Petitioner Memo
Re: Sewer Impact

COMMONWEALTH™ ENGINEERS, INC.
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DILLMAN WWTP WEST INTERCEPTOR - SUMMIT DISTRICT IMPACT MEMORANDUM

TO: City of Bloomington Utilities

FROM: Commonwealth Engineers, Inc.

DATE: September 5, 2023

SUBJECT: Dillman WWTP West Interceptor – Summit District Impact

1.0 Introduction

The Dillman Wastewater Treatment Plant (WWTP) Basin consists of three (3) main interceptors that convey sanitary flow south to the WWTP. The thirty-six (36) inch west interceptor generally follows Clear Creek Trail, the forty-two (42) inch central interceptor generally follows Clear Creek, and the forty-two (42) inch east interceptor generally follows Jackson Creek. The west and central interceptors converge near 5825 S Rogers Street. The interceptor then converges with the east interceptor near the confluence of Clear Creek and Jackson Creek. The forty-eight (48) inch interceptor then travels southwest to the treatment plant.

The WWTP has a permitted design capacity of 15 MGD with a peak capacity of 30 MGD. City of Bloomington Utilities (CBU) has made improvements to the WWTP to achieve a future capacity of 20 MGD and peak flow of 40 MGD. The influent pump station has a firm pumping capacity of 75 MGD with the largest unit out of service. The equalization (EQ) basin has a total capacity of 43 million gallons.

A development named Summit District is proposed to connect to the sanitary sewer collection system. The development is located on a 140 acre property located east of Weimer Road and west of the RCA Community Park as shown in **Figure 1-1**. The development will include a distribution of residential units, retail and commercial buildings, hotels, and a fire department. Full buildout of the property is estimated to occur by 2038. Under full buildout conditions, the sanitary sewer for the development will connect to Manhole 7597 in the Dillman WWTP West Interceptor Basin.

As a part of this study, the Dillman WWTP West Interceptor within the CBU's hydraulic collection system model was calibrated to dry weather and wet weather conditions. The hydraulic model is well calibrated and accurately represents the existing conditions of the collection system. The hydraulic model was utilized to evaluate planning-level alternative solutions to eliminate potential SSOs up to a defined level of control. **Figure 1-1** illustrates the extents of the Dillman WWTP West Interceptor model. The hydraulic model was developed and calibrated using the United States Environmental Protection Agency's (USEPA) hydraulic modeling program SWMM5 computational engine. The model is well calibrated and suitable for preliminary engineering alternative analyses.

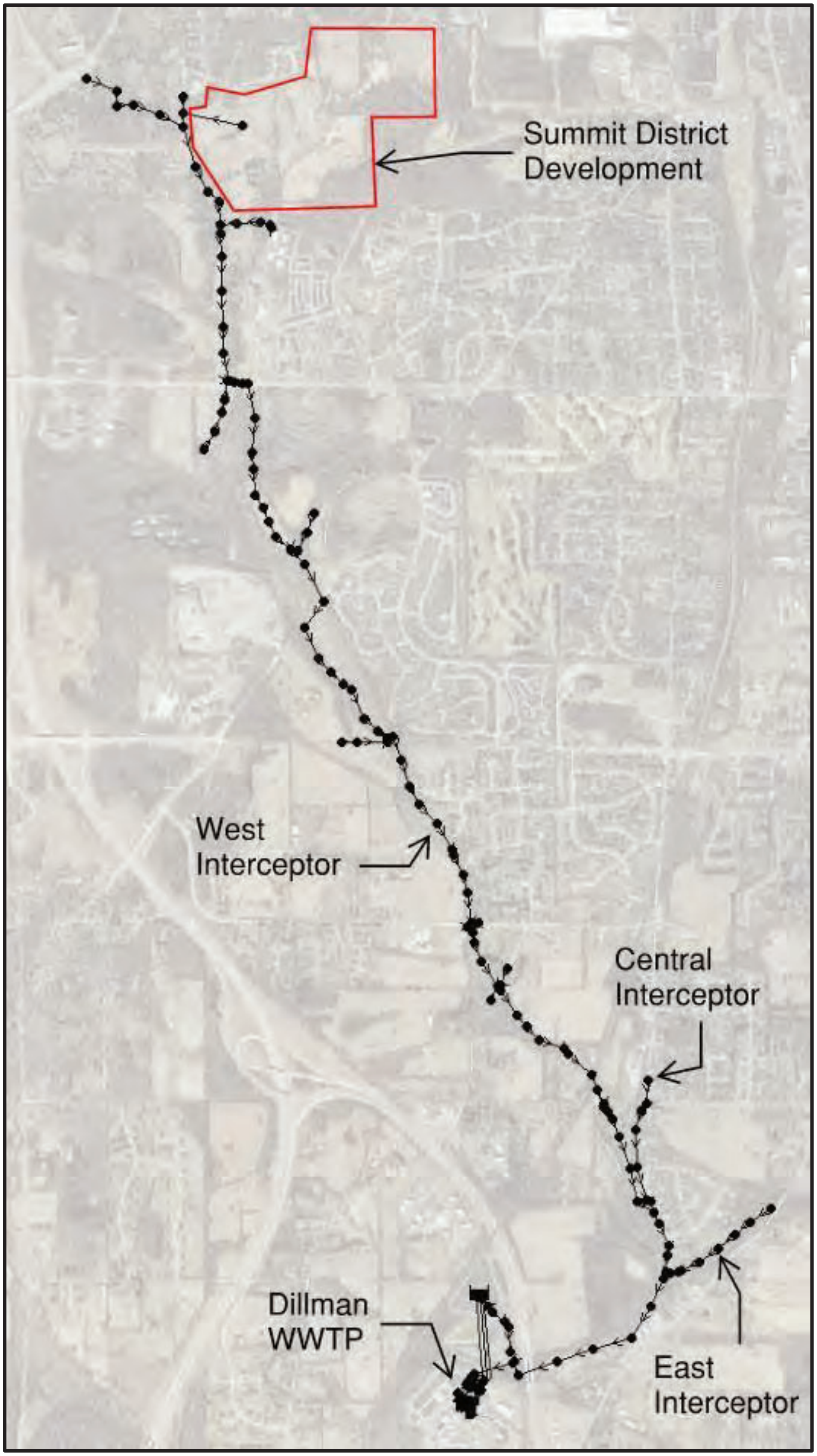


Figure 1-1: Dillman WWTP West Interceptor SWMM Hydraulic Model

2.0 Existing Conditions

To analyze the existing Dillman WWTP West Interceptor capacity during a large wet weather event, a fifty (50) year, one (1) hour storm was loaded into the model. The fifty (50) year, one (1) hour design storm equates to 2.89 inches of rain falling in one (1) hour. This design storm has been utilized for other similar SSO communities in the state. As shown in **Figure 2-1**, the downstream portion of the interceptor does not have the capacity to convey the peak flow. The majority of the flow reaching the WWTP comes from the Central Interceptor and East Interceptor.

Over the past five (5) years, MH 4749 near S. Rogers St. and Charlie Ave. has experienced several sanitary sewer overflows (SSOs). SSOs are prohibited in Indiana. The reality though is that sanitary sewer collection systems experience significant impacts due to infiltration and inflow. In older sanitary collection systems, infiltration and inflow can approach hydraulic behavior and wet weather response similar to a combined collection system. Growth within the Dillman WWTP sewershed is expected to occur further taxing the system and increasing the occurrence of SSOs. Specifically, the Summit District development adds additional flow to the collection system, further increasing the occurrence and volume of SSOs.

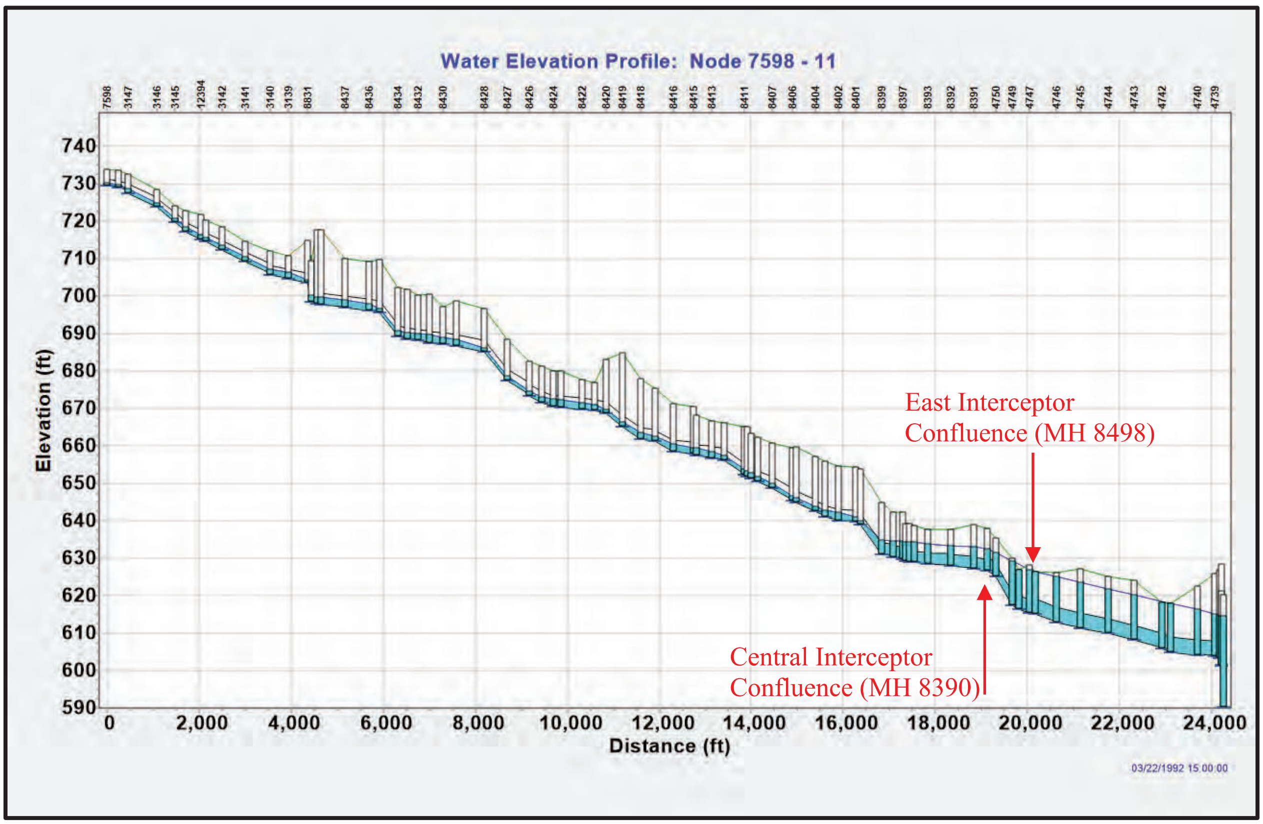


Figure 2-1: Dillman WWTP West Interceptor Hydraulic Grade Line 50-Year, 1-Hour Design Storm

3.0 Summit District's Impact to Sewer Near Connection Point

Under full buildout conditions, the development will be composed of residential units, retail and commercial buildings, hotels, and a fire department. The following calculations to determine average daily and peak daily flows were completed using the unit matrix provided by the developer and Section 327 Indiana Administrative Code 3-6-11.

Total Equivalent Dwelling Units (EDU) = 4,966

Flow per EDU = 310 gallons per day

Average Daily Flow (ADF) = 4,966 units X 310 gpd / unit = 1.54 MGD

Peaking Factor (PF) = 4

Peak Daily Flow (PDF) = 1.54 MGD X 4 = 6.16 MGD

The development is proposed to connect to the existing collection system at MH 7597, which is located on the twenty (20) inch sanitary sewer along Weimer Rd, as shown in **Figure 3-1**. Approximately 215 LF downstream of the proposed connection point, the sewer connects to the thirty (30) inch Dillman WWTP West Interceptor.

Table 3-1 includes a comparison of the full-flow capacity to the existing conditions flow and flow with Summit District. As shown in the table, the 20 (twenty) inch sewer is undersized for the peak design flow with Summit District. As shown in **Figure 3-2**, the hydraulic grade line (HGL) exceeds the crown of the pipe by less than one (1) foot during peak flow. It is recommended to monitor flows along the twenty (20) inch sewer as the development is built out to ensure there is adequate capacity during wet weather. Alternatively, if Summit District connects to MH 3147 or further downstream on the thirty (30) inch interceptor, no surcharging occurs for the peak wet weather flow.

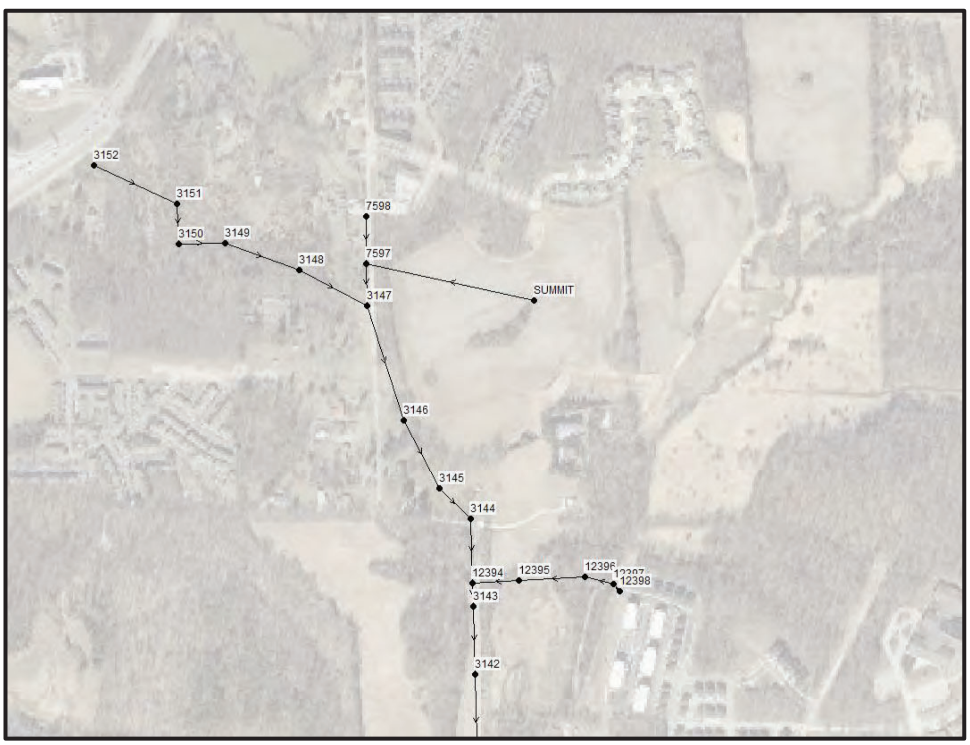


Figure 3-1: Summit District Connection to Existing Collection System

Table 3-1: 50-Year, 1-Hour Design Storm Flows Near the Connection Point with Summit District

	20-Inch Sewer Flow (MGD)	30-Inch Sewer Flow (MGD)
Full-Flow Capacity	4.3	20.6
Existing Conditions	1.9	11.0
Future Growth Conditions	8.0	17.5

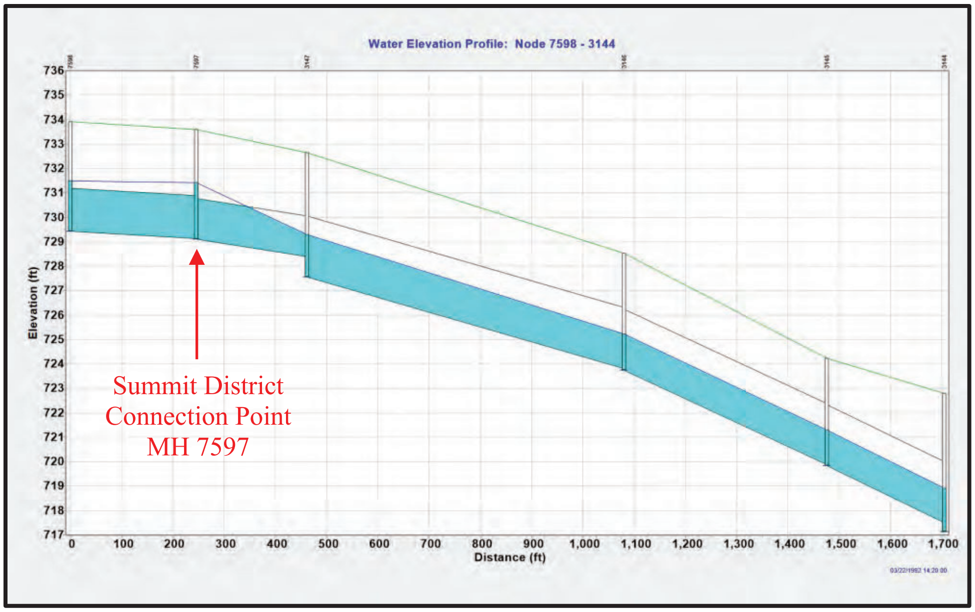


Figure 3-2: Connection Point of Summit District HGL 50-Year, 1-Hour Design Storm

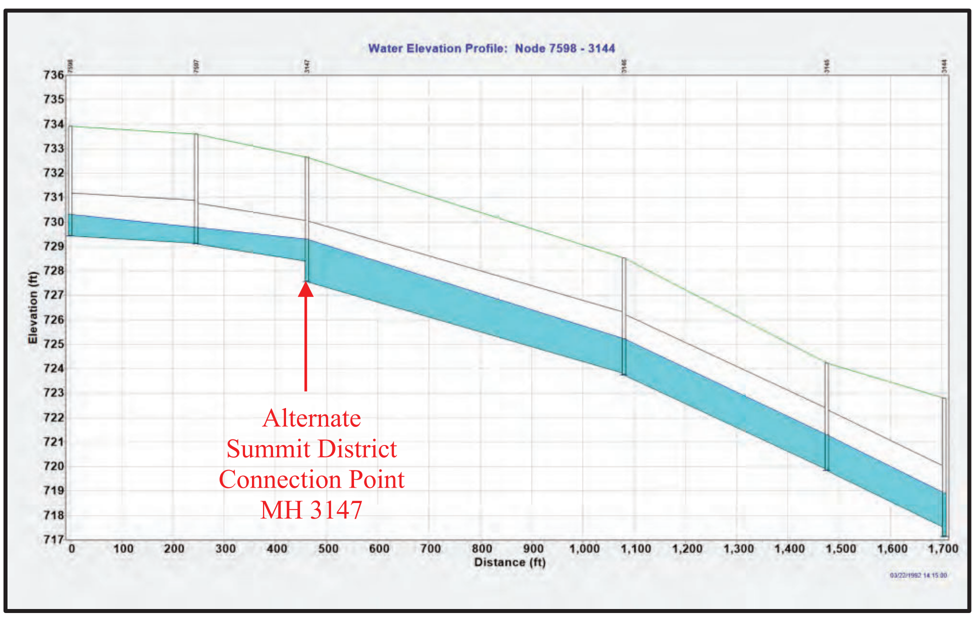


Figure 3-3: Alternate Connection Point of Summit District HGL 50-Year, 1-Hour Design Storm

4.0 Increase in Flow Reaching WWTP

During the metering period of May 2023 through August 2023, the existing conditions average dry weather flow was approximately 7.0 MGD. However, Monthly Report of Operation (MRO) data from May 2022 through July 2023 were reviewed to assess the average dry weather flow throughout year. It was determined that the yearly average dry weather flow is approximately 10.0 MGD. Assuming the interceptor was sized to receive these flows without surcharging, **Table 4-1** compares the dry weather and wet weather flow reaching the WWTP for the existing conditions and full buildout future flow conditions.

Table 4-1: Flow Reaching WWTP

	Existing Conditions (MGD)	Full Buildout Future Flow (MGD)	Increase in Flow (%)
Dry Weather	10.0	13.7	36.6
50 Year, 1 Hour	73.9	88.5	19.8

In addition to the Summit District development, several developments within the West Interceptor Basin are planned to connect to the collection system. Multiple developments in the Central and East Interceptor Basins are either currently under construction or recently completed. These Central and East Interceptor flows were not recorded during the metering period, so they are included in the future flow in **Table 4-1**.

The Summit District accounts for 46.5% of the future growth flow in the West Interceptor Basin. Additionally, the Summit District development increases the existing dry weather and wet weather flows by 15.4% and 8.3%, respectively. Calculations are shown below.

Future Growth in West Interceptor Basin = Full Buildout – Existing – Central and East Future Growth

= 13.7 MGD – 10.0 MGD – 0.4 MGD = 3.3 MGD

Summit District Share of Future Growth = Summit District Flow / Future Growth in West Interceptor

= 1.54 MGD / 3.3 MGD = 46.5%

Summit District Increase of Existing Dry Weather = Summit District Dry Weather / Existing Dry Weather

= 1.54 MGD / 10.0 MGD = 15.4%

Summit District Increase of Existing Wet Weather = Summit District Peak Flow / Existing Wet Weather

= 6.16 MGD / 73.9 MGD = 8.3%

5.0 Alternatives

Alternative solutions to eliminate potential sanitary sewer overflows occurring within Dillman WWTP West Interceptor Basin were developed for the fifty (50) year design storms. The following performance criteria were used when identifying and assessing alternative solutions for the collection system:

- Eliminate potential sanitary sewer overflows for the 50-year design storm.
- Achieve eight (8) feet of freeboard between the ground elevation and the maximum HGL in the collection system. If eight (8) feet of freeboard was not available, the HGL must be lower than the crown of the pipe.
- Firm (design) lift station pumping rate shall meet or exceed the peak inflow to each lift station.

Table 5-1 provides the total (construction and non-construction) cost of the three (3) alternatives presented below for the future growth conditions in the Dillman WWTP Basin.

Table 5-1: Alternative Total Cost Estimate

Alternative	Total Cost ($)
1	59,924,450
2	45,501,790
3	44,198,460

Alternative 1 – Wet Weather Overflow at MH 8397 and MH 4756 with Flow Control

Diversion structures at MH 8397 and MH 4756 will divert wet weather to a lift station located near W Church Lane. Both structures will include plates to control flow in the existing downstream interceptors and divert more toward the lift station. The lift station will pump to the existing EQ basin. The force main alignment is proposed to follow the Limestone Greenway, which was constructed in 2019.

Improvements considered in this alternative include:

- 36 MGD Lift Station*
- New Diversion Structures with Flow Control*
- 30” Diameter Gravity Sewer from MH 8397 and MH 4756 to new manhole (600 feet)*
- 36” Diameter Gravity Sewer from new manhole to new lift station (200 feet)*
- 36” Diameter Force Main from New Lift Station to EQ Basin (3,450 feet)*
- 36” Diameter Gravity Sewer from MH 3139 to MH 8831 (415 feet)
- 42” Diameter Gravity Sewer from MH 8399 to MH 8397 (460 feet)

Improvements required to address the existing issues include the items with asterisks above. Costs associated with these current improvements are estimated at $58,133,300. This value could be potentially reduced by designing a firm capacity station for current flows readily expandable to the future growth flow. The other items included above would be constructed as developments are connected to the system.

Alternative 2 – Wet Weather Relief Sewer

During wet weather, wastewater overflows a weir in a diversion structure at MH 8397. The wet weather sewer travels parallel to the existing West Interceptor. At two additional locations, diversion structures divert flow from the main interceptor to the wet weather sewer. A new wet weather lift station will accept flows in excess of the capacity of the influent pump station. The lift station will pump to the EQ basin. Challenges of this alternative include fitting the new gravity sewer on WWTP property dealing with other pipes and utilities. Additionally, this alternative requires a large diameter gravity sewer underneath I-69.

Improvements considered in this alternative include:

- 14 MGD Lift Station*
- 3 New Diversion Structures*
- 30" Diameter Gravity Relief Sewer from MH 8397 (1,800 feet)
- 42" Diameter Gravity Relief Sewer (1,150 feet)
- 48" Diameter Gravity Relief Sewer to Influent Pump Station (3,890 feet)*
- 24" Diameter Force Main from New Lift Station to EQ Basin (2,100 feet)*
- 36" Diameter Gravity Sewer Replacement from MH 3139 to MH 8831 (415 feet)

Improvements required to address the existing issues include the items with asterisks above. Note only two (2) diversion structures are required. Costs associated with these current improvements are estimated at $38,418,640. The other items included above would be constructed as developments are connected to the system.

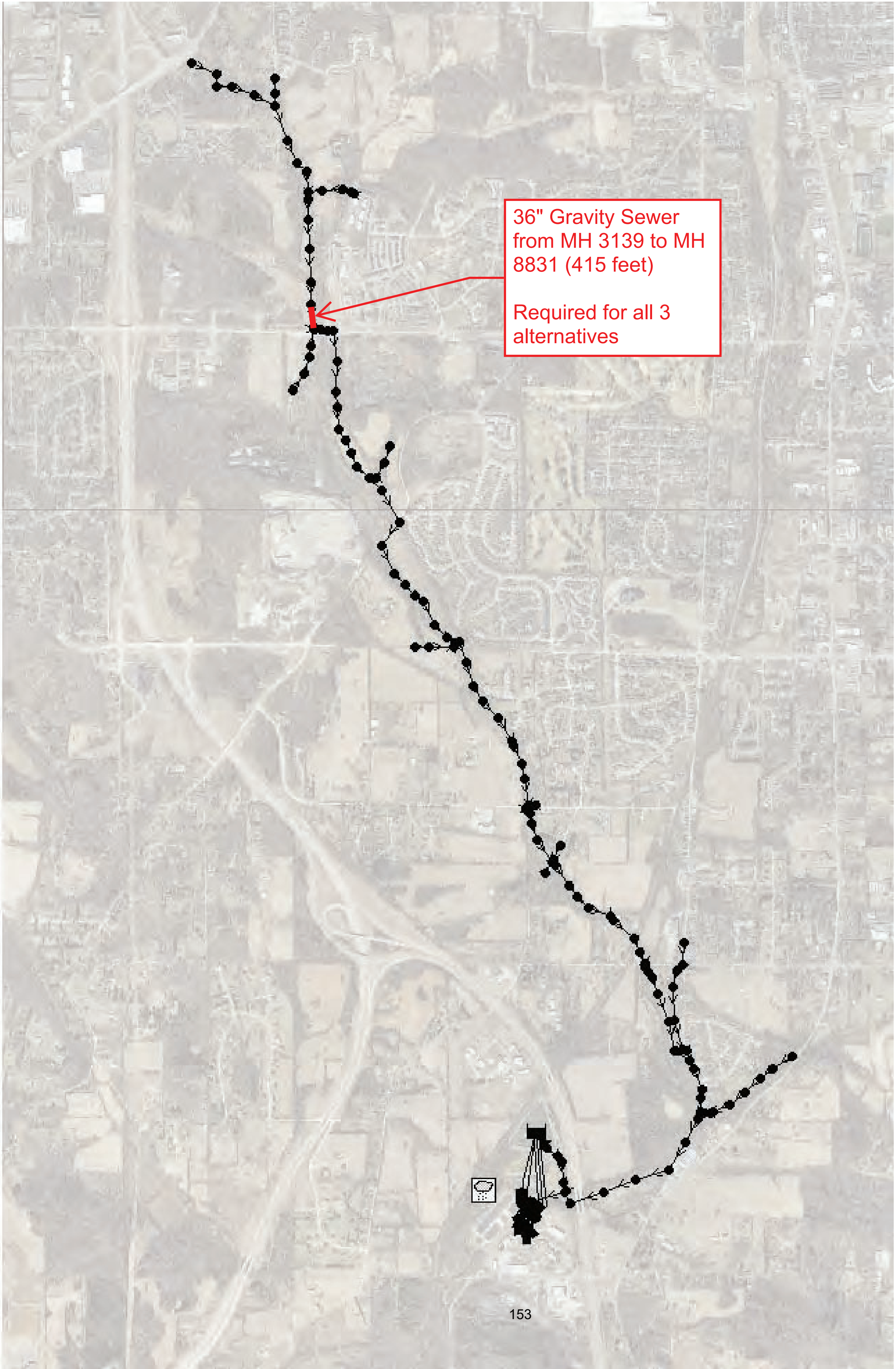
Alternative 3 – New Dry Weather Flow Sewer

A diversion structure at MH 8498 diverts all dry weather flow through a new gravity sewer. When the depth in the diversion structure exceeds the maximum dry weather depth, flow overtops a weir into the existing gravity sewer. A new wet weather lift station will accept flows in excess of the capacity of the influent pump station. The lift station will pump to the EQ basin. Challenges of this alternative include fitting the new gravity sewer on WWTP property dealing with other pipes and utilities. Additionally, this alternative requires a large diameter gravity sewer underneath I-69. The pipe replacement instead of a parallel sewer also requires significant bypass pumping.

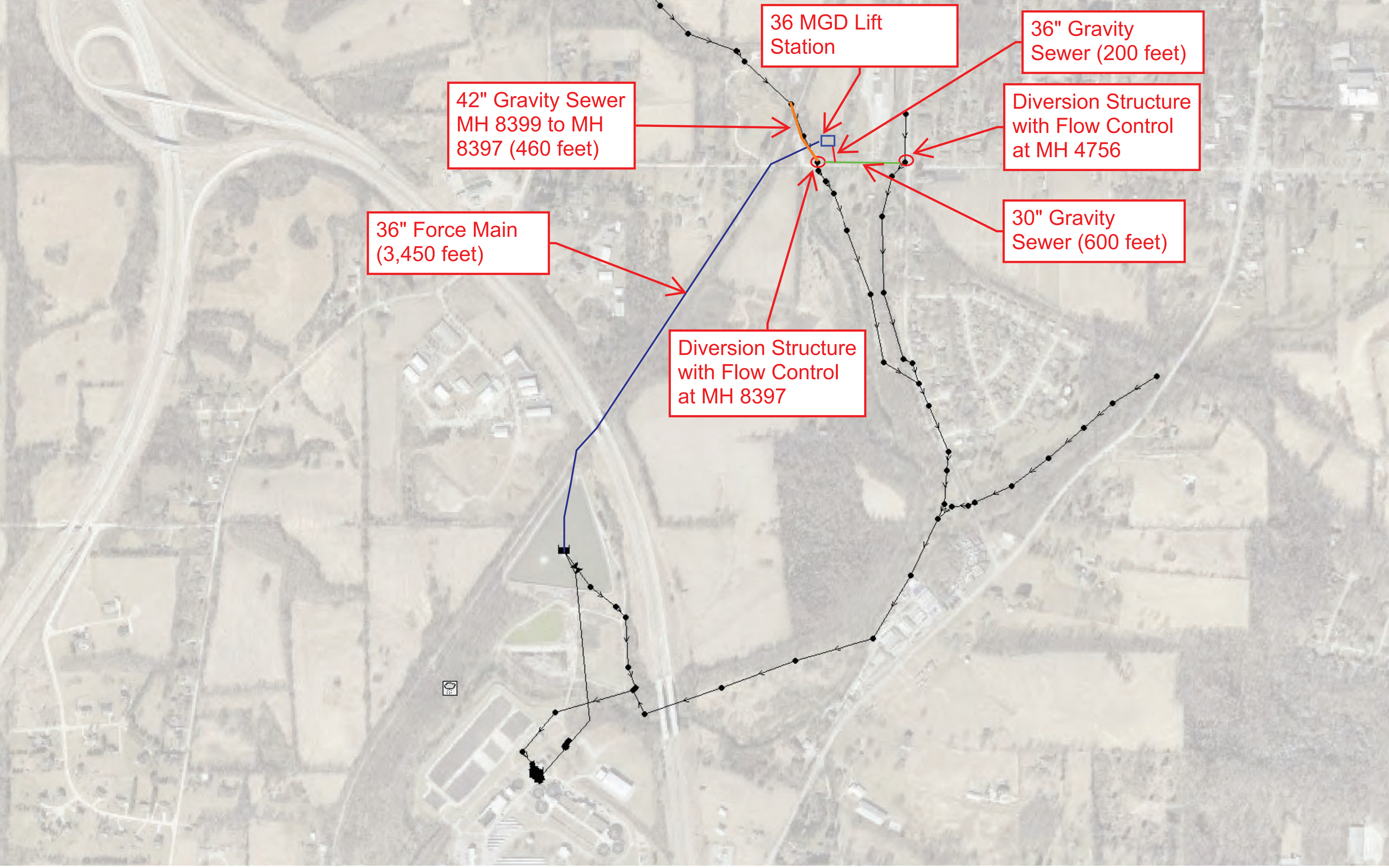
Improvements considered in this alternative include:

- 14 MGD Lift Station*
- New Diversion Structure*
- 48" Diameter Gravity Relief Sewer from MH 8498 (2,300 feet)*
- 54" Diameter Gravity Relief Sewer to Influent Pump Station (1,750 feet)*
- 24" Diameter Force Main from New Lift Station to EQ Basin (2,100 feet)*
- 36" Diameter Gravity Sewer Replacement from MH 3139 to MH 8831 (415 feet)
- 42" Diameter Gravity Sewer Replacement from MH 8396 to MH 8390 (1,790 feet)
- 48" Diameter Gravity Sewer Replacement from MH 8390 to MH 4747 (920 feet)

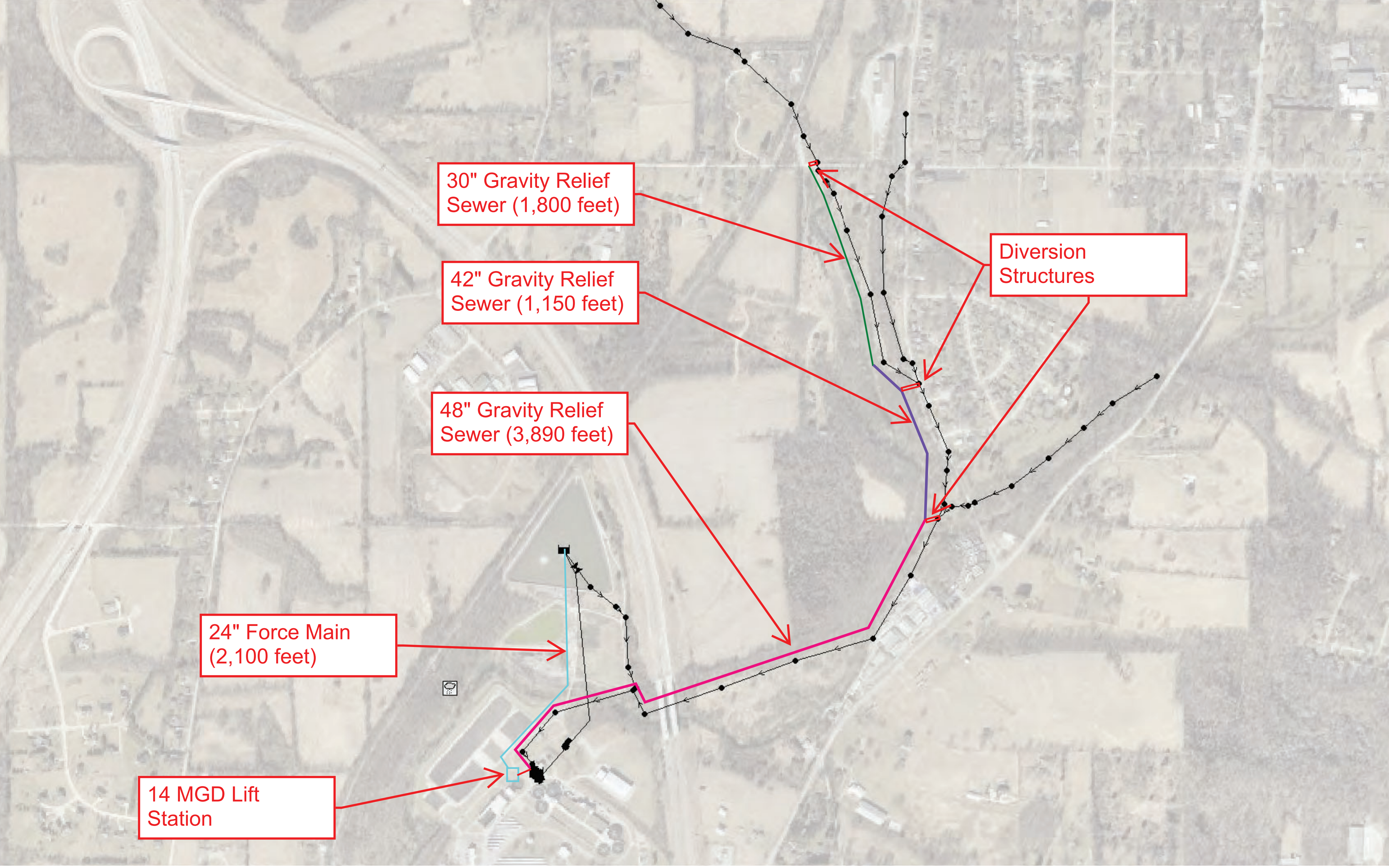
Improvements required to address the existing issues include the items with asterisks above. Costs associated with these current improvements are estimated at $38,300,230. The other items included above would be constructed as developments are connected to the system.


36" Gravity Sewer from MH 3139 to MH 8831 (415 feet)

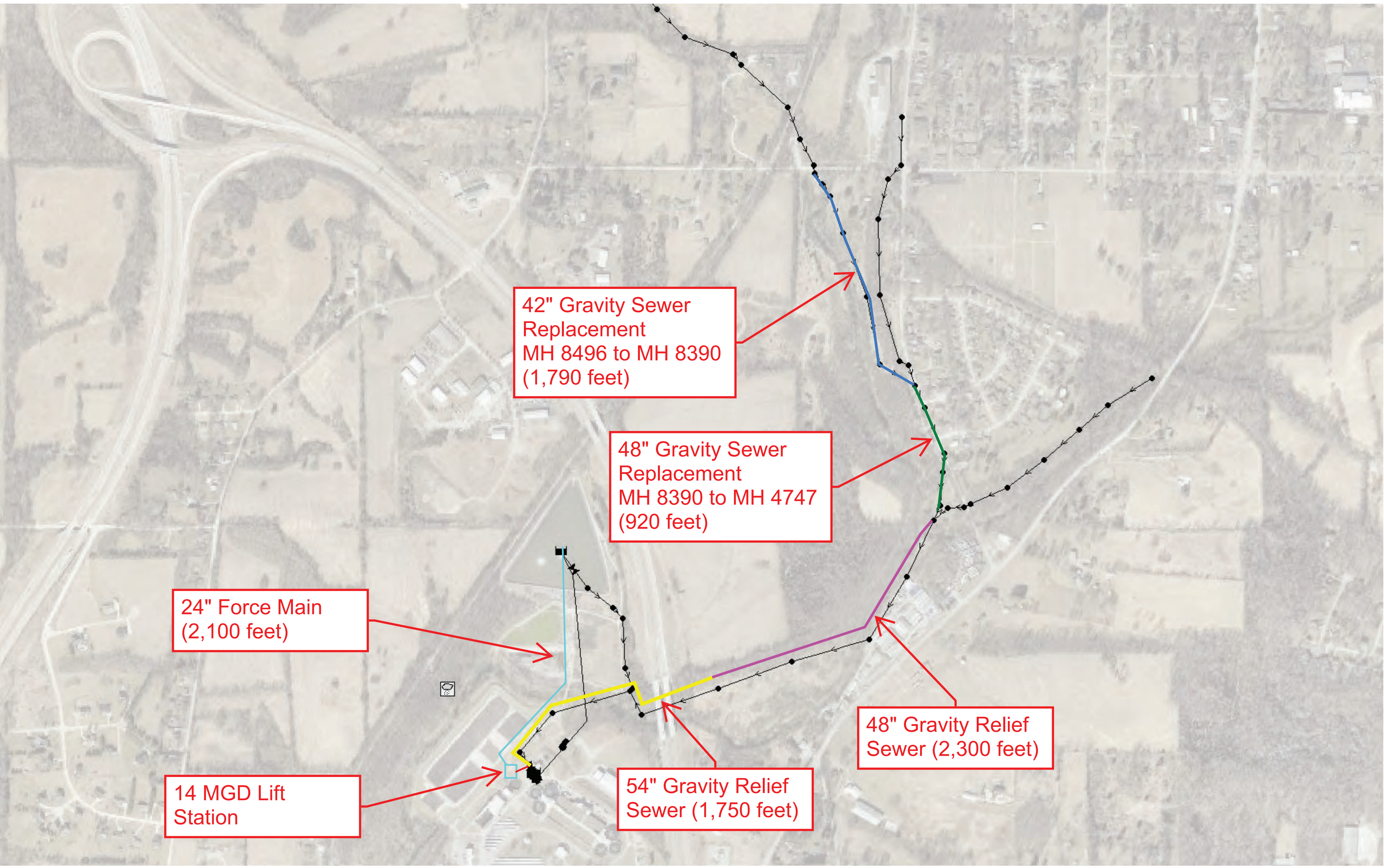
Required for all 3 alternatives



ALTERNATIVE 1



ALTERNATIVE 2



ALTERNATIVE 3

ALTERNATIVE 3						WWTP (A)	DS Gravity (A)	mid gravity (B)	US gravity (C)
Item	**Description**	**QNTY**	**UNIT**	**UNIT COST ($)**	**TOTAL COST ($)**				
1	MOBILIZATION/ DEMOBILIZATION (5%)	1	LS	1,563,000	1,563,000	804,000	516,000	86,000	157,000
2	CONTRACTOR CONSTRUCTION ENGINEERING (2%)	1	LS	613,000	613,000	315,000	202,000	34,000	62,000
3	MISC. UTILITY RELOCATION ALLOWANCE	1	LS	100,000	100,000	50,000	25,000	12,500	12,500
4	MAINTENANCE AND PROTECTION OF TRAFFIC	1	LS	100,000	100,000	20,000	50,000	20,000	10,000
5	TEMPORARY EROSION CONTROL	1	LS	100,000	100,000	20,000	40,000	15,000	25,000
6	BYPASS PUMPING	1	LS	500,000	500,000	25,000	40,000	220,000	215,000
7	14 MGD LIFT STATION	1	LS	13,946,500	13,946,500	13,946,500			
8	24-INCH DIAMETER FORCE MAIN	2,100	LF	370	777,000	777,000			
9	EQ BASIN DISCHARGE	1	LS	185,000	185,000	185,000			
10	CONNECTION FROM LIFT STATION	1	LS	500,000	500,000	500,000			
11	54-INCH DIAMETER GRAVITY RELIEF SEWER	1,400	LF	1,430	2,002,000		2,002,000		
12	54-INCH DIAMETER GRAVITY RELIEF SEWER - UNDER I-69	400	LF	8,080	3,232,000		3,232,000		
13	48-INCH DIAMETER GRAVITY RELIEF SEWER	2,250	LF	1,280	2,880,000		2,880,000		
14	48-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 8390 TO MH 4747)	920	LF	1,280	1,177,600			1,177,600	
15	42-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 8396 TO MH 8390)	1,790	LF	1,130	2,022,700				2,022,700
16	DIVERSION STRUCTURE	1	LS	185,000	185,000		185,000		
17	BEDROCK EXCAVATION	9,865	CY	250	2,466,200	251,000	1,654,000	187,100	374,100
18	LATERAL CONNECTIONS	2	EA	25,000	50,000			50,000	
19	36-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 3139 TO MH 8831)	415	LF	1,000	415,000				415,000
				CONSTRUCTION COST SUBTOTAL ($) =	**32,815,000**	**16,893,500**	**10,826,000**	**1,802,200**	**3,293,300**
				10% CONSTRUCTION CONTINGENCY (ROUNDED) =	**3,282,000**	**1,689,500**	**1,082,700**	**180,300**	**329,500**
				TOTAL CONSTRUCTION COST =	**36,097,000**	**18,583,000**	**11,908,700**	**1,982,500**	**3,622,800**
				25% NON-CONSTRUCTION COSTS (ROUNDED) =	**9,025,000**	**4,646,000**	**2,977,300**	**495,800**	**905,900**
				TOTAL COST =	**45,122,000**	**23,229,000**	**14,886,000**	**2,478,300**	**4,528,700**

9.70%	9.70%	11.50%	22%
$ 2,253,213.00	$ 1,443,942.00	$ 285,004.50	$ 996,314.00
	TOTAL =	$ 4,978,473.50	

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DILLMAN WWTP WEST INTERCEPTOR SWMM MODEL CALIBRATION, FUTURE GROWTH, & ALTERNATIVE TECHNICAL MEMORANDUM ADDENDUM NO. 1

TO: City of Bloomington Utilities

FROM: Commonwealth Engineers, Inc.

DATE: November 9, 2023 – Revised December 26, 2023

SUBJECT: SWMM Model Calibration, Future Growth, and Alternative Analysis

ATTACHMENTS: Attachment 1 – Rainfall Classification
Attachment 2 – Dry Weather Calibration and Validation Figures
Attachment 3 – Wet Weather Calibration and Validation Figures
Attachment 4 – Peak Hydraulic Grade Lines
Attachment 5 – Cost Estimate
Attachment 6 – Alternatives Hydraulic Grade Lines

1.0 Introduction

The project area includes the City of Bloomington Utilities (CBU) Dillman WWTP Basin, which is depicted in **Figure 1-1**. As shown, the Dillman WWTP Basin is defined as a separate sanitary basin and approximately consists of the area south of Vernal Pike. Specifically, this study is focused on the West Interceptor Basin within the Dillman WWTP Basin.

During dry weather, sanitary flow is conveyed by the Dillman WWTP West Interceptor south towards the WWTP. Two (2) other interceptors convey flow from the central and eastern portions of the Dillman WWTP Basin. The three (3) interceptors converge near S Old Indiana 37 and S Roger Street. From there, sanitary flow is conveyed through a forty-eight (48) inch interceptor to the WWTP.

During wet weather, the Dillman WWTP West Interceptor Basin experiences significant wet weather flows and sanitary sewer overflows (SSOs) are potentially occurring throughout the system. Within the study area, MH 4749 near S. Rogers St. and Charlie Ave. has experienced several SSOs over the past five (5) years. SSOs are prohibited in Indiana. The reality though is that sanitary sewer collection systems experience significant impacts due to infiltration and inflow. In older sanitary collection systems, infiltration and inflow can approach hydraulic behavior and wet weather response similar to a combined collection system. Growth in the Dillman WWTP sewershed is expected to further tax the system and increase the occurrence of SSOs.

The Dillman WWTP has a permitted design capacity of fifteen (15) MGD with a peak capacity of thirty (30) MGD. CBU has made improvements to the WWTP to achieve a future capacity of twenty (20) MGD and peak capacity of forty (40) MGD. The influent pump station has a firm pumping capacity of seventy-five (75) MGD with the largest unit out of service. The equalization (EQ) basin has a total capacity of forty-three (43) million gallons.

As a part of this study, extensive surveying and field data were collected in order to develop a hydraulic model that accurately represents the existing conditions of the collection system. From there, the model was calibrated to dry and wet weather conditions. The hydraulic model is well calibrated and accurately represents the existing conditions of the collection system. The hydraulic model was utilized to evaluate planning-level alternative solutions to eliminate potential SSOs up to a defined level of service. **Figure 1-2** illustrates the extents of the Dillman WWTP West Interceptor model. The hydraulic model was developed and calibrated using the United States Environmental Protection Agency's (USEPA) hydraulic modeling program SWMM5 computational engine. The model is well calibrated to dry and wet weather events and is suitable for preliminary engineering alternative analyses.

