City of PIQUA Ohio

FINAL REPORT

SANITARY SEWER SYSTEM MASTER PLAN

July 2012

CDM Smith

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Executive Summary

Purpose

The City of Piqua, Ohio (City) initiated this Sanitary Sewer System Master Plan in accordance with the Plan of Action submitted to the Ohio Environmental Protection Agency (OEPA). The intent of this report is to identify and prioritize the capital improvements necessary to achieve the following:

- Eliminate the SSO in accordance with the City's NPDES permit.
- Identify and eliminate deficiencies in the existing interceptor system to meet the criteria established in the Master Plan.
- Serve future development to meet long-term collection system needs.

Concurrently, the City is evaluating its wastewater treatment plant (WWTP) which requires close coordination between the two studies because the two systems, collection system and WWTP, must operate in concert to achieve the primary goal of eliminating the SSO.

Model Expansion and Data Collection

The existing hydrologic/hydraulic (H/H) "interceptor-only" sanitary sewer model was expanded based on as-built sewer records, geographical information system (GIS) data, and supplemented as necessary with field surveys. **Table ES-1** summarizes key enhancements to the Expanded Modeled which increased the accuracy of model results in part due to the following:

- The modeled area has been updated to reflect the City's current service area
- The modeled sewers have been expanded much further up into the collection system; adding 273 modeled pipe lengths with an increased pipe length of 63,984 feet (232% increase)
- 79 wet weather load points have been added to the model
- The increased number of load points will distribute average dry weather flow (ADWF)and wet weather flow throughout the modeled pipes, better simulating the varied distribution of these flows based on measured flow monitoring data (discussed later)
- The increased pipe length will more accurately route flows based on the system hydraulics and dynamic flow routing capabilities of SWMM5

Figure ES-1 graphically shows the increased coverage of the City's expanded collection system model compared to the original interceptor-only model.

Table ES-1 Model Enhancement

System	Calibration/Development Year	ADWF (MGD)	Modeled Area (acres)	Modeled Pipes	Modeled Pipe Length (ft)	RDII Load Points
Original	2004 (2007 Update)	4.54 (Constant)	4,760	86	27,554	6
Enhanced	2011	5.37 (Diurnal)	5,632	359	91,538	85

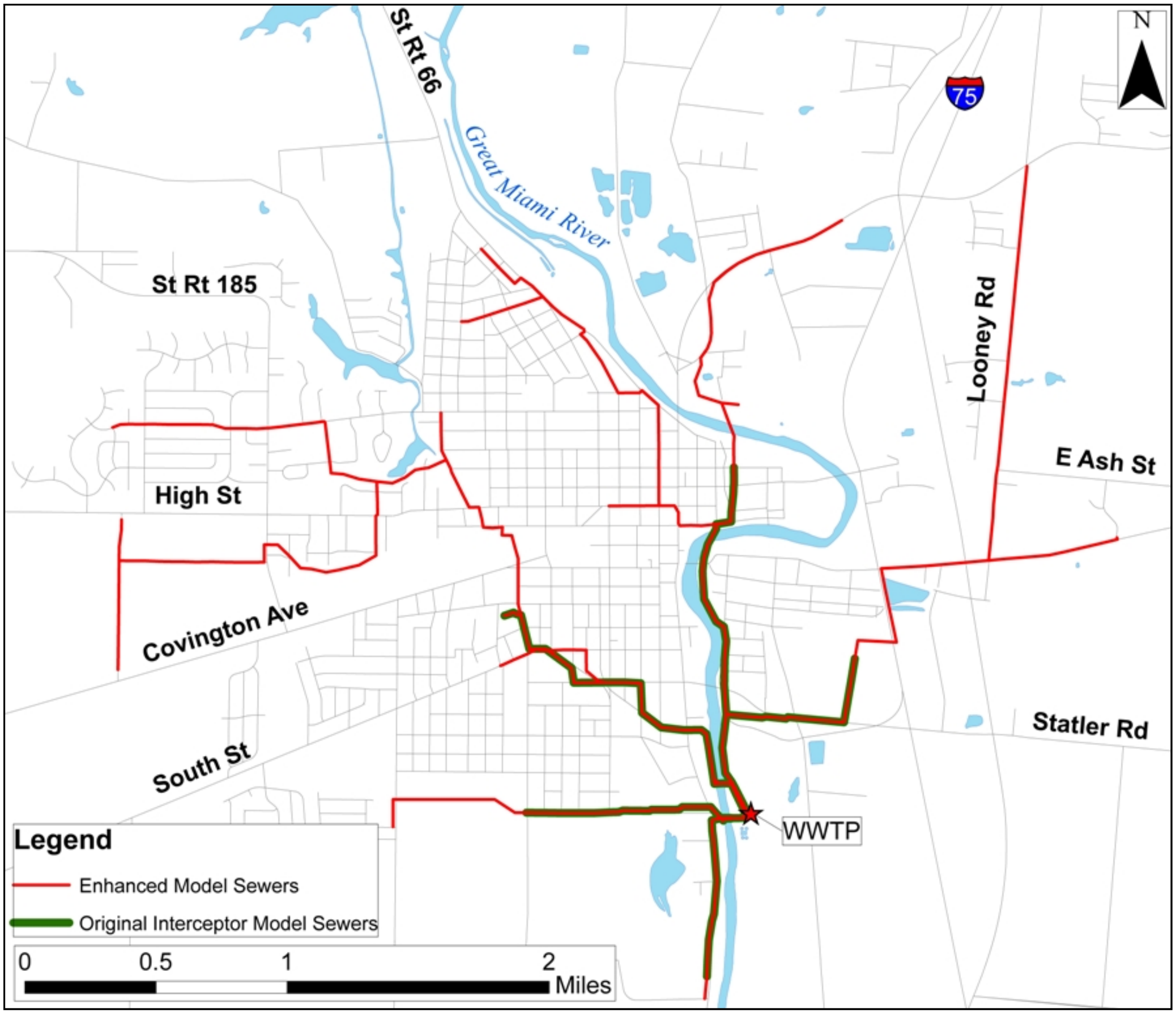


Figure ES-1
Comparison of Interceptor-Only and Expanded Model Extents

A Data Collection Program consisted primarily of collecting flow monitoring and rain gauge data via 16 temporary flow meters and two rain gauges installed for this project and was conducted between March and June 2011. In addition, SCADA data and written gate position data recorded by WWTP operations staff were used to accurately represent the hydraulic (boundary) conditions at the WWTP during model calibration. Flow meter and rain gauge locations used during the Data Collection Program are shown on **Figure ES-2**.

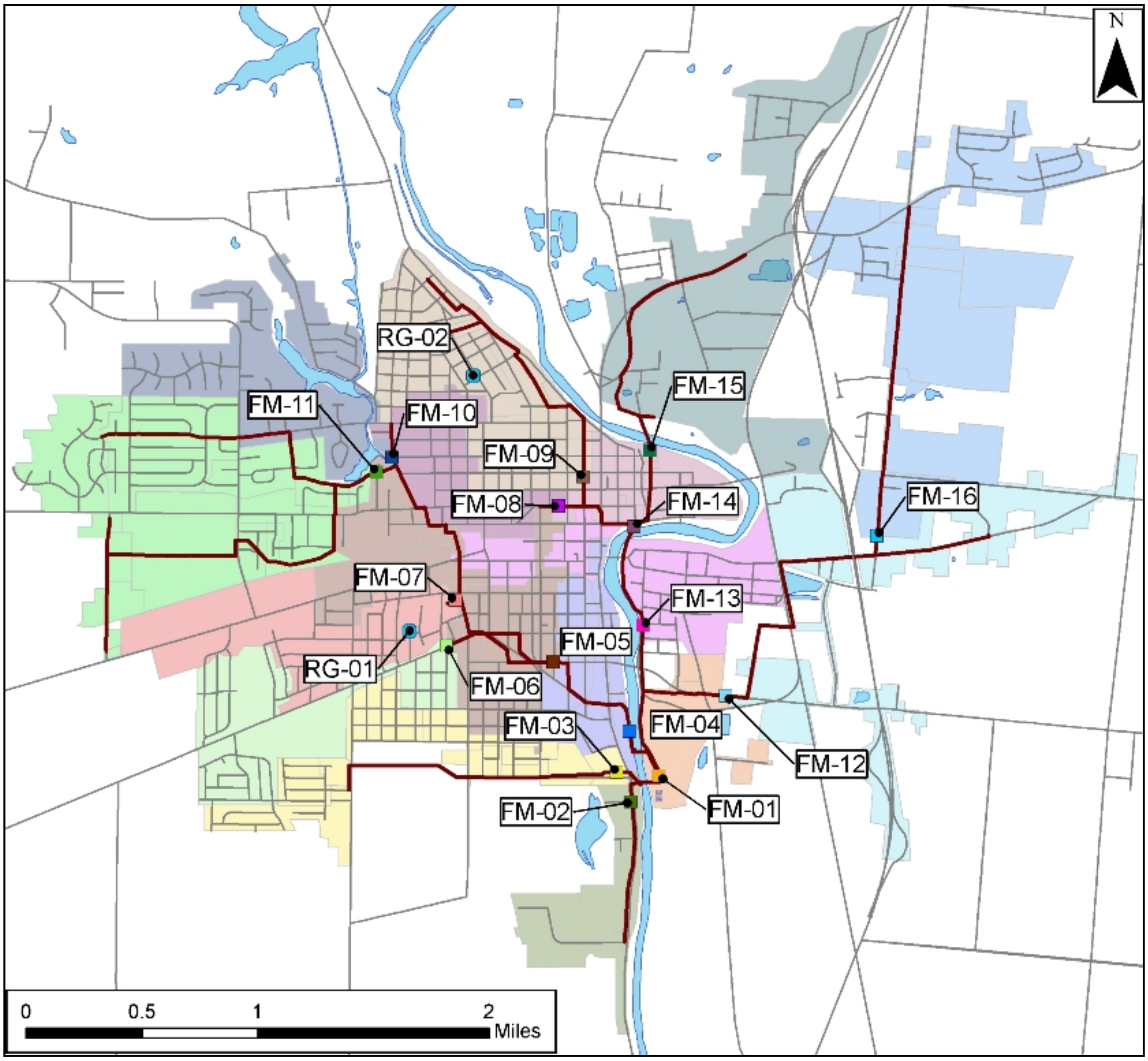


Figure ES-2
Flow Monitor and Rain Gauge Locations

Flow Characterization and Model Calibration

Based on measured flow monitoring data, dry weather flow (DWF) and wet weather flow (WWF) was characterized at each flow monitoring location. In addition to characterizing average and peak DWF and WWF unit hydrograph parameters, the flow data was used to identify a monitored sewershed's susceptibility to I/I and to calibrate the expanded sanitary sewer model.

Overall, the DWF calibration process achieved good, consistent results. WWF calibration was achieved for all three calibration events by accurately matching wet weather peak depths, velocities, and flow rates (hydrographs) as well as overall volume for each calibration event. The flow monitoring data collected and presented in calibration plots clearly indicate the sanitary sewer systems susceptibility and response to rainfall derived inflow and infiltration (RDII). **Figure ES-3** graphically presents the collection systems response to RDII using a three-colored gradation for sewersheds with a minimal, intermediate, and significant response to I/I.

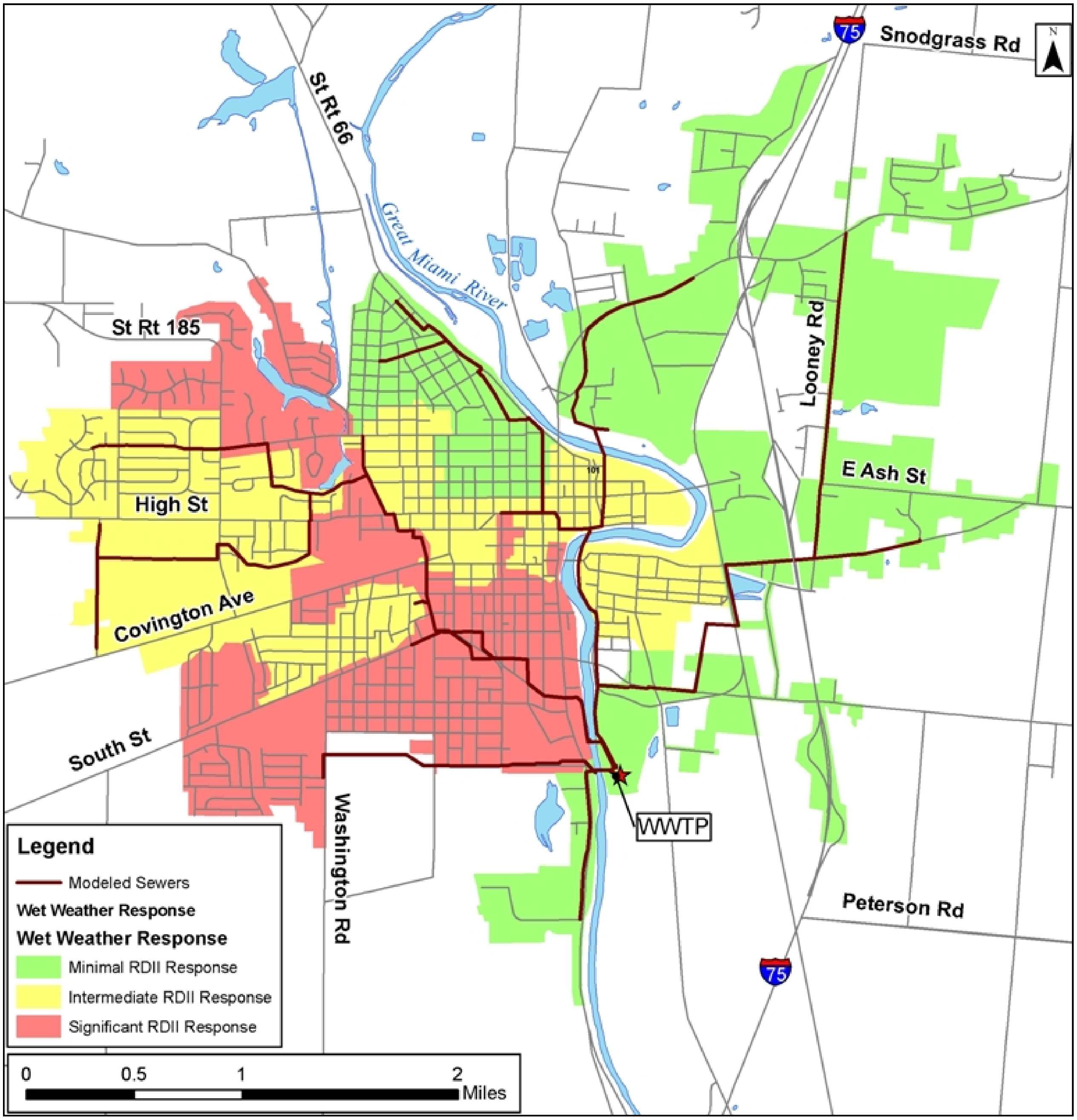


Figure ES-3
Graphical I/I Assessment

Existing Conditions System Assessment

Utilizing the calibrated expanded model, a DWF and WWF capacity assessment was performed. The DWF capacity assessment identified no system deficiencies. The WWF capacity assessment evaluated the modeled system for the calibrated rainfall events and for synthetic design storm events. **Figure ES-4** presents a WWF capacity assessment for calibration event 1; evaluating each individual pipe segment on the basis of peak flow rate to full pipe capacity, shown as a percentage. **Figure ES-5** presents a WWF capacity assessment for the 5-year 24-hour design storm; evaluating the collection system on the basis of manholes surcharging or flooding (surcharge to the point of flooding at the ground surface).

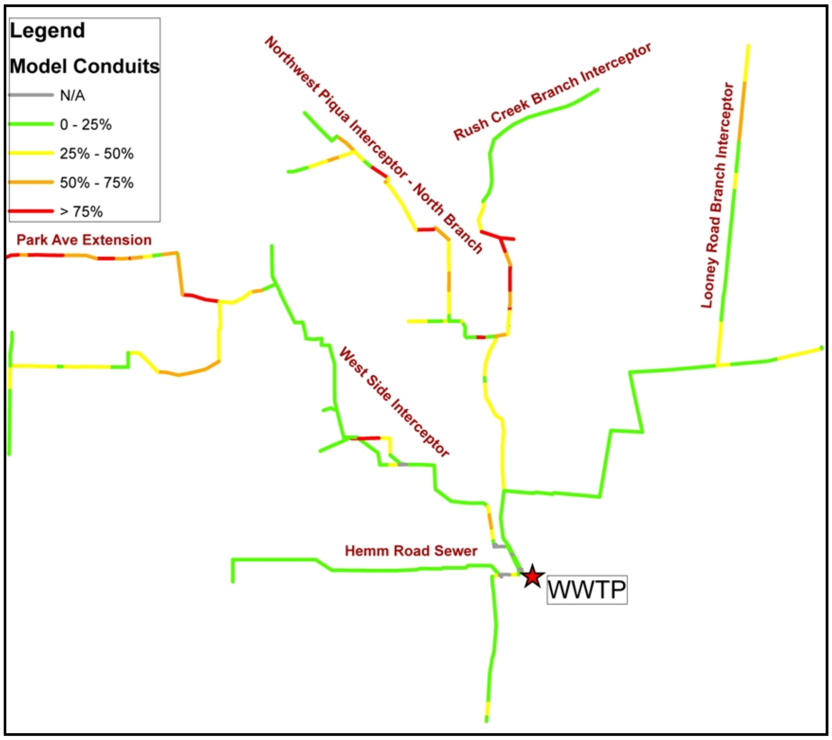


Figure ES-4
Calibration Event 1 Capacity Assessment (% Full) – Existing Conditions

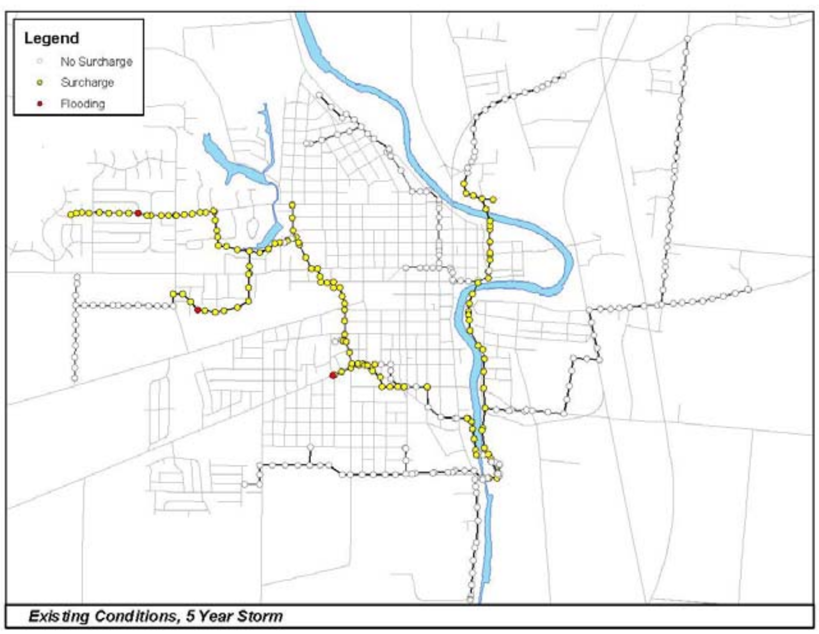


Figure ES-5
5-year Design Storm Capacity Assessment – Existing Conditions

Within the past 4 years, the City completed improvements to its sanitary sewer system which were designed to reduce the volume of SSO discharge and frequency of SSO occurrences. The constructed improvements consist of the following:

- 1 MG equalization basin at the WWTP
- Rehabilitation and lining of the West Interceptor

Table ES-2 presents the results of model analyses performed to evaluate the benefits of the constructed improvements. The results clearly identify a reduction in SSO volume and frequency of SSO occurrences. For each model simulation, implementation of the EQ basin and lining of the West Interceptor resulted in a SSO volume reduction of approximately 30 percent.

Table ES-2 SSO Reduction Resulting from Constructed Improvements

	SSO Volume, MG			SSO Frequency (occurrences)		
	Without EQ	With EQ	Reduction	Without EQ	With EQ	Reduction
Original Model	**992**	**678**	**314 (31.6%)**	**194**	**146**	**48%**
Expanded Model	**307**	**217**	**90 (29.3%)**	**88**	**58**	**30%**

Future Wastewater Flow Characterization and Capacity Assessment

Utilizing the calibrated expanded model, a DWF and WWF capacity assessment was performed for estimated future flow conditions. Future flows were categorized at two different temporal projections:

- Year 2030 projection to size additional facilities at the WWTP
- Ultimate Build-out projection to size alternatives to convey flows to the WWTP facility

Table ES-3 shows the increase in average daily DWF as seen over the entire collection system and which were used for planning purposes in the WWTP Facilities Plan. **Figure ES-6** presents the existing service area and the anticipated future development service areas.

Table ES-3 Dry Weather Flow Projections

DWF Scenario	Estimated Average Daily DWF (MGD)
Existing Conditions	3.5
Year 2030	7.0
Ultimate Build-out	9.3

Note: Estimated Average Day DWF for Year 2030 and Ultimate Build-out includes 1 MGD from the Village of Covington.

During ultimate dry weather conditions, 90% of the modeled sewer segments are flowing at less than half capacity. However, with the increased DWF from future build-out areas, 3 pipes in the system are over 100% capacity; reference **Figure ES-7**. In many pipe segments, the existing system cannot accommodate additional DWF capacity needs from future build-out without additional conveyance infrastructure being built.

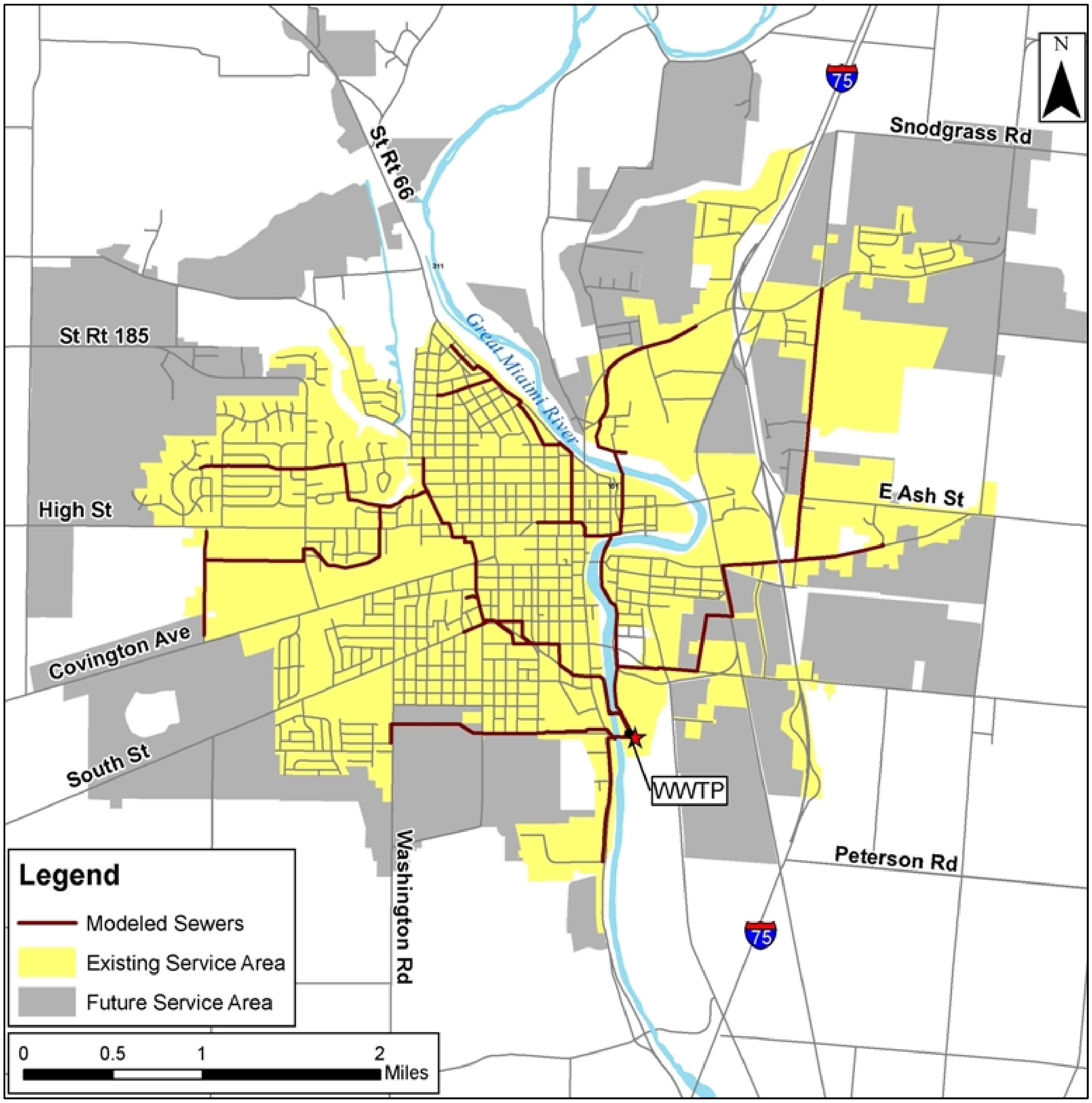


Figure ES-6
Existing and Future Service Areas

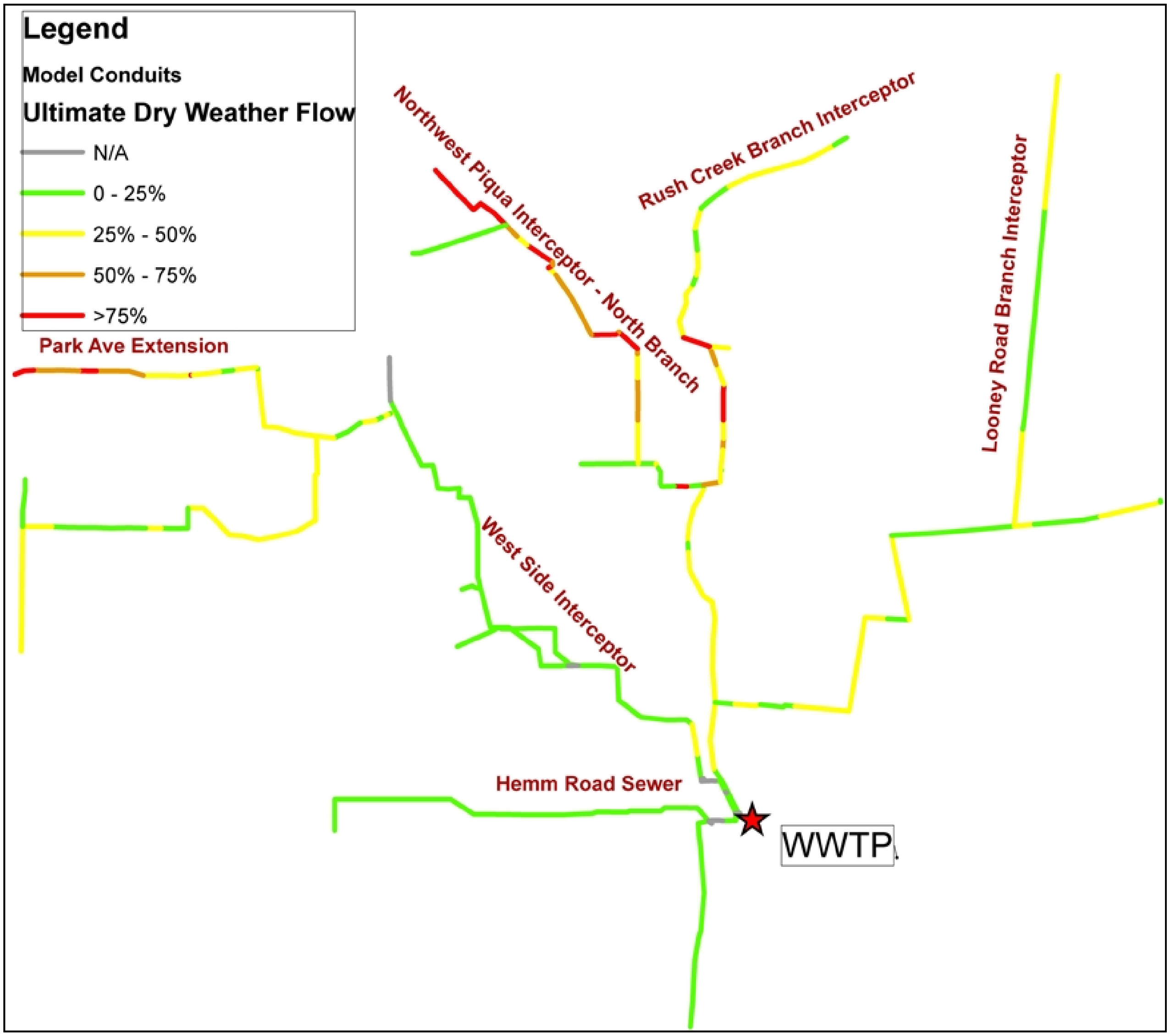


Figure ES-7
DWF Capacity Assessment – Ultimate Build-out

During the three calibration events, the system saw peak WWF rates in the range of 55%-64% of its full flow capacity, and 15%-20% of the modeled sewers are flowing more than 100% full, which indicates pipe surcharging with the potential for street or basement flooding. Across all three events, the problem areas are located along Northeast and West Interceptors, while the Hemm Road Interceptor had surplus capacity.

Figure ES-8 presents a WWF capacity assessment for calibration event 1; evaluating each individual pipe segment on the basis of peak flow rate to full pipe capacity, shown as a percentage. **Figure ES-9** presents a WWF capacity assessment for the 5-year 24-hour design storm; evaluating the collection system on the basis of manholes surcharging or flooding (surcharge to the point of flooding at the ground surface).

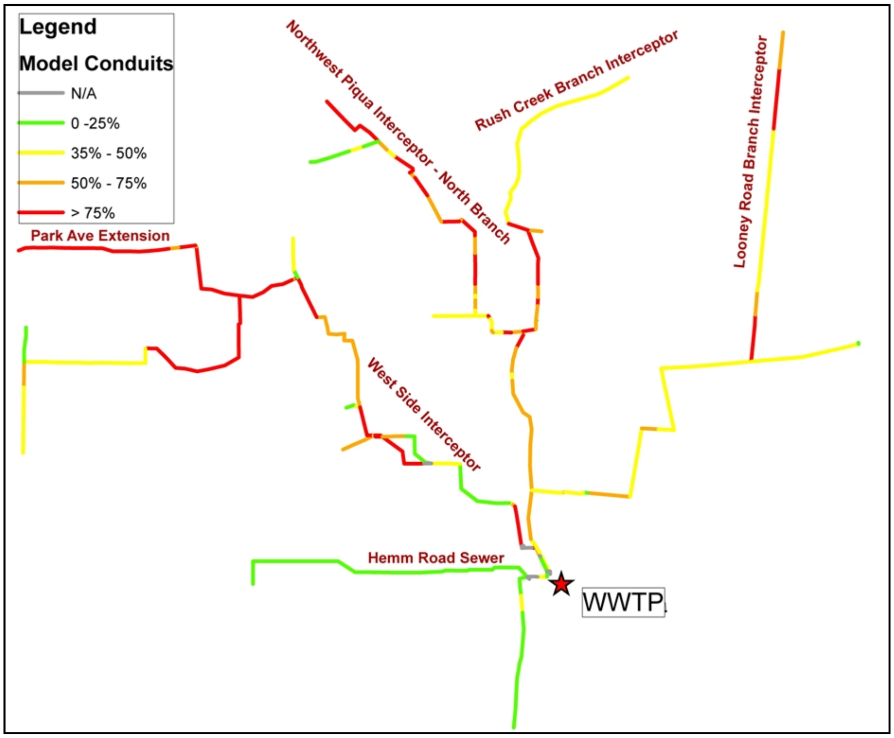


Figure ES-8
Calibration Event 1 Capacity Assessment – Ultimate Build-out

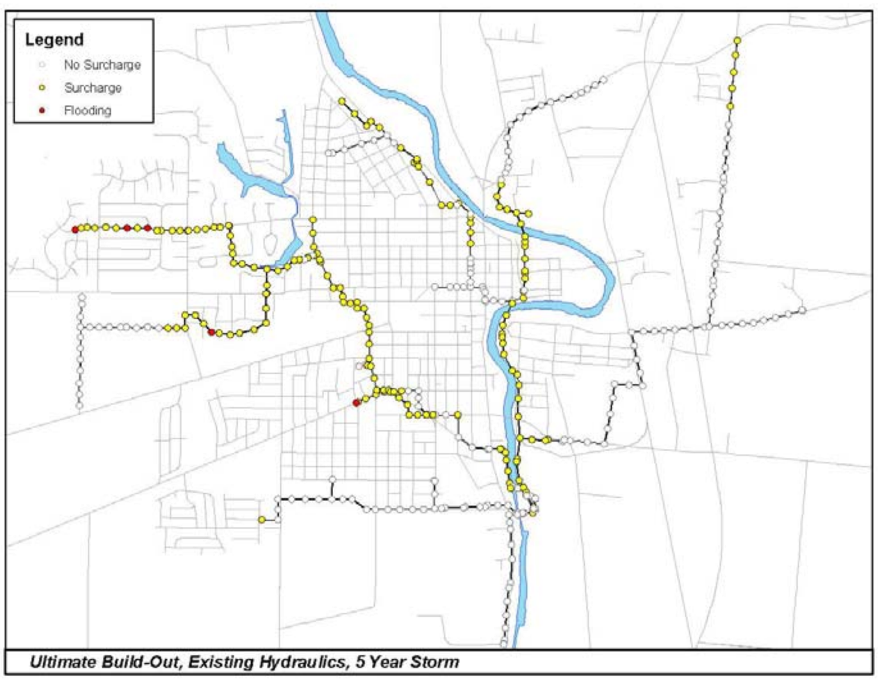


Figure ES-9
5-year Design Storm Capacity Assessment – Ultimate Build-out

Alternatives Development

To address the SSO and collection system deficiencies, a screening evaluation of potential system improvements was undertaken that considered the following:

- Increase system conveyance capacity
- Increased siphon capacity
- I/I reduction
- Additional flow equalization
- Increased treatment capacity at WWTP

Siphons Evaluation

The capacity of existing siphons has long been considered a bottleneck in the collection system by the City and was substantiated by previous modeling efforts with the EQ basin project, and is therefore a key area of evaluation in this Master Plan. The siphon evaluation was performed for two design storms (5-year and 10-year) and the calibrated rainfall event from early April 2011. Simulations were run for both existing conditions and ultimate build-out. At each siphon, the diameter required to convey flow within one additional pipe barrel was identified such that surcharging and/or SSO activation upstream of the siphon did not occur. **Table ES-4** shows the pipe size of an additional siphon barrel required to convey the WWF associated the each storm and model scenario.

Table ES-4 Required Pipe Size of Additional Siphon Barrel

Scenario	Storm	S-Creek Siphon		Great Miami River Siphon		Hemm Rd. Siphon	
		Size (in)	WWF (MGD)	Size (in)	WWF (MGD)	Size (in)	WWF (MGD)
Existing Conditions	5-Yr	16"	12.8	20"	16.4	-	3.1
	10-Yr	20"	15.1	24"	19.2	-	3.5
	April 2011	16"	9.9	16"	12.9	-	2.6
Ultimate Build-out	5-Yr	20"	14.4	20"	17.2	-	4.4
	10-Yr	20"	17.1	24"	21.5	-	5.0
	April 2011	16"	12.0	20"	14.6	-	3.7

Inflow and Infiltration Evaluation

An option to reduce rainfall induced inflow and infiltration (I/I) was evaluated to assess the benefit of removing I/I and the resulting reduction in collection system flow rates. For the I/I reduction evaluation, the R-values used to develop runoff entering the collection system model were incrementally reduced by 15%, 25%, and 50% within the sewersheds shown in red; reference Figure ES-3. **Table ES-5** identifies the peak flow rate at the WWTP for four different I/I Reduction scenarios, i.e. None, 15%, 25%, and 50% for the given rainfall events simulated.

Table ES-5 Potential Flow Rate Reductions to WWTP Resulting from I/I Elimination

I/I Reduction	Design Storms (MGD)										Continuous (2006-2011) (MGD)	
	6 Month		1 Year		2 Year		5 Year		10 Year			
	Existing	2030	Existing	2030	Existing	2030	Existing	2030	Existing	2030	Existing	2030
None	14	18.5	17.5	23	21	26	25	31	28	35	20	25
15%	13	18	16.5	22	19	25	23.5	30	26.5	33	19.5	24
25%	12	16.5	15.5	21	18	24	22	29	25	32	18	23
50%	11	16	13	19	15.5	22	19	26	22	30	15.5	21

Results of the I/I evaluation were discussed with the City at Workshop 2 and tt was agreed that the option to eliminate I/I not be considered as a potential collection system improvement and would not be evaluated further in this Master Plan. The City identified that it would rather expend money to build infrastructure and expand the WWTP in its efforts to eliminate the SSO.

Flow Equalization and WWTP Treatment Capacity Evaluation

The final screening evaluation to address the SSO and identify an alternative which will effectively eliminate SSO occurrences in the collection system pertains to the modeled boundary condition at the WWTP. The focus of this Sanitary Sewer System Master Plan is the collection system, which includes the constructed SSO to be eliminated, however, the hydraulic conditions at the WWTP influence the collection system hydraulics and activity of the SSO. Thus, the intent of this section is to identify an EQ storage volume and WWTP capacity which eliminate the SSO such that a modeled boundary condition is defined for the detailed Alternatives Evaluation. Refinement of EQ storage volume and treatment capacity will be addressed in the WWTP Facility Plan currently in development which will then consider cost, site conditions, and process requirements/constraints, etc. of the plant expansion needs. This evaluation was presented to the City during Workshop 2 and includes I/I reduction rates to demonstrate the (limited) impacts of I/I reduction on the potential improvements at the WWTP to eliminate the SSO; see **Figure ES-10**.

Assuming the City does not pursue I/I reduction as discussed previously, the following assessment can be made based on the 0% I/I Reduction curve (black line):

- The WWTP treatment rate would need to be upgraded to 21 MGD if the existing EQ basin (1 MG) was not upgraded with a pump station to use the remaining 2 MG of storage.
- The WWTP treatment rate would need to be upgraded to 17 MGD if a pump station were added such that the existing EQ basin could utilize the entire 3 MG of storage.
- If a second (equally sized) EQ basin were constructed with a pump station, the WWTP treatment rate would need to be upgraded to 13 MGD, utilizing 6 MG of EQ storage.

Results from the WWTP Facility Plan indicate that the most cost effective combination improvements at the WWTP are to upgrade the WWTP to 13 MGD peak hour capacity and provide 6 MG of EQ basin storage.

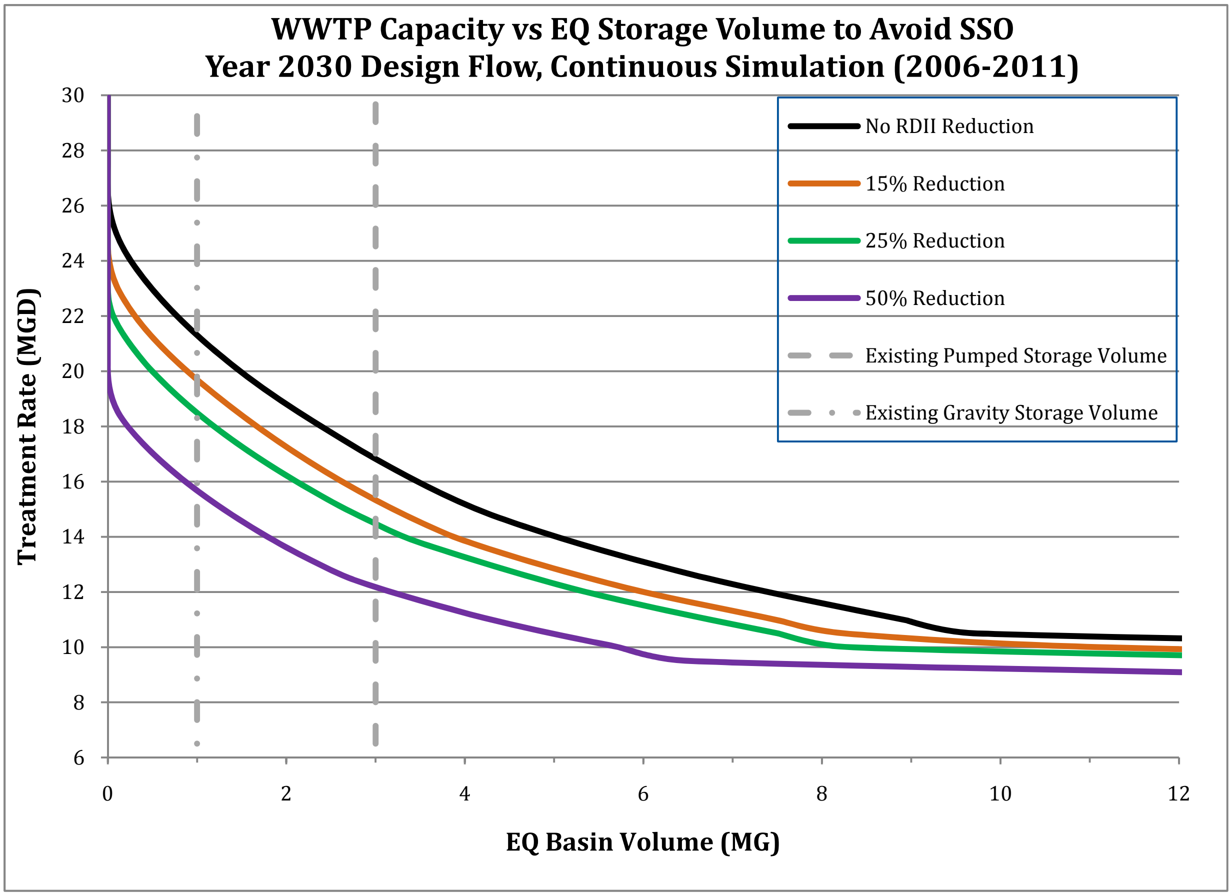


Figure ES-10
Necessary WWTP Rate versus EQ Basin Volume to Eliminate the SSO

Alternatives Evaluation

To address deficiencies and serve future development, the collection system was divided into distinct service areas to serve existing and future collection system needs. Five service areas were identified for detailed evaluation as follows:

- West Service Area
- North Central Service Area
- South Central Service Area
- Northeast Service Area
- East Service Area

For the purposes of sizing pipes and estimating cost, alternatives used Ultimate Build-out flows. All alternative evaluations presented in this Master Plan use design flows resulting from Ultimate Build-out conditions and a 5-year 24-hour design storm event. Recommended alternatives were checked against a 10-year 24-hour design storm to confirm that the proposed sewer system improvements did not have any flooding manholes.

West Service Area Alternatives Evaluation

Eight alternative alignments were developed to serve the West Service Area. **Alternative 8** was selected as the recommended alternative and consists of approximately 42,880 feet of new and replacement sanitary sewer ranging in size from 12- to 30-inch diameter at an average depth of approximately 13 feet and requires a new pump station and approximately 7,430 feet of force main; reference **Figure ES-11**.

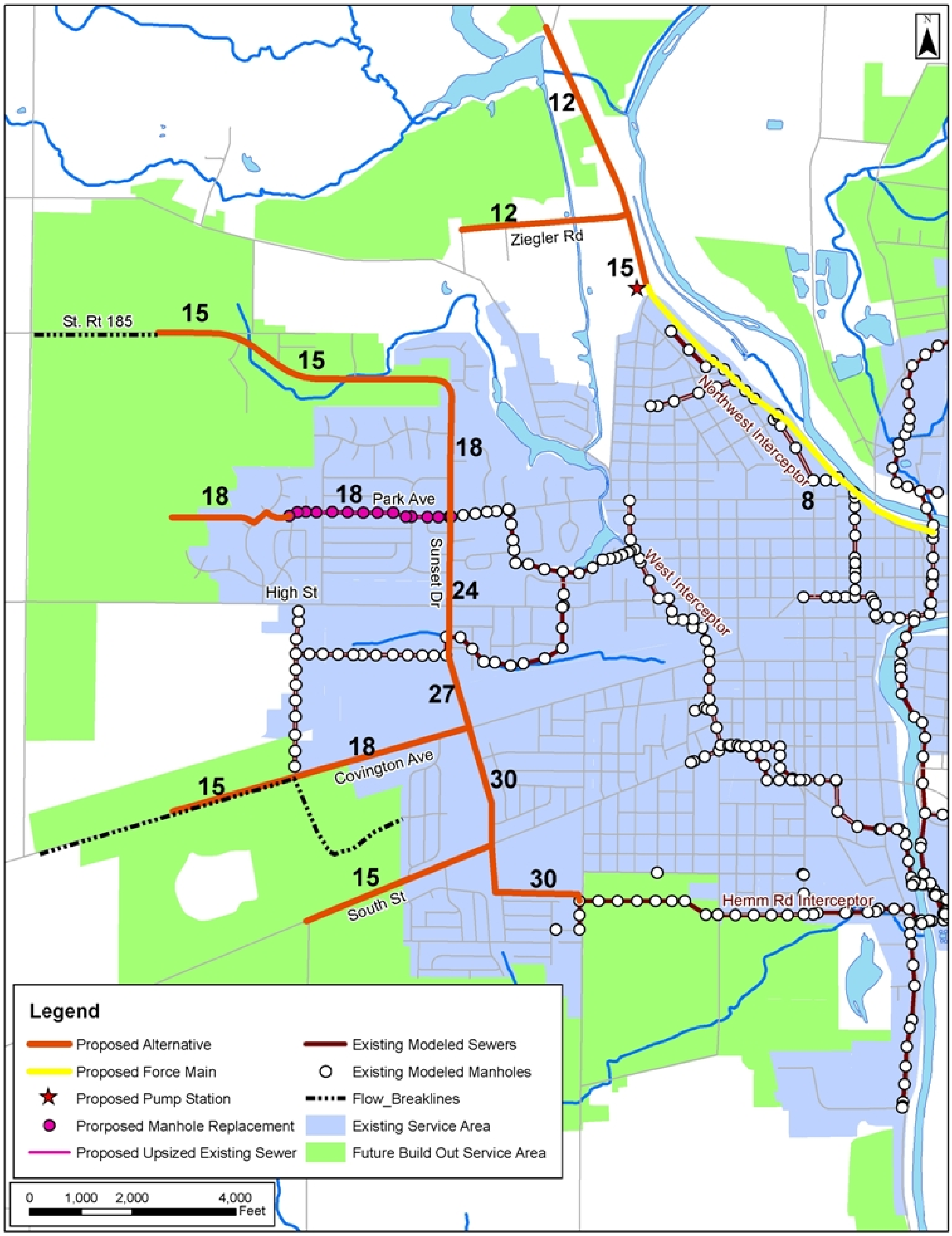


Figure ES-11
Alternative 8 – West Service Area

Northeast Service Area Alternatives Evaluation

Three alternatives were developed to serve future development in the NSA. **Alternative 2** was selected as the recommended alternative and consists of approximately 16,250 feet of new 12-inch diameter sanitary sewer with an average depth of approximately 13 feet; reference **Figure ES-12**.

Figure ES-12
Alternative 2 – Northeast Service Area

An alternatives evaluation was not necessary for the remaining service areas.

Implementation Plan

A two-phased Capital Improvement Plan (CIP) and implementation schedule was developed to address the wastewater system's main priority, eliminate the SSO, and the long-term needs to serve future development in areas not currently served by the sanitary sewer collection system while eliminating collection system deficiencies.

Phase 1 of the CIP pertains to improvements necessary to eliminate the SSO and consists of the following:

- Augmentation of the Great Miami River siphon.
- Upgrade the WWTP to a peak flow rate of 13 MGD.
- Increase flow equalization storage volume to 6 MG.

Phase 2 of the CIP pertains to collection system improvements that serve two purposes:

- Eliminate collection system deficiencies to meet Master Plan criteria.
- Serve future development.

Table ES-6 summarizes the proposed phased approach for implementing the CIP with relative to schedule and cost.

Table ES-6 Implementation Schedule and Costs

Phase	CIP Project	Item	Completion Date	Construction Cost	Project Cost
1	WWTP	Upgrade Treatment Capacity	Dec. 2017	WWTP Facility Plan	WWTP Facility Plan
		Increased Flow Equalization	Dec. 2017	WWTP Facility Plan	WWTP Facility Plan
	Siphon	Great Miami River	Dec. 2014	$ 550,000	$ 720,000
			Phase 1 Sub-Total	**$ 550,000**	**$ 720,000**
2	WSA	Phase A – S-Creek Siphon	As Necessary	$ 380,000	$ 500,000
		Phase B – Northwest Trunk 2	As Necessary	$ 5,320,000	$ 6,700,000
		Phase C – Sunset Dr. to South St.	As Necessary	$ 3,090,000	$ 3,890,000
		Phase D – Sunset Dr. to Park Ave.	As Necessary	$ 6,770,000	$ 8,530,000
		Phase E – Sunset Dr. out St. Rt. 185	As Necessary	$ 3,010,000	$ 3,790,000
			WSA Sub-Total	**$ 18,570,000**	**$ 23,410,000**
	NSA	Alternative	As Necessary	$ 3,490,000	$ 4,400,000
	NCSA	2 sewer extensions	As Necessary	$ 5,390,000	$ 6,790,000
	SCSA	1 sewer extension	As Necessary	$ 2,170,000	$ 2,730,000
	ESA	2 sewer extensions	As Necessary	$ 2,000,000	$ 3,500,000
			Phase 2 Sub-Total	**$ 31,620,000**	**$ 40,830,000**
			Phase 1 & Phase 2 CIP Total	**$ 32,170,000**	**$ 41,550,000**

Section 1
Introduction

This Sanitary Sewer System Master Plan was prepared for the City of Piqua (City) as identified in the Plan of Action submitted to the Ohio Environmental Protection Agency (OEPA). The intent of this report is to document the project tasks performed and develop a phased Capital Improvement Project (CIP) schedule. The project tasks are summarized as follows:

- Expand and enhance the existing hydrologic/hydraulic (H/H) computer model of the City's sanitary sewer system
- Calibrate the expanded H/H model based on information collected through the Data Collection Program
- Evaluate the system's ability to reduce sanitary sewer overflow (SSO) occurrences after the completion of two recent system improvements, as required in the NPDES permit
- Characterize inflow/infiltration (I/I) within existing service areas
- Establish existing levels of service provided by the sanitary sewer system
- Identify projected wastewater flow based on potential development and service area expansion
- Recommend collection system improvements to maintain the desired level of service, and identify any necessary facility upgrades through additional flow equalization and/or increased treatment capacity at the wastewater treatment plant (WWTP) to eliminate the SSO
- Identify a phased CIP schedule for recommended system improvements

The City's sanitary sewer system serves approximately 20,000 Piqua residents, commercial and industrial properties in Piqua, and other customers within Miami County townships and municipalities. The collection system is bisected by the Great Miami River and other small tributaries; thus requiring three siphons and deep interceptor sewers to convey wastewater to the WWTP. The WWTP is rated for 4.5 million gallons per day (MGD) treatment capacity, has capacity to sustain a peak wet weather flow of 8.3 MGD (design capacity), and includes 1 million gallons of flow equalization volume within a basin that can be expanded to 3 million gallon capacity. Two constructed SSOs are located just upstream of two siphons immediately tributary to the WWTP; one on the 36-inch West Interceptor and one on the 36-inch Hemm Road Interceptor.

Section 2

Model Expansion and Data Collection

The existing H/H sanitary sewer model was expanded based on as-built sewer records, geographical information system (GIS) data, and supplemented as necessary with field surveys. As presented in Section 3, the expanded model was calibrated based on the Data Collection Program described in this section; consisting of the collection and processing of flow monitoring data and rain gauge data.

2.1 Model Expansion

The initial task was to expand and enhance the City's existing "interceptor-only" model, using the publically available USEPA Storm Water Management Model version 5 (SWMM5) computer model, to include additional trunk sewers and main tributary sewers located further up in the collection system. An expanded SWMM5 model allowed for a more thorough understanding and more detailed evaluation of the existing system as well as being able to identify what the affects of future (build-out) conditions would have for master planning purposes. First, CDM Smith coordinated with the City to identify and obtain necessary information to accurately represent the physical parameters of the collection system in the hydraulic model. At the same time, available GIS and AutoCAD data was used to extract basic hydrologic parameters to coincide with the expanded collection system model. The following sub-sections summarize the process taken to expand the City's H/H sanitary sewer system model.

2.1.1 Hydraulic Model Expansion

The primary goal of this task was to create a GIS that contained all pertinent H/H information in a database to achieve the following:

- Allow for the efficient creation of the expanded model through import/export capabilities between the SWMM5 interface and ArcMap (GIS)
- Begin to create a GIS layer of the entire City collection system, which can be expanded to include manhole and pipe information (not used for the model) beyond the extents of the expanded model for use as an Asset Management tool
- Allow for QA/QC of input model data
- Provide effective means of reviewing model results and creating report exhibits by exporting model results back to GIS

The City provided "arrow maps" in both AutoCAD and PDF, which have been developed over time based on available sewer drawings, staff knowledge of the system, and modified to represent constructed improvements. The arrow maps are divided into 27 areas and include all sanitary sewers within the areas served by the City, indicating pipe size, pipe connectivity, flow direction, and manholes. Based on the 27 areas, manholes have been assigned a unique number which facilitated model expansion and data entry. The arrow maps provide a good level of spatial accuracy; however, the arrow maps are not in any coordinate system and thus do not line-up exactly with the County's GIS, which is based on state plane coordinates. Thus, a process was undertaken to get detailed sewer system data for model expansion into GIS, using the arrow maps as a guide and using scanned construction drawings and survey information provided by the City to accurately represent the collection system in the GIS environment used as a basis for the SWMM5 collection system model.

Understanding the connectivity and extent of the existing collection system (arrow maps), and reviewing past reports/studies performed on the collection system, additional trunk sewers tributary to the interceptor-only model were identified in a workshop for inclusion with the expanded model. **Figure 2-1** presents a comparison of the interceptor-only model (green) to that being developed for the expanded model (red).

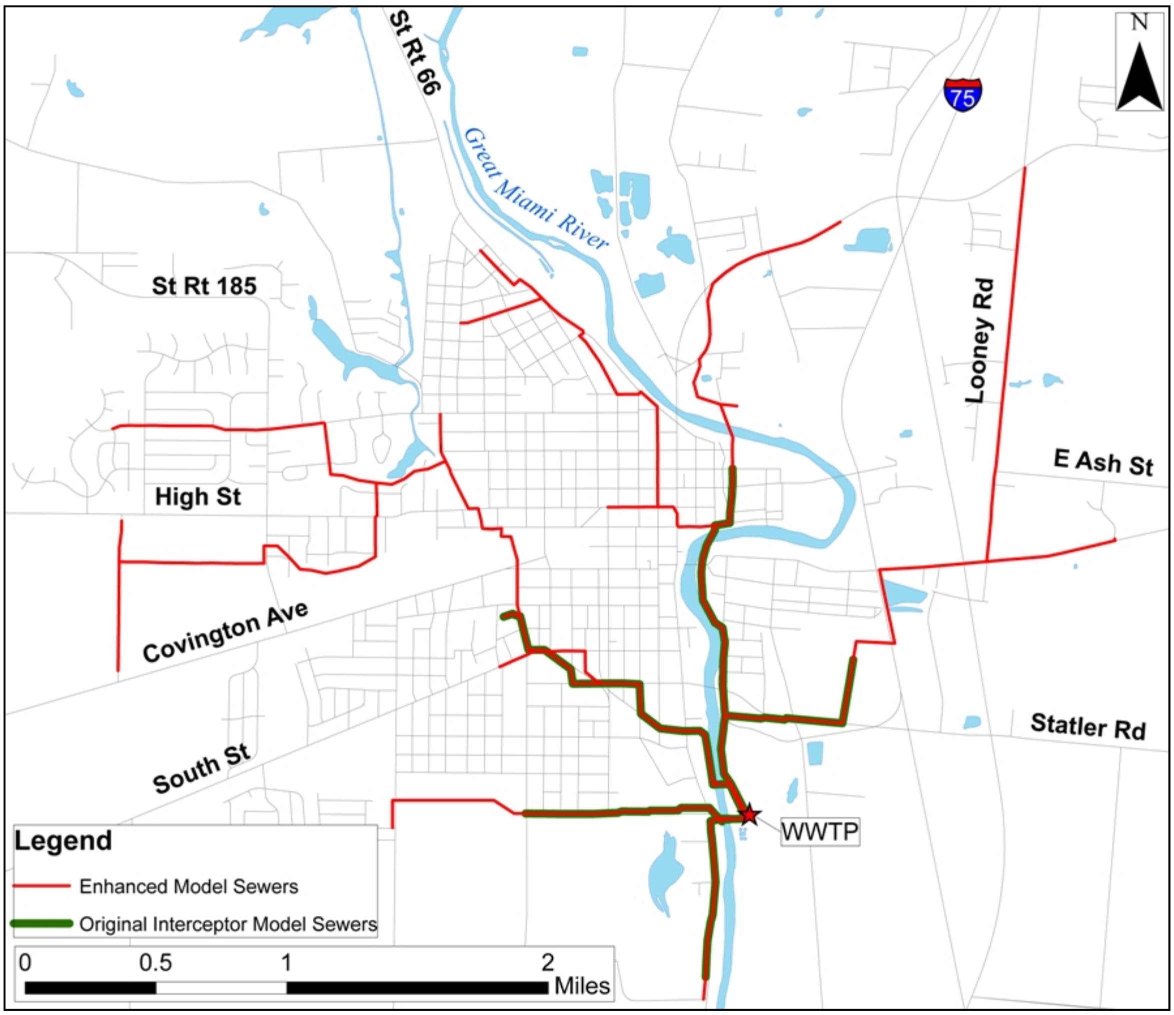


Figure 2-1
Comparison of Interceptor-Only and Expanded Model Extents

With the expanded model extents defined, as-built drawings of the selected interceptors and other tributary sewers were obtained and scanned such that the sewers could be used electronically for import to GIS. Not all sewers added to the expanded model had available as-built records. Approximately 70% of the model piping had available as-built drawings to develop the hydraulic network and connectivity, including the following sewers:

- West Interceptor

- Hemm Road Sewer
- Commerce Drive Sewer
- Miami River Interceptor
- East Piqua Interceptor
- Looney Road Branch Interceptor
- Garbry Road Branch Interceptor
- Rush Creek Interceptor
- WWTP/EQ facility

Figure 2-2 identifies the names of the sewers which were represented in the expanded H/H model and for which GIS shapefiles were made. Where available, the scanned as-built sewer drawings were geo-rectified in the GIS environment to accurately place the (to be) modeled pipe network spatially in the electronic environment with X-Y coordinates, pipe inverts, and begin the creation of the sewer network database.

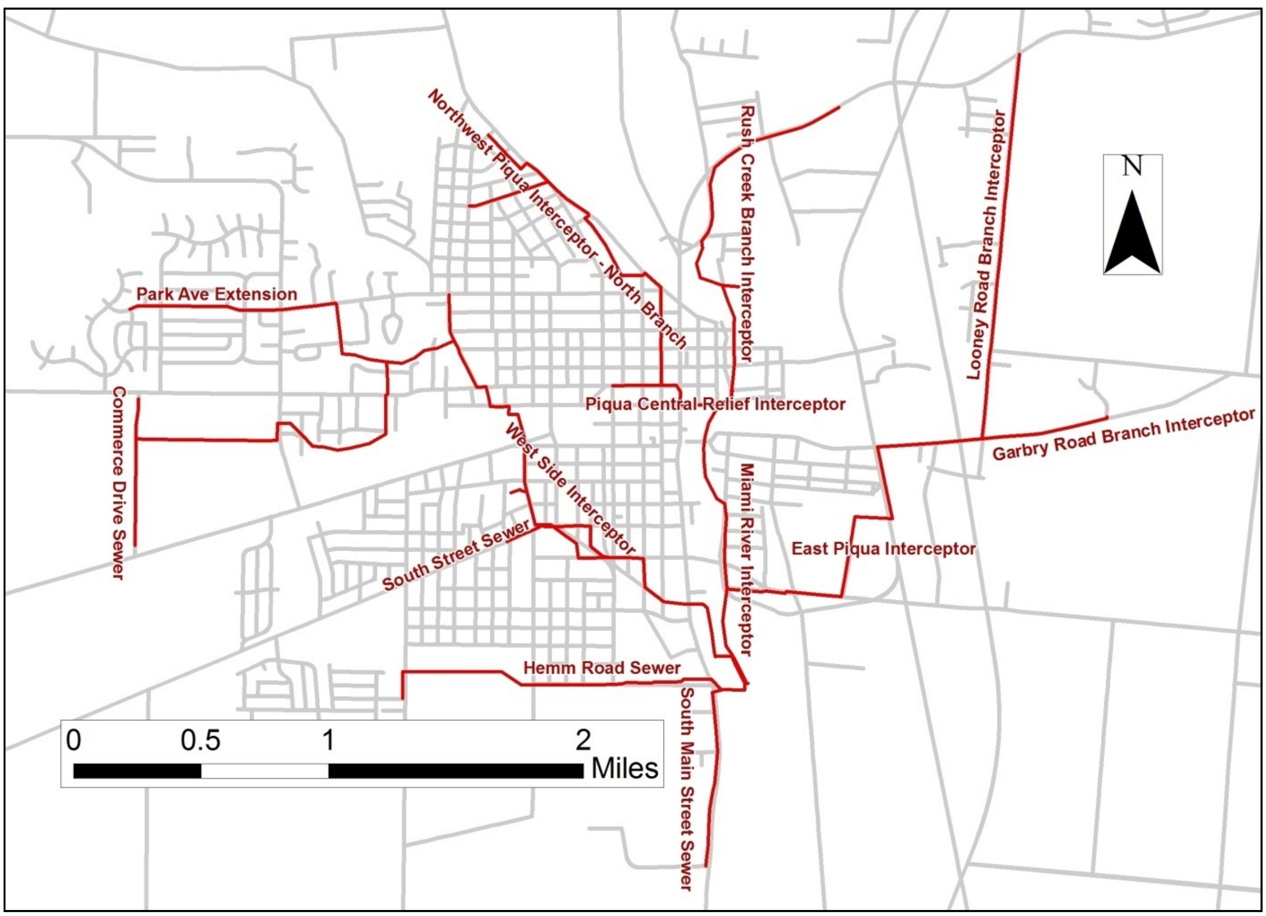


Figure 2-2
Model Expansion and Interceptor Names

After identifying the modeled pipes, CDM Smith compiled the reliable data from the arrow maps with available as-built drawings provided by the City. Data used from these information sources includes:

- Pipe/Manhole ID
- Vertical Datum (adjusted where necessary to ensure consistent datum)
- Upstream manhole invert(s) elevation
- Upstream manhole top-of-casting elevation
- Upstream pipe offset(s)
- Downstream manhole invert elevation
- Downstream manhole top-of-casting elevation
- Downstream pipe offset
- Pipe shape and diameter/dimensions
- Pipe length
- Pipe slope
- Pipe material

In the case of missing record drawings or record drawings that did not contain the pertinent data, the City provided field surveys of the missing manholes for spatial location, vertical elevation, and manhole depth (invert elevation). Conduit lengths and slopes were calculated based on upstream and downstream manhole locations and elevations. The locations of the surveyed manholes which supplemented the as-built records are shown on **Figure 2-3**.

It should be noted, the as-built drawings provided by the City were based on either a 1929 or 1988 vertical datum, or did not specify. Field survey measurements were reported with 1988 vertical datum. All elevations were converted to the 1988 datum for consistency and for modeling purposes. Prior to completing the model expansion, pipes and manholes were reviewed for QA/QC purposes; confirming the accuracy of the sewer attribute data entered into GIS and subsequently imported to the SWMM5 model. If inconsistencies were observed (i.e. ground/invert elevations, network connectivity, or pipe sizes) after the sewer data was imported to the model, data was cross-checked against the as-builts or surveyed data; resolving any inconsistencies with the City and/or additional field investigations/surveys.

2.1.2 Hydrologic Model Expansion

To coincide with the expansion of hydraulic model, the area served by sanitary sewers had to be delineated into subcatchments, or sewersheds of areas that were being metered, and the associated area determined which was represented by additional hydrologic parameters in the model. At this stage of the hydrologic model expansion, the subcatchments monitored with flow meters where identified and the area (measured in acres) was taken from GIS based on the upstream area tributary to each meter. **Figure 2-4** shows the limits of each sewershed defined by the area monitored by its corresponding flow monitor.

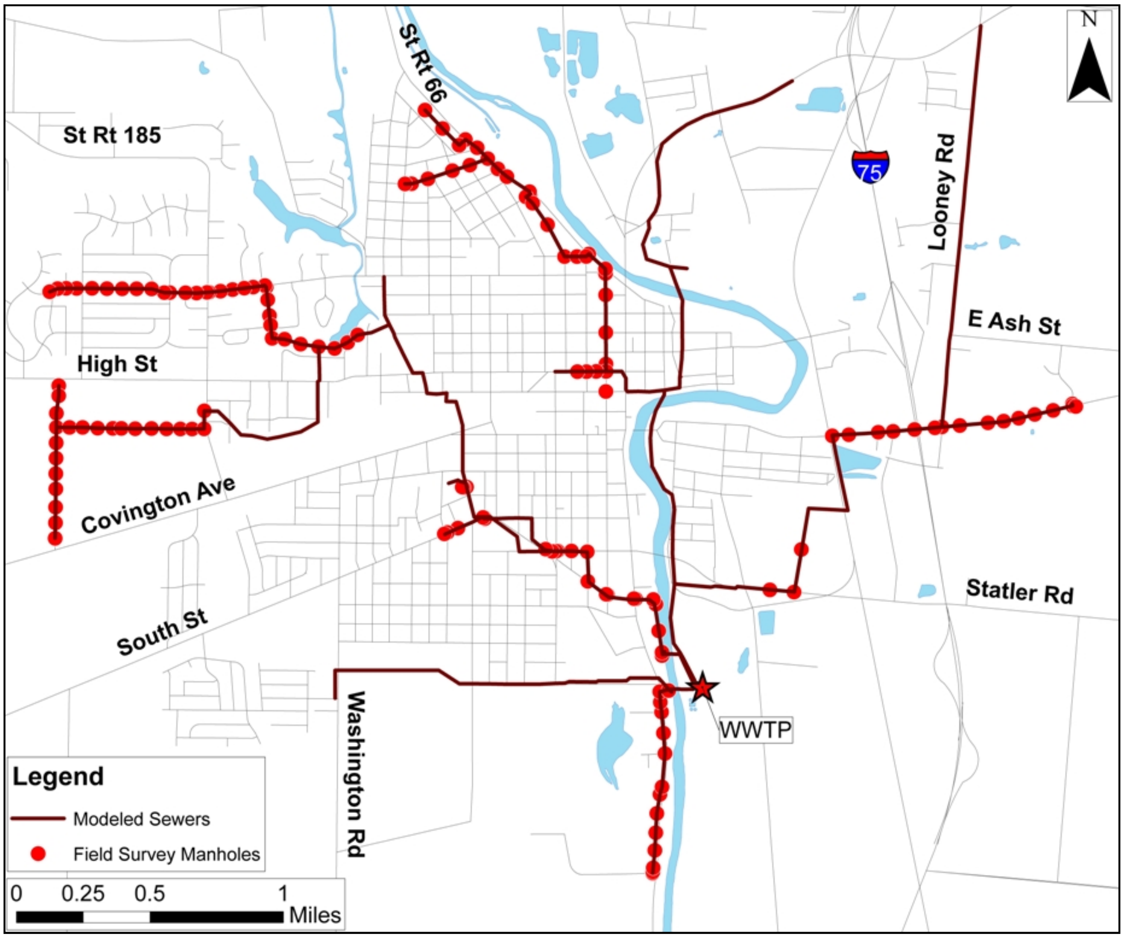


Figure 2-3
Field Surveyed Manholes

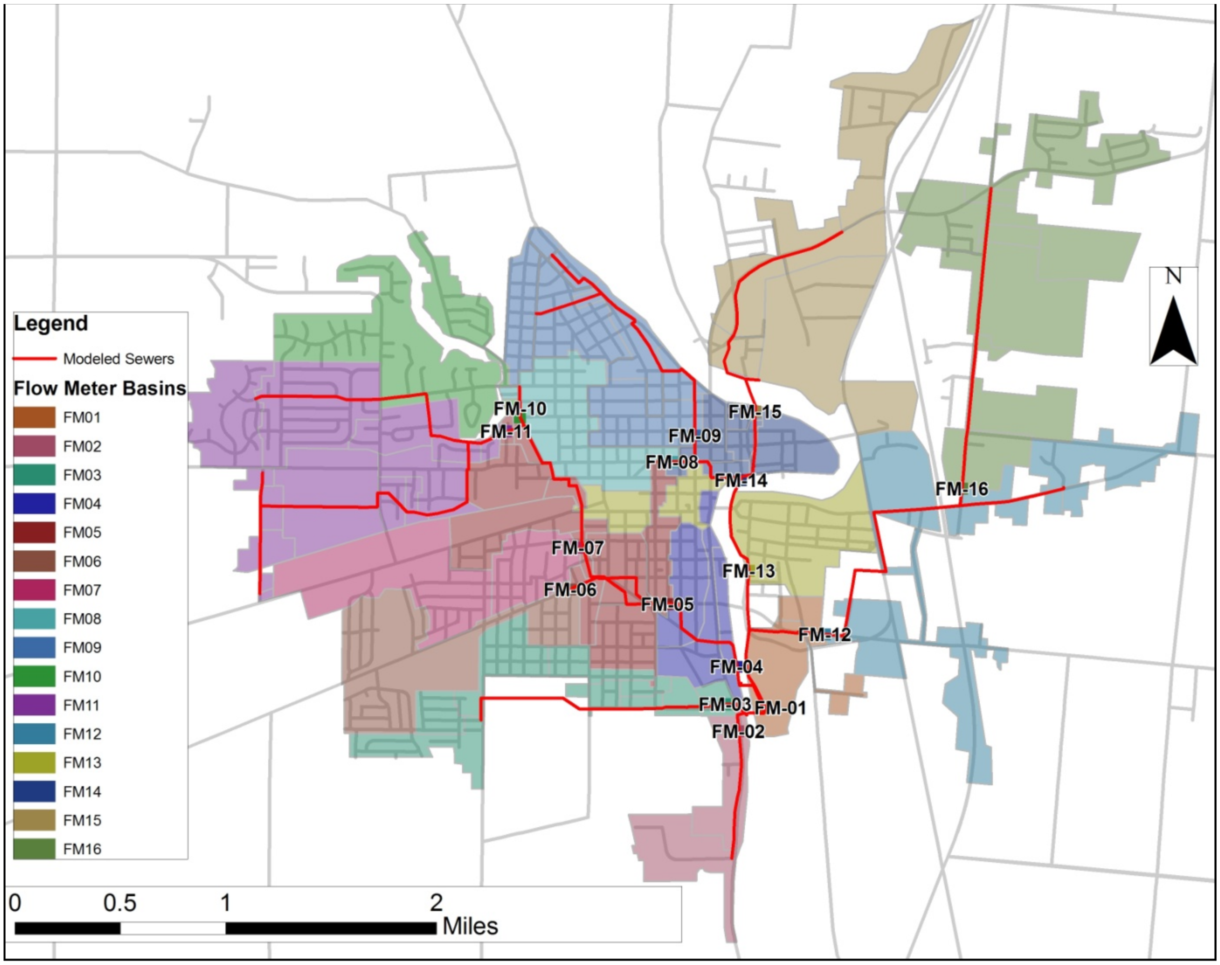


Figure 2-4
Sanitary Sewer Subcatchment Delineation, Identified by Flow Monitor Sewershed

For sanitary sewer modeling, subcatchment delineations are typically made by the dry weather service area defined by the property lines of those parcels being served by the sanitary sewer and not the tributary topographic area (based on contours); this approach was taken for this study as well. The project team chose to delineate sewersheds based on parcel boundaries for two primary reasons:

- I/I responses are often driven by private I/I sources. Therefore, the wet weather response is more closely related to the dry-weather service area than the topographic tributary area.
- Parcel boundaries are easily identified and provide reliable/measureable graphical representations.

As discussed in Section 3 – Flow Characterization and Model Calibration, additional hydrologic parameters were determined for input to the model, however the areas for each sewershed were based on the subcatchments delineation. **Table 2-1** identifies area tributary to each flow meter; identified as the Contributing Area and the Incremental Contributing Area. The total of the Incremental Contributing Area (5,632 acres) represents the total sewered area of the current sanitary sewer system. Area values in the Contributing Area column identify the total area tributary to each individual flow meter and are therefore greater due to the potential to double- or triple-count areas which are tributary to multiple flow meters, i.e. FM13 includes area accounted for at FM08, FM09, FM14, and FM15.

Table 2-1 Contributory Area to Flow Meter Locations

Flow Meter	Contributing Area (acres)	Incremental Contributing Area (acres)
FM-01	2,276	264
FM-02	134	134
FM-03	354	354
FM-04	2,012	152
FM-05	1,860	431
FM-06	260	260
FM-07	207	207
FM-08	158	158
FM-09	325	325
FM-10	322	322
FM-11	638	638
FM-12	1,513	692
FM-13	1,357	228
FM-14	1,129	131
FM-15	515	515
FM-16	821	821
	Total	5,632

2.1.3 Expanded Model Enhancement

The Expanded Model added substantial resolution and detail that did not exist in the previous Interceptor-Only Model. **Table 2-2** summarizes key enhancements to the Expanded Modeled which increased the accuracy of model results in part due to the following:

- The modeled area has been updated to reflect the City's current service area
- The modeled sewers have been expanded much further up into the collection system; adding 273 modeled pipe lengths with an increased pipe length of 63,984 feet (232% increase)
- 79 wet weather load points have been added to the model
- The increased number of load points will distribute average dry weather flow (ADWF)and wet weather flow throughout the modeled pipes, better simulating the varied distribution of these flows based on measured flow monitoring data (discussed later)
- The increased pipe length will more accurately route flows based on the system hydraulics and dynamic flow routing capabilities of SWMM5

Table 2-2 Model Enhancement

System	Calibration/Development Year	ADWF (MGD)	Modeled Area (acres)	Modeled Pipes	Modeled Pipe Length (ft)	RDII Load Points
Original	2004 (2007 Update)	4.54 (Constant)	4,760	86	27,554	6
Enhanced	2011	5.37 (Diurnal)	5,632	359	91,538	85

Note: RDII load points will be discussed in Section 3.

2.2 Data Collection

A Data Collection Program consisted primarily of collecting flow monitoring and rain gauge data via temporary flow meters and rain gauges installed for this project. In addition, the CDM Smith coordinated with the City to obtain appropriate information collected at the WWTP to accurately represent the hydraulic (boundary) conditions at the WWTP during model calibration. The Data Collection Program consisted of the following resources:

- 2 temporary rain gauges
- 16 temporary flow meters
- SCADA data from WWTP operations
- Written gate position data (headworks) from WWTP operations

2.2.1 Flow Monitoring and Rain Gauge Data

Flow monitoring and rain gauge data was collected for a period of three months between March and June 2011. **Figure 2-5** identifies the flow meter (FM-xx) and rain gauge (RG-yy) locations. As discussed in Section 3, this data was used to:

- Calibrate the model based on dry weather flows as measured at each meter location
- Calibrate the model based on wet weather flows as measured at each meter location
- Characterize each sewershed's response/susceptibility to I/I based on measured data at each meter location

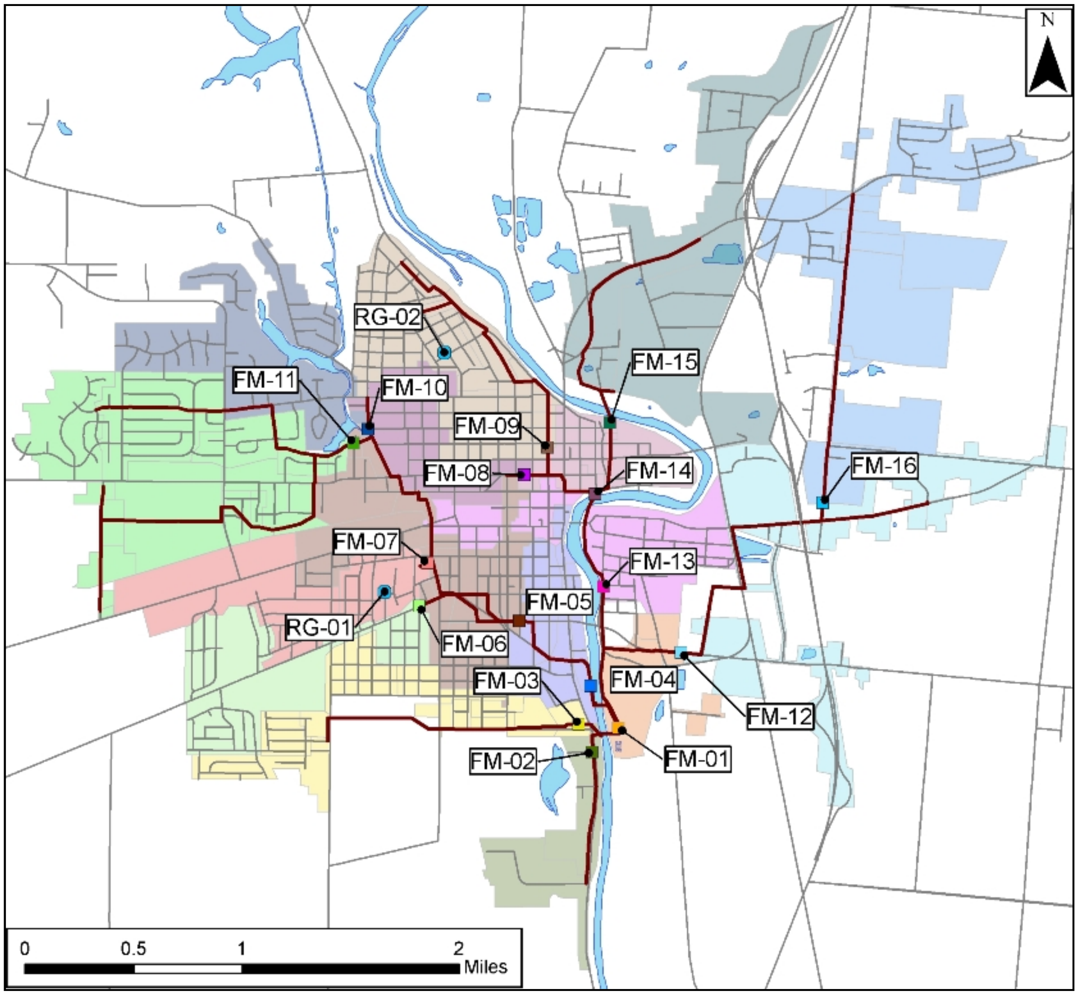


Figure 2-5
Flow Monitor and Rain Gauge Locations

2.2.1.1 Flow Meters

Flow meter locations were selected to provide sufficient coverage of the collection system based on the following criteria:

- Manhole accessibility
- Previous metering locations used to calibrate the Interceptor-Only model
- Strategically located to minimize the number of meters needed while providing the level of detail for model calibration based on the extents of the Expanded Model

The meters measured flow velocity and depth to calculate a flow rate and the meters were programmed to record this data on 5-minute increments. The work to install, maintain, and collect the flow monitoring and rain gauge data was performed by ADS Environmental Services.

For reference, **Figure 2-6** is presented to schematically illustrate the relationship of each meter to one another and the WWTP.

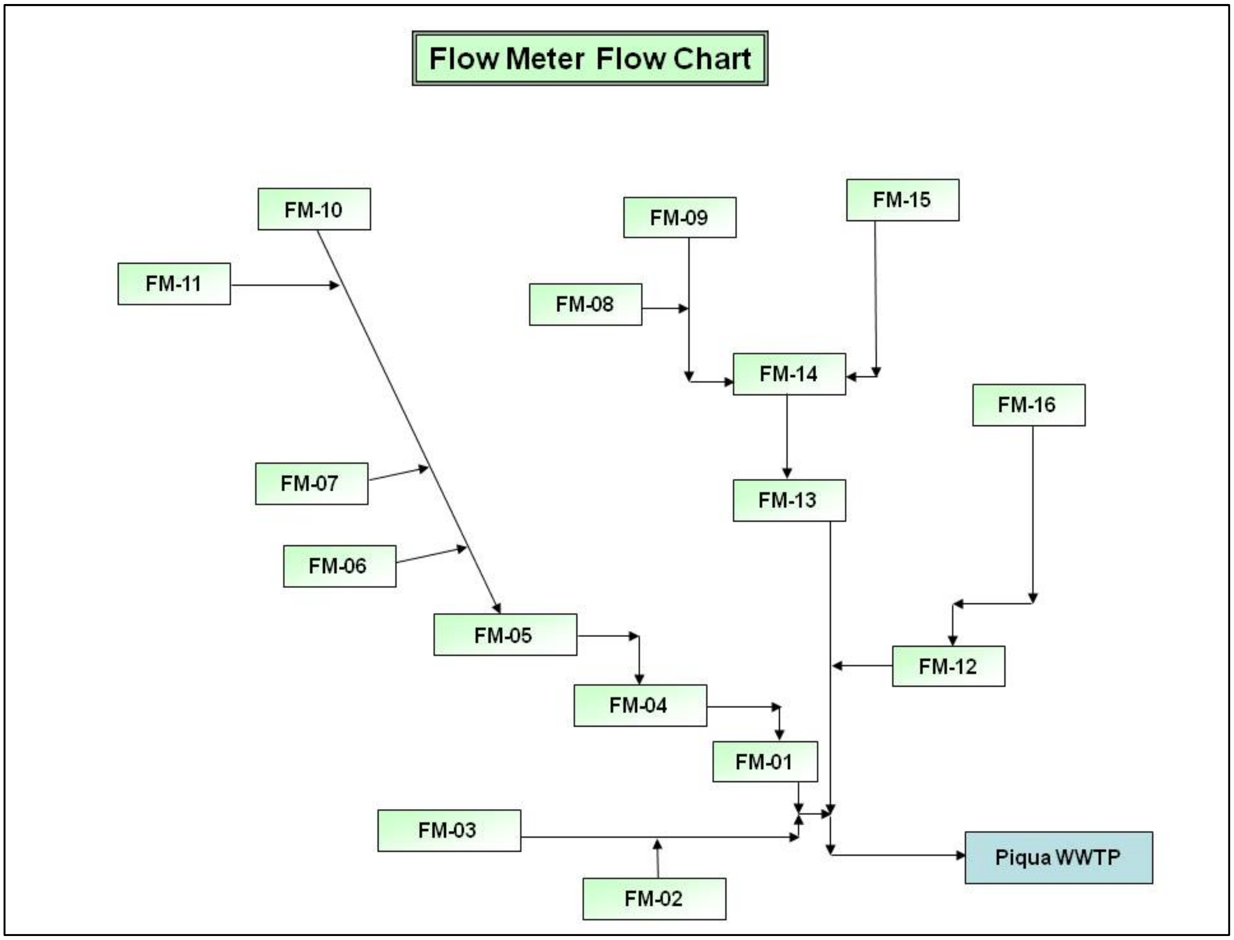


Figure 2-6
Flow Meter Schematic

2.2.1.2 Rain Gauges

Two temporary rain gauges were installed to collect rainfall data in concert with the flow monitoring of the collection system. The rain gauges were located to provide adequate coverage of the collection system to capture any potential spatial variation of rainfall across the system. Data from the tipping bucket rain gauges were reported in 5-minute increments which were used as direct rainfall inputs to the model during calibration.

The City also supplied historical rainfall data recorded at the WWTP (NCDC Co-op Station 336650) from 2006-2011. This data was used for long-term continuous model simulations of the collection system and SSO. A "hybrid" rainfall data input was created by supplementing the Co-op Station rainfall data with the temporary rain gauge data recorded in the spring of 2011.

2.2.1.3 QA/QC

To minimize potential downtime of a meter, data was collected once a week and screened at that time to verify proper operation of the meter. Once downloaded, ADS evaluated the data for accuracy prior to delivery to CDM Smith. Equipment malfunctions during the monitoring period were isolated and addressed promptly, which resulted in limited lost data at a handful of monitoring locations.

ADS supplied the data monthly, at which time the CDM Smith reviewed and evaluated the flow data for consistency and reasonableness. Flow depth, velocity, and rate were plotted for each flow meter along with rainfall measured at the nearest project rain gauge. Scatter plots were generated for each flow meter, which evaluated the flow velocity versus depth. Data consistency was identified from these graphs. The scatter plots provide insights to the conditions within a sewer such as surcharge, debris accumulation, tailwater effect, as well as condition of the flow meters themselves.

2.2.2 SCADA and WWTP Data

Data from the WWTP was requested due to the known relationship of plant operations on the collection system. In particular, the recently constructed 1 MG flow equalization basin has multiple points being monitored by SCADA both upstream and downstream of the facility. Additionally, two gates which are manually operated in the raw sewage junction chamber, primarily during wet weather, that impact the collection system hydraulics by using in-pipe system storage to mitigate peak flows. Knowing and understanding how the EQ basin and gates operate is important to the model calibration, particularly in the collection system reaches immediately upstream of the WWTP. The location and type of data collected, used to simulate boundary conditions at the WWTP are as follows:

- SCADA data
  - WWTP influent meter, flow (MGD)
  - EQ diversion structure, level (ft)
  - EQ basin, level (ft)
  - EQ drain outlet manhole, level (ft)
  - Raw sewage junction chamber, level (ft)
- WWTP operator notes (through May 18, 2011)
  - East Gate position (% open)
  - West Gate position (% open)
  - SSO activity, days
  - SSO activity, estimated flow (MGD)

The Expanded Model used for this Master Plan includes the relevant structures that directly influence the hydraulic conditions of the collection system reaching the plant; in particular, the plant influent pump station, the EQ basin, diversion chambers and gates, and the SSO.

Section 3

Flow Characterization and Model Calibration

Based on measured flow monitoring data, dry weather flow (DWF) and wet weather flow (WWF) were characterized at each flow monitoring location. In addition to characterizing average and peak DWF and WWF unit hydrograph parameters, the flow data was used to identify a monitored sewershed's susceptibility to I/I in addition to calibrating the sanitary sewer model.

3.1 Dry Weather Flow Characterization and Calibration

Dry weather days were determined by considering rainfall data and long-term trends in flow meter behavior; identifying multiple series of continuous 3-weekday periods and 3 weekends with distinct dry weather characteristics to develop weekday/weekend patterns and magnitudes for each metered sewershed. Average and peak DWF values were determined at each meter location based on the recorded data, and presented in **Table 3-1**.

Table 3-1 Measured Average and Peak DWF

Flow Meter ID	Average DWF		Peak DWF		Peaking Factor
	(MGD)	(cfs)	(MGD)	(cfs)	
FM-01	2.01	3.10	2.29	3.55	1.1
FM-02	0.27	0.42	0.33	0.52	1.2
FM-03	0.38	0.59	0.43	0.66	1.1
FM-04	1.92	2.97	2.17	3.35	1.1
FM-05	1.72	2.65	1.99	3.08	1.2
FM-06	0.28	0.43	0.33	0.51	1.2
FM-07	0.26	0.40	0.33	0.51	1.3
FM-08	0.22	0.34	0.30	0.46	1.3
FM-09	0.41	0.64	0.54	0.83	1.3
FM-10	0.30	0.46	0.39	0.61	1.3
FM-11	0.46	0.71	0.63	0.98	1.4
FM-12	0.92	1.42	1.06	1.64	1.2
FM-13	1.72	2.66	1.95	3.02	1.1
FM-14	1.32	2.04	1.53	2.37	1.2
FM-15	0.31	0.48	0.36	0.56	1.2
FM-16	0.42	0.66	0.50	0.77	1.2

Measured average DWF values were distributed upstream of the corresponding flow meter location such that each sewershed would reproduce the measured DWF in the model. The Expanded Model used 83 DWF load points to create an area weighted distribution of DWF throughout the 16 metered sewersheds. Weekday and weekend diurnal patterns were developed for periods of dry weather at each meter location and applied to the corresponding load points within each metered sewershed. The diurnal patterns were developed specifically for each meter location and DWF calibration completed. To achieve a DWF calibration for each sewershed, minor adjustments in the diurnal pattern were necessary to simulate the variable travel time of flow for load points to produce accurate timing and trends measured by the flow meters. **Figure 3-1** presents typical plots of measured versus modeled DWF hydraulic parameters, i.e. flow, depth, and velocity, for flow meter FM-11.

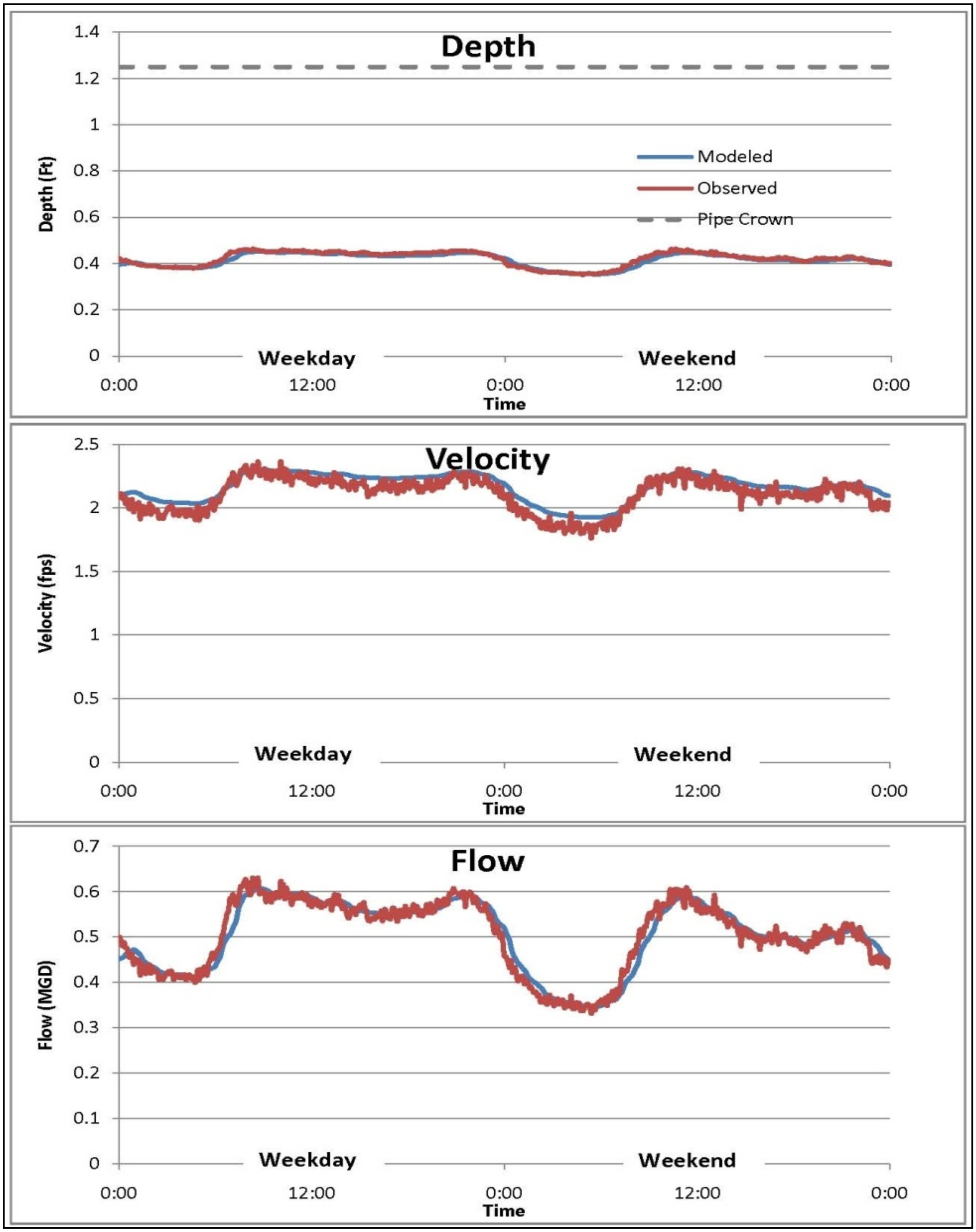


Figure 3-1
Sample DWF Calibration Plots Measured at FM-11

Overall, the DWF calibration process achieved good, consistent results. Based on a comparison of observed to modeled flow rates, the percent difference for average DWF varied between 0% to 5%; while the peak DWF varied between 1% and 11%. **Table 3-2** summarizes these results for each flow monitor. Plots of all DWF calibration results are located in **Appendix A**.

Table 3-2 DWF Calibration Results

	Average DWF			Peak DWF		
Flow Meter	Observed (MGD)	Modeled (MGD)	% Difference	Observed (MGD)[1]	Modeled (MGD)	% Difference
FM01	2.0	1.9	5%	2.29	2.15	6%
FM02	0.3	0.3	0%	0.33	0.31	6%
FM03	0.4	0.4	0%	0.43	0.41	4%
FM04	1.9	1.9	0%	2.17	2.15	1%
FM05	1.7	1.7	0%	1.99	1.93	3%
FM06	0.3	0.3	0%	0.33	0.32	4%
FM07	0.3	0.3	0%	0.33	0.29	10%
FM08	0.2	0.2	0%	0.30	0.26	11%
FM09	0.5	0.5	0%	0.54	0.52	3%
FM10	0.3	0.3	0%	0.39	0.36	8%
FM11	0.5	0.5	0%	0.63	0.61	4%
FM12	0.9	0.9	0%	1.06	1.02	3%
FM13	1.8	1.8	0%	1.95	1.93	1%
FM14	1.3	1.3	0%	1.53	1.42	7%
FM15	0.3	0.3	0%	0.36	0.34	7%
FM16	0.4	0.4	0%	0.50	0.48	4%

Note 1: Velocity measurements, especially in low-flow conditions, are susceptible to erratic data recording and therefore produce less reliable peak flow data.

3.2 Wet Weather Flow Characterization and Calibration

This sub-section summarizes the steps taken to calibrate the Expanded Model relative to measured rainfall events, analysis of measured flow data to estimate hydrologic parameters for input to the model, and the results of the model calibration.

3.2.1 Calibration Rainfall Events

The spring 2011 monitoring period recorded a number of rain events; measuring 19.8 inches (RG-01) and 21.3 inches (RG-01) of total rainfall over the 3 month data collection period. Review of the observed rainfall and flow monitoring data identified three distinct events with reliable flow monitoring data that could be analyzed at each temporary flow meter. Of these three events, the largest most intense rainfall (Event 1 with 2.37 inches) had dry antecedent moisture conditions; the smallest least intense rainfall (Event 2 with 1.06 inches) had relatively wet antecedent moisture conditions; and a third event with wet antecedent moisture conditions (Event 3 with 1.57 inches) had a double-peak. **Table 3-3** summarizes the calibration rainfall properties and identifies the rainfall event recurrence interval two ways, (1) based on total rainfall over the duration of the rainfall event and (2) based on the peak 1-hour intensity of the event.

Table 3-3 Calibration Rainfall Event Properties

Event	Date (2011)	Total Precipitation (in)	Duration (Hrs)	Recurrence Interval [1]	Peak Intensity (in/hr)	Recurrence Interval [2]
1	4/3 - 4/12	2.37	16	2 -Year	0.65	3-Month
2	4/18 - 4/24	1.06	17	< 2-Month	0.33	< 2-Month
3	4/24 - 5/2	1.57	28	4-Month	0.54	< 2-Month

Note: [1] Recurrence Interval based on Total Precipitation for the given Duration.

Note: [2] Recurrence Interval based on Peak Intensity determined by Peak Rainfall over 1-hour duration.

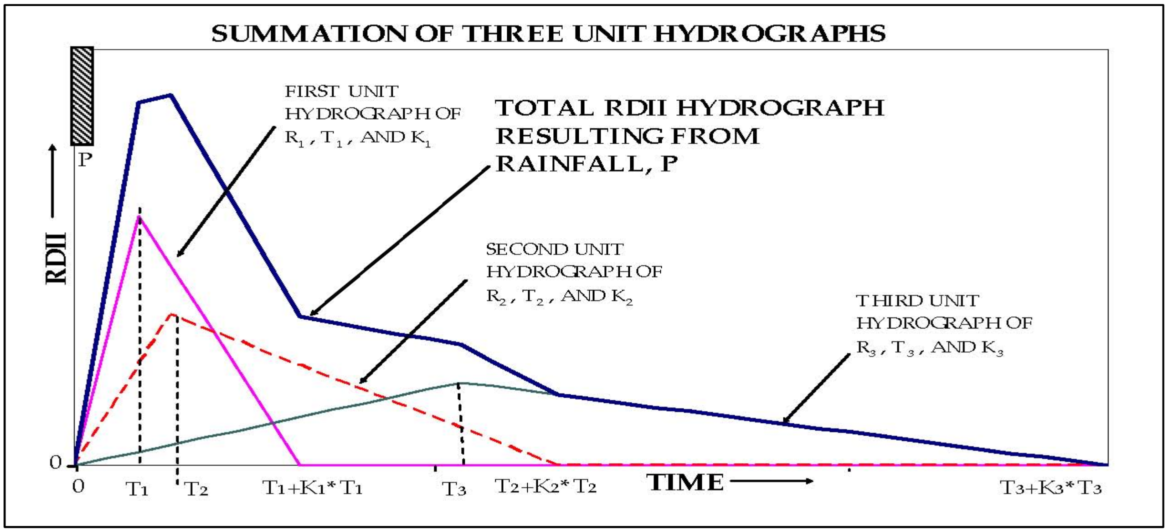
The recurrence intervals for the calibration rainfall events were determined using the "Rainfall Frequency Atlas of the Midwest", by Floyd A. Huff and James R. Angel, dated 1992. Each rainfall event can be considered relatively common (2-month to 3-month recurrence interval) when using the Peak Intensity over one hour; however, Event 1 can be considered a 2-year rainfall event when rainfall event Total Precipitation (2.37 inches) is used to identify the recurrence interval over the event duration (16 hours).

It should be noted that the SSO was active during each of the rainfall events based on WWTP operator notes and this activity was confirmed through model simulations as well. All flow meters recorded adequate data during these storms and showed distinct evidence of a RDII response.

3.2.2 WWF Characterization

WWF data measured as part of the Data Collection Program had to be analyzed to characterize hydrologic parameters for use as a model input. This was done using a publically available software package, the Sanitary Sewer Overflow Analysis and Planning (SSOAP) Toolbox, developed under the direction of the National Risk Management Research Laboratory of the U.S. Environmental Protection Agency (US EPA). The SSOAP Toolbox is a suite of computer software tools used to predict rainfall-derived infiltration and inflow (RDII) in sanitary sewer systems and is used to facilitate capacity analysis of these systems using SWMM5. Information from US EPAs document "Computer Tools for Sanitary Sewer System Capacity Analysis and Planning", EPA/600/R-07/111 October 2007, was used in preparation of this report.

WWF data analysis involves segregating observed flow data into its DWF and RDII components; essentially developing appropriate input parameters that characterized a RDII response in the model. Within the SSOAP Toolbox, a procedure to characterize WWF is known as the RTK method. The result of this analysis is a set of three RTK values, with each RTK parameter representing a unit hydrograph, that when summed together, represents the total hydrograph resulting from a particular rain event. **Figure 3-2** presents the relationship of the three RTK parameters comprising the total hydrograph. A complete and in-depth discussion of the RTK analysis is presented in the US EPA document referenced above.



EPA/600/R-07/111 October 2007

Figure 3-2 RTK Unit Hydrograph Example

3.2.3 Model Calibration

Using the three calibration rainfall events discussed in Section 3.2.1, CDM Smith completed the WWF calibration of the Expanded Model. Similar to the DWF calibration, the model was calibrated at each of the temporary flow monitoring locations for depth, velocity, and flow. Boundary condition data, such as gate position data at the WWTP, was input to the expanded model based on operator notes and aided with calibration as well. Calibration was achieved for all three calibration events by accurately matching wet weather peak depths, velocities, and flow rates (hydrographs) as well as overall volume for each calibration event.

Figure 3-3 presents typical plots of measured versus modeled WWF hydraulic parameters, i.e. flow, depth, and velocity, for flow meter FM-11. All WWF calibration plots can be seen in **Appendix B**.

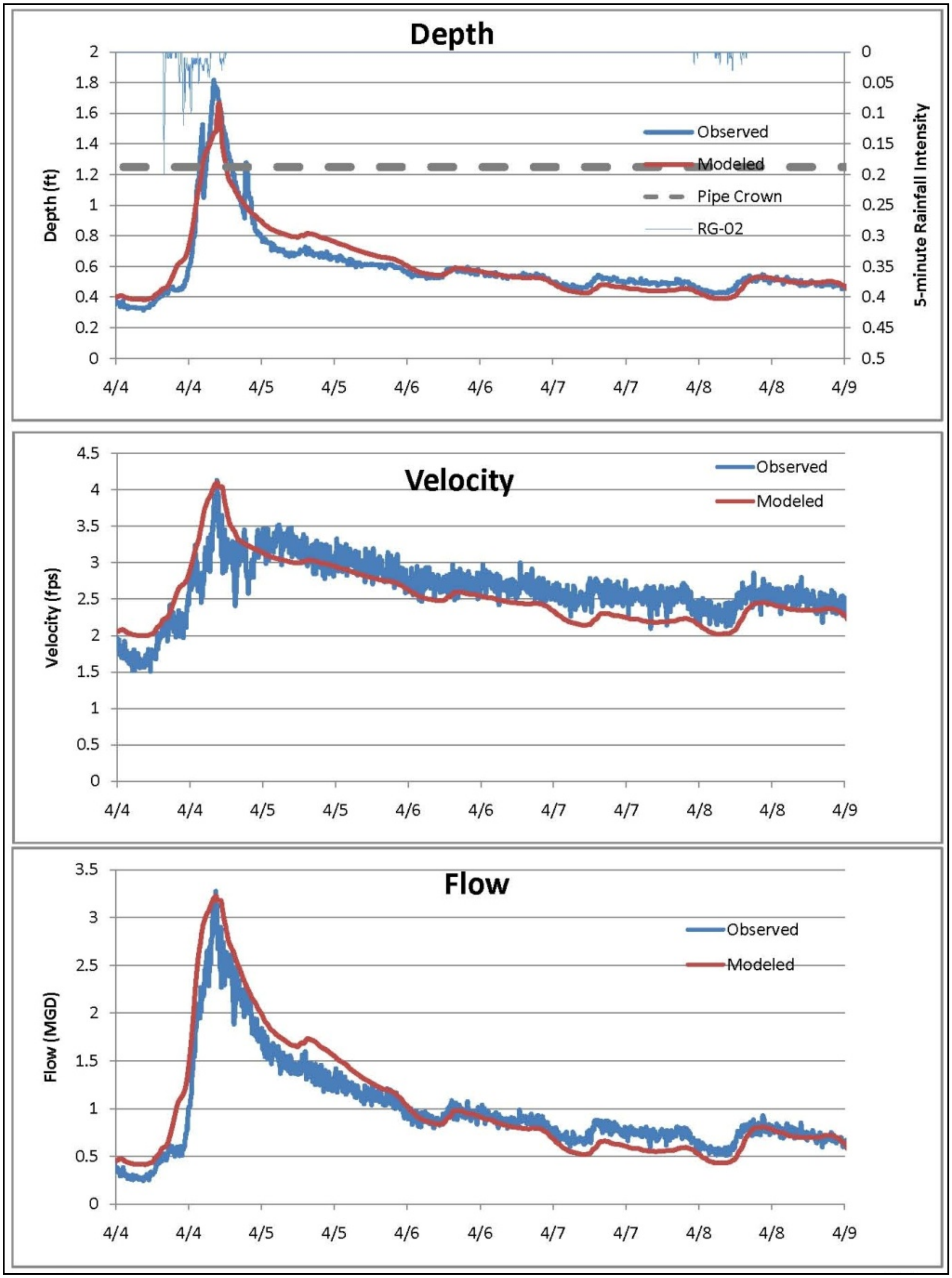


Figure 3-3
Sample WWF Calibration Plots Measured at FM-11

Overall, the WWF calibration process achieved good, consistent results for each of the three calibration rainfall events. For each rainfall event, **Tables 3-4, 3-5, and 3-6** identify metered and modeled values for Maximum Depth, Maximum Flow, and Total Volume.

Table 3-4 WWF Calibration Results, Event 1

	Maximum Depth (ft)			Maximum Flow (MGD)			Total Volume (MG)[1]		
Flow Meter	Modeled	Metered	% Difference	Modeled	Metered	% Difference	Modeled	Metered	% Difference
FM01[2]	8.4	8.2	2%	4.0	3.9	3%	9.1	8.3	9%
FM02	0.6	0.5	17%	0.4	0.5	-25%	1.2	1.2	0%
FM03	0.7	0.7	0%	1.4	1.6	-14%	3.1	3.0	3%
FM04	4.8	4.6	4%	10.9	11.1	-2%	17.0	15.8	7%
FM05	1.3	1.2	8%	9.9	11.2	-13%	15.6	15.2	3%
FM06[3]	0.6	1.1	-83%	2.5	3.1	-24%	2.9	2.8	3%
FM07[4]	0.4	0.3	25%	1.1	1.2	-9%	2.1	2.6	-24%
FM08[5]	0.5	0.3	40%	0.8	0.8	0%	1.7	1.7	0%
FM09	0.6	0.8	-33%	0.8	0.9	-13%	2.0	1.8	10%
FM10	0.9	0.7	22%	1.6	1.7	-6%	2.7	2.8	-4%
FM11	1.7	1.8	-6%	3.2	3.3	-3%	4.5	4.2	7%
FM12	0.7	0.6	14%	2.1	2.0	5%	5.4	4.8	11%
FM13[6]	14.8	12.9	13%	3.8	3.9	-3%	10.1	9.3	8%
FM14[6]	12.7	11.3	11%	3.0	2.7	10%	7.7	6.4	17%
FM15[6]	10.0	8.1	19%	0.9	0.7	22%	2.0	1.6	20%
FM16	0.9	0.8	11%	1.2	1.2	0%	2.7	2.5	7%

Note 1: Event Volume is calculated from 4/4/2011 to 4/8/2011

Note 2: Operation of the West Gate at the WWTP has significant impact on the flow rate through FM01

Note 3: Unknown downstream temporary restriction creates surcharge and velocity drop

Note 4: Velocity data is suspect in post wet-weather conditions

Note 5: Velocity data is suspect in all conditions and depth measurements contradict survey data

Note 6: Heavy surcharge of Miami River Interceptor yields suspect observed depth readings

Table 3-5 WWF Calibration Results, Event 2

	Maximum Depth (ft)			Maximum Flow (MGD)			Total Volume (MG)[1]		
Flow Meter	Modeled	Metered	% Difference	Modeled	Metered	% Difference	Modeled	Metered	% Difference
FM01[2]	8.3	8.1	2%	5.1	4.8	6%	12.6	9.7	23%
FM02	0.5	0.5	0%	0.5	0.5	0%	1.6	1.4	13%
FM03	0.7	0.7	0%	1.4	1.5	-7%	3.8	4.1	-8%
FM04	4.7	4.5	4%	9.1	8.9	2%	20.3	20.3	0%
FM05	1.2	1.1	8%	8.3	9.5	-14%	18.5	19.3	-4%
FM06	0.6	0.7	-17%	2.2	2.6	-18%	3.5	3.6	-3%
FM07[3]	0.3	0.3	0%	0.8	1.0	-25%	3.2	3.2	0%
FM08[4]	0.4	0.3	25%	0.5	1.0	-100%	1.5	2.7	-80%
FM09	0.6	0.6	0%	0.7	0.7	0%	2.7	2.5	7%
FM10	0.7	0.6	14%	1.4	1.5	-7%	3.1	3.3	-6%
FM11[5]	1.8	1.6	11%	2.4	2.4	0%	4.9	5.7	-16%
FM12	0.6	0.6	0%	1.9	2.0	-5%	6.5	6.4	2%
FM13[6]	14.7	13.4	9%	3.6	3.0	17%	11.8	12.0	-2%
FM14[6]	12.7	13.6	-7%	2.9	2.7	7%	8.8	8.9	-1%
FM15[6]	9.9	10.5	-6%	1.0	0.7	30%	2.0	2.3	-15%
FM16	0.9	0.8	11%	1.1	1.2	-9%	3.5	3.6	-3%

Note 1: Event Volume is calculated from 4/19/2011 to 4/24/2011

Note 2: Operation of the West Gate at the WWTP has significant impact on the flow rate through FM01

Note 3: Velocity data is suspect in post wet-weather conditions

Note 4: Velocity data is suspect in all conditions and depth measurements contradict survey data

Note 5: Unknown downstream restriction creates surcharge (modeled as orifice)

Note 6: Heavy surcharge of Miami River Interceptor yields suspect observed depth readings

Table 3-6 WWF Calibration Results, Event 3

	Maximum Depth (ft)			Maximum Flow (MGD)			Total Volume (MG)[1]		
Flow Meter	Modeled	Metered	% Difference	Modeled	Metered	% Difference	Modeled	Metered	% Difference
FM01[2]	9.2	8.8	4%	4.5	3.5	22%	8.6	3.1	64%
FM02[3]	0.5	0.8	-60%	0.5	0.5	0%	2.4	1.9	21%
FM03	0.7	0.7	0%	1.6	1.8	-13%	6.3	6.1	3%
FM04	6.2	5.1	18%	11.9	12.1	-2%	34.6	32.4	6%
FM05	1.4	1.3	7%	11.1	11.8	-6%	31.8	29.7	7%
FM06[5]	0.6	1.1	-83%	2.3	2.8	-22%	5.7	5.4	5%
FM07[6]	0.4	0.4	0%	0.9	1.5	-67%	4.5	5.4	-20%
FM08[7]	0.5	0.3	40%	0.9	1.1	-22%	4.2	4.4	-5%
FM09	0.7	0.7	0%	0.9	0.9	0%	4.5	3.7	18%
FM10[8]	1.1	1.6	-45%	2.3	2.2	4%	6.5	5.4	17%
FM11[9]	1.7	2.1	-24%	3.5	3.4	3%	8.2	8.4	-2%
FM12	0.7	0.7	0%	2.5	2.7	-8%	10.0	9.5	5%
FM13[10]	14.9	13.4	10%	4.2	4.2	0%	21.9	18.4	16%
FM14[10]	13.1	13.3	-2%	3.6	4.3	-19%	18.4	16.6	10%
FM15[10]	10.4	10.3	1%	1.1	1.0	9%	4.3	3.5	19%
FM16	1.0	0.9	10%	1.5	1.7	-13%	5.6	5.3	5%

Note 1: Event Volume is calculated from 4/24/2011 to 4/30/2011

Note 2: Operation of the West Gate at the WWTP has significant impact on the flow rate through FM01, velocity sensor failed on 4/25 and was down for remainder of event

Note 3: Unknown downstream conditions creates velocity drop, corresponding modeled depth rises much higher than observed depth response

Note 4: Velocity data is suspect in all conditions and depth measurements contradict survey data

Note 5: Unknown downstream restriction creates surcharge (modeled as orifice)

In summary, wet weather calibration of the Expanded Model was completed and identified to accurately reflect the RDII response from the metered sewersheds. Section 4 presents the results of the Existing System Capacity Assessment and Section 5 presents the results of the Future Conditions Capacity Assessment. The calibrated model was used to identify and describe sewer system deficiencies for a range of design storms and also to evaluate the system against long-term continuous rainfall simulations. Once the problem areas were identified and the future flow's characterized, detailed analyses were performed to identify a number of potential alternatives to serve the City's future wastewater collection needs.

3.3 I/I Assessment

The flow monitoring data collected and presented in the calibration plots following the RTK analysis clearly indicate the sanitary sewer systems susceptibility and response to rainfall derived inflow and infiltration (RDII). This sub-section identifies the sewersheds most heavily influenced by I/I based on analysis of the measured flow data.

Table 3-7 presents two types of values for each metered sewershed that provided insight to its RDII response. For each calibration rainfall event, the Observed Total R value used in RTK analysis is shown along with the wet weather Peaking Factor (Peak WWF/Average DWF). For reference, the Observed Total R value estimates the amount of rainfall that entered the sewer as a percentage of the total rainfall that fell over the sewershed. **Figure 3-4** graphically presents the collection systems response to RDII using a three-colored gradation for sewersheds with a minimal, intermediate, and significant response to I/I. The RDII gradation was established for each meter based on comparing/taking into consideration the R-value and peaking factors for the three calibration rain events and are categorized as follows.

- Significant RDII Response – FM03, FM04, FM05, FM06, FM10
- Intermediate RDII Response – FM07, FM08, FM11, FM13, FM14
- Minimal RDII Response – FM01, FM02, FM09, FM12, FM15, FM16

A sewershed's RDII response was categorized as Significant, Intermediate, or Minimal considering a meter's R-value and Peaking Factor evaluating all three calibration events collectively; without a distinct differentiator or range of values. A distinct range of values was not identified due to the sewershed's varying antecedent moisture conditions prior to each calibration event. The results from the I/I assessment was used in Section 6 to evaluate the potential effectiveness of eliminating I/I from the system by estimating the resultant decrease in wet weather flow reaching the WWTP.

Table 3-7 Calibration Event Observed R Values and Wet Weather Peaking Factors For Each Metered Sewershed

Flow Meter ID		Event 1			Event 2			Event 3		
	Average DWF (MGD)	Observed Total R	Peak WWF (MGD)	Peaking Factor	Observed Total R	Peak WWF (MGD)	Peaking Factor	Observed Total R	Peak WWF (MGD)	Peaking Factor
FM01	2.01	0.3%	13.8	6.9	0.2%	6.0	3.0	0.2%	4.2	2.1
FM02	0.27	4.3%	0.5	1.7	6.4%	0.5	1.9	11.1%	0.5	1.9
FM03	0.38	8.2%	1.5	3.9	10.0%	1.4	3.7	15.7%	1.6	4.2
FM04	1.92	7.6%	11.4	6.0	9.3%	9.2	4.8	15.7%	10.9	5.7
FM05	1.72	8.2%	9.9	5.8	10.5%	8.4	4.9	17.0%	9.5	5.5
FM06	0.28	10.6%	2.5	9.1	14.0%	2.2	7.8	19.0%	2.5	8.9
FM07	0.26	6.5%	1.1	4.3	4.6%	0.8	3.2	5.0%	0.5	2.1
FM08	0.22	8.5%	0.7	3.0	4.5%	0.8	3.6	10.0%	1.1	4.9
FM09	0.41	0.9%	0.8	1.8	2.2%	0.7	1.6	6.0%	0.9	2.2
FM10	0.30	7.5%	1.6	5.3	8.4%	1.6	5.4	10.0%	2.3	7.7
FM11	0.46	5.7%	3.0	6.7	6.5%	2.5	5.4	6.5%	2.3	5.0
FM12	0.92	1.6%	2.1	2.3	1.1%	1.9	2.1	1.4%	2.2	2.4
FM13	1.72	5.0%	3.7	2.2	6.5%	4.0	2.3	1.2%	4.6	2.7
FM14	1.32	3.6%	2.9	2.2	5.9%	3.2	2.4	12.4%	3.7	2.8
FM15	0.31	3.7%	0.9	2.9	1.8%	1.4	4.4	1.6%	1.1	3.5
FM16	0.42	2.6%	1.2	2.8	4.0%	1.2	2.7	5.2%	1.4	3.3

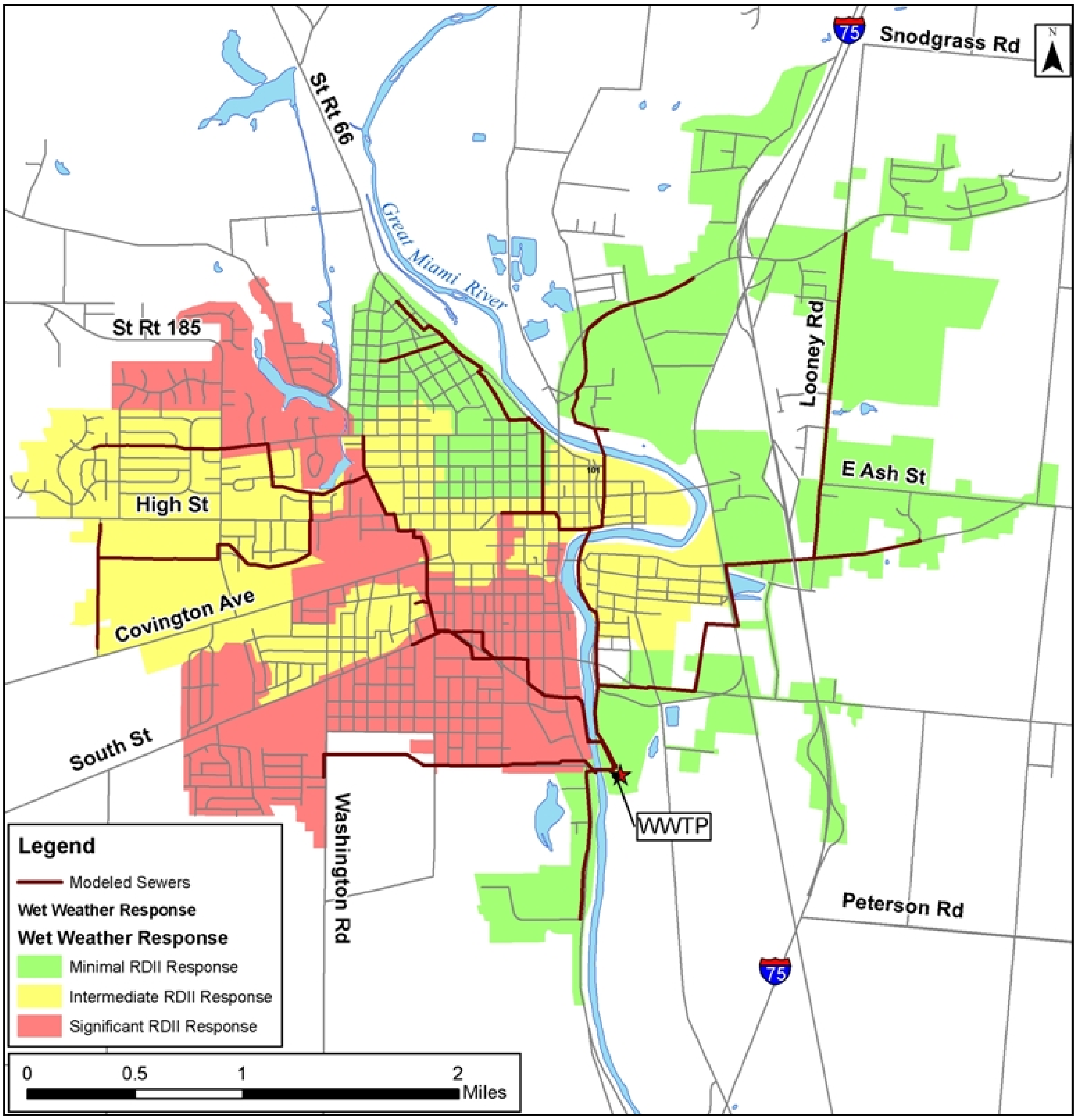


Figure 3-4
Graphical I/I Assessment

Section 4

Existing Conditions System Assessment

Utilizing the calibrated expanded model, this section presents the results of the sanitary sewer system capacity assessment for both dry weather and wet weather conditions. The WWF capacity assessment evaluated the modeled system for the calibrated rainfall events and for synthetic design storm events.

