Stantec

Meadow Brook Drainage Study

June 7, 2022

Prepared for:

Town of Norwood,
Department of Public Works

Prepared by:
Stantec Consulting Services, Inc.

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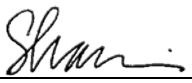
Prepared by 
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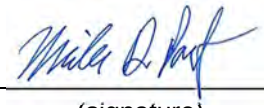
Stefani Harrison

Reviewed by 
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Michael DuPont

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Michael Carroll

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EXECUTIVE SUMMARY

The Town of Norwood (Town) has been contending with periodic stormwater flooding of varying degrees of severity in the Meadow Brook Watershed for many years. In the early 2000s the Town contracted with Fay Spofford & Thorndike (now Stantec) to develop a hydrologic/hydraulic (H&H) model to better understanding hydraulic capacities and limitations of the drainage network and to identify a set of system modifications to alleviate stormwater flooding.

Due to the intermittent nature of the flooding, Town resources have been focused on resolving more immediate and pressing issues. However, on June 28, 2020, an extreme rainfall caused significant flooding in the Town of Norwood. The Town's Department of Public Works (DPW) observed 4.5 inches of rainfall in the peak 90 minutes within the Meadow Brook watershed, a deluge well beyond the capacity of the Town's drainage system. This extreme storm event highlighted the need to further assess the Meadow Brook Watershed and implement improvements to the Town's drainage system to reduce the risk of flooding.

MODEL DEVELOPMENT AND CALIBRATION

This study involved re-building the H&H model of the Town's drain network using superior modeling tools and information that are currently available. In addition to translating the piping network, the following updates were also made:

- Ground surface mesh was created to model surface flows and surface flooding, including surveys of Meadow Brook transects, updated land use and building information, and record drawings of new developments
- Pipe networks (routing, elevations, sizes) were updated based on record drawings and field information gathered in key locations where historical data was unclear,
- Precipitation patterns (rainfall intensity) and boundary condition (river stages) were adjusted to account for future climate change impacts.
- A network of flow meters and a rain gauge were deployed for 12 weeks to capture data that was used to calibrate the H&H model.

MODEL ANALYSIS

H&H analyses were conducted to evaluate the performance of alternative stormwater management concepts to minimize flooding in key areas that Norwood DPW identified as especially vulnerable to flooding:

- Central Street at East Vernon Street
- Nahatan Street at the Railroad Underpass
- Guild Street at the Railroad Underpass
- Cross Street and Plimpton Street

- Broadway and East Hoyle Street
- Redwood Drive and Jacobsen Drive

Conveyance routing and pipe sizing were adjusted iteratively to achieve flood relief in a 10-year 2070 design storm while considering impacts to the community and capital expenditures. Stormwater detention was also incorporated to maintain present-day peak flows to Meadow Brook (which discharges to the Neponset River) in a present day 10-year design storm.

CAPITAL PLAN RECOMMENDATIONS

The following set of drain system improvements were developed to address flood risk in key locations in Meadow Brook Watershed, in design storms up to a 10-year return period. Proposed phasing starts downstream, and the upstream phases (4A, 4B, and 4C) could be implemented in the Town's order of preference as funds become available. In the face of a more extreme storm, such as the June 2020 rain event, these improvements would afford some flood relief, but flooding would still occur in the same low-lying locations where water has always ponded.

Phase	Project Concept	Summary	Planning-Level Opinion of Probable Capital Cost	
1	Hennessey	-New storage basin (9.5 MG) with new berm -Daylighted storm drain along the bottom -Outlet vault with screens and flow control -Recreational features and landscaping	$ 8,086,000	$ 9,495,000
	Meadow Brook	-Dredge and widen Meadow Brook, ~1,000 LF.	$ 1,409,000	
2	Murphy to Meadow Brook	-New parallel 5' x 7' box culvert, ~360 LF. -Daylighted Meadow Brook, ~300 LF.	$ 2,397,000	$ 2,397,000
3	Guild St	-Enlarged 78" pipe in Guild and Lenox Sts, and enlarged 84" pipe in Cross St, ~1,530 LF. -Improved drainage throughout.	$ 5,558,000	$ 5,558,000
4A	E. Vernon	-New 78" pipe in Broadway St, ~665 LF. -New 66" pipe in East Vernon St, ~120 LF.	$ 2,804,000	$ 4,635,000
	Nahatan Underpass	-Flow split vault, approx. 12' x 15' -New 78" pipe in Broadway St, ~275 LF -Improved drainage, Nahatan & Broadway Sts	$ 1,831,000	
4B	E. Hoyle	-Enlarged 78"-84" pipes in E. Hoyle St, MBTA parking lot, and Lenox St, ~1,330 LF. -New ~160 LF tunnel crossing under railroad.	$ 8,415,000	$10,406,000
	Washington St	-Enlarged 36" and 72" pipe in Washington and East Hoyle Sts, ~700 LF	$ 1,991,000	
4C	Jacobsen	-New 60" pipe in Pleasant St, ~2,000 LF. -New outfall at Neponset River.	$ 4,896,000	$ 4,896,000

1.0 BACKGROUND

The Town of Norwood (Town) has been contending with periodic stormwater flooding of varying degrees of severity in the Meadow Brook Watershed for many years. In the early 2000s the Town contracted with Fay Spofford & Thorndike (now Stantec) to conduct a study of the Meadow Brook Watershed to better define hydrologic features that generate stormwater runoff, develop a deeper understanding of conveyance system hydraulic capacities and limitations and to identify a set of system modifications to alleviate stormwater flooding. The study recommended increasing the capacity of Meadow Brook, upgrades to the stormwater piping network, and constructing stormwater storage.

Due to the intermittent nature of the flooding, Town resources have been focused on resolving more immediate and pressing issues. However, the June 28, 2020, storm event highlighted the need to further assess the Meadow Brook Watershed and implement improvements to the Town's drainage system to reduce the risk of flooding. The purpose of this report is to document the results of a supplemental study of the Meadow Brook watershed. The supplemental study involved updating and refining the 2004 analysis by taking advantage of superior modeling tools and data that are currently available to evaluate surface drainage patterns and flooding as well as account for better projections about climate change and future conditions.

For this study, a detailed hydrologic/hydraulic (H&H) model was built to reflect existing conditions and was used to project future conditions and to evaluate alternatives to mitigate flooding in the Meadow Brook watershed. Conceptual engineering is provided for the resulting recommended capital projects to manage the design storm.

1.1 2004 MEADOW BROOK DRAINAGE STUDY

In 2004, a drainage model was prepared for the Meadow Brook watershed by Fay, Spofford & Thorndike, resulting in the 2004 *Meadow Brook Drainage Study* (2004 Study). The H&H model was built using the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM) platform, which was considered state-of-the-art technology at that time. The modeling effort identified system bottlenecks that can result in flooding in large storms and analyzed conceptual improvements for flood relief. The recommendations from the report are described in Section 5.4.1.

1.2 JUNE 2020 FLOODING

On June 28, 2020, an extreme event caused significant flooding in the Town of Norwood. The Norwood Airport rain gauge registered more than 2.8 inches of rain during the peak hour of the storm, a deluge well beyond the capacity of the Town's drainage system. Moreover, the Town's Department of Public Works (DPW) observed 4.5 inches of rainfall in the peak 90 minutes within the Meadow Brook watershed. Media reports refer to widespread flooding, evacuations, and more than 75 calls related to severe weather. The Norwood Hospital was closed and evacuated when a severe basement flood caused electrical problems

and loss of power, and the hospital has remained closed through the writing of this report. Norwood DPW reported that the intense rainfall nearly overtopped the detention basin at the police/fire station that was built in the early 2000's and impacted first responders by flooding Nahatan Street. Major residential flooding was experienced in low-lying portions of Plimpton Ave and Cross Street.

The DPW indicated in a memorandum dated September 22, 2020, that "the recent June 28, 2020, storm event highlighted the need to start implementing some of the recommendations provided in the 2004 Meadowbrook Drainage Study." It should be noted that recommendations in this report, if implemented, would reduce the impact of flooding, but would not prevent all flooding in a storm of the magnitude observed in June 2020.

1.3 CHANGES IN MODELING TECHNOLOGY AND ASSUMPTIONS

In 2004, state-of-the-art modeling included generalizations about the routing and speed with which rainfall would get into the drainage network and identified manhole locations where the drainage system was full or surcharging. Since 2004, H&H modeling now allows incorporation of a ground surface to better simulate how rain is routed and conveyed both aboveground and through the drainage pipe network. Available data now includes a statewide digital elevation map (DEM) and improved information on soil types, impervious surfaces, building footprints, and other surface features that can be imported into the model to reliably simulate the movement of water over the ground surface. Model results can now easily be transferred to a geographic information system (GIS) to show the spatial extent and depth of flooding, a significant improvement in visualizing and communicating flood risk.

In addition to improved analytical tools, the academic community has made significant advancements in projecting the impacts of climate change, including changes in precipitation patterns in the Greater Boston region. Combining future storm events with appropriate river stage assumptions where Meadow Brook meets the Neponset River was an additional enhancement to the 2004 analysis.

The first step toward implementing capital drainage projects in Norwood was to leverage these improved analytical tools and data to better characterize present and future flooding and to confirm and adjust the project recommendations made in the 2004 Study. This report documents the process of building and calibrating the 2021 ICM H&H Model and presents a refined set of capital recommendations based on the updated modeling results.

2.0 MODEL DEVELOPMENT

In order to address the Town's stormwater collection system needs, a computer model was developed in the InfoWorks ICM (ICM) platform to assess performance of the system and analyze potential solutions. This model uses geospatial definition of impervious surfaces such as buildings and pavement and pervious surfaces such as lawns and parks to predict the movement and infiltration of rainwater over ground surfaces. The model also represents the sub-surface pipe network in order to predict the flow path(s) of rainwater routed through the Town into Meadow Brook. The sub-sections below describe the data used to create and the process employed the develop the model.

2.1 GEOSPATIAL REPRESENTATION OF THE WATERSHED

Data from various sources were brought together to create a geospatial representation of the watershed. Ground surface elevation and surface properties were first downloaded into a GIS and datums were either confirmed or converted. Then pipes and manholes were added into the GIS using Town data and the 2004 Study. Sections below explain each set of data in more detail.

2.1.1 Ground Surface and Land Use

MassGIS data downloaded included Digital Elevation Model (DEM), pervious coverage and buildings layer. DEM is a digital representation of the bare ground topographic surface of the Earth excluding trees, buildings, and any other surface objects. Ground surface elevations were converted from meters to feet and vary from approximately 280 feet at the highest point of the watershed in the vicinity of the High School to 40 feet in the lowest areas in the vicinity of the discharge point of Meadow Brook into the Neponset River. Pervious coverage layer shows where pervious areas such as lawns and parks are located, and buildings layer shows where building are located. This layer provides information on a 1-meter grid and was trimmed to the watershed area. Figure 1 shows a combination of all the layers mentioned in this section:

- Heat map (red high elevation to light blue low elevation – DEM/topography.
- White outline – watershed area.
- Light green shading – pervious areas.
- Light gray polygons – buildings.

The pervious layer and buildings layer were compared to make sure they generally lined up and there was no overlap, as shown in Figure 2.

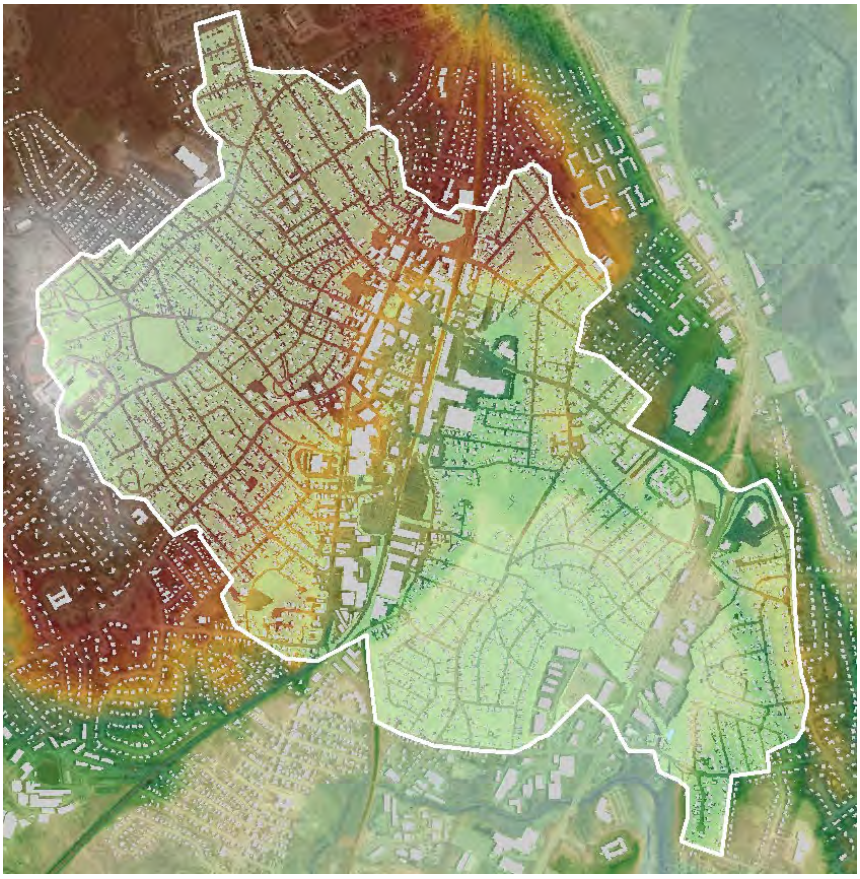


Figure 1 – Ground Surface and Land Use Layers in GIS

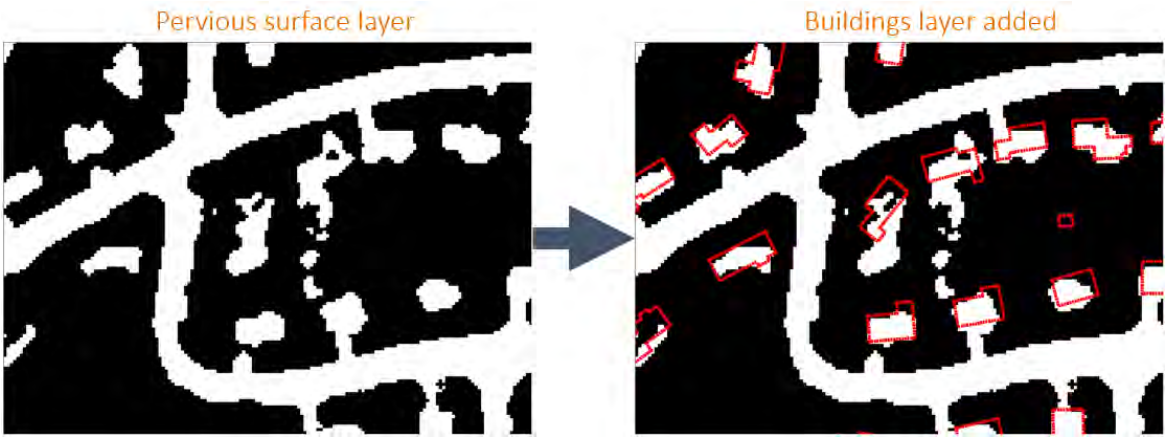


Figure 2 – Comparing Pervious Layer Against Buildings Layer

2.1.2 Pipes and Manholes

Because the Town did not already have a reliable GIS of the drain system, it needed to be created manually. Pipes, manholes, and catchment area were first drawn in GIS and pipe sizes and manhole numbers were added based on the 2004 Study. A map from the report was brought into GIS and scaled to match the areal image. Once lined up, the pipes and manholes were drawn as shown in Figure 3. Rim and inverts from appendix tables in the 2004 Study were also added to the manhole attributes table for locations where that data was available.