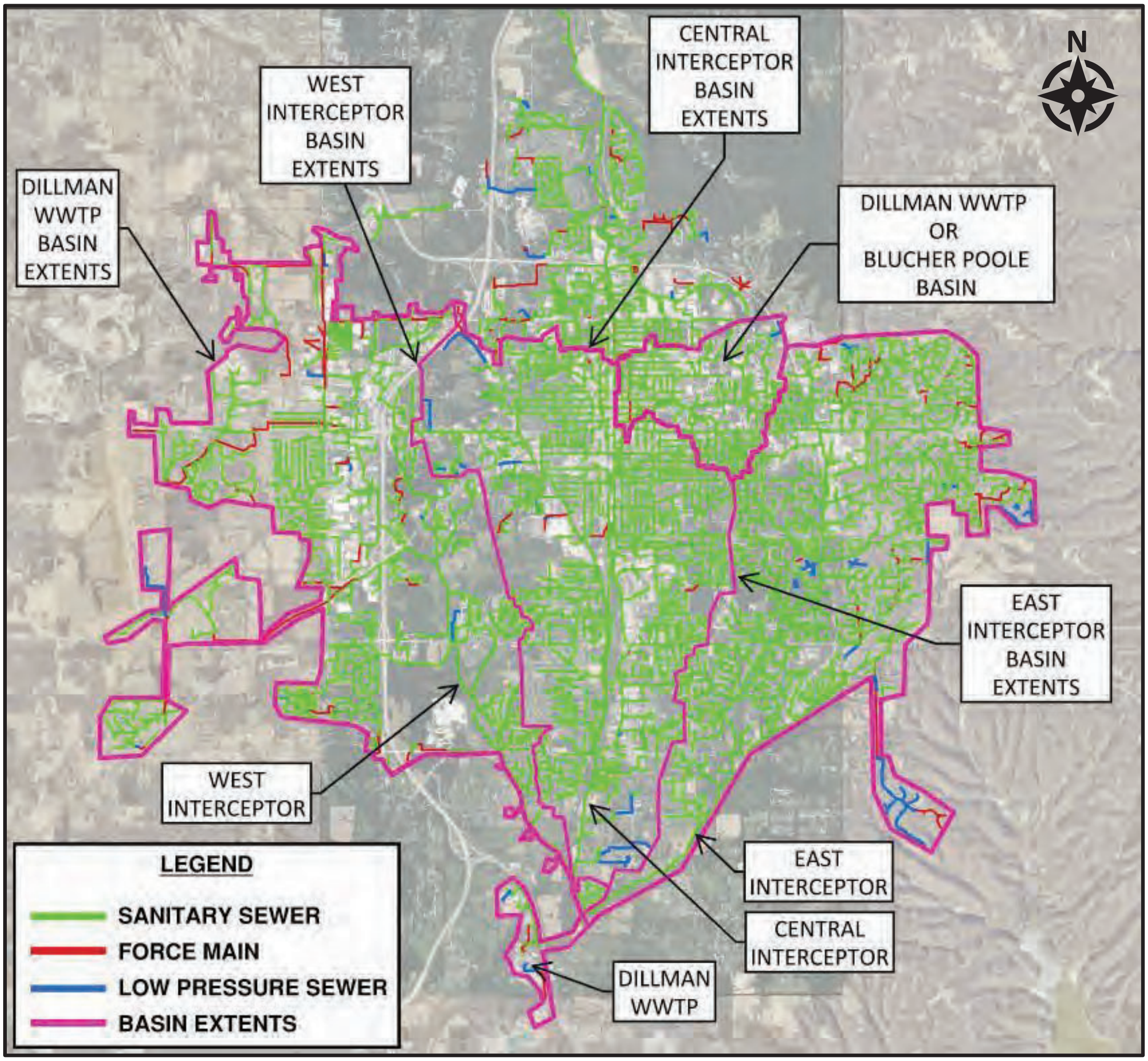


Figure 1-1: Dillman WWTP Basin

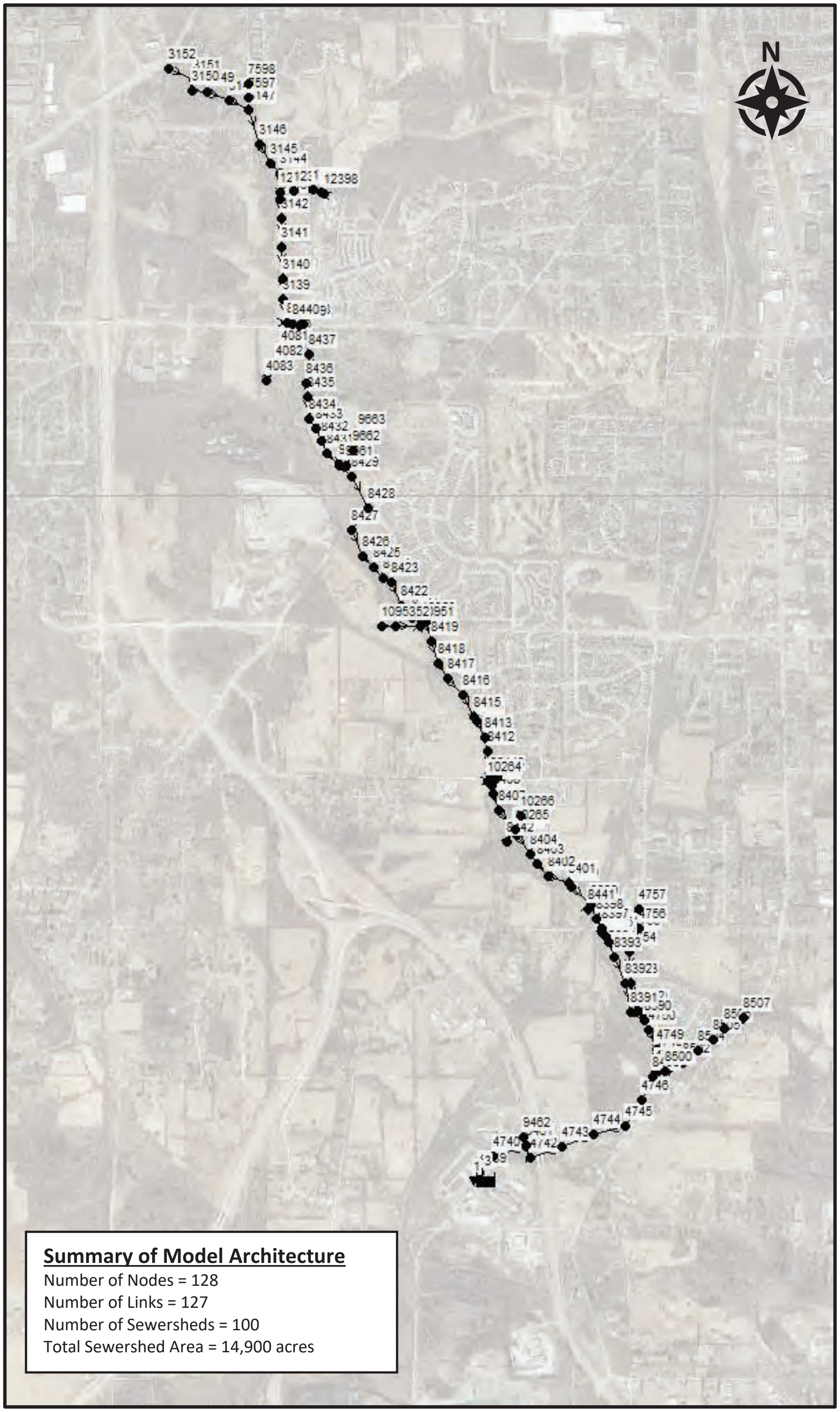


Figure 1-2: SWMM5 Model Architecture

2.0 Rainfall and Flow Meter Data

An accurate source of rainfall and flow meter data is necessary to develop a calibrated hydraulic model for the Dillman WWTP Basin. A temporary rain gauge and flow meters were installed as a part of this modeling effort. The following is a summary of the rainfall and flow meter data that was used for the model calibration.

2.1 Rainfall Data

One (1) temporary rainfall gauge was deployed at the Dillman WWTP and recorded data in five (5) minute intervals. **Figure 2-1** illustrates the location of the gauge in relation to the Dillman WWTP West Interceptor Basin. Rainfall data was downloaded and analyzed for the duration of the flow monitoring period from May 2023 through August 2023. Several wet weather events occurred during the flow monitoring period and are classified in **Table 2-1**. **Attachment 1** contains the detailed categorization of all wet weather events occurring during the flow monitoring period.

Table 2-1
Classification of Rainfall Events at Dillman WWTP

Date	Depth (in)	Duration (hr)	Recurrence Interval *
6/11/2023	0.93	1	4-6 Months
7/1/2023	0.66	1	< 2 Months
7/2/2023	0.99	1	4-6 Months
7/2/2023	2.67	48	6-9 Months
7/8/2023	0.74	1	2-3 Months
7/17/2023	1.10	1	6-9 Months
8/5/2023	1.66	1	2-5 Years

* Classification approximated using **Rainfall Frequency Atlas of the Midwest - Bulletin 71**.

2.2 Flow Meter Data

Flow metering was performed from May 2023 through August 2023. Six (6) temporary area-velocity (AV) flow meters were placed throughout the Dillman WWTP Basin. One (1) permanent flow meter is located on the Dillman WWTP West Interceptor. **Table 2-2** provides a summary of the flow meters, corresponding structure locations, and corresponding pipe diameters. **Figure 2-1** depicts the location of each flow meter used during dry and wet weather calibration and the contributary area to each meter, which represents the modeled SWMM5 subbasins.

Table 2-2
Summary of Flow Meters

Location in the Collection System (Manhole #)	Temporary/ Permanent	Pipe Diameter (in)	Meter Location (Influent/Effluent)
3148	Temporary	30	Influent
3144	Permanent	30	Influent
4080	Temporary	15	Influent
8391	Temporary	36	Influent
4752	Temporary	42	Influent
8501	Temporary	42	Influent
4740	Temporary	48	Influent

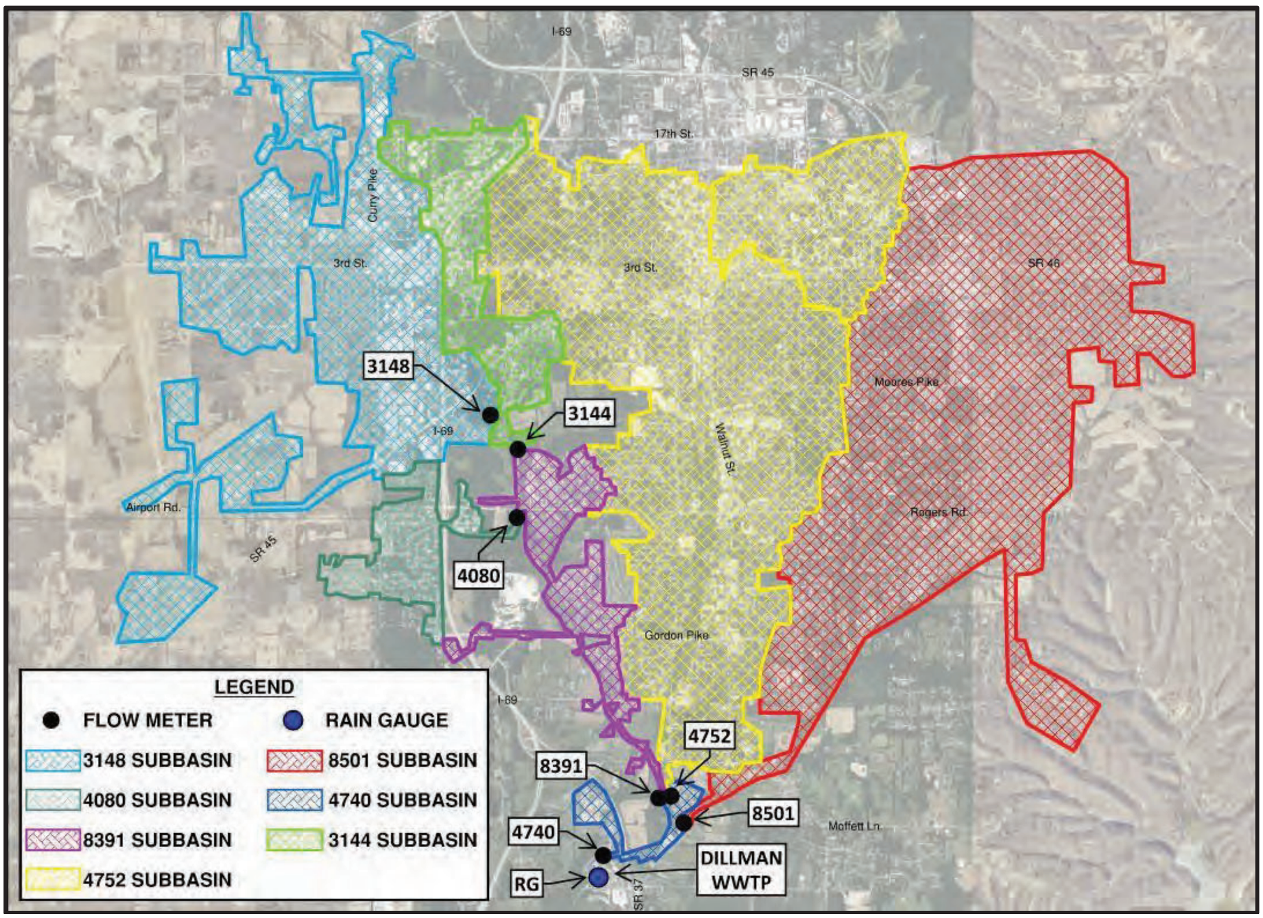


Figure 2-1: SWMM5 Flow Meter Subbasins

3.0 Model Calibration

Model calibration for both dry and wet weather conditions are critical components of collection system modeling. Proper dry weather calibration and validation ensure an accurate depiction of base sanitary flows and levels in the collection system. Likewise, proper wet weather calibration and validation ensure accurate predictions of the wet weather volumes and rates entering the collection system during various wet weather events along with corresponding effects to the hydraulic grade lines in the sanitary collection system. Dry and wet weather conditions were calibrated and validated separately, as summarized below.

3.1 Dry Weather Calibration and Validation

The flow metering data and rainfall data were reviewed to find an optimal seven (7) to fourteen (14) day span in which no significant rainfall had fallen during that span and no significant wet weather events had occurred in at least the two (2) preceding days. The dry weather span that occurred between May 26, 2023 and June 7, 2023 met these criteria (see **Figure 3-5**). During this period, the flow metering data was analyzed, and dry weather flow characteristics were calculated for each meter installed within the dry weather flow path. Dry weather calibration was performed by distributing the average dry weather flow metered at the monitoring locations to upstream nodes based on residential/business counts and approximate flow rates from industries and institutions. Diurnal patterns were also calculated based upon hourly and daily variation in the flow. These patterns allowed the average dry weather flow to accurately match the hydrographs collected by the flow meters.

Attachment 2 contains the graphical comparison of the modeled flow and depth data with the metered flow and depth data for the selected dry weather calibration period. As shown in **Attachment 2**, the model is adequately calibrated to dry weather conditions due to the consistent agreement between the metered data and model output.

The selected dry weather validation span to independently assess the dry weather calibration was July 23, 2023 to August 6, 2023 (see **Figure 3-5**). For the dry weather validation model run, the established dry weather flow patterns from the preceding calibration were not altered in the model, thus providing a secondary period in which the model output can be compared to the gauged metering data during dry weather. **Attachment 2** contains the graphical comparison of the modeled flow and depth data with the gauged metering data for the selected dry weather validation period. As shown, the model is adequately validated for planning-level purposes due to the consistent agreement between the metered data and model output.

3.2 Wet Weather Calibration & Validation

Generally, there are two (2) common methodologies in EPA SWMM5 utilized to calibrate collection system models to wet weather conditions. The first method is the Rainfall Derived Infiltration and Inflow (RDII) unit hydrograph method, which is commonly used to calibrate separate sewer areas. The second is the subcatchment method, which is used to calibrate combined sewer areas. The Dillman WWTP West Interceptor Basin is defined as a separate sanitary system; therefore; only the RDII unit hydrograph method was utilized during the wet weather calibration process. A summary of the RDII Unit Hydrograph Method, wet weather calibration, and wet weather validation is provided hereafter.

RDII Unit Hydrograph Method

Sanitary sewers are designed to collect and convey sanitary flows; however, collection systems are susceptible to collecting additional flows due to infiltration and inflow (I&I). Inflow is runoff that enters the system directly from manhole lids and frames, improperly connected downspouts, sump pumps, and cross-connections with storm sewers. Inflow usually occurs shortly after rainfall begins and quickly recedes once it stops. It is typically the major component of the Rainfall Derived Infiltration and Inflow (RDII) peak flow. During dry weather, groundwater can infiltrate into the system through leaks in pipes and manholes. During wet weather, an increase in infiltration can be expected. Infiltration processes typically extend beyond the end of the wet weather event and take longer to recede. Systems are usually designed to accommodate I&I, though these flows often exceed design allowances with system age and growth. An RDII hydrograph represents the total flow that enters the collection system in the form of I&I.

The RDII unit hydrograph method is based on fitting up to three (3) triangular hydrographs to an observed RDII hydrograph: (a) short-term I&I response, (b) intermediate-term I&I response, and (c) long-term I&I response. Each unit hydrograph is defined by three (3) parameters:

- *R* = fraction of rainfall volume that enters the sewer system.
- *T* = time from the onset of rainfall to the peak of the unit hydrograph.
- *K* = ratio of time to recession of the unit hydrograph to the time to peak.

An RTK unit hydrograph was developed for each of the seven (7) flow metering locations, which represents the Rainfall Derived Infiltration and Inflow entering the Dillman WWTP Basin.

Wet Weather Calibration and Validation

The wet weather calibration process began by examining the rainfall and flow metering data in order to select a wet weather calibration event. Calibration proceeded by developing model unit hydrographs, which were systematically adjusted and revised by adjusting the RTK calibration parameters until the modeled data matched the observed data for the primary calibration event. As shown in **Table 2-1**, the storm events on July 17, 2023 and August 5, 2023 were the largest storm events. Each of these events were initially selected for calibration. Calibrating to these events resulted in the model not being well calibrated to any other event in the metering period. Therefore, the next largest storm event on July 2, 2023 was selected for model calibration (See **Figure 3-5**).

When the model was calibrated to the July 2, 2023 event, it was observed that the wet weather event that occurred on July 17, 2023 resulted in observed responses from the flow meters that were much greater than the predicted responses from the hydraulic model as shown in **Figure 3-1**. Inversely, it was observed that the wet weather event that occurred on August 5, 2023 resulted in observed responses from the flow meters that were much lower than the predicted responses from the hydraulic model as shown in **Figure 3-1**.

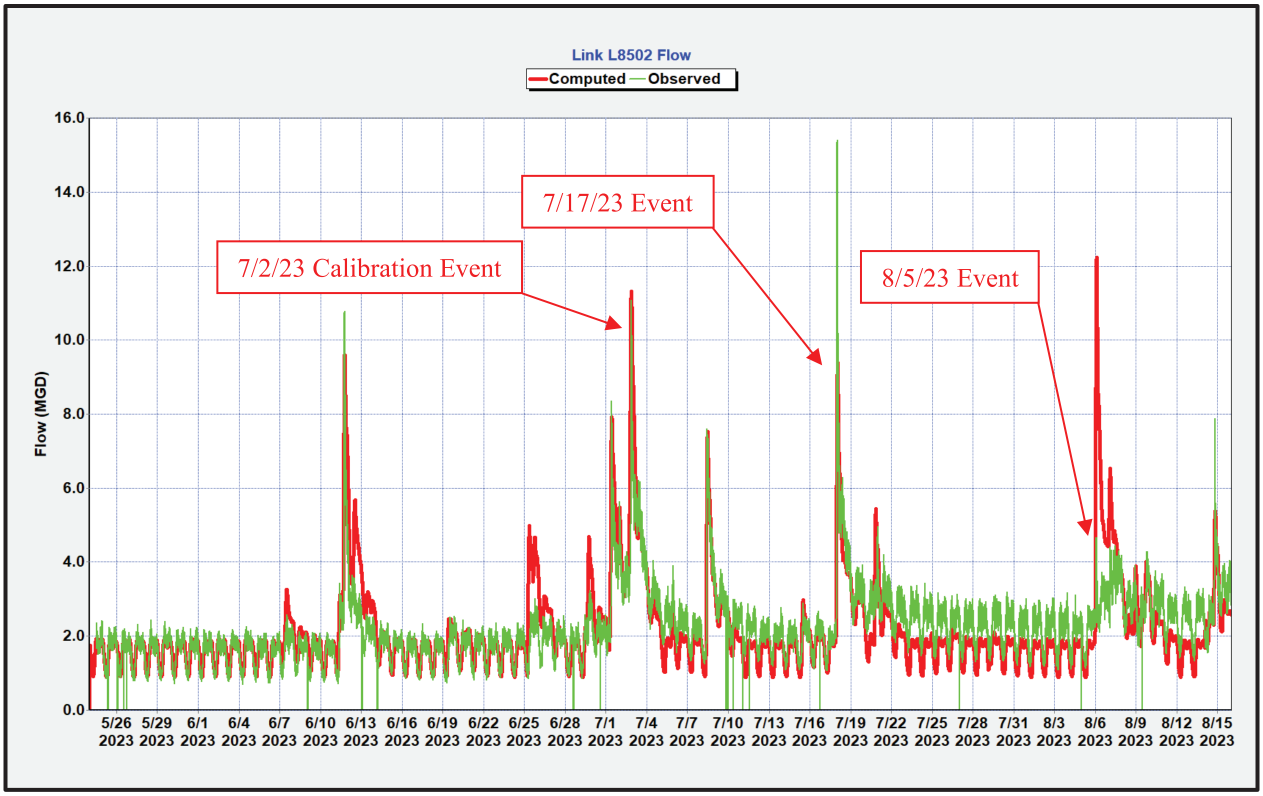


Figure 3-1: Wet Weather Calibration Spatial Variation

It is assumed that spatial variation of the storm caused these observed differences. Daily rainfall totals for three (3) rain gauges located in the City were gathered from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) site as shown in **Table 3-1**. **Figure 3-2** shows the location of the NOAA sites and the rain gauge deployed as part of this study. As detailed in **Table 3-1**, the study's rain gauge at Dillman WWTP recorded significantly less rain for the July 17, 2023 event and significantly more rain for the August 5, 2023 event compared to the NOAA gauges. This data suggests that more rain fell in the Dillman WWTP Basin than was recorded by the Dillman WWTP rain gauge for the July 17, 2023 event. Similarly, the data suggests a significant portion of the August 5, 2023 event missed the Dillman WWTP Basin.

Table 3-1
Study and NOAA Rain Gauge Storm Comparison

Station Name	7/17/23 Wet Weather Event	8/5/23 Wet Weather Event
Dillman WWTP RG	1.29	2.59
1.3 SE	2.42	1.57
2.7 E	2.65	1.41
Indiana University	2.06	Data Not Recorded

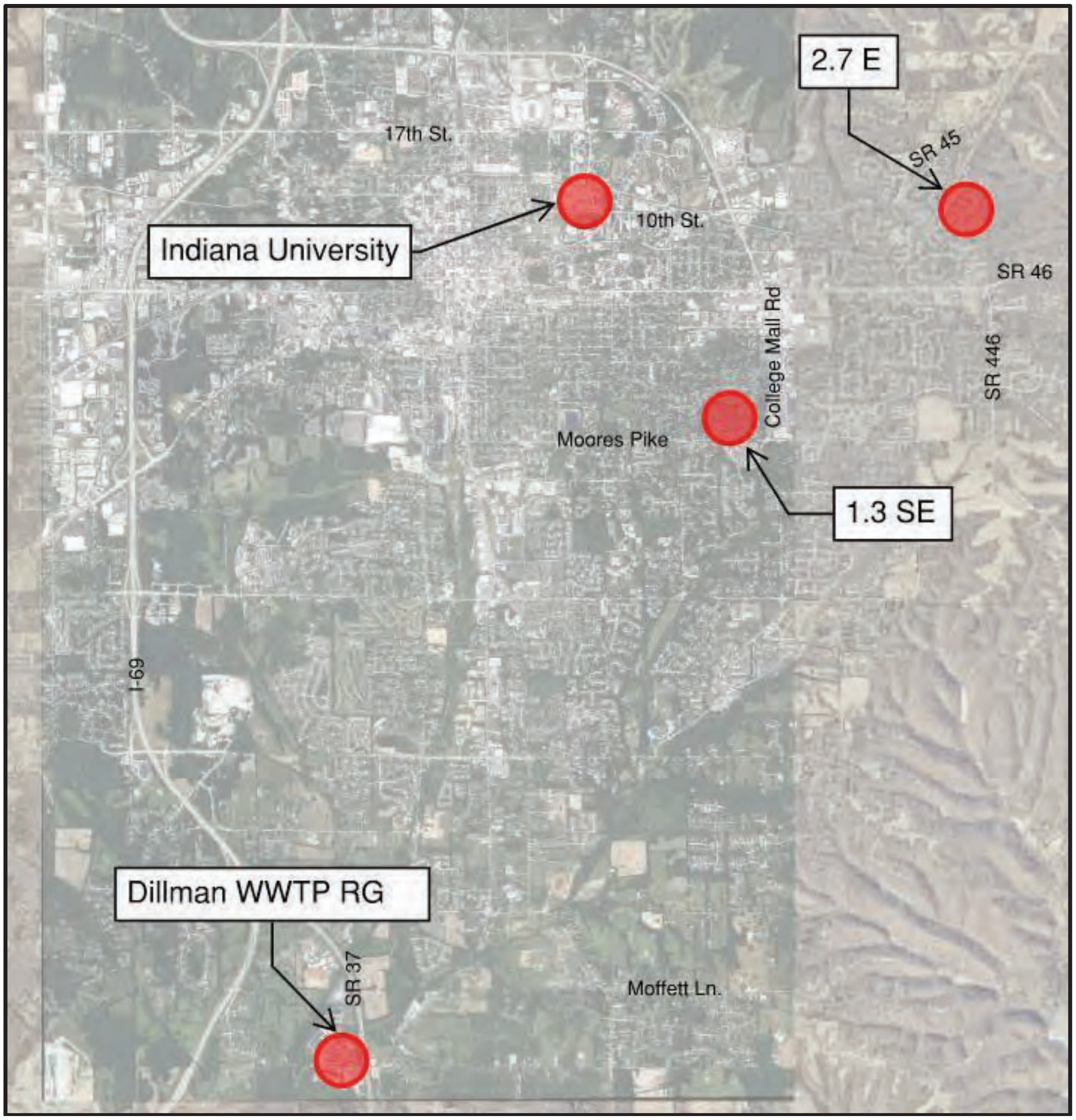


Figure 3-2: Study and NOAA Rain Gauge Locations

During the calibration, it was determined that restrictions are likely present downstream of MH 8391. This determination is based on observed depths in MH 8391 during the metering period. As shown in **Figure 3-3**, the depth generated in the model in MH 8391 was lower than the metered data. Since the flow at the structure is well calibrated, this suggests that potential downstream restrictions may have existed during the flow monitoring period.

Restrictions were systematically introduced via reducing the cross-sectional area of the sewer between MH 8390 and MH 8391 by sixty-six (66) percent. As shown in **Figure 3-4**, the depth generated in the model with added restrictions matched the metered data. It is advised that the City confirm this restriction and clean or repair this section of pipe.

The entire metering period was selected as the wet weather validation span. For the wet weather validation model run, the established RTK unit hydrographs from the preceding calibration were not altered in the model. **Attachment 3** contains the graphical comparison of the modeled flow and depth data with the gauged metering for the selected calibration and validation spans. As shown in **Attachment 3**, the model is adequately calibrated and validated and is suitable for preliminary engineering purposes.

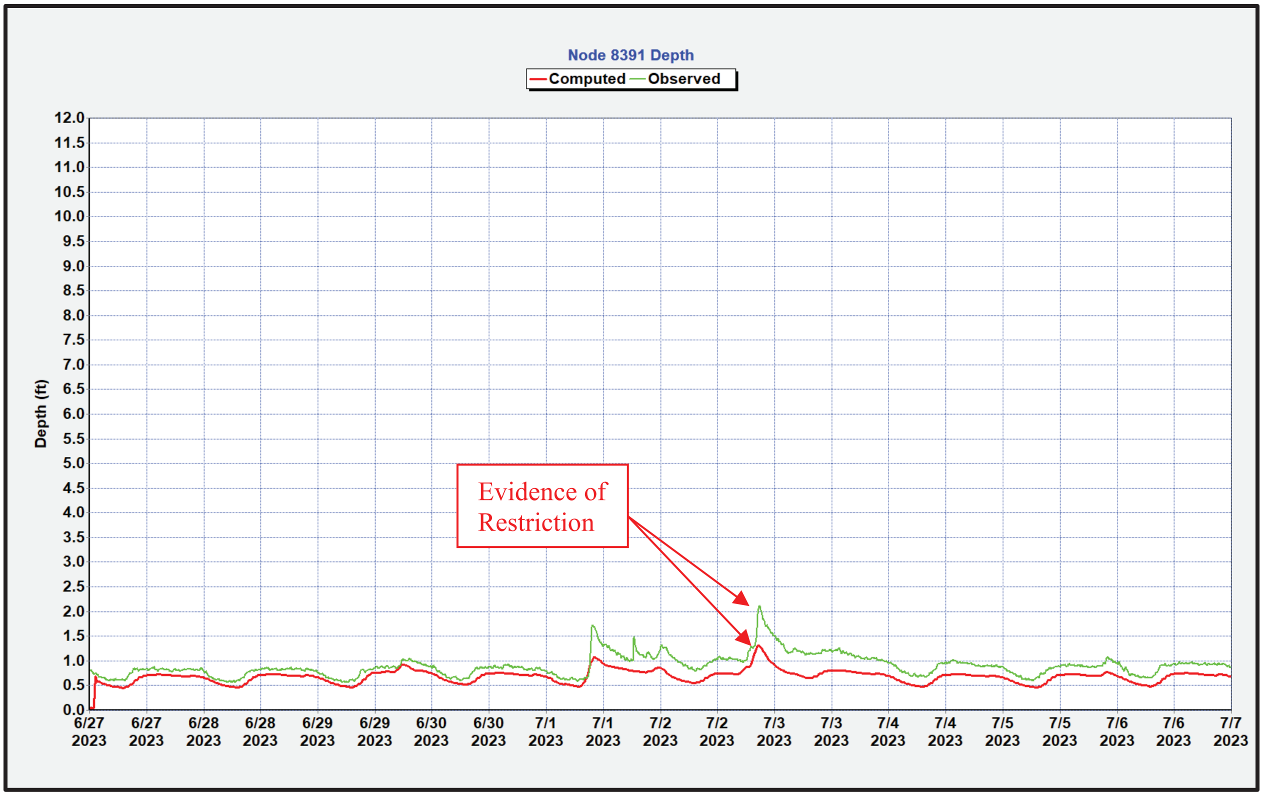


Figure 3-3: Meter MH 8391 Depth Without Restrictions Added

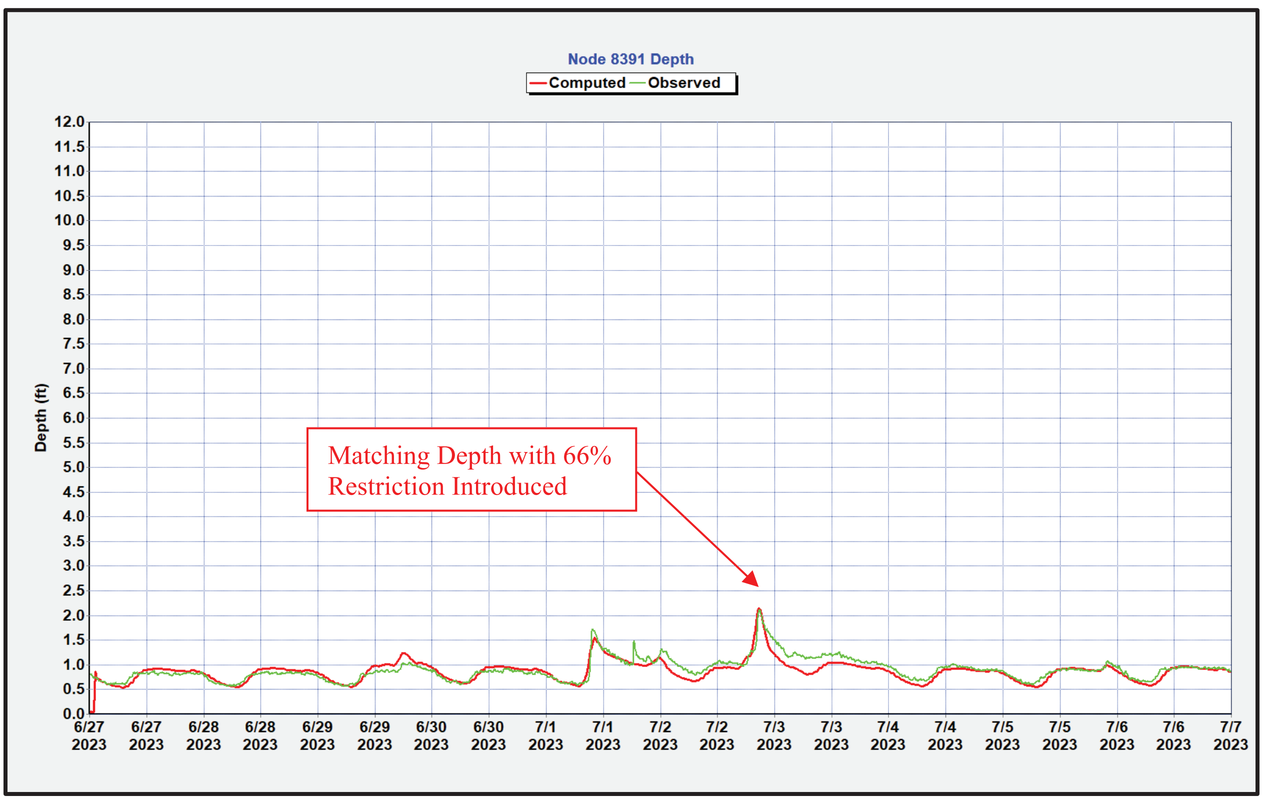


Figure 3-4: Meter MH 8391 Depth With Restrictions Added

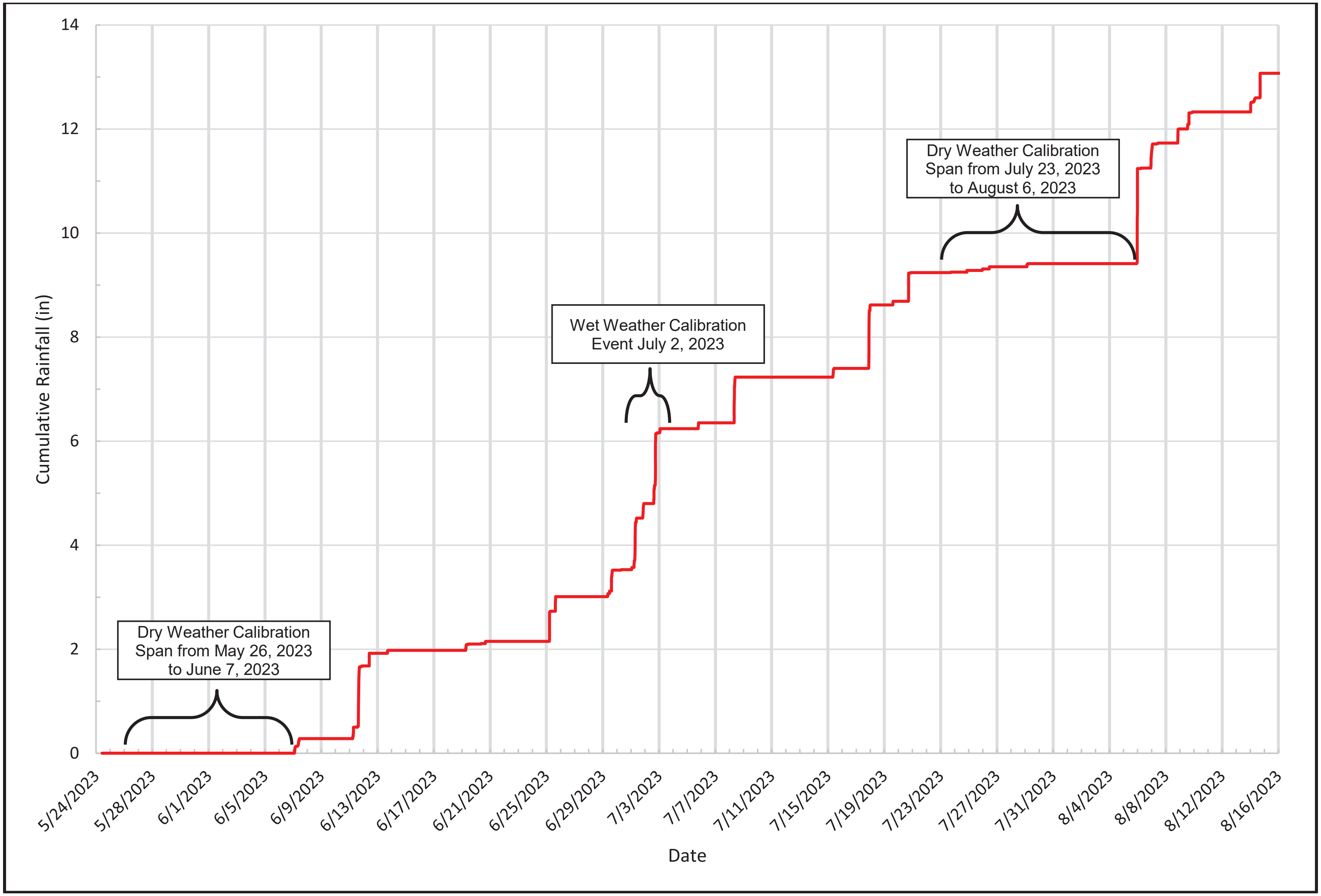


Figure 3-5: Cumulative Rainfall at Dillman WWTP

3.3 Dry Weather Flow Adjustment

Upon completion of dry weather and wet weather calibration and validation, it was observed that the dry weather flow for the metering period was lower than the yearly average dry weather flow into the Dillman WWTP. Monthly Operating Reports (MRO) from January 2021 through July 2023 were reviewed. Wet weather was omitted from the monthly average data as presented in **Figure 3-6**. It appears that beginning in April 2022, the dry weather flow is lower historic averages. The average dry weather flow from April 2022 through July 2023 was approximately ten (10) MGD. Based on discussions with CBU, it was determined that the modeled dry weather be artificially increased to match the average yearly dry weather flow into the WWTP. The dry weather flow reaching the WWTP in the model was increased to ten (10) MGD by equally distributing the additional flow across the model nodes.

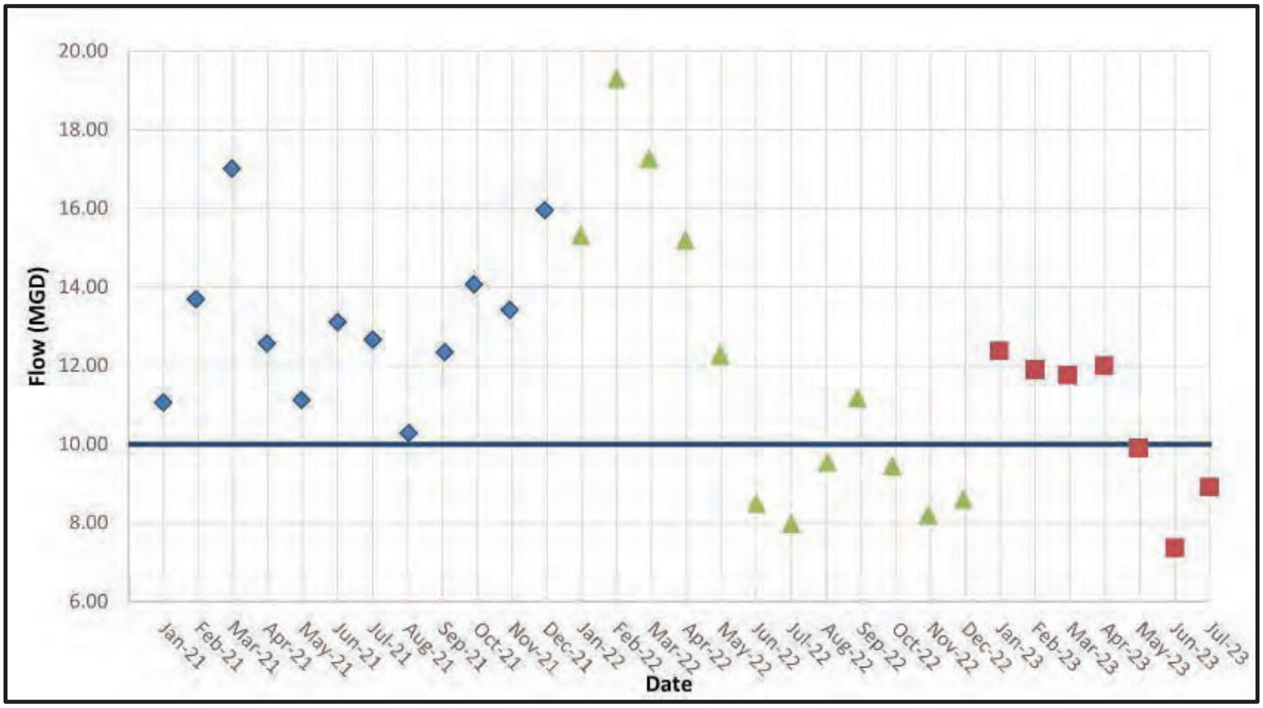


Figure 3-6: Average Monthly DWF into Dillman WWTP

4.0 Baseline Hydraulic Assessment

Upon completing the dry and wet weather calibration and validation of the West Interceptor, the existing system collection system model was analyzed using the ten (10) year, twenty-five (25) year, and fifty (50) year design storms (i.e. one (1) hour and twenty-four (24) hour storms) with the goal of identifying trouble spots in the collection system. **Table 4-1** contains a summary of design storms used during the baseline assessment; these design storms were created using the *Rainfall Frequency Atlas of the Midwest - Bulletin 71*. It is assumed the restrictions described in **Section 3.2** will be corrected and were therefore removed from the baseline assessment. **Figures 4-1 and 4-2** depict the hydraulic grade line (HGL) in the Dillman WWTP West Interceptor for the fifty (50) year, one (1) hour design storm. The HGL for the ten (10) year, and twenty-five (25) year, one (1) hour design storms are shown in **Attachment 4**.

As shown in **Figure 4-2**, the peak flow into the Dillman WWTP results in the sewer backing up. However, it should be noted that the interceptor is unable to convey the flow regardless of the WWTP capacity. **Figure 4-3** depicts the HGL in the downstream West Interceptor for the design storm with a free outfall replacing the WWTP. The portion of the West Interceptor downstream of the confluence with the Central Interceptor and East Interceptor is unable to convey the total flow from all three (3) interceptors.

Figure 4-4 illustrates the peak depth of flow and potential flooding locations for the fifty (50) year, one (1) hour design storm. It should be noted that the manholes on the WWTP property are bolted down and do not flood.

Table 4-1
Baseline Assessment Design Storms

Design Storm Recurrence Interval	Duration	Rainfall Depth (in)	Peak Flow at WWTP* (MGD)
10-Year	1-Hour	2.11	57.0
10-Year	24-Hour	4.49	54.1
25-Year	1-Hour	2.54	66.3
25-Year	24-Hour	5.40	63.7
50-Year	1-Hour	2.89	73.8
50-Year	24-Hour	6.15	71.8

* Assuming the collection system has the capacity to convey all flow without surcharging or SSOs occurring.

