TREKK
DESIGN GROUP, LLC

A D/WBE, SBA 8(A), WOSB Certified
Civil Engineering Firm

August 24, 2018

Missouri Department of Natural Resources/WPP/FAC
Attention: Ms. Cynthia Smith, P.E.
P.O. Box 176
Jefferson City, MO 65102-0176

RE: SCEAP Grant EPG-104-16

Dear Ms. Smith:

Please find enclosed the Facility Plan for wastewater treatment and collection system improvements serving the City of Fair Grove, Missouri, for your review.

Should you have any questions feel free to contact me at 417-890-9465 or by email at gperkins@trekkdesigngroup.com

Sincerely,

Gregory S. Perkins, P.E.
Senior Consultant/Project Manager
TREKK Design Group, LLC

c: Mr. Anthony Miller, Mayor
Ms. Emilie Twining-Gerdes

Table of Contents

List of Tables

List of Figures

Appendices

Definitions

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.

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 and utilities which are owned and maintained by the City.

Abbreviations

City	City of Fair Grove, Missouri
CCTV	Closed Circuit Television
Dia.	Diameter
DWF	Dry Weather Flow
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
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
NASSCO	National Association of Sewer Service Companies
O&M	Operation and Maintenance
PACP	Pipeline Assessment Certification Program
%	Percent
Q	Flow Rate
RDII	Rainfall Induced Inflow and Infiltration
Sec	Seconds or Section
SSES	Sanitary Sewer Evaluation Study
SCEAP	Small Community Engineering Assistance Program
TREKK	TREKK Design Group
WWF	Wet Weather Flow
WWTF	Wastewater Treatment Facility
Yr	Year

1 Executive Summary

1.1 General Overview

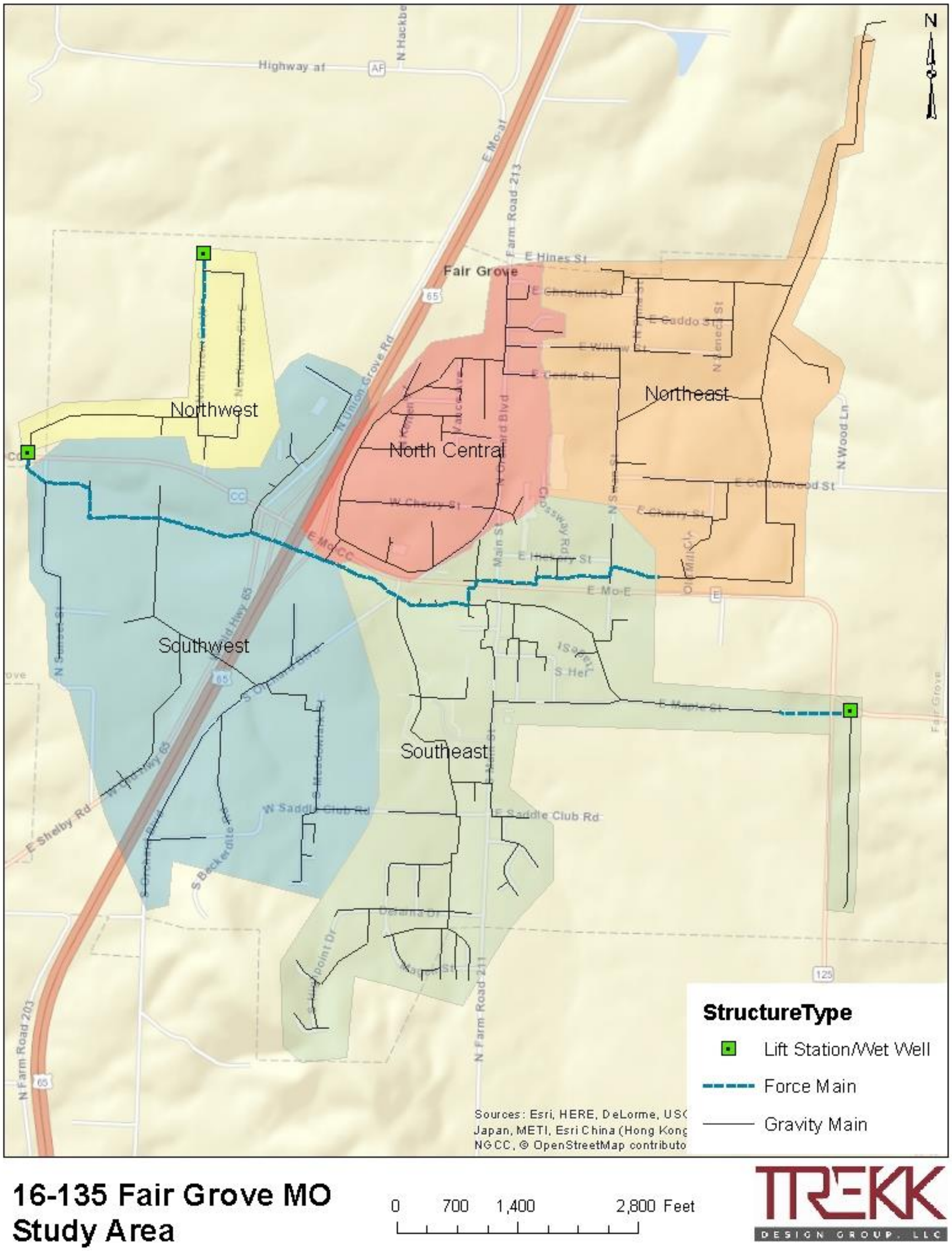
This executive summary is a general overview of TREKK's/Olsson's findings, conclusions, and recommendations of SSES conducted on the collection system with the City, herein referred to as the Study Area. This work is being performed as part of a SCEAP grant. The purpose of the study is to identify sources of I&I to prevent the overloading of the wastewater treatment facility and prevent SSO events. Field tasks performed as part of this SSES included: manhole inspections, acoustic sounding, lift station evaluations, flow monitoring, and iTracker data collection of the sanitary sewer collection system in the City of Fair Grove, Missouri (Study Area). Results from the field inspection activities are used to generate recommendations for collection system improvements within the Study Area. Figure 1-1 illustrates the Project Study Area. It should be noted that budget costs have been developed based on information available at this time and as the project moves into additional phases, construction costs to rehabilitate the public and private sewers, may go up or down depending on what defects are found during further condition assessment.

1.2 Project Objectives

This sanitary sewer I&I Pilot Study has several very important objectives. Primary among these are the following:

- Quantify dry and wet weather I&I flows within the Study Area.
- Identify I&I defects through field inspection activities.
- Perform defect flow analysis on identified I&I defects.
- Prioritize cost-effective rehabilitation recommendations ($/GPM).
- Document all work in an electronic format compatible with the City's GIS.
- Complete all work within the agreed upon time schedule and costs.
- Prepare a final report summarizing all work and develop an I&I Pilot Study that clearly outlines a road map to:
    - Cost-effectively reduce I&I
    - Improve the overall collection system performance
    - Meet state and federal reporting requirements, including MDNR's I&I Assessment and Reduction Plans and EPA's Capacity Management Operation and Maintenance (CMOM) Program

Figure 1-1: Project Study Area



1.3 Study Outline

The first task of this study consisting of I&I field investigation work was initiated in November of 2016 with the conducting of manhole inspections, acoustic sounding, and flow monitoring (flow meters and iTrackers) and concluded in June of 2017. These inspection activities are essential to any SSES to locate and quantify defects that contribute excessive RDII. This phase is further discussed in Section 2.

The second task of this SSES, I&I field investigation work was initiated in March of 2017 with the conducting of flow metering and concluded in June of 2017. Based on flow monitoring results line segments were chosen to be smoke tested in July of 2017. These inspection activities are essential to any SSES to quantify the amount of I&I in the system. This phase is further discussed in Section 3.

The third task of this SSES includes TREKK's conclusions and recommendations regarding the specifics of the cost-effective I&I reduction plan, discussed in Section 3. Basic study components included in each phase are shown in Table 1-1.

Table 1-1: General Study Components

Task	Purpose
I&I Investigation	Identifies and quantifies inflow and infiltration sources in the Study Area. Establish databases for each field inspection activity to facilitate inflow and infiltration abatement program.
Flow Monitoring	To quantify I&I in the City's sewer mains.
Final Recommendations	Presents specific recommended improvements to the collection system, outlines projected costs for system rehabilitation in the Study Area, and makes recommendations for continual study on the collection system.

1.4 Findings

Field inspection activities were conducted to locate, quantify, and evaluate RDII entering the City's wastewater collection system. The following paragraphs briefly discuss the findings of TREKK's evaluation of the wastewater collection system within the Study Area shown in Figure 1-1.

- The City maintains approximately 115,430 LF of gravity main sanitary sewer and 10,630 LF of force mains.
- 457 of the 474 manholes within the Study Area were inspected. The remaining 17 manholes were either identified as Buried, Not Found or Not Opened. 5 lamp holes were also inspected.
- A total of 439 individual line segments, representing approximately 103,430 linear feet of sanitary sewer were acoustic sounded for a pipe assessment and to prioritize location of CCTV work to be completed.
- All 3 of the City lift stations were inspected. Each lift station has 2 pumps and pump 1 at lift station 3 is not functional and needs to be repaired/replaced .
- 1 flow meter was installed to quantify the amount of I&I entering the system. Approximately 76% of the system flow can be attributed to I&I giving a peaking factor of 15.8. DNR considers anything above 2.5 peaking factor as excessive I&I.
- A total of 5 iTracker level monitors were installed to create sub-basins to assist in determining the sections of system that have a high amount of I&I.
- Smoke Testing results: The North Central and South East basins were smoke tested and a total of 47 smoke defects were found. There were 38 private sector defects, primarily consisting of cleanout defects, and 9 public sector defects consisting of 8 manhole defects.

1.5 Recommendations

1.5.1 Sanitary Sewer Evaluation Study

1.5.1.1 Smoke Testing

Smoke Testing is recommended to identify and confirm directly connected sources of I/I on both private property and the City owned portion of the system. Smoke testing is performed by injecting, through the vaporization of oil, into an isolated line segment with a high-capacity blower. The use of oil, instead of smoke bombs, allows for continuous smoke production while field crews canvass the area and conduct a perimeter check of all buildings in close proximity for evidence of smoke. It is recommended to smoke test the remaining 90,350 LF of the collection system that was not tested during this project.

1.5.1.2 Sewer Cleaning and CCTV Inspection Program

CCTV is an effective and accurate method of identifying the exact location of I/I entry into pipelines in the collection system. Since smoke may migrate through cracks in the soil, an exact measurement may not be possible during smoke testing.

1.5.1.3 Additional Field Investigation Activities

It is recommended to perform additional field investigation activities within the collection system once further stages of rehabilitation have been completed. These activities would include post rehab flow monitoring in basins where public and/or private rehabilitation has been performed. It is also recommended to perform manhole inspections on the manholes that were either buried or not located during the initial SSES once these manholes have been located or brought to grade.

Table 1-2: Sanitary Sewer Evaluation Study Cost Estimate

Description	Quantity	Unit	Unit Price	Extension
Sanitary Sewer Evaluation Study	1	LS	$500,000	$500,000
Contingency	10%			$50,000
Subtotal				**$550,000**
Engineering and Legal	25%			$137,500
Total				**$687,500**

1.5.2 Rehabilitation

1.5.2.1 Public and Private-Sector I&I Abatement Program

Removal of I&I can be achieved by removing any sources of water entering the sanitary sewer through defects found on the public and private side. Examples of public-sector defects include: main line and manhole (rim and wall) defects. Examples of private-sector defects include: broken and uncapped cleanouts, defective service laterals, etc.

1.5.2.2 Lift Station Improvements

Inspections were performed on all three lift stations within the study area. All pumps were operational except for pump 1 in lift station 3. It is recommended that this pump be replaced or repaired to bring back to working order. It is also recommended the City consider a chemical addition of a calcium nitrate solution such as BIOXIDE to be added to the main lift station to help control the formation of hydrogen sulfate gas for corrosion control.

Table 1-3: BIOXIDE Cost Estimate

Description	Quantity	Unit	Unit Price	Extension
BIOXIDE Calcium Nitrate Solution	7300	GAL	$ 3	$ 21,900
Chemical Dosing System and Storage	1	LS	$ 75,000	$ 75,000
Contingency	10%			$ 9,690
Subtotal				**$ 106,590**
Engineering and Legal	25%			$ 26,648
Total				**$ 133,238**
*BIOXIDE solution cost is for one year period.				

1.5.2.3 Manhole Rehabilitation

It is recommended to rehabilitate manholes in the collection system that were shown to be contributors of I&I and those with structural and/or H2S damage. It was found during manhole inspections that ten manholes could not be inspected due to either be buried or not found. It is recommended to locate these manholes and bring them to grade. Seven manholes could also not be opened due to corrosion and bolts being frozen or stripped. It is recommended to fix these manholes so that the lids can be removed and further inspected. Three manholes were noted as an Emergency Situation during manhole inspections. The City was notified of these manholes during inspections and they have since been repaired.

Table 1-4: Rehabilitation Cost Estimate

Description	Quantity	Unit	Unit Price	Extension
Rehabilitation	1	LS	$1,846,880	$1,846,880
Contingency	10%			$184,688
Subtotal				**$2,031,568**
Engineering and Legal	25%			$507,892
Total				**$2,539,460**

1.5.2.4 20 Year Capital Improvement Plan – Collection System

It is recommended to continue SSES efforts to inspect the remaining manholes that could not be located and were buried and begin fixing the largest contributors of I&I found during smoke testing in the first initial years of the CIP. It is recommended to re-evaluate the CIP after five years. TREKK has compiled a 20-year CIP for the collection system that will help to identify issues within the system that are attributing to I&I and then in subsequent years rehabilitate or replace the necessary components. The total budget is projected at $3,226,960 over the next 20 years. The SSES budget is $687,500 and the rehabilitation budget is $2,539,460.

