WASTEWATER MASTER PLAN

CITY OF MANOR, TEXAS

FINAL REPORT

OCTOBER 2024

GBA PN 15320

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City of Manor, Texas

Wastewater Master Plan

October 2024

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Acronyms and Abbreviations

ADDF	Average Daily Dry-Weather Flow
CCI	Construction Cost Index
CCN	Certificate of Convenience and Necessity
CCTV	Closed-Circuit Television
CIF	Community Impact Fee
CIP	Capital Improvement Plan
CIPP	Cured-in-Place Pipe
CIWEM	Chartered Institution of Water and Environmental Management
CNO	Could Not Open
CNL	Could Not Locate
ENR	Engineering News-Record
EPA	United States Environmental Protection Agency
ETJ	Extraterritorial Jurisdiction
FM	Farm-To-Market Road, Flow Meter, or Force Main (depending on context)
fps	Feet Per Second
I/I	Inflow and Infiltration
GIS	Geographic Information System
LF	Linear Feet
LS	Lift Station
LUE	Living Unit Equivalent
MG	Million Gallons
MGD	Million Gallons Per Day
MUD	Municipal Utility District
O&M	Operations & Maintenance
OPCC	Opinion of Probable Construction Cost
PCSWMM	Modeling Software running EPA's Storm Water Management Model (SWMM)
PDWF	Peak Dry Weather Flow
PVC	Polyvinyl Chloride
PWWF	Peak Wet Weather Flow
RDII	Rainfall Dependent Inflow and Infiltration
ROW	Right-of-Way
SRTC	Sensitivity-Based Radio Tuning Calibration
TCEQ	Texas Commission on Environmental Quality
UCM	Austin Utilities Criteria Manual
WWTP	Wastewater Treatment Plant

0 EXECUTIVE SUMMARY

The City of Manor (City) retained GBA to prepare a Wastewater Master Plan for the next 15-year period. The purpose of this plan is to guide the City towards a wastewater system that supports and serves the City's evolving needs and continued growth. Goals completed as part of this plan include the following:

- Collected manhole data in the field for sewers 12 inches or greater to develop the hydraulic model network and collect asset information.
- Developed growth areas and projected wastewater flows using the City-provided annual population growth rate of 7%.
- Established planning-level design criteria for existing and future infrastructure.
- Developed and calibrated a hydraulic model of the existing collection system in PCSWMM calibrated to 2022 flow monitoring data.
- Conducted model simulations for existing conditions, 5-year growth conditions, and 15-year growth conditions to identify necessary improvements to meet established design criteria.
- Conceptualized sewer extensions to accommodate growth in the future service areas and developed estimated costs.
- Developed a list of projects to address existing and future wastewater infrastructure needs, along with estimated costs, for present day, 5-year, and 15-year growth conditions.

A 5-year, 6-hour design storm event was utilized in the calibrated, hydraulic model to estimate peak wet weather flows in the existing wastewater collection system. This design storm method was selected based on established practices in modeling by the City of Austin and other nearby municipalities, and to provide a balance of conservatism and practicality when estimating inflow and infiltration (I/I) in the existing system. Design criteria from the Austin Utility Criteria Manual (UCM) was used to estimate design flows for extension projects that would extend City sewer service beyond current service limits.

The hydraulic model developed for this plan was calibrated to Fall 2022 flow monitoring data, which demonstrated excessive levels of inflow and infiltration (I/I) in the City's existing sewer system. To address condition and capacity concerns in the existing sewers, the City is currently engaged in I/I mitigation efforts. It is important to note that these I/I mitigation efforts have the potential to reduce peak wet weather flows in the existing system, but I/I mitigation should not be solely relied upon for solving capacity issues. If peak wet weather flows are reduced, then relief or upsizing projects may be delayed or avoided. However, the degree of I/I reduction that can be achieved is not certain. To determine if a relief project can be delayed or avoided, targeted post-rehabilitation flow monitoring will be required to confirm actual flow conditions after I/I reduction projects have been implemented.

If the city can mitigate inflow and infiltration (I/I), it may alleviate capacity concerns within the current system. However, the model simulations identified three project areas that are not currently sized to adequately convey peak flows during 5-year, 6-hour design storm conditions. These three projects are the Llano Street and Lampasas Street Interceptor, Pyrite Road Interceptor, and US-290 Interceptor. There are additional areas within the existing sewer system that will need relief or upsizing by the 15-year time horizon, including both existing Cottonwood Creek interceptors.

Regarding treatment facilities, the establishment of the East Travis Regional Wastewater Treatment Plant (WWTP) by the 15-year time horizon is imperative to serve the growth anticipated in East Manor. In addition, the Cottonwood Creek WWTP will need to be expanded to Phase 3 (0.6 MGD) by the 5-year time horizon, with its future operation dependent upon the phasing and capacity needs at the East Travis Regional WWTP. Similarly, the Wilbarger WWTP will require expansion to a minimum of 2.0 MGD by the 5-year time horizon.

Once the East Travis Regional WWTP is built, it is recommended to decommission existing lift stations 6 (Stonewater), 8 (Presidential Glen Ph. 4B), and 9 (Presidential Heights), rerouting these lift stations' flows via gravity sewer to the proposed regional plant. Decommissioning these lift stations would reduce capacity risks along the existing FM973 and US-290 interceptors, eliminate operations and maintenance (O&M) costs for these lift stations, and reduce capacity needs at Wilbarger WWTP. This could assist in delaying expansion of Wilbarger WWTP beyond 2.0 MGD. Eliminating these lift stations would also improve wastewater quality and reduce risk of H_2S production by eliminating hydraulic detention time in lift station wet wells and force mains.

Manor is growing rapidly and is expected to continue growing over the next 15 years. A majority of this growth is expected to occur in the eastern portions of the City and Travis County. Manor's wastewater system is currently comprised of approximately 335,000 feet of gravity sewer main, 1,370 manholes, 38,000 feet of force main, 13 lift stations, and 2 wastewater treatment plants. To provide wastewater service in the growing eastern region, a network of additional extension interceptors, lift stations, and force main will be required to collect and convey flows to the treatment plants. These extension projects have been conceptualized and summarized for this report.

A summary of recommended projects at each time horizon is presented in Table 0-1. A complete list of identified projects is presented in Table 0-2 and a map of all projects is presented in Figure 0-1. For a more detailed summary of identified projects, please refer to Section 7.

Table 0-1: Summary of Recommended Projects

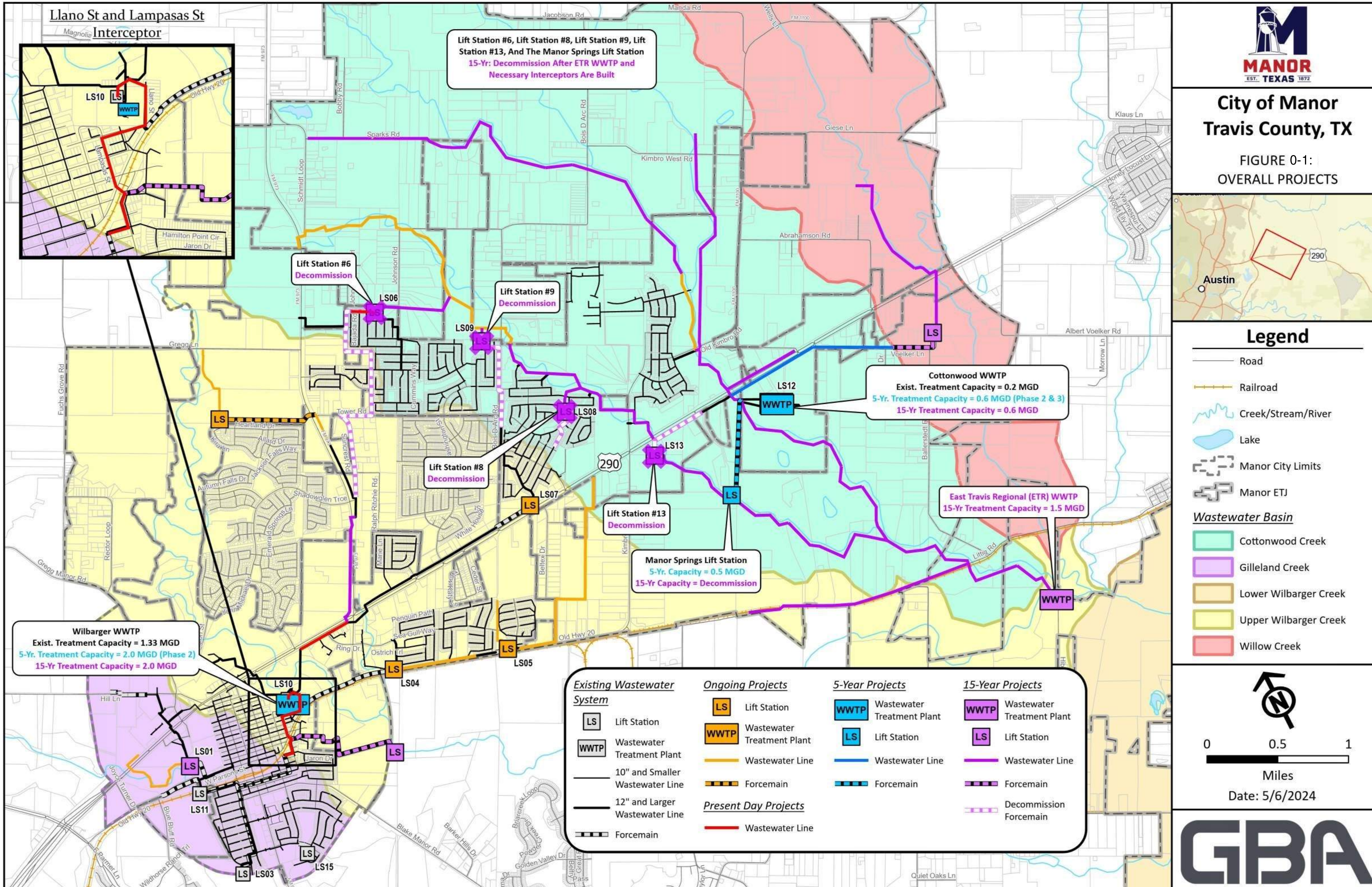
Projects / Time Horizon	Gravity Sewer: I/I Mitigation	Gravity Sewer: Relief and Upsizing	Gravity Sewer: Extensions for Growth	Lift Stations & Force Main: Lift Stations, Force Main	Lift Stations & Force Main: Decommission Lift Stations	Treatment Capacity	Capital Costs ($M)
Present Day	Continue	3 Projects, 7,000 LF	-	-	-	-	$9M Relief/Upsizing, $11M I/I Mitigation (spread out over 15 yrs)
5-year	Continue	-	1 Project, 6,600 LF	1 New LS, 3,800 LF FM	-	Expand Cottonwood & Wilbarger	$10M Extensions (Gravity, LS, FM) $31M Treatment
15-year	Continue	4 Projects, 16,000 LF	16 Projects, 83,600 LF	2 New LS, 7,100 LF FM	Decommission up to 5 LS	Regional WWTP (1.5 MGD)	$23M Relief/Upsizing $147M Extensions (Gravity, LS, FM) $58M Treatment
Total	*>40,000 LF Pipe Rehabilitated*	*7 Projects, 23,000 LF*	*17 Projects, 90,200 LF*	*3 New LS, 10,900 LF FM*	*Decommission up to 5 LS*	*Expand 2 WWTPs, Build Regional Plant*	***$289M Over 15 Years***

Manor, TX Wastewater Master Plan
Table 0-2: Overall Project List

Project ID	Infrastructure Type	Time Horizon	Current CIP Project ID	Project Name	Type of Improvement	Pipe Diameter (in)[1]	Total Length of Pipe (ft)	Lift Station or WWTP Flow Rate (mgd)	Planning-Level Construction OPCC without Contingency	Capital Cost (30% Contingency, 20% Engr./Survey,)[3]
WW.00.01	Existing/Relief	Present Day	-	Llano St and Lampasas St Interceptors[2]	Exist. Gravity Relief/Upsizing	18"-36"	4,060	-	$3,405,040	$5,652,000
WW.00.02	Existing/Relief	Present Day	-	Pyrite Rd Gravity Sewer (upstream of LS06) - *I/I Mitigation Potential*	Exist. Gravity Relief/Upsizing	18"	930	-	$584,010	$911,000
WW.00.03	Existing/Relief	Present Day	CIP-4	US 290 Interceptor (Still Necessary even if LS06/08/09 are Decommissioned)	Exist. Gravity Relief/Upsizing	24"	2,030	-	$1,596,488	$2,491,000
WW.00.04	Existing/Relief	Present Day	-	Rehabilitation and I/I Mitigation in Existing Sewers	Rehabilitation	-	40,440	-	$7,279,200	$11,356,000
WW.05.01	Treatment	5-Year	S-31	Cottonwood WWTP Expansion Ph. 3 (Expansion from 0.4 to 0.6 MGD)	Exist. WWTP Expansion	-	-	0.2	$3,260,000	$5,086,000
WW.05.02	Treatment	5-Year	-	Wilbarger WWTP Expansion (Expansion from 1.33 to 2.0 MGD)	Exist. WWTP Expansion	-	-	0.67	$16,750,000	$26,130,000
WW.05.03	New/Extension	5-Year	S-36	Manor Springs Lift Station Improvements	New LS to Serve Growth	6"(F)	3,760(F)	0.5	$1,606,289	$2,506,000
WW.05.04	New/Extension	5-Year	S-23	Voelker Ln. Wastewater Improvements	New Gravity to Serve Growth	12"	6,560	-	$4,595,771	$7,169,000
WW.15.01	Treatment	15-Year	S-39/40/41	East Travis Regional WWTP	New WWTP to Serve Growth	-	-	1.5	$37,403,000	$58,349,000
WW.15.02	Existing/Relief	15-Year	Dev. Agr.	Lift Station 1 (Las Entradas) and O09-006_O09-005	Exist. LS Expansion	18"	260	-	$164,430	$257,000
WW.15.03	Existing/Relief	15-Year	S-18	West Cottonwood Creek Existing Interceptor	Exist. Gravity Relief/Upsizing	24"-27"	8,500	-	$8,236,967	$12,850,000
WW.15.04	Existing/Relief	15-Year	S-16	East Cottonwood Creek Existing Interceptor	Exist. Gravity Relief/Upsizing	27"-33"	3,070	-	$3,392,810	$5,293,000
WW.15.05	Existing/Relief	15-Year	-	FM973 Interceptor (Not Necessary if LS06 is Decommissioned)	Exist. Gravity Relief/Upsizing	18"	4,220	-	$2,658,600	$4,147,000
WW.15.06	New/Extension	15-Year	S-38	South Cottonwood Creek Wastewater Interceptor Improvements Phase 1[2]	New Gravity to Serve Growth	39"-45"	7,960	-	$15,366,210	$25,508,000
WW.15.07	New/Extension	15-Year	S-38	South Cottonwood Creek Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	36"	8,910	-	$13,811,117	$21,545,000
WW.15.08	New/Extension	15-Year	S-23	Willow Creek Wastewater and Lift Station Improvements	New Gravity/LS to Serve Growth	24"(G), 6"(F)	2,160(G/F)	0.65	$1,642,456	$2,562,000
WW.15.09	New/Extension	15-Year	-	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	24"	5,210	-	$5,424,105	$8,462,000
WW.15.10	New/Extension	15-Year	-	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	15"-21"	7,710	-	$6,455,271	$10,070,000
WW.15.11	New/Extension	15-Year	-	East US290 Wastewater Improvements	New Gravity to Serve Growth	15"	2,920	-	$2,219,654	$3,463,000
WW.15.12	New/Extension	15-Year	-	North Cottonwood Creek East Tributary Wastewater Interceptor Improvements	New Gravity to Serve Growth	15"-18"	8,480	-	$6,720,382	$10,484,000
WW.15.13	New/Extension	15-Year	-	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	27"	7,390	-	$8,791,977	$13,715,000
WW.15.14	New/Extension	15-Year	-	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	27"	3,590	-	$4,424,675	$6,902,000
WW.15.15	New/Extension	15-Year	-	Littig Rd. Wastewater Improvements[2]	New Gravity to Serve Growth	12"	8,510	-	$5,961,816	$9,897,000
WW.15.16	New/Extension	15-Year	-	North Cottonwood Creek Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	21"-24"	7,238	-	$7,379,755	$11,512,000
WW.15.17	New/Extension	15-Year	-	North Cottonwood Creek Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	12"-18"	10,367	-	$8,035,168	$12,535,000
WW.15.18	New/Extension	15-Year	-	South Wilbarger Creek Lift Station Improvements	New LS to Serve Growth	4"(F)	5,040(F)	0.25	$1,287,296	$2,008,000
WW.15.19	New/Extension	15-Year	-	Lift Station #6 (Stonewater) Decommissioning	New Gravity to Abandon LS	18"	3,300	-	$3,134,355	$4,890,000
WW.15.20	New/Extension	15-Year	-	Lift Station #8 (Presidential Glen Ph. 4B) Decommissioning	New Gravity to Abandon LS	12"	1,400	-	$1,281,253	$1,999,000
WW.15.21	New/Extension	15-Year	-	Lift Station #9 (Presidential Heights) Decommissioning	New Gravity to Abandon LS	12"	500	-	$650,448	$1,015,000

Time Horizon	Capital Cost
Present Day	$ 20,410,000
5-Year	$ 40,891,000
15-Year	$ 227,463,000
Total, All Projects	**$ 288,764,000**

Notes:
1) For pipe diameters and lengths, gravity main is assumed, except where (F) indicates force main, and (G) indicates gravity main.
2) Select projects include an additional 10% contingency for railroad crossings to account for additional costs (permitting, extra boring length, etc.).
3) For new/extension projects not within the ROW or an exisitng easement, a unit cost of $87,900/acre was utilized for easement cost estimates.
The easement unit cost includes survey, easement acquisition, engineering fees, condemnation/attorney fees, and ROW agent fees.
LS06, LS08, and LS09 are recommended to be decommissioned and re-routed by gravity towards East Travis Regional WWTP once it is built. This reduces burden on Wilbarger WWTP and the FM973 interceptor, and reduces LS O&M costs.
Projects Not Included: The above list does not include Bell Farms LS upgrades (LS04), Carriage Hills LS or interceptor upgrades, Cottonwood Cr. WWTP Ph. 2 expansion to 0.4 MGD (developer-funded), or other projects currently in-progress.



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1 INTRODUCTION

1.1 Purpose

The purpose of this report is to update the City of Manor's wastewater master plan, providing a guide towards a wastewater system that beneficially supports and serves the City's evolving needs and continued growth. The existing master plan was developed in 2008 and was intended to forecast wastewater collection and treatment system needs for the city within a 10-year planning period. Growth within the city over the intervening period has occurred at a much more rapid rate than previously anticipated, prompting the need to update the plan and re-project flows for a 15-year period.

This master plan evaluates the projected wastewater demands for the next 15 years and introduces alternative strategies and timelines for addressing the potential need for system capacity improvements. In addition, this report provides planning-level estimates of the probable costs for the proposed alternatives. A flow monitoring and inflow and infiltration (I/I) study was performed under a separate project which culminated in a report titled *2023 Inflow & Infiltration Investigations Project – Preliminary Engineering Report*. The flow monitoring data was collected in the Fall of 2022 for that study and was used to model and evaluate the existing system's capacities.

1.2 Scope

The scope of this wastewater master planning project encompassed field data collection, hydraulic modeling of the collection system, growth projections, and proposed infrastructure improvements to meet current and future demands. This Master Plan study and its recommendations are focused on sanitary sewer interceptors with a diameter of 12 inches or greater. The adequacy of existing sewer lines with diameters less than 12 inches will depend on the specifics of new developments that connect to them and may require analysis on a case-by-case basis. Regarding wastewater treatment, this study is focused only on treatment capacity needs and does not cover specific treatment processes or technologies.

The study began with a survey of manholes connected to sewer mains with diameters of 12 inches and greater. The manhole survey data was assembled in GIS and then used to develop a hydraulic model of the collection system using the PCSWMM software. The hydraulic model was used to evaluate both the current capacity of the existing infrastructure as well as options for system improvements. Models of the existing system and future systems for the 5 and 15-year time horizons were developed. These models were evaluated to determine infrastructure needs required to serve current and future flows. Finally, a list of proposed improvements, including anticipated timing and cost, was created based on the analysis.

A summary of major tasks completed for this report is provided below:

- Collected physical data in the field for sewers 12 inches or greater to develop the hydraulic model network and collect asset information.
- Developed a hydraulic model of the existing collection system in PCSWMM and calibrated the model to align with actual flow data gathered during the Fall 2022 flow monitoring season.

- Developed flow projections for five-year and fifteen-year time horizons based on City-provided population and land use projections.
- Performed model simulations of the existing conditions, five-year growth conditions, and fifteen-year growth conditions to identify needed sewer system improvements.
- Selected design criteria consistent with current, local design requirements to be used for planning-level sizing and costing of improvements.
- Developed conceptual projects to serve new growth outside of the existing system with extension sewers, lift stations, and force main.
- Developed a comprehensive report detailing the work completed, analyses, and recommended improvements for the City's sanitary sewer system.

2 PLANNING INFORMATION, DATA COLLECTION AND ASSUMPTIONS

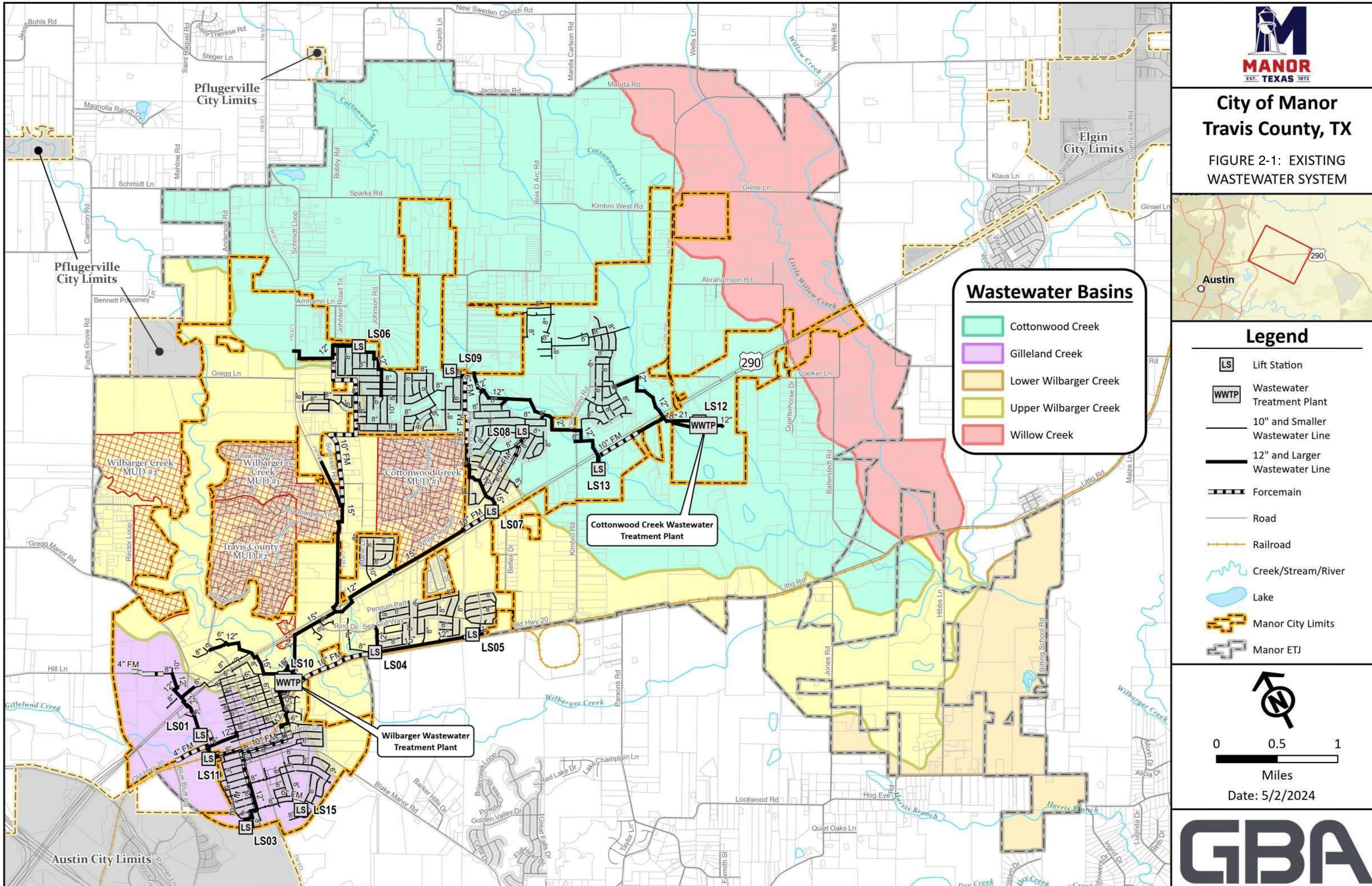
2.1 Wastewater Service Area

The City of Manor is in the eastern part of Travis County, Texas, along U.S. Highway 290. The City of Manor's existing wastewater service area is limited to its current Certificate of Convenience and Necessity (CCN) boundaries, which generally includes areas within City limits, approximately 10 square miles, and portions of its Extra-Territorial Jurisdiction (ETJ), encompassing approximately 20 square miles. Manor's wastewater system is currently comprised of approximately 335,000 feet of gravity sewer main, 1,370 manholes, 38,000 feet of force main, 13 lift stations, and 2 wastewater treatment plants. Figure 2-1 provides a map of Manor's existing wastewater system.

The extent of this report's study area generally follows Manor's extra-territorial jurisdiction (ETJ), as shown in Figure 2-1. The approximately 30 square mile study area includes portions of the Gilleland Creek Basin, Upper Wilbarger Creek Basin, Cottonwood Creek Basin, and Willow Creek Basin. The existing wastewater service area is served by the City's Wilbarger Wastewater Treatment Plant (WWTP) and the City's Cottonwood Creek WWTP. The Wilbarger WWTP serves portions of the Gilleland Creek Basin, Upper Wilbarger Creek Basin, and Cottonwood Creek Basin (namely Lift Stations 6, 8, and 9), while the Cottonwood Creek WWTP serves only the Cottonwood Creek Basin currently.

Most of the wastewater generated in the service area is currently treated at the Wilbarger WWTP, located on Llano Street off of Old Highway 20 on the southwestern side of the City. In 2020, the Wilbarger WWTP was expanded from 0.5 MGD to 1.33 MGD, which included a new onsite lift station (LS10), a new public works building, and provisions for future expansion up to 2.0 MGD. The Wilbarger WWTP is critical to maintaining wastewater service in the western portion of the City, particularly as rapid growth occurs in and around Manor.

The Cottonwood Creek Basin (approximately north and east of Paseo De Presidente Boulevard and Tower Road) is primarily served by the Cottonwood Creek WWTP, which is currently permitted for an average annual discharge of 0.2 MGD. The existing permit allows for permitted capacities of 0.2, 0.4, and 0.5 MGD, but amended phasing of 0.2, 0.4, 0.6 and 0.8 MGD capacities have been applied for at the Texas Commission on Environmental Quality (TCEQ), and a draft permit has been issued. Presently, Phase 2 expansion of the Cottonwood Creek WWTP is fully designed and set to begin upon confirmation that flows have reached a level appropriate to trigger the expansion. Phase 2 expansion will increase the Cottonwood Creek WWTP's capacity to 0.4 MGD. Other phases of expansion are planned for Cottonwood Creek WWTP (0.6 MGD at Phase 3, 0.8 MGD at Phase 4), and the timing and necessity of these phases is explored in Section 6 of this report.



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2.2 Municipal Utility Districts

A Municipal Utility District (MUD) is a special district that functions as an independent, limited government. MUDs provide developers an alternate way to finance infrastructure, such as water, sewer, drainage, and road facilities. There are MUDs directly adjacent to or encapsulated by Manor's city limits that have residents that are excluded from Manor's population numbers and wastewater service. The MUDs that comprise the ShadowGlen (Wilbarger Creek MUD #1 and #2 and Travis County MUD #2) and Presidential Meadows (Cottonwood Creek MUD #1) developments have an estimated combined total of nearly 4,000 single and multi-family units and a population of over 13,000. The Metro H2O WWTP is owned and operated by the MUDs and serves the MUDs wastewater treatment needs. These MUDs have been able to send flow to Manor's wastewater system only during agreed upon emergency circumstances through a system interconnect.

Prior to and during the Fall 2022 flow monitoring period (August to December 2022), the Wilbarger WWTP received flow from the ShadowGlen and Presidential Meadows MUDs because the WWTP that would typically treat MUD flows was failing and a new plant was under construction. These MUDs are now served by the new Metro H2O WWTP. The route by which the Presidential Meadows MUD contributes flow to Manor's wastewater system has not been confirmed, though the City believes the flow from this MUD was received during the flow monitoring period via a MUD system backup from the Metro H2O plant to the interconnect. Because these MUDs contributed flow to Manor's system during the flow monitoring period, the flows from the MUDs needed to be accounted for during model calibration. The model was calibrated using flow monitoring data, so the MUD contribution needed to be included in the model during calibration but removed during future growth modeling.

2.3 Future Land Use Assumptions

Future land use assumptions were used to develop projections of future wastewater flow contributions in the collection system model. The future land use assumptions were provided by the City in the "Future Land Use Map" of the City's *Destination 2050 Comprehensive Plan* report. A copy of this map is provided in Figure 2-2. This map provides approximate locations of various land use types across the City of Manor. These land uses provide information on the types, potential densities, and locations of future development. The City also provided information regarding the planned and in-progress developments in the form of a map, a copy of which is provided in Figure 2-3. This map was used to estimate which parcels were most likely to develop within the 5-year time horizon.

Future land use assumptions are important factors for projecting future wastewater flows and identifying the required infrastructure to serve planned growth. Future land use assumptions do not represent zoning regulations or requirements, and actual future land use may vary from these assumptions. Rather, these land use assumptions are a best approximation of the types of developments and densities the City may support in the future.

Table 2-1 provides the development density assumptions in terms of Living Unit Equivalent (LUE) per acre for each land use type assigned by the Comprehensive Plan. An LUE is a planning tool that estimates the typical flow of water or wastewater used/produced by a single-family residence.

These density estimates were developed as part of the City's latest Community Impact Fee (CIF) study. For the purposes of this study, one (1) LUE was assumed to represent 3 persons (or population equivalents) and produce 200 gallons per day (gpd) of wastewater. The 200 gpd/LUE wastewater production rate is an average rate developed based on flow monitoring.

Table 2-1: Density Assumptions for Future Land Use Types

Land Use Category	Category Abbreviation	Density Assumption (LUE/acre)
Commercial (Corridor)	C	2
Community Mixed Use	CMU	5
Downtown Mixed Use	DMU	4
Employment	E	1
High Density Single Family	SF-4	5
Mixed Density Neighborhood	MDNB	4
Multi-Family	MF	10
Neighborhood	NB	4
Neighborhood Mixed Use	NMU	5
Parks/Open Space	OS	0
Public/Semi-Public	P/SP	1

By applying both the LUE/acre density from Table 2-1 and the 200 gpd/LUE flow estimate to a given land area (in acres), an approximate wastewater production can be estimated for all land uses shown on the future land use map. The estimated wastewater production was then used in the hydraulic model of the collection system. Please refer to Section 4.2 for further discussion of the flow projections and distributions of flow.

Figure 2-2: Future Land Use Map from City's Comprehensive Plan

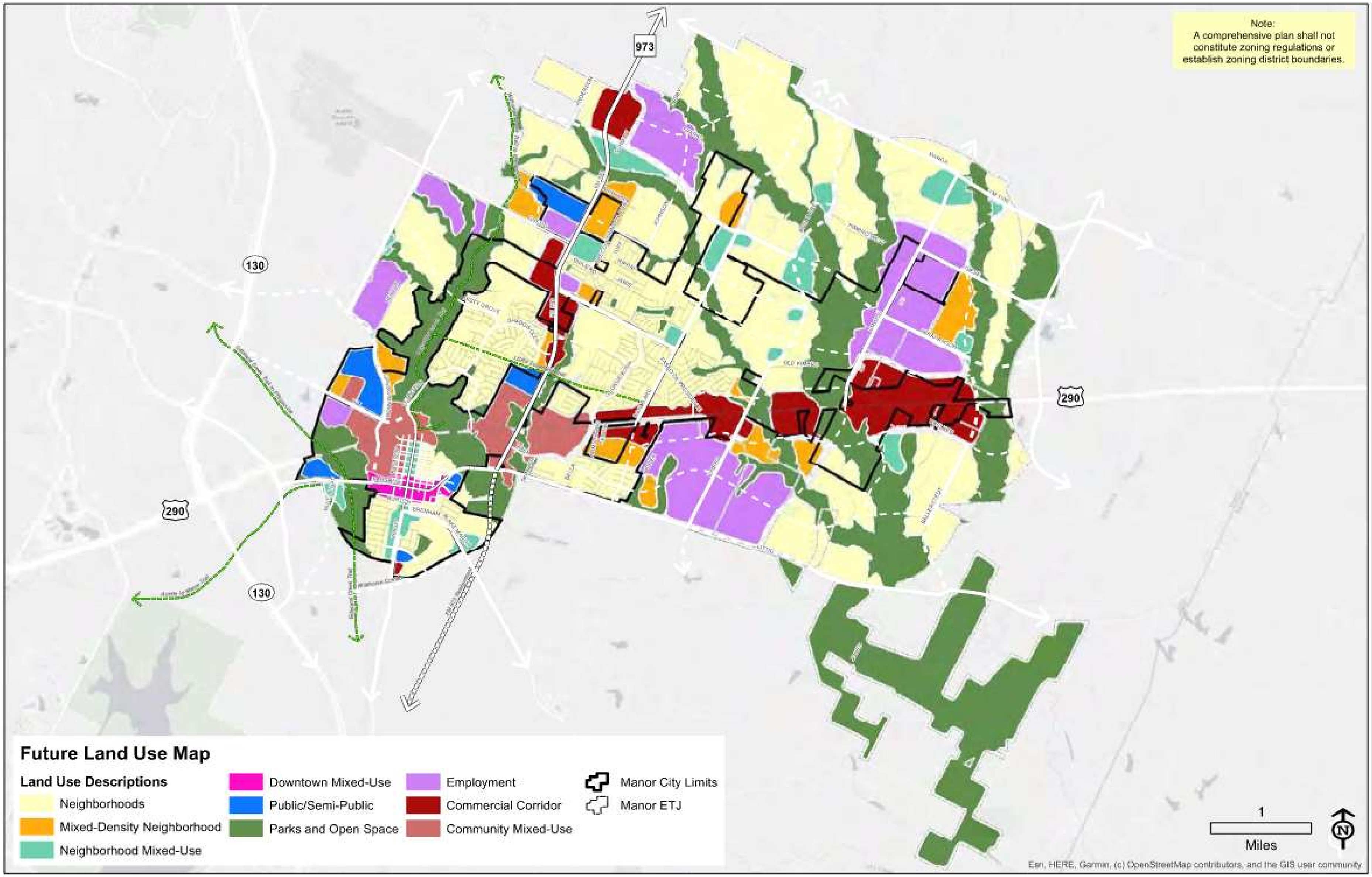
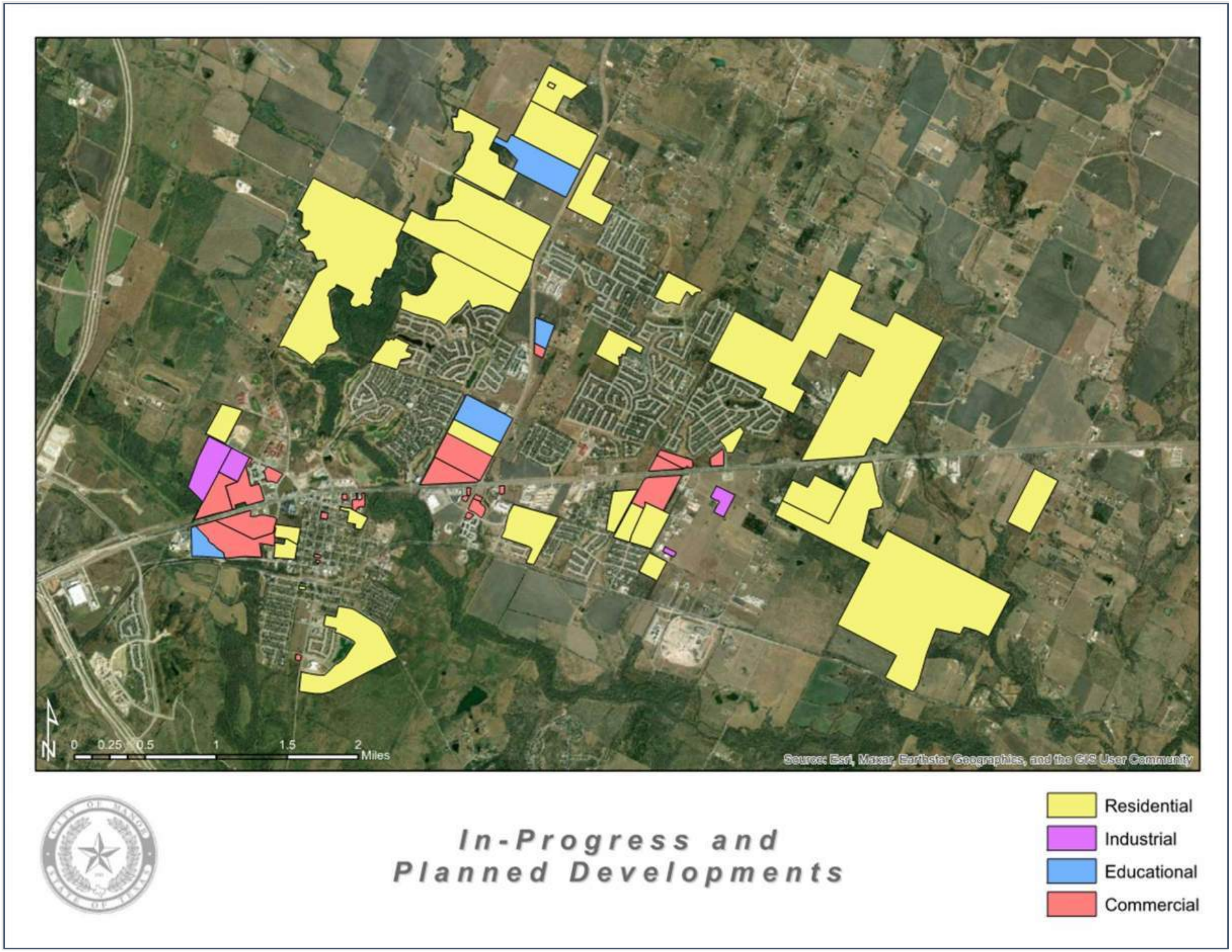


Figure 2-3: In-Progress and Planned Development Map (Spring 2023)



2.4 Population Projections

The population projections utilized for this report were determined by the City and held at a constant 7% annual growth rate for population and LUEs throughout the 15-year time horizon. The chosen growth rate is also being used as part of other ongoing planning studies (e.g., the most recent Rate Study and Water Master Plan) for the City to ensure consistency and alignment across the studies. The present number of LUEs within City limits was estimated at 6,845 based on a count of developed parcels. The population projections below are representative of population within City limits. It was assumed for this report that as the City provides wastewater service to more area, that area will be annexed into City limits over time.

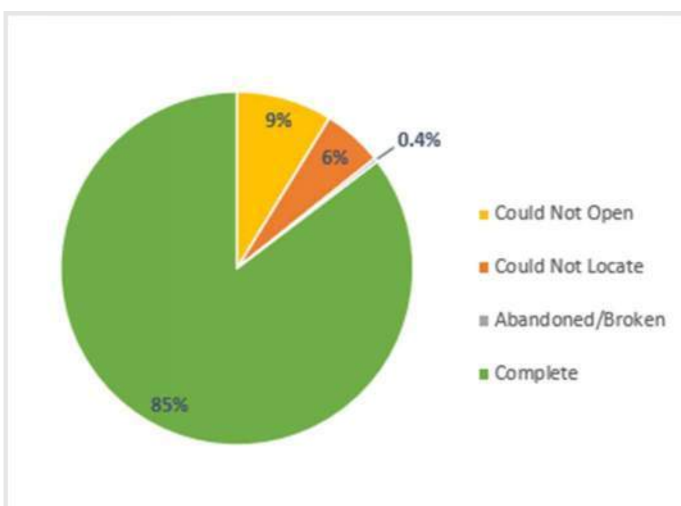
Table 2-2: Population and LUE Projections Assuming 7% Annual Growth Rate

Planning Time Horizon	Year	Present and Projected Populations[1]	Projected No. of LUEs[2]
Present	2023	20,535	6,845
5-year	2028	28,800	9,600
15-year	2038	56,700	18,900
1) Projected populations rounded to nearest 100 persons 2) Assumed 3 persons per LUE			

2.5 Manhole Survey

GBA field staff attempted survey and inspection of 273 City-owned manholes to create a hydraulic model of the existing wastewater collection system. Among these 273 manholes with attempted inspections, 233 were completed successfully, 24 were unable to be opened (i.e., Could Not Open or "CNO"), 15 manholes could not be located (i.e., Could Not Locate or "CNL"), and 1 manhole was abandoned. Figure 2-4 shows a pie chart and relative percentages of each inspection result. Manhole survey summary maps are provided in Appendix A.

Figure 2-4: Manhole Survey and Inspection Summary



The data collected during manhole inspections include X and Y coordinates, rim elevations, depths, and manhole cover sizes, as well as rim-to-invert depths and diameters of incoming and outgoing pipes. Manholes that were located but not able to be opened were considered partially inspected, as location and rim elevation data could still be collected. After GBA's initial attempt to locate and open each manhole, a list of CNO and CNL manholes was provided to City operations staff. City staff were able to open 23 manholes that were originally CNO and locate 6 manholes that were originally CNL, providing manhole depth measurements for use in the model.

2.6 Planning-Level Design Criteria

To model, size, and plan for new wastewater infrastructure, planning-level design criteria were established for this study. It is important to note that all sizing of improvements for this study are conceptual only; actual designs may vary from the conceptual designs presented in this report. Table 2-3 provides a summary of the criteria used to guide this study. This table is broken into three sections:

(1) Existing Infrastructure Flow Calculations (Modeled System),
(2) Future Infrastructure Flow Calculations (Extensions to Serve Growth Areas), and
(3) Conceptual Sizing of New Infrastructure (Relief, Replacement or Extensions).