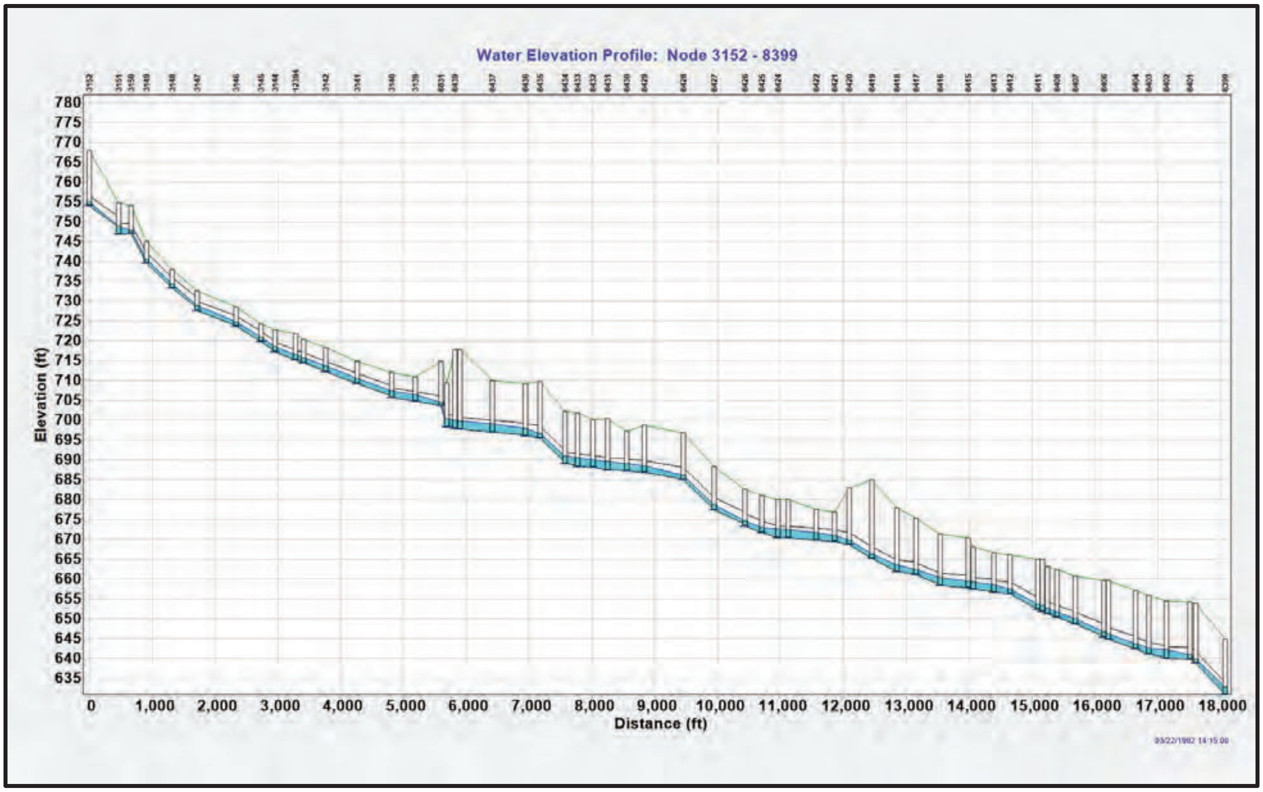


Figure 4-1: Upstream West Interceptor Hydraulic Grade Line 50-Year, 1-Hour Design Storm

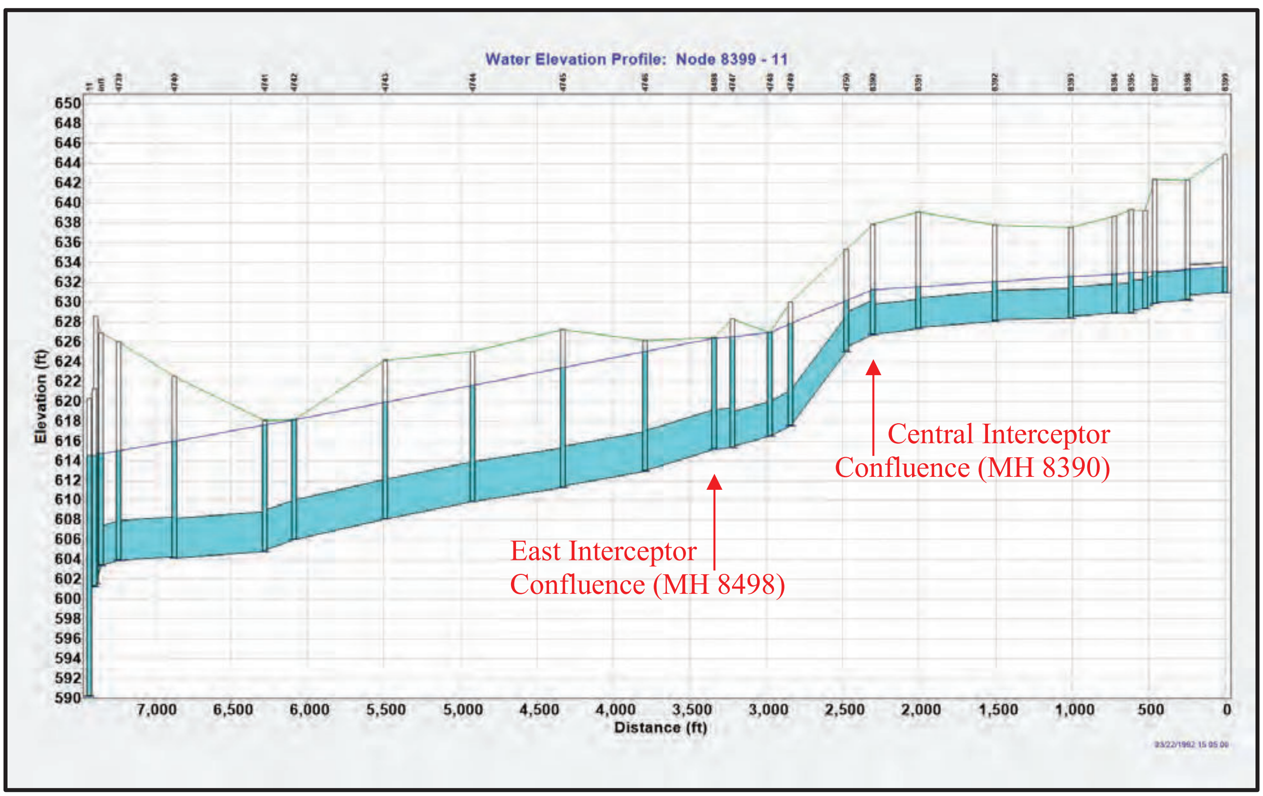


Figure 4-2: Downstream West Interceptor Hydraulic Grade Line 50-Year, 1-Hour Design Storm

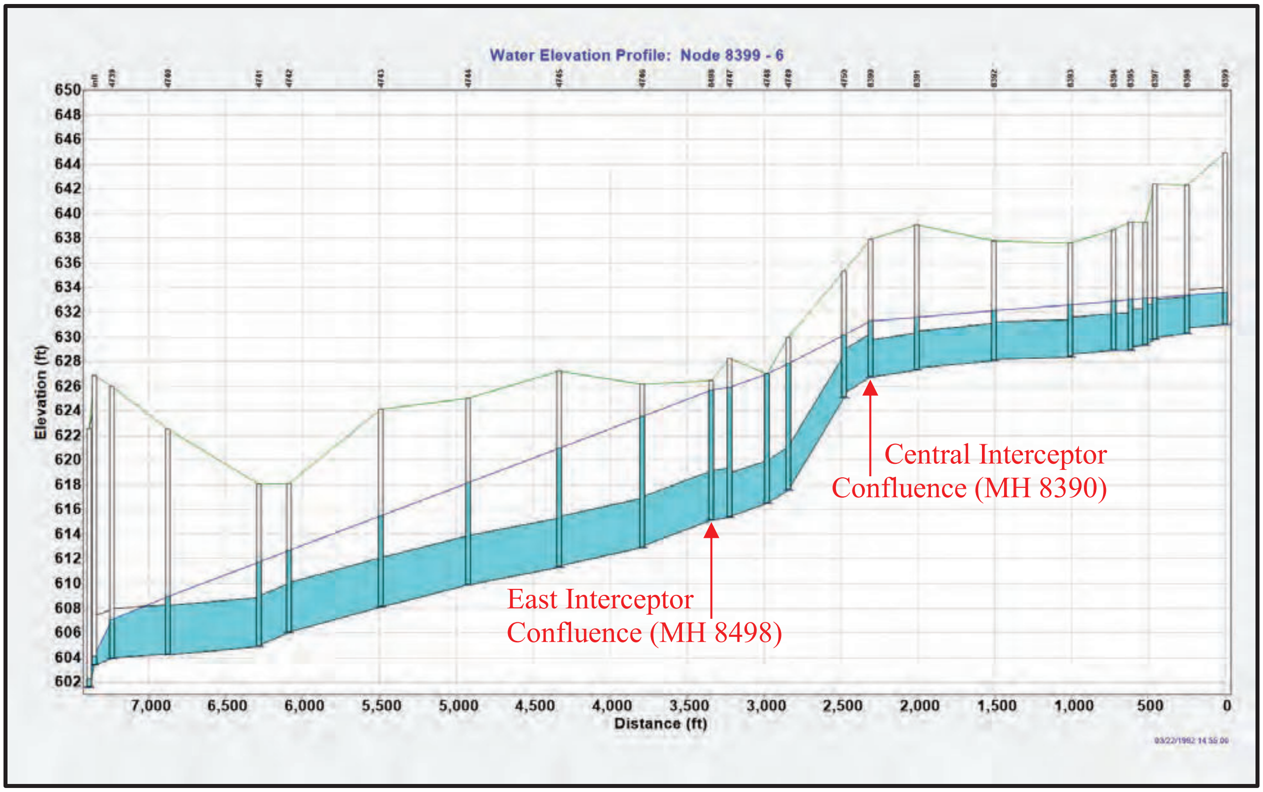


Figure 4-3: Downstream West Interceptor Hydraulic Grade Line 50-Year, 1-Hour Design Storm Without WWTP Capacity Limitations

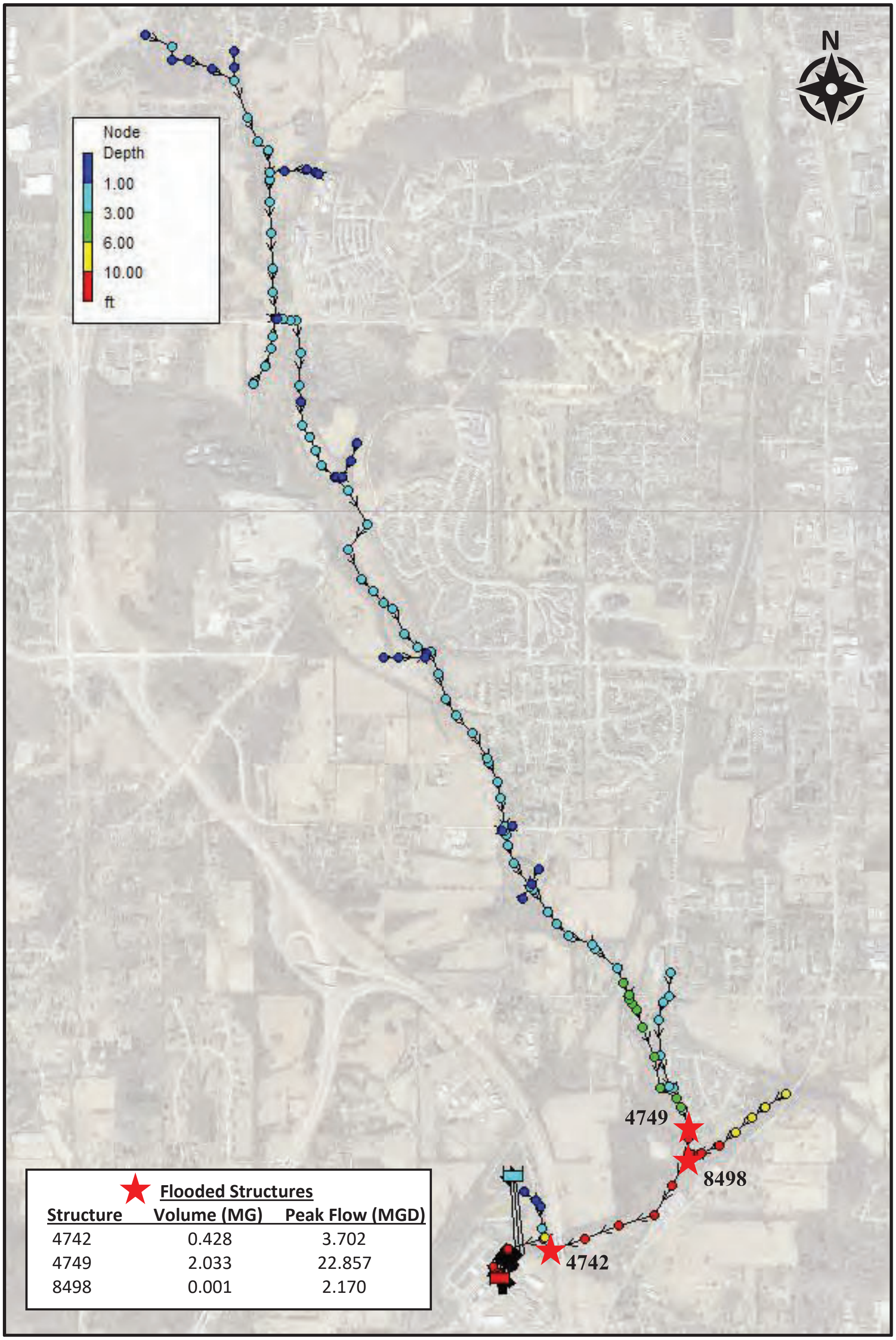


Figure 4-4: Existing System Peak Depth of Flow and Potential Flooding Locations for 50-Year 1-Hour Design Storm

5.0 Future Growth

After completing the baseline hydraulic assessment of the existing collection system, the calibrated model was adjusted to account for future growth conditions. Growth at four (4) locations is expected in the West Interceptor Basin based on discussions with CBU. These anticipated areas of growth for the future build-out conditions are shown in **Figure 5-1**. Approved wastewater flows within the central and eastern interceptor basins were also identified by CBU. **Table 5-1** displays the future flows associated with each growth area. Wet weather response for typical new sanitary construction was estimated using a peaking factor of four (4), and the RDII unit hydrograph values are summarized in **Table 5-2**. Following the addition of future growth, the model can be utilized as a planning-level tool to assess alternative solutions.

Table 5-1
Future Growth Design Flows

Area	Dry Weather Flow (MGD)
Summit District	1.32
NE Fullerton/I-69	1.66
4691 S Victor Pike	0.22
Westgate on 3rd	0.08
Central Interceptor Basin	0.15
East Interceptor Basin	0.23

Table 5-2
Future Growth Weather RDII Characteristics

Response	R[1]	T[2]	K[3]
Short Term	0.005	2	2
Medium-Term	0.009	4	5
Long-Term	0.03	10	10

[1]*R = fraction of rainfall that becomes I&I.*
[2]*T = time of hydrograph peak (hr).*
[3]*K = falling limb duration / rising limb duration. (dimensionless).*

The Summit District development is of key interest. The percentage of Summit District's dry weather flow to total future dry weather flow at several locations was calculated and is detailed in **Table 5-3**. The locations of measurement are shown on **Figure 5-1**. An example calculation for location A is shown below.

Summit District Percentage = Summit District Dry Weather / Total Future Dry Weather

= 1.32 MGD / 13.7 MGD = 9.6%

Table 5-3
Summit District's Dry Weather Flow Percentage

Location	Basins Serviced	Dry Weather Flow (MGD)	Summit District's Percentage
A	West + Central + East	13.7	9.7%
B	West + Central	11.5	11.5%
C	West	6.0	22.0%

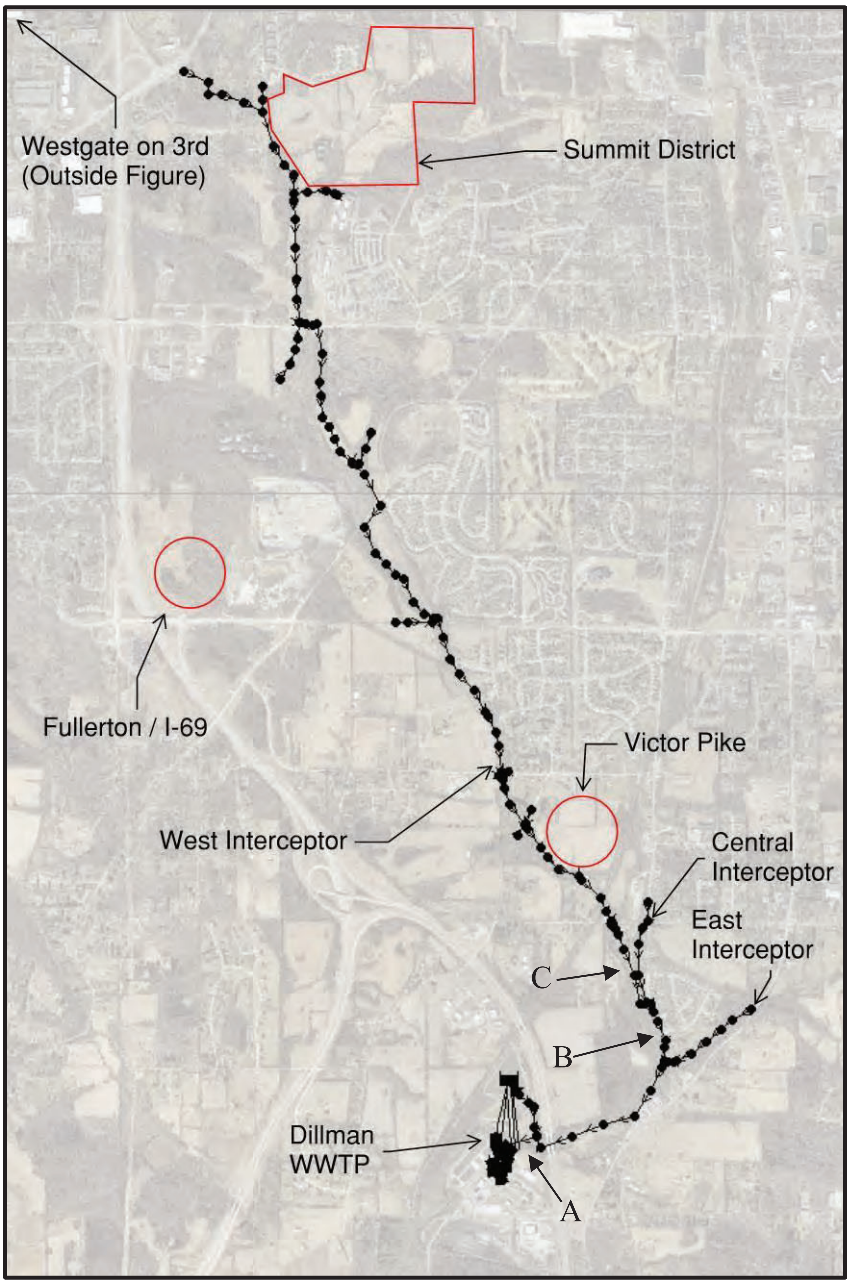


Figure 5-1: Potential Growth Areas

6.0 Alternative Analysis

Alternative solutions to eliminate potential sanitary sewer overflows occurring within the collection system under future growth conditions were developed for the fifty (50) year design storm. The following performance criteria were used when identifying and assessing alternative solutions for the Dillman WWTP West Interceptor:

- Eliminate potential sanitary sewer overflows for the 50-year design storm.
- Achieve eight (8) feet of freeboard between the ground elevation and the maximum hydraulic grade line (HGL) in the collection system. If eight (8) feet of freeboard was not available, the HGL must be lower than the crown of the pipe.
- Firm (design) lift station pumping rate shall meet or exceed the peak inflow to each lift station.

The eight (8) feet of freeboard requirement is set to protect homes from wastewater backing up into basements. However, the downstream portion of the interceptor is on the WWTP property and does not have any lateral connections to homes or businesses. Solutions with a relief sewer at the downstream portion of the system were allowed to have a minimum freeboard of six (6) feet in the existing pipe on the WWTP property.

Three (3) alternatives were developed to eliminate the potential sanitary sewer overflows and maximize the performance of the collection system. It should be noted that the alternatives do not account for future growth outside of what is stated in **Section 5.0**.

Under future growth conditions assuming no conveyance limitations, eighty-nine (89) MGD reaches the WWTP for the design storm. This exceeds the pumping capacity at the WWTP influent pump station by fourteen (14) MGD resulting in the collection system backing up. As described in **Section 4.0** and illustrated in **Figure 4-2**, the downstream interceptor is unable to convey the existing or future design storm flows regardless of the pumping capacity at the WWTP. The alternative solutions must address both of these issues.

Additionally, a section of interceptor north of Tapp Rd. is unable to convey the flow for the future growth conditions design storm and results in a freeboard of less than three (3) feet. This requires a section of pipe to be upsized. This solution is included in all alternatives and shown in **Figure 6-1**. The three (3) alternative figures for the downstream improvements are shown in **Figures 6-2, 6-3, and 6-4**. Cost estimates for each alternative are included in **Attachment 5**. Peak hydraulic grade lines for the fifty (50) year, one (1) hour design storm through each alternative are provided in **Attachment 6**.

The following describes each alternative solution to the fifty (50) year design storm. The gravity alternatives are separated into sections based on location in the system. These sections correspond to the flows in **Table 5-3**. Costs for each section and total cost are provided below.

- ***Alternative 1*** includes diversion structures at MH 8397 and MH 4756 to divert wet weather to a lift station located near W Church Lane. Both structures include plates to control flow in the existing downstream interceptors and divert more toward the lift station. The lift station will pump to the existing EQ basin. The force main alignment is proposed to follow the Limestone Greenway, which was constructed in 2019.

  Improvements considered in this alternative include:

  Lift Station Improvements
  - 36 MGD Lift Station
  - 2 Diversion Structures with Flow Control
  - 3,450-FT of 36-inch Dia. Force Main

- 460-FT of 42-inch Dia. Sanitary Sewer Replacement
- 200-FT of 36-inch Dia. Sanitary Sewer
- 600-FT of 30-inch Dia. Sanitary Sewer
- 415-FT of 36-inch Dia. Sanitary Sewer Replacement

Total: $59,937,000

- ***Alternative 2*** includes a diversion structure at MH 8397 to overflow wet weather into a relief sewer. The relief sewer travels parallel to the existing West Interceptor. At two additional locations, diversion structures divert flow from the main interceptor to the wet weather relief sewer. A new wet weather lift station on the WWTP property will accept flows in excess of the capacity of the influent pump station. The lift station will pump to the EQ basin. Challenges of this alternative include fitting the new gravity sewer on WWTP property dealing with other pipes and utilities. Additionally, this alternative requires a large diameter gravity sewer underneath I-69.

  Improvements considered in this alternative include:

  WWTP Improvements: $23,229,000
  - 14 MGD Lift Station
  - 2,100-FT of 24-inch Dia. Force Main

  (A) Downstream of Confluence with East Interceptor: $14,886,000
  - 1,800-FT of 54-inch Dia. Sanitary Relief Sewer
  - 2,250-FT of 48-inch Dia. Sanitary Relief Sewer
  - 1 Diversion Structure

  (B) Between Confluences with East Interceptor and Central Interceptor: $3,161,000
  - 970-FT of 42-inch Dia. Sanitary Relief Sewer
  - 1 Diversion Structure

  (C) Upstream of Confluence with Central Interceptor: $5,038,000
  - 1,830-FT of 30-inch Dia. Sanitary Relief Sewer
  - 415-FT of 36-inch Dia. Sanitary Sewer Replacement
  - 1 Diversion Structure

  Total: $46,314,000

- ***Alternative 3*** includes a diversion structure at MH 8498 diverts all dry weather flow through a new gravity sewer. When the depth in the diversion structure exceeds the maximum dry weather depth, flow overtops a weir into the existing gravity sewer. A new wet weather lift station on the WWTP property will accept flows in excess of the capacity of the influent pump station. The lift station will pump to the EQ basin. Challenges of this alternative include fitting the new gravity sewer on WWTP property dealing with other pipes and utilities. Additionally, this alternative requires a large diameter gravity sewer underneath I-69. The pipe replacement instead of a parallel sewer also requires significant bypass pumping.

  Improvements considered in this alternative include:

  WWTP Improvements: $23,229,000
  - 14 MGD Lift Station
  - 2,100-FT of 24-inch Dia. Force Main

(A) Downstream of Confluence with East Interceptor: $14,886,000

- 1,800-FT of 54-inch Dia. Sanitary Relief Sewer
- 2,250-FT of 48-inch Dia. Sanitary Relief Sewer
- 1 Diversion Structure

(B) Between Confluences with East Interceptor and Central Interceptor: $2,478,000

- 920-FT of 48-inch Dia. Sanitary Sewer Replacement

(C) Upstream of Confluence with Central Interceptor: $4,529,000

- 1,790-FT of 42-inch Dia. Sanitary Sewer Replacement
- 415-FT of 36-inch Dia. Sanitary Sewer Replacement

Total: $45,122,000

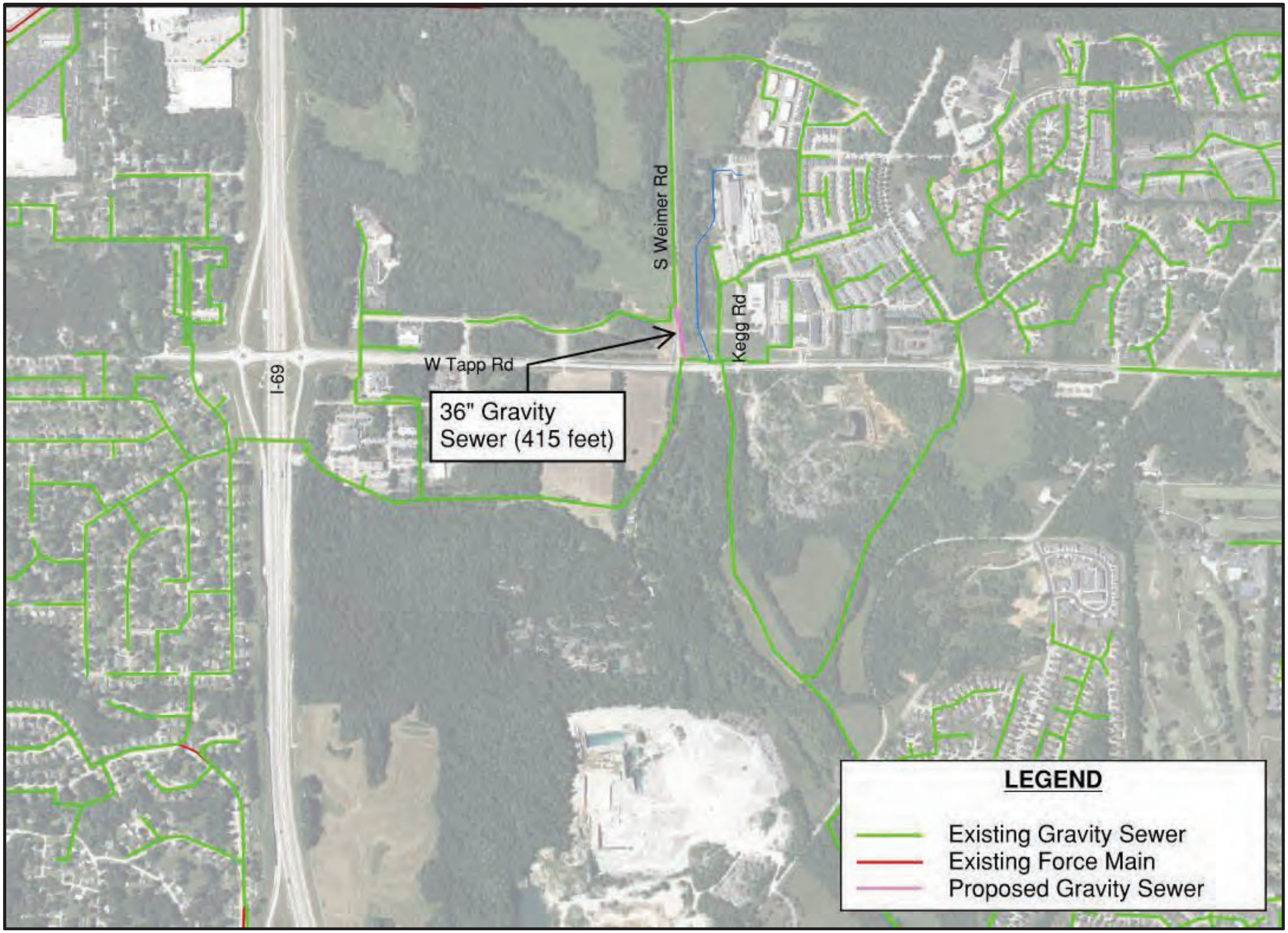


Figure 6-1: Upstream Solution for Alternatives 1, 2, and 3

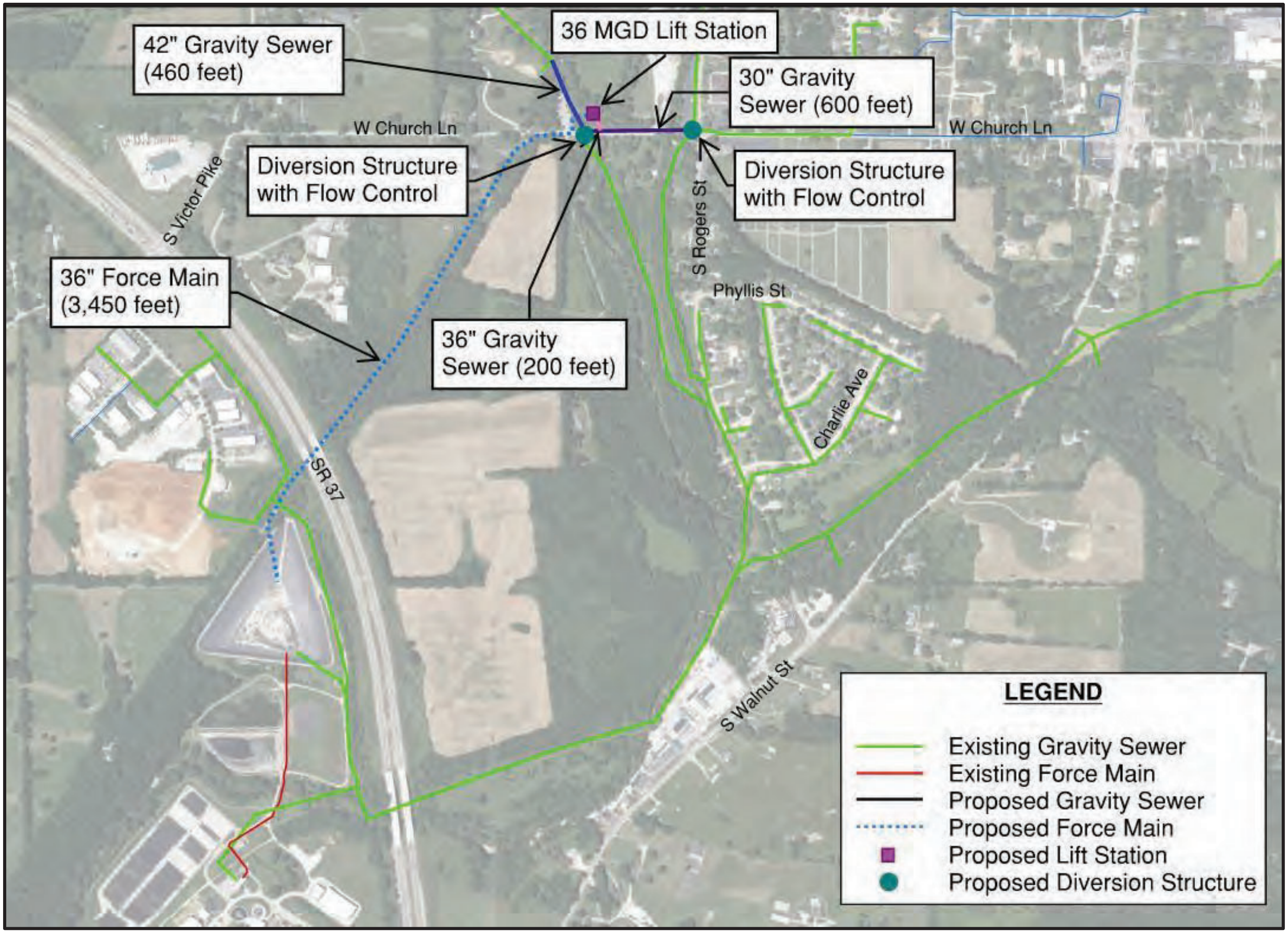


Figure 6-2: Alternative 1

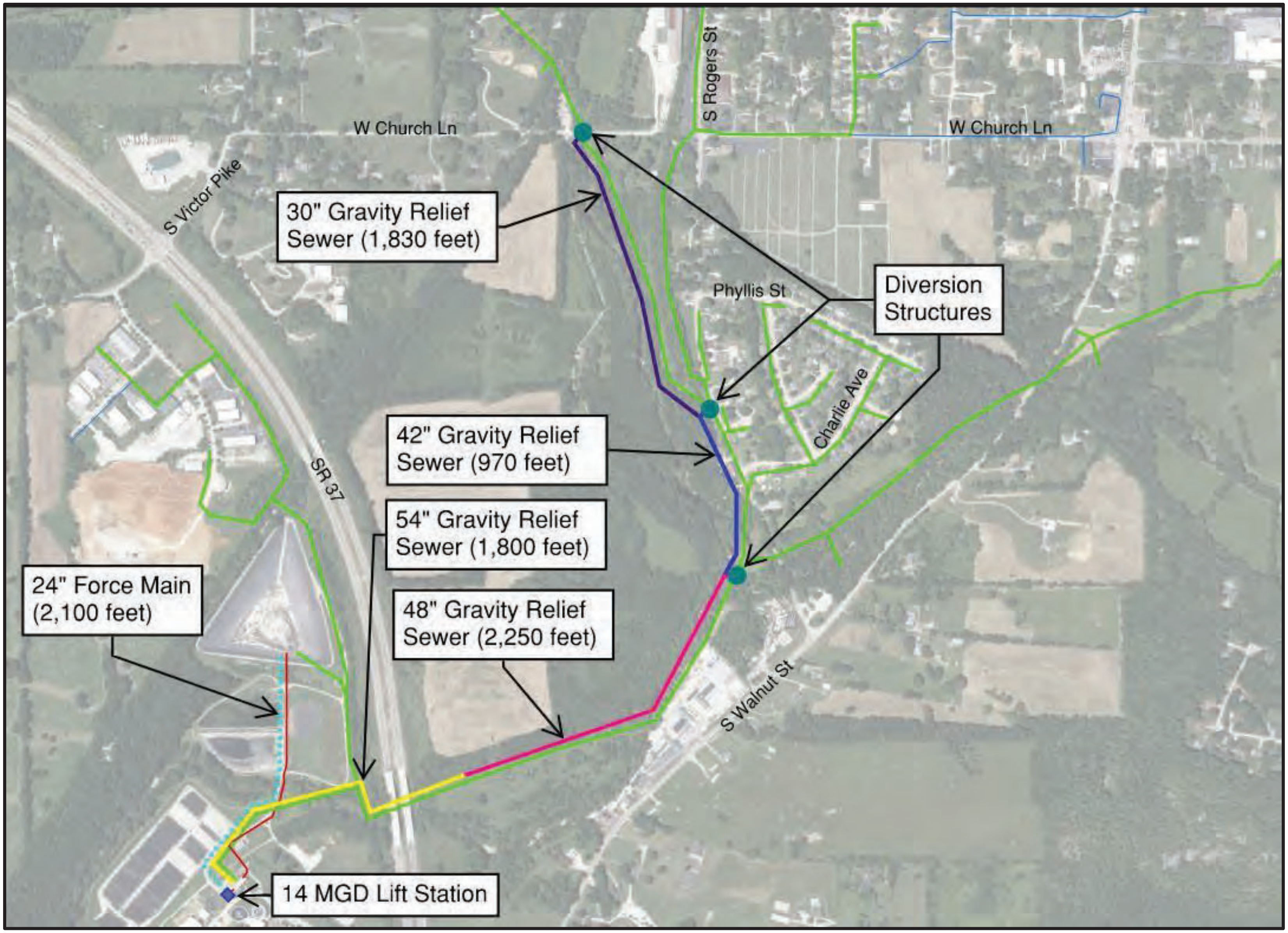


Figure 6-3: Alternative 2

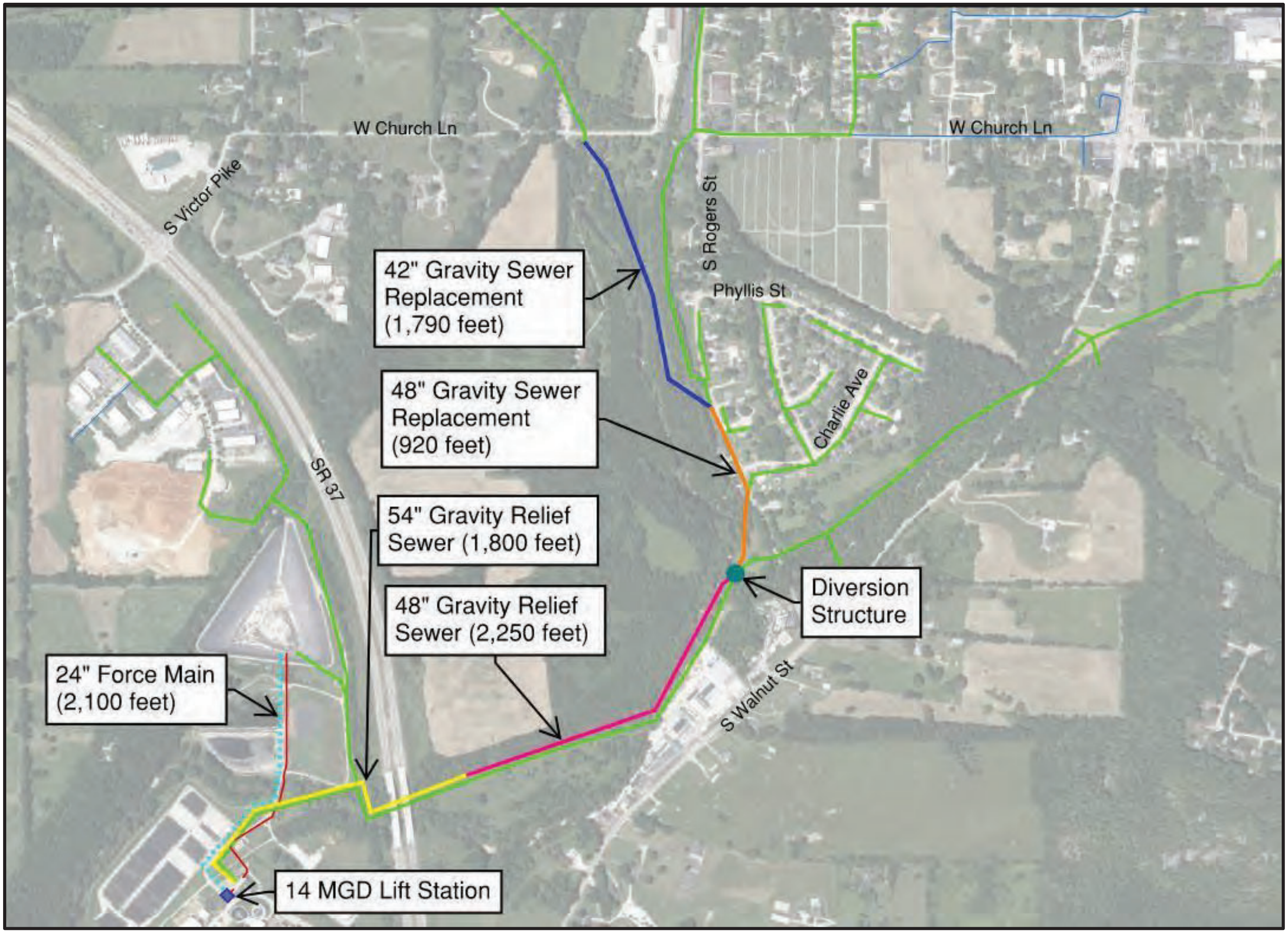


Figure 6-4: Alternative 3

Attachment 1

Rainfall Classifcation

Event #1: 6/11/2023

Duration	Rainfall (in)	Reccurence Interval
1 hr.	**0.93**	**4 - 6 Months**
2 hr.	1.13	4 - 6 Months
3 hr.	1.14	3 - 4 Months
6 hr.	1.17	2 - 3 Months
12 hr.	1.38	2 - 3 Months
18 hr.	1.40	2 - 3 Months
24 hr.	1.42	< 2 Months
48 hr.	1.64	2 - 3 Months

Event #2: 7/1/2023

Duration	Rainfall (in)	Reccurence Interval
1 hr.	0.66	< 2 Months
2 hr.	0.75	< 2 Months
3 hr.	0.87	< 2 Months
6 hr.	0.95	< 2 Months
12 hr.	0.99	< 2 Months
18 hr.	1.23	< 2 Months
24 hr.	1.27	< 2 Months
48 hr.	1.27	< 2 Months

Event #3: 7/2/2023

Duration	Rainfall (in)	Reccurence Interval
1 hr.	0.99	4 - 6 Months
2 hr.	1.04	3 - 4 Months
3 hr.	1.26	4 - 6 Months
6 hr.	1.36	3 - 4 Months
12 hr.	1.44	2 - 3 Months
18 hr.	1.44	2 - 3 Months
24 hr.	1.63	2 - 3 Months
48 hr.	2.67	6 - 9 Months

Event #4: 7/8/2023

Duration	Rainfall (in)	Reccurence Interval
1 hr.	0.74	2 - 3 Months
2 hr.	0.88	2 - 3 Months
3 hr.	0.88	< 2 Months
6 hr.	0.88	< 2 Months
12 hr.	0.88	< 2 Months
18 hr.	0.88	< 2 Months
24 hr.	0.88	< 2 Months
48 hr.	0.88	< 2 Months

Event #5: 7/17/2023

Duration	Rainfall (in)	Reccurence Interval
1 hr.	1.10	6 - 9 Months
2 hr.	1.11	4 - 6 Months
3 hr.	1.21	4 - 6 Months
6 hr.	1.22	2 - 3 Months
12 hr.	1.22	< 2 Months
18 hr.	1.22	< 2 Months
24 hr.	1.22	< 2 Months
48 hr.	1.29	< 2 Months

Event #6: 8/5/2023

Duration	Rainfall (in)	Reccurence Interval
1 hr.	1.66	2 - 5 Years
2 hr.	1.66	1 - 2 Years
3 hr.	1.66	9 Months – 1 Year
6 hr.	1.67	6 - 9 Months
12 hr.	1.67	4 - 6 Months
18 hr.	1.67	3 - 4 Months
24 hr.	2.00	4 - 6 Months
48 hr.	2.15	4 - 6 Months

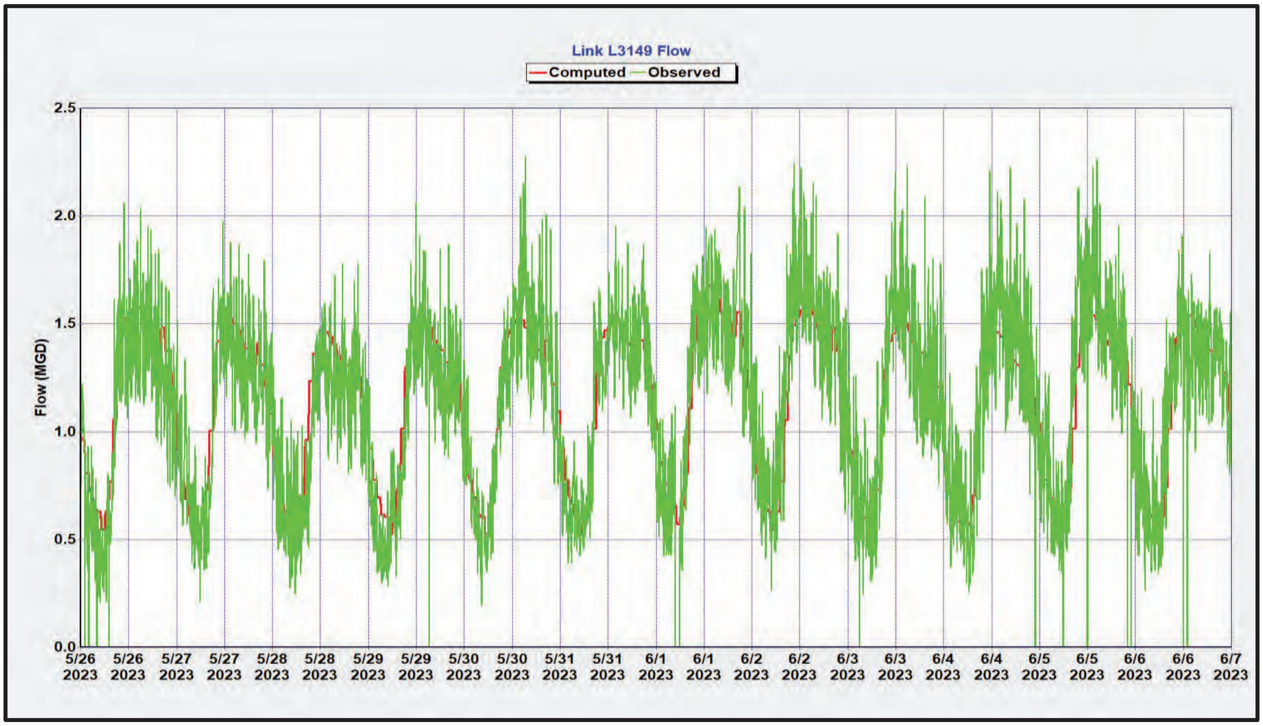
Attachment 2

Dry Weather Calibration & Validation Figures

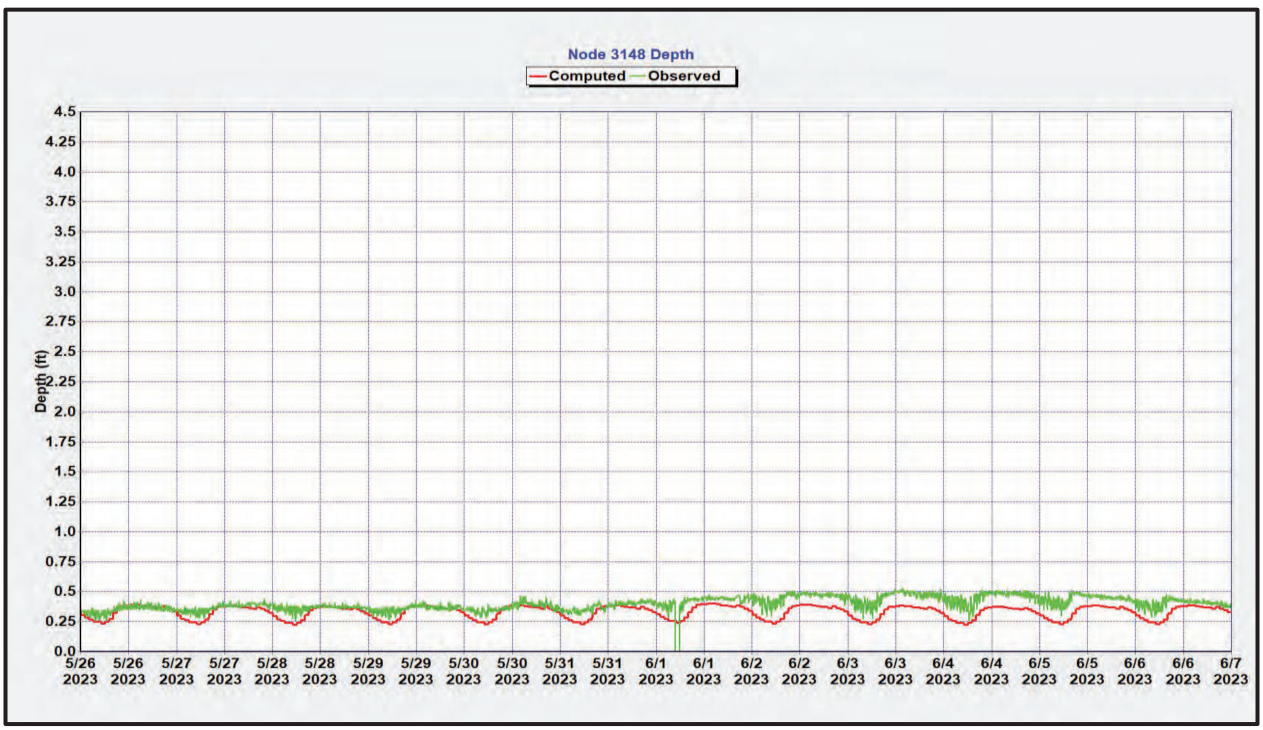
Dry Weather Calibration Period

May 26, 2023 – June 7, 2023

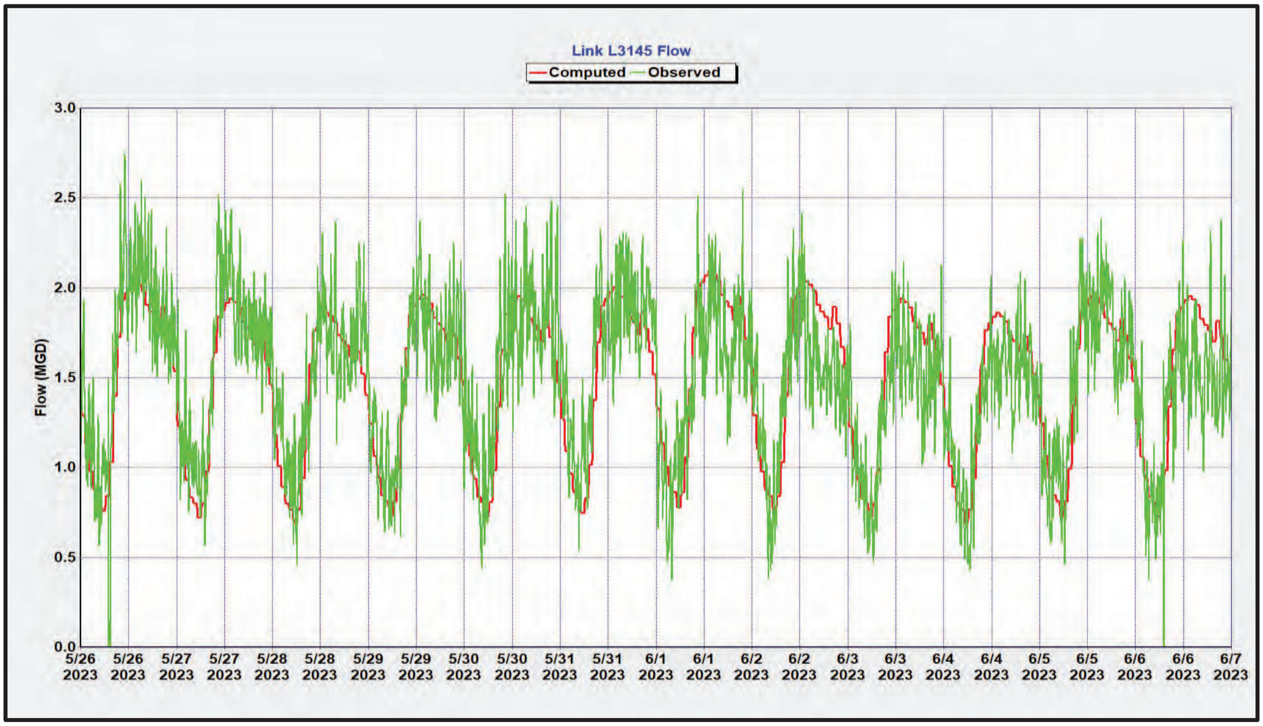
MH 3148 - 30-inch Influent: Flow (MGD)