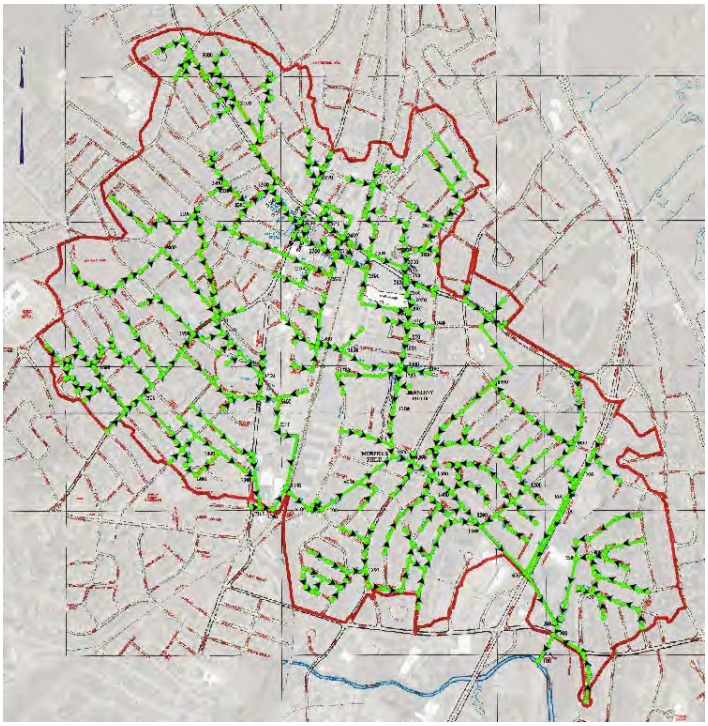


Figure 3 – 2004 Study Map Superimposed in GIS

The next step was to bring in, rotate and scale the Town of Norwood's Drain Map to confirm and adjust drainage network information including alignment and size. Figure 4 shows the Town's Drain Map, and Figure 5 shows a close-up of an area where the Town's Drain Map was superimposed on the 2004 map where pipe sizes from both figures can be compared.

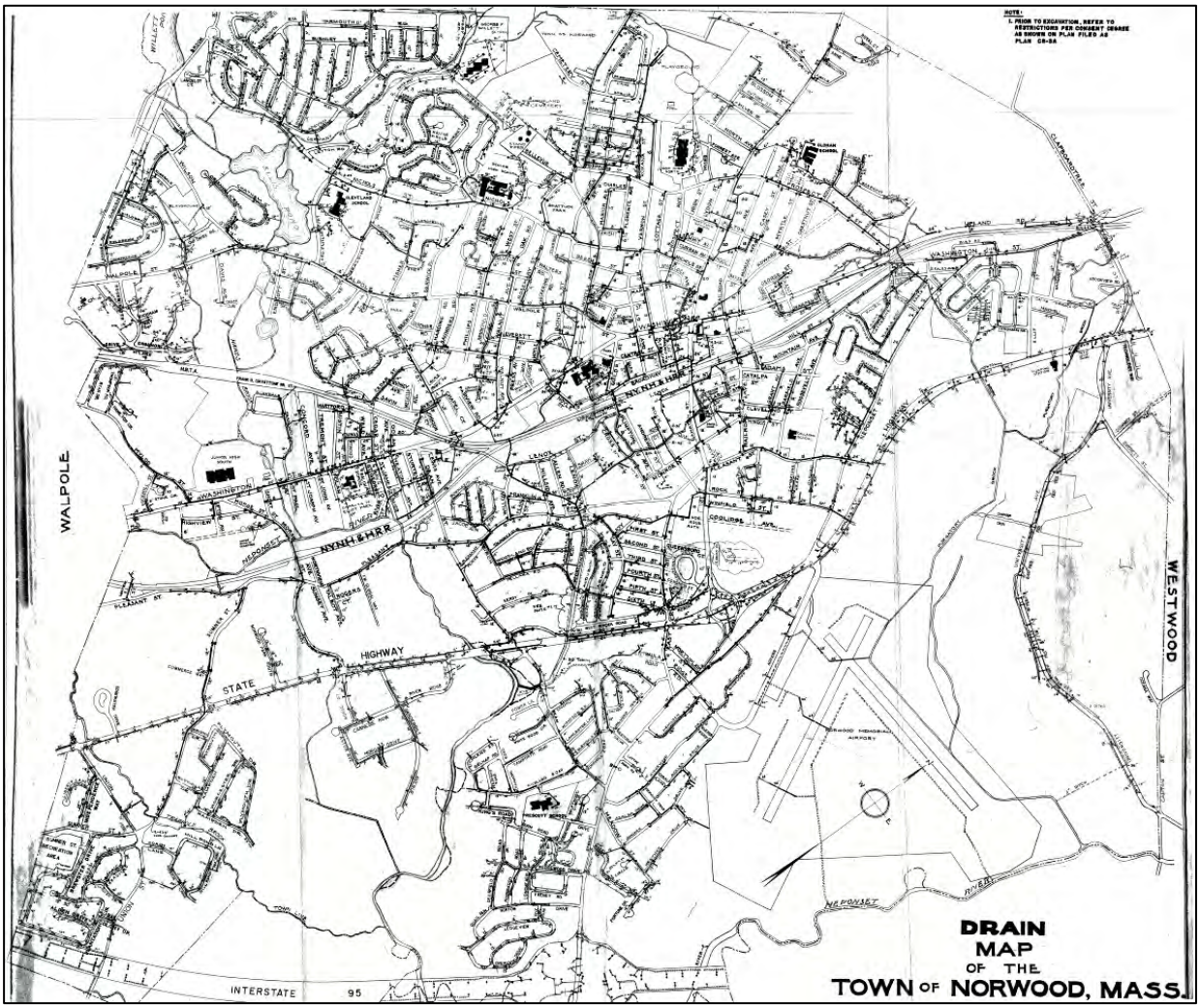


Figure 4 – Norwood Town Drain Map

Figure 5 – Town of Norwood's Drain Map Superimposed on 2004 Study Map

Missing manhole numbers were assigned a number stating at 10,000 because report manhole numbers ranged from 100 to 7,600. Manhole rims were all assigned an elevation based on the DEM, and missing inverts were assumed to be 6 feet below the rim. Each pipe segment was assigned attributes that included pipe upstream manhole ID and invert and downstream manhole ID and invert. Having this information in the GIS attributes table facilitates model import of GIS shapefiles into the modeling platform.

2.2 H&H MODEL BUILD

In order to import network data into ICM, it was important to make sure that ground surfaces, structure rim elevations and pipe inverts were represented in the same Vertical Datum (NAVD88 feet). Once Vertical Datums were converted or confirmed and the majority of the data was compiled into GIS, the data could be imported into ICM, and the model build process could begin.

2.2.1 Sub-Surface Infrastructure

Pipe and manholes were imported from GIS into ICM using the Data Import Centre in ICM and attributes table fields were mapped so that data would be properly assigned. Figure 6 shows in the stormwater collection and conveyance systems serving the Meadow Brook watershed using blue highlights to represent pipes and manholes. Yellow highlights represent open channels. The development of transects to better define the Meadow Brook geometry are described in Section 2.2.2.

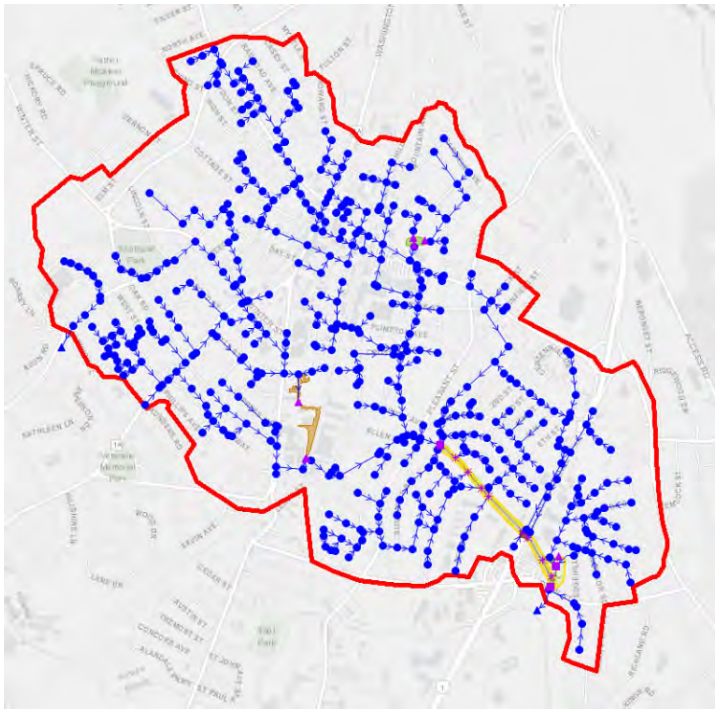


Figure 6 – ICM Model Build Snapshot

In addition to the GIS data import to ICM, the modeling team made specific requests for DPW to collect and confirm certain field measurements related to the drain network, where historical data was unclear or unexpected. Specifically, DPW provided pipe connectivity, flow direction, invert depth, estimated pipe size and shape, and/or record drawings for a number of specific locations including:

- Cottage Street
- Elkway Area
- Nahatan Street (various locations)
- Pleasant Street
- Plimpton Avenue / Cross Street
- Rock Street
- Washington Street
- Willow Street

2.2.2 Meadow Brook Transects

Because the DEM data from MassGIS cannot determine elevations below the water surface, Dawood Engineering, Inc., was retained to perform field survey of transects. Data was collected within the unimproved portion of Meadow Brook upstream of West Sixth Street, as well as the stretch that was improved in the 1990's by the U.S. Army Corps of Engineers (USACE), both in the dredged and concrete areas. In the surveying work, GPS observations were performed using a Trimble R10 Integrated GNSS receiver on four independent survey baselines, with a horizontal accuracy +/- 1 centimeter and a vertical accuracy of +/- 2 centimeters. Coordinates were recorded in the Massachusetts Coordinate System, Mainland Zone, and are referenced to the North American Datum of 1983 (NAD83, 2011), Epoch 2100.00, based on the KeyNetGPS Virtual Reference System. Elevations were referenced to the North American Vertical Datum of 1988 (NAVD88) vertical datum, based on the KeyNetGPS Virtual Reference System.

A total of nine transects were imported into the H&H model to create a river reach. A sample transect is shown in Figure 7. Four additional transects were generated by combining DEM at the river banks with record drawings from the USACE improvement work. Finally, bridge culverts were built in the H&H model where Meadow Brook crosses under Route 1 (based on the USACE Meadow Brook Restoration drawings) and Dean Street (based on the Norwood Light Department Master Substation drawings, in which the culvert was re-built).

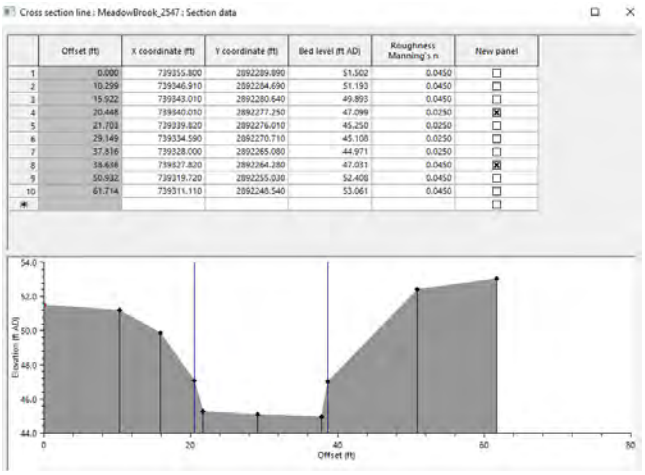


Figure 7 – Sample Meadow Brook Cross Section from ICM

2.2.3 Creation of a Surface Mesh

To create the surface mesh, several shapefiles were imported into ICM, including the DEM, the pervious coverage, and the buildings. The building shapefile was then raised 10 feet above “bare earth” DEM in order for to route water around the buildings. Initial assignments were made for roughness coefficients and infiltration assumptions, based on pervious coverage and soil types, that would later be adjusted during calibration.

Once this was complete the ground surface was meshed, and the sub-surface pipe network was connected to the 2D mesh as shown in Figure 8.

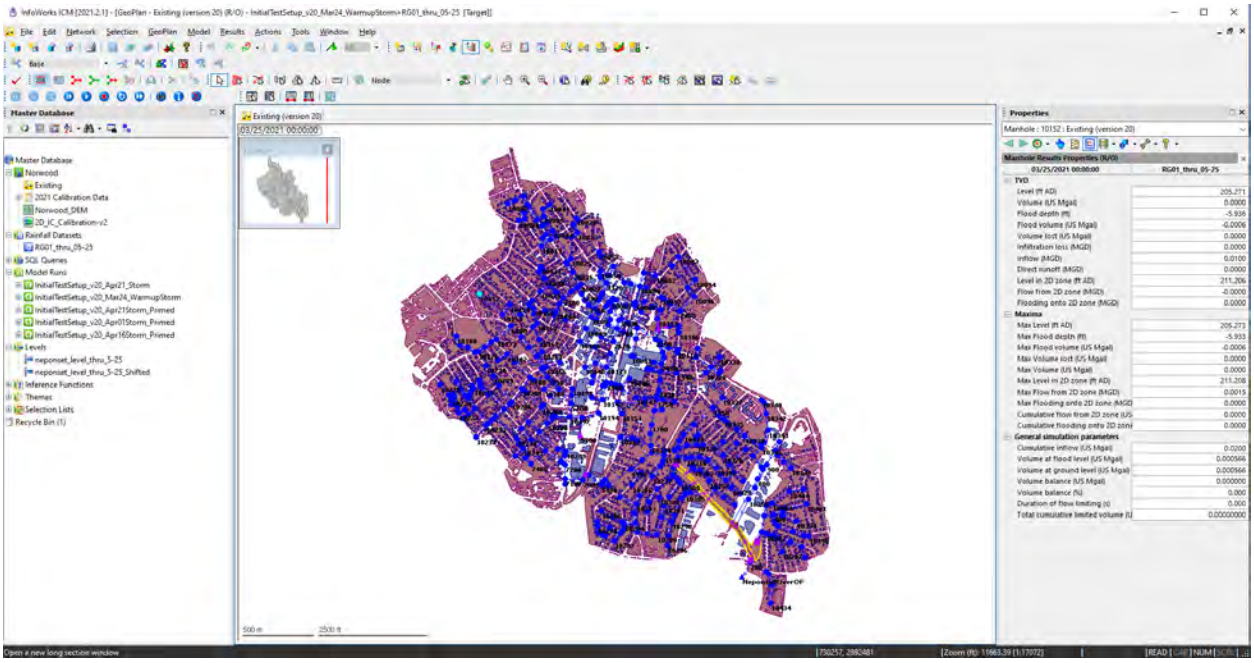


Figure 8 – Sub-Surface Pipe Network and 2D Mesh in ICM

2.2.4 Other Hydraulic Features

Other DPW records were used to establish a better representation of hydraulic features in the H&H model.

- Record drawings for the Norwood Light Department's Master Substation, which included the construction of the existing Neponset River outfall, were used to improve the representation of the outfall in the model.
- Police and Fire station record drawings were used to represent upgrades made to the drainage system during the construction of the new Police/Fire station.
- The Norwood Hospital has a small bowl-shaped parking area at the basement level that naturally pools rainwater; the hospital has dedicated catch basins and pair of pumps that conveys water to the Town's drain system on East Hoyle. Photos of the hospital pump tags were used to determine the pump capacity to include in the model.
- The Elkway Extension plan from 2002 was used to add the Town's drain system "leaching chambers" to the H&H model.

3.0 RAINFALL AND RIVER STAGE MODELING ASSUMPTIONS

Six (6) design storms representing existing and future conditions were used to analyze the calibrated and verified H&H model. This section describes the creation of present day and future (2070) 2-year, 5-year, and 10-year, 24-hour, SCS Type III design storms, as well as the assumptions made for river stage.