Using historic rainfall data, the reduction of SSO volume and frequency of SSO occurrences resulting from the sewer system improvements (i.e. construction of 1 MG equalization basin and lining of the West Interceptor) was evaluated and is presented in this section.

4.1 Dry Weather Flow Capacity Assessment

The calibrated expanded sanitary sewer system model was used to evaluate the existing dry weather capacity in each pipe segment in the modeled system. For each segment, the pipe size, slope, full-flow capacity, the measured average and peak dry weather flow rate and the percent full were identified under existing conditions. A detailed table identifying these results for each modeled segment can be found in **Appendix C.**

During dry weather conditions, the majority of the modeled sewer segments are flowing less than a quarter capacity, with the northwest interceptor being the only area in the system where segments are shown using more than 50% of the conveyance capacity. On average, the current system is only utilizing 11% of its available capacity and can more than accommodate the current average dry weather flow. **Figure 4-1**, shown below, identifies the percent full for each modeled pipe based on the flow monitoring data in the calibrated model.

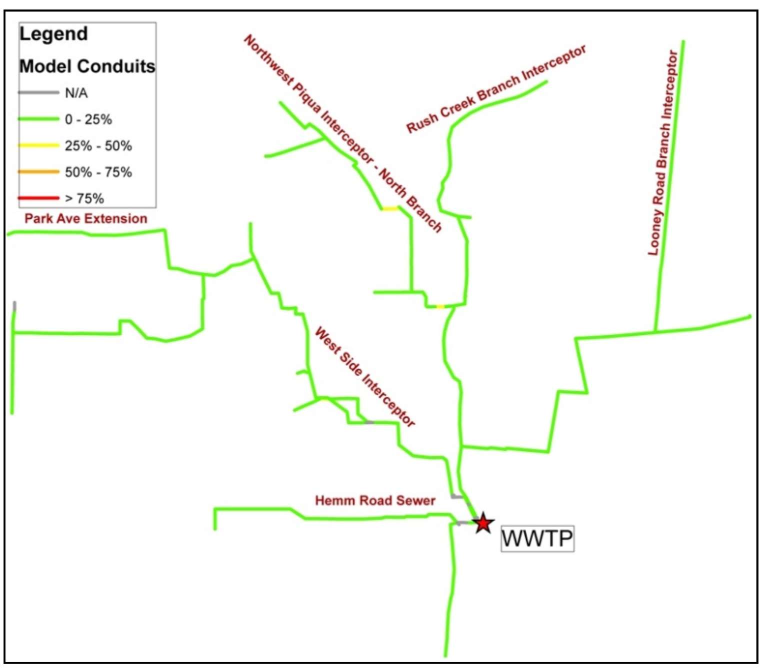


Figure 4-1:
DWF Capacity Assessment (% Full) – Existing Conditions

4.2 Wet Weather Flow Capacity Assessment

Similar to the dry weather capacity assessment, the calibrated expanded sanitary sewer system model was also used to evaluate the wet weather capacity on each pipe segment in the modeled system.

4.2.1 Measured Rain Event Assessment

For each modeled segment, the pipe size, slope, full-flow capacity, the measured average and peak wet weather flow rate and the percent full for were identified for each of the three measured (calibration) rain events that are based on observed wet weather flow monitoring data. A detailed table identifying these results for each modeled segment can be found in **Appendix C.**

During wet weather conditions, the existing system experiences a significant increase in the amount of flow being conveyed to the treatment plant. During the three calibration events, the system saw averages in the range of 40%-52% of its full flow capacity, and 5%-10% of the modeled sewers are flowing more than 100% full, which indicates pipe surcharging or potential surface flooding. Across all three events, the problem areas are located along northeast and west interceptors, while the Hemm Road interceptor exhibited no capacity concerns. **Figures 4-2, 4-3 and 4-4** show the modeled system for each of the three calibration events, and highlight areas of concern.

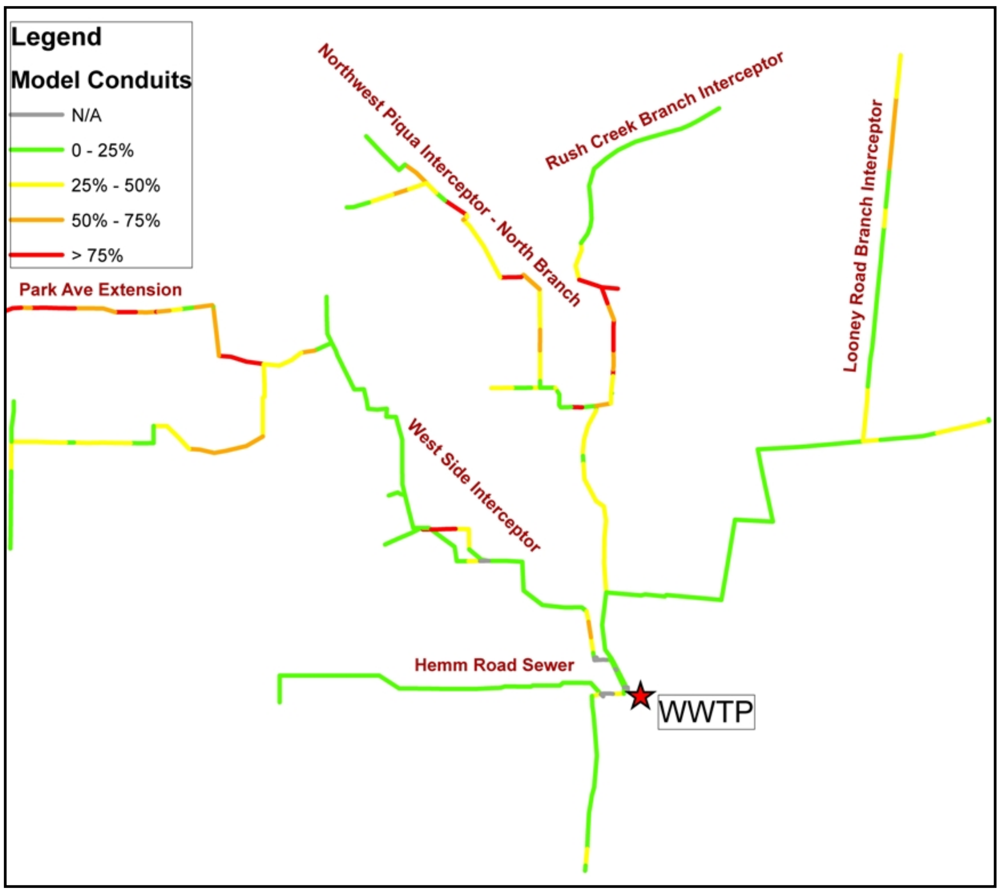


Figure 4-2
Calibration Event 1 Capacity Assessment (% Full) – Existing Conditions

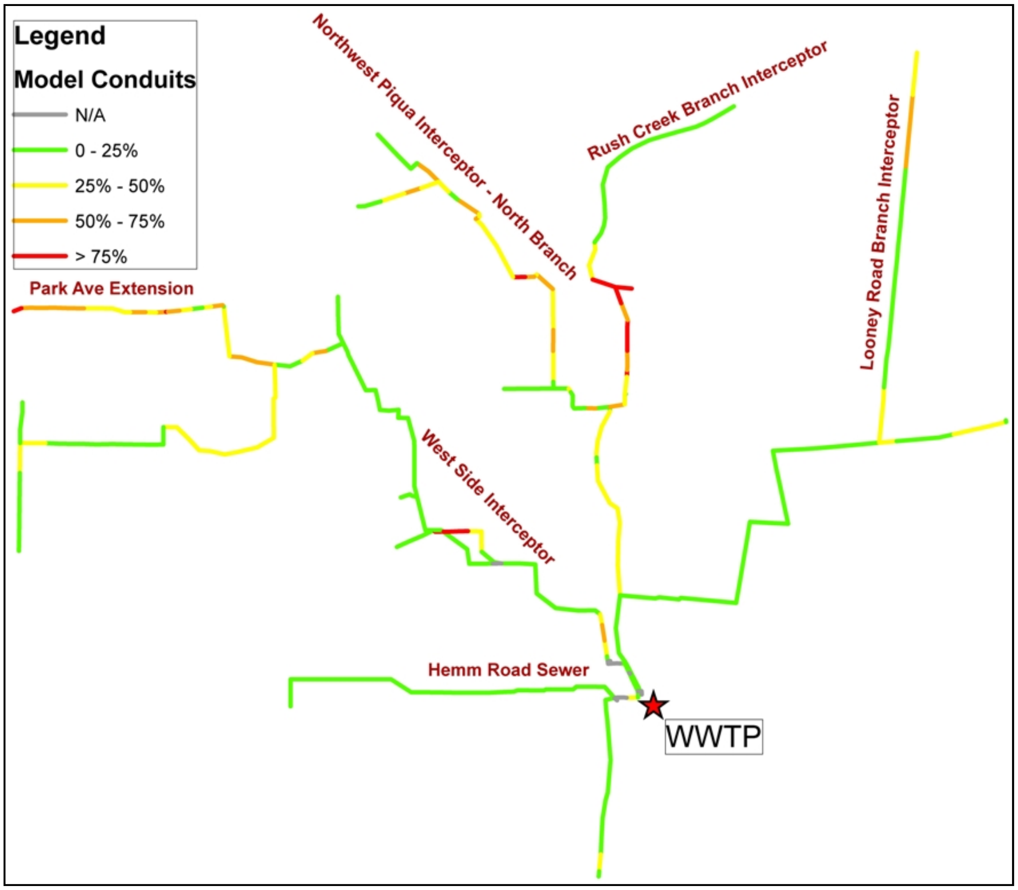


Figure 4-3
Calibration Event 2 Capacity Assessment (% Full) – Existing Conditions

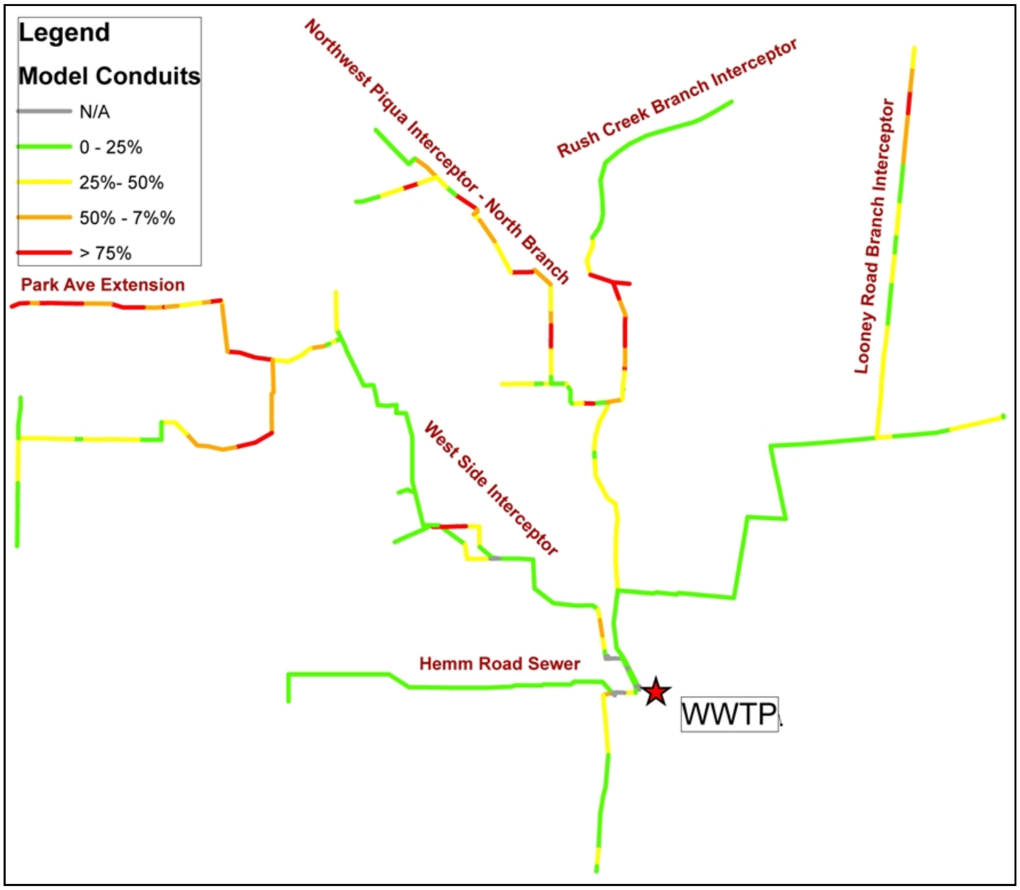


Figure 4-4
Calibration Event 3 Capacity Assessment (% Full) – Existing Conditions

4.2.2 Design Storm Assessment

To help identify if the existing sanitary sewer system can accommodate larger rain events than the observed measured rain events, the model was evaluated using synthetic design storm events; consisting of a 6-month, 1-year, 2-year, 5-year, and 10-year, 24-hour SCS type II synthetic rainfall hyetographs. The range of storm events that were evaluated provides an envelope of wet weather responses to identify where hydraulic limitations exist, then planning for collection system improvements to alleviate those problems.

Similar to measured rain event assessment, the Miami River Interceptor and West Interceptors are identified as the areas with the most capacity issues. The pipe surcharging along the Miami River Interceptor is caused by constraints downstream at the treatment plant, but due to the depth of the sewer, no surface flooding was observed. Flooding did occur along the West Interceptor for some of the larger design storms, which indicated that the piping infrastructure may be undersized for the current capacity demands. The Hemm Road Interceptor saw no surcharging or flooding, and similar to the measured rain event assessment, this sewer had surplus capacity available during peak wet weather flows. The following figures show the existing modeled system for each of the synthetic design storm events and illustrate the corresponding problem areas; reference **Figures 4-5, 4-6, 4-7, 4-8, 4-9**.

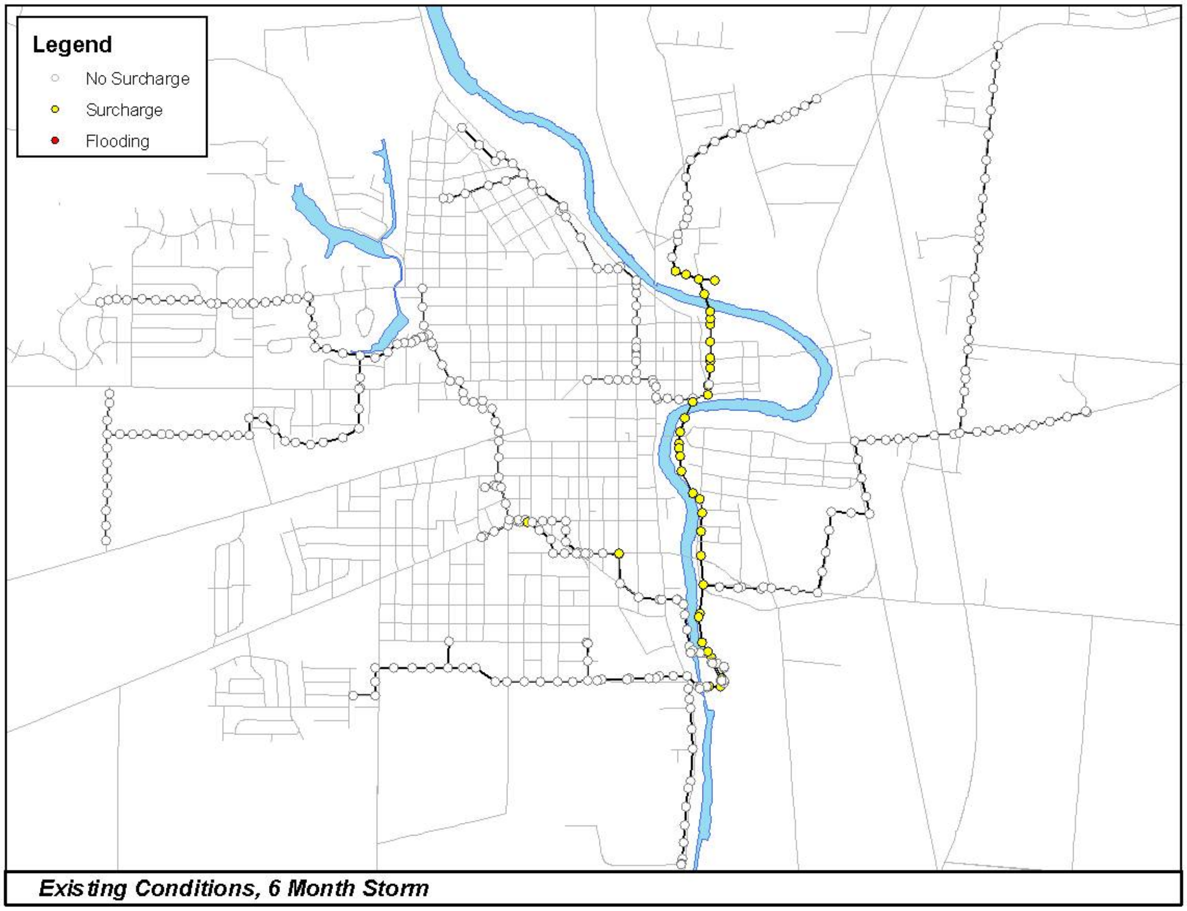


Figure 4-5
6-month Design Storm Capacity Assessment – Existing Conditions

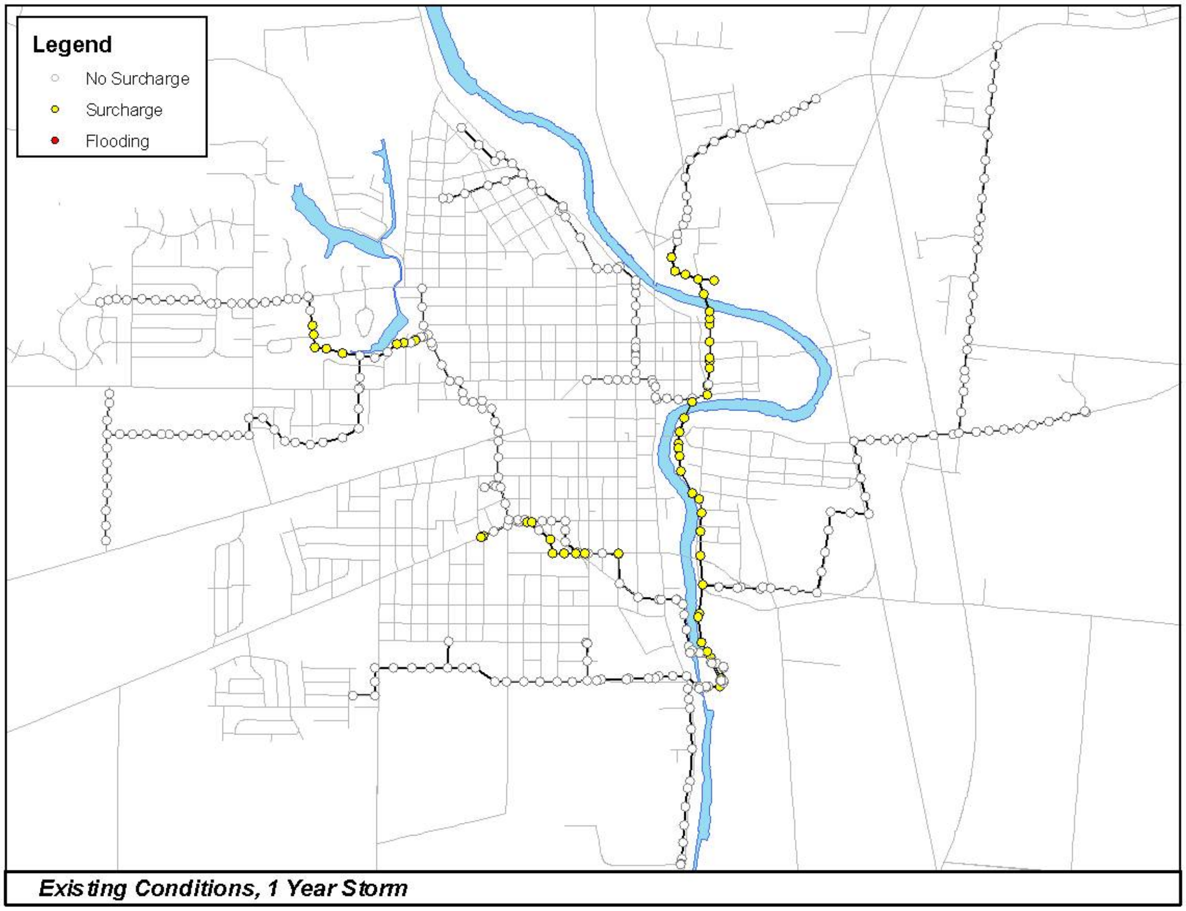


Figure 4-6
1-year Design Storm Capacity Assessment – Existing Conditions

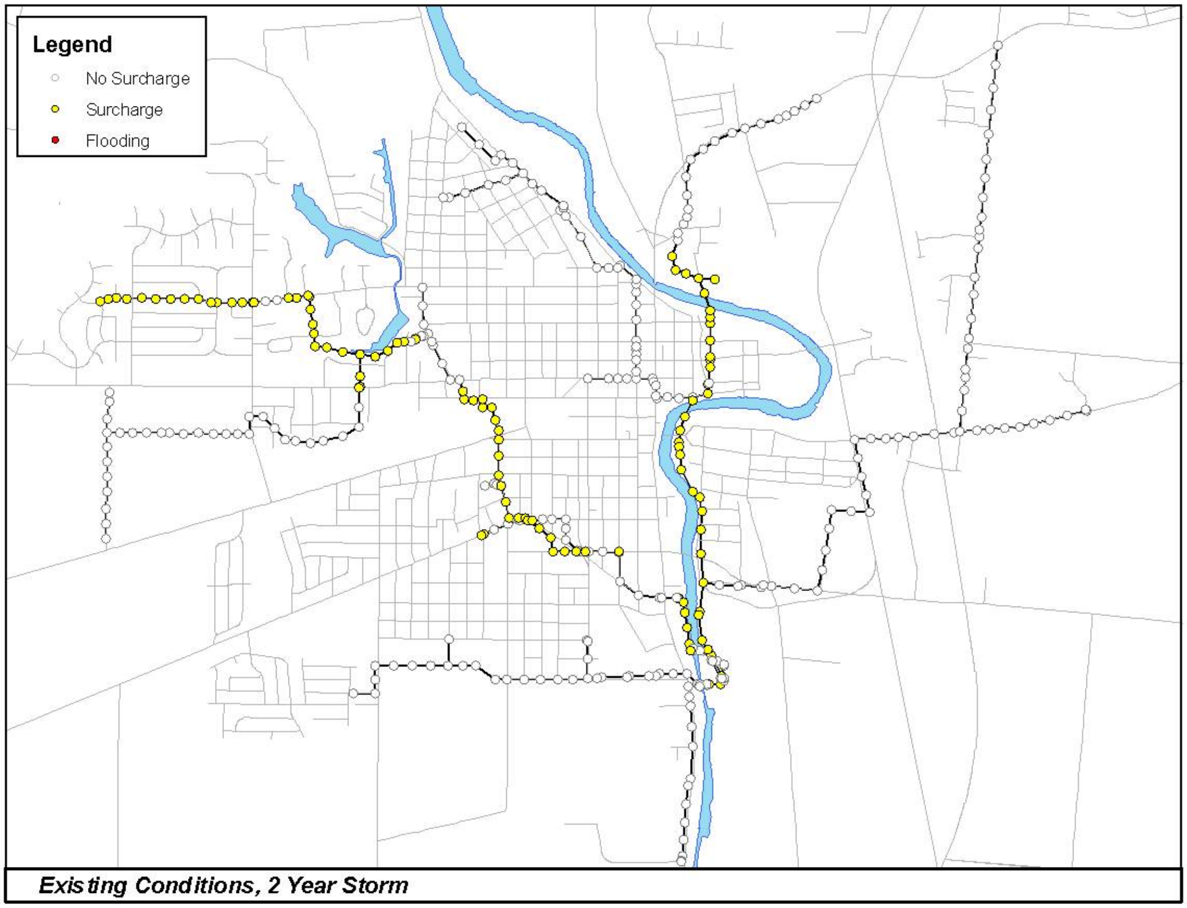


Figure 4-7
2-year Design Storm Capacity Assessment – Existing Conditions

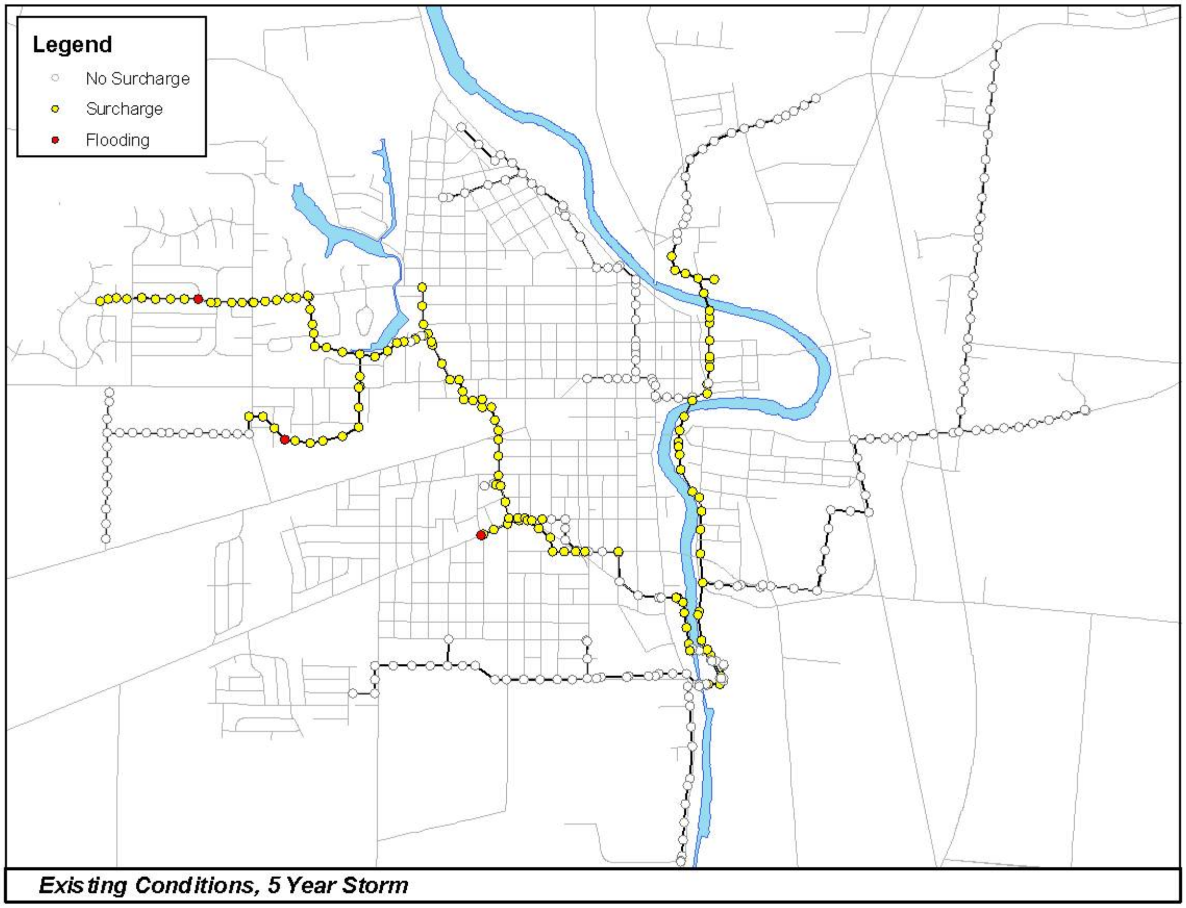


Figure 4-8
5-year Design Storm Capacity Assessment – Existing Conditions

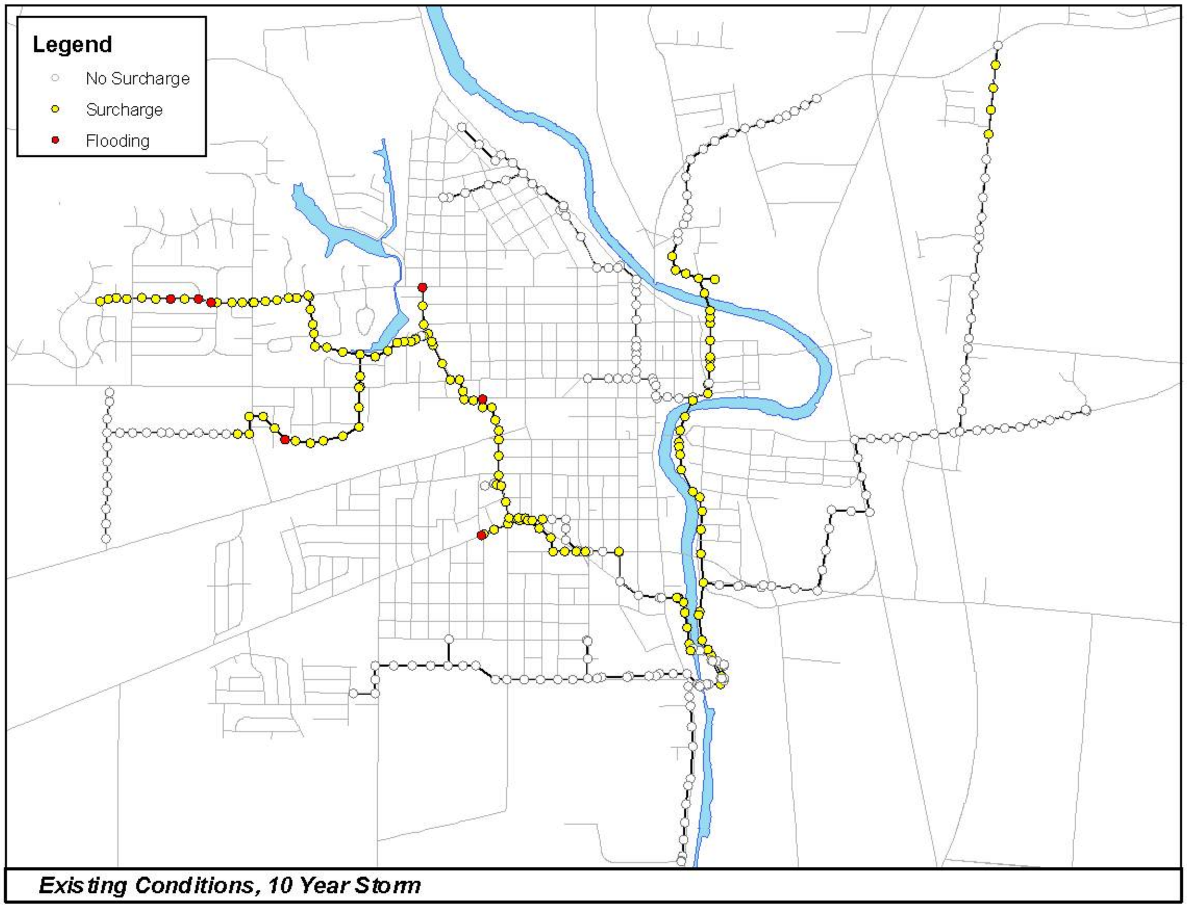


Figure 4-9
10-year Design Storm Capacity Assessment – Existing Conditions

4.3 Constructed Improvements Evaluation

The City completed the construction of improvements to its sanitary sewer system which were designed to reduce the volume of SSO discharge and frequency of SSO occurrences. The constructed improvements consist of the following:

- 1 MG equalization basin at the WWTP
- Rehabilitation and lining of the West Interceptor

Construction of the 1 MG flow equalization (EQ) basin was completed in October of 2009. The EQ basin is located downstream of the SSO, ahead of the WWTP, and functions by gravity; not requiring any pumping of wastewater. The EQ basin has a storage volume of 3 MG but would require pumping to utilize the total volume available. Rehabilitation of the West Interceptor took place between December and January of 2010/11; consisting of removing roots and debris, manhole replacements, and CIPP lining of approximately 1,020 linear feet of the 36-inch interceptor upstream of the SSO. Utilizing historic rainfall data collected at the WWTP, two types of continuous model simulations were performed to evaluate/demonstrate the benefits of SSO reduction resulting from these two sewer system improvements.

As described in Section 2, there are significant differences between the original hydraulic model, used as the basis of design for the EQ basin, and the expanded hydraulic model created for this Master Plan. Due to these differences, the evaluation to demonstrate the benefits of the constructed improvements considered both hydraulic models for comparison. For the evaluation, both models used the same 5-year rainfall data set, consisting of hourly rainfall data between January 1, 2000 and December 31, 2004, collected at the National Climatic Data Center Cooperative Station 336650 at the Piqua WWTP.

The evaluation considered both models with and without the EQ basin being simulated. Unfortunately, there is no way to conclusively evaluate the affects of lining the West Interceptor given the data available pre- and post-lining. As presented in **Table 4-1**, the benefit of the EQ basin is identified by the reduction in SSO volume and frequency of SSO occurrences. For each model simulation, implementation of the EQ basin resulted in a SSO volume reduction of approximately 30 percent.

Clearly, the values for volume and frequency of SSOs are dramatically different between the original and expanded model. The intent of this study was to expand the City's interceptor model and in so doing, create a more accurate model representing the City's sanitary sewer collection system. Based on the significant differences described in Section 2 and the subsequent model calibration described in Section 3, CDM Smith has high confidence in the Expanded Model and the H/H results being presented in this report. Hydraulically, both models simulated a consistent reduction in SSO volume; but the results associated with the Expanded Model are more realistic to simulate the City's sanitary sewer collection system operations.

Table 4-1 SSO Reduction Resulting from Constructed Improvements

	SSO Volume, MG			SSO Frequency (occurrences)		
	Without EQ	With EQ	Reduction	Without EQ	With EQ	Reduction
Original Model	992	678	314 (31.6%)	194	146	48%
Expanded Model	307	217	90 (29.3%)	88	58	30%

Section 5

Future Wastewater Flow Characterization and Capacity Assessment

Utilizing the calibrated expanded model, this section presents the results of the sanitary sewer system capacity assessment for both dry weather and wet weather conditions. The wet weather flow (WWF) capacity assessment will evaluate the modeled system for the calibrated rainfall events and for synthetic design storm events.

Future flows were categorized as dry weather and wet weather flow. This was done at two different temporal projections: a Year 2030 projection to size additional facilities at the WWTP, and an Ultimate Build-out projection to size alternatives to convey flows to the WWTP facility. The reason for the different flow conditions is to match flow needs with the service life of the sewer infrastructure. Sanitary sewers are expected to have a service life of 100 years that is more commensurate with ultimate flow projections.

5.1 Future Dry Weather Flow Capacity Assessment

Sections 5.2.1 and 5.2.2 show the projected DWF in the system for the 2030 and Ultimate Build-out conditions, respectively. **Table 5-1** shows the increase in average daily DWF as seen over the entire collection system. **Figure 5-1** presents the existing service area and the anticipated future development service areas.

Table 5-1 Dry Weather Flow Projections

DWF Scenario	Estimated Average Daily DWF (MGD)
Existing Conditions	3.5
Year 2030	7.0
Ultimate Build-out	9.3

Note: Estimated Average Day DWF for Year 2030 and Ultimate Build-out includes 1 MGD from the Village of Covington.

5.1.1 Year 2030 Dry Weather Flows

CDM Smith used population projections from Miami Valley Regional Planning Commission's traffic analysis zones (TAZ) to determine a future DWF in the sanitary system throughout the collection system. There are several commercial and industrial facilities that are currently vacant, but were assumed to be occupied for the Year 2030 DWF projection as part of redevelopment opportunities within the City. According to the City of Piqua Water Treatment Plant Planning and Preliminary Design – Preliminary Engineering Report and the TAZ projections, it was conservatively assumed that the commercial and industrial areas of the City will experience full build-out by the year 2030. This accounts for an additional average daily DWF of 0.91 MGD from commercial facilities and 1.99 MGD from industrial facilities. Due to the small projected increase in residential population, there is only a predicted average daily DWF of 0.1 MGD from residential areas.

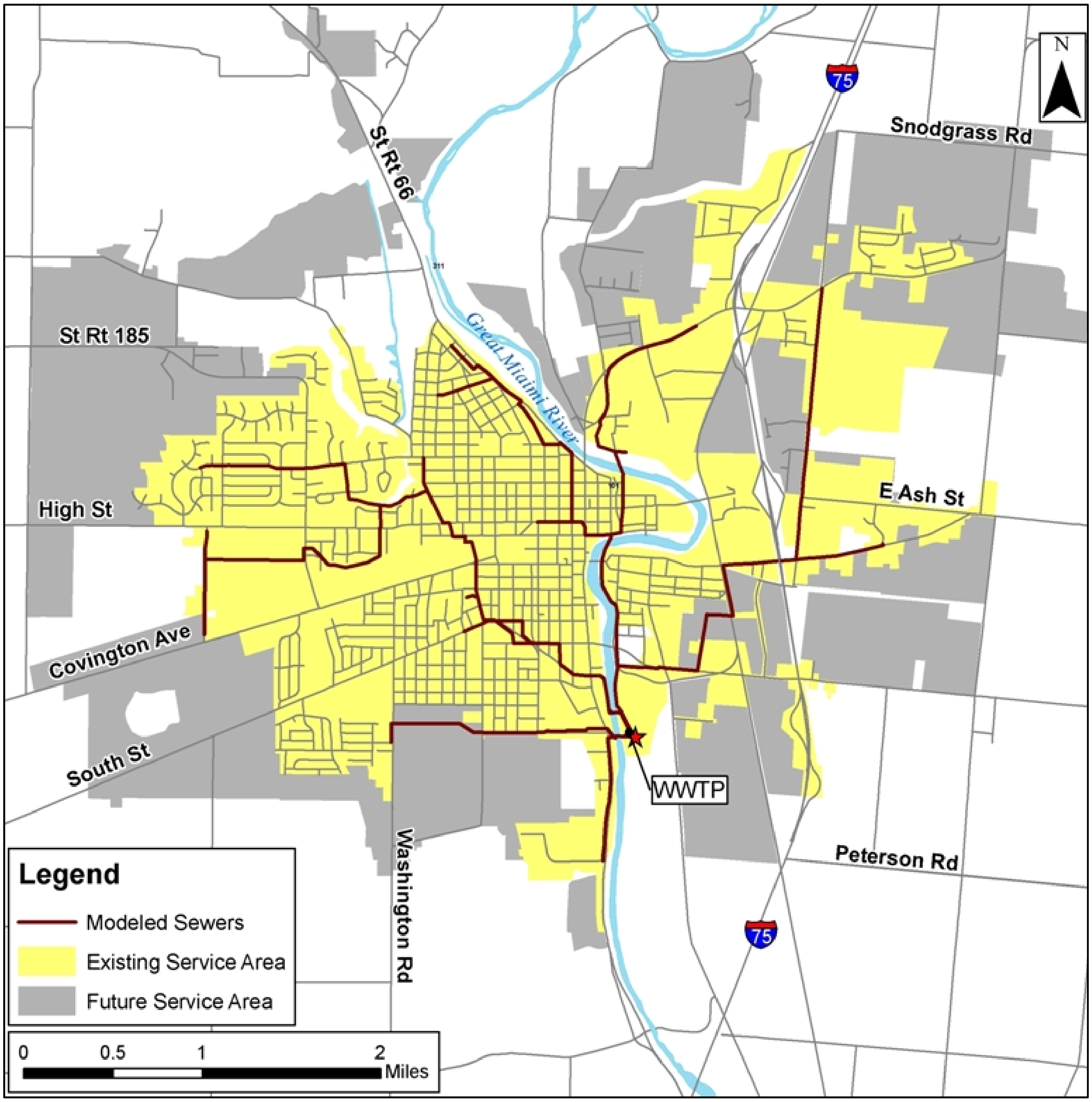


Figure 5-1
Existing and Future Service Areas

5.1.2 Ultimate Projection Dry Weather Flows

CDM Smith utilized the same TAZ population projections to determine a future dry weather flow in the sanitary collection system for an "ultimate build-out" condition to evaluate the future DWF impact on capacity for each pipe segment in the existing modeled system. The ultimate build-out is defined as the full land use development for areas within the sanitary sewer service area. The pipe size, slope, full-flow capacity, the measured average and peak DWF rate and the percent full for each pipe segment were identified for existing hydraulic conditions (i.e. existing pipe size, slope, sediment levels, etc). As stated above, the commercial and industrial flows were conservatively assumed to experience complete build-out by the year 2030, so there is no additional increase from those sources on average daily DWF. However, there is a significant projected increase in residential population between the year 2030 and the ultimate predictions as reported by the TAZ, with several residential land use areas to be developed. This accounts for an additional 2.2 MGD of average daily DWF throughout the collection system. A detailed table identifying these results for each modeled pipe segment can be found in **Appendix D.**

During ultimate dry weather conditions, 90% of the modeled sewer segments are flowing at less than half capacity. Similar to the existing dry weather flow capacity assessment, the northwest interceptor is the only area in the system where segments are shown using more than 75% of their capacity. However, with the increased dry weather from the future build out areas, 3 pipes in the system are over 100% capacity. The existing system cannot accommodate the additional capacity needs from the future build-out without additional conveyance infrastructure being built. **Figure 5-2**, shown below, identifies the percent full for each modeled pipe based on Ultimate Build-out projections in the calibrated model.

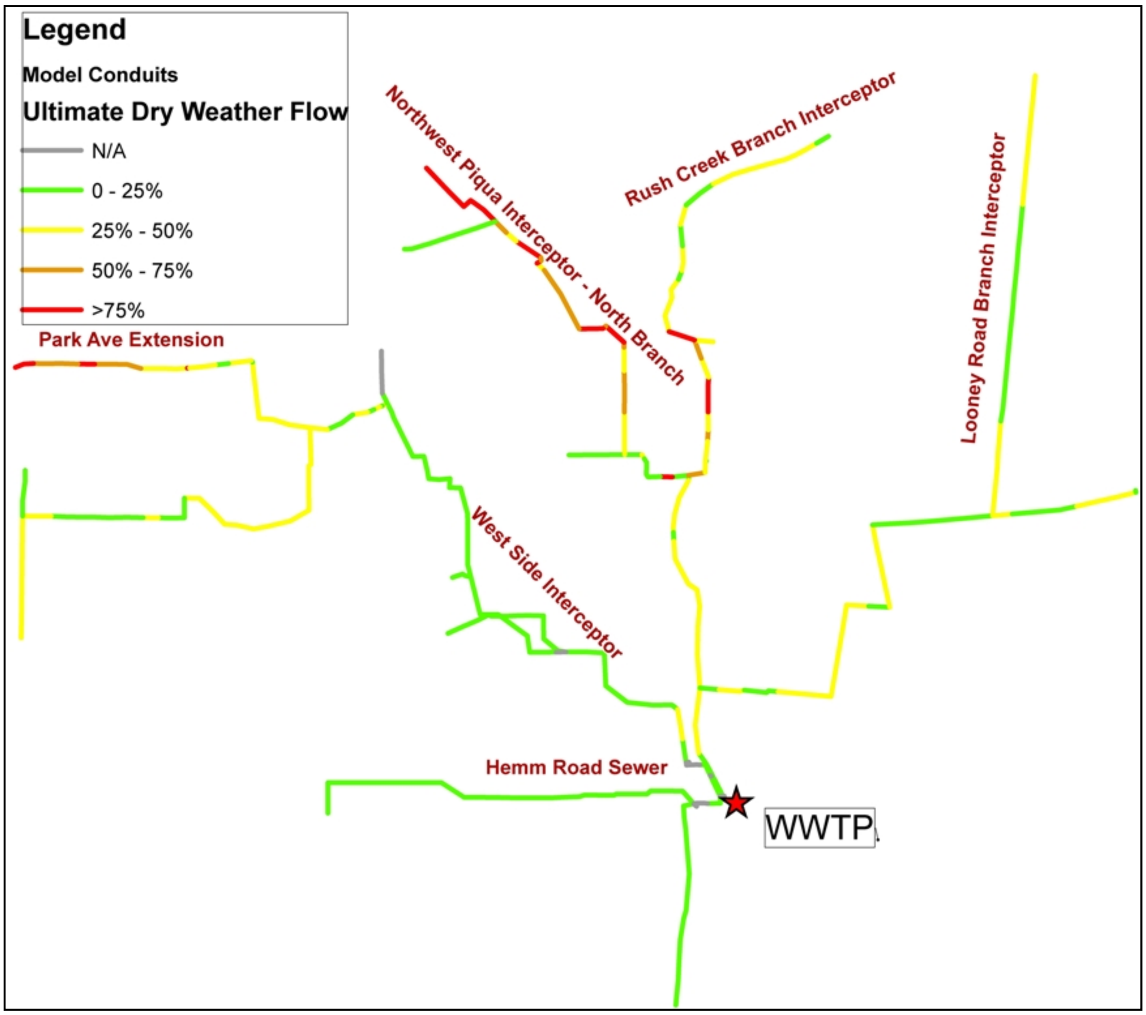


Figure 5-2
DWF Capacity Assessment – Ultimate Build-out

5.2 Future Wet Weather Flow Capacity Assessment

Similar to the future dry weather capacity assessment above, the calibrated expanded sanitary sewer system model was also used to evaluate the future WWF to the WWTP as well as capacity in each pipe segment of the existing modeled system. **Table 5-2** shows the increase in area contributing to WWF over the entire collection system.

Table 5-2 Additional Acreage Contributing to Wet Weather Flow

Type of Flow	Year 2030	Ultimate Build-out
Industrial	1,212	1,212
Commercial	239	239
Residential	152	3,640
Total	1,603	5,091

5.2.1 Year 2030 Estimated Wet Weather Flows

Wet weather flows in the collection system were modeled using both existing infrastructure and future conveyance infrastructure. Wet weather flow parameters as determined during the flow monitoring period were used for the areas with existing infrastructure as they are more representative of older pipes and as such, generate more RDII into the system. Future build-out areas were associated with an area of the City with newer pipes that have less I/I, so WWTP facilities would not be oversized due to an overly conservative I/I ratio.

5.2.2 Ultimate Build-out Estimated Wet Weather Flows

Similar to the 2030 projections, the existing infrastructure used wet weather flow parameters determined during the flow monitoring period and future build-out areas were associated with an area of the City with newer pipes that have less I/I so as to not oversize conveyance needs under ultimate build-out conditions. Thus, RTK values determined at FM09 (Wayne St, & Greene St.), representing a minimal RDII response, were used as hydrologic inputs for future development areas.

5.2.3 Measured Rain Event Assessment

For each modeled segment, the pipe size, slope, full-flow capacity, the measured average and peak wet weather flow rate and the percent full for were identified for each of the three measured (calibration) rain events that include the wet weather allocation from ultimate build-out areas. A detailed table identifying these results for each modeled segment can be found in **Appendix D.**

Similar to what was seen during the existing wet weather flow capacity assessment, during wet weather conditions the model experienced a significant increase in the amount of flow being conveyed to the treatment plant. During the three calibration events, the system saw averages in the range of 55%-64% of its full flow capacity, and 15%-20% of the modeled sewers are flowing more than 100% full, which indicates pipe surcharging with the potential for street or basement flooding. Across all three events, the problem areas are located along northeast and West Interceptors, while the Hemm Road Interceptor had surplus capacity. **Figures 5-3, 5-4 and 5-5** show the modeled system for each of the three calibration events, and highlight areas of concern.

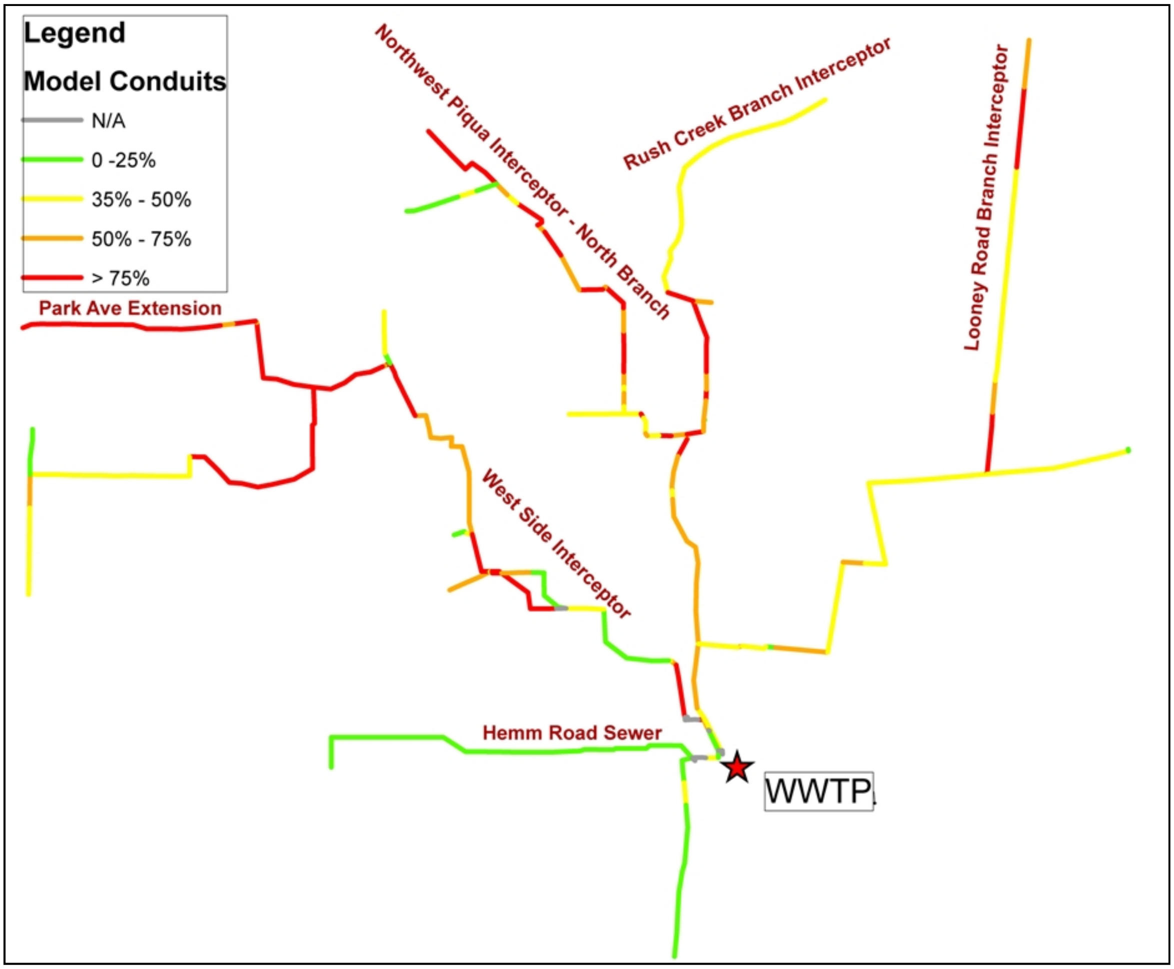


Figure 5-3
Calibration Event 1 Capacity Assessment – Ultimate Build-out

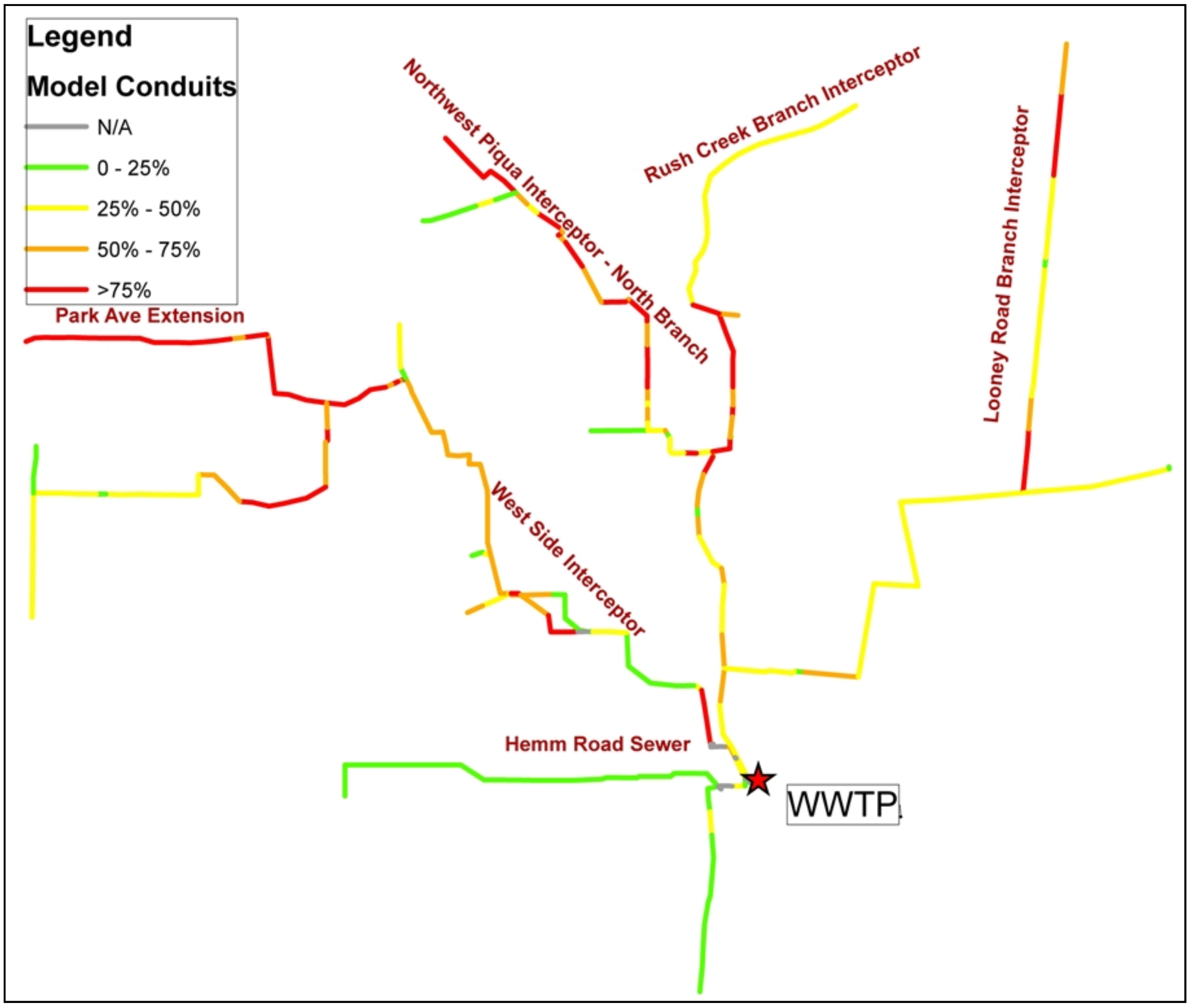


Figure 5-4
Calibration Event 2 Capacity Assessment – Ultimate Build-out

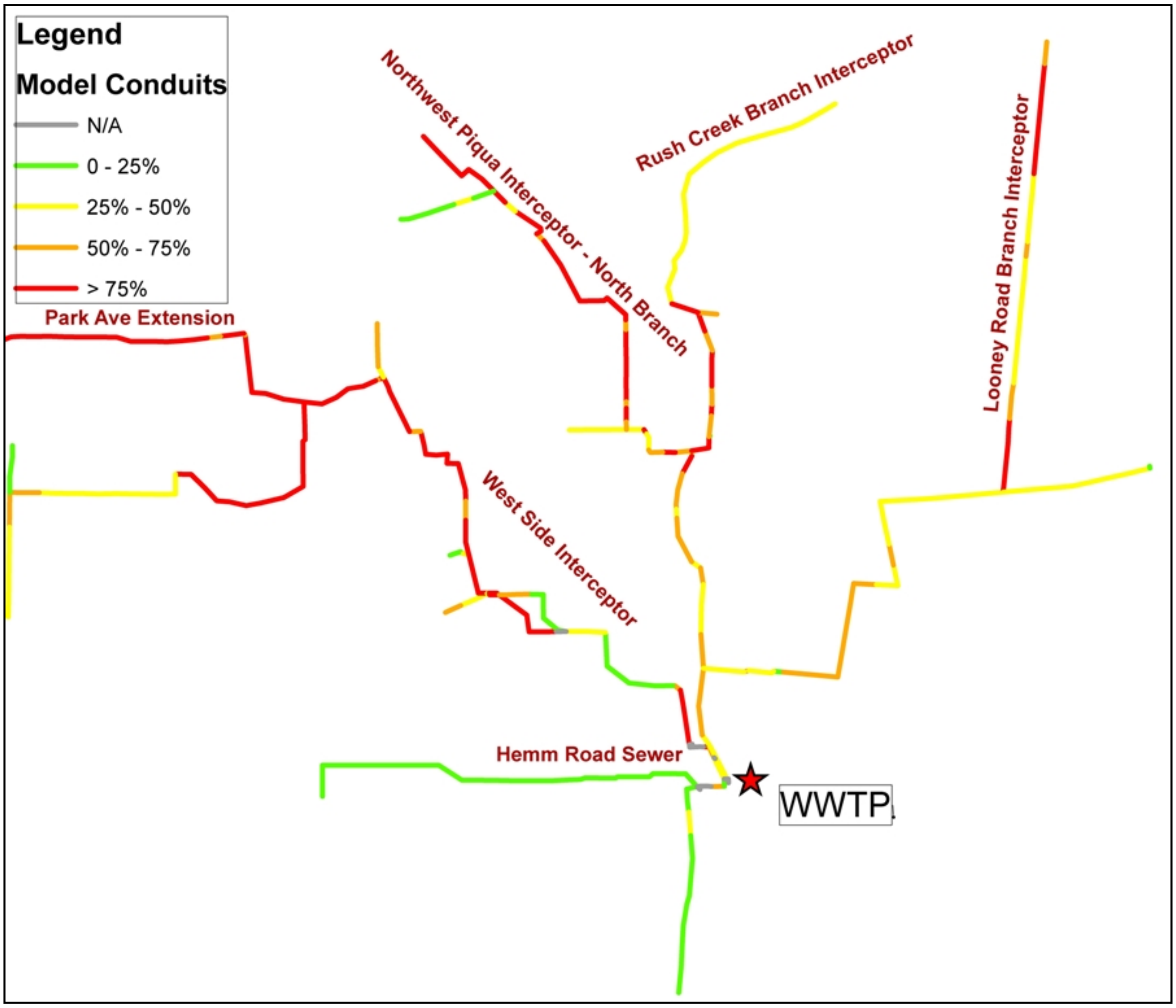


Figure 5-5
Calibration Event 3 Capacity Assessment – Ultimate Build-out

5.2.4 Design Storm Assessment for System Conveyance

To help identify if the existing sanitary sewer system can accommodate larger rain events than the observed measured rain events, the model was evaluated using synthetic design storm events; consisting of a 6-month, 1-year, 2-year, 5 year, and 10-year, 24-hour SCS type II synthetic rainfall hyetographs with the assumed wet weather allocation from the ultimate build-out areas. The range of storm events that were evaluated helped provide an envelope of wet weather responses necessary to identify areas of the existing sanitary sewer system that are in need of improvements.

Like the results from the measured rain event assessment for both future and existing scenarios, the Northeast and West Interceptors are identified as the areas with the most issues. Surcharging and street flooding occurred during all 5 synthetic design storm events, which indicated that the infrastructure is undersized and unable to accommodate for the future build-out capacity demands. Again, the Hemm Road Interceptor saw no surcharging or flooding, and just like the measured rain event assessments, had additional capacity available during wet weather events. The following figures show the existing modeled system for each of the five synthetic design storm events and illustrate the corresponding problem areas; reference **Figures 5-6, 5-7, 5-8, 5-9, 5-10**.

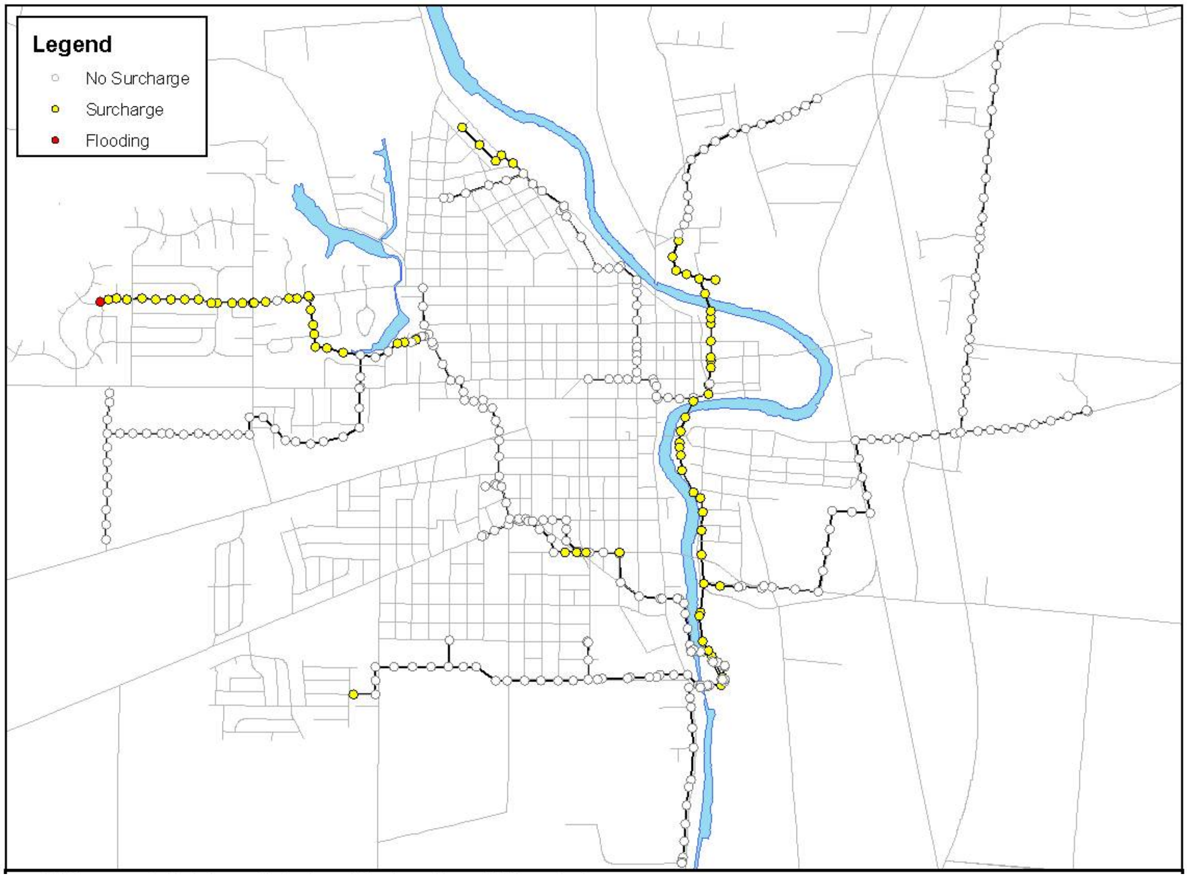


Figure 5-6
6-month Design Storm Capacity Assessment – Ultimate Build-out

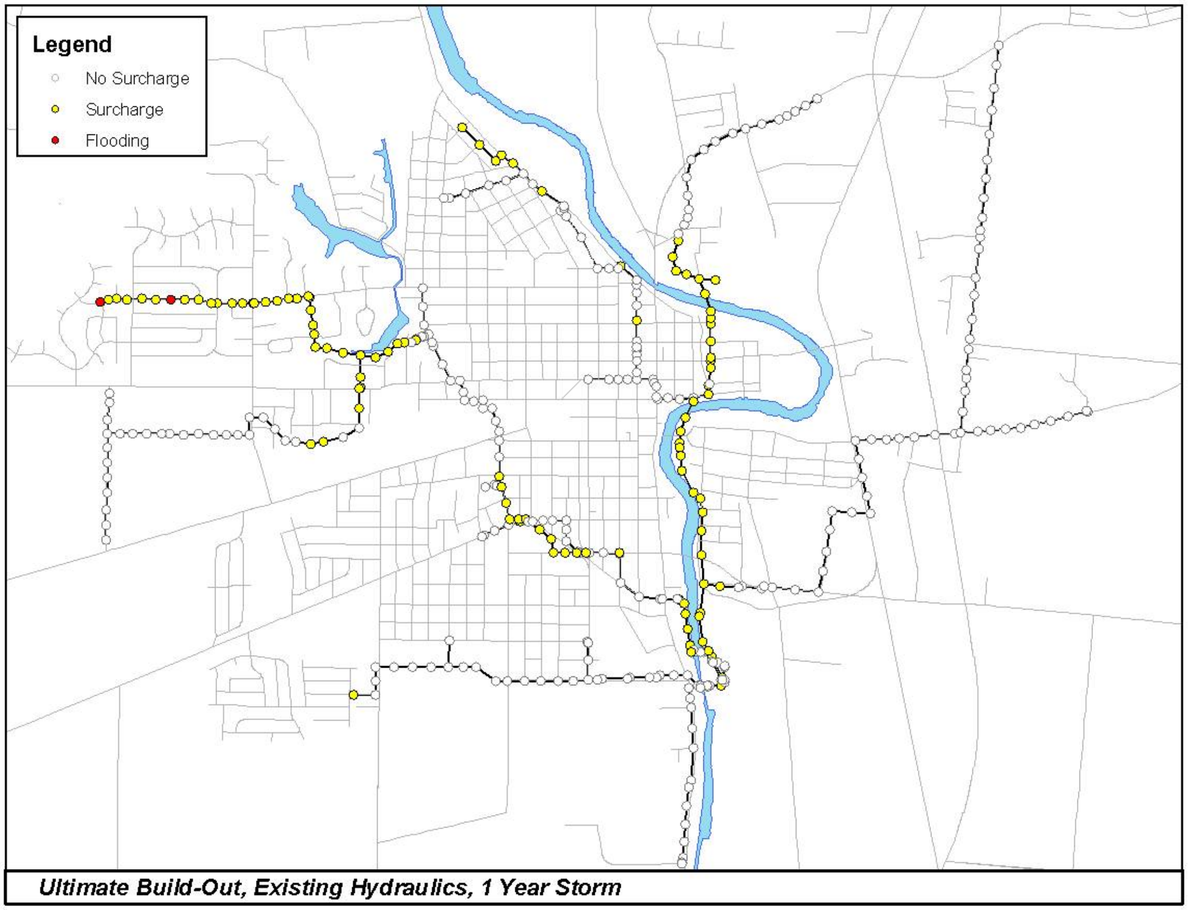


Figure 5-7
1-year Design Storm Capacity Assessment – Ultimate Build-out

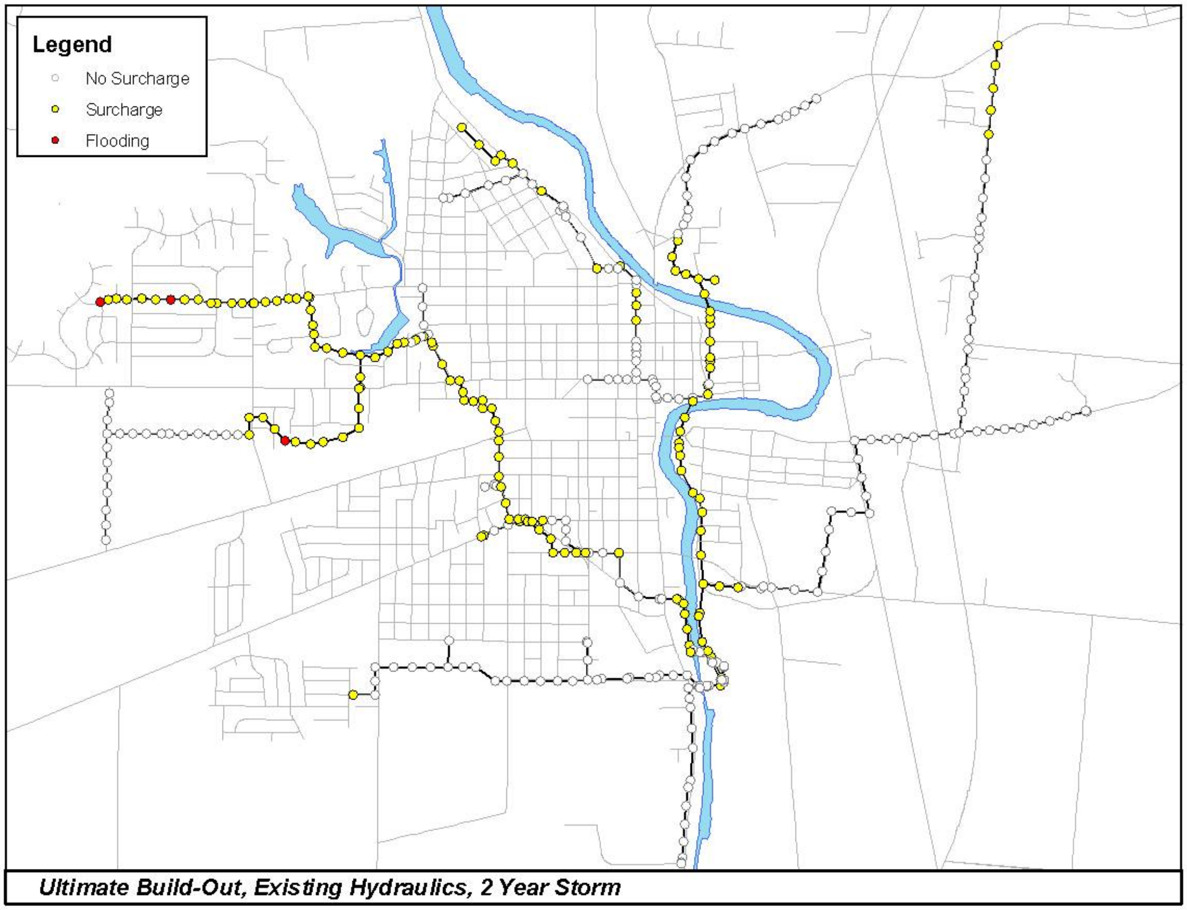


Figure 5-8
2-year Design Storm Capacity Assessment – Ultimate Build-out

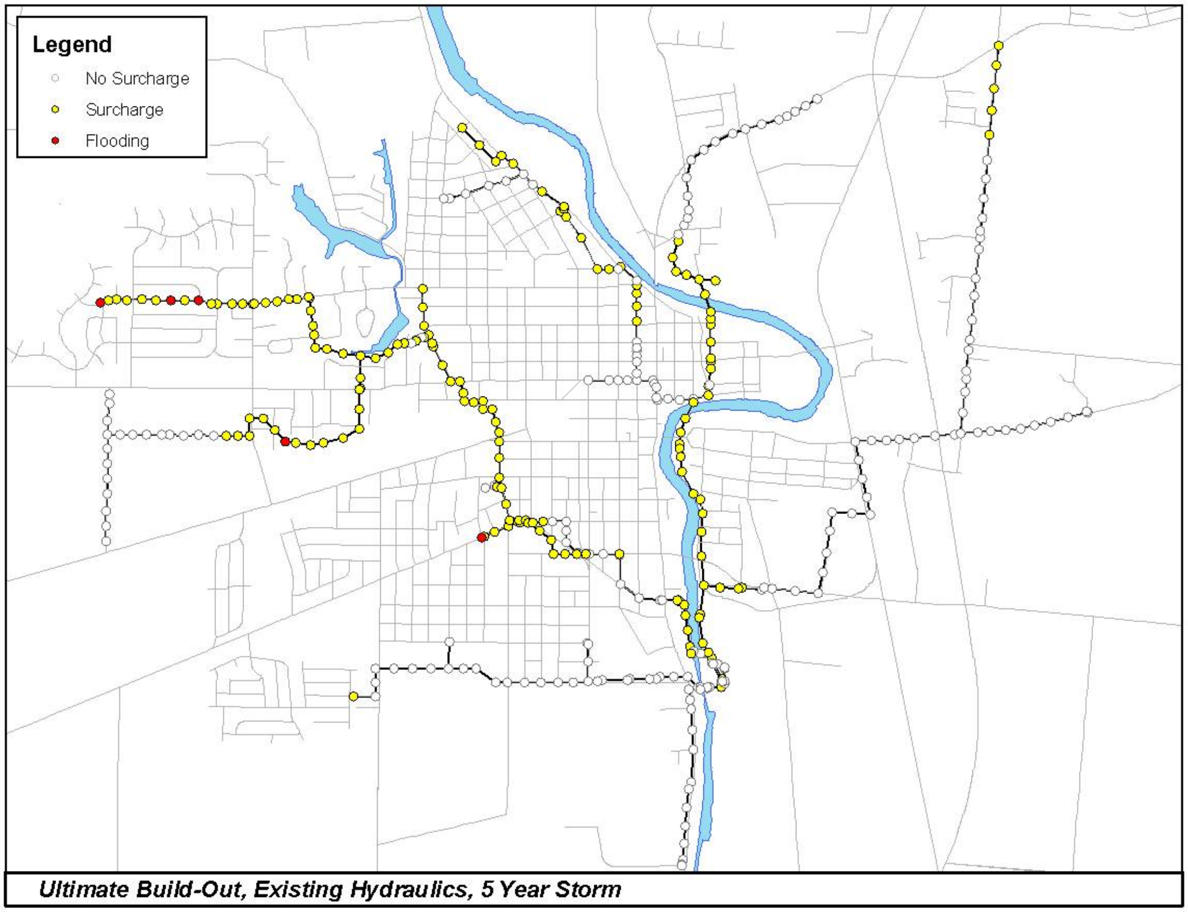


Figure 5-9
5-year Design Storm Capacity Assessment – Ultimate Build-out

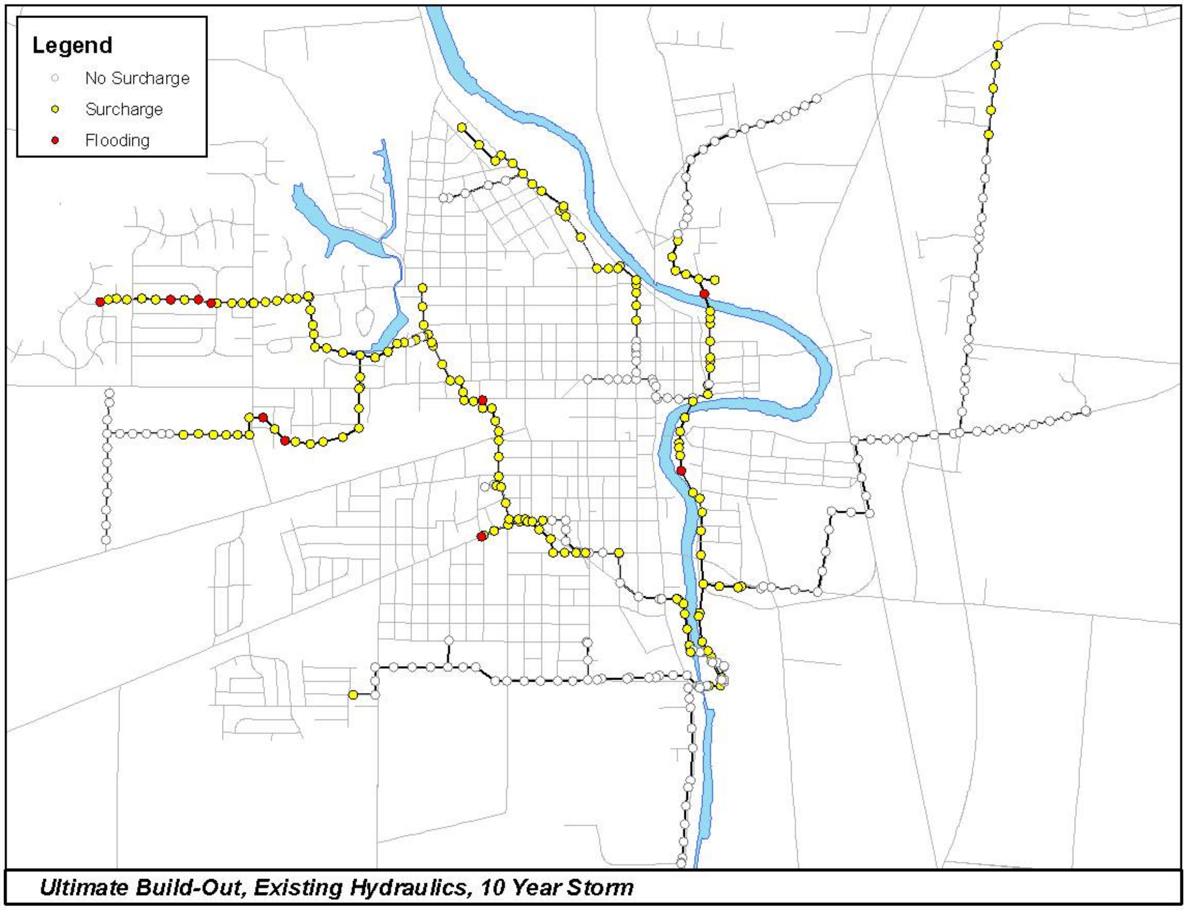


Figure 5-10
10-year Design Storm Capacity Assessment – Ultimate Build-out

Section 6

Alternatives Development

To address the SSO and collection system deficiencies identified in Sections 4 and 5, a screening evaluation of potential system improvements was undertaken. The intent was to evaluate what-if scenarios to screen-out individual improvements which were not as beneficial or as cost-effective and identify individual (or combination of) improvements that provided effective solutions to eliminating SSOs and consisted of the following options:

- Increase system conveyance capacity
- Increased siphon capacity
- I/I reduction
- Additional flow equalization
- Increased treatment capacity at WWTP

The need to upsize existing sewers and/or construct new relief/interceptor sewers and sewer extensions to serve existing and future built-out areas is evident based on the capacity assessments in Sections 4 and 5. The required improvements associated with increased conveyance capacity of the collection system will be addressed in detail in Section 7 – Alternative Evaluation, based on alternate new sewer alignments and the needs associated with future development.

6.1 Siphons Evaluation

The capacity of existing siphons has long been considered a bottleneck in the collection system by the City and was substantiated by previous modeling efforts with the EQ basin project, and is therefore a key area of evaluation in this Master Plan. Three siphons are represented in the expanded hydraulic model and are identified as follows: Great Miami River and S-Creek (located on the West Interceptor) and Hemm Road. The Great Miami River and Hemm Road siphons convey wastewater from the western service areas under the Great Miami River and are located just upstream of the WWTP. The S-Creek siphon is located approximately 3,600 feet upstream of the Great Miami River siphon and the SSO. **Figure 6-1** shows the location of the three siphons relative to one another, the WWTP, and the SSO.

Figure 6-1
Existing Siphon Locations

The siphon evaluation was performed for two design storms (5-year and 10-year) and the calibrated rainfall event from early April 2011. Simulations were run for both existing conditions and ultimate build-out. In all analyses, the hydraulic conditions of the collection system were modified to eliminate any restrictions to assure that the maximum potential flow rate was reaching each siphon and the WWTP was modeled as a free outfall to prevent a backwater condition. At each siphon, the diameter required to convey flow within one additional pipe barrel was identified such that surcharging and/or SSO activation upstream of the siphon did not occur. **Table 6-1** shows the pipe size of an additional siphon barrel required to convey the WWF associated the each storm and model scenario.

Table 6-1 Required Pipe Size of Additional Siphon Barrel

Scenario	Storm	S-Creek Siphon		Great Miami River Siphon		Hemm Rd. Siphon	
		Size (in)	WWF (MGD)	Size (in)	WWF (MGD)	Size (in)	WWF (MGD)
Existing Conditions	5-Yr	16"	12.8	20"	16.4	-	3.1
	10-Yr	20"	15.1	24"	19.2	-	3.5
	April 2011	16"	9.9	16"	12.9	-	2.6
Ultimate Build-out	5-Yr	20"	14.4	20"	17.2	-	4.4
	10-Yr	20"	17.1	24"	21.5	-	5.0
	April 2011	16"	12.0	20"	14.6	-	3.7

Note: The existing siphon configurations are as follows:
S-creek, two 16-inch diameter barrels
Great Miami River, two 16-inch diameter barrels
Hemm Road, one 8-inch and one 16-inch barrel

The following is a summary of the results/conclusions of the siphon evaluation:

- Under all scenarios, the Hemm Road siphon has adequate capacity to convey existing and projected future flows; thus no additional siphon barrels are necessary.
- For the S-Creek siphon, an additional pipe barrel of 16 inches or 20 inches diameter is required depending on the scenario modeled.
- For the Great Miami River siphon, an additional pipe barrel of 16 inches, 20 inches, or 24 inches diameter is required depending on the scenario modeled.

Due to the sensitive nature of constructing infrastructure in and around natural waterways, and to be conservative, the initial recommendation would be to construct the largest siphon barrel identified, or multiple barrels which provide the same capacity, based on the WWF rates shown such that future construction in the natural waterway can be avoided.

6.2 Inflow and Infiltration Evaluation

An option to reduce rainfall induced inflow and infiltration (I/I) was evaluated to assess the benefit of removing I/I and the resulting reduction in collection system flow rates. For this evaluation, the hydraulic conditions of the collection system, including siphons, were modified in the model environment to eliminate any hydraulic restrictions to assure that the maximum potential flow rate was reaching the WWTP.

As discussed in Section 3, the I/I assessment identified sewersheds more susceptible to I/I based on measured flow monitoring data and the R-values determined and used for model inputs as developed during model calibration. The sewersheds identified with red shading are the most susceptible to I/I and correspond to the areas which would be most suitable targets for I/I removal through pipe/manhole rehabilitation or sewer rehabilitation/replacement; reference **Figure 6-2**. For the I/I reduction evaluation, the R-values used to develop runoff entering the collection system model were incrementally reduced by 15%, 25%, and 50% within the sewersheds shown in red. The models were then run for a series of design storms and one continuous simulation to identify the peak flow rate reaching the WWTP. This is then compared against flow rates where no reduction in I/I was modeled.

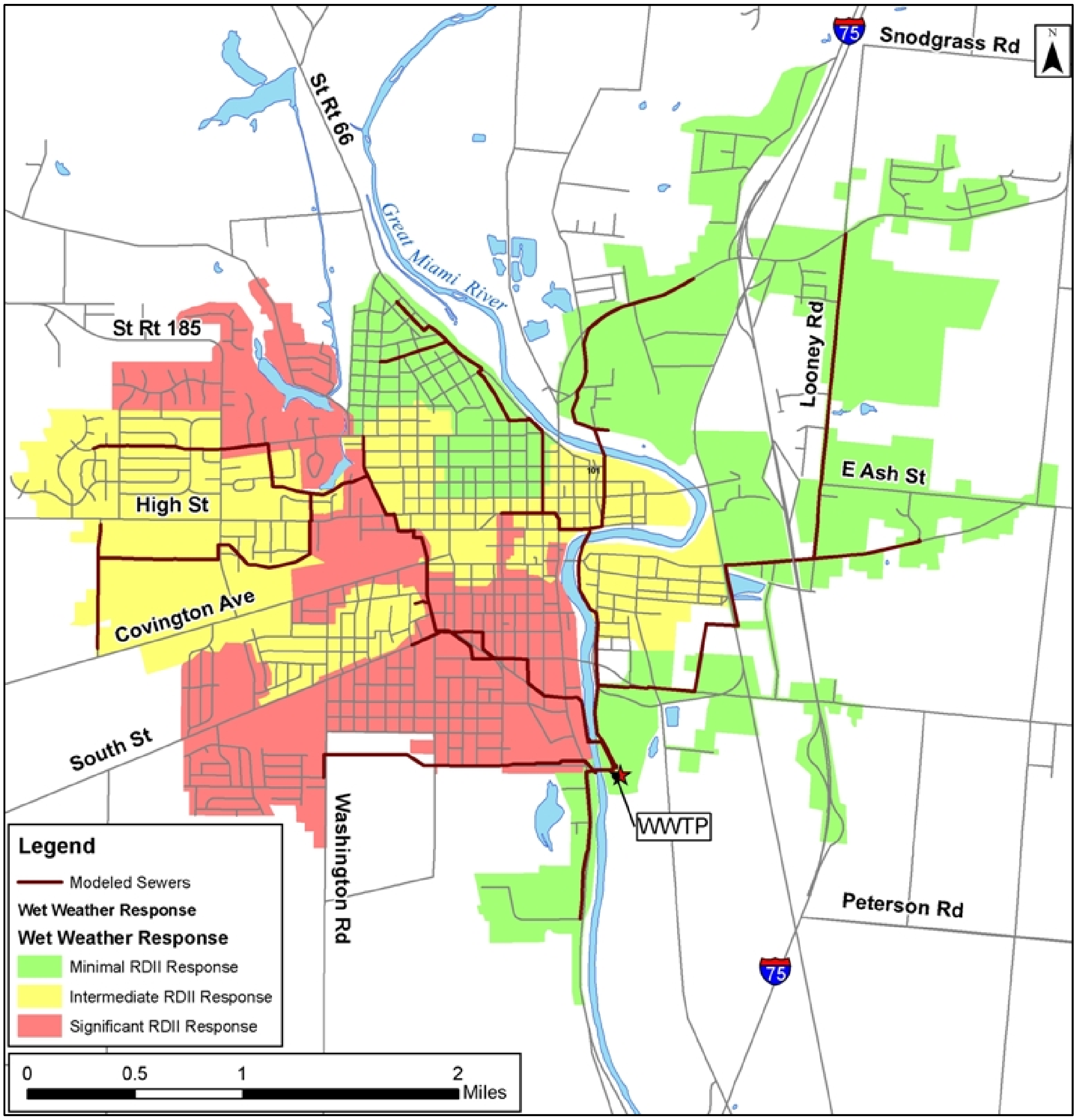


Figure 6-2
I/I Characterization

Table 6-2 identifies the peak flow rate at the WWTP for four different I/I Reduction scenarios, i.e. None, 15%, 25%, and 50% for the given rainfall events simulated. Overall, some general observations that can be made as follows:

- If a 15% reduction in I/I could be achieved in the red sewersheds, the City could expect approximately a 0.5-2 MGD (2.5% - 7.1%) decrease in peak flow rate based on the rainfall events simulated.

- If a 25% reduction in I/I could be achieved in the red sewersheds, the City could expect approximately a 2-3 MGD (8% - 14.3%) decrease in peak flow rate based on the rainfall events simulated.
- If a 50% reduction in I/I could be achieved in the red sewersheds, the City could expect approximately a 2.5-6 MGD (13.5% – 26.2%) decrease in peak flow rate based on the rainfall events simulated.

Table 6-2 Potential Flow Rate Reductions to WWTP Resulting from I/I Elimination

I/I Reduction	Design Storms (MGD)										Continuous (2006-2011) (MGD)	
	6 Month		1 Year		2 Year		5 Year		10 Year			
	Existing	2030	Existing	2030	Existing	2030	Existing	2030	Existing	2030	Existing	2030
None	14	18.5	17.5	23	21	26	25	31	28	35	20	25
15%	13	18	16.5	22	19	25	23.5	30	26.5	33	19.5	24
25%	12	16.5	15.5	21	18	24	22	29	25	32	18	23
50%	11	16	13	19	15.5	22	19	26	22	30	15.5	21

Note: Flow rates shown are the simulated peak rate received at the WWTP for the rain event specified. Potential future flows from the Village of Covington are not included in the table.

Results of the I/I evaluation were discussed with the City at Workshop 2 on February 1, 2012. A range of I/I removal was estimated due to the uncertainty of rainfall derived I/I that could feasibly be removed through Sewer System Evaluation Surveys (SSES) and subsequent sewer rehabilitation or replacement work. The work associated with executing SSES, e.g. smoke and dye testing, CCTV inspections, additional flow monitoring, coupled with the costs to fix defects, replace/rehab sewers, and rehabilitate manholes, makes estimating the potential cost to achieve the simulated I/I reductions very difficult. Another consideration discussed is the belief that substantial I/I originates on private property; limiting the City in its ability to effectively remove private I/I sources, which could account for half of the I/I volume.

It was agreed that the option to eliminate I/I not be considered as a potential collection system improvement and would not be evaluated further in this Master Plan. The City identified that it would rather expend money to build infrastructure and expand the WWTP in its efforts to eliminate the SSO. This view is supported by the positive impact already realized from constructing the 1 MG EQ basin and the City's need to upgrade the existing WWTP. The following sub-section will discuss how the City intends to eliminate the SSO with infrastructure improvements.

6.3 Flow Equalization and WWTP Treatment Capacity Evaluation

The final screening evaluation to address the SSO and identify an alternative which will effectively eliminate SSO occurrences in the collection system pertains to the modeled boundary condition at the WWTP; specifically, the EQ basin storage volume and WWTP treatment capacity necessary to prevent SSOs . The focus of this Sanitary Sewer System Master Plan is the collection system, which includes the constructed SSO to be eliminated, however, the hydraulic conditions at the WWTP influence the collection system hydraulics and activity of the SSO. A greater ability to process flow will enable more EQ capacity to be available for subsequent storm events and lower the HGL of the influent sewage to the plant. Thus, the intent of this section is to identify an EQ storage volume and WWTP capacity which eliminate the SSO such that a modeled boundary condition is defined for the detailed Alternatives Evaluation in Section 7. Refinement of EQ storage volume and treatment capacity will be addressed in the WWTP Facility Plan currently in development which will then consider cost, site conditions, and process requirements/constraints, etc. of the plant expansion needs.

Using estimated Year 2030 DWF, 1 MGD from the Village of Covington, WWF conditions resulting from continuous 5-year rainfall records (2006-2011) and the I/I reduction estimates discussed in Section 6.2, , modeled time series data tributary to the WWTP was used to evaluate necessary WWTP treatment rates against EQ basin storage volumes to prevent SSO occurrences. This evaluation was presented to the City during Workshop 2 and includes I/I reduction rates to demonstrate the (limited) impacts of I/I reduction on the potential improvements at the WWTP to eliminate the SSO; see **Figure 6-3**.

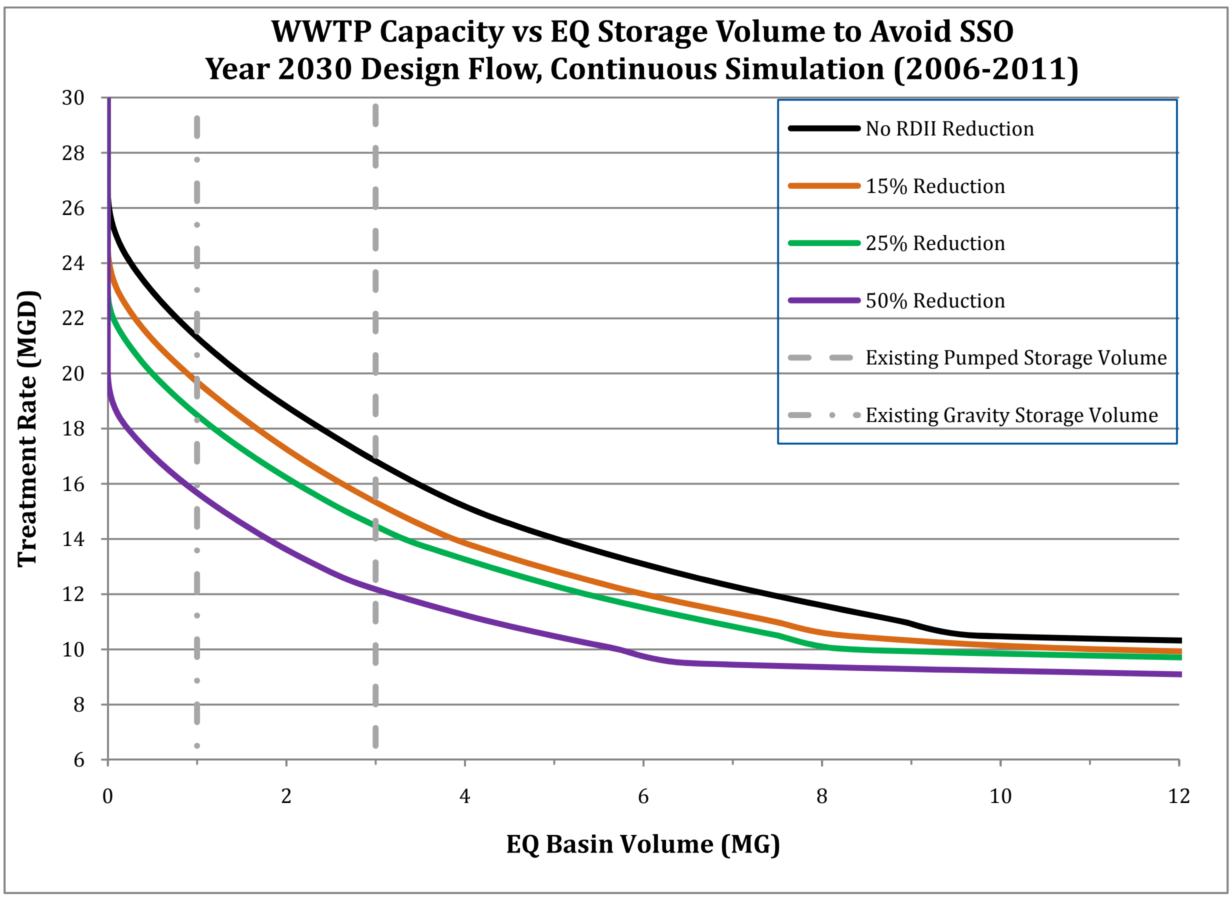


Figure 6-3
Necessary WWTP Rate versus EQ Basin Volume to Eliminate the SSO

The existing EQ basin has a storage volume of 3 MG, however, a pump station would need to be constructed to utilize the remaining 2 MG of available storage within the basin. The EQ basin currently functions as gravity-in gravity-out, using only 1 MG of storage.

Nominal I/I reductions of 15% and 25% in the red sewersheds do not demonstrate a significant reduction in flow reaching the WWTP. Achieving a 50% RDII reduction will be technically difficult, but demonstrates either 5 MGD less treatment capacity or 3-4 MG less EQ storage required to eliminate the SSO.

Assuming the City does not pursue I/I reduction as discussed in Section 6.2, the following assessment can be made based on the 0% I/I Reduction curve (black line):

- The WWTP treatment rate would need to be upgraded to 21 MGD if the existing EQ basin (1 MG) was not upgraded with a pump station to use the remaining 2 MG of storage.
- The WWTP treatment rate would need to be upgraded to 17 MGD if a pump station were added such that the existing EQ basin could utilize the entire 3 MG of storage.
- If a second (equally sized) EQ basin were constructed with a pump station, the WWTP treatment rate would need to be upgraded to 13 MGD peak hour capacity, utilizing 6 MG of EQ storage.

Results from the WWTP Facility Plan indicate that the most cost effective combination improvements at the WWTP are to upgrade the WWTP to 13 MGD peak hour capacity and provide 6 MG of EQ basin storage.

Section 7

Alternatives Evaluation

This section describes the approach taken to evaluate multiple alternatives to serve existing and future development and address SSO and sanitary sewer deficiencies based on criteria established for this Master Plan. A comprehensive approach was taken in developing the alternatives evaluation aimed at eliminating existing collection system deficiencies and/or proposing new infrastructure to serve future development for the Ultimate Build-out condition. The alternatives were evaluated from a hydraulics perspective, preliminary design criteria, and with detailed preliminary construction cost estimates.

Prior to preparing this Master Plan, an Alternatives Evaluation Workshop was held with the City to review the approach, analysis, and alternatives developed such that the collection system could meet existing and future needs while eliminating the SSO.

7.1 Approach

The approach for the alternatives evaluation involved dividing the sanitary sewer system into service areas such that a consistent evaluation of individual components of a complete alternative could be achieved; this was particularly import for the collection system west of the Great Miami River. Conversely, some service areas do not require any evaluation as the existing trunk and interceptor sewers have adequate capacity for existing and Ultimate Build-out conditions; thus these areas were eliminated from the Alternatives Evaluation.

7.1.1 Service Areas

Figure 7-1 identifies the five service areas defined primarily by the Great Miami River and I-75, and then further defined by the sewer system/modeled trunk and interceptor sewers. The five services areas are:

- West Service Area
- North Central Service Area
- South Central Service Area
- Northeast Service Area
- East Service Area

As discussed in Sections 4 and 5, the trunk and interceptor sewers serving the North Central, South Central, and East Service Areas have adequate conveyance capacity to serve existing and projected future flows, not requiring an alternatives evaluation. However, for master planning purposes, these three service areas have been shown with proposed sewer extensions from an existing interceptor to a conservative location to serve the anticipated future development.

The West and Northeast Service Areas however require an evaluation of potential alternatives to serve existing and future wastewater customers. The following subsections identify the criteria and assumptions used throughout the alternatives evaluation such that a consistent approach is taken to compare each alternative against the others.

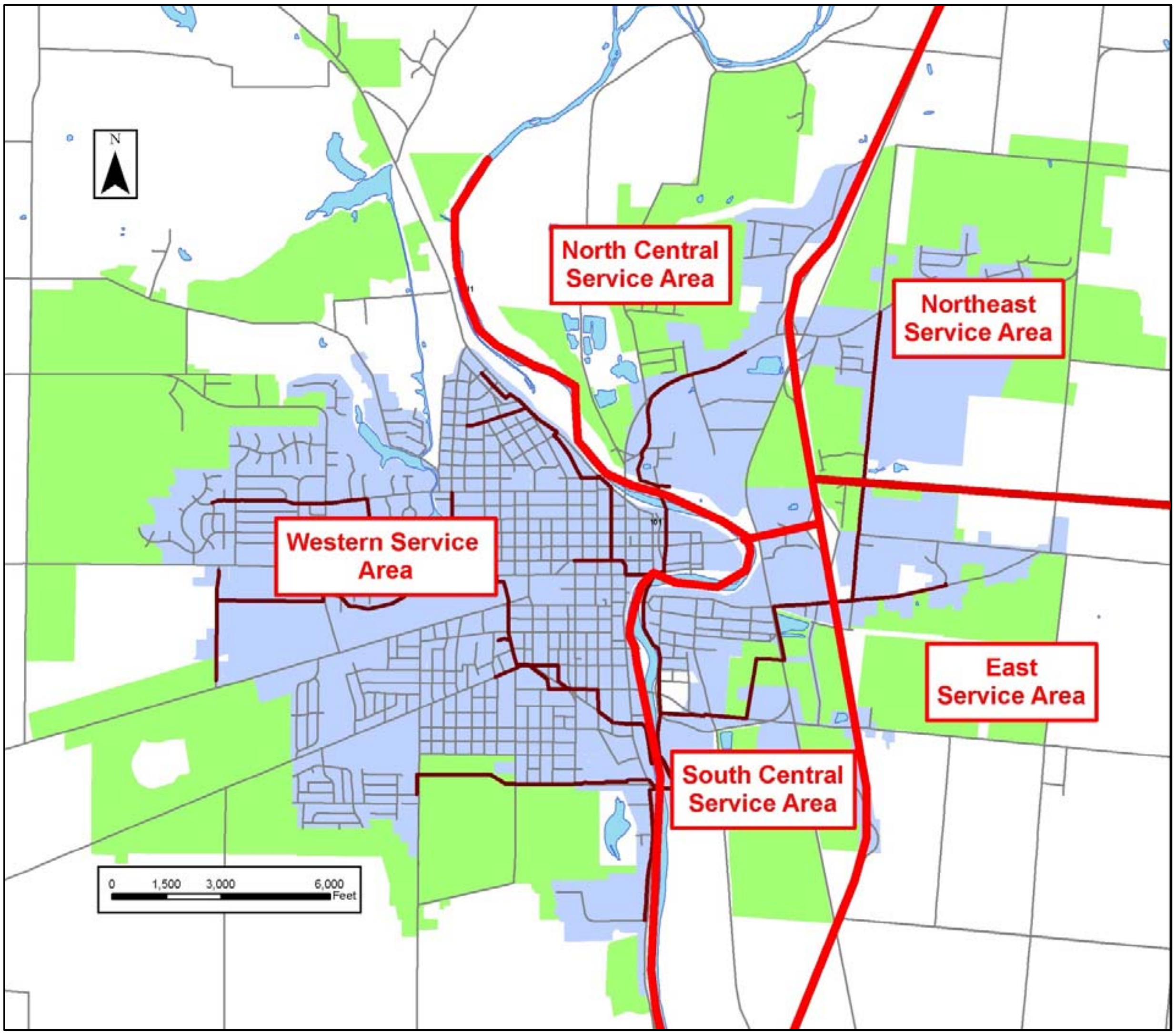


Figure 7-1
Alternatives Evaluation Service Areas

7.1.2 Level of Service

As presented in Section 5, estimated wastewater flows from future service areas, shown in green in Figure 7-1, were developed for two conditions; Year 2030 and Ultimate Build-out. For the purposes of sizing pipes and estimating cost, alternatives used Ultimate Build-out flows. Ultimate Build-out flows are greater than the Year 2030 flows and are more appropriate for use in sizing infrastructure with an assumed 100-year life.

The Alternatives Evaluation Workshop presented the potential improvements necessary and the corresponding cost estimates required to establish a level of service (LOS) for two design storm scenarios; i.e. the 2-year and 5-year 24-hour events. The cost difference between the improvements necessary to convey flows from the two design storms was marginal in most cases, and in some instances, the 5-year LOS cost was less than that for a 2-year LOS.

All alternative evaluations presented in this Master Plan use design flows resulting from Ultimate Build-out conditions and a 5-year 24-hour design storm event. Recommended alternatives were checked against a 10-year 24-hour design storm to confirm that the proposed sewer system improvements did not have any flooding manholes. If manhole flooding resulted from the 10-year design storm, the recommended improvements were resized and the cost estimates adjusted to eliminate the occurrence of surface flooding.

7.1.3 Assumptions

A number of assumptions were made to develop alternatives based on consistent criteria such that alternative alignments and associated cost estimates could be compared. Key assumptions that drive the hydraulic evaluation and impact the costs due to depth of sewer are as follows:

- Siphons at S-creek and the West Interceptor were augmented to eliminate hydraulic restrictions within the collection system.
- The boundary conditions at the WWTP were "upgraded" to reflect a condition that prevents SSO occurrences; i.e. treatment capacity increased to 13 MGD and EQ Basin storage volume increased to 6 MG requiring pumping.
- The City has not received water-in-basement complaints.
- Alternatives were sized such that the proposed improvements hydraulic grade line (HGL) for design flow is maintained in-pipe (no surcharging). In addition, existing trunk and interceptor sewer infrastructure was identified for replacement where the HGL was above the pipe crown such that surcharging was eliminated.
- Alternatives used a 12-foot manhole depth at the upstream extent of proposed sewers to establish vertical design points for each alignment.
- A minimum 18 inch vertical clearance was used at utility crossings.
- A minimum 4 foot cover over pipe crown was used at creek/canal crossings.

From the City of Piqua Design Criteria manual, the following bullets identify the primary criteria used that influenced the alternative alignments and costs estimates:

- Pipe slope is greater than or equal to the minimum slope allowed.
- Ductile iron pipe is used at sewer depths greater than 25 feet and at all creek/canal crossings. PVC is used at all other locations.
- Maximum spacing between manholes is 350 feet.
- Where new/replacement pipe is located in the right-of-way, compacted granular backfill is used.
- Where new/replacement pipe is located outside the right-of-way, native backfill is used.

7.2 West Service Area Alternatives Evaluation

Eight alternative alignments were developed to serve the West Service Area (WSA). Each alternative achieves the goal of serving anticipated future development west of the Great Miami River from the north end of the City to the south end and replaces existing infrastructure where necessary to relieve existing system deficiencies. **Figure 7-2** (from Section 5) is re-presented to identify the deficiencies of existing modeled infrastructure considered during the development of the eight alternative alignments. A summary of the primary considerations that drove the development of alternatives are as follows:

- The Hemm Road Sewer (and siphon) has sufficient capacity to convey Ultimate Build-out flows and the 5-year storm event.
- The West Interceptor and the Park Avenue Extension would require substantial replacement of existing infrastructure to afford adequate conveyance capacity for Ultimate Build-out flows and the 5-year event.
- In the lower reaches of the West Interceptor, approximately downstream of Covington Ave., surcharging can be eliminated for Ultimate Build-out flows and the 5-year event simply by augmenting the S-creek and West Interceptor siphons.
- The Northwest Interceptor would require replacement of existing infrastructure and its depth is relatively shallow; potentially limiting its ability to collect future flows from the northwest.
- The proposed Northwest Trunk Sewer was evaluated in the Riverside Drive right-of-way and outside of the right-of-way adjacent to the levy.

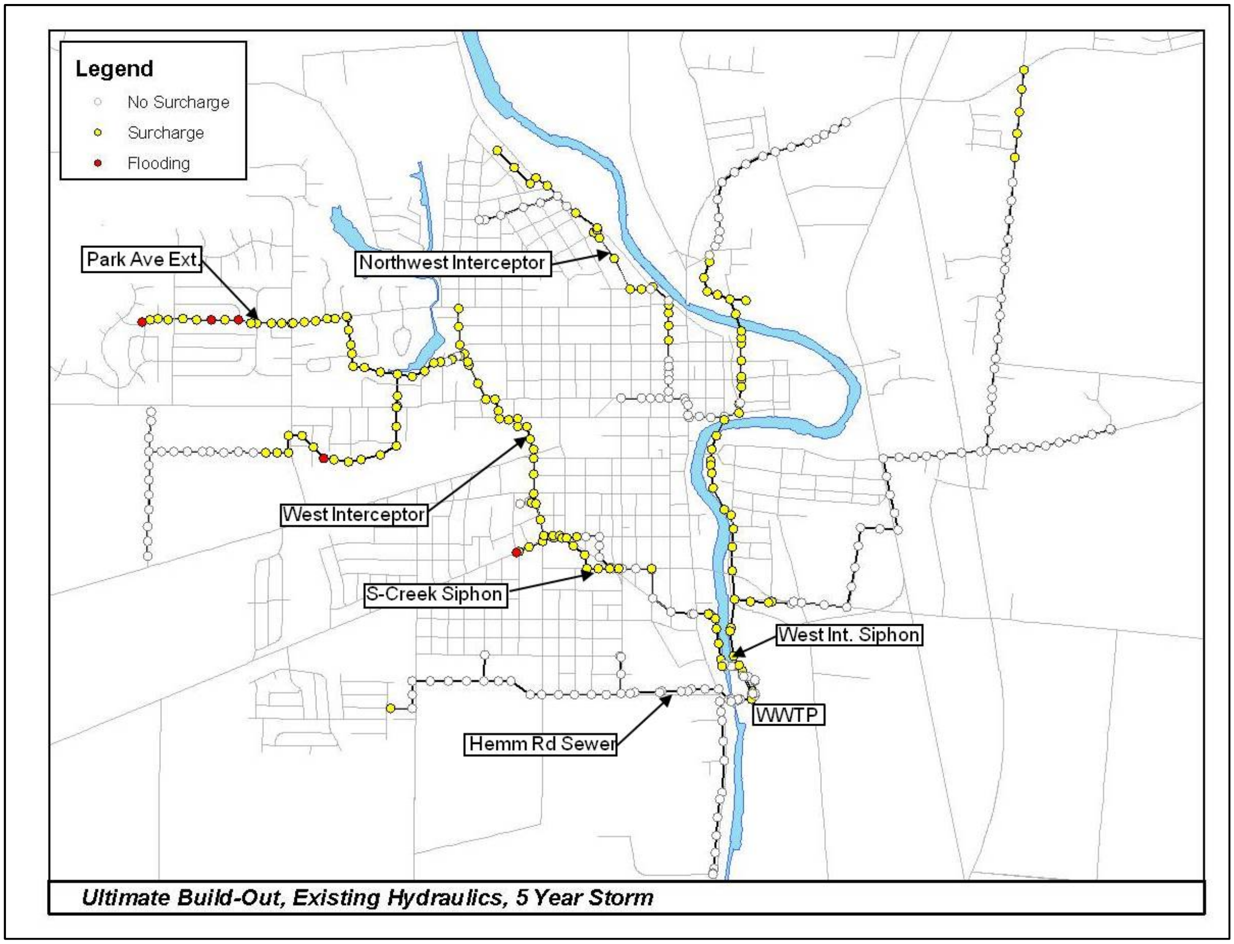


Figure 7-2
Existing System Capacity Deficiencies Considered during Alternative Alignment Development

The eight alternative alignments and associated cost estimates are presented in the subsequent sub-sections.

7.2.1 WSA Alternative Alignments

Alternative 1 consists of approximately 50,660 feet of new and replacement sanitary sewer ranging in size from 12- to 30-inch diameter at an average depth of approximately 15 feet; reference **Figure 7-3**.

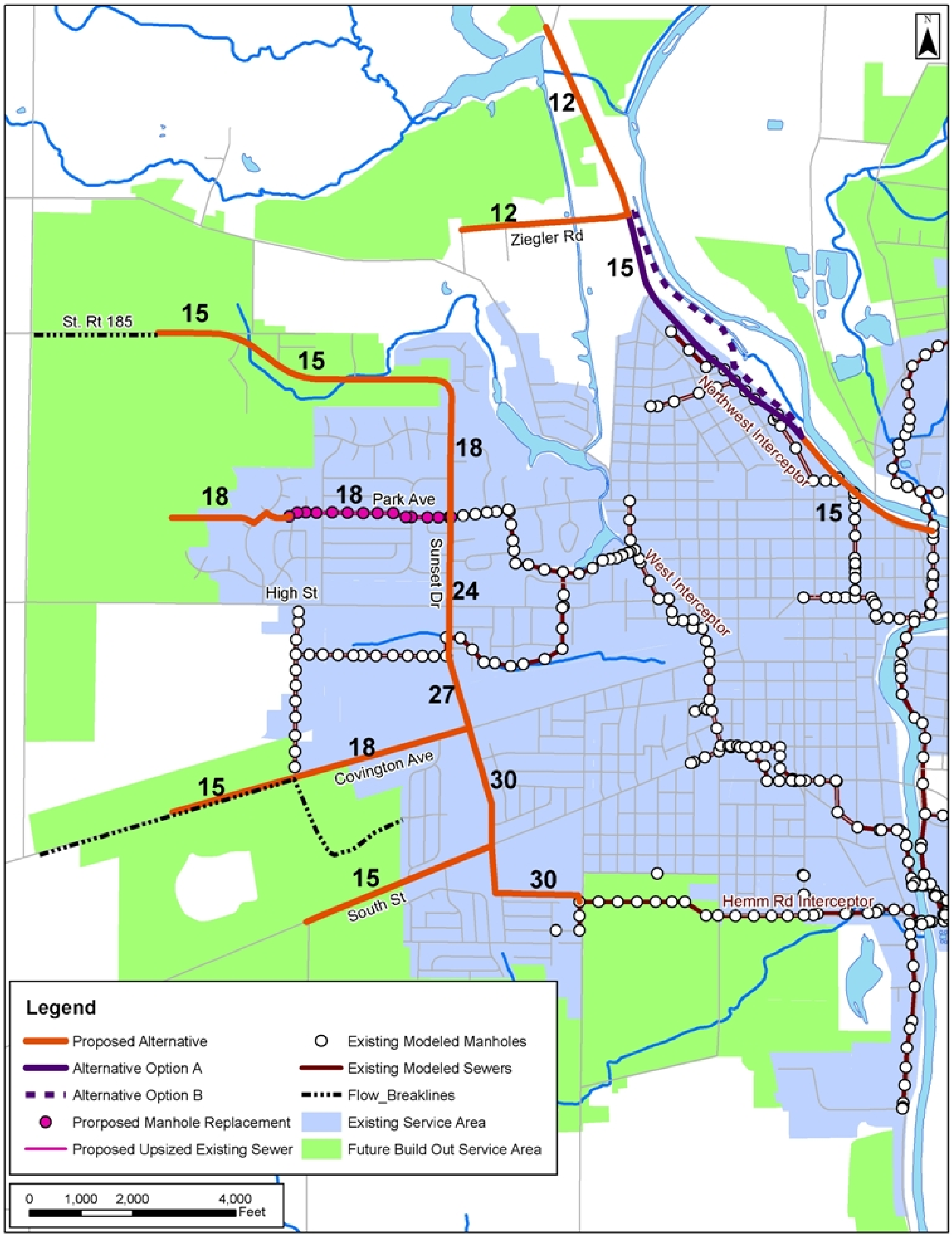


Figure 7-3
Alternative 1 – West Service Area

Alternative 2 consists of approximately 50,950 feet of new sanitary sewer ranging in size from 12- to 30-inch diameter at an average depth of approximately 18.5 feet; reference **Figure 7-4**.

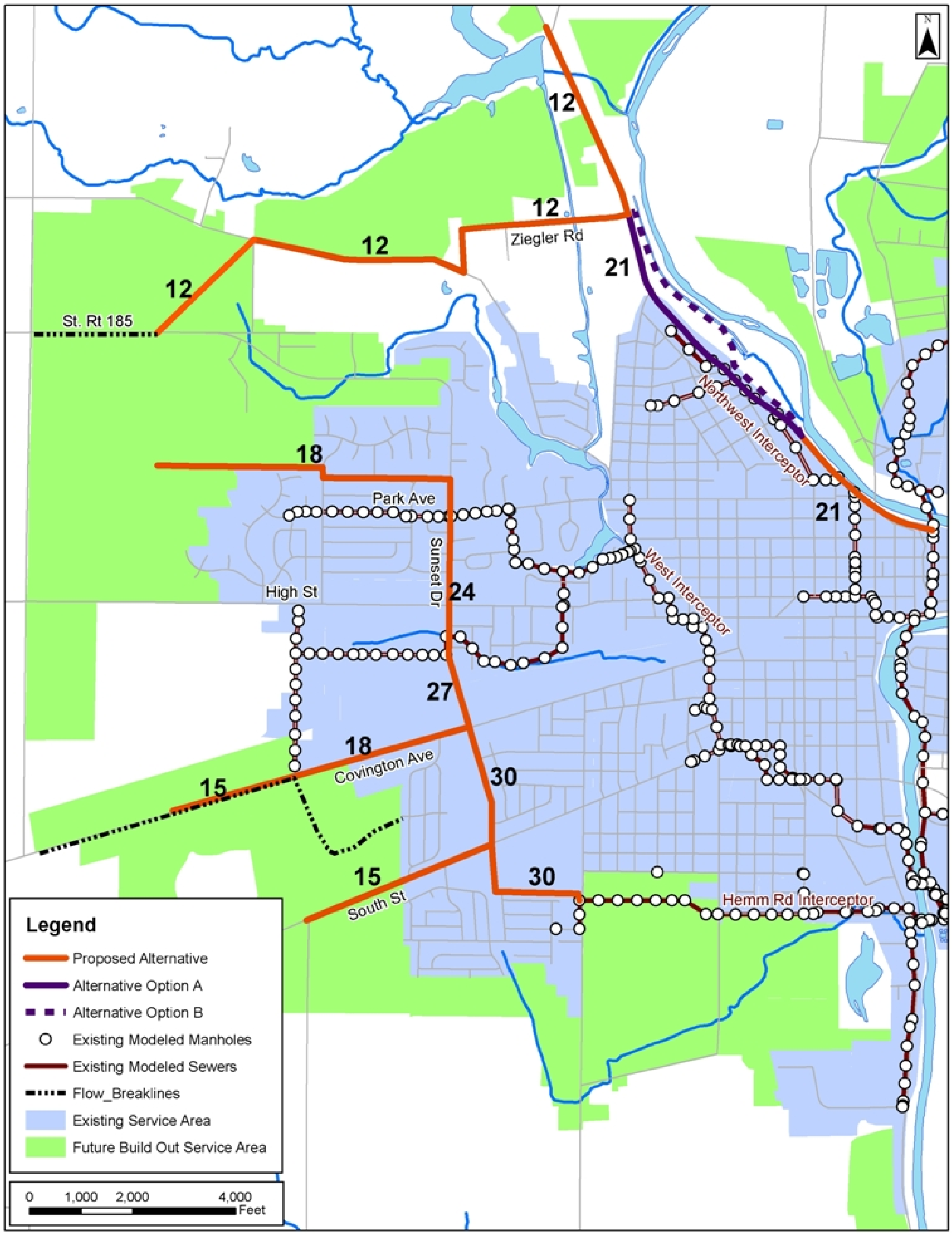


Figure 7-4
Alternative 2 – West Service Area

Alternative 3 consists of approximately 49,490 feet of new and replacement sanitary sewer ranging in size from 12- to 30-inch diameter at an average depth of approximately 19 feet; reference **Figure 7-5**.