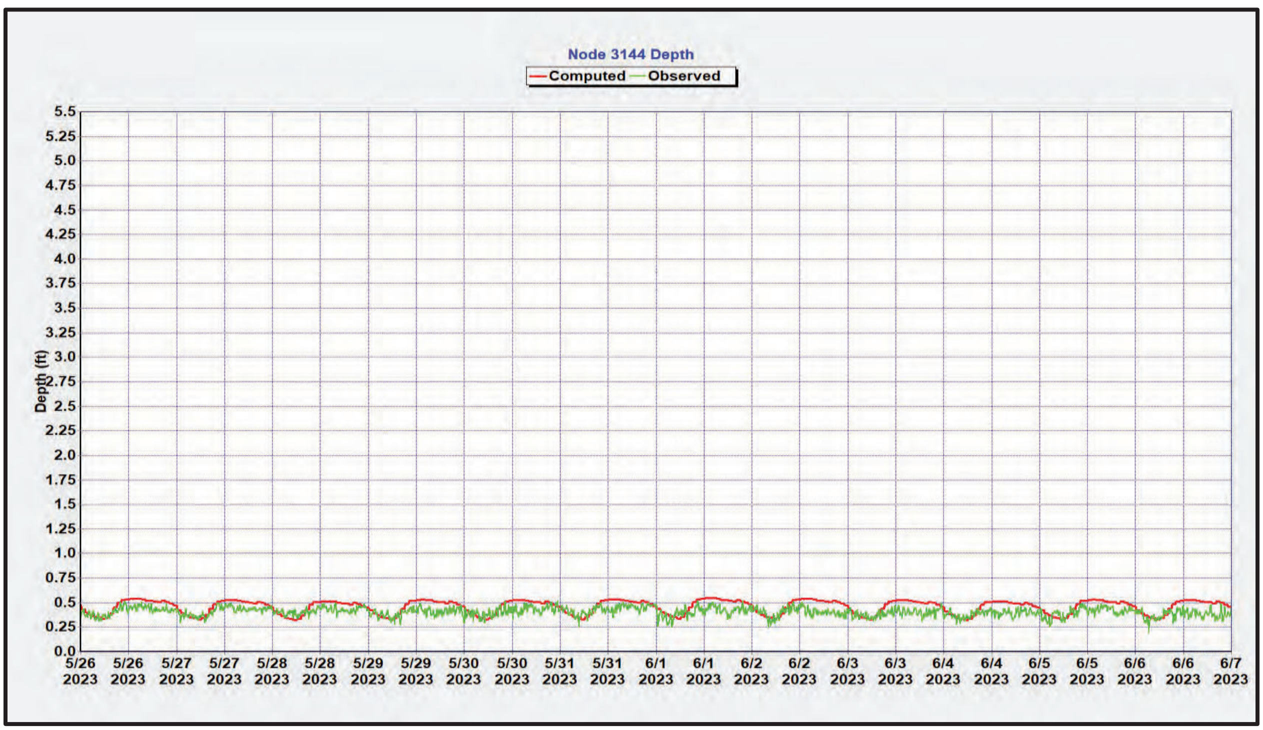
MH 3148 - 30-inch Influent: Depth (ft)



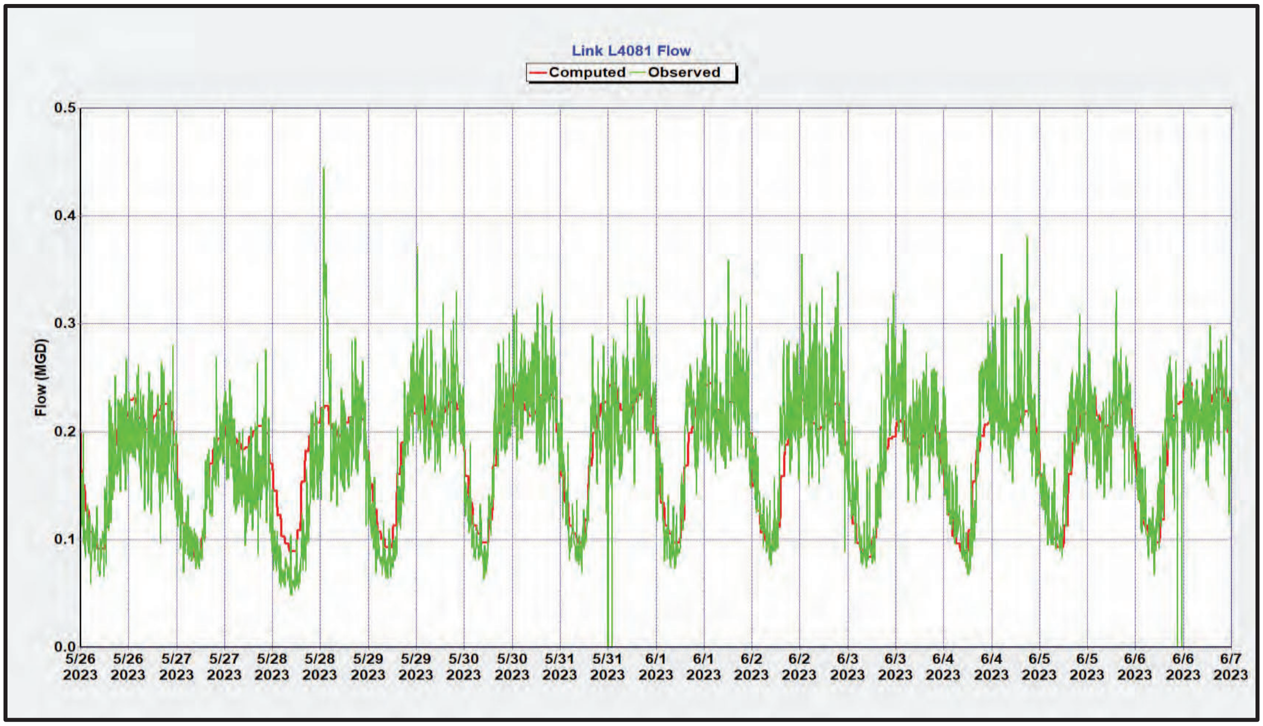
MH 3144 - 30-inch Influent: Flow (MGD)



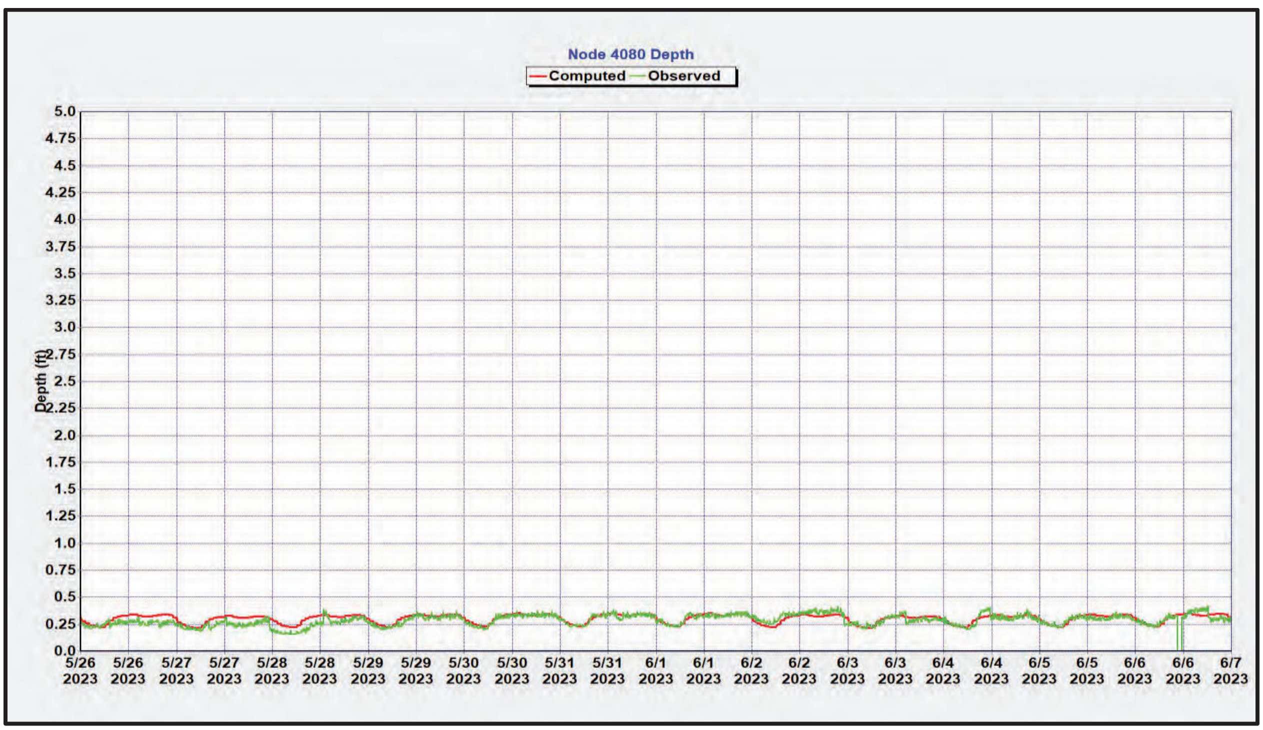
MH 3144 - 30-inch Influent: Depth (ft)



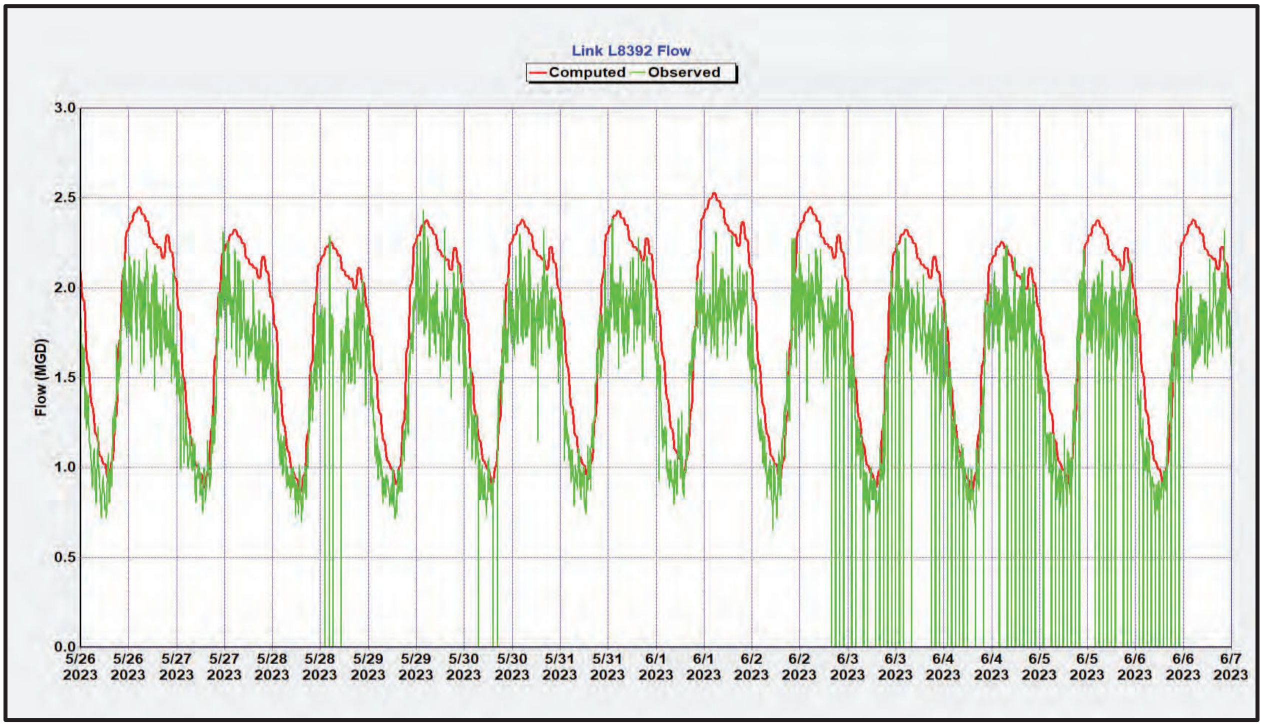
MH 4080 - 15-inch Influent: Flow (MGD)



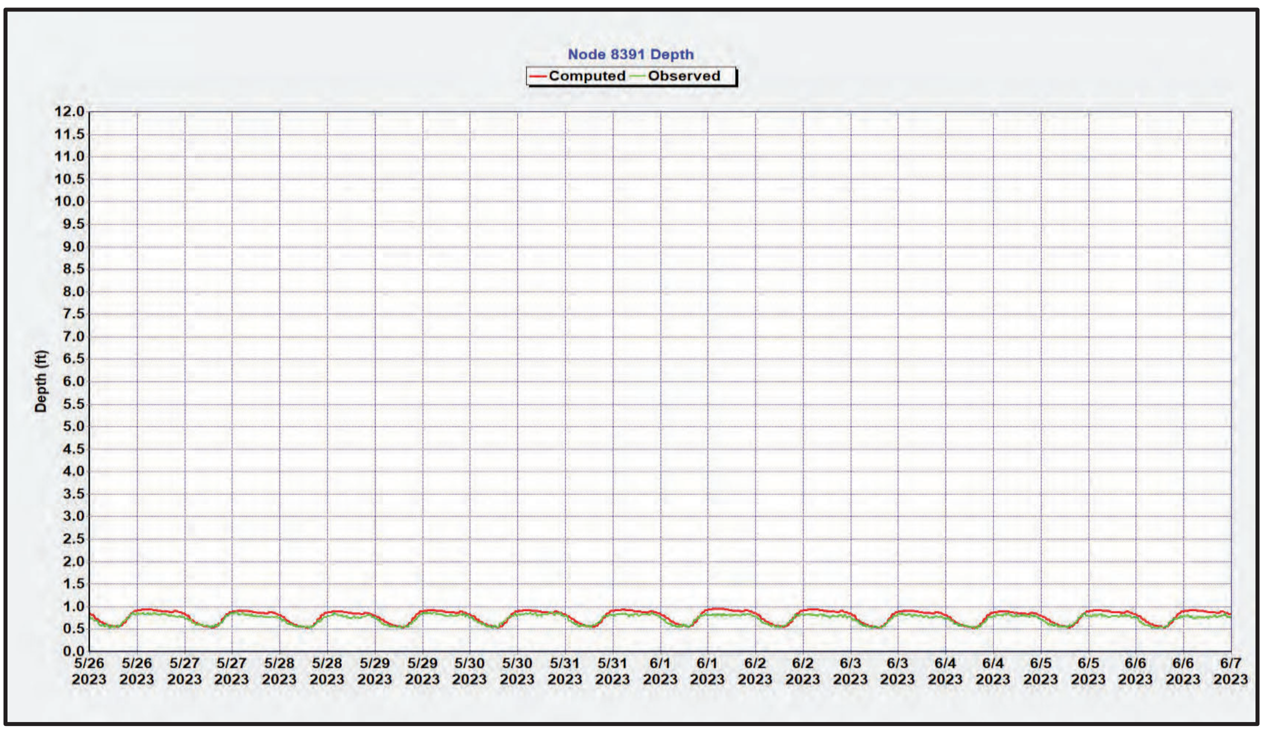
MH 4080 - 15-inch Influent: Depth (ft)



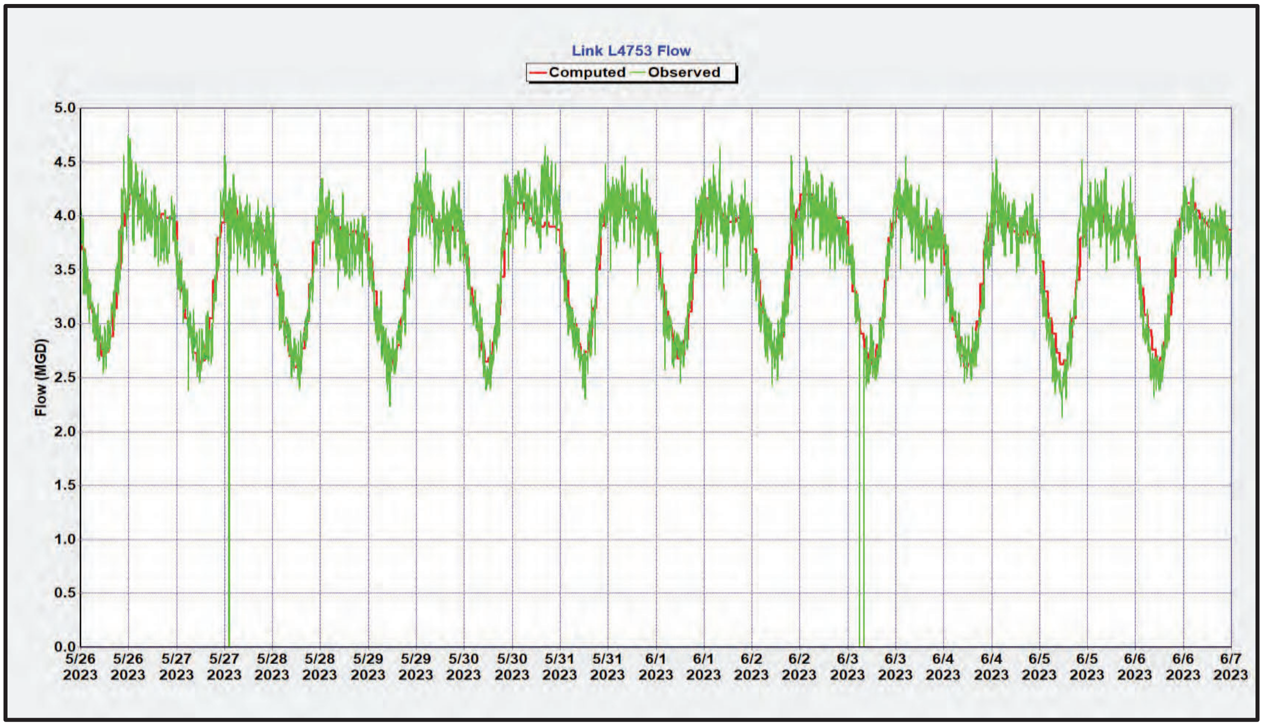
MH 8391 - 36-inch Influent: Flow (MGD)



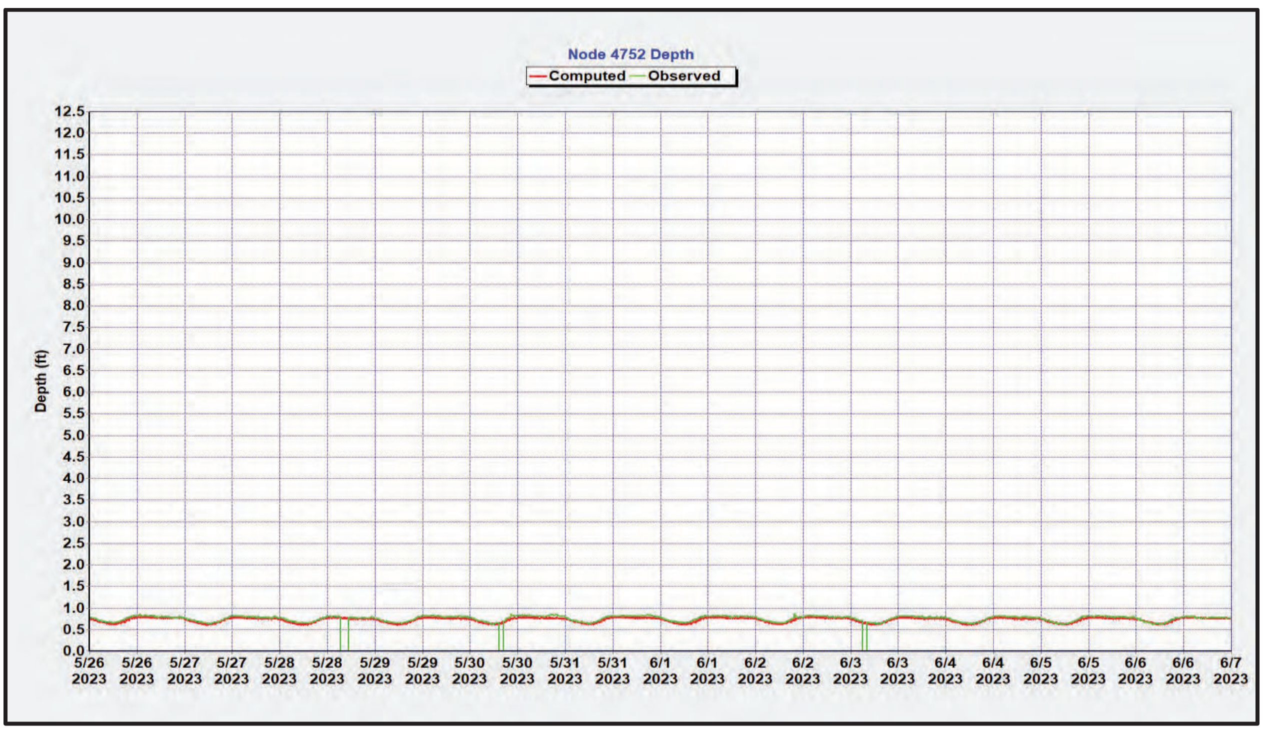
MH 8391 - 36-inch Influent: Depth (ft)



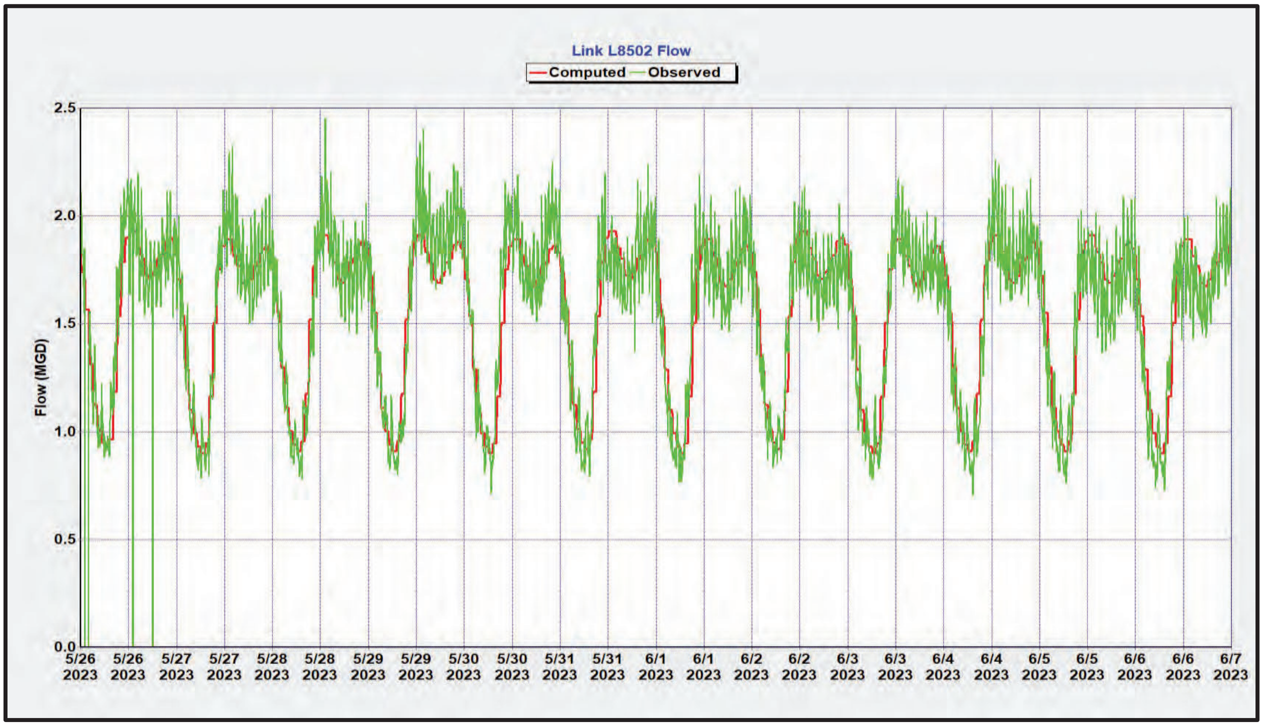
MH 4752 - 42-inch Influent: Flow (MGD)



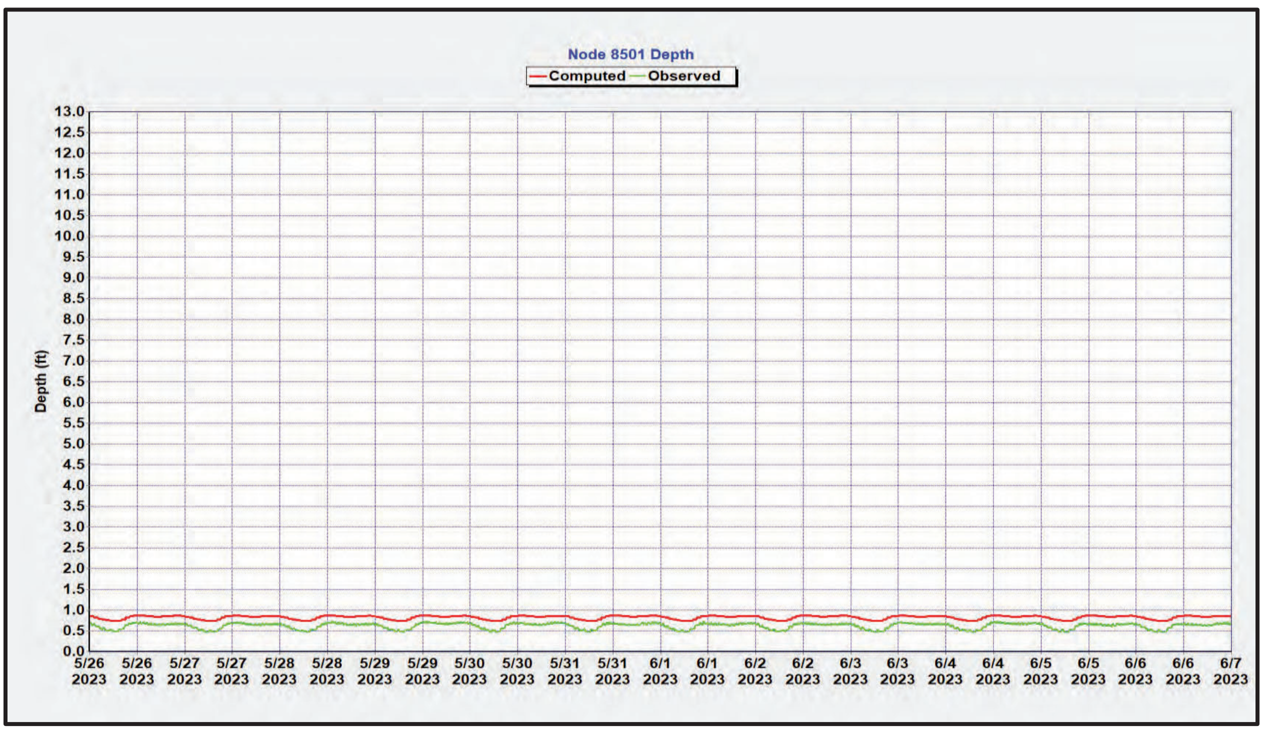
MH 4752 - 42-inch Influent: Depth (ft)



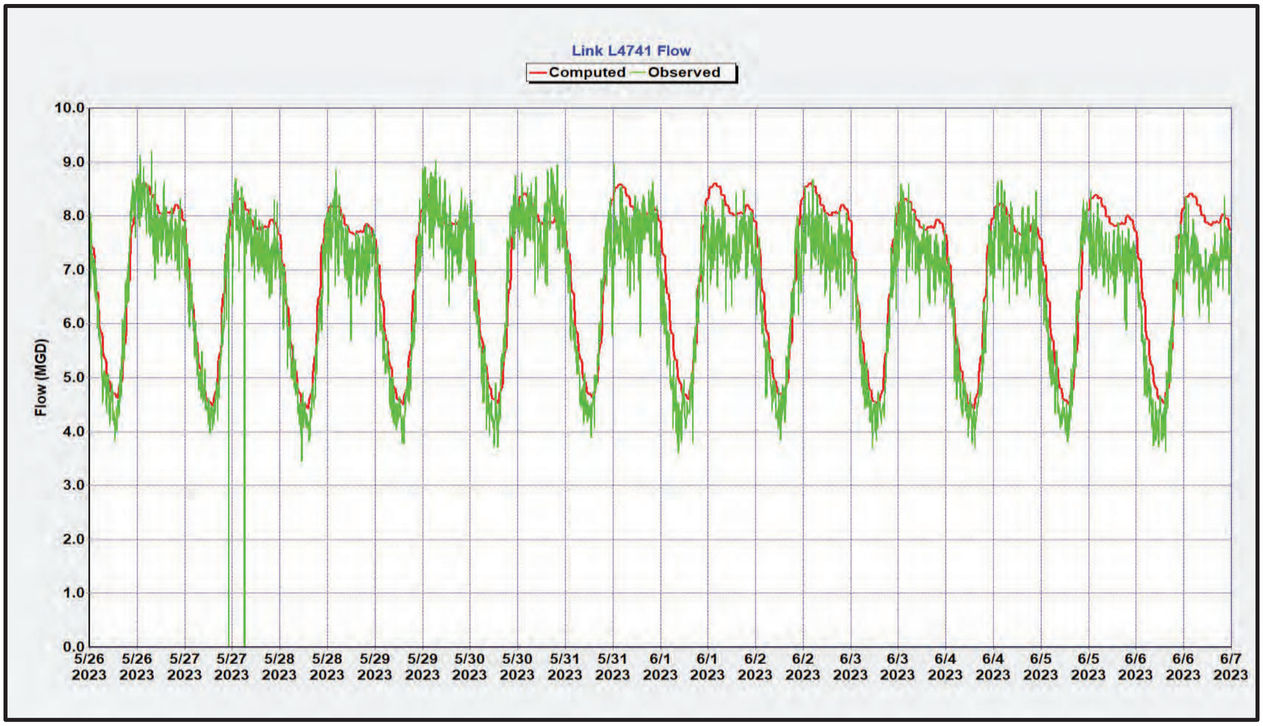
MH 8501 - 42-inch Influent: Flow (MGD)



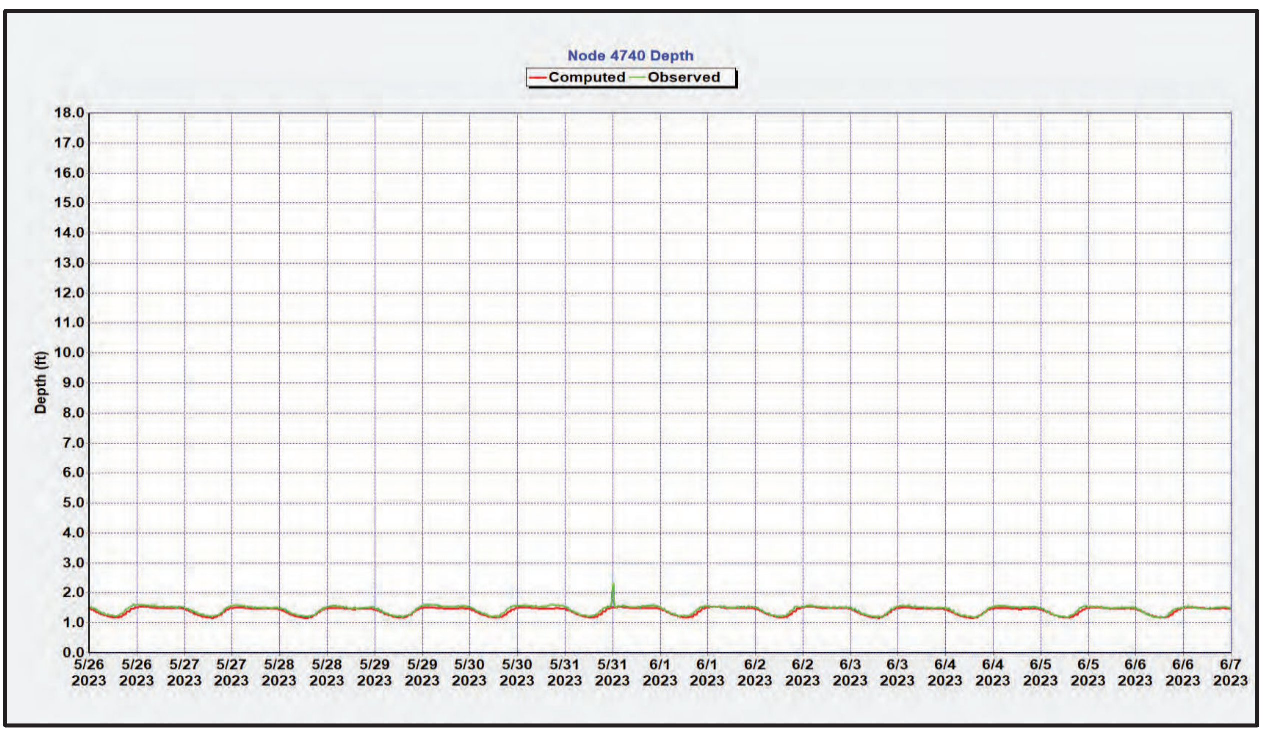
MH 8501 – 42-inch Influent: Depth (ft)



MH 4740 - 48-inch Influent: Flow (MGD)



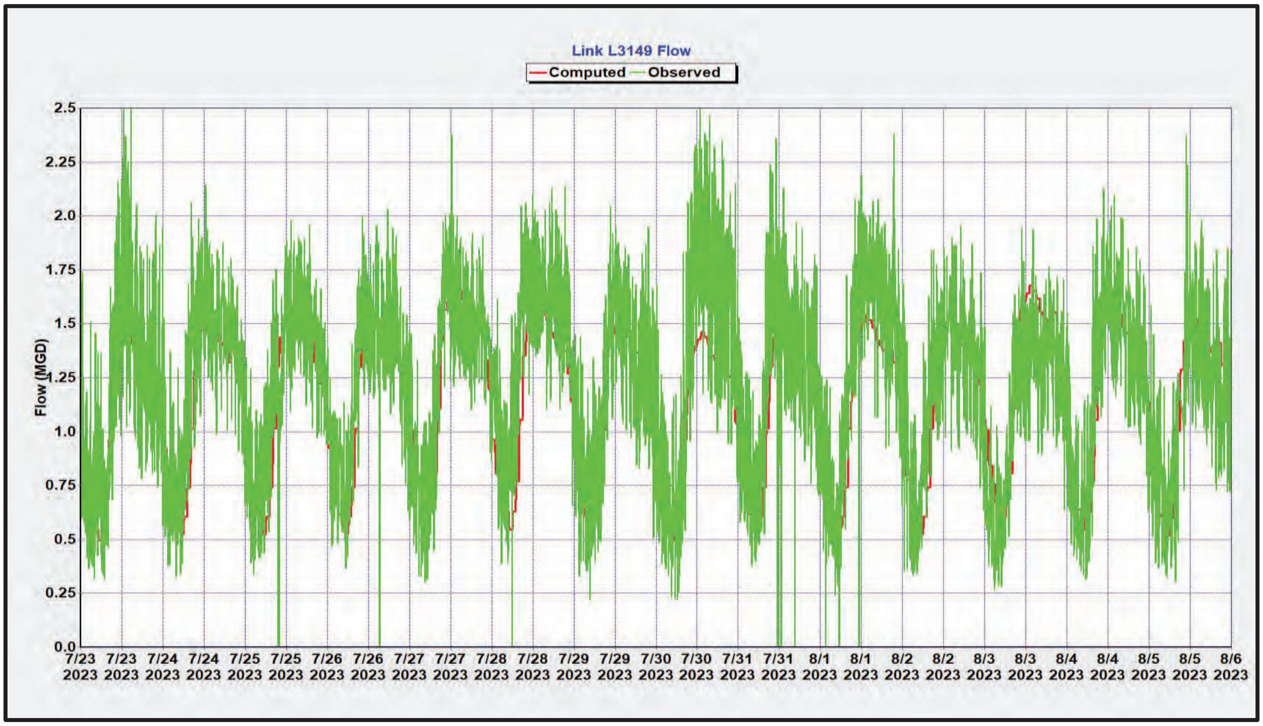
MH 4740 - 48-inch Influent: Depth (ft)



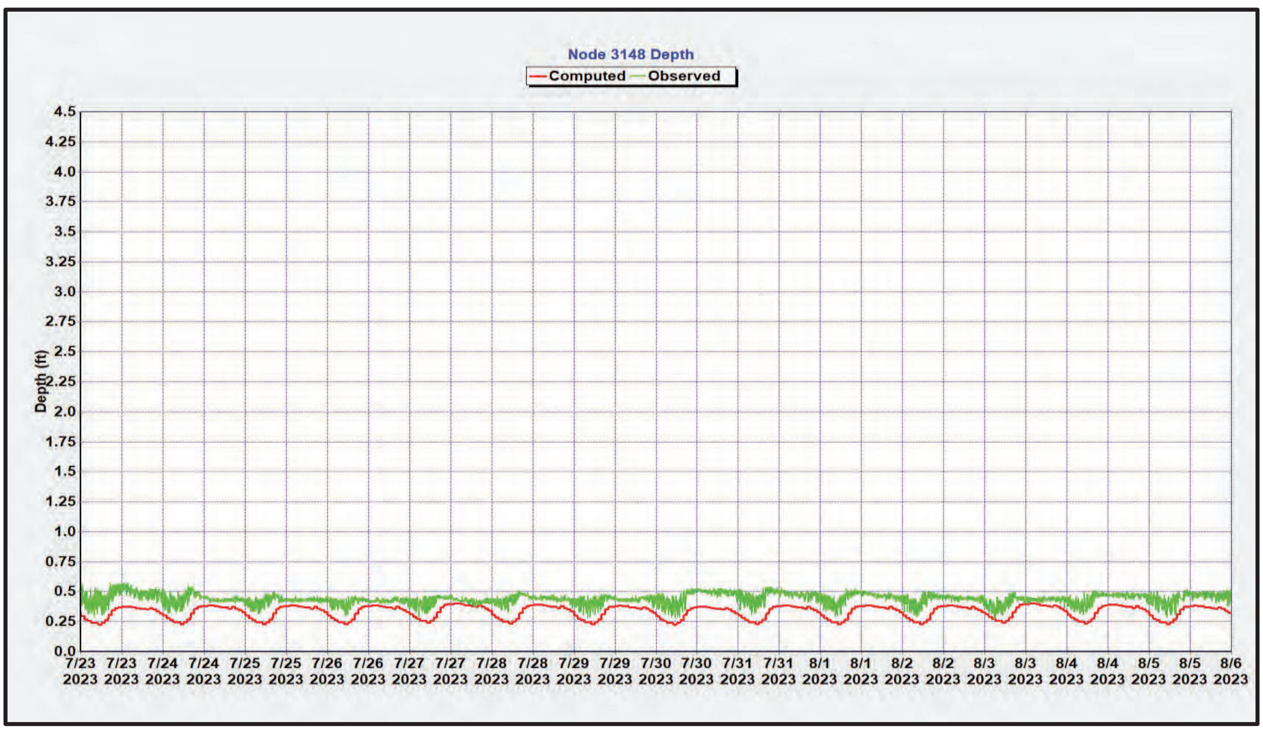
Dry Weather Validation Period

July 23, 2023 – August 6, 2023

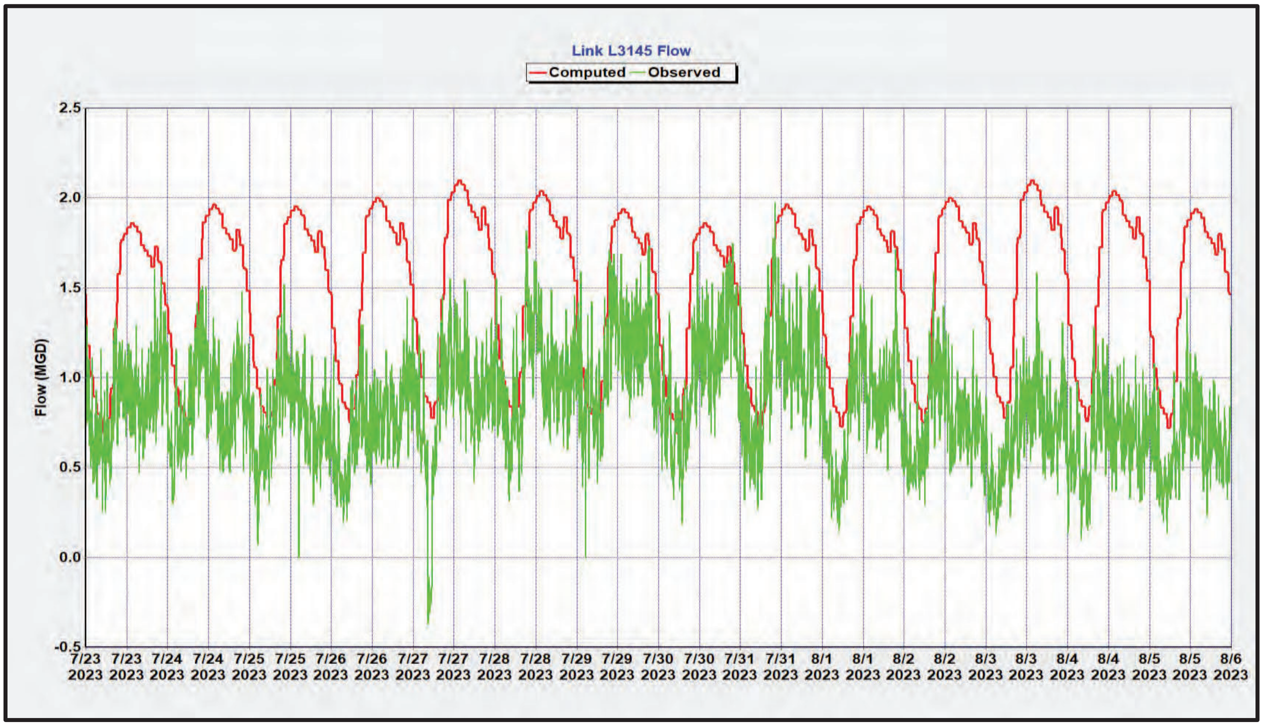
MH 3148 - 30-inch Influent: Flow (MGD)



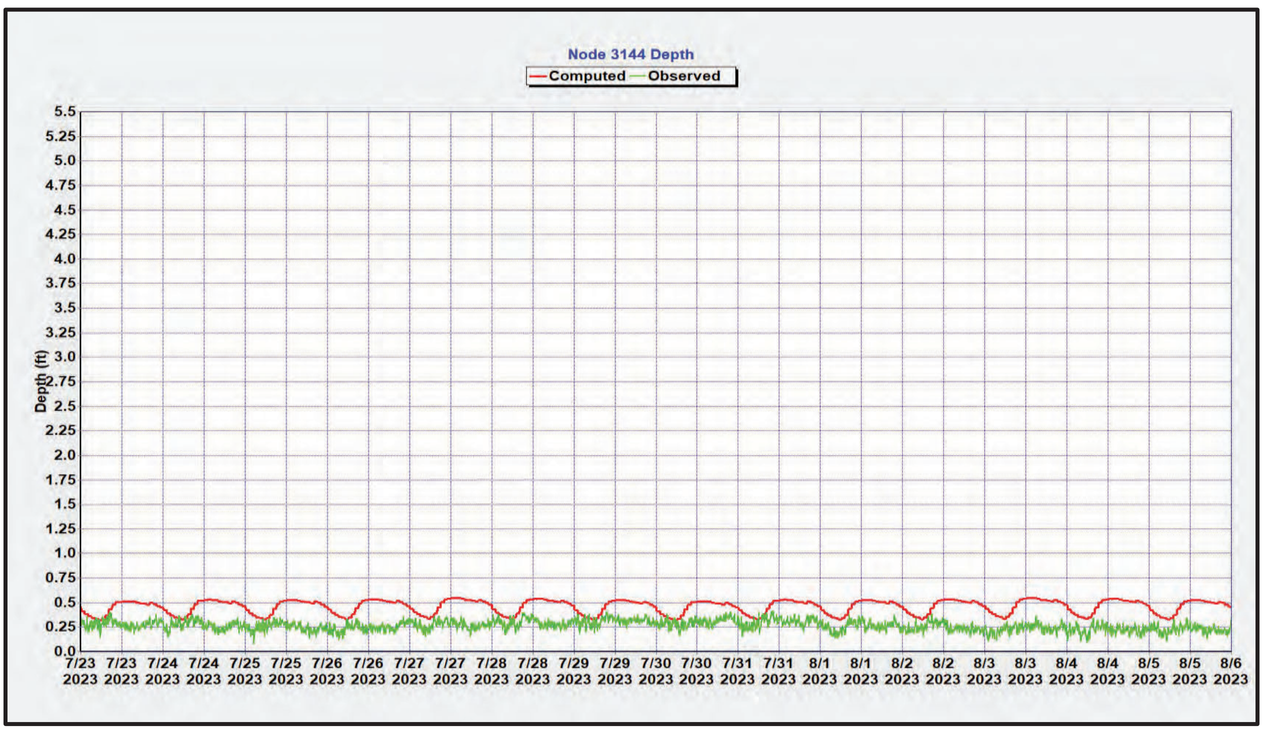
MH 3148 - 30-inch Influent: Depth (ft)