3.1 RAINFALL ASSUMPTIONS FOR DESIGN STORM

Two different sets of data were considered for developing the synthetic design storms. Both NOAA Atlas-14 and Cornell's Northeast Regional Climate Center (NRCC) rain data were reviewed. The project team, in coordination with the Town, decided to use NRCC rainfall data set since it is regionally specific and consistent with the Town of Norwood's Conservation Commission. NRCC data is also used by other municipalities in the Greater Boston Region. Storm characteristics for the present-day storms selected can be seen in Figure 9 and Table 1.

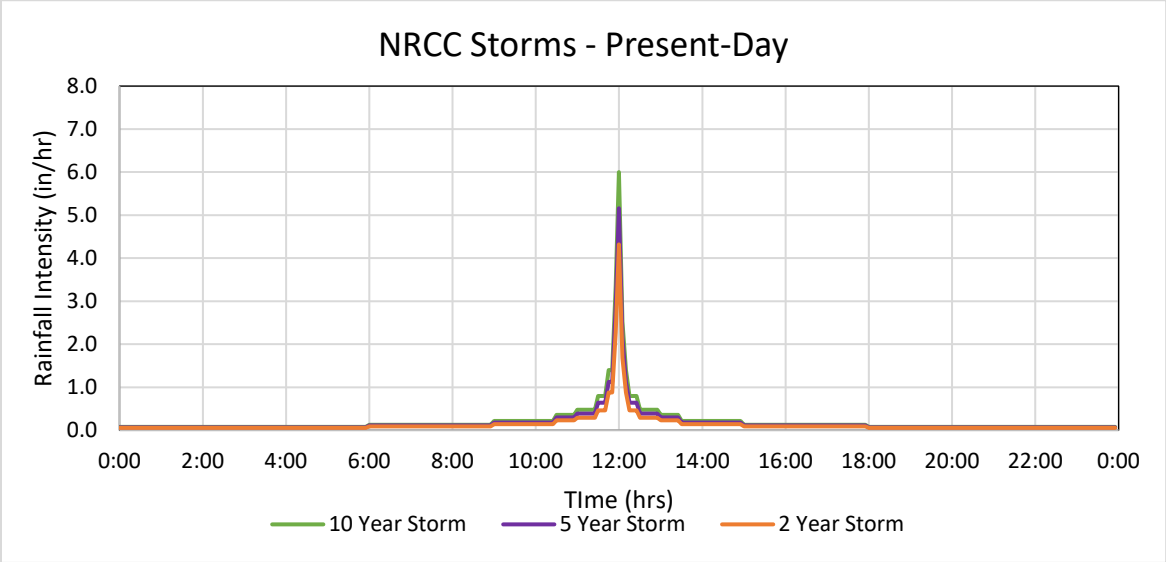


Figure 9 – Present-Day (as published in 2021) NRCC Storms

Table 1 – Present-Day (as published in 2021) NRCC Storm Characteristics

Storm Frequency	Total Rainfall (in)	Peak Hour Intensity (in/hr)	Peak 5-min Intensity (in/hr)
2-Year	3.27	1.14	4.32
5-Year	4.13	1.45	5.16
10-Year	4.94	1.74	6.00

For the projection of the future (2070) storms, three (3) reports were reviewed. The *MassDOT-FHWA Pilot Project Report: Climate Change and Extreme Weather Vulnerability Assessments and Adaptation Options for the Central Artery* projected a 10-year, 24-hour storm to be approximately 30% larger in 2070. The City of Cambridge's *Climate Change Vulnerability Assessment* mentions a projected increase in precipitation on the order of +10% to +30%. Lastly, the *Climate Change and Sea Level Rise Projections for Boston*, by the Boston Research Advisory Group, which was used as the basis for *Climate Ready Boston*, shows approximately a 30% increase for the year 2070. Based on the information from all the reports analyzed, the project team decided to use a 25% increase from the existing return frequency estimates to develop the 2070 synthetic design storms. Storm characteristics for the 2070 storms selected can be seen in Figure 10 and Table 2.

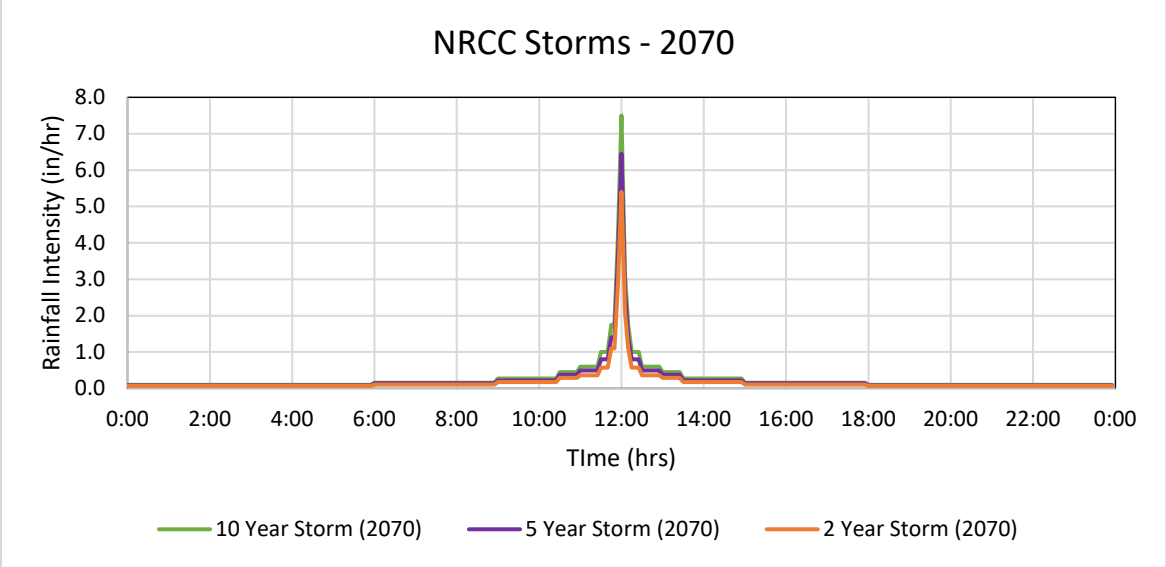


Figure 10 – 2070 NRCC Storms

Table 2 – 2070 NRCC Storm Characteristics

Storm Frequency	Total Rainfall (in)	Peak Hour Intensity (in/hr)	Peak 5-min Intensity (in/hr)
2-Year (2070)	4.09	1.43	5.40
5-Year (2070)	5.16	1.81	6.48
10-Year (2070)	6.18	2.18	7.56

When existing storms are projected to 2070 by increasing the total rainfall and intensities by 25%, the future storms tend to generally correspond to an existing storm with a higher return period. For example, when the 2-year storm is projected to 2070, the total rainfall is similar to an existing 5-year storm. And likewise, when an existing 5-year storm is projected to 2070, it is similar to an existing 10-year storm. In other words, a 10-year storm today will be equivalent to a 5-year storm in 2070. It should be noted that future storms can have higher peak intensities, even with similar total rainfall.

3.2 NEPONSET RIVER STAGE ASSUMPTIONS FOR MODEL BOUNDARY CONDITIONS

The Federal Emergency Management Agency (FEMA) *Flood Insurance Study* revised in 2020 was evaluated to determine what river stage should be used for to establish the boundary conditions at the Meadow Brook drainage system's discharge to the Neponset River. This analysis was performed in the vertical datum NAVD88, matching the Norwood GIS and H&H model. There were two locations for identifying boundary conditions along the Neponset River: the confluence of Meadow Brook, and the intersection of Pleasant Street at the location of an existing storm drain outfall.

Neponset River at Meadow Brook. As can be seen in the FEMA flood profile in Figure 11, the 10-year water surface elevation at Meadow Brook, highlighted in blue, reaches an elevation of approximately 46 feet, and the 100-year elevation, highlighted in green, reaches an elevation of approximately 48 feet. The significant change in storm recurrence (10-year to 100-year) does not appear to result in a significant change in river stage (2 feet). Although a 10-year rainfall event in Norwood will not always coincide with a 10-year river stage in the Neponset River (due to the spatial variability of rainfall and the time of concentration through the watershed), the project team made the reasonable assumption to use the 10-year water surface elevation (46 feet) in the Neponset River for all six (6) design storms.

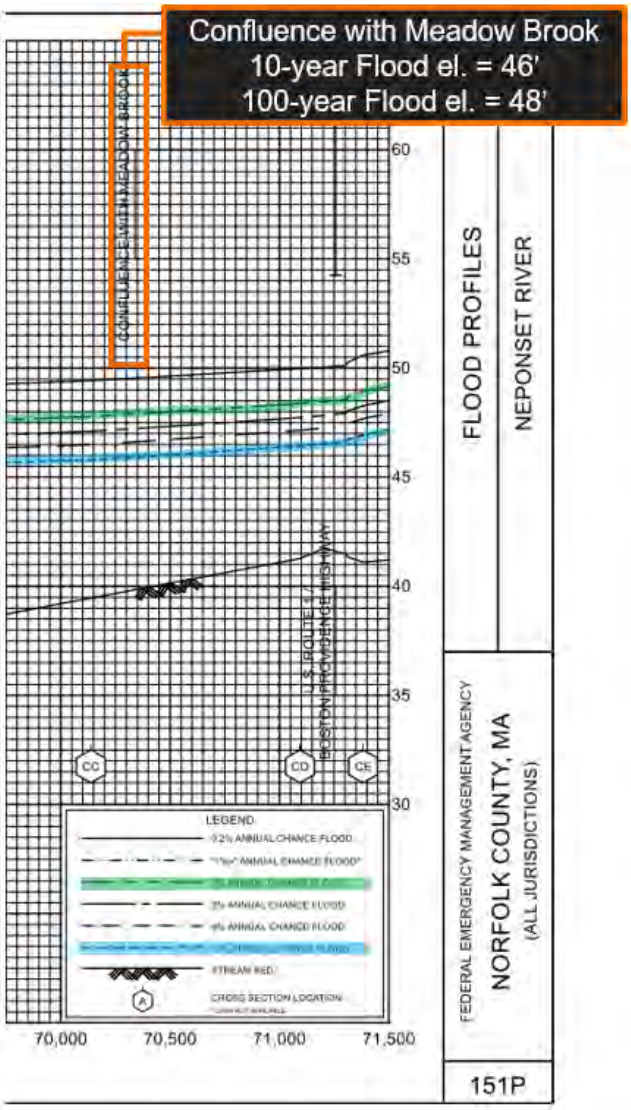


Figure 11 – FEMA Flood Insurance Study Flood Profiles, Neponset River at Meadow Brook

Neponset River at Pleasant Street Outfall. As can be seen in Figure 12, the 10-year water surface elevation at the Pleasant Street Outfall, highlighted in blue, reaches an elevation of approximately 51 feet, and the 100-year flood elevation, highlighted in green, reaches an elevation of approximately 53 feet. For the same reason mentioned above in the description for the boundary condition for Meadow Brook, the project team made a somewhat conservative decision to use the 10-year flood elevation (51 feet) in the Neponset River for all six (6) design storms.

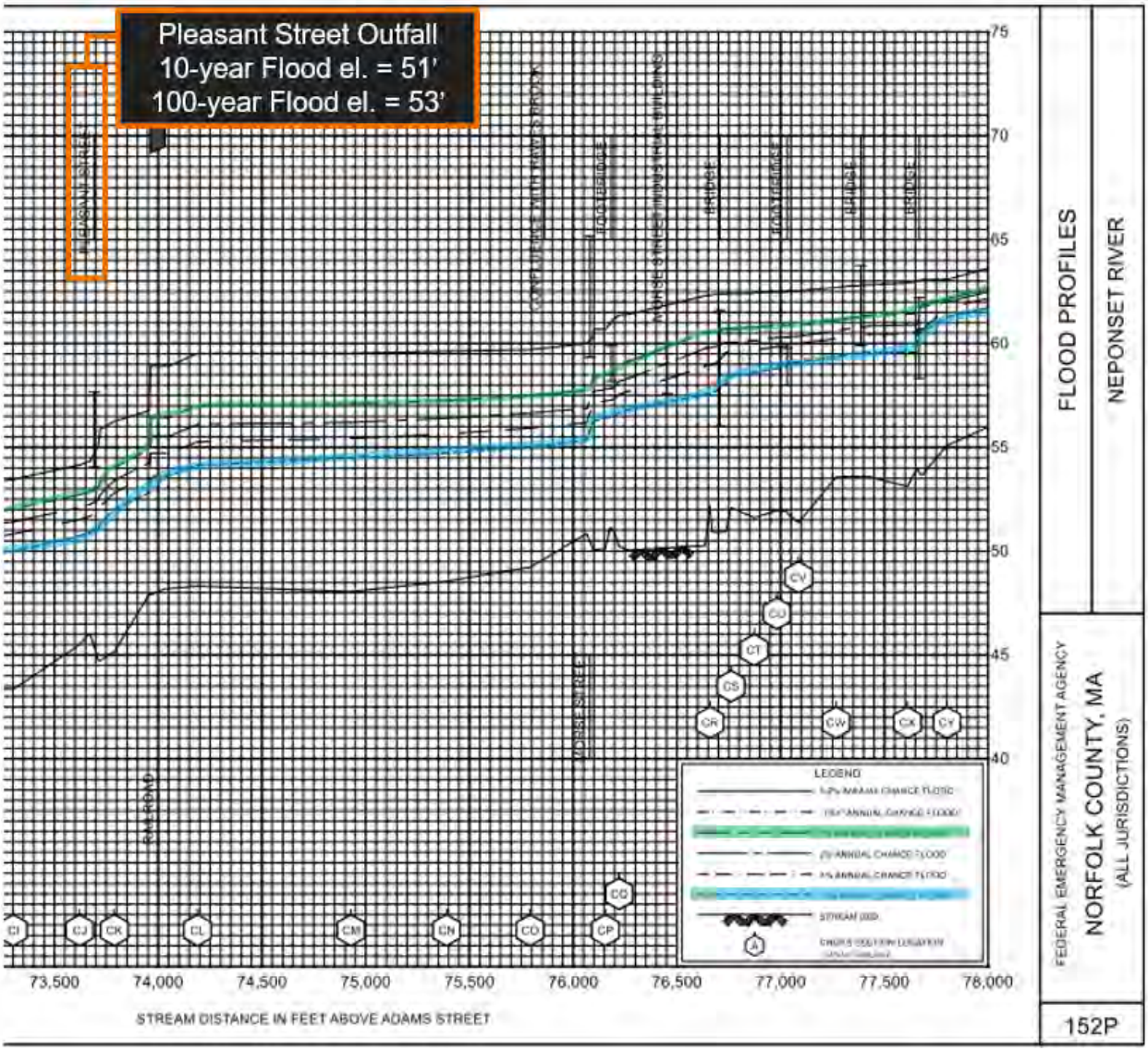


Figure 12 – FEMA Flood Insurance Study Flood Profiles, Neponset River at Pleasant Street