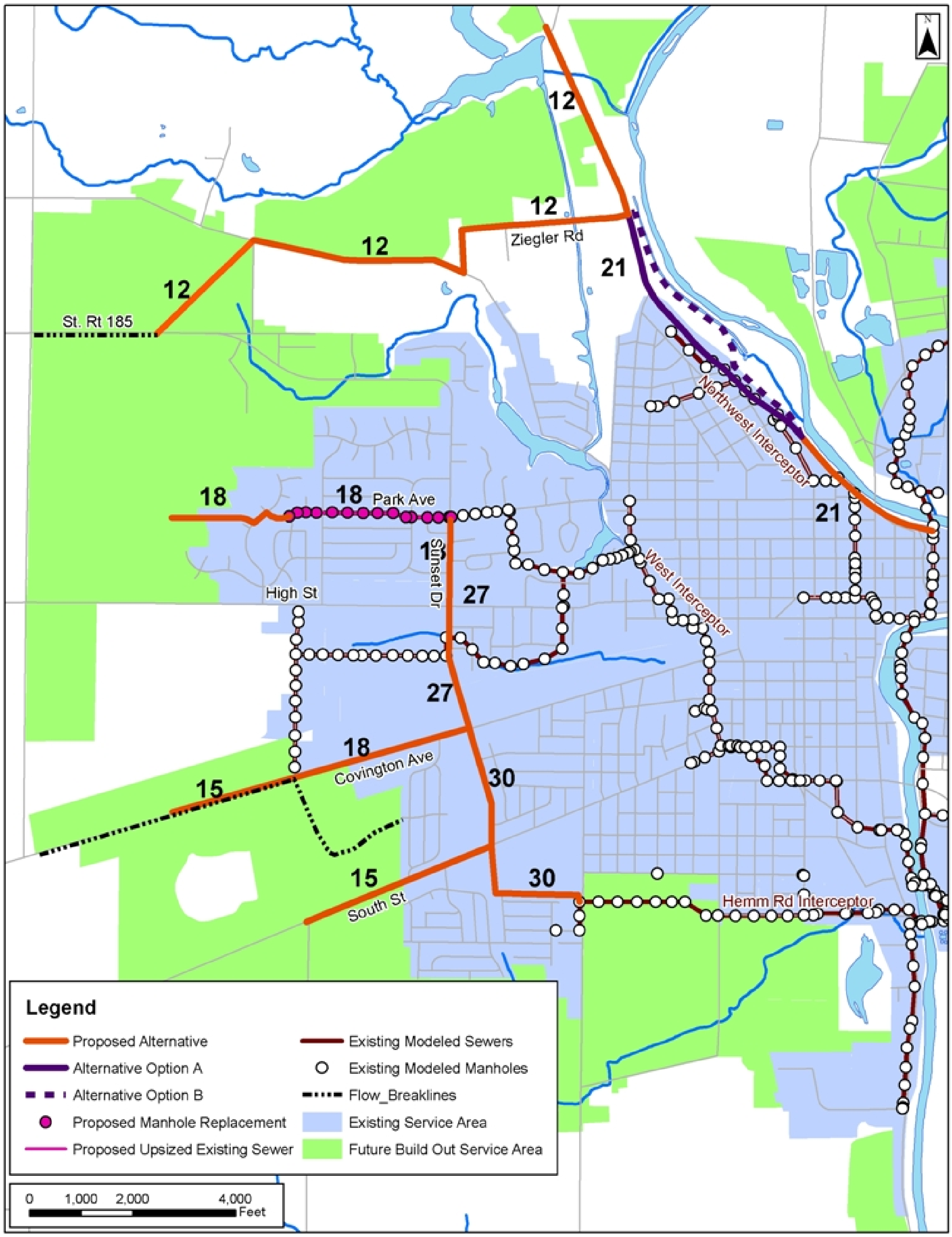


Figure 7-5
Alternative 3 – West Service Area

Alternative 4 consists of approximately 50,510 feet of new sanitary sewer ranging in size from 12- to 30-inch diameter at an average depth of approximately 19 feet; reference **Figure 7-6.**

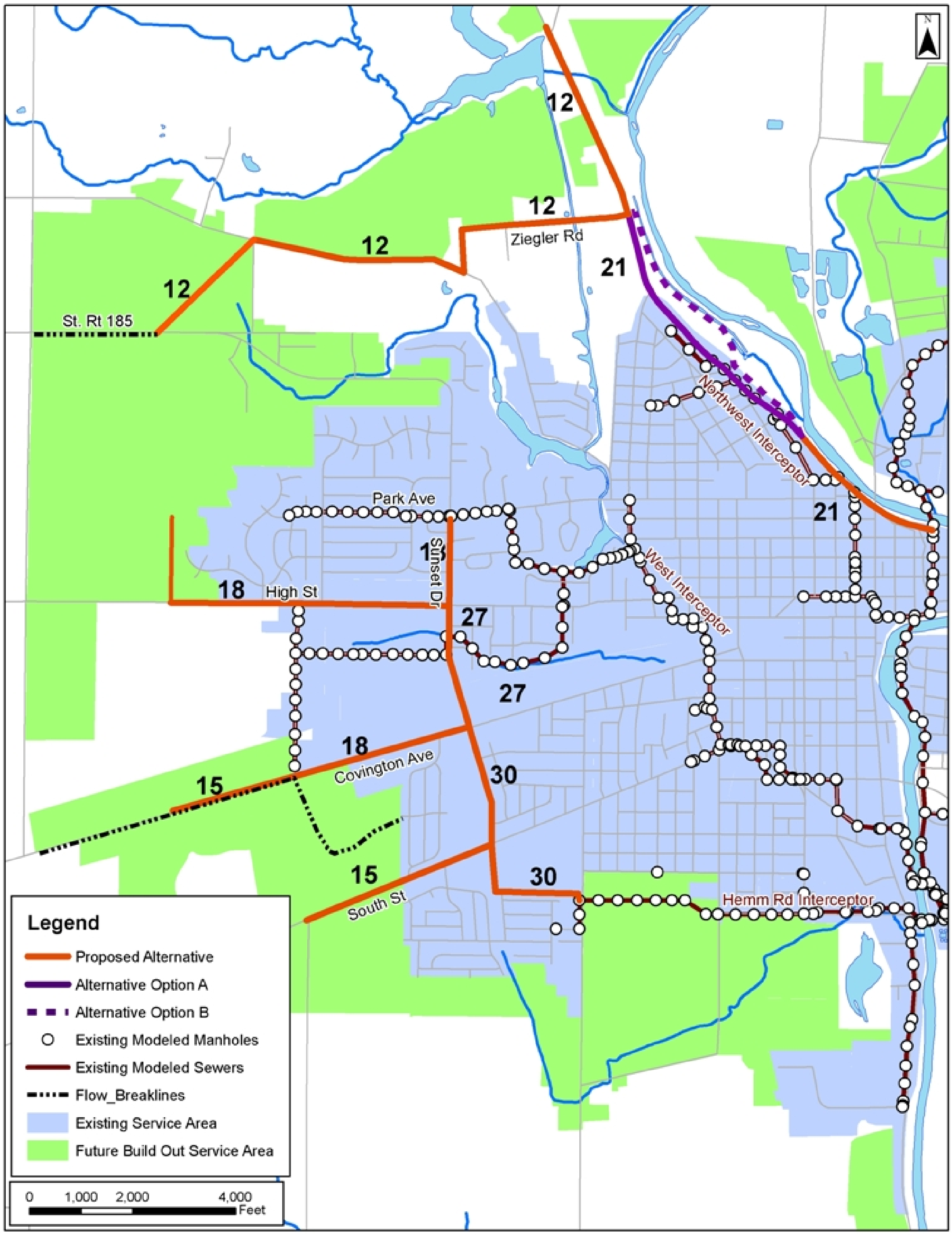


Figure 7-6
Alternative 4 – West Service Area

Alternative 5 consists of approximately 50,140 feet of new sanitary sewer ranging in size from 12- to 30-inch diameter at an average depth of approximately 19 feet; reference **Figure 7-7**.

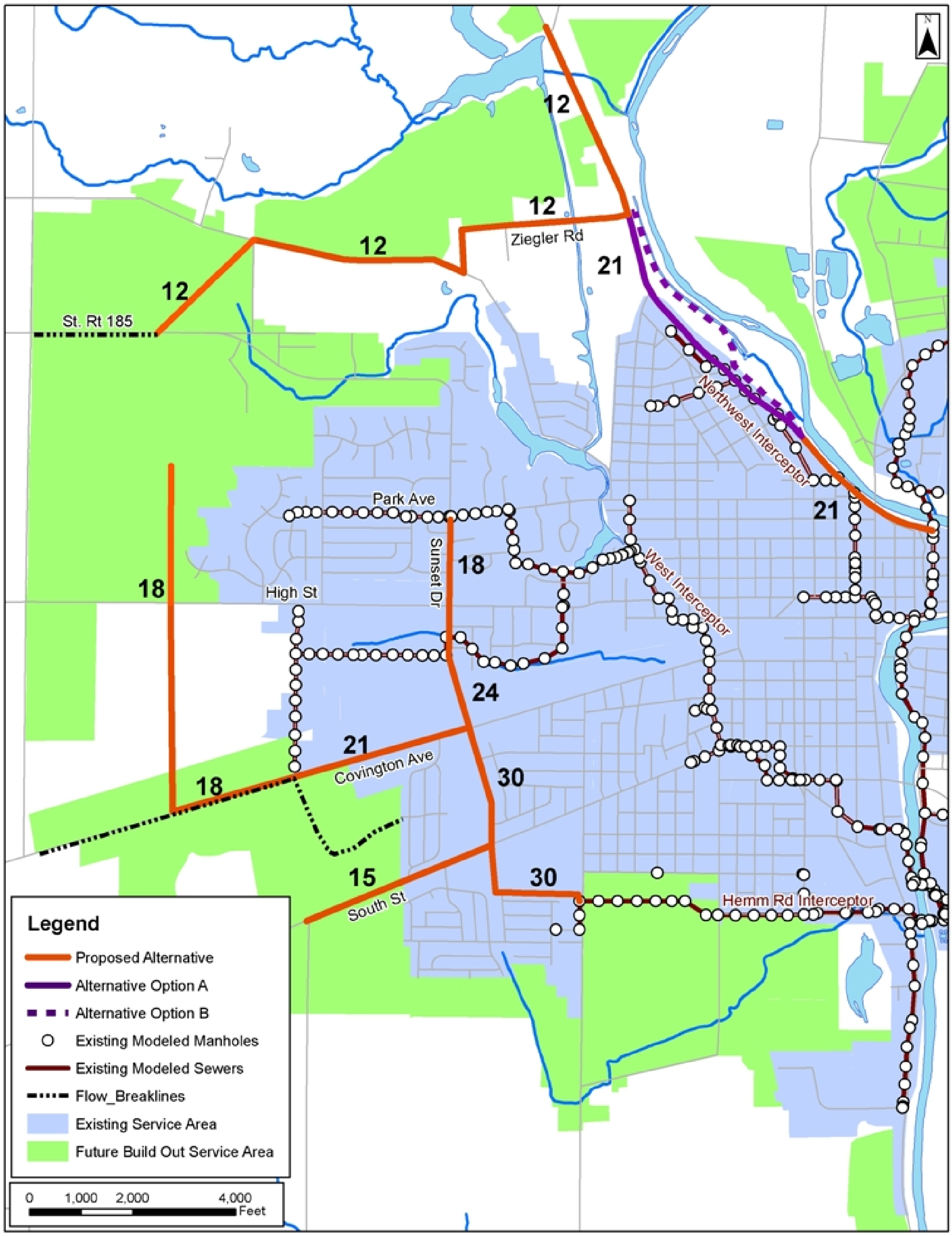


Figure 7-7
Alternative 5 – West Service Area

Alternative 6 consists of approximately 41,520 feet of new and replacement sanitary sewer ranging in size from 12- to 27-inch diameter at an average depth of approximately 21 feet; reference **Figure 7-8**.

Figure 7-8
Alternative 6 – West Service Area

Alternative 7 consists of approximately 46,870 feet of new and replacement sanitary sewer ranging in size from 12- to 24-inch diameter at an average depth of approximately 21.5 feet; reference **Figure 7-9**.

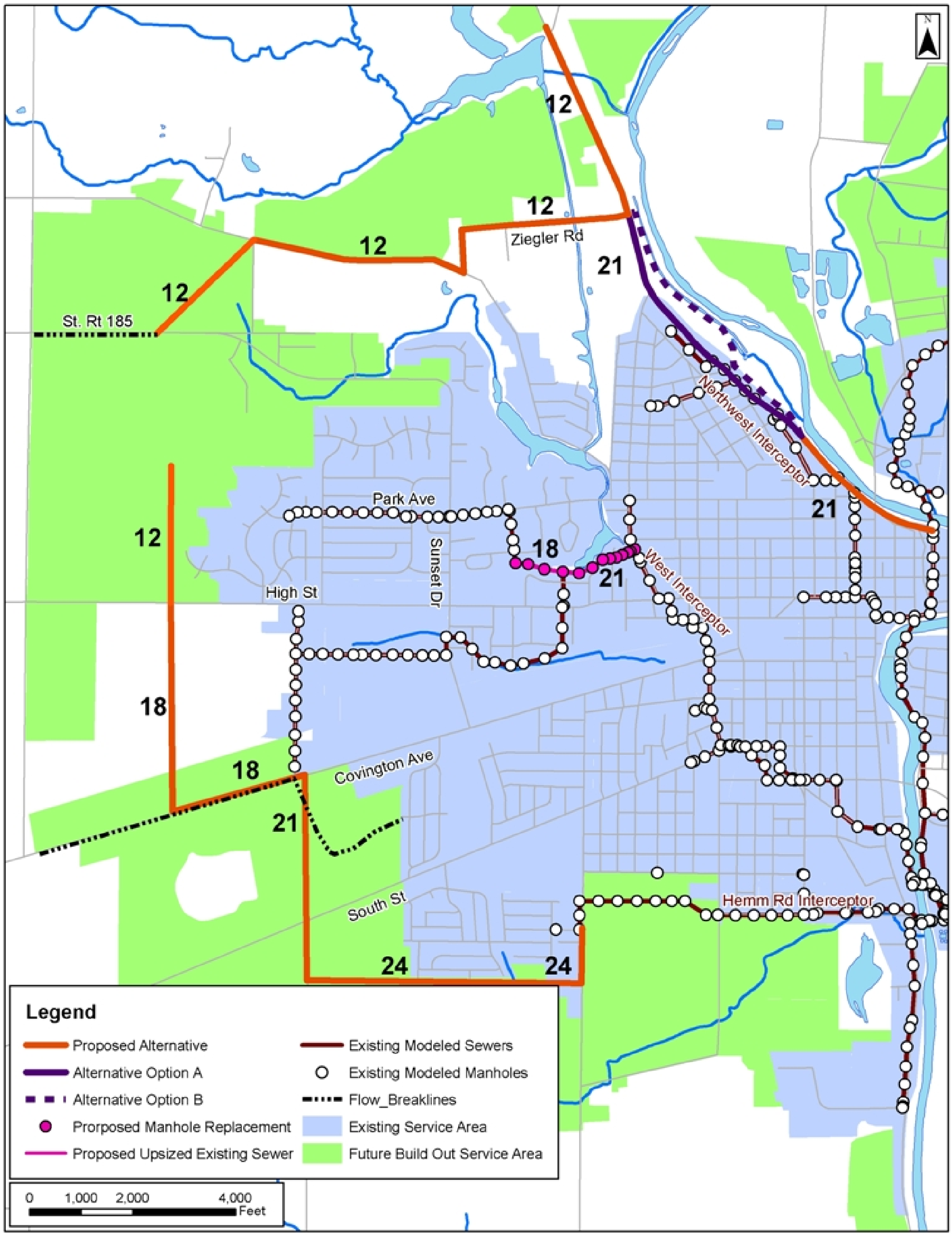


Figure 7-9
Alternative 7 – West Service Area

CDM Smith

Alternative 8 was developed based on discussions at the Alternatives Evaluation Workshop and modified Alternative 1 by replacing gravity sewer with a pump station and force main. Alternative 8 consists of approximately 42,880 feet of new and replacement sanitary sewer ranging in size from 12- to 30-inch diameter at an average depth of approximately 13 feet and requires a new pump station and approximately 7,430 feet of force main; reference **Figure 7-9**.

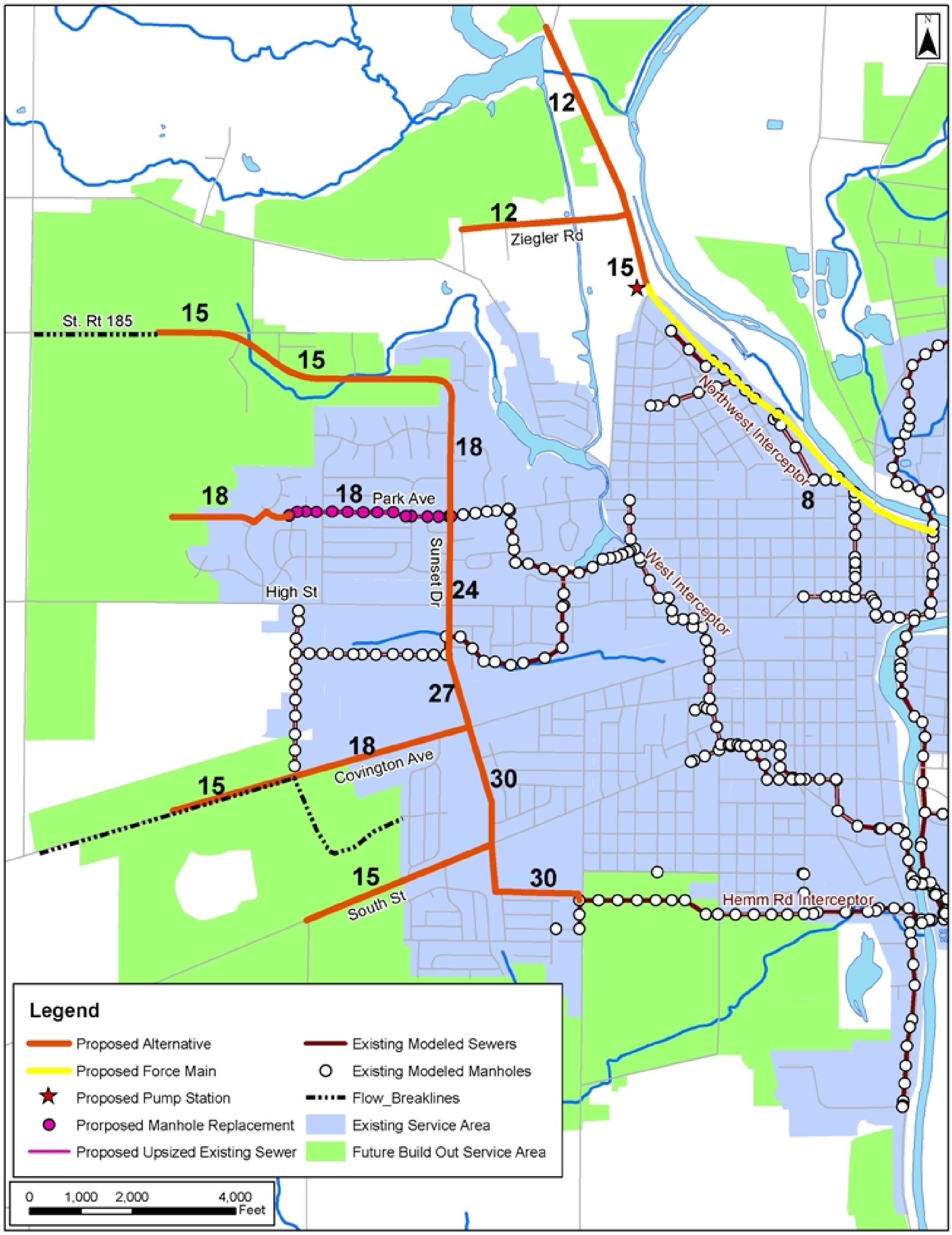


Figure 7-10
Alternative 8 – West Service Area

7.2.2 WSA Construction and Project Cost Estimates

Construction and project cost estimates were prepared for each alternative and included multiple variations to evaluate the Northwest Trunk Sewer with two horizontal alignments and the use of a siphon. This sub-section describes how these differences in horizontal and vertical alignment pertain to each alternative and the costs presented in the summary table as they relate to each alternative alignment.

The construction cost estimates are comprised of items that differentiate the alternatives from one another as depicted on the alternative alignment figures. The items are numerically identified one through three and correspond to the proposed sewer cost estimates, described as follows:

- Item 1 - included in Alternatives 6 and 7 and corresponds to the Hemm Road sewer extension that extends south, west, and then north to primarily serve future development only.
- Item 2 - included in Alternatives 1 through 5 and Alternative 8, corresponding to the Hemm Road sewer extension that follows Sunset Drive out to St. Rt. 185 with multiple small sewers extending westward to serve future development.
- Item 3 - included in all Alternatives and correspond to the Northwest Trunk Sewer which is primarily dedicated to serve future development and the proposed new Water Treatment Plant.

Some items are further identified with a letter which differentiates it from other alignments of the same item number; these differences are evident in the alternative alignment figures presented in this sub-section.

Alternatives 1 through 7 were evaluated with the Northwest Trunk Sewer having two different horizontal alignments. These alternatives involved constructing the proposed sewer inside and outside of the right-of-way. In addition, the Northwest Trunk Sewers vertical alignment was evaluated using a siphon just north of Riverside Park to minimize sewer depth.

Appendix E contains the detailed spreadsheets used to develop the construction cost for each proposed sewer alignment evaluated.

Project costs were developed using the following assumptions:

- 25% construction contingency
- 20% allowance for engineering
- 4% allowance for easement acquisition
- 2% for the City’s administrative and legal costs

Table 7-1 presents the itemized cost estimates for the alternatives evaluated which shows a variation in total project cost with a low of $22.9 million to a high of $36.9 million.

Table 7-1 West Service Area: Construction and Project Cost Estimates

Full West Service Alternatives							
Alt Number	Cost	Item	Length (FT)	3A- Inside RoW	3B- Outside RoW	3B- Outside RoW (w/ Siphon)	Alt. 8 : 3A- Inside RoW (w/ Lift Station and Force Main)
1 (and 8)	Construction Cost	2E	34,183	$ 10,130,373	$ 10,130,373	$ 10,130,373	$ 10,130,373
		3	16,474	$ 10,078,860	$ 7,663,968	$ 5,494,158	$ 4,425,357
		Contingency		$ 5,052,308	$ 4,448,585	$ 3,906,133	$ 3,638,932
		Total	50,657	$ 25,260,000	$ 22,240,000	$ 19,530,000	$ 18,190,000
	Project Cost	Engineering		$ 5,052,000	$ 4,448,000	$ 3,906,000	$ 3,638,000
		Easements		$ 1,010,400	$ 889,600	$ 781,200	$ 727,600
		Administration		$ 505,200	$ 444,800	$ 390,600	$ 363,800
		Total		**$ 31,830,000**	**$ 28,020,000**	**$ 24,610,000**	**$ 22,920,000**
2	Construction Cost	2F	26,535	$ 8,584,552	$ 8,584,552	$ 8,584,552	
		3 Extended	24,411	$ 13,757,911	$ 9,850,976	$ 7,425,722	
		Contingency		$ 5,585,616	$ 4,608,882	$ 4,002,569	
		Total	50,946	$ 27,930,000	$ 23,040,000	$ 20,010,000	
	Project Cost	Engineering		$ 5,586,000	$ 4,608,000	$ 4,002,000	
		Easements		$ 1,117,200	$ 921,600	$ 800,400	
		Administration		$ 558,600	$ 460,800	$ 400,200	
		Total		**$ 35,190,000**	**$ 29,030,000**	**$ 25,210,000**	
3	Construction Cost	2C	25,083	$ 7,925,407	$ 7,925,407	$ 7,925,407	
		3 Extended	24,411	$ 13,757,911	$ 9,850,976	$ 7,425,722	
		Contingency		$ 5,420,830	$ 4,444,096	$ 3,837,782	
		Total	49,494	$ 27,100,000	$ 22,220,000	$ 19,190,000	
	Project Cost	Engineering		$ 5,420,000	$ 4,444,000	$ 3,838,000	
		Easements		$ 1,084,000	$ 888,800	$ 767,600	
		Administration		$ 542,000	$ 444,400	$ 383,800	
		Total		**$ 34,150,000**	**$ 28,000,000**	**$ 24,180,000**	
4	Construction Cost	2B	26,100	$ 7,748,325	$ 7,748,325	$ 7,748,325	
		3 Extended	24,411	$ 13,757,911	$ 9,850,976	$ 7,425,722	
		Contingency		$ 5,376,559	$ 4,399,825	$ 3,793,512	
		Total	50,511	$ 26,880,000	$ 22,000,000	$ 18,970,000	
	Project Cost	Engineering		$ 5,376,000	$ 4,400,000	$ 3,794,000	
		Easements		$ 1,075,200	$ 880,000	$ 758,800	
		Administration		$ 537,600	$ 440,000	$ 379,400	
		Total		**$ 33,870,000**	**$ 27,720,000**	**$ 23,900,000**	
5	Construction Cost	2A	25,728	$ 8,323,751	$ 8,323,751	$ 8,323,751	
		3 Extended	24,411	$ 13,757,911	$ 9,850,976	$ 7,425,722	
		Contingency		$ 5,520,416	$ 4,543,682	$ 3,937,368	
		Total	50,139	$ 27,600,000	$ 22,720,000	$ 19,690,000	
	Project Cost	Engineering		$ 5,520,000	$ 4,544,000	$ 3,938,000	
		Easements		$ 1,104,000	$ 908,800	$ 787,600	
		Administration		$ 552,000	$ 454,400	$ 393,800	
		Total		**$ 34,780,000**	**$ 28,630,000**	**$ 24,810,000**	
6	Construction Cost	1B	25,045	$ 11,168,767	$ 11,168,767	$ 11,168,767	$ 11,168,767
		3	16,474	$ 10,078,860	$ 7,663,968	$ 5,494,158	$ 4,425,357
		Contingency		$ 5,311,907	$ 4,708,184	$ 4,165,731	$ 3,898,531
		Total	41,519	$ 26,560,000	$ 23,540,000	$ 20,830,000	$ 19,490,000
	Project Cost	Engineering		$ 5,312,000	$ 4,708,000	$ 4,166,000	$ 3,898,000
		Easements		$ 1,062,400	$ 941,600	$ 833,200	$ 779,600
		Administration		$ 531,200	$ 470,800	$ 416,600	$ 389,800
		Total		**$ 33,470,000**	**$ 29,660,000**	**$ 26,250,000**	**$ 24,560,000**
7	Construction Cost	1A	22,463	$ 9,641,549	$ 9,641,549	$ 9,641,549	
		3 Extended	24,411	$ 13,757,911	$ 9,850,976	$ 7,425,722	
		Contingency		$ 5,849,865	$ 4,873,131	$ 4,266,818	
		Total	46,874	$ 29,250,000	$ 24,370,000	$ 21,330,000	
	Project Cost	Engineering		$ 5,850,000	$ 4,874,000	$ 4,266,000	
		Easements		$ 1,170,000	$ 974,800	$ 853,200	
		Administration		$ 585,000	$ 487,400	$ 426,600	
		Total		**$ 36,860,000**	**$ 30,710,000**	**$ 26,880,000**	

7.2.3 WSA Alternatives Evaluation Conclusions

The WSA alternative alignments provide equal opportunity for service to future development in multiple ways. The primary considerations and/or differentiators between the alternatives are as follows:

7.2.3.1 Sunset Drive Alignment

- Allows for a phased construction approach to serve future development to the west.
- Relieves the Park Avenue and Commerce Drive sewers, which removes flow from the West Interceptor.
- Potential to eliminate the package WWTP at Bennett Drive which serves the Country Meadows Condominiums.
- Potential to eliminate the Stratford Drive lift station.
- Replacement of existing sewers is required for Alternatives 1 and 3.
- Proposed to collect flow from the Village of Covington.

7.2.3.2 Hemm Road Interceptor Extension for Future Development Only (Alternatives 6 and 7)

- Limited phasing potential.
- A sustained deep vertical alignment when compared to Sunset Drive alignment
- Flow tributary to the West Interceptor is not off-loaded, requiring sewer replacement in very close proximity to Franz Pond and the stream tributary to it.
- Although construction in an environmentally sensitive area is not preferred, West Interceptor near Franz Pond, the City believes this segment of sewer could be a source of substantial inflow, thus replacement could be a positive improvement for the collection system.

7.2.3.3 Northwest Trunk Sewer

- Construction outside of the Riverside Drive right-of-way is substantially less expensive but would require numerous easements and place construction near the levy of the Great Miami River.
- The existing Northwest Interceptor does not surcharge under existing conditions, thus not requiring improvements.
- Proposed improvements are only necessary to serve future development.
- Utilizing a siphon is less expensive than constructing the sewer by gravity only.
- A lift station and force main is the least expensive option to serve future development.

As discussed with the City during the Alternatives Evaluation Workshop, Alternative 1 was the preferred alternative but asked CDM Smith to investigate the lift station option associated with the Northwest Trunk Sewer improvements. Given the considerations above and the comparatively lowest cost of all alternatives, the recommended sewer alignment to serve the West Service Area is Alternative 1.

7.3 Northeast Service Area Alternatives Evaluation

The Northeast Service Area (NSA) is served by the Looney Road Interceptor which has conveyance capacity to maintain the HGL in-pipe for a 5-year design storm under existing conditions; the 10-year event does not flood manholes, thus under existing conditions the Looney Road sewer meets the Master Plan evaluation criteria. However to serve future development in the northeast area of the system, improvements are needed as the Looney Road sewer surcharges under Ultimate Build-out conditions.

Three alternatives were developed to serve future development in the NSA.

7.3.1 NSA Alternative Alignments

Alternative 1 consists of approximately 17,150 feet of new 12-inch diameter sanitary sewer with an average depth of approximately 18 feet; reference **Figure 7-11**.

Figure 7-11
Alternative 1 – Northeast Service Area

Alternative 2 consists of approximately 16,250 feet of new 12-inch diameter sanitary sewer with an average depth of approximately 13 feet; reference **Figure 7-12**.

Figure 7-12
Alternative 2 – Northeast Service Area

Alternative 3 consists of approximately 17,540 feet of new 12-inch diameter sanitary sewer with an average depth of approximately 13 feet; reference **Figure 7-13**.

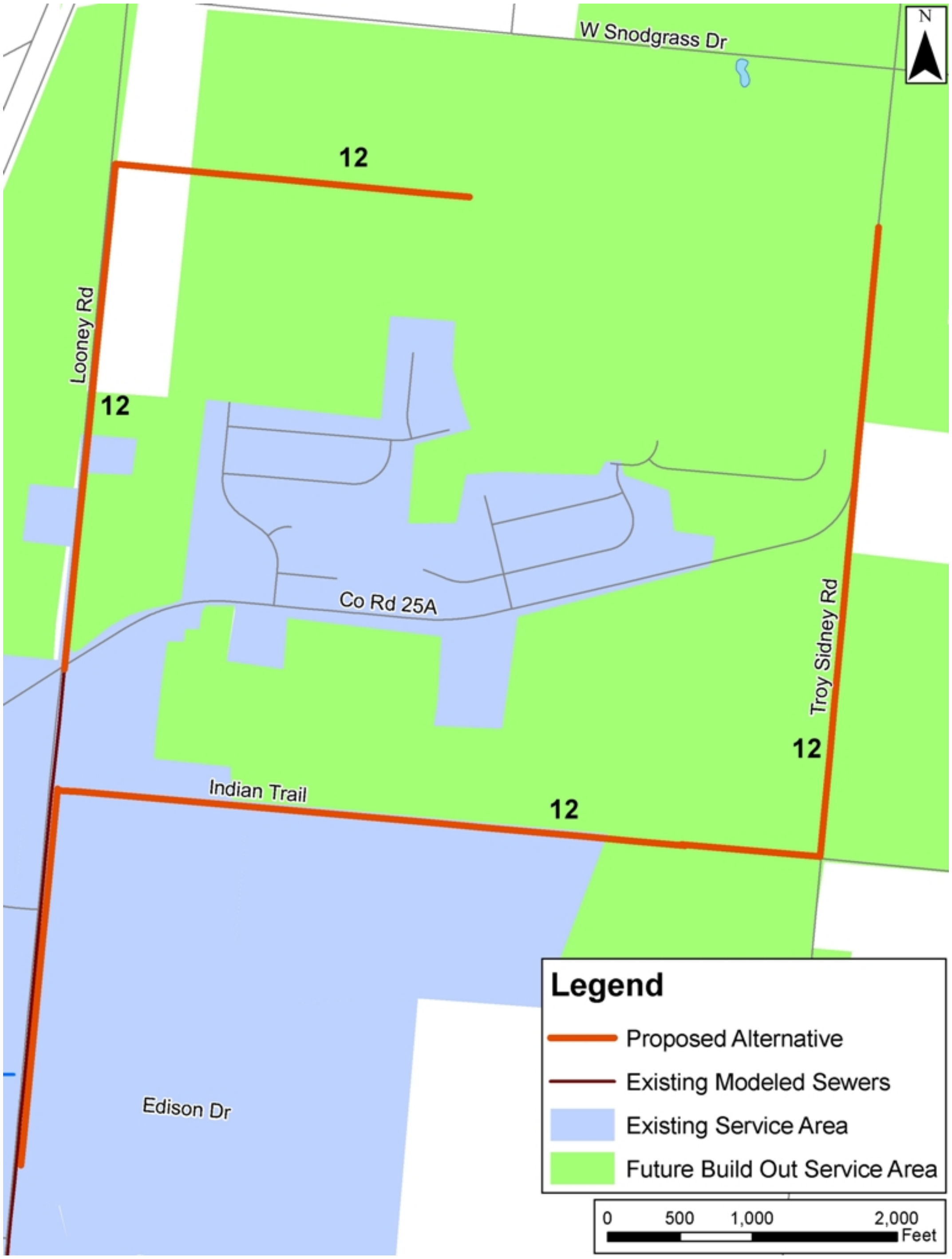


Figure 7-13
Alternative 3 – Northeast Service Area

7.3.2 NSA Construction and Project Cost Estimates

Table 7-2 presents the itemized cost estimates for the alternatives evaluated which shows a variation in total project cost with a low of $4.4 million and a high of $6.9 million.

Table 7-2 Northeast Service Area: Construction and Project Cost Estimates

Looney Road Alternatives				
Alternative		**Item**	**Length**	**Cost**
1	Construction Cost	Looney Trunk	5,950.00	$ 1,266,614.14
		Troy Sidney Ext.	11,204.00	$ 2,999,492.53
		Contingency		$ 1,066,527
		Total	17,154.00	$ 5,330,000
	Project Cost	Engineering		$ 1,066,000
		Easements		$ 213,200
		Administration		$ 106,600
		Total		**$ 6,720,000**
2	Construction Cost	Looney Trunk	8,000.00	$ 1,512,730.25
		Troy Sidney Ext.	8,248.00	$ 1,281,185.79
		Contingency		$ 698,479
		Total	16,248.00	$ 3,490,000
	Project Cost	Engineering		$ 698,000
		Easements		$ 139,600
		Administration		$ 69,800
		Total		**$ 4,400,000**
3	Construction Cost	Looney Trunk	5,950.00	$ 1,266,614.14
		Troy Sidney Ext.	11,585.00	$ 3,119,489.33
		Contingency		$ 1,096,526
		Total	17,535.00	$ 5,480,000
	Project Cost	Engineering		$ 1,096,000
		Easements		$ 219,200
		Administration		$ 109,600
		Total		**$ 6,900,000**

7.3.3 NSA Alternatives Evaluation Conclusions

The three NSA alternative alignments essentially provide equal opportunity for service to future development. Some considerations relative to the alternatives is as follows:

- Alternatives 1 and 2 split the Ultimate Build-out flow, routing the eastern most future development flow to a point downstream of the surcharged Looney Road Sewer, thus eliminating the need to replace the deficient sewer segments along Looney Road.
- Alternative 3 would create a redundant sewer along Indian Trail as there is an existing sewer serving the Piqua High School.

Given the considerations above and the fact that Alternative 2 is over $1M less expensive than Alternative 3, the recommended sewer alignment to serve future development is Alternative 2.

7.4 North Central, South Central, and East Service Areas Alternatives Evaluation

The existing interceptors have adequate capacity to serve future development in the North Central Service Area (NCSA), the South Central Service Area (SCSA), and the East Service Area (ESA). The need for sewer extensions to serve future development in these areas will be driven by development.

7.4.1 NCSA, SCSA, and ESA Sewer Extension Alignments

Figure 7-14 shows the proposed sewer extensions to serve future development in the NCSA and **Figure 7-15** shows the proposed sewer extensions to serve future development in the SCSA and ESA.

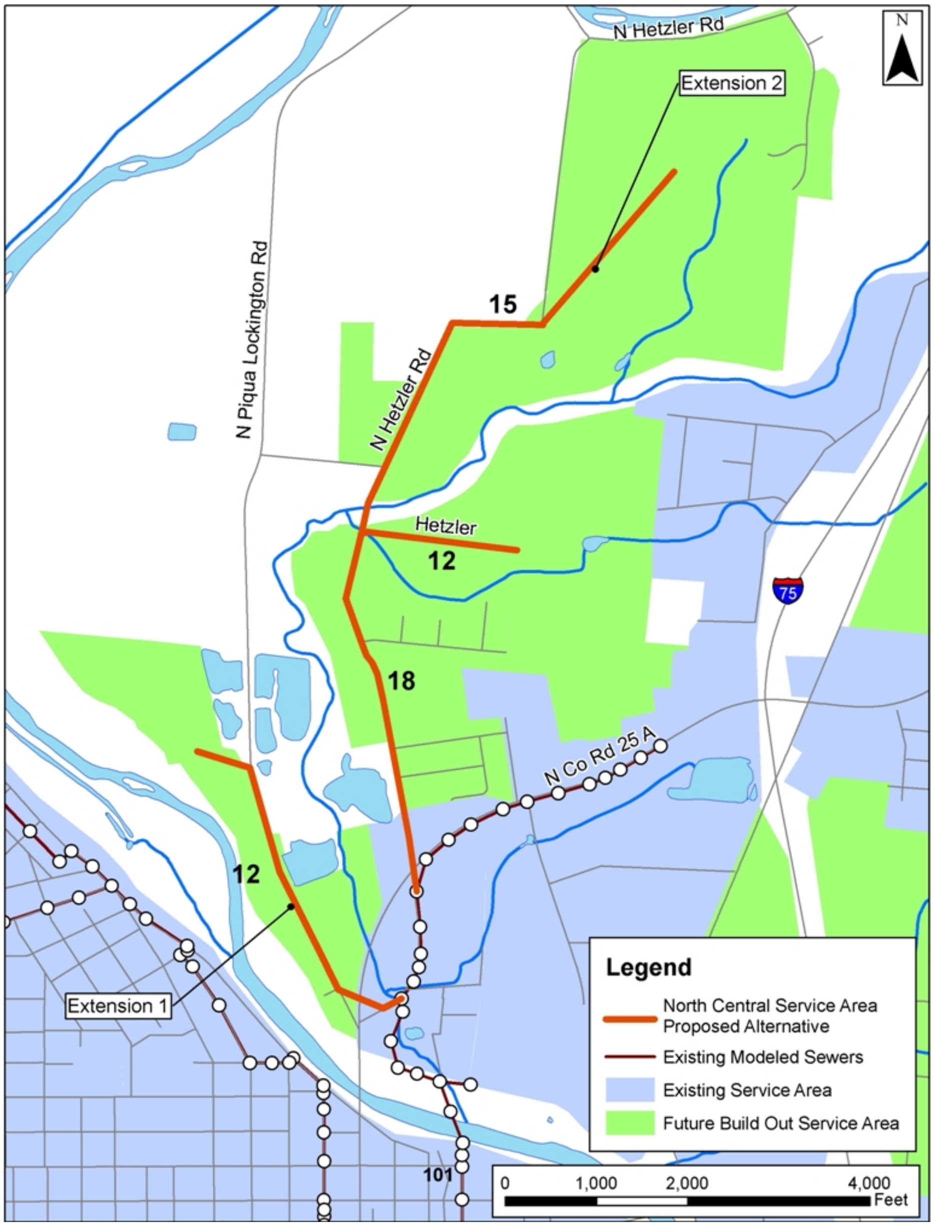


Figure 7-14
North Central Service Area – Sewer Extensions to Serve Future Development

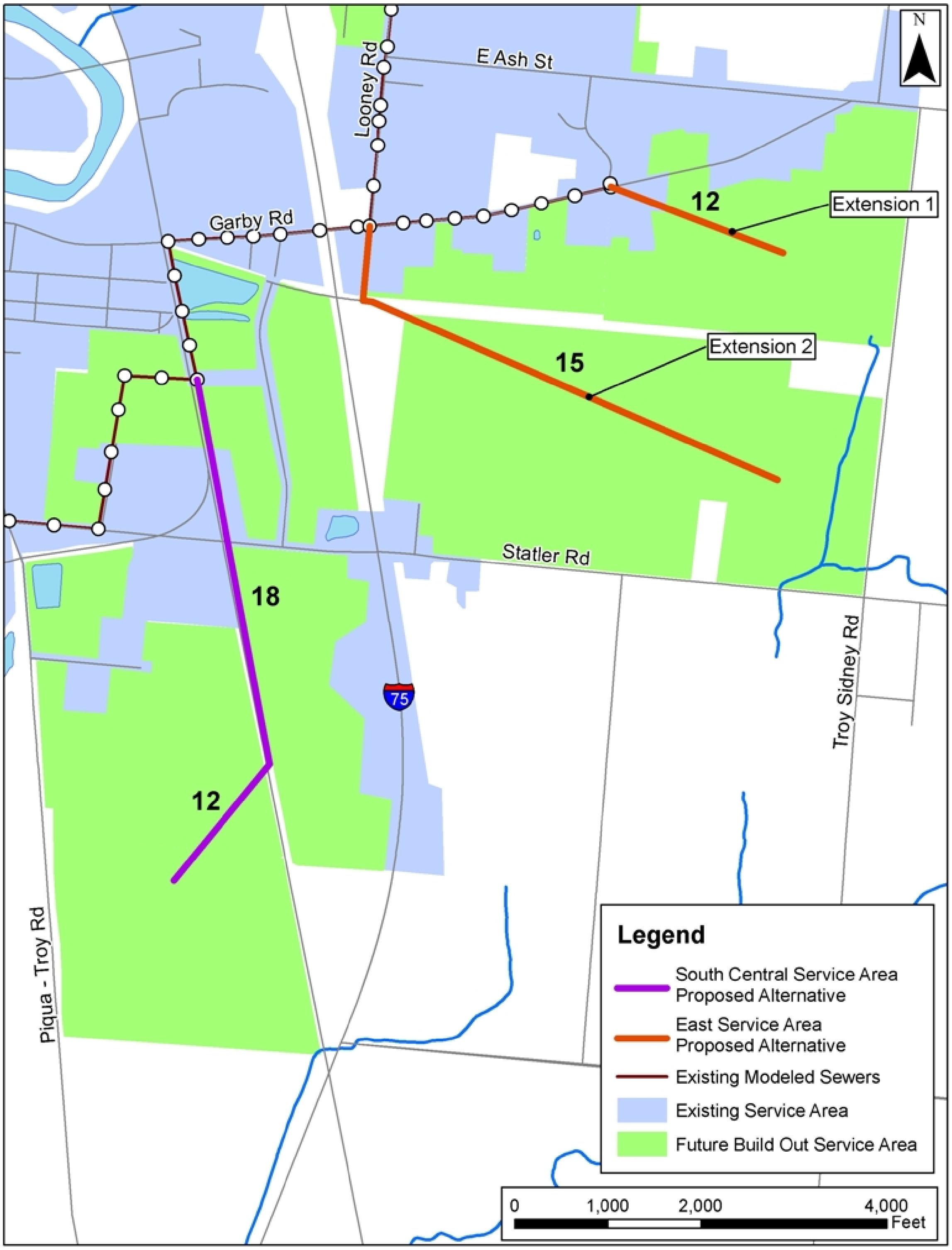


Figure 7-15
South Central and East Service Areas – Sewer Extensions to Serve Future Development

7.4.2 NCSA, SCSA, and ESA Construction and Project Cost Estimates

Table 7-3 presents the itemized cost estimates for the assumed extension sewers shown. To be conservative, estimated construction costs assume the sewers have an average depth of 15 feet and are located in the right-of-way; approximate pipe sizes are shown.

Table 7-3 NCSA, SCSA, and ESA Service Areas: Construction and Project Cost Estimates

NCSA, SCSA, and ESA Service Areas: Construction and Project Cost Estimates					
Alternative		Item	Length	Cost	
North Central Service Area	Construction Cost	Extension 1	3,992.00	$	1,033,922.83
		Extension 2	11,511.00	$	3,275,177.44
		Contingency		$	1,077,275
		Total	15,503.00	$	5,390,000
	Project Cost	Engineering		$	1,078,000
		Easements		$	215,600
		Administration		$	107,800
		Total		**$**	**6,790,000**
East Service Area	Construction Cost	Extension 1	5,658.00	$	1,226,717.39
		Extension 2	1,979.00	$	370,168.33
		Contingency		$	399,221
		Total	7,637.00	$	2,000,000
	Project Cost	Engineering		$	400,000
		Easements		$	80,000
		Administration		$	40,000
		Total		**$**	**3,500,000**
South Central Service Area	Construction Cost	Extension 1	5,824.00	$	1,739,716.75
		Contingency		$	434,929
		Total	5,824.00	$	2,170,000
	Project Cost	Engineering		$	434,000
		Easements		$	86,800
		Administration		$	43,400
		Total		**$**	**2,730,000**

Section 8
Implementation Plan

This section identifies and prioritizes the capital improvements necessary for the sanitary sewer system to achieve the following:

- Eliminate the SSO in accordance with the City's NPDES permit.
- Eliminate deficiencies in the existing interceptor system to meet the criteria established in this Master Plan.
- Serve future development for meeting long-term collection system needs.

A two-phased Capital Improvement Plan (CIP) and implementation schedule was developed to address the wastewater system's main priority, eliminate the SSO, and the long-term needs to serve future development in areas not currently served by the sanitary sewer collection system while eliminating collection system deficiencies.

8.1 CIP - Phase 1

Phase 1 of the sanitary sewer system CIP pertains to improvements to the Great Miami River siphon that is a portion of the solution for eliminating the SSO. The other portion of the solution for the SSO elimination is addressed in the Wastewater Treatment Plant Facility Plan. The analyses governing the recommendations included in Phase 1 are discussed in Section 6. The improvements in Phase 1 are identified with a proposed completion dates and are presented in sub-section 8.3.

8.1.1 WWTP Improvements

The Wastewater Treatment Plant Facility Plan recommendations focused on the boundary conditions at the plant relative to influent pumping capacity at the headworks and the storage volume for wet weather flow equalization. With coordination of the on-going WWTP Facilities Plan, the optimal combination of equalization storage volume versus treatment plant capacity is as follows:

- Upgrade the WWTP to a peak flow rate of 13 MGD.
- Increase flow equalization storage volume to 6 MG.

The cost for improvements at the WWTP is documented in the Facilities Plan and was not developed as part of this Sanitary Sewer System Master Plan.

8.1.2 Great Miami River Siphon Augmentation

The Great Miami River siphon, located on the West Interceptor, consists of 16-inch double barrel pipes and creates a hydraulic bottleneck during wet weather events. Augmentation of the existing siphon will eliminate localized surcharging upstream of the SSO on the West Interceptor, thus conveying greater flow rates to the WWTP for equalization and treatment. The recommended improvements for the siphon are identified as follows:

- Great Miami River Siphon – augment existing two 16-inch barrels with an additional 24-inch pipe

Using a unit cost assuming micro-tunneling, a 25% construction contingency, and the following Project Cost percentages for engineering (25%), easements (4%), and administration (2%), **Table 8-1** summarizes the costs for augmenting the existing siphon under the Great Miami River.

Table 8-1 Great Miami River Siphon Augmentation Costs – Phase 1

Siphon	Size (inches)	Approx. Length	Unit Cost ($/ft)	Siphon	Siphon Chamber Modification	Construction Cost	Project Cost
Great Miami River	24	400	850	$ 340,000	$ 100,000	$ 550,000	$ 720,000

8.2 CIP – Phase 2

Phase 2 of the CIP pertains to collection system improvements that serve two purposes:

- Eliminate collection system deficiencies to meet Master Plan criteria.
- Serve future development.

The analyses governing the recommendations included in Phase 2 are discussed in Section 7.

8.2.1 West Service Area

The recommended alternative to serve the ultimate build-out future condition in the West Service Area is Alternative 8.

Another siphon on the West Interceptor consists of 16-inch double barrel pipes under S-Creek and creates a hydraulic bottleneck during wet weather events causing collection system surcharging upstream of the siphon. Augmentation of the S-Creek siphon will eliminate localized surcharging. The recommended improvements for the siphon are identified as follows:

- S-Creek Siphon – augment existing two 16-inch barrels with an additional 20-inch pipe

Using a unit cost assuming micro-tunneling, a 25% construction contingency, and the following Project Cost percentages for engineering (25%), easements (4%), and administration (2%), Table 8-2 summarizes the costs for augmenting the existing siphon under S-Creek.

Table 8-2 S-Creek Siphon Augmentation Costs – Phase 2

Siphon	Size (inches)	Approx. Length	Unit Cost ($/ft)	Siphon	Siphon Chamber Modification	Construction Cost	Project Cost
S-Creek	20	250	800	$ 200,000	$ 100,000	$ 380,000	$ 500,000

WSA Alternative 8, utilizing a pump station along the Northwest Trunk Sewer alignment, is the preferred alternative to serve the West Service Area. As discussed in the alternatives evaluation, this alignment allows for a phased approach to serve future development west of the City as dictated by future development and off-load flow from the Park Avenue Extension and West Interceptor sewers; albeit, phasing would have to begin from the Hemm Road Interceptor, extending west then north along Sunset Drive to St. Rt. 185. Independent of the Sunset Drive sewer, the Northwest Trunk Sewer and pump station can be constructed at any time. A suggested phasing approach for construction of WSA Alternative 8 is as follows:

- Phase A – S-Creek Siphon – augment existing two 16-inch barrels with a single 20-inch barrel.
- Phase B - Northwest Trunk Sewer and pump station to serve the proposed Water Treatment Plant.
- Phase C – Sunset Drive sewer from the existing Hemm Road Sewer out South Street to assist with the connection of wastewater flow from the Village of Covington.
- Phase D – Sunset Drive sewer from South Street to Park Avenue to relieve the West Interceptor.
- Phase E – Extend Sunset Drive sewer out St. Rt. 185 to serve future development and/or eliminate the Country Meadows package WWTP.

8.2.1.1 Alternate WSA Phasing Considerations

The proposed WSA Alternative 8 improvements were developed to accommodate the ultimate build-out condition. However, there are some short-term improvement options that need to be considered by the City depending on how the WSA Alternative 1 is implemented to serve the new water treatment plant (WTP) and the needs to serve future development. These interim phasing considerations are identified as follows:

- To serve the new WTP, construct a force main which discharges to the existing Northwest Interceptor as this existing sewer has adequate capacity to accept the nominal wastewater flow from the WTP under existing conditions.
- At some time in the future, the combination of gravity sewer, Alternative 8 pump station, and force main recommended for the ultimate build-out condition should be constructed to serve future development to the northwest as needed.
- Under existing conditions and to eliminate in-system capacity deficiencies identified in Section 4, augmentation of the S-creek siphon is required to eliminate localized upstream surcharging of the West Interceptor from the siphon upstream to somewhere between South Street and Covington Avenue.
- Surcharging in the West Interceptor that remains after S-Creek siphon improvements will be eliminated between Park Avenue and Covington Avenue if the proposed Sunset Drive sewer is constructed from the Hemm Road Interceptor to Park Avenue. This is due to the new Sunset Drive sewer off-loading a considerable amount of existing sanitary flow from the West Interceptor and Park Avenue Extension sewer, essentially eliminating the surcharging being experienced under existing conditions.
- Once the Sunset Drive sewer is constructed, off-loading sanitary flow from the West Interceptor and Park Avenue Extension sewer, an alternate force main alignment (dashed yellow line) from the proposed Alternative 8 pump station becomes available which is shorter in length with less cost than the alignment shown in Alternative 8; reference **Figure 8-1**.
- The Washington Street force main (dashed yellow line) shown to discharge to the West Interceptor, is approximately 4,200 feet in length with an estimated construction cost of $440,000; whereas the Riverside force main is approximately 7,400 feet in length with an estimated construction cost of $780,000.

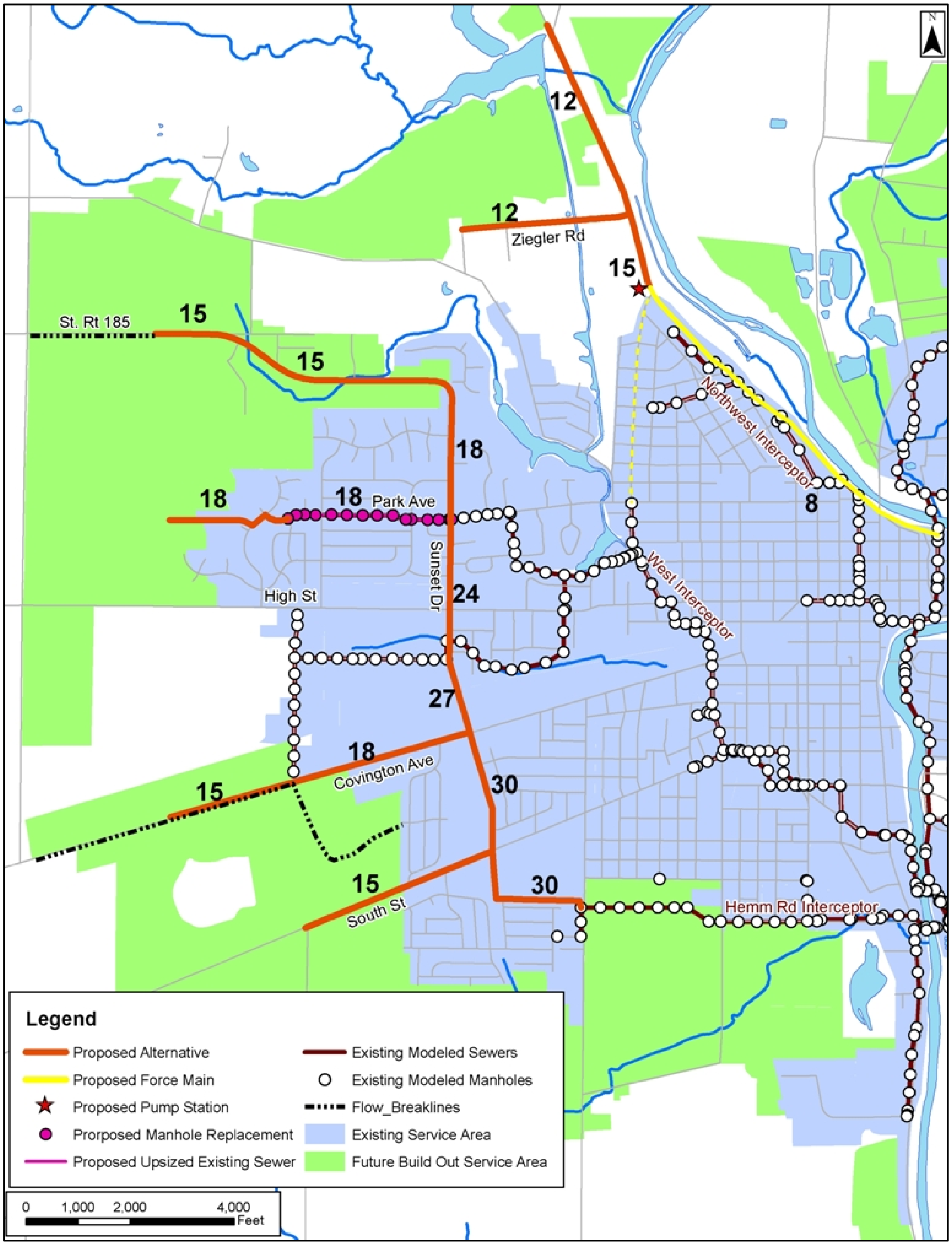


Figure 8-1
Alternative 8 – WSA Phasing Considerations Option

8.2.2 Northeast Service Area

Alternative 2 is the preferred alternative to serve the Northeast Service Area. The proposed improvements are only necessary to serve future development as collection system deficiencies in the Looney Road area were not evident under existing conditions.

8.2.3 North Central, South Central, and East Service Areas

The existing interceptor sewers serving the North Central, South Central, and East Service Areas have sufficient conveyance capacity to serve future development. The sewer extensions identified for these three service areas are necessary only to serve future development. In some areas adjacent to the anticipated future development, local sewers exist that were not included within the Expanded Model and therefore not hydraulically evaluated. As development occurs in these service areas, a hydraulic evaluation of the existing local sewers should be undertaken to determine if the existing sanitary sewer system can be utilized. Potential modification of the proposed sewer alignments developed as part of this Master Plan may be necessary as future development takes place.

8.3 CIP Implementation Schedule and Costs

Table 8-3 summarizes the proposed phased approach for implementing the CIP with relative to schedule and cost. A detailed cost estimate breaking down for each construction item can be found in section 7, tables 7-1, 7-2 and 7-3.

Table 8-3 Implementation Schedule and Costs

Phase	CIP Project	Item	Completion Date [1]	Construction Cost	Project Cost
1	WWTP	Upgrade Treatment Capacity	Dec. 2017	WWTP Facility Plan	WWTP Facility Plan
		Increased Flow Equalization	Dec. 2017	WWTP Facility Plan	WWTP Facility Plan
	Siphon	Great Miami River	Dec. 2014	$ 550,000	$ 720,000
			Phase 1 Sub-Total	**$ 550,000**	**$ 720,000**
2	WSA	Phase A – S-Creek Siphon	As Necessary	$ 380,000	$ 500,000
		Phase B – Northwest Trunk [2]	As Necessary	$ 5,320,000	$ 6,700,000
		Phase C – Sunset Dr. to South St.	As Necessary	$ 3,090,000	$ 3,890,000
		Phase D – Sunset Dr. to Park Ave.	As Necessary	$ 6,770,000	$ 8,530,000
		Phase E – Sunset Dr. out St. Rt. 185	As Necessary	$ 3,010,000	$ 3,790,000
			WSA Sub-Total	**$ 18,570,000**	**$ 23,410,000**
	NSA	Alternative 2	As Necessary	$ 3,490,000	$ 4,400,000
	NCSA	2 sewer extensions	As Necessary	$ 5,390,000	$ 6,790,000
	SCSA	1 sewer extension	As Necessary	$ 2,170,000	$ 2,730,000
	ESA	2 sewer extensions	As Necessary	$ 2,000,000	$ 3,500,000
			Phase 2 Sub-Total	**$ 31,620,000**	**$ 40,830,000**
			Phase 1 & Phase 2 CIP Total	**$ 32,170,000**	**$ 41,550,000**

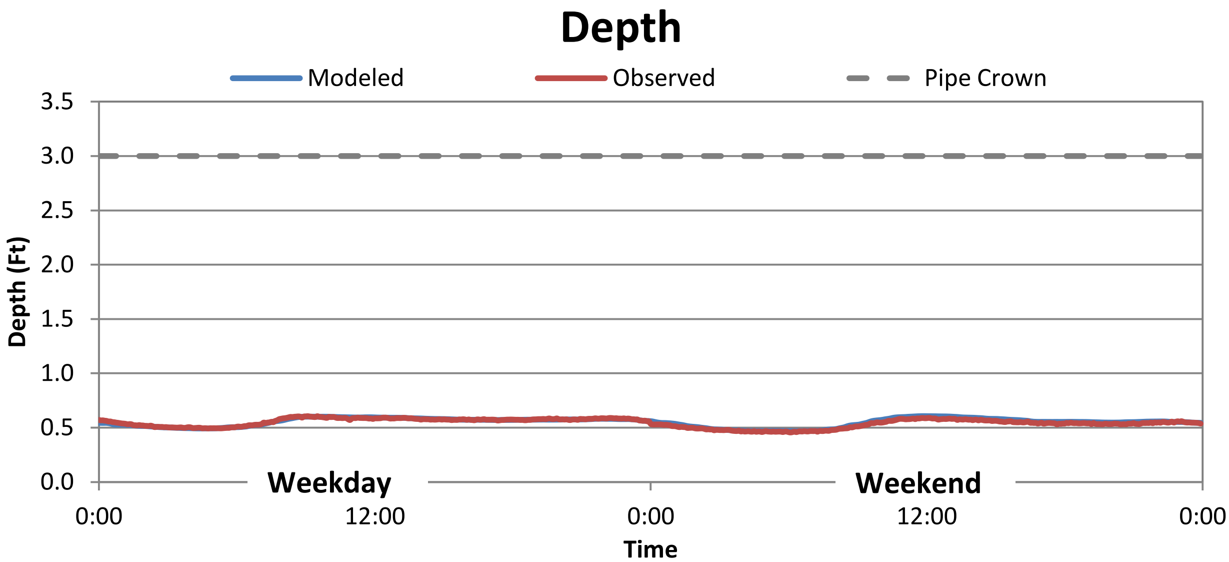
Notes: 1 The Completion Date for WWTP Improvements could change based on required period to perform pilot testing. Completion Dates identified As Necessary will be determined by the City to accommodate future development.

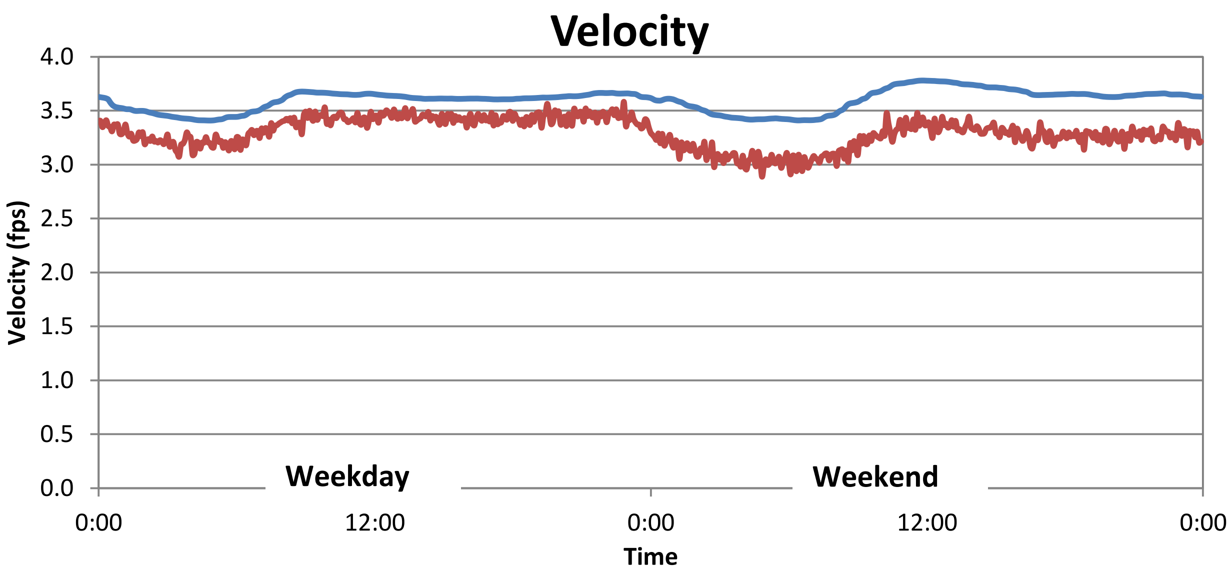
2. The costs for the WSA Phase B - Northwest Trunk represent the Riverside force main alignment cost.

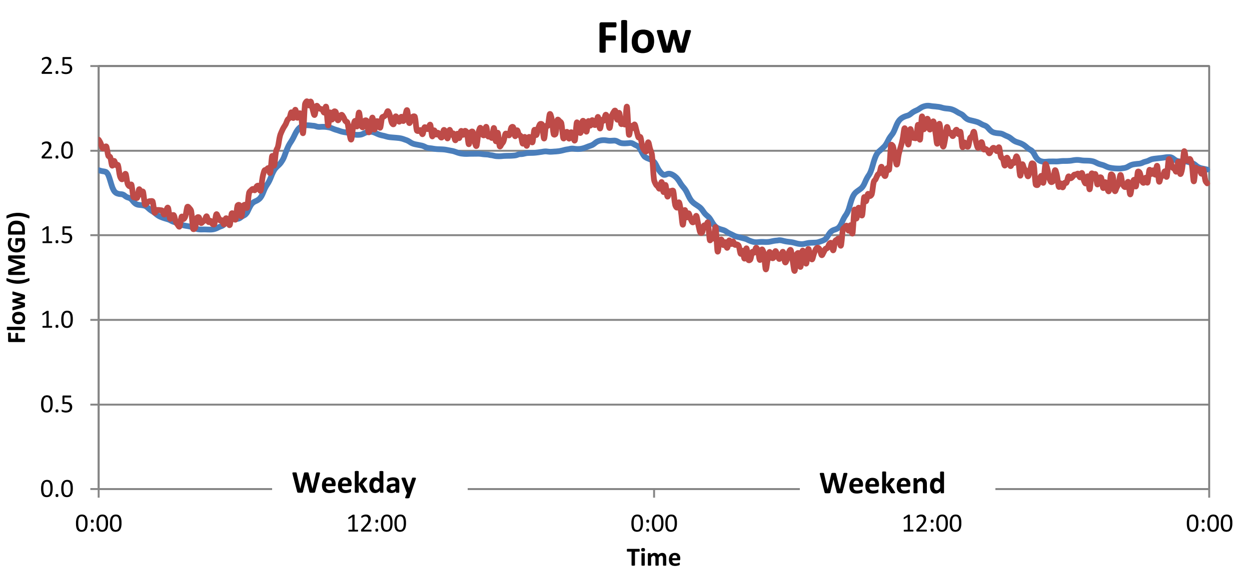
Appendix A

Dry Weather Flow Calibration Plots

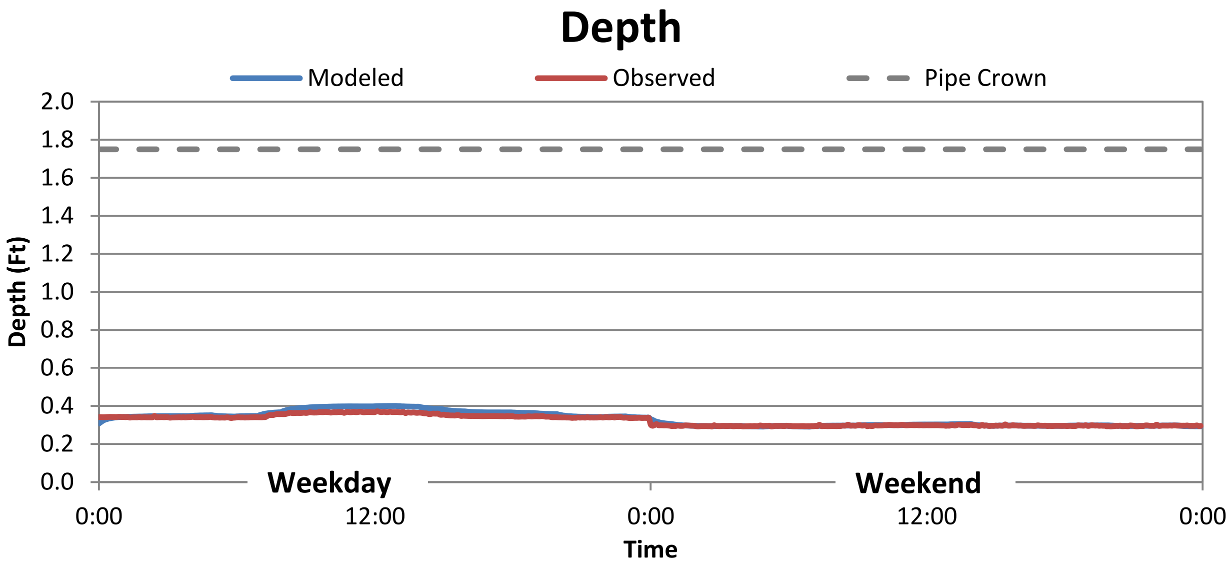
FM-01 DWF Calibration

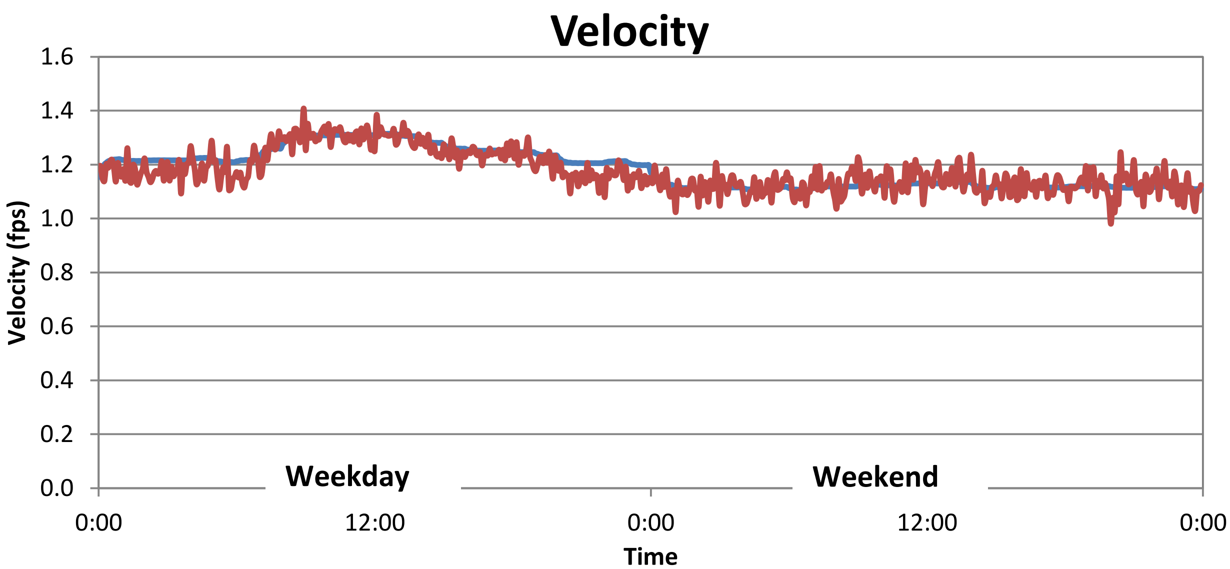


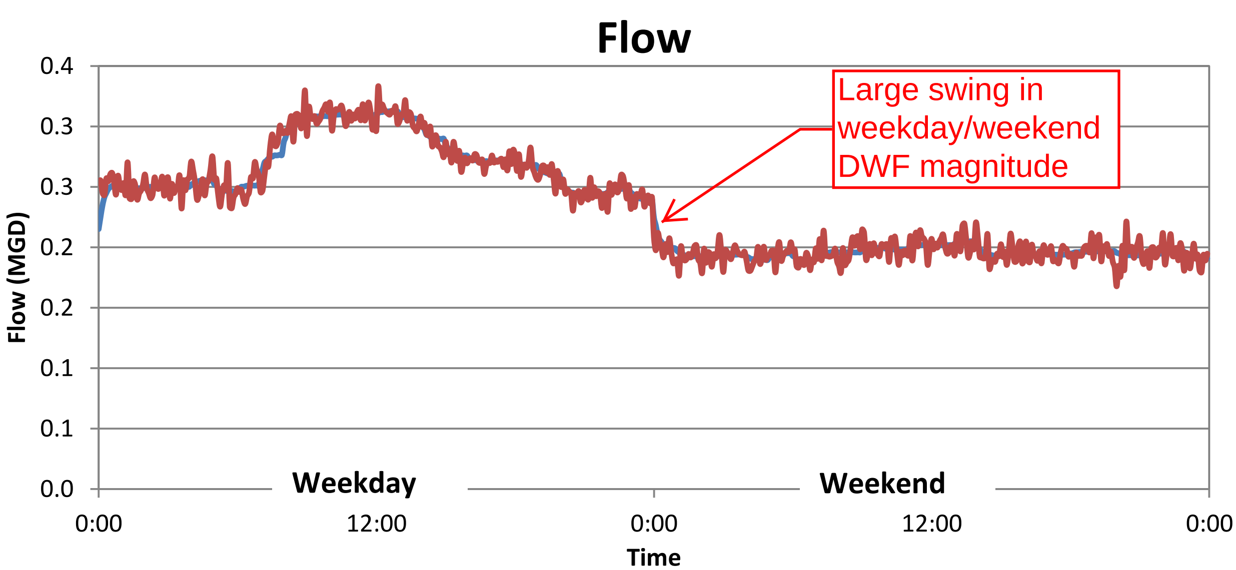




FM-02 DWF Calibration







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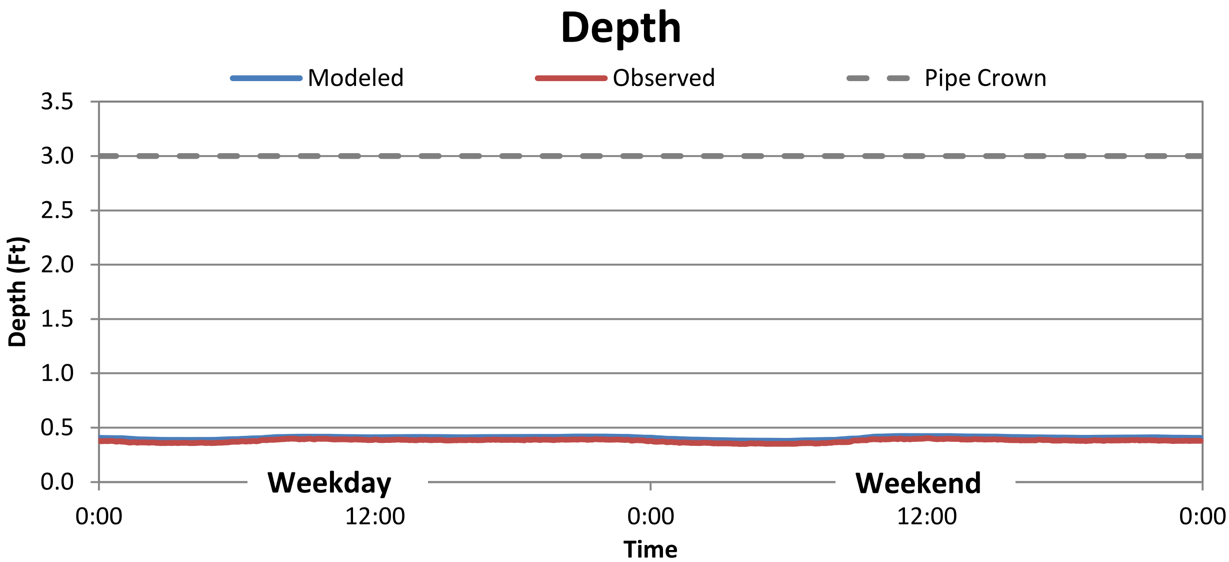

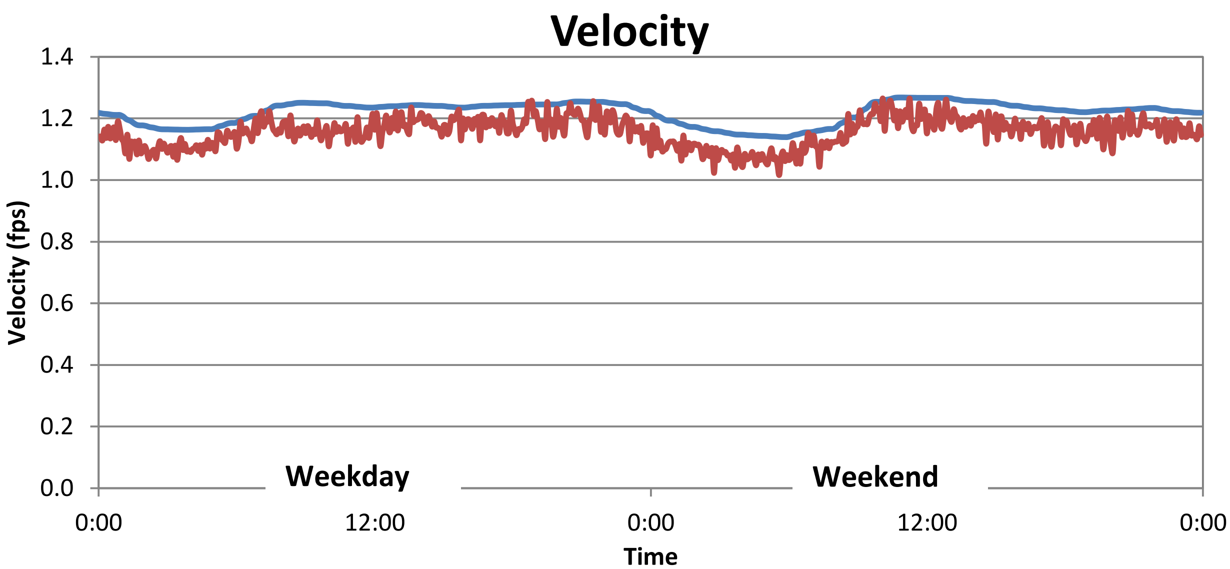

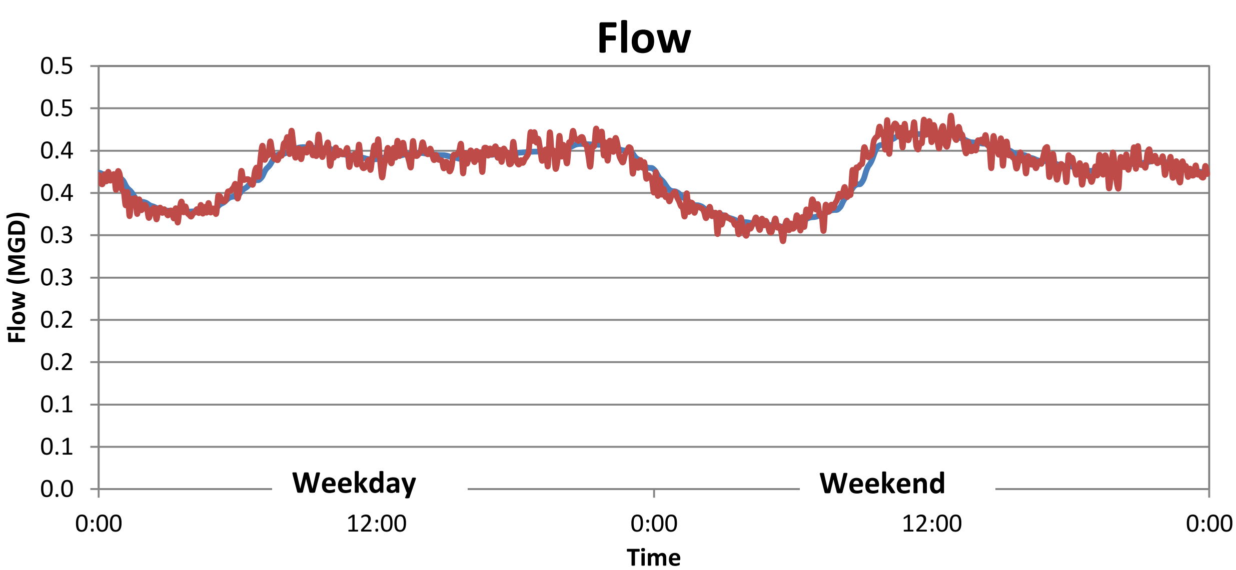

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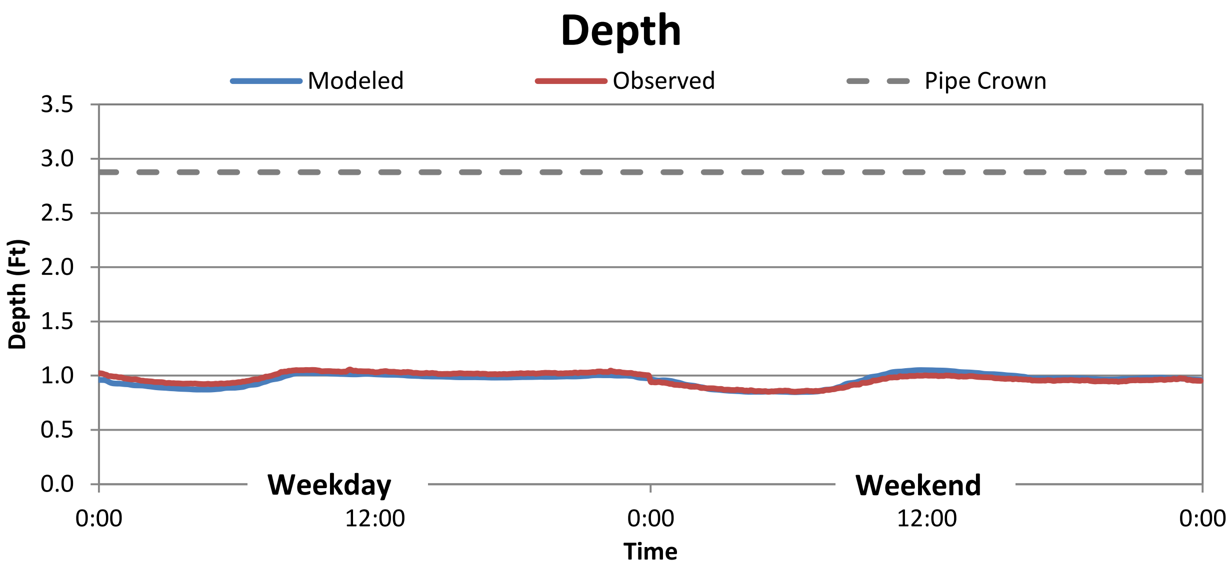

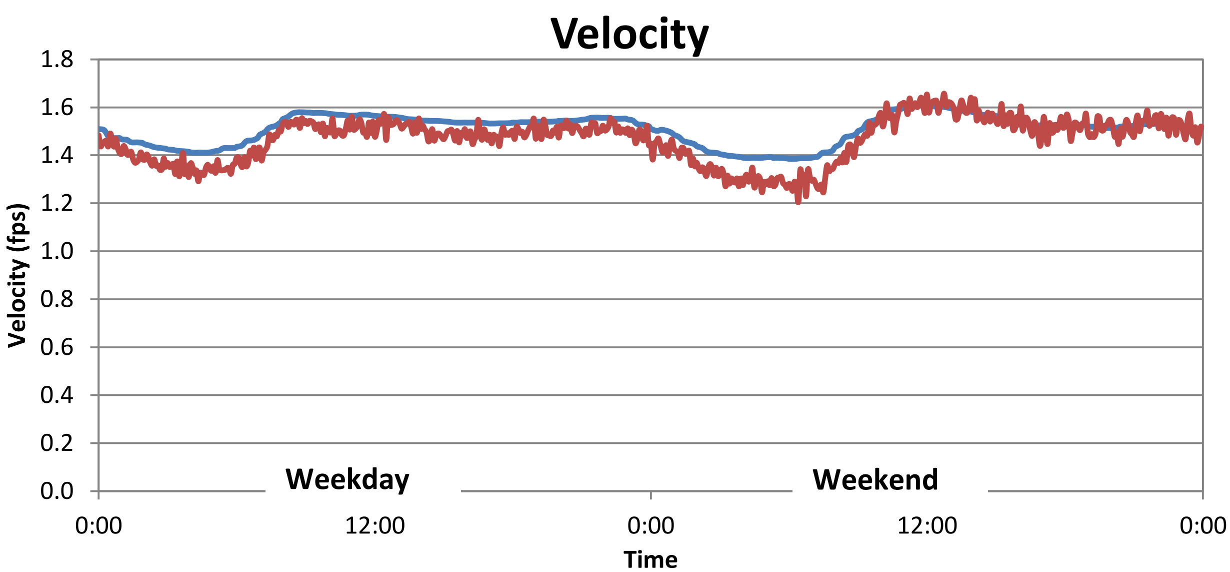

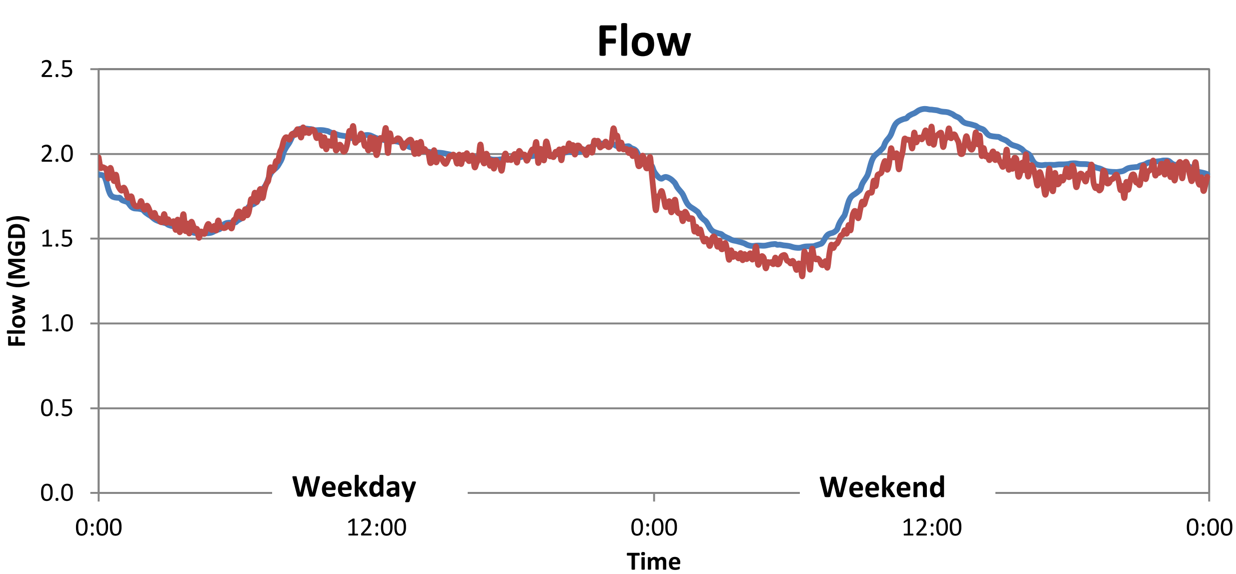

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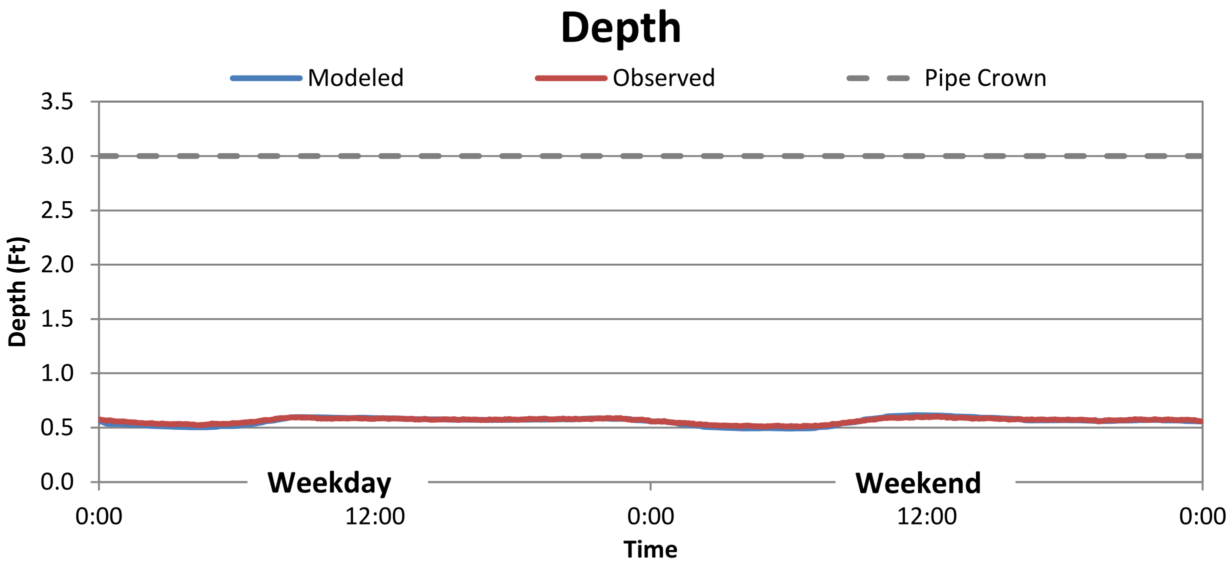
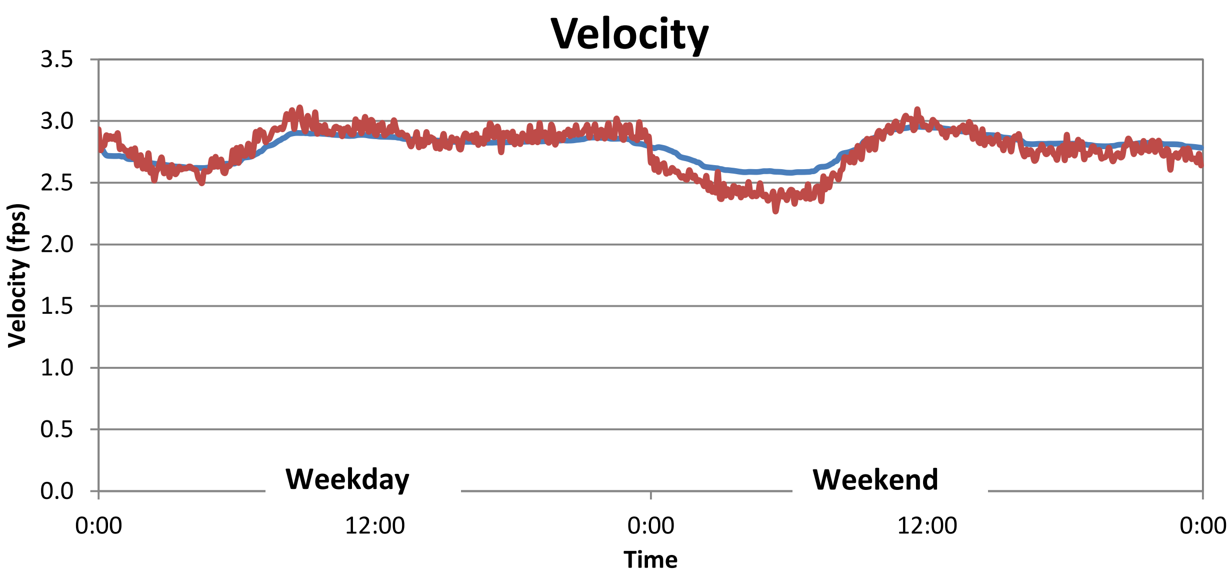
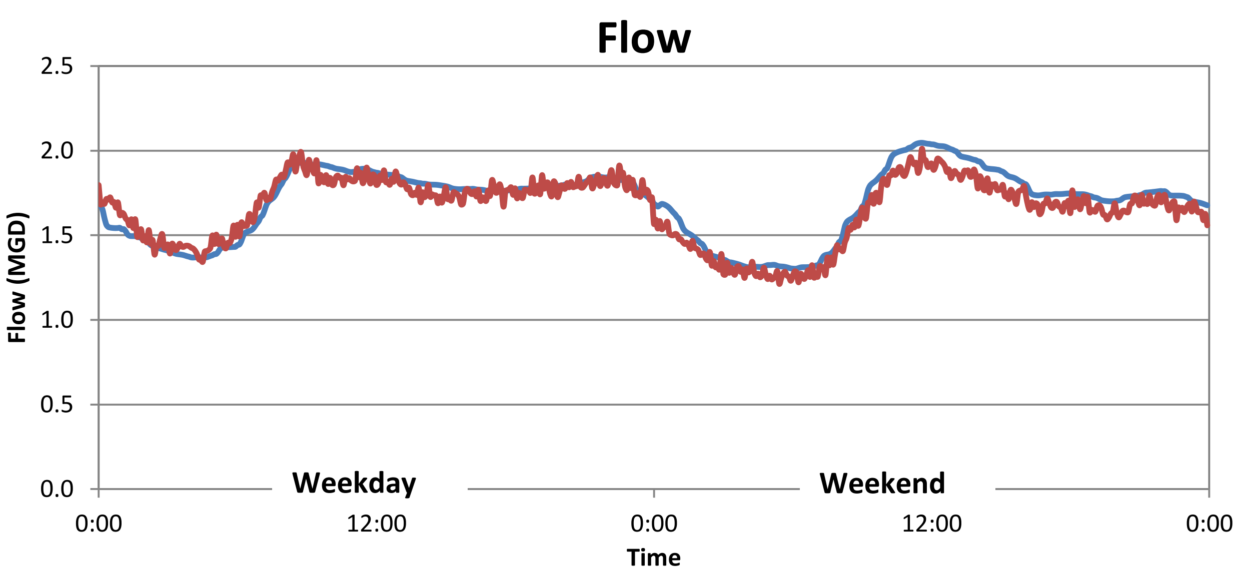
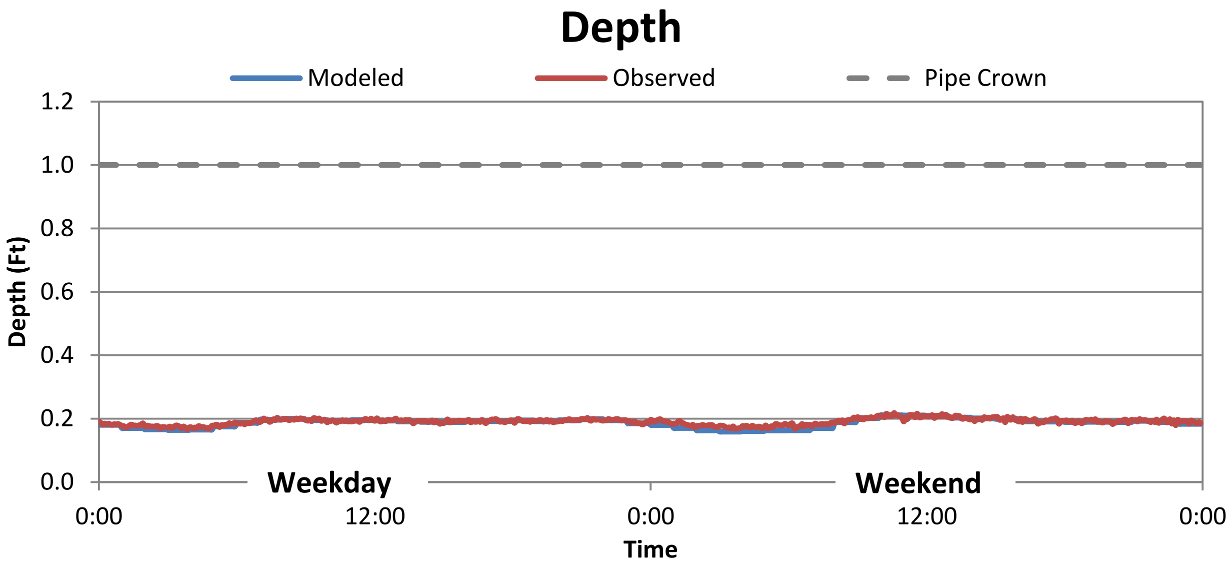
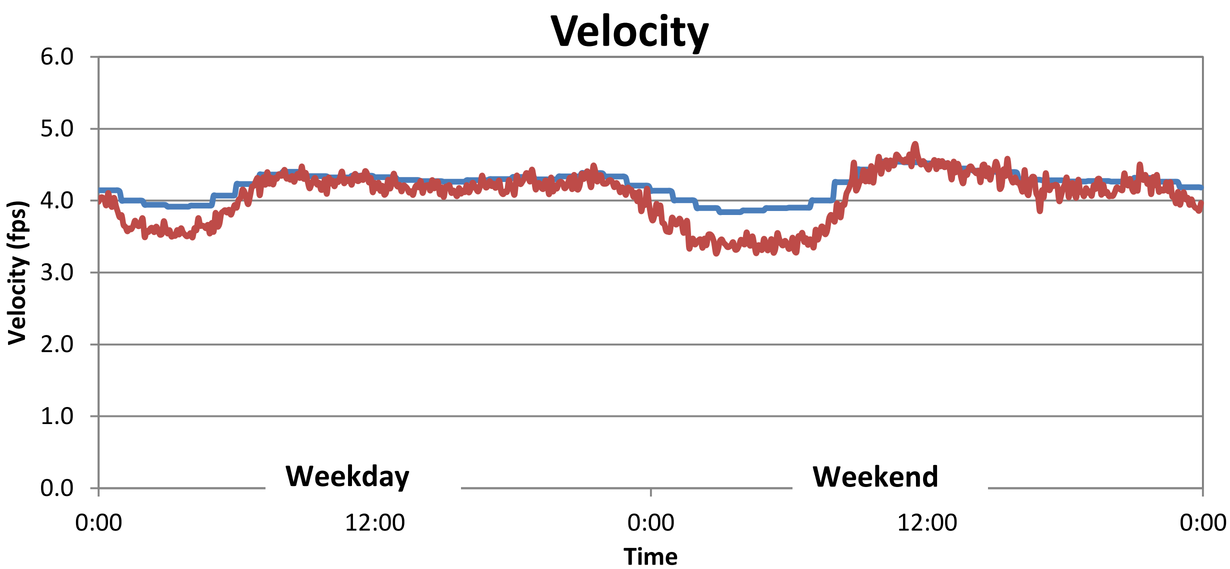


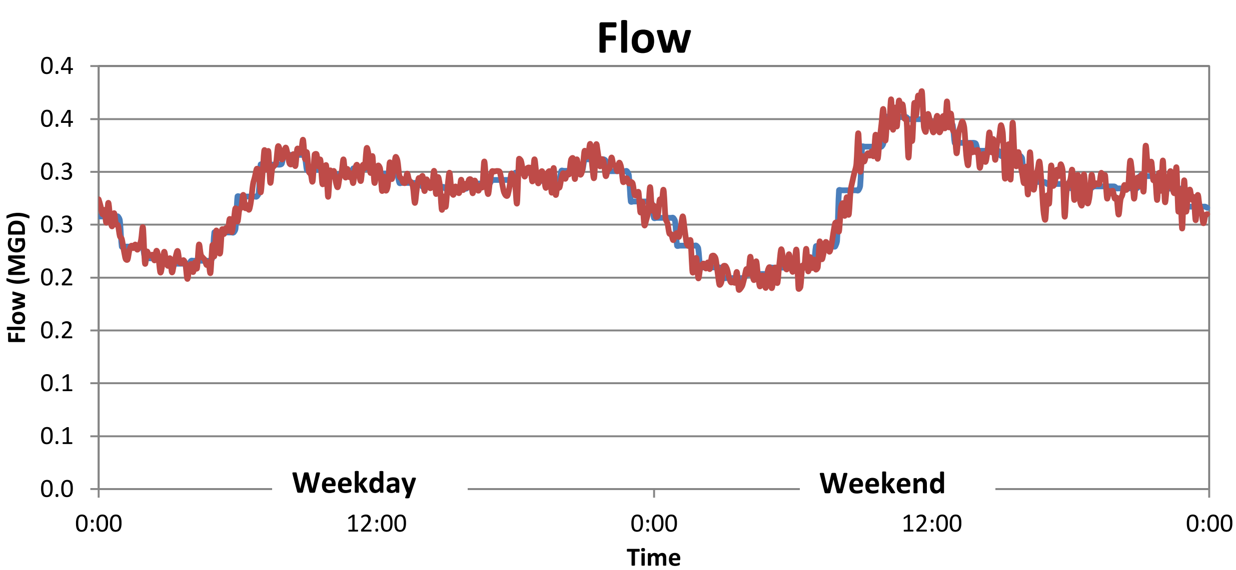




FM-06 DWF Calibration







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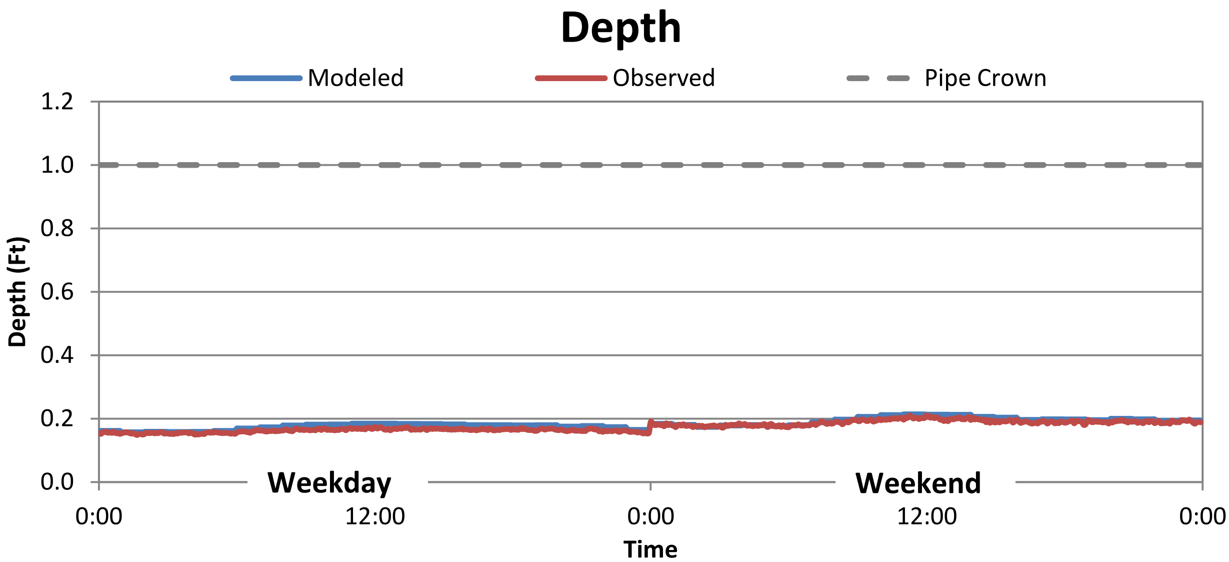
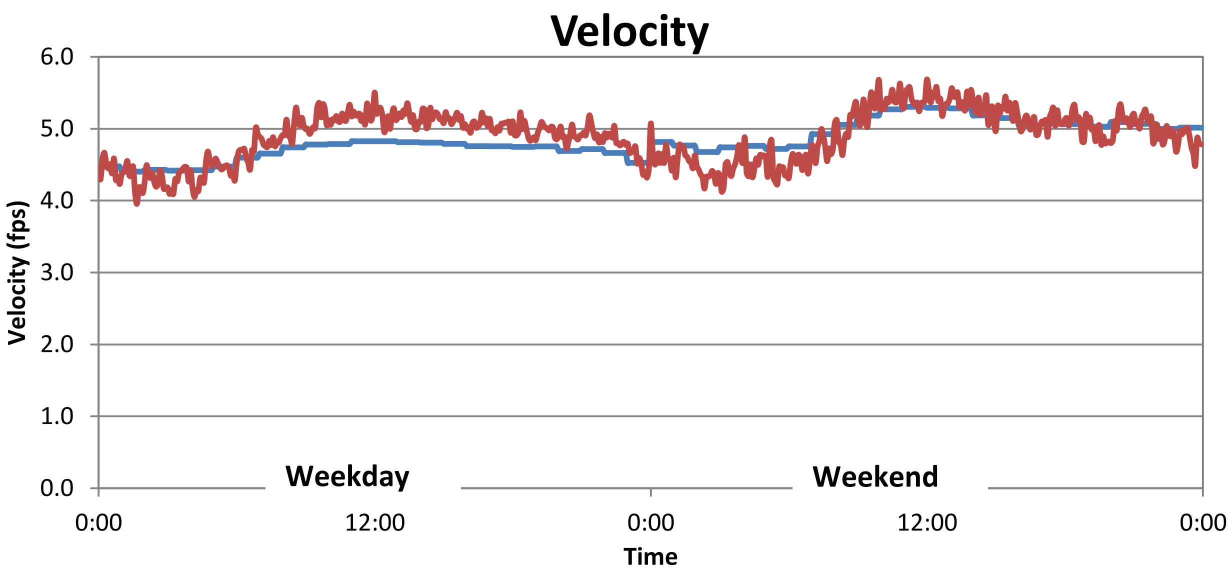
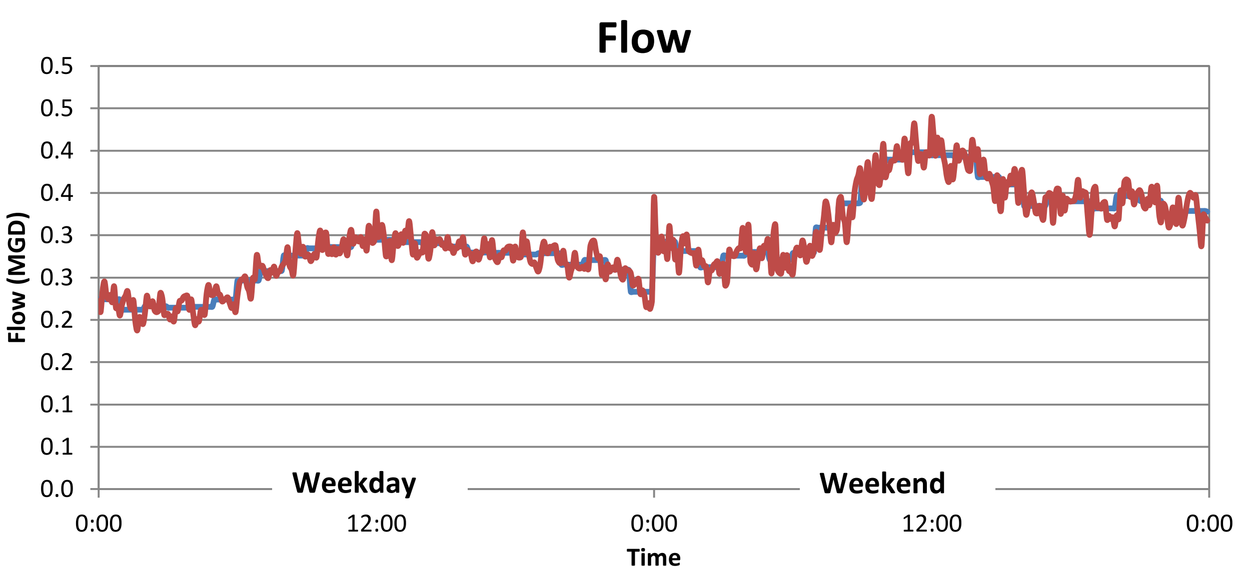
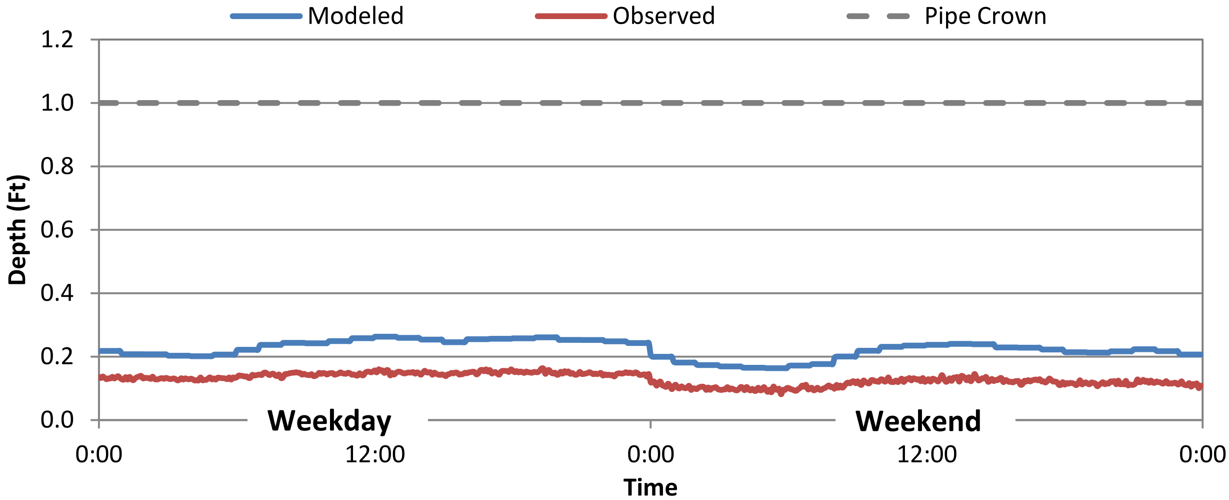




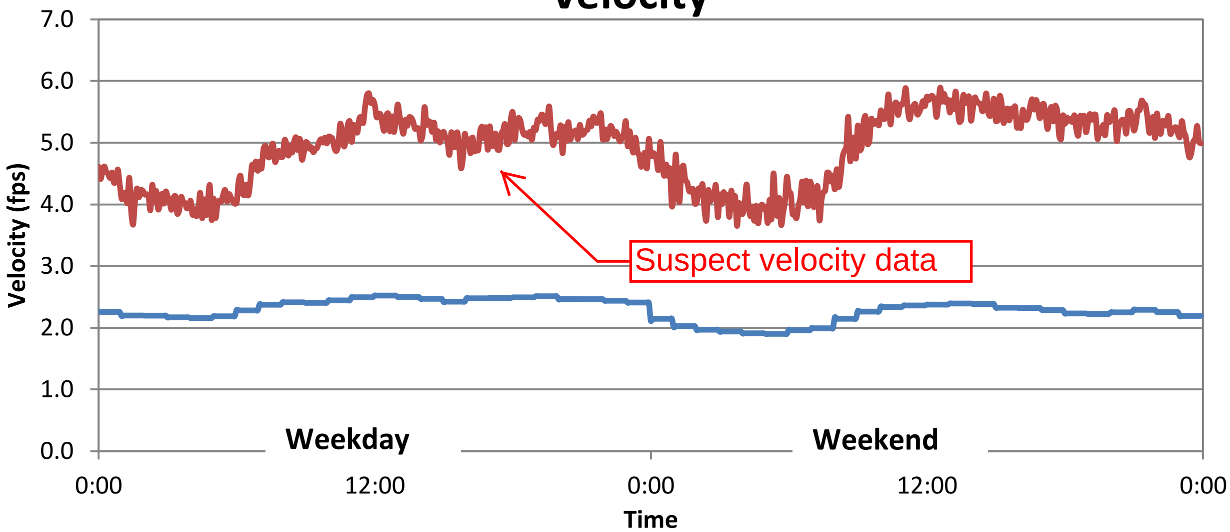


FM-08 DWF Calibration

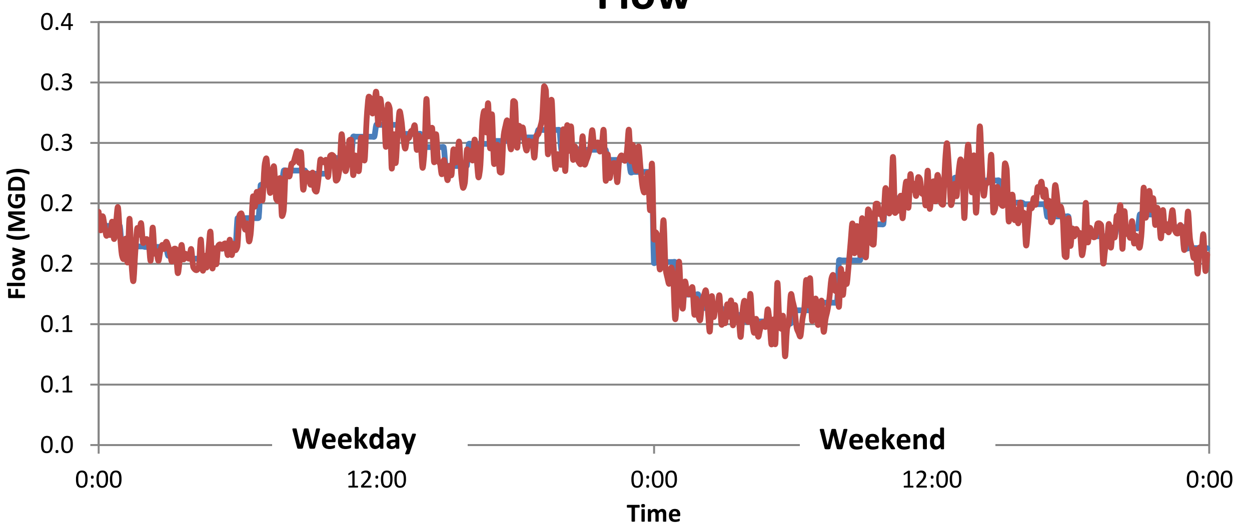
Depth



Velocity



Flow



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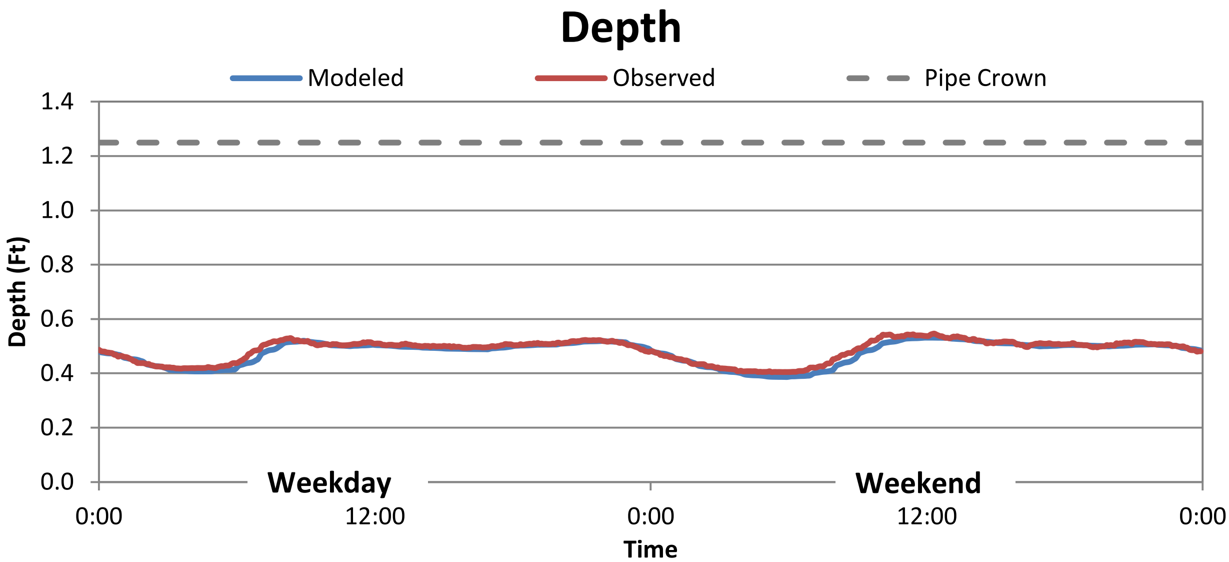