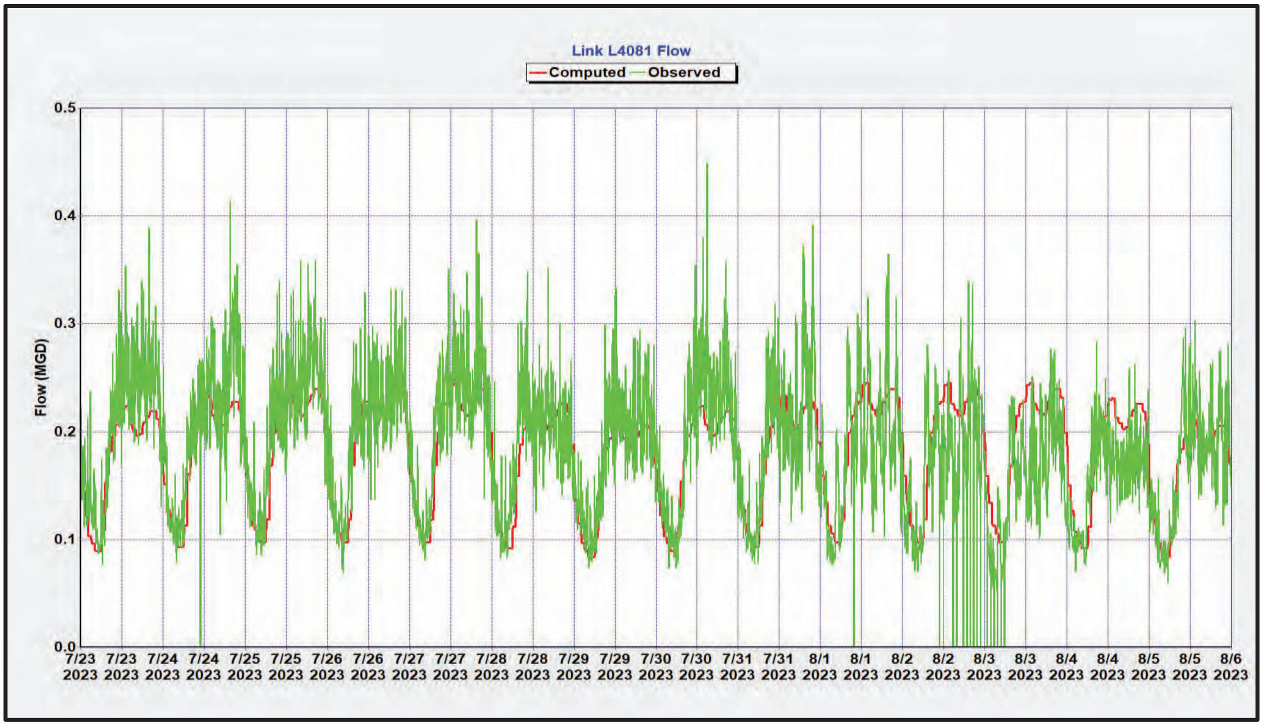
MH 3144 - 30-inch Influent: Flow (MGD)



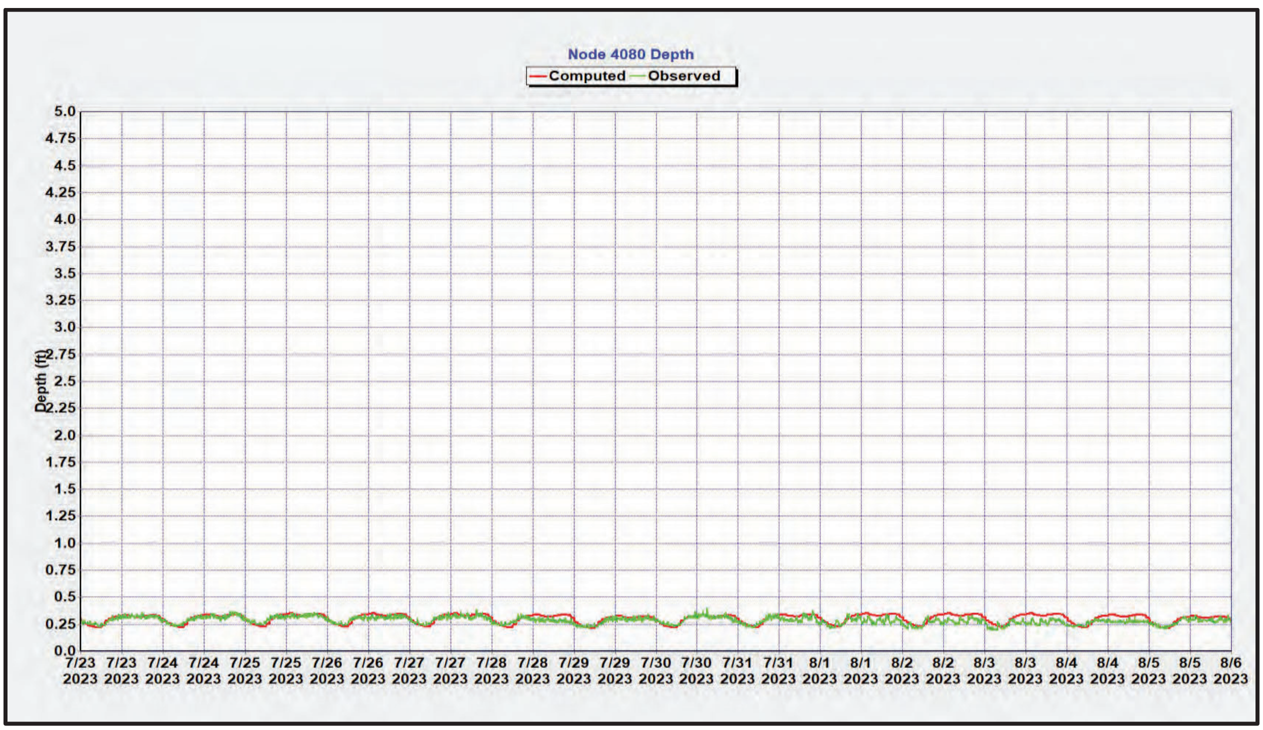
MH 3144 - 30-inch Influent: Depth (ft)



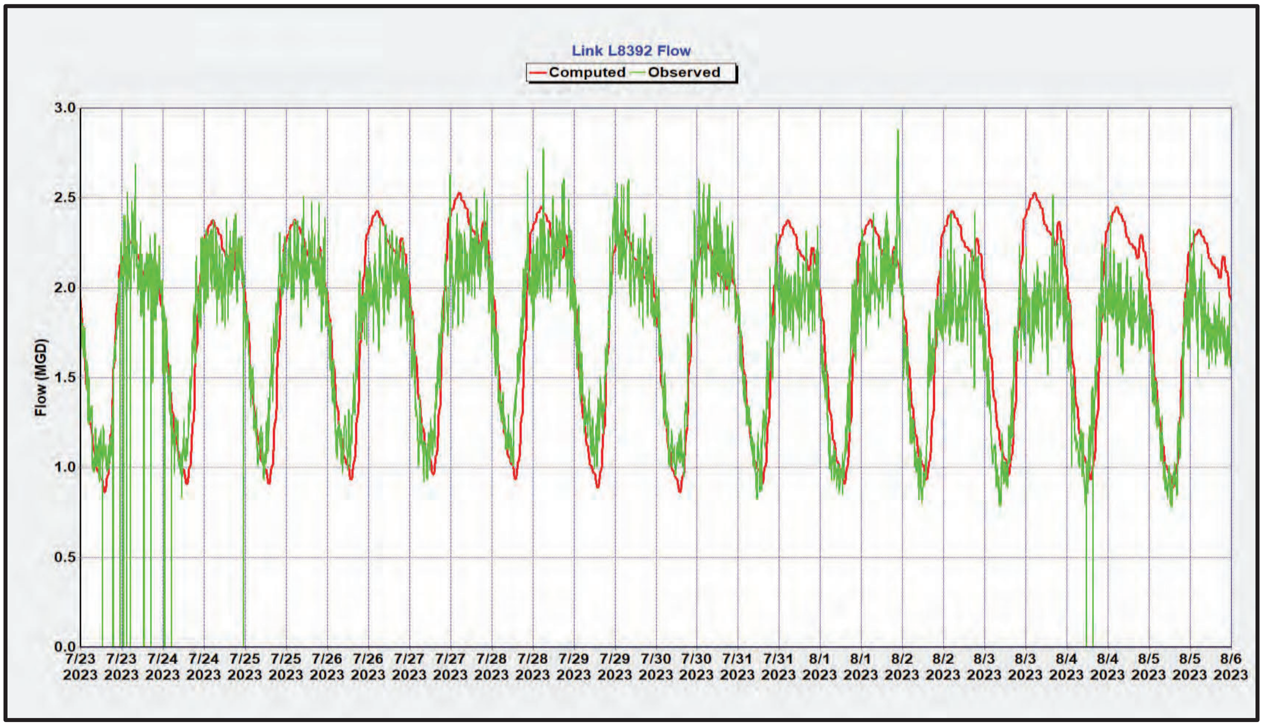
MH 4080 - 15-inch Influent: Flow (MGD)



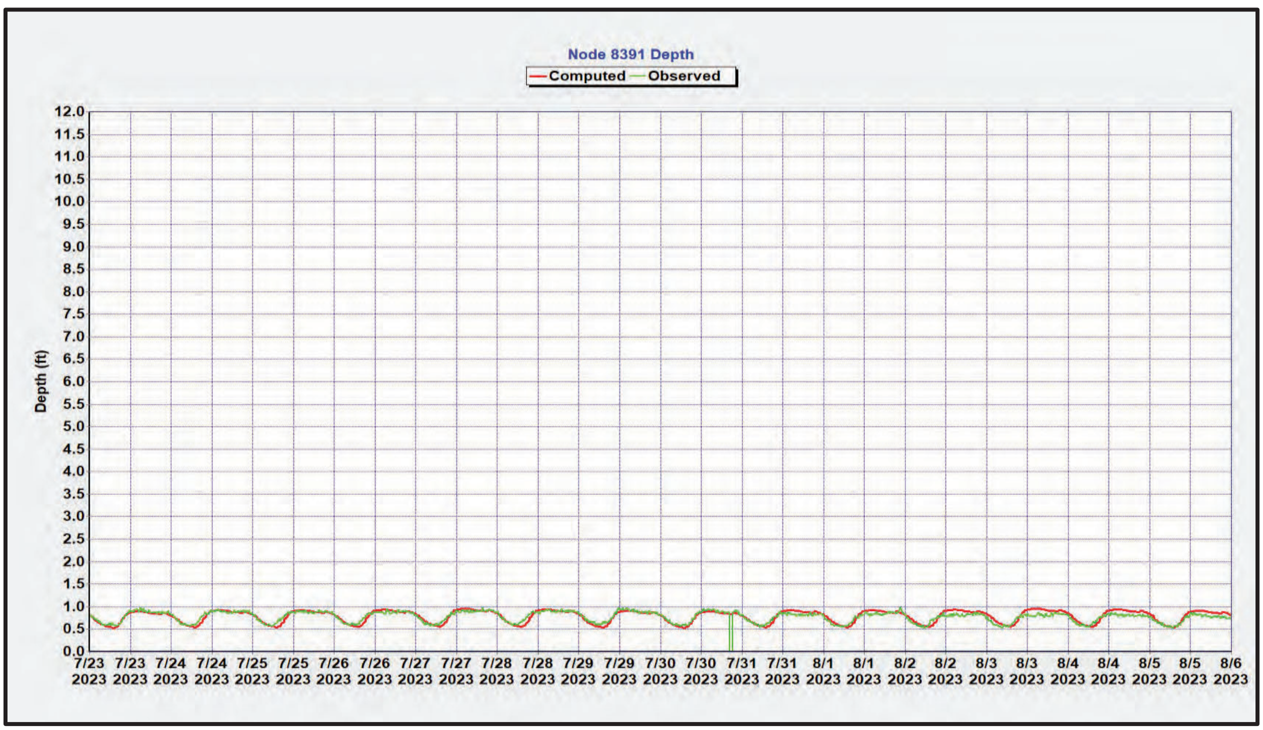
MH 4080 - 15-inch Influent: Depth (ft)



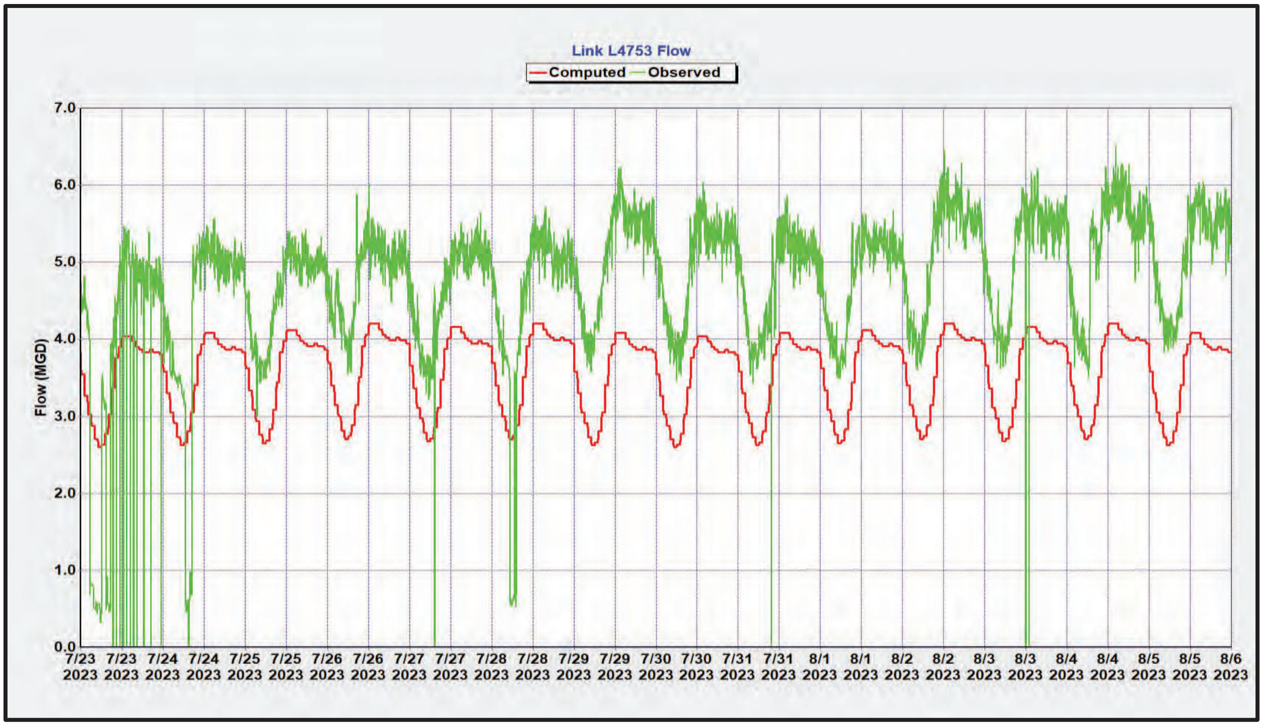
MH 8391 - 36-inch Influent: Flow (MGD)



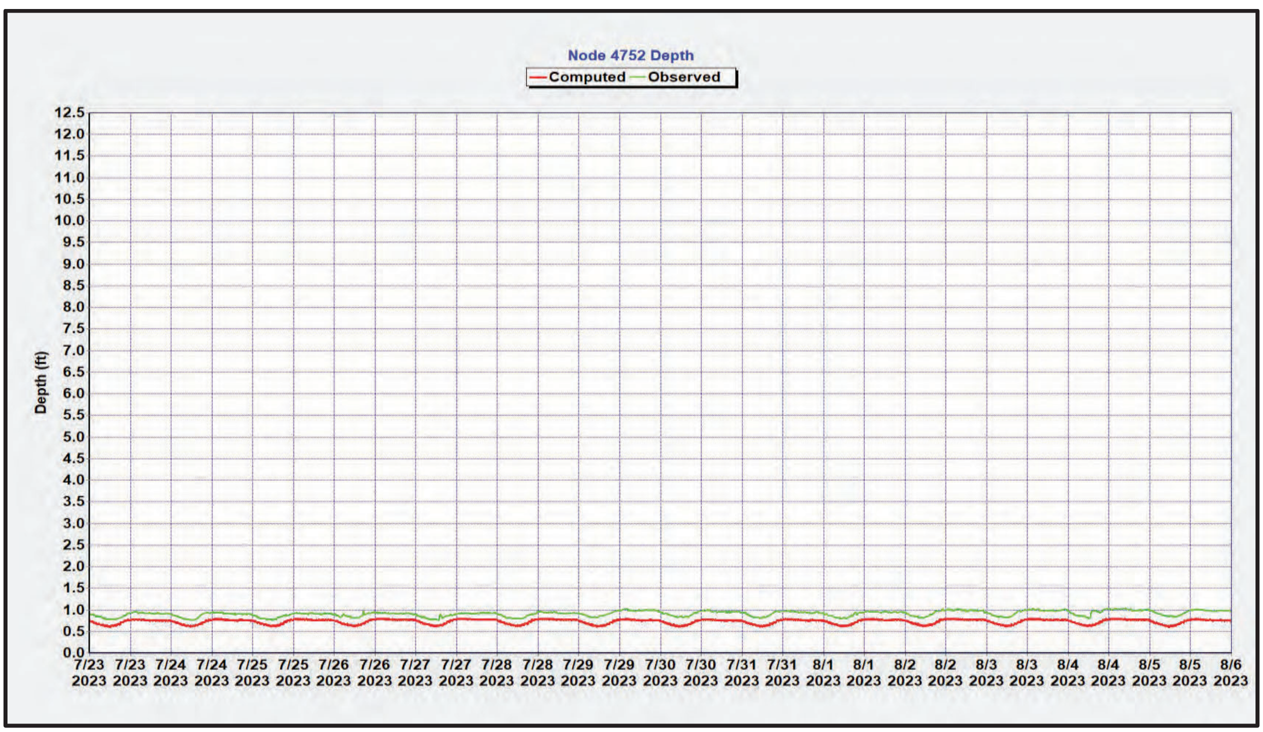
MH 8391 - 36-inch Influent: Depth (ft)



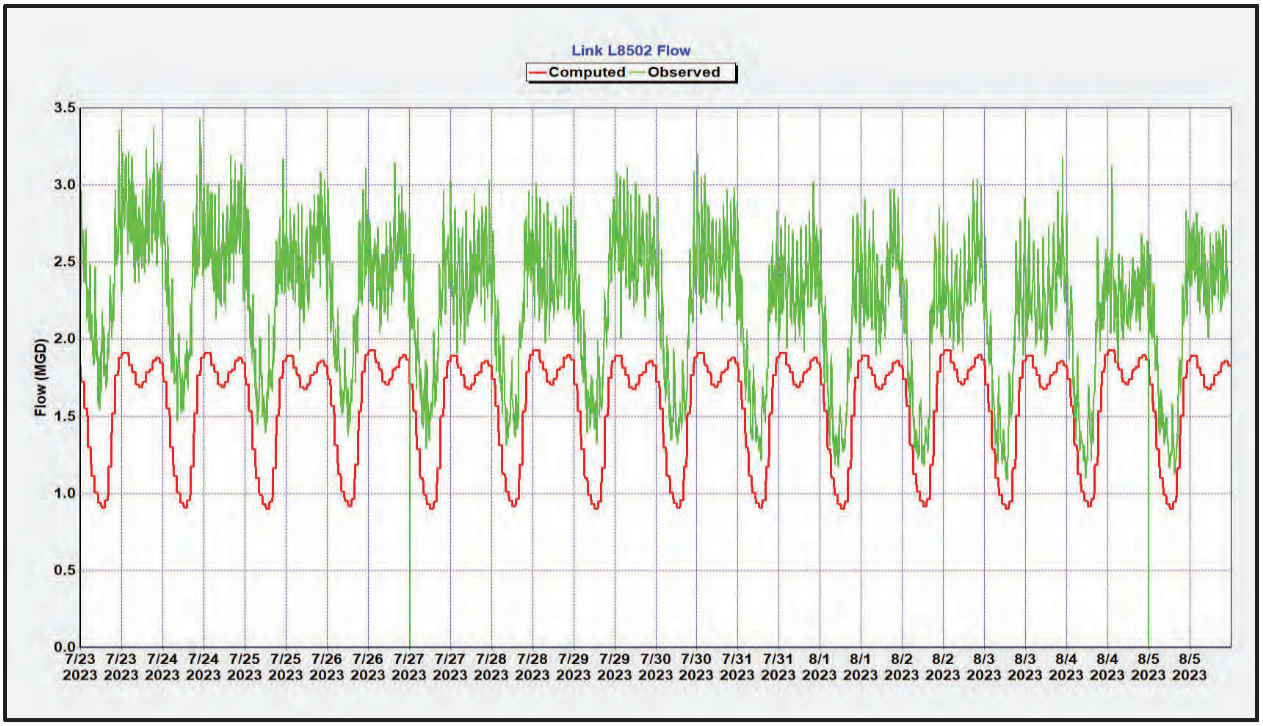
MH 4752 - 42-inch Influent: Flow (MGD)



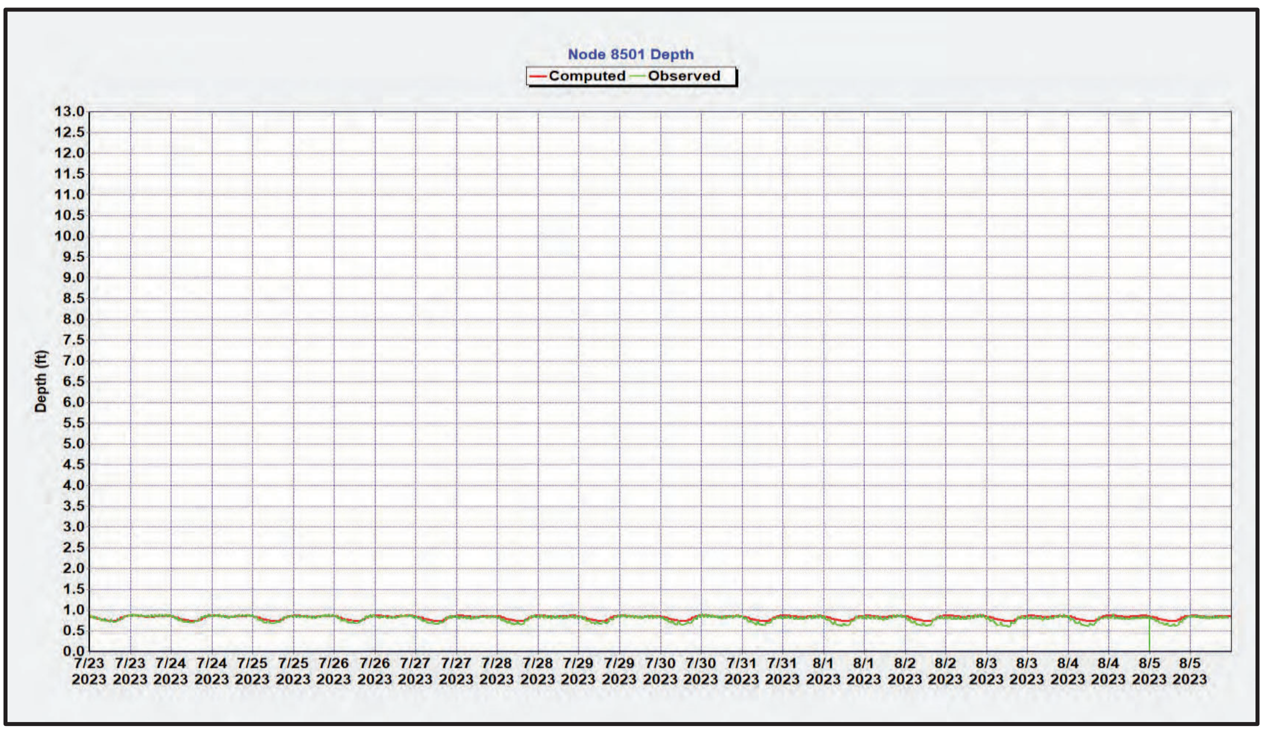
MH 4752 - 42-inch Influent: Depth (ft)



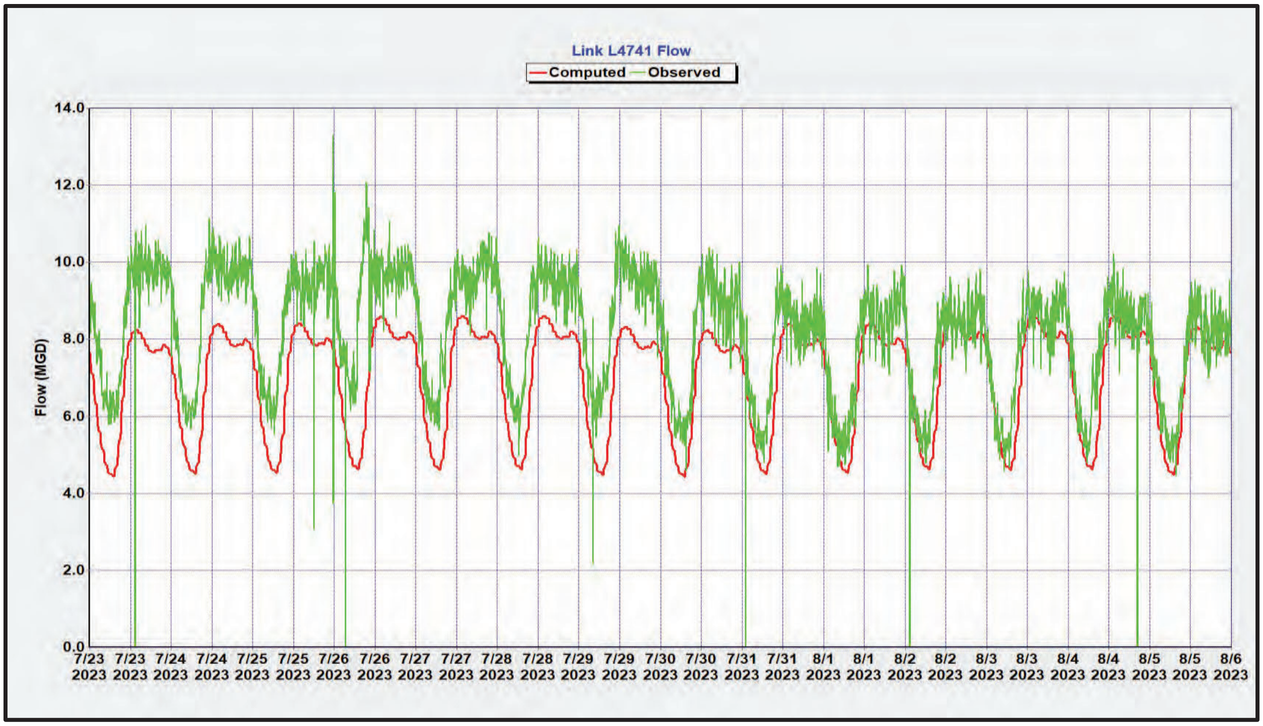
MH 8501 - 42-inch Influent: Flow (MGD)



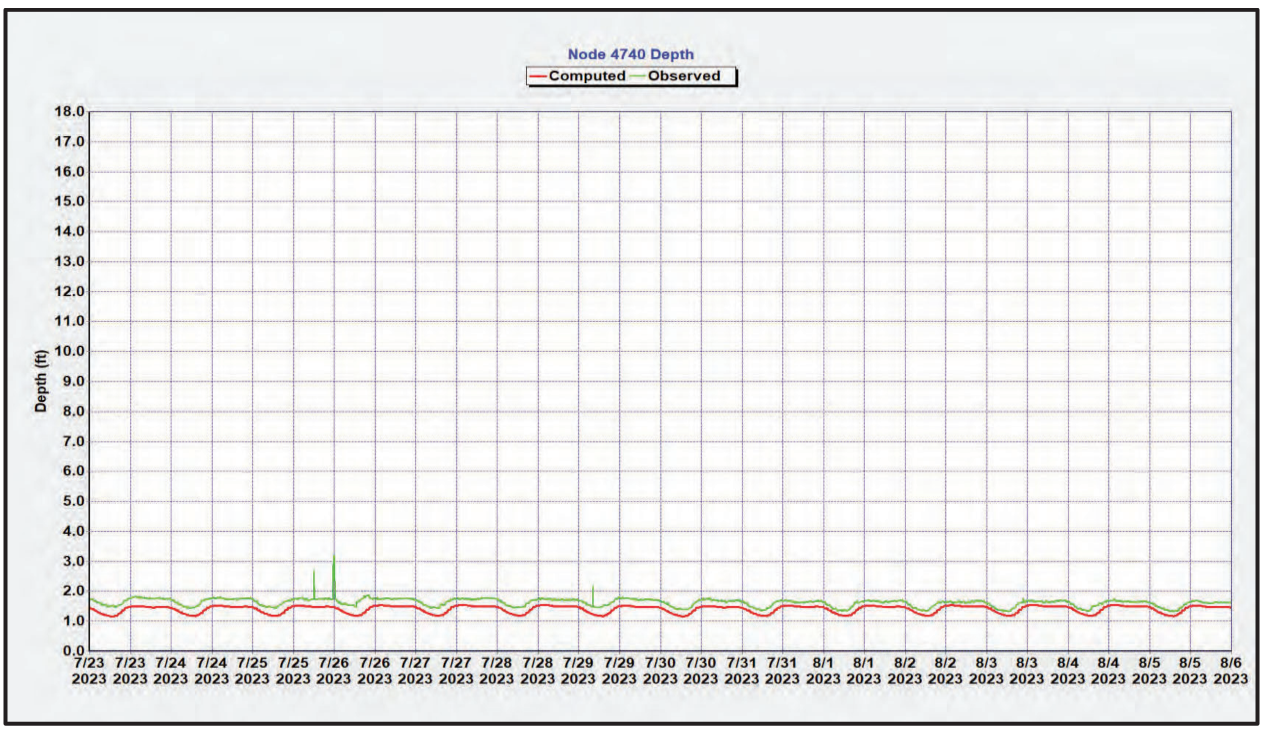
MH 8501 – 42-inch Influent: Depth (ft)



MH 4740 - 48-inch Influent: Flow (MGD)



MH 4740 - 48-inch Influent: Depth (ft)



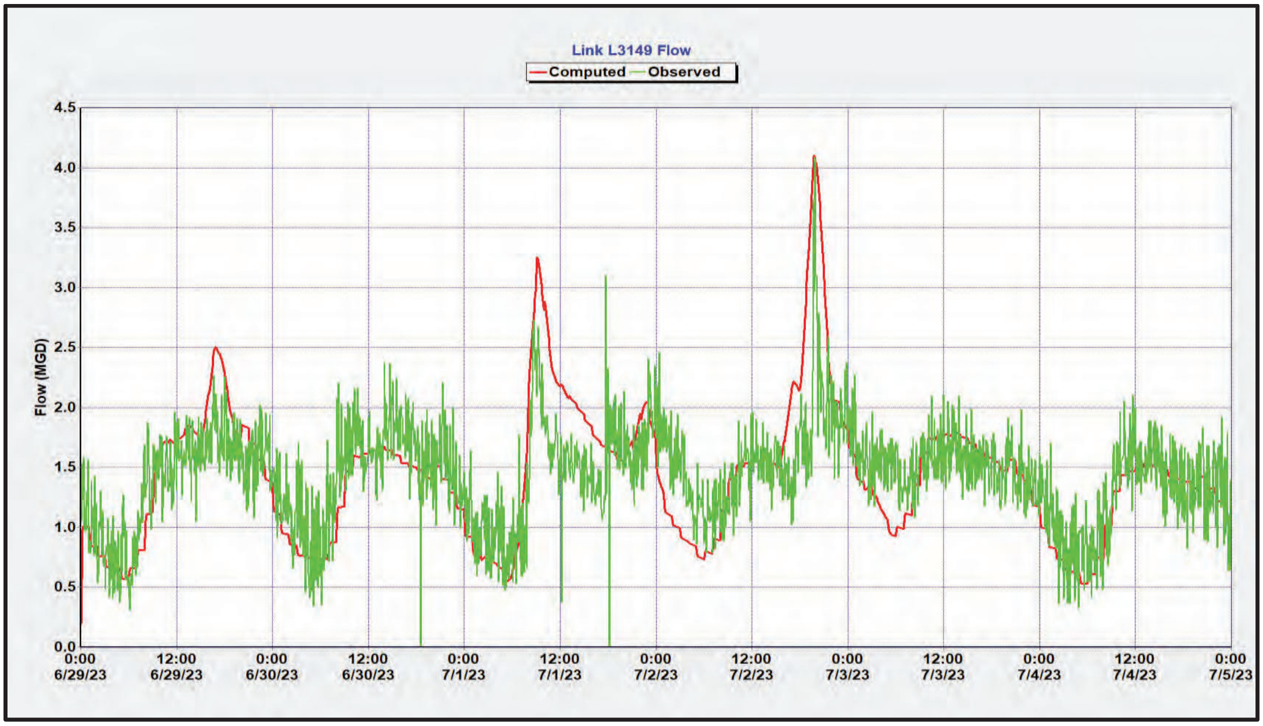
Attachment 3

Wet Weather Calibration & Validation Figures

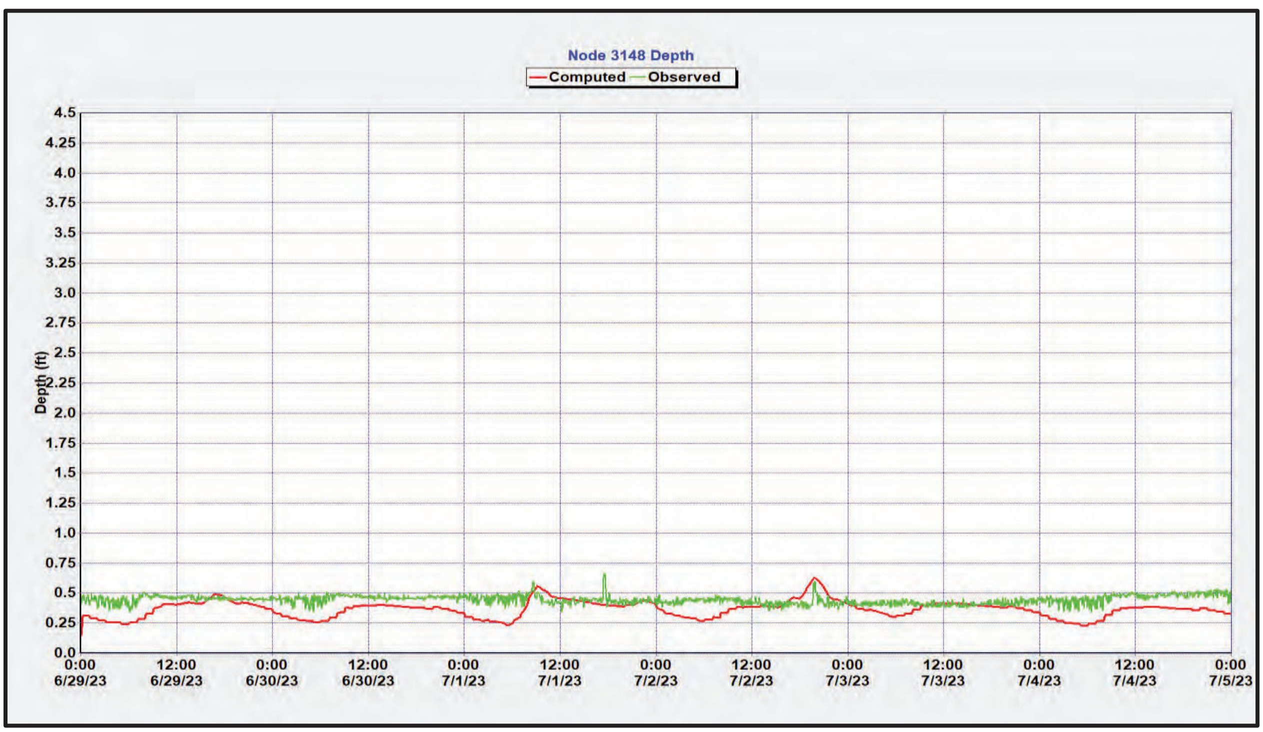
Wet Weather Calibration Event

July 2, 2023

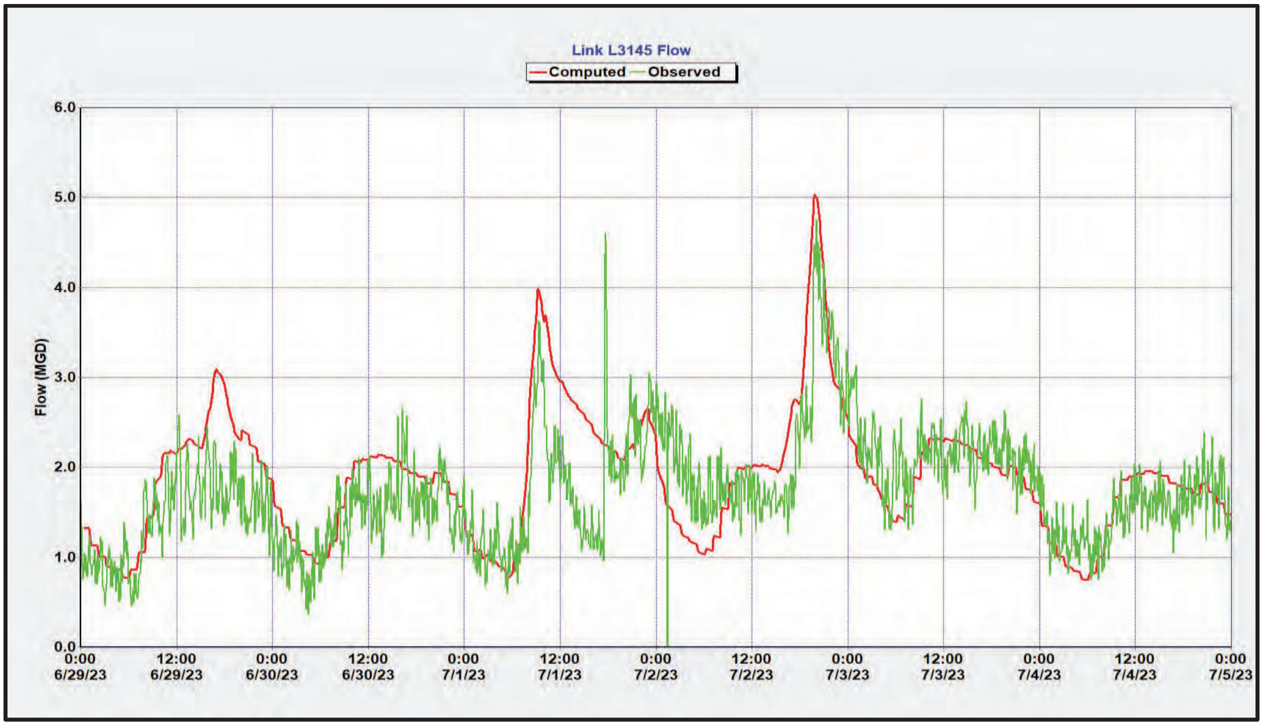
MH 3148 - 30-inch Influent: Flow (MGD)



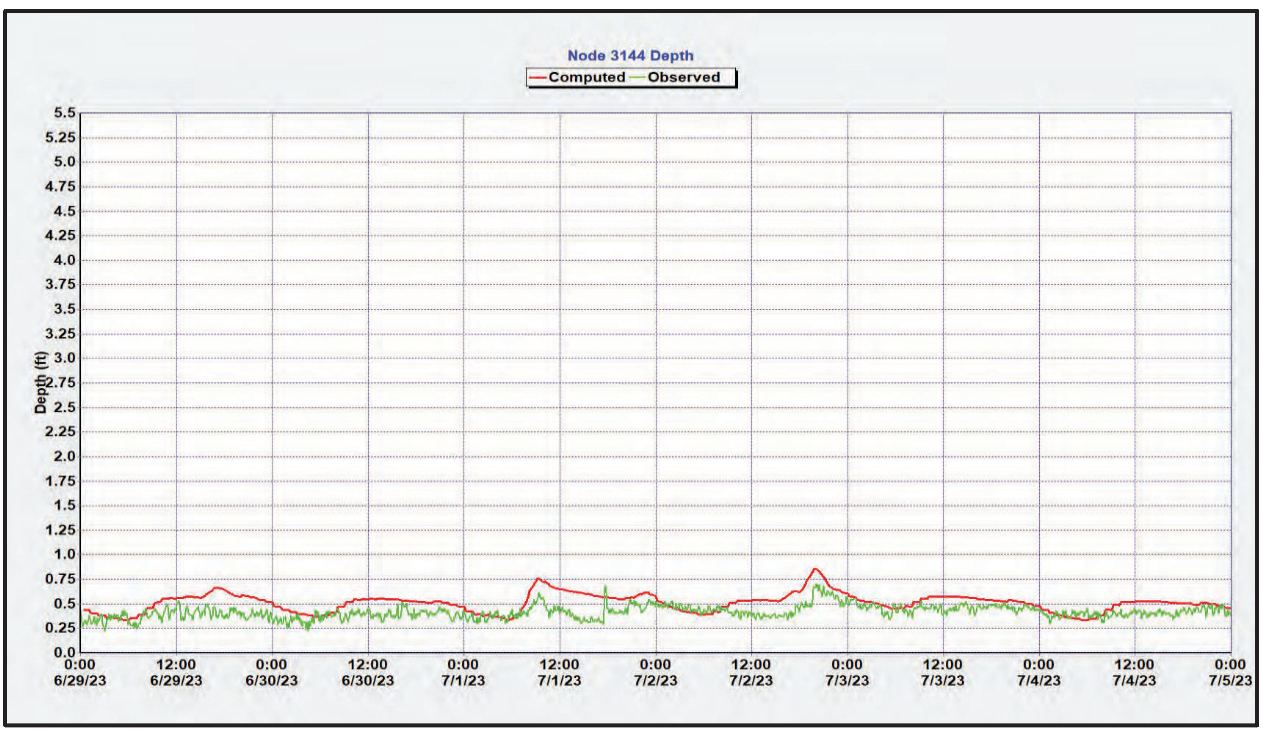
MH 3148 - 30-inch Influent: Depth (ft)



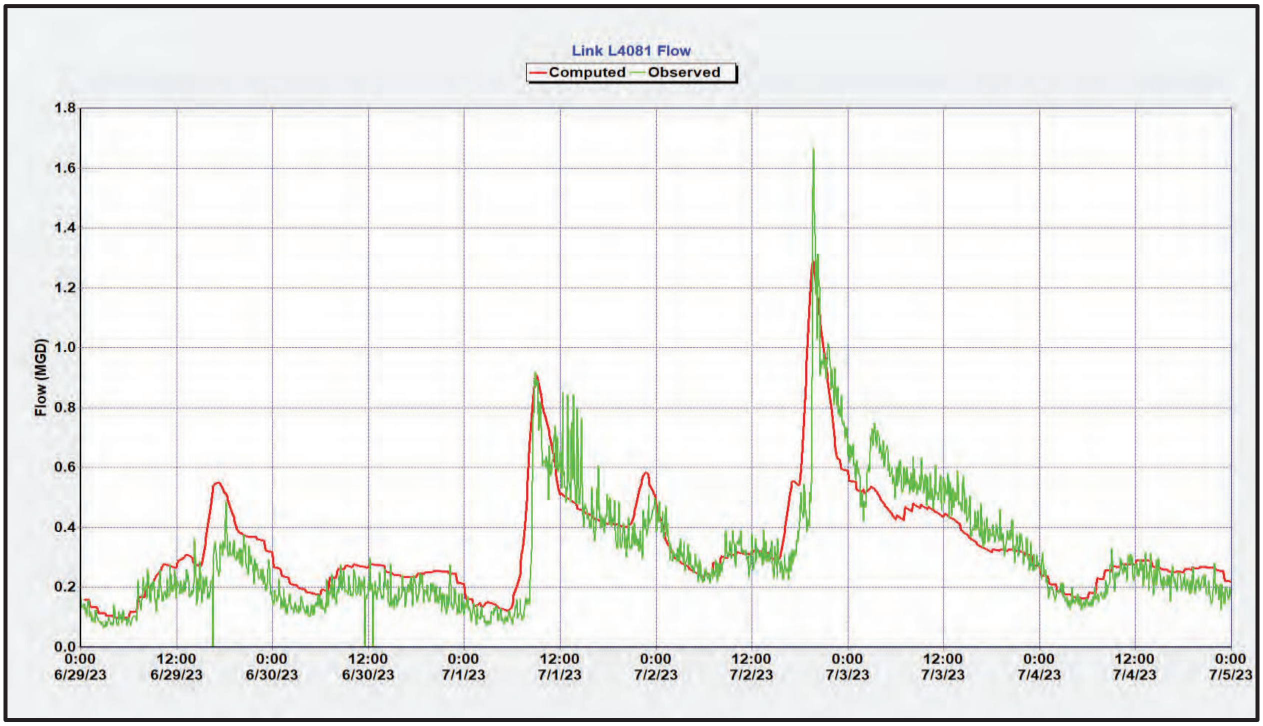
MH 3144 - 30-inch Influent: Flow (MGD)



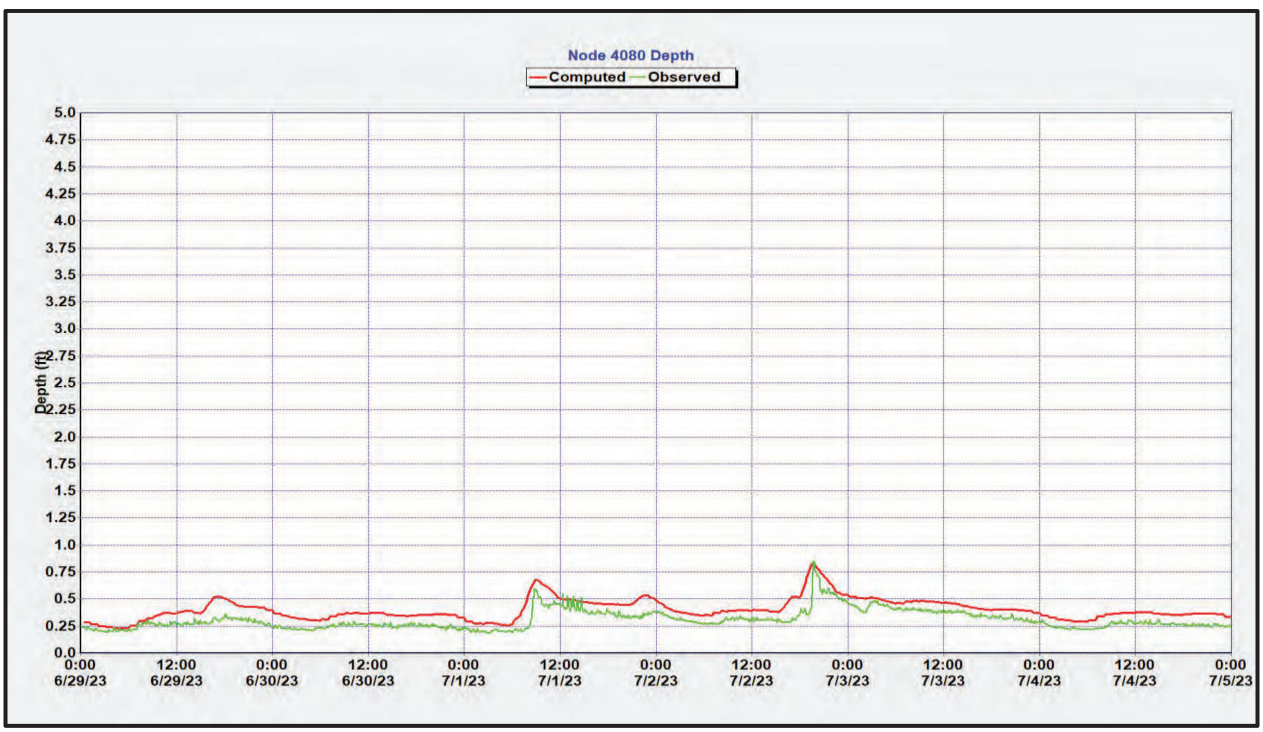
MH 3144 - 30-inch Influent: Depth (ft)



