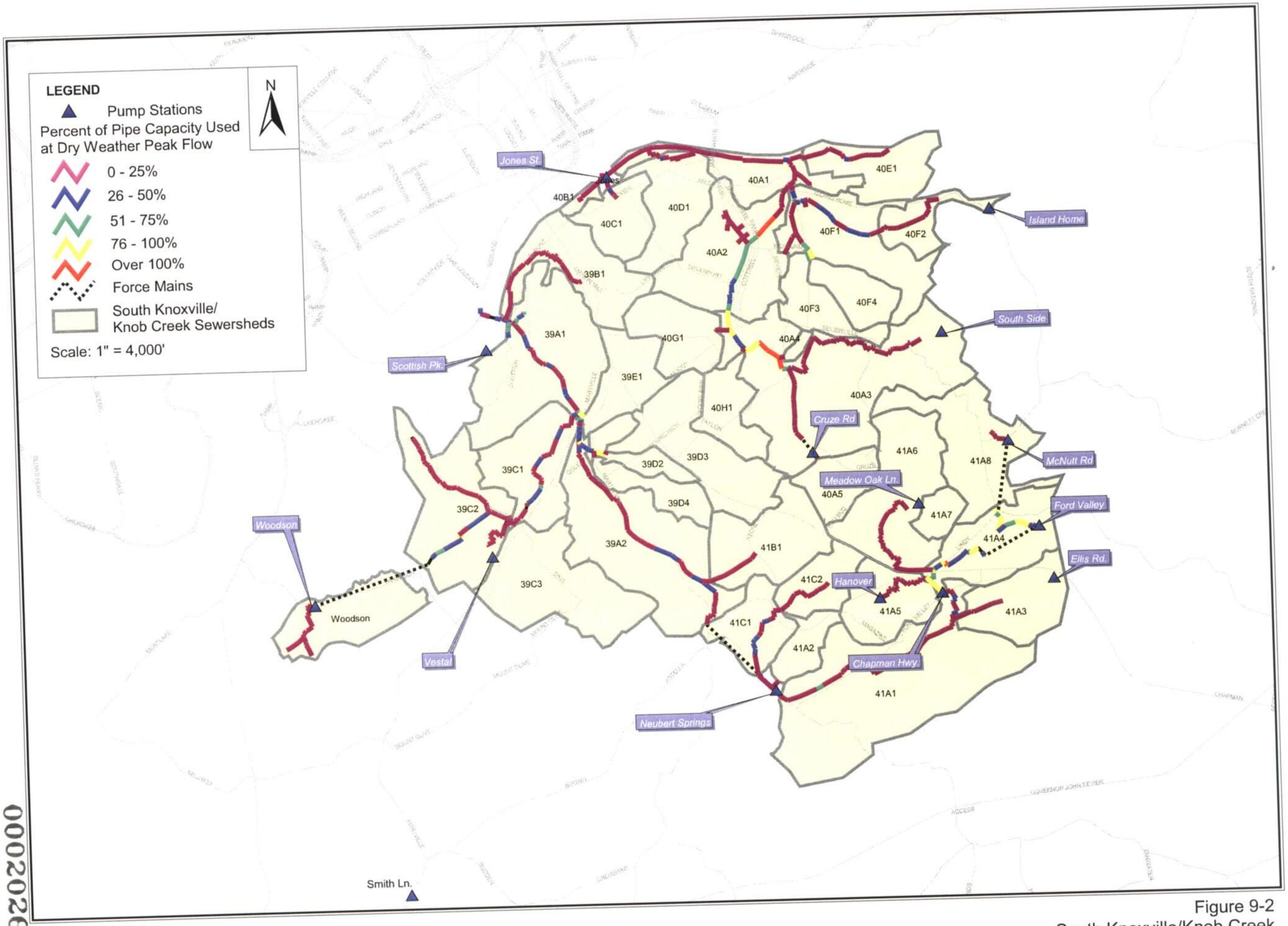

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Figure 9-2
South Knoxville/Knob Creek
2045 Dry Weather Flows

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convey the peak dry-weather flow. Pipes in either category would be recommended for upgrading. New pipe is typically designed such that less than 50 percent of the pipe capacity is used under peak dry-weather flow conditions, and as discussed in the next section, more than 50 percent of the pipe capacity may be needed to convey wet-weather flows in a system with high RDI/I. Based on the above criteria, several pipe segments north of the Cruze Road area are modeled to be between 75 and 100 percent of their capacity for projected dry-weather flows and thus are good candidates for future upgrading. Portions of the pipe segments between the Ford Valley pump station force main and the Chapman Highway pump station are also modeled between 75 and 100 percent capacity under future conditions.

9.3 Existing and Future Wet-Weather Model Analysis

To calibrate the model to wet-weather conditions, the output flows produced by the simulation using a real storm event were matched against the flows measured by the meters during that storm event. Where necessary, adjustments to hydrograph model load points were made so that each flow monitor reasonably matched the flow predicted at the same location in the model. The wet-weather calibration procedure is described in Section 4.3.3.

The calibration storm event chosen for South Knoxville/Knob Creek was the April 12, 2004 rainfall event. This was one of the largest events recorded during the 2004 flow monitoring period and produced the largest I/I into the sewer. R values were calculated for each of the sub-basins for the calibration storm event and are presented in **Table 9-2**. Section 3.3.1 discusses the definition of R value. In general, sub-basins with an R value greater than 5 percent are considered to have a high volume of RDI/I.

The calibrated R values for this event were used to calculate the gallons of RDI/I entering each sub-basin for the representative 24 hour planning storm event. The 24 hour planning storm event was previously developed by CDM to size wet-weather improvements for the collection system as described in Section 3.4. The volumes of RDI/I calculated for each sub-basin were divided by the footage of sewer in each sub-basin to obtain the volume of infiltration per linear foot of pipe. These values are reported in Table 9-2. This is the volume of RDI/I that might be expected to enter the sewer, if adequate capacity is available, resulting from the representative 24 hour storm event during the critical period for GWI (i.e., December to May). The 24 hour storm RDI/I volume is presented as a way of comparing the infiltration between sub-basins. The RDI/I per linear foot of sewer for each sub-basin is shown in **Figure 9-3**. In general, sub-basins with an RDI/I per linear foot of sewer greater than 50 are good candidates for rehabilitation and RDI/I reduction. None of the sub-basins was predicted to have over 50 gallons RDI/I per linear foot.

9.4 2045 Wet-Weather Storm Flows

As described in Section 3.4, a planning storm was used to predict to the performance of the collection system during a representative 24 hour storm event. The planning

Table 9-2: R Values and RDI/I for South Knoxville/Knob Creek Sewersheds

Sewershed	R Value %	RDII (gal/LF)[1]
39A1	3.5	8.0
39A2	4.4	15.7
39B1	2.1	10.5
39C1	6.3	23.9
39C2	2	8.4
39C3	2	11.1
39D2	4.5	15.1
39D3	4.14	20.8
39D4	3.6	12.8
39E1	7.2	21.7
40A1	3.4	11.5
40A2	3.5	11.6
40A3	1.6	15.6
40A4	1.6	14.6
40A5	5	24.0
40B1	1.9	11.3
40C1	1.9	5.1
40D1	1.9	5.7
40E1	3	26.6
40F1	2.6	10.4
40F2	3.2	12.6
40F3	4.5	19.5
40F4	2.7	12.6
40G1	3.2	15.2
40H1	2.6	13.7
41A1	9.1	38.0
41A2	4.3	11.5
41A3	7.7	27.1
41A4	9.1	32.5
41A5	2.4	9.3
41A6	2.1	9.4
41A8	7.5	27.0
41B1	4.4	14.9
41C1	4.3	11.8
41C2	4.3	14.8
WOODSON	4.9	17.1

[1] Represents predicted volume for a representative 24 hour storm.

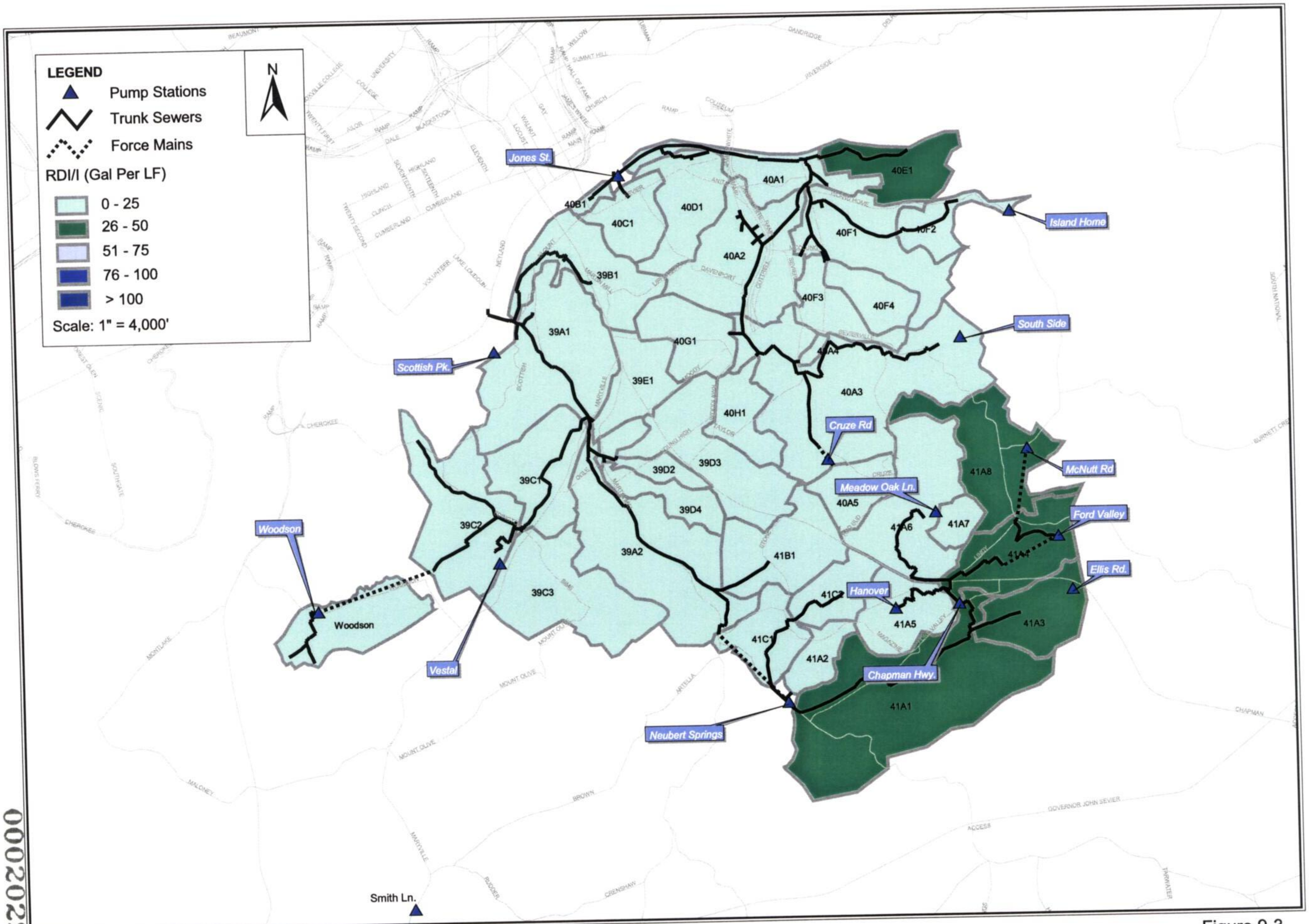

Figure 9-3
South Knoxville/Knob Creek
RDI/I (Gal Per LF) By Sub-basin Predicted for 24 Hour Planning Event

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storm and 2045 dry-weather flows were routed through the hydraulic model. The predicted pipe capacity at peak planning storm flows is shown in **Figure 9-4**. As shown in the figure, the hydraulic analysis predicts that the majority of the trunk sewers will be surcharged. Pipes were considered to be surcharged if the maximum predicted flow, Qmax, exceeded the design capacity of the sewer, Qdesign. Predicted overflow locations are also shown in Figure 9-4. Any overflow ranging from 10,000 gallons to 1,000,000 gallons is designated with a green dot. Any overflow ranging from 1 million to 2 million gallons is designated with a yellow dot. Areas previously indicated in Section 9.2 as being at or near capacity during projected dry-weather flows are also of concern during wet-weather flows. The area in the vicinity of 4th and Hoitt, as well as areas near Neubert Springs pump station and Meadow Oaks are projected to surcharge pipe capacities. In some instances, predicted overflows are indicated in the existing system in the Mary Vestal pump station, 4th and Hoitt, E. Moody / Davenport Road, Cruze Road pump station, and McNutt / Ford Valley pump station areas.

As explained in Sections 1.1 and 4.5, a total basin solution was developed for South Knoxville/Knob Creek to address future predicted wet-weather overflows. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution was analyzed to determine which are required to address the SSO locations on the Long-Term List.

9.5 Phase 1 CAP/ER Facility Improvements

The objective of the Phase 1 CAP/ER is to address SSOs identified on the Long-Term List of the SSOER in accordance with the CD. The SSOs listed on the Long-Term List that are capacity related are addressed by facility improvement projects as outlined for the South Knoxville/Knob Creek Basin in **Table 9-3**. This table lists all capacity related SSOs and a corresponding project ID, which addresses the SSO.

The SSOs on the Long-Term List that are not capacity related are addressed by either a "find and fix" facility improvement project or KUB's CSSAP Program. Many of the SSOs on the Long-Term List that are not capacity related are the result of a blockage (debris, grease, roots, etc.) that have been addressed by KUB's CSSAP Program. These include all the SSOs on the Long-Term List that have the designation "N/A" under the "Long Term Capital Project" field. However, if the source of the blockage could not be fixed by maintenance and re-occurred after flushing or root cutting, then these SSOs were assigned a "find and fix" facility improvement project. "Find and fix" facility improvement projects will first involve further investigation into the source of the SSO through the use of smoke testing, manhole inspection, and/or CCTV inspection. Next, a determination will be made of the type and extent of the improvement required to address the SSO. In some cases, the blockage may have been only partially removed and further flushing or cutting is required to address the SSO. In other cases, replacement of sagged pipe or lining of pipe to prevent root intrusion may be required.

