The City of Belton, Missouri

2007 Wastewater Collection System Master Plan

Final Draft Report

Prepared by:

Wade & Associates, Inc.

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Definitions

As-Built	-	Record drawings which theoretically reflect the field conditions of the sewer system after it was constructed. Records are normally provided by the contractor and approved and accepted by the City of Belton, MO.
Base Flow	-	The component of wastewater that originates from all wastewater uses such as residential, commercial, institutional and industrial customers.
Excessive I/I	-	Measured inflow and infiltration within a sanitary sewer system that is considered to be more expensive to transport and treat at the wastewater treatment facility than to eliminate through rehabilitation.
Five-Year Storm Event	-	A single rainfall event which has a 20% statistical probability of occurring during any given 12-month period.
Hydraulic Gradient	-	The vertical profile of a sewer system in plan view that defines the (grade line) elevation of free surface water as it flows through a sanitary sewer system.
Hydraulic Network	-	The interconnection of sanitary sewer pipes within a basin that terminates at a single discharge point and is defined by physical characteristics such as pipe length, diameter, invert elevation, rim elevation, and slope.
Infiltration	-	Ground water that enters into the sanitary sewer through defects in pipe and manholes such as cracks, separated joints, deteriorated manhole components, building foundation drains, and defective service laterals.
Inflow	-	Surface storm water that enters into the sanitary sewer through direct sources such as vented manhole lids, downspouts, area drains, indirect storm sewer connections, storm sewer cross-connections, and uncapped cleanouts below grade.
Invert	-	The bottom portion of the sanitary sewer pipe as measured at a manhole.
Manning's Coefficient	-	An empirical value that is assigned to pipes of differing materials as a function of the surface roughness of the pipe wall.
Overflow	-	A condition in which the wastewater flow rate in a sewer system exceeds the capacity of the sewer to the extent that raw wastewater is discharged to a navigable water way.
Overloaded Sewer	-	A condition in which the wastewater flow rate theoretically exceeds 100% of the design hydraulic capacity of the sewer.
Permanent Infiltration	-	Ground water that enters into the sanitary sewer system during the driest period of the year when the ground water table is lowest in elevation.
Private-Sector	-	Those facilities which are owned and maintained by the private property owners within the City.
Preventative Maintenance	-	Scheduled and implemented maintenance of the City's sanitary sewer system through systematic inspection, cleaning and budgeted rehabilitation in order to reduce the net annual cost of system maintenance.
Public-Sector	-	Those facilities which are owned and maintained by the City.
Slope	-	The degree of vertical fall of a sanitary sewer system measured in ft/100 ft between manholes.
Rainfall-Induced Infiltration	-	Peak infiltration that is normally measured 6-12 hours after the peak wastewater response to a measured rainfall event.

Abbreviations

City	City of Belton, MO
CCTV	Closed Circuit Television
Dept	Department
Dia.	Diameter
DWF	Dry Weather Flow
E	East
Ft	Feet
GIS	Graphical Interface System
GAL	Gallons
gpad	Gallons per Acre per Day
Gpcd	Gallons per Capita per Day
Gpd	Gallons per Day
gpd/IDM	Gal. Per Day Per Inch (dia) X Length of Pipe (mi)
Gpm	Gallons per Minute
GPS	Global Positioning System
Hr	Hour
Hrs	Hours
i	Rainfall Intensity
i.e.	That is
IDM	Inch (diameter) X Length of Pipe (miles)
I/I	Infiltration and Inflow
IN or in	Inches
LF or lf	Linear Feet
MG	Million Gallons
mgd	Million Gallons per Day
min	Minute
misc	Miscellaneous
O&M	Operation and Maintenance
%	Percent
PVC	Polyvinyl Chloride
Q	Flow Rate
Report	The 2007 Wastewater Collection System Master Plan
S	South
Sec	Seconds or Section
SSES	Sanitary Sewer Evaluation Study
sq mi	Square Mile
sq ft	Square Feet
WADE	Wade & Associates, Inc.
WWF	Wet Weather Flow
WWTF	Wastewater Treatment Facility
Yr	Year

I. EXECUTIVE SUMMARY

A. General

This executive summary is a general overview of the consultant's findings, conclusions, and recommendations for the 2007 Wastewater Collection System Master Plan conducted for the City of Belton, Missouri. The City retained the services of Wade & Associates, Inc. to develop a plan to provide wastewater collection to serve the projected future population: 1) provide comprehensive analysis and improvement recommendations to significantly reduce inflow and infiltration (I/I) within the wastewater collection system, 2) develop and conduct an impact fee and rate model for current and future capital financial needs for the City, and, 3) develop and implement a GIS (Geodatabase) system for the City. This report concludes the analysis considered for the City of Belton's wastewater collection system and the 2007 Wastewater Collection System Master Plan.

A successful wastewater collection system master plan begins with an accurate depiction of existing conditions of the collection system and then builds upon this foundation by using engineering methods such as hydraulic modeling to analyze and predict scenarios for future situations and conditions in the collection system. The City of Belton, Missouri is demographically situated within an area of the Kansas City Metropolitan Area that is experiencing significant growth. According to data provided by the City, Northern Cass County, which includes the City of Belton, is projected to experience a growth rate of approximately 2.46% per year for the next ten years. Based on the population projections provided by the City, it will be necessary for Belton to update and expand their existing collection system in order to sustain and manage the influx of population to the area.

The purpose of this 2007 Wastewater Collection System Master Plan is to provide the City of Belton with information concerning the capacity of its sanitary sewers at existing and future build-out conditions and to provide the City with a tool for evaluating and maintaining its wastewater system. This evaluation studied approximately 22 square miles within and around the City and considered the possible inclusion of wastewater flows from the City of Raymore. However, at the time of this report, the City decided that the consideration of Raymore's flows to Belton's WWTF were beyond the 20 year planning period of this project scope. The City's existing collection system discharges wastewater flows to three outlets. Two outlets discharge north of the City to the Little Blue Valley Sewer District (LBVSD) interceptor and one discharges to the City of Belton Wastewater Treatment Facility.

As part of this 2007 Wastewater Collection System Master Plan evaluation, Wade & Associates staff, along with City personnel, conducted flow monitoring and field inspection activities necessary to locate, quantify, and evaluate rainfall-induced inflow and infiltration (I/I) entering the City's wastewater collection system. Field inspections were conducted on a portion of the City's collection system and will be identified for the purpose of this Wastewater Collection System Master Plan as the Pilot Study Area. The City and Wade (including Wade's subconsultants) conducted all field inspection and GPS-method survey activities which provided Wade with the necessary measurements, locations, and quantities of defects to create a hydraulic model of the City's collection system to analyze the impact of rainfall-induced I/I on the system. With this hydraulic model, we can predict the behavior of the wastewater collection system under dry and wet-weather scenarios and recommend cost-effective improvements in order to reduce I/I. The model can also be used to create future growth scenarios and to recommend needed capacity improvements. In addition, these evaluation activities provided the necessary information to build a GIS Geodatabase that integrates with the City's existing GIS system.

Major project goals were:

- Evaluate the impact of I/I on the City's wastewater collection system
- Provide recommendations for reducing or eliminating I/I in the collection system
- Develop a priority ranking of recommended I/I improvements
- Develop a hydraulic model of the collection system using MWH Soft's InfoSewer Pro modeling software
- Evaluate the capacity of the existing wastewater collection system and identify limitations
- Prepare planning level cost estimates for recommended I/I elimination programs and system capacity improvements
- Provide general recommendations for improvement necessary to the collection system to sustain future growth development
- Develop and conduct an impact fee study and capital financial analysis model
- Develop a GIS layer (Geodatabase) containing vital information on the size, shape, and location of the City's sewer system
- Transfer the collection system information to the GBA Master Series Software Suite for utility maintenance and inventory management
- Provide training to City personnel in the use of GBA Master Series software, the City's GIS system (Geodatabase), and MWH Soft's InfoSewer Pro Software

To achieve the goals of this study, the following activities were performed: field surveys (performed by Midland GIS Solutions), temporary flow monitoring and quantification, flow data analysis, Pilot Study Area field inspection activities, cost-effectiveness analysis, and hydraulic modeling of the

wastewater collection system. The following sections briefly discuss the results of Wade and Associates' evaluation of the City of Belton's wastewater collection system.

B. Findings

1. The City of Belton, Missouri operates and maintains an extensive wastewater collection system covering approximately 22 square miles. The existing system contains approximately 583,280 linear feet of sewer.

2. For modeling purposes the wastewater collection system was divided into 12 basins (basins 1 through 12). Flows treated by the City of Kansas City, Missouri were not monitored in this evaluation but are included in the model for clarity. The remaining collection system which is located outside of the defined basin boundaries is included in the model and identified as basin 13.

3. Wade's subconsultant, Midland GIS Solutions, located (using GPS methods) approximately 2,414 sanitary sewer manholes within the City's collection system.

4. Basins 1 through 12 of the City's collection system were flow monitored for a 60-day period. Twelve (12) electronic flow monitors were installed to continuously monitor wastewater flow rates beginning April 5, 2005 and ending June 23, 2005. Flow monitors were installed at strategic locations for metering accuracy of basin connectivity. The data obtained during this monitoring period included a sufficient number of measured rainfall events to evaluate the system's response to rainfall-induced infiltration and inflow.

5. Five (5) continuously recording rain gauges were installed concurrently with the flow monitoring program. The gauges facilitated the evaluation of the relationship between rainfall intensity and peak wastewater flow rates within each of the basins.

6. Generally, adequate results were obtained from the flow and rainfall monitoring program. During the monitoring period, total rainfall ranged from 13.01 inches recorded for basin 8 to 10.14 inches recorded for basins 5 and 11. The highest rainfall intensity measured during the monitoring period was 1.69 inches/hour, recorded for basin 8.

7. A computerized hydraulic model was developed of all sanitary sewer lines within the City's wastewater collection system. The model was developed using MWH Soft's InfoSewer Pro Series Software. Data for the model was obtained from all available sources, including the City's existing as-built drawings and GPS data collected by Midland GIS Solutions for this

project. The model facilitated the evaluation of the collection system's performance in regard to impact of inflow and infiltration (I/I) on existing and future growth wastewater flows and the collection system's ability to safety transport flow to system outlets as well as to the City's WWTP.

8. The final hydraulic model was utilized to evaluate the system under various flow conditions. Initial simulations were run for dry and wet weather flows at the existing collection system configuration for a 5-year, 90-minute storm event at a 0% I/I removal rate and also at a 30% I/I removal rate. Next, modifications to the model were made to include future growth development of sanitary sewer lines. Future growth simulations were generated for a 5-year, 90-minute storm event at a 0% I/I removal rate and at a 30% I/I removal rate.

9. Peak daily flow under near saturated soil conditions (wet weather flow) contributed by each basin ranges from 0.694 mgd in basin 10 to 4.105 mgd in basin 4. Under near-saturated ground conditions, storm flow rates peaked by a factor of approximately 22 to 1 at the outlet in basin 11.

10. During the Pilot Study Area SSES, a total of 131 manholes were internally inspected, resulting in the identification of 246 potential sources of inflow and/or infiltration from manhole related defects.

11. A total of 305 visual pipe inspections were completed during the Pilot Study Area SSES manhole inspections. Using digital cameras, field crews were able to view approximately five to 15 feet up/down each sewer line. A total of 279 structural, I/I and/or maintenance-related defects such as cracked or broken pipe, roots, debris, offset joints, and collapsed or missing pipe were identified throughout the visual pipe inspection program.

12. Sanitary sewers totaling 33,530 linear feet were smoked tested as part of the Pilot Study Area SSES. The smoke test program located 49 defects within the public-sector and 96 defects within the private-sector within the Pilot Study Area of the City's collection system.

13. Based on the results of the Pilot Study Area smoke testing and visual pipe inspection programs, approximately 7,859 linear feet of sanitary sewer (30 individual line segments), were cleaned and internally CCTV inspected. The City's CCTV contractor, Pro-Clean Utility, LLC completed the CCTV inspections. Wade and Associates personnel reviewed the CCTV footage and developed a recommended pipeline rehabilitation schedule.

C. Recommendations

The projected cost for eliminating the frequency and severity of surcharging within the collection system as well as increasing the system capacity through the addition and replacement of selected sewers is approximately $44.4 million. The Recommended System Capital Improvement Program and its phases are outlined below. The program is categorized by Maintenance and Future Growth related projects.

Recommended Maintenance Projects:

1. Recommended Sanitary Sewer Evaluation Study

Based on the results obtained from the Pilot Study Area SSES, it is recommended that a comprehensive SSES be implemented over a six year period for the remaining collection system. **The total estimated cost to complete the sanitary sewer evaluation study on the remaining collection system is $928,400.**

2. Sanitary Sewer Rehabilitation

a. Recommended Pilot Study Area Rehabilitation:

Based on the investigative results of the Pilot Study Area SSES, multiple I/I defects were identified as cost-effective to eliminate for rehabilitation of the system. Also, recommended for rehabilitation are a number of manhole I/I defects that did not fall within the cost-effective analysis level when evaluated individually, but yet are types of defects known to contribute higher quantities of I/I. Left, unaddressed these type of defects (mainly defects occurring within the manhole cover to chimney sections) become major contributors of I/I into the collection system. Consequently, these defects were included in the recommended manhole rehabilitation schedule for the Pilot Study Area.

The Pilot Study Area SSES Rehabilitation Recommendations include: Private-sector rehabilitation of 24 I/I sources at an estimated cost of $11,800; Public-sector rehabilitation of six I/I sources at an estimated cost of $18,600; Rehabilitation of 43 manhole defect sources at a cost of $72,700; and Rehabilitation of 30 line segments representing approximately 8,000 lf (including 21 adjoining manhole replacements) are recommended for the pipeline rehabilitation program with an estimated cost of $705,900**. The total cost for implementing the Pilot Study Area Recommended Rehabilitation Program is approximately $809,000.**

b. Remaining Collection System Rehabilitation Recommendations:

The Pilot Study Area SSES identified 30 public- and private-sector defects within 33,500 linear feet of sanitary sewer pipeline that were cost-effective to remove at an estimated $30,400. **Based on the size of the entire collection system and rehabilitation costs recommended for the Pilot Study Area SSES, it is estimated that the cost for rehabilitation of the remaining collection system following the recommended sanitary sewer evaluation study will be approximately $2.95 million.**

3. Sewer Maintenance Program

It is recommended that the City implement a sewer maintenance program that will allow the entire collection system to be cleaned every three years during the City's 20 year planning period. **The estimated cost to conduct a sewer maintenance program through the year 2026 that includes system expansion projections is $8,925,400.**

4. Post Rehabilitation Analysis

It is recommended that upon completion of the recommended collection system sanitary sewer evaluation study and rehabilitation projects, the City conduct a post-rehabilitation analysis to assess the success of I/I removal from the collection system. The analysis program should include flow monitoring at 14 locations, flow analysis with I/I quantification, and hydraulic model recalibration. **The estimated total cost to conduct the post-rehabilitation analysis is $161,400.**

Recommended Future Growth Projects:

5. Recommended Pipeline Capacity Improvements

Capacity analysis of the existing collection system indicated 43,642 lf is needed for replacement sewer renewal. **It is estimated that construction of capacity related lines for the future growth collection system at 30% I/I removal is approximately $12,982,200.**

6. Lift Station Removal and Reconfiguration Program

The City has delineated five of its existing lift stations for removal to facilitate future growth improvements to the collection system. It is recommended that the Fairway Ridge, West Cimarron, Cedar Tree, East Cimarron, and Markey Meadows lift stations be decommissioned over a 3-year period and their flows re-routed within the collection system. **The estimated cost to remove the pump stations and construct relief/replacement lines is $1,099,800.**

7. Future Growth Collection System Expansion Program

Hydraulic analysis of future growth projections for the collection system at the design storm event indicated system expansion and pipeline capacity improvement is needed to safely transport flows at build-out conditions. **It is recommended that the City of Belton implement a Future Growth Collection System Expansion Program that includes upgrades and additions to the collection system in areas south and west of the city in order to safely accommodate flows from future development. The estimated cost to implement the Future Growth Expansion Program is $16,545,100 and should be conducted in phases, spanning the City's 20-year planning period.**

D. Summary

This 2007 Wastewater Collection System Master Plan Report includes several recommendations for eliminating the frequency and severity of surcharging within the collection system as well as increasing the system capacity through the addition and replacement of selected sewers within the Maintenance and Future Growth Capital Improvement Projects. Table I-1 outlines the estimated costs to implement the recommended system wide capital improvements for the City of Belton's wastewater collection system. Through the effective implementation of these programs, the City will be able to provide adequate transport of wastewater flows during the planning period associated with this project. Implementation of only a portion of the recommended system wide capital improvements will not result in sufficient transport capacity for future growth flows at the design storm event. **The total estimated cost to locate and eliminate 30% of Belton's collection system I/I and to provide adequate transport of existing and future wastewater flow to system outlets as well as to the City's treatment plant, is approximately $44.4 million.**

Table I-1
Recommended Capital Improvement Cost Summary

Description	Cost Estimate ($)
Maintenance Projects	
Sanitary Sewer Evaluation Study	$928,400
Sanitary Sewer Rehabilitation	$3,760,000
Sewer Maintenance Program	$8,925,400
Post Rehabilitation Analysis	$161,400
Future Growth Projects	
Recommended Pipeline Capacity Improvements	$12,982,200
Lift Station Removal and Reconfiguration	$1,099,800
Future Growth Collection System Expansion	$16,545,100
Total*:	**$44,402,300**

*Cost includes a 3% inflation rate per year beginning in 2008

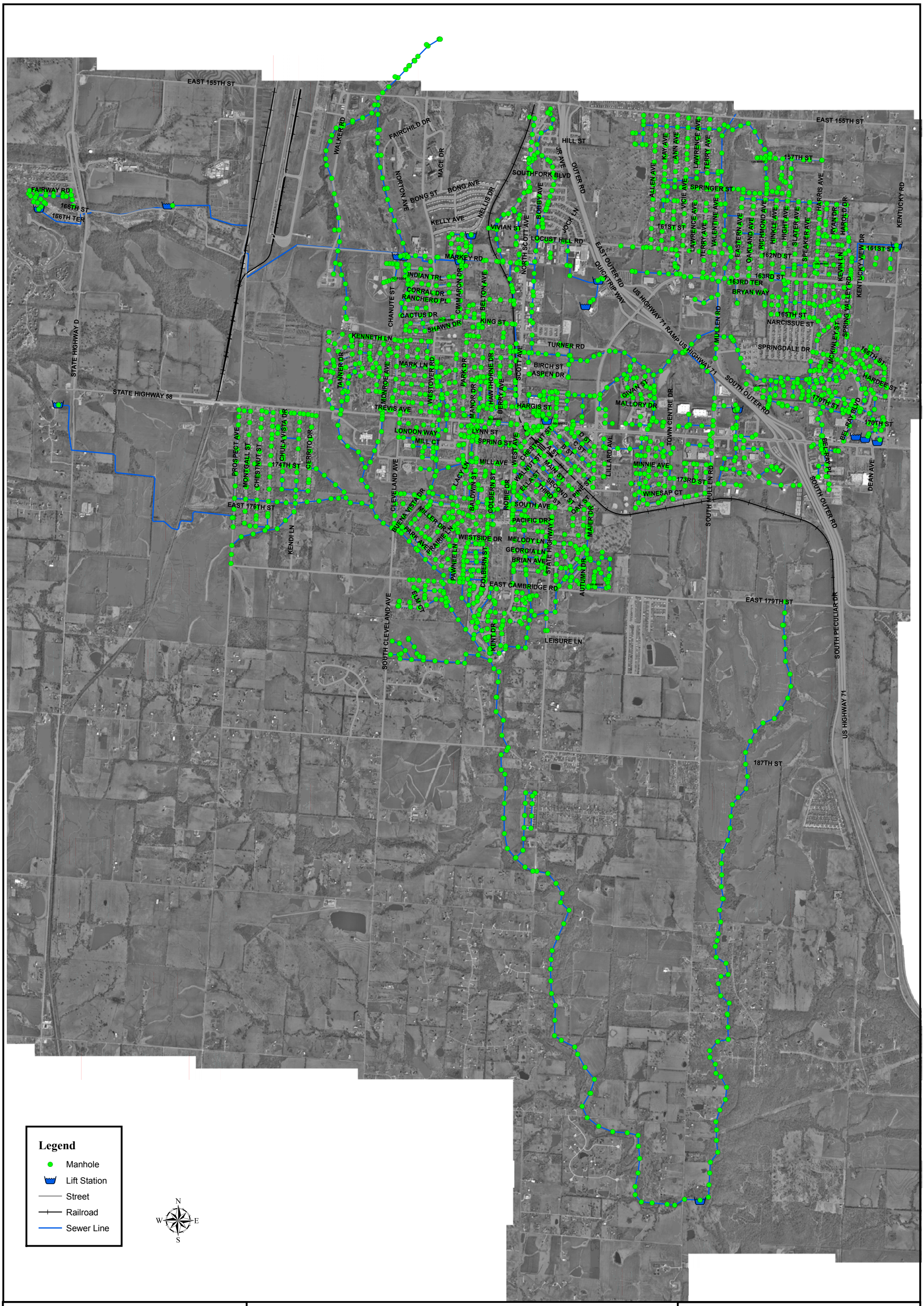
II. INTRODUCTION AND PROJECT BACKGROUND

A. Introduction

The purpose of the 2007 Wastewater Collection System Master Plan report is to provide the City of Belton with information concerning the integrity and capacity of its sanitary sewer system at existing and future growth conditions and to provide recommendations for improvements to the City's wastewater collection system. Currently, the City's collection system is divided into two watersheds, situated in the north and the south portions of the City. The dividing line between the two watersheds runs along Kenneth Lane to Gladden Elementary School diagonally, south to the intersection of Highway 58th and Scott Avenue and then follows along the Kansas City Southern Railroad Tracks. The collection system watershed north of the dividing line transports flows to the Little Blue Valley Interceptor via two outlets near East 155th Street. The collection system watershed south of the dividing line transports flows south to the City's recently constructed WWTF, approximately 3.5 miles south of the Belton City Limits. The boundary of the Study Area is irregular, but the area it covers can generally be described as being bounded on the east by US Highway 71 and Kentucky Road, on the west by State Highway D, on the north by East 155th Street, and bounded on the south by 211th Street. Figure A shows the existing collection system, defined for this report as the Study Area, for the City of Belton.

The City can also be divided into two distinct areas regarding areas of projected future growth development expected in the south and west areas of the City. The southern area is generally located between US Highway 71 and Cleveland Avenue and south of the existing Belton City Limits. The western area is generally bounded on the west by State Highway D, on the east by Prospect Avenue, on the north by 155th St., and bounded on the south by 183rd Street. Additional sewers required to accommodate projected future growth capacity in these areas are anticipated to carry flows to Johnson County Wastewater (JCW) and the City's WWTF. Future development flows will be discussed further in Section VII.

This Wastewater Collection System Master Plan Report will focus on the City's collection system under existing and future dry weather flows and estimated inflow and infiltration rates related to a 5-year design storm event. This report will present recommendations for improvements to provide adequate capacity for flows generated by projected future growth as well as impact of inflow and infiltration due to the 5-year design storm event. Discussion of the following topics will be addressed:



Belton, Mo 2007 Wastewater Master Plan	Figure A Study Area	WADE & ASSOCIATES, INC.

- Existing Wastewater Flow Rates
- Pilot Study Area Results
- Collection System Hydraulic Modeling
- Impact Fee Study
- Existing Sewer System Capacity
- Future Growth Land Use
- Future Wastewater Flow Rates
- Future Sewer System Capacity Requirements
- Capital Improvement Projects

B. Background of Study

An earlier Master Plan was completed in 1994 for the City of Belton that had addressed the City's wastewater collection system. However, due to dramatic demographic changes since 1994, the City determined that an updated plan is needed to address not only the next 20-year planning horizon, but also to address critical areas of regulation, conservation, customer expectations, and cost-effective services. Population projections provided by the City indicate that Belton has nearly doubled in population over the past 20 years, increasing from a population of 12,708 to 24,000. The City may attempt to annex land south of the City to accommodate approximately 550 acres of residential development. The City estimates it is increasing development at a rate of 300 acres per year and predicts that without the planned annexation, the City of Belton will run out of residential land in 5 years. The "Technical Memorandum – Population and Land Use" excerpted from the City's 2005 Water System Master Plan, is included as Appendix P and contains the population and land use projections for the City through 2045. As requested by the City, a 2025 planning period was used for the 2007 Wastewater Collection System Master Plan Report.

Historically, the City has experienced sanitary sewer hydraulic problems in the downtown area during wet-weather events, as well as in an area located to the west of Cleveland Avenue and east of the Southern Railroad. Both of these areas of the collection system transport flows to the City's Wastewater Treatment Plant. Problems historically occurring within this area include:

- Wastewater backups and surcharging
- Structural deterioration of pipes and manholes
- Increased frequency of unscheduled maintenance and associated capital expenditures

The two areas are defined for the purpose of this report as the Pilot Study Area and have been analyzed during a detailed sanitary sewer evaluation study discussed in Section V. Results from the Pilot Study Area analysis were also used to aid in developing recommendations for improvements to the existing wastewater collection system.

This Wastewater Collection System Master Plan will serve the City as a guide to the upgrade, expansion and rehabilitation of the City's wastewater collection system. The Wastewater Collection System Master Plan project includes an inventory of the physical characteristics of the City's existing collection system developed in ESRI's ArcGIS v.9, GIS software. The City requested the use of MWH Software's InfoSewer Pro™ software for hydraulic modeling due to its capability of working within the ArcGIS v.9 environment. The physical attributes of the collection system will be imported into GBA Master Series© Suite, a utility software capable of generating work orders and scheduling tasks, and transferred to the City upon completion of this project. A training workshop will be provided. The final software components developed during the Wastewater Collection System Master Plan project will allow the City to model, analyze, and schedule vital improvements to the collection system.

Included in this Wastewater Collection System Master Plan is a wastewater impact fee study and capital financial analysis, conducted by **Public Finance Consultants (PFC).** The goal of the impact fee study and analysis is to determine appropriate sewer rates and connection fees for the system. Another goal is to provide a rate model which the city may use in the future. PFC has performed similar studies as well as rate studies for surrounding Missouri communities, such as Grandview, Raytown, Harrisonville and Blue Springs.

C. Goals of Study

Key objectives for the 2007 Wastewater Collection System Master Plan include:

- Identify limitations of the existing wastewater collection system
- Develop an accurate hydraulic model of the collection system using MWH Soft's InfoSewer Pro™
- Determine improvements necessary for build-out development
- Develop a priority ranking of recommended improvements based on renewal and future growth development
- Prepare cost estimates for recommended improvements
- Schedule improvements over a 20 year planning period

- Conduct an impact fee study and capital financial analysis
- Develop a GIS system (Geodatabase) containing essential information on the size, shape, and location of the City's sewer system
- Transfer information to the GBA Master Series Suite for maintenance and inventory management
- Provide training to City personnel on the GBA Master Series software and MWH Soft's InfoSewer Pro Software

D. Study Outline

To achieve the project goals, it was necessary to separate the project into six phases: 1) GPS and field verification of the collection system, 2) temporary flow monitoring, 3) Pilot Study Area SSES and I/I Investigation, 4) hydraulic modeling, 5) final recommendations, and 6) data transfer. The following paragraphs discuss the phases in more detail.

Phase one of the study included locating and creating an inventory of the City's existing collection system infrastructure. The inventory included physical characteristics of the collection system line segments, including features such as rim and invert elevations, manhole depth, pipe size, pipe length, slope, and pipe material. Elevations for manhole components were located using GPS methods.

The second phase of the study was initiated in April of 2005 with a temporary flow monitoring program. Flow monitors were installed at key locations within the collection system. The flow monitoring program was established to evaluate the hydraulic behavior of the collection system under various rainfall events and conditions. The main objectives of this phase were to determine existing wastewater flow rates, quantify I/I rates for the Study Area and establish a correlation between peak flow response and rainfall. This phase is further discussed in Sections III and IV.

During the third phase of the study, Wade and Associates' field technicians and City personnel conducted extensive manhole inspections, visual pipe inspections, and smoke testing within the Pilot Study Area. The evaluations were needed to characterize and quantify sanitary sewer defects within the Pilot Study Area in order to analyze the impact of I/I on the collection system. This phase is further discussed in Section V.

The fourth phase of the study involved developing a hydraulic model of the City's sanitary sewer collection system. By using computerized hydraulic modeling software, the hydraulic impact of I/I as well as projected future growth conditions on the existing and proposed expansion of the wastewater collection system could be evaluated. Where peak flows exceeded the hydraulic capacity of segments

in the system, appropriate replacement lines were determined and the associated probable cost to implement the replacement sewer plan for the watershed could be defined. Section VI details the hydraulic modeling activities.

The fifth part of the study presents final recommendations for the City of Belton regarding the specifics of the rehabilitation plan and is discussed in Section VIII.

The sixth and final phase of this study includes transferring all GIS, modeling, and utility software data to the City and providing training to City personnel on the software.

Basic study components included in each phase are shown in Table II-1.

Table II-1
General Study Components

Phase	Task	Purpose
I	GPS and Field Verification	The physical characteristics of the collection system were recorded and verified using GPS methods.
II	Temporary Flow Monitoring and Quantification	Provides information regarding dry-weather and wet-weather flows. Temporary flow monitors in each basin quantify gross I/I and help determine the relationship between rainfall and peak flow response (basin rainfall sensitivity).
III	I/I Investigation	Identifies and quantifies I/I sources in the Pilot Study Area.
IV	Hydraulic Model	Allows computer simulation of the collection system hydraulic behavior under varying storm events, I/I reduction levels, and projected land use and future growth build-out conditions. Identifies replacement sewer requirements.
V	Final Recommendations	Presents specific recommended improvements resulting from Hydraulic Analysis.
VI	Data Transfer	Transfers the GIS, modeling, and utility software to City for use and training.

III. FLOW AND RAINFALL MONITORING PROGRAMS

A. Introduction

The analysis and development of a statistically accurate hydraulic model requires the collection of flow and rainfall data at critical points in the system. Results of the monitoring programs were used to evaluate the hydraulic behavior of the system under varying rainfall and groundwater conditions.

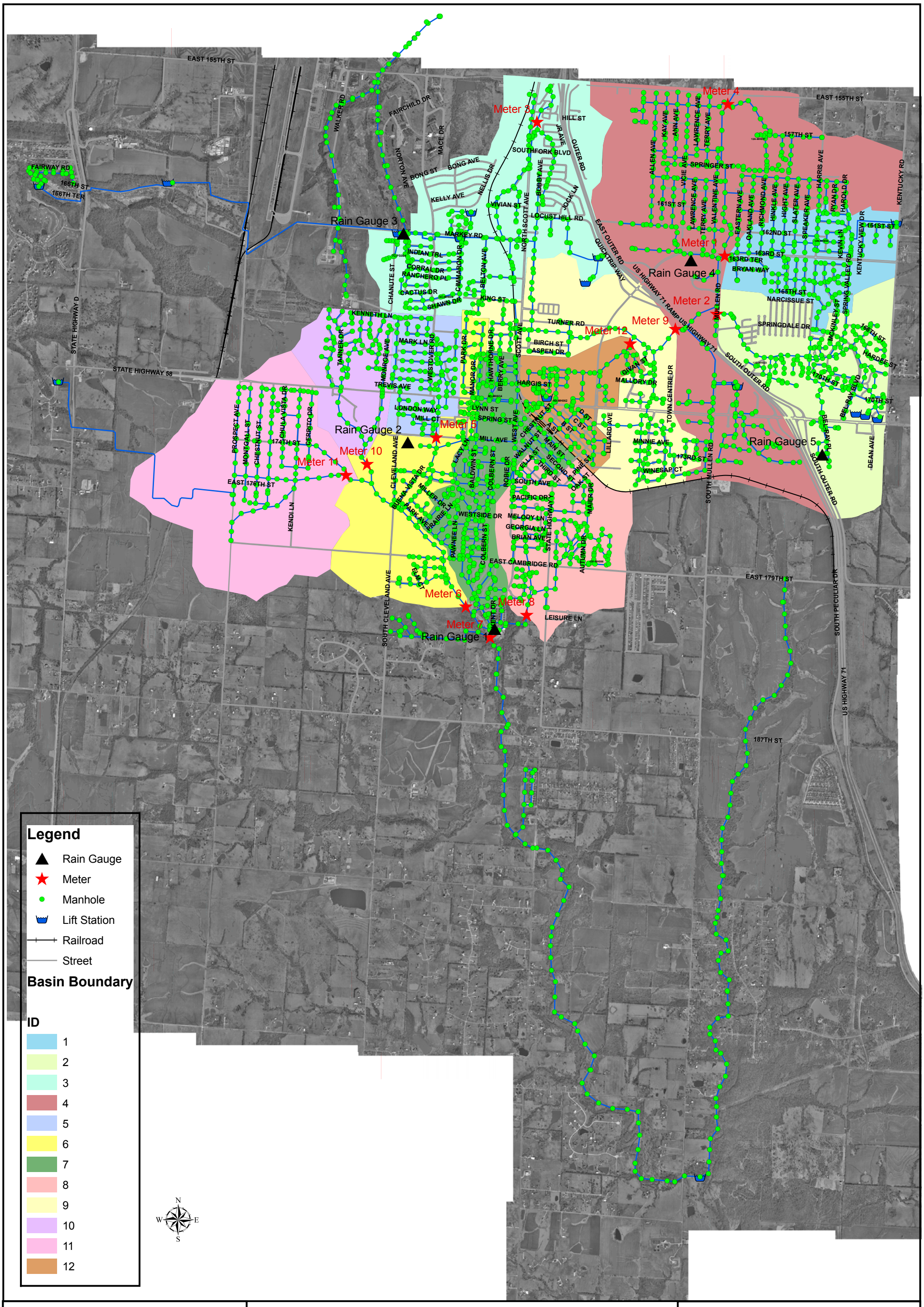
Rainfall impacts wastewater flows in two principal areas. First, high-intensity storm events can cause wastewater flow rates to increase dramatically in a short period of time. This can result in hydraulic bottlenecks, sewer surcharging and overflows due to the sewer system's limited capacity to transport the flow to a terminating point such as a pumping station or treatment facility. Second, moderate storm events of extended duration can introduce flows to the system which can be observed at the system outlet(s) where flows increase to a level that may be sustained for several hours or days. The result is increased treatment plant operation and energy costs. Typically, such rainfall events have minimal impacts on required relief/replacement sewers. The information from the analysis of flow data also facilitates prioritization of I/I removal based on its measured rates in various basins.

B. General Description

Electronic flow monitors were used to measure flows contributed by each basin. Each flow monitoring device has four components: 1) depth of flow and velocity sensors, 2) a central processing unit, 3) solid-state memory for data storage, and 4) an on-board clock to synchronize sensor recordings. Each monitor acquired and stored depth of flow and velocity readings at user-defined intervals, every 15 minutes. From the data collected, flow rates were computed using accepted engineering principals.

All rainfall events were recorded by continuously recording electronic rain gauges. Rain gauge measurement is based on the tipping-bucket principle and accurately records rainfall to one hundredth (0.01) of an inch.

Figure B shows the approximate installation locations of the rain gauge and flow monitoring devices. On a weekly basis, a portable computer was used in the field to retrieve data from each flow and rainfall monitoring device.



Belton, Mo 2007 Wastewater Master Plan	Figure B Rain Gauge and Flow Monitoring Locations	WADE & ASSOCIATES, INC.

C. Calibration and Site Investigation

Before each installation, calibration of flow and rainfall monitoring equipment was performed to the manufacturer's specifications. Calibration ensures that the equipment operates in a manner consistent with its design.

Site selection for flow and rainfall monitoring equipment is an integral part of the flow monitoring process. An ideal flow monitoring site should be located in the bottom reach of the basin. The site should be accessible, safe, and the flow stream should approximate a laminar flow situation. Rainfall monitoring sites should be located in open areas free of disturbances that might interfere with the natural distribution of precipitation.

D. Installation

After the site investigations and calibrations were completed, twelve (12) temporary flow monitors and five (5) temporary rainfall monitors were installed at sites in the Study Area. As mentioned above, Figure B shows the locations of the monitors in the system and their relative positions with respect to street intersections and the basin boundaries. Monitoring location site-sheets and rain gauge site-sheets are provided in Appendices A and B, respectively. Flow monitor depth and velocity sensors were mounted on an expandable ring and when possible installed a distance of approximately one to two pipe diameters into the upstream sewer pipe of the chosen manhole.

After each monitor installation, field crews tested the sensors to ensure that the monitor was working properly. The twelve (12) flow monitors and five (5) rain gauges were installed in the Study Area for approximately 60 days beginning April 5, 2005 and ending June 23, 2005. During the monitoring periods, a sufficient number of rainfall events occurred for flow analysis. A summary of each flow monitor and rain gauge site is presented in Tables III-1 and III-2, respectively.

Table III-1
Flow Monitor Site Inventory

Monitored Basin	Meter Location (manhole number)	Pipe Diam. (in)	Date Installed	Date Removed
1	12C-MH023	15	April 5, 2005	June 23, 2005
2	11C-MH002	15	April 5, 2005	June 23, 2005
3	9A-MH016	10	April 7, 2005	June 23, 2005
4	12A-MH043	27	April 7, 2005	June 23, 2005
5	8E-MH032	10	April 7, 2005	June 23, 2005
6	8G-MH033	18	April 8, 2005	June 23, 2005
7	9G-MH059	15	April 8, 2005	June 23, 2005
8	9G-MH015	12	April 8, 2005	June 22, 2005
9	11C-MH012	15	April 8, 2005	June 22, 2005
10	7E-MH014	10	April 11, 2005	June 22, 2005
11	7F-MH003	12	April 11, 2005	June 22, 2005
12	10D-MH007	18	April 9, 2005	June 22, 2005

Table III-2
Rain Gauge Site Inventory

Rain Gauge #	Location	Date Installed	Date Removed
1	Old WWTP	April 8, 2005	June 23, 2005
2	C.F. Yeokum Middle School	April 15, 2005	June 23, 2005
3	West Cimmeron Lift Station	April 8, 2005	June 23, 2005
4	Police Station	April 8, 2005	June 23, 2005
5	Comfort Systems H/C	April 11, 2005	June 23, 2005

E. Monitoring Procedures

During the monitoring period, field crews visited the metering locations weekly to download data and document field conditions. The following Quality Assurance Program was conducted to ensure the integrity of the data collected at each metering location:

- *Measure Power Supply.* Power levels were recorded and power supplies replaced, if necessary. The monitor is powered by a dry cell battery pack. A separate battery provides back-up power to memory, allowing the primary battery to be replaced without the loss of data.

- *Verify Depth of Flow and Velocity.* During the site visit, a field crew member descended the manhole to measure the depth and velocity of flow manually at the sensor. These readings were then compared to the monitor readings to assess monitor accuracy.
- *Measure Silt Level.* The field crew member measured and recorded the depth of any silt at the sensor.
- *Download of Raw Data.* Raw data was downloaded onto a laptop computer and later archived on CD and backup tapes.
- *Review of Raw Data.* After the data was collected, it was reviewed by the field crew to verify its integrity. All readings were checked for consistency and deviations in the flow patterns that would indicate system anomalies or equipment failure.

F. Monitoring Results

During the monitoring period, total rainfall ranged from 13.0 inches recorded for basin 8 to 10.1 inches recorded for basins 5 and 11. Appendix C lists the total daily rainfall recorded and the total rainfall over the monitoring period for each sub-basin. The highest rainfall intensity measured during the monitoring period was 1.69 inches/hour, recorded for basin 8 on June 4, 2005. Appendix D lists the peak one-hour rainfall intensities for the monitoring period.

To determine peak collection system flows, it is essential that associated rainfall events have moderate intensities. High intensity rainfall events usually result in peak wastewater flows that create surcharge, backups, and possibly overflows. The goal of the modeling effort is to evaluate the hydraulic behavior of the sewer system under open-channel conditions. Therefore, surcharges and backups produce non-representative data and must be used cautiously. Also, projecting the theoretical peak wastewater flows under these conditions is virtually impossible since storage and other volumetric losses reduce peak measured flows.

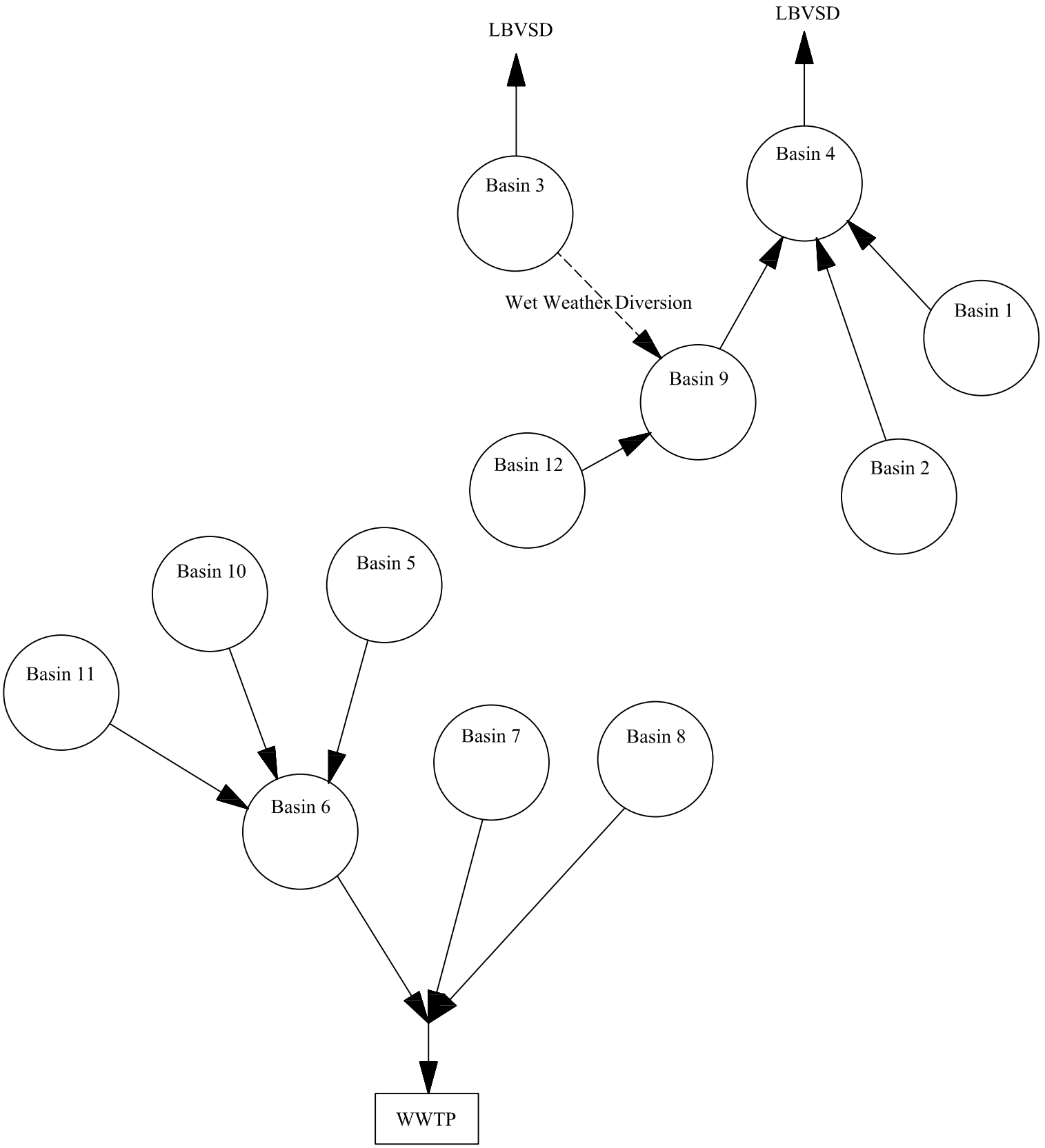
It is also important to use caution when evaluating hydraulic performance of a collection system based on total rainfall only. For example, a low intensity rainfall with a cumulative total of 2 to 3 inches may fall during a period of several hours, resulting in only minor inflow (peak) response in the collection system. However, a high intensity rainfall of 0.5 to 1.0 inch in 60 minutes may result in a greater inflow response in the collection system. Ideally, several rainfall events ranging from 0.1 to 1.0 inches per hour are normally required to project peak sanitary sewer system flows. Optimal results occur when using a storm duration that approximates the time of concentration for each sub-basin.

Average dry weather flow hydrographs of the flow data collected by each monitor are presented in Appendix E.

G. Summary of Flow and Rainfall Monitoring Programs

Flows recorded by the temporary flow monitors indicated the presence of inflow entering the system by responding quickly to rainfall events. This is a typical response from a system containing breaches, which allow surface run-off to enter the sanitary sewer. During rain events, flow monitors recorded hydraulic patterns that showed extended duration of elevated flow. These extended durations and elevated flow conditions are believed to be caused by infiltration seeping into the collection system through defects, e.g., offset or separated pipe joints, broken pipes, and deteriorated manhole structures.

A basin flow schematic is provided as Figure C. The schematic indicates the relative positions of each basin as well as the path of flows as they progress toward the collection system outlets.



Belton, MO 2007 Wastewater Master Plan	Figure C Basin Flow Schematic	WADE & ASSOCIATES, INC.

IV. FLOW DATA ANALYSIS

A. Introduction

As discussed in Section III, the quantification of wastewater flows is critical to the creation of a hydraulic model that will accurately predict behavior of any sanitary sewer system. Accurate and meaningful data can be obtained from the information gathered by the flow monitors. However, the techniques used to interpret the data are paramount in the development of a hydraulic model, which can be utilized in evaluating the system under various flow conditions.

For purposes of the model, tabulated results of the flow monitoring data discussed in Section III were separated into three flow components: 1) base diurnal flow plus permanent infiltration, 2) rainfall-induced infiltration, and 3) rainfall-induced inflow. Each flow component contributed to the development of the predictive hydraulic model in a significant way. The following is a brief overview of each flow component.

B. Base Flow

Base flow is defined as the component of measured flow that is comprised of wastewater discharged from residential, institutional, commercial, and industrial users. In addition, "permanent infiltration" is included so that the base flow hydrograph becomes the average daily diurnal measured flow during dry-weather periods. These dry-weather periods are selected to represent times of low groundwater tables with no rainfall-induced infiltration or inflow. Permanent infiltration occurs during low groundwater conditions through system defects such as broken pipe, pipe with separated or offset joints, or manhole structures. Permanent infiltration can also enter the sewer system from private laterals, such as broken service laterals or perimeter drains located in perched water tables.

Table IV-1 summarizes the basin and cumulative peak diurnal base flow rates for each of the flow monitoring sites and corresponding sub-basins within the Study Area. For modeling purposes, diurnal base flow patterns were used in lieu of a single average base flow rate. This allows for evaluation of the model under a "worst case scenario," that is, rainfall-induced. The values in Table IV-1 represent the peak of this diurnal base flow pattern.

Table IV-1
Peak Base Flow Rates

Basin ID	Pipe Footage	Cumulative Peak Base Flow (mgd)	Individual Basin Flow (mgd)	Gpd/lf
1	45,020	0.360	0.360	7.99
2	40,324	0.305	0.305	7.56
3	39,947	0.459	0.459	11.49
4	98,782	1.626	0.379	3.84
5	27,155	0.134	0.134	4.93
6	34,316	0.582	0.127	3.70
7	63,950	0.250	0.250	3.91
8	42,383	0.236	0.236	5.57
9	80,760	0.620	0.393	4.87
10	22,439	0.115	0.115	5.13
11	45,720	0.113	0.113	2.42
12	24,436	0.227	0.227	9.29

C. Infiltration

Infiltration is a component of flow, which usually enters the sanitary sewer system through underground cracks and defects. For the purpose of hydraulic model calibration, infiltration is separated into two categories: Permanent Infiltration (previously described), and Rainfall-Induced Infiltration. To create a hydraulic model reflecting a "worst case scenario," both categories of infiltration must be accounted for.

Rainfall-induced infiltration normally enters into the collection system through public- and private-sector defects hours after the onset of a storm event. Public-sector sources are defects on property maintained by the governing municipality. Private-sector sources are defects on private-property and are usually the responsibility of the property owner. Typical public and private infiltration sources are listed in Table IV-2.

Table IV-2
Typical Private and Public Infiltration Sources

Private Sector	Public Sector
Building Perimeter Drain	Defective Manhole Wall
Broken Service Lateral	Defective Manhole Invert/Bench
Broken/Defective Service Tap	Defective Manhole Pipe Seal
Jab-In Service Connection	Broken/Cracked Sewer Pipe
Sump Pump	Offset Pipe Joint
	Separated Pipe Joint

Measurement of rainfall-induced infiltration in a sewer system is made by comparing dry weather flow data, data collected during a period of time when no rainfall has occurred, to the measured flow data during and following each recorded rainfall event. To determine optimal rainfall-induced infiltration, flow data was evaluated for 6 to 12 hours after the occurrence of each rainfall event.

D. Inflow

Inflow is defined as storm-water that enters into a sanitary sewer system from the surface during and immediately after a measurable rainfall event. It is characterized by rapid changes in the instantaneous flow rate as recorded by the monitoring device. Inflow is generally the major contributor of peak system flows that result in wastewater backups, surcharges, and uncontrolled overflows or bypasses. System response to inflow varies depending on: 1) groundwater and soil conditions, 2) type and quantity of inflow sources, 3) rainfall intensity and duration, and 4) inflow source locations relative to the monitoring devices. Typical inflow sources are listed in Table IV-3.

Table IV-3
Typical Inflow Sources

Private Sector	Public Sector
Roof Downspout	Vented Cover (below grade)
Driveway Drain	Pick hole (below grade)
Exterior Stairwell Drain	Poor Manhole Cover/Frame Fit
Uncapped Cleanout	Cross-Connected Storm Sewer
Area (yard) Drain	Directly Connected Storm Inlet
	Indirect Storm Sewer Connection

By comparing the total peak flow during or following rainfall events to the average dry-day diurnal flow pattern, it is possible to determine the rate and quantity of inflow that enters into the sewer system at a control (monitoring) point. Inflow compiled from flow monitoring data for the Study Area normally peaked approximately 60 to 90 minutes following the peak intensity of a rainfall event within each individual basin. Table IV-4 shows the cumulative peak projected I/I flow rates for the design storm event.

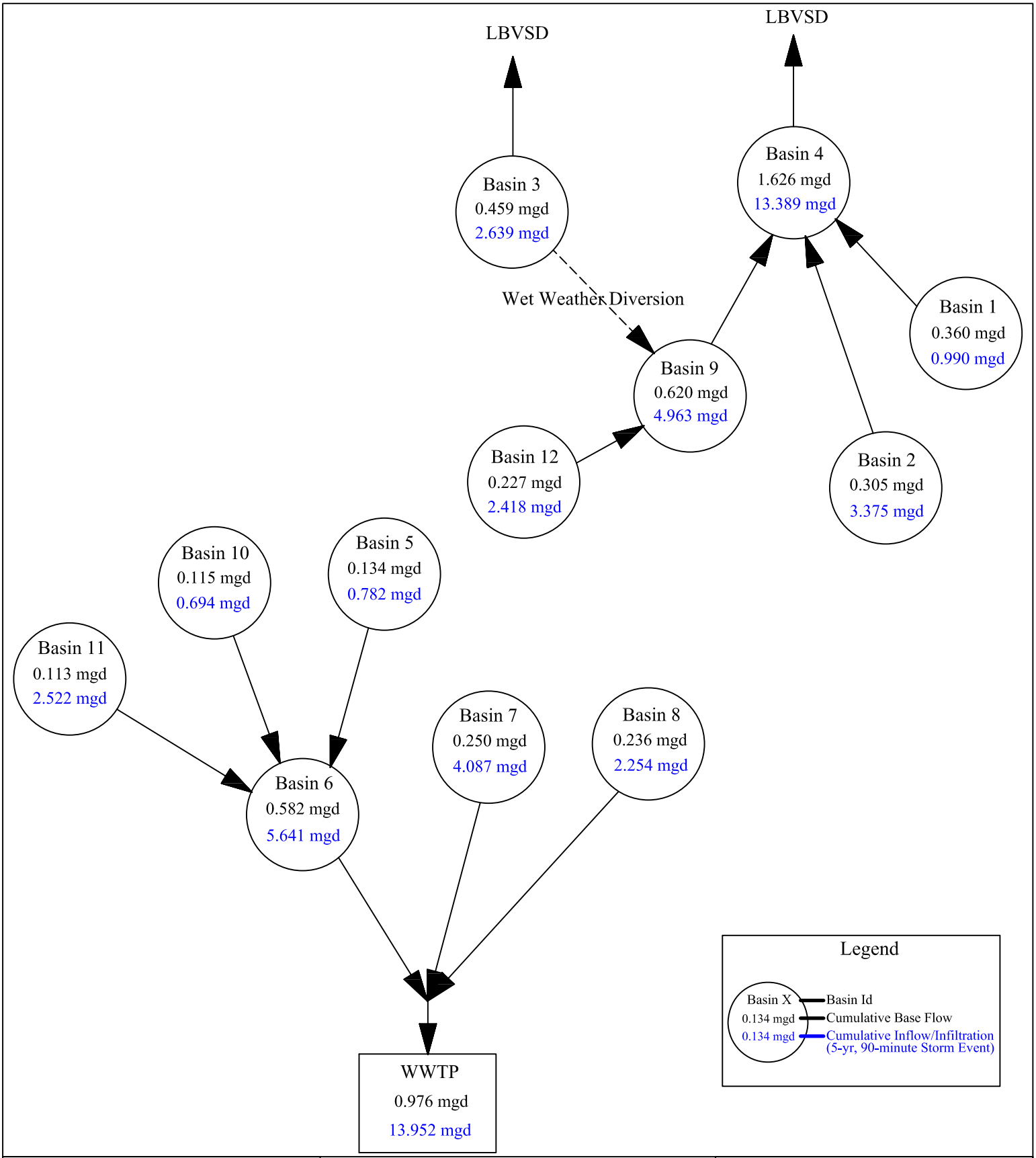
Table IV-4
Basin Peak Inflow and Infiltration Rates
(5-Year, 90-Minute Storm Event)

Basin ID	Pipe Footage	Cumulative Peak I/I Flow (mgd)	Individual Basin I/I Flow (mgd)	Individual Gpd/lf
1	45,020	0.990	0.990	21.99
2	40,324	3.375	3.375	83.70
3	39,947	2.639	2.639	66.06
4	98,782	13.389	4.105	41.56
5	27,155	0.782	0.782	28.80
6	34,316	5.641	1.643	47.88
7	63,950	4.087	4.087	63.91
8	42,383	2.254	2.254	53.18
9	80,760	4.963	2.545	31.51
10	22,439	0.694	0.694	30.93
11	45,720	2.522	2.522	55.16
12	24,436	2.418	2.418	98.95

E. Peak Basin Flow Rate

Peak basin flow rate is the summation of the base diurnal flow, including permanent infiltration, and inflow. Rainfall-induced infiltration is not considered when determining the peak basin flow rate since it usually occurs significantly after the inflow response has peaked. The peak design flows listed in Tables IV-1 and IV-4 represent control flows for the hydraulic model used for system calibration and analysis. They represent peak projected wastewater flow rates under existing system conditions.

Projected peak 5-year, 90-minute storm event flows were determined by adding the cumulative peak projected inflow to the cumulative base flow. Peaking factors at each monitoring location were determined by comparing the cumulative peak flow rate to the cumulative peak wet weather base flow. Peaking factors ranged from 22.3 at basin 11 to 2.8 at basin 1. A summary of peak flows is shown in Table IV-5. A flow schematic representation of cumulative basin diurnal flow and rainfall-induced I/I is shown in Figure D.



Belton, MO

2007 Wastewater Master Plan

Figure D

Basin Flow Summary

WADE & ASSOCIATES, INC.

Table IV-5
System Peaking Factors
(5-Year, 90-Minute Storm Event)

Basin ID	Cumulative Peak Base Flow (mgd)	Cumulative Average Base Flow (mgd)	Cumulative Peak Inflow (mgd)	Cumulative Peak Flow (mgd)	Peaking Factor
1	0.360	0.168	0.630	0.990	2.8
2	0.305	0.179	3.070	3.375	11.1
3	0.459	0.324	2.190	2.649	5.8
4	1.626	1.080	11.763	13.389	8.2
5	0.134	0.074	0.648	0.782	5.8
6	0.582	0.332	5.059	5.641	9.7
7	0.250	0.193	3.837	4.087	16.3
8	0.236	0.117	2.018	2.254	9.6
9	0.620	0.332	4.343	4.963	8.0
10	0.115	0.052	0.579	0.694	6.0
11	0.113	0.072	2.409	2.522	22.3
12	0.227	0.159	2.191	2.418	10.7

The peaking factors shown in Table IV-5 demonstrate the system's response to a rainfall event as a whole. However, to gain an understanding of how each individual basin reacts to a rainfall event, this peaking factor must be derived in a different manner. For each basin, projected peak flows were determined by subtracting the cumulative peak flow by the peak flows of the contributing upstream basins. The peak diurnal flow rates for each basin were derived in a similar manner. Projected peak basin flows were compared with the cumulative peak rate for each basin and a peaking factor was calculated. In this way, it is possible to isolate each basin from the rest of the system and establish which basins react most severely to rainfall. Based on its peaking factor, a severity ranking was assigned to each basin. Peaking factors ranged from 22.3:1 in basin 11 to 2.8:1 in basin 1. A summary of basin peaking factors and severity ranking is shown in Table IV-6.

Table IV-6
Basin Severity Ranking
(5-Year, 90-Minute Storm Event)

Basin ID	Individual Basin Peak Base Flow (mgd)	Individual Basin Peak Inflow (mgd)	Individual Basin Peak Flow (mgd)	Peaking Factor	Severity Ranking
1	0.360	0.630	0.990	2.8	12
2	0.305	3.070	3.375	11.1	4
3	0.459	2.190	2.639	5.7	11
4	0.341	3.720	4.061	11.9	3
5	0.134	0.648	0.782	5.8	10
6	0.220	1.423	1.643	7.5	7
7	0.250	3.837	4.087	16.3	2
8	0.236	2.018	2.254	9.6	6
9	0.393	2.152	2.545	6.5	8
10	0.115	0.579	0.694	6.0	9
11	0.113	2.409	2.522	22.3	1
12	0.227	2.191	2.418	10.7	5

F. Summary of Flow Data Analysis

The analysis of the flow data received from the flow monitoring program confirms that the wastewater collection system in the study area is experiencing periods of inflow and infiltration. Of the basins monitored, all but three in the study area will experience peaking factors greater than 3:1. Overall, the flow rates obtained from the flow data analysis are within the range of expected results, considering the age and condition of the system.

V. PILOT STUDY AREA

A. Field Surveys and Inspection Activities

A successful analysis of any collection system includes principal field activities to acquire data in order to create and maintain a computer model that accurately depicts system behavior under various conditions. Field activities are important in the accuracy of the resulting hydraulic model and the reliability of the final recommended improvement plan. Historically, the City experiences sanitary sewer hydraulic performance problems during wet-weather events in the downtown area, as well as in an area located to the west of Cleveland Avenue and east of the Southern Railroad. These two areas are defined for the purpose of this report as the Pilot Study Area and represent approximately 33,530 lf of pipeline. The following paragraphs discuss the various phases of work completed to identify the specific sources of I/I in both the public and private-sectors of the Pilot Study Area. Figure E shows the portion of the collection system chosen as the Pilot Study Area.

1. I/I Source Identification

   This section describes the work completed to identify the locations of contributing I/I sources in the selected basins. Inflow and infiltration enters into any publicly owned sanitary sewer system from public as well as private sources. Typical public-sector sources of I/I are illustrated in Figure F. Note that these sources are generally the responsibility of the City, since they originate within the realm of the collection system maintained by the City. However, an equally significant amount of I/I can enter from private sources as illustrated in Figure G. These sources are generally the responsibility of the property owner. Typically, they are considered illegal connections to the public sanitary sewer system. Therefore, the goal of this phase of the study was to locate, assess, and quantify these public- and private-sector defects through a series of inspections and testing activities.

2. Manhole Inspection

   Defective manholes are considered to be major contributors of excessive I/I in a sanitary sewer system. Accessible manholes were classified according to one of the following categories:

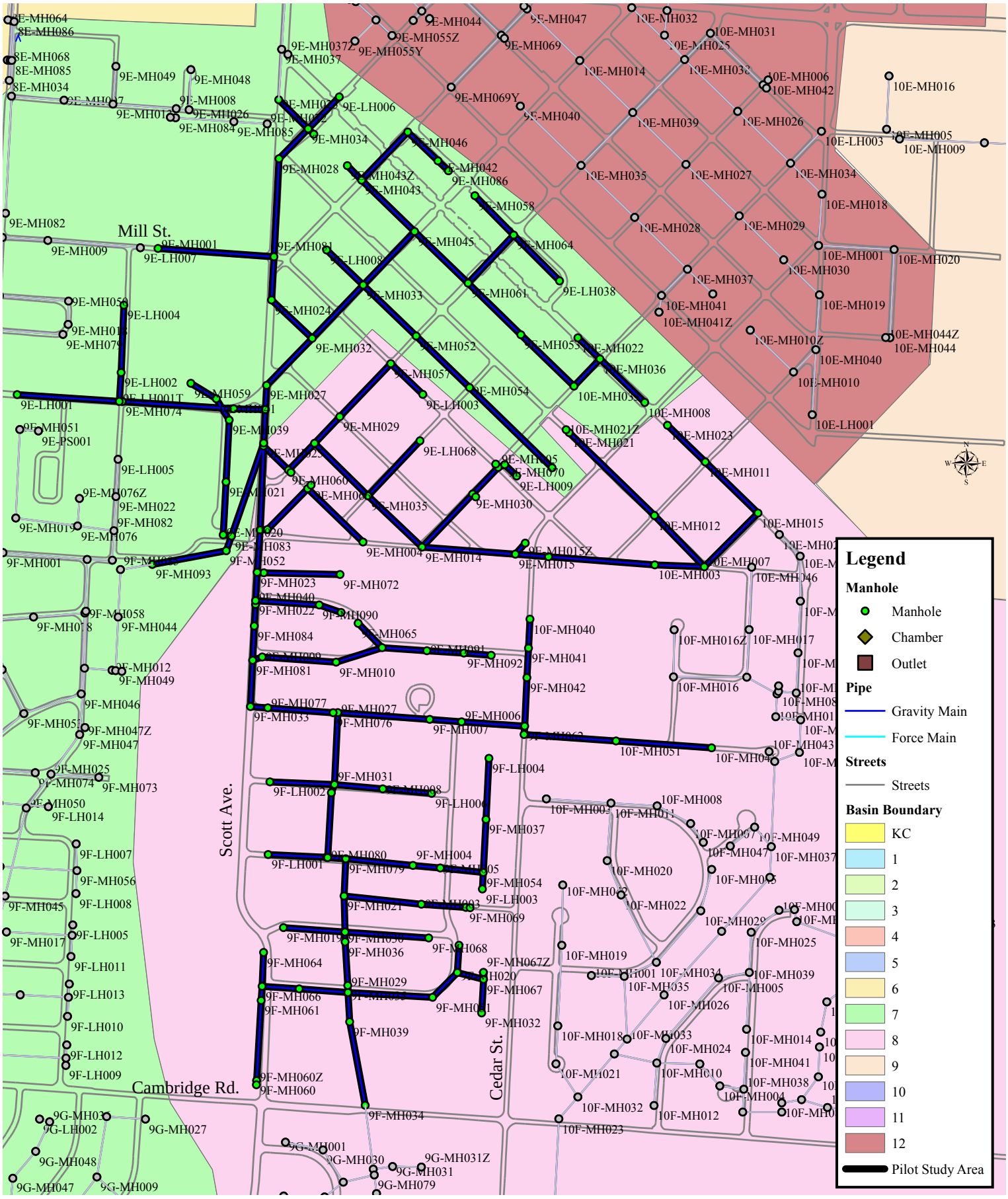


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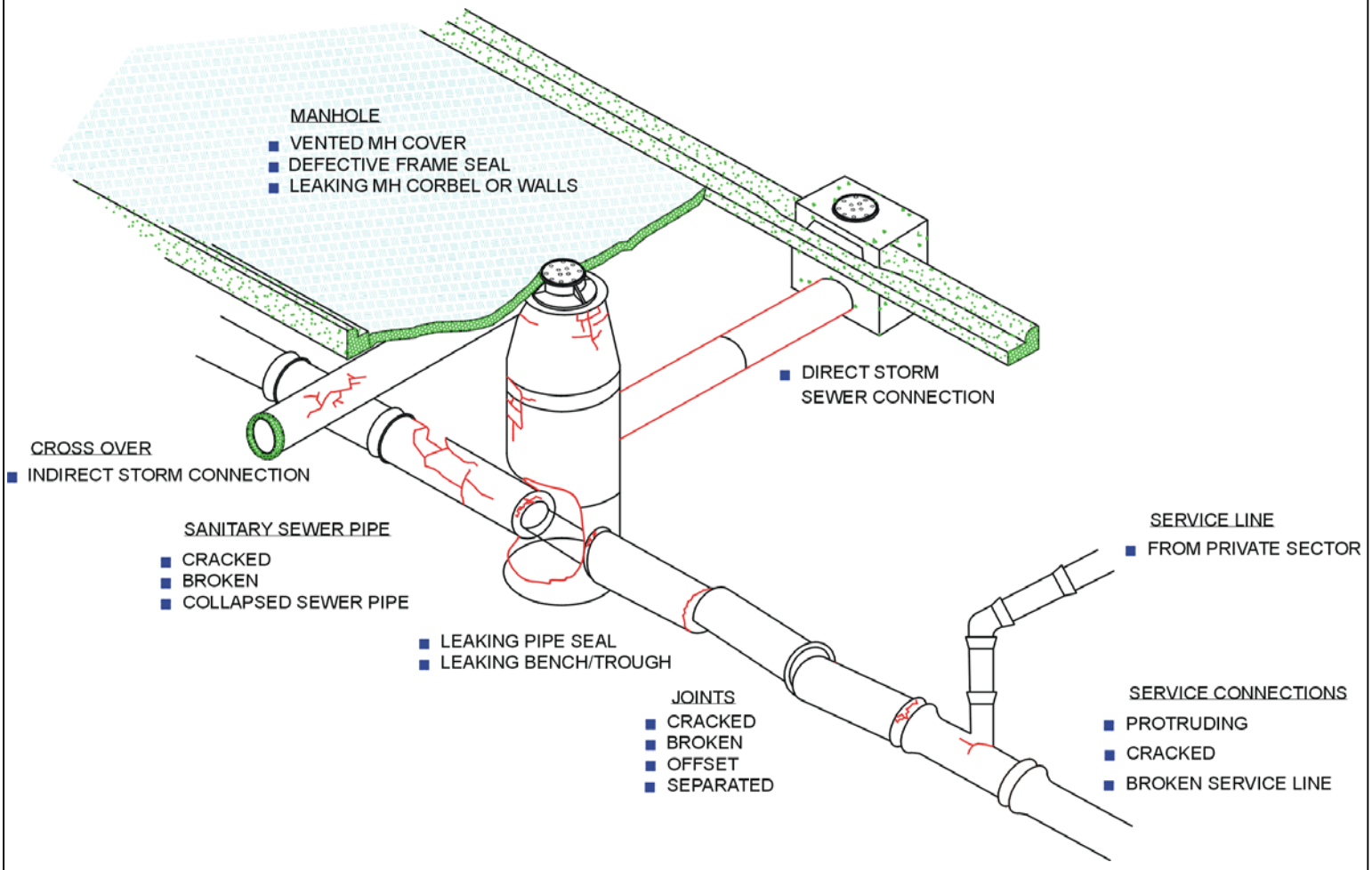
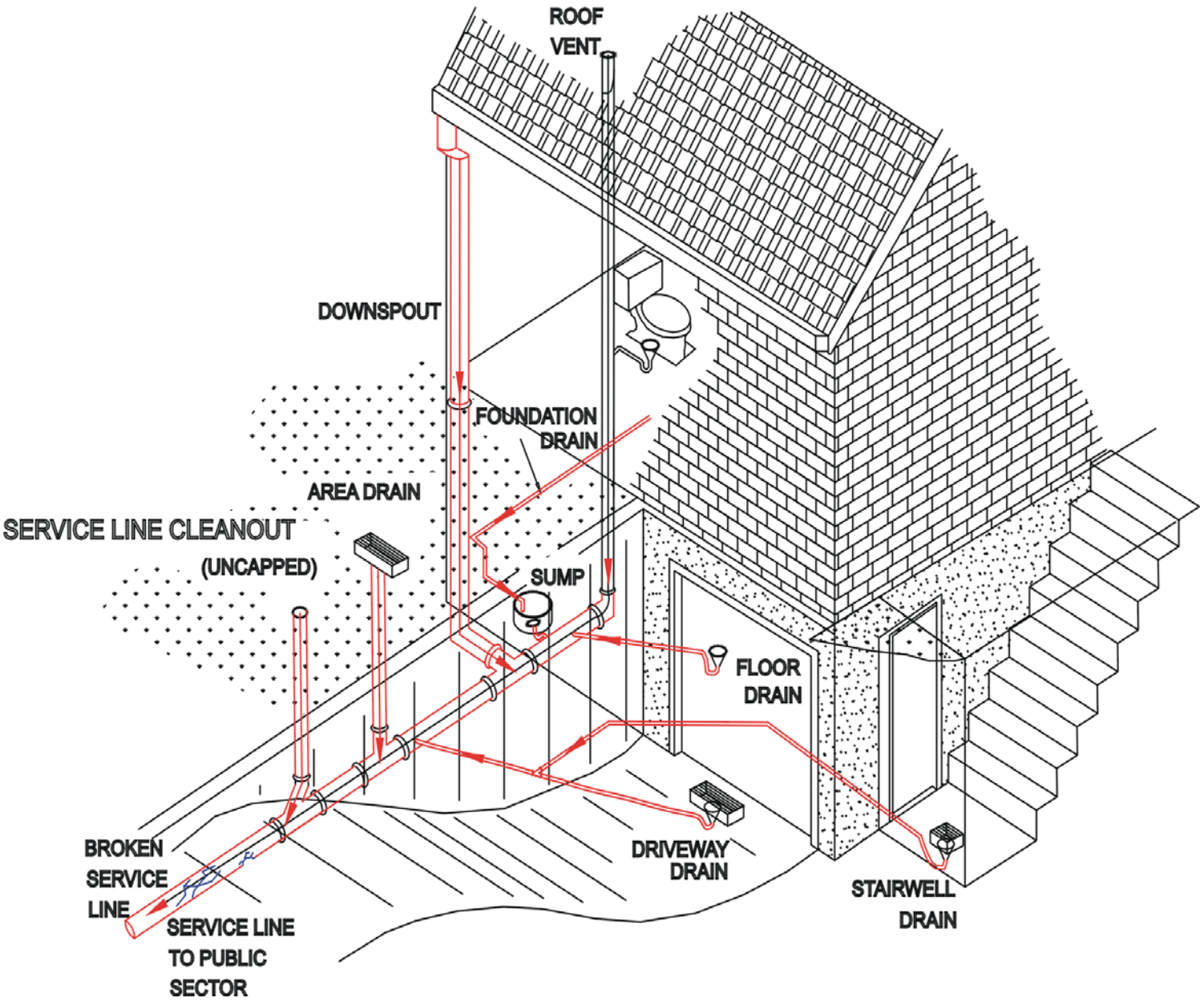
Figure E

Pilot Study Area

WADE & ASSOCIATES, INC.



Belton, MO 2007 Wastewater Master Plan	Figure F Typical Public Sector Inflow and Infiltration Sources	WADE & ASSOCIATES, INC.



Belton, MO 2007 Wastewater Master Plan	Figure G Typical Private Sector Inflow and Infiltration Sources	WADE & ASSOCIATES, INC.

Manhole Inspection Status:

- *Inspected.* Manhole inspection was completed. All pertinent data was recorded on standard City approved forms.
- *Reason Not Inspected.* Manhole inspection was not completed due to one of the following reasons:
  - *CNL-Could Not Locate.* Could not locate manhole, although there is reasonable certainty that manhole exists.
  - *DNE-Does Not Exist.* Manhole no longer exists.
  - *Buried.* Inspection of the manhole restricted by earth or paving materials.
  - *Haz/Atmos.* Atmosphere readings are at hazardous levels – unable to enter and inspect manhole due to OSHA regulations.
  - *Unsafe.* Unable to complete inspection due to other unsafe conditions.
  - *Sealed Lid.* Inspection of the manhole restricted by lid that could not be removed from frame.
  - *Traffic.* Inspection of manhole deemed unsafe due to heavy or fast traffic.
  - *Dog.* Inspection of manhole deemed unsafe due to dog.
  - *Other.* Inspection of manhole impossible due to situations such as locked gate or uncooperative property owner.

A total of 131 manholes were inspected within the Pilot Study Area. Additionally, four buried manhole structures could not be inspected. Table V-1 presents the final status of the manholes inspected by the field crews in the Pilot Study Area. Appendix F contains a list of the un-inspected manholes.

Table V-1
Pilot Study Area
Manhole Inspection Status Summary

Basin	Inspected	C.N.L.	D.N.E.	Buried	Haz/Atmos	Unsafe	Sealed Lid	Traffic	Dog	Other	Total
7	42	0	0	2	0	0	0	0	0	0	**44**
8	89	0	0	2	0	0	0	0	0	0	**91**
Totals	**131**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**135**

WADE and City personnel conducted inspections on various manhole components throughout the Pilot Study Area. Observations were recorded on standard WADE inspection forms. An example field form is shown in Figure H. Each inspection identified potential sources of inflow and infiltration, structural deficiencies, and other general information. The photo at the right shows several major root intrusions through the wall of manhole 9E-MH014. Components of each manhole evaluated are shown in Figure I. The following data was collected for each manhole inspected.

MANHOLE INSPECTION

City of Belton, MO

Date: ___ / ___ / ___

Crew: _____, _____, _____

Project No. _____

Manhole No. ( ) _____

Address: House No. _____

Street: _____

Locality: _____

Map No.: _____

Precipitation: _____
1 = None, 2 = Light Rain, 3 = Heavy Rain, 4 = Snow

Ground Conditions: _____
1 = Dry, 2 = Damp, 3 = Wet, 4 = Standing Water

Downstream Pipe Length: _____ (ft.)

☐ **Inspected**

Reason Not Inspected: _____

1 = C.N.L.
2 = D.N.E.
3 = Buried
4 = Haz/Atmos.
5 = Unsafe
6 = Sealed Lid
7 = Traffic
8 = Dog
9 = Other

Location Code: _____

1 = Paved Street
2 = Unpaved Street
3 = Paved Intersection
4 = Unpaved Intersection
5 = Alley
6 = Sidewalk
7 = Parking Lot
8 = Backyard
9 = Ditch
10 = Curb/Gutter
11 = Easement
12 = Private Residence

Manhole Diameter: _____.____(ft.)

Manhole Depth: _____.____(ft.)

☐ **Subject to Ponding**

Ponding Depth: _____.____(ft.)

Tributary Area: _____ (sq. ft.)

Grade Elevation Code: _____

1 = Even

2 = Above _____ (in.) no decimal

3 = Below _____ (in.) no decimal

Structure Type Codes:

1 = Brick
2 = Precast
3 = Block
4 = Clay Pipe
5 = Concrete Pipe
6 = Poured
7 = Rehab Coating
8 = Cast Iron
9 = PVC
10 = PVC-coated
11 = Rebar
12 = None
13 = Bitumastic
14 = Grout
15 = Other

See Attachment "A" for General Observation Codes.

	Type	Condition	I/I (gpm)	General Obs.	Comments
Cover: ……	G F P			____,____,____,____	

a. Diameter: ____.____ (in.)

b. Thickness: ____.____ (in.)

c. Type Code: _____

1=Light Duty, 2=Heavy Duty
3=Bolt Down, 4=Locking

d. ☐ Vented Cover

e. No. of Vents: _____

f. Vent Dia.: ____.____(in.)

	MH Area Photo		MH Photo Topside (N)		
	MH Defect Photo		MH Defect Photo		
	MH Defect Photo		MH Defect Photo		

	Type	Condition	I/I (gpm)	General Obs.	Comments
Cover-to-Frame Fit: ……	G F P	____		____,____,____,____	
Frame: ……..	G F P	____		____,____,____,____	

a. Inside Dia.: ____.____(in.)

b. Outside Dia.: ____.____(in.)

c. Dwell: ____.____ (in.)

d. Height: ____.____ (in.)

Frame-to-Chimney Seal: _____	G F P	____		____,____,____,____	
Chimney: …….. _____	G F P	____		____,____,____,____	

a. Height: ____.____ (in.)

Corbel: …….. _____	G F P	____		____,____,____,____	
Wall: …….. _____	G F P	____		____,____,____,____	
Bench: …….. _____	G F P	____		____,____,____,____	
Invert: …….. _____	G F P	____		____,____,____,____	
Steps: …….. _____	G F P	____		____,____,____,____	

a. No. Missing: _____

Pipe Seal: **Condition I/I (gpm)**

Seal #1. G F P _____

Seal #2. G F P _____

Seal #3. G F P _____

Seal #4. G F P _____

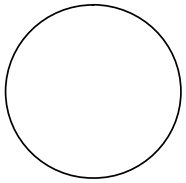
Seal #5. G F P _____

Seal #6. G F P _____

☐ **Evidence of Surcharge**

Surcharge Depth: _____.____ (ft.)

Comments: _____



Belton, MO

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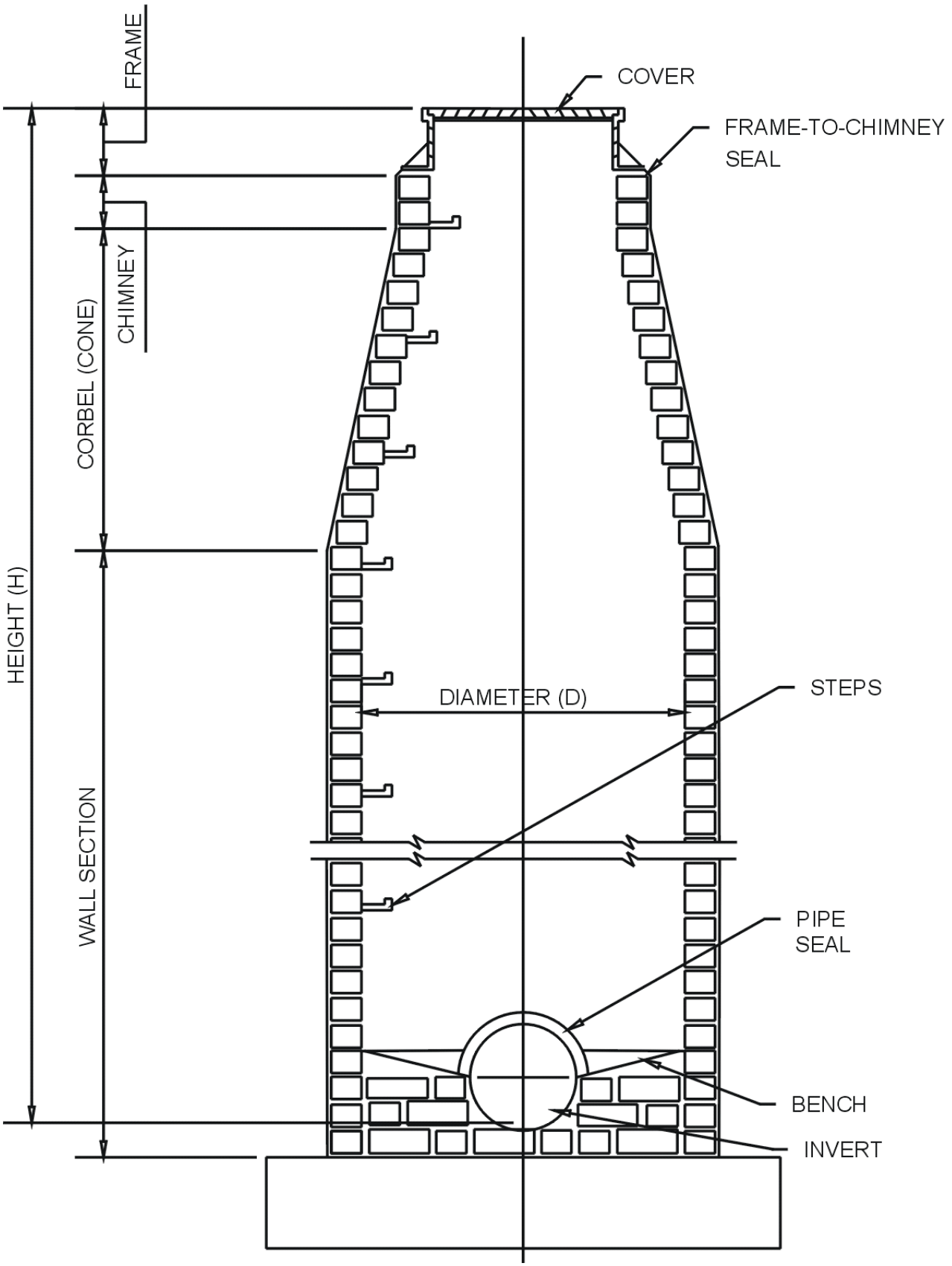
Figure H

Example Manhole Inspection Form

WADE & ASSOCIATES, INC.

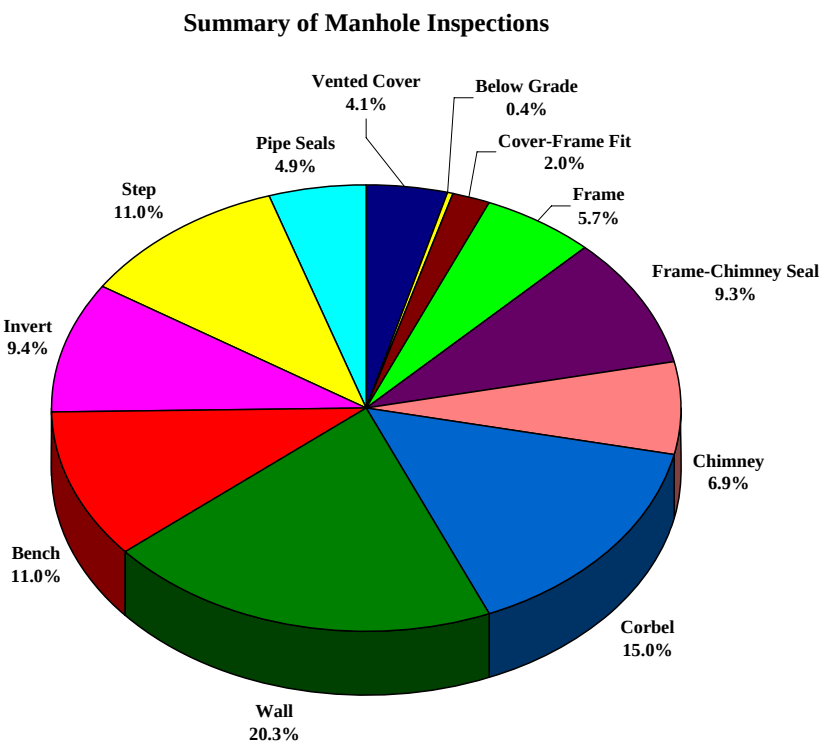


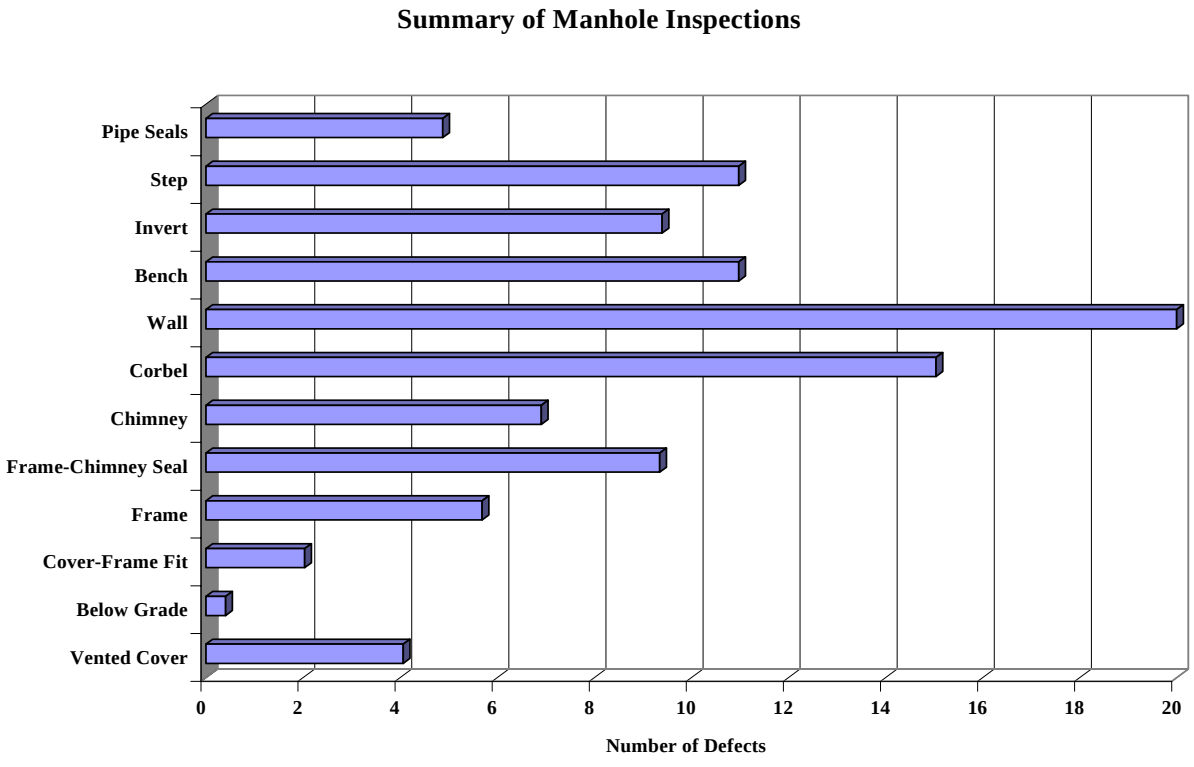
Belton, MO 2007 Wastewater Master Plan	Figure I Typical Manhole Detail	WADE & ASSOCIATES, INC.

***Manhole Inspection Assessment*:**

- *Date.* Calendar date that inspection was made or attempted and initials of crew members.
- *Manhole No.* Identification number of manhole correlating to numerical system developed by the City on a grid-location basis and recorded on the City's sewer maps.
- *Address.* Approximate location of manhole to street or building address.
- *Precipitation/Ground Conditions.* Coding of general atmosphere and ground precipitation at time of inspection.
- *Downstream Pipe Length.* Length from the inspected observation manhole to the manhole located downstream of the observed manhole.
- *Inspection and Reason Not Inspected.* Inspected, not inspected, could not locate or does not exist.
- *Location Code.* General proximity of manhole to street, easement, curb/gutter or private property.
- *Manhole Diameter*. Diameter of main barrel, in feet.
- *Manhole Depth.* Vertical distance, in feet, from center of pipe invert to top of frame.
- *Subject to Ponding/Ponding Depth/Tributary Area.* Estimated area of runoff tributary to manhole cover, in square feet; ponding condition.
- *Grade Elevation Code.* Cover elevation in relation to surface elevation.
- *Cover*. Type and condition, including number and diameter of pick holes and/or vent holes.
- *Cover-to-Frame Fit.* General fit of mating surfaces.
- *Frame.* Type, size and condition.
- *Frame-to-Chimney Seal.* Condition of seal between frame bottom and top row of the adjustment or corbel.
- *Chimney.* Type and condition of adjustment.
- *Corbel.* Type of material and general condition if present.
- *Wall.* Type of material and condition of main barrel.
- *Bench.* Type of material and general condition of manhole bottom, excluding trough.
- *Invert.* Type and condition of trough through manhole.
- *Steps.* Type, general condition and number of steps. Also evidence of missing or poorly placed steps.
- *Pipe Seal.* General condition and evidence of infiltration.
- *Evidence of Surcharge.* High water marks, grease lines, deposition or sludge on bench, tissue or rags on steps and evidence of overflow through cover.

Table V-2 shows the results of the defects identified during this phase of the study. A graphical representation of the defects identified is included as Figure J. It should be noted that the predominant defects observed in the manhole structures consist of wall defects, corbel defects, missing/deteriorated steps, and bench and invert defects. All of these defects have the potential to allow considerable amounts of I/I into the system. A final output report of the manholes inspected in the Pilot Study Area is located in Appendix G.





Belton, MO 2007 Wastewater Master Plan	Figure J Summary of Manhole Defects	WADE & ASSOCIATES, INC.

Table V-2
Pilot Study Area
Results of Manhole Inspections

Defect Category	Number of Observations per Basin*		Total
	Basin 7	Basin 8	
Total Manholes Inspected	42	89	**131**
Defect Type			
Vented Cover	3	7	**10**
Below Grade	0	1	**1**
Cover-Rim Fit	1	4	**5**
Frame	4	10	**14**
Frame-to-Chimney Seal	8	15	**23**
Chimney	4	13	**17**
Corbel	8	29	**37**
Wall	8	42	**50**
Bench	6	21	**27**
Invert	10	13	**23**
Steps	10	17	**27**
Leaking Pipe Seals	0	12	**12**
Total Defects	**62**	**184**	**246**
Defects/Manhole	**1.5**	**2.0**	**1.9**

*Observations shown are of manhole components in Fair and Poor condition.

3. Visual Pipe Inspection

All incoming and outgoing sanitary sewers, where feasible, were lamped from accessible manholes. In most cases lines were lamped for approximately 5 to 15 feet using digital camera technologies while inspecting the manhole structure. This permitted inspections of the pipes without actual entry into the manhole. Data collected during lamping was also used to identify sections of pipe that are structurally defective or require some form of maintenance or follow-up CCTV inspection. Inspections of private service connections, which discharge into a manhole, were also made. An example field form for visual pipe inspections is shown as Figure K. The results of the visual pipe inspection program are shown in Table V-3. General data that was collected under this inspection activity includes the following:

VISUAL PIPE INSPECTION

City of Belton, MO

Date: _____ / _____ / _____ **Project No. 0502**

Crew: _____,____, _____, _____ **Observation Manhole No. (** **)** _____

Lamping Direction	DS #1	US #2	US #3	US #4	US #5
To Manhole:	( )	( )	( )	( )	( )
Service	o	o	o	o	o
Rim-To-Invert Elevation (nearest tenth of a foot)	__ __ . __	__ __ . __	__ __ . __	__ __ . __	__ __ . __
Drop **Drop Type:** 1=Const. Ext.; 2=Const. Int. 3=Not Constructed	o _____	o _____	o _____	o _____	o _____
Pipe Diameter: (dia. in inches – no decimals)					
Type of Pipe: 1=VCP 4=RCP 7=OBG 2=PVC 5=CMP 8=Other 3 = DIP 6=CIP 9=Truss					
Pipe Shape: 1=Circular 3=Elliptic 2=Rectangular 4=Other					
Depth of Flow: (in.)	__ __ __ . __ __	__ __ __ . __ __	__ __ __ . __ __	__ __ __ . __ __	__ __ __ . __ __
Velocity of Flow: (ft./sec.)	__ __ . __	__ __ . __	__ __ . __	__ __ . __	__ __ . __
Roots: 1=Light 2=Medium 3=Heavy	___ @ _____ (ft)	___ @ _____ (ft)	___ @ _____ (ft)	___ @ _____ (ft)	___ @ _____ (ft)
Deposition: 1=Medium 2=Heavy					
Grease	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Mineral Deposit	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Longitudinal Cracks	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Circular Cracks	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Broken Pipe	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Collapsed Pipe	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Joint Infiltration	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Offset Joint: 1=Minor 3=Severe 2=Moderate	___ @ _____ (ft)	___ @ _____ (ft)	___ @ _____ (ft)	___ @ _____ (ft)	___ @ _____ (ft)
Protruding Tap	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Line Grade Poor	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Abandoned	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Permanent Plug	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)	o @ _____(ft)
Estimated Observed Length	__ __ __ (ft)	__ __ __ (ft)	__ __ __ (ft)	__ __ __ (ft)	__ __ __ (ft)
Photo Identification Nos.					

Comments: _____

_____

_____

_____

Belton, MO

2007 Wastewater Master Plan

Figure K

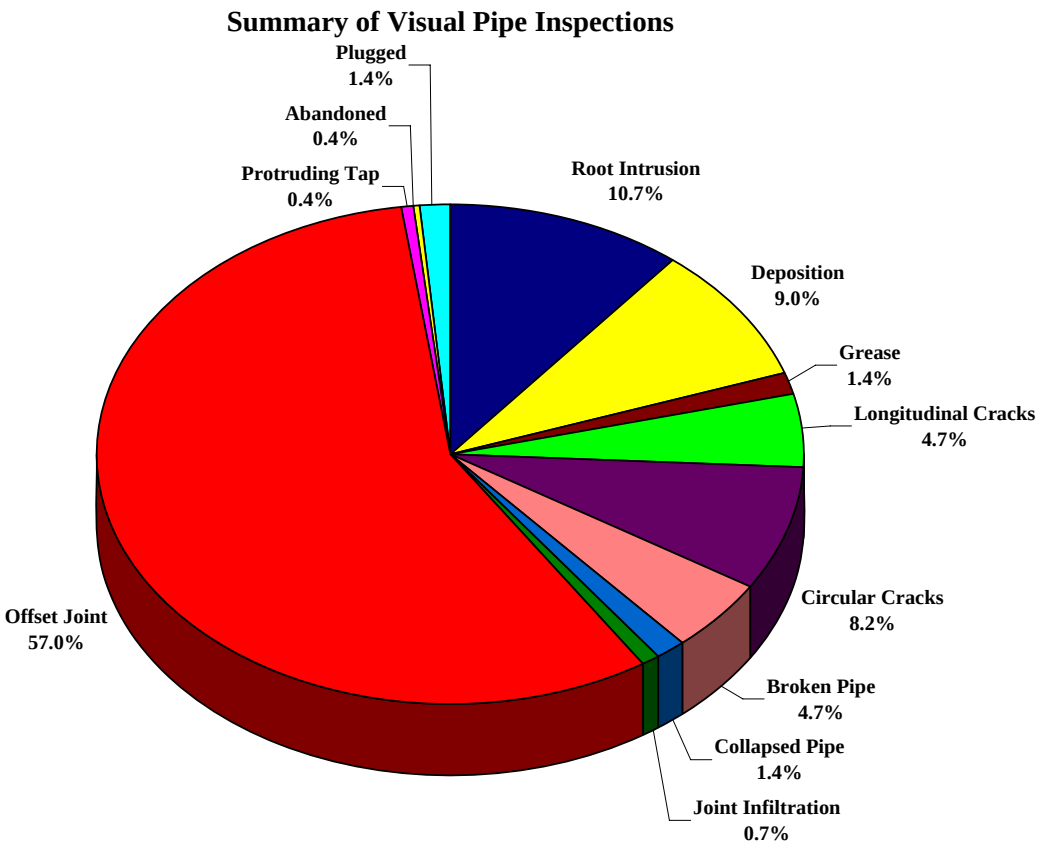
Example Visual Pipe Inspection Form

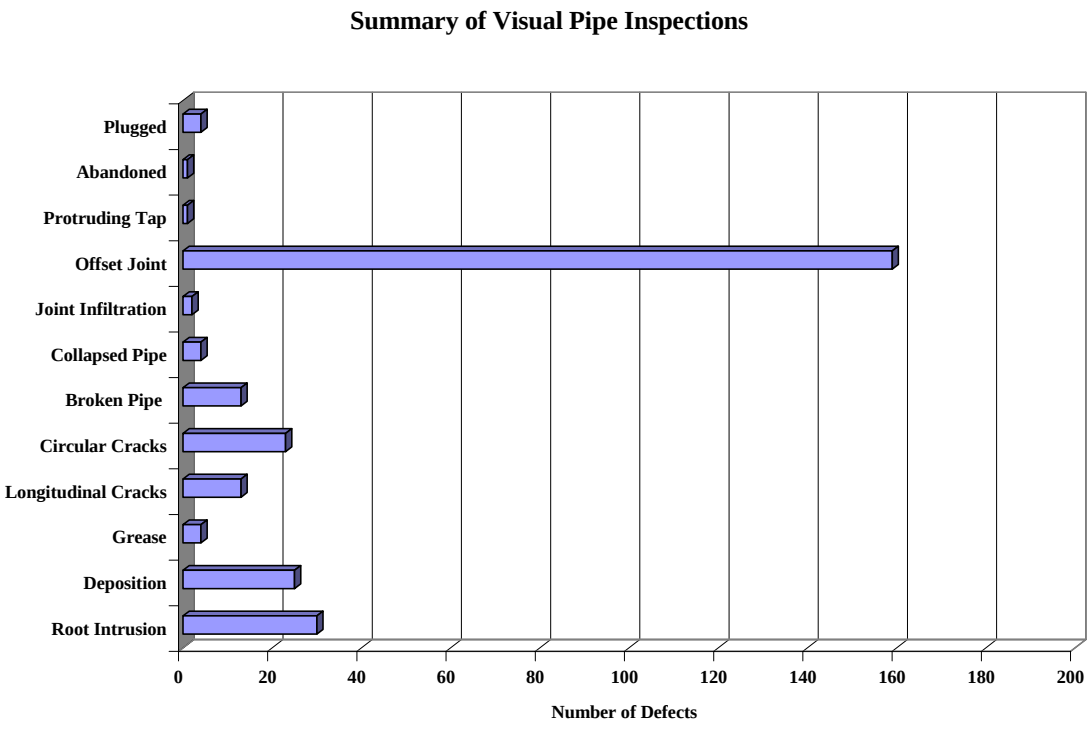
WADE & ASSOCIATES, INC.