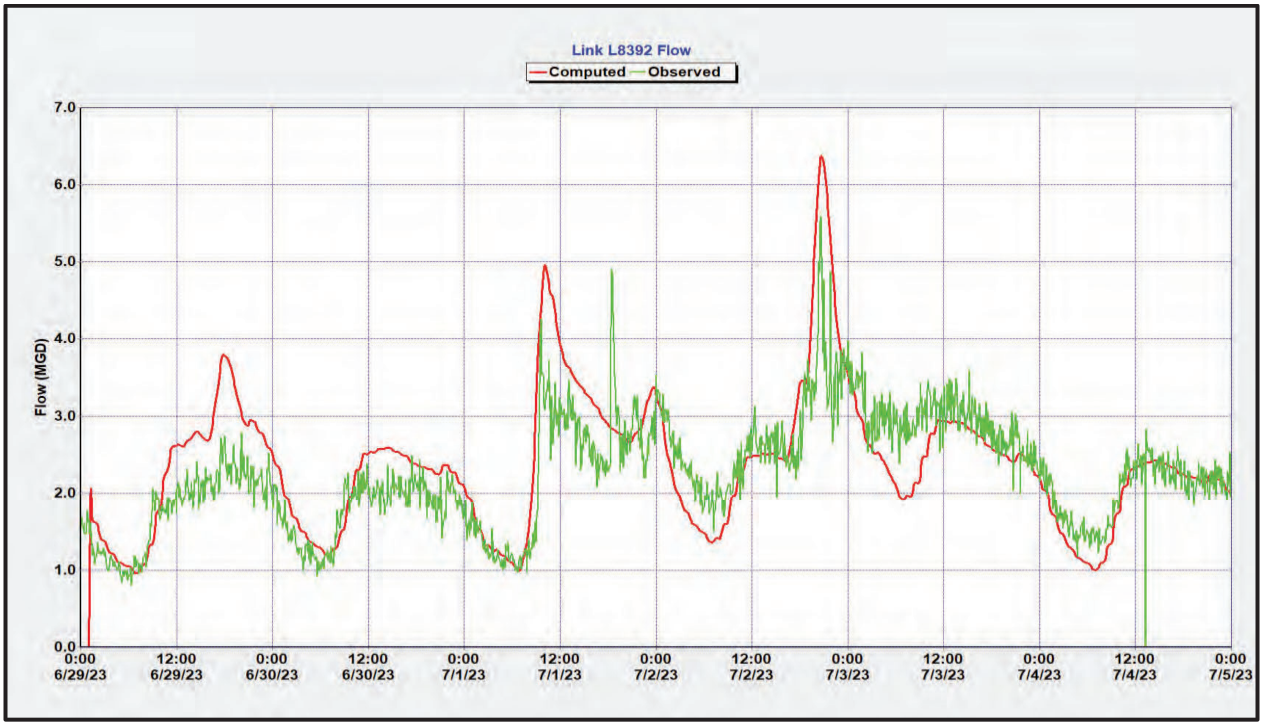
MH 4080 - 15-inch Influent: Flow (MGD)



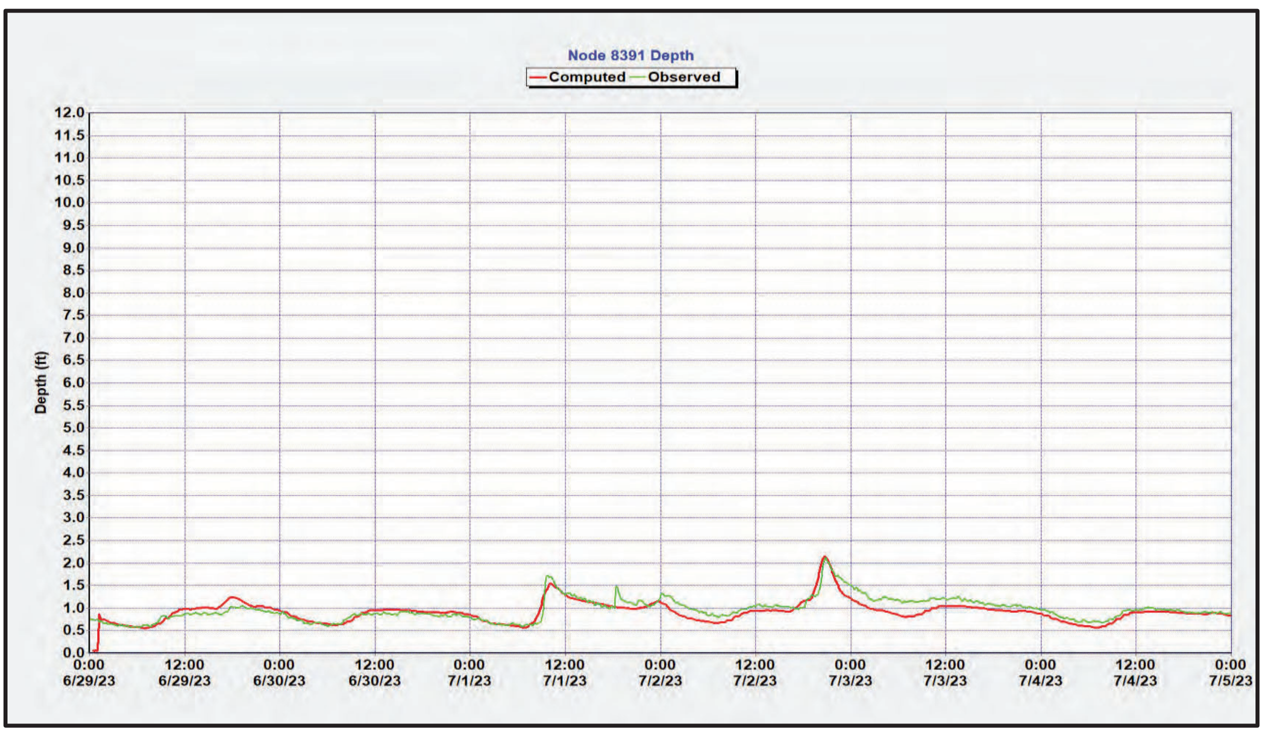
MH 4080 - 15-inch Influent: Depth (ft)



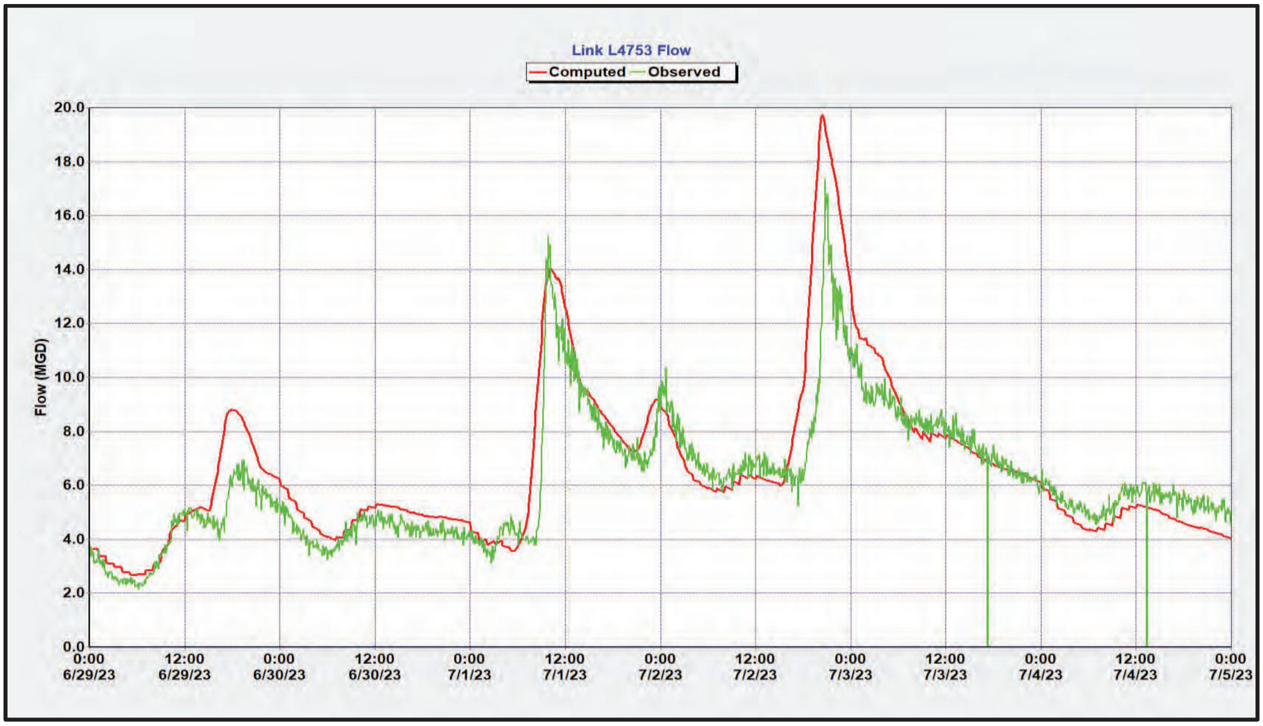
MH 8391 - 36-inch Influent: Flow (MGD)



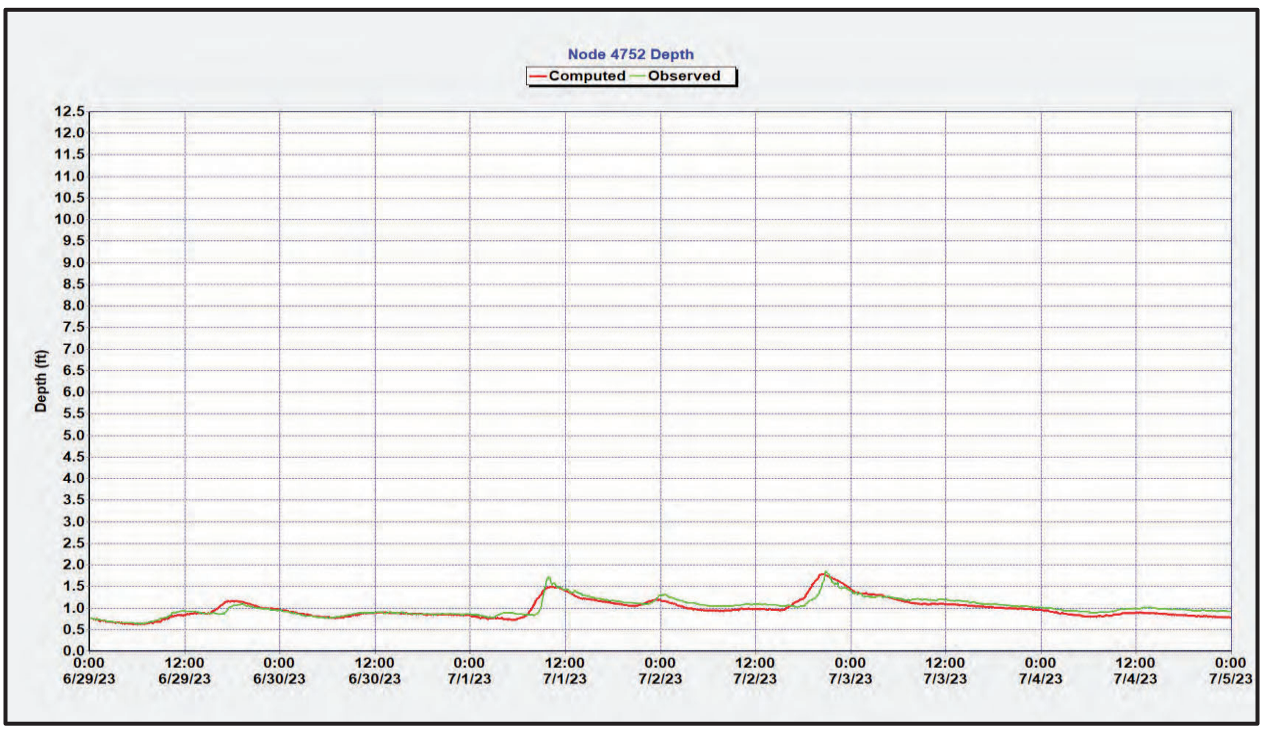
MH 8391 - 36-inch Influent: Depth (ft)



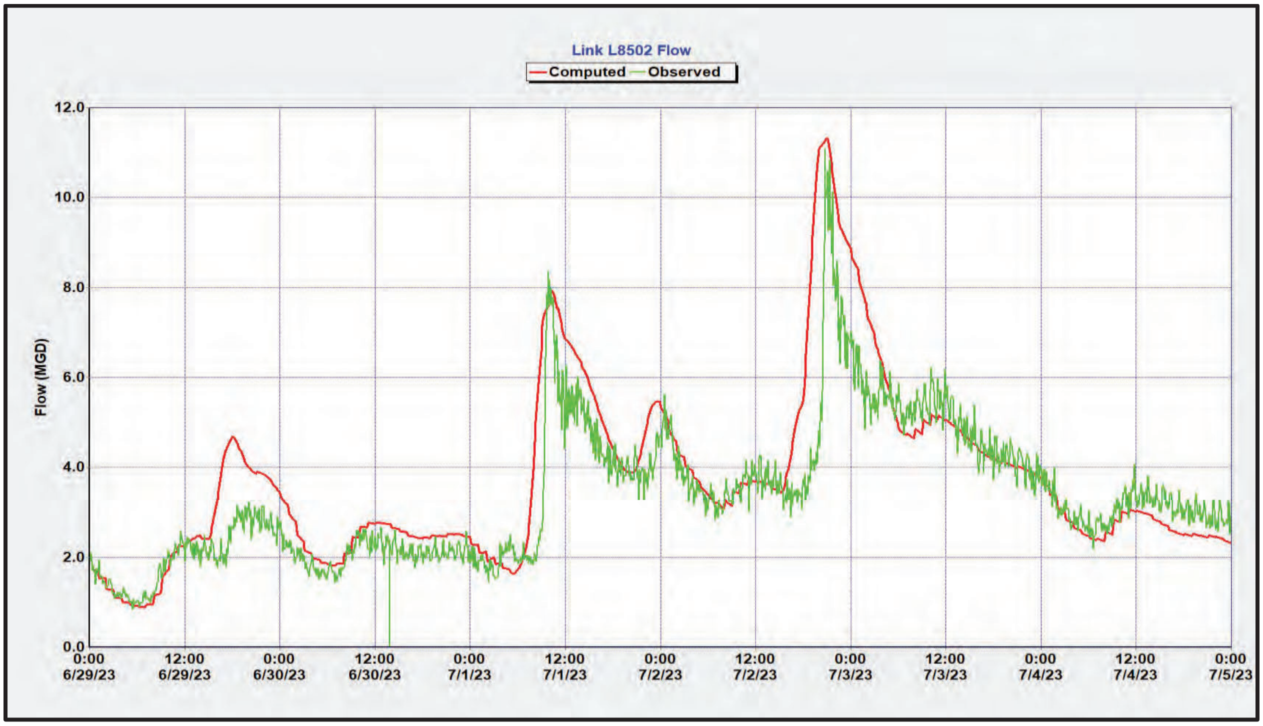
MH 4752 - 42-inch Influent: Flow (MGD)



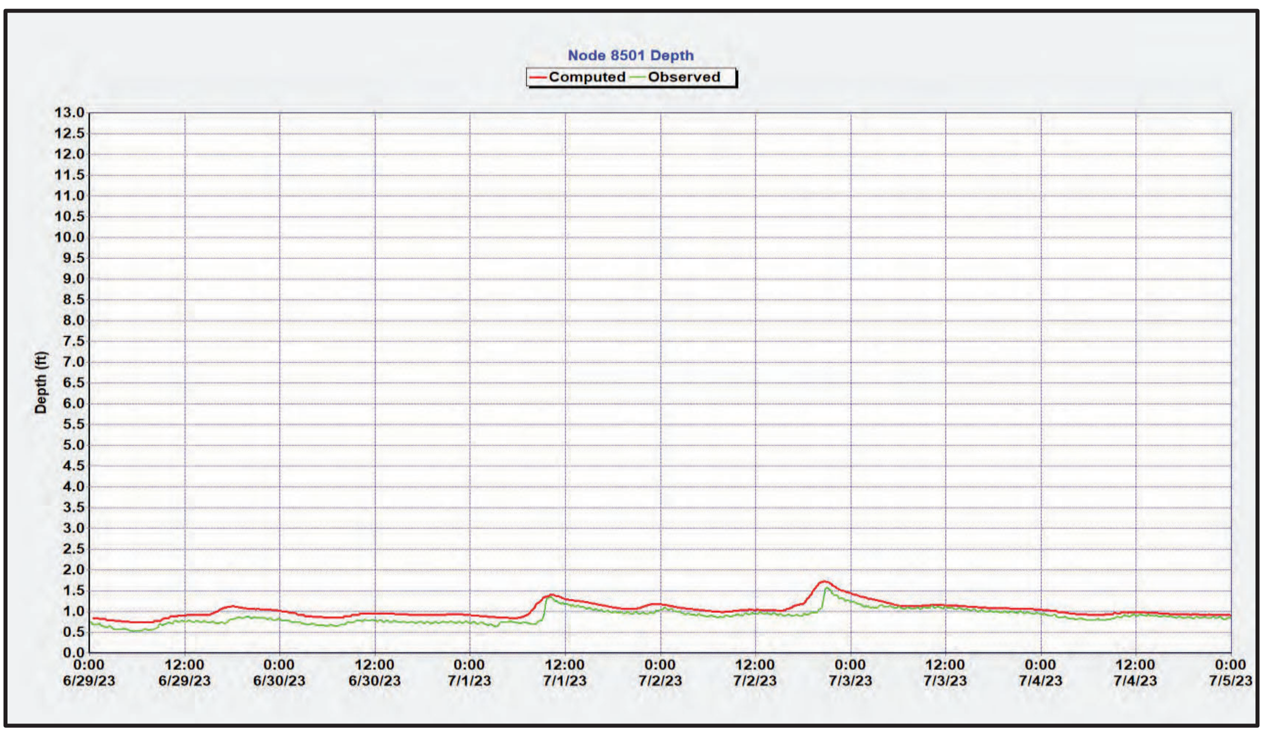
MH 4752 - 42-inch Influent: Depth (ft)



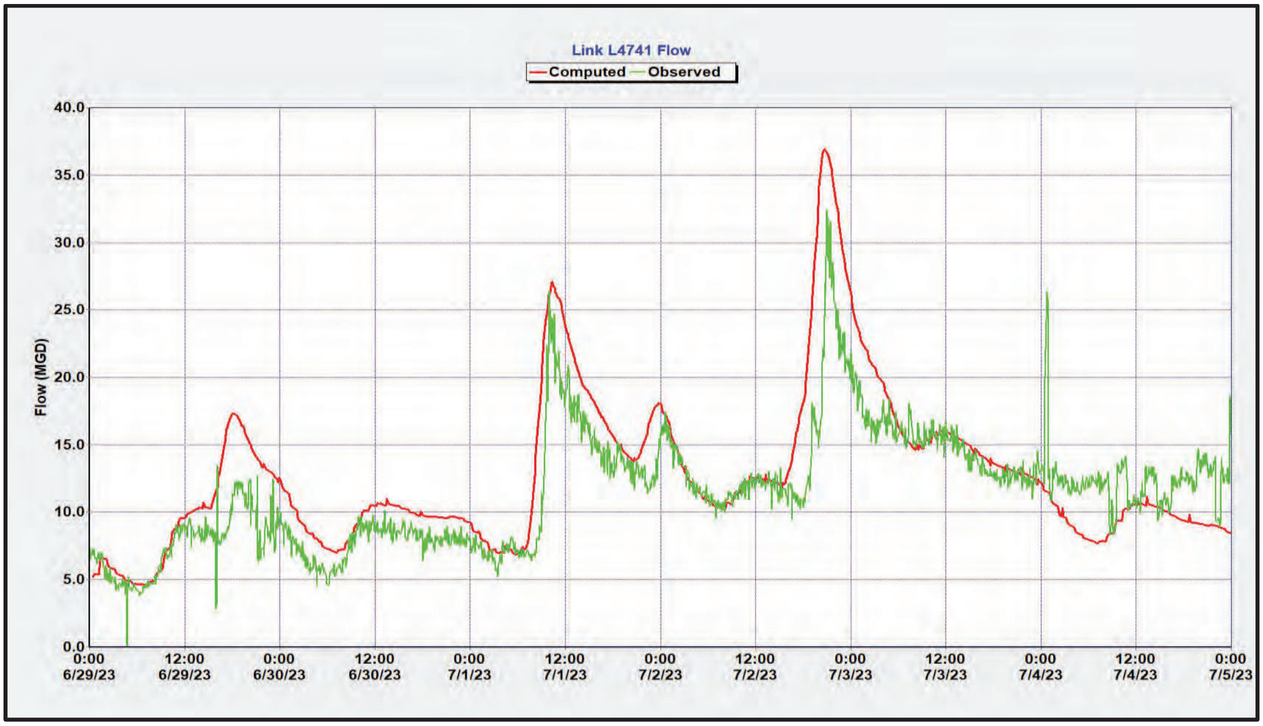
MH 8501 - 42-inch Influent: Flow (MGD)



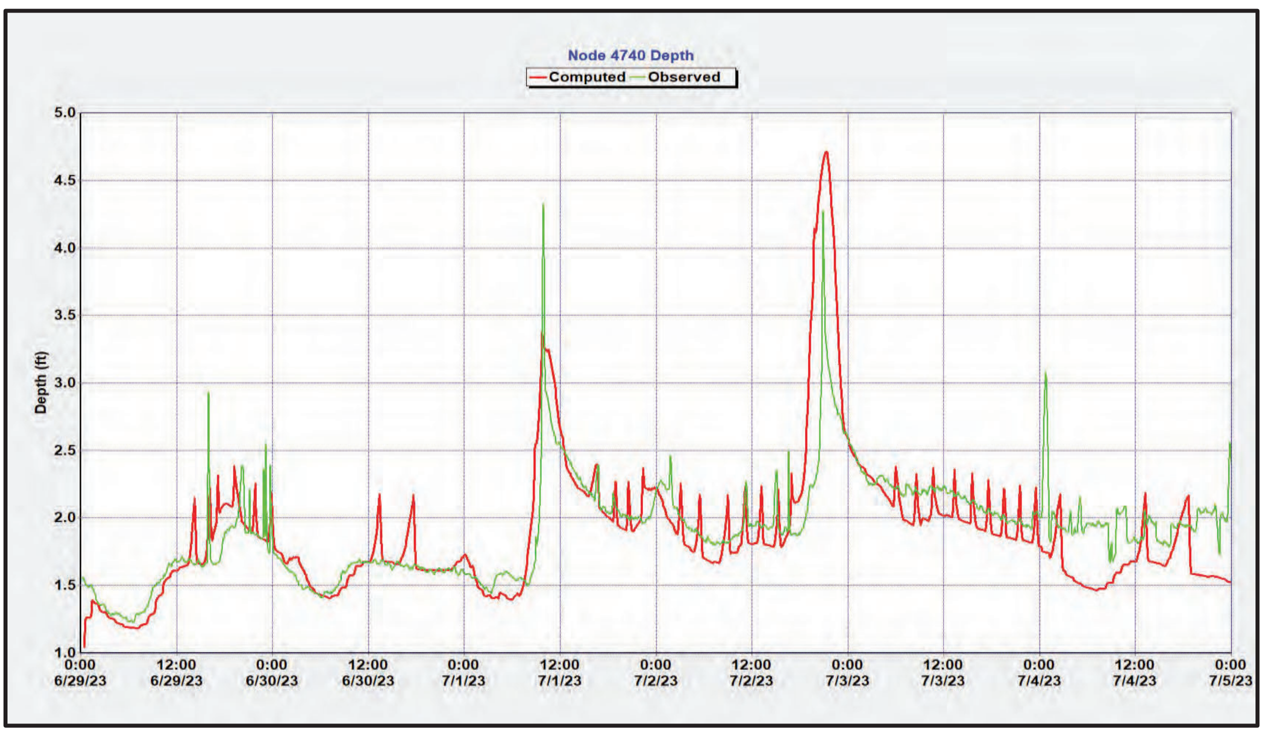
MH 8501 – 42-inch Influent: Depth (ft)



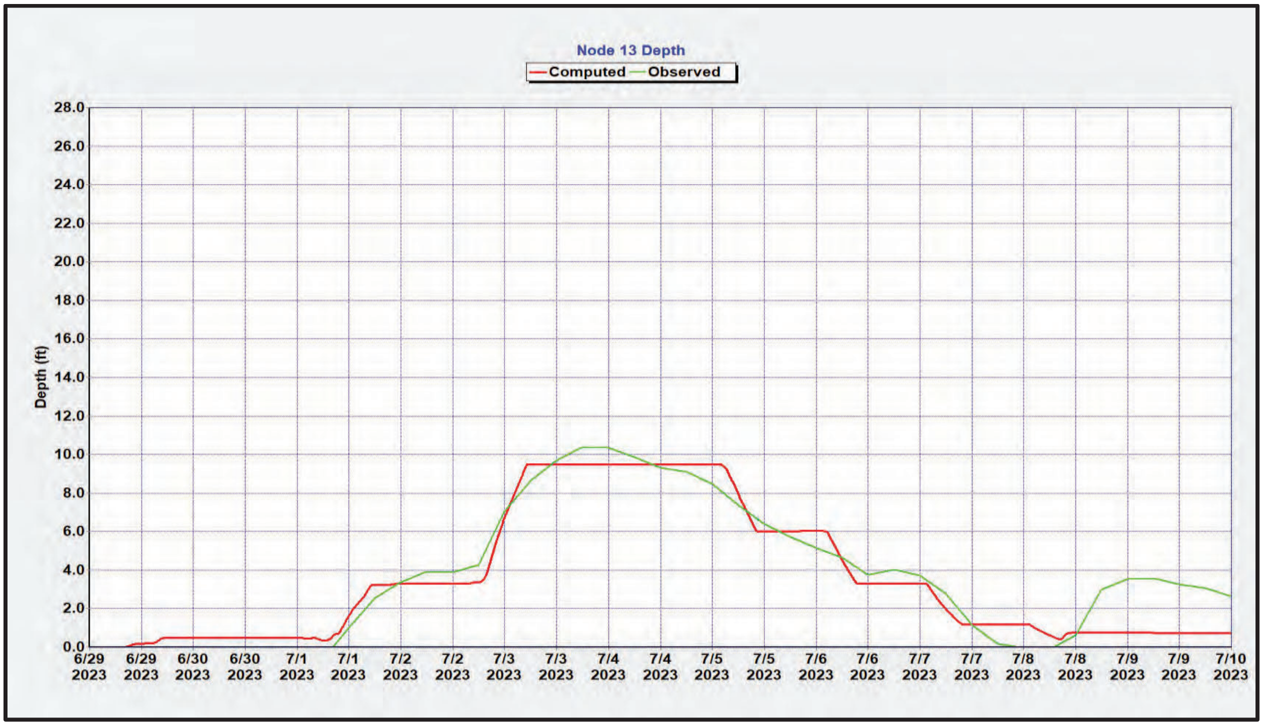
MH 4740 - 48-inch Influent: Flow (MGD)



MH 4740 - 48-inch Influent: Depth (ft)



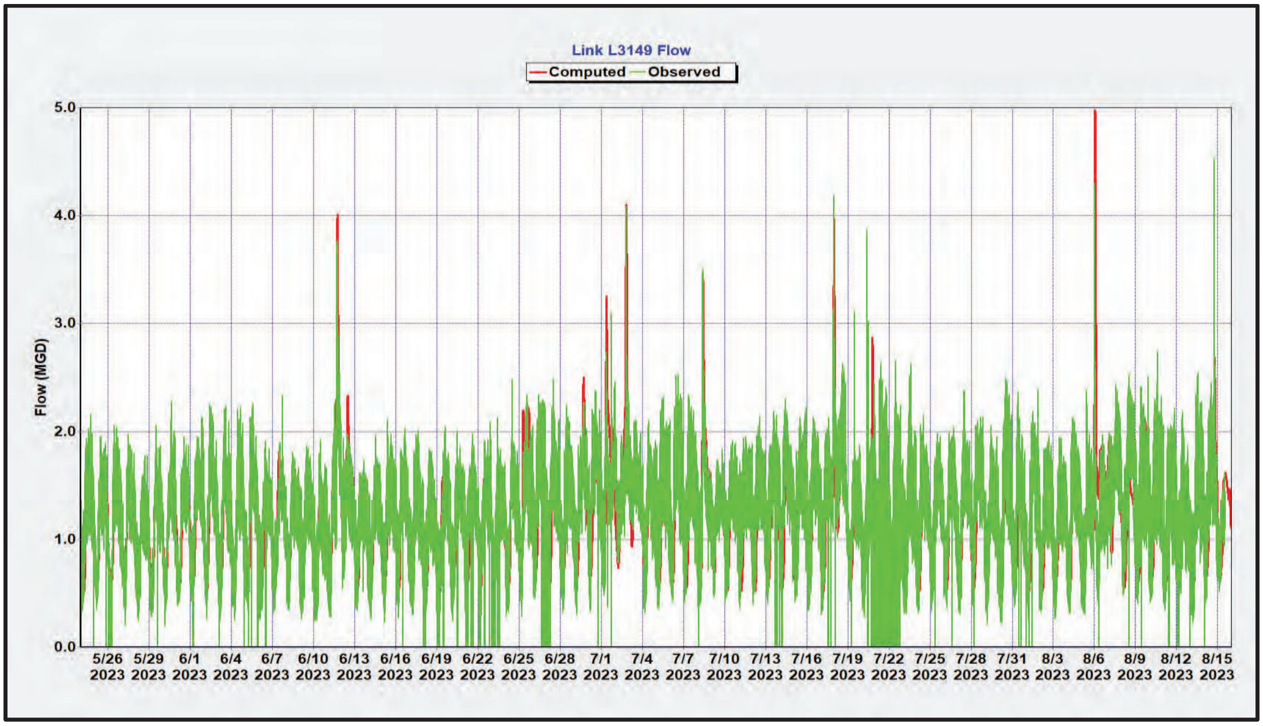
EQ Basin: Depth (ft)



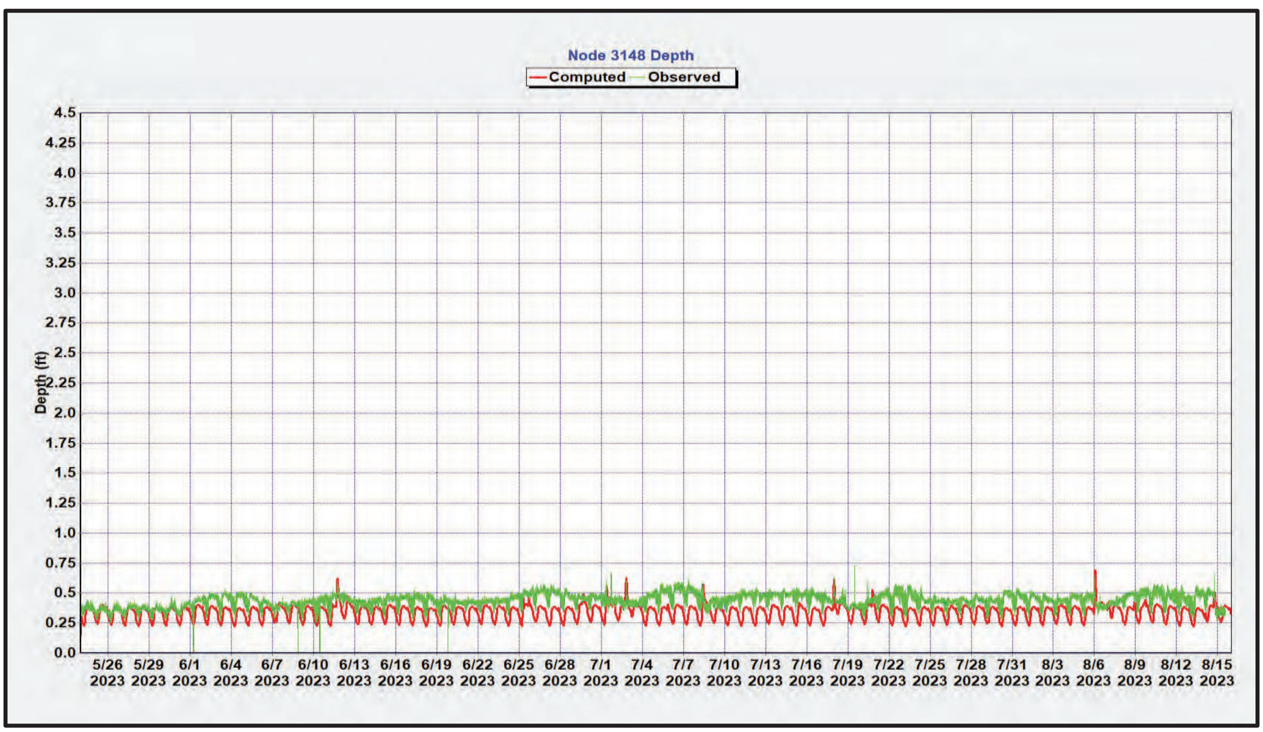
Wet Weather Full Span Validation Period

May 24, 2023 – August 14, 2023

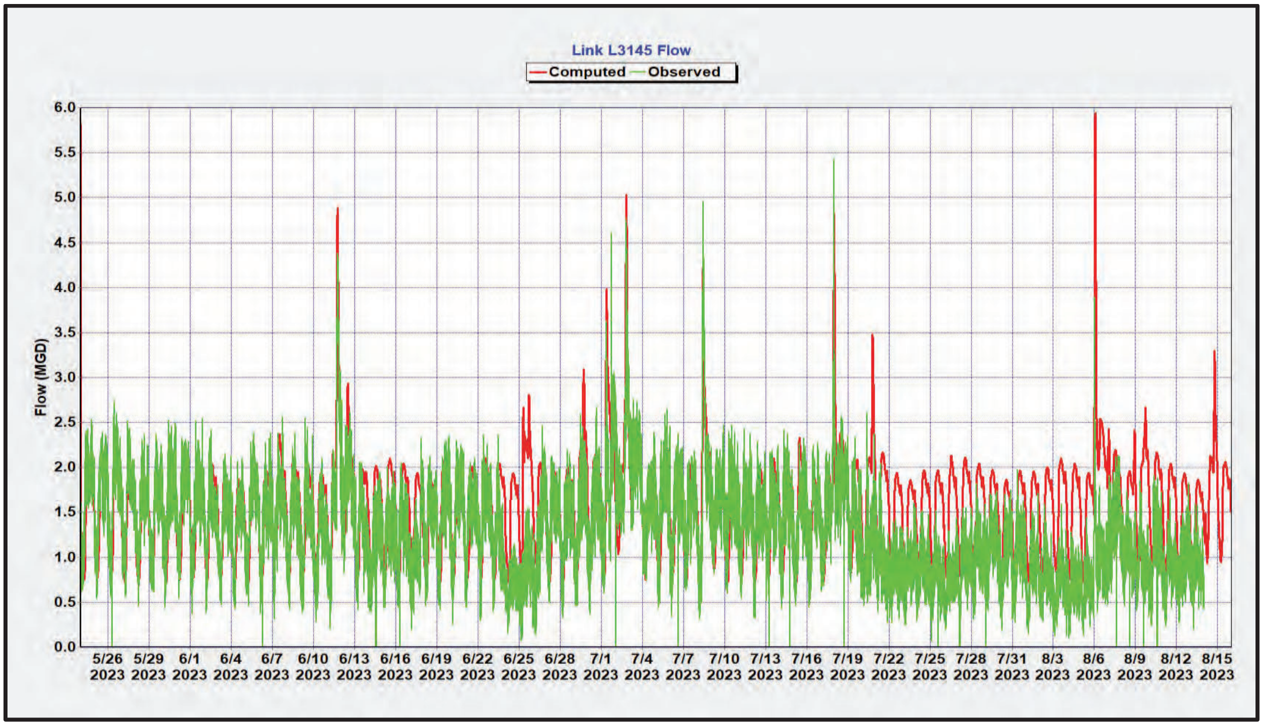
MH 3148 - 30-inch Influent: Flow (MGD)



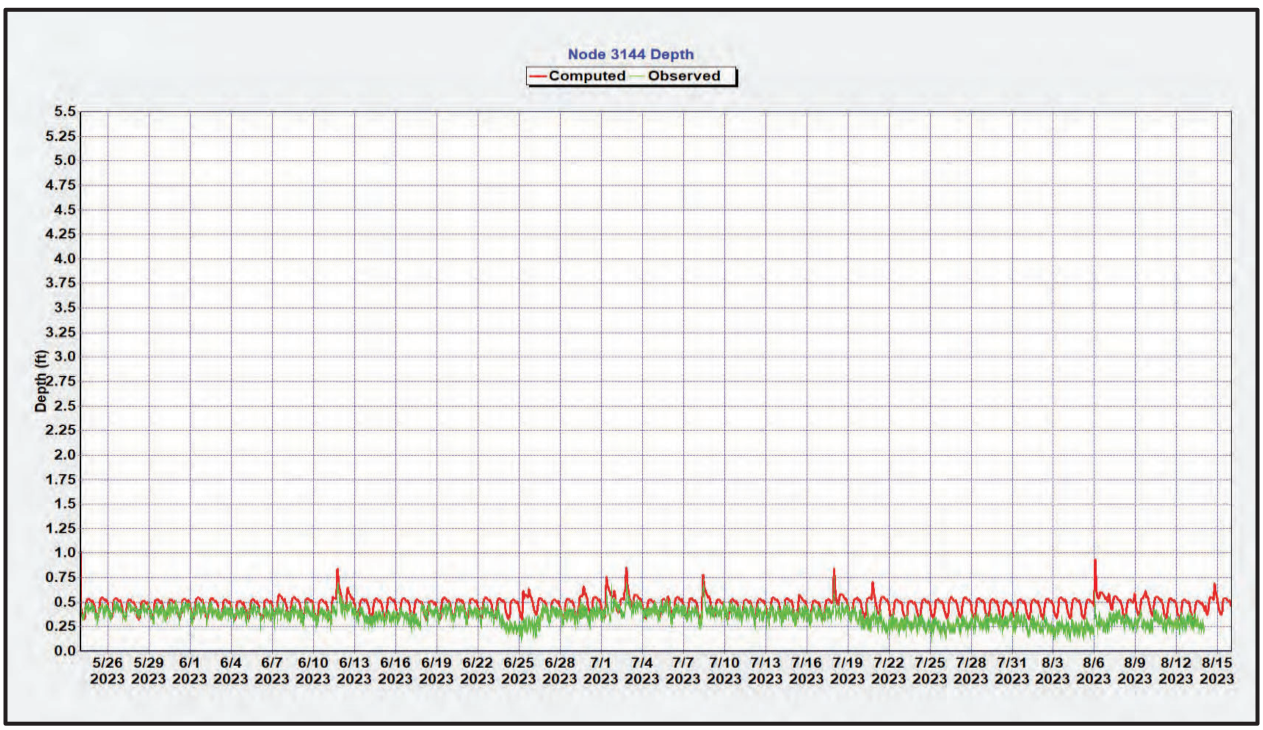
MH 3148 - 30-inch Influent: Depth (ft)



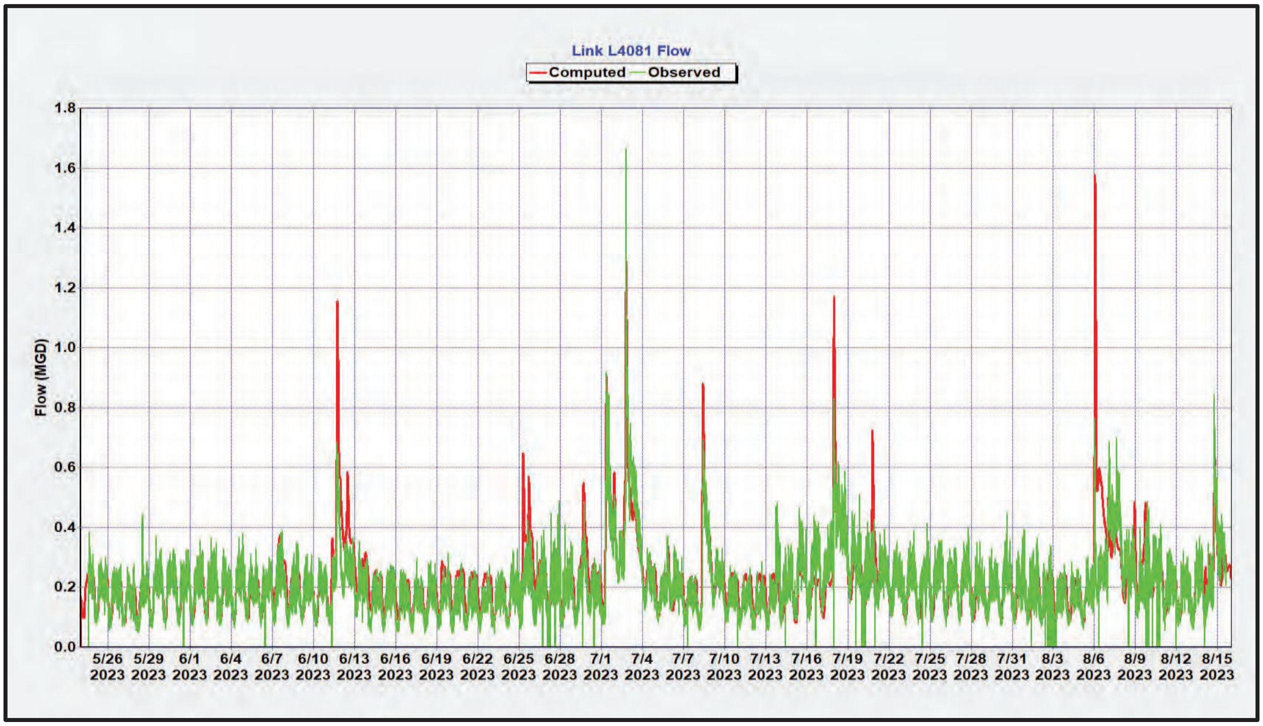
MH 3144 - 30-inch Influent: Flow (MGD)



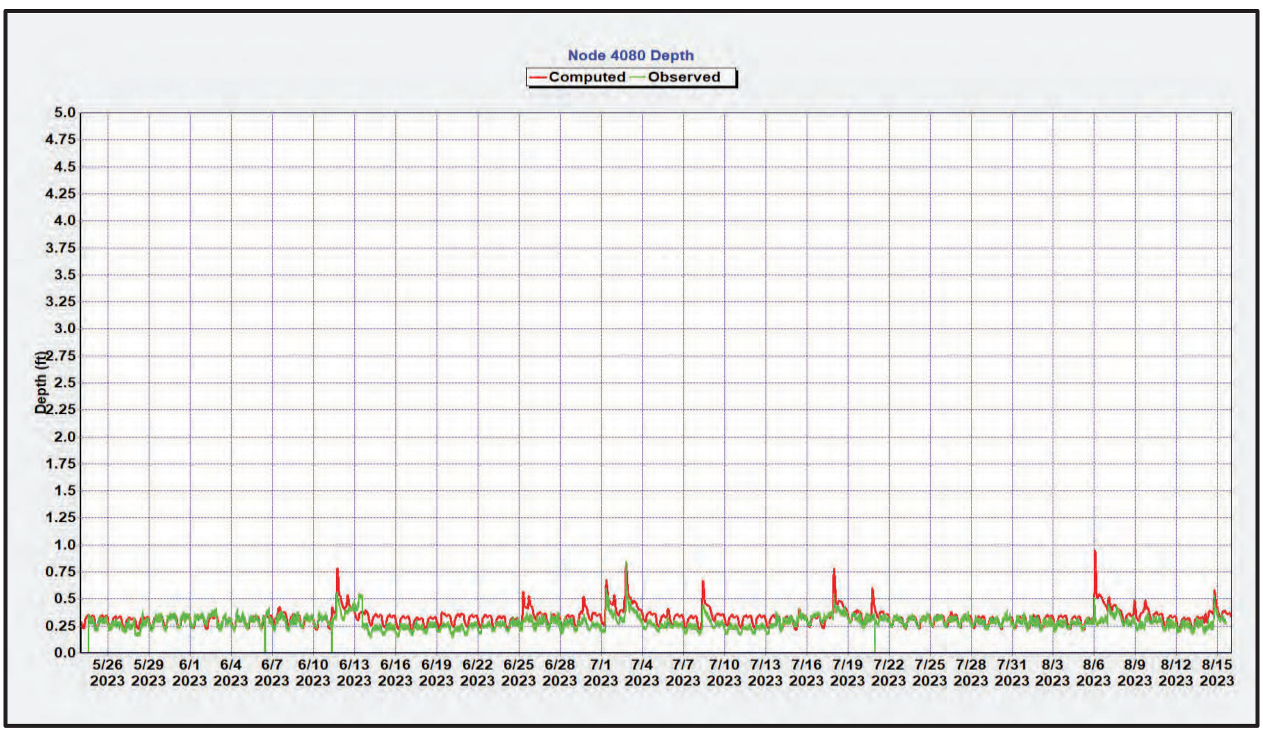
MH 3144 - 30-inch Influent: Depth (ft)