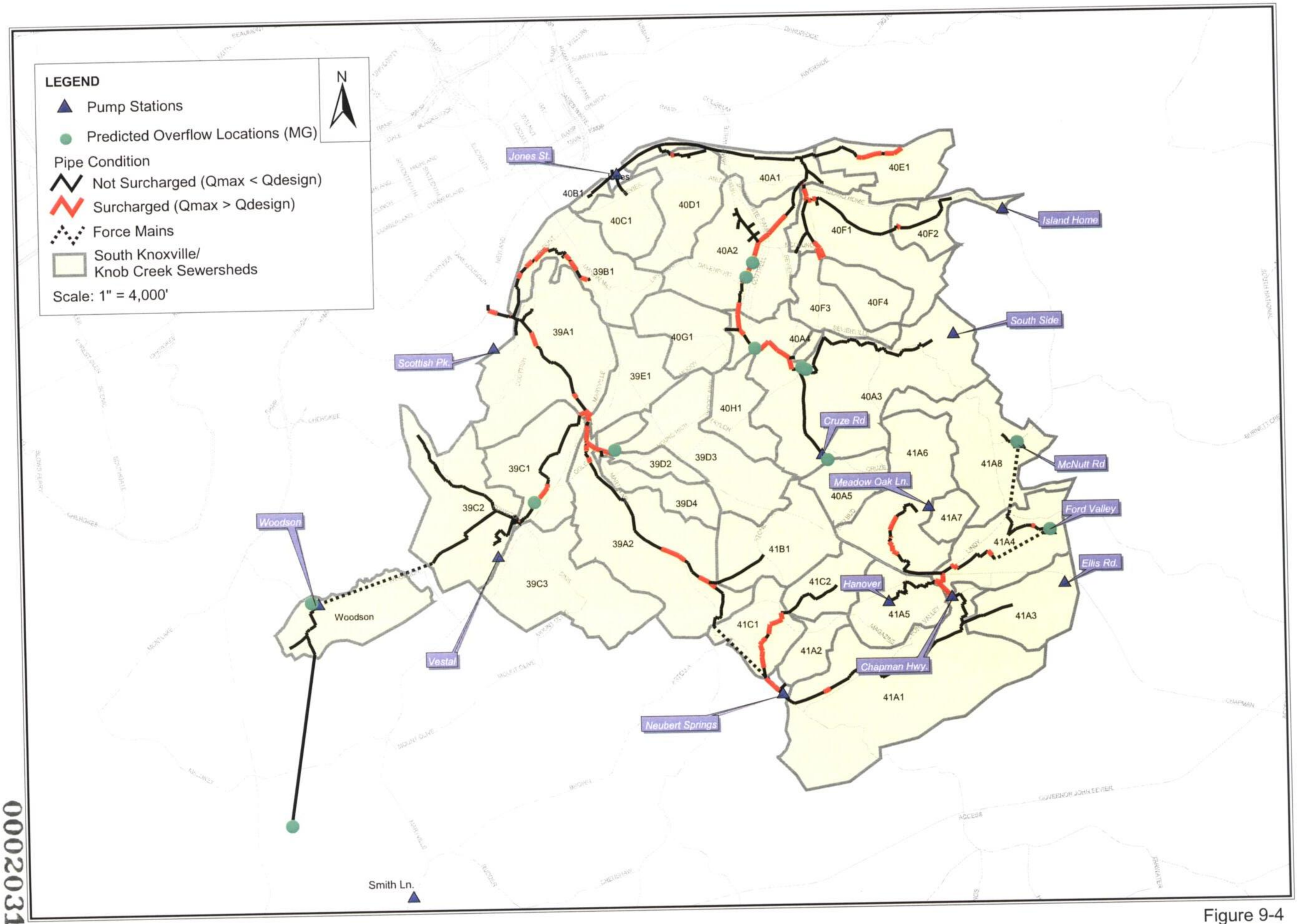

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Figure 9-4
South Knoxville/Knob Creek
2045 Wet Weather Flows

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Table 9-3: South Knoxville / Knob Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
6/17/04	1210 E MOODY AVE	MH 39	S-15
6/25/04	1210 E MOODY AVE	MH 39	S-15
7/27/04	1210 E MOODY AVE	MH 39	S-15
12/9/04	1210 E MOODY AVE	MH 39	S-15
7/29/01	1210 E MOODY AVE	Building Backup	S-15
3/17/02	130 CHAPPELL RD	MH 33	S-9
2/22/03	130 CHAPPELL RD	MH 61-1	S-9
12/9/04	212 ELLIS RD	MH 49-15 & 49-14	S-9
2/6/04	212 ELLIS RD	MH 49-15 & VALVE BOX	S-9
12/7/04	212 ELLIS ROAD	MH 49-15	S-9
5/3/02	2600 WOODSON DR	MH 2-1	S-16
4/10/03	2600 WOODSON DR	MH 2-1	S-16
5/5/03	2600 WOODSON DR	MH 2-1	S-16
2/17/01	2717 HACKMAN ST	MH 24-34	S-18, S-26, S-25
1/19/02	300 STONE RD	MH 8-44	S-14
1/23/02	300 STONE RD	MH 8-44	S-14
12/9/04	3301 WEST BLOUNT AVE	MH 14	S-28
12/13/01	3401 BLOUNT AVE	MH 16	S-28
3/17/02	3420 BLOUNT AVE	MH 16	S-28
2/22/03	3420 BLOUNT AVE	MH 16	S-28
1/19/02	3430 BLOUNT AVE	MH 16	S-28
1/23/02	3430 BLOUNT AVE	MH 16	S-28
2/17/03	3430 BLOUNT AVE	MH 15	S-28
12/13/01	3812 BLOUNT AVE	MH 29-1	S-2
1/19/02	3821 BLOUNT AVE	MH 29	S-2
1/23/02	3821 BLOUNT AVE	MH 29	S-2
1/19/02	3821 BLOUNT AVE	MH 29-1	S-2
1/23/02	3821 BLOUNT AVE	MH 29-1	S-2
4/10/03	3821 BLOUNT AVE	MH 29	S-2
7/30/01	3821 MARYVILLE PIKE & MARY VESTAL	MH 27-1	S-2
7/14/03	3821 W BLOUNT AVE	MH 29-2	S-2
7/10/03	3821 W BLOUNT AVE	MH 29-2 & 30	S-2
2/6/04	4105 W MARTIN MILL PIKE	MH 61-1	S-2
12/10/04	4105 W MARTIN MILL PIKE	MH 61-1	S-2
1/23/02	4111 MARTIN MILL PIKE	MH 31	S-2
12/1/04	436 MARYVILLE PIKE	MH 30	S-2
6/25/04	438 MARYVILLE PIKE	MH 29-2 & 30	S-2
12/9/04	438 MARYVILLE PIKE	MH 29-2 & 30	S-2
2/6/04	438 MARYVILLE PIKE	MH 30	S-2
3/6/04	438 MARYVILLE PIKE	MH 30	S-2
12/7/04	438 MARYVILLE PIKE	MH 30	S-2
11/24/04	438 MARYVILLE PIKE	MH 30 & 29-2	S-2
2/16/03	5230 MCNUTT RD	Building Backup	S-17
3/6/04	6205 THOMAS RD	Building Backup & MH 77	S-24 and S-27
2/6/04	6208 THOMAS RD	MH 77	S-24 and S-27
3/6/04	6208 THOMAS RD	MH 77	S-24 and S-27
2/22/03	6208 THOMAS RD	MH 77	S-24 and S-27
1/23/02	6516 JACKIE LN	MH 49-15	S-9
3/18/02	6528 JACKIE LN	MH 49-14	S-9
12/9/04	6555 CHAPMAN HWY	Building Backup & MH 49-	S-9
3/8/04	925 MARYVILLE PIKE	MH 27-344 & 27-345	S-19
9/17/04	925 MARYVILLE PIKE	MH 27-344 & 27-345	S-19
2/7/04	925 MARYVILLE PIKE	MH 27-345	S-19
12/9/04	925 MARYVILLE PIKE	MH 27-345, 27-40 & 27-33	S-19

Table 9-3: South Knoxville / Knob Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
11/19/03	925 MARYVILLE PIKE	MH 27-344 & 27-345	S-19
11/12/03	925 MARYVILLE PIKE	MH 27-345	S-19
1/19/01	BLOUNT AVE & MARTIN MILL PIKE	MH 29	S-2
2/22/01	BLOUNT AVE & MARTIN MILL PIKE	MH 29	S-2
3/17/02	BLOUNT AVE & MARTIN MILL PIKE	MH 29	S-2
5/3/02	BLOUNT AVE & MARYVILLE PIKE	MH 29 & 29-1	S-2
2/15/03	BLOUNT AVE & MARYVILLE PIKE	MH 29 & 29-1	S-2
2/22/03	BLOUNT AVE & MARYVILLE PIKE	MH 29 & 29-1	S-2
2/15/01	BLOUNT AVE & MARYVILLE PIKE	MH 29-1 to 29-11	S-2
1/19/01	BLOUNT AVE & MCCARTY AVE	MH 15	S-28
2/22/01	BLOUNT AVE & MCCARTY AVE	MH 15	S-28
5/7/03	CHAPMAN HWY & ELLIS RD	MH 49-14	S-9
5/6/03	CHAPMAN HWY & ELLIS RD	MH 49-15	S-9
7/12/04	FORD VALLEY LIFT STATION	MH 79	S-11
11/24/04	FORD VALLEY LIFT STATION	MH 79	S-11
12/7/04	FORD VALLEY LIFT STATION	MH 79	S-11
12/9/04	FORD VALLEY LIFT STATION	MH 79	S-11
2/6/04	FORD VALLEY LIFT STATION	Wetwell	S-11
3/6/04	FORD VALLEY LIFT STATION	Wetwell	S-11
6/25/04	FORD VALLEY LIFT STATION	Wetwell	S-11
2/23/01	FORD VALLEY LIFT STATION	MH 79	S-11
4/13/01	FORD VALLEY LIFT STATION	MH 79	S-11
7/29/01	FORD VALLEY LIFT STATION	MH 79	S-11
1/19/02	FORD VALLEY LIFT STATION	MH 79	S-11
1/24/02	FORD VALLEY LIFT STATION	MH 79	S-11
1/25/02	FORD VALLEY LIFT STATION	MH 79	S-11
3/18/02	FORD VALLEY LIFT STATION	MH 79	S-11
3/19/02	FORD VALLEY LIFT STATION	MH 79	S-11
2/16/03	FORD VALLEY LIFT STATION	Wetwell	S-11
5/7/03	FORD VALLEY LIFT STATION	Wetwell	S-11
5/22/01	GINNBROOKE LIFT STATION	MH 22	S-1
6/25/01	GINNBROOKE LIFT STATION	MH 22	S-1
6/29/01	GINNBROOKE LIFT STATION	MH 22	S-1
7/29/01	GINNBROOKE LIFT STATION	MH 22	S-1
9/21/02	GINNBROOKE LIFT STATION	MH 22	S-1
5/6/03	MARYVILLE PIKE & BLOUNT AVE	MH 29-2 & 30	S-2
9/22/02	MCCLUNG AVE & SOUTH HAVEN RD	Unidentified Manhole	S-18, S-26
2/6/04	MCNUTT LIFT STATION	MH 95	S-17
12/9/04	MCNUTT LIFT STATION	MH 95	S-17
2/22/03	MCNUTT ROAD LIFT STATION	MH 95	S-17
1/19/02	MCNUTT ROAD LIFT STATION	MH 95	S-17
1/24/02	MCNUTT ROAD LIFT STATION	MH 95	S-17
3/18/02	MCNUTT ROAD LIFT STATION	MH 95	S-17
3/19/02	MCNUTT ROAD LIFT STATION	MH 95	S-17
7/29/01	NEUBERT SPRINGS LIFT STATION	Wetwell	S-5
3/18/02	NEUBERT SPRINGS LIFT STATION	Wetwell	S-5
3/19/02	NEUBERT SPRINGS LIFT STATION	Wetwell	S-5
3/18/02	WOODSON DR & DEANBROOK RD	MH 2-1	S-16
2/14/03	WOODSON DR & DEANBROOK RD	MH 2-1	S-16
2/22/03	WOODSON DR & DEANBROOK RD	MH 2-1	S-16
5/11/03	WOODSON DR & DEANBROOK RD	MH 2-1	S-16
9/21/02	WOODSON LIFTSTATION	MH 2-1	S-16

1 SSOs from Long-Term List of SSOER that are capacity related. Non-capacity related SSOs are shown in Table 9-4.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 9-5 and shown on Figure 9-4.

Table 9-4 presents all SSOs on the Long-Term List that are not capacity related. In the project ID field is either a "find and fix" project ID that addresses the SSO or the designation "has been addressed by CSSAP Program", as discussed above.

Figure 9-5 presents a map showing the locations of all SSOs on the Long-Term List from 2001-2004 in South Knoxville/Knob Creek that require a facility improvement project to addresss. The SSOs are shown as green dots on the map. As discussed above, some SSOs on the Long-Term List were isolated cases of a blockage that have been addressed by the CSSAP Program and are not mapped on this figure.

The figure also shows the planned and completed facility projects to address the SSOs. Already completed improvement pipeline projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I and reducing the R value to 2 percent are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in the SSO Tables 9-3 and 9-4. **Table 9-5** lists all the projects on the map and a description of each project. Section 12 presents the Phase 1 CAP/ER implementation plan that provides start and end dates for each of these projects.

As Table 9-5 and Figure 9-5 detail for the South Knoxville/Knob Creek Basin, several projects have already been completed, and the additional facility improvements required for the Phase 1 CAP/ER include the following:

- Trunk sewer replacement
- A storage facility
- Rehabilitation to an R of 2 percent in several sub-basins
- Numerous "find and fix" sewer rehabilitation projects

Table 9-4: South Knoxville/Knob Creek Non Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
3/22/04	1024 VALLEY AVE	Building Backup	Addressed by CSSAP
12/25/03	1025 VALLEY AVE	Underground Flow	Addressed by CSSAP
3/7/02	106 ROYAL HEIGHTS DR	Building Backup	Addressed by CSSAP
5/4/02	1103 VALLEY AVE	Building Backup	Addressed by CSSAP
10/5/03	1115 SPRUCE DR	Building Backup	Addressed by CSSAP
1/10/03	1121 MOODY AVE	MH 40-4	Addressed by CSSAP
12/5/03	1127 MOODY AVE	MH 40-3	Addressed by CSSAP
7/11/03	117 LAKE FOREST CIR	MH 67-82	Addressed by CSSAP
3/30/04	119 CHILDRESS ST	Storm Sewer	Addressed by CSSAP
1/24/02	120 OVERBROOK DR	Building Backup	Addressed by CSSAP
4/16/04	121 WYNN ST	Building Backup	Addressed by CSSAP
7/9/02	1413 TAYLOR RD	MH 57-87	Addressed by CSSAP
7/10/03	1413 TAYLOR RD	MH 57-87	Addressed by CSSAP
9/29/04	1744 HILLWOOD DR	Building Backup	Addressed by CSSAP
12/27/04	1822 PRICE AVE	Building Backup	Addressed by CSSAP
3/18/02	1824 LENLAND AVE	MH 24-134	Addressed by CSSAP
2/6/04	1827 PRICE AVE	MH 24-222 & 24-223	Addressed by CSSAP
3/1/03	200 BRANCROFF DR	Building Backup	Addressed by CSSAP
1/5/04	200 KEEBLE AVE	MH 62-67	Addressed by CSSAP
12/31/02	202 MAPLE LOOP RD	Building Backup	Addressed by CSSAP
6/29/04	205 LINDY DR	MH 70-3	Addressed by CSSAP
1/31/02	2313 SOUTH HAVEN RD	Broken Sewer	S-2
4/12/04	2320 CHAPMAN HWY	Private MH	Addressed by CSSAP
12/26/03	2320 CHAPMAN HWY	Building Backup	Addressed by CSSAP
10/2/01	2323 BLOUNT AVE	MH 2-9	Addressed by CSSAP
1/15/01	2327 SOUTH HAVEN RD	MH 24-30	Addressed by CSSAP
3/31/04	2327 SOUTHSIDE DR	MH 57-47	Addressed by CSSAP
10/15/01	2349 MOODY AVE	MH 36-4	Addressed by CSSAP
10/25/04	2500 MARYVILLE PIKE	MH 33-2	Addressed by CSSAP
3/29/03	2628 PEACHTREE ST	MH 24-61	Addressed by CSSAP
1/10/02	2702 MARTIN MILL PIKE	MH 2-64	Addressed by CSSAP
5/10/03	2712 HACKMAN ST	MH 24-34	S-18, S-26, S-25
9/30/02	301 WOODLAWN PIKE	MH 45-49	Addressed by CSSAP
1/28/02	306 HERMITAGE DR	MH 66-103	Addressed by CSSAP
6/30/04	308 HERMITAGE DR	MH 66-102	Addressed by CSSAP
6/4/04	309 HIALEAH DR	MH 62-25	Addressed by CSSAP
11/24/04	310 BRANDAU DR	MH 17-143 & 17-133	Addressed by CSSAP
2/11/04	3215 SOUTH HAVEN RD	Lateral	Addressed by CSSAP
3/11/02	3308 ISLAND HOME LIFT STATION	MH 24-300	Addressed by CSSAP
7/28/03	3422 GLENHURST RD	Building Backup	Addressed by CSSAP
9/26/01	3609 ALPINE DR	Building Backup	S-21
9/30/01	3609 ALPINE DR	Building Backup	S-21
2/1/03	3712 SOUTH HAVEN RD	MH 57-6	Addressed by CSSAP
11/7/01	3821 BLOUNT AVE	MH 28-1	S-2
1/31/03	401 BRANDAU DR	MH 17-137	Addressed by CSSAP
9/7/02	401 BRANDAU DR	MH 17-133	Addressed by CSSAP
9/30/02	418 WOODLAWN PK	Building Backup	Addressed by CSSAP
10/30/03	4211 CHAPMAN HWY	MH 69	Addressed by CSSAP
11/24/03	424 W BLOUNT AVE	MH 2-24	Addressed by CSSAP
2/22/01	433 SEVIER AVE	MH 1-45	Addressed by CSSAP
5/12/02	4400 W MARTIN MILL	Building Backup	Addressed by CSSAP