***Visual Pipe Inspection Assessment*:**

- *Date.* Calendar date that segment was inspected.
- *Observation Manhole*. Identification number of manhole from which pipes were lamped.
- *Lamping Direction*. Viewing direction from observation manhole, either upstream or downstream.
- *Forward Manhole*. Identification number of ending manhole of line segment being lamped.
- *Rim-to-Invert Elevation.* Vertical distance from pipe invert to cover for each pipe segment.
- *Drop*. Yes or no.
- *Drop Type*. Constructed external, constructed internal, not constructed.
- *Pipe Size.* Diameter or dimension (inches) of pipe.
- *Pipe Material*. Type of material (e.g., VCP, RCP, DIP, CMP, etc.).
- *Pipe Shape*. Circular, rectangular, elliptical.
- *Depth of Flow*. Estimated in inches (in pipe).
- *Velocity of Flow*. Estimated in feet per second (in pipe).
- *Observations.* Type and extent of observations (e.g., roots, deposition, grease, cracks, broken or collapsed pipe, offset or separated joint, joint infiltration, protruding tap, poor line grade, plugged and abandoned segment).
- *Estimated Observed Length.* Estimated length of line that is actually viewed by crew.
- *Comments.* General comments regarding inspection.

Visual pipe inspections yielded 279 defects out of a total 305 inspections. The predominant defects discovered were offset joints, roots, depositions, and circular cracks. The photo at the right shows a broken pipe looking upstream from manhole 10E-MH015 to manhole 10E-MH011 in basin 8. Basin 7 of the Pilot Study Area yielded the most observed visual pipe defects per inspection, averaging 1.02 defects per inspection. Comparisons of the different types of pipe defects observed are shown in Figure L. A final report of the visual pipe inspection program is included in Appendix H.





Belton, MO 2007 Wastewater Master Plan	Figure L Summary of Visual Pipe Defects	WADE & ASSOCIATES, INC.

Table V-3
Pilot Study Area
Results of Visual Pipe Inspections

Defect Category	Number of Observations		
	Basin 7	**Basin 8**	**Total**
Total Inspections	104	201	**305**
Defect Type			
Root Intrusion	13	17	**30**
Deposition	12	13	**25**
Grease	1	3	**4**
Longitudinal Cracks	3	10	**13**
Circular Cracks	8	15	**23**
Broken Pipe	2	11	**13**
Collapsed Pipe	1	3	**4**
Joint Infiltration	0	2	**2**
Offset Joint	64	95	**159**
Protruding Tap	0	1	**1**
Abandoned	0	1	**1**
Plugged	2	2	**4**
Total Observations	**106**	**173**	**279**
Observations/Inspection	**1.02**	**0.86**	**0.91**

4. Smoke Testing

Wade and City personnel performed smoke testing on all line segments within the Pilot Study Area to detect I/I sources in the public- and private-sectors. This "rainfall-simulation test" was used to augment the manhole and lamping inspections. Smoke testing was performed by injecting white smoke into an isolated line segment with high-capacity blowers that force smoke into the sewer. For optimum results, smoke testing is generally performed during periods of dry soil conditions. This is due to the fact that groundwater tends to restrict the migration of the smoke towards the surface. The accompanying photo shows a line defect in a ditch along line segment 9E-LH002 to 9E-LH001A (Basin 7).

A public relations and notification program was implemented to minimize public concerns raised by the smoke testing. Such activities incorporated distribution of door-hanger notifications, inclusion on the www.wadeprojects.com web site, and communications with the City on daily testing activities.

Results of the smoke test program were recorded on standard WADE smoke testing forms for entry into a computer database. A sample smoke testing field form is shown in Figure M. Additionally, observed defects were photographed and documented for follow-up rehabilitation. Field sketches of all observed sources were made on an attached field form to efficiently facilitate future identification of the source(s). Smoke testing does not reveal all sources of excessive I/I, since factors such as traps, sags, leaves and deposition, and high water levels may have restricted smoke migration to the source in question. A total of 33,530 linear feet of sanitary sewer was tested. Table V-4 summarizes the quantities of pipe smoke-tested for each basin.

Table V-4
Pilot Study Area
Smoke Testing Summary

Basin ID	Total Segments Tested	Total Footage Tested	% Footage Tested by Basin
7	52	13,408	40
8	91	20,122	60
Total	**143**	**33,530**	**100**

The following itemizes the type of data recorded during the testing of each line:

Smoke Testing Assessment

- *Date.* Calendar date of test conducted.
- *Line Segment.* Identification of line segment tested.
- *Weather Conditions.* General temperatures and presence of precipitation.
- *Private-Sector I/I.* Type and location (addresses) of sources identified by smoke on private property.
- *Public-Sector I/I.* Type and location (station) of sources identified by smoke in the public-sector of the sewer system.

For direct inflow sources such as curb inlets and area drains, an estimate of the drainage area was made and recorded. Specific I/I sources included under public- and private-sector I/I are listed in Table V-5. Figure N graphically represents the results of smoke testing activities. A final report of the smoke testing is included in Appendix I.

Date: _____/_____/_____
Crew: _____, _____
Crew No. _____

SMOKE TESTING

City of Belton, MO

Project No. 0502
Sub-Basin No._____

Line Segment: ( ) _____ **To** ( ) _____
Upstream **Downstream**

Weather Conditions: _____
1 = 110-90°, 2 = 90-80°, 3 = 80-70°, 4 = 70°-below
Ground Conditions: _____
1 = dry, 2 = moist, 3 = wet, 4 = saturated
Precipitation: _____
1 = dry, 2 = drizzle, 3 = rain
Last Rain Event: ____/____/____

Pipe Length (ft.): _____
Pipe Diameter (in.): _____
Status Code: _____
Measure Code: _____

Status Code:
1=C.N.L. 4=Line too long
2=D.N.E. 5=Diameter too large
3=Buried 6=Complete

Measure Code:
1=Scaled from Map 4=Total Station
2=Walking Wheel 5=Estimated
3=Tape Measure

PART A: PRIVATE SECTOR

Smoke Defect No.	Bldg. Defect No.	Address	Defect Type	*Optional*: Footage (0=DS MH)	Offset (L/R)	Offset Footage	Tributary Area (sq. ft.)	Smoke Intensity	Photo ID
A									
B									
C									
D									
E									
F									
G									
H									
I									
J									

Defect Type:
1 = Downspout
2 = Uncapped Cleanout
3 = Driveway Drain
4 = Stairwell Drain
5 = Foundation Drain
6 = Area Drain
7 = Service Lateral
8 = Window Well
9 = Plumbing Defect

Smoke Intensity:
1 = Light
2 = Medium
3 = Heavy

PART B: PUBLIC SECTOR

Defect No.	Defect Type	Footage (0=DS MH)	*Optional*: Offset (L/R)	Offset Footage	Tributary Area (sq. ft.)	Smoke Intensity	Photo ID	Comments
S								
T								
U								
V								
W								
X								
Y								
Z								

Defect Type:
1=Curb Inlet
2=Area Drain
3=Line Defect
4=Indirect Storm
5=Manhole Defect
6=Drainage Crossing
7=Water Valve
8=Direct Storm

Smoke Intensity:
1=Light
2=Medium
3=Heavy

Additional Comments: _____

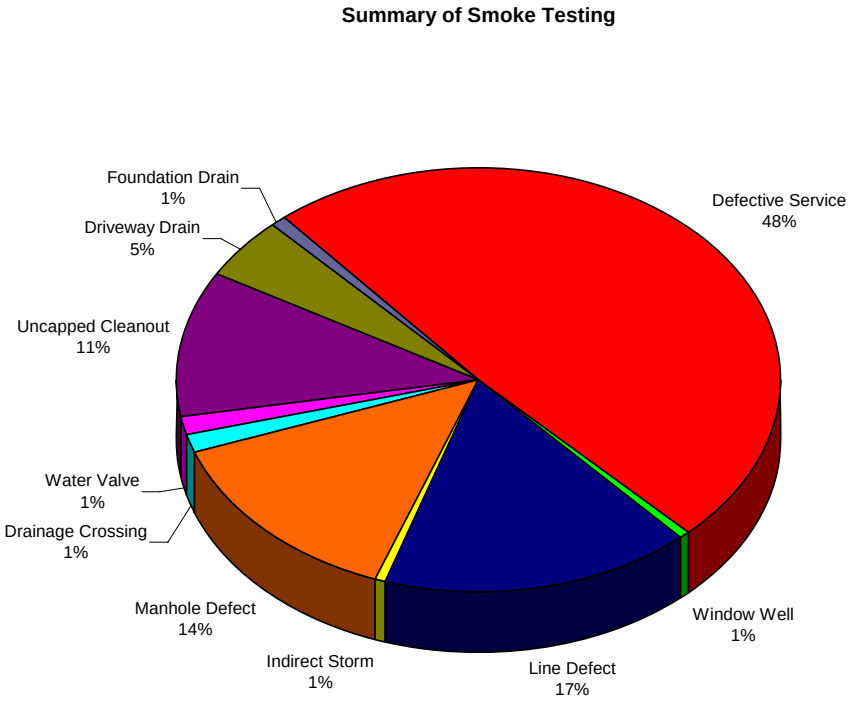
Belton, MO

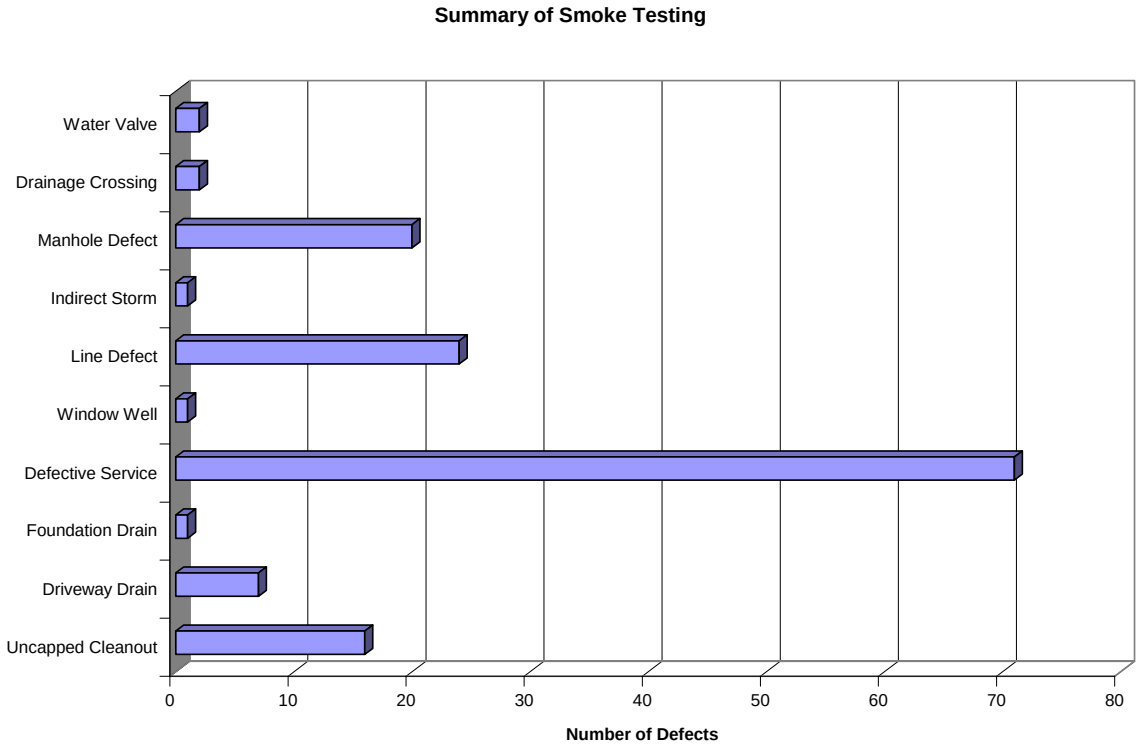
2007 Wastewater Master Plan

Figure M

Example Smoke Testing Form

WADE & ASSOCIATES, INC.





Belton, MO 2007 Wastewater Master Plan	Figure N Summary of Smoke Testing Defects	WADE & ASSOCIATES, INC.

Table V-5
Pilot Study Area
Results of Smoke Testing

Defect Category	Total Number of I/I Defects		
	Basin 7	Basin 8	Total
Public-Sector Defect Type			
Main Line Defect	13	11	**24**
Indirect Storm	1	0	**1**
Manhole Defect	5	15	**20**
Drainage Crossing	0	2	**2**
Water Valve	1	1	**2**
Private-Sector Defect Type			
Uncapped Cleanout	5	11	**16**
Driveway Drain	0	7	**7**
Foundation Drain	1	0	**1**
Defective Service	34	37	**71**
Window Well	0	1	**1**
Total Public Sector	20	29	**49**
Total Private Sector	40	56	**96**
Total I/I Sources	**60**	**85**	**145**
Total Basin Footage Tested	**13,408**	**20,122**	**33,530**
Defects per 1,000 Feet	**4.47**	**4.22**	**4.32**

5. CCTV Inspections

The best method of accurately identifying the exact location of I/I entry into pipelines in the collection system is through the use of closed circuit television inspection (CCTV). Since smoke may migrate through cracks in the soil, an exact measurement may not be possible during smoke testing.

Pro-Clean Utility, LLC, the City's CCTV Contractor, conducted cleaning and CCTV inspections on approximately 7,900 linear feet of sanitary sewer within the Pilot Study Area. Figure O shows an example CCTV inspection form. Figure P depicts the location of all CCTV inspected line segments within the Pilot Study Area. Wade and Associates personnel reviewed the inspection data and CCTV tapes and made recommendations for repairs and improvements. The final CCTV inspection report with the recommended pipeline rehabilitation schedule for the Pilot Study Area is included as Appendix J.

PRO-**CLEAN UTILITY LLC.**

4309 SW 60TH
ELDORADO, KS 67042 (316)655-6480

VIDEO INSPECTION LOG

DATE: 8/29/2005 PROJECT OWNER: INSITUFORM TECH.
TECHNICIAN: JIM BRAWNER CITY & STATE: BELTON, MO
PRO-CLEAN JOB#: 905MO
LOCATION: NORTHWEST OF ELLA ST SOUTHWEST OF MAIN ST

PIPE LENGTH: 352 FIELD MEASUREMENT: 352 DATA VIEW: 350

DIAMETER : 8" TYPE OF PIPE: VCP FLOW: NORTHWEST

MH # 9E-MH061 DEPTH : 8' MH# 9E-MH045 DEPTH: 8'

VIDEO TAPE# 1-904MO INSITUFORM JOB# 100940

COMMENTS :

FOOTAGE	OBSERV.	DESCRIPTION / ADDRESS OF SERVICE		CLOCK REF.	
0.0	MH	MH# 9E-MH061			
44.6	SC			2:00	CAP
49.0	LD	LONGITD. DEFECT			
65.8	CP	CRACKED PIPE			
67.6	CP	CRACKED PIPE			
74.3	BISC	CRACKED PIPE		12:00	LIVE
75.8	BISC	CRACKED PIPE		12:00	LIVE
91.6	CP	CRACKED PIPE			
92.8	SC			3:00	CAP
107.8	SC			2:00	CAP
116.5	BISC			12:00	LIVE
120.1	BISC			3:00	LIVE
135.3	BISC	PROT. 1"		9:00	LIVE
141.4	SC			2:00	CAP
165.1	BISC			12:00	LIVE
168.5	SC			2:00	CAP
176.9	CP	CRACKED PIPE			
195.6	SC			9:00	LIVE
221.0	BISC	PROT.1/2"		12:00	LIVE
231.7	SC			2:00	CAP
231.7	CP	CRACKED PIPE			
252.9	SC			9:00	CAP
255.9	SC			3:00	LIVE
273.0	CP	CRACKED PIPE			
275.3	CP	CRACKED PIPE			
276.9	SC			2:00	LIVE
279.8	SC			2:00	CAP
281.0	BISC			12:00	LIVE
294.2	CP	CRACKED PIPE			
306.8	SAG	START SAG IN PIPE			
311.1	BISC			12:00	LIVE
312.8	SC			2:00	CAP
325.0	SAG	END SAG IN PIPE			
347.7	CP	CRACKED PIPE			
350.0	MH	MH# 9E-MH045			

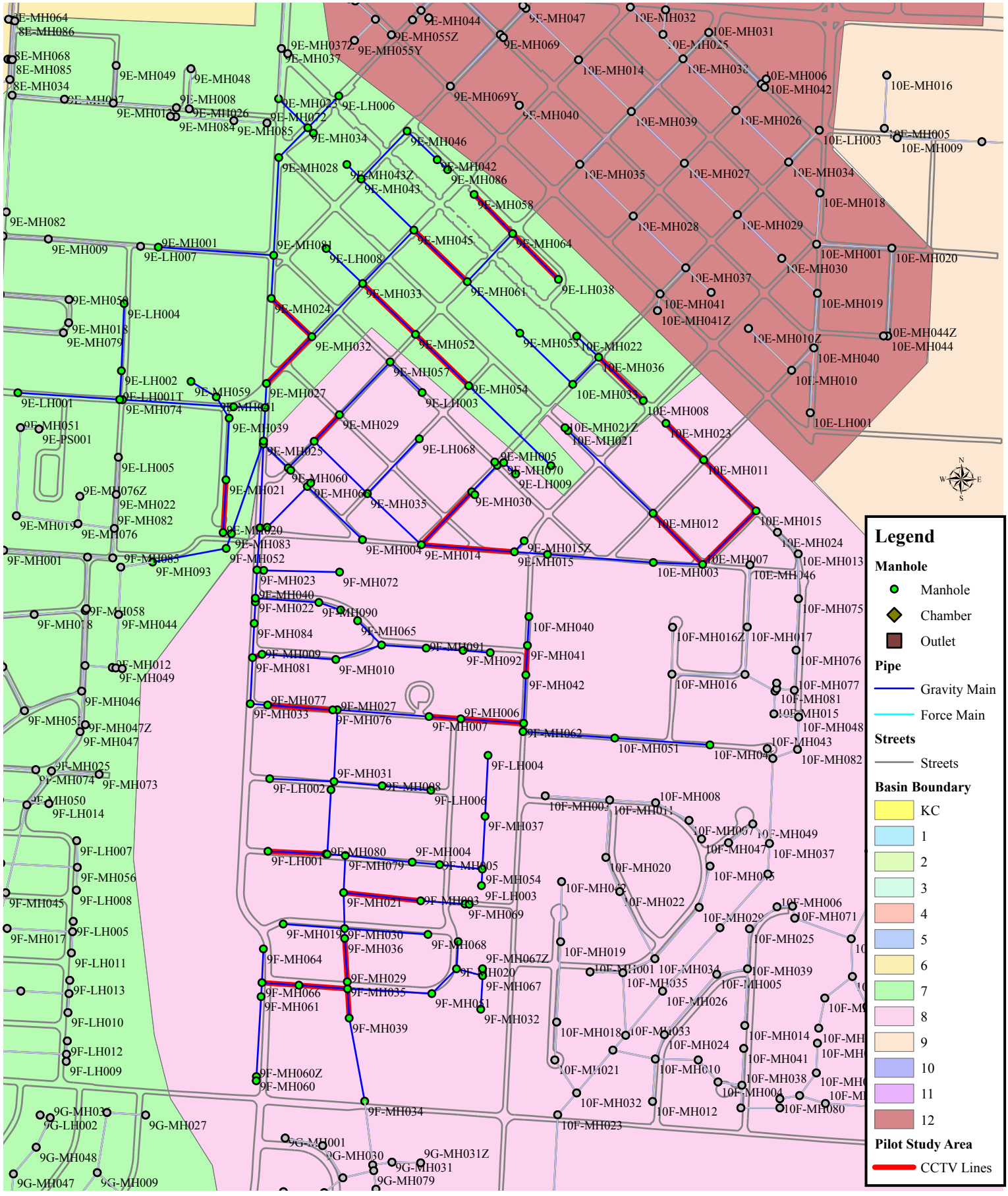
Belton, MO

2007 Wastewater Master Plan

Figure O

Example CCTV Inspection Form

WADE & ASSOCIATES, INC.



Belton, MO

2007 Wastewater Master Plan

Figure P

Pilot Study Area
CCTV Inspected Lines

WADE & ASSOCIATES, INC.

6. Field Surveys and GIS Geodatabase Development

Midland GIS Solutions was contracted to conduct GPS field surveys of the City of Belton's collection system and to develop a GIS Geodatabase of the surveyed utility features for the 2007 Wastewater Collection System Master Plan. Information collected by Midland GIS Solutions included manhole rim and invert measurements (GPS x,y coordinate locations and vertical, z, rim elevations were recorded), pipe diameter and invert elevations, pipe material, and pipe length as well as lift station features. Approximately 2,414 sanitary sewer features were captured during the field survey activities. The GPS survey data was referenced to the County Geographic Reference System (GRS) used by the City's existing GIS program. All field survey data was recorded and downloaded on a daily basis.

Midland GIS Solutions used the GPS field survey attribute data, the City's existing as-built construction plans, and AutoCAD sewer drawings to populate the personal GIS Geodatabase for the City's use. The Geodatabase was created using GBA Master Series© software and integrates with ESRI ArcGIS© v.9 GIS software. The completed GIS/GBA Master Series personal Geodatabase contains the collection system features discussed above as well as hyperlinking of the City's as-built drawings to the Geodatabase line segment features. The final task for the Geodatabase development is transfer and installation of the completed GIS/GBA Master Series personal Geodatabase and software to the City by Midland GIS Solutions. Midland GIS Solutions will also provide training to the City in the use of the Geodatabase. The data transfer will occur at the conclusion of the project.

B. Cost-Effectiveness Analysis

One of the goals of this study is to develop a least-cost improvement plan to reduce excessive I/I and effectively manage the remaining peak wastewater flows by increasing the capacity of the collection system. It is impossible to remove all sources of I/I in the collection system, therefore, a cost-effectiveness analysis (CEA) was conducted to identify a least-cost improvement plan. The CEA was performed using I/I sources identified within approximately 33,530 lf of pipeline representing the Pilot Study Area.

The procedures followed for the Pilot Study Area CEA are briefly described as follows:

- Tabulation of all identified I/I sources within the Pilot Study Area were computer-generated using Pipedream©, Wade & Associates proprietary hydraulic modeling software series. Pipedream© incorporates data regarding I/I related defects into the model and calculates a flow rate for each I/I defect source. The listing ranks I/I sources on the basis of cost to remove an I/I flow (normally "$/gpm"). The compiled listing of all identified I/I is included in Appendix K. A resulting "elimination cost curve" was plotted showing the incremental percentage of I/I removed and corresponding removal cost.
- For each 10% incremental reduction of I/I in the Pilot Study Area, a hydraulic analysis was performed on the hydraulic model. The hydraulic model showed where replacement sewers were required. The estimated cost for restoring system hydraulic reliability under the designated rainfall conditions was also calculated. The resulting curve was plotted showing incremental percentage of I/I removed and the corresponding replacement sewer costs for safe transport to the system outlet.
- An estimate for additional costs to store and treat wet-weather flows for the Pilot Study Area was computed and operational costs required to maintain the treatment plant was determined. The resultant treatment cost vs. incremental I/I removal was plotted.

The curves described above were numerically added to produce a total cost curve. The lowest point on the curve was considered to be the cost-effective point. In other words, this point represents the minimum cost for the City to adequately improve the system within the Pilot Study Area. This procedure is consistent with the applicable parts of 40 CFR, Part 35.2030 of the Federal Regulations.

1. I/I Removal Costs:

   Unit removal costs for public- and private-sector I/I were based on historical records collected from similar projects in Missouri, Oklahoma, Kansas, and Texas. All costs are based on outside contract pricing. The assumption in this analysis is that specialized utility contractors through competitive pricing will perform all rehabilitation. Allowances were made, though, for local construction cost and a standard cost schedule was entered into Pipedream©. Estimated unit removal rates, expressed in $/gpm, were also estimated from other projects that have resulted in successful elimination of I/I. A final tabulation of I/I reduction costs for this study is shown in Table V-6.

Table V-6
Pilot Study Area
Summary of Incremental I/I Elimination Costs

% I/I Removed	Removed I/I (mgd)	Remaining I/I (mgd)	I/I Removal Cost ($)
0.0%	0.00	1.74	$0
10.8%	0.18	1.56	$1,800
20.8%	0.36	1.38	$4,770
30.0%	0.52	1.22	$9,420
31.0%	0.54	1.20	$11,700
33.0%	0.57	1.17	$19,680
35.0%	0.61	1.13	$34,680
36.0%	0.62	1.12	$46,560
37.0%	0.64	1.10	$64,920
38.0%	0.66	1.08	$94,440
38.9%	0.67	1.07	$151,560

*Note: Based on a 5-year, 90-minute storm event

2. Replacement Sewer Costs:

For each 10% incremental reduction in I/I (including 0% elimination and intermediary increments), a revised hydraulic model was created to determine the replacement sewer requirements and the respective cost estimate for each alternative. Prices for the replacement sewer cost estimate for the Pilot Study Area were based on estimated unit price per linear foot from past projects. In Section VI, Table VI-7 provides a summary of the unit costs used for replacement sewer construction. The costs are reflective of planning-level estimates and may vary significantly depending on the final selected implementation plan and schedule.

A final tabulation of replacement requirements and their respective costs for incremental reduction levels of I/I for the Pilot Study Area are provided in Table V-7.

Table V-7
Pilot Study Area
Summary of Incremental Replacement Sewer Costs
(5-year, 90-minute storm event)

% I/I Removed	I/I Removed (mgd)	Remaining I/I (mgd)	Replacement Sewer Cost
0.0%	0.00	1.74	$211,700
10.8%	0.18	1.56	$149,000
20.8%	0.36	1.38	$115,100
30.0%	0.52	1.22	$49,400
31.0%	0.54	1.20	$49,400
33.0%	0.57	1.17	$49,400
35.0%	0.61	1.13	$47,400
36.0%	0.62	1.12	$47,400
37.0%	0.64	1.10	$47,400
38.0%	0.66	1.08	$28,700
38.9%	0.67	1.07	$9,700

*Replacement sewer costs include 30% Legal, Administrative, Design, and Contingencies fees

3. Treatment Costs:

As part of the cost-effectiveness analysis, the project team evaluated the impact of extraneous I/I on treatment costs. The volume of I/I was quantified at the outlets to the Pilot Study Area. I/I volumes needed for the cost-effectiveness analysis were based on a 5-year, 90-minute storm event. The Pipedream© model was used to determine the volume of I/I entering the Pilot Study Area. Inflow, infiltration, and base flows were calculated by the hydraulic model for a period of three days, a period of time sufficient to allow infiltration flows to recede and sewer flows to return to normal. Base flow volumes for a three-day period were then removed, resulting in the residual I/I volume. Since these flows represent a 5-year, 90-minute storm event of 1.57 inches per hour of rainfall, total volumes were normalized to a 1-year period using an average annual rainfall of 33.9 inches. I/I volumes for a 5-year, 90-minute storm are shown in Table V-8.

Table V-8
Pilot Study Area
Summary of Incremental I/I Volumes
(5-year, 90-minute storm event)

% I/I Removed	Total Storm Volume (mg)	Total Base Flow Volume (mg)	Total I/I Volume (mg)	Normalized I/I Volume (mg)
0.0%	1.37	0.17	1.20	25.82
10.8%	1.27	0.17	1.10	23.69
20.8%	1.17	0.17	1.00	21.61
30.0%	1.09	0.17	0.92	19.84
31.0%	1.08	0.17	0.91	19.67
33.0%	1.06	0.17	0.89	19.22
35.0%	1.04	0.17	0.87	18.81
36.0%	1.03	0.17	0.86	18.59
37.0%	1.02	0.17	0.85	18.38
38.0%	1.01	0.17	0.84	18.16
38.9%	1.00	0.17	0.83	17.94

*Note: Normalized I/I volume calculated for an average annual rainfall of 33.9 inches.

Annual operation, maintenance, and treatment costs for excessive I/I in the Pilot Study Area were determined using $1,250/million gallons. To compare treatment costs to capital costs for I/I elimination and replacement sewers, it is necessary to determine the present worth of the treatment cost. The following criteria were used:

- A planning period of 20 years for system improvements
- A discount rate of 8.25% was used to calculate the present worth cost for annual O&M for debt service and capital costs

Treatment costs for the Pilot Study Area are shown in Table V-9.

Table V-9
Pilot Study Area
Summary of Treatment Costs
(5-year, 90-minute storm event)

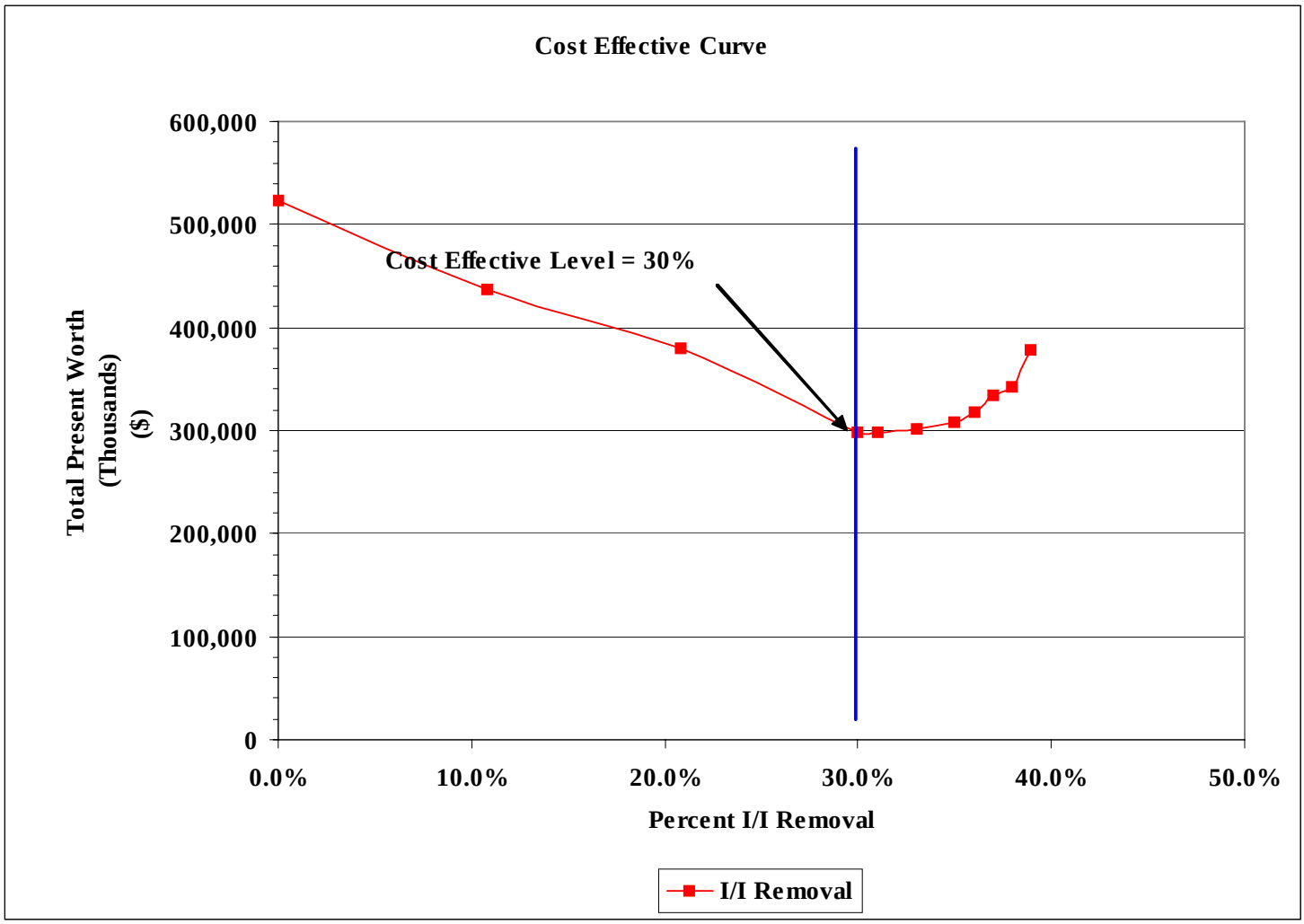
I/I Removed (%)	Normalized Annual I/I Volume (mg)	Annual Treatment Cost ($)	Present-Worth Treatment Cost ($)
0.0%	25.82	$32,281	$311,400
10.8%	23.69	$29,609	$285,600
20.8%	21.61	$27,017	$260,600
30.0%	19.84	$24,804	$239,300
31.0%	19.67	$24,588	$237,200
33.0%	19.22	$24,021	$231,700
35.0%	18.81	$23,509	$226,800
36.0%	18.59	$23,239	$224,200
37.0%	18.38	$22,969	$221,600
38.0%	18.16	$22,699	$219,000
38.9%	17.94	$22,429	$216,400

*Notes: Annual treatment and O&M cost based on $1,250/million gallons treated.
Present-worth based on 8.25% for 20 years (P/A, 8.25, 20) = 9.646.

4. Summary of Cost-Effectiveness Analysis:

Results of cost analysis for I/I removal, replacement sewers, and treatment were combined on the basis of net present-worth. Values were numerically added at each increment of I/I elimination and a final cost-effective point was determined. The analysis shows that the optimum present-worth alternative is approximately 30% removal of I/I, anything less than or greater than this percentage would yield a greater total present-worth cost.

Figure Q and Table V-10 summarizes the present-worth analysis for each cost component of the sewer system improvement plan. **The minimum total present-worth cost of $298,100 is at the 30% I/I removal point for the Pilot Study Area**. All costs presented in Table V-10 represent improvements for a 5-year, 90-minute, design storm event protection plan.



Belton, MO

2007 Wastewater Master Plan

Figure Q

Cost-Effectiveness Analysis

WADE & ASSOCIATES, INC.

Table V-10
Pilot Study Area
Summary of Cost-Effectiveness Analysis
(5-year, 90-minute storm event)

I/I Removed (%)	I/I Removal Cost ($)	Replacement Sewer Cost ($)	Present-Worth Treatment Cost ($)	Total Cost ($)
0.0%	$0	$211,700	$311,400	$523,100
10.8%	$1,800	$149,000	$285,600	$436,400
20.8%	$4,800	$115,100	$260,600	$380,500
30.0%	$9,400	$49,400	$239,300	$298,100
31.0%	$11,700	$49,400	$237,200	$298,300
33.0%	$19,700	$49,400	$231,700	$300,800
35.0%	$34,700	$47,400	$226,800	$308,900
36.0%	$46,600	$47,400	$224,200	$318,200
37.0%	$64,900	$47,400	$221,600	$333,900
38.0%	$94,400	$28,700	$219,000	$342,100
38.9%	$151,600	$9,700	$216,400	$377,700

Results of the Pilot Study Area CEA show the recommended least-cost alternative of I/I reduction, transport, and treatment at approximately 30%. The 38.9% I/I reduction level represents all I/I flow contributed from defects located during the Pilot Study Area field inspection activities. The remaining 61.1% of extrapolated I/I flow (based on the Pilot Study Area I/I reduction level) was not detected during these activities.

For the purposes of the cost-effectiveness analysis, it was assumed that 100% of the flow from defects targeted for correction would be abated. Thus, replacement sewer sizes and costs, along with present worth treatment costs were established for each I/I reduction level based on this assumption. However, it is understood that some defects will "reactivate" over the 20-year planning period due to continuing deterioration of the system.

VI. ANALYSIS AND HYDRAULIC MODELING

A. Objective

The evaluation of the system's ability to safely transport peak wastewater flows to the system outlets was a significant part of this sanitary sewer evaluation study. For the purpose of this study, the 5-year design storm event was imposed on the existing collection system via a computer generated hydraulic model, to determine the need for replacement sewers. The model was developed using MWH Soft's InfoSewer Pro™ Series Software.

By definition, the collection system is the network of gravity sewer pipes and manhole structures. It does not include pumping stations, force mains, holding facilities and control structures in the defined area. In principle, sanitary sewer systems are designed to transport domestic, commercial, and industrial wastes to the treatment facility. Although the design criteria used to size gravity sewers has changed over the years, some reserve capacity has formerly been considered for modest amounts of infiltration. Under existing conditions, however, the system does not have adequate capacity to transport peak flows (including infiltration and inflow) during major rainfall events. This results in collection system backups. Generally, these backups occur as a result of one or more of the following:

- General deterioration of the collection system due to age
- Indirect cross-connections between storm and sanitary sewers
- Illegal I/I connections under current plumbing codes

All of the above conditions may have been imposed on the City's collection system over the past several years and must be considered for modeling purposes. The resultant hydraulic model of the system has been developed and analyzed under these conditions.

The purpose of this analysis is to:

- Determine theoretical hydraulic capacity of the existing sewer system
- Analyze the current loads imposed on the existing system
- Analyze design storm loads imposed on the existing system
- Analyze design storm loads, after a flow reduction at the CEA level, imposed on the existing system
- Analyze future growth design storm event loads imposed on the existing system
- Identify and locate replacement sewers required to meet the specified design criteria

- Establish estimated costs for replacement sewers for both existing and future growth conditions

The resultant model is by no means a document that should be used to begin construction of replacement sewers. Necessary and additional design must be considered. However, the model will provide the City of Belton with a tool to establish design criteria for such improvements.

Although the type and quantity of data is important in modeling sanitary sewer systems, it is equally important to evaluate and use the data in a manner that will yield the greatest benefit.

B. Hydraulic Modeling and Analysis

Hydraulic behavior in sanitary sewer systems is principally a function of the following attributes: a) physical characteristics of the system network such as pipe length, slope, diameter, and material, b) maintenance-related problems such as roots, grease, and deposition, c) system configuration, d) basin size and orientation, and e) type and locations of I/I defects. Peak flows move through the system in a dynamic fashion due to attenuation and system travel time. For the 2007 Wastewater Collection System Master Plan hydraulic model, MWH Soft's InfoSewer Pro™ hydraulic modeling software was selected because of its ability to work within ESRI's ArcMap v.9 and for its compatibility with GBA Master Series software.

For the purpose of analyzing the Pilot Study Area and performing the cost effectiveness evaluation, Wade and Associate's used its own proprietary hydraulic modeling software series, Pipedream©. Pipedream© allows the combination of all data (including system defect data) collected during field inspection activities into comprehensive databases which in turn can be utilized by the software to assign flow rates to each defect found and assess the impact of I/I related defects on the system. Currently, four of the five comprehensive databases have been developed within Pipedream© for the Pilot Study Area. These include the databases for manhole inspections, visual pipe inspections, smoke testing, and TV inspections. Building inspections were the only SSES activity component not included as part this study.

C. Network Development

The model network for the 2007 Wastewater Collection System Master Plan was created using the Geodatabase developed by Midland GIS Solutions for this project. The Geodatabase contains the GPS manhole coordinates, manhole ID's, rim and invert elevations, pipe diameters, line segment lengths, slopes, and pipe roughness coefficients (n-values) for all known manholes and line segments in the

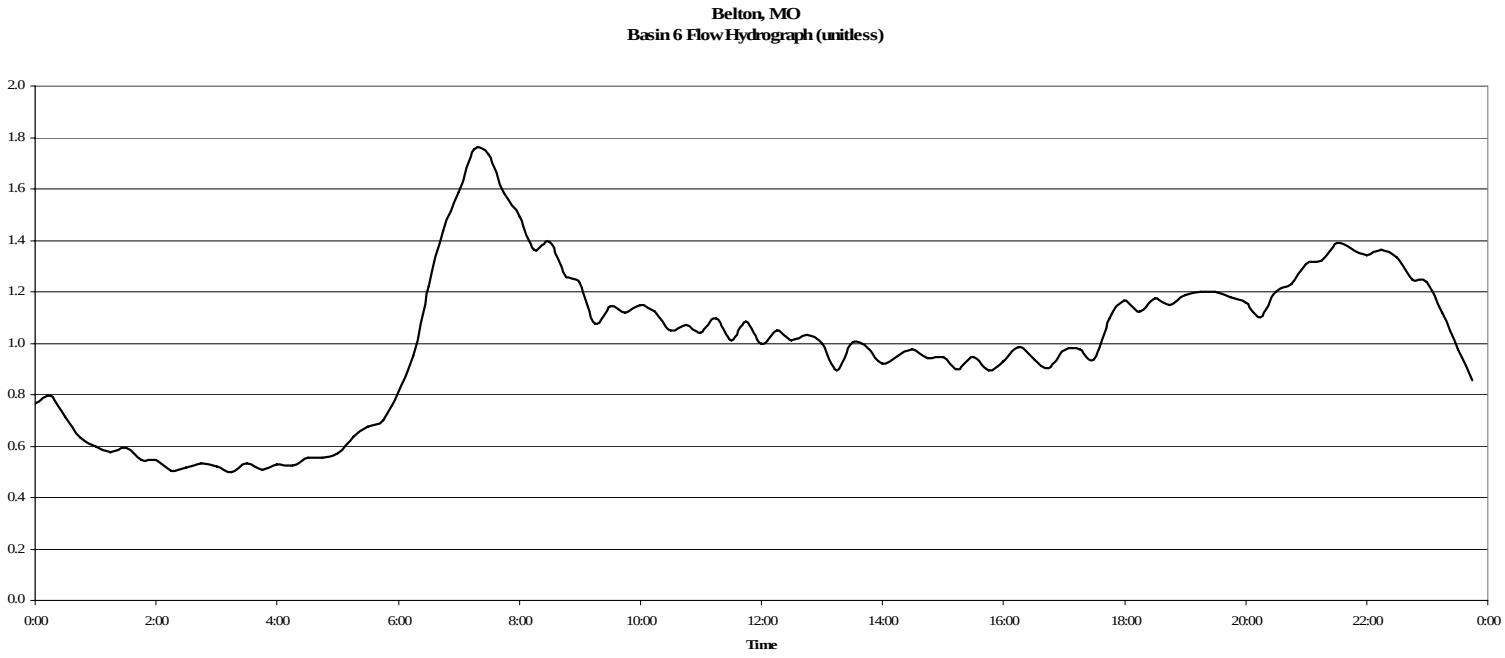
existing collection system. Once the Geodatabase was compiled it was imported into InfoSewer ProTM, and a connectivity check was performed. This ensured all pipes were properly connected and accounted for in the model. Critical connections such as cross-connections, bypasses, and possible split flow configurations were field-verified. These connections represent key points in the model that impact the theoretical hydraulic performance of the system. City as-built data was referenced to resolve missing data or discrepancies in the model. Appendix L contains the Pipe Inventory Summary Report showing footage for existing pipe sizes by basin included in the existing system hydraulic model. The pipe inventory report does not include force mains or 4" stub outs/lamp holes, but does include footage for 4" gravity sewers. Approximately 61,073 linear feet of sewer located outside of the flow monitoring study area also connects to the City's WWTF. This area was designated as basin 13 for modeling purposes.

Pipe roughness coefficients (Manning's n-values) used in model calculations were based on pipe material. N-value assignments were established in collaboration with, and approved by the City. Rehabilitated lines (CIPP) were assigned an n-value of 0.013, PVC lines were assigned an n-value of 0.013, RCP lines were assigned an n-value of 0.014, and VCP lines were assigned an n-value of 0.015 within the model.

D. Modeling Procedures

1. Creation of Dry Weather Flow (DWF) Hydrographs:

   Flow monitoring data collected by the temporary monitors was evaluated for days that were not significantly influenced by preceding measured storm events. Data collected from these metering periods, called "dry days," were used to develop an average diurnal flow pattern for each basin monitored. An average of at least five "dry days" were taken to develop a flow pattern for the hydrographs. For example, Figure R shows the DWF hydrograph created from the flow monitoring data for basin 6. The dry day flow peaking factor for basin 6 is 1.753, calculated by dividing the maximum dry day flow by the average dry day flow. The DWF hydrographs created were adjusted so that the average daily flow equaled one unit. This is done to ensure that the DWF hydrographs do not amplify peak flows in the model. Table VI-1 shows the dates used to calculate the DWF hydrographs and base flow for each monitoring location.



Belton, MO 2007 Wastewater Master Plan	Figure R Basin 6 DWF Hydrograph	WADE & ASSOCIATES, INC.

Table VI-1
Dry Days Used for DWF Basin Hydrographs

Monitored Basin ID	Weekday				
	Monday	Tuesday	Wednesday	Thursday	Friday
1	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
2	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
3	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
4	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
5	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
6	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
7	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
8	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
9	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
10	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
11	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05
12	05/2/05	05/03/05	04/05/05	05/05/05	05/06/05

DWF hydrographs are utilized by InfoSewer Pro™ to model the basin base flow through the system. The accumulative monitored flow for each basin is distributed evenly over each basin's loading manholes. InfoSewer Pro™ uses the assigned DWF hydrograph and the load at each manhole to calculate a base flow hydrograph which it then time routes through the system until it reaches the temporary flow monitoring location or system outlet. The calculated base flow hydrographs at these locations were compared with the measured hydrographs from the temporary metering devices. System flow contribution and the shape of the unit hydrograph were adjusted when necessary to achieve system calibration.

2. Inflow/Rainfall-Induced Infiltration Hydrograph:

Flow monitoring results of the collection system study area indicated that rainfall-induced inflow and infiltration is significant in all of the monitored basins. As discussed in Section IV, all meter sites showed inflow and rainfall-induced infiltration response. Therefore, this hydrograph becomes a critical part of the hydraulic model, since it can have a major impact on replacement sewer requirements.

Inflow and rainfall-induced infiltration hydrographs, like the base flow hydrographs, were created using the flow monitoring data. The hydraulic model was calibrated using three monitored rain fall events, June 1st, 8th, and 12th. For each rainfall event, basin hydrographs

were created using InfoSewer Pro™. The variables associated with using this method were adjusted until the wet weather flow (WWF) matched the flow monitoring data. An example for the June 8th calibration process is shown in Figure S. After all three storm events were calibrated to the model, the variables for each basin were plotted to project the values for the design storm. The projected design storm hydrographs were input into the model, along with the design storm hydrograph, and computed in the model. A model verification run was conducted on the June 4th storm event which approximates the 5-year, 90-minute storm event. The results of the calibration/verification run were satisfactory to achieve model calibration. Appendix M contains model output files showing the design storm hydrographs compared to the dry weather flow hydrographs.

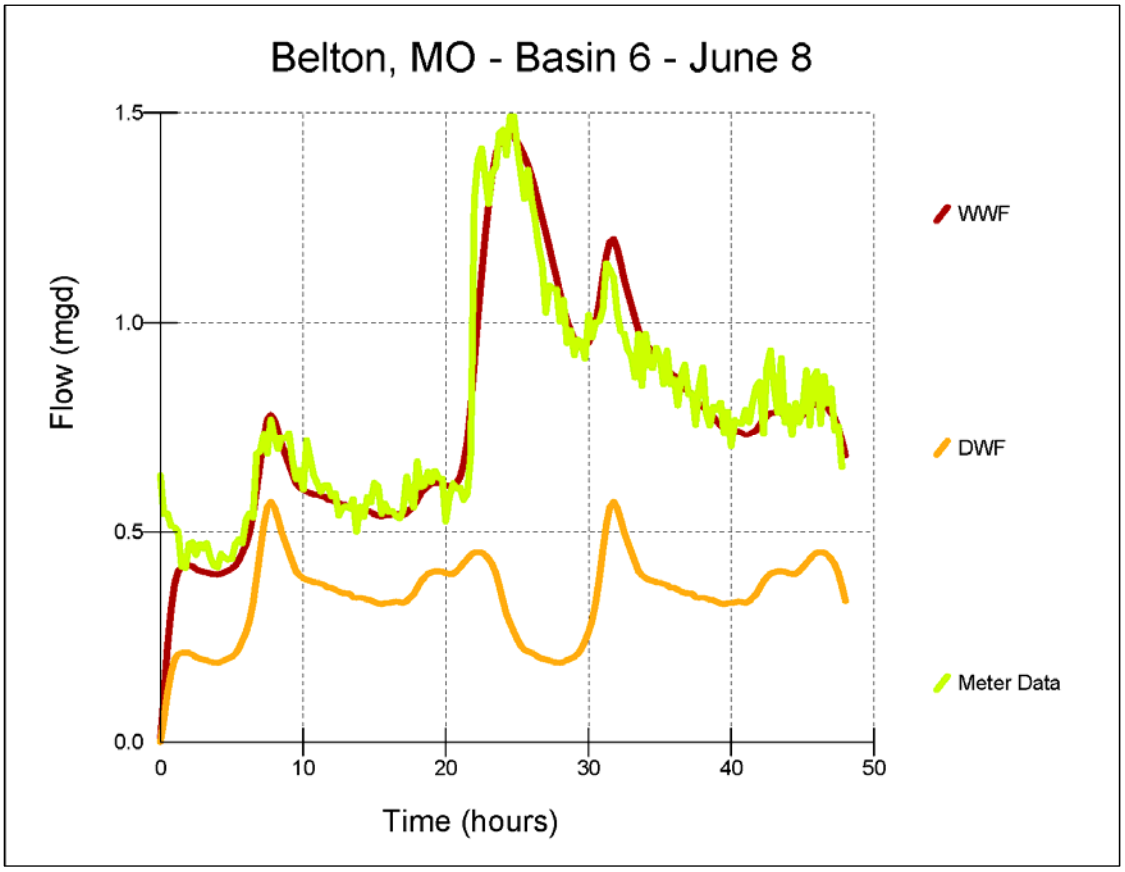


Figure S: Basin 6 – June 8th WWF Calibration Graph.

E. Design Storm Selection

For the purpose of this study a 5-year, storm event was used for the model calibration. A storm duration of 90-minutes was selected based on time of concentration calculations using the Kirpich equation and by examining flow meter data after storm events to evaluate when responses occurred.

At the monitoring points of basins 4 and 6 the approximate response time to rainfall events was between 60 to 90-minutes, with the equivalent 5-year design storm event yielding a time of concentration closer to 90-minutes. For this reason a 90-minute storm event was selected for model calibration. Design storm rainfall intensities are based on the document entitled "Precipitation Frequency Estimates for the Kansas City Metropolitan Area," by C. Bryan Young and Bruce M. McEnroe of the University of Kansas, sponsored by the Kansas City Metro Chapter of the American Public Works Association. The 5-year, 90-minute storm event for the Kansas City Metropolitan Area has a peak intensity of 1.57 in/hr.

F. Existing System Model

A hydraulic model of the existing collection system representing existing I/I conditions was prepared for a 5-year, 90-minute storm event at 0% I/I elimination. Additionally, a hydraulic model scenario representing reduced I/I levels was created for a 5-year, 90-minute storm event at an estimated 30% I/I elimination from the entire collection system. The application of 30% I/I reduction level represents the cost effective level for I/I elimination found for the Pilot Study Area during the CEA. These modeling scenarios compared current hydraulic capacities to peak flow rates for the selected storm event. Results of the modeling effort indicated that capacity improvements are needed, primarily along the major interceptors. Appendix N contains flow analysis reports showing all overloaded line segments for the 5-year design storm at 0% and at the estimated 30% I/I elimination runs. The flow analysis reports also list the replacement pipe size, replacement pipe cost, and the percent over capacity for each overloaded line segment. Total estimated cost for replacing all overloaded line segments for the 5-year, 90-minute storm event is $7,790,600. The total estimated cost for replacing all overloaded line segments for the 5-year, 90-minute storm event, after an estimated 30% system wide reduction in I/I, is $2,488,100. Table VI-2 summarizes the number of overloaded line segments and the replacement cost associated with the design storm event.

Table VI-2
Existing System Replacement Sewer Cost

Storm Event	I/I Reduction	Number of Replacement Lines	Total Cost	Total Cost w/ 30% Legal, Admin, Design and Contingencies
5-year	0%	171	**$5,992,800**	**$7,790,600**
5-year	30%	62	**$1,913,900**	**$2,488,100**

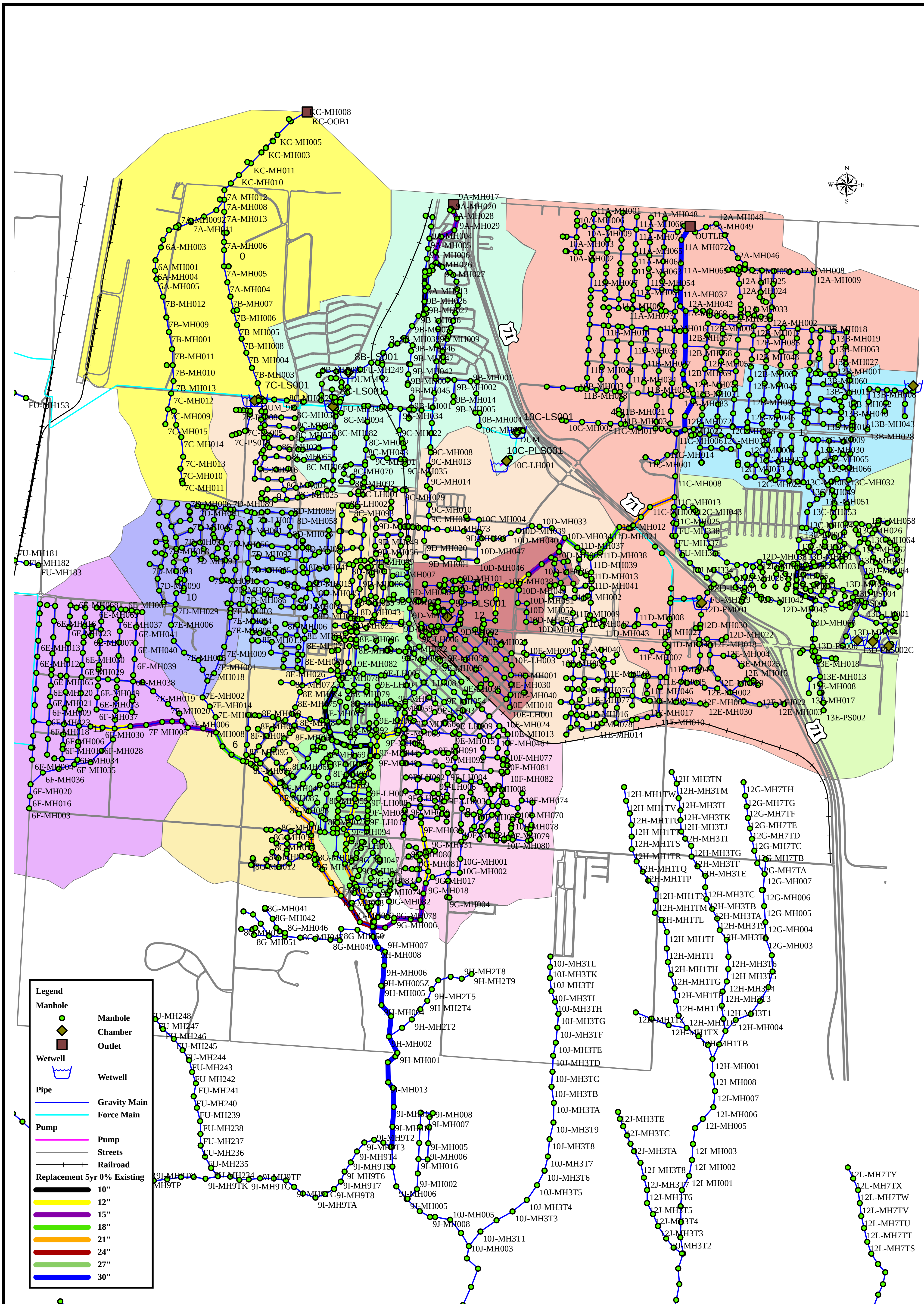
- Modeling Results:

  A model of the entire collection system under existing I/I conditions (that is, 0% I/I eliminated from the system) was developed using the flow routing conditions discussed previously. The model compared current hydraulic capacities to peak flow rates under the 5-year, 90-minute design storm event. Results of the model indicated possible overflows and surcharged conditions distributed throughout the collection system.

  A hydraulic gradient analysis and pipeline continuity check were conducted to identify where capacity improvements would be required in order to safely transport design storm induced flows to the system outlet. **The approximate cost to implement a sewer capacity improvement plan, at 0% I/I removal under existing flow conditions, is $7,790,600**. The costs associated to implement the capacity improvements eliminate all overflows and allow minor surcharging at a few locations along the lower reaches of the system. Actual construction costs could be higher due to the location of required replacement sewers. Costs associated for replacement sewers are for planning level only. Table VI-3 summarizes the replacement sewer cost for existing conditions at 0% I/I removal. Figure T shows the location of all capacity related replacement lines for existing conditions in the collection system

Table VI-3
Replacement Sewer Requirements for Existing Conditions
(5-yr, 90-minute storm event, 0% I/I Removal)

Basin	Replacement Sewer Cost ($)		
	Pipe < 15 in	Pipe ≥ 15 in	Total Cost
1	$0	$0	**$0**
2	$138,100	$0	**$138,100**
3	$138,400	$162,600	**$301,000**
4	$5,700	$1,355,300	**$1,361,000**
5	$0	$0	**$0**
6	$0	$714,800	**$714,800**
7	$728,900	$226,900	**$955,800**
8	$133,700	$63,700	**$197,400**
9	$0	$259,300	**$259,300**
10	$0	$0	**$0**
11	$88,000	$160,500	**$248,500**
12	$141,400	$114,700	**$256,100**
13	$0	$1,560,800	**$1,560,800**
Sub-Total			**$5,992,800**
Total with 30% Legal, Administration, Design and Contingencies			**$7,790,600**



Belton, MO

2007 Wastewater Master Plan

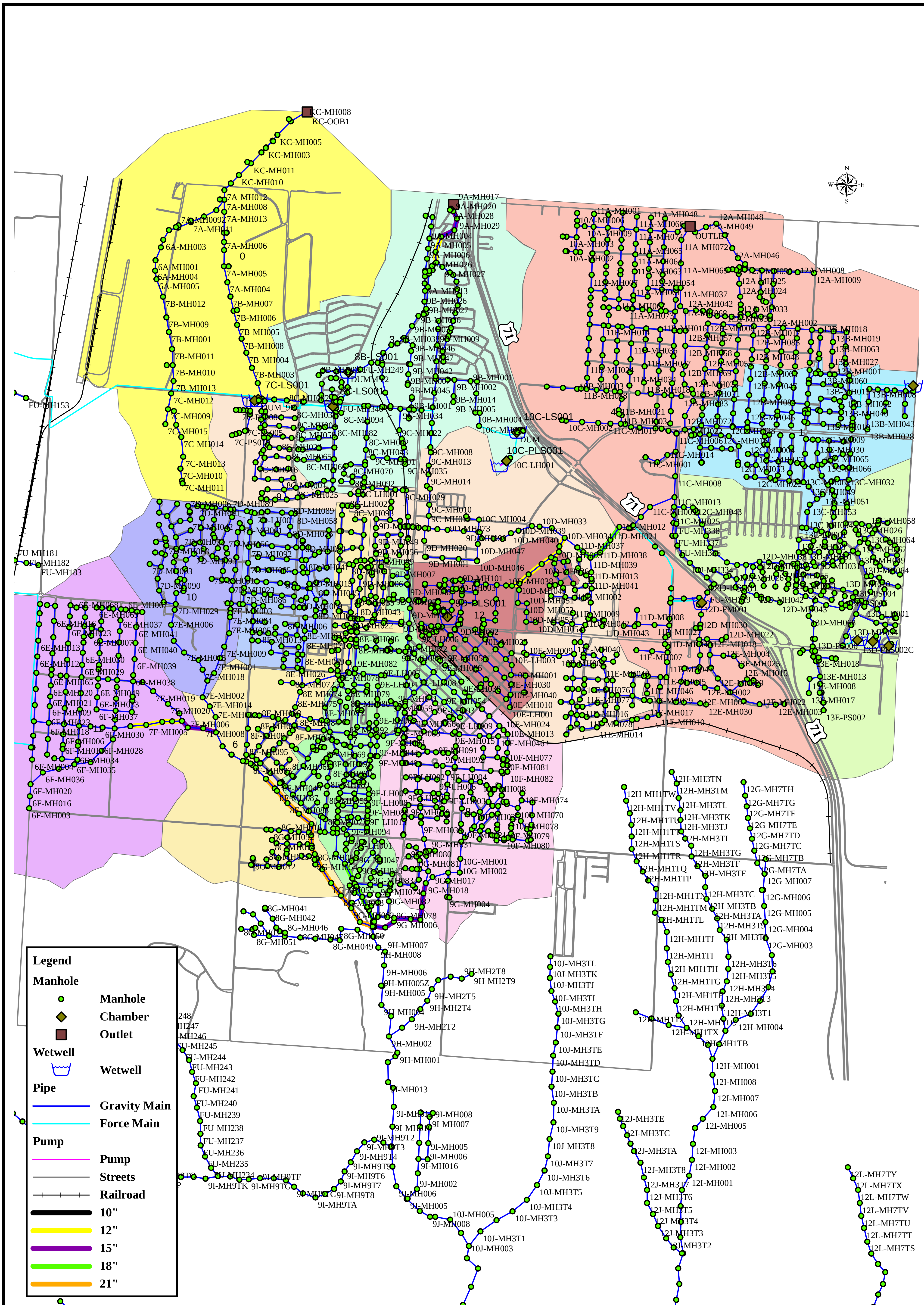
Figure T

Capactiy Improvement Sewers
Existing Conditions
Design Storm, 0% I/I Removal

WADE & ASSOCIATES, INC.

An additional modeling scenario was created to simulate flows in the entire collection system after an estimated system-wide 30% I/I reduction at the cost effectiveness level using the same flow routing conditions discussed previously. The model was used to compare current hydraulic capacities to peak flow rates at the 5-year, 90-minute design storm event after the estimated 30% inflow and infiltration reduction. Results of the model indicated possible overflows and surcharged conditions distributed throughout the collection system.

A hydraulic gradient analysis and pipeline continuity check were conducted to identify where capacity improvements would be required in order to safely transport design storm induced flows to the system outlet. **The approximate cost to implement a sewer capacity improvement plan, after an estimated 30% I/I removal from the entire system under existing flow conditions, is $2,488,100**. Actual construction costs could be higher due to the location of required replacement sewers. Costs associated for replacement sewers are for planning level only. A more detailed quantification of the replacement sewer plan for existing conditions at an estimated 30% I/I reduction is shown in Table VI-4. Figure U shows the location of all capacity related replacement lines for this scenario. As illustrated in Figure U and Table VII-4, by reducing the amount of projected I/I in the existing collection system, the number, size, and cost of replacement sewers is greatly reduced. Appendix O contains the recommended capacity improvement sewer lines for existing conditions at 0% and 30% I/I removal, respectively.



Belton, MO

2007 Wastewater Master Plan

Figure U

Capactiy Improvement Sewers
Existing Conditions
Design Storm, 30% I/I Removal

WADE & ASSOCIATES, INC.

Table VI-4
Replacement Sewer Requirements for Existing Conditions
(30% I/I Removal)

Basin	Replacement Sewer Cost ($)		
	Pipe < 15 in	Pipe ≥ 15 in	Total Cost
1	$0	$0	**$0**
2	$33,500	$0	**$33,500**
3	$69,100	$92,000	**$161,100**
4	$15,600	$0	**$15,600**
5	$0	$0	**$0**
6	$0	$589,700	**$589,700**
7	$0	$197,000	**$197,000**
8	$0	$63,700	**$63,700**
9	$21,900	$183,700	**$205,600**
10	$0	$0	**$0**
11	$113,900	$23,500	**$137,400**
12	$154,100	$0	**$154,100**
13	$0	$356,200	**$356,200**
Sub-Total			**$1,913,900**
Total with 30% Legal, Administration, Design and Contingencies			**$2,488,100**

G. Future Growth Model

A major goal of the 2007 Wastewater Collection System Master Plan is the analysis of system capacity requirements in regard to future growth planning for the City of Belton. As stated previously, the City of Belton is currently experiencing significant growth and is projected to sustain a growth rate of approximately 2.46% per year for the next ten years. It was anticipated that the projected future growth demands on the collection system would be a significant factor in replacement sewer requirements for the 2007 Wastewater Collection System Master Plan study.

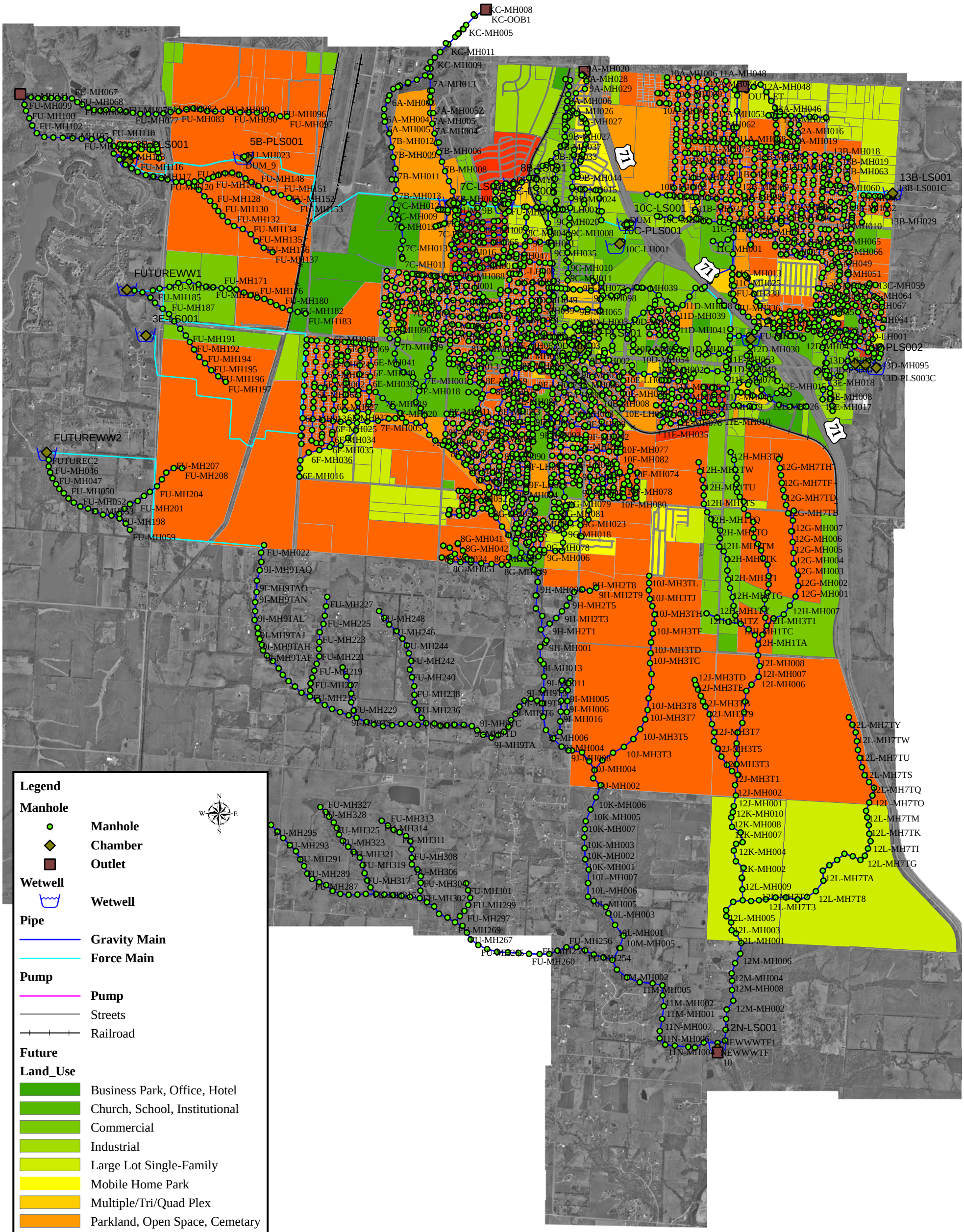
In an effort to maintain consistency for population projections, the City of Belton provided its existing and future growth land use projection data previously developed for the City's 2005 Water System Master Plan. This data provided information on undeveloped areas rezoned for development, new construction, projected land use types and average population densities. The City also provided contour elevation data. The existing and future land use projection data was imported into the Geodatabase and incorporated into the wastewater hydraulic model. The "Technical Memorandum – Population and Land Use" excerpted from the City's 2005 Water System Master Plan, is included as Appendix P and contains the population and land use projections for the City through 2045. As requested by the City, a 2025 planning period was used for the 2007 Wastewater Collection System Master Plan Report.

To analyze the City's future growth demands on the collection system, estimated collection system expansions were added to the hydraulic model network at theoretical locations based on contour elevations. The collection system expansions included one pump station, 207 manholes, and 207 sewer lines to carry the projected flows. All projected future land use flow was directed into loading manholes based on potential connections and direction of flow from contour elevations. Figure V depicts the projected future growth areas, by land use type, and includes the predicted collection system expansions incorporated into the model analysis. Table VI-5, lists the approximate existing, projected, and total acreages developed for each basin.

Table VI-5
Projected Future Growth by Acres

Basin	Existing Basin (acres)	Future Development (acres)	Total Projected Basin (acres)	Estimated Percent Developed
1	243	50	359	67.7%
2	295	138	621	47.5%
3	472	144	740	63.8%
4	904	366	1,536	58.9%
5	161	0	201	80.1%
6	197	219	516	38.2%
7	292	3	341	85.6%
8	249	139	451	55.2%
9	423	211	727	58.2%
10	183	48	260	70.4%
11	280	487	846	33.1%
12	100	78	228	43.9%
13	39	6,238	6,277	0.6%
KC	211	829	1,040	20.3%
Total:	**4,049**	**8,950**	**14,143**	**28.6%**

The City's 2005 Water System Master Plan provides a projected growth rate for the Northern Cass County area, including the City of Belton, of approximately 2.46% per year for the next 10 years. Data for average population density/acre, and land use type from the City's Water System Master Plan/Technical Memorandum were used for calculating flow rates for the future growth projections. Table VI-6 lists the average density (units/acre), occupancy (people/unit), average daily flow per person, daily flow peaking factor, and the calculated flow rate for each land use type incorporated into the hydraulic model.



Belton, MO 2007 Wastewater Master Plan	Figure V Future Growth Land Use Configuration	WADE & ASSOCIATES, INC.

Table VI-6
Land Use Future Growth Flows

Land Use Type	Average Density (units/acre)	Occupancy (people/unit)	Average Daily Flow (GPCD)	Peaking Factor	Flow Rate/Acre
Single Family	3	2.7	100	2.55	2,066
Large Lot Single Family	0.2	2.7	100	2.55	138
Two-Family	4	2.7	100	1.79	1,933
Multi/Tri/Quad plex	10	2.7	100	1.53	4,131
Mobil Home Park	7	2.7	100	1.53	2,892
Business Park, Office, Hotel	n/a	n/a	n/a	2.00	911
Commercial	n/a	n/a	n/a	2.00	1,215
Industrial	n/a	n/a	n/a	2.00	1,215
Church, School, Institutional					
- Elementary School		700	10	4.00	
- Middle School		1,070	10	4.00	
- High School		2,470	10	4.00	

Using the land use projections provided by the City and the InfoSewer Pro™ DWF hydrographs representing the type of land use, base flow projections were determined for each land use type identified in the hydraulic model. For residential areas, peak base flow rates for the future growth projections were calculated using the average density (units/acre), the occupancy (people/unit), and the peak daily flow rate per person. Residential land use was divided into five types: 1) Single Family, 2) Large Lot Single Family, 3) Two-Family, 4) Multi/Tri/Quad plex, and 5) Mobile Home Park. Peak daily base flow rates for the five residential land use types range from 153 to 255 gpcd. For non-residential areas, peak base flow rates were estimated as a percentage of residential types. Commercial and Industrial areas were estimated to contribute approximately 75% of the Single Family average daily base flow with a 2:1 peaking factor. Business Park, Office, and Hotels land use types were estimated to contribute approximately 75% of the Commercial/Industrial peak daily base flow. For School, Church, and Institutional land use types, three sub-categories were used to help identify the size of the institution: 1) Elementary School, 2) Middle School, and 3) High School. Flow rates for this category were not based on acreage but rather on an estimated population size for the institution.

In addition to base flow projections, inflow and infiltration flow rates were determined. Typically, base flow rates for land use type can vary significantly. However, I/I rates generally do not vary to the same degree by land use type as does base flow amounts. The effects of I/I on the collection system are commonly more dependent on the size and condition of the sewer system. In some older

residential areas, I/I contributions may be higher than in other land use areas, due to deteriorated and aging service laterals and perimeter drains. Since construction materials and practices have dramatically improved in recent years, it is considered that residential areas will not produce significantly higher I/I contributions for future growth areas.

- Modeling Results:

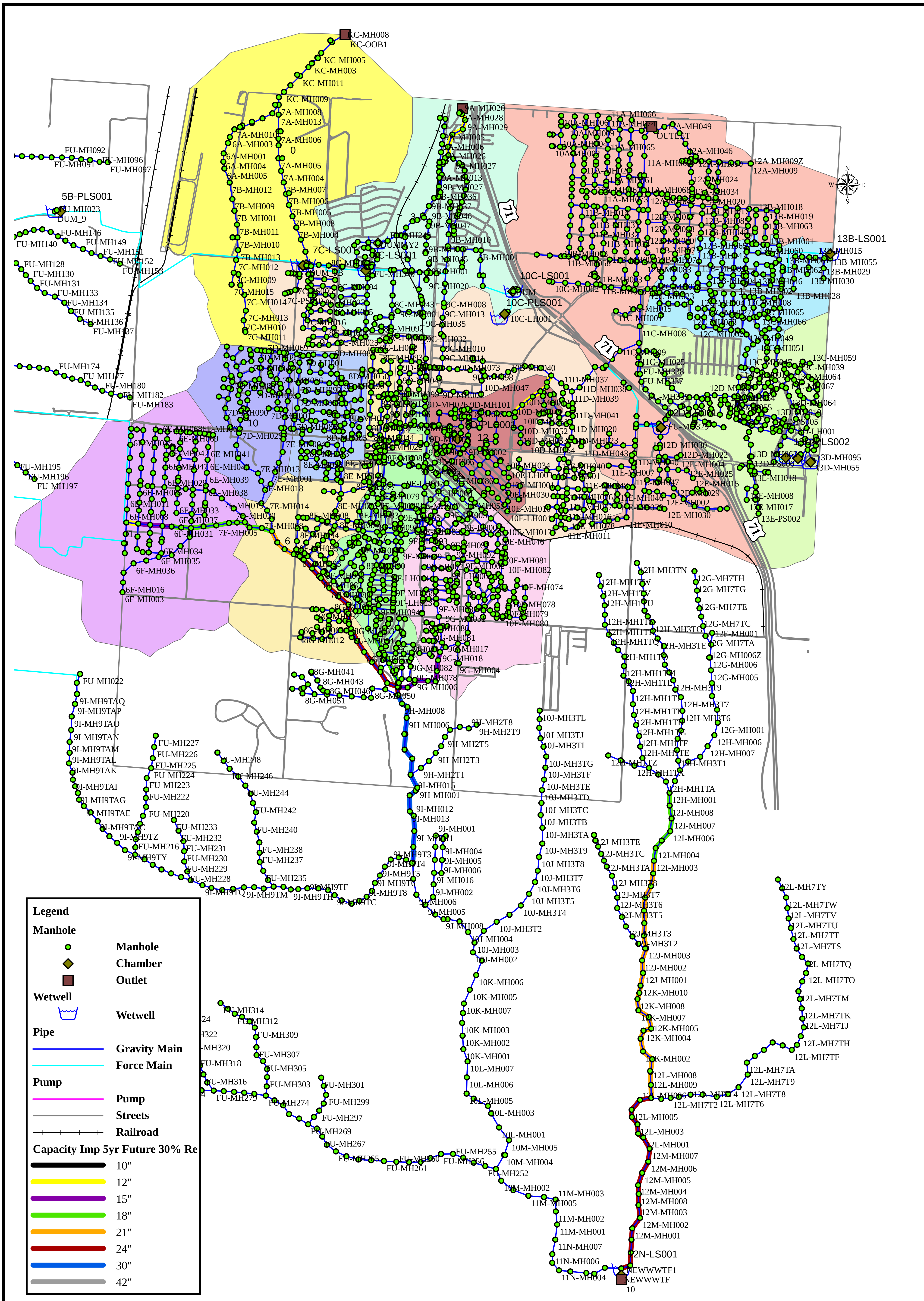
  Hydraulic modeling was conducted on wastewater flows developed from future growth land use projections for the 5-year, 90-minute design storm event at the estimated 30% I/I removal. As anticipated, hydraulic modeling results indicated that capacity improvements are required. Cost estimates were based on comparable unit price per lineal foot from past projects. Variables in the cost estimating tables were pipe diameter and depth of potential excavation. A summary of the unit costs for replacement sewer construction is shown in Table VI-7.

Table VI-7
Replacement Sewer Unit Cost Guideline
($ per lineal foot)

Pipe Dia. (in)	Cost ($)
6	$70
8	$76
10	$95
12	$114
15	$142
18	$170
21	$188
24	$205
27	$222
30	$240
33	$280
36	$298
42	$357

During a 5-year storm event, under future growth flow configuration, surcharging and overflows would occur along several main interceptors throughout the City. Figure W shows the location of all capacity related replacement lines for the design storm event, after 30% I/I removal. Appendix Q contains a flow analysis report showing all overloaded sewer lines in the Study Area for future growth analysis with the 30% I/I reduction factor.

A hydraulic gradient analysis and pipeline continuity check were conducted to identify where capacity improvements would be required in order to safely transport design storm induced



Belton, MO

2007 Wastewater Master Plan

Figure W

Capactiy Improvement Sewers
Future Conditions
Design Storm, 30% I/I Removal

WADE & ASSOCIATES, INC.

flows to the system outlet. The analysis indicated that approximately 43,642 linear feet of pipeline capacity improvements would be required. **The approximate cost to implement a sewer pipeline capacity improvement plan, after the estimated 30% I/I removal under future growth flow conditions, is $12,982,200.** The costs associated to implement the capacity improvements eliminate all predicted overflows and allow minor surcharging at a few locations along the lower reaches of the system. Costs are reflective of planning-level estimates and may vary significantly depending on the final selected implementation plan and schedule. Appendix R contains the recommended capacity improvement sewer lines for future growth conditions at the design storm event with the estimated 30% I/I removal.

VII. Impact Fee Study

A. Introduction

Public Finance Consultants was contracted to conduct an impact fee study and capital financial analysis for the City for the City of Belton as part of the 2007 Wastewater Collection System Master Plan. Their analysis included a review of the following items: 1) city ordinances, 2) past rates/impact fees, 3) customer based revenues and expenses, 4) current financial condition of the sewer fund, 5) population projections, 6) current sewer bond obligations, 7) capital improvement recommendations, and 8) sewer rates and impacts fees of up to five local cities.

A Microsoft Excel copy of the new rate model is included on the CD located on the inside back cover of this report.

City of Belton, Missouri

2006 Sewer Rate Study

Public Finance Consultants, Inc.
January 2007

January 25, 2007

John Bergin
Wade & Associates, Inc.
1201 Wakarusa Drive
Lawrence, KS 66049

Dear Mr. Bergin:

In accordance with our agreement with Wade & Associates, we are pleased to submit this *Sewer Rate Study* for the City of Belton, Missouri. Based on a comprehensive review of Sewer Fund finances, and the information provided to us on the City's proposed sewer line improvements and expansions and sewer plant improvements and expansions, this report warns of significant sewer rate increases necessary to return the Sewer Fund to financial health and pay for the proposed capital plans. We are submitting along with this report a customized spreadsheet model that will calculate the necessary rate increases based on assumptions supplied by the City. It also estimates sewer connection fees based on different policy scenarios. The City should update this model and review possible rate changes annually as it proceeds with its capital plan.

The purpose of this report is to present the findings of our financial review of the City of Belton's Sewer Fund and the resulting recommendations for setting sewer rates as the City pursues its Wastewater Master Plan and Wastewater Treatment Facility Expansion Project. The study includes:

- ✓ Overview of the Sewer Fund current financial condition
- ✓ Forecast of revenue requirements for the period 2008-2027
- ✓ Determination of rates and connections fees based on assumed policy goals
- ✓ Analysis of the change in customer bills with comparison to other area cities
- ✓ A customized spreadsheet model to calculate rates and connection fees

Data for this study is in fiscal years, unless otherwise noted, and was collected from interviews with City staff, City budgets, annual financial reports, ordinances, the City billing system or supplied by engineering firms engaged by the City. The data and assumptions in this report and associated model were submitted previously to the City for review. We recommend that before the City take any action they verify all the assumptions contained in Appendices A and B, and make any adjustments they feel necessary. Any adjustments will affect the results discussed in this letter.

Sincerely,

Julie Carmichael Stacy Miller

Executive Summary

The cash flow forecast for the Sewer Fund includes rate increases of 30% in the first year, another 20% in the second year and 3% thereafter for the rest of the forecast period. These increases are intended to move the fund closer to the minimum standards for financial health described later in the *Financial Analysis* section, and were chosen as a starting point for further policy discussion. Even with these significant increases, the Sewer Fund cash balance as a percent of expenditures does not approach the metro average of 35% until around 2012.

The rate model described in this report will give the City the capability of setting appropriate sewer rates throughout its 20 year capital plan. As capital projects change, efficiencies are achieved, or costs increase or decrease over the years, the model can be updated with new assumptions to calculate necessary rate adjustments. Three conclusions hold true regardless of the specific policy parameters the city chooses for the model:

- ✓ **Rate increases will occur throughout the forecast period and most likely continue after the forecast period.** Because of the level of investment called for in the master plan, it is likely most if not all growth-related projects will be bond financed. Some will not start until midway through the forecast period. This means debt service cost will continue after the forecast period and the City should expect additional rate increases. For this reason it is essential the City continue to review its sewer rates annually.

- ✓ **Regardless of how the Master Plan is implemented, an immediate and significant rate increase is needed.** The cash balance in the Sewer Fund has been declining since 2004, and the fund currently owes the Water Fund an estimated $500,000+ borrowed to over expenses in 2006 and 2007. Even if the City does not implement its Master Plan in 2008 and makes no other budget adjustments, a significant rate increase would be needed just to cover expenses. The recommended rate increase in 2008 is the first step to return the fund to financial health.

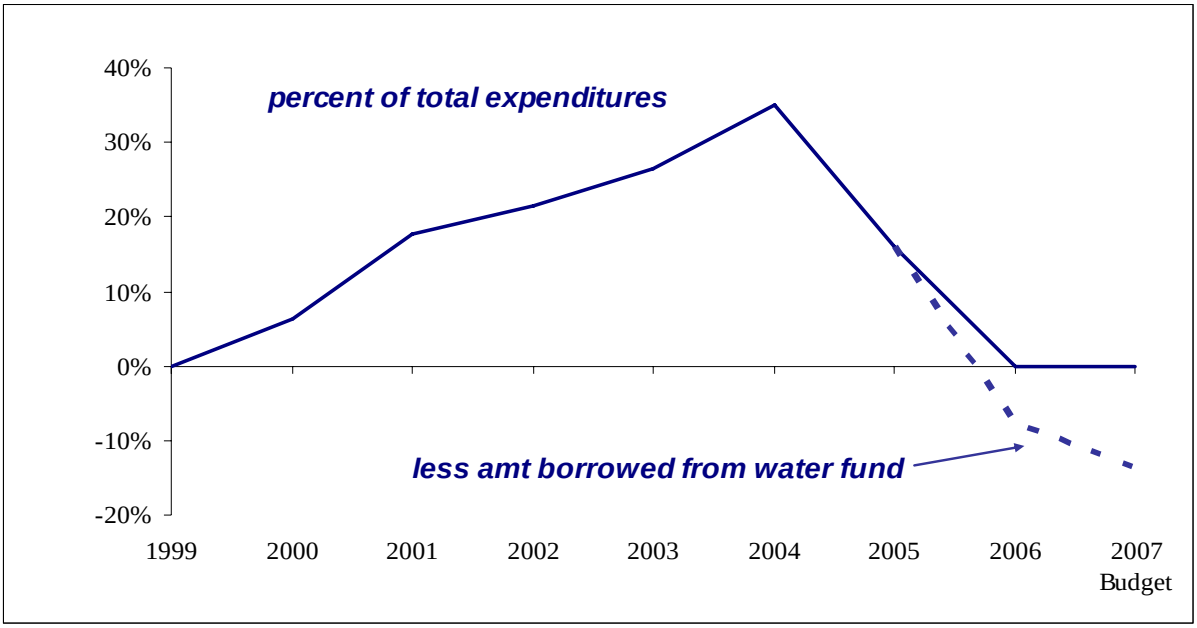
- ✓ **The City may face higher borrowing costs due to historical and current financial condition of the Fund.** Credit rating agencies and investors will look closely at the City's credit worthiness, largely measured by the financial ratios evaluated in this report. Because credit ratings can have a significant effect on the cost of borrowing, the City may decide to implement higher increases than are discussed in this report, in order to move the Fund to solvency prior to entering the bond markets. Higher increases will improve the Sewer Fund's financial condition more quickly but they may be more difficult to implement politically.

However the City decides to phase in the rate increases, because of the current financial condition of the Sewer Fund there must be some increases in the first few years of the forecast period and those increases will be significant.

Financial Overview

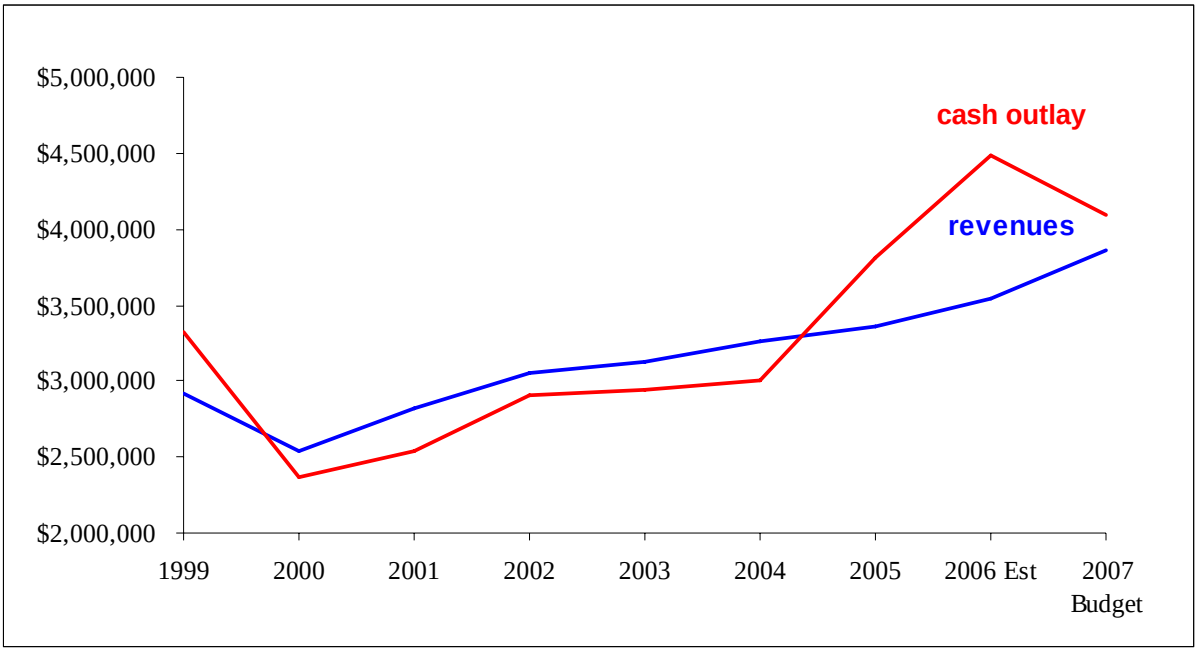
The financial health of the Sewer Fund is evaluated based on three indicators: cash balance, operating ratio, and coverage ratio. A fund's operating cash balance is generally defined as year-end unrestricted cash and investments and is analyzed as a percent of total expenditures. It is tracked both in terms of its level and its trend. While it is important to maintain an adequate level of cash reserves, an operating cash balance which is declining over time can reveal a structural imbalance between revenues and expenses. Cities generally set their own policies on the level of reserves to be maintained based on specific risks, expenditure patterns, and pending capital improvements. A review of metro area cities shows fund balances ranging between 20% and 50% of expenditures with an average of 35%. Exhibit 1 shows that cash balances in the City's Sewer Fund have declined steadily from 2004 to reach 0% in 2006 and is expected to be 0% in to 2007 as well. In addition, the Sewer Fund has an outstanding loan to the Water Fund that totaled $320,000 in 2006. The Finance Department estimates an additional $240,000 will be borrowed to cover expenses in 2007.

Exhibit 1
Ending Unrestricted Cash and Cash Equivalents



A look at the structural balance graph in Exhibit 2 shows the reason for this decrease in cash. The past five years have seen revenues growing an average of 4% per year, while expenditures have been increasing at an annual rate of about 8%. While revenues have grown, on average, about 4% a year for the last ten years, there was a 27% increase in cash outlay from 2004 to 2005 due to one-time debt and contractual expenses. This higher level of cash outlay is expected to be maintained in 2006 and 2007, however, largely driven by a 15% increase in personnel costs, and a 20% increase in payments to Little Blue Valley. 2006 and 2007 also estimate higher capital expenditures, $570,000 and $328,000 respectively, compared with an annual average of about $150,000 for the prior five years. Even with rate adjustments to increase revenue, some structural imbalance between revenues and expenditures is likely to continue.

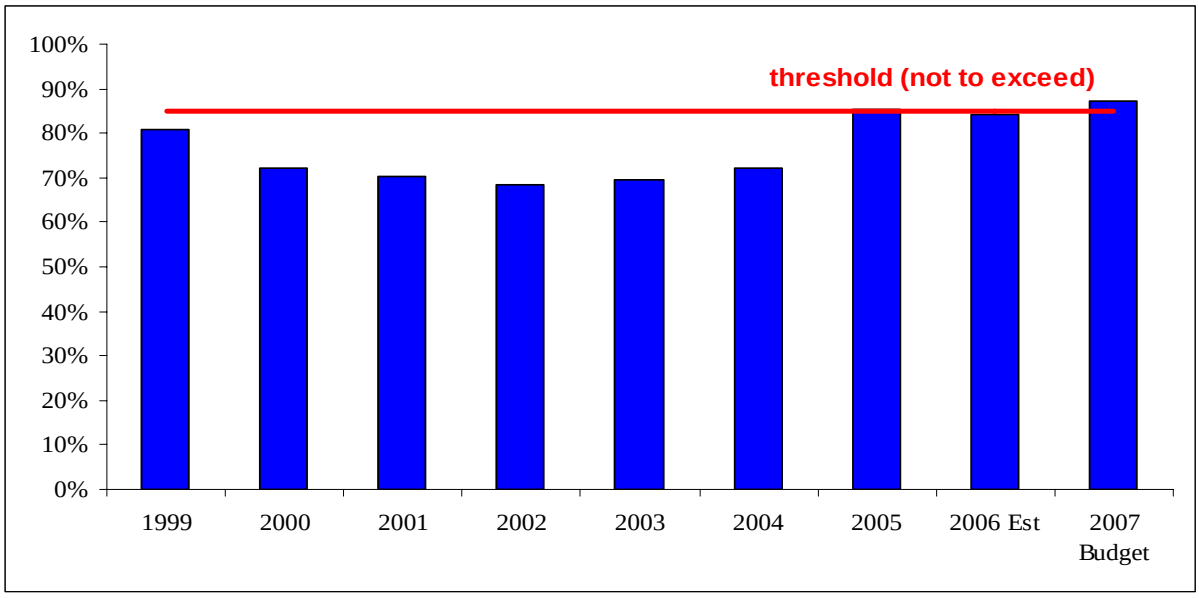
Exhibit 2
Structural Balance



One of the largest expense items is the transfer to the General Fund for overhead, franchise fees and PILOT payments. In 2007 this transfer is budgeted to be over $1 million or 50% of operating costs. A survey of other local governments shows this transfer to be significantly higher than in other jurisdictions. General Fund transfers from the sewer funds of other local jurisdictions, for all purposes, range between 10% and 20%. We presented this information to the City in more detail in June 2006. It is our understanding the City is reviewing its overhead allocation to ensure it reflects a specific formula that seeks to recover identifiable General Fund costs and meets all legal requirements.

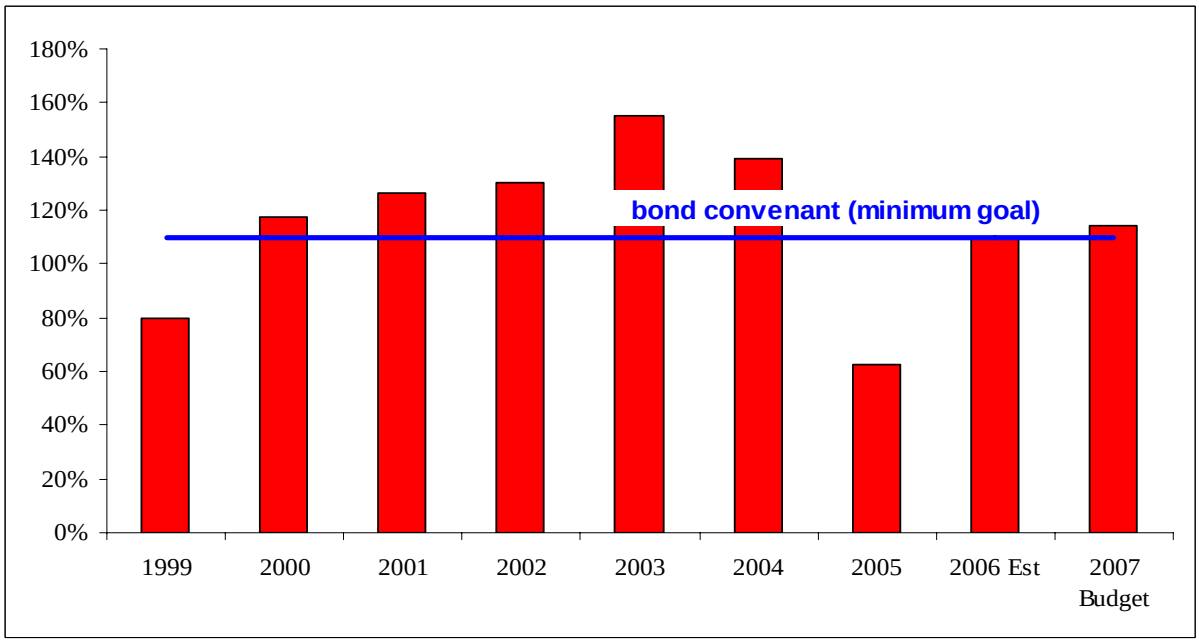
The revenue/cash outlay imbalance experienced by the Sewer Fund can also be seen in Exhibit 3 which shows the operating ratio over the past 8 years. The operating ratio, measured as operating and maintenance expenses divided by total operating revenues, is one measure of profitability. The operating ratio should be at or below the general industry standard of 85%. The Sewer Fund currently just meets industry standards for profitability with ratios at or below 85%. However, since 2004 the operating ratio has been increasing as operating expenses have grown faster than revenues.

