Benefit-Cost Analysis Methods Summary

2022 FEMA BRIC Grant Application

Town of Mebane, NC – Sanitary Sewer Rehabilitation Project

Introduction

FEMA requires that all projects funded through the Building Resilient Infrastructure and Communities (BRIC) program are cost-effective and designed to increase resilience and reduce risk of injuries, loss of life, and damage and destruction of property, including critical services and facilities.

This technical report documents that the Sanitary Sewer Rehabilitation Project submitted by the Town of Mebane, North Carolina under the BRIC Fiscal Year 2022 application cycle satisfies applicable cost-effectiveness requirements in compliance with OMB circular A-94 using FEMA benefit-cost analysis (BCA) methods and tools. The report covers the proposed mitigation activity, BCA approach including pre-mitigation and post-mitigation losses, and analysis results. Analysis documentation also includes a completed FEMA BCA Toolkit Version 6.0 and a BCA report.

Proposed Mitigation Activity

The Town of Mebane proposes to rehabilitate their sanitary sewer system. The sewer rehabilitation measures will use nature-based solutions to mitigate function loss and provide increased resiliency to the sewer infrastructure, mitigate any future loss of service to community lifelines and critical facilities.

Historic Events and Vulnerability

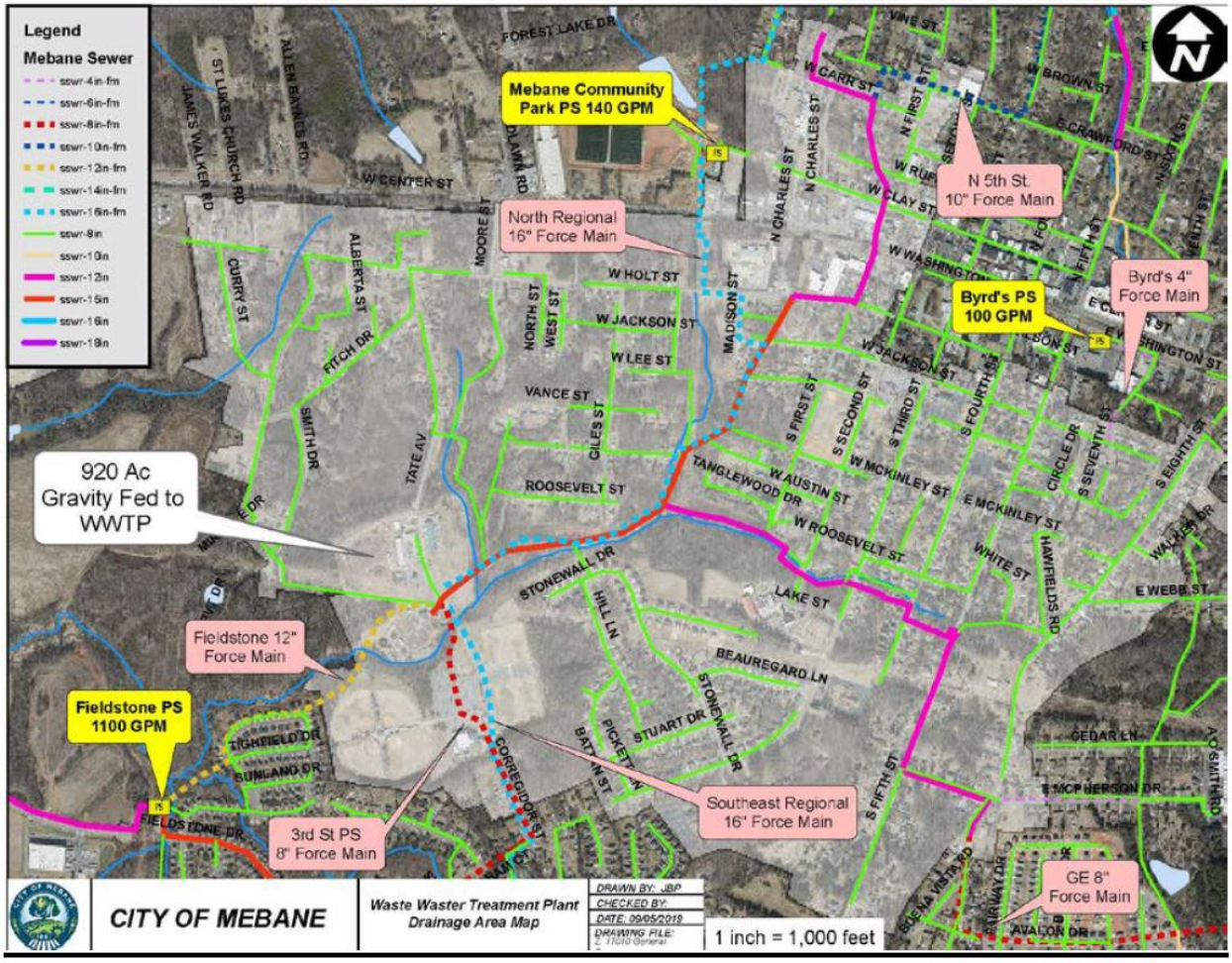
In accordance with the FEMA BCA Reference Guide and Supplement, expected losses associated with modeled events may be used in the BCA Toolkit. The proposed project will mitigate functional losses within the wastewater infrastructure, which may accelerate due to increasing intensity and frequency of rainfall events associated with climate change. Therefore, the BCA is based upon expected losses that will be avoided by restoring and stabilizing wastewater infrastructure.

- Deteriorated sewer mains located near streams or areas of high groundwater
- Deteriorated lines allow water to infiltrate mains and manholes reducing sewer capacity of lines and thus increase treatment plant costs and reduce efficiency
- Rehab of sewer lines and manholes will increase capacity in lines and reduce potential for overflows

Expected losses are estimated using loss of functions avoided for sewer and electrical power infrastructure through implementation of the proposed project.

Project Overview

Map 1: Mebane Wastewater Treatment System



The City of Mebane is experiencing incredible growth and significant portions of its sanitary sewer system are aging. The aging portions of the system, through a combination of ordinary flaws and outdated designs, is allowing substantial amounts of inflow and infiltration into the infrastructure. Maintaining infrastructure systems is an ongoing process and collection systems are similar in this commitment to streets, water distribution systems, water and wastewater plants, and even buildings. Older portions of collection systems are often overlooked in this process because they continue to achieve their primary objective – collect and transport wastewater to wastewater treatment plants.

Mebane's collection system continues to transport wastewater to the Water Resource Recovery Facilities (WRRF) but the amount of inflow that it transports is problematic. The

inflow volumes impact the WRRF through reduced treatment rates and increased treatment and expansion costs. The inflow also increases the chances for sanitary sewer overflows while also reducing the effective capacity of a system. The City's WRRF experiences a peak factor over 3.5 on the storms evaluated when 2.5 would match the NC Minimum Design Criteria. The two sewersheds that were further evaluated within this report are examples of this. The Third Street pump station in only at about 30% of actual flow in dry weather but the pump station regularly pumps for 24 hours during peak events and the Fifth Street pump station doesn't pump at all during dry weather but it averaged pumping 160,000 gallons per day during the studied rain events. The 160,000 gallons per day does not include the inflow that bypassed Fifth Street and went to North Regional.

When addressing inflow and infiltration eliminating I&I is unrealistic. The goal is to reduce I&I to a more manageable level. The industry expectation for new sewer lines and manholes includes an "acceptable" rate of infiltration and the industry concurs that eliminating I&I is impossible.

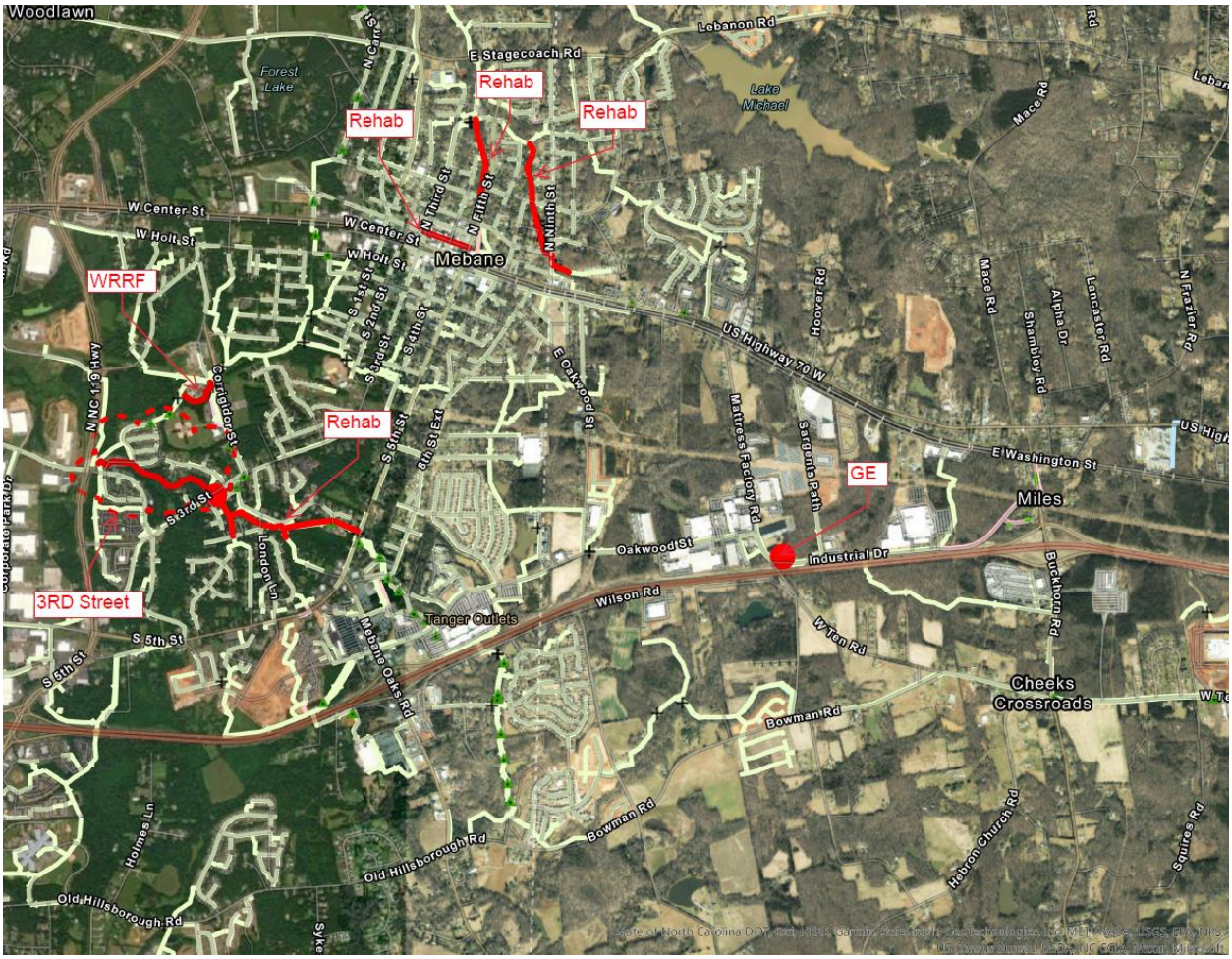
However, reducing I&I is possible and the recommendations and goals for the Third Street and Fifth Street sewersheds represent a phased implementation-based approach. For Mebane's collection system this is specifically oriented on reducing inflow.

An additional intermediate step is to complete further investigation on the WRRF's primary outfall line. Completing the primary outfall line investigation before the Third and Fifth Street Outfall rehabilitation projects will allow for prioritization of the three outfall lines. These prioritized long-term solutions will address the sewer outfalls and sewer outfall manholes. These are larger scale projects that will require budgeting and design and will serve to more comprehensively address I&I.

Additional recommendations are to evaluate and smoke test the Byrd's and Woodlawn Estates Pump Stations. These stations have limited total volume but a surprising amount of inflow.

In summary, addressing I/I through projects that investigate/study/identify sources, making point repairs to eliminate inflow, and rehabilitating sewer lines and manholes to reduce infiltration and inflow, should result in reclaiming some of the lost capacity within the collection and pumping systems and at the WRRF. As a result, reclaimed sewer flow capacity would be available for future developments, while upgrading an existing portion of sewer infrastructure that has been around since as early as the 1920s. It is important to note that the expectation is not that the identified projects or others will eliminate infiltration and inflow within the system but that I&I would be reduced to a more acceptable level.

Map 2: Proposed Rehabilitation Locations



Project and Maintenance Costs

Table 1 provides total project and annual maintenance costs for implementing the proposed mitigation activity. Project costs were estimated in accordance with FEMA Hazard Mitigation Assistance (HMA) Guidance and do not include management costs requested. In accordance with the FEMA BCA Reference Guide and Supplement, annual maintenance costs are assumed to be between .5 and 1% of the mitigation project costs and will cover inspections and maintenance.

Table 1: Mitigation Costs

Mitigation Activity	Project Cost (no contingency or admin)	Annual Maintenance Cost
Wastewater Infrastructure Rehab	$2,826,200.00	$20,000.00

Estimate of Probable Cost

City of Mebane - Sanitary Sewer Rehabilitation
BRIC Funding Application

Item	Description	Estimated Quantity	Unit	Estimated Price	Estimated Cost
1	Mobilization	1	LS	$ 110,200.00	$ 110,200.00
2	Traffic Control	1	LS	$ 33,500.00	$ 33,500.00
3	Stabilization Stone	1000	TN	$ 65.00	$ 65,000.00
4	Seeding and Mulching	1	LS	$ 30,000.00	$ 30,000.00
5	8" CIPP Liner	5800	LF	$ 75.00	$ 435,000.00
6	10" CIPP Liner	5000	LF	$ 85.00	$ 425,000.00
7	12" CIPP Liner	2000	LF	$ 95.00	$ 190,000.00
8	15" CIPP Liner	4000	LF	$ 105.00	$ 420,000.00
9	Vent Piping	15	EA	$ 4,000.00	$ 60,000.00
10	Manhole Rehabilitation	850	VF	$ 250.00	$ 212,500.00
11	Wateright, Bolted Ring and Cover	60	EA	$ 2,750.00	$ 165,000.00
12	New Ring and Cover (non perforated) including pavement patching	25	EA	$ 4,000.00	$ 100,000.00
13	Gravity Sewer Point Repairs	10	EA	$ 10,000.00	$ 100,000.00
14	Access Improvements	5	EA	$ 20,000.00	$ 100,000.00
15	Protruding Tap Removal	30	EA	$ 1,000.00	$ 30,000.00
				Costruction Subtotal:	**$ 2,476,200.00**
				Contingency	$ 123,800.00
				Construction Total:	**$ 2,600,000.00**

Engineering	$ 185,000.00
Surveying	$ 45,000.00
Construction Admin	$ 50,000.00
Construction Inspection	$ 85,000.00
ER-EID	$ 35,000.00
Engineering Total	**$ 400,000.00**

Project Total	**$ 3,000,000.00**

Project Useful Life

According to the FEMA 2009 BCA Reference Guide Appendix D: Project Useful Life Summary, a project useful life of 50 years should be applied to Utility Mitigation Projects – Major, e.g. power lines and sewer lines.

Number of Customers Served

Losses avoided for municipal utilities are accounted for in Benefit-Cost Calculator using the number of customers served and number of impact days if compromised by heavy rainfall

and flooding. Analysts estimated the service area for sewer utilities at risk using geospatial analysis and expert judgement.

The total population of Mebane in the 2020 census was 17,797 people. The population of people impacted by this project would be 7,660 residents, or 43% of the population of Mebane. The latest Census report indicates that 11.2% of the population lives in poverty and that the percentage of the minority population is as follows:

Black or African American 24.7%

American Indian and Alaska Native 0.2%

Hispanic or Latino 6.9%

Two or More Races 3.1%

This project is located in Census Tracts 212.05, 212.06, and 212.07 in Alamance County, North Carolina with a 2018 overall Social Vulnerability Index scores of 0.5405, 0.6349 and 0.6364.

Benefit-Cost Analysis Approach

Software and References

Following the FEMA BCA Reference Guide and Supplement, this analysis uses a combination anecdotal evidence provided by The Town of Mebane's Public Works Department and expected damages for municipal utility failure to calculate the damages before and after the proposed mitigation project is implemented. The expected damage scenarios use engineering assessments, statistical determinations of likely occurrence, and associated damages during expected events. This is consistent with FEMA's expected damages approach as detailed in the FEMA BCA Reference Guide and Supplement to the Benefit-Cost Analysis Reference Guide.

The proposed Sanity Sewer Rehabilitation project addresses four primary vulnerabilities:

1) Sewer line rehabilitation will reduce potential for overflow due to I&I.
2) Raising and rehabilitating manholes will prevent floodwater from entering collection system
3) Increase capacity within collections system and WRRF
4) Incorporate trenchless technologies (CIPP and pipe bursting, etc.) to rehab sewer mains

Sewer Service Disruption due to Heavy Rainfall

Table 2: Service disruption events in 2020

Rain Event	Event Interval	Precipitation Amount	Functional Downtime
August 2020	3x / year	2.65 inches	8 Hours

September 2020	3x / year	2.31 inches	8 Hours
November 2020	3x / year	2.40 inches	8 Hours

25 Year Storm Expected Timeline of Repairs to Gravity Sewer Line

Day 1: Identification of Loss of Service

Flood event happens and disrupts wastewater services, 24-36 hours for flood waters to fully recede until sewer line failure can be identified and accessed by Town of Mebane staff.

Day 2: Begin Temporary Bypass Operations

The Town of Mebane will locate a manhole upstream of the break, plug the manhole and begin to pump and haul wastewater to the treatment plant until the repairs are completed. The Town of Mebane will stabilize access to the broken pipe location and assess the damage.

Day 3: Site Stabilization and Repair Prep

Once the Town has access, they will need to determine if they have adequate supplies (pipes, fittings, ect.) to perform the repair and order additional supplies not on hand. Due to the large size of the gravity line, repair materials may be difficult to source due to current national supply chain issues. Pump and haul operations would continue during this time.

Day 4: Permanent Repair

Begin permanent repair activities, including new pipe installation, concrete blocking (if required), pipe bedding and backfill, etc. The Town should complete the permanent repair in approximately 24 hours.

Day 5: Restoration of Services

Once the repair has been completed, the Town will remove the plug in the upstream manhole and stop the pump and haul operations, remove remaining equipment and supplies, and return the construction area to preconstruction characteristics.

Analysts assume that the 25-year functional disruption expected for the sewer system will be completely mitigated by the project. Disruption may occur with higher precipitation events. Analysts assumed that the 25-year precipitation event would damage and disrupt municipal utility services similar to a 10-year event before mitigation. Table 4 shows pre and post mitigation entries into the Benefit-Cost Estimator for sewer structures.

Table 3: Expected disruption events post mitigation efforts

Event	Loss of Function Pre-Mitigation	Loss of Function Post-Mitigation
0.33-year	8 hours	0 days
5-year	2 days	0 days
10-year	5 days	0 days
25-year		5 days

Analysis Results

The benefit-cost ratio for the project is listed in Table 4 below. Costs provided in the determination of the BCR include maintenance costs over the project useful life of the mitigation project. Using the FY22 BRIC 3% discount rate, the total project BCR is **2.83** which demonstrates that the mitigation project is **a cost-effective solution**. The BCA report is provided in Appendix B and the BCA Excel Spreadsheet is attached to the project application.