1.5.2.5 20 Year Capital Improvement Plan – WWTF

While typical operation and maintenance items should continue to be budgeted for through the life of the plant, the only significant capital improvements recommended for the treatment plant over the next 20 years are filter media replacement (both filters) and potentially the addition of a mechanical bar screen prior to the influent pump station. **A budget estimate for replacing the sand media in both filters is $100,000.** Several options exist for mechanical screening of influent wastewater, which can range in price from $400,000 to $1,000,000 or more. Should the city decide to investigate adding mechanical screening, an engineering study should be performed to evaluate options.

1.6 Recommended Improvement Cost Summary

The recommended improvement cost summary for the Study Area and additional investigation work is provided as Table 1-5.

Table 1-5: Recommended Improvement Cost Summary

Description of Improvements	Cost Estimate
City Improvements	
Sanitary Sewer Evaluation Studies	$687,500
Rehabilitation	$2,539,460
Lift Station Improvements	$133,328
Sand Filter Media Replacement	$100,000
Total Cost:	**$3,460,288**

2 Field Surveys and Inspection Activities

2.1 Existing Wastewater System

The City of Fair Grove's existing wastewater system consists of a mostly gravity-flow collection system with three lift stations that serve the Northwest Basin, Southwest Basin, and Southeast Basin and a mechanical WWTF permitted under Missouri State Operating Permit number MO-0111708. The collection system consists of 115,430 feet of gravity mains, 474 manholes, 23 lampholes, and 10,630 feet of force main consisting of 3" and 8" from the 3 lift stations. The gravity sewer mains range in size from 4-inch to 15-inch in diameter. A listing of the approximate lengths of pipe by basin and diameter is provided in Table 2-1 based on current mapping data.

Table 2-1: Sanitary Collection System Line Inventory

Pipe Diameter (inches)	Approximate Sewer Line Lengths (feet)					
	North Central Basin	North East Basin	North West Basin	South East Basin	South West Basin	Combined Service Area
4	214	0	0	115	0	329
6	222	0	0	251	0	473
8	16,798	17,269	7,235	36,941	22,182	100,426
10	0	8,629	35	803	4,283	13,751
15	0	455	0	0	0	455
Gravity Line Total	**16,798**	**26,354**	**7,270**	**38,110**	**26,465**	**115,434**
6" F.M.	0	8,731	1,046	852	0	10,629

The sanitary sewer collection system for Fair Grove consists primarily of polyvinyl chloride (PVC) gravity lines and a small portion of ductile iron pipe (DIP). A significant portion of the collection system is 8-inch PVC. The city's collection system was installed in the early 1990s, along with the original WWTF. All of the manholes are constructed of pre-cast concrete sections and lampholes are made of PVC.

The system is divided into five basins which are generally divided by the east-west Highway CC, north-south Highway 65, and the north-south topographic ridge line that separates the south two basins. A great majority of the city's wastewater flows to the main lift station on the west side of town. This flow is subsequently pumped across the city to a manhole in the northeast basin and from there flows by gravity to the WWTF.

The collection system has three lift stations. The main lift station is located along Highway CC, between the northwest and southwest basins. This lift station receives wastewater from all basins expect the northeast basin. The other two lift stations, located in the northwest and southeast basins, both pump flow to the main lift station. The main lift station pumps the collected wastewater to the northeast basin, where it flows by gravity to the WWTF.

2.2 Study Area for Collection System Investigations

The entirety of the collection system, where accessible, was the focus area for field investigations. TREKK Design Group developed a field investigation plan for the study area that included manhole inspections, acoustic sounding, smoke testing, rainfall monitoring, flow monitoring, and water depth monitoring in strategic manholes. Rainfall and flow to the main lift station were monitored from March 16, 2017 through May 15, 2017. During this time, the additional fieldwork was also performed.

Manhole inspections and acoustic sounding were performed throughout the study area where accessible. The results of the acoustic sounding were used to determine which lines needed to be cleaned prior to smoke testing. After city staff cleaned the sewer lines that were partially- or fully-blocked, the north central and southeast basins were then chosen as the most effective areas of the collection system to be smoke-tested. The smoke testing results were used to identify system defects in the study area and determine which sewer lines could benefit most for CCTV inspection to better qualify the defects.

2.3 I&I Source Identification

Two important factors must be carefully considered in developing a successful program to reduce wet-weather sanitary sewer backups, overflows and bypasses. The first factor involves the measurement of total I&I from a defined basin. Total I&I from the basin was quantified during flow analysis. Once this has been established and a determination has been made that excessive I&I exists, the specific sources of I&I need to be identified in both public and private sectors.

This section describes the work completed to identify the location of I&I sources in the Study Area. I&I enters into any sanitary sewer system from the public as well as private sectors. Typical public sector sources of I&I are shown in Figure 2-1. Note that they are the responsibility of the City since they originate within the City-owned collection system. However, an equally significant amount of I&I can enter from private sources such as those illustrated in Figure 2-2. These sources are generally the responsibility of the property owner. However, more communities are either paying for the repairs of the defects or assisting the homeowners with these repairs. 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 as summarized in this section.

Figure 2-1: Typical Public Sector Inflow and Infiltration Sources

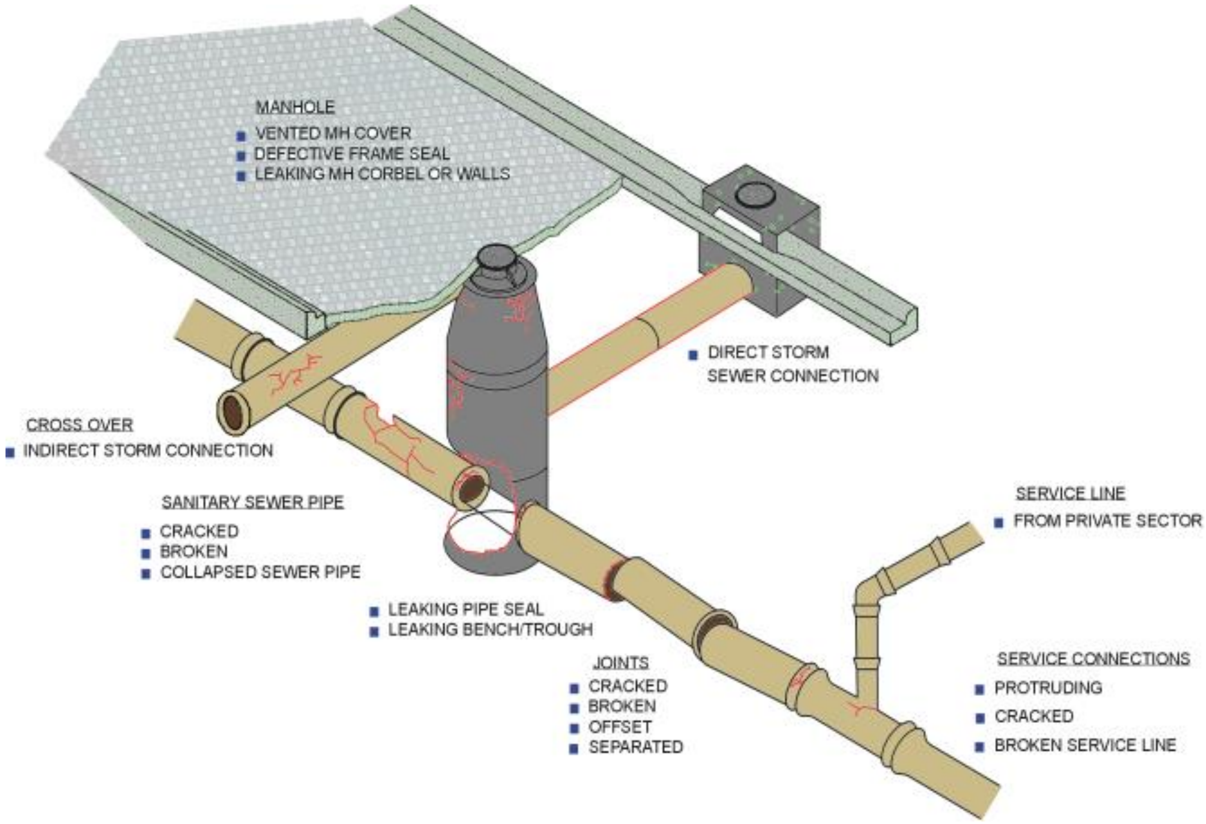
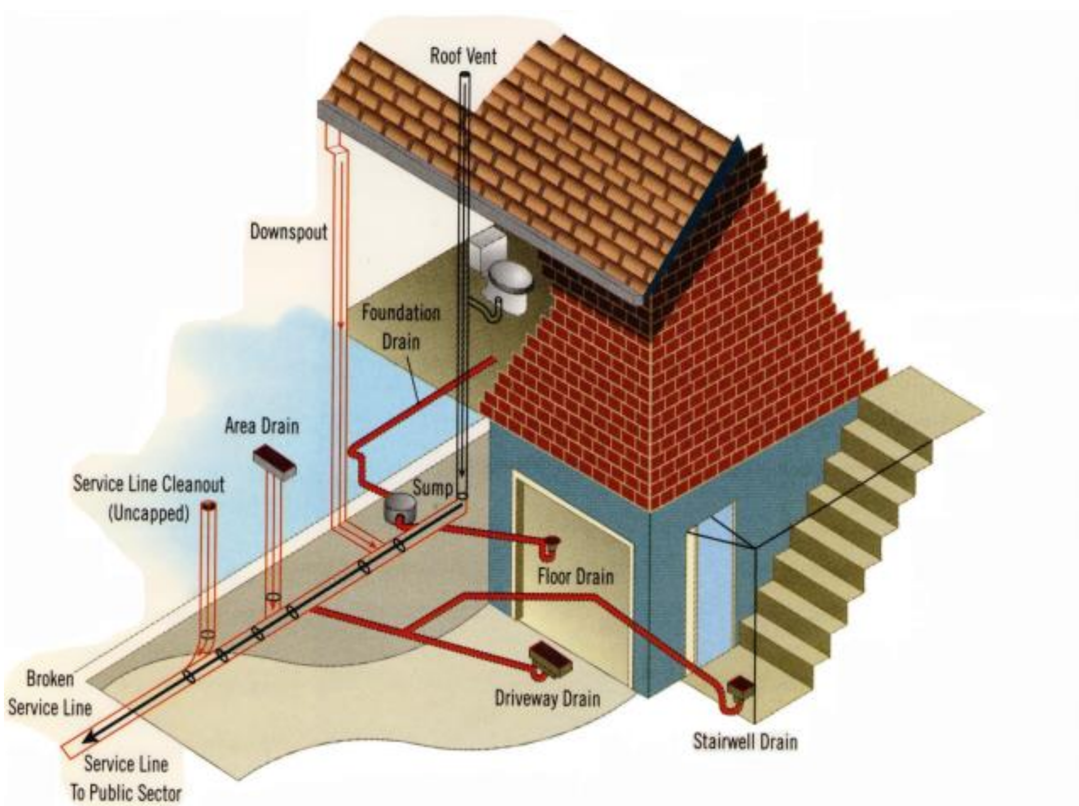


Figure 2-2: Typical Private Sector Inflow and Infiltration Sources



2.4 Manhole Inspections

Manhole inspections were performed by TREKK. All manhole inspections were recorded on electronic TREKK field forms and photographic records were used to supplement and substantiate manhole inspection observations. Manhole inspections were conducted to identify I&I sources and structural/maintenance defects in the manholes.

A total of 457 manholes and 5 lamp holes were inspected. The structures were noted as being comprised of one of two materials: pre-cast concrete or PVC. Precast manholes tend to only have three or four seams running horizontally around the circumference of the structure – where the floor meets the wall, the wall meets the bell, the bell meets the chimney, and the chimney meets the lid frame. Standard practice is to place a thick, bituminous gasket at each of the joints to retain flexibility over time and maintain a seal even after settling or ground movement.

Of the 462 structures evaluated, 457 manholes (100%) were pre-cast concrete, and 4 lampholes were PVC and 1 was pre-cast concrete. Seventeen additional manholes marked for evaluation were not inspected due to inaccessibility. Seventy-six of the 462 manholes inspected showed evidence of surcharge and 58 showed evidence of I&I. Twenty manholes showed evidence of hydrogen sulfide corrosion and three exhibited an emergency situation such as an overflow. All of the manholes that showed evidence of I&I were precast concrete. Detailed results of the manhole inspections can be found in TREKK's findings report previously submitted to the city.

Inspection of various manhole components was conducted and recorded on the electronic TREKK field forms for later entry into the defect database. Components of each manhole evaluated are shown in Figure 2-3. An example field form is shown in Figure 2-4. The following data was collected for each manhole inspected:

- *Date* - Calendar date that inspection was made or attempted.
- *Manhole No.* - Identification number of manhole correlating to numerical system developed by the City and recorded on the City's sewer atlas maps.
- *Connecting Manhole* - Upstream or downstream manhole designation for line segment to which pipes were lamped.
- *Inspection Status if not inspected* - Inspected, not inspected, could not locate or does not exist.
- *Location* - General proximity of manhole to street, easement, curb/gutter or private property.
- *Evidence of Surcharge* - High water marks, grease lines, deposition or sludge on bench, tissue or rags on steps and evidence of overflow through cover.
- *Pipe Location* - Viewing direction from observation manhole of incoming and outgoing pipes in a clock position.

- *Flow Direction* - Viewing direction from observation manhole, either upstream (in) or downstream (out).
- *Service* - Identification of incoming or outgoing pipe as a service connection
- *Stub Out* - Identification of incoming or outgoing pipe as a stub out
- *Force Main* - Identification of incoming or outgoing pipe as a force main
- *Pipe Diameter* - Diameter or dimension (inches) of pipe.
- *Type of Pipe* - Type of material (e.g., VCP, RCP, DIP, CMP, etc.)
- *Observations* - Type and extent of observation (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).
- *Maintenance* - Recommendation for line cleaning and/or CCTV inspection.