4.0 MODEL CALIBRATION

4.1 FLOW METERING PROGRAM

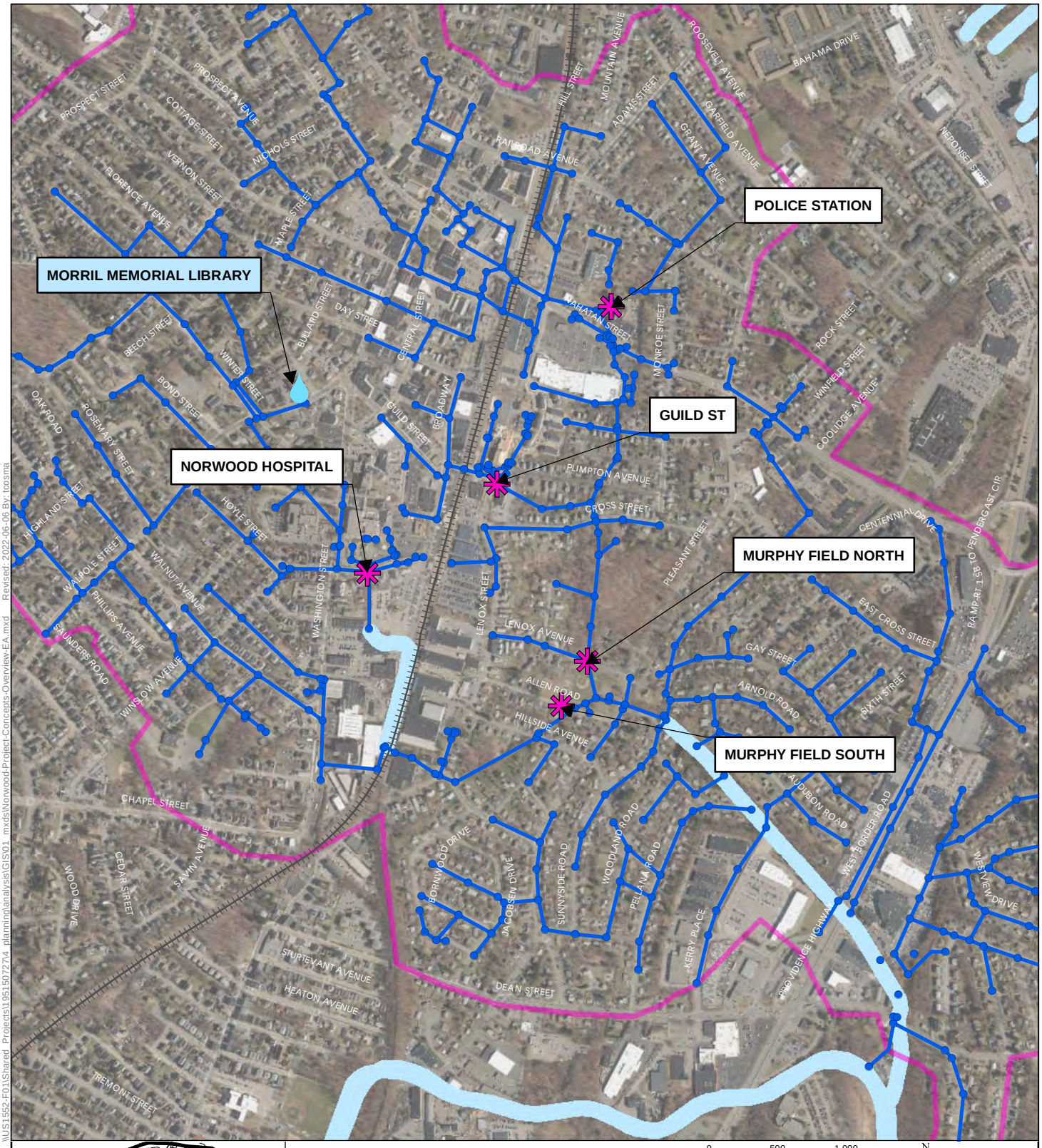
A flow metering program was established to collect detailed data on actual flows in the drain network. Areas of simulated flooding in the 2004 Study were identified, and sensor locations were selected to collect data from each of the major branches (by measurement or calculation), at major bottlenecks, and in locations where level fluctuations lead to flooding. The locations of sensors were finalized in a workshop on March 4, 2021:

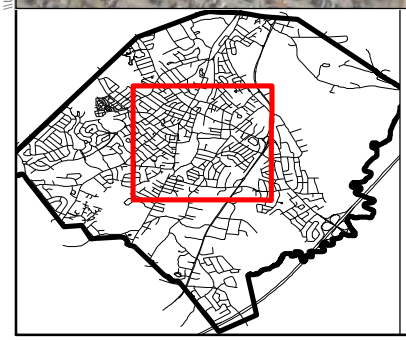
- Police Station, downstream of the detention basin
- Guild Street Underpass
- East Hoyle Street (Norwood Hospital)
- Murphy Field North
- Murphy Field South

The sensor at the Police Station measured both level and velocity in order to confirm the direction of flow. The other sensors measured only level.

A rain gauge was installed at the Morril Memorial Library to provide rainfall totals and intensity during the monitoring period.

Figure 13 shows the location of the flow sensors and rain gauge. Appendix A contains the flow metering report, including installation logs. Flow meters were installed from March 17 to June 17, 2021.





Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Open Waterway
- Watershed Area
- RailRoad
- Rain Gauge
- Meter

0 500 1,000 Feet

1 inch = 1,000 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
13

Title
2021 Flow Sensors and Rain Gauge Installation Locations

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4.2 RAINFALL DATA SUMMARY

Rainfall data was collected from a rain gauge installed on the roof of the Morrill Memorial Library at 33 Walpole Street in Norwood. The library is generally central to the watershed and has a flat roof with minimal interference from nearby structures.

Rainfall was recorded for the same period that flow meters were installed. Table 3 shows the twenty-seven (27) rain events recorded throughout the recording period, with the storms selected for calibration indicated in bold.

Table 3 – Summary of Rainfall Events Recorded in 2021 Monitoring Program

Event #	Event Start	Event End	Event Total (in)	Peak Hour Intensity (in/hr)
1	3/18/2021 15:25	3/19/2021 2:05	0.76	0.13
2	3/25/2021 1:15	3/25/2021 10:55	0.11	0.08
3	**3/28/2021 13:00**	**3/29/2021 0:50**	**0.84**	**0.31**
4	3/31/2021 22:35	4/1/2021 10:10	0.93	0.18
5	4/12/2021 7:35	4/12/2021 7:40	0.01	0.01
6	4/12/2021 15:35	4/12/2021 15:40	0.01	0.01
7	4/15/2021 17:55	4/17/2021 12:05	1.82	0.21
8	4/21/2021 14:35	4/21/2021 18:35	0.49	0.32
9	4/22/2021 15:40	4/22/2021 15:45	0.01	0.01
10	4/25/2021 8:40	4/25/2021 12:25	0.22	0.12
11	4/28/2021 2:55	4/28/2021 4:40	0.19	0.13
12	4/28/2021 22:05	4/28/2021 22:10	0.01	0.01
13	4/29/2021 11:25	4/30/2021 2:50	0.43	0.09
14	4/30/2021 23:35	5/1/2021 2:30	0.13	0.07
15	**5/4/2021 0:15**	**5/4/2021 11:30**	**0.80**	**0.16**
16	**5/5/2021 2:00**	**5/5/2021 8:30**	**0.22**	**0.15**
17	**5/5/2021 14:55**	**5/6/2021 5:00**	**0.21**	**0.09**
18	5/10/2021 1:25	5/10/2021 6:05	0.42	0.15
19	5/16/2021 20:35	5/16/2021 20:40	0.01	0.01
20	5/22/2021 0:20	5/22/2021 0:25	0.01	0.01
21	5/26/2021 21:15	5/27/2021 5:45	0.21	0.14
22	**5/28/2021 19:35**	**5/29/2021 16:40**	**2.17**	**0.29**
23	5/30/2021 2:45	5/31/2021 8:05	0.71	0.09
24	6/4/2021 16:05	6/4/2021 17:20	0.05	0.04
25	6/8/2021 16:45	6/8/2021 19:00	0.04	0.03
26	6/11/2021 23:05	6/12/2021 1:05	0.17	0.14
27	6/14/2021 9:35	6/14/2021 15:05	0.47	0.15

4.3 SELECTED STORM FOR CALIBRATION

The H&H model was calibrated using three (3) storms that occurred during the metering period. Note that the May 4-5 storm is a consolidation of 3 lines in Table 3. These storms are summarized in more detail in Table 4.

Table 4 – Summary of Recorded Rainfall Events Selected for Model Calibration

Event #	Event Start	Event End	Event Total (in)	Peak Hour Intensity (in/hr)	Peak 5-min Intensity (in/hr)	Event Duration (hr)	Preceding 24hr Rainfall (in)
3	3/28/21 13:00	3/29/2021 0:50	0.84	0.31	0.84	11.83	0.00
11-13	5/4/21 0:15	5/6/2021 5:00	1.23	0.16	0.48	31.5	0.00
16	5/28/21 19:35	5/29/2021 16:40	2.17	0.29	0.36	21.08	0.00

These storms were selected taking into consideration different factors such as rainfall depth, intensity, and duration:

- The March 28-29 storm was fast and spatially variable, with a total depth of 0.84 inches and a dation of nearly 12 hours.
- The May 4-5 storm had more spread-out rainfall, with some periods of rain on already saturated ground, these events were recorded as three back-to-back events with 0.80, 0.22, and 0.21 inches of rain with durations of 11, 6.5, and 14 hours, respectively
- The May 28-29 storm had periods of prolonged heavy rainfall, with a total depth of 2.17 inches and a duration of nearly 21 hours.

4.4 STREAM GAUGE DATA / TAILWATER CONDITIONS

Although a static river stage was used as a model boundary condition for simulating design storms, the calibration process integrated actual river stage data that was collected for the same record of data as the flow meters and rain gauge. The data was downloaded from *the National Water Information System USGS Water Data for USA* website (nwis.waterdata.usgs.gov). As can be seen in Figure 14, the location

of the Neponset River gauge in Norwood is between Pleasant Street and the railroad tracks which is approximately 3,500 feet upstream of the Meadow Brook confluence with the Neponset River.

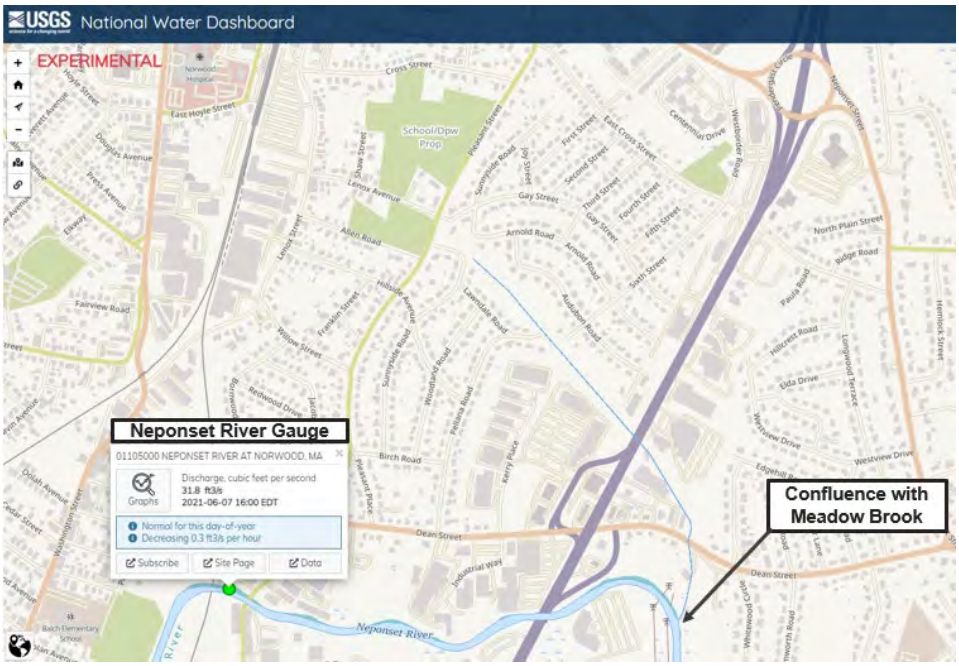


Figure 14 – USGS Neponset River Gauge Location

The FEMA Food Insurance Study profiles were used to convert the USGS gauge data to the corresponding river stage at the confluence of Meadow Brook. Figure 15 shows a FEMA profile of the Neponset River containing the Pleasant Street and Railroad crossings. Using this profile, Stantec estimated the 10-year flood elevation at the river gauge is approximately 53 feet, and the 10-year flood elevation at the confluence of Meadow Brook is approximately 46 feet. The difference between these two locations (7 feet) was subtracted from the USGS gauge data in order to better represent boundary conditions at the confluence of Meadow Brook and the Neponset River. This allowed calibration to be performed using actual river stage data collected during the metering period.

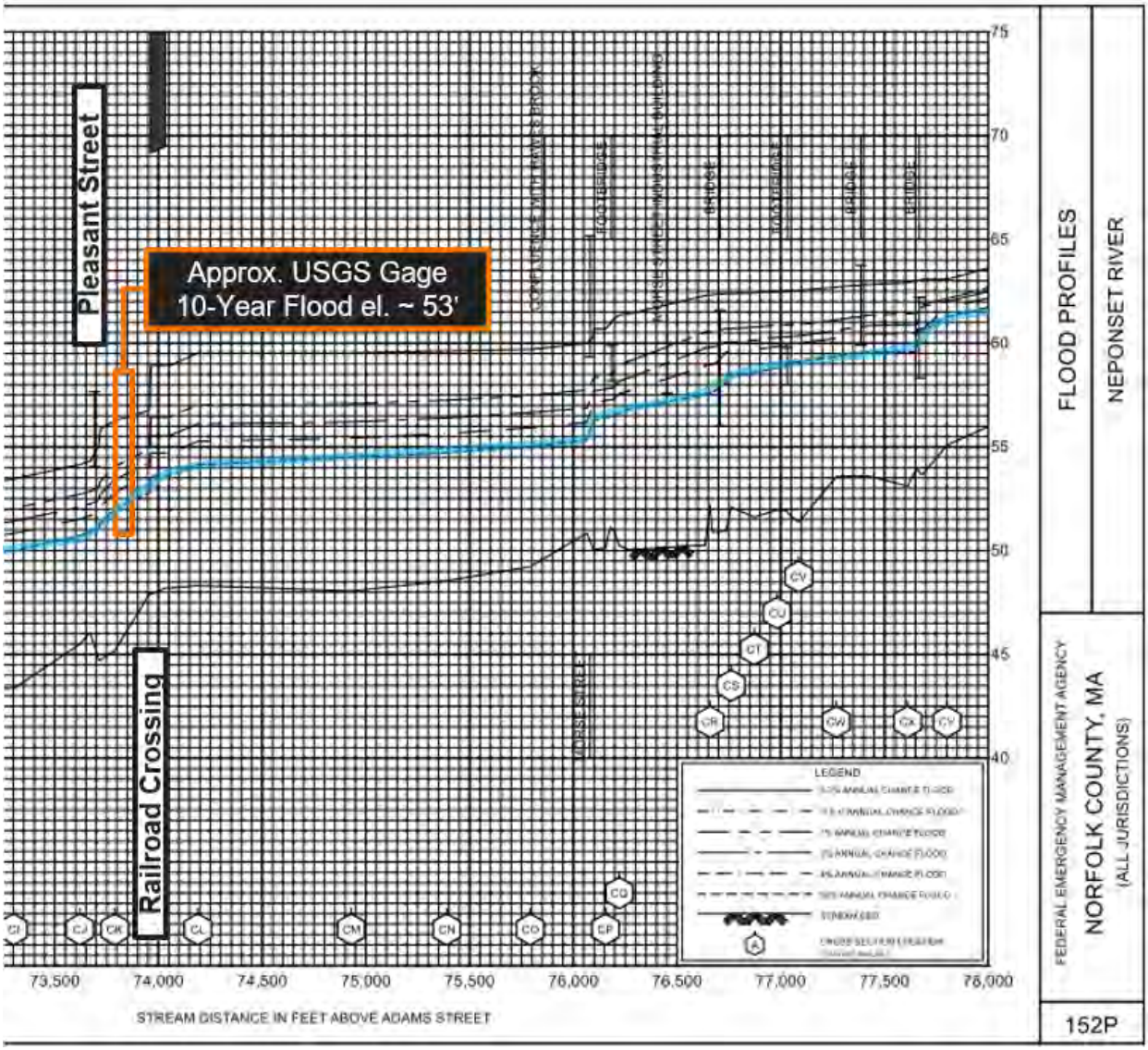


Figure 15 – FEMA Flood Profile of the Approximate USGS Gauge Location

4.5 MODEL CALIBRATION PROCESS AND REMARKS

The calibration process involved using actual data to compare against simulated modeled data. Using the rainfall data described in Section 4.2 and 4.3 and the river stage data described in Section 4.4, a simulation was performed by applying the observed rainfall over the entire Meadow Brook watershed to assess the initial accuracy of the model. The model simulated the movement of rain flows overland and through the storm drain network, and simulated flows were compared against flow meter data described

in Section 4.1. Based on these initial findings, several model components were modified to better match observed conditions:

- Missing infrastructure: In some areas of the simulated network, flooding was projected but the drain network was not full. In these cases, observations in online mapping tools were used to identify the existence of critical surface inlets that were not included in the drain map. These were added into the model.