Table 9-4: South Knoxville/Knob Creek Non Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
3/8/03	4411 CYPRESS LN	MH 62-21	Addressed by CSSAP
9/16/02	4411 CYPRESS LN	Building Backup	Addressed by CSSAP
7/26/01	443 YOUNG HIGH PK	Building Backup	Addressed by CSSAP
3/25/01	4505 JOE LEWIS RD	MH 27-289	Addressed by CSSAP
7/16/04	4517 SEVIERVILLE PIKE	MH 57-27	Addressed by CSSAP
2/22/03	4523 SEVIERVILLE PIKE	MH 57-30	Addressed by CSSAP
5/12/04	4523 SEVIERVILLE PIKE	MH 57-31	S-29
6/25/04	4523 SEVIERVILLE PIKE	MH 57-31	Addressed by CSSAP
9/5/03	5031 SEVIERVILLE PIKE	MH 97-12	Addressed by CSSAP
8/12/01	5031 SEVIERVILLE PIKE	MH 97-12	Addressed by CSSAP
3/15/02	530 AVENUE A	MH 40-2	S-20
4/6/01	5307 JONATHAN WAY	MH 4-15	Addressed by CSSAP
10/27/03	5615 CILLA RD	MH 17-91	Addressed by CSSAP
11/26/03	5902 NEUBERT SPRINGS RD	MH 17-175	Addressed by CSSAP
7/23/01	6103 MANCHESTER RD	MH 66-28	Addressed by CSSAP
4/13/01	614 SEVIER AVE	MH 1-43	S-6
11/10/03	614 SEVIER AVE	MH 1-43	S-6
5/19/03	615 SEVIER AVE	MH 1-43	S-6
3/19/02	615 SEVIER AVE	MH 1-43	S-6
4/14/01	615 SEVIER AVE	Building Backup	S-6
3/19/02	615 SEVIER AVE	Building Backup & MH 1-43	S-6
5/15/03	620 CENTEROAK DR	Building Backup	Addressed by CSSAP
3/11/04	6204 THOMAS RD	MH 76	Addressed by CSSAP
11/19/03	633 LATHAM AVE	MH 36-15	Addressed by CSSAP
5/21/01	6421 SHETLAND DR	Building Backup	Addressed by CSSAP
11/24/04	6555 CHAPMAN HWY	Building Backup & MH 49-15	S-9
5/24/02	701 LAKE FOREST DR	MH 67-54	S-10
3/19/03	717 INGERSOLL AVE	MH 40-9	Addressed by CSSAP
6/27/03	809 OLIVER RD	MH 17-171	Addressed by CSSAP
6/5/04	850 TALLY HO DR	MH 62-21	Addressed by CSSAP
11/24/04	ELLIS ROAD LIFT STATION	MH 49-15	S-9
12/30/03	FORD VALLEY LIFT STATION	Wetwell	S-11
3/20/03	FORD VALLEY LIFT STATION	Wetwell	S-11
3/30/03	FORD VALLEY LIFT STATION	Wetwell	S-11
3/31/03	FORD VALLEY LIFT STATION	Wetwell	S-11
3/13/03	FORD VALLEY LIFT STATION	Wetwell	S-11
3/6/04	GINNBROOK LIFT STATION	Wetwell	S-1
11/11/02	GINNBROOKE LIFT STATION	MH 22	Addressed by CSSAP
3/18/02	MARTIN MILL PIKE & CHURCHLAND ST	MH 28-19	Addressed by CSSAP
5/23/02	MARTIN MILL PIKE & LIPPENCOTT ST	MH 2-65	Addressed by CSSAP
7/22/01	NEUBERT SPRINGS LIFT STATION	Wetwell	Addressed by CSSAP
3/18/02	SOUTH HAVEN RD & MCCLUNG AVE	Unidentified Manhole	S-2
10/4/02	WOODSON DR	MH 2-1	Addressed by CSSAP
5/31/04	WOODSON DRIVE LIFT STATION	MH 2-1	S-16

1 SSOs from Long-Term List of SSOER that are non-capacity related. Capacity related SSOs are shown in Table 9-3.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 9-5 and shown on Figure 9-4.

N
W
E
S
2000 0 2000 4000 Feet

S-6
S-26
S-15
S-18
S-15
S-25
S-21
S-29
S-28
S-2
S-2
S-17
S-10
S-19
S-20
S-11
S-14
S-24
S-27
S-9
S-16
S-5
S-1

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- South Knoxville and Knob Creek Basins
- WWTP

Improvement Projects

- Completed Improvement Projects
- CAP/ER Improvement Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- Find and Fix Projects
- Completed Rehabilitation Project
- CAP/ER Storage Facility
- Pump Station Upgrade

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South Knoxville/Knob Creek Phase 1 CAP/ER Facility Improvement Projects

Figure 9-5

Table 9-5: South Knoxville / Knob Creek Project Descriptions

Project ID	Project Name	Project Description[1]
S-1	Ginnbrook Pump Station Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Ginnbrook Pump Station
S-2	Goose Creek Trunk Sewer Replacement and Siphon Upgrade Project	Replace approximately 230 lf of existing sewer with 12-in sewer, Replace approximately 1100 lf of existing sewer with 15-in sewer, Replace approximately 1000 lf of existing sewer 30-in sewer, Replace approximately 60 lf of existing sewer with 36-in sewer
S-5	South Knoxville/Knob Creek Storage Facility	Design and construction of an approximately 4 MG storage facility
S-6	Sevier Avenue and Jones Street Collector Project	Rehabilitate approximately 3,100 lf of existing sewer and reroute approximately 352 lf of 8-in sewer
S-9	Ellis Road Rehabilitation Project	Find and fix work to rehabilitate approximately 3,940 lf of sewer in the vicinity of 6555 Chapman Highway, 6516 Jackie Lane, 212 Ellis Road, and 6528 Jackie Lane.
S-10	Sub-basin 41A6 Rehabilitation Project	Find and fix work to rehabilitate approximately 13,000 lf of sewer in Sub-basin 41A6 in the vicinity of 701 Lake Forest Rd.
S-11	Ford Valley Pump Station Upgrade Project	Upgrade pump station
S-14	Stone Road Rehabilitation Project	Rehabilitation in 41B1 to reduce R value to 2%
S-15	Trunk Replacement in Sub-basin 40A2 Project	Replace approximately 2,800 lf of sewer with 24-in sewer
S-16	Woodson Drive Trunk Replacement and Pump Station Upgrade Project	Replace approximately 260 lf of existing sewer and upgrade pump station
S-17 (IAP 4)	Island Home Rehabilitation Project	Find and fix work to rehabilitate approximately 9,400 lf of existing sewer in the vicinity of 5320 McNutt and McNutt Road pump station
S-18 (IAP 3)	South Haven Phases I & II Project	Relocate, rehabilitate and upsize approximately 4,700 lf
S-19 (IAP 1)	Maryville Pike Pipe Replacement Project	Replace approximately 800 lf of existing sewer
S-20	Avenue A Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 530 Avenue A
S-21	Alpine Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 3609 Alpine Avenue.

Table 9-5: South Knoxville / Knob Creek Project Descriptions

S-24 (IAP 5)	East Ford Valley Rehabilitation Project	Rehabilitation in Sub-basin 41A4 to reduce R value to 2%
S-25 (IAP 11)	South Haven Phase III Project	Rehabilitation in Sub-basin 40F1 to reduce R value to 2%
S-26	Trunk Sewer Replacement Project in Sub-basin 40F1	Replace 700 lf of existing sewer with 18-inch sewer
S-27	Trunk Sewer Replacement Project in Sub-basin 41A4	Replace approximately 175 lf of existing sewer with 12-inch sewer and 3,700 lf of existing sewer with 15-inch diameter sewer
S-28	Trunk Sewer Project	Trunk sewer project to correct reverse slopes in vicinity of 3430 Blount Ave
S-29	4500 block Sevierville Pike Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4523 Sevierville Pike.

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Section 10
Williams Creek

10.1 Hydraulic Model Description

The Williams Creek hydraulic model consists of almost six miles of trunk sewer and includes all major sewer pipes 10-inches in diameter or larger. The flows from Williams Creek are treated at the Kuwahee WWTP. Flows from Forks of the River Pump Station enter Williams Creek at the intersection of Riverside Drive and Delrose Drive. Forks of the River PS collects flow from an area called Swamp Bottom Creek, located approximately 3.5 miles southeast of Williams Creek. Williams Creek also receives backwash water and clarifier sludge flows from the Mark B. Whitaker Water Plant downstream of the Forks of the River pump station force main. Sludge flow from the Loves Creek WWTP is pumped to a northern branch of trunk sewer in Williams Creek near Martin Luther King Jr. Avenue. **Figure 10-1** shows the Williams Creek modeled trunk sewers, sub-basins, and the locations where flows from Forks of the River, Loves Creek WWTP, and the Mark B. Whitaker Water Plant enter the system.

10.2 Existing and Future Dry-Weather Model Analysis

To calibrate the model to dry-weather conditions, the output flows produced by the simulation using 2005 dry-weather input hydrographs were matched against the flows measured by the meters in the 2005 flow monitoring program. The 2005 flow monitoring program is discussed in Section 2. The dry-weather calibration procedure is described in Section 4.2.3. A summary of the average 2005 calibrated dry-weather flows for each sub-basin is presented in **Table 10-1**. The 2005 average dry-weather flow in Williams Creek is 2.5 mgd. As discussed in Section 3.2.4, dry-weather flows in Williams Creek were projected for year 2025. The 2025 wastewater flow components for Williams Creek sub-basins are also shown in Table 10-1. The total dry-weather Williams Creek flow is predicted to increase to 2.8 mgd in 2025.

Peak dry-weather flows in 2025 were simulated based on the 2025 flow projections. The percent of pipe capacity used during peak dry-weather flow is shown in **Figure 10-2**. The figure color codes the pipe according to the capacity used. Yellow indicates that between 75 and 100 percent of the pipe capacity is used to convey the peak dry-weather flow. Red indicates that over 100 percent of the pipe capacity is required to convey the peak dry-weather flow. Pipes in either category would be recommended for upgrading. New pipe is typically designed such that less than 50 percent of the pipe capacity is used under peak dry-weather flow conditions, and as discussed in the next section, more than 50 percent of the pipe capacity may be needed to convey wet-weather flows in a system with high RDI/I.

10.3 Existing and Future Wet-Weather Model Analysis

To calibrate the model to wet-weather conditions, the output flows produced by the simulation using a real storm event were matched against the flows measured by the

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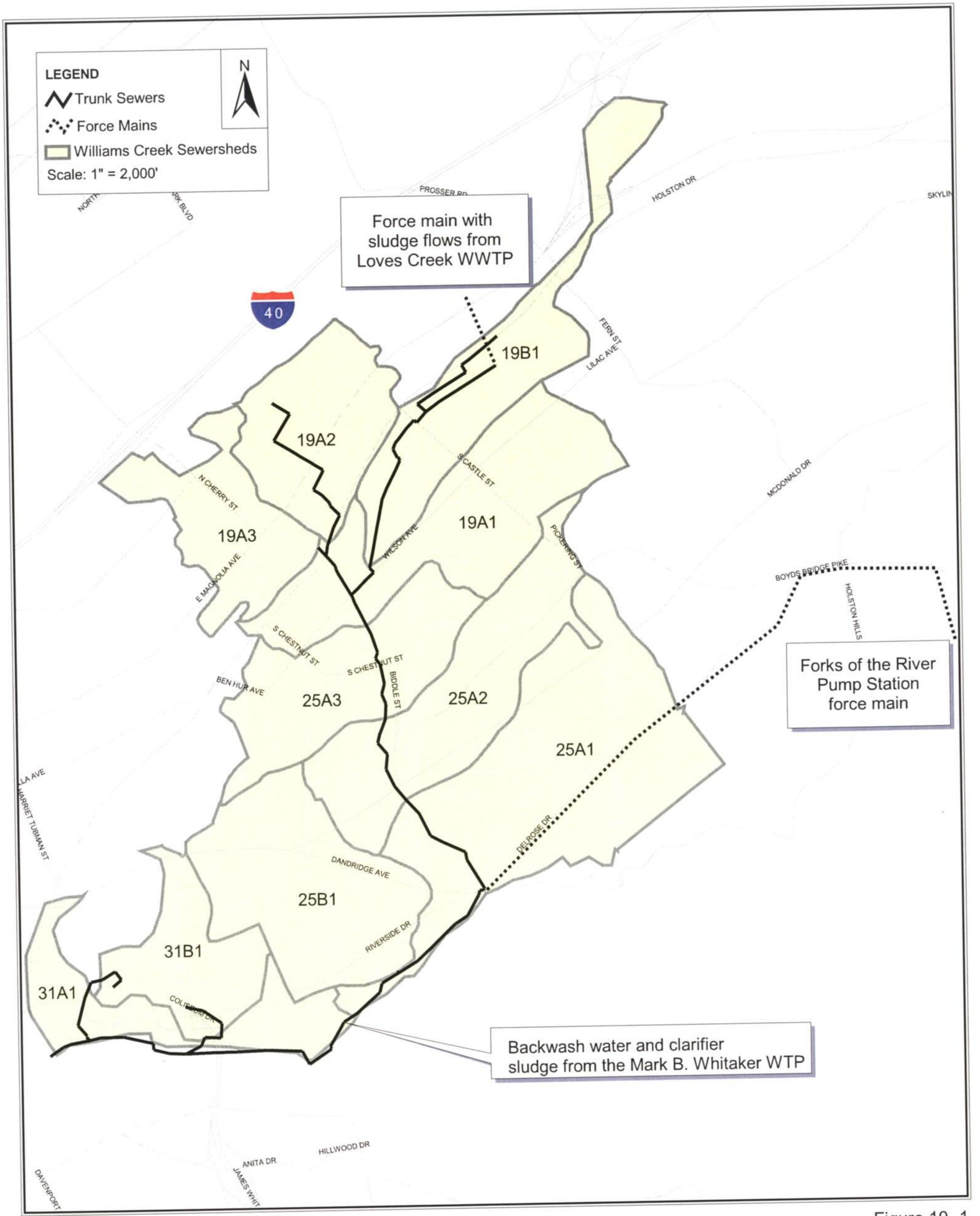