Figure 2-3: Typical Manhole Detail

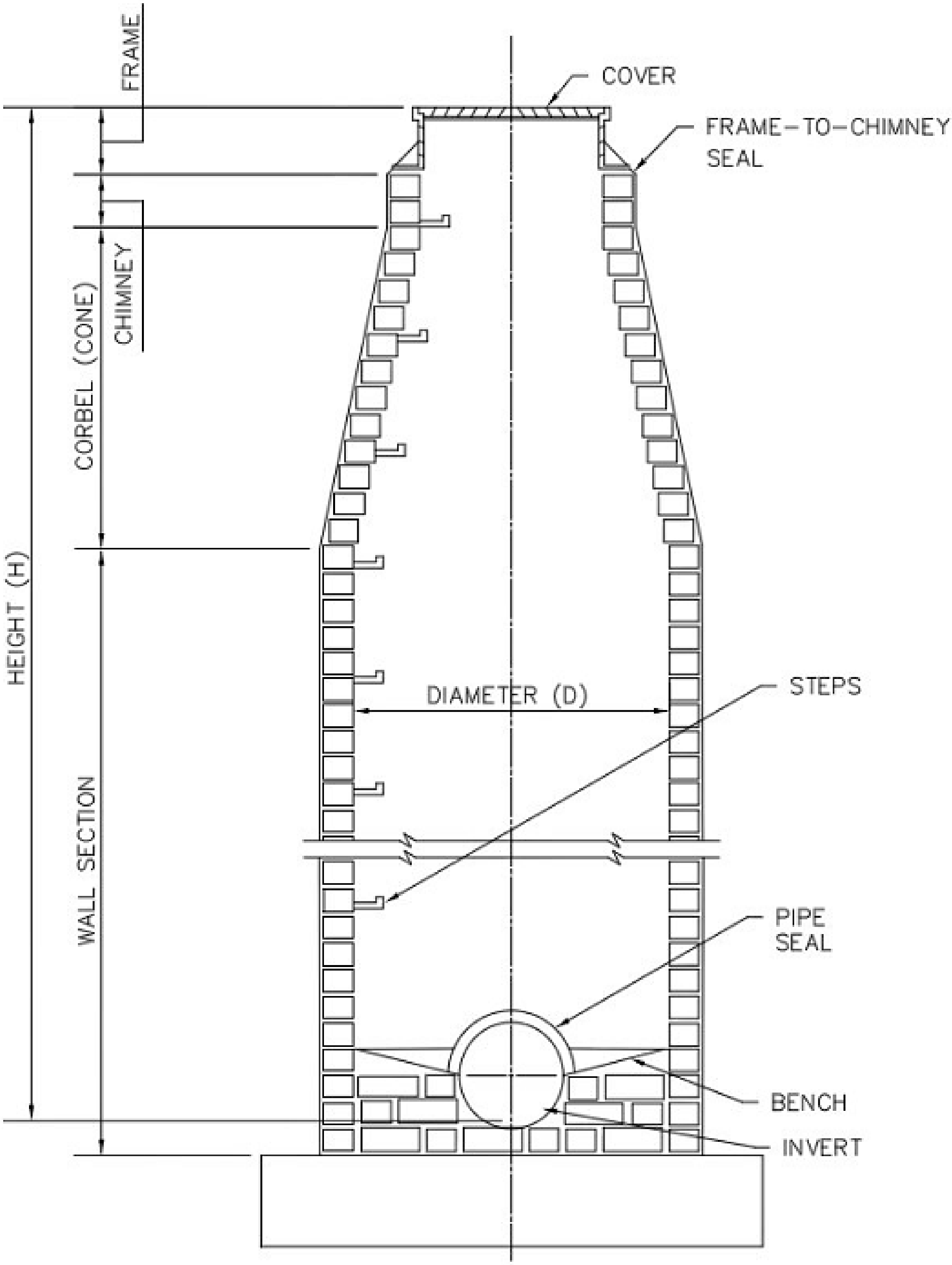


Figure 2-4: Example Manhole Inspection Form

NE-092, Surface Inspection, Manhole

Project	16-135 Fair Grove, MO - SCEAP Grant SSES
Created	2016-08-01 19:22:28 UTC by Jared Swearengin
Updated	2016-11-22 17:13:05 UTC by Amanda Bybee
Location	37.3851304203916, -93.1395330280066
Inspection Status	Inspection Complete

Manhole Information

Manhole ID Number	NE-092
Inspection Status	Surface Inspection
Structure Type	Manhole
Basin	Northeast
Area Photo	
Date	2016-08-01
Time	14:17
Surveyed By	Tony White, City of Fair Grove

Figure 2-4: Example Manhole Inspection Form (Continued)

Topside Photo	
360 Photo	
Manhole Depth	6.68
Manhole Material	Precast
Manhole Use	Sanitary
Frame Condition	Corroded
Cover Condition	Corroded
Surcharge	Yes
Infiltration and Inflow	Yes
Hydrogen Sulfide	Yes
Emergency Situation	No
Overflow	No
Location Details	Treeline

Figure 2-4: Example Manhole Inspection Form (Continued)

Additional Information	Moderate to severe Hydrogen Sulfide throughout manhole, 8-12 inches of manhole wall material sitting on bench from Hydrogen Sulfide, stream of Infiltration and Inflow above out pipe has worn 4x4 area in bench/trough, 4 inches flow at 5.25 feet per second

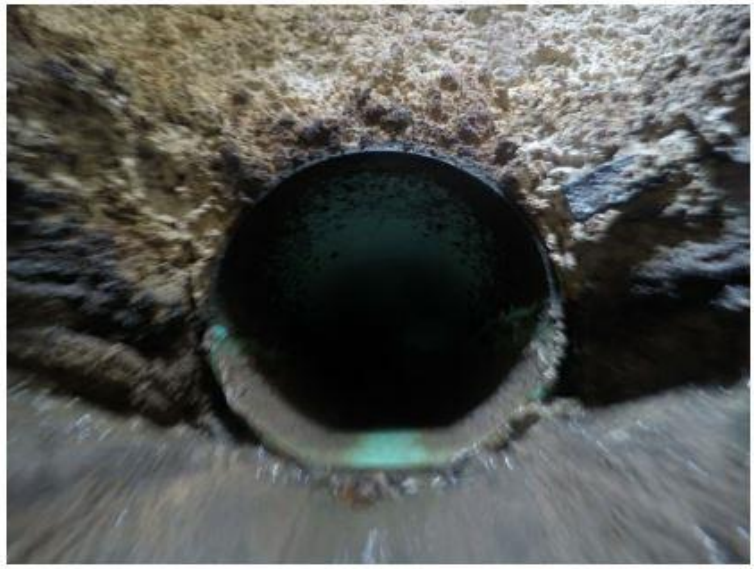
1, 10, Polyvinyl Chloride, Out, NE-091

Pipe Number	1
Clock Position	12
Direction	Out
Connecting Manhole ID Number	NE-091
Invert Depth (Feet)	7.05
Pipe Size	10
Pipe Material	Polyvinyl Chloride
Pipe Photo	
Acoustic Sounding Complete	Yes
Acoustic Sounding Test Number	2240
Acoustic Sounding Score	9
Acoustic Sounding Date	2016-11-22
Comments	I&I stream above pipe and around pipe seal.
CCTV Complete	No

2, 10, Polyvinyl Chloride, In, NE-093

Pipe Number	2
Clock Position	6
Direction	In
Connecting Manhole ID Number	NE-093
Invert Depth (Feet)	6.3
Pipe Size	10
Pipe Material	Polyvinyl Chloride

Figure 2-4: Example Manhole Inspection Form (Continued)

Pipe Photo	
CCTV Complete	No

Quality Control/Quality Assurance

Pipe Connecitvity	

Each inspection identified potential sources of I&I, structural deficiencies, and other general information. A breakdown of these manhole inspections conducted in the city including defect types and count is illustrated in Table 2-2. Inspections also allowed creation of a permanent and comprehensive database to correct deficiencies associated with normal operation and maintenance of the collection system.

An area photo as well as a topside photo was taken of each manhole with a tablet and was directly input into each manholes inspection form. A map of the manholes and the inspection results can be found in Figure 2-7 and a larger map can be found in Appendix B. TREKK is only able to confirm the locations of the structures (manholes and lamp holes) that were inspected. Any other structure locations shown on maps or documents is derived from City data. Structures that were not inspected is due to a lack of access to the structure. A further discussion of the inspection results and the defect flow analysis is included in Section 4.

Table 2-2: Results of Manhole Inspections

Results of Manhole Inspections	City
Total Manholes Inspected	457
Total Lamp Holes Inspected	5
Not Inspected[1]	17
Total Structures	479
Defect Type	
Evidence of Surcharge	88
Infiltration and Inflow	69
Hydrogen Sulfide	21
Emergency Situation[2]	3
Overflow	2
Total Defects	**183**

[1]Structures not inspected were noted as either buried, not found, or could not open.
[2]The City was notified of manholes marked as an Emergency Situation during inspections and they have since been repaired.

2.5 Acoustic Sounding

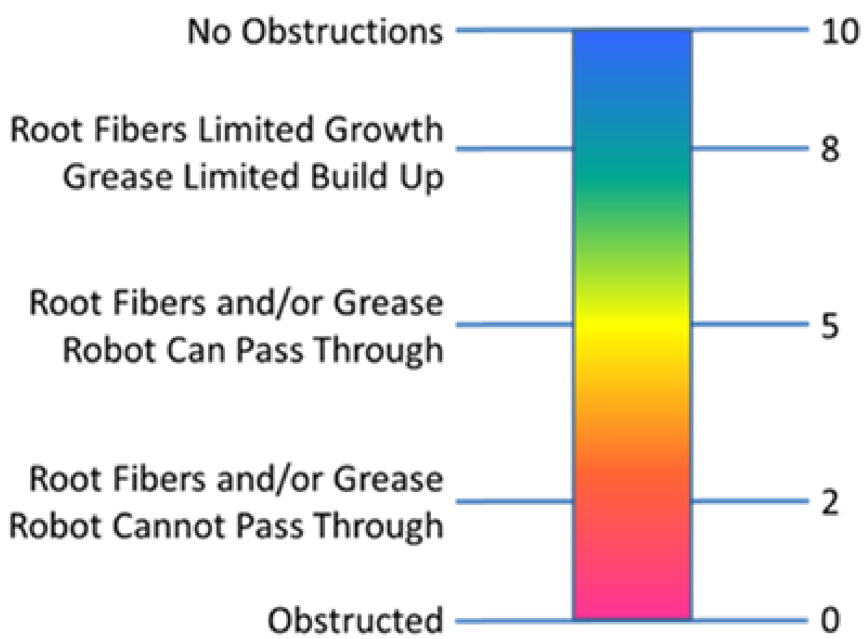
An acoustic assessment of 439 line segments in the study area, totaling approximately 103,430 LF of sewer main, was performed using the SL-RAT, which is short for Sewer Line Rapid Assessment Tool. This acoustic assessment evaluates the aggregate blockage within a combined sewer pipe section using an acoustic method. The approach allows the pipe sections to be evaluated rapidly with no confined space entry, impact to traffic or service disruption. Figure 2-5 illustrates the SL-RAT during field work. All data collected from acoustic evaluations was documented and recorded. The documentation includes a list of all the structures visited and GIS maps identifying observed blockage condition.

A rating system is used to define the quality of each segment. The SL-RAT gives each line tested a score from 0 to 10 depending on the amount of sound able to travel through the pipe. The rating system used on a scale of 0-10 is defined below and graphically illustrated in Figure 2-6:

- 0 **Blocked**
- 1-3 **Poor**
- 4-6 **Fair**
- 7-10 **Good**

Figure 2-5: SL-RAT Performing an Acoustic Sounding Test

Figure 2-6: SL-RAT Aggregate Rating System



Acoustic sounding was performed prior to flow monitoring and smoke testing to ensure lines would be free and clear for smoke to pass through cleanly. The acoustic sounding results can also prioritize maintenance for lines that need to be cleaned and televised. Acoustic sounding results along with manhole status for the study area are shown in Figure 2-7. Table 2-3 illustrates the amount of acoustic testing performed in the City. Not all pipe segments were tested due to lack of access to the manhole structures. A large map showing Manhole Inspections and Acoustic Sounding Results is available in Appendix B.

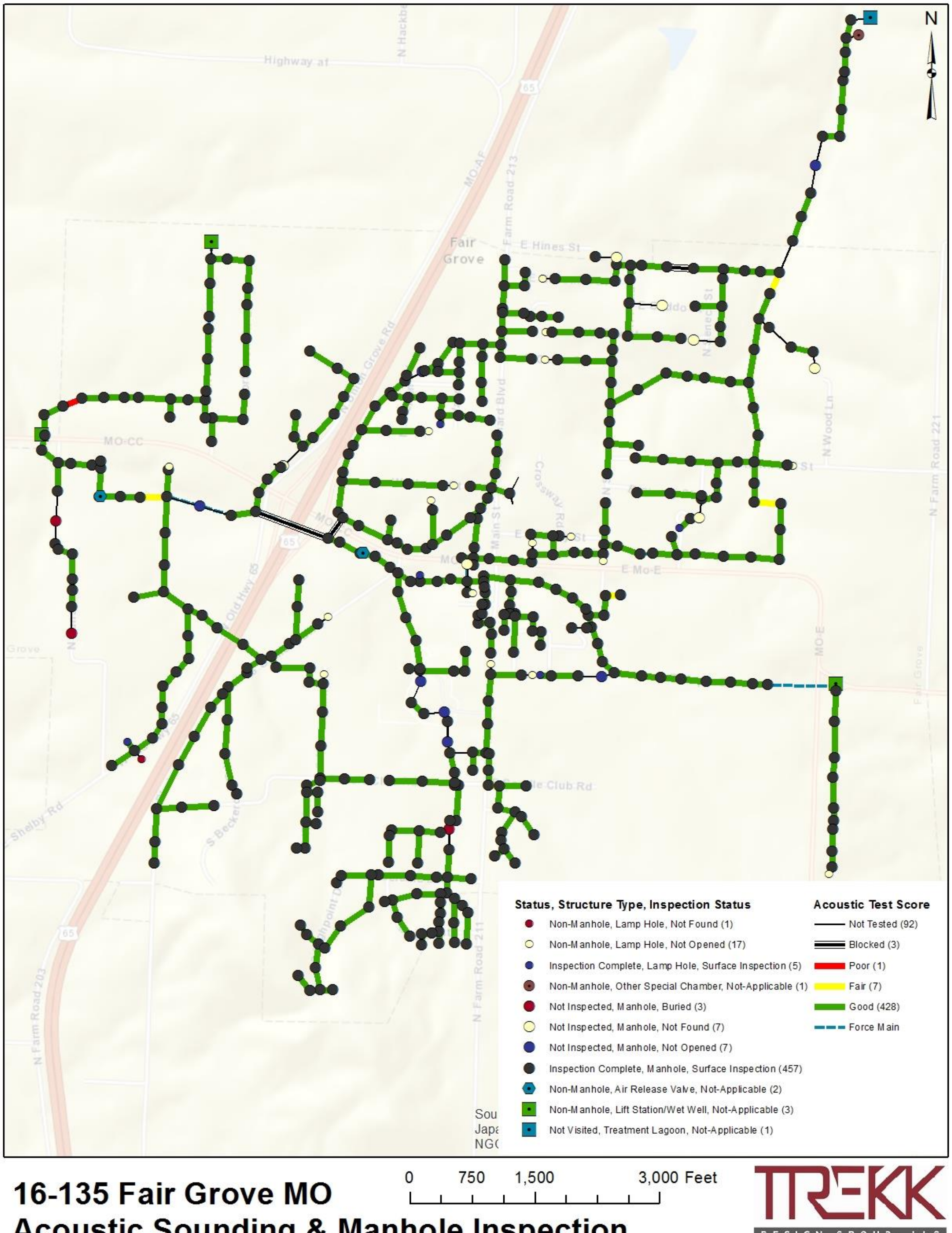
Table 2-3 Acoustic Sounding Summary

Study Area Basin ID	Total Acoustic Sounded Footage	Total City Footage	% Total Tested
City	103,430	115,434	89.6%
Notes: The total city footage was calculated based on City's GIS Data and TREKK's Smoke Testing GIS Data.			