- Hospital basement area – surface mesh modification: Initial model runs showed surface flows from Washington Street sheeting across the Norwood Hospital's southern parking lots and into the hospital's basement access area, which is shaped like a depressed bowl. Many feet of water were building up in this location, even in the smallest design storm (2-year return period) despite the inclusion of the hospital's pumps in the H&H model. While flooding in this location was a significant issue in the June 2020 storm, the Town confirmed that flooding in this location does not normally occur even in sizeable storms. The project team felt the DEM was not accurately reflecting the detailed surface conditions, and that sheet flows during actual storms would be somewhat impeded by curbs. It is also anticipated that Norwood Hospital will eventually make improvements on its parcel to redirect water away from the basement access area. As such, a wall was built into the surface mesh to redirect overland flows away from the basement access area, and the modeling for this project thus requires local drainage to route these flows from the street into the pipe network.

- Surface roughness: Although street pavement can, in some cases, have a manning's roughness coefficient as low as 0.013, modeled time to peak matches more closely with observed data when this value is assumed to be 0.016. Using a variety of storms, roughness coefficients for pervious areas were similarly calibrated and adjusted in conjunction with the impervious surfaces to match the timing of the runoff observed at the temporary flow meters.

- Infiltration parameters: Based on regional NRCS soil condition maps, the Town was initially assumed to have mostly sandy soils that are capable of infiltrating rainfall at a comparably higher rate than clay soils. However, initial calibration runs indicated that too much water was infiltrating. Adjusting the model input parameters for pervious land uses to represent a clay/sand mixture soil yielded a closer correlation with observed data. Maximum and minimum infiltration rates were then fine-tuned upstream of each flow meter to match observed flow rates within 25% of the observed peak flow rate.

4.6 PEAK FLOWS AND VOLUME COMPARISON TABLES

The model results for depth were compared to the actual data from metered locations. For the Police Station sensor, velocity was also compared. The goal of the calibration plots was to try to best match the metered data and simulated results so that the general shape of the time series matched, while also trying to get agreement on peak levels (+/- 25%).

Figure 16 shows an example of a calibration plot for the flow meter at East Hoyle Street, for the May 28-29 storm event. The blue line indicates the model's simulation of pipe flow over the storm event and the red line shows the actual flow depth as measured by the flow meter. This graphic was evaluated throughout the calibration process, and parameters were adjusted and the model re-run in order to make the calibration plots better match up. The calibration plot shown below is for the fully calibrated model and demonstrates the good agreement between the model simulation and the actual storm drain network performance.

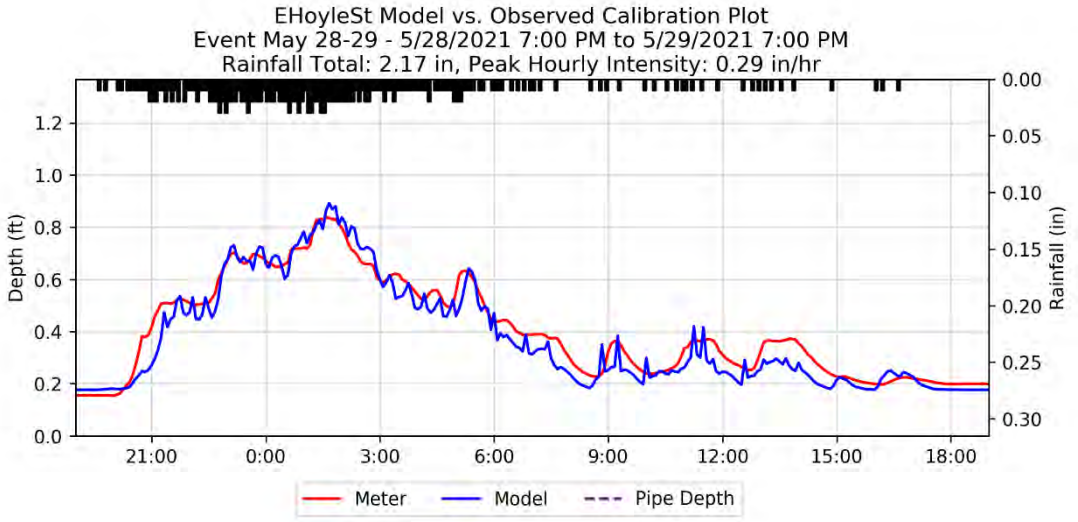


Figure 16 – Sample Calibration Plot for East Hoyle Street, May 28-29 Storm

The full set of calibration plots are included in Appendix B. In the end, the calibration plots show that the model has been adequately calibrated Town-wide to match actual flows in a variety of storms.

5.0 MODEL ANALYSIS

This section provides a summary of the hydrologic and hydraulic modeling objectives, approach, and results. Full model results are provided in Appendix C.

5.1 MODELING OBJECTIVE

The objective in identifying, analyzing, and refining infrastructure concepts for flood management was to minimize flooding in key areas that Norwood DPW identified as especially vulnerable to flooding, as evidenced by repeat flooding calls and known property damage. These key locations are:

- Central Street at East Vernon Street
- Nahatan Street at the Railroad Underpass
- Guild Street at the Railroad Underpass
- Cross Street and Plimpton Street
- Broadway and East Hoyle Street
- Redwood Drive and Jacobsen Drive

In the 2004 Study, it was noted that model-predicted flooding in other upstream areas of the watershed were identified as non-critical, with a recommendation that the areas be monitored for flooding. Since then, reports of flooding and the Town's concerns have remained focused on the above-listed neighborhoods and have not extended to the areas of the watershed farther upstream.

5.2 MODELING APPROACH

Conducting H&H modeling to evaluate the performance of alternative stormwater management concepts was an iterative process that focused on the key locations identified in Section 5.1. When developing alternative piping layouts, consideration was given to minimizing reliance on or modifications to existing pipes below private properties and existing structures and minimizing community disruption during construction.

Once stormwater conveyance routing was conceptualized for a given location, pipe sizes in the model were purposely made excessively large to maximize stormwater that could be moved out of that location during the largest design storm (10-year 2070 design storm). Note that in the case of two locations (Nahatan Street underpass and Jacobsen Drive), two different drainage conveyance routes were evaluated. Once peak flow rates for each location were understood, Manning's Equation was used to estimate the approximate pipe sizes and slopes needed to convey the flow without surcharging the system. The resulting pipe sizes and slopes were then used for inclusion in the proposed system modeling.

Stormwater detention was also incorporated to retain enough volume that peak flows to Meadow Brook (which discharges to the Neponset River) would not increase in a present day 10-year design storm.

Modeling results are summarized in this section for three different conditions:

- Existing System Model: reflects the existing drain system.
- 2004 Recommendations Model: reflects the existing system model, modified to reflect the recommendations from the 2004 Study.
- Proposed System Model: reflects the existing system model, modified to reflect the representative set of improvements to manage flooding throughout thew watershed.

5.3 EXISTING SYSTEM MODELING RESULTS

The six design storms were simulated using the calibrated H&H model with the existing pipe network represented, referred to as existing system model runs. The purpose of this modeling exercise was to establish the extent and depth of predicted flooding for a variety of storms and to establish a baseline against which predicted flooding for each of the conceptual flood control concepts could be compared.

5.3.1 Total Flooded Area: Existing System Model

The model output characterizes flooding at a range of discrete depths, ranging from three inches to three feet. Flooding at 3-inch depth is highly sensitive to slight variations in the surface mesh, and furthermore would be contained by a standard curb or could be driven through in a vehicle. While 3-inch deep flooding is shown on the flood maps, this “nuisance flooding” was not accounted for in totalizing flooded areas. To characterize flooded areas, two thresholds were selected: flooding 6 inches or deeper (“all flooding”), and all flooding 18 inches or deeper (“deep flooding”). Deep flooding is a subset of all flooding, and that area is represented in both areas. The delineation of each location, from which flooded area is calculated, is shown in Figure C-19 in Appendix C.

Table 5 provides a summary of flooded area in key locations predicted by the existing system model for each design storm. The table summarizes all flooding (6” depth and greater) and deep flooding (18” and greater). The area subject to flooding increases with design storm size. As expected, based on design storm characteristics, the 2-year 2070 storm and 5-year present day storm have similar results. Likewise, the 5-year 2070 storm and 10-year present day storm have similar results.

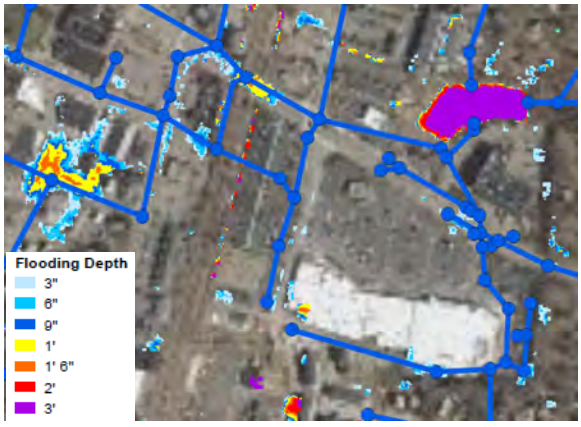
Table 5 – Flooded Area in Design Storms, Existing System Model

Location	Simulated Flooded Area (ac) ≥ 6" Depth, Existing System					
	2-Yr Present Day	2-Yr 2070	5-Yr Present Day	5-Yr 2070	10-Yr Present Day	10-Yr 2070
Central St at East Vernon St	0.83	1.07	1.07	1.30	1.24	1.46
Nahatan St Underpass	0.19	0.47	0.47	0.68	0.64	0.87
Guild St Underpass	0.05	0.12	0.11	0.24	0.20	0.29
Cross St	0.37	0.71	0.71	0.91	0.80	1.06
Murphy Field	1.80	2.06	2.07	2.20	2.17	2.41
East Hoyle St at Broadway	0.40	0.68	0.68	0.83	0.78	1.08
Jacobsen Dr at Redwood Dr	1.28	2.49	2.54	3.18	3.08	3.31
Location	**Simulated Flooded Area (ac) ≥ 18" Depth, Existing System**					
	2-Yr Present Day	2-Yr 2070	5-Yr Present Day	5-Yr 2070	10-Yr Present Day	10-Yr 2070
Central St at East Vernon St	0.09	0.23	0.23	0.36	0.33	0.51
Nahatan St Underpass	0.01	0.33	0.33	0.41	0.40	0.45
Guild St Underpass	0.00	0.01	0.01	0.06	0.03	0.09
Cross St	0.12	0.22	0.22	0.27	0.26	0.40
Murphy Field	0.37	0.71	0.72	0.89	0.86	1.14
East Hoyle St at Broadway	0.00	0.00	0.00	0.00	0.00	0.08
Jacobsen Dr at Redwood Dr	0.11	0.36	0.38	0.69	0.66	0.83

5.3.2 Flood Extents and Depths: Existing System Model

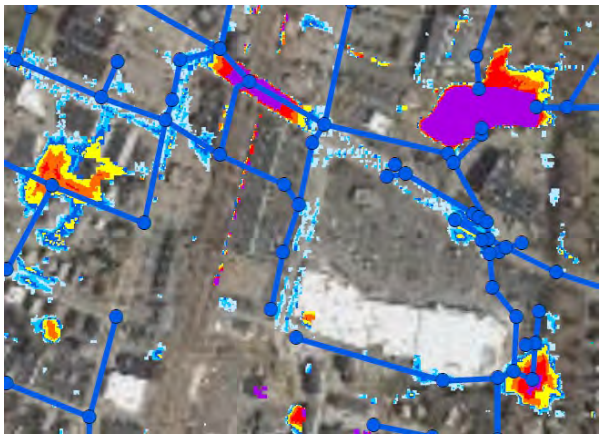
Figures C-1 through C-6 in Appendix C show the extent of model-predicted flooding produced by the existing system model runs, for the six design storms. In order to verify the modeling was accurate in extreme events, the rain record at Norwood Airport was reviewed to identify the dates of large historic storm events. Norwood DPW pulled records for flood-related calls on those dates of heavy rain. These calls were compared with model-simulated flooding in a 10-year storm and were determined to be in similar areas of the watershed as the model-predicted flooding in an extreme event.

Close-up comparisons for several of the key locations are shown in Figure 17 through **Figure** 19 below, illustrating the progressive magnitude of flooding in the 2-, 5-, and 10-year present day design storms and the 10-year 2070 design storm.

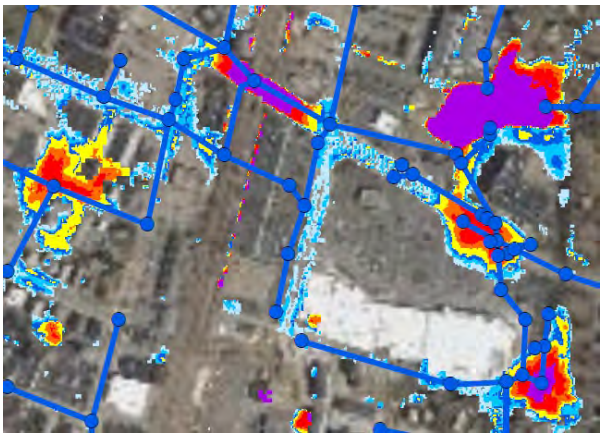


2-Year Present Day Design Storm

5-Year Present Day Design Storm

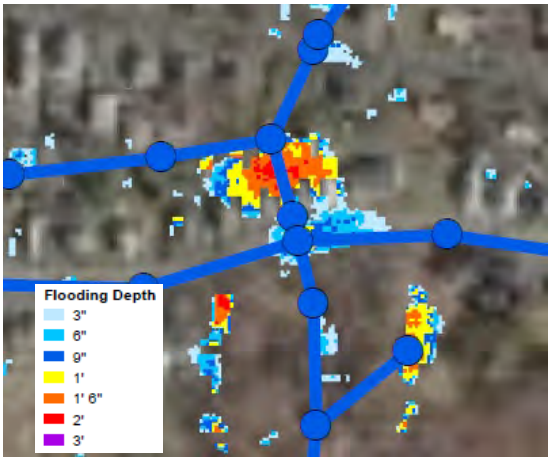


10-Year Present Day Design Storm

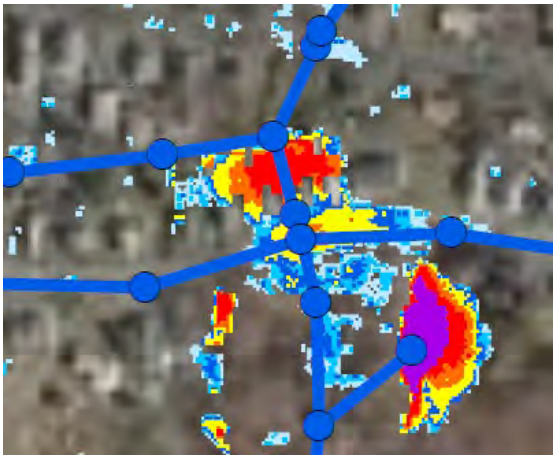


10-Year 2070 Design Storm

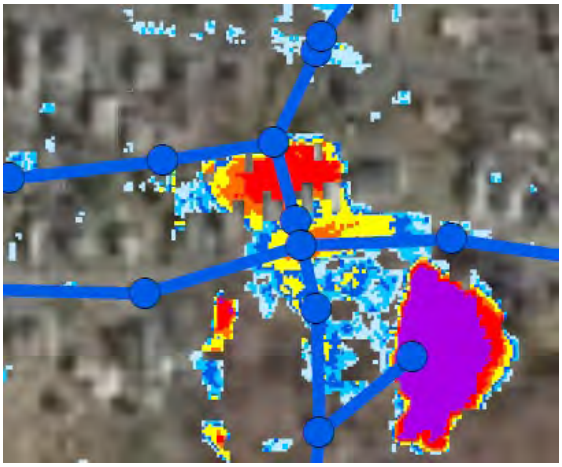
Figure 17 – Design Storm Flooding with Existing Infrastructure: East Vernon and Nahatan Area