2.6.1 Definitions

Below is a list of basic definitions used to describe planning and design criteria:

- **ADDF**: Average Daily Dry Weather Flow is the normal wastewater flow generated in the sanitary sewer system during dry weather conditions. This flow includes wastewater production and permanent infiltration naturally present during dry conditions. This flow does not include rainfall-induced infiltration and inflow.
- **PDWF**: Peak Dry Weather Flow is the instantaneous peak flow generated in the sanitary sewer system over the course of a 24-hour period, during dry weather conditions. This peak is a natural outcome of increased wastewater production at times of peak usage throughout the day. In primarily residential areas, there is typically a peak in the morning and/or a peak in the evening.
- **PWWF**: Peak Wet Weather Flow is the instantaneous peak flow generated in the sanitary sewer system during wet weather conditions. This peak is an outcome of increased inflow and infiltration entering the sewer system during or directly after a rainfall event.
- **I/I**: Inflow and Infiltration is rainfall-induced flow entering the sanitary sewer system. Infiltration generally enters sewers through underground defects such as defective pipes, pipe joints, and manholes. Inflow generally enters from above-ground sources, such as private sewer laterals, downspouts, foundation drains, yard and area drains, storm sump pumps, manhole covers, and cross connections from storm drains.
- **Surcharge**: Surcharge is generally defined as the situation in which the entrance and exit of a gravity sewer pipe are submerged by flow, and the pipe is flowing full and under pressure. Surcharge conditions are generally not ideal, and either indicate an immediate pipe capacity restriction or a downstream bottleneck.
- **Critical Surcharge**: Surcharge levels that are at higher risk of causing a sanitary sewer overflow (SSO).

2.6.2 Flow Calculations

The PCSWMM design storm model of the existing system was primarily used to identify necessary capacity improvements for the City's *existing sewers*, at the present, 5-year, and 15-year time horizons. For sewer extensions, the Austin Utilities Criteria Manual (UCM) guidance and GIS analysis were primarily used to conceptually size the *future sewer extensions* needed to serve growth areas outside of City limits, at the 5-year and 15-year time horizons. Therefore, flow calculations for the existing infrastructure (interceptors and lift stations) modeled in PCSWMM differed from flow calculations for future infrastructure (sewer extensions), which were not modeled in PCSWMM.

Flows from future growth were still plugged into the PCSWMM model of the existing system for future growth scenario modeling in order to demonstrate impacts of growth on the existing sewers. To represent peak wet weather flows from future growth in the PCSWMM model, the synthetic unit hydrograph based on data from flow meter Basin 2C of the 2022 flow monitoring period was assigned to future growth model nodes. Basin 2C was chosen as a representative basin for new growth areas because the sewers in this basin were primarily built within the last 10-20 years, and it demonstrated an average level of I/I for Manor's collection system. (Please see Figure 3-1 for a map of Fall 2022 flow monitoring basins.)

2.6.3 Design Storm

The 5-year, 6-hour design storm was chosen because there is precedence for its use in modeling by the City of Austin and other cities in the Central Texas area. It also represents a moderately conservative storm event to plan for, particularly for systems demonstrating higher levels of I/I. Storm events with higher recurrence intervals (such as 10-year, 25-year, or 50-year) may be overly burdensome to ratepayers of systems with high I/I levels, but storms with lower recurrence intervals (such as 1-year or 2-year) may be insufficient for predicting areas at higher risk of sanitary overflows and backups.

2.6.4 Critical Surcharge

The calibrated PCSWWM model was used to identify locations in the existing system with potential for surcharge under design storm conditions. Not all surcharge of existing sewers requires immediate mitigation, however. To identify higher risk surcharge, critical surcharge criteria were developed to help identify the need for capacity improvement projects. The two-part criteria used during this study is stated in terms of surcharge above the crown of pipe and in terms of minimum "freeboard" (or the distance between maximum surcharge level and manhole rim). This criteria is based on similar criteria used by the Environmental Protection Agency (EPA) in recent sewer consent decrees. It is important to note that this is a criteria for judging the severity of surcharge, not a pipe sizing tool. New gravity sewers (relief, replacement, or extensions) should not be designed to surcharge under design flow conditions.

Levels of surcharge predicted by the hydraulic model will vary widely across the system and depend on factors such as design storm intensity, existing pipe capacities, projected upstream flows and infiltration and inflow (I/I), and downstream bottlenecks. Some sewer agencies allow surcharge in their systems to specified levels (e.g., "surcharge up to 100% of pipe diameter over the crown of pipes"), while other agencies do not allow any surcharge in their systems.

Surcharge may not be acceptable at locations where sewers are relatively shallow (e.g., less than 10 vertical feet from the surface) because of the increased risk of overflow. Surcharge may be more acceptable in locations with particularly deep sewers (e.g., 20 feet or more below the surface) because of the lower risk of overflow. Therefore, it is sometimes pragmatic to allow some surcharge in the existing system before relief sewers are deemed necessary. However, as mentioned previously, all new or relief sewers should be designed for no resulting surcharge during design flow conditions.

2.6.5 Conceptual Pipe Sizing

The Austin UCM Q65/Q85 method of pipe sizing requires pipes be sized to either reach a maximum of 65% of their full capacity during peak dry weather flows (PDWF), or 85% of their capacity during peak wet weather flows (PWWF). This method of sizing provides a safety factor to account for higher than anticipated I/I during a storm event. During peak wet weather storms, Austin UCM requires that pipes be designed such that the peak wet weather flow (PWWF) shall not exceed 85% of the capacity of the pipe flowing full for all pipes 15 inches in diameter and below, and 80% of the capacity for all pipes 18 inches and above. Based on flow monitoring, Manor's wastewater system has a history of surcharging and backup during storm events, so this excess 15%-20% capacity would help to reduce risk of excessive surcharging and overflow. Designing the system with additional capacity provides flexibility for accommodating increased wastewater flows associated with population growth and denser development.

The City of Manor has historically sized pipes to reach full flow (Q_{full}) capacity during peak wet weather events. This is a less conservative method that will still accommodate storm events without providing as much safety factor for growth or increased I/I. Allowing pipes to reach full capacity during the design flow reduces costs by requiring smaller pipe sizes but leaves less room for accommodating future growth and expansion. Backup and surcharging are a greater risk to a system sized using this method. Because of Manor's rapid growth and higher rates of I/I, the more conservative Austin UCM Q65/Q85 approach was chosen for this study and is recommended for future designs.

Table 2-3: Planning-Level Design Criteria

Criteria	Value or Range
Existing Infrastructure Flow Calculations (Modeled System)	
Average Daily Dry Weather Flow (ADDF)	Model Calibrated to Flow Meter Data
Peak Dry Weather Flows (PDWF)	Model Calibrated to Flow Meter Data
Modeled I/I for Existing System(1)	RTK Unit Hydrograph Calibrated to Respective Flow Meter Basin
Modeled I/I for Growth(2)	RTK Unit Hydrograph Calibrated to Flow Meter Basin 2C (representative of new development)
Peak Wet Weather Flows (PWWF)	Design Storm Model (PDWF + I/I)
Design Storm(3)	5-year, 6-hour Event (4.1 inches)
Critical Surcharge Criteria(4)	Flow Depths > 24” above crown of pipe Flow Depths ≤ 36” below manhole rim
Future Infrastructure Flow Calculations (Extensions to Serve Growth Areas)	
Average Daily Dry Weather Flow (ADDF)(5)	200 gpd/LUE
Peak Dry Weather Flows (PDWF)(6)	$Q = \left[\frac{(18 + (0.0206 * ADDF)^{0.5})}{(4 + 0.0206 * ADDF)^{0.5})}\right] * ADDF$
Peak Wet Weather Flows (PWWF)(6)	Q = PDWF + 750 gpd/acre
Conceptual Sizing of New Infrastructure (Relief, Replacement or Extensions)	
Peak Flow Conveyance Criteria(7)	Austin UCM Q65/Q85
Gravity Pipe Capacity	Manning’s Equation
Manning’s Coefficient (n)	0.013
Gravity Pipe Velocity(8)	2-10 fps
Lift Station Capacity	Maximum 2-hr Peak Flow from Model
Force Main Velocity	3-6 fps

Notes:

1) Inflow and Infiltration (I/I) in the existing system was estimated using synthetic unit hydrographs (calibrated using the RTK method) for each flow meter basin.
2) Flows from new growth areas were plugged into the existing system during growth scenario modeling. To represent flows from growth in the model, flow meter basin 2C’s synthetic unit hydrograph was used. Basin 2C was chosen because it is considered an acceptable representation of I/I in Manor’s newer sewer basins.
3) Precipitation frequency estimates for design storm provided by NOAA Atlas 14.
4) Based on criteria used in recent EPA Consent Decrees. This criterion defines high risk (critical) surcharge levels in the existing sewer system and was used to define the necessity of capacity improvement projects for existing gravity sewers. It is important to note that new gravity sewers (relief, replacement or extensions) will NOT be designed to surcharge under design flow conditions.
5) Estimated from wastewater flow monitoring data.
6) Sourced from Austin Utilities Criteria Manual (UCM), which is commonly used and accepted throughout the Austin metropolitan area.
7) Sourced from Austin Utilities Criteria Manual (UCM). All gravity sewer projects were conceptually sized to reach a maximum of 80 to 85% of their capacity during peak wet weather flows (PWWF), depending on pipe diameter.
8) Texas Commission on Environmental Quality (TCEQ Chapter 217) design standards.

2.7 Cost Data

Planning level cost equations and tables were developed using past wastewater project data from the Austin metropolitan area and other commonly referenced guidance documents, such as those developed by the EPA. Costs should be considered planning-level only and may not reflect costs of actual construction. ENR Construction Cost Index (CCI) data were used for the Dallas metropolitan area (the closest metropolitan area to Manor with CCI indices) to adjust historical cost data for inflation to better reflect present-day costs. All referenced cost equations were adjusted to account for inflation using the February 2024 CCI for Dallas (CCI = 7824. Please see enr.com/economics/historical_indices for more information regarding ENR CCI values).

The following cost equations were developed to represent lump sum construction costs for typical wastewater improvement projects and may not be representative of more unique situations. Cost equations were generally fit to ENR-adjusted construction bid costs from multiple Central Texas wastewater projects bid within the past five years. If an identified project was already designed or estimated (e.g., Cottonwood Creek WWTP Expansion Phase 3), then the most recent opinion of probable cost was used instead of the cost equations below. The cost equations are representative of construction costs and do not include other soft costs or contingencies (such as easement acquisition, financing, legal, or insurance costs). To estimate a capital cost for each project, a 30% factor was applied to the construction cost to account for soft costs such as engineering design and survey, and then another 20% contingency factor was applied to account for unanticipated costs and scope changes. A summary of the cost equations is presented in Table 2-4 below.

Table 2-4: Planning-Level Construction Cost Equations

Project Type	**General Cost Equation**	**Units**
Gravity Sewer	$y = 322 * 1.038^{x}$	y is $/LF, x is diameter (in)
Steel Encasement	$y = 50x$	y is $/LF, x is casing diam. (in)
Force Main	$y = 18x$	y is $/LF, x is diameter (in)
Lift Station	$y = 1{,}500{,}000 * (x^{0.62})$	y is $, x is capacity (MGD)
Treatment	$y = 25x$	y is $, x is capacity (gpd)

3 EXISTING COLLECTION SYSTEM

3.1 Current Capacities and Projections

Table 3-1 describes the primary interceptor corridors serving Manor. Table 3-2 provides a summary of known information regarding Manor's lift stations, including those lift stations that were modeled. Previously decommissioned lift stations (LS02 at Wilbarger WWTP and LS14 at Manor Heights) are not included in the table or model. Modeled interceptors and lift stations are shown in Figure 4-2.

Table 3-1. Summary of Major Interceptor Corridors

Corridor Name	Pipe Diameter Range	Approx. Length (ft)	Corridor Description
Old Manor	12"-18"	16,600	• Old Manor encompasses all of the interceptors from Flow Meter Basins 1, 3, 4, 8, and 13 (see Figure 3-1) • Flows combine with the flows from Old Hwy 20 before reaching the Llano street interceptor then the Wilbarger WWTP
FM973 and Stonewater	15"	7,400	• Receives flows from the Stonewater Basin and Manor High School • Flows into the US-290 Interceptor • Includes LS06 and associated force main
US-290 and Presidential Glen	12"-24"	14,600	• Receives flow from FM973, Presidential Heights, Presidential Glen, Greenbury, and Stonewater. • Flows directly into the Wilbarger WWTP • The 24" line also received flow from the Wilbarger Creek MUD #1 and Travis County MUD #2 during the 2022 Flow Monitoring Period • Includes LS06, LS07, LS08, and LS09
Cottonwood Creek Basin	12"-21"	31,900	• Consists of the East and West Cottonwood Creek Interceptors • Flows from these interceptors are the only flows that the Cottonwood Creek WWTP currently treats • Includes LS12 and LS13
Old Hwy 20	18"	2,800	• Consists of Carriage Hills Lift Station (LS05) and Bell Farms Lift Station (LS04) • Flows from interceptors are primarily from subdivisions along Old Hwy 20 • There is planned development upstream of the Carriage Hills Lift Station (Manor Commercial Park)

Table 3-2. Summary of Lift Stations

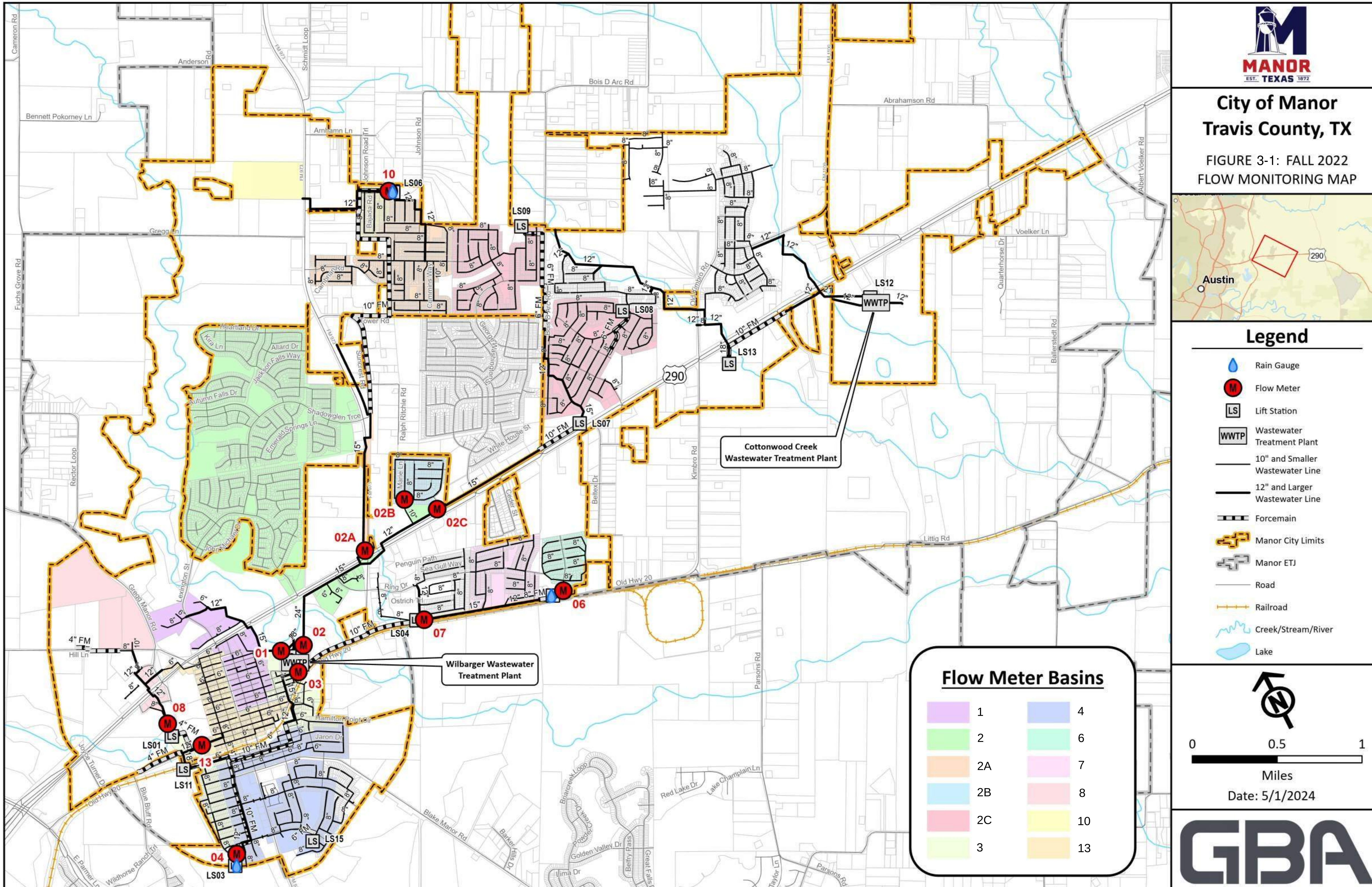
ID	Name/ Location	Modeled	No. of Pumps	Firm Capacity (gpm)	Force Main Diam. (in)	Force Main Length (ft)	Description
LS01	Las Entradas	Yes	2	200	4	980	Serves old high school and areas along Gregg Manor Rd. Developer agreement (Las Entradas) will expand this LS for growth.
LS03	Wildhorse Creek	Yes	2	1075	10	6,390	Serves Wildhorse Creek subdivision southwest of Old Manor. Force main combines with LS11's on S Bastrop St.
LS04	Bell Farms	Yes	2	1600	10	4,040	Serves Bell Farms subdivision and adjacent properties along Old Hwy 20. Currently undergoing capacity improvements; capacity shown reflects upgrades.
LS05	Carriage Hills	Yes	2	650	6	510	Serves Carriage Hills subdivision on Old Hwy 20; will be expanded to serve areas east (e.g., Manor Commercial Park). Design of expansion complete.
LS06	Stonewater	Yes	2	1100	10	11,030	Serves Stonewater subdivision and new high school.
LS07	US-290 (Pres. Glen)	Yes	2	1060	10	1,550	Serves Presidential Glen subdivision (Phase 1). Currently undergoing capacity improvements; capacity shown reflects upgrades.
LS08	Woodrow Wilson St.	No	2	415	6	1,800	Serves Presidential Glen subdivision (Phase 4B). Not included in model due to its size and location.
LS09	Presidential Heights	Yes	2	470	6	3,900	Serves Presidential Heights neighborhood.
LS10	Wilbarger WWTP	No	3	1675	18	440	Serves Wilbarger Creek WWTP, delivering flow to the headworks. Not included in collection system model because the WWTP was not modeled.
LS11	Carrie Manor	Yes	2	806	10	4,290	Serves portion of Old Manor. Force main combines with LS3's on S Bastrop St.
LS12	Cottonwood Cr. WWTP	Yes	2	555	8	260	Serves WWTP and east interceptor of Cottonwood Creek Basin.
LS13	Old Kimbro Rd.	Yes	2	944	10	2,620	Serves west interceptor of Cottonwood Creek Basin.
LS15	Lagos	No	2	311	6	750	Serves Lagos development (Phases 4 and 5) in the southwest part of Manor. Not included in model due to its size and location.

3.2 Flow Characteristics

Prior to the wastewater master plan study, a flow analysis was performed under a separate project to better understand the City's wastewater system and flow conditions. During the Fall 2022 flow monitoring project, the system was separated into 12 interconnected drainage basins with a total length of gravity wastewater pipes of approximately 67,500 linear feet. Flow meters were strategically located to measure flows generated by these basins. Please see Figure 3-1 to see the layout of flow meter locations and basins.

During the Fall 2022 flow monitoring period (8/22/2022-12/16/2022), the City experienced overall rainfall that was comparable to historical averages, with a total depth of rainfall of 11.6 inches. Of the 12 meter locations, 8 meters experienced surcharge during the flow monitoring period. Flow meters 1, 2, 3, 4, 8, and 10 all exhibited surcharge due to backup caused by downstream restriction. Flow meters 2A, 2C, and 3 exhibited surcharge due to pressurized flow caused by lack of capacity. Recommendations provided in the report titled *2023 Inflow & Infiltration Investigations Project – Preliminary Engineering Report* included CCTV inspections and smoke testing in Flow Meter Basins 1, 2B, 3, 4, 8, 10, and 13 to address the excessive inflow and infiltration conditions.

The flow meter data and analysis results were used to assist in the calibration of the PCSWMM model developed for this project. The flow monitoring results of the City's sanitary sewer system provided useful data in respect to ADDF and infiltration and inflow (I/I). The flow meter reactions were varied for the rainfall events, however all meters reacted to several of the rain events, with increased flows indicating I/I. The flow monitoring sites also provided insight into the capacity limitations of the system. For more information about flow characteristics and I/I conditions, please refer to the report titled *2023 Inflow & Infiltration Investigations Project – Preliminary Engineering Report*.



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3.3 Review of Proposed Infrastructure Projects

Table 3-3 lists and describes all wastewater capital improvement projects (CIP) listed under the most recent community impact fee (CIF) update provided by the City. These projects were taken into consideration when analyzing the design storm model runs.

Table 3-3. Status of Ongoing or Planned Wastewater Projects from February 2023 CIF

Project Name	CIP PN / GBA PN	Description	Status
West Cottonwood Gravity Line, Phase 2	S-18	Serves West Cottonwood Sub-Basin up to Bois D'Arc Ln, 21" and 24" gravity wastewater line sized for ultimate capacity.	Complete
Willow Lift Station and Force Main	S-23	Lift station and force main to serve 220 LUEs in Willow Basin along US-290.	Pending
Expand Cottonwood WWTP to 0.40 MGD Capacity	S-30	New treatment plant capacity to serve additional growth.	Pending
Expand Cottonwood WWTP to 0.60 MGD Capacity	S-31	New treatment plant capacity to serve additional growth.	Pending
Wilbarger Basin Gravity Line to Lift Station (off Gregg Lane)	S-33	New wastewater line to serve growth along Gregg Lane.	Pending
Wilbarger Basin Lift Station and Force Main (off Gregg Lane)	S-34	New lift station and force main to serve growth along Gregg Lane.	Pending
Gravity line from City Limits to tie in to Wastewater line to Cottonwood	S-35	New gravity wastewater line to extend wastewater service to City Limits for future growth.	Complete
Lift Station and Force main to Cottonwood WWTP	S-36	New lift station and force main to serve areas south of US Hwy 290 along Old Kimbro Road.	Pending
Expand Cottonwood WWTP to 0.80 MGD Capacity	S-37	New treatment plant capacity to serve additional growth.	Pending

Table 3-3 Continued			
Project Name	**CIP PN / GBA PN**	**Description**	**Status**
East Travis County Regional WWTP - with Elgin - Phase 1 - 1.1 MGD and 39" trunk main	S-38	Build new plant at Regional Site, road, and electrical improvements	Pending
Bell Farms Lift Station Expansion	CIP-2	Upgrades at existing lift station.	Nearing Completion
Presidential Glen Lift Station Expansion	CIP-3	Upgrades at existing lift station.	Nearing Completion
US-290 WW Line Expansion	CIP-4	Expand existing wastewater line along US-290 to serve growth.	Pending

4 MODEL DEVELOPMENT

4.1 Introduction

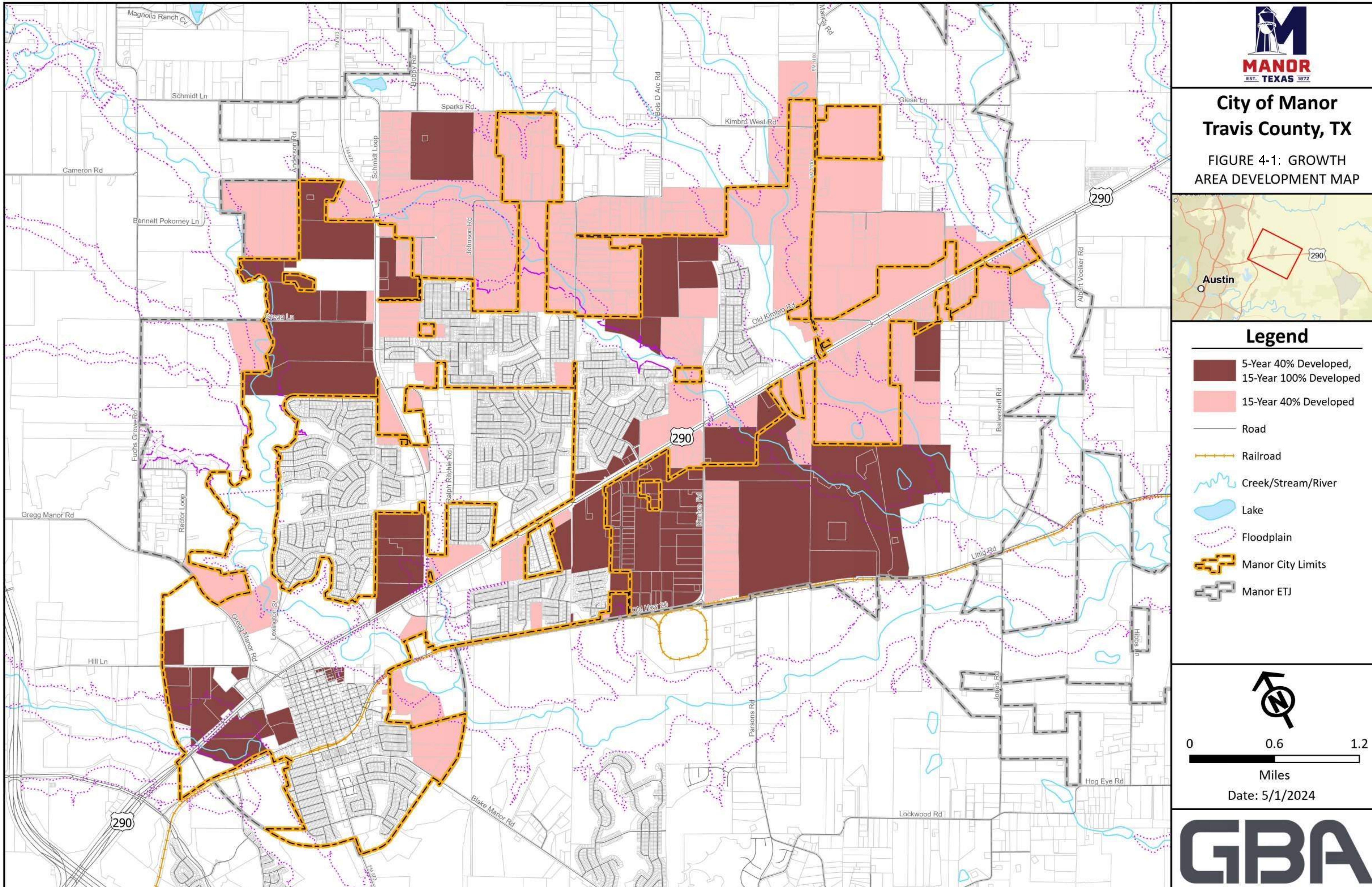
A hydraulic model of the City's sanitary sewer network was developed using GIS and data collected during the manhole survey. The PCSWMM modeling software by Computational Hydraulics International (CHI) was used to create the model. The model was used to determine the impact of population growth on the existing sanitary sewer network. The future growth scenarios modeled for this study were the 5-year and 15-year growth conditions. Section 4.2 provides further detail on growth projections utilized in the model for both time horizons.

4.2 Flow Projections

The overall goal for developing flow projections was to spatially assign growth across Manor's ETJ in a logical manner to align with the City's 7% annual growth rate assumption for the 5- and 15-year time horizons (Table 2-2). As previously mentioned, growth projections were developed based on the future land use map (Figure 2-2) from the City's Comprehensive Plan, as well as the planned and in-progress developments map supplied by the City (Figure 2-3). LUE/acre assumptions for each future land use type, as outlined in Table 2-1, were used to estimate the potential wastewater production for any given parcel. Because the Manor Comprehensive Plan excluded floodplain from developable land area, the same assumption was used for this analysis.

To estimate a zone of growth for the 5-year time horizon, the City's planned and in-progress development map was used. After overlaying the land use assumptions and LUE/acre estimates, a factor of 0.4 (or 40%) was required to align land use and LUE/ac assumptions with the 7% annual population growth assumption. This means that 40% of the developable (non-floodplain) land area within all the planned and in-progress tracts are assumed to be developed by the 5-year time horizon. This provided the necessary geographical information to input growth into the model. The area assumed to be 40% developed by the 5-year time horizon is shown in dark red in Figure 4-1. The floodplain boundaries are also shown to indicate those areas that were considered undevelopable for the purposes of this study.

To estimate a zone of growth for the 15-year time horizon, it was assumed that more lots would be developed around and near the current city limits and the planned and in-progress lots. To align with the 7% annual growth rate assumption, it was assumed that 100% of the current planned and in progress lots are developed by the 15-year time horizon, and 40% of the remainder of the 15-year growth zone is developed by the 15-year time horizon. The area assumed to be 40% developed by the 15-year time horizon is shown in light red/pink in Figure 4-1. The dark red area is assumed to be 100% developed by the 15-year time horizon.



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4.3 Existing System Model Network Development and Flow Assignment

The model network was developed using existing GIS and the data collected during the manhole survey. In cases of missing data, values were retrieved from city-provided GIS data, record drawings, or interpolated between known data points. Only pipes 12 inches or greater in diameter were included in this model. Figure 4-2 shows the modeled collection system.

The twelve flow meter locations from the 2022 I/I Reduction project were imported into the appropriate manholes in the model, as well as their respective basins. Parcels encompassed in the flow metering basins were imported into the model as subcatchments. Every parcel was assigned a receiving manhole and a living unit equivalent (LUE) count, resulting in each receiving manhole being assigned a total LUE count. The LUE count was utilized to account for variations in wastewater generation from single-family homes, apartments, schools, restaurants, retail properties, and other property types. The sewer shed areas for each flow meter basin were distributed among the manholes based on a weighted system, accounting for the number of LUEs assigned to each manhole.

In summary, the built model network included 273 manholes, 66,000 linear feet of gravity sewer, 32,900 linear feet of force main, and 10 lift stations (Figure 4-2). The lengths of modeled gravity sewers and force main are summarized according to diameter and corresponding flow metering basin in Table 4-1.

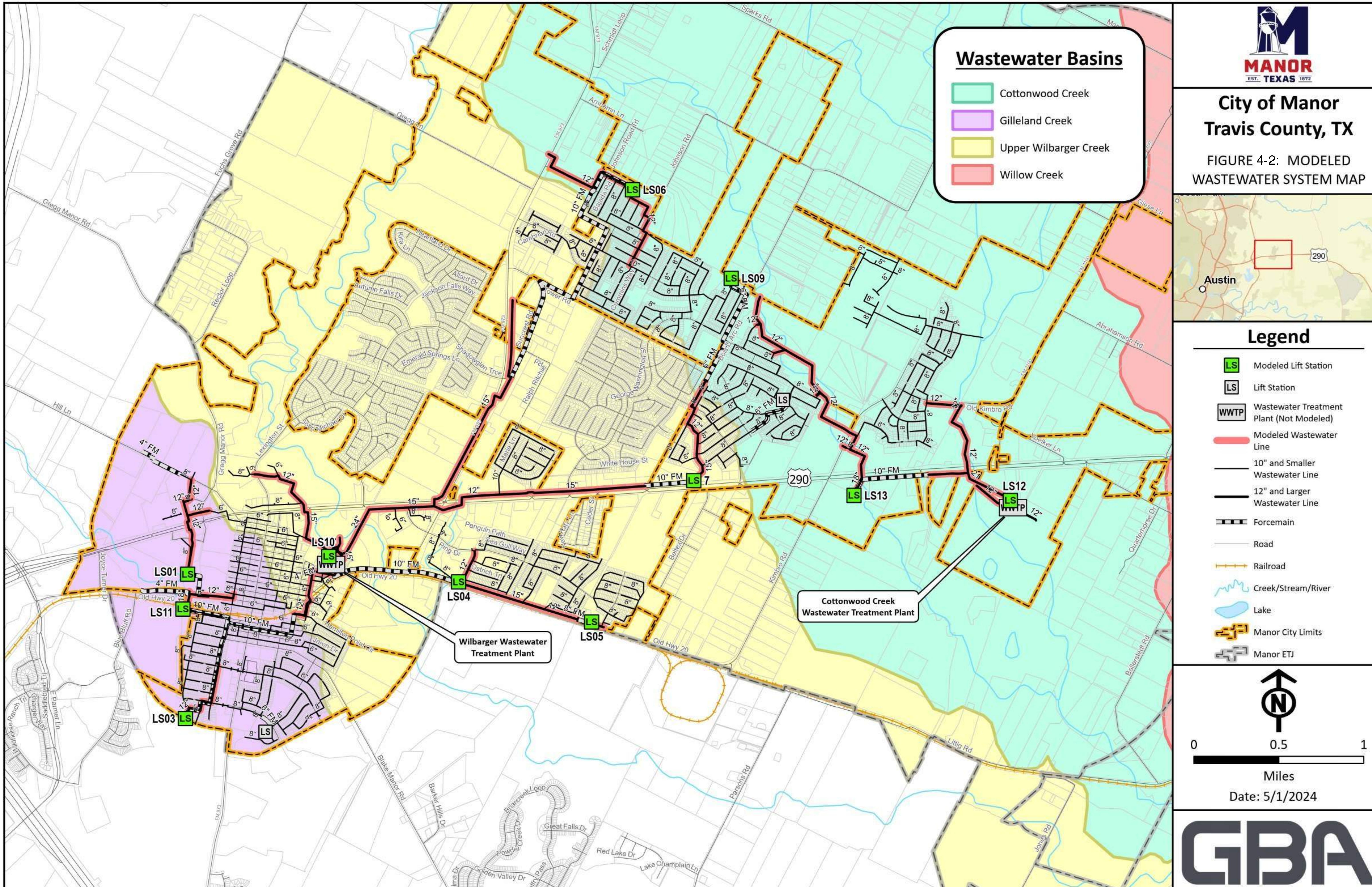

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Table 4-1: Modeled Pipes by Diameter

	Gravity Main						Force Main				
Flow Meter Basin	12"	15"	18"	21"	24"	Totals	4"	6"	8"	10"	Totals
1	1,340	2,612				3,953					
2	1,567	4,145			1,508	7,219					
2A		10,147				10,147				11,026	11,026
2B											
2C	3,086	4,252				7,337		3,900		1,553	5,453
3	2,816	1,502	576			4,893	980		7,999		8,979
4			2,062			2,062					
6											
7	1,434	2,482				3,915			511		511
8	3,587					3,587					
10	3,554					3,553					
13	845					845					
Unmetered: Cottonwood Creek	13,176		562	1,625		15,360		256	2,622		2,878
Unmetered: All Else	1,096	1,566			500	3,163				4,038	4,038
Totals	**32,500**	**26,705**	**3,120**	**1,625**	**2,008**	**66,034**	**980**	**4,157**	**11,132**	**16,617**	**32,885**

** All lengths in linear feet*

4.4 Model Calibration

4.4.1 Dry Weather Calibration

Average daily dry weather flows (ADDF) for each flow monitoring basin were retrieved from the 2022 Flow Monitoring Report by averaging the flows from Sep 27, 2022 - Oct 4, 2022, which was the driest week of the flow monitoring period. The ADDF was then normalized by dividing them by the total number of Living Unit Equivalents (LUEs) within each respective basin, yielding a unit flow per LUE value for each flow metering basin (Table 4-2). To distribute flows throughout the system, the average flow entering each manhole was determined by multiplying the unit flow per LUE by the number of estimated LUEs served by that particular manhole.

Table 4-2: Unit Flow per LUE

Flow Metering Basin	Estimated No. of LUEs Upstream of Meter	Avg. Daily Dry Weather Flow (MGD)	Estimated ADDF/LUE (gpd/LUE)
1	103	0.045	436
2	2,267	0.386	170
2A	1,070	0.129	121
2B	303	0.069	228
2C	1,570	0.189	120
3	360	0.130	360
4	819	0.171	209
6	240	0.051	211
7	419	0.1874	447
8	15	0.065	4,333(1)
10	201	0.064	317
13	290	0.023	80

1) *An abnormally high ADDF per LUE was estimated for Basin 8 due to the challenge of estimating exact LUE counts in basins primarily comprised of multi-family residential and commercial land uses.*

Time patterns were created by using the Time Pattern Creator tool in PCSWMM. Hourly and weekend time patterns were generated based off the dry weather period used for calibration. The outputs of the time pattern creator are hourly multipliers, in which the hourly time pattern has hourly multipliers that are applied to weekdays, while the weekend time pattern has hourly multipliers which are utilized on the weekend. Figure 4-3 shows an example of an hourly time pattern created by PCSWMM. The hourly and weekend time patterns were created for each flow meter basin and assigned to the manholes within their respective flow meter basins.

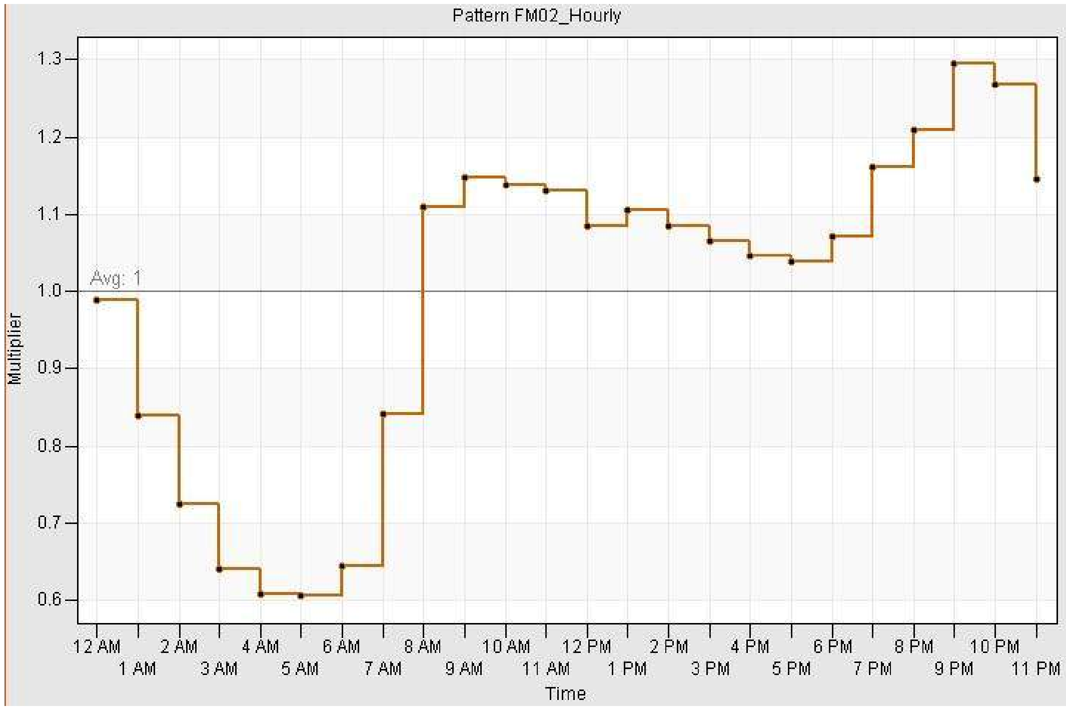


Figure 4-3: Hourly Time Pattern

The model was run after inputting the average flows and time patterns to the manholes, and the model results were compared to the flow meter data. ADDF measured by flow meter data was compared against ADDF calculated by the model. Total volumes for the dry weather period (measured versus modeled) were also compared (Table 4-3). The hydrographs showing modeled and metered flow for the dry weather period for each flow meter are provided in Appendix B.

Table 4-3: Dry Weather Calibration Results

Flow Meter	Metered ADDF (MGD)	Modeled ADDF (MGD)	Diff (MGD)	% Diff	Metered Total Volume (MG)	Modeled Total Volume (MG)	Diff (MG)	% Diff
1	0.31	0.31	0.00	0%	0.04	0.05	0.01	19%
2	5.78	5.86	0.08	1%	0.84	0.90	0.07	8%
2A	1.32	1.35	0.03	2%	0.19	0.24	0.05	26%
2B	0.48	0.48	0.00	0%	0.07	0.07	0.00	2%
2C	1.29	1.32	0.03	2%	0.19	0.20	0.01	7%
3	2.69	2.72	0.03	1%	0.39	0.43	0.04	9%
4	1.20	1.19	-0.01	0%	0.17	0.18	0.00	3%
6	0.35	0.35	0.00	0%	0.05	0.05	0.00	6%
7	1.66	1.66	0.00	0%	0.24	0.27	0.04	15%
8	0.45	0.45	0.00	0%	0.07	0.07	0.01	8%
10	0.45	0.44	0.00	0%	0.06	0.07	0.00	7%
13	0.16	0.16	0.00	0%	0.02	0.03	0.01	28%
Total	16.15	13.32	0.17	**1%**	2.33	2.57	0.23	**10%**

4.4.2 Wet Weather Calibration

The RTK Hydrograph method was chosen to model rainfall dependent inflow and infiltration (RDII) in PCSWMM. RDII is produced as groundwater and stormwater enter through defects in the sanitary network. A RTK unit hydrograph was used to define the proportion of rainfall falling on the basin that enters the sewer system as RDII and the timeframe this rainfall enters the system during and after the storm event. The RTK unit hydrograph is a combination of three separate unit hydrograph triangles which represent slow, medium, and fast responses of flow entering a sanitary network (Figure 4-4). Each response represents RDII that enters a system during and after a rainfall event. The R value symbolizes the fraction of rainfall that is entering the system, which is shown in the figure as the magnitude of the peak, T is the time to peak, and K is the falling limb ratio, which predicts how long the system will respond to a storm event. The slow response can be associated with slow infiltration, which occurs immediately following a rain event and can persist for several hours or even days. The medium response is associated with moderate infiltration that occurs during and soon after an event, when soil surrounding a pipe becomes saturated and starts infiltrating. The fast response time is associated with rapid inflow that enters the system through more direct connections and pathways (such as cracks or holes in manhole frames and covers).

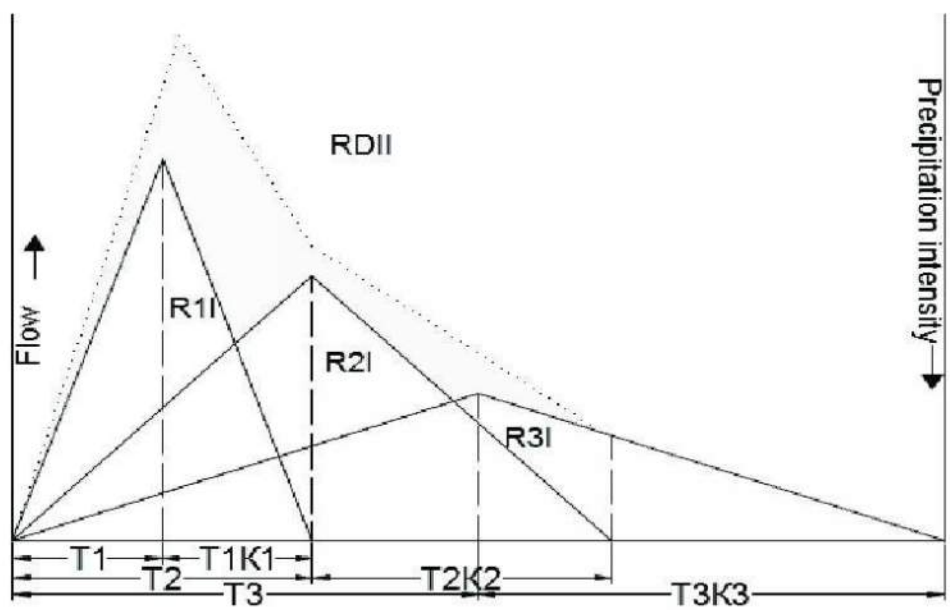


Figure 4-4: RTK Hydrograph

A unit hydrograph was developed for each flow monitoring basin, featuring unique sets of short-, medium-, and long-term R, T, and K values, along with an assigned rain gage. The City of Manor had a total of three rain gages collecting rainfall during the flow monitoring period, as illustrated in Figure 3-1. The Thiessen polygon method was utilized to establish a hypothetical rain gage for each flow monitoring basin, determined by the proximity of the basin to the nearest rain gages.