Table 4: BCR summary

Description	Benefits	Costs	BCR (FY22 3% Rate)
Sanitary Sewer Rehabilitation Project	$9,460,320	$3,340,795	**2.83**

Description	Benefits	Costs	BCR (7% Rate)
Sanitary Sewer Rehabilitation Project	$5,074,258	$3,102,215	**1.64**

Appendix A – Mebane Inflow and Infiltration Study

CITY OF MEBANE

Collection System

Inflow and Infiltration Study

March 2020

PREPARED BY:

alley, williams, carmen, and king, inc

Engineering • Architecture • Land Surveying

Josh Johnson, P.E.

Brent Mills, P.E.

Franz Holt, P.E.

NORTH CAROLINA PROFESSIONAL SEAL 33170 ENGINEER JOSHUA S. JOHNSON

740 Chapel Hill Road (27215) - P.O. Box 1179 - Burlington, North Carolina 27216

Tel. - (336)226-5534 - *Fax* – (336)226-3034 - awck.com

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EXECUTIVE SUMMARY

The City of Mebane, like most municipalities, experiences infiltration and inflow into its sanitary sewer collection system. Inflow and infiltration are rain and ground water that enters into a sewer collection system. This infiltration and inflow (I&I) can result in prolonged pump times, reduced wastewater capacity, accelerated degradation of the sewer system, excessive pump times and reduced wastewater capacity that can affect growth and economic development opportunities while increasing the risk of sanitary sewer overflows in affected sewersheds within the City.

Alley, Williams, Carmen & King (AWCK) recently completed a study of the City of Mebane's wastewater collection system. The study was broken into two sections. The first portion of the study was a desktop analysis of the entire collection system and the second section was a further study and investigation of the identified two primary sections which included smoke testing. The study identified several significant points of inflow into the collection system and had several recommendations and goals.

Overall Collection System Analysis and Results

The City of Mebane's collection system includes 19 pump stations, 8 of which pump directly to the Water Resources Recovery Facility (WRRF) or to the primary sewer outfall that goes directly to the plant. The others pump to pump stations that then go to the WRRF or primary outfall. We used the pumps at the pump stations as flow meters to estimate the actual flows coming from the collection systems to the pump stations. The collection systems for each pump station are called sewersheds.

By reviewing dry weather and wet weather run times, and the pumping rate from each pump station, we determined average dry and wet weather flow times. This evaluation showed that several sewersheds in Mebane have significant peaks in flow during wet weather events – which is supported by data from the WRRF. We also evaluated infiltration against inflow by looking at non-rain days during the extremely wet month of February 2019. This allowed us to verify that the primary issue in Mebane is inflow into the collection system. Inflow is rainwater that goes from stormwater runoff directly, or almost directly, into the collection system.

The collection system analysis showed that the collection system peaked at approximately 3.5 times the dry weather flow. A standard system would have a peak factor of 2.5. Two specific sewersheds were identified for immediate additional analysis – Third Street and Fifth Street. Secondary recommendations include smoke testing of the primary outfall to the WRRF and investigating the pumping capacities of the GE and GKN Pump Stations.

Third Street and Fifth Street Sewershed Analysis and Results

The evaluation of the Third Street and Fifth Street Sewersheds included reviewing the pump stations sewersheds, reviewing the prior study of the Fifth Street area, and smoke testing of the two sewersheds. The Fifth Street Pump Station is upstream of the North Regional Pump Station and is bypassed during dry weather, it only pumps during wet weather events but during the storm events in our study, it averaged 160,000 gallons per day. This 160,000 gallons per day is in addition to the unmeasured amount of I&I that bypasses Fifth Street and goes directly to North Regional in wet weather. The Fifth Street sewershed had previously been monitored for I&I

through sewer flow meters in 2012 and we used this study to concentrate smoke testing of the sewershed.

The Third Street Pump Station showed a peak factor (wet weather flows / dry weather flows) of 6.0 during the study storm events and it contributed 473,000 gallons per day of I&I during these events. The combination of the peak factor and I&I volume are substantial and led to the further investigation of the Third Street sewershed.

The smoke testing process involved AWCK injecting liquid smoke into sewer manholes to identify areas of concern, cross connections, and failures of the collection system. These areas are found when smoke is visible in areas that should not be connected to the collection system like storm drains, roof drains, open cleanouts, and coming from the ground. The results of the smoke testing included 27 previously unmapped sewer manhole, 87 damaged sewer cleanouts, 10 damaged manholes, 23 point repairs, and 24 storm sewer structures that are connected to the sewer system in some way.

Recommendations

The final recommendations are divided into short term, intermediate term, and long-term steps. These steps are prioritized in order to begin addressing inflow and infiltration while recognizing that addressing I&I is a long-term maintenance program. The short term and intermediate steps are generally less expensive and aimed at addressing low hanging fruit. As an example, the City's Utilities Department has already begun to address cleanout repairs and minor point repairs. The next step is to further the investigation of the Fifth Street sewershed by working with AWCK and a contractor to identify and fix issues in the field. These issues are identifiable through smoke testing, but solutions can't be determined without equipment on site.

An additional intermediate step is to complete further investigation on the WRRF's primary outfall line. By completing the primary outfall line investigation before the Third and Fifth Street Outfall rehabilitation projects, it can be determined which of the three outfalls should be a priority. The long-term solutions are to address the sewer outfalls and sewer outfall manholes. These are larger scale projects that will require budgeting and design and will serve to more comprehensively address I&I.

As a whole, the City of Mebane's collection system has an inflow and infiltration problem that stresses the City's Water Resources Recovery Factory and the City's collection system infrastructure. I&I is more severe in some sewersheds than others. The I&I problem can be reduced but not eliminated. In order to reduce I&I the City needs to begin reinvesting into collection system improvements that seek to reduce I&I. This maintenance plan begins with short term and intermediate steps that will transition to long term steps like sewer outfall rehabilitation.

1. INTRODUCTION

The City of Mebane, like most municipalities, experiences a varying degree of infiltration and inflow (I&I) into its sanitary sewer collection system which can surcharge a sewer system. This can result in prolonged pump times, reduced wastewater capacity, accelerated degradation of the sewer system, excessive pump times and reduced wastewater capacity that can affect growth and economic development opportunities while increasing the risk of sanitary sewer overflows in affected sewersheds within the City.

The City contracted with Alley, Williams, Carmen, and King, Inc. (AWCK) to investigate the I&I issues seen at the Water Resources Recovery Facility (WRRF). Since most of the City's wastewater is pumped to the centrally located WRRF, a desktop analysis was completed of the pump stations to identify sewersheds where I&I was the most prevalent. The desktop analysis identified targeted areas of further study which included the Third Street and Fifth Street sewersheds. Using smoke testing, problem areas within the Third and Fifth Street sewersheds were narrowed down to specific potential sources where I&I is likely to occur. The evaluation period included data from July 2018-August 2019 with some additional information in February 2020.

2. BACKGROUND

2.1. Definition of Infiltration and Inflow

Infiltration and inflow into sewerlines is the process in which non-wastewater flows work their way into the wastewater collection system. Typically, this involves rainwater and groundwater either running directly into the sewer system or seeping into the sewer system. Infiltration is the process of groundwater that seeps into sewerlines. Infiltration often happens when groundwater is alongside of the sewer line and it seeps into the system underground through joints in the pipe, connections to manholes, or in cracks or breaks in the pipe. Infiltration is highest during extended wet weather. In the Piedmont of North Carolina, this is primarily during the winter months. Infiltration can be measured in comparing the total flow from a system during an extended dry period (Summer 2018) to an extended wet period (Winter of 2019) and by evaluating flow rates after storms.

Inflow is when rainwater runs directly into the sewer system. This often occurs through broken clean out caps, illicit storm drainage connections, illicit roof drainage connections, broken manholes, or manholes that are flooded in storm events. Inflow is directly tied to surface runoff and typically peaks within the first 24 hours of the 6-36 hour period. In a practical sense inflow also includes some rainfall induced infiltration which cannot be separated out from inflow.

Both infiltration and inflow are substantially worse during wet weather and the most susceptible areas are along sewer outfall lines, near streams and floodplains, and in older downtown areas

where illicit drains are often tied onto the system. In many cities, Mebane included, these outfall lines were installed either prior to or just after the clean water act of 1972. The primary pipe material of these outfalls is vitrified clay pipe.

2.2. Mebane's Collection System

The City's sewer collection system is a mixture of vitrified clay pipe (VCP), ductile iron pipe (DIP), and polyvinyl chloride pipe (PVC) that was installed over approximately the last 100 years. Each of these pipe types have strengths and weaknesses but VCP over 50 years old is particularly susceptible to I&I. VCP was originally installed because its chemical properties made it unsusceptible to industrial wastewater discharge that were in place throughout the piedmont during the majority of the 20th century. Unfortunately, older VCP was installed in 2' and 4' lengths of pipe at that time. This is in comparison to the 20' standard of today's DIP and PVC. Additionally, the joints on older VCP were hard to install correctly. The result is that older VCP has poorly installed joints every 2'-4' while new DIP and PVC pipe have watertight joints every 18'-20'. Studies have shown that many of the old VCP joints leak during wet weather.

The City of Mebane's sewer system consists of a series of collector sewerlines in neighborhoods that drain to sewer outfall lines that are typically near streams or low areas. The outfall lines then typically go to pump stations. The pump stations pump sewer toward the wastewater treatment plant (Water Resources Recovery Facility – WRRF) on Moadams Creek. In many cases smaller pump stations pump to larger pump stations or the primary sewer outfall that runs from the railroad beside Moadams Creek to the WRRF. An overall map of the entire sewer system is in the appendices.

3. DESKTOP ANALYSIS – PUMP STATION DATA AND PRIORITIES

3.1. Pump Station Background

To better understand how pump stations impact the collection system's flow utilization, a desktop analysis was conducted prior to beginning a study of specific sewersheds. With data available from each of the 19 City of Mebane pump stations as well as the (WRRF), understanding of where pipe capacity is being compromised the most could be narrowed down to individual sections and sewersheds. By using the pump station data, we were able to monitor sewer flows without having to install temporary flow meters. It is important to understand that the goal of the study was to evaluate I&I and not pump stations. The pump station data was used for sewershed evaluation not to evaluate the pump stations themselves.

The goal of this monitoring/metering was to establish a dry weather flow for each pump station and then to compare that to wet weather flows for each pump station. The difference in the two would provide an estimate of the I/I for that pump station. The different pump station collection systems can then be compared to each other directly by dividing the I/I by the inch/mile of lines

within that specific portion of the collection system. This, as well as staff input and general familiarity with the system, allowed for prioritization of areas for additional investigation. The data evaluated was from January 1, 2018 through August 31, 2019.

While the pump station data is useful to evaluate the sewersheds to each pump station, the data does have inconsistencies. The data is taken from Mebane staff pump station readings. Readings were generally not available during weekends. SCADA data was reviewed but the data was deemed unreliable due to significant issues with it. The data used is reliable in most cases but can be problematic with pump stations that pump to each other. This "daisy-chaining" of pump stations creates inconsistencies between the data that show up in some cases. As such, the pump station data for certain storm events may not have been relative to all pump stations and certain calculations may not be as accurate as desired. The data paints an accurate picture of the pump stations and the collection system but in some cases, there are inconsistencies when viewed closely. Data that was viewed as inconsistent is either grayed out in the report tables or is defined as inconsistent within the report. The availability of reliable SCADA data in the future could be used to update this report.

Pump stations that pump to each other (daisy-chaining) include the following:

1. Woodlawn Estates pumps to North Regional Pump Station.
2. Brookhollow and Richmond Hills pump to West Ten which in turn pumps to Southeast Regional. West Ten became operational in mid-year 2019, until that point Brookhollow and Richmond Hills were not tributary to Mebane.
3. Arbor Creek pumps to Terrell Street which pumps to Fieldstone. GKN and Governors Green also pump to Fieldstone.
4. Gravelly Hill and LJ Rodgers pump to GE.
5. Walmart pumps to Farrar Lane.

Third Street, Byrd's, and Fifth Street do not pump to other pump stations. Dry weather flow to Fifth Street is diverted to North Regional but when the line becomes surcharged then sewer flows into the wet well in order to reduce the strain on North Regional.

3.2. GKN and GE Reduced Capacities

During the initial review of the pump station data, inconsistencies with GKN and GE Pump Stations were present. City and AWCK staff completed pump drawdowns on these pump stations (as well as several others) and determined that neither pump station was pumping at its design capacity. Both pump stations are designed to pump 500 gallons per minute or 288,000 gallons per day but GKN pumps approximately 250 GPM (144,000 GPD) and GE pumps approximately 300 GPM (172,800 GPD).

Pump Station Name	Design Pump Capacity		Actual Pump Capacity	
	GPM	GPD	GPM	GPD
GKN	500	288,000	250	144,000
GE	500	288,000	300	172,800

Figure 1: GKN & GE Reduced Capacity

The reduction in capacity for both GKN and GE is a significant issue to be resolved by the Mebane Utilities Department but the reduction in capacity is not directly related to infiltration and inflow. As a result, the actual capacity information is used throughout the rest of this report. A separate evaluation of the pumps in question needs to be completed in order to restore the appropriate pumping capacity at both stations.

3.3. Dry Weather Sewer Flows

In general, 2018 and 2019 were very wet but there were two dry periods that could be evaluated to estimate the dry weather or base sewer flows. Dry weather days from July 2018, July 2019, and August 2019 were used to create the baseline dry weather flow for each sewershed. This calculation for each sewershed is shown below. A map of the sewersheds is available in the appendices. This table and the following tables represent a full evaluation of the sewersheds to each pump station and then break out the primary pump stations from the contributing pump stations in order to show the sewersheds not the actual pump stations. The total gallons pumped from each sewershed to the WRRF is included at the bottom of the table.

Pump Station Name	Pump Station Design Capacity		Dry Weather - Sewershed Flows			
	Design ADF (GPD)	Actual ADF (GPD)	July 2018 Dry ADF (GPD)	July 2019 ADF (GPD)	August 2019 Dry ADF (GPD)	Adjusted AVG DRY ADF (GPD)
North Regional	1,005,120	1,005,120	261,540	254,238	275,955	**263,911**
Woodlawn Estates	28,800	28,800	~~210~~	1,230	1,500	**980**
Fifth St	259,200	259,200	0		0	**0**
Southeast Regional	1,002,240	1,002,240	114,840	103,356	142,692	**120,296**
West Ten	403,200	403,200	~~0~~	7,986	10,776	**9,381**
Brookhollow	316,800	316,800	42,900	18,150	19,800	**26,950**
Richmond Hills	46,080	46,080	3,552	3,264	3,024	**3,280**
Fieldstone	633,600	633,600	137,250	140,280	113,850	**130,460**
GKN	288,000	***144,000***	96,000	101,250	112,500	**103,250**
Governors Green	115,200	115,200	19,200	20,400	22,800	**20,800**
Terrell St	230,400	230,400	97,350	88,530	84,150	**90,010**
Arbor Creek	144,000	144,000	27,450	33,150	29,850	**30,150**
GE	288,000	***172,800***	30,600	43,320	49,920	**41,280**
Gravelly Hill	115,200	115,200	21,600	24,000	22,800	**22,800**
LJ Rodgers	115,200	115,200	1,800	1,080	1,080	**1,320**
Farrar Ln	288,000	288,000	53,700	57,000	45,036	**51,912**
Walmart	51,840	51,840	24,300	8,640	8,964	**13,968**
Third Street	316,800	316,800	89,100	99,000	95,700	**94,600**
Byrds	57,600	57,600	1,980	1,200	1,020	**1,400**
Totals	**5,705,280**	**5,446,080**	1,023,372	1,006,074	1,041,417	**1,026,748**

Figure 2:Dry Weather ADF - Sewersheds

3.4. Wet Weather Sewer Flows and I&I

The extended wet weather from August 2018 through July 2019 provided many opportunities to evaluate wet weather events. Unfortunately, several of the events coincided with weekends for which pump station data was incomplete. We were able to evaluate four storm events from the initial period of differing sizes that provide a comprehensive look at the pump stations during wet weather events. For additional information we also included the storm event of February 7, 2020. The storms have a variety of rain totals and duration, but all five storms provided significant I&I for evaluation. Most of the storms resulted in good data for all watersheds but there are some storms where specific pump stations had questionable data.

Pump Station Name	Pump Station Design Capacity	Dry Weather - Sewershed Flows	9/18/18 - 1.4" Rain Event (End of Hurricane Florence)		
	Actual ADF (GPD)	Adjusted AVG DRY ADF (GPD)	9/18/18 Pump Run Times (Hours)	9/18/18 (Gallons)	I/I (Gallons)
North Regional	1,005,120	**263,911**	7.06	739,182	475,271
Woodlawn Estates	28,800	**980**		0	
Fifth St	259,200	**0**	1.68	45,360	45,360
Southeast Regional	1,002,240	**120,296**	2.57	268,308	148,012
West Ten	403,200	**9,381**			
Brookhollow	316,800	**26,950**	5.10	168,300	141,350
Richmond Hills	46,080	**3,280**	1.02	4,896	1,616
Fieldstone	633,600	**130,460**	10.34	273,270	142,810
GKN	***144,000***	**103,250**	12.70	190,500	87,250
Governors Green	115,200	**20,800**	2.60	31,200	10,400
Terrell St	230,400	**90,010**	10.08	187,470	97,460
Arbor Creek	144,000	**30,150**	3.63	54,450	24,300
GE	***172,800***	**41,280**	10.60	143,280	102,000
Gravelly Hill	115,200	**22,800**	3.60	43,200	20,400
LJ Rodgers	115,200	**1,320**	0.36	4,320	3,000
Farrar Ln	288,000	**51,912**	3.93	89,388	37,476
Walmart	51,840	**13,968**	5.28	28,512	14,544
Third Street	316,800	**94,600**	16.60	547,800	453,200
Byrds	57,600	**1,400**	0.88	5,280	3,880
Totals	**5,446,080**	**1,026,748**		**2,824,716**	**1,808,329**

Figure 3: 9/18/18 Rain Event I/I – Sample

The 'I/I (Gallons)' column is the increase in flow over the dry weather flows based upon the pump run times for each event. Figure 3 is for the 9/18/18 storm event and shows several pump stations with significant I&I. The additional events averaged to provide the summary presented in Figure 4 as follows:

Pump Station Name	Pump Station Design Capacity	Dry Weather - Sewershed Flows	Five Rain Events Average - I&I			
	Actual ADF (GPD)	Adjusted AVG DRY ADF (GPD)	AVG Pump Run Times (Hours)	AVG Gallons	I/I Gallons	Peak Factor (Wet/Dry)
North Regional	1,005,120	**263,911**	8.92	929,225	665,314	3.52
Woodlawn Estates	28,800	**980**	1.50	4,490	3,510	4.58
Fifth St	259,200	**0**	5.94	160,515	160,515	
Southeast Regional	1,002,240	**120,296**	4.27	392,942	272,646	3.27
West Ten	403,200	**9,381**	5.65	52,428	43,047	5.59
Brookhollow	316,800	**26,950**	5.40	178,200	151,250	6.61
Richmond Hills	46,080	**3,280**	1.39	6,672	3,392	2.03
Fieldstone	633,600	**130,460**	10.51	236,385	105,925	1.81
GKN	***144,000***	**103,250**	13.38	200,625	97,375	1.94
Governors Green	115,200	**20,800**	2.83	33,900	13,100	1.63
Terrell St	230,400	**90,010**	12.09	222,915	132,905	2.48
Arbor Creek	144,000	**30,150**	4.47	67,125	36,975	2.23
GE	***172,800***	**41,280**	14.98	231,960	190,680	5.62
Gravelly Hill	115,200	**22,800**	2.75	33,000	10,200	1.45
LJ Rodgers	115,200	**1,320**	0.39	4,680	3,360	3.55
Farrar Ln	288,000	**51,912**	4.11	98,432	46,520	1.90
Walmart	51,840	**13,968**	4.59	24,808	10,840	1.78
Third Street	316,800	**94,600**	17.20	567,600	473,000	6.00
Byrds	57,600	**1,400**	3.22	19,308	17,908	13.79
Totals	**5,446,080**	**1,026,748**		**3,465,210**	**2,438,462**	3.37

Figure 4: Dry Weather vs. Wet Weather and Peak Factor

The above figure shows the total I&I and the average peak factor during the selected storm events for all I/I. This information indicates that several sewersheds have significant I&I issues. There are also several pump stations that see wet weather spikes in excess of 2.5 times their dry weather flows as shown below. Pump stations are typically permitted and designed using a peak factor of 2.5 per NC DEQ. When peak factors routinely run higher than 2.5 they are evident of reduced capacity at a pump station.