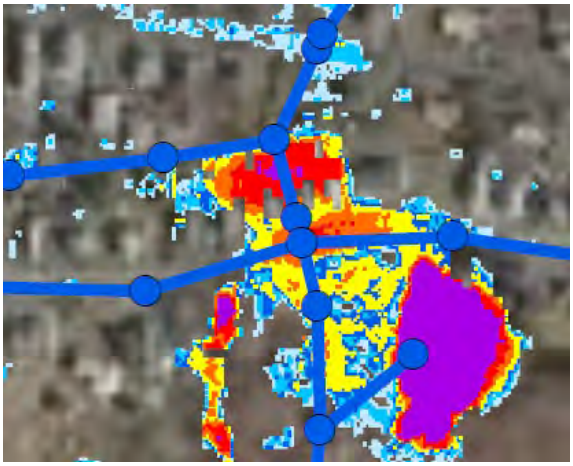
2-Year Present Day Design Storm



5-Year Present Day Design Storm

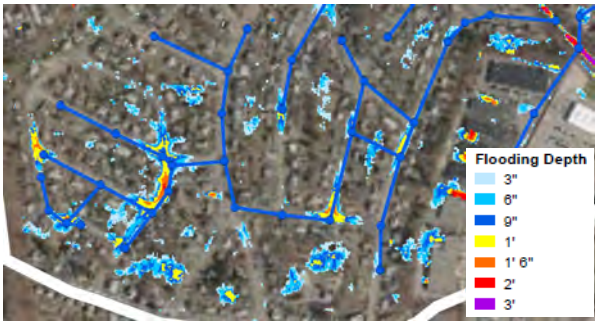


10-Year Present Day Design Storm

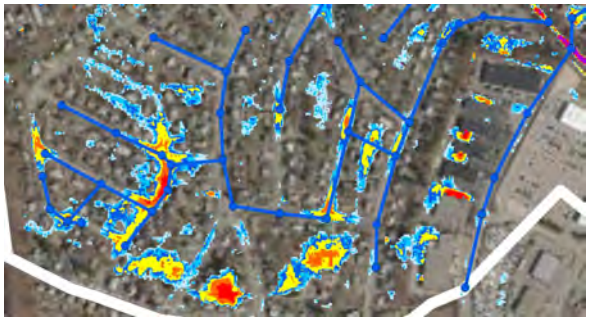


10-Year 2070 Design Storm

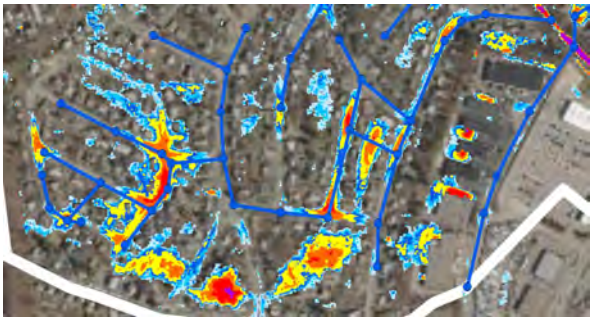
Figure 18 – Design Storm Flooding with Existing Infrastructure: Cross/Plimpton Area



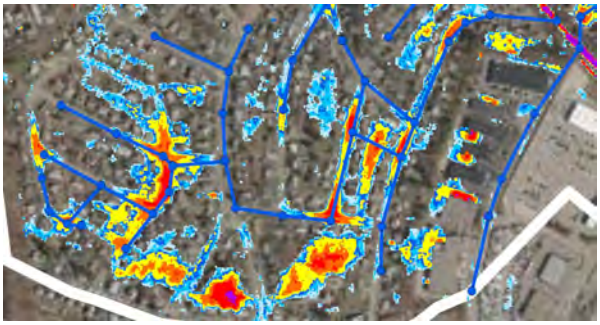
2-Year Present Day Design Storm



5-Year Present Day Design Storm



10-Year Present Day Design Storm



10-Year 2070 Design Storm

Figure 19 – Design Storm Flooding with Existing Infrastructure: Jacobson/Pellana Area

5.3.3 Peak Flood Depth: Existing System Model

Simulated peak flood depths in key locations were identified for the existing system model runs using the six design storms. These simulated depths represent the deepest flooding at a designated location over the course of the 24-hour storm simulation period and may occur during only one model time step. This information should be considered in combination with duration, described in the next section.

Simulated peak flood depths are shown in Table 6, and increase with storm size, reflecting the relative precipitation characteristics of the design storms. The existing system model indicates that the Nahatan Street underpass is subject to the deepest flooding most design storms. The Cross Street area is also subject to greater peak flood depths. It should be noted that the Cross Street area is measured in the low-lying bowl in the backyards of the homes on Cross Street, where localized flooding is deepest, but in large events, flooding also flows from those backyards and floods Cross Street, as shown in Figure 18.

Table 6 – Peak Flood Depth in Design Storms, Existing System Model

Location	Simulated Peak Flood Depth (ft), Existing System					
	2-Yr Present Day	2-Yr 2070	5-Yr Present Day	5-Yr 2070	10-Yr Present Day	10-Yr 2070
Central St at East Vernon St	1.38	1.57	1.57	1.83	1.77	2.06
Nahatan St Underpass	1.45	3.58	3.60	4.29	4.17	4.63
Guild St Underpass	0.54	1.14	1.09	1.65	1.47	1.89
Cross St	1.93	2.47	2.47	2.68	2.63	2.89
Murphy Field	1.66	1.89	1.90	2.02	1.99	2.19
East Hoyle St at Broadway	0.76	0.87	0.87	0.96	0.94	1.02
Jacobsen Dr at Redwood Dr	1.67	2.10	2.12	2.34	2.31	2.45

5.3.4 Flood Duration: Existing System Model

In addition to peak flood depth, duration of flooding is an important measure in characterizing a flood event. For each key location in each storm simulation, the project team calculated the total duration of simulated flooding (greater than 6” depth) and the total duration of simulated deep flooding (greater than 18” depth).

Flood durations vary by location, with Guild St underpass and East Hoyle St at Broadway experiencing shorter flood durations than the other locations.

The duration of deep flooding (18” depth or greater) at Nahatan St underpass is an important parameter because it is near the police and fire station, and the underpass serves as a critical route for emergency response vehicles.

It should also be noted that duration of flooding for the Cross Street area is measured in the low-lying bowl in the backyards of the homes on Cross Street, where localized flooding lingers because there does not appear to be a drain the lowest area of the bowl shape and floods can subside only through the slow process of infiltration. In the model, simulated flooding persisted beyond the end of the 24 hour simulation period, and thus was not quantifiable. However, simulated flooding within Cross Street is less deep (as shown in Figure 18), and can drain through catch basins once the drain network has available capacity. Street flooding lasts for a considerably shorter amount of time in the Existing System model: 1.5 to 1.75 hours (18” or 6” depth) while the drain network is beyond capacity, and then drains immediately after.

Table 7 – Duration of Flooding in Design Storms, Existing System Model

Location	Simulated Duration of Flooding (min) ≥ 6" Depth, Existing System					
	2-Yr Present Day	2-Yr 2070	5-Yr Present Day	5-Yr 2070	10-Yr Present Day	10-Yr 2070
Central St at East Vernon St	70	85	90	110	105	125
Nahatan St Underpass	45	60	65	85	80	105
Guild St Underpass	5	10	10	15	15	25
Cross St*	>12 hours	>12 hours	>12 hours	>12 hours	>12 hours	>12 hours
Murphy Field	140	160	160	190	185	225
East Hoyle St at Broadway	35	45	45	60	60	85
Jacobsen Dr at Redwood Dr	380	440	445	490	485	545
Location	**Simulated Duration of Flooding (min) ≥ 18" Depth, Existing System**					
	2-Yr Present Day	2-Yr 2070	5-Yr Present Day	5-Yr 2070	10-Yr Present Day	10-Yr 2070
Central St at East Vernon St	0	15	20	35	30	45
Nahatan St Underpass	0	40	40	55	50	65
Guild St Underpass	0	0	0	5	0	15
Cross St	15	45	45	80	70	105
Murphy Field	20	45	50	75	70	100
East Hoyle St at Broadway	0	0	0	0	0	0
Jacobsen Dr at Redwood Dr	165	240	240	275	270	305

*Simulated flooding >6" deep in the Cross Street backyards extended beyond the end of the simulation period, so exact durations were not derived.

5.4 RE-RUNNING OF 2004 RECOMMENDATIONS

The six design storms were simulated with the calibrated H&H model using the existing pipe network, modified to reflect the collection system improvements recommended in the 2004 Study. This model is referred to as the 2004 recommendations model. The purpose of this modeling was to replicate the 2004 analysis using tools and data available today, to evaluate the findings from 2004.

5.4.1 Summary of 2004 Recommendations

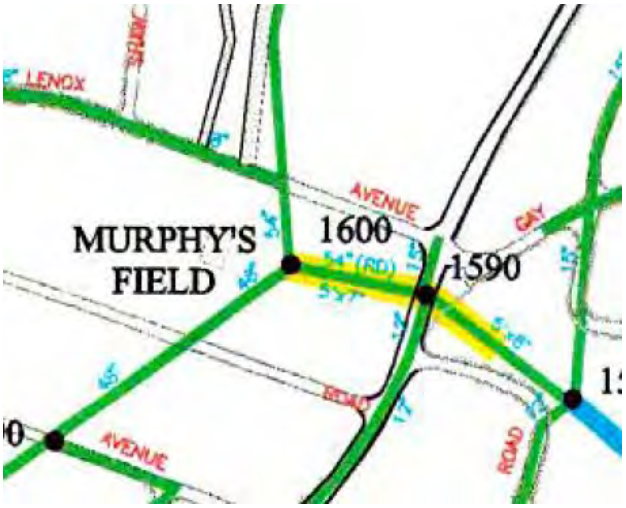
The 2004 Study introduced in Section 1.1 identified the following recommendations for capital projects summarized in Table 8 below.

Table 8 – 2004 Study Capital Project Recommendations

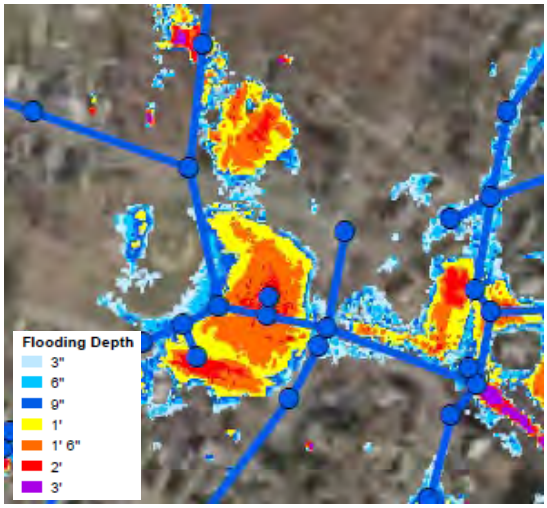
Recommendation	Description	Estimated Cost (2004 $)
Meadow Brook Improvements	Improve the 1000 feet of Meadow Brook upstream of West Sixth Street.	$790,000
Pellana Road Neighborhood Relief	Improve/enlarge the drain system between Birch Road/Pleasant Street and Pellana Road at Meadow Brook.	$1,740,000
Stormwater Storage	Create 21 acre-feet of stormwater storage at Hennessey Field (will also need storage at Murphy Field and/or wetland restoration)	$960,000
Murphy Field to Meadow Brook	Improve/enlarge the existing 7’ x 5’ box culvert with a parallel 7’ x 5’ box culvert.	$580,000
Downtown Relief	Improve/enlarge the drain system from East Vernon at Central down Broadway, under Guild, and along Cross Street	$4,270,000

5.4.2 Comparison of Results

The team found that the 2021 ICM existing system model simulated flooding in generally the same areas as the 2004 SWMM Baseline Model used for the 2004 Study. However, the extent and depth of flooding can be simulated in far greater detail with the ICM surface mesh; a level of detail that was not available during the development of the 2004 Study. Figure 20 shows an example of the improvement in predicted flooding provided by the more refined 2021 ICM Existing System Model as compared to the 2004 SWMM Baseline Model. As shown, the 2004 model could only indicate the manholes where flooding was likely to occur, whereas the current model shows far greater detail on extent and depth.



2004 SWMM Baseline Model,
10-Year, Present Day Design Storm



2021 ICM Existing System Model,
10-Year, Present Day Design Storm

Figure 20 – 2004 SWMM Baseline Model vs. 2021 ICM Existing System Model: Murphy Field Area

The projects summarized in Table 7, were incorporated into the 2021 ICM model, referred to as the 2004 recommendations model. Figures C-7 through C-12 in Appendix C show the distribution of flooding, by depth, in the prior recommendations model runs, for the six design storms. Evaluation of these results revealed that while the projects recommended in 2004 were generally in suitable locations, the ability to better understand how flows are conveyed overland and connect to the drain network today calls for refinement of the recommended strategy.

5.5 PROPOSED SYSTEM MODELING RESULTS

A set of conceptual improvements to the drain system was developed as part of this study based on the project objectives and modeling approach outlined above, and considering the recommendations from 2004. These improvements are intended to work together to reduce flooding throughout the watershed. The version of the calibrated H&H model containing the improvements is referred to as the proposed system model.

The capital improvement concepts are described in greater detail in Section 6. It should be noted that for two of the key locations (Nahatan Underpass and Jacobsen Drive) an alternative concept was developed and costed, but in both cases the proposed system represents the preferred approach.

The six design storms were simulated using the proposed system model. The purpose of this modeling was to illustrate the extent and depth of flooding in a variety of storms after all the proposed improvements have been built, and to evaluate the flood reduction (benefit) achieved.

5.5.1 Total Flooded Area: Existing vs. Proposed

As in Section 5.3.1, flooded area simulated with the proposed system model was identified for each location using two thresholds: flooding 6 inches or deeper (“all flooding”), and all flooding 18 inches or deeper (“deep flooding”).

The flooded areas from the proposed system model runs were compared with against the existing system model runs to characterize the benefits of the proposed projects, shown in Table 9. The proposed improvements would significantly reduce the flooded areas in each location in almost all storm scenarios.

Simulated flooded area six inches or deeper is generally reduced by 50-90% in most storm scenarios in most locations. Notably, flooding (6” or deeper) at the Guild Street underpass in small storms does not show a substantial percent reduction because the flooded area is very small in the existing system model. Murphy Field is the other location with a smaller percent reduction in flood area. Murphy Field is shaped like a bowl with a relatively flat bottom that is very close to the elevation of Meadow Brook. As such, when Meadow Brook fills, the flood area in Murphy Field extends rapidly.

Simulated flood area 18 inches or greater is reduced dramatically (in many cases, completely) in most storm scenarios in most locations. Deep flooding (18” or deeper) at the Guild Street underpass in small storms does not show a substantial percent reduction because the flooded area is very small in the existing system model. It should be noted that Murphy Field actually shows a simulated flood area increase in the 10-year 2070 design storm. The reason for this is that the stormwater detention basin just upstream of Murphy Field within Hennessey Field (See Section 6.6) is sized to capture peak stormwater flows in a 10-year present day event and would overflow in a larger 10-year 2070 storm. Additional storage elsewhere in the watershed (e.g., MBTA Storage in Section 6.7) can be implemented in the decades to come to handle the additional peak stormwater flows anticipated with future storm events, which would reduce the flooded area in a future extreme event.