The Sensitivity-based Radio Tuning Calibration (SRTC) tool in PCSWMM was applied to calibrate modeled data with observed flow meter data. The SRTC tool establishes sensitivity gradients for short, medium, and long-term R, T, and K values, allowing for simultaneous observation of effects across multiple wet weather events. Initial unit hydrographs were generated by estimating R, T, and K values based on computed and observed data from the dry weather calibrated model results. Subsequently, an iterative approach was adopted, adjusting R, T, and K values for each flow meter until the weighted averages of the peaks and total volumes for all observed and usable wet weather responses were within the ranges suggested by the Chartered Institution of Water and Environmental Management (CIWEM): -15% to +25% for peak flow, and -10% to +20% for total volume (Table 4-4). In addition, 45-degree plots were prepared to visually demonstrate how the model's predictions are aligning with the metered flow data (Appendix C).

Table 4-4 shows the wet weather calibration results, including percent differences between the modeled and metered volumes and peak flows for each significant storm response observed during the 2022 flow monitoring period. One storm that was ultimately excluded from consideration during calibration was the November 25, 2022. It was discussed with the City during a model review meeting held on December 7, 2023 that the sewer system's dramatic response to the November 25, 2022 storm was most likely attributed to several compounding factors, including wetter soil conditions from smaller storm events occurring in the weeks prior to November 25, as well as the contribution of excessive flows from the Municipal Utility Districts (MUDs) connected to Manor's sewers during the flow monitoring period.

It was uncertain whether on of the largest MUDs was sending flows to Manor's system regularly or only during larger storm events. These MUDs are no longer contributing flow to Manor's system however, and should not dictate model calibration or analysis. The City also expressed concern that the calibration was overly conservative. After discussing the factors that led to abnormal peak flows during the November 25, 2022 storm event, it was decided that an alternate calibration approach would be more representative of typical storm events observed in the Manor sewer system. The alternate calibration approach results in a better match between metered peaks and modeled peaks for the other storm events that occurred throughout the Fall 2022 flow monitoring period.

Flow meter Basins 2A and 10 have total volume percent differences that exceed the CIWEM acceptable range. This can be attributed to the October 16, 2022 storm that caused a lower-than-average response in these basins. As stated above, the model is calibrated to represent more typical storm events in the Manor sewer system. Similarly, flow meter Basin 13 has a total peak flow percent difference that falls slightly below the CIWEM acceptable range. This is because Basin 13 had three storms in November that caused a higher-than-average response. Excursions like these from the acceptable ranges may be unavoidable in situations where flow meter data does not align as expected with rainfall data.

Table 4-4: Wet Weather Calibration Results

Flow Meter	Basin Area (Acres)	No. of Storm Events with Observable Responses	Weighted Avg. % Difference, Total Volume	Weighted Avg. % Difference, Peak Flow
1	118	7	8%	5%
2	760	7	20%	-4%
2A	215	6	39%*	13%
2B	58	8	8%	-4%
2C	354	8	1%	-12%
3	117	7	19%	-14%
4	258	7	15%	-9%
6	50	6	13%	2%
7	100	6	19%	-6%
8	136	8	16%	25%
10	93	4	27%*	10%
13	100	11	-3%	-19%*
Acceptable Range (CIWEM), % Difference			-10% to +20%	-15% to +25%

*Excursions from the acceptable range are noted with an asterisk. Excursions are typically caused by basins with lower flows or erratic flow monitoring data, which can present challenges to achieving ideal calibration. Overall, the calibration is adequate for planning-level purposes.

4.5 Future Growth Model Development

The future growth projections were incorporated into the model by importing the number of LUEs and the sewershed area into the nearest downstream, modeled manhole (Refer to Section 4.2 for more insight to the development of growth projections). The nearest downstream manhole was determined by the future growth area's location and topography. Extension interceptor lines were conceptualized and included in the final plan as extension projects (Section 7.10) to serve new growth and tie into the existing infrastructure, but these lines were not included in the model. Only projected flows from these extensions were incorporated into the model. The future growth models did not include planned or ongoing improvements; however, known improvements were considered when developing recommendations.

5 MODEL RESULTS ANALYSIS

5.1 Overview of Modeling Results

The existing model, 5-year growth model, and 15-year growth model were simulated with the 5-year, 6-hr design storm (see Section 2.6.3 for more information regarding the design storm). This chapter provides an analysis of the results derived from these simulations. In the maps illustrating the results (Figure 5-1 through Figure 5-3), only manholes meeting the critical surcharge criteria outlined in Section 2.6.4 are depicted as orange circles. The red circles denote manholes experiencing flooding during the simulation period. While the model might indicate flooding, it does not imply that the system will actually flood. It is recommended that further on-site evaluation and data collection (e.g., checking manholes for evidence of surcharge, targeted flow monitoring) be conducted before initiating any project based on modeling results.

To represent pipes in the maps, orange lines symbolize pipes undergoing surcharge during peak wet weather conditions due to backup, stemming from downstream restrictions such as undersized pipes or inadequate lift station capacity. Red lines represent pipes experiencing surcharge due to capacity limitations, indicative of undersized pipe during peak wet weather conditions. When evaluating projects, pipes surcharging due to backup are of lesser concern compared to those surcharging due to capacity limitations.

5.2 Existing System Design Storm Results

The analysis of the existing system under the 5-year design storm reveals three areas of concern (Figure 5-1).

- The Llano St. and Lampasas St. Interceptors receive flows from most of Old Manor before flowing into Wilbarger Creek WWTP, making it an important corridor. This stretch of sewer also has relatively shallow manholes, making it prone to surcharge..
- The Pyrite Road Interceptor that flows into the Stonewater Lift Station (LS06) is undersized when the design storm is run under existing conditions. This interceptor is located in Basin 10 which demonstrated particularly high rates of inflow during Fall 2022 Flow monitoring. Therefore, a potential alternative approach to upsizing the wastewater line would be to mitigate I/I in the upstream system.
- The US-290 interceptor receives flow from FM973, Presidential Heights, Presidential Glen, and Greenbury. This project is of lower priority due to lower levels of surcharge in the existing conditions scenario, but may become a bigger issue as more development occurs upstream.
- LS03, also known as the Wildhorse Creek Lift Station, demonstrated some backup issues in the existing conditions model. However, upon further investigation, these issues are not expected to occur due to recent upgrades at this facility. Because LS03 was recently upgraded, it was assumed that these model results were of little concern. I/I in Old Manor should, however, be further investigated and mitigated so that issues do not arise at LS03 and other lift stations serving the older, downtown area.

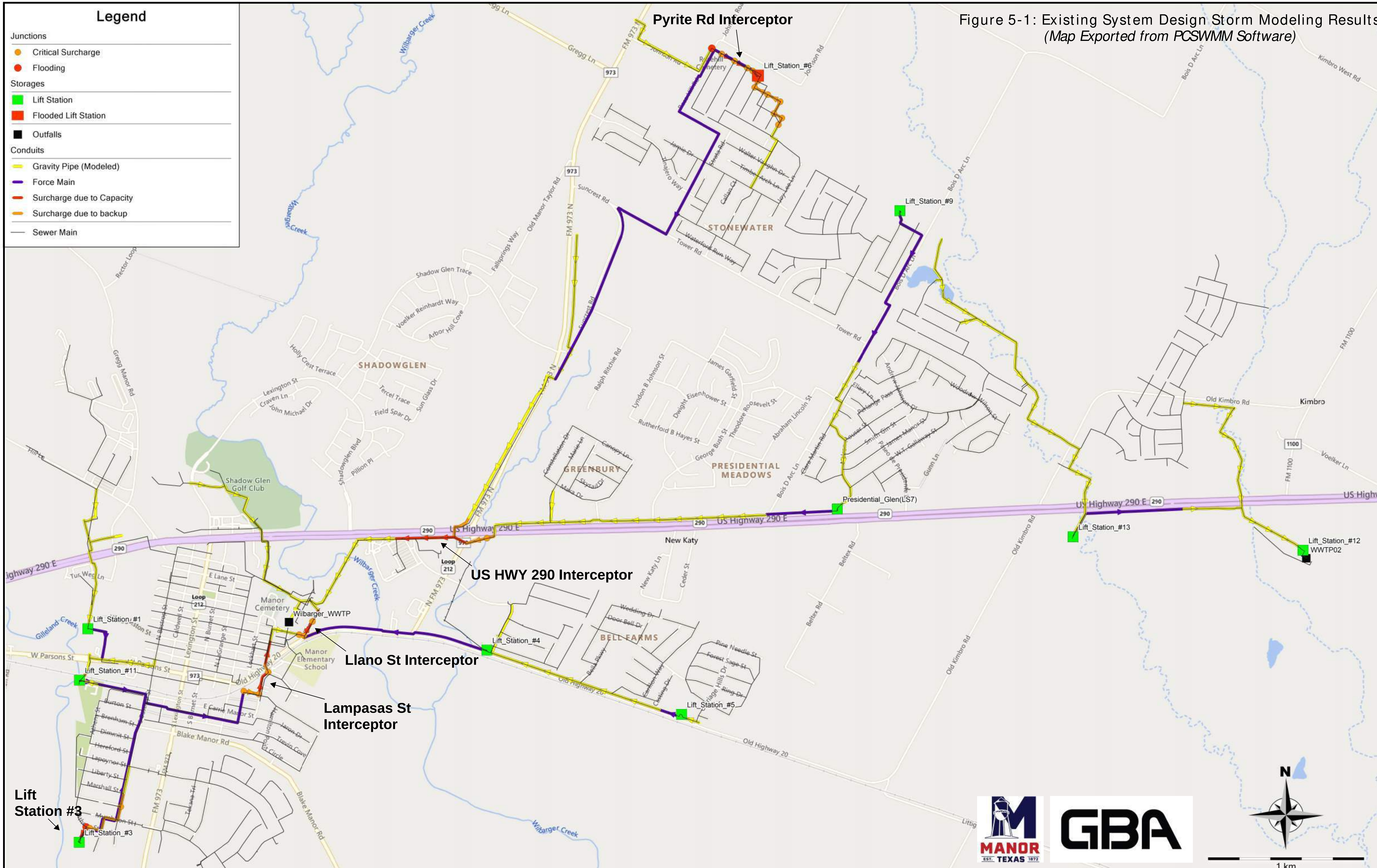


Figure 5-1: Existing System Design Storm Modeling Results
(Map Exported from PCSWMM Software)
Legend
Junctions
Critical Surcharge
Flooding
Storages
Lift Station
Flooded Lift Station
Outfalls
Conduits
Gravity Pipe (Modeled)
Force Main
Surcharge due to Capacity
Surcharge due to backup
Sewer Main
Pyrite Rd Interceptor
Lift_Station_#6
Lift_Station_#9
STONEWATER
SHADOWGLEN
GREENBURY
PRESIDENTIAL MEADOWS
Presidential_Glen(LS7)
Lift_Station_#13
Lift_Station_#12
WWTP02
Kimbro
New Katy
US HWY 290 Interceptor
Wilbarger_WWTP
Lift_Station_#4
BELL FARMS
Lift_Station_#5
Llano St Interceptor
Lampasas St Interceptor
Lift_Station_#1
Lift_Station_#11
Lift Station #3
Lift_Station_#3
Shadow Glen Golf Club
Manor Cemetery
Manor Elementary School
US Highway 290 E
Old Highway 20
Wilbarger Creek
Gilleland Creek
MANOR TEXAS
GBA
N
1 km

5.3 5-year System Design Storm Results

The results from the 5-year growth model simulation conducted with the design storm are presented in Figure 5-2. The two projects that were identified as areas of concern in the 5-year growth scenario are already undergoing improvements.

- The Old Hwy 20 Interceptor serves Carriage Hills and Bell Farms along with some unmetered properties along Simmer Run. LS04 is also shown to be undersized and cannot keep up with the flows coming from contributing basins, though there is an ongoing project to upgrade this facility. Lift station improvements and pipe bursting from Carriage Hills are under design and being reviewed by TCEQ. Therefore, no projects were identified to address these model concerns.
- The FM973 interceptor is surcharging due to backup from the US-290 Interceptor but is not critical in the 5-year growth scenario. However, it does become more critical in the 15-year growth scenario.

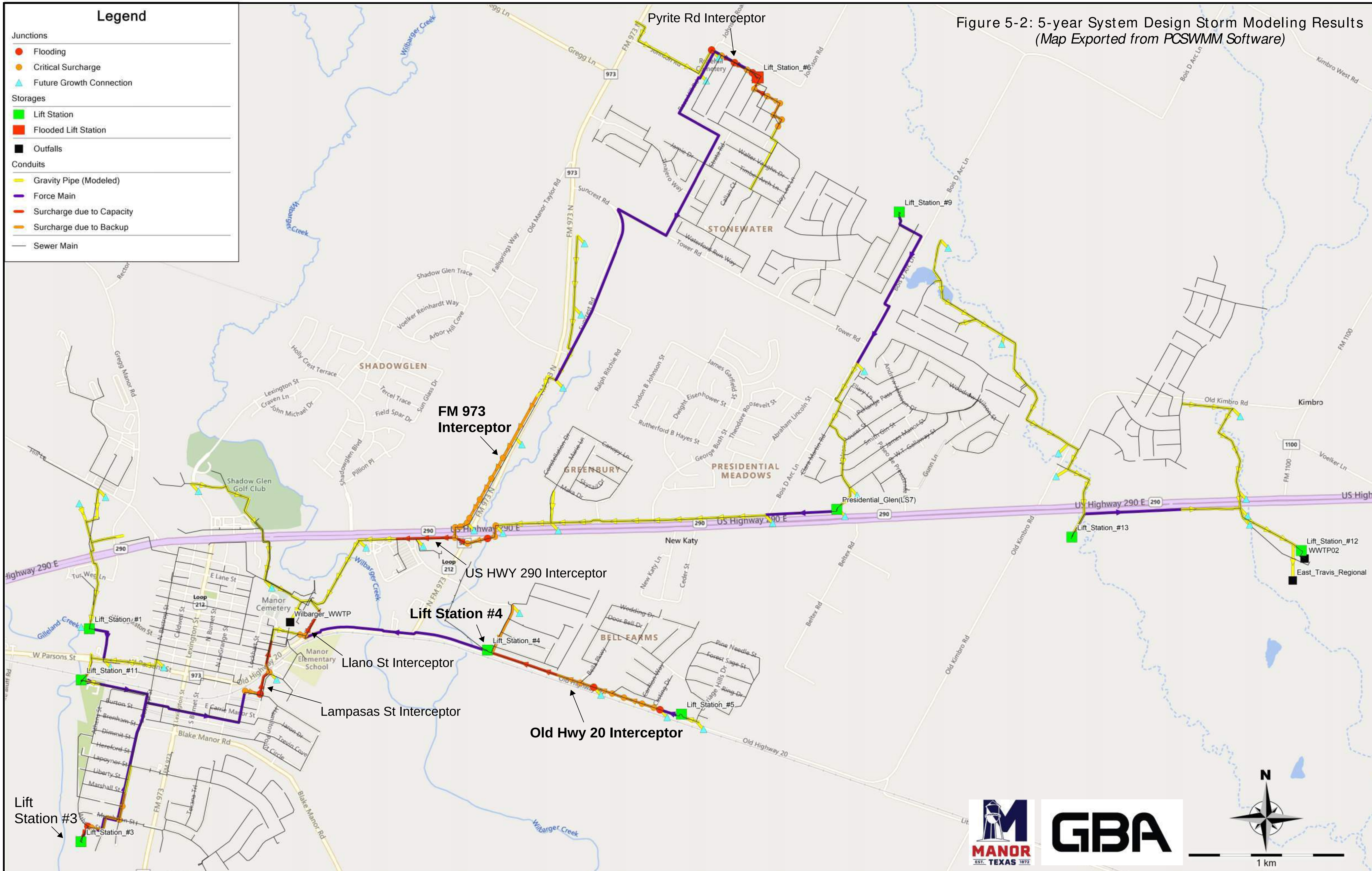


Figure 5-2: 5-year System Design Storm Modeling Results
(Map Exported from PCSWMM Software)

5.4 15-year System Design Storm Results

Similar to the 5-year growth model findings, the previously identified areas of concern have shown exacerbation in terms of surcharging and flooding (Figure 5-3). With the integration of the 15-year growth projection into the model, multiple areas in the wastewater system will be undersized unless improvements are made.

- Lift Station 1, also known as Las Entradas or Old High School Lift Station, and the pipe immediately following the lift station create backup in the 15-year growth scenario (Figure 5-3). However, there is an agreement that requires the developer to expand this LS to accommodate future growth.
- The FM973 Interceptor shows flooding and undersized pipes in the 15-year growth scenario. This project will not be necessary if Lift Station 6 is decommissioned, however.
- Both the East and West Cottonwood Creek interceptors are unable to accommodate for projected 15-year growth. These interceptors were not monitored in the 2022 Flow Monitoring Period; however, the growth projections in the Cottonwood Creek Basin are significant enough to warrant improvements.
- Another project identified during the 15-year future growth scenario was the decommissioning of Lift Stations 6, 8, and 9. This would come after the addition of the East Travis Regional Plant. Flows directed toward these lift stations would be redirected through the addition of an interceptor to flow by gravity to the new treatment plant. This would alleviate capacity concerns created by these three lift stations, removing the need for improvements along FM973 and reducing flows to the Wilbarger WWTP.

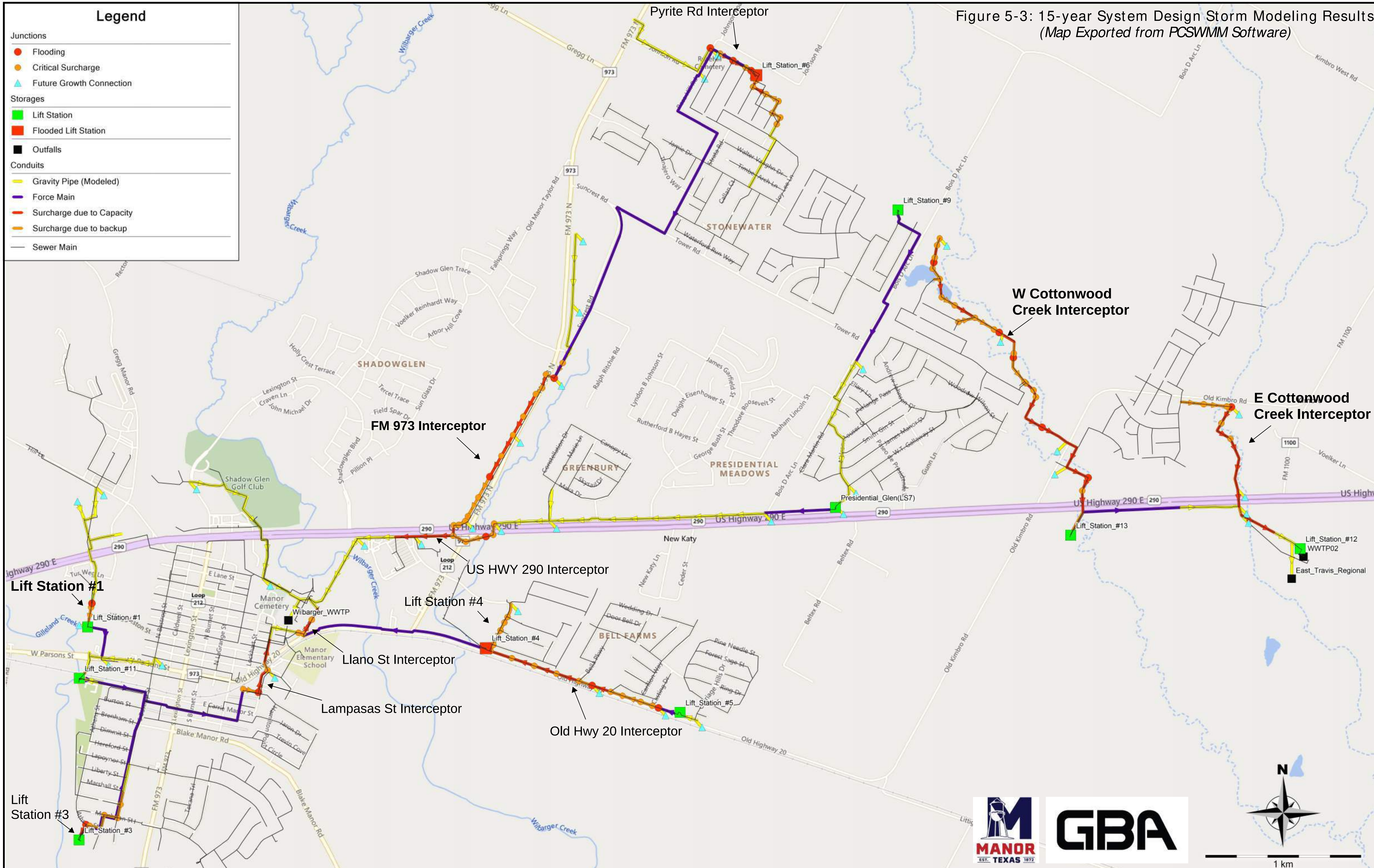


Figure 5-3: 15-year System Design Storm Modeling Results
(Map Exported from PCSWMM Software)

5.5 15-year System Free Flow Results

A free flow model scenario was developed for the 15-year growth conditions whereby pipe capacities were increased until no surcharging or flooding was predicted in the model under 5-year, 6-hour design storm conditions. In the previous non-free flow design storm models, flood loss and surcharging diminish peak flows progressing downstream of any bottlenecks. The free flow analysis assumes that any flow entering the system will flow through the system and to the outfall without encountering restrictions or flood loss. This model scenario enables a comparison between a) the maximum 15-year free flow peaks that could be experienced without upstream flow restrictions and b) the existing full flow capacity of every modeled pipe. Additionally, this analysis facilitates the identification of capacity concerns not highlighted in the non-free flow design storm models, either due to flood loss, surcharging, or other flow restrictions upstream. The findings from the free flow analysis significantly influence the identification and delineation of necessary projects and their extents. The map depicted in Figure 5-4 denotes pipes in red where the maximum 15-year free flow capacity exceeds the existing pipe's full flow capacity.

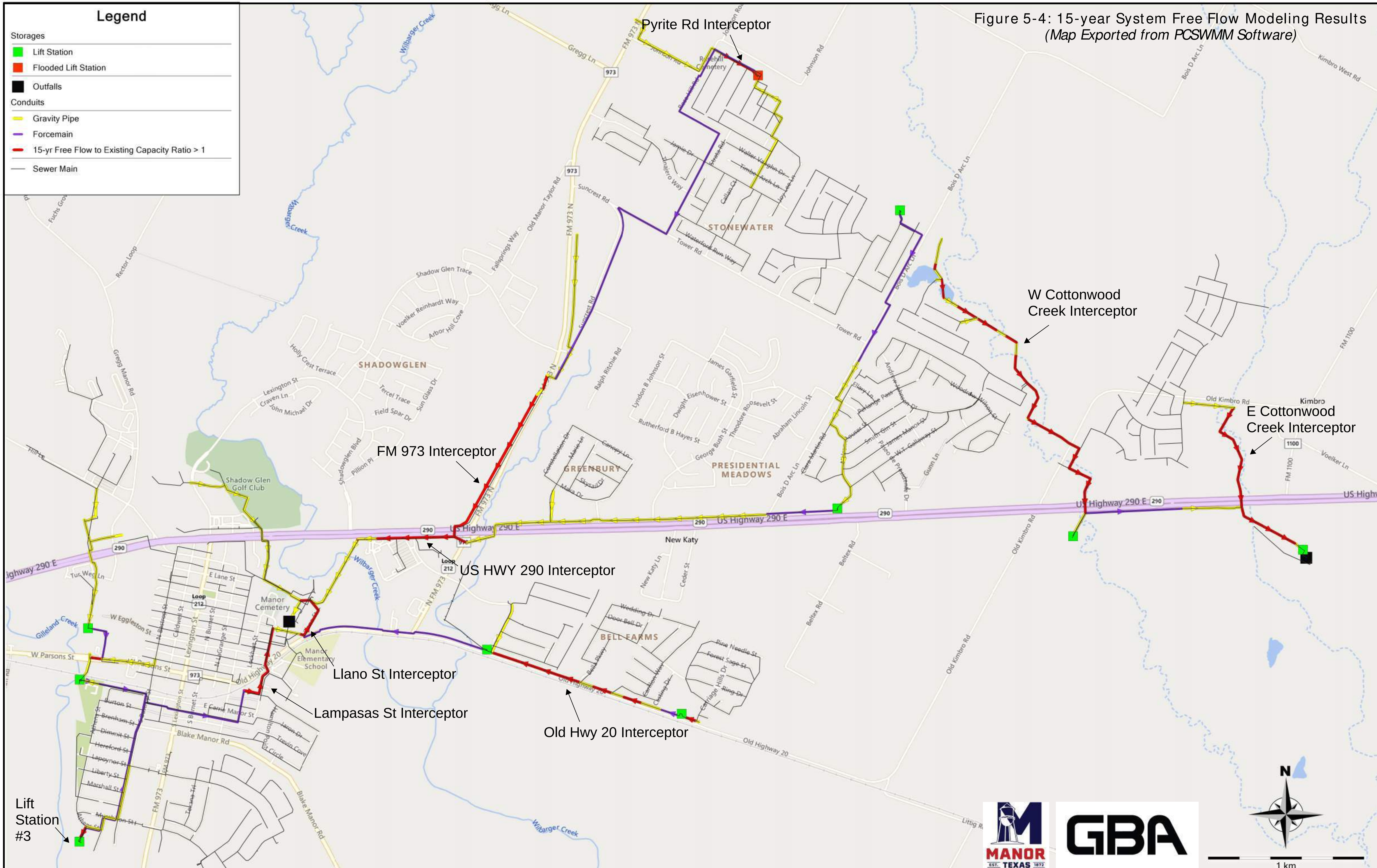
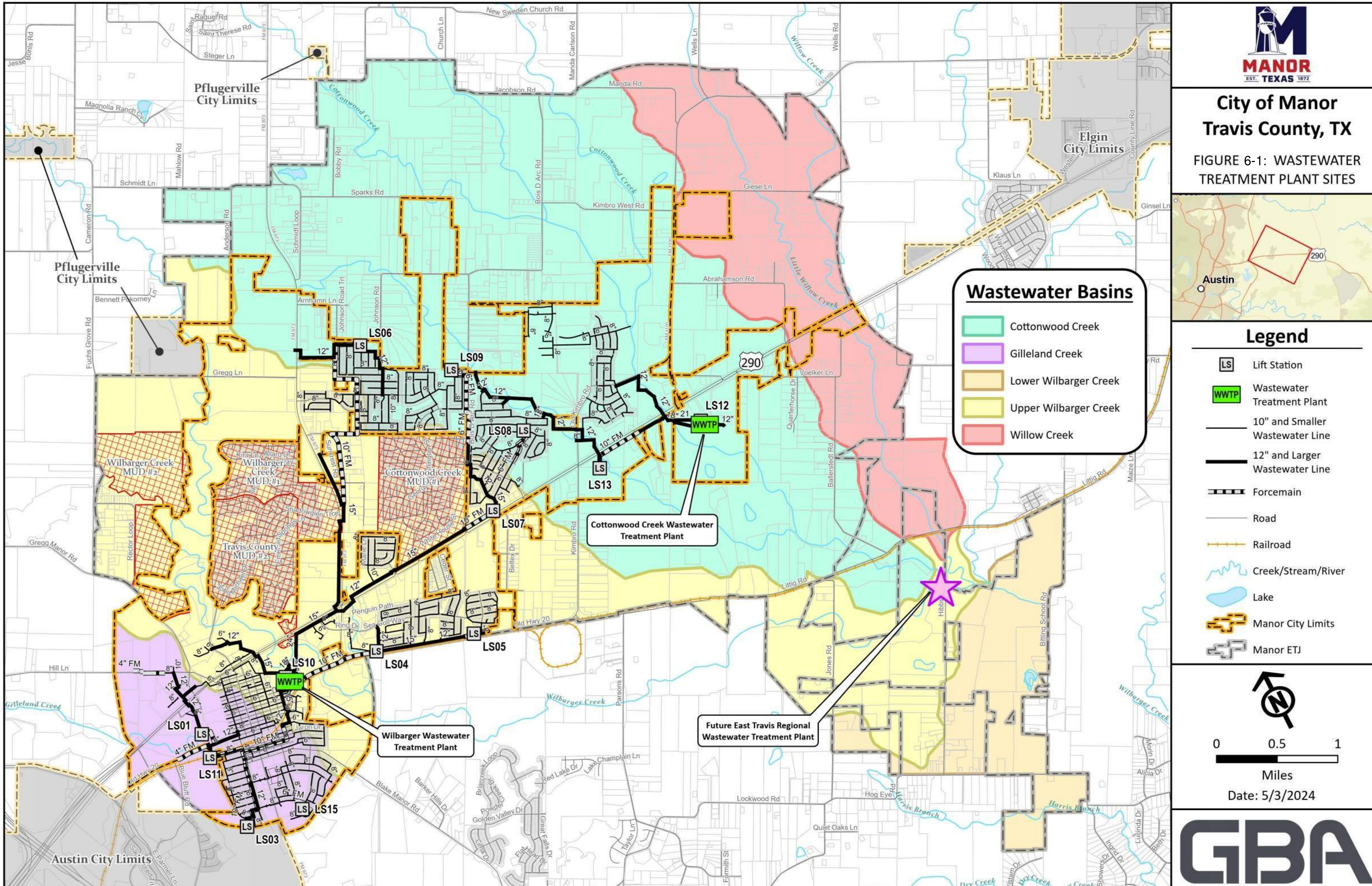


Figure 5-4: 15-year System Free Flow Modeling Results
(Map Exported from PCSWMM Software)

6 TREATMENT CAPACITY ANALYSIS

The City of Manor currently operates two wastewater treatment plants (WWTPs): the Wilbarger WWTP and the Cottonwood Creek WWTP. A third WWTP has previously been proposed southeast of the Cottonwood Creek WWTP. The third WWTP would be located near the confluence of the Cottonwood Creek, Willow Creek, and Wilbarger Creek, south of Littig Road. This proposed WWTP is referred to in this report as the East Travis Regional WWTP, and it would be strategically located to serve a large area within Manor's eastern ETJ and potentially other municipalities within the region. A map showing the locations of each WWTP is provided in Figure 6-1.

This section describes the projected capacity allocations and phasing for each of the three WWTPs at the 5-year and 15-year time horizons. To assess future treatment plant capacity needs and establish logical timing of expansions, rated plant capacities were compared against flow projections developed during collection system modeling. It is important to note that exact timing of capacity expansions will be dictated by actual influent flows to the WWTPs. TCEQ Chapter 217 Rules require that plant expansion design commence at 75% of permitted phase capacity and construction start at 90% of permitted phase capacity. Therefore, monitoring of WWTP influent flows will be essential to ensure adequate capacity is available as the City grows.



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6.1 East Travis Regional Wastewater Treatment Plant (Future Plant)

The East Travis Regional WWTP is essential for serving future growth in the eastern reaches of Manor's ETJ. This treatment plant is proposed to be located near the intersection of Littig Road and Ballerstedt Road, near the confluence of Cottonwood Creek, Wilbarger Creek, and Willow Creek. The new WWTP would be situated at the downstream end of the three primary drainage basins within Manor's ETJ.

The East Travis Regional WWTP was conceptualized as part of previous studies, including Manor's 2008 Wastewater Master Plan Update, and has been included in the City's most recent 10-year wastewater CIP. The plant would be strategically located to ultimately serve a larger area than the current Cottonwood Creek WWTP and is anticipated to eventually allow the Cottonwood Creek WWTP to either be repurposed for wastewater reuse or decommissioned entirely. Recent planning efforts for the East Travis Regional WWTP have assumed an initial capacity of 1.5 MGD. Upon analyzing population and flow projections developed for this report, it was determined that a 1.5 MGD capacity would be required at minimum by the 15-year time horizon to serve growth, and it may be strategic to design the facility to handle additional capacity above 1.5 MGD (e.g., 2.0 MGD) to defer further upgrades.

6.2 Cottonwood Creek Wastewater Treatment Plant

The Cottonwood Creek WWTP currently has a capacity of 0.2 MGD and is located south of the intersection of US-290 and FM1100. This WWTP was designed to be phased from 0.2 MGD up to a maximum of 0.8 MGD in four separate phases. Presently, Phase 2 expansion of the Cottonwood Creek WWTP is fully designed and set to begin upon confirmation that flows have reached a level appropriate to trigger the expansion. Phase 2 expansion will increase the Cottonwood Creek WWTP's capacity to 0.4 MGD. The other phases of expansion that are planned for Cottonwood Creek WWTP are Phase 3 (0.6 MGD Total) and Phase 4 (0.8 MGD Total).

Upon analyzing population and flow projections developed for this report, it was determined that Phase 2 and 3 of the expansion will need to occur within the next five years to serve projected growth. It was also concluded that Phase 4 may be unnecessary, as the East Travis Regional WWTP will be a more permanent location for the City to invest in additional treatment capacity. Regardless, the 0.8 MGD permitted capacity will ensure sufficient capacity within the basin to serve growth if the regional plant cannot be constructed and commissioned before the Phase 3 (0.6 MGD) plant capacity is reached.

The Cottonwood Creek WWTP was conceptualized as a temporary facility that would provide service in Manor's eastern reaches prior to the construction of a much larger and more permanent facility (the East Travis Regional WWTP). Despite it being designed for a shorter life cycle, the Cottonwood Creek WWTP will still serve a critical role in phasing the East Travis Regional WWTP. Due to its location upstream of the proposed site of the regional WWTP, the Cottonwood Creek WWTP will be able to reduce the total influent flow reaching the East Travis Regional plant, which could be strategic during high flow events or during regional plant startup and maintenance. In this way, the Cottonwood Creek WWTP will provide the City some treatment redundancy and operational flexibility when determining how much influent flow to allocate to either facility. For this reason, it is recommended that the Cottonwood Creek WWTP remain in service at least until the East Travis Regional WWTP has adequate capacity and redundancy to serve the entire Cottonwood Creek basin. This may require the Cottonwood Creek WWTP to remain in service beyond the initial construction of 1.5 MGD at the regional facility.

It is also important to note that Phase 3 expansion of the Cottonwood Creek WWTP will permit the City to delay construction of the East Travis Regional plant until average daily flows increase beyond 0.6 MGD. However, once the East Travis Regional WWTP is online, this additional capacity should eliminate the need for Phase 4 expansion of the Cottonwood Creek WWTP.

6.3 Wilbarger Wastewater Treatment Plant

The Wilbarger WWTP, located in Old Manor at the intersection of Llano Street and Old Highway 20, is permitted to be expanded from 1.33 MGD to 2.0 MGD. Average daily dry weather flows at Wilbarger WWTP from January to April 2024 were approximately 1 MGD, or 75% of the current 1.33 MGD capacity. As mentioned previously, the TCEQ Chapter 217 Rules require that plant expansion design commence at 75% of permitted phase capacity and construction start at 90% of permitted phase capacity. Design of the Wilbarger WWTP expansion has begun, and construction of the expansion will be essential within the next five years to keep up with projected growth. However, the timing of further expansions beyond 2.0 MGD will depend on several factors.

Expanding Wilbarger WWTP beyond 2.0 MGD is expected to be more costly than expanding from 1.33 to 2.0 MGD. The current design and layout of multiple ancillary systems (such as the on-site lift station, chemical feed systems, yard and outfall piping, electrical service, etc.) generally allows for efficient expansion to the 2.0 MGD capacity. However, expansion beyond the 2.0 MGD capacity would require these systems to be increased in capacity beyond the current design provisions. This may mean duplicate systems or wholesale replacement of existing equipment with larger capacity equipment, thus reducing or negating economies of scale. Increasing the permitted capacity beyond the current 2.0 MGD would also require a major permit amendment through the TCEQ. The permit amendment process typically takes a minimum of a year and can extend up to three years if the application is protested and a case referred to the State Office of Administrative Hearings. The expansion beyond 2.0 MGD may also require the City to acquire additional land around the current plant to accommodate the expansion. For these reasons, expansion of Wilbarger WWTP beyond 2.0 MGD would be costly, and any opportunity to postpone or indefinitely avoid such an expansion would be preferable.

6.4 Decommissioning Lift Stations 6, 8, and 9

To delay expansion of Wilbarger WWTP beyond 2.0 MGD, it is recommended that the City decommission lift stations 6 (Stonewater), 8 (Presidential Glen Ph. 4B), and 9 (Presidential Heights), rerouting their flows via gravity sewer to the proposed East Travis Regional WWTP once it is built. This would shift an estimated 0.5-0.6 MGD of ADDF away from the Wilbarger WWTP toward the new East Travis Regional WWTP. This decommissioning effort is expected to eliminate the need for expansion of Wilbarger WWTP beyond 2.0 MGD within the 15-year planning window of this study. However, it is not known whether this would permanently eliminate the need for expansion beyond 2.0 MGD, because the City's growth within the

Wilbarger Creek and Gilleland Creek basins may eventually exceed the projections developed for this study. With the recent adoption of Senate Bill 2038 which allows de-annexation from adjacent municipal ETJs, there is increased potential for growth to exceed what has been projected for this study.

Decommissioning lift stations 6, 8, and 9 would have multiple benefits besides delaying further expansion at Wilbarger WWTP. Operations and maintenance costs associated with these lift stations would be eliminated, which could equate to several hundred thousand dollars saved each year. Also, based on hydraulic modeling of the 15-year growth condition, it is anticipated that a costly upsizing project of the existing interceptor paralleling FM973 would be required in the future if LS06 (Stonewater) remains in service. If LS06 is eliminated though, the interceptor along FM973 is expected to have adequate capacity throughout the 15-year planning period. The costs associated with decommissioning lift stations 6, 8, and 9 would entail lift station decommissioning expenses, the cost of gravity sewer to convey flows to the East Travis Regional WWTP, and the cost of additional capacity required at East Travis Regional WWTP.

Another potential benefit of eliminating these lift stations would be the improvement of wastewater quality and reduction of H_2S production. By eliminating hydraulic detention time in lift station wet wells and force mains, wastewater quality issues, odor concerns, and maintenance concerns may be avoided.

6.5 Projected Capacity Allocations

Table 6-1 summarizes the approximate capacities being planned for each WWTP, as well as projected average daily flows, for each planning horizon.

As is shown in Table 6-1, present day ADDF estimates for Wilbarger WWTP and Cottonwood Creek WWTP are 1 MGD and 0.05 MGD respectively and are based on influent flow data from the first quarter of 2024 as provided by the City. By the 5-year time horizon, the Wilbarger WWTP must be expanded to 2 MGD to serve the projected growth in flows. Also, the Cottonwood Creek WWTP must be expanded to 0.6 MGD (Phase 3) by the 5-year time horizon.

The 15-year time horizon is split into two separate scenarios: Scenario 1, in which it is assumed that no decommissioning of lift stations has taken place; and Scenario 2, in which it is assumed that lift stations 6, 8, and 9 have been decommissioned and flows rerouted to East Travis Regional WWTP. It is assumed that the East Travis Regional WWTP will be fully operational by the 15-year time horizon in either scenario, and that the East Travis Regional WWTP will treat all flows in excess of the Cottonwood Creek WWTP's 0.6 MGD capacity. It is recommended that the City decommission lift stations 6, 8, and 9 because by the 15-year time horizon, ADDF at Wilbarger WWTP is projected to exceed the 2 MGD capacity in Scenario 1.

It is important to note that in Scenario 2 of the 15-year time horizon, in which lift stations 6, 8, and 9 are decommissioned, the projected ADDF for Wilbarger WWTP is approximately 1.6 MGD, or 80% of its 2 MGD capacity, and the projected ADDF for East Travis Regional WWTP is approximately 1.4 MGD, or 93% of its 1.5 MGD capacity. For these reasons, it is anticipated that expansion of Wilbarger WWTP and East Travis Regional WWTP beyond their 15-year capacities may be required just outside this study's 15-year planning window. This is dependent on growth continuing at projected rates however, and actual rates of growth will dictate actual timing and necessity of expansions. To delay or avoid further expansion of Wilbarger WWTP beyond 2 MGD, the City may need to reconsider further ETJ releases (as allowed under recent Senate Bill 2038) from the City of Austin that could be served by the Wilbarger plant, as these areas are not accounted for in this study and could increase capacity needs above 2 MGD.

Table 6-1: Projected Treatment Capacity Allocations

	Wilbarger WWTP		**Cottonwood Cr. WWTP**		**East Travis Regional WWTP**		**Total, All WWTPs**	
Time Horizon	Anticipated Capacity (MGD)	Projected ADDF (MGD)	Anticipated Capacity (MGD)	Projected ADDF (MGD)	Anticipated Capacity (MGD)	Projected ADDF (MGD)	Anticipated Capacity (MGD)	Projected ADDF (MGD)
Present (1)	1.33	1.0	0.2	0.05	-	-	1.5	1.1
5-year	2.0	1.3	0.6	0.4	-	-	2.6	1.7
15-year:								
Scenario 1, No LS Decomm. (2)	2.0	2.1	0.6	0.6 (4)	1.5	0.9	4.1	3.6
Scenario 2, LS 6,8,9 Decomm. (3)	2.0	1.6	0.6	0.6 (4)	1.5	1.4	4.1	3.6

Notes:

(1) Present ADDF estimates are based on recent (Jan-Apr 2024) plant influent flow data provided by City.

(2) This scenario represents the 15-year time horizon assuming no lift stations have been decommissioned.

(3) This scenario represents the 15-year time horizon assuming lift stations 6, 8, and 9 have been decommissioned and flows rerouted to East Travis Regional.

(4) It is assumed that by the 15-year time horizon, Cottonwood Creek WWTP will reach its 0.6 MGD capacity and the remainder of flow in the Cottonwood Cr. Basin will be treated at East Travis Regional.

6.6 Recommended Treatment Capacity Projects

Below is a summary of projects recommended for each WWTP based on the capacity analysis described above:

1) Wilbarger WWTP
    a. Within 5 Years: Expand to 2 MGD
    b. Beyond this study (>15 Years): Potential for Expansion Beyond 2 MGD
2) Cottonwood Creek WWTP
    a. Within 5 Years: Expand to 0.6 MGD (Execute Phases 2 and 3)
    b. Beyond this study (>15 Years): Potential for Decommissioning or Reuse
3) East Travis Regional WWTP
    a. Within 15 Years: Design and Construct 1.5 MGD Facility
    b. Beyond this study (>15 Years): Potential for Expansion Beyond 1.5 MGD

7 OVERALL RECOMMENDATIONS AND CONCLUSIONS

This section outlines the conceptual projects identified from modeling, as well as the planning-level costs estimated for each identified project.

7.1 Development of Planning Level Opinion of Probable Costs

All planning-level costs of projects are in February 2024 dollars and include the opinion of probable construction cost (OPCC), along with a 20% construction contingency, a 30% factor for engineering and other soft costs, and an additional 10% contingency for projects involving railroad crossings. The inclusion of the railroad crossing contingency is due to additional engineering costs for obtaining permits and additional construction costs due to longer bores.