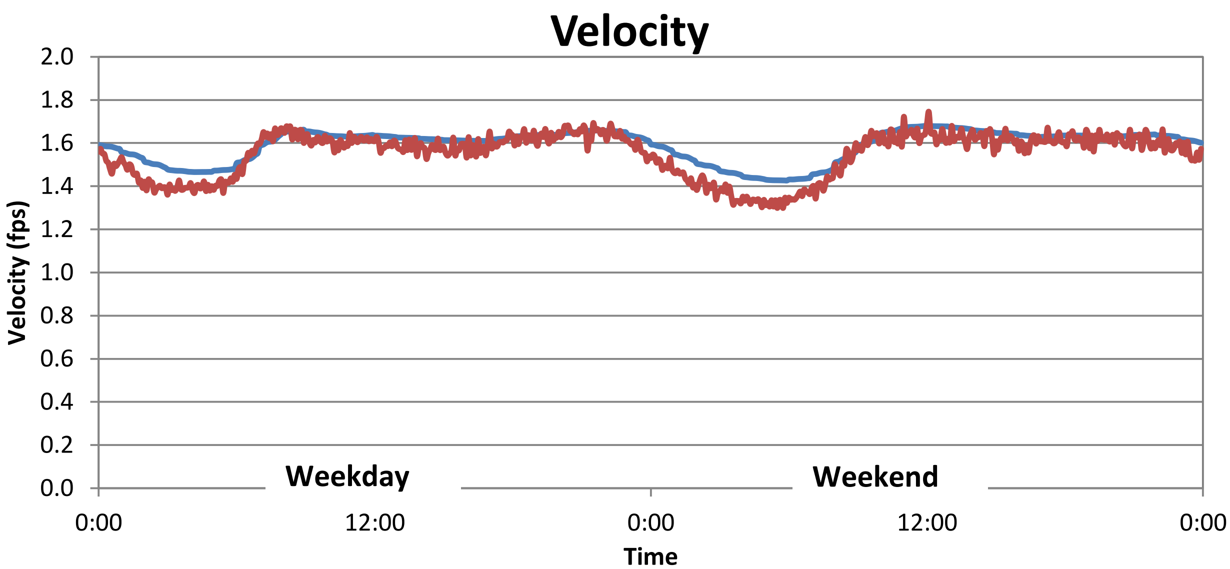

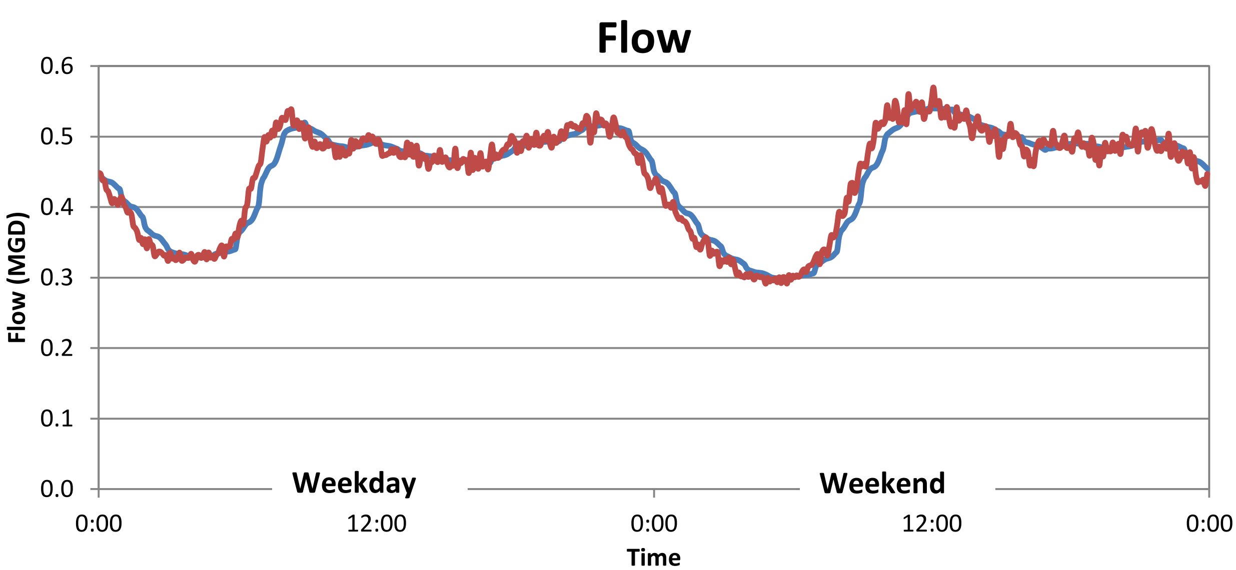

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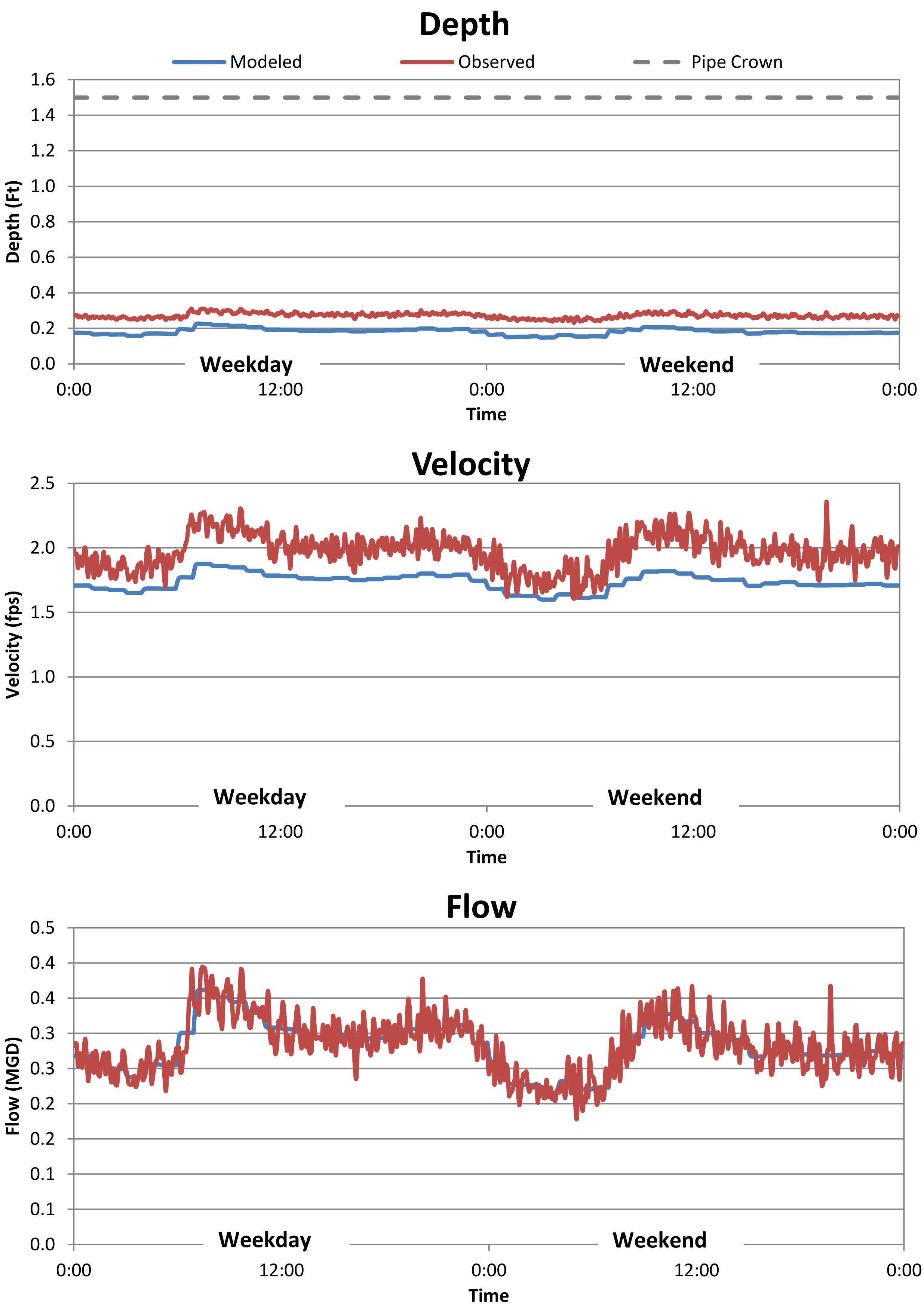

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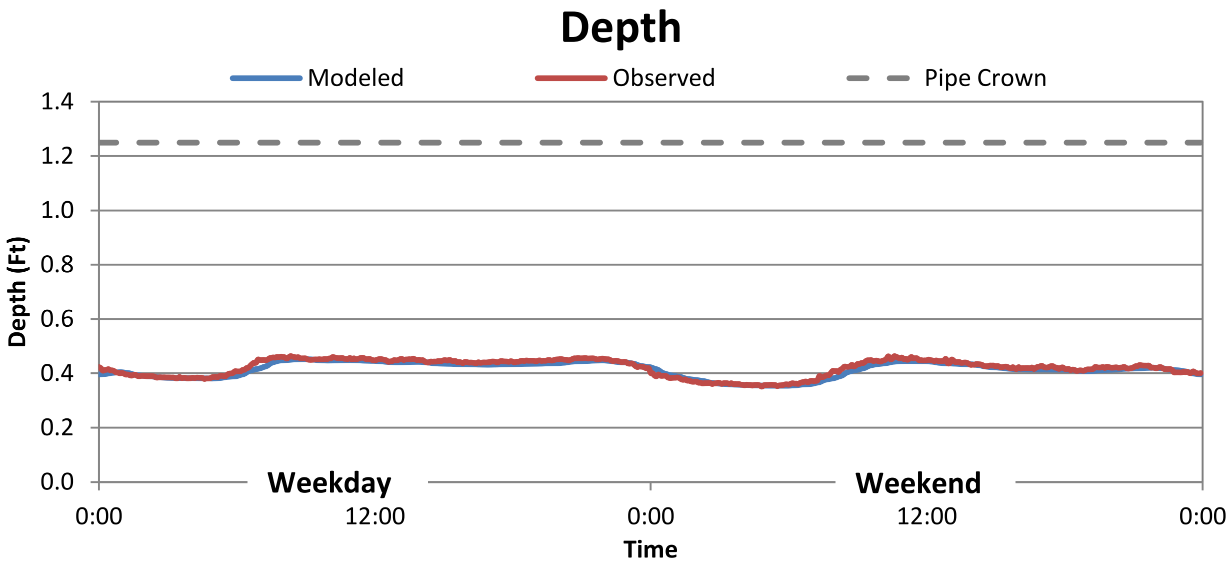

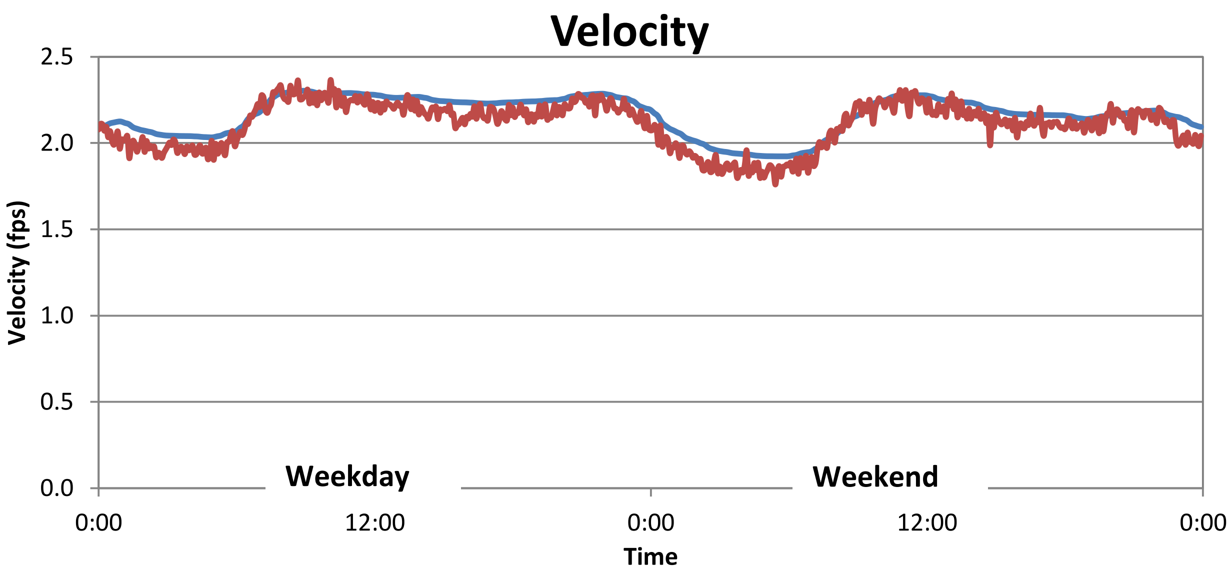

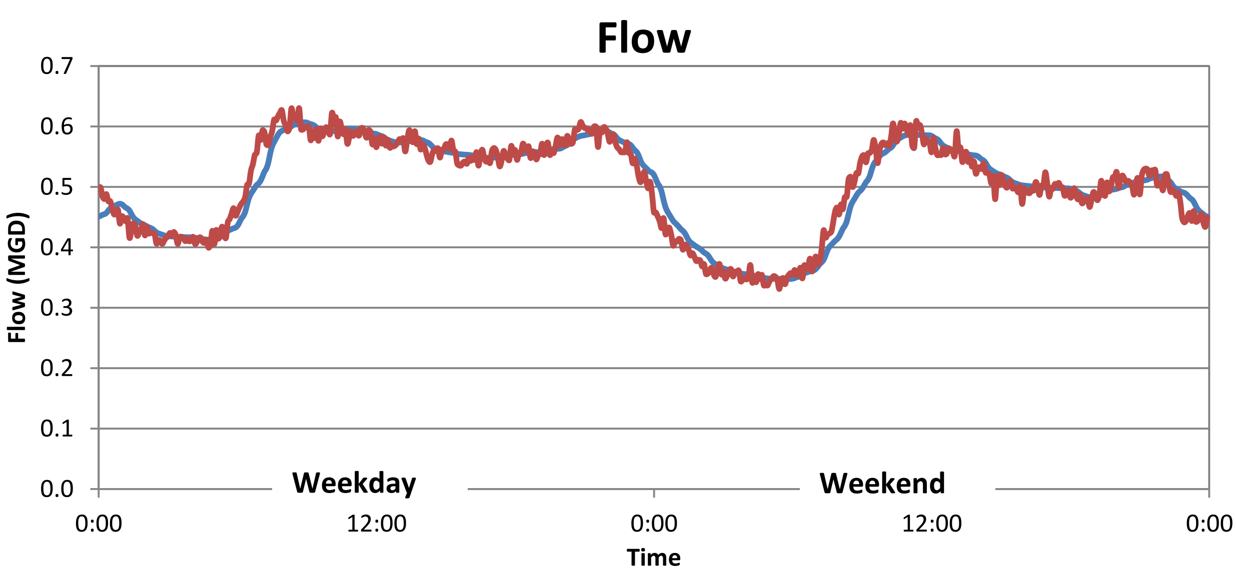

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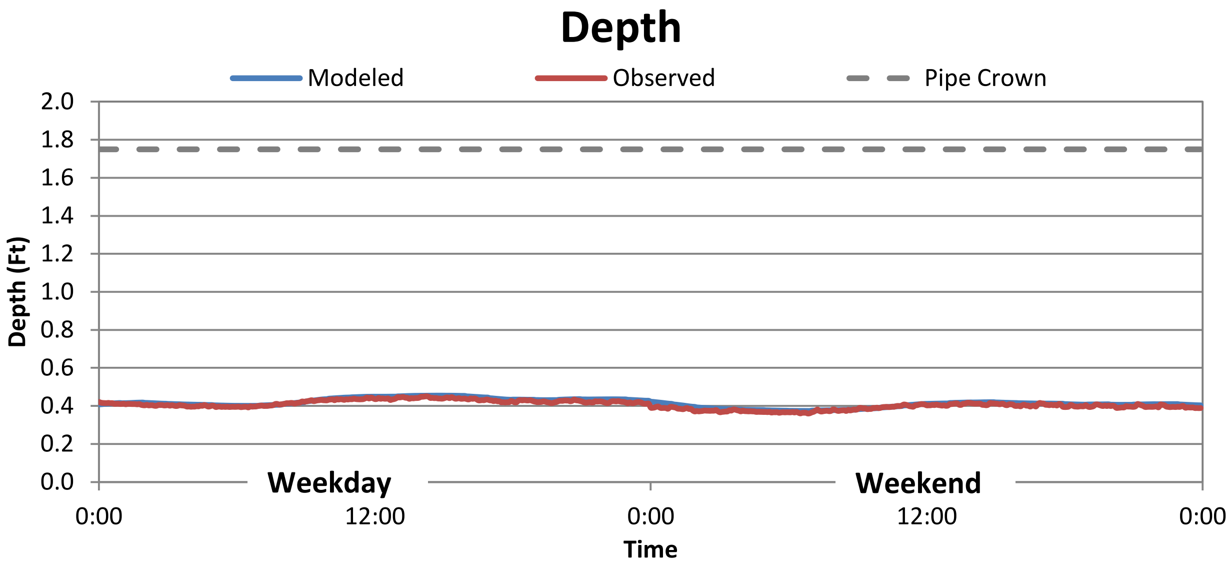
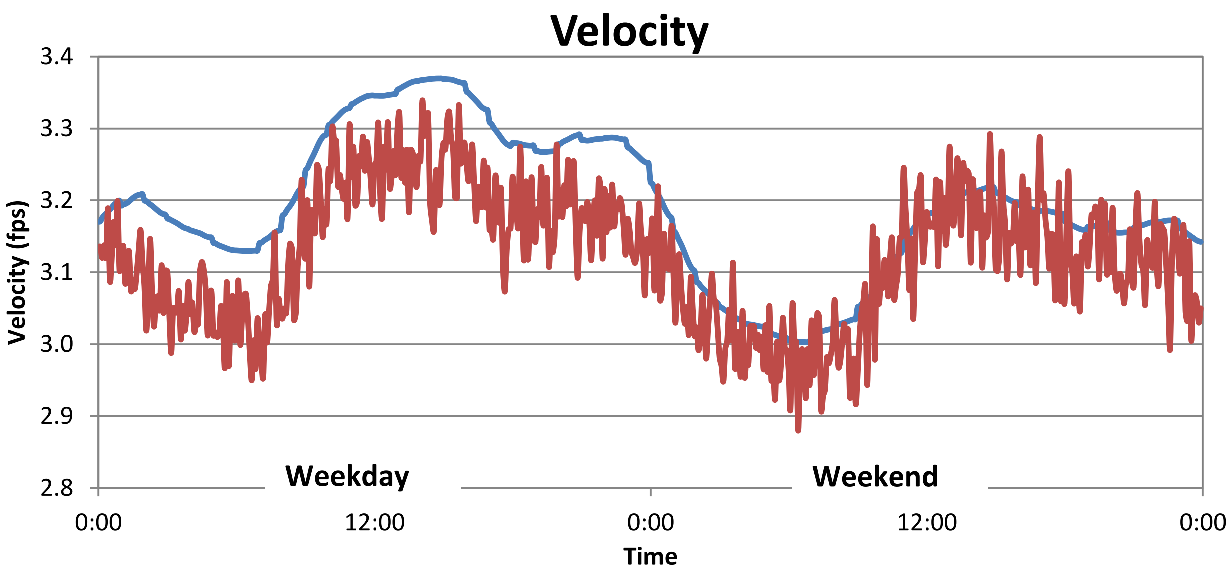
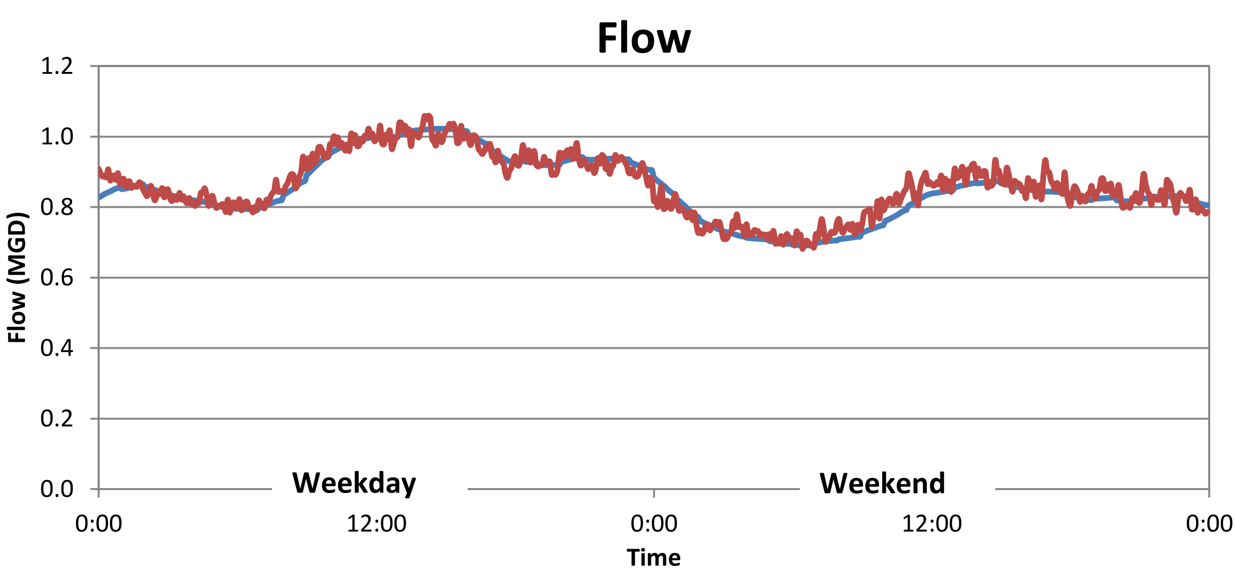
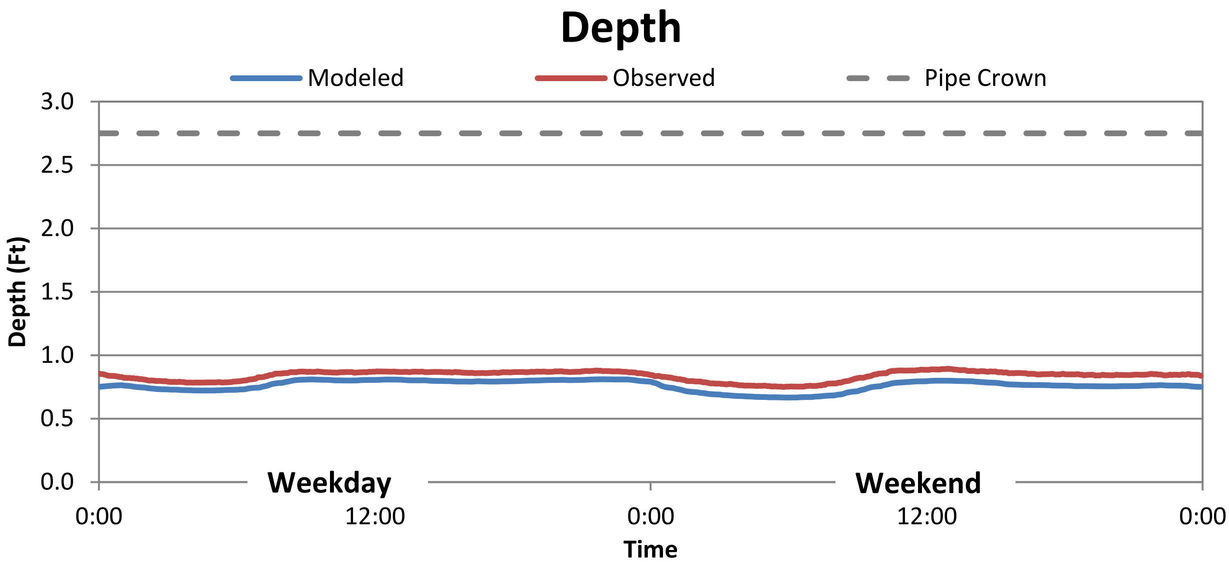
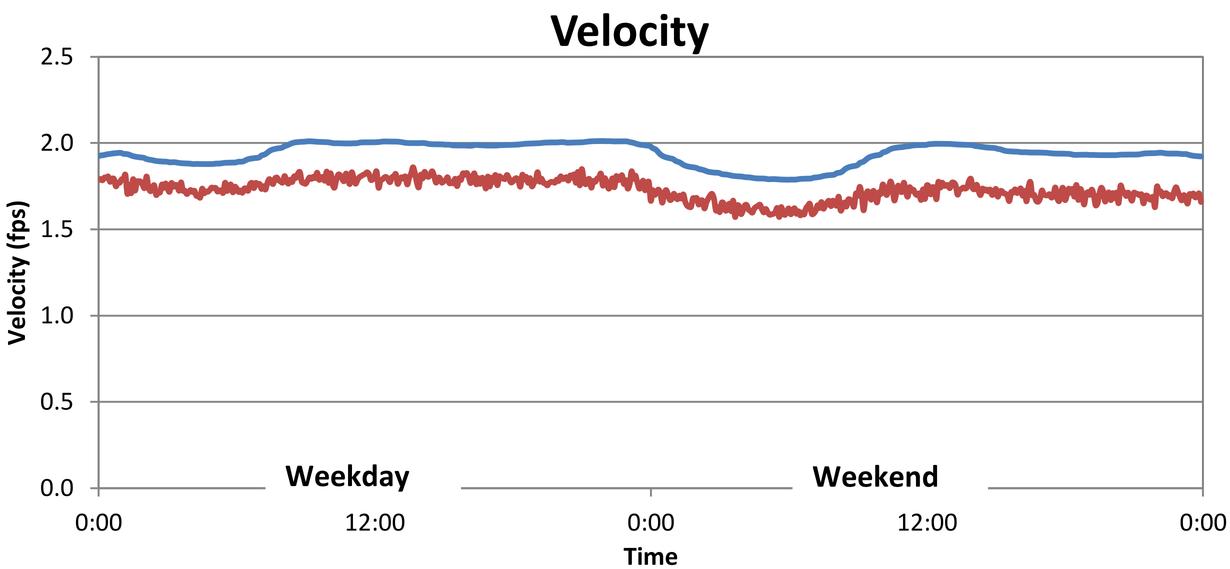


