Group One Sanitary Sewer System and WWTP Remedial Measures Plan

Submittal to:

The United States Environmental Protection Agency and

The Kentucky Department for Environmental Protection

from

Lexington-Fayette Urban County Government

October 12, 2011

Prepared by:

HAZEN AND SAWYER
Environmental Engineers & Scientists

Lexington-Fayette Urban County Government
DEPARTMENT OF ENVIRONMENTAL QUALITY & PUBLIC WORKS

Jim Gray
Mayor

Cheryl Taylor
Commissioner

October 12, 2011

RE: Civil Action No. 5:06-cv-386
Lexington-Fayette Urban County Government – Kentucky
Group 1 Sanitary Sewer System and WWTP Remedial Measures Plan

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
Box 7611 Ben Franklin Station
Washington, D.C. 20044-7611
DOJ No. 90-5-1-1-08858

Chief
Water Programs Enforcement Branch
Environmental Protection Agency Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Sir / Madam:

In accordance with the provisions of Section VII, Paragraph 15.G.(i) of the above referenced document, the Lexington-Fayette Urban County Government (LFUCG) is providing the Group 1 Sanitary Sewer System and WWTP Remedial Measures Plan. This plan is the work product of various professional engineering firms that compiled the required information via independent contracts with LFUCG. The team of Hazen and Sawyer, CDM, and Stantec Consulting Services prepared this report under the direction of LFUCG.

If you should have any questions, please contact me at (859) 425-2400.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signed

10/12/11
Date

Charles H. Martin, P.E., Director
Division of Water Quality
Lexington-Fayette Urban County Government

cc: Director of the Division of Enforcement
Department for Environmental Protection
300 Fairs Oaks Lane
Frankfort, KY 40601

Janet Graham, LFUCG, Commissioner of Law
Cheryl Taylor, LFUCG, Commissioner of Environmental Quality & Public Works

Enclosure

2 copies – Water Programs Enforcement Branch
1 copy – all other addresses

The following listing is submitted with this report to facilitate the reviewer. The requirements of the Consent Decree Part VII.15.G.are included below with a reference to the specific area of the report that fulfills the requirement.

	Consent Decree Requirement (from VII.15.G Sanitary Sewer System and WWTP Remdial Measures Plan)	Location in RMP Report
ii	The Sanitary Sewer System and WWTP Remedial Measures Plan (RMP) shall identify all measures necessary to achieve adequate capacity. If insufficient capacity to accommodate projected Peak Flows exists in any portion of the system, identify and propose measures to provide adequate capacity.	Section 3
iii	The RMP shall identify all WWTP upgrades and repair measures necessary to achieve WWTP compliance with all NPDES permit limitations for LFUCG's WWTPs and requirements and to eliminate wet weather Unpermitted Bypasses.	Section 3F
iv	The RMP shall identify the degree to which sources of Excessive I/I shall be removed, the degree to which Excessive I/I removal is expected to alleviate capacity constraints, and propose specific remedial measures that will address those capacity limitations not expected to be addressed by Excessive I/I removal.	Section 4
v	The RMP shall identify all measures necessary to eliminate all cross-connections, and Recurring SSOs caused by physical degradation of sewers, inadequate Pumping Stations capacities, or inadequate Pumping Station reliability.	Section 3
vi	The RMP shall, for purposes of developing schedules, prioritize the remedial measures based upon: **a** relative likely human health and environmental impact risks **b** Recurring SSO frequencies of activations **c** total annual Recurring SSO volumes LFUCG may also take into account cost-effectiveness and risks associated with implementation. The RMP shall provide a description of the methodology used to apply the above factors	Section 5
vii	The RMP shall provide estimated capital, O&M, and present value costs for each identified remedial measure. The RMP shall provide an expeditious schedule for design, construction, and placement in service of all proposed measures that is in no even later than eleven years from the Effective Date of the CD, or in the event that remedial measures include a WWTP upgrade, thirteen years from the Effective Date of the CD only for such WWTP upgrade and other remedial measures associated with the WWTP upgrade.	Table 5-3

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* Figures without page numbers follow their respective section of text.

Executive Summary

A. Background

The Sanitary Sewer System and WWTP Remedial Measures Plan (RMP) is being developed pursuant to Paragraph VII.15.G (Sanitary Sewer System and WWTP Remedial Measures Plan) of the Consent Decree (CD) for the Lexington-Fayette Urban County Government (LFUCG). The CD was lodged on March 14, 2008 and became effective on January 3, 2011. The RMP is organized according to the major sewersheds within the LFUCG service area as defined in the CD and shown on Figure ES-1:

- Group One: West Hickman, East Hickman, and Wolf Run (contains the West Hickman WWTP) – addressed in this report.
- Group Two: Cane Run and Town Branch (contains the Town Branch WWTP) – addressed in a future report.
- Group Three: North Elkhorn and South Elkhorn – addressed in a future report.

The CD requires that LFUCG eliminate recurring sanitary sewer overflows (SSOs) and unpermitted bypasses at the wastewater treatment plant within 11 to 13 years of the effective date of the CD. This report summarizes the RMP for the Group One Sewersheds, which includes the West Hickman WWTP. It presents the evaluation methodology, solution development process, project development, a prioritized implementation plan, and capital cost estimates.

B. Alternatives and Major Issues

SSOs are caused by capacity restrictions, sewer line blockages, and/or deteriorating sewers. They occur most frequently (but not always) during heavy rainfall events when rain enters the sanitary sewer system through pipe defects (infiltration and inflow, or I/I) or illegal private connections and the resulting flow exceeds the capacity of the sewer collection and pumping systems. SSO elimination efforts typically involve increasing system capacity and/or repairing the system to reduce the amount of rainwater entering the sewer system. In the development of this RMP the following "general solutions" were evaluated:

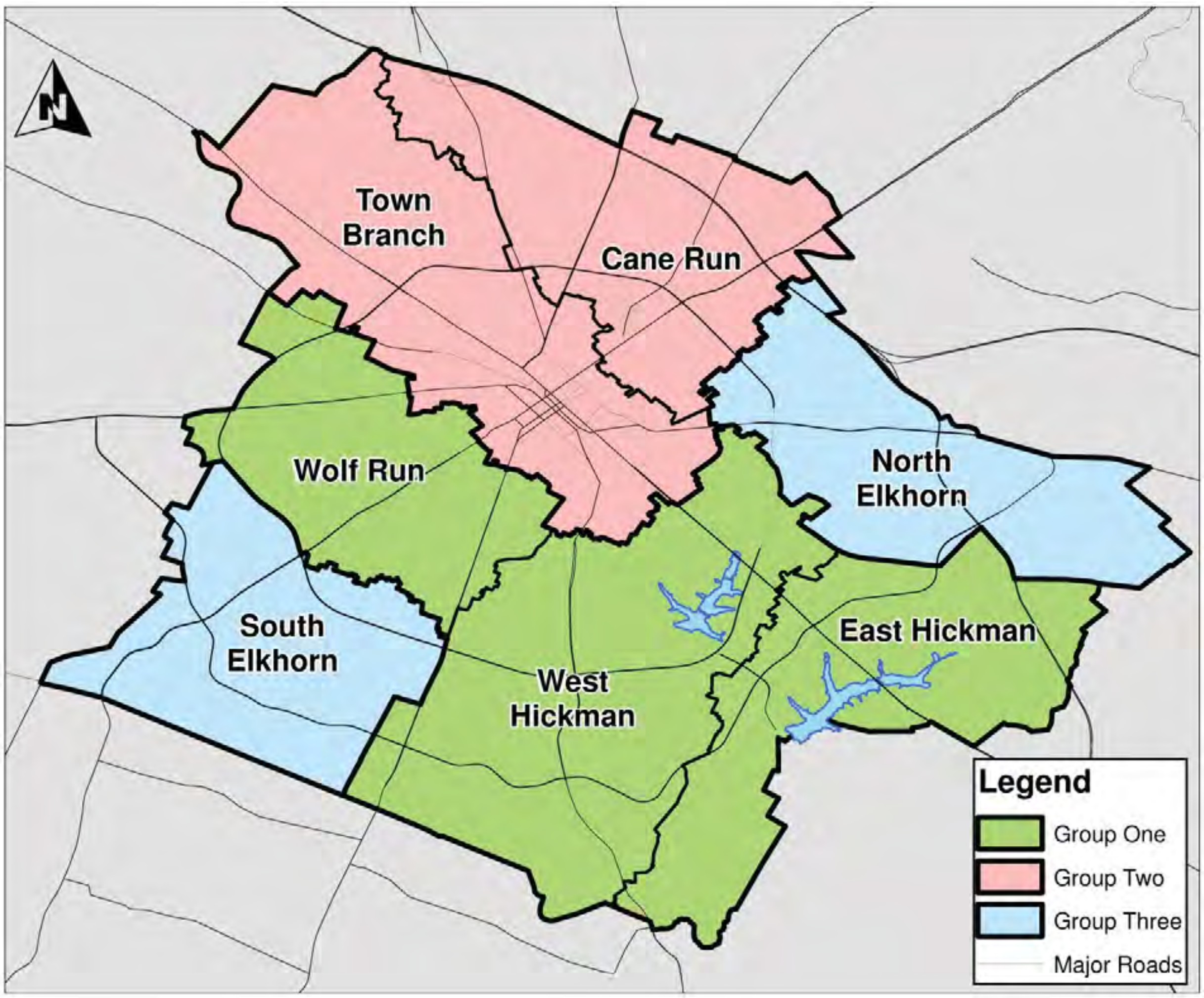
- Increasing system capacity by upsizing pipes and pump stations
- Rehabilitating (repairing) the system, including disconnecting illegal private connections, to reduce I/I such that system capacity is not exceeded
- Providing equalization (EQ) storage for the excess flows during rain events

Thorough analyses of these "toolbox options" were conducted to develop the most cost-effective solutions for the SSO eliminations. During the RMP development the following major decisions were made that affected the recommended solutions:

- The Level of Control (LOC), also referred to as the Level of Service, is a critical program decision. This decision sets the performance criteria of the program, i.e. the intensity and duration of storm event for which no capacity-related SSOs would be expected to occur. After much deliberation and public scrutiny, the 2-year, 24-hour storm event was selected for the LOC. Resolution No. 389-2011 passed on September 15, 2011 by the

Urban County Council adopted the 2-year, 24-hour storm event as the design storm to form the basis of the LFUCG Sanitary Sewer System and WWTP Remedial Measures Plan. Besides controlling SSOs, the performance criteria include meeting the defined criteria of the Capacity Assurance Program as required by Paragraph VII.16.B of the Consent Decree. Based on this LOC no significant pipe surcharging would occur for the 2-year, 24-hour storm event.

Figure ES-1: Groups and Drainage Sewersheds with Future Expansion Areas



- LFUCG's experience with obtaining I/I reduction through rehabilitation and repairs, measured by pre-construction and post-construction flow monitoring, has not been encouraging. While system rehabilitation has been and will continue to be an element of significant investment for LFUCG (currently budgeted at $5 million per year), it was decided that system rehabilitation would not be an integral part of the RMP solutions. Instead, I/I reduction obtained through system rehabilitation will in effect increase the LOC above the selected 2-year, 24-hour storm event. All proposed system improvements are to be designed based on an assumption that there will be no I/I reduction resulting from rehabilitation and other capacity management, operation and maintenance (CMOM) activities.

- Evaluations of LFUCG's two wastewater treatment plants indicate that they both can treat approximately 70 million gallons per day (MGD) while meeting permitted discharge limits. Their peak capacity listed on their NPDES discharge permits is 64 MGD. For the purpose of the RMP both WWTPs are assumed to have peak capacities of 70 MGD, which will reduce the volume of EQ storage required as compared to limiting the peak capacities to 64 MGD. Improvements at the WWTPs will not include any capacity expansions, but will include improvements in reliability and redundancy.
- In general, the number of EQ basins and tanks should be kept to a minimum, as the facilities require cleaning and maintenance and would not be welcomed additions to established residential neighborhoods.
- Sanitary sewer improvements necessary for the development of Expansion Area 1 (in the southeast portion of the East Hickman Sewershed) are included in the RMP in accordance with LFUCG's current 201 Facilities Plan. The Expansion Area 1 improvements will eliminate SSOs that occur at four separate pump stations.

C. Proposed Remedial Measures

Capital construction necessary to eliminate recurring SSOs in the three Group One sewersheds is shown on figures ES-2 through ES-4. The following table indicates the infrastructure to be constructed, and the estimated capital costs of these improvements.

Table ES-1: Proposed Infrastructure and Estimated Capital Costs

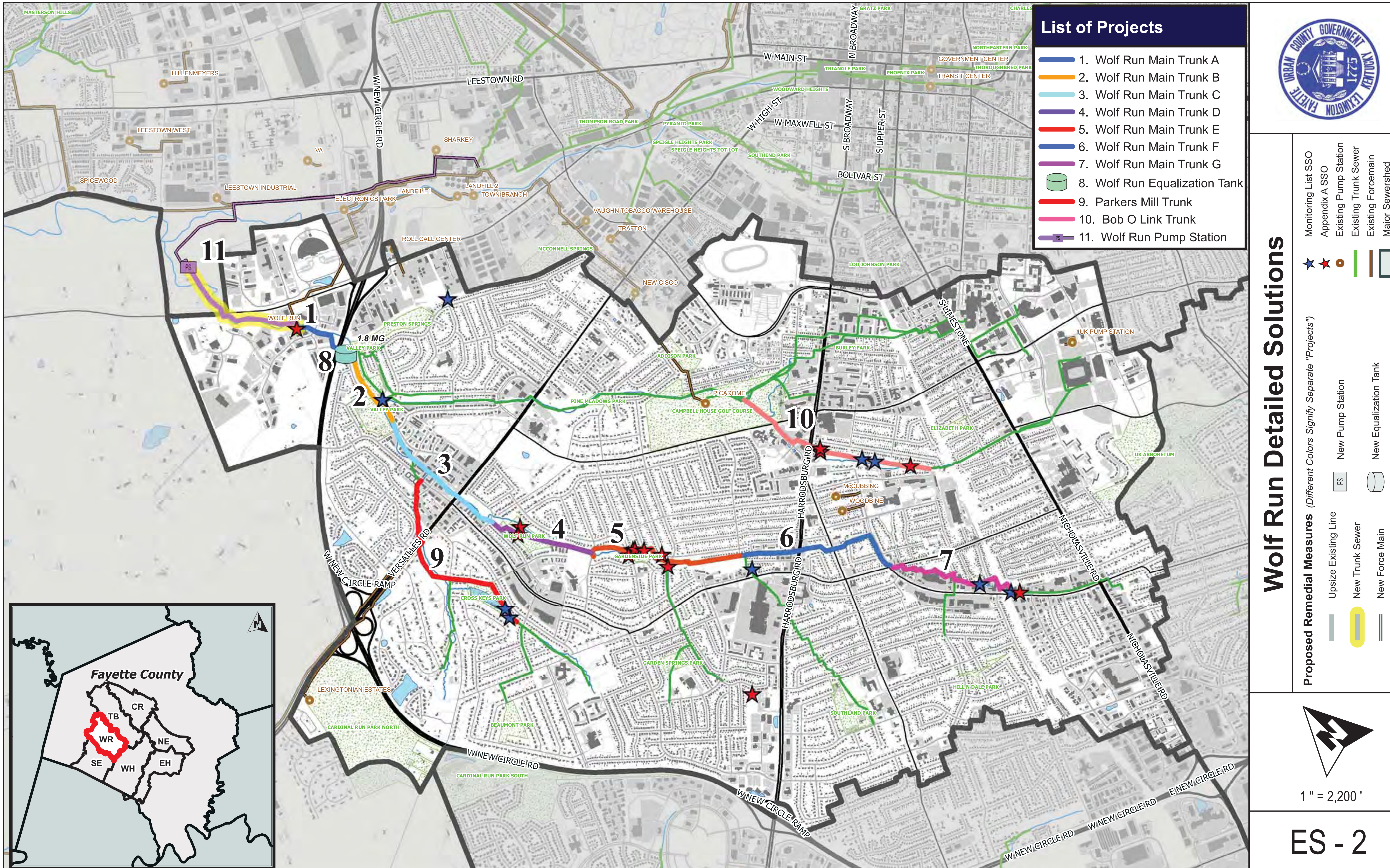
Sewershed	West Hickman	East Hickman	Wolf Run
Pipelines – new or replaced	72,445 LF	66,160 LF	33,839 LF
EQ Basin/tank location(s)	WH7, WHWWTP	East Hickman Pump Station	Wolf Run Equalization Tank
EQ Basin/tank volume	44 MG	4.3 MG	1.8 MG
WWTP Upgrade – estimated cost	$22.6 million	n/a	n/a
Total estimated capital costs	$219 million	$71 million	$33 million
Total estimated capital costs for Group One = $323 million			

The proposed improvements were divided into distinct projects (see Figures ES-2, ES-3, and ES-4 for the locations of these projects), and each project was prioritized based on frequency and severity of SSOs and potential health risks to the public. An Implementation Plan was developed based on the priorities, while considering necessary "predecessor" projects. Predecessor projects are projects that should be completed prior to the subject project. Typically they are downstream of the subject project and are needed to increase capacity so that SSOs are not relocated or new SSOs are not created. The proposed Implementation Plan shows the currently proposed schedule for design and construction of each project, and is shown in Figure ES-5 and detailed in Section 5 of this report. The project phasing is based on anticipated cash flow from LFUCG's financial modeling. It should be noted that this schedule is considered tentative until the RMPs for Group Two and Group Three are developed and the capital projects for the entire city can be prioritized and scheduled.

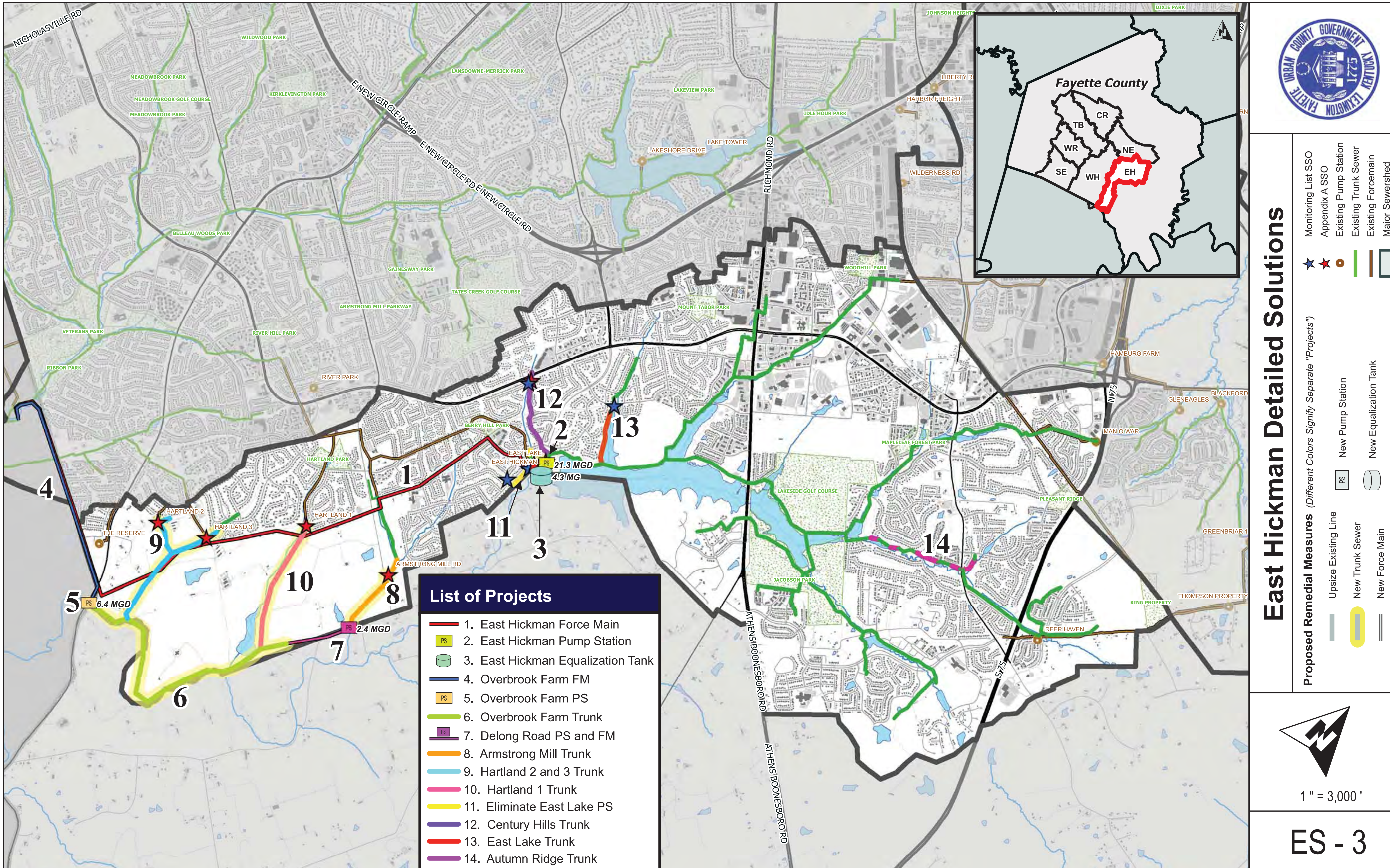
D. Near-term Action Items

This Group One Sanitary Sewer System and WWTP Remedial Measures Plan has been submitted to the US EPA for review and approval. While EPA is reviewing the document, LFUCG will be proceeding with the following items:

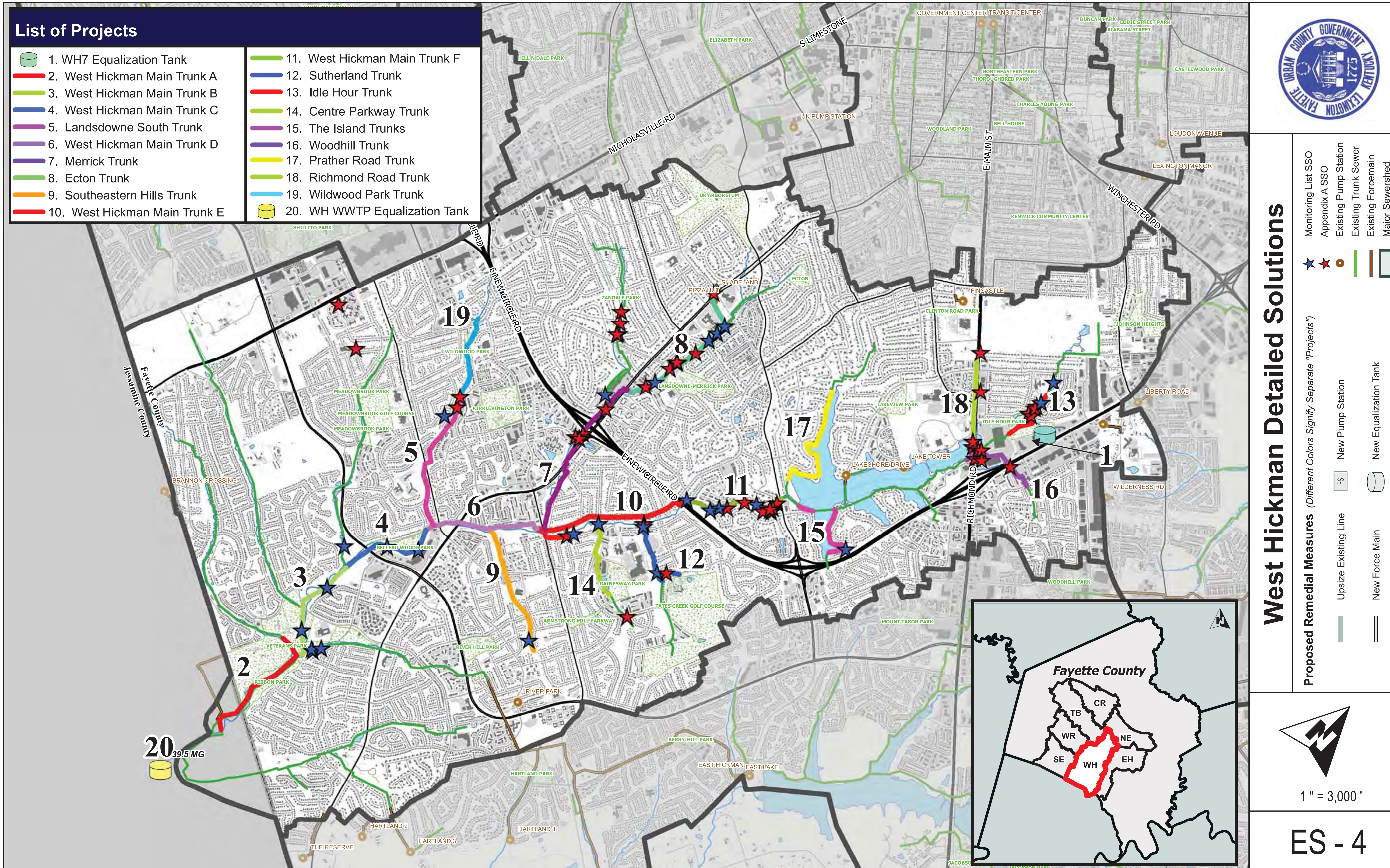
1. Developing a streamlined process for procurement of engineering and construction services
2. Developing a streamlined process for property and easement acquisition
3. Proceeding with major system rehabilitation efforts
4. Initiating certain capital projects that are essential, with well-defined scopes that are not likely to be changed by the regulatory review process. Initiating a Private Property Task Force to develop a more aggressive program for reducing I/I from private property (especially sump pumps).



