Appendix F
Turners Falls Technical Memo – Field Investigations

WRIGHT-PIERCE
Engineering a Better Environment

Memorandum

Date: **3/3/2023**

Project No.: **21005**

To: **Town of Montague, MA**

From: **Wright-Pierce; Lisa Muscanell-DePaola, PE; Lindsey Sylvester, PE; Meghan Otis**

Subject: **Turners Falls, Lake Pleasant, and Montague Center Wastewater Collection System Study - FINAL**

Introduction

Background

The Town of Montague was issued an Administrative Order (CWA-AO-R01-FY20-31) from the U.S. Environmental Protection Agency (EPA) on June 11, 2020, addressing compliance with its National Pollutant Discharge Elimination System (NPDES) permit (No. MA0100137) to meet numeric effluent limitations and minimize Combined Sewer Overflows (CSOs) in the Turners Falls Wastewater Collection System. Wright-Pierce developed and submitted a draft update of the Town's Long-Term Control Plan (LTCP) for the Town's review, under a separate project. Part of the recommendations of the CSO LTCP Update included a collection system study of the village of Turners Falls.

Within the village of Turners Falls, the Town owns and operates one Wastewater Pollution Control Facility (WPCF), five wastewater pumping stations, three regulators with flow monitoring equipment installed, two CSOs, and one buffer line. As of 2005, approximately 90 percent of the Town's sewer system was separated. Since then, the Town has completed one additional sewer separation project on approximately 300 linear feet of combined sewer along Crocker Avenue between Avenue B and Marshall Street. Excess flow during rainstorms from the combined sewer systems can discharge through the Town's permitted CSO on Greenfield Road and/or the permitted CSO on I Street.

Purpose

The Administrative Order specifically brought attention to "excursions of the water quality criterion for E. coli bacteria in the Connecticut River" from untreated combined sewage that was discharged from CSO outfalls between 2018 and 2019 and required an update to the Town's CSO LTCP. This memorandum details the field investigations conducted in support of the implementation plan outlined in the CSO LTCP Update. The field investigations were also used to expand the Town's existing asset inventory.

Field investigations were also conducted within the wastewater collection systems in the villages of Lake Pleasant and Montague Center. This work complimented the work being performed in the village of Turners Falls. As a result, the Town was able to complete Town-wide flow monitoring efforts throughout four villages, including Millers Falls, which is submitted under a separate memorandum.

Wright-Pierce assisted the Town in applying for and receiving an Asset Management Grant through the Massachusetts Department of Environmental Protection (MassDEP). This funding covered the completion of the work in Turners Falls in addition to matching with in-kind services from the Town.

Flow, Rainfall, and Night Flow Isolation Monitoring Program

Flow Monitoring Program

The flow metering program included the installation, maintenance, and analysis of five meters in the villages of Turners Falls, Lake Pleasant, and Montague Center over the course of a 10-week monitoring period from March 30 through June 8, 2022. During this period, sewer data was documented at 15-minute intervals and reviewed for general trends and anomalies. Flow meter locations were based on the Town's GIS database as developed by RCAP Solutions.

Wright-Pierce field technicians installed and maintained these five meters. Site visits were conducted as needed to address data issues or equipment issues noted during data review. Manual depth and velocity measurements were taken periodically at site visits to check and calibrate the meters. Data was collected and automatically uploaded to Telog Enterprise, a Trimble Water data viewing portal. Wright-Pierce routinely reviewed the flow metering data on Enterprise to monitor proper data collection. Any issues were identified by Wright-Pierce and addressed in the field.

One of the meters (WPFM07) was originally installed in Lake Pleasant but was relocated about a month after the start of the flow monitoring period due to low flows that were undetectable by the meter. This meter was relocated to Turners Falls (WPFM09) to split up a larger flow meter basin.

At the end of the flow monitoring period, Wright-Pierce conducted a review of the data collected and made necessary data edits before performing an infiltration and inflow (I/I) analysis.

The flow monitoring program was supplemented with data from three meters installed and maintained by ADS Environmental Services at the CSO regulators. Wright-Pierce analyzed the data from these three meters over the course of the 10-week monitoring period.

All nine flow meter locations are shown in **Map 1**, including the meter that was relocated. A schematic of the meter locations shown in **Map 1** is depicted in **Figure 1**.

Basemap by ESRI.

WPFM02
Combined with AVEA upstream
Infiltration Excessive: No (3,201 GPD/IDM)
Inflow Excessive: Yes (32%)

AVEA
Combined with WPFM02 downstream
Infiltration Excessive: No
Inflow Excessive: Yes

7THL
No upstream combinations
Infiltration Excessive: No (632 GPD/IDM)
Inflow Excessive: Yes (49%)

WPFM09
Combined with GFLDRD downstream
Infiltration Excessive: No
Inflow Excessive: No

WPFM01
Combined with GFLDRD downstream
Infiltration Excessive: No
Inflow Excessive: No

WPFM08
Combined with WPFM06 and WPFM07 upstream
Infiltration Excessive: No (883 GPD/IDM)
Inflow Excessive: No (12%)

GFLDRD
Combined with WPFM01 and WPFM09 upstream
Infiltration Excessive: No (815 GPD/IDM)
Inflow Excessive: No (7%)

WPFM07
Combined with WPFM08 downstream
Infiltration Excessive: No
Inflow Excessive: No

WPFM06
Combined with WPFM08 downstream
Infiltration Excessive: No
Inflow Excessive: No

Basin Name
- 7THL
- AVEA
- GFLDRD
- WPFM01
- WPFM02
- WPFM06
- WPFM07
- WPFM08
- WPFM09
- Unmetered
- Pressurized Main
- Meter Location
- Manhole
- Meter Basin Outline

N

0 1,000 2,000 4,000 6,000 Feet

Turners Falls Metering Results
Montague, MA

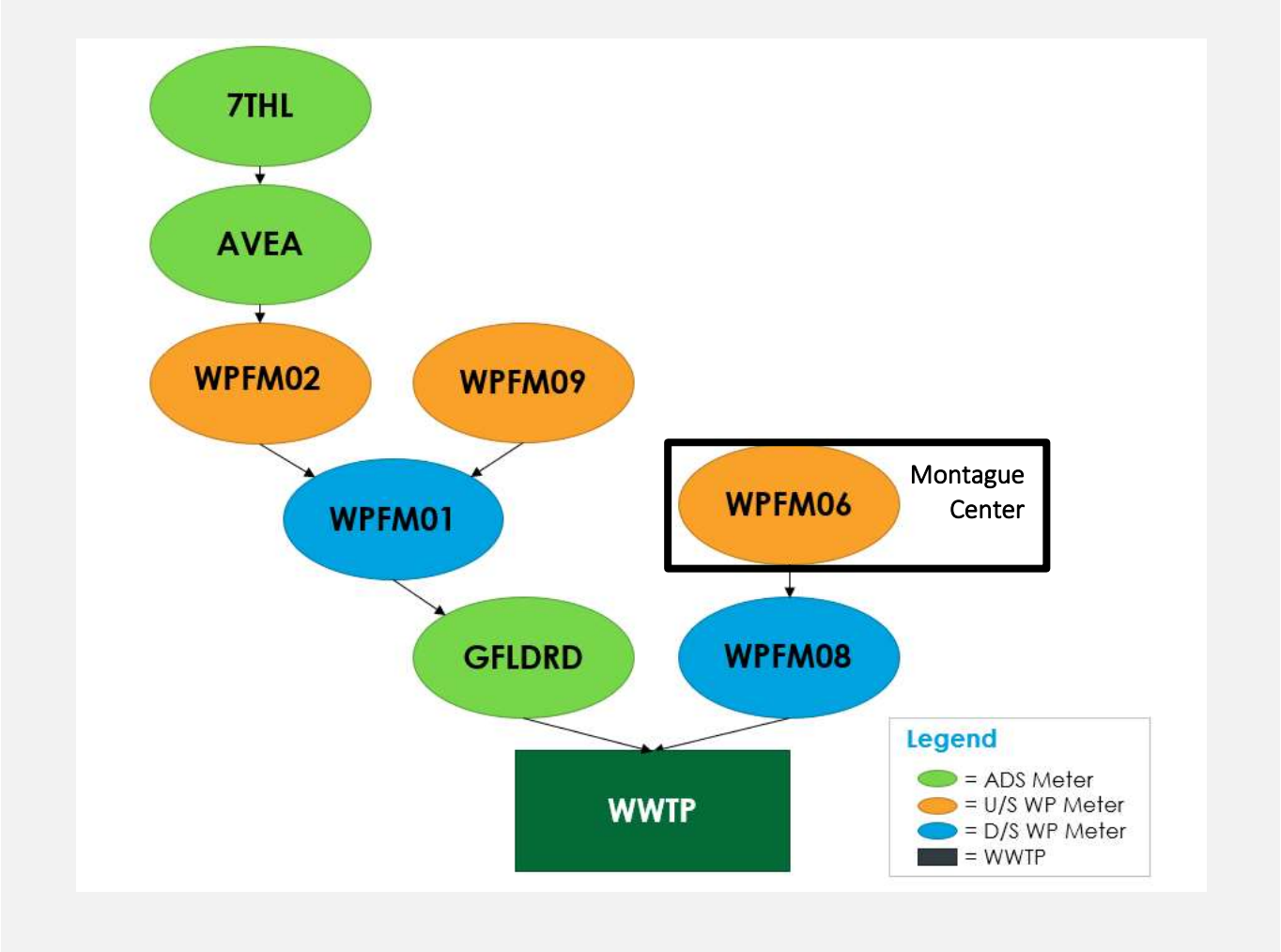
PROJ NO:	DATE:
21005	1/3/2023

WRIGHT-PIERCE
Engineering a Better Environment

MAP: 1

KTM W:\GIS_Development\Projects\MA\Montague\21005_LCTP_Update\MXDs\Figures_Fieldwork_20221109.aprx - TurnersMeterResult11x17-Portrait