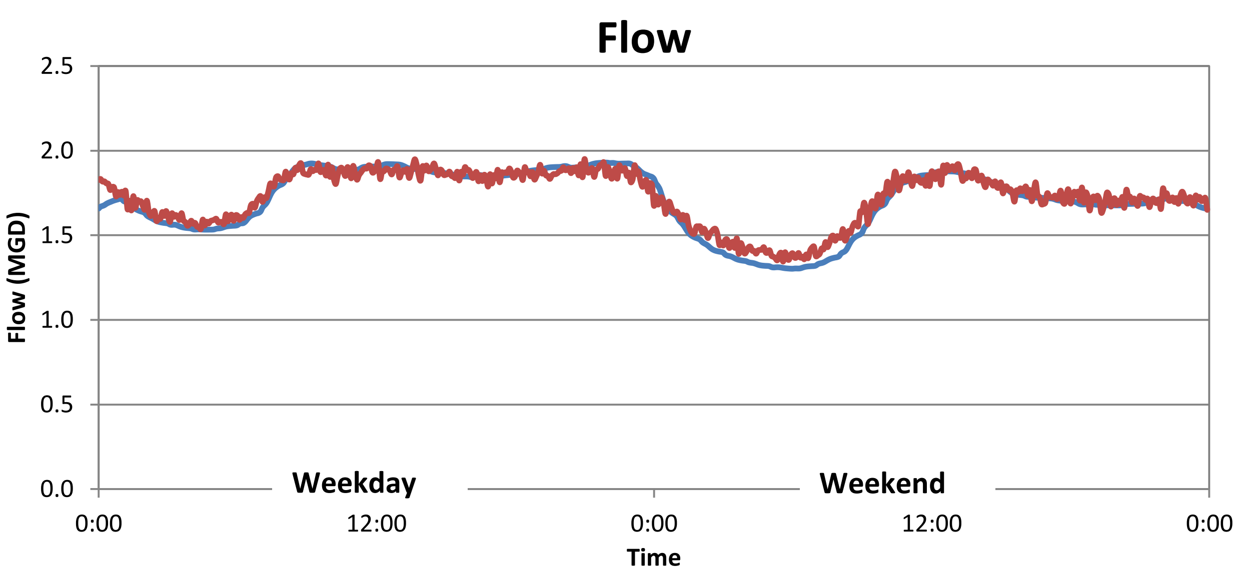




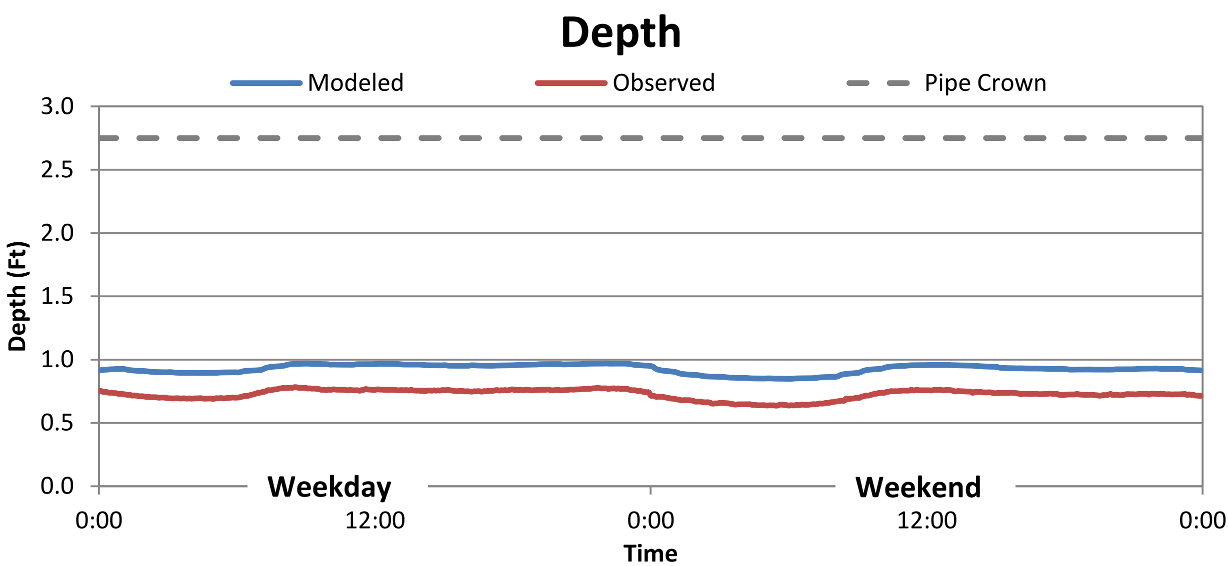
FM-13 DWF Calibration

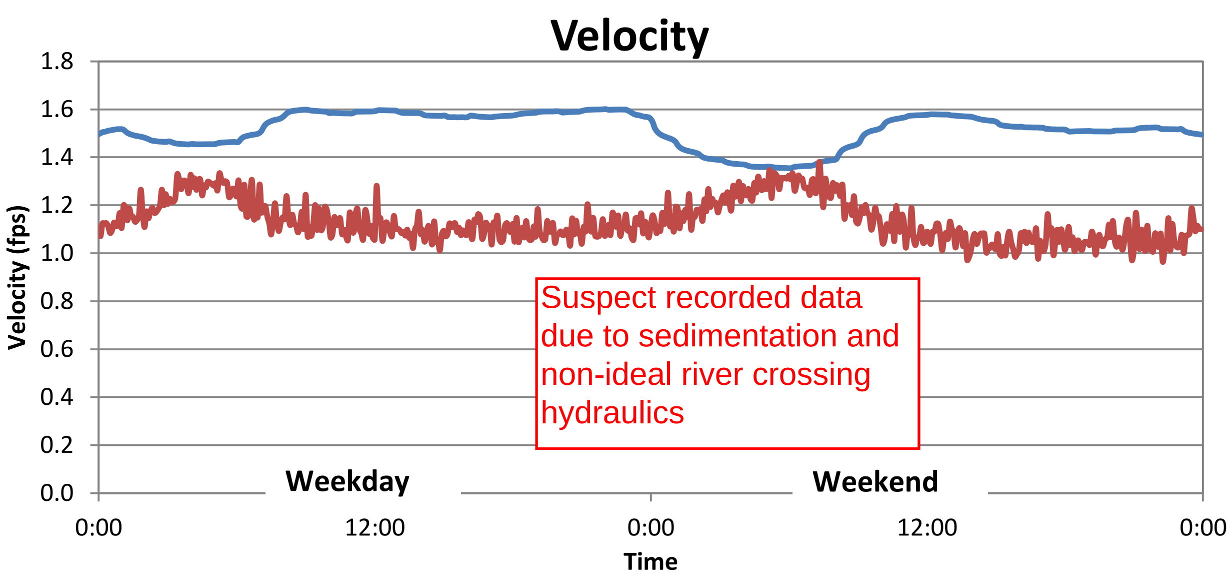


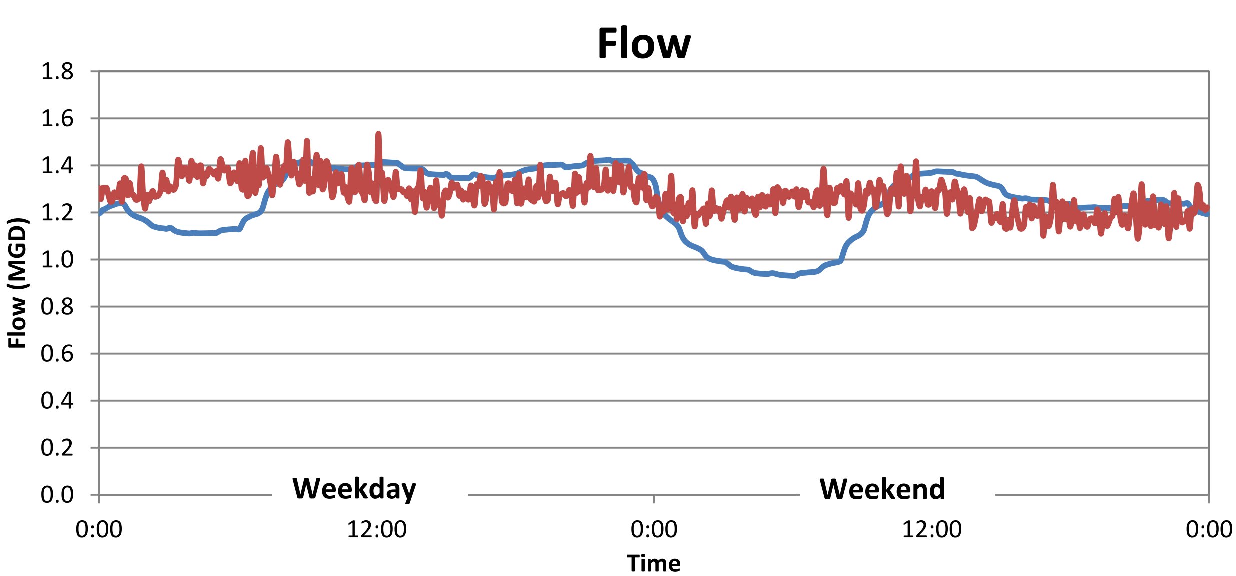




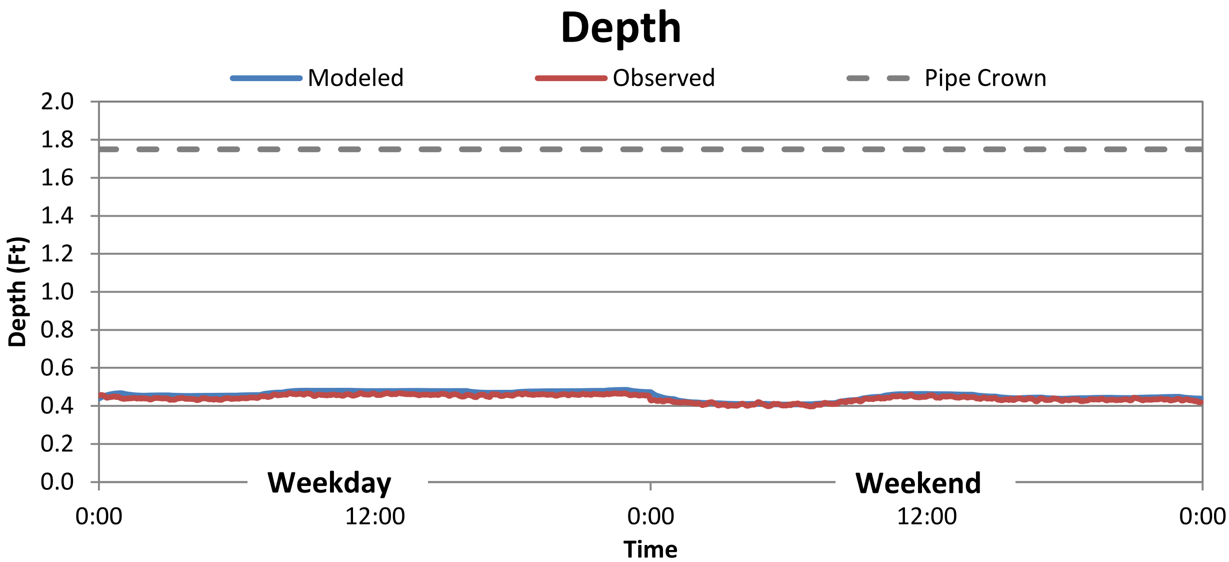
FM-14 DWF Calibration

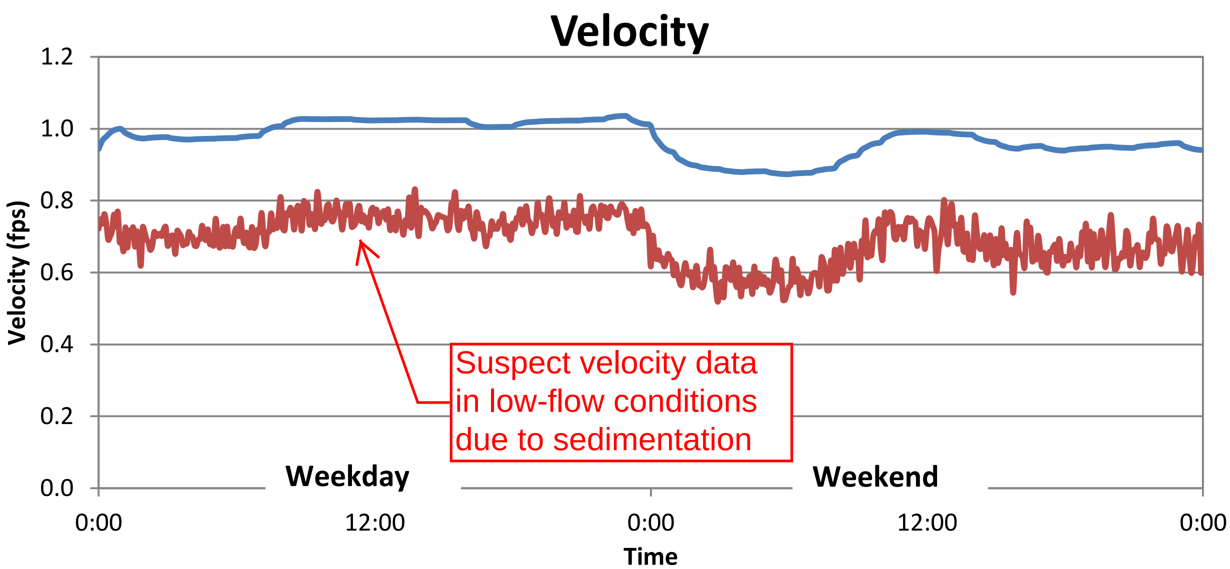


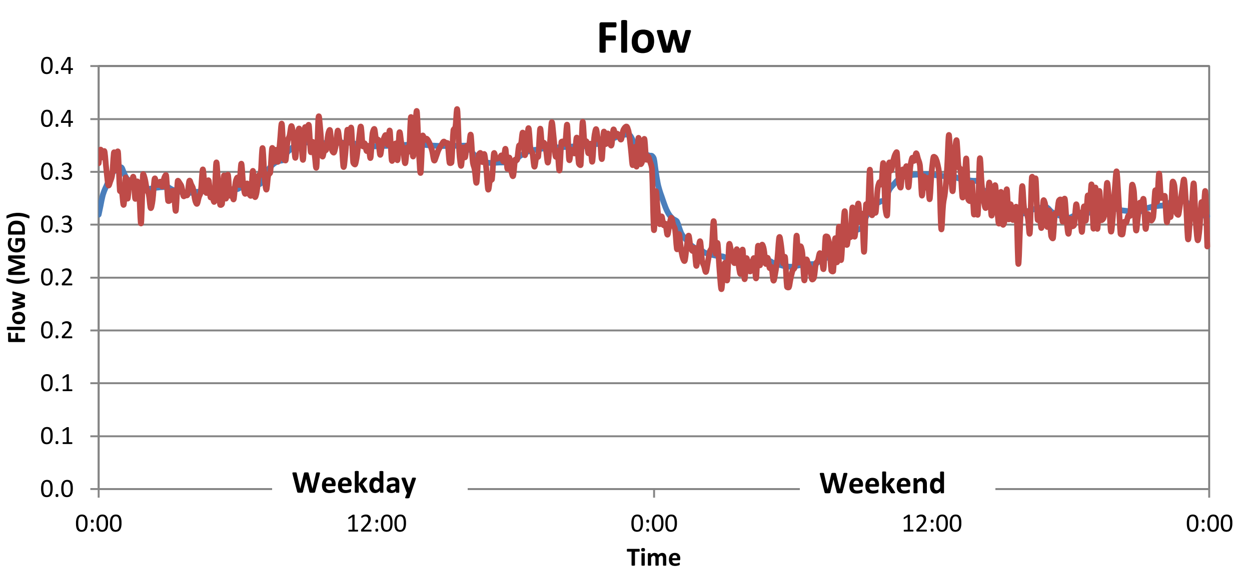




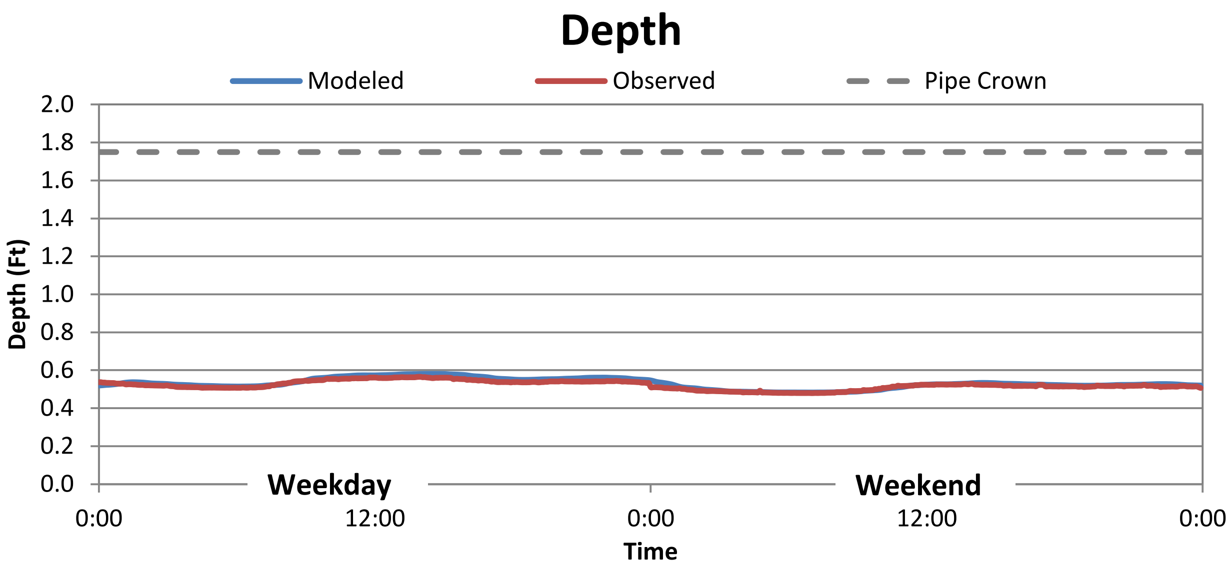
FM-15 DWF Calibration

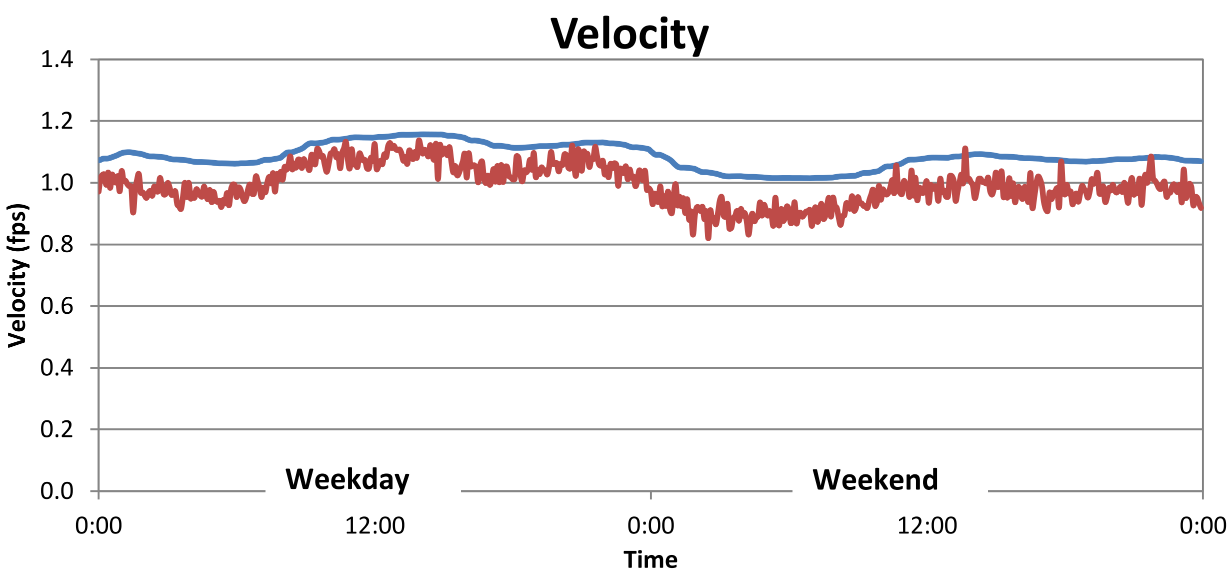


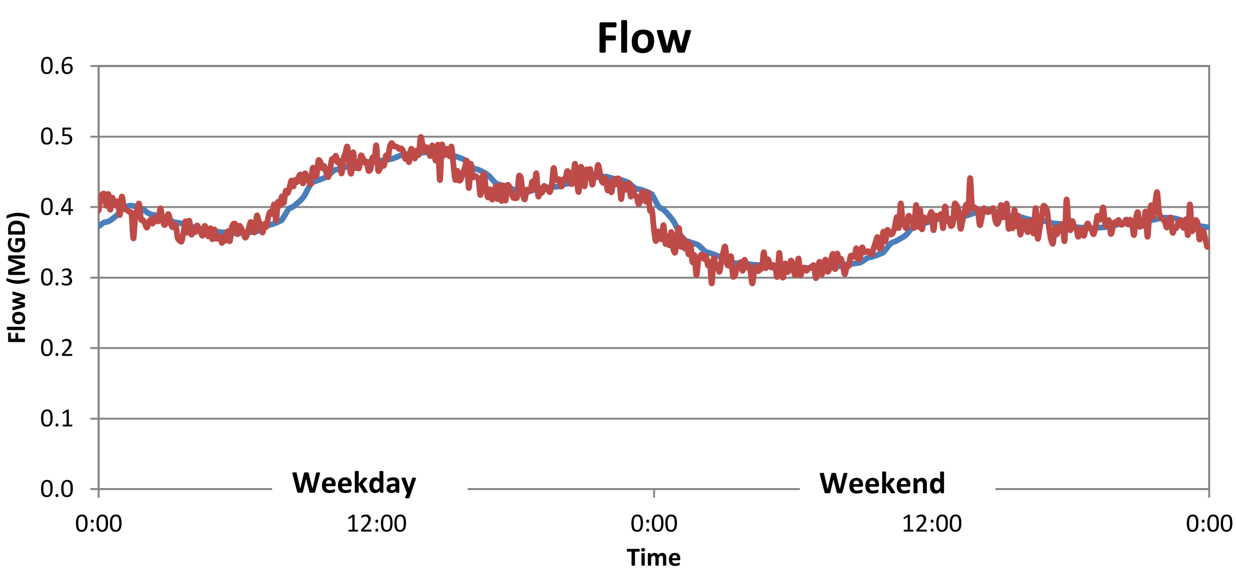




FM-16 DWF Calibration



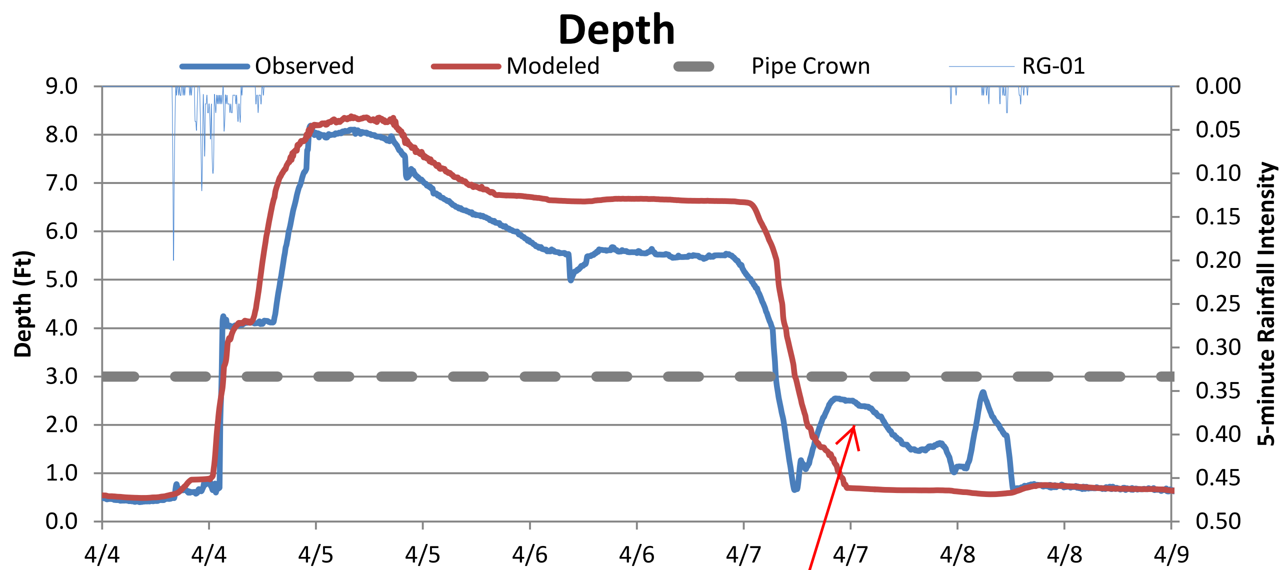


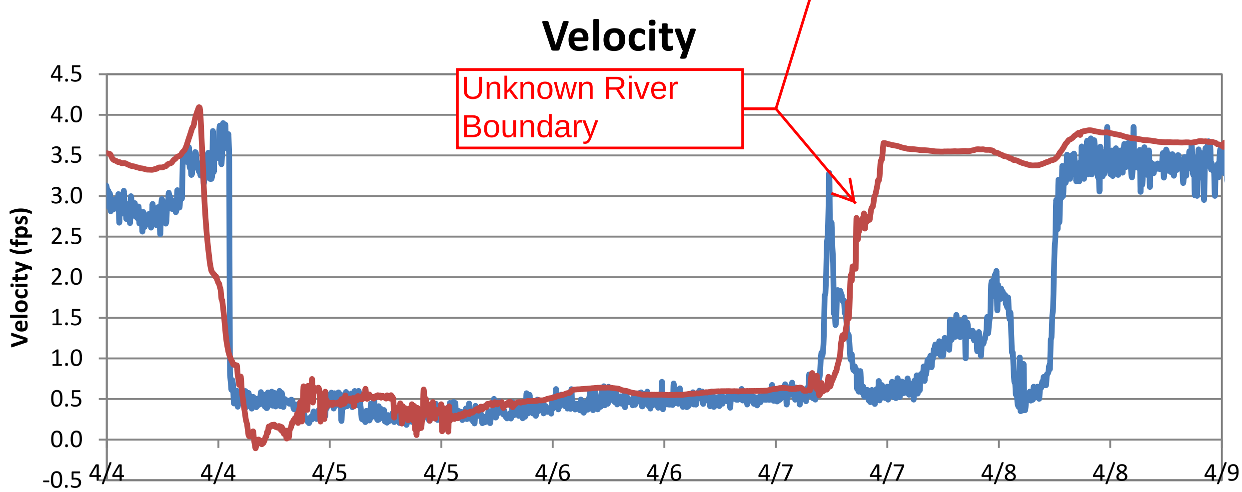


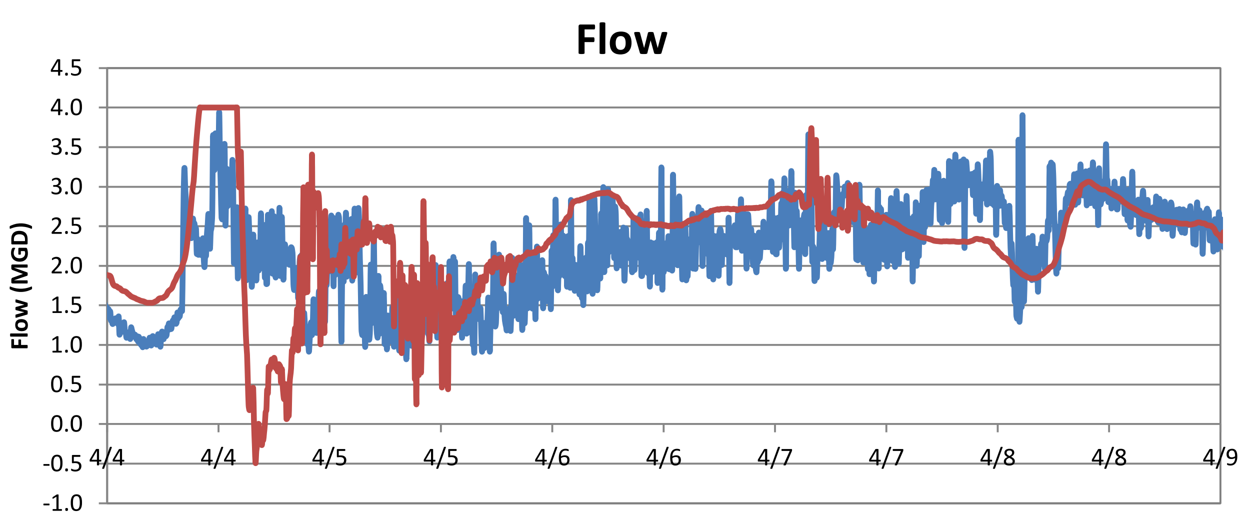
Appendix B

Wet Weather Flow Calibration Plots – Event 1

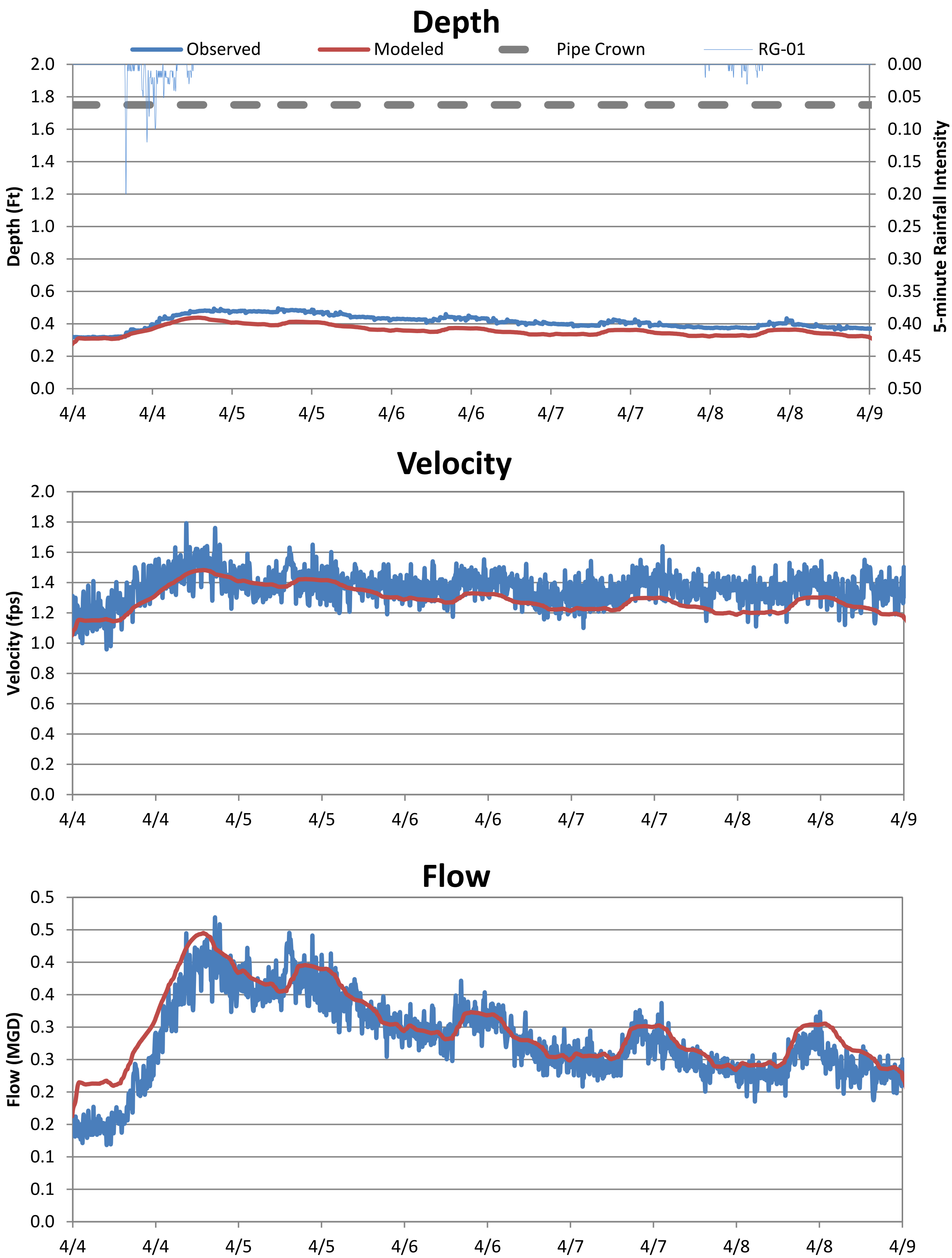
FM-01 WWF Event 1 Calibration



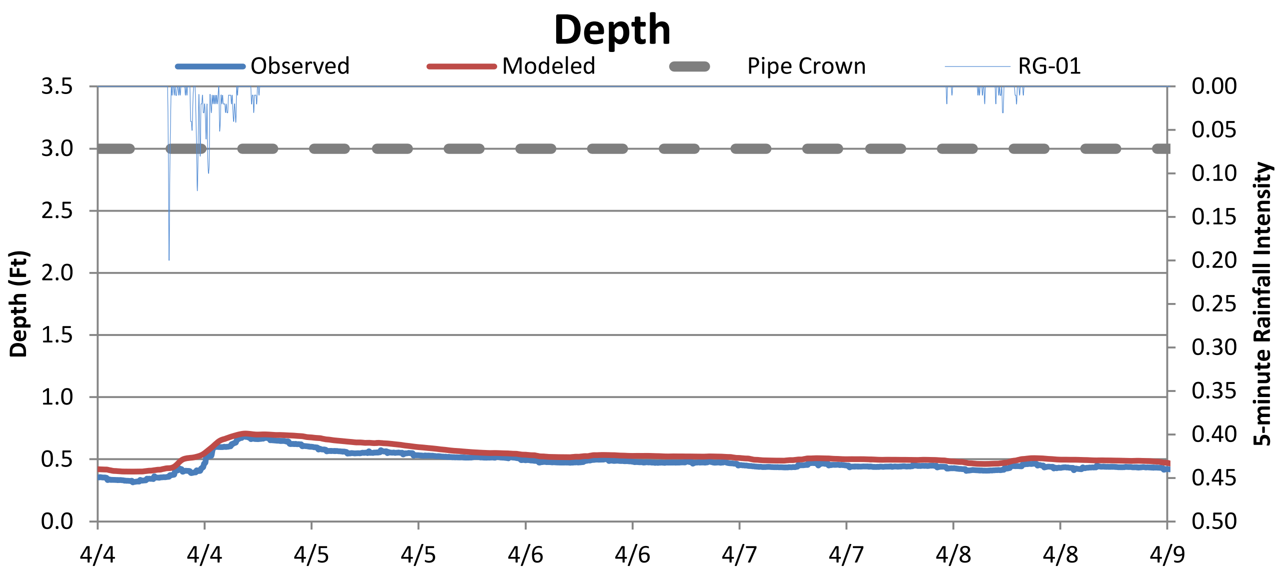


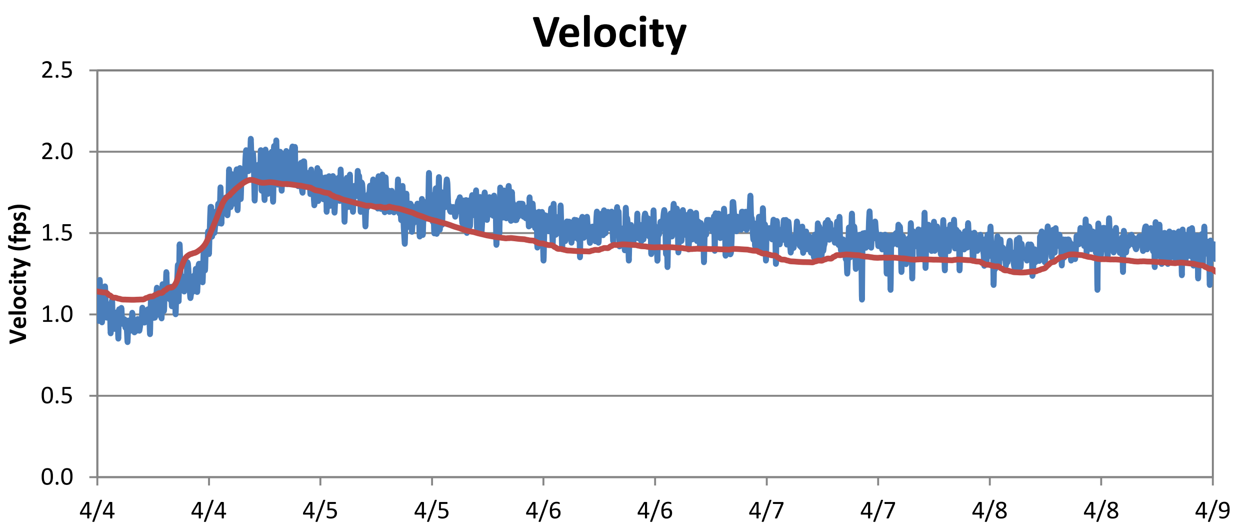


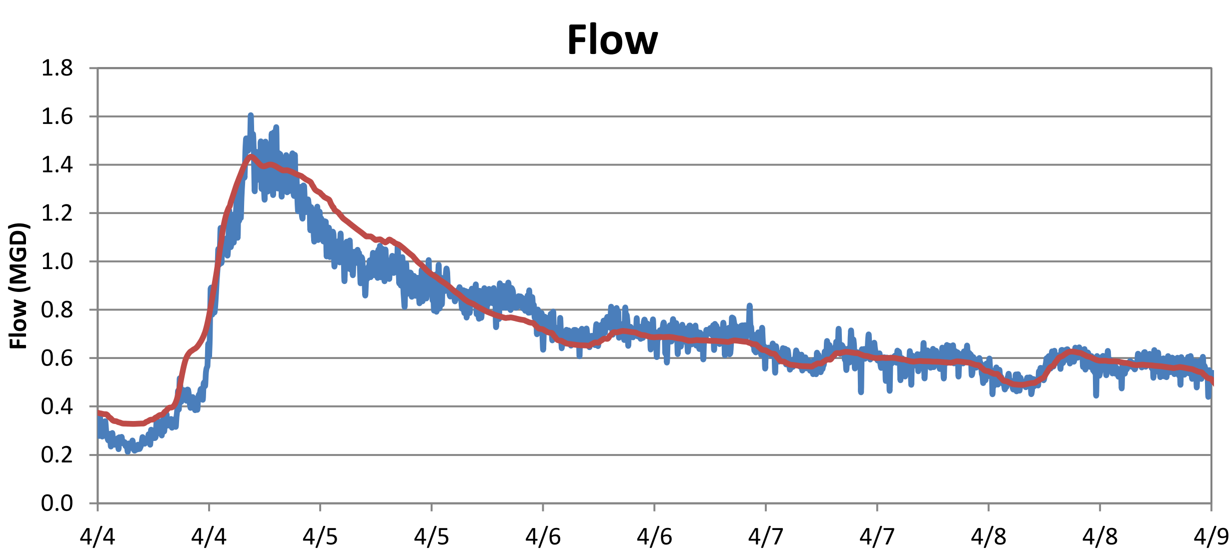
FM-02 WWF Event 1 Calibration



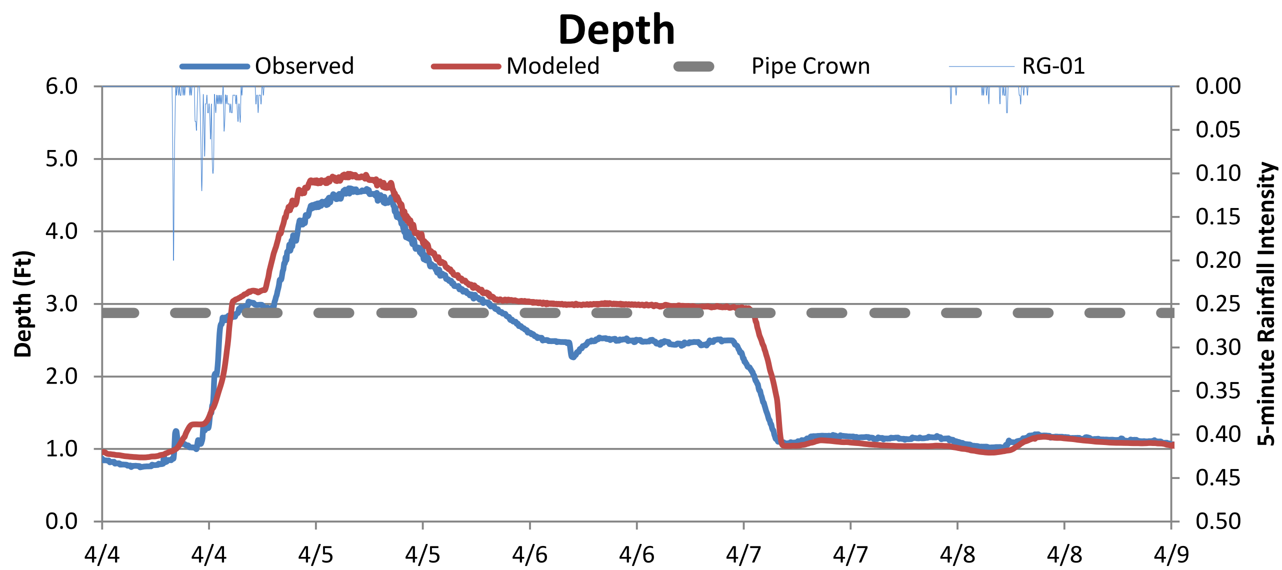
FM-03 WWF Event 1 Calibration

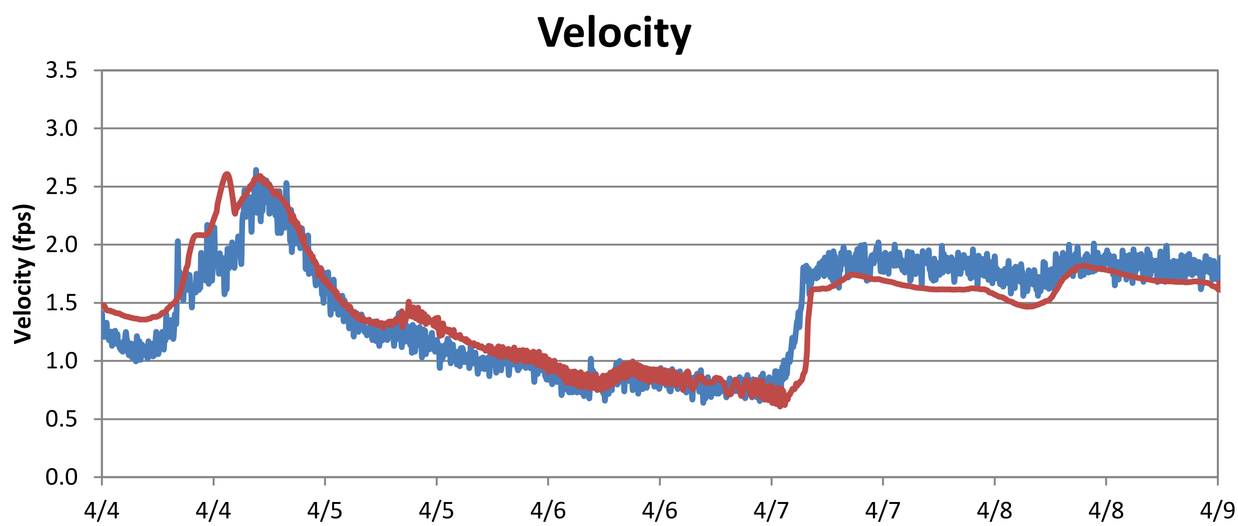


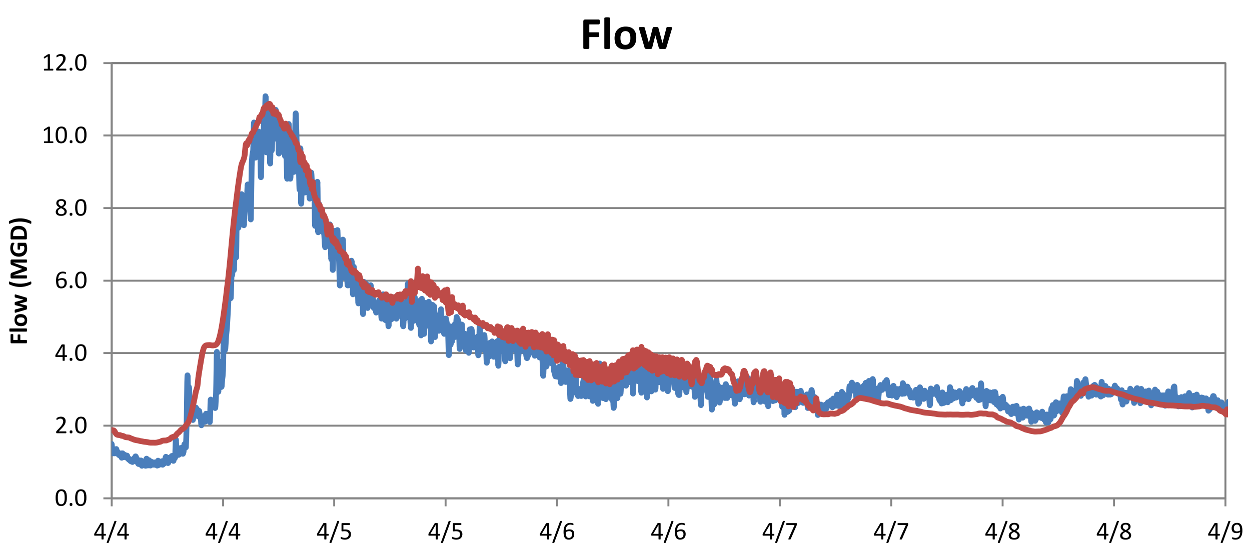




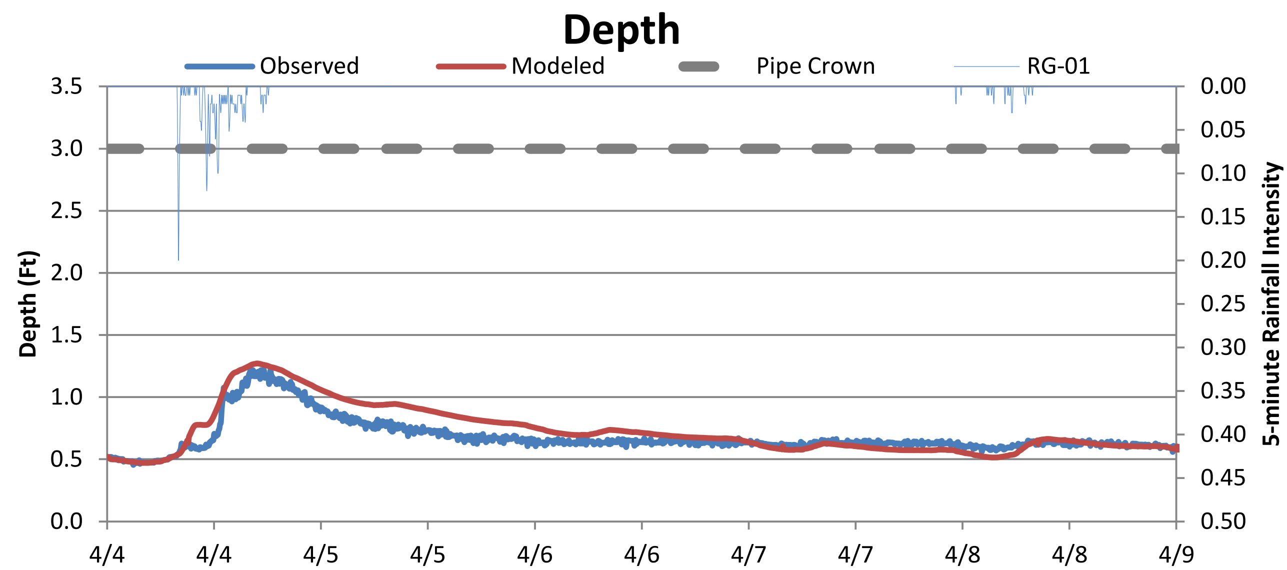
FM-04 WWF Event 1 Calibration

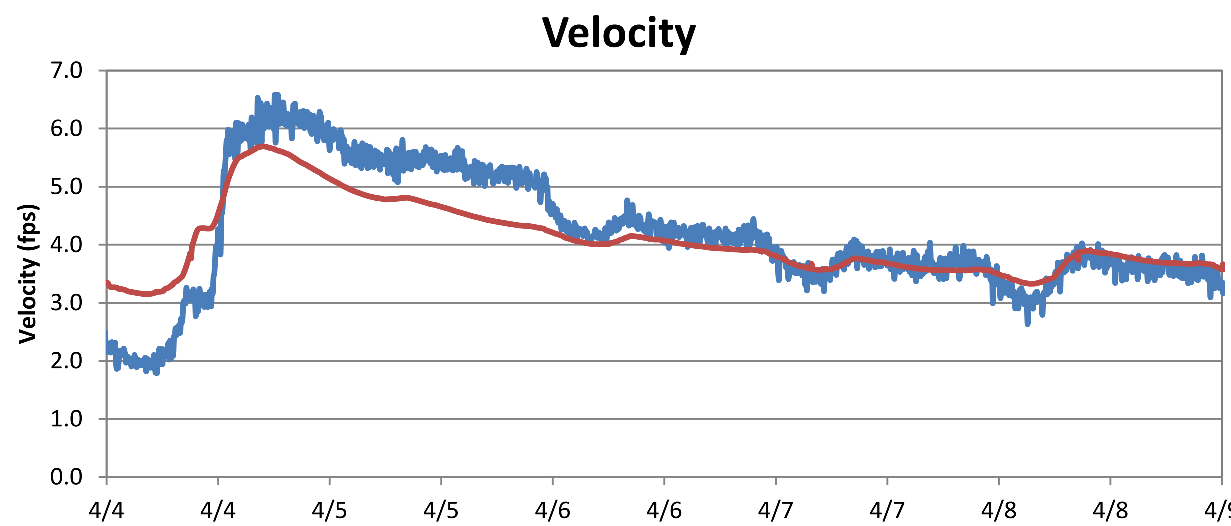


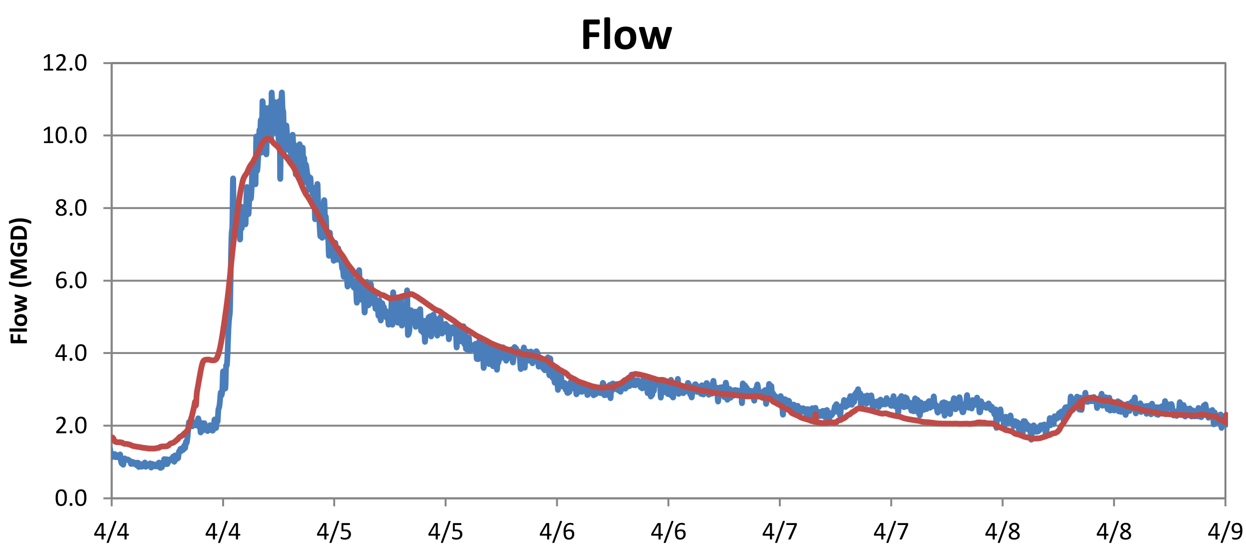




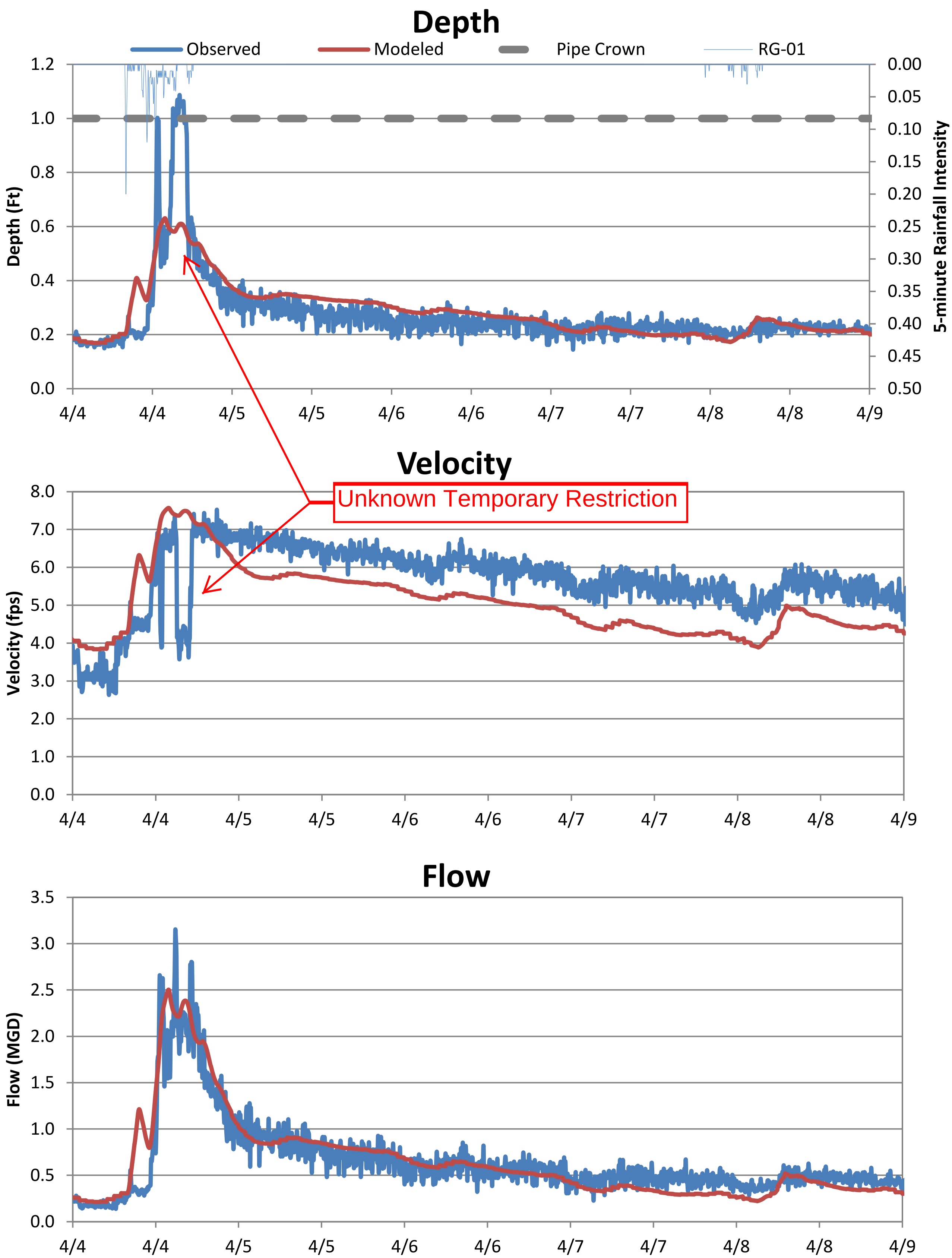
FM-05 WWF Event 1 Calibration



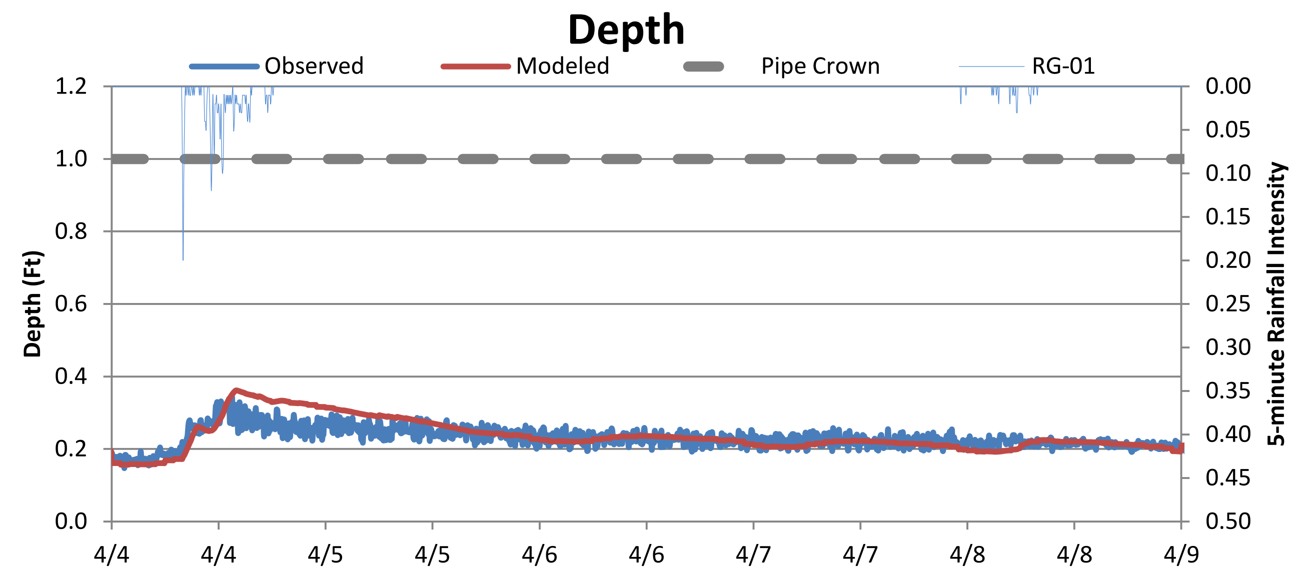


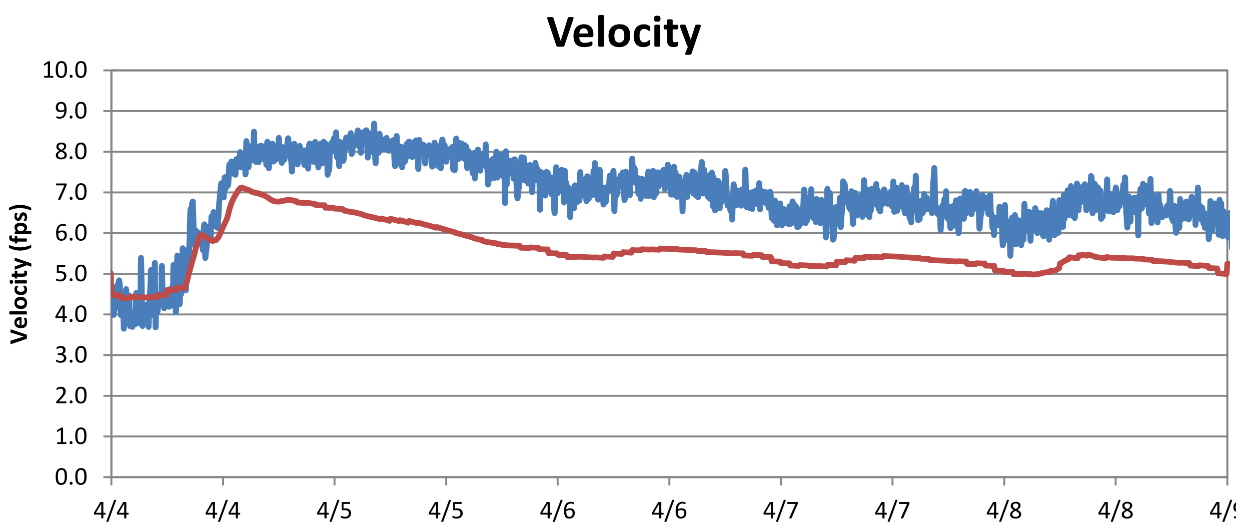


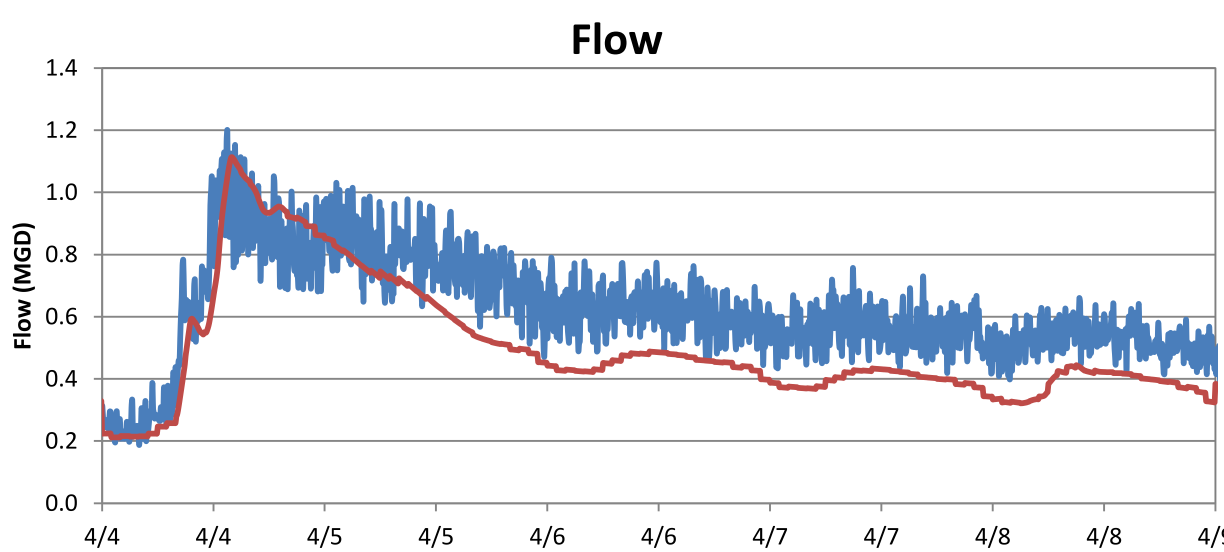
FM-06 WWF Event 1 Calibration



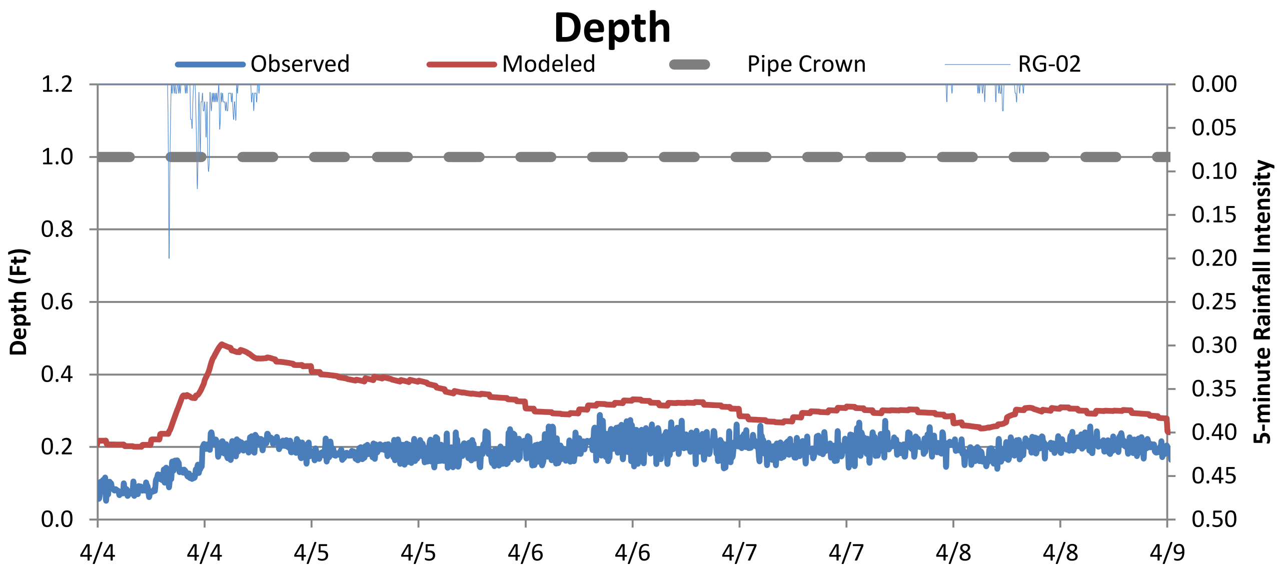
FM-07 WWF Event 1 Calibration

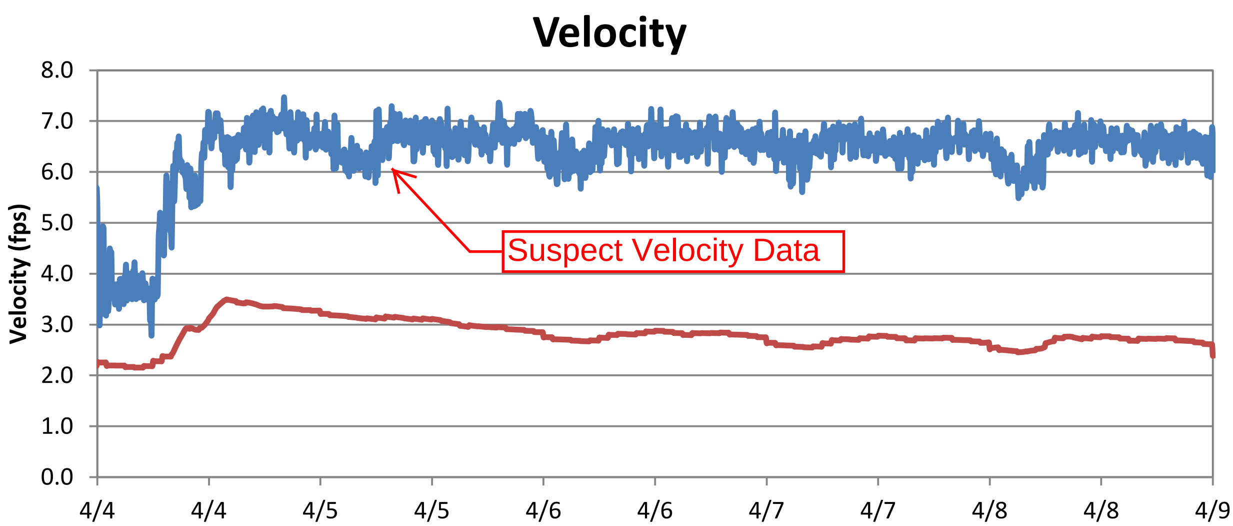


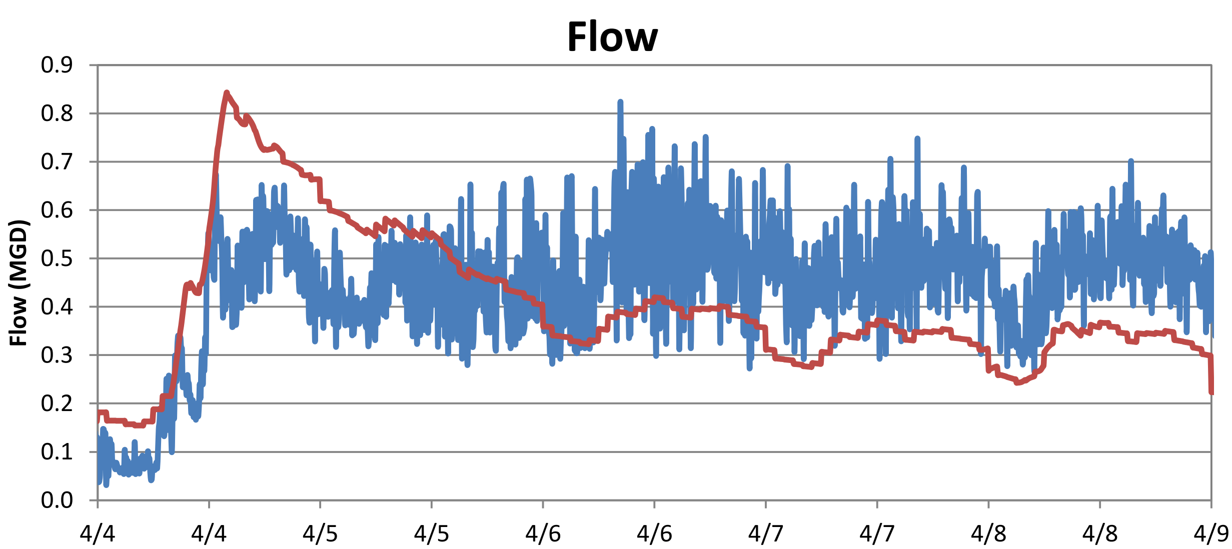




FM-08 WWF Event 1 Calibration

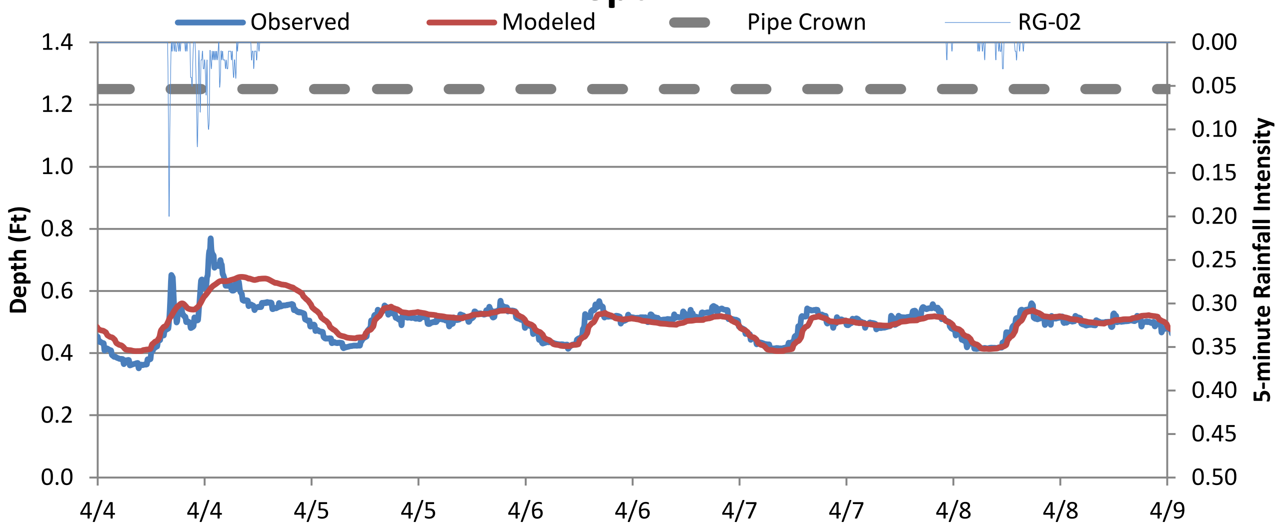




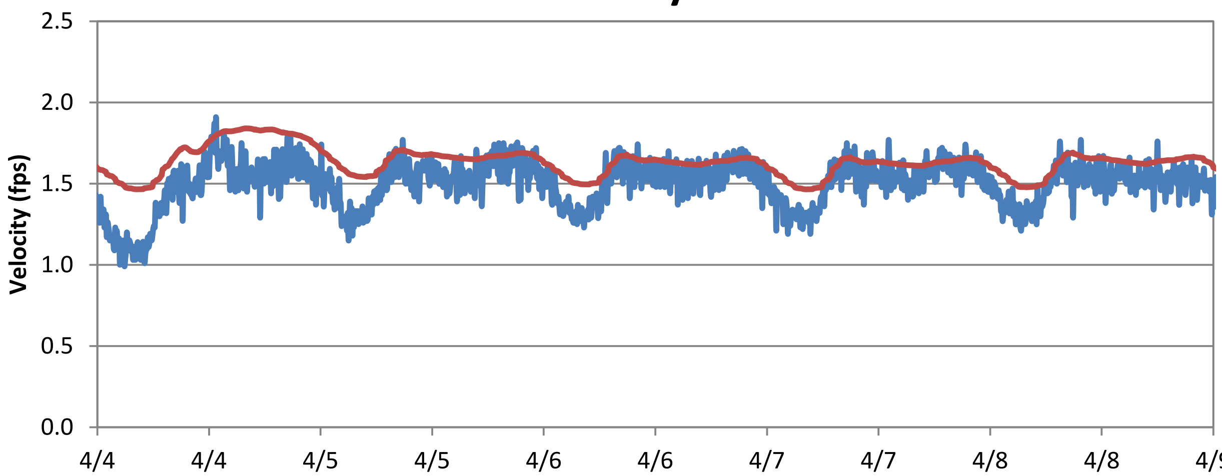


FM-09 WWF Event 1 Calibration

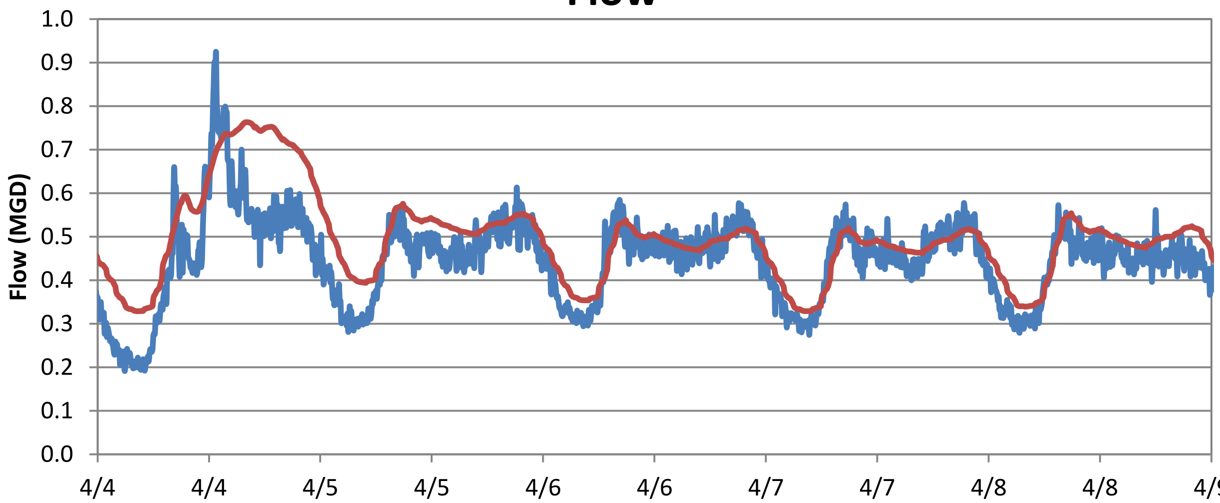
Depth



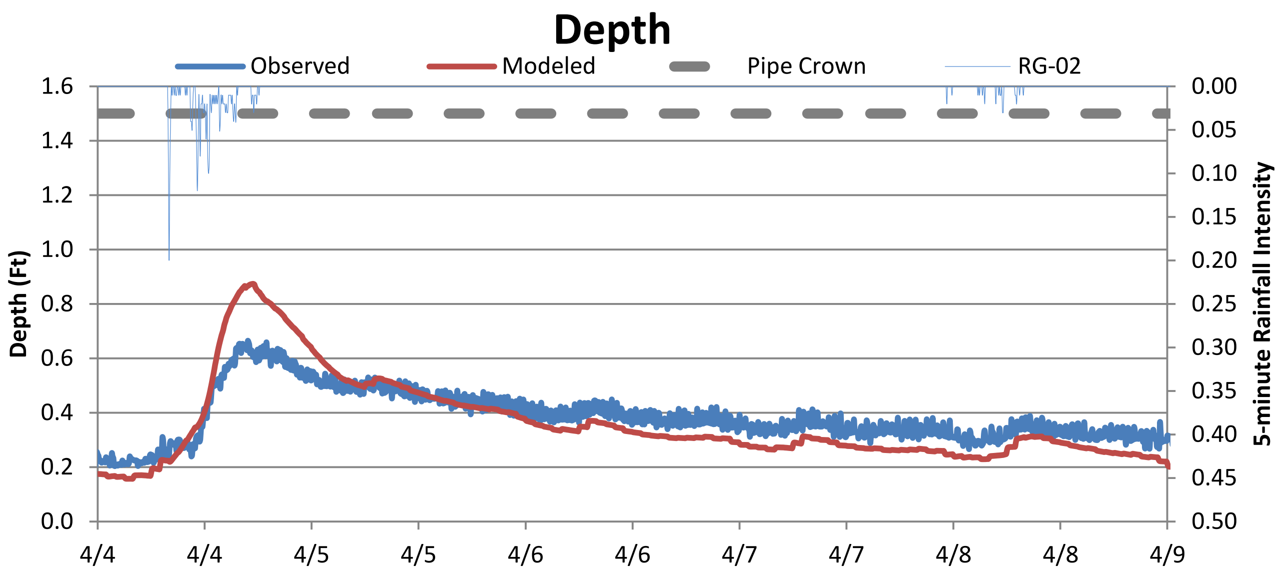
Velocity

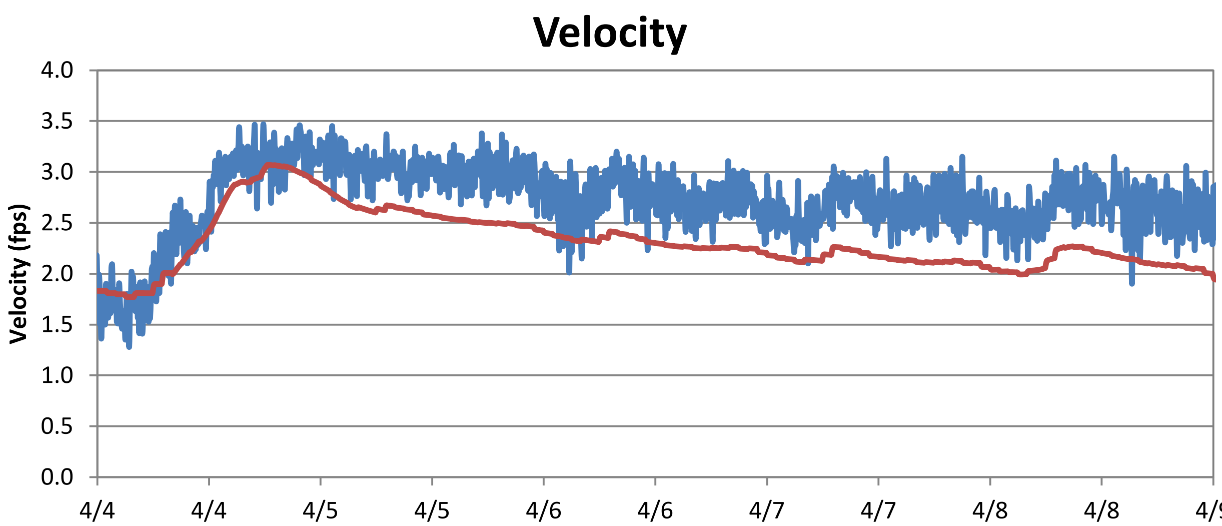


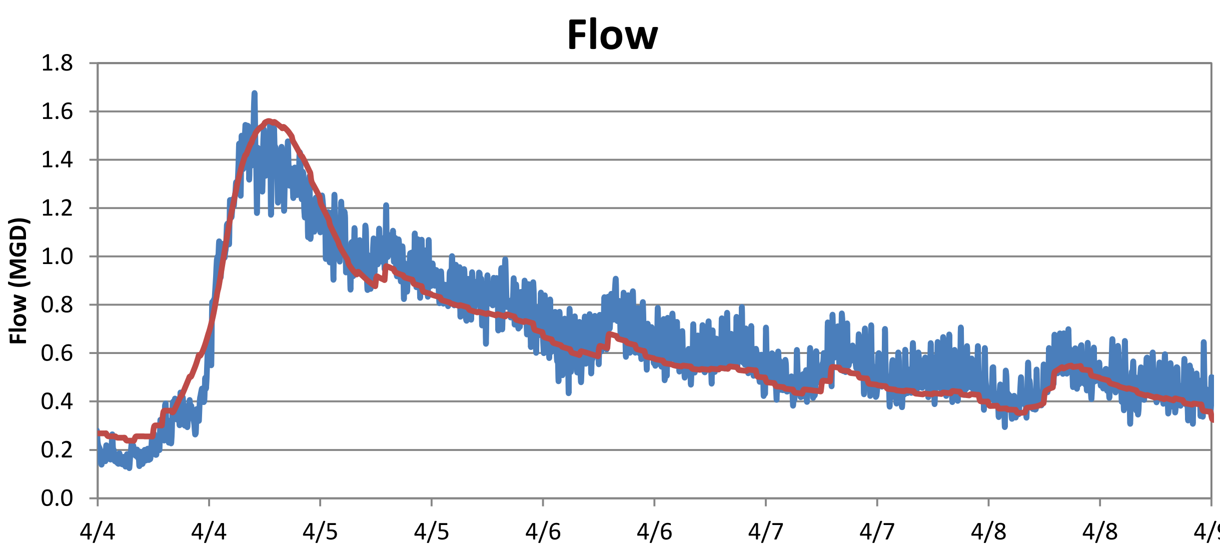
Flow



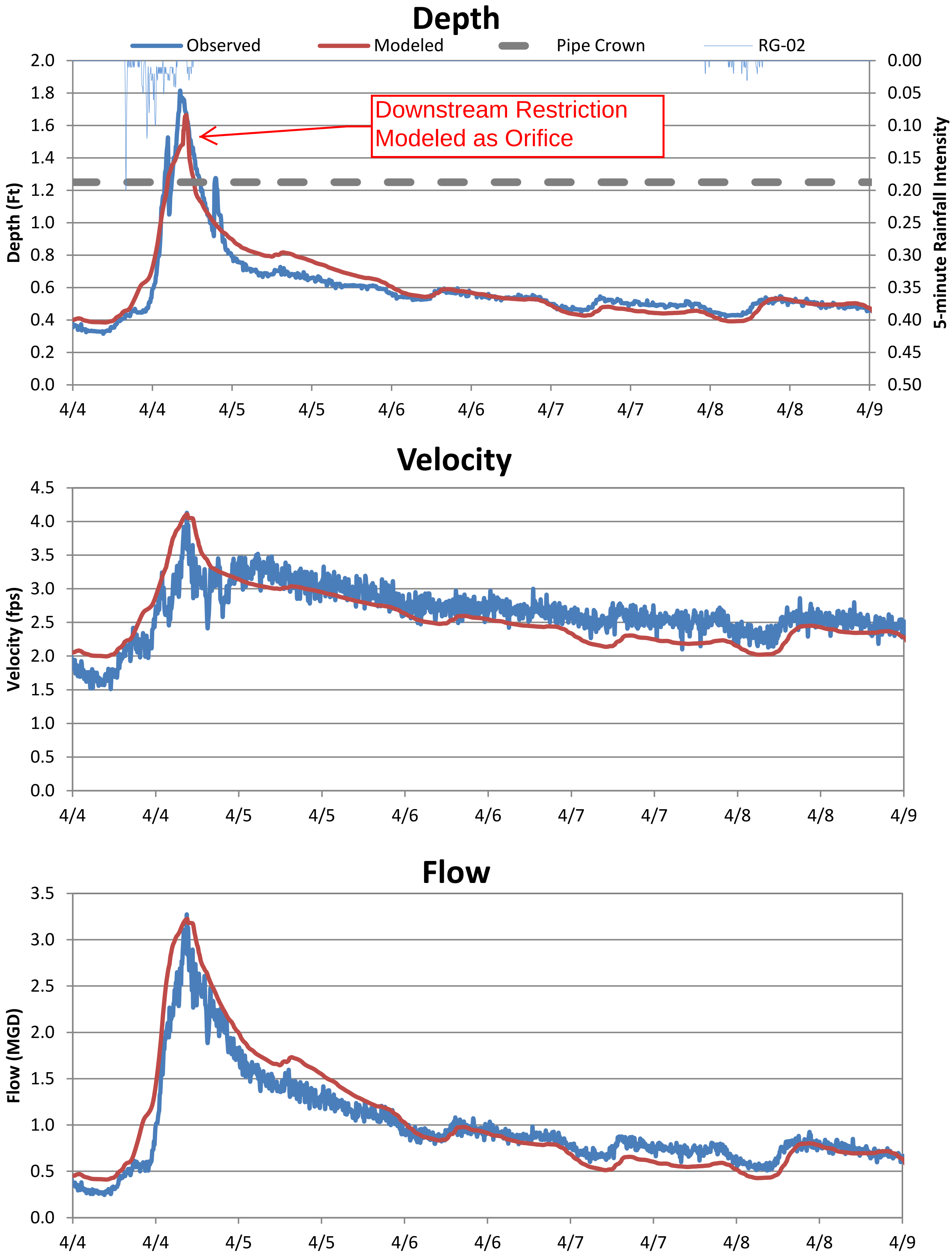
FM-10 WWF Event 1 Calibration



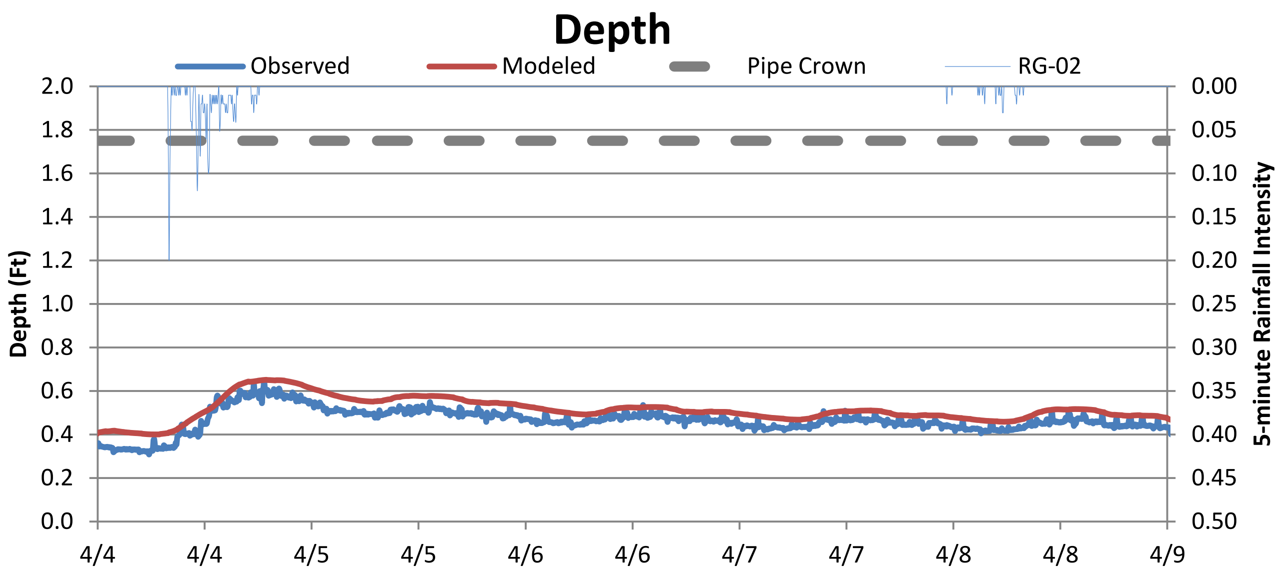


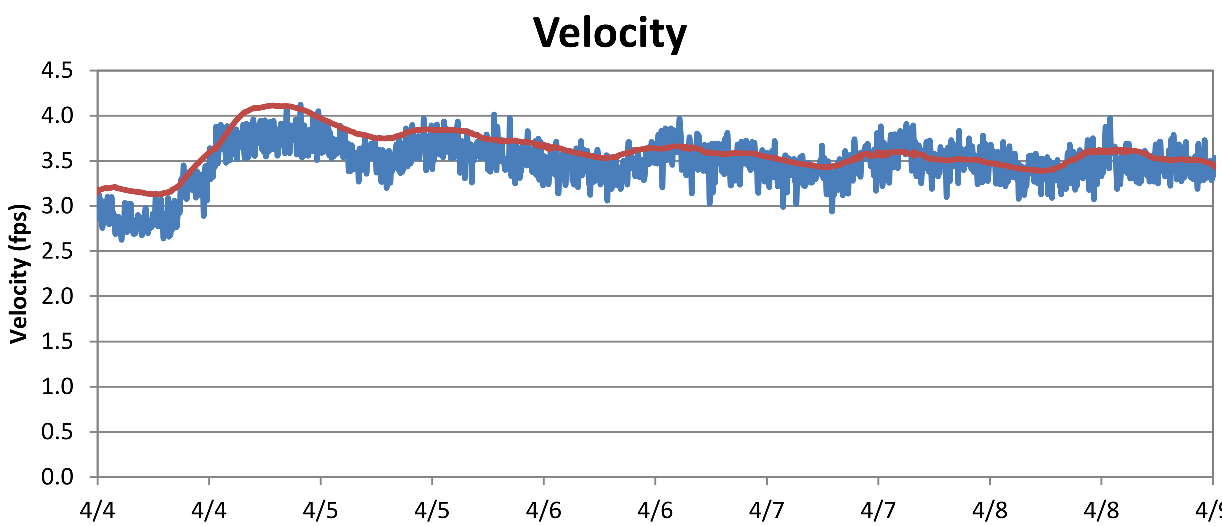


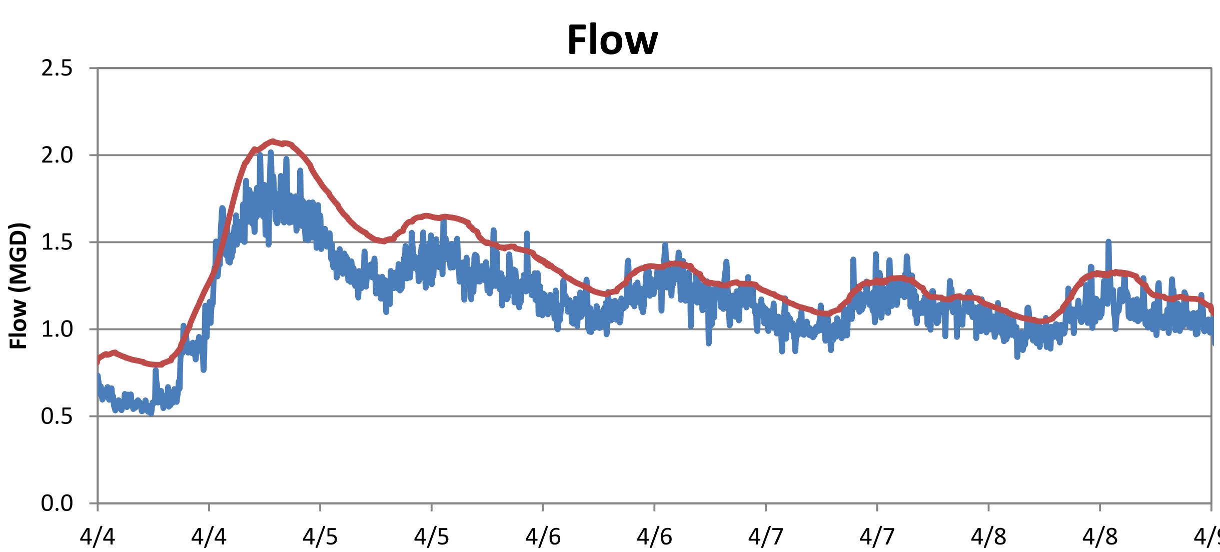
FM-11 WWF Event 1 Calibration



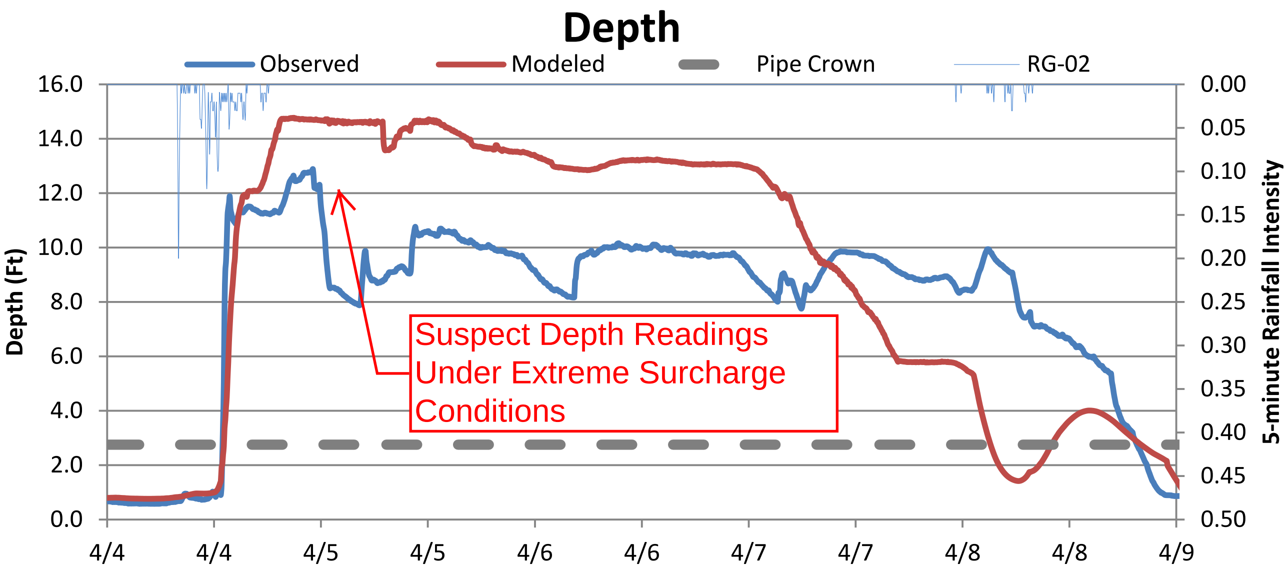
FM-12 WWF Event 1 Calibration

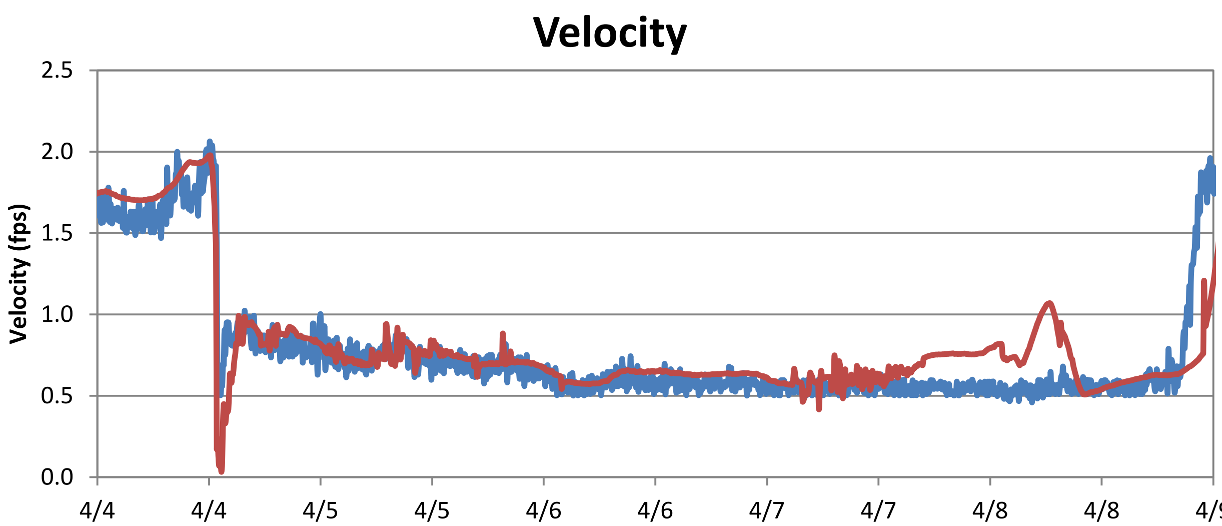


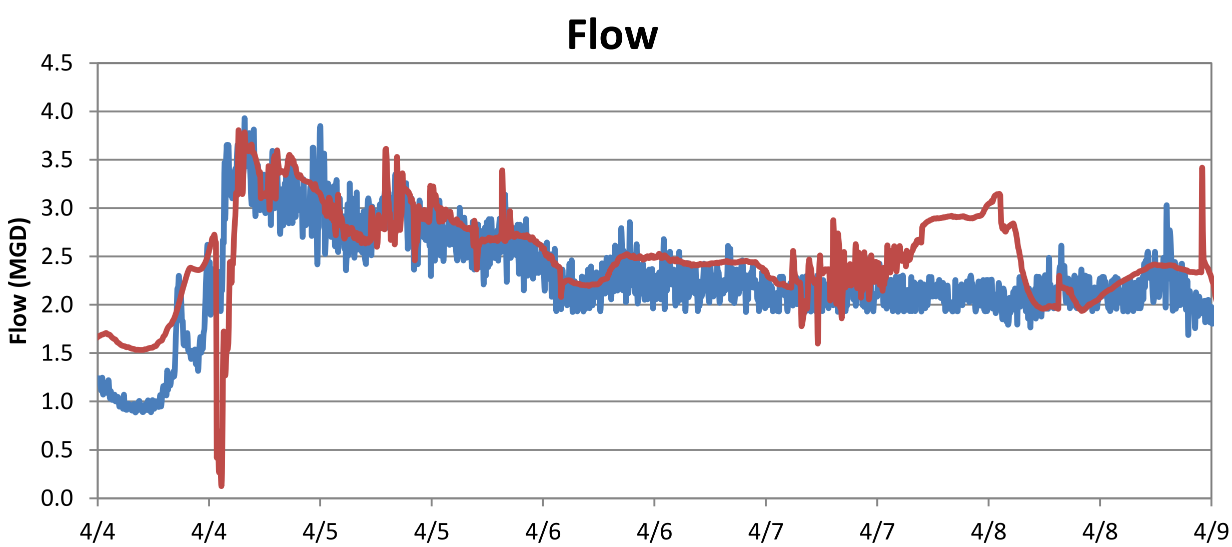




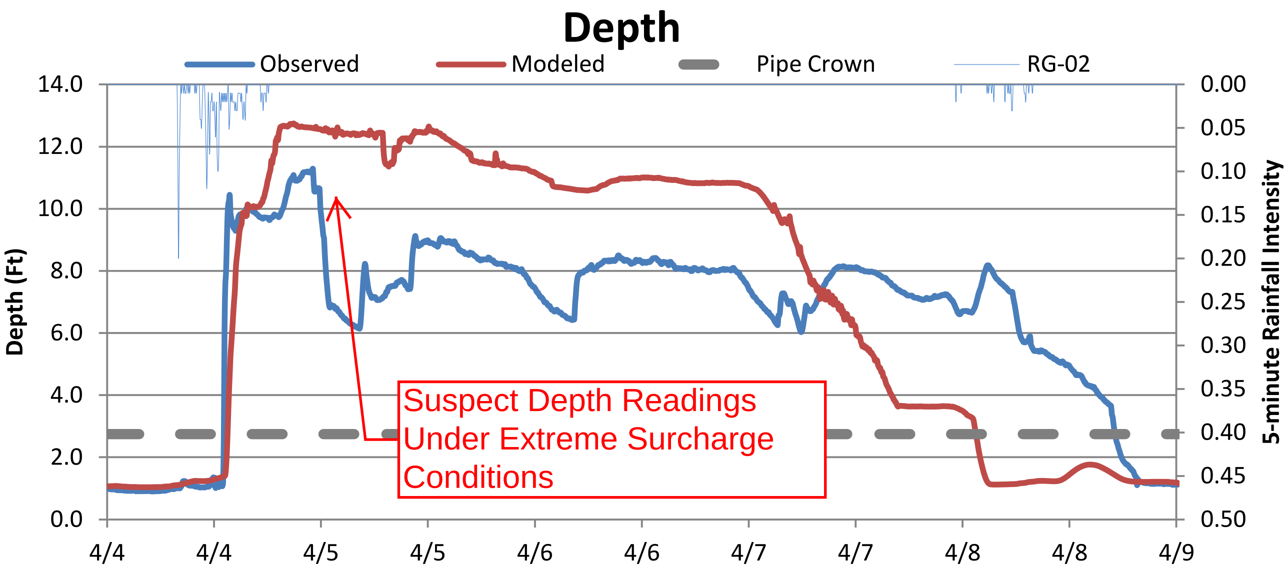
FM-13 WWF Event 1 Calibration

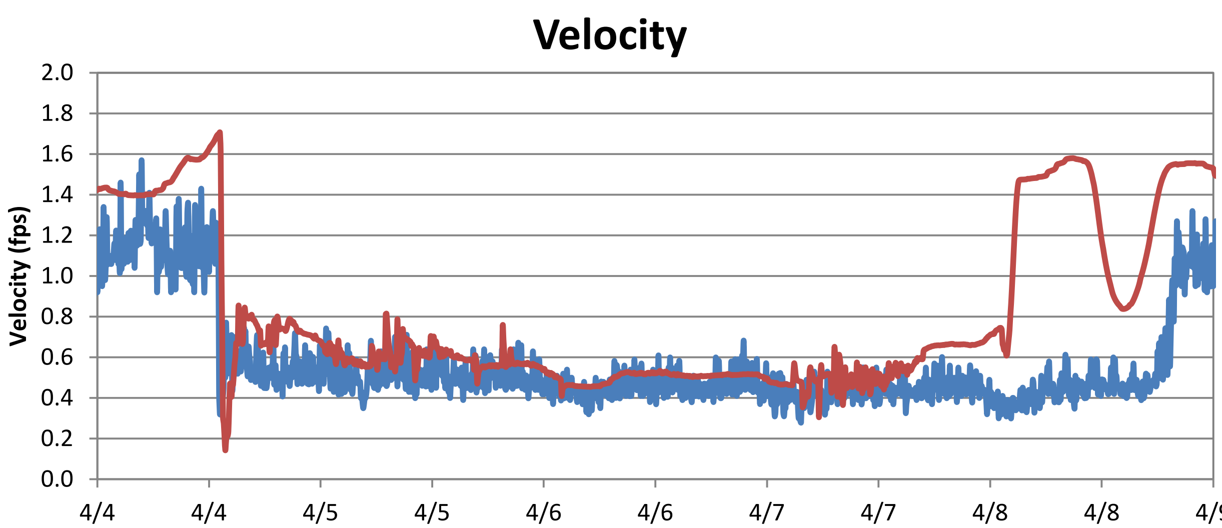


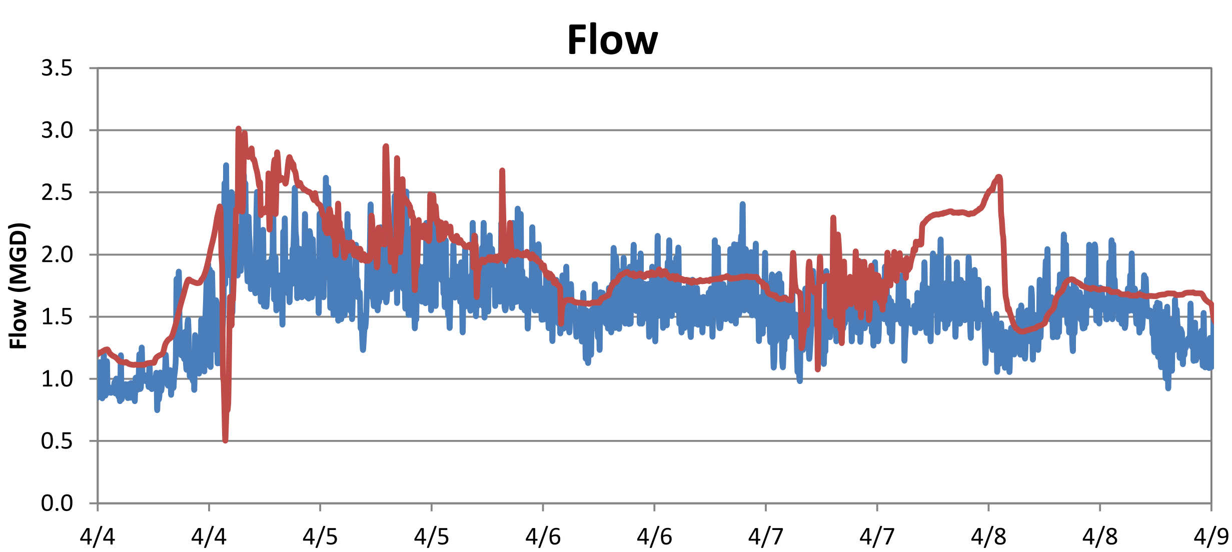




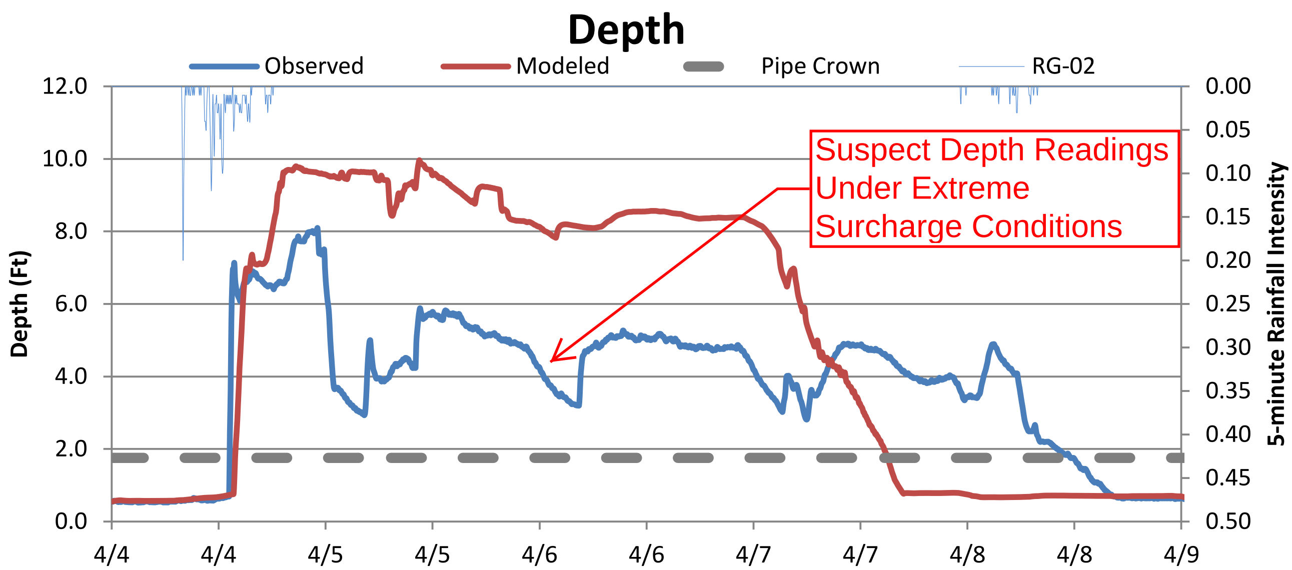
FM-14 WWF Event 1 Calibration

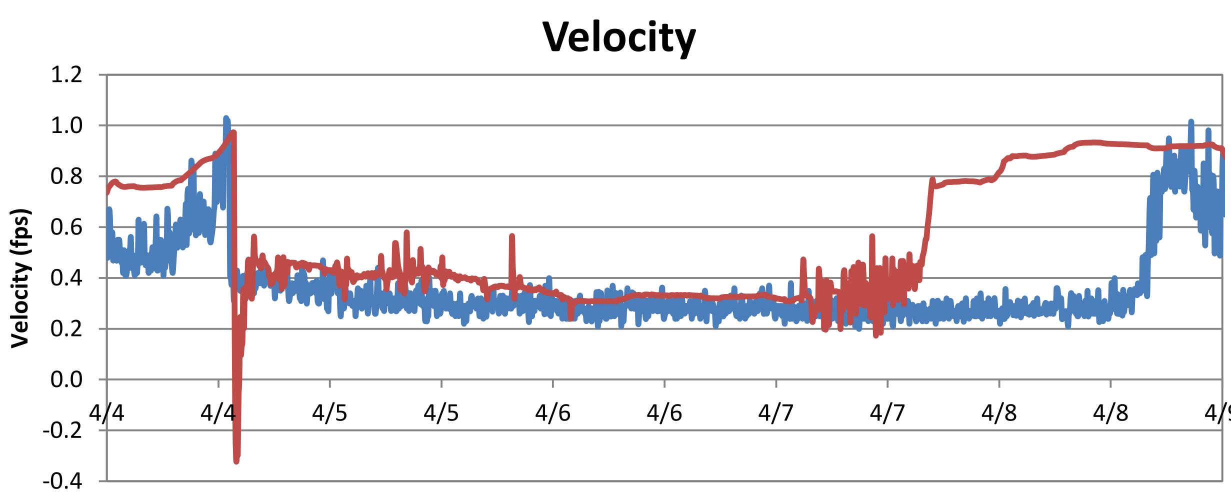


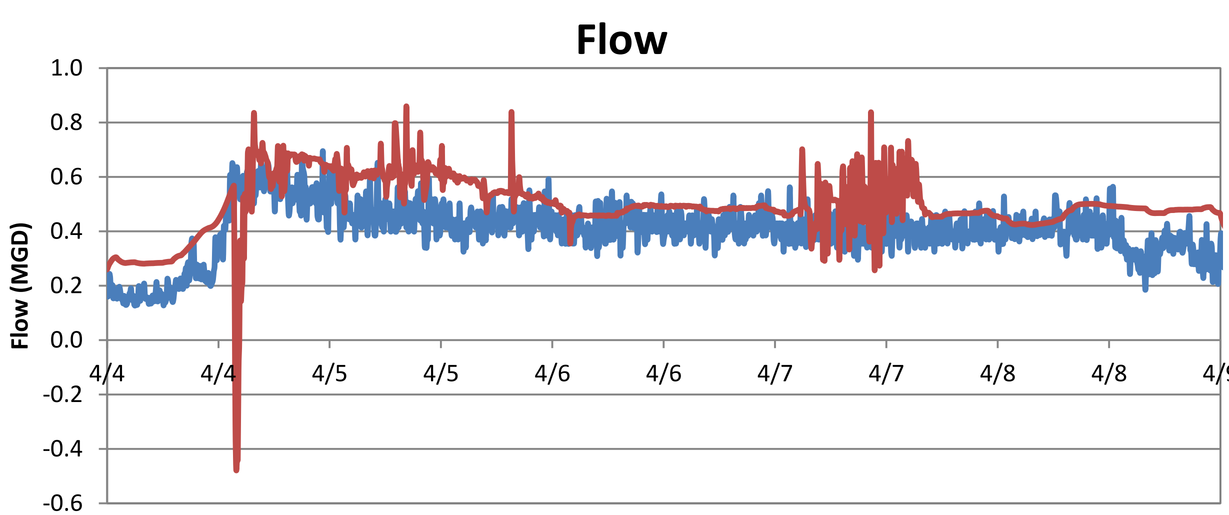




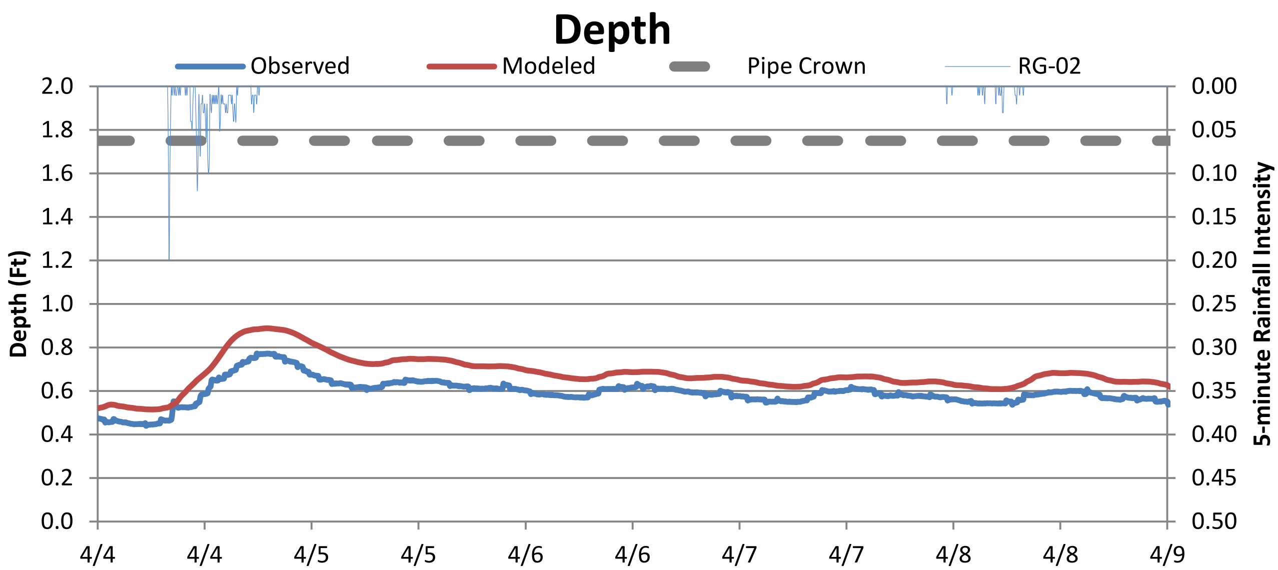
FM-15 WWF Event 1 Calibration

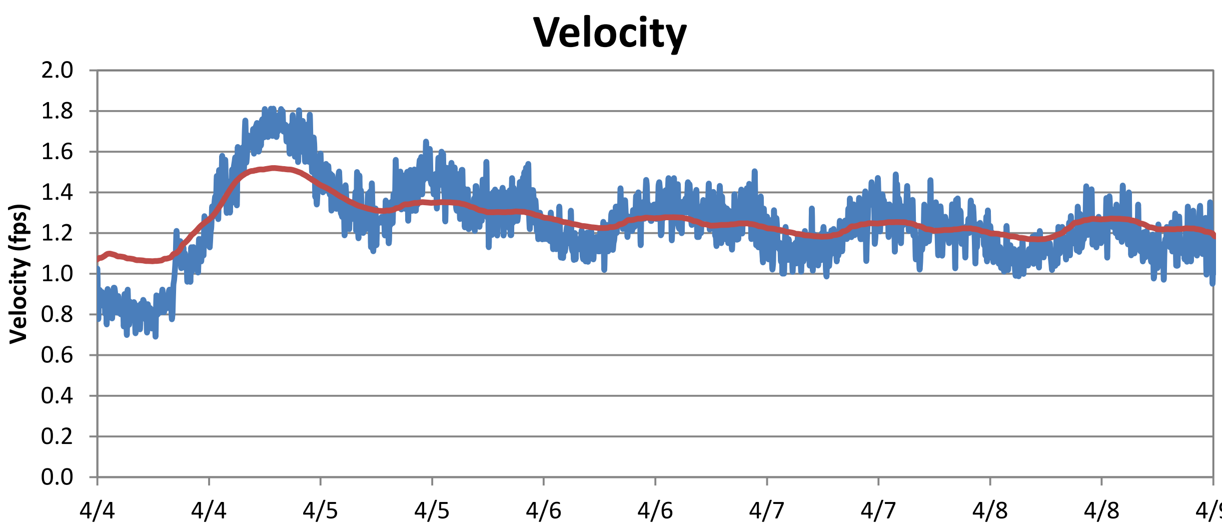


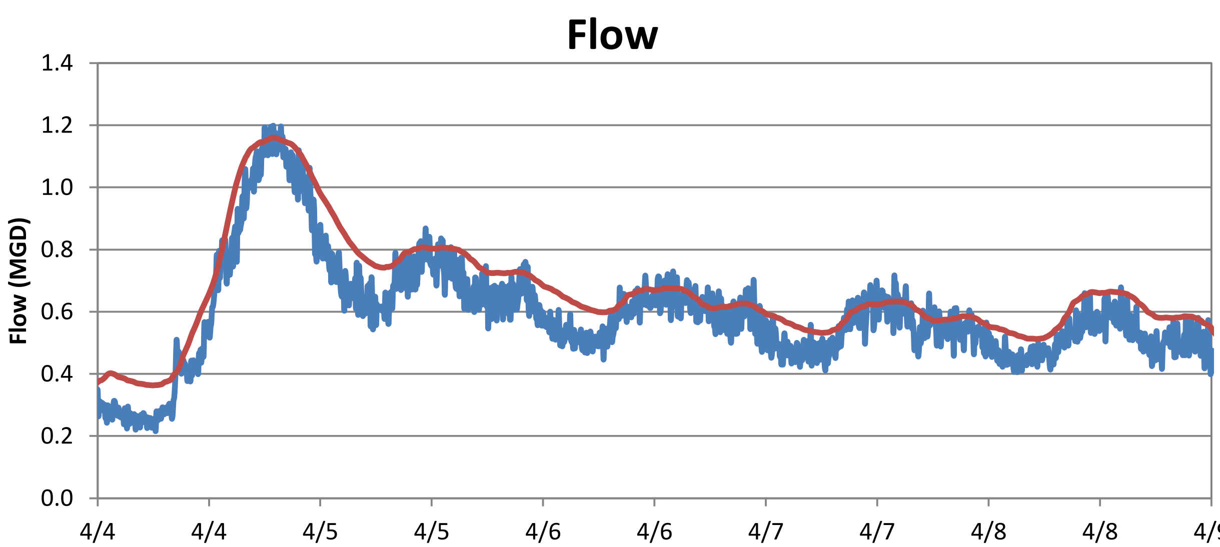




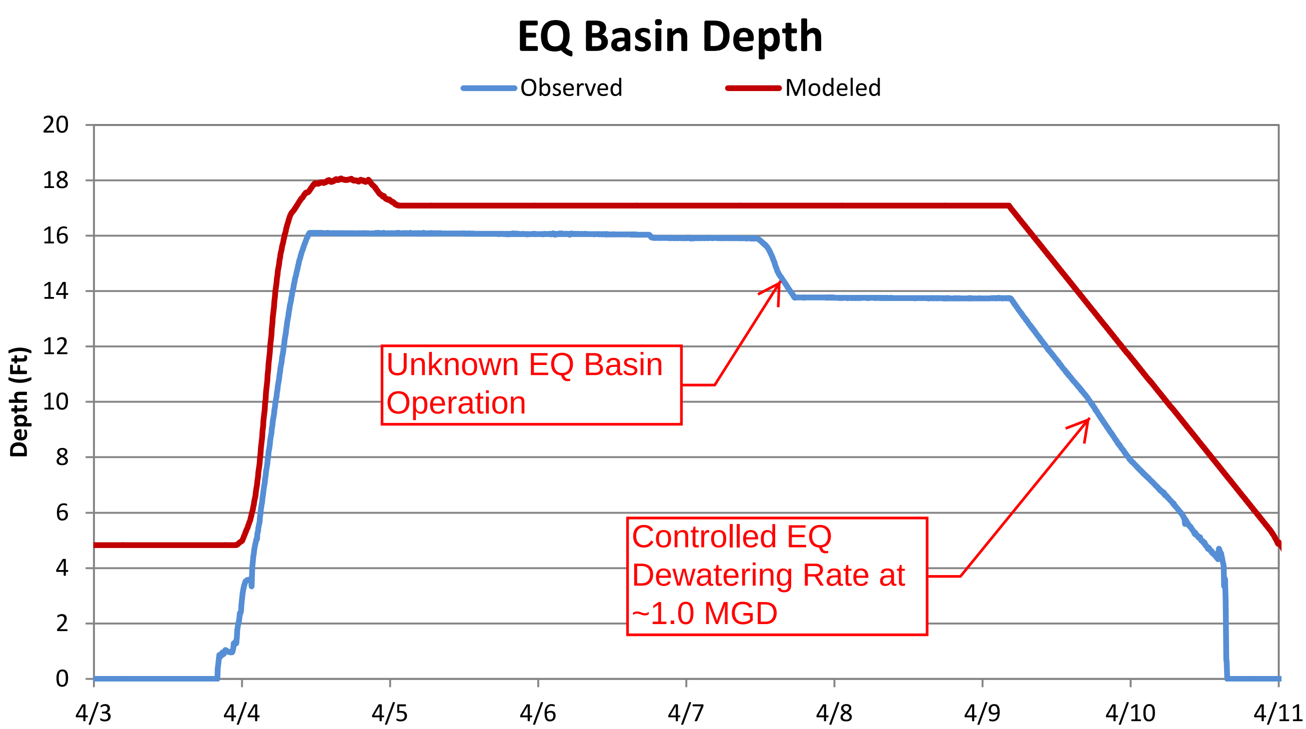
FM-16 WWF Event 1 Calibration

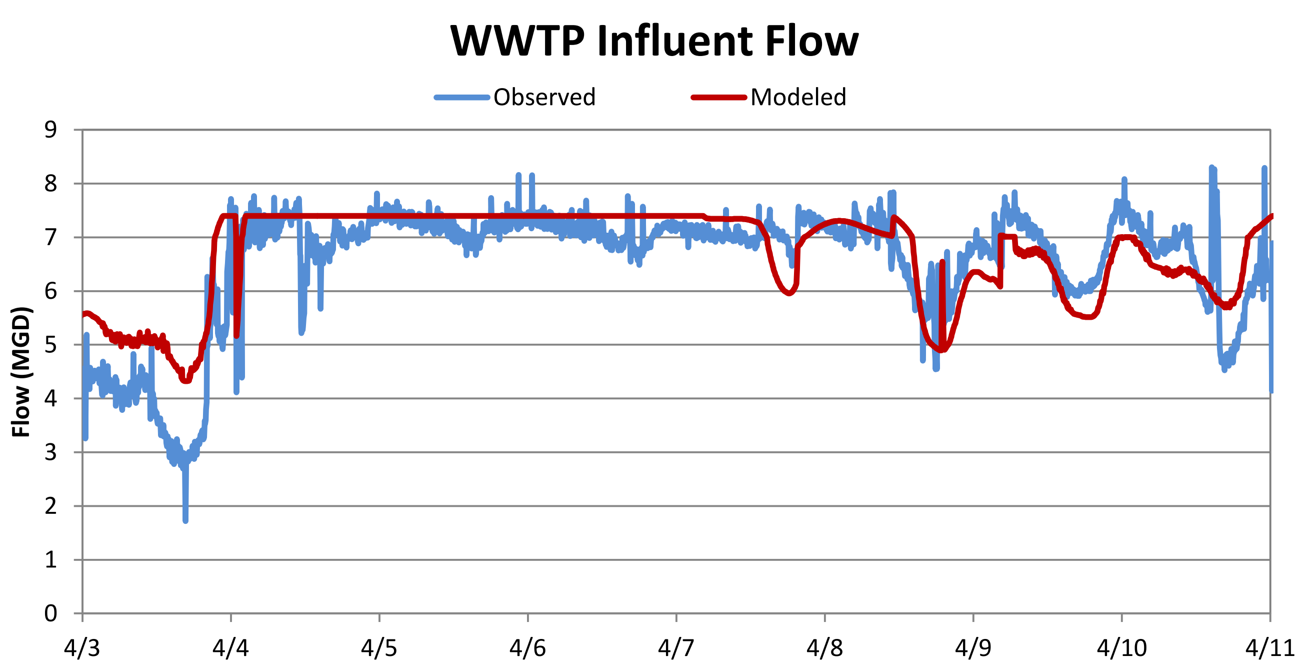




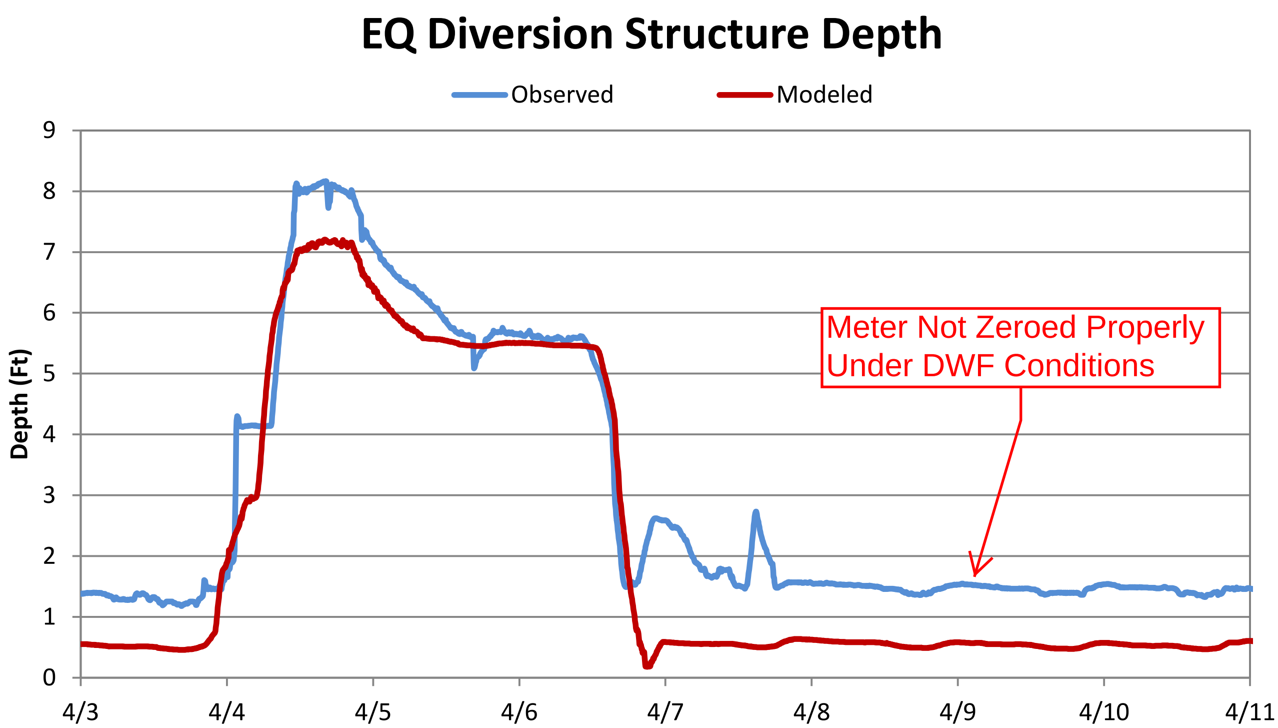


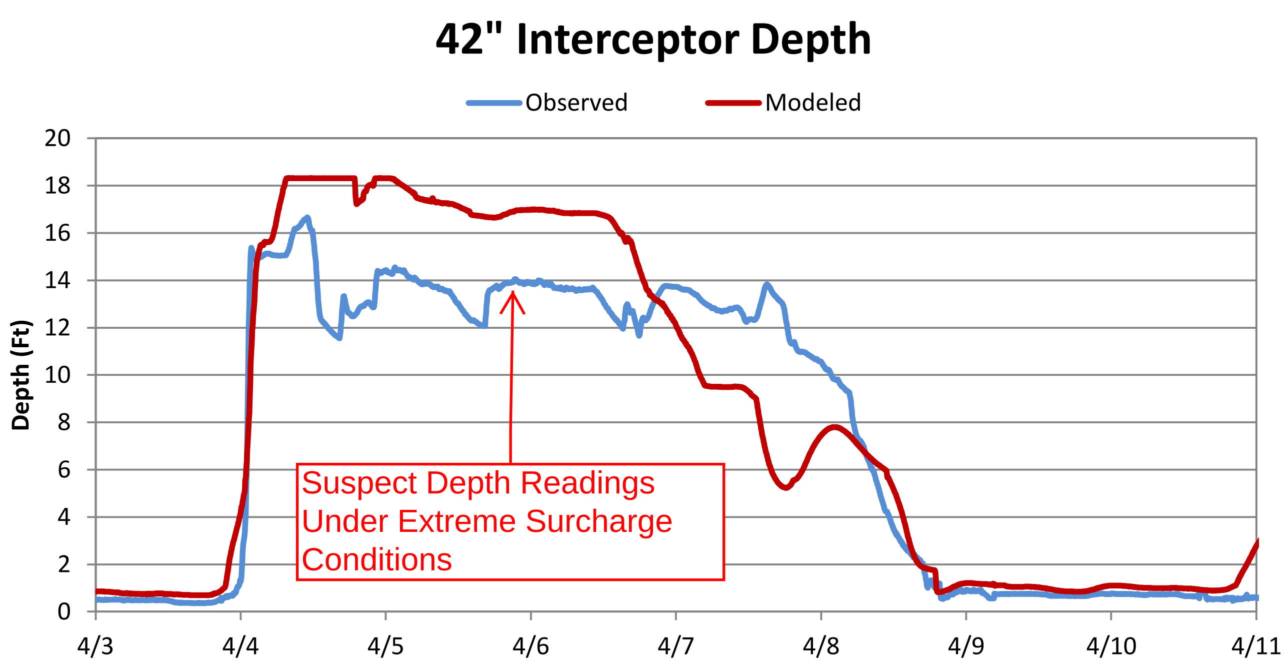
SCADA Meter WWF Event 1 Calibration





SCADA Meter WWF Event 1 Calibration



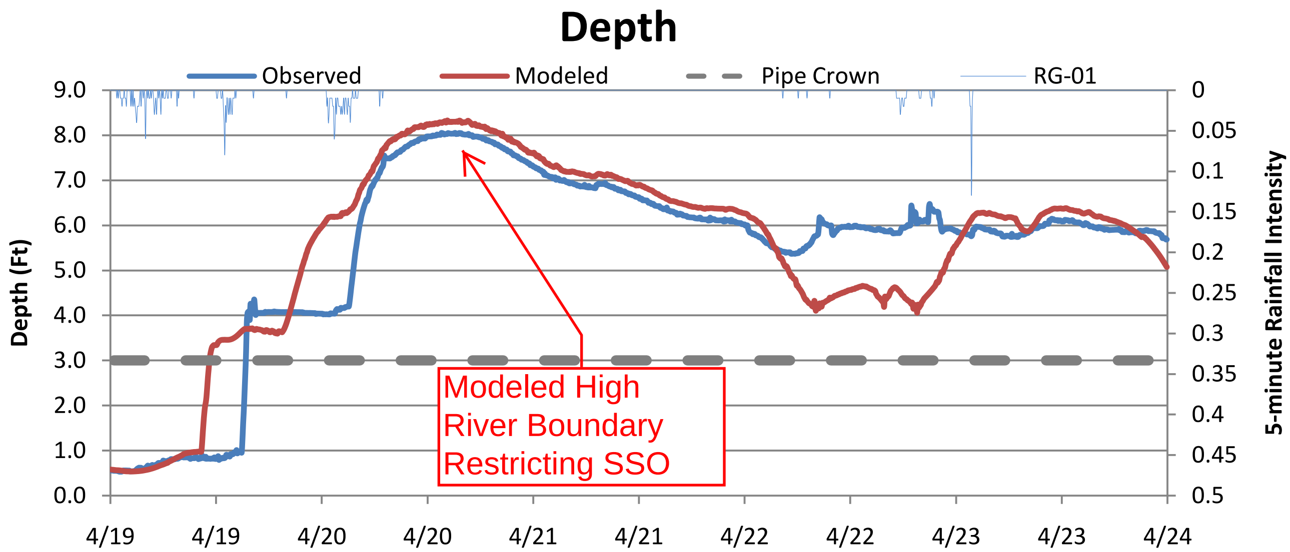


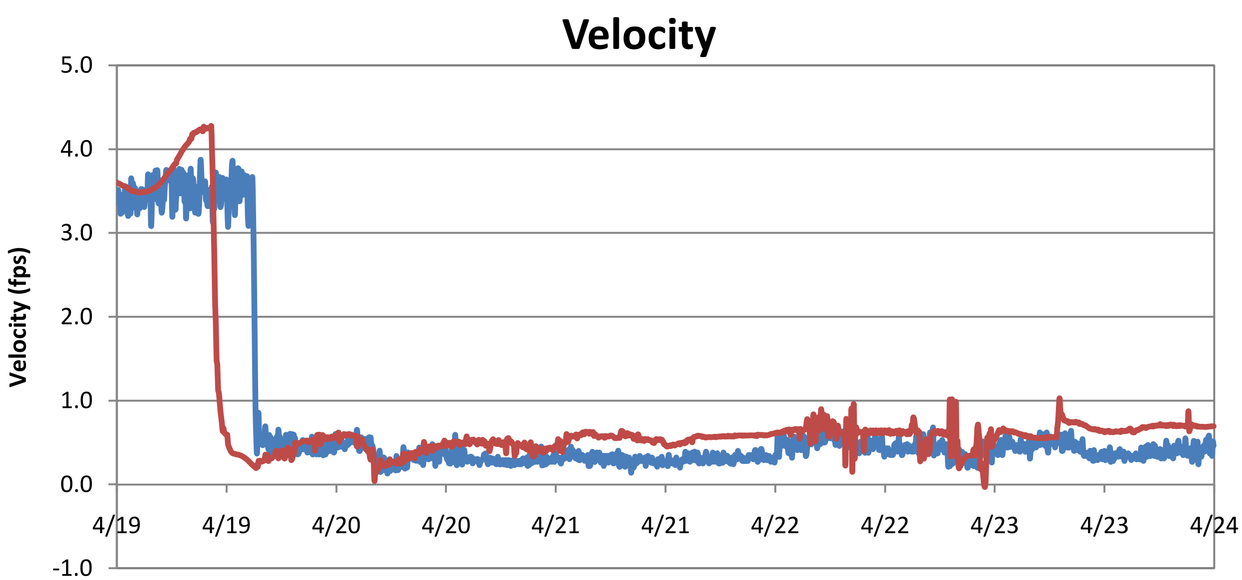
Appendix B

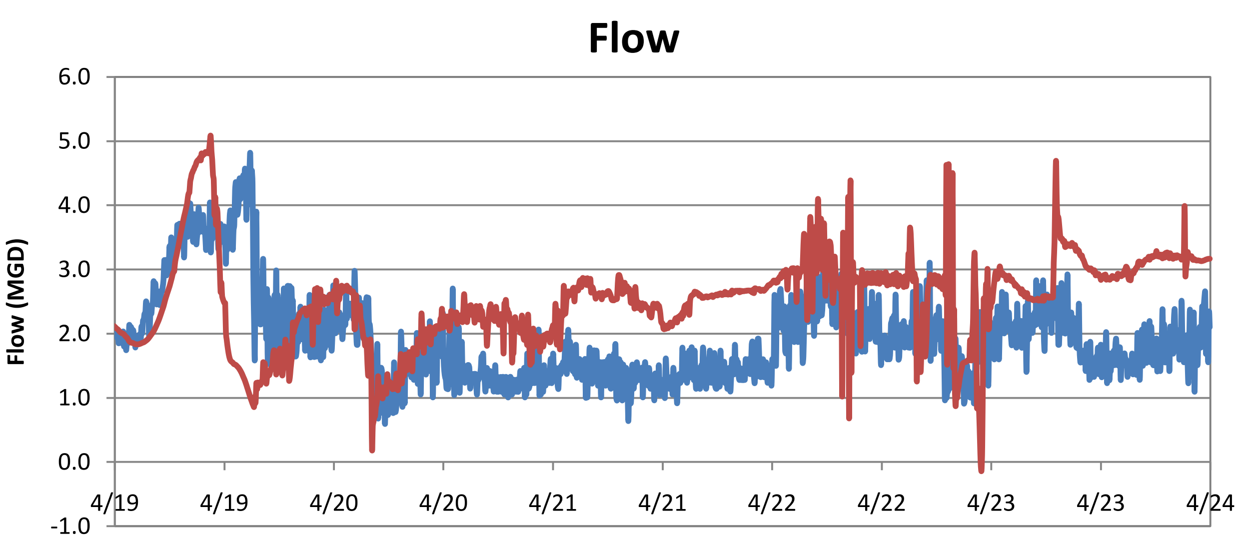
Wet Weather Flow Calibration Plots – Event 2

CDM Smith

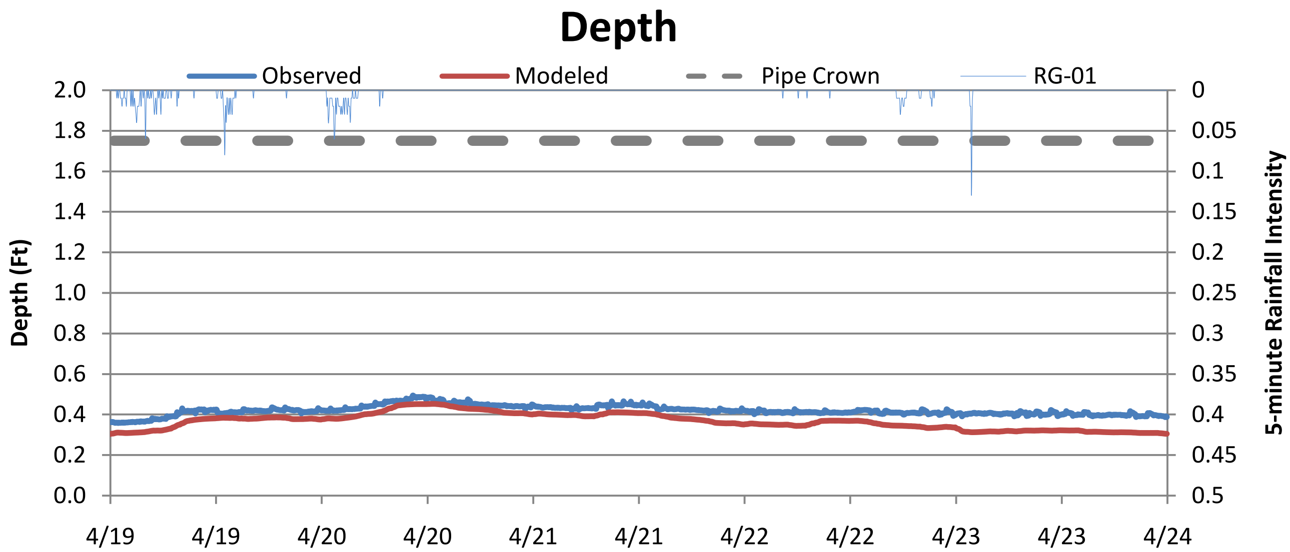
FM-01 WWF Event 2 Calibration

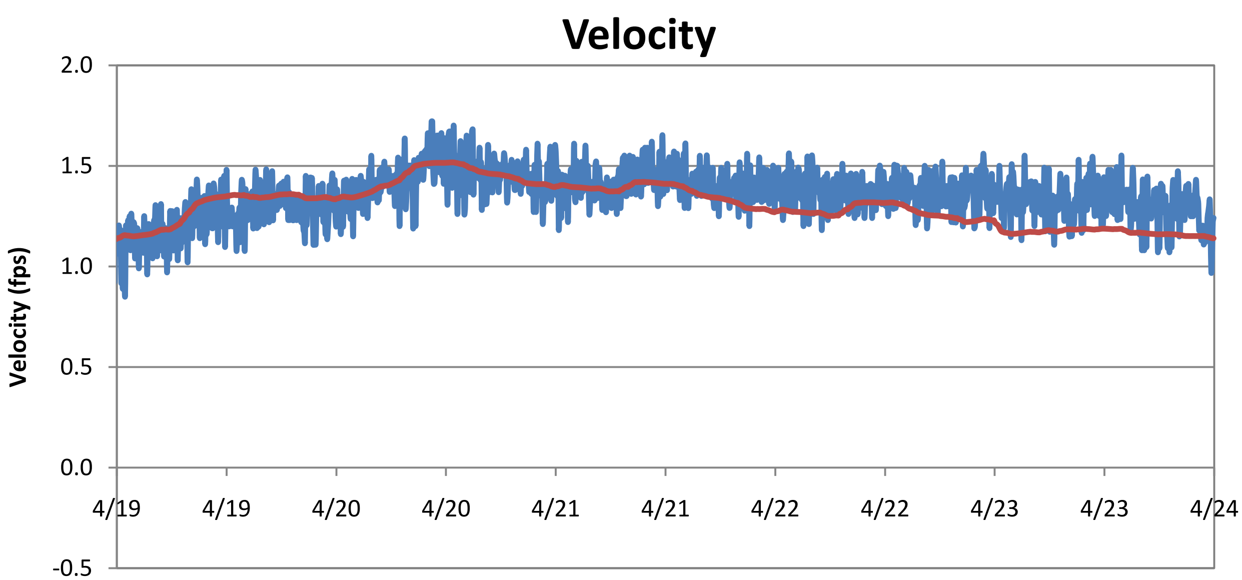


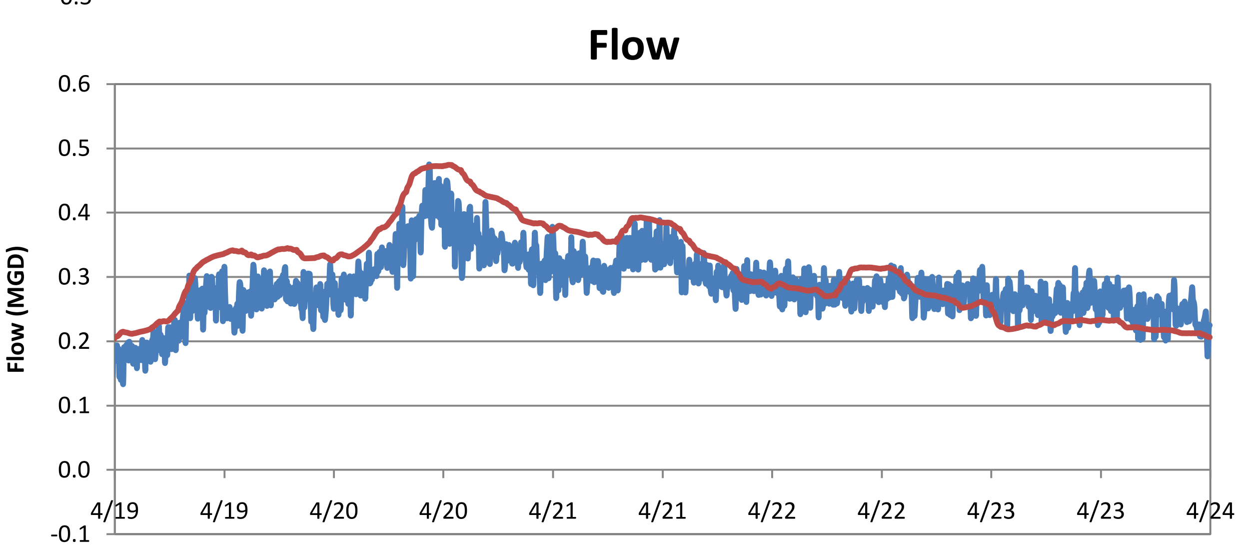




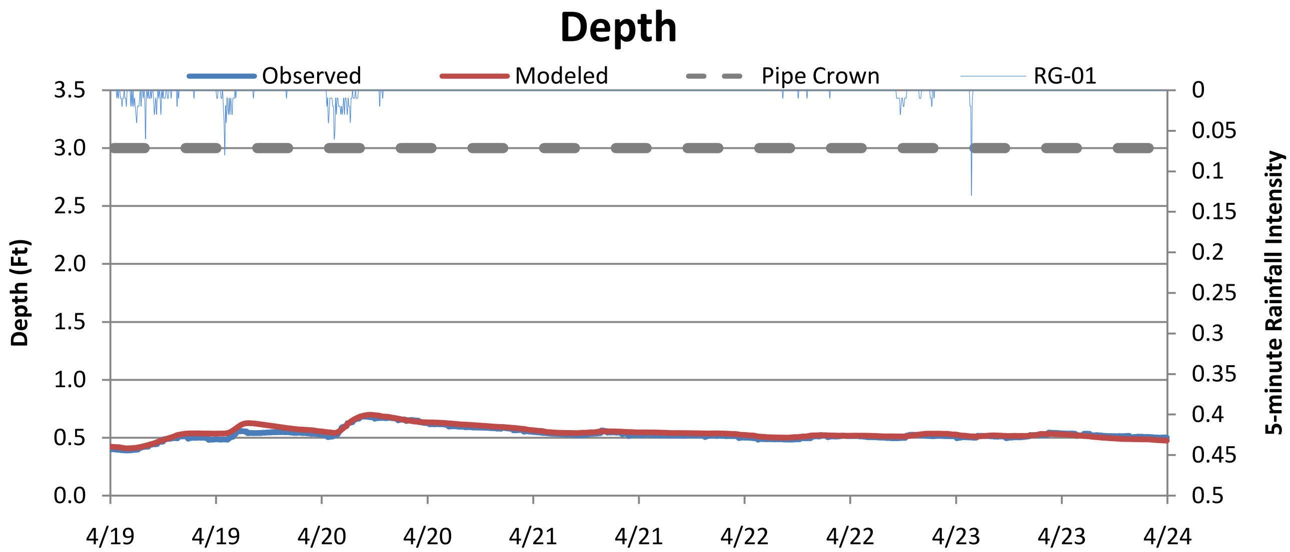
FM-02 WWF Event 2 Calibration

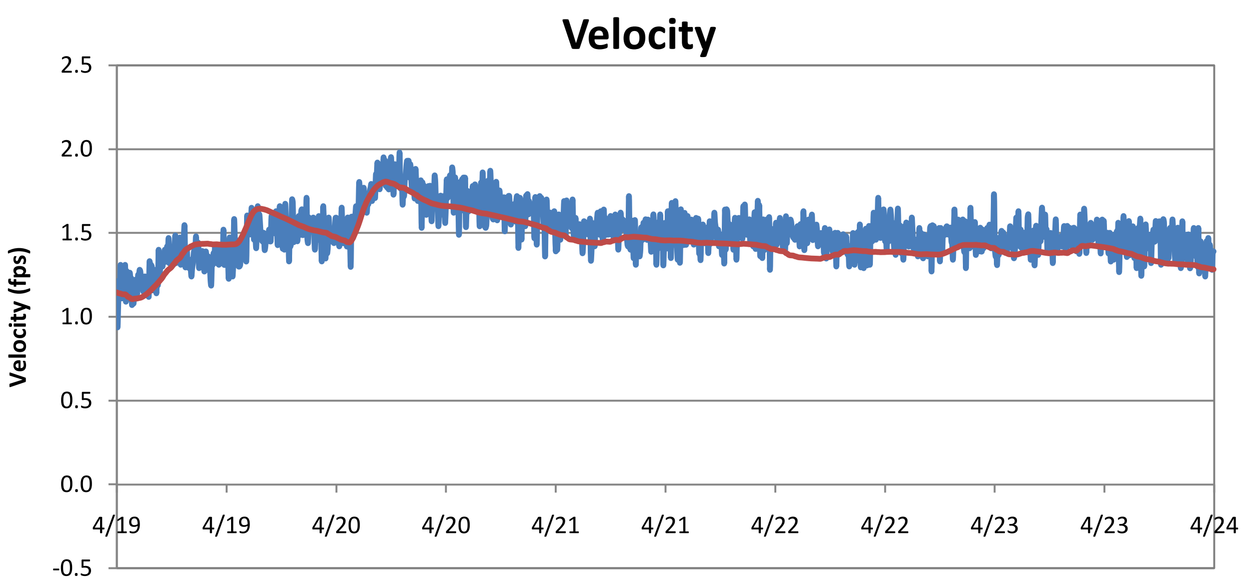


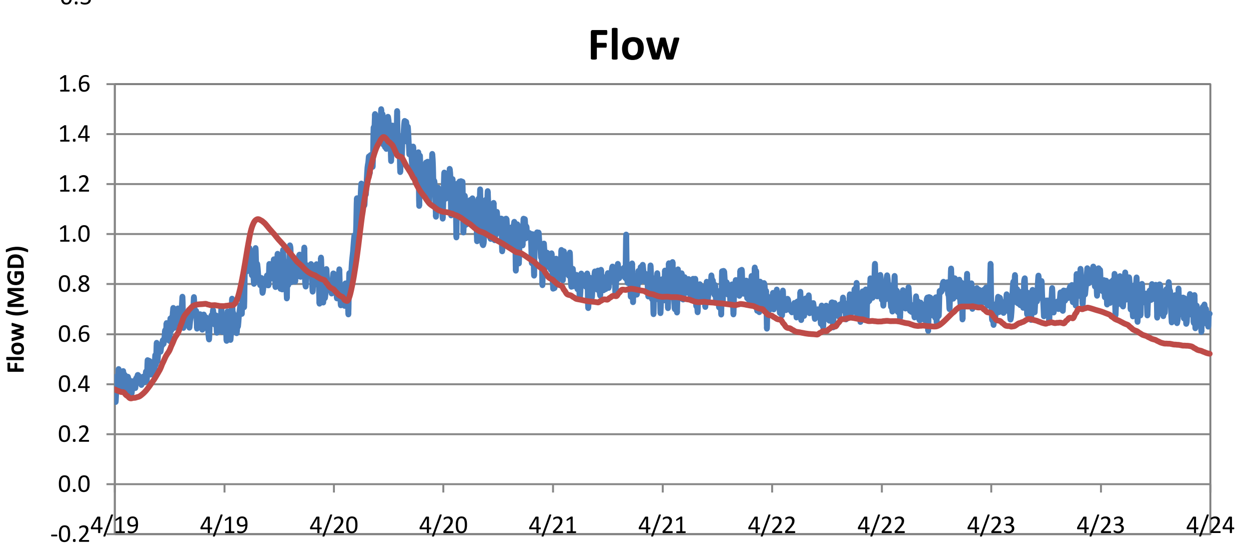


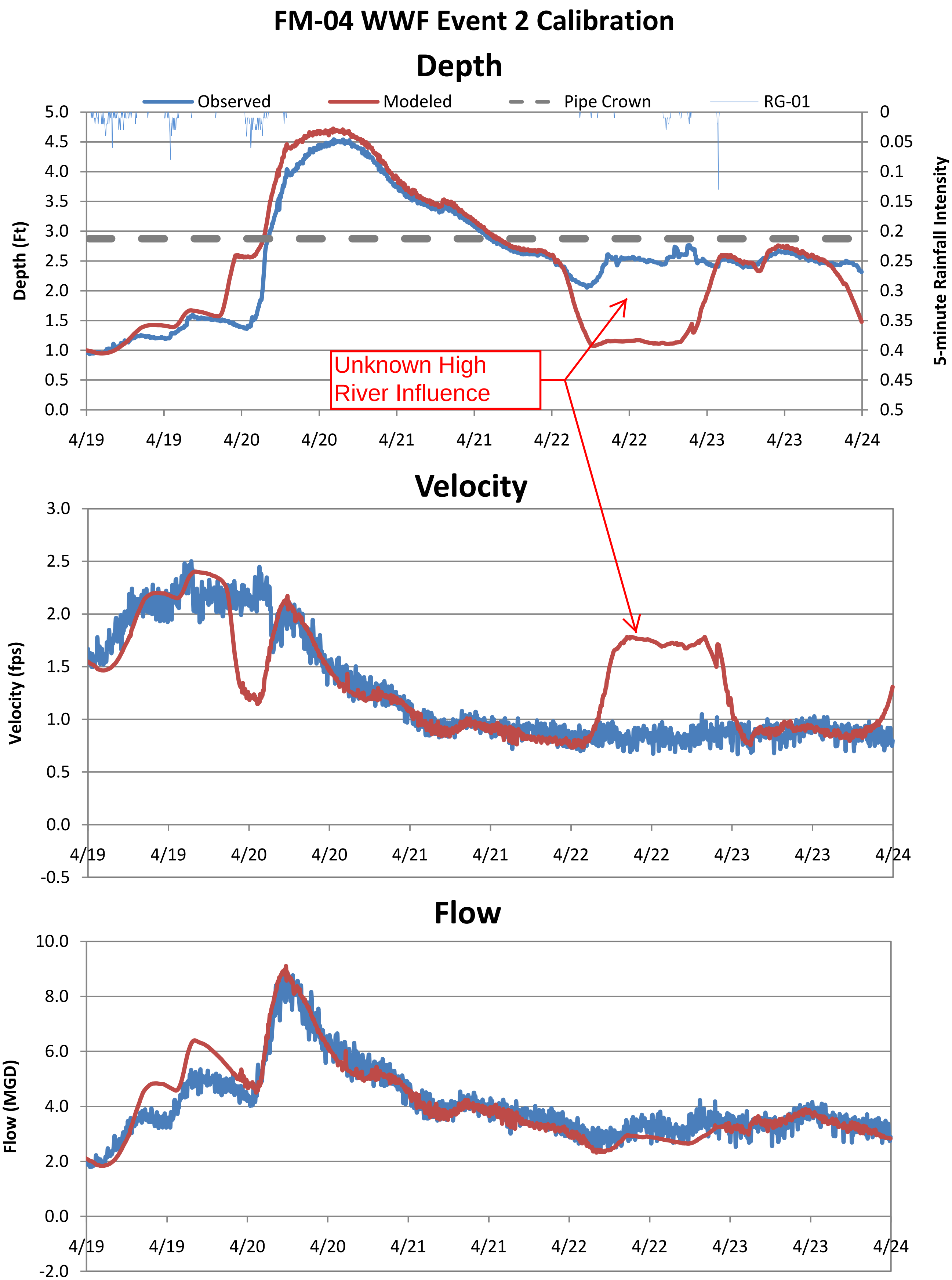


FM-03 WWF Event 2 Calibration



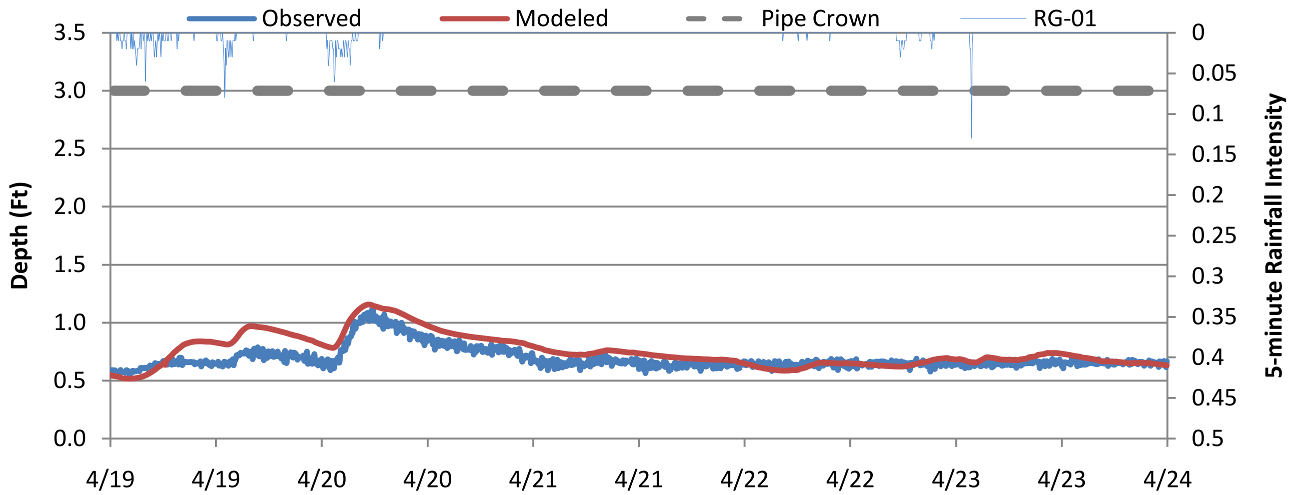




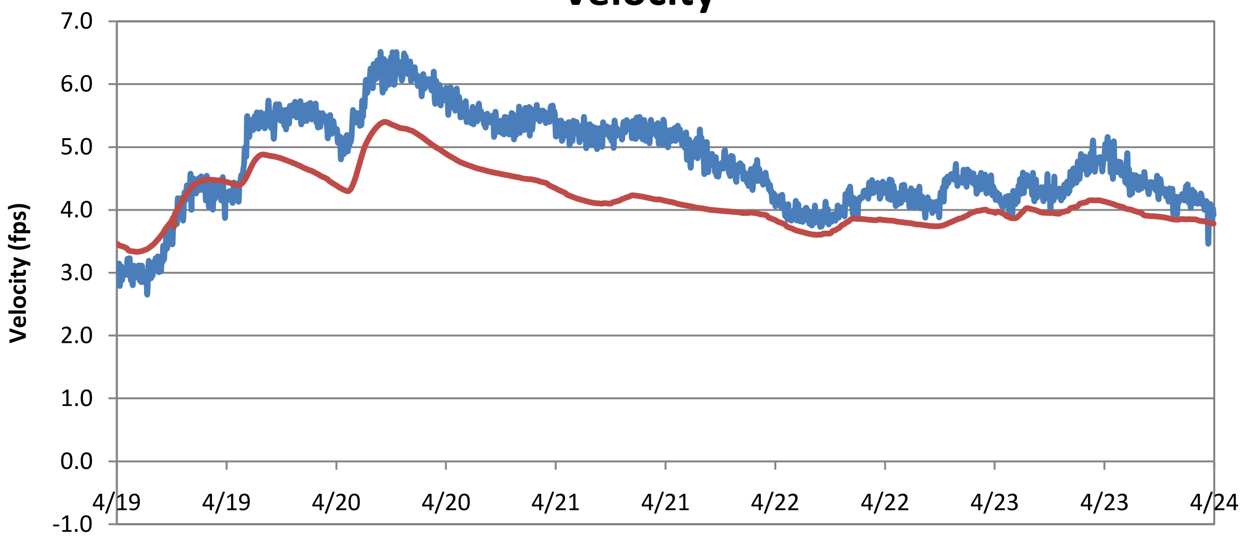

FM-04 WWF Event 2 Calibration
Depth
Observed
Modeled
Pipe Crown
RG-01
Depth (Ft)
5-minute Rainfall Intensity
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
4/19
4/19
4/20
4/20
4/21
4/21
4/22
4/22
4/23
4/23
4/24
Unknown High
River Influence
Velocity
Velocity (fps)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
4/19
4/19
4/20
4/20
4/21
4/21
4/22
4/22
4/23
4/23
4/24
Flow
Flow (MGD)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
4/19
4/19
4/20
4/20
4/21
4/21
4/22
4/22
4/23
4/23
4/24