Table 2-4: Acoustic Sounding Results

Acoustic Sounding Score	Total Segments	Total Sewer Footages	% Totals
Blocked	3	1,556.8	1.5%
Poor	1	241.4	0.23%
Fair	7	1,413.7	1.4%
Good	428	100,218.1	96.9%

Figure 2-7: Acoustic Sounding & Manhole Inspection Results



2.6 Flow Monitoring and iTrackers

Table 2-5: TREKK Flow Meter Site Summary

Meter ID	Manhole Number	Pipe Dia. (in)	Date Installed	Date Removed	Meter Days
16-135_1	SW-017	10	3/16/17	5/15/17	60

An ISCO 2150 area/velocity flow meter was installed and maintained by the TREKK in one location: Site 16-135_1 (Manhole ID: SW-017). The meter was installed from March 16, 2017 through May 15, 2017. The location of this flow meter is shown in figure 2-9. Based on the flow and rain data minor analysis is able to be performed including Average daily dry weather flow (ADDF) and I&I for the respective basins in gallons.

Average daily dry weather flow (ADDF) is defined as the 7-day low flow during the monitoring period. This component of measured flow is comprised of wastewater discharged from commercial, industrial, institutional, and residential users during dry weather and low groundwater conditions. In addition, "permanent infiltration" is included when calculating dry weather flow. These dry weather periods are selected to represent times of low groundwater tables with no RDII. Permanent infiltration occurs during high groundwater conditions through system defects such as broken or cracked pipe or pipe with separated or offset joints. 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 2-6 provides the ADDF calculated for each of the flow meter. Hydrographs from the flow meter maintained by TREKK can be found in Appendix C.

Table 2-6: Flow Meter ADDF Data

Meter ID/Manhole	Tributary Pipe Footage	7-day ADDF (MGD)	Min ADDF (MGD)
16-135_1/SW-017	78,002	0.12	0.01

Analyzing the total flow recorded vs the ADDF allows us to predict the amount of flow that is attributable to I&I. I&I was calculated by multiplying the ADDF by the number of days in the study and subtracting the subtotal from the total flow that was recorded.

Figure 2-8: Site 16-135_1 Flow Meter Hydrograph

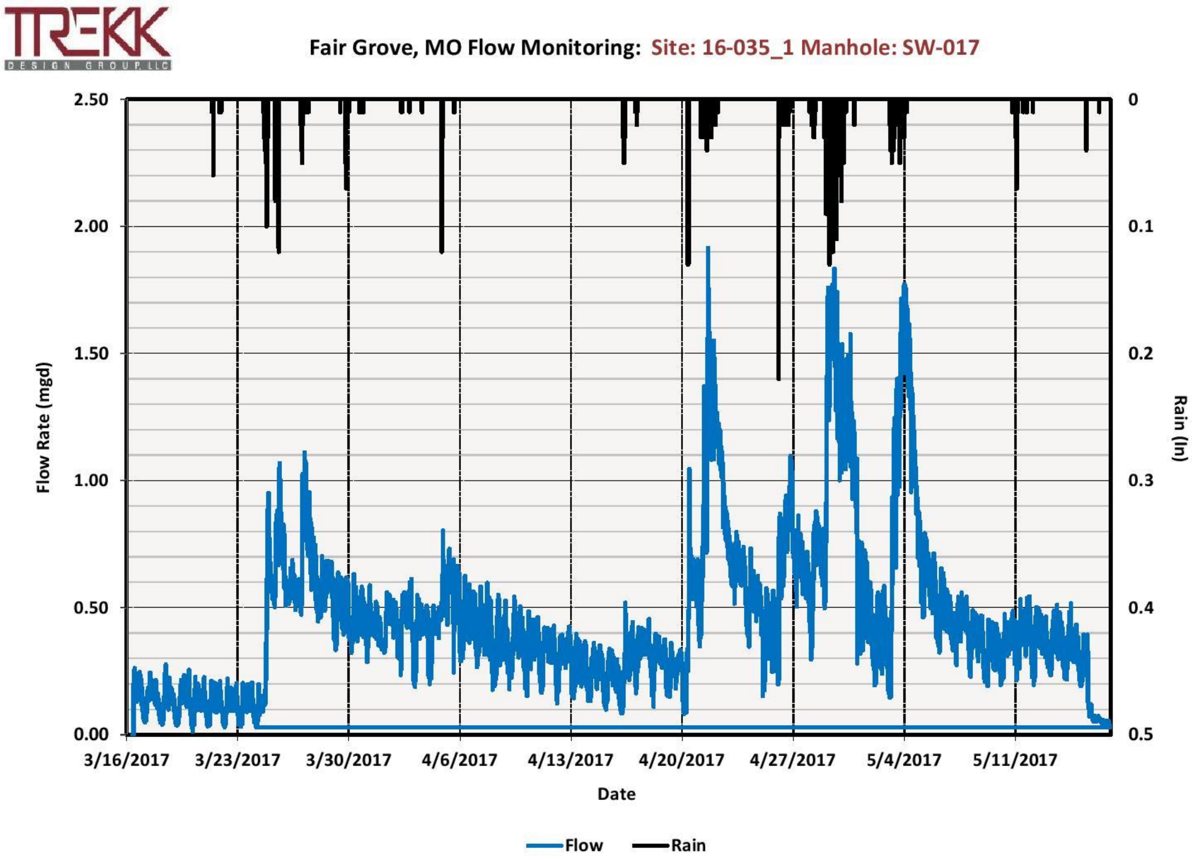
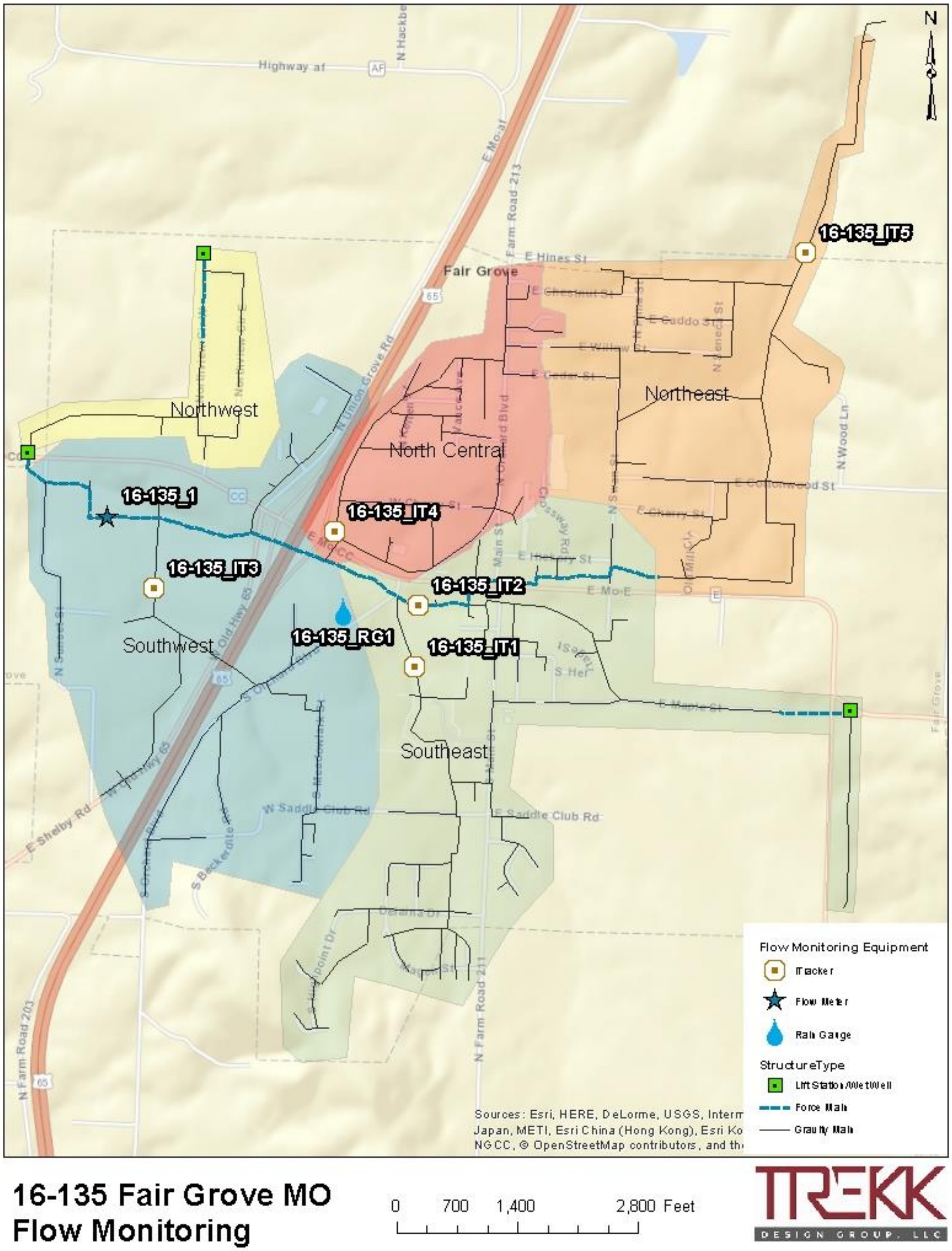


Table 2-7: I&I Calculated from Flow Meter Data

Study Area Basin ID	Flow Total (Million Gallons)	ADDF (MGD)	ADDF Projected (Million Gallons)	I&I as % of Total Flow	Peaking Factor*	Instantaneous Peak Flow (MGD)	Peak Hourly Flow (Gallons/Hour)
All Except Northeast basin	29.65	0.12	7.04	76.27%	15.77	1.92	59,292
*DNR considers a peaking factor greater than 2.5 to be excessive I&I.							

Figure 2-9: Flow Meter and iTracker Installation Map

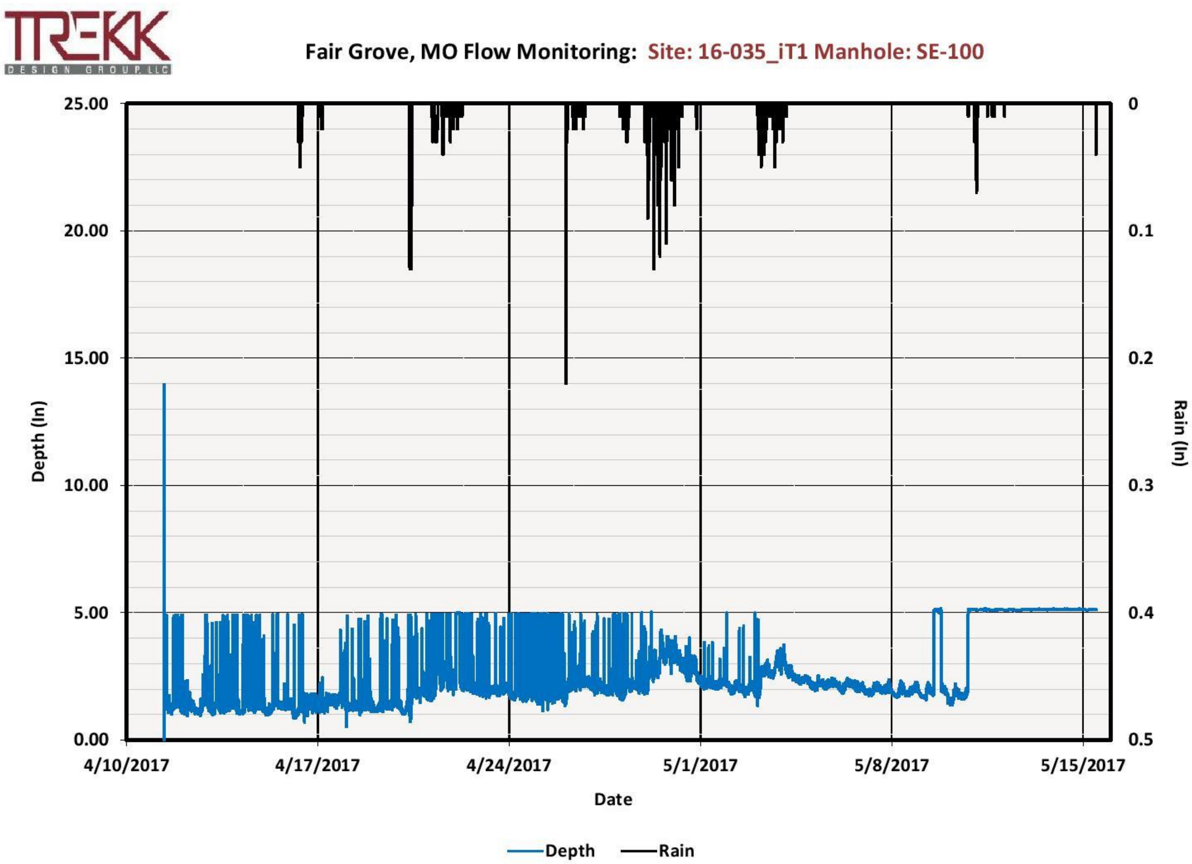


iTracker level sensors were installed to record flow levels within the manhole and visible I&I before, during and after significant rainfall events. iTrackers were installed without confined space entry and mounted from a tension bar at the top of the manhole. Five sites were selected for installation to create basins and help to better determine which basins are contributing most to I&I. Figure 2-9 shows the location of the flow meter, iTracker's, and rain gauge. All iTracker graphs are provided in Appendix D.