It should be noted that West Ten Road has limited data to evaluate. The peak factor is based upon the station's run times for only two events. One of the events produced a run time of 2.2 hours and one a run time of 9.3 hours. An additional storm event was briefly evaluated and included a 2.3 hour run time. Since West Ten Road has been online less than 1 year, it remains unclear if it is a problem currently. The Brookhollow and Richmond Hills Pump Stations include

time from before and after rehabilitation work was completed on their sewersheds in the spring of 2019. The limited data since that work was completed was inconclusive.

3.5. Infiltration vs. Inflow

In an effort to separate out infiltration vs. inflow, we evaluated infiltration in two different ways. While the results of separating out inflow vs. infiltration are not as reliable as combining the two, a general narrowing of the sources can improve prioritization. The first evaluation was for a wet weather – non-rain period from February 2019. As previously discussed, a significant portion of the study period was very wet and there were limited days available during these wet weather periods where storm events did not appear to be substantially impacting pump station flows. Groundwater during this time should have been significantly elevated but the run times were not affected by rain events. This period appears to be a representative sample period based upon the weather records and the flows recorded.

The second evaluation included looking at the September 2018 rain event and determining how much infiltration existed after the initial storm. Exact times for this were not available so we evaluated the 2-3 days post storm event and compared this data to the EPA standard of 3,000 gpd/in-mile. Infiltration rates in excess of the 3,000 gpd/in-mile are considered severe by the EPA.

Pump Station Name	Pump Station Design Capacity	Dry Weather - Sewershed Flows	Wet Weather Non-Rain - Infiltration			9/19/19-9/21/18 Infiltration 2				
	Actual ADF (MGD)	Adjusted AVG DRY ADF	Feb 2019 Wet Weather non-rain (GPD)	Infiltration (GPD)	Infiltration (gpd/in-mile)	9/19-9/21 Gallons	9/19-9/21 (GPD)	Infiltration (GPD)	Days	Infiltration (gpd/in-mile)
North Regional	1,005,120	**263,911**	345,927	82,016	516	1,226,037	408,679	144,768	3	911
Woodlawn Estates	28,800	**980**	630			0	0	-980	3	-570
Fifth St	259,200	**0**	4,455	4,455	36	0	0	0	3	0
Southeast Regional	1,002,240	**120,296**	147,804	147,804	1,095	271,440	90,480	-29,816	3	-221
West Ten	403,200	**9,381**				0		-9,381		-564
Brookhollow	316,800	**26,950**	29,700	2,750	37			-26,950		-366
Richmond Hills	46,080	**3,280**	3,504	224	56			-3,280		-820
Fieldstone	633,600	**130,460**	125,100			392,580	130,860	400	3	6
GKN	144,000	**103,250**	120,000	16,750	460	421,500	140,500	37,250	3	1,023
Governors Green	115,200	**20,800**	25,200	4,400	223	69,600	23,200	2,400	3	122
Terrell St	230,400	**90,010**	92,700	2,690	76	306,300	102,100	12,090	3	340
Arbor Creek	144,000	**30,150**	34,500	4,350	172	112,500	37,500	7,350	3	290
GE	172,800	**41,280**	58,920	17,640	505	213,600	71,200	29,920	3	856
Gravelly Hill	115,200	**22,800**	26,400	3,600	254	72,000	24,000	1,200	3	85
LJ Rodgers	115,200	**1,320**	1,080			13,200	4,400	3,080	3	693
Farrar Ln	288,000	**51,912**	49,728			171,672	57,224	5,312	3	265
Walmart	51,840	**13,968**	9,072			77,328	25,776	11,808	3	1,783
Third Street	316,800	**94,600**	132,000	37,400	513	739,200	184,800	90,200	4	1,236
Byrds	57,600	**1,400**	1,380			62,700	20,900	19,500	3	7,693
Totals	**5,446,080**	**1,026,748**	**1,216,896**	**324,079**	**379**	**4,149,657**		**294,871**	**3.08**	**112**

Figure 5: Wet Weather Infiltration

When looking at infiltration rates in both ways, it becomes obvious that the data being evaluated is not perfect. Negative infiltration rates exist in several cases which is unrealistic, but the chart above can be used to establish a general trend. A negative infiltration rate (which is grayed out or in red) is representative of when a pump station has less daily flow than the dry weather period. The general trend shows that the Byrd's pump station is the only one that exceeded 3,000 GPD in either evaluation method.

The primary use of this chart is to show that the biggest issues that the City is seeing are from **inflow** and not infiltration. As noted previously inflow is primarily caused by direct connections with surface water (like open pipes or manholes), storm drainage interconnections, roof drains, missing cleanout caps, and overtopping of sewer manholes by flooded streams.

3.6. Non-Pump Station Sewersheds

The City of Mebane only has one large sewershed that is not related to a pump station. This is the drainage area to the primary outfall that runs along Moadams Creek. Like many of Mebane's outfall lines, the primary outfall is over 50 years old and built of clay sewerlines. The line is not metered separately but total flows are measured at the WRRF which include the flow from the outfall and the contributing pump stations.

At some point in time, the manholes on this outfall line were raised by the City and the WRRF reported a substantial increase in I&I at that point in time. This is likely due to improvements in transporting of wastewater that reduced previously unknown sewer overflows. As such, we recommend that the primary outfall be further evaluated for inflow and infiltration in the future.

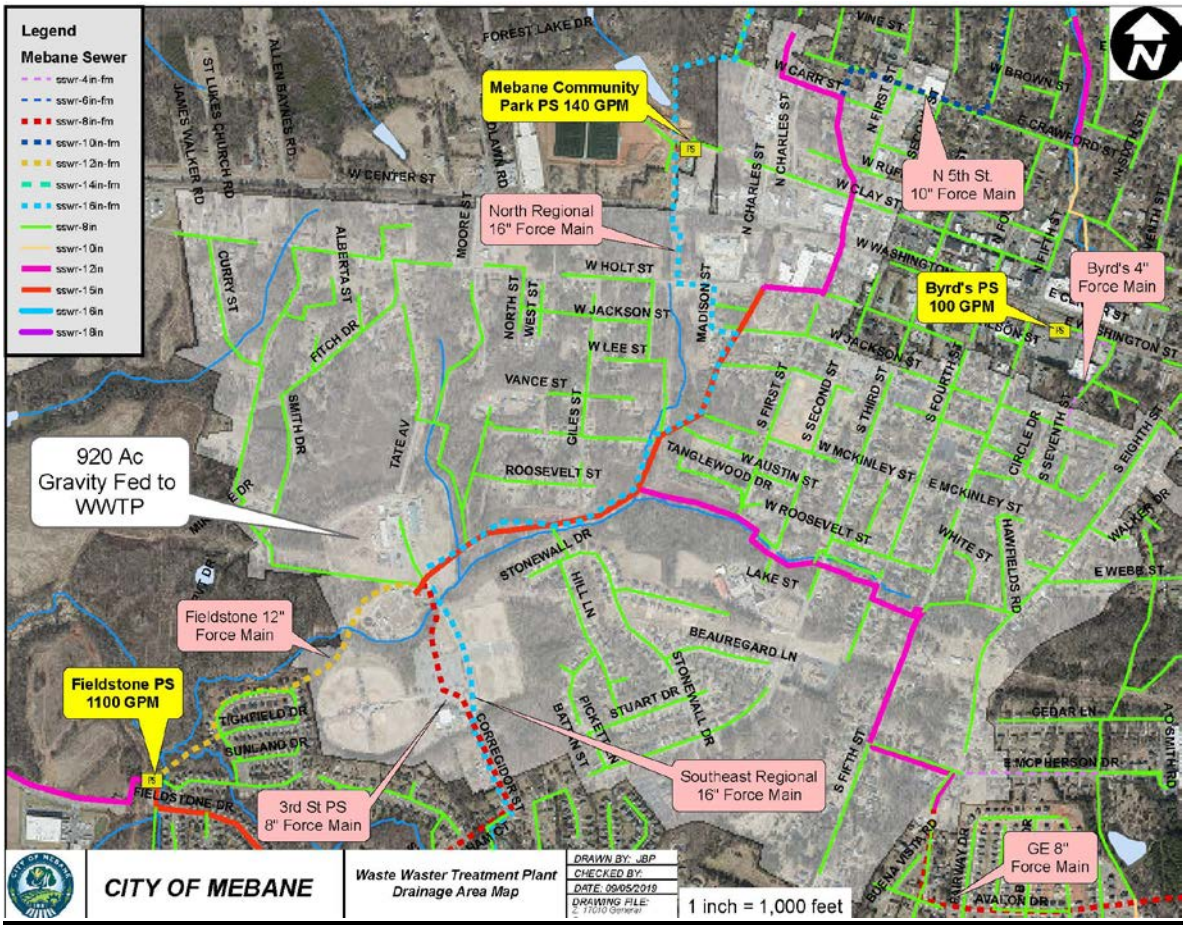


Figure 6: Primary Outfall Map with Pump Stations

3.7. Water Resources Recovery Facility and I&I

The City of Mebane's WRRF receives flow from all the pump stations in Mebane in addition to the primary outfall sewershed. The WRRF sees significant increases in flows based upon wet weather. These flows range on a monthly basis 1.283 MGD in July 2018 to a peak of 2.088 MGD in April 2019. These flows represent a monthly average with dry weather flows less than 1.283 MGD and peak wet weather flows in excess of 5.8 MGD. The following charts compare the pump station pumped flows to the actual flows at the pump station.

Total Flows (MGD) & Percentages	Dry Weather Days				Infiltration Check	
	July-18	July-19	August-19	AVG Dry Day	Feb 2019 - Wet Weather - No Rain	9/19/18 thru 9/21/18
Total Pump Stations	1.023	1.006	1.041	1.027	1.217	4.038
WRRF	1.120	1.240	1.230	1.197	1.320	4.790
Pump Station % of WRRF Flow	91.3%	81.1%	84.6%	85.8%	92.2%	84.3%

Figure 7: Pump Stations vs. WRRF - Dry Weather (in MGD)

Total Flows (MGD) & Percentages	Wet Weather Events					
	9/18/2018	10/11/2018	11/13/2018	6/19/2019	2/7/2020	AVG Rain Event
	1.4"	2.75"	3.5"	1."	3"	
Total Pump Stations	2.825	2.393	4.098	2.200	5.471	3.465
WRRF	4.780	3.230	4.750	2.600	6.490	4.370
Pump Station % of WRRF Flow	59.1%	74.1%	86.3%	84.6%	84.3%	79.3%

Figure 8: Pump Stations vs. WRRF - Wet Weather (in MGD)

As shown above, the WRRF peaks when the pump stations peak. The interesting note is that the pump stations make up 86% of the dry weather flows and 79% of rain events. This is most likely due to pump stations pumping at slightly higher rates during peak storm events due to head conditions on the pumps and the increased time when both pumps are pumping from pump stations. An additional reason could be that the direct gravity flow to the outfall line makes up 14% of dry weather flow but it makes up 21% of wet weather flow. If this is the case, then it highlights that the primary outfall to the WRRF needs to be further evaluated. The above information confirms the previous conclusion that infiltration is moderate in the system – the daily flows during dry days in the wet February 2019 are very similar to the typical dry weather flows and the flows after the 9/18 storm event (the end of Hurricane Florence) do not begin to approach the 3,000 GPD/in-mile threshold for severe infiltration.

3.8. Immediate Prioritization

In order to prioritize further sewershed evaluation, it is important to note several factors about the data evaluation. The first is that when the North Regional Pump Station came online, the Fifth Street Pump Station was taken offline for daily flow. The pump station only pumps when the line into it becomes surcharged or flows at greater than approximately ½ to ¾ full. Therefore, all of the flow shown above in regard to Fifth Street is I/I but for that flow to even enter Fifth

Street, North Regional must have significant I/I. This I&I was previously identified as a problem within a flow monitoring study in 2012 but the sewershed was not further investigated at that time.

The second factor is the sheer volume of I&I being pumped to the wastewater treatment plant. Several pump stations show pumping in excess of 100,000 gallons per day to the plant during wet weather but the four pump stations that stand out are North Regional, Third Street, and to a lesser extent Southeast Regional. Looking at the total volume of I&I eliminates several smaller sewersheds like Byrd's and LJ Rodgers from prioritized investigation. These pump stations exhibit significant I&I but the sewersheds are very small, therefore the impacts downstream are minimal and the pump stations themselves appear to have sufficient capacity. Likewise, the Southeast Regional Pump Station has a very large drainage area but the I/I totals are significantly less than North Regional and Third Street. Third Street also has several rain events where the pump station ran 24 hours continuously during rain events.

As a result, the sewersheds for the Third Street and North Regional / Fifth Street Pump Stations were prioritized for further study. Smoke testing was completed on both sewersheds and this information follows in Section IV of this report. These sewersheds exhibited the highest I&I totals, significant peak factors, and both have outside factors that are concerning.

The reduced pumping capacity at the GKN and GE Pump Stations is also very problematic and needs to be addressed outside of this study. While the reduced pumping capacity is problematic, if the capacity is returned to the design capacities of 288,000 gallons per day then the stations do not have capacity issues. After the pump stations are restored then the pump run times at both stations should be evaluated during dry and wet weather to verify that I&I is not a concern.

3.9. Future Investigations

As noted above the primary outfall line wasn't evaluated during this study. The primary outfall needs to be smoke tested and surveyed. The smoke testing will be intended to identify sources of inflow and the surveying will provide data to allow for hydraulic modeling of the outfall to determine the capacity of the system to transport sewer to the WRRF.

In addition to I&I volume, pump station peak factors can provide evidence about pump stations that see peaks in run times during rain events. The pump stations that stand out for this are Byrd's, West Ten, Brookhollow, and Woodlawn Estates. West Ten and Brookhollow are both in Efland. Brookhollow was part of the previously mentioned point repair work done on the Efland system and it's unclear at this time the impact of this work. The West Ten peak is primarily due to the pump stations run times during one rain event. The recommendation for the Efland stations is to reevaluate the stations after full SCADA data is available.

Byrd's and Woodlawn Estates both serve very small drainage areas and both stations are either new (Woodlawn) or have just been rehabilitated (Byrd's). Due to the small volume of I&I it is recommended that these stations also be reevaluated after full SCADA data is available. It may also be worthwhile to smoke test these two sewersheds due to the limited cost of doing so due to the limited time required.

4. FURTHER STUDY/INVESTIGATION – Third Street and Fifth Street Sewersheds

The Third Street Pump Station and Fifth Street Pump Station Sewersheds were chosen for further study. This included looking at the entire sewershed including the pump stations, smoke testing, and further investigation into wet weather flows.

4.1. 3rd Street

The 3rd Street Pump Station consists of approximately 8 miles of gravity sanitary sewer serving more than 500 residences, multiple businesses, restaurants, two car washes, and a medical park. From the pump station, wastewater is sent to the Water Resources Recovery Facility (WRRF) less than 1 mile away through an 8" force main.

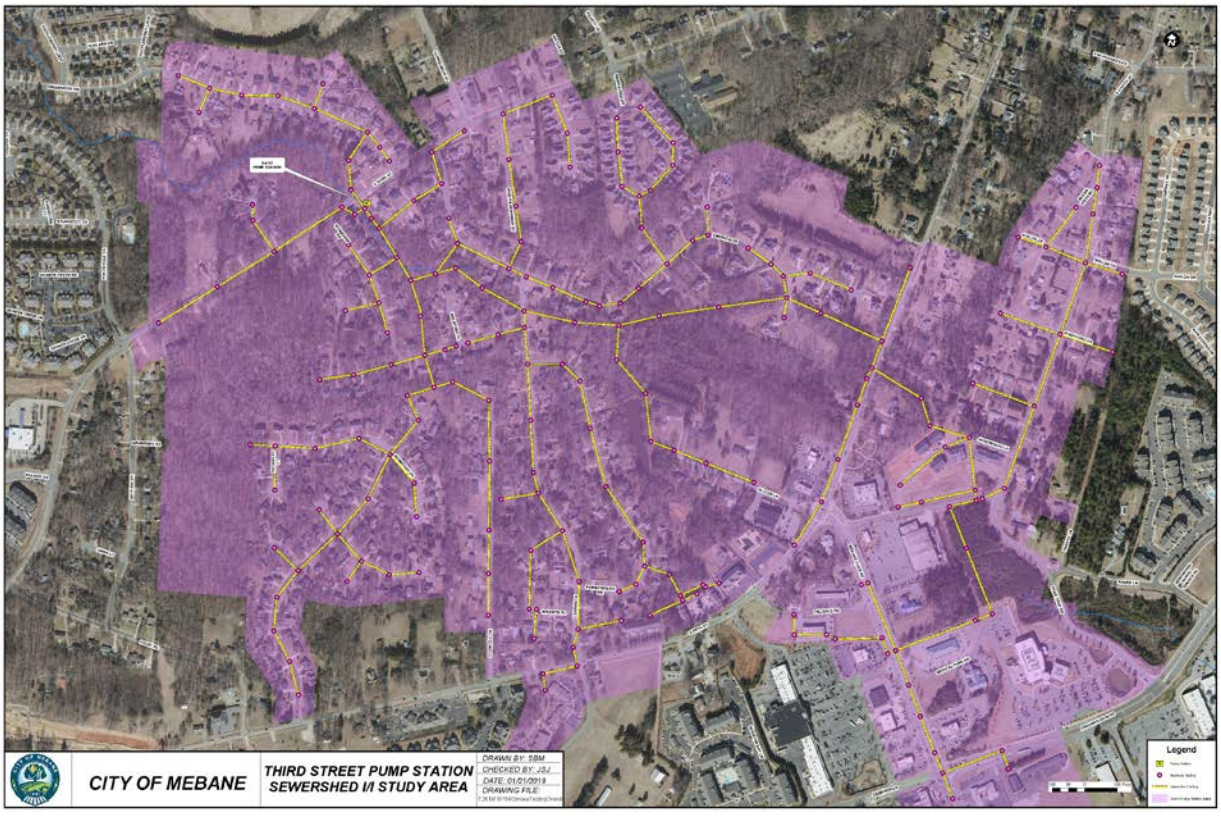


Figure 9: 3rd Street Sewershed

4.2. 5th Street

The 5th Street Pump Station is made up of approximately 16 miles of gravity sewer serving the downtown district and mostly residential properties that includes historic neighborhoods, multi-family buildings, as well as some newer development from the 2000's. Utilizing results from a 2012 flow-monitoring report, AWCK narrowed down the significant I&I concern to an approximately 8.5-mile total length of gravity sewer. This reduced sewershed area includes older neighborhoods, the historic downtown, and an apartment complex, eliminating the newer developments, where I&I is expected not to be a major concern. Upon the construction of the North Regional Pump Station, the 5th Street Pump Station is now by-passed by most wastewater flow, only in use during and after strong storm events when the lines are surcharged due to I&I. Wastewater that flows into 5th Street Pump Station is forced to a gravity manhole less than one mile away, where it is carried through a 12" gravity sewer to the WWTP.