FM-05 WWF Event 2 Calibration

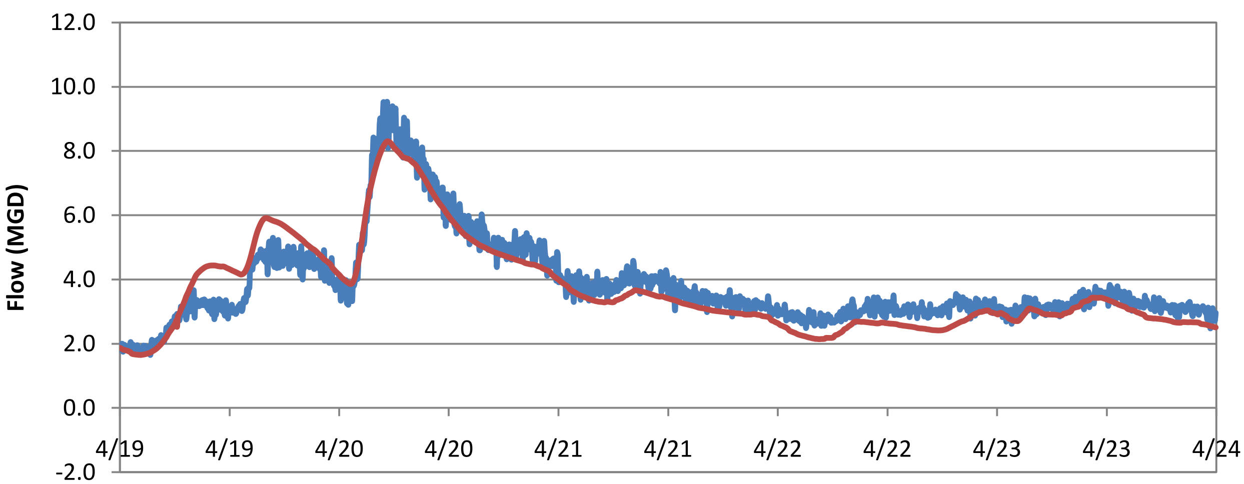
Depth



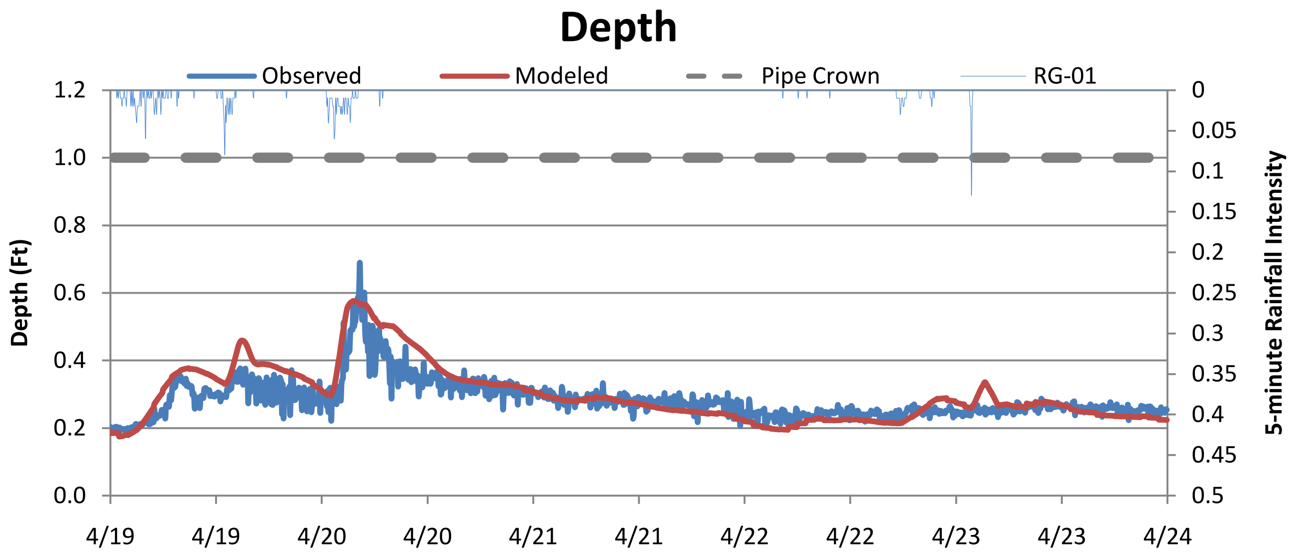
Velocity

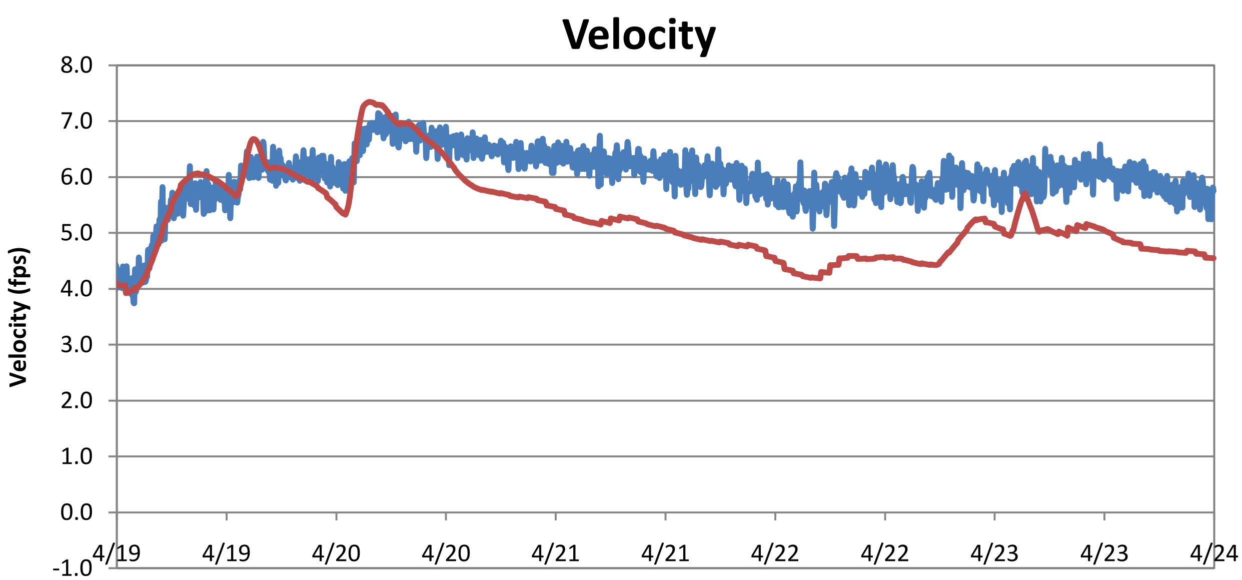


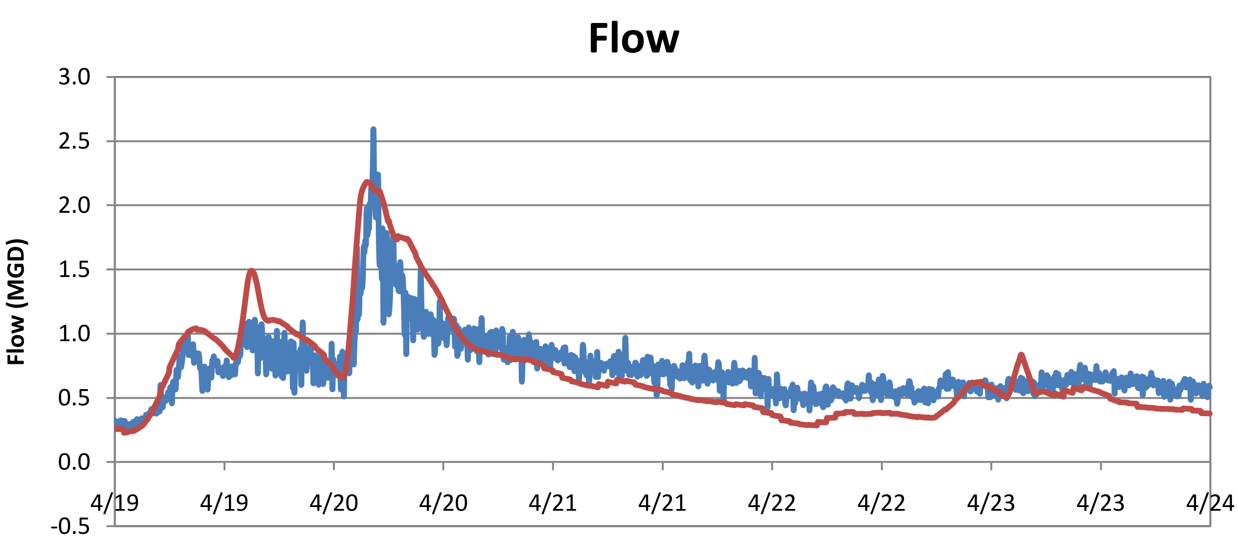
Flow



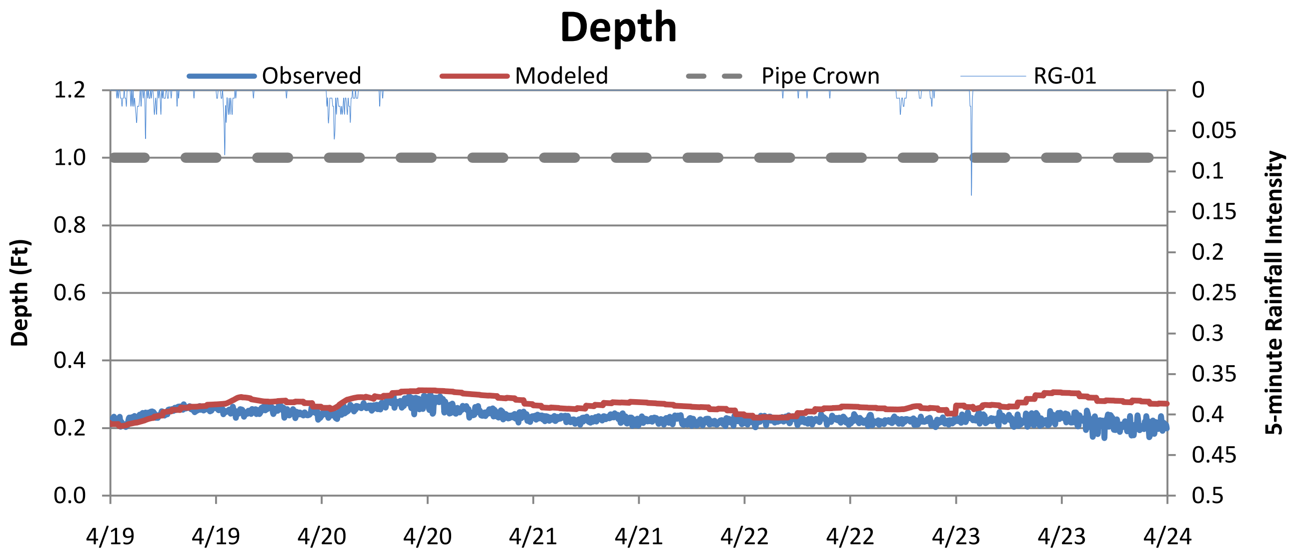
FM-06 WWF Event 2 Calibration

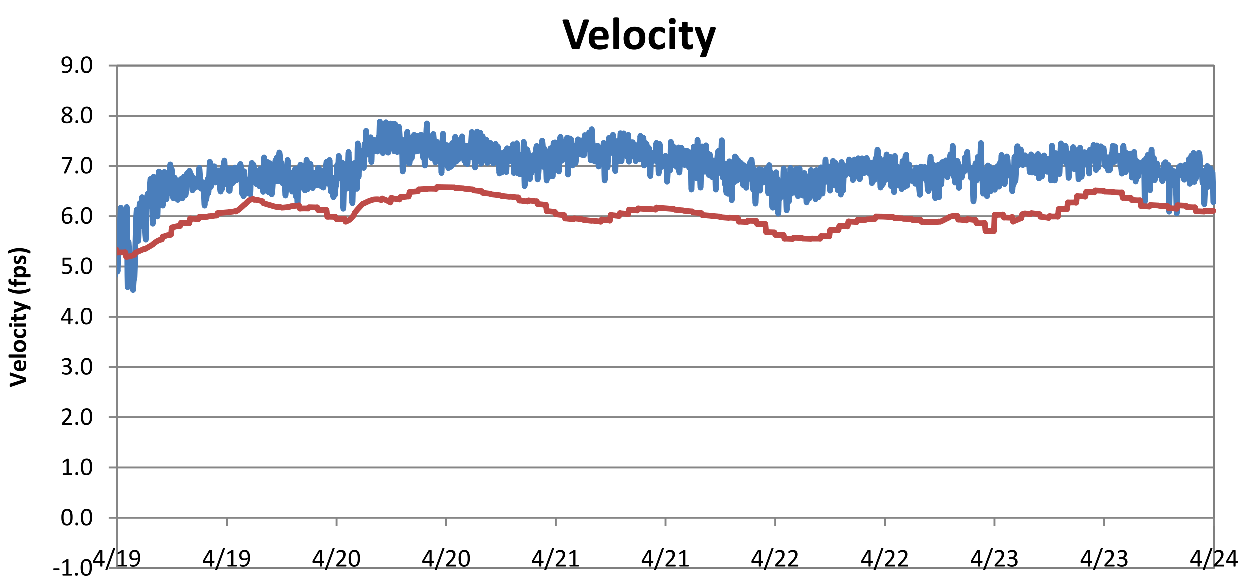


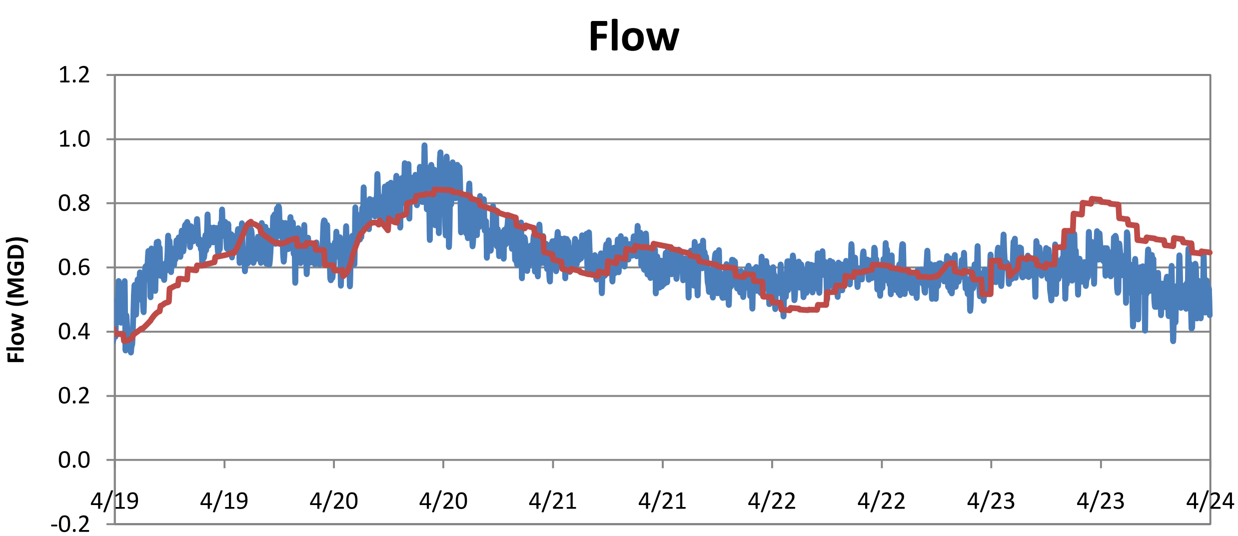




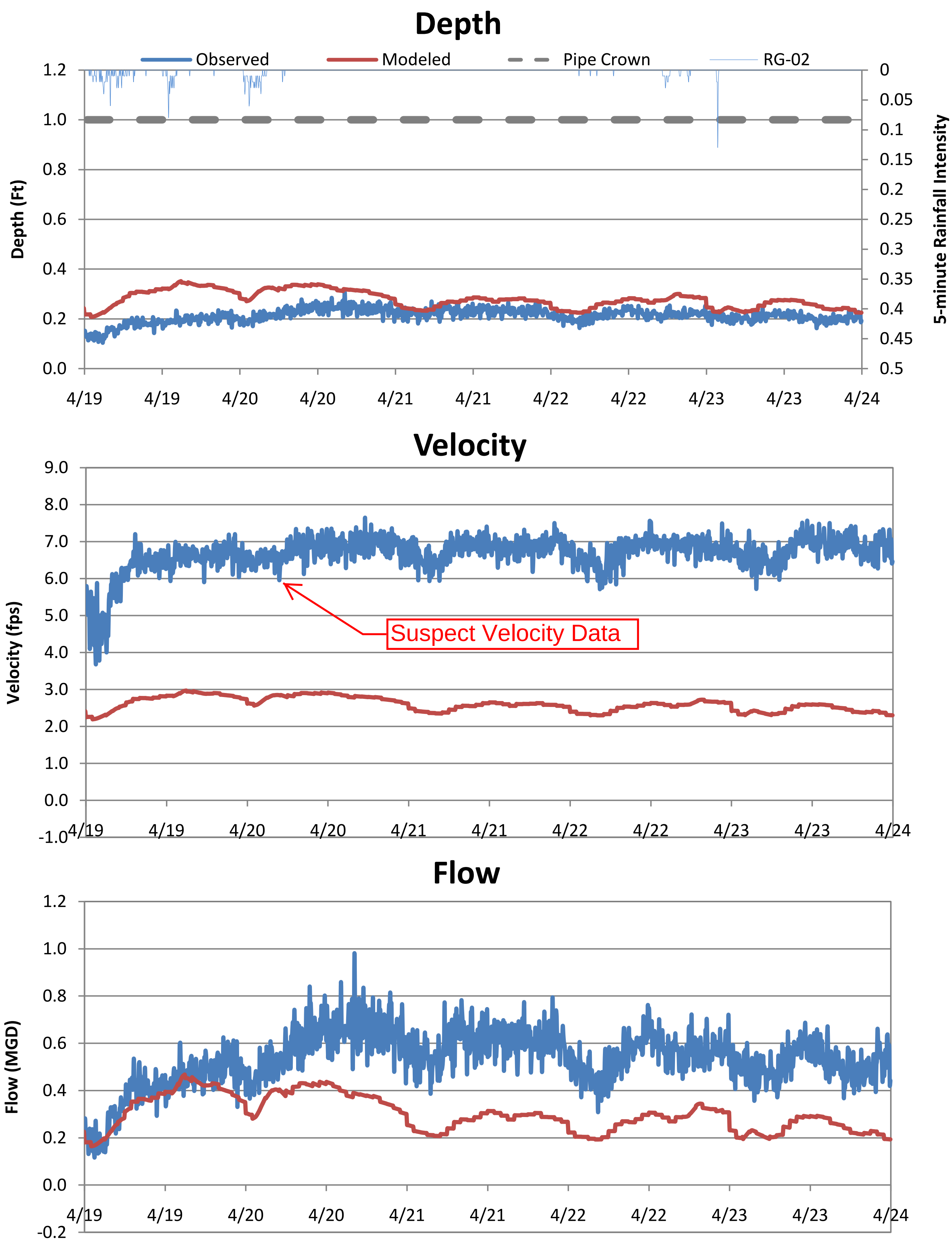
FM-07 WWF Event 2 Calibration



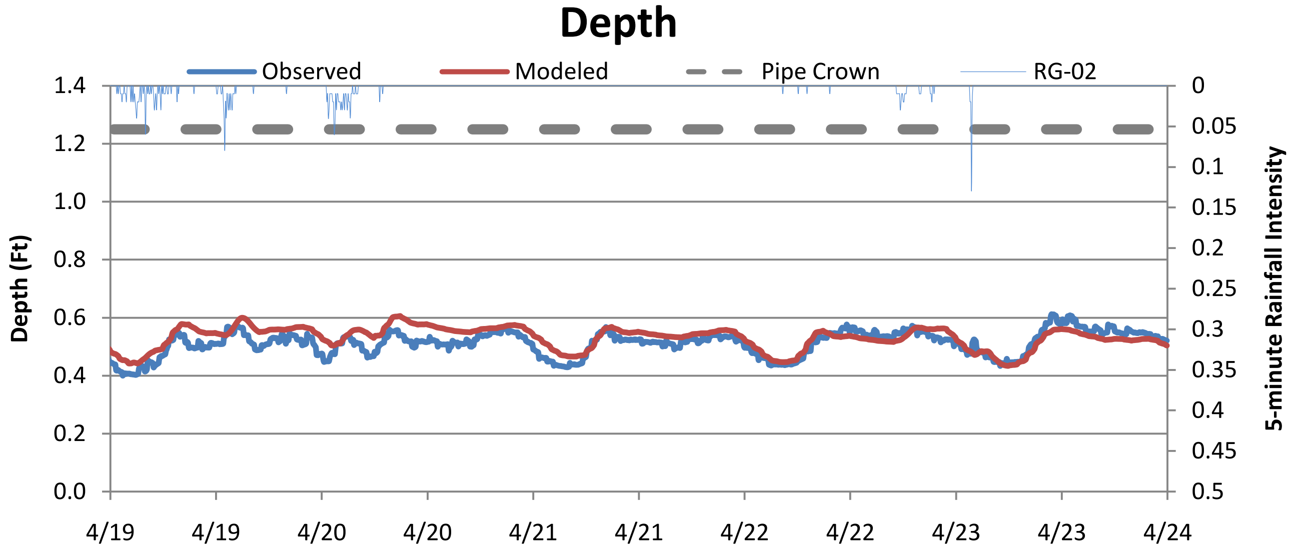


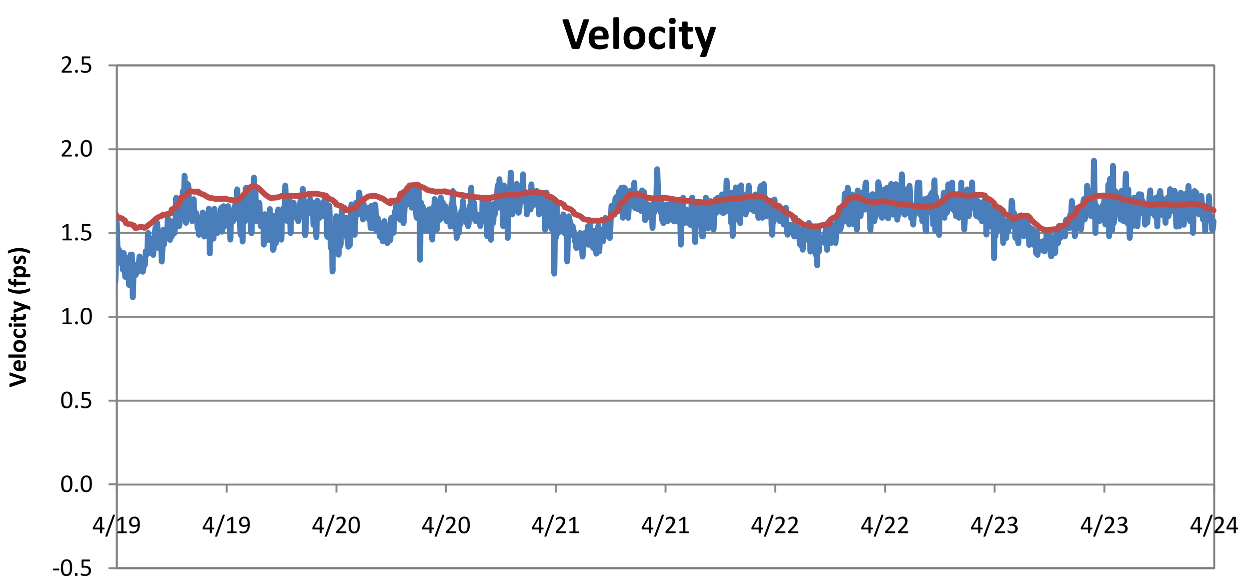


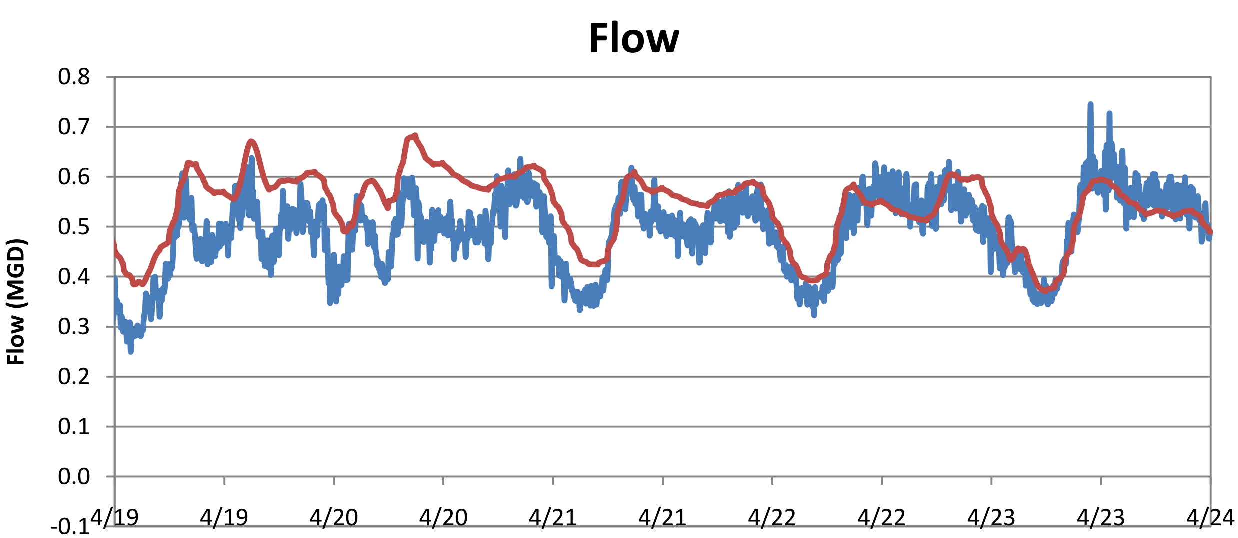
FM-08 WWF Event 2 Calibration



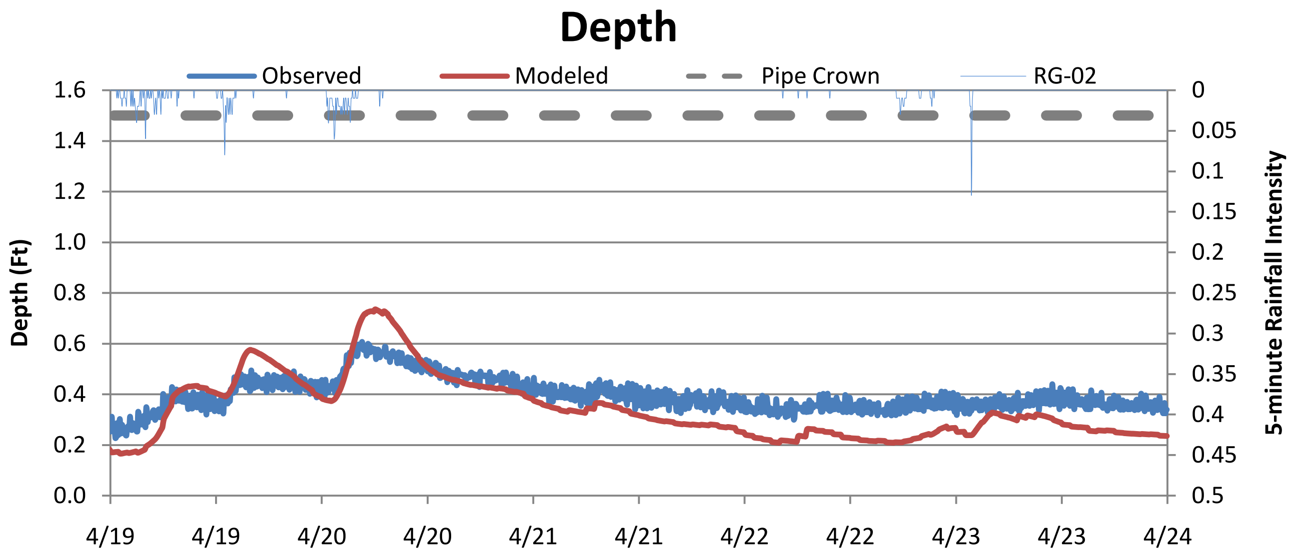
FM-09 WWF Event 2 Calibration

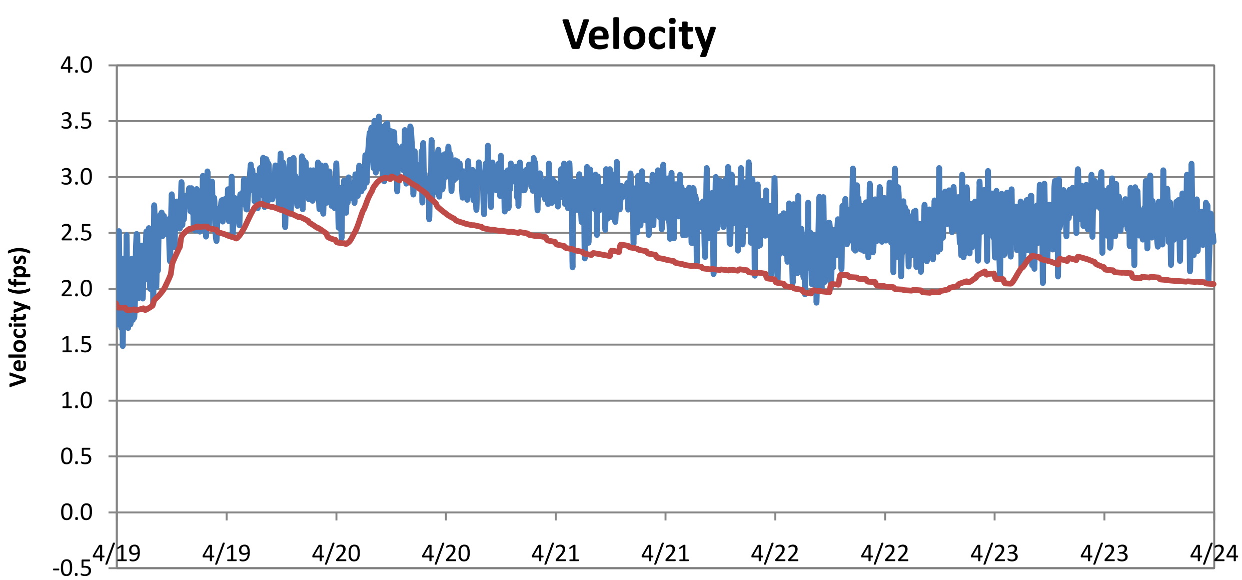


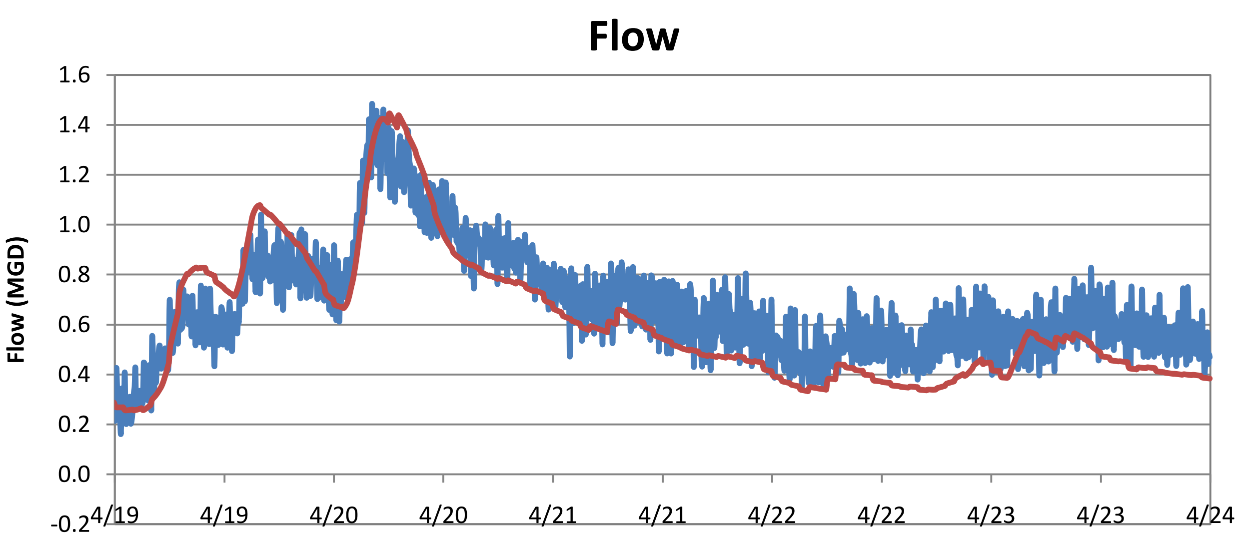




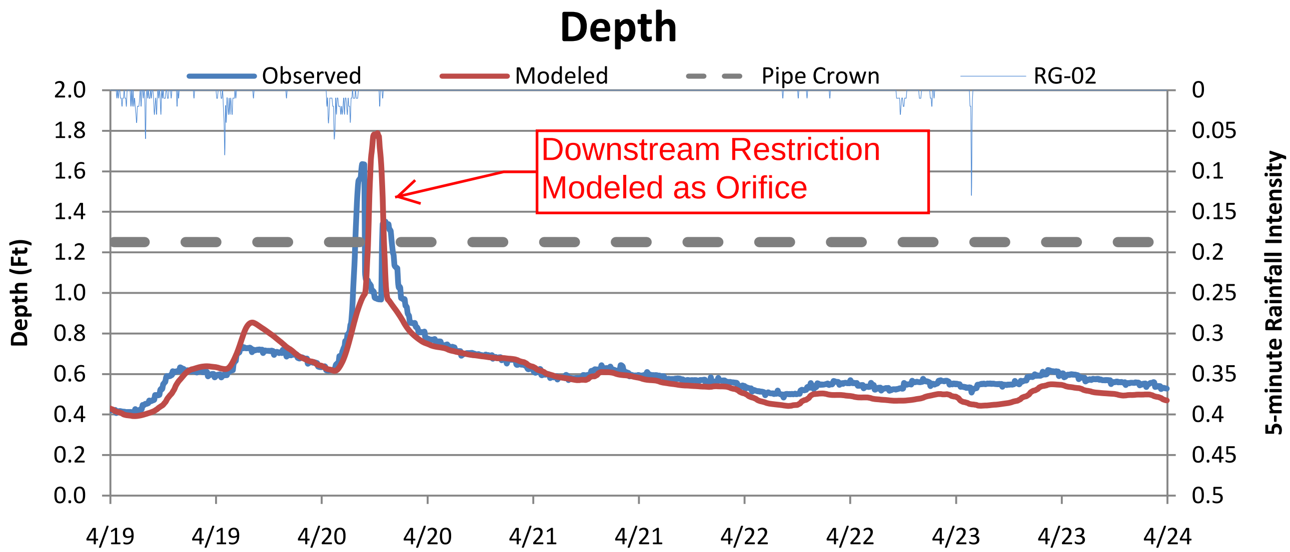
FM-10 WWF Event 2 Calibration

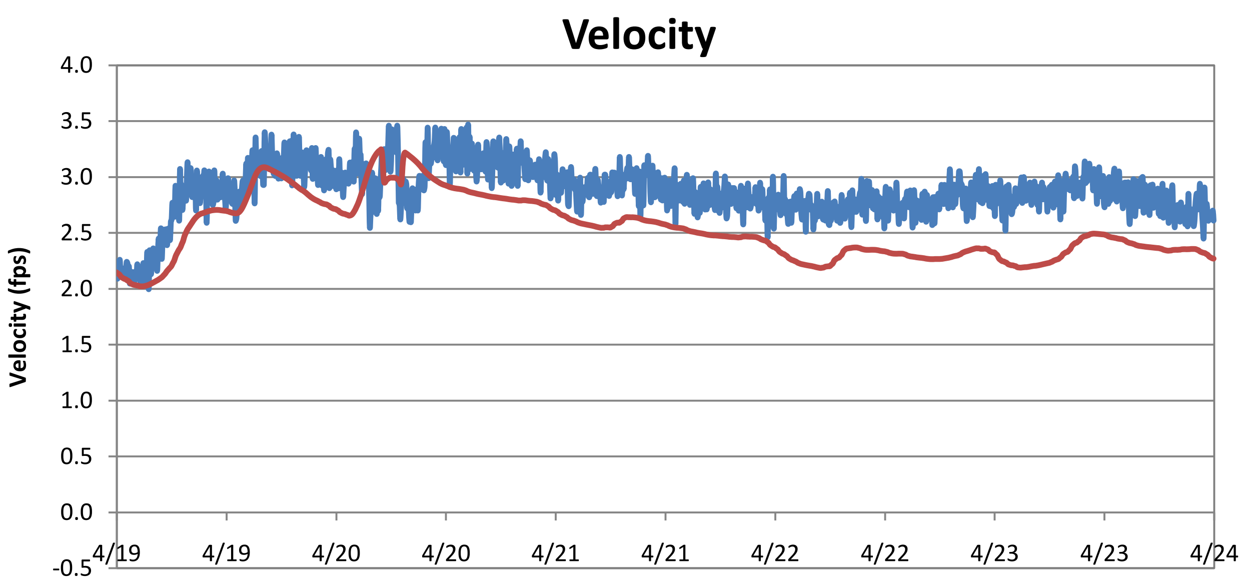


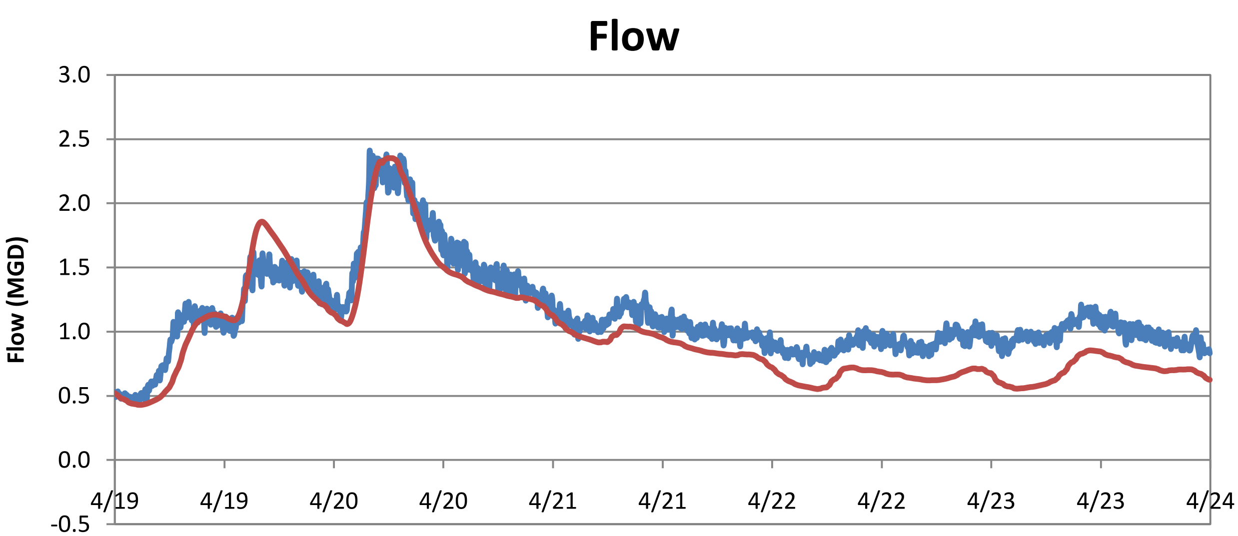




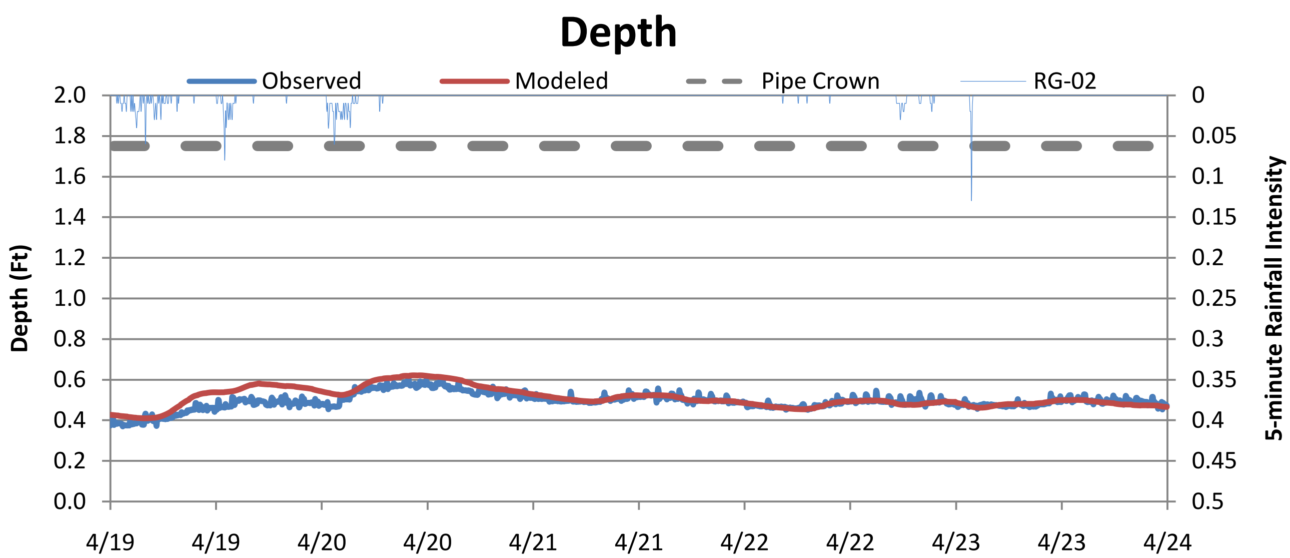
FM-11 WWF Event 2 Calibration

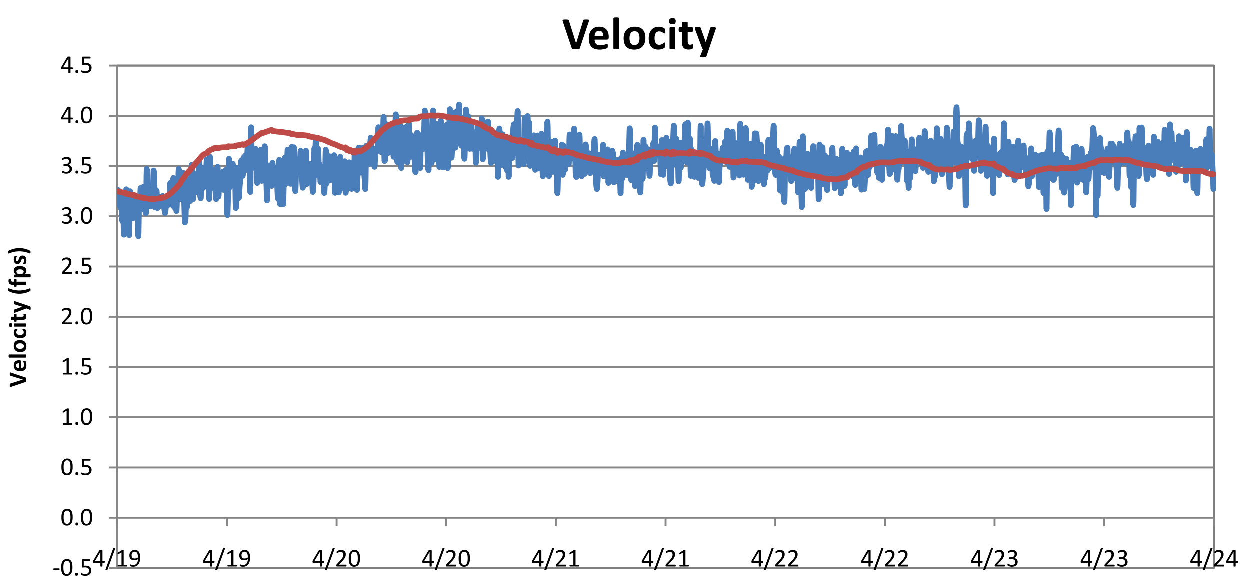


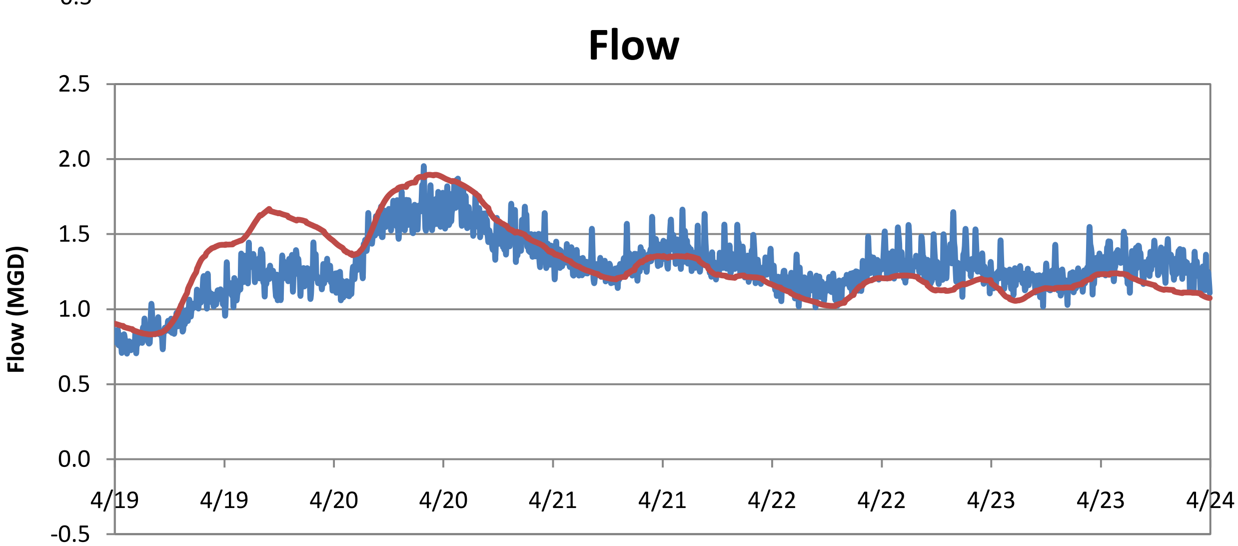




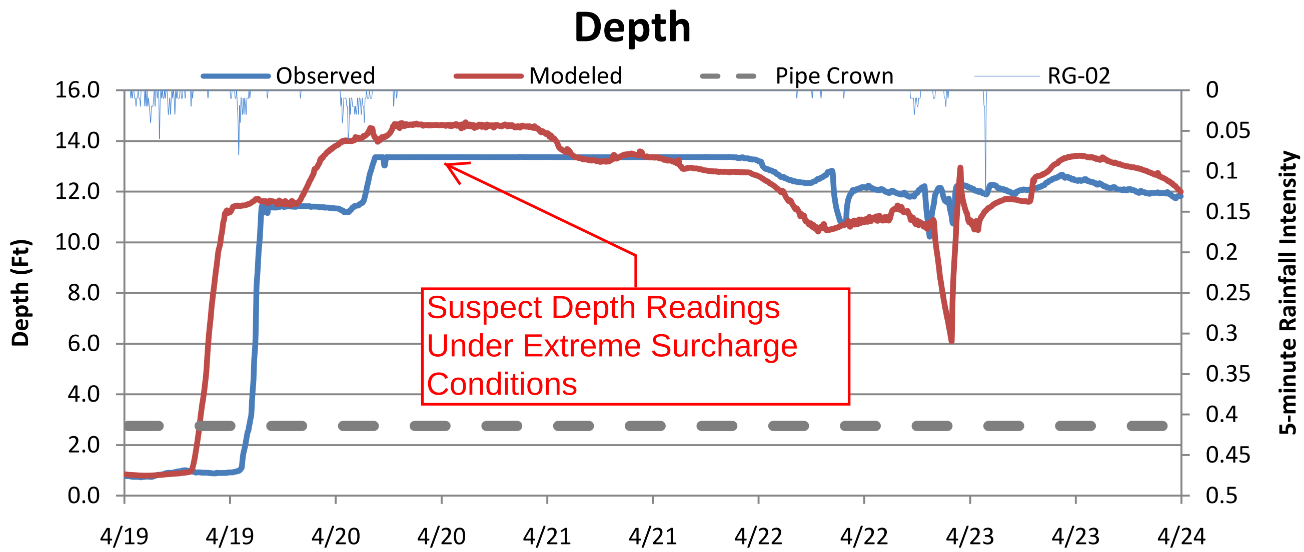
FM-12 WWF Event 2 Calibration

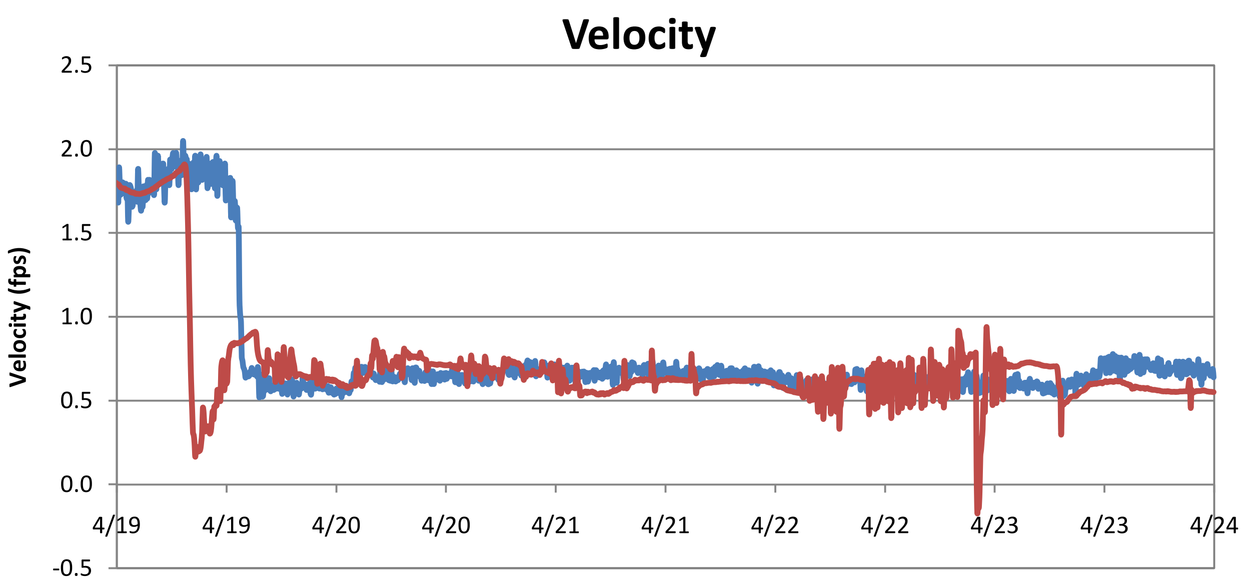


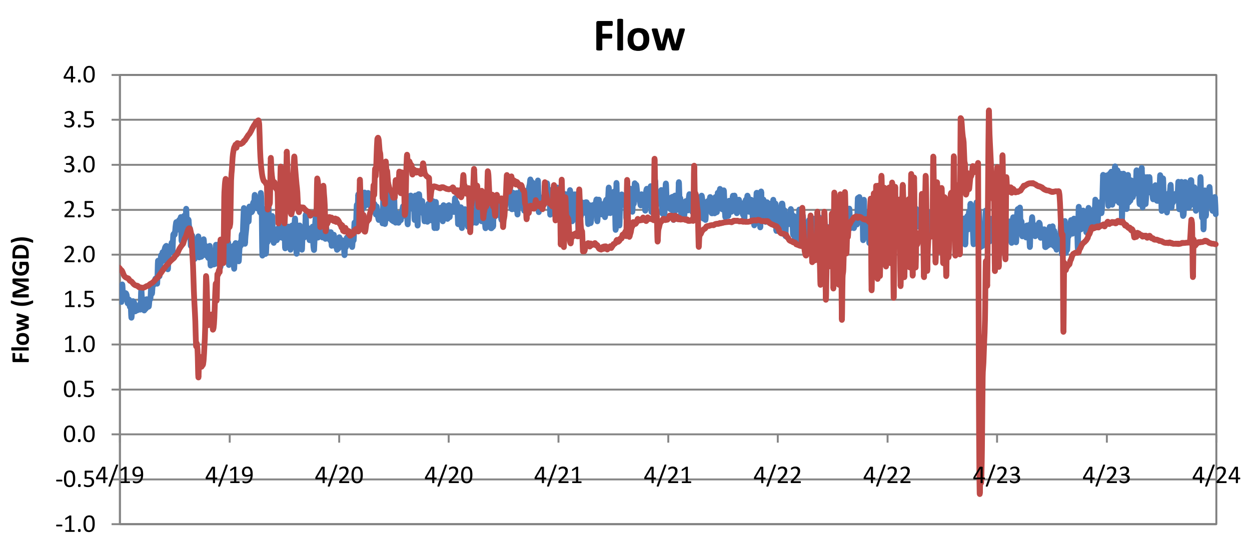




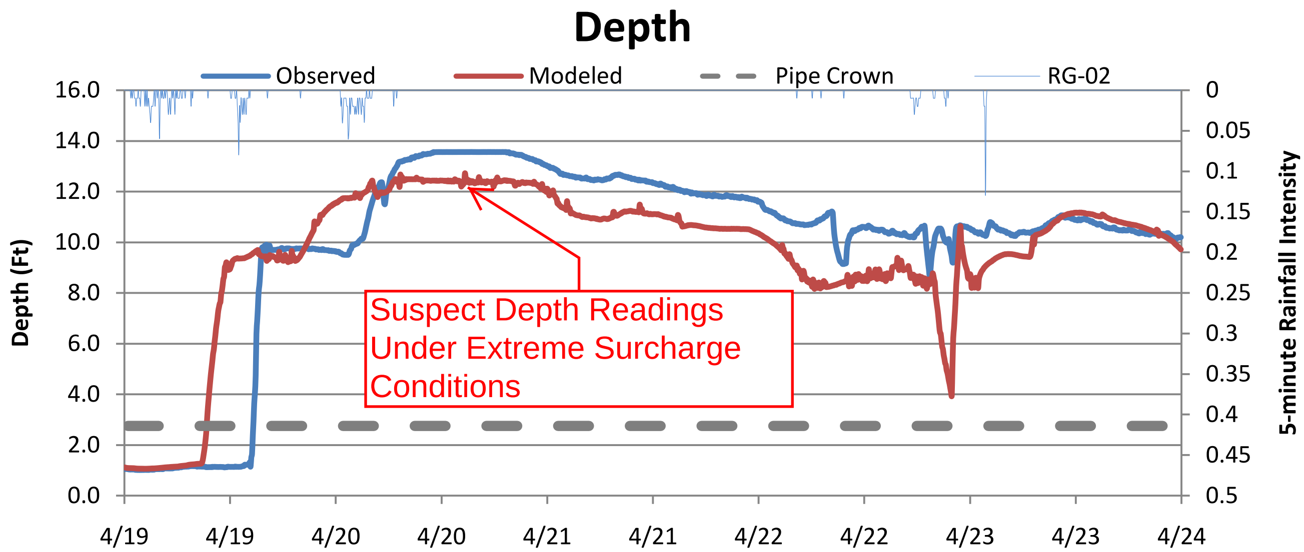
FM-13 WWF Event 2 Calibration

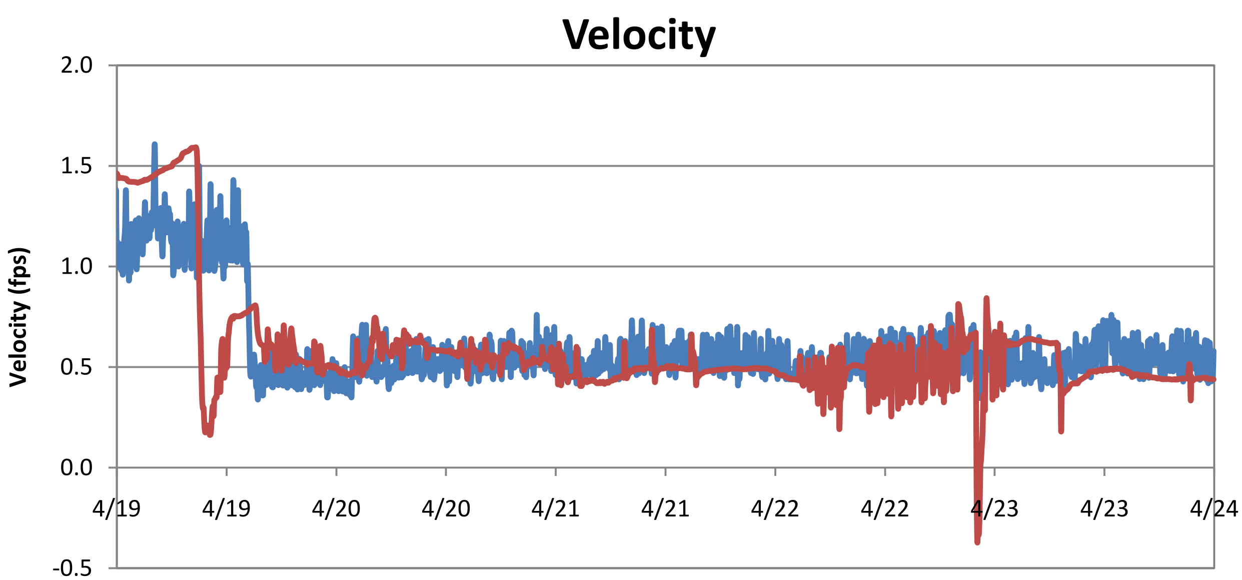


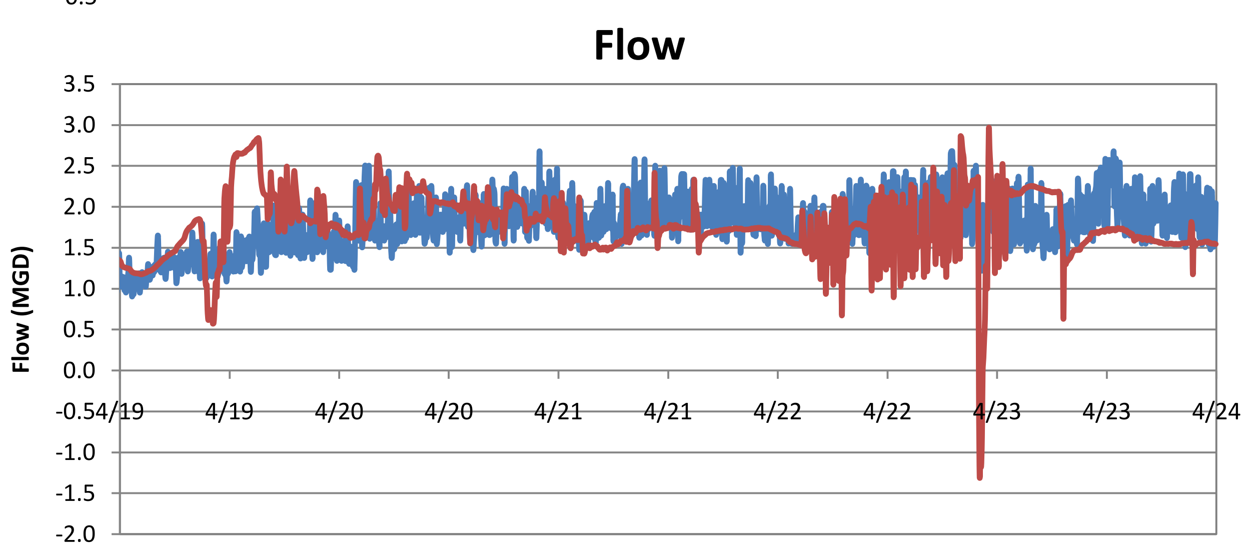




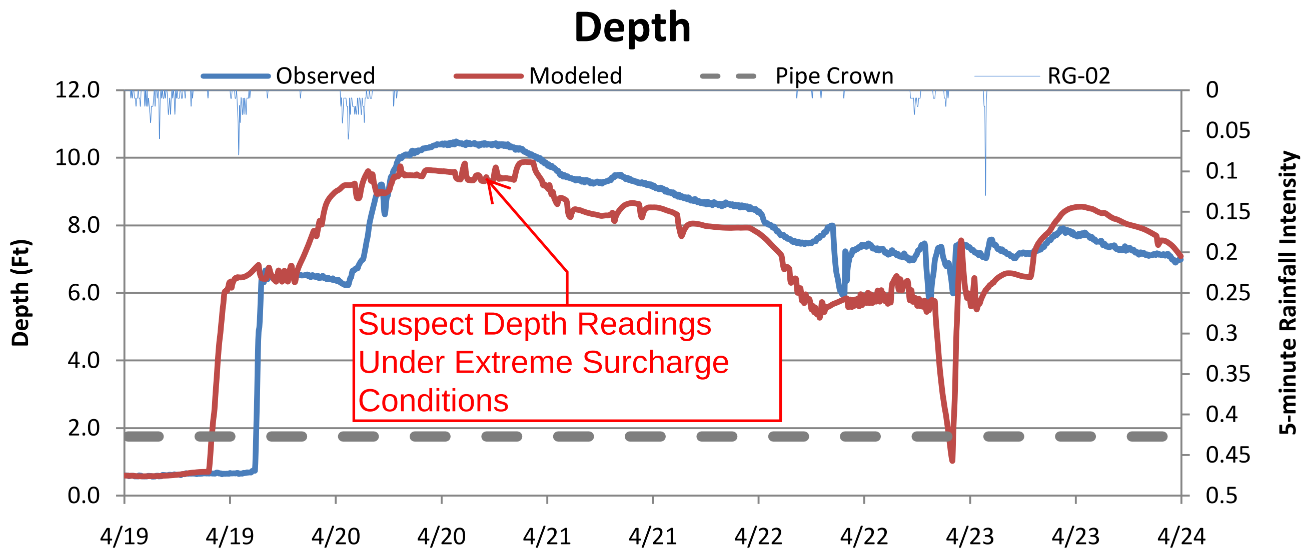
FM-14 WWF Event 2 Calibration

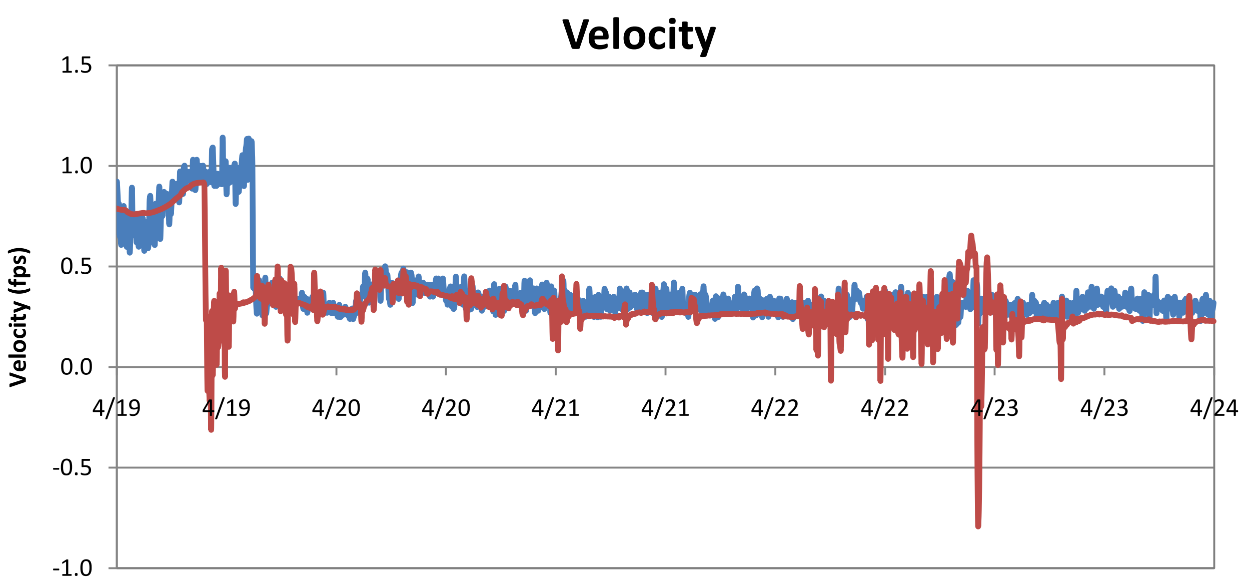


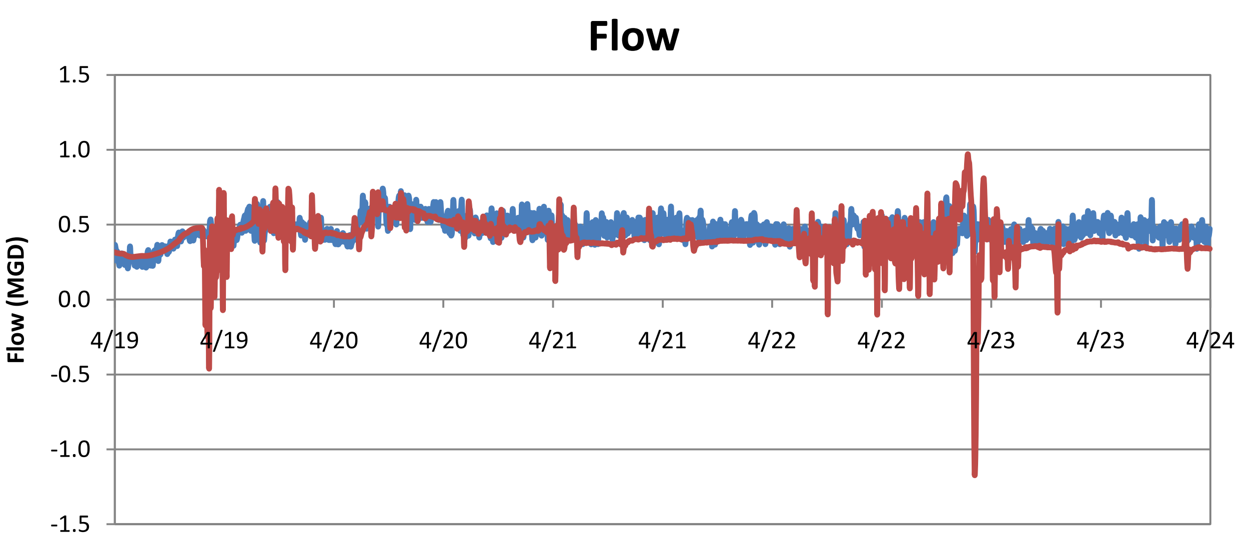




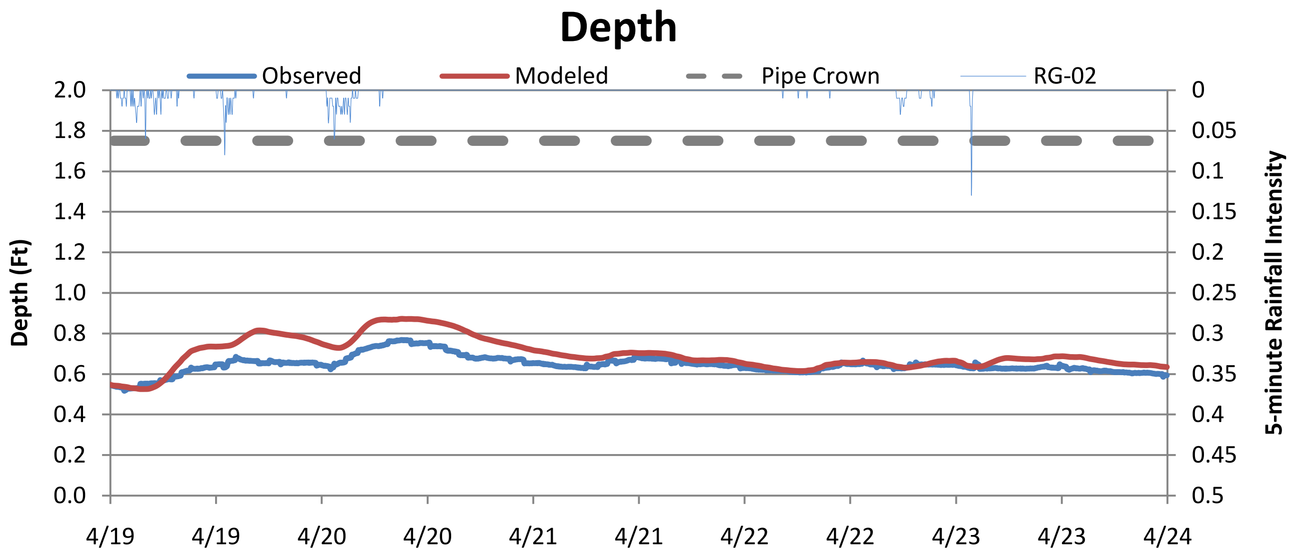
FM-15 WWF Event 2 Calibration

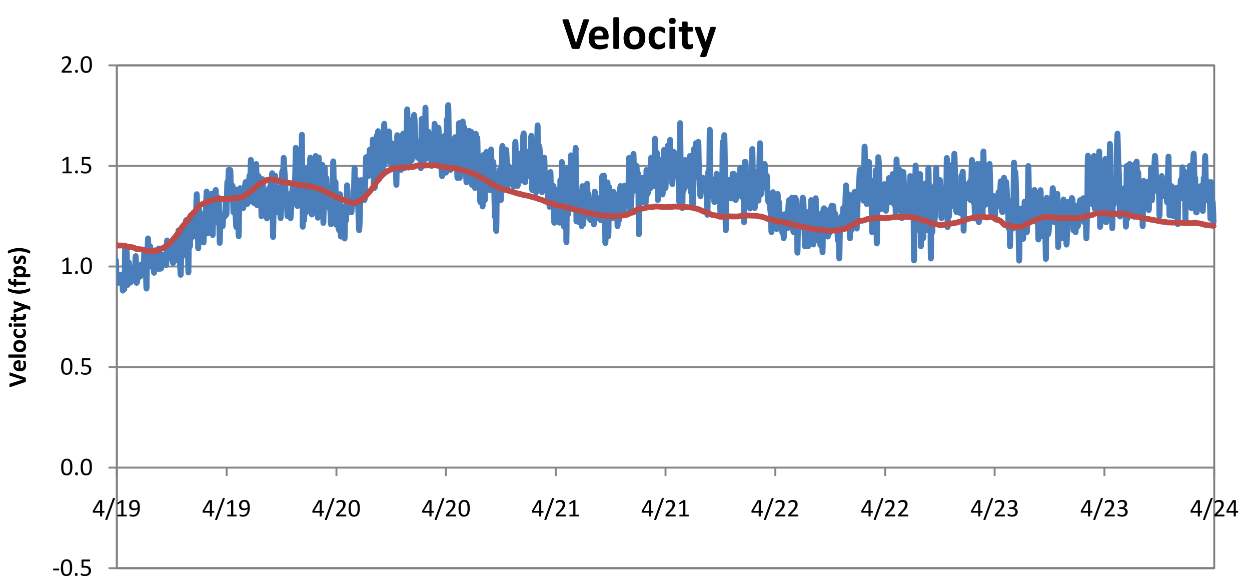


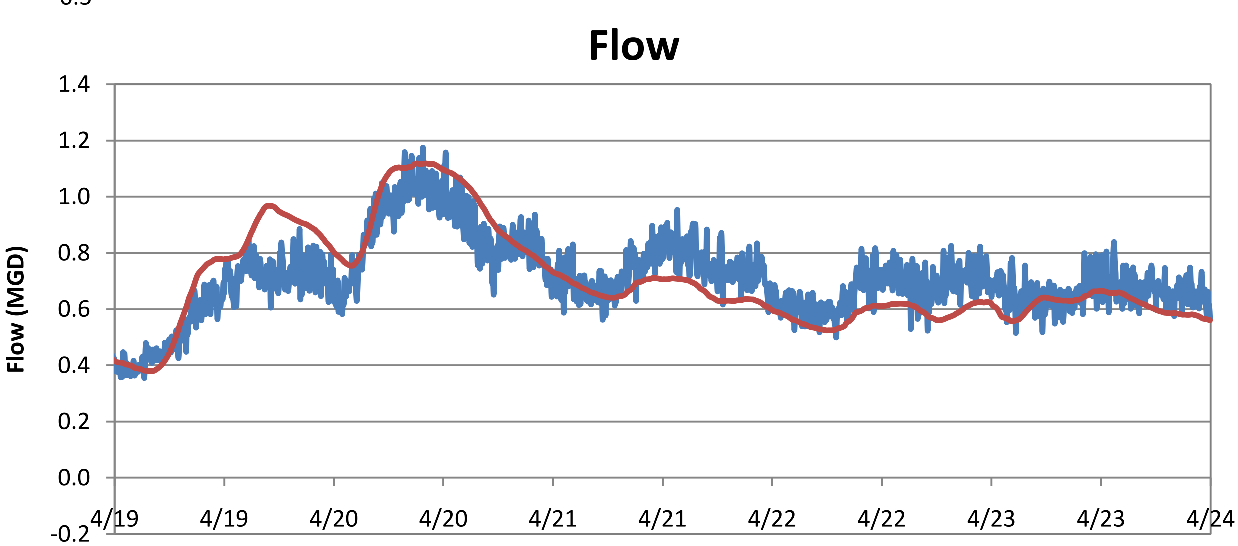




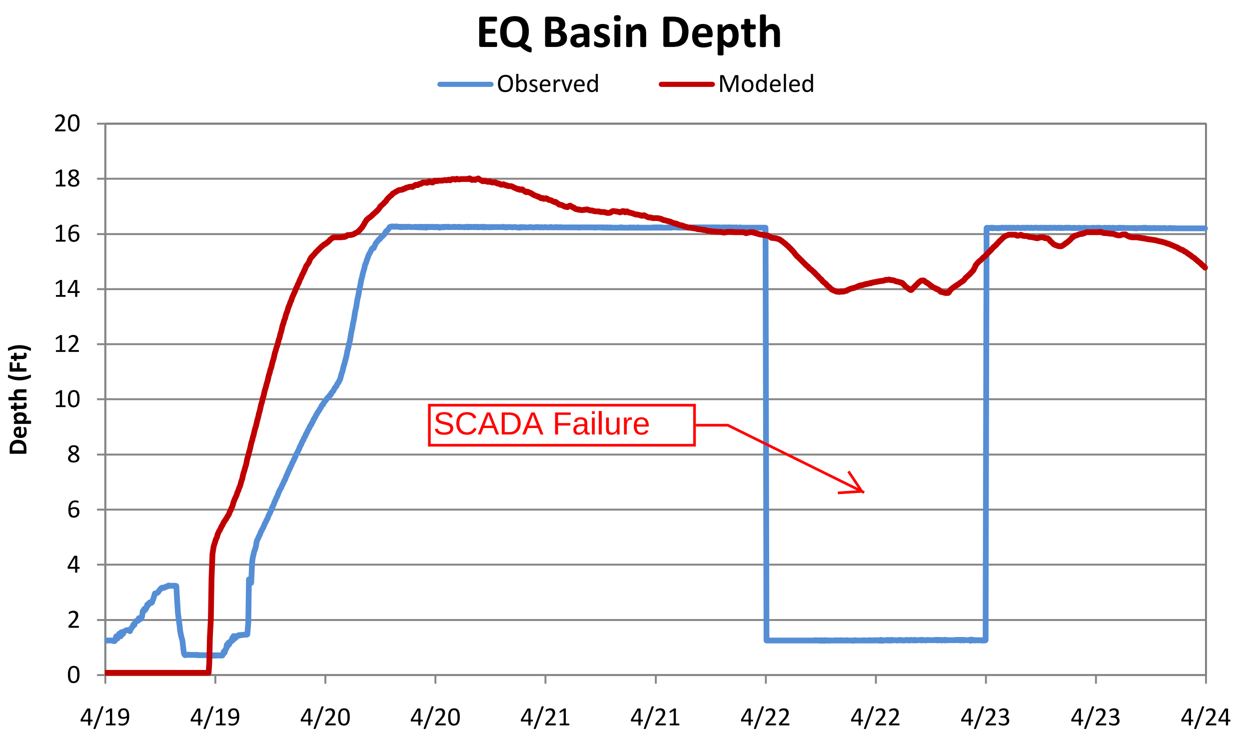
FM-16 WWF Event 2 Calibration

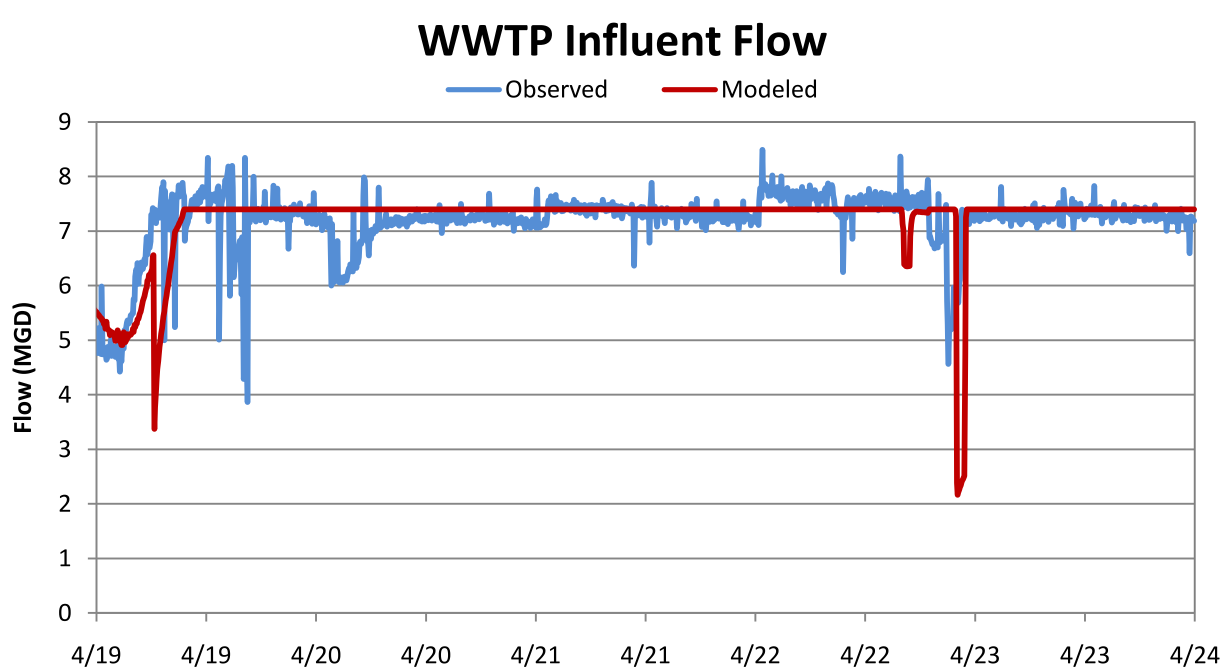






SCADA Meter WWF Event 2 Calibration





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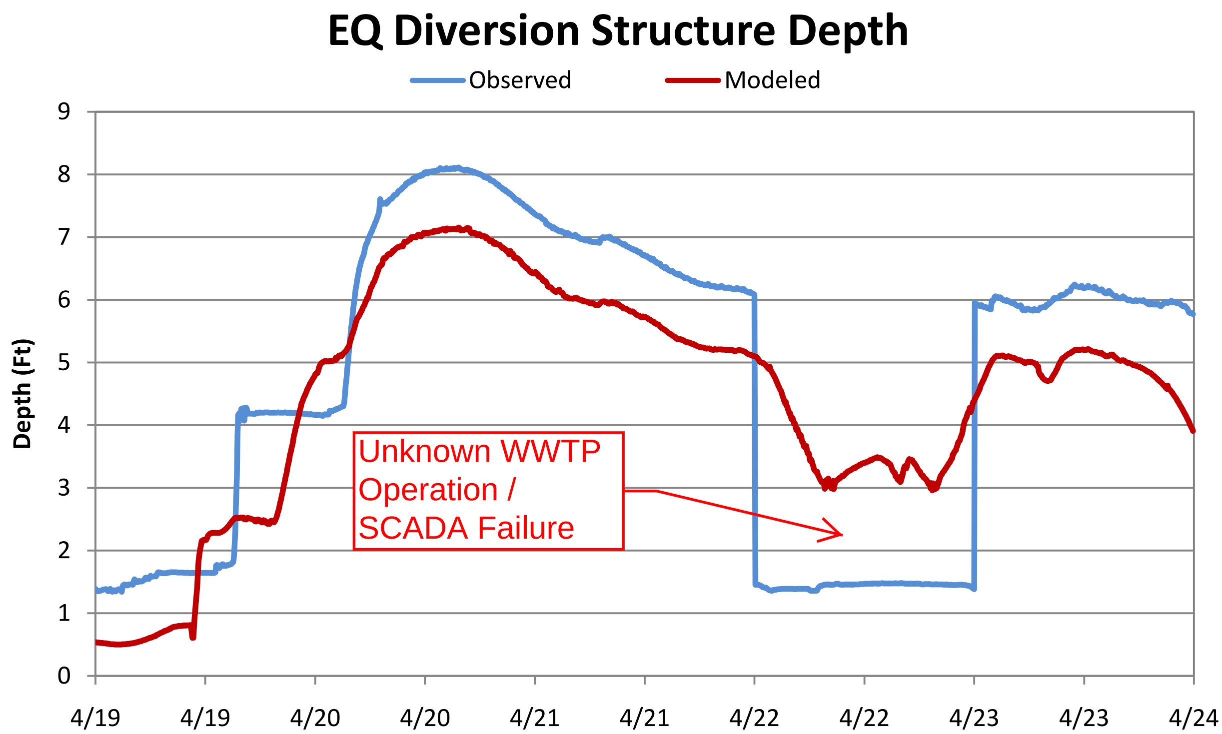
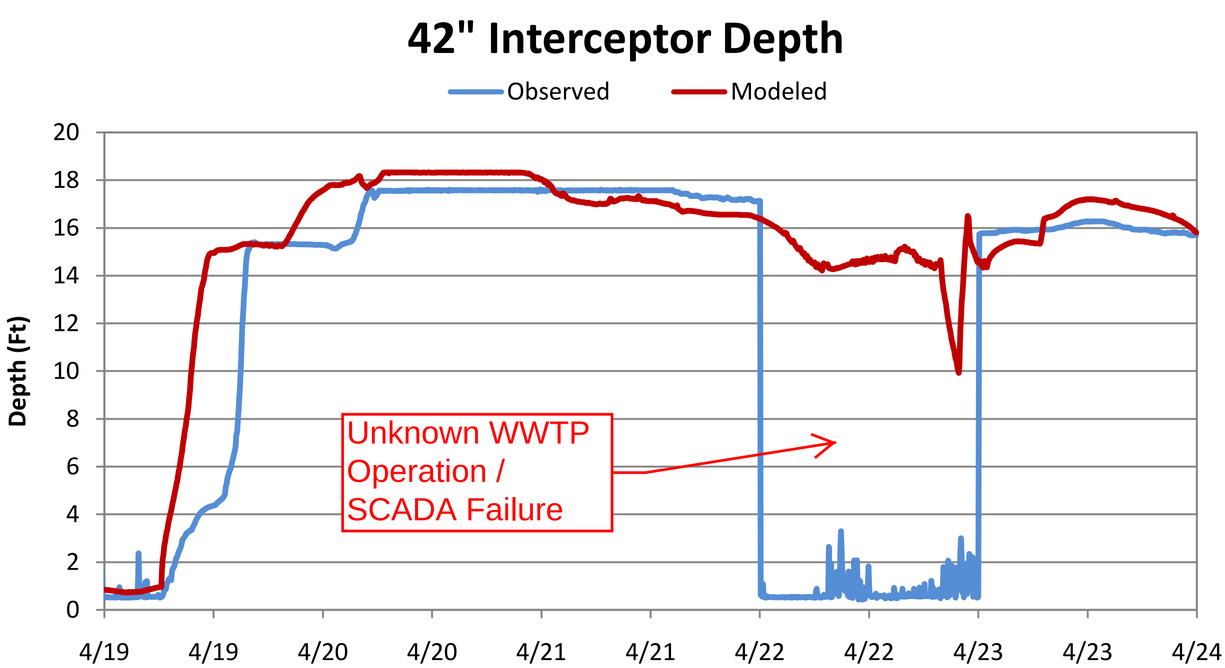


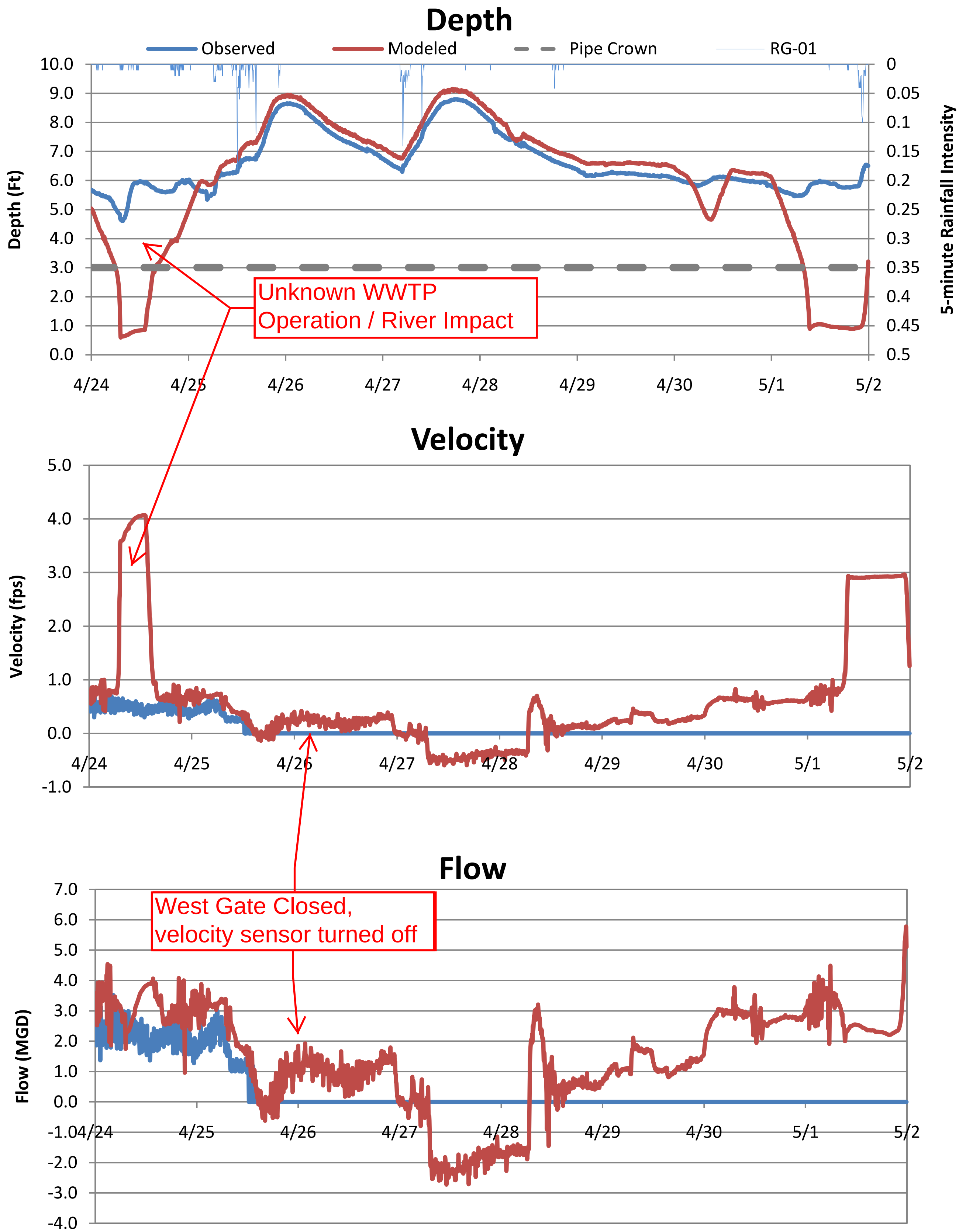


Appendix B

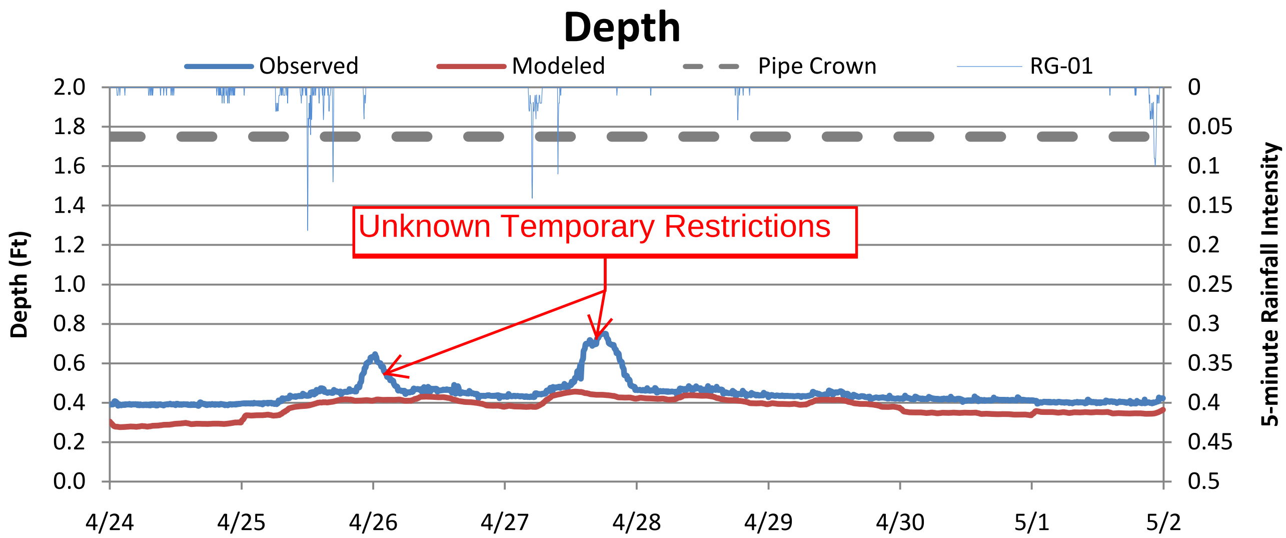
Wet Weather Flow Calibration Plots – Event 3

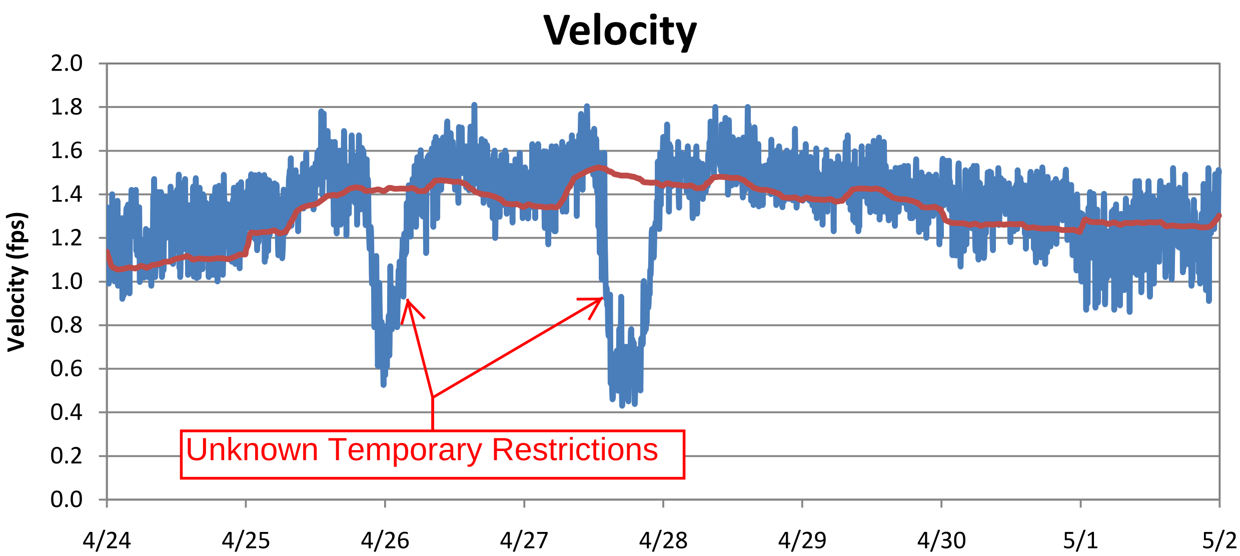
CDM Smith

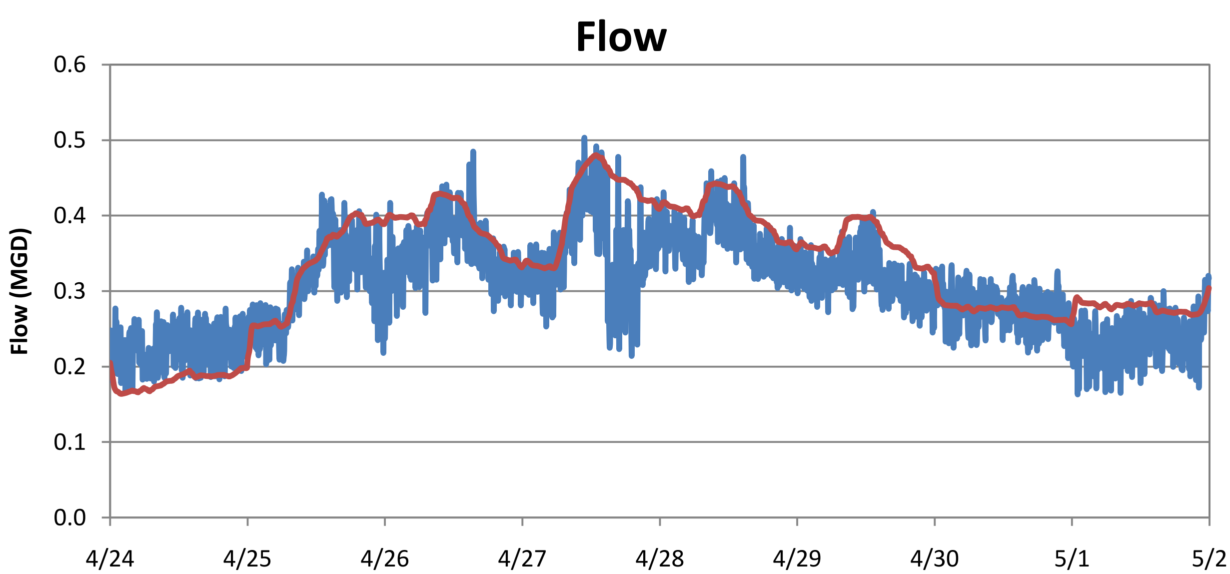
FM-01 WWF Event 3 Calibration



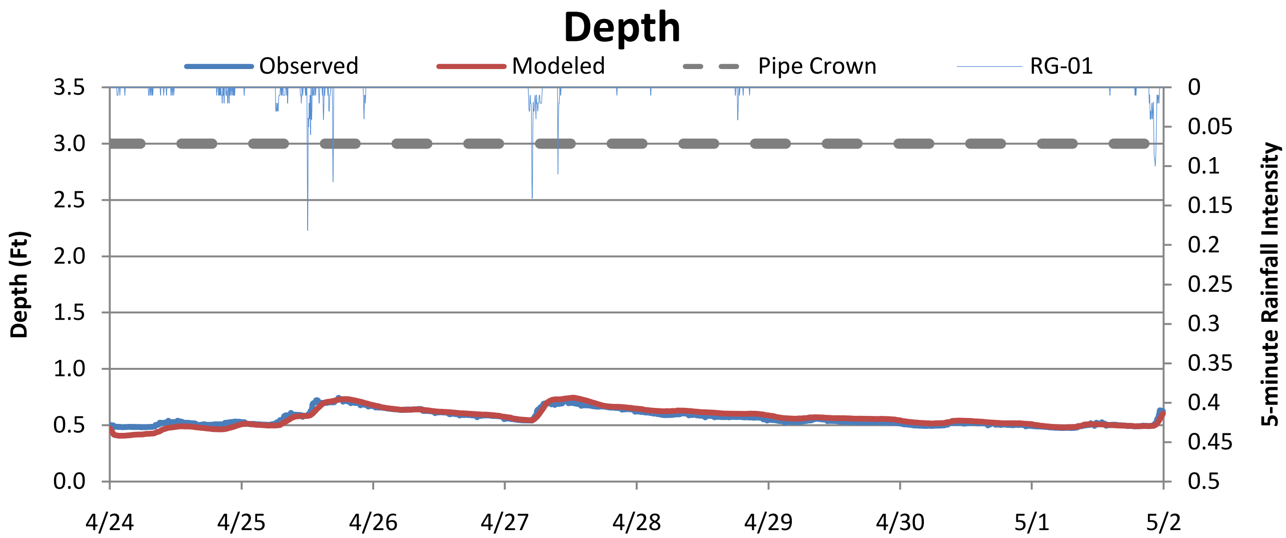
FM-02 WWF Event 3 Calibration

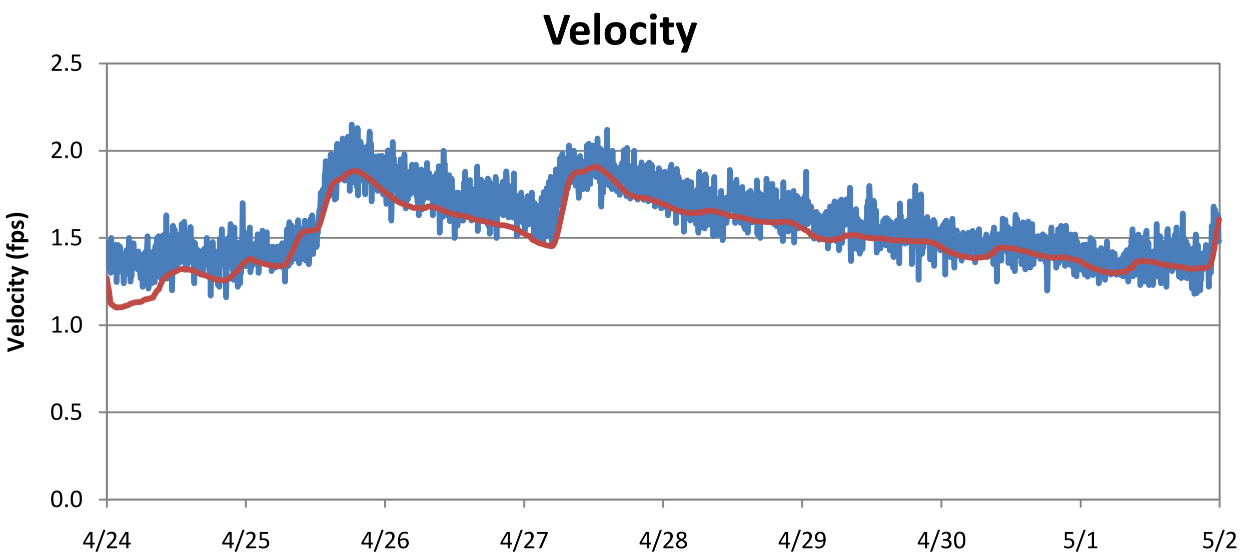


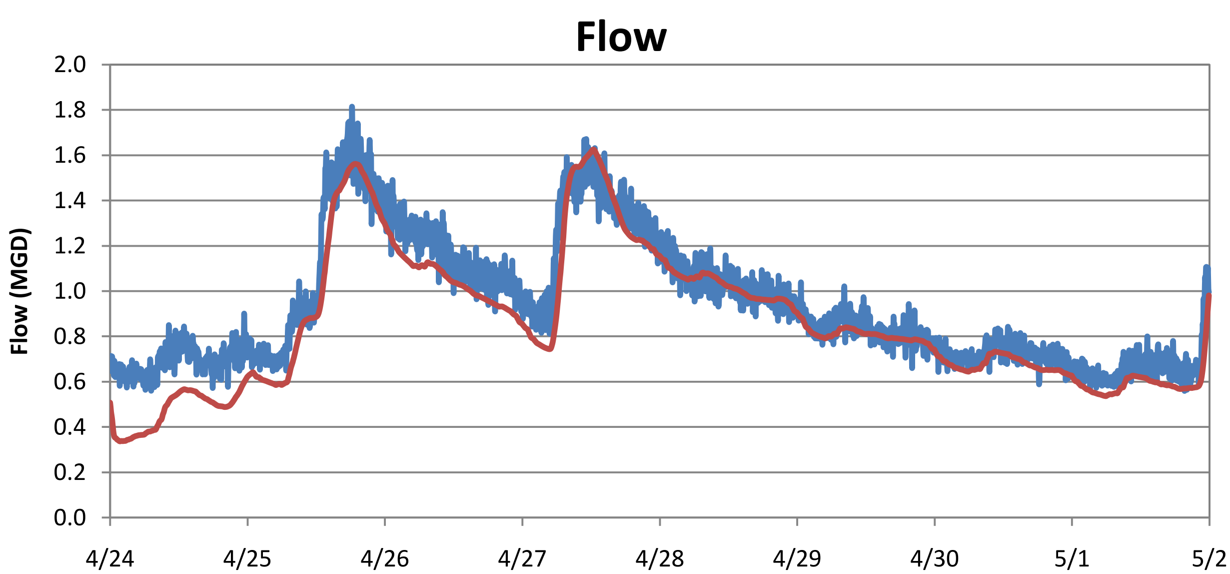




FM-03 WWF Event 3 Calibration







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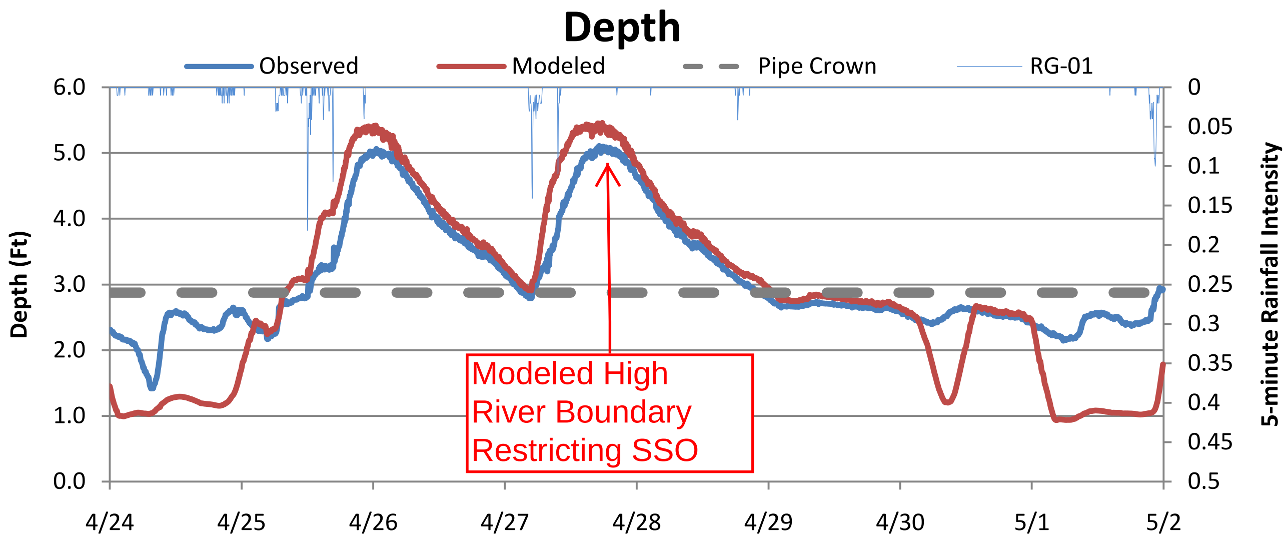
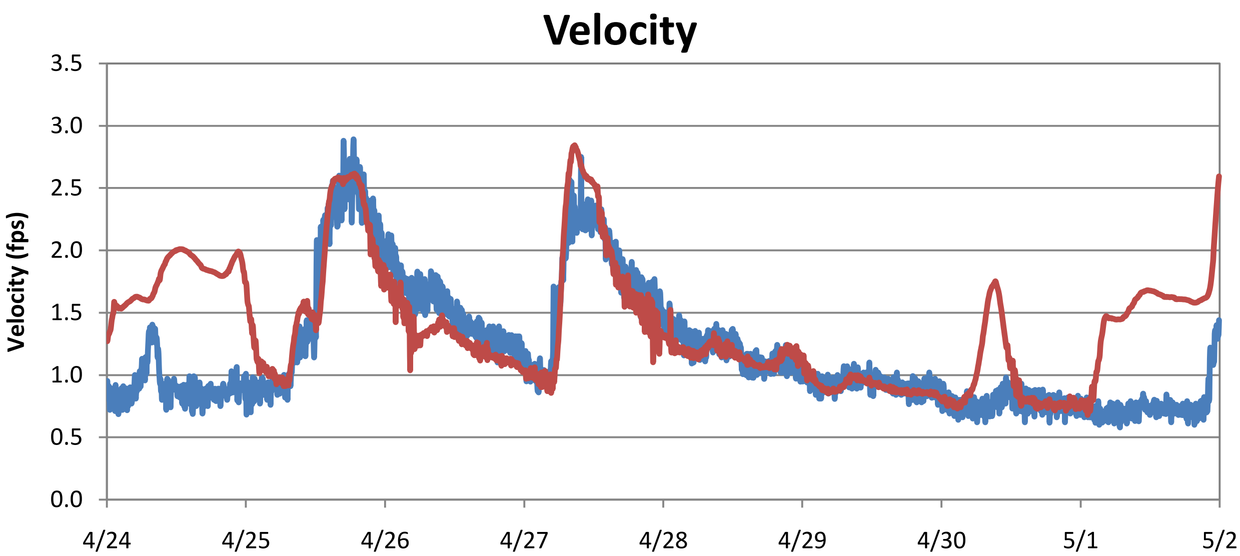
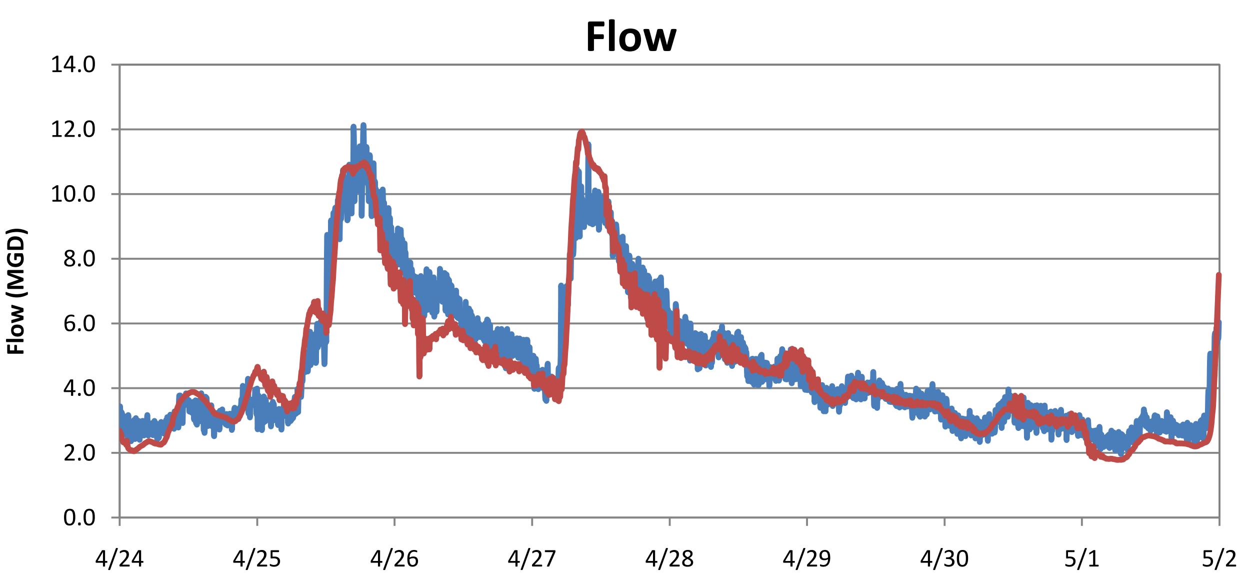
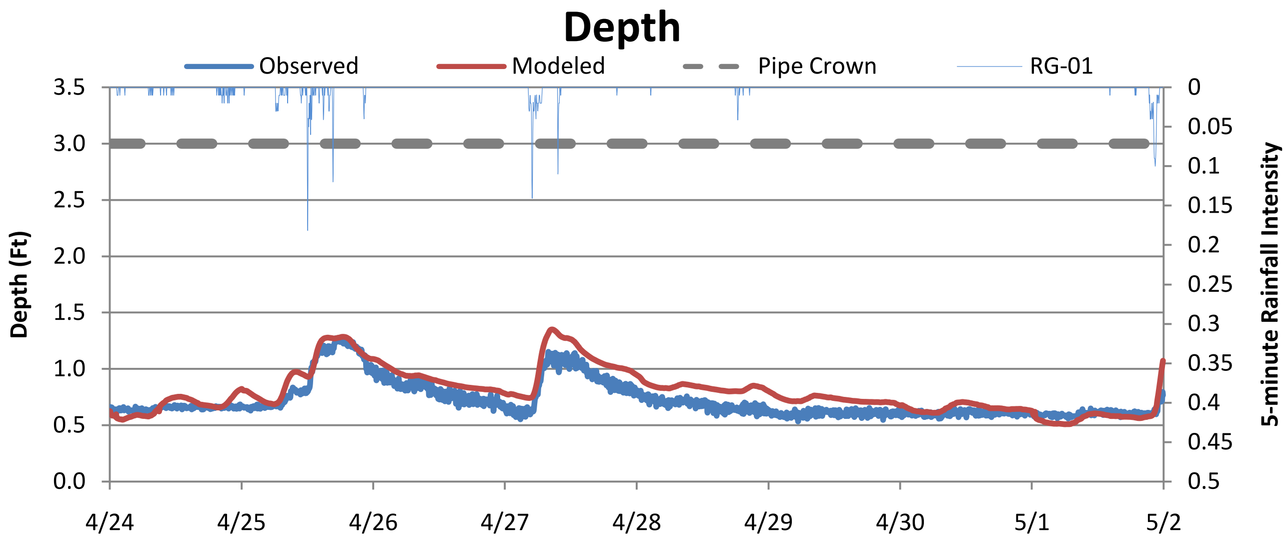
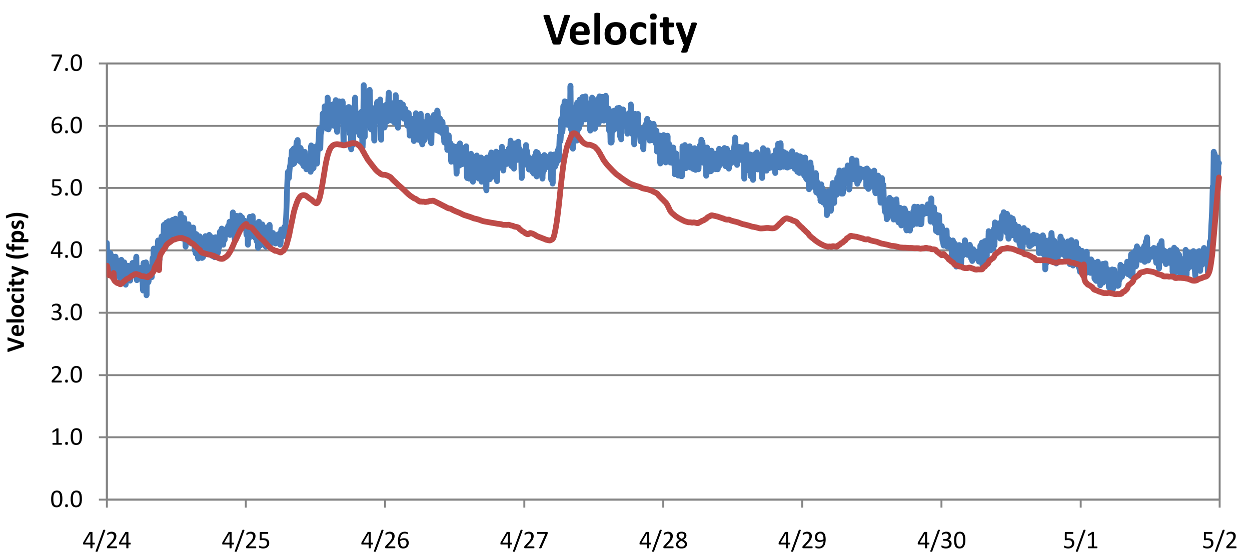


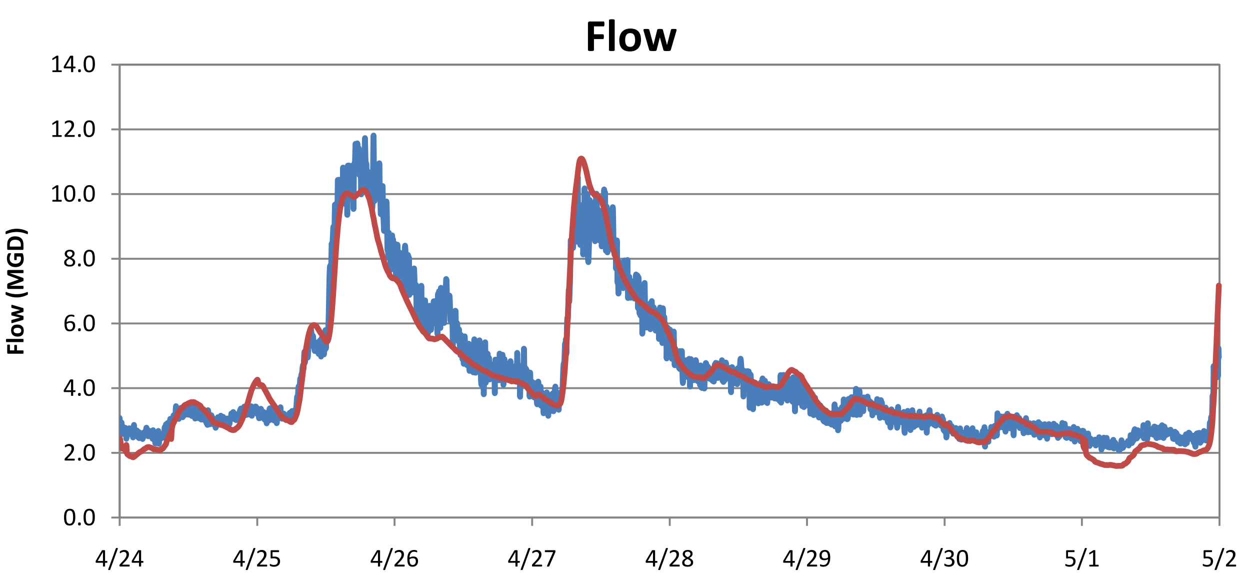




FM-05 WWF Event 3 Calibration







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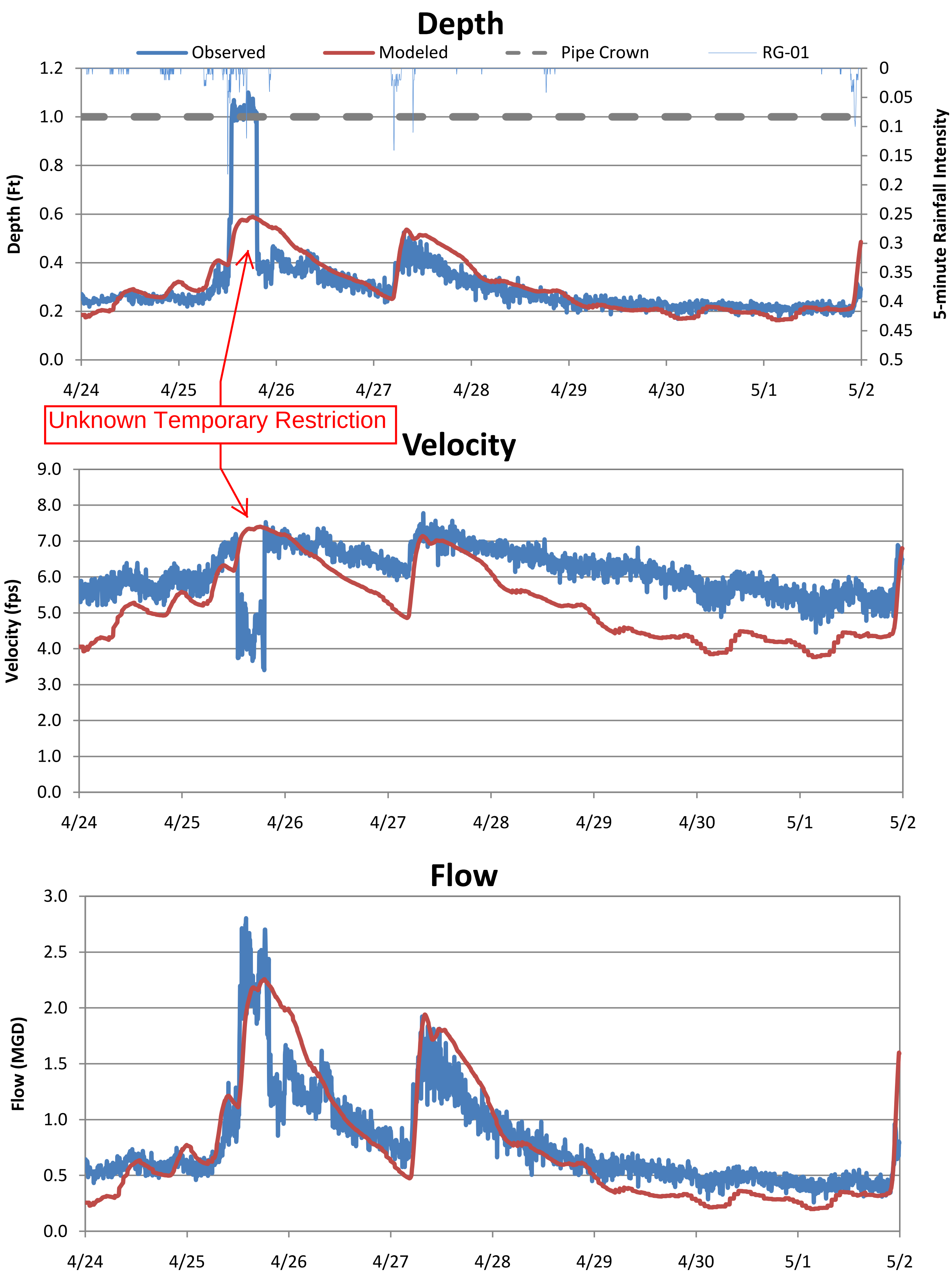
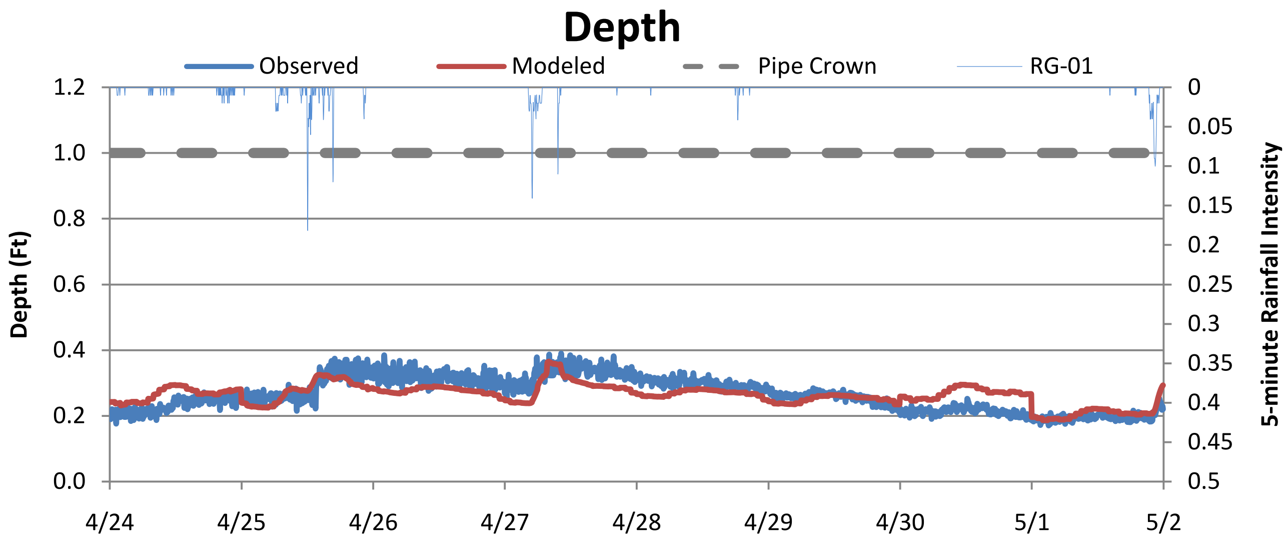
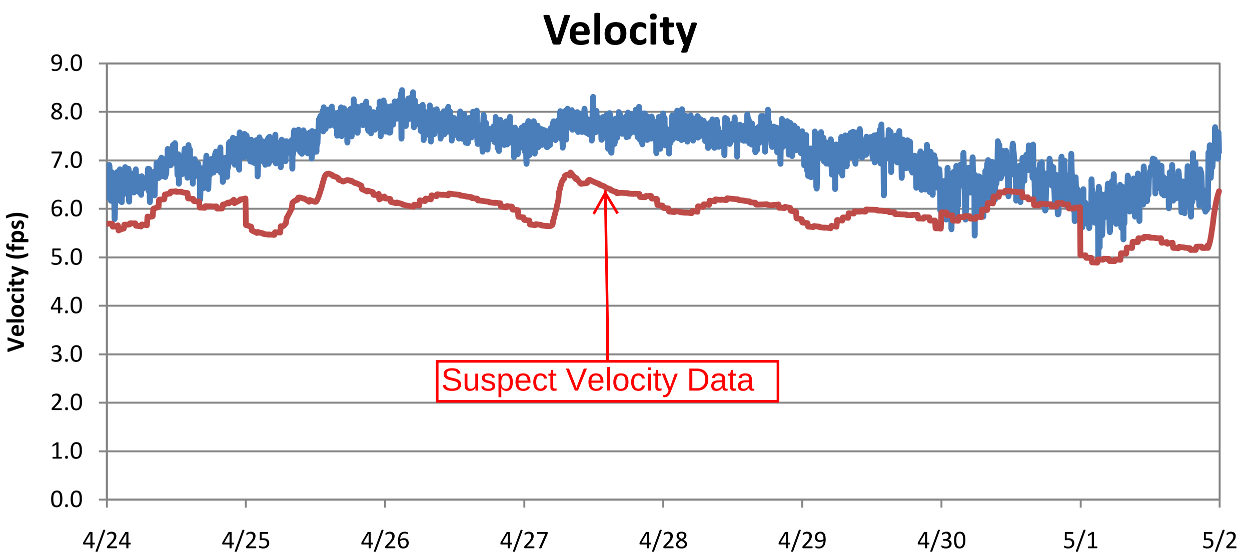
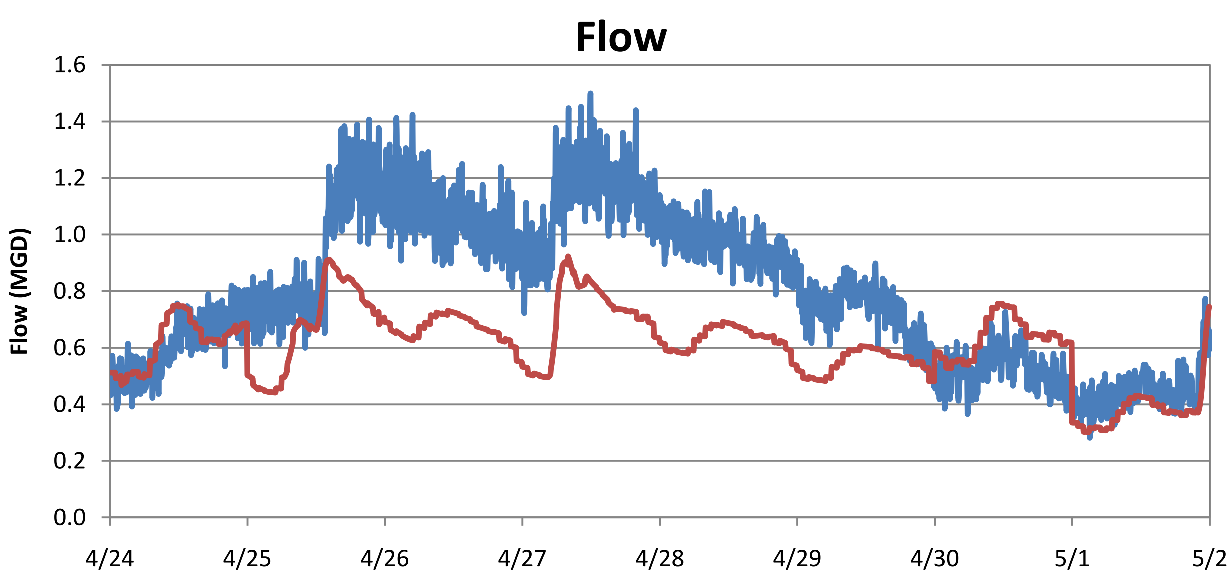