Figure 1 Turners Falls Flow Meter Schematic



A summary of the flow monitoring locations is listed in **Table 1.**

Table 1 Summary of Turners Falls Flow Monitoring Locations

Meter Basin	Village	Start Date	End Date	Manhole ID	Gross Basin Size (LF)	Net Basin Size (LF)	Net Basin IDM [1]	Metered Pipe Diameter [2] (in)
WPFM01	Turners Falls	3/30/2022	6/8/2022	TPR-20	85,132	29,960	76.24	24
WPFM02	Turners Falls	3/30/2022	6/8/2022	AVF-1	57,448	10,702	36.39	20
WPFM06	Montague Center	3/30/2022	6/7/2022	PS-MAM-3	9,845	9,845	16.65	12
WPFM08	Turners Falls/ Lake Pleasant	3/30/2022	6/8/2022	GE-32	43,255	22,681	49.01	15
WPFM09	Turners Falls	4/25/2022 [3]	6/7/2022	WAL-8	44,443	44,443	81.22	15
7THL [4]	Turners Falls	Ongoing	Ongoing	SS-10	19,459	19,459	42.74	14
AVEA [4]	Turners Falls	4/8/2022	6/13/2022	AV-12	46,746	27,287	60.13	21
GFLDRD [4]	Turners Falls	Ongoing	Ongoing	SH-6	150,295	18,444	51.13	36

Note:

1. Inch-diameter-mile (IDM) is the relative size of each meter basin calculated from pipe diameters and lengths. Calculations do not include length of pipe for force mains or sewers outside of the project area.
2. Diameter is the average of the pipe width and height measured at meter installation.
3. This meter was previously installed in Lake Pleasant (at WPFM07) on 3/30/2022 but was relocated on 4/25/2022 due to low flows that were undetectable by the meter.
4. These meters were installed and maintained by ADS Environmental Services. The data from these meters was used to supplement our analysis.

Rain Monitoring Program

As part of this project, Wright-Pierce installed, maintained, and removed one rain gauge within the flow metering area.

The rain data was collected and automatically uploaded to Telog Enterprise. Wright-Pierce reviewed the rain data on Enterprise alongside the flow monitoring data for trends and anomalies. Rain data was reviewed to determine if suitable rain events were captured for each meter location to perform an I/I evaluation.

Rain events approximately 0.50 inches or greater were considered suitable for performing the I/I evaluation. A total of seven rain events greater than 0.50 inches were recorded throughout the monitoring period. **Table 2** summarizes the rain events that occurred during the flow monitoring program.

Table 2 Summary of Rain Events Greater than 0.50 Inches

Date of Rain Event	Total Rainfall (inches)
3/31/2022 – 4/1/2022	0.92
4/7/2022 – 4/8/2022	1.28
4/16/2022	0.59
4/19/2022	1.14
5/16/2022	0.53
5/22/2022	0.58
6/9/2022	0.98

Groundwater Monitoring Program

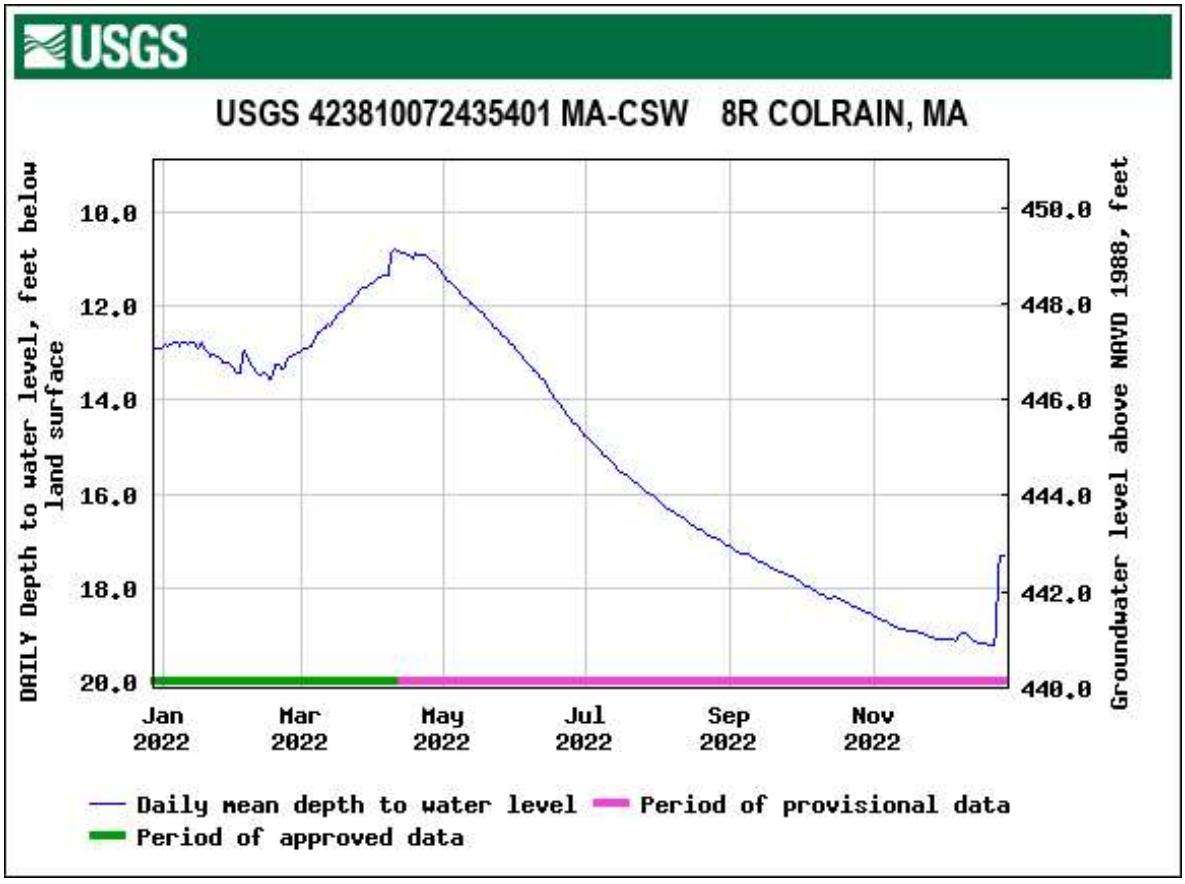
Along with the flow meters and rain gauge, Wright-Pierce installed and maintained one groundwater piezometer. The groundwater gauge was co-located with flow meter WPFM01, and the groundwater data was collected during the same time period as the flow monitoring program. The gauge was installed in the manhole wall, above the channel. The gauge equipment was kept free of debris to allow groundwater to flow freely in the tubing. Manual depth measurements were taken during each site visit.

This piezometer did not record active groundwater during the monitoring period. This indicates that the local groundwater was not high enough to reach the elevation of the connecting pipe crowns in that manhole.

Wright-Pierce obtained available United States Geological Survey (USGS) groundwater data from the local well monitoring site in Colrain, Massachusetts in lieu of the piezometer data. Review of the USGS data during the flow monitoring program indicates that groundwater levels were generally lowest in March (winter) and June (summer), highest in April (spring), and gradually decreased in May. This trend is typical and, per the MassDEP guidelines, preferred for this analysis.

A graph of the groundwater depths at the USGS Colrain site are shown in **Figure 2**.

Figure 2 Groundwater Levels During Flow Monitoring Period



Night Flow Isolations

Night flow isolations (NFI) were performed to supplement the flow monitoring program and to find smaller areas of excessive infiltration that can be targeted for closed-circuit television (CCTV) pipe inspections.

On the night of Wednesday, May 18, 2022, Wright-Pierce staff performed NFIs in areas of suspected infiltration, based on a preliminary analysis of the flow monitoring data, which indicated that meter basins GFLDRD, WPFM02, and 7THL had excessive infiltration. Instantaneous flow measurements were taken at selected manholes using a pole-mounted flow measuring device. The measurements took place between 10:00 PM and 4:00 AM, when wastewater production is expected to be the lowest. The measurements also took place during higher groundwater levels and after a rain event of 0.53 inches on May 16, 2022. This means that active infiltration should have been present.

Night flows for each isolation area were normalized based on inch-diameter-mile (IDM) to compare rates more accurately across each area. A rate of 4,000 gallons per day per inch diameter mile (GPD/IDM) is considered a benchmark for areas having excessive infiltration as per the MassDEP Guidelines for Performing I/I Analyses and Sewer System Evaluation Surveys (SSES) dated May 2017 (Guidelines).

Map 2 shows the areas targeted for NFIs and the infiltration rate results. **Table 3** contains the results of the NFIs, ranked according to the net infiltration rate of the isolation area. In this table, the areas of excessive infiltration are highlighted in blue.