Figure 10: 5th Street Pump Station Sewershed

5. THIRD AND FIFTH STREET PUMP STATION and SEWERSHED INFORMATION

5.1. 3rd Street Background and Information

The 3rd Street Pump Station is designed as a duplex (2) pump station that is designed to have two 550 GPM pumps within it. Pump stations are rated with their largest pump out of service. The intent being that a pump station will function if one pump is out of service. Therefore, the pump station is designed with a firm capacity of 792,000 gallons per day (550 gallons per minute X 1440 minutes per day). The design capacity would then be the 792,000 GPD divided by the peak factor. The minimum peak factor allowed per the NC Minimum Design Standards is 2.5. This would yield an original design capacity of 316,800 GPD. The design capacity is also considered the permitting capacity (the capacity allocation that NC DEQ looks at when permitting projects).

This design capacity can be significantly reduced over time due to a multitude of issues that comes with normal aging. The City of Mebane had recently completed a drawdown test on the pump station and found it to be pumping approximately as designed. As such we assumed the pumps to be pumping at their design capacity of 550 GPM. Using the designed pump rate and the average flow data from 2018, 3rd Street Pump Station has an average capacity utilization of 41%. This number, even if the pumps are performing below 550 GPM, paired with lack of potential additional future flows, does not suggest future analysis/rehabilitation of the pump station is needed beyond those that are expected as a system ages. Despite the average capacity utilization settling below 50%, flow entering the pump station does still exceed the design capacity at times due to I&I – specifically during and immediately after rain events.

While the 3rd Street Pump Station serves a generally newer district of Mebane compared to other regions, the drainage area does contain a high number of services. This demands multiple connections, joints, and tie-in points to be present, each one adding a vulnerable location for possible I&I to occur. In addition to these connection points, the outfall running to the pump station runs continuously alongside a USGS stream and flood zone.

5.2. 5th Street

As with the 3rd Street Pump Station, prior to any smoke testing, the 5th Street Pump Station was analyzed to better understand the I&I concern to the system. Following the construction of North Regional Pump Station in 2014, all permitted wastewater flow began to bypass 5th Street Pump Station to North Regional. Surcharges in flow, however, can still be diverted back to 5th Street Pump Station via a weir system installed in an upstream manhole, therefore pump run times can be directly tied to I&I from this section of the collection system.

The 5th Street Pump Station is designed as a duplex (2) pump station to have two 450 GPM pumps within it. Although present use is minimized, the pump station is designed with a firm capacity of 648,000 gallons per day (450 gallons per minute X 1440 minutes per day), which results in a design capacity of 259,200 GPD. Only activated during surcharges during and following rain events, one of the City's short-term goals is to reduce I/I from sewershed enough that the 5th Street Pump Station can be taken offline entirely.

The 5th Street Pump Station collection system encompasses the historic downtown Mebane, which includes infrastructure dating back to at least 1921. In addition to this aging system, the drainage area includes both newer and well-established neighborhoods, some of which were omitted from this study due to low I&I concerns. The main outfall line also runs inside of a flood zone bordering a USGS stream as well as intersects storm sewer alignments in multiple locations, both adding potential I&I to the system.

The Fifth Street Pump Station was the subject of a metering study completed in 2012 by Hydrostructures, PA. The 2012 report divided the pump station into several metering basins and then prioritized areas based upon the results of storms in November 2011. The report prioritized the highlighted areas below for further investigation, but it did not separate out inflow from infiltration.

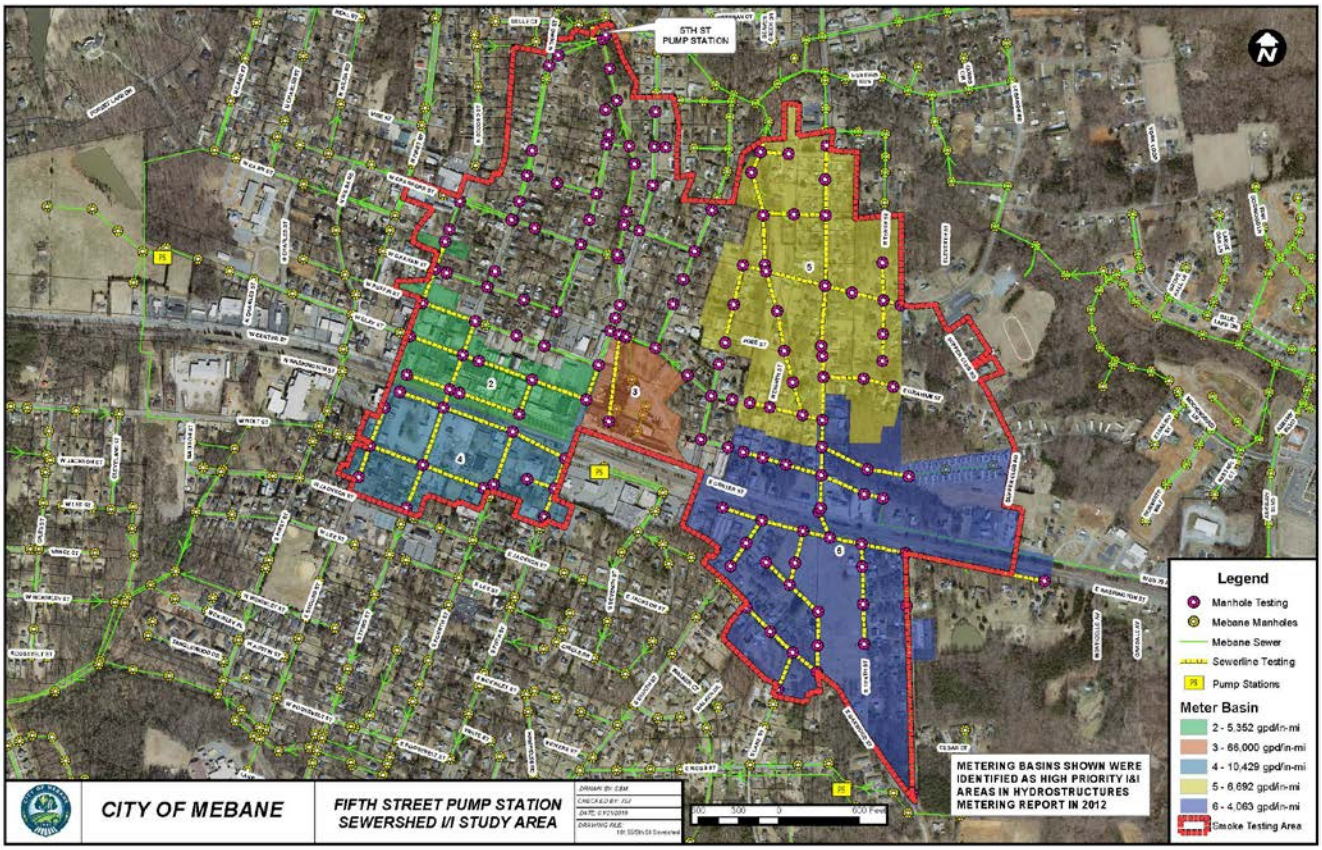


Figure 11: Fifth Street Pump Station - 2012 I&I Study

6. SMOKE TESTING

After desktop analysis of the pump stations, the study transitioned to smoke testing of the identified collection areas. Two primary ways that a collection system experiences increased wastewater flow are through pump station issues and increased infiltration and inflow. Smoke testing is an industry standard way to find and evaluate infiltration and inflow, particularly inflow.

6.1. Process

AWCK, with the City of Mebane's assistance, identified two of the most essential outfalls to be tested. AWCK used liquid smoke, a manhole liquid smoke blower, and GIS unit to smoke test the sewer lines and map points and areas of concern for the City. To smoke test sections of line, AWCK personnel first identified a manhole that was both accessible for the smoke machine and undamaged, so to maximize smoke being blown into the collection system. After placing the smoke machine on the manhole, the smoke engine was started and smoke allowed to blow into the manhole, filling the connecting line(s). AWCK then studied each leg of sewer tied into the manhole by walking along each line, simultaneously looking for signs of smoke rising from the ground, houses, cleanouts, and manholes. Smoke machine setups allowed for various lengths of

sewer to be tested. Each setup time was dependent on several factors; number of lines in/out, size and slope of lines, number of services in each line, and volume of smoke exiting through needed repairs. A setup was complete once visible smoke was no longer seen at a manhole along the study walk, and all areas and points of concern were recorded using the Trimble GPS system.

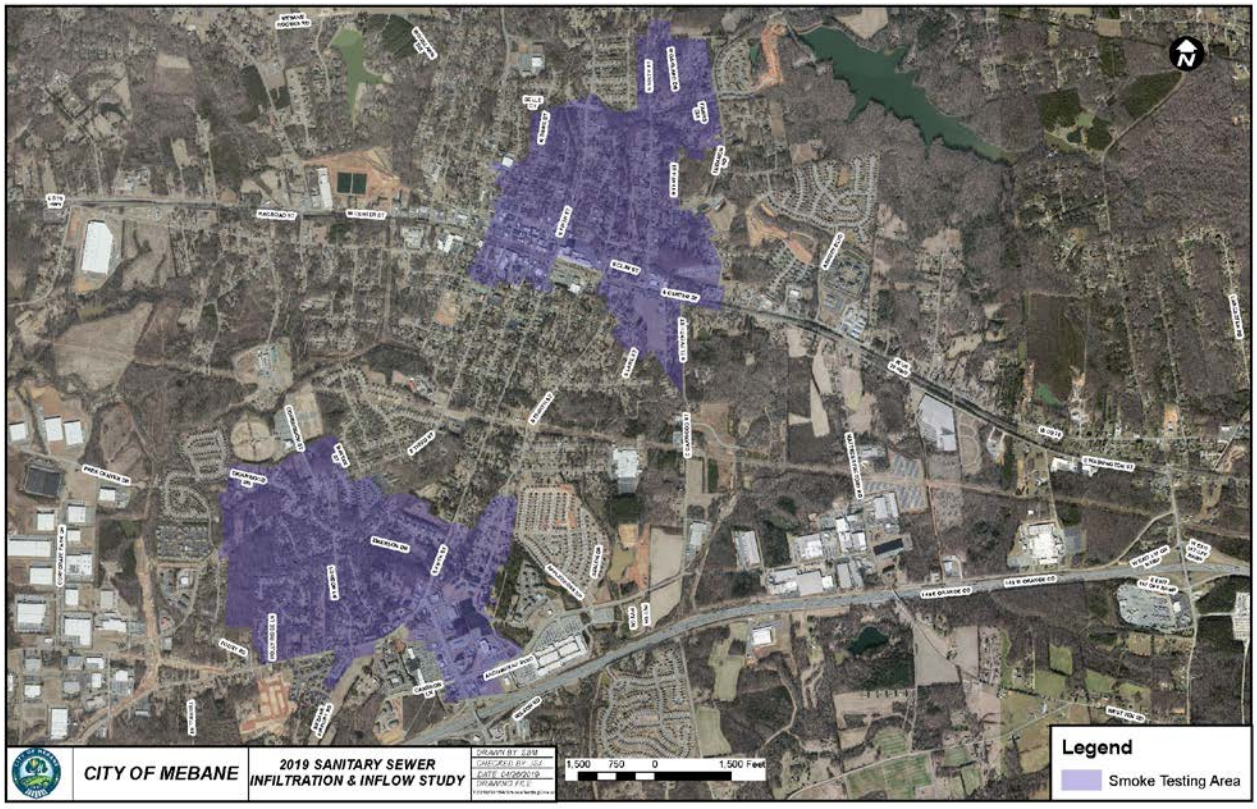


Figure 12: Smoke Testing Areas

After the field investigation was complete all GIS identified points were uploaded into map packages containing the City of Mebane Collection System. Approximately 89,000 LF of sanitary sewer line was tested between the two sewersheds, and in total, 360 sewer manholes were tested (209 in 3rd Street, 151 in 5th Street), 27 of which were previously unmapped. Sections of unmapped manholes and lines were mapped using the handheld GIS unit and added to the City of Mebane's GIS database.

6.2. Smoke Testing Results

Smoke testing verified the existence of many expected sources of inflow, including missing/damaged cleanouts, damaged manholes, and aging infrastructure flaws. In addition to these findings, several potentially more significant inflow sources were discovered during the study.

Smoke testing of the 3rd Street and 5th Street pump stations exposed a variety of inflow sources into the sewer system. These findings ranged from cleanouts with broken tops, to damaged manholes, to storm drain structures producing smoke during the study. A summary of the two sewersheds and their corresponding findings are found below:

Infiltration & Inflow Study Areas

3rd Street Pump Station

- 8+/- miles of sewer tested
- 206 manholes tested
- 17 unmapped manholes discovered
- 37 damaged cleanouts
- 8 damaged manholes

5th Street Pump Station

- 8.5+/- miles of sewer tested
- 151 manholes tested
- 10 unmapped manholes located
- 50 damaged cleanouts
- 2 damaged manholes
- 23 point repairs identified
- 24 storm sewer structures

The issues were broken out based on short, intermediate, and long-range recommended goals and categorized further to distinguish between types of repair. Included below are descriptions, plans of action, and tables summarizing the recommended short, intermediate, and long-term goals for repair work to begin addressing the inflow & infiltration of 3rd Street and 5th Street Pump Stations.

6.2.1. Damaged Service Cleanouts

The 3rd Street and 5th Street Pump Stations identified 87 cleanouts that were either damaged needing repair or missing parts, allowing considerable amounts of inflow into the sewer system during wet weather. Many of these cleanouts were found to be flush with the surrounding grade, some on slopes or in low areas, creating easy access points for inflow. With a 4-inch sanitary sewer service having the ability to carry a maximum capacity of 240 gallons per minute, those susceptible to inflow will likely allow any accessible water to enter the system. Ten manholes were found to have some form of structural damage, ranging from cracks in cones to broken ring and covers, each allowing inflow and infiltration. These infrastructure flaws are not uncommon to discover during any I&I study but are problematic for inflow and should be addressed.

Figure 13: Damaged Cleanout Cap and Manhole Ring

6.2.2. Outfall Manholes

Smoke testing the main outfall line for both 3rd Street and 5th Street Pump Stations revealed the current state of numerous manholes. The North Carolina Department of Environment and Natural Resources requires new manholes placed in the 100-year flood zone to be installed using watertight lids and vented every 1,000 feet or to be raised 24" above the 100-year flood elevation. Most structures appeared not to adhere to these criteria, with numerous manholes consisted of perforated lids within the flood zone, leaving them at risk to rising stream elevation during flooding. Non-watertight manholes that become overtopped can be the source of significant inflow during storm events.

Figure 14: 5th Street Manholes with Perforated Lids in Flood Zone

6.2.3. Storm Sewer Cross Connections

Smoke testing of the 5th Street Pump Station uncovered several I&I locations, including numerous potential sanitary sewer/storm sewer cross connections. Downtown Mebane and the immediate surrounding areas, part of the original square mile of city limits, is home to some of the oldest sanitary sewer infrastructure in the City, and was carefully studied due to the high probability of I&I. Through investigation, there were 24 different locations of smoke appearing from storm drain structures. Each separate site is subject to a differing size watershed and inflow calculation, so individual analysis was not performed. As reference, however, a 0.50-acre watershed would create almost 13,000 gallons of stormwater runoff during a 1" storm event. These issues could be cross connections, pipe degrading, joint separations, or a combination of these problems.

Figure 15: Typical Smoke from Storm Drainage via Sewer System Smoking

6.3. Smoke Testing Recommendations

6.3.1. Short Range – Utilities Department – cleanouts, manholes, point repairs

Damaged cleanouts, manholes, and point repairs were grouped into the same classification for priority and repair type. The identified locations are easily accessible, repair materials are relatively inexpensive, and the work requires excavating and repairs that City of Mebane Utilities Department are comfortable with performing. Setting these concerns as high priority and repairing in-house will eliminate potentially high volumes of stormwater from entering the system.

6.3.2 Short Range – Engineering & Contractor – storm sewers

This project is centered around the possible storm drain cross connections and interconnections with the 5th Street Pump Station sanitary sewer outfall. Investigation will include roof drain analysis in the field, loading various roof drains and observing their downstream connections. Additionally, video of the storm drain and sanitary sewer line will be recorded in the areas of concern and studied for any defects or irregular alignments surrounding the existing lines. The field investigation and result analysis can be done through joint efforts between the City of Mebane Public Works Department, Alley, Williams, Carmen & King, and a contractor to address the issues identified. The process for this work would be the following:

i. <u>Roof Drain Investigation</u>

- Alongside the City of Mebane Public Works Department, potential roof drain tie-ins will be investigated.
- Public Works to gain access to roof (via boom lift or other means) and water (via City of Mebane hydrant) and allow water to drain into roof gutters.
- AWCK to monitor downstream storm drain and sanitary sewer structures (manhole or otherwise) to confirm tie-ins.

ii. Cross Connections

- Storm drain structures producing smoke during testing will be investigated.
- Sections of storm drain lines identified as potential cross connections will be videoed (City of Mebane to provide camera) and reviewed by AWCK for connection points or potential infiltration of sewer.
- As necessary, sections of sanitary sewer lines to be videoed for connection points or exfiltration concerns.

iii. Fixing Identified Issues

It is recommended that the City contract with a local contractor to be on call to address the issues identified above. This can be done through identifying specific issues and a contract that includes a minimum daily rate so that adjustments can be made readily in the field while excavation is ongoing. This will prevent delays and interruptions to citizens and businesses in downtown.

6.3.3 Intermediate Range – Engineering Design & Bid – manhole upgrades & rim adjustments

Throughout the study, it was observed that many of the manholes located along both main outfalls to the pump stations were installed with perforated lids and set at low elevations. Located directly alongside perineal streams, as many as 28 manholes are within the 100-year floodplain, with 9 others possibly sitting in unmapped floodplains. Bringing these manholes up to modern design criteria would reduce inflow entering the system as a result of rising surface waters. Due to the scope of work that includes major manhole adjustments and flood elevation analysis, it is recommended these repairs be completed by a combination of engineering design and a reputable contractor.

6.3.4 Long Term – Engineering Design & Bid – CIPP & manhole rehabilitation

This project centers around the main outfall leading to the 3rd Street and 5th Street Pump Stations. The project would total approximately 6,100 linear feet and 22 manholes on along the 3rd Street Outfall and approximately 7,000 linear feet and 24 manholes along the 5th Street Outfall. Improvements include cured-in-place pipe lining of the existing sanitary sewer and grouting and sealing existing manholes with a cementitious epoxy linear.

These outfalls leading to the pump stations are located alongside mapped streams, making them subject to high water tables and rising surface waters (see intermediate range). Being larger scale projects, the rehabilitation will require engineering plans and specifications, and should be awarded to a contractor experienced in this specific type of rehabilitation work. This project is expected to address a significant amount of I/I coming into the sewer system through pipe cracks, joints, root obstructions, and manhole leaks.

Included below is a summary of smoke testing recommendations and projected costs for each repair.