Wolf Run Detailed Solutions
List of Projects
1. Wolf Run Main Trunk A
2. Wolf Run Main Trunk B
3. Wolf Run Main Trunk C
4. Wolf Run Main Trunk D
5. Wolf Run Main Trunk E
6. Wolf Run Main Trunk F
7. Wolf Run Main Trunk G
8. Wolf Run Equalization Tank
9. Parkers Mill Trunk
10. Bob O Link Trunk
11. Wolf Run Pump Station
Monitoring List SSO
Appendix A SSO
Existing Pump Station
Existing Trunk Sewer
Existing Forcemain
Major Sewershed
Proposed Remedial Measures (Different Colors Signify Separate "Projects")
Upsize Existing Line
New Trunk Sewer
New Force Main
New Pump Station
New Equalization Tank
1.8 MG
Fayette County
TB
CR
WR
NE
SE
WH
EH
W MAIN ST
LEESTOWN RD
W NEW CIRCLE RD
W HIGH ST
W MAXWELL ST
S BROADWAY
N BROADWAY
S UPPER ST
BOLIVAR ST
S LIMESTONE
HARRODSBURG RD
NICHOLASVILLE RD
VERSAILLES RD
W NEW CIRCLE RAMP
E NEW CIRCLE RD
1 " = 2,200 '
ES - 2



East Hickman Detailed Solutions
Proposed Remedial Measures (Different Colors Signify Separate "Projects")
Upsize Existing Line
New Trunk Sewer
New Force Main
New Pump Station
New Equalization Tank
Monitoring List SSO
Appendix A SSO
Existing Pump Station
Existing Trunk Sewer
Existing Forcemain
Major Sewershed
Fayette County
CR
TB
WR
NE
SE
WH
EH
1 " = 3,000 '
ES - 3
List of Projects
1. East Hickman Force Main
2. East Hickman Pump Station
3. East Hickman Equalization Tank
4. Overbrook Farm FM
5. Overbrook Farm PS
6. Overbrook Farm Trunk
7. Delong Road PS and FM
8. Armstrong Mill Trunk
9. Hartland 2 and 3 Trunk
10. Hartland 1 Trunk
11. Eliminate East Lake PS
12. Century Hills Trunk
13. East Lake Trunk
14. Autumn Ridge Trunk
21.3 MGD
4.3 MG
6.4 MGD
2.4 MGD
NICHOLASVILLE RD
E NEW CIRCLE RAMP
E NEW CIRCLE RD
RICHMOND RD
ATHENS BOONESBORO RD
ARMSTRONG MILL RD
WILDWOOD PARK
MEADOWBROOK PARK
MEADOWBROOK GOLF COURSE
KIRKLEVINGTON PARK
LANSDOWNE-MERRICK PARK
LAKEVIEW PARK
IDLE HOUR PARK
LAKESHORE DRIVE
LAKE TOWER
BELLEAU WOODS PARK
GAINESWAY PARK
TATES CREEK GOLF COURSE
ARMSTRONG MILL PARKWAY
VETERANS PARK
RIVER HILL PARK
RIBBON PARK
RIVER PARK
BERRY HILL PARK
HARTLAND PARK
EAST LAKE
EAST HICKMAN
HARTLAND 1
HARTLAND 2
HARTLAND 3
THE RESERVE
MOUNT TABOR PARK
WOODHILL PARK
MAPLELEAF FOREST PARK
LAKESIDE GOLF COURSE
JACOBSON PARK
DEER HAVEN
PLEASANT RIDGE
KING PROPERTY
THOMPSON PROPERTY
GREENBRIAR 1
GLENEAGLES
BLACKFORD
MAN O WAR
HAMBURG FARM
WILDERNESS RD
HARBOR FREIGHT
LIBERTY RD
JOHNSON HEIGHTS
DIXIE PARK



List of Projects
1. WH7 Equalization Tank
2. West Hickman Main Trunk A
3. West Hickman Main Trunk B
4. West Hickman Main Trunk C
5. Landsdowne South Trunk
6. West Hickman Main Trunk D
7. Merrick Trunk
8. Ecton Trunk
9. Southeastern Hills Trunk
10. West Hickman Main Trunk E
11. West Hickman Main Trunk F
12. Sutherland Trunk
13. Idle Hour Trunk
14. Centre Parkway Trunk
15. The Island Trunks
16. Woodhill Trunk
17. Prather Road Trunk
18. Richmond Road Trunk
19. Wildwood Park Trunk
20. WH WWTP Equalization Tank
39.5 MG
Fayette County
Jessamine County
NICHOLASVILLE RD
S LIMESTONE
E NEW CIRCLE RD
E MAIN ST
WINCHESTER RD
RICHMOND RD
LAKESHORE DRIVE
LAKE TOWER
LIBERTY ROAD
WILDERNESS RD
LOUDON AVENUE
LEXINGTON MANOR
UK PUMP STATION
BRANNON CROSSING
RIVER PARK
EAST HICKMAN
EAST LAKE
HARTLAND 1
HARTLAND 2
HARTLAND 3
THE RESERVE
FINCASTLE
LEXINGTON FAYETTE URBAN COUNTY GOVERNMENT 1775
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Upsize Existing Line
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Fayette County
CR
TB
WR
NE
SE
WH
EH
1 " = 3,000 '
ES - 4

Section 1 Background

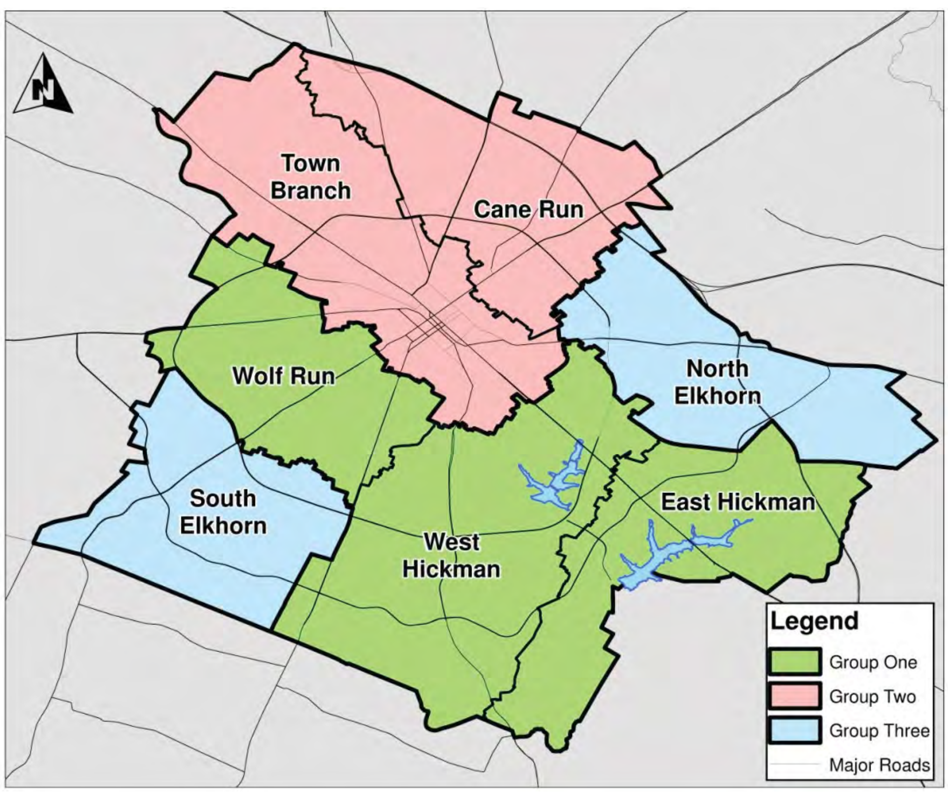
The Group One Sanitary Sewer System and WWTP Remedial Measures Plan (RMP) consists of specific projects that, when implemented, will result in adequate capacity in the Group One portions of the sanitary sewer system and the West Hickman Wastewater Treatment Plant (WHWWTP). Provision of adequate capacity for these facilities will eliminate recurring Sanitary Sewer Overflows (SSOs). In addition, wet-weather related Unpermitted Bypasses and overloading of the WHWWTP resulting in current NPDES permit noncompliance will be eliminated for conditions that do not exceed the selected design wet-weather event described in Section 2.

A. Consent Decree

The RMP was developed pursuant to Paragraph VII.15.G (Sanitary Sewer System and WWTP Remedial Measures Plan) of the Consent Decree (CD) for the Lexington-Fayette Urban County Government (LFUCG). The CD was lodged on March 14, 2008 and became effective on January 3, 2011. The RMP is organized according to the major sewersheds within the LFUCG service area as defined in the CD and shown on Figure 1-1:

- Group One: West Hickman, East Hickman, and Wolf Run (contains the West Hickman WWTP) – addressed in this report.
- Group Two: Cane Run and Town Branch (contains the Town Branch WWTP) – addressed in a future report.
- Group Three: North Elkhorn and South Elkhorn – addressed in a future report.

Figure 1-1: Groups and Drainage Sewersheds with Future Expansion Areas



This report summarizes the RMP for the Group One Sewersheds. It presents the evaluation methodology, solution development process, project development, a prioritized implementation plan and cost estimates.

B. Specific Sanitary Sewer System and WWTP Remedial Measures Plan Requirements

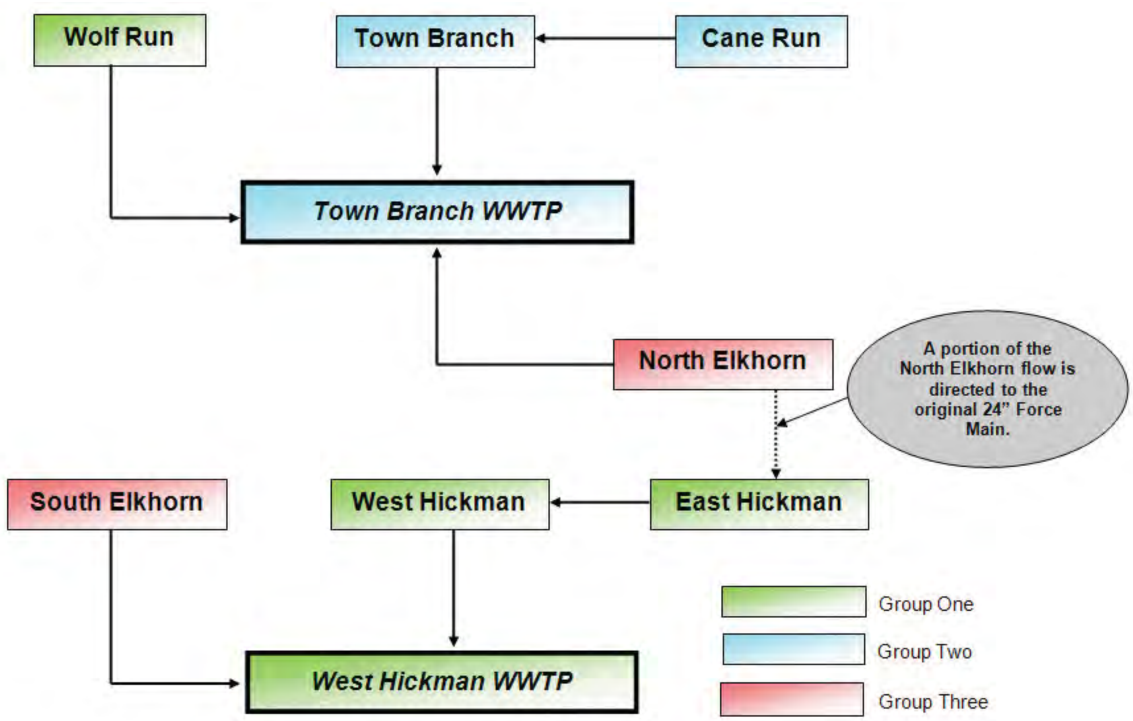
Specific requirements of the CD (Section VII.15.G) related to the RMP are listed below:

- Specific measures and schedules that will result in adequate capacity such that recurring SSOs, unpermitted WWTP bypasses, and NPDES permit noncompliance are eliminated.
- Peak flows shall include conditions considered in the Sanitary Sewer Assessment; identify and propose measures to provide adequate capacity.
- Identify all WWTP upgrades and repairs necessary for permit compliance and wet-weather bypass elimination.
- Identify the degree to which excessive inflow and infiltration (I/I) shall be removed, the degree to which I/I removal will alleviate capacity constraints, and propose remedial measures to address capacity limitations not addressed by I/I removal.
    a) Anticipated I/I removal rates shall be per industry standards and local experience.
    b) May include increases in pump station (PS) and sewer capacity, equalization (EQ) basins, or WWTP capacity increases.
- Eliminate all cross connections and recurring SSOs from physical degradation of sewers, inadequate PS capacity, or inadequate PS reliability.
- Prioritize the remedial measures based on the following and include a description of prioritization methodology related to these factors:
    a) Human health and environmental impacts
    b) SSO frequency
    c) SSO volume
    d) Cost-effectiveness and "risks associated with implementation"
- Provide estimated capital, O&M, and present value costs for each remedial measure using year-specific dollars.
- Provide an expeditious schedule for design, construction, and placement in service.
    a) No later than 11 years from effective date of the CD, except that the upgrades can extend to 13 years if WWTP work is to be done.
    b) Include milestone dates for each project: preliminary design, final design, permitting, contract award, begin construction, and end construction.
- There shall be no restrictions on LFUCG implementing interim remedial measures prior to RMP approval.

The SSOs that are discussed and addressed as part of this RMP are the 111 SSOs listed in Appendix A of the CD. Within those, there are 9 cross connections, 7 basement backups, and 12 maintenance-related SSOs. The remaining 83 SSOs are at manholes and pump stations and will be eliminated by the implementation of remedial measures implemented over the next 11 to 13 years. The explicit removal of cross connections will be another objective of this and subsequent RMPs. The basement backups will be addressed by a combination of increased system capacity, long-term I/I reduction, and the installation of backtrap valves.

A schematic of the flow paths comprising the LFUCG Sewersheds is provided in Figure 1-2. The flow paths have recently and are still undergoing major changes. One major change includes the redirection of most of the North Elkhorn Pump Station effluent from the East Hickman gravity sewer system to a direct discharge at the Town Branch WWTP. Another change is the redirection of flow from South Elkhorn Pump Station from the West Hickman gravity sewer system to a direct discharge at the West Hickman WWTP. These flow redirections provided significant additional capacity in the portions of the gravity sewer system that had previously received the pump station discharges.

Figure 1-2: Existing Sewershed Flow Routing



C. Related Studies

The following related reports were prepared in accordance with the requirements of the Consent Decree and were submitted for review by EPA and the DOW:

- Sanitary Sewer Assessment Work Plan (June 2008) – Documents the procedures and schedule for completing a condition assessment and performance evaluation of the Sanitary Sewer System.

- Hydraulic Model Report (July 2008) – Documents the selection of the hydrologic and hydraulic model of the wastewater collection system. This model was used to complete a capacity assessment and to develop all proposed remedial measures.
- Capacity Assessment Work Plan (September 2008) – Documents the assumptions, tools and protocols to be used to determine the hydraulic capacities of the Sanitary Sewer System, and to compare these capacities to flow conditions resulting from existing and projected future flows under dry and wet-weather conditions.
- Group One Sanitary Sewer Assessment Report (April 2011) – Documents the results of the sanitary sewer assessment field investigations and capacity assessment of the Group One Sewersheds. This report includes documentation of the sanitary sewer field activities and results, pumping station design, capacity, and equipment adequacy evaluation, hydraulic model development, the estimation of future flows, hydrologic and hydraulic calibration, capacity assessment results, and improvements completed during the SSA studies. The Group One models continued to be improved during the course of developing this RMP, as described in Section 2.

D. Projects Completed to Date or In-Progress

LFUCG has initiated several capacity enhancement projects and activities in advance of initiating this RMP. These projects are described in Section 7 of the Group One Sanitary Sewer Assessment Report (April 2011). Major capital projects are summarized below:

1) Status of Projects from CD Paragraph VII.15.A

a) North Elkhorn Force Main Diversion

At the time of lodging, the flow from the North Elkhorn Pump Station discharged to gravity sewers in the East Hickman sewershed. To restore hydraulic capacity at the East Hickman Pump Station and allow for a capacity upgrade at the North Elkhorn Pump Station, the majority of the North Elkhorn Pump Station flow was diverted to the Town Branch WWTP. Minimal flow has been maintained in the existing 24-inch force main to maintain hydraulic integrity of other discharges into the 24-inch force main. This project included upgrading the pump station to 13,400 gpm and the installation of approximately 7 miles of new 30- and 36-inch force main.

The North Elkhorn Pump Station currently pumps approximately 75% of its total flow through the newly constructed force main to the Town Branch WWTP. The remaining 25% of the flow is pumped through the pre-existing 24-inch force main to the East Hickman sewershed. Force mains from other pump stations manifold into this pre-existing 24” force main and the portion of flow from the North Elkhorn Pump Station is required to maintain hydraulic integrity. This force main will remain in service at least temporarily and used to aid in distribution of flows to reduce overflow risk in the system.

This project was required to be completed within 24 months from lodging date of the Consent Decree; the deadline was therefore March 14, 2010. The pump station was upgraded first and put into service prior to the force main installation. With a completion date of October 2009, this project was finished within the directed timeframe.

b) *South Elkhorn Pump Station and Force Main*

Due to high rates of infiltration and inflow in the contributing sewershed, the South Elkhorn Pump Station has had a very high incidence of SSOs. In order to eliminate this recurring SSO, the pump station and its associated force main were upgraded to a new capacity of 12,000 gpm. This expansion included the installation of a new wet well, five pumps, and seven miles of 36-inch force main to transport flow directly to the West Hickman WWTP.

This project was required to be completed within 30 months from lodging date of the Consent Decree; the deadline was therefore September 14, 2010. With a completion date of September 2010, this project was finished within the directed timeframe.

c) *Deep Springs Pump Station (Group 3)*

The Deep Springs Pump Station is to be replaced with a new pump station that will have an increased capacity. The force main will also be upgraded to manifold into the new North Elkhorn force main.

This project was required to be complete within 30 months of the completion date of the North Elkhorn Force Main Diversion Project, which would be April 2012, but no later than 54 months from the lodging date of the Consent Decree, (August 14, 2012); the deadline is therefore April 2012. This project is currently under construction and will be completed within the directed timeframe.

d) *Dixie Pump Station (Group 3)*

The Dixie Pump Station is to be upgraded to include an increase in the firm pumping capacity. The force main will also be upgraded to manifold into the new North Elkhorn force main.

This project was required to be complete within 30 months within the completion date of the North Elkhorn Force Main Diversion Project, which would be April 2012, but no later than 54 months from the lodging date of the Consent Decree, which would be August 14, 2012; the deadline is therefore April 2012. This project is currently under construction and will be completed within the directed timeframe.

2) <u>Other Capital Improvement Projects Underway</u>

a) *Wolf Run Pump Station*

The Wolf Run Pump Station has an estimated capacity of less than 10 MGD based on drawdown testing from September 2008 and is a recurring SSO. This pump station will be relocated downstream and the capacity increased to 20 MGD. A new force main that discharges to the Town Branch WWTP is included in this work. The design for this project is complete. Construction is expected to commence within the next 12 months, pending property acquisition.

b) *Expansion Area 2A Pump Station (Group 3)*

The Expansion Area 2A Pump Station has been designed to eliminate four smaller pump stations in the North Elkhorn sewershed and to provide expansion capacity to a developing section of the service area. The four pump stations being eliminated are: Man O' War, Blackford, Greenbriar #1, and Gleneagles. The Man O' War and Greenbriar #1 pump stations are listed as recurring SSOs. The flow to these existing pump stations will flow by gravity to the new Expansion Area 2A Pump Station, which will have a capacity of 7400 gpm. The design for this project is complete. Construction is expected to commence in the near future, pending property acquisition.

c) *Bluegrass Airport Pump Station*

The Bluegrass Airport Pump Station was a recurring SSO due to a combination of inadequate wet weather capacity and electrical/mechanical failures. This pump station had a design operating condition of 192 gpm; however, drawdown testing showed that the pumps were producing a flow of approximately 95 gpm. Although this pump station only runs infrequently, it receives runway runoff during de-icing operations (high glycol concentration events) and requires a higher flow capacity. The upgrades to the system included the addition of a wetwell, two new pumps rated for 429 gpm, a new valve vault, a new generator for back-up power, and a new 6" force main (approximately 9000 linear feet). This project has been completed and placed in service.

d) *Griffin Gate Pump Station (Group 2)*

The Griffin Gate Pump Station had a design operating condition of 150 gpm and LFUCG staff noted that the pumps were unreliable and experienced extreme short cycling. The pumps and wet wells have been replaced and the new rated capacity is 188 gpm. This project was completed in June 2011.

E. Definitions and Acronyms

In order to provide a clear understanding of terms used, some of the more common and significant definitions and acronyms are provided. They are organized into terms that are defined in the CD where applicable.

1) <u>Definitions included in the Consent Decree</u>

The following definitions and acronyms are included in the CD (Introduction) and are relevant to capacity assessment activities:

“Building Backup” shall mean a subcategory of SSOs which occurs when a wastewater backup occurs into a building and is caused by blockages, malfunctions, or flow conditions in the Sanitary Sewer System. A wastewater backup that is caused by a blockage or other malfunction of a Private Lateral is not a Building Backup.

“Capacity, Management, Operations, and Maintenance” or “CMOM” shall mean, for the purpose of the Consent Decree only, a flexible program of accepted industry practices to properly manage, operate and maintain sanitary wastewater collection, transmission and treatment systems, investigate capacity-constrained areas of these systems, and respond to SSO events.

“Consent Decree” or “Decree” shall mean the United States of America and the Commonwealth of Kentucky v. Lexington-Fayette, Civil Action No. 5:06-cv-386 and all its attachments.

“Day” (whether or not capitalized) shall mean a calendar day unless expressly stated to be a working day. In computing due dates under the Consent Decree, where the last day would fall on a Saturday, Sunday, or federal holiday, the period shall run until the close of business of the next working day.

“EPA” shall mean the United States Environmental Protection Agency and any successor departments or agencies of the United States.

“EPPC” shall mean the Environmental and Public Protection Cabinet of the Commonwealth of Kentucky. (Note: the EPPC has been replaced by the Energy & Environment Cabinet or EEC).

“Excessive Inflow/Infiltration” Or “Excessive I/I” shall mean the Inflow/Infiltration (I/I) that LFUCG determines can be cost-effectively eliminated as determined by a cost-effectiveness analysis that compares the costs of eliminating the I/I with the total costs for transportation and treatment of the I/I (including capital costs of increasing transmission and treatment capacity, and resulting operating costs).

“Force Main” (FM) shall mean all sanitary sewer lines that operate under pressure due to pumping of sanitary wastewater at a pump station except for those sanitary sewer lines that serve a single structure or building.

“Gravity Sewer Line” shall mean a pipe that receives, contains and conveys wastewater not normally under pressure, but is intended to flow unassisted under the influence of gravity. Gravity sewers are typically not intended to flow full under normal operating conditions.

“I/I” shall mean the total quantity of water from Infiltration and Inflow without distinguishing the source.

“Infiltration” as defined by 40 C.F.R. § 35.2005(b)(20) shall mean water other than wastewater that enters a sanitary sewer system (including sewer service connections and foundation drains) from the ground through such means as defective pipes, pipe joints, connections, or manholes.

“Inflow” as defined by 40 C.F.R. § 35.2005(b)(21) shall mean water other than wastewater that enters a sanitary sewer system (including sewer service connections) from sources such as, but not limited to, roof leaders, cellar drains, yard drains, area drains, drains from springs and swampy areas, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, storm water, surface runoff, street wash waters, or drainage.

“LFUCG” shall mean the Lexington-Fayette Urban County Government, a municipality within the meaning of that term in CWA, established under the laws of the Commonwealth of Kentucky.

“LFUCG’s WWTPs” shall mean West Hickman Creek WWTP and the Town Branch WWTP.

“Major Gravity Line” shall mean any of the following: all Gravity Sewer Lines that are twelve inches in diameter or larger; all eight inch Gravity Sewer Lines that are necessary to accurately represent flow attributable to a service area in each of the sewersheds; all Gravity Sewer Lines that convey wastewater from one Pumping Station service area to another pumping station service area; and all Gravity Sewer Lines that substantially contribute, or that LFUCG knows will likely substantially contribute, to recurring SSOs.

“One Hour Peak Flow” as that term is used in Paragraph 16.B of the CD for the CMOM Capacity Assurance Program only, shall mean the greatest flow in a sewer averaged over a sixty (60) minute period at a specific location expected to occur as a result of a representative 2-year 24-hour storm event.

“Paragraph” shall mean a portion of the Consent Decree identified by an Arabic numeral.

“Parties” shall mean the parties to this Consent Decree: the United States, the Commonwealth, and LFUCG.

“Peak Flow” as that term is used in Subparagraphs 15.D – 15.G of the CD, shall be determined based upon sound engineering judgment and commonly accepted design practice.

“Private Lateral” shall mean that portion of a sanitary sewer conveyance pipe, including that portion in the public right of way, that extends from the wastewater main to the single-family, multi-family, apartment, other dwelling unit, business, industry, institution or structure to which wastewater service is or has been provided. Private Laterals do not include connector joints at LFUCG's sewer line.

"Pumping Station" (PS) shall mean all pumping stations owned or operated by LFUCG except for pump stations that serve a single structure or building, and except for the pump station serving Southland Christian Church in Jessamine County.

"Recurring SSO" shall mean, for the purpose of the Consent Decree only, an SSO that occurs in the same location more than once per twelve (12) month rolling period.

"Reporting Year" shall mean each annual period commencing at the start of LFUCG's fiscal year on July 1 of each year.

"Reporting Year Covered by the Consent Decree." A Reporting Year is covered by this Consent Decree if any part of the Reporting Year falls after the Effective Date of, and before the termination of this Decree.

"Sanitary Sewer Overflow" or "SSO" shall mean, for the purpose of the Consent Decree only, any discharge to waters of the United States from the Sanitary Sewer System through point sources not specified in any KPDES permit (otherwise known as "unpermitted Discharges"), as well as any release of wastewater from the Sanitary Sewer System to public or private property that does not reach waters of the United States, such as a release to a land surface or structure that does not reach waters of the United States; provided, however, that releases or wastewater backups into buildings that are caused by blockages, flow conditions, or malfunctions in a Private Lateral, or other piping or conveyance system that is not owned or operationally controlled by LFUCG are not SSOs. SSOs include any cross-connections between LFUCG's Sewer System and its MS4 which allow wastewater to pass from the Sanitary Sewer System to the MS4, but do not include exfiltration that does not reach waters of the United States, or land surface or structures.

"Sanitary Sewer System" shall mean the wastewater collection and transmission systems (WCTS) owned or operated by LFUCG designed to collect and convey municipal sewage (domestic, commercial and industrial) to a WWTP. The Sanitary Sewer System does not include LFUCG's MS4.

"Section" shall mean a portion of the Consent Decree identified by a Roman numeral.

"Sewershed" shall mean a section of LFUCG's WCTS that is a distinct drainage or wastewater collection area and designated as such by LFUCG. For purposes of this Consent Decree, the sewersheds have been grouped as follows: Group One consists of West Hickman, East Hickman, and Wolf Run Sewersheds; Group Two consists of Cane Run and Town Branch Sewersheds; and Group Three consists of North Elkhorn and South Elkhorn Sewersheds.

“Ten States Standards” shall mean the applicable edition, incorporated by reference by Kentucky Regulation 401 KAR 5:005 § 29, of the “Recommended Standards for Wastewater Facilities: Policies for the Design, Review, and Approval of Plans and Specifications for Wastewater Collection and Treatment Facilities, Wastewater Committee of the Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.”

“Town Branch WWTP” shall mean the wastewater treatment plant located at 301 Lisle Industrial Avenue, Lexington, Kentucky, owned and operated by LFUCG, which discharges to Town Branch Creek from outfall 001 and pursuant to KPDES Permit No. KY0021491.

“Unpermitted Bypass” shall mean any discharge to the waters of the United States from any of LFUCG’s WWTPs which constitutes a prohibited bypass as defined in 40 C.F.R. § 122.41(m), and 401 KAR 5:065 Section 1(13).

“Wastewater Collection and Transmission Systems” or “WCTS” shall mean the municipal sanitary wastewater collection and transmission systems, including all pipes, force mains, gravity sewer lines, lift stations, pumping stations, manholes and appurtenance thereto, which are owned or operated by LFUCG.

“WWTP” shall mean wastewater treatment plant.