The estimated unit cost for acquiring easements for new infrastructure projects outside of existing right-of-way (ROW) or pre-existing easements was approximately $88,000 per acre. This unit cost was determined by averaging the expenses of recent utility infrastructure easements in Central Texas for both developed and undeveloped areas and includes easement survey costs, engineering, ROW agent, condemnation, attorney fees, and easement acquisition costs.

All OPCCs are considered planning-level, and actual costs may vary significantly depending on final design, project scope and bidding environment. Planning-level construction cost estimates for both new and existing infrastructure projects were estimated based on the following assumptions:

- Gravity Lines: Gravity pipe construction costs generally cover excavation, pipe, ditch checks, manholes, extra depth, erosion control, restoration, and mobilization. The gravity pipe construction estimates also assume that 10% of gravity line length will be encased with a steel casing to account for roadway and stream crossings.
- Lift Stations: The cost for lift station construction generally covers erosion control, site work, wet well, pumps, site piping, electrical work, controls, jib crane, hoist, fencing, access road, restoration, and appurtenances. The lift station unit costs were calculated based on averaging construction costs from past lift station projects.
- Force Mains: Force main construction costs generally cover excavation, pipe, erosion control, and restoration.

7.2 Field Investigations Prior to Design

To confirm a relief project's urgency and necessity, field investigations and targeted flow metering are recommended before initiating design and construction. The hydraulic model is most accurate nearest the meter locations used for model calibration. Locations in the model that are relatively far upstream or downstream from a meter location are more likely to be imprecise in terms of flow predictions. Many site-specific factors in the collection system can impact flow conditions at a particular location that may not be readily apparent from flow data collected far downstream of that location (such as branching interceptors or diversions). Also, timing and scale of future growth may vary from growth projections assumed in this report, which may drastically change the necessity of projects listed below under future time horizons. Therefore, it is in the City's best interest to confirm and corroborate model results and project necessity before embarking on a costly relief or replacement project.

Table 7-1 describes the primary benefits and costs of performing targeted field investigations and flow monitoring prior to relief project implementation. Overall, these investigations are highly recommended and can help confirm the necessity and urgency of a project identified from modeling.

Table 7-1: Benefits and Costs of Targeted Investigations Prior to Relief Design

Benefits	Costs
+ Verify site-specific flow conditions necessitate a project at all, potentially saving City budget if a project is eliminated, postponed, or reduced in scope + Determine level of risk of postponing a project if flow conditions are not as concerning as originally predicted/modeled + Verify presence or absence of surcharge evidence (rags, high water marks, high water levels) + Verify site-specific hydraulics for fine-tuned modeling, such as diameters or pipe inverts that could not be collected during initial manhole inspections	- Additional costs of performing field investigations, flow monitoring and any supplementary modeling - Delays timeline toward project completion if project is essential

7.3 Ongoing I/I Mitigation

The City of Manor is currently engaged in I/I mitigation efforts. It is important to note that the impacts of these I/I mitigation efforts could result in lower peak wet weather flows in the interceptors. If peak wet weather flows are reduced from what has been projected for this plan, then relief or upsizing projects may be delayed or avoided. To determine whether a relief project can be delayed or avoided, however, will require targeted, post-rehabilitation flow monitoring to confirm actual flow conditions after I/I reduction projects have been implemented.

7.4 Recommended Model Calibration Updates

As a wastewater system grows and improves, it is important that the associated hydraulic model accounts for such changes over time. The current calibration is not final and should be updated when new flow monitoring data becomes available. It is typically recommended that new flow monitoring data be collected and the hydraulic model re-calibrated at least once every five years.

Modeling a system such as Manor's is an ongoing, collaborative process to account for the dynamics of a growing city. Now that the model is fully developed, the City will have opportunities to re-calibrate the model to new flow meter data collected in the future. As the City performs I/I reduction projects, the future flow meter data will ideally reflect a reduction in I/I. This new flow meter data can be used to re-calibrate the model, which could in turn reduce modeled peak flows during storm events. If the modeled peak flows are reduced based on new flow data, then the flows used for sizing relief projects or new sewer projects may also be reduced accordingly. This would reduce expenses for the City by reducing required pipe sizes. Therefore, it is in the City's best interest to perform regular flow monitoring and re-calibration of the hydraulic model to ensure the most up-to-date information is being used to guide CIP decision making.

7.5 Project Summary

Table 7-2 and Figure 7-1 present a summary of all projects identified as part of this collection system master planning project. Further descriptions of the recommended projects are provided in the sections below. IDs for each project (e.g., "WW.00.01") are formatted such that the middle two digits represent the time horizon by which the project becomes necessary ("00" for present day, "05" for 5-year growth conditions, etc.), and the second two digits represent a unique project number for that time horizon. Though parts of the existing system are overloaded and need relief prior to the 15-year growth horizon, all sizing recommendations are based on the 15-year growth condition flows.

Table 7-2: Overall Project List

Project ID	Infrastructure Type	Time Horizon	Current CIP Project ID	Project Name	Type of Improvement	Pipe Diameter (in)[1]	Total Length of Pipe (ft)	Lift Station or WWTP Flow Rate (mgd)	Planning-Level Construction OPCC without Contingency	Capital Cost (30% Contingency, 20% Engr./Survey,)[3]
WW.00.01	Existing/Relief	Present Day	-	Llano St and Lampasas St Interceptors[2]	Exist. Gravity Relief/Upsizing	18"-36"	4,060	-	$3,405,040	$5,652,000
WW.00.02	Existing/Relief	Present Day	-	Pyrite Rd Gravity Sewer (upstream of LS06) - *I/I Mitigation Potential*	Exist. Gravity Relief/Upsizing	18"	930	-	$584,010	$911,000
WW.00.03	Existing/Relief	Present Day	CIP-4	US 290 Interceptor (Still Necessary even if LS06/08/09 are Decommissioned)	Exist. Gravity Relief/Upsizing	24"	2,030	-	$1,596,488	$2,491,000
WW.00.04	Existing/Relief	Present Day	-	Rehabilitation and I/I Mitigation in Existing Sewers	Rehabilitation	-	40,440	-	$7,279,200	$11,356,000
WW.05.01	Treatment	5-Year	S-31	Cottonwood WWTP Expansion Ph. 3 (Expansion from 0.4 to 0.6 MGD)	Exist. WWTP Expansion	-	-	0.2	$3,260,000	$5,086,000
WW.05.02	Treatment	5-Year	-	Wilbarger WWTP Expansion (Expansion from 1.33 to 2.0 MGD)	Exist. WWTP Expansion	-	-	0.67	$16,750,000	$26,130,000
WW.05.03	New/Extension	5-Year	S-36	Manor Springs Lift Station Improvements	New LS to Serve Growth	6"(F)	3,760(F)	0.5	$1,606,289	$2,506,000
WW.05.04	New/Extension	5-Year	S-23	Voelker Ln. Wastewater Improvements	New Gravity to Serve Growth	12"	6,560	-	$4,595,771	$7,169,000
WW.15.01	Treatment	15-Year	S-39/40/41	East Travis Regional WWTP	New WWTP to Serve Growth	-	-	1.5	$37,403,000	$58,349,000
WW.15.02	Existing/Relief	15-Year	Dev. Agr.	Lift Station 1 (Las Entradas) and O09-006_O09-005	Exist. LS Expansion	18"	260	-	$164,430	$257,000
WW.15.03	Existing/Relief	15-Year	S-18	West Cottonwood Creek Existing Interceptor	Exist. Gravity Relief/Upsizing	24"-27"	8,500	-	$8,236,967	$12,850,000
WW.15.04	Existing/Relief	15-Year	S-16	East Cottonwood Creek Existing Interceptor	Exist. Gravity Relief/Upsizing	27"-33"	3,070	-	$3,392,810	$5,293,000
WW.15.05	Existing/Relief	15-Year	-	FM973 Interceptor (Not Necessary if LS06 is Decommissioned)	Exist. Gravity Relief/Upsizing	18"	4,220	-	$2,658,600	$4,147,000
WW.15.06	New/Extension	15-Year	S-38	South Cottonwood Creek Wastewater Interceptor Improvements Phase 1[2]	New Gravity to Serve Growth	39"-45"	7,960	-	$15,366,210	$25,508,000
WW.15.07	New/Extension	15-Year	S-38	South Cottonwood Creek Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	36"	8,910	-	$13,811,117	$21,545,000
WW.15.08	New/Extension	15-Year	S-23	Willow Creek Wastewater and Lift Station Improvements	New Gravity/LS to Serve Growth	24"(G), 6"(F)	2,160(G/F)	0.65	$1,642,456	$2,562,000
WW.15.09	New/Extension	15-Year	-	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	24"	5,210	-	$5,424,105	$8,462,000
WW.15.10	New/Extension	15-Year	-	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	15"-21"	7,710	-	$6,455,271	$10,070,000
WW.15.11	New/Extension	15-Year	-	East US290 Wastewater Improvements	New Gravity to Serve Growth	15"	2,920	-	$2,219,654	$3,463,000
WW.15.12	New/Extension	15-Year	-	North Cottonwood Creek East Tributary Wastewater Interceptor Improvements	New Gravity to Serve Growth	15"-18"	8,480	-	$6,720,382	$10,484,000
WW.15.13	New/Extension	15-Year	-	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	27"	7,390	-	$8,791,977	$13,715,000
WW.15.14	New/Extension	15-Year	-	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	27"	3,590	-	$4,424,675	$6,902,000
WW.15.15	New/Extension	15-Year	-	Littig Rd. Wastewater Improvements[2]	New Gravity to Serve Growth	12"	8,510	-	$5,961,816	$9,897,000
WW.15.16	New/Extension	15-Year	-	North Cottonwood Creek Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	21"-24"	7,238	-	$7,379,755	$11,512,000
WW.15.17	New/Extension	15-Year	-	North Cottonwood Creek Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	12"-18"	10,367	-	$8,035,168	$12,535,000
WW.15.18	New/Extension	15-Year	-	South Wilbarger Creek Lift Station Improvements	New LS to Serve Growth	4"(F)	5,040(F)	0.25	$1,287,296	$2,008,000
WW.15.19	New/Extension	15-Year	-	Lift Station #6 (Stonewater) Decommissioning	New Gravity to Abandon LS	18"	3,300	-	$3,134,355	$4,890,000
WW.15.20	New/Extension	15-Year	-	Lift Station #8 (Presidential Glen Ph. 4B) Decommissioning	New Gravity to Abandon LS	12"	1,400	-	$1,281,253	$1,999,000
WW.15.21	New/Extension	15-Year	-	Lift Station #9 (Presidential Heights) Decommissioning	New Gravity to Abandon LS	12"	500	-	$650,448	$1,015,000

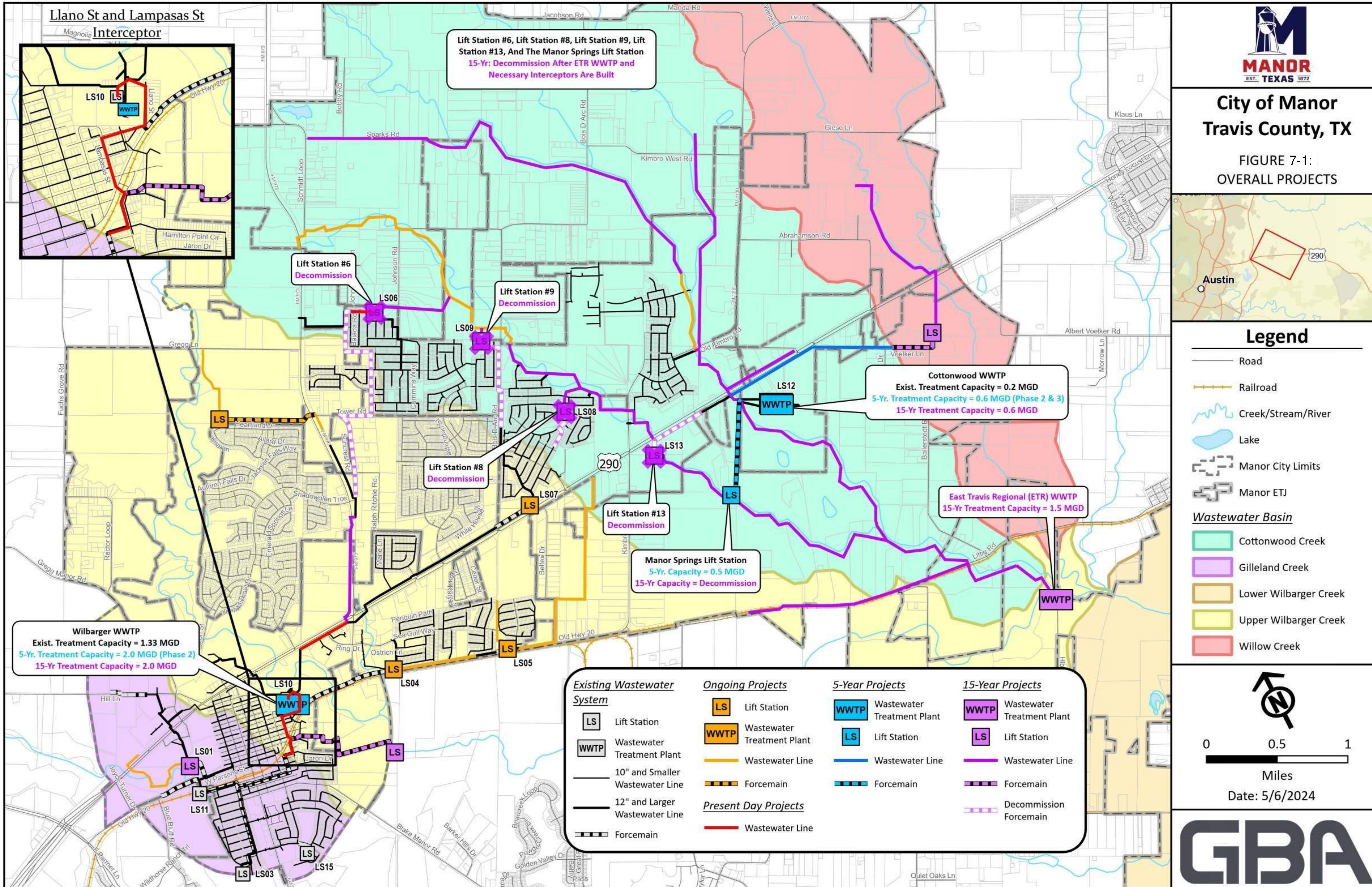
Time Horizon	Capital Cost
Present Day	$ 20,410,000
5-Year	$ 40,891,000
15-Year	$ 227,463,000
Total, All Projects	**$ 288,764,000**

Notes:

1) For pipe diameters and lengths, gravity main is assumed, except where (F) indicates force main, and (G) indicates gravity main.
2) Select projects include an additional 10% contingency for railroad crossings to account for additional costs (permitting, extra boring length, etc.).
3) For new/extension projects not within the ROW or an exisitng easement, a unit cost of $87,900/acre was utilized for easement cost estimates.
The easement unit cost includes survey, easement acquisition, engineering fees, condemnation/attorney fees, and ROW agent fees.

LS06, LS08, and LS09 are recommended to be decommissioned and re-routed by gravity towards East Travis Regional WWTP once it is built. This reduces burden on Wilbarger WWTP and the FM973 interceptor, and reduces LS O&M costs.

Projects Not Included: The above list does not include Bell Farms LS upgrades (LS04), Carriage Hills LS or interceptor upgrades, Cottonwood Cr. WWTP Ph. 2 expansion to 0.4 MGD (developer-funded), or other projects currently in-progress.



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7.6 Present Day Projects

Present day projects (those requiring attention under existing conditions) are presented in Figure 7-2, along with ongoing projects. Further description of present-day projects is provided below.

Llano St. and Lampasas St. Interceptor (WW.00.01)

The Llano St. and Lampasas St. Interceptor was predicted to severely surcharge under peak wet weather flows during the existing system design storm model run. It is recommended as the top priority relief project due to the higher risk of overflow (Refer to Section 7.9 for more information outlining the methodology in prioritizing relief-type projects). The 4,060 ft stretch of pipe runs through Old Manor, from the terminus of the LS03 and LS11 combined force main, to the Wilbarger WWTP, making it a crucial segment of sewer in Old Manor. The interceptor currently has pipe sizes ranging from 12" – 24" and is proposed to be upsized to 18" – 36" diameter pipes to adequately convey peak flows.

Pyrite Rd. Interceptor (WW.00.02)

The Pyrite Rd. Interceptor was shown to severely surcharge in the existing system design storm model. The stretch of pipe that is proposed to be improved is approximately 930 ft in length and serves Manor High School and portions of the Stonewater subdivision (Figure 7-2). The existing pipe segment has a 12" diameter and is proposed to be upsized to 18" based on modeling results.

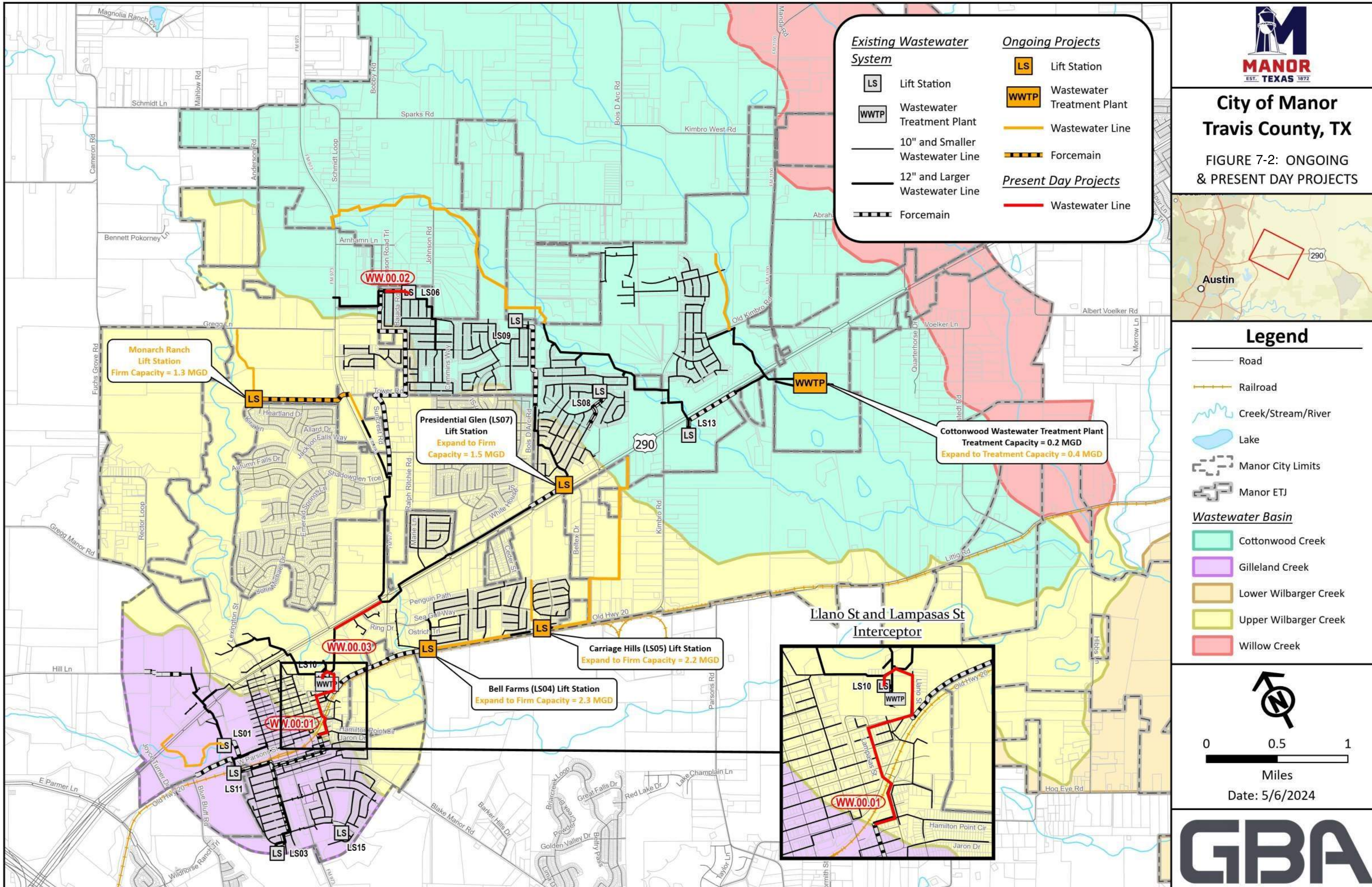
This project may be avoided or delayed if I/I mitigation efforts are successful in Basin 10. Fall 2022 flow data for meter basin 10 informed the model calibration for this portion of the system, and this flow meter basin demonstrated abnormally high peaks during Fall 2022 storm events. If peak flows in this basin are reduced through I/I mitigation efforts and future flow monitoring confirms this, a project along Pyrite Rd. may be avoided.

US-290 Interceptor (WW.00.03)

The US-290 Interceptor was shown to have undersized pipes and moderate surcharging in the existing system design storm model. The stretch of pipe that is proposed to be improved is approximately 2,090 ft in length and conveys flows from FM973, Presidential Heights, Presidential Glen, and Greenbury to the Wilbarger WWTP (Figure 7-2). The existing pipe has diameters ranging from 12" – 15" and is proposed to be upsized to 24".

Rehabilitation and I/I Mitigation in Existing Sewers (WW.00.04)

The City is committed to rehabilitating its existing gravity sewers and mitigating I/I. Potential rehabilitation methods include Cured-in-Place Pipe (CIPP), pipe bursting, and manhole lining, depending on condition. For a planning-level estimate of possible rehabilitation costs, it was assumed that one third of the total sewer line in the seven high-risk basins (1, 2B, 3, 4, 8, 10, and 13) identified during I/I investigations will need rehabilitation, roughly 40,000 LF. A unit cost of $180/LF of pipe rehabilitated was used, which is estimated from past I/I reduction projects GBA has designed and observed.



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7.7 5-year Projects

Five-year projects (projects requiring attention under 5-year growth conditions) are presented in Figure 7-3. Further description of 5-year projects is provided below.

Cottonwood WWTP Expansion Ph. 3 (WW.05.01)

Phase 3 of the Cottonwood Creek WWTP expansion will increase its capacity to 0.6 MGD. This phase, along with Phase 2, is crucial within the next five years to accommodate anticipated population growth in the Cottonwood Creek Basin. The Cottonwood Creek WWTP will play a vital role in phasing in the larger East Travis Regional WWTP. Its strategic location upstream of the proposed regional plant allows for operational flexibility during peak events or plant maintenance. It is recommended that Cottonwood Creek WWTP continues operating until the East Travis Regional WWTP achieves adequate capacity and redundancy. Additionally, Phase 3 expansion will enable the City to postpone construction of the regional plant until average daily flows are close to surpassing 0.6 MGD. Completion of the regional facility is expected to eliminate the need for Phase 4 expansion of the Cottonwood Creek WWTP.

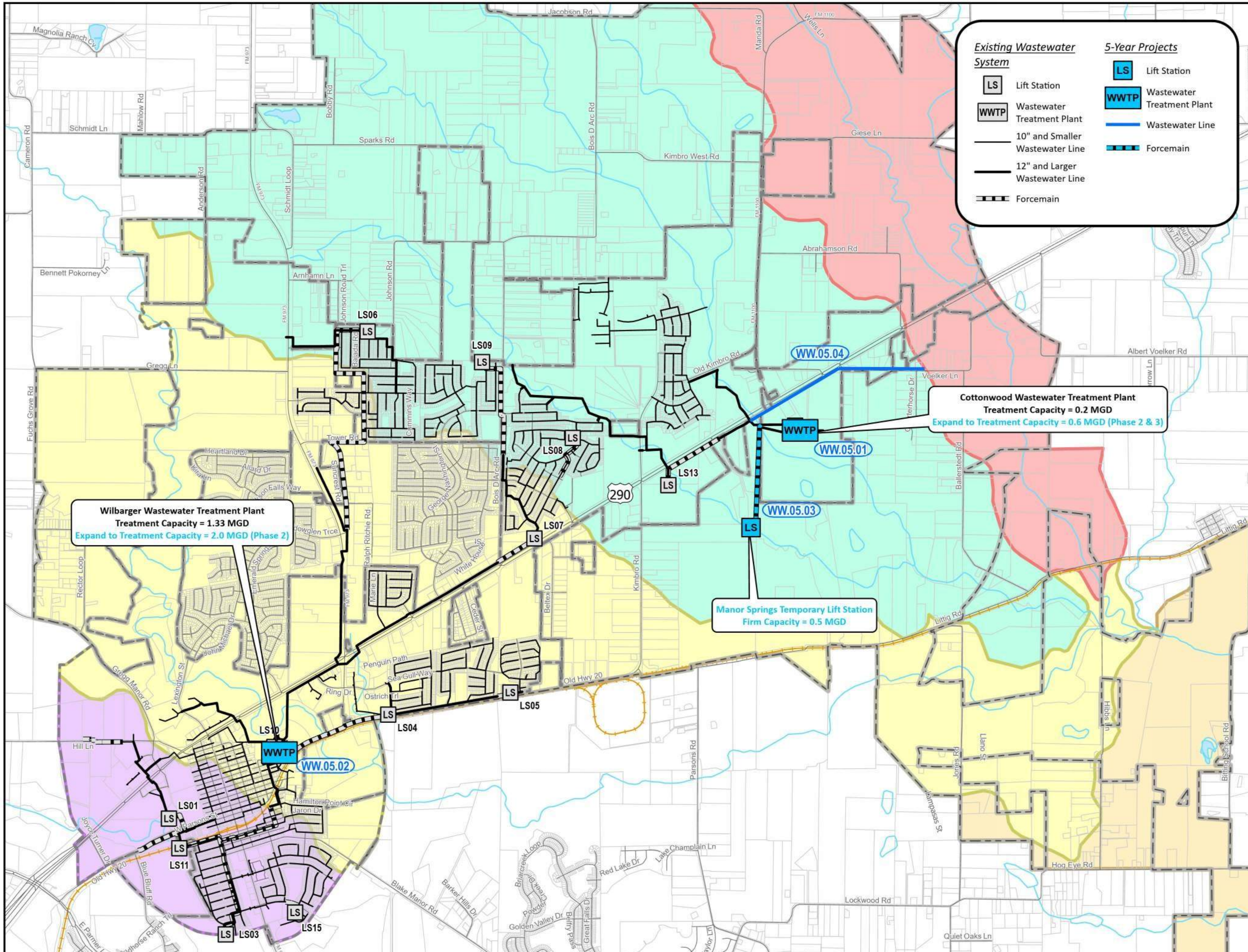
Wilbarger WWTP Expansion Ph. 2 (WW.05.02)

Phase 2 expansion of the Wilbarger WWTP, which would increase capacity from 1.33 MGD to 2.0 MGD, is crucial for keeping pace with projected growth. Current average daily flows to the plant are approximately 75% of the current capacity. The TCEQ Chapter 217 Rules mandate that expansion design begins at 75% capacity and construction starts at 90%. While the current design allows for efficient expansion to 2.0 MGD, further expansion beyond 2.0 MGD would incur significantly higher costs due to the need for increased capacity in ancillary systems, potential permit amendments, and land acquisition. Any opportunity to delay or avoid expansion beyond 2.0 MGD would be advantageous due to these factors.

Extension Projects Summary

There are two future extension projects proposed for the five-year time horizon. The Manor Springs Lift Station (WW.05.03) is proposed due to developer interest in the parcels located north of Littig Rd and east of Old Kimbro Rd. This lift station would be required to provide wastewater service to these parcels and temporarily convey flows to the Cottonwood Creek WWTP. The other five-year extension project includes a 12” gravity extension to serve development along Voelker Ln. and East US-290 (WW.05.04). For a summary of all extension projects, please see Table 7-4.

Two projects identified in the 5-year design storm modeling are either fully designed or being constructed. Therefore, these projects are not being added to the recommended project list for this master plan. They include the Old Hwy 20 Interceptor and LS04 (Bell Farms), both of which serve the Bell Farms and Carriage Hills subdivisions. These sewers and lift stations were shown to be undersized in the 5-year growth condition model, and are currently being addressed as part of ongoing projects.



City of Manor
Travis County, TX

FIGURE 7-3:
5-YEAR PROJECTS

Legend

- Road
- Railroad
- Creek/Stream/River
- Lake
- Manor City Limits
- Manor ETJ

Wastewater Basin

- Cottonwood Creek
- Gilleland Creek
- Lower Wilbarger Creek
- Upper Wilbarger Creek
- Willow Creek

0 0.5 1

Miles

Date: 5/6/2024

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7.8 15-year Projects

Fifteen-year projects (projects requiring attention under 15-year growth conditions) are presented in Figure 7-4. Further description of 15-year projects is provided below.

East Travis Regional WWTP (WW.15.01)

The East Travis Regional WWTP is crucial for accommodating future growth in Manor's eastern areas. It is proposed near the intersection of Littig Road and Ballerstedt Road, at the confluence of Cottonwood Creek, Wilbarger Creek, and Willow Creek drainage basins. This WWTP has been conceptualized as part of previous studies and included in the city's recent 10-year wastewater CIP. This plant will serve a larger area than the current Cottonwood Creek WWTP, potentially allowing the City to phase out or repurpose the Cottonwood Creek WWTP. An initial capacity of 1.5 MGD is assumed for the first phase of the regional plant, but additional capacity beyond 1.5 MGD may be required soon after the 15-year time horizon, depending on actual growth conditions.

LS01 Expansion (WW.15.02)

LS01, also referred to as the “Old High School” or “Las Entradas” Lift Station, was shown to be undersized in the 15-year growth conditions model. The 15-year free flow model scenario shows that if this lift station is upsized, then the pipe immediately downstream of the lift station, O09-006_O09-005, may be undersized due to the increase in flow. The downstream pipe currently has a diameter of 12” and it is recommended to be upsized to a diameter of 18”. As previously stated, there is an agreement with the developer that states that they are responsible for the expansion of this lift station.

West Cottonwood Creek Interceptor (WW.15.03)

The West Cottonwood Creek Interceptor was predicted to surcharge during the 15-year growth conditions model run. The 8,050 ft stretch of existing pipe receives flows from the West portion of the Cottonwood Creek basin north of US-290 and flows into LS13 before being pumped east to the Cottonwood Creek WWTP (Figure 7-4). The interceptor currently has pipe sizes ranging from 12” – 18” and is proposed to be upsized to 24” – 27” diameter pipes to convey future flows.

East Cottonwood Creek Interceptor (WW.15.04)

The East Cottonwood Creek Interceptor was predicted to undergo surcharging during the 15-year growth conditions model run. The 3,070 ft stretch of pipe receives flows from the East portion of the Cottonwood Creek Basin north of US-290 (Figure 7-4). The interceptor currently has pipe sizes ranging from 12” – 21” and is proposed to be upsized to 27” – 33” diameter pipes to convey future flows.

FM973 Interceptor (WW.15.05)

The FM973 Interceptor was shown to have undersized pipes and flooding in the 15-year growth conditions model. The stretch of pipe that is proposed to be improved is approximately 4,220 ft in length and receives and conveys flows from Stonewater, Manor High School, and other growth areas along FM973 (Figure 7-4). The existing pipe segment has a diameter of 15” and is proposed to be upsized to 18”.

IMPORTANT: If LS06 (Stonewater) is decommissioned and its flows are rerouted to the proposed East Travis Regional Plant, the FM973 improvements may not be necessary within the planning window of this study, based on modeling results and growth assumptions.

Extension Projects Summary

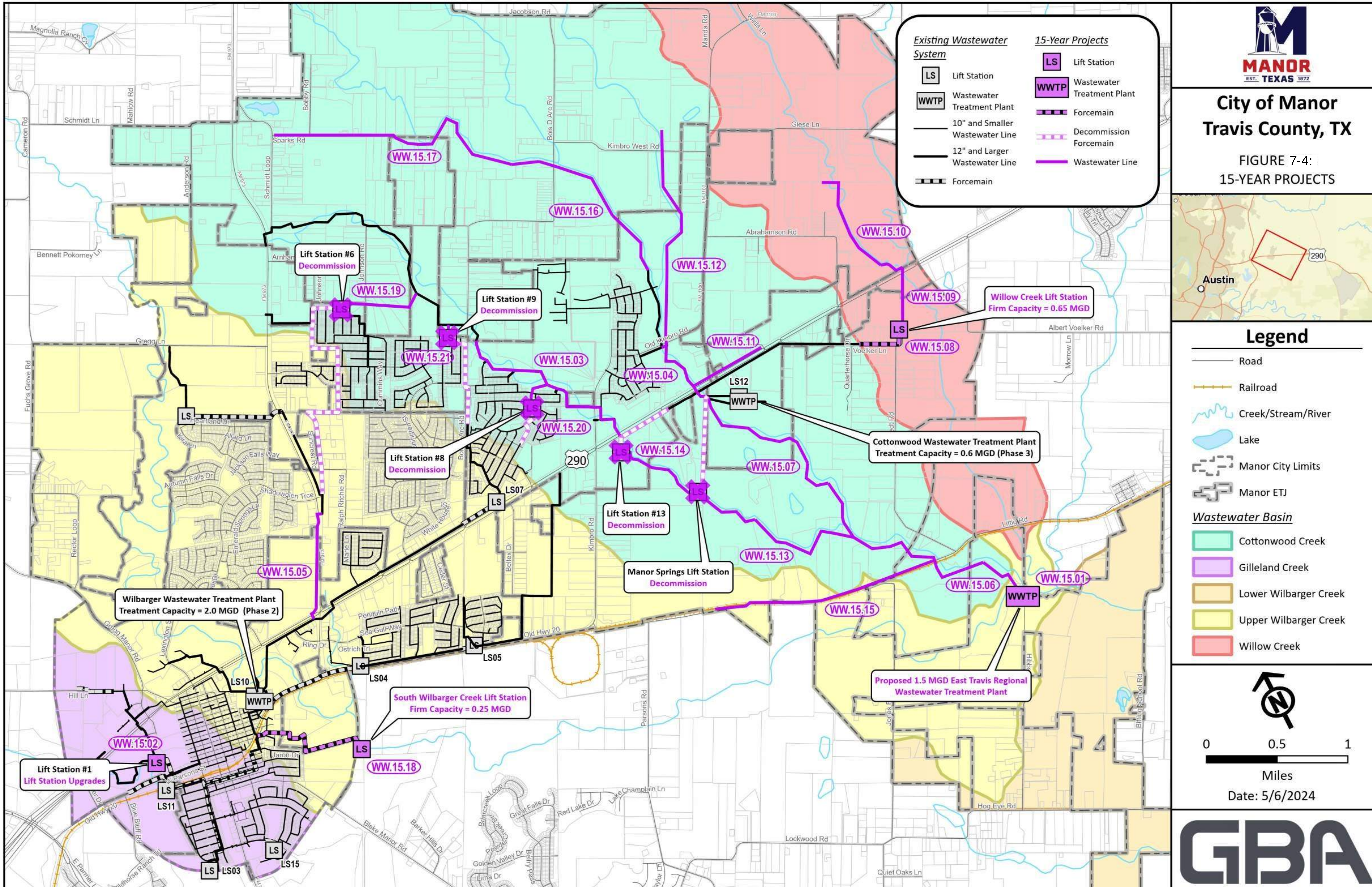
A majority of the 15-year extension projects are located in the Cottonwood Creek basin due to anticipation of growth in the eastern portions of the City. These projects include approximately 70,000 LF of gravity sewer extensions to serve new growth. In addition, lift stations 6, 8, and 9 are proposed to be decommissioned to alleviate pressure on the Wilbarger WWTP and reduce operational costs, rerouting flows by gravity to the East Travis Regional WWTP (WW.15.19 – WW.15.21). LS13 and the Manor Springs Lift Station and are also proposed to be decommissioned by the 15-year time horizon, assuming the East Travis Regional WWTP and the necessary gravity interceptors are built to allow for decommissioning (WW.15.01, WW.15.06, WW.15.13, WW.15.14).

Growth anticipated in the Willow Creek basin may necessitate the construction of approximately 13,000 LF of gravity interceptor and a roughly 0.65 MGD lift station (WW.15.08, WW.15.09, WW.15.10).

Approximately 8,500 LF of gravity sewer is proposed to serve development along Littig Rd and Kimbro Rd and ultimately convey flows to East Travis Regional WWTP via the South Cottonwood Creek Interceptor (WW.15.15).

The South Wilbarger Creek Lift Station is proposed to serve the southwest portion of the Upper Wilbarger Creek basin within city limits, with an associated capacity of roughly 0.25 MGD (WW.15.18).

For a summary of all extension projects, please see Table 7-4.



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7.9 Relief Project Prioritization

Relief-type projects for existing interceptors were prioritized based on various factors, such as the number of manholes meeting critical surcharge criteria, total flood loss, and the maximum ratio of 15-year free flow capacity to the existing pipe's full flow capacity. Table 7-3 presents these factors for each relief-type project, which were then ranked within each time horizon. Future extension projects were not prioritized in this way because they were not modeled and are heavily driven by development demands. Relief-type projects are more dependent on modeling results and the condition and capacity of existing interceptors. Extension-type projects should proceed as development requires them, while relief-type projects should proceed after modeling and monitoring confirm increased capacity risks in the existing sewers.

Table 7-3: Existing Infrastructure Project Prioritization

Project ID	Project Name	Time Horizon	Total Flood Volume(1) (MG)	No. of MHs Exceeding Surcharge Criteria(1)	Max. 15-year Free Flow-to-Existing Capacity Ratio	Relief Project Priority Rank
WW.00.01	Llano/Lampasas St Interceptor	Present Day	0	6	4.0	1
WW.00.02	Pyrite Rd Interceptor	Present Day	0	7	2.3	2
WW.00.03	US-290 Interceptor	Present Day	0	1	4.0	3
WW.15.03	West Cottonwood Creek Interceptor	15-year	0.08	20	2.7	4
WW.15.02	FM973 Interceptor	15-year	0.07	12	1.3	5
WW.15.04	East Cottonwood Creek Interceptor	15-year	0	7	2.9	6
WW.15.01	Lift Station 1 Expansion	15-year	N/A	N/A	N/A	7

(1): Data presented is derived from the model corresponding to the designated time horizon for each project.

***IMPORTANT**: Actual order of project implementation will depend on actual growth conditions and confirmation of project needs based on flow monitoring and investigation.*

7.10 Extension Projects Summary

Table 7-4 provides further description of extension-type projects conceptualized for the plan. Extension-type projects are those that extend City sewer service out beyond current service limits with new interceptors, lift stations, and force main. These projects are primarily development and growth driven.

Table 7-4: Extension Projects Summary

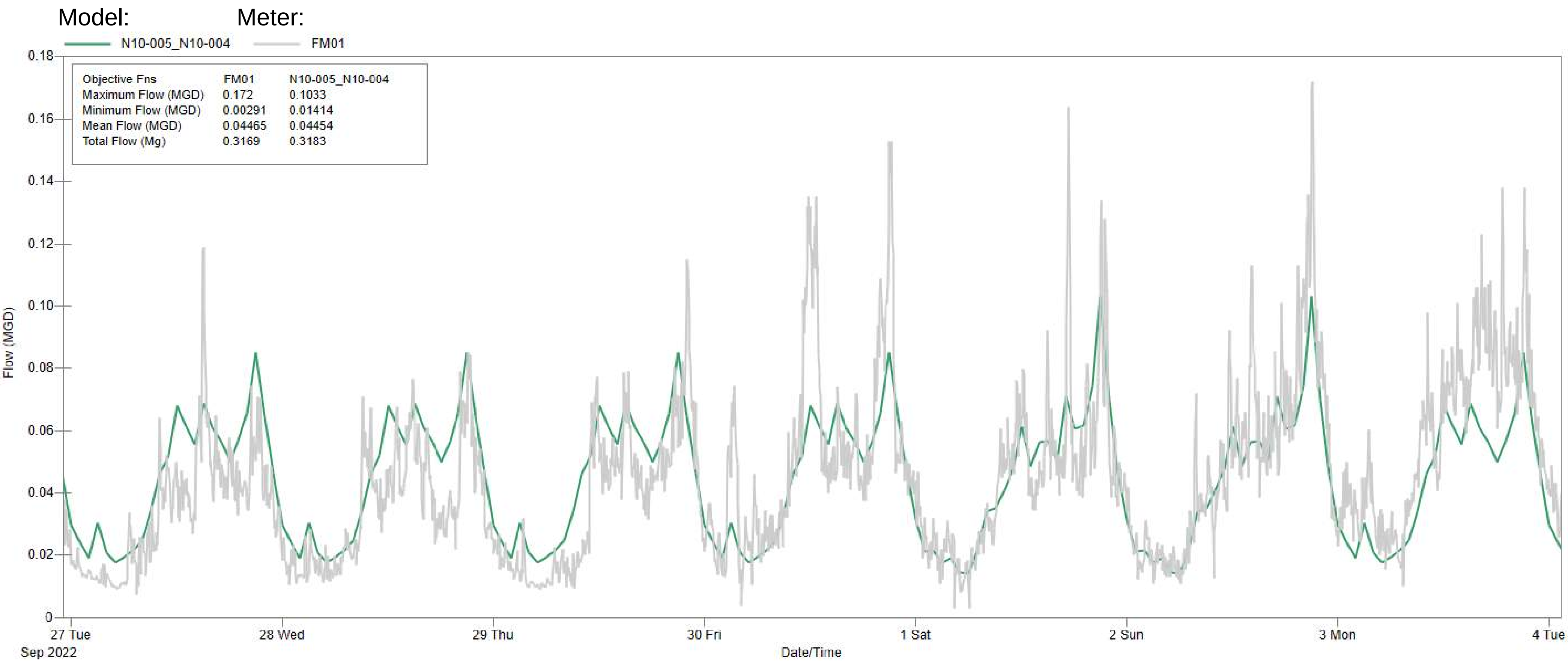
Project ID	Project Name	Time Horizon	Project Description
WW.05.03	Manor Springs Lift Station Improvements	5-year	This project includes a temporary 0.5 MGD Lift Station and a 12" Forcemain that will discharge into the Cottonwood Creek Wastewater Interceptor. Flows will go the Cottonwood Creek WWTP until the East Travis Regional WWTP is built. The temporary Lift Station will be decommissioned once the East Travis Regional WWTP and wastewater interceptors are built.
WW.05.04	Voelker Ln. Wastewater Improvements	5-year	This project includes a 12" Gravity Main that will discharge into the Cottonwood Creek Wastewater interceptor. This wastewater line will serve development along Voelker Ln. and East US-290.
WW.15.06	South Cottonwood Creek Wastewater Interceptor Improvements Phase 1	15-year	This interceptor includes a 39", 42" and 45" Gravity Main in the Cottonwood Creek basin. The interceptor will run from the Cottonwood Creek WWTP to the East Travis Regional WWTP.
WW.15.07	South Cottonwood Creek Wastewater Interceptor Improvements Phase 2	15-year	This interceptor includes a 36" Gravity Main in the Cottonwood Creek basin. The interceptor will run from the Cottonwood Creek WWTP to the East Travis Regional WWTP.
WW.15.08	Willow Creek Lift Station Improvements	15-year	This project includes a temporary 0.65 MGD Lift Station, a 6" Forcemain, and a 27" Gravity Main that will discharge into the Cottonwood Creek Wastewater Interceptor. Flows will go the Cottonwood Creek WWTP until the East Travis Regional WWTP is built. The temporary Lift Station will be decommissioned once the East Travis Regional WWTP and wastewater interceptors are built.
WW.15.09	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 1	15-year	This interceptor includes a 24" Gravity Main in the Willow Creek basin. The interceptor will connect to the temporary Willow Creek Lift Station.
WW.15.10	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 2	15-year	This interceptor includes a 15", 18", and 21" Gravity Main in the Willow Creek basin.
WW.15.11	East US-290 Wastewater Improvements	15-year	This project includes a 15" Gravity Main on the Cottonwood Creek basin. This wastewater will serve development along East US-290.
WW.15.12	North Cottonwood Creek East Tributary Wastewater Interceptor Improvements	15-year	This interceptor includes a 15" and 18" Gravity Main in the Cottonwood Creek basin.
WW.15.13	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 1	15-year	This interceptor includes a 27" Gravity Main in the Cottonwood Creek basin. The interceptor will connect to the North Cottonwood Creek West Tributary Wastewater Interceptor and relieve flows going to the Cottonwood Creek WWTP. This project will also include the decommissioning of the Manor Springs Lift Station after completion of this interceptor.
WW.15.14	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 2	15-year	This interceptor includes a 27" Gravity Main in the Cottonwood Creek basin. This project will also include the decommissioning of Lift Station #13 after completion of this interceptor.
WW.15.15	Littig Rd. Wastewater Improvements	15-year	This project includes a 12" Gravity Main that will discharge into the South Cottonwood Creek Interceptor. This wastewater main will serve development along Littig and Kimbro Rd.
WW.15.16	North Cottonwood Creek Wastewater Interceptor Improvements Phase 1	15-year	This interceptor includes a 21" and 24" Gravity Main in the Cottonwood Creek basin.
WW.15.17	North Cottonwood Creek Wastewater Interceptor Improvements Phase 2	15-year	This interceptor includes a 12" and 18" Gravity Main in the Cottonwood Creek basin.
WW.15.18	South Wilbarger Creek Lift Station Improvements	15-year	This project includes a 0.25 MGD Lift Station and a 4" Forcemain serving the south western portion of the Upper Wilbarger Creek basin within city limits.
WW.15.19	Lift Station #6 Decommissioning	15-year	This project includes decommissioning Lift Station #6 and a 18" Gravity Main connecting to the North Cottonwood Creek West Tributary Interceptor.
WW.15.20	Lift Station #8 Decommissioning	15-year	This project includes decommissioning Lift Station #8 and a 12" Gravity Main connecting to the North Cottonwood Creek West Tributary Interceptor.
WW.15.21	Lift Station #9 Decommissioning	15-year	This project includes decommissioning Lift Station #9 and a 12" Gravity Main connecting to the North Cottonwood Creek West Tributary Interceptor.