Exhibit 3
Operating Ratio



In Exhibit 4, the coverage ratio highlights another aspect of the fund's financial condition. The coverage ratio reflects the fund's annual ability to meet debt service payments and is measured as net revenue divided by debt service. Coverage ratio minimums are specified in the bond ordinances authorizing the issuance of debt. The City currently has two outstanding issues that will be retired in 2013. The coverage ratio minimum is 110%. Municipal credit industry standards for coverage, however, are somewhat higher, usually around 170%.
In 2005, according to the City's independent audit, revenues were not sufficient to meet the coverage requirements of the City's bond ordinance. While this is expected to improve in 2006 and 2007, coverage is still lower than credit industry standards of around 170%.

Exhibit 4
Coverage Ratio



Overall, the analysis of the operating balance, operating ratio, and coverage ratio indicate some serious challenges for the Sewer Fund. The Fund is dependent on loans from the Water Fund to meet its expenses making it very difficult to finance ongoing maintenance needs or respond to any unanticipated events. Current revenues should be sufficient to adequately cover debt service requirements, but there is little cushion. A significant rate increase will be needed to correct this situation. A rate increase of 20% in FY2008 would just cover expenses in that year and provide enough cash to pay back the Water Fund by 2012. This does not yet take into account any new capital spending under the proposed master plan.

Summary of Wastewater Master Plan and Wastewater Treatment Facility Expansion Project

The City has engaged Wade and Associates and Carollo Engineers to review its sewer system and recommend capital improvements. The consultants proposed projects to increase operational efficiencies of the system, meet the needs of an anticipated increase in population growth, and provide possible alternatives to purchasing sewer services from Little Blue Valley. Based on the information provided to us from Wade and Carollo, they recommend a total investment in the City's sewer system of $72 million dollars over the next twenty years (figures are in 2006 dollars). More than 35% percent of that investment ($26 million) occurs in the first 3 years. Of the $72 million proposed about 20% is for maintenance of and improvements to the current system with the remainder for new sewer lines and plant expansion. To put this plan in perspective, the City's capital pay-as-you-go program and revenue bond debt service payments total less than $10 million over the past 10 years.

Sewer Fund Forecast

Forecasting future revenues and expenses for the Sewer Fund necessitates making assumptions about certain demographic factors such as population growth and making certain policy choices such as which capital projects get bonded and which are paid for with current revenues. Many of these assumptions and policy choices have a significant impact on the resulting forecast. As time goes on these assumptions can change as projects get revised or outside providers change their rates. We strongly recommend the city review these assumptions annually, make any adjustments in the spreadsheet model provided with this report and review the results.

The assumptions used to generate the results discussed in this report are described in full detail in Appendices A and B. Assumptions are based on historical analysis where appropriate. All assumptions have been previously submitted to the City. The City should verify those assumptions when considering the recommended rate changes.

Forecast Results

The cash flow forecast for the Sewer Fund is shown in Exhibit 5. The first five years of the forecast period are shown here for discussion purposes and the entire forecast is shown in Appendix C. The forecast includes rate increases of 30% in the first year, another 20% in the second year and 3% thereafter for the rest of the forecast period. These increases are intended

to move the fund closer to the minimum standards for financial health described earlier in the *Financial Analysis* section. The target ratio of unreserved cash to total expenditures in the model is equal to the metro average of 35%; the bond coverage ratio (net revenue divided by debt service) should be at least 110% preferably closer to 170%.

Exhibit 5
Financial Forecast

	2007	2008	2009	2010	2011	2012
Service charge revenue increase		30.0%	20.0%	3.0%	3.0%	3.0%
Revenues						
Charges for Services						
Sewer Services		4,416,930	5,432,824	5,758,793	6,104,321	6,470,580
Air Base		125,000	125,000	125,000	125,000	125,000
Sewer Connection Fee		547,500	563,925	580,843	598,268	616,216
Other Charges		69,319	71,399	73,541	75,747	78,019
Interest Income		250,000	250,000	250,000	250,000	250,000
Miscellaneous		7,000	7,000	7,000	7,000	7,000
Expenses						
Personnel		686,552	714,014	861,550	1,019,748	1,060,537
Operating Expenses		529,873	561,665	595,365	699,223	741,177
Little Blue Sewer Services		1,051,850	1,146,517	1,249,703	1,245,159	1,357,223
KCMO Sewer Services		-	-	-	-	-
JoCo Sewer Services		-	-	-	-	-
Repayment to Water Fund		112,629	112,629	112,629	112,629	112,629
Capital improvements		864,652	573,668	903,492	586,745	939,830
Debt service/lease pymts.		958,944	1,662,100	2,275,078	2,371,827	2,389,644
Interfund Charges						
Overhead		907,310	726,659	541,324	592,826	631,787
Franchise Tax		-	-	-	-	-
In Lieu of Tax		-	-	-	-	-
Increase(decrease) in cash		303,939	952,896	256,035	532,180	313,988
Cash balance		303,939	1,256,835	1,512,870	2,045,050	2,359,038
balance as % of expenditures	0%	6%	23%	23%	31%	33%
bond coverage ratio	114%	234%	199%	156%	152%	157%

As can be seen by the highlighted row in Exhibit 5 the cash balance as a percent of expenditures does not approach the metro average of 35% until around 2012. The Fund does achieve a balance that would be at least in the lower range of those in the metro area (20%-50%) by the second year. Since rate hikes higher than 30% might not be politically feasible to consider, this approach was chosen as a starting point for further policy discussion. The City should use the model to experiment with different rate increase scenarios and consider the resulting effects on fund balance. These different scenarios will reveal the policy choice the City must make. Higher increases will improve the Sewer Fund's financial condition more quickly but they will be more difficult to implement politically. However the City decides to phase in the rate increases, the bottom line is that because of the current financial condition of the Sewer Fund there must be some increases in the first few years of the forecast period and those increases will be significant.

The forecast in Exhibit 5 also shows that the coverage ratio minimum of (110%) is met for all years but that the higher goal of reaching the industry standard of (or 170%) is met only in the first two years. As more debt is added, the coverage ratio declines, and with so many projects occurring in the first few years of the capital plan, debt service increases quickly, reaching more than $2.5 million by the fifth year. Higher rate increases, at least 8-10% annually would be needed after the second year if coverage of 170% was to be maintained. Here again the City should use the model to decide how best to phase in rates to achieve the 170% goal. In all years, however, the minimum coverage of 110% must be maintained.

Rates and Connection Fees

Exhibit 6 shows the rates and connection fees generated by the model when using the forecast detailed in the previous section. While only five years of rates are shown here for discussion purposes, rates for the full twenty-year forecast are shown in Appendix D. Rates and fees for 2007 are from the 2007 budget. It is important to note that these calculated rates and fees will change if any of the assumptions for the forecast are adjusted. Exhibit 7 shows the impact of these rate changes on sample customer bills for average residential and commercial customers. The residential, commercial, and industrial profiles used to calculate these bills are representative of the data from the City's billing system. The profiles for small and large residential customers are for illustrative purposes only. The City has the option to change these profiles and view the impact on estimated bills. Due to differences in consumption levels, percentage increases in fund revenue may not directly translate to the same percentage increase in customer bills.

Exhibit 6
Sewer Rates and Connection Fees

	2007	2008	2009	2010	2011	2012
Minimum Charge	9.35	11.83	12.35	14.86	14.43	15.49
Volume Charge per 100 gallons	0.6236	0.8134	1.0088	0.9929	1.0400	1.0568
Gallons free of volume charge	1,500	1,500	1,500	1,500	1,500	1,500
Connection Fee per unit	$0	$2,500	$2,500	$2,500	$2,500	$2,500

Currently, the City does not have a sewer connection fee. Since about 80% of the project costs in the proposed capital plan are growth-related, the City would like to implement a sewer connection fee to ensure that new customers pay for most of those expenditures. However, since the plan calls for such significant investment the resulting connection fees recovering all growth-related costs may prove so high as to discourage development. The model assumes that only 30% of growth-related project costs (including interest charges) are recovered over the 20-year forecast period. This results in a connection fee of $2,500. This recovery rate is a not recommendation but simply a starting point for policy discussion.

Exhibit 7
Customer Profiles

	Monthly Usage All Year	Winter =	92%
Small residential	2,000	1,800	of all year consumption, residential only
Average residential	5,000	4,600	
Large residential	12,000	11,000	
Commercial	15,000		
Industrial	60,000		

Est. Monthly Bills:	*2008*			
	Sewer Bill		Increase (Decrease)	
	2007	2008	Amount	%
Small residential	11.22	14.27	3.05	27%
Average residential	28.68	37.05	8.36	29%
Large residential	68.59	89.10	20.51	30%
Commercial	93.54	121.64	28.10	30%
Industrial	374.16	487.67	113.51	30%

Est. Monthly Bills:	*2009*			
	Sewer Bill		Increase (Decrease)	
	2008	2009	Amount	%
Small residential	14.27	15.38	1.11	8%
Average residential	37.05	43.62	6.58	18%
Large residential	89.10	108.19	19.08	21%
Commercial	121.64	148.54	26.90	22%
Industrial	487.67	602.50	114.83	24%

Est. Monthly Bills:	*2010*			
	Sewer Bill		Increase (Decrease)	
	2009	2010	Amount	%
Small residential	15.38	17.84	2.46	16%
Average residential	43.62	45.64	2.02	5%
Large residential	108.19	109.19	1.00	1%
Commercial	148.54	148.90	0.36	0%
Industrial	602.50	595.71	(6.79)	-1%

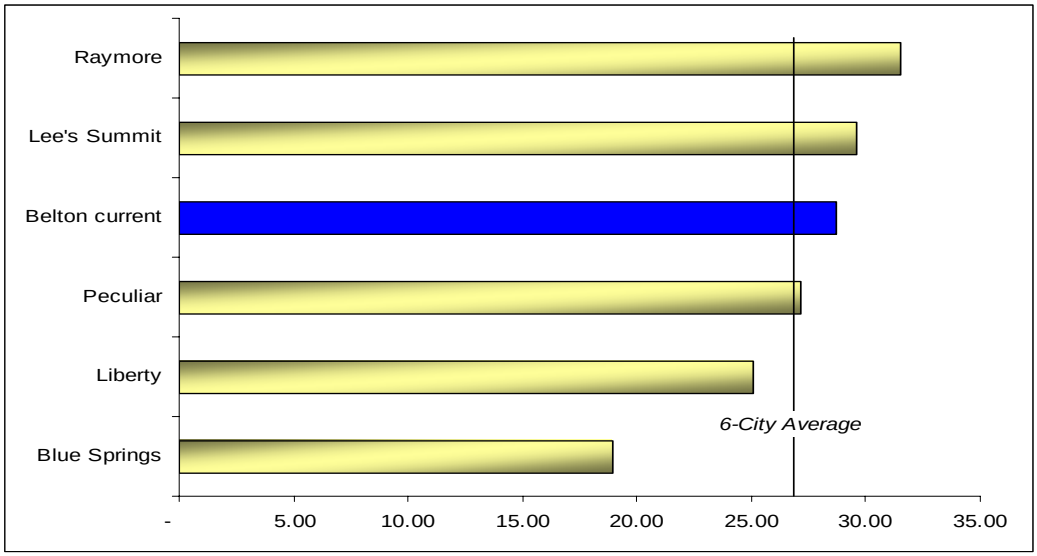
Est. Monthly Bills:	*2011*			
	Sewer Bill		Increase (Decrease)	
	2010	2011	Amount	%
Small residential	17.84	17.55	(0.29)	-2%
Average residential	45.64	46.67	1.03	2%
Large residential	109.19	113.23	4.04	4%
Commercial	148.90	154.83	5.93	4%
Industrial	595.71	622.83	27.12	5%

Est. Monthly Bills:	*2012*			
	Sewer Bill		Increase (Decrease)	
	2011	2012	Amount	%
Small residential	17.55	18.66	1.11	6%
Average residential	46.67	48.25	1.58	3%
Large residential	113.23	115.89	2.66	2%
Commercial	154.83	158.16	3.33	2%
Industrial	622.83	633.72	10.89	2%

Comparison to Other Area Cities

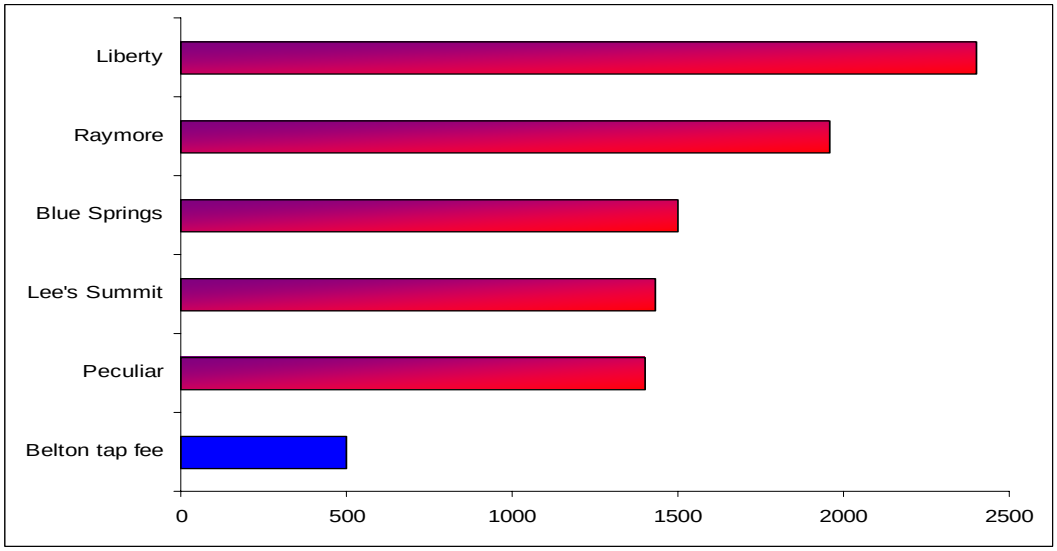
Exhibits 8 and 9 show a comparison of Belton's average residential sewer bill and connection fees compared to five other area cities. The survey group was chosen by the City based on proximity and an experience in residential growth similar to that facing Belton. The City's current rate puts customers' residential bills just above the group average. The first rate increase of 30% would raise the City's average monthly residential bill to about $37, an $8 increase. This would place Belton's sewer bills in the upper range of the survey group.

Exhibit 8
Comparison of 2006 Average Residential Sewer Bills



Belton's current tap fee of $500 is on the low end; however, as it is only a tap fee it is not intended to recover sewer system capital costs. For policy discussion purposes, the model assumes a 30% recovery on growth associated costs through the connection fee. This results in a connection fee of $2,500 and would put the City in the upper range of the survey group.

Exhibit 9
Comparison of 2006 Sewer Connection Fees



Conclusions

The rate model described in this report will give the City the capability of setting appropriate sewer rates throughout its 20 year capital plan. As capital projects change, efficiencies are achieved, or costs increase or decrease over the years, the model can be updated with new assumptions to calculate necessary rate adjustments. Three conclusions hold true regardless of the specific policy parameters the city chooses for the model:

- ✓ **Rate increases will occur throughout the forecast period and most likely continue after the forecast period.** Because of the level of investment called for in the master plan, it is likely most if not all growth-related projects will be bond financed. Some will not start until midway through the forecast period. This means debt service cost will continue after the forecast period and the City should expect additional rate increases. For this reason it is essential the City continue to review its sewer rates annually.

- ✓ **Regardless of how the Master Plan is implemented, an immediate and significant rate increase is needed.** The cash balance in the Sewer Fund has been declining since 2004, and the fund currently owes the Water Fund an estimated $500,000+ borrowed to over expenses in 2006 and 2007. Even if the City does not implement its Master Plan in 2008 and makes no adjustment to overhead charges, a significant rate increase would be needed just to cover expenses. The recommended 30% rate increase in 2008 is the first step to return the fund to financial health.

- ✓ **The City may face higher borrowing costs due to historical and current financial condition of the Fund.** Credit rating agencies and investors will look closely at the City's credit worthiness, largely measured by the financial ratios evaluated in this report. Because credit ratings can have a significant effect on the cost of borrowing, the City may decide to implement higher increases than are discussed in this report, in order to move the Fund to solvency prior to entering the bond markets. Higher increases will improve the Sewer Fund's financial condition more quickly but they may be more difficult to implement politically.

APPENDIX A
Model Assumptions

Consumption & Customer Base

The most recent complete year of billing records (calendar 2005) shows about 7,300 sewer customers. More than 90% of those accounts were residential. Water records show an average winter usage of about 6,250 gallons per month.

> *Forecast Assumption.* From 2008-2027 consumption for City customers is projected to increase about 3% annually, reflecting the population estimates supplied by Wade. This translates to about 5,900 new sewer accounts over the twenty-year forecast period.

Revenues

Sewer charges provide the majority of revenue, accounting for 85 to 90% of total revenue in the sewer fund. The next largest source is interest income accounting for about 5% of revenue. Other sources include payments from the sewer services contract with the air base, and other miscellaneous revenue.

> *Forecast Assumption* In the absence of rate adjustments, sewer charges are projected to increase about 3% per year, based on the assumption of future growth in population. The forecast in Exhibit 5 does reflect rate increases that will be discussed in detail in the forecast results section. Other revenues are conservatively projected to remain at their 2007 budgeted levels.

Currently, the City does not have a sewer connection fee, rather a tap fee of $500 per connection. Since about 80% of the project costs in the proposed capital plan are growth-related, the City would like to implement a sewer connection fee to ensure that new customers pay for most of those expenditures. However, since the plan calls for such significant investment the resulting connection fees may prove so high as to discourage development. For example, the total cost for growth related projects is $57 million. That amount divided by the estimated number of new accounts over the twenty-year forecast period, 5,900 would result in a connection fee of about $9,700. Even if those project costs were spread over the number of new accounts anticipated within the next forty years, 12,000, the connection fee would be about $4,800. These general calculations are noted only to illustrate magnitude of the investment and do not include financing costs as most projects will probably all be bonded.

> *Forecast Assumption* The model assumes that only 30% of growth-related project costs (including interest charges) are recovered over the 20-year forecast period. This results in a connection fee of $2,500. This recovery rate is a not recommendation but simply a starting point for policy discussion.

Revenue Requirements (Expenses)

The revenue required for the continued operation of sewer activities must be sufficient to meet the cash requirements for operation and maintenance of the system, debt service, and expenses for annual capital improvements. An analysis of these costs in the Sewer fund reveals that 70% are fixed, that is they will be incurred regardless of changes in consumption and the remaining 30% of costs vary directly with consumption.

Personnel costs have historically accounted for about 15% of total costs and grown on average about 6% a year from 1999 to budget 2007. Salary and benefits per employee has increased about 4% over this same period. Other operating costs such as supplies, utilities, and contractual services account for about 10% of total costs and have grown about at an average annual rate of about 3% of the same period.

> *Forecast Assumption – Personnel Costs* Per employee personnel costs are anticipated to rise about 4% a year. A total of eight additional Sewer employees are anticipated as the wastewater treatment facility expands, with four employees added in 2010-2011 with the first expansion and four more in 2014-2015 with the second planned expansion. The model assumes additional staff will be paid the average salary.
>
> *Forecast Assumption – Other Operating Costs* Other operating costs are calculated to grow based on the assumed flows into the Belton plant. Flow in general is assumed to grow at 3% a year (population) with 45% of that flow directed to the Belton plant at the beginning of the forecast period increasing to 54% of total flow directed to the Belton plant by the end of the forecast period. This results in an annual average rate of increase of 7%.

The cost of purchasing sewer services from Little Blue Valley has increased significantly since 1999 rising from 12% of total costs to 24% of total costs. It is by far the fasted growing cost faced by the Sewer Fund. The increase is fueled both by rate increases from Little Blue Valley and an increased flow directed there. Currently the City sends about 55% of its flow to Little Blue Valley.

> *Forecast Assumption* The model calculates purchased sewer costs based on assumptions of rate increase for Little Blue Valley (about 6% a year) and assumed flows to Little Blue Valley. The percentage of the City's wastewater flow directed to that facility will fall over the forecast period as the City's own treatment facility is expanded. By the end of the forecast period only 35% of the City's flow is directed to Little Blue Valley. The City anticipates sending the remaining 11% of flow to two new providers Kansas City and Johnson County. As no timing or cost data is available for these providers at this time, the model conservatively assumes the same average cost as Little Blue Valley. This results in an annual average increase for purchased sewer services of 8% over the entire forecast period.

Transfers to the General Fund for overhead, pilot payments, and franchise tax have generally remained at about 25% of total costs and between 50% and 65% of operating costs since 1997. As discussed earlier, the overhead allocation methodology is being reviewed.

> *Forecast Assumption* The model assumes that overhead is reduced and that ultimately transfers to the General Fund will be about 20% of operating expenditures. This is phased in as 40% of operating costs in the first year of the forecast, then 30%, then 20%. Each reduction translates into between $100,000 and $200,000 less going to the General Fund.

Capital expenditures and debt service payments on revenue bonds have averaged about $1 million a year over the past ten years, with capital expenditures accounting for about 25% of that. Anticipated capital expenditures in 2006 and 2007 are somewhat higher.

> *Forecast Assumption* The model assumes annual maintenance expenditures of about $250,000 a year. Project costs for sewer line improvement and expansion were supplied by Wade and Associates. Cost for treatment plant improvement and expansion were supplied by Carollo Engineers. All numbers were provided in 2006 dollars. The model assumes 2% inflation. Because of the magnitude of investment in the first few years of the capital plan, the model assumes most of the project costs will be bonded. Only about $7.3 million (2006 dollars) in sewer line maintenance costs are assumed to be pay-as-you-go over the 20-year forecast period. The remaining $64.9 million of investment is assumed to be bonded for 20 years at 5% interest on line improvement projects and 1.5% (state revolving fund rate) for line expansion and treatment plant projects.

APPENDIX B

Forecast Assumptions (2008-2017)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Revenue assumptions											
Revenue increase		30.0%	20.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Connection fee recovery of growth projects		30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Customer assumptions											
Customer increase		3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Metered flow to LBV		55%	55%	55%	50%	50%	50%	50%	50%	50%	50%
Meter flow to Belton Plants		45%	45%	45%	50%	50%	50%	50%	50%	50%	50%
Expenditure assumptions											
New hires		-	-	2.00	2.00	-	-	2.00	2.00	-	-
Avg. increase in personnel exp.	8%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Operating expenses	6%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Little Blue	17%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Overhead allocation percentage	48%	40%	30%	20%	20%	20%	20%	20%	20%	20%	20%
Capital expenditures	$328,300	$864,652	$573,668	$903,492	$586,745	$939,830	$600,349	$721,995	$649,653	$621,793	$629,229
Debt Service	$625,538	$958,944	$1,662,100	$2,275,078	$2,371,827	$2,389,644	$2,475,928	$1,813,901	$1,830,714	$2,350,627	$3,283,064
Debt Service assumptions											
Interest Rate	5%										
SRF Rate	2%										
SRF Funding for Lines - Maint.	No										
SRF Funding for Lines - Growth	Yes										
SRF Funding for Plant - Renewal	Yes										
SRF Funding for Plant - Growth	Yes										
Financial Results											
Cash as a Percent of Exp's	0%	6%	23%	23%	31%	33%	45%	65%	81%	86%	78%
Bond Coverage Ratio	114%	234%	199%	156%	152%	157%	158%	216%	213%	173%	129%
Percent bonded vs. PAYG	53% vs. 47%	74% vs. 26%	72% vs. 28%	80% vs. 20%	72% vs. 28%	80% vs. 20%	72% vs. 28%	74% vs. 26%	79% vs. 21%	84% vs. 16%	86% vs. 14%

APPENDIX B

Forecast Assumptions (2018-2027)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Revenue assumptions										
Revenue increase	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Connection fee recovery of growth p	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Customer assumptions										
Customer increase	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Metered flow to LBV	50%	45%	45%	45%	45%	45%	45%	45%	45%	45%
Meter flow to Belton Plants	50%	50%	55%	55%	55%	55%	55%	55%	55%	55%
Expenditure assumptions										
New hires	-	-	-	-	-	-	-	-	-	-
Avg. increase in personnel exp.	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Operating expenses	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Little Blue	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Overhead allocation percentage	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Capital expenditures	$636,814	$644,550	$652,441	$660,490	$668,700	$677,074	$685,615	$694,327	$703,214	$712,278
Debt Service	$3,910,782	$3,989,571	$4,069,936	$4,151,909	$4,235,520	$4,320,804	$4,374,556	$4,429,383	$4,485,306	$4,542,348
Debt Service assumptions										
Interest Rate										
SRF Rate										
SRF Funding for Lines - Maint.										
SRF Funding for Lines - Growth										
SRF Funding for Plant - Renewal										
SRF Funding for Plant - Growth										
Financial Results										
Cash as a Percent of Exp's	69%	69%	67%	67%	67%	68%	70%	73%	76%	80%
Bond Coverage Ratio	112%	122%	121%	123%	126%	128%	131%	135%	138%	141%
Percent bonded vs. PAYG	86% vs. 14%	86% vs. 14%	86% vs. 14%	86% vs. 14%	86% vs. 14%	86% vs. 14%	86% vs. 14%	86% vs. 14%	86% vs. 14%	

APPENDIX C

Forecast (2008-2017)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Service charge revenue increase		30.0%	20.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Revenues											
Charges for Services											
Sewer Services		4,416,930	5,432,824	5,758,793	6,104,321	6,470,580	6,858,815	7,270,344	7,706,565	8,168,958	8,659,096
Air Base		125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
Sewer Connection Fee		547,500	563,925	580,843	598,268	616,216	634,703	653,744	673,356	693,557	714,363
Other Charges		69,319	71,399	73,541	75,747	78,019	80,360	82,771	85,254	87,811	90,446
Interest Income		250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Miscellaneous		7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Expenses											
Personnel		686,552	714,014	861,550	1,019,748	1,060,537	1,102,959	1,286,262	1,482,465	1,541,764	1,603,435
Operating Expenses		529,873	561,665	595,365	699,223	741,177	785,647	832,786	882,753	935,718	991,861
Little Blue Sewer Services		1,051,850	1,146,517	1,249,703	1,245,159	1,357,223	1,479,373	1,612,517	1,757,643	1,915,831	2,088,256
KCMO Sewer Services		-	-	-	-	-	-	-	-	-	-
JoCo Sewer Services		-	-	-	-	-	-	-	-	-	-
Repayment to Water Fund		112,629	112,629	112,629	112,629	112,629	-	-	-	-	-
Capital improvements		864,652	573,668	903,492	586,745	939,830	600,349	721,995	649,653	621,793	629,229
Debt service/lease pymts.		958,944	1,662,100	2,275,078	2,371,827	2,389,644	2,475,928	1,813,901	1,830,714	2,350,627	3,283,064
Interfund Charges											
Overhead		907,310	726,659	541,324	592,826	631,787	673,596	746,313	824,572	878,663	936,710
Franchise Tax		-	-	-	-	-	-	-	-	-	-
In Lieu of Tax		-	-	-	-	-	-	-	-	-	-
Increase(decrease) in cash		303,939	952,896	256,035	532,180	313,988	838,026	1,375,084	1,419,374	1,087,930	313,350
Cash balance		303,939	1,256,835	1,512,870	2,045,050	2,359,038	3,197,063	4,572,148	5,991,522	7,079,452	7,392,802
balance as % of expenditures	0%	6%	23%	23%	31%	33%	45%	65%	81%	86%	78%
bond coverage ratio	114%	234%	199%	156%	152%	157%	158%	216%	213%	173%	129%

APPENDIX C

Forecast (2008-2017)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Service charge revenue increase	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Revenues										
Charges for Services										
Sewer Services	9,178,642	9,729,360	10,313,122	10,931,909	11,587,824	12,283,093	13,020,079	13,801,283	14,629,360	15,507,122
Air Base	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
Sewer Connection Fee	735,794	757,868	780,604	804,022	828,143	852,987	878,577	904,934	932,082	960,045
Other Charges	93,159	95,954	98,832	101,797	104,851	107,997	111,237	114,574	118,011	121,551
Interest Income	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Miscellaneous	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Expenses										
Personnel	1,667,572	1,734,275	1,803,646	1,875,792	1,950,823	2,028,856	2,110,010	2,194,411	2,282,187	2,373,475
Operating Expenses	1,051,373	1,114,456	1,296,112	1,373,879	1,456,311	1,543,690	1,636,311	1,734,490	1,838,559	1,948,873
Little Blue Sewer Services	2,276,199	2,246,608	2,448,803	2,669,195	2,909,423	3,171,271	3,456,685	3,767,787	4,106,887	4,476,507
KCMO Sewer Services	-	-	-	-	-	-	-	-	-	-
JoCo Sewer Services	-	-	-	-	-	-	-	-	-	-
Repayment to Water Fund	-	-	-	-	-	-	-	-	-	-
Capital improvements	636,814	644,550	652,441	660,490	668,700	677,074	685,615	694,327	703,214	712,278
Debt service/lease pymts.	3,910,782	3,989,571	4,069,936	4,151,909	4,235,520	4,320,804	4,374,556	4,429,383	4,485,306	4,542,348
Interfund Charges										
Overhead	999,029	1,019,068	1,109,712	1,183,773	1,263,311	1,348,763	1,440,601	1,539,338	1,645,527	1,759,771
Franchise Tax	-	-	-	-	-	-	-	-	-	-
In Lieu of Tax	-	-	-	-	-	-	-	-	-	-
Increase(decrease) in cash	(152,174)	216,654	193,908	304,692	418,729	535,619	688,113	843,056	999,772	1,157,466
Cash balance	7,240,628	7,457,282	7,651,191	7,955,883	8,374,612	8,910,230	9,598,343	10,441,399	11,441,172	12,598,637
balance as % of expenditures	69%	69%	67%	67%	67%	68%	70%	73%	76%	80%
bond coverage ratio	112%	122%	121%	123%	126%	128%	131%	135%	138%	141%

APPENDIX D

Rates (2008-2017)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Minimum Charge	9.35	11.83	12.35	14.86	14.43	15.49	14.60	13.40	13.59	14.85	17.14
Volume Charge per 100 gallons	0.6236	0.8134	1.0088	0.9929	1.0400	1.0568	1.1158	1.1825	1.2212	1.2385	1.2355
Gallons free of volume charge	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Connection Fee per unit	$500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500

Rates (2018-2027)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Minimum Charge	18.40	18.47	18.73	18.78	18.83	18.90	18.94	18.99	19.05	19.13
Volume Charge per 100 gallons	1.2555	1.3019	1.3456	1.3953	1.4464	1.4986	1.5530	1.6087	1.6660	1.6607
Gallons free of volume charge	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Connection Fee per unit	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500

Sewer Rate Study
Technical Document

Model Description

The interactive rate model used to complete the 2006 Sewer Rate Study is programmed in the Excel workbook **RATEMODEL.XLS** which contains the following worksheets:

SUMMARY contains an overview of the critical assumptions used to calculate future sewer rates, and the estimated impact on monthly bills for different classes of customers.

FORECAST contains financial data from city budgets, financial reports, and other city documents. Revenues and cash outlays are forecasted based on user input assumptions. Two financial targets, coverage ratio and operating balance as a percent of cash outlays, are calculated based on user input of revenue increases.

RATE SCHEDULE calculates future sewer rates based on user assumptions from FORECAST for service charge revenue increase, fixed-cost recovery, gallons free of volume charge, number of customers, and average consumption. Calculates a connection fee per unit equal to the total cost of growth projects over the 20 year period, divided by the forecast of all new customers over the 20 year period, times the user input for connection fee cost recovery.

The model requires input of the capital expenditures estimated by Wade & Associates (line maintenance and growth) and Carollo Engineers (plant renewal and growth). The capital expenditures are entered in the Excel workbook **CAPITALFORECAST.XLS** which contains the following worksheets:

MAINTENANCE - LINES contains capital expenditures (in 2006 dollars) for line maintenance as forecasted by Wade & Associates. User classifies projects as either PAYG or debt-financed.

GROWTH - LINES contains capital expenditures (in 2006 dollars) for new lines required for anticipated population growth as forecasted by Wade & Associates. User classifies projects as either PAYG or debt-financed.

MAINTENANCE - PLANT contains capital expenditures (in 2006 dollars) for plant maintenance as forecasted by Carollo Engineers. User classifies projects as either PAYG or debt-financed.

GROWTH - PLANT contains capital expenditures (in 2006 dollars) for plant expansion as forecasted by Carollo Engineers. User classifies projects as either PAYG or debt-financed.

SUMMARY FOR RATE MODEL sums up capital expenditures from above four sheets and inflates constant dollar values according to user entered inflation rate.

Sewer Rate Study
Technical Document

Definition of Terms

Cash balance
Unrestricted cash and investments from the previous period plus revenue less total cash outlay less amounts due to other funds. To ensure adequate funds for operations, most cities maintain a minimum operating balance equal to some percentage of total cash outlays.

Coverage ratio
Calculated as net revenue (revenues less current expenditures, not including capital) divided by debt service. Moody's Investor Service measures the median for water and sewer coverage ratios at 170%. The official statement for outstanding sewer bonds sets the legally required minimum at 110%.

General fund transfer
The transfer to the General Fund for the reimbursement of administrative services is an operating expense, results in a reduction of net revenue, and has a significant impact on the debt service coverage ratio. It is listed separately to highlight its importance as a policy issue. The budget contains an estimate for the current year. The model estimates transfers for future years based on user-entered assumptions for overhead allocation percentage.

Fixed costs
Those costs that do not change with changes in consumption. Personnel, half of operating costs, capital improvements, transfer to General Fund, and debt service are considered fixed costs, representing about 70% of total costs in the 2007 budget.

Fixed cost recovery
The amount of fixed costs recovered with the minimum charge. Currently, about 30% of fixed costs are recovered with the service charge. To ensure adequate funds to cover fixed costs, regardless of changes in consumption, some cities have policies for fixed cost recovery.

Variable costs
Those costs which vary directly with changes in consumption. Half of operating costs and payments to the Little Blue are considered variable costs and represent about 30% of total costs in the 2007 budget.

Sewer Rate Study
Technical Document

Model Maintenance

I. Update Excel Workbook CAPITALFORECAST.XLS

A. Change the beginning year in all sheets (cell E3).

B. For each of the following sheets: Maintenance Capital-Lines, Growth Capital-Lines, Maintenance Capital-Plant, Growth Capital-Plant review the lines between the orange shading for changes in project costs and/or timing. Copy/Paste may be used but DO NOT "CUT" numbers as this will compromise the links. Enter project totals in Column D. Enter yearly amounts where appropriate in Columns E through X. DATA MUST BE IN CONSTANT DOLLAR TERMS. See the data check line below the last orange row to verify data entry.

C. Review each project to select funding choice. Copy the entire line for each project, but only once, and INSERT/COPIED CELLS to one of the sections below the orange shading. A project to be funded PAYG should be copied and pasted between the green lines. A project to be debt financed should be copied and pasted between the purple lines.

D. Verify that the data check line (just below the last purple row) shows 0 across all years—this ensures all projects have been selected for at least one but not more than one of the funding options.

E. In the sheet Summary for Rate Model, enter in the assumption for inflation in cell E1 and the constant dollar year in which the capital project are valued in cell E2.

II. UPDATE Excel Workbook RATEMODEL.XLS, spreadsheet *FORECAST*

All cells requiring user input are shaded yellow. Password to enter data in spreadsheet is **belton** (all lowercase).

A. Update year in cell D8, as the first fiscal year to be forecasted.

B. Lines 12-13, update the rate structure in place for the current fiscal year.

C. Lines 14 & 15, review assumptions for *gallons free of volume charge* and the *fixed cost recovery*. Changes to these assumptions can lessen the impact of rate increases on the small user. For instance, offering more gallons free of volume charge or decreasing the fixed cost recovery will reduce the minimum bill.

D. Lines 16, 19, 20, change average monthly usage and the forecast for customer increases if a new analysis of current usage and population forecasts warrants such a change.

E. Line 22, forecast the estimated amount of metered flow to LBV vs. Belton plants based on current and forecasted plant capacities, existing contract with LBV and other information provided by the City's sewer treatment plant supervisor.

F. Line 28, review *Connection Fee assumptions* and change as desired to manage the level of those fees.

G. Lines 31- 40, review revenue and operating expenditure assumptions and change as needed. The assumption for Little Blue Valley refers to the *rate* charged. Any increase in flows to Little Blue Valley is covered in line 22.

H. Lines 41-42, review the assumption for the increase in payments to KCMO and Johnson County for purchased sewer services. Increases are used to calculate total payment and should take into account increases in rate and flow.

I. Line 43, the assumption for Overhead Allocation is used to calculate the overhead as a percent of operating expenses. Thus an assumption of 40% will mean the General Fund transfer for overhead will be calculated as .4*(sum of operating expenditures).

J. Lines 46,47 refer to any planned capital expenditures that do not appear in the wastewater master plan (i.e. were not entered into CAPITALFORECAST.XLS)

K. Lines 49-53 of the forecast, PAYG capital expenditures, should be entered from the CAPITALFORECAST.XLS workbook, *Summary for Rate Model* sheet, lines 7-12. The user should verify years between the two workbooks match.

L. Line 56, update debt service numbers for all outstanding sewer bond issues using debt schedules.

M. Lines 58-65, update bond issuance assumptions. The SRF rate, according to the Missouri Department of Natural Resources, is currently about 30% of the market rate. The user can update this assumption to reflect Belton's rate experiences or expectations. The user can also choose which category of projects will be funded through the SRF program. The user will *not* be able to select financing for individual projects.

N. Lines 68-72, Principal New Bond Issues, should be entered from the CAPITALFORECAST.XLS workbook, *Summary for Rate Model* sheet, lines 17-21. The user should verify years between the two workbooks match.

O. Lines 76-98, update revenue and expense data for the current fiscal year in shaded cells C76 through C98 using City budgets and annual reports. Beginning cash balance should be reduced by any loans due to other Funds.

P. Lines 104 and 105, enter in the balance of any loans from the Water Fund and the schedule to repay that loan. Enter both as *positive* numbers.

Q. Enter in trial revenue increases in row 110. Evaluate the impact on the fund by reviewing rows 139-140.

III. REVIEW RESULTS IN *SUMMARY*

A. Review customer impact
The user has the option to view the impact of the proposed rates on different customer classes below and above the average. The user has the option to change customers profiles in rows 53-59.

B. Run alternative scenarios
Run alternative scenarios by changing revenue increases (see section II.Q, above), or forecast assumptions.

VIII. RECOMMENDED CAPITAL IMPROVEMENT PLAN

A. Introduction

Several surrounding communities of the Kansas City Metropolitan Area are expected to experience significant growth over the next 30 years. As conveyed earlier, the City of Belton, is projected to experience a population growth rate of approximately 2.46% per year for the next ten years. Based on the population projections provided by the City, it will be necessary for Belton to update and expand their existing collection system in order to sustain and manage the influx of population to the area.

The Recommended Capital Improvement Program for the City of Belton is divided into two main categories: maintenance and future growth related projects. Maintenance related Capital Improvement Projects are projects requiring attention prior to the consideration of future growth related flows. Future growth related projects are projects which will either change the existing system flow configuration or will require attention after the impact of future growth flows are applied. Figure X shows the Capital Improvement Program estimated project cost and schedule summary. Scheduling of the program components is based on the pressing need for a complete system integrity evaluation and rehabilitation as well as accounting for growth in projected areas of the City. The Recommended Capital Improvement Projects are estimated on a yearly basis except for the post rehabilitation flow monitoring program and the post rehabilitation I/I data analysis. The following paragraphs discuss each of the recommended maintenance and future growth related CIP projects in more detail.

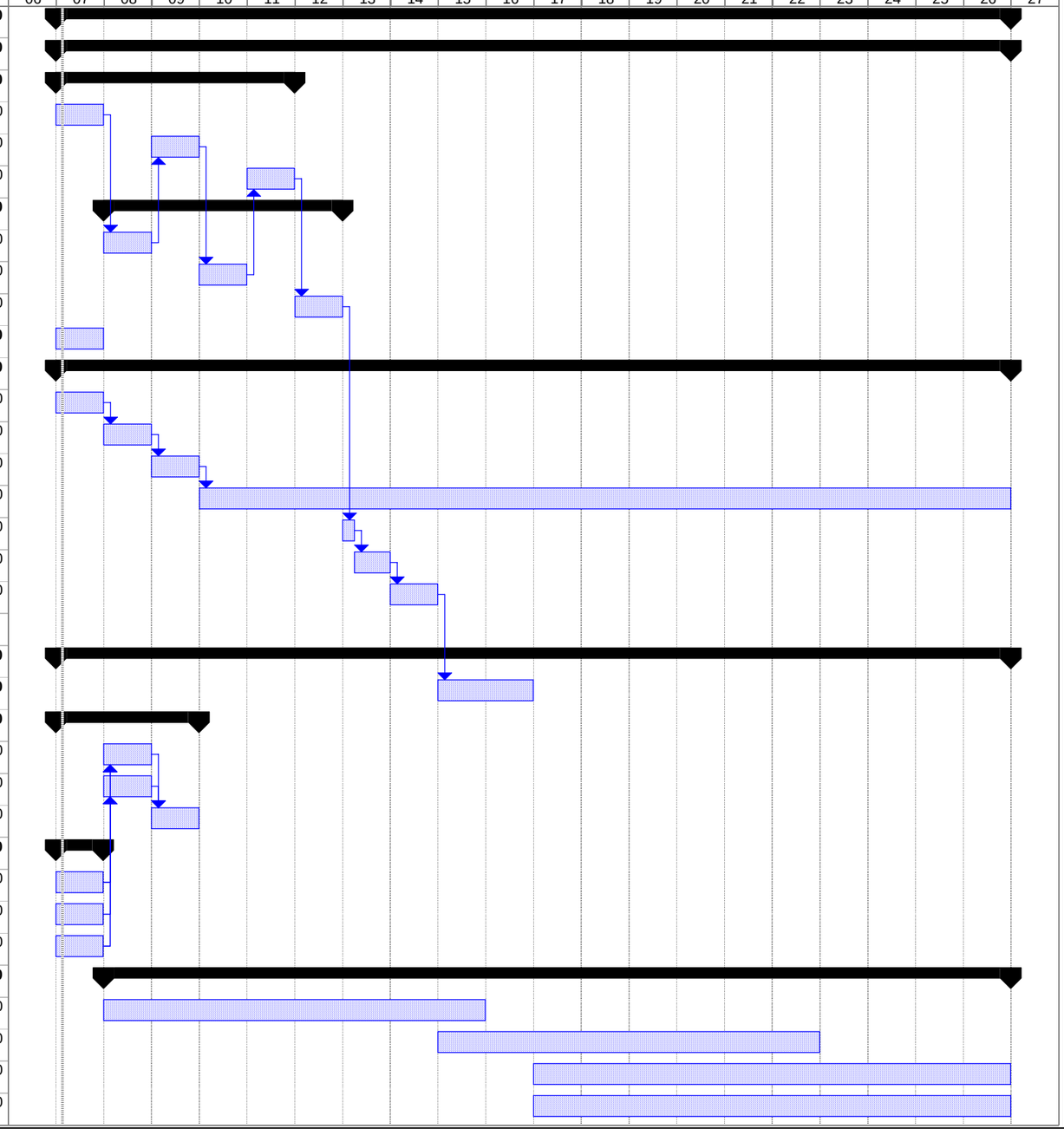
B. Maintenance Related Projects

1. Recommended Sanitary Sewer Evaluation Study

   It is recommended that a Sanitary Sewer Evaluation Survey be conducted on the City's remaining collection system that was not included in the Pilot Study Area SSES. In order for this Capital Improvement Program to succeed, the City will have to investigate, locate, and eliminate at least an estimated 30% of inflow and infiltration in the existing collection system. Eliminating a smaller percentage of I/I will not yield the desired results. As mentioned previously, Figure X shows the projected scheduling for the Capital Improvement Program. It is recommended that the remaining collection system be evaluated within a 6 year period based upon I/I severity rankings established during the flow data analysis of this study (see Section IV). It is recommended that a Study Area be evaluated one year and any rehabilitation of that Study Area be concluded by the following year. The additional SSES program should begin in 2007 with the evaluation of basins 2, 6, 11, and follow with the unstudied collection

Belton, Missouri
Wastewater Master Plan
Capital Improvement Program

ID	Task Name	Present Day Cost	Total Cost
1	**Capital Improvement Program**	**$33,898,200.00**	**$44,402,300.00**
2	**Maintanence Projects**	**$10,744,900.00**	**$13,775,200.00**
3	**Sanitary Sewer Evaluation Study**	**$874,900.00**	**$928,400.00**
4	Basins 2, 6, 7, 8, 11	$291,500.00	$291,500.00
5	Basins 4, 9, 10, 12	$304,700.00	$323,200.00
6	Basins 1, 3, 5, 13	$278,700.00	$313,700.00
7	**Sanitary Sewer Rahabilitation**	**$2,709,200.00**	**$2,951,000.00**
8	Basins 2, 6, 7, 8, 11	$982,600.00	$1,012,100.00
9	Basins 4, 9, 10, 12	$942,200.00	$1,029,600.00
10	Basins 1, 3, 5, 13	$784,400.00	$909,300.00
11	**Pilot Study Area Rehabilitation**	**$809,000.00**	**$809,000.00**
12	**Sewer Maintenance Program**	**$6,222,000.00**	**$8,925,400.00**
13	First third of the system	$311,100.00	$311,100.00
14	Second third of the system	$311,100.00	$320,400.00
15	Third third of the system	$311,100.00	$330,000.00
16	Maintenance Each Three Year Period	$5,288,700.00	$7,963,900.00
17	**Post Rehabilitation Flow Monitoring**	$79,000.00	$94,300.00
18	**Post Rehabilitation I/I Data Analysis**	$20,800.00	$24,900.00
19	**Post Rehabilitation Modeling**	$30,000.00	$42,200.00
20			
21	**Growth Projects**	**$23,153,300.00**	**$30,627,100.00**
22	**Recommend Pipeline Capacity Improvements**	**$10,248,300.00**	**$12,982,200.00**
23	**Lift Station Removal**	**$1,083,200.00**	**$1,099,800.00**
24	Disconnect Fairay Ridge Lift Station	$19,500.00	$20,100.00
25	Disconnect Cedar Tree lift station	$476,800.00	$491,100.00
26	Disconnect/Bypass West Cimarron Lift Station	$28,000.00	$29,700.00
27	**East Cimarron and Markey Meadows Lift Stations**	**$558,900.00**	**$558,900.00**
28	Disconnect East Cimarron Lift Station	$63,800.00	$63,800.00
29	Disconnect Markey Meadows Lift Station	$84,900.00	$84,900.00
30	Construct Relief/Replacement Lines before disconnection of MMLS and ECLS	$410,200.00	$410,200.00
31	**Future Growth Sewer Lines and Manholes**	**$11,821,800.00**	**$16,545,100.00**
32	Southeast	$1,970,900.00	$2,230,000.00
33	South	$3,260,300.00	$4,457,000.00
34	Northwest	$3,764,300.00	$5,630,500.00
35	West	$2,826,300.00	$4,227,600.00



Project: Schedule2
Date: Wed 2/14/07

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Figure X

systems within basins 7 and 8. Based on the severity rankings, basins 4, 9, 10, 12, should be evaluated in 2009 and basins 1, 3, 5, and 13 should conclude the SSES in 2011. Figures Y, Z, and AA show the general locations of the Study Areas for the 2007, 2009, and 2011 SSES's, respectively.

The total estimated cost to complete the recommended sanitary sewer evaluation study on the entire collection system is $928,400. A summary of activities and costs associated with completing the recommended SSES activities within the City's entire collection system is presented as Table VIII-1.

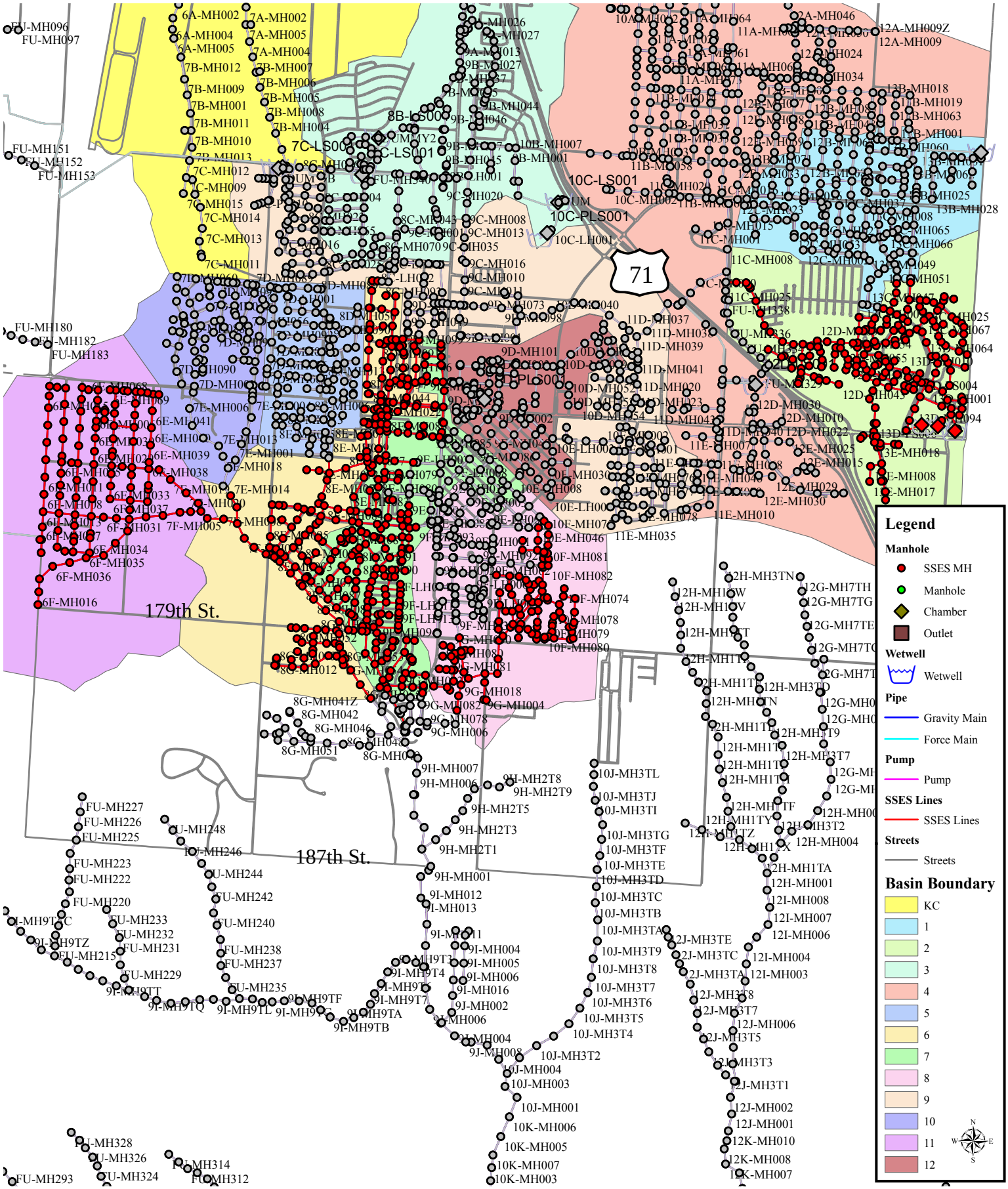
Table VIII-1
Recommended SSES Activities

Activity	Quantity	Units	Unit Cost ($)	Sub-Total Cost ($)
Project Administration	1	Lump Sum	$25,000	$25,000
Internal Manhole Inspections	2,350	Each	$65.00	$152,800
Smoke Testing	549,773	lf	$0.32	$175,900
Building Inspections	9,500	Each	$40.00	$380,000
Vehicle Mileage	4,000	Miles	$0.5	$2,000
I/I Defect Analysis	1	Lump Sum	$10,000	$10,000
Reporting	1	Lump Sum	$15,000	$15,000
Sub-Total:				**$760,700**
Total with 15% Legal, Administration, and Contingencies*:				**$928,400**
Estimated Cost per Year				
2007 – Basins 2, 6, 7, 8, and 11				$291,500
2009 – Basins 4, 9, 10, and 12*				$323,200
2011 – Basins 1, 3, 5, and 13*				$313,700
Total*:				**$928,400**

*Cost includes a 3% inflation rate per year beginning in 2008.

2. Remaining Collection System Rehabilitation Recommendations

The Pilot Study Area SSES activities identified 30 public- and private-sector defects in 33,500 linear feet of pipe that are cost effective to remove. The total estimated cost to eliminate the 30 defects is approximately $30,400. **Based on existing system size and rehabilitation cost in the Pilot Study Area it is estimated that it will cost approximately $2.95 million to rehabilitate the remaining collection system following completion of the recommended SSES program**. However, this cost is based on result estimates from a small portion of Belton's wastewater collection system. Upon completion of the entire collection system rehabilitation, a new cost-effectiveness analysis should be performed to identify the actual cost



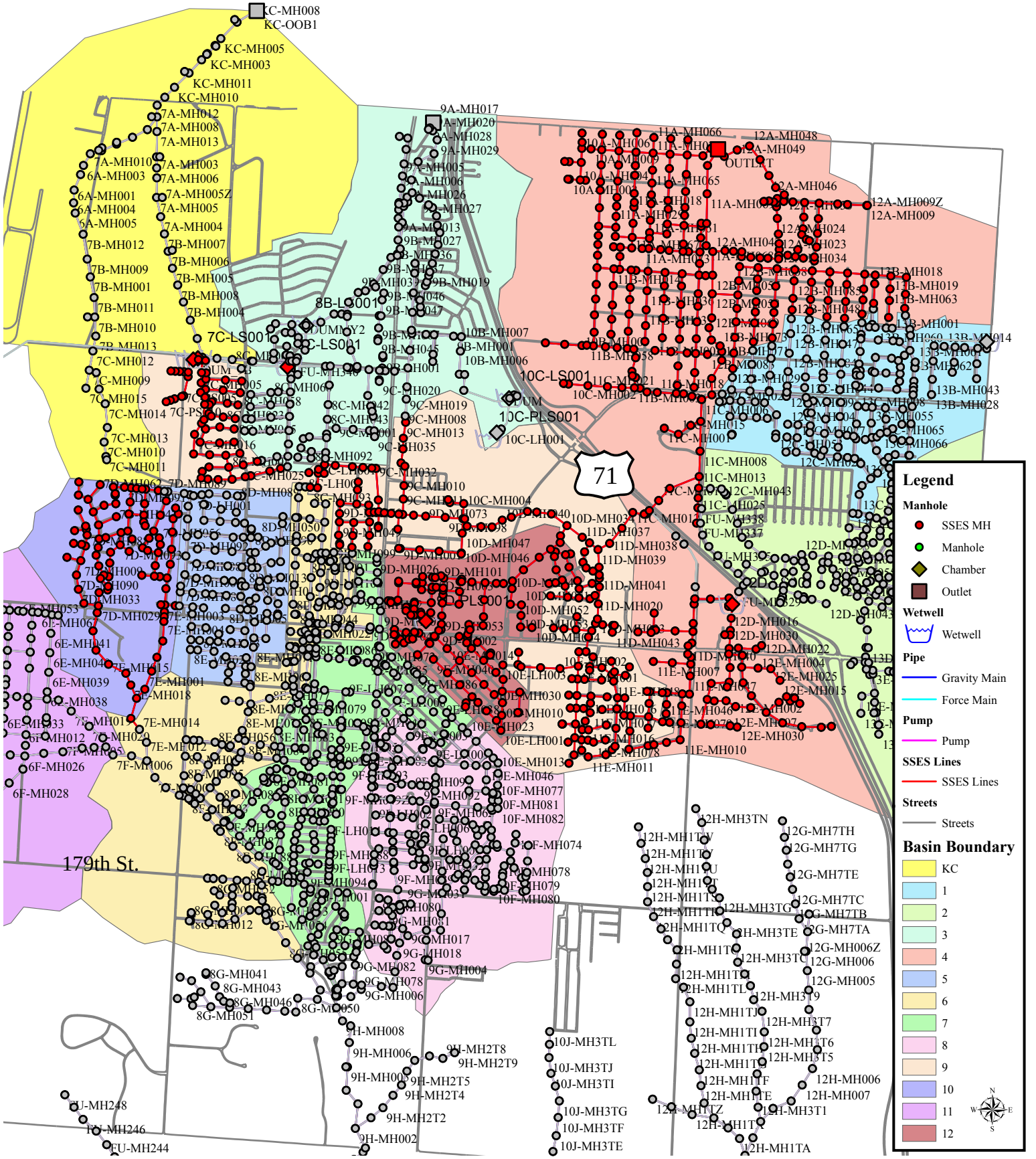
Belton, MO

2007 Wastewater Master Plan

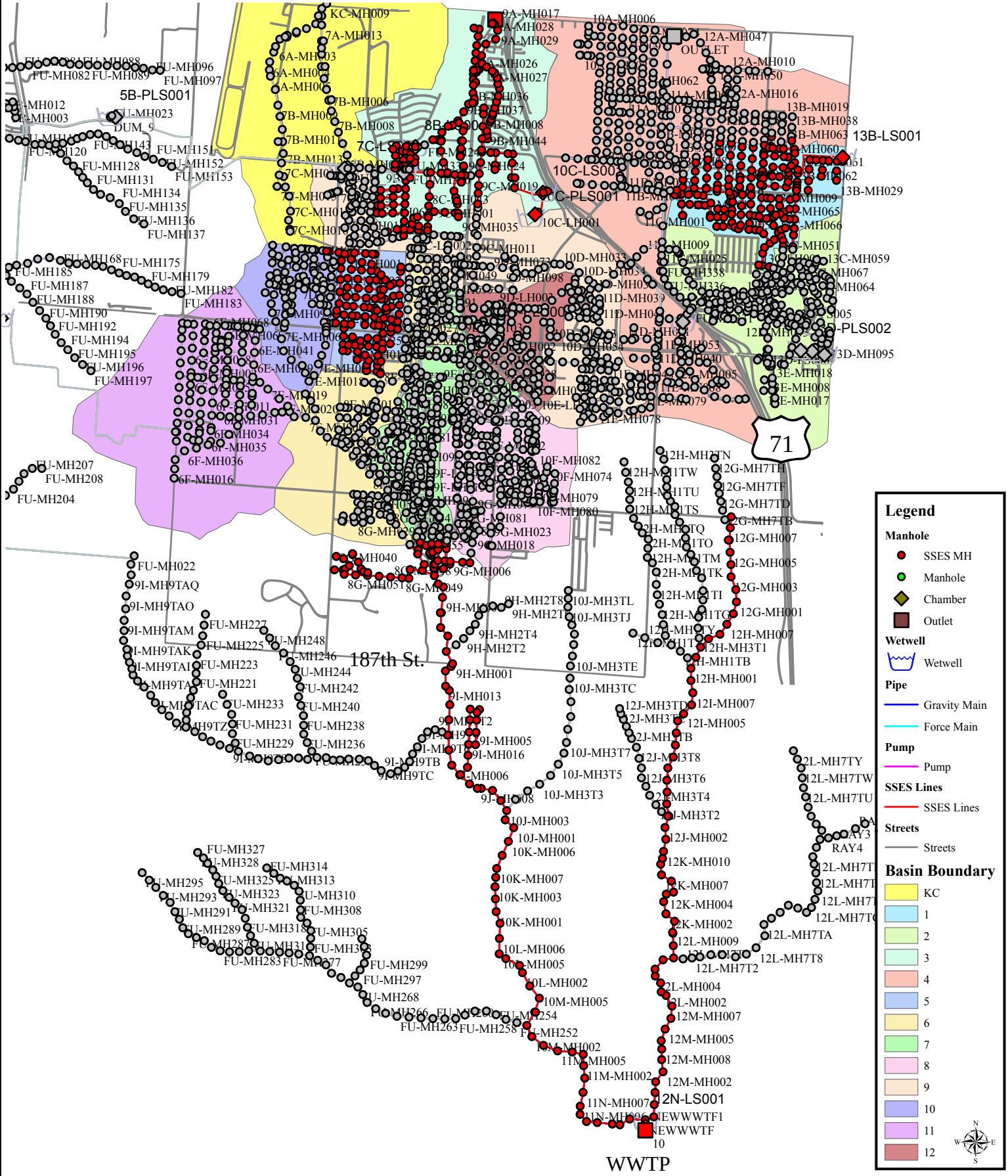
Figure Y

2007 Sanitary Sewer Evaluation Study
Basins 2, 6, 7, 8, 11

WADE & ASSOCIATES, INC.



Belton, MO 2007 Wastewater Master Plan	Figure Z 2009 Sanitary Sewer Evaluation Study Basins 4, 9, 10, 12	WADE & ASSOCIATES, INC.



Belton, MO 2007 Wastewater Master Plan	Figure AA 2011 Sanitary Sewer Evaluation Study Basins 1, 3, 5, 13	WADE & ASSOCIATES, INC.

effective level for the entire collection system. It is recommended that major repairs located during the SSES should be completed based on the previous year's findings (i.e., a broken line located in basin 2 during the 2007 SSES activities should be repaired by the following year, if not immediately necessary). A summary of estimated costs associated with completing the system rehabilitation based on the recommended yearly SSES schedule is presented in Table VIII-2.

Table VIII-2
Recommended System Rehabilitation

Activity	Quantity	Units	Unit Cost ($)	Sub-Total Cost ($)
System Rehabilitation	550,000	lf	$4.00	$2,200,000
Sub-Total:				**$2,200,000**
Total with 15% Legal, Administration, Design and Contingencies*				**$2,951,000**
Estimated Cost per Year				
2008 – Basins 2, 6, 7, 8, and 11*				$1,012,100
2010 – Basins 4, 9, 10, and 12*				$1,029,600
2012 – Basins 1, 3, 5, and 13*				$909,300
Total*:				**$2,951,000**

*Cost includes a 3% inflation rate per year beginning in 2008.

3. Recommended Pilot Study Area Rehabilitation

a) Private-Sector Rehabilitation

Sanitary sewer defects located on private property are contributors of excessive I/I to the collection system. Cost analysis of the field data collected during the Pilot Study Area SSES activities have shown that several sources of private-sector I/I, such as uncapped cleanouts, driveway drains, and a service lateral are cost-effective to remove.

The total estimated cost to disconnect or repair the 24 sources of inflow from private-property is $11,800. The cost estimates for private-sector I/I removal includes administrative costs associated with this aspect of the program. A summary of the private-sector sources recommended for removal is presented in Table VIII-3. Appendix S contains a list of all recommended private-sector I/I which is cost effective to remove.

Table VIII-3
I/I Reduction Program – Private-Sector I/I Abatement

Type of Rehabilitation	Number of Repairs	Unit Cost ($)	Total Cost ($)
Repair Uncapped Cleanouts	16	$25	$400
Repair Service Lateral	1	$1,000	$1,000
Disconnect Driveway Drains	7	$1,200	$8,400
Sub-Total:			**$9,800**
Total with 20% Legal, Administration, and Contingencies:			**$11,800**

b) Public-Sector Rehabilitation

1) Recommended Manhole Rehabilitation:

Information summarized in Section V identified a total of 246 I/I-related defects within the 131 manholes inspected in the Pilot Study Area. This is an average of 1.9 defects per manhole.

A total of 85 defective manholes are determined to be in need of rehabilitation. Section V of this report identified that the cost effective level to rehabilitate identified defects is 30% I/I removal. When evaluated individually, these manhole related defects did not fall within the study's cost-effectiveness level for removal. However when left unaddressed, these type of defects (mainly defects occurring within the manhole cover to chimney sections) become major contributors of I/I into the collection system over time. Consequently, these defects were included in the recommended preliminary manhole rehabilitation schedule for the Pilot Study Area.

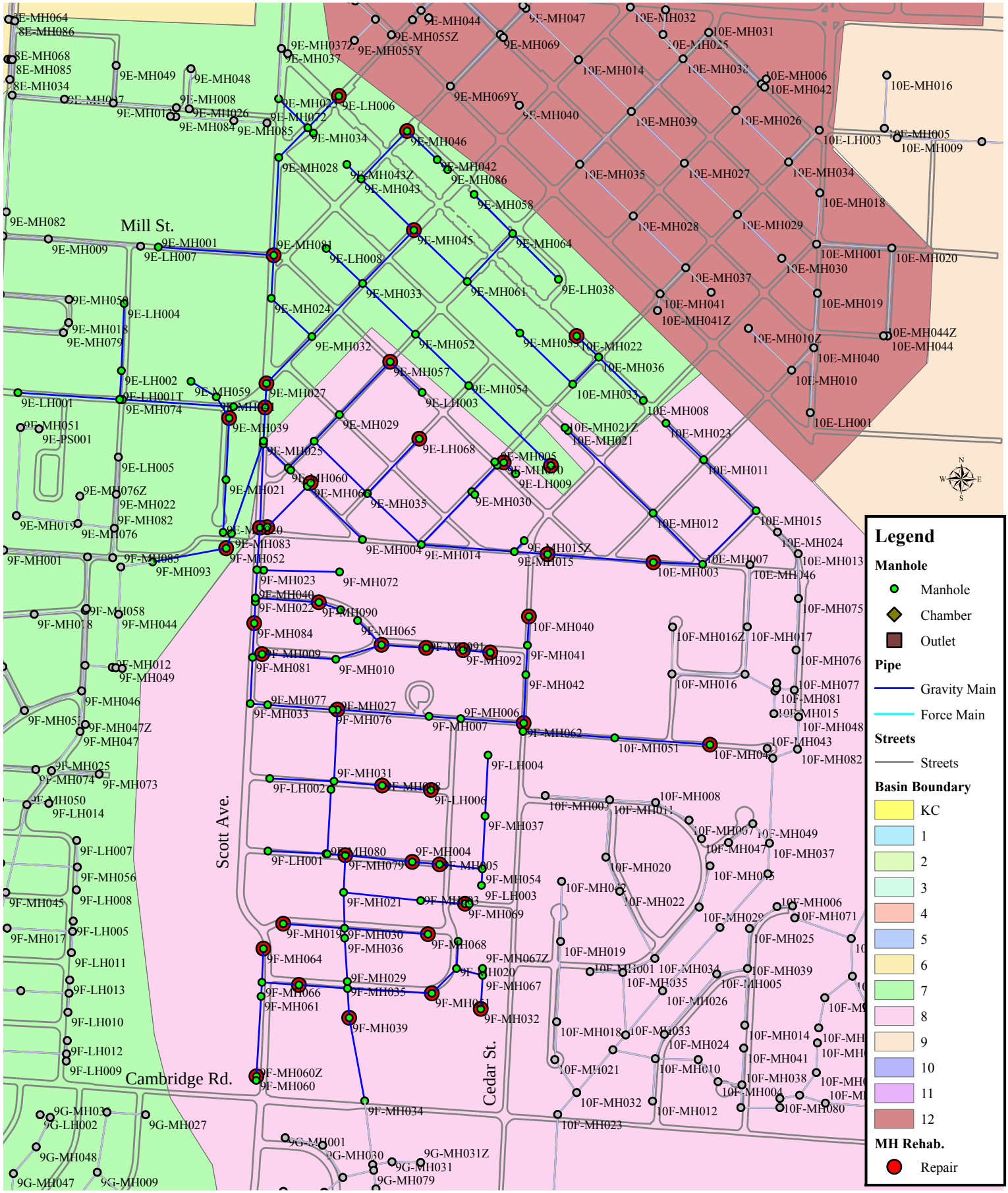
A total of $162,800 has been budgeted for this work. Of this total, $27,100 has been set aside for contingencies such as engineering, administration, inspection, and potential construction overages. Table VIII-4 summarizes the preliminary manhole rehabilitation schedule before any cross-reference with the recommended pipeline rehabilitation/replacement sewer program and represents all manholes identified as needing rehabilitation. A detailed listing of all manholes requiring rehabilitation before cross-referencing with the pipeline replacement sewer program is included as Appendix T.

Table VIII-4
I/I Reduction Program
Preliminary Manhole Rehabilitation

Type of Rehabilitation	Basin 7	Basin 8	Total	Unit Cost	Total Cost
Replace Cover, Frame, and Frame Seal	4	9	13	$600	**$7,800**
Replace Frame Seal	2	6	8	$400	**$3,200**
Replace Cover, Frame, Frame Seal, & Chimney	0	1	1	$1,000	**$1,000**
Replace Frame Seal and Chimney	4	9	13	$800	**$10,400**
Grade Adjustment	2	4	6	$200	**$1,200**
Wall Rehabilitation (vertical feet)	44	244	288	$200/VF	**$57,600**
Complete Manhole Replacement	2	7	9	$2,500	**$22,500**
Pressure Grout Precast Manhole Joints	2	7	9	$400	**$3,600**
Bench, Invert, Pipe Seal Rehabilitation	4	25	29	$400	**$11,600**
Remove Steps	7	8	15	$300	**$4,500**
Surfacing & Restoration (total cost estimate)	$4,100	$8,200	$12,300	L.S.	**$12,300**
Manhole Rehabilitation Cost per Basin	**$29,100**	**$106,600**	**$135,700**		
Sub-Total:					**$135,700**
Legal, Administration, and Contingencies (20%):					**$27,100**
Total Preliminary Manhole Rehabilitation:					**$162,800**

It is recommended that all defective manholes that are adjoined to recommended pipeline replacement sewers be included in one pipeline rehabilitation/replacement construction contract. Currently there are 21 such manholes. As previously stated, there were no manhole related defects that were identified within the cost effective level for removal, however these defects should not be overlooked since these type of defects are known to become major I/I contributors into the collection system. Appendix U contains the recommended manhole rehabilitation schedule. This schedule contains all manholes exhibiting defects occurring in the cover to the chimney sections of the manhole. Several other defects are also included where active I/I was discovered. Table VIII-5 summarizes the $72,700 budgeted for manholes to be rehabilitated. Figure AB shows the location of all 43 manholes recommended for rehabilitation.

As mentioned in Section V, Appendix G contains a listing of 4 manhole structures that could not be completely inspected during the manhole inspection program for the Pilot Study Area SSES. This may be due to reasons such as no access, buried, or may not exist. It is recommended that the final disposition of these manholes be included in the recommended manhole rehabilitation program.



Belton, MO 2007 Wastewater Master Plan	Figure AB Pilot Study Area Recommended Manhole Rehabilitation	WADE & ASSOCIATES, INC.

Table VIII-5
I/I Reduction Program
Recommended Manhole Rehabilitation

Type of Rehabilitation	Basin 7	Basin 8	Total	Unit Cost	Total Cost
Replace Cover, Frame, and Frame Seal	4	8	12	$600	**$7,200**
Replace Frame Seal	1	5	6	$400	**$2,400**
Replace Cover, Frame, Frame Seal, & Chimney	0	1	1	$1,000	**$1,000**
Replace Frame Seal and Chimney	2	8	10	$800	**$8,000**
Grade Adjustment	2	4	6	$200	**$1,200**
Wall Rehabilitation (vertical feet)	11	44	55	$200/VF	**$11,000**
Complete Manhole Replacement	1	4	5	$2,500	**$12,500**
Pressure Grout Precast Manhole Joints	1	7	8	$400	**$3,200**
Bench, Invert, Pipe Seal Rehabilitation	1	10	11	$400	**$4,400**
Remove Steps	1	0	1	$300	**$300**
Surfacing & Restoration (total cost estimate)	$3,000	$6,400	$9,400	L.S.	**$9,400**
Manhole Rehabilitation Cost per Basin	**$13,500**	**$47,100**	**$60,600**		
Sub-Total:					**$60,600**
Legal, Administration, and Contingencies (20%):					**$12,100**
Total Preliminary Manhole Rehabilitation:					**$72,700**

2) Public-Sector I/I Elimination:

Defects on public property are contributors of excessive I/I to the collection system. Cost analysis of the field data collected during the Pilot Study Area SSES activities have shown that a few public-sector I/I defects, such as line defects, an indirect storm connection, and a drainage crossing are cost effective to remove.

The total estimated cost to repair six cost effective sources of inflow from public-property is $18,600. The cost estimates for public-sector I/I removal include administrative costs associated with this aspect of the program. A summary of the public-sector sources recommended for removal is presented in Table VIII-6. Appendix V contains a list of all recommended public-sector I/I which is cost effective to remove.

Table VIII-6
I/I Reduction Program – Public-Sector I/I Abatement

Type of Rehabilitation	Number of Repairs	Unit Cost ($)	Total Cost ($)
Line Defects	4	$2,500	$10,000
Indirect Storm	1	$3,000	$3,000
Drainage Crossing	1	$2,500	$2,500
Sub-Total:			**$15,500**
Total with 20% Legal, Administration, and Contingencies:			**$18,600**

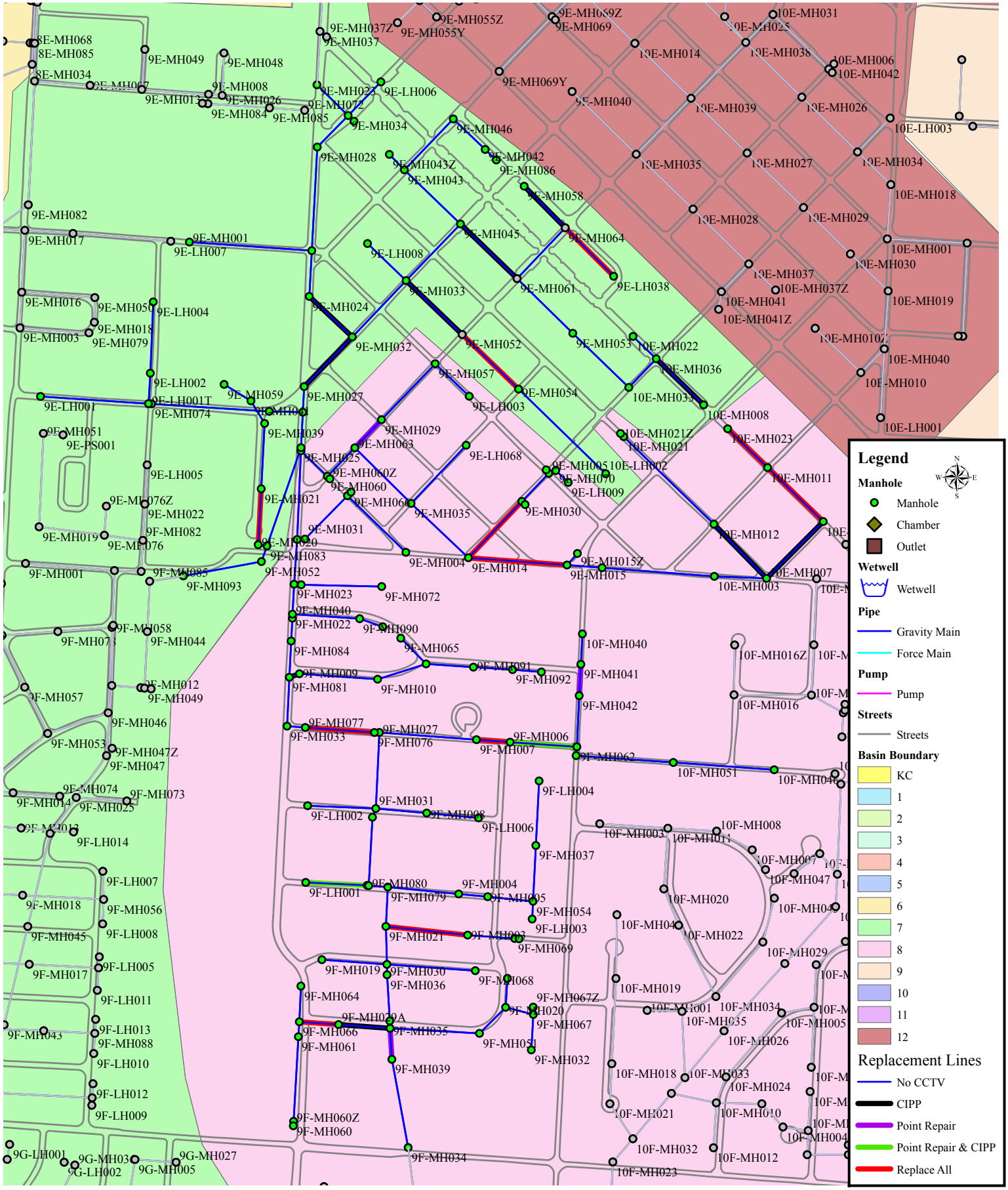
3) Recommended Pipeline Rehabilitation:

The study identified numerous locations in the Pilot Study Area where I/I was entering the collection system through defects in the pipelines. These defects include open/exposed pipe joints with active I/I and other major deficiencies such as voids, and broken or partially collapsed pipe. All defects were initially located by smoke testing activities and recommended for cleaning and CCTV inspection. A total of 30 individual line segments, representing approximately 7,895 linear feet of sanitary sewer, were recommended for cleaning and CCTV inspections. The City, using its contractor Pro-Clean Utility, completed cleaning and CCTV inspection of these line segments. As discussed previously, it is recommended that all defective manholes that are adjoined to recommended pipeline replacement sewers be included in one pipeline rehabilitation/replacement construction contract. Figure AC shows the locations and type of recommended rehabilitation for each line segment in the Pilot Study Area.

The total estimated cost to complete the pipeline rehabilitation program is $705,900 including a 30% contingency of $162,900 for engineering, inspection, legal, and general administration costs. A general breakdown of the costs to implement the recommended pipeline rehabilitation program is shown in Table VIII-7. As mentioned previously in Section V, a detailed listing of line segments recommended for rehabilitation can be found in Appendix J.

Table VIII-7
Pipeline Rehabilitation Summary

Type of Rehabilitation	Unit	Quantity	Unit Cost ($)	Total Cost ($)
CIPP	lf	2,415	$35	$84,600
Replacement	lf	5,242	$76	$398,400
Point Repair	Each	3	$2,500	$7,500
Manhole Replacement	Each	21	$2,500	$52,500
Sub-Total:				**$543,000**
Total with 30% Legal, Administration, and Contingencies:				**$705,900**



Belton, MO

2006 Wastewater Master Plan

Figure AC

Pilot Study Area
Recommended Line Rehabilitation

WADE & ASSOCIATES, INC.

4. Sewer Maintenance Program

It is recommended that the City implement a sewer maintenance program to accomplish annual cleaning and CCTV of approximately 33% of the collection system. A QA/QC component of the annual program should include cleaning & CCTV of an additional 5 to 10% of the system by a contractor.

As of 2005, the collection system contained approximately 583,280 linear feet of sewer system. A complete cleaning of the existing collection system would cost an estimated $961,600. By the year 2026, it is projected that the collection system will have increased in size to approximately 664,752 linear feet, excluding force mains. The estimated cost to conduct a sewer maintenance program incorporating future collection system expansion over the course of the planning period is $8,925,400. Table VIII-8 contains the estimated cost summary to implement the recommended maintenance program. It is also suggested that the City review and compare the possible cost savings of purchasing additional cleaning and television vehicles and employing added personnel in implementing the overall sewer maintenance program.

Table VIII-8
Sewer Maintenance Program

Year	Unit	Quantity	Clean and TV Unit Cost ($)	Total Cost* ($)
2007 – 1st Third	lf	194,427	$1.6	$311,100
2008 – 2nd Third	lf	194,427	$1.6	$320,400
2009 – 3rd Third	lf	194,427	$1.6	$330,000
2010-2012	lf	594,414	$1.6	$1,066,800
2013-2015	lf	604,297	$1.6	$1,181,000
2016-2018	lf	621,513	$1.6	$1,322,000
2019-2021	lf	642,532	$1.6	$1,494,000
2022-2024	lf	657,145	$1.6	$1,678,200
2025-2026	lf	664,752	$1.6	$1,221,800
Total Cost*:				**$8,925,400**

*Cost includes a 3% inflation rate per year beginning in 2008.

5. Post Rehabilitation Flow Monitoring and Analysis

It is recommended that upon completion of the recommended SSES and rehabilitation projects for the entire collection system, the City conduct a post rehabilitation flow monitoring and analysis program to assess the amount of I/I removed from the collection system. The post-rehabilitation program should include installation of at least 14 flow meters with 12 of the flow meters re-installed at their original monitoring locations. The two additional flow meters should be installed at locations to enable monitoring of the interceptor lines entering the wastewater treatment facility. An estimated cost to conduct the post rehabilitation flow monitoring study is $94,300. Following completion of the recommended post rehabilitation flow monitoring program, flow analysis should be conducted to determine the actual amount of I/I flow removed from the system. The estimated cost to conduct the post rehabilitation analysis is $24,900.

Recommendations for replacement sewers were based on hydraulic modeling analysis incorporating future growth flows. The future growth scenarios incorporated the City of Belton's population projections through the year 2025, an estimated 30% I/I removal within the existing system, and used a 5-year, 90-minute design storm event. It is recommended, that if the post rehabilitation analysis results indicate less than 30% I/I has been removed, the model should be recalibrated to provide new flow projections. The estimated cost to conduct this post rehabilitation hydraulic modeling is $42,200. The total estimated cost to complete the recommended Post Rehabilitation Flow Monitoring and Analysis Program is $161,400.

C. Future Growth Related Projects

1. Recommended Pipeline Capacity Improvements

To identify replacement sewer lines, a post-rehabilitation hydraulic model of the wastewater collection system was prepared utilizing the future growth land use area and evaluated using the 5-year, 90-minute design storm event. This model assumes that approximately 30% of the identified inflow and infiltration were removed. Replacement sewer recommendations were established based on comparison of existing hydraulic conditions or flow capacity to peak flows rates under the 5-year, 90-minute design storm event. Where surcharging occurred, a more detailed hydraulic gradient analysis was performed. Results of the model indicated replacement sewer requirements scattered throughout the Study Area.

Specifically, the hydraulic analysis indicates that approximately 43,642 lineal feet of replacement sewer lines will be required to transport the remaining storm-induced flows to the

City's wastewater treatment facility without incident of system backups. As mentioned in Section VI of this report, Appendix R contains a listing of all recommended capacity improvement sewer lines. Figure AD shows all the recommended replacement sewers lines utilizing the future growth land use configuration under the 5-year, 90-minute storm event. The total estimated cost for the recommended pipeline capacity improvement program is $12,982,200.

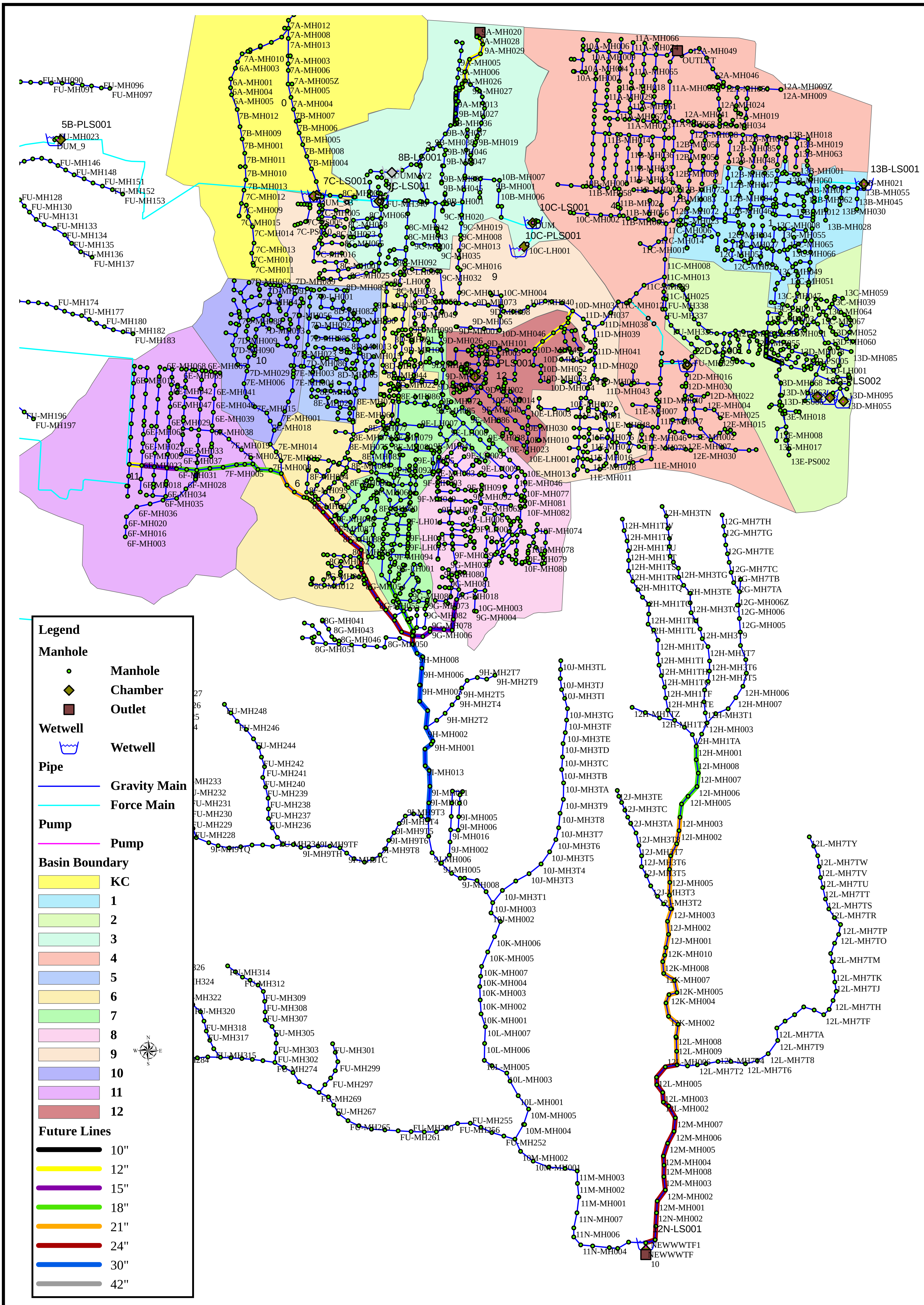
2. Lift Station Removal and Reconfiguration Program

   a) The Fairway Ridge Lift Station: The Fairway Ridge lift station will be disconnected and flows re-routed to Johnson County Wastewater. Figure AE shows the future flow routing after the Fairway Ridge lift station is decommissioned. The total estimated cost to decommission the Fairway Ridge lift station is $19,500. The removal of the Fairway Ridge lift station is scheduled as a 2007 Capital Improvement Project.

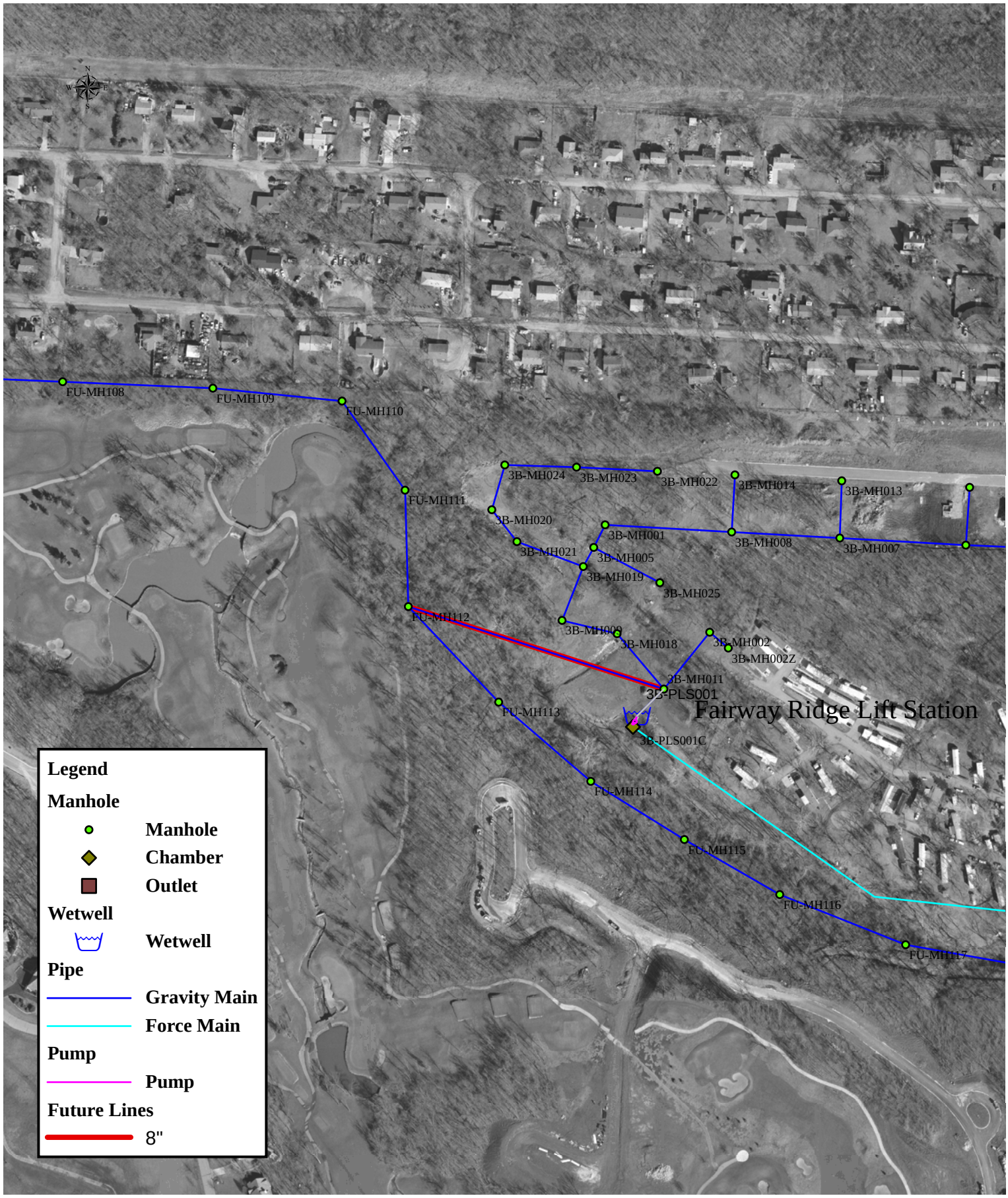
   b) The West Cimarron Lift Station: The current flows from the sub-division directly to the south of the West Cimarron Lift Station, will be re-routed to bypass the lift station and connect to manhole 7C-MH003 in order to be treated by Kansas City, MO. Figure AF shows the location of the new 12" line segment required to divert flows from the West Cimarron lift station in the future growth scenario. The total estimated cost to bypass the West Cimarron lift station and construct a 12" sewer under Markey Road is $28,000. The removal of the West Cimarron Lift Station is scheduled as a 2008 Capital Improvement Project.

   c) The Cedar Tree Lift Station: The Cedar Tree Lift Station will be disconnected and flows routed under US Highway 71 to manhole 11C-MH025. Approximately nine new manholes and 10 new line segments, comprising approximately 2,683 linear feet, will be required to bypass the Cedar Tree Lift Station and connect to manhole 11C-MH025. Approximately 164 feet of new sewer lines will be required to construct lines underneath US Highway 71. Figure AG shows the location of the new manholes and line segments after re-routing flows previously going to the Cedar Tree Lift Station. The total estimated cost to disconnect the Cedar Tree Lift Station and construct the new manholes and line segments to convey flows to manhole 11C-MH025 is $463,700. The removal of the Cedar Tree Lift Station (12D-LS001) is scheduled as a 2007 Capital Improvement Project.

   d) The East Cimarron Lift Station: The East Cimarron lift station will be disconnected. Flows entering existing manhole 8C-MH049 will be diverted north, under Markey Road to future manhole FU-MH339. Flows from manhole 8B-MH014 will also be diverted to



Belton, MO 2007 Wastewater Master Plan	Figure AD	WADE & ASSOCIATES, INC.
	Recommended Replacement Sewer Lines	



Belton, MO

2007 Wastewater Master Plan

Figure AE

Fairway Ridge Lift Station
Disconnect and Divert Flows to JCW

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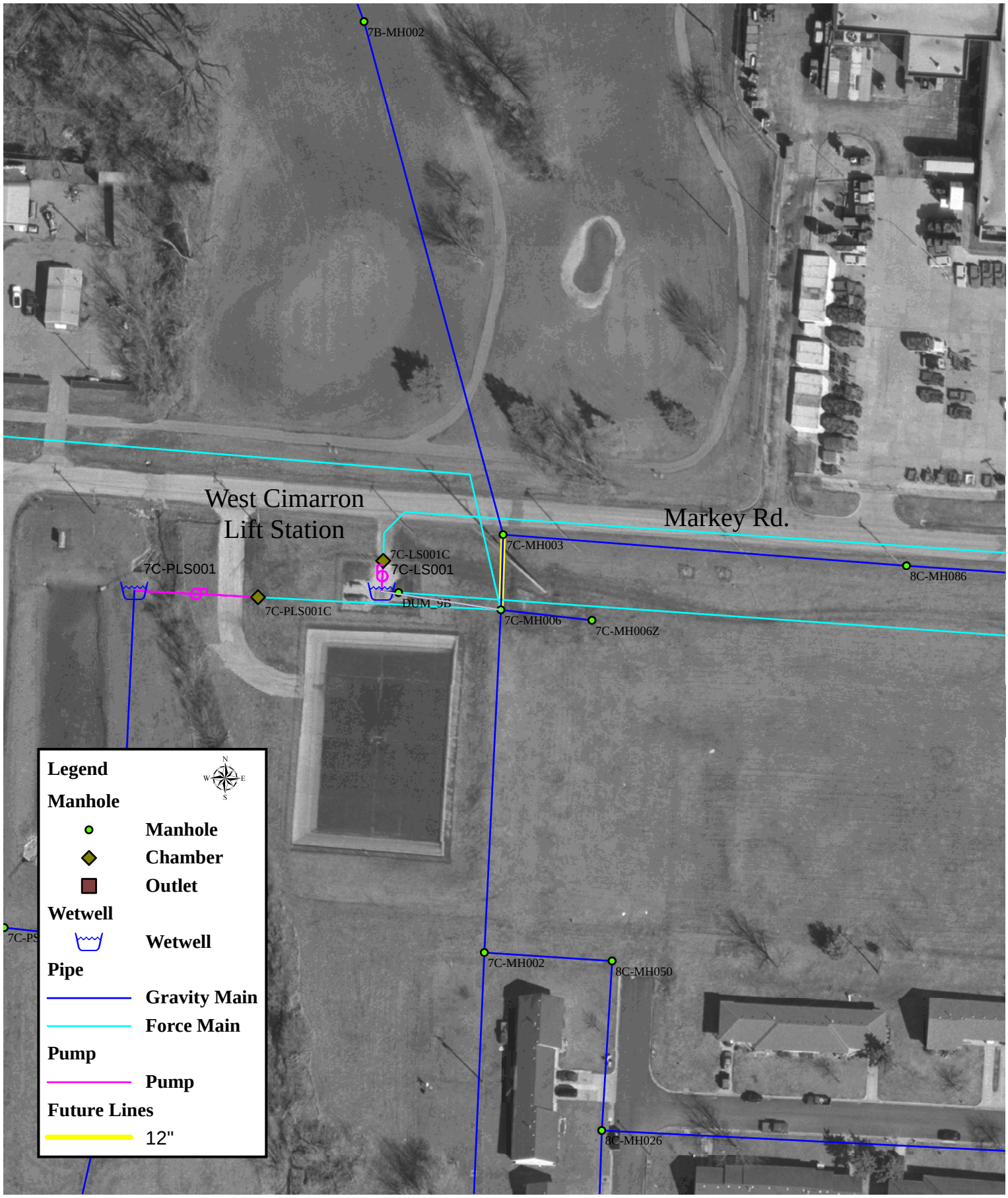

Belton, MO

2007 Wastewater Master Plan

Figure AF

West Cimarron Lift Station
Future Growth Bypass Line to KCMO

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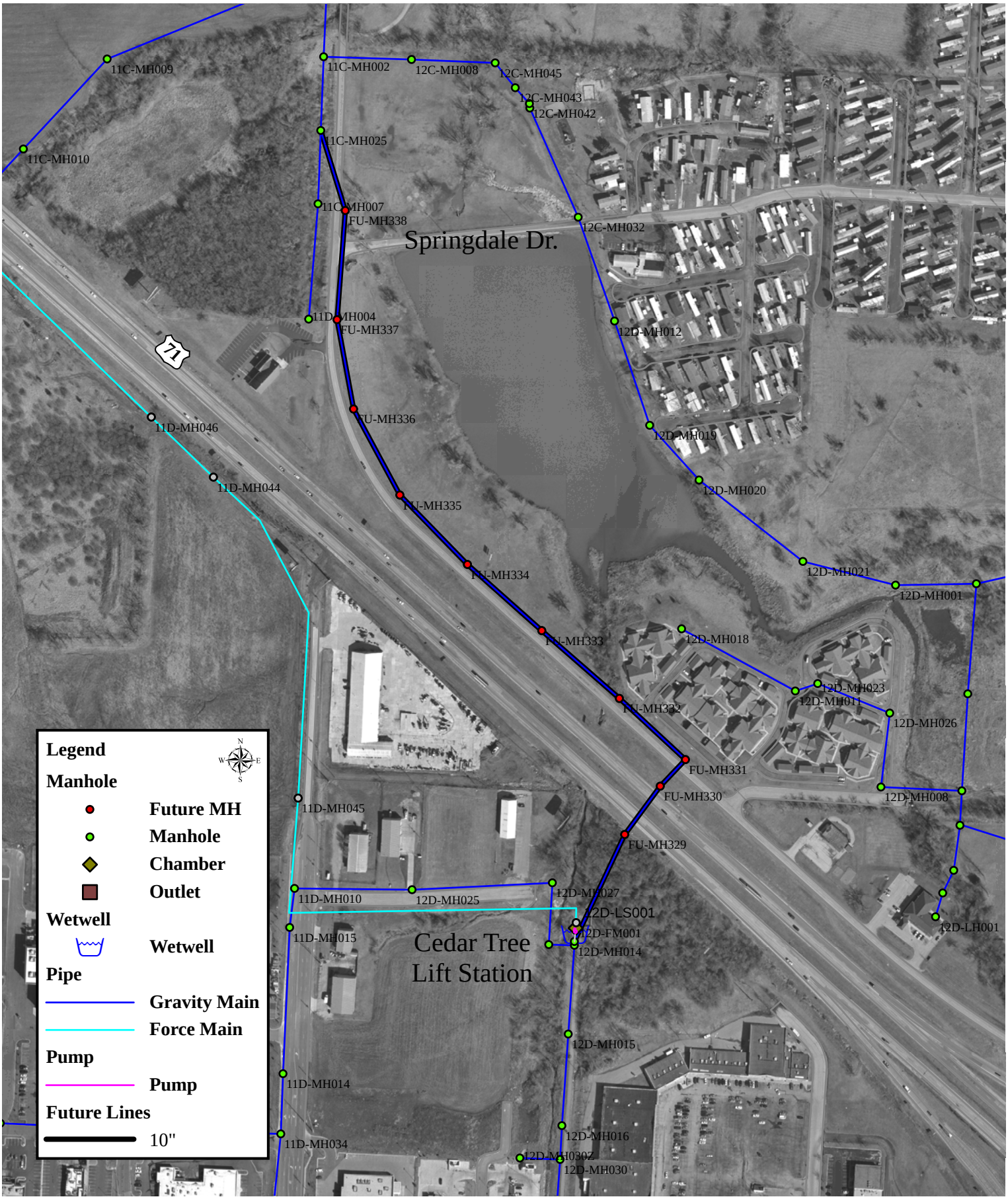


Belton, MO

2007 Wastewater Master Plan

Figure AG

Cedar Tree Lift Station
Disconnect and Construct New Sewer Lines

WADE & ASSOCIATES, INC.