“West Hickman Creek WWTP” shall mean the wastewater treatment plant located at 645 West Hickman Plant Road/Ash Grove Pike, Nicholasville, Jessamine County, Kentucky, owned and operated by LFUCG, which discharges to West Hickman Creek from outfall 001 and pursuant to KPDES Permit No. KY0021504.

2) Additional Definitions and Acronyms

The following additional definitions and acronyms are used in this report:

“Average Daily Flow” (ADF) shall mean the total flow over a given period, divided by the number of days in the period.

“BWWF” or “Base Wastewater Flow” is domestic (or sanitary) wastewater from residential, commercial, institutional (schools, churches, hospitals, etc.) sources, and industrial wastewater sources.

“CAP” shall mean Capacity Assurance Program.

“CAWP” shall mean Capacity Assessment Work Plan.

“gpcd” means gallons per capita per day and refers to wastewater generation rate per person.

“GWI” means Groundwater Infiltration which is defined as the groundwater entering the collection system through defective pipes, pipe joints, and manhole walls.

“HMR” shall mean Hydraulic Model Report

“RDI/I” means rainfall-dependent infiltration/inflow.

“RMP” means Sanitary Sewer System and WWTP Remedial Measures Plan(s).

“SSAWP” shall mean the Sanitary Sewer Assessment Work Plan.

“TBWWTP” shall mean Town Branch Wastewater Treatment Plant.

“WHWWTP” shall mean West Hickman Wastewater Treatment Plant.

Section 2 Methodology

A. Modeling

The hydraulic models utilized for the development of the Group One Sanitary Sewer System and WWTP Remedial Measures Plan (RMP) were developed and calibrated as part of the Capacity Assessment portion of the Consent Decree work. The documentation for these models is included in the Sanitary Sewer Hydraulic Modeling Report (HMR) which was submitted to the EPA in July 2008. Further documentation of these models and their use in the Group One Capacity Assessment are included in the Group One Sanitary Sewer Assessment Report (SSA Report), which was submitted in April 2011. Further adjustments were made during the preparation of the RMP to ensure that up-to-date available information was used due to the construction of new major infrastructure between the original model calibration and the development of the RMP. Key changes include the construction of the new North Elkhorn Pump Station and Force Main and the new South Elkhorn Pump Station and Force Main, which were included as early SSO reduction projects. These new facilities changed the direction and discharge point for a large portion of the flow in the Group One area. The new Bluegrass Field Pump Station was also constructed and directed flows away from Wolf Run Pump Station and to the new South Elkhorn Pump Station.

1) <u>General Modeling Approach</u>

The hydraulic models used for the RMP were based on the Capacity Assessment models that include the pump stations with a history of overflows and associated force mains, all major gravity sewer lines of 12 inches diameter and greater as well as pipes downstream and immediately upstream of recurring SSO locations. Pump stations were modeled as described in the Group One SSA Report. The models were refined as necessary using the 2009 SSA flow monitoring data, manhole inspection data conducted in 2009, and design drawings for the newly constructed infrastructure described above. In addition, future condition models were further refined with more detailed wet weather response and future development area based on discussions with pertinent LFUCG Planning Staff and was coordinated with the 2007 Lexington-Fayette County Comprehensive Plan. New pump stations and sewers were added and sized to accommodate the needs of the Urban Service Area expansion. The model was updated to reflect these changes during the development of the Remedial Measures.

2) <u>Current Model Refinement</u>

As described previously, SSA flow monitoring data from 2009 was used to validate and refine, where necessary, the calibration of the collection system models. This is standard procedure when maintaining hydraulic models of a collection system. These models are dynamic in simulation and development, with updated information being entered as knowledge of the system is refined and improved. In addition, the improvements to the system described in Section 1 were added to the models.

The capacity of the wastewater system was then re-assessed under these conditions (which are shown in the SSA Report).

3) Modeled Sewer Flows (Future Conditions)

The capacity of the wastewater system was also assessed under projected future conditions, which was the year 2035 since that was the projection date for LFUCG Planning's Traffic Analysis Zone (TAZ) data and is sufficiently conservative, being longer than the typical 20-year projections used in overflow control planning. This date essentially represents build-out conditions for the current Urban Service Area. The following describes the methodology used in developing the wastewater response for the future development. The new developments were divided into two categories; the first consists of the new development within the existing sub-catchments (called infill) and the second consists of new expansion areas as defined in the Comprehensive Plan and development of larger undeveloped land within the current service area. The conditions for defining both future dry weather flow and wet weather flow for the expansion areas are described in the section below.

Infill of Existing Areas with future development

Future residential development was projected by Planning's TAZ data to occur in several sub-catchments. Additional dry weather flow and wet weather flow were added to the current sub-catchments to account for the future development. The population increase used the same methodology as described in the HMR.

Dry Weather Flow

The future dry-weather flow (DWF) component of all future areas was generated through Traffic Analysis Zone (TAZ) predicted populations as well Comprehensive Plan population predictions. This increase was applied to the existing average DWF for each catchment as follows:

- 15 gpcd of groundwater infiltration flow (GWI) for all new residential areas
- 65 gpcd of sanitary flow for all new residential areas.

The existing diurnal normalized patterns in the model were used to simulate infill future development in the current developed areas.

Wet Weather Flow RTK Parameters (WWF sanitary sewer model parameters)

As described in the HMR, the Rainfall Dependent I/I (RDI/I) that occurs was simulated using a unit hydrograph procedure called RTK. The RTK method utilizes up to three unit hydrographs to represent the Rainfall Dependent Inflow/Infiltration (RDI/I) response to rainfall. A more detailed description of the RTK method can be found in the HMR. Future RDI/I was applied to future development areas where there are no currently defined sub-catchments. This was done by applying a "future development RTK" to future development areas. The tributary area DWF was estimated by computing the future added population at 9 people per acre. This value was derived by reviewing current land use and population densities. The RTK parameters from similar existing developments were then applied to these areas to estimate future I/I response. The "future development RTK" parameters were derived by obtaining an average calibrated RTK for a set of existing sub-catchments that are 5-10 years old. This was to take into account current, more restrictive construction standards.

By following this process, LFUCG is better utilizing actual data to dynamically simulate the effects of future development during dry and wet weather. This approach is much more valuable and representative than using a traditional peaking factor approach which does not allow for dynamic simulation of future RDI/I.

B. Corrective Actions Toolbox

The following measures are typically part of developing a RMP:

- Sewer rehabilitation as a means of restoring existing sewer capacity by reducing infiltration and inflow.
- Equalization storage to reduce downstream peak flows.
- Increased conveyance capacity through gravity sewer construction or pump station/force main upgrades.
- Increased wastewater treatment capacity through existing process expansion, optimization, or the use of other wet-weather treatment processes.
- Diversion of flows to other sewersheds with sufficient capacity, typically via pumping.

Reducing I/I is often associated with rehabilitating sewer lines and manholes that could be sources of groundwater or wet-weather flows. The contributions of RDI/I and the cost of removing these connections should be evaluated as an alternative. Remedial measures alternatives should take into account the impacts of improvements on the whole system, including the impact on downstream facilities and the ability to treat additional flows conveyed to wastewater treatment plants.

Initial evaluations considered each of these alternatives individually. However, improvement alternatives that combine these improvements to cost-effectively meet system performance objectives were also developed. The final alternatives chosen meet LFUCG's Level of Control objectives and regulatory requirements, as well as budget and schedule constraints.

1) Conveyance

The intent of the conveyance improvement alternative was to determine the sizes of replacement or parallel gravity sewers and/or pump stations and force mains needed to convey all wet-weather flows for the design storm to the existing treatment facility. If this "transport and treat" alternative resulted in peak wet-weather flows at the wastewater treatment plant that exceeded existing capacity, then either the addition of equalization storage at the plant or a capacity upgrade was required as part of the alternative.

This alternative was simulated with the system model assuming that the basic system configuration remains the same. For example, gravity sewers were installed at the same locations and slopes as the existing system and pump stations discharged at the same locations as currently used.

Pipes were sized using the model by first routing wet-weather flows through a model system where pipe sizes had been increased to a size that is larger than that required to convey flows. Peak wet-weather flows at each modeled pipe were then exported to a spreadsheet or other design tool to compute replacement and/or parallel pipe sizes needed to meet the planning criteria. In developing cost estimates for this alternative, the condition of the existing sewers was considered to determine whether a complete replacement, a parallel sewer, or a parallel sewer and rehabilitation of the existing sewer lines was appropriate.

2) Storage

The theoretical storage improvement scenario consisted of locating flow equalization storage facilities in the vicinity of SSOs or basement backups. In practicality, the RMP considered storage facilities in feasible upstream locations to provide downstream benefits. In some cases, depending on system hydraulics, downstream storage facilities can reduce hydraulic grade lines sufficiently so as to eliminate upstream surcharging and overflows as well. So that this alternative was not a total exercise in theory, short or moderate relief sewers were sometimes added to the alternative so that storage facilities were simulated in locations where land acquisition and facility construction are feasible.

Similar to the situation discussed in the conveyance improvement alternative, the RMP storage evaluation considered if any additional improvements were needed for an equal level of control to other improvement alternatives. For example, if a conveyance alternative included replacing an aging trunk sewer that has evidence of structural problems as well as insufficient capacity, then the storage alternative also required rehabilitation of this trunk sewer. Including all improvements needed to provide an equal level of control is an important principle in RMP alternatives analysis to allow a reasonable comparison of the alternatives considered, even though the final solution may allow differences in phased implementation of the individual components of a given alternative (e.g., the storage facility is constructed in year two of the plan and the trunk sewer is rehabilitated in year 10). A “storage” alternative may not truly include only storage facilities, but this approach can still be a valuable and logical way of developing improvement alternatives conceptually.

3) I/I Reduction

The I/I reduction improvement alternative conceptually consisted of rehabilitating only the sewers required to reduce I/I sufficiently to eliminate all overflows and/or basement back-ups. There is too much uncertainty in determining achievable I/I removal rates, especially at the RMP development level. Therefore, in practicality, the RMP development made simplifying assumptions as to how a rehabilitation program would be implemented. Flow monitoring data was typically used as a means of calibrating the hydrology and hydraulics of the sewer system model. This same data was used to develop a hypothetical sewer rehabilitation program for I/I reduction for the purposes of alternatives analysis. Conversely, the RMP alternatives may feature rehabilitation projects resulting from condition assessment information (i.e., SSA results) and evaluation of flow monitoring results, but RDI/I removals may be assumed to be negligible for the purpose of sizing facilities for adequate capacity. This resulted in achieving a level of control that actually exceeds the target.

The R-value, which represents the fraction or percentage of rainfall that enters the sewer system as RDI/I, is a useful parameter in setting priorities for sewer rehabilitation. In the system hydrologic model, each model sewershed was assigned an R-value or range of R-values to represent RDI/I contributions under various seasonal or antecedent moisture conditions. These R-values were either determined by directly available flow monitoring data within the sewershed or through the model development and calibration process. The latter assigned R-values from surrogate areas predicted to have similar RDI/I responses to directly monitored areas because of their similarities in characteristics, such as sewer age, construction practices, soils characteristics, and/or maintenance and repair histories.

I/I reduction improvement alternatives are suggested to be developed based on the simulation of rehabilitation in sewersheds that have the highest R-values or R-value derived RDI/I per lineal foot of sewer, or R-value derived R-1 values (peaking factor), and those that are located upstream from overflows and/or basement backups. In some cases, depending on system hydraulics, as described previously with storage, rehabilitating areas downstream of an overflow or basement backup can reduce the hydraulic grade line sufficiently upstream to reduce problems there.

4) Flow Diversion

From the analysis results of the previously described improvement alternatives, the RMP evaluation will determine the relative benefits and feasibility of conveyance, storage, and/or I/I reduction throughout the various problem locations of the sewer system. From this, one or more improvement alternatives should be developed that represent a more optimized combination of conveyance, storage, and/or I/I reduction based on these results.

Another alternative to consider is diversion of flows to another sewershed (typically via pumping) that has adequate capacity, or where adequate capacity can be achieved more cost-effectively.

C. Solution Development Process

Conveyance, rehabilitation, and storage are the three general solution methods for alleviating capacity problems within a sewer system. Developed alternatives can be exclusively one of these methods or more typically a combination of two or more of the methods.

For each sewershed, the starting point in the remedial measure alternatives development process began with development of alternatives representing one of the general solutions. These alternatives consisted of only one technique, and their main goal was to develop a better understanding of the model and its response to the different types of potential improvements. The second round of alternatives consisted of combining techniques. Based on the results of the first and second round of alternative development, the third set of alternatives, known as composite alternatives, were developed. All were evaluated using future projected WWF conditions. Except for the sewer rehabilitation alternative, current RDI/I rates for existing sewers and appropriate assumptions for future sewershed areas were used.

Development and simulation of sewer system improvement alternatives is an iterative process that benefits from using a structured approach so as not to bias results. An important principle in developing alternatives is for each alternative to provide the same level of control and the same level of infrastructure renewal. For example, in evaluating a conveyance alternative that increases peak wet-weather flows to the wastewater treatment plant beyond its existing capacity, some provision for how the flow will be handled at the plant must be included. By comparison, an alternative that includes storage and/or RDI/I reduction measures may reduce peak flows to the wastewater treatment plant. To properly compare these alternatives, the conveyance alternative should include either wet-weather storage at the plant and/or increases in wet-weather treatment capacity so the level-of-control of the alternatives is equal.

1) General Solutions

   The process of developing a cost-effective plan to address overflows can be compared to a funnel. We start with a wide range of possible solutions as demonstrated in Section 2B and then further refine the possibilities until we reach the preferred solution. In reality, there are infinite combinations of solutions available to achieve our goal of eliminating recurring overflows. Since the time and budget to develop the plan is limited, we rely on past experience, intuition, and other local factors to quickly reduce the number of possible solutions to a manageable level. In our experience, an effective method is to develop what we call system-wide or "general" solutions for all overflows. Under this process, a couple of solution strategies are developed that apply uniformly to a particular area. The improvements needed to implement each strategy are sized using the model and then high level planning costs are developed using industry typical type unit costs. For this particular project, the three Group One Sewersheds were divided into areas. The outlet from each area was defined as the boundary condition for all general solutions and did not change. For example, the outlet from the Wolf Run sewershed will be the new Wolf Run PS (which has been designed and its constructing is anticipated to commence in the next 12 months). The capacity of this pump station was the boundary condition for all general solutions in the Wolf Run sewershed. Table 2-1 summarizes the boundary conditions for each general solution.

Table 2-1: General Solution Boundary Conditions

Sewershed	Boundary Condition
Wolf Run	New Wolf Run Pump Station
West Hickman	Current West Hickman WWTP peak capacity
East Hickman	Future East Hickman Pump Station Capacity

This process is useful for quickly gaining insight into how cost-effective system storage might be versus peak flow conveyance. This process is also useful in conducting a cost-benefit analysis for helping to define the cost-effective level of control. The general solutions provide enough cost information to compute the relative costs of designing to a higher level of control. The result is a knee-of-the-curve that shows where the incremental costs exceed the incremental benefit. This analysis was conducted as part of this project and will be presented in subsequent sections.

The solution process started with a general or regional solution approach to help gain critical insight into the types of solutions that may rise as more cost effective than others. It was also used to compare the cost-effectiveness of changing levels of overflow risk (traditionally called "level of control").

A set of regional solutions that apply uniformly to a particular sewershed was developed to address recurring SSOs and other unpermitted discharges and bypasses identified during the Capacity Assessment and SSA activities. These general solutions include:

- **Convey and regional storage:** All conveyance to a regional EQ tank at the sewershed boundary sized based on the boundary condition.
- **Local storage:** series of off-line or in-line storage at selected locations where storage construction is feasible to minimize pipe upsizing.

The 24-hour synthetic design storm was used for the sizing and verifying the performance of improvements for each general solution strategy for peak flows. For the development of the knee-of-the-curve, we sized improvements for a range of design storms for the "convey and regional storage" option. It is important to note that the sizing for the 2-year storm was done to achieve compliance with Capacity Assurance Program (CAP) requirements, which is defined by surcharge rather than overflows. This is an important consideration when deciding on the level of control.

The costs of the general solutions were then calculated and summarized. The results provided a good picture of the range of costs that LFUCG would expect to see along the range of possible solutions. This provides the significant benefit of understanding, at an early stage, what the cost of the program might be. In addition, the results allow us to quickly see how much upsizing is required and what effect local storage may have on the extent of upsizing.

2) <u>Detailed Solutions</u>

Once the general solutions were developed, detailed solutions were developed that would be analyzed further and resulted in a recommended plan. As mentioned previously, the general solutions provided key insight into what the detailed solutions involved. However, other factors were considered when developing the detailed solutions. The first step in developing the detailed solutions was to establish a target level of control. As described previously, the general solutions played a large role in this determination but additional information was utilized to help inform the detailed solution. This information included:

- SSA field data - The condition of the pipes in the system played a role in deciding what the detailed solutions might be. For example, choosing a conveyance solution is likely more cost effective if a stretch of pipe is in very poor structural condition and in need of replacement. Therefore, any solution would include the cost of pipe replacement, but a local storage option would also include storage tank. Local storage would be more expensive and is therefore eliminated in most cases.

- LFUCG preferences – It is important to discuss the suite of available options with key stakeholders before significant time is spent on numerous options. One of the biggest strategy discussions usually involves the desirability of having numerous remote storage facilities. These facilities require significant maintenance and can be difficult to site especially in an area as densely populated as Lexington. Therefore, the overall preference was to minimize regional or remote storage unless there was a significant potential savings over upsizing downstream pipes.

- Flow monitoring data – The decision to provide storage or upsize a pipe can be affected by the proposed I/I reduction strategy (see Section 4). For example, construction of equalization can be done in a phased manner to allow for an adaptive approach where the effectiveness of I/I removal can be assessed over time. This might result in lower ultimate EQ volumes. Conversely, construction of conveyance pipes is not as adaptive. It would be very risky to design a new pipe assuming a certain I/I removal rate only to learn that I/I removal was not as successful as projected. If that were the case, additional pipe construction would be required to provide the required capacity. Therefore, the flow data was useful to identify where a long term I/I removal strategy could be expected to provide cost savings in potential storage volumes and pipe construction.

- Other key factors – There are other key strategic and local condition factors that were taken into account when developing the detailed solutions. These factors are based on current commitments, previous planning, and other issues. These factors are summarized in the following subsection.

These factors plus the general solutions results were used to define a set of detailed solution alternatives for each watershed. Section 3 summarizes the general and detailed solutions.

D. Key Factors and Critical Decisions for Screening Solutions

As described above, there were some very important factors and decisions that were made prior to the development of the detailed solutions. These factors played a role in defining the boundary conditions for the general solutions. These factors and decisions are summarized by sewershed.

1) <u>All Sewersheds</u>

Improvements are sized with no assumptions regarding I/I removal: While I/I is a key long term strategy for LFUCG, the proposed remedial measures were developed assuming no I/I reduction because assuming a specific I/I removal rate is a risky proposition and local results have been less than successful. In addition, the actual amount of I/I that can be reduced through sewer rehabilitation has the potential for significant variability and uncertainty. Conservative procedures for including I/I removal in new conveyance capacity improvements is a systematic process which reduces I/I first, reassess I/I rates and then determines new conveyance capacity based on those new I/I rates. The short time frame for elimination of recurring overflows does allow for an evaluation of I/I removal effectiveness before new conveyance capacity is needed. Therefore, not including I/I reduction as an alternative provides higher probability of successfully meeting or exceeding the program goals within a shorter implementation period.

For this reason, some utilities, including LFUCG, have decided to size facilities and provide the selected level of control (LOC) without relying on a specified I/I removal. The overall long term I/I removal strategy is described in Section 4. Additionally, I/I reduction through sewer rehabilitation would increase the LOC that LFUCG could provide above the selected design storm. For instance, the facilities originally designed for a two-year return period would handle larger storm events as a result of the increased capacity due to the reduction of I/I conveyance.

Pipe replacement was assumed for additional conveyance in all areas except Lower West Hickman Trunk: When providing additional conveyance capacity, there are two options. The first option is to provide a new pipe with the ability to convey the peak flows alone. The other option is to construct a parallel relief sewer that, when combined with the capacity of the existing sewer, provides the total needed conveyance capacity. The decision to replace or parallel is not as straightforward as it might seem and needs a relatively detailed assessment to determine the most cost-effective approach. Factors such as pipe condition, pipe location, bypass pumping costs, asset management goals, vicinity to creeks, traffic, etc. all play a role in the decision. These factors will be evaluated during the final design phase. For the costing of solutions, we conservatively assumed all pipes that are undersized are being replaced with new larger pipes to convey peak flows. The only exception to this approach was the main trunk sewer tributary to the West Hickman WWTP within Veterans Park. This area was selected for parallel relief because it was readily apparent that a new relief sewer would be significantly smaller and construction would be straightforward due to the amount of space available. Since this sewer is so close to the WWTP, it is clear that bypass pumping costs would be quite significant. Finally, recent CCTV data indicates that the existing pipe is in excellent condition and has a long remaining useful life. Therefore there is no structural reason to replace the pipe in the next 25 years.

All Improvements to be constructed within the current Urban Service Area: LFUCG has a well established boundary known as the Urban Service Area (USA). The boundary serves to protect the pastoral nature of the area surrounding Lexington which, of course, includes many horse farms, which makes it unique. The USA also helps to encourage redevelopment and control suburban sprawl that has plagued many communities. Therefore, LFUCG is following through with its strong commitment to maintaining the USA in accordance with the Comprehensive Plan by not recommending the construction or installation of the RMP improvements outside of the USA.

2) Wolf Run Sewershed

Picadome Pump Station capacity will not be increased - The Picadome Pump Station was constructed less than 10 years ago to provide relief to the overwhelmed Wolf Run Pump Station by redirecting flow to the Town Branch WWTP. Model results showed that the combination of the Picadome Pump Station flow redirection and remaining downstream gravity conveyance capacity provides adequate conveyance capacity in the Wolf Run system. An early project decision was made to not consider increasing the capacity of the Picadome Pump Station since it was highly unlikely that new pumps and additional force main capacity at the new Picadome Pump Station would be a cost effective solution to reduce flows to the Wolf Run Pump Station.

The new Wolf Run Pump Station will be sized for 20 MGD - Available flow monitoring data was used to help determine the preferred design capacity. This size was based on initial modeling as well as consideration for capacity at the Town Branch WWTP. The upper limit for capacity was established at approximately 20 MGD based on capacity at the Town Branch WWTP. Modeling was performed to evaluate the EQ volume needed if the pump station was sized for 15 MGD versus 20 MGD. The model results showed that there would be a significant reduction in EQ size with a 20 MGD capacity which would not cost significantly more than a 15 MGD pump station. Therefore, it was decided that 20 MGD would be the target capacity. This capacity limitation was used as a boundary condition for the general and detailed solutions. The new pump station design is complete with construction expected to begin within twelve months.

Trunk sewers are in relatively poor condition – CCTV data from the SSA work showed that many of the trunk sewers in the Wolf Run Sewershed are in poor structural condition. This means that even if local equalization could reduce upsizing, significant rehabilitation would be needed to provide a reliable level of control.

3) East Hickman Sewershed

All flow from the new North Elkhorn Pump Station will go to Town Branch WWTP – The new North Elkhorn Pump Station and force main has been put into service and currently discharges approximately 75 percent of its effluent to the Town Branch WWTP, and the remainder to the East Hickman sewershed. The split flow is required to maintain a minimum flow to the old force main until the existing pump stations currently connected to that force main are eliminated or redirected. This flow diversion has significantly improved capacity in the East Hickman Sewershed. There was initial consideration to maintain the viability of the existing North Elkhorn Force Main to allow additional total flow to be pumped, or to provide backup service in the event of an emergency line break in the new force main. However, the existing force main has had several failures and would need to be replaced in order to be utilized reliably for capacity. A brief analysis showed that it was not cost effective to install a new force main and provide the additional capacity needed in the East Hickman Sewershed if the North Elkhorn Pump Station was diverted back to East Hickman. In addition, it would be very challenging to manage the much lower dry weather flows through both force mains. There would be significant problems with odors and corrosion to materials from hydrogen sulfide oxidation due to the very long detention times. Therefore, it was decided early in the process to eliminate the option of handling any flow from the North Elkhorn Pump Station in East Hickman.

Future flows from Expansion Area 1 would be handled in accordance with the 201 Facilities Plan Update – Expansion Area 1 is located in the southeast portion of the East Hickman Sewershed. This area is adjacent to several SSO pump stations including Hartland #1, Hartland #2, Hartland #3, and Armstrong Mill Road pump stations. The 201 Facilities Plan calls for elimination of these pump stations with gravity conveyance to a new pump station further downstream (See Section 3). There will need to be one additional intermediate pump station. These improvements are carried forward, with sizing refined based on model results, in this RMP and serve to provide future capacity while eliminating several pump station overflows.

The Blue Sky WWTP Elimination flows will be conveyed to East Hickman Pump Station – The elimination of the Blue Sky WWTP is included as one of the Supplemental Environmental projects in the Consent Decree. Based on available information, the best route for the new pump station and force main is to convey the flows directly to the East Hickman Pump Station. The capacity of the new pump station has not been finalized but available data shows that a 6-inch force main would provide necessary capacity for current flows. The peak capacity of this size force main was used to establish the flows from the future Blue Sky WWTP elimination.

The East Hickman Pump Station and Force Main are being replaced - The East Hickman Pump Station and its force main are in poor condition and in need of replacement regardless of the current capacity issues. Therefore, the replacement of the current pump station and force main is included in all scenarios.

4) <u>West Hickman Sewershed</u>

Wastewater Treatment Plant upgrades will focus on achieving reliable current peak capacities. No additional peak flow treatment will be provided - The current rated peak sustained capacity at the West Hickman WWTP is 64 MGD, with an average daily rated capacity of 33.9 MGD. A separate analysis determined that the West Hickman WWTP can actually treat a maximum capacity of 70 MGD while still meeting permitted discharge limits. Therefore the plant provides a sustained peaking factor of approximately 2, which is well within typical design criteria. The Capacity Assessment showed that future average dry weather flow to the plants in the future would be less than the current design capacity. Therefore, there is no need to provide additional average flow capacity. Additional capacity, therefore, would only provide additional peaking factor. There are reliability issues at the WWTP that will require critical improvements to be made to ensure that the current design capacities can be reliably maintained and permit limits can be met. These improvements are summarized in Section 3. LFUCG believes that providing peak flow attenuation at the West Hickman WWTP is a better strategy for managing peak flows. This is due to the fact that significantly increasing peak treatment capacity could result in more challenging operations during average dry weather flow with oversized treatment units or numerous units offline. There is also the challenge of preparing all treatment processes for extreme peak flow fluctuations. Equalization would provide a more consistent flow through the plant resulting in lower risks of a plant upset. In addition, there is a significant amount of land available at the West Hickman WWTP to construct equalization very cost effectively. In fact there are existing storage lagoons on site that might be reconfigured to provide wet weather equalization.