Figure 10- 1
Williams Creek
Location Map

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Table 10-1: Williams Creek Average Dry-Weather Flows

Sewershed	2005 Dry-Weather Flow (mgd)	2025 Dry-Weather Flow (mgd)
19A1	0.209	0.225
19A2	0.203	0.223
19A3	0.107	0.114
19B1	0.128	0.135
25A1	0.491	0.533
25A2	0.125	0.138
25A3	0.141	0.151
25B1	0.091	0.096
31A1	0.127	0.134
31B1	0.059	0.060
Forks of the River PS	0.864	1.032
Total	**2.5**	**2.8**

LEGEND

Percent of Pipe Capacity Used at Dry Weather Peak Flow

- 0 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%
- Over 100%

Williams Creek Sewersheds

Force Mains

Scale: 1" = 2,000'

N

Force main with sludge flows from Loves Creek WWTP

19B1

19A2

19A3

19A1

25A3

25A2

25A1

25B1

31B1

31A1

Forks of the River Pump Station force main

Backwash water and clarifier sludge from the Mark B. Whitaker WTP

40

PROSSER R

HOLSTON DR

SKYLINE D

FERN ST

LILAC AVE

BEAMAN LAKE RD

MCDONALD DR

N CHERRY ST

S CASTLE ST

WILSON AVE

PICKERING ST

BOYDS BRIDGE PIKE

HOLSTON HILLS R

E MAGNOLIA AVE

MARTIN LUTHER KING JR AVE

S CHESTNUT ST

BEN HUR AVE

BIDDLE ST

BROOKS AVE

DELROSE DR

LA AVE

HARRIET TUBMAN ST

DANDRIDGE AVE

RIVERSIDE DR

COLISEUM DR

ISLAND HOME AVE

HILLWOOD DR

ANITA DR

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Figure 10-2
Williams Creek
2025 Peak Dry Weather Flow with Existing Alignment

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meters during that storm event. Where necessary, adjustments to hydrograph model load points were made so that each flow monitor reasonably matched the flow predicted at the same location in the model. The wet-weather calibration procedure is described in Section 4.3.3.

The calibration storm event chosen for Williams Creek was the March 27, 2005 rainfall event. This was one of the largest events recorded during the 2005 flow monitoring period and produced the largest I/I into the sewer. R values were calculated for each of the sub-basins for the calibration storm event and are presented in **Table 10-2**. Section 3.3.1 discusses the definition of R value. In general, sub-basins with an R value greater than 5 percent are considered to have a high volume of RDI/I.

The calibrated R values for this event were used to calculate the gallons of RDI/I entering each sub-basin for the representative 24 hour planning storm event. Sub-basins with high volumes of RDI/I per linear foot are good candidates for comprehensive sanitary sewer rehabilitation as the greatest amount of RDI/I can be removed per linear foot of sewer rehabilitated in these sub-basins. The 24 hour planning storm event was previously developed by CDM to size wet-weather improvements for the collection system as described in Section 3.4. The volume of RDI/I calculated for each sub-basin was divided by the footage of sewer in each sub-basin to obtain the volume of infiltration per linear foot of pipe. These values are reported in Table 10-2. This is the volume of RDI/I that might be expected to enter the sewer, if adequate capacity is available, resulting from the representative 24 hour storm event during the critical period for GWI (i.e., December to May). The 24 hour storm RDI/I volume is presented as a way of comparing the infiltration between sub-basins. The RDI/I per linear foot of sewer for each sub-basin is shown in **Figure 10-3**. In general, sub-basins with an RDI/I per linear foot of sewer greater than 50 were considered good candidates for rehabilitation and RDI/I reduction. The value of 50 gallons per day per linear foot is project specific to KUB and was used to identify sub-basins where comprehensive rehabilitation was thought to reduce or eliminate a downstream capacity related improvement. Most sub-basins were predicted to have less than 25 gallons RDI/I per linear foot of sewer. One sub-basin, 19A2, was predicted to have between 25 and 50 gallons RDI/I per linear foot. Sub-basin 25A1 was predicted to have over 50 gallons RDI/I per linear foot.

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LEGEND

RDII (Gal per LF)

- 0 - 25
- 26 - 50
- 51 - 75
- 75 - 100
- > 100

Trunk Sewers

Force Mains

Scale: 1" = 2,000'

N

Force main with sludge flows from Loves Creek WWTP

Forks of the River Pump Station force main

Backwash water and clarifier sludge from the Mark B. Whitaker WTP

19A1

19A2

19A3

19B1

25A1

25A2

25A3

25B1

31A1

31B1

PROSSER RD

HOLSTON DR

SKYLINE

FERN ST

LILAC AVE

BEAMAN LAKE RD

MCDONALD DR

S CASTLE ST

PICKERING ST

WILSON AVE

N CHERRY ST

E MAGNOLIA AVE

MARTIN LUTHER KING JR AVE

S CHESTNUT ST

BEN HUR AVE

BIDDLE ST

BROOKS AVE

BOYDS BRIDGE PIKE

HOLSTON HILLS RD

DELROSE DR

DANDRIDGE AVE

RIVERSIDE DR

HARRIET TUBMAN ST

COLISEUM DR

ISLAND HOME AVE

HILLWOOD DR

ANITA DR

Figure 10-3
Williams Creek
RDI/I (Gal Per LF) By Sub-basin Predicted for 24 Hour Planning Event

CDM

Table 10-2: R Values and RDI/I for Williams Creek Sub-basins

Sub-basin	R Value (%)	RDII (gal/LF)[1]
19A1	4.5	17.8
19A2	10.2	43.2
19A3	4.5	16.7
19B1	8.5	18.8
25A1	15.4	72.8
25A2	2.6	9.7
25A3	2.6	9.6
25B1	2.6	11.4
31A1	3.0	14.3
31B1	3.0	9.0

[1] Represents Volume for 2 year planning storm event.

10.4 2025 Wet-Weather Storm Flows

As described in Section 3.4, a planning storm was used predict the performance of the collection system during a representative 24 hour storm event. The planning storm and 2025 average dry-weather flows were routed through the hydraulic model. The predicted pipe capacity at peak planning storm flows is shown in **Figure 10-4**. As shown in the figure, the hydraulic analysis predicts that the majority of the trunk sewers will be surcharged. Pipes were considered to be surcharged if the maximum predicted flow, Qmax, exceeded the design capacity of the sewer, Qdesign. Predicted overflow locations are also shown in Figure 10-4. Any overflow ranging from 10,000 gallons to 1,000,000 gallons is designated with a green dot. Any overflow ranging from 1 million to 2 million gallons is designated with a yellow dot. The largest overflow predicted by the model occurs just downstream of where the Forks of the River force main empties into the Williams Creek system. This overflow is predicted to be approximately 0.24 million gallons during the planning storm event. Actual overflows have also occurred at this location as reported on the Long-Term List. There are a couple of smaller overflows predicted throughout the collection system.

As explained in Sections 1.1 and 4.5, a total basin solution was developed for Williams Creek to address future predicted wet-weather overflows. For this Phase 1 CAP/ER, each of the individual projects in the total basin solution was analyzed to determine which are required to address the SSO locations on the Long-Term List.

10.5 Phase 1 CAP/ER Facility Improvements

The objective of the Phase 1 CAP/ER is to address SSOs identified on the Long-Term List of the SSOER in accordance with the CD. The SSOs listed on the Long-Term List that are capacity related are addressed by facility improvement projects as outlined for the Williams Creek Basin in **Table 10-3**. This table lists all capacity related SSOs and a corresponding project ID, which addresses the SSO.

The SSOs on the Long-Term List that are not capacity related are addressed by either a "find and fix" facility improvement project or KUB's CSSAP Program. Many of the

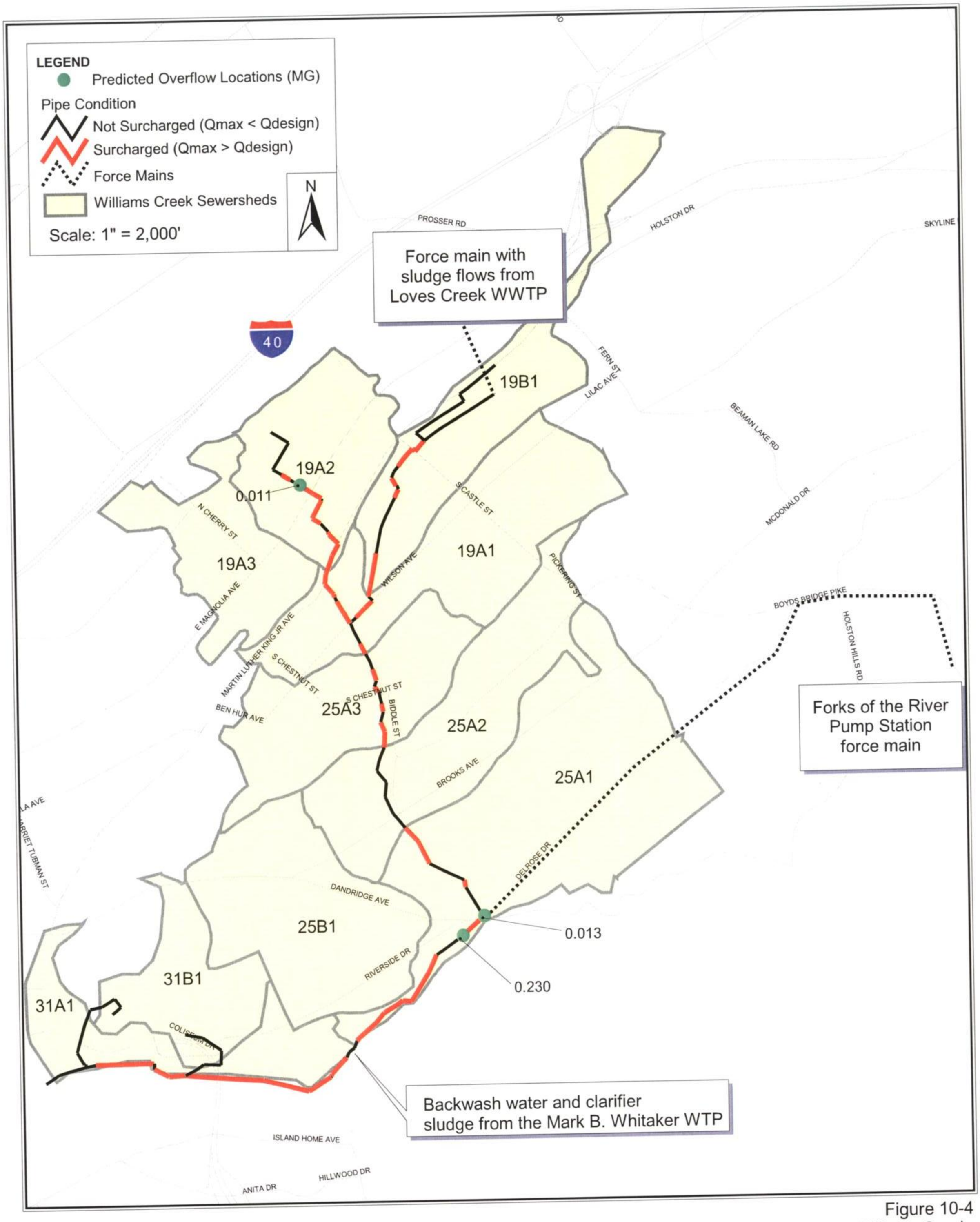


Figure 10-4
Williams Creek
2025 Peak Wet Weather Flow with Existing Alignment

CDM

0002047

Table 10-3: Williams Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
3/29/04	2363 RIVERSIDE DR	MH 11	W-2
5/1/03	2400 BROOKS AVE	MH 18	W-1
5/6/03	2500 RIVERSIDE DR	MH 12	W-2
9/22/03	2500 RIVERSIDE DR	MH 12	W-2
3/13/03	2505 DELROSE DR	MH 11-1 & 12	W-2
11/6/03	2505 DELROSE DR	MH 12	W-2
1/5/04	2505 DELROSE DR	MH 12	W-2
2/6/04	2505 DELROSE DR	MH 12	W-2
3/6/04	2505 DELROSE DR	MH 12	W-2
7/27/04	2505 DELROSE DR	MH 12	W-2
9/17/04	2505 DELROSE DR	MH 12	W-2
10/19/04	2505 DELROSE DR	MH 12	W-2
11/24/04	2505 DELROSE DR	MH 12	W-2
12/1/04	2505 DELROSE DR	MH 12	W-2
12/7/04	2505 DELROSE DR	MH 12	W-2
12/9/04	2505 DELROSE DR	MH 12	W-2
3/3/03	509 HARRISON ST	Building Backup	W-6
2/28/03	515 S HARRISON ST	Building Backup	W-6

1 SSOs from Long-Term List of SSOER that are capacity related. Non-capacity related SSOs are shown in Table 10-4.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 10-5 and shown on Figure 10-4.

SSOs on the Long-Term List that are not capacity related are the result of a blockage (debris, grease, roots, etc.) that have been addressed by KUB's CSSAP Program. These include all the SSOs on the Long-Term List that have the designation "N/A" under the "Long Term Capital Project" field. However, if the source of the blockage could not be fixed by maintenance and re-occurred after flushing or root cutting, then these SSOs were assigned a "find and fix" facility improvement project. "Find and fix" facility improvement projects will first involve further investigation into the source of the SSO through the use of smoke testing, manhole inspection, and/or CCTV inspection. Next, a determination will be made of the type and extent of the improvement required to address the SSO. In some cases, the blockage may have been only partially removed and further flushing or cutting is required to address the SSO. In other cases, replacement of sagged pipe or lining of pipe to prevent root intrusion may be required.

Table 10-4 presents all SSOs on the Long-Term List that are not capacity related. In the project ID field is either a find and fix project ID that addresses the SSO or the designation "has been addressed by CSSAP Program", as discussed above.

Figure 10-5 presents a map showing the locations of all SSOs on the Long-Term List from 2001-2004 in Williams Creek that require a facility improvement project to address to SSO. The SSOs are shown as green dots on the map. As discussed above, some SSOs on the Long-Term List were isolated cases of a blockage that have been addressed by the CSSAP Program and are not mapped on this figure.