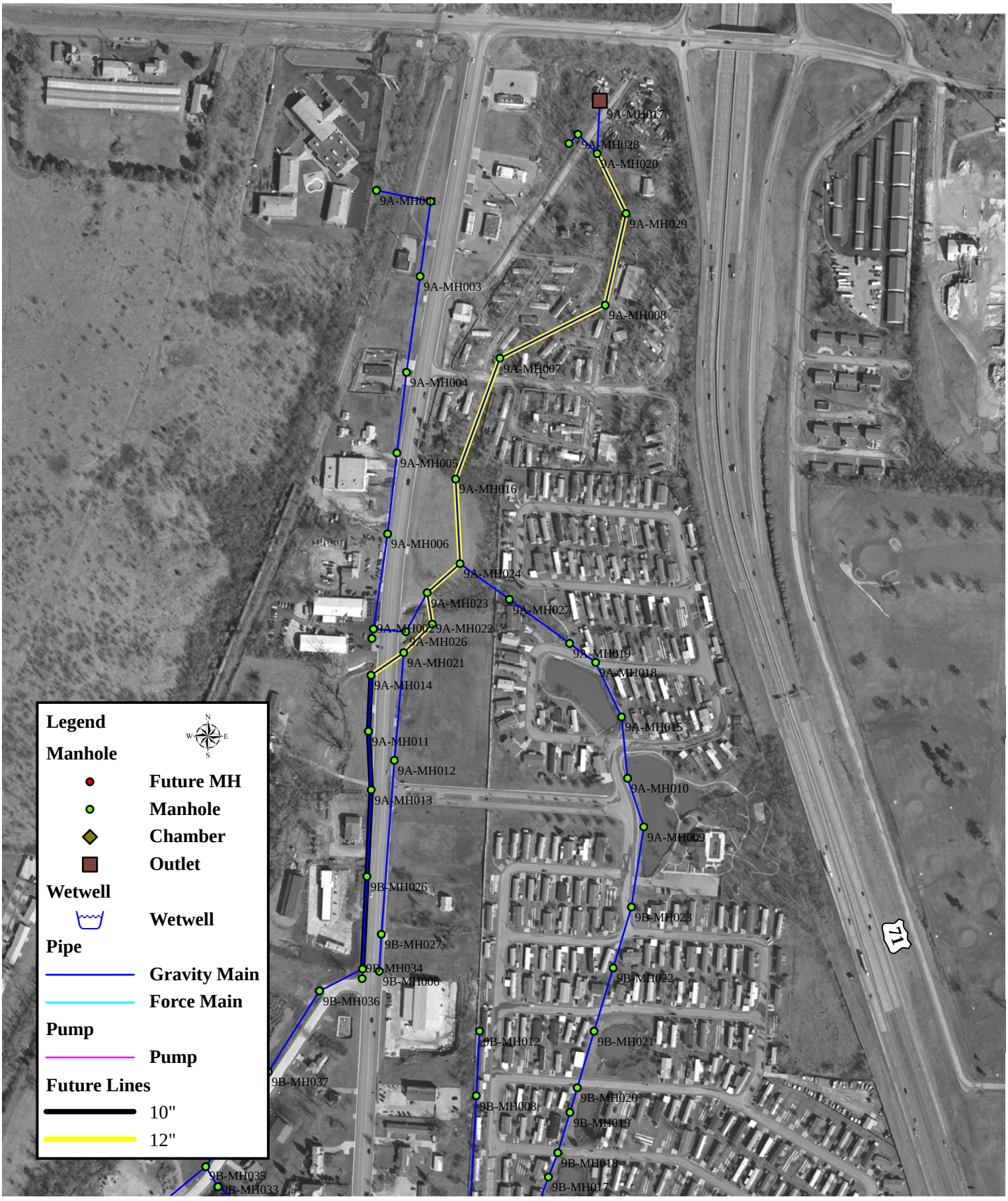
future manhole FU-MH339. Approximately 383 feet of sewer lines and two new manholes will be added as part of this project. The total estimated cost of decommissioning the East Cimarron lift station is $67,700. Figure AH shows the location of the East Cimarron lift station. The removal of the East Cimarron Lift Station is scheduled as a 2009 Capital Improvement Project.

e) The Markey Meadows Lift Station: The Markey Meadows lift station will also be disconnected. Flows from the disconnected East Cimarron lift station will be re-routed to the Markey lift station, where 2 additional sewer lines and manhole will be constructed to connect the former Markey Meadows lift station and manhole 9B-MH043Z. Figure AH illustrates the location of the Markey Meadows Lift Station. These flows will then travel downstream to the LBVSD interceptor. The total estimated cost of decommissioning the Markey Meadows lift station is $90,100. The removal of the Markey Meadows Lift Station is scheduled as a 2009 Capital Improvement Project.

f) East Cimarron and Markey Meadows Replacement Lines: Before the disconnection of the East Cimarron and Markey Meadows lift stations, approximately 2,900 feet of sewer lines in basin 3 should be upsized in order to increase capacity and safely transport the future growth flows resulting from disconnecting these two lift stations. The total estimated cost of constructing relief/replacement lines for the decommissioning the Markey Meadows and East Cimarron lift stations is $435,200. Figure AI portrays the size and location of the upsized replacement sewers. This replacement line work is scheduled as a 2009 Capital Improvement Project.

Table VIII-9 shows the cost summary for all lift station removal projects. The total estimated cost to disconnect the five (5) lift stations is $1,105,000.

Belton, MO 2007 Wastewater Master Plan	Figure AH Markey Meadows and East Cimarron Lift Stations	WADE & ASSOCIATES, INC.



Belton, MO

2007 Wastewater Master Plan

Figure AI

E. Cimarron and Markey Meadows LS
Recommended Replacement Lines

WADE & ASSOCIATES, INC.

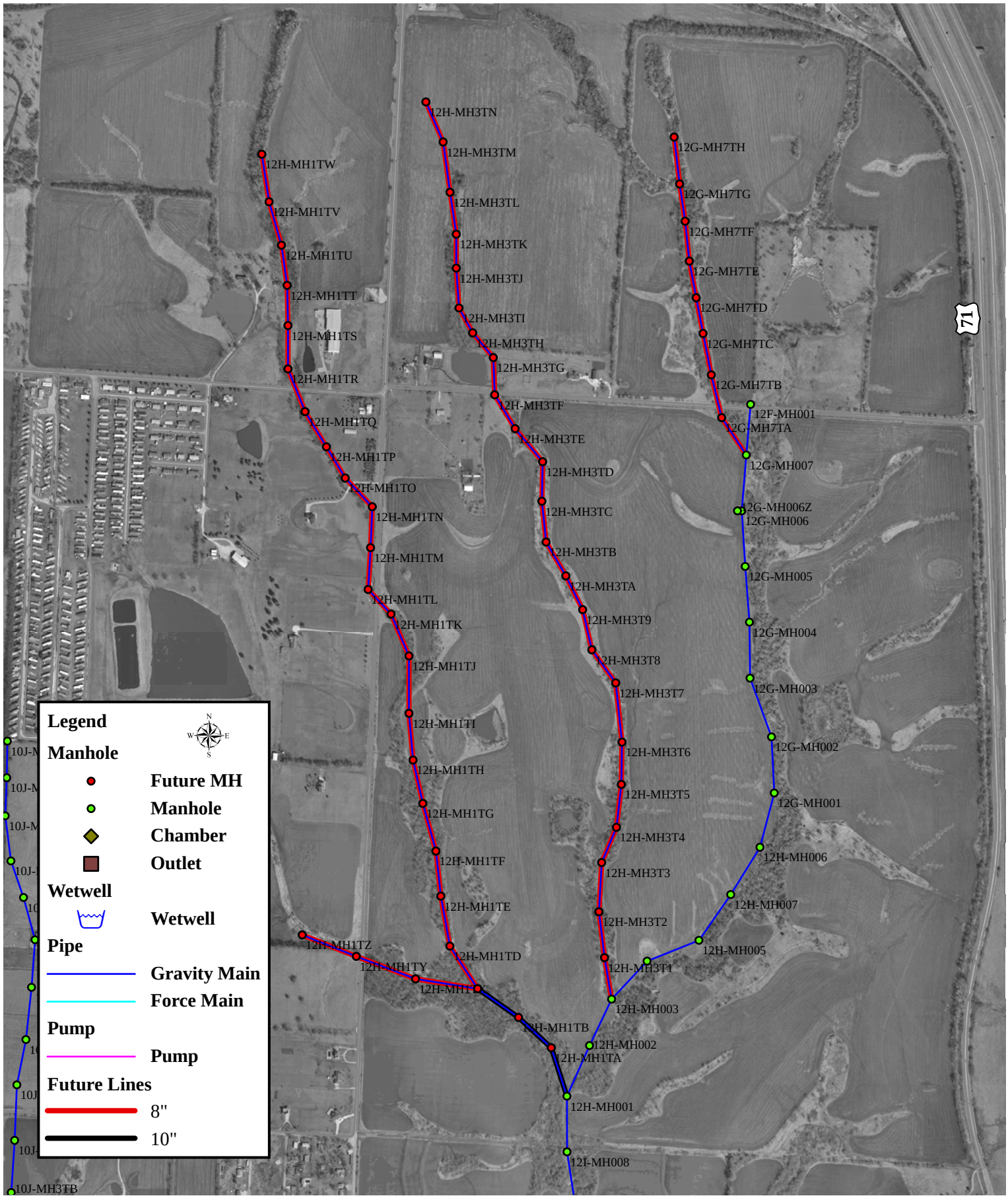
Table VIII-9
Lift Station Removal

Task	Quantity	Unit	Unit Cost ($)	Sub-Total Cost ($)
Fairway Ridge Lift Station				
Disconnect Fairway Ridge LS	1	Each	$15,000	$15,000
West Cimarron Lift Station				
Disconnect/Bypass W. Cimarron LS	1	Each	$15,000	$15,000
12” Sewer Line	57	lf	$114	$7,000
Cedar Tree Lift Station				
Disconnect Cedar Tree Lift Station	1	Each	$15,000	$15,000
10” Sewer Line	2,519	lf	$96	$241,800
HWY 71 Crossing	165	lf	$510	$85,000
Manhole Additions	10	Each	$2,500	$25,000
East Cimarron Lift Station				
Disconnect East Cimarron LS	1	Each	$15,000	$15,000
8” Sewer Line	383	lf	$76	$29,000
Manhole Additions	2	Each	$2,500	$5,000
Markey Meadows Lift Station				
Disconnect Markey Meadows LS	1	Each	$15,000	$15,000
8” Sewer Line	620	lf	$76	$47,000
Manhole Additions	1	Each	2,500	$2,500
ECLS and MMLS Replacement Lines				
10” Sewer Line	908	lf	$96	$87,000
12” Sewer Line	2,002	lf	$114	$228,000
Sub-Total:				$832,300
Total with 30% Legal, Administration, and Contingencies*:				**$1,099,800**

*Cost includes a 3% inflation rate per year beginning in 2008.

3. Future Growth Collection System Expansion Program

The City of Belton will be required to construct sanitary sewer lines to facilitate the continued growth of the population. It is anticipated that the City will experience most of its growth southeast and west of the City. Figure AJ (southeast) shows the area where growth is anticipated to occur first within the next 8 years of this published report. Figure AK (south) shows the area where growth is anticipated to occur first within the next 8-15 years of this published report. Figure AL (northwest) shows the area where growth is anticipated to occur first within the next 10-20 years of this published report. Flows from this northwest area are expected to be treated by Johnson County Wastewater. Figure AM (west) shows the area where growth is anticipated to occur first within the next 10-20 years of this published report. Table VIII-10 shows the future growth cost summary by each growth area.



Belton, MO

2007 Wastewater Master Plan

Figure AJ

Future Growth Sewer Lines and Manholes
Southeast (8 years out)

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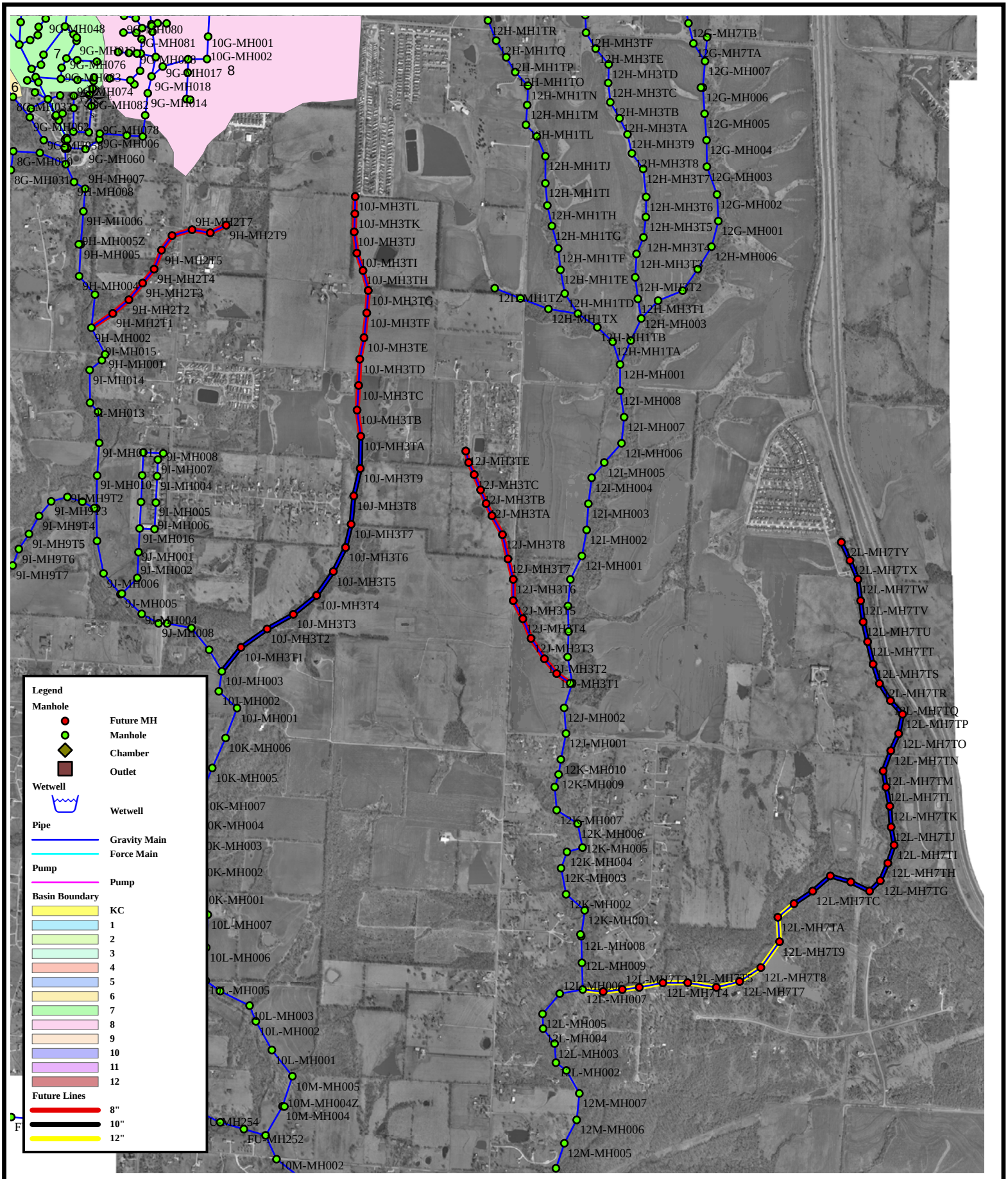


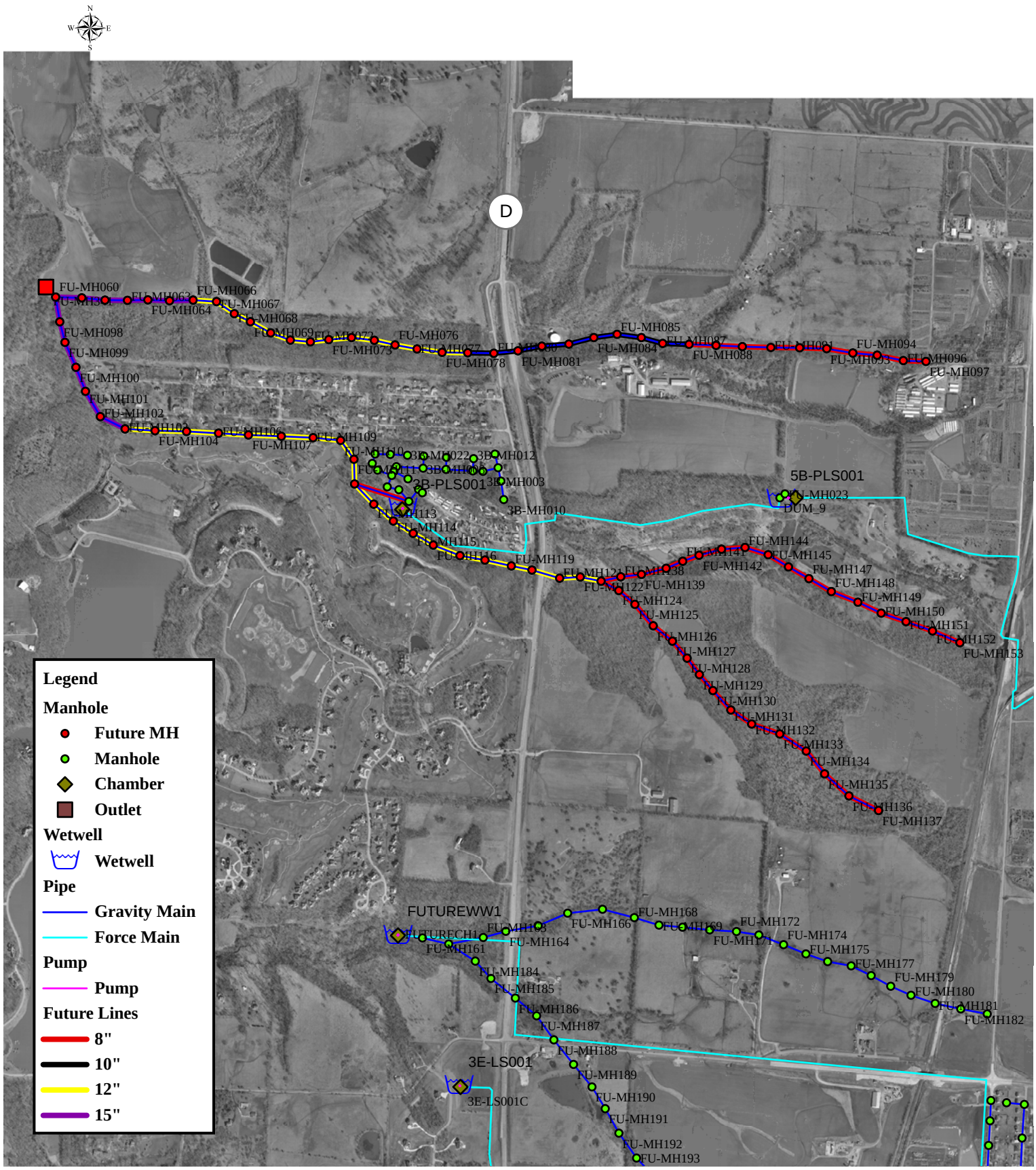
Belton, MO

2007 Wastewater Master Plan

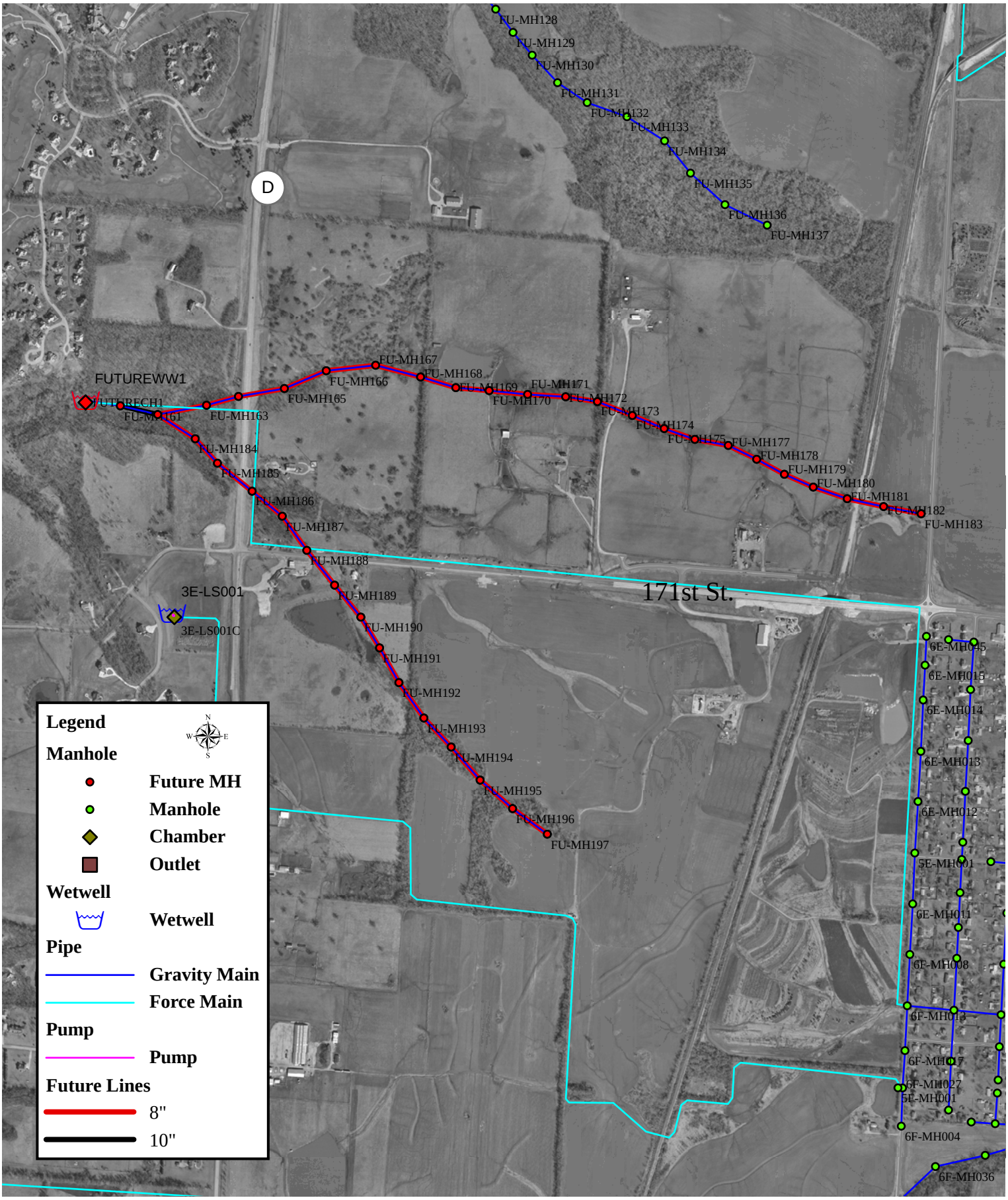
Figure AK

Future Growth Sewer Lines and Manholes
South (8-15 years out)

WADE & ASSOCIATES, INC.



Belton, MO 2007 Wastewater Master Plan	Figure AL Future Growth Sewer Lines and Manholes Northwest (10-20 years out)	WADE & ASSOCIATES, INC.



Belton, MO

2007 Wastewater Master Plan

Figure AM

Future Growth Sewer Lines and Manholes
West (10-20 years out)

WADE & ASSOCIATES, INC.

Table VIII-10
Recommended Future Growth Collection System Expansion

Planning Period[1]	Task	Quantity	Unit	Unit Cost ($)	Sub-Total Cost ($)
8 years	**Southeast**				
	Manhole Additions	57	Each	$2,500	$142,500
	8" Sewer Lines	16,777	lf	$76	$1,275,100
	10" Sewer Lines	1,037	lf	$95	$98,500
8-15 years	**South**				
	Manhole Additions	78	Each	$2,500	$195,000
	8" Sewer Lines	10,331	lf	$76	$785,200
	10" Sewer Lines	11,361	lf	$95	$1,079,300
	12" Sewer Lines	3,933	lf	$114	$448,400
10-20 years	**Northwest – To JCW**				
	Manhole Additions	95	Each	$2,500	$237,500
	8" Sewer Lines	11,644	lf	$76	$884,900
	10" Sewer Lines	2,497	lf	$95	$237,200
	12" Sewer Lines	9,165	lf	$114	$1,044,800
	15" Sewer Lines	3,273	lf	$142	$464,800
	18" Sewer Lines	155	lf	$170	$26,400
10-20 years	**West**				
	Manhole Additions	38	Each	$2,500	$95,000
	8" Sewer Lines	10,134	lf	$76	$770,200
	10" Sewer Lines	580	lf	$95	$55,100
	15" Sewer Lines	652	lf	$142	$92,600
	171st St. Lift Station[2]	1	Each	$520,000	$520,000
	8" Force Main[3]	10,867	lf	$59	$641,200
Sub-Total:					**$9,093,700**
Total with 30% Legal, Administration, and Contingencies[4]:					**$16,545,100**

[1]Years beyond the base year of this report (2007).
[2]Pump Station, Wet Well, Utilities. Does not include O&M Costs.
[3]Force Main, Air Release, Easements, Rock Ripping
[4]Cost includes a 3% inflation rate per year beginning in 2008.

D. Summary

This 2007 Wastewater Collection System Master Plan Report includes several recommendations for eliminating the frequency and severity of surcharging within the collection system as well as increasing the system capacity through the addition and replacement of selected sewers within the recommended Capital Improvement Projects. Table VIII-11, provides the recommended system-wide improvements to the City of Belton's wastewater collection system. Through the effective implementation of these programs, the City will be able to provide adequate transport of wastewater flows during a 5-year, 90-minute storm event. Implementation of only a portion of the recommended system-wide improvements will not result in sufficient transport capacity for future growth flows at the design storm event. **The total estimated cost to identify and eliminate 30% of the City of Belton's I/I and to provide adequate transport of existing and future wastewater flows to the system outlets as well as to the wastewater treatment plant is $44.4 million.**

Table VIII-11
Recommended System Improvement Cost Estimate

Description	Cost Estimate ($)
Maintenance Projects	
Sanitary Sewer Evaluation Study	$928,400
Sanitary Sewer Rehabilitation	$3,760,000
Sewer Maintenance Program	$8,925,400
Post Rehabilitation Analysis	$161,400
Future Growth Projects	
Recommended Pipeline Capacity Improvements	$12,982,200
Lift Station Removal and Reconfiguration	$1,099,800
Future Growth Collection System Expansion	$16,545,100
Total*:	**$44,402,300**

*Cost includes a 3% inflation rate per year beginning in 2008

Appendix A
Monitoring Site Sheets

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 05 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address Between Mullen & Eastern, On 163rd St

Serial No. SE9 Site ID 1 Pipe Size 14" Surcharge ☐Y ☒N

Site Description 163rd St Pipe Material PVC Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 3.00 Velocity (fps) 1.50 Depth of Debris (in) 0.00

Manhole Depth (ft.) 19.66 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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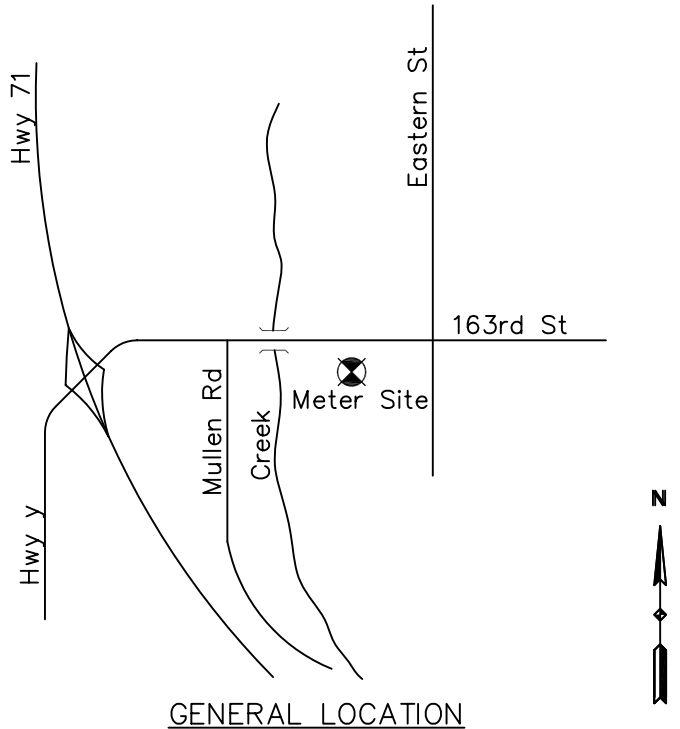

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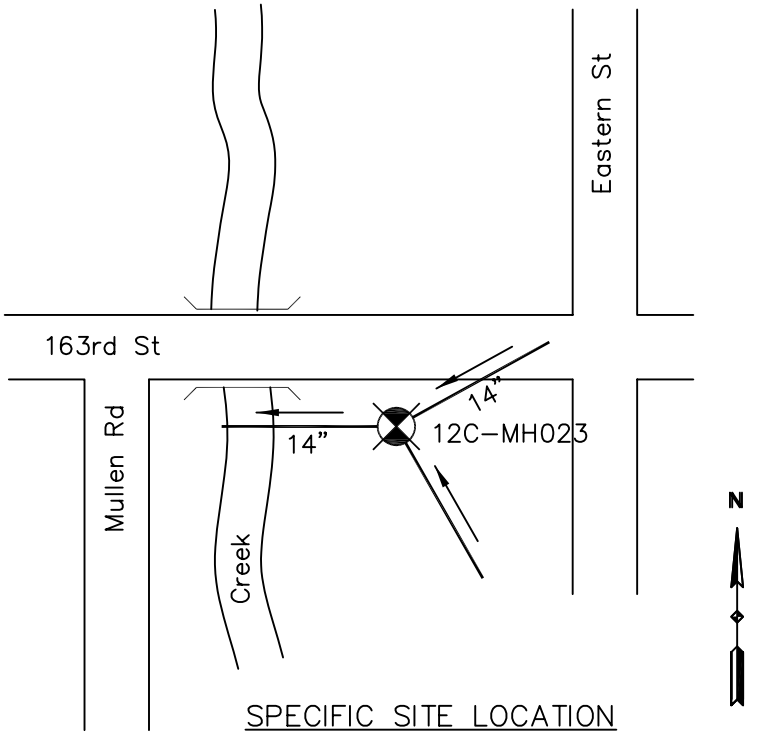

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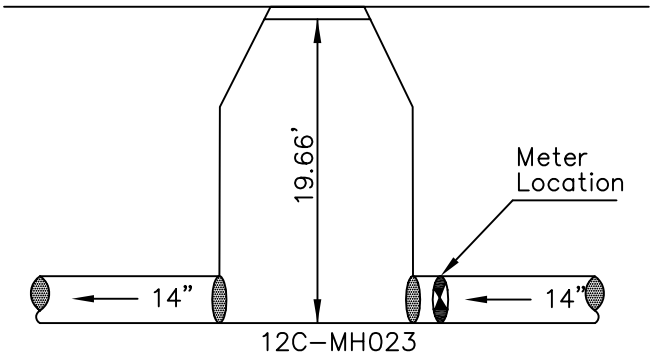

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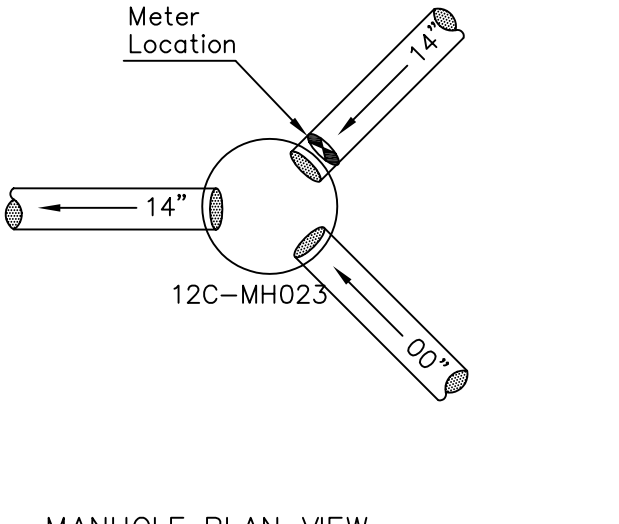

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 , 05, 05

Project No. 0502 Project Location City Wide Crew WGB , , , ,

Address Between Mullen & Eastern, On 163rd St

Serial No. SE9 Site ID 1 Pipe Size 14" Surcharge Y☐ N☒

Site Description 163rd St Pipe Material PVC Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 3.00 Velocity (fps) 1.50 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 19.66 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

Photo ID: WF0415005 (area), WF0415006 (t.s.), WF0415008 (u.s.), WF0415007 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 05 / 05

Project No. 0502 Project Location City Wide Crew WGB , , , ,

Address Mullen Rd

Serial No. PVO Site ID 2 Pipe Size 14.75" Surcharge ☐Y ☒N

Site Description Mullen Rd Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 3.00 Velocity (fps) 2.00 Depth of Debris (in) 0.00

Manhole Depth (ft.) 14.70 Manhole Dia. (ft.) 5.00 Flow Characteristic ☒G ☐ F ☐ P

Comments:

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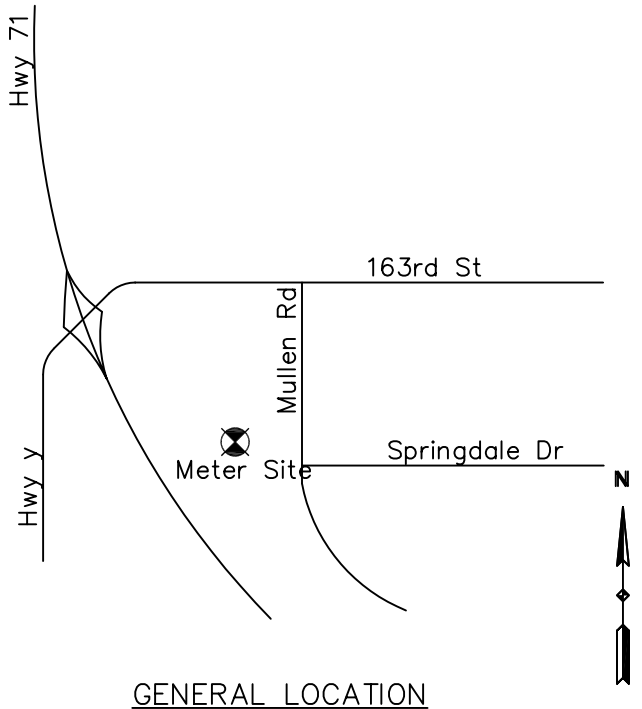

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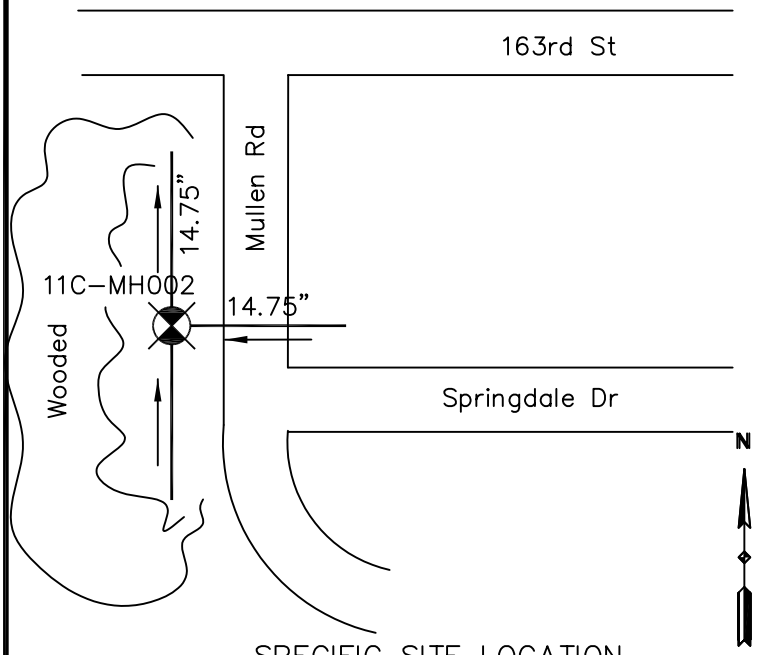

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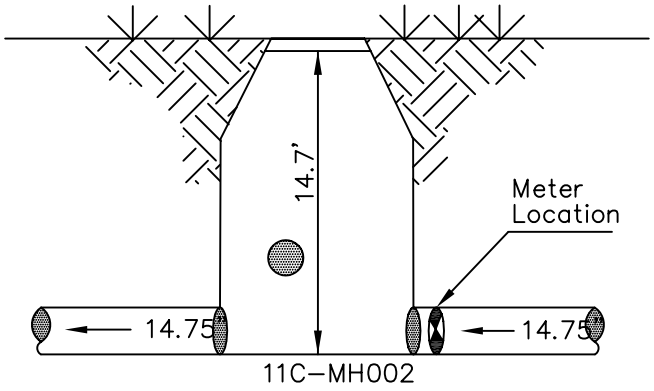

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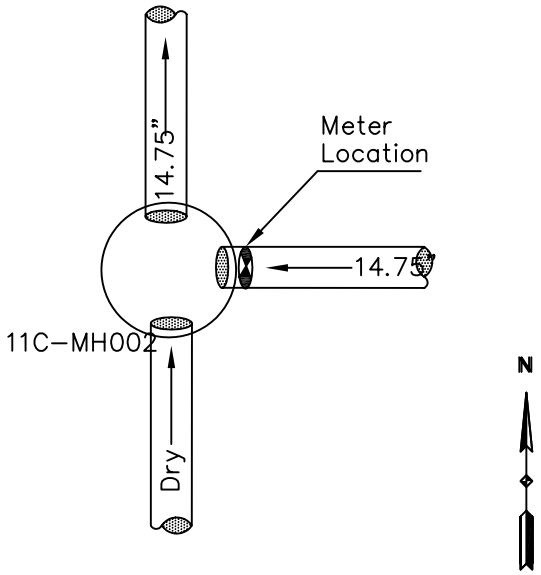

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 05 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address Mullen Rd

Serial No. PVO Site ID 2 Pipe Size 14.75" Surcharge Y☐ N☒

Site Description Mullen Rd Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 3.00 Velocity (fps) 2.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 14.70 Manhole Dia. (ft.) 5.00 Flow Characteristic ☒G ☐ F☐ P

Comments:

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GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 3)

City of Belton, MO

Date 04 / 05 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address Mullen Rd

Serial No. PVO Site ID 2 Pipe Size 14.75" Surcharge Y☐ N☒

Site Description Mullen Rd Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 3.00 Velocity (fps) 2.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 14.70 Manhole Dia. (ft.) 5.00 Flow Characteristic ☒G ☐ F☐ P

Comments:

Photo ID: AF0406009 (area), AF0406008 (t.s.), AF0406005 (u.s.), AF0406006 (u.s.), AF0406007 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

N

CROSS SECTION

MANHOLE PLAN VIEW

N

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 07 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 155th & Scott Ave

Serial No. SBL Site ID 3 Pipe Size 10" Surcharge ☒Y ☐N

Site Description Scott Ave Pipe Material VCP Depth of Surcharge (ft.) 6.00

Depth of Flow (in.) 3.00 Velocity (fps) 4.00 Depth of Debris (in) 0.00

Manhole Depth (ft.) 15.70 Manhole Dia. (ft.) 3.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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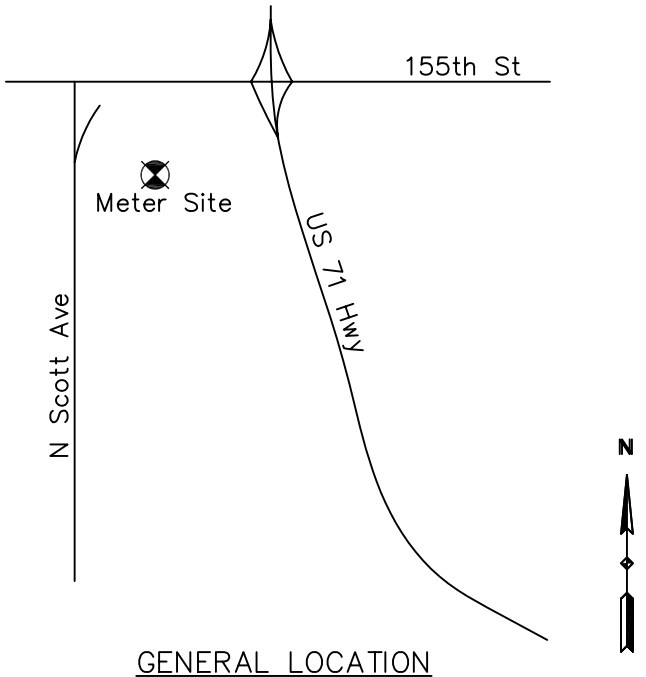

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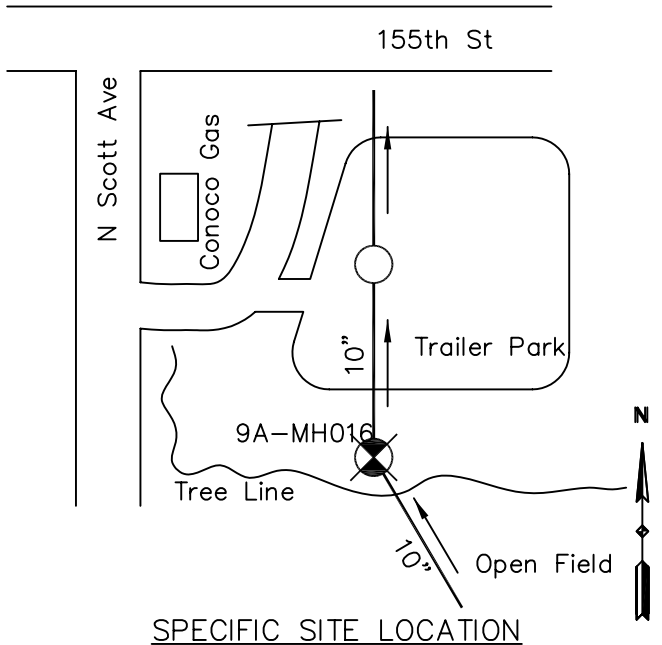

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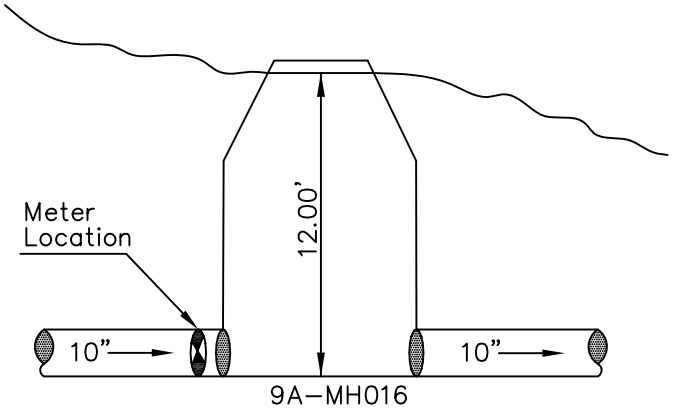

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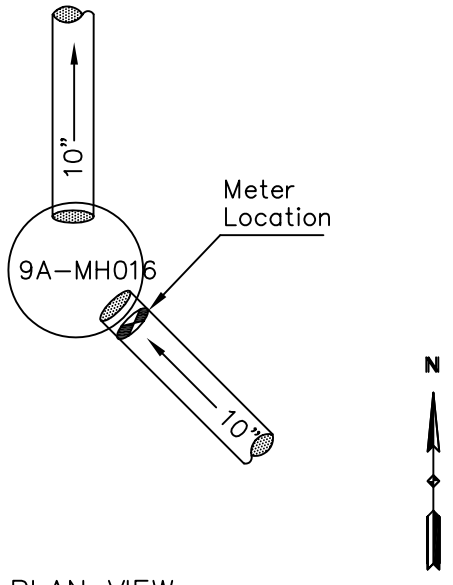

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 07 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 155th & Scott Ave

Serial No. SBL Site ID 3 Pipe Size 10" Surcharge Y☒ N☐

Site Description Scott Ave Pipe Material VCP Depth of Surcharge (ft.) 6.00

Depth of Flow (in.) 3.00 Velocity (fps) 4.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 15.70 Manhole Dia. (ft.) 3.00 Flow Characteristic ☐G ☒F ☐P

Comments:

Photo ID: AF0415010 (area), AF0415011 (t.s.), AF0415013 (u.s.), AF0415012 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 07 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 7101 155th St

Serial No. PZY Site ID 4 Pipe Size 26.75" Surcharge ☐Y ☒N

Site Description 155th St Pipe Material RCP Depth of Surcharge (ft.) 0

Depth of Flow (in.) 5.00 Velocity (fps) 4.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 14.00 Manhole Dia. (ft.) 5.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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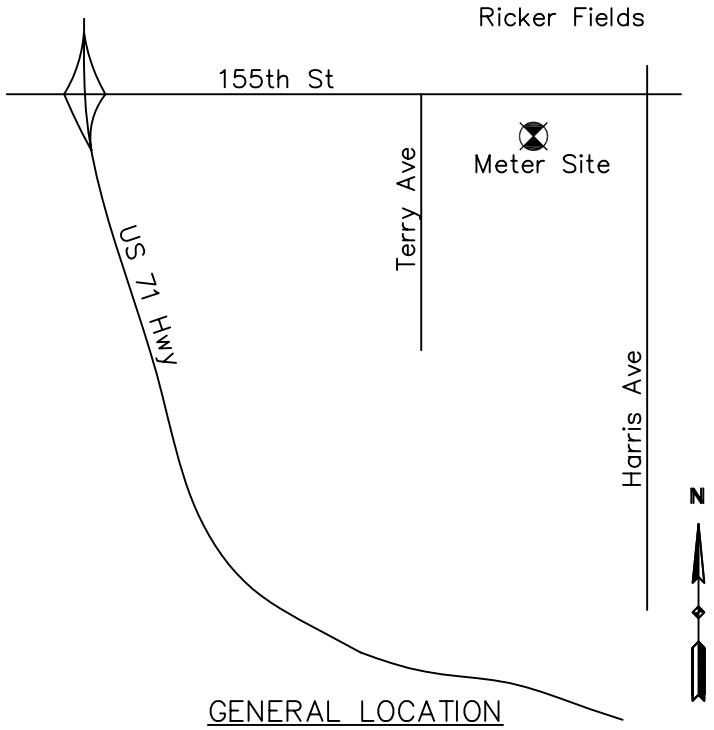

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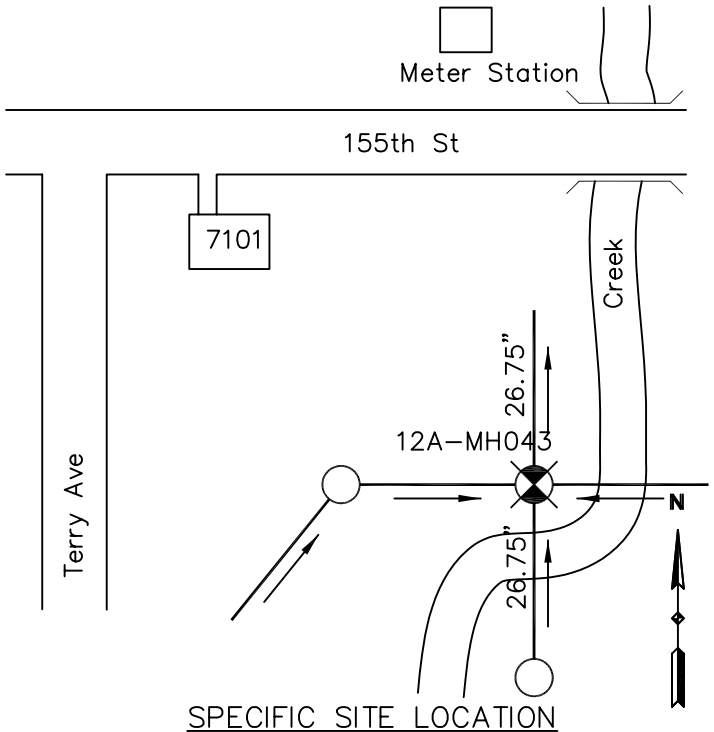

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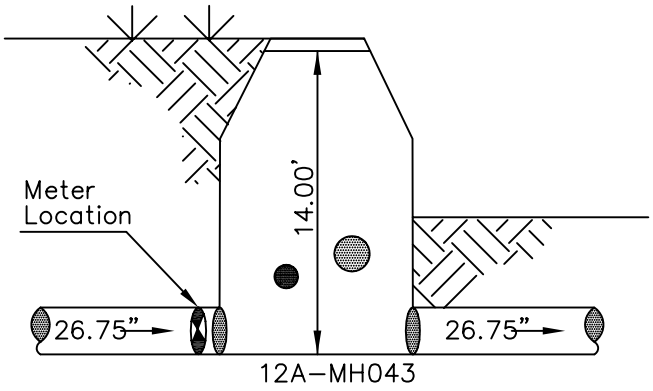

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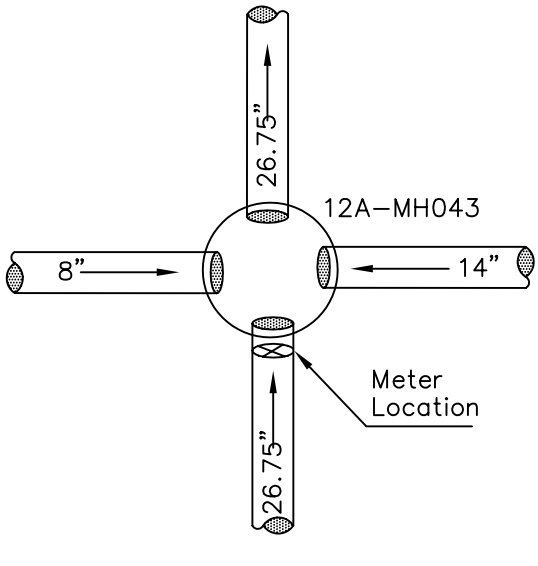

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 07 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 7101 155th St

Serial No. PZY Site ID 4 Pipe Size 26.75" Surcharge Y☐ N☒

Site Description 155th St Pipe Material RCP Depth of Surcharge (ft.) 0

Depth of Flow (in.) 5.00 Velocity (fps) 4.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 14.00 Manhole Dia. (ft.) 5.00 Flow Characteristic ☐G ☒F ☐P

Comments:

Photo ID: WF040701 (area), WF0407002 (t.s.), WF0407003 (u.s.), WF0407004 (u.s.), WF0407006 (u.s.), WF0407005 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 3)

City of Belton, MO

Date 04 / 07 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 7101 155th St

Serial No. PZY Site ID 4 Pipe Size 26.75" Surcharge Y☐ N☒

Site Description 155th St Pipe Material RCP Depth of Surcharge (ft.) 0

Depth of Flow (in.) 5.00 Velocity (fps) 4.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 14.00 Manhole Dia. (ft.) 5.00 Flow Characteristic ☐G ☒F ☐P

Comments:

Photo ID: WF040701 (area), WF0407002 (t.s.), WF0407003 (u.s.), WF0407004 (u.s.), WF0407006 (u.s.), WF0407005 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

N

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 07 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 412 Mill Rd

Serial No. TJI Site ID 5 Pipe Size 10" Surcharge ☒Y ☐N

Site Description Mill Rd Pipe Material VCP Depth of Surcharge (ft.) 7

Depth of Flow (in.) 3.00 Velocity (fps) 1.60 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 9.60 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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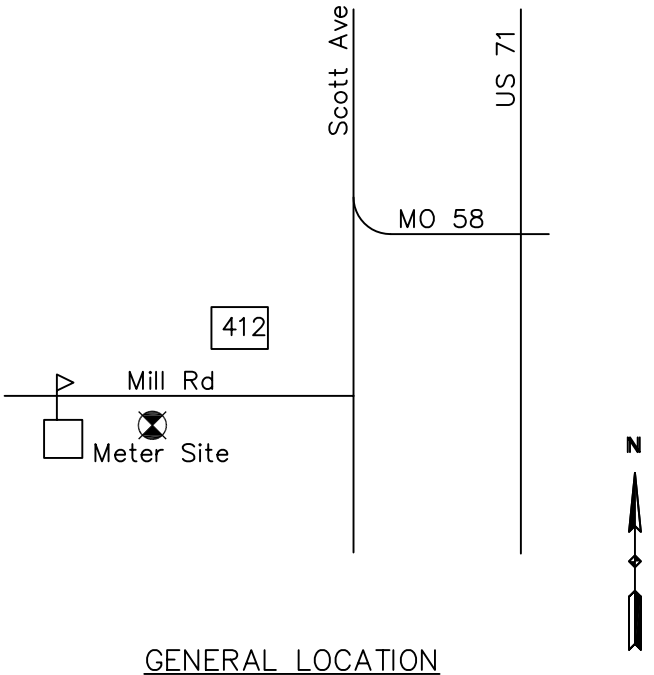

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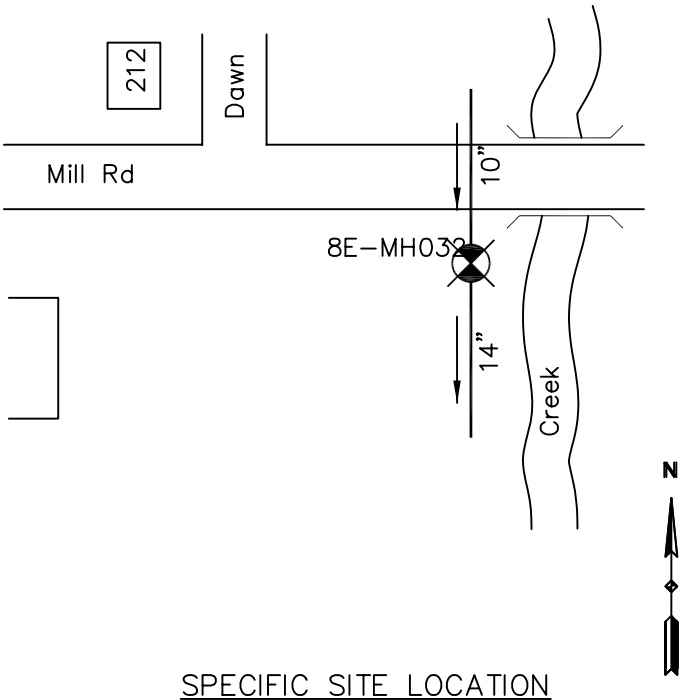

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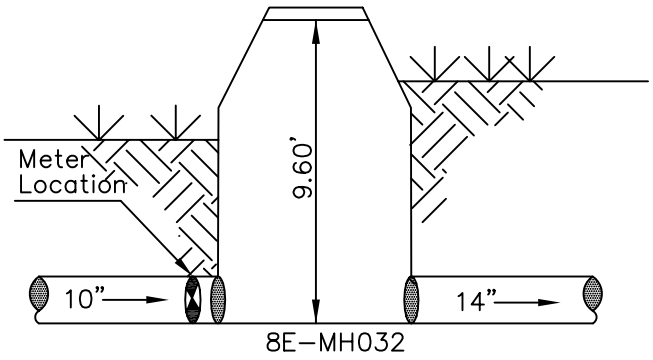

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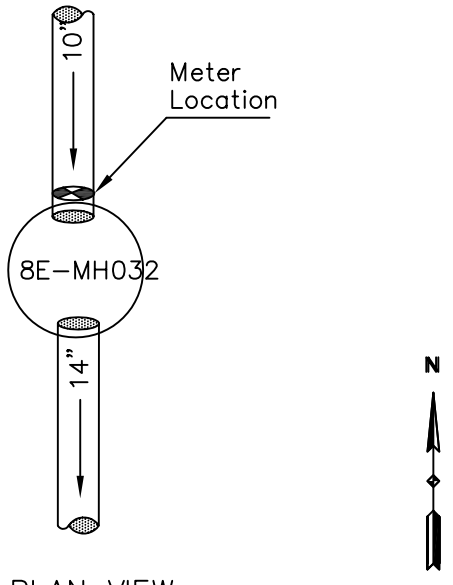

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 07 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 412 Mill Rd

Serial No. TJI Site ID 5 Pipe Size 10" Surcharge Y☒ N☐

Site Description Mill Rd Pipe Material VCP Depth of Surcharge (ft.) 7

Depth of Flow (in.) 3.00 Velocity (fps) 1.60 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 9.60 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , , ,

Address Inside Old WWTP Gate

Serial No. SDW Site ID 6 Pipe Size 18" Surcharge ☐Y ☒N

Site Description SW Side of Road Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 5.00 Velocity (fps) 7.30 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 10.70 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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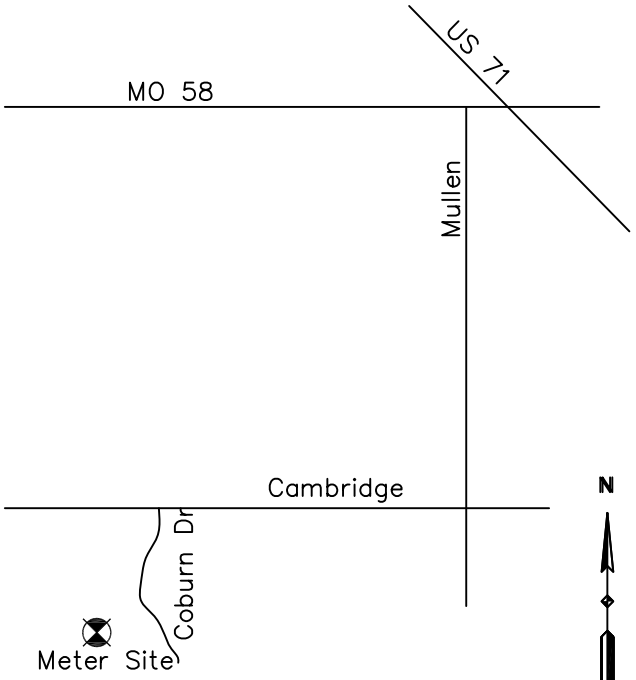

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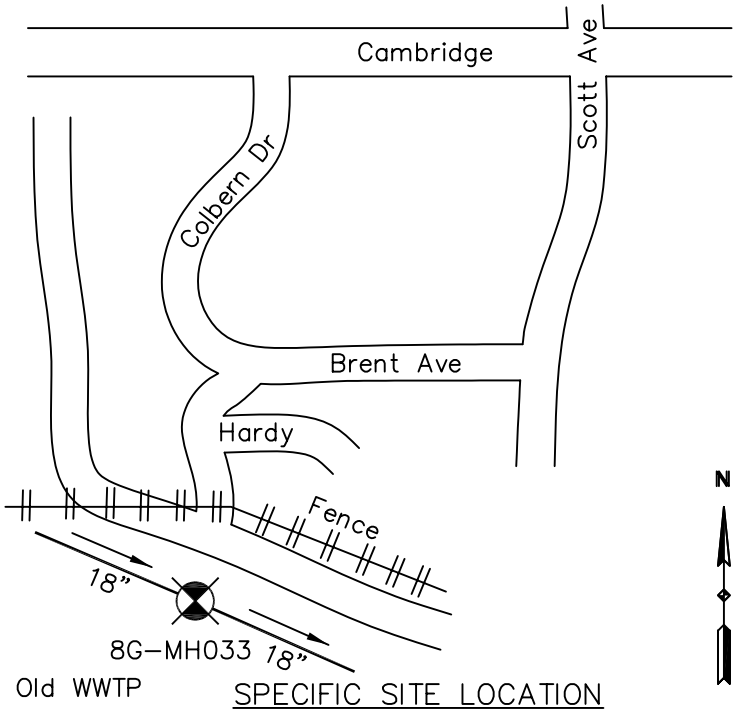

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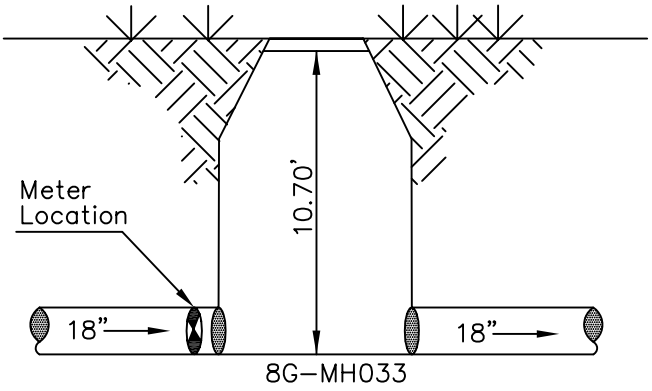

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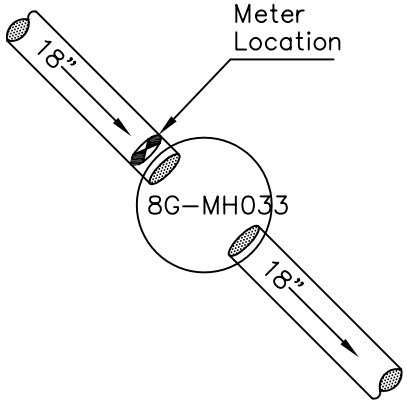

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address Inside Old WWTP Gate

Serial No. SDW Site ID 6 Pipe Size 18" Surcharge Y☐ N☒

Site Description SW Side of Road Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 5.00 Velocity (fps) 7.30 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 10.70 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

Photo ID: WF0408001 (area), WF0408002 (t.s.), WF0408004 (u.s.), WF0408003 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address

Serial No. SEO Site ID 7 Pipe Size 15" Surcharge ☐Y ☒N

Site Description Old WWTP 15" Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 4.00 Velocity (fps) 1.25 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 3.30 Manhole Dia. (ft.) 3.00 Flow Characteristic ☒G ☐ F ☐ P

Comments:

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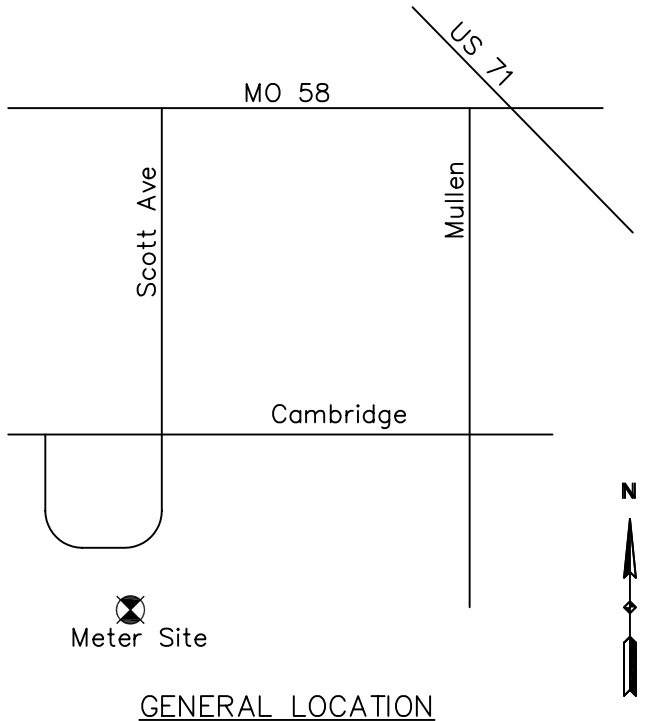

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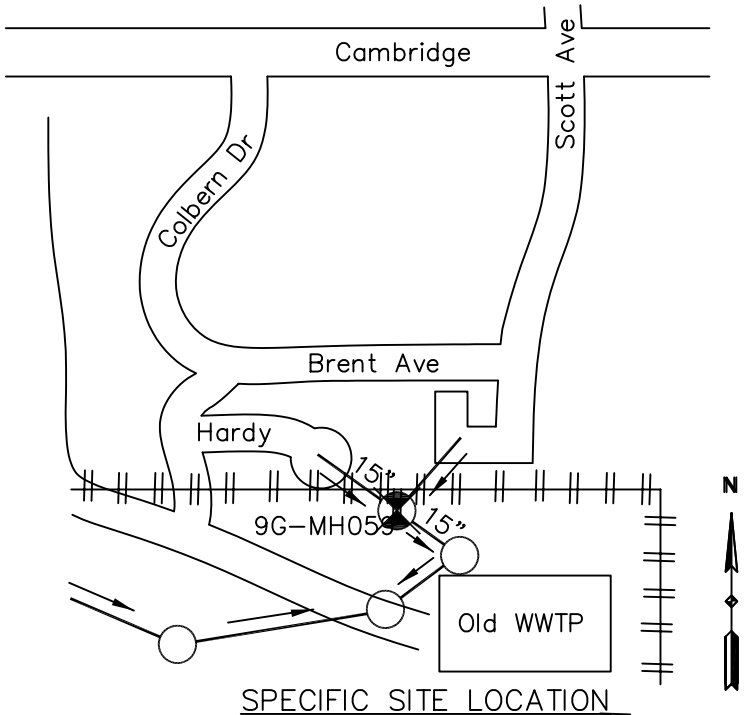
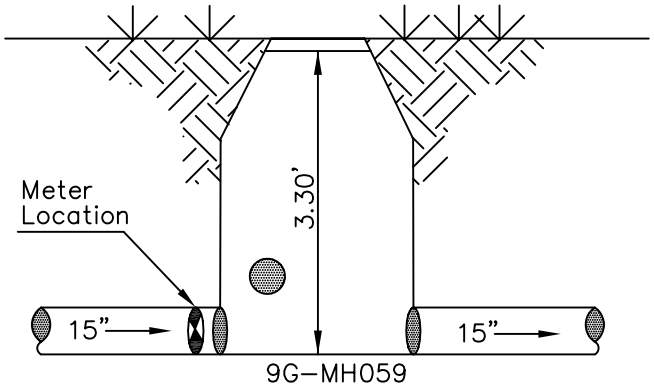


SPECIFIC SITE LOCATION



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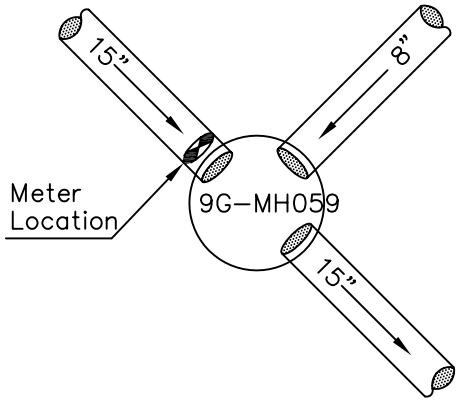

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address

Serial No. SEO Site ID 7 Pipe Size 15" Surcharge Y ☐ N ☒

Site Description Old WWTP 15" Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 4.00 Velocity (fps) 1.25 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 3.30 Manhole Dia. (ft.) 3.00 Flow Characteristic ☒ G ☐ F ☐ P

Comments:

Photo ID: WF0408006 (area), WF0408007 (t.s.), WF0408009 (u.s.), WF0408010 (u.s.), WF0408008 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 3)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address

Serial No. SEO Site ID 7 Pipe Size 15" Surcharge Y ☐ N ☒

Site Description Old WWTP 15" Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 4.00 Velocity (fps) 1.25 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 3.30 Manhole Dia. (ft.) 3.00 Flow Characteristic ☒ G ☐ F ☐ P

Comments:

Photo ID: WF0408006 (area), WF0408007 (t.s.), WF0408009 (u.s.), WF0408010 (u.s.), WF0408008 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

N

CROSS SECTION

MANHOLE PLAN VIEW

N

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 1116 S. Hwy Y

Serial No. TI8 Site ID 8 Pipe Size 12" Surcharge ☐Y ☒N

Site Description Under Barbwire Fence Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 3.00 Velocity (fps) 1.50 Depth of Debris (in) 0.00

Manhole Depth (ft.) 5.00 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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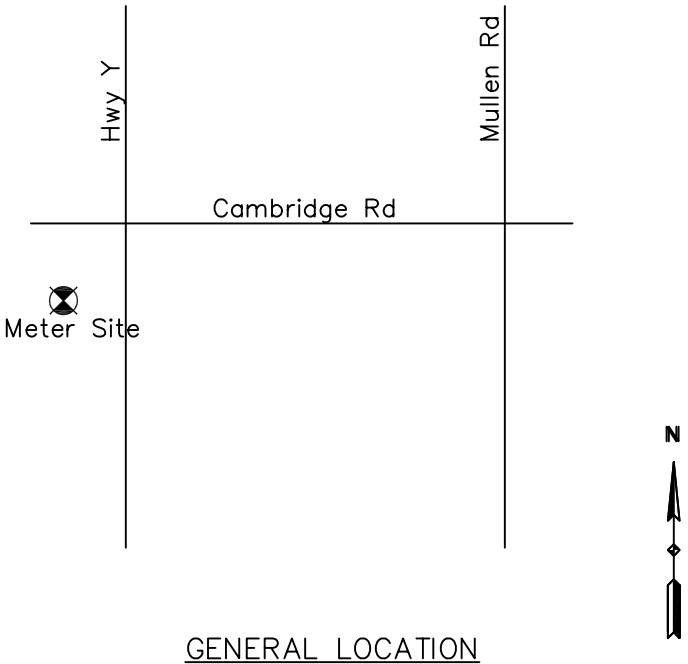

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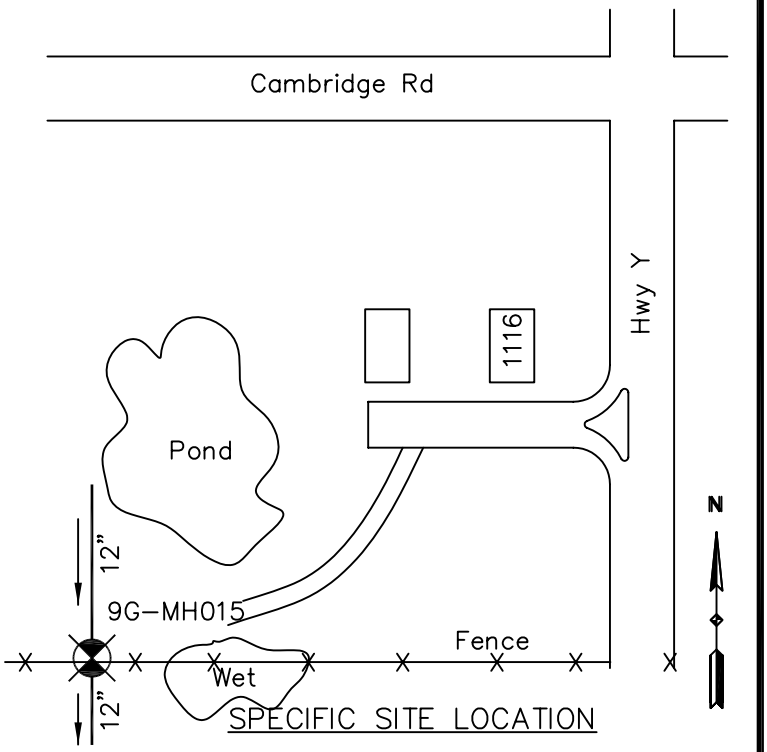
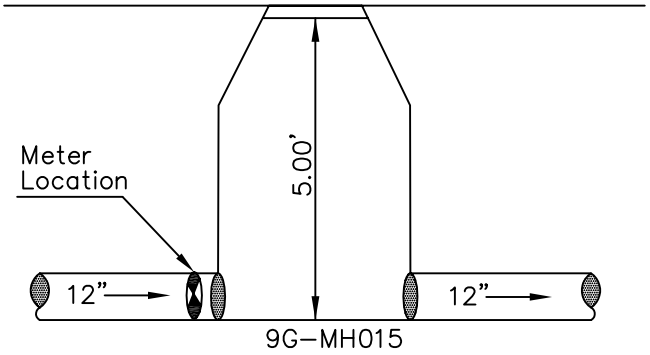
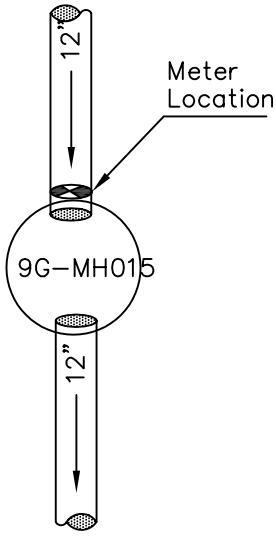


SPECIFIC SITE LOCATION



CROSS SECTION



MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 , 08, 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 1116 S. Hwy Y

Serial No. TI8 Site ID 8 Pipe Size 12" Surcharge Y☐ N☒

Site Description Under Barbwire Fence Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 3.00 Velocity (fps) 1.50 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 5.00 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

Photo ID: WF0408015 (area), WF0408016 (t.s.), WF0408018 (u.s.), WF0408017 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , , ,

Address

Serial No. TVA Site ID 9 Pipe Size 15" Surcharge ☒Y ☐N

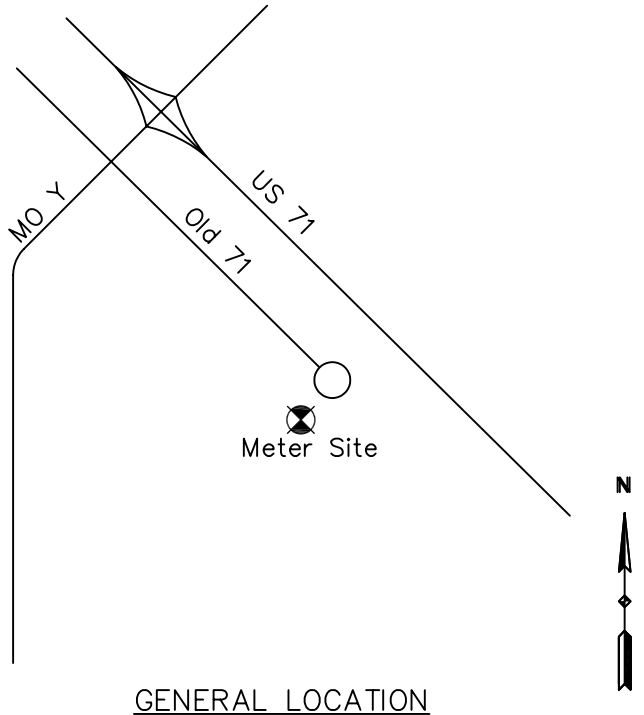
Site Description US 71 Pipe Material VCP Depth of Surcharge (ft.) 2.00

Depth of Flow (in.) 4.00 Velocity (fps) 2.50 Depth of Debris (in) 0.00

Manhole Depth (ft.) 9.00 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments: Meter owned by the City of Belton, MO.

Photo ID: WF0408011 (area), WF0408012 (t.s.), WF0408014 (u.s.), WF0408013 (d.s.)



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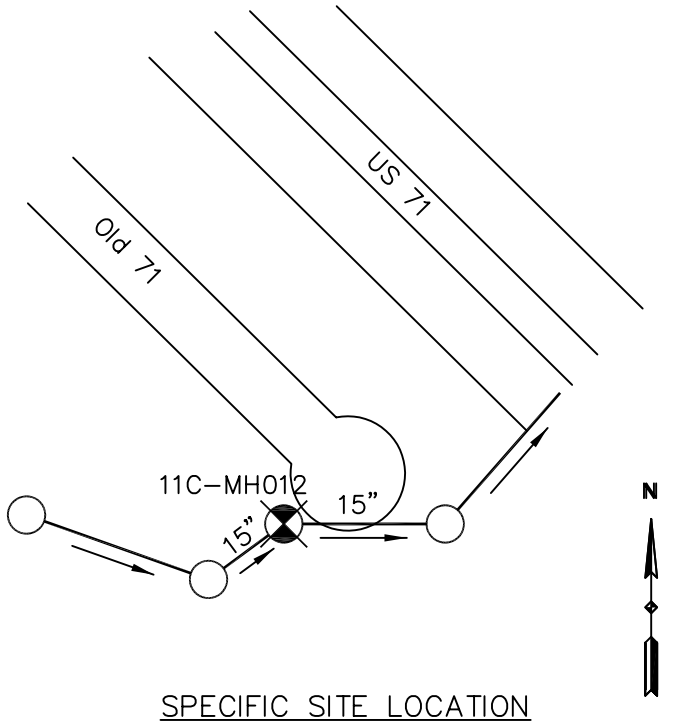

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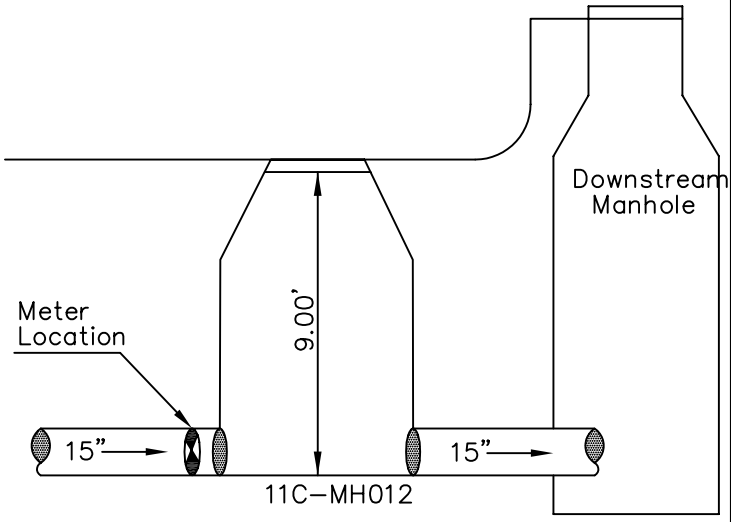

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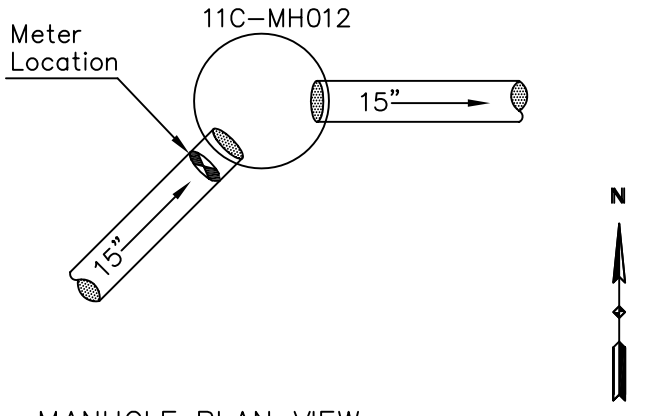

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address

Serial No. TVA Site ID 9 Pipe Size 15" Surcharge Y☒ N☐

Site Description US 71 Pipe Material VCP Depth of Surcharge (ft.) 2.00

Depth of Flow (in.) 4.00 Velocity (fps) 2.50 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 9.00 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments: Meter owned by the City of Belton, MO.

Photo ID: WF0408011 (area), WF0408012 (t.s.), WF0408014 (u.s.), WF0408013 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 11 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address

Serial No. TT9 Site ID 10 Pipe Size 10" Surcharge Y☐ N☒

Site Description Middle Creek Elementary Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 2.00 Velocity (fps) 1.50 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 8.50 Manhole Dia. (ft.) 4.00 Flow Characteristic ☒G ☐ F☐ P

Comments:

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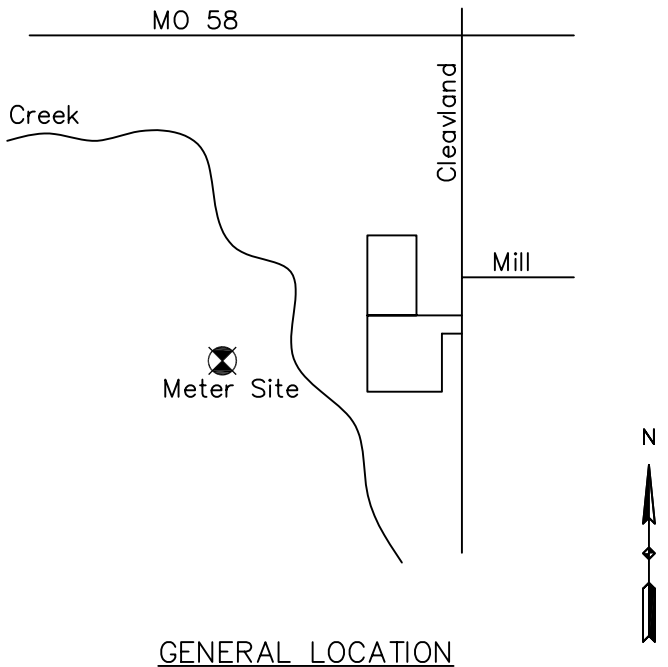

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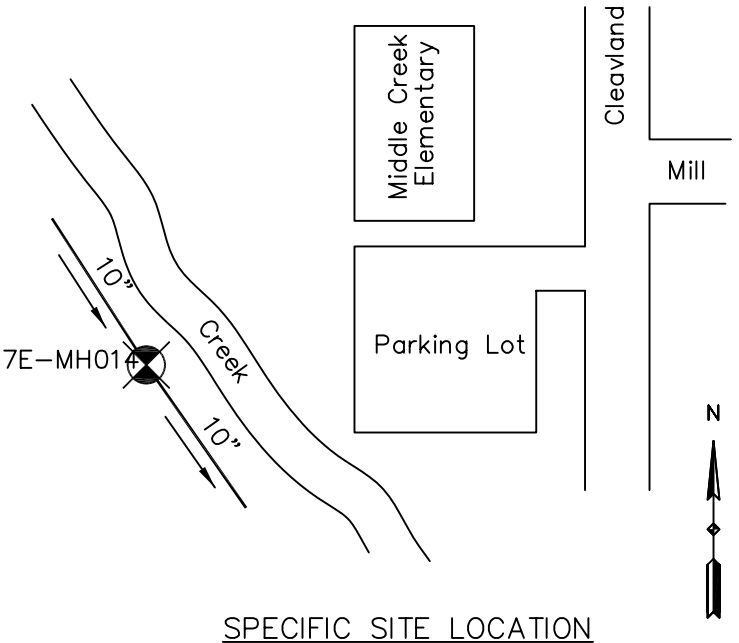
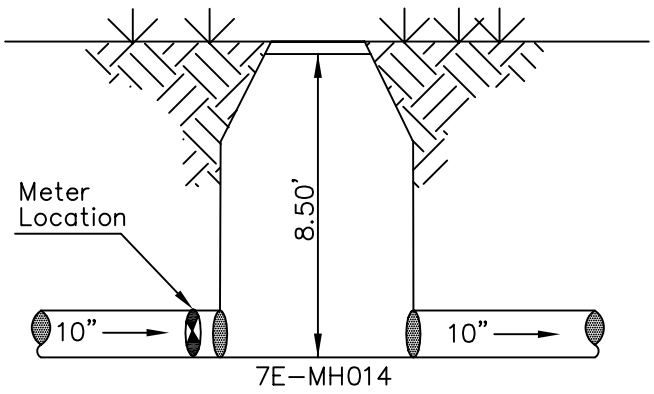


SPECIFIC SITE LOCATION



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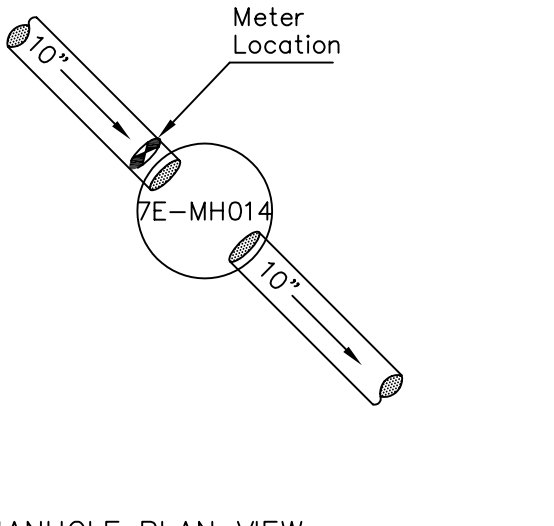


MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 , 11 , 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address

Serial No. TT9 Site ID 10 Pipe Size 10" Surcharge Y☐ N☒

Site Description Middle Creek Elementary Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 2.00 Velocity (fps) 1.50 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 8.50 Manhole Dia. (ft.) 4.00 Flow Characteristic ☒G ☐ F ☐ P

Comments:

Photo ID: WF0502001 (area), WF0502002 (t.s.), WF0411002 (u.s.), WF0411001 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 11 / 05

Project No. 0502 Project Location City Wide Crew WGB , , , ,

Address

Serial No. S8W Site ID 11 Pipe Size 12" Surcharge Y☒ N☐

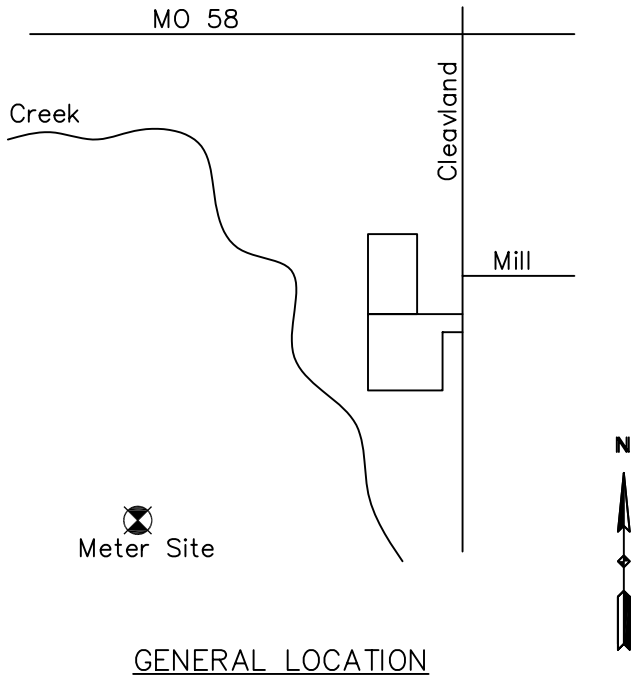
Site Description South West of Middle Creek Elementary Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 0.00 Velocity (fps) 0.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 10.70 Manhole Dia. (ft.) 4.00 Flow Characteristic ☒G ☐ F ☐ P

Comments: Meter Owned by the City of Belton, MO

Photo ID: WF0502003 (area), WF0502004 (t.s.), WF0411004 (u.s.), WF0411003 (d.s.)