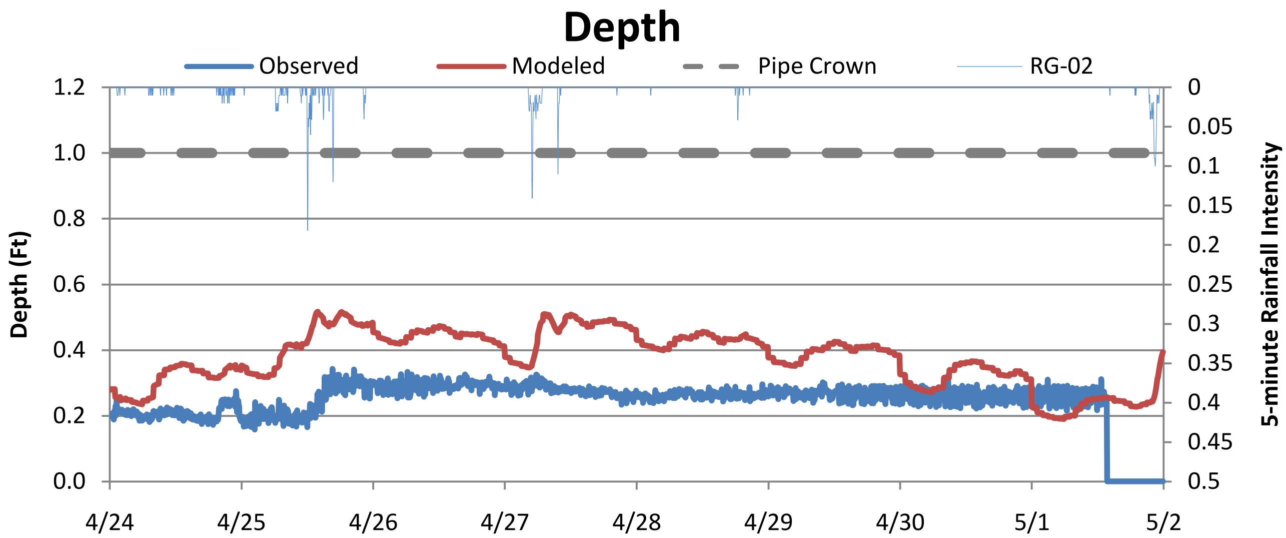
FM-07 WWF Event 3 Calibration

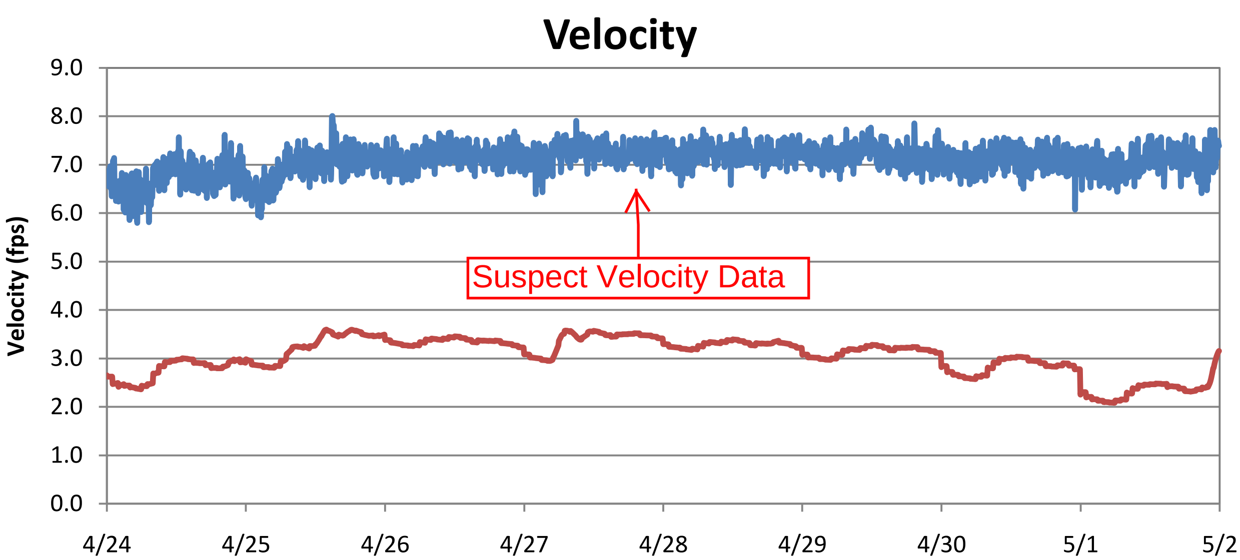


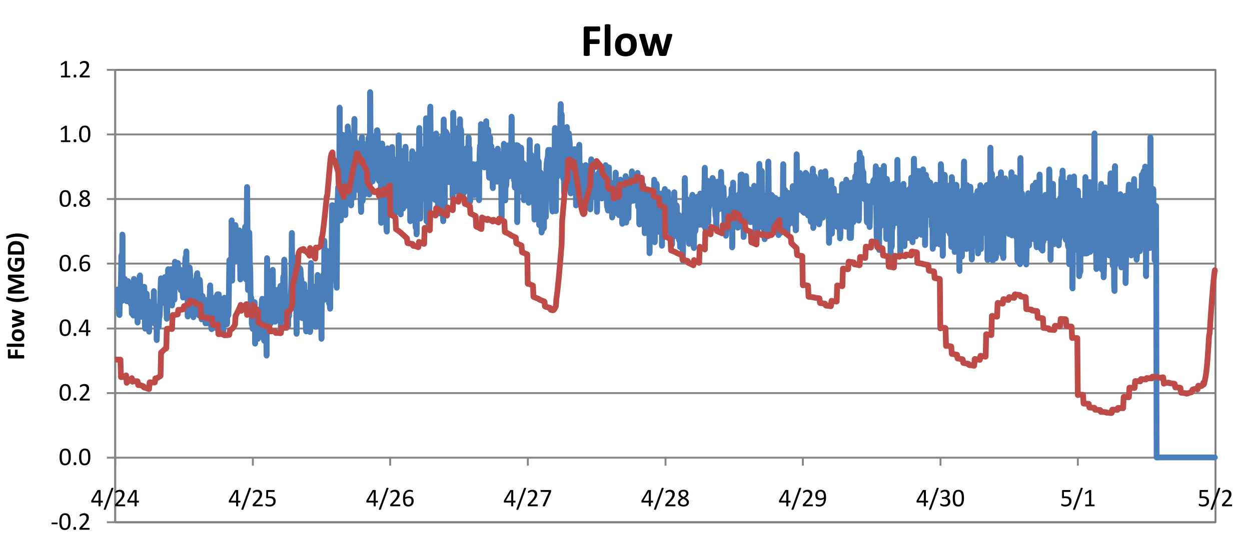




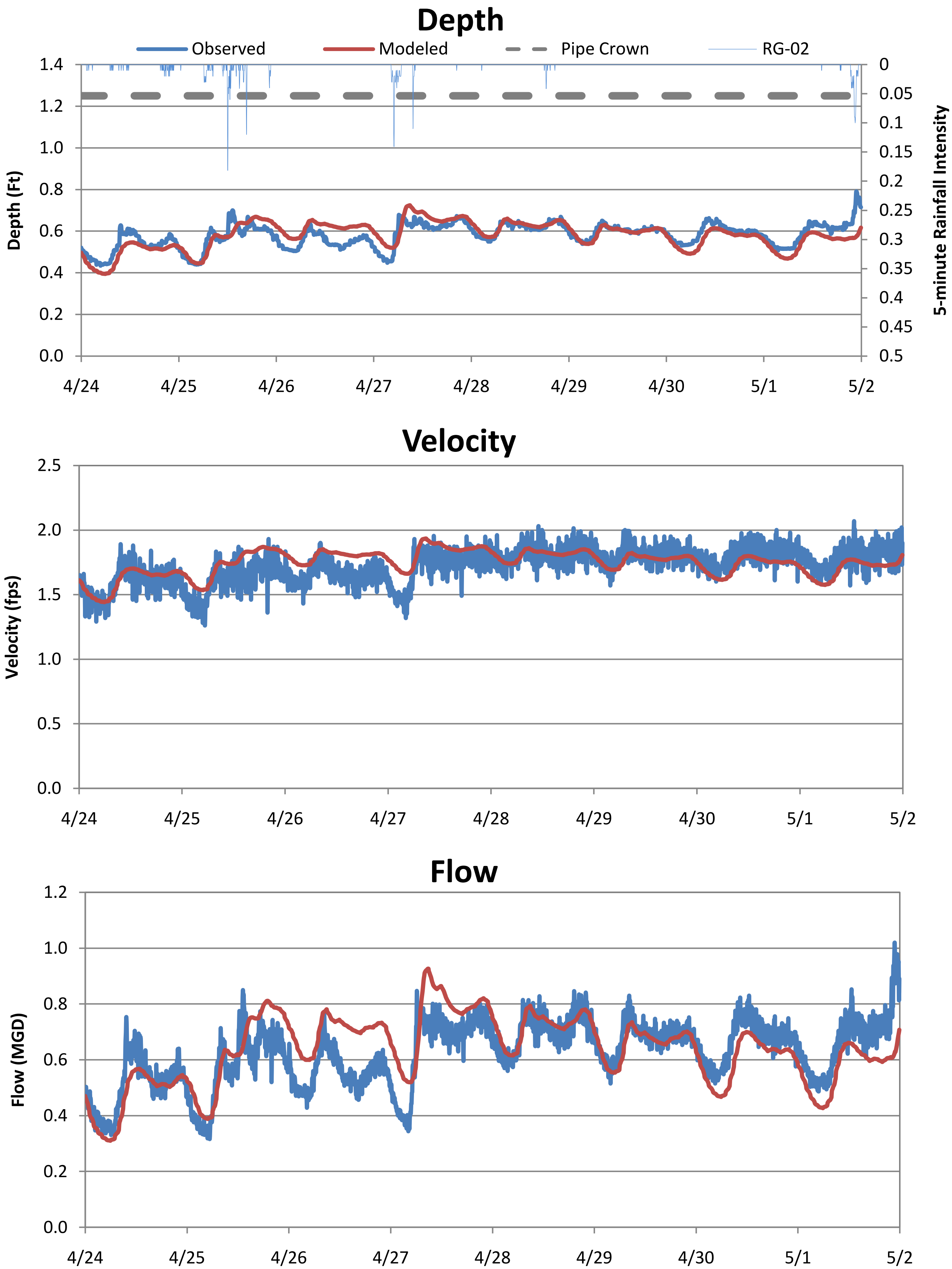
FM-08 WWF Event 3 Calibration



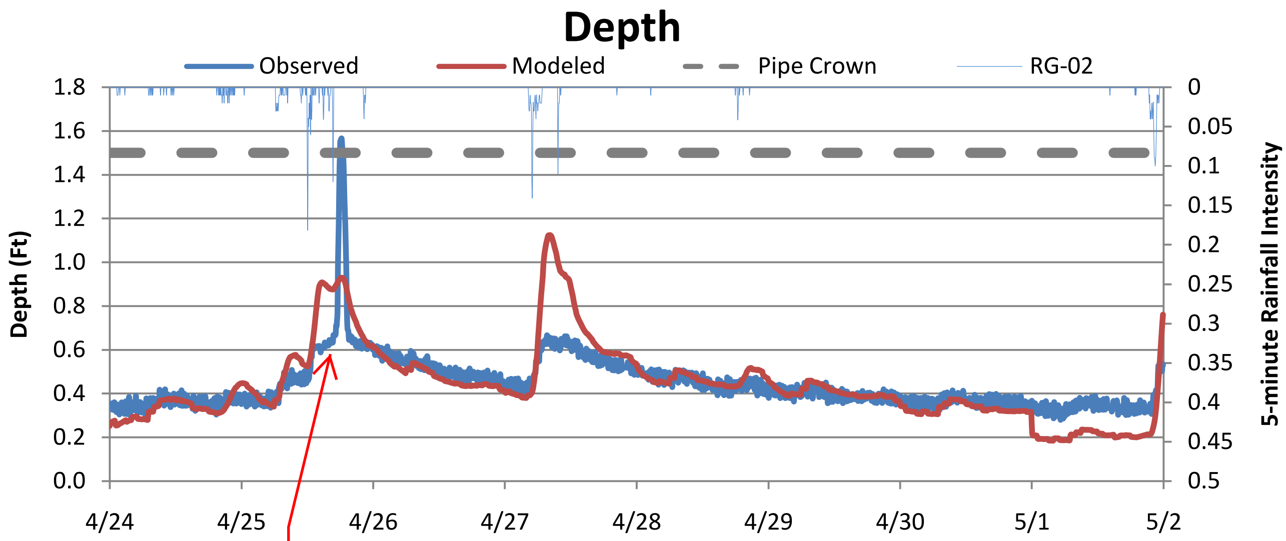


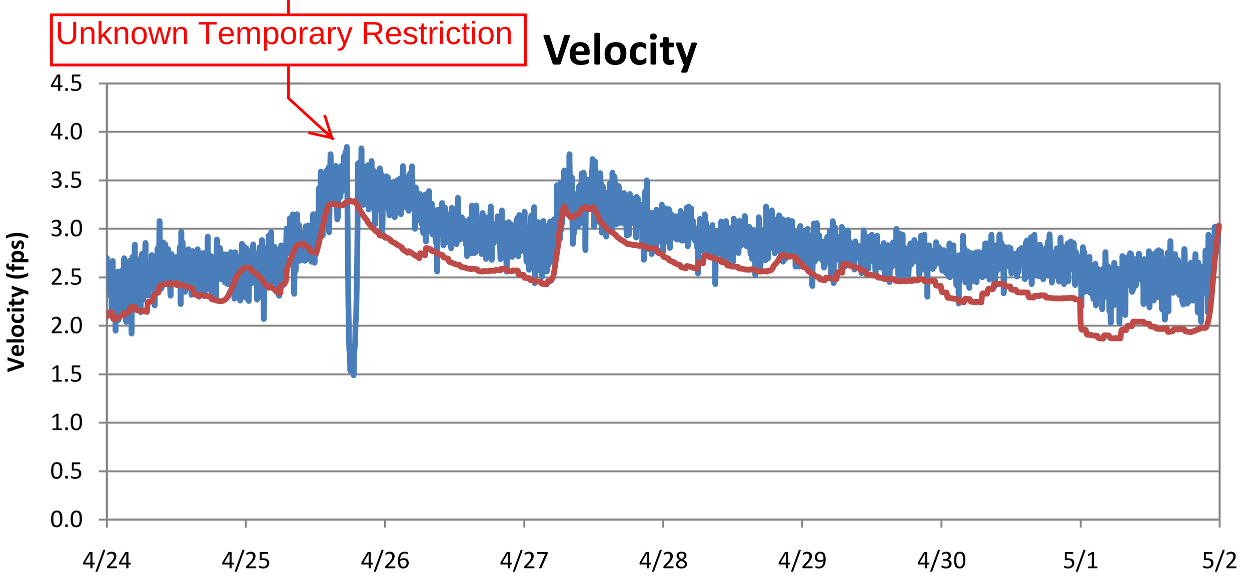


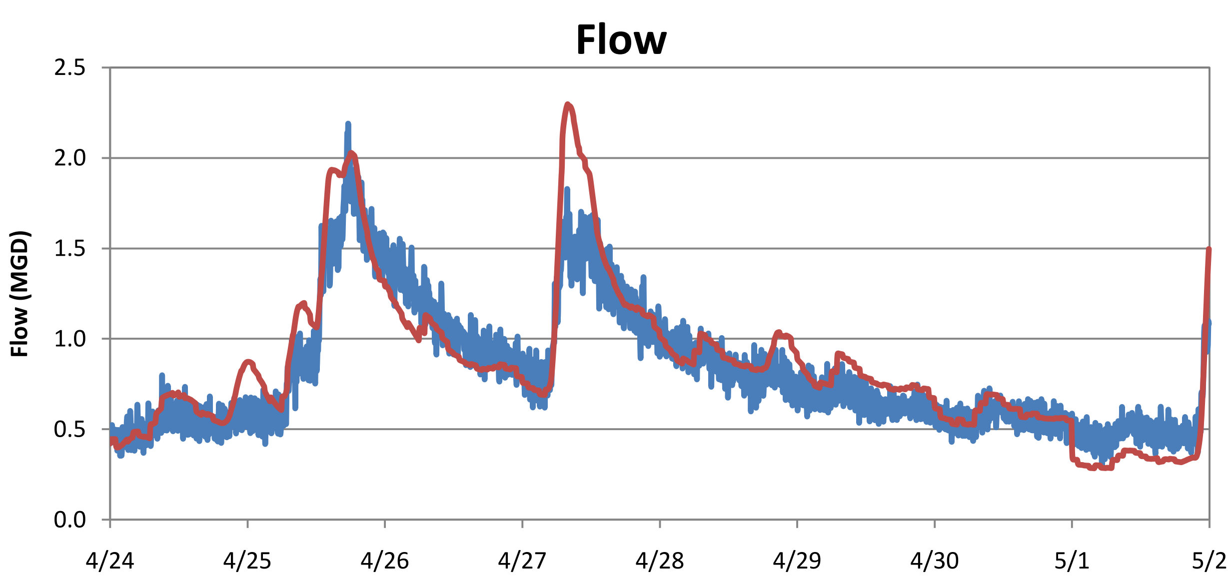
FM-09 WWF Event 3 Calibration



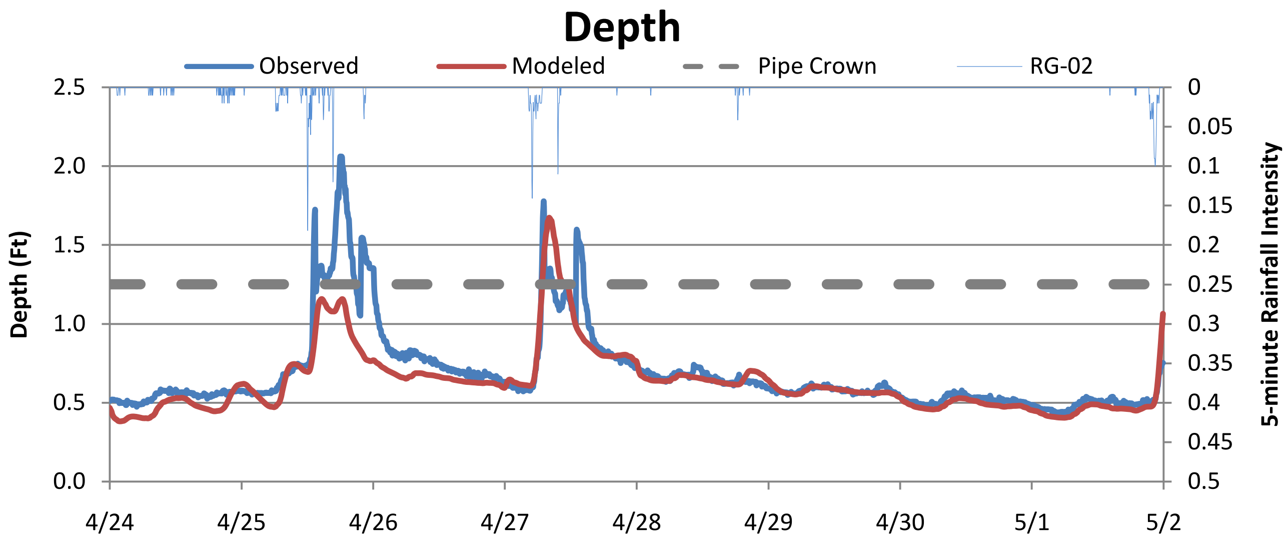
FM-10 WWF Event 3 Calibration

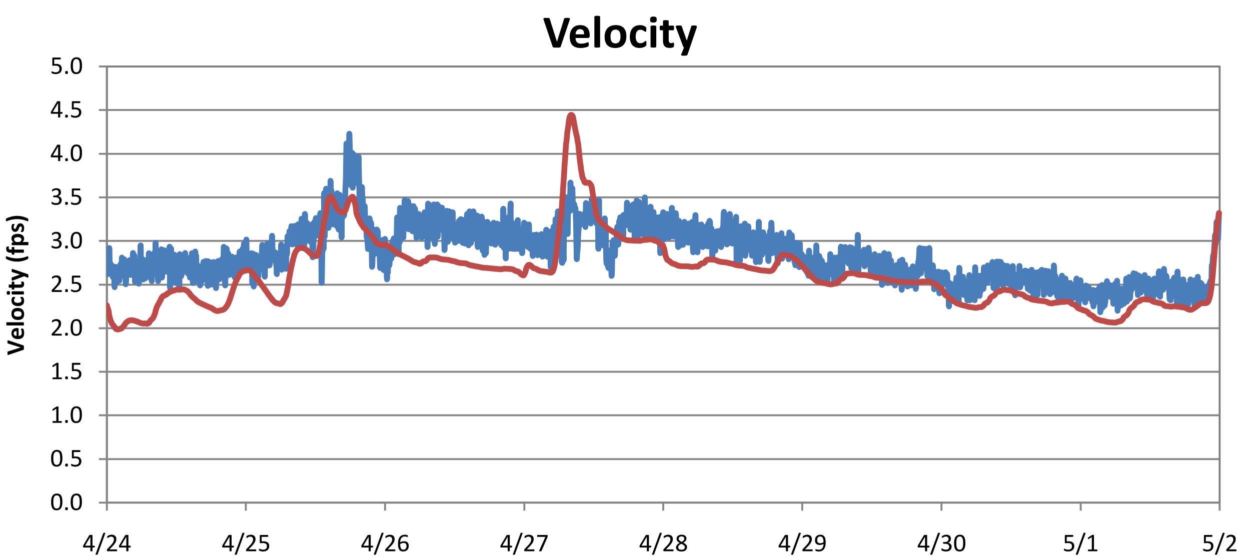


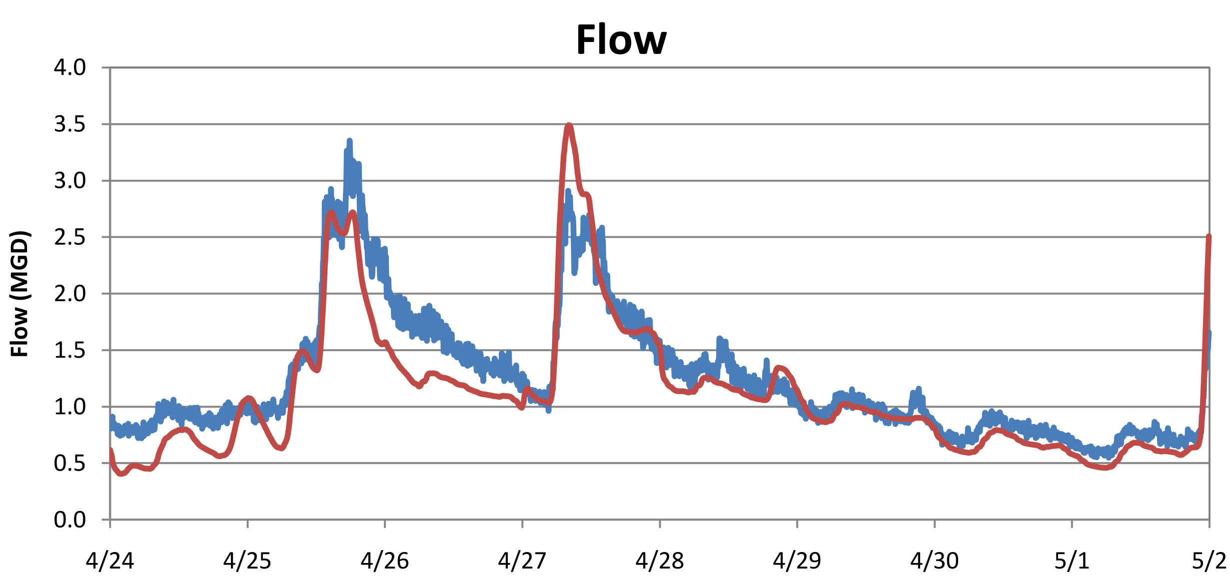




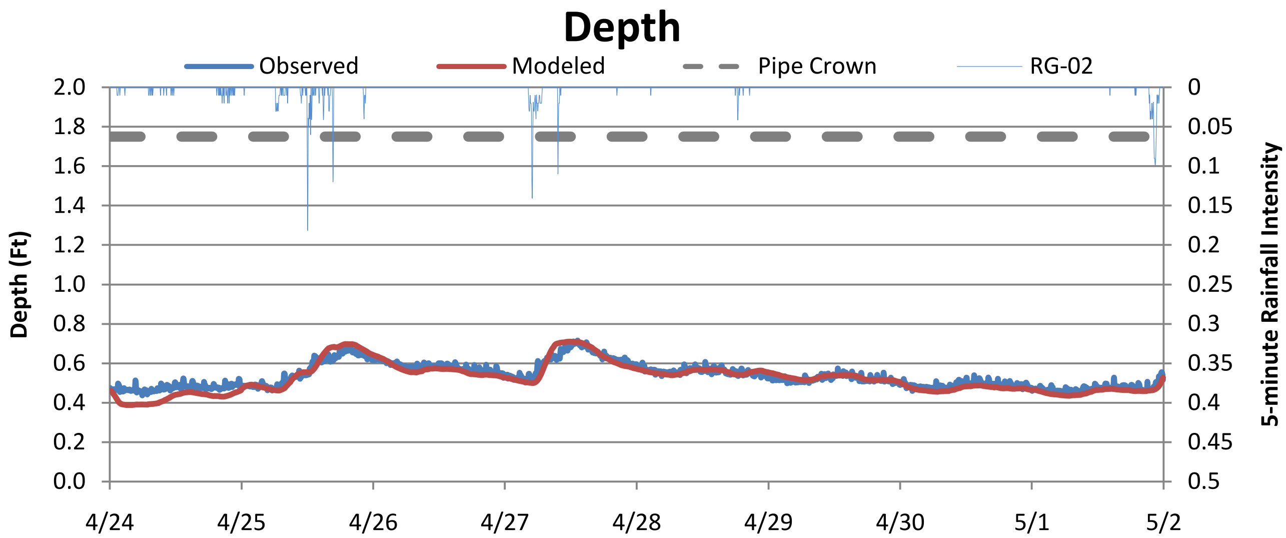
FM-11 WWF Event 3 Calibration

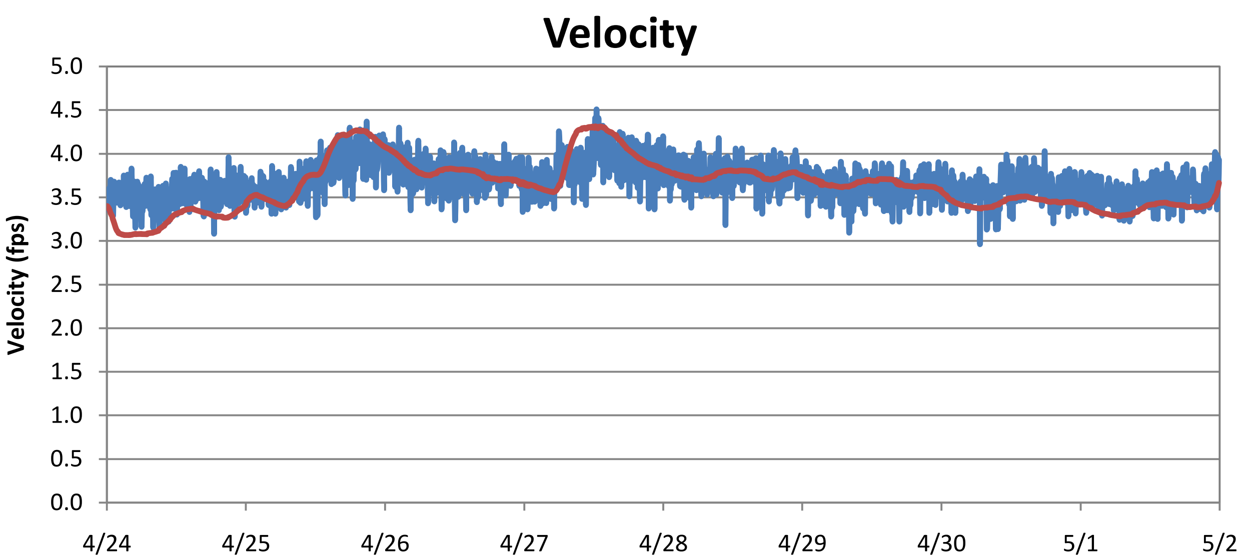


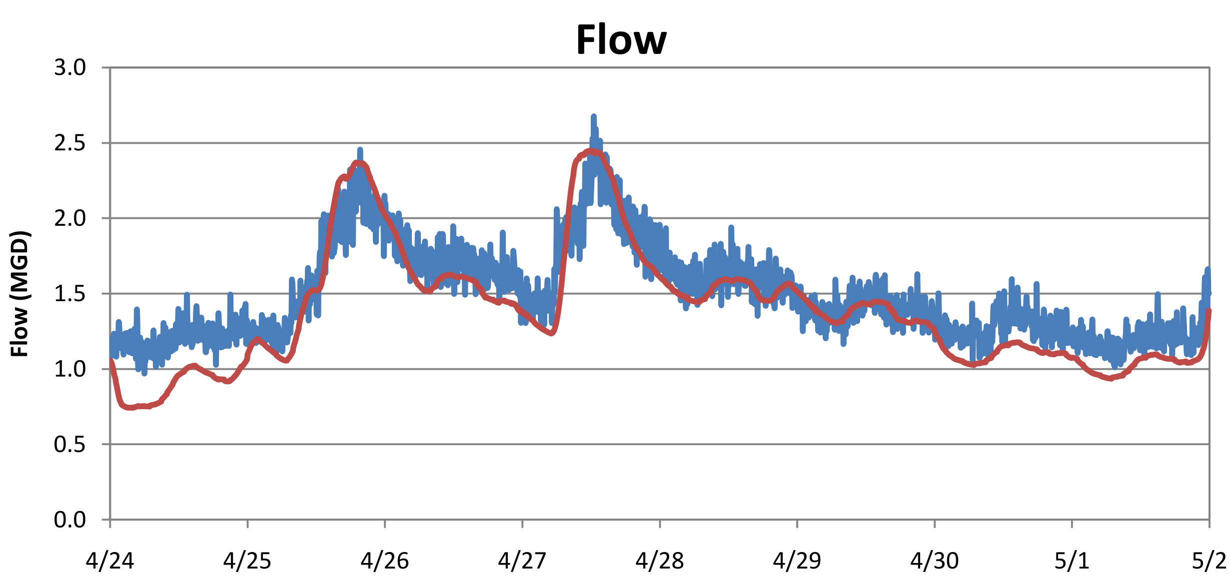




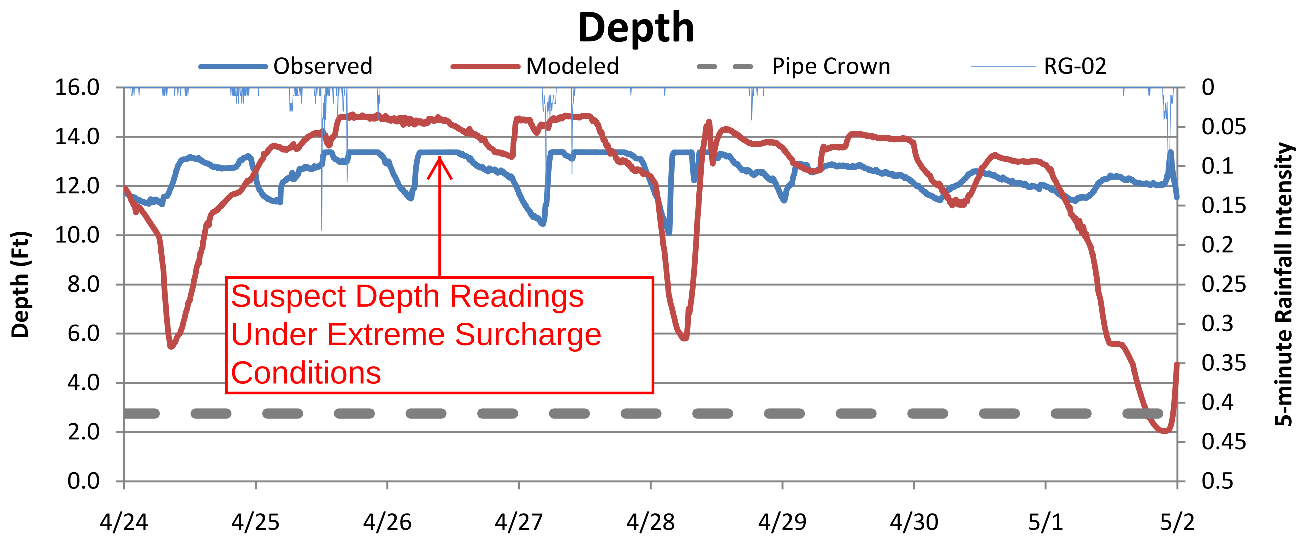
FM-12 WWF Event 3 Calibration

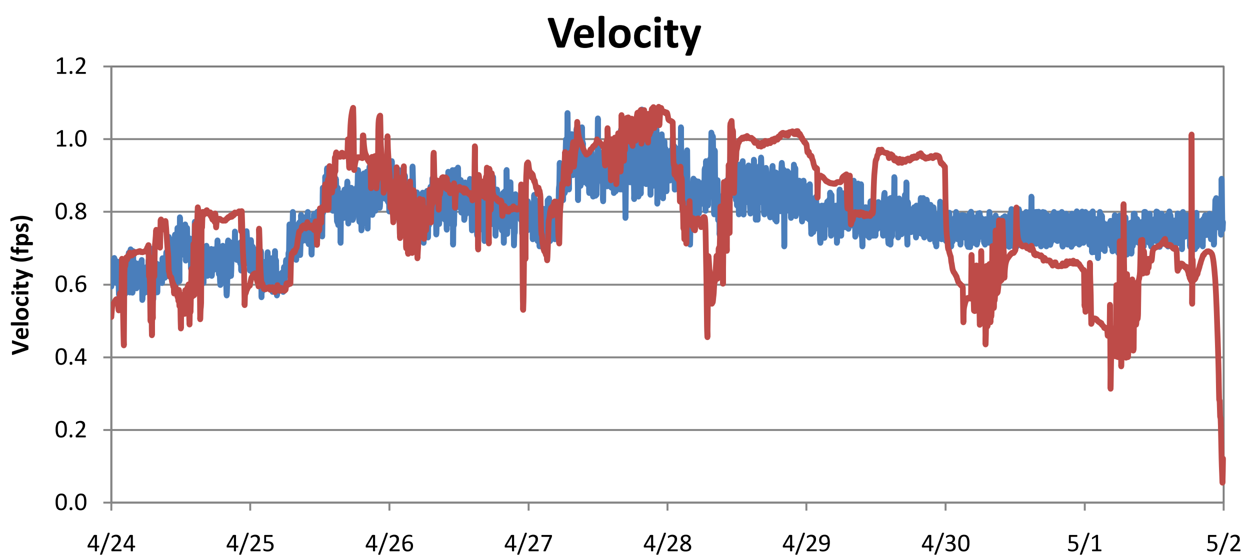


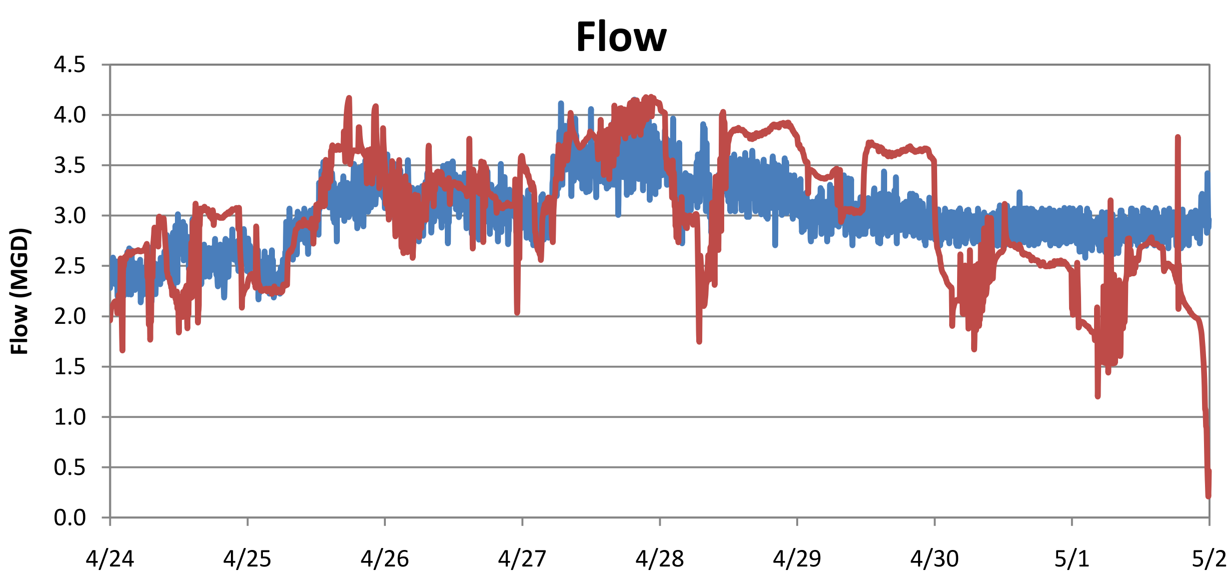




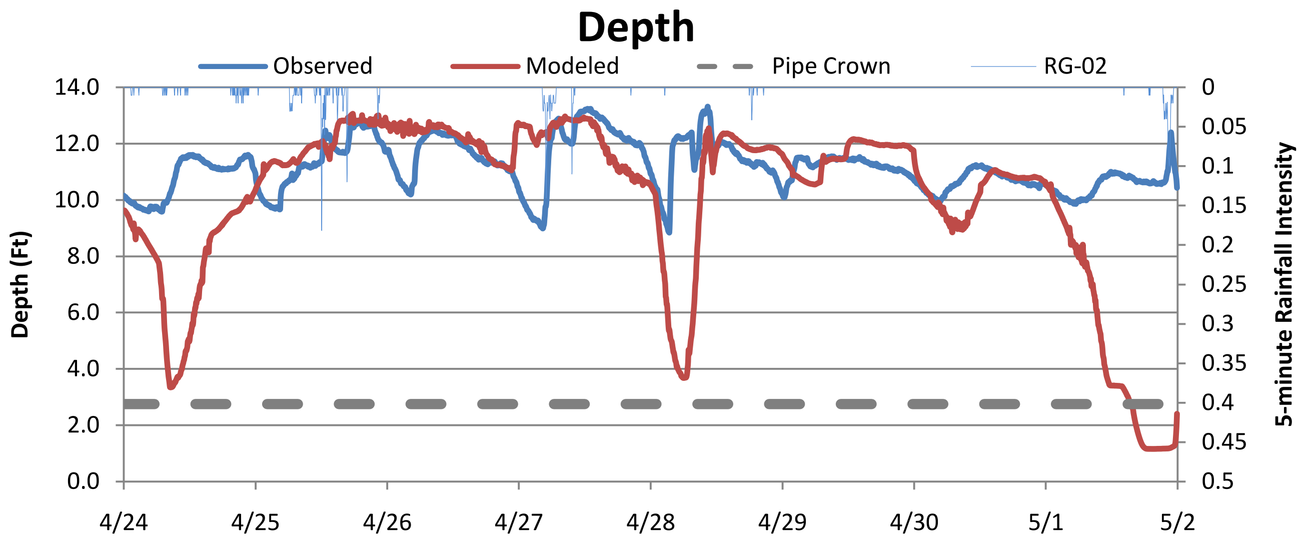
FM-13 WWF Event 3 Calibration

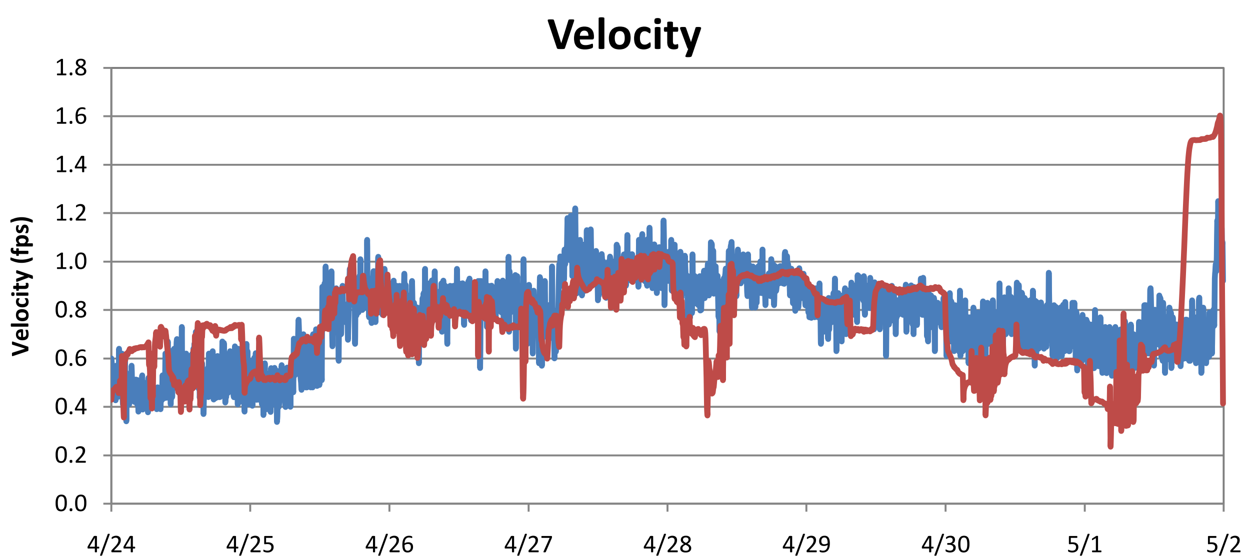


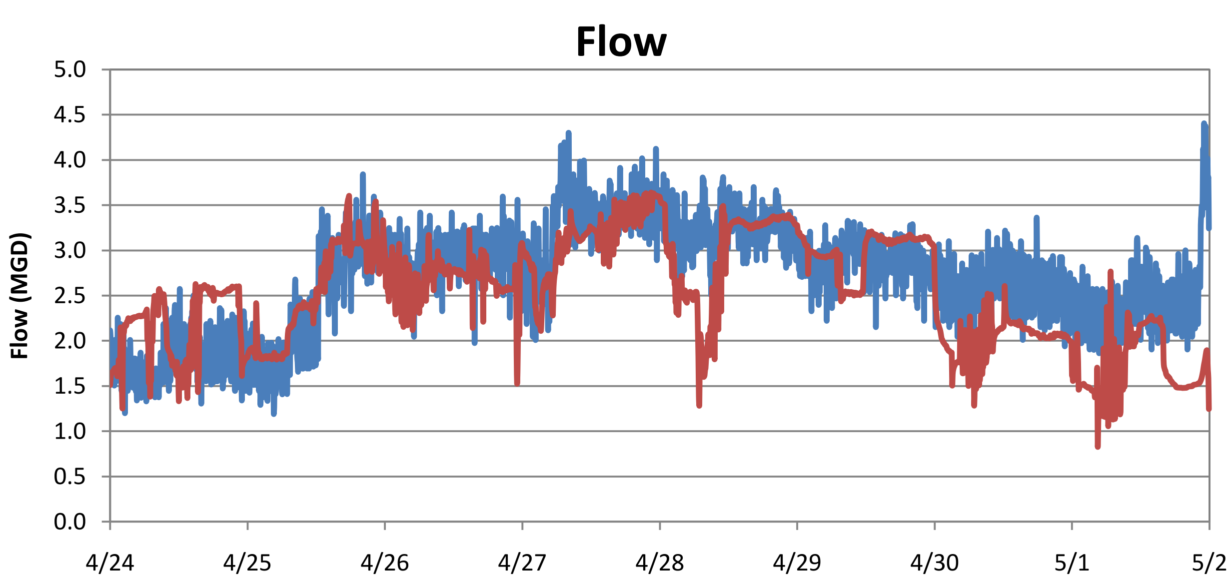




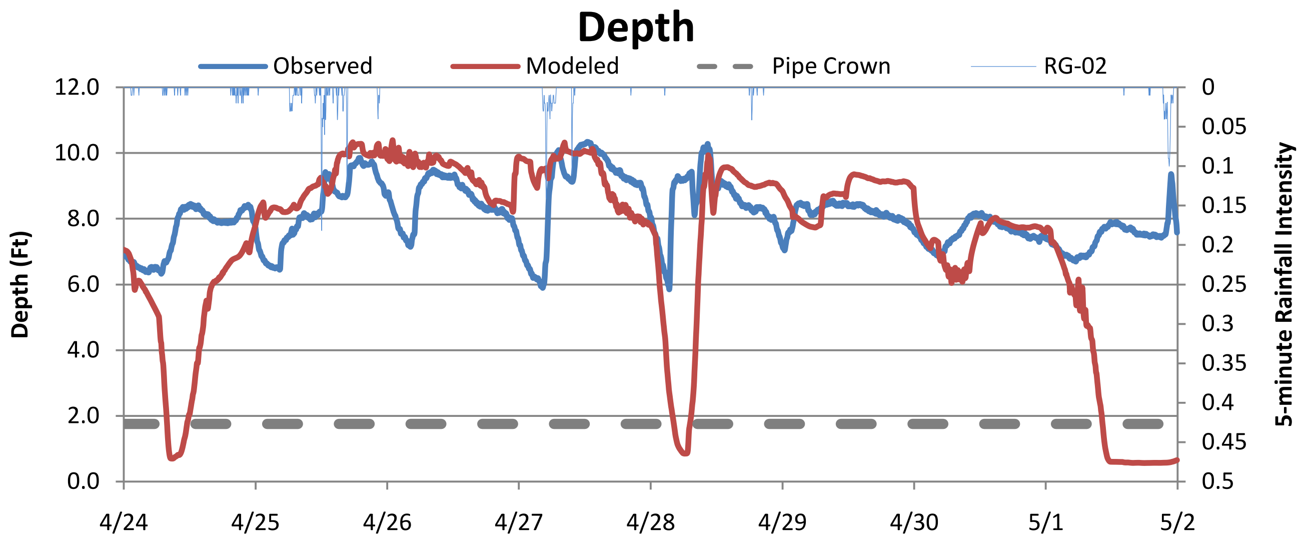
FM-14 WWF Event 3 Calibration

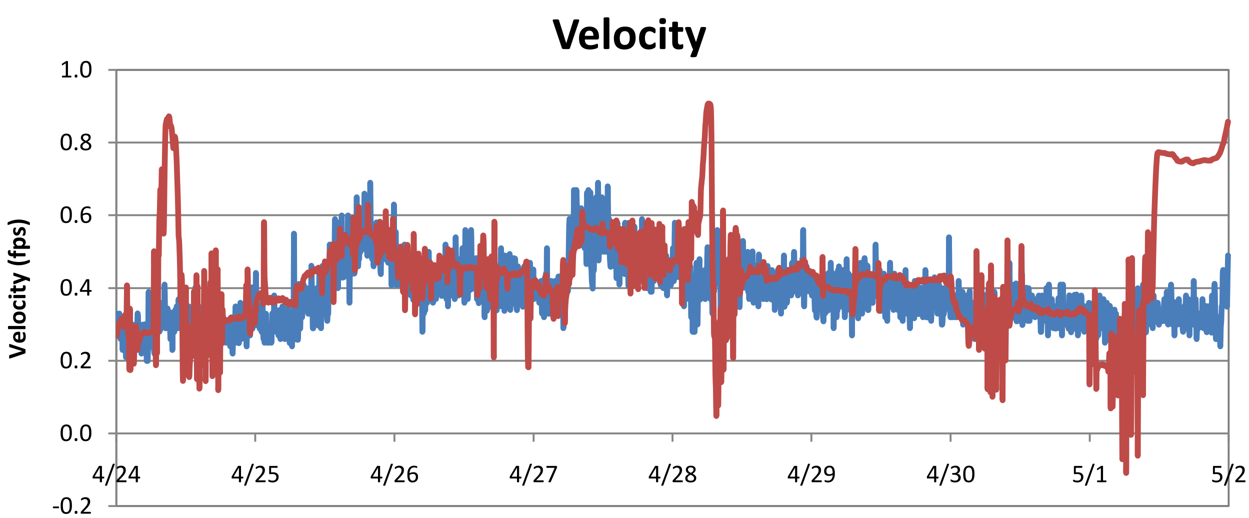


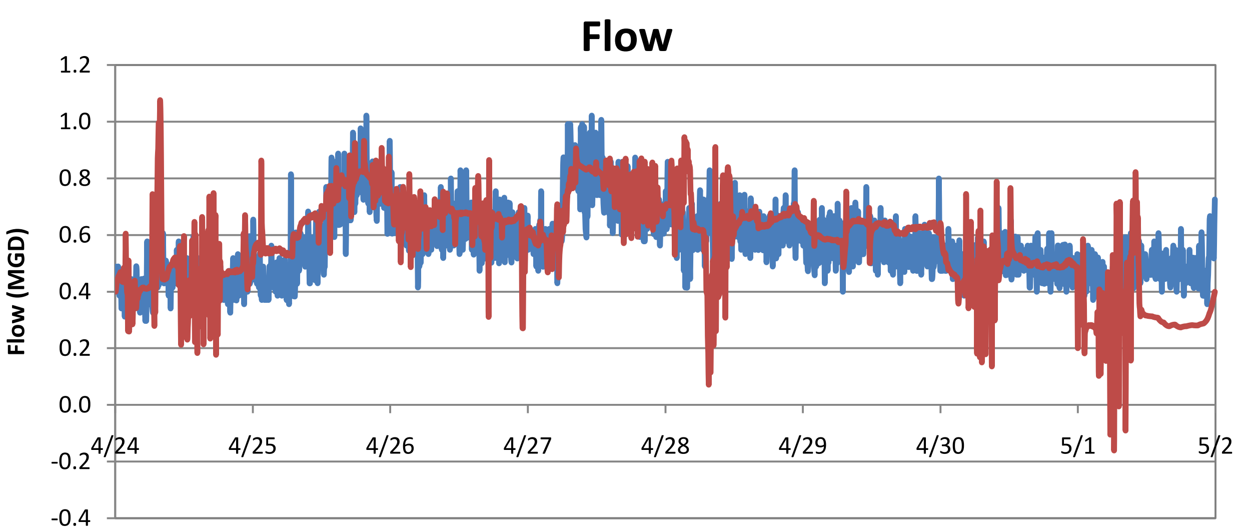




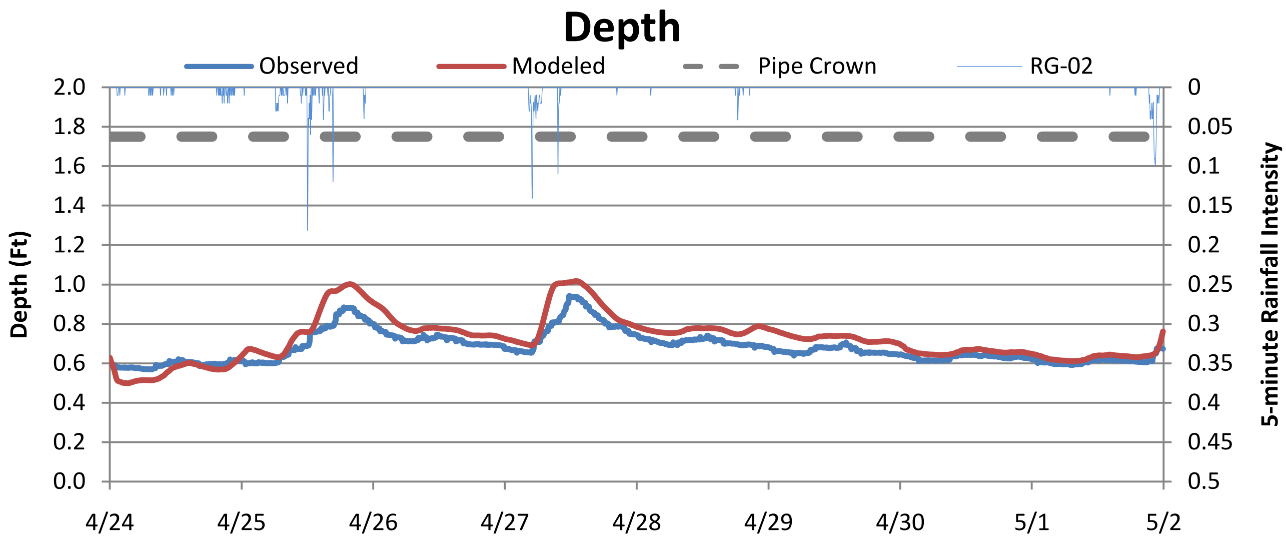
FM-15 WWF Event 3 Calibration

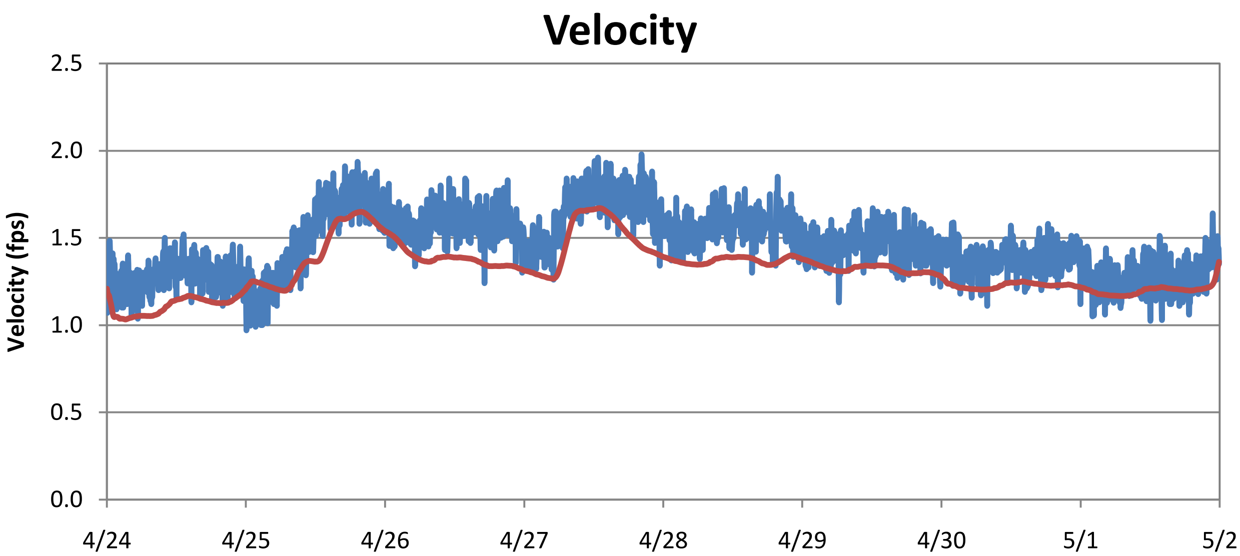


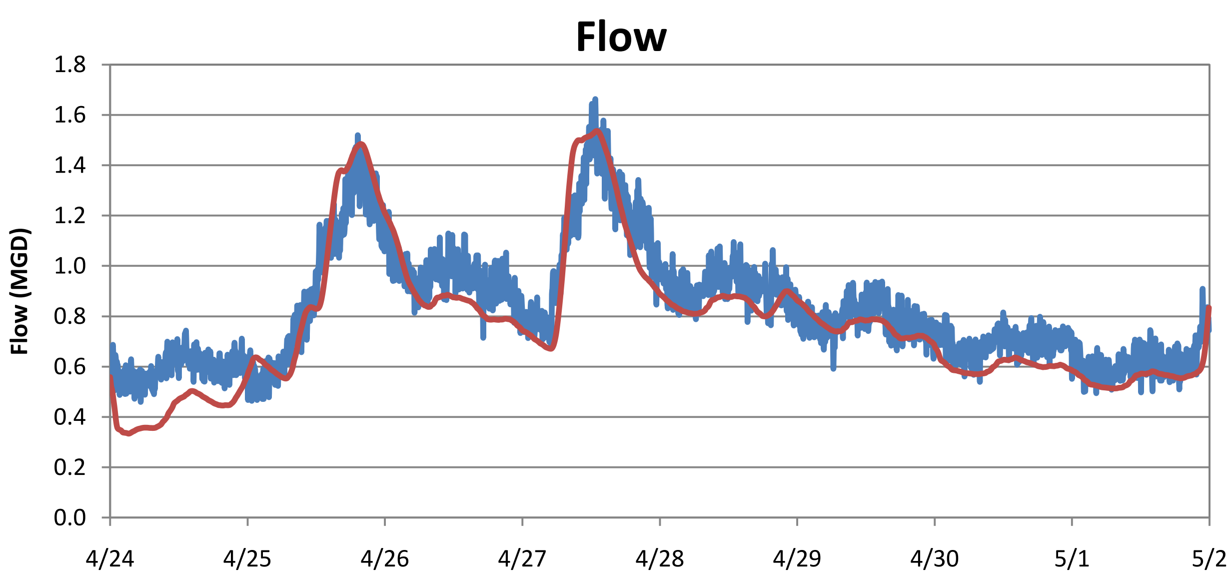




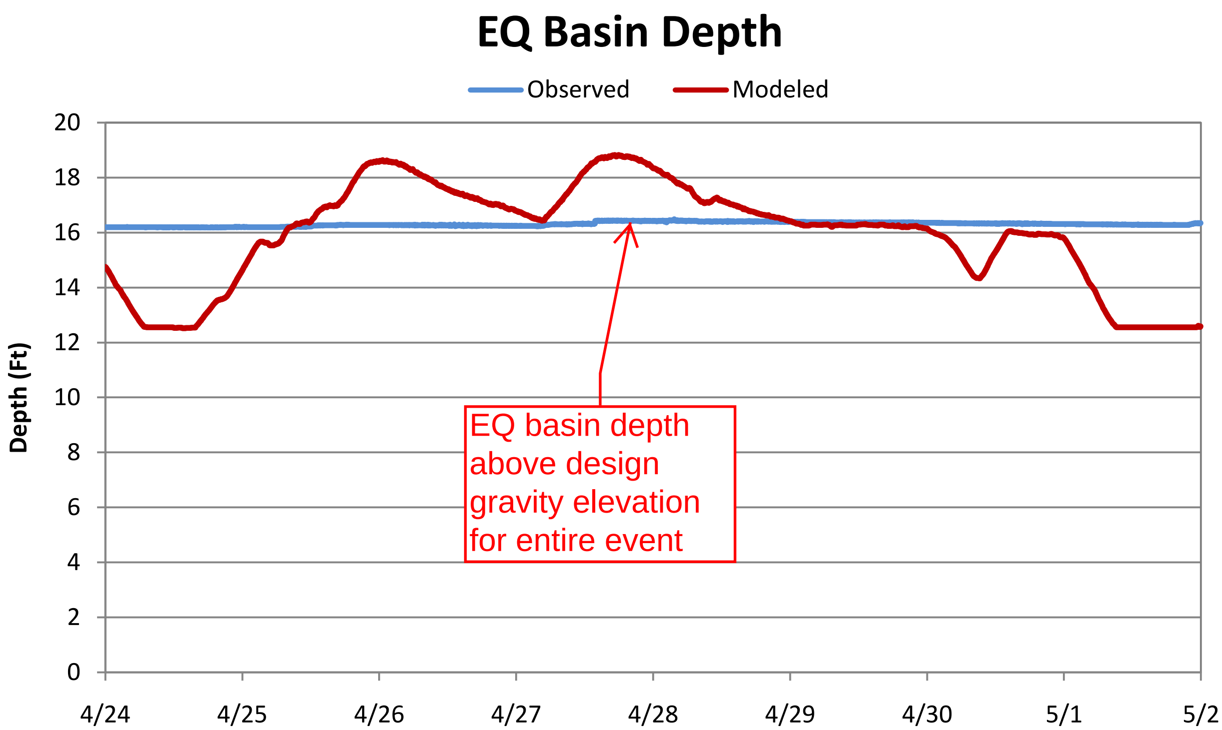
FM-16 WWF Event 3 Calibration

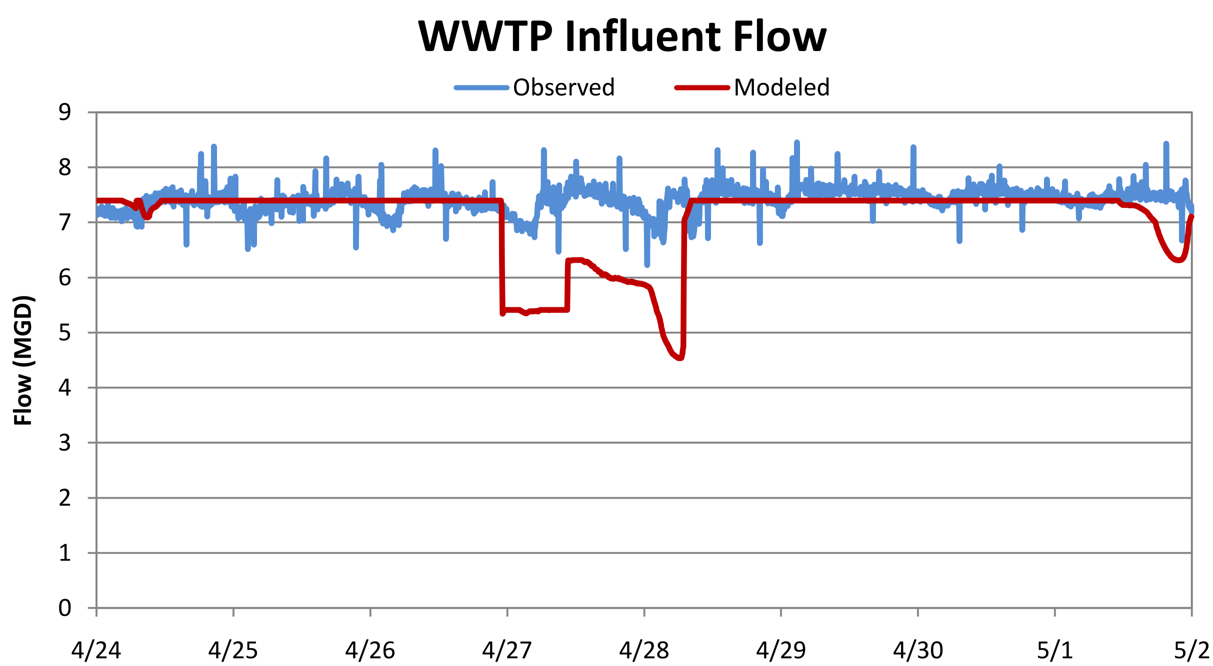




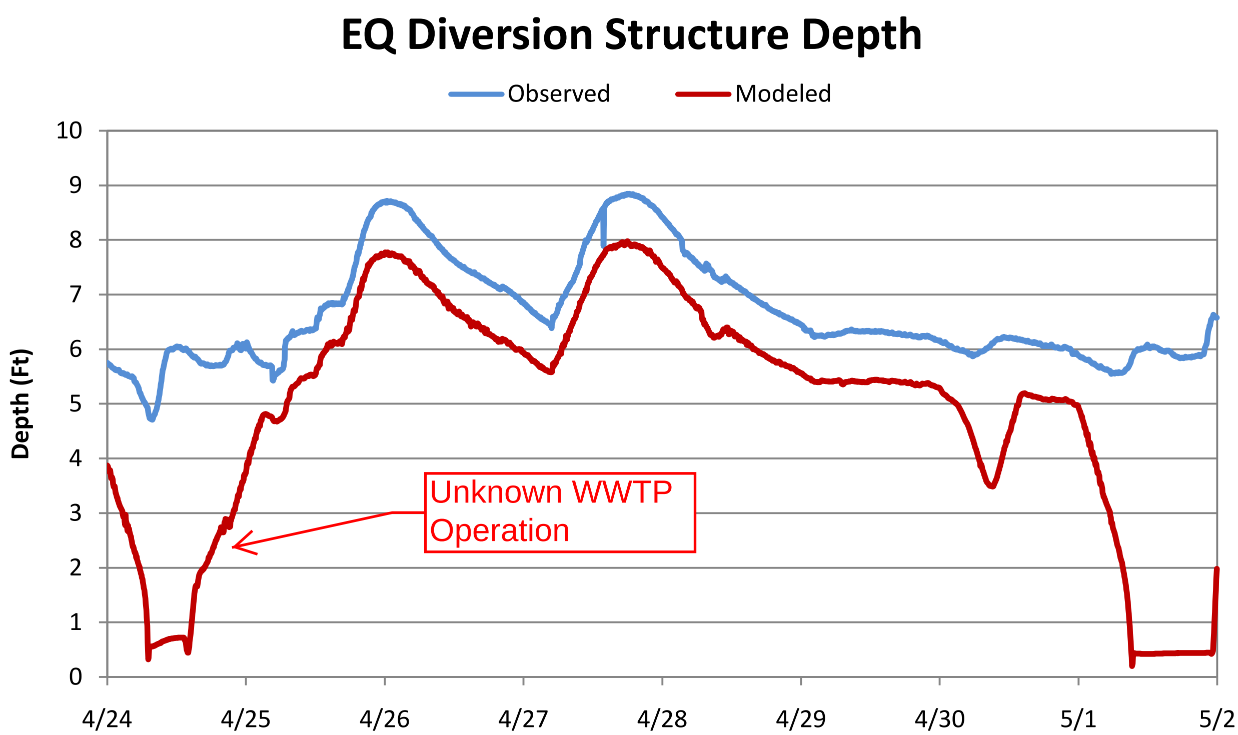


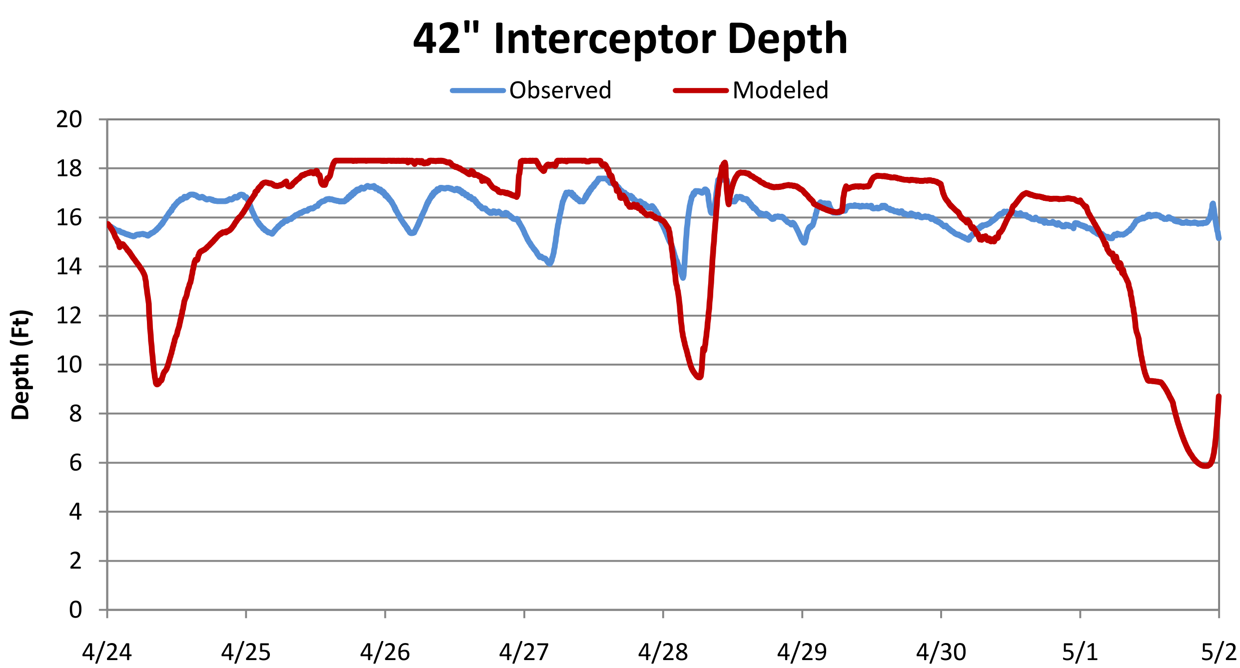
SCADA Meter WWF Event 3 Calibration





SCADA Meter WWF Event 3 Calibration





Appendix C

Existing Flow Capacity Assessment

CDM Smith

Existing Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

Segment ID (US_DS)	Pipe Size (in)	Slope (%)	Full-Flow Capacity (MGD)	DWF			Event 1			Event 2			Event 3		
				Ave DWF (MGD)	Peak DWF (MGD)	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity
01-001_05-008	30	1.2001	29.12	0.15	0.17	<1%	0.60	4.14	2%	0.57	3.92	2%	0.67	4.62	2%
01-002_01-001	30	0.0982	8.33	0.15	0.17	2%	0.60	4.14	7%	0.57	3.92	7%	0.67	4.62	8%
01-012_01-013	10	0.0993	0.45	0.03	0.03	6%	0.12	4.14	26%	0.11	3.93	25%	0.13	4.63	29%
01-013_01-002	30	0.1014	8.47	0.13	0.15	2%	0.55	4.14	6%	0.52	3.92	6%	0.61	4.62	7%
04-053_04-054	12	3.4974	4.32	0.33	0.40	8%	1.11	3.36	26%	0.84	2.54	20%	0.92	2.78	21%
04-054_04-055	12	3.0048	4.00	0.33	0.40	8%	1.11	3.36	28%	0.84	2.54	21%	0.92	2.78	23%
04-055_18-033	12	2.7509	3.83	0.33	0.40	9%	1.11	3.36	29%	0.84	2.54	22%	0.92	2.78	24%
05-001_08-034	30	1.0001	26.59	0.26	0.29	<1%	1.07	4.13	4%	1.01	3.91	4%	1.19	4.62	4%
05-002_05-001	30	2.0004	37.60	0.20	0.23	<1%	0.82	4.13	2%	0.78	3.92	2%	0.92	4.62	2%
05-003_05-002	30	0.501	18.82	0.20	0.23	1%	0.82	4.13	4%	0.78	3.92	4%	0.92	4.62	5%
05-004_05-003	30	0.498	18.76	0.20	0.23	1%	0.82	4.13	4%	0.78	3.92	4%	0.92	4.62	5%
05-005_05-004	30	0.5	18.80	0.20	0.23	1%	0.82	4.13	4%	0.78	3.92	4%	0.92	4.62	5%
05-006_05-005	30	2.028	37.86	0.15	0.17	<1%	0.60	4.14	2%	0.57	3.92	2%	0.67	4.62	2%
05-007_05-006	30	1.2001	29.12	0.15	0.17	<1%	0.60	4.14	2%	0.57	3.92	2%	0.67	4.62	2%
05-008_05-007	30	1.2001	29.12	0.15	0.17	<1%	0.60	4.14	2%	0.57	3.92	2%	0.67	4.62	2%
05-009_05-005	12	0.0995	0.73	0.05	0.06	7%	0.22	4.14	30%	0.21	3.92	29%	0.25	4.63	34%
06-001_18-035	12	5.4737	5.40	0.28	0.35	5%	2.62	9.45	48%	2.26	8.16	42%	2.26	8.17	42%
06-002_06-001	12	4.9959	5.16	0.28	0.35	5%	2.62	9.45	51%	2.16	7.81	42%	2.26	8.17	44%
06-003_06-002	12	2.4988	3.65	0.28	0.35	8%	2.62	9.45	72%	2.16	7.81	59%	2.26	8.17	62%
06-004_06-003	12	2.5053	3.66	0.28	0.35	8%	2.62	9.45	72%	2.16	7.81	59%	2.26	8.17	62%
07-001_08-012	12	1.0001	2.31	0.03	0.04	2%	0.14	4.13	6%	0.14	3.93	6%	0.16	4.62	7%
08-001_23-001	36	2.2727	65.17	0.37	0.42	<1%	4.56	12.31	7%	1.45	3.91	2%	6.68	18.04	10%
08-002_08-001	36	0.1018	13.79	0.37	0.42	3%	1.48	4.00	11%	1.40	3.78	10%	1.65	4.46	12%
08-003_08-002	36	0.1045	13.97	0.37	0.42	3%	1.48	4.00	11%	1.40	3.78	10%	1.65	4.46	12%
08-004_08-003	36	1.0001	43.23	0.37	0.42	<1%	1.48	4.00	3%	1.40	3.78	3%	1.65	4.46	4%
08-005_08-004	36	0.9621	42.40	0.37	0.42	<1%	1.48	4.00	3%	1.40	3.78	3%	1.65	4.46	4%
08-006_08-005	36	1.0151	43.55	0.35	0.40	<1%	1.40	3.99	3%	1.33	3.78	3%	1.56	4.45	4%
08-007_08-006	36	1.0094	43.43	0.35	0.40	<1%	1.40	3.99	3%	1.33	3.78	3%	1.56	4.45	4%
08-008_08-007	36	1.0557	44.42	0.35	0.40	<1%	1.40	3.99	3%	1.33	3.78	3%	1.56	4.45	4%
08-009_08-008	36	0.1957	19.12	0.33	0.38	2%	1.38	4.13	7%	1.31	3.91	7%	1.54	4.61	8%
08-010_08-009	30	0.1479	10.22	0.33	0.38	3%	1.38	4.13	14%	1.31	3.91	13%	1.54	4.61	15%
08-011_08-010	12	1.0001	2.31	0.05	0.05	2%	0.19	4.14	8%	0.18	3.93	8%	0.22	4.61	9%
08-012_08-011	12	1.0001	2.31	0.03	0.04	2%	0.14	4.13	6%	0.14	3.93	6%	0.16	4.62	7%
08-026_08-010	30	2.5162	42.17	0.29	0.33	<1%	1.19	4.13	3%	1.13	3.91	3%	1.33	4.61	3%
08-027_08-026	30	1.0001	26.59	0.28	0.31	1%	1.14	4.13	4%	1.08	3.91	4%	1.27	4.61	5%
08-028_08-027	30	2.0004	37.60	0.28	0.31	<1%	1.14	4.13	3%	1.08	3.91	3%	1.27	4.61	3%
08-034_08-028	30	1.0001	26.59	0.26	0.29	<1%	1.07	4.13	4%	1.01	3.91	4%	1.19	4.62	4%
09-001_09-100	12	0.3398	1.35	0.21	0.26	16%	1.44	6.77	107%	1.08	5.07	80%	1.55	7.34	115%
09-002_09-001	12	0.3578	1.38	0.21	0.26	15%	1.44	6.77	104%	1.08	5.07	78%	1.55	7.34	113%
09-006_09-002	12	0.3205	1.31	0.21	0.26	16%	1.44	6.77	110%	1.08	5.08	82%	1.55	7.34	119%
09-007_09-006	10	0.5926	1.12	0.09	0.11	8%	0.70	7.96	63%	0.53	5.94	47%	0.75	8.52	67%
09-008_09-007	10	0.4715	1.00	0.09	0.11	9%	0.72	8.15	72%	0.53	5.94	53%	0.76	8.61	76%
09-009_09-008	10	0.4139	0.93	0.09	0.11	9%	0.70	7.94	75%	0.53	5.94	56%	0.77	8.73	83%
09-009_09-099	10	0.4413	0.96	0.09	0.11	9%	0.70	7.94	73%	0.53	5.94	54%	0.75	8.50	78%
09-063_09-009	10	0.2259	0.69	0.09	0.11	13%	0.70	7.95	102%	0.53	5.94	76%	0.75	8.49	109%
09-072_09-063	10	0.2997	0.79	0.09	0.11	11%	0.70	7.95	88%	0.53	5.94	66%	0.75	8.49	94%
09-073_09-072	10	0.291	0.78	0.09	0.11	11%	0.70	7.95	90%	0.53	5.95	67%	0.75	8.49	96%
09-074_09-073	10	0.3886	0.90	0.09	0.11	10%	0.70	7.95	78%	0.53	5.95	58%	0.75	8.50	83%
09-075_09-074	10	0.2428	0.71	0.09	0.11	12%	0.70	7.95	98%	0.53	5.95	73%	0.75	8.50	105%
09-076_09-075	10	0.1988	0.65	0.09	0.11	14%	0.70	7.95	109%	0.53	5.95	81%	0.75	8.50	116%
09-100_20-045	12	0.0833	0.67	0.21	0.26	32%	1.44	6.77	215%	1.08	5.07	161%	1.55	7.33	233%
11-003_18-029	27	0.1406	7.53	0.81	0.99	11%	5.20	6.45	69%	4.18	5.18	55%	6.29	7.80	84%
11-004_11-003	27	0.1422	7.57	0.80	0.98	11%	5.13	6.44	68%	4.12	5.17	54%	6.20	7.78	82%
11-005_11-004	27	0.1385	7.47	0.80	0.98	11%	5.13	6.44	69%	4.12	5.17	55%	6.20	7.78	83%
11-006_11-005	27	0.1378	7.45	0.80	0.98	11%	5.13	6.44	69%	4.12	5.17	55%	6.20	7.79	83%
11-007_11-006	27	0.1394	7.49	0.80	0.98	11%	5.13	6.44	68%	4.12	5.17	55%	6.20	7.79	83%

Existing Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

Segment ID (US_DS)	Pipe Size (in)	Slope (%)	Full-Flow Capacity (MGD)	DWF			Event 1			Event 2			Event 3		
				Ave DWF (MGD)	Peak DWF (MGD)	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity
11-008_11-007	27	0.14	7.51	0.80	0.98	11%	5.13	6.44	68%	4.12	5.18	55%	6.21	7.79	83%
11-009_11-008	27	0.1376	7.45	0.80	0.98	11%	5.13	6.44	69%	4.12	5.18	55%	6.21	7.79	83%
11-010_11-009	27	0.142	7.56	0.80	0.98	11%	5.13	6.44	68%	4.13	5.18	55%	6.21	7.79	82%
11-012_11-010	27	0.1394	7.49	0.80	0.98	11%	5.13	6.44	68%	4.13	5.18	55%	6.21	7.79	83%
11-013_11-012	27	0.1421	7.57	0.75	0.93	10%	4.82	6.39	64%	3.88	5.14	51%	5.80	7.68	77%
11-014_11-013	24	0.2513	6.37	0.75	0.93	12%	4.82	6.39	76%	3.88	5.14	61%	5.80	7.68	91%
11-015_11-014	24	0.25	6.35	0.75	0.92	12%	4.77	6.39	75%	3.84	5.13	60%	5.73	7.67	90%
11-015A_11-015	24	0.253	6.39	0.75	0.92	12%	4.77	6.39	75%	3.84	5.13	60%	5.73	7.67	90%
11-016_11-015A	24	0.2526	6.39	0.75	0.92	12%	4.77	6.39	75%	3.84	5.13	60%	5.73	7.67	90%
11-017_11-016	10	8.6016	3.69	0.48	0.59	13%	3.17	6.65	86%	2.38	4.98	65%	3.40	7.12	92%
11-018_11-017	10	29.2345	6.37	0.48	0.59	7%	3.17	6.65	50%	2.38	4.99	37%	3.40	7.12	53%
11-019_11-018	18	0.3017	3.74	0.48	0.59	13%	3.17	6.65	85%	2.38	4.99	64%	3.40	7.13	91%
11-020_11-019	10	9.4581	4.46	0.47	0.59	11%	3.15	6.64	70%	2.36	4.98	53%	3.36	7.10	75%
11-021_11-020	15	0.3852	2.41	0.47	0.59	20%	3.15	6.64	130%	2.36	4.98	98%	3.36	7.10	139%
11-024_11-021	15	0.2963	2.12	0.47	0.59	22%	3.15	6.64	149%	2.36	4.98	111%	3.36	7.11	159%
11-031_11-032	18	0.3728	4.16	0.47	0.58	11%	3.14	6.70	75%	2.36	5.05	57%	3.33	7.10	80%
11-032_11-024	18	0.3379	3.96	0.47	0.58	12%	3.11	6.65	79%	2.37	5.06	60%	3.33	7.10	84%
11-034_11-031	18	0.3162	3.83	0.46	0.57	12%	3.07	6.74	80%	2.30	5.05	60%	3.24	7.11	85%
11-035_11-034	12	0.3015	1.27	0.26	0.32	20%	1.73	6.73	136%	1.30	5.06	102%	1.86	7.24	147%
11-036_11-035	12	0.2991	1.26	0.26	0.32	20%	1.73	6.74	137%	1.30	5.06	103%	1.86	7.25	147%
11-047A_11-047B	12	0.4363	1.53	0.20	0.25	13%	1.35	6.76	88%	1.00	5.04	66%	1.46	7.35	96%
11-047B_11-034	12	0.4816	1.60	0.20	0.25	12%	1.35	6.75	84%	1.00	5.04	63%	1.51	7.58	94%
11-047C_11-047A	12	0.3736	1.41	0.20	0.25	14%	1.35	6.76	95%	1.00	5.04	71%	1.45	7.29	103%
11-066_11-047C	12	0.3965	1.45	0.16	0.20	11%	1.09	6.75	75%	0.81	5.04	56%	1.28	7.96	88%
11-067_11-066	12	0.3955	1.45	0.16	0.20	11%	1.09	6.76	75%	0.81	5.04	56%	1.26	7.84	87%
11-068_11-067	12	0.2974	1.26	0.16	0.19	12%	1.06	6.76	84%	0.79	5.05	63%	1.19	7.62	95%
11-069_11-068	12	0.298	1.26	0.16	0.19	12%	1.06	6.76	84%	0.79	5.05	63%	1.19	7.57	94%
11-070_11-069	12	0.297	1.26	0.16	0.19	12%	1.06	6.76	84%	0.79	5.05	63%	1.15	7.33	91%
11-071_11-070	12	0.2974	1.26	0.15	0.19	12%	1.01	6.76	80%	0.75	5.05	60%	1.09	7.33	87%
11-075_11-071	12	0.2955	1.26	0.15	0.19	12%	1.01	6.76	80%	0.75	5.05	60%	1.09	7.33	87%
11-076_11-075	12	0.297	1.26	0.13	0.17	11%	0.91	6.77	72%	0.68	5.05	54%	0.99	7.33	78%
11-083_11-076	10	0.7908	1.26	0.13	0.17	11%	0.91	6.77	72%	0.68	5.05	54%	0.99	7.33	78%
11-084_11-083	10	1.0262	1.44	0.13	0.17	9%	0.91	6.77	63%	0.68	5.05	47%	0.99	7.33	69%
11-109_11-084	10	0.6438	1.14	0.04	0.04	3%	0.24	6.74	21%	0.18	5.04	16%	0.26	7.32	23%
11-110_11-109	10	0.6787	1.17	0.04	0.04	3%	0.24	6.74	21%	0.18	5.04	15%	0.26	7.32	22%
11-111_11-110	10	1.0763	1.47	0.04	0.04	2%	0.24	6.74	16%	0.18	5.04	12%	0.26	7.32	18%
11-112_11-111	10	0.4368	0.94	0.04	0.04	4%	0.24	6.74	26%	0.18	5.04	19%	0.26	7.33	28%
11-113_11-112	10	0.4882	0.99	0.04	0.04	4%	0.24	6.74	24%	0.18	5.04	18%	0.26	7.33	27%
11-114_11-113	10	0.5133	1.02	0.04	0.04	4%	0.24	6.75	24%	0.18	5.05	18%	0.26	7.33	26%
11-115_11-114	10	0.5556	1.06	0.04	0.04	3%	0.24	6.75	23%	0.18	5.05	17%	0.26	7.33	25%
11-116_11-115	10	1.6027	1.80	0.04	0.04	2%	0.24	6.75	13%	0.18	5.05	10%	0.26	7.33	15%
11-117_11-116	10	0.4799	0.98	0.04	0.04	4%	0.24	6.75	25%	0.18	5.05	18%	0.26	7.34	27%
11-121_11-117	10	0.5449	1.05	0.04	0.04	3%	0.24	6.75	23%	0.18	5.05	17%	0.26	7.34	25%
11-122_11-121	10	0.2929	0.77	0.02	0.03	3%	0.15	6.73	20%	0.11	5.04	15%	0.16	7.31	21%
11-123_11-122	10	0.2885	0.76	0.02	0.03	3%	0.15	6.78	20%	0.11	5.04	15%	0.16	7.32	22%
11-124_11-123	10	0.2	0.64	0.02	0.02	3%	0.13	6.80	21%	0.10	5.05	15%	0.14	7.37	23%
11-125_11-124	10	0.2066	0.65	0.02	0.02	3%	0.13	6.80	20%	0.10	5.05	15%	0.14	7.37	22%
11-126_11-125	10	0.2	0.64	0.01	0.01	<1%	0.04	6.71	7%	0.03	5.11	5%	0.05	7.35	7%
11-127_11-126	10	0.2033	0.64	0.01	0.01	<1%	0.04	6.71	7%	0.03	5.11	5%	0.05	7.35	7%
11-128_11-127	10	0.2	0.64	0.01	0.01	<1%	0.04	6.71	7%	0.03	5.11	5%	0.05	7.35	7%
11-129_11-128	10	0.2	0.64	0.00	0.00	<1%	0.01	6.56	2%	0.01	4.77	1%	0.01	7.16	2%
11-130_11-129	10	0.2	0.64	0.00	0.00	<1%	0.01	6.57	2%	0.01	4.78	1%	0.01	7.16	2%
11-131_11-123	10	0.3	0.78	0.00	0.01	<1%	0.03	14.52	4%	0.02	10.89	3%	0.03	15.43	4%
11-132_11-131	10	0.3033	0.78	0.00	0.00	<1%	0.02	6.81	3%	0.02	5.11	2%	0.02	7.49	3%
11-133_11-132	10	0.305	0.78	0.02	0.03	3%	0.03	1.50	4%	0.03	1.50	4%	0.03	1.50	4%
12-001_11-016	24	0.25	6.35	0.27	0.33	4%	1.62	6.02	25%	1.46	5.40	23%	2.33	8.67	37%

Existing Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

Segment ID (US_DS)	Pipe Size (in)	Slope (%)	Full-Flow Capacity (MGD)	DWF			Event 1			Event 2			Event 3		
				Ave DWF (MGD)	Peak DWF (MGD)	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity
12-003_12-001	18	0.2513	3.17	0.27	0.33	8%	1.59	5.91	50%	1.44	5.35	45%	2.31	8.59	73%
12-004_12-003	18	0.2547	3.19	0.27	0.32	8%	1.59	5.97	50%	1.44	5.43	45%	2.31	8.67	72%
13-001_14-041	12	0.0837	0.67	0.22	0.27	33%	0.38	1.75	57%	0.34	1.56	51%	0.46	2.11	69%
13-002_13-001	12	0.5878	1.77	0.22	0.27	12%	0.38	1.75	22%	0.34	1.56	19%	0.46	2.11	26%
13-007_13-002	12	0.2193	1.08	0.22	0.27	20%	0.38	1.75	35%	0.34	1.55	31%	0.46	2.11	43%
13-008_13-007	8	0.1747	0.33	0.03	0.04	10%	0.06	1.74	17%	0.05	1.55	16%	0.07	2.10	21%
13-010_13-008	8	0.0812	0.22	0.01	0.02	6%	0.02	1.78	10%	0.02	1.54	9%	0.03	2.10	12%
13-014_13-010	8	0.4356	0.52	0.01	0.02	2%	0.02	1.78	4%	0.02	1.62	4%	0.03	2.10	5%
13-015_13-014	8	0.4614	0.53	0.01	0.02	2%	0.02	1.78	4%	0.02	1.54	4%	0.03	2.10	5%
13-016_13-015	8	0.5124	0.56	0.01	0.02	2%	0.02	1.78	4%	0.02	1.54	3%	0.03	2.10	5%
13-021_13-123	12	0.0829	0.66	0.19	0.23	28%	0.33	1.75	49%	0.29	1.56	44%	0.39	2.11	59%
13-047_13-021	12	0.1632	0.93	0.07	0.09	8%	0.13	1.74	14%	0.11	1.56	12%	0.15	2.12	16%
13-070_13-047	12	0.239	1.13	0.07	0.09	6%	0.13	1.74	11%	0.11	1.56	10%	0.15	2.12	14%
13-071_13-070	12	0.2644	1.19	0.07	0.09	6%	0.13	1.74	11%	0.11	1.56	10%	0.15	2.12	13%
13-123_13-007	12	0.2392	1.13	0.19	0.23	16%	0.33	1.75	29%	0.29	1.56	26%	0.39	2.11	35%
14-001_16-018	12	0.2102	1.06	0.32	0.40	31%	0.56	1.73	53%	0.50	1.55	48%	0.68	2.11	65%
14-002_14-001	12	0.284	1.23	0.32	0.40	26%	0.56	1.73	46%	0.50	1.55	41%	0.68	2.10	56%
14-003_14-002	12	0.3579	1.38	0.32	0.40	23%	0.56	1.73	41%	0.50	1.55	36%	0.68	2.10	49%
14-007_14-003	12	0.2113	1.06	0.30	0.37	28%	0.52	1.74	49%	0.46	1.55	44%	0.63	2.11	59%
14-008_14-007	12	0.1221	0.81	0.30	0.37	37%	0.52	1.74	64%	0.46	1.55	57%	0.63	2.11	78%
14-009_14-008	12	0.2678	1.19	0.30	0.37	25%	0.52	1.74	43%	0.46	1.55	39%	0.63	2.11	53%
14-021_14-009	12	0.081	0.66	0.30	0.37	45%	0.52	1.74	79%	0.46	1.55	70%	0.63	2.11	96%
14-022_14-021	12	0.0571	0.55	0.30	0.37	54%	0.52	1.74	94%	0.46	1.55	84%	0.63	2.11	114%
14-036_14-022	12	0.1929	1.01	0.22	0.27	22%	0.38	1.74	38%	0.34	1.56	34%	0.46	2.11	46%
14-038_14-047	12	0.2475	1.15	0.22	0.27	19%	0.38	1.75	33%	0.34	1.55	30%	0.46	2.11	40%
14-039_14-038	12	0.0869	0.68	0.22	0.27	32%	0.38	1.75	56%	0.34	1.55	50%	0.46	2.11	68%
14-041_14-039	12	0.1889	1.00	0.22	0.27	22%	0.38	1.75	38%	0.34	1.55	34%	0.46	2.11	46%
14-047_14-036	12	0.1548	0.91	0.22	0.27	24%	0.38	1.75	42%	0.34	1.56	38%	0.46	2.11	51%
15-001_15-039	12	0.5602	1.73	0.18	0.25	11%	0.87	4.72	50%	0.49	2.66	28%	0.97	5.29	56%
15-002_15-001	12	0.9368	2.24	0.17	0.23	7%	0.84	5.07	38%	0.47	2.81	21%	0.95	5.69	42%
15-004_15-002	12	0.6234	1.82	0.17	0.23	9%	0.84	5.07	46%	0.47	2.81	26%	0.95	5.69	52%
15-005_15-004	12	0.6218	1.82	0.17	0.22	9%	0.84	5.08	46%	0.47	2.81	26%	0.95	5.69	52%
15-039_15-040	18	0.5177	4.90	0.69	0.84	14%	1.70	2.46	35%	1.24	1.79	25%	1.97	2.87	40%
15-040_15-041	18	0.0824	1.95	0.69	0.84	35%	1.70	2.46	87%	1.24	1.79	63%	1.97	2.87	101%
15-041_15-042	18	0.8522	6.29	0.69	0.84	11%	1.70	2.46	27%	1.24	1.79	20%	1.97	2.87	31%
15-042_16-061	18	0.4148	4.38	0.69	0.84	16%	1.70	2.45	39%	1.24	1.79	28%	1.98	2.86	45%
16-012_16-013	15	0.1185	1.56	0.44	0.54	28%	0.76	1.73	49%	0.68	1.54	44%	0.93	2.10	59%
16-013_16-014	15	0.2209	2.13	0.44	0.54	21%	0.76	1.73	36%	0.68	1.55	32%	0.93	2.10	43%
16-014_16-015	15	0.1263	1.61	0.50	0.61	31%	0.86	1.70	53%	0.78	1.54	48%	1.05	2.08	65%
16-015_15-039	15	0.2917	2.45	0.50	0.61	21%	0.86	1.70	35%	0.78	1.54	32%	1.05	2.08	43%
16-017_16-036	15	0.1	1.43	0.44	0.54	31%	0.76	1.73	53%	0.68	1.55	48%	0.93	2.10	65%
16-018_16-017	12	0.1486	0.89	0.32	0.40	36%	0.56	1.73	63%	0.50	1.55	57%	0.68	2.10	77%
16-036_16-012	15	0.1053	1.47	0.44	0.54	30%	0.76	1.73	52%	0.68	1.55	46%	0.93	2.10	63%
16-058_16-062	33	0.272	14.53	1.18	1.38	8%	6.38	5.43	44%	2.83	2.41	19%	3.79	3.23	26%
16-058A_16-058	18	0.2575	3.45	0.69	0.84	20%	1.70	2.45	49%	1.24	1.79	36%	1.98	2.86	57%
16-059_16-058A	18	0.0226	1.02	0.69	0.84	68%	1.70	2.45	166%	1.24	1.79	121%	1.98	2.86	194%
16-060_16-059	18	0.2818	3.61	0.69	0.84	19%	1.70	2.45	47%	1.24	1.79	34%	1.98	2.86	55%
16-061_16-060	18	0.2299	3.26	0.69	0.84	21%	1.70	2.45	52%	1.24	1.79	38%	1.98	2.86	61%
16-062_19-074	33	0.0467	6.02	1.18	1.38	20%	6.44	5.48	107%	2.83	2.41	47%	3.79	3.22	63%
17-001_16-058	20	0.0984	2.46	0.46	0.53	19%	2.86	6.24	116%	2.75	6.00	112%	2.33	5.10	95%
17-002_17-001	21	0.197	3.95	0.46	0.53	12%	3.97	8.67	100%	3.19	6.96	81%	3.66	7.99	93%
17-003_17-002	12	108.7709	24.08	0.14	0.61	<1%	1.75	12.36	7%	1.78	12.57	7%	1.96	13.86	8%
17-023_17-024	21	0.0682	2.32	0.32	0.38	14%	2.51	7.94	108%	2.29	7.26	99%	2.56	8.09	110%
17-023a_17-023	21	0.0959	2.76	0.28	0.35	10%	2.59	9.14	94%	2.04	7.19	74%	2.20	7.75	80%
17-024_17-002	21	0.1649	3.61	0.32	0.38	9%	2.64	8.36	73%	2.02	6.38	56%	2.50	7.90	69%
17-025_17-023a	21	0.1357	3.28	0.28	0.35	9%	2.41	8.51	74%	1.99	7.00	61%	1.86	6.55	57%

Existing Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

Segment ID (US_DS)	Pipe Size (in)	Slope (%)	Full-Flow Capacity (MGD)	DWF			Event 1			Event 2			Event 3		
				Ave DWF (MGD)	Peak DWF (MGD)	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity
17-043_17-025	21	0.0246	1.40	0.28	0.34	20%	1.92	6.78	138%	1.64	5.80	118%	1.88	6.63	135%
17-044_17-043	21	0.04	1.78	0.26	0.32	14%	1.89	7.39	106%	1.69	6.58	95%	1.67	6.51	94%
17-045_17-044	21	0.0375	1.62	0.26	0.32	16%	1.90	7.42	118%	1.75	6.83	108%	1.84	7.18	114%
18-029_18-030	30	0.1006	8.43	0.81	0.99	10%	5.20	6.45	62%	4.18	5.18	50%	6.29	7.80	75%
18-030_18-031	30	0.1026	8.52	0.86	1.06	10%	5.62	6.51	66%	4.52	5.24	53%	6.83	7.91	80%
18-031_18-033	30	0.0978	8.31	0.92	1.12	11%	5.69	6.17	68%	4.58	4.97	55%	6.90	7.49	83%
18-033_18-099	30	0.1	8.41	1.26	1.53	15%	6.73	5.33	80%	5.37	4.25	64%	7.87	6.24	94%
18-034_18-038	30	0.1015	8.47	1.26	1.53	15%	6.73	5.33	79%	5.37	4.25	63%	7.84	6.21	93%
18-035_18-036	12	2.2017	2.97	0.28	0.35	9%	2.62	9.45	88%	2.17	7.82	73%	2.26	8.17	76%
18-036_18-039A	12	1.5103	2.46	0.28	0.35	11%	2.62	9.45	106%	2.17	7.82	88%	2.26	8.17	92%
18-038_18-039	30	0.1087	8.76	1.26	1.53	14%	6.73	5.33	77%	5.37	4.25	61%	7.83	6.20	89%
18-039_18-040	30	0.1512	10.34	1.28	1.55	12%	6.85	5.36	66%	5.48	4.28	53%	7.99	6.24	77%
18-039A_18-083	12	0.0707	0.80	0.28	0.35	35%	2.62	9.45	328%	2.17	7.82	271%	2.26	8.17	284%
18-040_18-041	30	0.1492	10.27	1.28	1.55	12%	6.85	5.35	67%	5.48	4.28	53%	7.99	6.24	78%
18-041_18-042	30	0.1505	9.58	1.28	1.55	13%	6.85	5.35	72%	5.48	4.28	57%	7.99	6.24	83%
18-042_18-043	30	0.1484	9.51	1.28	1.55	13%	6.85	5.35	72%	5.48	4.28	58%	7.99	6.24	84%
18-043_18-044	30	0.1513	9.60	1.28	1.55	13%	6.85	5.35	71%	5.47	4.28	57%	7.99	6.24	83%
18-045_22-048	30	2.0826	35.62	1.60	1.95	4%	9.69	6.07	27%	7.78	4.87	22%	10.27	6.43	29%
18-046_18-045	24	1.3166	16.82	0.28	0.35	2%	2.62	9.45	16%	2.16	7.81	13%	2.26	8.16	13%
18-079_18-088	24	0.0714	3.92	0.28	0.35	7%	2.62	9.45	67%	2.16	7.81	55%	2.26	8.17	58%
18-082_18-079	12	0.0684	0.79	0.28	0.35	35%	2.62	9.45	334%	2.17	7.82	276%	2.26	8.17	288%
18-083_18-082	12	0.0714	0.80	0.28	0.35	35%	2.62	9.45	327%	2.17	7.82	270%	2.26	8.17	282%
18-088_18-097	24	0.0714	3.92	0.28	0.35	7%	2.62	9.45	67%	2.16	7.81	55%	2.26	8.16	58%
18-097_18-098	24	0.0691	3.85	0.28	0.35	7%	2.62	9.45	68%	2.16	7.81	56%	2.26	8.16	59%
18-098_18-046	24	0.0712	3.91	0.28	0.35	7%	2.62	9.45	67%	2.16	7.81	55%	2.26	8.16	58%
18-099_18-034	30	0.1	8.41	1.26	1.53	15%	6.73	5.33	80%	5.37	4.25	64%	7.86	6.22	93%
19-074_19-074B	33	0.089	8.31	1.18	1.38	14%	6.24	5.31	75%	2.83	2.41	34%	3.79	3.22	46%
19-074B_19-074C	33	0.0887	8.85	1.18	1.38	13%	5.76	4.89	65%	2.83	2.41	32%	3.79	3.23	43%
19-074C_19-075	33	0.0795	8.38	1.18	1.38	14%	4.46	3.79	53%	2.85	2.43	34%	3.81	3.24	46%
19-075_19-076	33	0.3648	19.22	1.49	1.73	8%	5.20	3.48	27%	3.31	2.22	17%	4.21	2.82	22%
19-076_19-082	33	0.0814	9.08	1.62	1.88	18%	5.79	3.57	64%	3.48	2.15	38%	4.35	2.69	48%
19-077_19-078	33	0.0792	9.65	1.62	1.88	17%	4.04	2.49	42%	3.48	2.15	36%	4.35	2.68	45%
19-078_19-079	33	0.0745	8.11	1.62	1.88	20%	4.15	2.56	51%	3.48	2.15	43%	4.34	2.68	54%
19-079_19-080	33	0.0943	9.12	1.62	1.88	18%	4.20	2.59	46%	3.48	2.15	38%	4.34	2.68	48%
19-080_19-081	33	0.0914	8.98	1.62	1.88	18%	4.24	2.61	47%	3.48	2.15	39%	4.34	2.68	48%
19-081_24-007	33	0.0807	8.44	1.62	1.88	19%	4.27	2.63	51%	3.48	2.15	41%	4.34	2.67	51%
19-082_19-077	33	0.0685	8.97	1.62	1.88	18%	4.49	2.77	50%	3.48	2.14	39%	4.34	2.68	48%
20-039_20-086	12	0.5963	1.78	0.21	0.26	12%	1.43	6.76	80%	1.07	5.06	60%	1.54	7.25	86%
20-040_20-039	12	1.4935	2.82	0.21	0.26	8%	1.44	6.77	51%	1.07	5.06	38%	1.54	7.25	54%
20-041_20-040	12	0.2618	1.18	0.21	0.26	18%	1.43	6.76	121%	1.07	5.07	91%	1.54	7.25	130%
20-042_20-041	12	0.5222	1.67	0.21	0.26	13%	1.43	6.76	86%	1.07	5.07	64%	1.54	7.25	92%
20-043_20-042	12	1.3483	2.68	0.21	0.26	8%	1.43	6.76	53%	1.07	5.07	40%	1.62	7.66	61%
20-044_20-043	12	0.5	1.63	0.21	0.26	13%	1.43	6.77	88%	1.07	5.07	66%	1.55	7.33	95%
20-045_20-044	12	0.2906	1.24	0.21	0.26	17%	1.44	6.77	115%	1.08	5.07	86%	1.55	7.33	125%
20-083_11-036	12	0.3018	1.27	0.26	0.32	20%	1.73	6.74	136%	1.30	5.06	102%	1.86	7.25	147%
20-084_20-083	12	0.6005	1.79	0.26	0.32	14%	1.73	6.73	97%	1.30	5.06	73%	1.86	7.25	104%
20-085_20-084	12	0.6335	1.84	0.21	0.26	12%	1.44	6.76	78%	1.07	5.06	58%	1.54	7.25	84%
20-086_20-085	12	0.607	1.80	0.21	0.26	12%	1.44	6.77	80%	1.07	5.06	60%	1.54	7.25	85%
21-027A_27-027	15	0.5661	3.15	0.10	0.13	3%	0.32	3.03	10%	0.24	2.35	8%	0.34	3.25	11%
21-048_21-078	48	0.4063	55.10	1.82	2.29	3%	11.11	6.12	20%	9.11	5.01	17%	11.72	6.45	21%
21-070_21-071	36	2.6096	64.85	1.83	2.23	3%	15.19	8.28	23%	13.91	7.58	21%	15.59	8.50	24%
21-071_21-072	36	0.3061	20.73	1.83	2.23	9%	13.17	7.18	64%	9.00	4.91	43%	11.93	6.51	58%
21-072_21-073A	35	0.0313	5.92	1.86	2.27	31%	12.43	6.68	210%	9.10	4.89	154%	12.16	6.53	206%
21-073_21-074A	34	0.1011	10.96	1.86	2.27	17%	12.25	6.58	112%	9.11	4.90	83%	12.23	6.57	112%
21-073A_21-073	34	0.0267	5.25	1.86	2.27	35%	12.50	6.71	238%	9.11	4.89	173%	12.21	6.56	232%
21-074_21-075	36	0.4444	28.82	1.86	2.27	6%	9.73	5.22	34%	7.83	4.20	27%	6.13	3.29	21%

Existing Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

Segment ID (US_DS)	Pipe Size (in)	Slope (%)	Full-Flow Capacity (MGD)	DWF			Event 1			Event 2			Event 3		
				Ave DWF (MGD)	Peak DWF (MGD)	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity
21-074A_21-074	34	0.1119	11.53	1.86	2.27	16%	12.32	6.62	107%	9.12	4.90	79%	12.25	6.58	106%
21-076_21-070	36	0.8125	36.18	1.83	2.23	5%	19.87	10.83	55%	12.67	6.91	35%	15.00	8.18	41%
21-078_21-076	36	1.9313	55.79	1.83	2.23	3%	12.40	6.76	22%	10.47	5.71	19%	11.91	6.49	21%
22-001_21-048	48	0.641	74.54	1.75	2.14	2%	10.69	6.09	14%	8.56	4.88	11%	11.36	6.48	15%
22-020_22-001	48	0.2965	50.69	1.68	2.05	3%	10.27	6.13	20%	8.30	4.95	16%	11.01	6.57	22%
22-026_22-020	48	0.3282	53.34	1.68	2.05	3%	10.27	6.13	19%	8.30	4.95	16%	11.01	6.57	21%
22-036_22-026	36	0.3067	25.94	1.67	2.05	6%	10.27	6.13	40%	8.30	4.95	32%	11.01	6.57	42%
22-048_22-036	36	0.2893	23.25	1.64	2.00	7%	10.02	6.11	43%	8.07	4.92	35%	10.69	6.51	46%
23-001A_24-000	30	0.0996	8.39	0.57	0.62	7%	3.82	6.72	46%	3.86	6.79	46%	4.04	7.11	48%
23-002_23-001	21	0.023	1.56	0.20	0.24	13%	0.55	2.78	35%	0.49	2.48	32%	0.63	3.16	40%
23-003_23-002	21	0.1226	3.60	0.20	0.24	5%	0.45	2.30	13%	0.47	2.41	13%	0.60	3.05	17%
23-004_23-003	21	0.125	3.63	0.20	0.24	5%	0.45	2.30	12%	0.47	2.41	13%	0.59	3.01	16%
23-005_23-004	21	0.0525	2.35	0.20	0.24	8%	0.45	2.30	19%	0.47	2.41	20%	0.56	2.84	24%
23-006_23-005	21	0.0793	2.89	0.12	0.15	4%	0.27	2.19	9%	0.29	2.31	10%	0.38	3.07	13%
23-007_23-006	21	0.1314	3.72	0.12	0.15	3%	0.27	2.20	7%	0.29	2.32	8%	0.34	2.71	9%
23-008_23-007	21	0.2017	4.61	0.12	0.15	3%	0.27	2.20	6%	0.29	2.32	6%	0.29	2.33	6%
23-009_23-008	21	0.0891	3.07	0.12	0.15	4%	0.27	2.20	9%	0.29	2.31	9%	0.29	2.33	9%
23-010_23-009	21	0.112	3.44	0.12	0.15	4%	0.27	2.20	8%	0.29	2.32	8%	0.29	2.33	8%
23-011_23-010	21	0.1713	4.25	0.12	0.15	3%	0.27	2.20	6%	0.29	2.32	7%	0.29	2.33	7%
23-012_23-011	21	0.0202	1.46	0.12	0.15	8%	0.27	2.20	19%	0.29	2.33	20%	0.29	2.33	20%
23-013_23-012	21	0.581	7.83	0.12	0.15	2%	0.27	2.20	3%	0.29	2.33	4%	0.29	2.33	4%
23-014_23-013	21	0.1244	3.62	0.12	0.15	3%	0.27	2.20	8%	0.29	2.33	8%	0.29	2.33	8%
24-002_RS_Jun	42	0.1286	21.71	2.50	2.87	11%	7.41	2.97	34%	8.00	3.21	37%	6.75	2.70	31%
24-003_24-003A	36	0.0957	13.37	1.86	2.27	14%	15.75	8.46	118%	7.60	4.08	57%	5.82	3.13	44%
24-003A_EQDivChamb	36	0.0882	16.69	1.86	2.27	11%	9.46	5.08	57%	7.60	4.08	46%	5.82	3.12	35%
24-004_24-002	42	0.1605	24.26	2.50	2.87	10%	7.38	2.96	30%	8.00	3.20	33%	6.75	2.70	28%
24-004A_24-004	42	0.1544	23.79	2.50	2.86	10%	7.30	2.93	31%	8.01	3.21	34%	6.77	2.71	28%
24-005_24-004A	42	0.1607	24.27	2.50	2.86	10%	7.21	2.89	30%	8.01	3.21	33%	6.76	2.71	28%
24-006_24-006A	42	0.087	17.86	2.49	2.86	14%	7.37	2.96	41%	8.02	3.21	45%	6.77	2.72	38%
24-006A_24-005	42	0.0881	17.97	2.50	2.86	14%	7.23	2.90	40%	8.00	3.20	44%	6.75	2.70	38%
24-007_24-006	42	0.0567	14.42	2.49	2.86	17%	7.50	3.01	52%	7.99	3.20	55%	6.75	2.70	47%
24-008_24-007	21	1.4038	12.17	0.82	0.93	7%	4.30	5.26	35%	2.64	3.23	22%	2.88	3.52	24%
24-009_24-044	21	0.8102	9.24	0.82	0.93	9%	2.16	2.64	23%	1.93	2.36	21%	2.49	3.05	27%
24-010_24-009	21	2.045	14.69	0.82	0.93	6%	2.16	2.64	15%	1.93	2.36	13%	2.49	3.05	17%
24-011_24-045	21	4.1828	21.00	0.82	0.93	4%	2.16	2.64	10%	1.93	2.36	9%	2.49	3.05	12%
24-012_24-011	21	0.5979	7.94	0.79	0.91	10%	2.13	2.69	27%	1.90	2.39	24%	2.46	3.10	31%
24-013_24-012	21	0.5988	7.95	0.79	0.91	10%	2.13	2.69	27%	1.90	2.39	24%	2.47	3.11	31%
24-014_24-013	21	0.6023	7.97	0.58	0.67	7%	1.70	2.93	21%	1.54	2.67	19%	2.07	3.57	26%
24-015_24-014	21	0.5975	7.94	0.58	0.67	7%	1.70	2.93	21%	1.54	2.67	19%	2.07	3.57	26%
24-016_24-015	21	0.5886	7.88	0.58	0.67	7%	1.70	2.93	22%	1.54	2.67	20%	2.07	3.57	26%
24-017_24-016	21	0.6031	7.98	0.58	0.67	7%	1.70	2.93	21%	1.54	2.67	19%	2.07	3.57	26%
24-018_24-017	21	0.5051	7.30	0.58	0.67	8%	1.70	2.93	23%	1.54	2.67	21%	2.07	3.57	28%
24-019_24-018	21	0.743	8.85	0.58	0.67	7%	1.70	2.94	19%	1.54	2.67	17%	2.07	3.57	23%
24-020_24-019	21	0.6059	7.99	0.53	0.61	7%	1.60	3.02	20%	1.47	2.76	18%	1.98	3.73	25%
24-021_24-020	21	0.52	7.41	0.53	0.61	7%	1.60	3.02	22%	1.47	2.76	20%	1.98	3.73	27%
24-022_24-021	21	0.5885	7.88	0.53	0.61	7%	1.60	3.02	20%	1.47	2.77	19%	1.98	3.73	25%
24-044_24-008	21	1.0136	10.34	0.82	0.93	8%	2.73	3.34	26%	2.56	3.13	25%	2.74	3.36	27%
24-045_24-010	21	1.9152	14.21	0.82	0.93	6%	2.16	2.64	15%	1.93	2.36	14%	2.49	3.05	18%
25-001_24-022	21	0.5845	7.85	0.53	0.61	7%	1.60	3.02	20%	1.47	2.77	19%	1.98	3.73	25%
25-002_25-001	21	0.6783	8.46	0.46	0.53	5%	1.45	3.18	17%	1.35	2.95	16%	1.85	4.04	22%
25-003_25-002	21	0.5781	7.81	0.46	0.53	6%	1.45	3.18	19%	1.35	2.95	17%	1.85	4.05	24%
25-004_25-003	21	0.6915	8.54	0.46	0.53	5%	1.45	3.18	17%	1.35	2.95	16%	1.85	4.05	22%
25-005_25-004	21	0.6078	8.01	0.46	0.53	6%	1.45	3.18	18%	1.35	2.95	17%	1.85	4.05	23%
25-006_25-005	21	0.7954	9.16	0.46	0.53	5%	1.45	3.18	16%	1.35	2.95	15%	1.85	4.05	20%
25-007_25-006	21	0.6685	8.40	0.46	0.53	5%	1.45	3.18	17%	1.35	2.95	16%	1.85	4.05	22%
25-008_25-007	21	0.7926	9.14	0.46	0.53	5%	1.45	3.18	16%	1.35	2.95	15%	1.85	4.05	20%

Existing Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

Segment ID (US_DS)	Pipe Size (in)	Slope (%)	Full-Flow Capacity (MGD)	DWF			Event 1			Event 2			Event 3		
				Ave DWF (MGD)	Peak DWF (MGD)	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity
25-014_25-008	21	0.0619	2.56	0.36	0.42	14%	1.25	3.49	49%	1.19	3.31	47%	1.67	4.65	65%
25-017_25-014	21	0.0642	2.60	0.36	0.42	14%	1.19	3.32	46%	1.13	3.16	44%	1.58	4.40	61%
25-019_25-017	21	0.0579	2.47	0.33	0.39	13%	1.16	3.50	47%	1.10	3.32	44%	1.54	4.66	62%
25-025_25-019	21	0.1041	3.31	0.33	0.38	10%	1.16	3.50	35%	1.10	3.32	33%	1.54	4.66	47%
25-033_25-025	21	0.1072	3.36	0.33	0.38	10%	1.16	3.50	34%	1.10	3.32	33%	1.54	4.66	46%
25-034_25-033	21	0.1033	3.30	0.33	0.38	10%	1.16	3.50	35%	1.10	3.32	33%	1.54	4.66	47%
25-035_25-034	21	0.0939	3.15	0.27	0.31	9%	0.94	3.50	30%	0.90	3.33	28%	1.26	4.66	40%
25-036_25-035	21	0.0978	3.21	0.27	0.31	8%	0.94	3.50	29%	0.90	3.33	28%	1.26	4.67	39%
25-037_25-036	21	0.1268	3.66	0.27	0.31	7%	0.94	3.50	26%	0.90	3.33	24%	1.26	4.67	34%
25-038_25-037	21	0.0852	3.00	0.27	0.31	9%	0.94	3.50	31%	0.90	3.33	30%	1.26	4.67	42%
25-039_25-038	21	0.1118	3.43	0.27	0.31	8%	0.94	3.51	27%	0.90	3.33	26%	1.26	4.67	37%
25-040_25-039	21	0.183	4.39	0.27	0.31	6%	0.94	3.51	21%	0.90	3.34	20%	1.26	4.67	29%
25-041_25-008	8	0.9861	0.78	0.10	0.11	12%	0.20	2.05	26%	0.16	1.65	21%	0.18	1.88	24%
25-042_25-041	8	1.0228	0.79	0.05	0.06	7%	0.11	2.04	14%	0.09	1.65	11%	0.10	1.87	13%
25-043_25-042	8	1.0786	0.81	0.05	0.06	7%	0.11	2.04	13%	0.09	1.65	11%	0.10	1.87	12%
25-044_25-043	8	0.9648	0.77	0.05	0.06	7%	0.11	2.04	14%	0.09	1.65	11%	0.10	1.88	13%
25-045_25-044	8	1.0541	0.80	0.05	0.06	7%	0.11	2.04	14%	0.09	1.65	11%	0.10	1.88	12%
25-046_25-045	8	0.5273	0.57	0.05	0.06	9%	0.11	2.04	19%	0.09	1.65	15%	0.10	1.88	18%
25-047_25-046	8	0.5971	0.61	0.05	0.06	9%	0.11	2.04	18%	0.09	1.65	15%	0.10	1.88	17%
25-048_25-047	8	0.5111	0.56	0.05	0.06	10%	0.11	2.05	19%	0.09	1.65	16%	0.10	1.88	18%
25-048_25-049	8	4.9202	1.74	0.05	0.05	3%	0.09	2.04	5%	0.07	1.64	4%	0.09	1.89	5%
26-001_25-040	21	0.0732	2.78	0.27	0.31	10%	0.94	3.51	34%	0.90	3.34	32%	1.26	4.67	45%
26-002_26-001	21	0.0645	2.61	0.20	0.23	8%	0.70	3.51	27%	0.67	3.34	26%	0.94	4.68	36%
26-003_26-002	21	0.1208	3.57	0.20	0.23	6%	0.70	3.51	20%	0.67	3.34	19%	0.94	4.68	26%
26-004_26-003	21	0.1147	3.48	0.20	0.23	6%	0.70	3.51	20%	0.67	3.35	19%	0.94	4.68	27%
26-005_26-004	12	0.2012	1.04	0.20	0.23	19%	0.70	3.51	68%	0.67	3.34	64%	0.94	4.68	90%
26-006_26-005	12	0.2208	1.09	0.20	0.23	18%	0.70	3.51	65%	0.67	3.35	62%	0.94	4.68	86%
26-007_26-006	12	0.1685	0.95	0.19	0.22	20%	0.68	3.51	71%	0.65	3.35	68%	0.90	4.68	95%
26-016_26-007	12	0.2097	1.06	0.12	0.14	11%	0.42	3.52	40%	0.40	3.36	38%	0.56	4.69	53%
26-017_26-016	12	0.2325	1.11	0.10	0.12	9%	0.35	3.51	32%	0.34	3.35	30%	0.47	4.69	42%
27_022_27-021	15	0.621	3.30	0.13	0.16	4%	1.58	12.30	48%	1.14	8.89	34%	1.75	13.70	53%
27-001_17-045	21	0.1011	2.83	0.26	0.32	9%	1.82	7.11	64%	1.81	7.07	64%	1.50	5.86	53%
27-003_27-001	21	0.0512	2.01	0.26	0.32	13%	1.72	6.71	85%	1.71	6.70	85%	1.53	5.99	76%
27-004_27-003	8	0.3502	0.46	0.11	0.14	24%	0.36	3.25	79%	0.63	5.64	136%	0.39	3.46	83%
27-020_27-003	15	0.1333	1.42	0.14	0.18	10%	1.55	10.79	109%	1.49	10.39	105%	1.34	9.36	95%
27-021_27-020	15	0.122	1.36	0.13	0.16	9%	1.57	12.24	115%	1.55	12.12	114%	1.49	11.66	110%
27-023_27_022	15	0.6376	3.34	0.13	0.16	4%	1.60	12.50	48%	1.14	8.87	34%	1.79	13.95	53%
27-024_27-023	15	0.6363	3.34	0.13	0.16	4%	1.62	12.63	48%	1.20	9.34	36%	1.40	10.90	42%
27-025_27-024	15	0.5066	2.98	0.13	0.16	4%	0.39	3.03	13%	0.30	2.34	10%	0.42	3.25	14%
27-026_27-025	15	0.6734	3.44	0.10	0.13	3%	0.32	3.03	9%	0.24	2.35	7%	0.34	3.25	10%
27-027_27-026	15	0.5797	3.19	0.10	0.13	3%	0.32	3.03	10%	0.24	2.35	8%	0.34	3.25	11%
27-028_21-027A	15	0.6457	3.36	0.10	0.13	3%	0.32	3.03	9%	0.24	2.35	7%	0.34	3.25	10%
27-029_27-028	15	0.5474	3.10	0.10	0.13	3%	0.32	3.03	10%	0.24	2.35	8%	0.34	3.25	11%
27-030_27-029	12	2.2918	3.50	0.10	0.13	3%	0.32	3.03	9%	0.24	2.35	7%	0.34	3.25	10%
27-031_27-030	12	2.8045	3.87	0.10	0.13	3%	0.32	3.03	8%	0.24	2.35	6%	0.34	3.25	9%
27-032_27-031	12	1.0621	2.38	0.10	0.13	4%	0.32	3.03	13%	0.24	2.35	10%	0.34	3.25	14%
27-041_27-032	12	0.6989	1.93	0.03	0.04	2%	0.10	3.03	5%	0.07	2.36	4%	0.10	3.26	5%
27-042_27-041	12	0.7299	1.97	0.03	0.04	2%	0.10	3.04	5%	0.07	2.36	4%	0.10	3.26	5%
27-043_27-042	12	0.7574	2.01	0.03	0.04	2%	0.10	3.04	5%	0.07	2.37	4%	0.10	3.26	5%
27-044_27-043	12	0.5719	1.75	0.03	0.04	2%	0.10	3.04	5%	0.07	2.37	4%	0.10	3.26	6%
27-045_27-044	12	0.7029	1.94	0.03	0.04	2%	0.10	3.04	5%	0.07	2.37	4%	0.10	3.26	5%
27-046_27-045	12	0.6865	1.91	0.03	0.04	2%	0.10	3.04	5%	0.07	2.37	4%	0.10	3.26	5%
27-047_27-046	12	0.7965	2.06	0.03	0.04	2%	0.10	3.04	5%	0.07	2.37	4%	0.10	3.26	5%
DivChamber_24-001	36	0.013	4.93	0.57	0.62	12%	6.05	10.65	123%	3.91	6.87	79%	4.11	7.23	83%

Appendix D

Future Flow Capacity Assessment

CDM Smith

Future Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

Segment ID (US_DS)	Pipe Size (in)	Slope (%)	Full-Flow Capacity (MGD)	DWF			Event 1			Event 2			Event 3		
				Ave DWF (MGD)	Peak DWF (MGD)	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity	Peak WWF (MGD)	Peaking Factor	% Full Flow Capacity
01-001_05-008	30	1.2001	29.12	0.35	0.40	1%	1.29	3.68	4%	1.06	3.01	4%	1.21	3.43	4%
01-002_01-001	30	0.0982	8.33	0.35	0.40	4%	1.30	3.68	16%	1.06	3.01	13%	1.21	3.43	14%
01-012_01-013	10	0.0993	0.45	0.02	0.03	5%	0.92	40.03	205%	0.67	29.17	149%	0.80	35.10	180%
01-013_01-002	30	0.1014	8.47	0.35	0.40	4%	1.25	3.58	15%	1.02	2.91	12%	1.16	3.31	14%
04-053_04-054	12	3.4974	4.32	0.45	0.54	10%	0.96	2.13	22%	0.98	2.17	23%	0.96	2.14	22%
04-054_04-055	12	3.0048	4.00	0.45	0.54	11%	0.96	2.13	24%	0.98	2.17	24%	0.96	2.14	24%
04-055_18-033	12	2.7509	3.83	0.45	0.54	12%	0.96	2.13	25%	0.98	2.17	26%	0.96	2.14	25%
05-001_08-034	30	1.0001	26.59	0.41	0.47	2%	1.70	4.14	6%	1.43	3.49	5%	1.66	4.03	6%
05-002_05-001	30	2.0004	37.60	0.41	0.47	1%	1.52	3.71	4%	1.26	3.08	3%	1.45	3.54	4%
05-003_05-002	30	0.501	18.82	0.41	0.47	2%	1.52	3.71	8%	1.26	3.08	7%	1.45	3.54	8%
05-004_05-003	30	0.498	18.76	0.41	0.47	2%	1.52	3.71	8%	1.26	3.08	7%	1.45	3.54	8%
05-005_05-004	30	0.5	18.80	0.38	0.43	2%	1.49	3.93	8%	1.23	3.26	7%	1.42	3.75	8%
05-006_05-005	30	2.028	37.86	0.35	0.40	<1%	1.29	3.68	3%	1.06	3.01	3%	1.21	3.43	3%
05-007_05-006	30	1.2001	29.12	0.35	0.40	1%	1.29	3.68	4%	1.06	3.01	4%	1.21	3.43	4%
05-008_05-007	30	1.2001	29.12	0.35	0.40	1%	1.29	3.68	4%	1.06	3.01	4%	1.21	3.43	4%
05-009_05-005	12	0.0995	0.73	0.03	0.03	4%	0.19	7.18	27%	0.19	6.88	25%	0.22	8.15	30%
06-001_18-035	12	5.4737	5.40	0.12	0.16	2%	2.46	20.06	45%	2.05	16.70	38%	2.09	17.10	39%
06-002_06-001	12	4.9959	5.16	0.12	0.16	2%	2.46	20.06	48%	2.05	16.70	40%	2.09	17.10	41%
06-003_06-002	12	2.4988	3.65	0.12	0.16	3%	2.46	20.06	67%	2.05	16.70	56%	2.09	17.10	57%
06-004_06-003	12	2.5053	3.66	0.12	0.16	3%	2.46	20.06	67%	2.05	16.70	56%	2.09	17.10	57%
07-001_08-012	12	1.0001	2.31	0.02	0.02	<1%	0.13	6.84	5%	0.12	6.55	5%	0.14	7.75	6%
08-001_23-001	36	2.2727	65.17	0.62	0.70	<1%	2.29	3.69	4%	1.97	3.17	3%	2.28	3.67	3%
08-002_08-001	36	0.1018	13.79	0.61	0.69	4%	2.22	3.67	16%	1.91	3.14	14%	2.21	3.64	16%
08-003_08-002	36	0.1045	13.97	0.61	0.69	4%	2.22	3.67	16%	1.91	3.14	14%	2.21	3.64	16%
08-004_08-003	36	1.0001	43.23	0.61	0.69	1%	2.22	3.67	5%	1.91	3.14	4%	2.21	3.64	5%
08-005_08-004	36	0.9621	42.40	0.61	0.69	1%	2.22	3.67	5%	1.91	3.14	4%	2.21	3.64	5%
08-006_08-005	36	1.0151	43.55	0.59	0.66	1%	2.14	3.66	5%	1.83	3.13	4%	2.12	3.62	5%
08-007_08-006	36	1.0094	43.43	0.59	0.66	1%	2.14	3.66	5%	1.83	3.13	4%	2.12	3.62	5%
08-008_08-007	36	1.0557	44.42	0.59	0.66	1%	2.14	3.66	5%	1.83	3.13	4%	2.12	3.62	5%
08-009_08-008	36	0.1957	19.12	0.59	0.66	3%	2.14	3.66	11%	1.83	3.13	10%	2.12	3.62	11%
08-010_08-009	30	0.1479	10.22	0.58	0.65	6%	2.11	3.67	21%	1.81	3.15	18%	2.10	3.64	21%
08-011_08-010	12	1.0001	2.31	0.02	0.03	1%	0.17	7.03	7%	0.16	6.73	7%	0.19	7.97	8%
08-012_08-011	12	1.0001	2.31	0.02	0.02	<1%	0.13	6.84	5%	0.12	6.55	5%	0.14	7.75	6%
08-026_08-010	30	2.5162	42.17	0.42	0.48	1%	1.81	4.28	4%	1.53	3.63	4%	1.77	4.20	4%
08-027_08-026	30	1.0001	26.59	0.42	0.47	2%	1.76	4.22	7%	1.49	3.57	6%	1.73	4.13	6%
08-028_08-027	30	2.0004	37.60	0.42	0.47	1%	1.76	4.22	5%	1.49	3.57	4%	1.73	4.13	5%
08-034_08-028	30	1.0001	26.59	0.41	0.47	2%	1.70	4.14	6%	1.43	3.49	5%	1.66	4.03	6%
09-001_09-100	12	0.3398	1.35	0.48	0.59	35%	1.88	3.95	140%	1.78	3.73	132%	1.89	3.97	141%
09-002_09-001	12	0.3578	1.38	0.48	0.59	34%	1.88	3.95	136%	1.78	3.73	129%	1.89	3.97	137%
09-006_09-002	12	0.3205	1.31	0.48	0.59	36%	1.88	3.95	144%	1.78	3.73	136%	1.89	3.98	145%
09-007_09-006	10	0.5926	1.12	0.48	0.59	43%	1.41	2.97	127%	1.36	2.86	122%	1.44	3.02	129%
09-008_09-007	10	0.4715	1.00	0.48	0.59	48%	1.42	2.98	142%	1.37	2.87	137%	1.41	2.95	141%
09-009_09-008	10	0.4139	0.93	0.48	0.59	51%	1.42	2.98	152%	1.37	2.87	146%	1.41	2.95	151%
09-009_09-099	10	0.4413	0.96	0.48	0.59	49%	1.42	2.98	147%	1.37	2.87	142%	1.41	2.95	146%
09-063_09-009	10	0.2259	0.69	0.48	0.59	69%	1.42	2.98	206%	1.37	2.87	198%	1.41	2.95	204%
09-072_09-063	10	0.2997	0.79	0.48	0.59	60%	1.42	2.98	179%	1.37	2.87	172%	1.41	2.95	177%
09-073_09-072	10	0.291	0.78	0.48	0.59	61%	1.42	2.98	181%	1.37	2.87	174%	1.41	2.95	180%
09-074_09-073	10	0.3886	0.90	0.48	0.59	53%	1.42	2.98	157%	1.37	2.87	151%	1.41	2.95	155%
09-075_09-074	10	0.2428	0.71	0.48	0.59	67%	1.42	2.98	199%	1.36	2.87	191%	1.41	2.95	197%
09-076_09-075	10	0.1988	0.65	0.48	0.59	74%	1.42	2.98	219%	1.37	2.87	211%	1.42	2.97	219%
09-100_20-045	12	0.0833	0.67	0.48	0.59	71%	1.88	3.95	282%	1.78	3.73	267%	1.89	3.97	284%
11-003_18-029	27	0.1406	7.53	0.89	1.11	12%	5.51	6.18	73%	4.73	5.31	63%	5.99	6.71	80%
11-004_11-003	27	0.1422	7.57	0.88	1.09	12%	5.45	6.18	72%	4.67	5.29	62%	5.92	6.71	78%
11-005_11-004	27	0.1385	7.47	0.88	1.09	12%	5.45	6.18	73%	4.67	5.30	63%	5.93	6.72	79%
11-006_11-005	27	0.1378	7.45	0.88	1.09	12%	5.45	6.18	73%	4.67	5.30	63%	5.93	6.73	80%
11-007_11-006	27	0.1394	7.49	0.88	1.09	12%	5.45	6.18	73%	4.67	5.30	62%	5.94	6.73	79%
11-008_11-007	27	0.14	7.51	0.88	1.09	12%	5.45	6.18	73%	4.67	5.30	62%	5.94	6.73	79%

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11-009_11-008	27	0.1376	7.45	0.88	1.09	12%	5.45	6.18	73%	4.67	5.30	63%	5.94	6.73	80%
11-010_11-009	27	0.142	7.56	0.88	1.09	12%	5.45	6.18	72%	4.67	5.30	62%	5.94	6.73	78%
11-012_11-010	27	0.1394	7.49	0.88	1.09	12%	5.45	6.18	73%	4.67	5.30	62%	5.94	6.73	79%
11-013_11-012	27	0.1421	7.57	0.87	1.08	11%	5.17	5.95	68%	4.42	5.09	58%	5.56	6.40	73%
11-014_11-013	24	0.2513	6.37	0.87	1.08	14%	5.17	5.95	81%	4.42	5.09	69%	5.56	6.40	87%
11-015_11-014	24	0.25	6.35	0.86	1.07	14%	5.12	5.95	81%	4.38	5.09	69%	5.49	6.38	86%
11-015A_11-015	24	0.253	6.39	0.86	1.07	13%	5.12	5.95	80%	4.38	5.09	68%	5.49	6.38	86%
11-016_11-015A	24	0.2526	6.39	0.86	1.07	13%	5.12	5.95	80%	4.38	5.09	69%	5.49	6.38	86%
11-017_11-016	10	8.6016	3.69	0.86	1.07	23%	3.80	4.42	103%	3.20	3.72	87%	3.79	4.40	103%
11-018_11-017	10	29.2345	6.37	0.86	1.07	14%	3.80	4.42	60%	3.20	3.71	50%	3.79	4.40	59%
11-019_11-018	18	0.3017	3.74	0.86	1.07	23%	3.80	4.42	102%	3.20	3.71	85%	3.79	4.40	101%
11-020_11-019	10	9.4581	4.46	0.86	1.07	19%	3.78	4.39	85%	3.17	3.69	71%	3.75	4.36	84%
11-021_11-020	15	0.3852	2.41	0.86	1.07	36%	3.78	4.39	156%	3.17	3.69	132%	3.75	4.36	155%
11-024_11-021	15	0.2963	2.12	0.86	1.07	41%	3.78	4.40	179%	3.17	3.69	150%	3.75	4.36	177%
11-031_11-032	18	0.3728	4.16	0.86	1.07	21%	3.75	4.36	90%	3.16	3.67	76%	3.72	4.33	90%
11-032_11-024	18	0.3379	3.96	0.86	1.07	22%	3.75	4.36	95%	3.15	3.67	80%	3.72	4.33	94%
11-034_11-031	18	0.3162	3.83	0.86	1.07	22%	3.68	4.28	96%	3.10	3.61	81%	3.66	4.26	96%
11-035_11-034	12	0.3015	1.27	0.48	0.59	38%	2.13	4.47	168%	1.95	4.10	154%	2.12	4.45	167%
11-036_11-035	12	0.2991	1.26	0.48	0.59	38%	2.13	4.47	169%	1.95	4.10	155%	2.12	4.45	168%
11-047A_11-047B	12	0.4363	1.53	0.38	0.48	25%	1.55	4.06	102%	1.17	3.05	76%	1.55	4.05	102%
11-047B_11-034	12	0.4816	1.60	0.38	0.48	24%	1.55	4.06	97%	1.16	3.04	73%	1.55	4.06	97%
11-047C_11-047A	12	0.3736	1.41	0.38	0.48	27%	1.55	4.06	110%	1.17	3.05	83%	1.55	4.05	110%
11-066_11-047C	12	0.3965	1.45	0.38	0.48	26%	1.35	3.52	93%	1.02	2.65	70%	1.36	3.56	94%
11-067_11-066	12	0.3955	1.45	0.38	0.48	26%	1.36	3.56	94%	1.02	2.66	70%	1.38	3.60	95%
11-068_11-067	12	0.2974	1.26	0.38	0.48	30%	1.33	3.46	105%	1.00	2.61	79%	1.33	3.48	106%
11-069_11-068	12	0.298	1.26	0.38	0.48	30%	1.32	3.46	105%	1.00	2.61	79%	1.34	3.49	106%
11-070_11-069	12	0.297	1.26	0.38	0.48	30%	1.32	3.46	105%	1.00	2.62	80%	1.34	3.49	106%
11-071_11-070	12	0.2974	1.26	0.38	0.48	30%	1.28	3.34	102%	0.97	2.54	77%	1.29	3.38	103%
11-075_11-071	12	0.2955	1.26	0.38	0.48	31%	1.28	3.35	102%	0.97	2.54	77%	1.29	3.38	103%
11-076_11-075	12	0.297	1.26	0.38	0.48	30%	1.20	3.14	95%	0.93	2.42	74%	1.22	3.18	97%
11-083_11-076	10	0.7908	1.26	0.38	0.48	30%	1.20	3.14	95%	0.93	2.42	73%	1.22	3.18	96%
11-084_11-083	10	1.0262	1.44	0.38	0.48	27%	1.20	3.14	83%	0.93	2.42	64%	1.22	3.18	85%
11-109_11-084	10	0.6438	1.14	0.22	0.27	19%	0.46	2.08	40%	0.40	1.81	35%	0.47	2.15	41%
11-110_11-109	10	0.6787	1.17	0.21	0.26	18%	0.45	2.11	38%	0.39	1.83	33%	0.46	2.18	40%
11-111_11-110	10	1.0763	1.47	0.21	0.26	14%	0.45	2.11	30%	0.39	1.83	26%	0.46	2.18	31%
11-112_11-111	10	0.4368	0.94	0.21	0.26	23%	0.45	2.11	48%	0.39	1.83	42%	0.46	2.18	49%
11-113_11-112	10	0.4882	0.99	0.21	0.26	21%	0.45	2.11	45%	0.39	1.83	39%	0.46	2.18	47%
11-114_11-113	10	0.5133	1.02	0.21	0.26	21%	0.45	2.11	44%	0.39	1.83	38%	0.46	2.18	46%
11-115_11-114	10	0.5556	1.06	0.21	0.26	20%	0.45	2.11	42%	0.39	1.84	37%	0.46	2.18	44%
11-116_11-115	10	1.6027	1.80	0.21	0.26	12%	0.45	2.11	25%	0.39	1.83	22%	0.46	2.18	26%
11-117_11-116	10	0.4799	0.98	0.21	0.26	22%	0.45	2.11	46%	0.39	1.83	40%	0.46	2.18	47%
11-121_11-117	10	0.5449	1.05	0.21	0.26	20%	0.45	2.11	43%	0.39	1.83	37%	0.46	2.18	44%
11-122_11-121	10	0.2929	0.77	0.21	0.26	28%	0.37	1.76	49%	0.35	1.63	45%	0.39	1.84	51%
11-123_11-122	10	0.2885	0.76	0.21	0.26	28%	0.37	1.75	49%	0.35	1.62	45%	0.39	1.84	51%
11-124_11-123	10	0.2	0.64	0.19	0.24	30%	0.33	1.74	52%	0.31	1.62	49%	0.35	1.83	55%
11-125_11-124	10	0.2066	0.65	0.19	0.24	29%	0.33	1.74	51%	0.31	1.62	48%	0.35	1.82	54%
11-126_11-125	10	0.2	0.64	0.19	0.24	30%	0.26	1.38	41%	0.26	1.39	42%	0.28	1.46	44%
11-127_11-126	10	0.2033	0.64	0.19	0.24	30%	0.26	1.38	41%	0.26	1.39	41%	0.28	1.46	43%
11-128_11-127	10	0.2	0.64	0.19	0.24	30%	0.26	1.38	41%	0.26	1.39	42%	0.28	1.46	44%
11-129_11-128	10	0.2	0.64	0.19	0.24	30%	0.25	1.31	39%	0.25	1.32	39%	0.25	1.34	40%
11-130_11-129	10	0.2	0.64	0.19	0.24	30%	0.25	1.31	39%	0.25	1.32	39%	0.25	1.34	40%
11-131_11-123	10	0.3	0.78	0.02	0.04	2%	0.07	4.00	9%	0.06	3.54	8%	0.07	4.28	9%
11-132_11-131	10	0.3033	0.78	0.02	0.03	3%	0.04	1.93	5%	0.04	1.74	5%	0.04	2.01	6%
11-133_11-132	10	0.305	0.78	0.02	0.03	3%	0.03	1.29	4%	0.03	1.29	4%	0.03	1.29	4%
12-001_11-016	24	0.25	6.35	0.01	0.01	<1%	1.32	131.79	21%	1.18	117.93	19%	1.71	171.15	27%
12-003_12-001	18	0.2513	3.17	0.01	0.01	<1%	1.30	130.15	41%	1.16	116.41	37%	1.69	168.99	53%
12-004_12-003	18	0.2547	3.19	0.01	0.01	<1%	1.30	130.14	41%	1.16	116.40	36%	1.69	168.97	53%
13-001_14-041	12	0.0837	0.67	0.55	0.67	82%	0.76	1.38	113%	0.74	1.35	110%	0.86	1.57	129%
13-002_13-001	12	0.5878	1.77	0.55	0.67	31%	0.76	1.38	43%	0.74	1.35	42%	0.86	1.57	49%

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13-007_13-002	12	0.2193	1.08	0.55	0.67	51%	0.76	1.38	70%	0.74	1.35	68%	0.86	1.57	80%
13-008_13-007	8	0.1747	0.33	0.46	0.56	141%	0.57	1.23	173%	0.57	1.24	175%	0.59	1.27	179%
13-010_13-008	8	0.0812	0.22	0.45	0.55	200%	0.55	1.23	246%	0.55	1.24	248%	0.55	1.24	248%
13-014_13-010	8	0.4356	0.52	0.45	0.55	87%	0.55	1.23	106%	0.55	1.24	107%	0.55	1.24	107%
13-015_13-014	8	0.4614	0.53	0.45	0.55	84%	0.55	1.23	103%	0.55	1.24	104%	0.55	1.24	104%
13-016_13-015	8	0.5124	0.56	0.45	0.55	80%	0.55	1.23	98%	0.55	1.24	99%	0.55	1.24	99%
13-021_13-123	12	0.0829	0.66	0.09	0.11	13%	0.22	2.54	33%	0.18	2.09	27%	0.28	3.18	41%
13-047_13-021	12	0.1632	0.93	0.04	0.06	4%	0.09	2.49	9%	0.08	2.15	8%	0.11	3.11	12%
13-070_13-047	12	0.239	1.13	0.04	0.04	3%	0.09	2.47	8%	0.07	2.04	6%	0.11	3.08	10%
13-071_13-070	12	0.2644	1.19	0.04	0.04	3%	0.09	2.47	7%	0.07	2.04	6%	0.11	3.08	9%
13-123_13-007	12	0.2392	1.13	0.09	0.11	8%	0.22	2.54	19%	0.18	2.09	16%	0.28	3.17	24%
14-001_16-018	12	0.2102	1.06	0.59	0.73	56%	0.87	1.46	82%	0.83	1.40	78%	1.01	1.70	95%
14-002_14-001	12	0.284	1.23	0.59	0.73	48%	0.87	1.47	71%	0.83	1.40	67%	1.01	1.71	82%
14-003_14-002	12	0.3579	1.38	0.59	0.73	43%	0.87	1.47	63%	0.83	1.40	60%	1.01	1.71	73%
14-007_14-003	12	0.2113	1.06	0.59	0.72	55%	0.85	1.44	80%	0.81	1.38	76%	0.98	1.67	92%
14-008_14-007	12	0.1221	0.81	0.59	0.72	73%	0.85	1.44	105%	0.81	1.38	100%	0.98	1.67	121%
14-009_14-008	12	0.2678	1.19	0.59	0.72	49%	0.85	1.44	71%	0.81	1.38	68%	0.98	1.67	82%
14-021_14-009	12	0.081	0.66	0.59	0.72	89%	0.85	1.44	129%	0.81	1.38	123%	0.98	1.67	149%
14-022_14-021	12	0.0571	0.55	0.59	0.72	106%	0.85	1.44	153%	0.81	1.38	147%	0.98	1.67	177%
14-036_14-022	12	0.1929	1.01	0.55	0.67	54%	0.76	1.38	75%	0.74	1.35	73%	0.86	1.57	85%
14-038_14-047	12	0.2475	1.15	0.55	0.67	48%	0.76	1.38	66%	0.74	1.34	64%	0.86	1.57	75%
14-039_14-038	12	0.0869	0.68	0.55	0.67	80%	0.76	1.38	111%	0.74	1.34	108%	0.86	1.57	126%
14-041_14-039	12	0.1889	1.00	0.55	0.67	55%	0.76	1.38	75%	0.74	1.34	73%	0.86	1.57	86%
14-047_14-036	12	0.1548	0.91	0.55	0.67	60%	0.76	1.38	83%	0.74	1.35	81%	0.86	1.57	95%
15-001_15-039	12	0.5602	1.73	0.10	0.13	6%	0.74	7.62	43%	0.37	3.78	21%	0.63	6.47	37%
15-002_15-001	12	0.9368	2.24	0.10	0.13	4%	0.74	7.55	33%	0.37	3.75	16%	0.62	6.34	28%
15-004_15-002	12	0.6234	1.82	0.10	0.13	5%	0.74	7.55	40%	0.37	3.75	20%	0.62	6.34	34%
15-005_15-004	12	0.6218	1.82	0.10	0.13	5%	0.74	7.55	40%	0.37	3.75	20%	0.62	6.34	34%
15-039_15-040	18	0.5177	4.90	0.74	0.91	15%	1.74	2.35	35%	1.30	1.75	26%	1.80	2.44	37%
15-040_15-041	18	0.0824	1.95	0.74	0.91	38%	1.74	2.35	89%	1.30	1.75	66%	1.80	2.44	92%
15-041_15-042	18	0.8522	6.29	0.74	0.91	12%	1.74	2.35	28%	1.30	1.75	21%	1.80	2.44	29%
15-042_16-061	18	0.4148	4.38	0.74	0.91	17%	1.74	2.36	40%	1.30	1.76	30%	1.80	2.44	41%
16-012_16-013	15	0.1185	1.56	0.64	0.79	41%	0.99	1.55	63%	0.93	1.45	59%	1.17	1.83	75%
16-013_16-014	15	0.2209	2.13	0.64	0.79	30%	0.99	1.55	46%	0.93	1.45	43%	1.17	1.83	55%
16-014_16-015	15	0.1263	1.61	0.64	0.79	40%	1.02	1.59	63%	0.95	1.49	59%	1.22	1.91	76%
16-015_15-039	15	0.2917	2.45	0.64	0.79	26%	1.02	1.59	42%	0.95	1.49	39%	1.22	1.91	50%
16-017_16-036	15	0.1	1.43	0.64	0.79	45%	0.99	1.55	69%	0.93	1.45	65%	1.17	1.83	82%
16-018_16-017	12	0.1486	0.89	0.59	0.73	67%	0.87	1.46	97%	0.83	1.40	93%	1.01	1.70	113%
16-036_16-012	15	0.1053	1.47	0.64	0.79	44%	0.99	1.55	67%	0.93	1.45	63%	1.17	1.83	80%
16-058_16-062	33	0.272	14.53	1.95	2.44	13%	4.33	2.22	30%	3.92	2.01	27%	4.29	2.20	30%
16-058A_16-058	18	0.2575	3.45	0.74	0.91	21%	1.74	2.36	50%	1.30	1.76	38%	1.80	2.44	52%
16-059_16-058A	18	0.0226	1.02	0.74	0.91	72%	1.74	2.36	170%	1.30	1.76	127%	1.80	2.44	176%
16-060_16-059	18	0.2818	3.61	0.74	0.91	20%	1.74	2.36	48%	1.30	1.76	36%	1.80	2.44	50%
16-061_16-060	18	0.2299	3.26	0.74	0.91	23%	1.74	2.36	53%	1.30	1.76	40%	1.80	2.44	55%
16-062_19-074	33	0.0467	6.02	1.95	2.41	32%	4.32	2.21	72%	3.91	2.00	65%	4.28	2.19	71%
17-001_16-058	20	0.0984	2.46	1.14	1.49	46%	2.57	2.26	104%	2.64	2.32	107%	2.63	2.31	107%
17-002_17-001	21	0.197	3.95	1.14	1.50	29%	2.66	2.34	67%	2.77	2.44	70%	3.47	3.05	88%
17-003_17-002	12	108.7709	24.08	0.08	0.08	<1%	1.35	17.10	6%	1.52	19.26	6%	1.51	19.03	6%
17-023_17-024	21	0.0682	2.32	1.06	1.23	45%	2.06	1.95	89%	2.07	1.96	89%	2.01	1.90	86%
17-023a_17-023	21	0.0959	2.76	1.04	1.21	38%	2.12	2.04	77%	2.06	1.98	75%	1.96	1.88	71%
17-024_17-002	21	0.1649	3.61	1.06	1.23	29%	2.17	2.05	60%	2.07	1.96	57%	2.14	2.02	59%
17-025_17-023a	21	0.1357	3.28	1.04	1.21	32%	2.13	2.04	65%	1.99	1.91	61%	2.06	1.98	63%
17-043_17-025	21	0.0246	1.40	1.04	1.21	75%	2.01	1.93	144%	1.88	1.80	134%	2.01	1.93	144%
17-044_17-043	21	0.04	1.78	1.03	1.20	58%	1.97	1.92	111%	1.81	1.77	102%	2.00	1.95	113%
17-045_17-044	21	0.0375	1.62	1.03	1.20	64%	1.95	1.90	121%	1.82	1.77	112%	2.01	1.95	124%
18-029_18-030	30	0.1006	8.43	0.89	1.11	11%	5.51	6.18	65%	4.73	5.31	56%	5.95	6.67	71%
18-030_18-031	30	0.1026	8.52	0.95	1.17	11%	5.94	6.28	70%	5.10	5.39	60%	6.48	6.85	76%
18-031_18-033	30	0.0978	8.31	0.95	1.17	11%	5.96	6.30	72%	5.10	5.39	61%	6.48	6.85	78%
18-033_18-099	30	0.1	8.41	1.40	1.72	17%	6.88	4.90	82%	5.79	4.12	69%	7.33	5.22	87%

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18-034_18-038	30	0.1015	8.47	1.40	1.72	17%	6.90	4.91	81%	5.79	4.12	68%	7.33	5.22	87%
18-035_18-036	12	2.2017	2.97	0.12	0.16	4%	2.46	20.06	83%	2.05	16.70	69%	2.09	17.10	71%
18-036_18-039A	12	1.5103	2.46	0.00	0.01	<1%	0.57	157.27	23%	0.44	121.02	18%	0.46	124.91	19%
18-038_18-039	30	0.1087	8.76	1.52	1.87	17%	8.59	5.64	98%	7.28	4.78	83%	8.62	5.66	98%
18-039_18-040	30	0.1512	10.34	1.53	1.88	15%	8.71	5.68	84%	7.38	4.82	71%	8.78	5.72	85%
18-039A_18-083	12	0.0707	0.80	0.00	0.01	<1%	0.57	157.02	72%	0.44	120.97	55%	0.46	124.87	57%
18-040_18-041	30	0.1492	10.27	1.53	1.88	15%	8.71	5.68	85%	7.38	4.81	72%	8.77	5.72	85%
18-041_18-042	30	0.1505	9.58	1.53	1.88	16%	8.71	5.68	91%	7.37	4.81	77%	8.77	5.72	92%
18-042_18-043	30	0.1484	9.51	1.53	1.88	16%	8.71	5.68	92%	7.37	4.81	78%	8.77	5.72	92%
18-043_18-044	30	0.1513	9.60	1.53	1.88	16%	8.71	5.68	91%	7.37	4.81	77%	8.77	5.72	91%
18-045_22-048	30	2.0826	35.62	1.57	1.93	4%	9.57	6.10	27%	8.04	5.12	23%	9.56	6.09	27%
18-046_18-045	24	1.3166	16.82	0.01	0.01	<1%	0.57	57.10	3%	0.44	44.04	3%	0.45	45.47	3%
18-079_18-088	24	0.0714	3.92	0.01	0.01	<1%	0.57	57.17	15%	0.44	44.07	11%	0.45	45.49	12%
18-082_18-079	12	0.0684	0.79	0.01	0.01	1%	0.57	57.12	73%	0.44	44.08	56%	0.46	45.50	58%
18-083_18-082	12	0.0714	0.80	0.01	0.01	1%	0.57	57.17	71%	0.44	44.09	55%	0.46	45.51	57%
18-088_18-097	24	0.0714	3.92	0.01	0.01	<1%	0.57	57.15	15%	0.44	44.07	11%	0.45	45.49	12%
18-097_18-098	24	0.0691	3.85	0.01	0.01	<1%	0.57	57.11	15%	0.44	44.04	11%	0.45	45.48	12%
18-098_18-046	24	0.0712	3.91	0.01	0.01	<1%	0.57	57.11	15%	0.44	44.04	11%	0.45	45.47	12%
18-099_18-034	30	0.1	8.41	1.40	1.72	17%	6.90	4.91	82%	5.79	4.12	69%	7.33	5.22	87%
19-074_19-074B	33	0.089	8.31	2.02	2.45	24%	4.39	2.18	53%	3.99	1.98	48%	4.35	2.15	52%
19-074B_19-074C	33	0.0887	8.85	2.02	2.46	23%	4.39	2.18	50%	3.98	1.97	45%	4.35	2.16	49%
19-074C_19-075	33	0.0795	8.38	2.02	2.47	24%	4.37	2.17	52%	3.97	1.97	47%	4.34	2.15	52%
19-075_19-076	33	0.3648	19.22	2.07	2.53	11%	4.62	2.23	24%	4.15	2.00	22%	4.45	2.15	23%
19-076_19-082	33	0.0814	9.08	2.15	2.61	24%	4.75	2.21	52%	4.25	1.98	47%	4.47	2.08	49%
19-077_19-078	33	0.0792	9.65	2.15	2.58	22%	4.72	2.20	49%	4.24	1.98	44%	4.31	2.01	45%
19-078_19-079	33	0.0745	8.11	2.15	2.58	26%	4.67	2.17	58%	4.23	1.97	52%	4.31	2.01	53%
19-079_19-080	33	0.0943	9.12	2.15	2.58	24%	4.60	2.15	50%	4.23	1.97	46%	4.33	2.02	47%
19-080_19-081	33	0.0914	8.98	2.15	2.56	24%	4.55	2.12	51%	4.23	1.97	47%	4.34	2.02	48%
19-081_24-007	33	0.0807	8.44	2.15	2.55	25%	4.50	2.10	53%	4.22	1.97	50%	4.34	2.02	51%
19-082_19-077	33	0.0685	8.97	2.15	2.58	24%	4.74	2.21	53%	4.24	1.98	47%	4.39	2.04	49%
20-039_20-086	12	0.5963	1.78	0.48	0.59	27%	1.88	3.95	105%	1.77	3.72	99%	1.88	3.94	105%
20-040_20-039	12	1.4935	2.82	0.48	0.59	17%	1.88	3.95	67%	1.77	3.72	63%	1.88	3.95	67%
20-041_20-040	12	0.2618	1.18	0.48	0.59	40%	1.88	3.95	159%	1.77	3.72	150%	1.88	3.95	159%
20-042_20-041	12	0.5222	1.67	0.48	0.59	29%	1.88	3.95	113%	1.77	3.72	106%	1.88	3.95	113%
20-043_20-042	12	1.3483	2.68	0.48	0.59	18%	1.88	3.95	70%	1.77	3.72	66%	1.88	3.95	70%
20-044_20-043	12	0.5	1.63	0.48	0.59	29%	1.88	3.95	115%	1.78	3.73	109%	1.89	3.97	116%
20-045_20-044	12	0.2906	1.24	0.48	0.59	38%	1.88	3.95	151%	1.78	3.73	143%	1.89	3.97	152%
20-083_11-036	12	0.3018	1.27	0.48	0.59	38%	2.13	4.47	168%	1.95	4.10	154%	2.12	4.45	167%
20-084_20-083	12	0.6005	1.79	0.48	0.59	27%	2.13	4.47	119%	1.95	4.10	109%	2.12	4.45	119%
20-085_20-084	12	0.6335	1.84	0.48	0.59	26%	1.88	3.95	102%	1.77	3.72	96%	1.88	3.94	102%
20-086_20-085	12	0.607	1.80	0.48	0.59	26%	1.88	3.95	105%	1.77	3.72	99%	1.88	3.94	104%
21-027A_27-027	15	0.5661	3.15	0.68	0.79	22%	1.20	1.76	38%	1.06	1.55	33%	1.09	1.60	35%
21-048_21-078	48	0.4063	55.10	1.80	2.24	3%	10.98	6.10	20%	9.08	5.05	16%	10.99	6.10	20%
21-070_21-071	36	2.6096	64.85	1.80	2.21	3%	13.51	7.49	21%	9.08	5.03	14%	13.20	7.32	20%
21-071_21-072	36	0.3061	20.73	1.80	2.21	9%	11.59	6.43	56%	9.08	5.03	44%	11.80	6.54	57%
21-072_21-073A	35	0.0313	5.92	1.81	2.22	31%	11.65	6.42	197%	9.15	5.04	155%	11.71	6.45	198%
21-073_21-074A	34	0.1011	10.96	1.81	2.22	17%	11.77	6.49	107%	9.14	5.04	83%	12.00	6.61	110%
21-073A_21-073	34	0.0267	5.25	1.81	2.22	35%	11.56	6.37	220%	9.14	5.04	174%	11.75	6.48	224%
22-038_22-026	8	2.7297	1.20	0.01	0.01	<1%	0.05	4.75	4%	0.03	2.62	2%	0.00	0.11	0%
21-074_21-075	36	0.4444	28.82	1.81	2.22	6%	12.12	6.68	42%	9.13	5.03	32%	12.41	6.84	43%
21-074A_21-074	34	0.1119	11.53	1.81	2.22	16%	11.80	6.50	102%	9.13	5.03	79%	12.11	6.67	105%
21-076_21-070	36	0.8125	36.18	1.80	2.21	5%	15.44	8.56	43%	9.08	5.04	25%	19.09	10.58	53%
21-078_21-076	36	1.9313	55.79	1.80	2.21	3%	11.91	6.60	21%	9.08	5.04	16%	12.10	6.71	22%
22-001_21-048	48	0.641	74.54	1.69	2.07	2%	10.52	6.22	14%	8.78	5.19	12%	10.59	6.26	14%
22-020_22-001	48	0.2965	50.69	1.65	2.02	3%	10.15	6.16	20%	8.55	5.19	17%	10.29	6.25	20%
22-026_22-020	48	0.3282	53.34	1.65	2.02	3%	10.15	6.17	19%	8.55	5.19	16%	10.29	6.25	19%
22-036_22-026	36	0.3067	25.94	1.65	2.02	6%	10.15	6.16	39%	8.55	5.19	33%	10.29	6.25	40%
22-048_22-036	36	0.2893	23.25	1.62	1.99	7%	9.91	6.12	43%	8.34	5.15	36%	9.98	6.16	43%
23-001A_24-000	30	0.0996	8.39	0.99	1.08	12%	3.67	3.72	44%	3.39	3.43	40%	5.52	5.59	66%

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23-002_23-001	21	0.023	1.56	0.37	0.38	24%	0.67	1.82	43%	0.72	1.97	46%	0.72	1.98	46%
23-003_23-002	21	0.1226	3.60	0.35	0.37	10%	0.63	1.80	18%	0.68	1.95	19%	0.69	1.96	19%
23-004_23-003	21	0.125	3.63	0.35	0.37	10%	0.63	1.80	17%	0.68	1.95	19%	0.69	1.96	19%
23-005_23-004	21	0.0525	2.35	0.35	0.37	15%	0.63	1.80	27%	0.68	1.95	29%	0.69	1.96	29%
23-006_23-005	21	0.0793	2.89	0.24	0.25	8%	0.50	2.10	17%	0.53	2.23	18%	0.53	2.24	18%
23-007_23-006	21	0.1314	3.72	0.24	0.25	6%	0.41	1.70	11%	0.44	1.86	12%	0.44	1.86	12%
23-008_23-007	21	0.2017	4.61	0.24	0.25	5%	0.41	1.71	9%	0.44	1.86	10%	0.44	1.86	10%
23-009_23-008	21	0.0891	3.07	0.16	0.17	5%	0.31	1.97	10%	0.33	2.11	11%	0.34	2.11	11%
23-010_23-009	21	0.112	3.44	0.16	0.17	5%	0.31	1.97	9%	0.33	2.11	10%	0.34	2.11	10%
23-011_23-010	21	0.1713	4.25	0.16	0.17	4%	0.31	1.97	7%	0.33	2.11	8%	0.34	2.11	8%
23-012_23-011	21	0.0202	1.46	0.16	0.17	11%	0.31	1.97	21%	0.33	2.11	23%	0.34	2.11	23%
23-013_23-012	21	0.581	7.83	0.16	0.17	2%	0.31	1.97	4%	0.33	2.11	4%	0.34	2.11	4%
23-014_23-013	21	0.1244	3.62	0.11	0.12	3%	0.26	2.30	7%	0.27	2.41	8%	0.27	2.43	8%
24-002_RS_Jun	42	0.1286	21.71	4.69	5.35	22%	9.18	1.96	42%	7.99	1.70	37%	9.29	1.98	43%
24-003_24-003A	36	0.0957	13.37	1.81	2.22	14%	10.53	5.80	79%	9.14	5.04	68%	11.18	6.16	84%
24-003A_EQDivChamb	36	0.0882	16.69	1.81	2.22	11%	10.50	5.79	63%	9.15	5.04	55%	11.20	6.17	67%
24-004_24-002	42	0.1605	24.26	4.69	5.35	19%	9.18	1.96	38%	8.02	1.71	33%	9.29	1.98	38%
24-004A_24-004	42	0.1544	23.79	4.69	5.35	20%	9.19	1.96	39%	8.01	1.71	34%	9.28	1.98	39%
24-005_24-004A	42	0.1607	24.27	4.69	5.35	19%	9.18	1.96	38%	8.04	1.71	33%	9.29	1.98	38%
24-006_24-006A	42	0.087	17.86	4.69	5.35	26%	9.19	1.96	51%	8.02	1.71	45%	9.28	1.98	52%
24-006A_24-005	42	0.0881	17.97	4.69	5.35	26%	9.18	1.96	51%	8.03	1.71	45%	9.29	1.98	52%
24-007_24-006	42	0.0567	14.42	4.69	5.35	33%	9.19	1.96	64%	8.05	1.72	56%	9.29	1.98	64%
24-008_24-007	21	1.4038	12.17	2.45	2.72	20%	5.09	2.08	42%	4.25	1.73	35%	5.12	2.09	42%
24-009_24-044	21	0.8102	9.24	2.45	2.72	27%	4.77	1.94	52%	4.22	1.72	46%	4.96	2.02	54%
24-010_24-009	21	2.045	14.69	2.45	2.72	17%	4.77	1.95	32%	4.22	1.72	29%	4.96	2.02	34%
24-011_24-045	21	4.1828	21.00	2.45	2.72	12%	4.77	1.95	23%	4.22	1.72	20%	4.96	2.02	24%
24-012_24-011	21	0.5979	7.94	2.39	2.64	30%	4.69	1.97	59%	4.14	1.74	52%	4.88	2.05	61%
24-013_24-012	21	0.5988	7.95	2.39	2.64	30%	4.69	1.97	59%	4.14	1.74	52%	4.88	2.05	61%
24-014_24-013	21	0.6023	7.97	1.89	2.10	24%	3.74	1.98	47%	3.38	1.78	42%	4.02	2.12	50%
24-015_24-014	21	0.5975	7.94	1.89	2.10	24%	3.74	1.98	47%	3.38	1.78	43%	4.02	2.12	51%
24-016_24-015	21	0.5886	7.88	1.89	2.10	24%	3.74	1.98	48%	3.38	1.78	43%	4.02	2.12	51%
24-017_24-016	21	0.6031	7.98	1.89	2.10	24%	3.74	1.98	47%	3.38	1.78	42%	4.02	2.12	50%
24-018_24-017	21	0.5051	7.30	1.89	2.10	26%	3.74	1.98	51%	3.38	1.79	46%	4.02	2.12	55%
24-019_24-018	21	0.743	8.85	1.89	2.10	21%	3.74	1.98	42%	3.38	1.79	38%	4.02	2.12	45%
24-020_24-019	21	0.6059	7.99	1.82	2.02	23%	3.61	1.99	45%	3.27	1.80	41%	3.90	2.14	49%
24-021_24-020	21	0.52	7.41	1.82	2.02	25%	3.62	1.99	49%	3.27	1.80	44%	3.90	2.14	53%
24-022_24-021	21	0.5885	7.88	1.82	2.02	23%	3.62	1.99	46%	3.27	1.80	42%	3.90	2.14	49%
24-044_24-008	21	1.0136	10.34	2.45	2.72	24%	4.77	1.94	46%	4.22	1.72	41%	5.06	2.06	49%
24-045_24-010	21	1.9152	14.21	2.45	2.72	17%	4.77	1.95	34%	4.22	1.72	30%	4.96	2.02	35%
25-001_24-022	21	0.5845	7.85	1.82	2.02	23%	3.62	1.99	46%	3.27	1.80	42%	3.90	2.14	50%
25-002_25-001	21	0.6783	8.46	1.62	1.80	19%	3.31	2.04	39%	3.00	1.85	35%	3.60	2.22	43%
25-003_25-002	21	0.5781	7.81	1.62	1.80	21%	3.32	2.04	42%	3.00	1.85	38%	3.60	2.22	46%
25-004_25-003	21	0.6915	8.54	1.62	1.80	19%	3.32	2.05	39%	3.00	1.85	35%	3.60	2.22	42%
25-005_25-004	21	0.6078	8.01	1.62	1.80	20%	3.32	2.05	41%	3.00	1.85	37%	3.60	2.22	45%
25-006_25-005	21	0.7954	9.16	1.62	1.80	18%	3.32	2.05	36%	3.00	1.85	33%	3.60	2.22	39%
25-007_25-006	21	0.6685	8.40	1.62	1.80	19%	3.32	2.05	40%	3.00	1.85	36%	3.60	2.22	43%
25-008_25-007	21	0.7926	9.14	1.25	1.39	14%	2.51	2.01	27%	2.41	1.93	26%	2.95	2.36	32%
25-014_25-008	21	0.0619	2.56	1.06	1.17	41%	2.19	2.07	86%	2.13	2.02	83%	2.65	2.51	104%
25-017_25-014	21	0.0642	2.60	0.99	1.10	38%	2.06	2.07	79%	2.00	2.01	77%	2.48	2.50	95%
25-019_25-017	21	0.0579	2.47	0.99	1.11	40%	2.06	2.07	83%	2.00	2.01	81%	2.48	2.50	101%
25-025_25-019	21	0.1041	3.31	0.99	1.11	30%	2.06	2.07	62%	2.00	2.01	60%	2.48	2.50	75%
25-033_25-025	21	0.1072	3.36	0.99	1.11	30%	2.06	2.07	61%	2.00	2.01	60%	2.48	2.50	74%
25-034_25-033	21	0.1033	3.30	0.49	0.54	15%	1.44	2.97	44%	1.34	2.76	41%	1.81	3.72	55%
25-035_25-034	21	0.0939	3.15	0.34	0.38	11%	1.13	3.30	36%	1.03	3.02	33%	1.41	4.12	45%
25-036_25-035	21	0.0978	3.21	0.34	0.38	11%	1.13	3.30	35%	1.03	3.03	32%	1.41	4.12	44%
25-037_25-036	21	0.1268	3.66	0.34	0.38	9%	1.13	3.30	31%	1.03	3.03	28%	1.41	4.12	39%
25-038_25-037	21	0.0852	3.00	0.34	0.38	11%	1.13	3.30	38%	1.03	3.03	34%	1.41	4.12	47%
25-039_25-038	21	0.1118	3.43	0.34	0.38	10%	1.13	3.30	33%	1.03	3.03	30%	1.41	4.12	41%
25-040_25-039	21	0.183	4.39	0.34	0.38	8%	1.13	3.30	26%	1.03	3.03	24%	1.41	4.12	32%