Appendix A: Manhole Survey Summary Maps

Manhole Survey Summary Maps Not Included

Appendix B: Dry Weather Calibration Summary

FM 01



Model:
Meter:
N10-005_N10-004
FM01
Objective Fns FM01 N10-005_N10-004
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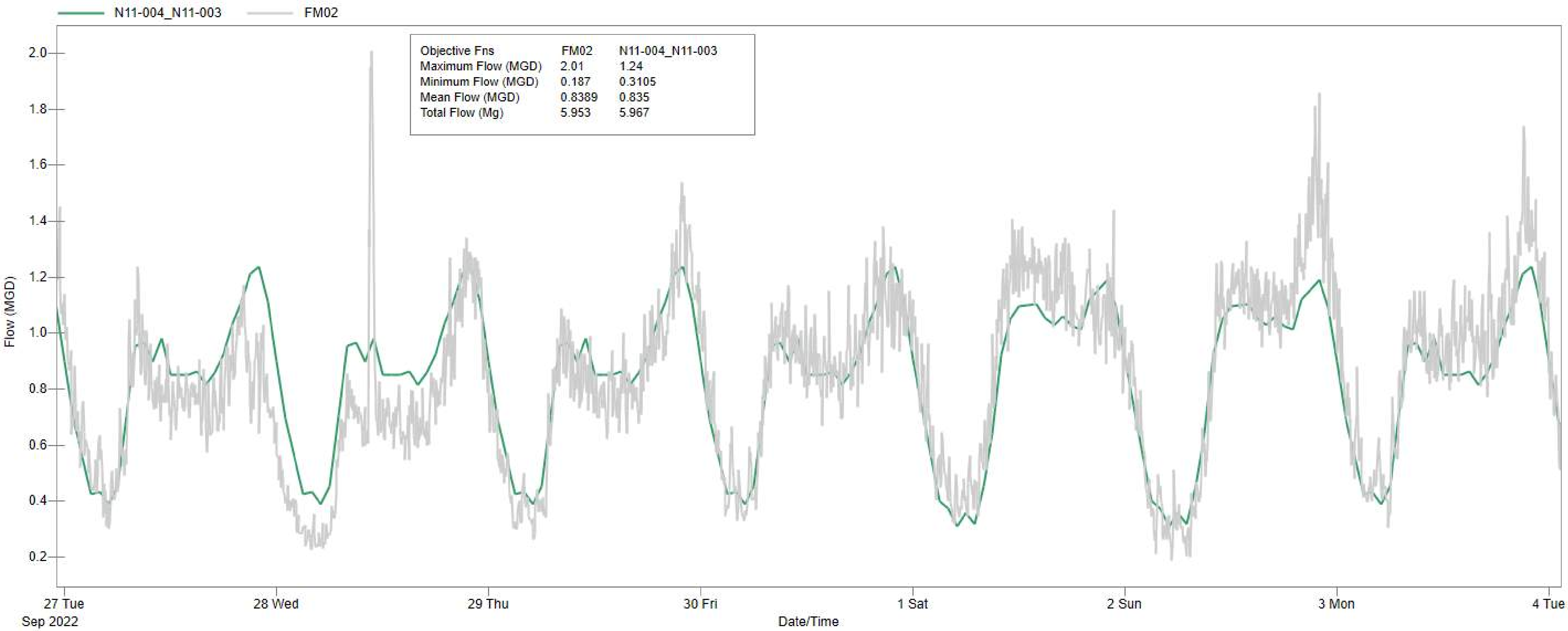
Minimum Flow (MGD) 0.00291 0.01414
Mean Flow (MGD) 0.04465 0.04454
Total Flow (Mg) 0.3169 0.3183
Flow (MGD)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0
27 Tue
Sep 2022
28 Wed
29 Thu
30 Fri
1 Sat
2 Sun
3 Mon
4 Tue
Date/Time

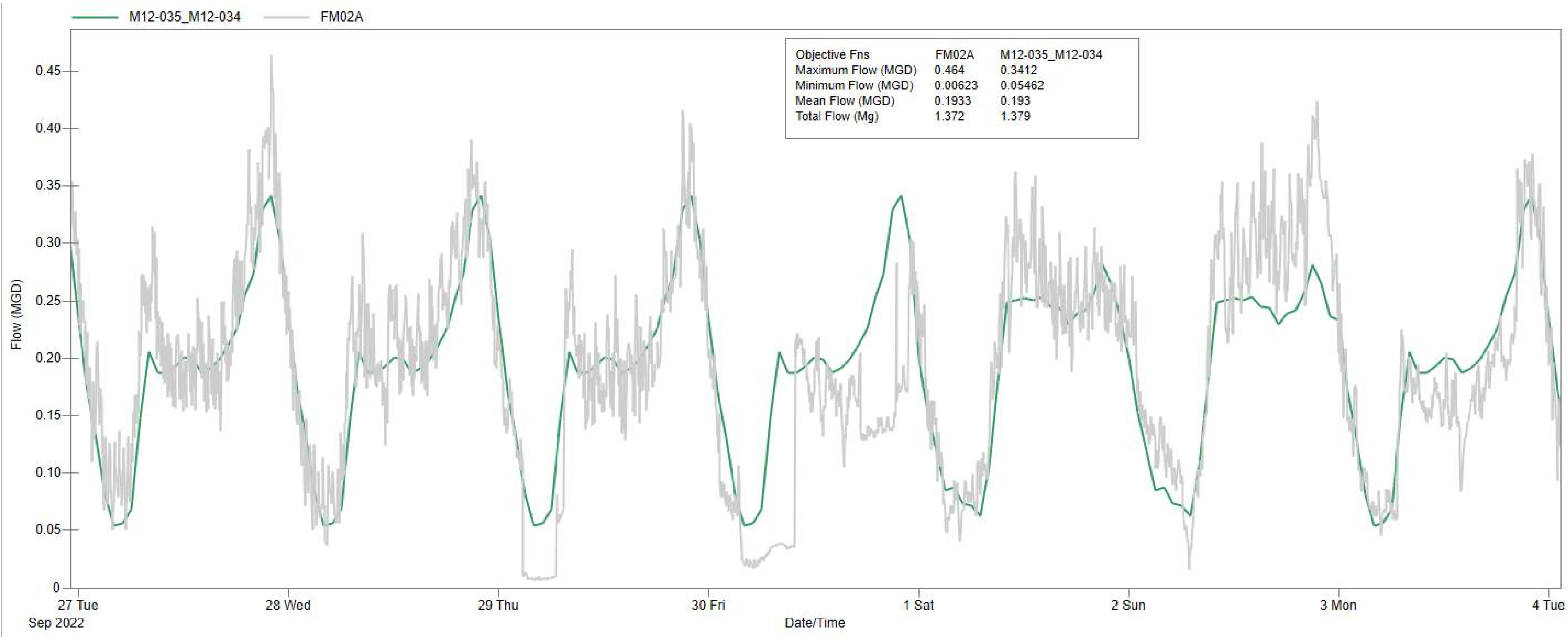
FM 02

Model: Meter:

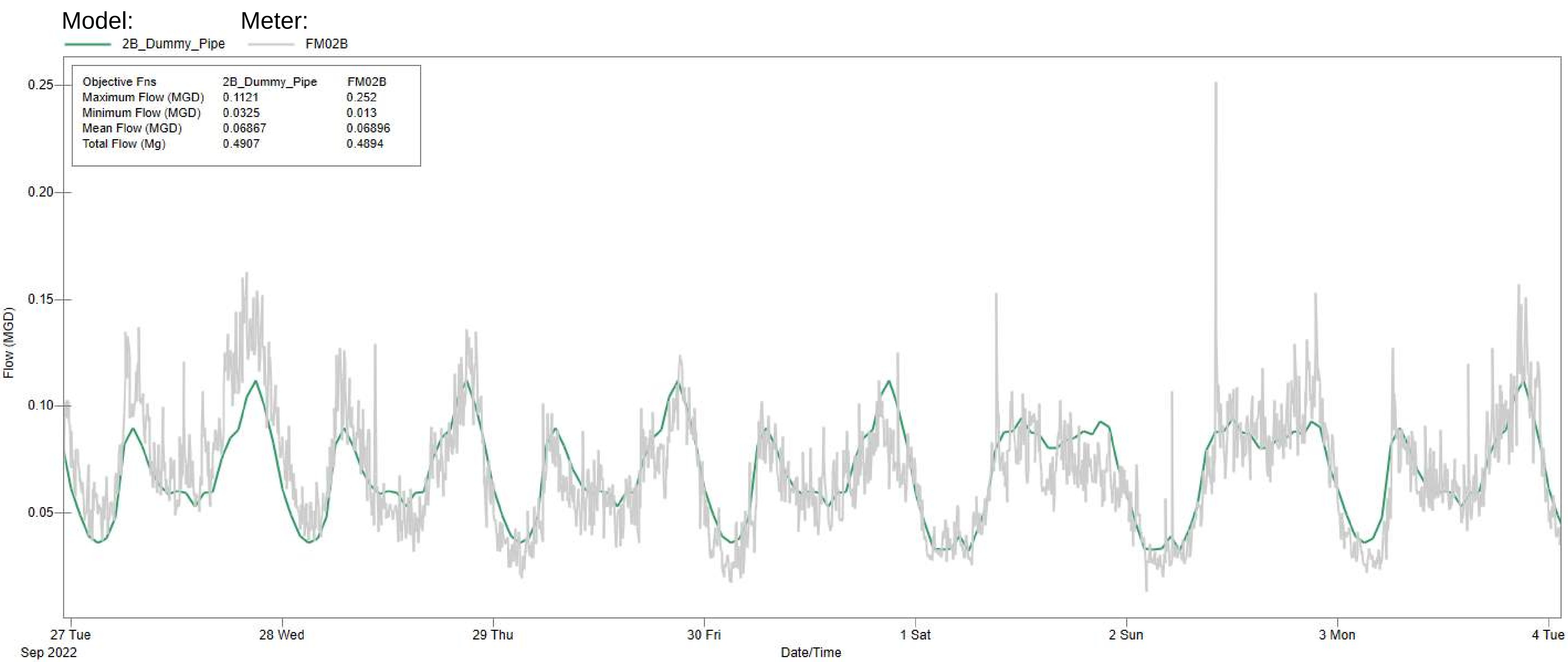


FM 02A

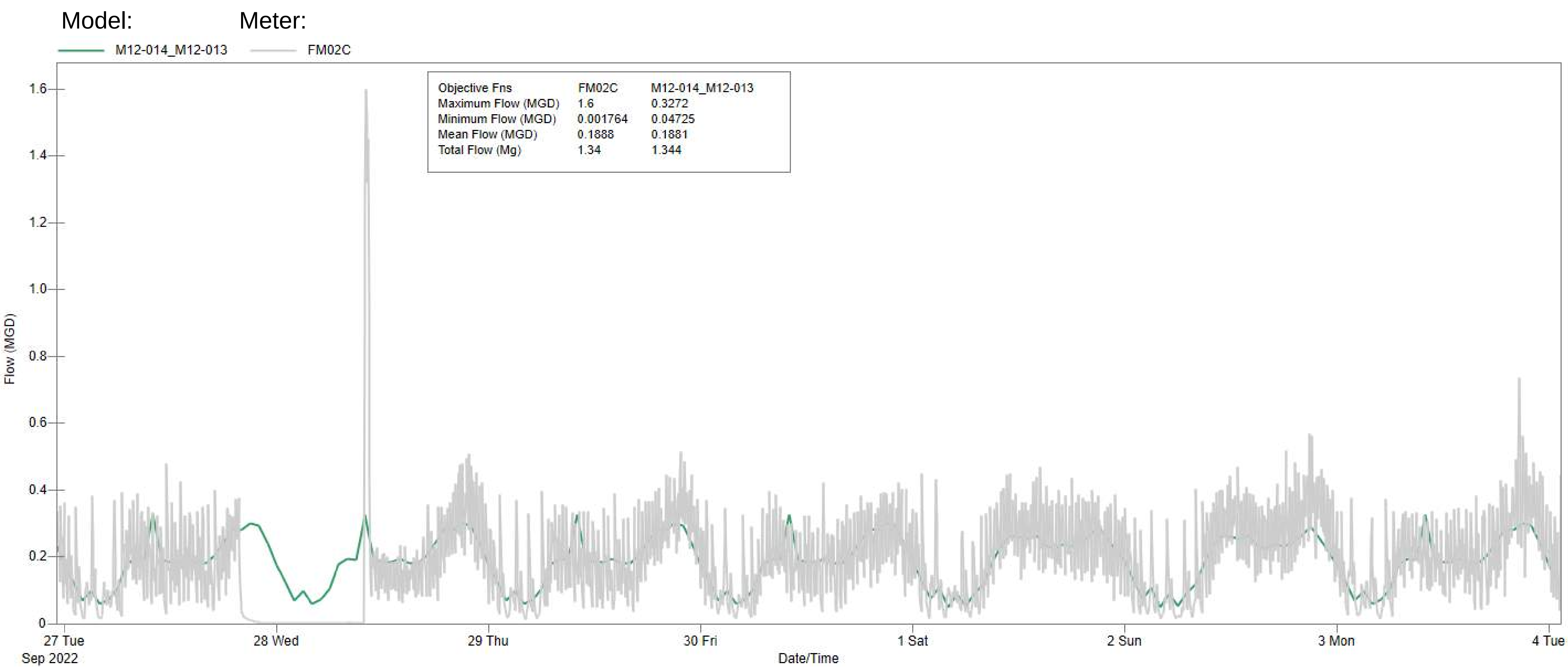
Model: Meter:



FM 02B

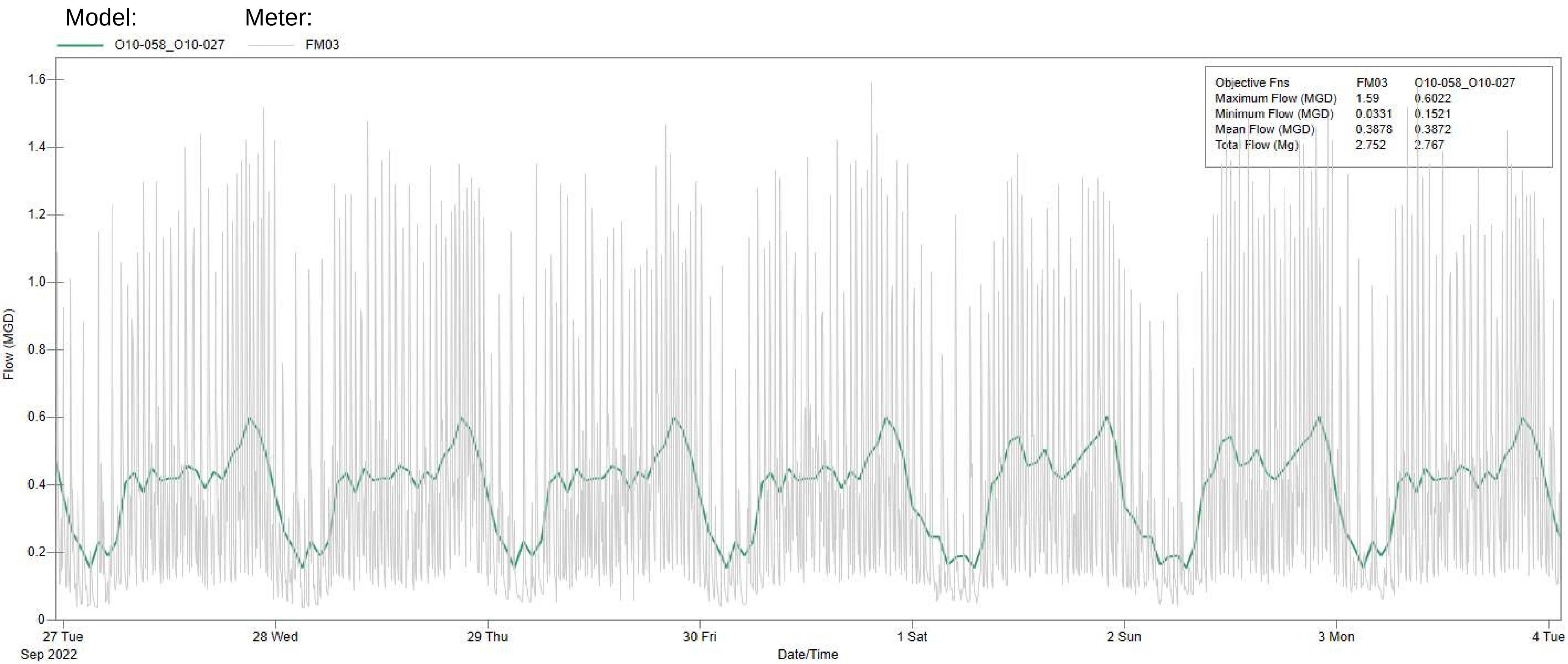

Model:
Meter:
2B_Dummy_Pipe
FM02B
Objective Fns | 2B_Dummy_Pipe | FM02B
Maximum Flow (MGD) | 0.1121 | 0.252
Minimum Flow (MGD) | 0.0325 | 0.013
Mean Flow (MGD) | 0.06867 | 0.06896
Total Flow (Mg) | 0.4907 | 0.4894
0.25
0.20
0.15
0.10
0.05
Flow (MGD)
27 Tue
Sep 2022
28 Wed
29 Thu
30 Fri
1 Sat
2 Sun
3 Mon
4 Tue
Date/Time

FM 02C



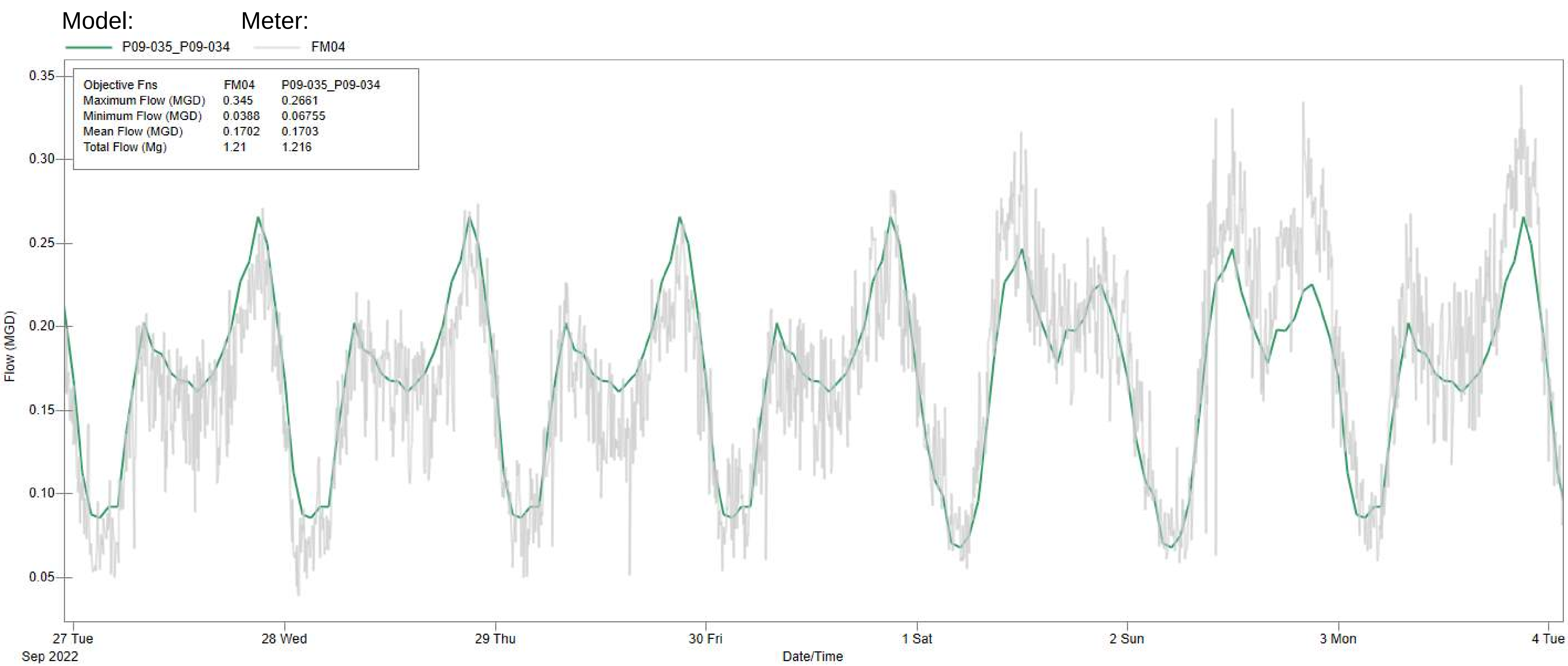
Model:
Meter:
M12-014_M12-013
FM02C
Objective Fns FM02C M12-014_M12-013
Maximum Flow (MGD) 1.6 0.3272
Minimum Flow (MGD) 0.001764 0.04725
Mean Flow (MGD) 0.1888 0.1881
Total Flow (Mg) 1.34 1.344
Flow (MGD)
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
27 Tue
Sep 2022
28 Wed
29 Thu
30 Fri
1 Sat
2 Sun
3 Mon
4 Tue
Date/Time

FM 03



*Spikes in metered flows are indicative of lift station flow characteristics. FM03 is located downstream of several lift stations, namely LS03 (Wildhorse Creek LS) and LS11 (Carrie Manor LS). Model are reflective of average flows rather than erratic spikes.

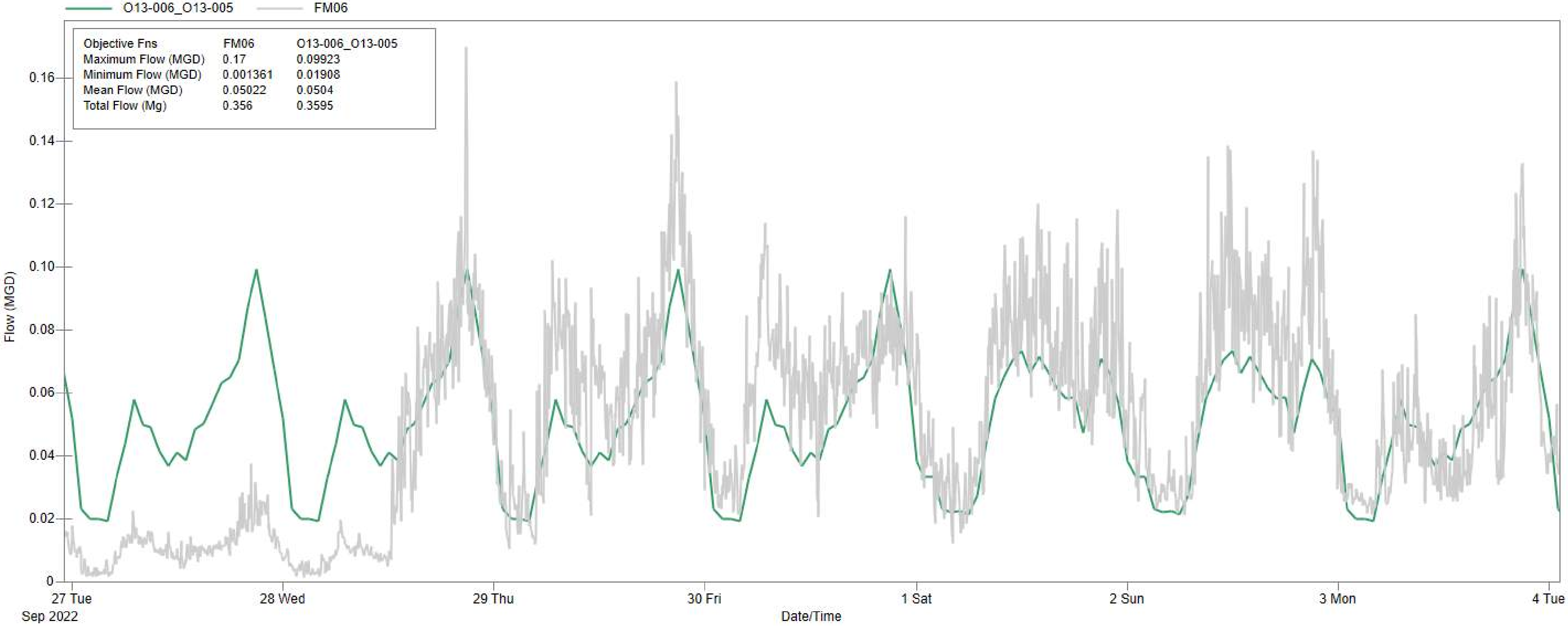
FM 04



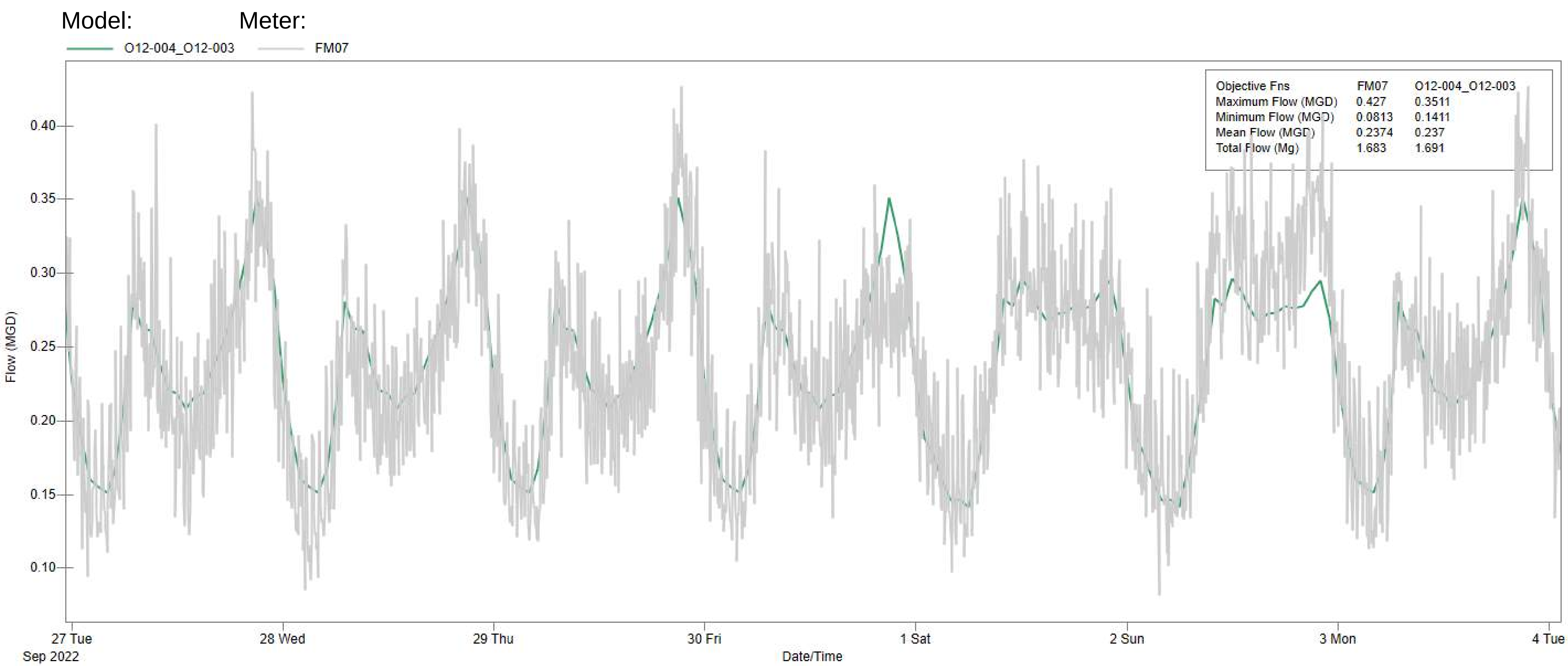
Model:
Meter:
P09-035_P09-034
FM04
Objective Fns | FM04 | P09-035_P09-034
Maximum Flow (MGD) | 0.345 | 0.2661
Minimum Flow (MGD) | 0.0388 | 0.06755
Mean Flow (MGD) | 0.1702 | 0.1703
Total Flow (Mg) | 1.21 | 1.216
Flow (MGD)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
27 Tue
Sep 2022
28 Wed
29 Thu
30 Fri
1 Sat
2 Sun
3 Mon
4 Tue
Date/Time

FM 06

Model: Meter:



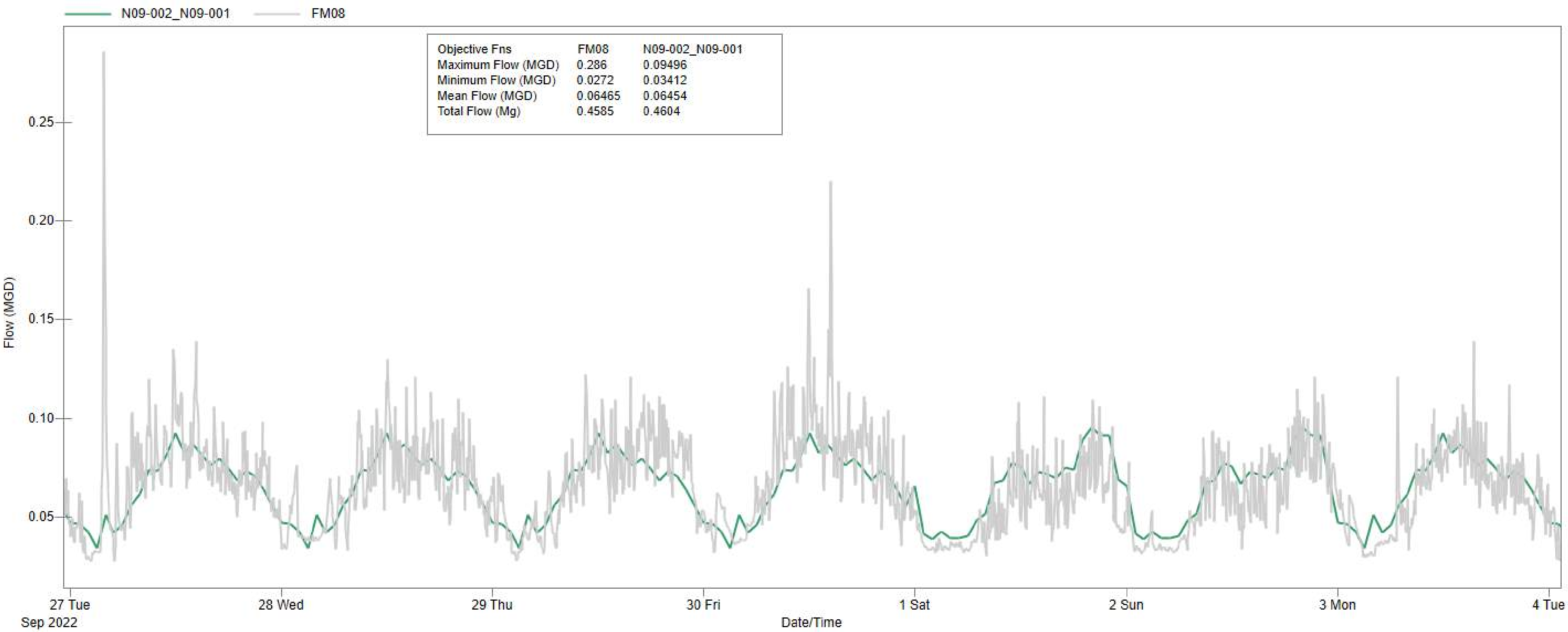
FM 07



Model:
Meter:
O12-004_O12-003
FM07
Objective Fns
FM07
O12-004_O12-003
Maximum Flow (MGD)
0.427
0.3511
Minimum Flow (MGD)
0.0813
0.1411
Mean Flow (MGD)
0.2374
0.237
Total Flow (Mg)
1.683
1.691
Flow (MGD)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
27 Tue
Sep 2022
28 Wed
29 Thu
30 Fri
1 Sat
2 Sun
3 Mon
4 Tue
Date/Time

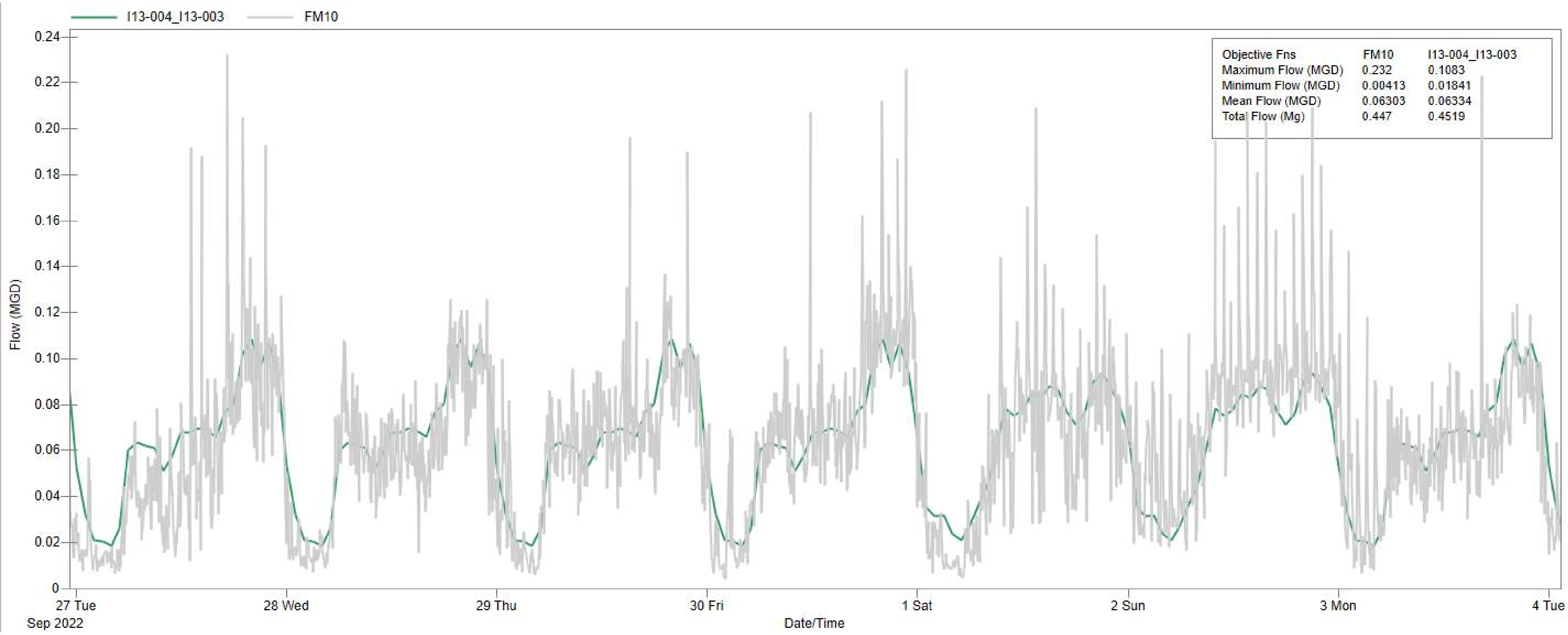
FM 08

Model: Meter:



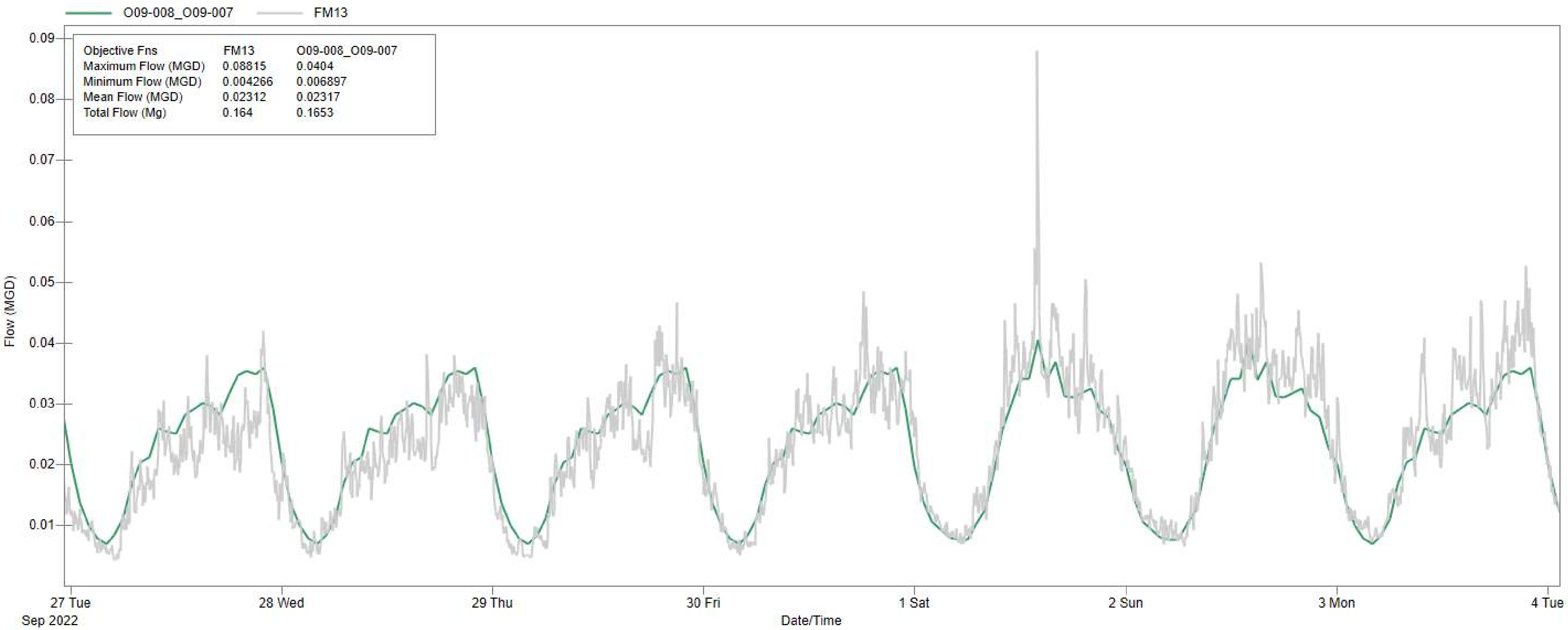
FM 10

Model: Meter:



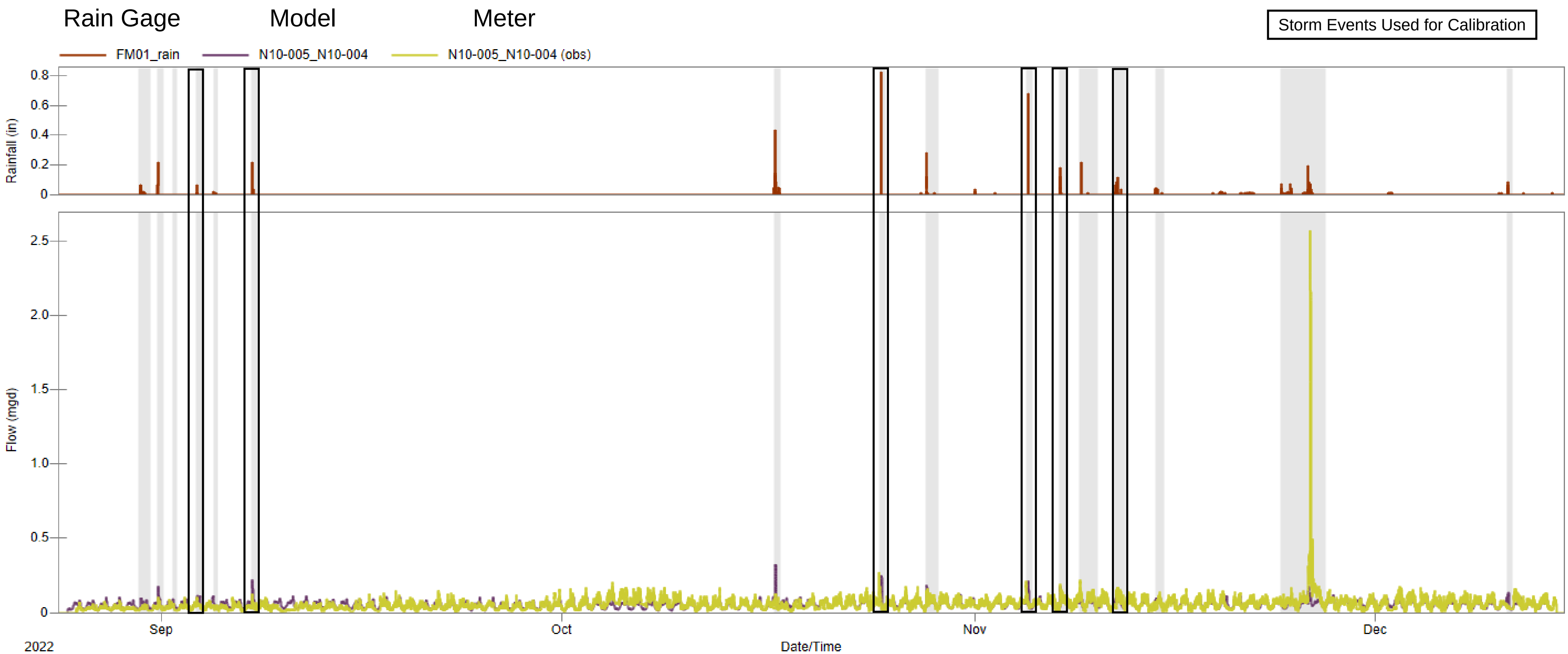
FM 13

Model: Meter:

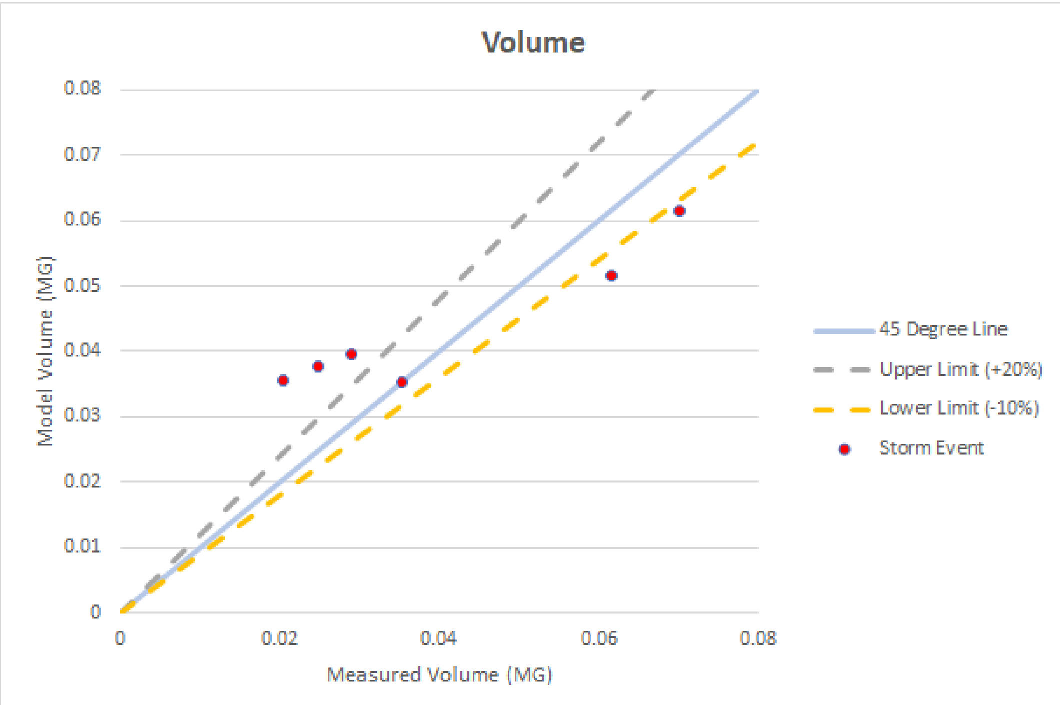


Appendix C: Wet Weather Calibration Summary

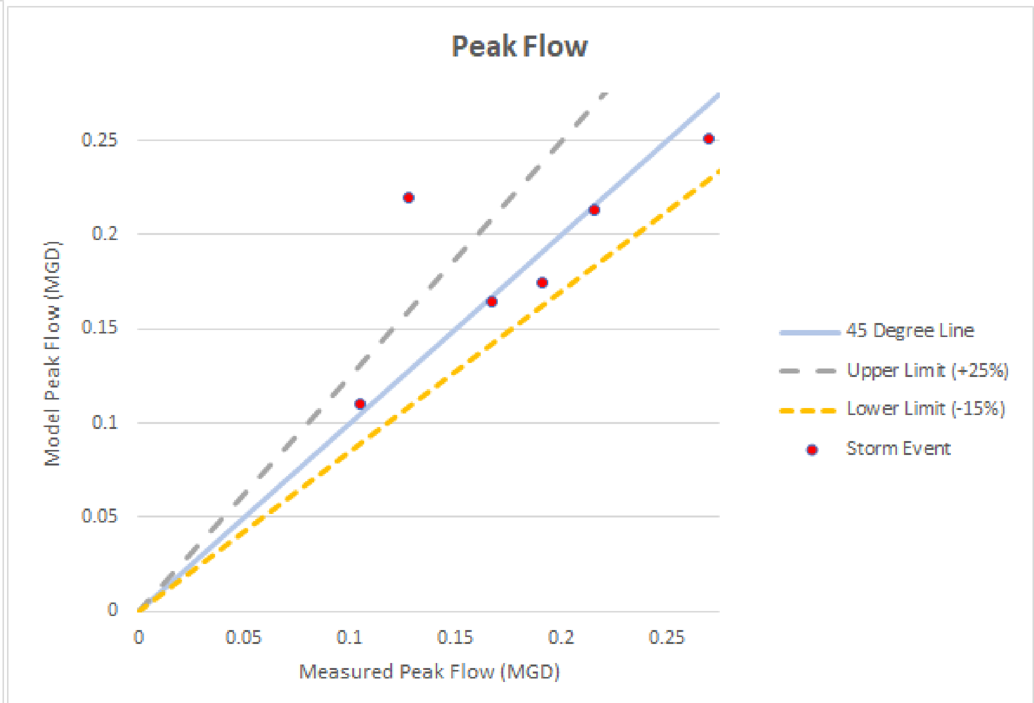
FM01



Rain Gage
Model
Meter
Storm Events Used for Calibration
FM01_rain
N10-005_N10-004
N10-005_N10-004 (obs)
Rainfall (in)
Flow (mgd)
Sep
Oct
Nov
Dec
2022
Date/Time

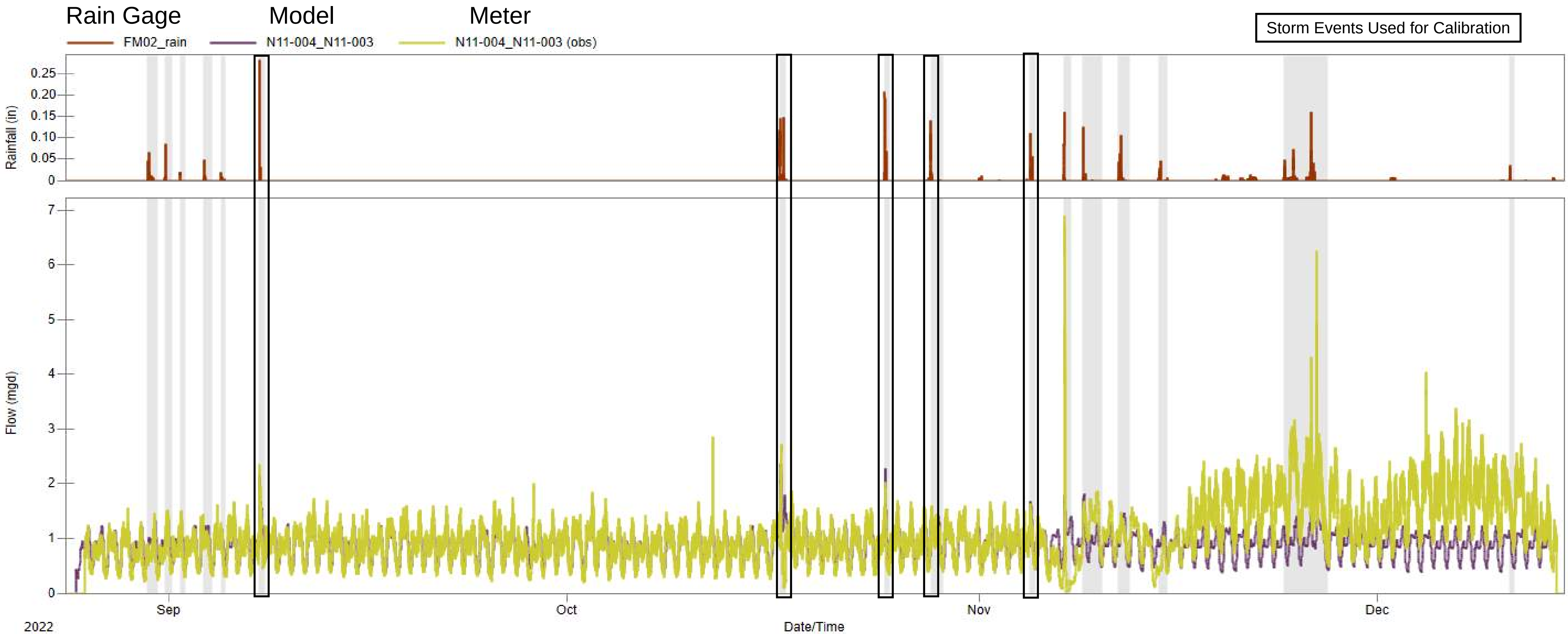


Volume
Model Volume (MG)
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

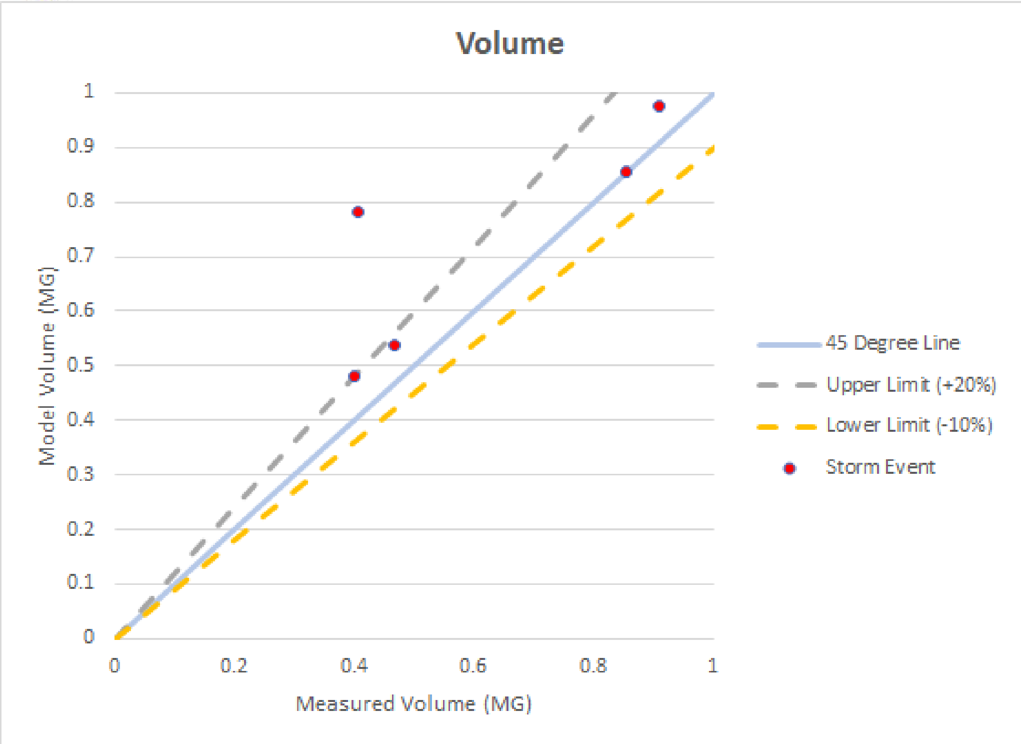


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

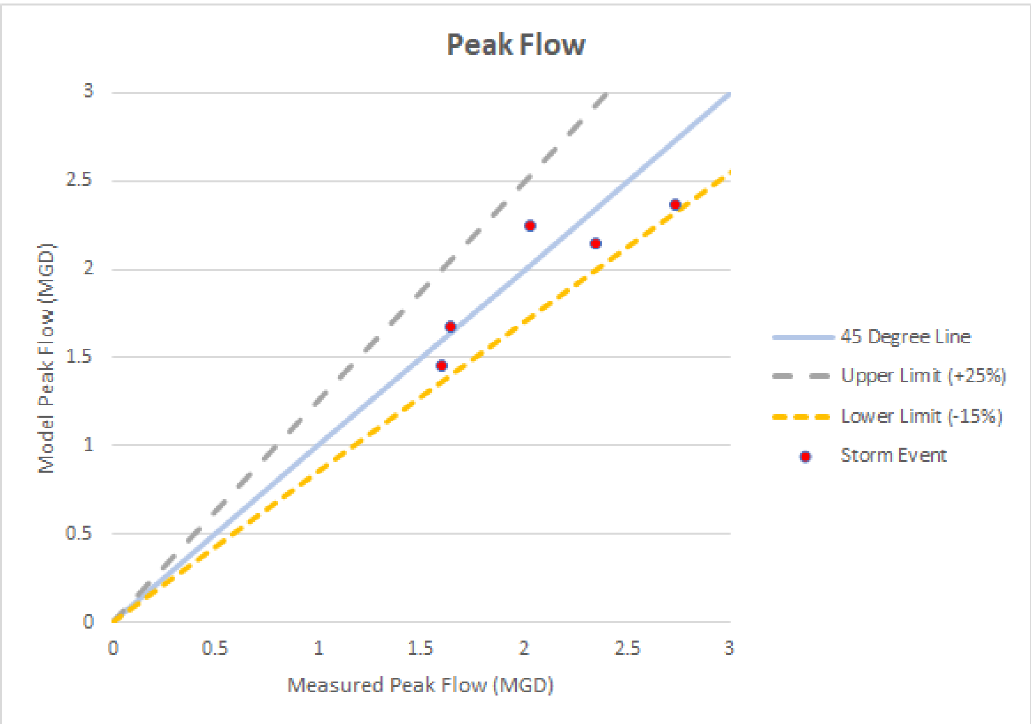
FM02



Rain Gage
Model
Meter
FM02_rain
N11-004_N11-003
N11-004_N11-003 (obs)
Storm Events Used for Calibration
Rainfall (in)
Flow (mgd)
Sep
Oct
Nov
Dec
2022
Date/Time

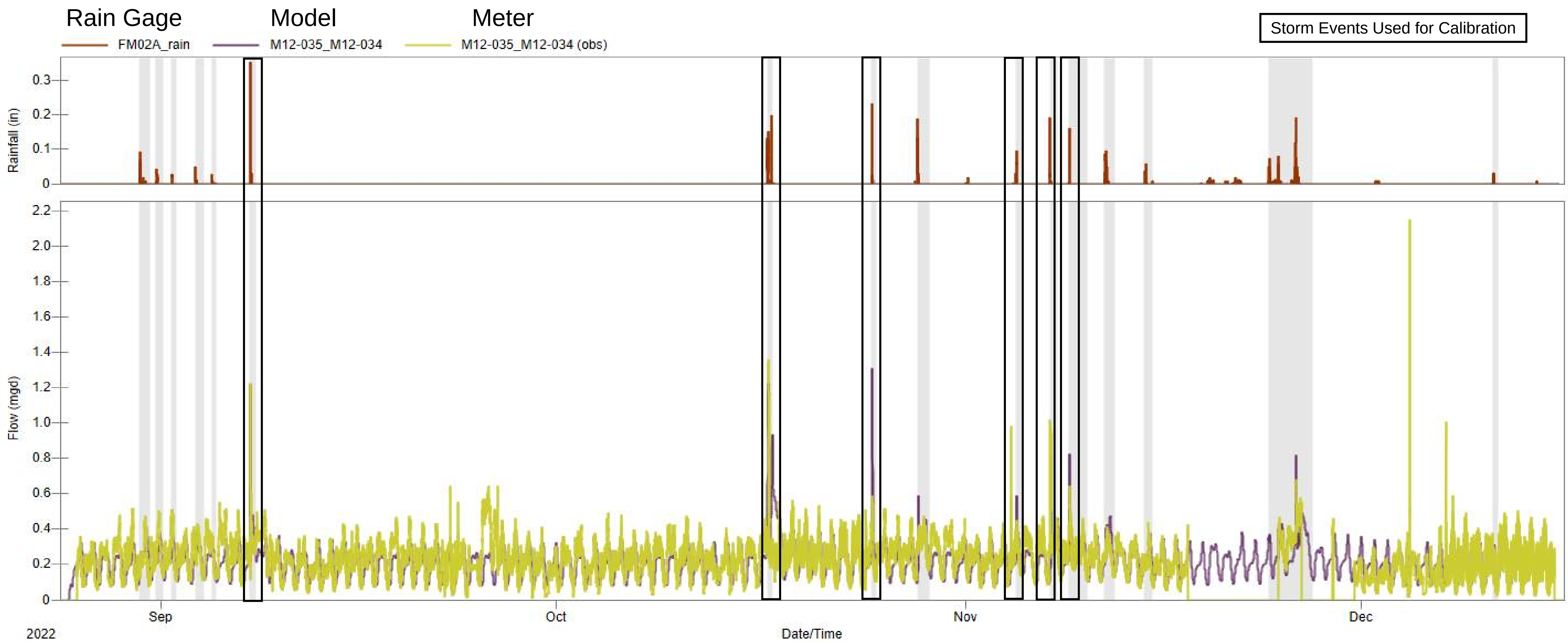


Volume
Model Volume (MG)
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

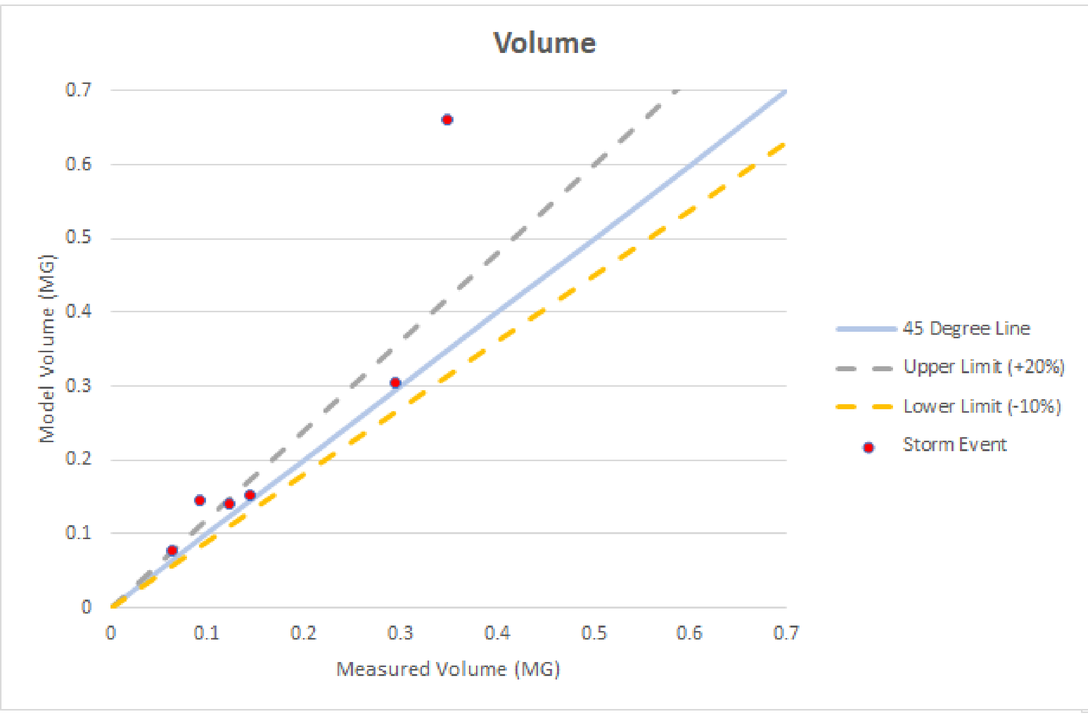


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

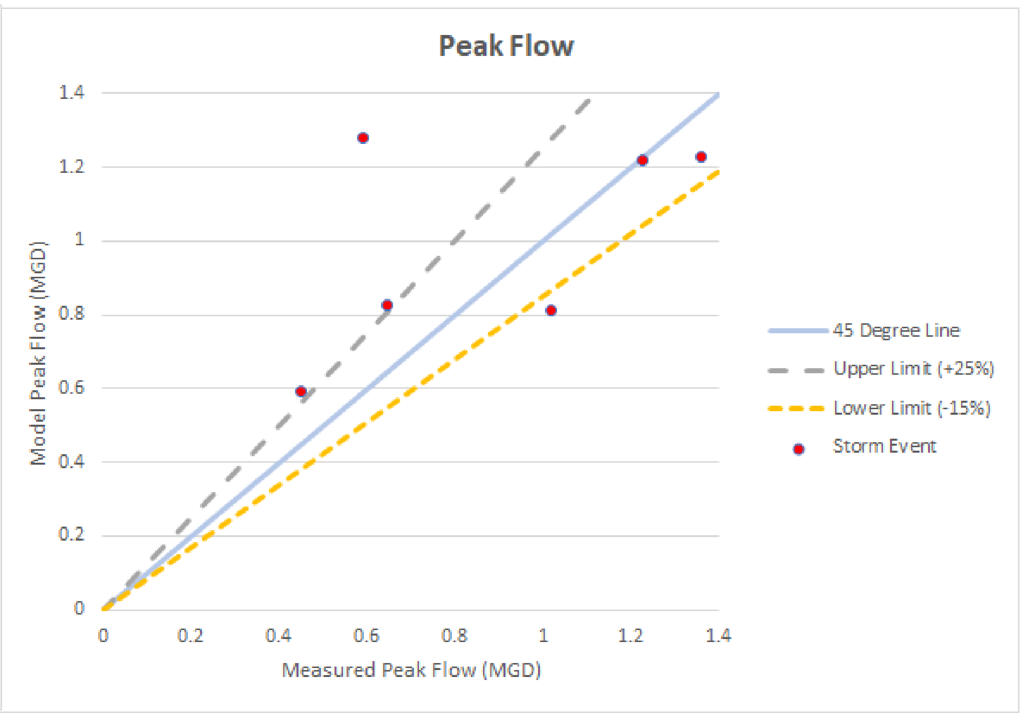
FM02A



Rain Gage
Model
Meter
FM02A_rain
M12-035_M12-034
M12-035_M12-034 (obs)
Storm Events Used for Calibration
Rainfall (in)
0.3
0.2
0.1
0
Flow (mgd)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Sep
Oct
Nov
Dec
2022
Date/Time

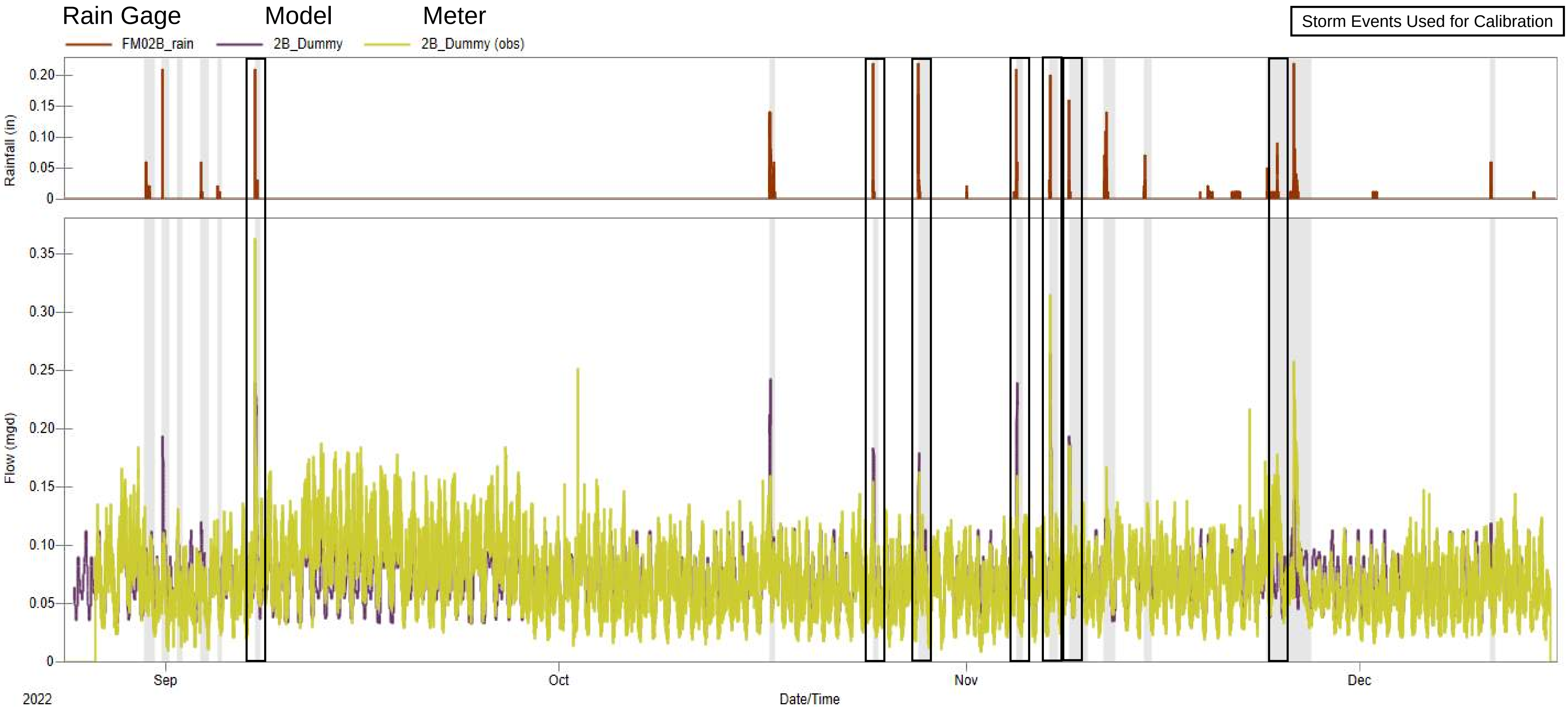


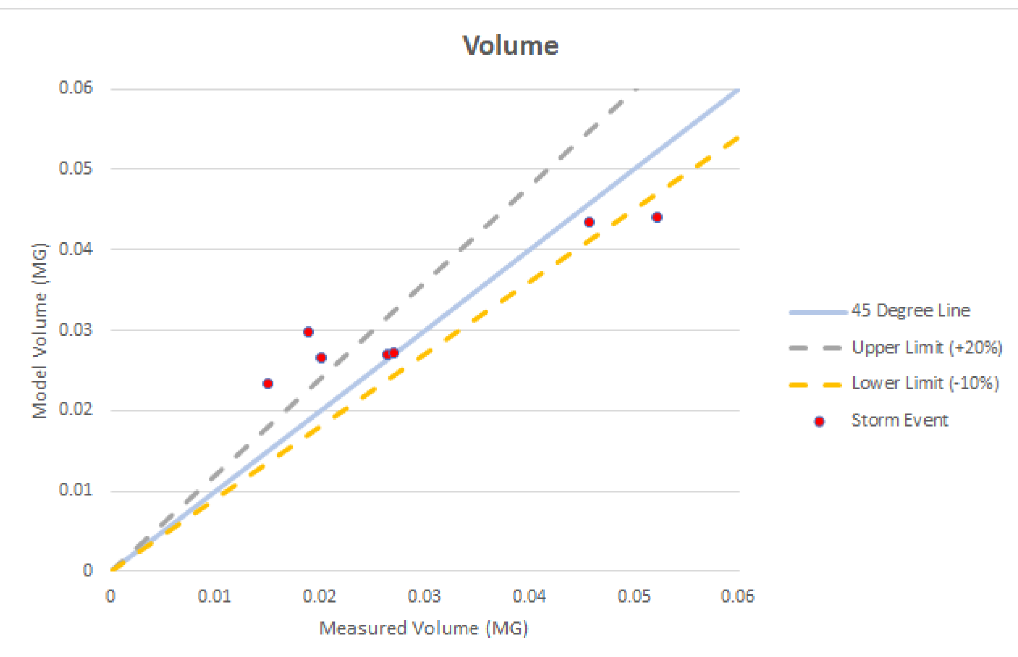
Volume
Model Volume (MG)
Measured Volume (MG)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

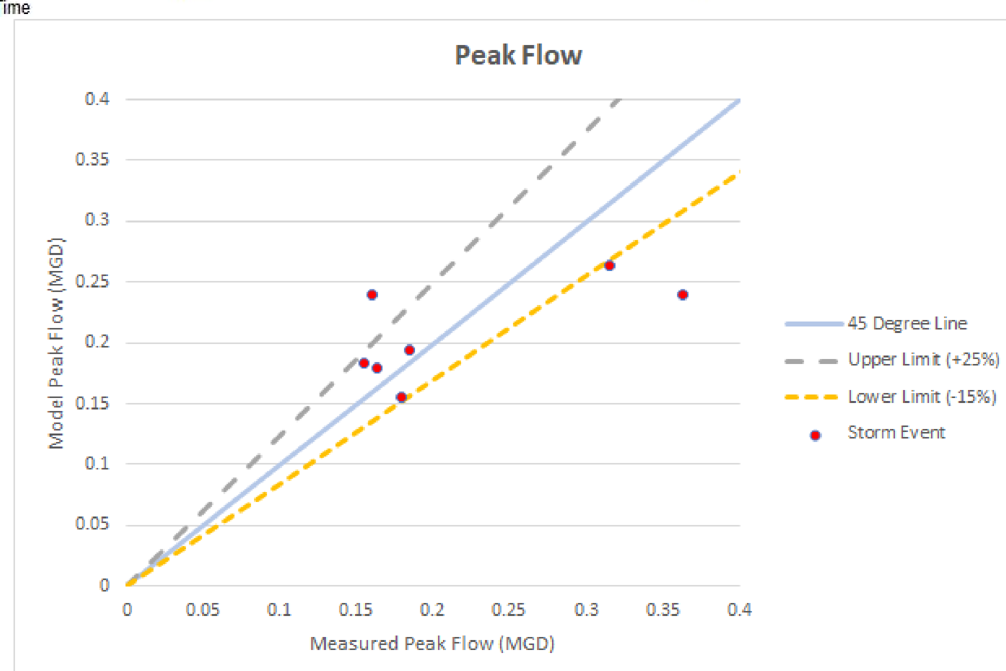


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

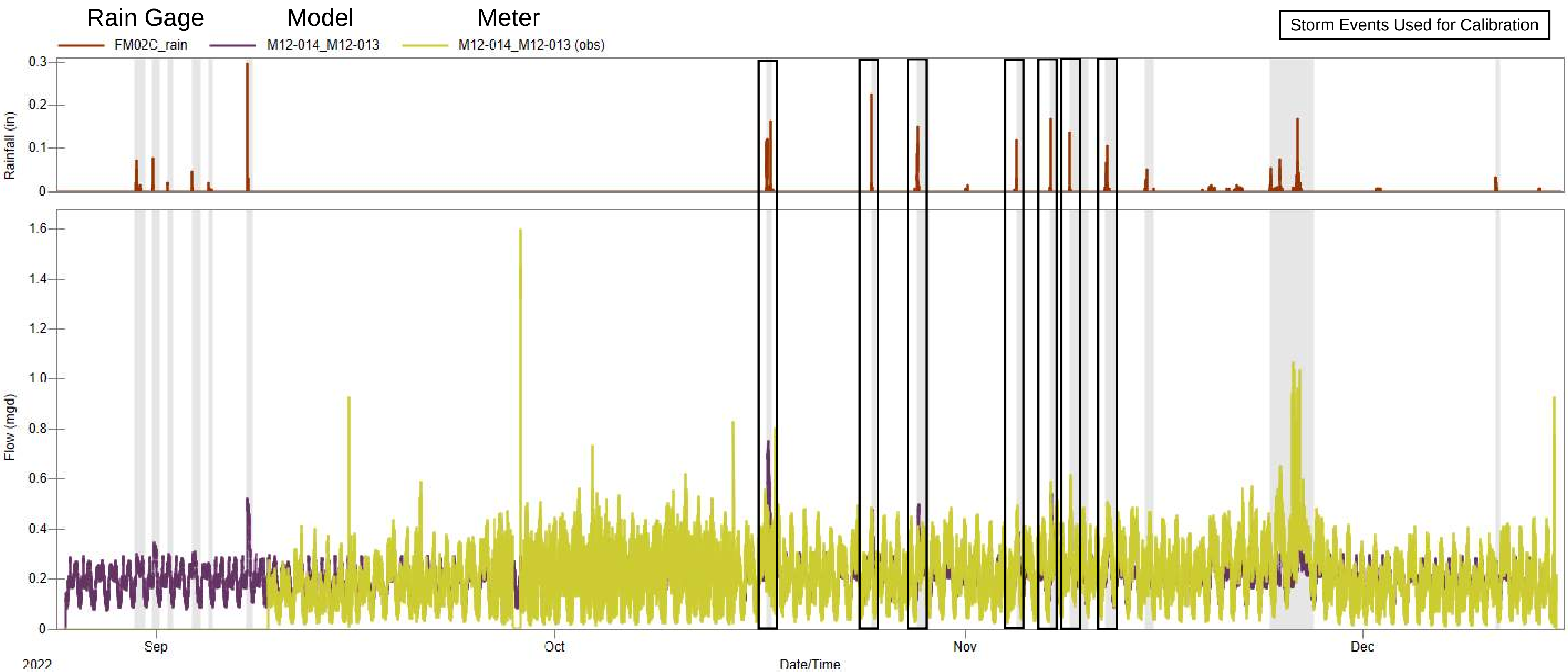
FM02B


Rain Gage
Model
Meter
FM02B_rain
2B_Dummy
2B_Dummy (obs)
Storm Events Used for Calibration
Rainfall (in)
0.20
0.15
0.10
0.05
0
Flow (mgd)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
Sep
Oct
Nov
Dec
2022
Date/Time

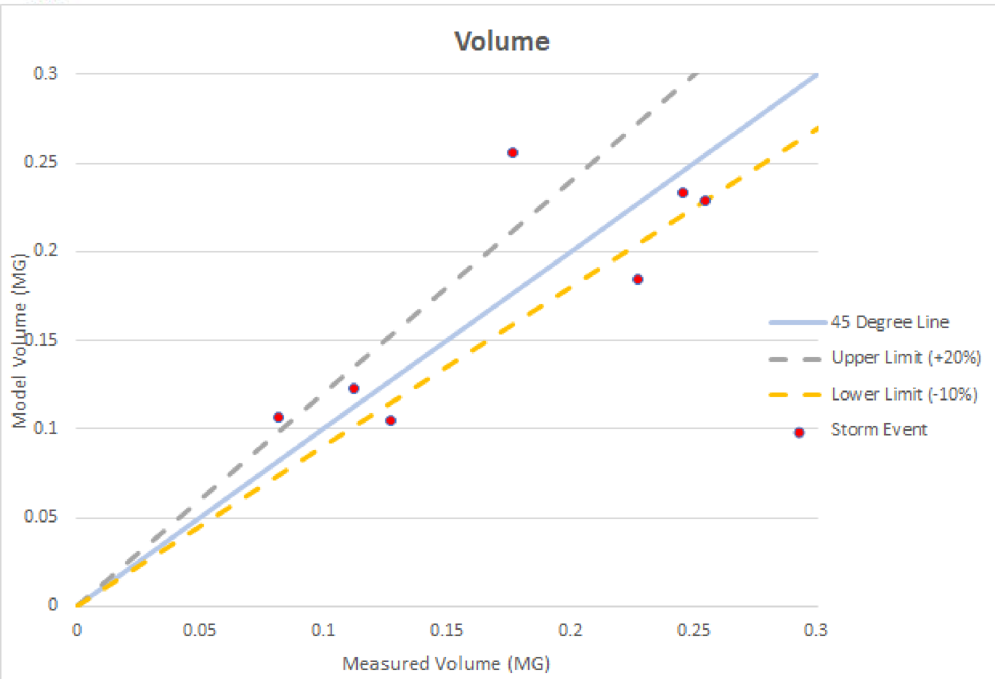

Volume
Model Volume (MG)
Measured Volume (MG)
0
0.01
0.02
0.03
0.04
0.05
0.06
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

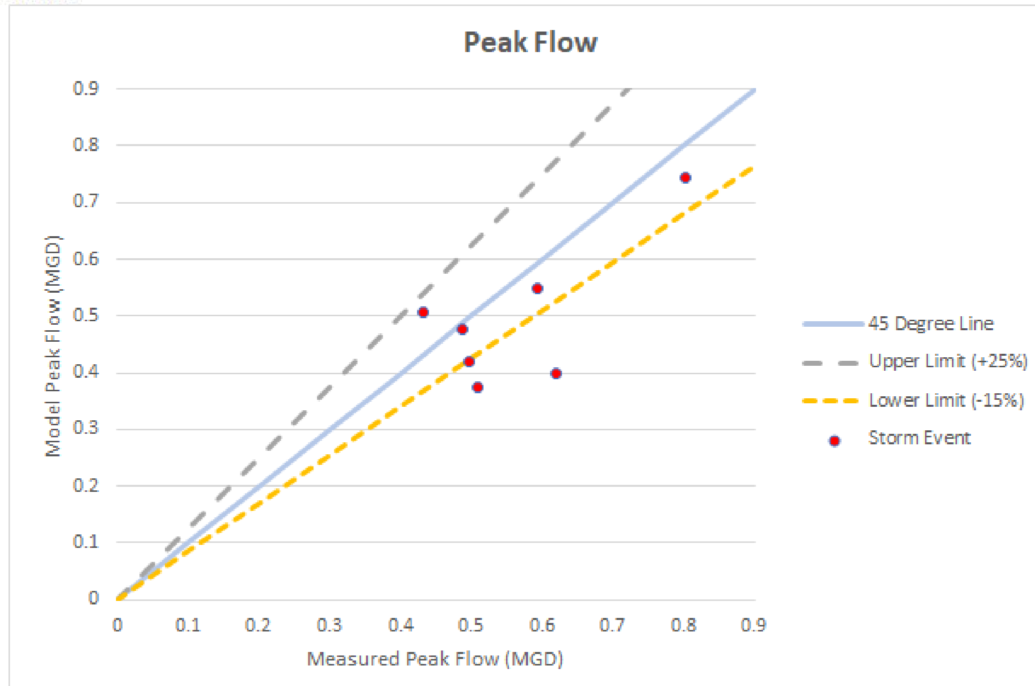
FM02C



Rain Gage
Model
Meter
FM02C_rain
M12-014_M12-013
M12-014_M12-013 (obs)
Storm Events Used for Calibration
Rainfall (in)
0.3
0.2
0.1
0
Flow (mgd)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Sep
Oct
Nov
Dec
2022
Date/Time

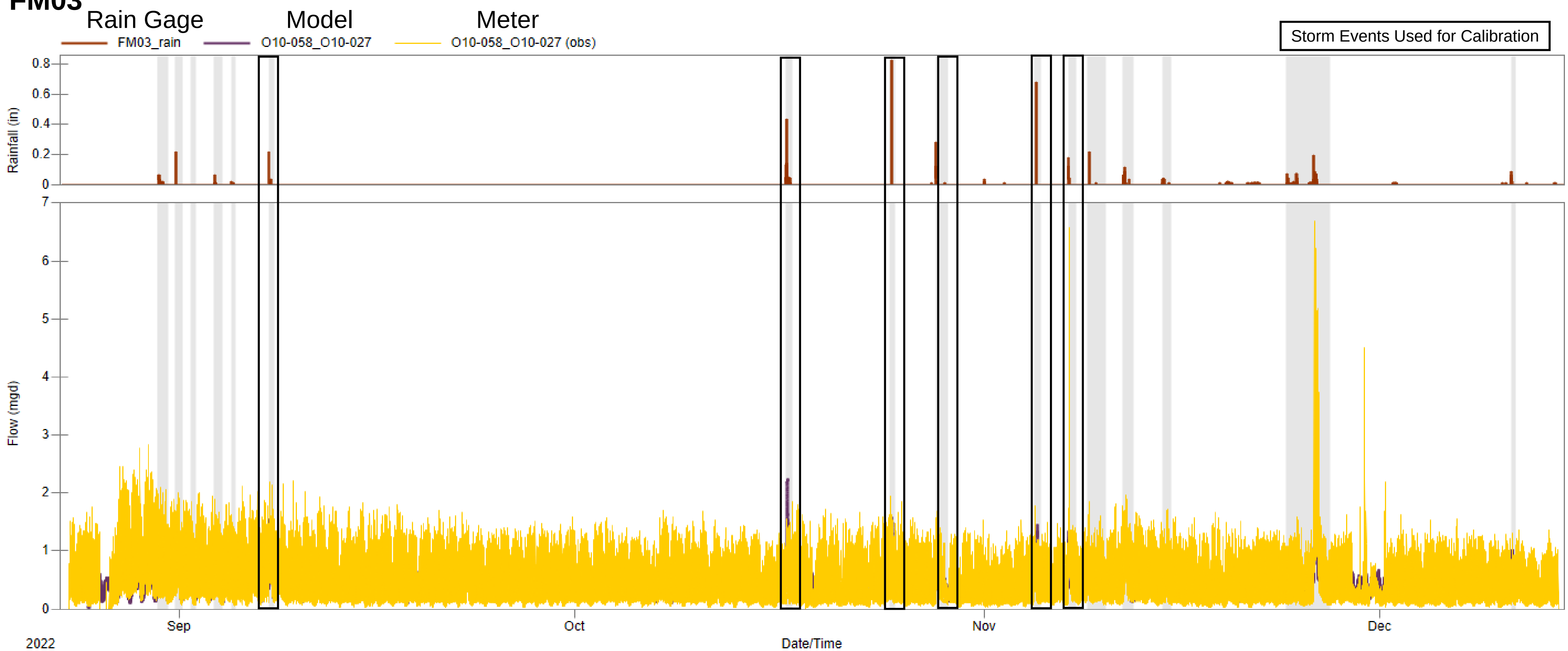


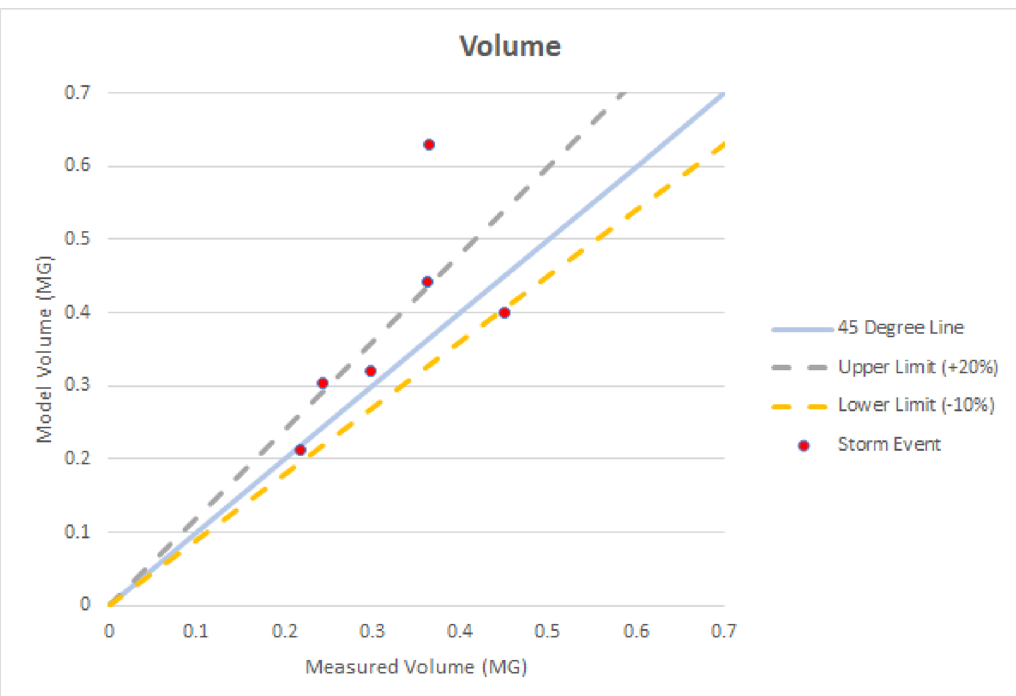
Volume
Model Volume (MG)
Measured Volume (MG)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
0.2
0.25
0.3
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