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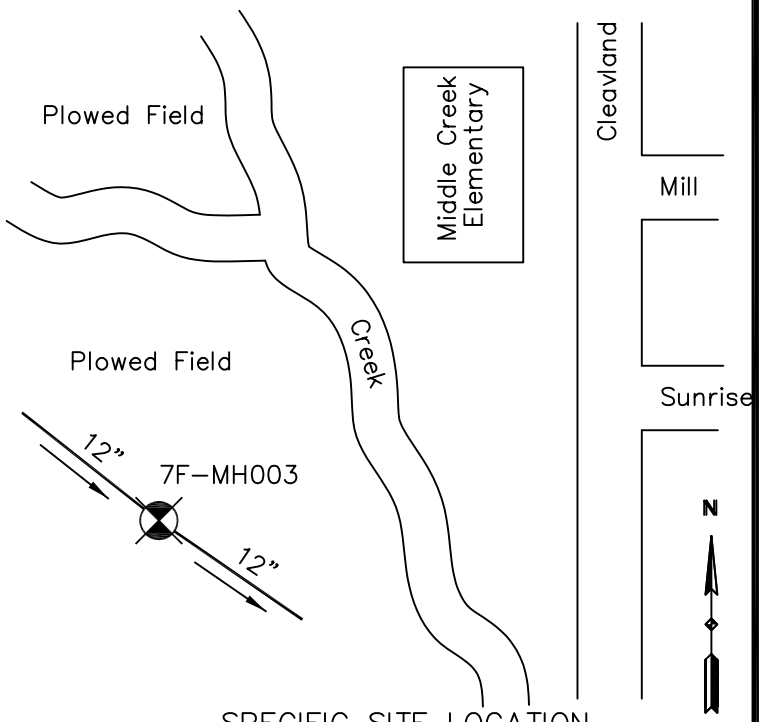
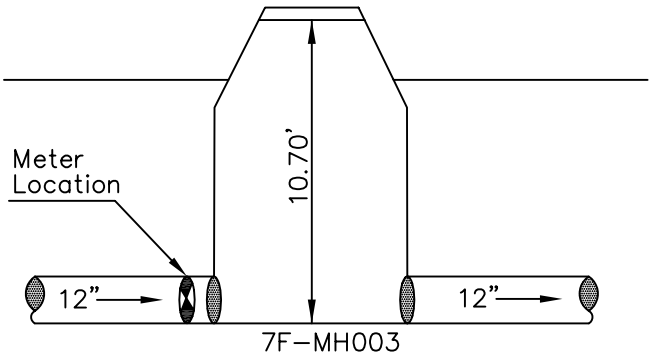


SPECIFIC SITE LOCATION



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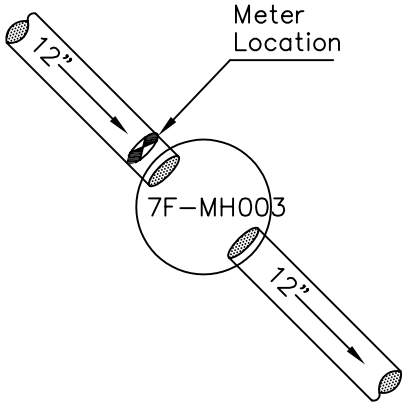

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 11 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address

Serial No. S8W Site ID 11 Pipe Size 12" Surcharge Y☒ N☐

Site Description South West of Middle Creek Elementary Pipe Material VCP Depth of Surcharge (ft.) 0.00

Depth of Flow (in.) 0.00 Velocity (fps) 0.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 10.70 Manhole Dia. (ft.) 4.00 Flow Characteristic ☒G ☐ F☐ P

Comments: Meter Owned by the City of Belton, MO

Photo ID: WF0502003 (area), WF0502004 (t.s.), WF0411004 (u.s.), WF0411003 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 1)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 412 Taylor

Serial No. S8X Site ID 12 Pipe Size 10" Surcharge Y☒ N☐

Site Description Bradford Subdivision Pipe Material VCP Depth of Surcharge (ft.) 7.00

Depth of Flow (in.) 1.50 Velocity (fps) 3.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 9.00 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

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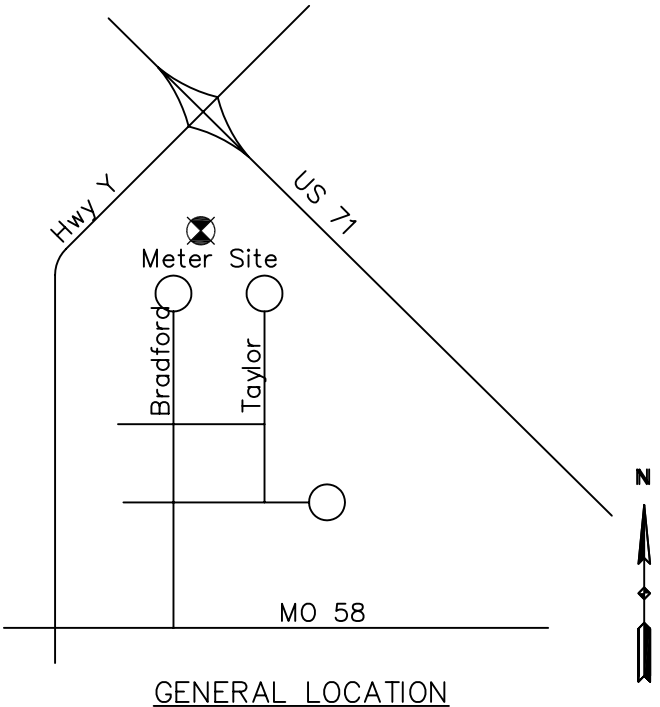

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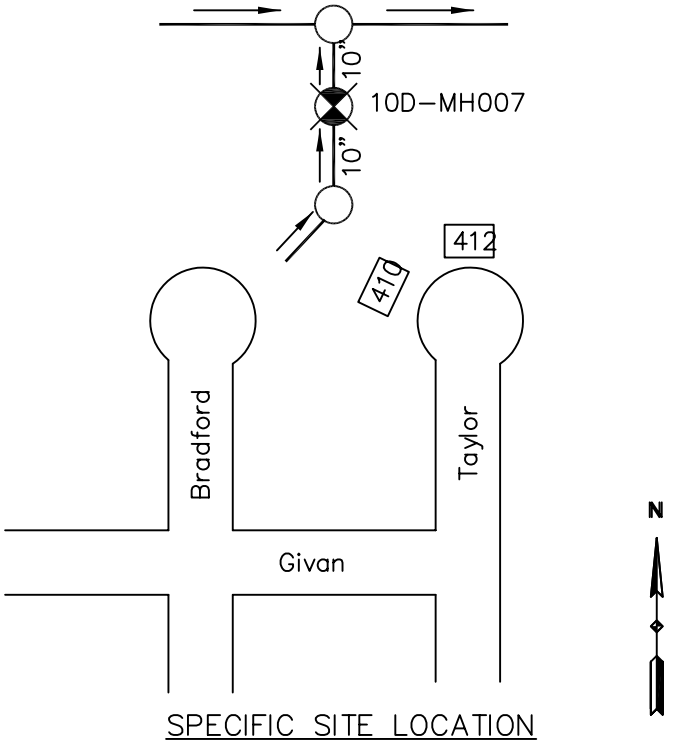
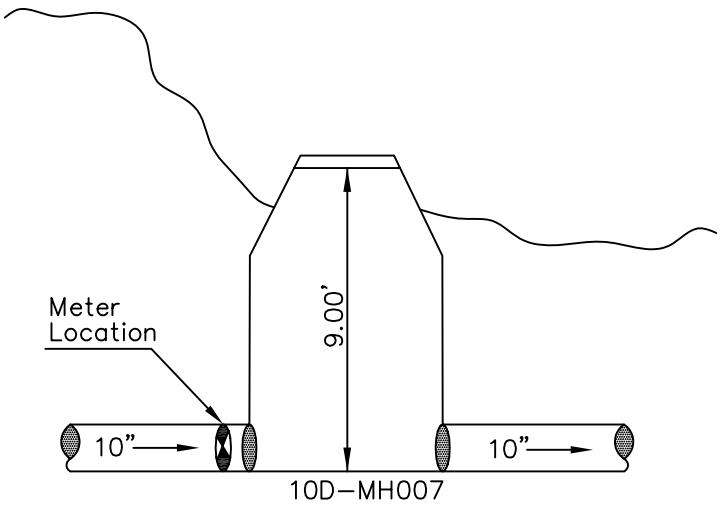


SPECIFIC SITE LOCATION



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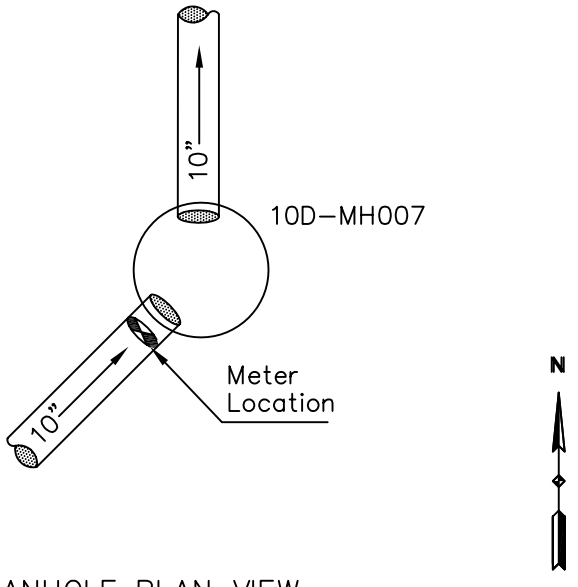


MANHOLE PLAN VIEW

METER SITE LOCATION (PAGE 2)

City of Belton, MO

Date 04 / 08 / 05

Project No. 0502 Project Location City Wide Crew WGB , , ,

Address 412 Taylor

Serial No. S8X Site ID 12 Pipe Size 10" Surcharge Y☒ N☐

Site Description Bradford Subdivision Pipe Material VCP Depth of Surcharge (ft.) 7.00

Depth of Flow (in.) 1.50 Velocity (fps) 3.00 Depth of Debris (in.) 0.00

Manhole Depth (ft.) 9.00 Manhole Dia. (ft.) 4.00 Flow Characteristic ☐G ☒F ☐P

Comments:

Photo ID: WF0415003 (area), WF0415004 (t.s.), WF0415002 (u.s.), WF0415001 (d.s.)

GENERAL LOCATION

SPECIFIC SITE LOCATION

CROSS SECTION

MANHOLE PLAN VIEW

Appendix B
Rain Gauge Site Sheets

RAIN GAUGE SITE LOCATION

City of Belton, MO

Date 04 / 08 / 05

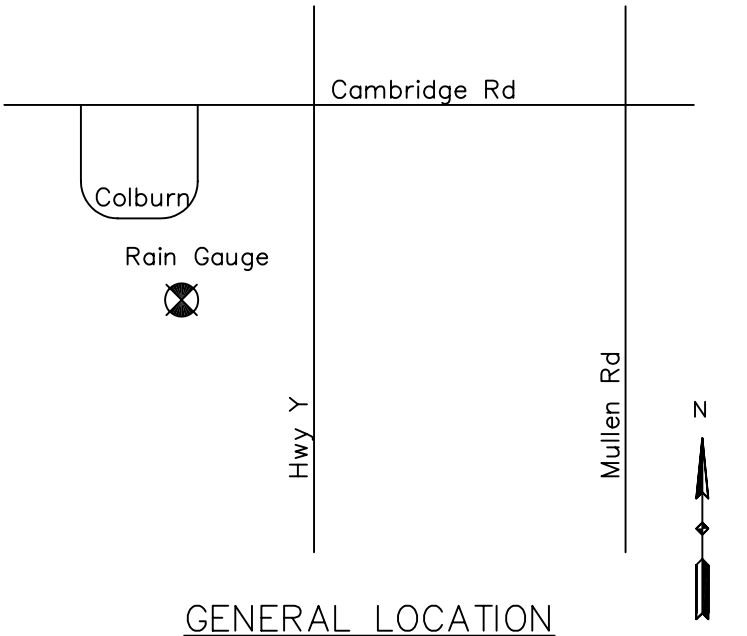
Project No. 0502 Project Location City Wide CREW WGB, , , ,

Address

Serial No. Site ID 1

Site Description Old WWTP, on Top of Maintainance Building

Comments: Photo ID: WR0411004



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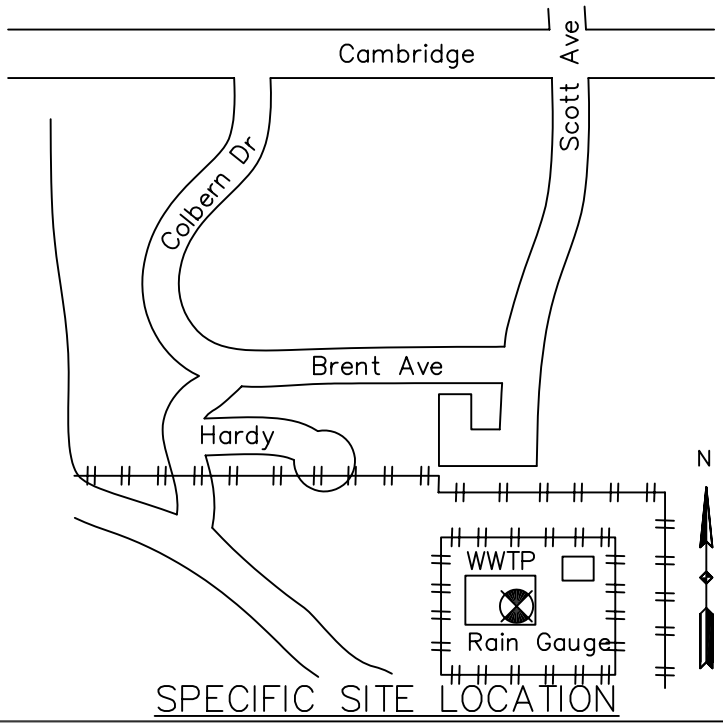


SPECIFIC SITE LOCATION

N

SITE LOCATION

RAIN GAUGE SITE LOCATION
City of Belton, MO

Date 04 / 15 / 05

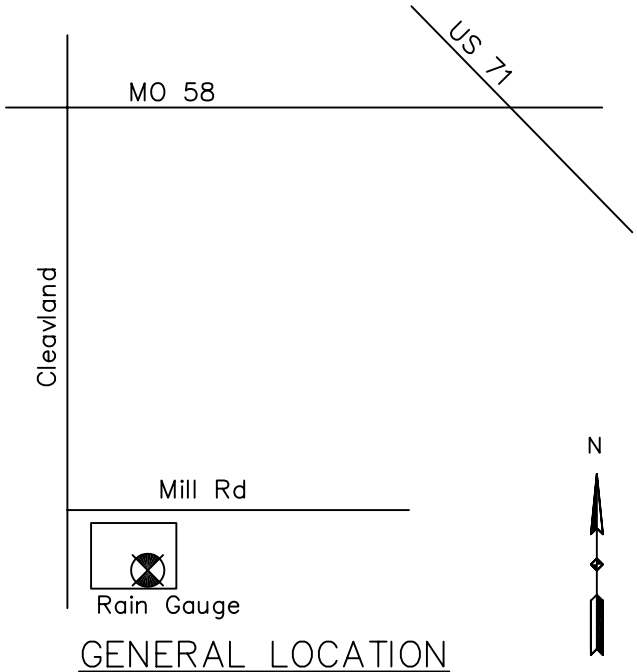
Project No. 0502 Project Location City Wide CREW WGB, , , ,

Address

Serial No. Site ID 2

Site Description South West Corner of Yeokum Middle School

Comments: Photo ID: WF0415009



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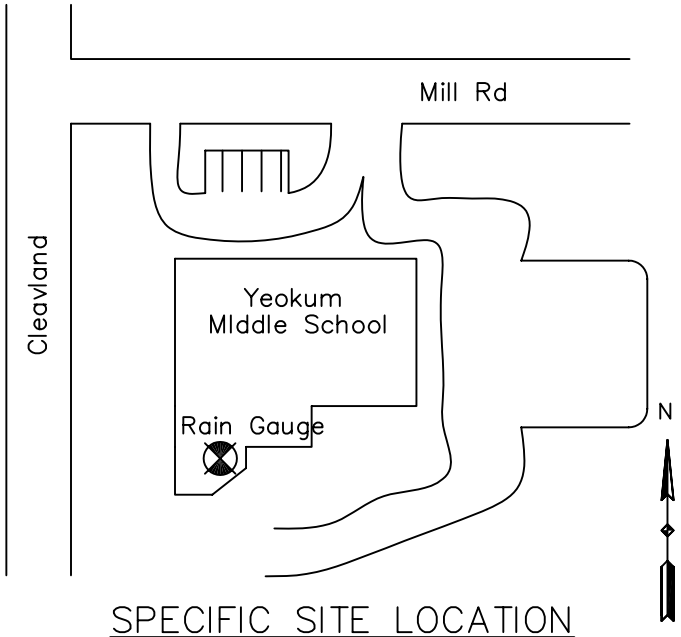


SPECIFIC SITE LOCATION

N

SITE LOCATION

RAIN GAUGE SITE LOCATION
City of Belton, MO

Date 04 / 08 / 05

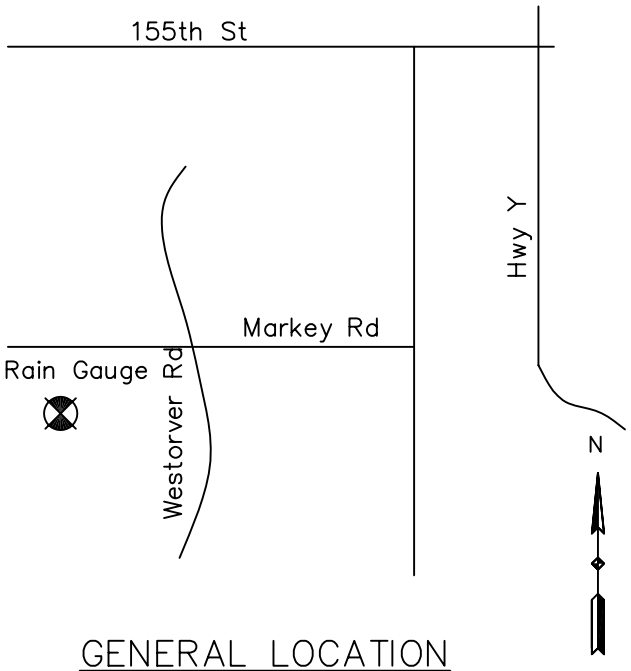
Project No. 0502 Project Location City Wide CREW WGB, , , ,

Address

Serial No. Site ID 3

Site Description Wst Cimmeron Lift Station

Comments: Photo ID: WR0411001



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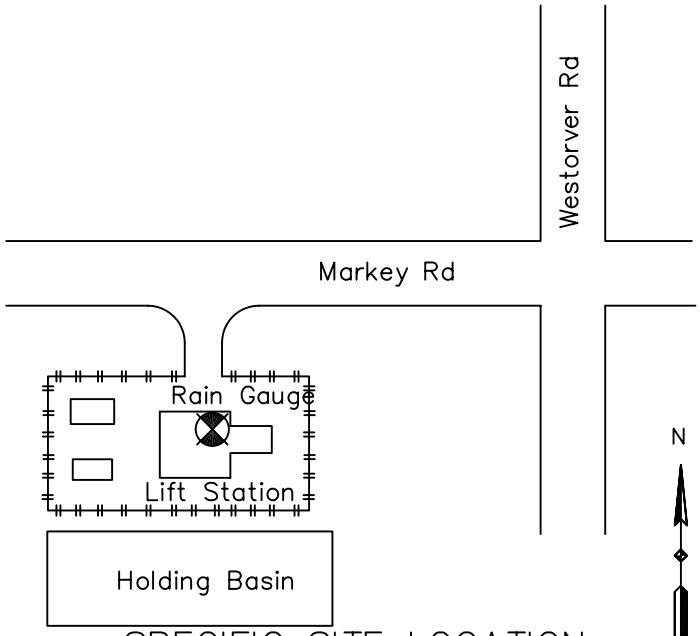


SPECIFIC SITE LOCATION

SITE LOCATION

N

RAIN GAUGE SITE LOCATION

City of Belton, MO

Date 04 / 08 / 05

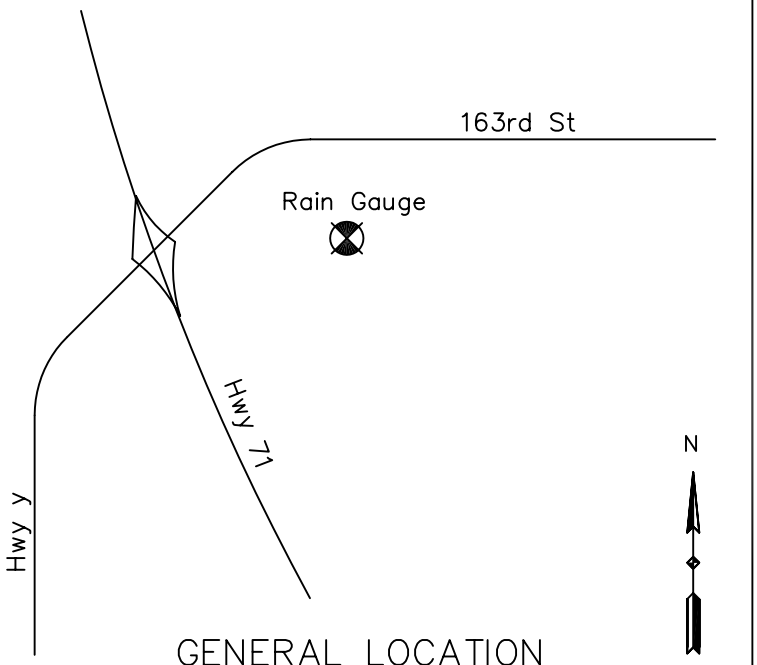
Project No. 0502 Project Location City Wide CREW WGB, , , ,

Address

Serial No. Site ID 4

Site Description Police Station

Comments: Photo ID: WR0411002



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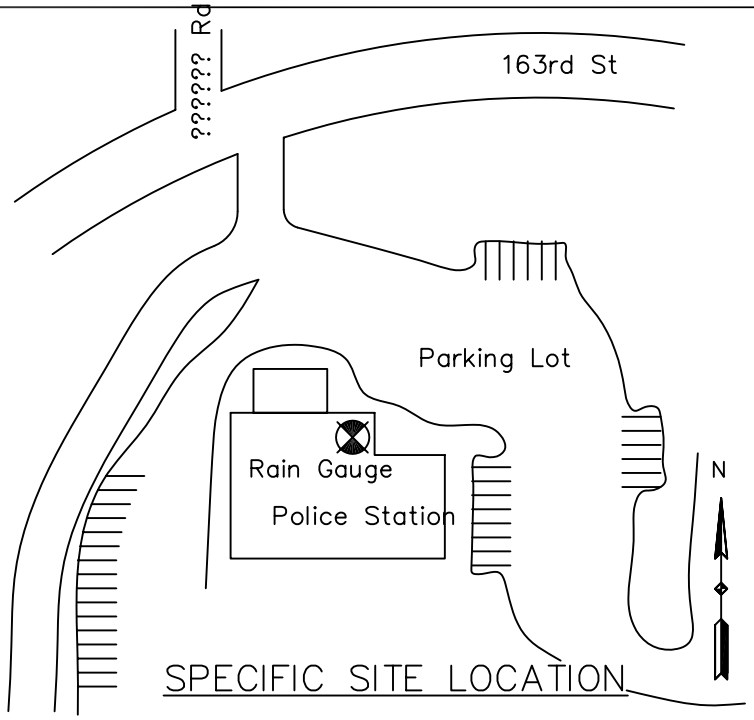


SPECIFIC SITE LOCATION

N

SITE LOCATION

RAIN GAUGE SITE LOCATION
City of Belton, MO

Date 04 / xx / 05

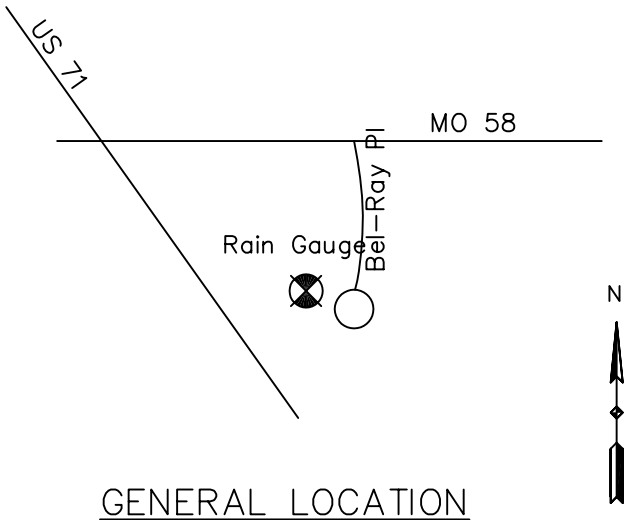
Project No. 0502 Project Location City Wide CREW WGB, , , ,

Address 17232 Bel-Ray Plaza

Serial No. _____ Site ID 5

Site Description On Roof of Comfort Systems H/C (816) 322-1013

Comments: Photo ID: WR0411003



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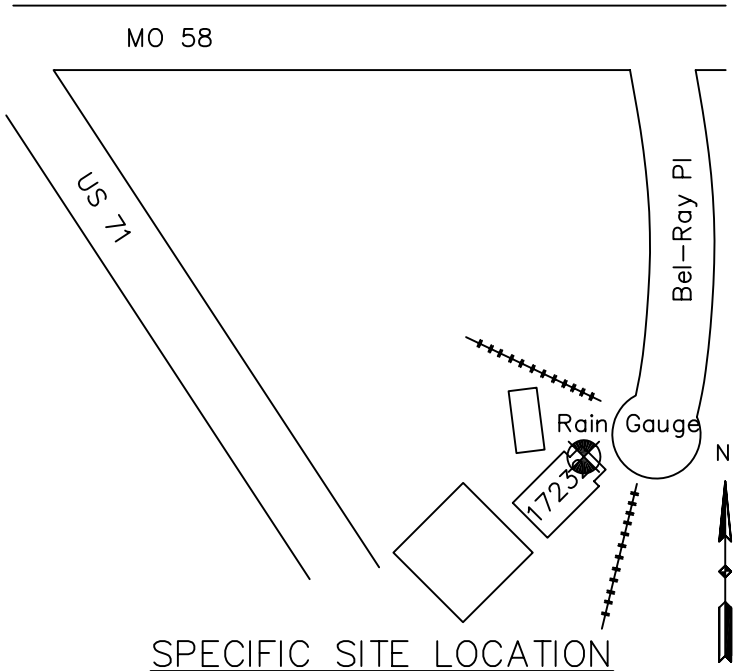


SPECIFIC SITE LOCATION

SITE LOCATION

N

Appendix C
Total Daily Rainfall

Total Daily Rainfall per Basin (inchs)

Rain Event	Basin Number											
	1	2	3	4	5	6	7	8	9	10	11	12
10-Apr-05	0.15	0.08	0.25	0.08	0.00	0.12	0.12	0.24	0.15	0.25	0.00	0.08
11-Apr-05	1.12	0.71	0.83	0.71	0.00	0.40	0.40	0.79	1.12	0.81	0.00	0.56
12-Apr-05	0.01	0.01	0.07	0.01	0.00	0.03	0.03	0.06	0.01	0.07	0.00	0.01
18-Apr-05	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
21-Apr-05	0.00	0.05	0.00	0.05	0.00	0.09	0.09	0.18	0.00	0.09	0.00	0.00
22-Apr-05	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.00	0.02	0.02	0.01
25-Apr-05	0.14	0.13	0.17	0.13	0.16	0.18	0.18	0.19	0.14	0.18	0.16	0.15
26-Apr-05	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01
28-Apr-05	0.18	0.17	0.19	0.17	0.15	0.17	0.17	0.18	0.18	0.19	0.15	0.17
29-Apr-05	0.03	0.02	0.03	0.02	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03
7-May-05	0.05	0.05	0.09	0.05	0.08	0.08	0.08	0.08	0.05	0.09	0.08	0.07
8-May-05	0.10	0.08	0.05	0.08	0.05	0.10	0.10	0.14	0.10	0.10	0.05	0.08
11-May-05	0.01	0.01	0.15	0.01	0.05	0.03	0.03	0.00	0.01	0.08	0.05	0.03
12-May-05	0.75	0.38	0.94	0.38	0.89	1.00	1.00	1.11	0.75	1.03	0.89	0.82
13-May-05	1.43	1.76	1.38	1.76	1.05	1.39	1.39	1.73	1.43	1.56	1.05	1.24
14-May-05	0.11	0.10	0.11	0.10	0.07	0.09	0.09	0.10	0.11	0.11	0.07	0.09
27-May-05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
31-May-05	0.02	0.02	0.03	0.02	0.04	0.03	0.03	0.02	0.02	0.03	0.04	0.03
1-Jun-05	0.11	0.08	0.23	0.08	0.27	0.26	0.26	0.24	0.11	0.24	0.27	0.19
3-Jun-05	0.70	0.67	1.02	0.67	0.93	0.93	0.93	0.92	0.70	0.97	0.93	0.82
4-Jun-05	3.73	3.67	4.02	3.67	3.35	3.48	3.48	3.61	3.73	3.82	3.35	3.54
5-Jun-05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
7-Jun-05	0.00	0.01	0.00	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.02	0.01
8-Jun-05	0.49	0.48	0.81	0.48	0.89	0.87	0.87	0.85	0.49	0.83	0.89	0.69
9-Jun-05	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-Jun-05	0.48	0.53	0.37	0.53	0.49	0.52	0.52	0.55	0.48	0.46	0.49	0.49
11-Jun-05	0.32	0.32	0.37	0.32	0.39	0.45	0.45	0.50	0.32	0.44	0.39	0.36
12-Jun-05	0.84	0.86	0.65	0.86	0.80	0.81	0.81	0.82	0.84	0.74	0.80	0.82
13-Jun-05	0.41	0.47	0.36	0.47	0.36	0.49	0.49	0.62	0.41	0.49	0.36	0.39
Total:	**11.23**	**10.69**	**12.18**	**10.69**	**10.14**	**11.58**	**11.58**	**13.01**	**11.23**	**12.6**	**10.14**	**10.69**

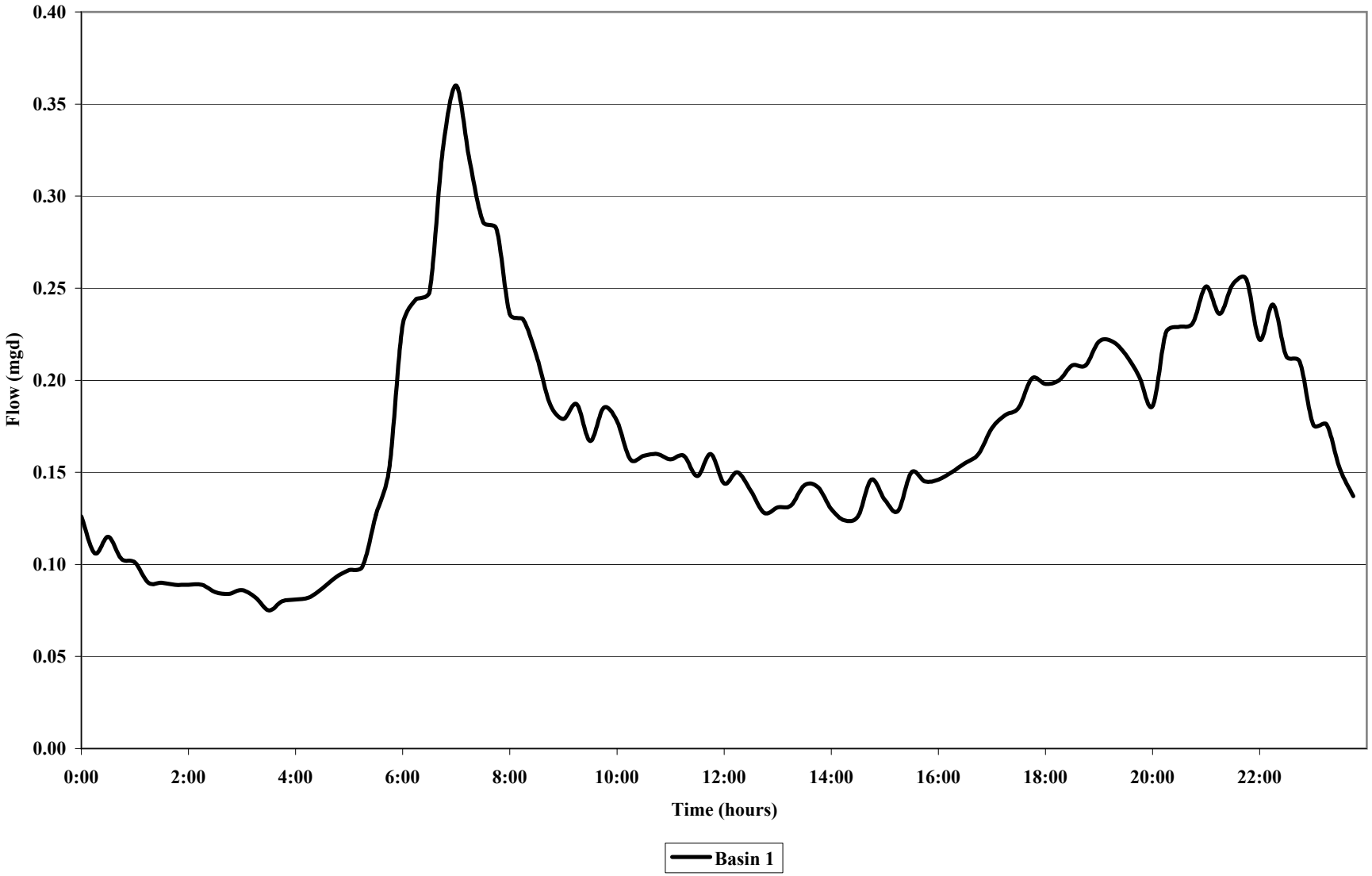
Appendix D
Rainfall Intensities

Peak One-Hour Rainfall Intensities per Basin (inches/hour)

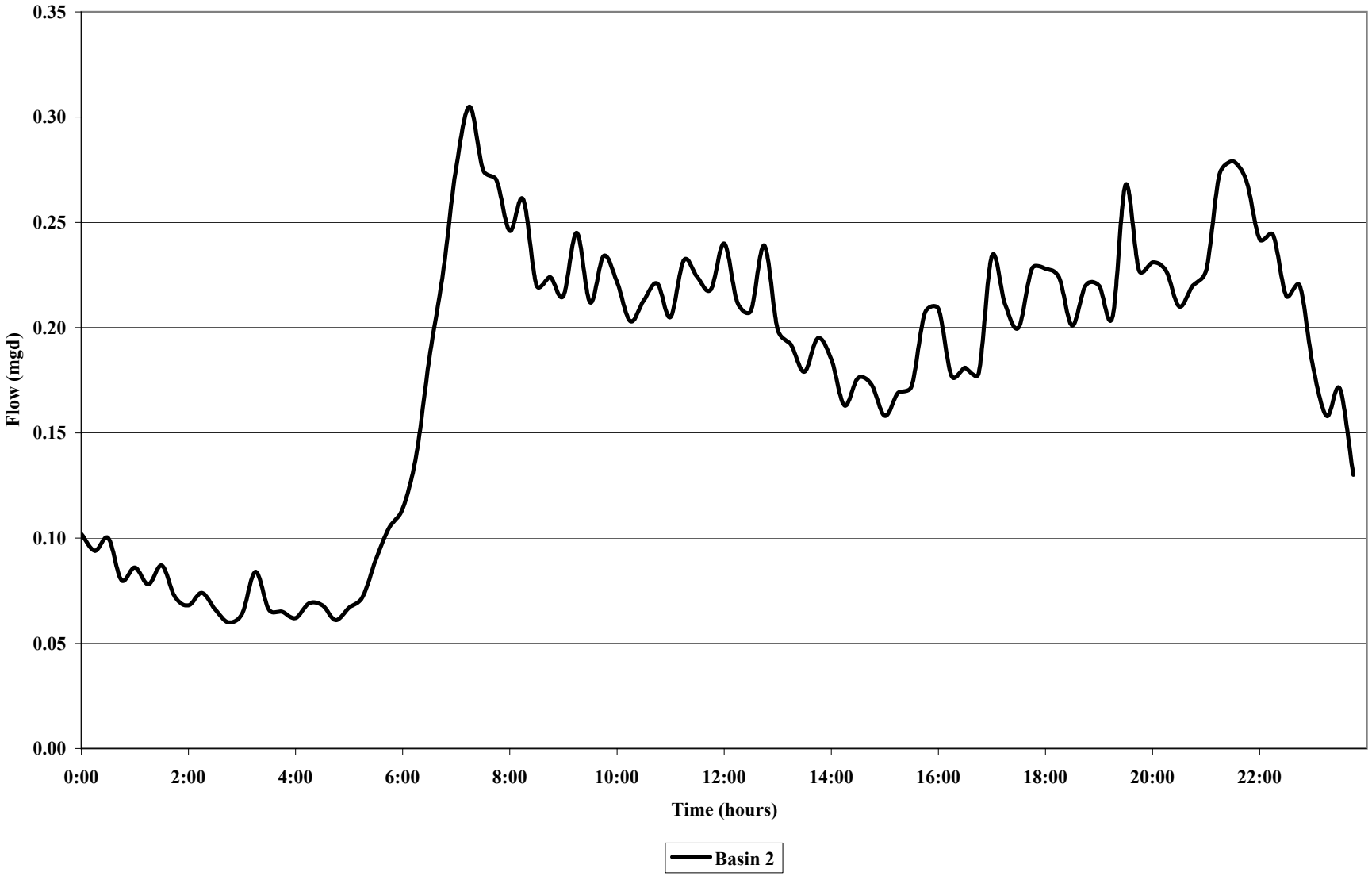
Rain Event	Basin Number											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
10-Apr-05	0.41	0.21	0.34	0.21	0.00	0.12	0.12	0.23	0.41	0.29	0.00	0.21
11-Apr-05	0.45	0.23	0.28	0.23	0.00	0.21	0.21	0.41	0.45	0.34	0.00	0.23
12-Apr-05	0.01	0.01	0.05	0.01	0.00	0.02	0.02	0.04	0.01	0.05	0.00	0.01
18-Apr-05	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
21-Apr-05	0.00	0.05	0.00	0.05	0.00	0.09	0.09	0.18	0.00	0.09	0.00	0.00
22-Apr-05	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01
25-Apr-05	0.08	0.07	0.10	0.07	0.09	0.11	0.11	0.12	0.08	0.11	0.09	0.09
26-Apr-05	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01
28-Apr-05	0.09	0.06	0.09	0.06	0.08	0.09	0.09	0.09	0.09	0.09	0.08	0.08
29-Apr-05	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02
7-May-05	0.04	0.03	0.05	0.03	0.04	0.04	0.04	0.06	0.04	0.06	0.04	0.03
8-May-05	0.07	0.04	0.05	0.04	0.03	0.07	0.07	0.10	0.07	0.06	0.03	0.05
11-May-05	0.01	0.01	0.15	0.01	0.05	0.03	0.03	0.00	0.01	0.08	0.05	0.03
12-May-05	0.85	0.60	0.93	0.60	0.89	1.00	1.00	1.16	0.85	1.04	0.89	0.82
13-May-05	0.70	0.61	0.54	0.61	0.49	0.66	0.66	0.83	0.70	0.69	0.49	0.60
14-May-05	0.10	0.07	0.11	0.07	0.07	0.10	0.10	0.14	0.10	0.12	0.07	0.09
27-May-05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
31-May-05	0.01	0.01	0.03	0.01	0.04	0.03	0.03	0.02	0.01	0.03	0.04	0.03
1-Jun-05	0.09	0.05	0.17	0.05	0.23	0.22	0.22	0.22	0.09	0.19	0.23	0.16
3-Jun-05	0.30	0.20	0.58	0.20	0.54	0.51	0.51	0.50	0.30	0.49	0.54	0.41
4-Jun-05	1.52	1.32	1.67	1.32	1.37	1.51	1.51	1.69	1.52	1.65	1.37	1.45
5-Jun-05	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03
7-Jun-05	0.00	0.01	0.00	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.02	0.01
8-Jun-05	0.31	0.21	0.62	0.21	0.69	0.68	0.68	0.66	0.31	0.64	0.69	0.50
9-Jun-05	0.01	0.06	0.00	0.06	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
10-Jun-05	0.47	0.48	0.18	0.48	0.38	0.45	0.45	0.52	0.47	0.35	0.38	0.43
11-Jun-05	0.18	0.15	0.16	0.15	0.17	0.20	0.20	0.22	0.18	0.19	0.17	0.17
12-Jun-05	0.30	0.21	0.31	0.21	0.41	0.39	0.39	0.36	0.30	0.34	0.41	0.36
13-Jun-05	0.24	0.19	0.19	0.19	0.19	0.28	0.28	0.36	0.24	0.28	0.19	0.21
Peak:	**1.52**	**1.32**	**1.67**	**1.32**	**1.37**	**1.51**	**1.51**	**1.69**	**1.52**	**1.65**	**1.37**	**1.45**

Appendix E
DWF Hydrographs

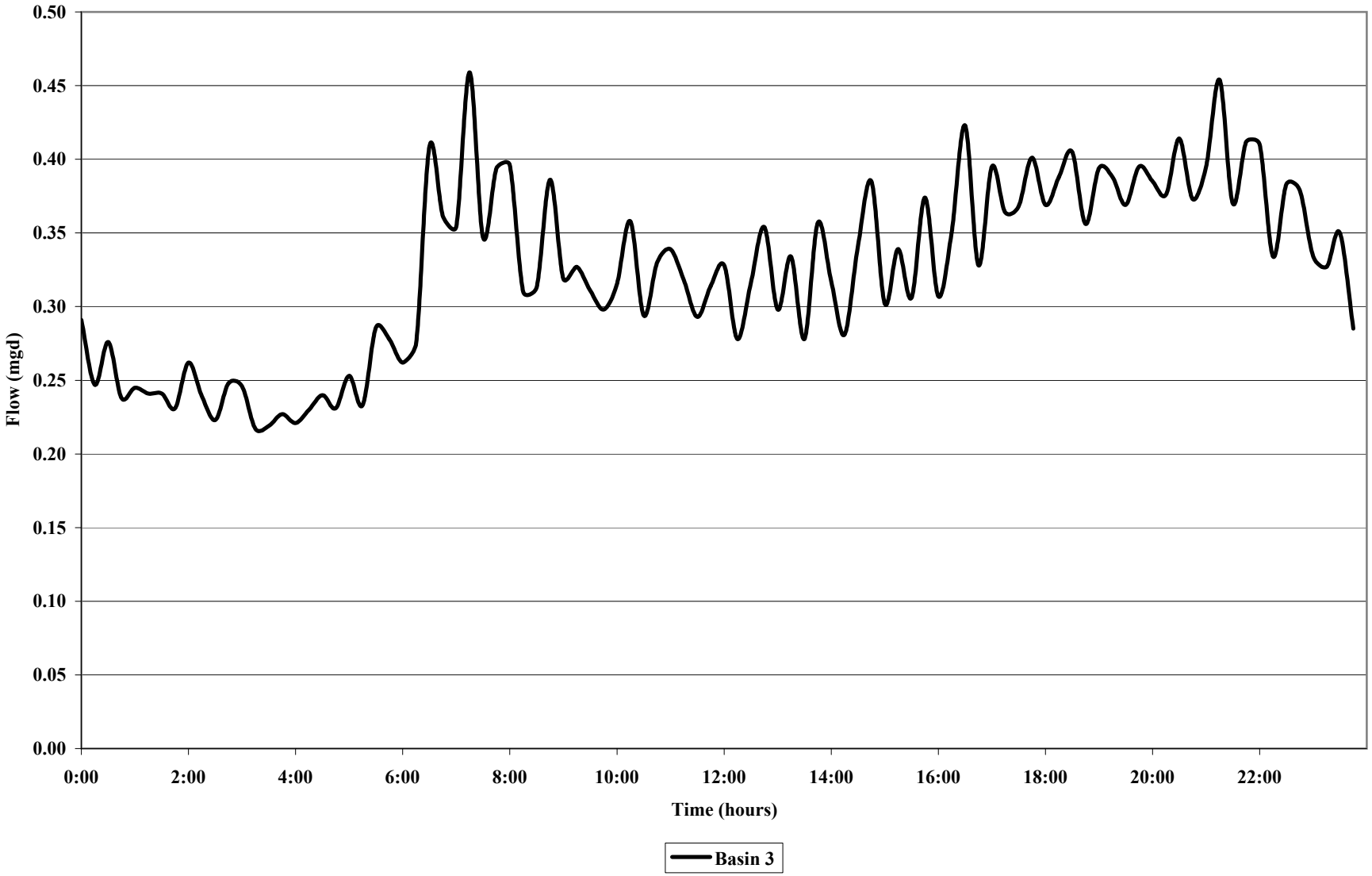
Basin 1 - DWF Hydrograph



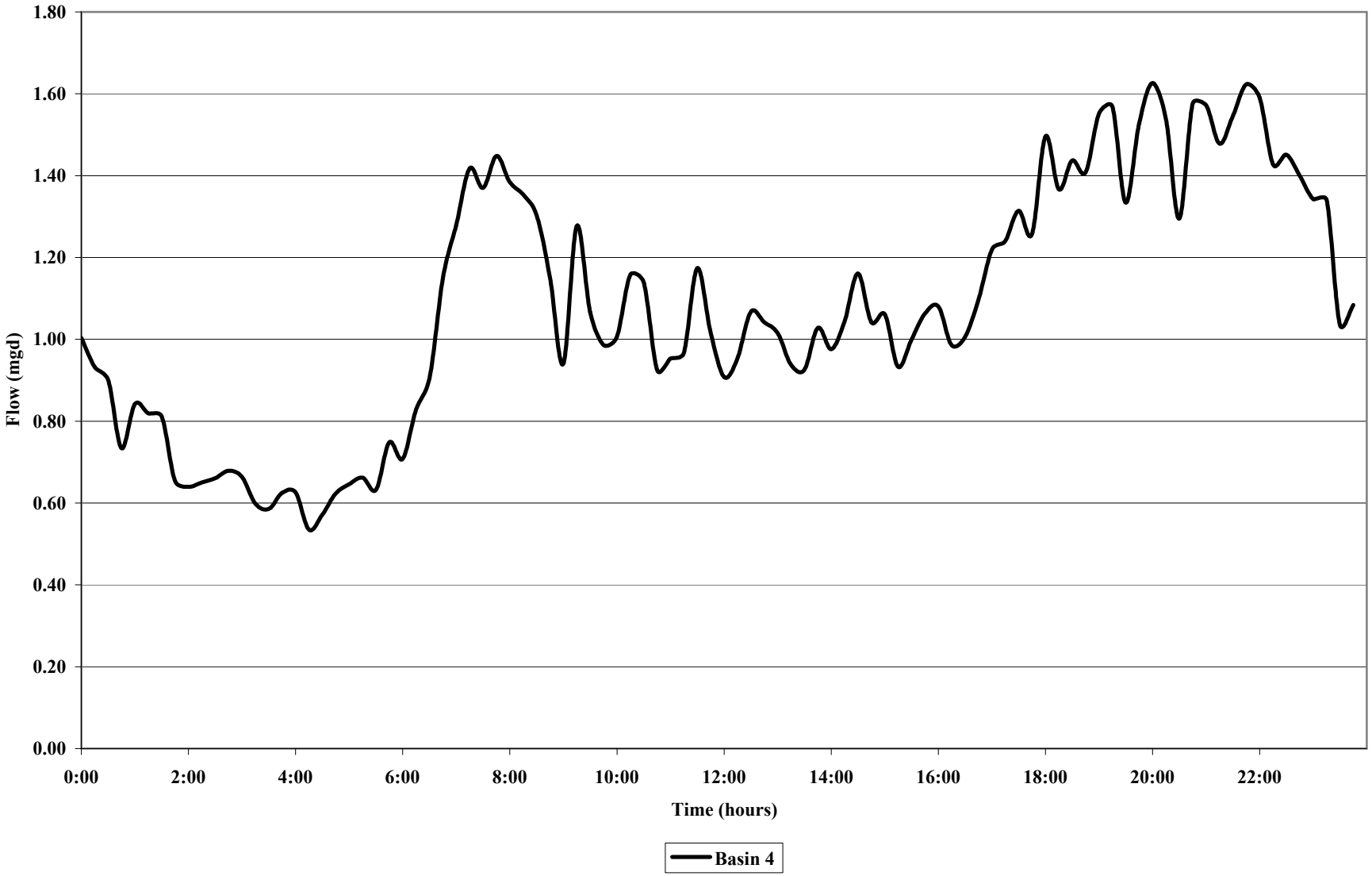
Basin 2 - DWF Hydrograph



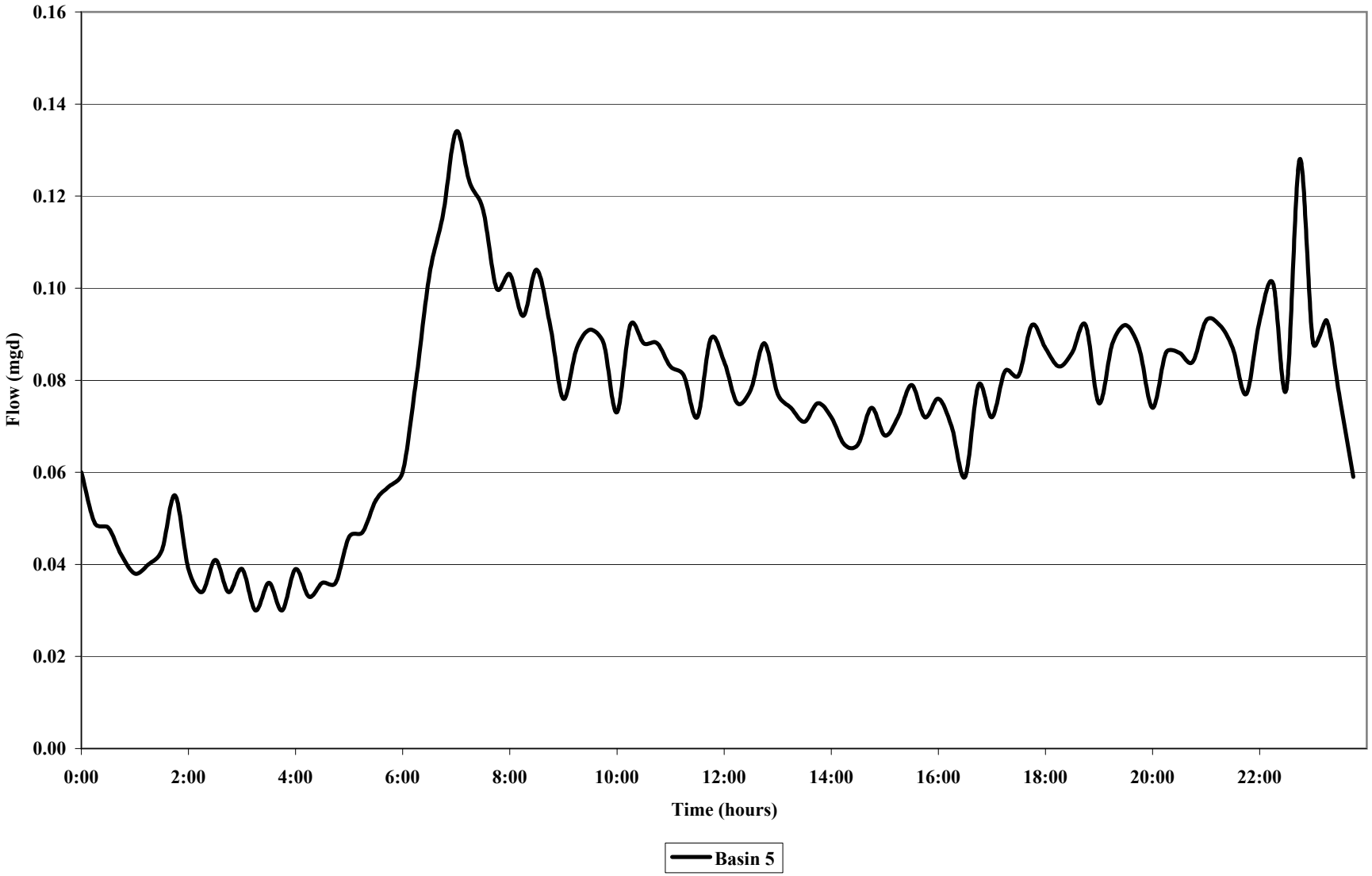
Basin 3 - DWF Hydrograph



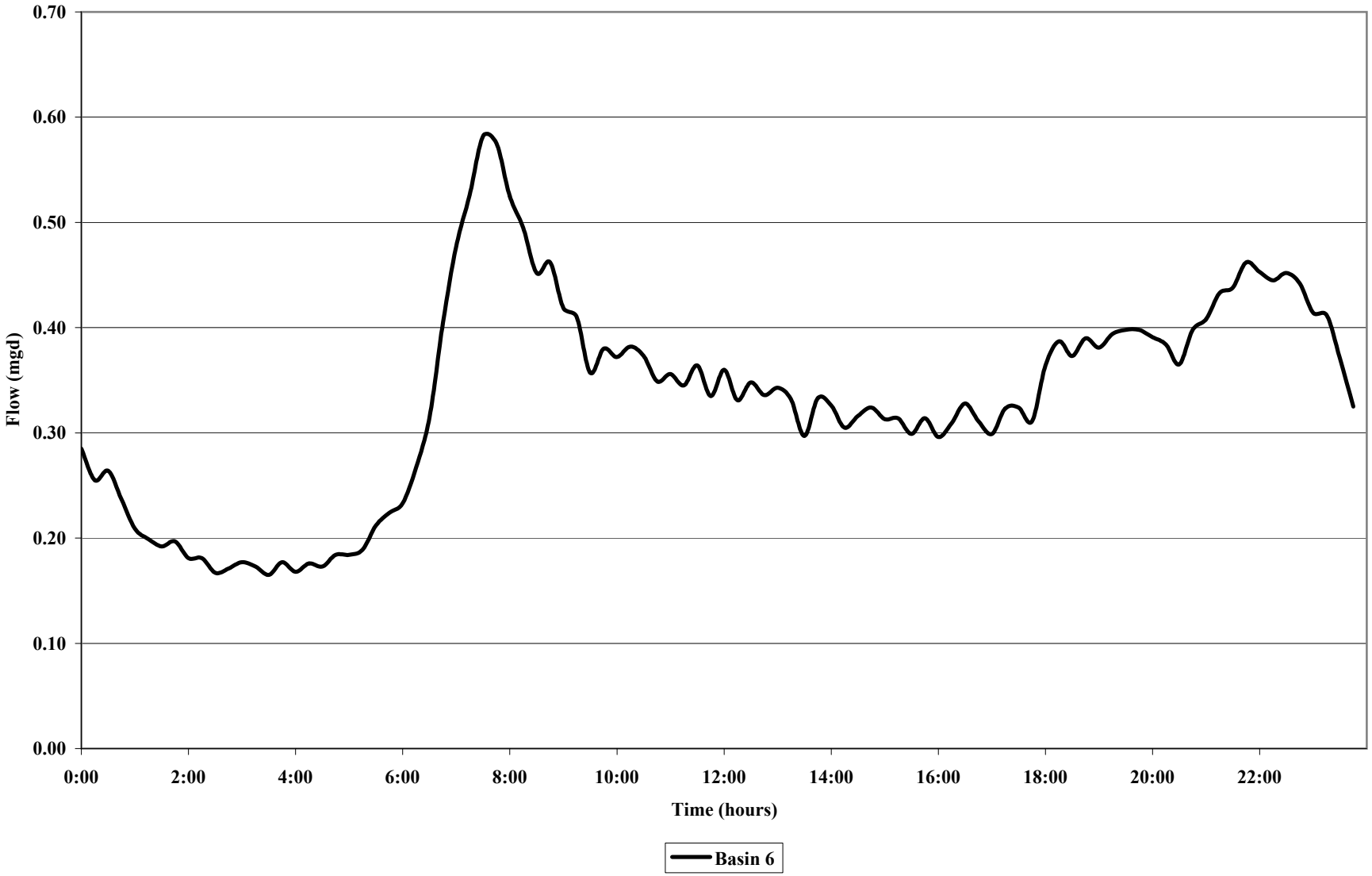
Basin 4 - DWF Hydrograph



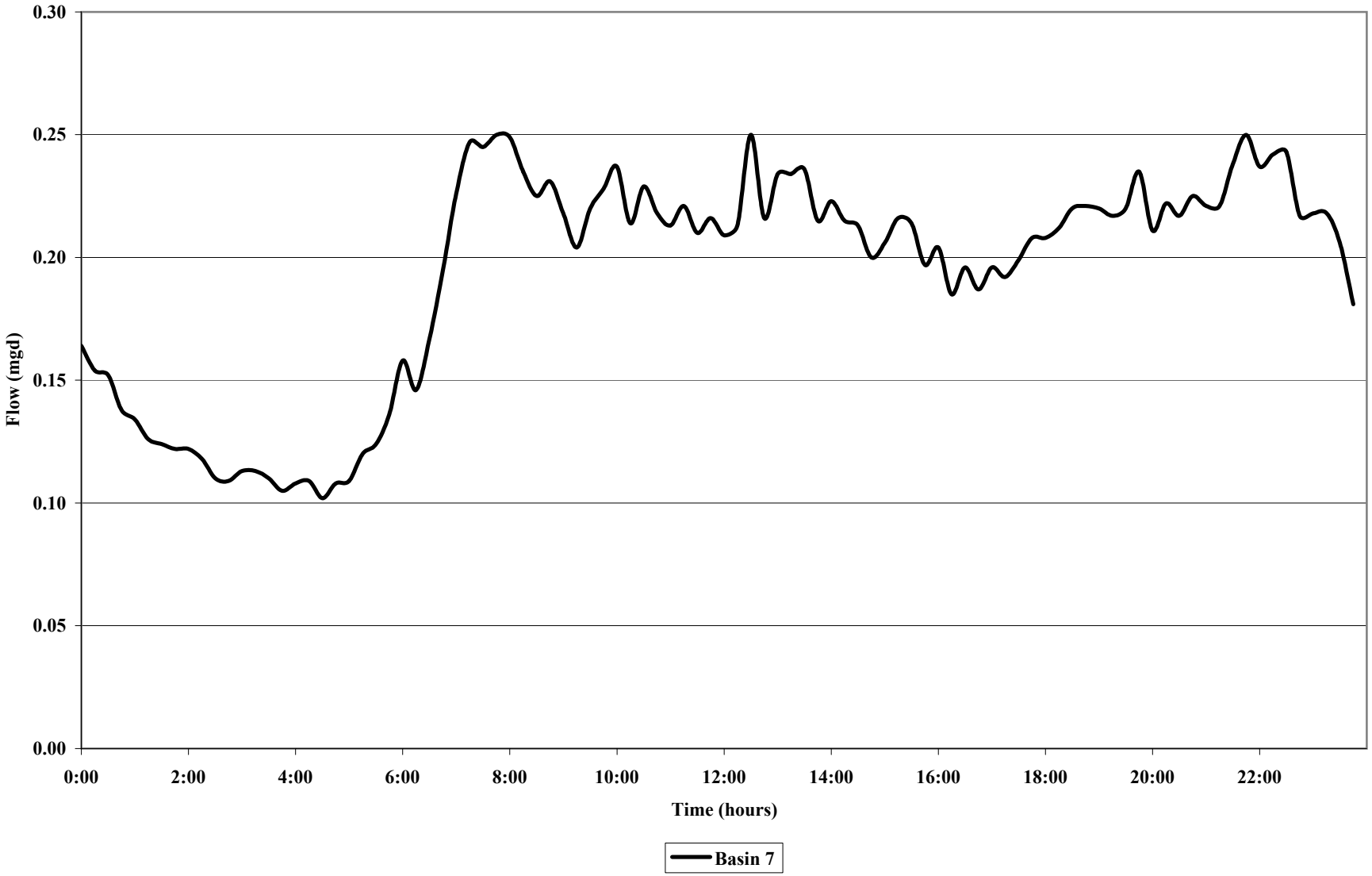
Basin 5 - DWF Hydrograph



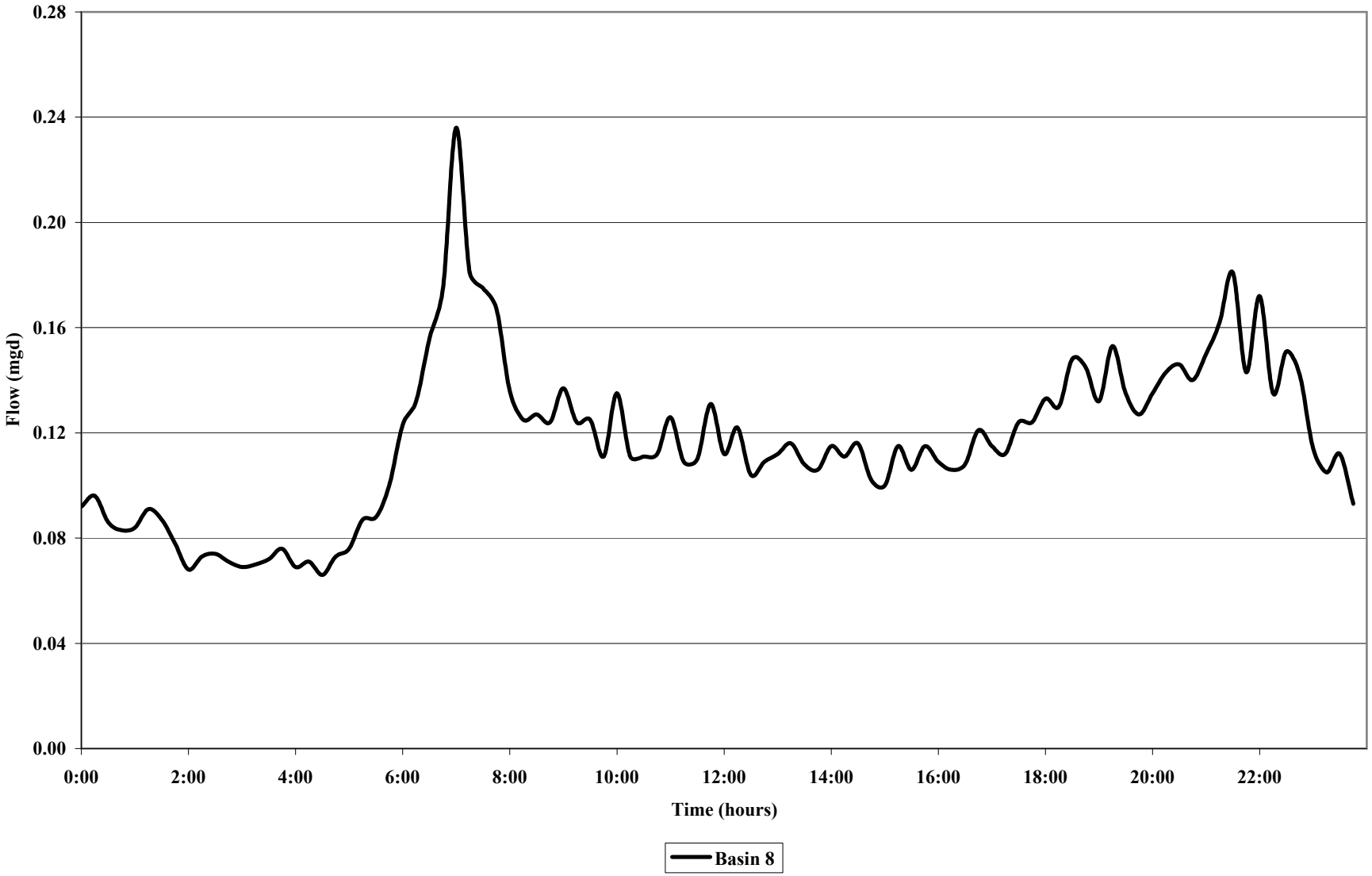
Basin 6 - DWF Hydrograph



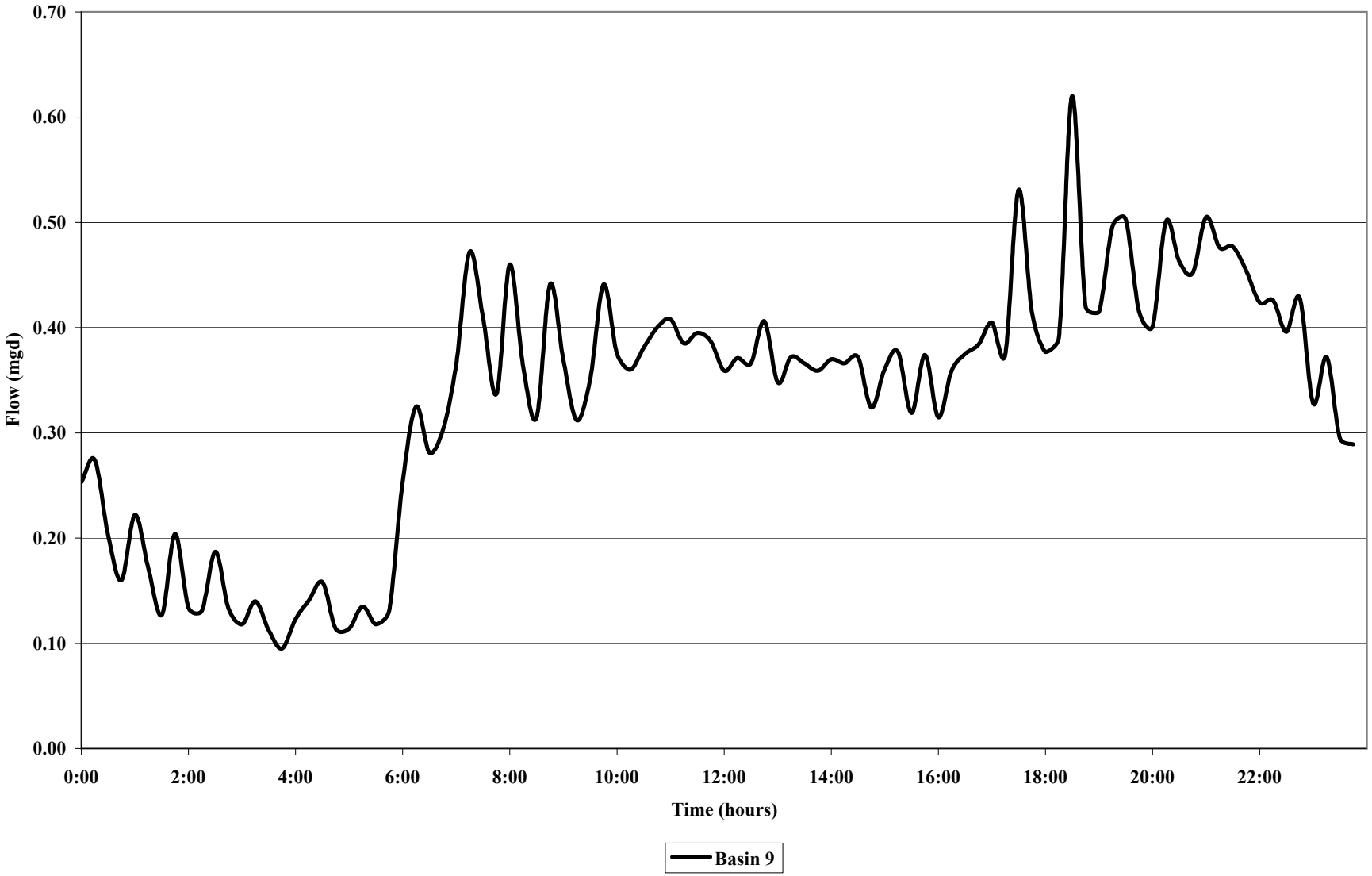
Basin 7 - DWF Hydrograph



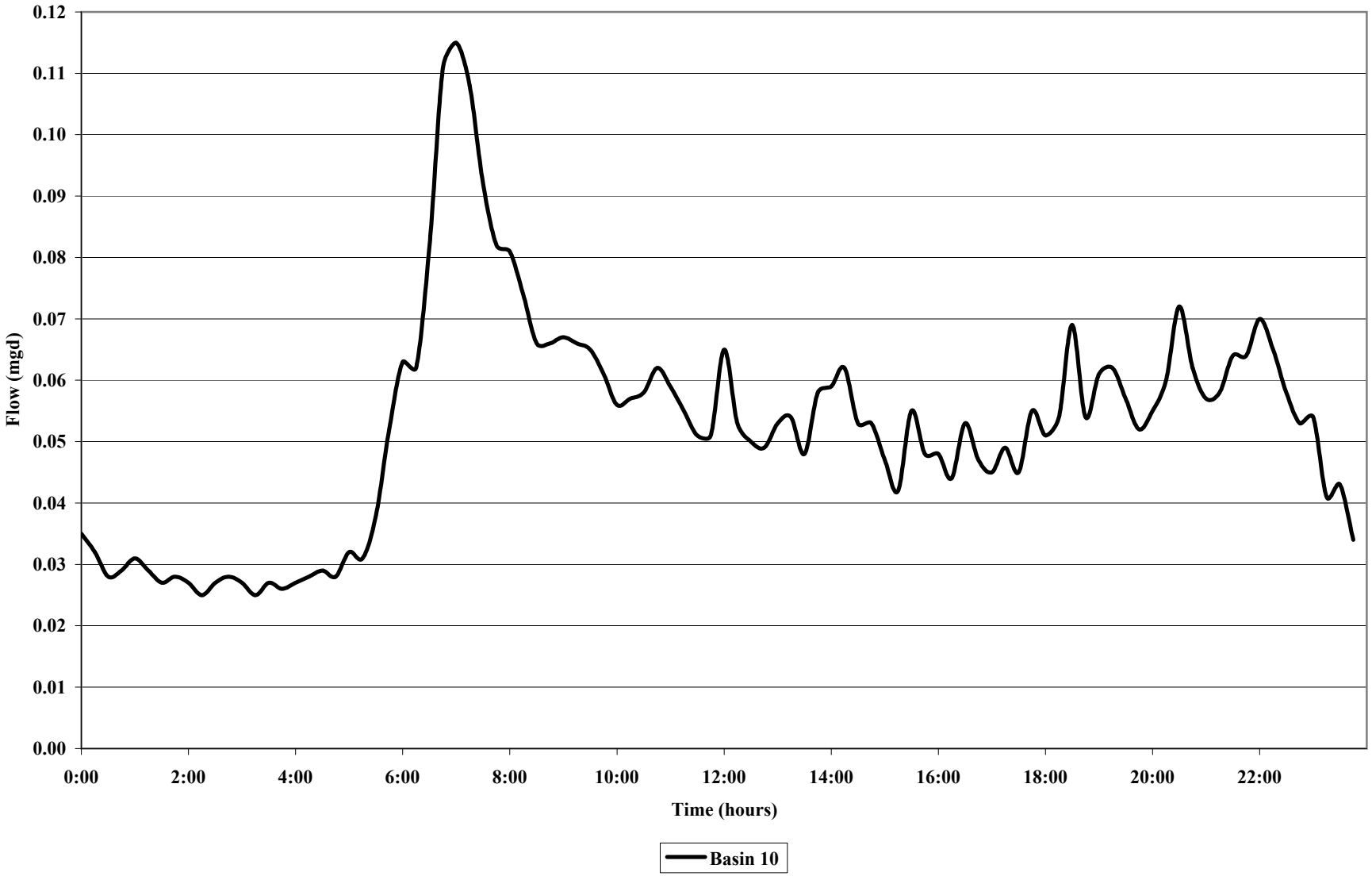
Basin 8 - DWF Hydrograph



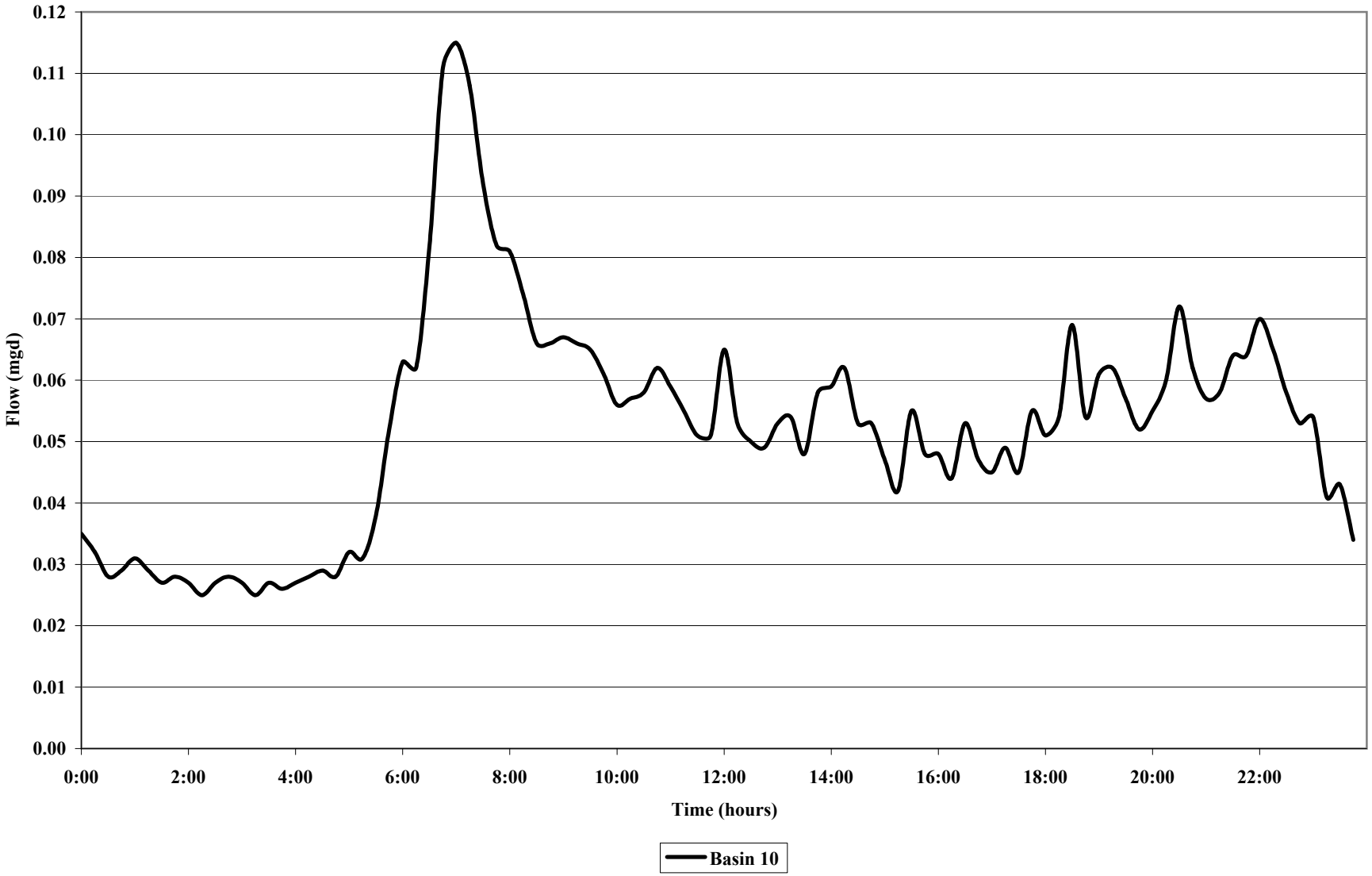
Basin 9 - DWF Hydrograph



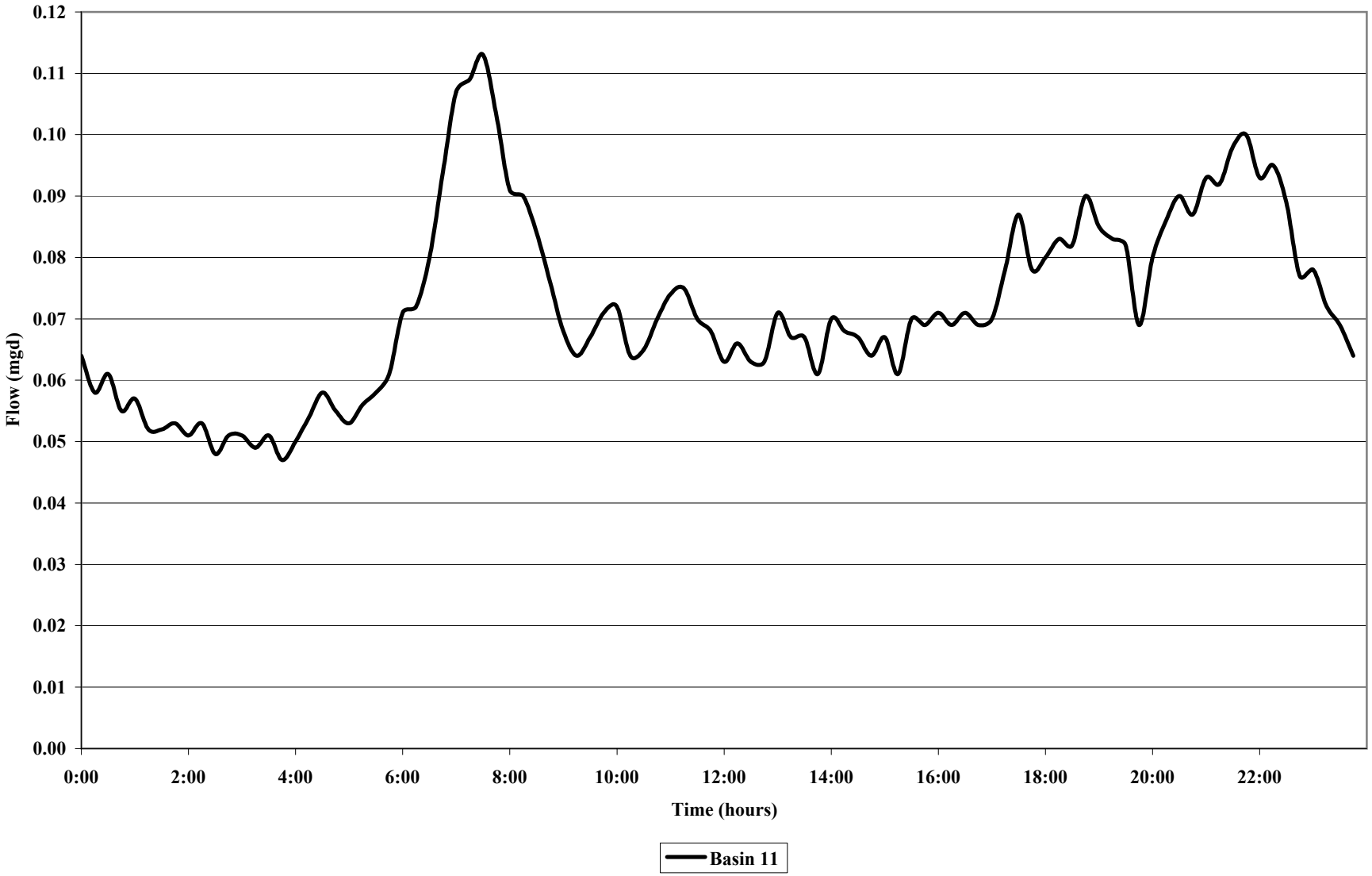
Basin 10 - DWF Hydrograph



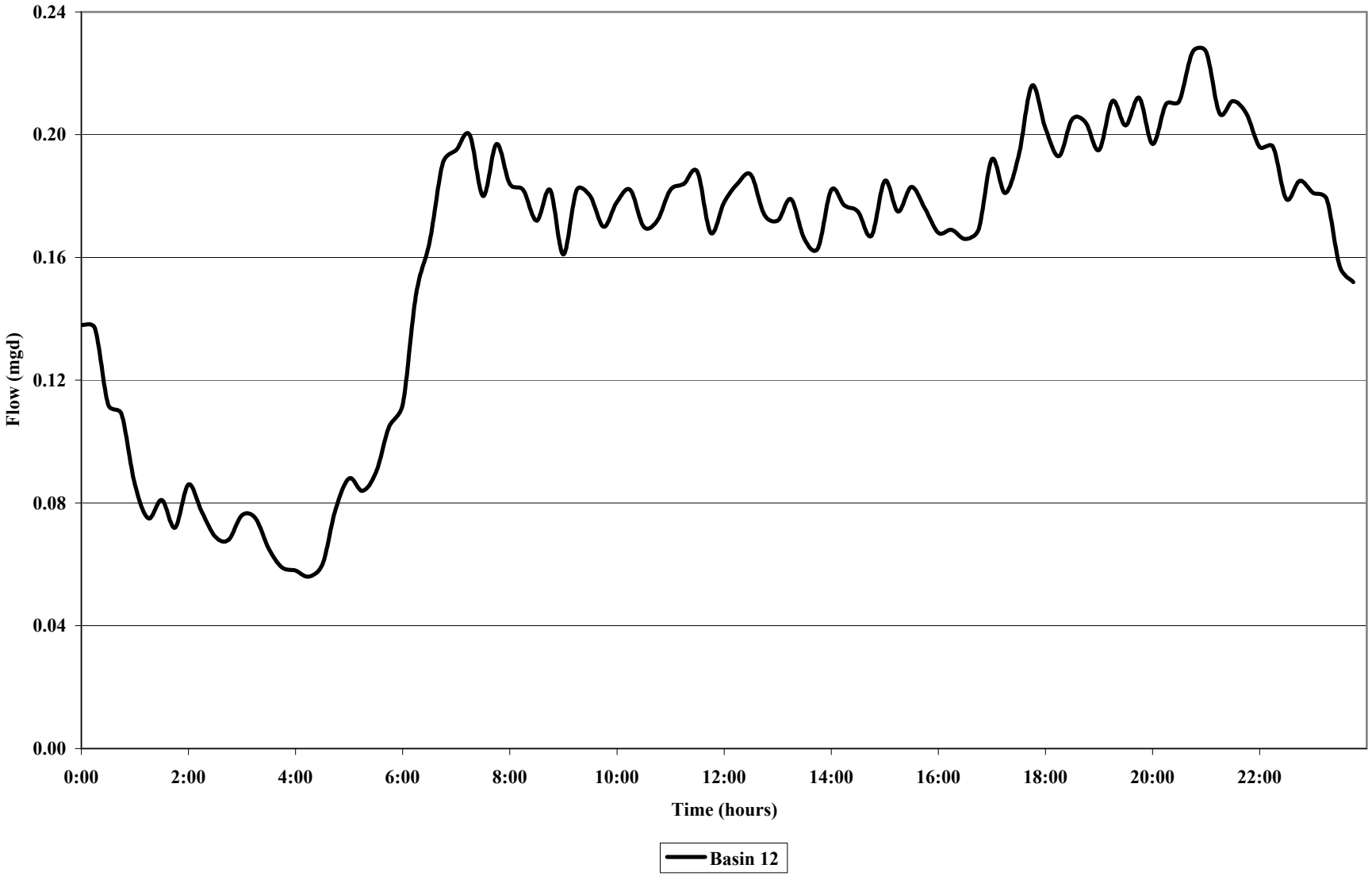
Basin 10 - DWF Hydrograph



Basin 11 - DWF Hydrograph



Basin 12 - DWF Hydrograph



Appendix F
Un-inspected Manholes Summary

Manhole Status Report

8:36:16 AM Wednesday, December 21, 2005

Manhole No.		Address		Location	Date	Status
(7)	10E-LH002		HACKBERRY ST & SECOND ST	S OF INT, MIDDLE OF ALLEY	07/01/05	Buried
(7)	9E-LH001A	310	COLBERN RD	INT OF WALNUT & COLBERN	06/29/05	Buried
(8)	9F-LH006	121	MELODY LN		07/11/05	Buried
(8)	9F-MH084	101	SUNRISE DR		07/08/05	Buried

Appendix G
Inspected Manholes Summary

Manhole Inspection Summary Report

2:06:04 PM Wednesday, January 18, 2006

Basin: 7

Vent Cover:		3			**Inspected:**	42
Below Grade:		0			**C.N.L.:**	0
Cover-Frame Fit:	(F)	0	(P)	1	**D.N.E.:**	0
Frame:	(F)	3	(P)	1	**Buried:**	2
Frame-Chimney Seal:	(F)	7	(P)	1	**Haz / Atmos.:**	0
Chimney:	(F)	4	(P)	0	**Unsafe:**	0
Corbel:	(F)	8	(P)	0	**Sealed Lid:**	0
Wall:	(F)	6	(P)	2	**Traffic:**	0
Bench:	(F)	4	(P)	2	**Dog:**	0
Invert:	(F)	10	(P)	0	**EOL:**	0
Step:	(F)	5	(P)	5	**Other:**	0
Pipe Seals:	(F)	0	(P)	0		

Total Basin Records: 44

Basin: 8

Vent Cover:		7			**Inspected:**	89
Below Grade:		1			**C.N.L.:**	0
Cover-Frame Fit:	(F)	1	(P)	3	**D.N.E.:**	0
Frame:	(F)	9	(P)	1	**Buried:**	2
Frame-Chimney Seal:	(F)	14	(P)	1	**Haz / Atmos.:**	0
Chimney:	(F)	9	(P)	4	**Unsafe:**	0
Corbel:	(F)	28	(P)	1	**Sealed Lid:**	0
Wall:	(F)	35	(P)	7	**Traffic:**	0
Bench:	(F)	17	(P)	4	**Dog:**	0
Invert:	(F)	10	(P)	3	**EOL:**	0
Step:	(F)	13	(P)	4	**Other:**	0
Pipe Seals:	(F)	8	(P)	4		

Total Basin Records: 91

Total For All Basins

Vent Cover:		10			**Inspected:**	131
Below Grade:		1			**C.N.L.:**	0
Cover-Frame Fit:	(F)	1	(P)	4	**D.N.E.:**	0
Frame:	(F)	12	(P)	2	**Buried:**	4
Frame-Chimney Seal:	(F)	21	(P)	2	**Haz / Atmos.:**	0
Chimney:	(F)	13	(P)	4	**Unsafe:**	0
Corbel:	(F)	36	(P)	1	**Sealed Lid:**	0
Wall:	(F)	41	(P)	9	**Traffic:**	0
Bench:	(F)	21	(P)	6	**Dog:**	0
Invert:	(F)	20	(P)	3	**EOL:**	0
Step:	(F)	18	(P)	9	**Other:**	0
Pipe Seals:	(F)	8	(P)	4		
Total Fairs / Poors:	(F)	191	(P)	44		

Total Records: 135

Appendix H
Visual Pipe Inspection Summary

Visual Pipe Defects Summary Report

4:26:14 PM Tuesday, February 14, 2006

Basin: 7

Roots:	13	**Collapsed Pipe:**	1
Deposition:	12	**Joint Infiltration:**	0
Grease:	1	**Offset Joint:**	64
Mineral Deposit:	0	**Protruding Tap:**	0
Longitudinal Cracks:	3	**Line Grade Poor:**	0
Circular Cracks:	8	**Abandoned:**	0
Broken Pipe:	2	**Plugged:**	2

Total Inspections For 7 :104

Basin: 8

Roots:	17	**Collapsed Pipe:**	3
Deposition:	13	**Joint Infiltration:**	2
Grease:	3	**Offset Joint:**	95
Mineral Deposit:	0	**Protruding Tap:**	1
Longitudinal Cracks:	10	**Line Grade Poor:**	0
Circular Cracks:	15	**Abandoned:**	1
Broken Pipe:	11	**Plugged:**	2

Total Inspections For 8 :201

Basin Totals

Roots:	30	**Collapsed Pipe:**	4
Deposition:	25	**Joint Infiltration:**	2
Grease:	4	**Offset Joint:**	159
Mineral Deposit:	0	**Protruding Tap:**	1
Longitudinal Cracks:	13	**Line Grade Poor:**	0
Circular Cracks:	23	**Abandoned:**	1
Broken Pipe:	13	**Plugged:**	4

Total Inspections For Selected Basin(s): 305

Appendix I
Smoke Testing Summary

Smoke Summary Report

4:43:10 PM Tuesday, February 14, 2006

	Private Sector		Public Sector	
Basin: 7	**Lines = 52**	**Footage = 13,408 ft.**		
	Downspout:	0	Curb Inlet:	0
	Uncapped	5	Area Drain:	0
	Driveway Drain:	0	Line Defect:	13
	Stairwell Drain:	0	Indirect Storm:	1
	Foundation Drain:	1	Manhole Defect:	5
	Area Drain:	0	Drainage Crossing:	0
	Defective Service:	34	Water Valve:	1
	Window Well:	0	Direct Storm:	0
	Plumbing Defect:	0		
Basin: 8	**Lines = 91**	**Footage = 20,122 ft.**		
	Downspout:	0	Curb Inlet:	0
	Uncapped	11	Area Drain:	0
	Driveway Drain:	7	Line Defect:	11
	Stairwell Drain:	0	Indirect Storm:	0
	Foundation Drain:	0	Manhole Defect:	15
	Area Drain:	0	Drainage Crossing:	2
	Defective Service:	37	Water Valve:	1
	Window Well:	1	Direct Storm:	0
	Plumbing Defect:	0		
Basin Totals	**Lines = 143**	**Footage = 33,530 ft.**		
	Downspout:	0	Curb Inlet:	0
	Uncapped	16	Area Drain:	0
	Driveway Drain:	7	Line Defect:	24
	Stairwell Drain:	0	Indirect Storm:	1
	Foundation Drain:	1	Manhole Defect:	20
	Area Drain:	0	Drainage Crossing:	2
	Defective Service:	71	Water Valve:	2
	Window Well:	1	Direct Storm:	0
	Plumbing Defect:	0		

Appendix J
TV Inspection Summary

Belton, MO
TV Inspection Summary and Recommendations

Basinup	Up	Basindn	Dn	Diameter	Length	Pipe Type	Length TV'd	Camera Direction	Observations	Recommendations	Priority	# of Dye Tests	Dyed-Water Test Location
A	9E-MH061	A	9E-MH045	8	352	VCP	350	DS	40'CC, 49'FL, 65'CC, 67'CC, 74'TBA,CM, 76'TBA,CM, 92'CL, 95'CM, 116'TBA, 135'TBI, 177'CC, 221'TBI, 232'CC, 272'CC, 275'CC, 281'TBI, 294'FC, 307'Sag, 311'TBA, 348'CM, Insp. Complete	CIPP	2		
A	9E-LH038	A	9E-MH064	8	306	VCP	246	US/DS	45'TBI, 50'DSF, 59'TBI, 60'CL, 61'HSV, 86'TBI,ID, 102'CL, 104'TBI,CM, 129'HVV, 137'TBA, 146'DSF, 186'MSC to 6" pipe, 205'ISSRB, 215'ISSRB, 220'ISSRB, 230'ISSRB, 246' MMC to PVC, MSC to 8", Insp. Abandoned	Replace All	1		
A	9E-MH058	A	9E-MH064	8	263	VCP	261	US	26' MMC to PVC, 40' MMC to VCP, 125'TBI, 137'TBA, 139'TBA, 141'DAE, 147'HVV,DAE, 148'HVS, 189'TBA, 245'TBA, 258'MMC to PVC, Insp. Complete	CIPP	2		
A	9E-MH054	A	9E-MH052	6	348	VCP	319	US/DS	26'RFJ, 30'RFJ, 62'TBA, 63'FC, 70'DAE, 73'TBI, 79' RFJ, 80'RFJ, 82'RFJ, 83'CC, 93'RFJ, 95'RMJ, 97'RMJ, 101'RBB, 105'RMJ, 107'RFJ, 108'RBB, 109'CL 110'RBB **Reverse Setup** 18'CL, 28'JO, 33'JS, 39'JS, 41'JS, 65'RFJ, 66'TBA,RFL, 75'RFJ, 80'RFJ, 87'TBA, 88'RFJ,	Replace All with 8"	1		
A	9E-MH052	A	9E-MH033	6	347	VCP	346	DS	19'FL, 25'CL, 27'CC, 37'CL, 62'MMC to PVC, 65'MMC to VCP, 76'MMC to PVC, 79'MMC to VCP, 123'RFJ, 154'FC, 155'TBI, 159'CL, 181'RFJ, 193'RFJ,JS, 199'FC, 250'FC, 303'JO, 320'BVV, 346' Insp. Complete	Replace All with 8"	2		
A	9E-MH032	A	9E-MH027	8	311	VCP	308	DS/US	41'TBI, 91'TBA, 109'HVV, 139'TBI, 185'ID, 194'ID, 206'ID, 276'ID, 277'TBI **Reverse Setup** 31'IG, 32' Insp. Complete	CIPP	2		
B	9F-MH009A	B	9F-MH009	8	164	VCP	160	DS	63'TBA, 106'ISGT,ID, 160' Insp. Complete	Point Repair Fix Break in @ 63', Fix joint @ 106'	3		
B	9F-MH081	B	9F-MH009	8	48	VCP	48	DS	4'TBI, 9'TBA, 17'CM, 22'JO, 22'MMC to PVC, 33' MMC to VCP, 37'JS, 48' Insp. Complete	CIPP	2		
B	10E-MH012	B	10E-MH007	6	340	VCP	338	DS	49'TBA, 115'MMC to PVC, 136'RMJ, 138' to 195'RFJ, 197'HSV, 223'OBM, 234'FC, 235'TBA, 252'RFJ, 238' Insp. Complete	Replace All with 8"	2		
B	10E-MH015	B	10E-MH007	8	360	VCP	360	DS	25'TBA, 30'TBA, 90'TBA, 96'TBA, 166'TBI,CL, 318'HSV,ID, 327'IR, 339'FM, 342'FM, 357'HSV, 360' Insp. Complete	CIPP	2	1	327'

Belton, MO
TV Inspection Summary and Recommendations

Basinup	Up	Basindn	Dn	Diameter	Length	Pipe Type	Length TV'd	Camera Direction	Observations	Recommendations	Priority	# of Dye Tests	Dyed-Water Test Location
B	10E-MH023	B	10E-MH011	6	250	VCP	123	US	1'HVV, 40'IR, 94'CL, 106'CL, 117'Sag, 119'TBA, 121'TBI, 123' MSC to 5", Insp. Abandoned	Replace All with 8"	1		
B	10E-MH011	B	10E-MH015	6	347	VCP	346	DS	47'CL, 49'JO, 94'ID, 99'TBA, 102'OBZ(rod), 127'TFC,ID, 136'Sag, 149'Sag, 176'TBA, 223'TBA,RFC,IR 237'RFJ, 241'RFJ, 247'RFJ, 251'TBI,RFC,HSV, 256'RFJ, 264'CC, 290'CM, 292'TBA, 340'TBA, 343'BVV, 346'Insp. Complete	Replace All with 8"	1		
A	10E-MH008	A	10E-MH036	6	296	VCP	294	US	159'TBA, 162'TBA, 231'TBA, 232'CC, 234'FC, 263'TBA, 266'TBA, 294' Insp. Complete	Replace All with 8"	2		
B	9E-MH030	B	9E-MH014	6	349	VCP	308	DS/US	56'TBI, 76'TBA,RFC, 81'RFJ, 87'RFJ, 88'RFB, 92'TBI **Reverse Setup** 1'FM,ISSRH, 17'MMC to PVC, 21'MMC to VCP, 23'JS,HSV, 50'FL, 52'FM,DV, 109'CM, 119'CM, 123'CL, 128'FL, 136'CL, 140'RBB, 143'RBB, 145'-154'RFJ, 190'-198'RFJ, 200RBB, 202'RMJ, 205'RFJ, 206'RFJ,	Replace All with 8"	1		
A	9E-LH001	A	9E-MH074	6	498	VCP	498	US	16'FL, 17'ACO(LH001A), 64'TBA, 91'TBA, 154'TBA, 215'TBA, 224'TBI, 238'TBA, 384'DSF, 410'DAZ, 411'TBI, 450'DAZ, 468'DAZ, 495'DAZ.	Replace All with 8"	2		
A	9E-MH059	A	9E-MH059Z	6	140	VCP	140	US	Insp. Complete	Replace All with 8"	2		
B	9E-MH029	B	9E-MH063	6	174	VCP	173	DS	72'TBI, 83'CL,TBI, 173' Insp. Comp.	Replace All with 8"	2		
A	9E-MH021	A	9E-MH020	8	254	VCP	250	DS	16'-68'RFJ, 31' Sag, 98'RFJ, 99'CC, 104'TPI, 108'RFJ, 110'JO, 120'RFJ, 129'CC, 135'CM,RFJ, 141'CM, 161'TBI,DSC, 215'FM, 217'TBI, 218'CL, 221'-246'FL, 250' Insp. Complete	Replace All	1		
A	9E-MH024	A	9E-MH032	8	266	VCP	263	DS	9'FM, 24'IR, 50'TBC, 57'ID, 63'IR, 81'IR, 105'TBA,CL, 110'TBA, 129'RFJ, 138'DAE,IR, 145'DAE,ID,CL, 154'DAE, 155'RFC, 184'TBA,CL, 232'DAE, 263 Insp. Complete	CIPP	2		

Belton, MO
TV Inspection Summary and Recommendations

Basinup	Up	Basindn	Dn	Diameter	Length	Pipe Type	Length TV'd	Camera Direction	Observations	Recommendations	Priority	# of Dye Tests	Dyed-Water Test Location
B	9E-MH015	B	9E-MH014	8	444	VCP	443	DS	70'TBA,111'TBA,TBA,BVV,MMC to PVC, 114' MMC to PVC, 116'HSV, 137'HVV,TBI, 151'CL, 173'TBA,CL, 218'TBA, 225'FM, 227'TBA, 249'BSV,OBS, 279'TBA, 282'JO, MMC to PVC, 289'MMC to VCP, 308'TBI, 352'ID, 359'TBA, 379'TBA,ID, 436 Sag, 439'TBA,RFL, 440'RFJ, 443' Ins	Replace All	1		
B	9F-MH077	B	9F-MH076	8	315	VCP	310	DS	3'JO, 8'Sag, 24'IG, 41'FM, 68'JA, 113'MMC to PVC, 117'MMC to VCP, 128'FC, 186'FC, 197'JA, 199'FM, 218'TBI, 241'TBI, FC, 256'RFJ, 307'FM, 310' Insp. Complete	Replace All	1		
B	9F-MH041	B	9F-MH042	6	140	VCP	140	DS/US	45'Sag, 47'JA, 48' Insp. Abandoned, **Reverse Setup** 5'J0, 25'TBA, 54'JO, 92'JA,JO	Replace All with 8"	2		
B	9F-MH062	B	9F-MH006	8	300	VCP	299	US	1'FC,Sag, 36'RML, 90'FM, 93'CL, 96'CL, 103'FL, 106'TBI, 193'HVV, 194'TBI,FM, 214'TBI, 296'JO, 299' Insp. Complete	CIPP	2		
B	9F-MH006	B	9F-MH007	8	152	VCP	149	DS	1'RFJ, 5'DSC, 18'CC, 38'TBI,FL,HVV, 40'CM, 66'TBA, 99'TBA, 145'Sag, 148'FM, 149'BSV Insp. Complete	Replace All	1		
B	9F-LH001	B	9F-MH075	8	277	VCP	269	US	18'CL, 21'TBI,HVV, 22'FM, 24'RFL, 78'MMC to PVC, 102'MMC to VCP, 137'MMC to PVC, 140'MMC to VCP, 147'RBL, 200'TBI, 244'TBI,RMC, 254'CL, 256'TBA, 262'TBA, 269' Insp. Complete	CIPP	2		
B	9F-MH003	B	9F-MH021	8	370	VCP	369	DS	1'CL, 5'RMJ, 8'CL, 13'RFJ,CL, 16'RMJ,CL, 22'JO,RFJ,CL, 28'RFJ,FL, 32'RFB,CM, 34'CM, 43'RMJ,CM, 54'CL, 58'FL, 64'-78'CL, 88'FM, 99'CL, 114'CM, 124'FL, 139'CL, 149'CC, 165'CM, 184'RFJ, 199'RFJ, 218'ID, 234'RFJ, 244'RFJ, 33O'RFJ, 340'RFJ, 345'RFJ, 350'RFJ, 3	Replace All	1		
B	9F-MH066	B	9F-MH029A	8	172	VCP	172	DS	67'CL, 72'BSV,RMB,DV, 92'CM,RFB, 99'TBA, 113'TBA	Replace All	1		
B	9F-MH029A	B	9F-MH029	8	238	VCP	235	DS	190'TBA,RBL, 191'RFJ, 193'TBA,RFJ, 198'RFJ, 203'RFJ, 224'RFJ, 234'RMJ, 249'RTJ, 267'TBA, 319'TBA, 337'TBA, 407' Insp. Complete	CIPP	2		
B	9F-MH036	B	9F-MH035	10	205	INSITUPIPE	205	DS	Insp. Complete	None			