The figure also shows the planned and completed facility projects to address the SSOs. Already completed improvement pipeline projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I and reducing the R value to 2 percent are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in the SSO Tables 10-3 and 10-4. **Table 10-5** lists all the projects on the map and a description of each project. Section 12 presents the Phase 1 CAP/ER implementation plan that provides start and end dates for each of these projects.

As Table 10-5 and Figure 10-5 detail for the Williams Creek Basin, several projects have already been completed, and the additional facility improvements required for the Phase 1 CAP/ER include the following:

- Two trunk sewer replacement projects
- Rehabilitation to an R of 2 percent in one sub-basin
- Numerous "find and fix" sewer rehabilitation projects

Table 10-4: Williams Creek Non Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
4/25/02	1114 GRONER DR	MH 22 & 23	W-5
11/24/04	121 ELMWOOD ST	MH 18	Addressed by CSSAP
2/22/03	121 ELMWOOD ST	MH 18	Addressed by CSSAP
6/29/01	121 S ELMWOOD ST	MH 18	W-8
6/29/01	121 S ELMWOOD ST	Building Backup & MH 18	W-8
11/26/01	129 ELMWOOD ST	Building Backup	W-8
11/26/01	133 ELMWOOD ST	Building Backup	W-8
3/28/03	134 ELMWOOD ST	Building Backup	Addressed by CSSAP
1/31/04	2007 RIVERSIDE DR	MH 4-25	Addressed by CSSAP
1/20/02	2007 RIVERSIDE DR	MH 4-25	Addressed by CSSAP
9/16/01	2111 MOHAWK AVE	MH 4-2	Addressed by CSSAP
12/3/04	2226 RIVERSIDE DR	MH 4-9	Addressed by CSSAP
2/26/01	2424 SELMA AVE	MH 37-5	Addressed by CSSAP
11/26/01	2436 LINDEN AVE	Building Backup	Addressed by CSSAP
1/22/01	2451 LINDEN AVE	Building Backup	Addressed by CSSAP
1/12/01	2456 LINDEN AVE	Storm Sewer	Addressed by CSSAP
5/20/04	2500 E FIFTH AVE	Building Backup	Addressed by CSSAP
4/9/03	2525 MCDONALD RD	MH 21-3	Addressed by CSSAP
2/2/01	2531 PARKVIEW AVE	Building Backup	Addressed by CSSAP
12/14/04	2555 FIFTH AVE	Lateral	W-4
5/7/04	2564 WOODBINE AVE	Building Backup	Addressed by CSSAP
1/31/04	2565 E FIFTH AVE	Building Backup	Addressed by CSSAP
2/23/04	2565 E FIFTH AVE	Building Backup	Addressed by CSSAP
10/9/01	2565 E FIFTH AVE	Building Backup & MH 5-134	W-4
12/2/03	2565 E FIFTH AVE	Building Backup	W-4
12/3/03	2565 E FIFTH AVE	Building Backup	W-4
10/9/01	2565 FIFTH AVE	MH 5-134	Addressed by CSSAP
1/6/01	2574 WOODBINE AVE	Building Backup	Addressed by CSSAP
3/11/02	2606 LINDEN AVE	Building Backup	Addressed by CSSAP
2/20/03	2612 SELMA AVE	Building Backup	Addressed by CSSAP
4/19/04	2614 SUNSET AVE	MH 28-14	W-7
4/29/04	2614 SUNSET AVE	MH 28-14	W-7
7/28/04	2615 LINDEN AVE	Building Backup	Addressed by CSSAP
7/26/01	2655 WILSON AVE	MH 7	W-6
11/6/03	2725 E GOV JOHN SEVIER HWY	Building Backup	Addressed by CSSAP
2/18/04	2725 E GOV JOHN SEVIER HWY	Building Backup	Addressed by CSSAP
4/14/04	2725 E GOV JOHN SEVIER HWY	Building Backup	Addressed by CSSAP
11/15/01	2806 FIFTH AVE	Unidentified Manhole	Addressed by CSSAP
3/17/02	2806 SELMA AVE	MH 2-5	W-6
3/17/02	2806 SELMA AVE	Building Backup & MH 2-5	W-6
3/18/02	2812 E MAGNOLIA AVE	Building Backup	Addressed by CSSAP
5/1/03	2820 WOODBINE AVE	MH 5-61	Addressed by CSSAP
1/24/03	2833 MAGNOLIA AVE	MH 5-52	Addressed by CSSAP
1/24/03	2833 MAGNOLIA AVE	Building Backup & MH 5-52	W-1
1/26/03	3032 WOODBINE AVE	MH 5-86	Addressed by CSSAP
2/22/01	3118 WATERPLANT ROAD	Unidentified Manhole	Addressed by CSSAP
3/7/01	3205 WILSON AVE	Building Backup	Addressed by CSSAP
1/17/02	3311 ASHLAND AVE	Building Backup	Addressed by CSSAP
5/4/04	416 CURIE PL	Building Backup	Addressed by CSSAP
3/19/02	508 SURREY RD	Building Backup	Addressed by CSSAP
4/21/03	515 HARRISON ST	Building Backup	W-6
9/6/02	600 MILLIGAN ST	MH 5-181	Addressed by CSSAP
9/2/03	603 BEN HUR AVE	MH 41	Addressed by CSSAP
7/4/02	608 CASTLE ST	MH 2-26 & 2-31	Addressed by CSSAP
1/7/02	806 GRAVES ST	MH 31-1	Addressed by CSSAP
1/3/04	815 CHESTNUT ST	MH 28-2	Addressed by CSSAP
7/25/01	ALLEY NEAR E MAGNOLIA AVEN	Storm Sewer	W-1

1 SSOs from Long-Term List of SSOER that are non-capacity related. Capacity related SSOs are shown in Table 10-3.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 10-5 and shown on Figure 10-4.

N
W
E
S
1000 0 1000 Feet
W-1
W-2
W-3
W-4
W-5
W-6
W-7
W-8
W-9
LEGEND
SSOs from Long-Term List requiring facility improvement projects
Trunk Sewers
Collector Sewers
Pump Station
Williams Creek Basin
Improvement Projects
Completed Improvement Projects
CAP/ER Improvement Projects
CAP/ER Sewer Rehabilitation to an R=2%
Find and Fix Projects
CDM
Williams Creek
Phase 1 CAP/ER
Facility Improvement Projects
Figure 10-5
0002051

Table 10-5: Williams Creek Project Descriptions		
Project ID	**Project Name**	**Project Description[1]**
W-1	Sub-basin 19A2 Rehabilitation	Rehabilitation to reduce R to 2% in Sub-basin 19A2.
W-2 (IAP 9)	Williams Creek Trunk Line Replacement (Downstream of Golf Course)	Replace approximately 3,100 lf of existing sewer with 36-in sewer.
W-3	Rehabilitation of Trunk Sewer	Slip line approximately 6,100 lf of existing 24-in sewer.
W-4	E. Fifth Avenue Sewer Replacement Project	Find and fix work to identify and address cause of overflow in the vicinity of 2555 Fifth Avenue and 2565 E. Fifth Avenue.
W-5	Groner Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1114 Groner Road.
W-6	Selma Avenue - Harrison Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2806 Selma Avenue, 509 Harrison Street, and 515 Harrison Street.
W-7	Sunset Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2614 Sunset Avenue.
W-8	South Elmwood Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 121, 129 and 133 South Elmwood Street.
W-9	Williams Creek Trunk Line Replacement (Sub-basin 19A1)	Replace approximately 360 lf of existing sewer with 15-in sewer.

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Section 11
Loves Creek and Eastbridge

11.1 Basin Descriptions

Figure 11-1 presents the basin boundaries, sewers, and treatment plants for the Loves Creek and Eastbridge Basins.

The Loves Creek basin contains approximately 27,000 acres of service area, 120 miles of gravity sewer, and 13 pump stations. The wastewater from Loves Creek basin is treated at the Loves Creek WWTP. The basin includes approximately 12,700 acres of service area obtained from the Northeast Knoxville Utility District in late 2003. Approximately 12,000 acres of the area obtained from Northeast Knox Utility District is unsewered. The sewered area obtained from Northeast Knoxville Utility District contains approximately 3.6 miles of gravity sewers, an undetermined amount of low pressured sewers, and three pump stations. The Loves Creek basin also includes KUB service areas that were formerly in the Sinking Creek and Swampond Creek service areas. These areas are approximately 8,000 total acres and contain 7,500 acres of unsewered area. The sewerered area contains 22.5 miles of gravity sewer and five pump stations. The Loves Creek basin boundary is delineated by the KUB service area border and either topographic drainage patterns (for unsewered portions) or collection system flow direction and treatment plant (for sewered portions). The construction and/or elimination of pump stations could alter the location of sewage treatment for particular areas.

The Eastbridge basin includes approximately 24.2 miles of gravity sewers, an undetermined amount of low-pressure sewers, and 7 pump stations. Approximately 28,000 of the roughly 30,000 acres in the area are unsewered, much of which was obtained from the Northeast Knox Utility District in late 2003. Included in this area is approximately 9,700 acres (roughly 9,200 unsewered acres), 8.4 miles of gravity sewer, and 1 pump station in what used to be known as KUB's Lyons Creek service area. The basin boundary is delineated by the KUB service area border and either topographic drainage patterns (for unsewered portions) or collection system flow direction and treatment plant (for sewered portions). The construction and/or elimination of pump stations could alter the location of sewage treatment for particular areas.

Few capacity related SSOs have occurred in the Love's Creek Basin and no capacity related overflows have occurred in the Eastbridge Basin. Therefore, a complete hydraulic capacity analysis that was performed for the six basins discussed in Sections 5-10 was not performed for these basins. All SSOs on the Long-Term List are still addressed in this Phase 1 CAP/ER; however, a full hydraulic modeling analysis was not required to adequately address them.

LEGEND

- Pump Station
- Trunk Sewers
- Collector Sewers
- Force Mains
- Wastewater Treatment Plant

Scale: 1" = 10,000'

N

Eastbridge

Loves Creek

East Bridge

East Bridge

Lyons Creek

Wingate

Kohls

John Sevier

Eastwood

Loves Creek

Pelham Rd.

Ruggles Ferry

Emily Av.

Burlington

River Run

Crestwood

Wayland Rd

Holston Hills

0002054

Figure 11-1
Loves Creek and Eastbridge Basins

CDM

11.2 Phase 1 CAP/ER Facility Improvements

As stated in Section 1, the objective of the Phase 1 CAP/ER is to address SSOs identified on the Long-Term List of the SSOER in accordance with the CD. The few capacity related SSOs in Love's Creek on the Long-Term List are listed in **Table 11-1** along with a corresponding facility improvement project ID, which addresses the SSO. There are no capacity related SSOs in Eastbridge on the Long-Term List.

The SSOs on the Long-Term List that are not capacity related are addressed by either a "find and fix" facility improvement project or KUB's CSSAP Program. Many of the SSOs on the Long-Term List that are not capacity related are the result of a blockage (debris, grease, roots, etc.) that have been addressed by KUB's CSAAP Program. These include all the SSOs on the Long-Term List that have the designation "N/A" under the "Long Term Capital Project" field. However, if the source of the blockage could not be fixed by maintenance and re-occurred after flushing or root cutting, then these SSOs were assigned a "find and fix" facility improvement project. "Find and fix" facility improvement projects will first involve further investigation into the source of the SSO through the use of smoke testing, manhole inspection, and/or CCTV inspection. Next, a determination will be made of the type and extent of the improvement required to address the SSO. In some cases, the blockage may have been only partially removed and further flushing or cutting is required to address the SSO. In other cases, replacement of sagged pipe or lining of pipe to prevent root intrusion may be required.

Table 11-2 presents all SSOs on the Long-Term List in the Loves Creek Basin that are not capacity related and **Table 11-3** presents the same for the Eastbridge Basin. In the project ID field is either a "find and fix" project ID that addresses the SSO or the designation "addressed by CSSAP Program".

Figure 11-2 presents a map showing the locations of all SSOs on the Long-Term List from 2001-2004 in Loves Creek and Eastbridge that require a facility improvement project to address the SSO. The SSOs are shown as green dots on the map. As discussed above, some SSOs on the Long-Term List were isolated cases of a blockage that have been addressed by the CSAAP Program and are not mapped on this figure.

The figure also shows the planned facility projects to address the SSOs. Planned trunk sewer improvement projects are shown in red. Planned collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

Each of the planned projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in the SSO Tables 11-1 through 11-3. **Table 11-4** lists all the projects on the map and a description of

Table 11-1: Loves Creek Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
9/20/04	3001 SHELBOURNE RD	MH 82-1	L-9
12/17/04	3001 SHELBOURNE RD	MH 82-1	L-9
1/23/02	4436 WASHINGTON CT	MH 74-17	L-10
1/25/02	201 TULANE RD	MH 21-1	L-1
3/18/02	201 TULANE RD	MH 21-1	L-1
2/22/03	203 CHILHOWEE DR	MH 25	L-1
9/23/02	3301 MAGNOLIA AVE	MH 61-3	L-7
1/24/02	3301 MAGNOLIA AVE	MH 61-9	L-7
2/18/03	4102 HOLSTON HILLS RD	MH 73 & 75	L-3, L-2
2/22/03	4200 HOLSTON HILLS RD	MH 76-1 & 78	L-3, L-2

1 SSOs from Long-Term List of SSOER that are capacity related. Non-capacity related SSOs are shown in Table 11-2.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 11-4 and shown on Figure 11-2.