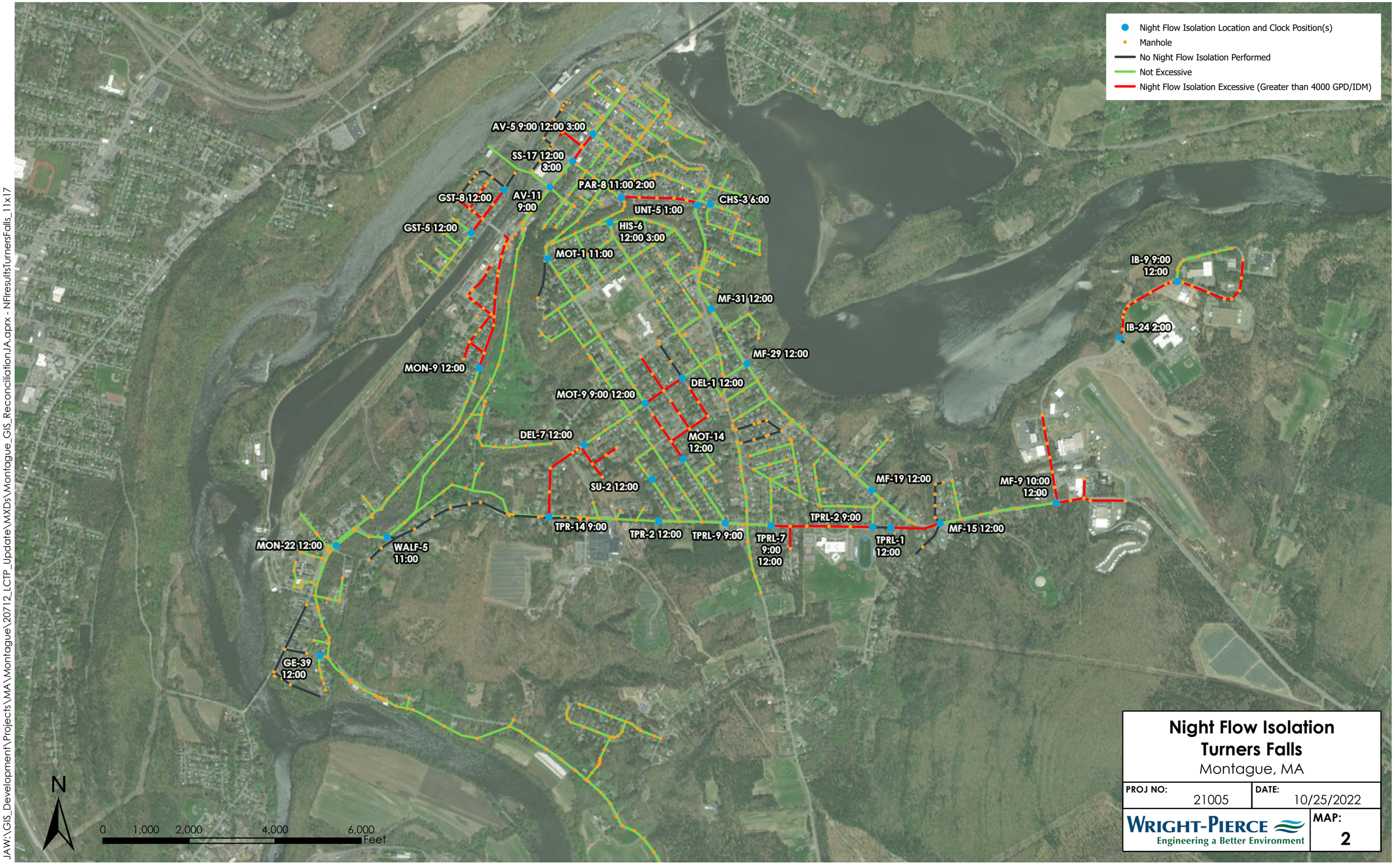
Table 3 Summary of Infiltration from Turners Falls Night Flow Isolations

Reading Number [1]	Meter Basin	Length (LF)	Net Infiltration Rate [2] (GPD/IDM)
IB-24-2:00	GFLDRD	1,506	Surcharged [4,5]
TPRL-1-12:00	GFLDRD	860	46,826
MF-9-10:00	GFLDRD	1,502	28,750 [4]
TPRL-7-12:00	GFLDRD	2,120	7,598
IB-9-12:00	GFLDRD	1,712	6,986 [4]
PAR-8-11:00	7THL	1,337	5,896
SS-17-12:00	WPFM02	1,109	5,818
GST-8-12:00	WPFM02	1,959	5,384
MOT-14-12:00	GFLDRD	2,830	5,090
MF-9-12:00	GFLDRD	1,526	4,913 [4]
TPR-14-9:00	GFLDRD	2,434	4,865
MOT-9-12:00	GFLDRD	1,470	4,594
GST-5-12:00	WPFM02	2,407	3,799 [6]
WALF-5-11:00	GFLDRD	5,492	2,550
AV-5-3:00	WPFM02	7,946	2,254
MF-19-12:00	GFLDRD	2,256	2,157
HIS-6-12:00	7THL	1,846	2,002
AV-5-9:00	WPFM02	485	1,834
MON-9-12:00	GFLDRD	41,905	1,535
CHS-3-6:00	WPFM02	2,698	1,445
TPRL-9-12:00	GFLDRD	3,408	933
MF-31-12:00	7THL	2,532	931

Reading Number [1]	Meter Basin	Length (LF)	Net Infiltration Rate [2] (GPD/IDM)
MF-29-12:00	7THL	2,997	856
AV-5-12:00	WPFM02	2,456	855
MON-22-12:00	GFLDRD	11,656	704
DEL-1-12:00	GFLDRD	4,523	611
HIS-6-3:00	7THL	3,046	457
TPRL-7-9:00	GFLDRD	4,505	377
TPR-2-12:00	GFLDRD	3,036	327
MOT-1-11:00	WPFM02	1,712	309
SS-17-3:00	WPFM02	10,187	269
GE-39-12:00	N/A [3]	390	190
IB-9-9:00	GFLDRD	1,243	187
SU-2-12:00	GFLDRD	1,705	187
MOT-9-9:00	GFLDRD	4,488	110
AV-11-9:00	WPFM02	2,232	51
MF-15-12:00	GFLDRD	2,707	Negligible
TPRL-2-9:00	GFLDRD	3,382	Negligible
TPRL-9-9:00	GFLDRD	2,494	Negligible
DEL-7-12:00	GFLDRD	2,851	Negligible
UNT-5-1:00	7THL	4,576	Negligible

Note:

1. The nomenclature of the NFIs represent the number of the manhole identification and the clock position of the connecting pipe that the measurement was taken.
2. Infiltration rates ≥ 4,000 GPD/IDM are considered excessive and are highlighted in blue.
3. Reading number GE-39-12:00 was taken adjacent to meter site GFLDRD.
4. NFI was taken in an industrial area where there may be nighttime discharges affecting the flow. Although reported, the infiltration rate is inconclusive.
5. Reading taken in a manhole directly upstream of a pump station.
6. Infiltration rate was very close to the 4,000 GPD/IDM threshold and was included.



Night Flow Isolation
Turners Falls
Montague, MA

PROJ NO:	DATE:
21005	10/25/2022

WRIGHT-PIERCE
Engineering a Better Environment

MAP: 2

JAW:\GIS_Development\Projects\MA\Montague\20712_LCTP_Update\MXDs\Montague_GIS_ReconciliationJA.aprx - NFIresultsTurnersFalls_11x17

Surcharge was observed at reading number IB-24-2:00. This reading is directly upstream of the Industrial Boulevard pump station and downstream of Lightlife Foods, Inc, a known industrial discharger. It is suspected that the surcharge is related to both nighttime industrial discharges and the pump station not being on at the time of the measurement. Since the infiltration rate could not be determined, it is recommended that this area is investigated further.

Infiltration and Inflow (I/I) Analysis

I/I analysis is a process of using the flow monitoring data collected to locate and quantify additional water entering the collection system. The collection system is designed to convey wastewater for treatment. When additional water, such as groundwater or rainwater, enters the system, it is also conveyed and treated. This additional water reduces the capacity of the system for wastewater conveyance and increases the cost of treatment overall. The goal of the I/I analysis is to find out how much additional water is getting into the system and where. Once the location and extent of the I/I is determined, plans can be made to repair or replace portions of the collection system to reduce it.

To quantify the I/I, Wright-Pierce used an in-house analysis application to conduct both dry and wet weather analyses on the data collected from the flow meters.

Dry Weather Analysis

The dry weather analysis is used to determine the base flow of a system during dry weather, when the only additional non-wastewater flows are assumed to be groundwater infiltration. Dry weather flow is defined as base sanitary flow (BSF) plus base infiltration (BI). BSF includes domestic, commercial, institutional, and industrial wastewater, whereas BI is infiltration that is assumed to occur in the system at all times.

Dry Days

Dry weather days for the I/I evaluation were selected based on days that met the following criteria:

- Days that do not have rainfall.
- Days that do not have preceding rainfall up to 3 days prior, based on:
  - Cumulative rainfall that is not equal to or greater than 0.10 inch up to one day prior.
  - Cumulative rainfall that is not equal to or greater than 0.40 inch up to three days prior.

The flow on these days is known as the average dry day flow (ADDF). **Table 4** summarizes the resulting ADDF on weekdays in each flow meter basin. These are gross values based on the metering and include any upstream meters, as noted. Flow is divided into weekday and weekend flow to account for changes that occur throughout the course of a week due to wastewater discharges from businesses, offices, and schools.