Table 9 – Comparison of Flooded Area, Existing vs. Proposed

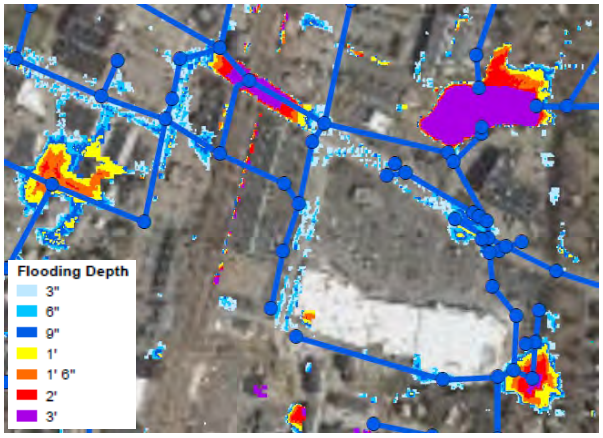
Simulated Flooded Area (ac) ≥ 6" Depth Existing vs Proposed System Model									
Location	2-Year Storm, Present Day			2-Year Storm, 2070			5-Year Storm, Present Day		
	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction
Central St at East Vernon St	0.83	0.20	**76%**	1.07	0.32	**71%**	1.07	0.31	**71%**
Nahatan St Underpass	0.19	0.10	**47%**	0.47	0.14	**70%**	0.47	0.14	**70%**
Guild St Underpass	0.05	0.05	**0%**	0.12	0.09	**26%**	0.11	0.08	**25%**
Cross St	0.37	0.17	**53%**	0.71	0.19	**73%**	0.71	0.19	**73%**
Murphy Field	1.80	1.01	**44%**	2.06	1.34	**35%**	2.07	1.35	**35%**
East Hoyle St at Broadway	0.40	0.03	**92%**	0.68	0.18	**74%**	0.68	0.18	**74%**
Jacobsen Dr at Redwood Dr	1.28	0.20	**84%**	2.49	0.31	**88%**	2.54	0.31	**88%**
Location	5-Year Storm, 2070			10-Year Storm, Present Day			10-Year Storm, 2070		
	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction
Central St at East Vernon St	1.30	0.46	**65%**	1.24	0.40	**67%**	1.46	0.66	**55%**
Nahatan St Underpass	0.68	0.21	**70%**	0.64	0.19	**70%**	0.87	0.34	**61%**
Guild St Underpass	0.24	0.12	**51%**	0.20	0.11	**48%**	0.29	0.13	**55%**
Cross St	0.91	0.21	**77%**	0.80	0.21	**74%**	1.06	0.25	**77%**
Murphy Field	2.20	1.75	**20%**	2.17	1.60	**26%**	2.41	2.77	**-15%**
East Hoyle St at Broadway	0.83	0.39	**53%**	0.78	0.31	**61%**	1.08	0.56	**48%**
Jacobsen Dr at Redwood Dr	3.18	0.47	**85%**	3.08	0.43	**86%**	3.31	0.62	**81%**

Simulated Flooded Area (ac) ≥ 18" Depth, Existing vs Proposed System Model									
Location	2-Year Storm, Present Day			2-Year Storm, 2070			5-Year Storm, Present Day		
	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction
Central St at East Vernon St	0.09	0.00	**99%**	0.23	0.00	**100%**	0.23	0.00	**100%**
Nahatan St Underpass	0.01	0.00	**100%**	0.33	0.00	**100%**	0.33	0.00	**100%**
Guild St Underpass	0.00	0.00		0.01	0.00	**48%**	0.01	0.00	**50%**
Cross St	0.12	0.01	**93%**	0.22	0.03	**87%**	0.22	0.03	**87%**
Murphy Field	0.37	0.01	**98%**	0.71	0.04	**95%**	0.72	0.04	**95%**
East Hoyle St at Broadway	0.00	0.00	**100%**	0.00	0.00	**100%**	0.00	0.00	**100%**
Jacobsen Dr at Redwood Dr	0.11	0.00	**100%**	0.36	0.00	**100%**	0.38	0.00	**100%**
Location	5-Year Storm, 2070			10-Year Storm, Present Day			10-Year Storm, 2070		
	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction	Existing System	Proposed System	% Flooded Area Reduction
Central St at East Vernon St	0.36	0.00	**100%**	0.33	0.00	**100%**	0.51	0.01	**99%**
Nahatan St Underpass	0.41	0.01	**98%**	0.40	0.01	**98%**	0.45	0.16	**64%**
Guild St Underpass	0.06	0.01	**91%**	0.03	0.00	**87%**	0.09	0.01	**92%**
Cross St	0.27	0.05	**81%**	0.26	0.05	**82%**	0.40	0.07	**82%**
Murphy Field	0.89	0.13	**85%**	0.86	0.10	**89%**	1.14	1.30	**-14%**
East Hoyle St at Broadway	0.00	0.00	**100%**	0.00	0.00	**100%**	0.08	0.00	**99%**
Jacobsen Dr at Redwood Dr	0.69	0.00	**100%**	0.66	0.00	**100%**	0.83	0.00	**100%**

*Proposed System simulations at Guild St underpass: minor variations in the surface mesh caused irregularities in the 2-year present day design storm. In this sole instance, Proposed System flooded area results were set equal to Existing System.

5.5.2 Flood Extents and Depths: Existing vs. Proposed

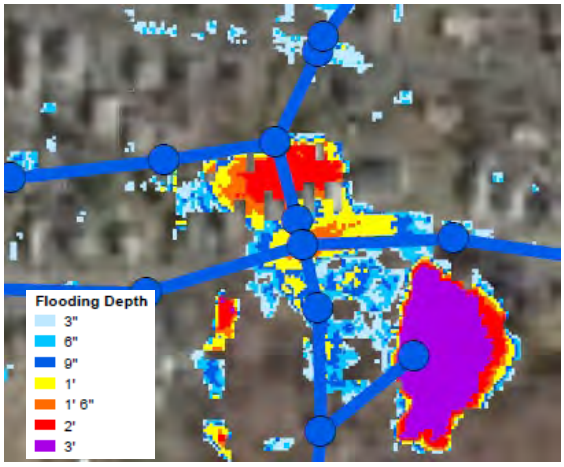
Figures C-13 through C-18 in Appendix C show the distribution of flooding, by depth, in the proposed system model runs, for the six design storms. Close-up comparisons for several of the key locations are shown in Figure 21 through Figure 23 below, illustrating the flood reduction that could be achieved during the 10-year design storm through the implementation of these projects.



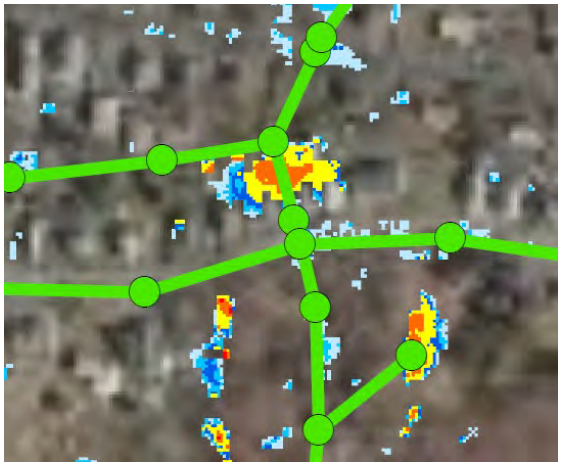
Existing System Model,
10-Year Present Day Design Storm

Proposed System Model,
10-Year Present Day Design Storm

Figure 21 – Existing vs. Proposed System Flooding: East Vernon and Nahatan Area

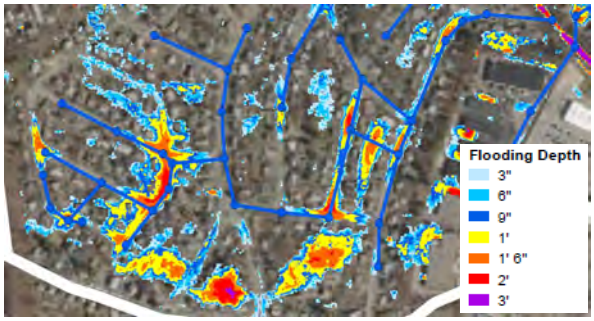


Existing System Model,
10-Year Present Day Design Storm

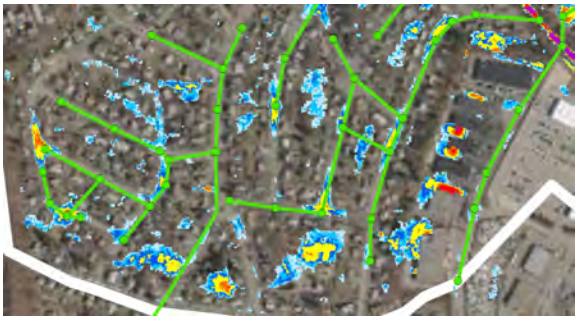


Proposed System Model,
10-Year Present Day Design Storm

Figure 22 – Existing vs. Proposed System Flooding: Cross/Plimpton Area



Existing System Model,
10-Year Present Day Design Storm



Proposed System Model,
10-Year Present Day Design Storm

Figure 23 – Existing vs. Proposed System Flooding: Jacobson/Pellana Area

5.5.3 Peak Flood Depth: Existing vs. Proposed

As in Section 5.3.3, peak flood depths in key locations were identified for the proposed system model runs using the six design storms.

The peak flood depths from the proposed system model runs were compared with against the existing system model runs to characterize the benefits of the proposed projects, shown in Table 10. Peak flood depth is reduced by 30-70% in most locations in most storm scenarios. Many of these key locations are bowl-shaped, and retain some flooding at the peak of the storm due to intense simulated rainfall and natural topography.

Table 10 – Comparison of Peak Flood Depths, Existing vs. Proposed

Simulated Peak Flood Depth (ft), Existing vs Proposed System Model									
Location	2-Year Storm, Present Day			2-Year Storm, 2070			5-Year Storm, Present Day		
	Existing System	Proposed System	% Flood Depth Reduction	Existing System	Proposed System	% Flood Depth Reduction	Existing System	Proposed System	% Flood Depth Reduction
Central St at East Vernon St	1.38	0.51	**63%**	1.57	0.65	**59%**	1.57	0.64	**59%**
Nahatan St Underpass	1.45	0.91	**38%**	3.58	1.11	**69%**	3.60	1.10	**69%**
Guild St Underpass	0.54	0.47	**13%**	1.14	0.62	**46%**	1.09	0.59	**45%**
Cross St	1.93	1.33	**31%**	2.47	1.47	**41%**	2.47	1.47	**40%**
Murphy Field	1.66	1.04	**37%**	1.89	1.26	**33%**	1.90	1.27	**33%**
East Hoyle St at Broadway	0.76	0.24	**69%**	0.87	0.46	**47%**	0.87	0.46	**47%**
Jacobsen Dr at Redwood Dr	1.67	0.49	**71%**	2.10	0.61	**71%**	2.12	0.61	**71%**
Location	5-Year Storm, 2070			10-Year Storm, Present Day			10-Year Storm, 2070		
	Existing System	Proposed System	% Flood Depth Reduction	Existing System	Proposed System	% Flood Depth Reduction	Existing System	Proposed System	% Flood Depth Reduction
Central St at East Vernon St	1.83	0.83	**55%**	1.77	0.76	**57%**	2.06	1.05	**49%**
Nahatan St Underpass	4.29	1.37	**68%**	4.17	1.31	**69%**	4.63	2.22	**52%**
Guild St Underpass	1.65	0.63	**62%**	1.47	0.63	**57%**	1.89	0.71	**62%**
Cross St	2.68	1.60	**40%**	2.63	1.56	**41%**	2.89	1.71	**41%**
Murphy Field	2.02	1.46	**28%**	1.99	1.42	**29%**	2.19	2.25	**-3%**
East Hoyle St at Broadway	0.96	0.68	**30%**	0.94	0.63	**33%**	1.02	0.83	**19%**
Jacobsen Dr at Redwood Dr	2.34	0.72	**69%**	2.31	0.69	**70%**	2.45	0.83	**66%**

5.5.4 Flood Duration: Existing vs. Proposed

As in Section 5.3.4, simulated duration of ≥6”- and ≥18”-deep flooding was calculated for key locations in each storm simulation.

Table 11 provides a summary of flood duration results between the existing system model and the proposed system model, and how the durations could be reduced with implementation of the proposed projects.

Flood durations vary by location. The proposed projects would reduce flood duration at the two underpasses at Guild St and Nahatan St somewhat (generally 30-40% reduction when considering flooding 6” depth or greater), but generally eliminating deep flooding. This is important because these underpasses are critical routes across the railroad tracks, and minimizing deep flooding is necessary for emergency response vehicles to pass.

At other locations, flood duration (6” depth or greater):

- is substantially reduced by 70-100% - namely at Central St / East Vernon St, East Hoyle St / Broadway, and Jacobsen Dr / Redwood Dr.

Table 11 – Comparison of Duration of Flooding, Existing vs. Proposed

Simulated Duration of Flooding (min) ≥ 6" Depth, Existing vs Proposed System Model									
Location	2-Year Storm, Present Day			2-Year Storm, 2070			5-Year Storm, Present Day		
	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction
Central St at East Vernon St	70	5	**93%**	85	20	**76%**	90	20	**78%**
Nahatan St Underpass	45	30	**33%**	60	40	**33%**	65	40	**38%**
Guild St Underpass	5	0	**100%**	10	10	**0%**	10	10	**0%**
Cross St*	>12 hours	>12 hours	**N/A**	>12 hours	>12 hours	**N/A**	>12 hours	>12 hours	**N/A**
Murphy Field	140	125	**11%**	160	140	**13%**	160	145	**9%**
East Hoyle St at Broadway	35	0	**100%**	45	0	**100%**	45	0	**100%**
Jacobsen Dr at Redwood Dr	380	0	**100%**	440	10	**98%**	445	15	**97%**
Location	5-Year Storm, 2070			10-Year Storm, Present Day			10-Year Storm, 2070		
	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction
Central St at East Vernon St	110	30	**73%**	105	30	**71%**	125	40	**68%**
Nahatan St Underpass	85	55	**35%**	80	55	**31%**	105	70	**33%**
Guild St Underpass	15	10	**33%**	15	10	**33%**	25	15	**40%**
Cross St*	>12 hours	>12 hours	**N/A**	>12 hours	>12 hours	**N/A**	>12 hours	>12 hours	**N/A**
Murphy Field	190	170	**11%**	185	165	**11%**	225	200	**11%**
East Hoyle St at Broadway	60	15	**75%**	60	15	**75%**	85	20	**76%**
Jacobsen Dr at Redwood Dr	490	25	**95%**	485	25	**95%**	545	35	**94%**

Simulated Duration of Flooding (min) ≥ 18" Depth, Existing vs Proposed System Model									
Location	2-Year Storm, Present Day			2-Year Storm, 2070			5-Year Storm, Present Day		
	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction
Central St at East Vernon St	0	0		15	0	**100%**	20	0	**100%**
Nahatan St Underpass	0	0		40	0	**100%**	40	0	**100%**
Guild St Underpass	0	0		0	0		0	0	
Cross St	15	0	**100%**	45	0	**100%**	45	0	**100%**
Murphy Field	20	0	**100%**	45	0	**100%**	50	0	**100%**
East Hoyle St at Broadway	0	0		0	0		0	0	
Jacobsen Dr at Redwood Dr	165	0	**100%**	240	0	**100%**	240	0	**100%**
Location	5-Year Storm, 2070			10-Year Storm, Present Day			10-Year Storm, 2070		
	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction	Existing System	Proposed System	% Flood Duration Reduction
Central St at East Vernon St	35	0	**100%**	30	0	**100%**	45	0	**100%**
Nahatan St Underpass	55	0	**100%**	50	0	**100%**	65	15	**77%**
Guild St Underpass	5	0	**100%**	0	0		15	0	**100%**
Cross St	80	10	**88%**	70	10	**86%**	105	20	**81%**
Murphy Field	75	0	**100%**	70	0	**100%**	100	40	**60%**
East Hoyle St at Broadway	0	0		0	0		0	0	
Jacobsen Dr at Redwood Dr	275	0	**100%**	270	0	**100%**	305	0	**100%**

*Simulated flooding >6" deep in the Cross Street backyards extended beyond the end of the simulation period, so exact durations were not derived.