Table 11-2: Loves Creek Non Capacity Related SSOs[1]

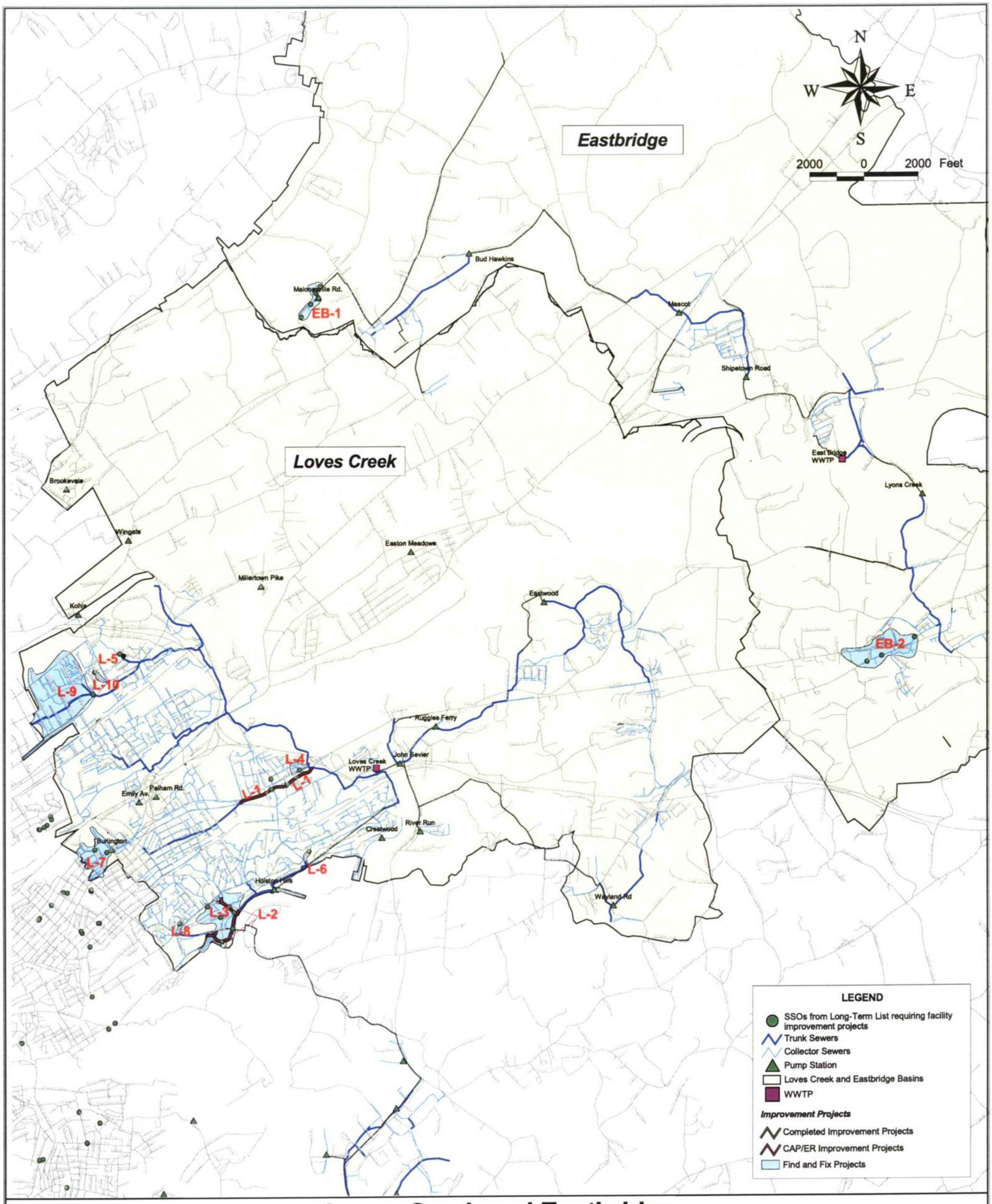
Date	Address	Overflow Location	Project ID[2]
6/3/02	EASTWOOD LIFT STATION	Wetwell	Addressed by CSSAP
1/19/01	PALMER LN & BRAKEBILL RD	MH 57 or 58	Addressed by CSSAP
12/19/01	1425 COESTA DR	Building Backup	Addressed by CSSAP
2/7/01	1438 PATRICIA CR	Building Backup	Addressed by CSSAP
1/5/04	1508 CLIFFSIDE LN	MH 104-19 & 104-20	Addressed by CSSAP
7/15/03	1514 CLIFFSIDE LN	MH 104-22	Addressed by CSSAP
12/17/02	1536 CLIFFSIDE LN	Building Backup	Addressed by CSSAP
2/22/03	1600 PROSSER RD	MH 29-191	Addressed by CSSAP
2/11/03	1601 ROBERT HUFF LN	MH 72-64	Addressed by CSSAP
10/14/04	1711 TRANSPORT LN	Grinder Pump	Addressed by CSSAP
5/17/04	1711 TRANSPORT LN	Grinder Pump	Addressed by CSSAP
5/15/03	201 DELTA RD	Unnumbered	Addressed by CSSAP
3/18/02	201 DELTA RD	Building Backup	Addressed by CSSAP
3/22/02	201 TULANE RD	MH 21-1	L-1
11/25/02	205 CHILHOWEE DR	Building Backup	L-1
1/22/03	205 CHILHOWEE DR	Building Backup	L-1
7/5/03	2306 AULT RD	MH 29-301	Addressed by CSSAP
3/13/02	2329 PROSSER RD	Building Backup	Addressed by CSSAP
12/15/04	2701 MARY EMILY LN	Grinder Pump	Addressed by CSSAP
10/10/04	2701 MARY EMILY LN	Building Backup	Addressed by CSSAP
2/1/01	3101 CROSS VALLEY RD	MH 82-94 & 82-93	Addressed by CSSAP
2/22/01	3118 WATERPLANT ROAD	Unidentified Manhole	Addressed by CSSAP
3/1/02	312 TRACER LN	MH 27-17	Addressed by CSSAP
3/1/02	312 TRACER LN	MH 27-17	Addressed by CSSAP
4/19/04	317 BRAKEBILL RD	MH 54	Addressed by CSSAP
9/3/02	3415 MCDONALD DR	MH 72-80	L-8
7/9/03	3505 BELLEVIEW RD	MH 82-38	Addressed by CSSAP
8/23/04	3616 SKYLINE DR	Building Backup	Addressed by CSSAP
5/31/02	3716 HOLSTON HILLS RD	MH 72-19	L-2, L-3
4/7/02	3722 HOLSTON HILLS RD	MH 72-19	L-2, L-3
5/14/03	3745 CATALPA AVE	Building Backup	Addressed by CSSAP
3/21/02	3800 MCDONALD DR	MH 83	L-3
3/31/02	3800 MCDONALD DR	MH 83 & 84	L-3
4/25/02	3841 SPEEDWAY CR	Building Backup	Addressed by CSSAP
10/24/01	3915 HOLSTON HILLS RD	MH 76-6	L-2, L-3
4/16/01	3946 LINDEN AVE	MH 32-77	Addressed by CSSAP
10/21/01	4014 HOLSTON HILLS RD	MH 72-12	L-2, L-3
7/30/03	4102 HOLSTON HILLS RD	MH 73	L-2, L-3
12/5/02	4102 HOLSTON HILLS RD	MH 73	L-2, L-3
3/18/02	4201 ASHEVILLE HWY	Building Backup	Addressed by CSSAP
11/8/01	4213 SHANGRILA DR	Building Backup & MH 29-436	Addressed by CSSAP
11/8/01	4213 SHANGRI-LA DR	MH 29-436	Addressed by CSSAP
12/27/01	4229 LILAC AVE	MH 44-13	Addressed by CSSAP
4/30/01	4311 VALLEY VIEW DR	Lateral	Addressed by CSSAP
4/17/02	4401 NORWALK AVE	Building Backup	Addressed by CSSAP
3/25/03	4414 ASHEVILLE HWY	MH 34-11	Addressed by CSSAP
6/23/02	4506 EXEMOUTH DR	MH 65-78	Addressed by CSSAP
1/17/01	4516 ASHEVILLE HWY	Lateral	Addressed by CSSAP
3/14/02	4516 ASHEVILLE HWY	Building Backup	Addressed by CSSAP

Table 11-2: Loves Creek Non Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
2/16/01	4716 HOLSTON HILLS RD	MH 42	L-6
3/7/03	4770 CENTERLINE DR	MH 66-15	Addressed by CSSAP
3/7/04	4900 ASHEVILLE HWY	MH 30	Addressed by CSSAP
12/22/01	5001 HOLSTON DR	Building Backup	Addressed by CSSAP
4/22/01	510 MICHAEL STREET	MH 40-3	Addressed by CSSAP
6/1/03	5111 WYNDCROFT DR	MH 42	Addressed by CSSAP
6/1/03	5111 WYNDCROFT LN	Building Backup & MH 42	Addressed by CSSAP
6/10/03	5208 MOHAWK DR	MH 25-22	Addressed by CSSAP
6/10/03	5208 MOHAWK DR	Building Backup & MH 5-22	Addressed by CSSAP
2/5/01	5300 MILLERTOWN PIKE	MH 48-22	Addressed by CSSAP
2/9/01	5315 SHADY DELL TRL	MH 34-8,34-7,34-6,34-4	Addressed by CSSAP
5/3/02	5338 MILLERTOWN PIKE	MH 48-12	Addressed by CSSAP
2/12/02	5411 ASHEVILLE HWY	MH 16-8	L-4
6/27/01	5515 GREEN VALLEY DR	MH 39	Addressed by CSSAP
2/8/01	5804 HOLSTON HILLS RD	Building Backup	Addressed by CSSAP
3/18/02	5816 HOLSTON HILLS RD	Building Backup	Addressed by CSSAP
11/10/03	5915 MEADOWLAND DR	Building Backup	Addressed by CSSAP
2/28/02	6402 RUGGLES FERRY PIKE	MH 3-2	Addressed by CSSAP
2/28/02	6402 RUGGLES FERRY PIKE	MH 3-2	Addressed by CSSAP
3/7/04	6410 HAMMER RD	Broken Force Main	Addressed by CSSAP
3/9/04	6410 HAMMER RD	Broken Force Main	Addressed by CSSAP
12/12/02	7210 STRAWBERRY PLAINS PIKE	MH 35	Addressed by CSSAP
12/12/02	7210 STRAWBERRY PLAINS PIKE	MH 35	Addressed by CSSAP
12/30/03	7224 REGION LN	MH 9-1	Addressed by CSSAP
12/30/03	7224 REGION LN	MH 9-1	Addressed by CSSAP
7/26/01	BRENTWOOD RD	MH 66-14	L-5
9/13/01	CHILHOWEE DR	MH 61-59	Addressed by CSSAP
6/3/02	EASTWOOD LIFT STATION	Wetwell	Addressed by CSSAP
1/19/01	PALMER LN & BRAKEBILL RD	MH 57 or 58	Addressed by CSSAP
7/5/04	RUGGLES FERRY LIFT STATION	MH 3	Addressed by CSSAP

1 SSOs from Long-Term List of SSOER that are non-capacity related. Capacity related SSOs are shown in Table 11-1.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 11-4 and shown on Figure 11-2.



Loves Creek and Eastbridge Phase 1 CAP/ER Facility Improvement Projects

CDM

Figure 11-2

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Table 11-3: Eastbridge Non Capacity Related SSOs[1]

Date	Address	Overflow Location	Project ID[2]
7/5/04	BUD HAWKINS LIFT STATION	Wetwell	Addressed by CSSAP
7/12/02	BUD HAWKINS LIFT STATION	Wetwell	Addressed by CSSAP
2/26/03	BUD HAWKINS LIFT STATION	Wetwell	Addressed by CSSAP
3/20/03	LIMESTONE LN & MASCOT RD	Broken Force Main	Addressed by CSSAP
2/5/03	MALONEYVILLE RD LIFT STATION	Grease Trap	EB-1
6/11/02	RUTLEDGE PIKE & THREE POINTS RD	6" Force Main at	Addressed by CSSAP
10/19/04	2229 SHIPETOWN RD	Building Backup	Addressed by CSSAP
10/19/04	2229 SHIPETOWN RD	Broken Pipe	Addressed by CSSAP
10/7/04	4300 ROBERTS RD	Grinder Pump	Addressed by CSSAP
12/29/02	4800 MALONEYVILLE RD	Lateral	EB-1
8/2/02	4800 MALONEYVILLE RD	MH 93-1	EB-1
4/6/04	4900 MALONEYVILLE RD	MH 93-1	Addressed by CSSAP
8/9/04	5001 MALONEYVILLE RD	MH 93-10	Addressed by CSSAP
10/14/02	5001 MALONEYVILLE RD	Unidentified Manhole	EB-1
12/13/02	5109 MALONEYVILLE RD	MH 93-7	EB-1
7/29/03	5109 MALONEYVILLE RD	MH 93-10	EB-1
4/12/04	6310 ROBERTS RD	Grinder Pump	Addressed by CSSAP
2/23/03	7025 WASHINGTON PIKE	Air Relief Valve	Addressed by CSSAP
3/24/03	7513 WASHINGTON PIKE	Broken Force Main	Addressed by CSSAP
5/2/04	7519 WASHINGTON PIKE	Grinder Pump	Addressed by CSSAP
4/5/02	8616 STRAWBERRY PLAINS PIKE	MH 21-5	EB-2
8/14/02	8714 STRAWBERRY PLAINS PIKE	MH 21-2	EB-2
3/22/02	9005 STRAWBERRY PLAINS PIKE	MH 9	EB-2

1 SSOs from Long-Term List of SSOER that are non-capacity related. There were no capacity related SSOs for this basin.

2 Project ID of improvement project(s) that addresses this SSO. Project IDs are described on Table 11-4 and shown on Figure 11-2.

Table 11-4: Loves Creek and Eastbridge Project Descriptions[1]

Project ID	Project Name	Project Description[1]
L-1	Asheville Highway west of I-40 Trunk Replacement	Replace approximately 5,030 lf of existing 18-in pipe.
L-2	Boyds Bridge Pike and Holston Hills Trunk Replacement	Replace approximately 4,190 lf of existing 10-in, 500 lf of 12-in, and 330 lf of 15-in pipe.
L-3	River View Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4102, 4200, 3722, 3716, and 4014 Holston Hills Road.
L-4	Asheville Highway Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 5411 Asheville Highway.
L-5	Brentwood Shortline Repair	Find and fix work to identify and address cause of overflow in the vicinity of Brentwood Road
L-6	Holston Hills Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4716 Holston Hills Road.
L-7	Magnolia Avenue Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3301 Magnolia Avenue.
L-8	McDonald Drive Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3415 McDonald Drive.
L-9	Shelbourne Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3001 Shelbourne Road.
L-10	Washington Court Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4436 Washington Court.
EB-1	Maloneyville Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of Maloneyville Road (MH 93-1, 93-7, 93-10, and at the lift station).
EB-2	Strawberry Plains Pike Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 8616, 8714, and 9005 Strawberry Plains Pike.

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

each project. Section 12 presents the Phase 1 CAP/ER implementation plan that provides start and end dates for each of these projects.

As Table 11-4 and Figure 11-2 detail for the Loves Creek and Eastbridge basins, several projects have already been completed, and the facility improvements required for the Phase 1 CAP/ER include the following:

- Trunk sewer replacement
- Several "find and fix" sewer rehabilitation projects

Section 12
Implementation Plan

This section summarizes the implementation plan for the Phase 1 CAP/ER. The implementation plan summarizes the facility improvements required to address SSOs in the planning area in accordance with the CD. The plan also lists the fiscal year for starting and completing all work specified in this Phase 1 CAP/ER.

The implementation plan includes a combination of the following types of projects:

- Sewer replacement projects
- Equalization storage tanks
- Rehabilitation to an R of 2 percent
- "Find and fix" collector sewer rehabilitation projects

These types of projects are discussed in Section 4. The implementation plan includes projects that have been completed as well as those that are planned. The previous report sections presented how these projects address the SSOs in the planning area in accordance with the CD. **Tables 12-1 through 12-7** present each facility improvement project including a project ID, project name, project description, start date, and end date. Start date and end date are given as fiscal year in accordance with the CD. It was assumed that the Phase 1 CAP/ER would be approved during Fiscal Year 05/06 and that Fiscal Year 05/06 represented the first year of the seven year schedule to complete the Phase 1 CAP/ER projects. KUB prioritized projects within the seven year period based on severity and frequency of the SSO, proximity to public areas, and the complexity of the improvement project.

Approximate sizing and extents of each project are given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Figures 12-1 through 12-8 present maps of each basin showing the planned and completed facility projects to address the SSOs. Already completed pipeline improvement projects are shown in green. Planned trunk sewer improvement projects are shown in red. Planned collector system rehabilitation projects with the goal of finding and fixing major sources of I/I and reducing the R value to 2 percent are shaded pink. Collector system projects with the goal of finding and fixing other sewer defects are shown in blue.