Site 1 (16-135_IT1)

iTracker 1 was installed in manhole SE-100. The level graph is provided in Figure 2-10.

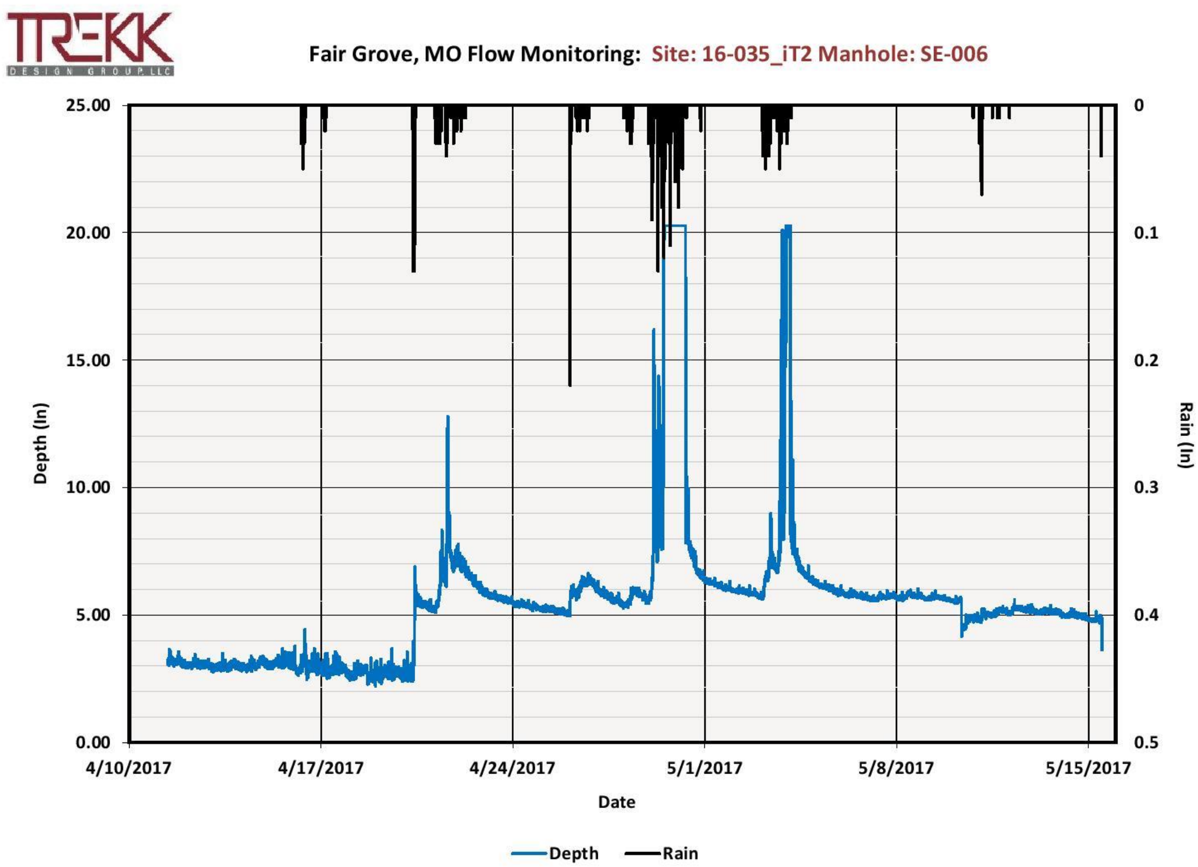
Figure 2-10: iTracker1 Level Graph



Site 2 (16-135_IT2)

iTracker 2 was installed in manhole SE-006. Data from iTracker2 and iTracker4 provided the best case for large amounts of I&I that may be identifiable via smoke testing. Both sites seem to have more inflow than infiltration suggesting direction connections to the sanitary sewer. The level graph is provided in Figure 2-11.

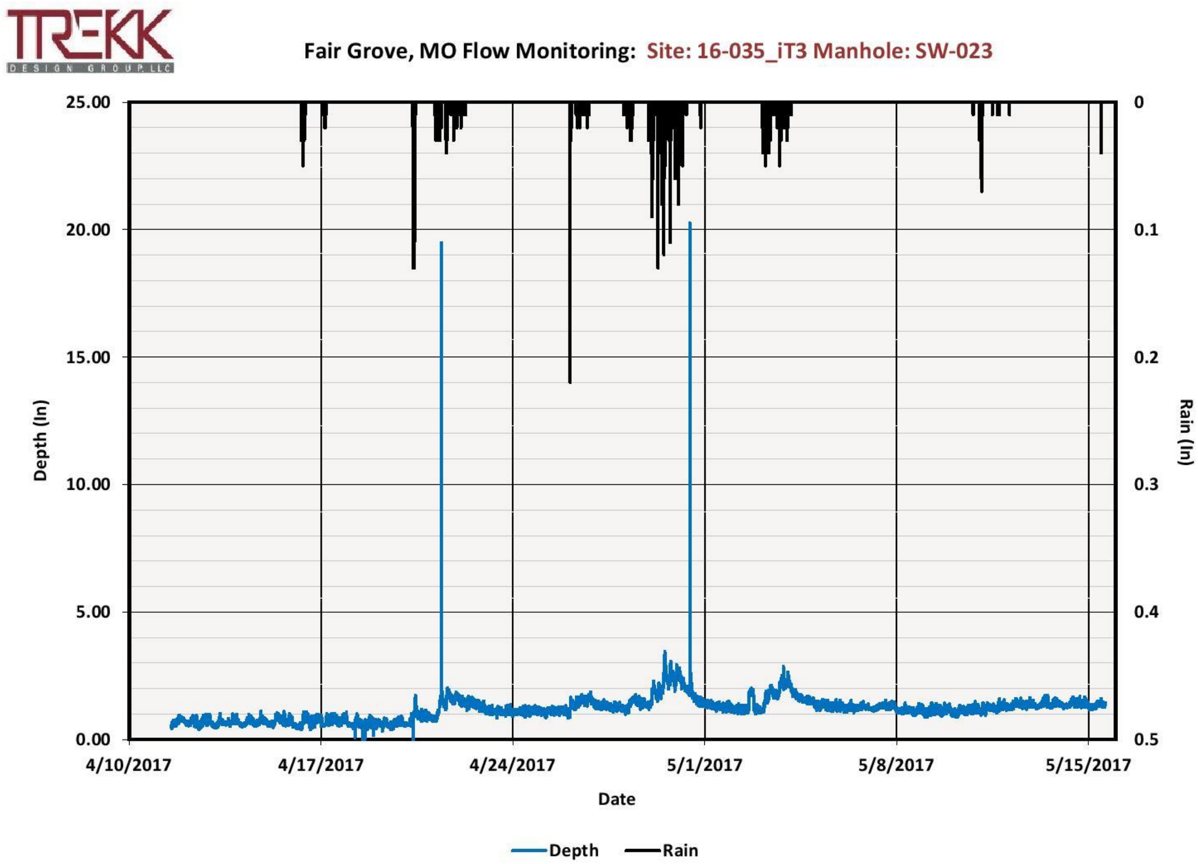
Figure 2-11: iTracker2 Level Graph



Site 3 (16-135_IT3)

iTracker 3 was installed in manhole SW-023. Assuming a similar velocity iTracker3 did not have nearly the amount of volume when compared to iTrackers 2 & 4. The level graph is provided in Figure 2-12.

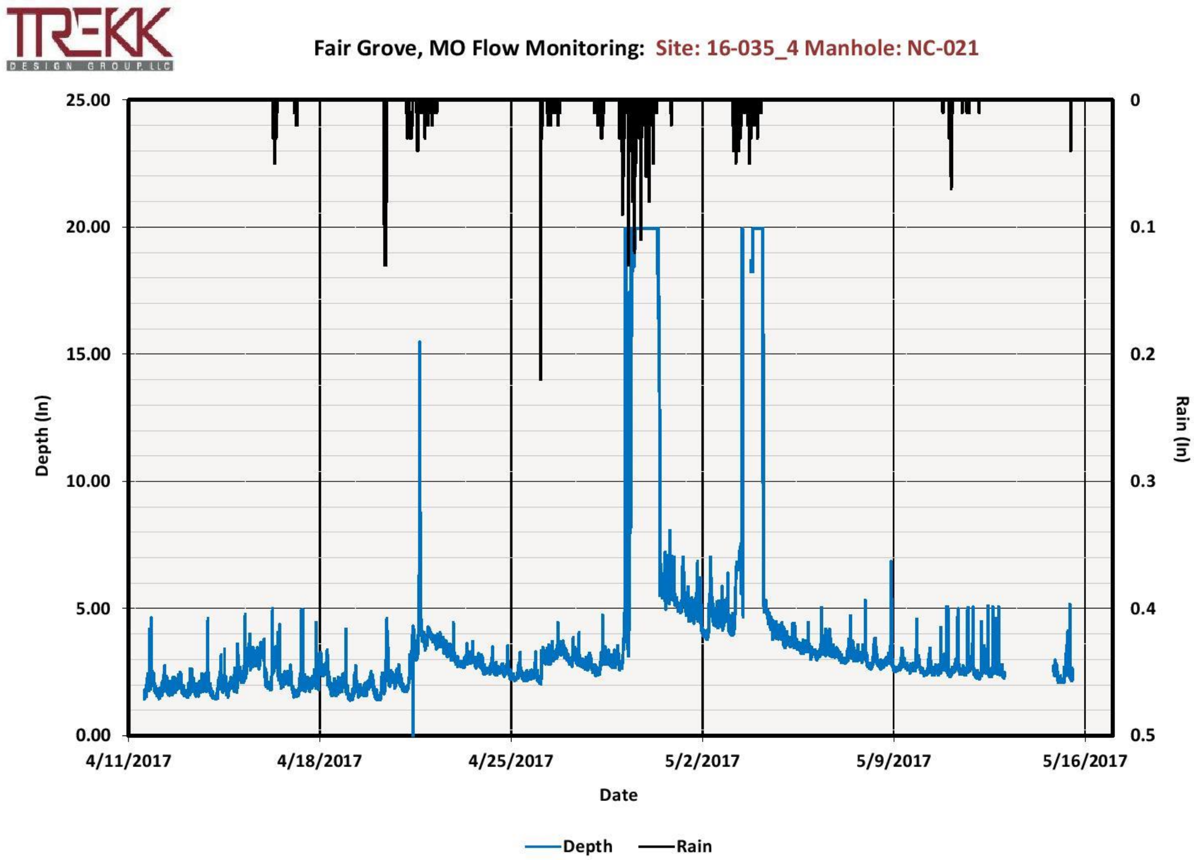
Figure 2-12: iTracker3 Level Graph



Site 4 (16-135_IT4)

iTracker 4 was installed in manhole NC-021. Data from iTracker2 and iTracker4 provided the best case for large amounts of I&I that may be identifiable via smoke testing. Both sites seem to have more inflow than infiltration suggesting direction connections to the sanitary sewer. It appears that this site experienced surcharged conditions during significant rain events while the iTrackers were installed. The level graph is provided in Figure 2-13.

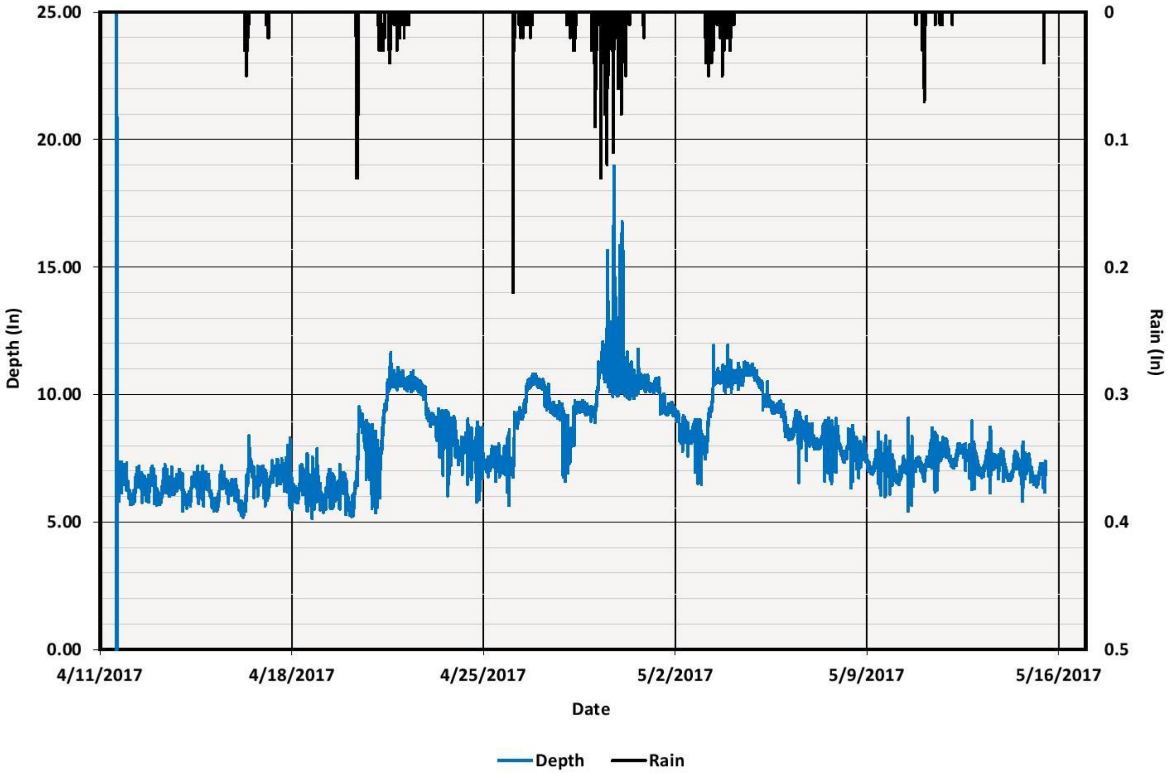
Figure 2-13: iTracker4 Level Graph



Site 5 (16-135_IT5)

iTracker 5 was installed in manhole NE-013. iTracker5 is located closest to the wastewater treatment facility. Its data includes flow from the flow meter and iTrackers 1 – 4. It does not seem to have significant I&I compared to iTracker 2 & 4. The level graph is provided in Figure 2-14.