Table 4 Summary of Gross Average Dry Day (Weekday) Flow

Meter Basin	Upstream Meters	Gross Average Dry Day Flow (ADDF) (MGD)
WPFM01	WPFM02 and WPFM09	0.498
WPFM02	7THL and AVEA (ADS meters)	0.429
WPFM06	None	0.057
WPFM08	WPFM06	0.101
WPFM09	None	0.540
7THL [1]	None	0.087
AVEA [1]	7THL (ADS meter)	0.511
GFLDRD [1]	WPFM01	0.742

Note:

1. These meters were installed and maintained by ADS Environmental Services. The data from these meters was used to supplement the analysis.

Meter site WPFM01 is upstream of meter site GFLDRD. During the flow monitoring period, a flow imbalance occurred between these two flow meter sites, and the sites were combined to resolve the flow balance issue. In general, flow imbalances can result from such things as flow differences that are less than the sensitivity of the metering equipment, inaccurately mapped pipes, or unknown conditions such as legacy overflow weirs or combined sewer inflows. Further SSES field investigations in the meter basins with flow imbalances are recommended, such as closed-circuit television (CCTV) pipe inspections, manhole inspections, and dye testing to find potential inaccurately mapped pipes, legacy overflow weirs, or combined sewer inflows.

Similarly, meter site WPFM09 is upstream of meter site WPFM01. During the flow monitoring period, a flow imbalance occurred between these two flow meter sites, and site WPFM09 was combined with site GFLDRD to resolve the flow balance issues to perform the analysis, since WPFM01 is upstream and also imbalanced with GFLDRD.

Due to their proximity to each other, meter sites WPFM02 and AVEA had very similar flow values. Understandably this also caused a flow imbalance. As a result, only meter site WPFM02 was analyzed.

The data at meter site WPFM06 was heavily influenced by the Montague Center pump station and could not be analyzed for I/I, however, was required for the flow balance with the downstream site, WPFM08.

Base Infiltration

BI enters the wastewater collection system through pipe joints, pipe defects from main sewer lines and service laterals, and defective manhole walls, benches, and pipe seals, typically from groundwater. BI for the project area was based on analysis of the flow meter data and calculated using the Stevens-Schutzbach equation, which uses

the ADDFs and minimum night flows to estimate BI. The dry day analysis considers only weekdays because these days show the most consistent flow patterns and typically higher ADDFs, making BI estimates more conservative.

Due to imbalances seen between some of the meters, only sites WPFM02, WPFM08, 7THL, and GFLDRD were analyzed. **Table 5** provides a summary of the BI estimated during the flow monitoring period for these four-meter basins. The gross unit rate for a basin is inclusive of all sub-areas within it. The net rate shows infiltration attributable solely to that portion of the basin not included in sub-areas.

A total of 0.308 million gallons per day (MGD) of BSF and 0.535 MGD of BI was identified in the meter basins based on analyses of the flow metering data. Per the MassDEP Guidelines, further investigation and rehabilitation may be cost-effective in basins where BI flows equal or exceed 4,000 GPD/IDM. Excessive infiltration was not identified in any of the meter basins.

Table 5 Summary of Base Infiltration Analysis

Meter Basin	Net ADDF [1] (MGD)	Net BI (MGD)	Net BSF (MGD)	Net Pipe Length (LF)	Net IDM [2]	Net BI Unit Rate (GPD/IDM)
WPFM02	0.342	0.266	0.076	37,989	96.52	3,201
WPFM08	0.101	0.072	0.029	43,255	81.57	883
7THL [3]	0.087	0.027	0.060	19,459	42.74	632
GFLDRD [3]	0.313	0.170	0.143	92,847	208.58	815
Total	**0.843**	**0.535**	**0.308**			

Note:

1. ADDF is based on the selected dry days.
2. IDM calculations do not include length of pipe for force mains or sewers outside the project area.
3. These meters were installed and maintained by ADS Environmental Services. The data from these meters was used to supplement our analysis.

Wet Weather Analysis

Inflow in a wastewater collection system is defined by MassDEP as water other than sanitary flow that enters a sewer system. Inflow is a direct result of stormwater runoff and can enter the wastewater collection system through numerous sources, such as downspouts, sump pumps, area drains, and service lateral cleanouts. In the public sector, inflow enters the wastewater collection system through sources such as cross connections between sanitary and storm sewers, catch basins, and storm ditches; and sources such as manhole defects at the cover, frame seal, and corbel area. Large breaks or collapses in pipes may also become sources of inflow into the system. High inflow can be expected in any combined areas of an existing wastewater collection system.

According to MassDEP, inflow is expected to occur during wet weather and is reported as the peak inflow rate and the total inflow volume for the duration of the event. Inflow can further be separated into direct and delayed

inflow. Direct inflow occurs immediately at the start of rainfall and finishes after the rainfall ends. Delayed inflow occurs after the rainfall ends and finishes after the system has stopped responding to the rainfall entirely. Direct inflow can be referred to as rain derived I/I and delayed inflow can be referred to as rainfall induced infiltration. Direct inflow can also be described as the period in which there is a rapid response to rainfall. Therefore, delayed inflow is the more gradual response to rainfall.

Per the MassDEP Guidelines, the inflow volumes calculated for the flow monitoring data were projected and evaluated for the 1-year, 6-hour design storm. Unlike the infiltration results, inflow volumes within 80 percent of the total system inflow volume are considered excessive and warrant additional investigation to identify specific sources. **Table 6** summarizes the results of the inflow analysis for the 1-year, 6-hour design storm, which produces approximately 1.67 inches of rain in the Turners Falls area. A total of 1.607 MG of inflow was estimated in the project area based on analysis of the flow metering data. This is approximately twice as much as the ADDF (0.843 MGD) and three times the resulting total flow, if the 1-year, 6-hour design storm inflow volume occurred at the same time as the ADDF.

Table 6 Summary of Inflow Analysis for the 1-Year, 6-Hour Design Storm

Meter Basin	Net Peak Inflow Rate [1] (MGD)	Net Total Inflow Volume (MG)	Net Direct Inflow Volume [2] (MG)	Net Delayed Inflow Volume [3] (MG)
WPFM02	0.000	0.515	0.000	0.421
WPFM08	0.061	0.185	0.018	0.167
7THL	2.560	0.790	0.810	0.016
GFLDRD	0.133	0.185	0.086	0.356
Total	**2.282**	**1.607**	**0.914**	**0.960**

Notes:

1. Peak inflow is determined over a 1-hour period.
2. Direct inflow is calculated per MassDEP Guidelines.
3. Delayed inflow is calculated per MassDEP Guidelines

Summary of I&I Analysis

Based on the flow monitoring data, an estimated 0.535 MGD of BI and 1.607 MG of inflow were estimated in the project area. **Table 7** summarizes the BI results and ranking for the meter basins. The ranking is based on the 4,000 GPD/IDM guideline per MassDEP. Excessive infiltration was not identified in any of the meter basins in Turners Falls or Montague Center.

Table 7 Summary of Base Infiltration (BI) by Meter Basin

Meter Basin	Village	Net BI (MGD)	Net BI Unit Rate (GPD/IDM)	BI Ranking
WPFM02	Turners Falls	0.266	3,201	1
WPFM08	Turners Falls/ Montague Center/ Lake Pleasant	0.072	883	2
GFLDRD	Turners Falls	0.170	815	3
7THL	Turners Falls	0.027	632	4
Total		**0.535**		

Table 8 summarizes the inflow results and ranking for the meter basins. The ranking is based on MassDEP's 80 percent threshold, and meter basins that account for at least 80 percent of the total system inflow volume are highlighted blue. Excessive inflow was identified in two meter basins in Turners Falls.

Table 8 Summary of Inflow by Meter Basin

Meter Basin	Village	Net Peak Inflow Rate [1,2] (MGD)	Net Inflow Volume [2] (MG)	Percent Total Inflow [3]	Cumulative Percent [3]	Inflow Ranking
7THL	Turners Falls	2.560	0.790	49%	49%	1
WPFM02	Turners Falls	0.000	0.515	32%	81%	2
WPFM08	Turners Falls/ Montague Center/ Lake Pleasant	0.061	0.185	12%	93%	3
GFLDRD	Turners Falls	0.133	0.117	7%	100%	4
Total		**2.282**	**1.607**	**100%**		

Notes:

1. Peak inflow is determined over a 1-hour period.
2. Inflow results for a 1-year, 6-hour design storm.
3. Values are rounded.
4. Blue highlights represent meter basins prioritized for further SSES investigations.

The meter basins prioritized for source investigation work based on excessive BI and inflow results are listed in the **Infiltration and Inflow Conclusions and Recommendations** section with detailed recommendations for further investigation. Some source investigation work has already been completed as part of this project. The results of this work are presented in the following section – **Sewer System Evaluation Survey Investigation Results**.

Sewer System Evaluation Survey Investigation Results

The sanitary sewer evaluation survey (SSES) work included manhole inspections, closed-circuit television (CCTV) pipe inspections, and smoke testing to better understand the sewer system condition and to identify and quantify the specific sources of I/I. SSES work was based on the results of the I/I analysis.

CCTV pipe inspections and manhole inspections can identify structural and operation and maintenance (O&M) issues within the sewer system in the public domain. In general, CCTV inspections identify infiltration sources, and manhole inspections can identify both infiltration and inflow sources. Smoke testing is performed to help identify public and private sources of I/I, such as catch basins, drain manholes, sump pumps, yard drains, and roof leaders that are, or could be, connected to the sanitary sewer system.

Manhole Inspections

A National Association of Sewer Service Companies (NASSCO) Manhole Assessment Certification Program (MACP) certified Wright-Pierce employee conducted each manhole inspection following NASSCO's MACP inspection standards. The purpose of the manhole inspections was to determine the structural condition of each manhole, as well as to locate O&M issues including potential sources of I/I. Level 2 inspections can gather detailed information concerning all components of the manhole without entry. The inspector uses specialized (remote) camera equipment capable of observing and photographing defects present in the manhole.