***The trunk sewer under the reservoir in WH-7 will be allowed to surcharge above CAP criteria* -** The existing sewer under the reservoir in the WH-7 sub-sewershed is a ductile iron pipe and temporary surcharging is not anticipated to result in exfiltration. Since the pipe is in good condition and the hydraulic pressure of the water in the reservoir is acting on the pipe it would be more likely to create infiltration into the pipe because of the pressure gradient. Replacement of this pipe would be controversial and unnecessary for preventing overflows. Therefore, in developing the RMP, we are allowing an exception to the CAP requirement for the LOC in this area. Another location where the CAP criteria will not be met is upstream of the Lakeshore Drive Pump Station which does not currently overflow, but the level of the sewer relative to the wet well results in surcharging during wet weather. However, this is not causing overflows or basement flooding based on available data.

E. Costing Tool

At the onset of the RMP process it was acknowledged that a consistent and credible basis for establishing costs was essential to the decision-making process. As such, it was determined that a costing tool would be developed to assure that consistent and justifiable planning-level costs are applied to RMP alternatives. Therefore, a custom Microsoft Access based costing tool was utilized to develop and compare and manage multiple solutions for consideration.

The base costing tool was developed from a similar tool used for developing the RMP for another Region 4 community. This baseline tool was refined to meet the needs of the LFUCG RMP. The costing tool software was used for the detailed solutions while a spreadsheet method of costing, using similar unit costs as the Access Costing tool, was used to cost the general solutions. The accuracy of the individual estimates was based upon the Association for the Advancement of Cost

Engineering (AACE), Class 4 standards, which is appropriate in the planning phase. The cost curves included in the costing tool were originally developed using a "bottom-up" costing procedure for a range of facility types and facility sizes. Cost curves were developed for the following facilities that comprise RMP improvements:

- Gravity sewers
- Pump stations
- Force mains
- Equalization storage
- Storage/conveyance tunnel
- Tunnel shafts

The construction cost estimates and cost curves/equations were then confirmed and refined through a variety of sources including:

1. Recent bid information from LFUCG;
2. Recent bid information for equalization tanks used for SSO control;
3. Planning level cost information developed by the consulting team for other studies; and,
4. EPA Technology Fact Sheets, WERF studies and similar reference material.

The raw construction costs were then converted to fully loaded capital costs to be used for remedial measures project estimates. The capital costs were developed by applying factors to the construction cost; these factors are shown in Table 2-2 below.

Table 2-2: Capital Cost Factors

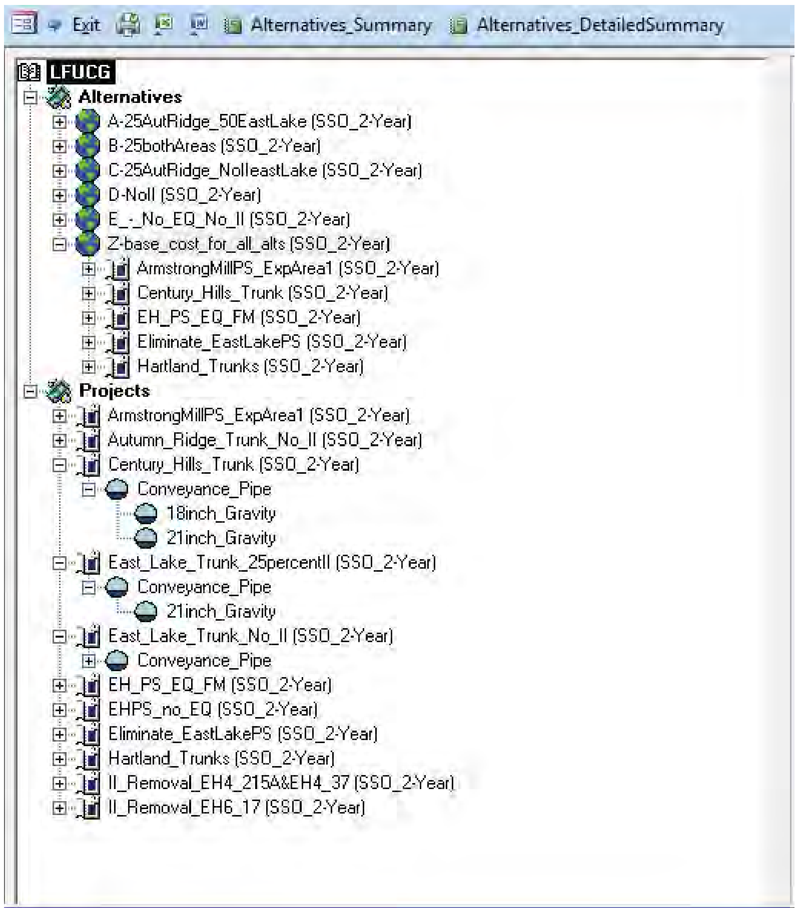
Item	Percentage	Notes
Preliminary Study	2%	Of Initial Construction Cost
Land Acquisition		$100k purchase or $1k easement / acre
Design	10%	Of Initial Construction Cost
Construction Administration	5%	Of Initial Construction Cost
Field Engineering	5%	Of Initial Construction Cost
Contingency	30%	Of Construction
Administration	1%	Of Initial Construction Cost
Legal/Finance	5%	Of Initial Construction Cost

Annual operation and maintenance costs were developed by applying a percentage to the capital cost. These percentages are based on previous experience and are as follows:

- Gravity Sewers: 1% of construction costs
- Equalization Tanks: 2% of construction costs
- Force Mains: 2% of construction costs
- Pump Stations: 3.5% of construction costs

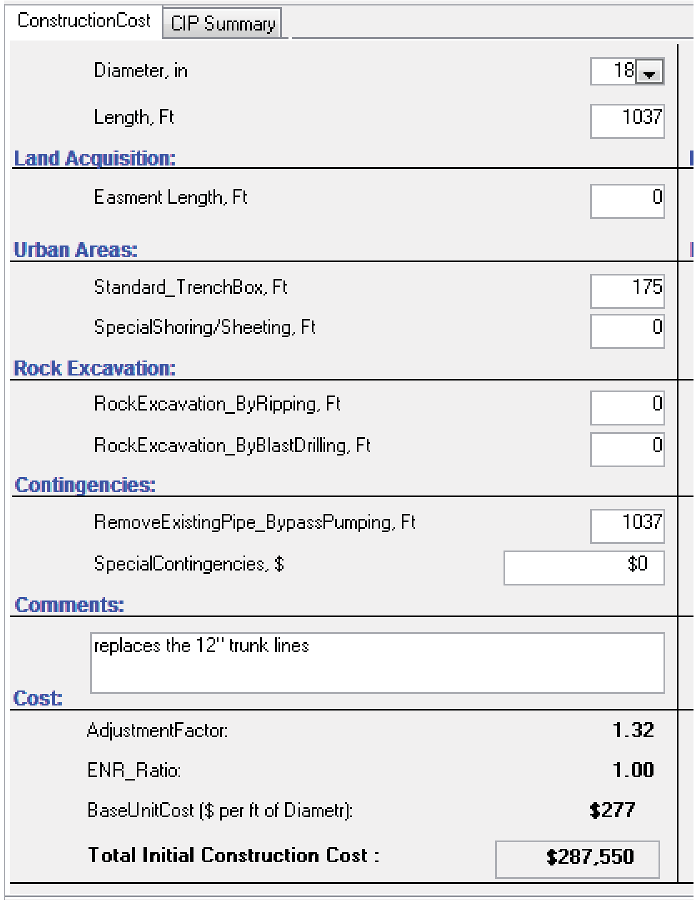
The user starts by defining projects in the tool. Each project comprises a collection of facilities which could include any number or combinations of gravity sewers, pump stations, etc. The projects can be combined to form alternatives. An alternative can be developed from any number of projects. The same project can be included in numerous alternatives. Any edit to a particular project would then be instantly reflected in any alternative that includes that project. Figure 2-1 below shows a screen capture of the overall screen with Alternatives, Projects, and Facilities.

Figure 2-1: Opening Screen Showing Costing Tool Structure



There are user-defined inputs for each type of facility. The flexibility for site specific information is commensurate with a planning level exercise. For example, gravity sewer costs are affected by urban versus off-road construction. In addition, there may be rock excavation or very deep excavations with special shoring and sheeting. Figure 2-2 below is a screen capture showing the user input screen for a gravity sewer example.

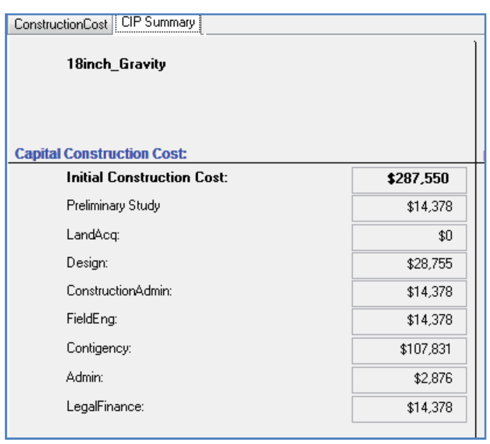
Figure 2-2: Gravity Sewer User Input Screen



Costing Tool Output

The user input screen shows the raw construction costs for each facility. There is also a tab that the user can click on to see the CIP cost and each cost component (see Figure 2-3) for an example CIP cost.

Figure 2-3: CIP Summary for Facility



The costing tool develops both a raw construction cost and a capital construction cost (CIP) for each facility, project, and alternative. Therefore the user can see the costs at any level. The tool also calculates operation and maintenance costs based on an annual percentage of construction.

A summary for each alternative can be automatically generated and printed or exported for further review. The key assumptions used in developing the CIP costs can be changed within the software but are not user defined so that the overall consistency of the costing can be protected.

Overall this costing tool is a very powerful tool to develop the planning level cost estimates for each project very quickly. It enables the comparison of multiple alternatives very quickly and is easy to use. The data for costing is stored in easy to use format much less prone to error than traditional spreadsheet methods.

F. Public Involvement

Throughout the work conducted for the SSA field investigations, the preparation of the Group 1 SSSA Report and this Group 1 Remedial Measures Plan LFUCG has consistently kept the public informed of the Consent Decree compliance process and progress. They have also solicited input from the public, community stakeholders, and public policymakers related to key decisions required for the RMP development. The following meetings were held as part of this public involvement process:

- Fayette County Neighborhood Association – January 27, 2011
- Fayette County Public Schools – February 3, 2011
- Lexington Homebuilders Association – February 10, 2011
- Commerce Lexington (Chamber of Commerce) – February 24, 2011
- LFUCG Stormwater Stakeholders – March 4, 2011
- Public information meetings for residents – March 7, 14 and 21, 2011
- LFUCG Environmental Quality Commission presentations:
  - January 18, 2011
  - April 19, 2011
  - June 21, 2011
- LFUCG Mayor and Chief Administrative Officer – June 22, 2011
- LFUCG Council Committee of the Whole – August 23, 2011
- Presentation of the Group 1 RMP to residents – September 12 and 19, 2011

In addition to the meetings listed above, a web page was established within the Lexington government website to provide access to critical information and documents, and to allow the public to view the progress of the various initiatives. This website (http://www.lexingtonky.gov/RemedialMeasures) will be maintained throughout the implementation of the remedial measures, so that residents and other stakeholders are informed of work anticipated or under way in their neighborhoods.

Section 3 Remedial Measures Development

This section summarizes the results of the General Solutions, the level of control selection, the detailed solutions development and analysis, and the selected alternatives for each of the Group One Sewersheds.

A. Selection of Level of Control (LOC)

One of the most important decisions in developing the RMP is to decide on the target Level of Control (LOC). The LOC refers to conditions within the collection system that are considered acceptable under specified situations. For example, a LOC might be no overflows resulting from a 2-year return period design storm model simulation. An LOC may be defined by something other than overflows. For example, the level of control may be defined by a level of surcharging in the collection system.

While evaluating the appropriate target LOC for the LFUCG, key definitions and requirements contained within the Consent Decree were considered. Following are some key definitions from the Consent Decree:

- **One Hour Peak Flow (Capacity Assurance Program Only)**: The greatest flow in a sewer averaged over a sixty minute period at a specific location expected to occur as a result of a representative 2-year 24-hour storm event.
- **Peak Flow (Capacity Assessment and RMP)**: Shall be determined based upon sound engineering judgment and commonly accepted design practice.
- **Recurring SSO**: An SSO that occurs in the same location more than once per twelve month rolling period.
- **Unpermitted Bypass**: Any discharge to the Waters of the United States from any of LFUCG's WWTPs which constitutes a prohibited bypass as defined in 40 CFR 122.41(m) and 401 KAR 5:065 Section 1(13).

The Consent Decree requires LFUCG to develop the RMP to eliminate recurring SSOs and Unpermitted Bypasses. In the selection of the target LOC for LFUCG it is important to consider the following:

- It is fiscally impractical to completely eliminate all SSOs under all conditions.
- KRS 224.16-040 sets forth factors that must be considered when reviewing the RMP. These factors include cost-effectiveness, which is a component of this plan.

The LOC was selected using a combination of cost-effectiveness analysis, review of Consent Decree requirements, stakeholder preference, and target LOCs for other Region 4 utilities.

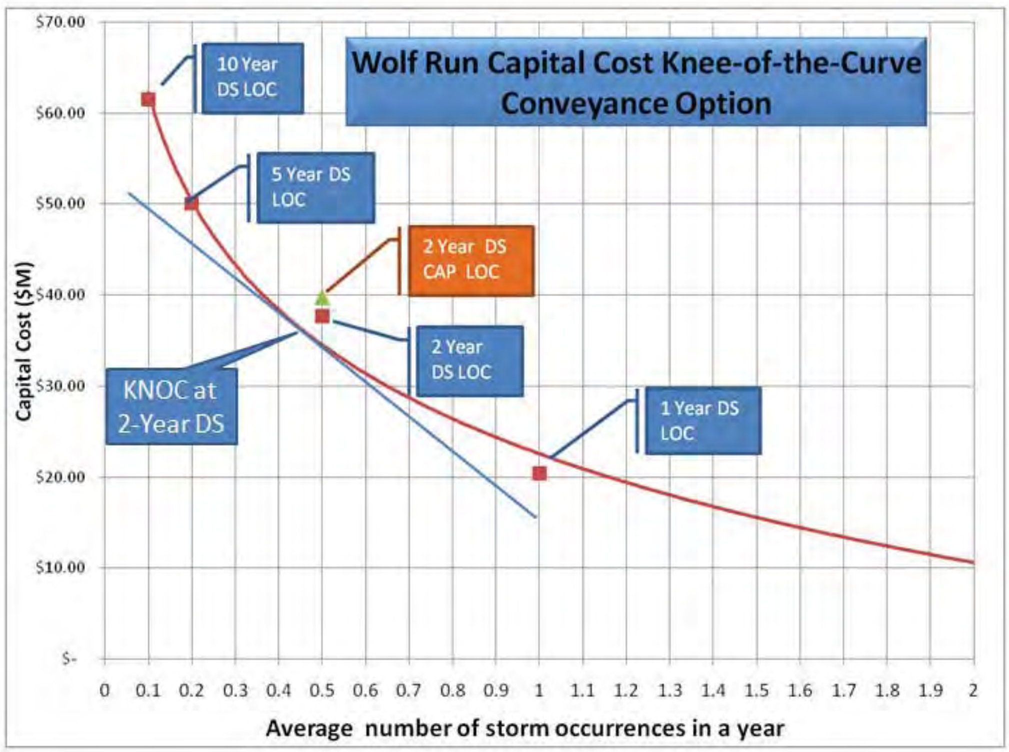
Cost Effectiveness Analysis

The cost effectiveness analysis was conducted by developing a representative knee-of-the-curve plot. The Wolf Run Sewershed was selected for this target analysis because it represents a typical condition in terms of Appendix A overflows. The average number of Appendix A overflows in each sewershed is 14. The Wolf Run sewershed has 16 Appendix A SSOs and is therefore a good representative of the system as a whole. The knee-of-the-curve was developed by sizing and costing conveyance solution improvements to meet the following target LOC:

- 1-year, 24-hour design storm; no overflows
- 2-year, 24-hour design storm; no overflows
- 5-Year, 24-hour design storm; no overflows
- 10-Year, 24-hour design storm; no overflows
- 2-year, 24-hour design storm; CAP Criteria (no surcharging over 2')

Figure 3-1 shows the resulting curve.

Figure 3-1: Level of Control Knee-of-the-Curve



The plot shows that the knee is located in the vicinity of the 2-Year design storm level of control. Another interesting conclusion from the plot is that there is not a significant difference in the estimated capital cost between the no-overflow and CAP criteria, because the level of control was used to mainly target where conveyance improvements were triggered. Once triggered, all improvements were sized to convey the peak flow at full pipe based on Manning's Equation capacity. Therefore, based on cost-effectiveness, the 2-Year design storm is the optimum LOC.

Review of Consent Decree Requirements

There are three key requirements in the Consent Decree that impact the target LOC. These are:

1. Eliminate recurring SSOs: LFUCG must eliminate recurring SSOs which are SSOs that occur more than once per 12 month rolling period.

2. Eliminate Unpermitted Bypasses: LFUCG must eliminate Unpermitted Bypasses at the WWTP, which are defined by the prohibited bypass provision in 40 CFR 122.41.
3. Capacity Assurance Program (CAP): LFUCG must certify capacity prior to allowing new connections within two years of the effective date of the Consent Decree. Capacity, for purposes of this requirement, is defined as ability to convey the peak hour flow from a 2-Year, 24-hour storm event without surcharging more than 2 feet above the pipe crown or within 3 feet of a manhole rim.

Two of the three requirements relate to an LOC for a 2-year or more frequent return interval. The recurring SSO elimination requirement is based on an overflow frequency definition which is not the same as or defined by a specified rainfall event. Nevertheless, it is reasonable to estimate that the flow resulting from a 2-Year, 24-hour design storm will not occur more than once in a given year. In addition, the CAP criteria allows for new flow as long as the added flow, along with other future added flows, does not cause surcharging as defined by the Consent Decree. This requirement corresponds to the CAP Criteria LOC described in the cost-effectiveness analysis, which is a higher LOC than the 2-Year overflow LOC located at the knee-of-the-curve. The requirement to eliminate unpermitted bypasses does not include any definition of "elimination"; however, this is to be defined by the selected LOC.

Target LOC for Other Utilities within Region 4

There are several utilities within Region 4 that have already developed or are in the process of developing RMPs for addressing overflows. In selecting the appropriate LOC for LFUCG, the LOCs of other Region 4 utilities were considered. Table 3-1 summarizes our review of these utilities.

Table 3-1. Select LOC for Other Region 4 Utilities

Utility	Selected LOC
Knoxville Utilities Board (KUB)	2-Year 24-hour design storm with CAP criteria
Atlanta	2-Year design storm
Louisville MSD	Varies but significant majority are 2-Year design storm

This table shows that other Region 4 utilities have also selected the 2-year LOC for either overflows or CAP criteria as the preferred LOC.

Stakeholder Input

LFUCG solicited significant stakeholder involvement in order to help determine the target LOC. These included 3 public meetings in March 2011 as well as other meetings with:

- LFUCG Council, Mayor, Water Quality Staff
- Commerce Lexington, Homebuilders Association, media, etc.
- Civic and neighborhood associations

Preliminary costs for various levels of control were presented to the stakeholders. Based on input received from these meetings, there was significant support for the selection of the 2-year

24-hour design storm CAP LOC, especially when potential impacts to rates were presented. In addition, the LFUCG Council has selected the 2-Year 24-hour design storm CAP criteria as the LOC in Resolution No. 389-2011, which is included at the end of this Section.

Selected Level of Control

The selected LOC for the Group 1 RMP is the 2-year 24-hour CAP criteria LOC with one exception, the West Hickman trunk sewer just downstream of sub-basin WH-7 that runs under the reservoir. This ductile iron line is expected to temporarily surcharge, but these events are not anticipated to result in exfiltration. Since the pipe is in good condition and the hydraulic pressure of the water in the reservoir is acting on the pipe it would be more likely to create infiltration into the pipe because of the pressure gradient. In addition, this line will not overflow in the 2-year or even 5-year 24-hour design storm, based on the hydraulic models. Therefore, there is still a high level of control.

The LOC was selected after a review of each criteria described above and is strongly supported by the review of cost-effectiveness, Consent Decree requirements, stakeholder Input as well as accepted LOC from other Region 4 utilities.

Further support is demonstrated when evaluating the true level of protection against SSOs. The model results show that if the 2-year LOC improvements are constructed, there are only 5 locations in the Group 1 sewersheds where an overflow is predicted during a 5-year 24-hour design storm. This shows that the 2-year CAP criteria LOC provides a greater protection against overflows than the 2-Year design storm for almost all overall locations. These remaining locations will be targeted for priority I/I removal to further increase the level of protection.

B. General Solutions

General Solutions were developed for the Wolf Run, East Hickman and West Hickman sewersheds. The General Solutions consisted of exploring two general alternatives as described in Section 2. These were:

- **GS1 - Convey and Regional Storage:** All conveyance to a regional equalization (EQ) tank at the sewershed boundary sized based on the boundary condition.
- **GS2 - Local Storage:** Series of off-line or in-line storage tanks at selected locations where storage construction is feasible and minimizes pipe upsizing.

For both General Solutions options, improvements were sized to achieve a target LOC equal to the Capacity Assurance Program (CAP) criteria. The target LOC is defined in the Consent Decree as no surcharging more than 2 feet above the pipe crown during the one-hour peak flow from a 2-year, 24-hour storm, or not within 3 feet of the rim of the manhole. For GS1, improvements were also sized to eliminate overflows during a 1-year, 5-year and 10-year design storm for the Wolf Run Sewershed. This was done to develop a representative knee-of-the-curve to help evaluate the target LOC.

1) Wolf Run Sewershed General Solutions

The Wolf Run Sewershed is comprised of 16 of the system-wide 83 CD Appendix A wet weather overflows. The boundary condition considered for the Wolf Run Sewershed was the proposed 20 MGD Wolf Run Pump Station. Any flows that reach the pump station in excess of 20 MGD will be stored in an equalization tank (EQ). GS1 (conveyance) included upsizing all pipes as necessary to convey flows from the 2-year, 24-hour design storm without violating CAP criteria anywhere in the system. The proposed EQ tank would be located upstream of the proposed Wolf Run Pump Station. Figure 3-2 shows the pipes that require upsizing and the location and size of the regional equalization tank at the end of Kilrush Drive. GS2 (local EQ) included the sizing and placement of local equalization tanks that have the goal of reducing or eliminating downstream conveyance upsizing. The locations of the equalization tanks were determined based on a detailed review of locations where siting is feasible and where it may have the biggest impact. Figure 3-3 shows the results of the local EQ option.

Figure 3-2: Wolf Run GS1

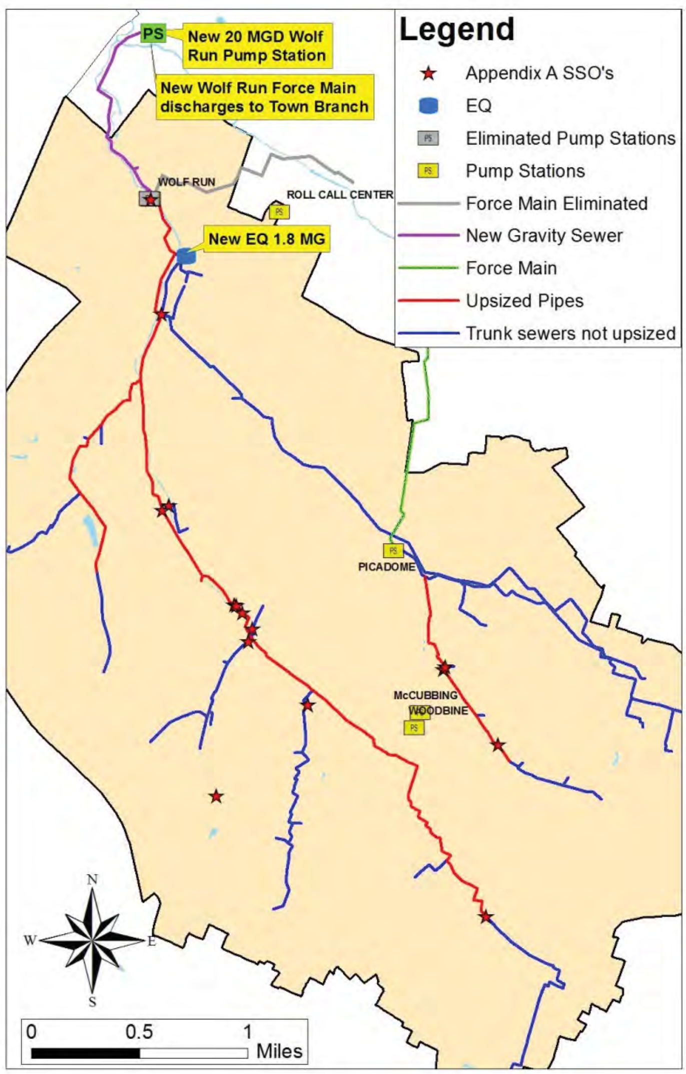
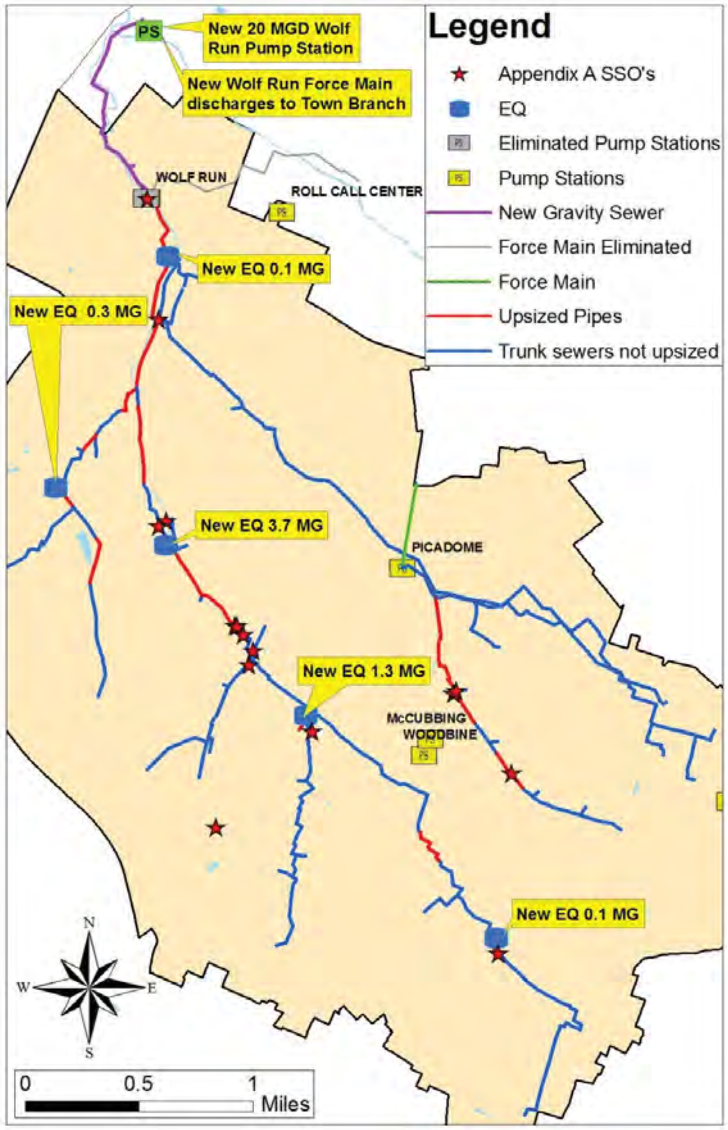


Figure 3-3: Wolf Run GS2 EQ



General Solutions Costs

Table 3-2 shows the projected capital costs to implement each of the Wolf Run General Solutions.