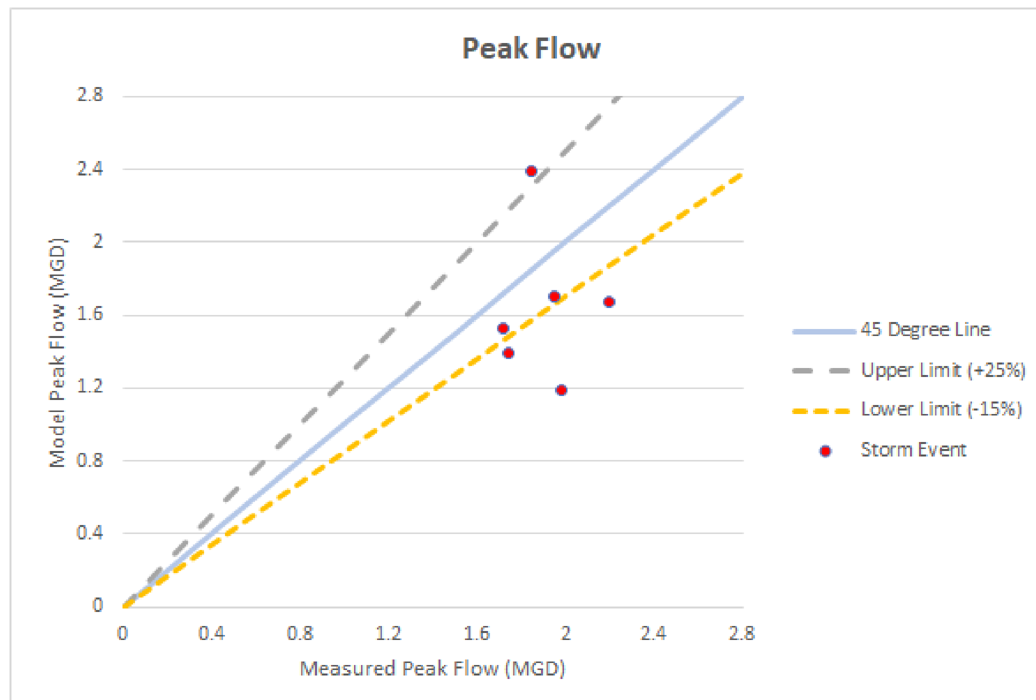


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

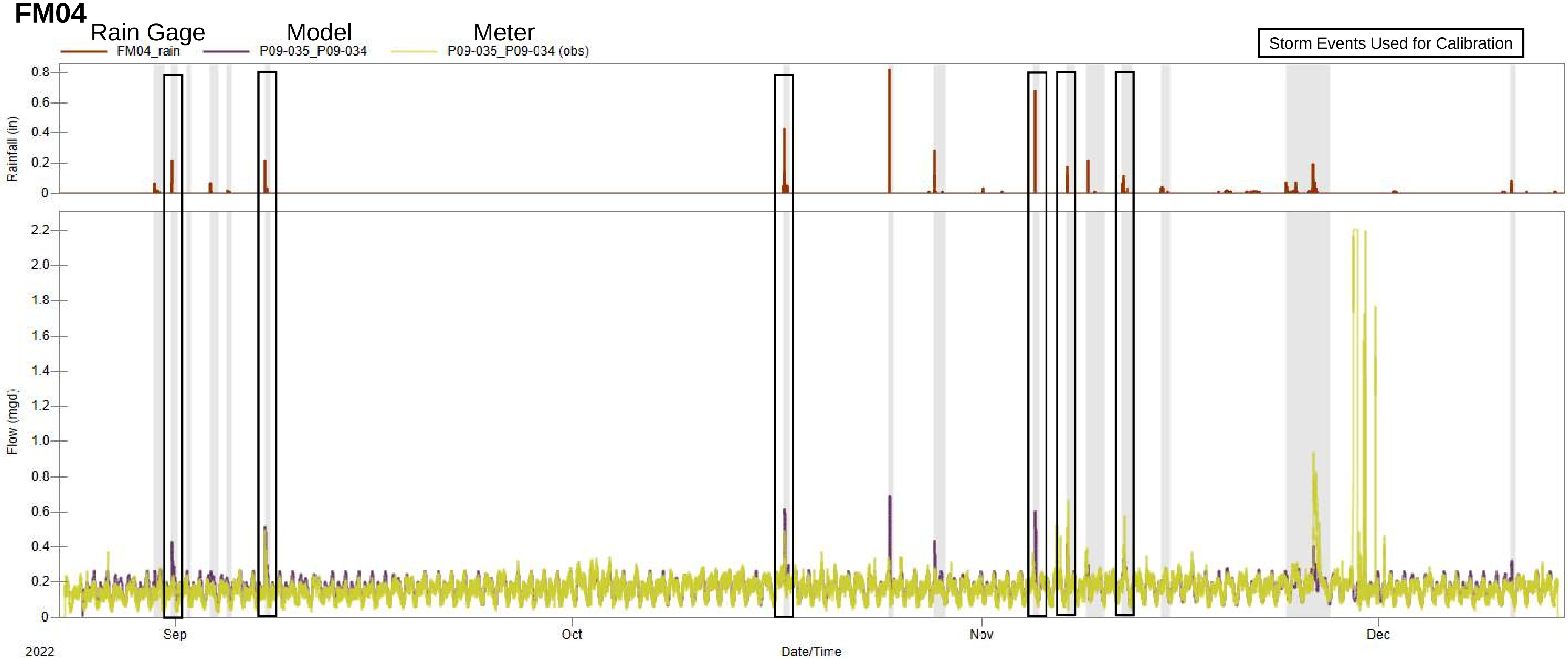
FM03


Rain Gage
Model
Meter
FM03_rain
O10-058_O10-027
O10-058_O10-027 (obs)
Storm Events Used for Calibration
Rainfall (in)
0.8
0.6
0.4
0.2
0
Flow (mgd)
7
6
5
4
3
2
1
0
Sep
Oct
Nov
Dec
2022
Date/Time

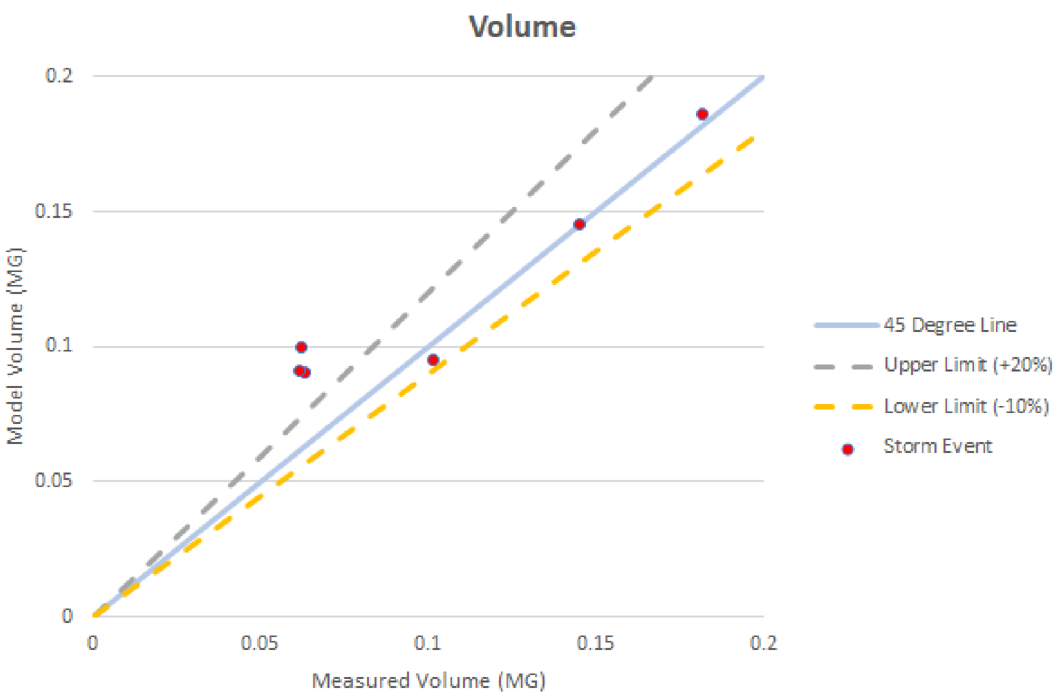

Volume
Model Volume (MG)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event


Peak Flow
Model Peak Flow (MGD)
2.8
2.4
2
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2
2.4
2.8
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

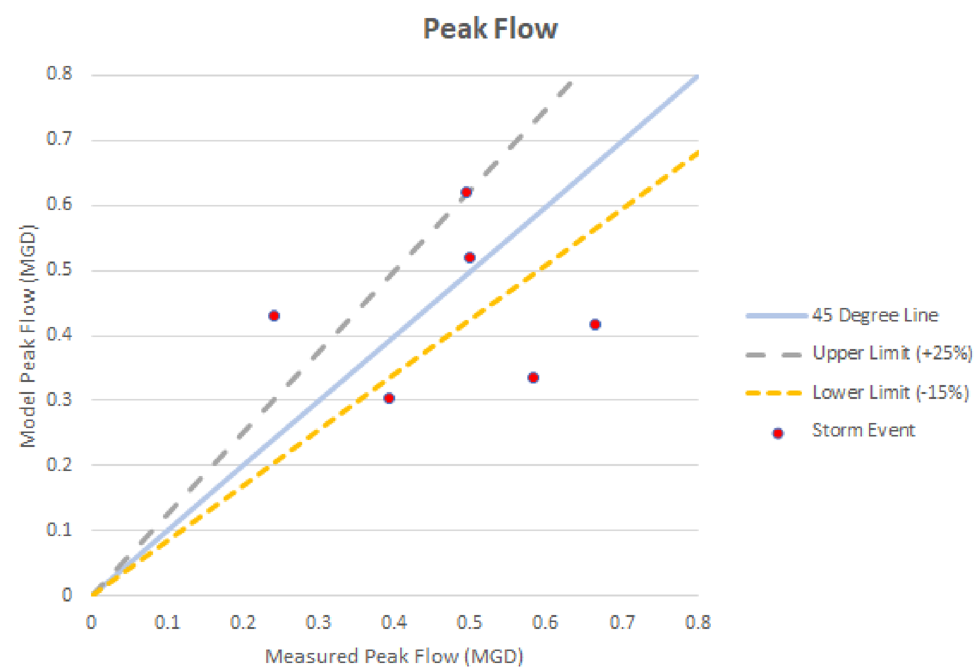
FM04



Rain Gage
FM04_rain
Model
P09-035_P09-034
Meter
P09-035_P09-034 (obs)
Storm Events Used for Calibration
Rainfall (in)
Flow (mgd)
Sep
Oct
Nov
Dec
2022
Date/Time

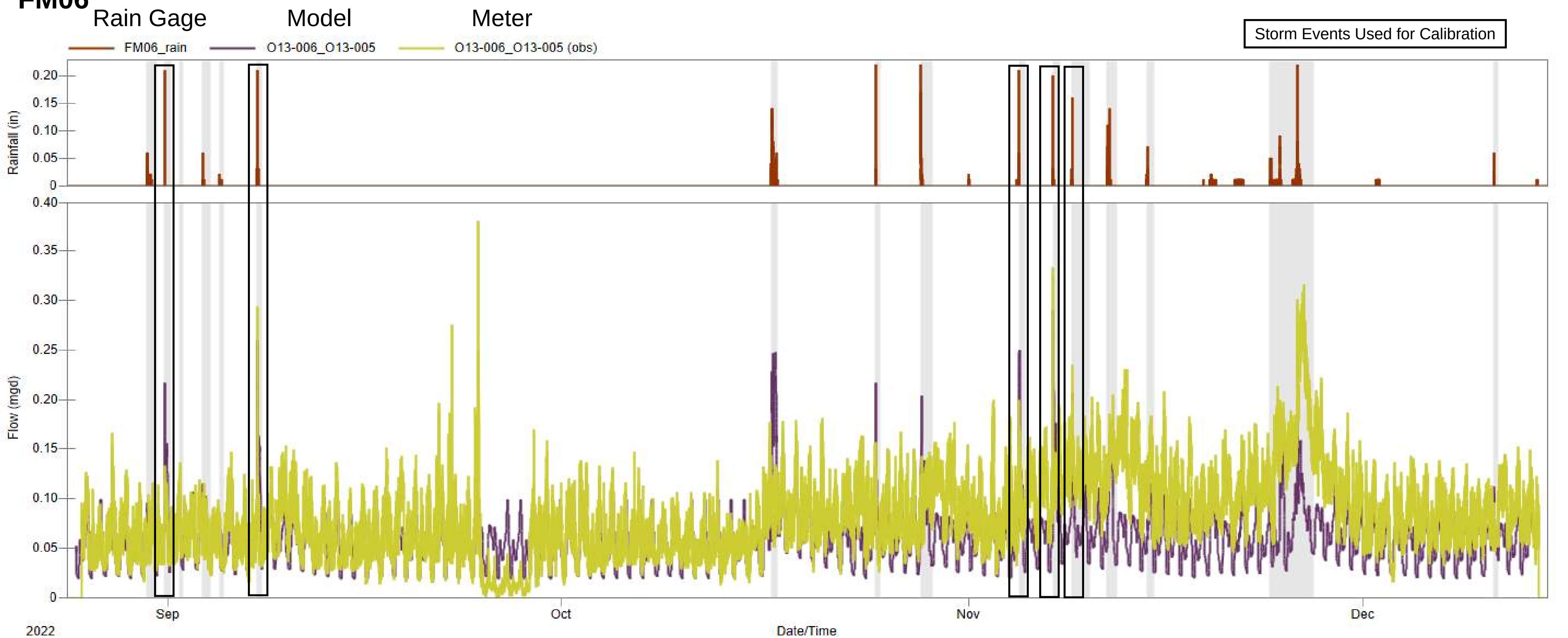


Volume
Model Volume (MG)
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

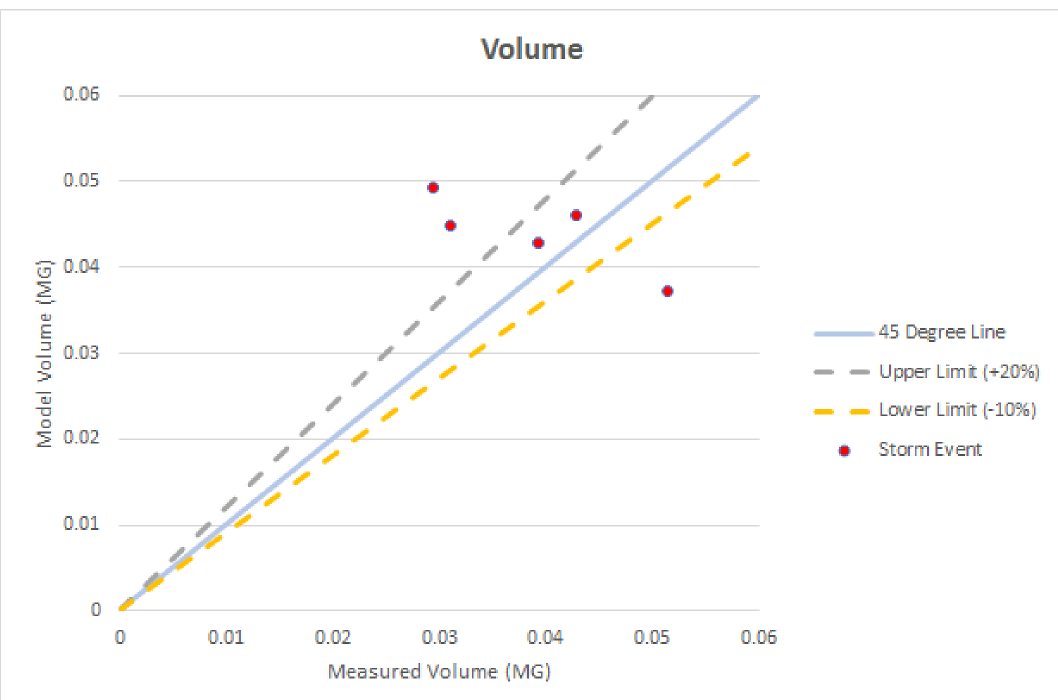


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

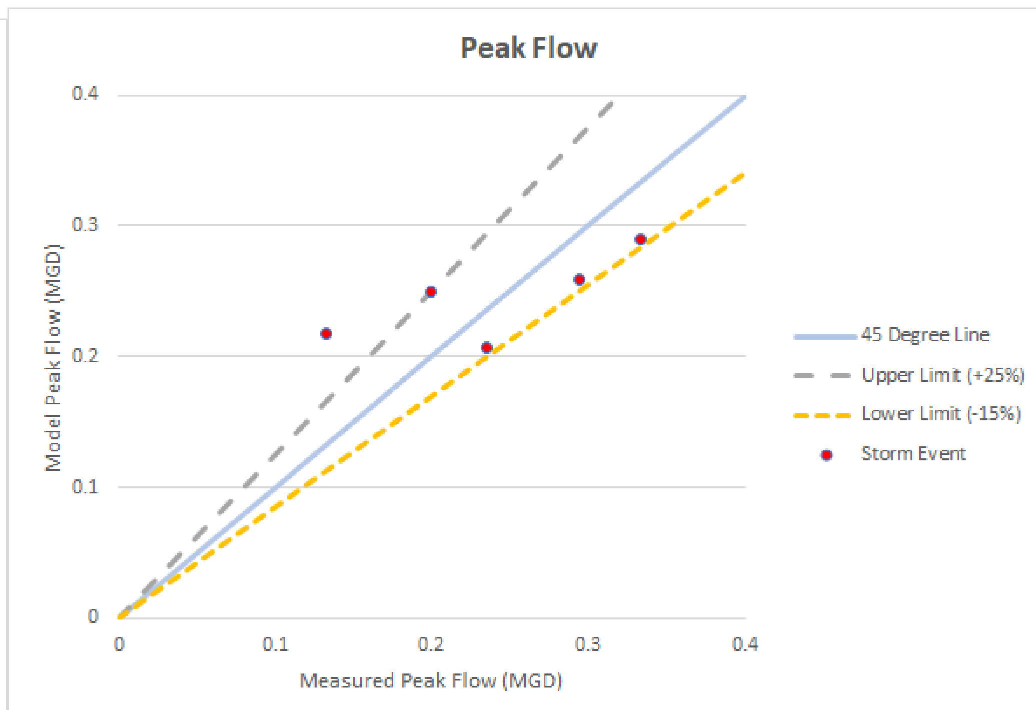
FM06



Rain Gage
Model
Meter
FM06_rain
O13-006_O13-005
O13-006_O13-005 (obs)
Storm Events Used for Calibration
Rainfall (in)
0.20
0.15
0.10
0.05
0
Flow (mgd)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
Sep
Oct
Nov
Dec
2022
Date/Time

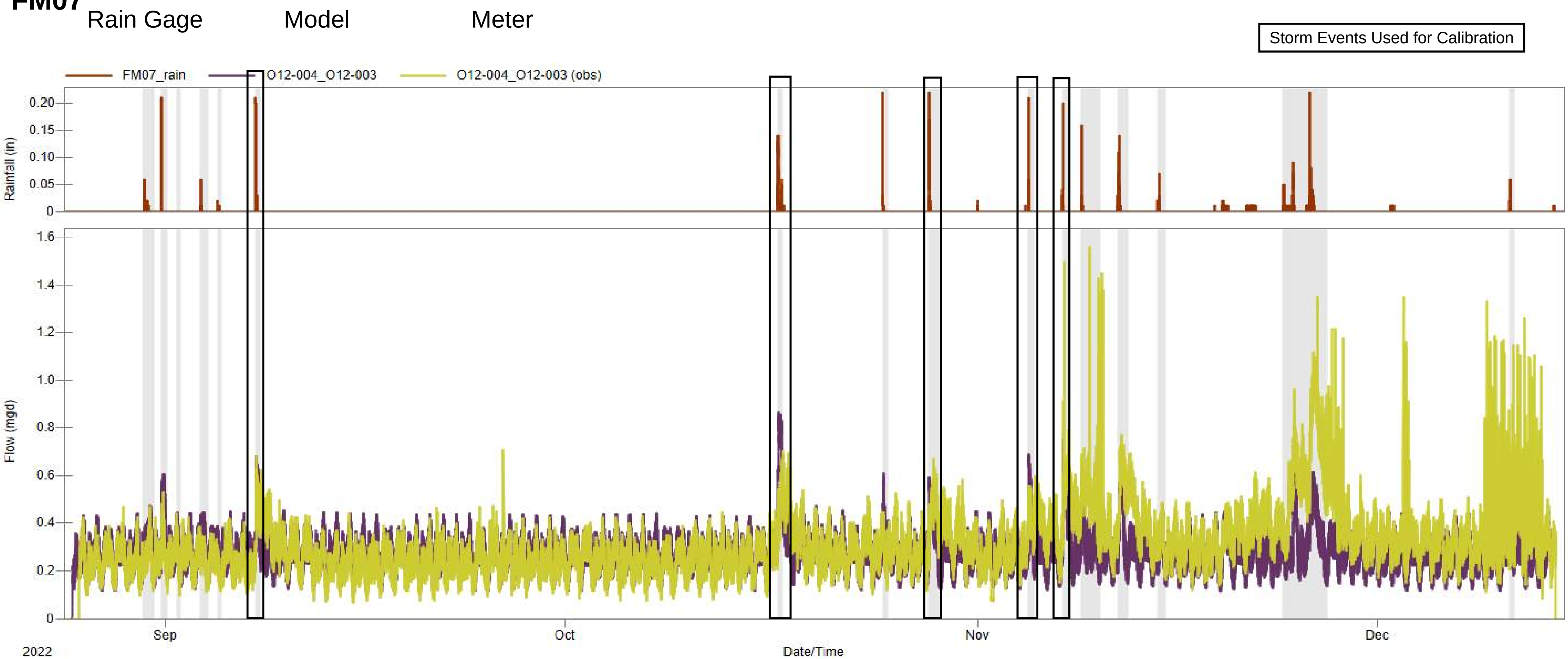


Volume
0.06
0.05
0.04
0.03
0.02
0.01
0
Model Volume (MG)
0
0.01
0.02
0.03
0.04
0.05
0.06
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

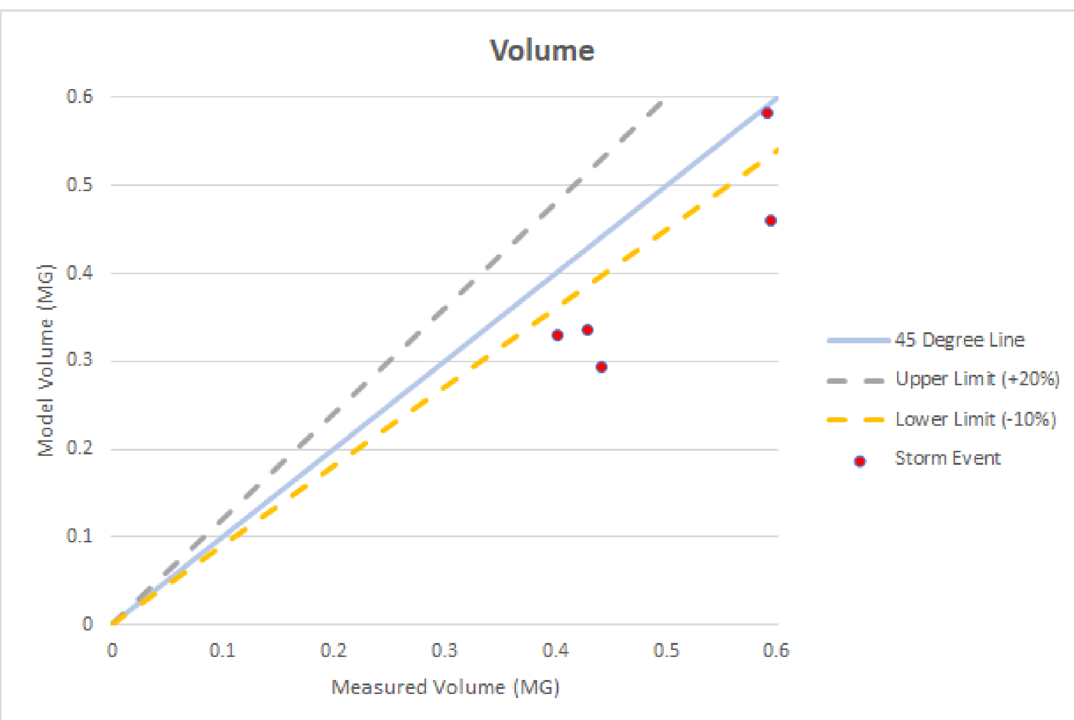


Peak Flow
0.4
0.3
0.2
0.1
0
Model Peak Flow (MGD)
0
0.1
0.2
0.3
0.4
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

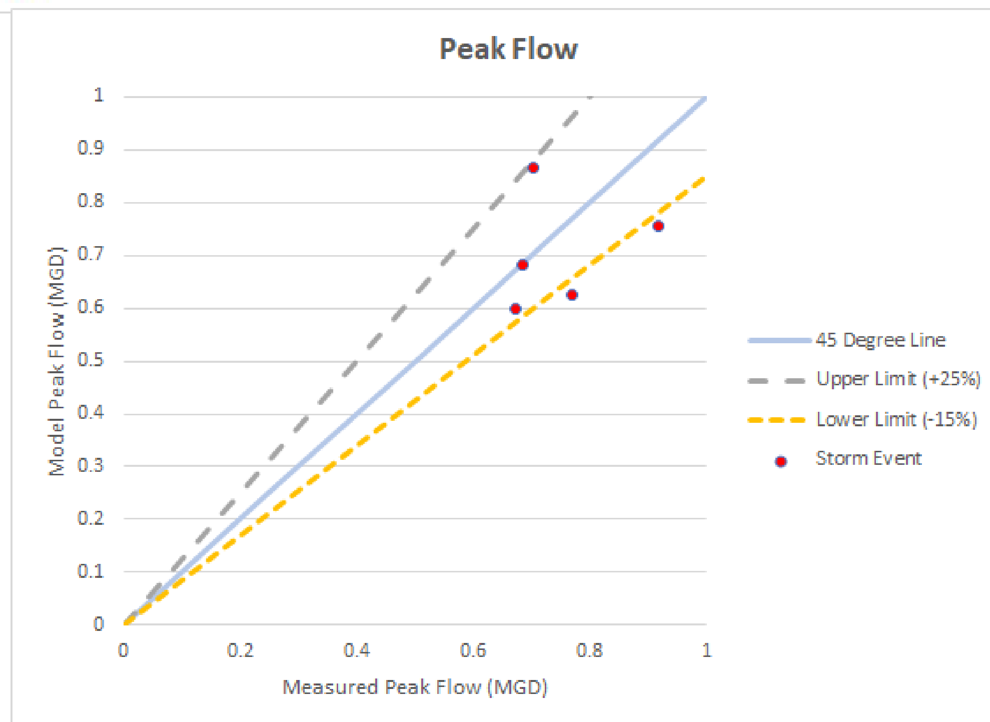
FM07



Rain Gage
Model
Meter
Storm Events Used for Calibration
FM07_rain
O12-004_O12-003
O12-004_O12-003 (obs)
Rainfall (in)
Flow (mgd)
Sep
Oct
Nov
Dec
2022
Date/Time

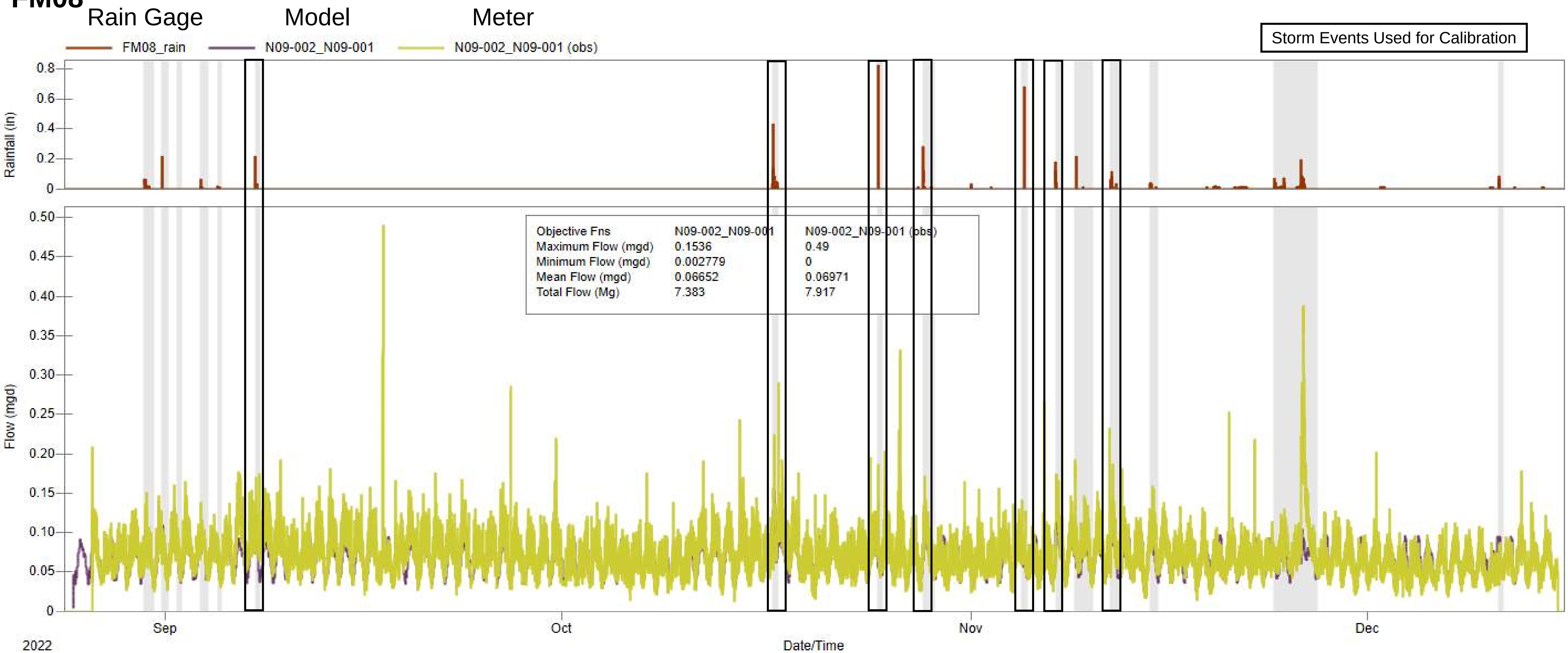


Volume
Model Volume (MG)
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

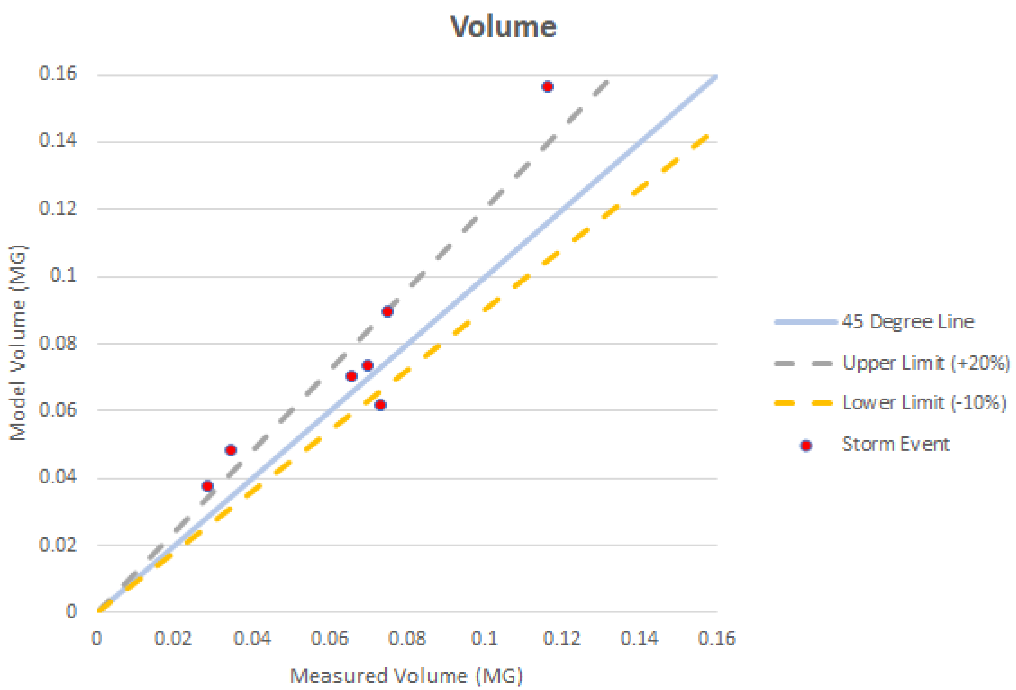


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event

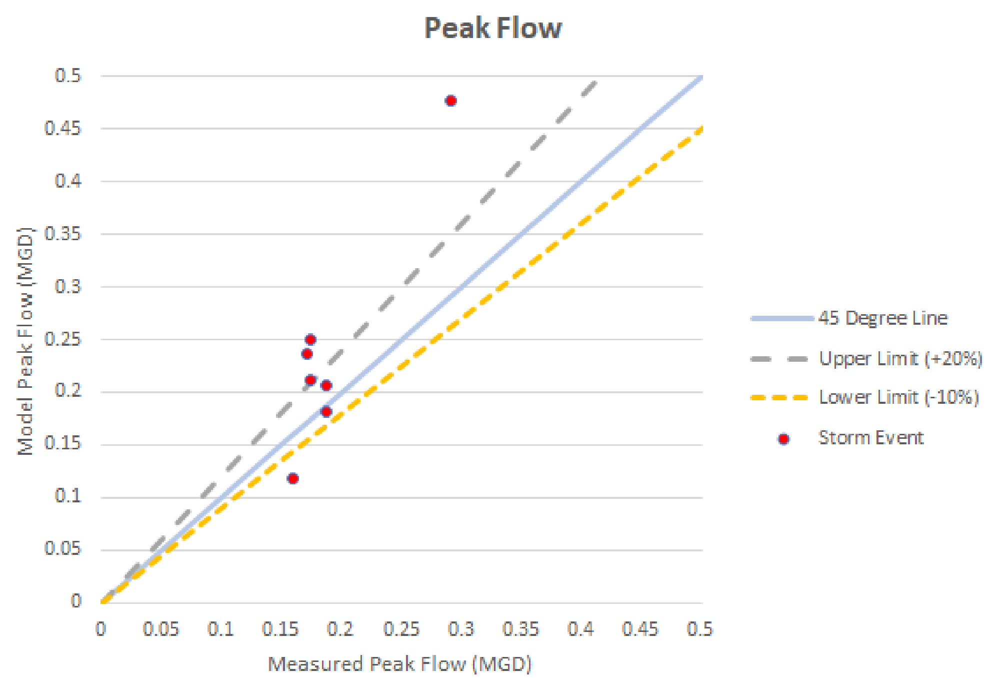
FM08



Rain Gage
Model
Meter
FM08_rain
N09-002_N09-001
N09-002_N09-001 (obs)
Storm Events Used for Calibration
Rainfall (in)
Flow (mgd)
Objective Fns
N09-002_N09-001
N09-002_N09-001 (obs)
Maximum Flow (mgd)
0.1536
0.49
Minimum Flow (mgd)
0.002779
0
Mean Flow (mgd)
0.06652
0.06971
Total Flow (Mg)
7.383
7.917
Sep
Oct
Nov
Dec
2022
Date/Time

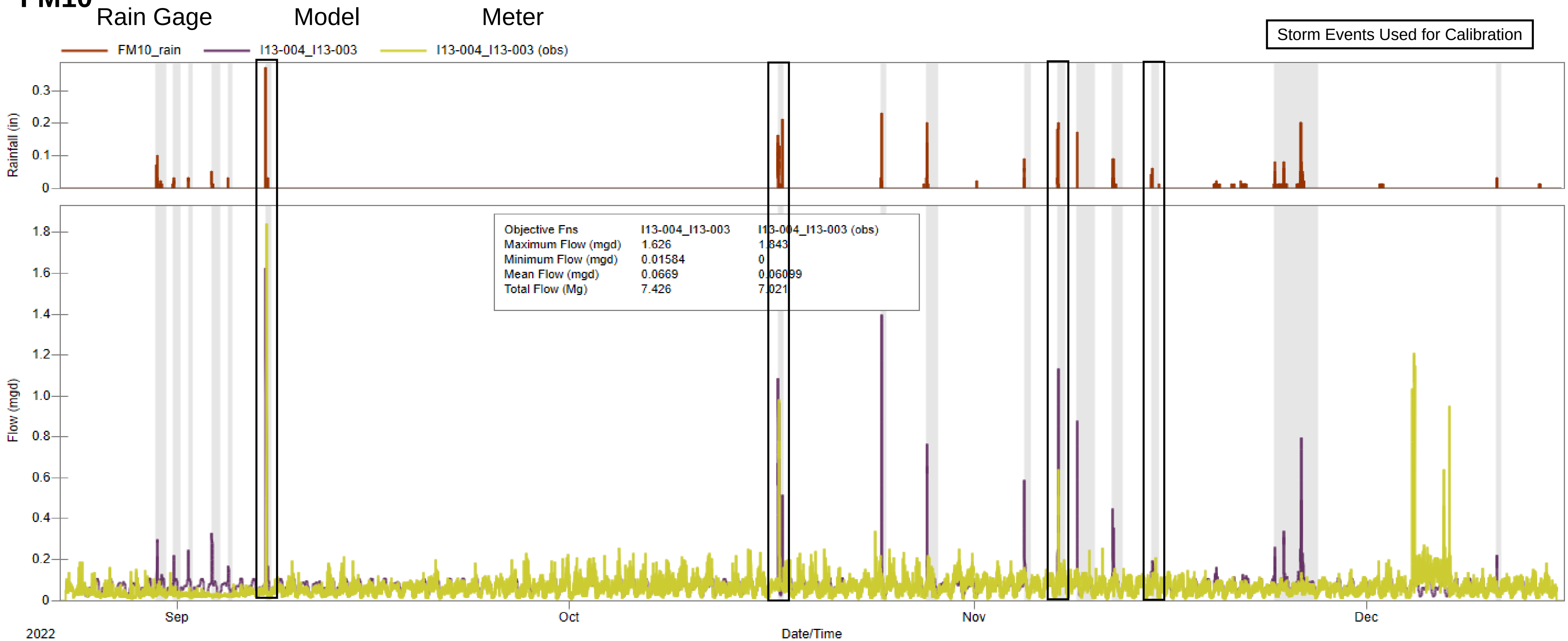


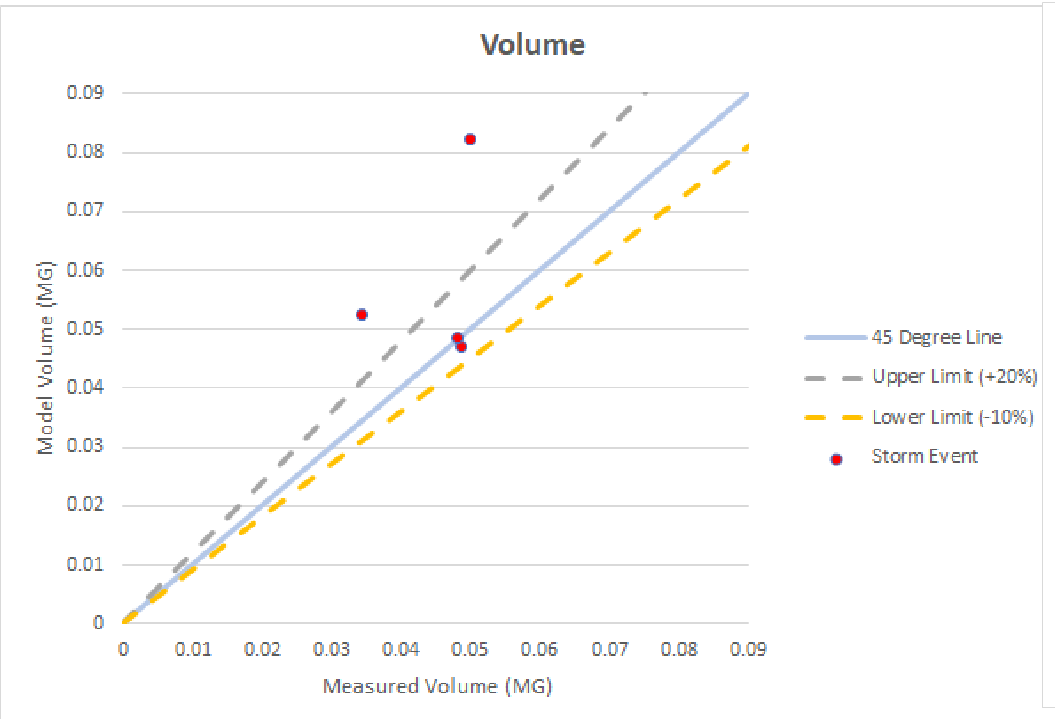
Volume
Model Volume (MG)
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