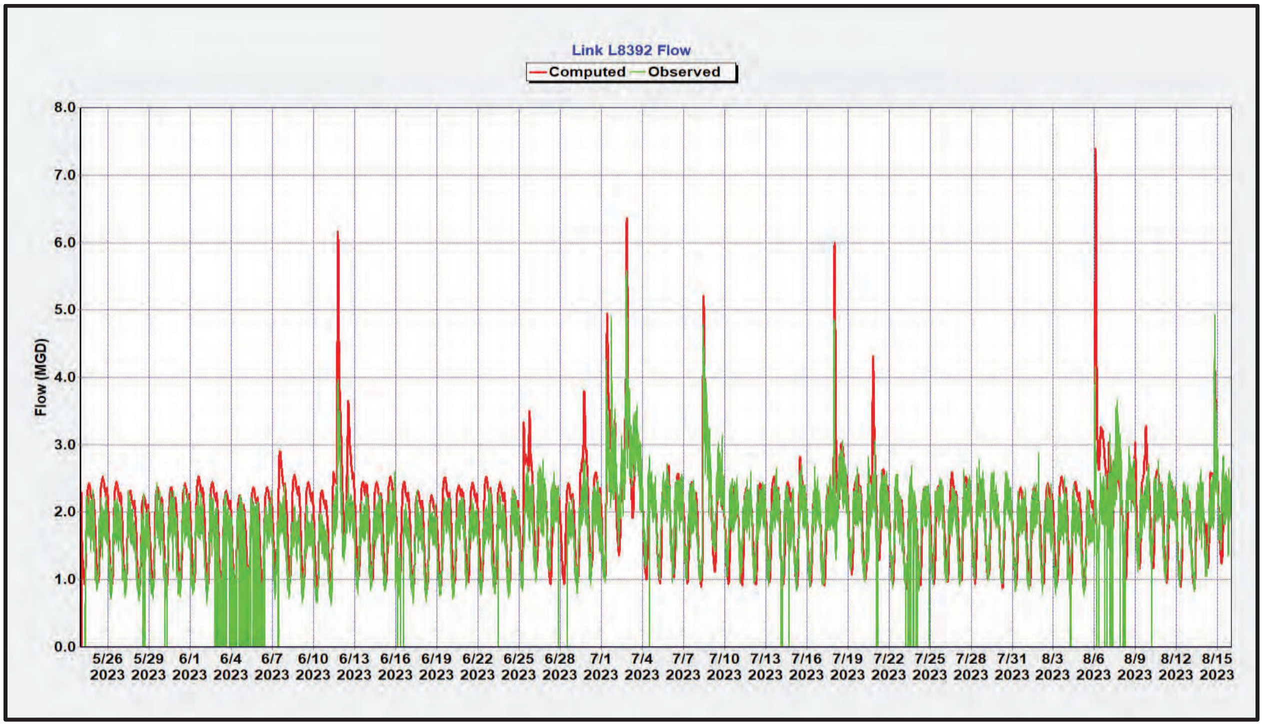
MH 4080 - 15-inch Influent: Flow (MGD)



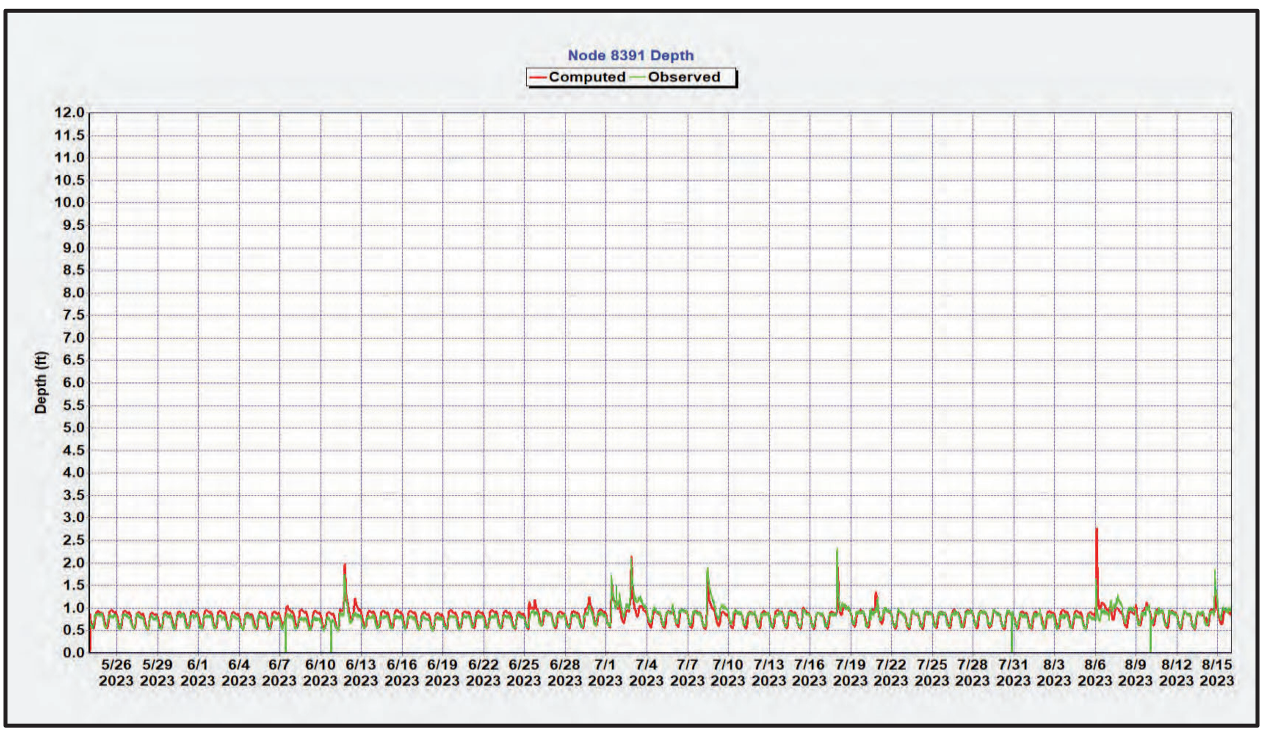
MH 4080 - 15-inch Influent: Depth (ft)



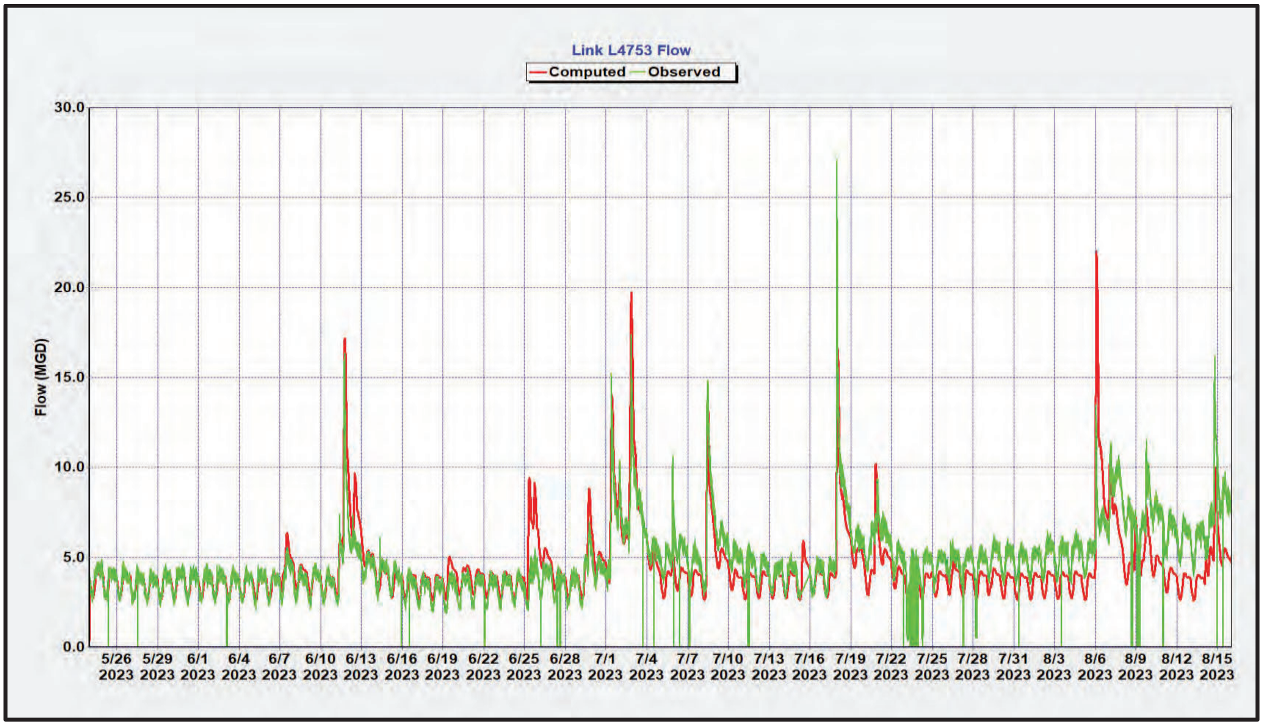
MH 8391 - 36-inch Influent: Flow (MGD)



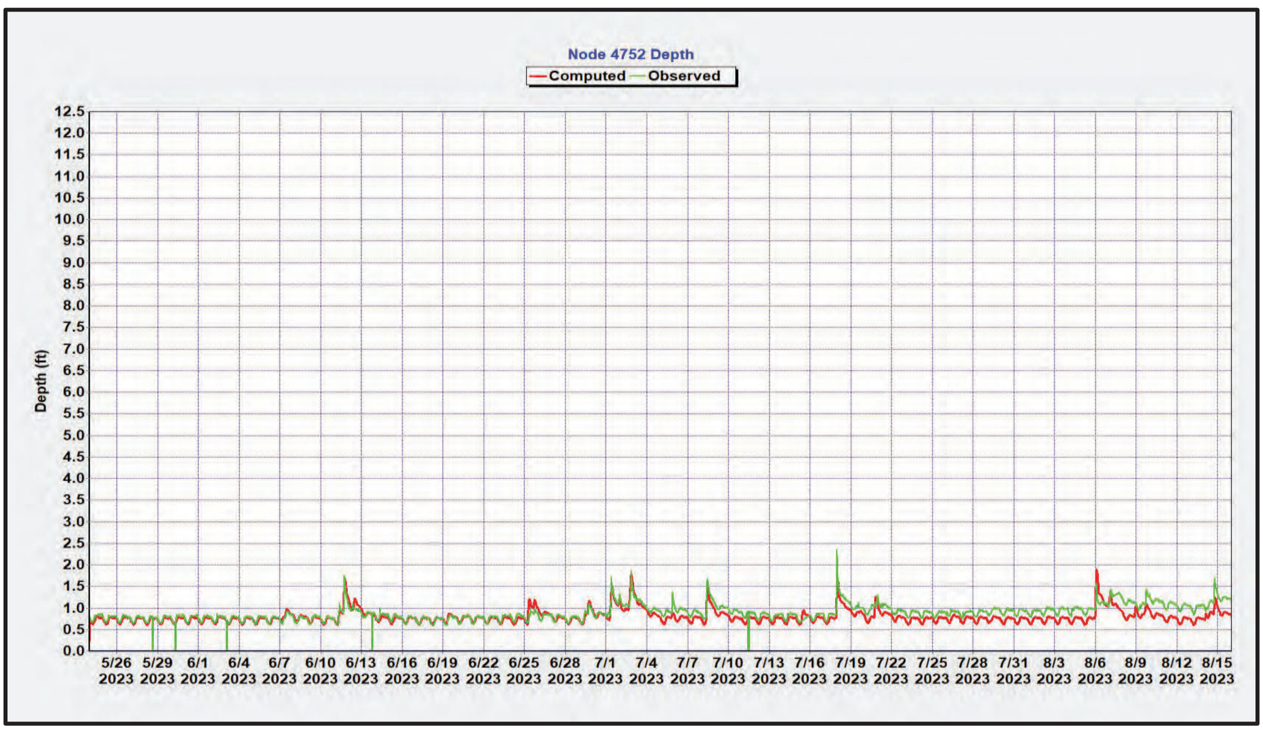
MH 8391 - 36-inch Influent: Depth (ft)



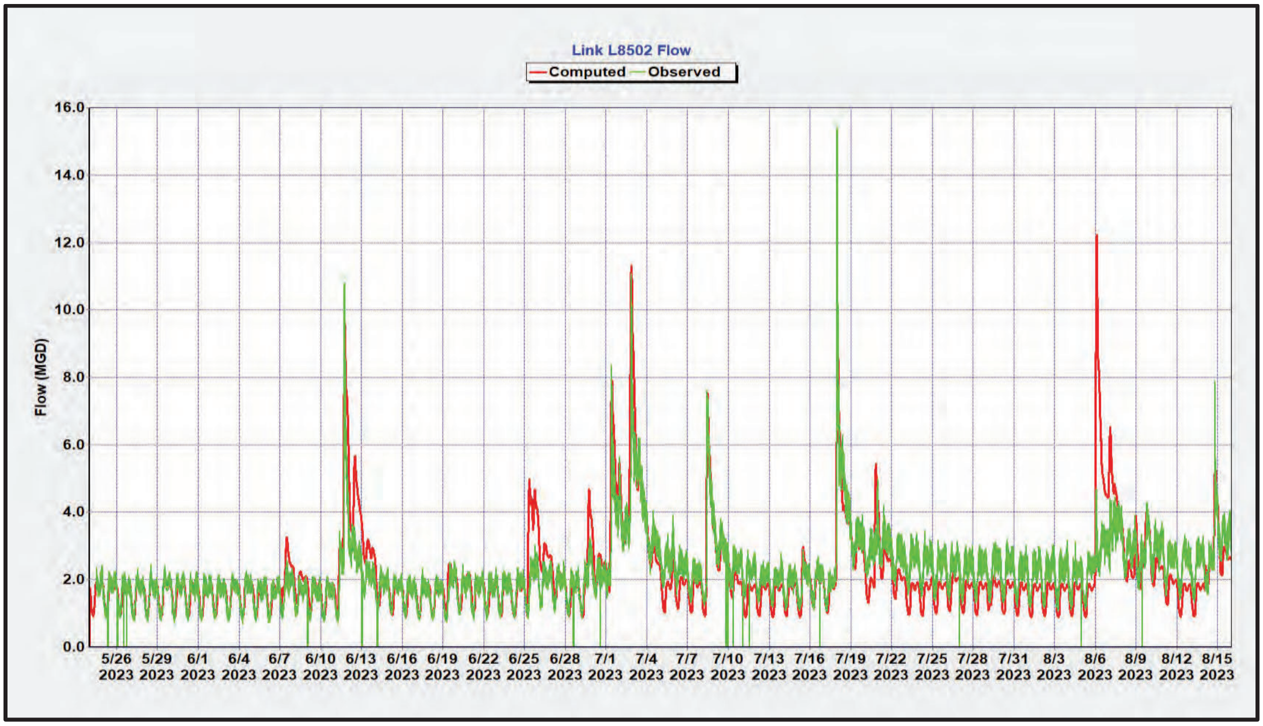
MH 4752 - 42-inch Influent: Flow (MGD)



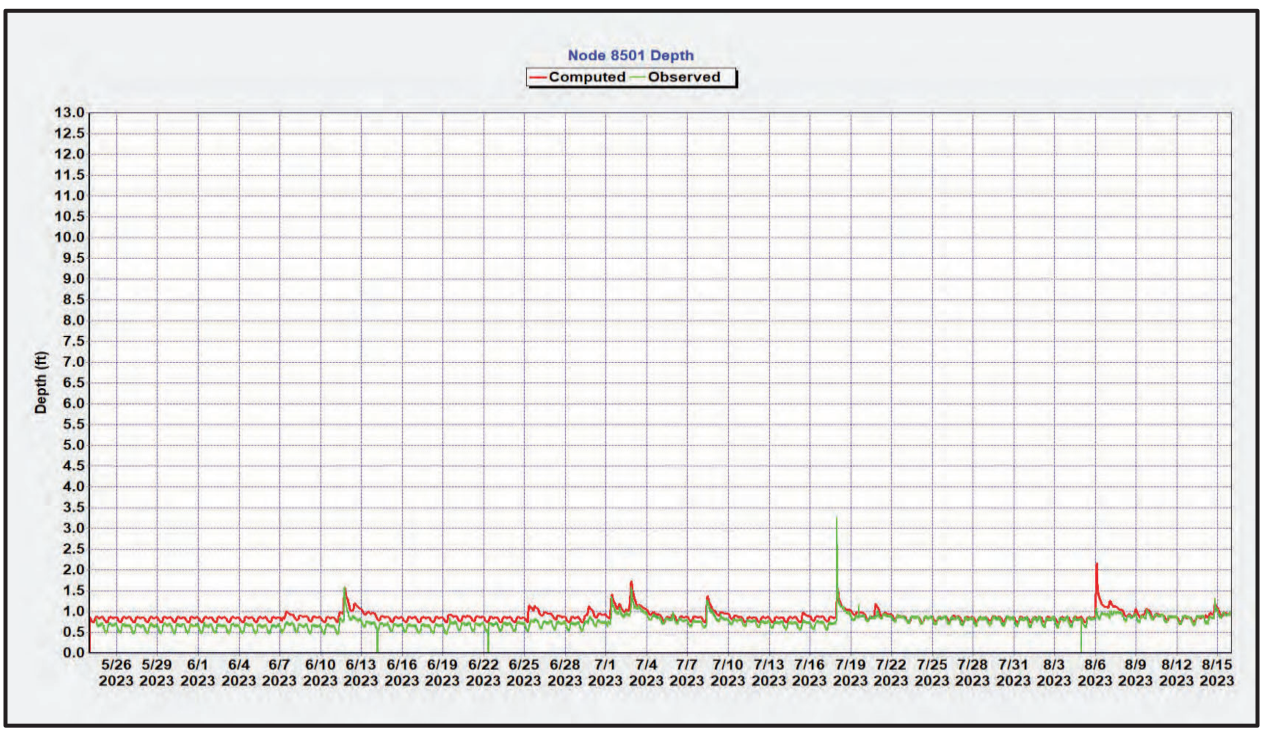
MH 4752 - 42-inch Influent: Depth (ft)



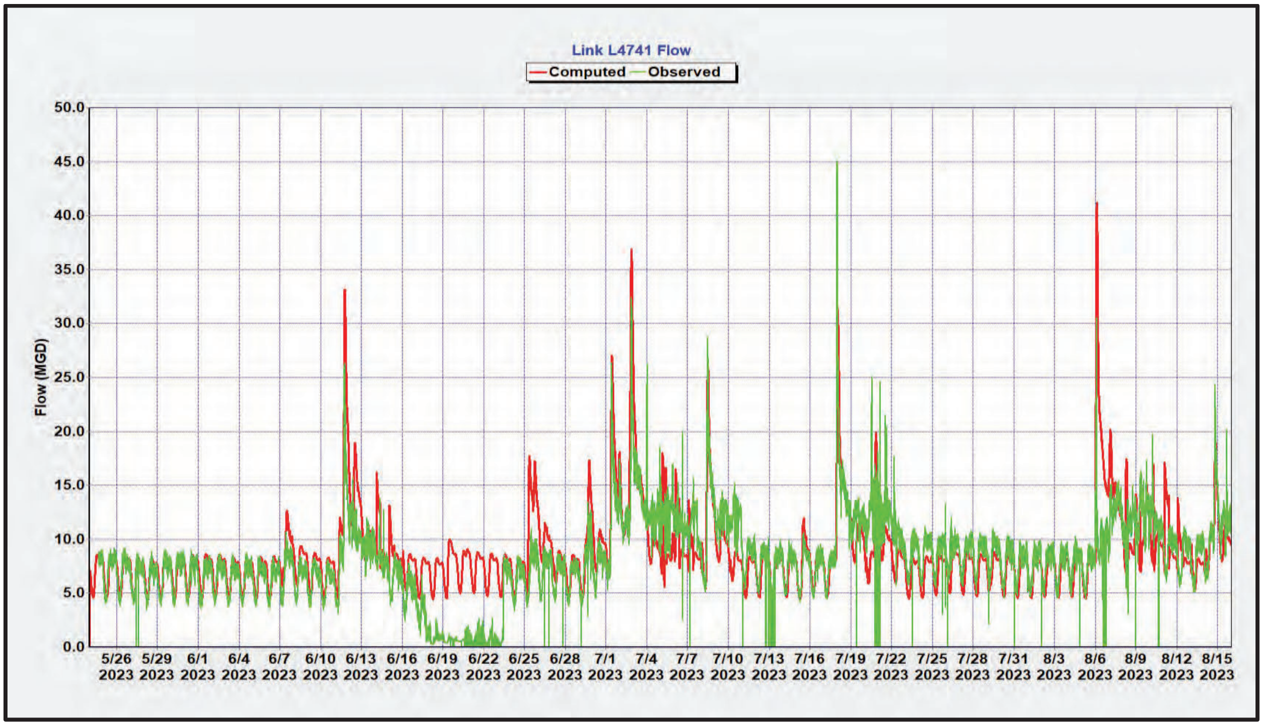
MH 8501 - 42-inch Influent: Flow (MGD)



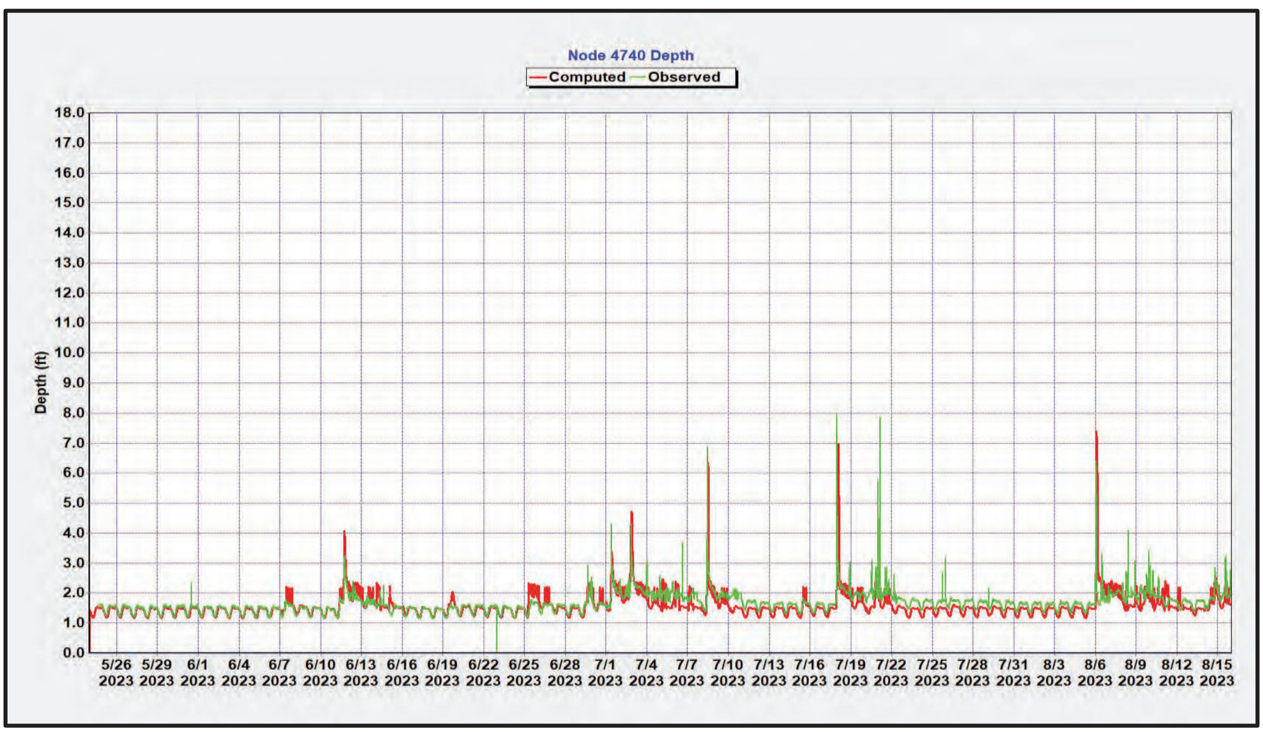
MH 8501 – 42-inch Influent: Depth (ft)



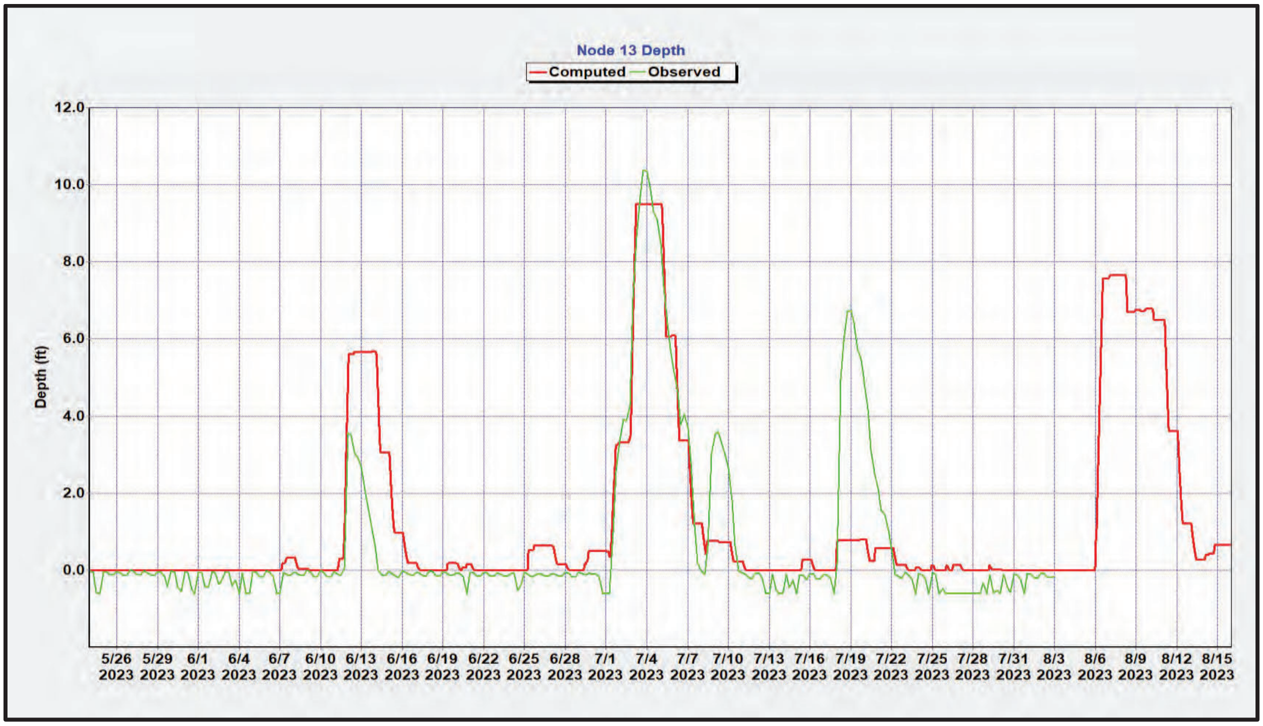
MH 4740 - 48-inch Influent: Flow (MGD)



MH 4740 - 48-inch Influent: Depth (ft)

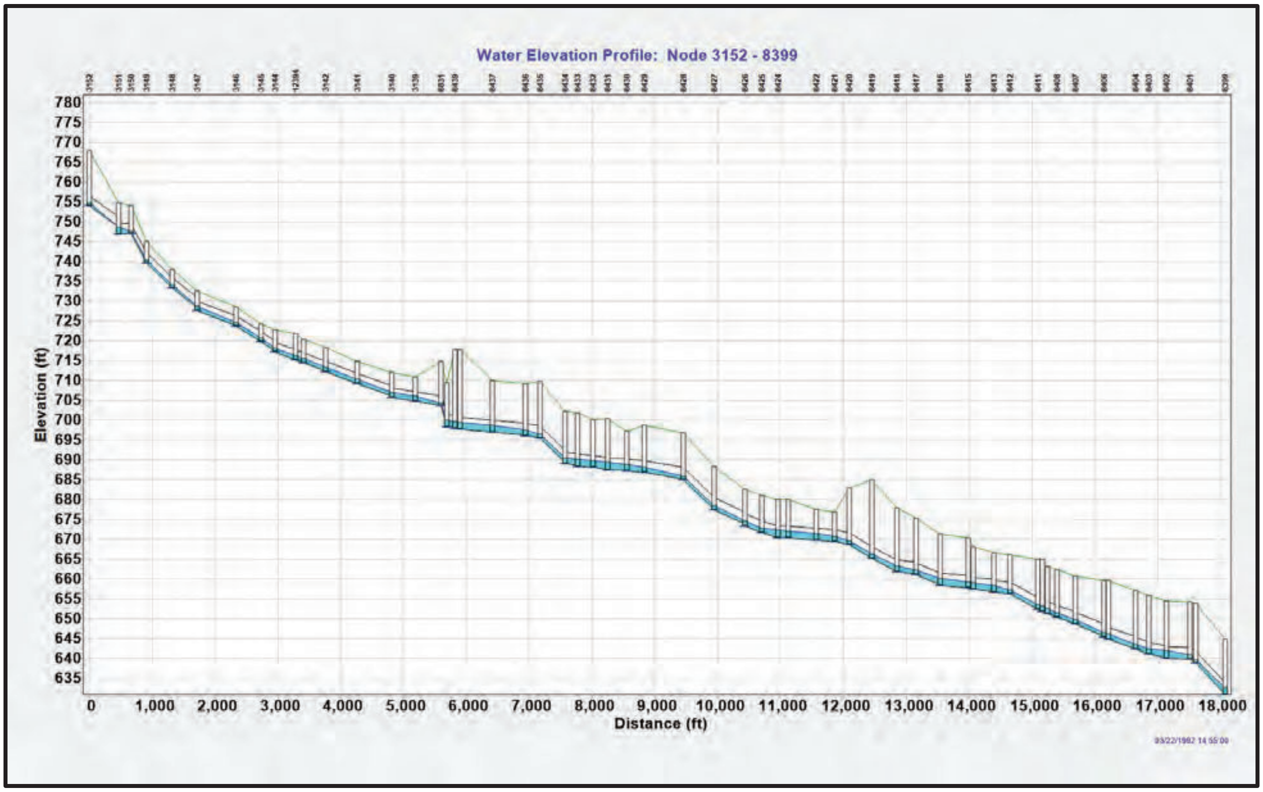


EQ Basin: Depth (ft)

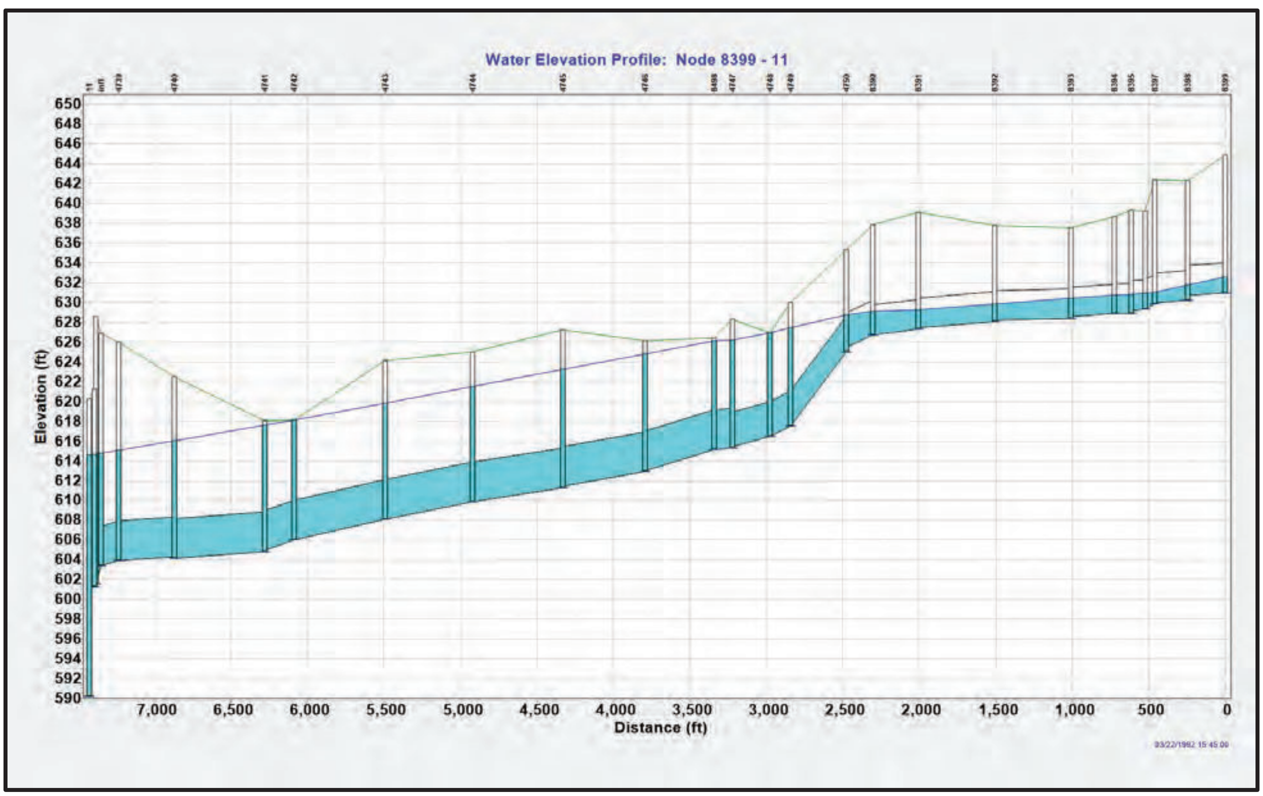


Attachment 4

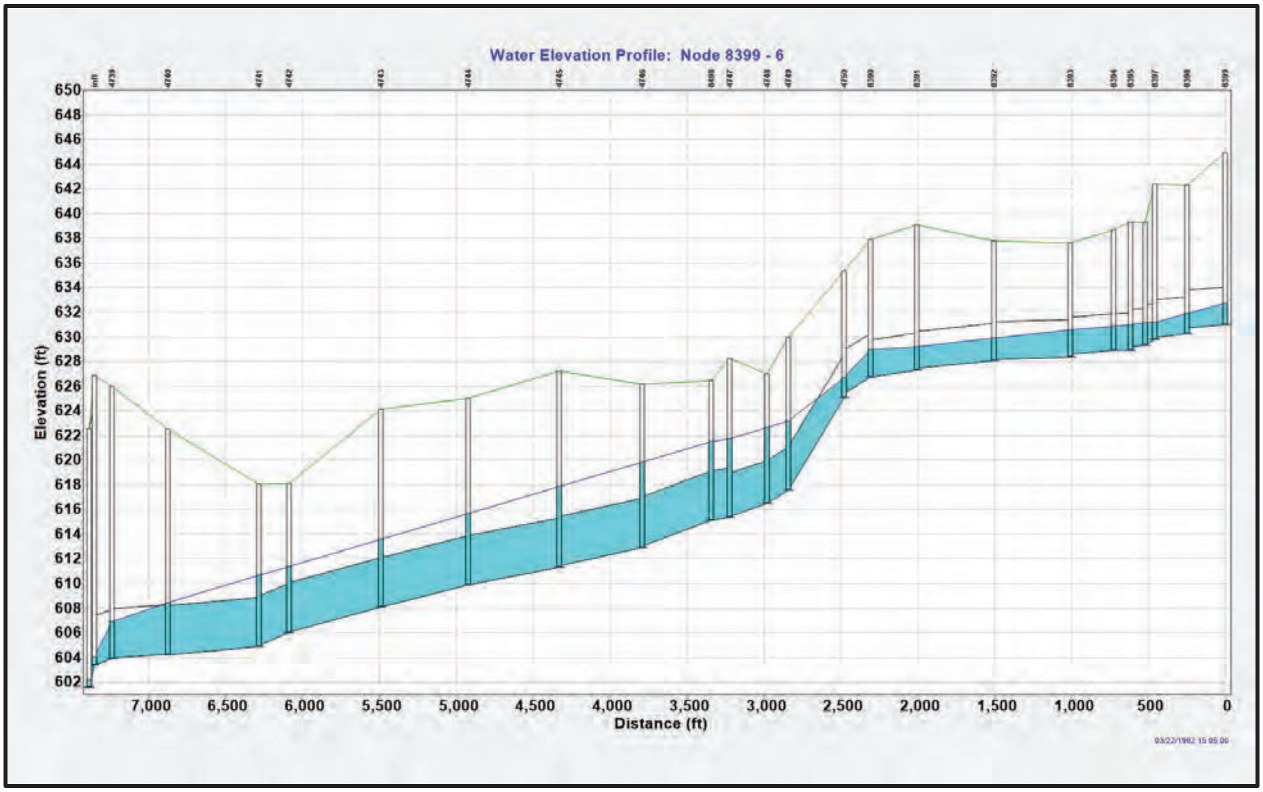
Peak Hydraulic Grade Lines



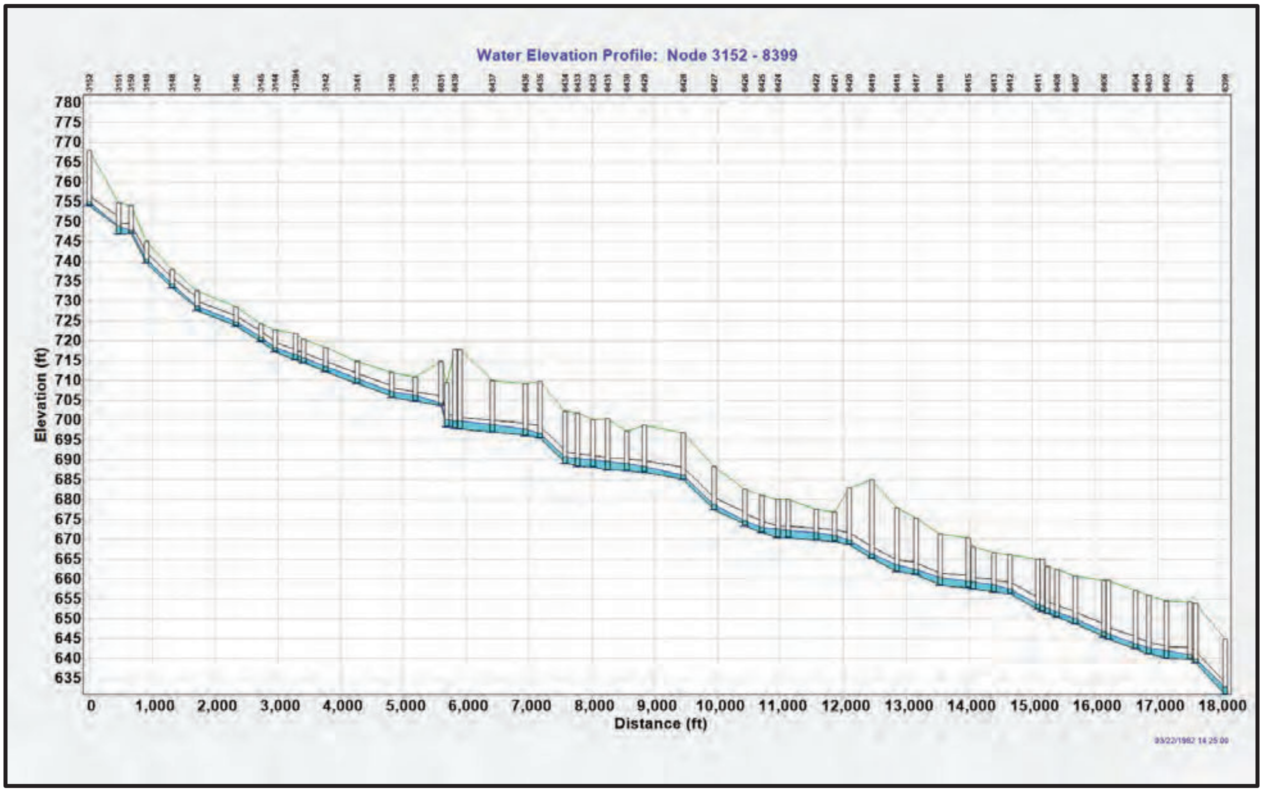
Upstream West Interceptor Hydraulic Grade Line 10-Year, 1-Hour Design Storm



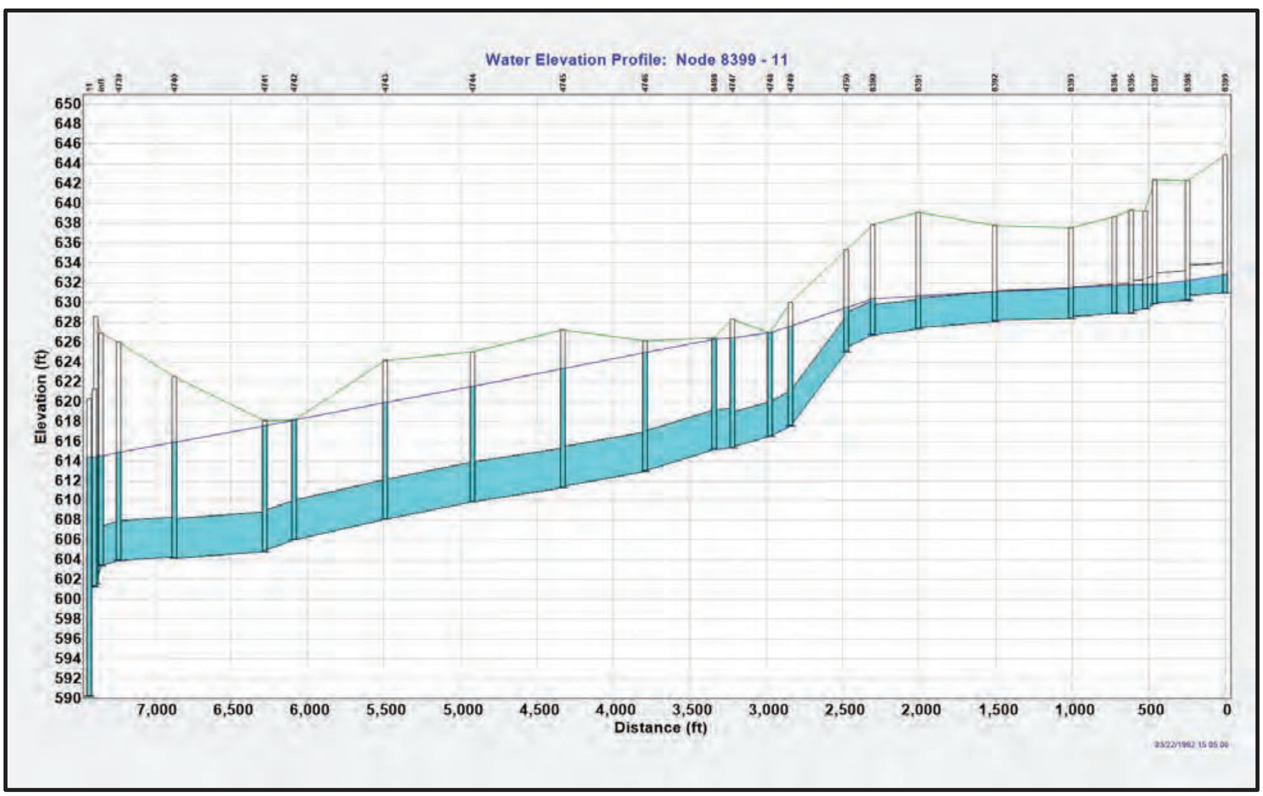
Downstream West Interceptor Hydraulic Grade Line 10-Year, 1-Hour Design Storm



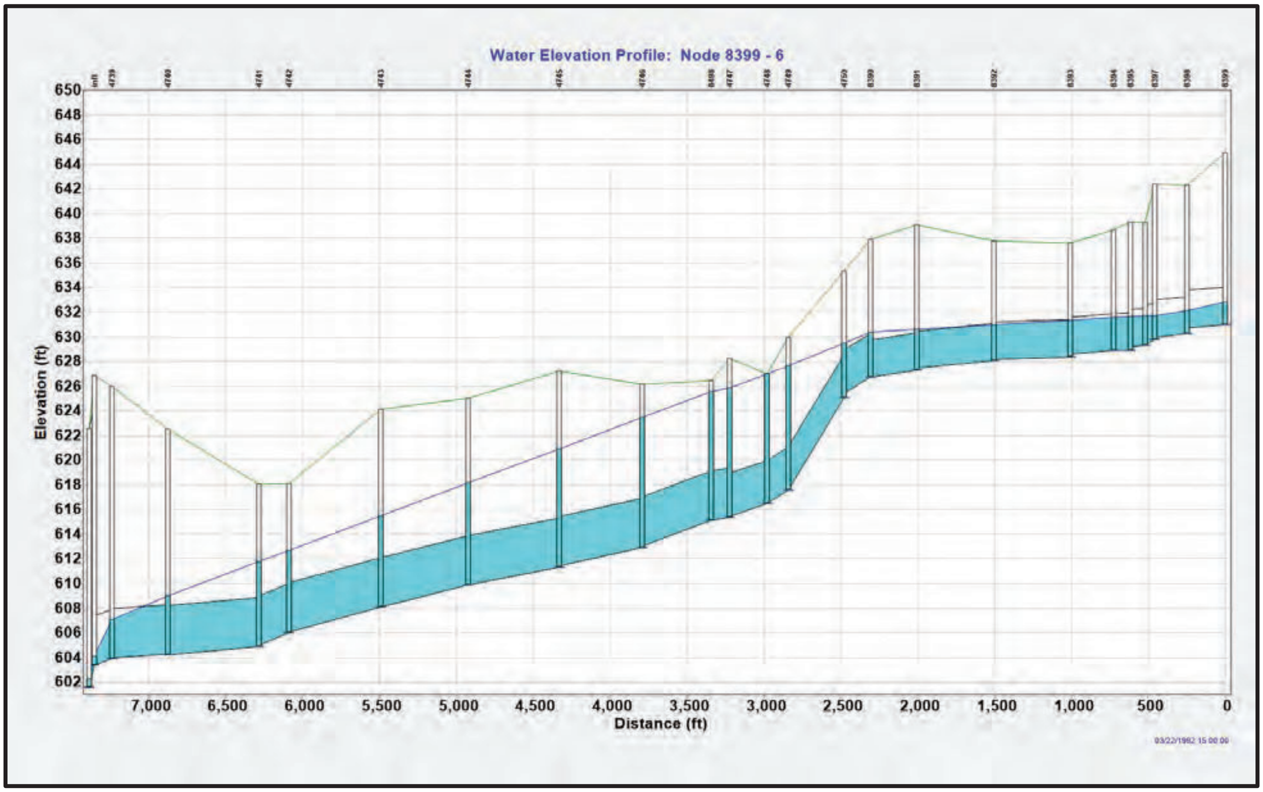
Downstream West Interceptor Hydraulic Grade Line 10-Year, 1-Hour Design Storm Without WWTP Capacity Limitations



Upstream West Interceptor Hydraulic Grade Line 25-Year, 1-Hour Design Storm



Downstream West Interceptor Hydraulic Grade Line 25-Year, 1-Hour Design Storm



Downstream West Interceptor Hydraulic Grade Line 25-Year, 1-Hour Design Storm Without WWTP Capacity Limitations