Table 3-2: Wolf Run General Solutions Estimated Project Capital Cost

General Solution	Pipe Replacement (LF)	EQ Volume (MG)	Capital Cost Estimate ($M)
GS1 – Conveyance	35,985	1.8	$37.1
GS2 - Local EQ	18,127	5.5 (5 tanks)	$43.2

**Note: Costs do not include the new 20 MGD Wolf Run PS/FM or gravity sewer to convey flow from the old Wolf Run Pump Station to the new pump station being located downstream from the existing pump station.*

Table 3-2 shows that, while the localized EQ significantly reduced the length of pipe that would be upsized, the total estimated capital cost is higher.

A comparison of Figure 3-2 and 3-3 shows that the majority of the savings in pipe upsizing are located in the upstream portion of the Wolf Run trunk sewer that crosses Harrodsburg Road near Allendale. According to the SSA investigations, these pipes are in relatively poor condition and need replacement in the near future. Therefore, based on cost and the fact that the pipe savings are in an area with pipes in poor structural condition, local storage would not be a cost-effective solution in the Wolf Run area.

Another key observation in the Wolf Run area is that the results show that the Picadome Pump Station, which was constructed to relieve flow in the downstream Picadome trunk, is clearly performing its intended function since there are no capacity issues along the trunk sewer downstream of Picadome Pump Station. In addition, the pump station is significantly reducing flows to the Wolf Run Pump Station even if it hasn't completely eliminated the need for equalization.

2) <u>East Hickman Sewershed General Solutions</u>

With the elimination of flow from the North Elkhorn Pump Station, gravity conveyance issues within the East Hickman Sewershed will be greatly reduced. The majority of the capacity issues are associated with pump station overflows. In fact, 7 of the 8 East Hickman CD Appendix A SSOs are located at pump stations. Four of the pump station overflows will be eliminated by the Expansion Area 1 Plan, which is described in Section 2 and shown in Figure 3-4 below. Another pump station overflow, Man O' War, will be eliminated and conveyed to the North Elkhorn Sewershed. The boundary condition for the East Hickman service area is the East Hickman Pump Station which discharges flow to the West Hickman Sewershed. Due to the lack of gravity conveyance issues within the East Hickman Sewershed and because 5 of the 8 overflows already have mitigation plans, only GS1 was selected for costing in East Hickman. Figure 3-4 shows the facilities that result from this GS. This figure shows that very few gravity sewer improvements are needed and it also shows the layout of the EA1 Plan. Table 3-3 shows the cost summary for the East Hickman GS1.

Figure 3-4: East Hickman GS1

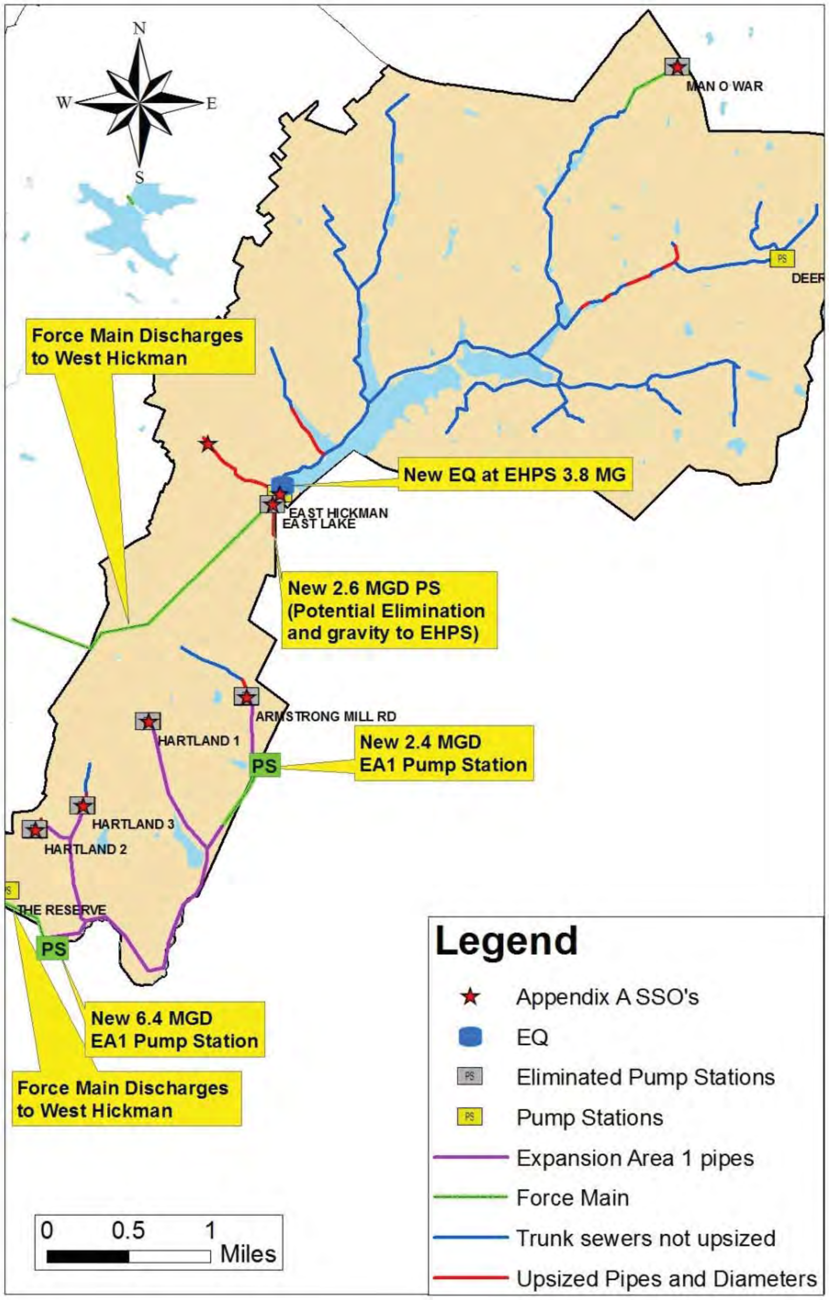


Table 3-3: East Hickman General Solutions Estimated Project Capital Cost

General Solution	Pipe Replacement (LF)	New Sewer Pipe (LF)	EQ Volume (MG)	New PS Capacity (MGD)	Capital Cost Estimate ($M)
GS1 – Conveyance	10,000	30,313	3.8	11.4	$47.7

** Note: Costs do not include new East Hickman Pump Station and force main since this option is the same for all solutions.*

The results of the General Solution analysis confirms that the extent of gravity sewer upsizing improvements is relatively small and comprises only $5.8 M of the $47.7 M total for this sewershed. Therefore, it is highly unlikely that upstream local equalization storage would be cost effective. However, since replacement of East Hickman Pump Station and force main is desired in any scenario, there is merit in evaluating increasing the pump station capacity to convey peak flows instead of providing EQ at the pump station. Another issue to address is the potential to eliminate the East Lake Pump Station and convey the flow by gravity to a new East Hickman Pump Station. Otherwise, the East Lake Pump Station would need to be upsized to 2.6 MGD.

3) West Hickman Sewershed General Solutions

The West Hickman sewershed has by far the most CD Appendix A related SSOs of any sewershed, comprising 37 of the 83 wet weather overflow locations. This sewershed includes the West Hickman WWTP which also receives flow from the East Hickman and South Elkhorn Sewersheds. The new South Elkhorn Force Main discharges at the bottom of the West Hickman Sewershed and was relocated from its previous discharge location to help alleviate capacity issues in the trunk sewer. As with the Wolf Run Sewershed, two General Solutions were developed and evaluated. These are:

- **GS1 - Convey and Regional Storage:** All peak flow conveyance to the West Hickman WWTP with an EQ tank at the WWTP to store flows above peak capacity of 70 mgd.
- **GS2 - Local Storage:** Series of off-line or in-line storage tanks at selected locations where storage construction is feasible and minimizes pipe upsizing. Additional EQ tank at the West Hickman WWTP to store flows above peak capacity of 70 mgd.

Under both scenarios, the East Hickman Pump Station force main continues to discharge to its existing discharge location. This is because the preferred alignment for a new East Hickman FM was not determined when the General Solutions were developed. Figure 3-5 shows the improvements needed to address the existing overflows and the unpermitted bypasses at the WWTP; Figure 3-6 shows the improvements needed under the local EQ option; and Table 3-4 summarizes the costs associated with each General Solution.

Figure 3-5: West Hickman GS1

Figure 3-6: West Hickman GS2

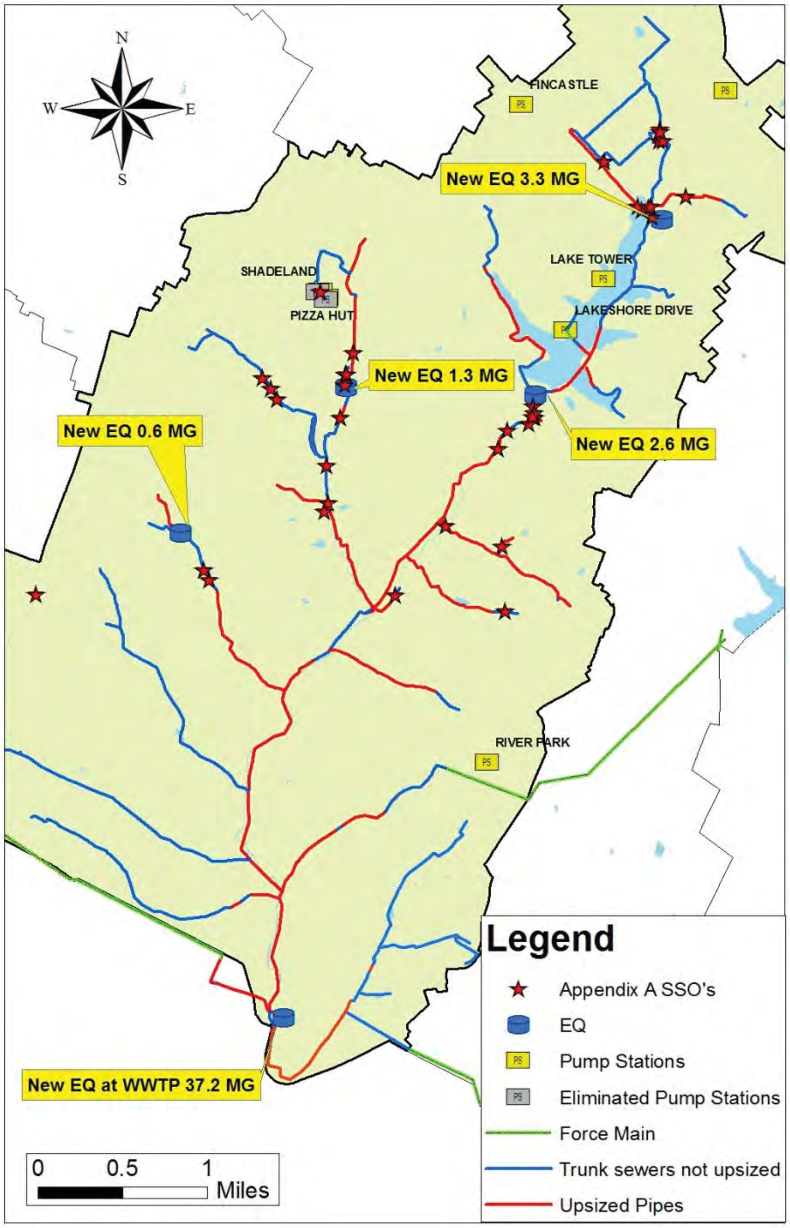


Table 3-4: West Hickman General Solutions Estimated Project Capital Cost

General Solution	Pipe Replacement (LF)	EQ Volume (MG)	Capital Cost Estimate ($M)
GS1 – Conveyance	90,320	43.6	$223
GS2 - Local EQ	81,477	45.1 (5 tanks)	$232

As Table 3-4 shows, there is little difference in the total estimated capital cost between the EQ and Conveyance General Solutions for the West Hickman service area. As expected, the local EQ solution does reduce the expected length of pipe that needs replacement under the conveyance option, but the difference is not significant. Further, given the general approach to minimize remote storage, there is little evidence to show that remote equalization is a preferred strategy in West Hickman. In either case, significant volume of equalization is needed at the West Hickman WWTP (43.6 MG versus 37.2 MG). In addition, further analysis showed that, in most cases, locating these remote storage facilities would be very challenging. One exception is the northern-most equalization tank located in subbasin WH-7 near Richmond Road. This tank is included in the detailed solution to eliminate the need to upsize the trunk sewer that travels underneath the reservoir just downstream of WH-7.

C. Detailed Solutions

Once the General Solutions were completed, the results were evaluated and then detailed solutions were developed for each Sewershed. These detailed solutions were developed based on the criteria listed in Section 2. The following is a description of the detailed solutions developed and evaluated for each sewershed. Each detailed solution was then divided into projects and then entered into the costing tool to develop planning level cost estimates. The evaluation included field investigations and desktop reviews as necessary to determine if alignment changes were likely or if there were other major constructability concerns. These reviews also enabled a more detailed estimate of cost over the General Solutions which included estimating and quantifying the cost factors available in the costing tool as described in Section 2. As mentioned previously, all improvements were sized to meet the CAP criteria under the 2-year, 24-hour design storm as described in the Consent Decree under 2035 development conditions (except for the West Hickman trunk sewer under the reservoir, as described above). In some cases additional model refinements based on available field data refined sizing that was done during the development of the General Solutions.

1) <u>Wolf Run Sewershed Detailed Solutions</u>

Based on the review of the General Solutions, it became apparent that GS1 was the preferred solution. This was due to the following reasons:

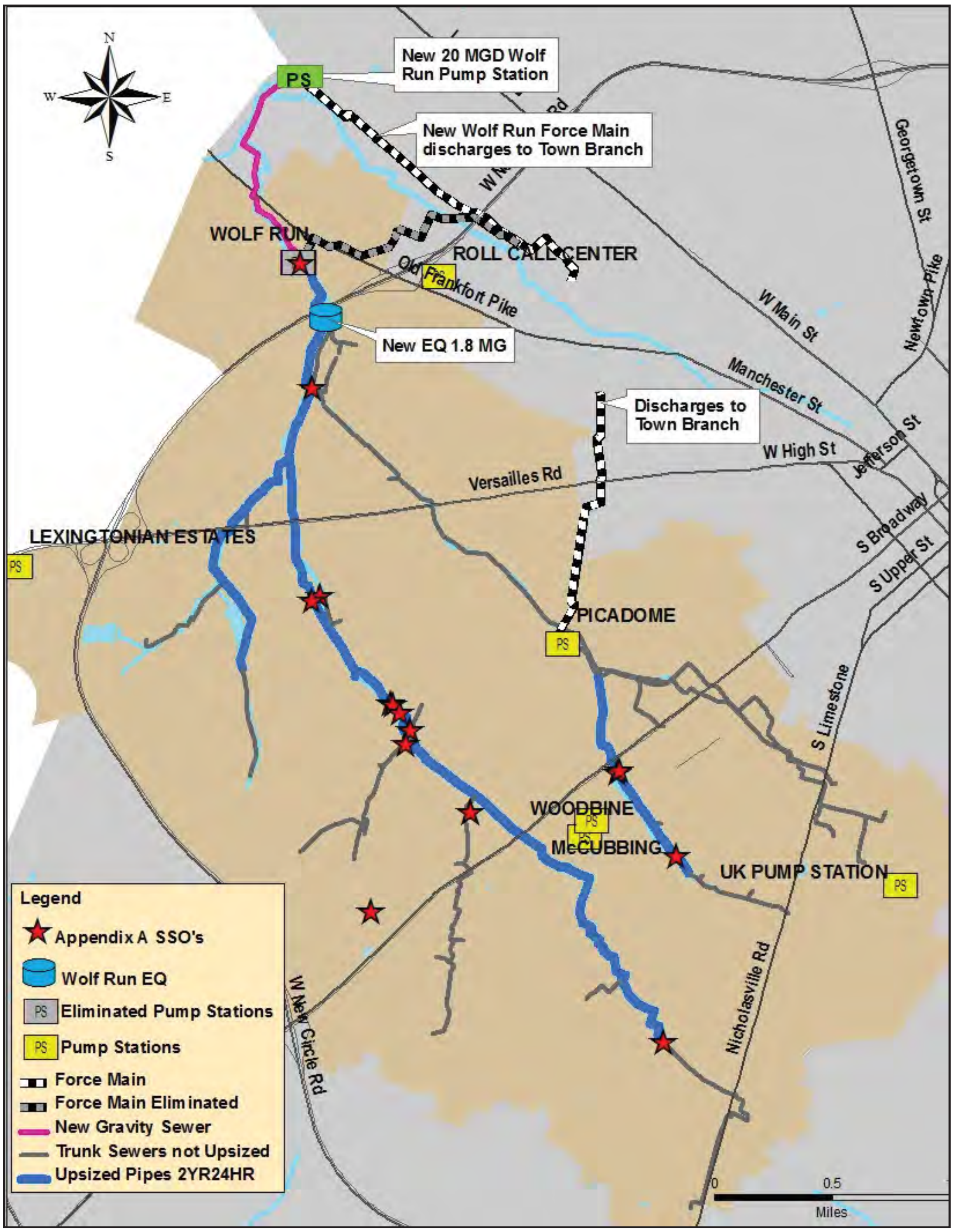
- GS1 was less expensive than GS2.
- The majority of the pipes that would not be upsized under GS2 (but were upsized in GS1) would need rehabilitation in the near future.
- LFUCG prefers to limit the number of remote storage facilities due to amount of operation and maintenance required to handle numerous tanks.

Therefore the GS1 solution was selected for refinement as the preferred detailed solution in the Wolf Run Sewershed. Figure 3-7 shows the facilities associated with this detailed solution. More detail is provided in the Appendices and in Section 5 regarding specific projects. However, the following summarizes the key features:

- A 1.8 MG EQ storage tank to be located at the end of Kilrush Drive adjacent to New Circle Road
- Upsizing of nearly 34,000 linear feet of gravity sewer to provide additional conveyance

The total estimated capital cost to implement the Wolf Run detailed solution is approximately $33 million. This cost does not include the new 20 MGD Wolf Run Pump Station and Force Main or the new gravity sewer from the current pump station to the new pump station.

Figure 3-7: Wolf Run Detailed Solution



2) <u>East Hickman Sewershed Detailed Solutions</u>

Hydraulic modeling of the East Hickman General Solution confirmed that constructing local equalization upstream of the East Hickman Pump Station (EHPS) does not provide significant benefit. Therefore, conveyance to the EHPS was selected for the detailed solutions. In addition to the conveyance General Solution, LFUCG had previously planned to replace the EHPS and relocate its force main due to condition and capacity issues. The new force main is to be routed directly to the West Hickman WWTP. All detailed solutions involve this new force main alignment. The alignment was derived from a detailed review of available options as well as a field investigation. Another key element of all East Hickman alternatives is the elimination of the East Lake Pump station. This pump station is within 450 feet of the East Hickman Pump Station and its elimination would require a deeper wet well for the new EHPS. A detailed solution alternative involves upsizing the new EHPS to convey peak flows to the West Hickman WWTP instead of providing on-site EQ. In order to ensure an equivalent comparison, the incremental increase in storage at the West Hickman WWTP was included in the cost estimate.

The following summarizes the detailed solutions for the East Hickman Sewershed for final analysis:

- EH1: New East Hickman Pump Station constructed with the same capacity as the current pump station but would be firm capacity (21.3 MGD) and convey flow directly to the West Hickman WWTP. Construct new 4.3 MG EQ tank at the new East Hickman Pump Station. Construct new gravity sewer to eliminate East Lake Pump Station.
- EH2: Same as EH1 but construct new 35.7 MGD pump station and 42" force main to convey peak flows to the West Hickman WWTP without EQ storage.

Table 3-5 shows the estimated capital costs for each option:

Table 3-5: East Hickman Sewershed Detailed Solution Options

Detailed Solution	Capital Cost Estimate ($M)
EH1 – EQ at EHPS	$71
EH2 – No EQ at EHPS	$69

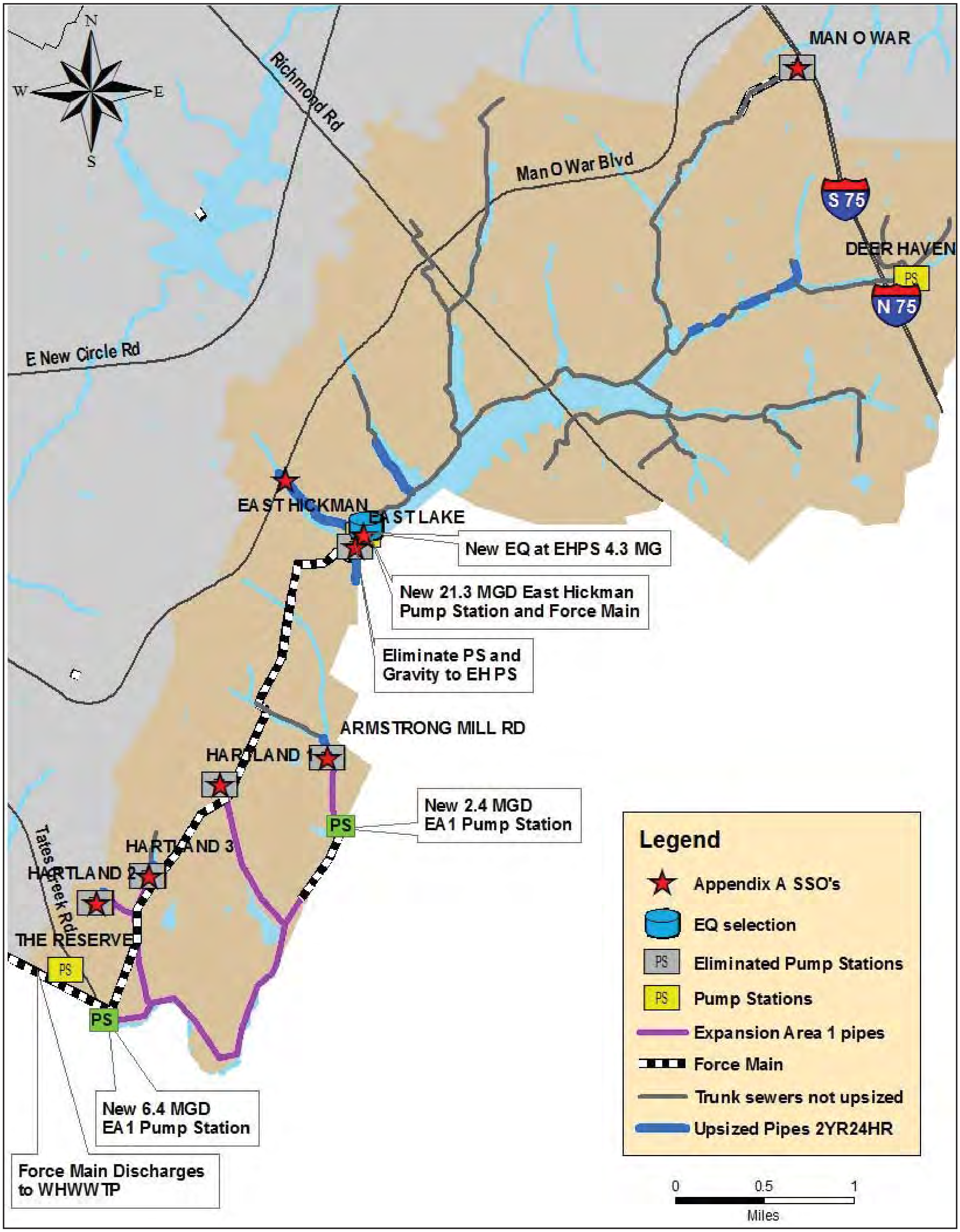
** Note: EH2 includes cost for additional EQ at West Hickman WWTP*

The cost estimate shows that the capital costs for each alternative are essentially equal with some small cost savings associated with constructing a peak flow pump station. However, there were other issues to take into consideration while evaluating the two alternatives. First, the construction of a new 42-inch force main would increase the detention time in the force main by over 35%. This could lead to increased operation issues (odor, corrosion, etc) and would likely result in higher chemical costs. In addition, the peak dry weather flow velocity would be only 1.4 feet/second, which could result in significant deposition and heavy biofilm accumulations which can decrease pipe capacity. Maintaining the current pump station capacity and force main size will result in a peak dry weather velocity of 2.7 feet/second which will serve to convey solids through the force main. Also, the construction of equalization may allow for opportunities to evaluate benefits of I/I removal. Therefore, the preferred solution is EH1, which allows for more effective operation of the East Hickman Pump Station and may allow for an evaluation of the benefits of I/I removal upstream of the pump station. The key features of the preferred detailed solution include:

- New 21.3 MGD East Hickman Pump Station with new 4.3 MG equalization tank
- Approximately 26,000 linear feet of new 30" force main.
- Approximately 10,000 linear feet of pipe replacement
- Approximately 30,200 linear feet of new gravity sewer and force main
- Two new pump stations totaling 8.8 MGD

Figure 3-8 shows the preferred detailed solution.

Figure 3-8: East Hickman Detailed Solution



3) <u>West Hickman Sewershed Detailed Solutions</u>
Two alternatives were evaluated for the West Hickman sewershed based on the results of the General Solutions analysis. These are the following:

- **WH1 – Conveyance and EQ Hybrid Solution:**
  - The capacity of West Hickman Treatment Plant will remain the same at 70 MGD. An on-site EQ tank will be located at the treatment plant to store excess peak flow.
  - Sewers will be upsized, as necessary, to meet the Capacity Assurance Program (CAP) criteria. Sewer sizing will assume no I/I removal. One exception will be the trunk sewer from Richmond Road to the vicinity of the dam (manholes WH7_32 to WH7_554), which will be allowed to surcharge but not overflow.
  - New remote equalization tank along trunk sewer near Richmond Road in the WH-7 subbasin to eliminate the need to upsize the pipe under the reservoir.
  - Elimination of the Shadeland and Pizza Hut pump stations with a new gravity sewer.