Level 2 MACP inspections were performed at 51 manholes in the Turners Falls area. These inspections were selected based on the NFI results and were completed in most of the areas with excessive infiltration rates within the GFLDRD meter basin and in all the areas with excessive infiltration rates within the WPFM02 meter basin. Additional manhole inspections were completed along Montague City Road. All manhole inspections were performed during daytime hours between September 26, 2022 and September 28, 2022. The inspections took place during lower groundwater levels and during relatively dry weather conditions. This means that active I/I may not have been observed.

All inspections were completed at-grade. Manholes were opened and visually inspected for defects. Wright-Pierce used reporting software to collect data and produce NASSCO MACP reports and condition ratings. The completed manhole inspection reports are included in **Appendix A**. A Wright-Pierce NASSCO MACP certified engineer then performed an independent review of ten percent of the reports and photographs to provide quality control for the manhole inspections.

The probability of an asset failing is referred to as the likelihood of failure (LoF) and is determined by the asset's physical condition. The LoF of manholes is based on the NASSCO MACP quick rating, which is calculated from the frequency and condition rating of both structural and O&M defects observed during the manhole inspection. The LoF has a range of 0 to 6, where 0 represents an absence of asset information, 1 represents the lowest LoF, and 6 represents the highest LoF.

The results from the manhole inspections are summarized in **Table 9.** Most manholes have an LoF of 3 and the highest LoF is 5. Inspected manholes and their rehabilitation recommendations are depicted in **Map 3**.

Turners Falls Manhole Rehabilitation

Montague, MA

PROJ NO:	DATE:
21005	1/3/2023

WRIGHT-PIERCE
Engineering a Better Environment

MAP: 3

JA W:\GIS_Development\Projects\MA\Montague\20701_LCTP_Update\MXDs\Montague_GIS_Reconciliation.JA.aprx - Turners-ManholeRehab-11x17-Landscape

Table 9 Summary of Manhole LoF Scores

Likelihood of Failure (LoF), Rounded	Number of Manholes
0	0
1	0
2	0
3	28
4	20
5	3
6	0
Total	**51**

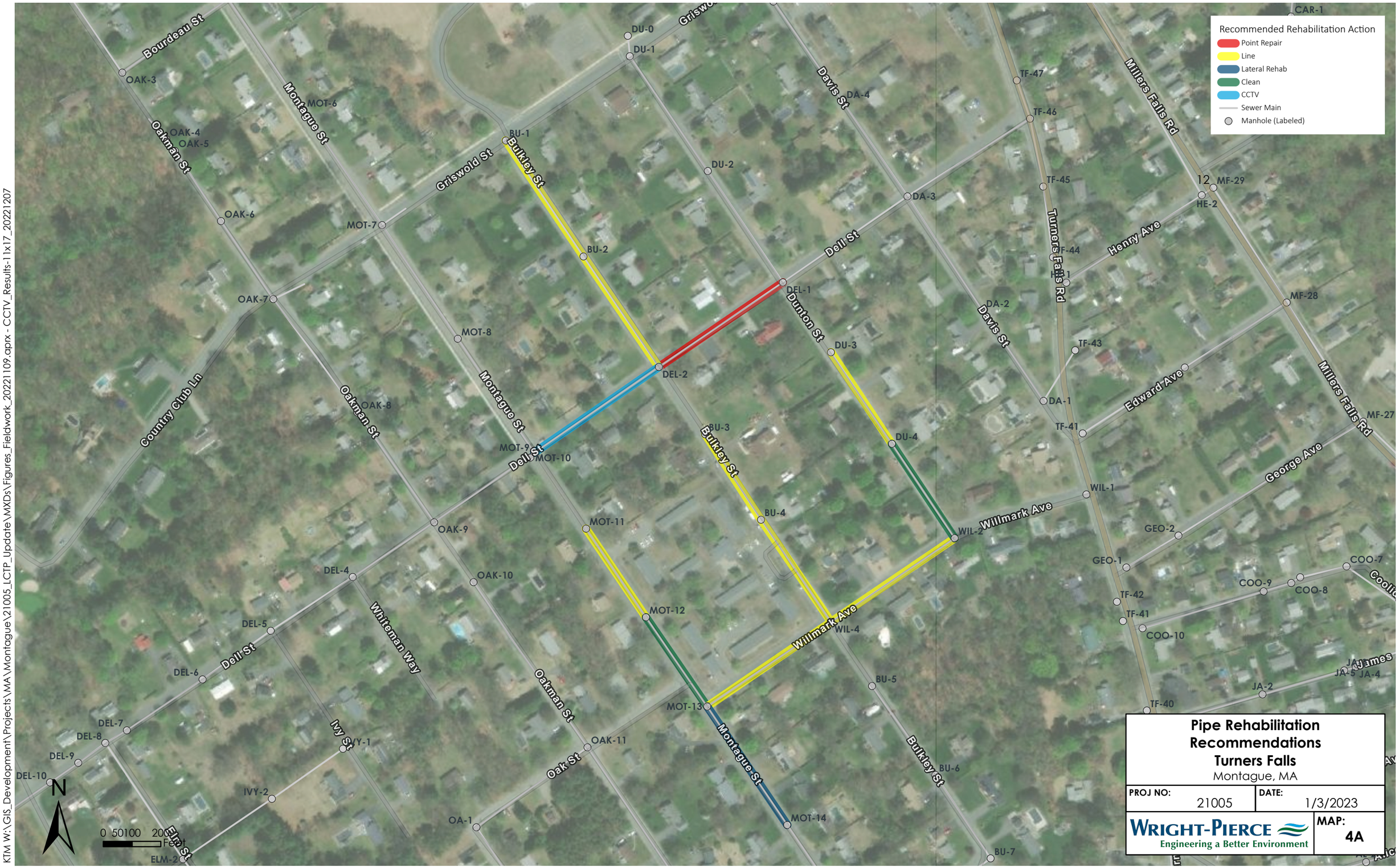
Closed-Circuit Television Inspections

CCTV pipe inspections were performed by Town staff and Wright-Pierce on approximately 5,900 linear feet (LF) of gravity sewer pipes in the Turners Falls area. Town staff cleaned the pipes and recorded the inspection video. A NASSCO Pipeline Assessment Certification Program (PACP) certified Wright-Pierce employee coded the observations and defects using certified NASSCO PACP software.

These areas for inspection were based on the results of the night flow isolations and included isolation areas with excessive infiltration. Inspections were completed in most of the areas with excessive infiltration rates within the GFLDRD meter basin. The purpose of CCTV inspection is to determine the condition of the sewer pipes, as well as to locate and quantify any potential sources of I/I that may be entering the system. The inspections took place in 2022 on October 12 through 14 and October 19 through 21 during daytime hours. The inspections took place during lower groundwater levels and during relatively dry weather conditions, except for October 14 when approximately 1 inch of rainfall occurred and after approximately 0.50 inch of rainfall occurred on October 18. This means that active I/I may not have been observed, except for inspections completed on October 14 and 19.

Pipe inspections were conducted by flushing the sewer pipes between manholes using a high-pressure jetter to loosen any debris and provide a clear view of the infrastructure. A camera was then run through the pipe, so the operator could see the entire pipe above the water line from the inside. The camera is mounted to a robotic vehicle, which can navigate through the sewer pipes and can rotate to almost any angle to get a closer look at any defects seen by the operator. The entire inspection was recorded on video for review. Any defect in the pipe was noted as well as the distance of the defect from the camera launching manhole. A Wright-Pierce NASSCO PACP certified engineer then performed an independent review of twenty percent of the reports and videos to provide quality control for the pipe inspections. The CCTV inspection reports are included in **Appendix B**. Inspected pipe segments and their rehab recommendations are depicted in **Map 4**.

One gravity sewer pipe segment (DEL-2 to MOT-9) could not be CCTV inspected in its entirety due to a joint offset and high-water levels preventing the camera from accessing the full pipe. This pipe segment will need to be



Pipe Rehabilitation Recommendations
Turners Falls
Montague, MA

PROJ NO:	DATE:
21005	1/3/2023

WRIGHT-PIERCE
Engineering a Better Environment

MAP: **4A**

KTM W:\GIS_Development\Projects\MA\Montague\21005_LCTP_Update\MXDs\Figures_Fieldwork_20221109.aprx - CCTV_Results-11x17_20221207

Recommended Rehabilitation Action
- Point Repair
- Lateral Rehab
- No Action
- Sewer Main
- Manhole (Labeled)

Nadeau Ave
Coolidge Ave
Chestnut St
Vladish Ave
Emond Ave
Millers Falls Rd
Norman Cir
Cross St
Turnpike Rd
Laurel Ln
Hillside Rd
Franklin Commons

AL-2
CHE-1
CHE-2
CHE-3
CC-1
COO-5
MF-21
MF-20
MF-19
MF-18
MF-17
MF-16
MF-15
MF-14
VL-2
VL-3
VL-4
VL-5
VL-6
VL-7
VL-8
VL-9
EM-1
NC-1
NC-2
NC-3
NC-4
NC-5
NC-6
NC-7
NC-8
8
TPRL-1
TPRL-2
TPRL-3
TPRL-4
TPRL-5
TPRL-6
TPRL-7
LL-1
HS-1

N

0 50100 200 Feet

Pipe Rehabilitation Recommendations
Turners Falls
Montague, MA

PROJ NO:	DATE:
21005	1/3/2023

WRIGHT-PIERCE
Engineering a Better Environment

MAP: **4B**

KTM W:\GIS_Development\Projects\MA\Montague\21005_LCTP_Update\MXDs\Figures_Fieldwork_20221109.aprx - CCTV_Results-11x17_20221207

rehabilitated in order to inspect it. Pipe segment LL-1 to TPRL-6 could not be inspected due to being on private property and was the only pipe segment with access limitations.