Figure 2-14: iTracker5 Level Graph



2.7 Smoke Testing

Line segments within the City were smoke tested to detect I&I sources in the public and private sectors, except for lines blocked or surcharged. Sanitary lines tested are shown in Figure 2-16. Lines to be smoke tested were determined based on the flow meter and iTracker data collected. Sites 1 and 2 from the iTracker data collected showed the most significant increases in level during rain events and therefor line segments upstream of these meters were chosen for smoke testing. Smoke testing was performed by injecting, through the vaporization of oil, into an isolated line segment with two (2) high-capacity blowers (rated at 6,211 cfm). The use of liquid oil, instead of smoke bombs, allows for continuous smoke production while field crews canvass the area and conduct a perimeter check of all buildings in close proximity for evidence of smoke.

A thorough public relations and notification program was implemented to minimize public concerns raised by smoke testing. The notification program included distribution of door-hanger notifications, street signs indicating smoke testing activities within the area, information posted on the City's website, and daily communication with the City's Fire, Police, and Public Works Departments. Smoke testing activities included a minimum of 48 hours advance notification to all residents and businesses within the Study Area. The telephone numbers of TREKK Design Group's director of field personnel and project manager were provided on all pamphlets enabling residents to contact TREKK for more information or with any special needs and concerns they may have.

Typically, 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 restrict smoke migration to the source in question. Other investigative techniques such as building inspections, CCTV inspections and dyed-water tracing may be used in those circumstances in order to find additional I&I sources. A total of 25,087 linear feet of sanitary sewers were smoke tested. Table 2-8 summarizes the quantities of pipe smoke tested in the Study Area.

Table 2-8: Smoke Testing Summary

Study Area Basin ID	Total Segments Smoked	Total Smoked Footage	Total City Footage	% Total
North Central	58	12,317	115,434	11%
South East	78	12,770	115,434	11%
Notes: The total city footage was calculated based on City's GIS Data and TREKK's Smoke Testing GIS Data.				

Each positively identified source was photographically documented and located using a GPS tablet. The tablet, used in conjunction with an external receiver, has the capability of providing sub-meter accuracy. Defect information was directly entered into a database stored online. A shapefile was extracted from the database and imported into ArcGIS to show the exact location of the smoke testing defects, including all defect information stored in the database. The GPS units ensure that all defect sources are referenced to allow for efficient repair.

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

- *Line Segment* - Identification of line segment tested.
- *Surface* - Percent of area that is paved surface.
- *Status* - Determination of identified smoke on private property or public sector of sewer system.
- *Defect Type* - Type of defect that produced smoke.
- *Smoke Intensity* - Light, medium, or heavy intensity.
- *House Number* - The house number is recorded for defects located on private property.
- *Street* - Street name that the public or private property defect is located at.
- *Tributary Area* - The estimate tributary area (square feet) to the defect.
- *GPS Offset* - Distance (ft) and direction of offset.
- *Comments* - Any noteworthy observation not included in general data.
- *Latitude*
- *Longitude*
- *Date* - Date testing occurred.

For direct inflow sources such as uncapped cleanouts and driveway 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 2-9. Photographic records were used to supplement and substantiate smoke testing observations. A larger map showing Smoke Testing Results is available in Appendix F.

Figure 2-15: Smoke Testing Defect Examples

The photo to the left shows a manhole defect smoking in a creek bed identified during smoke testing in Fair Grove, MO. This is an example of a smoke testing defect found on the public side.

The photo to the right shows a cleanout defect identified during smoke testing in Fair Grove, MO. This defect is an example of a private side defect.

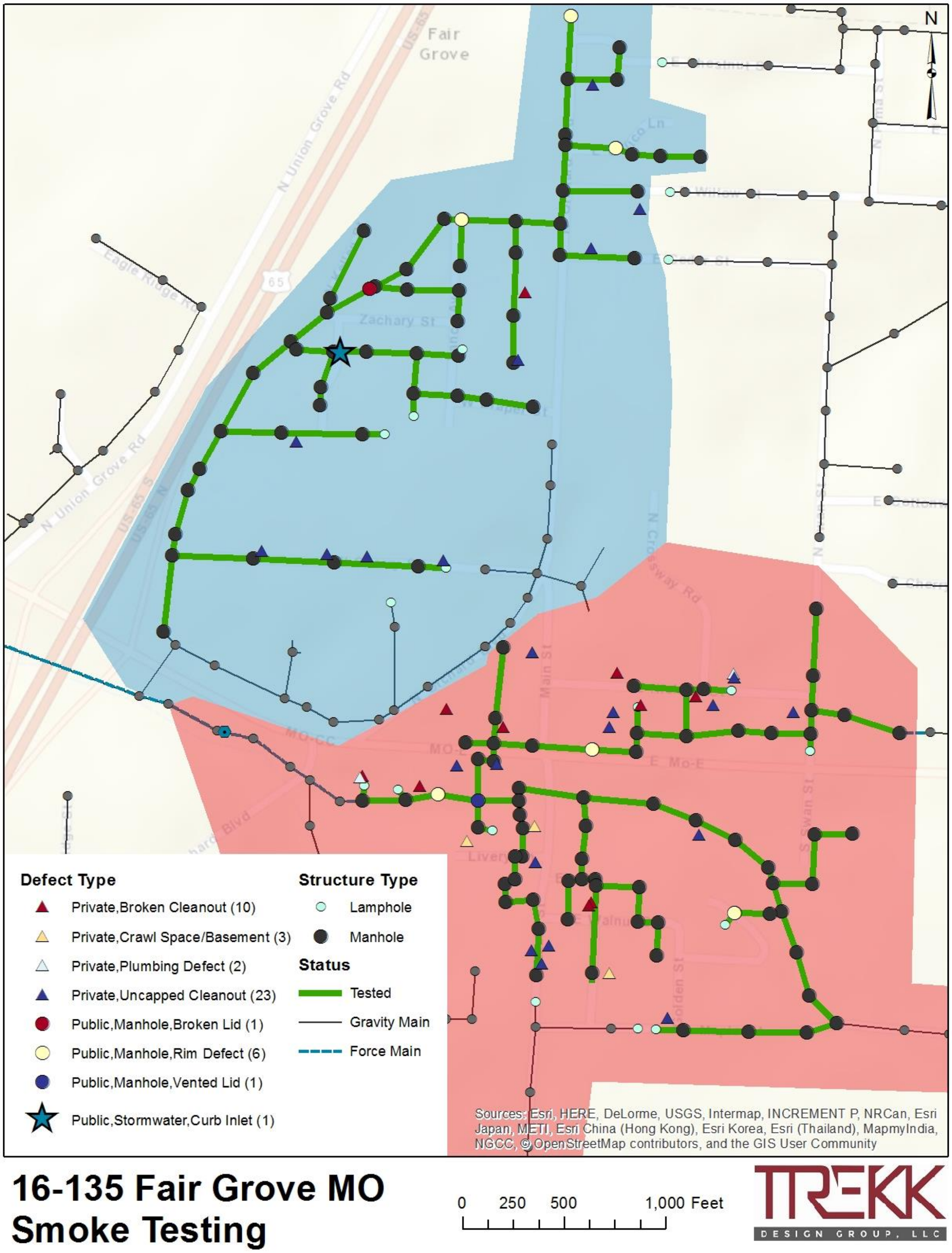
A PDF copy of the smoke testing defect table and the smoke testing defect map are included as Appendix E. A summary of smoke testing defects is shown in Table 2-9.

Table 2-9: Results of Smoke Testing

Defect Type	Total
Public-Sector	*9*
Stormwater Defect – Curb Inlet	1
Manhole Defect – Vented Lid	1
Manhole Defect – Rim Defect	6
Manhole Defect – Broken Lid	1
Private-Sector	*38*
Crawl Space/Basement	3
Cleanout – Broken	10
Cleanout – Uncapped	23
Plumbing Defect	2
Total I&I Sources	47
Total Smoked Footage	25,087
Total I&I Sources/1,000 LF	1.87

Table 2-9 shows the number of defects in the private sector was higher than those found in the public sector. Due to the shallower depth of the service laterals and surface exposure of cleanouts to outdoor activities, it is not uncommon to see a higher number of private sector defects. Additionally, due to their lower construction cost, repairs to private sector defects are typically less expensive than public sector defects. Line segments exhibiting smoke from public sources, other than manholes, may need to be included in a future CCTV inspection program. Additionally, service laterals that exhibit smoke may also be included in the CCTV inspection program.

Figure 2-16: Smoke Testing Defect Summary



*A Larger map can be found appendices.

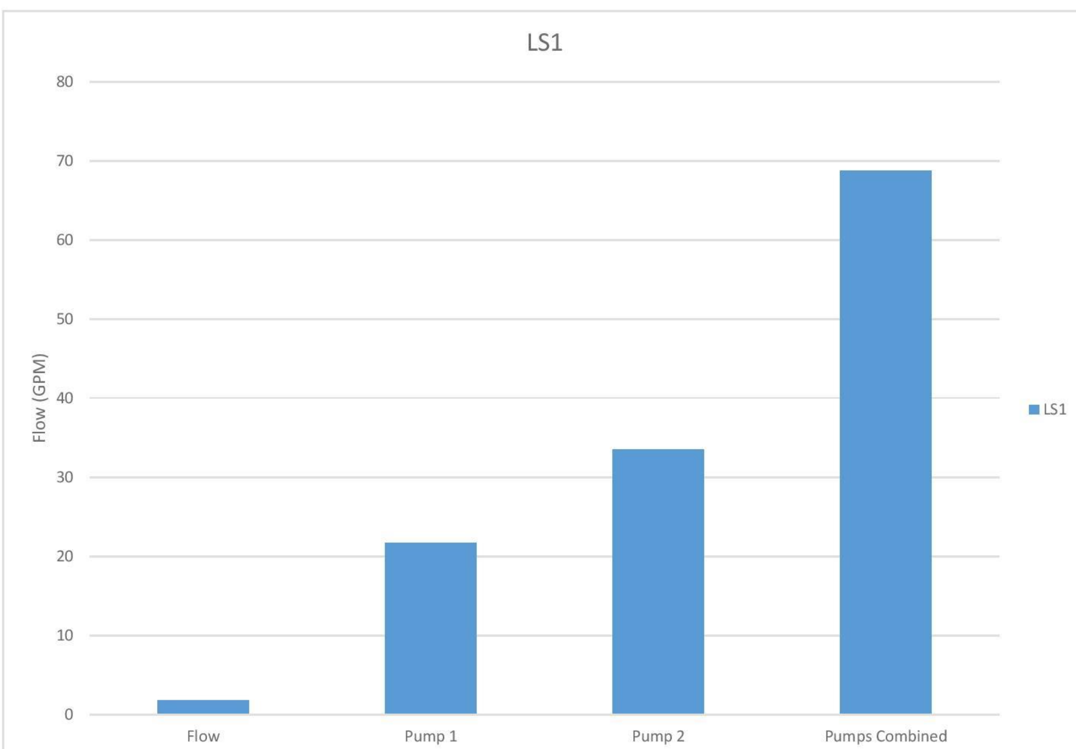
2.8 Lift Station Inspections

A visual inspection of the three pump stations LS1, LS2, and LS3 were performed to evaluate the condition of the pumps at each station. This visual assessment evaluates the location, wet well diameter, flow, and operating functionality. The approach allows the pumps to be evaluated rapidly with no impact to traffic or service disruption. All data collected from the visual inspections was documented and recorded. The documentation includes a list of all the structures visited and GIS maps identifying observed blockage condition. The following Figures 2-17 through 2-19 show the results from the inspections.

Lift Station 1

This lift station is located on the southeast side of Fair Grove. The lift station services a small number of houses along South Grove Road. A visual inspection was performed in February of 2017. Both pumps were found to be in working order and no defects were recorded.