- **WH2 - Tunnel Option:**
  - The improvements upstream of the reservoir dam near Alumni Drive would be the same as the WH1 Option.
  - A new conveyance/storage tunnel (approximately 23,000 linear feet) would be constructed parallel to the existing interceptor starting near Alumni Drive and terminating at the West Hickman WWTP. The size of the tunnel will vary from 8' to 20'.
  - The capacity of West Hickman WWTP will remain the same at 70 MGD. Additional EQ storage will be located at the West Hickman WWTP to store flows above 70 MGD after the tunnel storage is exhausted.
  - Side trunk sewers will be upsized, as necessary, to meet the Capacity Assurance Program (CAP) criteria. Except as noted below, sewer sizing will assume no I/I removal in collector system rehabilitation areas.
  - Elimination of the Shadeland and Pizza Hut pump stations with new gravity sewer

These alternatives were developed after a review of the General Solution results. The tunnel option was added after the General Solutions were completed. As described previously, upsizing the sewer that travels under the reservoir in WH-7 (manhole WH7_32 to WH7_554) is a very challenging and potentially risky project. Therefore, off-line equalization was selected under both options to avoid upsizing the sewer under the reservoir. The model results showed that it is possible to eliminate recurring SSOs with this approach, but there is surcharging above 2' in the trunk sewer. However, the pipe is ductile iron, investigations show it to be in good condition, and temporary surcharging is not anticipated to result in exfiltration.

In addition, there is no evidence that this surcharging would cause an increased risk in basement flooding.

The tunnel option was considered to determine the financial feasibility to combine the peak conveyance and storage benefits that tunnels can provide. In combined sewer systems, tunnels are often found to be cost-effective at reducing overflows. Several tunnel diameters were explored for this model to balance the size of the tunnel, and hence its storage capabilities, against the need for equalization at the West Hickman WWTP. The analysis showed that a 20-foot diameter tunnel was required to convey and store the excess peak flow to eliminate the need for additional storage at the West Hickman WWTP. Eight drop shafts were needed at several locations of the tunnel to accommodate CAP criteria. Table 3-6 shows the summary of costs for the detailed solutions alternatives

Table 3-6: West Hickman Sewershed Detailed Solution Options

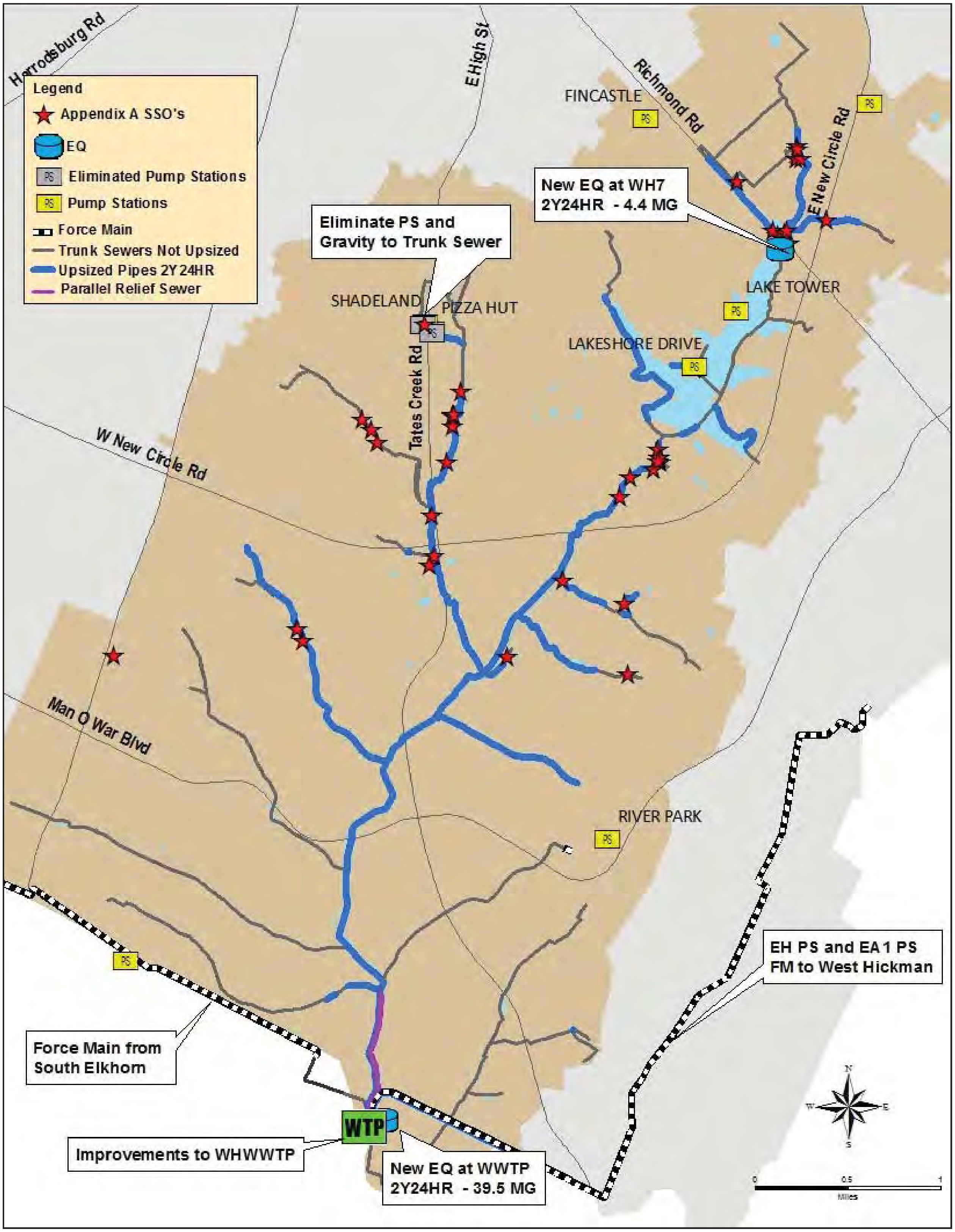
Detailed Solution Alternative	Capital Cost Estimate ($M)
WH1 – EQ in WH-7 and at WWTP	$181
WH2A – EQ in WH-7 at WWTP, and 8' diameter tunnel	$287
WH2B – EQ in WH-7 at WWTP, and 12' diameter tunnel	$272
WH2C – EQ in WH-7 and 20' diameter tunnel	$257

Table 3-6 clearly shows that the tunnel solutions are not cost-effective. Therefore the selected alternative is WH1, which generally includes:

- Approximately 69,300 linear feet of pipe replacement
- Approximately 4,000 linear feet of new parallel pipe
- New 4.4 MG equalization tank located in WH-7
- New 39.6 MG equalization tank at the West Hickman WWTP

Figure 3-9 shows the preferred detailed solution.

Figure 3-9: West Hickman Detailed Solution



D. Cross Connections

Of the nine cross connections listed in Appendix A of the CD, only one, at 782 Allendale Drive, is in a Group One sewershed. This cross connection will be eliminated with the reconstruction of the Wolf Run Trunk Sewer in a project identified as Wolf Run Main Trunk F.

E. Pump Station Reliability and Capacity Upgrades

To satisfy the requirements of Section VII(15)(C) of the CD, LFUCG completed the Pumping Station Design, Capacity, and Equipment Condition Adequacy Evaluation for the pump stations listed in Appendix H of the CD. The Group One Sewersheds included the following pump stations:

- Hartland #1 Pump Station
- Hartland #2 Pump Station
- Hartland #3 Pump Station
- Armstrong Mill Pump Station
- East Hickman Pump Station
- East Lake Pump Station
- Shadeland Pump Station
- Wolf Run Pump Station

The majority of these pump stations (Hartland #1, #2, and #3, Armstrong Mill, East Lake, and Shadeland) will be eliminated as part of the RMP implementation in the near future and therefore do not require reliability upgrades. The remaining pump stations (Wolf Run and East Hickman Pump Stations) are both being replaced (as discussed below) and the necessary reliability provisions are incorporated into the proposed pump station improvements.

LFUCG has evaluated pump station reliability in accordance with Section VII(16)(E) in their Sanitary Sewer Pumping Station Operation Plan for Power Outage. Any recommended Group One pump station improvements from this study will be implemented by LFUCG in actions separate from the RMP implementation.

F. Wastewater Treatment Plant Upgrades

The West Hickman WWTP was originally constructed in 1972 with a rated average daily capacity of 5 mgd. Since the original construction, the WWTP has undergone three expansions and several phases of improvement projects. In 1982, the WWTP was expanded to 16.8 mgd average daily flow with a peak day hydraulic capacity of 32 mgd. A second treatment expansion occurred in 1992 when capacity was increased to 22.3 mgd daily average flow with a daily peak capacity of 52 mgd. The third and most recent expansion occurred in 2001 when the treatment capacity was increased to its current capacity of 33.87 mgd average daily flow and a rated 64 mgd peak daily capacity. Several small improvement projects have occurred since 2001, including the replacement of the influent screw pumps with screw centrifugal pumps, a chemical feed system for phosphorus precipitation and a geodesic cover for Aerated Sludge Holding Tank #4. Currently LFUCG is under design of electrical/SCADA improvements to West Hickman's instrumentation/electrical system and aeration blowers, with construction planned to start in the fall of 2011.

An evaluation of the West Hickman WWTP was conducted to investigate the hydraulic flow and organic loading rate that would receive effective treatment before an unpermitted bypass or NPDES non-compliance event occurred. Eliminating unpermitted bypasses is a requirement of the USEPA Consent Decree and this WWTP evaluation recommends upgrades, repairs, and replacements to reduce the potential for a bypass or KPDES permit non-compliance. Maintaining treatment reliability is a primary concern. The West Hickman staff currently regulates the peak flows into the WWTP with use of influent gates. Flows in excess of 70 MGD are restricted from flowing into the WWTP to prevent any unpermitted bypasses or overloading conditions at the WWTP.

The average daily Biological Oxygen Demand (BOD) concentration to the West Hickman WWTP is 156 mg/l which generates 44,000 pounds of BOD per day. During peak flow events of 70 MGD the BOD concentration reduces to an average of 60 mg/l in response to the dilution factor created by the stormwater I/I. The West Hickman WWTP is capable of effectively treating the current average daily organic loading and the peak organic loading.

The hydraulic peak capacity at the West Hickman WWTP is limited in part by the hydraulic detention time of the chlorine contact basins at a peak flow of 71 MGD. An overflow event could occur at the Aeration Zone 2 Influent Channel at a flow greater than 70 MGD also illustrating the maximum hydraulic capacity. The weir loading of the secondary clarifiers is the next limiting process at a peak flow capacity of 86.7 MGD.

The organic and hydraulic capacity of the existing treatment units is therefore slightly greater than 70 MGD which supports the decision of the WWTP staff to regulate the peak flow into the WWTP to a maximum of 70 MGD while effectively maintaining compliance with the following NPDES discharge limits shown on Table 3-7:

Table 3-7: West Hickman WWTP Effluent Limitations

Effluent Characteristics	Discharge Limitations			
	Lbs/day		Other Units (specify)	
	Monthly Average	Weekly Average	Monthly Average	Weekly Average
Flow, design (33.87 mgd)	N/A	N/A	Report	Report[3]
Biochemical Oxygen Demand (5-Day), Carbonaceous	2825	4237	10 mg/L	15 mg/L
Total Suspended Solids	8474	12711	30 mg/L	45 mg/L
Fecal Coliform Bacteria, N/100	N/A	N/A	200	400
Ammonia (as N)	1130 2825	1695 4237	4 mg/L[1] 10 mg/L[2]	6 mg/L[1] 15.5 mg/L[2]

Total residual Chlorine (TRC)	N/A	N/A	0.011 mg/L	0.019 mg/L[3]
Phosphorous[1]	N/A	N/A	N/A	1 mg/L[3]

[1] *Effective May 1 – October 31*
[2] *Effective November 1 – April 30*
[3] *Daily maximum limitations*

Further evaluation of the West Hickman WWTP was conducted to determine the need for future remedial projects to maintain reliability of the treatment process while limiting the risk for any unpermitted bypasses or NPDES non-compliance events.

The current West Hickman treatment facility includes the following:

- One (1) Influent Pumping Station with six (6) screw centrifugal pumps
- One (1) Raw Sewage Pumping Station with four (4) centrifugal pumps
- One (1) Coarse Bar Screens
- Three (3) Mechanical Fine Screens
- Two (2) Grit Removal Basins with supporting dewatering equipment
- Eight (8) Biological Phosphorus Removal Basins
- Eight (8) First Stage Aeration Basins
- Six (6) Second Stage Aeration Basins
- Eight (8) Final Clarifiers
- Four (4) Chlorine Disinfection Contact Tanks
- One (1) Dechlorination Mixing Chamber
- One (1) Post Aeration Ladder
- Two (2) RAS/WAS Pumping Stations with three (3) pumps located in the "old" building and two (2) centrifugal pumps located in the "new" building.
- Two (2) Gravity Thickeners
- One (1) Thickening Centrifuge (currently out of service and not planned for use)
- Three (3) uncovered Aerated Sludge Holding (ASH) Tanks
- One (1) covered Aerated Sludge Holding (ASH) Tank
- Three (3) Belt Filter Presses

As with any WWTP, the equipment and structures have a limited operating life due to the harsh environment to which they are exposed. A large portion of the existing equipment, piping and concrete is over 20 years old. LFUCG has replaced equipment such as pumps as needed, but to maintain reliability they have to plan for contingencies of future replacement and modifications to address new regulatory requirements. After site inspections of the West Hickman WWTP, work sessions were conducted with members of the LFUCG staff and consultants to discuss areas of concern for not only today's needs, but also for planned replacement of equipment that may be nearing the end of its useful life.

Remedial projects are recommended to sustain current treatment reliability. A schedule for these improvements and updates is not formalized because of the nature of these improvement recommendations. Many of these recommendations will need to be addressed upon equipment failure or when the useful life of the previous installment has been met. The recommendations address maintaining treatment reliability for the evaluated true peak capacity of 70 MGD. The recommendations do not provide for expansion capacity greater than 70 MGD. The following summary discusses the areas requiring attention for the long term (20 year cycle) dependability of the West Hickman WWTP process operations:

Influent Pumping – Influent pumping of the raw wastewater uses the Influent Pumping Station which was constructed in 1992 and included screening and grit removal. This is the primary alternative for raw wastewater pumping. In the 2001 expansion fine screening replaced the course screening equipment. The fine screens are judged to be in good condition but the abrasive nature of the raw wastewater is taking a toll on the grit removal equipment and the grit pumps and the grit concentrators will need replacement. The Raw Sewage Pumping Station is part of the original WWTP construction and was not planned for future use, but has been pressed into service to assist the handling of high peak flows. The Raw Sewage Pump Station is not equipped with screening or grit removal. If this pumping station is continued for use it is recommended to install fine screening and grit removal. Without these facilities, grit and debris are being carried into the downstream treatment basins. This shortens the operating life of pipes, valves and equipment and also reduces the capacity in the basins for biological treatment. An additional need is the replacement of the pump station influent valves as they are old and not functioning very well.

As stated, the Influent Pumping Station is the recommended facility for transporting the raw wastewater into the West Hickman WWTP and the older Raw Sewage Pumping Station was not planned for future use due it's deficiencies with no grit removal or fine screening. The Raw Sewage Pumping Station is placed into service during peak flows to assist the Influent Pumping Station which has some hydraulic limitations with flow channels and grit removal. It is recommended to perform a thorough Preliminary Engineering Study to evaluate elimination of the Raw Sewage Pumping Station and modifications to the newer Influent Pumping Station in which one facility would pump, screen and de-grit the total raw wastewater. Placing the total operation at one facility would be more cost efficient and effective. The long term goal is to maintain reliability and improve operation.

Biological Phosphorus Removal (BPR) – The 2001 expansion included the installation of the Biological Phosphorus Removal (BPR) basins. The basins were designed for a limited hydraulic detention time based on influent flows. A "leaping" weir was installed to allow flows in excess of the design rating to overflow the leaping weir and go directly to the Aeration Zone 2 influent channel. Use of the leaping weir has led to operational concerns for actual flow control and effective mixing of the flow stream. Currently, the staff manually controls the weir elevation. Improvements for more effective, automatic weir control and better mixing are recommended. The 2001 BPR construction established a peak raw influent flow rating to the BPR basins of approximately 27 mgd. The staff controls the mixture of raw influent flow and Return Activated Sludge to the basins at a total combined flow of 42 mgd preventing washout and insufficient detention time in the basins. Initial discussions on BPR treatment capacity have taken place and it is recommended to perform a Preliminary Engineering Study to evaluate the BPR basins treatment capacity while considering options for future expansion to accommodate the total sewage flow. Consideration for BPR Basin expansion should include the options of constructing additional new basins or modifying the "old" primary clarifier tanks, which are not currently being used. The Preliminary Engineering Study should also evaluate the increased capacity of the chemical feed facility to assist with future phosphorus treatment.

Aeration Zone 1 – Aeration Zone 1 currently is supplied air by one centrifugal blower and supplemented by the Aeration Zone 2 blowers. Supplementing from the Aeration Zone 2 blowers is not efficient as there are differences in head pressures between the two zones and the air supply piping from Zone 2 to Zone 1 is small and constricting creating excessive friction loss. A project is currently in design to refurbish two of the Zone 2 blowers and move them to the Zone 1 blower building. The Aeration Zone 1 diffusers are also planned for replacement. The existing aeration piping is remaining, but some of the main air control valves are being replaced. The service life of fine bubble membrane diffusers is estimated at 7 years and it is recommended to plan on replacing the air diffusers and air control valves within approximately 7 - 8 years of the current replacement project. The aeration piping, is not part of the current replacement project, but will require replacement in the future.

Aeration Zone 2 – The blowers that provide air to Zone 2 have a capacity issue with trying to provide air for both Zone 1 (supplemental) and Zone 2 during the warm summer months when there is more oxygen demand. The staff members have concerns with the blowers overheating and shutting down. Mechanical fans are currently used to help dissipate heat from the blower motors. The aeration capacity of a WWTP is a vital component of biological treatment. The current blower improvement project includes refurbishing all four Zone 2 blowers. Two of the blowers will be relocated to Zone 1 and two will remain for Zone 2. Future planning not part of the current project includes the installation of two additional blowers for Zone 2. The blower facility should be improved with the installation of new blowers, adequately sized piping and aeration control valves. It is recommended to add the new blowers to assist with process reliability.

Clarifier Flow Distribution – The hand wheel operated flow distribution gates are in bad condition and are difficult to turn. It is recommended to replace the eight adjustable weir gates. The operators were recently replaced through the WWTP's maintenance program and should be available for reuse when the gates are replaced.

Disinfection – The West Hickman WWTP utilizes gaseous chlorine for disinfection. The current system is manually controlled and is not flow paced, which is inefficient. An ongoing SCADA project is adding the capability to feed chlorine based on effluent flow. This would automatically change chlorine feed rates based on flows and chlorine residuals, thus providing only the needed amount of chlorine for disinfection. Due to the harsh nature of chlorine, it is believed that the existing chlorine feed system will require either replacement or a major overhaul within the next 13 years and it is recommended to anticipate this need and budget accordingly.

Dechlorination – The West Hickman WWTP uses sulfur dioxide for dechlorination. Again this system is presently manually controlled, but the SCADA project will add the capability for automatic control based on effluent flows. It is also believed that this system will require either replacement or a major overhaul within 13 years and its replacement should be budgeted.

Final Effluent – The final effluent flows by gravity into West Hickman Creek. West Hickman Creek can be greatly influenced by heavy rains and swells to a level that restricts the gravity outfall from the WWTP. During past (rare) flood events the final effluent has surcharged back into the WWTP and reduced the volume of treated effluent being discharged from the plant. To prevent this problem, it is recommended that a flood pumping station be constructed. This pumping station would pump the WWTP flows into West Hickman Creek when the creek's water level prohibits normal discharge.

Return Activated Sludge Pumping - Three of the RAS pumps were installed in 1980 and two in 1990. These pumps are nearing the end of their expected operating life and they will likely need replacing in the near future. All five pumps should be replaced with more efficient pumps and the continued use of variable frequency drives (VFDs) is recommended. The VFDs allow for more efficient control of RAS through pumping rates.

Waste Activated Sludge Pumping- The two WAS pumps were installed in year 2000 and have already reached a 10 year operating life which is the normally expected life cycle. It is highly probable that the WAS pumps will require replacement within the next 13 years. The continued use of VFDs is recommended. The VFDs improve the efficiency of the sludge wasting and should save on power costs. Budgeting for pump replacement is recommended.

Waste Sludge Thickening – Waste activated sludge normally has a total suspended concentration of 6,000 to 9,000 mg/l. This can require large holding basins to contain the waste sludge and the contents will be primarily water. The West Hickman WWTP uses gravity thickeners to concentrate the waste sludge before pumping it to sludge holding. This reduces the size required for sludge holding tanks and provides a more efficient sludge handling process by reducing the volume of sludge that must be dewatered. The two gravity thickeners are small and require a very low sludge loading rate to keep from overloading them. The two existing tanks do not provide adequate capacity and overflowing solids are common. These overflowing solids return to the wastestream and go through biological treatment again. This is an inefficient process and returns additional solids to the wastestream. Additional gravity thickeners or mechanical style thickeners are recommended.

Waste Sludge Holding – The 2001 expansion project converted the anaerobic digesters to open tank aerobic holding tanks. The West Hickman WWTP has experienced odor complaints and a residential subdivision is located near the WWTP. Recently, a geodesic dome was installed on one of the aerobic sludge holding tanks. This was done to reduce odors being emitted from the tank's contents. The WWTP has restricted use of the open tanks due to the potential for odor release. This singular holding tank is undersized for the needs of the WWTP. Installing a similar cover on the second holding tank is recommended because it would double the capacity for odor reduction sludge storage to approximately 940,000 gallons.

Waste Sludge Dewatering – In 1992, three belt filter presses (BFPs) were installed for dewatering of waste sludge. The BFPs have accumulated 20 years of use and are showing a lot of wear. Belts, bearings and rollers have been replaced when needed, but they are nearing the end of their service life. It is recommended to replace the BFPs with either new BFPs or centrifuges. LFUCG pays for sludge disposal based on the load and the use of centrifuges should provide a thicker sludge cake and reduce disposal costs.

Dewatered Sludge Truck Loading Station -An additional need for the sludge dewatering is an expansion of the truck loading station. The existing station is a single bay facility that requires the removal of a storage vehicle and the deposit of a second before dewatering operations can resume. Dewatering may have to stop until the vehicles are exchanged or if an authorized truck driver is not on site the operation could be halted for a delaying period of time. A second truck bay would resolve several issues with the existing layout and is therefore recommended.

As can be observed from the summary of the sludge handling facilities, there are numerous concerns which include the lack of capacity and remaining service life. The sludge handling system includes several facilities, operating in coordination to produce an effective and cost conscious operation. It is recommended to perform a Preliminary Engineering Study to evaluate improvements to the total sludge handling system. An evaluation that evaluates the total system would offer the advantage of evaluating all facilities operating in a cohesive manner.

Scum/Grease Facility – The West Hickman WWTP does not currently have scum or grease control facilities. Large accumulations of scum and grease present problems with blinding of the belt filter presses, blocking of flows through channels and pipes, and creating nuisance odors. Grease facilities would provide removal, containment, and thickening which would help maintain a more effective treatment system. Scum and grease have historically been a problem at this WWTP. It is recommended that scum and grease control facilities be installed at the West Hickman WWTP.

Non-Potable Water System – The West Hickman WWTP uses a portion of the treated effluent for wash down water and chemical make-up water throughout the treatment plant. This provides an economical use of reclaimed water versus the alternative of purchasing potable water. The existing non-potable water system consists of 18 centrifugal pumps and it is difficult to balance the demand with the pump output. Also the NPW pumps were installed in the 1992 expansion project and they are nearing the end of their effective operating life. It is recommended that an efficient, easily controlled non-potable water system be installed.

Emergency Electrical Power – Currently, an emergency power source is provided for the influent pump station but not provided for the aeration blowers; therefore, if a power outage occurs the biological treatment portion of the facility would not receive any aeration. This is not normally a serious problem for short term durations, but can be a serious problem for an extended outage. The biological segment is the core of the treatment process. During a power outage, the Mixed Liquor Suspended Solids (MLSS) will settle to the bottom of the basins and the raw influent, with a weak concentration of pollutants based on the dilution of stormwater, will flow through the Aeration Basins. If the dilution factor is present, the final effluent should not be seriously affected but the effluent quality may not be as good as if aeration was provided. Maintaining consistent aeration is a benefit for the treatment system and the receiving stream. While it is not required of the West Hickman WWTP by the state regulatory agency to have emergency electrical power generation for aeration due to the WWTP's classification class, it would be advantageous for the treatment system. It is recommended to perform an electrical power study to determine the electrical loadings and size a new emergency generator to accommodate those loadings. This will require involvement of LFUCG staff to determine what processes they want to be connected to emergency power.

Odor Control Facilities – Odor control has been a concern at the West Hickman WWTP in the interest of being a good neighbor and also for the health and wellness of employees. Areas in the WWTP that register a high odor control priority are the headworks facility, waste sludge holding tanks and the sludge dewatering building. A residential subdivision is located near the WWTP and residents have issued odor complaints. The headworks and dewatering building are both currently furnished with odor control but neither system is totally effective. An odor control project is budgeted for the Dewatering Building and it is desired by plant personnel to install a new odor control system for the headworks facility which would include the newly modified raw sewage pumping channels.

Road Improvements – The main road into West Hickman WWTP and the adjacent plant roads are in bad condition and it is recommended they are repaved. The main road has not been repaved in a number of years and has drastically degraded. The road receives a heavy transportation load from chemical delivery trucks and sludge hauling vehicles.

The following table provides an estimate of probable costs related to the West Hickman WWTP upgrade projects that would provide continued reliability:

Table 3-8: Estimate of Cost for West Hickman WWTP Upgrades

Facility	Component	Estimated Cost
Influent Pump Station	(2) Grit Removal Equipment, pumps, concentrators	$860,000
	Additional grit removal unit with Structure	$1,300,000
Raw Sewage Pump Station	(3) Fine Screening	$940,000
	Grit Removal Facility with Collector, Pumps, Concentrator and Structure	$2,200,000
	PS Influent Valves	$120,000
Flow Diversion "leaping weir"	Mixing	$120,000
	Weir Modulating Control	$140,000
Biological Phosphorus Removal (BPR)	(4) Additional BPR Basins with Mixing Equipment	$3,200,000
	Chemical Feed Facility (alum)	$280,000
Aeration Zone 1	(366) Aeration Diffuser Mats, including new piping and anchors	$1,196,000
Aeration Zone 2	(2) New Aeration Blowers and piping improvements	$1,200,000
	(6,480) Aeration Diffusers, including new anchors	$589,000
Clarifier Flow Distribution	(8) Weir Gate Replacement	$240,000
Disinfection	Automatic Chemical Feed System	$140,000
Dechlorination	Automatic Chemical Feed System	$120,000
Final Effluent	Flood Pumping Station, with Flood Pumps	$2,800,000
Returned Activated Sludge Pumping	(5) Pump Replacement	$280,000
Waste Activated Sludge Pumping	(2) Replacement	$120,000
Waste Sludge Thickening	Additional Gravity Thickener	$820,000
	(2) Thickened Sludge Pumping	$70,000
Waste Sludge Holding	Install Additional Geodesic Cover with odor control	$179,500
Waste Sludge	(3) Replace the Belt Filter Presses	$1,250,000

Table 3-8: Estimate of Cost for West Hickman WWTP Upgrades

Facility	Component	Estimated Cost
Dewatering	New Sludge Loading Facility with Conveyor (1 additional truck bay)	$380,000
Scum/grease Facility	Install a Scum Concentrator and Scum Pumps	$576,000
Non-potable Water System	(4) New NPW Pumps and Controls & Removal of Exiting	$320,000
Emergency Electrical Power	New Emergency Generator for the Aeration Blowers with Switchgear (2000 KV)	$780,000
Odor Control Facilities	Headworks System	$1,140,000
	Dewatered Sludge Building System	$860,000
Road Repair	Repave the Entrance and Interior Plant Roads	$400,000
Estimated Total Cost (Construction Only)		**$22,620,500**

G. Group One Detailed Solutions Summary

Table 3-9 below summarizes the preferred solutions and associated costs for each sewershed.