Like manholes, the probability of an asset failing is referred to as the LoF and is determined by the asset's physical condition. The LoF of pipes is based on the NASSCO PACP quick rating, which is calculated from the frequency and condition rating of both structural and O&M defects observed during the CCTV pipe inspection. The LoF has a range of 0 to 6, where 0 represents an absence of asset information, 1 represents the lowest LoF, and 6 represents the highest LoF.

The results from the CCTV pipe inspections are summarized in **Table 10**. Most pipe segments have an LoF of 3, and the highest LoF is 5.

Table 10 Summary of Pipe LoF Scores

Likelihood of Failure (LoF), Rounded	Number of Pipes	Length of Pipes (LF)
0	0	0
1	3	1,059
2	5	1,582
3	8	2,229
4	2	282
5	3	725
6	0	0
Total	**21**	**5,878**

Smoke Testing

Wright-Pierce conducted smoke testing on approximately 90,000 LF of sanitary sewer pipes in the Turners Falls area. Wright-Pierce staff performed smoke testing in areas of suspected inflow, based on a preliminary analysis of the flow monitoring data, which indicated that meter basins WPFM01, WPFM02, GFLDRD, AVEA, and 7THL had excessive inflow.

Smoke testing was conducted to identify locations where the Town stormwater system, or other extraneous water sources, are directly connected into the sanitary sewer system. These include catch basins, roof leaders, floor drains, sump pumps, area drains, and manholes. Smoke testing can also identify breaks in sewer laterals if they are close enough to the surface and if ground conditions are dry (and groundwater table is low). This concept assumes that wherever smoke can exit the system there is the potential for inflow.

Smoke may also exit anywhere there is any small opening in a sanitary sewer collection system connection such as through a sewer roof vent on a home or through a sewer manhole pick hole. These observations of smoke were not

considered to be defects, as they are supposed to be connected into the sewer system and allow a negligible amount of extraneous water into the system.

Before smoke testing began, extensive notification efforts were conducted by Wright-Pierce and the Town. This included going door-to-door to each residence and business with notices, as well as a notification on the Town's website. A call log was established to record any telephone calls from residents about the notices they received. Residents with health concerns such as respiratory problems, were given special instructions prior to testing in their area. The Town Fire and Police Departments were informed daily where the crew planned on smoke testing. Wright-Pierce conducted smoke testing from July 11, 2022 through July 15, 2022 during daytime hours. The testing took place during lower groundwater levels and during relatively dry weather conditions, except for July 14 when approximately 1 inch of rainfall occurred. This means that the rainfall could have impacted the smoke testing results and not resulted in as many positive smoke observations as expected.

Testing was performed by placing a gas-powered blower over centrally located manholes. Non-toxic, liquid smoke was pumped into the blower, which then filled the sewer system. After placing the blower and filling the lines with smoke, Wright-Pierce field staff visually inspected the area. Any locations where smoke was observed were considered potential inflow sources into the sewer collection system.

The Town has several areas they are aware of that still have combined sewer and stormwater elements. This combined system is known to exist in the areas of High Street, 7th Street, and L Street. These areas are depicted in **Map 5** and are based on the 2003 Existing Sewers figure in the Town's 2005 LTCP and discussions with the Town in 2021. Smoke observations in these areas were documented, but these observations were separated from the observations found in areas that are supposed to be part of separated systems.

The results of the smoke test survey are summarized in **Table 11**. Mapbooks detailing each observation can be found in **Appendices C** (Inflow-Contributing Defects) **and D** (Non-Defect Observations).

Basemap by ESRI.

- Catch Basin
- Cleanout Cap defective/broken
- Drain Manhole
- Driveway drain
- Cleanout Cap Missing
- Home/Structure/Building
- Other
- Pump Station
- Roof Drain
- Sewer Manhole Frame
- Sewer Manhole Vent Hole
- Yard Drain
- Catch Basin (Non-Smoking)
- Manhole (Non-Smoking)
- Sewer Main
- Combined Sewer Boundary

N

0 150 300 600 Feet

Overview of Smoked Features

Montague, MA

PROJ NO:	DATE:
21005	1/3/2023

WRIGHT-PIERCE Engineering a Better Environment

MAP: 5

X:\Z WK\GIS_Development\Project\MA\Montague\21005_LCTP_Update\MXDs\Montague_GIS_ReconciliationA.aprx - SmokeOverAll24.Landscape221104

Table 11 Summary of Smoke Testing Results

Observations	Number of Occurrences within Supposed Separated Areas	Number of Occurrences within Known Combined Areas	Total Number of Occurrences
Potential Stormwater Cross-Connections			
Catch Basin Smoked	32	31	**63**
Drain Manhole Smoked	0	4	**4**
Driveway Drain Smoked	1	0	**1**
Yard Drain Smoked	0	1	**1**
Cleanout Smoked (cleanout missing or broken)	7	2	**9**
Subtotal	**40**	**38**	**78**
Sewer Manhole Defects and Observations			
Frame Smoked	2	0	**2**
Pickhole Smoked	119	21	**140**
Vent Hole Smoked	14	17	**31**
Subtotal	**135**	**38**	**173**
Other Observations			
Smoke from Ground	2	1	**3**
Smoke from Under Porch	4	0	**4**
Smoke from Manhole (unknown if drain or sewer)	1	0	**1**
Smoke from Pump Station[1]	1	0	**1**
Smoke in or from Home/Structure/Building	17	3	**20**
Subtotal	**25**	**4**	**29**

Notes:

1. Possible defective cover, frame, and/or chimney but probably not a major source of inflow. Further investigation recommended to determine extent of defect.

Field and office staff were notified by residents when smoke entered their home, particularly in the basements or the bathrooms of their homes. This indicated that there may be a shower or toilet that is not used daily, faulty plumbing, or a loose or illicit sewer connection to the Town's sanitary sewer system. Although none of the residents indicated that a sump pump was present, there were nine homes where the source of the smoke could not be determined to be a shower or toilet that is not used daily or faulty plumbing, and further investigation is recommended.

Summary of SSES Activities and Findings

The SSES study consisted of approximately 5,900 LF of CCTV pipe inspections, 51 manhole inspections, and 90,000 LF of smoke testing. The field investigations resulted in identifying the following deficiencies with a high potential to contribute I/I into the sewer:

- 51 manholes with an LoF of 3 or higher.
- 3,236 LF of sewer pipes with an LoF of 3 or higher; and
- 40 potential stormwater cross-connections.

Addressing the issues that have been identified by field investigations should result in a reduction of I/I.

Infiltration and Inflow Conclusions and Recommendations

This section provides the results of the I/I quantification and recommends improvements and other corrective actions to address the identified deficiencies. Improvements identified aim to reduce I/I into the sanitary sewer system. Proposed improvements are recommended for defects found during the fieldwork performed or based on regional experience and discussions with Town staff. **Appendix E** summarizes the recommended investigations.

Wright-Pierce utilized InfoAsset Planner, an asset management software developed by Innovyze, to assist with assigning rehabilitation actions and associated rehabilitation costs to each individual asset inspected during this project. The software uses a customized decision tree to produce planning level rehabilitation recommendations based on GIS and inspection data. Wright-Pierce created the customized decision tree and reviewed the planning level rehabilitation recommendation outputs. The recommendations are for planning level purposes only and are not intended as final recommendations. Other factors, including operating scheme, design standards and approaches, and natural impacts may impact the final recommendation.

Criteria

Based on the results from the flow metering and I/I analysis, preliminary recommendations for SSES work were made for each meter basin. The recommendations prioritize the meter basins for I/I investigations using the criteria set forth in the MassDEP Guidelines.

There were no meter basins in the villages of Montague Center or Lake Pleasant that had excessive I/I. Thus, "Low Priority" inflow investigations are recommended in these villages. More details on Low Priority investigations are in the following sections.

Infiltration

Per the MassDEP Guidelines, meter basins with infiltration rates equal to or greater than 4,000 GPD/IDM should be prioritized for SSES work, particularly manhole inspections, night flow isolations, and closed-circuit television (CCTV)

pipe inspections. These meter basins are identified as "High Priority" and Wright-Pierce recommends completing the SSES work within a timeframe that is cost feasible to the Town.

Further investigation and/or rehabilitation is not recommended in meter basins with BI flows less than 4,000 GPD/IDM as it may not be cost-effective.

Inflow

For inflow, the MassDEP Guidelines state that initial SSES work should be performed in the meter basins that contribute to 80 percent of the total inflow volume, when analyzing inflow for the 1-year, 6-hour design storm. These meter basins are identified as "High Priority" and Wright-Pierce recommends completing the SSES work within a timeframe that is cost feasible to the Town.

A major goal of 314 CMR12.04(2) is to identify and eliminate all public and private inflow sources. This work included some investigation of private inflow sources with smoke testing, but did not include other types of investigations, such as lateral inspections. Private sources can be a major contributor of inflow. Thus, all areas of the wastewater collection system that are impacted by inflow shall eventually have a recommended SSES plan or additional studies to address inflow. Wright-Pierce recommends that any meter basins with inflow issues, which were not identified as "High Priority", are identified as "Low Priority" and that SSES work be completed after the “High Priority” work and within a timeframe that is cost feasible to the Town. Recommended SSES work associated with inflow typically includes smoke testing, dye testing, and building inspections.