Belton, MO
TV Inspection Summary and Recommendations

Basinup	Up	Basindn	Dn	Diameter	Length	Pipe Type	Length TV'd	Camera Direction	Observations	Recommendations	Priority	# of Dye Tests	Dyed-Water Test Location
B	9F-MH029	B	9F-MH039	10	135	INSITUPIPE	137	DS	22' OBM	Point Repair to Remove Obstruction @ 22'	2		

Appendix K
I/I Elimination Report

I / I Reduction Program - Combined Report

Pilot Study - 0% I/I Removal

4:42:27 PM Tuesday, February 14, 2006

No.	Source Item	Line Segment				Location	Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM ($)	I/I Elim (%)
1	sUncpd Clnout	(7)	9E-MH024	-(7)	9E-MH032	810 WALNUT ST	A	17.790	25	1.41	17.790	25.00	1.4723
2	sUncpd Clnout	(8)	9E-LH068	-(8)	9E-MH035	517 FOURTH ST	B	6.180	25	4.05	23.970	50.00	1.9838
3	sUncpd Clnout	(8)	9F-MH041	-(8)	9F-MH042	511 Y HWY (CEDAR ST)	A	4.160	25	6.01	28.130	75.00	2.3281
4	sUncpd Clnout	(7)	10E-MH022	-(7)	10E-MH036	621 MAIN ST	A	2.640	25	9.47	30.770	100.00	2.5466
5	Ind. Storm	(7)	9E-MH032	-(7)	9E-MH027	119	S	14.590	150	10.28	45.360	250.00	3.7541
6	Line Defect	(7)	9E-LH002	-(7)	9E-LH001A	39	U	44.480	500	11.24	89.840	750.00	7.4355
7	sUncpd Clnout	(8)	9E-MH030	-(8)	9E-MH014	809 HACKBERRY ST	A	2.100	25	11.90	91.940	775.00	7.6093
8	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027	112 HOLLYWOOD	C	2.080	25	12.02	94.020	800.00	7.7814
9	sUncpd Clnout	(8)	10E-MH023	-(8)	10E-MH011	811 BLD E MAIN ST	B	2.080	25	12.02	96.100	825.00	7.9536
10	sUncpd Clnout	(8)	10E-MH023	-(8)	10E-MH011	810 MAIN ST	C	2.080	25	12.02	98.180	850.00	8.1257
11	sUncpd Clnout	(7)	9E-MH023	-(7)	9E-MH034	122 MAIN ST	B	1.760	25	14.20	99.940	875.00	8.2714
12	sUncpd Clnout	(7)	9E-MH033	-(7)	9E-MH032	708 WALNUT ST	B	1.320	25	18.94	101.260	900.00	8.3806
13	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011	106A SOUTH AVE	A	29.440	600	20.38	130.700	1,500.00	10.817
14	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011	106B SOUTH AVE	B	29.440	600	20.38	160.140	2,100.00	13.253
15	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011	108A SOUTH AVE	C	29.440	600	20.38	189.580	2,700.00	15.690
16	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011	110A SOUTH AVE	D	29.440	600	20.38	219.020	3,300.00	18.126
17	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011	110B SOUTH AVE	E	29.440	600	20.38	248.460	3,900.00	20.563
18	sUncpd Clnout	(8)	9F-MH091	-(8)	9F-MH026	211 PACIFIC DR	A	1.040	25	24.04	249.500	3,925.00	20.649
19	sUncpd Clnout	(8)	10E-MH023	-(8)	10E-MH011	816 MAIN ST	F	1.040	25	24.04	250.540	3,950.00	20.735
20	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027	114 HOLLYWOOD	D	1.030	25	24.27	251.570	3,975.00	20.820
21	Line Defect	(7)	9E-LH001	-(7)	9E-LH001A	5	S	17.790	500	28.11	269.360	4,475.00	22.293
22	Line Defect	(7)	9E-LH002	-(7)	9E-LH001A	17	T	17.790	500	28.11	287.150	4,975.00	23.765
23	Line Defect	(7)	9E-LH002	-(7)	9E-LH001A	46	V	17.790	500	28.11	304.940	5,475.00	25.238
24	sDrive Drain	(8)	9F-MH062	-(8)	9F-MH006	202 HOLLYWOOD	A	21.030	600	28.53	325.970	6,075.00	26.978
25	sDrive Drain	(8)	10F-MH046	-(8)	10F-MH051	400 CATRON	A	21.030	600	28.53	347.000	6,675.00	28.719
26	sUncpd Clnout	(7)	9E-MH037	-(7)	9E-MH023	112 S SCOTT AVE	B	0.870	25	28.74	347.870	6,700.00	28.791
27	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027	115 HOLLYWOOD	A	0.310	25	80.65	348.180	6,725.00	28.816
28	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027	117 HOLLYWOOD	B	0.310	25	80.65	348.490	6,750.00	28.842
29	sServ. Lat.	(7)	9E-MH001	-(7)	9E-MH081	116 MILL ST	B	7.280	600	82.42	355.770	7,350.00	29.444
30	Drainage Xing	(8)	10E-MH015	-(8)	10E-MH007	33	T	5.260	500	95.06	361.030	7,850.00	29.880
31	Frame Seal	(8)	9F-MH005	-( )				3.450	350	101.45	364.480	8,200.00	30.165
32	Frame Seal	(7)	9E-MH033	-( )		IN STREET		3.140	350	111.46	367.620	8,550.00	30.425
33	sServ. Lat.	(7)	9E-MH001	-(7)	9E-MH081	110 MILL ST	A	3.640	600	164.84	371.260	9,150.00	30.726
34	sServ. Lat.	(8)	10E-MH021	-(8)	10E-MH012	819 2ND ST	C	2.910	600	206.19	374.170	9,750.00	30.967
35	sServ. Lat.	(8)	9E-LH068	-(8)	9E-MH035	811 HERSCHEL ST	A	2.910	600	206.19	377.080	10,350.00	31.208
36	sServ. Lat.	(8)	9E-MH057	-(8)	9E-MH029	503 FOURTH ST	A	2.910	600	206.19	379.990	10,950.00	31.449
37	Drainage Xing	(8)	10E-MH015	-(8)	10E-MH007	33	S	2.210	500	226.24	382.200	11,450.00	31.632
38	sServ. Lat.	(8)	10E-MH011	-(8)	10E-MH015	903 MAIN ST	A	2.430	600	246.91	384.630	12,050.00	31.833
39	Pipe Seal	(8)	9E-MH010	-( )			2.	0.780	200	256.41	385.410	12,250.00	31.898
40	Pipe Seal	(8)	9E-MH031	-( )			1.	0.780	200	256.41	386.190	12,450.00	31.962
41	Pipe Seal	(8)	9E-MH031	-( )			2.	0.780	200	256.41	386.970	12,650.00	32.027
42	Pipe Seal	(8)	9F-MH075	-( )			1.	0.780	200	256.41	387.750	12,850.00	32.091
43	Pipe Seal	(8)	9E-MH010	-( )			3.	0.310	100	322.58	388.060	12,950.00	32.117
44	Pipe Seal	(8)	9E-MH014	-( )			2.	0.310	100	322.58	388.370	13,050.00	32.143
45	Pipe Seal	(8)	9E-MH015	-( )			2.	0.310	100	322.58	388.680	13,150.00	32.168
46	Pipe Seal	(8)	9F-MH010	-( )			1.	0.310	100	322.58	388.990	13,250.00	32.194
47	Pipe Seal	(8)	9F-MH010	-( )			2.	0.310	100	322.58	389.300	13,350.00	32.219
48	Pipe Seal	(8)	9F-MH030	-( )			2.	0.310	100	322.58	389.610	13,450.00	32.245
49	Pipe Seal	(8)	9F-MH092	-( )			1.	0.310	100	322.58	389.920	13,550.00	32.271
50	Pipe Seal	(8)	9F-MH092	-( )			2.	0.310	100	322.58	390.230	13,650.00	32.296
51	Water Valve	(8)	10E-MH015	-(8)	10E-MH007	0	U	2.100	700	333.33	392.330	14,350.00	32.470
52	Chimney	(8)	10E-MH004	-( )				0.980	350	357.14	393.310	14,700.00	32.551
53	Chimney	(8)	9F-MH019	-( )				0.980	350	357.14	394.290	15,050.00	32.632
54	Wall	(7)	9E-MH064	-( )		IN STREET		1.000	400	400.00	395.290	15,450.00	32.715
55	sServ. Lat.	(7)	9E-MH052	-(7)	9E-MH033	418 SECOND ST	A	1.460	600	410.96	396.750	16,050.00	32.836

Pilot Study - 0% I/I Removal

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No.	Source Item	Line Segment				Location	Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM ($)	I/I Elim (%)
56	Chimney	(8)	10E-MH024	-( )				0.850	350	411.76	397.600	16,400.00	32.906
57	Chimney	(8)	9F-MH060	-( )				0.850	350	411.76	398.450	16,750.00	32.977
58	Line Defect	(8)	10E-MH015	-(8)	10E-MH007	248	V	1.210	500	413.22	399.660	17,250.00	33.077
59	Line Defect	(8)	10E-MH015	-(8)	10E-MH007	330	W	1.210	500	413.22	400.870	17,750.00	33.177
60	Bench	(8)	9F-MH077	-( )				0.460	200	434.78	401.330	17,950.00	33.215
61	sServ. Lat.	(7)	9E-MH054	-(7)	9E-MH052	516 SECOND ST	B	1.210	600	495.87	402.540	18,550.00	33.315
62	Frame Seal	(8)	10E-MH024	-( )				0.690	350	507.25	403.230	18,900.00	33.372
63	Frame Seal	(8)	9E-MH029	-( )		INT OF ELLA AND 4TH ST		0.690	350	507.25	403.920	19,250.00	33.430
64	Frame Seal	(8)	9E-MH030	-( )				0.690	350	507.25	404.610	19,600.00	33.487
65	Frame Seal	(8)	9E-MH057	-( )		INT OF THIRD AND ELLA		0.690	350	507.25	405.300	19,950.00	33.544
66	Frame Seal	(8)	9F-MH004	-( )				0.690	350	507.25	405.990	20,300.00	33.601
67	Frame Seal	(8)	9F-MH008	-( )				0.690	350	507.25	406.680	20,650.00	33.658
68	Frame Seal	(8)	9F-MH019	-( )				0.690	350	507.25	407.370	21,000.00	33.715
69	Frame Seal	(8)	9F-MH032	-( )				0.690	350	507.25	408.060	21,350.00	33.772
70	Frame Seal	(8)	9F-MH039	-( )		IN FRONT OF CHURCH		0.690	350	507.25	408.750	21,700.00	33.829
71	Frame Seal	(8)	9F-MH060	-( )				0.690	350	507.25	409.440	22,050.00	33.886
72	Frame Seal	(8)	9F-MH066	-( )		FRONT YARD		0.690	350	507.25	410.130	22,400.00	33.943
73	Frame Seal	(8)	9F-MH068	-( )				0.690	350	507.25	410.820	22,750.00	34.001
74	Frame Seal	(8)	9F-MH070	-( )		IN DRIVEWAY		0.690	350	507.25	411.510	23,100.00	34.058
75	Frame Seal	(8)	9F-MH091	-( )		FRONTYARD		0.690	350	507.25	412.200	23,450.00	34.115
76	Line Defect	(8)	9F-MH041	-(8)	9F-MH042	28	S	0.970	500	515.46	413.170	23,950.00	34.195
77	Frame Seal	(7)	10E-MH022	-( )				0.630	350	555.56	413.800	24,300.00	34.247
78	Frame Seal	(7)	9E-LH002	-( )		IN FRONT YARD		0.630	350	555.56	414.430	24,650.00	34.299
79	Frame Seal	(7)	9E-MH020	-( )		FRONT YARD NEXT TO		0.630	350	555.56	415.060	25,000.00	34.351
80	Wall	(7)	9E-MH032	-( )		IN STREET		0.720	400	555.56	415.780	25,400.00	34.411
81	Frame Seal	(7)	9E-MH054	-( )				0.630	350	555.56	416.410	25,750.00	34.463
82	Frame Seal	(7)	9E-MH074	-( )		INT OF WALNUT &		0.630	350	555.56	417.040	26,100.00	34.515
83	Frame Seal	(7)	9E-MH080	-( )		S OF INT WALNUT &		0.630	350	555.56	417.670	26,450.00	34.568
84	Frame Seal	(7)	9F-MH052	-( )		BELTON HIGH PARKING		0.630	350	555.56	418.300	26,800.00	34.620
85	Wall	(8)	10E-MH015	-( )		INT OF MAIN ST AND		0.720	400	555.56	419.020	27,200.00	34.679
86	Wall	(8)	9E-MH014	-( )				0.720	400	555.56	419.740	27,600.00	34.739
87	Wall	(8)	9E-MH029	-( )		INT OF ELLA AND 4TH ST		0.720	400	555.56	420.460	28,000.00	34.798
88	Wall	(8)	9E-MH030	-( )				0.720	400	555.56	421.180	28,400.00	34.858
89	Line Defect	(7)	9E-MH059Z	-(7)	9E-MH059	8	S	0.890	500	561.80	422.070	28,900.00	34.932
90	sServ. Lat.	(8)	9E-MH015	-(8)	9E-MH014	210 SOUTH AVE	C	1.050	600	571.43	423.120	29,500.00	35.019
91	Bench	(8)	9F-MH002	-( )		INT OF CEDAR &		0.330	200	606.06	423.450	29,700.00	35.046
92	Bench	(8)	9F-MH019	-( )				0.330	200	606.06	423.780	29,900.00	35.073
93	sFound. Drain	(7)	9E-MH054	-(7)	9E-MH052	702 HERSCHEL ST	D	0.490	300	612.24	424.270	30,200.00	35.114
94	sServ. Lat.	(8)	9F-MH004	-(8)	9F-MH079	119 GEORGIA	A	0.970	600	618.56	425.240	30,800.00	35.194
95	sServ. Lat.	(8)	10E-MH003	-(8)	10E-MH004	801 THIRD STREET	A	0.970	600	618.56	426.210	31,400.00	35.274
96	Cover To Rim	(8)	9F-MH069	-( )				0.520	400	769.23	426.730	31,800.00	35.317
97	Cover To Rim	(8)	9F-MH090	-( )		IN DRIVEWAY		0.520	400	769.23	427.250	32,200.00	35.360
98	Line Defect	(8)	9E-MH029	-(8)	9E-MH063	108	S	0.610	500	819.67	427.860	32,700.00	35.411
99	sServ. Lat.	(8)	9E-MH015	-(8)	9E-MH014	206 SOUTH AVE	A	0.730	600	821.92	428.590	33,300.00	35.471
100	sServ. Lat.	(8)	9E-MH014	-(8)	9E-MH035	604 FOURTH ST	A	0.730	600	821.92	429.320	33,900.00	35.532
101	Cover To Rim	(7)	9E-MH027	-( )		INT OF SCOTT &		0.470	400	851.06	429.790	34,300.00	35.571
102	Wall	(8)	9E-MH070	-( )				0.460	400	869.57	430.250	34,700.00	35.609
103	Wall	(8)	9F-LH002	-( )				0.460	400	869.57	430.710	35,100.00	35.647
104	Wall	(8)	9F-MH075	-( )				0.460	400	869.57	431.170	35,500.00	35.685
105	Corbel	(7)	9E-MH032	-( )		IN STREET		0.310	300	967.74	431.480	35,800.00	35.710
106	Corbel	(7)	9E-MH043	-( )		IN ST, S. OF MAIN ST,		0.310	300	967.74	431.790	36,100.00	35.736
107	Corbel	(7)	9E-MH045	-( )				0.310	300	967.74	432.100	36,400.00	35.762
108	Corbel	(7)	9E-MH054	-( )				0.310	300	967.74	432.410	36,700.00	35.787
109	Corbel	(7)	9E-MH064	-( )		IN STREET		0.310	300	967.74	432.720	37,000.00	35.813
110	Corbel	(7)	9E-MH080	-( )		S OF INT WALNUT &		0.310	300	967.74	433.030	37,300.00	35.839
111	Corbel	(8)	10E-MH003	-( )				0.310	300	967.74	433.340	37,600.00	35.864
112	Corbel	(8)	10E-MH004	-( )				0.310	300	967.74	433.650	37,900.00	35.890
113	Corbel	(8)	10E-MH012	-( )		INT OF PINE ST & 2ND ST		0.310	300	967.74	433.960	38,200.00	35.916

Pilot Study - 0% I/I Removal

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No.	Source Item	Line Segment				Location	Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM ($)	I/I Elim (%)
114	Corbel	(8)	10E-MH021	-( )				0.310	300	967.74	434.270	38,500.00	35.941
115	Corbel	(8)	9E-MH014	-( )				0.310	300	967.74	434.580	38,800.00	35.967
116	Corbel	(8)	9E-MH015	-( )				0.310	300	967.74	434.890	39,100.00	35.993
117	Corbel	(8)	9E-MH029	-( )		INT OF ELLA AND 4TH ST		0.310	300	967.74	435.200	39,400.00	36.018
118	Corbel	(8)	9E-MH030	-( )				0.310	300	967.74	435.510	39,700.00	36.044
119	Corbel	(8)	9E-MH035	-( )				0.310	300	967.74	435.820	40,000.00	36.070
120	Corbel	(8)	9E-MH057	-( )		INT OF THIRD AND ELLA		0.310	300	967.74	436.130	40,300.00	36.095
121	Corbel	(8)	9E-MH063	-( )				0.310	300	967.74	436.440	40,600.00	36.121
122	Line Defect	(7)	9E-MH024	-(7)	9E-MH032	216	S	0.490	500	1,020.41	436.930	41,100.00	36.162
123	Line Defect	(8)	10E-MH012	-(8)	10E-MH007	83	S	0.490	500	1,020.41	437.420	41,600.00	36.202
124	Corbel	(8)	10E-MH007	-( )		INT OF OAK, SOUTH &		0.780	800	1,025.64	438.200	42,400.00	36.267
125	Vented Cover	(8)	9E-LH003	-( )				0.360	400	1,111.11	438.560	42,800.00	36.296
126	Vented Cover	(8)	9E-LH068	-( )				0.360	400	1,111.11	438.920	43,200.00	36.326
127	sServ. Lat.	(7)	9E-MH074	-(7)	9E-MH075	115 WALNUT ST	A	0.490	600	1,224.49	439.410	43,800.00	36.367
128	sServ. Lat.	(7)	9E-MH054	-(7)	9E-MH052	706 HERSCHEL ST	C	0.490	600	1,224.49	439.900	44,400.00	36.407
129	sServ. Lat.	(7)	9E-LH006	-(7)	9E-MH034	121 MAIN ST	A	0.490	600	1,224.49	440.390	45,000.00	36.448
130	sServ. Lat.	(8)	9F-MH007	-(8)	9F-MH027	121 HOLLYWOOD	E	0.490	600	1,224.49	440.880	45,600.00	36.488
131	sServ. Lat.	(8)	10F-MH051	-(8)	9F-MH002	305 CATRON	A	0.490	600	1,224.49	441.370	46,200.00	36.529
132	sServ. Lat.	(8)	10F-MH046	-(8)	10F-MH051	309 CATRON	C	0.490	600	1,224.49	441.860	46,800.00	36.570
133	sServ. Lat.	(8)	10E-MH021	-(8)	10E-MH012	717 2ND ST	A	0.490	600	1,224.49	442.350	47,400.00	36.610
134	sServ. Lat.	(8)	9E-MH015	-(8)	9E-MH014	204 SOUTH AVE	B	0.490	600	1,224.49	442.840	48,000.00	36.651
135	Line Defect	(7)	9E-MH054	-(7)	9E-MH052	311	U	0.360	500	1,388.89	443.200	48,500.00	36.680
136	Line Defect	(8)	9E-MH030	-(8)	9E-MH014	29	S	0.360	500	1,388.89	443.560	49,000.00	36.710
137	Chimney	(8)	10F-MH046	-( )				0.350	500	1,428.57	443.910	49,500.00	36.739
138	Chimney	(8)	9E-MH066	-( )				0.350	500	1,428.57	444.260	50,000.00	36.768
139	Chimney	(8)	9F-MH005	-( )				0.350	500	1,428.57	444.610	50,500.00	36.797
140	Chimney	(8)	9F-MH042	-( )				0.350	500	1,428.57	444.960	51,000.00	36.826
141	Chimney	(8)	9F-MH092	-( )				0.350	500	1,428.57	445.310	51,500.00	36.855
142	Vented Cover	(8)	9F-LH001	-( )				0.270	400	1,481.48	445.580	51,900.00	36.877
143	Vented Cover	(8)	9F-LH002	-( )				0.270	400	1,481.48	445.850	52,300.00	36.900
144	Corbel	(7)	9E-MH061	-( )				0.190	300	1,578.95	446.040	52,600.00	36.916
145	Bench	(8)	10E-MH004	-( )				0.190	300	1,578.95	446.230	52,900.00	36.931
146	Corbel	(8)	10F-MH040	-( )				0.190	300	1,578.95	446.420	53,200.00	36.947
147	Corbel	(8)	9F-MH002	-( )		INT OF CEDAR &		0.190	300	1,578.95	446.610	53,500.00	36.963
148	Corbel	(8)	9F-MH004	-( )				0.190	300	1,578.95	446.800	53,800.00	36.978
149	Corbel	(8)	9F-MH005	-( )				0.190	300	1,578.95	446.990	54,100.00	36.994
150	Corbel	(8)	9F-MH019	-( )				0.190	300	1,578.95	447.180	54,400.00	37.010
151	Corbel	(8)	9F-MH020	-( )				0.190	300	1,578.95	447.370	54,700.00	37.026
152	Corbel	(8)	9F-MH021	-( )		IN SW CORNER OF		0.190	300	1,578.95	447.560	55,000.00	37.041
153	Corbel	(8)	9F-MH041	-( )				0.190	300	1,578.95	447.750	55,300.00	37.057
154	Corbel	(8)	9F-MH042	-( )				0.190	300	1,578.95	447.940	55,600.00	37.073
155	Corbel	(8)	9F-MH062	-( )		INTERSECTION OF		0.190	300	1,578.95	448.130	55,900.00	37.088
156	Corbel	(8)	9F-MH063	-( )		FRONT YARD		0.190	300	1,578.95	448.320	56,200.00	37.104
157	Corbel	(8)	9F-MH064	-( )		FRONT YARD		0.190	300	1,578.95	448.510	56,500.00	37.120
158	Corbel	(8)	9F-MH066	-( )		FRONT YARD		0.190	300	1,578.95	448.700	56,800.00	37.136
159	Corbel	(8)	9F-MH077	-( )				0.190	300	1,578.95	448.890	57,100.00	37.151
160	Chimney	(7)	10E-MH036	-( )		INT OF MAIN &		0.310	500	1,612.90	449.200	57,600.00	37.177
161	Chimney	(7)	9E-MH074	-( )		INT OF WALNUT &		0.310	500	1,612.90	449.510	58,100.00	37.203
162	sServ. Lat.	(7)	9E-MH059Z	-(7)	9E-MH059	110 WALNUT ST	A	0.360	600	1,666.67	449.870	58,700.00	37.233
163	sServ. Lat.	(7)	9E-MH033	-(7)	9E-MH032	711 WALNUT ST	A	0.360	600	1,666.67	450.230	59,300.00	37.262
164	sServ. Lat.	(7)	9E-MH052	-(7)	9E-MH033	408 SECOND ST	B	0.360	600	1,666.67	450.590	59,900.00	37.292
165	sServ. Lat.	(8)	10E-MH007	-(8)	10E-MH003	403 SOUTH AVE	A	0.360	600	1,666.67	450.950	60,500.00	37.322
166	sServ. Lat.	(8)	10E-MH007	-(8)	10E-MH003	403 SOUTH AVE	B	0.360	600	1,666.67	451.310	61,100.00	37.352
167	sServ. Lat.	(8)	10F-MH046	-(8)	10F-MH051	311 CATRON	B	0.360	600	1,666.67	451.670	61,700.00	37.381
168	sServ. Lat.	(8)	10F-MH046	-(8)	10F-MH051	307 CATRON	E	0.360	600	1,666.67	452.030	62,300.00	37.411
169	sServ. Lat.	(8)	9E-MH014	-(8)	9E-MH035	620 FOURTH ST	B	0.360	600	1,666.67	452.390	62,900.00	37.441
170	Corbel	(7)	10E-MH022	-( )				0.160	300	1,875.00	452.550	63,200.00	37.454

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No.	Source Item	Line Segment				Location	Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM ($)	I/I Elim (%)
171	Corbel	(8)	9F-MH027	-( )				0.160	300	1,875.00	452.710	63,500.00	37.468
172	Corbel	(8)	9F-MH060	-( )				0.160	300	1,875.00	452.870	63,800.00	37.481
173	Corbel	(8)	9F-MH070	-( )		IN DRIVEWAY		0.160	300	1,875.00	453.030	64,100.00	37.494
174	Line Defect	(7)	9E-MH052	-(7)	9E-MH033	195	S	0.240	500	2,083.33	453.270	64,600.00	37.514
175	Line Defect	(7)	9E-MH052	-(7)	9E-MH033	213	T	0.240	500	2,083.33	453.510	65,100.00	37.534
176	Bench	(7)	9E-MH032	-( )		IN STREET		0.140	300	2,142.86	453.650	65,400.00	37.545
177	Bench	(8)	9F-LH001	-( )				0.140	300	2,142.86	453.790	65,700.00	37.557
178	Bench	(8)	9F-MH041	-( )				0.140	300	2,142.86	453.930	66,000.00	37.569
179	Bench	(7)	9E-MH020	-( )		FRONT YARD NEXT TO		0.220	500	2,272.73	454.150	66,500.00	37.587
180	Bench	(7)	9E-MH024	-( )				0.220	500	2,272.73	454.370	67,000.00	37.605
181	Bench	(7)	10E-MH022	-( )				0.130	300	2,307.69	454.500	67,300.00	37.616
182	Bench	(7)	9E-MH064	-( )		IN STREET		0.130	300	2,307.69	454.630	67,600.00	37.626
183	Bench	(8)	9E-MH066	-( )				0.130	300	2,307.69	454.760	67,900.00	37.637
184	Bench	(8)	9F-MH011	-( )		BEHIND ADDRESS		0.130	300	2,307.69	454.890	68,200.00	37.648
185	Bench	(8)	9F-MH064	-( )		FRONT YARD		0.130	300	2,307.69	455.020	68,500.00	37.659
186	Bench	(8)	9F-MH071	-( )		IN DRIVEWAY		0.130	300	2,307.69	455.150	68,800.00	37.669
187	Cover To Rim	(8)	9F-MH023	-( )		EAST OF HIGH SCHOOL		0.170	400	2,352.94	455.320	69,200.00	37.684
188	Chimney	(8)	9E-MH029	-( )		INT OF ELLA AND 4TH ST		0.210	500	2,380.95	455.530	69,700.00	37.701
189	Chimney	(8)	9F-MH009	-( )		IN DRIVEWAY		0.210	500	2,380.95	455.740	70,200.00	37.718
190	Chimney	(8)	9F-MH027	-( )				0.210	500	2,380.95	455.950	70,700.00	37.736
191	Chimney	(8)	9F-MH070	-( )		IN DRIVEWAY		0.210	500	2,380.95	456.160	71,200.00	37.753
192	Line Defect	(8)	9F-MH036	-(8)	9F-MH035	9	T	0.210	500	2,380.95	456.370	71,700.00	37.770
193	Vented Cover	(7)	9E-LH001	-( )		IN STREET		0.160	400	2,500.00	456.530	72,100.00	37.784
194	Wall	(7)	9E-MH043	-( )		IN ST, S. OF MAIN ST,		0.160	400	2,500.00	456.690	72,500.00	37.797
195	Wall	(7)	9E-MH045	-( )				0.160	400	2,500.00	456.850	72,900.00	37.810
196	Wall	(7)	9E-MH054	-( )				0.160	400	2,500.00	457.010	73,300.00	37.823
197	Wall	(8)	10E-MH003	-( )				0.160	400	2,500.00	457.170	73,700.00	37.837
198	Wall	(8)	10E-MH011	-( )		INT OF PINE ST & MAIN		0.160	400	2,500.00	457.330	74,100.00	37.850
199	Wall	(8)	10E-MH012	-( )		INT OF PINE ST & 2ND ST		0.160	400	2,500.00	457.490	74,500.00	37.863
200	Wall	(8)	10E-MH021	-( )				0.160	400	2,500.00	457.650	74,900.00	37.876
201	Wall	(8)	9E-MH015	-( )				0.160	400	2,500.00	457.810	75,300.00	37.890
202	Wall	(8)	9E-MH035	-( )				0.160	400	2,500.00	457.970	75,700.00	37.903
203	Wall	(8)	9E-MH036	-( )				0.160	400	2,500.00	458.130	76,100.00	37.916
204	Wall	(8)	9E-MH057	-( )		INT OF THIRD AND ELLA		0.160	400	2,500.00	458.290	76,500.00	37.929
205	Wall	(8)	9E-MH063	-( )				0.160	400	2,500.00	458.450	76,900.00	37.943
206	sServ. Lat.	(7)	9E-LH001	-(7)	9E-LH001A	310 W WALNUT ST	B	0.240	600	2,500.00	458.690	77,500.00	37.962
207	sServ. Lat.	(7)	9E-LH001	-(7)	9E-LH001A	310 W WALNUT ST	E	0.240	600	2,500.00	458.930	78,100.00	37.982
208	sServ. Lat.	(7)	9E-MH052	-(7)	9E-MH033	402 SECOND ST	C	0.240	600	2,500.00	459.170	78,700.00	38.002
209	sServ. Lat.	(7)	9E-MH043	-(7)	9E-MH045	324 MAIN ST	B	0.240	600	2,500.00	459.410	79,300.00	38.022
210	sServ. Lat.	(7)	9E-MH061	-(7)	9E-MH045	417 SECOND ST	B	0.240	600	2,500.00	459.650	79,900.00	38.042
211	sServ. Lat.	(8)	10E-MH007	-(8)	10E-MH003	405 SOUTH AVE	D	0.240	600	2,500.00	459.890	80,500.00	38.062
212	sServ. Lat.	(8)	10E-MH007	-(8)	10E-MH003	405 SOUTH AVE	E	0.240	600	2,500.00	460.130	81,100.00	38.082
213	sServ. Lat.	(8)	9F-MH010	-(8)	9F-MH009	PACIFIC DR	B	0.240	600	2,500.00	460.370	81,700.00	38.102
214	sServ. Lat.	(8)	10E-MH023	-(8)	10E-MH011	810 MAIN ST	E	0.240	600	2,500.00	460.610	82,300.00	38.121
215	sServ. Lat.	(8)	9E-MH057	-(8)	9E-MH029	502 THIRD ST	B	0.240	600	2,500.00	460.850	82,900.00	38.141
216	sServ. Lat.	(8)	9E-MH004	-(8)	9E-MH062	523 FIFTH ST	A	0.240	600	2,500.00	461.090	83,500.00	38.161
217	Chimney	(7)	10E-MH022	-( )				0.190	500	2,631.58	461.280	84,000.00	38.177
218	Chimney	(7)	9E-MH080	-( )		S OF INT WALNUT &		0.190	500	2,631.58	461.470	84,500.00	38.193
219	Line Defect	(7)	9E-MH054	-(7)	9E-MH052	208	S	0.180	500	2,777.78	461.650	85,000.00	38.207
220	Line Defect	(7)	9E-MH054	-(7)	9E-MH052	217	T	0.180	500	2,777.78	461.830	85,500.00	38.222
221	Bench	(8)	9E-MH010	-( )				0.100	300	3,000.00	461.930	85,800.00	38.231
222	Bench	(8)	9E-MH029	-( )		INT OF ELLA AND 4TH ST		0.100	300	3,000.00	462.030	86,100.00	38.239
223	Bench	(8)	9E-MH031	-( )				0.100	300	3,000.00	462.130	86,400.00	38.247
224	sServ. Lat.	(7)	9E-LH001	-(7)	9E-LH001A	206 W WALNUT ST	A	0.180	600	3,333.33	462.310	87,000.00	38.262
225	sServ. Lat.	(7)	9E-LH001	-(7)	9E-LH001A	310 W WALNUT ST	C	0.180	600	3,333.33	462.490	87,600.00	38.277
226	sServ. Lat.	(7)	9E-LH001	-(7)	9E-LH001A	310 W WALNUT ST	D	0.180	600	3,333.33	462.670	88,200.00	38.292
227	sServ. Lat.	(7)	9E-MH032	-(7)	9E-MH027	807 WALNUT ST	A	0.180	600	3,333.33	462.850	88,800.00	38.307
228	sServ. Lat.	(7)	9E-MH061	-(7)	9E-MH045	417 SECOND ST	A	0.180	600	3,333.33	463.030	89,400.00	38.322

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No.	Source Item	Line Segment					Location	Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM ($)	I/I Elim (%)
229	sServ. Lat.	(8)	10E-MH015	-(8)	10E-MH007		604 OAK ST	A	0.180	600	3,333.33	463.210	90,000.00	38.337
230	sServ. Lat.	(8)	10E-MH023	-(8)	10E-MH011		803 MAIN ST	A	0.180	600	3,333.33	463.390	90,600.00	38.351
231	Water Valve	(7)	9E-MH061	-(7)	9E-MH045		229	S	0.200	700	3,500.00	463.590	91,300.00	38.368
232	Bench	(8)	9F-MH035	-( )					0.140	500	3,571.43	463.730	91,800.00	38.380
233	Wall	(7)	9E-LH006	-( )			INT OF MAIN ST &		0.110	400	3,636.36	463.840	92,200.00	38.389
234	Wall	(7)	9E-MH020	-( )			FRONT YARD NEXT TO		0.110	400	3,636.36	463.950	92,600.00	38.398
235	Wall	(7)	9E-MH061	-( )					0.110	400	3,636.36	464.060	93,000.00	38.407
236	Wall	(8)	10F-MH040	-( )					0.110	400	3,636.36	464.170	93,400.00	38.416
237	Wall	(8)	9E-MH010	-( )					0.110	400	3,636.36	464.280	93,800.00	38.425
238	Wall	(8)	9E-MH031	-( )					0.110	400	3,636.36	464.390	94,200.00	38.434
239	Wall	(8)	9F-LH001	-( )					0.110	400	3,636.36	464.500	94,600.00	38.443
240	Wall	(8)	9F-MH002	-( )			INT OF CEDAR &		0.110	400	3,636.36	464.610	95,000.00	38.452
241	Wall	(8)	9F-MH004	-( )					0.110	400	3,636.36	464.720	95,400.00	38.462
242	Wall	(8)	9F-MH005	-( )					0.110	400	3,636.36	464.830	95,800.00	38.471
243	Wall	(8)	9F-MH006	-( )			INTER OF HOLLYWOOD		0.110	400	3,636.36	464.940	96,200.00	38.480
244	Wall	(8)	9F-MH007	-( )					0.110	400	3,636.36	465.050	96,600.00	38.489
245	Wall	(8)	9F-MH008	-( )					0.110	400	3,636.36	465.160	97,000.00	38.498
246	Wall	(8)	9F-MH019	-( )					0.110	400	3,636.36	465.270	97,400.00	38.507
247	Wall	(8)	9F-MH020	-( )					0.110	400	3,636.36	465.380	97,800.00	38.516
248	Wall	(8)	9F-MH021	-( )			IN SW CORNER OF		0.110	400	3,636.36	465.490	98,200.00	38.525
249	Wall	(8)	9F-MH029	-( )					0.110	400	3,636.36	465.600	98,600.00	38.534
250	Wall	(8)	9F-MH041	-( )					0.110	400	3,636.36	465.710	99,000.00	38.543
251	Wall	(8)	9F-MH042	-( )					0.110	400	3,636.36	465.820	99,400.00	38.553
252	Wall	(8)	9F-MH051	-( )			FRONT YARD		0.110	400	3,636.36	465.930	99,800.00	38.562
253	Wall	(8)	9F-MH061	-( )			FRONT YARD		0.110	400	3,636.36	466.040	100,200.00	38.571
254	Wall	(8)	9F-MH062	-( )			INTERSECTION OF		0.110	400	3,636.36	466.150	100,600.00	38.580
255	Wall	(8)	9F-MH063	-( )			FRONT YARD		0.110	400	3,636.36	466.260	101,000.00	38.589
256	Wall	(8)	9F-MH064	-( )			FRONT YARD		0.110	400	3,636.36	466.370	101,400.00	38.598
257	Wall	(8)	9F-MH066	-( )			FRONT YARD		0.110	400	3,636.36	466.480	101,800.00	38.607
258	Wall	(8)	9F-MH070	-( )			IN DRIVEWAY		0.110	400	3,636.36	466.590	102,200.00	38.616
259	Wall	(8)	9F-MH077	-( )					0.110	400	3,636.36	466.700	102,600.00	38.625
260	Wall	(8)	9F-MH079	-( )					0.110	400	3,636.36	466.810	103,000.00	38.635
261	Wall	(8)	9F-MH091	-( )			FRONTYARD		0.110	400	3,636.36	466.920	103,400.00	38.644
262	Bench	(7)	10E-MH033	-( )			IN STREET		0.080	300	3,750.00	467.000	103,700.00	38.650
263	Bench	(7)	10E-MH036	-( )			INT OF MAIN &		0.080	300	3,750.00	467.080	104,000.00	38.657
264	Bench	(7)	9E-MH023	-( )					0.080	300	3,750.00	467.160	104,300.00	38.663
265	Bench	(7)	9E-MH053	-( )			BEHIND HOUSE IN ALLEY		0.080	300	3,750.00	467.240	104,600.00	38.670
266	Bench	(7)	9E-MH061	-( )					0.080	300	3,750.00	467.320	104,900.00	38.677
267	Bench	(8)	10E-MH015	-( )			INT OF MAIN ST AND		0.080	300	3,750.00	467.400	105,200.00	38.683
268	Bench	(8)	9E-MH030	-( )					0.080	300	3,750.00	467.480	105,500.00	38.690
269	Bench	(8)	9F-MH076	-( )					0.080	300	3,750.00	467.560	105,800.00	38.697
270	Line Defect	(8)	9F-MH029	-(8)	9F-MH039		115	S	0.120	500	4,166.67	467.680	106,300.00	38.707
271	Line Defect	(8)	9F-MH029	-(8)	9F-MH039		118	T	0.120	500	4,166.67	467.800	106,800.00	38.716
272	Vented Cover	(8)	9F-MH037	-( )					0.090	400	4,444.44	467.890	107,200.00	38.724
273	sServ. Lat.	(7)	9E-MH081	-(7)	9E-MH024		310 S SCOTT AVE	A	0.120	600	5,000.00	468.010	107,800.00	38.734
274	sServ. Lat.	(7)	9E-LH008	-(7)	9E-MH033		318 SECOND ST	A	0.120	600	5,000.00	468.130	108,400.00	38.744
275	sServ. Lat.	(7)	9E-MH054	-(7)	9E-MH052		510 SECOND ST	A	0.120	600	5,000.00	468.250	109,000.00	38.754
276	sServ. Lat.	(7)	10E-LH002	-(7)	9E-MH054		602 SECOND ST	A	0.120	600	5,000.00	468.370	109,600.00	38.764
277	sServ. Lat.	(7)	9E-MH037	-(7)	9E-MH023		112 S SCOTT AVE	A	0.120	600	5,000.00	468.490	110,200.00	38.774
278	sServ. Lat.	(7)	9E-MH058	-(7)	9E-MH064		421 MAIN ST	C	0.120	600	5,000.00	468.610	110,800.00	38.783
279	sServ. Lat.	(7)	10E-MH008	-(7)	10E-MH036		709 MAIN ST	A	0.120	600	5,000.00	468.730	111,400.00	38.793
280	Line Defect	(8)	9F-MH036	-(8)	9F-MH035		5	S	0.100	500	5,000.00	468.830	111,900.00	38.802
281	sServ. Lat.	(8)	9F-LH006	-(8)	9F-MH008		119 MELODY	A	0.120	600	5,000.00	468.950	112,500.00	38.812
282	sServ. Lat.	(8)	10F-MH051	-(8)	9F-MH002		601 S CATRON	B	0.120	600	5,000.00	469.070	113,100.00	38.822
283	sServ. Lat.	(8)	10F-MH046	-(8)	10F-MH051		307 CATRON	D	0.120	600	5,000.00	469.190	113,700.00	38.832
284	sServ. Lat.	(8)	10E-MH021	-(8)	10E-MH012		816 2ND ST	B	0.120	600	5,000.00	469.310	114,300.00	38.841
285	sServ. Lat.	(8)	10E-MH023	-(8)	10E-MH011		810 MAIN ST	D	0.120	600	5,000.00	469.430	114,900.00	38.851

Pilot Study - 0% I/I Removal

4:42:27 PM Tuesday, February 14, 2006

No.	Source Item	Line Segment				Location	Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM ($)	I/I Elim (%)
286	sServ. Lat.	(8)	9E-MH035	-(8)	9E-MH063	508 FOURTH ST	A	0.120	600	5,000.00	469.550	115,500.00	38.861
287	Bench	(7)	9E-MH021	-( )		FRONT YARD		0.050	300	6,000.00	469.600	115,800.00	38.865
288	Bench	(7)	9E-MH025	-( )				0.050	300	6,000.00	469.650	116,100.00	38.870
289	Bench	(8)	10E-MH007	-( )		INT OF OAK, SOUTH &		0.050	300	6,000.00	469.700	116,400.00	38.874
290	Bench	(8)	10E-MH021	-( )				0.050	300	6,000.00	469.750	116,700.00	38.878
291	Bench	(8)	10F-MH046	-( )				0.050	300	6,000.00	469.800	117,000.00	38.882
292	Bench	(8)	9E-MH014	-( )				0.050	300	6,000.00	469.850	117,300.00	38.886
293	Bench	(8)	9E-MH015	-( )				0.050	300	6,000.00	469.900	117,600.00	38.890
294	Bench	(8)	9F-MH009	-( )		IN DRIVEWAY		0.050	300	6,000.00	469.950	117,900.00	38.894
295	Bench	(8)	9F-MH021	-( )		IN SW CORNER OF		0.050	300	6,000.00	470.000	118,200.00	38.899
296	Bench	(8)	9F-MH066	-( )		FRONT YARD		0.050	300	6,000.00	470.050	118,500.00	38.903
297	Bench	(8)	9F-MH090	-( )		IN DRIVEWAY		0.050	300	6,000.00	470.100	118,800.00	38.907
298	sServ. Lat.	(7)	10E-MH036	-(7)	10E-MH033	704 MAIN ST	A	0.100	600	6,000.00	470.200	119,400.00	38.915
299	sServ. Lat.	(8)	10E-MH011	-(8)	10E-MH015	921 MAIN ST	B	0.100	600	6,000.00	470.300	120,000.00	38.923
300	Line Defect	(8)	9F-MH066	-(8)	9F-MH029	313	S	0.070	500	7,142.86	470.370	120,500.00	38.929
301	sServ. Lat.	(8)	9F-MH026	-(8)	9F-MH010	127 PACIFIC DR	A	0.080	600	7,500.00	470.450	121,100.00	38.936
302	sServ. Lat.	(7)	9E-MH086	-(7)	9E-MH042	319 LOOP RD	A	0.070	600	8,571.43	470.520	121,700.00	38.942
303	sServ. Lat.	(8)	9F-MH010	-(8)	9F-MH009	110 PACIFIC DR	A	0.060	600	10,000.00	470.580	122,300.00	38.947
304	sServ. Lat.	(8)	10E-MH015	-(8)	10E-MH007	601 OAK ST	B	0.060	600	10,000.00	470.640	122,900.00	38.952
305	sServ. Lat.	(7)	9E-MH043	-(7)	9E-MH045	314 MAIN ST	A	0.050	600	12,000.00	470.690	123,500.00	38.956
306	sServ. Lat.	(7)	9E-MH058	-(7)	9E-MH064	401 MAIN ST	A	0.040	600	15,000.00	470.730	124,100.00	38.959
307	Line Defect	(7)	9E-MH058	-(7)	9E-MH064	136	S	0.020	500	25,000.00	470.750	124,600.00	38.961
308	Line Defect	(7)	9E-LH038	-(7)	9E-MH064	246	S	0.020	500	25,000.00	470.770	125,100.00	38.962
309	sServ. Lat.	(7)	9E-MH023	-(7)	9E-MH034	113 B S SCOTT AVE	A	0.020	600	30,000.00	470.790	125,700.00	38.964
310	sServ. Lat.	(7)	9E-MH058	-(7)	9E-MH064	417 MAIN ST	B	0.020	600	30,000.00	470.810	126,300.00	38.966
311	sServ. Lat.	(7)	9E-LH038	-(7)	9E-MH064	501 LOOP RD	A	0.020	600	30,000.00	470.830	126,900.00	38.967

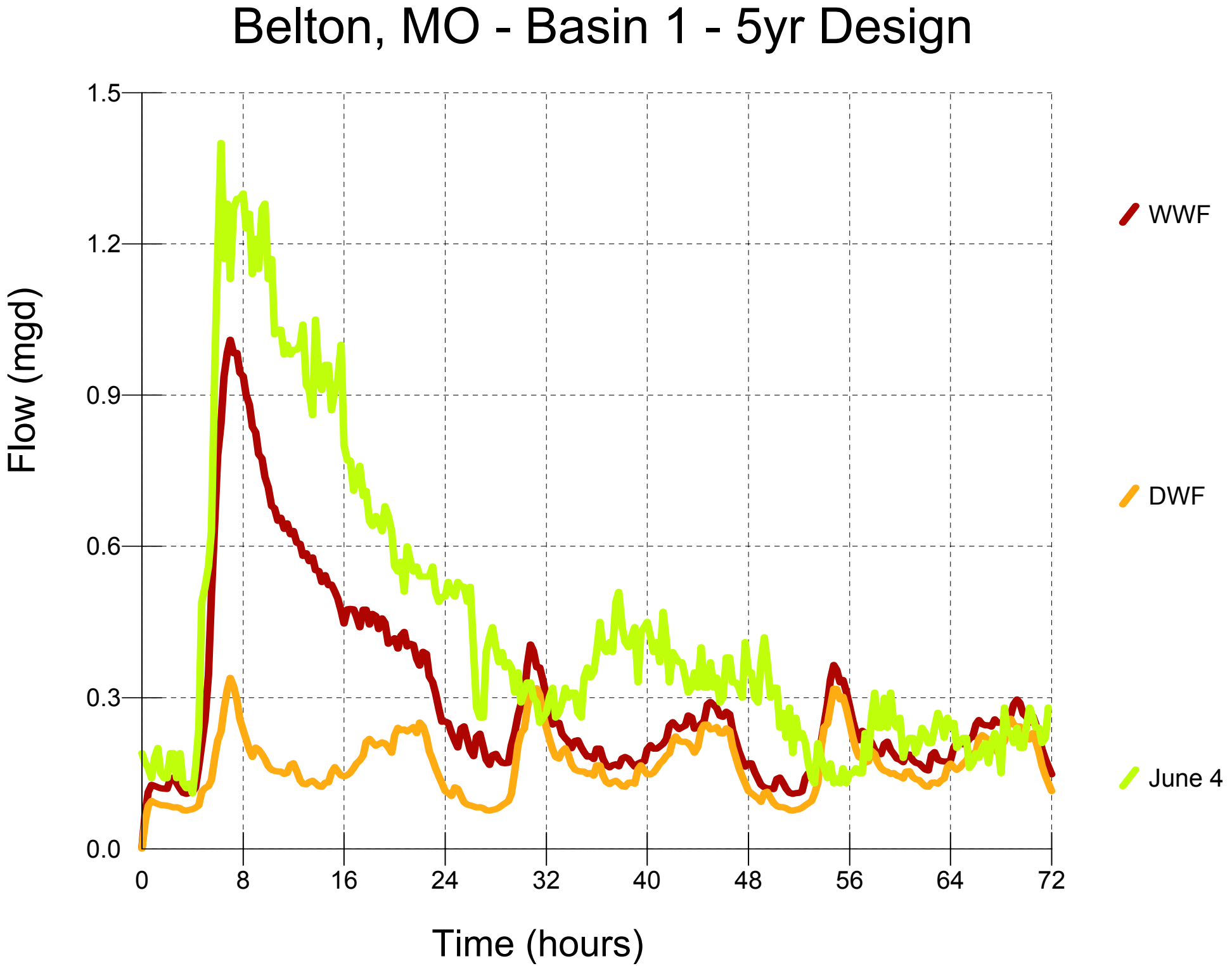
Appendix L
Complete Pipe Inventory Report

Belton, Missouri
Pipe Inventory Summary Report

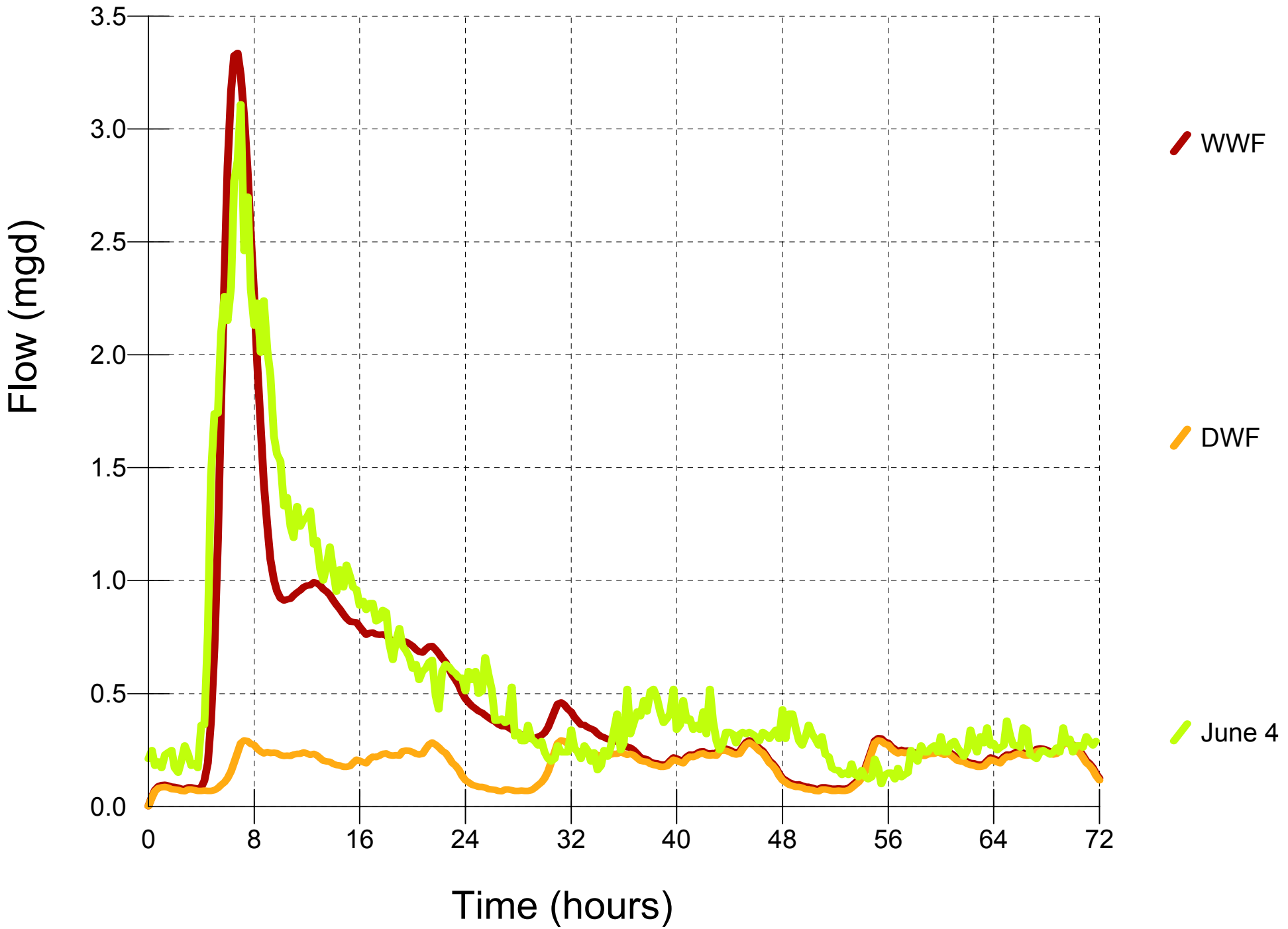
Pipe Size (in)	Basin													Total Footage (ft)
	1	2	3	4	5	6	7	8	9	10	11	12	13	
4*	0	189	0	0	0	0	0	0	566	0	0	0	0	**755**
6	0	309	454	73	22	665	8,219	5,174	0	0	0	7,863	80	**22,859**
8	41,493	35,058	31,415	78,825	25,189	21,304	44,892	29,177	43,435	19,714	31,599	12,259	12,310	**426,670**
10	0	266	2,663	5,317	1,944	1,435	5,759	7,417	3,772	2,581	4,125	3,895	0	**39,174**
12	0	0	0	693	0	3,815	2,661	596	7,702	144	220	0	16,523	**32,354**
15	1,465	3,969	1,612	1,750	0	2,282	2,418	0	1,864	0	0	0	6,080	**21,440**
18	0	0	0	1,640	0	4,816	0	0	0	0	0	0	2,226	**8,682**
21	0	0	0	238	0	0	0	0	0	0	0	0	304	**542**
24	0	0	0	7,109	0	0	0	0	0	0	0	0	0	**7,109**
27	0	0	0	0	0	0	0	0	0	0	0	0	5,598	**5,598**
30	0	0	0	0	0	0	0	0	0	0	0	0	3,429	**3,429**
32	0	0	0	0	0	0	0	0	0	0	0	0	12	**12**
36	0	0	0	0	0	0	0	0	0	0	0	0	14,511	**14,511**
Total	**42,958**	**39,791**	**36,144**	**95,645**	**27,155**	**34,317**	**63,949**	**42,364**	**57,339**	**22,439**	**35,944**	**24,017**	**61,073**	**583,135**
% of Total	7.37%	6.82%	6.20%	16.40%	4.66%	5.88%	10.97%	7.26%	9.83%	3.85%	6.16%	4.12%	10.47%	100.00%

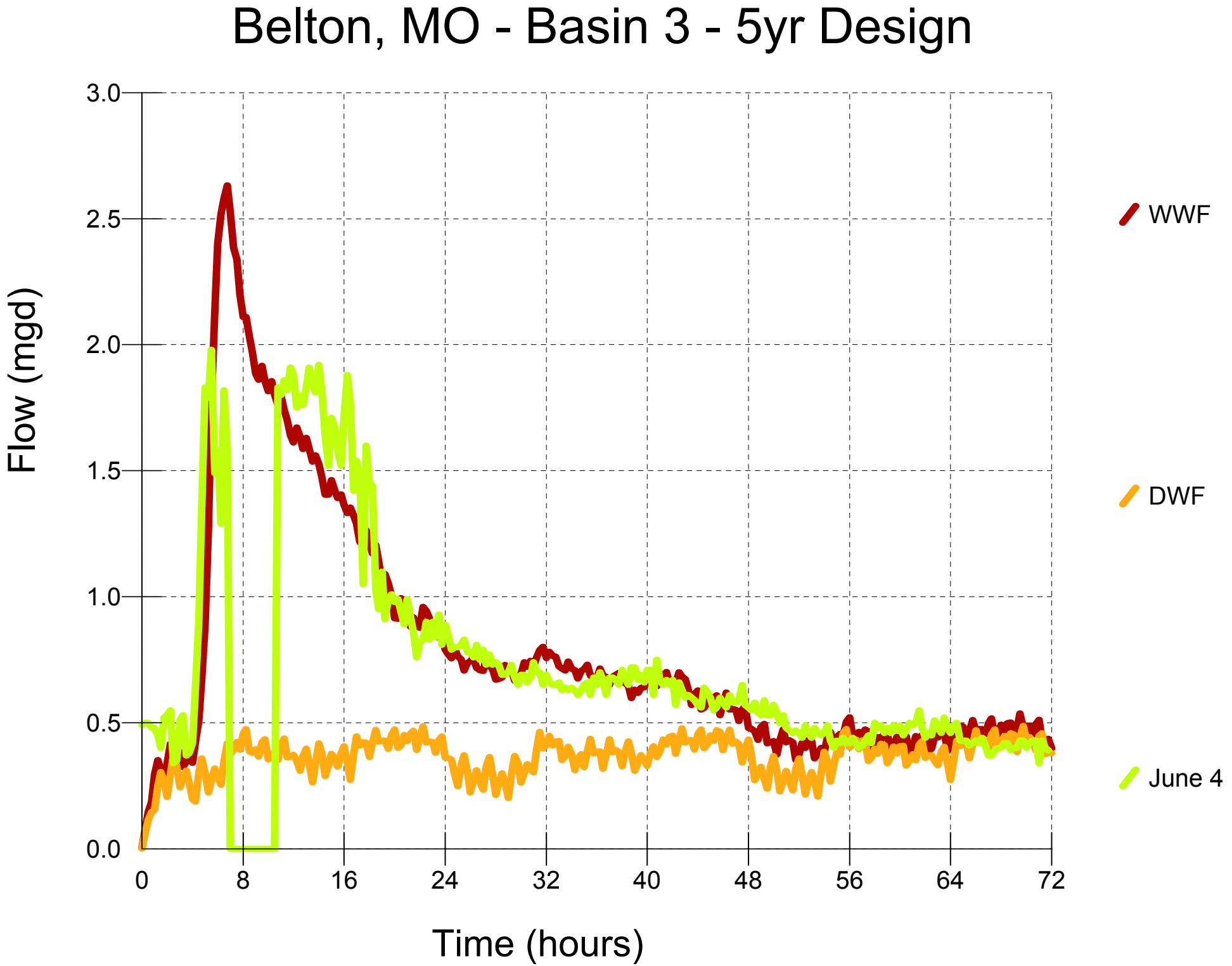
*4" Gravity pipeline - footage does not include force main or stub out lines.

Appendix M
Wet Weather Hydrograph Comparisons (June 4th Event)

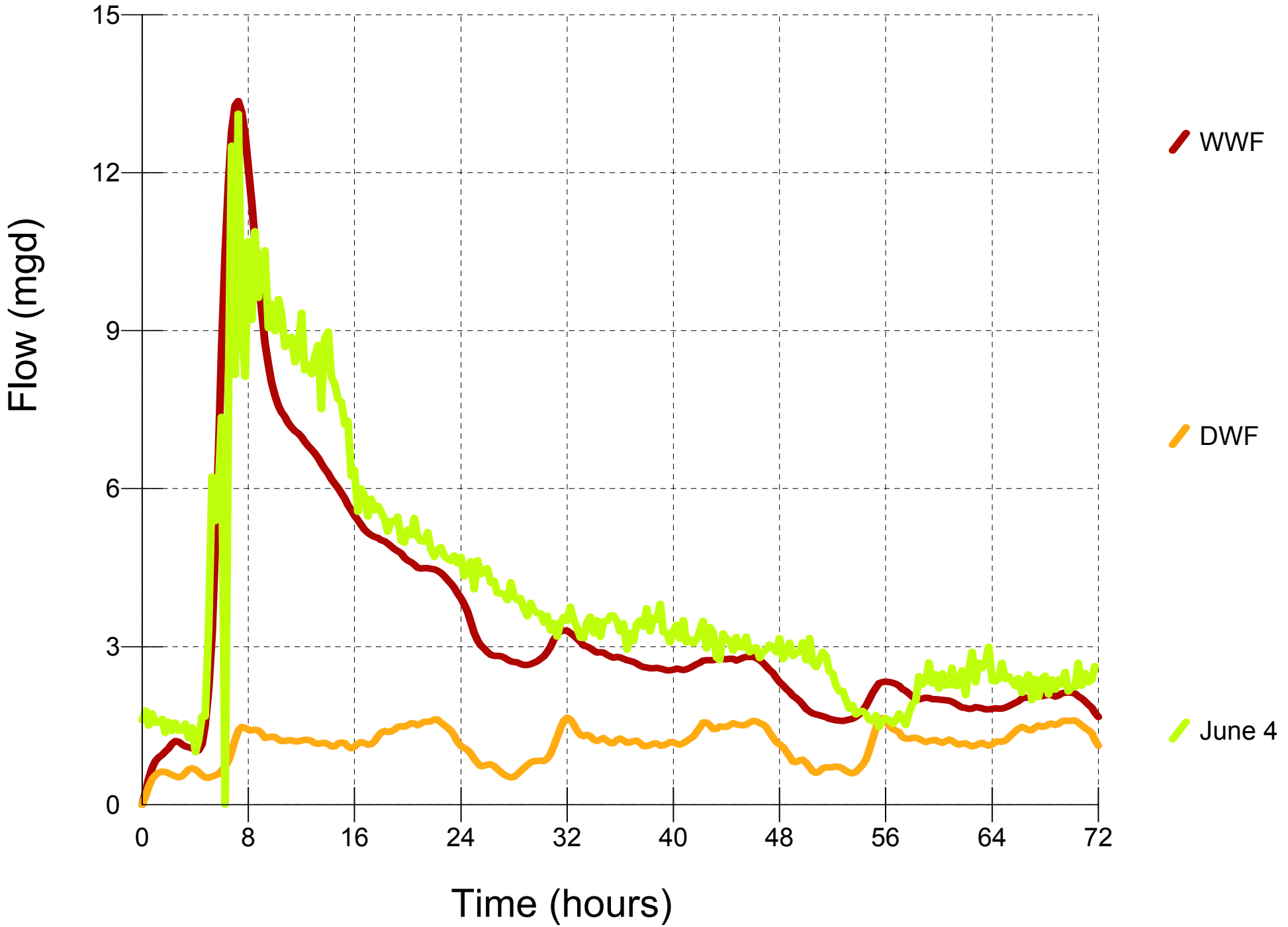

Belton, MO - Basin 1 - 5yr Design
Flow (mgd)
1.5
1.2
0.9
0.6
0.3
0.0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4

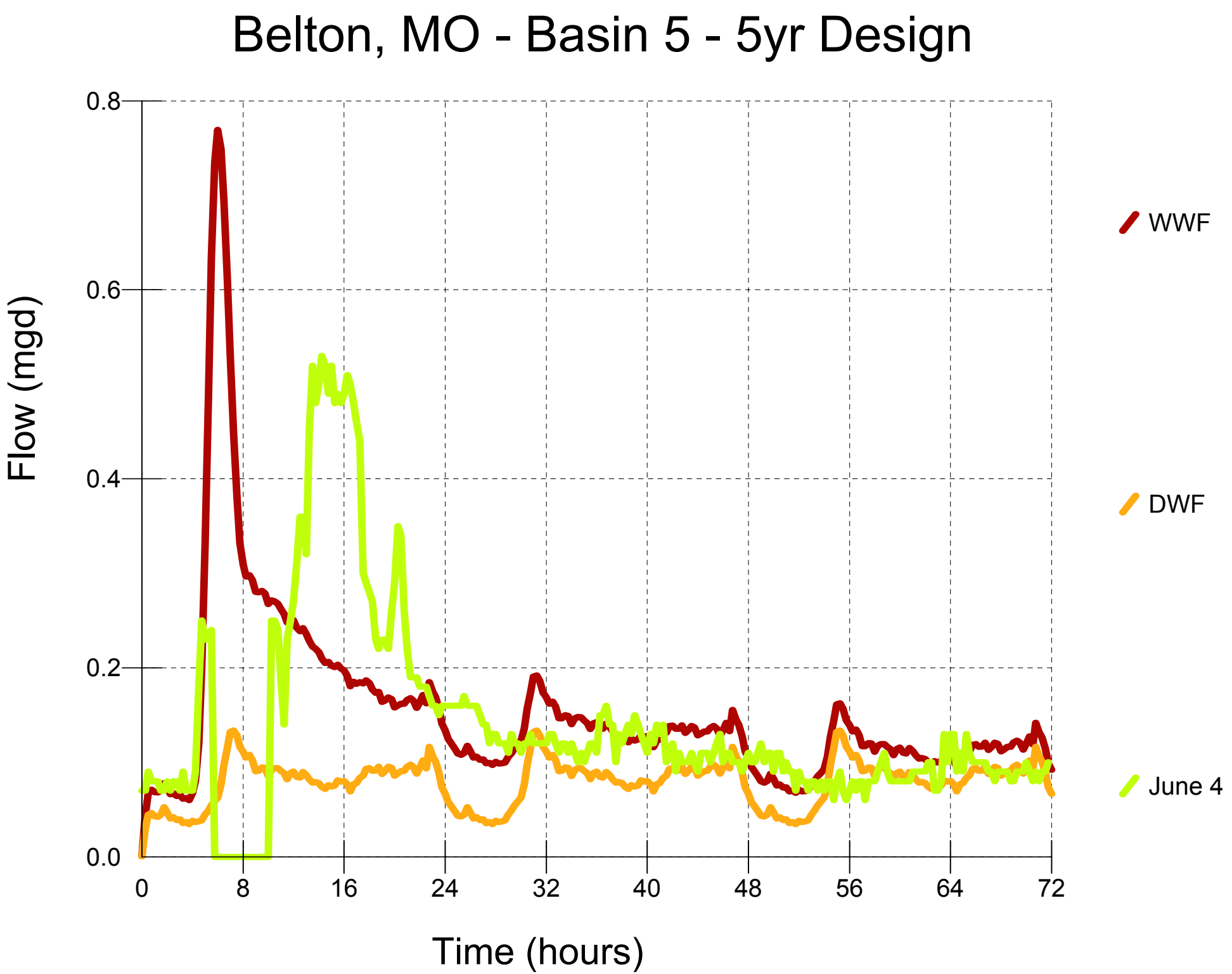
Belton, MO - Basin 2 - 5yr Design

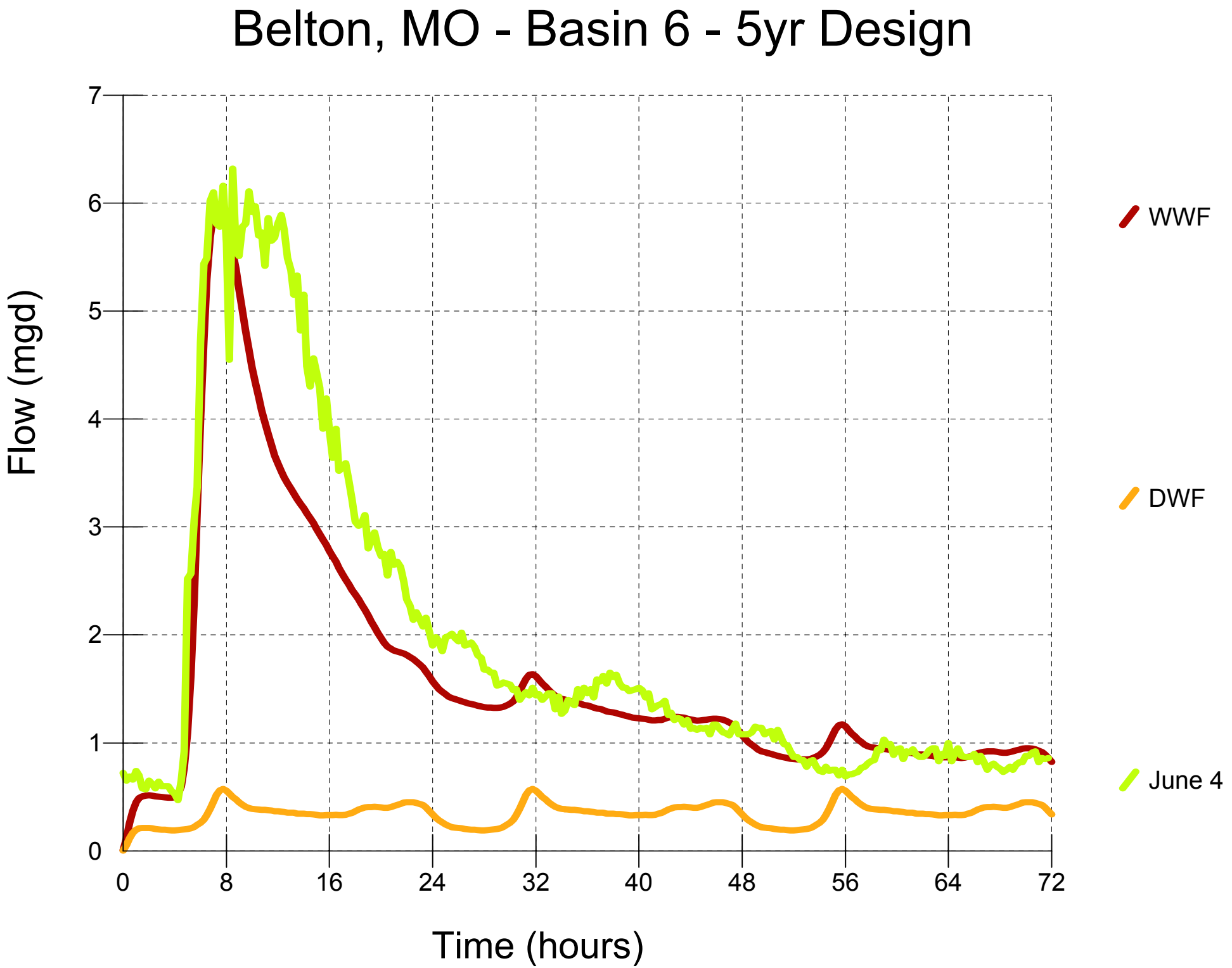


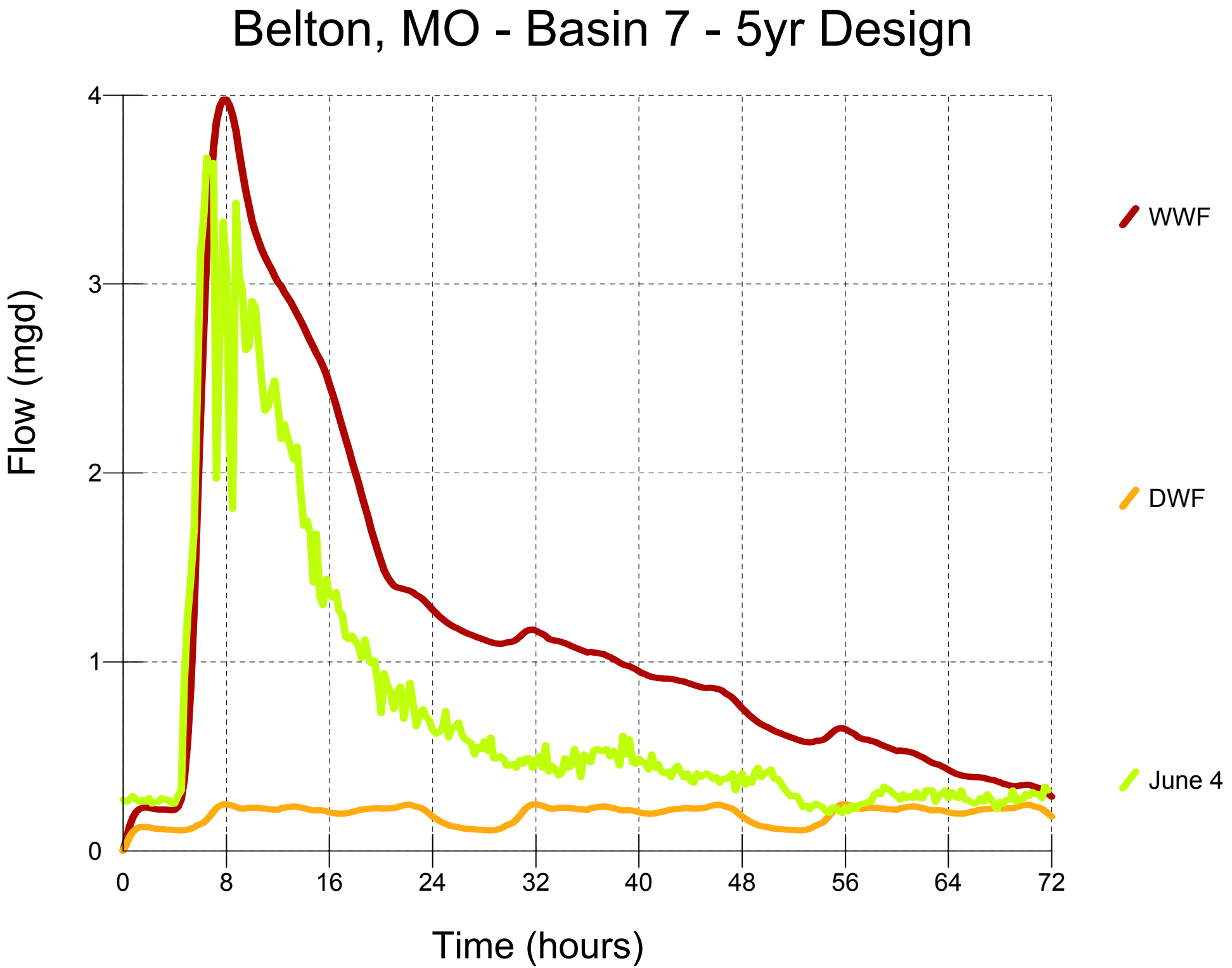

Belton, MO - Basin 3 - 5yr Design
Flow (mgd)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4

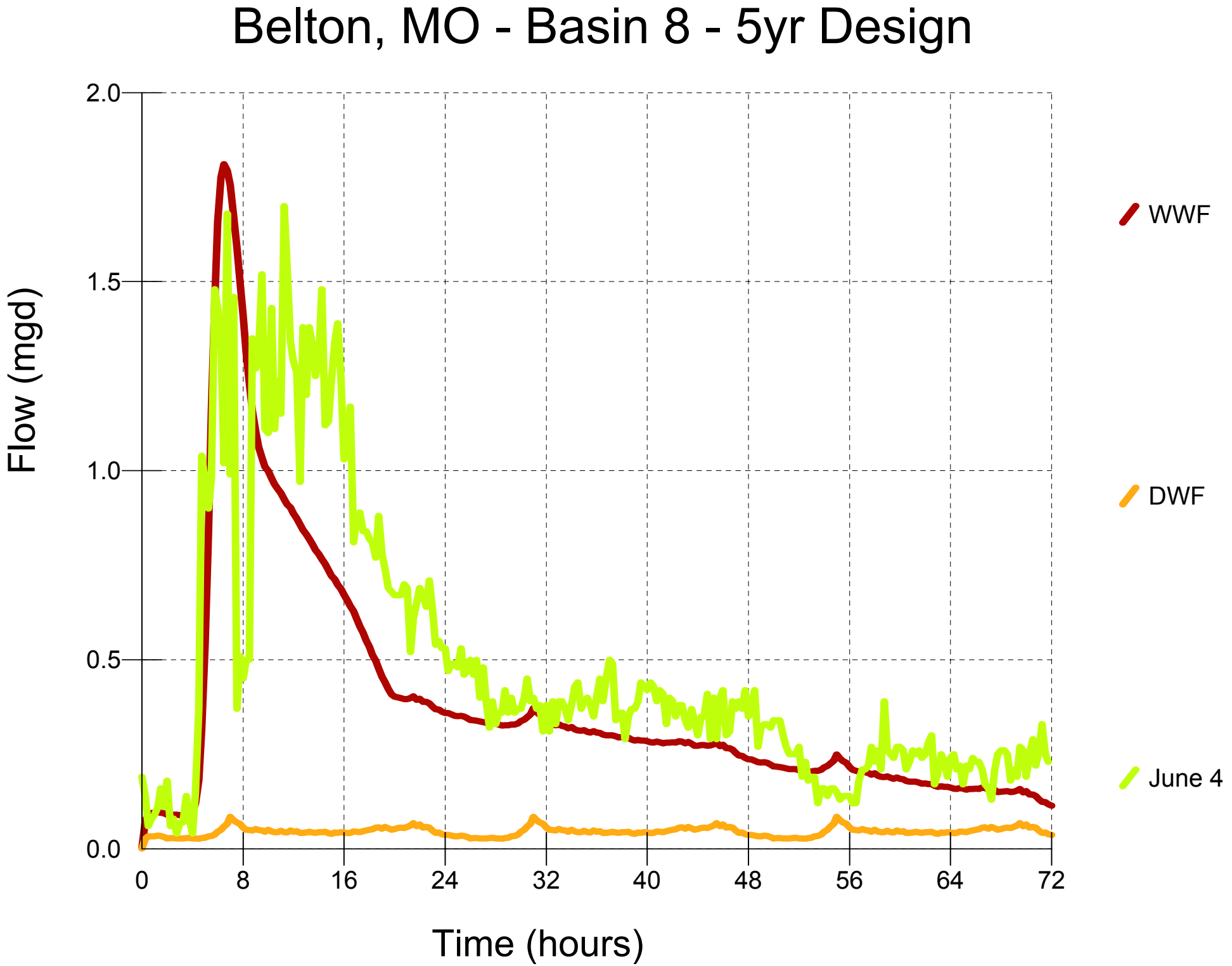
Belton, MO - Basin 4 - 5yr Design

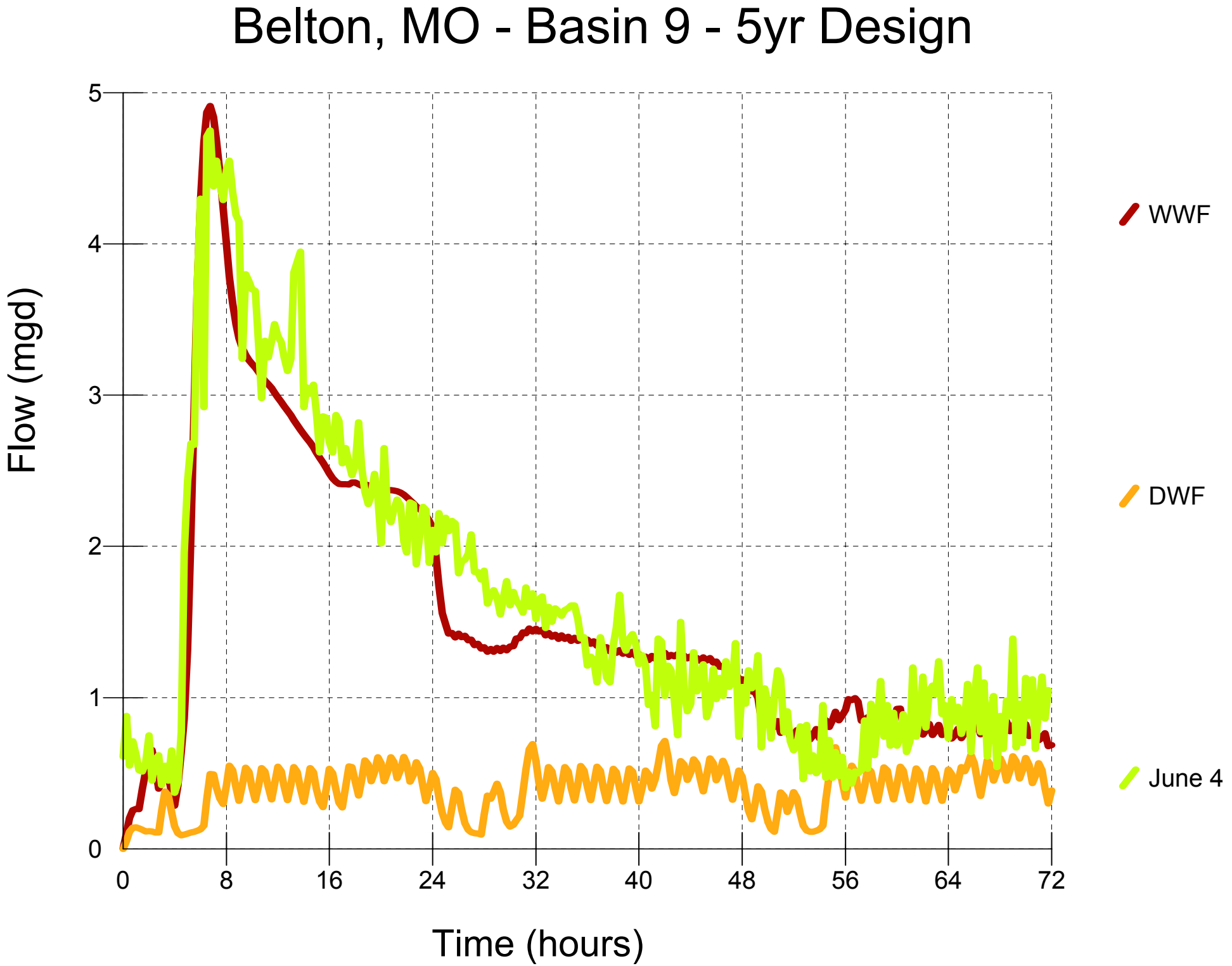


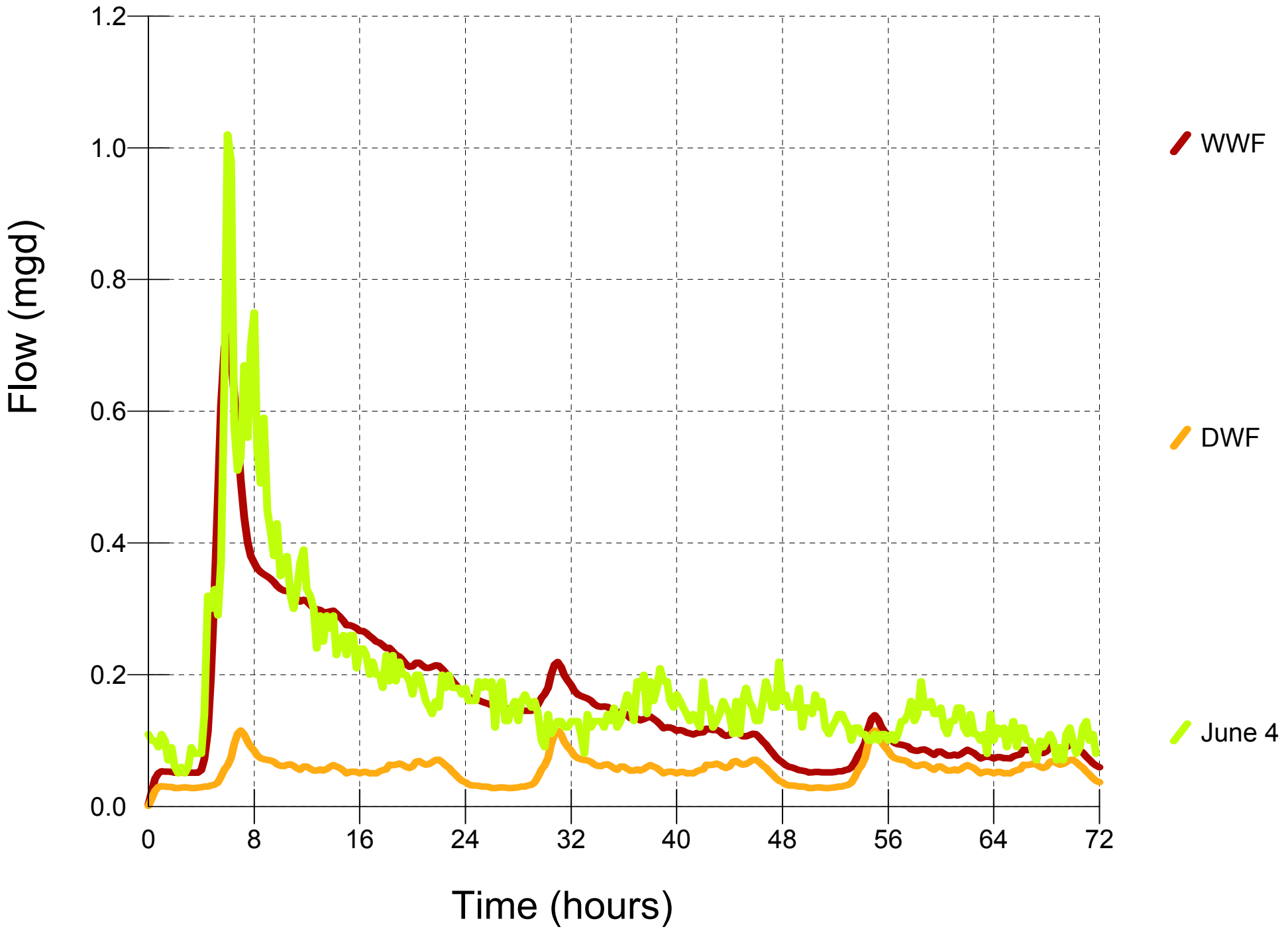

Belton, MO - Basin 5 - 5yr Design
Flow (mgd)
0.8
0.6
0.4
0.2
0.0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4

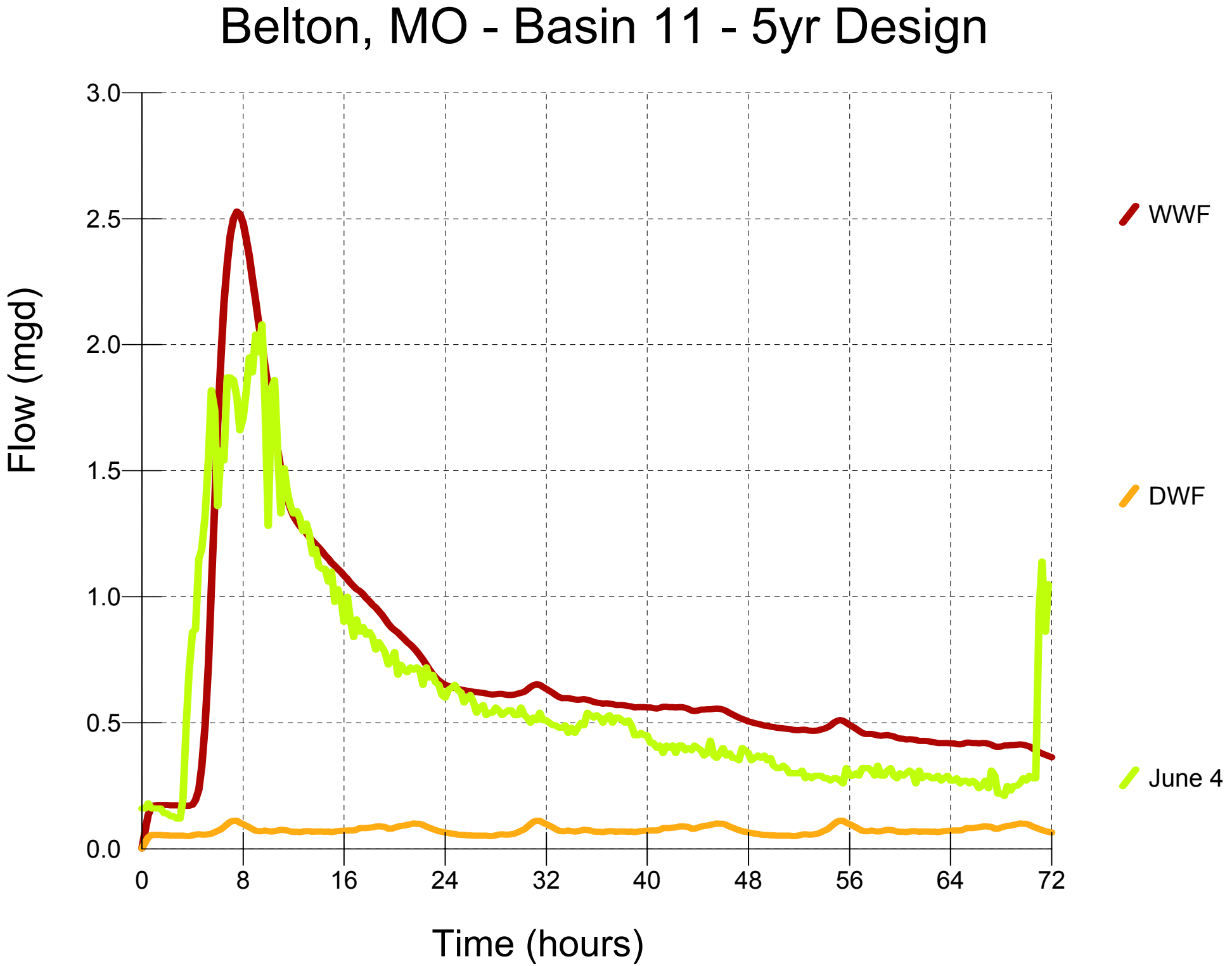

Belton, MO - Basin 6 - 5yr Design
Flow (mgd)
0
1
2
3
4
5
6
7
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4

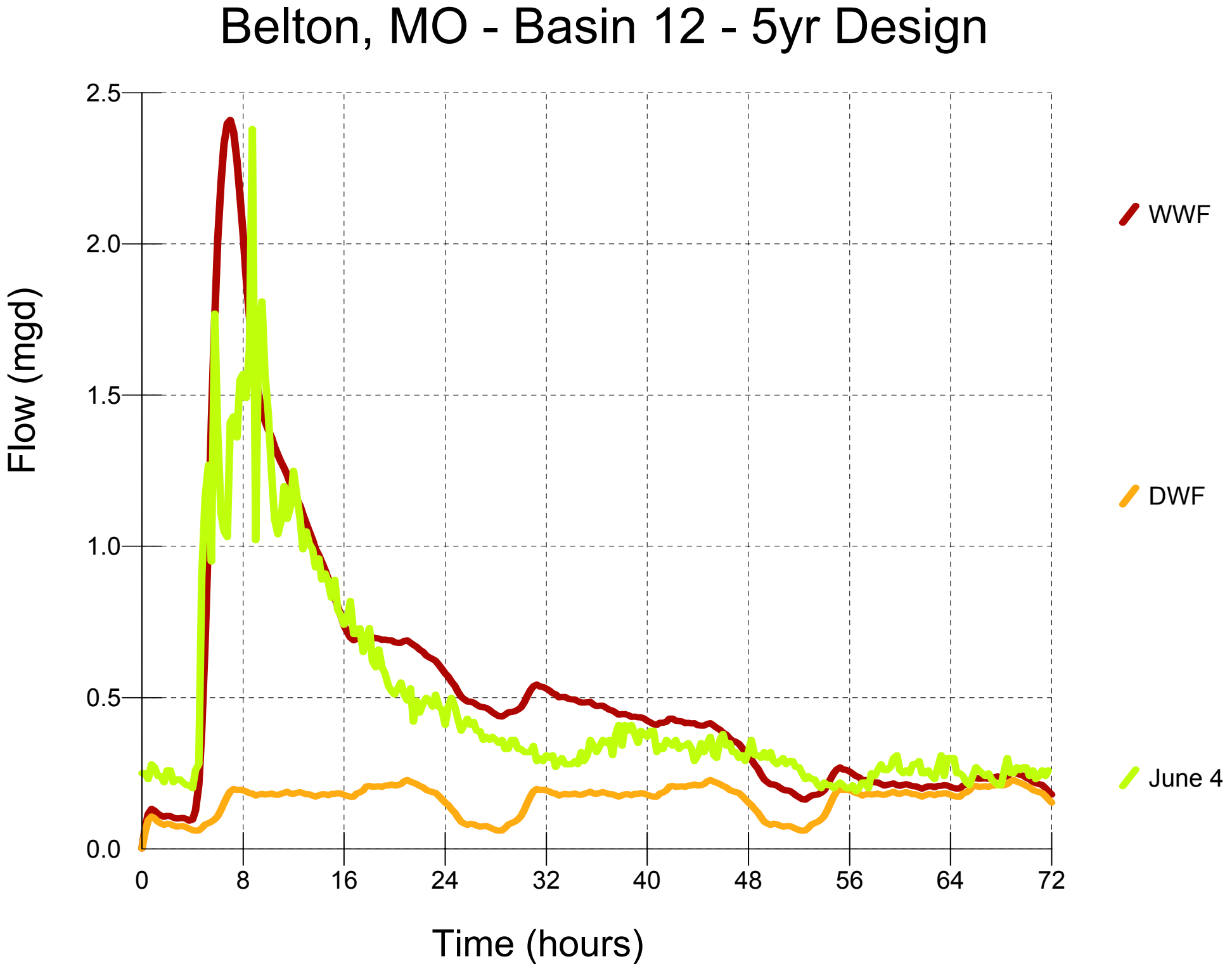

Belton, MO - Basin 7 - 5yr Design
Flow (mgd)
4
3
2
1
0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4


Belton, MO - Basin 8 - 5yr Design
Flow (mgd)
2.0
1.5
1.0
0.5
0.0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4


Belton, MO - Basin 9 - 5yr Design
Flow (mgd)
0
1
2
3
4
5
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4


Belton, MO - Basin 10 - 5yr Design
Flow (mgd)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4


Belton, MO - Basin 11 - 5yr Design
Flow (mgd)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4


Belton, MO - Basin 12 - 5yr Design
Flow (mgd)
2.5
2.0
1.5
1.0
0.5
0.0
0
8
16
24
32
40
48
56
64
72
Time (hours)
WWF
DWF
June 4

Appendix N
Flow Analysis Reports for Existing Conditions
(0% and 30% I/I Elimination)

Belton, MO
Flow Analysis Report
Existing System - Overloaded Lines for the 5-year, 90-minute storm event