Table 3-9: Detailed Solutions Summary

RMP Preliminary Capital Cost for 2Yr24Hr			
	Quantities		
Item	**West Hickman**	**East Hickman**	**Wolf Run**
≤15" (ft)	9,955	17,987	2,679
18"-24" (ft)	34,635	12,61	17,650
27"-36" (ft)	5,925	2,200	10,142
42"-54" (ft)	18,001	-	3,368
60"-72" (ft)	3,929	-	-
>72" (ft)	-	-	-
Force Main (ft)	-	33,359	-
Subtotal Pipe (ft)	**72,445**	**66,160**	**33,839**
PS Improvements (MGD)	-	30.1	20
EQ (MG)	44	4.3	1.8
WWTP Improvements (ea)	1	-	-
Total Capital Cost ($M)	**$218**	**$71**	**$33**

RESOLUTION NO. 389 -2011

A RESOLUTION APPROVING THE RECOMMENDATION OF THE DIVISION OF WATER QUALITY TO SELECT A "TWO-YEAR/24 HOUR" STORM EVENT AS THE "DESIGN STORM" TO FORM THE BASIS OF IMPLEMENTATION OF THE LFUCG SANITARY SEWER SYSTEM REMEDIAL MEASURES PLANS REQUIRED BY THE U.S. EPA CONSENT DECREE.

WHEREAS, the Urban County Government, the United States Environmental Protection Agency ("EPA"), and the Commonwealth of Kentucky have entered into a Consent Decree in a case styled *United States, et al. v. Lexington-Fayette Urban County Government*, United States District Court for the Eastern District of Kentucky, Case No. 5:06-CV-00386 ("Consent Decree"), wherein the Urban County Government is required to develop Remedial Measure Plans to address wet weather overflows and sewer capacity related issues; and

WHEREAS, the Consent Decree requires the Urban County Government to eliminate Sanitary Sewer Overflows (SSOs) with 11 to 13 years of January 3, 2011; and

WHEREAS, pursuant to the Consent Decree failure to meet the SSO elimination criteria will result in significant, recurring, and cumulative financial penalties; and

WHEREAS, failure to meet the requirements of the Consent Decree is likely to result in further legal action by the United States Department of Justice; and

WHEREAS, the Consent Decree requires three separate "Remedial Measures Plans" (Group 1, Group 2, and Group 3) broken down by watershed; and

WHEREAS, each Remedial Measures Plan (RMP) must recommend a "design" storm to provide a basis for sizing of sanitary sewer infrastructure (pipes, pump stations, storage tanks, and treatment plants); and

WHEREAS, the Group 1 Remedial Measures Plan is due to be sent to the EPA in October 2011; and

WHEREAS, the Division of Water Quality has employed expert engineering services to study the appropriate design standards for LFUCG's sanitary sewer system, held numerous public meetings to gain input from Fayette County residents, and otherwise considered the appropriate "design" storm to form the basis of the Remedial Measures Plans to comply with the Consent Decree; and

WHEREAS, the Division of Water presented the Urban County Council with detailed information related to costs and benefits of various "design storms" and has recommended that a "Two-Year/24 Hour" storm event is the appropriate "design storm" to form the basis of the sanitary sewer system Remedial Measures Plans to comply with the requirements of the Consent Decree; and

WHEREAS, after consideration the Urban County Council agrees with the recommendation of the Division of Water Quality;

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT:

Section 1 – That the recommendation of the Division of Water Quality that a "Two-Year/24 Hour" storm event is the appropriate "design storm" to form the basis of the LFUCG sanitary sewer system Remedial Measures Plans to comply with the requirements of the Consent Decree be and hereby is approved.

Section 2 - That a "Two-Year/24 Hour" storm event be and hereby is adopted as the "design storm" to form the basis of the LFUCG Sanitary Sewer System Remedial Measures Plans required to be implemented by the Consent Decree.

Section 3 - That this Resolution shall become effective on the date of its passage.

PASSED URBAN COUNTY COUNCIL: September 15, 2011

MAYOR

ATTEST:

CLERK OF URBAN COUNTY COUNCIL

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Section 4 Inflow/Infiltration (I/I) Program Strategy and Prioritization

A. Background

Flow monitoring was performed in the Group One sewersheds as part of the Capacity Assessment and the Sanitary Sewer Assessment (SSA) to fulfill the requirements in Paragraph VII.15.B(vi) of the Consent Decree. Flow monitoring locations were selected to quantify the wet weather response from the collection system and identify those areas with excessive inflow and infiltration.

SSA flow monitoring was performed for a four (4) month period from January 16, 2009 to May 16, 2009. A total of 110 fixed location meters and 3 variable location (i.e. floating) meters were installed in the Group One sewersheds.

Monitoring locations were selected, to the extent practical, to provide complete coverage of the collection system, encompass a minimum upstream collection system length of 10,000 linear feet, and concentrate meters in areas upstream of known sanitary sewer overflows (SSOs) and areas where previous Capacity Assessment flow monitoring (Spring 2008) indicated a significant wet weather response.

Hydraulic models of the trunk sewers in the Group One sewersheds were developed and calibrated in accordance with the requirements outlined in Paragraph VII15.E(i) of the Consent Decree. The models identify hydraulic performance of the trunk sewer system for the 2-year, 24-hour storm under both existing and future development conditions.

Flow monitoring results from the 2009 monitoring period, as well as a summary of the hydraulic modeling results were published in a report entitled Group One Sanitary Sewer System Assessment Report, dated April 13, 2011. This report was submitted to the EPA per the requirements outlined in Paragraph VII.15.F of the Consent Decree.

B. Wet Weather Response Prioritization

Inflow and infiltration (I/I) reduction through sewer rehabilitation provides a means of restoring wet weather capacity in sanitary sewer systems. Prioritization of areas within the collection system is necessary to focus rehabilitation efforts where I/I removal benefits will be maximized and capital expenditures will be most cost-effective.

Prioritization of collection system areas in the Group One sewersheds was performed based on the wet weather response observed during the 2009 flow monitoring period. A summary of the flow monitoring locations and their contributing collection system areas (metersheds) utilized in the 2009 monitoring period is presented in Figure 4-1, which is located at the end of this section.

General priorities were established for each of the metersheds depicted in Figure 4.1. Metersheds were assigned a priority of High, Medium, or Low. Priorities were assigned based on:

- Magnitude of difference between the dry weather and wet weather peak flows; and
- Proximity to known sanitary sewer overflows (SSOs).

General priorities based on wet weather response and proximity to known SSOs in each of the three Group One sewersheds are presented in Figure 4-2 (located at the end of this section).

C. Level of Control Prioritization

The Sanitary Sewer System and WWTP Remedial Measures Plan (RMP) identifies those capital projects and system improvements that are necessary to address capacity issues within the Group One sewersheds for a 2-year level of control. The occurrence of wet weather events in excess of the selected level of control may result in SSOs within the system.

To minimize the potential for SSOs resulting from wet weather events in excess of the selected level of control, collection system rehabilitation can be prioritized based on their proximity to potential future SSO locations. I/I removal in these areas can be effective at increasing the level of control in these areas and eliminating a future wet weather SSO.

The hydraulic models for the Group One sewersheds were used to predict SSO locations for a rainfall event with a 5-year return interval and assuming that all conveyance and storage improvement projects identified within the RMP have been constructed. A graphical summary of the SSO locations predicted by the hydraulic model under these two conditions (and assuming the future growth condition) is presented in Figure 4-3, which is located at the end of this section.

Five SSOs were predicted in the Group One sewersheds resulting from the occurrence of a 5-year rainfall event for the Year 2035 conditions and with the assumption that all conveyance and storage improvements (designed for a 2-year level of control) were in place. Two of the SSOs occurred at wet weather storage tanks located at East Hickman Pump Station and Wolf Run Pump Station. The remaining three SSOs occurred at manholes within the conveyance system of the West Hickman sewershed. Prioritization of collection system rehabilitation by level of control yields these three collection system areas where I/I removal could be effective at eliminating a potential SSO resulting from rainfall events in excess of the selected 2-year level of control. These three collection system areas are depicted in Figure 4-4 (located at the end of this section). The three areas were selected as those areas upstream of the model predicted SSOs that occurred in the conveyance system during a 5-year storm. Predicted SSOs at the storage tanks adjacent to the pump stations were not included; the areas upstream of these SSOs encompass too large a portion of the collection system to be considered useful for prioritization.

D. Strategy

Determining the effectiveness of proposed collection system rehabilitation at reducing the wet weather response in the system is uncertain. Historically achieved I/I removal rates vary widely, both locally and across the nation. Reliance on a prescribed I/I removal effectiveness when sizing conveyance and storage improvements presents an inherent risk. If targeted I/I reductions are not achieved, conveyance and storage improvements will be too small to restore adequate wet weather capacity in the system.

In order to ensure an achievable level of control from implementation of the Sanitary Sewer System and WWTP Remedial Measures Plan (RMP) in the Group One sewersheds, I/I removal within the collection system was not considered when sizing conveyance and storage improvements. Conveyance and storage improvements were designed to completely restore adequate capacity in the system for the 2-year, 24-hour rainfall event with no assumed I/I reduction in the collection system.

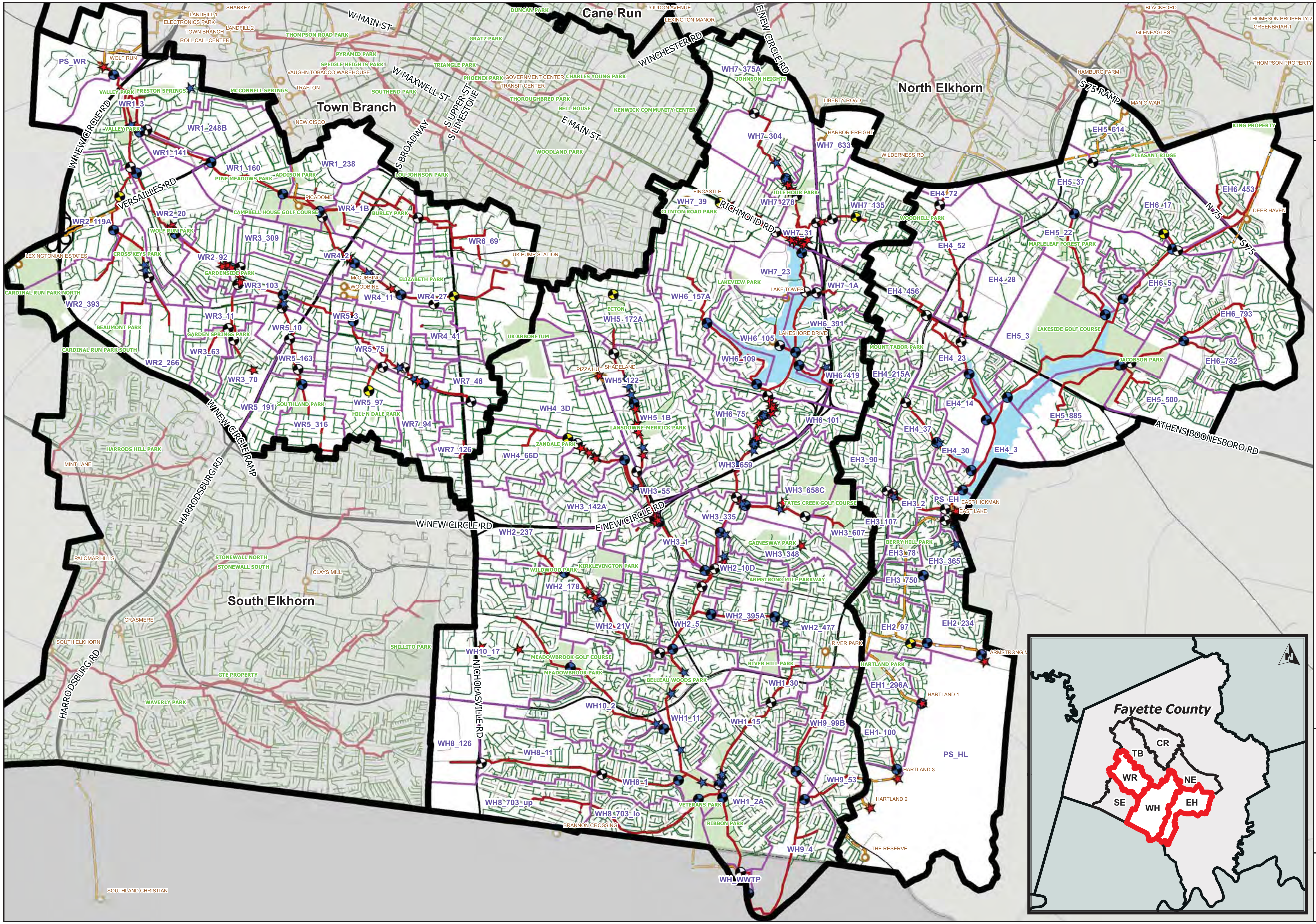
LFUCG intends to aggressively pursue collection system rehabilitation on a programmatic basis concurrent with implementation of the conveyance and storage improvements outlined in the RMP. Beginning in FY2012, LFUCG proposes to increase their annual budget for collection system rehabilitation from $1.5 million to $5 million and intends to maintain this funding level over the life of the RMP implementation.

An extensive amount of field inspections in the wastewater collection system in the Group One sewersheds were conducted as part of the SSA field activities. Field activities included: closed circuit television inspection (CCTV) of approximately 675,000 linear feet of sewer pipe; approximately 9,900 manhole inspections; and smoke testing of approximately 2,500,000 linear feet of sewer pipe. Collected defect information on the sewer system's condition will be used by LFUCG to develop rehabilitation recommendations in prioritized collection system areas. Additional sewer inspection information collected by LFUCG as part of their Gravity Line Preventative Maintenance Program (GLPMP) efforts will also be considered when developing rehabilitation recommendations.

Flow monitoring was also performed as part of the SSA to aid in identifying the wet weather I/I contribution within the collection system areas of the Group One sewersheds. Wet weather response data will be used by LFUCG to identify opportunities for private property I/I removal. Such efforts may include targeted mailings and outreach programs to encourage participation in LFUCG's voluntary Sump Pump Redirection Program.

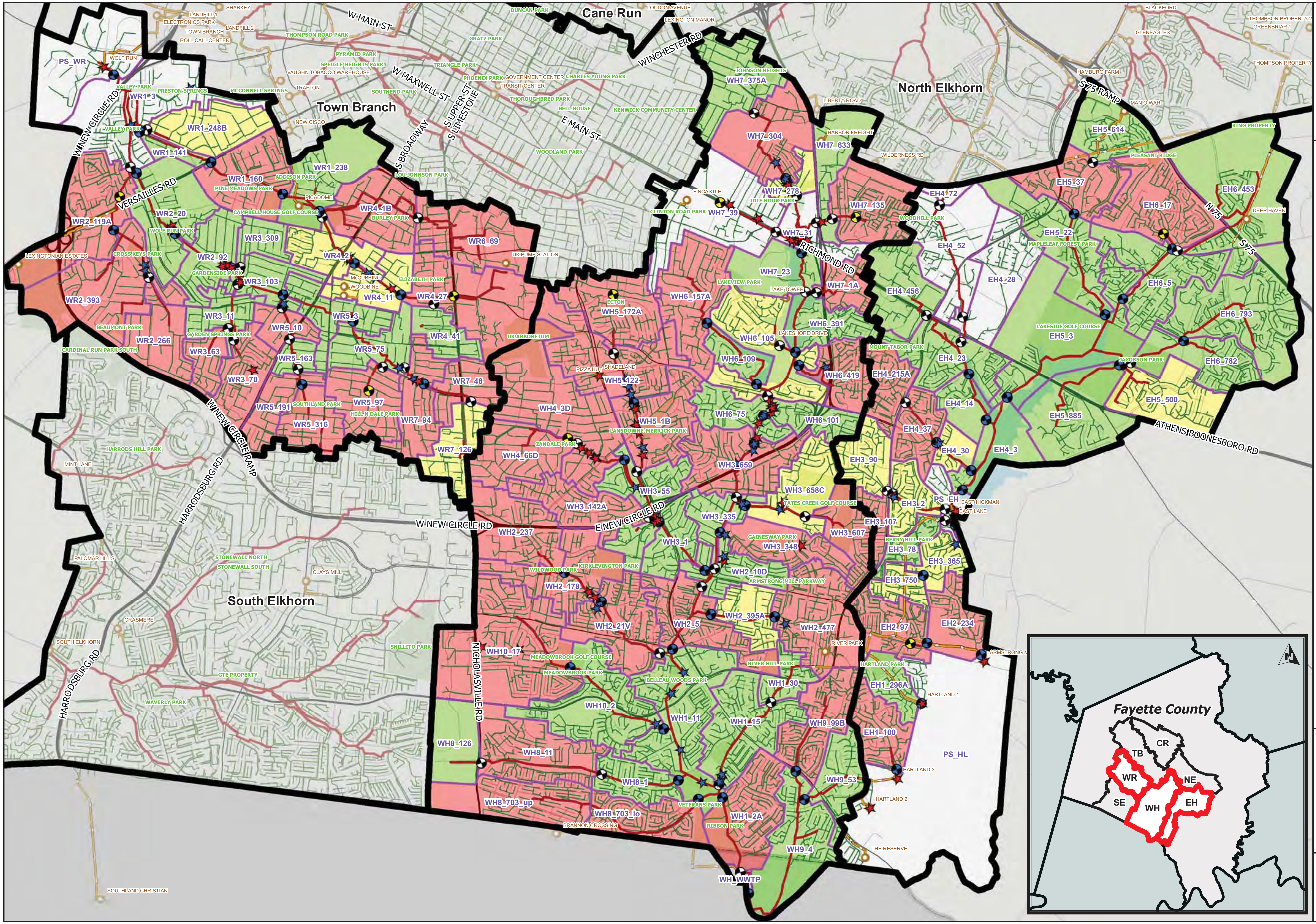
The wet weather and level of control prioritizations outlined above in Sections 4B and 4C will be used as the basis for prioritizing their programmatic collection system rehabilitation efforts. The results of these efforts will very likely yield an increase in level of control for Remedial Measures improvements above that of a two-year design storm.

2009 Flow Monitoring Locations



- Pump Station
- Collector Sewer (< 12" Diam.)
- Forcemain
- Trunk Sewer (>= 12" Diam.)
- Major Sewershed
- "Floating" Flow Meter
- Flow Meter
- Flow/Groundwater Meter
- Flow Meter Sewershed
- Monitoring List SSO
- Appendix A SSO

1 " = 4,000 '



Wet Weather Response Prioritizations

I/I Removal Priority

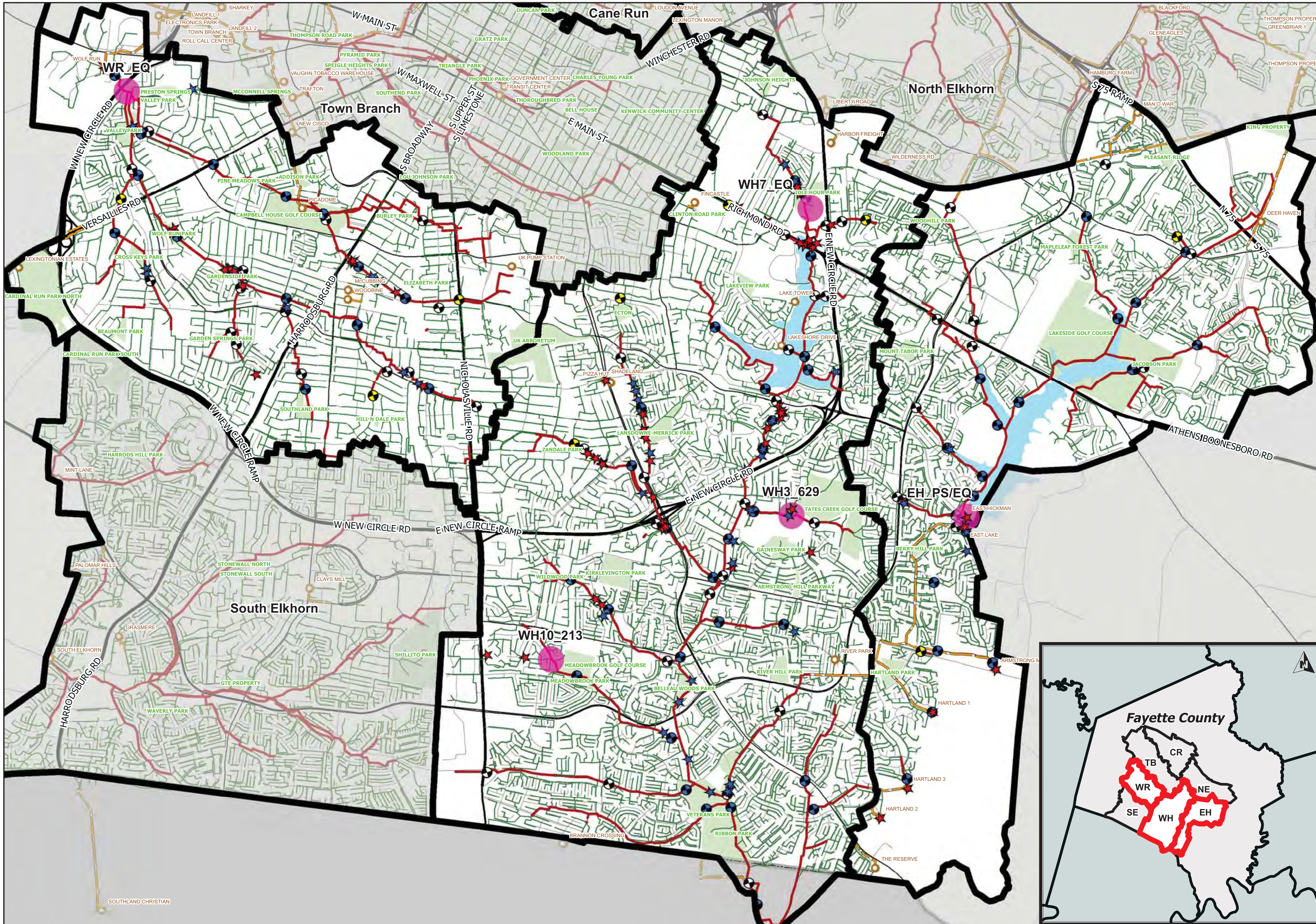
- Uncertain
- Low
- Medium
- High

- Pump Station
- Collector Sewer (< 12" Diam.)
- Forcemain
- Trunk Sewer (>= 12" Diam.)
- Major Sewershed

- Monitoring List SSO
- Appendix A SSO
- "Floating" Flow Meter
- Flow Meter
- Flow/Groundwater Meter
- Flow Meter Sewershed

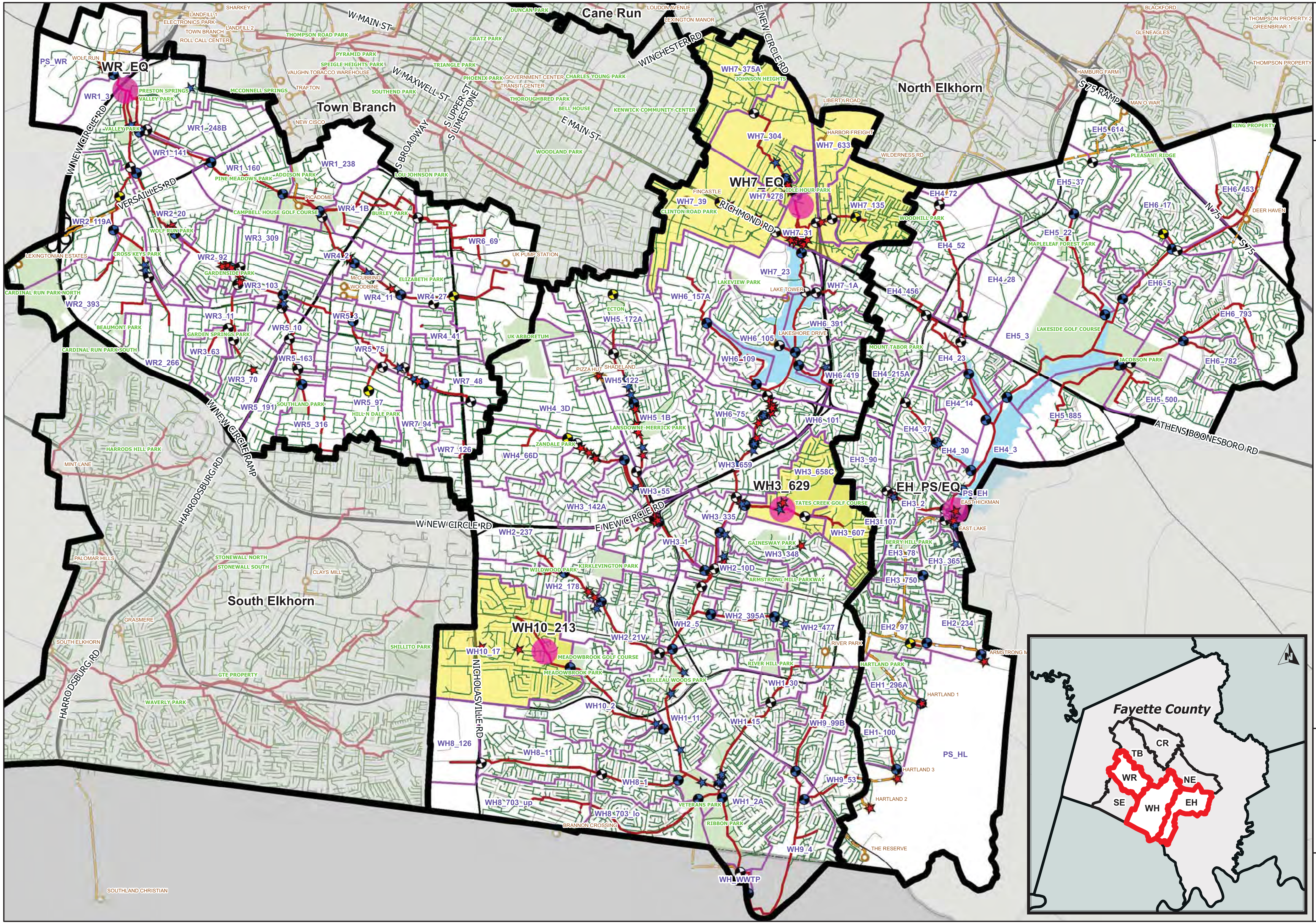
1 " = 4,000 '

SSO Locations for 5-year Storm and 2-year LOS



- Pump Station
- Collector Sewer (< 12" Diam.)
- Forcemain
- Trunk Sewer (>= 12" Diam.)
- Major Sewershed
- "Floating" Flow Meter
- Flow Meter
- Flow/Groundwater Meter
- Monitoring List SSO
- Appendix A SSO
- Model Predicted SSO Locations for 5-year Rainfall Event with 2-year Level of Service Remedial Measures Plan

1 " = 4,000 '



Level of Service (LOS) Prioritizations

- Pump Station
- Collector Sewer (< 12" Diam.)
- Forcemain
- Trunk Sewer (>= 12" Diam.)
- Major Sewershed
- "Floating" Flow Meter
- Flow Meter
- Flow/Groundwater Meter
- High Priority I/I Removal Metersheds
- Monitoring List SSO
- Appendix A SSO
- Model Predicted SSO Locations for 5-year Rainfall Event with 2-year Level of Service Remedial Measures Plan

1 " = 4,000 '

Section 5 Prioritization and Schedule

A. Prioritization Process

1) Project Prioritization Process Overview

The Group One Sanitary Sewer System and WWTP Remedial Measures Plan (RMP) consists of projects to be implemented to address capacity issues within the Group One sewersheds. These projects will provide improvements to the sanitary sewer system and result in the elimination of recurring SSOs, wet-weather Unpermitted Bypasses at the WWTP, and recurring NPDES permit violations related to excess flow for a 2-year, 24-hour storm.