INFLOW & INFILTRATION REPAIRS/TIMING/COSTS

	Repair Type	SHORT TERM	INTERMEDIATE TERM	LONG TERM
3RD STREET PUMP STATION SEWERSHED	CLEANOUT REPAIR	CITY STAFF		
	MANHOLE REPAIR	$10,000		
	MANHOLE COVER UPGRADE & RIM ADJUSTMENT		$35,000	
	OUTFALL CIPP			$1,200,000
	MANHOLE REHABILITATION			$200,000

	Repair Type	SHORT TERM	INTERMEDIATE TERM	LONG TERM
5TH STREET PUMP STATION SEWERSHED	CLEANOUT REPAIR	CITY STAFF		
	MINOR POINT REPAIR	CITY STAFF		
	MANHOLE COVER UPGRADE & RIM ADJUSTMENT		$35,000	
	STORM SEWER CROSS-CONNECTION INVESTIGATION & REPAIR	$150,000		
	OUTFALL CIPP			$ 1,300,000.00
	MANHOLE REHABILITATION			$ 350,000.00

recommended work performed by City of Mebane Public Works
recommended work - informal bid performed by contractor
investigation performed by City of Mebane staff and AWCK staff
repair work - informal bid performed by contractor
engineering design, formal bid, construction administration

Figure 13: Summary of Recommendations and Goals for Inflow & Infiltration Repairs

Completing the recommended goals for these sewersheds should directly correlate to a reduced inflow and infiltration being allowed into the sanitary sewer systems. In addition to alleviating excessive pumping at the pump stations, a reduced I&I into the infrastructure can improve the overall efficiency and capacity of the system.

7 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, while the City of Mebane is experiencing incredible growth, significant portions of its sanitary sewer system are aging. The aging portions of the system, through a combination of ordinary flaws and outdated designs, is allowing substantial amounts of inflow and infiltration into the infrastructure. Maintaining infrastructure systems is an ongoing process and collection systems are similar in this commitment to streets, water distribution systems, water and wastewater plants, and even buildings. Older portions of collection systems are often overlooked in this process because they continue to achieve their primary objective – collect and transport wastewater to wastewater treatment plants.

Mebane's collection system continues to transport wastewater to the WRRF but the amount of inflow that it transports is problematic. The inflow volumes impact the WRRF through reduced treatment rates and increased treatment and expansion costs. The inflow also increases the chances for sanitary sewer overflows while also reducing the effective capacity of a system. The City's WRRF experiences a peak factor over 3.5 on the storms evaluated when 2.5 would match the NC Minimum Design Criteria. The two sewersheds that were further evaluated within this report are examples of this. The Third Street pump station in only at about 30% of actual flow in dry weather but the pump station regularly pumps for 24 hours during peak events and the Fifth Street pump station doesn't pump at all during dry weather but it averaged pumping 160,000 gallons per day during the studied rain events. And the 160,000 gallons per day does not include the inflow that bypassed Fifth Street and went to North Regional.

When addressing inflow and infiltration eliminating I&I is unrealistic. The goal is to reduce I&I to a more manageable level. The industry expectation for new sewerlines and manholes includes an "acceptable" rate of infiltration and the industry concurs that eliminating I&I is impossible.

However, reducing I&I is possible and the recommendations and goals for the Third Street and Fifth Street sewersheds represent a phased implementation-based approach. For Mebane's collection system this is specifically oriented on reducing inflow. The steps in Figure 13 begin that process.

An additional intermediate step is to complete further investigation on the WRRF's primary outfall line. Completing the primary outfall line investigation before the Third and Fifth Street Outfall rehabilitation projects will allow for prioritization of the three outfall lines. These

prioritized long-term solutions will address the sewer outfalls and sewer outfall manholes. These are larger scale projects that will require budgeting and design and will serve to more comprehensively address I&I.

Additional recommendations are to evaluate and smoke test the Byrd's and Woodlawn Estates Pump Stations. These stations have limited total volume but a surprising amount of inflow.

The desktop analysis also identified the Efland pump stations are potentially problematic and noted that the data since repairs were made to the Efland system is limited. These pump stations were noted to be reviewed when additional data was available. If reliable SCADA information is available with at least 6 months of data, then it would be worthwhile to regularly update this study with new data. By definition inflow and infiltration are directly rain dependent so improvements are difficult to measure but creating and maintaining information may allow for future trends to be evaluated.

In summary, addressing I/I through projects that investigate/study/identify sources, making point repairs to eliminate inflow, and rehabilitating sewer lines and manholes to reduce infiltration and inflow, should result in reclaiming some of the lost capacity within the collection and pumping systems and at the WRRF. As a result, reclaimed sewer flow capacity would be available for future developments, while upgrading an existing portion of sewer infrastructure that has been around since as early as the 1920s. It is important to note that the expectation is not that the identified projects or others will eliminate infiltration and inflow within the system but that I&I would be reduced to a more acceptable level.

Appendices List

Appendix 1 – Desktop Analysis Exhibits

- Exhibit 1A – Mebane Sewersheds
- Exhibit 1B – Mebane Sewersheds - Flows
- Exhibit 1B – Pump Station Data Analysis – Dry Weather Evaluation
- Exhibit 1C – Pump Station Data Analysis – Wet Weather Events
- Exhibit 1D – Pump Station Data Analysis – Wet Weather Events Average
- Exhibit 1E – Pump Station Data Analysis – Infiltration
- Exhibit 1F – Pump Station Data Analysis – I&I Analysis
- Exhibit 1G – Sewershed to Primary Outfall to WRRF

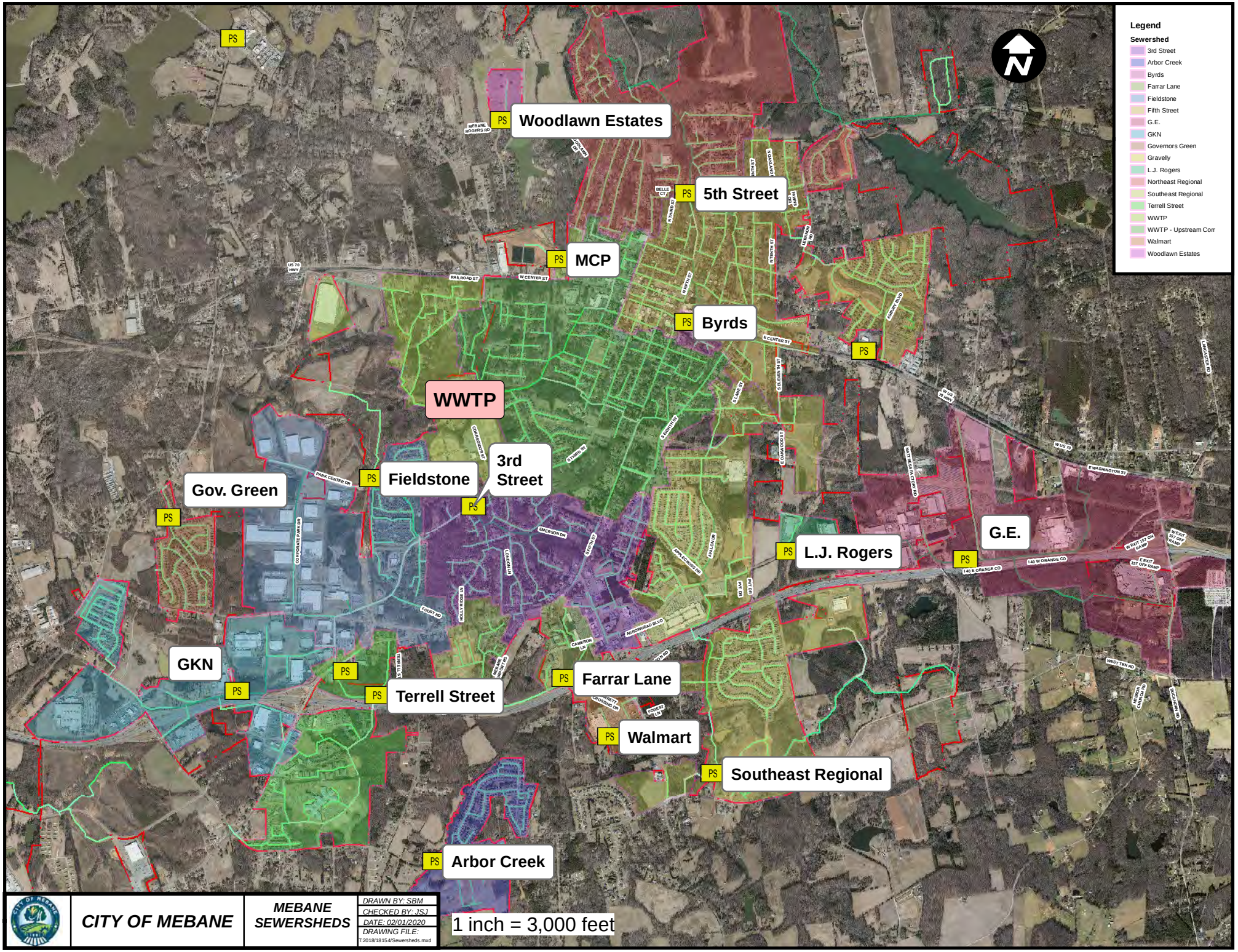
Appendix 2 – Exhibit Maps

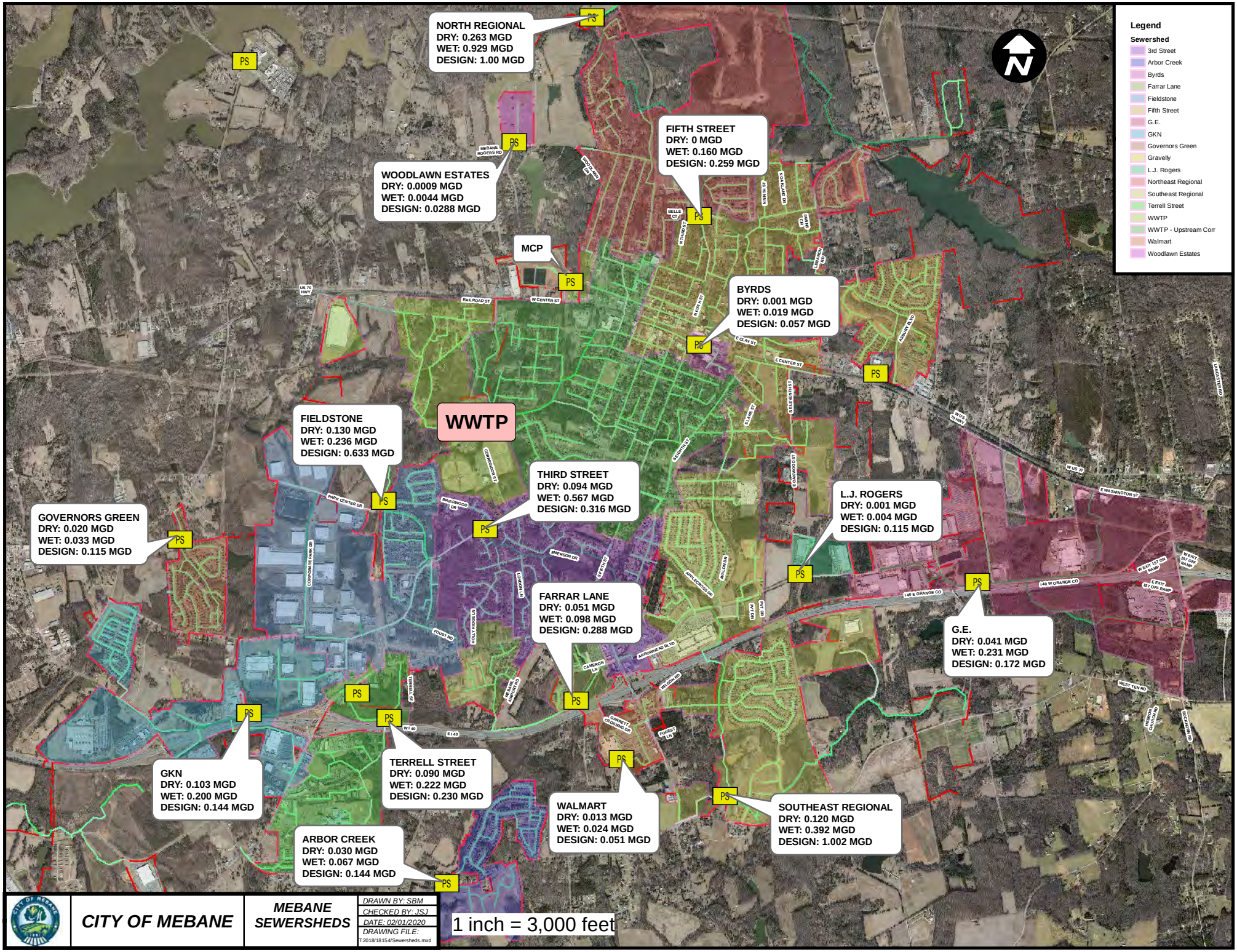
- Exhibit 2A – 3rd Street Pump Station Study Area
- Exhibit 2B – 5th Street Pump Station Study Area
- Exhibit 2C – Overall Smoke Testing Map
- Exhibit 2D – 3rd Street Pump Station Repair Map
- Exhibit 2E – 5th Street Pump Station Repair Map

Appendix 3 – Project Recommendations & Cost Estimates

- Inflow & Infiltration Repairs/Timing/Costs Chart
- Plan of Action – Storm Drainage Cross Connections
- 3rd Street Outfall Rehabilitation Exhibit
- 3rd Street Outfall Rehabilitation Cost Estimate
- 5th Street Outfall Rehabilitation Exhibit
- 5th Street Outfall Rehabilitation Cost Estimate

APPENDIX 1
DESKTOP ANALYSIS EXHIBITS


Legend
Sewershed
3rd Street
Arbor Creek
Byrds
Farrar Lane
Fieldstone
Fifth Street
G.E.
GKN
Governors Green
Gravelly
L.J. Rogers
Northeast Regional
Southeast Regional
Terrell Street
WWTP
WWTP - Upstream Corr
Walmart
Woodlawn Estates
Woodlawn Estates
5th Street
MCP
Byrds
WWTP
3rd Street
Fieldstone
Gov. Green
L.J. Rogers
G.E.
GKN
Terrell Street
Farrar Lane
Walmart
Southeast Regional
Arbor Creek
PS
N
CITY OF MEBANE
MEBANE SEWERSHEDS
DRAWN BY: SBM
CHECKED BY: JSJ
DATE: 02/01/2020
DRAWING FILE:
T:2018/18154/Sewersheds.mxd
1 inch = 3,000 feet


NORTH REGIONAL
DRY: 0.263 MGD
WET: 0.929 MGD
DESIGN: 1.00 MGD
WOODLAWN ESTATES
DRY: 0.0009 MGD
WET: 0.0044 MGD
DESIGN: 0.0288 MGD
FIFTH STREET
DRY: 0 MGD
WET: 0.160 MGD
DESIGN: 0.259 MGD
MCP
BYRDS
DRY: 0.001 MGD
WET: 0.019 MGD
DESIGN: 0.057 MGD
WWTP
FIELDSTONE
DRY: 0.130 MGD
WET: 0.236 MGD
DESIGN: 0.633 MGD
THIRD STREET
DRY: 0.094 MGD
WET: 0.567 MGD
DESIGN: 0.316 MGD
GOVERNORS GREEN
DRY: 0.020 MGD
WET: 0.033 MGD
DESIGN: 0.115 MGD
L.J. ROGERS
DRY: 0.001 MGD
WET: 0.004 MGD
DESIGN: 0.115 MGD
FARRAR LANE
DRY: 0.051 MGD
WET: 0.098 MGD
DESIGN: 0.288 MGD
G.E.
DRY: 0.041 MGD
WET: 0.231 MGD
DESIGN: 0.172 MGD
GKN
DRY: 0.103 MGD
WET: 0.200 MGD
DESIGN: 0.144 MGD
TERRELL STREET
DRY: 0.090 MGD
WET: 0.222 MGD
DESIGN: 0.230 MGD
WALMART
DRY: 0.013 MGD
WET: 0.024 MGD
DESIGN: 0.051 MGD
SOUTHEAST REGIONAL
DRY: 0.120 MGD
WET: 0.392 MGD
DESIGN: 1.002 MGD
ARBOR CREEK
DRY: 0.030 MGD
WET: 0.067 MGD
DESIGN: 0.144 MGD
PS
N
Legend
Sewershed
3rd Street
Arbor Creek
Byrds
Farrar Lane
Fieldstone
Fifth Street
G.E.
GKN
Governors Green
Gravelly
L.J. Rogers
Northeast Regional
Southeast Regional
Terrell Street
WWTP
WWTP - Upstream Corr
Walmart
Woodlawn Estates
CITY OF MEBANE
MEBANE SEWERSHEDS
DRAWN BY: SBM
CHECKED BY: JSJ
DATE: 02/01/2020
DRAWING FILE:
T:2018/18154/Sewersheds.mxd
1 inch = 3,000 feet

Dry Weather Evaluation

Pump Station Name	Pump Station Design Capacity		Dry Weather - Sewershed Flows			
	Design ADF (GPD)	Actual ADF (GPD)	July 2018 Dry ADF (GPD)	July 2019 ADF (GPD)	August 2019 Dry ADF (GPD)	Adjusted AVG DRY ADF (GPD)
North Regional	1,005,120	1,005,120	261,540	254,238	275,955	**263,911**
Woodlawn Estates	28,800	28,800	~~210~~	1,230	1,500	**980**
Fifth St	259,200	259,200	0		0	**0**
Southeast Regional	1,002,240	1,002,240	114,840	103,356	142,692	**120,296**
West Ten	403,200	403,200	~~0~~	7,986	10,776	**9,381**
Brookhollow	316,800	316,800	42,900	18,150	19,800	**26,950**
Richmond Hills	46,080	46,080	3,552	3,264	3,024	**3,280**
Fieldstone	633,600	633,600	137,250	140,280	113,850	**130,460**
GKN	288,000	***144,000***	96,000	101,250	112,500	**103,250**
Governors Green	115,200	115,200	19,200	20,400	22,800	**20,800**
Terrell St	230,400	230,400	97,350	88,530	84,150	**90,010**
Arbor Creek	144,000	144,000	27,450	33,150	29,850	**30,150**
GE	288,000	***172,800***	30,600	43,320	49,920	**41,280**
Gravelly Hill	115,200	115,200	21,600	24,000	22,800	**22,800**
LJ Rodgers	115,200	115,200	1,800	1,080	1,080	**1,320**
Farrar Ln	288,000	288,000	53,700	57,000	45,036	**51,912**
Walmart	51,840	51,840	24,300	8,640	8,964	**13,968**
Third Street	316,800	316,800	89,100	99,000	95,700	**94,600**
Byrds	57,600	57,600	1,980	1,200	1,020	**1,400**
Totals	**5,705,280**	**5,446,080**	1,023,372	1,006,074	1,041,417	**1,026,748**