Future Flow Capacity Assessment - Dry Weather Flow, and Wet Weather Events 1, 2 and 3

25-041_25-008	8	0.9861	0.78	0.19	0.21	25%	0.32	1.64	41%	0.28	1.45	36%	0.30	1.56	39%
25-042_25-041	8	1.0228	0.79	0.15	0.17	19%	0.23	1.52	30%	0.21	1.39	27%	0.22	1.46	28%
25-043_25-042	8	1.0786	0.81	0.15	0.17	19%	0.23	1.52	29%	0.21	1.39	26%	0.22	1.46	28%
25-044_25-043	8	0.9648	0.77	0.15	0.17	20%	0.23	1.52	30%	0.21	1.39	28%	0.22	1.46	29%
25-045_25-044	8	1.0541	0.80	0.15	0.17	19%	0.23	1.52	29%	0.21	1.39	27%	0.22	1.46	28%
25-046_25-045	8	0.5273	0.57	0.15	0.17	27%	0.23	1.52	41%	0.21	1.39	38%	0.22	1.46	40%
25-047_25-046	8	0.5971	0.61	0.15	0.17	25%	0.23	1.52	39%	0.21	1.39	35%	0.22	1.46	37%
25-048_25-047	8	0.5111	0.56	0.15	0.17	27%	0.23	1.52	42%	0.21	1.39	38%	0.22	1.46	40%
25-048_25-049	8	4.9202	1.74	0.07	0.08	4%	0.13	1.78	7%	0.13	1.82	8%	0.14	1.92	8%
26-001_25-040	21	0.0732	2.78	0.34	0.38	12%	1.13	3.30	41%	1.03	3.03	37%	1.41	4.12	51%
26-002_26-001	21	0.0645	2.61	0.34	0.38	13%	0.97	2.85	37%	0.89	2.61	34%	1.18	3.45	45%
26-003_26-002	21	0.1208	3.57	0.34	0.38	10%	0.97	2.85	27%	0.89	2.61	25%	1.18	3.45	33%
26-004_26-003	21	0.1147	3.48	0.34	0.38	10%	0.97	2.85	28%	0.89	2.61	26%	1.18	3.45	34%
26-005_26-004	12	0.2012	1.04	0.34	0.38	33%	0.97	2.87	94%	0.89	2.63	86%	1.17	3.47	113%
26-006_26-005	12	0.2208	1.09	0.34	0.38	31%	0.97	2.87	90%	0.89	2.63	82%	1.17	3.47	108%
26-007_26-006	12	0.1685	0.95	0.34	0.38	36%	0.96	2.83	101%	0.88	2.59	92%	1.15	3.40	121%
26-016_26-007	12	0.2097	1.06	0.32	0.35	30%	0.78	2.45	74%	0.70	2.21	66%	0.89	2.79	84%
26-017_26-016	12	0.2325	1.11	0.32	0.35	29%	0.74	2.33	66%	0.66	2.09	60%	0.83	2.61	74%
27_022_27-021	15	0.621	3.30	0.76	0.88	23%	1.45	1.92	44%	1.23	1.63	37%	1.35	1.79	41%
27-001_17-045	21	0.1011	2.83	1.03	1.20	36%	1.98	1.93	70%	2.05	2.00	72%	1.84	1.79	65%
27-003_27-001	21	0.0512	2.01	1.03	1.20	51%	1.97	1.92	98%	1.79	1.75	89%	1.73	1.69	86%
27-004_27-003	8	0.3502	0.46	0.10	0.12	22%	0.33	3.33	72%	0.26	2.55	55%	0.26	2.58	56%
27-020_27-003	15	0.1333	1.42	0.93	1.08	65%	1.66	1.79	117%	1.50	1.61	105%	1.51	1.63	106%
27-021_27-020	15	0.122	1.36	0.89	1.04	66%	1.58	1.78	117%	1.44	1.61	106%	1.46	1.63	107%
27-023_27_022	15	0.6376	3.34	0.76	0.88	23%	1.49	1.98	45%	1.20	1.59	36%	1.38	1.83	41%
27-024_27-023	15	0.6363	3.34	0.76	0.88	23%	1.34	1.78	40%	1.18	1.56	35%	1.26	1.67	38%
27-025_27-024	15	0.5066	2.98	0.76	0.88	25%	1.34	1.78	45%	1.18	1.56	40%	1.21	1.60	41%
27-026_27-025	15	0.6734	3.44	0.68	0.79	20%	1.20	1.76	35%	1.05	1.55	31%	1.09	1.60	32%
27-027_27-026	15	0.5797	3.19	0.68	0.79	21%	1.20	1.76	38%	1.06	1.55	33%	1.09	1.60	34%
27-028_21-027A	15	0.6457	3.36	0.68	0.79	20%	1.20	1.76	36%	1.06	1.55	31%	1.09	1.60	32%
27-029_27-028	15	0.5474	3.10	0.65	0.76	21%	1.15	1.76	37%	1.01	1.55	33%	1.04	1.60	34%
27-030_27-029	12	2.2918	3.50	0.65	0.76	19%	1.15	1.77	33%	1.01	1.55	29%	1.04	1.60	30%
27-031_27-030	12	2.8045	3.87	0.65	0.76	17%	1.15	1.77	30%	1.01	1.55	26%	1.04	1.60	27%
27-032_27-031	12	1.0621	2.38	0.65	0.76	27%	1.15	1.77	48%	1.01	1.55	42%	1.04	1.60	44%
27-041_27-032	12	0.6989	1.93	0.41	0.48	21%	0.73	1.77	38%	0.63	1.53	33%	0.67	1.61	34%
27-042_27-041	12	0.7299	1.97	0.41	0.48	21%	0.73	1.77	37%	0.63	1.53	32%	0.67	1.61	34%
27-043_27-042	12	0.7574	2.01	0.41	0.48	21%	0.73	1.77	36%	0.63	1.53	31%	0.67	1.61	33%
27-044_27-043	12	0.5719	1.75	0.41	0.48	24%	0.73	1.77	42%	0.63	1.53	36%	0.67	1.61	38%
27-045_27-044	12	0.7029	1.94	0.41	0.48	21%	0.73	1.77	38%	0.63	1.53	33%	0.67	1.61	34%
27-046_27-045	12	0.6865	1.91	0.41	0.48	22%	0.73	1.77	38%	0.63	1.53	33%	0.67	1.61	35%
27-047_27-046	12	0.7965	2.06	0.41	0.48	20%	0.73	1.77	36%	0.63	1.53	31%	0.67	1.61	32%
DivChamber_24-001	36	0.013	4.93	1.81	2.22	37%	6.50	3.58	132%	9.79	5.40	199%	12.31	6.78	250%

Appendix E

Detailed Alternative Cost Breakdown Tables – Western Service Area

CDM Smith

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 1A Hemm Ext to South of 185 - Alt. 7
LOS 5-YR

Segment ID (DSMH -- USMH)	1 - 7	7 - 8	8-24	24-33	33 -52	52- 62	Ex. MH 11-016 - Ex. MH 11-034	Ex. MH 20-083 - Ex. MH 11-034	
Length, feet	2,100.0	350.0	5,064.0	2,869.4	6,722.4	2,887.0	1,542.0	928.0	22,462.7
PIPE SIZE, inches	24.0	24.0	24.0	21.0	18.0	12.0	21.0	18.0	
TYPE(C for	C	C	C	C	B	C	C	C	
AVG. CUT, feet	21.2	21.2	21.2	25.2	23.7	15.8	11.6	13.9	19.2
TR. WIDTH, feet	4.0	4.0	4.0	4.0	3.5	2.5	3.5	3.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5									
Trench Excavation cost, $/cubic yard	$ 33.00	$ 33.00	$ 33.00	$ 39.00	$ 37.00	$ 28.00	$ 18.00	$ 22.00	
Backfill cost, $/cubic yard	$22.00	$22.00	$22.00	$22.00	$42.90	$22.00	$22.00	$22.00	
Native Fill = $22.00/C.Y.									
Granular Backfill Material - $42.90/C.Y.									
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ -	$ -	$ -	$ -	$ 7.30	$ -	$ -	$ -	
Excavation	$ 134.93	$ 134.93	$ 134.93	$ 188.98	$ 147.77	$ 53.22	$ 35.06	$ 51.46	
Tunneling Cost									
Trench Shoring	$ 39.00	$ 39.00	$ 39.00	$ 65.00	$ 60.00	$ 21.00	$ 12.50	$ 16.50	
Pipe	$ 22.50	$ 46.80	$ 22.50	$ 38.10	$ 12.50	$ 7.30	$ 16.50	$ 12.50	
Pipe, laying and handling	$ 12.50	$ 12.50	$ 12.50	$ 11.50	$ 9.30	$ 7.30	$ 11.50	$ 9.30	
Backfill	$ 54.53	$ 54.53	$ 54.53	$ 68.15	$ 109.55	$ 25.04	$ 20.84	$ 28.18	
Restoration (Street)	$ -	$ -	$ -	$ -	$ 29.00	$ -	$ -	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ 5.00	$ 5.00	$ 5.00	$ -	$ 5.00	$ 5.00	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ 35,311.80	$ 21,251.20	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,960.00	$ 2,640.00	
Traffic	$ -	$ -	$ -	$ -	$ 8.00	$ -	$ -	$ -	
Utilities	$ -	$ -	$ -	$ -	$ 5.00	$ -	$ -	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 270.46	$ 294.76	$ 270.46	$ 378.73	$ 390.43	$ 120.85	$ 103.39	$ 124.94	
COST PER LINEAR FOOT	**$ 271.00**	**$ 295.00**	**$ 271.00**	**$ 379.00**	**$ 391.00**	**$ 121.00**	**$ 104.00**	**$ 125.00**	**$ 287.12**
(Rounded to nearest dollar)									
Total Segment Cost	$ 569,100.00	$ 103,250.00	$ 1,372,344.00	$ 1,087,491.23	$ 2,628,445.50	$ 349,327.00	$ 199,639.80	$ 139,891.20	**$ 6,449,488.73**
No. of Non-drop Manholes	6	0	16	9	19	11	9	6	76
No of Drop Manhols	0	1	0	0	0	0	0	0	1
Avg Manhole Depth (Ft)	21.2	21.2	21.2	25.2	23.7	15.8	11.6	13.9	
Riser Cost	$131	$131	$131	$131	$131	$131	$131	$131	
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,116	$1,117	$1,116	$1,115	$1,116	$1,117	
MANHOLE COST PER SEGMENT	$ 46,753.56	$ 10,426.78	$ 124,708.16	$ 79,433.28	$ 160,386.60	$ 35,018.39	$ 23,669.47	$ 17,611.68	**$ 498,007.92**

Land Acquisition Cost

June 2003 (ENR CCI: 6694) **$ 6,947,573.64**

May 2012 (ENR CCI: 9289.65) **$ 9,641,564.80**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe

N
MH-62
12"
MH-52
18"
18"
MH-33
21"
MH-24
24"
MH-8
MH-7
24"
MH-1
11-034
18"
21"
11-016
20-083
Proposed Manholes
Upzised Existing Sewers
Proposed Alternative
Existing Manholes
Existing Sewers
0
750
1,500
3,000
Feet

DATE: April 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 1B Hemm ext. to St Rt 185 - Alt. 6
LOS 5-YR

Segment ID (DSMH -- USMH)	1 - 7	7 - 8	8-24	24-33	33 -52	52- 62	62- 70	Ex. MH 11-016 - Ex. MH 11-034	Ex. MH 20-083 - Ex. MH 11-034	
Length, feet	2,100.0	350.0	5,064.0	2,869.4	6,722.4	2,887.0	2,582.0	1,542.0	928.0	25,044.7
PIPE SIZE, inches	27.0	27.0	27.0	21.0	18.0	15.0	12.0	21.0	18.0	
TYPE(C for	C	C	C	C	B	C	C	C	C	
AVG. CUT, feet	20.2	20.2	20.2	25.0	26.5	21.1	14.1	11.6	13.9	22.2
TR. WIDTH, feet	4.5	4.5	4.5	4.0	3.5	3.5	2.5	3.5	3.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5										
Trench Excavation cost, $/cubic yard	$ 28.00	$ 28.00	$ 28.00	$ 39.00	$ 40.00	$ 33.00	$ 25.00	$ 18.00	$ 22.00	
Backfill cost, $/cubic yard	$22.00	$22.00	$22.00	$22.00	$42.90	$22.00	$22.00	$22.00	$22.00	
Native Fill = $22.00/C.Y.										
Granular Backfill Material -$42.90/C.Y.										
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ -	$ -	$ -	$ -	$ 7.30	$ -	$ -	$ -	$ -	
Excavation	$ 122.79	$ 122.79	$ 122.79	$ 187.40	$ 178.49	$ 117.40	$ 42.49	$ 35.06	$ 51.46	
Tunneling Cost										
Trench Shoring	$ 41.00	$ 41.00	$ 41.00	$ 65.00	$ 69.00	$ 39.00	$ 16.50	$ 12.50	$ 16.50	
Pipe	$ 23.00	$ 72.90	$ 23.00	$ 38.10	$ 33.80	$ 10.30	$ 7.30	$ 16.50	$ 12.50	
Pipe, laying and handling	$ 14.50	$ 14.50	$ 14.50	$ 11.50	$ 9.30	$ 8.30	$ 7.30	$ 11.50	$ 9.30	
Backfill	$ 56.80	$ 56.80	$ 56.80	$ 67.47	$ 125.01	$ 49.51	$ 21.63	$ 20.84	$ 28.18	
Restoration (Street)	$ -	$ -	$ -	$ -	$ 29.00	$ -	$ -	$ -	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ 5.00	$ 5.00	$ 5.00	$ -	$ 5.00	$ 5.00	$ 5.00	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 35,311.80	$ 21,251.20	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,960.00	$ 2,640.00	
Traffic	$ -	$ -	$ -	$ -	$ 8.00	$ -	$ -	$ -	$ -	
Utilities	$ -	$ -	$ -	$ -	$ 5.00	$ -	$ -	$ -	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 265.09	$ 314.99	$ 265.09	$ 376.47	$ 466.91	$ 231.50	$ 102.22	$ 103.39	$ 124.94	
COST PER LINEAR FOOT	**$ 266.00**	**$ 315.00**	**$ 266.00**	**$ 377.00**	**$ 467.00**	**$ 232.00**	**$ 103.00**	**$ 104.00**	**$ 125.00**	**$ 299.95**
(Rounded to nearest dollar)										
Total Segment Cost	$ 558,600.00	$ 110,250.00	$ 1,347,024.00	$ 1,081,752.49	$ 3,139,345.39	$ 669,784.00	$ 265,946.00	$ 199,639.80	$ 139,891.20	**$ 7,512,232.88**

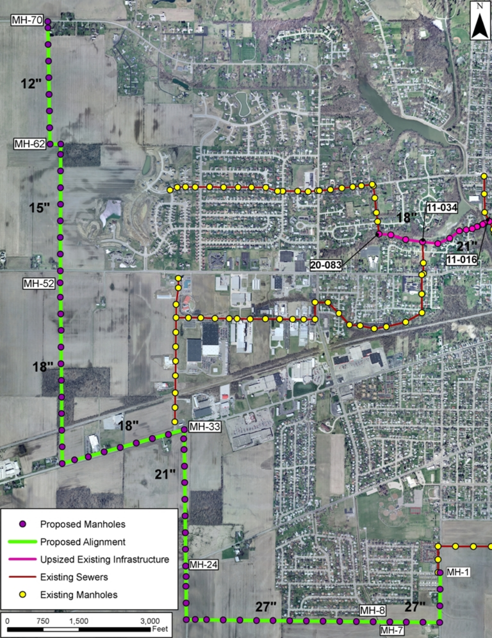
No. of Non-drop Manholes	6	0	16	9	19	11	11	9	6	87
No of Drop Manhols	0	1	0	0	0	0	0	0	0	1
Avg Manhole Depth (Ft)	20.2	20.2	20.2	25.0	26.5	21.1	14.1	11.6	13.9	
Riser Cost	$154	$154	$154	$131	$131	$131	$131	$131	$131	
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,116	$1,117	$1,116	$1,115	$1,115	$1,116	$1,117	
MANHOLE COST PER SEGMENT	$ 50,783.52	$ 10,975.68	$ 135,454.72	$ 78,938.10	$ 174,225.44	$ 85,369.02	$ 32,611.92	$ 23,669.47	$ 17,611.68	**$ 535,746.48**

June 2003 (ENR CCI: 6694) **$ 8,048,067.36**

May 2012 (ENR CCI: 9289.65) **$ 11,168,785.96**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe


N
MH-70
12"
MH-62
15"
18"
11-034
21"
11-016
20-083
MH-52
18"
18"
MH-33
21"
MH-24
MH-1
27"
MH-8
27"
MH-7
Proposed Manholes
Proposed Alignment
Upsized Existing Infrastructure
Existing Sewers
Existing Manholes
0
750
1,500
3,000
Feet

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 2 A - Alt. 5
LOS: 5 Yrs

Segment ID (DSMH -- USMH)	1 - 18	18 - 24	24-25	25 - 31	10 - 62	18 - Hemm Ex 34	Hemm Ex 34- Hemm Ex 41	Hemm Ex 41 - Hemm Ex 61		
Length, feet	5,015.5	1,778.7	350.0	1,973.1	3,901.9	3,324.2	3,016.6	6,367.7		25,727.6
PIPE SIZE, inches	30.0	24.0	18.0	18.0	15.0	21.0	18.0	18.0		
TYPE(C for	B	B	B	B	B	B	B	C		
AVG. CUT, feet	18.1	19.5	14.3	14.3	10.8	13.2	15.7	15.7		15.2
TR. WIDTH, feet	4.5	4.0	3.5	3.5	3.0	3.5	3.5	3.5		
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5										
Trench Excavation cost, $/cubic yard	$ 25.00	$ 28.00	$ 22.00	$ 22.00	$ 19.00	$ 20.00	$ 25.00	$ 25.00		
Backfill cost, $/cubic yard	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$22.00		
Native Fill = $22.00/C.Y.										
Granular Backfill Material -$42.90/C.Y.										
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**		
Breaking Pavement	$ 8.30	$ 8.30	$ 7.30	$ 7.30	$ 6.30	$ 7.30	$ 7.30	$ -		
Excavation	$ 97.92	$ 104.89	$ 53.02	$ 52.87	$ 29.75	$ 44.35	$ 66.06	$ 66.06		
Tunneling Cost										
Trench Shoring	$ 28.00	$ 36.00	$ 16.50	$ 16.50	$ 11.50	$ 33.00	$ 31.00	$ 16.50		
Pipe	$ 39.00	$ 22.50	$ 33.80	$ 12.50	$ 10.30	$ 16.50	$ 12.50	$ 12.50		
Pipe, laying and handling	$ 16.50	$ 12.50	$ 9.30	$ 9.30	$ 8.30	$ 11.50	$ 9.30	$ 9.30		
Backfill	$ 93.50	$ 95.02	$ 57.28	$ 57.06	$ 33.80	$ 49.54	$ 64.95	$ 33.31		
Restoration (Street)	$ 34.00	$ 31.00	$ 29.00	$ 29.00	$ 26.00	$ 29.00	$ 29.00	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.00		
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Traffic	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ -		
Utilities	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00		
TOTALS	$ 338.22	$ 331.20	$ 227.20	$ 205.52	$ 146.95	$ 212.19	$ 241.11	$ 144.67		
COST PER LINEAR FOOT	**$ 339.00**	**$ 332.00**	**$ 228.00**	**$ 206.00**	**$ 147.00**	**$ 213.00**	**$ 242.00**	**$ 145.00**	**$ 222.02**	
(Rounded to nearest dollar)										
Total Segment Cost	$ 1,700,254.50	$ 590,515.12	$ 79,800.00	$ 406,448.30	$ 573,577.54	$ 708,058.86	$ 730,017.20	$ 923,316.50	**$ 5,711,988.02**	
No. of Non-drop Manholes	17	6	1	7	12	18	18	12		91
No of Drop Manhols	0	0		0	0	0	0	0		
Avg Manhole Depth (Ft)	18.1	19.5		14.3	10.8	13.2	15.7	15.7		
Riser Cost	$154	$131		$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116		$1,116	$1,117	$1,118	$1,119	$1,116		
MANHOLE COST PER SEGMENT	$ 66,280.59	$ 21,983.70		$ 20,888.42	$ 30,444.48	$ 51,152.92	$ 57,115.44	$ 38,040.96	**$ 285,906.51**	**$ 5,997,894.52**

June 2003 (ENR CCI: 6694) **$ 5,997,985.52**

May 2012 (ENR CCI: 9289.65) **$ 8,323,764.39**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe


N
Hemm Ex 61
MH-31
18"
18"
MH-24
24"
21"
MH-18
30"
18"
Hemm Ex 34
Hemm Ex 41
MH-10
15"
30"
MH-1
MH-62
Legend
Proposed Manholes
Proposed Alignment
Ex Manholes
Ex Sewers
0 500 1,000 2,000
Feet

DATE: April 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 2 B - Alt 4
LOS: 5-YR

Segment ID (DSMH -- USMH)	1 - 18	18-24	24-25	25 - 26	26 - 31	10 - 62	18 - 79	79 - Hemm Ex 41	26 - 95	95 - 100	
Length, feet	5,015.5	1,731.9	350.0	350.0	1,669.9	3,901.9	3,324.2	2,666.6	5,414.8	1,675.0	26,099.7
PIPE SIZE, inches	30.0	27.0	27.0	27.0	18.0	15.0	18.0	15.0	18.0	18.0	
TYPE(C for	B	B	B	B	B	B	B	B	B	C	
AVG. CUT, feet	18.1	18.7	18.7	18.7	13.4	11.2	10.8	13.6	10.7	10.7	14.9
TR. WIDTH, feet	4.5	4.5	4.5	4.5	3.5	3.0	3.5	3.0	3.5	3.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5											
Trench Excavation cost, $/cubic yard	$ 25.00	$ 26.00	$ 26.00	$ 26.00	$ 20.00	$ 19.00	$ 16.00	$ 25.00	$ 16.00	$ 16.00	
Backfill cost, $/cubic yard	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$22.00	
Native Fill = $22.00/C.Y.											
Granular Backfill Material - $42.90/C.Y.											
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ 8.30	$ 8.30	$ 8.30	$ 8.30	$ 7.30	$ 6.30	$ 7.30	$ 6.30	$ 7.30	$ -	
Excavation	$ 97.92	$ 105.34	$ 105.34	$ 105.46	$ 45.03	$ 30.63	$ 29.01	$ 49.04	$ 28.85	$ 28.85	
Tunneling Cost											
Trench Shoring	$ 33.00	$ 36.00	$ 36.00	$ 36.00	$ 14.50	$ 11.50	$ 11.50	$ 16.50	$ 11.50	$ 11.50	
Pipe	$ 39.00	$ 23.00	$ 72.90	$ 23.00	$ 12.50	$ 10.30	$ 12.50	$ 10.30	$ 12.50	$ 12.50	
Pipe, laying and handling	$ 16.50	$ 14.50	$ 14.50	$ 14.50	$ 9.30	$ 8.30	$ 9.30	$ 8.30	$ 9.30	$ 9.30	
Backfill	$ 93.50	$ 99.74	$ 99.74	$ 99.89	$ 52.05	$ 35.32	$ 37.59	$ 46.86	$ 37.26	$ 19.11	
Restoration (Street)	$ 34.00	$ 34.00	$ 34.00	$ 34.00	$ 29.00	$ 26.00	$ 29.00	$ 26.00	$ 29.00	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Traffic	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ -	
Utilities	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 343.22	$ 341.89	$ 391.79	$ 342.14	$ 190.68	$ 149.35	$ 157.21	$ 184.30	$ 156.71	$ 88.26	
COST PER LINEAR FOOT	**$ 344.00**	**$ 342.00**	**$ 392.00**	**$ 343.00**	**$ 191.00**	**$ 150.00**	**$ 158.00**	**$ 185.00**	**$ 157.00**	**$ 89.00**	**$ 204.90**
(Rounded to nearest dollar)											
Total Segment Cost	$ 1,725,332.00	$ 592,296.12	$ 137,200.00	$ 120,050.00	$ 318,941.35	$ 585,283.20	$ 525,226.76	$ 493,327.48	$ 850,118.73	$ 149,075.00	**$ 5,347,775.64**

No. of Non-drop Manholes	17	6	1	1	6	12	9	9	16	5	77	
No of Drop Manhols	0			0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	18.1	18.7	18.7	18.7	13.4	11.2	10.8	13.6	10.7	10.7		
Riser Cost	$154	$154	$154	$154	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,116	$1,116	$1,117	$1,116	$1,117	$1,117	$1,118		
MANHOLE COST PER SEGMENT	$ 66,280.59	$ 23,974.80	$ 3,996.80	$ 3,998.88	$ 17,196.96	$ 30,947.52	$ 22,730.04	$ 26,063.82	$ 40,299.20	$ 12,598.50	**$ 235,488.61**	**$ 5,583,264.24**

June 2003 (ENR CCI: 6694) **$ 5,583,341.24**

May 2012 (ENR CCI: 9289.65) **$ 7,748,337.64**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.

Upsizing Existing Infrastructure
ductile iron pipe

N
MH-31
18"
18"
MH-24
27"
MH-95
MH-24
27"
MH-18
18"
30"
15"
Hemm Ex 34
Hemm Ex 41
MH-10
15"
30"
MH-1
MH-62
Legend
Proposed Manholes
Proposed Alternative
Existing Manholes
Existing Sewers
0 500 1,000 2,000
Feet

DATE: April 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 2 C - Alt. 3
LOS: 5 YR

Segment ID (DSMH -- USMH)	1 - 18	18-24	24-25	25 - 26	26 - 31	10 - 62	18 - 79	79 - Hemm Ex 41	Ex. MH 20-045 - Ex. MH 09-076	PA_Ext-1 - Ex. MH 09-076	
Length, feet	5,015.5	1,731.9	350.0	350.0	1,669.9	3,901.9	3,324.2	2,666.6	3,173.0	2,900.0	25,083.0
PIPE SIZE, inches	30.0	27.0	27.0	27.0	18.0	15.0	18.0	15.0	18.0	18.0	
TYPE(C for	B	B	B	B	B	B	B	B	B	C	
AVG. CUT, feet	18.1	18.7	18.7	18.7	13.4	11.2	10.8	13.6	13.0	11.8	14.8
TR. WIDTH, feet	4.5	4.5	4.5	4.5	3.5	3.0	3.5	3.0	3.5	3.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	2.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5											
Trench Excavation cost, $/cubic yard	$ 25.00	$ 26.00	$ 26.00	$ 26.00	$ 20.00	$ 19.00	$ 16.00	$ 25.00	$ 20.00	$ 18.00	
Backfill cost, $/cubic yard	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$22.00	
Native Fill =$22.00/C.Y.											
Granular Backfill Material - $42.90/C.Y.											
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ 8.30	$ 8.30	$ 8.30	$ 8.30	$ 7.30	$ 6.30	$ 7.30	$ 6.30	$ 7.30	$ -	
Excavation	$ 97.92	$ 105.34	$ 105.34	$ 105.46	$ 45.03	$ 30.63	$ 29.01	$ 49.06	$ 43.65	$ 63.22	
Tunneling Cost											
Trench Shoring	$ 33.00	$ 36.00	$ 36.00	$ 36.00	$ 14.50	$ 11.50	$ 11.50	$ 16.50	$ 14.50	$ 12.50	
Pipe	$ 39.00	$ 23.00	$ 72.90	$ 23.00	$ 12.50	$ 10.30	$ 12.50	$ 10.30	$ 12.50	$ 12.50	
Pipe, laying and handling	$ 16.50	$ 14.50	$ 14.50	$ 14.50	$ 9.30	$ 8.30	$ 9.30	$ 8.30	$ 9.30	$ 9.30	
Backfill	$ 93.50	$ 99.74	$ 99.74	$ 99.89	$ 52.05	$ 35.32	$ 37.59	$ 46.89	$ 49.77	$ 22.19	
Restoration (Street)	$ 34.00	$ 34.00	$ 34.00	$ 34.00	$ 29.00	$ 26.00	$ 29.00	$ 26.00	$ 29.00	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 72,661.70	$ -	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,600.00	$ -	
Traffic	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ -	
Utilities	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 343.22	$ 341.89	$ 391.79	$ 342.14	$ 190.68	$ 149.35	$ 157.21	$ 184.35	$ 187.02	$ 126.71	
COST PER LINEAR FOOT	**$ 344.00**	**$ 342.00**	**$ 392.00**	**$ 343.00**	**$ 191.00**	**$ 150.00**	**$ 158.00**	**$ 185.00**	**$ 188.00**	**$ 127.00**	**$ 220.94**
(Rounded to nearest dollar)											
Total Segment Cost	$ 1,725,332.00	$ 592,296.12	$ 137,200.00	$ 120,050.00	$ 318,941.35	$ 585,283.20	$ 525,226.76	$ 493,327.48	$ 675,785.70	$ 368,300.00	**$ 5,541,742.61**

No. of Non-drop Manholes	17	6	1	1	6	12	9	9	15	9	76	
No of Drop Manhols	0			0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	18.1	18.7	18.7	18.7	13.4	11.2	10.8	13.6	13.0	11.8		
Riser Cost	$154	$154	$154	$154	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,116	$1,116	$1,117	$1,116	$1,117	$1,117	$1,118		
MANHOLE COST PER SEGMENT	$ 66,280.59	$ 23,974.80	$ 3,996.80	$ 3,998.88	$ 17,196.96	$ 30,947.52	$ 22,730.04	$ 26,072.07	$ 42,201.75	$ 23,950.62	**$ 169,125.59**	**$ 5,710,868.19**

June 2003 (ENR CCI: 6694) **$ 5,710,944.19**

May 2012 (ENR CCI: 9289.65 **$ 7,925,419.91**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe


N
18"
18"
20-045
PA Ex 1
09-076
MH-26
18"
27"
MH-26
27"
MH-18
18"
15"
MH-79
Hemm Ex 41
30"
MH-10
30"
15"
MH-1
MH-62
Legend
Proposed Manholes
Proposed Alignment
Upsized Existing Sewers
Existing Manholes
Existing Sewer
0
500
1,000
2,000
Feet

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 2 E - Alt. 1
LOS: 5 YR

	PHASE C	PHASE D				PHASE C	PHASE D		PHASE E					PHASE D		
Segment ID (DSMH -- USMH)	1 - 10	10 - 18	18 - 24	24 - 25	25 - 31	10 - 62	18 - 79	79 - Hemm Ex 41	31 - 113	113-114	114 - 118	118-119	119-125	Ex. MH 20-045 - Ex. MH 09-076	PA_Ext-1 - Ex. MH 09-076	
Length, feet	2,667.0	2,348.5	1,778.6	350.0	2,323.1	3,901.9	3,324.2	2,666.6	4,550.0	350.0	1,400.0	350.0	2,100.0	3,173.0	2,900.0	34,182.9
PIPE SIZE, inches	30.0	30.0	27.0	24.0	24.0	15.0	18.0	15.0	18.0	18.0	15.0	15.0	15.0	18.0	18.0	
TYPE(C for	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	
AVG. CUT, feet	18.1	18.1	18.7	13.9	13.9	11.2	10.8	13.6	11.4	11.4	12.4	12.4	12.4	13.0	11.8	13.5
TR. WIDTH, feet	4.5	4.5	4.5	4.0	4.0	3.0	3.5	3.0	3.5	3.5	3.0	3.0	3.0	3.5	3.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5																
Trench Excavation cost, $/cubic yard	$ 25.00	$ 25.00	$ 26.00	$ 22.00	$ 22.00	$ 19.00	$ 16.00	$ 25.00	$ 16.00	$ 16.00	$ 21.00	$ 21.00	$ 21.00	$ 20.00	$ 18.00	
Backfill cost, $/cubic yard	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$22.00	
Native Fill = $22.00/C.Y.																
Granular Backfill Material - $42.90/C.Y.																
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ 8.30	$ 8.30	$ 8.30	$ 8.30	$ 8.30	$ 6.30	$ 7.30	$ 6.30	$ 7.30	$ 7.30	$ 6.30	$ 6.30	$ 6.30	$ 7.30	$ -	
Excavation	$ 97.92	$ 97.92	$ 105.12	$ 58.96	$ 58.96	$ 30.63	$ 29.01	$ 49.06	$ 30.74	$ 30.74	$ 37.61	$ 37.61	$ 37.61	$ 43.65	$ 35.73	
Tunneling Cost																
Trench Shoring	$ 33.00	$ 33.00	$ 36.00	$ 16.50	$ 16.50	$ 11.50	$ 11.50	$ 16.50	$ 11.50	$ 11.50	$ 12.50	$ 12.50	$ 12.50	$ 14.50	$ 12.50	
Pipe	$ 39.00	$ 39.00	$ 23.00	$ 46.80	$ 22.50	$ 10.30	$ 12.50	$ 10.30	$ 12.50	$ 33.80	$ 10.30	$ 29.40	$ 10.30	$ 12.50	$ 12.50	
Pipe, laying and handling	$ 16.50	$ 16.50	$ 14.50	$ 12.50	$ 12.50	$ 8.30	$ 9.30	$ 8.30	$ 9.30	$ 9.30	$ 8.30	$ 8.30	$ 8.30	$ 9.30	$ 9.30	
Backfill	$ 93.50	$ 93.50	$ 99.46	$ 59.84	$ 59.84	$ 35.32	$ 37.59	$ 46.89	$ 41.15	$ 41.15	$ 41.23	$ 41.23	$ 41.23	$ 49.77	$ 22.19	
Restoration (Street)	$ 34.00	$ 34.00	$ 34.00	$ 31.00	$ 31.00	$ 26.00	$ 29.00	$ 26.00	$ 29.00	$ 29.00	$ 26.00	$ 26.00	$ 26.00	$ 29.00	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 72,661.70	$ -	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,600.00	$ -	
Traffic	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ -	
Utilities	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 343.22	$ 343.22	$ 341.37	$ 254.91	$ 230.61	$ 149.35	$ 157.21	$ 184.35	$ 162.49	$ 183.79	$ 163.25	$ 182.35	$ 163.25	$ 187.02	$ 99.22	
COST PER LINEAR FOOT	**$ 344.00**	**$ 344.00**	**$ 342.00**	**$ 255.00**	**$ 231.00**	**$ 150.00**	**$ 158.00**	**$ 185.00**	**$ 163.00**	**$ 184.00**	**$ 164.00**	**$ 183.00**	**$ 164.00**	**$ 188.00**	**$ 100.00**	**$ 204.00**
(Rounded to nearest dollar)																
Total Segment Cost	$ 917,448.00	$ 807,884.00	$ 608,281.20	$ 89,250.00	$ 536,626.17	$ 585,283.20	$ 525,226.76	$ 493,327.48	$ 741,650.00	$ 64,400.00	$ 229,600.00	$ 64,050.00	$ 344,400.00	$ 675,785.70	$ 290,000.00	**$ 6,973,212.50**

No. of Non-drop Manholes	9	8	6	1	7	12	9	9	12	1	4	1	7	15	9	110	
No of Drop Manhols	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	18.1	18.1	18.7	13.9	13.9	11.2	10.8	13.6	11.4	11.4	12.4	12.4	12.4	13.0	11.8		
Riser Cost	$154	$154	$154	$131	$131	$131	$131	$131	$131	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,115	$1,116	$1,115	$1,116	$1,117	$1,116	$1,117	$1,117	$1,118	$1,118	$1,119	$1,120	$1,117	$1,118		
MANHOLE COST PER SEGMENT	$ 35,089.72	$ 31,190.86	$ 23,937.84	$ 2,938.00	$ 20,572.97	$ 30,947.52	$ 22,730.04	$ 26,072.07	$ 31,324.80	$ 2,611.40	$ 10,969.60	$ 2,743.40	$ 19,210.80	$ 42,201.75	$ 23,950.62	**$ 326,491.40**	**$ 7,299,703.90**

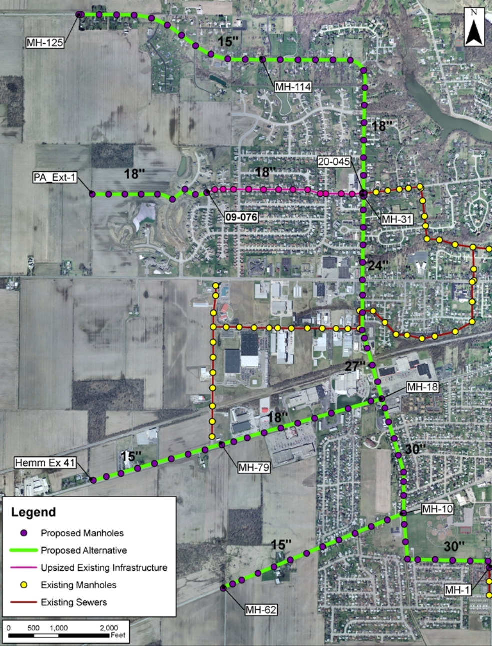
June 2003 (ENR CCI: 6694) **$ 7,299,813.90**

May 2012 (ENR CCI: 9289.65) **$ 10,130,375.14**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe

	ORIGINAL	UPDATED ENRCCI	PROJECT	
PHASE A		$ 380,000.00	$ 460,000.00	$ 380,000.00
PHASE B	$ 3,188,854.04	$ 5,318,068.33	$6,434,862.68	$ 5,320,000.00
PHASE C	$ 1,568,768.44	$ 3,094,900.35	$3,744,829.42	$ 3,090,000.00
PHASE D	$ 4,219,975.46	$ 6,774,775.68	$8,197,478.58	$ 6,770,000.00
PHASE E	$ 1,510,960.00	$ 3,014,662.23	$3,647,741.30	$ 3,010,000.00
	CONTINGENCY		$ -	
		$ 18,582,406.59	###########	$ 18,570,000.00
CONTINGENCY	$ 3,669,798.99			
	$ 917,449.75			


N
MH-125
15''
MH-114
18''
PA_Ext-1
18''
18''
20-045
09-076
MH-31
24''
27''
MH-18
18''
30''
Hemm Ex 41
15''
MH-79
MH-10
15''
30''
MH-1
MH-62
Legend
Proposed Manholes
Proposed Alternative
Upsized Existing Infrastructure
Existing Manholes
Existing Sewers
0 500 1,000 2,000
Feet

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 2 F - Alt. 2
LOS: 5 YR

Segment ID (DSMH -- USMH)	1 - 18	18 - 24	24 - 25	25 - 31	10 - 62	18 - 79	79 - Hemm Ex 41	31 - 218	
Length, feet	5,015.5	2,431.9	350.0	1,973.1	3,901.9	3,324.2	2,666.6	6,872.0	26,535.2
PIPE SIZE, inches	30.0	27.0	24.0	24.0	15.0	18.0	15.0	18.0	
TYPE(C for	B	B	B	B	B	B	B	B	
AVG. CUT, feet	18.1	18.7	13.9	13.9	11.2	10.8	13.6	13.4	14.2
TR. WIDTH, feet	4.5	4.5	4.0	4.0	3.0	3.5	3.0	3.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5									
Trench Excavation cost, $/cubic yard	$ 25.00	$ 26.00	$ 22.00	$ 22.00	$ 19.00	$ 16.00	$ 25.00	$ 20.00	
Backfill cost, $/cubic yard	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90	
Native Fill =$22.00/C.Y.									
Granular Backfill Material - $42.90/C.Y.									
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ 8.30	$ 8.30	$ 8.30	$ 8.30	$ 6.30	$ 7.30	$ 6.30	$ 7.30	
Excavation	$ 97.92	$ 105.12	$ 58.89	$ 58.89	$ 30.63	$ 29.01	$ 49.06	$ 45.10	
Tunneling Cost									
Trench Shoring	$ 33.00	$ 36.00	$ 16.50	$ 16.50	$ 11.50	$ 11.50	$ 16.50	$ 14.50	
Pipe	$ 39.00	$ 23.00	$ 46.80	$ 22.50	$ 10.30	$ 12.50	$ 10.30	$ 12.50	
Pipe, laying and handling	$ 16.50	$ 14.50	$ 12.50	$ 12.50	$ 8.30	$ 9.30	$ 8.30	$ 9.30	
Backfill	$ 93.50	$ 99.46	$ 59.74	$ 59.74	$ 35.32	$ 37.59	$ 46.89	$ 52.16	
Restoration (Street)	$ 34.00	$ 34.00	$ 31.00	$ 31.00	$ 26.00	$ 29.00	$ 26.00	$ 29.00	
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Traffic	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	
Utilities	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 343.22	$ 341.37	$ 254.74	$ 230.44	$ 149.35	$ 157.21	$ 184.35	$ 190.86	
COST PER LINEAR FOOT	**$ 344.00**	**$ 342.00**	**$ 255.00**	**$ 231.00**	**$ 150.00**	**$ 158.00**	**$ 185.00**	**$ 191.00**	**$ 226.81**
(Rounded to nearest dollar)									
Total Segment Cost	$ 1,725,332.00	$ 831,696.12	$ 89,250.00	$ 455,776.17	$ 585,283.20	$ 525,226.76	$ 493,327.48	$ 1,312,552.00	**$ 6,018,443.72**

No. of Non-drop Manholes	17	6	1	7	12	9	9	20	81	
No of Drop Manhols	0	0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	18.1	18.7	13.9	13.9	11.2	10.8	13.6	13.4		
Riser Cost	$154	$154	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,116	$1,116	$1,117	$1,116	$1,117	$1,117		
MANHOLE COST PER SEGMENT	$ 66,280.59	$ 23,937.84	$ 2,936.90	$ 20,558.30	$ 30,947.52	$ 22,730.04	$ 26,072.07	$ 57,395.60	**$ 167,391.19**	**$ 6,185,834.91**

June 2003 (ENR CCI: 6694) **$ 6,185,915.91**

May 2012 (ENR CCI: 9289.65) **$ 8,584,566.66**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.

Upsizing Existing Infrastructure
ductile iron pipe


N
18"
MH-218
MH-31
24"
MH-24
27"
MH-18
18"
15"
MH-79
Hemm Ex 41
30"
MH-10
15"
30"
MH-62
MH-1
Legend
Proposed Manholes
Alternative2_Conduits
Ex Manholes
Ex Sewers
0
500
1,000
2,000
Feet

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 3 A (in RoW) - Alts. 1 & 6
LOS: 5 YR

Segment ID (DSMH -- USMH)	101 - 105	105 - 311	311 - 412	311 - 308	308 -307	307 - 301	
Length, feet	1,176.6	8,055.3	3,990.6	801.0	350.0	2,100.3	16,473.8
PIPE SIZE, inches	15.0	15.0	12.0	12.0	12.0	12.0	
TYPE(C for	C	B	B	B	B	B	
AVG. CUT, feet	29.3	29.3	17.7	11.8	11.8	11.8	18.6
TR. WIDTH, feet	3.5	3.5	3.0	2.5	2.5	2.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5							
Trench Excavation cost, $/cubic yard	$ 45.00	$ 45.00	$ 32.00	$ 27.00	$ 27.00	$ 21.00	
Backfill cost, $/cubic yard	$22.00	$42.90	$42.90	$42.90	$42.90	$42.90	
Native Fill = $22.00/C.Y.							
Granular Backfill Material - $42.90/C.Y.							
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ -	$ 7.30	$ 6.30	$ 6.30	$ 6.30	$ 6.30	
Excavation	$ 222.04	$ 222.04	$ 81.77	$ 38.35	$ 38.35	$ 29.79	
Tunneling Cost							
Trench Shoring	$ 90.00	$ 90.00	$ 28.00	$ 18.50	$ 18.50	$ 12.50	
Pipe	$ 29.40	$ 29.40	$ 7.30	$ 7.30	$ 20.20	$ 7.30	
Pipe, laying and handling	$ 8.30	$ 8.30	$ 7.30	$ 6.00	$ 6.00	$ 6.00	
Backfill	$ 72.81	$ 141.98	$ 67.64	$ 45.59	$ 44.44	$ 33.58	
Restoration (Street)	$ -	$ 29.00	$ 26.00	$ 23.50	$ 23.50	$ 23.50	
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ -	$ -	$ -	$ -	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	
Traffic	$ -	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	
Utilities	$ -	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 459.55	$ 579.02	$ 275.31	$ 196.54	$ 208.29	$ 169.97	
COST PER LINEAR FOOT	**$ 460.00**	**$ 580.00**	**$ 276.00**	**$ 197.00**	**$ 209.00**	**$ 170.00**	**$ 419.01**
(Rounded to nearest dollar)							
Total Setment Cost	$ 541,231.40	$ 4,672,068.20	$ 1,101,397.32	$ 157,797.00	$ 73,150.00	$ 357,056.95	**$ 6,902,700.87**

No. of Non-drop Manholes	4	23	13	6	1	10	57	
No of Drop Manhols	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	29.3	29.3	17.7	14.8	14.5	11.8		
Riser Cost	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,115	$1,116	$1,116	$1,116	$1,117		
MANHOLE COST PER SEGMENT	$ 39,605.44	$ 227,731.28	$ 44,634.07	$ 18,336.66	$ 3,018.12	$ 26,610.97	**$ 359,936.54**	**$ 7,262,637.41**

June 2003 (ENR CCI: 6694) **$ 7,262,694.41**

May 2012 (ENR CCI: 9289.6 **$ 10,078,876.79**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.

Upsizing Existing Infrastructure
ductile iron pipe

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Alternative 3 A w/ Siphon
LOS: 5 yr

Segment ID (DSMH -- USMH)	101 - 105	105 - 311	311 - 412	311 - 301	Siphon Barrel 1	Siphon Barrel 2		
Length, feet	1,176.6	8,055.3	3,990.6	3,251.3	200.0	200.0	16,473.8	
PIPE SIZE, inches	18.0	18.0	12.0	12.0	10.0	10.0		
TYPE(C for	C	B	B	B	C	C		
AVG. CUT, feet	22.3	22.3	20.5	5.0	5.0	5.0	17.5	
TR. WIDTH, feet	3.5	3.5	3.0	2.5	2.5	2.5		
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5								
Trench Excavation cost, $/cubic yard	$ 34.00	$ 34.00	$ 36.00	$ 8.00	$ 8.00	$ 8.00		
Backfill cost, $/cubic yard	$22.00	$42.90	$42.90	$42.90	$61.49	$61.49		
Native Fill = $22.00/C.Y.								
Granular Backfill Material - $42.90/C.Y.								
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**		
Breaking Pavement	$ -	$ 7.30	$ 6.30	$ 6.30	$ -	$ -		
Excavation	$ 127.71	$ 127.71	$ 106.76	$ 4.81	$ 4.81	$ 4.81		
Tunneling Cost								
Trench Shoring	$ 45.00	$ 45.00	$ 39.00	$ 4.20	$ 4.20	$ 4.20		
Pipe	$ 33.80	$ 33.80	$ 15.80	$ 7.30	$ 15.80	$ 15.80		
Pipe, laying and handling	$ 9.30	$ 9.30	$ 7.30	$ 7.30	$ 6.00	$ 6.00		
Backfill	$ 52.16	$ 101.71	$ 81.18	$ 5.96	$ 9.49	$ 9.49		
Restoration (Street)	$ -	$ 29.00	$ 26.00	$ 23.50	$ -	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ -	$ -	$ 5.00	$ 5.00		
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -		
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00		
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ 5,000.00	$ 5,000.00		
Traffic	$ -	$ 8.00	$ 8.00	$ 8.00	$ -	$ -		
Utilities	$ -	$ 11.00	$ 11.00	$ 11.00	$ -	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 20.00	$ 20.00		
TOTALS	$ 304.97	$ 404.83	$ 333.33	$ 110.37	$ 95.30	$ 95.30		
COST PER LINEAR FOOT	**$ 305.00**	**$ 405.00**	**$ 334.00**	**$ 111.00**	**$ 96.00**	**$ 96.00**	**$ 322.63**	
(Rounded to nearest dollar)								
Total Segment Cost	$ 358,859.95	$ 3,262,392.45	$ 1,332,850.38	$ 360,898.19	$ 24,200.00	$ 24,200.00	**$ 5,315,000.97**	
No. of Non-drop Manholes	4	23	13	10	0	0	50	
No of Drop Manhols	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	22.3	22.3	20.5	5.0	5.0	5.0		
Riser Cost	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,115	$1,116	$1,116	$1,117	$1,118		
MANHOLE COST PER SEGMENT	$ 32,279.92	$ 185,609.54	$ 98,941.18	$ 17,710.00	$ -	$ -	**$ 334,540.64**	**$ 5,649,541.61**

Junction Boxes for Siphons	**$ 100,000.00**
June 2003 (ENR CCI: 6694)	**$ 5,749,591.61**
May 2012 (ENR CCI: 9289.65	**$ 7,979,053.25**
CCI Adjustment Factor: 1.3877	

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe
For Siphon Junction Boxes assume $50,000 per structure (2 per siphon)

N
MH-412
12"
MH-311
12"
MH-301
15"
18"
15"
MH-101
Legend
Proposed Manholes
Proposed Alternative
Ex Manholes
Ex Sewers
0 500 1,000 2,000
Feet

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 3 B - Alignments 1 &6
LOS: 5 yr

Segment ID (DSMH -- USMH)	101 - 105	105 - 111	111 - 268	268 - 311	311 - 412	311 - 308	308 -307	307 - 301	
Length, feet	1,176.6	2,027.7	5,592.6	436.6	3,990.6	801.0	350.0	2,100.3	16,475.4
PIPE SIZE, inches	15.0	15.0	15.0	12.0	12.0	12.0	12.0	12.0	
TYPE(C for	C	B	C	C	B	B	B	B	
AVG. CUT, feet	25.1	25.1	25.1	17.6	17.6	12.0	12.0	12.0	18.3
TR. WIDTH, feet	3.5	3.5	3.5	3.0	3.0	2.5	2.5	2.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5									
Trench Excavation cost, $/cubic yard	$ 39.00	$ 39.00	$ 39.00	$ 32.00	$ 32.00	$ 21.00	$ 21.00	$ 21.00	
Backfill cost, $/cubic yard	$22.00	$42.90	$22.00	$22.00	$42.90	$42.90	$42.90	$42.90	
Native Fill =$22.00/C.Y.									
Granular Backfill Material - $42.90/C.Y.									
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ -	$ 7.30	$ -	$ -	$ 6.30	$ 6.30	$ 6.30	$ 6.30	
Excavation	$ 165.16	$ 165.16	$ 165.16	$ 81.30	$ 81.30	$ 30.33	$ 30.33	$ 30.33	
Tunneling Cost									
Trench Shoring	$ 65.00	$ 65.00	$ 65.00	$ 28.00	$ 28.00	$ 12.50	$ 12.50	$ 12.50	
Pipe	$ 29.40	$ 29.40	$ 29.40	$ 7.30	$ 7.30	$ 7.30	$ 20.20	$ 7.30	
Pipe, laying and handling	$ 8.30	$ 8.30	$ 8.30	$ 7.30	$ 7.30	$ 7.30	$ 7.30	$ 7.30	
Backfill	$ 60.97	$ 118.90	$ 60.97	$ 34.44	$ 67.16	$ 33.76	$ 33.76	$ 33.76	
Restoration (Street)	$ -	$ 29.00	$ -	$ -	$ 26.00	$ 23.50	$ 23.50	$ 23.50	
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ 5.00	$ 5.00	$ -	$ -	$ -	$ -	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dewatering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Traffic	$ -	$ 8.00	$ -	$ -	$ 8.00	$ 8.00	$ 8.00	$ 8.00	
Utilities	$ -	$ 11.00	$ -	$ -	$ 11.00	$ 11.00	$ 11.00	$ 11.00	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 365.83	$ 474.06	$ 365.83	$ 195.35	$ 274.37	$ 172.00	$ 184.90	$ 172.00	
COST PER LINEAR FOOT	**$ 366.00**	**$ 475.00**	**$ 366.00**	**$ 196.00**	**$ 275.00**	**$ 172.00**	**$ 185.00**	**$ 172.00**	**$ 314.86**
(Rounded to nearest dollar)									
Total Segment Cost	$ 430,631.94	$ 963,143.25	$ 2,046,898.92	$ 85,567.72	$ 1,097,406.75	$ 137,772.00	$ 64,750.00	$ 361,257.62	**$ 5,187,428.20**

No. of Non-drop Manholes	4	6	17	2	13	6	1	10	59	
No of Drop Manhols	0	0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	25.1	25.1	25.1	17.6	17.6	12.0	12.0	12.0		
Riser Cost	$131	$131	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,115	$1,116	$1,116	$1,116	$1,117		
MANHOLE COST PER SEGMENT	$ 35,256.24	$ 52,896.36	$ 149,907.02	$ 6,838.58	$ 44,463.77	$ 16,128.00	$ 2,688.00	$ 26,890.00	**$ 335,067.97**	**$ 5,522,496.17**

June 2003 (ENR CCI: 6694) **$ 5,522,555.17**

May 2012 (ENR CCI: 9289.65) **$ 7,663,981.16**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe

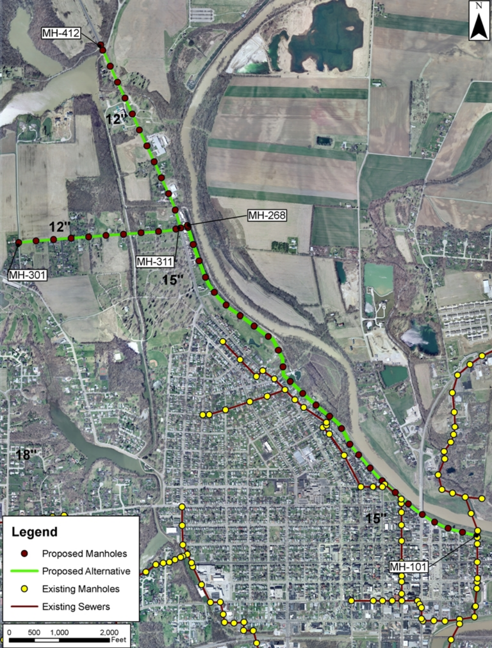
DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Alternative 3 B w/ Siphon - Alts. 1 & 6
LOS: 5 yr

Segment ID (DSMH -- USMH)	101 - 105	105 - 111	111 - 268	268 - 311	311 - 412	311 - 301	Siphon Barrel 1	Siphon Barrel 2		
Length, feet	1,176.6	2,027.7	5,592.6	436.6	3,990.6	3,251.3	200.0	200.0	16,475.4	
PIPE SIZE, inches	15.0	15.0	15.0	12.0	12.0	12.0	10.0	10.0		
TYPE(C for	C	B	C	C	B	B	C	C		
AVG. CUT, feet	19.8	19.8	19.8	13.7	13.7	11.8	5.0	5.0	16.4	
TR. WIDTH, feet	3.5	3.5	3.5	2.5	2.5	2.5	2.5	2.5		
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5										
Trench Excavation cost, $/cubic yard	$ 31.00	$ 31.00	$ 31.00	$ 25.00	$ 25.00	$ 21.00	$ 8.00	$ 8.00		
Backfill cost, $/cubic yard	$22.00	$42.90	$22.00	$22.00	$42.90	$42.90	$61.49	$61.49		
Native Fill =$22.00/C.Y.										
Granular Backfill Material - $42.90/C.Y.										
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**		
Breaking Pavement	$ -	$ 7.30	$ -	$ -	$ 6.30	$ 6.30	$ -	$ -		
Excavation	$ 103.18	$ 103.18	$ 103.18	$ 41.14	$ 41.14	$ 29.79	$ 4.81	$ 4.81		
Tunneling Cost										
Trench Shoring	$ 35.00	$ 35.00	$ 35.00	$ 16.50	$ 16.50	$ 12.50	$ 4.20	$ 4.20		
Pipe	$ 10.30	$ 10.30	$ 10.30	$ 7.30	$ 7.30	$ 7.30	$ 15.80	$ 15.80		
Pipe, laying and handling	$ 8.30	$ 8.30	$ 8.30	$ 7.30	$ 7.30	$ 7.30	$ 6.00	$ 6.00		
Backfill	$ 45.63	$ 88.98	$ 45.63	$ 20.72	$ 40.40	$ 32.92	$ 9.49	$ 9.49		
Restoration (Street)	$ -	$ 29.00	$ -	$ -	$ 23.50	$ 23.50	$ -	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ 5.00	$ 5.00	$ -	$ -	$ 5.00	$ 5.00		
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00		
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000.00	$ 5,000.00		
Traffic	$ -	$ 8.00	$ -	$ -	$ 8.00	$ 8.00	$ -	$ -		
Utilities	$ -	$ 11.00	$ -	$ -	$ 11.00	$ 11.00	$ -	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 20.00	$ 20.00		
TOTALS	$ 239.41	$ 333.05	$ 239.41	$ 129.95	$ 193.43	$ 170.61	$ 95.30	$ 95.30		
COST PER LINEAR FOOT	**$ 240.00**	**$ 334.00**	**$ 240.00**	**$ 130.00**	**$ 194.00**	**$ 171.00**	**$ 96.00**	**$ 96.00**	**$ 223.90**	
(Rounded to nearest dollar)										
Total Segment Cost	$ 282,381.60	$ 677,241.78	$ 1,342,228.80	$ 56,754.10	$ 774,170.58	$ 555,978.29	$ 24,200.00	$ 24,200.00	**$ 3,688,755.15**	
No. of Non-drop Manholes	4	6	17	2	13	10	0	0	52	
No of Drop Manhols	0	0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	19.8	19.8	19.8	13.7	13.7	11.8	5.0	5.0		
Riser Cost	$131	$131	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,115	$1,116	$1,117	$1,117	$1,118		
MANHOLE COST PER SEGMENT	$ 14,809.00	$ 22,219.50	$ 62,972.25	$ 5,811.54	$ 37,788.01	$ 26,610.97	$ -	$ -	**$ 170,211.27**	**$ 3,858,966.42**

Junction Boxes for Siphons **$ 100,000.00**
June 2003 (ENR CCI: 6694) **$ 3,959,018.42**

May 2012 (ENR CCI: 9289.65) **$ 5,494,167.40**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe
For Siphon Junction Boxes assume $50,000 per structure (2 per siphon)


N
MH-412
12"
MH-268
12"
MH-311
MH-301
15"
18"
15"
MH-101
Legend
Proposed Manholes
Proposed Alternative
Existing Manholes
Existing Sewers
0 500 1,000 2,000
Feet

DATE: June 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 3 A (in RoW) Lift Station and Force main - Alts. 1 & 6
LOS: 5 YR

Segment ID (DSMH -- USMH)	212 - 311	311 - 412	311 - 308	308 -307	307 - 301	212 - Ex. MH 17-044		
Length, feet	1,450.0	3,990.6	801.0	350.0	2,100.3	7,429.0		8,691.9
PIPE SIZE, inches	18.0	12.0	12.0	12.0	12.0	8.0		
TYPE(C for	B	B	B	B	B	B		
AVG. CUT, feet	11.8	14.3	10.7	10.7	10.7	5.0		11.7
TR. WIDTH, feet	3.5	2.5	2.5	2.5	2.5	2.5		
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5								
Trench Excavation cost, $/cubic yard	$ 18.00	$ 25.00	$ 19.00	$ 19.00	$ 19.00	$ 8.00		
Backfill cost, $/cubic yard	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90		
Native Fill = $22.00/C.Y.								
Granular Backfill Material - $42.90/C.Y.								
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**		
Breaking Pavement	$ 7.30	$ 6.30	$ 6.30	$ 6.30	$ 6.30	$ 6.30		
Excavation	$ 35.91	$ 42.94	$ 24.52	$ 24.52	$ 24.52	$ 4.81		
Tunneling Cost								
Trench Shoring	$ 12.50	$ 16.50	$ 11.50	$ 11.50	$ 11.50	$ 4.20		
Pipe	$ 12.50	$ 7.30	$ 7.30	$ 7.30	$ 7.30	$ 11.50		
Pipe, laying and handling	$ 9.30	$ 7.30	$ 7.30	$ 7.30	$ 7.30	$ 6.00		
Backfill	$ 43.60	$ 42.78	$ 28.69	$ 28.69	$ 28.69	$ 7.28		
Restoration (Street)	$ 29.00	$ 23.50	$ 23.50	$ 23.50	$ 23.50	$ 23.50		
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	$ -	$ -	$ -	$ -		
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -		
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00		
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -		
Traffic	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00		
Utilities	$ -	$ -	$ -	$ -	$ -	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00		
TOTALS	$ 190.11	$ 186.62	$ 149.11	$ 149.11	$ 149.11	$ 103.60		
COST PER LINEAR FOOT	**$ 191.00**	**$ 187.00**	**$ 150.00**	**$ 150.00**	**$ 150.00**	**$ 104.00**	**$**	**262.72**
(Rounded to nearest dollar)								
Total Setment Cost	$ 276,950.00	$ 746,237.90	$ 120,150.00	$ 52,500.00	$ 315,050.25	$ 772,616.00	**$**	**2,283,504.15**

Pump Station Cost = $ 775,000

No. of Non-drop Manholes	4	11	11	11	11	2		48
No of Drop Manhols	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	11.8	14.3	10.7	10.7	10.7	5.0		
Riser Cost	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,118	$1,119	$1,120		
MANHOLE COST PER SEGMENT	$ 10,664.16	$ 32,839.07	$ 27,738.55	$ 27,749.55	$ 27,760.55	$ 3,550.00	**$**	**130,301.89**

Force Main Cost: $ 780,000.00

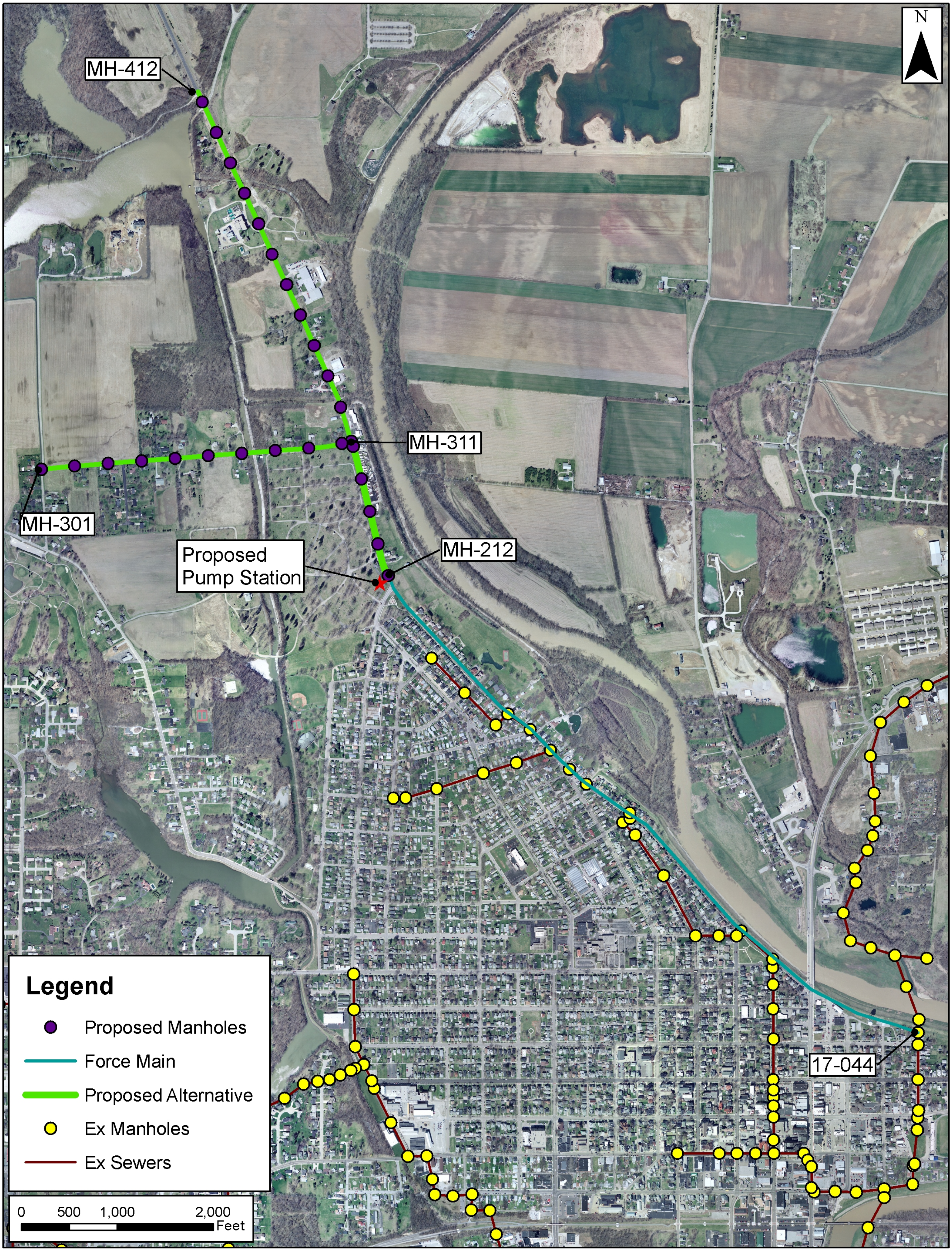
June 2003 (ENR CCI: 6694) **$ 3,188,854.04**

May 2012 (ENR CCI: 9289.65) **$ 4,425,364.09**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.

Upsizing Existing Infrastructure
ductile iron pipe


N
MH-412
MH-311
MH-301
Proposed Pump Station
MH-212
17-044
Legend
Proposed Manholes
Force Main
Proposed Alternative
Ex Manholes
Ex Sewers
0
500
1,000
2,000
Feet

DATE: June 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 3 A (in RoW) Lift Station and
Force main to West Interceptor - Alt 8a
LOS: 5 YR

Segment ID (DSMH -- USMH)	212 - 311	311 - 412	311 - 308	308 -307	307 - 301	212 - Ex. MH 12-004		
Length, feet	1,450.0	3,990.6	801.0	350.0	2,100.3	4,217.0		8,691.9
PIPE SIZE, inches	18.0	12.0	12.0	12.0	12.0	8.0		
TYPE(C for	B	B	B	B	B	B		
AVG. CUT, feet	11.8	14.3	10.7	10.7	10.7	5.0		11.7
TR. WIDTH, feet	3.5	2.5	2.5	2.5	2.5	2.5		
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5								
Trench Excavation cost, $/cubic yard	$ 18.00	$ 25.00	$ 19.00	$ 19.00	$ 19.00	$ 8.00		
Backfill cost, $/cubic yard	$42.90	$42.90	$42.90	$42.90	$42.90	$42.90		
Native Fill = $22.00/C.Y.								
Granular Backfill Material - $42.90/C.Y.								
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**		
Breaking Pavement	$ 7.30	$ 6.30	$ 6.30	$ 6.30	$ 6.30	$ 6.30		
Excavation	$ 35.91	$ 42.94	$ 24.52	$ 24.52	$ 24.52	$ 4.81		
Tunneling Cost								
Trench Shoring	$ 12.50	$ 16.50	$ 11.50	$ 11.50	$ 11.50	$ 4.20		
Pipe	$ 12.50	$ 7.30	$ 7.30	$ 7.30	$ 7.30	$ 11.50		
Pipe, laying and handling	$ 9.30	$ 7.30	$ 7.30	$ 7.30	$ 7.30	$ 6.00		
Backfill	$ 43.60	$ 42.78	$ 28.69	$ 28.69	$ 28.69	$ 7.28		
Restoration (Street)	$ 29.00	$ 23.50	$ 23.50	$ 23.50	$ 23.50	$ 23.50		
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	$ -	$ -	$ -	$ -		
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -		
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00		
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -		
Traffic	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00		
Utilities	$ -	$ -	$ -	$ -	$ -	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00		
TOTALS	$ 190.11	$ 186.62	$ 149.11	$ 149.11	$ 149.11	$ 103.60		
COST PER LINEAR FOOT	**$ 191.00**	**$ 187.00**	**$ 150.00**	**$ 150.00**	**$ 150.00**	**$ 104.00**	**$**	**224.28**
(Rounded to nearest dollar)								
Total Setment Cost	$ 276,950.00	$ 746,237.90	$ 120,150.00	$ 52,500.00	$ 315,050.25	$ 438,568.00	**$**	**1,949,456.15**

Pump Station Cost = **$** **775,000**

No. of Non-drop Manholes	4	11	11	11	11	2		48
No of Drop Manhols	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	11.8	14.3	10.7	10.7	10.7	5.0		
Riser Cost	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,118	$1,119	$1,120		
MANHOLE COST PER SEGMENT	$ 10,664.16	$ 32,839.07	$ 27,738.55	$ 27,749.55	$ 27,760.55	$ 3,550.00	**$**	**130,301.89**

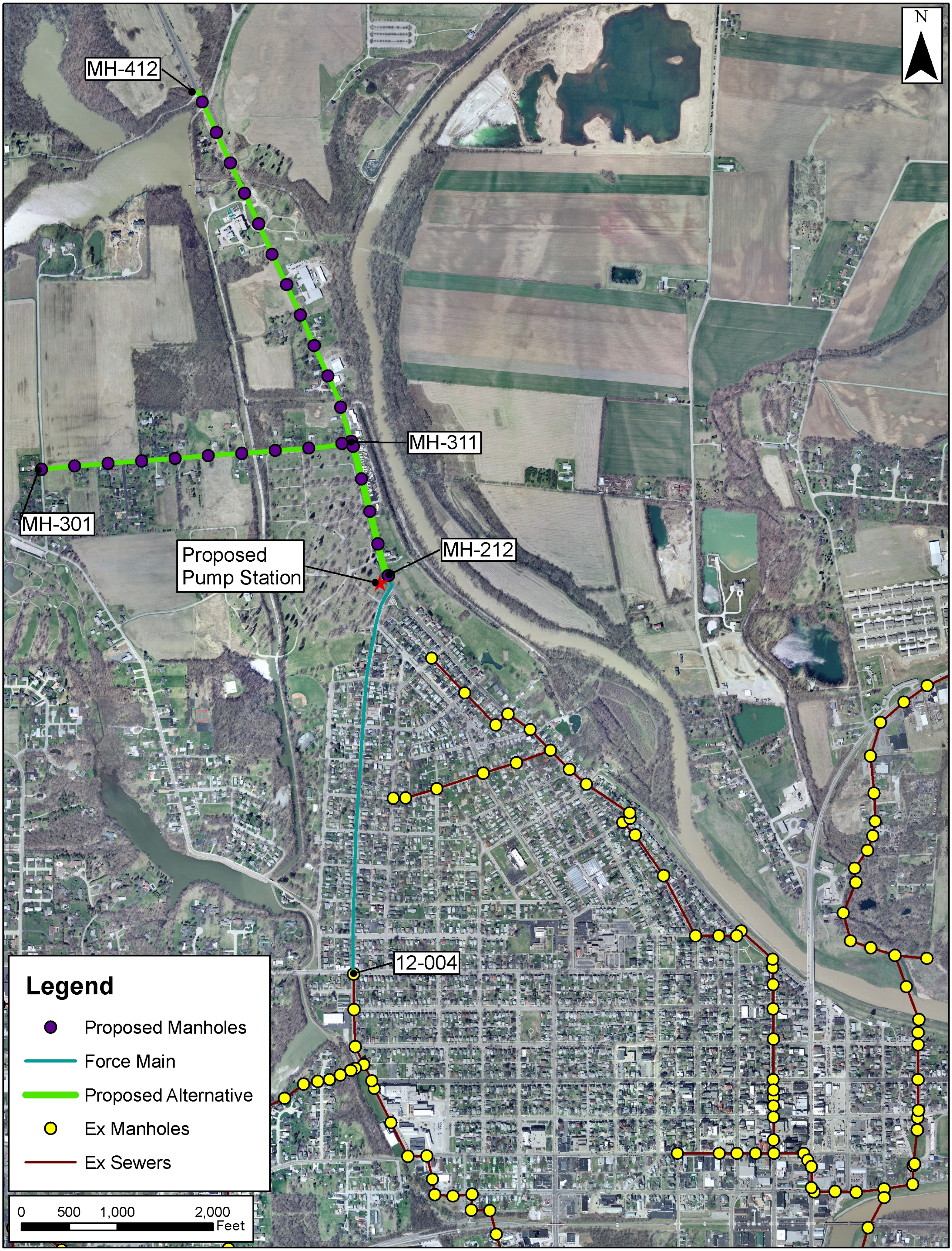
Force Main Cost: $ 440,000.00

June 2003 (ENR CCI: 6694) **$** **2,854,806.04**

May 2012 (ENR CCI: 9289.65 **$** **3,961,785.63**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe


N
MH-412
MH-311
MH-301
Proposed
Pump Station
MH-212
12-004
Legend
Proposed Manholes
Force Main
Proposed Alternative
Ex Manholes
Ex Sewers
0 500 1,000 2,000
Feet

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Alternative 3 A (in RoW) Extention to St Rt 185 - Alts 2,3,4,5,7
LOS 5-YR

Segment ID (DSMH -- USMH)	101 - 105	105 - 311	311 - 412	311 - 308	308 -307	307 - 514	514 - 608	
Length, feet	1,176.6	8,055.3	3,990.6	801.0	350.0	7,422.5	2,615.0	24,411.0
PIPE SIZE, inches	21.0	21.0	12.0	18.0	12.0	12.0	12.0	
TYPE(C for	C	B	B	B	B	B	C	
AVG. CUT, feet	30.0	30.0	17.7	15.5	15.5	15.5	12.7	23.3
TR. WIDTH, feet	4.0	4.0	3.0	3.5	2.5	2.5	2.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5								
Trench Excavation cost, $/cubic yard	$ 47.00	$ 47.00	$ 32.00	$ 25.00	$ 28.00	$ 28.00	$ 23.00	
Backfill cost, $/cubic yard	$22.00	$42.90	$42.90	$42.90	$42.90	$42.90	$22.00	
Native Fill = $22.00/C.Y.								
Granular Backfill Material - $42.90/C.Y.								
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ -	$ 8.30	$ 6.30	$ 7.30	$ 6.30	$ 6.30	$ -	
Excavation	$ 271.56	$ 271.56	$ 81.77	$ 65.43	$ 52.34	$ 52.34	$ 35.10	
Tunneling Cost								
Trench Shoring	$ 84.80	$ 108.00	$ 28.00	$ 21.00	$ 21.00	$ 21.00	$ 14.50	
Pipe	$ 38.10	$ 38.10	$ 20.20	$ 12.50	$ 20.20	$ 7.30	$ 7.30	
Pipe, laying and handling	$ 11.50	$ 11.50	$ 7.30	$ 9.30	$ 7.30	$ 7.30	$ 7.30	
Backfill	$ 83.93	$ 163.66	$ 67.64	$ 64.12	$ 47.79	$ 47.79	$ 18.70	
Restoration (Street)	$ -	$ 31.00	$ 26.00	$ 29.00	$ 23.50	$ 23.50	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ -	$ -	$ -	$ -	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Traffic	$ -	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ -	
Utilities	$ -	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 526.88	$ 683.11	$ 288.21	$ 259.65	$ 229.43	$ 216.53	$ 119.90	
COST PER LINEAR FOOT	**$ 527.00**	**$ 684.00**	**$ 289.00**	**$ 260.00**	**$ 230.00**	**$ 217.00**	**$ 120.00**	**$ 389.02**
(Rounded to nearest dollar)								
Total Segment Cost	$ 620,062.93	$ 5,509,818.36	$ 1,153,274.73	$ 208,260.00	$ 80,500.00	$ 1,610,686.84	$ 313,800.00	**$ 9,496,402.86**

No. of Non-drop Manholes	4	23	13	6	1	16	10	73	
No of Drop Manhols	0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	30.0	30.0	17.7	15.5	15.5	15.5	12.7		
Riser Cost	$131	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,115	$1,116	$1,116	$1,116	$1,116	$1,116		
MANHOLE COST PER SEGMENT	$ 40,360.00	$ 232,070.00	$ 44,634.07	$ 18,902.58	$ 3,150.43	$ 50,406.88	$ 27,770.80	**$ 417,294.76**	**$ 9,913,697.62**

June 2003 (ENR CCI: 6694) **$ 9,913,770.62**

May 2012 (ENR CCI: 9289.6! **$ 13,757,339.49**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Alternative 3 A 2 w/ Siphon
LOS: 5 yr

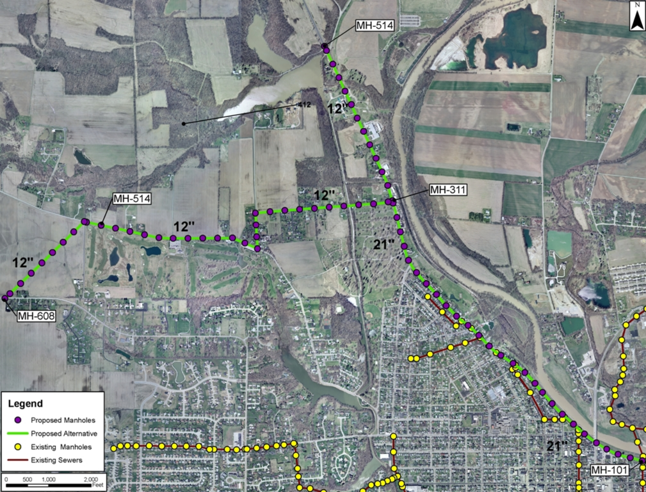
Segment ID (DSMH -- USMH)	101 - 105	105 - 311	311 - 412	311 - 514	514 - 608	Siphon Barrel 1	Siphon Barrel 2		
Length, feet	1,176.6	8,055.3	3,990.6	8,573.5	2,615.0	200.0	200.0		24,811.0
PIPE SIZE, inches	21.0	21.0	12.0	12.0	12.0	10.0	10.0		
TYPE(C for	C	B	B	B	C	C	C		
AVG. CUT, feet	25.2	25.2	13.7	11.1	12.8	5.0	5.0		18.8
TR. WIDTH, feet	4.0	4.0	2.5	2.5	2.5	2.5	2.5		
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5									
Trench Excavation cost, $/cubic yard	$ 39.00	$ 39.00	$ 25.00	$ 19.00	$ 23.00	$ 8.00	$ 8.00		
Backfill cost, $/cubic yard	$22.00	$42.90	$42.90	$42.90	$22.00	$61.49	$61.49		
Native Fill = $22.00/C.Y.									
Granular Backfill Material - $42.90/C.Y.									
Controlled Density Backfill - $61.49/C.Y.									
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**		
Breaking Pavement	$ -	$ 8.30	$ 6.30	$ 6.30	$ -	$ -	$ -		
Excavation	$ 189.13	$ 189.13	$ 41.14	$ 25.32	$ 35.44	$ 4.81	$ 4.81		
Tunneling Cost									
Trench Shoring	$ 65.00	$ 74.00	$ 16.50	$ 11.50	$ 14.50	$ 4.20	$ 4.20		
Pipe	$ 38.10	$ 38.10	$ 7.30	$ 7.30	$ 7.30	$ 15.80	$ 15.80		
Pipe, laying and handling	$ 11.50	$ 11.50	$ 7.30	$ 7.30	$ 7.30	$ 6.00	$ 6.00		
Backfill	$ 68.22	$ 133.02	$ 40.40	$ 30.07	$ 18.94	$ 9.49	$ 9.49		
Restoration (Street)	$ -	$ 31.00	$ 23.50	$ 23.50	$ -	$ -	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ -	$ -	$ 5.00	$ 5.00	$ 5.00		
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00		
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ 5,000.00	$ 5,000.00		
Traffic	$ -	$ 8.00	$ 8.00	$ 8.00	$ -	$ -	$ -		
Utilities	$ -	$ 11.00	$ 11.00	$ 11.00	$ -	$ -	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 20.00	$ 20.00		
TOTALS	$ 408.95	$ 536.05	$ 193.43	$ 162.29	$ 120.48	$ 95.30	$ 95.30		
COST PER LINEAR FOOT	**$ 409.00**	**$ 537.00**	**$ 194.00**	**$ 163.00**	**$ 121.00**	**$ 96.00**	**$ 96.00**	**$**	**294.02**
(Rounded to nearest dollar)									
Total Segment Cost	$ 481,225.31	$ 4,325,690.73	$ 774,170.58	$ 1,397,483.76	$ 316,415.00	$ 24,200.00	$ 24,200.00	**$**	**7,294,985.38**

No. of Non-drop Manholes	4	23	13	23	9	0	0		63	
No of Drop Manhols	0	0	0	0	0	0	0			
Avg Manhole Depth (Ft)	25.2	25.2	13.7	11.1	12.8	5.0	5.0			
Riser Cost	$131	$131	$131	$131	$131	$131	$131			
Base Cost (Base, Frame and Lid)	$1,115	$1,115	$1,116	$1,116	$1,116	$1,117	$1,118			
MANHOLE COST PER SEGMENT	$ 35,308.64	$ 203,024.68	$ 37,788.01	$ 59,021.91	$ 25,135.20	$ -	$ -	**$**	**360,278.44**	**$ 7,655,263.82**

Junction Boxes for Siphons	**$**	**100,000.00**
June 2003 (ENR CC	**$**	**7,755,326.82**
May 2012 (ENR CC	**$**	**10,762,532.35**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe
For Siphon Junction Boxes assume $50,000 per structure (2 per siphon)



MH-514
412
12"
MH-514
12"
MH-311
12"
12"
21"
MH-608
21"
MH-101
Legend
Proposed Manholes
Proposed Alternative
Existing Manholes
Existing Sewers
0 500 1,000 2,000 Feet
N

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Alternative 3 B (out of RoW) Extended to St Rt 185 - Alts 2,3,4,5,7
LOS: 5 yr

Segment ID (DSMH -- USMH)	101 - 105	105 - 111	111 - 268	268 - 311	311 - 412	311 - 308	308 -307	307 - 514	514 - 608	
Length, feet	1,176.6	2,027.7	5,592.6	436.6	3,990.6	801.0	350.0	6,722.5	2,615.0	23,712.5
PIPE SIZE, inches	21.0	21.0	21.0	12.0	12.0	12.0	12.0	18.0	12.0	
TYPE(C for	C	B	C	C	B	B	B	B	C	
AVG. CUT, feet	25.1	25.1	25.1	17.6	17.6	15.5	15.5	15.5	12.6	19.6
TR. WIDTH, feet	4.0	4.0	4.0	3.0	3.0	3.5	3.5	3.5	2.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5										
Trench Excavation cost, $/cubic yard	$ 39.00	$ 39.00	$ 39.00	$ 32.00	$ 32.00	$ 23.00	$ 23.00	$ 23.00	$ 23.00	
Backfill cost, $/cubic yard	$22.00	$42.90	$22.00	$22.00	$42.90	$42.90	$42.90	$42.90	$22.00	
Native Fill = $22.00/C.Y.										
Granular Backfill Material - $42.90/C.Y.										
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ -	$ 8.30	$ -	$ -	$ 6.30	$ 7.30	$ 7.30	$ 7.30	$ -	
Excavation	$ 188.75	$ 188.75	$ 188.75	$ 81.30	$ 81.30	$ 57.40	$ 56.28	$ 56.28	$ 34.83	
Tunneling Cost										
Trench Shoring	$ 65.00	$ 65.00	$ 65.00	$ 28.00	$ 28.00	$ 18.50	$ 18.50	$ 18.50	$ 14.50	
Pipe	$ 38.10	$ 38.10	$ 38.10	$ 20.20	$ 20.20	$ 12.50	$ 20.20	$ 12.50	$ 7.30	
Pipe, laying and handling	$ 11.50	$ 11.50	$ 11.50	$ 7.30	$ 7.30	$ 7.30	$ 20.20	$ 9.30	$ 7.30	
Backfill	$ 68.05	$ 132.70	$ 68.05	$ 34.44	$ 67.16	$ 60.12	$ 58.50	$ 58.50	$ 18.50	
Restoration (Street)	$ -	$ 31.00	$ -	$ -	$ 26.00	$ 29.00	$ 29.00	$ 29.00	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ 5.00	$ 5.00	$ -	$ -	$ -	$ -	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Traffic	$ -	$ 8.00	$ -	$ -	$ 8.00	$ 8.00	$ 8.00	$ 8.00	$ -	
Utilities	$ -	$ 11.00	$ -	$ -	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	
TOTALS	$ 408.41	$ 526.36	$ 408.41	$ 208.25	$ 287.27	$ 204.12	$ 222.68	$ 201.38	$ 119.42	
COST PER LINEAR FOOT	**$ 409.00**	**$ 527.00**	**$ 409.00**	**$ 209.00**	**$ 288.00**	**$ 205.00**	**$ 223.00**	**$ 202.00**	**$ 120.00**	**$ 287.58**
(Rounded to nearest dollar)										
Total Segment Cost	$ 481,225.31	$ 1,068,582.09	$ 2,287,381.58	$ 91,243.13	$ 1,149,284.16	$ 164,205.00	$ 78,050.00	$ 1,499,349.04	$ 313,800.00	**$ 6,819,320.31**

No. of Non-drop Manholes	4	6	17	1	11	6	1	16	9	62	
No of Drop Manhols	0	0	0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	25.1	25.1	25.1	17.6	17.6	14.8	14.5	14.5	12.6		
Riser Cost	$131	$131	$131	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,115	$1,116	$1,116	$1,116	$1,116	$1,117		
MANHOLE COST PER SEGMENT	$ 35,256.24	$ 52,896.36	$ 149,907.02	$ 3,419.29	$ 37,623.19	$ 18,336.66	$ 3,018.12	$ 48,289.92	$ 24,884.82	**$ 279,102.10**	**$ 7,098,422.41**

June 2003 (ENR CCI: 6694) **$ 7,098,484.41**

May 2012 (ENR CCI: 9289.65) **$ 9,850,992.72**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe

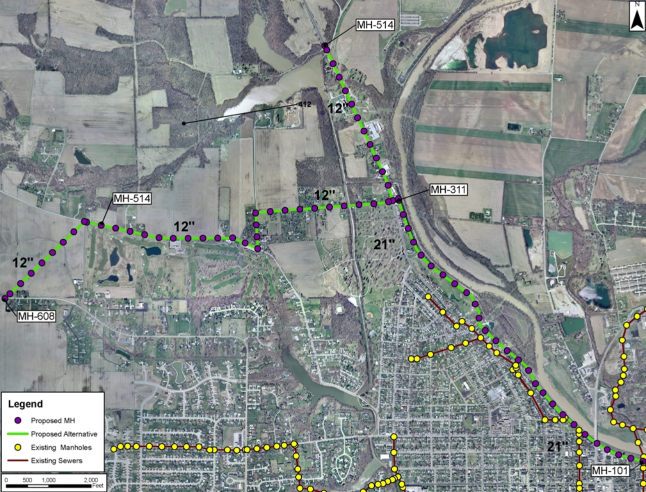
DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: 3 B (out of RoW) Extension to St Rt 185 w/ Siphon - Alts 2,3,4,5,7
LOS: 5 yr

Segment ID (DSMH -- USMH)	101 - 105	105 - 111	111 - 268	268 - 311	311 - 412	311 - 514	514 - 608	Siphon Barrel 1	Siphon Barrel 2	
Length, feet	1,176.6	2,027.7	5,592.6	436.6	3,990.6	7,873.5	2,615.0	200.0	200.0	23,712.5
PIPE SIZE, inches	21.0	21.0	21.0	12.0	12.0	12.0	12.0	10.0	10.0	
TYPE(C for	C	B	C	C	B	B	C	C	C	
AVG. CUT, feet	19.8	19.8	19.8	13.7	13.7	11.6	11.8	5.0	5.0	16.4
TR. WIDTH, feet	4.0	4.0	4.0	2.5	2.5	2.5	2.5	2.5	2.5	
Excavation Multiplier	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5										
Trench Excavation cost, $/cubic yard	$ 31.00	$ 31.00	$ 31.00	$ 25.00	$ 25.00	$ 21.00	$ 21.00	$ 8.00	$ 8.00	
Backfill cost, $/cubic yard	$22.00	$42.90	$22.00	$22.00	$42.90	$42.90	$22.00	$61.49	$61.49	
Native Fill = $22.00/C.Y.										
Granular Backfill Material - $42.90/C.Y.										
ITEMS	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	**COST**	
Breaking Pavement	$ -	$ 8.30	$ -	$ -	$ 6.30	$ 6.30	$ -	$ -	$ -	
Excavation	$ 117.91	$ 117.91	$ 117.91	$ 41.32	$ 41.32	$ 29.30	$ 29.79	$ 4.81	$ 4.81	
Tunneling Cost										
Trench Shoring	$ 35.00	$ 35.00	$ 35.00	$ 16.50	$ 16.50	$ 12.50	$ 12.50	$ 4.20	$ 4.20	
Pipe	$ 16.50	$ 16.50	$ 16.50	$ 7.30	$ 7.30	$ 7.30	$ 7.30	$ 15.80	$ 15.80	
Pipe, laying and handling	$ 11.50	$ 11.50	$ 11.50	$ 7.30	$ 7.30	$ 7.30	$ 7.30	$ 6.00	$ 6.00	
Backfill	$ 50.52	$ 98.51	$ 50.52	$ 20.84	$ 40.64	$ 32.14	$ 16.88	$ 9.49	$ 9.49	
Restoration (Street)	$ -	$ 31.00	$ -	$ -	$ 23.50	$ 23.50	$ -	$ -	$ -	
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ 5.00	$ 5.00	$ -	$ -	$ 5.00	$ 5.00	$ 5.00	
Maintaining Flow	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
De-watering	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	
Removing and replacing existing structures	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000.00	$ 5,000.00	
Traffic	$ -	$ 8.00	$ -	$ -	$ 8.00	$ 8.00	$ -	$ -	$ -	
Utilities	$ -	$ 11.00	$ -	$ -	$ 11.00	$ 11.00	$ -	$ -	$ -	
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 20.00	$ 20.00	
TOTALS	$ 268.43	$ 369.73	$ 268.43	$ 130.26	$ 193.85	$ 169.33	$ 110.77	$ 95.30	$ 95.30	
COST PER LINEAR FOOT	**$ 269.00**	**$ 370.00**	**$ 269.00**	**$ 131.00**	**$ 194.00**	**$ 170.00**	**$ 111.00**	**$ 96.00**	**$ 96.00**	**$ 212.18**
(Rounded to nearest dollar)										
Total Segment Cost	$ 316,502.71	$ 750,237.90	$ 1,504,414.78	$ 57,190.67	$ 774,170.58	$ 1,338,498.40	$ 290,265.00	$ 24,200.00	$ 24,200.00	**$ 5,031,280.04**

No. of Non-drop Manholes	4	6	17	1	11	23	9	0	0	62	
No of Drop Manhols	0	0	0	0	0	0	0	0	0		
Avg Manhole Depth (Ft)	19.8	19.8	19.8	13.7	13.7	11.6	11.8	5.0	5.0		
Riser Cost	$131	$131	$131	$131	$131	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,117	$1,115	$1,116	$1,117	$1,117	$1,117	$1,118		
MANHOLE COST PER SEGMENT	$ 14,809.00	$ 22,219.50	$ 62,972.25	$ 2,913.63	$ 32,060.93	$ 60,611.67	$ 23,948.69	$ -	$ -	**$ 219,535.67**	**$ 5,250,815.71**

Junction Boxes for Siphons	**$ 100,000.00**
June 2003 (ENR CCI: 6694)	**$ 5,350,877.71**
May 2012 (ENR CCI: 9289.65)	**$ 7,425,734.06**
CCI Adjustment Factor: 1.3877	

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
*Bypass Pumping Assumes $2290 a day at 100ft of pipe constructed a day.
Upsizing Existing Infrastructure
ductile iron pipe
For Siphon Junction Boxes assume $50,000 per structure (2 per siphon)



N
MH-514
412
12"
MH-311
12"
MH-514
12"
21"
12"
MH-608
21"
MH-101
Legend
Proposed MH
Proposed Alternative
Existing Manholes
Existing Sewers
0 500 1,000 2,000 Feet

Appendix E

Detailed Alternative Cost Breakdown Tables – Northeast Service Area

CDM Smith

DATE: June 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Looney Rd. 1

Segment ID (DSMH -- USMH)	1-1 - 1-38	2-1 - 2-9	2-9 - 2-18			
Length, feet	11,204.0	2,800.0	3,150.0	17,154.0		
PIPE SIZE, inches	12.0	12.0	12.0			
TYPE(C for	C	B	C			
AVG. CUT, feet	18.3	16.8	12.1	18.3		
TR. WIDTH, feet	3.0	2.5	2.5			
Excavation Multiplier	1.3	1.3	1.3			
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5						
Trench Excavation cost, $/cubic yard	$ 32.00	$ 30.00	$ 21.00			
Backfill cost, $/cubic yard	$22.00	$42.90	$22.00			
Native Fill =$22.00/C.Y.						
Granular Backfill Material -$42.90/C.Y.						
ITEMS	**COST**	**COST**	**COST**			
Breaking Pavement	$ -	$ 6.30	$ -			
Excavation	$ 84.59	$ 60.61	$ 30.61			
Tunneling Cost						
Trench Shoring	$ 28.00	$ 24.00	$ 12.50			
Pipe	$ 7.30	$ 7.30	$ 7.30			
Pipe, laying and handling	$ 7.30	$ 7.30	$ 7.30			
Backfill	$ 36.18	$ 52.77	$ 17.54			
Restoration (Street)	$ -	$ 23.50	$ -			
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ 5.00			
Maintaining Flow	$ -	$ -	$ -			
De-watering	$ 10.00	$ 10.00	$ 10.00			
Removing and replacing existing structures	$ -	$ -	$ -			
Traffic	$ -	$ 8.00	$ -			
Utilities	$ -	$ -	$ -			
Miscellaneous	$ 2.00	$ 2.00	$ 2.00			
TOTALS	$ 180.36	$ 201.78	$ 92.25			
COST PER LINEAR FOOT	**$ 181.00**	**$ 202.00**	**$ 93.00**	**$ 168.27**		
(Rounded to nearest dollar)					$ 912,704.03	$1,259,531.56
Total Setment Cost	$ 2,027,924.00	$ 565,600.00	$ 292,950.00	**$ 2,886,474.00**	$ 2,161,391.40	$2,982,720.13

No. of Non-drop Manholes	38	9	9		56
No of Drop Manhols	0	0	0		
Avg Manhole Depth (Ft)	18.3	16.8	12.1		
Riser Cost	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,116		
MANHOLE COST PER SEGMENT	$ 133,467.40	$ 29,833.52	$ 24,320.51	**$ 187,621.43**	**$ 3,074,095.43**

June 2003 (ENR CCI: 6694) **$ 3,074,095.43**

May 2012 (ENR CCI: 9289.65) **$ 4,266,106.67**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'

*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.

Upsizing Existing Infrastructure
ductile iron pipe

N
2-11
12"
2-18
1-38
12"
2-01
12"
12"
1-25
1-01
Legend
Proposed Manholes
Proposed Alternative
Existing Manholes
Existing Sewers
0
500
1,000
2,000
Feet

DATE: June 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Looney Rd. 2

Segment ID (DSMH -- USMH)	1-1 - 1-28	2-1 - 2-9	2-9 - 2-24		
Length, feet	8,248.0	2,800.0	5,200.0	16,248.0	
PIPE SIZE, inches	12.0	12.0	12.0		
TYPE(C for	C	B	C		
AVG. CUT, feet	13.0	16.9	11.6	13.0	
TR. WIDTH, feet	2.5	2.5	2.5		
Excavation Multiplier	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5					
Trench Excavation cost, $/cubic yard	$ 23.00	$ 30.00	$ 21.00		
Backfill cost, $/cubic yard	$22.00	$42.90	$22.00		
Native Fill =$22.00/C.Y.					
Granular Backfill Material - $42.90/C.Y.					
ITEMS	**COST**	**COST**	**COST**		
Breaking Pavement	$ -	$ 6.30	$ -		
Excavation	$ 36.13	$ 60.98	$ 29.27		
Tunneling Cost					
Trench Shoring	$ 14.50	$ 24.00	$ 12.50		
Pipe	$ 7.30	$ 7.30	$ 7.30		
Pipe, laying and handling	$ 7.30	$ 7.30	$ 7.30		
Backfill	$ 19.45	$ 53.18	$ 16.46		
Restoration (Street)	$ -	$ 23.50	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ 5.00	$ -	$ 5.00		
Maintaining Flow	$ -	$ -	$ -		
De-watering	$ 10.00	$ 10.00	$ 10.00		
Removing and replacing existing structures	$ -	$ -	$ -		
Traffic	$ -	$ 8.00	$ -		
Utilities	$ -	$ -	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00		
TOTALS	$ 101.68	$ 202.56	$ 89.83		
COST PER LINEAR FOOT	**$ 102.00**	**$ 203.00**	**$ 90.00**	**$ 115.56**	
(Rounded to nearest dollar)					
Total Setment Cost	$ 841,296.00	$ 568,400.00	$ 468,000.00	**$ 1,877,696.00**	###########
					$ 1,512,730.25

No. of Non-drop Manholes	29	9	9			47
No of Drop Manhols	0	0	0			
Avg Manhole Depth (Ft)	13.0	16.9	11.6			
Riser Cost	$131	$131	$131			
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,116			
MANHOLE COST PER SEGMENT	$ 81,908.15	$ 29,954.95	$ 23,696.82	**$ 135,559.92**	**$ 2,013,255.92**	

June 2003 (ENR CC **$ 2,013,255.92**

*MH Costs are doubled if Depth is greater than 20'

May 2012 (ENR CCI **$ 2,793,916.04**

*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be

CCI Adjustment Factor: 1.3877

Upsizing Existing Infrastructure

ductile iron pipe

N
2-11
12"
2-24
12"
2-01
1-28
12"
1-19
12"
1-01
Legend
Proposed Manholes
Proposed Alternative
Existing Manholes
Existing Sewers
0 500 1,000 2,000
Feet

DATE: June 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: Looney Rd. 3

Segment ID (DSMH -- USMH)	3-1 - 3-8	3-8 - 1-38	2-1 - 2-9	2-9 - 2-18		
Length, feet	2,607.0	8,978.0	2,800.0	3,150.0	17,535.0	
PIPE SIZE, inches	12.0	12.0	12.0	12.0		
TYPE(C for	B	C	B	C		
AVG. CUT, feet	13.0	18.7	16.8	12.1	13.0	
TR. WIDTH, feet	2.5	3.0	2.5	2.5		
Excavation Multiplier	1.3	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5						
Trench Excavation cost, $/cubic yard	$ 23.00	$ 34.00	$ 30.00	$ 21.00		
Backfill cost, $/cubic yard	$42.90	$22.00	$42.90	$22.00		
Native Fill =$22.00/C.Y.						
Granular Backfill Material -$42.90/C.Y.						
ITEMS	**COST**	**COST**	**COST**	**COST**		
Breaking Pavement	$ 6.30	$ -	$ 6.30	$ -		
Excavation	$ 35.94	$ 91.92	$ 60.61	$ 30.61		
Tunneling Cost						
Trench Shoring	$ 14.50	$ 31.00	$ 24.00	$ 12.50		
Pipe	$ 7.30	$ 7.30	$ 7.30	$ 7.30		
Pipe, laying and handling	$ 7.30	$ 7.30	$ 7.30	$ 7.30		
Backfill	$ 37.66	$ 37.20	$ 52.77	$ 17.54		
Restoration (Street)	$ 23.50	$ -	$ 23.50	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ -	$ 5.00	$ -	$ 5.00		
Maintaining Flow	$ -	$ -	$ -	$ -		
De-watering	$ 10.00	$ 10.00	$ 10.00	$ 10.00		
Removing and replacing existing structures	$ -	$ -	$ -	$ -		
Traffic	$ 8.00	$ -	$ 8.00	$ -		
Utilities	$ -	$ -	$ -	$ -		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00	$ 2.00		
TOTALS	$ 152.49	$ 191.72	$ 201.78	$ 92.25		
COST PER LINEAR FOOT	**$ 153.00**	**$ 192.00**	**$ 202.00**	**$ 93.00**	**$ 170.01**	
(Rounded to nearest dollar)						
Total Setment Cost	$ 398,871.00	$ 1,723,776.00	$ 565,600.00	$ 292,950.00	**$ 2,981,197.00**	
No. of Non-drop Manholes	9	28	9	9		55
No of Drop Manhols	0	0	0	0		
Avg Manhole Depth (Ft)	13.0	18.7	16.8	12.1		
Riser Cost	$131	$131	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,115	$1,116	$1,116		
MANHOLE COST PER SEGMENT	$ 25,338.42	$ 99,873.96	$ 29,833.52	$ 24,320.51	**$ 179,366.40**	**$ 3,160,563.40**

June 2003 (ENR CCI: 6694) **$ 3,160,563.40**

May 2012 (ENR CCI: 9289.65) **$ 4,386,103.47**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.

Upsizing Existing Infrastructure
ductile iron pipe

N
2-11
12"
2-18
1-38
12"
2-01
3-08
12"
12"
1-25
3-01
Legend
Proposed Manholes
Proposed Alternative
Existing Manholes
Existing Sewers
0
500
1,000
2,000
Feet

Appendix E

Detailed Alternative Cost Breakdown Tables – East Service Area

CDM Smith

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: East Service Area - Extension 1

Segment ID (DSMH -- USMH)	Existing MH 25-008 - 11	11 - 15		
Length, feet	890.0	4,768.0		5,658.0
PIPE SIZE, inches	15.0	15.0		
TYPE(C for	B	C		
AVG. CUT, feet	15.0	15.0		
TR. WIDTH, feet	3.0	3.0		
Excavation Multiplier	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5				
Trench Excavation cost, $/cubic yard	$ 27.00	$ 27.00		
Backfill cost, $/cubic yard	$42.90	$22.00		
Native Fill =$22.00/C.Y.				
Granular Backfill Material -$42.90/C.Y.				
ITEMS	**COST**	**COST**		
Breaking Pavement	$ 6.30	$ -		
Excavation	$ 58.50	$ 58.50		
Tunneling Cost				
Trench Shoring	$ 18.50	$ 18.50		
Pipe	$ 10.30	$ 10.30		
Pipe, laying and handling	$ 8.30	$ 8.30		
Backfill	$ 53.63	$ 27.50		
Restoration (Street)	$ 26.00	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ -	$ 5.00		
Maintaining Flow	$ -	$ -		
De-watering	$ 10.00	$ 10.00		
Removing and replacing existing structures	$ -	$ -		
Traffic	$ 8.00	$ -		
Utilities	$ 4.00	$ 4.00		
Miscellaneous	$ 2.00	$ 2.00		
TOTALS	$ 205.53	$ 144.10		
COST PER LINEAR FOOT	**$ 206.00**	**$ 145.00**		**$ 154.60**
(Rounded to nearest dollar)				
Total Setment Cost	$ 183,340.00	$ 691,360.00		**$ 874,700.00**

No. of Non-drop Manholes	3	12		15	
No of Drop Manhols	0	0			
Avg Manhole Depth (Ft)	15.0	15.0			
Riser Cost	$131	$131			
Base Cost (Base, Frame and Lid)	$1,115	$1,116			
MANHOLE COST PER SEGMENT	$ 9,240.00	$ 36,972.00		**$ 9,240.00**	**$ 883,940.00**

June 2003 (ENR CCI: 6694) **$ 883,955.00**

*MH Costs are doubled if Depth is greater than : May 2012 (ENR CCI: 9289.65) **$ 1,226,717.39**

*Removing and Replacing Existing Structures
cost is based on $440/ Manhole Removed.
Assumed to be the same # to be added.

CCI Adjustment Factor: 1.3877

Upsizing Existing Infrastructure
ductile iron pipe

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: East Service Area - Extension 2

Segment ID (DSMH -- USMH)	Existing MH 25-048 - 5		
Length, feet	1,979.0		1,979.0
PIPE SIZE, inches	12.0		
TYPE(C for	C		
AVG. CUT, feet	15.0		15.0
TR. WIDTH, feet	2.5		
Excavation Multiplier	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5			
Trench Excavation cost, $/cubic yard	$ 27.00		
Backfill cost, $/cubic yard	$22.00		
Native Fill =$22.00/C.Y.			
Granular Backfill Material - $42.90/C.Y.			

ITEMS	COST		
Breaking Pavement	$ -		
Excavation	$ 48.75		
Tunneling Cost			
Trench Shoring	$ 18.50		
Pipe	$ 7.30		
Pipe, laying and handling	$ 7.30		
Backfill	$ 23.43		
Restoration (Street)	$ -		
Restoration (Sidewalks, Driveways, Sod)	$ 5.00		
Maintaining Flow	$ -		
De-watering	$ 10.00		
Removing and replacing existing structures	$ -		
Traffic	$ -		
Utilities	$ 4.00		
Miscellaneous	$ 2.00		
TOTALS	$ 126.28		
COST PER LINEAR FOOT	**$ 127.00**	**$ 127.00**	
(Rounded to nearest dollar)			
Total Setment Cost	$ 251,333.00	**$ 251,333.00**	

No. of Non-drop Manholes	5		5	
No of Drop Manhols	0			
Avg Manhole Depth (Ft)	15.0			
Riser Cost	$131			
Base Cost (Base, Frame and Lid)	$1,115			
MANHOLE COST PER SEGMENT	$ 15,400.00	**$ 15,400.00**		**$ 266,733.00**

June 2003 (ENR CCI: 6694) **$ 266,738.00**

May 2012 (ENR CCI: 9289.65 **$ 370,168.33**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
Upsizing Existing Infrastructure
ductile iron pipe

Appendix E

Detailed Alternative Cost Breakdown Tables – South Central Service Area

CDM Smith

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: South Central Service Area

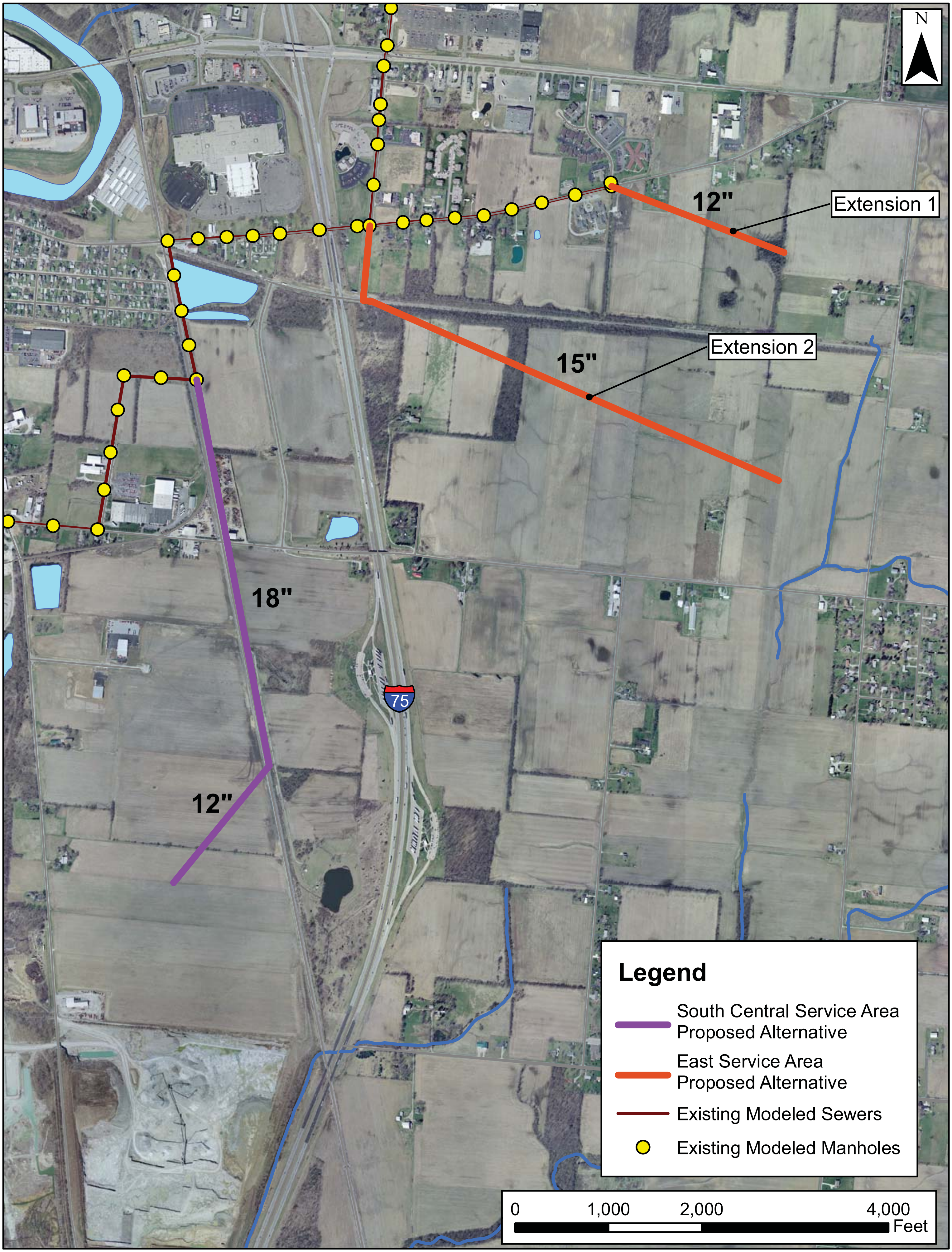
Segment ID (DSMH -- USMH)	Existing MH 24-019 - 11	11 - 15	
Length, feet	4,204.0	1,620.0	5,824.0
PIPE SIZE, inches	18.0	12.0	
TYPE(C for	B	B	
AVG. CUT, feet	15.0	15.0	15.0
TR. WIDTH, feet	3.5	2.5	
Excavation Multiplier	1.3	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5			
Trench Excavation cost, $/cubic yard	$ 23.00	$ 27.00	
Backfill cost, $/cubic yard	$42.90	$42.90	
Native Fill =$22.00/C.Y.			
Granular Backfill Material - $42.90/C.Y.			
ITEMS	**COST**	**COST**	
Breaking Pavement	$ 7.30	$ 6.30	
Excavation	$ 58.14	$ 48.75	
Tunneling Cost			
Trench Shoring	$ 18.50	$ 18.50	
Pipe	$ 12.50	$ 7.30	
Pipe, laying and handling	$ 9.30	$ 7.30	
Backfill	$ 61.17	$ 45.68	
Restoration (Street)	$ 29.00	$ 23.50	
Restoration (Sidewalks, Driveways, Sod)	$ -	$ -	
Maintaining Flow	$ -	$ -	
De-watering	$ 10.00	$ 10.00	
Removing and replacing existing structures	$ -	$ -	
Traffic	$ 8.00	$ 8.00	
Utilities	$ 4.00	$ 4.00	
Miscellaneous	$ 2.00	$ 2.00	
TOTALS	$ 219.91	$ 181.33	
COST PER LINEAR FOOT	**$ 220.00**	**$ 182.00**	**$ 209.43**
(Rounded to nearest dollar)			
Total Setment Cost	$ 924,880.00	$ 294,840.00	**$ 1,219,720.00**

No. of Non-drop Manholes	11	4	15	
No of Drop Manhols	0	0		
Avg Manhole Depth (Ft)	15.0	15.0		
Riser Cost	$131	$131		
Base Cost (Base, Frame and Lid)	$1,115	$1,116		
MANHOLE COST PER SEGMENT	$ 33,880.00	$ 12,324.00	**$ 33,880.00**	**$ 1,253,600.00**

June 2003 (ENR CCI: 6694) **$ 1,253,615.00**

May 2012 (ENR CCI: 9289.65 **$ 1,739,716.75**
CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.
Upsizing Existing Infrastructure
ductile iron pipe



N
12"
Extension 1
Extension 2
15"
18"
12"
75
Legend
South Central Service Area Proposed Alternative
East Service Area Proposed Alternative
Existing Modeled Sewers
Existing Modeled Manholes
0
1,000
2,000
4,000
Feet

Appendix E

Detailed Alternative Cost Breakdown Tables – North Central Service Area

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: North Central Service Area - Extension 1

Segment ID (DSMH -- USMH)	Existing MH 27-024 - 5	
Length, feet	3,992.0	3,992.0
PIPE SIZE, inches	12.0	
TYPE(C for	B	
AVG. CUT, feet	15.0	15.0
TR. WIDTH, feet	2.5	
Excavation Multiplier	1.3	
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5		
Trench Excavation cost, $/cubic yard	$ 27.00	
Backfill cost, $/cubic yard	$42.90	
Native Fill =$22.00/C.Y.		
Granular Backfill Material -$42.90/C.Y.		

ITEMS	**COST**	
Breaking Pavement	$ 6.30	
Excavation	$ 48.75	
Tunneling Cost		
Trench Shoring	$ 18.50	
Pipe	$ 7.30	
Pipe, laying and handling	$ 7.30	
Backfill	$ 45.68	
Restoration (Street)	$ 23.50	
Restoration (Sidewalks, Driveways, Sod)	$ -	
Maintaining Flow	$ -	
De-watering	$ 10.00	
Removing and replacing existing structures	$ -	
Traffic	$ 8.00	
Utilities	$ 4.00	
Miscellaneous	$ 2.00	
TOTALS	$ 181.33	
COST PER LINEAR FOOT	**$ 182.00**	**$ 182.00**
(Rounded to nearest dollar)		
Total Setment Cost	$ 726,544.00	**$ 726,544.00**

No. of Non-drop Manholes	6	6	
No of Drop Manhols	0		
Avg Manhole Depth (Ft)	15.0		
Riser Cost	$131		
Base Cost (Base, Frame and Lid)	$1,115		
MANHOLE COST PER SEGMENT	$ 18,480.00	**$ 18,480.00**	**$ 745,024.00**

June 2003 (ENR CCI: 6694) **$ 745,030.00**

May 2012 (ENR CCI: 9289.65) **$ 1,033,922.83**

CCI Adjustment Factor: 1.3877

*MH Costs are doubled if Depth is greater than 20'
*Removing and Replacing Existing Structures cost is based on $440/ Manhole Removed. Assumed to be the same # to be added.

Upsizing Existing Infrastructure
ductile iron pipe

DATE: May 2012
PROJECT: Piqua Sewer Master Plan
JOB NO.47268.81959
Description: North Central Service Area - Extension 2

Segment ID (DSMH -- USMH)	Existing MH 25-008 - 19	19 - 15	11 - 24		
Length, feet	7,582.0	2,206.0	1,723.0		11,511.0
PIPE SIZE, inches	18.0	15.0	12.0		
TYPE(C for	B	C	B		
AVG. CUT, feet	15.0	15.0	15.0		
TR. WIDTH, feet	3.5	3.0	2.5		
Excavation Multiplier	1.3	1.3	1.3		
Sand = 1.5; Clay = 1.0; Shale = 1.3; Rock = 1.5					
Trench Excavation cost, $/cubic yard	$ 23.00	$ 27.00	$ 27.00		
Backfill cost, $/cubic yard	$42.90	$22.00	$42.90		
Native Fill =$22.00/C.Y.					
Granular Backfill Material -$42.90/C.Y.					
ITEMS	**COST**	**COST**	**COST**		
Breaking Pavement	$ 7.30	$ -	$ 6.30		
Excavation	$ 58.14	$ 58.50	$ 48.75		
Tunneling Cost					
Trench Shoring	$ 18.50	$ 18.50	$ 18.50		
Pipe	$ 12.50	$ 10.30	$ 7.30		
Pipe, laying and handling	$ 9.30	$ 8.30	$ 7.30		
Backfill	$ 61.17	$ 27.50	$ 45.68		
Restoration (Street)	$ 29.00	$ -	$ 23.50		
Restoration (Sidewalks, Driveways, Sod)	$ -	$ 5.00	$ -		
Maintaining Flow	$ -	$ -	$ -		
De-watering	$ 10.00	$ 10.00	$ 10.00		
Removing and replacing existing structures	$ -	$ -	$ -		
Traffic	$ 8.00	$ -	$ 8.00		
Utilities	$ 4.00	$ 4.00	$ 4.00		
Miscellaneous	$ 2.00	$ 2.00	$ 2.00		
TOTALS	$ 219.91	$ 144.10	$ 181.33		
COST PER LINEAR FOOT	**$ 220.00**	**$ 145.00**	**$ 182.00**	**$**	**199.94**
(Rounded to nearest dollar)					
Total Setment Cost	$ 1,668,040.00	$ 319,870.00	$ 313,586.00	**$**	**2,301,496.00**

No. of Non-drop Manholes	19	6	5		30	
No of Drop Manhols	0	0	0			
Avg Manhole Depth (Ft)	15.0	15.0	15.0			
Riser Cost	$131	$131	$131			
Base Cost (Base, Frame and Lid)	$1,115	$1,116	$1,116			
MANHOLE COST PER SEGMENT	$ 58,520.00	$ 18,486.00	$ 15,405.00	**$**	**58,520.00**	**$ 2,360,016.00**
			June 2003 (ENR CCI: 6694)	**$**	**2,360,046.00**	
*MH Costs are doubled if Depth is greater than :			May 2012 (ENR CCI: 9289.65)	**$**	**3,275,177.44**	

*Removing and Replacing Existing Structures
cost is based on $440/ Manhole Removed.
Assumed to be the same # to be added.

CCI Adjustment Factor: 1.3877

Upsizing Existing Infrastructure
ductile iron pipe

N
Extension 2
15"
12"
75
18"
12"
Extension 1
Legend
North Central Service Area Proposed Alternative
Existing Modeled Sewers
Existing Modeled Manholes
0
1,000
2,000
4,000
Feet