The development of the RMP is being done in accordance with the requirements of Paragraph VII.15.G of the Consent Decree. Specifically, Paragraph VII.15.G(vi) identifies criteria to prioritize the sanitary sewer system remedial measures as follows:

a) Relative likely human health and environmental impact risks
b) Recurring SSO frequencies of activation
c) Total annual recurring SSO volumes
d) May also take into account cost-effectiveness and risks associated with implementation

The tasks of prioritizing the Group One RMP projects and developing a detailed implementation plan were conducted in a four-step process described below. This process was designed to comply with the requirements of the CD and fit within LFUCG's estimated annual capital expenditure budget.

2) Prioritization Methodology

The prioritization of the RMP in Step 1 incorporates many factors into the methodology of determining priority and schedule. These factors include:

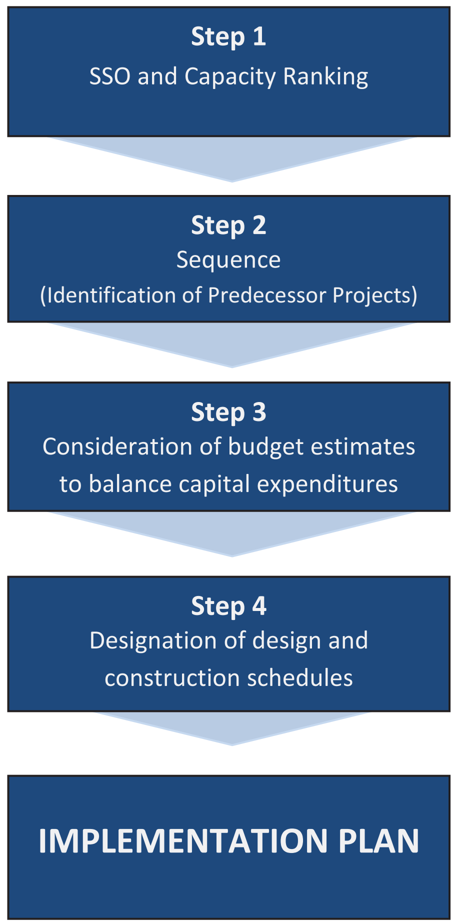
- Frequency and volume of SSOs
- Capacity restrictions in the collection system
- Logical sequence (necessary predecessor projects)
- Cash flow (balancing capital costs with annual expenditure budgets)

A prioritization methodology chart is provided to illustrate the process in Figure 5-1. SSOs (identified in Appendix A of the Consent Decree and/or shown by the hydraulic model as surcharging or overflowing during a 2-year, 24-hour storm) were grouped into clusters with other SSOs in close proximity. Proposed capital projects were developed that addressed each cluster and individual wet-weather SSO. The hydraulic model results provided information related to the frequency and volume of SSOs for each cluster. A database was created and populated with the following information:

- Total number of SSOs in each cluster
- Total number of Appendix A SSOs in each cluster
- Total volume overflowed during the 2-year storm

- Frequency of overflows in a 2-year period (i.e. an SSO estimated to occur during a 6-month storm would have a 2-year frequency of 4, whereas an SSO estimated to overflow only during a 5-year storm would have a frequency of 0.4)
- Subject project (the specific project that would eliminate the Recurring SSO cluster)
- Predecessor projects, generally downstream of the subject project

Figure 5-1: Prioritization and Implementation Methodology



Each cluster was ranked first by frequency, then by the sum of the rankings for total volume, total SSOs, and Appendix A SSOs. The resulting list consisted of the Step 1 rankings. The highest priority projects involve the elimination of frequent and high-volume SSOs; the lowest priority projects do not eliminate SSOs, but increase collection system capacity such that surcharging is eliminated in the 2-year storm. Table 5-1 is an example of the Step 1 rankings; the complete rankings can be found in Table 5-2, located at the end of this Section.

Table 5-1: Example of Step 1 Ranking

Priority	SSO Cluster Name	Total SSO Ranking	Total Volume Ranking	Total App A SSO Ranking	Criticality	2-Year Frequency	Predecessor Projects	Subject Project
1	WH6C	4	3	1	8	4.0	WHMT A-E	WHMT F
2	WR2D	5	4	3	12	4.0	WRMT A-C	WRMT D-E
3	WH7C	6	5	4	15	4.0	Idle Hour EQ	Richmond Road
4	SHDL_PS	3	11	2	16	4.0	WHMT A-D, Merrick	Ecton Trunk
5	WH3D	7	2	7	16	4.0	WHMT A-E	Sutherland
6	WH2A	2	9	9	20	4.0	WHMT A-C	Lansdowne South
7	WH3B	8	8	5	21	4.0	WHMT A-D	Merrick

B. Implementation Plan Methodology

Once the projects were prioritized based on frequency, volume, and numbers of SSOs, **Step 2** consisted of sorting the projects according to logical sequence by considering the required predecessor projects. This consisted of identifying any projects which should be completed prior to initiating the subject project (i.e. adequate downstream conveyance is needed before upstream conveyance is increased or SSOs could be "relocated"). In the development of the implementation plan the predecessor projects were scheduled to occur before their subject projects.

In a separate exercise, LFUCG conducted a financial impact study based on initial RMP cost estimates for the entire sewer system. This financial study identified feasible annual rate increases, which were based on assumed annual expenditures. **Step 3** incorporated consideration of the resulting annual capital budgets in determining the appropriate timeframe for each improvement project. The ranked projects from Step 2 were distributed across the 13-year implementation period in a manner that balances capital expenditures with LFUCG budgeting. While some early predecessor projects will not result in the elimination of SSOs, other early projects will address high-priority SSOs. Implementation of the RMP projects in accordance with this schedule will result in the elimination of all recurring SSOs, as required by the Consent Decree

Step 4 consisted of determining the specific schedule for the design and construction of each project. For the purpose of the RMP, design and construction phases ranged from one to two year durations, except for the West Hickman WWTP equalization. This very large individual project will be split into separate phases so that the final storage volume can be adjusted based on I/I removal accomplished during other RMP projects, as well as LFUCG's annual rehabilitation projects. The developed implementation schedules are included in Table 5-2, located at the end of this section. Overview maps that summarize the projects in each of the sewersheds are also located at the end of this section as Figures 5-2, 5-3 and 5-4. Appendix 1 of this report includes Project Detail Sheets, which are one page summaries for each project.

C. Incorporation of Remedial Measures for Groups Two and Three

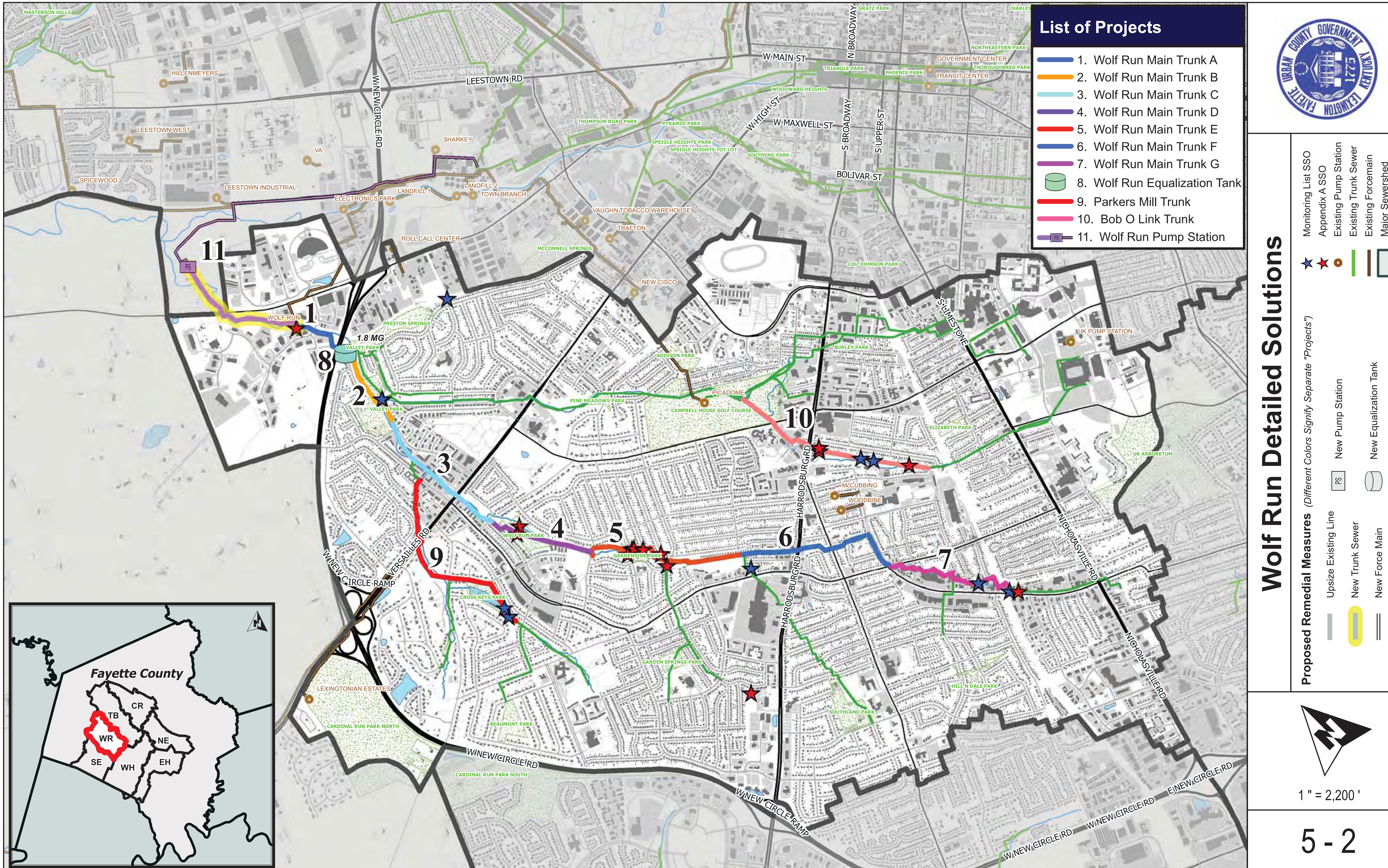
The Implementation Plan developed for Group One, described in this document, is tentative and will be reevaluated during the preparation of the Group Two RMP and again during the development of the Group Three RMP. Due to the interrelationships between the sanitary sewer systems in different sewersheds, required improvements in all three groups should be considered before establishing the final, city-wide Sanitary Sewer System and WWTP Remedial Measures Plan. LFUCG will use this prioritization in the interim until the Remedial Measures for Groups Two and Three are developed.

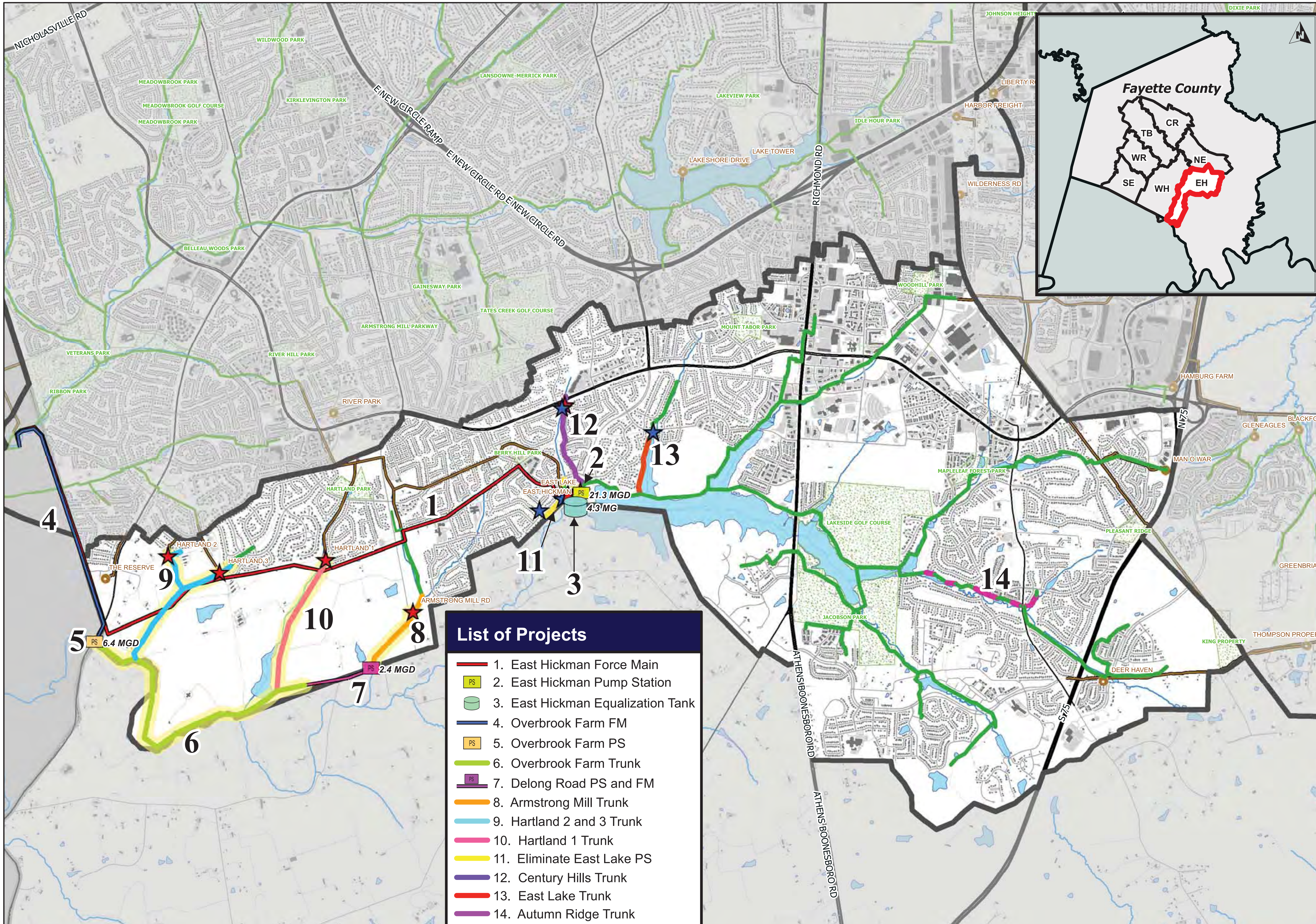
It should be noted that this schedule is considered tentative until the RMPs for Group Two and Group Three are developed and the capital projects for the entire city can be prioritized and scheduled.

LFUCG Group 1 SSO Cluster Prioritization

Cumulative Priority	Cluster Name	2YR Frequency	Total Volume	Total SSOs	AppA SSOs	Cluster Ranking (Total Volume)	Cluster Ranking (Total SSOs)	Cluster Ranking (AppA SSOs)	Ranking Sumation	Predecessor Projects	Subject Project
1	WH6C	4.0	2.38	11	7	3	4	1	5	WHMT A-E	WHMT F
2	WR2D	4.0	2.37	11	6	4	5	3	8	WRMT A-C	WRMT D-E
3	WH7C	4.0	1.96	10	6	5	6	4	10	Lex.Mall EQ	Richmond Road
4	SHDL_PS	4.0	0.80	12	7	11	3	2	5	WHMT A-D, Merrick	Ecton Trunk
5	WH3D	4.0	2.76	9	3	2	7	7	14	WHMT A-E	Sutherland
6	WH2A	4.0	1.50	12	2	9	2	9	11	WHMT A-C	Landsdowne South
7	WH3B	4.0	1.52	7	4	8	8	5	13	WHMT A-D	Merrick
8	WH2B	4.0	1.53	12	0	7	1	16	17	WHMT A-D	South Eastern Hills
9	WH7A	4.0	0.51	6	4	12	10	6	16	Lex.Mall EQ	Idle Hour
10	WR4A	4.0	1.05	5	3	10	11	8	19	-	Bob o'Link
11	WR_PS	4.0	7.66	1	1	1	18	11	29	-	In Progress
12	WR1B	4.0	1.93	3	1	6	15	12	27	WRMT A	WRMT B
13	WH3A	4.0	0.50	7	1	13	9	13	22	WHMT A-E	Centre Parkway
14	WR2B	4.0	0.32	4	2	15	12	10	22	WRMT A-B	WRMT C
15	EH3A	4.0	0.28	4	1	16	13	14	27	EH PS, FM, & EQ	Century Hills
16	WR2A	4.0	0.40	2	0	14	16	17	33	WRMT A-B	Parkers Mill
17	WH7B	4.0	0.23	2	1	17	17	15	32	Lex.Mall EQ	Woodhill
18	WH6D	4.0	0.20	4	0	18	14	18	32	WHMT A-F	The Island
19	WH6A	4.0	0.19	1	0	19	19	19	38	WHMT A-F	Prather Road
20	EH_PS_3	2.0	0.72	5	2	20	21	20	41	-	EH PS, FM, & EQ
21	WR7A	2.0	0.09	6	1	21	20	21	41	WRMT A-E	WRMT F
22	WH10A	2.0	0.08	2	0	22	22	23	45	WHMT A	WHMT B
23	WH3C	2.0	0.02	2	1	24	24	22	46	WHMT A-D	WHMT E
24	WR2C	2.0	0.03	2	0	23	23	24	47	WRMT A-B	Parkers Mill
25	EH4	1.0	0.06	2	0	25	25	25	50	EH PS, FM, & EQ	East Lake
26	WH9A	1.0	0.02	1	0	26	26	26	52	-	-
27	WH10B	0.4	0.00	2	0	27	27	28	55	WHMT A	WHMT B
28	EH_PS_AMRD	0.4	0.00	1	1	28	28	27	55	-	Expansion Area #1
29	WH5A	0.0	0.00	14	3	29	29	30	59	Complete	Zandale
30	WH1	0.0	0.00	5	0	30	30	37	67	-	WHMT A
31	WH10	0.0	0.00	2	1	33	33	31	64	Maintenance	Cleaning
32	WH6B	0.0	0.00	4	0	31	31	38	69	-	-
33	WR3A	0.0	0.00	1	1	35	35	32	67	-	-
34	WH10C	0.0	0.00	3	0	32	32	39	71	WHMT A	WHMT B
35	EH_PS_HL2	0.0	0.00	1	1	36	36	33	69	Expansion Area #1	Hartland Trunk Extensions
36	WH1C	0.0	0.00	2	0	34	34	40	74	WHMT A-B	WHMT C
37	EH_PS_HL3	0.0	0.00	1	1	37	37	34	71	Expansion Area #1	Hartland Trunk Extensions
38	EH_PS_HL1	0.0	0.00	1	1	38	38	35	73	Expansion Area #1	Hartland Trunk Extensions
39	WR5A	0.0	0.00	1	0	41	41	29	70	-	-
40	EH_PS_MAN	0.0	0.00	1	1	39	39	36	75	-	-
41	WR1A	0.0	0.00	1	0	40	40	41	81	-	-

Table 5-2


Wolf Run Detailed Solutions
List of Projects
1. Wolf Run Main Trunk A
2. Wolf Run Main Trunk B
3. Wolf Run Main Trunk C
4. Wolf Run Main Trunk D
5. Wolf Run Main Trunk E
6. Wolf Run Main Trunk F
7. Wolf Run Main Trunk G
8. Wolf Run Equalization Tank
9. Parkers Mill Trunk
10. Bob O Link Trunk
11. Wolf Run Pump Station
Monitoring List SSO
Appendix A SSO
Existing Pump Station
Existing Trunk Sewer
Existing Forcemain
Major Sewershed
Proposed Remedial Measures (Different Colors Signify Separate "Projects")
Upsize Existing Line
New Trunk Sewer
New Force Main
New Pump Station
New Equalization Tank
1.8 MG
Fayette County
TB
CR
WR
NE
SE
WH
EH
W NEW CIRCLE RD
LEESTOWN RD
W MAIN ST
W MAXWELL ST
W HIGH ST
S BROADWAY
N BROADWAY
S UPPER ST
BOLIVAR ST
S LIMESTONE
HARRODSBURG RD
NICHOLASVILLE RD
VERSAILLES RD
W NEW CIRCLE RAMP
E NEW CIRCLE RD
1 " = 2,200 '
5 - 2



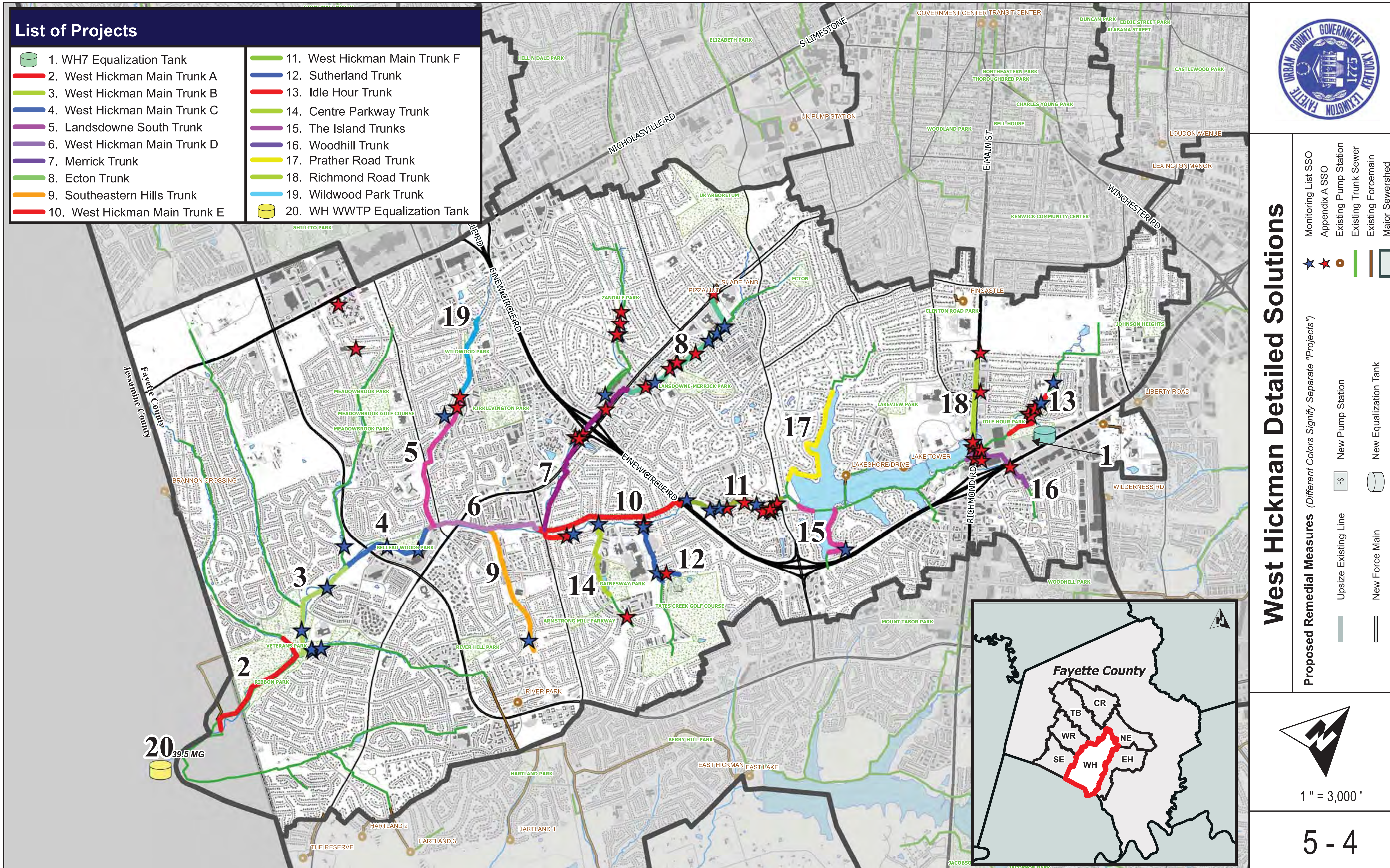
East Hickman Detailed Solutions

Monitoring List SSO
Appendix A SSO
Existing Pump Station
Existing Trunk Sewer
Existing Forcemain
Major Sewershed

Proposed Remedial Measures *(Different Colors Signify Separate "Projects")*

Upsize Existing Line
New Trunk Sewer
New Force Main
New Pump Station
New Equalization Tank

1 " = 3,000 '


List of Projects
1. WH7 Equalization Tank
2. West Hickman Main Trunk A
3. West Hickman Main Trunk B
4. West Hickman Main Trunk C
5. Landsdowne South Trunk
6. West Hickman Main Trunk D
7. Merrick Trunk
8. Ecton Trunk
9. Southeastern Hills Trunk
10. West Hickman Main Trunk E
11. West Hickman Main Trunk F
12. Sutherland Trunk
13. Idle Hour Trunk
14. Centre Parkway Trunk
15. The Island Trunks
16. Woodhill Trunk
17. Prather Road Trunk
18. Richmond Road Trunk
19. Wildwood Park Trunk
20. WH WWTP Equalization Tank
39.5 MG
Fayette County
Jessamine County
NICHOLASVILLE RD
S LIMESTONE
E NEW CIRCLE RD
E MAIN ST
WINCHESTER RD
RICHMOND RD
Fayette County
CR
TB
WR
NE
SE
WH
EH
West Hickman Detailed Solutions
Proposed Remedial Measures (Different Colors Signify Separate "Projects")
Upsize Existing Line
New Force Main
New Pump Station
New Equalization Tank
Monitoring List SSO
Appendix A SSO
Existing Pump Station
Existing Trunk Sewer
Existing Forcemain
Major Sewershed
1 " = 3,000 '
5 - 4