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Each of the planned and completed projects that addresses an SSO is labeled with a project ID number. The project IDs listed on the figure match the project IDs in Tables 12-1 through 12-7.

Table 12-1: First Creek Implementation Plan[1]

Project ID	Project Name	Project Description	Start Date	End Date
1-1	Upper First Creek Collector Project (Mini-basin 1A1, 2A2, and 3D1)	Find and fix work to identify and address cause of overflow in the vicinity of 4811 Beverly Road, 4144 Oakland Drive, and 5511 Dogwood Road.	FY 05/06	FY 06/07
1-2	Lower First Creek Collector Project (Mini-basin 8B2)	Find and fix work to identify and address cause of overflow in the vicinity of 2412, 2514, 2528, 2806, 2808, 2900, 2528, 2700, and 2808 Tecoma Drive, 3501 Whittle Springs Road, Islington Avenue, 1800 Linden Avenue, 2524 Underwood Place, and 3008 Valley View Drive.	FY 05/06	FY 07/08
1-3	First Creek Storage Tanks	Design and construction of the upper First Creek storage tank and lower First Creek storage tank.	FY 04/05	FY 07/08
1-4	Lower Fountain City Pipe Replacement Project	Replace approximately 2,293 lf existing sewer with 36-in sewer.	FY 05/06	FY 07/08
1-5	Upper Fountain City Pipe Replacement Project	Replace approximately 1,053 lf of existing sewer with 12-in, 1,856 lf with 24-in, and 595 lf with 27-in pipe.	FY 05/06	FY 07/08
1-6	Sub-basin 08A1 Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Broadway and Powers Street, and Broadway and Ridgeway Lane	FY 04/05	FY 07/08
1-11	Fountain City Trunkline Replacement Phase IV Project	Replace approximately 724 lf of existing sewer with 15-in, 1,823 lf with 18-in, and 444 lf with 24-in pipe.		Completed 2003
1-12	Cedar Lane Area Sanitary Sewer Rehabilitation Project	Pipe rehabilitation of approximately 8,500 lf of existing sewer		Completed 2004
1-13	Fair Drive Sanitary Sewer Rehabilitation / Replacement Project	Pipe replacement and rehabilitation of approximately 8,200 lf of existing sewer.		Completed 2005
1-14	Wilderness Road Area Gravity Sewer Replacement Project - Phase II	Replace approximately 1,200 lf of existing 8-in, 340 lf 10-in, and 3,900 lf of 12-in pipe.		Completed 2003
1-15	Replace trunk sewer upstream of lower storage unit	Replace approximately 3,700 lf of existing 54-in, and 331 lf of 18-in pipe.	FY 11/12	FY 12/13
1-16	Clearview Street Sewer Project	Replace approximately 4,060 lf of existing 8-in, 227 lf 10-in, and 181 lf of 12-in pipe.		Completed 2003
1-17	Fountain Road Trunkline Sewer Improvement Project	Replace approximately 321 lf of existing 12-in, 430 lf 15-in, and 2,880 lf of 16-in pipe.		Completed 2005
1-18	Greenfield Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2333, 2352 Greenfield Lane and 2826, 2820 North Hills Boulevard		Completed 2005
1-19	Edgewood Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1620 Edgewood Avenue	FY 09/10	FY 10/11
1-20	Vine Middle School Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 214 Bertrand Street.	FY 05/06	FY 06/07
1-21	College Park Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 106 College Park Lane.	FY 10/11	FY 11/12
1-22	E. Jackson Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 400 E. Jackson Avenue.	FY 11/12	FY 12/13
1-23	Oglewood Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1307 Oglewood Avenue.	FY 11/12	FY 12/13

Table 12-1: First Creek Implementation Plan[1]

Project ID	Project Name	Project Description	Start Date	End Date
1-24	Fulton Short Line Project	Replace approximately 520 lf of existing 8-in pipe.		Completed 2003
1-25 (IAP 6)	Sub-basins 3&4 Rehabilitation Project	Rehabilitation to reduce R to 2% in Sub-basins 03B1, 03B2, and 04B1.	FY 05/06	FY 06/07
1-26	Cherry Street Rehabilitation Project	Find and fix work to identify and address cause of overflow at 1918 Cherry Street	FY 11/12	FY 12/13
1-27	Fair Drive Replacement Project	Find and fix work to identify and address cause of overflows at 2538, 2541, and 2544 Fair Drive	FY 10/11	FY 11/12

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table 12-2: Second Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
2-1	Lower Second Creek Replacement/Rehabilitation at I40/I275 Junction	Replace approximately 1,300 lf of existing sewer with 30-in sewer, replace approximately 3100 lf of existing sewer with 36-in sewer, replace approximately 1200 lf of existing sewer with 42-in sewer, and rehabilitate approximately 2,400 lf of trunk line between replacement segments.	FY 06/07	FY 08/09
2-2	Lower Second Creek Replacement/Rehabilitation at Woodland	Replace approximately 2,500 lf of existing sewer with 30-in sewer and rehabilitate approximately 1,200 lf of trunk line between replacement segments.	FY 06/07	FY 07/08
2-3	Second Creek Rehabilitation of Sub-basin 23E1 Near Woodland and Central	Rehabilitation in Sub-basin 23E1 to reduce R value to 2%	FY 05/06	FY 06/07
2-4	Dutch Valley Collector Rehabilitation (Sub-basin 10B1)	Rehabilitate 10-in collection system piping in Sub-basin 10B1.	FY 05/06	FY 06/07
2-5	Rickard and Wilson Collector Rehabilitation (Sub-basin 10C1)	Rehabilitate 10-in collection system piping in Sub-basin 10C1.	FY 05/06	FY 06/07
2-6	Pilleaux Pump Station Collector Rehabilitation (Sub-basin 5A4)	Rehabilitate approximately 19,600 lf of sewer in Sub-basin 5A4.	FY 04/05	FY 05/06
2-8 (IAP 10)	Subbasin 15 Rehabilitation	Rehabilitation in Sub-basin 15D2 to reduce R value to 2%.		Completed 2005
2-9	Second Creek Trunk Sewer Improvements Phase I	Replace approximately 4,100 lf of existing sewer with 30-in sewer		Completed 2004
2-10	Second Creek Trunk Sewer Improvements Phase II	Replace approximately 3,700 lf of existing sewer with 30-in sewer, replace approximately 1,400 lf of existing sewer with 36-inch sewer.		Completed 2004
2-11	Burnside Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2523 Burnside Street.	FY 12/13	FY 12/13
2-12	Camelia Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Camelia Road and Merchant Drive and 412 Merchant Drive.	FY 10/11	FY 10/11
2-13	Cedar Heights Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5511 Cedar Heights Road and 5605 Pinecrest Road.	FY 10/11	FY 10/11
2-14	Central Avenue Pike Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5500 Central Avenue Pike.	FY 10/11	FY 10/11
2-15	1000 block Elm Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1025 Elm Street.	FY 11/12	FY 11/12
2-16	1600 block Elm Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1611 Elm Street and 801 West Oldham Avenue.	FY 11/12	FY 11/12

Table 12-2: Second Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
2-17	Shasta Drive Rehabilitaiton Project	Find and fix work to identify and address cause of overflow in the vicinity of 5108 Fennel Road and 805 Shasta Drive.	FY 11/12	FY 11/12
2-18	Nicholas Road - Clinton Highway Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4500 Nicholas Road and 4200 Clinton Highway.	FY 12/13	FY 12/13
2-19	Cumberland Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1000 Phillip Fulmer Way, 1509 Cumberland Avenue, and Seventeenth Street and White Avenue.	FY 12/13	FY 12/13
2-20	Sierra Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5609 Sierra Road.	FY 10/11	FY 10/11
2-21	Morelia Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 120 E. Morelia Avenue.	FY 11/12	FY 11/12
2-22	Dale Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 345 Dale Avenue.	FY 12/13	FY 12/13

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table 12-3: Third Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
3-2	Subbasin 11 Rehabilitation Project (approximately 25% rehabilitation)	Find and fix work to identify and address cause of overflow in the vicinity of 5815 Wooded Acres Drive, 6512 Shaftsbury Drive, and 6525 Tewksbury Drive.	FY 04/05	FY 07/08
3-3	Subbasin 9 Rehabilitation Project	Rehabilitation to reduce R to 2% in Sub-basins 09A1, 09A2, 09A4, and 09D1.	FY 04/05	FY 07/08
3-4	Upper McKamey and Third Creek Road Replacement Project	Replace approximately 3,141 lf of existing sewer with 36-in sewer and approximately 1500 lf with 15-in sewer.	FY 05/06	FY 07/08
3-5	Third Creek Storage Facility Project	Design and construction of a storage facility in Third Creek Basin (approximately 4.5 MG storage on Land Parcel # 093GB006)	FY 05/06	FY 07/08
3-6	Interstate 40 and Middlebrook Pike Trunk Replacement Project	Replace approximately 400 lf of existing sewer with 15-in sewer, 750 lf with 24-in sewer, 2,000 lf with 30-in sewer, and 7,000 lf with 36-in sewer.	FY 08/09	FY 09/10
3-7	Neyland Drive Trunk Replacement Project	Replace approximately 5,900 lf of existing sewer with 48-in sewer.	FY 08/09	FY 10/11
3-8	Third Creek Bike Trail Pipe Replacement Project	Replace approximately 1,200 lf of existing sewer with 24-in sewer.	FY 08/09	FY 10/11
3-11	Sutherland Avenue Collector Rehabilitation Project (Sub-basin 28B1)	Find and fix work to identify and address cause of overflow in the vicinity of 3110, 3204, and 3208 Sutherland Avenue, 409 North Bellemeade Avenue, Sutherland Avenue and North Bellemeade Avenue, and 5824 Stoneleigh Road.	FY 05/06	FY 07/08
3-12	Clinch and 21st Street Collector Rehabilitation Project (Sub-basin 35B3)	Find and fix work to identify and address cause of overflow in the vicinity of Twenty First Street and Twenty First Street and Laurel Avenue.	FY 10/11	FY 10/11
3-14	McKamey Road Interconnection Project	Project will involve constructing a hydraulic connection between the upper and lower McKamey Road Sewers.	FY 10/11	FY 11/12
3-15	Ball Camp Pike Improvement Project	Replace approximately 600 lf of existing sewer with 12-in sewer.	FY 10/11	FY 11/12
3-16	Painter Avenue Trunk Replacement Project	Replace approximately 2,200 lf of existing sewer with 48-in sewer and 200 lf with 54-in sewer.	FY 10/11	FY 11/12

Table 12-3: Third Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
3-17	McKamey Road Relief Sewer Project	Construct approximately 3,600 lf of 15-in sewer and 1,400 lf of 18-in sewer.		Completed 2002
3-20	Citico Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 600 and 605 Citico Street.	FY 11/12	FY 12/13
3-21	Deerfield Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4428 Deerfield Rd)	FY 10/11	FY 11/12
3-22	Fountain Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4337 Fountain Drive.	FY 11/12	FY 12/13
3-23	Hillvale Circle Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of the SSO at Hillvale Circle.	FY 12/13	FY 12/13
3-24	Montgomery Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 3624 Montgomery Avenue.	FY 12/13	FY 12/13
3-25	Rolling Ridge Interconnection Project	Replace Rolling Ridge pump station with gravity sewer.	FY 10/11	FY 11/12
3-26	PCP, CPE, and CCP	Wastewater evaluation studies of the Kuwahee WWTP.	FY 05/06	FY 06/07
3-27	Montgomery Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1811 and 1816 Sterchi Street and 3608 and 3618 Montgomery Avenue.	FY 11/12	FY 12/13
3-29	Highland Hills Road Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 409, 411, and 419 Highland Hills Road.	FY 12/13	FY 12/13

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table 12-4: Fourth Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
4-1	Chukar Road Rehabilitation (Sub-basin 32A3) Project	Find and fix work to identify and address cause of overflow in the vicinity of 410, 2513, 2621, 2624, 2644, and 2645 Chukar Road.	FY 07/08	FY 08/09
4-2	Gleason Drive Collector Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 8013 and 8044 Gleason Drive.	FY 07/08	FY 08/09
4-3	Middlebrook Pike Rehabilitation (Sub-basin 27C3) Project	Find and fix work to identify and address cause of overflow in the vicinity of 7350, 7351, and 7424 Middlebrook Pike.	FY 07/08	FY 08/09
4-4	Northshore Drive Trunk Replacement Project	Replace approximately 3,600 lf of existing sewer with 36-in sewer (IAP 2).	FY 07/08	FY 08/09
4-6	Shadyland Drive Rehabilitation (Sub-basin 36A2) Project	Find and fix work to identify and address cause of overflow in the vicinity of 7000 Rotherwood Drive and 7112 and 7712 Shadyland Drive.	FY 07/08	FY 08/09
4-17	Storage Tank	Storage upstream of Walker Springs Pump Station.	FY 04/05	FY 06/07
4-18	Papermill Phases I, II, and III Project	Replace approximately 3,500 lf of existing sewer with 15-in sewer and approximately 1,000 lf with 36-in sewer.	FY 04/05	FY 06/07
4-19	Northshore Drive Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 5501 and 6410 Northshore Drive and Northshore Drive and Lyons Bend Road.	FY 11/12	FY 12/13
4-21	Black Bear Road Project	Find and fix work to identify and address cause of overflow in the vicinity of 2313 Black Bear Road.	FY 11/12	FY 12/13
4-22	Nightingale Lane Project	Find and fix work to identify and address cause of overflow in the vicinity of 6614 and 6617 Nightingale Lane.		Completed 2005
4-23	5205 Bent River Blvd Project	Find and fix work to identify and address cause of overflow in the vicinity of 5205 Bent River Boulevard.	FY 10/11	FY 11/12
4-24	Kerri Way Project	Find and fix work to identify and address cause of overflow in the vicinity of 7505 Kerri Way.	FY 10/11	FY 11/12
4-25	Lonas Drive Project	Find and fix work to identify and address cause of overflow in the vicinity of 4930 Lonas Drive.	FY 10/11	FY 11/12
4-26	Midpark Drive Project	Find and fix work to identify and address cause of overflow in the vicinity of 1721 Midpark and Midpark and Beard Drive.	FY 10/11	FY 11/12
4-27	Southfork Project	Find and fix work to identify and address cause of overflow in the vicinity at 2501 Miss Ellie Drive (private).	FY 11/12	FY 12/13
4-28	Queensridge Pump Station Upgrade Project	Upsize Queensridge Pump Station.	FY 10/11	FY 10/11
4-31	Kingston Pike @ Gallahar View Project	Find and fix work to identify and address cause of overflow in the vicinity of 8401 and 8403 Kingston Pike.	FY 11/12	FY 12/13
4-32	PCP, CPE, and CCP	Wastewater evaluation studies of the Fourth Creek WWTP.	FY 05/06	FY 06/07