Attachment 5

Cost Estimate

ALTERNATIVE 1					
Item	**Description**	**QNTY**	**UNIT**	**UNIT COST ($)**	**TOTAL COST ($)**
1	MOBILIZATION/ DEMOBILIZATION (5%)	1	LS	2,076,000	2,076,000
2	CONTRACTOR CONSTRUCTION ENGINEERING (2%)	1	LS	814,000	814,000
3	MISC. UTILITY RELOCATION ALLOWANCE	1	LS	100,000	100,000
4	MAINTENANCE AND PROTECTION OF TRAFFIC	1	LS	100,000	100,000
5	TEMPORARY EROSION CONTROL	1	LS	100,000	100,000
6	BYPASS PUMPING	1	LS	100,000	100,000
7	36 MGD LIFT STATION	1	LS	34,434,200	34,434,200
8	36-INCH DIA. FORCE MAIN	3,050	LF	480	1,464,000
9	36-INCH DIA. FORCE MAIN - TRENCHLESS	400	LF	2,250	900,000
10	EQ BASIN DISCHARGE	1	LS	185,000	185,000
11	DIVERSION STRUCTURE WITH FLOW CONTROL	2	LS	222,000	444,000
12	42-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 8399 TO MH 8397)	460	LF	1,130	519,800
13	36-INCH DIA. GRAVITY SEWER	200	LF	1,000	200,000
14	30-INCH DIA. GRAVITY SEWER	600	LF	880	528,000
15	BEDROCK EXCAVATION	4,840	CY	250	1,210,000
16	36-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 3139 TO MH 8831)	415	LF	1,000	415,000
				CONSTRUCTION COST SUBTOTAL ($) =	**43,590,000**
				10% CONSTRUCTION CONTINGENCY (ROUNDED) =	**4,359,000**
				TOTAL CONSTRUCTION COST =	**47,949,000**
				25% NON-CONSTRUCTION COSTS (ROUNDED) =	**11,988,000**
				TOTAL COST =	**59,937,000**

ALTERNATIVE 2					
Item	Description	QNTY	UNIT	UNIT COST ($)	TOTAL COST ($)
1	MOBILIZATION/ DEMOBILIZATION (5%)	1	LS	1,604,000	1,604,000
2	CONTRACTOR CONSTRUCTION ENGINEERING (2%)	1	LS	629,000	629,000
3	MISC. UTILITY RELOCATION ALLOWANCE	1	LS	100,000	100,000
4	MAINTENANCE AND PROTECTION OF TRAFFIC	1	LS	100,000	100,000
5	TEMPORARY EROSION CONTROL	1	LS	100,000	100,000
6	BYPASS PUMPING	1	LS	100,000	100,000
7	14 MGD LIFT STATION	1	LS	13,946,500	13,946,500
8	24-INCH DIA. FORCE MAIN	2,100	LF	370	777,000
9	EQ BASIN DISCHARGE	1	LS	185,000	185,000
10	CONNECTION FROM LIFT STATION	1	LS	500,000	500,000
11	54-INCH DIA. GRAVITY SEWER	1,400	LF	1,430	2,002,000
12	54-INCH DIA. GRAVITY SEWER - UNDER I-69	400	LF	8,080	3,232,000
13	48-INCH DIA. GRAVITY RELIEF SEWER	2,250	LF	1,280	2,880,000
14	42-INCH DIA. GRAVITY RELIEF SEWER	970	LF	1,130	1,096,100
15	30-INCH DIA. GRAVITY RELIEF SEWER	1,830	LF	880	1,610,400
16	DIVERSION STRUCTURE	3	LS	185,000	555,000
17	BEDROCK EXCAVATION	15,400	CY	250	3,850,000
18	36-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 3139 TO MH 8831)	415	LF	1,000	415,000
				CONSTRUCTION COST SUBTOTAL ($) =	**33,682,000**
				10% CONSTRUCTION CONTINGENCY (ROUNDED) =	**3,369,000**
				TOTAL CONSTRUCTION COST =	**37,051,000**
				25% NON-CONSTRUCTION COSTS (ROUNDED) =	**9,263,000**
				TOTAL COST =	**46,314,000**

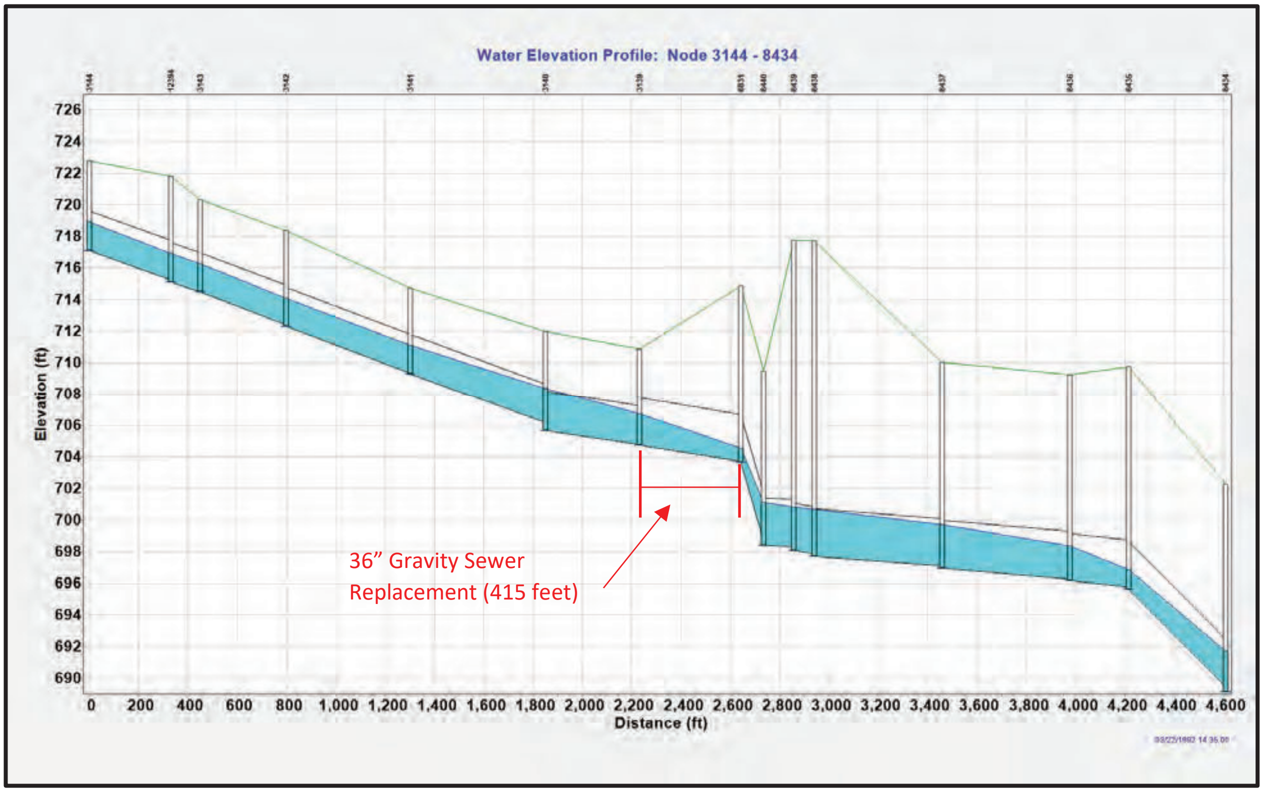
ALTERNATIVE 3					
Item	**Description**	**QNTY**	**UNIT**	**UNIT COST ($)**	**TOTAL COST ($)**
1	MOBILIZATION/ DEMOBILIZATION (5%)	1	LS	1,563,000	1,563,000
2	CONTRACTOR CONSTRUCTION ENGINEERING (2%)	1	LS	613,000	613,000
3	MISC. UTILITY RELOCATION ALLOWANCE	1	LS	100,000	100,000
4	MAINTENANCE AND PROTECTION OF TRAFFIC	1	LS	100,000	100,000
5	TEMPORARY EROSION CONTROL	1	LS	100,000	100,000
6	BYPASS PUMPING	1	LS	500,000	500,000
7	14 MGD LIFT STATION	1	LS	13,946,500	13,946,500
8	24-INCH DIAMETER FORCE MAIN	2,100	LF	370	777,000
9	EQ BASIN DISCHARGE	1	LS	185,000	185,000
10	CONNECTION FROM LIFT STATION	1	LS	500,000	500,000
11	54-INCH DIAMETER GRAVITY RELIEF SEWER	1,400	LF	1,430	2,002,000
12	54-INCH DIAMETER GRAVITY RELIEF SEWER - UNDER I-69	400	LF	8,080	3,232,000
13	48-INCH DIAMETER GRAVITY RELIEF SEWER	2,250	LF	1,280	2,880,000
14	48-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 8390 TO MH 4747)	920	LF	1,280	1,177,600
15	42-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 8396 TO MH 8390)	1,790	LF	1,130	2,022,700
16	DIVERSION STRUCTURE	1	LS	185,000	185,000
17	BEDROCK EXCAVATION	9,865	CY	250	2,466,200
18	LATERAL CONNECTIONS	2	EA	25,000	50,000
19	36-INCH DIA. GRAVITY SEWER REPLACEMENT (MH 3139 TO MH 8831)	415	LF	1,000	415,000
				CONSTRUCTION COST SUBTOTAL ($) =	**32,815,000**
				10% CONSTRUCTION CONTINGENCY (ROUNDED) =	**3,282,000**
				TOTAL CONSTRUCTION COST =	**36,097,000**
				25% NON-CONSTRUCTION COSTS (ROUNDED) =	**9,025,000**
				TOTAL COST =	**45,122,000**

Attachment 6

Alternatives Hydraulic Grade Lines

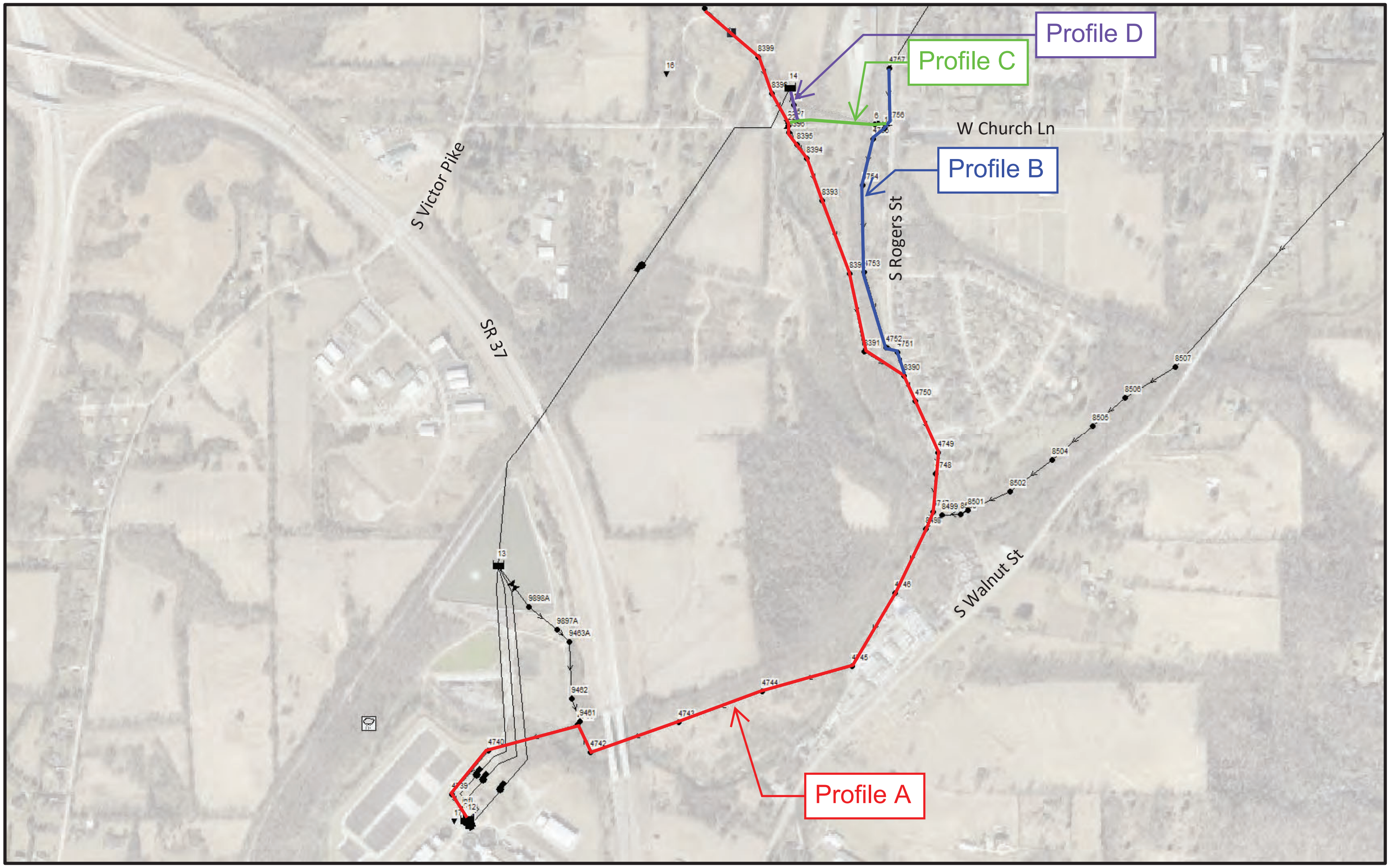
Upstream Solution for Alternatives 1, 2, and 3

Profile Shown



Profile A Hydraulic Grade Line 50-Year, 1-Hour Design Storm

Alternative 1



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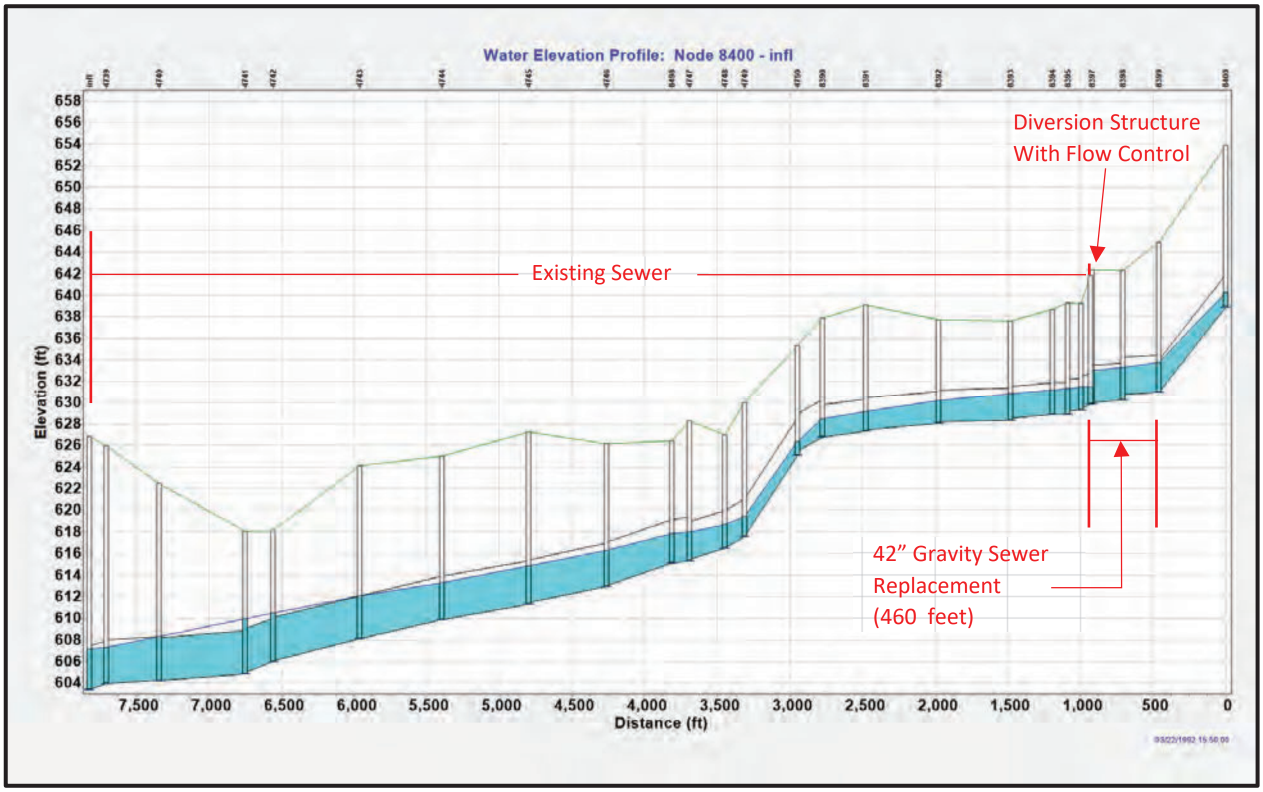
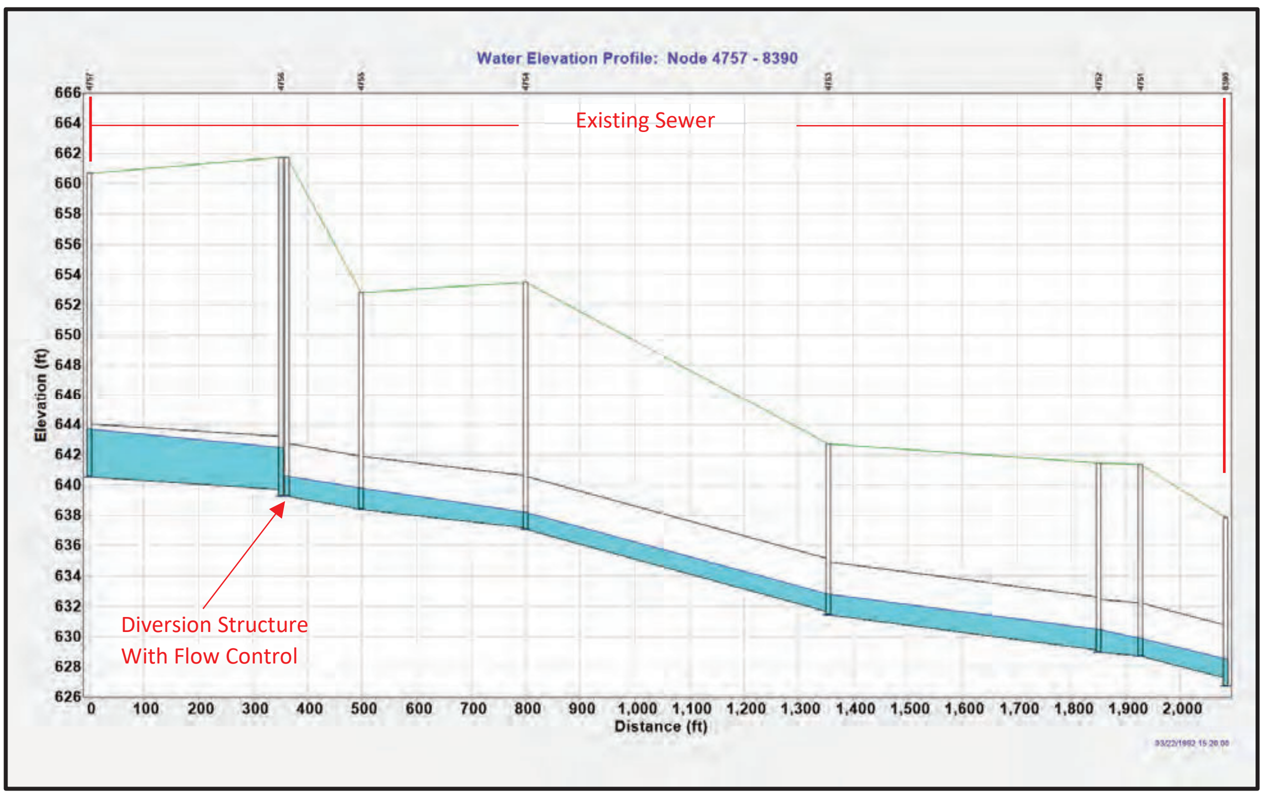
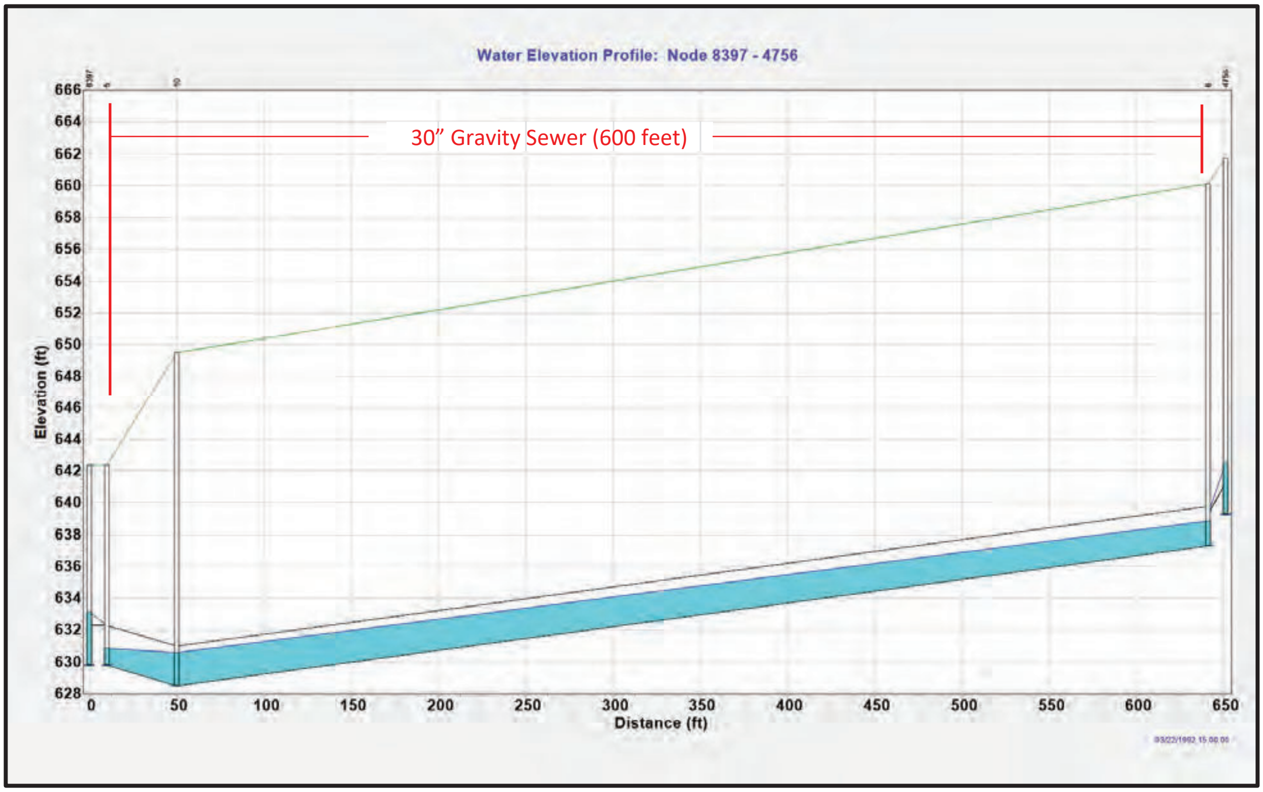


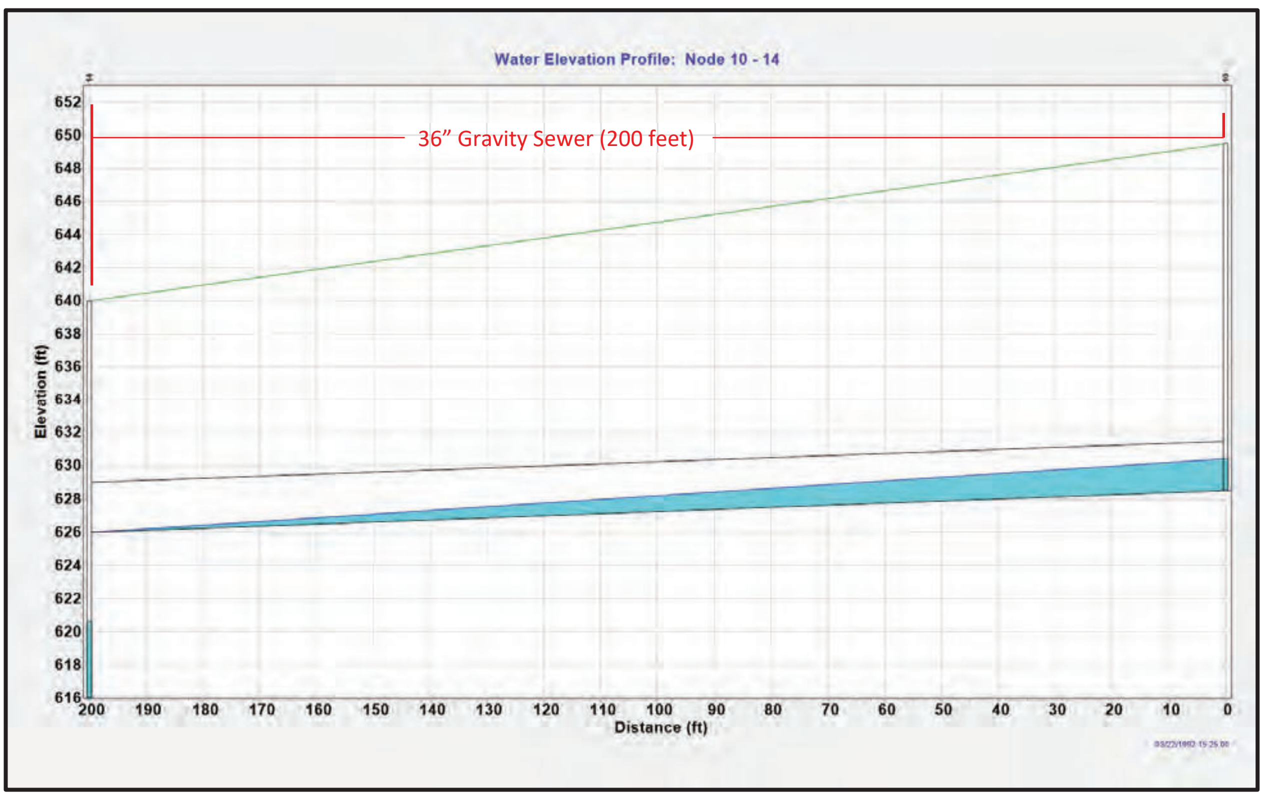
Profile A Hydraulic Grade Line 50-Year, 1-Hour Design Storm



Profile B Hydraulic Grade Line 50-Year, 1-Hour Design Storm

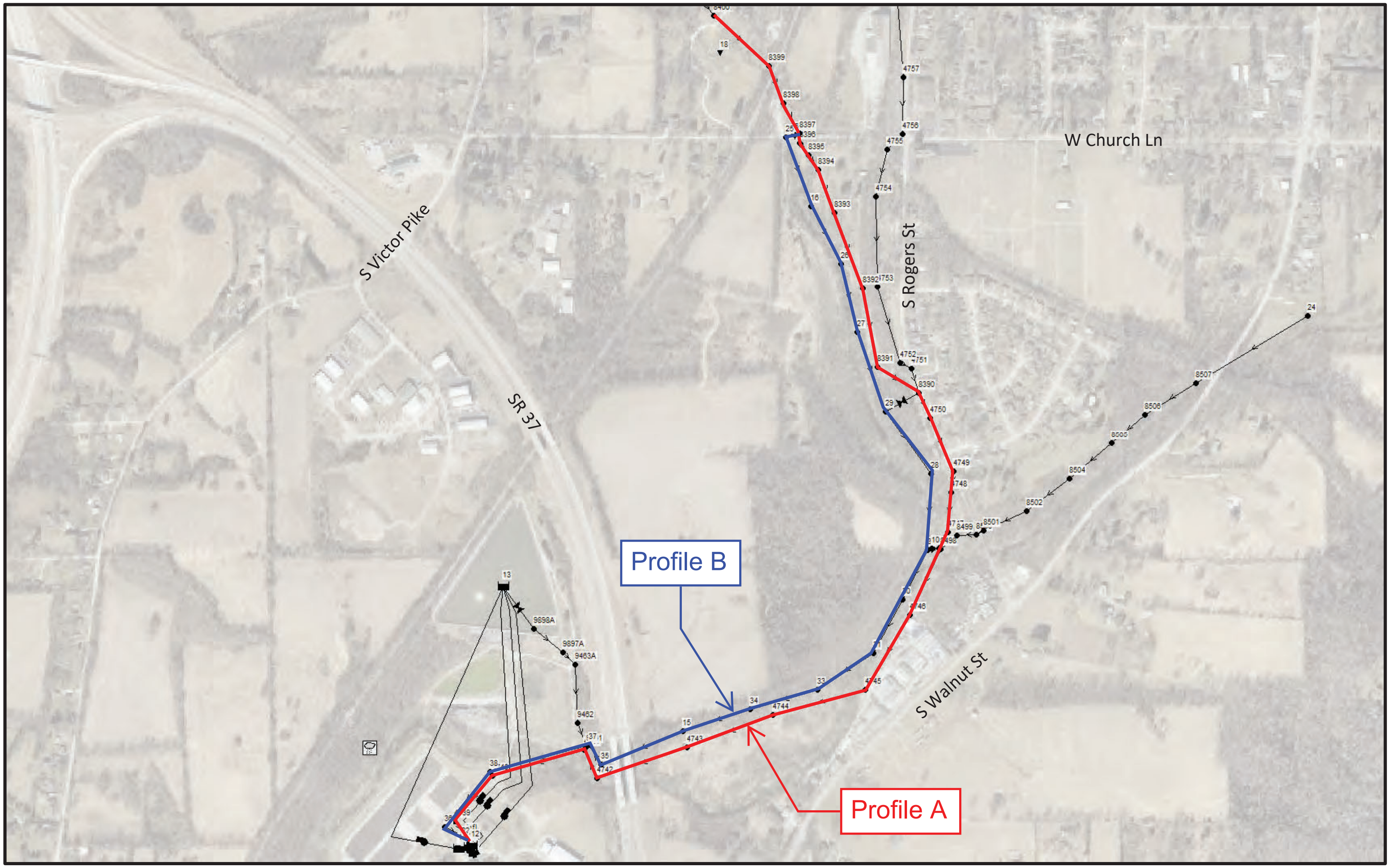


Profile C Hydraulic Grade Line 50-Year, 1-Hour Design Storm



Profile D Hydraulic Grade Line 50-Year, 1-Hour Design Storm

Alternative 2



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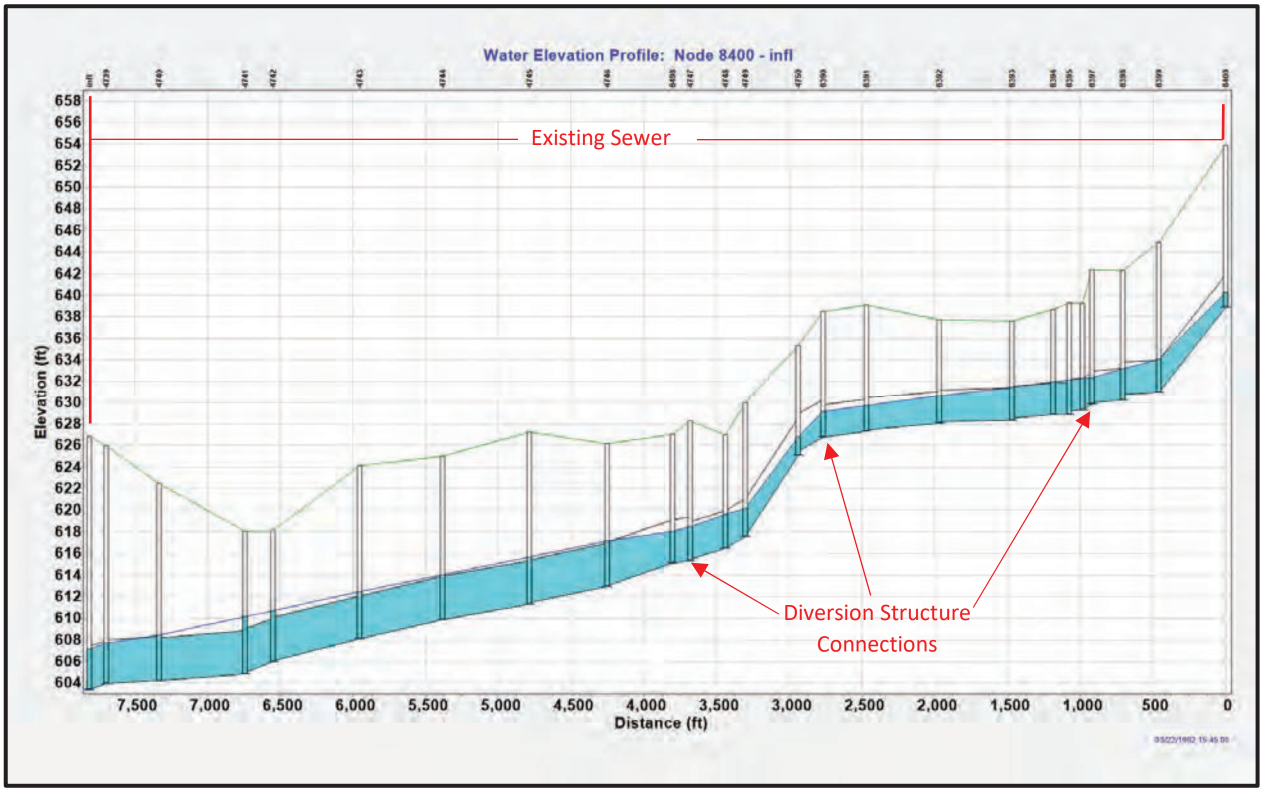
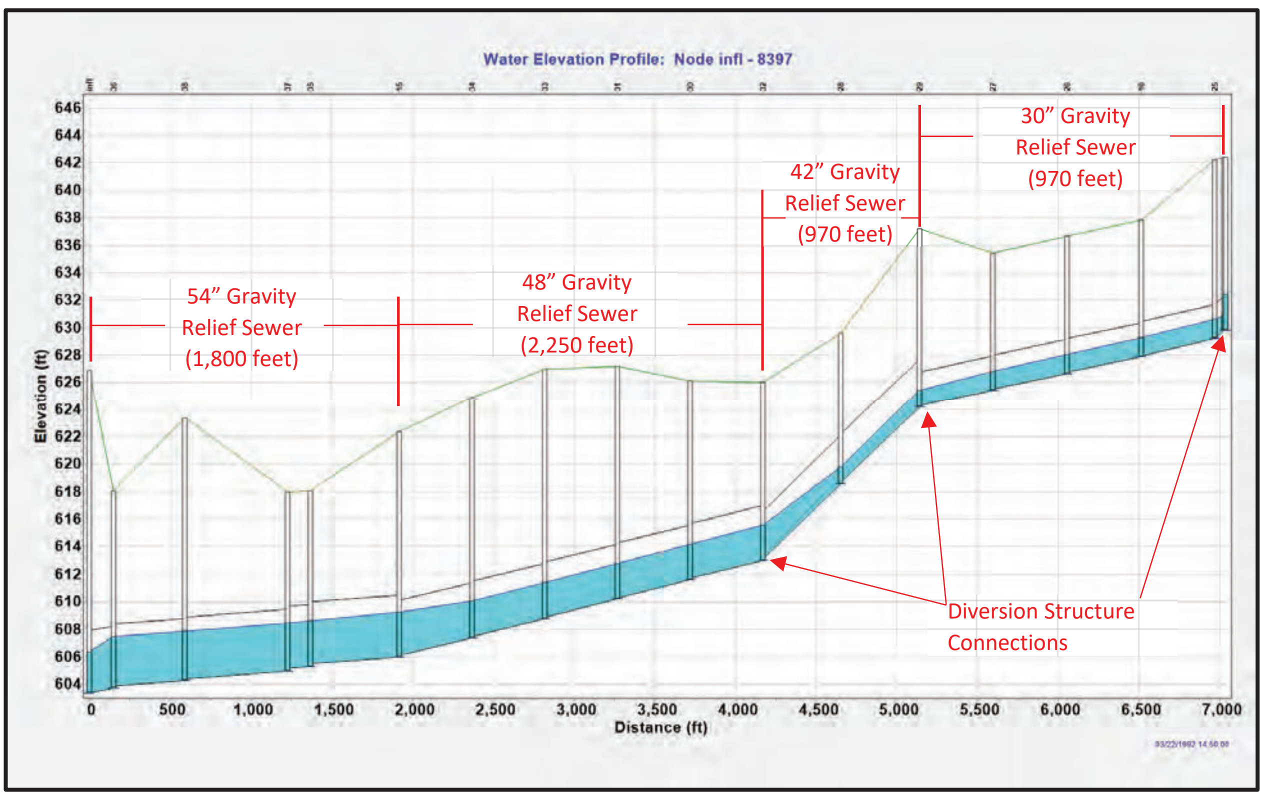
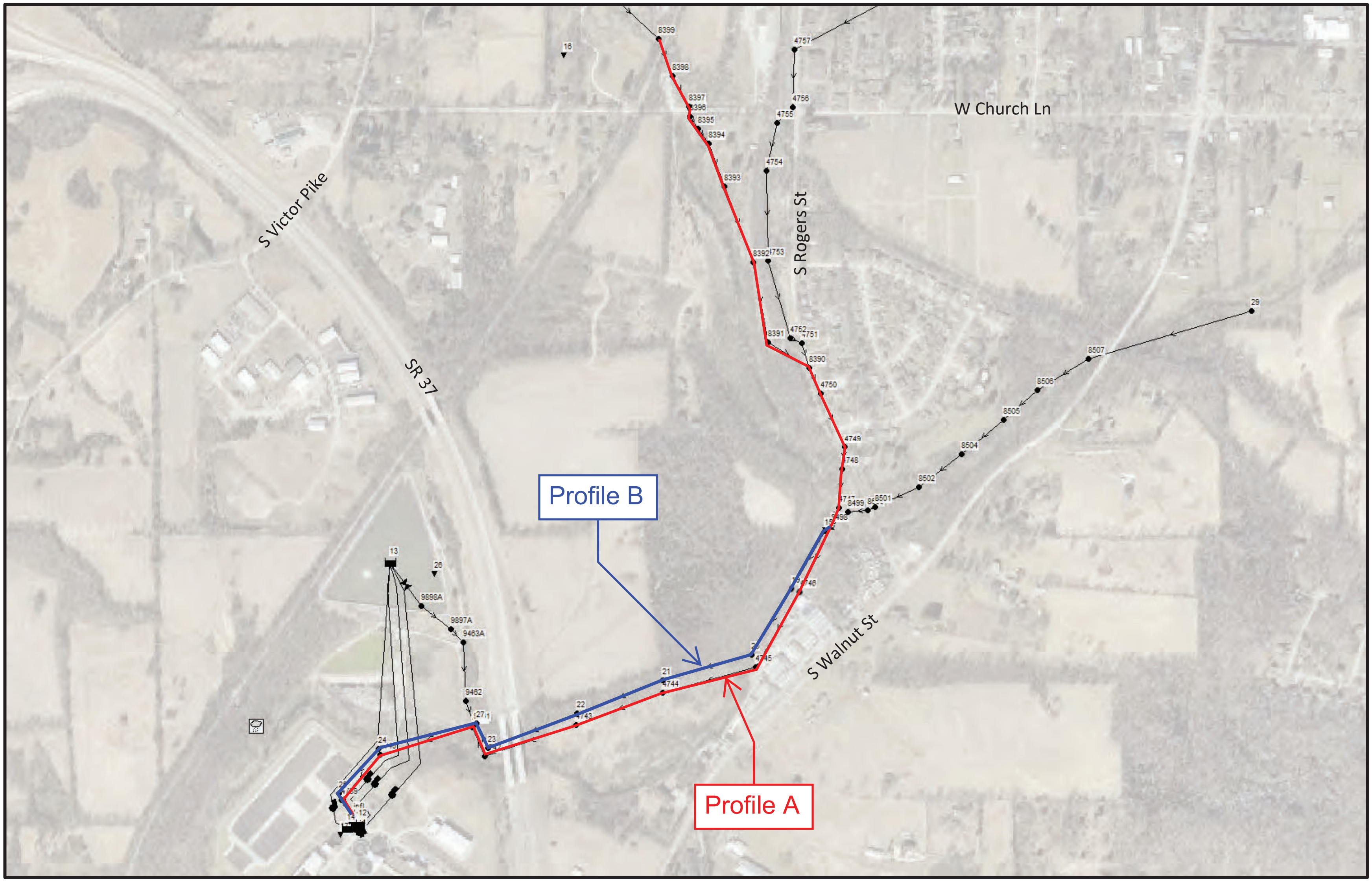


Profile A Hydraulic Grade Line 50-Year, 1-Hour Design Storm



Profile B Hydraulic Grade Line 50-Year, 1-Hour Design Storm

Alternative 3



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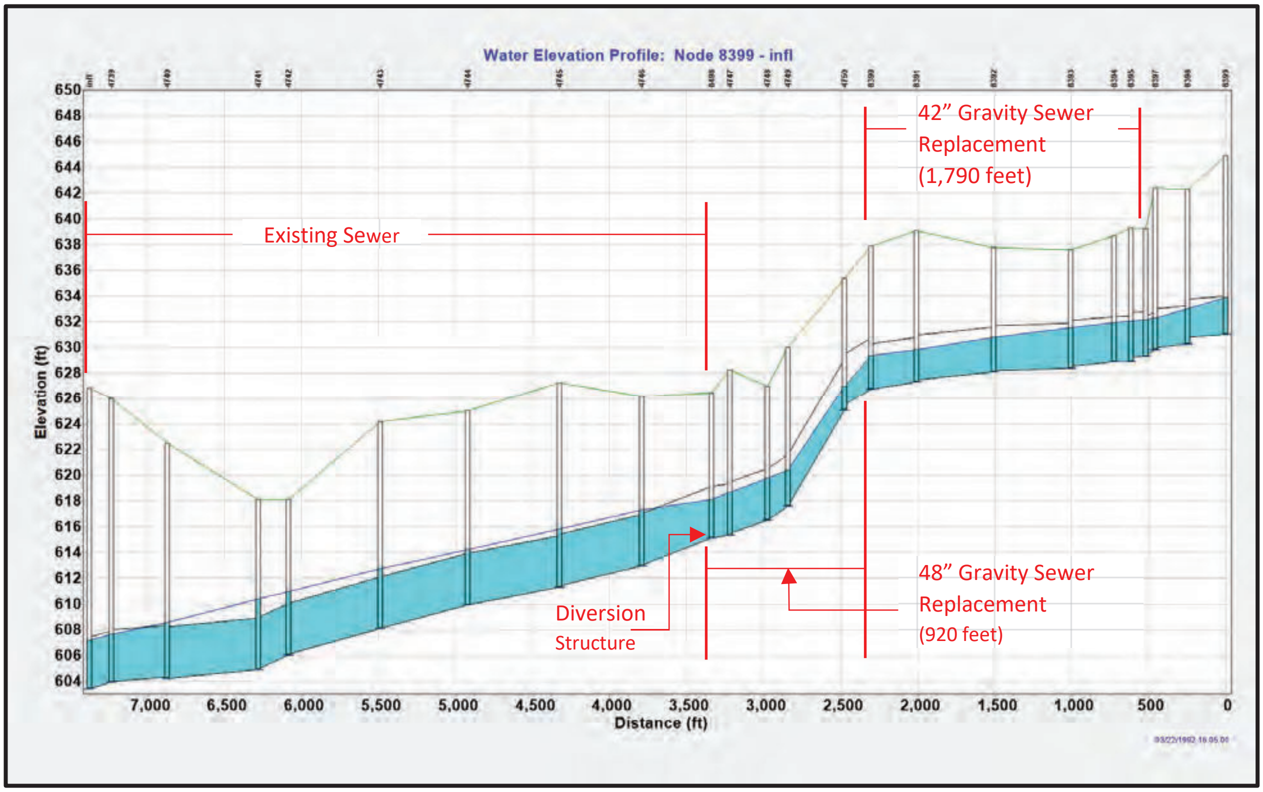
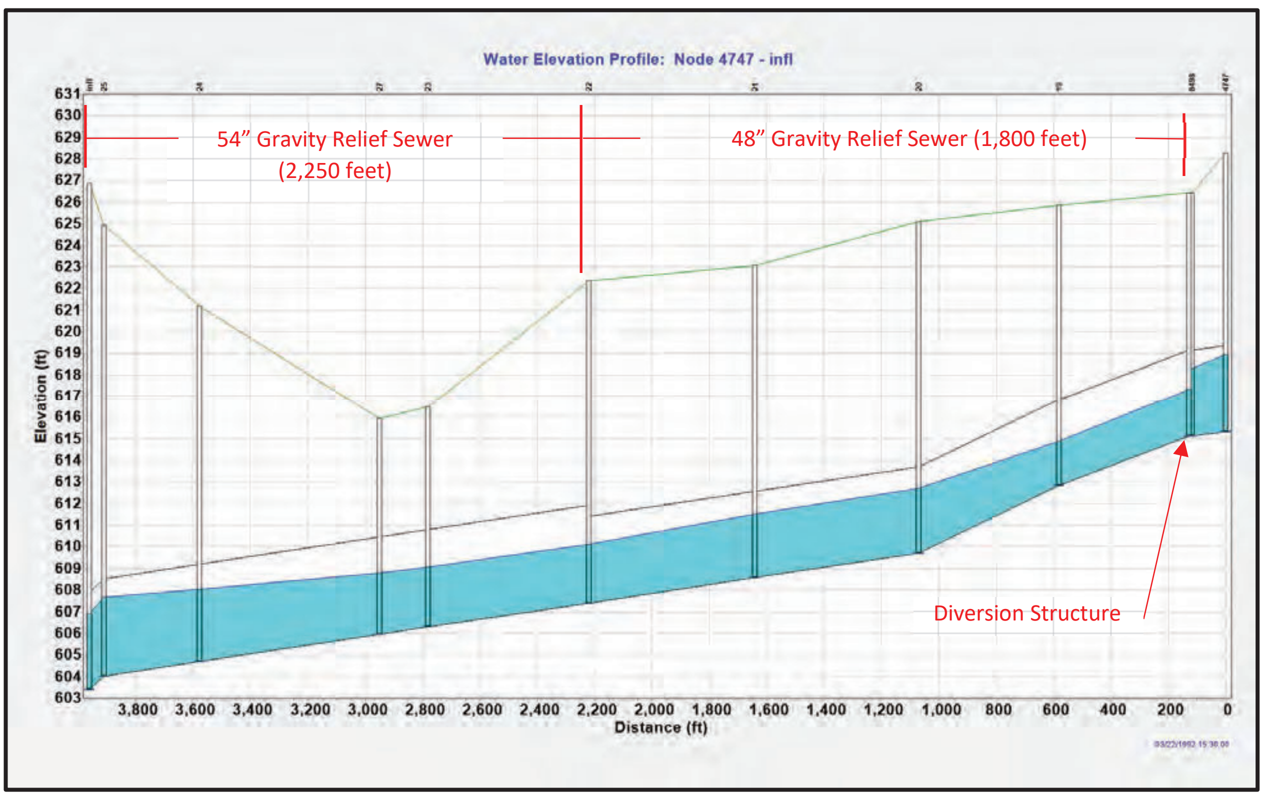


Profile A Hydraulic Grade Line 50-Year, 1-Hour Design Storm



Profile B Hydraulic Grade Line 50-Year, 1-Hour Design Storm