Wet Weather Events

	Pump Station Design Capacity	Dry Weather - Sewershed Flows	9/18/18 - 1.4" Rain Event (End of Hurricane Florence)			10/11/18 - 2.75" Rain Event (Hurricane Michael)			11/13/18 - 3.5" Rain Event			6/19/19 - 1.9" Rain Event			2/7/20 - 3" Rain Event		
Pump Station	**Actual ADF (MGD)**	**Adjusted AVG DRY ADF**	**9/18/18 Pump Run Times**	**9/18/18 GPD**	**I/I (Gallons)**	**10/11/18 Pump Run Times**	**10/11/18 GPD**	**I/I (Gallons)**	**11/13/18 Pump Run Times**	**11/13/18 GPD**	**I/I (Gallons)**	**6/19/2019**	**2/7/20 GPD**	**I/I (Gallons)**	**2/7/20 Pump Run Times**	**2/7/20 GPD**	**I/I (Gallons)**
North Regional	1,005,120	**263,911**	7.06	739,182	475,271	6.50	680,550	416,639	9.41	981,417	717,506	6.89	721,383	457,472	14.73	1,537,341	1,273,430
Woodlawn Estates	28,800	**980**		0	-980		0		1.27	3,810	2,830	1.59	4,770	3,790	1.63	4,890	3,910
Fifth St	259,200	**0**	1.68	45,360	45,360	2.80	75,600	75,600	9.90	267,300	267,300		0	0	9.40	253,800	253,800
Southeast Regional	1,002,240	**120,296**	2.57	268,308	148,012	2.44	254,736	134,440	3.16	329,904	209,608	2.95	300,108	179,812	10.21	683,724	563,428
West Ten	403,200	**9,381**										2.20	7,872		9.10	382,200	372,819
Brookhollow	316,800	**26,950**	5.10	168,300	141,350	2.00	66,000	39,050	9.00	297,000	270,050	2.40	79,200	52,250	8.50	280,500	253,550
Richmond Hills	46,080	**3,280**	1.02	4,896	1,616	1.18	5,664	2,384	1.75	8,400	5,120	1.11	5,328	2,048	1.89	9,072	5,792
Fieldstone	633,600	**130,460**	10.34	273,270	142,810	8.78	222,660	92,200	10.55	235,320	104,860	7.96	115,260		12.38	214,290	83,830
GKN	***144,000***	**103,250**	12.70	190,500	87,250	11.60	174,000	70,750	11.50	172,500	69,250	9.30	139,500	36,250	17.70	265,500	162,250
Governors Green	115,200	**20,800**	2.60	31,200	10,400	2.80	33,600	12,800	3.30	39,600	18,800	***11.80***	***141,600***	***120,800***	2.60	31,200	10,400
Terrell St	230,400	**90,010**	10.08	187,470	97,460	8.53	149,220	59,210	13.27	248,880	158,870	7.35	129,000	38,990	16.46	306,090	216,080
Arbor Creek	144,000	**30,150**	3.63	54,450	24,300	3.70	55,500	25,350	4.64	69,600	39,450	3.16	47,400	17,250	5.93	88,950	58,800
GE	***172,800***	**41,280**	10.60	143,280	102,000	10.90	160,560	119,280	23.80	421,680	380,400	7.20	104,160	62,880	22.40	367,440	326,160
Gravelly Hill	115,200	**22,800**	3.60	43,200	20,400	2.50	30,000	7,200	No data		-22,800	2.30	27,600	4,800	2.60	31,200	8,400
LJ Rodgers	115,200	**1,320**	0.36	4,320	3,000	0.47	5,640	4,320	0.56	6,720	5,400	0.18	2,160	840	0.38	4,560	3,240
Farrar Ln	288,000	**51,912**	3.93	89,388	37,476	4.57	98,490	46,578	3.99	92,214	40,302	2.49	63,738	11,826	5.56	148,332	96,420
Walmart	51,840	**13,968**	5.28	28,512	14,544	7.15	38,610	24,642	5.09	27,486	13,518	2.03	10,962		3.42	18,468	4,500
Third Street	316,800	**94,600**	16.60	547,800	453,200	9.90	326,700	232,100	26.20	864,600	770,000	8.70	287,100	192,500	24.60	811,800	717,200
Byrds	57,600	**1,400**	0.88	5,280	3,880	2.68	16,080	14,680	5.19	31,140	29,740	2.10	12,600	11,200	5.24	31,440	30,040
Totals	**5,446,080**	**1,026,748**		**2,824,716**	**1,807,349**		**2,393,610**	**1,377,223**		**4,097,571**	**3,080,204**		**2,199,741**	**1,192,708**		**5,470,797**	**4,444,049**

Wet Weather Events Average

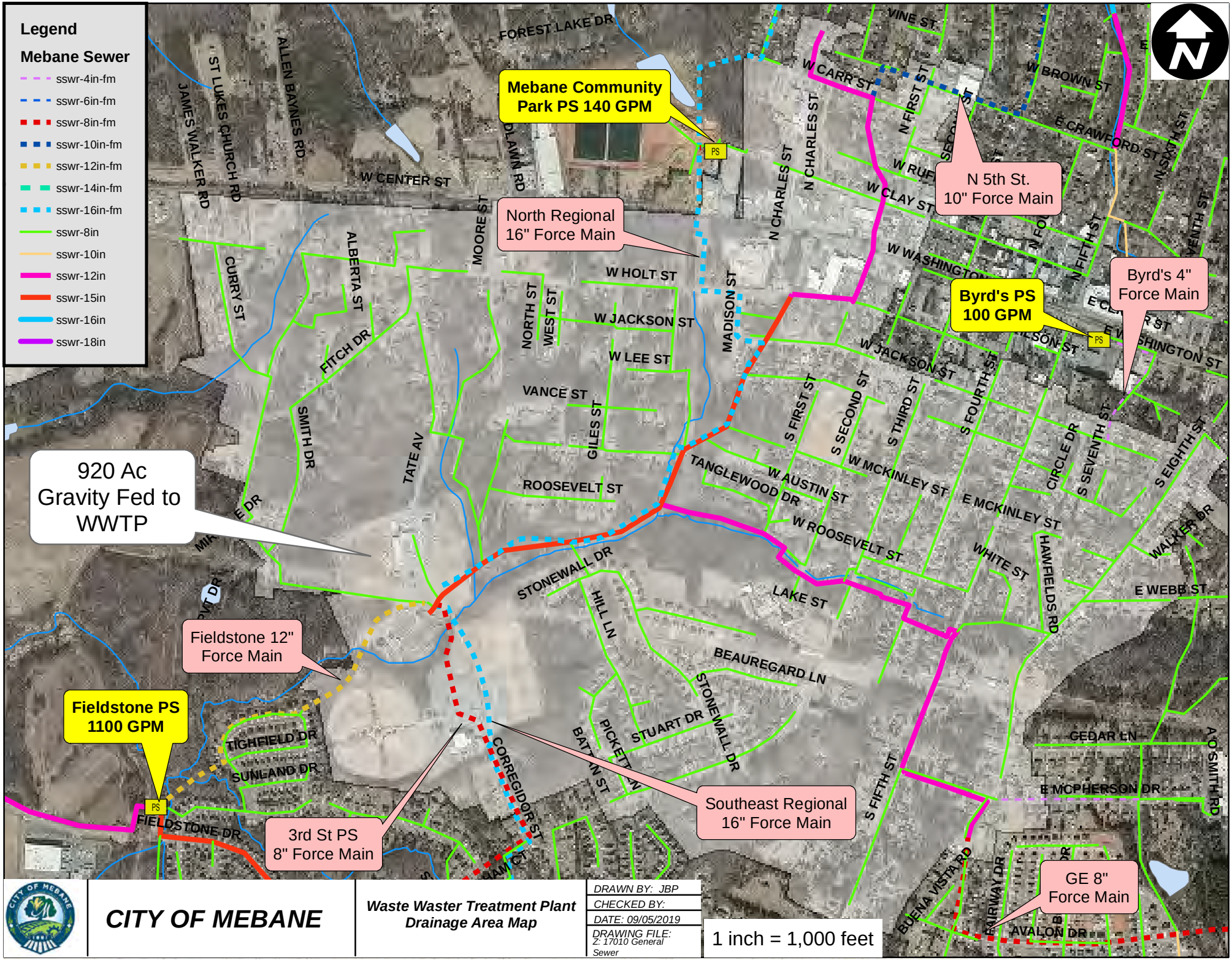
Pump Station Name	Pump Station Design Capacity	Dry Weather - Sewershed Flows	Five Rain Events Average - I&I			
	Actual ADF (GPD)	Adjusted AVG DRY ADF (GPD)	AVG Pump Run Times (Hours)	AVG Gallons	I/I Gallons	Peak Factor (Wet/Dry)
North Regional	1,005,120	**263,911**	8.92	929,225	665,314	3.52
Woodlawn Estates	28,800	**980**	1.50	4,490	3,510	4.58
Fifth St	259,200	**0**	5.94	160,515	160,515	
Southeast Regional	1,002,240	**120,296**	4.27	392,942	272,646	3.27
West Ten	403,200	**9,381**	5.65	52,428	43,047	5.59
Brookhollow	316,800	**26,950**	5.40	178,200	151,250	6.61
Richmond Hills	46,080	**3,280**	1.39	6,672	3,392	2.03
Fieldstone	633,600	**130,460**	10.51	236,385	105,925	1.81
GKN	***144,000***	**103,250**	13.38	200,625	97,375	1.94
Governors Green	115,200	**20,800**	2.83	33,900	13,100	1.63
Terrell St	230,400	**90,010**	12.09	222,915	132,905	2.48
Arbor Creek	144,000	**30,150**	4.47	67,125	36,975	2.23
GE	***172,800***	**41,280**	14.98	231,960	190,680	5.62
Gravelly Hill	115,200	**22,800**	2.75	33,000	10,200	1.45
LJ Rodgers	115,200	**1,320**	0.39	4,680	3,360	3.55
Farrar Ln	288,000	**51,912**	4.11	98,432	46,520	1.90
Walmart	51,840	**13,968**	4.59	24,808	10,840	1.78
Third Street	316,800	**94,600**	17.20	567,600	473,000	6.00
Byrds	57,600	**1,400**	3.22	19,308	17,908	13.79
Totals	**5,446,080**	**1,026,748**		**3,465,210**	**2,438,462**	3.37

Infiltration Analysis

Pump Station Name	Pump Station Design Capacity	Dry Weather - Sewershed Flows	Wet Weather Non-Rain - Infiltration			9/19/19-9/21/18 Infiltration 2				
	Actual ADF (MGD)	Adjusted AVG DRY ADF	Feb 2019 Wet Weather non-rain (GPD)	Infiltration (GPD)	Infiltration (gpd/in-mile)	9/19-9/21 Gallons	9/19-9/21 GPD	Infiltration (GPD)	Days	Infiltration (gpd/in-mile)
North Regional	1,005,120	**263,911**	345,927	82,016	516	1,226,037	408,679	144,768	3	911
Woodlawn Estates	28,800	**980**	630			0	0	-980	3	-570
Fifth St	259,200	**0**	4,455	4,455	36	0	0	0	3	0
Southeast Regional	1,002,240	**120,296**	147,804	147,804	1,095	271,440	90,480	-29,816	3	-221
West Ten	403,200	**9,381**				0		-9,381		-564
Brookhollow	316,800	**26,950**	29,700	2,750	37			-26,950		-366
Richmond Hills	46,080	**3,280**	3,504	224	56			-3,280		-820
Fieldstone	633,600	**130,460**	125,100			392,580	130,860	400	3	6
GKN	144,000	**103,250**	120,000	16,750	460	421,500	140,500	37,250	3	1,023
Governors Green	115,200	**20,800**	25,200	4,400	223	69,600	23,200	2,400	3	122
Terrell St	230,400	**90,010**	92,700	2,690	76	306,300	102,100	12,090	3	340
Arbor Creek	144,000	**30,150**	34,500	4,350	172	112,500	37,500	7,350	3	290
GE	172,800	**41,280**	58,920	17,640	505	213,600	71,200	29,920	3	856
Gravelly Hill	115,200	**22,800**	26,400	3,600	254	72,000	24,000	1,200	3	85
LJ Rodgers	115,200	**1,320**	1,080			13,200	4,400	3,080	3	693
Farrar Ln	288,000	**51,912**	49,728			171,672	57,224	5,312	3	265
Walmart	51,840	**13,968**	9,072			77,328	25,776	11,808	3	1,783
Third Street	316,800	**94,600**	132,000	37,400	513	739,200	184,800	90,200	4	1,236
Byrds	57,600	**1,400**	1,380			62,700	20,900	19,500	3	7,693
Totals	**5,446,080**	**1,026,748**	**1,216,896**	**324,079**	**379**	**4,149,657**		**294,871**	**3.08**	**112**

I/I Analysis
Complete Information

	Pump Station Design Capacity				Dry Weather - Sewershed Flows								9/18/18 - 1.4" Rain Event (End of Hurricane Florence)			10/11/18 - 2.75" Rain Event (Hurricane Michael)			11/13/18 - 3.5" Rain Event			6/19/19 - 1.9" Rain Event			2/7/20 - 3" Rain Event			Rain Event Average - I&I			
Pump Station	**Design GPM**	**Design ADF (GPD)**	**Actual GPM**	**Actual ADF (GPD)**	**July 2018 Dry Pump Run Times (Hours)**	**July 2018 Dry ADF (GPD)**	**July 2019 Dry Pump Run (Hours)**	**July 2019 ADF (GPD)**	**August 2019 Dry Pump Run (Hours)**	**August 2019 Dry ADF (GPD)**	**Average Hours**	**Adjusted AVG DRY ADF (GPD)**	**9/18/18 Pump Run Times (Hours)**	**9/18/18 (GPD)**	**I/I (Gallons)**	**10/11/18 Pump Run Times (Hours)**	**10/11/18 (GPD)**	**I/I (Gallons)**	**11/13/18 Pump Run Times (Hours)**	**11/13/18 (GPD)**	**I/I (Gallons)**	**6/19/2019 Pump Run Times (Hours)**	**6/19/19 (GPD)**	**I/I (Gallons)**	**2/7/20 Pump Run Times (Hours)**	**2/7/20 (GPD)**	**I/I (Gallons)**	**AVG Pump Run Times (Hours)**	**AVG (GPD)**	**I/I (Gallons)**	**Peak Factor (Wet/Dry)**
North Regional	1745	1,005,120	1745	1,005,120	2.50	261,540	2.44	254,238	2.65	275,955	**2.53**	**263,911**	7.06	739,182	475,271	6.50	680,550	416,639	9.41	981,417	717,506	6.89	721,383	457,472	14.73	1,537,341	1,273,430	8.92	929,225	665,314	3.52
Woodlawn Estates	50	28,800	50	28,800	~~0.07~~	~~210~~	0.41	1,230	0.50	1,500	**0.46**	**980**		0	-980		0		1.27	3,810	2,830	1.59	4,770	3,790	1.63	4,890	3,910	1.50	4,490	3,510	4.58
Fifth St	450	259,200	450	259,200	0.00	0			0.00	0	**0.00**	**0**	1.68	45,360	45,360	2.80	75,600	75,600	9.90	267,300	267,300		0	0	9.40	253,800	253,800	5.94	160,515	160,515	
Southeast Regional	1740	1,002,240	1740	1,002,240	1.10	114,840	0.99	103,356	1.47	142,692	**1.19**	**120,296**	2.57	268,308	148,012	2.44	254,736	134,440	3.16	329,904	209,608	2.95	300,108	179,812	10.21	683,724	563,428	4.27	392,942	272,646	3.27
West Ten	700	403,200	700	403,200		~~0~~	0.70	7,986	0.80	10,776	**0.75**	**9,381**										2.20	7,872	-1,509	9.10	382,200	372,819	5.65	52,428	43,047	5.59
Brookhollow	550	316,800	550	316,800	1.30	42,900	0.55	18,150	0.60	19,800	**0.82**	**26,950**	5.10	168,300	141,350	2.00	66,000	39,050	9.00	297,000	270,050	2.40	79,200	52,250	8.50	280,500	253,550	5.40	178,200	151,250	6.61
Richmond Hills	80	46,080	80	46,080	0.74	3,552	0.68	3,264	0.63	3,024	**0.68**	**3,280**	1.02	4,896	1,616	1.18	5,664	2,384	1.75	8,400	5,120	1.11	5,328	2,048	1.89	9,072	5,792	1.39	6,672	3,392	2.03
Fieldstone	1100	633,600	1100	633,600	5.30	137,250	5.31	140,280	5.05	113,850	**5.22**	**130,460**	10.34	273,270	142,810	8.78	222,660	92,200	10.55	235,320	104,860	7.96	115,260		12.38	214,290	83,830	10.51	236,385	105,925	1.81
GKN	500	288,000	***250***	***144,000***	6.40	96,000	6.75	101,250	7.50	112,500	**6.95**	**103,250**	12.70	190,500	87,250	11.60	174,000	70,750	11.50	172,500	69,250	9.30	139,500	36,250	17.70	265,500	162,250	13.38	200,625	97,375	1.94
Governors Green	200	115,200	200	115,200	1.60	19,200	1.70	20,400	1.90	22,800	**1.73**	**20,800**	2.60	31,200	10,400	2.80	33,600	12,800	3.30	39,600	18,800	***11.80***	***141,600***	***120,800***	2.60	31,200	10,400	2.83	33,900	13,100	1.63
Terrell St	400	230,400	400	230,400	5.20	97,350	5.07	88,530	4.75	84,150	**5.01**	**90,010**	10.08	187,470	97,460	8.53	149,220	59,210	13.27	248,880	158,870	7.35	129,000	38,990	16.46	306,090	216,080	12.09	222,915	132,905	2.48
Arbor Creek	250	144,000	250	144,000	1.83	27,450	2.21	33,150	1.99	29,850	**2.01**	**30,150**	3.63	54,450	24,300	3.70	55,500	25,350	4.64	69,600	39,450	3.16	47,400	17,250	5.93	88,950	58,800	4.47	67,125	36,975	2.23
GE	500	288,000	***300***	***172,800***	3.00	30,600	3.80	43,320	4.10	49,920	**3.63**	**41,280**	10.60	143,280	102,000	10.90	160,560	119,280	23.80	421,680	380,400	7.20	104,160	62,880	22.40	367,440	326,160	14.98	231,960	190,680	5.62
Gravelly Hill	200	115,200	200	115,200	1.80	21,600	2.00	24,000	1.90	22,800	**1.90**	**22,800**	3.60	43,200	20,400	2.50	30,000	7,200	No data		-22,800	2.30	27,600	4,800	2.60	31,200	8,400	2.75	33,000	10,200	1.45
LJ Rodgers	200	115,200	200	115,200	0.15	1,800	0.09	1,080	0.09	1,080	**0.11**	**1,320**	0.36	4,320	3,000	0.47	5,640	4,320	0.56	6,720	5,400	0.18	2,160	840	0.38	4,560	3,240	0.39	4,680	3,360	3.55
Farrar Ln	500	288,000	500	288,000	2.60	53,700	1.90	57,000	1.80	45,036	**2.10**	**51,912**	3.93	89,388	37,476	4.57	98,490	46,578	3.99	92,214	40,302	2.49	63,738	11,826	5.56	148,332	96,420	4.11	98,432	46,520	1.90
Walmart	90	51,840	90	51,840	***4.50***	24,300	1.60	8,640	1.66	8,964	**2.59**	**13,968**	5.28	28,512	14,544	7.15	38,610	24,642	5.09	27,486	13,518	2.03	10,962		3.42	18,468	4,500	4.59	24,808	10,840	1.78
Third Street	550	316,800	550	316,800	2.70	89,100	3.00	99,000	2.90	95,700	**2.87**	**94,600**	16.60	547,800	453,200	9.90	326,700	232,100	26.20	864,600	770,000	8.70	287,100	192,500	24.60	811,800	717,200	17.20	567,600	473,000	6.00
Byrds	100	57,600	100	57,600	0.33	1,980	0.20	1,200	0.17	1,020	**0.23**	**1,400**	0.88	5,280	3,880	2.68	16,080	14,680	5.19	31,140	29,740	2.10	12,600	11,200	5.24	31,440	30,040	3.22	19,308	17,908	13.79
Totals		**5,705,280**	**9,455**	**5,446,080**		1,023,372		1,006,074		1,041,417		**1,026,748**		**2,824,716**	**1,807,349**		**2,393,610**	**1,377,223**		**4,097,571**	**3,080,204**		**2,199,741**	**1,191,199**		**5,470,797**	**4,444,049**		**3,465,210**	**2,438,462**	3.37