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table 12-5: South Knoxville / Knob Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
S-1	Ginnbrook Pump Station Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of Ginnbrook Pump Station	FY 06/07	FY 06/07
S-2	Goose Creek Trunk Sewer Replacement and Siphon Upgrade Project	Replace approximately 230 lf of existing sewer with 12-in sewer, Replace approximately 1100 lf of existing sewer with 15-in sewer, Replace approximately 1000 lf of existing sewer 30-in sewer, Replace approximately 60 lf of existing sewer with 36-in sewer	FY 06/07	FY 08/09
S-5	South Knoxville/Knob Creek Storage Facility	Design and construction of an approximately 4 MG storage facility	FY 05/06	FY 07/08
S-6	Sevier Avenue and Jones Street Collector Project	Rehabilitate approximately 3,100 lf of existing sewer and reroute approximately 352 lf of 8-in sewer	FY 08/09	FY 09/10
S-9	Ellis Road Rehabilitation Project	Find and fix work to rehabilitate approximately 3,940 lf of sewer in the vicinity of 6555 Chapman Highway, 6516 Jackie Lane, 212 Ellis Road, and 6528 Jackie Lane.	FY 08/09	FY 09/10
S-10	Mini-basin 41A6 Rehabilitation Project	Find and fix work to rehabilitate approximately 13,000 lf of sewer in Sub-basin 41A6 in the vicinity of 701 Lake Forest Rd.	FY 05/06	FY 08/09
S-11	Ford Valley Pump Station Upgrade Project	Upgrade pump station	FY 08/09	FY 09/10
S-14	Stone Road Rehabilitation Project	Rehabilitation in 41B1 to reduce R value to 2%	FY 04/05	FY 05/06
S-15	Trunk Replacement in Sub-basin 40A2 Project	Replace approximately 2,800 lf of sewer with 24-in sewer	FY 10/11	FY 11/12
S-16	Woodson Drive Trunk Replacement and Pump Station Upgrade Project	Replace approximately 260 lf of existing sewer and upgrade pump station		Completed 2004
S-17 (IAP 4)	Island Home Rehabilitation Project	Find and fix work to rehabilitate approximately 9,400 lf of existing sewer in the vicinity of 5320 McNutt and McNutt Road pump station		Completed 2004
S-18 (IAP 3)	South Haven Phases I & II Project	Relocate, rehabilitate and upsize approximately 4,700 lf		Completed 2005
S-19 (IAP 1)	Maryville Pike Pipe Replacement Project	Replace approximately 800 lf of existing sewer		Completed 2005
S-20	Avenue A Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 530 Avenue A	FY 10/11	FY 10/11
S-21	Alpine Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 3609 Alpine Avenue.	FY 11/12	FY 12/13
S-24 (IAP 5)	East Ford Valley Rehabilitation Project	Rehabilitation in Sub-basin 41A4 to reduce R value to 2%	FY 04/05	FY 05/06
S-25 (IAP 11)	South Haven Phase III Project	Rehabilitation in Sub-basin 40F1 to reduce R value to 2%	FY 04/05	FY 05/06
S-26	Trunk Sewer Replacement Project in Sub-basin 40F1	Replace 700 lf of existing sewer with 18-inch sewer	FY 10/11	FY 11/12
S-27	Trunk Sewer Replacement Project in Sub-basin 41A4	Replace approximately 175 lf of existing sewer with 12-inch sewer and 3,700 lf of existing sewer with 15-inch diameter sewer	FY 10/11	FY 11/12
S-28	Trunk Sewer Project	Trunk sewer project to correct reverse slopes in vicinity of 3430 Blount Ave	FY 06/07	FY 08/09
S-29	4500 block Sevierville Pike Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 4523 Sevierville Pike.		Completed 2003

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table 12-6: Williams Creek Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
W-1	Sub-basin 19A2 Rehabilitation	Rehabilitation to reduce R to 2% in Sub-basin 19A2.	FY 09/10	FY 11/12
W-2 (IAP 9)	Williams Creek Trunk Line Replacement (Downstream of Golf Course)	Replace approximately 3,100 lf of existing sewer with 36-in sewer.	FY 04/05	FY 05/06
W-3	Rehabilitation of Trunk Sewer	Replace approximately 6,100 lf of existing sewer with 24-in sewer.		Completed 2003
W-4	E. Fifth Avenue Sewer Replacement Project	Find and fix work to identify and address cause of overflow in the vicinity of 2555 Fifth Avenue and 2565 E. Fifth Avenue.	FY 05/06	FY 05/06
W-5	Groner Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 1114 Groner Road.	FY 11/12	FY 12/13
W-6	Selma Avenue - Harrison Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2806 Selma Avenue, 509 Harrison Street, and 515 Harrison Street.	FY 11/12	FY 12/13
W-7	Sunset Avenue Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 2614 Sunset Avenue.	FY 11/12	FY 11/12
W-8	South Elmwood Street Rehabilitation Project	Find and fix work to identify and address cause of overflow in the vicinity of 121, 129 and 133 South Elmwood Street.	FY 11/12	FY 12/13
W-9	Williams Creek Trunk Line Replacement (Sub-basin 19A1)	Replace approximately 360 lf of existing sewer with 15-in sewer.	FY 11/12	FY 12/13

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

Table 12-7: Loves Creek and Eastbridge Implementation Plan[1]

Project ID	Project Name	Project Description[1]	Start Date	End Date
L-1	Asheville Highway west of I-40 Trunk Replacement	Replace approximately 5,030 lf of existing 18-in pipe.	FY 10/11	FY 11/12
L-2	Boyds Bridge Pike and Holston Hills Trunk Replacement	Replace approximately 4,190 lf of existing 10-in, 500 lf of 12-in, and 330 lf of 15-in pipe.	FY 10/11	FY 11/12
L-3	River View Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4102, 4200, 3722, 3716, and 4014 Holston Hills Road.	FY 10/11	FY 11/12
L-4	Asheville Highway Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 5411 Asheville Highway.	FY 10/11	FY 11/12
L-5	Brentwood Shortline Repair	Find and fix work to identify and address cause of overflow in the vicinity of Brentwood Road	FY 11/12	FY 12/13
L-6	Holston Hills Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4716 Holston Hills Road.	FY 11/12	FY 12/13
L-7	Magnolia Avenue Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3301 Magnolia Avenue.	FY 11/12	FY 12/13
L-8	McDonald Drive Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3415 McDonald Drive.	FY 10/11	FY 11/12
L-9	Shelbourne Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 3001 Shelbourne Road.	FY 11/12	FY 12/13
L-10	Washington Court Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 4436 Washington Court.	FY 11/12	FY 12/13
EB-1	Maloneyville Road Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of Maloneyville Road (MH 93-1, 93-7, 93-10, and at the lift station).	FY 10/11	FY 11/12
EB-2	Strawberry Plains Pike Rehabilitation	Find and fix work to identify and address cause of overflow in the vicinity of 8616, 8714, and 9005 Strawberry Plains Pike.	FY 10/11	FY 11/12

[1]Approximate sizing and extents of each project is given for planning level purposes. The exact sizing and extent of each project will be determined during preliminary design. Other modifications to the projects may occur during preliminary design. For example, it may be determined that parallel relief sewers would be more cost effective than replacement sewers for some projects. Any modifications will be explained in the quarterly updates submitted after approval of the Phase 1 CAP/ER.

N
W
E
S

2000 0 2000 4000 Feet

1-24
1-1
1-25
1-25
1-21
1-11
1-17
1-1
1-12
1-27
1-5
1-25
1-6
1-13
1-4
1-13
1-3
1-6
1-2
1-19
1-18
1-16
1-14
1-23
1-26
1-15
1-3
1-2
1-22
1-20

Brookevale
Wingate
Kohls
Pilleaux Road
Emily Avenue
Pelham Road
Burlington
Jones Street
Island Home

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- First Creek Basin

Improvement Projects

- Completed Improvement Projects
- CAP/ER Improvement Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- Find and Fix Projects
- CAP/ER Storage Facility

CDM

First Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure 12-1

0002075

N
W
E
S
2000 0 2000 4000 Feet
2-6
Pilleaux Road
2-13
2-20
2-14
2-17
2-12
2-9
2-18
2-4
2-8
2-5
2-21
2-10
2-2
2-11
2-2
2-3
2-16
2-15
2-1
2-22
2-19
Jones Street
Kuwahee WWTP
Cheowa
Scottish Pike

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- Second Creek Basin
- WWTP

Improvement Projects

- Completed Improvement Projects
- CAP/ER Improvement Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- Find and Fix Projects

CDM

Second Creek
Phase 1 CAP/ER
Facility Improvement Projects

Figure 12-2

0002076

N
W
E
S

2000 0 2000 4000 Feet

Pilleaux Road
Clinton Highway
Schaad Road
Rolling Ridge
Amherst Road
Lyons View
Chedwe
Scottish Pike
Kuwahee WWTP
Woodson
Vestal

3-3
3-3
3-3
3-22
3-21
3-15
3-4
3-14
3-17
3-4
3-5
3-2
3-25
3-24
3-6
3-27
3-20
3-12
3-6
3-16
3-8
3-11
3-23
3-26
3-7
3-28

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- Third Creek Basin
- WWTP

Improvement Projects

- Completed Improvement Projects
- CAP/ER Improvement Projects
- Find and Fix Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- CAP/ER Storage Facility
- Pump Station Upgrade

Third Creek
Phase 1 CAP/ER
Facility Improvement Projects

CDM

Figure 12-3

0002077

N
W
E
S
2000 0 2000 4000 Feet
Rolling Ridge
Amherst Road
Walker Springs
Highland Point
Queensbury Drive
Lyons View
Chatsworth
Tom Hill
Fourth Creek WWTP
4-1
4-27
4-21
4-26
4-25
4-3
4-24
4-22
4-18
4-4
4-17
4-31
4-2
4-19
4-32
4-6
4-28
4-23
LEGEND
SSOs from Long-Term List requiring facility improvement projects
Trunk Sewers
Collector Sewers
Force Main
Fourth Creek Basin
Pump Station
WWTP
Improvement Projects
Completed Improvement Projects
CAP/ER Improvement Projects
CAP/ER Sewer Rehabilitation to an R=2%
Find and Fix Projects
CAP/ER Storage Facility
Pump Station Upgrade
CDM
Fourth Creek Phase 1 CAP/ER Facility Improvement Projects
Figure 12-4
0002078

N
W
E
S
2000 0 2000 4000 Feet

S-6
S-26
S-15
S-18
S-15
S-25
S-21
S-29
S-28
S-2
S-2
S-19
S-20
S-17
S-10
S-11
S-14
S-24
S-27
S-9
S-16
S-5
S-1

LEGEND

- SSOs from Long-Term List requiring facility improvement projects
- Trunk Sewers
- Collector Sewers
- Pump Station
- South Knoxville and Knob Creek Basins
- WWTP

Improvement Projects

- Completed Improvement Projects
- CAP/ER Improvement Projects
- CAP/ER Sewer Rehabilitation to an R=2%
- Find and Fix Projects
- Completed Rehabilitation Project
- CAP/ER Storage Facility
- Pump Station Upgrade

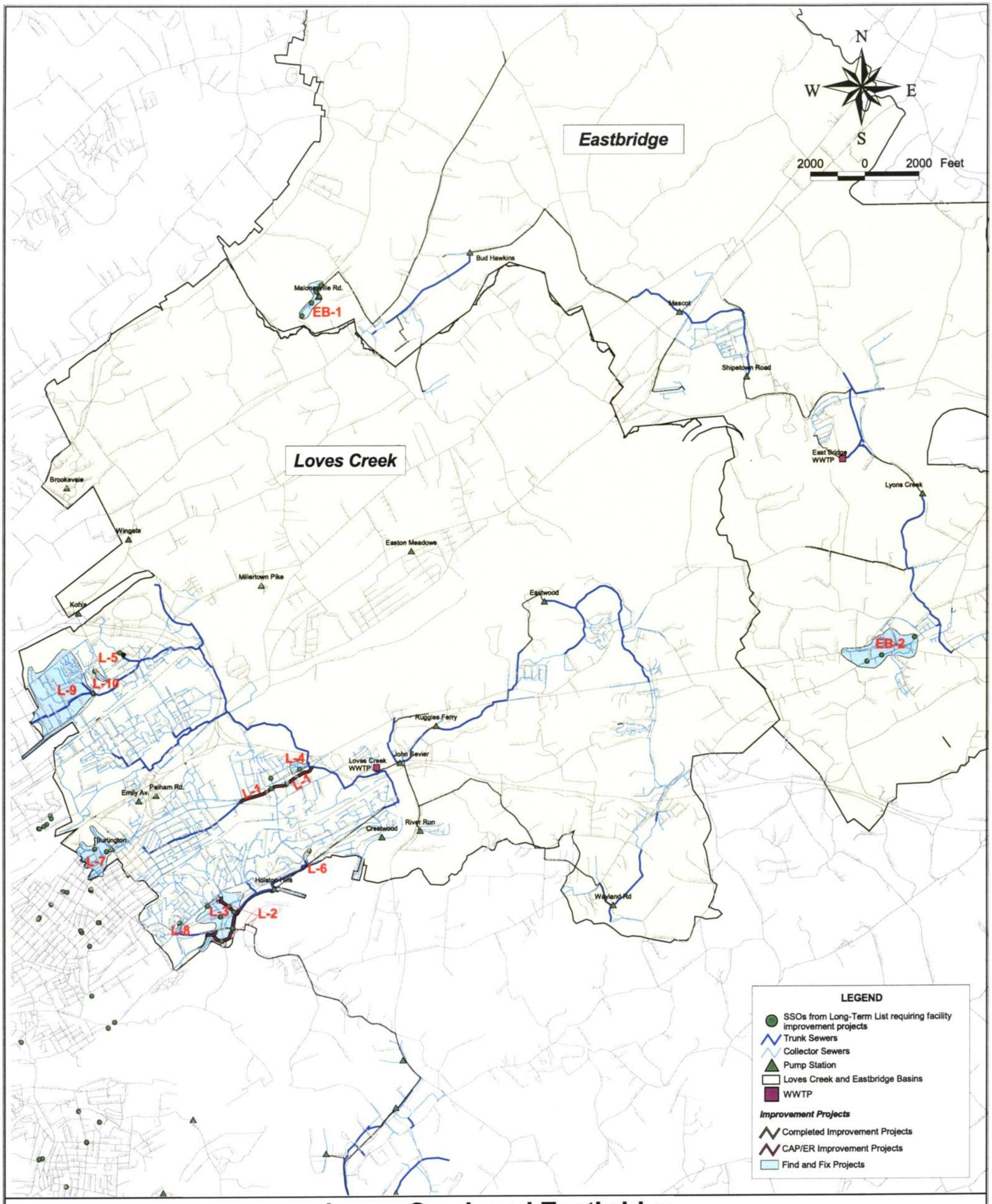
6/02/2009

CDM

South Knoxville/Knob Creek Phase 1 CAP/ER Facility Improvement Projects

Figure 12-5

N
W
E
S
1000 0 1000 Feet
W-1
W-8
W-4
W-6
W-9
W-7
W-3
W-5
W-2
LEGEND
SSOs from Long-Term List requiring facility improvement projects
Trunk Sewers
Collector Sewers
Pump Station
Williams Creek Basin
Improvement Projects
Completed Improvement Projects
CAP/ER Improvement Projects
CAP/ER Sewer Rehabilitation to an R=2%
Find and Fix Projects
CDM
Williams Creek
Phase 1 CAP/ER
Facility Improvement Projects
Figure 12-6
0002080



CDM

Loves Creek and Eastbridge Phase 1 CAP/ER Facility Improvement Projects

Figure 12-7

0002081