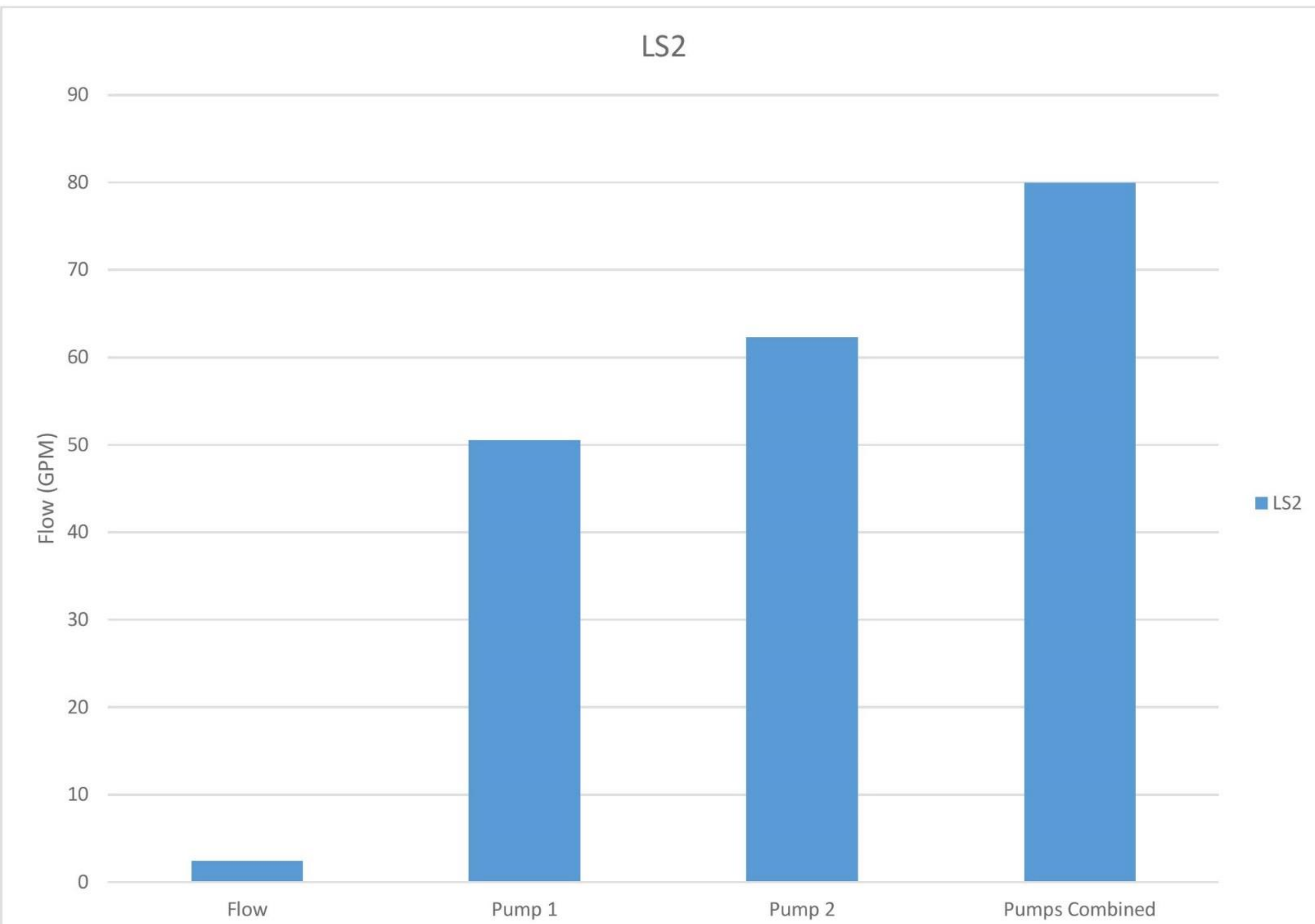
Figure 2-17: LS1 Lift Station Inspection



Lift Station 2

This lift station is located on the west side of the City. The lift station services the majority of flow from the town and pumps it back east towards the treatment plant and discharges into manhole NE-099. A visual inspection was performed in February of 2017. Both pumps were found to be in working order and no defects were recorded. Manholes located downstream from the discharge of this lift station were found to have sever hydrogen sulfide damage during manhole inspections. These manholes have since been replaced. It is recommended to consider a chemical addition of a calcium nitrate solution such as Bioxide to be added to the main lift station to control the formation of hydrogen sulfide for corrosion protection.

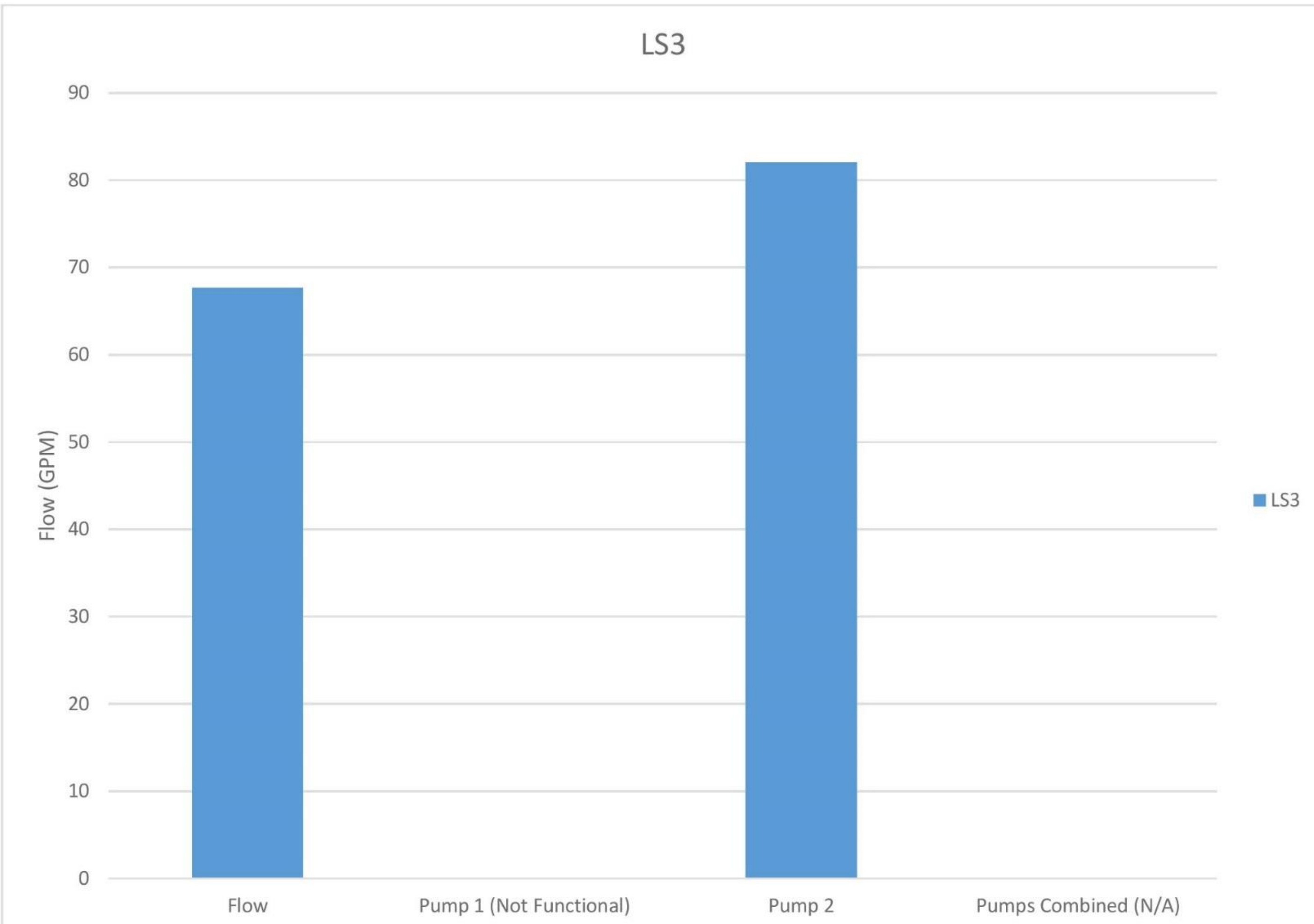
Figure 2-18: LS2 Lift Station Inspection



Lift Station 3

This lift station is located on the northwest side of the City. The lift station services a small number of residences along East Northview Circle. A visual inspection was performed in February of 2017. One pump was found to be not functioning and the City was notified. This pump is to be repaired.

Figure 2-19: LS3 Lift Station Inspections



3 Field Data Analysis

3.1 Objective

Although the type and quantity of data is important, it is equally important to evaluate and use the data in a manner that will yield the greatest benefit. As discussed previously, it is important to capture representative I&I field data from sewer systems when they are most responsive to rainfall and antecedent ground conditions. This field data was then quantified, categorized, and statistical relationships calculated to facilitate defect flow analysis.

Each field inspection activity located defects, which may or may not contribute I&I to the system, depending on their type and/or location. Based on the information gathered in the field, it was possible to estimate which defects will contribute I&I flows, and which will not. Defects, which were determined to be I&I contributors, were separated into four categories: (1) public sector inflow, (2) public sector infiltration, (3) private sector inflow, and (4) private sector infiltration. In this way, the potential impact of I&I-related defects on the system, as they relate to their location in the sanitary sewer system, could be determined. This section will summarize the analysis of I&I sources that were located in the study area.

3.2 Public Sector Inflow/Infiltration Sources

Public sector I&I sources were identified through manhole inspection and smoke testing field activities described previously in Section 2. Unit I&I rates (GPM) were assigned to each source type based on a rating condition used in the field and/or the estimated runoff area that is tributary to the inflow source.

A summary of quantities and estimated flow rates from public sector I&I sources are presented in Table 3-1.

Table 3-1: Summary of Public Sector Inflow/Infiltration

Inflow/Infiltration Source	Number of Sources	Flow Rate (gpm)
Manhole – Broken Lid	1	10.85
Manhole – Rim Defect	6	6.10
Manhole – Vented Lid	1	10.85
Stormwater – Curb Inlet	1	67.86
Total Public-Sector I&I:	**9**	**95.66**

3.3 Private Sector Inflow/Infiltration Sources

Private sector I&I sources were identified through smoke testing as previously described in Section 3. Unit I&I rates (GPM) were computed for each source using methods similar to those described for public sector I&I. A summary of quantities and estimated flow rates from private sector I&I sources are presented in Table 3-2.

Table 3-2: Summary of Private Sector Inflow/Infiltration

Inflow/Infiltration Source	Number of Sources	Flow Rate (gpm)
Cleanout - Broken	10	169.55
Cleanout - Uncapped	23	55.59
Crawl Space/Basement	3	0.00
Plumbing Defect	2	0.00
Total Private-Sector I&I:	**38**	**225.14**

3.4 I&I Source Summary

Total quantification of inflow and infiltration from individual sources identified under the field inspection activities is shown in Table 3-3.

Table 3-3: Summary of I&I Source Quantification

Source Type	Number of Sources	Flow Rate (GPM)	% GPM of Total
Public-Sector	9	95.66	29.82%
Private-Sector	38	225.14	70.18%
Total:	**47**	**320.80**	**100%**

4 Wastewater Treatment Facility

4.1 Identification

The name and mailing address of the Publicly Owned Treatment Works (POTW) system continuing authority is:

City of Fair Grove
81 S Orchard Blvd
Fair Grove, MO 65648
Mr. Anthony Miller, Mayor
Mr. Kenny Hokanson, Public Works Director

Mayor Miller and Mr. Hokanson can be contacted at City Hall, phone number 417-795-2353. The city's POTW is operated under Missouri State Operating Permit (MSOP) MO-0111708 as part of the National Pollutant Discharge Elimination System (NPDES) and is regulated at the state level by MoDNR. Regional MoDNR regulatory authority is provided by personnel staffed in the Southwest Regional Office (SWRO) of MoDNR, located in Springfield, Missouri. A copy of the city's POTW operating permit can be found in Appendix A.

4.2 Planning Area

Fair Grove is currently listed as a "4th Class" city by Missouri Roster. The planning area for this facility plan includes the area served by the City of Fair Grove's existing wastewater collection system as shown in Exhibit 1. In general, this area is representative of the city's incorporated limits, approximately 3.2 square miles.

The city has several commercial establishments but no major industries. With a 2010 United States (U.S.) Census population of 1,393, the City of Fair Grove also serves as a bedroom community to larger regional cities, such as Springfield, Missouri, located eighteen miles to the southwest (2010 U.S. census population of 159,498). The service area is dissected by three major features: east-west Highway CC, north-south Highway 65, and the north-south topographic ridge line.

Fair Grove has no definitive plans to expand its sewer utility service area in the foreseeable future as the area's population has shown only modest growth in recent years and there are still infill land opportunities within the current service area. Accordingly, this report focuses only on Fair Grove's existing sewer service area.

4.3 Topographic, Geological, Soil, & Climate Characteristics of Planning Area

4.3.1 Topographic

The lowest elevation in the service area is along the western stretch of State Highway CC with an elevation of approximately 1,150 ft-USGS. The high elevation ridge in the service area is along the south side of the city, with elevations over 1,300 ft-USGS. The general slope of the service area and surrounding land is to the west toward the Little Pomme de Terre River. A tributary of the Pomme de Terre River runs through the collection system service area from south to northwest – the Little Pomme de Terre River. The Little Pomme de Terre River generally has running water except during drought conditions.

4.3.2 Geology & Soil

The geology and soils in Greene County are influenced by many different geologic formations. Fair Grove is located on the Springfield Plateau, a sub-region of the greater Ozark Plateau. Rocks in the area consist primarily of limestone and shale. Regional soils vary in depth from non-existent at frequent rocky outcroppings to greater than five feet in depth. Soils tend to be moderately- to well-drained, gently- to moderately-sloping, and composed highly of fragmented rock and clay before giving way to bedrock. Regional formations are composed of limestone rocks which contribute to the karst nature of the area. Karst landscapes are caused by easily dissolvable bedrock, which creates cracks, caves, fissures, natural bridges, and sinkholes.

4.3.3 Climate

Fair Grove's service area experiences a moderate climate that is similar to that of the county as a whole. Approximately 24 miles south-west of Fair Grove is a National Climate Data Center (NCDC) recording facility operated in cooperation by the National Weather Service and National Oceanic and Atmospheric Administration (station ID #KSGF). From the compiled recordings from 1981 to 2010, Fair Grove experiences an average high temperature of 88°F in the summer and an average low of 24°F in the winter. From compiled recordings from 1888 to 2015 a record high of 113°F was set on August 3, 1954 and a record low of -16°F in December 1989.