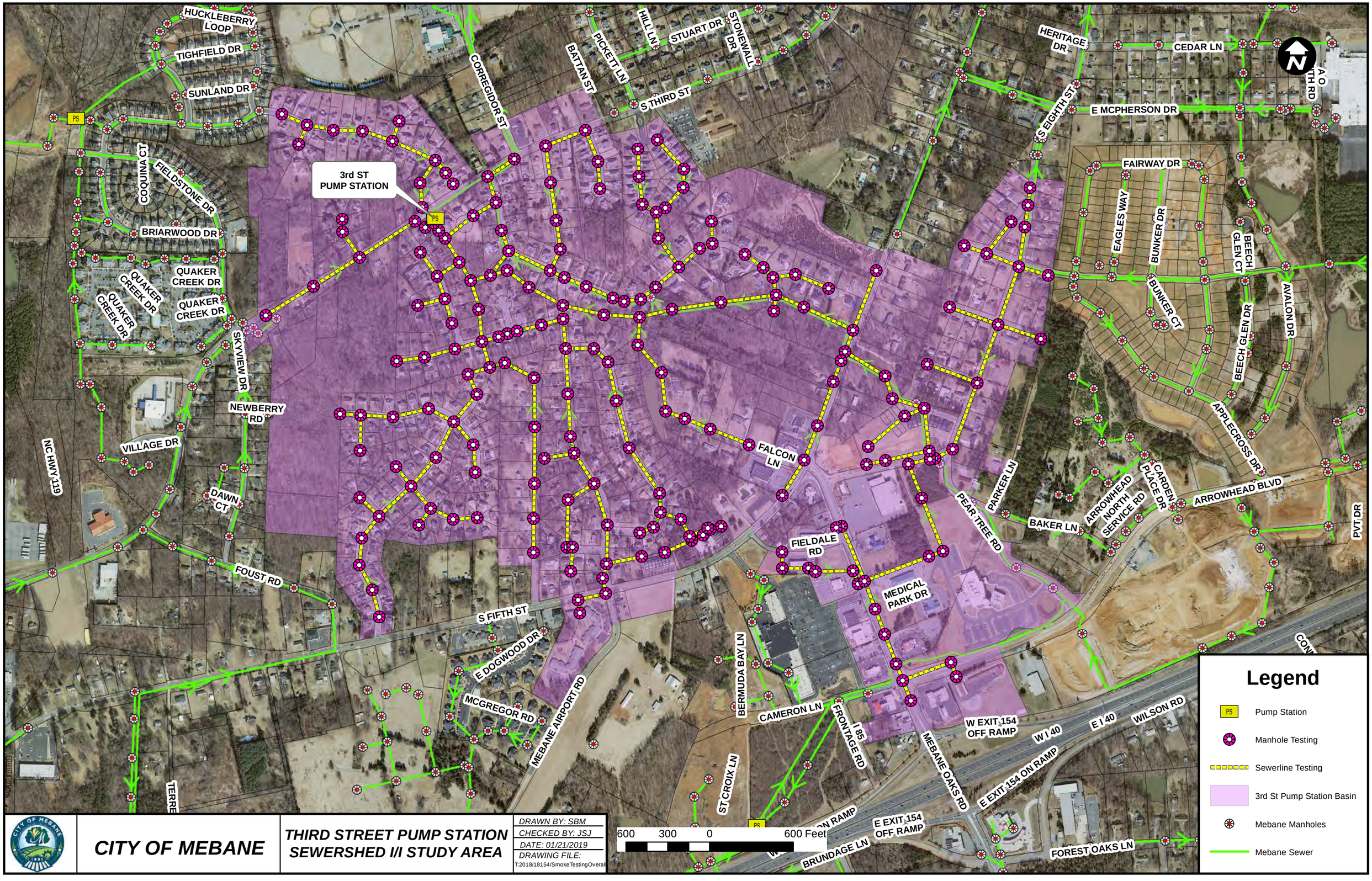
CITY OF MEBANE

Waste Wastewater Treatment Plant Drainage Area Map

DRAWN BY:	JBP
CHECKED BY:	
DATE:	09/05/2019
DRAWING FILE:	Z: 17010 General Sewer

1 inch = 1,000 feet

APPENDIX 2
SMOKE TESTING EXHIBITS



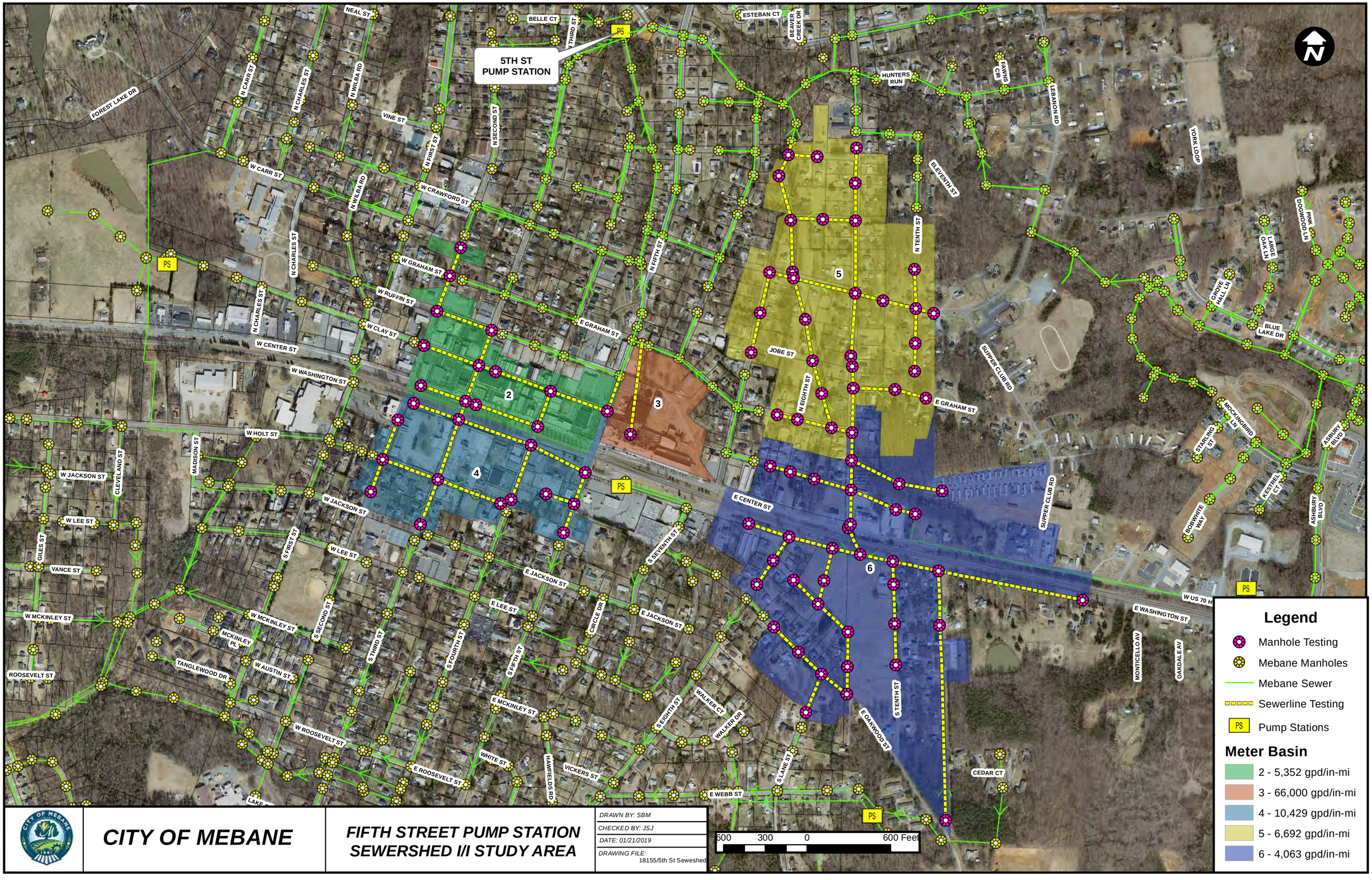
Legend

- PS — Pump Station
- Manhole Testing
- Sewerline Testing
- 3rd St Pump Station Basin
- Mebane Manholes
- Mebane Sewer

CITY OF MEBANE

THIRD STREET PUMP STATION SEWERSHED I/I STUDY AREA

DRAWN BY: SBM
CHECKED BY: JSJ
DATE: 01/21/2019
DRAWING FILE:
T:2018/18154/SmokeTestingOverall



CITY OF MEBANE

FIFTH STREET PUMP STATION SEWERSHED I/I STUDY AREA

DRAWN BY: SBM
CHECKED BY: JSJ
DATE: 01/21/2019
DRAWING FILE: 18155/5th St Seweshed

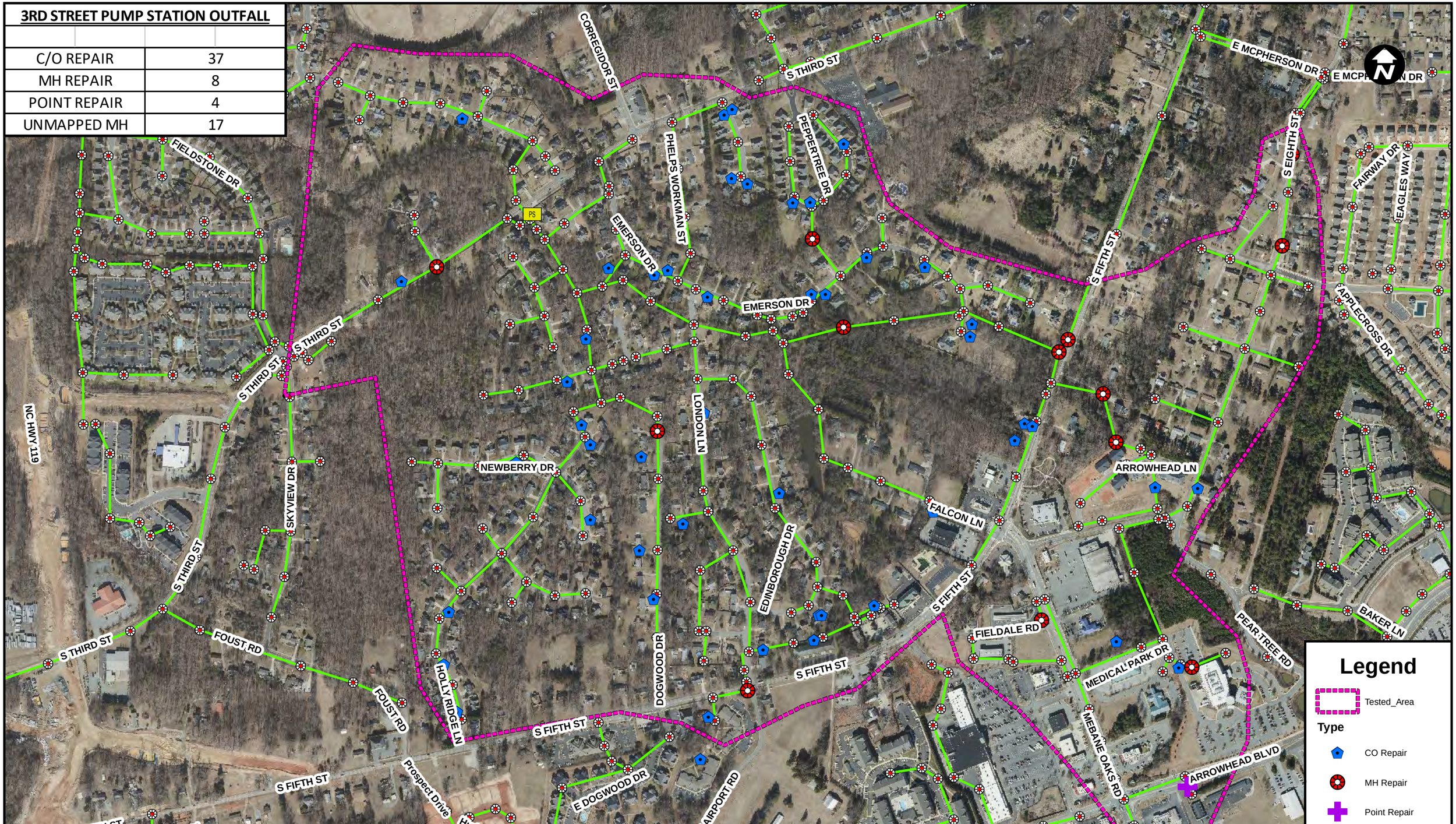
MEBANE ROGERS RD
WOODLAWN DR
BELLE CT
N NINTH ST
N OAKLAND DR
FAWNS DR
N THIRD ST
LEBANON RD
N TENTH ST
US 70 HWY
RAILROAD ST
W CENTER ST
N FIFTH ST
E CLAY ST
E CENTER ST
ASBURY BLVD
LANCASTER RD
S ELEVENTH ST
S LANE ST
W US 70 HWY
S EIGHTH ST
CORREGIDOR ST
BATAN ST
S THIRD ST
E OAKWOOD ST
MATTRESS FACTORY RD
W US 70
E WASHINGTON ST
PARK CENTER DR
BRIARWOOD DR
EMERSON DR
S FIFTH ST
CORPORATE PARK DR
LONDON LN
APPLECROSS DR
AVALON DR
W EXIT 157 ON RAMP
W EXIT 157 OFF RAMP
I 40 W ORANGE CO
I 40 E ORANGE CO
E EXIT 157 OFF RAMP
PVT DR
PVT DR
HOLLY RIDGE LN
FOUST RD
ARROWHEAD BLVD
CAMERON LN
WILSON RD
WEST TEN RD
TERRELL ST
MEBANE AIRPORT RD

CITY OF MEBANE	2019 SANITARY SEWER INFILTRATION & INFLOW STUDY	DRAWN BY: SBM CHECKED BY: JSJ DATE: 04/26/2019 DRAWING FILE: T:2018/18154/SmokeTestingOverall	1,500 750 0 1,500 Feet

Legend

Smoke Testing Area

3RD STREET PUMP STATION OUTFALL	
C/O REPAIR	37
MH REPAIR	8
POINT REPAIR	4
UNMAPPED MH	17



Legend

- Tested_Area

Type

- CO Repair
- MH Repair
- Point Repair
- Pump Station
- Mebane Manholes
- Mebane Sewer

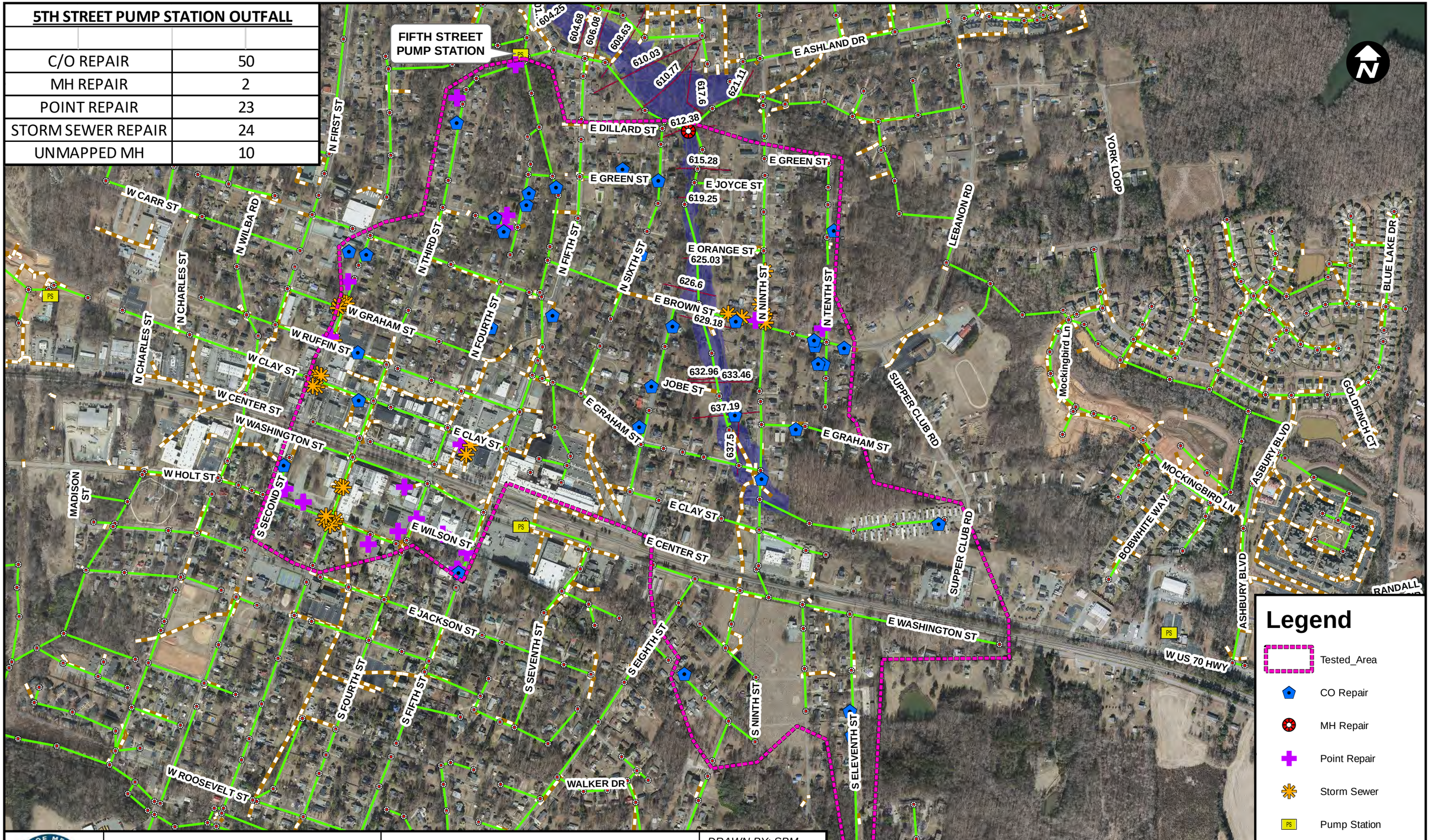
CITY OF MEBANE

CITY OF MEBANE

THIRD STREET PUMP STATION SMOKE TESTING RESULTS

DRAWN BY: SBM
CHECKED BY: JSJ
DATE: 07/05/2019
DRAWING FILE: T:2018/18154/SmokeTestingOverall

5TH STREET PUMP STATION OUTFALL	
C/O REPAIR	50
MH REPAIR	2
POINT REPAIR	23
STORM SEWER REPAIR	24
UNMAPPED MH	10



CITY OF MEBANE

FIFTH STREET PUMP STATION SMOKE TESTING RESULTS

DRAWN BY: SBM
CHECKED BY: JSJ
DATE: 07/05/2019
DRAWING FILE:
T:2018/18155/SmokeTestingOveral