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
1	10D-MH007_10D-MH034	10D-MH007	10D-MH034	10	246.30	0.021	2.433	0.015	1.798	135%	3.374	12	$28,079
2	10D-MH009_10D-MH035	10D-MH009	10D-MH035	10	240.40	0.008	2.404	0.015	1.080	223%	3.673	15	$34,137
3	10D-MH012_10D-MH036	10D-MH012	10D-MH036	10	410.40	0.009	2.165	0.015	1.131	191%	3.848	15	$58,277
4	10D-MH019_10D-MH037	10D-MH019	10D-MH037	10	190.20	0.011	1.961	0.015	1.308	150%	2.455	12	$21,683
5	10D-MH020_10D-MH038	10D-MH020	10D-MH038	10	229.40	0.019	1.929	0.015	1.687	114%	1.947	10	$21,793
6	10D-MH021_10D-MH020	10D-MH021	10D-MH020	8	271.10	0.008	0.716	0.015	0.623	115%	1.304	10	$25,755
7	10D-MH022_10D-MH020	10D-MH022	10D-MH020	10	353.10	0.003	1.194	0.015	0.655	182%	1.229	12	$40,254
8	10D-MH024_10D-MH023	10D-MH024	10D-MH023	10	292.20	0.004	1.113	0.015	0.820	136%	1.539	12	$33,311
9	10D-MH029_10D-MH030	10D-MH029	10D-MH030	12	158.90	0.005	1.532	0.015	1.461	105%	1.685	12	$18,115
10	10D-MH030_10D-MH031	10D-MH030	10D-MH031	12	288.20	0.005	1.543	0.015	1.449	106%	1.672	12	$32,855
11	10D-MH031_10D-MH041	10D-MH031	10D-MH041	12	223.50	0.004	1.551	0.015	1.271	122%	2.658	15	$31,737
12	10D-MH034_11D-MH037	10D-MH034	11D-MH037	15	394.20	0.009	4.032	0.015	3.403	118%	6.385	18	$67,014
13	10D-MH035_10D-MH007	10D-MH035	10D-MH007	10	137.60	0.007	2.418	0.015	1.002	241%	3.409	15	$19,540
14	10D-MH036_10D-MH009	10D-MH036	10D-MH009	10	284.00	0.012	2.190	0.015	1.346	163%	2.525	12	$32,376
15	10D-MH037_10D-MH012	10D-MH037	10D-MH012	10	321.50	0.011	2.128	0.015	1.261	169%	2.367	12	$36,651
16	10D-MH038_10D-MH019	10D-MH038	10D-MH019	10	147.30	0.010	1.943	0.015	1.249	156%	2.343	12	$16,793
17	10D-MH048_10D-MH022	10D-MH048	10D-MH022	10	346.90	0.005	1.162	0.015	0.823	141%	1.545	12	$39,547
18	10E-MH039_10E-MH038	10E-MH039	10E-MH038	8	349.40	0.005	0.721	0.015	0.482	149%	1.009	10	$33,193
19	10J-MH002_10J-MH001	10J-MH002	10J-MH001	36	373.20	0.001	11.900	0.014	9.714	123%	15.780	42	$133,233
20	10J-MH004_10J-MH003	10J-MH004	10J-MH003	30	378.50	0.002	11.906	0.014	10.656	112%	14.797	33	$105,980
21	10J-MH005_10J-MH004	10J-MH005	10J-MH004	30	423.30	0.002	11.905	0.014	10.829	110%	15.037	33	$118,524
22	10J-MH006_10J-MH005	10J-MH006	10J-MH005	30	374.90	0.002	11.921	0.014	10.324	115%	14.335	33	$104,972
23	11A-MH033_11A-MH034	11A-MH033	11A-MH034	8	291.40	0.003	5.658	0.015	0.399	136%	0.836	10	$27,683
24	11A-MH034_11A-MH035	11A-MH034	11A-MH035	8	235.00	0.005	2.256	0.015	0.470	118%	0.983	10	$22,325
25	11A-MH035_11A-MH036	11A-MH035	11A-MH036	8	64.10	0.004	2.259	0.015	0.445	319%	1.513	12	$7,308
26	11A-MH036_11A-MH037	11A-MH036	11A-MH037	8	111.10	0.002	2.263	0.015	0.337	422%	2.080	15	$15,777
27	11A-MH037_11A-MH069	11A-MH037	11A-MH069	24	604.60	0.008	2.26	0.014	11.946	103%	12.864	24	$123,943
28	11A-MH055_11A-MH054	11A-MH055	11A-MH054	8	199.60	0.003	11.97	0.013	0.425	176%	0.771	10	$18,962
29	11A-MH059_11A-MH055	11A-MH059	11A-MH055	8	351.80	0.008	9.759	0.013	0.691	107%	1.253	10	$33,421
30	11A-MH067_11A-MH014	11A-MH067	11A-MH014	8	217.00	0.003	4.131	0.013	0.462	100%	0.837	10	$20,615
31	11A-MH068_11A-MH037	11A-MH068	11A-MH037	24	453.90	0.003	5.673	0.014	7.164	152%	13.988	30	$108,936
32	11A-MH069_11A-MH072	11A-MH069	11A-MH072	24	578.70	0.008	12.01	0.014	12.152	101%	13.087	24	$118,634
33	11A-MH072_12A-MH043	11A-MH072	12A-MH043	24	341.30	0.005	5.674	0.014	9.748	126%	14.371	27	$75,769
34	11B-MH010_11A-MH011	11B-MH010	11A-MH011	8	265.80	0.003	2.258	0.013	0.417	101%	0.755	10	$25,251
35	11B-MH049_11A-MH033	11B-MH049	11A-MH033	8	233.40	0.006	11.961	0.015	0.511	101%	1.069	10	$22,173
36	11C-MH004_11D-MH046T	11C-MH004	11D-MH046T	18	277.40	0.002	11.97	0.014	3.143	157%	5.105	21	$52,152
37	11C-MH006_12C-MH023	11C-MH006	12C-MH023	24	228.70	0.004	11.972	0.014	8.555	103%	9.213	24	$46,884
38	11C-MH012_11C-MH005	11C-MH012	11C-MH005	18	237.00	0.004	11.977	0.014	4.075	121%	6.619	21	$44,556
39	11D-MH021_11C-MH012	11D-MH021	11C-MH012	15	390.40	0.004	11.981	0.014	2.501	197%	6.606	21	$73,396
40	11D-MH033_11D-MH039	11D-MH033	11D-MH039	15	221.30	0.005	11.993	0.015	2.663	152%	4.997	18	$37,621
41	11D-MH037_11D-MH033	11D-MH037	11D-MH033	15	188.60	0.006	12	0.015	2.749	147%	5.159	18	$32,062
42	11D-MH038_11D-MH021	11D-MH038	11D-MH021	15	399.70	0.009	11.913	0.014	3.618	136%	6.335	18	$67,949
43	11D-MH039_11D-MH038	11D-MH039	11D-MH038	15	269.50	0.002	11.914	0.014	1.601	306%	6.038	24	$55,248
44	12A-MH042_11A-MH068	12A-MH042	11A-MH068	24	179.70	0.005	11.922	0.014	9.641	113%	14.214	27	$39,894
45	12B-MH008_12B-MH056	12B-MH008	12B-MH056	8	289.20	0.004	11.906	0.013	0.504	123%	0.914	10	$27,474
46	12B-MH010_12B-MH008	12B-MH010	12B-MH008	8	381.40	0.004	11.925	0.013	0.469	129%	0.850	10	$36,233

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Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
47	12B-MH056_12B-MH082	12B-MH056	12B-MH082	8	290.60	0.003	0.634	0.013	0.452	140%	0.820	10	$27,607
48	12B-MH057_12A-MH042	12B-MH057	12A-MH042	24	485.60	0.002	10.735	0.014	6.232	172%	12.168	30	$116,544
49	12B-MH058_12B-MH057	12B-MH058	12B-MH057	24	376.90	0.001	10.727	0.014	4.863	221%	12.243	33	$105,532
50	12B-MH069_12B-MH058	12B-MH069	12B-MH058	24	494.40	0.002	9.866	0.014	6.618	149%	12.923	30	$118,656
51	12B-MH070_12B-MH073	12B-MH070	12B-MH073	24	117.90	0.002	9.815	0.014	5.994	164%	11.703	30	$28,296
52	12B-MH071_12B-MH070	12B-MH071	12B-MH070	24	178.70	0.003	9.809	0.014	7.390	133%	10.896	27	$39,672
53	12B-MH072_12B-MH071	12B-MH072	12B-MH071	24	425.20	0.002	9.816	0.014	6.082	161%	11.875	30	$102,048
54	12B-MH073_12B-MH074	12B-MH073	12B-MH074	24	213.90	0.002	9.826	0.014	5.346	184%	10.439	30	$51,336
55	12B-MH074_12B-MH075	12B-MH074	12B-MH075	24	257.30	0.002	9.838	0.014	6.548	150%	12.785	30	$61,752
56	12B-MH075_12B-MH069	12B-MH075	12B-MH069	24	208.60	0.003	9.846	0.014	7.350	134%	10.837	27	$46,310
57	12C-MH023_12B-MH072	12C-MH023	12B-MH072	24	335.70	0.004	9.812	0.014	8.906	110%	13.131	27	$74,526
58	12D-MH001_12D-MH021	12D-MH001	12D-MH021	15	260.60	0.005	3.236	0.013	2.914	111%	4.739	18	$44,302
59	12D-MH007_12D-MH001	12D-MH007	12D-MH001	15	220.00	0.006	3.218	0.013	3.122	103%	5.076	18	$37,400
60	12D-MH014_12D-LS001	12D-MH014	12D-LS001	8	18.30	0.009	0.997	0.015	0.637	157%	1.332	10	$1,739
61	12D-MH021_12D-MH020	12D-MH021	12D-MH020	15	358.90	0.004	3.260	0.013	2.749	119%	4.471	18	$61,013
62	12D-MH029_12D-MH014	12D-MH029	12D-MH014	8	10.30	0.008	0.994	0.015	0.589	169%	1.232	10	$979
63	12D-MH038_12D-MH007	12D-MH038	12D-MH007	15	338.70	0.004	2.948	0.013	2.595	114%	4.220	18	$57,579
64	13D-MH013_13D-MH014	13D-MH013	13D-MH014	8	198.60	0.008	1.000	0.015	0.622	161%	1.301	10	$18,867
65	13D-MH014_13D-MH021	13D-MH014	13D-MH021	8	242.30	0.009	1.020	0.015	0.636	160%	1.331	10	$23,019
66	13D-MH023_13D-MH090	13D-MH023	13D-MH090	8	260.50	0.015	1.049	0.013	0.957	110%	1.736	10	$24,748
67	13D-MH028_13D-MH013	13D-MH028	13D-MH013	8	228.90	0.008	0.983	0.015	0.613	160%	1.282	10	$21,746
68	13D-MH042_13D-MH039	13D-MH042	13D-MH039	10	78.60	0.002	0.521	0.015	0.495	105%	0.571	10	$7,467
69	13D-MH090_13D-MH093	13D-MH090	13D-MH093	8	263.30	0.009	1.070	0.013	0.746	144%	1.352	10	$25,014
70	13D-MH091_13D-MH021	13D-MH091	13D-MH021	8	298.40	0.007	1.415	0.013	0.653	217%	1.925	12	$34,018
71	13D-MH092_13D-MH091	13D-MH092	13D-MH091	8	137.20	0.009	1.391	0.013	0.720	193%	2.124	12	$15,641
72	13D-MH093_13D-MH092	13D-MH093	13D-MH092	8	164.00	0.013	1.084	0.013	0.894	121%	1.621	10	$15,580
73	6E-MH064_7E-MH016	6E-MH064	7E-MH016	8	234.60	0.008	0.700	0.015	0.588	119%	1.230	10	$22,287
74	6F-MH022_7F-MH005	6F-MH022	7F-MH005	10	392.40	0.005	1.649	0.015	0.861	192%	2.927	15	$55,721
75	6F-MH023_6F-MH024	6F-MH023	6F-MH024	8	372.60	0.006	0.536	0.015	0.524	102%	1.096	10	$35,397
76	6F-MH026_6F-MH022	6F-MH026	6F-MH022	10	391.20	0.008	1.623	0.015	1.080	150%	2.027	12	$44,597
77	6F-MH030_6F-MH026	6F-MH030	6F-MH026	10	299.00	0.004	1.054	0.015	0.778	135%	1.460	12	$34,086
78	6F-MH031_6F-MH030	6F-MH031	6F-MH030	10	298.80	0.002	1.033	0.015	0.501	206%	1.704	15	$42,430
79	7A-MH007_7A-MH008	7A-MH007	7A-MH008	8	324.50	0.002	0.471	0.015	0.296	159%	0.620	10	$30,828
80	7E-MH002_7E-MH014	7E-MH002	7E-MH014	10	283.50	0.003	0.702	0.015	0.681	103%	0.786	10	$26,933
81	7E-MH019_7E-MH020	7E-MH019	7E-MH020	8	481.30	0.007	0.740	0.015	0.577	128%	1.207	10	$45,724
82	7F-MH001_7F-MH010	7F-MH001	7F-MH010	15	319.40	0.004	3.024	0.015	2.377	127%	4.460	18	$54,298
83	7F-MH002_7F-MH004	7F-MH002	7F-MH004	10	244.00	0.006	1.689	0.015	0.964	175%	1.809	12	$27,816
84	7F-MH003_7F-MH006	7F-MH003	7F-MH006	12	219.70	0.006	2.522	0.015	1.508	167%	3.154	15	$31,198
85	7F-MH004_7F-MH003	7F-MH004	7F-MH003	10	241.40	0.004	1.716	0.015	0.791	217%	2.693	15	$34,279
86	7F-MH005_7F-MH002	7F-MH005	7F-MH002	10	402.40	0.005	1.675	0.015	0.850	197%	2.892	15	$57,141
87	7F-MH006_7F-MH008	7F-MH006	7F-MH008	12	379.80	0.005	2.548	0.015	1.392	183%	2.912	15	$53,932
88	7F-MH007_7F-MH009	7F-MH007	7F-MH009	15	379.10	0.003	2.992	0.015	2.126	141%	3.989	18	$64,447
89	7F-MH008_7F-MH007	7F-MH008	7F-MH007	12	330.40	0.010	2.563	0.015	1.975	130%	4.132	15	$46,917
90	7F-MH009_7F-MH001	7F-MH009	7F-MH001	15	302.80	0.004	3.007	0.015	2.305	130%	4.325	18	$51,476
91	8B-LS001T_8C-MH014	8B-LS001T	8C-MH014	8	134.60	0.001	0.242	0.013	0.235	103%	0.426	10	$12,787
92	8C-MH014_8C-LS001	8C-MH014	8C-LS001	8	8.50	0.001	0.289	0.013	0.281	103%	0.509	10	$808

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Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
93	8C-MH014_8C-LS001W	8C-MH014	8C-LS001W	8	8.50	0.004	0.486	0.013	0.471	103%	0.855	10	$808
94	8E-MH017_8F-MH005	8E-MH017	8F-MH005	8	282.60	0.002	0.602	0.013	0.336	179%	0.610	10	$26,847
95	8E-MH031_8E-MH017	8E-MH031	8E-MH017	8	330.00	0.003	0.483	0.013	0.422	115%	0.765	10	$31,350
96	8E-MH033_8E-MH021	8E-MH033	8E-MH021	8	124.50	0.002	0.381	0.013	0.372	102%	0.675	10	$11,828
97	8E-MH037_8E-MH031	8E-MH037	8E-MH031	8	509.30	0.002	0.461	0.013	0.367	126%	0.665	10	$48,384
98	8E-MH073_8E-MH074	8E-MH073	8E-MH074	12	168.30	0.005	1.669	0.015	1.459	114%	1.683	12	$19,187
99	8F-MH004_8F-MH070	8F-MH004	8F-MH070	8	359.20	0.003	0.681	0.013	0.456	149%	0.826	10	$34,124
100	8F-MH005_8F-MH014	8F-MH005	8F-MH014	8	191.80	0.003	0.646	0.013	0.394	164%	0.714	10	$18,221
101	8F-MH006_8F-MH072	8F-MH006	8F-MH072	8	152.20	0.017	1.177	0.013	1.015	116%	1.840	10	$14,459
102	8F-MH009_8F-MH020	8F-MH009	8F-MH020	10	139.20	0.007	1.531	0.013	1.187	129%	1.930	12	$15,869
103	8F-MH011_8F-MH006	8F-MH011	8F-MH006	8	161.90	0.016	1.131	0.013	1.002	113%	1.817	10	$15,381
104	8F-MH014_8F-MH004	8F-MH014	8F-MH004	8	131.30	0.003	0.655	0.015	0.386	170%	0.808	10	$12,474
105	8F-MH019_8F-MH009	8F-MH019	8F-MH009	10	149.30	0.008	1.455	0.013	1.283	113%	2.086	12	$17,021
106	8F-MH070_9F-MH078	8F-MH070	9F-MH078	8	250.00	0.008	0.698	0.013	0.677	103%	1.227	10	$23,750
107	8F-MH075_8F-MH076	8F-MH075	8F-MH076	18	96.60	0.002	5.006	0.015	2.826	177%	7.022	24	$19,803
108	8F-MH077_8F-MH078	8F-MH077	8F-MH078	18	322.30	0.003	5.039	0.015	3.193	158%	5.557	21	$60,593
109	8F-MH078_8F-MH087	8F-MH078	8F-MH087	18	79.60	0.002	5.197	0.015	2.686	194%	6.674	24	$16,318
110	8F-MH079_8F-MH080	8F-MH079	8F-MH080	18	402.30	0.002	5.257	0.015	2.430	216%	6.039	24	$82,472
111	8F-MH085_8F-MH086	8F-MH085	8F-MH086	10	110.80	0.011	1.611	0.013	1.478	109%	2.404	12	$12,632
112	8F-MH086_8G-MH032	8F-MH086	8G-MH032	15	512.70	0.003	2.211	0.015	2.092	106%	2.414	15	$72,804
113	8F-MH087_8F-MH088	8F-MH087	8F-MH088	18	400.60	0.003	5.217	0.015	3.096	169%	5.388	21	$75,313
114	8F-MH088_8F-MH079	8F-MH088	8F-MH079	18	383.20	0.002	5.237	0.015	2.687	195%	6.677	24	$78,556
115	8G-MH004_8G-MH030	8G-MH004	8G-MH030	18	166.00	0.004	5.431	0.015	3.603	151%	6.271	21	$31,208
116	8G-MH007_8G-MH026	8G-MH007	8G-MH026	18	253.20	0.003	5.347	0.015	3.147	170%	5.477	21	$47,602
117	8G-MH008_8G-MH009	8G-MH008	8G-MH009	18	295.50	0.002	5.604	0.015	2.453	228%	6.095	24	$60,578
118	8G-MH026_8G-MH004	8G-MH026	8G-MH004	18	61.00	0.003	5.422	0.015	3.317	163%	5.772	21	$11,468
119	8G-MH030_8G-MH008	8G-MH030	8G-MH008	18	125.50	0.001	5.580	0.015	1.741	320%	5.923	27	$27,861
120	8G-MH033_9G-MH062	8G-MH033	9G-MH062	18	398.80	0.002	5.658	0.015	2.376	238%	5.905	24	$81,754
121	8G-MH055_8G-MH033	8G-MH055	8G-MH033	18	395.70	0.003	5.641	0.015	3.276	172%	5.702	21	$74,392
122	9A-MH007_9A-MH008	9A-MH007	9A-MH008	10	364.30	0.005	2.591	0.015	0.830	312%	2.824	15	$51,731
123	9A-MH008_9A-MH029	9A-MH008	9A-MH029	10	290.40	0.005	2.610	0.015	0.828	315%	2.816	15	$41,237
124	9A-MH009_9A-MH010	9A-MH009	9A-MH010	8	158.40	0.007	0.791	0.013	0.642	123%	1.163	10	$15,048
125	9A-MH010_9A-MH015	9A-MH010	9A-MH015	8	190.20	0.009	0.807	0.013	0.738	109%	1.338	10	$18,069
126	9A-MH011_9A-MH014	9A-MH011	9A-MH014	8	173.20	0.016	1.429	0.013	0.987	145%	1.790	10	$16,454
127	9A-MH013_9A-MH011	9A-MH013	9A-MH011	8	181.00	0.036	1.417	0.015	1.275	111%	2.667	10	$17,195
128	9A-MH014_9A-MH021	9A-MH014	9A-MH021	10	123.10	0.007	1.437	0.013	1.160	124%	1.886	12	$14,034
129	9A-MH015_9A-MH018	9A-MH015	9A-MH018	8	186.80	0.011	0.822	0.015	0.700	117%	1.464	10	$17,746
130	9A-MH016_9A-MH007	9A-MH016	9A-MH007	10	398.00	0.010	2.567	0.015	1.227	209%	4.175	15	$56,516
131	9A-MH018_9A-MH019	9A-MH018	9A-MH019	8	99.50	0.008	0.830	0.015	0.595	140%	1.244	10	$9,453
132	9A-MH019_9A-MH027	9A-MH019	9A-MH027	8	230.30	0.008	0.849	0.015	0.594	143%	1.244	10	$21,879
133	9A-MH021_9A-MH022	9A-MH021	9A-MH022	10	124.70	0.008	1.523	0.013	1.293	118%	2.102	12	$14,216
134	9A-MH022_9A-MH023	9A-MH022	9A-MH023	10	98.30	0.008	1.530	0.013	1.230	124%	2.000	12	$11,207
135	9A-MH023_9A-MH024	9A-MH023	9A-MH024	8	135.50	0.007	1.686	0.013	0.652	259%	1.921	12	$15,447
136	9A-MH024_9A-MH016	9A-MH024	9A-MH016	10	261.50	0.010	2.539	0.015	1.235	206%	4.202	15	$37,133
137	9A-MH027_9A-MH024	9A-MH027	9A-MH024	8	188.80	0.008	0.863	0.015	0.594	145%	1.242	10	$17,936
138	9A-MH029_9A-MH020	9A-MH029	9A-MH020	10	205.40	0.019	2.623	0.015	1.675	157%	3.142	12	$23,416

Belton, MO
Flow Analysis Report
Existing System - Overloaded Lines for the 5-year, 90-minute storm event

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
139	9B-MH023_9A-MH009	9B-MH023	9A-MH009	8	250.60	0.005	0.780	0.015	0.458	170%	0.958	10	$23,807
140	9B-MH026_9A-MH013	9B-MH026	9A-MH013	8	267.90	0.016	1.406	0.015	0.867	162%	1.815	10	$25,451
141	9B-MH031_9B-MH030	9B-MH031	9B-MH030	8	380.20	0.023	1.090	0.015	1.026	106%	2.146	10	$36,119
142	9B-MH032_9B-MH031	9B-MH032	9B-MH031	8	358.10	0.022	1.062	0.015	1.008	105%	2.108	10	$34,020
143	9B-MH034_9B-MH026	9B-MH034	9B-MH026	8	286.10	0.026	1.389	0.015	1.092	127%	2.284	10	$27,180
144	9C-MH005_9B-MH032	9C-MH005	9B-MH032	8	43.10	0.005	1.035	0.015	0.490	211%	1.667	12	$4,914
145	9C-MH006_9C-MH013	9C-MH006	9C-MH013	10	326.50	0.005	0.991	0.015	0.872	114%	1.006	10	$31,018
146	9C-MH013_9C-MH014	9C-MH013	9C-MH014	10	220.90	0.005	0.998	0.015	0.885	113%	1.021	10	$20,986
147	9C-MH014_9C-MH015	9C-MH014	9C-MH015	10	288.50	0.005	1.008	0.015	0.885	114%	1.021	10	$27,408
148	9C-MH015_9C-MH016	9C-MH015	9C-MH016	10	101.40	0.005	1.012	0.015	0.832	122%	1.562	12	$11,560
149	9C-MH025_9C-MH026	9C-MH025	9C-MH026	8	49.10	0.007	0.745	0.015	0.586	127%	1.225	10	$4,665
150	9E-MH025_9E-MH083	9E-MH025	9E-MH083	10	463.90	0.004	1.008	0.015	0.764	132%	1.433	12	$52,885
151	9E-MH060_9E-MH036	9E-MH060	9E-MH036	8	163.90	0.001	0.322	0.015	0.187	172%	0.391	10	$15,571
152	9E-MH083_9F-MH052	9E-MH083	9F-MH052	10	73.90	0.005	1.073	0.015	0.853	126%	1.600	12	$8,425
153	9F-MH012_9F-MH024	9F-MH012	9F-MH024	10	130.10	0.006	1.158	0.013	1.106	105%	1.799	12	$14,832
154	9F-MH024_9F-MH047	9F-MH024	9F-MH047	10	313.60	0.003	1.199	0.013	0.765	157%	1.243	12	$35,751
155	9F-MH025_9F-MH050	9F-MH025	9F-MH050	10	198.20	0.004	1.248	0.013	0.918	136%	1.492	12	$22,595
156	9F-MH029_9F-MH039	9F-MH029	9F-MH039	10	138.40	0.003	1.070	0.015	0.709	151%	1.330	12	$15,778
157	9F-MH030_9F-MH036	9F-MH030	9F-MH036	10	46.30	0.004	0.938	0.015	0.730	128%	1.370	12	$5,279
158	9F-MH033_9F-MH077	9F-MH033	9F-MH077	8	81.90	0.006	0.545	0.015	0.522	104%	1.091	10	$7,781
159	9F-MH034_9G-MH011	9F-MH034	9G-MH011	10	303.80	0.004	1.102	0.015	0.789	140%	1.481	12	$34,634
160	9F-MH035_9F-MH029	9F-MH035	9F-MH029	10	32.90	0.004	0.951	0.015	0.809	118%	1.517	12	$3,751
161	9F-MH039_9F-MH034	9F-MH039	9F-MH034	10	400.10	0.005	1.089	0.015	0.877	124%	1.645	12	$45,612
162	9F-MH044_9F-MH049	9F-MH044	9F-MH049	10	253.00	0.006	1.143	0.015	0.959	119%	1.800	12	$28,842
163	9F-MH047_9F-MH025	9F-MH047	9F-MH025	10	230.40	0.005	1.218	0.013	0.975	125%	1.585	12	$26,266
164	9F-MH049_9F-MH012	9F-MH049	9F-MH012	10	16.80	0.006	1.148	0.015	0.956	120%	1.793	12	$1,916
165	9F-MH052_9F-MH093	9F-MH052	9F-MH093	10	355.10	0.003	1.099	0.015	0.640	172%	1.200	12	$40,482
166	9F-MH053_8F-MH011	9F-MH053	8F-MH011	8	396.50	0.022	1.025	0.015	1.012	101%	2.116	10	$37,668
167	9F-MH078_9F-MH083	9F-MH078	9F-MH083	8	242.50	0.007	0.715	0.013	0.650	110%	1.179	10	$23,038
168	9F-MH079_9F-MH021	9F-MH079	9F-MH021	8	175.70	0.010	0.859	0.015	0.669	128%	1.400	10	$16,692
169	9F-MH080_9F-MH079	9F-MH080	9F-MH079	8	85.50	0.003	0.781	0.013	0.443	176%	0.803	10	$8,123
170	9F-MH081_9F-MH033	9F-MH081	9F-MH033	8	218.50	0.005	0.541	0.015	0.490	110%	1.025	10	$20,758
171	9F-MH083_9F-MH046	9F-MH083	9F-MH046	8	381.50	0.008	0.913	0.013	0.709	129%	1.285	10	$36,243
172	9F-MH085_9F-MH044	9F-MH085	9F-MH044	10	224.60	0.002	1.126	0.015	0.609	185%	1.142	12	$25,605
173	9F-MH093_9F-MH085	9F-MH093	9F-MH085	10	152.40	0.003	1.110	0.015	0.700	159%	1.313	12	$17,374
174	9G-MH006_9G-MH078	9G-MH006	9G-MH078	12	88.00	0.002	2.256	0.013	1.146	197%	3.377	18	$14,960
175	9G-MH008_9G-MH006	9G-MH008	9G-MH006	12	407.10	0.003	2.259	0.013	1.230	184%	3.625	18	$69,207
176	9G-MH011_9G-MH079	9G-MH011	9G-MH079	10	27.70	0.002	1.116	0.013	0.664	168%	1.958	15	$3,934
177	9G-MH014_9G-MH015	9G-MH014	9G-MH015	12	334.80	0.002	2.252	0.013	1.141	197%	3.364	18	$56,916
178	9G-MH015_9G-MH016	9G-MH015	9G-MH016	12	321.00	0.003	2.263	0.013	1.342	169%	2.433	15	$45,582
179	9G-MH016_9G-MH008	9G-MH016	9G-MH008	12	240.30	0.003	2.260	0.013	1.235	183%	3.641	18	$40,851
180	9G-MH018_9G-MH014	9G-MH018	9G-MH014	12	260.70	0.002	2.240	0.013	1.041	215%	3.068	18	$44,319
181	9G-MH037_9G-MH045	9G-MH037	9G-MH045	10	340.10	0.013	1.403	0.015	1.391	101%	1.605	10	$32,310
182	9G-MH040_9G-MH041	9G-MH040	9G-MH041	15	87.30	0.003	3.998	0.015	1.962	204%	5.554	21	$16,413
183	9G-MH041_9G-MH066	9G-MH041	9G-MH066	15	576.00	0.003	4.049	0.013	2.337	173%	5.732	21	$108,288
184	9G-MH042_9G-MH040	9G-MH042	9G-MH040	15	138.30	0.003	3.830	0.015	1.998	192%	5.654	21	$26,001

Belton, MO
Flow Analysis Report
Existing System - Overloaded Lines for the 5-year, 90-minute storm event

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
185	9G-MH045_9G-MH042	9G-MH045	9G-MH042	15	410.20	0.003	3.720	0.015	1.913	194%	5.415	21	$77,118
186	9G-MH049_9G-MH037	9G-MH049	9G-MH037	10	157.20	0.008	1.380	0.015	1.097	126%	2.059	12	$17,921
187	9G-MH053_9G-MH059	9G-MH053	9G-MH059	21	236.20	0.005	11.970	0.015	6.579	182%	14.837	27	$52,437
188	9G-MH054_9G-MH052	9G-MH054	9G-MH052	21	34.70	0.004	9.759	0.015	5.260	186%	11.863	27	$7,704
189	9G-MH056_9G-MH057	9G-MH056	9G-MH057	15	27.90	0.002	4.131	0.015	1.576	262%	4.461	21	$5,246
190	9G-MH058_9G-MH054	9G-MH058	9G-MH054	18	336.90	0.003	5.673	0.015	2.990	190%	7.431	24	$69,065
191	9G-MH059_9H-MH008	9G-MH059	9H-MH008	27	296.70	0.002	12.010	0.015	6.723	179%	13.246	33	$83,076
192	9G-MH062_9G-MH058	9G-MH062	9G-MH058	18	403.70	0.003	5.674	0.015	3.068	185%	7.625	24	$82,759
193	9G-MH066_9G-MH056	9G-MH066	9G-MH056	15	363.80	0.003	4.087	0.013	2.379	172%	5.834	21	$68,395
194	9G-MH078_9G-MH060	9G-MH078	9G-MH060	12	256.80	0.002	2.258	0.013	1.105	204%	3.258	18	$43,656
195	9G-MH079_9G-MH013	9G-MH079	9G-MH013	10	88.50	0.003	1.167	0.013	0.749	156%	1.218	12	$10,089
196	9H-MH002_9H-MH001	9H-MH002	9H-MH001	27	451.60	0.002	11.961	0.014	8.711	137%	12.425	30	$108,384
197	9H-MH003_9H-MH002	9H-MH003	9H-MH002	27	503.70	0.003	11.970	0.014	9.742	123%	13.894	30	$120,888
198	9H-MH004_9H-MH003	9H-MH004	9H-MH003	27	364.80	0.001	11.972	0.014	5.274	227%	12.232	36	$108,711
199	9H-MH005_9H-MH004	9H-MH005	9H-MH004	27	477.90	0.002	11.977	0.014	8.901	135%	12.695	30	$114,696
200	9H-MH006_9H-MH005	9H-MH006	9H-MH005	27	501.10	0.002	11.981	0.014	8.165	147%	15.016	33	$140,308
201	9H-MH007_9H-MH006	9H-MH007	9H-MH006	27	340.10	0.004	11.993	0.014	11.375	105%	12.250	27	$75,503
202	9H-MH008_9H-MH007	9H-MH008	9H-MH007	27	195.90	0.003	12.000	0.014	9.636	125%	13.743	30	$47,016
203	9I-MH009_9J-MH007	9I-MH009	9J-MH007	30	493.80	0.001	11.913	0.014	8.293	144%	14.523	36	$147,153
204	9I-MH010_9I-MH009	9I-MH010	9I-MH009	27	492.40	0.001	11.914	0.014	6.089	196%	14.123	36	$146,736
205	9I-MH011_9I-MH010	9I-MH011	9I-MH010	27	493.10	0.001	11.922	0.014	6.970	171%	12.817	33	$138,068
206	9J-MH007_9J-MH006	9J-MH007	9J-MH006	30	497.90	0.002	11.906	0.014	11.010	108%	11.857	30	$119,496
207	9J-MH008_10J-MH006	9J-MH008	10J-MH006	30	127.20	0.002	11.925	0.014	11.789	101%	12.695	30	$30,528
												Total Cost:	**$8,631,115**

Belton, MO
Flow Analysis Report
Existing System - Overloaded Lines for the 5-year, 90-minute design storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
1	10D-MH009_10D-MH035	10D-MH009	10D-MH035	10	240.40	0.008	1.683	0.015	1.080	156%	2.026	12	$27,406
2	10D-MH012_10D-MH036	10D-MH012	10D-MH036	10	410.40	0.009	1.515	0.015	1.131	134%	2.122	12	$46,786
3	10D-MH019_10D-MH037	10D-MH019	10D-MH037	10	190.20	0.011	1.373	0.015	1.308	105%	1.510	12	$20,599
4	10D-MH022_10D-MH020	10D-MH022	10D-MH020	10	353.10	0.003	0.832	0.015	0.655	127%	1.229	12	$40,254
5	10D-MH031_10D-MH041	10D-MH031	10D-MH041	12	223.50	0.004	1.277	0.015	1.271	100%	1.466	15	$31,737
6	10D-MH035_10D-MH007	10D-MH035	10D-MH007	10	137.60	0.007	1.693	0.015	1.002	169%	1.880	12	$15,687
7	10D-MH036_10D-MH009	10D-MH036	10D-MH009	10	284.00	0.012	1.534	0.015	1.346	114%	1.553	12	$32,376
8	10D-MH037_10D-MH012	10D-MH037	10D-MH012	10	321.50	0.011	1.489	0.015	1.261	118%	2.367	12	$36,651
9	10D-MH038_10D-MH019	10D-MH038	10D-MH019	10	147.30	0.010	1.360	0.015	1.249	109%	1.441	12	$13,994
10	10E-MH039_10E-MH038	10E-MH039	10E-MH038	8	349.40	0.005	0.503	0.015	0.482	104%	1.009	10	$33,193
11	11A-MH035_11A-MH036	11A-MH035	11A-MH036	8	64.10	0.004	1.019	0.015	0.445	229%	1.513	12	$7,308
12	11A-MH036_11A-MH037	11A-MH036	11A-MH037	8	111.10	0.002	1.024	0.015	0.337	304%	1.147	12	$12,666
13	11A-MH055_11A-MH054	11A-MH055	11A-MH054	8	199.60	0.003	0.539	0.013	0.425	127%	0.771	10	$18,962
14	11A-MH068_11A-MH037	11A-MH068	11A-MH037	24	453.90	0.003	7.662	0.014	7.164	107%	7.715	27	$100,766
15	11C-MH004_11D-MH046T	11C-MH004	11D-MH046T	18	277.40	0.002	3.468	0.014	3.143	110%	5.105	21	$52,152
16	11D-MH021_11C-MH012	11D-MH021	11C-MH012	15	390.40	0.004	3.455	0.014	2.501	138%	4.379	18	$66,368
17	11D-MH033_11D-MH039	11D-MH033	11D-MH039	15	221.30	0.005	3.013	0.015	2.663	113%	3.073	18	$37,621
18	11D-MH037_11D-MH033	11D-MH037	11D-MH033	15	188.60	0.006	3.003	0.015	2.749	109%	3.172	18	$32,062
19	11D-MH039_11D-MH038	11D-MH039	11D-MH038	15	269.50	0.002	3.446	0.014	1.601	215%	4.229	21	$50,666
20	12B-MH056_12B-MH082	12B-MH056	12B-MH082	8	290.60	0.003	0.454	0.013	0.452	100%	0.820	10	$27,607
21	12B-MH057_12A-MH042	12B-MH057	12A-MH042	24	485.60	0.002	7.556	0.014	6.232	121%	9.187	27	$107,804
22	12B-MH058_12B-MH057	12B-MH058	12B-MH057	24	376.90	0.001	7.554	0.014	4.863	155%	9.495	30	$90,456
23	12B-MH069_12B-MH058	12B-MH069	12B-MH058	24	494.40	0.002	6.941	0.014	6.618	105%	7.127	27	$109,757
24	12B-MH070_12B-MH073	12B-MH070	12B-MH073	24	117.90	0.002	6.909	0.014	5.994	115%	8.837	27	$26,174
25	12B-MH072_12B-MH071	12B-MH072	12B-MH071	24	425.20	0.002	6.898	0.014	6.082	113%	8.966	27	$94,395
26	12B-MH073_12B-MH074	12B-MH073	12B-MH074	24	213.90	0.002	6.916	0.014	5.346	129%	7.882	27	$47,486
27	12B-MH074_12B-MH075	12B-MH074	12B-MH075	24	257.30	0.002	6.923	0.014	6.548	106%	7.051	27	$57,121
28	12D-MH014_12D-LS001	12D-MH014	12D-LS001	8	18.30	0.009	0.721	0.015	0.637	113%	1.332	10	$1,739
29	12D-MH029_12D-MH014	12D-MH029	12D-MH014	8	10.30	0.008	0.718	0.015	0.589	122%	1.232	10	$979
30	13D-MH013_13D-MH014	13D-MH013	13D-MH014	8	198.60	0.008	0.698	0.015	0.622	112%	1.301	10	$18,867
31	13D-MH014_13D-MH021	13D-MH014	13D-MH021	8	242.30	0.009	0.712	0.015	0.636	112%	1.331	10	$23,019
32	13D-MH028_13D-MH013	13D-MH028	13D-MH013	8	228.90	0.008	0.687	0.015	0.613	112%	1.282	10	$21,746
33	13D-MH090_13D-MH093	13D-MH090	13D-MH093	8	263.30	0.009	0.747	0.013	0.746	100%	1.352	10	$25,014
34	13D-MH091_13D-MH021	13D-MH091	13D-MH021	8	298.40	0.007	0.987	0.013	0.653	151%	1.184	10	$28,348
35	13D-MH092_13D-MH091	13D-MH092	13D-MH091	8	137.20	0.009	0.971	0.013	0.720	135%	1.306	10	$13,034
36	6F-MH022_7F-MH005	6F-MH022	7F-MH005	10	392.40	0.005	1.154	0.015	0.861	134%	1.615	12	$44,734
37	6F-MH026_6F-MH022	6F-MH026	6F-MH022	10	391.20	0.008	1.135	0.015	1.080	105%	1.246	12	$44,597
38	6F-MH031_6F-MH030	6F-MH031	6F-MH030	10	298.80	0.002	0.724	0.015	0.501	145%	0.940	12	$34,064
39	7A-MH007_7A-MH008	7A-MH007	7A-MH008	8	324.50	0.002	0.471	0.015	0.296	159%	0.620	10	$30,828
40	7F-MH002_7F-MH004	7F-MH002	7F-MH004	10	244.00	0.006	1.183	0.015	0.964	123%	1.809	12	$27,816
41	7F-MH003_7F-MH006	7F-MH003	7F-MH006	12	219.70	0.006	1.766	0.015	1.508	117%	3.154	15	$31,198
42	7F-MH004_7F-MH003	7F-MH004	7F-MH003	10	241.40	0.004	1.201	0.015	0.791	152%	1.485	12	$27,520
43	7F-MH005_7F-MH002	7F-MH005	7F-MH002	10	402.40	0.005	1.172	0.015	0.850	138%	1.595	12	$45,874
44	7F-MH006_7F-MH008	7F-MH006	7F-MH008	12	379.80	0.005	1.784	0.015	1.392	128%	2.912	15	$53,932
45	8C-MH014_8C-LS001	8C-MH014	8C-LS001	8	8.50	0.001	0.282	0.013	0.281	100%	0.509	10	$808
46	8E-MH017_8F-MH005	8E-MH017	8F-MH005	8	282.60	0.002	0.420	0.013	0.336	125%	0.610	10	$26,847

Belton, MO
Flow Analysis Report
Existing System - Overloaded Lines for the 5-year, 90-minute design storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
47	8F-MH004_8F-MH070	8F-MH004	8F-MH070	8	359.20	0.003	0.474	0.013	0.456	104%	0.826	10	$34,124
48	8F-MH005_8F-MH014	8F-MH005	8F-MH014	8	191.80	0.003	0.450	0.013	0.394	114%	0.714	10	$18,221
49	8F-MH014_8F-MH004	8F-MH014	8F-MH004	8	131.30	0.003	0.457	0.015	0.386	118%	0.808	10	$12,474
50	8F-MH075_8F-MH076	8F-MH075	8F-MH076	18	96.60	0.002	3.506	0.015	2.826	124%	4.918	21	$18,161
51	8F-MH077_8F-MH078	8F-MH077	8F-MH078	18	322.30	0.003	3.528	0.015	3.193	110%	3.684	21	$60,592
52	8F-MH078_8F-MH087	8F-MH078	8F-MH087	18	79.60	0.002	3.641	0.015	2.686	136%	4.674	21	$14,965
53	8F-MH079_8F-MH080	8F-MH079	8F-MH080	18	402.30	0.002	3.682	0.015	2.430	152%	4.230	21	$75,633
54	8F-MH087_8F-MH088	8F-MH087	8F-MH088	18	400.60	0.003	3.656	0.015	3.096	118%	5.388	21	$75,313
55	8F-MH088_8F-MH079	8F-MH088	8F-MH079	18	383.20	0.002	3.669	0.015	2.687	137%	4.677	21	$72,042
56	8G-MH004_8G-MH030	8G-MH004	8G-MH030	18	166.00	0.004	3.799	0.015	3.603	105%	4.157	21	$31,208
57	8G-MH007_8G-MH026	8G-MH007	8G-MH026	18	253.20	0.003	3.742	0.015	3.147	119%	5.477	21	$47,602
58	8G-MH008_8G-MH009	8G-MH008	8G-MH009	18	295.50	0.002	3.918	0.015	2.453	160%	4.269	21	$55,554
59	8G-MH026_8G-MH004	8G-MH026	8G-MH004	18	61.00	0.003	3.793	0.015	3.317	114%	3.827	21	$11,468
60	8G-MH030_8G-MH008	8G-MH030	8G-MH008	18	125.50	0.001	3.901	0.015	1.741	224%	4.327	24	$25,728
61	8G-MH033_9G-MH062	8G-MH033	9G-MH062	18	398.80	0.002	3.958	0.015	2.376	167%	4.136	21	$74,975
62	8G-MH055_8G-MH033	8G-MH055	8G-MH033	18	395.70	0.003	3.948	0.015	3.276	121%	5.702	21	$74,392
63	9A-MH007_9A-MH008	9A-MH007	9A-MH008	10	364.30	0.005	1.828	0.015	0.830	220%	2.824	15	$51,731
64	9A-MH008_9A-MH029	9A-MH008	9A-MH029	10	290.40	0.005	1.829	0.015	0.828	221%	2.816	15	$41,237
65	9A-MH011_9A-MH014	9A-MH011	9A-MH014	8	173.20	0.016	1.071	0.013	0.987	109%	1.790	10	$16,454
66	9A-MH016_9A-MH007	9A-MH016	9A-MH007	10	398.00	0.010	1.823	0.015	1.227	149%	2.303	12	$45,372
67	9A-MH023_9A-MH024	9A-MH023	9A-MH024	8	135.50	0.007	1.240	0.013	0.652	190%	1.921	12	$15,447
68	9A-MH024_9A-MH016	9A-MH024	9A-MH016	10	261.50	0.010	1.811	0.015	1.235	147%	2.318	12	$29,811
69	9A-MH029_9A-MH020	9A-MH029	9A-MH020	10	205.40	0.019	1.830	0.015	1.675	109%	1.932	12	$23,416
70	9B-MH023_9A-MH009	9B-MH023	9A-MH009	8	250.60	0.005	0.506	0.015	0.458	111%	0.958	10	$23,807
71	9B-MH026_9A-MH013	9B-MH026	9A-MH013	8	267.90	0.016	1.060	0.015	0.867	122%	1.815	10	$25,451
72	9C-MH005_9B-MH032	9C-MH005	9B-MH032	8	43.10	0.005	0.845	0.015	0.490	172%	1.025	10	$4,095
73	9C-MH006_9C-MH013	9C-MH006	9C-MH013	10	326.50	0.005	0.989	0.015	0.872	113%	1.006	12	$37,221
74	9C-MH013_9C-MH014	9C-MH013	9C-MH014	10	220.90	0.005	0.990	0.015	0.885	112%	1.021	12	$25,183
75	9C-MH014_9C-MH015	9C-MH014	9C-MH015	10	288.50	0.005	0.996	0.015	0.885	113%	1.021	12	$32,889
76	9C-MH015_9C-MH016	9C-MH015	9C-MH016	10	101.40	0.005	0.998	0.015	0.832	120%	1.562	12	$11,560
77	9C-MH025_9C-MH026	9C-MH025	9C-MH026	8	49.10	0.007	0.646	0.015	0.586	110%	1.225	10	$4,665
78	9E-MH060_9E-MH036	9E-MH060	9E-MH036	8	163.90	0.001	0.224	0.015	0.187	120%	0.391	10	$15,571
79	9F-MH024_9F-MH047	9F-MH024	9F-MH047	10	313.60	0.003	0.836	0.013	0.765	109%	1.243	12	$35,751
80	9F-MH029_9F-MH039	9F-MH029	9F-MH039	10	138.40	0.003	0.749	0.015	0.709	106%	0.818	12	$19,930
81	9F-MH052_9F-MH093	9F-MH052	9F-MH093	10	355.10	0.003	0.765	0.015	0.640	120%	1.200	12	$40,482
82	9F-MH080_9F-MH079	9F-MH080	9F-MH079	8	85.50	0.003	0.546	0.013	0.443	123%	0.803	10	$8,123
83	9F-MH085_9F-MH044	9F-MH085	9F-MH044	10	224.60	0.002	0.784	0.015	0.609	129%	1.142	12	$25,605
84	9F-MH093_9F-MH085	9F-MH093	9F-MH085	10	152.40	0.003	0.773	0.015	0.700	110%	0.807	12	$17,374
85	9G-MH006_9G-MH078	9G-MH006	9G-MH078	12	88.00	0.002	1.578	0.013	1.146	138%	2.077	15	$12,496
86	9G-MH008_9G-MH006	9G-MH008	9G-MH006	12	407.10	0.003	1.577	0.013	1.230	128%	2.229	15	$57,809
87	9G-MH011_9G-MH079	9G-MH011	9G-MH079	10	27.70	0.002	0.780	0.013	0.664	117%	1.080	12	$3,158
88	9G-MH014_9G-MH015	9G-MH014	9G-MH015	12	334.80	0.002	1.575	0.013	1.141	138%	2.069	15	$47,542
89	9G-MH015_9G-MH016	9G-MH015	9G-MH016	12	321.00	0.003	1.581	0.013	1.342	118%	2.433	15	$45,582
90	9G-MH016_9G-MH008	9G-MH016	9G-MH008	12	240.30	0.003	1.578	0.013	1.235	128%	2.239	15	$34,123
91	9G-MH018_9G-MH014	9G-MH018	9G-MH014	12	260.70	0.002	1.567	0.013	1.041	151%	1.887	15	$37,020
92	9G-MH040_9G-MH041	9G-MH040	9G-MH041	15	87.30	0.003	2.793	0.015	1.962	142%	3.682	18	$14,841

Belton, MO
Flow Analysis Report
Existing System - Overloaded Lines for the 5-year, 90-minute design storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
93	9G-MH041_9G-MH066	9G-MH041	9G-MH066	15	576.00	0.003	2.829	0.013	2.337	121%	3.800	18	$97,920
94	9G-MH042_9G-MH040	9G-MH042	9G-MH040	15	138.30	0.003	2.675	0.015	1.998	134%	3.748	18	$23,511
95	9G-MH045_9G-MH042	9G-MH045	9G-MH042	15	410.20	0.003	2.598	0.015	1.913	136%	3.590	18	$69,734
96	9G-MH053_9G-MH059	9G-MH053	9G-MH059	21	236.20	0.005	8.361	0.015	6.579	127%	10.838	24	$48,421
97	9G-MH054_9G-MH052	9G-MH054	9G-MH052	21	34.70	0.004	6.824	0.015	5.260	130%	8.665	24	$7,114
98	9G-MH056_9G-MH057	9G-MH056	9G-MH057	15	27.90	0.002	2.888	0.015	1.576	183%	2.958	18	$4,743
99	9G-MH058_9G-MH054	9G-MH058	9G-MH054	18	336.90	0.003	3.965	0.015	2.990	133%	5.205	21	$63,338
100	9G-MH059_9H-MH008	9G-MH059	9H-MH008	27	296.70	0.002	8.386	0.015	6.723	125%	10.273	30	$71,208
101	9G-MH062_9G-MH058	9G-MH062	9G-MH058	18	403.70	0.003	3.967	0.015	3.068	129%	5.341	21	$75,896
102	9G-MH066_9G-MH056	9G-MH066	9G-MH056	15	363.80	0.003	2.856	0.013	2.379	120%	3.868	18	$61,846
103	9G-MH078_9G-MH060	9G-MH078	9G-MH060	12	256.80	0.002	1.580	0.013	1.105	143%	2.004	15	$36,466
104	9G-MH079_9G-MH013	9G-MH079	9G-MH013	10	88.50	0.003	0.816	0.013	0.749	109%	1.218	12	$10,089
105	9H-MH004_9H-MH003	9H-MH004	9H-MH003	27	364.80	0.001	8.365	0.014	5.274	159%	9.699	33	$102,144
106	9H-MH006_9H-MH005	9H-MH006	9H-MH005	27	501.10	0.002	8.369	0.014	8.165	102%	8.793	30	$120,264
107	9I-MH010_9I-MH009	9I-MH010	9I-MH009	27	492.40	0.001	8.325	0.014	6.089	137%	8.685	30	$118,176
108	9I-MH011_9I-MH010	9I-MH011	9I-MH010	27	493.10	0.001	8.327	0.014	6.970	119%	9.941	30	$118,344
												Total Cost:	**$4,274,429**

Appendix O
Replacement Sewer Lines for Existing Conditions
(0% and 30% I/I Elimination)

Belton, MO
Replacement Sewer Lines
Existing System - 5yr, 90-minute Design Storm Event

Count	Basin	ID	Up MH	Dn MH	Max Flow (mgd)	Length (ft)	Slope	New Dia (in)	Old Dia (in)	Estimated Replacement Cost
1	9	10D-MH007_10D-MH034	10D-MH007	10D-MH034	2.433	246	0.021	15	10	$26,355
2	12	10D-MH009_10D-MH035	10D-MH009	10D-MH035	2.404	240	0.008	15	10	$25,723
3	12	10D-MH012_10D-MH036	10D-MH012	10D-MH036	2.165	410	0.009	15	10	$43,913
4	12	10D-MH019_10D-MH037	10D-MH019	10D-MH037	1.961	190	0.011	12	10	$16,928
5	12	10D-MH020_10D-MH038	10D-MH020	10D-MH038	1.929	229	0.019	12	10	$20,417
6	12	10D-MH022_10D-MH020	10D-MH022	10D-MH020	1.194	353	0.003	12	10	$31,426
7	9	10D-MH034_11D-MH037	10D-MH034	11D-MH037	4.032	394	0.009	18	15	$49,275
8	12	10D-MH035_10D-MH007	10D-MH035	10D-MH007	2.418	138	0.007	15	10	$14,724
9	12	10D-MH036_10D-MH009	10D-MH036	10D-MH009	2.190	284	0.012	15	10	$30,388
10	12	10D-MH037_10D-MH012	10D-MH037	10D-MH012	2.128	322	0.011	12	10	$28,614
11	12	10D-MH038_10D-MH019	10D-MH038	10D-MH019	1.943	147	0.010	12	10	$13,110
12	12	10D-MH048_10D-MH022	10D-MH048	10D-MH022	1.162	347	0.005	12	10	$30,875
13	4	11A-MH035_11A-MH036	11A-MH035	11A-MH036	1.417	64	0.004	12	8	$5,705
14	4	11A-MH036_11A-MH037	11A-MH036	11A-MH037	1.423	111	0.002	15	8	$11,888
15	4	11A-MH037_11A-MH069	11A-MH037	11A-MH069	12.296	605	0.008	30	24	$120,920
16	4	11A-MH068_11A-MH037	11A-MH068	11A-MH037	10.870	454	0.003	30	24	$90,780
17	4	11A-MH069_11A-MH072	11A-MH069	11A-MH072	12.313	579	0.008	30	24	$115,740
18	4	11A-MH072_12A-MH043	11A-MH072	12A-MH043	12.330	341	0.005	30	24	$68,260
19	4	11C-MH004_11D-MH046T	11C-MH004	11D-MH046T	4.943	277	0.002	21	18	$39,946
20	4	11C-MH005_11C-MH011	11C-MH005	11C-MH011	4.926	10	0.039	21	18	$1,484
21	4	11C-MH006_12C-MH023	11C-MH006	12C-MH023	8.819	229	0.004	30	24	$45,740
22	4	11C-MH009_11C-MH013	11C-MH009	11C-MH013	5.061	648	0.008	21	18	$93,312
23	4	11C-MH010_11C-MH009	11C-MH010	11C-MH009	5.031	335	0.008	21	18	$48,183
24	4	11C-MH011_11C-MH004	11C-MH011	11C-MH004	4.929	33	0.014	21	18	$4,680
25	4	11C-MH012_11C-MH005	11C-MH012	11C-MH005	4.927	237	0.004	21	18	$34,128
26	9	11D-MH021_11C-MH012	11D-MH021	11C-MH012	4.918	390	0.004	18	15	$48,800
27	9	11D-MH033_11D-MH039	11D-MH033	11D-MH039	4.056	221	0.005	18	15	$27,663
28	9	11D-MH037_11D-MH033	11D-MH037	11D-MH033	4.035	189	0.006	18	15	$23,575
29	9	11D-MH038_11D-MH021	11D-MH038	11D-MH021	4.906	400	0.009	18	15	$49,963
30	9	11D-MH039_11D-MH038	11D-MH039	11D-MH038	4.893	270	0.002	18	15	$33,688
31	4	11D-MH046T_11C-MH010	11D-MH046T	11C-MH010	5.013	100	0.017	21	18	$14,400
32	4	12A-MH042_11A-MH068	12A-MH042	11A-MH068	10.856	180	0.005	30	24	$35,940
33	4	12A-MH043_OUTLET	12A-MH043	OUTLET	13.389	55	0.011	30	24	$11,042
34	4	12B-MH057_12A-MH042	12B-MH057	12A-MH042	10.735	486	0.002	30	24	$97,120
35	4	12B-MH058_12B-MH057	12B-MH058	12B-MH057	10.727	377	0.001	30	24	$75,380
36	4	12B-MH069_12B-MH058	12B-MH069	12B-MH058	9.866	494	0.002	30	24	$98,880
37	4	12B-MH070_12B-MH073	12B-MH070	12B-MH073	9.815	118	0.002	30	24	$23,580
38	4	12B-MH071_12B-MH070	12B-MH071	12B-MH070	9.809	179	0.003	30	24	$35,740
39	4	12B-MH072_12B-MH071	12B-MH072	12B-MH071	9.816	425	0.002	30	24	$85,040
40	4	12B-MH073_12B-MH074	12B-MH073	12B-MH074	9.826	214	0.002	30	24	$42,780
41	4	12B-MH074_12B-MH075	12B-MH074	12B-MH075	9.838	257	0.002	30	24	$51,460
42	4	12B-MH075_12B-MH069	12B-MH075	12B-MH069	9.846	209	0.003	30	24	$41,720
43	4	12C-MH023_12B-MH072	12C-MH023	12B-MH072	9.812	336	0.004	30	24	$67,140
44	2	13D-MH013_13D-MH014	13D-MH013	13D-MH014	1.000	199	0.008	10	8	$15,293
45	2	13D-MH014_13D-MH021	13D-MH014	13D-MH021	1.020	242	0.009	10	8	$18,658
46	2	13D-MH023_13D-MH090	13D-MH023	13D-MH090	1.049	261	0.015	10	8	$20,059
47	2	13D-MH028_13D-MH013	13D-MH028	13D-MH013	0.983	229	0.008	10	8	$17,626
48	2	13D-MH090_13D-MH093	13D-MH090	13D-MH093	1.070	263	0.009	10	8	$20,275
49	2	13D-MH091_13D-MH021	13D-MH091	13D-MH021	1.415	298	0.007	10	8	$22,977
50	2	13D-MH092_13D-MH091	13D-MH092	13D-MH091	1.391	137	0.009	10	8	$10,565
51	2	13D-MH093_13D-MH092	13D-MH093	13D-MH092	1.084	164	0.013	10	8	$12,628
52	11	6F-MH022_7F-MH005	6F-MH022	7F-MH005	1.649	392	0.005	15	10	$41,987
53	11	6F-MH026_6F-MH022	6F-MH026	6F-MH022	1.623	391	0.008	12	10	$34,817
54	11	6F-MH030_6F-MH026	6F-MH030	6F-MH026	1.054	299	0.004	12	10	$26,611
55	11	6F-MH031_6F-MH030	6F-MH031	6F-MH030	1.033	299	0.002	12	10	$26,594
56	6	7F-MH001_7F-MH010	7F-MH001	7F-MH010	3.024	319	0.004	18	15	$39,925
57	11	7F-MH002_7F-MH004	7F-MH002	7F-MH004	1.689	244	0.006	15	10	$26,108
58	11	7F-MH003_7F-MH006	7F-MH003	7F-MH006	2.522	220	0.006	15	12	$23,508
59	11	7F-MH004_7F-MH003	7F-MH004	7F-MH003	1.716	241	0.004	15	10	$25,830
60	11	7F-MH005_7F-MH002	7F-MH005	7F-MH002	1.675	402	0.005	15	10	$43,057
61	6	7F-MH006_7F-MH008	7F-MH006	7F-MH008	2.548	380	0.005	15	12	$40,639
62	6	7F-MH007_7F-MH009	7F-MH007	7F-MH009	2.992	379	0.003	18	15	$47,388
63	6	7F-MH008_7F-MH007	7F-MH008	7F-MH007	2.563	330	0.010	15	12	$35,353
64	6	7F-MH009_7F-MH001	7F-MH009	7F-MH001	3.007	303	0.004	18	15	$37,850
65	3	8B-LS001T_8C-MH014	8B-LS001T	8C-MH014	0.242	135	0.001	10	8	$10,365
66	3	8C-MH014_8C-LS001	8C-MH014	8C-LS001	0.289	9	0.001	10	8	$655
67	7	8E-MH017_8F-MH005	8E-MH017	8F-MH005	0.602	283	0.002	10	8	$21,761
68	7	8E-MH031_8E-MH017	8E-MH031	8E-MH017	0.483	330	0.003	10	8	$25,410
69	7	8E-MH037_8E-MH031	8E-MH037	8E-MH031	0.461	509	0.002	10	8	$39,217
70	7	8F-MH004_8F-MH070	8F-MH004	8F-MH070	0.681	359	0.003	10	8	$27,659
71	7	8F-MH005_8F-MH014	8F-MH005	8F-MH014	0.646	192	0.003	10	8	$14,769
72	7	8F-MH006_8F-MH072	8F-MH006	8F-MH072	1.177	152	0.017	10	8	$11,720

Belton, MO
Replacement Sewer Lines
Existing System - 5yr, 90-minute Design Storm Event

Count	Basin	ID	Up MH	Dn MH	Max Flow (mgd)	Length (ft)	Slope	New Dia (in)	Old Dia (in)	Estimated Replacement Cost
73	7	8F-MH009_8F-MH020	8F-MH009	8F-MH020	1.531	139	0.007	12	10	$12,389
74	7	8F-MH011_8F-MH006	8F-MH011	8F-MH006	1.131	162	0.016	10	8	$12,467
75	7	8F-MH014_8F-MH004	8F-MH014	8F-MH004	0.655	131	0.003	10	8	$10,111
76	7	8F-MH019_8F-MH009	8F-MH019	8F-MH009	1.455	149	0.008	12	10	$13,288
77	7	8F-MH020_8F-MH085	8F-MH020	8F-MH085	1.542	150	0.013	12	10	$13,315
78	7	8F-MH070_9F-MH078	8F-MH070	9F-MH078	0.698	250	0.008	10	8	$19,250
79	6	8F-MH077_8F-MH078	8F-MH077	8F-MH078	5.039	322	0.003	21	18	$46,412
80	6	8F-MH078_8F-MH087	8F-MH078	8F-MH087	5.197	80	0.002	21	18	$11,463
81	6	8F-MH079_8F-MH080	8F-MH079	8F-MH080	5.257	402	0.002	21	18	$57,932
82	6	8F-MH080_8G-MH007	8F-MH080	8G-MH007	5.271	281	0.008	21	18	$40,522
83	7	8F-MH085_8F-MH086	8F-MH085	8F-MH086	1.611	111	0.011	12	10	$9,862
84	6	8F-MH087_8F-MH088	8F-MH087	8F-MH088	5.217	401	0.003	21	18	$57,687
85	6	8F-MH088_8F-MH079	8F-MH088	8F-MH079	5.237	383	0.002	21	18	$55,181
86	6	8G-MH004_8G-MH030	8G-MH004	8G-MH030	5.431	166	0.004	21	18	$23,904
87	6	8G-MH007_8G-MH026	8G-MH007	8G-MH026	5.347	253	0.003	21	18	$36,461
88	6	8G-MH008_8G-MH009	8G-MH008	8G-MH009	5.604	296	0.002	21	18	$42,552
89	6	8G-MH009_8G-MH055	8G-MH009	8G-MH055	5.620	401	0.012	21	18	$57,730
90	6	8G-MH026_8G-MH004	8G-MH026	8G-MH004	5.422	61	0.003	21	18	$8,784
91	6	8G-MH030_8G-MH008	8G-MH030	8G-MH008	5.580	126	0.001	21	18	$18,072
92	13	8G-MH033_9G-MH062	8G-MH033	9G-MH062	5.658	399	0.002	24	18	$65,005
93	6	8G-MH055_8G-MH033	8G-MH055	8G-MH033	5.641	396	0.003	21	18	$56,981
94	3	9A-MH007_9A-MH008	9A-MH007	9A-MH008	2.591	364	0.005	15	10	$38,981
95	3	9A-MH008_9A-MH029	9A-MH008	9A-MH029	2.610	290	0.005	15	10	$31,073
96	3	9A-MH011_9A-MH014	9A-MH011	9A-MH014	1.429	173	0.016	10	8	$13,337
97	3	9A-MH013_9A-MH011	9A-MH013	9A-MH011	1.417	181	0.036	10	8	$13,937
98	3	9A-MH014_9A-MH021	9A-MH014	9A-MH021	1.437	123	0.007	12	10	$10,956
99	3	9A-MH016_9A-MH007	9A-MH016	9A-MH007	2.567	398	0.010	15	10	$42,586
100	3	9A-MH021_9A-MH022	9A-MH021	9A-MH022	1.523	125	0.008	12	10	$11,099
101	3	9A-MH022_9A-MH023	9A-MH022	9A-MH023	1.530	98	0.008	12	10	$8,749
102	3	9A-MH023_9A-MH024	9A-MH023	9A-MH024	1.686	136	0.007	12	8	$12,060
103	3	9A-MH024_9A-MH016	9A-MH024	9A-MH016	2.539	262	0.010	15	10	$27,981
104	3	9A-MH027_9A-MH024	9A-MH027	9A-MH024	0.863	189	0.008	10	8	$14,538
105	3	9A-MH029_9A-MH020	9A-MH029	9A-MH020	2.623	205	0.019	15	10	$21,978
106	3	9B-MH026_9A-MH013	9B-MH026	9A-MH013	1.406	268	0.016	10	8	$20,629
107	3	9B-MH034_9B-MH026	9B-MH034	9B-MH026	1.389	286	0.026	10	8	$22,030
108	7	9E-MH025_9E-MH083	9E-MH025	9E-MH083	1.008	464	0.004	12	10	$41,288
109	7	9E-MH083_9F-MH052	9E-MH083	9F-MH052	1.073	74	0.005	12	10	$6,578
110	7	9F-MH012_9F-MH024	9F-MH012	9F-MH024	1.158	130	0.006	12	10	$11,579
111	7	9F-MH024_9F-MH047	9F-MH024	9F-MH047	1.199	314	0.003	12	10	$27,911
112	7	9F-MH025_9F-MH050	9F-MH025	9F-MH050	1.248	198	0.004	12	10	$17,640
113	8	9F-MH034_9G-MH011	9F-MH034	9G-MH011	1.102	304	0.004	12	10	$27,039
114	8	9F-MH039_9F-MH034	9F-MH039	9F-MH034	1.089	400	0.005	12	10	$35,609
115	7	9F-MH043_9F-MH094	9F-MH043	9F-MH094	1.320	194	0.020	12	10	$17,302
116	7	9F-MH044_9F-MH049	9F-MH044	9F-MH049	1.143	253	0.006	12	10	$22,517
117	7	9F-MH045_9F-MH043	9F-MH045	9F-MH043	1.307	451	0.040	12	10	$40,122
118	7	9F-MH046_9F-MH053	9F-MH046	9F-MH053	0.933	286	0.026	10	8	$22,015
119	7	9F-MH047_9F-MH025	9F-MH047	9F-MH025	1.218	230	0.005	12	10	$20,506
120	7	9F-MH049_9F-MH012	9F-MH049	9F-MH012	1.148	17	0.006	12	10	$1,496
121	7	9F-MH050_9F-MH045	9F-MH050	9F-MH045	1.277	427	0.022	12	10	$38,030
122	7	9F-MH052_9F-MH093	9F-MH052	9F-MH093	1.099	355	0.003	12	10	$31,604
123	7	9F-MH053_8F-MH011	9F-MH053	8F-MH011	1.025	397	0.022	10	8	$30,531
124	7	9F-MH078_9F-MH083	9F-MH078	9F-MH083	0.715	243	0.007	10	8	$18,673
125	7	9F-MH083_9F-MH046	9F-MH083	9F-MH046	0.913	382	0.008	10	8	$29,376
126	7	9F-MH085_9F-MH044	9F-MH085	9F-MH044	1.126	225	0.002	12	10	$19,990
127	7	9F-MH086_9G-MH049	9F-MH086	9G-MH049	1.353	225	0.014	12	10	$20,005
128	7	9F-MH093_9F-MH085	9F-MH093	9F-MH085	1.110	152	0.003	12	10	$13,564
129	7	9F-MH094_9F-MH086	9F-MH094	9F-MH086	1.338	255	0.019	12	10	$22,669
130	13	9G-MH006_9G-MH078	9G-MH006	9G-MH078	2.256	88	0.002	15	12	$9,416
131	13	9G-MH008_9G-MH006	9G-MH008	9G-MH006	2.259	407	0.003	15	12	$43,560
132	8	9G-MH011_9G-MH079	9G-MH011	9G-MH079	1.116	28	0.002	12	10	$2,466
133	8	9G-MH013_9G-MH033	9G-MH013	9G-MH033	1.185	382	0.010	12	10	$34,025
134	8	9G-MH014_9G-MH015	9G-MH014	9G-MH015	2.252	335	0.002	15	12	$35,824
135	13	9G-MH015_9G-MH016	9G-MH015	9G-MH016	2.263	321	0.003	15	12	$34,347
136	13	9G-MH016_9G-MH008	9G-MH016	9G-MH008	2.260	240	0.003	15	12	$25,713
137	8	9G-MH018_9G-MH014	9G-MH018	9G-MH014	2.240	261	0.002	15	12	$27,895
138	8	9G-MH033_9G-MH018	9G-MH033	9G-MH018	1.289	300	0.014	12	10	$26,674
139	7	9G-MH037_9G-MH045	9G-MH037	9G-MH045	1.403	340	0.013	12	10	$30,269
140	7	9G-MH040_9G-MH041	9G-MH040	9G-MH041	3.998	87	0.003	21	15	$12,572
141	7	9G-MH041_9G-MH066	9G-MH041	9G-MH066	4.049	576	0.003	21	15	$82,944
142	7	9G-MH042_9G-MH040	9G-MH042	9G-MH040	3.830	138	0.003	21	15	$19,916
143	7	9G-MH045_9G-MH042	9G-MH045	9G-MH042	3.720	410	0.003	21	15	$59,069
144	7	9G-MH049_9G-MH037	9G-MH049	9G-MH037	1.380	157	0.008	12	10	$13,991

Belton, MO
Replacement Sewer Lines
Existing System - 5yr, 90-minute Design Storm Event

Count	Basin	ID	Up MH	Dn MH	Max Flow (mgd)	Length (ft)	Slope	New Dia (in)	Old Dia (in)	Estimated Replacement Cost
145	13	9G-MH051_9G-MH053	9G-MH051	9G-MH053	11.947	33	0.052	30	21	$6,580
146	13	9G-MH053_9G-MH059	9G-MH053	9G-MH059	11.949	236	0.005	30	21	$47,240
147	13	9G-MH054_9G-MH052	9G-MH054	9G-MH052	9.738	35	0.004	27	21	$6,177
148	13	9G-MH055_9G-MH054	9G-MH055	9G-MH054	4.135	114	0.069	21	15	$16,431
149	13	9G-MH056_9G-MH057	9G-MH056	9G-MH057	4.131	28	0.002	21	15	$4,018
150	13	9G-MH057_9G-MH055	9G-MH057	9G-MH055	4.132	35	0.086	21	15	$5,026
151	13	9G-MH058_9G-MH054	9G-MH058	9G-MH054	5.652	337	0.003	24	18	$54,915
152	13	9G-MH059_9H-MH008	9G-MH059	9H-MH008	11.939	297	0.002	30	27	$59,340
153	13	9G-MH060_9G-MH052	9G-MH060	9G-MH052	2.262	275	0.041	15	12	$29,468
154	13	9G-MH062_9G-MH058	9G-MH062	9G-MH058	5.656	404	0.003	24	18	$65,804
155	7	9G-MH066_9G-MH056	9G-MH066	9G-MH056	4.087	364	0.003	21	15	$52,388
156	13	9G-MH078_9G-MH060	9G-MH078	9G-MH060	2.258	257	0.002	15	12	$27,478
157	8	9G-MH079_9G-MH013	9G-MH079	9G-MH013	1.167	89	0.003	12	10	$7,877
158	13	9H-MH001_9I-MH015	9H-MH001	9I-MH015	11.859	101	0.006	30	27	$20,200
159	13	9H-MH002_9H-MH001	9H-MH002	9H-MH001	11.871	452	0.002	30	27	$90,320
160	13	9H-MH003_9H-MH002	9H-MH003	9H-MH002	11.883	504	0.003	30	27	$100,740
161	13	9H-MH004_9H-MH003	9H-MH004	9H-MH003	11.887	365	0.001	30	27	$72,960
162	13	9H-MH005_9H-MH004	9H-MH005	9H-MH004	11.894	478	0.002	30	27	$95,580
163	13	9H-MH006_9H-MH005	9H-MH006	9H-MH005	11.903	501	0.002	30	27	$100,220
164	13	9H-MH007_9H-MH006	9H-MH007	9H-MH006	11.917	340	0.004	30	27	$68,020
165	13	9H-MH008_9H-MH007	9H-MH008	9H-MH007	11.926	196	0.003	30	27	$39,180
166	13	9I-MH010_9I-MH009	9I-MH010	9I-MH009	11.809	492	0.001	30	27	$98,480
167	13	9I-MH011_9I-MH010	9I-MH011	9I-MH010	11.819	493	0.001	30	27	$98,620
168	13	9I-MH012_9I-MH011	9I-MH012	9I-MH011	11.834	469	0.006	30	27	$93,720
169	13	9I-MH013_9I-MH012	9I-MH013	9I-MH012	11.839	181	0.007	30	27	$36,220
170	13	9I-MH014_9I-MH013	9I-MH014	9I-MH013	11.852	494	0.006	30	27	$98,820
171	13	9I-MH015_9I-MH014	9I-MH015	9I-MH014	11.857	236	0.007	30	27	$47,240
									Total Cost:	**$5,993,000**

Belton, MO
Replacement Sewer Lines
Existing System at 5yr Design Storm Event with 30% I/I Reduction

Count	Basin	ID	Up MH	Dn MH	Max Flow (mgd)	Length (ft)	Slope	New Dia (in)	Old Dia (in)	Estimated Replacement Cost
1	9	10D-MH007_10D-MH034	10D-MH007	10D-MH034	1.703	246	0.021	12	10	$ 21,921
2	12	10D-MH009_10D-MH035	10D-MH009	10D-MH035	1.683	240	0.008	12	10	$ 21,396
3	12	10D-MH012_10D-MH036	10D-MH012	10D-MH036	1.515	410	0.009	12	10	$ 36,526
4	12	10D-MH019_10D-MH037	10D-MH019	10D-MH037	1.373	190	0.011	12	10	$ 16,928
5	12	10D-MH035_10D-MH007	10D-MH035	10D-MH007	1.693	138	0.007	12	10	$ 12,247
6	12	10D-MH036_10D-MH009	10D-MH036	10D-MH009	1.534	284	0.012	12	10	$ 25,276
7	12	10D-MH037_10D-MH012	10D-MH037	10D-MH012	1.489	322	0.011	12	10	$ 28,614
8	12	10D-MH038_10D-MH019	10D-MH038	10D-MH019	1.360	147	0.010	12	10	$ 13,110
9	4	11A-MH035_11A-MH036	11A-MH035	11A-MH036	1.019	64	0.004	12	8	$ 5,705
10	4	11A-MH036_11A-MH037	11A-MH036	11A-MH037	1.024	111	0.002	12	8	$ 9,888
11	9	11D-MH021_11C-MH012	11D-MH021	11C-MH012	3.455	390	0.004	18	15	$ 48,800
12	9	11D-MH033_11D-MH039	11D-MH033	11D-MH039	3.013	221	0.005	18	15	$ 27,663
13	9	11D-MH037_11D-MH033	11D-MH037	11D-MH033	3.003	189	0.006	18	15	$ 23,575
14	9	11D-MH038_11D-MH021	11D-MH038	11D-MH021	3.451	400	0.009	18	15	$ 49,963
15	9	11D-MH039_11D-MH038	11D-MH039	11D-MH038	3.446	270	0.002	18	15	$ 33,688
16	2	13D-MH091_13D-MH021	13D-MH091	13D-MH021	0.987	298	0.007	10	8	$ 22,977
17	2	13D-MH092_13D-MH091	13D-MH092	13D-MH091	0.971	137	0.009	10	8	$ 10,565
18	11	6F-MH022_7F-MH005	6F-MH022	7F-MH005	1.154	392	0.005	12	10	$ 34,924
19	11	7F-MH002_7F-MH004	7F-MH002	7F-MH004	1.183	244	0.006	12	10	$ 21,716
20	11	7F-MH003_7F-MH006	7F-MH003	7F-MH006	1.766	220	0.006	15	12	$ 23,508
21	11	7F-MH004_7F-MH003	7F-MH004	7F-MH003	1.201	241	0.004	12	10	$ 21,485
22	11	7F-MH005_7F-MH002	7F-MH005	7F-MH002	1.172	402	0.005	12	10	$ 35,814
23	6	7F-MH006_7F-MH008	7F-MH006	7F-MH008	1.784	380	0.005	15	12	$ 40,639
24	6	7F-MH008_7F-MH007	7F-MH008	7F-MH007	1.795	330	0.010	15	12	$ 35,353
25	6	8F-MH077_8F-MH078	8F-MH077	8F-MH078	3.528	322	0.003	21	18	$ 46,412
26	6	8F-MH078_8F-MH087	8F-MH078	8F-MH087	3.641	80	0.002	21	18	$ 11,463
27	6	8F-MH079_8F-MH080	8F-MH079	8F-MH080	3.682	402	0.002	21	18	$ 57,932
28	6	8F-MH080_8G-MH007	8F-MH080	8G-MH007	3.690	281	0.008	21	18	$ 40,522
29	6	8F-MH087_8F-MH088	8F-MH087	8F-MH088	3.656	401	0.003	21	18	$ 57,687
30	6	8F-MH088_8F-MH079	8F-MH088	8F-MH079	3.669	383	0.002	21	18	$ 55,181
31	6	8G-MH004_8G-MH030	8G-MH004	8G-MH030	3.799	166	0.004	21	18	$ 23,904
32	6	8G-MH007_8G-MH026	8G-MH007	8G-MH026	3.742	253	0.003	21	18	$ 36,461
33	6	8G-MH008_8G-MH009	8G-MH008	8G-MH009	3.918	296	0.002	21	18	$ 42,552
34	6	8G-MH009_8G-MH055	8G-MH009	8G-MH055	3.934	401	0.012	21	18	$ 57,730
35	6	8G-MH026_8G-MH004	8G-MH026	8G-MH004	3.793	61	0.003	21	18	$ 8,784
36	6	8G-MH030_8G-MH008	8G-MH030	8G-MH008	3.901	126	0.001	21	18	$ 18,072
37	13	8G-MH033_9G-MH062	8G-MH033	9G-MH062	3.958	399	0.002	21	18	$ 57,428
38	6	8G-MH055_8G-MH033	8G-MH055	8G-MH033	3.948	396	0.003	21	18	$ 56,981
39	3	9A-MH007_9A-MH008	9A-MH007	9A-MH008	1.828	364	0.005	15	10	$ 38,981
40	3	9A-MH008_9A-MH029	9A-MH008	9A-MH029	1.829	290	0.005	15	10	$ 31,073
41	3	9A-MH016_9A-MH007	9A-MH016	9A-MH007	1.823	398	0.010	12	10	$ 35,422
42	3	9A-MH023_9A-MH024	9A-MH023	9A-MH024	1.240	136	0.007	10	8	$ 10,434
43	3	9A-MH024_9A-MH016	9A-MH024	9A-MH016	1.811	262	0.010	12	10	$ 23,274
44	3	9A-MH029_9A-MH020	9A-MH029	9A-MH020	1.830	205	0.019	15	10	$ 21,978
45	13	9G-MH006_9G-MH078	9G-MH006	9G-MH078	1.578	88	0.002	15	12	$ 9,416
46	13	9G-MH008_9G-MH006	9G-MH008	9G-MH006	1.577	407	0.003	15	12	$ 43,560
47	8	9G-MH014_9G-MH015	9G-MH014	9G-MH015	1.575	335	0.002	15	12	$ 35,824
48	13	9G-MH015_9G-MH016	9G-MH015	9G-MH016	1.581	321	0.003	15	12	$ 34,347
49	13	9G-MH016_9G-MH008	9G-MH016	9G-MH008	1.578	240	0.003	15	12	$ 25,713
50	8	9G-MH018_9G-MH014	9G-MH018	9G-MH014	1.567	261	0.002	15	12	$ 27,895
51	7	9G-MH040_9G-MH041	9G-MH040	9G-MH041	2.793	87	0.003	18	15	$ 10,913
52	7	9G-MH041_9G-MH066	9G-MH041	9G-MH066	2.829	576	0.003	18	15	$ 72,000
53	7	9G-MH042_9G-MH040	9G-MH042	9G-MH040	2.675	138	0.003	18	15	$ 17,288
54	7	9G-MH045_9G-MH042	9G-MH045	9G-MH042	2.598	410	0.003	18	15	$ 51,275
55	13	9G-MH055_9G-MH054	9G-MH055	9G-MH054	2.890	114	0.069	18	15	$ 14,263
56	13	9G-MH056_9G-MH057	9G-MH056	9G-MH057	2.888	28	0.002	18	15	$ 3,488
57	13	9G-MH057_9G-MH055	9G-MH057	9G-MH055	2.889	35	0.086	18	15	$ 4,363
58	13	9G-MH058_9G-MH054	9G-MH058	9G-MH054	3.952	337	0.003	21	18	$ 48,514
59	13	9G-MH060_9G-MH052	9G-MH060	9G-MH052	1.582	275	0.041	15	12	$ 29,468
60	13	9G-MH062_9G-MH058	9G-MH062	9G-MH058	3.955	404	0.003	21	18	$ 58,133
61	7	9G-MH066_9G-MH056	9G-MH066	9G-MH056	2.856	364	0.003	18	15	$ 45,475
62	13	9G-MH078_9G-MH060	9G-MH078	9G-MH060	1.580	257	0.002	15	12	$ 27,478
									Total Cost:	**$ 1,913,965**

Appendix P
Technical Memorandum – “Population and Land Use”

Technical Memorandum – Population and Land Use

This technical memorandum is intended to develop population and land use projections for a 20 year planning period. The study period extends to the year 2025. The information will be used to model future water demand for the City of Belton's Water System Master Plan.

Study Area Description

The study area boundary includes the existing Belton City limits as well as potential growth areas to the south and west. The City currently consists of approximately 8,730 acres of developed and undeveloped land. It is generally bounded on the north by the Cass County line (155th St.), Holmes Road on the west, Missouri Highway 71 on the east, and 187th St. to the south. Future population and land use projections, include an additional 5,925 acres of potential annexation area identified by the City.

Current and Projected Population

Population projections have been prepared based on historical data provided by the City, and data that are available through the Mid-America Regional Council (MARC). MARC compiles and updates local and regional U.S. Census Bureau data, employment, birth and death rates, immigration and emigration rates and economic data to forecast local and regional demographic trends in the Kansas City metropolitan area, including Belton and all of Cass County.

The *2002 Long-Range Population, Households and Employment Forecast* prepared by MARC clearly states that Cass County will lead the Kansas City metropolitan area and the component Counties in *rate of population growth* over the forecast period through

2030. In particular, "North Cass County", including Belton, Raymore, and Pleasant Hill Township and the surrounding area is forecast to grow by 78% over the 30 year period. The area defined by MARC as "North Cass County" is shown by census tracts on Figure 2 – 1.

Several surrounding communities in the area were selected as being similar in growth or representative of the rate of growth that is being experienced in the City of Belton. These areas are identified as *Community Analysis Areas* or CAA's by MARC. The growth rate projections in the selected areas are included for comparison purposes in this report. The areas selected for comparison are CAA's identified by MARC in the *2002 Long Range Plan* as North Cass County, Eastern Jackson County and Olathe. Census tract identification and maps of these selected areas are included in Appendix A. The forecast growth rates for these areas are included in Table 2 – 1.

The MARC also compiles annual U.S. Census Bureau updates of the area's estimated city populations. The 2003 Census Bureau population estimates for Belton were 21,931 for the year 2000 and 23,575 in 2003. This represents a 2.45% annual rate of growth for the City over the three year period between 2000 and 2003. It is consistent with MARC's projected population growth rate of 2.46% per year for North Cass County through 2010. This rate of growth applied to the City through 2010 yields an estimate population of nearly 28,000.

To arrive at a population forecast through the year 2025, MARC's projected growth rates for North Cass County were applied. The resulting projection for Belton is a population of 37,208 in 2025. When comparing this number with historical and projected growth rates in the selected CAAs, it appears reasonable. The population history and forecast for Belton is shown on Table 2 – 1.

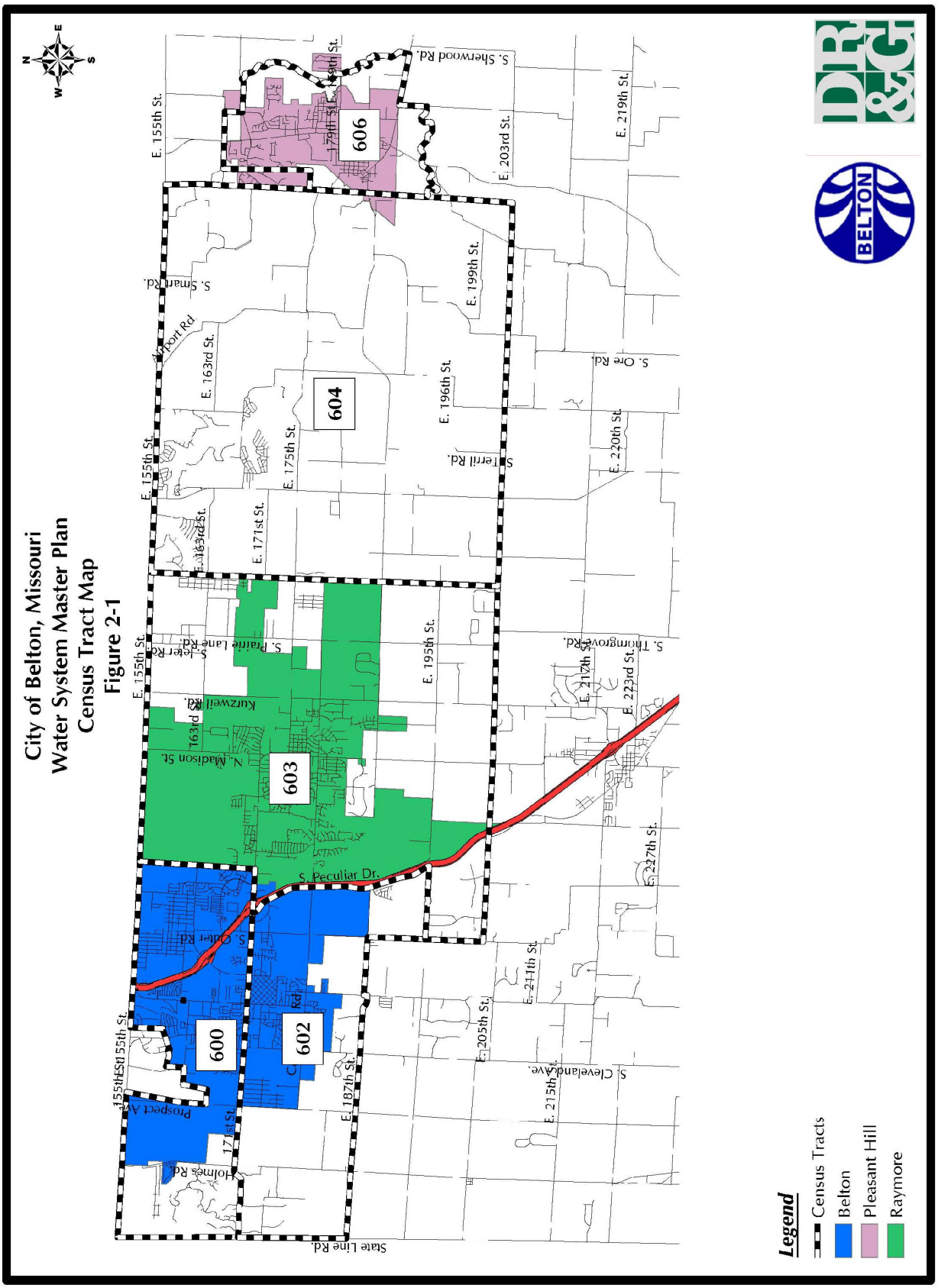

City of Belton, Missouri
Water System Master Plan
Census Tract Map
Figure 2-1
606
604
603
602
600
E. 155th St.
E. 163rd St.
E. 171st St.
E. 175th St.
E. 179th St.
E. 187th St.
E. 195th St.
E. 199th St.
E. 203rd St.
E. 205th St.
E. 211th St.
E. 215th St.
E. 217th St.
E. 219th St.
E. 220th St.
E. 223rd St.
E. 227th St.
S. Sherwood Rd.
S. Smart Rd.
S. Airport Rd.
S. Ore Rd.
S. Terril Rd.
S. Prairie Lane Rd.
S. Peculiar Dr.
S. Outer Rd.
S. Cleveland Ave.
S. Timmgrove Rd.
N. Madison St.
Kurzweil Rd.
Holmes Rd.
Prospect Ave.
State Line Rd.
Legend
Census Tracts
Belton
Pleasant Hill
Raymore

Table 2-1
Study Area Historical Population and Forecast Population

	Population History & Forecast						Belton	
Year	North Cass Co.	Growth % annual	E Jackson incl. Lee's Summit	Growth % annual	Olathe	Growth % annual	History & Forecast Belton	Growth % annual
1970	19,801		31,342		18,694		12,270	
1980	24,467	2.15	62,400	7.13	38,071	7.37	13,533	1.00
1990	33,636	3.20	89,296	3.65	62,574	5.09	18,270	3.10
2000	46,012	3.21	115,394	2.60	80,203	2.51	21,931	1.80
2003							23,575	2.45
2010	58,722	2.46	138,133	1.81	101,660	2.40	27,947	2.46
2015							31,236	2.25
2020	70,584	1.86	156,167	1.23	119,950	1.67	34,251	1.86
2025							37,208	1.67
2030	81,722	1.48	173,371	1.05	137,347	1.36		

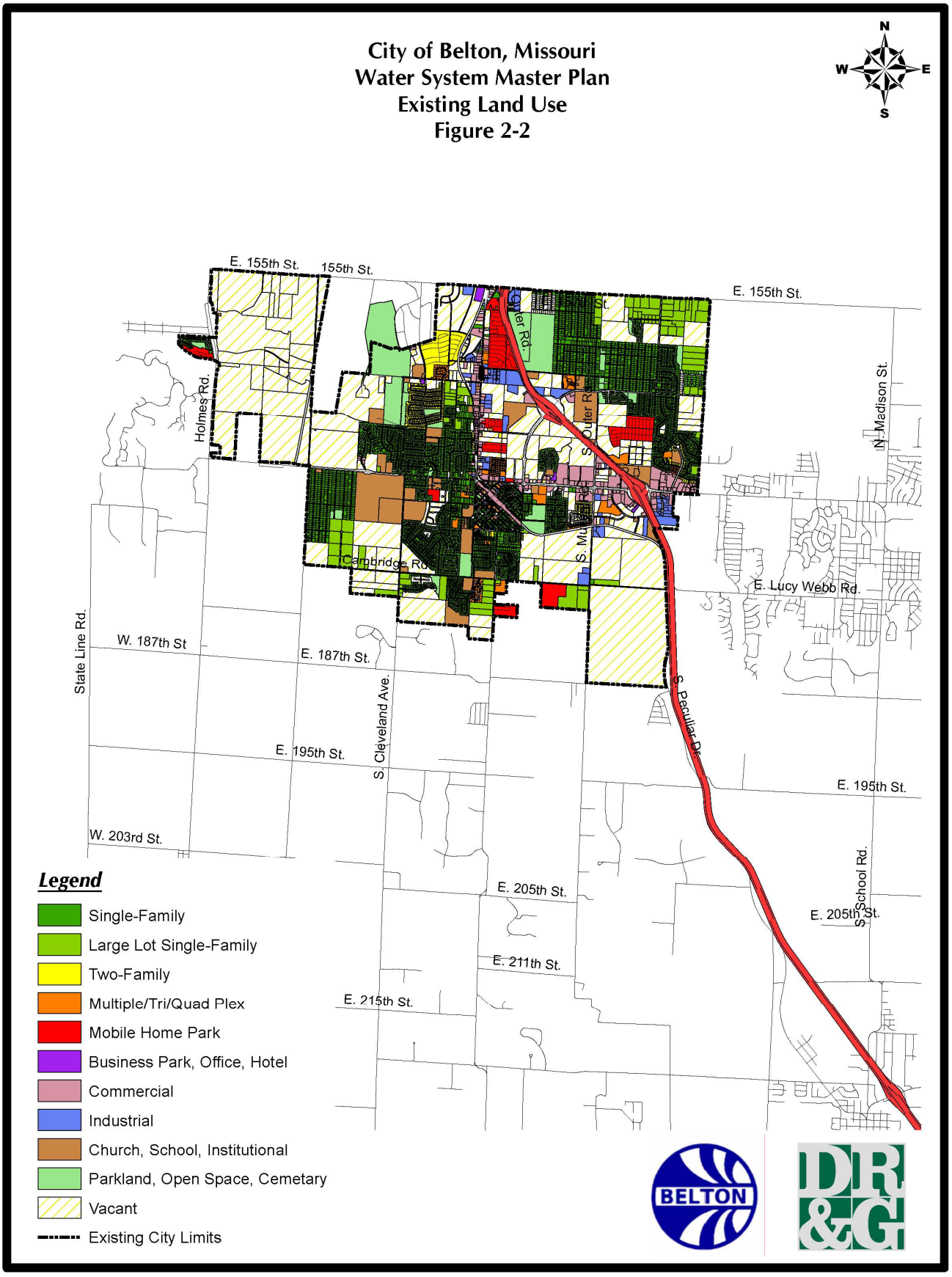
2003 U.S. Census Bureau for Belton

Current and Projected Land Use

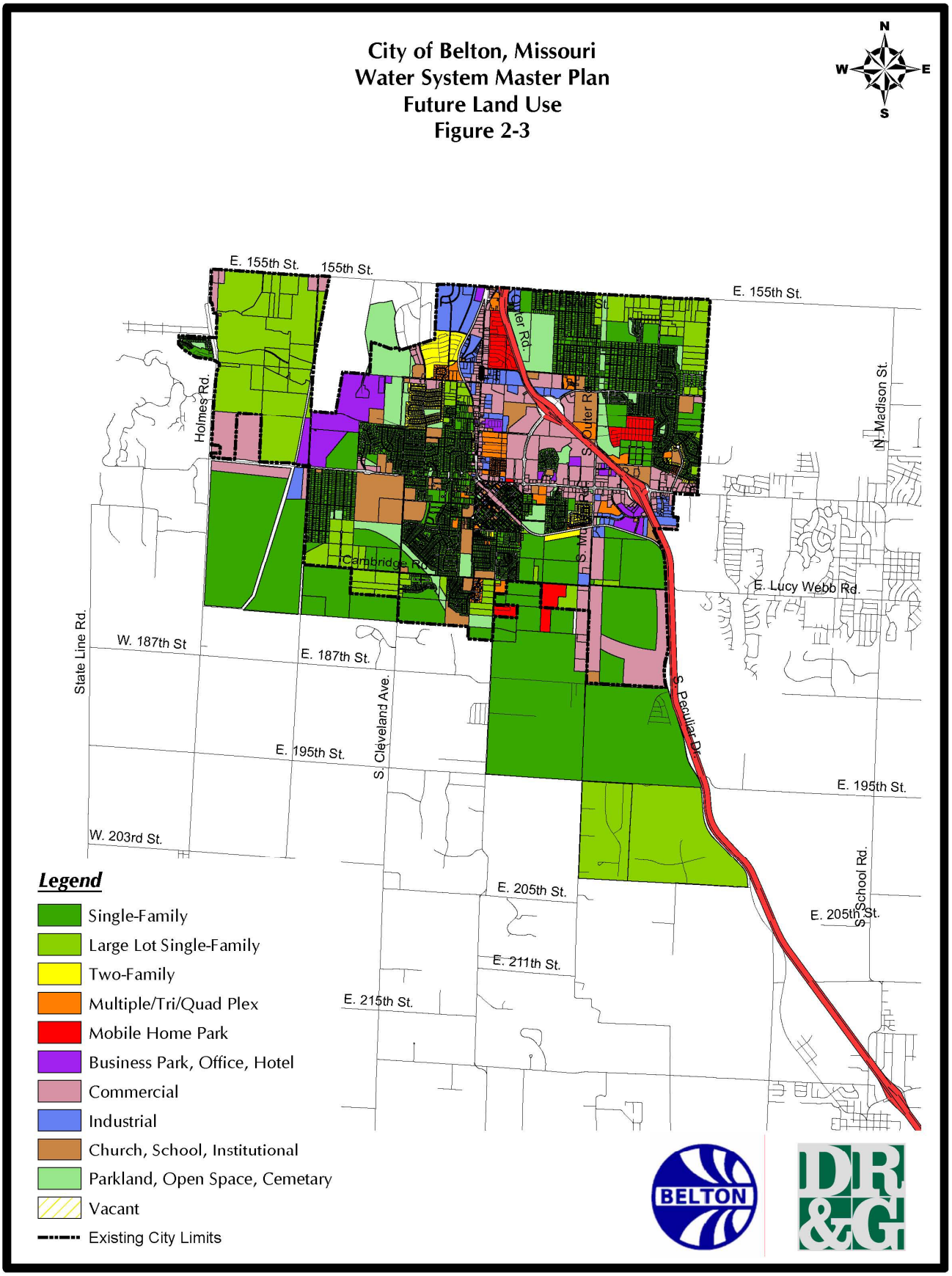
To prepare the Water System Master Plan, population projections need to be matched with land use projections to estimate system water demands for the study period. The City initially provided partial information on existing and fully developed land uses. The data included parcel identification information for approximately 60% of the City. The missing parcel data on current land uses have since been updated and the land use information is illustrated on Figure 2 – 2. Future land use projections include 5,925 acres identified by the City as potential annexation area through the study period. These areas are south and west of the current City boundaries. The Belton City staff provided an estimate of future land uses. These are summarized on Figure 2 – 3.

To project residential land use for 2015 and 2025, a linear increase in annual residential land development, from the year 2005 (current) to ultimate was assumed. This approach requires an approximation of the year in which ultimate population development conditions will occur.

City of Belton, Missouri
Water System Master Plan
Existing Land Use
Figure 2-2



City of Belton, Missouri
Water System Master Plan
Future Land Use
Figure 2-3



The current and ultimate populations were established by applying demographic data and housing unit density data acquired in the year 2000 Census. The census recorded an average household size of 2.71 people and a housing unit vacancy rate of 5%. Average housing unit densities were then assigned to each residential land use type as shown on Table 2 - 2. The household size and vacancy rate data were applied to the estimated housing unit densities for each residential type. With these assumptions, the current population is estimated to be 24,445. This correlates well with the most recent U.S. Census Bureau data for Belton. This procedure was used to verify the unit density estimates.