Recommendations

Infiltration

BI for each meter basin was presented in **Table 7**. As previously discussed, it is considered cost-effective to investigate meter basins with BI rates of 4,000 GPD/IDM or greater. Source investigation work might include manhole inspections, further night flow isolations, and closed-circuit television (CCTV) pipe inspections. Further investigation and rehabilitation are not generally recommended in meter basins with BI flows less than 4,000 GPD/IDM as it may not be cost-effective. However, Wright-Pierce recommends that these basins be reassessed within a timeframe that is cost feasible to the Town to evaluate any changes over time.

Night flow isolations were also completed to pinpoint smaller areas of high BI within the meter basins and to collect flow information in areas that were not metered. A summary of the excessive night flow measurements was provided in **Table 3**.

There were no meter basins in Turners Falls with rates over the excessive BI threshold. However, night flow isolation measurements revealed 13 excessive readings, which can help to further narrow down sources of infiltration in the area. Of these 13 readings, one was surcharged and three were inconclusive due to influence from a nearby pump station and/or were in an industrial area where nighttime discharges may have affected the flow. Wright-Pierce recommends that these smaller areas, identified in the night flow measurements, should be investigated within a timeframe that is cost feasible to the Town. Some of these areas were already inspected as part of this project.

Areas that should be prioritized for infiltration source investigations are summarized in **Table 12**. Areas that were already inspected as part of this project are indicated as “completed” in the table.

Table 12 Excessive Infiltration Investigations Recommended and Completed

NFI Basin	Meter Basin	Village	Reason	Manhole Investigation	CCTV Pipe Investigation	Additional Information
GST-5-12:00	WPFM02	Turners Falls	Excessive Infiltration Rate	Completed	**Recommended**	
GST-8-12:00	WPFM02	Turners Falls	Excessive Infiltration Rate	Completed	**Recommended**	
SS-17-12:00	WPFM02	Turners Falls	Excessive Infiltration Rate	**Recommended**	**Recommended**	
PAR-8-11:00	7THL	Turners Falls	Excessive Infiltration Rate	**Recommended**	**Recommended**	
MOT-9-12:00	GFLDRD	Turners Falls	Excessive Infiltration Rate	Completed	Completed	
MOT-14-12:00	GFLDRD	Turners Falls	Excessive Infiltration Rate	Completed	Completed	
TPRL-1-12:00	GFLDRD	Turners Falls	Excessive Infiltration Rate	Completed	Completed	
TPRL-7-12:00	GFLDRD	Turners Falls	Excessive Infiltration Rate	Completed	Completed	
TPR-14-9:00	GFLDRD	Turners Falls	Excessive Infiltration Rate	Completed	**Recommended**	
IB-9-12:00	GFLDRD	Turners Falls	Inconclusive	**Recommended**	**Recommended**	In an industrial area where there may be nighttime discharges affecting flow
IB-24-2:00	GFLDRD	Turners Falls	Surcharged	**Recommended**	**Recommended**	Directly upstream of a pump station; In an industrial area where there may be nighttime discharges affecting flow
MF-9-10:00	GFLDRD	Turners Falls	Inconclusive	**Recommended**	**Recommended**	In an industrial area where there may be nighttime discharges affecting flow

NFI Basin	Meter Basin	Village	Reason	Manhole Investigation	CCTV Pipe Investigation	Additional Information
MF-9-12:00	GFLDRD	Turners Falls	Inconclusive	**Recommended**	**Recommended**	In an industrial area where there may be nighttime discharges affecting flow

As indicated in **Table 12**, manhole inspections and CCTV pipe inspections were completed in half of the areas with excessive infiltration rates within the GFLDRD meter basin. Additional manhole inspections were completed in the areas with excessive infiltration rates within the WPFM02 meter basin, and also along Montague City Road to determine if rehabilitation was needed for the manholes within the Roadway Flooding Protection Project area. The other areas with excessive infiltration rates and areas that were surcharged or had inconclusive measurements should be investigated further to determine if excessive infiltration is a concern.

Inflow

Total inflow for each meter basin during a 1-year, 6-hour design storm was presented in **Table 8**. As previously discussed, it is cost-effective to investigate inflow in meter basins that contribute to the top 80 percent of total inflow.

A major goal of these investigations is to identify and then mitigate all public and private sources to address inflow. Thus, all areas of the wastewater collection system that are impacted by inflow should eventually have a recommended source investigation plan or additional studies to address it. Wright-Pierce recommends that these basins be reassessed within a timeframe that is cost feasible to the Town to evaluate any changes over time.

Areas that were prioritized for inflow source investigations based on wet weather flow measurements are summarized in **Table 13**.

Table 13 Areas Recommended Investigation Inflow Sources

Meter Basin	Village	Reason
7THL	Turners Falls	This basin contributes to nearly half of the total inflow predicted to occur in the Turners Falls area during a 1-year, 6-hour design storm.
WPFM02	Turners Falls	This basin contributes to nearly a third of the total inflow predicted to occur in the Turners Falls area during a 1-year, 6-hour design storm.

Smoke testing was completed in the areas with excessive inflow.

Proposed Pipe and Manhole Improvements

In making pipe and manhole rehabilitation recommendations, the cost-effective analysis (C/E/A) and the LoF of the structure were considered. It is not typically cost-effective to try to remove I/I from every identified defect, nor is it likely that a repair will be able to remove 100 percent of the estimated I/I.

In accordance with the MassDEP Guidelines, a ratio greater than 1.0 comparing the treatment and transport (T&T) cost to the estimated rehabilitation cost is cost-effective to remove.

Wright-Pierce calculated the T&T cost for Turners Falls using the Town's Actual & Budgeted Expenses & Encumbrances report for the September 2022 period and the meter flow values from the 2022 flow monitoring. WPCF expenses were included, and some expenses were allocated by the percentage of flow in Turners Falls. The Town's total T&T expenses ($3,358,293) was divided by the average daily flow of wastewater treated (868,000 GPD) resulting in a T&T cost of $3.87 per GPD.

A C/E/A was performed using T&T costs based on the 2022 flow monitoring data and the estimated rehabilitation costs. As stated in the MassDEP Guidelines, a life cycle evaluation of a 20-year planning period is suggested.

Table 14 summarizes the estimated T&T costs for both present day and 20-year planning period and shows the projected 20-year C/E/A ratio. This C/E/A assumes that rehabilitation can remove 50 percent of the base infiltration as required by MassDEP Guidelines.

Table 14 Summary of Infiltration and C/E/A Results

Meter Basin	Village	Base Infiltration (GPD)	Estimated T&T Cost [1]	Estimated 20-Year T&T Cost	Estimated Total Rehab Cost [2]	20-Year C/E/A Ratio
GFLDRD	Turners Falls	170,000	$657,800	$13,156,000	$696,802	1.81
WPFM02	Turners Falls	266,000	$1,029,200	$20,584,000	$33,460	1.99
WPFM08	Turners Falls/ Montague Center/ Lake Pleasant	72,000	$278,600	$5,572,000	$- [3]	2.00
7THLCSO	Turners Falls	27,000	$104,500	$2,090,000	$- [3]	2.00
Total		**535,000**	**$2,070,100**	**$41,402,000**	**$730,262**	**-**

Notes:

1. Estimated T&T Cost is $3.87/GPD using the Town's 2022 annual budget and average daily flow from the 2022 flow monitoring.
2. Estimated Total Rehab Cost is the sum of manhole and pipe rehab costs. It does not include engineering and contingency costs.
3. There are no recommended pipe or manhole improvements in this meter basin.

Because the 20-year C/E/A ratio is greater than 1.00 in all basins investigated, all of the proposed pipe and manhole improvements are considered cost effective.

Inspected manholes and their rehabilitation recommendations are depicted in **Map 3**. Inspected pipe segments and their rehab recommendations are depicted in **Map 4.**

For this project, defects contributing directly to inflow into the sewer collection system were identified for immediate corrective action. These included replacing the vented manhole covers and defective cleanout caps found during smoke testing in areas the Town presumed to have separate sanitary and stormwater sewer systems. Immediate corrective actions were also recommended for any CCTV pipe inspections that could not be completed. A summary of these actions is found in **Table 15**.

Table 15 Summary of Recommended Immediate Corrective Actions

Rehab Recommendation	Number of Occurrences
Replace Vented Manhole Covers [1]	14
Replace Defective Cleanout Caps [2]	7
Rehabilitate Pipe Segment (DEL-2 to MOT-9)	1
Access Pipe Segment (LL-1 to TPRL-6)	1

Notes:

1. Before replacing vented manhole covers, determine why the covers are vented. For instance, if it is vent hydrogen sulfide gas, replacement should be discussed before implementing.
2. Before replacing defective cleanout caps, determine if they are publicly or privately owned.

Pipes and manholes that received an LoF of 3 or higher have been identified as “Priority 1 Improvements”. Wright-Pierce recommends that Priority 1 Improvements are implemented for higher priority rehabilitation, repair, or replacement within a timeframe that is cost feasible to the Town. Infrastructure with high LoF ratings contribute to system I/I and are likely to fail soon. Increased I/I in the system reduces hydraulic capacity and increases the likelihood of sanitary sewer overflows (SSOs) or could create a major disruption in service and potentially impact the environment and/or public health if not addressed.