APPENDIX 3
SMOKE TESTING RECOMMENDATIONS AND PROJECT ESTIMATES

INFLOW & INFILTRATIONREPAIRS/TIMING/COSTS

	Repair Type	SHORT TERM	INTERMEDIATE TERM	LONG TERM
3RD STREET PUMP STATION SEWERSHED	CLEANOUT REPAIR	CITY STAFF		
	MANHOLE REPAIR	$10,000		
	MANHOLE COVER UPGRADE & RIM ADJUSTMENT		$35,000	
	OUTFALL CIPP			$1,200,000
	MANHOLE REHABILITATION			$200,000

	Repair Type	SHORT TERM	INTERMEDIATE TERM	LONG TERM
5TH STREET PUMP STATION SEWERSHED	CLEANOUT REPAIR	CITY STAFF		
	MINOR POINT REPAIR	CITY STAFF		
	MANHOLE COVER UPGRADE & RIM ADJUSTMENT		$35,000	
	STORM SEWER CROSS-CONNECTION INVESTIGATION & REPAIR	$150,000		
	OUTFALL CIPP			$ 1,300,000.00
	MANHOLE REHABILITATION			$ 350,000.00

recommended work performed by City of Mebane Public Works

recommended work - informal bid performed by contractor

investigation performed by City of Mebane staff and AWCK staff

repair work - informal bid performed by contractor

engineering design, formal bid, construction administration

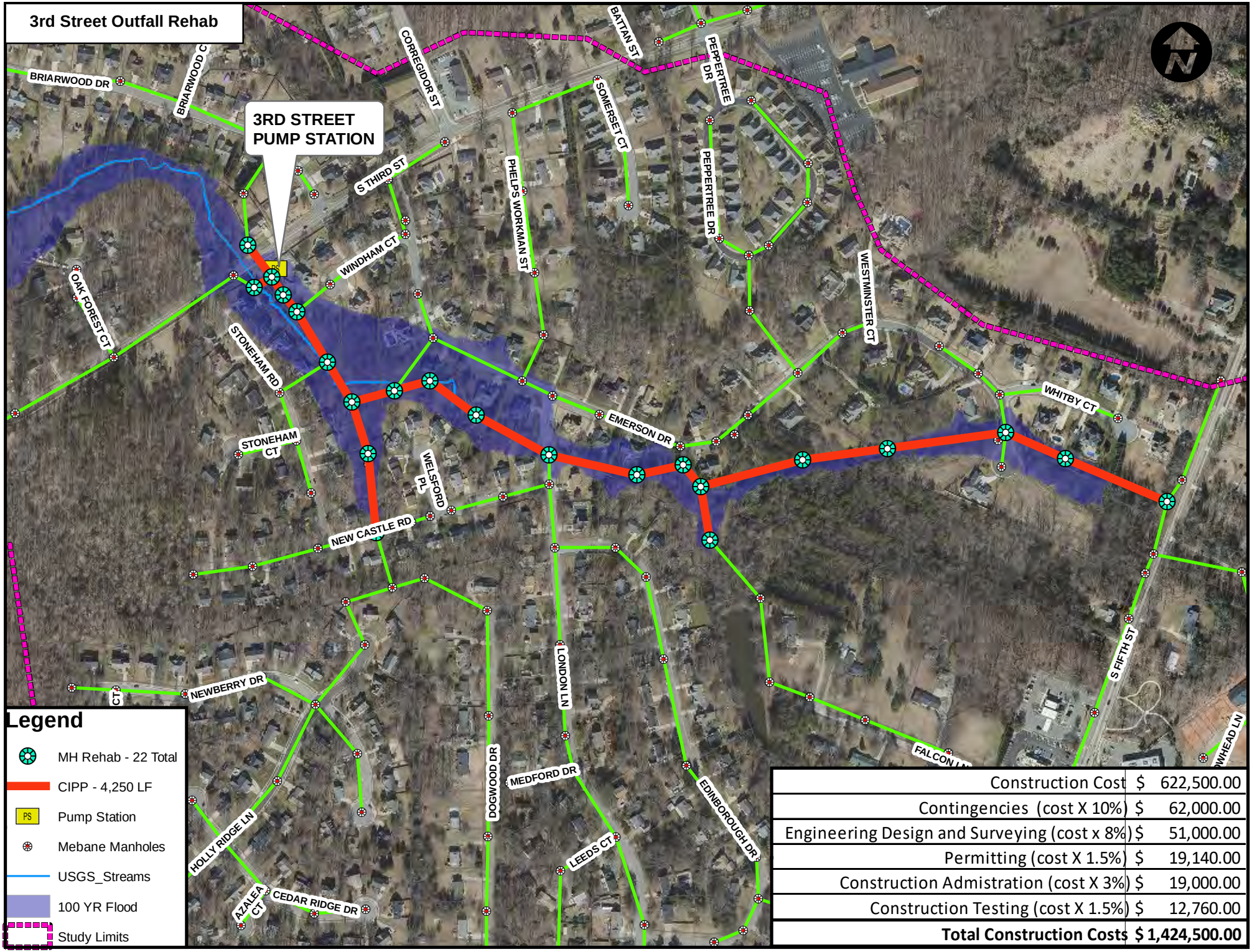
Storm Drain Investigation – Action Plan

i. This project is centered around the possible storm drain cross connections and interconnections with the 5th Street Pump Station sanitary sewer outfall. Investigation will include roof drain analysis in the field, loading various roof drains and observing their downstream connections. Additionally, video of the storm drain and sanitary sewer line will be recorded in the areas of concern and studied for any defects or irregular alignments surrounding the existing lines. The field investigation and result analysis can be done through joint efforts between the City of Mebane Public Works Department, Alley, Williams, Carmen & King, and a contractor to address the issues identified. The process for this work would be the following:

ii. <u>Roof Drain Investigation</u>
- Alongside the City of Mebane Public Works Department, potential roof drain tie-ins will be investigated.
- Public Works to gain access to roof (via boom lift or other means) and water (via City of Mebane hydrant) and allow water to drain into roof gutters.
- AWCK to monitor downstream storm drain and sanitary sewer structures (manhole or otherwise) to confirm tie-ins.

iii. <u>Cross Connections</u>
- Storm drain structures producing smoke during testing will be investigated.
- Sections of storm drain lines identified as potential cross connections will be videoed (City of Mebane to provide camera) and reviewed by AWCK for connection points or potential infiltration of sewer.
- As necessary, sections of sanitary sewer lines to be videoed for connection points or exfiltration concerns.

iv. <u>Fixing Identified Issues</u>
- It is recommended that the City contract with a local contractor to be on call to address the issues identified above. This can be done through identifying specific issues and a contract that includes a minimum daily rate so that adjustments can be made readily in the field while excavation is ongoing. This will prevent delays and interruptions to citizens and businesses in downtown.

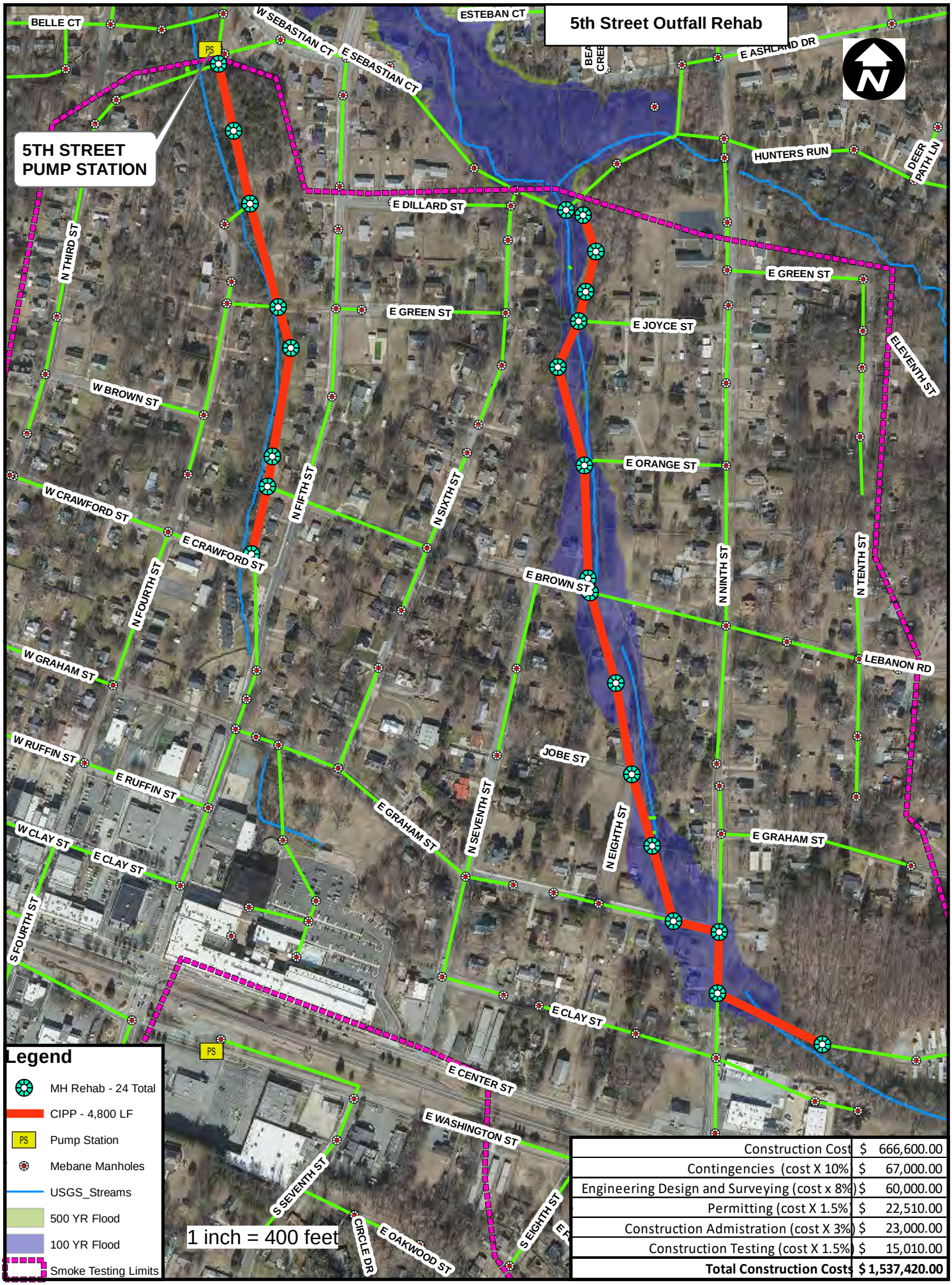


Construction Cost	$	622,500.00
Contingencies (cost X 10%)	$	62,000.00
Engineering Design and Surveying (cost x 8%)	$	51,000.00
Permitting (cost X 1.5%)	$	19,140.00
Construction Admistration (cost X 3%)	$	19,000.00
Construction Testing (cost X 1.5%)	$	12,760.00
Total Construction Costs	**$**	**1,424,500.00**

City of Mebane
Preliminary Estimate for
3rd Street Pump Station Outfall Rehabilitation
4,250 LF, 22 MH

Estimated Construction Costs

Item No.	Description	Estimated Quantity	Unit	Estimated Unit Price	*Estimated Amount*
1	8" CIPP Liner	800	LF	$ 80.00	$ 64,000.00
2	10" CIPP Liner	3,450	LF	$ 90.00	$ 310,500.00
4	Heavy Cleaning of 8"-10" Pipe	2,125	LF	$ 4.00	$ 8,500.00
5	8"-10" Point Repair	9	EA	$ 8,000.00	$ 72,000.00
6	Watertight Ring & Cover	20	EA	$ 1,500.00	$ 30,000.00
7	Vent Piping on Existing Manhole	5	EA	$ 3,000.00	$ 15,000.00
8	Manhole Rehabilitation	300	VF	$ 225.00	$ 67,500.00
9	Misc. Stone	100	TN	$ 100.00	$ 10,000.00
10	Temporary Stream Crossing	2	EA	$ 17,500.00	$ 35,000.00
11	Traffic Control	1	LS	$ 10,000.00	$ 10,000.00
12	Mobilization (cost X 2.5%)	1	LS	$ 15,600.00	$ 15,600.00
				Construction Cost	$ 622,500.00
				Contingencies (cost X 10%)	$ 62,000.00
				Engineering Design and Surveying (cost x 8%)	$ 51,000.00
				Permitting (cost X 1.5%)	$ 19,140.00
				Construction Admistration (cost X 3%)	$ 19,000.00
				Construction Testing (cost X 1.5%)	$ 12,760.00
				Total Construction Costs	***$ 1,424,500.00***



Construction Cost	$ 666,600.00
Contingencies (cost X 10%)	$ 67,000.00
Engineering Design and Surveying (cost x 8%)	$ 60,000.00
Permitting (cost X 1.5%)	$ 22,510.00
Construction Admistration (cost X 3%)	$ 23,000.00
Construction Testing (cost X 1.5%)	$ 15,010.00
Total Construction Costs	**$ 1,537,420.00**

City of Mebane
Preliminary Estimate for
5th Street Pump Station Outfall Rehabilitation
4,800 LF, 24 MH

Estimated Construction Costs

Item No.	Description	Estimated Quantity	Unit	Estimated Unit Price	*Estimated Amount*
1	8" CIPP Liner	3,100	LF	$ 80.00	$ 248,000.00
2	12" CIPP Liner	1,200	LF	$ 100.00	$ 120,000.00
3	16" CIPP Liner	500	LF	$ 120.00	$ 60,000.00
2	Heavy Cleaning of 8"-16" Pipe	2,400	LF	$ 4.00	$ 9,600.00
3	8"-16" Point Repair	10	EA	$ 6,000.00	$ 60,000.00
4	Watertight Ring & Cover	21	EA	$ 1,500.00	$ 31,500.00
5	Vent Piping on Existing Manhole	5	EA	$ 3,000.00	$ 15,000.00
6	Manhole Rehabilitation	300	VF	$ 225.00	$ 67,500.00
7	Misc. Stone	100	TN	$ 100.00	$ 10,000.00
8	Temporary Stream Crossing	2	EA	$ 17,500.00	$ 35,000.00
9	Traffic Control	1	LS	$ 10,000.00	$ 10,000.00
10	Mobilization (cost X 2.5%)	1	LS	$ 16,700.00	$ 16,700.00
				Construction Cost	$ 666,600.00
				Contingencies (cost X 10%)	$ 67,000.00
				Engineering Design and Surveying (cost x 8%)	$ 60,000.00
				Permitting (cost X 1.5%)	$ 22,510.00
				Construction Admistration (cost X 3%)	$ 23,000.00
				Construction Testing (cost X 1.5%)	$ 15,010.00
				Total Construction Costs	***$ 1,537,420.00***

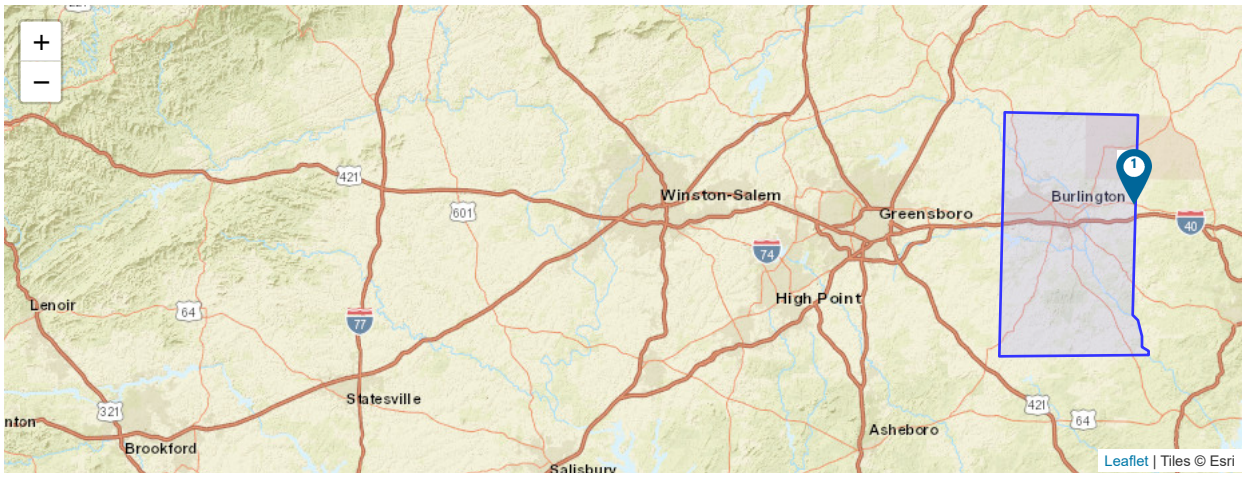
Appendix B – BCA Report

FEMA Benefit-Cost Calculator

V.6.0 (Build 20230103.1822 | Release Notes)

Benefit-Cost Analysis

Project Name: City of Mebane Sewer Rehabilitation



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Other @ Mebane, North Carolina		DFA - Infrastructure Failure	$ 5,074,258	$ 3,102,215	1.64	$ 9,460,320	$ 3,340,795	2.83
TOTAL (SELECTED)				**$ 5,074,258**	**$ 3,102,215**	**1.64**	**$ 9,460,320**	**$ 3,340,795**	**2.83**
TOTAL				**$ 5,074,258**	**$ 3,102,215**	**1.64**	**$ 9,460,320**	**$ 3,340,795**	**2.83**

Property Configuration

Property Title:	Other @ Mebane, North Carolina
Property Location:	27302, Alamance, North Carolina
Property Coordinates:	36.09579000000008, -79.26617999999996
Hazard Type:	Infrastructure Failure
Mitigation Action Type:	Other
Property Type:	Utilities
Analysis Method Type:	Historical Damages

Cost Estimation

Other @ Mebane, North Carolina

Project Useful Life (years):	50
Project Cost:	$2,826,200
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$20,000

Damage Analysis Parameters - Damage Frequency Assessment

Other @ Mebane, North Carolina

Year of Analysis was Conducted:	2022
Year Property was Built:	1920
Analysis Duration:	103 Use Default:Yes

Utilities Properties

Other @ Mebane, North Carolina

Type of Service:	Wastewater
Number of Customers Served:	7,660
Value of Unit of Service ($/person/day):	$60 Use Default:Yes
Total Value of Service Per Day ($/day):	$459,600

Historical Damages Before Mitigation

Other @ Mebane, North Carolina

		WASTEWATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL		
Damage Year	Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)	Current Dollars?	Inflated Damages ($)
2020	0.33	0.33	0	0	0	0	0	151,668	No	151,668

Comments

-

Damages Before Mitigation:

Mebane Public Works director Kyle Smith estimates that approximately 3 times per year, the wastewater system is inundated sufficiently so that the Town cannon accurately measure inflow and infiltration (I&I), meaning they could be pumping at zero percent efficiency and system overflows could be widespread. Approximate downtime for each event is approximately 8 hours.

Annualized Damages Before Mitigation

Other @ Mebane, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
0.33	151,668	459,600
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	151,668	459,600

Expected Damages After Mitigation

Other @ Mebane, North Carolina

	WASTEWATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	5	0	0	0	0	0	2,298,000

Annualized Damages After Mitigation
Other @ Mebane, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	2,298,000	91,920
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	2,298,000	91,920

Benefits-Costs Summary
Other @ Mebane, North Carolina

Total Standard Mitigation Benefits:	$5,074,258
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$5,074,258
Total Mitigation Project Cost:	$3,102,215
Benefit Cost Ratio - Standard:	1.64
Benefit Cost Ratio - Standard + Social:	1.64