The city experiences an average yearly rainfall total of slightly over 45 inches. Of this, approximately 26 inches falls between April and September. The heaviest single-day rainfall recorded at the Springfield NCDC was 6.3 inches, which occurred on November 24, 1987. The average seasonal snowfall is 14 inches and the greatest snow depth at one time recorded at the Springfield NCDC recording facility was 18 inches on February 20, 1912. The average relative humidity in mid-afternoon is approximately 55%.

4.4 Existing WWTF

The existing WWTF came on line in the early 1990s. The facility is owned and operated by the City of Fair Grove under National Pollutant Discharge Elimination System (NPDES) Permit Number MO-0111708. The operator is Kenny Hokanson, a Class "B" operator. Operation assistance is provided by Bert Bond, a Class "A" operator with Clean Stream Enterprises, LLC. The facility is located northeast of Fair Grove. It discharges to a tributary of Pomme de Terre River.

The original system consisted of an influent pump station, an oxidation ditch, two clarifiers, one sludge holding tank, two polishing filters, and an ultraviolet (UV) disinfection channel. It was designed for a population equivalent of 1,730, an average daily flow of 173,000 gpd, and a peak daily flow of 628,000 gpd. The WWTF was upgraded in 2009 to accommodate the town's growing population. The upgrade added a second oxidation ditch, a second sludge holding tank, and a new UV system. All the existing equipment remained in use, except for the UV system which was replaced. The upgraded facility was designed for a population equivalent of 4,000 and an average daily flow of 400,000 gpd.

An evaluation was completed to verify the existing facility has the capacity to meet the design population of 4,000 and the design flow of 400,000 gpd. If the facility has the capacity to meet the design flow, it will be able to meet the 2037 projected flow of 182,200 gpd. The oxidation ditches, clarifiers, and polishing filters were included in the evaluation.

The original oxidation ditch is a 33-foot-by-106-foot oval with a total design volume of 176,500 gallons. The new oxidation ditch is a 41-foot-by-100-foot oval with a total design volume of 285,500 gallons. The ditches are operated in series. Combined, they provide 462,000 gallons of storage. At the design flow of 400,000 gpd, a maximum capacity of 15 lb BOD/person/day (as specified in the DNR 10 CSR 20-8.010 Design Guides), and a BOD loading rate of 0.17 lb BOD/person/day, the total storage volume required is 339,100 gallons. The provided volume is 35% more than the required volume, therefore the oxidation ditches are adequately sized to handle the design flow.

Each oxidation ditch is equipped with two rotors. Based on the design flow, a design BOD loading rate of 680 pounds per day, and a design TKN loading rate of 133 pounds per day, 1,800 pounds of oxygen per day are required to aerate the wastewater. With only one rotor in operation in each oxidation ditch, the system can provide 3,000 pounds of oxygen per day. This is 67% more oxygen than required, therefore the rotors are adequately sized for aeration.

The facility has two equally sized, circular clarifiers. Each clarifier has a 33-foot diameter, a 12-foot liquid depth, and a 12-foot-by-12-foot square weir. Under normal operating conditions flow is split evenly to each clarifier. The DNR Design Guides require one square foot of clarifier surface area for every

1,000 gallon of wastewater flow. Based on the design flow, 400 square feet of clarifier surface area is required. With only one clarifier in use, there are 855 square feet of clarifier surface area. This is more than double the required surface area, therefore the clarifiers are adequately sized. The design guides require one foot of weir length for every 10,000 gallons per day of wastewater. Each clarifier has 48 feet of weir length, therefore with only one clarifier in operation the facility can treat 480,000 gallons per day. This is more than the design flow; therefore, the weir length is adequate.

The facility has two equally sized polishing filters. Each filter bed is 18 feet by 6 feet, for a total bed area of 108 square feet. The MoDNR design guides limit the filtration rate to a maximum of 5 gallons per minute per square bed area. To filter the entire design volume at 5 gallons per minute, a 55 square foot bed area with clean media is required. One filter bed as twice the required area, therefore the filters are adequately sized.

During a visit to the treatment facility on April 27, 2018, Olsson engineers observed one polishing filter in operation and one polishing filter off-line for repairs. The filter in operation appeared to be having difficulty accommodating the incoming flow. As established above, each filter should be able to handle the entire flow. It is likely that the filter media has become clogged and is not able to pass 5 gallons per minute per square foot. It is recommended that the filter media be cleaned. If the system still struggles to pass the entire flow with one filter off-line, the media should be replaced.

The facility has two sludge storage tanks. The original tank has a storage volume of 64,000 gallons and the new tank has a storage volume of 222,400 gallons. Combined, the two sludge storage tanks provide the system with 286,400 gallons of total storage volume. Based on 0.4 tons of sludge production per million gallons of influent wastewater, the design daily sludge production for the plant is 320 pounds per day. At 2% solids, this results in 1,918 gallons of sludge per day. The sludge storage tanks provide close to 150 days of storage capacity, assuming no decanting. Decanting is provided out of the sludge storage tanks; therefore, the actual sludge storage capacity is greater than 150 days. This is well over the detention time of 15 days specified in the MoDNR Design Guides. The city has expressed no concerns with the sludge storage tanks' capacities or aeration and mixing capabilities. The stabilized waste sludge is land applied on an adjacent field.

The facility's NPDES permit requires seasonal disinfection, from April 1 through October 31. Disinfection is provided by a Trojan UV 3000B system consisting of 2 banks with 24 lamps each.

4.5 Planning Period

A twenty-year planning period was considered with regards to growth, facilities, and infrastructure improvements for this Wastewater System Facility Plan. While this planning period was applied in consideration of developing projects, satisfying permit requirements, and securing the funding needed to meet the objectives of the city's desired rehabilitation schedule, it is not indicative of the design life of the existing wastewater system or of the improvements recommended.

4.6 Population Projection

The 2010 U.S. Census population for Fair Grove is 1,393 people, with an occupied housing unit count of 421 units. This calculates to approximately 3.21 people per household. Utilizing the U.S. Census Bureau's decennial census data from 1970 to 2010, a growth rate of 1.0% was calculated from the average change in population. This 1.0% annual growth rate was used to calculate the projected yearly population until the end of the 20-year planning period in 2037, which has an estimated population of 1,822. Tabulated historical and projected populations are provided in Table 4-1.

Table 4-1: Fair Grove, MO Historic & Projected Population Data

Year	Population	
	Historical	Projected (1% Growth Rate)
1970	431	
1980	863	
1990	919	
2000	1,107	
2010	1,393	
2011		1,407
2012		1,421
2013		1,435
2014		1,450
2015		1,464
2016		1,479
2017		1,493
2018		1,508
2019		1,524
2020		1,539
2021		1,554

Year	Population	
	Historical	Projected (1% Growth Rate)
2022		1,570
2023		1,585
2024		1,601
2025		1,617
2026		1,633
2027		1,650
2028		1,666
2029		1,683
2030		1,700
2031		1,717
2032		1,734
2033		1,751
2034		1,769
2035		1,786
2036		1,804
2037		1,822

5 Recommended Improvement Plan

5.1 Introduction

This section discusses TREKK's recommended improvement plan for the collection system in the study area based on field inspection services: manhole inspections, acoustic sounding, lift station evaluations, and flow monitoring (flow meter and iTrackers). The goal of the improvement plan will be to reduce I&I, overflows, and the general "health" of the system.

5.2 20 Year Capital Improvement Plan – Collection System

A Capital Improvement Plan (CIP) is tool used to help communities coordinate the location, schedule, expenditures, financing options, and other details of capital improvements over a multi-year period. These improvements can include equipment, engineering studies to prioritize repairs and replacements, rehabilitation or replacement of system components, etc. CIP's can vary in length but are typically 5+ years and should be updated on a regular schedule (semi-annually or annually). Committing to the implementation of the CIP will help the City to understand: how the system operates, the importance of eliminating I&I, the importance of proper collection and treatment of sewage, and that continuous investment in the system is necessary for its proper operation.

TREKK has compiled a 20-year CIP for the collection system that will help to identify issues within the system that are attributing to I&I and then in subsequent years rehabilitate or replace the necessary components. As part of this plan, it is recommended that flow monitoring be performed every 5 years in order to examine the effectiveness of the program (both the investigations that will identify issues and the methods used to remedy them). The plan starts with the City currently collecting $38.75 per connection. Over the course of nine (9) years the City will be on a schedule to increase their rates in order to reach 2% of the Median Household Income by 2027. Included in the SSES recommendations there are 17 manhole locates (for buried, lost manholes, or unable to open), smoke testing, acoustic sounding, CCTV, flow monitoring, and level monitoring. Included in the rehabilitation recommendations includes smoke testing repairs (or I&I abatements), point repairs, CIPP & lateral grouting, manhole rehabilitation, and sewer main replacement. The total budget is projected at $3,326,960 over the 20 years. The SSES budget is $687,500 and the rehabilitation budget is $2,539,460.

The United States Environmental Protection Agency (EPA) estimates that between 23,000 and 75,000 sanitary sewer overflow (SSO) events occur per year in the United States (excluding basement backups). Studies conducted by the Water Environment Research Foundation (WERF), estimate that some municipalities experience up to 80% of the I&I entering the sanitary sewers is contributed from private property. Allowing these sources to remain connected simply increases the cost of relief sewers, maintenance related cost, and transportation and treatment costs.

The Water Environment Federation (WEF) Collection System Committee has compiled a virtual library of municipalities that have established and are currently developing Private Property Rehabilitation Programs (PPRP). Detailed information on these PPRP's can be found on the Water Environment web site located at www.wef.org.

It is recommended that all cost-effective private sector defects be included in a private sector I&I reduction program. Allowing these sources to remain connected simply increases the cost of relief sewers, maintenance related cost, transportation and treatment costs. It should also be noted that, over time defects that have been abated may be re-introduced to the sewer system. A private sector I&I reduction program would entail building inspections of every property in the basin, residential or commercial, and CCTV of all service laterals. A pre and post CCTV inspection would be performed and documented on all service laterals that required repair. During building inspections, defects that were not found during smoke testing would be located such as sump pumps discharging directly to the sanitary sewer and basement floor drains. All defects found during smoke testing and building inspections would be documented and repaired. Final inspections would be performed on all properties requiring repair to be certain all repairs met not only the client's standards, but the homeowners as well.

Table 5-1: Private Property Rehabilitation Program Cost Estimates

Description	Quantity	Unit	Unit Price	Extension
Building Evaluations	650	EA	$ 250	$ 162,500
I&I Abatement Program	165	EA	$ 150	$ 24,750
I&I Abatement Rehabilitation	165	EA	$ 1,750	$ 288,750
Contingency	10%			$ 47,600
Subtotal				**$ 523,600**
Engineering and Legal	25%			$ 130,900
Total				**$ 654,500**

5.3 Funding Mechanisms

The current monthly sewer bill for Fair Grove is $44.30 based on 5,000-Gallons of water usage per month. This equated to approximately 1.19% of the Median Household Income (MHI) of $44,792. Although grants are available through multiple agencies, such as Missouri Department of Natural Resources (MoDNR), United State Department of Agriculture (USDA,) and Missouri Department of Economic Development – Community Block Grant Program (CDBG). USDA and CDBG typically requires user rates to be at 2% of the MHI. This would require the user rated to be increased to $74.65 over a period of time in order to be eligible for certain funding. TREKK recommends that the City implement an aggressive I/I reduction program, but it is not recommended that the City apply for funding to complete this program at this time. Upon completion of rehabilitation of the collection system and reevaluation of project needs, it is recommended the facility plan including updated project recommendations and costs be submitted to the Missouri Water and Wastewater Review Committee (MWWRC) along with evaluating and discussing additional funding options. The MWWRC includes the Missouri Department of Natural Resources (MoDNR) – State Revolving Fund and Public Drinking Water Branch, United States Department of Agriculture (USDA) – Rural Development, and the Missouri Department of Economic Development – Community Block Grant Program). In addition to the public finance methods that include funding through MoDNR, USDA, and CDBG, there is also the option to finance through a private source. The private finance method includes receiving funding through a private agency such as a bank or lender. Regardless of the finance method selected, anticipated charges for users with the recommended CIP include user rate increases over the next 7 years.

The CIP was created with all recommended projects, each of different time lines. The updated surplus/deficit is before any grants and/or loans are given or taken out by the City. Over the 20 years included in the CIP, the City would be in a $1,348,757 deficit. This is the amount the City would need accumulate in loans/grants to afford all recommended projects with the recommended rate increases.

5.4 20 Year Capital Improvement Plan - WWTF

The WWTF was upgraded within the last 10 years. The upgrades included a new influent pump station, oxidation ditch, sludge holding tank, electrical control building, UV disinfection system, and discharge structure. The capacity of the upgraded plant is for a design population of 4,000 and a design flow of 400,000 gallons per day. Based on these parameters, the design capacity of the plant is not anticipated to be exceeded within the 20-year planning period. The plant is operating well, and no major deficiencies have been identified by the city or the treatment plant operators.

While typical operation and maintenance items should continue to be budgeted for through the life of the plant, the only significant capital improvements recommended for the treatment plant over the next 20 years are filter media replacement (both filters) and potentially the addition of a mechanical bar screen prior to the influent pump station. A budget estimate for replacing the sand media in both filters is $100,000. Several options exist for mechanical screening of influent wastewater, which can range in price from $400,000 to $1,000,000 or more. Should the city decide to investigate adding mechanical screening, an engineering study should be performed to evaluate options.

With the city currently monitoring for total phosphorus and total nitrogen as part of their current operating permit, it is possible that limits for these nutrients could be put into place within the 20-year planning period. The city's current extended aeration treatment plant should have no problems meeting the anticipated total nitrogen effluent limit. However, with the potential for low total phosphorus limits in the future, the city's polishing filter should be maintained in case it is needed as part of a chemical phosphorus removal system. As long as wet weather flows are properly managed, no additional treatment plant processes are anticipated to be needed within the planning period. The full CIP can be found in Appendix F.

Appendices

Appendix A – Operating Permit

Appendix B – Manhole Inspection and Acoustic Sounding Map

Appendix C – Flow Monitoring Graphs

Appendix D – iTracker Graphs

Appendix E – Smoke Testing Defect List and Map

Appendix F – Capital Improvement Plan