Future land uses were identified by the City staff. This included an estimated number of acres for each residential and non-residential development type for the ultimate development. Residential development will include a total of 7,650 acres. At the current household size and occupancy rates, the fully developed population for the study area will be approximately 50,800 people. Should an annual population growth rate of 1.4% be sustained beyond the year 2025 as forecast by MARC, the ultimate population for the area will be reached as early as 2045. A linear rate of residential development was assumed over the 40 years period to 2045 and applied to each residential use type as shown on Table 2 - 2. When the assumed housing unit densities, occupancy rate and household sizes are applied to the land use forecast a reasonable correlation with the previously discussed population forecast is produced. This provides verification of the land use estimates.

Non-residential land uses were projected by calculating the number of acres per capita for the current land use and the ultimate land use. Changes in the acreage per capita for non-residential uses were applied linearly as development occurs. The results for non-residential land use development are also shown in Table 2- 2.

Table 2 - 2

Belton Population and Land Use Estimates

Land Use Type	Average Density Units/acre	Year 2005			Year 2015			Year 2025			Year 2045		
		2005 Acres	# of Units	Population*	2015 Acres	# of Units	Population*	2025 Acres	# of Units	Population*	2045 Acres	# of Units	Population*
RESIDENTIAL													
Single-Family	3	1,611	4,833	12,443	2,291	6873	17,694	2,971	8,913	22,946	4,331	12,993	33,450
Large Lot Single family	0.20	513	103	264	973	195	501	1,432	286	738	2,352	470	1,211
Two-Family	4	314	1,257	3,237	341	1365	3,515	368	1,473	3,793	422	1,689	4,348
Multi / Tri / Quad plex	10	129	1,291	3,323	163	1630	4,195	197	1,968	5,068	265	2,646	6,812
Mobil Home Park	7	287	2,011	5,177	285	1994	5,134	282	1,977	5,090	278	1,943	5,003
RESIDENTIAL - Developed		**2,854**	**9,495**	**24,445**	**4,053**	**12,057**	**31,040**	**5,251**	**14,618**	**37,635**	**7,648**	**19,741**	**50,824**
NON-RESIDENTIAL			Percent of Total	Acres per 1000 cap		Percent of Total	Acres per 1000 cap		Percent of Total	Acres per 1000 cap		Percent of Total	Acres per 1000 cap
Business Park, Office, Hotel		13	0.3%	0.5	150	2.5%	4.8	800	9.2%	9.7	1,010	7.2%	19.9
Commercial		322	7.2%	13.2	328	5.4%	10.6	795	9.1%	21.1	2,817	20.1%	55.4
Industrial		176	3.9%	7.2	223	3.7%	7.2	275	3.1%	7.3	377	2.7%	7.4
Church, School, Institutional		579	12.9%	23.7	714	11.7%	23.0	866	9.9%	23.0	1,153	8.2%	22.7
Parkland, Open Space, Cemetary		559	12.4%	22.9	652	10.7%	21.0	753	8.6%	20.0	1,002	7.2%	19.7
NON-RESIDENTIAL - Developed		**1,650**			**2,067**			**3,488**			**6,359**		
TOTAL Developed		**4,504**			**6,120**			**8,739**			**14,007**		
Vacant, Agricultural		4,225			8,535			5,916			648		
TOTAL CITY		**8,730**			**14,654**			**14,654**			**14,654**		
Future Annexation		5,925											
TOTAL W / ANNEXATION		**14,654**											

*** average 2.71 people per household and 5% vacancy**

Appendix Q
Flow Analysis Reports for Future Conditions
(30% I/I Removal)

Belton, MO
Flow Analysis Report
Future Growth - Overloaded Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
1	10D-MH009_10D-MH035	10D-MH009	10D-MH035	10	240	0.008	1.746	1.612	0.015	1.080	162	2.03	12	$27,406
2	10D-MH012_10D-MH036	10D-MH012	10D-MH036	10	410	0.009	1.552	1.367	0.015	1.131	137	2.12	12	$46,786
3	10D-MH022_10D-MH020	10D-MH022	10D-MH020	10	353	0.003	0.757	1.152	0.015	0.655	116	1.23	12	$40,254
4	10D-MH035_10D-MH007	10D-MH035	10D-MH007	10	138	0.007	1.767	1.758	0.015	1.002	176	1.88	12	$15,687
5	10D-MH036_10D-MH009	10D-MH036	10D-MH009	10	284	0.012	1.603	1.188	0.015	1.346	119	2.52	12	$32,376
6	10D-MH037_10D-MH012	10D-MH037	10D-MH012	10	322	0.011	1.487	1.175	0.015	1.261	118	2.37	12	$36,651
7	10D-MH038_10D-MH019	10D-MH038	10D-MH019	10	147	0.010	1.273	1.017	0.015	1.249	102	1.44	10	$13,994
8	10J-MH002_10J-MH001	10J-MH002	10J-MH001	36	373	0.001	14.388	1.476	0.014	9.714	148	15.78	42	$133,233
9	10J-MH004_10J-MH003	10J-MH004	10J-MH003	30	379	0.002	12.914	1.208	0.014	10.656	121	14.80	33	$105,980
10	10J-MH005_10J-MH004	10J-MH005	10J-MH004	30	423	0.002	12.875	1.185	0.014	10.829	119	15.04	33	$118,524
11	10J-MH006_10J-MH005	10J-MH006	10J-MH005	30	375	0.002	12.833	1.239	0.014	10.324	124	14.33	33	$104,972
12	10K-MH001_10L-MH007	10K-MH001	10L-MH007	36	398	0.001	14.418	1.069	0.014	13.450	107	14.48	36	$118,664
13	10K-MH002_10K-MH001	10K-MH002	10K-MH001	36	413	0.001	14.418	1.169	0.014	12.290	117	19.97	42	$147,549
14	10K-MH003_10K-MH002	10K-MH003	10K-MH002	36	397	0.001	14.416	1.012	0.014	14.193	102	15.29	36	$118,396
15	10L-MH003_10L-MH002	10L-MH003	10L-MH002	36	254	0.001	14.388	1.044	0.014	13.742	105	14.80	36	$75,782
16	11A-MH035_11A-MH036	11A-MH035	11A-MH036	8	64	0.004	0.893	2.002	0.015	0.445	201	0.93	10	$6,090
17	11A-MH036_11A-MH037	11A-MH036	11A-MH037	8	111	0.002	0.899	2.657	0.015	0.337	267	1.15	12	$12,666
18	11A-MH055_11A-MH054	11A-MH055	11A-MH054	8	200	0.003	0.602	1.411	0.013	0.425	142	0.77	10	$18,962
19	11A-MH068_11A-MH037	11A-MH068	11A-MH037	24	454	0.003	8.763	1.219	0.014	7.164	122	10.56	27	$100,766
20	11B-MH010_11A-MH011	11B-MH010	11A-MH011	8	266	0.003	0.429	1.026	0.013	0.417	103	0.76	10	$25,251
21	11D-MH021_11C-MH012	11D-MH021	11C-MH012	15	390	0.004	3.057	1.219	0.014	2.501	122	4.38	18	$66,368
22	11D-MH039_11D-MH038	11D-MH039	11D-MH038	15	270	0.002	3.009	1.874	0.014	1.601	188	4.23	21	$50,666
23	12B-MH008_12B-MH056	12B-MH008	12B-MH056	8	289	0.004	0.511	1.009	0.013	0.504	101	0.91	10	$27,474
24	12B-MH010_12B-MH008	12B-MH010	12B-MH008	8	381	0.004	0.502	1.068	0.013	0.469	107	0.85	10	$36,233
25	12B-MH056_12B-MH082	12B-MH056	12B-MH082	8	291	0.003	0.519	1.143	0.013	0.452	115	0.82	10	$27,607
26	12B-MH057_12A-MH042	12B-MH057	12A-MH042	24	486	0.002	8.625	1.380	0.014	6.232	138	9.19	27	$107,804
27	12B-MH058_12B-MH057	12B-MH058	12B-MH057	24	377	0.001	8.621	1.767	0.014	4.863	177	9.50	30	$90,456
28	12B-MH069_12B-MH058	12B-MH069	12B-MH058	24	494	0.002	8.013	1.207	0.014	6.618	121	9.76	27	$109,757
29	12B-MH070_12B-MH073	12B-MH070	12B-MH073	24	118	0.002	8.010	1.332	0.014	5.994	134	8.84	27	$26,174
30	12B-MH071_12B-MH070	12B-MH071	12B-MH070	24	179	0.003	8.010	1.080	0.014	7.390	108	10.90	27	$39,672
31	12B-MH072_12B-MH071	12B-MH072	12B-MH071	24	425	0.002	8.007	1.313	0.014	6.082	132	8.97	27	$94,395
32	12B-MH073_12B-MH074	12B-MH073	12B-MH074	24	214	0.002	8.010	1.494	0.014	5.346	150	10.44	30	$51,336
33	12B-MH074_12B-MH075	12B-MH074	12B-MH075	24	257	0.002	8.011	1.220	0.014	6.548	122	9.65	27	$57,121
34	12B-MH075_12B-MH069	12B-MH075	12B-MH069	24	209	0.003	8.011	1.086	0.014	7.350	109	10.84	27	$46,310
35	12D-MH014_FU-MH329	12D-MH014	FU-MH329	8	322	0.010	0.890	1.148	0.013	0.773	115	1.40	10	$30,558
36	12D-MH029_12D-MH014	12D-MH029	12D-MH014	8	10	0.008	0.888	1.504	0.015	0.589	151	1.23	10	$979
37	12H-MH001_12I-MH008	12H-MH001	12I-MH008	12	396	0.003	2.811	2.301	0.013	1.218	231	3.59	18	$67,388
38	12H-MH1TD_12H-MH1TC	12H-MH1TD	12H-MH1TC	8	363	0.009	0.775	1.043	0.013	0.741	105	1.34	10	$34,488
39	12I-MH001_12J-MH007	12I-MH001	12J-MH007	12	394	0.002	3.130	2.853	0.013	1.094	286	3.22	18	$66,997
40	12I-MH002_12I-MH001	12I-MH002	12I-MH001	12	398	0.002	3.093	2.700	0.013	1.142	271	3.37	18	$67,643
41	12I-MH003_12I-MH002	12I-MH003	12I-MH002	12	396	0.003	3.055	2.569	0.013	1.185	258	3.50	18	$67,286
42	12I-MH004_12I-MH003	12I-MH004	12I-MH003	12	394	0.003	3.013	2.458	0.013	1.222	247	3.60	18	$66,929
43	12I-MH005_12I-MH004	12I-MH005	12I-MH004	12	299	0.003	2.971	2.281	0.013	1.298	229	3.83	18	$50,762
44	12I-MH006_12I-MH005	12I-MH006	12I-MH005	12	390	0.003	2.927	2.147	0.013	1.359	215	4.01	18	$66,351
45	12I-MH007_12I-MH006	12I-MH007	12I-MH006	12	397	0.004	2.883	2.045	0.013	1.405	205	4.14	18	$67,473
46	12I-MH008_12I-MH007	12I-MH008	12I-MH007	12	401	0.003	2.848	2.183	0.013	1.300	219	3.83	18	$68,170
47	12J-MH001_12K-MH010	12J-MH001	12K-MH010	12	398	0.007	4.290	2.239	0.013	1.910	225	5.63	18	$67,643
48	12J-MH002_12J-MH001	12J-MH002	12J-MH001	12	387	0.005	4.254	2.495	0.013	1.700	250	5.01	18	$65,773
49	12J-MH003_12J-MH002	12J-MH003	12J-MH002	12	390	0.003	4.217	3.455	0.013	1.217	347	5.41	21	$73,302

Belton, MO
Flow Analysis Report
Future Growth - Overloaded Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
50	12J-MH003Z_12J-MH003	12J-MH003Z	12J-MH003	8	30	0.004	0.940	1.898	0.013	0.494	190	1.46	12	$3,420
51	12J-MH004_12J-MH003	12J-MH004	12J-MH003	12	403	0.006	3.288	1.860	0.013	1.762	187	5.19	18	$68,476
52	12J-MH005_12J-MH004	12J-MH005	12J-MH004	12	384	0.007	3.244	1.714	0.013	1.887	172	3.42	15	$54,500
53	12J-MH007_12J-MH006	12J-MH007	12J-MH006	12	402	0.003	3.166	2.565	0.013	1.231	257	3.63	18	$68,391
54	12J-MH3T1_12J-MH003Z	12J-MH3T1	12J-MH003Z	8	250	0.011	0.892	1.076	0.013	0.826	108	1.50	10	$23,791
55	12J-MH3T2_12J-MH3T1	12J-MH3T2	12J-MH3T1	8	291	0.011	0.837	1.010	0.013	0.826	101	1.50	10	$27,601
56	12K-MH001_12L-MH008	12K-MH001	12L-MH008	12	396	0.005	4.350	2.800	0.013	1.549	281	4.57	18	$67,388
57	12K-MH002_12K-MH001	12K-MH002	12K-MH001	12	369	0.004	4.348	2.925	0.013	1.482	293	4.37	18	$62,747
58	12K-MH003_12K-MH002	12K-MH003	12K-MH002	12	402	0.003	4.349	3.648	0.013	1.188	366	5.28	21	$75,482
59	12K-MH004_12K-MH003	12K-MH004	12K-MH003	12	261	0.002	4.345	4.300	0.013	1.007	431	4.48	21	$49,068
60	12K-MH005_12K-MH004	12K-MH005	12K-MH004	12	244	0.003	4.340	3.222	0.013	1.343	323	5.97	21	$45,797
61	12K-MH006_12K-MH005	12K-MH006	12K-MH005	12	367	0.003	4.334	3.534	0.013	1.222	355	5.44	21	$68,902
62	12K-MH007_12K-MH006	12K-MH007	12K-MH006	12	378	0.004	4.327	3.093	0.013	1.395	310	6.20	21	$71,008
63	12K-MH008_12K-MH007	12K-MH008	12K-MH007	12	350	0.007	4.319	2.261	0.013	1.904	227	5.61	18	$59,500
64	12K-MH009_12K-MH008	12K-MH009	12K-MH008	12	198	0.002	4.309	3.766	0.013	1.141	378	5.07	21	$37,206
65	12K-MH010_12K-MH009	12K-MH010	12K-MH009	12	230	0.003	4.298	3.157	0.013	1.357	317	6.04	21	$43,146
66	12L-MH001_12M-MH007	12L-MH001	12M-MH007	15	396	0.003	5.481	2.586	0.013	2.113	259	7.40	24	$81,221
67	12L-MH002_12L-MH001	12L-MH002	12L-MH001	15	198	0.003	5.477	2.343	0.013	2.330	235	5.72	21	$37,149
68	12L-MH003_12L-MH002	12L-MH003	12L-MH002	15	287	0.002	5.474	3.351	0.013	1.628	336	5.70	24	$58,835
69	12L-MH004_12L-MH003	12L-MH004	12L-MH003	15	286	0.002	5.471	2.910	0.013	1.874	292	6.56	24	$58,651
70	12L-MH005_12L-MH004	12L-MH005	12L-MH004	15	221	0.003	5.465	2.488	0.013	2.190	250	7.67	24	$45,346
71	12L-MH006_12L-MH005	12L-MH006	12L-MH005	15	401	0.002	5.459	2.718	0.013	2.002	273	7.01	24	$82,123
72	12L-MH007_12L-MH006	12L-MH007	12L-MH006	15	353	0.002	5.451	2.844	0.013	1.911	285	6.69	24	$72,263
73	12L-MH009_12L-MH007	12L-MH009	12L-MH007	15	401	0.004	4.382	1.725	0.013	2.532	173	6.21	21	$75,313
74	12L-MH7T1_12L-MH007	12L-MH7T1	12L-MH007	10	310	0.004	1.071	1.208	0.013	0.884	121	1.44	12	$35,297
75	12L-MH7T2_12L-MH7T1	12L-MH7T2	12L-MH7T1	10	291	0.004	1.055	1.190	0.013	0.884	119	1.44	12	$33,208
76	12L-MH7T3_12L-MH7T2	12L-MH7T3	12L-MH7T2	10	259	0.004	1.038	1.171	0.013	0.884	117	1.44	12	$29,566
77	12L-MH7T4_12L-MH7T3	12L-MH7T4	12L-MH7T3	10	354	0.004	1.021	1.152	0.013	0.884	116	1.44	12	$40,381
78	12L-MH7T5_12L-MH7T4	12L-MH7T5	12L-MH7T4	10	370	0.004	1.003	1.130	0.013	0.884	113	1.44	12	$42,183
79	12L-MH7T6_12L-MH7T5	12L-MH7T6	12L-MH7T5	10	438	0.004	0.983	1.109	0.013	0.884	111	1.44	12	$49,974
80	12L-MH7T7_12L-MH7T6	12L-MH7T7	12L-MH7T6	10	361	0.004	0.964	1.087	0.013	0.884	109	1.44	12	$41,136
81	12L-MH7T8_12L-MH7T7	12L-MH7T8	12L-MH7T7	10	384	0.004	0.947	1.068	0.013	0.884	107	1.44	12	$43,738
82	12L-MH7T9_12L-MH7T8	12L-MH7T9	12L-MH7T8	10	481	0.004	0.930	1.049	0.013	0.884	105	1.44	12	$54,834
83	12L-MH7TA_12L-MH7T9	12L-MH7TA	12L-MH7T9	10	369	0.004	0.912	1.028	0.013	0.884	103	1.44	12	$42,010
84	12L-MH7TB_12L-MH7TA	12L-MH7TB	12L-MH7TA	10	317	0.004	0.893	1.007	0.013	0.884	101	1.44	12	$36,082
85	12M-MH001_12N-MH002	12M-MH001	12N-MH002	15	350	0.003	5.500	2.621	0.013	2.092	263	7.33	24	$71,791
86	12M-MH002_12M-MH001	12M-MH002	12M-MH001	15	404	0.002	5.503	2.662	0.013	2.061	267	7.22	24	$82,718
87	12M-MH003_12M-MH002	12M-MH003	12M-MH002	15	397	0.002	5.505	3.212	0.013	1.708	322	5.98	24	$81,344
88	12M-MH004_12M-MH008	12M-MH004	12M-MH008	15	271	0.003	5.499	2.391	0.013	2.293	240	5.62	21	$50,930
89	12M-MH005_12M-MH004	12M-MH005	12M-MH004	15	399	0.002	5.494	3.239	0.013	1.691	325	5.92	24	$81,795
90	12M-MH006_12M-MH005	12M-MH006	12M-MH005	15	398	0.002	5.488	3.001	0.013	1.823	301	6.38	24	$81,529
91	12M-MH007_12M-MH006	12M-MH007	12M-MH006	15	401	0.004	5.480	2.030	0.013	2.691	204	6.60	21	$75,351
92	12M-MH008_12M-MH003	12M-MH008	12M-MH003	15	341	0.002	5.504	2.792	0.013	1.965	280	6.88	24	$69,987
93	12N-MH001_12N-LS001	12N-MH001	12N-LS001	36	35	0.002	19.934	1.061	0.014	18.724	106	20.16	36	$10,341
94	12N-MH002_12N-MH005	12N-MH002	12N-MH005	18	397	0.003	5.506	1.548	0.013	3.547	155	7.64	24	$81,344
95	12N-MH004_12N-MH001	12N-MH004	12N-MH001	18	291	0.003	5.519	1.562	0.013	3.523	157	7.59	24	$59,635
96	12N-MH005_12N-MH004	12N-MH005	12N-MH004	18	398	0.002	5.513	2.070	0.013	2.655	208	5.72	24	$81,672
97	13D-MH023_13D-MH090	13D-MH023	13D-MH090	8	261	0.015	0.981	1.022	0.013	0.957	102	1.74	10	$24,748
98	13D-MH065_13D-MH068	13D-MH065	13D-MH068	8	242	0.006	0.676	1.094	0.013	0.616	110	1.12	10	$23,000

Belton, MO
Flow Analysis Report
Future Growth - Overloaded Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
99	13D-MH090_13D-MH093	13D-MH090	13D-MH093	8	263	0.009	0.989	1.322	0.013	0.746	133	1.35	10	$25,014
100	13D-MH091_13D-MH021	13D-MH091	13D-MH021	8	298	0.007	1.111	1.697	0.013	0.653	170	1.18	10	$28,348
101	13D-MH092_13D-MH091	13D-MH092	13D-MH091	8	137	0.009	1.107	1.533	0.013	0.720	154	1.31	10	$13,034
102	13D-MH093_13D-MH092	13D-MH093	13D-MH092	8	164	0.013	0.996	1.111	0.013	0.894	111	1.62	10	$15,580
103	13E-MH001_13E-MH009	13E-MH001	13E-MH009	8	217	0.003	0.382	1.020	0.015	0.374	102	0.78	10	$20,596
104	13E-MH004_13E-MH018	13E-MH004	13E-MH018	8	130	0.005	0.540	1.128	0.015	0.477	113	1.00	10	$12,303
105	13E-MH006_13E-MH011	13E-MH006	13E-MH011	6	253	0.006	0.362	1.460	0.015	0.247	147	1.11	10	$23,997
106	13E-MH011_13E-MH001	13E-MH011	13E-MH001	6	47	0.006	0.377	1.595	0.015	0.236	160	1.06	10	$4,418
107	13E-MH012_13E-MH016	13E-MH012	13E-MH016	8	72	0.004	0.550	1.265	0.015	0.434	127	0.91	10	$6,869
108	13E-MH018_13E-MH012	13E-MH018	13E-MH012	8	144	0.005	0.545	1.136	0.015	0.478	114	1.00	10	$13,699
109	13E-PS002_13E-MH006	13E-PS002	13E-MH006	4	189	0.007	0.316	3.554	0.015	0.089	357	1.18	10	$17,927
110	6A-MH001_6A-MH002	6A-MH001	6A-MH002	8	344	0.005	1.406	2.893	0.015	0.485	290	1.65	12	$39,171
111	6A-MH002_6A-MH003	6A-MH002	6A-MH003	8	195	0.004	1.452	3.234	0.015	0.448	324	1.52	12	$22,242
112	6A-MH003_7A-MH010	6A-MH003	7A-MH010	8	278	0.004	1.510	3.484	0.015	0.432	349	2.67	15	$39,448
113	6A-MH004_6A-MH001	6A-MH004	6A-MH001	8	260	0.014	1.336	1.687	0.015	0.790	169	1.65	10	$24,653
114	6A-MH005_6A-MH004	6A-MH005	6A-MH004	8	211	0.014	1.279	1.605	0.015	0.795	161	1.66	10	$20,007
115	6F-MH013_6F-MH023	6F-MH013	6F-MH023	8	368	0.018	2.903	3.219	0.015	0.899	323	3.06	12	$41,952
116	6F-MH021_6F-MH026	6F-MH021	6F-MH026	8	272	0.005	0.872	1.796	0.015	0.484	180	1.01	10	$25,831
117	6F-MH022_7F-MH005	6F-MH022	7F-MH005	10	392	0.005	4.100	4.750	0.015	0.861	476	4.76	18	$66,708
118	6F-MH023_6F-MH024	6F-MH023	6F-MH024	8	373	0.006	2.992	5.694	0.015	0.524	571	3.23	15	$52,910
119	6F-MH024_6F-MH025	6F-MH024	6F-MH025	10	377	0.007	3.081	2.903	0.015	1.058	291	3.60	15	$53,563
120	6F-MH025_6F-MH031	6F-MH025	6F-MH031	10	283	0.022	3.141	1.730	0.015	1.810	174	3.40	12	$32,205
121	6F-MH026_6F-MH022	6F-MH026	6F-MH022	10	391	0.008	4.091	3.776	0.015	1.080	379	5.98	18	$66,504
122	6F-MH030_6F-MH026	6F-MH030	6F-MH026	10	299	0.004	3.149	4.035	0.015	0.778	405	4.30	18	$50,830
123	6F-MH031_6F-MH030	6F-MH031	6F-MH030	10	299	0.002	3.144	6.259	0.015	0.501	628	4.18	21	$56,175
124	7A-MH001_7A-MH007	7A-MH001	7A-MH007	8	343	0.010	1.839	2.668	0.015	0.687	268	2.34	12	$39,080
125	7A-MH007_7A-MH008	7A-MH007	7A-MH008	8	325	0.002	1.862	6.260	0.015	0.296	628	2.97	18	$55,165
126	7A-MH008_7A-MH012	7A-MH008	7A-MH012	15	238	0.002	3.452	1.983	0.015	1.736	199	4.91	21	$44,726
127	7A-MH009_7A-MH011	7A-MH009	7A-MH011	8	334	0.010	1.729	2.557	0.015	0.674	257	2.29	12	$38,122
128	7A-MH010_7A-MH009	7A-MH010	7A-MH009	8	239	0.004	1.617	3.613	0.015	0.446	362	2.75	15	$33,896
129	7A-MH011_7A-MH001	7A-MH011	7A-MH001	8	356	0.010	1.805	2.706	0.015	0.665	271	2.26	12	$40,630
130	7A-MH012_KC-MH009	7A-MH012	KC-MH009	15	228	0.003	3.532	1.647	0.015	2.138	165	4.01	18	$38,675
131	7B-MH001_7B-MH009	7B-MH001	7B-MH009	8	370	0.004	1.023	2.444	0.015	0.417	245	1.42	12	$42,180
132	7B-MH009_7B-MH012	7B-MH009	7B-MH012	8	515	0.014	1.118	1.402	0.015	0.795	141	1.66	10	$48,944
133	7B-MH010_7B-MH011	7B-MH010	7B-MH011	8	399	0.004	0.893	2.163	0.015	0.411	217	1.40	12	$45,486
134	7B-MH011_7B-MH001	7B-MH011	7B-MH001	8	428	0.016	0.947	1.104	0.015	0.855	111	1.79	10	$40,660
135	7B-MH012_6A-MH005	7B-MH012	6A-MH005	8	463	0.014	1.199	1.503	0.015	0.795	151	1.66	10	$43,985
136	7B-MH013_7B-MH010	7B-MH013	7B-MH010	8	389	0.011	0.710	1.005	0.015	0.705	101	1.47	10	$36,984
137	7F-MH001_7F-MH010	7F-MH001	7F-MH010	15	319	0.004	5.242	2.198	0.015	2.377	221	6.73	21	$60,048
138	7F-MH002_7F-MH004	7F-MH002	7F-MH004	10	244	0.006	4.179	4.319	0.015	0.964	433	5.33	18	$41,480
139	7F-MH003_7F-MH006	7F-MH003	7F-MH006	12	220	0.006	4.522	2.990	0.015	1.508	300	5.13	18	$37,349
140	7F-MH004_7F-MH003	7F-MH004	7F-MH003	10	241	0.004	4.197	5.286	0.015	0.791	530	4.38	18	$41,038
141	7F-MH005_7F-MH002	7F-MH005	7F-MH002	10	402	0.005	4.150	4.867	0.015	0.850	488	4.70	18	$68,408
142	7F-MH006_7F-MH008	7F-MH006	7F-MH008	12	380	0.005	4.559	3.265	0.015	1.392	327	4.74	18	$64,566
143	7F-MH007_7F-MH009	7F-MH007	7F-MH009	15	379	0.003	5.111	2.397	0.015	2.126	240	6.02	21	$71,271
144	7F-MH008_7F-MH007	7F-MH008	7F-MH007	12	330	0.010	4.613	2.328	0.015	1.975	234	6.72	18	$56,168
145	7F-MH009_7F-MH001	7F-MH009	7F-MH001	15	303	0.004	5.164	2.233	0.015	2.305	224	6.52	21	$56,927
146	7F-MH010_8F-MH074	7F-MH010	8F-MH074	18	87	0.004	5.280	1.391	0.015	3.783	140	6.58	21	$16,356
147	8E-MH017_8F-MH005	8E-MH017	8F-MH005	8	283	0.002	0.469	1.388	0.013	0.336	139	0.61	10	$26,847

Belton, MO
Flow Analysis Report
Future Growth - Overloaded Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
148	8F-MH004_8F-MH070	8F-MH004	8F-MH070	8	359	0.003	0.504	1.103	0.013	0.456	111	0.83	10	$34,124
149	8F-MH005_8F-MH014	8F-MH005	8F-MH014	8	192	0.003	0.487	1.233	0.013	0.394	124	0.71	10	$18,221
150	8F-MH014_8F-MH004	8F-MH014	8F-MH004	8	131	0.003	0.495	1.279	0.015	0.386	128	0.81	10	$12,474
151	8F-MH074_8F-MH093	8F-MH074	8F-MH093	18	118	0.003	5.277	1.692	0.015	3.110	170	5.41	21	$22,184
152	8F-MH075_8F-MH076	8F-MH075	8F-MH076	18	97	0.002	6.471	2.283	0.015	2.826	229	7.02	24	$19,803
153	8F-MH076_8F-MH077	8F-MH076	8F-MH077	18	369	0.010	6.477	1.122	0.015	5.752	113	6.64	18	$62,798
154	8F-MH077_8F-MH078	8F-MH077	8F-MH078	18	322	0.003	6.497	2.028	0.015	3.193	203	7.93	24	$66,072
155	8F-MH078_8F-MH087	8F-MH078	8F-MH087	18	80	0.002	6.577	2.441	0.015	2.686	245	6.67	24	$16,318
156	8F-MH079_8F-MH080	8F-MH079	8F-MH080	18	402	0.002	6.562	2.691	0.015	2.430	270	8.27	27	$89,311
157	8F-MH080_8G-MH007	8F-MH080	8G-MH007	18	281	0.008	6.536	1.225	0.015	5.318	123	9.26	21	$52,904
158	8F-MH087_8F-MH088	8F-MH087	8F-MH088	18	401	0.003	6.574	2.117	0.015	3.096	212	7.69	24	$82,123
159	8F-MH088_8F-MH079	8F-MH088	8F-MH079	18	383	0.002	6.572	2.438	0.015	2.687	245	6.68	24	$78,556
160	8F-MH093_8F-MH075	8F-MH093	8F-MH075	18	67	0.005	5.277	1.258	0.015	4.180	126	7.28	21	$12,540
161	8G-MH004_8G-MH030	8G-MH004	8G-MH030	18	166	0.004	6.698	1.853	0.015	3.603	186	8.95	24	$34,030
162	8G-MH007_8G-MH026	8G-MH007	8G-MH026	18	253	0.003	6.639	2.103	0.015	3.147	211	7.82	24	$51,906
163	8G-MH008_8G-MH009	8G-MH008	8G-MH009	18	296	0.002	6.998	2.844	0.015	2.453	285	8.34	27	$65,601
164	8G-MH009_8G-MH055	8G-MH009	8G-MH055	18	401	0.012	7.022	1.097	0.015	6.380	110	7.36	18	$68,153
165	8G-MH026_8G-MH004	8G-MH026	8G-MH004	18	61	0.003	6.694	2.012	0.015	3.317	202	8.24	24	$12,505
166	8G-MH030_8G-MH008	8G-MH030	8G-MH008	18	126	0.001	6.974	3.993	0.015	1.741	401	7.84	30	$30,120
167	8G-MH033_9G-MH062	8G-MH033	9G-MH062	18	399	0.002	7.033	2.950	0.015	2.376	296	8.08	27	$88,534
168	8G-MH055_8G-MH033	8G-MH055	8G-MH033	18	396	0.003	7.048	2.145	0.015	3.276	215	8.14	24	$81,119
169	9A-MH007_9A-MH008	9A-MH007	9A-MH008	10	364	0.005	2.207	2.651	0.015	0.830	266	2.82	15	$51,731
170	9A-MH008_9A-MH029	9A-MH008	9A-MH029	10	290	0.005	2.264	2.726	0.015	0.828	274	2.82	15	$41,237
171	9A-MH011_9A-MH014	9A-MH011	9A-MH014	8	173	0.016	1.250	1.263	0.013	0.987	127	1.79	10	$16,454
172	9A-MH014_9A-MH021	9A-MH014	9A-MH021	10	123	0.007	1.262	1.085	0.013	1.160	109	1.89	12	$14,034
173	9A-MH016_9A-MH007	9A-MH016	9A-MH007	10	398	0.010	2.201	1.787	0.015	1.227	179	2.30	12	$45,372
174	9A-MH018_9A-MH019	9A-MH018	9A-MH019	8	100	0.008	0.694	1.163	0.015	0.595	117	1.24	10	$9,453
175	9A-MH019_9A-MH027	9A-MH019	9A-MH027	8	230	0.008	0.704	1.180	0.015	0.594	118	1.24	10	$21,879
176	9A-MH022_9A-MH023	9A-MH022	9A-MH023	10	98	0.008	1.296	1.051	0.013	1.230	105	2.00	12	$11,207
177	9A-MH023_9A-MH024	9A-MH023	9A-MH024	8	136	0.007	1.475	2.257	0.013	0.652	226	1.92	12	$15,447
178	9A-MH024_9A-MH016	9A-MH024	9A-MH016	10	262	0.010	2.193	1.770	0.015	1.235	178	2.32	12	$29,811
179	9A-MH027_9A-MH024	9A-MH027	9A-MH024	8	189	0.008	0.714	1.199	0.015	0.594	120	1.24	10	$17,936
180	9A-MH029_9A-MH020	9A-MH029	9A-MH020	10	205	0.019	2.308	1.374	0.015	1.675	138	3.14	12	$23,416
181	9B-MH023_9A-MH009	9B-MH023	9A-MH009	8	251	0.005	0.545	1.186	0.015	0.458	119	0.96	10	$23,807
182	9B-MH026_9A-MH013	9B-MH026	9A-MH013	8	268	0.016	1.215	1.396	0.015	0.867	140	1.81	10	$25,451
183	9B-MH034_9B-MH026	9B-MH034	9B-MH026	8	286	0.026	1.200	1.096	0.015	1.092	110	2.28	10	$27,180
184	9B-MH043Z_9B-MH043	9B-MH043Z	9B-MH043	8	156	0.004	0.549	1.108	0.013	0.494	111	0.89	10	$14,782
185	9E-MH025_9E-MH083	9E-MH025	9E-MH083	10	464	0.004	0.796	1.040	0.015	0.764	104	0.88	10	$44,071
186	9E-MH083_9F-MH052	9E-MH083	9F-MH052	10	74	0.005	0.864	1.011	0.015	0.853	101	0.98	10	$7,021
187	9F-MH024_9F-MH047	9F-MH024	9F-MH047	10	314	0.003	0.944	1.231	0.013	0.765	123	1.24	12	$35,751
188	9F-MH025_9F-MH050	9F-MH025	9F-MH050	10	198	0.004	0.985	1.070	0.013	0.918	107	1.49	12	$22,595
189	9F-MH052_9F-MH093	9F-MH052	9F-MH093	10	355	0.003	0.874	1.361	0.015	0.640	137	1.20	12	$40,482
190	9F-MH085_9F-MH044	9F-MH085	9F-MH044	10	225	0.002	0.899	1.472	0.015	0.609	148	1.14	12	$25,605
191	9F-MH093_9F-MH085	9F-MH093	9F-MH085	10	152	0.003	0.890	1.268	0.015	0.700	127	1.31	12	$17,374
192	9G-MH006_9G-MH078	9G-MH006	9G-MH078	12	88	0.002	1.809	1.574	0.013	1.146	158	2.08	15	$12,496
193	9G-MH008_9G-MH006	9G-MH008	9G-MH006	12	407	0.003	1.798	1.457	0.013	1.230	146	2.23	15	$57,809
194	9G-MH014_9G-MH015	9G-MH014	9G-MH015	12	335	0.002	1.769	1.545	0.013	1.141	155	2.07	15	$47,542
195	9G-MH015_9G-MH016	9G-MH015	9G-MH016	12	321	0.003	1.784	1.325	0.013	1.342	133	2.43	15	$45,582
196	9G-MH016_9G-MH008	9G-MH016	9G-MH008	12	240	0.003	1.788	1.443	0.013	1.235	145	2.24	15	$34,123

Belton, MO
Flow Analysis Report
Future Growth - Overloaded Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
197	9G-MH018_9G-MH014	9G-MH018	9G-MH014	12	261	0.002	1.764	1.690	0.013	1.041	170	1.89	15	$37,020
198	9G-MH040_9G-MH041	9G-MH040	9G-MH041	15	87	0.003	2.944	1.496	0.015	1.962	150	3.68	18	$14,841
199	9G-MH041_9G-MH066	9G-MH041	9G-MH066	15	576	0.003	2.963	1.264	0.013	2.337	127	3.80	18	$97,920
200	9G-MH042_9G-MH040	9G-MH042	9G-MH040	15	138	0.003	2.807	1.401	0.015	1.998	141	3.75	18	$23,511
201	9G-MH045_9G-MH042	9G-MH045	9G-MH042	15	410	0.003	2.700	1.407	0.015	1.913	141	3.59	18	$69,734
202	9G-MH053_9G-MH059	9G-MH053	9G-MH059	21	236	0.005	11.812	1.790	0.015	6.579	180	14.84	27	$52,437
203	9G-MH054_9G-MH052	9G-MH054	9G-MH052	21	35	0.004	10.051	1.905	0.015	5.260	191	11.86	27	$7,704
204	9G-MH056_9G-MH057	9G-MH056	9G-MH057	15	28	0.002	3.032	1.917	0.015	1.576	192	4.46	21	$5,246
205	9G-MH058_9G-MH054	9G-MH058	9G-MH054	18	337	0.003	7.048	2.350	0.015	2.990	236	7.43	24	$69,065
206	9G-MH059_9H-MH008	9G-MH059	9H-MH008	27	297	0.002	12.336	1.829	0.015	6.723	183	13.25	33	$83,076
207	9G-MH062_9G-MH058	9G-MH062	9G-MH058	18	404	0.003	7.064	2.295	0.015	3.068	230	7.63	24	$82,759
208	9G-MH066_9G-MH056	9G-MH066	9G-MH056	15	364	0.003	2.964	1.242	0.013	2.379	125	3.87	18	$61,846
209	9G-MH078_9G-MH060	9G-MH078	9G-MH060	12	257	0.002	1.819	1.641	0.013	1.105	165	2.00	15	$36,466
210	9H-MH002_9H-MH001	9H-MH002	9H-MH001	27	452	0.002	12.639	1.446	0.014	8.711	145	16.02	33	$126,448
211	9H-MH003_9H-MH002	9H-MH003	9H-MH002	27	504	0.003	12.340	1.263	0.014	9.742	127	13.89	30	$120,888
212	9H-MH004_9H-MH003	9H-MH004	9H-MH003	27	365	0.001	12.333	2.331	0.014	5.274	234	18.45	42	$130,234
213	9H-MH005_9H-MH004	9H-MH005	9H-MH004	27	478	0.002	12.348	1.383	0.014	8.901	139	12.69	30	$114,696
214	9H-MH006_9H-MH005	9H-MH006	9H-MH005	27	501	0.002	12.361	1.509	0.014	8.165	151	15.02	33	$140,308
215	9H-MH007_9H-MH006	9H-MH007	9H-MH006	27	340	0.004	12.332	1.081	0.014	11.375	108	16.22	30	$81,624
216	9H-MH008_9H-MH007	9H-MH008	9H-MH007	27	196	0.003	12.333	1.276	0.014	9.636	128	13.74	30	$47,016
217	9I-MH009_9J-MH007	9I-MH009	9J-MH007	30	494	0.001	12.627	1.518	0.014	8.293	152	14.52	36	$147,153
218	9I-MH010_9I-MH009	9I-MH010	9I-MH009	27	492	0.001	12.630	2.068	0.014	6.089	207	14.12	36	$146,736
219	9I-MH011_9I-MH010	9I-MH011	9I-MH010	27	493	0.001	12.651	1.809	0.014	6.970	182	12.82	33	$138,068
220	9J-MH007_9J-MH006	9J-MH007	9J-MH006	30	498	0.002	12.634	1.144	0.014	11.010	115	15.29	33	$139,412
221	9J-MH008_10J-MH006	9J-MH008	10J-MH006	30	127	0.002	12.781	1.081	0.014	11.789	108	16.37	33	$35,616
222	FU-MH329_FU-MH330	FU-MH329	FU-MH330	8	163	0.010	0.894	1.154	0.013	0.773	116	1.40	10	$15,521
223	FU-MH330_FU-MH331	FU-MH330	FU-MH331	8	99	0.010	0.897	1.158	0.013	0.772	116	1.40	10	$9,425
224	FU-MH331_FU-MH332	FU-MH331	FU-MH332	8	245	0.010	0.899	1.160	0.013	0.773	116	1.40	10	$23,279
225	FU-MH332_FU-MH333	FU-MH332	FU-MH333	8	280	0.010	0.901	1.165	0.013	0.772	117	1.40	10	$26,646
226	FU-MH333_FU-MH334	FU-MH333	FU-MH334	8	271	0.010	0.905	1.168	0.013	0.772	117	1.40	10	$25,722
227	FU-MH334_FU-MH335	FU-MH334	FU-MH335	8	264	0.010	0.908	1.170	0.013	0.773	117	1.40	10	$25,076
228	FU-MH335_FU-MH336	FU-MH335	FU-MH336	8	266	0.010	0.911	1.176	0.013	0.772	118	1.40	10	$25,232
229	FU-MH336_FU-MH337	FU-MH336	FU-MH337	8	247	0.010	0.915	1.183	0.013	0.771	119	1.40	10	$23,462
230	FU-MH337_FU-MH338	FU-MH337	FU-MH338	8	298	0.010	0.916	1.181	0.013	0.773	118	1.40	10	$28,278
231	FU-MH338_11C-MH025	FU-MH338	11C-MH025	8	228	0.010	0.915	1.181	0.013	0.772	118	1.40	10	$21,639
232	KC-MH001_KC-MH003	KC-MH001	KC-MH003	18	154	0.001	3.858	1.739	0.015	2.211	174	5.49	24	$31,468
233	KC-MH002_KC-MH004	KC-MH002	KC-MH004	18	229	0.001	3.913	2.429	0.015	1.606	244	3.99	24	$47,007
234	KC-MH003_KC-MH002	KC-MH003	KC-MH002	18	18	0.003	3.887	1.289	0.015	3.007	129	5.23	21	$3,309
235	KC-MH004_KC-MH005	KC-MH004	KC-MH005	18	187	0.003	4.095	1.281	0.015	3.187	128	5.55	21	$35,081
236	KC-MH005_KC-MH006	KC-MH005	KC-MH006	18	470	0.003	4.288	1.067	0.013	4.007	107	6.04	21	$88,417
237	KC-MH006_KC-MH007	KC-MH006	KC-MH007	18	446	0.004	4.471	1.042	0.013	4.277	105	6.45	21	$83,905
238	KC-MH009_KC-MH010	KC-MH009	KC-MH010	15	284	0.003	3.583	1.738	0.015	2.055	174	3.86	18	$48,314
239	KC-MH010_KC-MH011	KC-MH010	KC-MH011	15	417	0.005	3.639	1.456	0.015	2.492	146	4.68	18	$70,856
240	KC-MH011_KC-MH001	KC-MH011	KC-MH001	18	374	0.003	3.788	1.169	0.015	3.231	117	5.62	21	$70,275
													Total Cost:	**$12,009,777**

Appendix R
Replacement Capacity Improvement Sewer Lines

Belton, MO
Flow Analysis Report
Recommended Capactiy Improvement Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
1	10D-MH009_10D-MH035	10D-MH009	10D-MH035	10	240	0.008	1.746	1.612	0.015	1.080	162	2.03	12	$27,406
2	10D-MH012_10D-MH036	10D-MH012	10D-MH036	10	410	0.009	1.552	1.367	0.015	1.131	137	2.12	12	$46,786
3	10D-MH035_10D-MH007	10D-MH035	10D-MH007	10	138	0.007	1.767	1.758	0.015	1.002	176	1.88	12	$15,687
4	10D-MH036_10D-MH009	10D-MH036	10D-MH009	10	284	0.012	1.603	1.188	0.015	1.346	119	2.52	12	$32,376
5	10D-MH037_10D-MH012	10D-MH037	10D-MH012	10	322	0.011	1.487	1.175	0.015	1.261	118	2.37	12	$36,651
6	11A-MH035_11A-MH036	11A-MH035	11A-MH036	8	64	0.004	0.893	2.002	0.015	0.445	201	1.51	12	$7,308
7	11A-MH036_11A-MH037	11A-MH036	11A-MH037	8	111	0.002	0.899	2.657	0.015	0.337	267	1.15	12	$12,666
8	12D-MH029_12D-MH014	12D-MH029	12D-MH014	8	10	0.008	0.888	1.504	0.015	0.589	151	1.23	10	$979
9	12H-MH001_12I-MH008	12H-MH001	12I-MH008	12	396	0.003	2.811	2.301	0.013	1.218	231	3.59	18	$67,388
10	12I-MH001_12J-MH007	12I-MH001	12J-MH007	12	394	0.002	3.130	2.853	0.013	1.094	286	4.86	21	$74,091
11	12I-MH002_12I-MH001	12I-MH002	12I-MH001	12	398	0.002	3.093	2.700	0.013	1.142	271	5.08	21	$74,806
12	12I-MH003_12I-MH002	12I-MH003	12I-MH002	12	396	0.003	3.055	2.569	0.013	1.185	258	5.27	21	$74,411
13	12I-MH004_12I-MH003	12I-MH004	12I-MH003	12	394	0.003	3.013	2.458	0.013	1.222	247	3.60	18	$66,929
14	12I-MH005_12I-MH004	12I-MH005	12I-MH004	12	299	0.003	2.971	2.281	0.013	1.298	229	3.83	18	$50,762
15	12I-MH006_12I-MH005	12I-MH006	12I-MH005	12	390	0.003	2.927	2.147	0.013	1.359	215	4.01	18	$66,351
16	12I-MH007_12I-MH006	12I-MH007	12I-MH006	12	397	0.004	2.883	2.045	0.013	1.405	205	4.14	18	$67,473
17	12I-MH008_12I-MH007	12I-MH008	12I-MH007	12	401	0.003	2.848	2.183	0.013	1.300	219	3.83	18	$68,170
18	12J-MH001_12K-MH010	12J-MH001	12K-MH010	12	398	0.007	4.290	2.239	0.013	1.910	225	8.50	21	$74,806
19	12J-MH002_12J-MH001	12J-MH002	12J-MH001	12	387	0.005	4.254	2.495	0.013	1.700	250	7.56	21	$72,738
20	12J-MH003_12J-MH002	12J-MH003	12J-MH002	12	390	0.003	4.217	3.455	0.013	1.217	347	5.41	21	$73,302
21	12J-MH004_12J-MH003	12J-MH004	12J-MH003	12	403	0.006	3.288	1.860	0.013	1.762	187	7.83	21	$75,727
22	12J-MH005_12J-MH004	12J-MH005	12J-MH004	12	384	0.007	3.244	1.714	0.013	1.887	172	8.39	21	$72,155
23	12J-MH007_12J-MH006	12J-MH007	12J-MH006	12	402	0.003	3.166	2.565	0.013	1.231	257	5.47	21	$75,633
24	12K-MH001_12L-MH008	12K-MH001	12L-MH008	12	396	0.005	4.350	2.800	0.013	1.549	281	6.89	21	$74,524
25	12K-MH002_12K-MH001	12K-MH002	12K-MH001	12	369	0.004	4.348	2.925	0.013	1.482	293	6.59	21	$69,391
26	12K-MH003_12K-MH002	12K-MH003	12K-MH002	12	402	0.003	4.349	3.648	0.013	1.188	366	5.28	21	$75,482
27	12K-MH004_12K-MH003	12K-MH004	12K-MH003	12	261	0.002	4.345	4.300	0.013	1.007	431	4.48	21	$49,068
28	12K-MH005_12K-MH004	12K-MH005	12K-MH004	12	244	0.003	4.340	3.222	0.013	1.343	323	5.97	21	$45,797
29	12K-MH006_12K-MH005	12K-MH006	12K-MH005	12	367	0.003	4.334	3.534	0.013	1.222	355	5.44	21	$68,902
30	12K-MH007_12K-MH006	12K-MH007	12K-MH006	12	378	0.004	4.327	3.093	0.013	1.395	310	6.20	21	$71,008
31	12K-MH008_12K-MH007	12K-MH008	12K-MH007	12	350	0.007	4.319	2.261	0.013	1.904	227	8.47	21	$65,800
32	12K-MH009_12K-MH008	12K-MH009	12K-MH008	12	198	0.002	4.309	3.766	0.013	1.141	378	5.07	21	$37,206
33	12K-MH010_12K-MH009	12K-MH010	12K-MH009	12	230	0.003	4.298	3.157	0.013	1.357	317	6.04	21	$43,146
34	12L-MH001_12M-MH007	12L-MH001	12M-MH007	15	396	0.003	5.481	2.586	0.013	2.113	259	7.40	24	$81,221
35	12L-MH002_12L-MH001	12L-MH002	12L-MH001	15	198	0.003	5.477	2.343	0.013	2.330	235	8.16	24	$40,508
36	12L-MH003_12L-MH002	12L-MH003	12L-MH002	15	287	0.002	5.474	3.351	0.013	1.628	336	5.70	24	$58,835
37	12L-MH004_12L-MH003	12L-MH004	12L-MH003	15	286	0.002	5.471	2.910	0.013	1.874	292	6.56	24	$58,651
38	12L-MH005_12L-MH004	12L-MH005	12L-MH004	15	221	0.003	5.465	2.488	0.013	2.190	250	7.67	24	$45,346
39	12L-MH006_12L-MH005	12L-MH006	12L-MH005	15	401	0.002	5.459	2.718	0.013	2.002	273	7.01	24	$82,123
40	12L-MH007_12L-MH006	12L-MH007	12L-MH006	15	353	0.002	5.451	2.844	0.013	1.911	285	6.69	24	$72,263
41	12L-MH009_12L-MH007	12L-MH009	12L-MH007	15	401	0.004	4.382	1.725	0.013	2.532	173	6.21	21	$75,313
42	12M-MH001_12N-MH002	12M-MH001	12N-MH002	15	350	0.003	5.500	2.621	0.013	2.092	263	7.33	24	$71,791
43	12M-MH002_12M-MH001	12M-MH002	12M-MH001	15	404	0.002	5.503	2.662	0.013	2.061	267	7.22	24	$82,718
44	12M-MH003_12M-MH002	12M-MH003	12M-MH002	15	397	0.002	5.505	3.212	0.013	1.708	322	5.98	24	$81,344
45	12M-MH004_12M-MH008	12M-MH004	12M-MH008	15	271	0.003	5.499	2.391	0.013	2.293	240	8.03	24	$55,535
46	12M-MH005_12M-MH004	12M-MH005	12M-MH004	15	399	0.002	5.494	3.239	0.013	1.691	325	5.92	24	$81,795
47	12M-MH006_12M-MH005	12M-MH006	12M-MH005	15	398	0.002	5.488	3.001	0.013	1.823	301	6.38	24	$81,529
48	12M-MH007_12M-MH006	12M-MH007	12M-MH006	15	401	0.004	5.480	2.030	0.013	2.691	204	9.42	24	$82,164
49	12M-MH008_12M-MH003	12M-MH008	12M-MH003	15	341	0.002	5.504	2.792	0.013	1.965	280	6.88	24	$69,987

Belton, MO
Flow Analysis Report
Recommended Capactiy Improvement Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
50	12N-MH001_12N-LS001	12N-MH001	12N-LS001	36	35	0.002	19.934	1.061	0.014	18.724	106	30.42	42	$12,388
51	12N-MH002_12N-MH005	12N-MH002	12N-MH005	18	397	0.003	5.506	1.548	0.013	3.547	155	7.64	24	$81,344
52	12N-MH004_12N-MH001	12N-MH004	12N-MH001	18	291	0.003	5.519	1.562	0.013	3.523	157	7.59	24	$59,635
53	12N-MH005_12N-MH004	12N-MH005	12N-MH004	18	398	0.002	5.513	2.070	0.013	2.655	208	5.72	24	$81,672
54	13D-MH023_13D-MH090	13D-MH023	13D-MH090	8	261	0.015	0.981	1.022	0.013	0.957	102	1.74	10	$24,748
55	13D-MH090_13D-MH093	13D-MH090	13D-MH093	8	263	0.009	0.989	1.322	0.013	0.746	133	1.35	10	$25,014
56	13D-MH091_13D-MH021	13D-MH091	13D-MH021	8	298	0.007	1.111	1.697	0.013	0.653	170	1.18	10	$28,348
57	13D-MH092_13D-MH091	13D-MH092	13D-MH091	8	137	0.009	1.107	1.533	0.013	0.720	154	1.31	10	$13,034
58	13D-MH093_13D-MH092	13D-MH093	13D-MH092	8	164	0.013	0.996	1.111	0.013	0.894	111	1.62	10	$15,580
59	6F-MH013_6F-MH023	6F-MH013	6F-MH023	8	368	0.018	2.903	3.219	0.015	0.899	323	3.06	12	$41,952
60	6F-MH021_6F-MH026	6F-MH021	6F-MH026	8	272	0.005	0.872	1.796	0.015	0.484	180	1.01	10	$25,831
61	6F-MH022_7F-MH005	6F-MH022	7F-MH005	10	392	0.005	4.100	4.750	0.015	0.861	476	4.76	18	$66,708
62	6F-MH023_6F-MH024	6F-MH023	6F-MH024	8	373	0.006	2.992	5.694	0.015	0.524	571	3.23	15	$52,910
63	6F-MH024_6F-MH025	6F-MH024	6F-MH025	10	377	0.007	3.081	2.903	0.015	1.058	291	3.60	15	$53,563
64	6F-MH025_6F-MH031	6F-MH025	6F-MH031	10	283	0.022	3.141	1.730	0.015	1.810	174	6.16	15	$40,115
65	6F-MH026_6F-MH022	6F-MH026	6F-MH022	10	391	0.008	4.091	3.776	0.015	1.080	379	5.98	18	$66,504
66	6F-MH030_6F-MH026	6F-MH030	6F-MH026	10	299	0.004	3.149	4.035	0.015	0.778	405	4.30	18	$50,830
67	6F-MH031_6F-MH030	6F-MH031	6F-MH030	10	299	0.002	3.144	6.259	0.015	0.501	628	2.77	18	$50,796
68	7F-MH001_7F-MH010	7F-MH001	7F-MH010	15	319	0.004	5.242	2.198	0.015	2.377	221	6.73	21	$60,048
69	7F-MH002_7F-MH004	7F-MH002	7F-MH004	10	244	0.006	4.179	4.319	0.015	0.964	433	5.33	18	$41,480
70	7F-MH003_7F-MH006	7F-MH003	7F-MH006	12	220	0.006	4.522	2.990	0.015	1.508	300	5.13	18	$37,349
71	7F-MH004_7F-MH003	7F-MH004	7F-MH003	10	241	0.004	4.197	5.286	0.015	0.791	530	4.38	18	$41,038
72	7F-MH005_7F-MH002	7F-MH005	7F-MH002	10	402	0.005	4.150	4.867	0.015	0.850	488	4.70	18	$68,408
73	7F-MH006_7F-MH008	7F-MH006	7F-MH008	12	380	0.005	4.559	3.265	0.015	1.392	327	4.74	18	$64,566
74	7F-MH007_7F-MH009	7F-MH007	7F-MH009	15	379	0.003	5.111	2.397	0.015	2.126	240	6.02	21	$71,271
75	7F-MH008_7F-MH007	7F-MH008	7F-MH007	12	330	0.010	4.613	2.328	0.015	1.975	234	6.72	18	$56,168
76	7F-MH009_7F-MH001	7F-MH009	7F-MH001	15	303	0.004	5.164	2.233	0.015	2.305	224	6.52	21	$56,927
77	7F-MH010_8F-MH074	7F-MH010	8F-MH074	18	87	0.004	5.280	1.391	0.015	3.783	140	6.58	21	$16,356
78	8F-MH074_8F-MH093	8F-MH074	8F-MH093	18	118	0.003	5.277	1.692	0.015	3.110	170	5.41	21	$22,184
79	8F-MH075_8F-MH076	8F-MH075	8F-MH076	18	97	0.002	6.471	2.283	0.015	2.826	229	7.02	24	$19,803
80	8F-MH076_8F-MH077	8F-MH076	8F-MH077	18	369	0.010	6.477	1.122	0.015	5.752	113	14.29	24	$75,727
81	8F-MH077_8F-MH078	8F-MH077	8F-MH078	18	322	0.003	6.497	2.028	0.015	3.193	203	7.93	24	$66,072
82	8F-MH078_8F-MH087	8F-MH078	8F-MH087	18	80	0.002	6.577	2.441	0.015	2.686	245	6.67	24	$16,318
83	8F-MH079_8F-MH080	8F-MH079	8F-MH080	18	402	0.002	6.562	2.691	0.015	2.430	270	6.04	24	$82,472
84	8F-MH080_8G-MH007	8F-MH080	8G-MH007	18	281	0.008	6.536	1.225	0.015	5.318	123	13.22	24	$57,687
85	8F-MH087_8F-MH088	8F-MH087	8F-MH088	18	401	0.003	6.574	2.117	0.015	3.096	212	7.69	24	$82,123
86	8F-MH088_8F-MH079	8F-MH088	8F-MH079	18	383	0.002	6.572	2.438	0.015	2.687	245	6.68	24	$78,556
87	8F-MH093_8F-MH075	8F-MH093	8F-MH075	18	67	0.005	5.277	1.258	0.015	4.180	126	7.28	21	$12,540
88	8G-MH004_8G-MH030	8G-MH004	8G-MH030	18	166	0.004	6.698	1.853	0.015	3.603	186	8.95	24	$34,030
89	8G-MH007_8G-MH026	8G-MH007	8G-MH026	18	253	0.003	6.639	2.103	0.015	3.147	211	7.82	24	$51,906
90	8G-MH008_8G-MH009	8G-MH008	8G-MH009	18	296	0.002	6.998	2.844	0.015	2.453	285	6.10	24	$60,578
91	8G-MH009_8G-MH055	8G-MH009	8G-MH055	18	401	0.012	7.022	1.097	0.015	6.380	110	15.85	24	$82,185
92	8G-MH026_8G-MH004	8G-MH026	8G-MH004	18	61	0.003	6.694	2.012	0.015	3.317	202	8.24	24	$12,505
93	8G-MH030_8G-MH008	8G-MH030	8G-MH008	18	126	0.001	6.974	3.993	0.015	1.741	401	4.33	24	$25,728
94	8G-MH033_9G-MH062	8G-MH033	9G-MH062	18	399	0.002	7.033	2.950	0.015	2.376	296	5.90	24	$81,754
95	8G-MH055_8G-MH033	8G-MH055	8G-MH033	18	396	0.003	7.048	2.145	0.015	3.276	215	8.14	24	$81,119
96	9A-MH007_9A-MH008	9A-MH007	9A-MH008	10	364	0.005	2.207	2.651	0.015	0.830	266	1.56	12	$41,531
97	9A-MH008_9A-MH029	9A-MH008	9A-MH029	10	290	0.005	2.264	2.726	0.015	0.828	274	1.55	12	$33,106
98	9A-MH011_9A-MH014	9A-MH011	9A-MH014	8	173	0.016	1.250	1.263	0.013	0.987	127	1.79	10	$16,454

Belton, MO
Flow Analysis Report
Recommended Capactiy Improvement Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
99	9A-MH014_9A-MH021	9A-MH014	9A-MH021	10	123	0.007	1.262	1.085	0.013	1.160	109	1.89	12	$14,034
100	9A-MH016_9A-MH007	9A-MH016	9A-MH007	10	398	0.010	2.201	1.787	0.015	1.227	179	2.30	12	$45,372
101	9A-MH022_9A-MH023	9A-MH022	9A-MH023	10	98	0.008	1.296	1.051	0.013	1.230	105	2.00	12	$11,207
102	9A-MH023_9A-MH024	9A-MH023	9A-MH024	8	136	0.007	1.475	2.257	0.013	0.652	226	1.92	12	$15,447
103	9A-MH024_9A-MH016	9A-MH024	9A-MH016	10	262	0.010	2.193	1.770	0.015	1.235	178	2.32	12	$29,811
104	9A-MH029_9A-MH020	9A-MH029	9A-MH020	10	205	0.019	2.308	1.374	0.015	1.675	138	3.14	12	$23,416
105	9B-MH026_9A-MH013	9B-MH026	9A-MH013	8	268	0.016	1.215	1.396	0.015	0.867	140	1.81	10	$25,451
106	9B-MH034_9B-MH026	9B-MH034	9B-MH026	8	286	0.026	1.200	1.096	0.015	1.092	110	2.28	10	$27,180
107	9G-MH006_9G-MH078	9G-MH006	9G-MH078	12	88	0.002	1.809	1.574	0.013	1.146	158	2.08	15	$12,496
108	9G-MH008_9G-MH006	9G-MH008	9G-MH006	12	407	0.003	1.798	1.457	0.013	1.230	146	2.23	15	$57,809
109	9G-MH014_9G-MH015	9G-MH014	9G-MH015	12	335	0.002	1.769	1.545	0.013	1.141	155	2.07	15	$47,542
110	9G-MH015_9G-MH016	9G-MH015	9G-MH016	12	321	0.003	1.784	1.325	0.013	1.342	133	2.43	15	$45,582
111	9G-MH016_9G-MH008	9G-MH016	9G-MH008	12	240	0.003	1.788	1.443	0.013	1.235	145	2.24	15	$34,123
112	9G-MH018_9G-MH014	9G-MH018	9G-MH014	12	261	0.002	1.764	1.690	0.013	1.041	170	1.89	15	$37,020
113	9G-MH040_9G-MH041	9G-MH040	9G-MH041	15	87	0.003	2.944	1.496	0.015	1.962	150	3.68	18	$14,841
114	9G-MH041_9G-MH066	9G-MH041	9G-MH066	15	576	0.003	2.963	1.264	0.013	2.337	127	3.80	18	$97,920
115	9G-MH042_9G-MH040	9G-MH042	9G-MH040	15	138	0.003	2.807	1.401	0.015	1.998	141	3.75	18	$23,511
116	9G-MH045_9G-MH042	9G-MH045	9G-MH042	15	410	0.003	2.700	1.407	0.015	1.913	141	3.59	18	$69,734
117	9G-MH053_9G-MH059	9G-MH053	9G-MH059	21	236	0.005	11.812	1.790	0.015	6.579	180	10.84	24	$48,421
118	9G-MH054_9G-MH052	9G-MH054	9G-MH052	21	35	0.004	10.051	1.905	0.015	5.260	191	8.67	24	$7,114
119	9G-MH056_9G-MH057	9G-MH056	9G-MH057	15	28	0.002	3.032	1.917	0.015	1.576	192	2.96	18	$4,743
120	9G-MH058_9G-MH054	9G-MH058	9G-MH054	18	337	0.003	7.048	2.350	0.015	2.990	236	7.43	24	$69,065
121	9G-MH059_9H-MH008	9G-MH059	9H-MH008	27	297	0.002	12.336	1.829	0.015	6.723	183	10.27	30	$71,208
122	9G-MH062_9G-MH058	9G-MH062	9G-MH058	18	404	0.003	7.064	2.295	0.015	3.068	230	7.63	24	$82,759
123	9G-MH066_9G-MH056	9G-MH066	9G-MH056	15	364	0.003	2.964	1.242	0.013	2.379	125	3.87	18	$61,846
124	9G-MH078_9G-MH060	9G-MH078	9G-MH060	12	257	0.002	1.819	1.641	0.013	1.105	165	2.00	15	$36,466
125	9H-MH002_9H-MH001	9H-MH002	9H-MH001	27	452	0.002	12.639	1.446	0.014	8.711	145	12.42	30	$108,384
126	9H-MH003_9H-MH002	9H-MH003	9H-MH002	27	504	0.003	12.340	1.263	0.014	9.742	127	13.89	30	$120,888
127	9H-MH004_9H-MH003	9H-MH004	9H-MH003	27	365	0.001	12.333	2.331	0.014	5.274	234	7.52	30	$87,552
128	9H-MH005_9H-MH004	9H-MH005	9H-MH004	27	478	0.002	12.348	1.383	0.014	8.901	139	12.69	30	$114,696
129	9H-MH006_9H-MH005	9H-MH006	9H-MH005	27	501	0.002	12.361	1.509	0.014	8.165	151	11.65	30	$120,264
130	9H-MH007_9H-MH006	9H-MH007	9H-MH006	27	340	0.004	12.332	1.081	0.014	11.375	108	16.22	30	$81,624
131	9H-MH008_9H-MH007	9H-MH008	9H-MH007	27	196	0.003	12.333	1.276	0.014	9.636	128	13.74	30	$47,016
132	9I-MH010_9I-MH009	9I-MH010	9I-MH009	27	492	0.001	12.630	2.068	0.014	6.089	207	8.68	30	$118,176
133	9I-MH011_9I-MH010	9I-MH011	9I-MH010	27	493	0.001	12.651	1.809	0.014	6.970	182	9.94	30	$118,344
134	10D-MH007_10D-MH034	10D-MH007	10D-MH034	10	246	0.003	1.775	0.984	0.015	0.655	271	1.23	12	$28,079
135	12J-MH006_12J-MH005	12J-MH006	12J-MH005	12	385	0.010	3.201	0.921	0.013	2.343	137	10.42	21	$72,324
136	12L-MH008_12L-MH009	12L-MH008	12L-MH009	15	401	0.001	4.372	0.830	0.013	1.013	432	2.49	21	$75,370
137	8E-MH085_9E-MH012	8E-MH085	9E-MH012	12	169	0.002	0.018	0.024	0.015	0.864	2	0.00	0	$0
138	9A-MH013_9A-MH011	9A-MH013	9A-MH011	8	181	0.002	1.229	0.961	0.015	0.298	413	0.62	10	$17,195
139	9A-MH021_9A-MH022	9A-MH021	9A-MH022	10	125	0.002	1.292	0.996	0.013	0.594	218	0.97	12	$14,216
140	9G-MH051_9G-MH053	9G-MH051	9G-MH053	21	33	0.001	11.802	0.580	0.015	2.982	396	4.91	24	$6,745
141	9G-MH055_9G-MH054	9G-MH055	9G-MH054	15	114	0.001	3.044	0.320	0.015	1.111	274	2.08	18	$19,397
142	9G-MH057_9G-MH055	9G-MH057	9G-MH055	15	35	0.001	3.033	0.285	0.015	1.283	236	2.41	18	$5,933
143	9G-MH060_9G-MH052	9G-MH060	9G-MH052	12	275	0.001	1.829	0.392	0.013	0.791	231	1.43	15	$39,107
144	9H-MH001_9I-MH015	9H-MH001	9I-MH015	27	101	0.003	12.643	0.896	0.014	10.118	125	14.43	30	$24,240
145	9I-MH009Z_9I-MH009	9I-MH009Z	9I-MH009	15	30	0.003	0.017	0.007	0.015	1.909	1	0.00	0	$0
146	9I-MH012_9I-MH011	9I-MH012	9I-MH011	27	469	0.003	12.660	0.862	0.014	9.914	128	14.14	30	$112,464
147	9I-MH013_9I-MH012	9I-MH013	9I-MH012	27	181	0.004	12.655	0.840	0.014	11.989	106	17.10	30	$43,464

Belton, MO
Flow Analysis Report
Recommended Capactiy Improvement Lines for the 5-year, 90-minute storm event - 30% I/I Reduction

Count	ID	From ID	To ID	Diameter (in)	Length (ft)	Slope	Max Flow (mgd)	Max q/Q	N Value	Capacity (mgd)	% Over Capacity	Replacement Capacity (mgd)	Replacement Pipe Size (in)	Replacement Pipe Cost ($)
148	9I-MH014_9I-MH013	9I-MH014	9I-MH013	27	494	0.002	12.655	0.871	0.014	7.675	165	10.95	30	$118,584
149	9I-MH015_9I-MH014	9I-MH015	9I-MH014	27	236	0.004	12.650	0.789	0.014	12.002	105	17.12	30	$56,688
													Total Cost:	**$7,859,877**

Appendix S
Recommended Private-Sector I/I Elimination Report

I / I Reduction Program - Private Report

Recommended Private-Sector I/I Removal

8:33:57 AM Thursday, February 16, 2006

No.	Source Item	Segment					Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM I/I Public	CUM I/I Private	CUM Cost ($)	I/I Elim (%)
1	sUncpd Clnout	(7)	9E-MH024	-(7)	9E-MH032		A	17.790	25	1.4	17.790	0.000	17.790	25	1.47
2	sUncpd Clnout	(8)	9E-LH068	-(8)	9E-MH035		B	6.180	25	4.0	23.970	0.000	23.970	50	1.98
3	sUncpd Clnout	(8)	9F-MH041	-(8)	9F-MH042		A	4.160	25	6.0	28.130	0.000	28.130	75	2.33
4	sUncpd Clnout	(7)	10E-MH022	-(7)	10E-MH036		A	2.640	25	9.5	30.770	0.000	30.770	100	2.55
5	sUncpd Clnout	(8)	9E-MH030	-(8)	9E-MH014		A	2.100	25	11.9	32.870	0.000	32.870	125	2.72
6	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027		C	2.080	25	12.0	34.950	0.000	34.950	150	2.89
7	sUncpd Clnout	(8)	10E-MH023	-(8)	10E-MH011		B	2.080	25	12.0	37.030	0.000	37.030	175	3.06
8	sUncpd Clnout	(8)	10E-MH023	-(8)	10E-MH011		C	2.080	25	12.0	39.110	0.000	39.110	200	3.24
9	sUncpd Clnout	(7)	9E-MH023	-(7)	9E-MH034		B	1.760	25	14.2	40.870	0.000	40.870	225	3.38
10	sUncpd Clnout	(7)	9E-MH033	-(7)	9E-MH032		B	1.320	25	18.9	42.190	0.000	42.190	250	3.49
11	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011		A	29.440	600	20.4	71.630	0.000	71.630	850	5.93
12	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011		B	29.440	600	20.4	101.070	0.000	101.070	1,450	8.36
13	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011		C	29.440	600	20.4	130.510	0.000	130.510	2,050	10.80
14	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011		D	29.440	600	20.4	159.950	0.000	159.950	2,650	13.24
15	sDrive Drain	(8)	9F-MH072	-(8)	9F-MH011		E	29.440	600	20.4	189.390	0.000	189.390	3,250	15.67
16	sUncpd Clnout	(8)	9F-MH091	-(8)	9F-MH026		A	1.040	25	24.0	190.430	0.000	190.430	3,275	15.76
17	sUncpd Clnout	(8)	10E-MH023	-(8)	10E-MH011		F	1.040	25	24.0	191.470	0.000	191.470	3,300	15.85
18	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027		D	1.030	25	24.3	192.500	0.000	192.500	3,325	15.93
19	sDrive Drain	(8)	9F-MH062	-(8)	9F-MH006		A	21.030	600	28.5	213.530	0.000	213.530	3,925	17.67
20	sDrive Drain	(8)	10F-MH046	-(8)	10F-MH051		A	21.030	600	28.5	234.560	0.000	234.560	4,525	19.41
21	sUncpd Clnout	(7)	9E-MH037	-(7)	9E-MH023		B	0.870	25	28.7	235.430	0.000	235.430	4,550	19.49
22	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027		A	0.310	25	80.6	235.740	0.000	235.740	4,575	19.51
23	sUncpd Clnout	(8)	9F-MH007	-(8)	9F-MH027		B	0.310	25	80.6	236.050	0.000	236.050	4,600	19.54
24	sServ. Lat.	(7)	9E-MH001	-(7)	9E-MH081		B	7.280	600	82.4	243.330	0.000	243.330	5,200	20.14

Appendix T
Preliminary Manhole Rehabilitation Schedule

/// REDUCTION PROGRAM PRELIMINARY MANHOLE REHABILITATION SCHEDULE FOR BELTON, MO

REHAB CODE DESCRIPTIONS

A- REPLACE COVER/FRAME/FRAME SEAL
B- REPLACE FRAME SEAL
C- REPLACE COVER/FRAME/FRAME SEAL/CHIMNEY
D- REPLACE FRAME SEAL/CHIMNEY
E-GRADEADJUSTMENT
F-INTERIOR MANHOLE REHABILITATION
G-MANHOLE REPLACEMENT
H-PRESSURE GROUT PRECAST MANHOLE JOINTS
I-COVER INSERT
J-BENCH, TROUGH & PIPE SEALS
K-FLATTOP REPLACEMENT
L- REPLACE STEPS

BASIN NUM.	MANHOLE NUM.	LOCATION	DIA. (ft.)	DEPTH (ft.)	GRADE (in.)	MANHOLE TYPE	REHAB. CODES												REHAB. COST	RE-SUR-FACING COST	TOTAL COST
							A	B	C	D	E	F	G	H	I	J	K	L			
7	10E-LH002	Other	0.0	0.0	Buried	N/A	0	0	0	0	1	0	0	0	0	0	0	0	$200	$80	$280
7	10E-MH022	Paved Street	4.0	2.6	0	Precast	0	0	0	1	0	0	0	1	0	1	0	0	$1,600	$350	$1,950
7	10E-MH036	Paved Intersection	4.0	4.5	0	Brick	0	0	0	1	0	0	0	0	0	0	0	0	$800	$350	$1,150
7	9E-LH006	Paved Street	0.5	4.7	0	Clay Pipe	0	0	0	0	1	1	0	0	0	0	0	0	$1,140	$350	$1,490
7	9E-MH020	Easement	4.0	7.9	4	Block	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$80	$2,580
7	9E-MH024	Paved Street	4.0	5.8	0	Brick	0	0	0	0	0	0	0	0	0	1	0	0	$400	$0	$400
7	9E-MH027	Paved Intersection	4.0	6.1	0	Brick	1	0	0	0	0	0	0	0	0	0	0	0	$600	$350	$950
7	9E-MH032	Paved Street	4.0	5.4	0	Brick	0	0	0	0	0	1	0	0	0	1	0	1	$1,780	$0	$1,780
7	9E-MH034	Paved Street	4.0	8.9	0	Brick	0	0	0	0	0	0	0	0	0	0	0	1	$300	$0	$300
7	9E-MH039	Easement	4.0	4.1	0	Precast	1	0	0	0	0	0	0	0	0	0	0	0	$600	$80	$680
7	9E-MH043	Paved Street	4.0	7.3	0	Brick	0	0	0	0	0	1	0	0	0	0	0	1	$1,760	$0	$1,760
7	9E-MH045	Paved Street	5.0	8.3	0	Brick	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
7	9E-MH046	Paved Street	4.0	8.3	0	Brick	1	0	0	0	0	0	0	0	0	0	0	1	$900	$350	$1,250
7	9E-MH053	Alley	4.0	9.7	0	Rehab Coating	0	0	0	0	0	0	0	0	0	0	0	1	$300	$0	$300
7	9E-MH054	Paved Street	4.0	3.9	0	Brick	0	1	0	0	0	1	0	0	0	0	0	0	$1,180	$350	$1,530
7	9E-MH061	Paved Street	4.0	8.1	0	Rehab Coating	0	0	0	0	0	1	0	1	0	0	0	1	$2,320	$0	$2,320
7	9E-MH064	Paved Street	4.0	8.0	0	Brick	0	0	0	0	0	1	0	0	0	1	0	0	$2,000	$0	$2,000
7	9E-MH074	Paved Intersection	4.0	5.3	0	Brick	0	0	0	1	0	0	0	0	0	0	0	1	$1,100	$350	$1,450
7	9E-MH080	Paved Street	4.0	5.7	0	Brick	0	0	0	1	0	1	0	0	0	0	0	0	$1,940	$350	$2,290
7	9E-MH081	Paved Intersection	4.0	6.5	0	Brick	1	0	0	0	0	0	0	0	0	0	0	0	$600	$350	$950
7	9F-MH052	Parking Lot	4.0	7.9	0	Precast	0	1	0	0	0	0	0	0	0	0	0	0	$400	$350	$750
8	10E-MH003	Paved Street	4.0	12.4	0	Brick	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
8	10E-MH004	Paved Street	4.0	3.5	0	Brick	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$350	$1,550
8	10E-MH007	Paved Intersection	4.0	3.5	0	Brick	0	0	0	0	0	1	0	0	0	1	0	0	$1,100	$0	$1,100
8	10E-MH011	Paved Intersection	4.0	7.8	0	Brick	0	0	0	0	0	1	0	0	0	0	0	1	$1,860	$0	$1,860
8	10E-MH012	Paved Intersection	4.0	7.5	0	Brick	0	0	0	0	0	1	0	0	0	0	0	1	$1,800	$0	$1,800
8	10E-MH015	Paved Intersection	4.0	8.0	0	Brick	0	0	0	0	0	1	0	0	0	1	0	0	$2,000	$0	$2,000
8	10E-MH021	Paved Street	4.0	7.1	0	Brick	0	0	0	0	0	1	0	0	0	1	0	1	$2,120	$0	$2,120
8	10F-MH040	Paved Street	4.0	6.3	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$1,660	$0	$1,660
8	10F-MH046	Paved Street	4.0	4.5	0	Block	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$350	$1,550
8	9E-LH068	Paved Street	0.3	2.7	-3	Clay Pipe	1	0	0	0	1	0	0	0	0	0	0	0	$800	$350	$1,150

/// REDUCTION PROGRAM PRELIMINARY MANHOLE REHABILITATION SCHEDULE FOR BELTON, MO

REHAB CODE DESCRIPTIONS

A- REPLACE COVER/FRAME/FRAME SEAL	E-GRADEADJUSTMENT	I-COVER INSERT
B- REPLACE FRAME SEAL	F-INTERIOR MANHOLE REHABILITATION	J-BENCH, TROUGH & PIPE SEALS
C- REPLACE COVER/FRAME/FRAME SEAL/CHIMNEY	G-MANHOLE REPLACEMENT	K-FLATTOP REPLACEMENT
D- REPLACE FRAME SEAL/CHIMNEY	H-PRESSURE GROUT PRECAST MANHOLE JOINTS	L- REPLACE STEPS

BASIN NUM.	MANHOLE NUM.	LOCATION	DIA. (ft.)	DEPTH (ft.)	GRADE (in.)	MANHOLE TYPE	REHAB. CODES												REHAB. COST	RE-SURFACING COST	TOTAL COST
							A	B	C	D	E	F	G	H	I	J	K	L			
8	9E-MH005	Paved Intersection	4.0	4.3	0	Brick	0	0	0	0	0	1	0	0	0	1	0	0	$1,260	$0	$1,260
8	9E-MH010	Paved Street	4.0	9.1	0	Precast	0	0	0	0	0	0	0	1	0	1	0	0	$800	$0	$800
8	9E-MH014	Paved Street	4.0	7.3	0	Brick	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
8	9E-MH015	Paved Street	4.0	6.4	0	Brick	0	0	0	0	0	1	0	0	0	1	0	1	$1,980	$0	$1,980
8	9E-MH029	Paved Intersection	4.0	5.9	0	Brick	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
8	9E-MH030	Paved Street	4.0	7.1	0	Brick	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
8	9E-MH031	Easement	4.0	7.7	2	Precast	0	1	0	0	0	0	0	1	0	1	0	0	$1,200	$80	$1,280
8	9E-MH035	Paved Street	4.0	6.9	0	Brick	0	0	0	0	0	1	0	0	0	0	0	1	$1,680	$0	$1,680
8	9E-MH036	Paved Street	4.0	8.2	0	Brick	0	0	0	0	0	1	0	0	0	0	0	0	$1,640	$0	$1,640
8	9E-MH057	Paved Intersection	4.0	4.3	0	Brick	0	1	0	0	0	1	0	0	0	0	0	0	$1,260	$350	$1,610
8	9E-MH063	Paved Street	4.0	5.7	0	Brick	0	0	0	0	0	1	0	0	0	0	0	1	$1,440	$0	$1,440
8	9E-MH066	Easement	4.0	7.0	5	Precast	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$80	$1,280
8	9E-MH070	Ditch	1.5	3.3	11	Precast	1	0	0	0	0	0	0	1	0	0	0	0	$1,000	$80	$1,080
8	9F-LH001	Paved Street	0.7	3.4	0	Clay Pipe	0	0	0	0	0	1	0	0	0	0	0	0	$680	$0	$680
8	9F-LH002	Paved Street	0.5	3.7	0	Clay Pipe	0	0	0	0	0	1	0	0	0	0	0	0	$740	$0	$740
8	9F-LH006	Other	0.0	0.0	Buried	N/A	0	0	0	0	1	0	0	0	0	0	0	0	$200	$80	$280
8	9F-MH002	Paved Intersection	4.0	6.6	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$1,720	$0	$1,720
8	9F-MH004	Paved Street	4.0	6.4	0	Block	1	0	0	0	0	1	0	0	0	0	0	0	$1,880	$350	$2,230
8	9F-MH005	Paved Street	4.0	5.7	0	Block	0	0	1	0	0	1	0	0	0	0	0	0	$2,140	$350	$2,490
8	9F-MH006	Paved Intersection	4.0	13.2	0	Block	1	0	0	0	0	1	0	0	0	0	0	0	$3,240	$350	$3,590
8	9F-MH007	Paved Street	4.0	12.4	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$2,880	$0	$2,880
8	9F-MH008	Paved Street	4.0	6.4	0	Block	1	0	0	0	0	1	0	0	0	0	0	0	$1,880	$350	$2,230
8	9F-MH009	Parking Lot	4.0	6.3	2	Precast	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$350	$1,550
8	9F-MH010	Easement	4.0	9.2	8	Precast	0	0	0	0	0	0	0	0	0	1	0	1	$700	$0	$700
8	9F-MH011	Backyard	4.0	7.5	3	Precast	0	0	0	0	0	0	0	0	0	1	0	0	$400	$0	$400
8	9F-MH019	Easement	4.0	7.2	0	Block	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$80	$2,580
8	9F-MH020	Easement	4.0	7.7	3	Block	0	0	0	0	0	1	0	0	0	0	0	0	$1,540	$0	$1,540
8	9F-MH021	Backyard	4.0	12.7	20	Block	0	0	0	0	0	1	0	0	0	1	0	0	$2,940	$0	$2,940
8	9F-MH026	Easement	4.0	8.8	3	Precast	1	0	0	0	0	0	0	0	0	0	0	0	$600	$80	$680
8	9F-MH027	Paved Street	4.0	13.8	0	Precast	0	0	0	1	0	0	0	1	0	0	0	0	$1,200	$350	$1,550
8	9F-MH029	Easement	4.0	13.3	4	Block	0	0	0	0	0	1	0	0	0	0	0	0	$2,660	$0	$2,660

/// REDUCTION PROGRAM PRELIMINARY MANHOLE REHABILITATION SCHEDULE FOR BELTON, MO

REHAB CODE DESCRIPTIONS

A- REPLACE COVER/FRAME/FRAME SEAL	E-GRADEADJUSTMENT	I-COVER INSERT
B- REPLACE FRAME SEAL	F-INTERIOR MANHOLE REHABILITATION	J-BENCH, TROUGH & PIPE SEALS
C- REPLACE COVER/FRAME/FRAME SEAL/CHIMNEY	G-MANHOLE REPLACEMENT	K-FLATTOP REPLACEMENT
D- REPLACE FRAME SEAL/CHIMNEY	H-PRESSURE GROUT PRECAST MANHOLE JOINTS	L- REPLACE STEPS

BASIN NUM.	MANHOLE NUM.	LOCATION	DIA. (ft.)	DEPTH (ft.)	GRADE (in.)	MANHOLE TYPE	REHAB. CODES												REHAB. COST	RE-SUR-FACING COST	TOTAL COST
							A	B	C	D	E	F	G	H	I	J	K	L			
8	9F-MH030	Sidewalk	4.0	10.3	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$2,460	$0	$2,460
8	9F-MH032	Easement	4.0	3.1	0	Precast	0	1	0	0	0	0	0	0	0	0	0	0	$400	$80	$480
8	9F-MH035	Curb/Gutter	4.0	12.9	0	Precast	0	0	0	0	0	0	0	0	0	1	0	0	$400	$0	$400
8	9F-MH039	Easement	4.0	10.2	2	Precast	1	0	0	0	0	0	0	0	0	0	0	0	$600	$80	$680
8	9F-MH041	Paved Street	4.0	6.9	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$1,780	$0	$1,780
8	9F-MH042	Paved Street	3.0	10.3	0	Block	0	0	0	1	0	1	0	0	0	0	0	0	$2,860	$350	$3,210
8	9F-MH051	Easement	4.0	7.2	3	Block	0	0	0	0	0	1	0	0	0	0	0	0	$1,440	$0	$1,440
8	9F-MH060	Easement	4.0	8.2	4	Precast	0	0	0	1	0	0	0	1	0	0	0	0	$1,200	$80	$1,280
8	9F-MH062	Paved Intersection	4.0	7.8	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$1,960	$0	$1,960
8	9F-MH063	Easement	4.0	7.1	2	Block	0	0	0	0	0	1	0	0	0	0	0	0	$1,420	$0	$1,420
8	9F-MH064	Easement	4.0	7.2	0	Block	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$80	$2,580
8	9F-MH066	Easement	4.0	8.6	4	Block	0	1	0	0	0	1	0	0	0	0	0	0	$2,120	$80	$2,200
8	9F-MH068	Sidewalk	4.0	7.8	0	Block	0	1	0	0	0	0	0	0	0	0	0	0	$400	$350	$750
8	9F-MH069	Paved Street	4.0	10.8	0	Block	1	0	0	0	0	0	0	0	0	0	0	0	$600	$350	$950
8	9F-MH070	Parking Lot	4.0	7.7	0	Precast	0	0	0	1	0	0	0	1	0	0	0	0	$1,200	$350	$1,550
8	9F-MH072	Backyard	4.0	9.0	8	Precast	0	0	0	0	0	0	0	0	0	0	0	1	$300	$0	$300
8	9F-MH075	Paved Street	4.0	10.8	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$2,560	$0	$2,560
8	9F-MH077	Paved Street	4.0	7.9	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$1,980	$0	$1,980
8	9F-MH079	Paved Street	4.0	13.6	0	Block	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
8	9F-MH084	Other	0.0	0.0	Buried	N/A	0	0	0	0	1	0	0	0	0	0	0	0	$200	$80	$280
8	9F-MH090	Parking Lot	4.0	10.8	0	Precast	1	0	0	0	0	0	0	0	0	1	0	0	$1,000	$350	$1,350
8	9F-MH091	Easement	4.0	8.6	0	Precast	0	1	0	0	0	0	0	1	0	0	0	0	$800	$80	$880
8	9F-MH092	Easement	4.0	8.4	0	Precast	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$80	$1,280
							13	**8**	**1**	**13**	**5**	**39**	**9**	**9**	**0**	**29**	**0**	**15**	**$123,100**	**$12,210**	**$135,310**

Appendix U
Recommended Manhole Rehabilitation Schedule

/// REDUCTION PROGRAM RECOMMENDED MANHOLE REHABILITATION SCHEDULE FOR BELTON, MO

REHAB CODE DESCRIPTIONS

A- REPLACE COVER/FRAME/FRAME SEAL	E-GRADEADJUSTMENT	I-COVER INSERT
B- REPLACE FRAME SEAL	F-INTERIOR MANHOLE REHABILITATION	J-BENCH, TROUGH & PIPE SEALS REHABILITATION
C- REPLACE COVER/FRAME/FRAME SEAL/CHIMNEY	G-MANHOLE REPLACEMENT	K-FLATTOP REPLACEMENT
D- REPLACE FRAME SEAL/CHIMNEY	H-PRESSURE GROUT PRECAST MANHOLE JOINTS	L- REPLACE STEPS

BASIN NUM.	MANHOLE NUM.	LOCATION	DIA. (ft.)	DEPTH (ft.)	GRADE (in.)	MANHOLE TYPE	REHAB. CODES												REHAB. COST	RE-SUR-FACING COST	TOTAL COST
							A	B	C	D	E	F	G	H	I	J	K	L			
7	9E-MH027	Paved Intersection	4.0	6.1	0	Brick	1	0	0	0	0	0	0	0	0	0	0	0	$600	$350	$950
7	9E-MH039	Easement	4.0	4.1	0	Precast	1	0	0	0	0	0	0	0	0	0	0	0	$600	$80	$680
7	9E-MH046	Paved Street	4.0	8.3	0	Brick	1	0	0	0	0	0	0	0	0	0	0	1	$900	$350	$1,250
7	9E-MH081	Paved Intersection	4.0	6.5	0	Brick	1	0	0	0	0	0	0	0	0	0	0	0	$600	$350	$950
7	9F-MH052	Parking Lot	4.0	7.9	0	Precast	0	1	0	0	0	0	0	0	0	0	0	0	$400	$350	$750
7	10E-MH022	Paved Street	4.0	2.6	0	Precast	0	0	0	1	0	0	0	1	0	1	0	0	$1,600	$350	$1,950
7	9E-MH080	Paved Street	4.0	5.7	0	Brick	0	0	0	1	0	1	0	0	0	0	0	0	$1,940	$350	$2,290
7	10E-LH002	Other	0.0	0.0	Buried	N/A	0	0	0	0	1	0	0	0	0	0	0	0	$200	$80	$280
7	9E-LH006	Paved Street	0.5	4.7	0	Clay Pipe	0	0	0	0	1	1	0	0	0	0	0	0	$1,140	$350	$1,490
7	9E-MH045	Paved Street	5.0	8.3	0	Brick	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
8	9E-LH068	Paved Street	0.3	2.7	-3	Clay Pipe	1	0	0	0	1	0	0	0	0	0	0	0	$800	$350	$1,150
8	9E-MH070	Ditch	1.5	3.3	11	Precast	1	0	0	0	0	0	0	1	0	0	0	0	$1,000	$80	$1,080
8	9F-MH004	Paved Street	4.0	6.4	0	Block	1	0	0	0	0	1	0	0	0	0	0	0	$1,880	$350	$2,230
8	9F-MH008	Paved Street	4.0	6.4	0	Block	1	0	0	0	0	1	0	0	0	0	0	0	$1,880	$350	$2,230
8	9F-MH026	Easement	4.0	8.8	3	Precast	1	0	0	0	0	0	0	0	0	0	0	0	$600	$80	$680
8	9F-MH039	Easement	4.0	10.2	2	Precast	1	0	0	0	0	0	0	0	0	0	0	0	$600	$80	$680
8	9F-MH069	Paved Street	4.0	10.8	0	Block	1	0	0	0	0	0	0	0	0	0	0	0	$600	$350	$950
8	9F-MH090	Parking Lot	4.0	10.8	0	Precast	1	0	0	0	0	0	0	0	0	1	0	0	$1,000	$350	$1,350
8	9E-MH031	Easement	4.0	7.7	2	Precast	0	1	0	0	0	0	0	1	0	1	0	0	$1,200	$80	$1,280
8	9E-MH057	Paved Intersection	4.0	4.3	0	Brick	0	1	0	0	0	1	0	0	0	0	0	0	$1,260	$350	$1,610
8	9F-MH032	Easement	4.0	3.1	0	Precast	0	1	0	0	0	0	0	0	0	0	0	0	$400	$80	$480
8	9F-MH068	Sidewalk	4.0	7.8	0	Block	0	1	0	0	0	0	0	0	0	0	0	0	$400	$350	$750
8	9F-MH091	Easement	4.0	8.6	0	Precast	0	1	0	0	0	0	0	1	0	0	0	0	$800	$80	$880
8	9F-MH005	Paved Street	4.0	5.7	0	Block	0	0	1	0	0	1	0	0	0	0	0	0	$2,140	$350	$2,490
8	10E-MH004	Paved Street	4.0	3.5	0	Brick	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$350	$1,550
8	10F-MH046	Paved Street	4.0	4.5	0	Block	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$350	$1,550
8	9E-MH066	Easement	4.0	7.0	5	Precast	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$80	$1,280
8	9F-MH009	Parking Lot	4.0	6.3	2	Precast	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$350	$1,550
8	9F-MH027	Paved Street	4.0	13.8	0	Precast	0	0	0	1	0	0	0	1	0	0	0	0	$1,200	$350	$1,550
8	9F-MH060	Easement	4.0	8.2	4	Precast	0	0	0	1	0	0	0	1	0	0	0	0	$1,200	$80	$1,280
8	9F-MH070	Parking Lot	4.0	7.7	0	Precast	0	0	0	1	0	0	0	1	0	0	0	0	$1,200	$350	$1,550

/// REDUCTION PROGRAM RECOMMENDED MANHOLE REHABILITATION SCHEDULE FOR BELTON, MO

REHAB CODE DESCRIPTIONS

A- REPLACE COVER/FRAME/FRAME SEAL	E-GRADEADJUSTMENT	I-COVER INSERT
B- REPLACE FRAME SEAL	F-INTERIOR MANHOLE REHABILITATION	J-BENCH, TROUGH & PIPE SEALS REHABILITATION
C- REPLACE COVER/FRAME/FRAME SEAL/CHIMNEY	G-MANHOLE REPLACEMENT	K-FLATTOP REPLACEMENT
D- REPLACE FRAME SEAL/CHIMNEY	H-PRESSURE GROUT PRECAST MANHOLE JOINTS	L- REPLACE STEPS

BASIN NUM.	MANHOLE NUM.	LOCATION	DIA. (ft.)	DEPTH (ft.)	GRADE (in.)	MANHOLE TYPE	REHAB. CODES												REHAB. COST	RE-SUR-FACING COST	TOTAL COST
							A	B	C	D	E	F	G	H	I	J	K	L			
8	9F-MH092	Easement	4.0	8.4	0	Precast	0	0	0	1	0	0	0	0	0	1	0	0	$1,200	$80	$1,280
8	9F-LH006	Other	0.0	0.0	Buried	N/A	0	0	0	0	1	0	0	0	0	0	0	0	$200	$80	$280
8	9F-MH084	Other	0.0	0.0	Buried	N/A	0	0	0	0	1	0	0	0	0	0	0	0	$200	$80	$280
8	10E-MH003	Paved Street	4.0	12.4	0	Brick	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
8	10F-MH040	Paved Street	4.0	6.3	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$1,660	$0	$1,660
8	9E-MH010	Paved Street	4.0	9.1	0	Precast	0	0	0	0	0	0	0	1	0	1	0	0	$800	$0	$800
8	9F-MH019	Easement	4.0	7.2	0	Block	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$80	$2,580
8	9F-MH051	Easement	4.0	7.2	3	Block	0	0	0	0	0	1	0	0	0	0	0	0	$1,440	$0	$1,440
8	9F-MH062	Paved Intersection	4.0	7.8	0	Block	0	0	0	0	0	1	0	0	0	1	0	0	$1,960	$0	$1,960
8	9F-MH064	Easement	4.0	7.2	0	Block	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$80	$2,580
8	9F-MH029A	Easement	4.0	0.0	Buried	N/A	0	0	0	0	1	0	0	0	0	0	0	0	$200	$80	$280
8	9F-MH079	Paved Street	4.0	13.6	0	Block	0	0	0	0	0	0	1	0	0	0	0	0	$2,500	$350	$2,850
							12	**6**	**1**	**10**	**6**	**9**	**5**	**8**	**0**	**11**	**0**	**1**	**$51,100**	**$9,330**	**$60,430**

Appendix V
Recommended Public-Sector I/I Elimination Report

I / I Reduction Program - Public Report

Recommended Public-Sector I/I Removal

9:23:04 AM Thursday, February 16, 2006

No.	Source Item	Segment					Def No.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I (GPM)	CUM I/I Public	CUM I/I Private	CUM Cost ($)	I/I Elim (%)
1	Ind. Storm	(7)	9E-MH032	-(7)	9E-MH027		S	14.590	150	10.3	14.590	14.590	0.000	150	1.21
2	Line Defect	(7)	9E-LH002	-(7)	9E-LH001A		U	44.480	500	11.2	59.070	59.070	0.000	650	4.89
3	Line Defect	(7)	9E-LH001	-(7)	9E-LH001A		S	17.790	500	28.1	76.860	76.860	0.000	1,150	6.36
4	Line Defect	(7)	9E-LH002	-(7)	9E-LH001A		T	17.790	500	28.1	94.650	94.650	0.000	1,650	7.83
5	Line Defect	(7)	9E-LH002	-(7)	9E-LH001A		V	17.790	500	28.1	112.440	112.440	0.000	2,150	9.31
6	Drainage Xing	(8)	10E-MH015	-(8)	10E-MH007		T	5.260	500	95.1	117.700	117.700	0.000	2,650	9.74