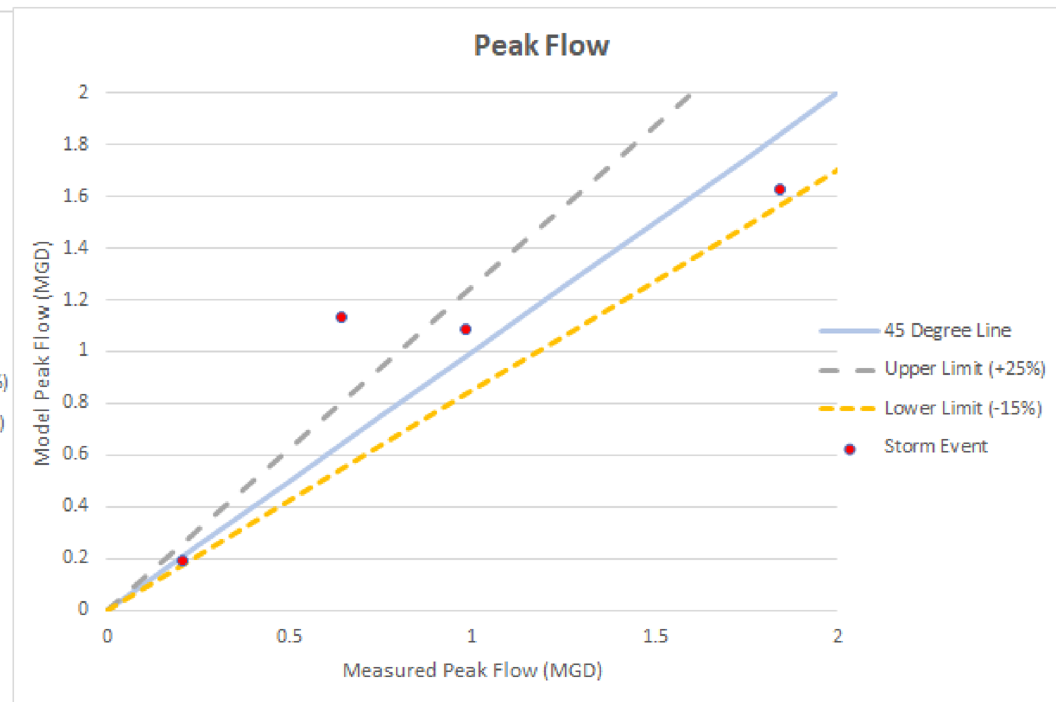


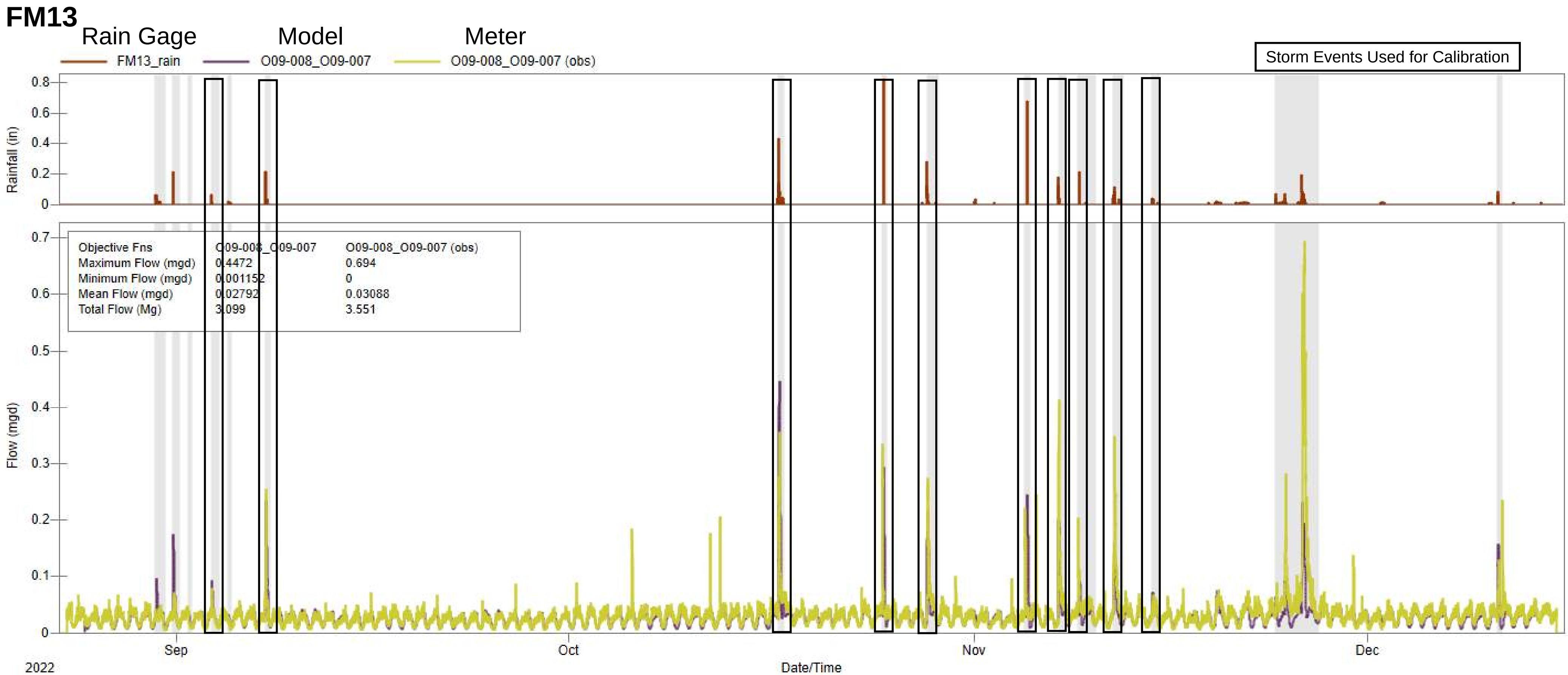
Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event

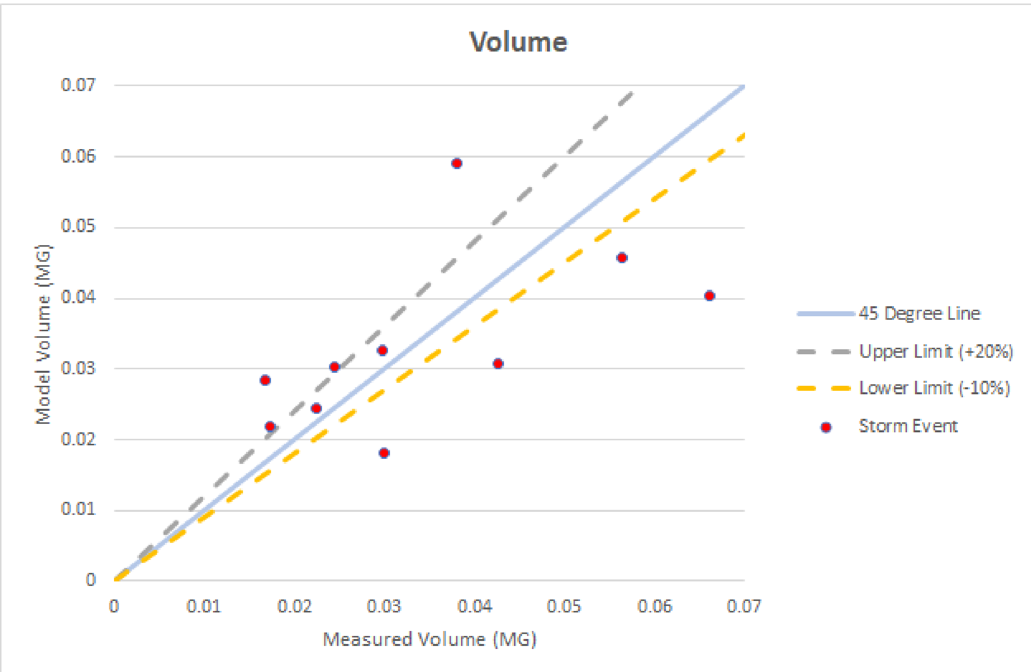
FM10

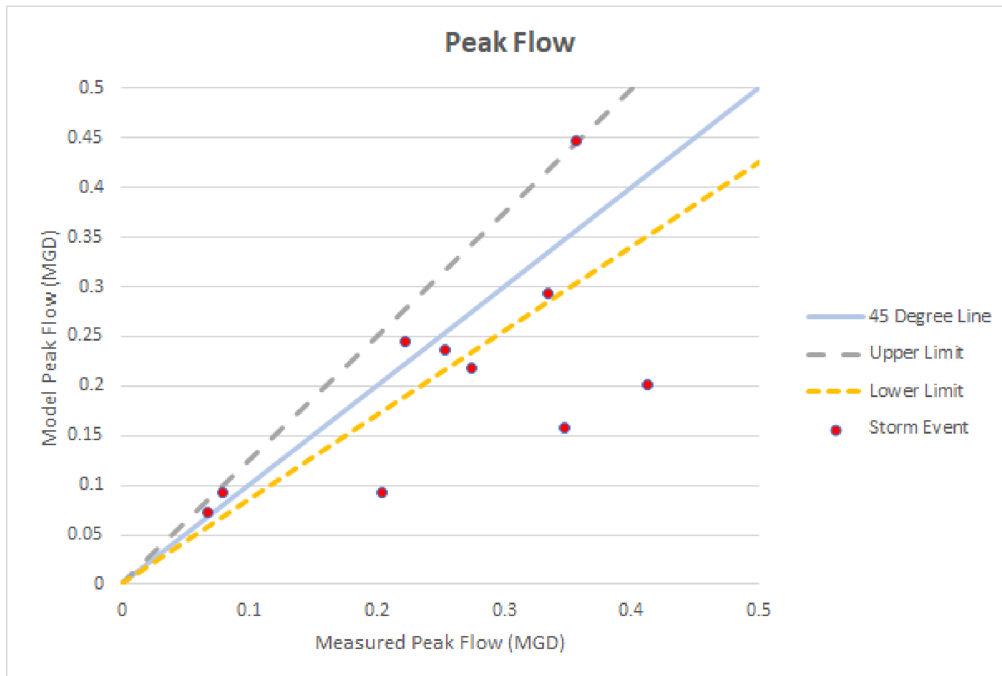

Rain Gage
Model
Meter
FM10_rain
I13-004_I13-003
I13-004_I13-003 (obs)
Storm Events Used for Calibration
Rainfall (in)
Flow (mgd)
Objective Fns | I13-004_I13-003 | I13-004_I13-003 (obs)
Maximum Flow (mgd) | 1.626 | 1.843
Minimum Flow (mgd) | 0.01584 | 0
Mean Flow (mgd) | 0.0669 | 0.06099
Total Flow (Mg) | 7.426 | 7.021
Sep
Oct
Nov
Dec
2022
Date/Time


Volume
Model Volume (MG)
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit (+25%)
Lower Limit (-15%)
Storm Event


FM13
Rain Gage
Model
Meter
FM13_rain
O09-008_O09-007
O09-008_O09-007 (obs)
Storm Events Used for Calibration
Rainfall (in)
Flow (mgd)
Objective Fns
Maximum Flow (mgd)
Minimum Flow (mgd)
Mean Flow (mgd)
Total Flow (Mg)
0.4472
0.694
0.001152
0
0.02792
0.03088
3.099
3.551
Sep
Oct
Nov
Dec
2022
Date/Time


Volume
Model Volume (MG)
Measured Volume (MG)
45 Degree Line
Upper Limit (+20%)
Lower Limit (-10%)
Storm Event


Peak Flow
Model Peak Flow (MGD)
Measured Peak Flow (MGD)
45 Degree Line
Upper Limit
Lower Limit
Storm Event

Appendix D: Overall Projects Map (24”x36”) and Project List (11”x17”)

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Table 7-2: Overall Project List

Project ID	Infrastructure Type	Time Horizon	Current CIP Project ID	Project Name	Type of Improvement	Pipe Diameter (in)[1]	Total Length of Pipe (ft)	Lift Station or WWTP Flow Rate (mgd)	Planning-Level Construction OPCC without Contingency	Capital Cost (30% Contingency, 20% Engr./Survey,)[3]
WW.00.01	Existing/Relief	Present Day	-	Llano St and Lampasas St Interceptors[2]	Exist. Gravity Relief/Upsizing	18"-36"	4,060	-	$3,405,040	$5,652,000
WW.00.02	Existing/Relief	Present Day	-	Pyrite Rd Gravity Sewer (upstream of LS06) - *I/I Mitigation Potential*	Exist. Gravity Relief/Upsizing	18"	930	-	$584,010	$911,000
WW.00.03	Existing/Relief	Present Day	CIP-4	US 290 Interceptor (Still Necessary even if LS06/08/09 are Decommissioned)	Exist. Gravity Relief/Upsizing	24"	2,030	-	$1,596,488	$2,491,000
WW.00.04	Existing/Relief	Present Day	-	Rehabilitation and I/I Mitigation in Existing Sewers	Rehabilitation	-	40,440	-	$7,279,200	$11,356,000
WW.05.01	Treatment	5-Year	S-31	Cottonwood WWTP Expansion Ph. 3 (Expansion from 0.4 to 0.6 MGD)	Exist. WWTP Expansion	-	-	0.2	$3,260,000	$5,086,000
WW.05.02	Treatment	5-Year	-	Wilbarger WWTP Expansion (Expansion from 1.33 to 2.0 MGD)	Exist. WWTP Expansion	-	-	0.67	$16,750,000	$26,130,000
WW.05.03	New/Extension	5-Year	S-36	Manor Springs Lift Station Improvements	New LS to Serve Growth	6"(F)	3,760(F)	0.5	$1,606,289	$2,506,000
WW.05.04	New/Extension	5-Year	S-23	Voelker Ln. Wastewater Improvements	New Gravity to Serve Growth	12"	6,560	-	$4,595,771	$7,169,000
WW.15.01	Treatment	15-Year	S-39/40/41	East Travis Regional WWTP	New WWTP to Serve Growth	-	-	1.5	$37,403,000	$58,349,000
WW.15.02	Existing/Relief	15-Year	Dev. Agr.	Lift Station 1 (Las Entradas) and O09-006_O09-005	Exist. LS Expansion	18"	260	-	$164,430	$257,000
WW.15.03	Existing/Relief	15-Year	S-18	West Cottonwood Creek Existing Interceptor	Exist. Gravity Relief/Upsizing	24"-27"	8,500	-	$8,236,967	$12,850,000
WW.15.04	Existing/Relief	15-Year	S-16	East Cottonwood Creek Existing Interceptor	Exist. Gravity Relief/Upsizing	27"-33"	3,070	-	$3,392,810	$5,293,000
WW.15.05	Existing/Relief	15-Year	-	FM973 Interceptor (Not Necessary if LS06 is Decommissioned)	Exist. Gravity Relief/Upsizing	18"	4,220	-	$2,658,600	$4,147,000
WW.15.06	New/Extension	15-Year	S-38	South Cottonwood Creek Wastewater Interceptor Improvements Phase 1[2]	New Gravity to Serve Growth	39"-45"	7,960	-	$15,366,210	$25,508,000
WW.15.07	New/Extension	15-Year	S-38	South Cottonwood Creek Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	36"	8,910	-	$13,811,117	$21,545,000
WW.15.08	New/Extension	15-Year	S-23	Willow Creek Wastewater and Lift Station Improvements	New Gravity/LS to Serve Growth	24"(G), 6"(F)	2,160(G/F)	0.65	$1,642,456	$2,562,000
WW.15.09	New/Extension	15-Year	-	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	24"	5,210	-	$5,424,105	$8,462,000
WW.15.10	New/Extension	15-Year	-	Willow Creek West Tributary Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	15"-21"	7,710	-	$6,455,271	$10,070,000
WW.15.11	New/Extension	15-Year	-	East US290 Wastewater Improvements	New Gravity to Serve Growth	15"	2,920	-	$2,219,654	$3,463,000
WW.15.12	New/Extension	15-Year	-	North Cottonwood Creek East Tributary Wastewater Interceptor Improvements	New Gravity to Serve Growth	15"-18"	8,480	-	$6,720,382	$10,484,000
WW.15.13	New/Extension	15-Year	-	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	27"	7,390	-	$8,791,977	$13,715,000
WW.15.14	New/Extension	15-Year	-	South Cottonwood Creek West Tributary Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	27"	3,590	-	$4,424,675	$6,902,000
WW.15.15	New/Extension	15-Year	-	Littig Rd. Wastewater Improvements[2]	New Gravity to Serve Growth	12"	8,510	-	$5,961,816	$9,897,000
WW.15.16	New/Extension	15-Year	-	North Cottonwood Creek Wastewater Interceptor Improvements Phase 1	New Gravity to Serve Growth	21"-24"	7,238	-	$7,379,755	$11,512,000
WW.15.17	New/Extension	15-Year	-	North Cottonwood Creek Wastewater Interceptor Improvements Phase 2	New Gravity to Serve Growth	12"-18"	10,367	-	$8,035,168	$12,535,000
WW.15.18	New/Extension	15-Year	-	South Wilbarger Creek Lift Station Improvements	New LS to Serve Growth	4"(F)	5,040(F)	0.25	$1,287,296	$2,008,000
WW.15.19	New/Extension	15-Year	-	Lift Station #6 (Stonewater) Decommissioning	New Gravity to Abandon LS	18"	3,300	-	$3,134,355	$4,890,000
WW.15.20	New/Extension	15-Year	-	Lift Station #8 (Presidential Glen Ph. 4B) Decommissioning	New Gravity to Abandon LS	12"	1,400	-	$1,281,253	$1,999,000
WW.15.21	New/Extension	15-Year	-	Lift Station #9 (Presidential Heights) Decommissioning	New Gravity to Abandon LS	12"	500	-	$650,448	$1,015,000

Notes:

1) For pipe diameters and lengths, gravity main is assumed, except where (F) indicates force main, and (G) indicates gravity main.
2) Select projects include an additional 10% contingency for railroad crossings to account for additional costs (permitting, extra boring length, etc.).
3) For new/extension projects not within the ROW or an exisitng easement, a unit cost of $87,900/acre was utilized for easement cost estimates.
The easement unit cost includes survey, easement acquisition, engineering fees, condemnation/attorney fees, and ROW agent fees.

LS06, LS08, and LS09 are recommended to be decommissioned and re-routed by gravity towards East Travis Regional WWTP once it is built. This reduces burden on Wilbarger WWTP and the FM973 interceptor, and reduces LS O&M costs.

Projects Not Included: The above list does not include Bell Farms LS upgrades (LS04), Carriage Hills LS or interceptor upgrades, Cottonwood Cr. WWTP Ph. 2 expansion to 0.4 MGD (developer-funded), or other projects currently in-progress.

Time Horizon	Capital Cost	
Present Day	$	20,410,000
5-Year	$	40,891,000
15-Year	$	227,463,000
Total, All Projects	**$**	**288,764,000**

Appendix E: Recommendations for Updating and Leveraging the Sanitary Sewer Model

Appendix E: Recommendations for Updating and Leveraging the Sanitary Sewer Model

Introduction and Background:

Computer capacity models provide the means to evaluate sanitary sewer systems in many ways, such as determining system strengths and weaknesses as they relate to system operation, analyzing development inquiries, and future growth master planning. Computer capacity models can be leveraged for sanitary sewer CIP development to identify, size, and schedule necessary system improvements.

This document provides recommendations to maintain and utilize the sanitary sewer model developed for the City of Manor's Wastewater Master Plan. The model was developed utilizing the PCSWMM software. Geographical Information Systems (GIS), project records, and field data were collected and utilized to input physical attribute data into the model. Because of the complexity of the model and the investment made by the City, this document was created to identify a practical approach to maintain the hydraulic model of the City's wastewater collection system. The recommended work tasks were developed with the understanding that the City may not have the required resources in-house to complete them, at least initially. Also, some of the recommendations may differ from the City's current practice for GIS maintenance and record keeping. The model will need to be consistently maintained, however, to realize its full value.

The model requires consistency in its structure, including how model network additions and changes are implemented. Initial development of the model included gravity sewers with a diameter of 12-inches or greater, and most lift stations and force mains. Extensive fieldwork was conducted to collect the piping and manhole information used in the model. Not all manholes could be located or opened, however, creating gaps in the data. These gaps in elevations were generally filled using interpolated estimates or best-available information (such as LiDAR elevation data). Estimated drainage areas (basins) were assigned to manholes to distribute flows in the model. Dry- and wet-weather calibrations were conducted using recorded rainfall and flow data at previous flow monitoring sites throughout the City's system. Future growth planning documents and discussions with City planners were conducted to project and spatially distribute growth for the five and fifteen-year model scenarios.

As scoped for the modeling effort, GBA used a combination of existing GIS data and newly collected manhole data to create the network for the sewer model. The GIS layer was created to provide the data in an optimal format for the model. This GIS layer included most of the model set-up information needed for the project. The field survey provided information for approximately 250 manholes and 100,000 feet of pipe. Ten of the City's thirteen active lift stations were included in the model. Lift station data was provided by the City.

Three model scenarios were developed for the project to inform the Master Plan. These modeled time horizons are listed below and are recommended to be updated when re-calibration is conducted:

- Existing Conditions (approximately 2023)
- 5-Year Growth Conditions (2028)
- 15-Year Growth Conditions (2038)

There are numerous approaches for maintaining and leveraging a sanitary sewer model. The activities detailed in this memo are recommended as a starting place. First, it is recommended that the City maintain information in GIS as specified below on a consistent annual basis. Also, a complete re-calibration of the model should be conducted at least every 5 years, or at the time of a master plan update. The re-calibration should utilize the best-available flow monitoring data in the City's repository. Five distinct tasks are recommended and described below:

1. Sanitary Sewer GIS Network Maintenance – Annual
2. Flow Monitoring and Data Repository – 5 Year Cycle (Systemwide)
3. Future Growth Planning – Annual
4. Model Updates – Annual
5. Model Calibration – 5 Year Cycle

1. Sanitary Sewer GIS Network Maintenance – Annual

GIS network maintenance plays a significant role in the maintenance of the hydraulic model. Specific data gaps, when filled via field work/investigations, should be consistently and regularly updated in GIS. There are specific GIS attribute fields that were captured during field investigations by GBA that are critical to the model input. The attributes shown below will need to be maintained and updated in the City's GIS, to ensure efficient updates to the model. Specific additions and modifications to the GIS database schema are detailed below.

Manhole Attributes:	Pipe Attributes:	Lift Station Attributes:
MH ID	Pipe ID	Lift Station ID
MH Rim Elevation	US Manhole ID	Wet Well Cross-Section Area
MH Invert Elevation	DS Manhole ID	Rim Elevation
MH Diameter	Pipe Size	Invert Elevation
Surcharge Evidence Flag	Pipe Material	Pump "On" Depth
	Pipe Length	Pump "Off" Depth
	US Invert Elevation	Pump Curve
	DS Invert Elevation	Record Drawings

Recommendations for maintaining GIS data to ensure efficient integration into the model are outlined below:

- Establish or adopt a GIS database schema that includes all the attributes shown above that are necessary to the upkeep of the hydraulic model;
- Perform a gap analysis to identify areas, features, and attributes missing from the current database as well as those that should be included for modeling activities to consolidate all wastewater data into a single geodatabase;
- Continue using the wastewater infrastructure ID system developed by GBA;
- Provide developers and consultants with a blank file geodatabase containing the wastewater asset schema and require them to populate the file with all necessary "as-built" data and submit it for review before project closeout;
- Develop a process for integrating/appending newly provided "as-built" GIS data provided by developers/consultants into the City's master GIS database.

2. Flow Monitoring and Data Repository

Flow monitoring is necessary for evaluating sanitary sewer performance and flow conditions. Flow monitoring can provide answers and insights for the following questions and scenarios:

- ***Does the system have surcharge issues?*** Flow monitoring can be used to assess the risk or occurrence of surcharge. It can also help identify the cause of the surcharge. For example, if backup surcharge is occurring, then there is likely a downstream capacity restriction.
- ***Does the system have excessive I/I?*** Flow monitoring can also establish the relative leakiness of the sewer system, and when strategically located, it can isolate I/I issues.
- ***Utilize in modeling to calibrate existing system.*** Observed base flows and reactions to storm events can be used to calibrate model flows at monitoring sites.
- ***Utilize in modeling to project peak design flows.*** Once the model is calibrated to flow data, it can be used to project peak flows and simulate system responses for various design storms.
- ***Utilize in modeling to verify locations that have capacity issues.*** The model results can be compared to monitoring site flow levels to verify if there is a problem. For example, if the flow monitoring data shows there has been surcharge, the model can be reviewed to verify if it also identifies this problem.

As the City collects more flow monitoring data for use in studies and designs, a central repository can be created to store and organize that data. The *Flow Monitoring Data Repository* can be linked to GIS. It is recommended that both the data and any reports be kept in the repository to help with evaluations of the data for modeling needs. (i.e., If the meters were in during a dry year, then the meter data for that session should not be used for wet weather calibration). The flow data will also be used to recalibrate the model as recommended on a 5-year basis. An example of a *Flow Monitoring Data Repository* in GIS is shown in **Figure 1**. It should be noted that flow data can be utilized for many aspects of sanitary sewer surveillance besides modeling and is recommended to be conducted as an independent program.

Targeted Flow Monitoring for Relief Sewer Evaluation

A single targeted flow monitoring session is recommended for investigating problem areas identified in the existing conditions wastewater model. This would allow the City to confirm the necessity of sanitary sewer improvements in areas identified in the model as critically surcharged. **Figure 2** shows the recommended locations for this targeted flow monitoring investigation. The rationale for the 5 temporary flow meters are described as follows:

- FM02E will be placed along the US Highway 290 interceptor, downstream of where the FM973 interceptor ties in. This line was shown to surcharge in the existing system wastewater model, and a flow meter would help confirm capacity issues.
- FM03A will be placed at the downstream end of the Llano Street interceptor, near the Wilbarger WWTP, to confirm the presence and extent of surcharge predicted by the model. This will help determine if improvements will be necessary.
- FM03B will be placed along Lampasas Street to confirm the presence and extent of surcharge shown in the wastewater model. This will help determine if improvements will be necessary.
- FM03C will be placed in a manhole on the upstream end of the Lampasas Street interceptor, near the discharge point of the combined force main from LS3 and LS11. This flowmeter is necessary to evaluate how much flow is entering these interceptors from the force main.
- FM10 will be placed along Pyrite Road, farther upstream than the Fall 2022 location, to help evaluate the extent and cause of surcharging.

Systemwide Flow Monitoring for Model Calibration

It is recommended that systemwide flow monitoring be conducted at least every 5 years, if not more often if need arises. A comprehensive metering session once every 5 years will provide flow data necessary for re-calibrating the model and evaluating system performance. However, it should be noted that flow monitoring during particularly dry conditions may not be usable in model calibration and would therefore require an extended or additional meter session. The flow meter locations should be similar to those used during the Fall 2022 flow monitoring session, with some adjustments, such as the addition of flow meters in the Cottonwood Creek Basin. **Figure 3** shows the recommended locations for the 5-year flow monitoring effort. Targeted flow metering will also be required in the future to quantify the flow to be redirected when lift stations 6, 8, and 9 are decommissioned.

3. Future Growth Planning – Annual

Documents pertaining to future growth should be compared to documents used in the Master Plan report on an annual basis. Also, as development occurs and sewers are built, the master plan should be annotated accordingly. New planning documents and an updated Master Plan sewer map should be maintained in a *Future Growth Repository* to be utilized for updating the model and master plan.

New Development Impacts. The model can be used to evaluate new development impacts. It is recommended that new development impact analyses are conducted when the new development has differed from the City's current plan. Aspects of development to consider are:

- Is the development within the drainage basin? If so, have the flows from the development already been accounted for (i.e., large industries or multi-family projects can add significant daily volumes versus subdivision flows)?
- If not in the watershed, will the sewage be pumped into a basin and does the system have sufficient capacity?
- How will flows be assigned to the new development?
- What is the timing of the development relative to other planned developments and system demands/improvements?

Once the evaluation process has been established, the model is available to determine the impact on the modeled downstream system. It is important to note that the model currently only includes those pipes of 12-inch diameter or greater, so only those sewers that are modeled can be assessed in this way. A method for modeling new developments should be established that adheres to City development requirements. The model can help predict available capacity in the sewer segments downstream of the development to evaluate the need for any improvements. The peak flow from the new development can then be added in to determine how much available capacity will be used under existing and future scenarios. The City can then make decisions about potential upgrades and/or developer cost sharing to implement.

4. Model Updates – Annual Checks

Generally, the model should be updated annually, but only when significant changes have occurred, and the model is needed for specific development evaluations. Potential updates should be listed and checked to see if model updates are prudent. Detailed scenarios where model updates are necessary and how to perform the updates are outlined below:

- New developments:
  - Assign sewershed area, number of contributing LUEs (or estimate wastewater generation quantities) and flow patterns to the nearest downstream receiving manhole
- New infrastructure:
  - For new gravity lines greater than or equal to 12 inches in diameter, import updated GIS data as shapefiles into the PCSWMM model and ensure connectivity

        - For new lift stations, import updated GIS data into the PCSWMM model including wet well and force main details; manually add pump information (pump curve, start-up, and shut-off depths) to the model
    - Changes to existing gravity lines:
        - Update the pipe size, pipe material, and manhole rim and invert elevations
    - Changes to existing lift stations:
        - Update wet well area, wet well depth, pump curve, start-up and shut-off depths, force main size, force main material, and force main alignment as applicable

5. Model Calibration

There are two types of calibration situations that are recommended. One is for partial re-calibration and the other is total re-calibration of the model. Partial re-calibrations would be based on significant growth in an isolated area of the system. It is recommended that the system be monitored on a case-by-case basis to measure increases in base flow to identify where model changes are needed in the short term. The flow monitoring plan shown in **Figure 3** should generally be followed for base flow checks of each basin and re-calibration should be considered for basins that exceed a 20 percent increase in base flow.

Total re-calibration of the model should be conducted on a set schedule and is usually not conducted every year. For the City of Manor, it is recommended that re-calibration of the entire modeled collection system be conducted on a 5-year cycle because of the anticipated rapid development of the City's sewer. The model re-calibration will utilize the *Flow Monitoring Data Repository*. The recommended re-calibration method is provided below:

- Partial Re-calibration:
    - When new flow meter data becomes available and varies +/- 20% from 2022 Flow Monitoring Data used for original calibration (See Figure 3)
        - Compare flow metering data for dry weather flow to the modeled average dry weather flow at that location
        - Collect at least 3 months of representative flow metering data capturing both dry and wet weather conditions with flow meters and rain gages appropriately placed
        - Update average daily dry-weather flows (ADDFs) and time patterns for dry weather calibration
        - Recalibrate unit hydrographs for wet weather events
    - Changes to land use
        - If land within a flow meter basin undergoes significant changes impacting wastewater generation, perform flow monitoring and recalibrate that specific basin
    - Observed deficiencies (backups, surcharging, etc.)

    - If deficiencies are observed in the field but not predicted in the model, perform flow monitoring and recalibrate that specific area

- Total Re-Calibration:
  - On a cycle appropriate for the overall city growth (Every 5 years recommended).
    - Objective: Update the City Wastewater Master Plan and re-calibrate the model
    - Add changes to model network – Manholes, pipes, lift stations, etc.
      - Use city GIS that has been updated annually
      - Create new GIS model layer and compare to previous model layer
    - Select most recent and usable year of flow data (use *Flow Monitoring Data Repository*)
    - Distribute average dry weather flows throughout the system
    - Update time patterns for dry weather conditions
    - Re-calibrate R, T, K hydrographs to selected storm events
    - Update future growth models
      - Review plans from *Future Growth Repository*.
    - Analyze model results and update plan

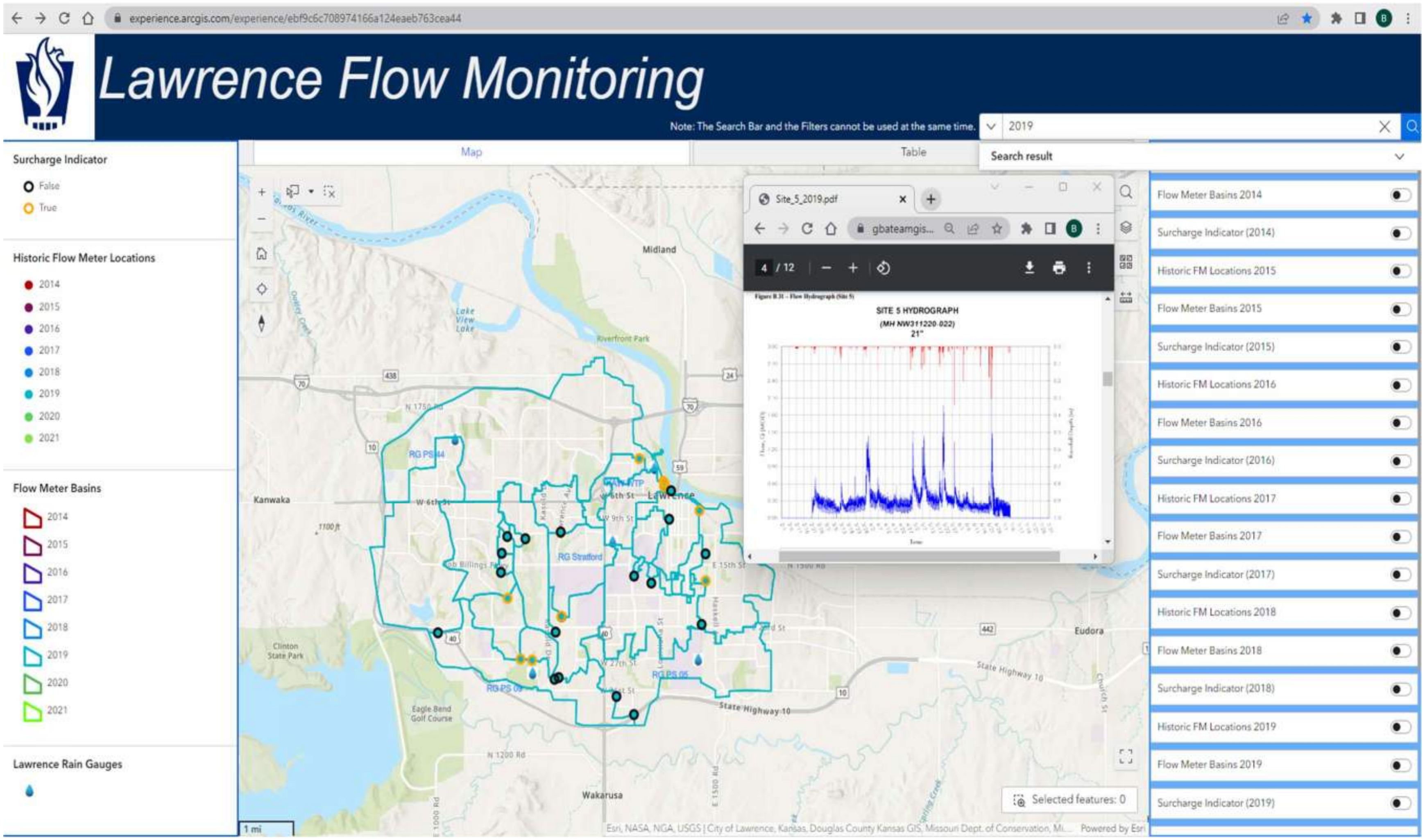

Figure 1: Web-Based Flow Monitoring Repository Example

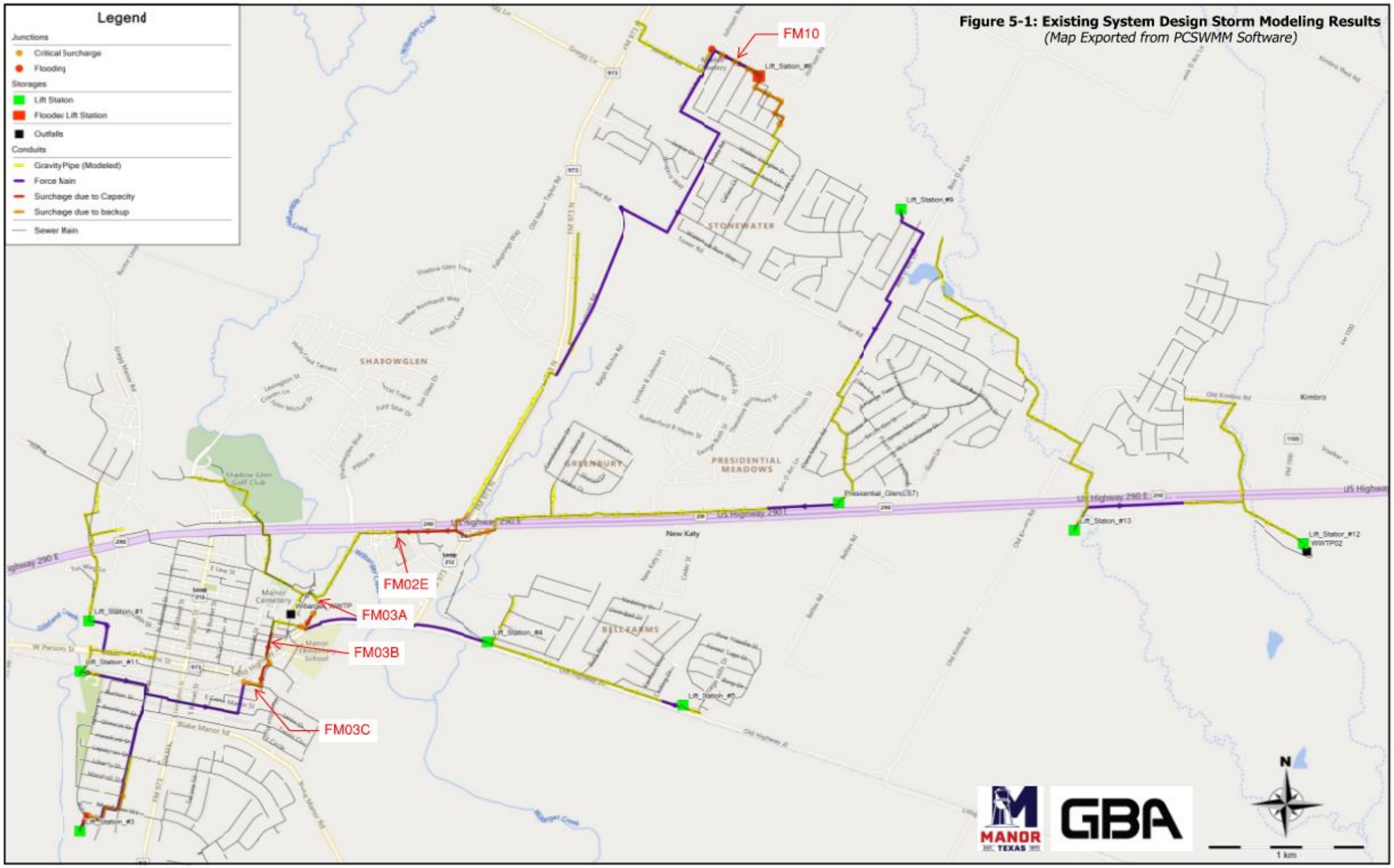

Figure 2: Recommended Targeted Flow Monitoring Plan (for Investigating Potential Relief Projects)

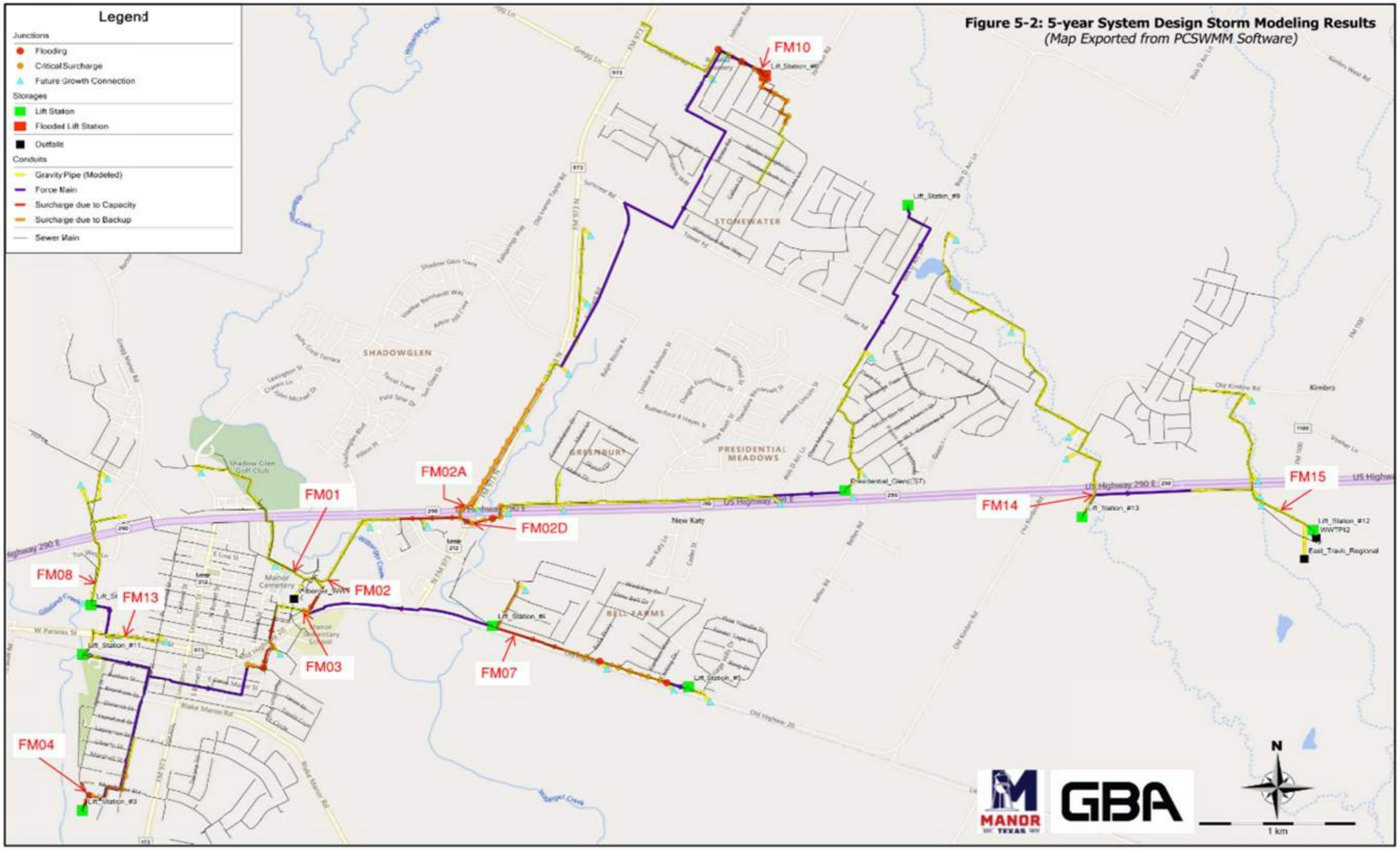

Figure 3: Recommended 5-Year Flow Monitoring Plan (for Model Updates and Re-Calibration)

Model Maintenance Budget:

Preliminary budget estimates for GBA to perform the outlined work are shown in Table 1. Actual costs will vary depending on scope and timing. With a 7% growth rate, it is estimated that approximately 30 to 50 pipe and manhole structures for pipes 12 inches or larger will be added to the system each year and subsequently incorporated into the model. Flow monitoring is estimated to cost $10,000 per meter, per three-month session. Future growth planning involves analyzing the impact of future developments on the sewer system, at a cost of $5,000 per development. Model updates include integrating the updated GIS dataset into the model. Model calibration is estimated to cost approximately $10,000 per basin.

Table 1: Estimated Budget to Perform Outlined Work

Task	Low Unit Range	High Unit Range	Low Cost	High Cost
1. Sanitary Sewer GIS Network Maintenance (Segments)	30	50	$1,000	$2,000
2. Flow Monitoring Repository (Flow Meters)	5	12	$50,000	$120,000
3. Future Growth Planning (New Development Review)	1	3	$5,000	$15,000
4. Model Updates From GIS Network (Segments)	30	50	$3,000	$5,000
5. Model Calibration – Targeted Basins	1	3	$10,000	$30,000
		Total Annual Costs	$69,000	$172,000
5. Model Calibration – Entire System (All Basins)	12		$120,000 (every five years)	
		5-Year Total Costs	$189,000	$292,000