Pipes and manholes that received an LoF of less than 3 were identified as “Priority 2 Improvements”. Priority 2 Improvements are recommended for cost-effective rehabilitation or repair that is lower in priority. Wright-Pierce recommends that these improvements are implemented after the Priority 1 Improvements and within a timeframe that is cost feasible to the Town.

Table 16 summarizes the priority recommendations for pipes and manholes in Turners Falls.

Table 16 Summary of Recommended Priority Improvements

Meter Basin	Village	Priority 1			Priority 2		
		# of Manholes	# of Pipe Segments	LF of Pipe	# of Manholes	# of Pipe Segments	LF of Pipe
GFLDRD	Turners Falls	40	11	3,613	0	4	1,254
WPFM02	Turners Falls	11	-	-	0	-	-
7THL	Turners Falls	-	-	-	-	-	-
WPFM08	Turners Falls/ Montague Center/ Lake Pleasant	-	-	-	-	-	-
Total		**51**	**11**	**3,613**	**0**	**4**	**1,254**

There were 40 manholes and 3,613 LF of sewer pipe found in Turners Falls requiring Priority 1 Improvements, and 1,254 LF of sewer pipe found requiring Priority 2 Improvements at this time.

Pipes and manholes that had no recommended improvements because no defects were found during the inspections have been identified as "No Action" and are summarized in **Table 17**.

Table 17 Summary of Manholes and Pipes Requiring No Action

Meter Basin	Village	# of Manholes	# of Pipe Segments	LF of Pipe
GFLDRD	Turners Falls	0	6	2,043
WPFM02	Turners Falls	0	- [2]	- [2]
7THL	Turners Falls	- [1]	- [2]	- [2]
WPFM08	Turners Falls/ Montague Center/ Lake Pleasant	- [1]	- [2]	- [2]

Notes:

1. Manhole inspections were not performed in this meter basin
2. Pipe inspections were not performed in this meter basin.

Proposed Catch Basin Investigations

Thirty-two catch basins smoked within supposed separated areas during the smoke testing investigations conducted in Turners Falls. The location of the separated areas is based on the 2003 Existing Sewers figure in the Town's 2005 LTCP and discussions with the Town in 2021. It is recommended that dye testing be conducted in

these catch basins to verify the presence of a potential direct cross-connection. The smoke testing results only indicate a potential connection, which could either be a combined system or defects in the stormwater and sanitary sewer assets that allow flow between these systems. If these catch basins are directly connected to the sewer system, it is recommended that the Town disconnect these assets from the sewer collection system and redirect them to the stormwater drain system. If there are defects in the catch basins, manholes, or pipes, improvements should be made to rehabilitate them. Dye testing and inspections should be completed before design occurs, in order to gather more detailed information.

Table 18 shows a summary of the catch basins that require further investigation. These are only catch basins within the supposed separated areas.

Table 18 Recommended Catch Basin Investigations

Catch Basin ID	Nearest Address
WP_0169	1 G STREET
WP_0170	1 G STREET
WP_0171	2 G STREET
WP_0233	250 AVENUE A
WP_0232	250 AVENUE A
WP_0234	250 AVENUE A
WP_0235	249 AVENUE A
WP_FOUND_1000	249 AVENUE A
WP_FOUND_0001	249 AVENUE A
WP_0377	85 L ST
WP_0296	109 L ST
WP_0317	105 L ST
WP_0253	83 5TH ST
WP_0264	90 5TH ST
WP_0318	83 5TH ST
WP_0263	7 T ST
WP_0474	90 7TH ST
WP_0218	128 7TH ST

Catch Basin ID	Nearest Address
WP_0215	201 AVENUE A
WP_FOUND_0999	201 AVENUE A
WP_0218	128 7TH STREET
WP_FOUND_0998	201 AVENUE A
WP_0474	90 7TH ST
WP_0599	64 CROCKER AVE
WP_0339	71 PARK ST
WP_0337	72 PARK ST
WP_0731	20 MILLERS FALLS RD
WP_0726	26 MILLERS FALLS RD
WP_0778	1 HENRY AVE P
WP_0732	56 MILLERS FALLS RD
WP_0605	15 DAVIS ST
WP_0923	15 OAKMAN ST

Proposed Building Investigations

Based on field observations and responses from residents, smoke entered or was observed from seventeen homes during the smoke testing. This indicated that there may be a shower or toilet that is not used daily, faulty plumbing, or a loose or illicit sewer connection to the Town's sanitary sewer system.

In order to rule out illicit sewer connections, such as sump pumps, it is recommended that building inspections be conducted in these homes to verify the presence of a potential illicit sewer connection. If there are illicit sewer connections are present, it is recommended that the Town work with the homeowner to disconnect these assets from the sewer collection system and redirect them either to the yard or to the stormwater drain system.

The addresses of homes that require further investigation are:

1. 9 G Street
2. 25 L Street
3. 104 Fourth Street
4. 83 K Street
5. 12 Central Street
6. 7 Crocker Avenue

7. 25 Worchester Avenue
8. 145 Second Street
9. 15 Hillside Avenue

Planning Level Costs for Proposed Improvements and Recommendations

Priority Improvement Program

Structures that received an LoF of 3 or higher have been identified as the highest priority for rehabilitation, repair, or replacement. These pipes and manholes may have limited hydraulic capacity, contribute I/I in the system and have a higher likelihood of failure. They increase the possibility of an SSO occurrence and may cause a disruption in service and potentially impact the environment and/or public health if not addressed. All of the manholes with recommended improvements had an LoF of 3 or higher, so all the recommended manhole improvements are considered Priority 1. Eleven of the CCTV inspected pipe segments with recommended improvements had an LoF of 3 or higher, so these were also categorized as Priority 1 Improvements.

Unit costs provided in the following tables are based on average bid tabulations based on Wright-Pierce reviewed design projects and on Wright-Pierce estimates for services. These planning-level costs were developed using standard cost estimating procedures consistent with industry standards using unit cost information. These costs are based on a typical, pre-2022 bid climate and do not include inflation. The current bid climate and inflation should be considered when these improvements are made.

Table 19 provides the total estimated rehabilitation, repair, and replacement costs for all manholes and pipes categorized as Priority 1 Improvements. Catch basins with potential indirect connections and homes with potential illicit sewer connections that require investigation are included as Priority 1 Improvements under the category "Further Investigation".

Table 19 Priority 1 Improvement Program Costs

Corrective Action	Unit Cost	Quantity	Cost
Manhole Repairs			
Clean	$200 / EA	18	$3,600.00
Frame Seal Wrap	$1,000 / EA	15	$15,000.00
Line Chimney	$2,000 / EA	13	$26,000
Replace Cover, Frame, and Frame Seal	$2,000 / EA	2	$4,000
Point Repair	$1,300 / EA	7	$9,100
Line Manhole	$4,000 / EA	19	$76,000
Replace Chimney	$1,500 / EA	1	$1,500
Root Removal	$400 / EA	14	$5,600
Grout Manhole	$200 / VF	88	$1,100

Corrective Action	Unit Cost	Quantity	Cost
Manhole Repair Subtotal	-	-	$141,900
Pipe Repairs			
Clean	$3 / LF	566	$1,700
Line (<18”)	$200 / LF	1,343	$268,700
Point Repair	$18,000 / EA	2	$36,000
Lateral Rehab	$6,750 / EA	2	$13,500
CCTV (<18”)	$3 / LF	387	$1,200
Pipe Repair Subtotal			$321,100
Further Investigation			
Dyed Water Testing – Catch Basins	$1,000 / EA	32	$32,000
Building Inspections	$1,000 / EA	9	$9,000
Further Investigation Subtotal			$41,000
TOTAL			
Priority 1 Improvement Program Subtotal			$504,000
Construction Contingency (25%)			$126,000
Construction Subtotal			$630,000
Engineering and Administrative Fees (30%)			$151,200
Priority 1 Improvement Program Total			**$781,200**

Structures that received an LoF lower than 3, but a C/E/A ratio higher than 1 have been identified as the second highest priority for rehabilitation, repair, or replacement. These pipes and manholes are cost-effective to repair but have a lower likelihood of failure. Four of the CCTV inspected pipe segments with recommended improvements had an LoF lower than 3, so these were categorized as Priority 2 Improvements.

Table 20 provides the total estimated rehabilitation, repair, and replacement costs for all manholes and pipes categorized as Priority 2 Improvements.

Table 20 Priority 2 Improvement Costs

Corrective Action	Unit Cost	Quantity	Cost
Pipe Repairs			
Line (<18")	$200 / LF	1,254	$250,800
Priority 2 Improvement Program Subtotal			$250,800
Construction Contingency (25%)			$62,700
Construction Subtotal			$313,500
Engineering and Administrative Fees (30%)			$75,200
Priority 2 Improvement Program Total			$388,700

No Action

Structures with no defects identified during inspections have been identified as requiring no action and are not recommended for improvements at this time.

List of Appendices

Appendix A Turners Falls Manhole Inspection Reports
Appendix B Turners Falls CCTV Pipe Inspection Reports
Appendix C Turners Falls Smoke Testing Site Reports, Inflow-Contributing Defects
Appendix D Turners Falls Smoke Testing Site Reports, Non-Defect Observations
Appendix E Summary of Recommended Investigations

Appendices are available for download at this link:

https://wrightpierce.sharepoint.com/:b:/s/FTP/Eb9qB27ZloJCsasD5ZjNIHcBM28Q5fu84BWyTuwEjJcWIA?e=wiZ11o