- shows a modest reduction at Murphy Field, largely because it is hydraulically connected to Meadow Brook, and the proposed projects are designed to maintain a similar outflow through Meadow Brook to the Neponset River.

In the vast majority of the key locations and storm scenarios, the deep flooding (18" depth or greater) is completely eliminated.

The Cross Street location merits separate discussion because flood duration is measured in the low-lying backyard bowl where modeled floods subside only through the slow process of infiltration. In all scenarios modeled, simulated flooding (6" depth or greater) persisted beyond the end of the 24 hour simulation period, and thus was not quantifiable. However, simulated flooding within Cross Street, shown in Figure 22 is drastically reduced with the proposed projects.

Flooding in the backyards comes from intense rainfall and overland stormwater flows from the properties within the area bounded by Cross St, Monroe St, Plimpton Ave, and Lenox St, and the model does not show a significant amount of flow from streets to the private properties. This study included a variety of preliminary modeling scenarios run in an attempt to further alleviate the backyard flooding. Because flooding is very sensitive to slight variations in the surface (including curbs, fences, landscaping, and driveways), Section 6.5 describes some concepts that should be evaluated in greater detail with higher-resolution topography data. Most notably, the model suggests that better surface drainage of the backyards at the low point would allow the bowl-shaped area to drain after there is capacity in the drain network, substantially decreasing the duration of flooding. The rate of drainage would depend heavily on the type of drains installed and would be evaluated in discussion with the neighborhood once site survey work is completed for the Cross Street improvements.

5.6 STORAGE

The Neponset River watershed experiences flooding in low lying areas during large storms, and under the Wetlands Protection Act, Norwood would not be able to increases peak discharge flowrates to the Neponset River. Stormwater detention would be needed to route flood flows away from key locations while maintaining existing peak flows into the Neponset River. A total stormwater detention volume of approximately 9 million gallons (or approximately 33 acre-feet) was estimated using the H&H model to be needed to accommodate the recommended infrastructure improvements without increasing peak flows to the Neponset River in the present day 10-year design storm. This storage could be located at one or multiple sites within the Meadow Brook watershed.

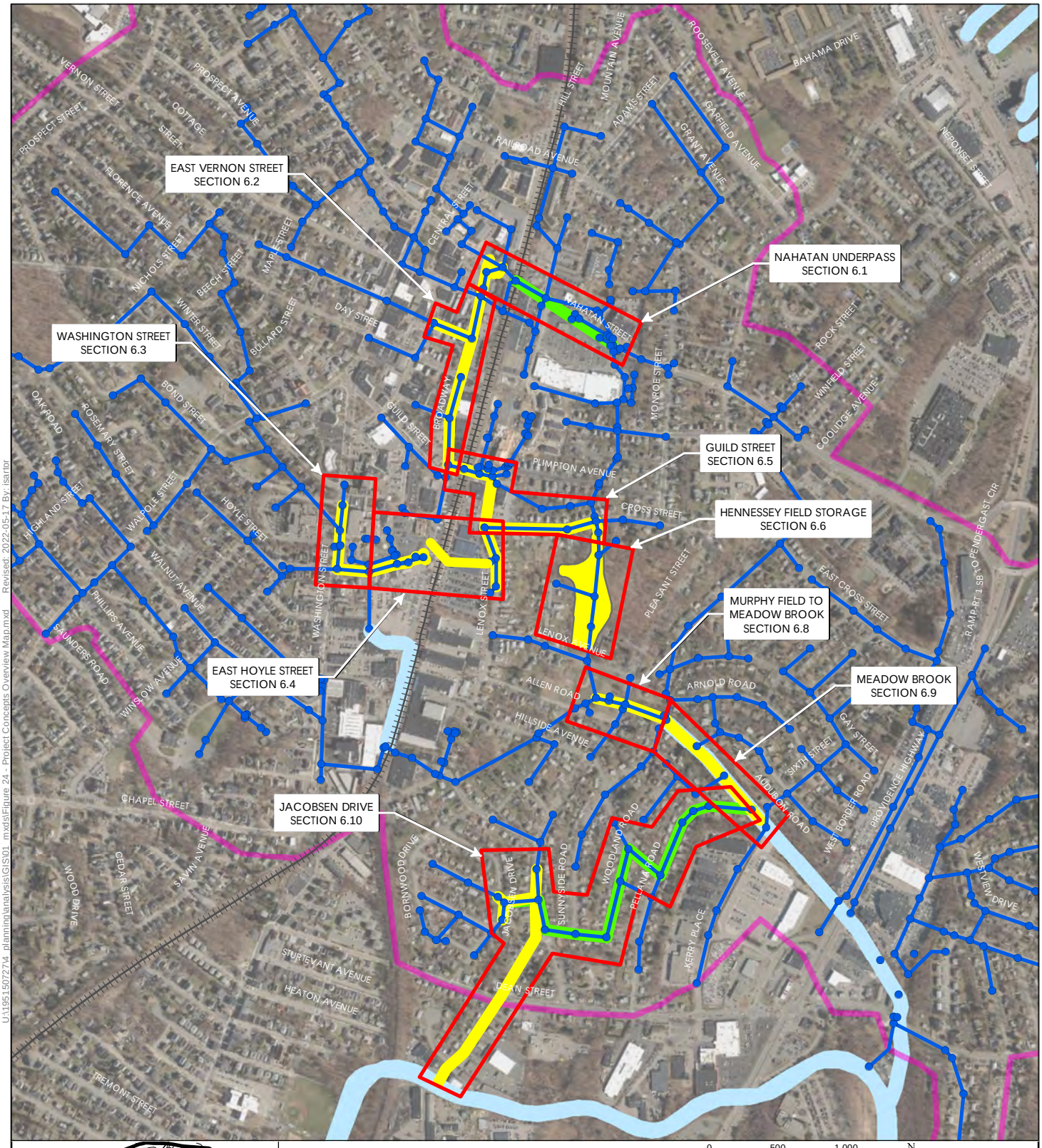
Hennessey Field was identified as the preferred location to maximize storage. As will be discussed in Section 6.5, it appears this location has sufficient area to provide the storage volume needed. However, if needed, additional storage volume under the MBTA parking lot could be evaluated. Storage under the Shaw's parking lot was considered but was deemed infeasible by the Town.

6.0 CAPITAL PLAN RECOMMENDATIONS

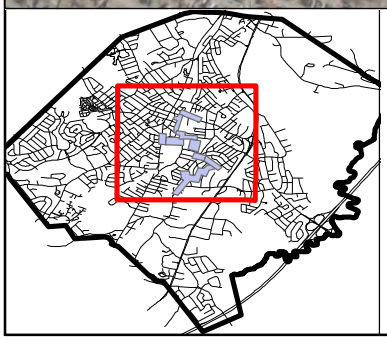
The following set of drain system improvements were developed to address flood risk in certain key locations in Meadow Brook Watershed, in design storms up to a 10-year return period. In the face of a more extreme storm, such as the June 2020 rain event, these improvements would afford some flood relief, but flooding would still occur in the same low-lying locations where water has always ponded.

These concepts are presented at a conceptual level including engineering concepts, a map to indicate the extent and nature of work, and opinions of probable construction costs (OPCC) with additional considerations to provide a planning-level estimate of capital costs. Pipe sizes listed are based on conveying peak flows under the 10-year 2070 event. The OPCC estimates are considered Class 4 estimates with a level of accuracy of -30% to +50%, and they contain a scope contingency of 20% plus a market conditions factor of an additional 20% to reflect the unstable market conditions observed in the past year. Appendix D contains the detailed assumptions and OPCC for each concept. This section also includes a recommendation for how to approach phasing the improvements to fit into a capital plan.

An overview of the proposed projects is shown in Figure 24.



U:\195\15072\74 planninganalysis\GIS\01 mxd\sFigure 24 - Project Concepts Overview Map.mxd Revised: 2022-05-17 By: isartor



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Proposed Concepts
- Proposed Alternative
- Project Concept Location
- Open Waterway
- Watershed Area
- RailRoad

0 500 1,000 Feet
1 inch = 1,000 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
24

Title
Project Concepts Overview Map

6.1 NAHATAN UNDERPASS

Nahatan Street crosses under a railroad bridge in a very low-lying configuration that traps runoff and results in deep flooding during large storms. This is especially problematic because Nahatan Street is the busiest roadway crossing below the railroad in the vicinity, and it also serves as a critical lifeline for emergency response vehicles coming from the nearby police/fire station. Reducing flooding at the Nahatan underpass requires infrastructure of significant scale. Two alternatives are described below. Both alternatives will require improvements to the surface drainage to capture more stormwater that current sheet flows along Nahatan Street and Broadway. The Town plans to repave Nahatan Street in the coming years, and it is recommended to alter the street cross section to build up the crown of the street to better channel and capture stormwater flows. Alternatively, sheet flows may be intercepted using linear drainage grates like those pictured below in Figure 25.

Figure 25 – Linear Drainage Grate for Collecting Sheet Flows

The proposed concept is shown in Figure 26 and would send all flows upstream of the Nahatan underpass away from the Nahatan Street corridor, and instead route them south along Broadway Street. Major improvements involve a new approximately 12’ x 15’ flow diversion structure just upstream of the Nahatan underpass to re-route flows south. Sheet flows from Broadway and Nahatan Streets would be intercepted using linear drainage grates. The significant advantage to this concept is the reliance on the existing drain network downstream of the underpass and avoiding major new construction along the length of Nahatan in front of the police/fire station. A preliminary estimate of construction duration is approximately 14 weeks, which does not account for Contractor startup/mobilization activities. The drain crossing the railroad east of Cottage Street East would be plugged to disconnect the drain system and ensure that storm flows do not traverse back to the Nahatan Street corridor. This concept would need to be constructed in conjunction with the East Vernon concept.

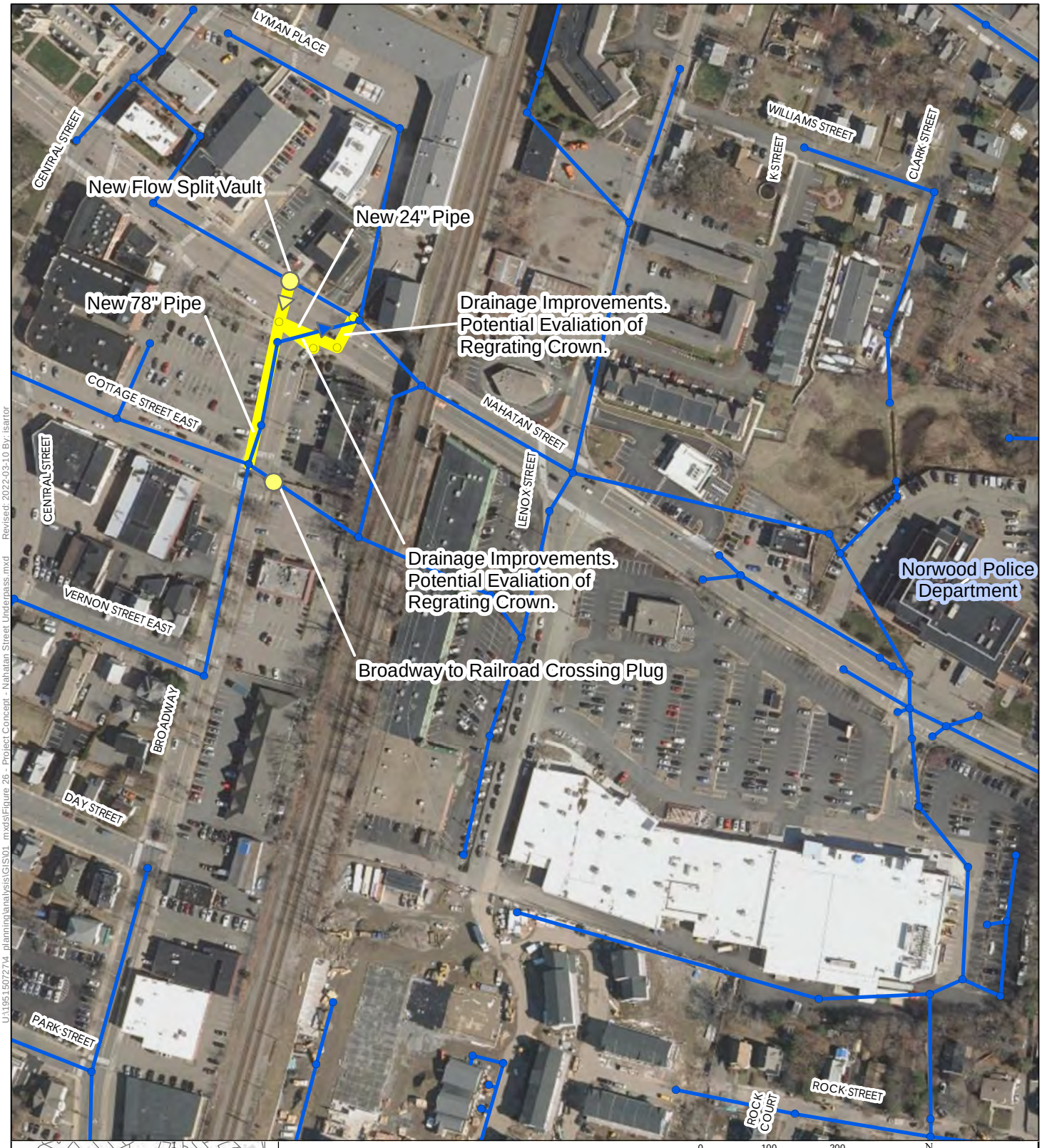
An alternative concept is shown in Figure 27. This alternative would route all drainage flows north of Cottage Street East through the Nahatan Street corridor, primarily within a new 72” drain pipe from the Nahatan Street underpass to the box culverts at the entrance to Shaw’s supermarket. An approximately 10’ x 10’ flow split vault with a weir would be built within Nahatan Street just east of the railroad crossing

to allow flows from large storms to overflow into a new 36" pipe that connects with the existing 36" drain system downstream on the police station property. The vault would also receive surface drainage from Nahatan Street in the bowl-shaped underpass beneath the railroad, using linear drainage grates. This corridor is heavily congested with underground utilities and traffic and serves as a key corridor for emergency response due to its proximity to the police/fire station. A preliminary estimate of construction duration is approximately 18 weeks, which does not account for Contractor startup/mobilization activities. Two pipes in the vicinity of Broadway and Cottage Street East would be plugged to disconnect the drain system and ensure that storm flows from Nahatan stay within the Nahatan corridor.

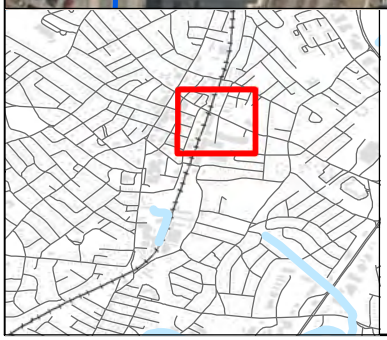
Table 12 – Nahatan Street Underpass Drainage Concepts – Est. Capital Cost

Major Components:	**Proposed:** -Flow split vault, approx. 12' x 15' -New 78" pipe in Broadway St, approx. 275 LF -Drainage improvements on Nahatan & Broadway Sts	**Alternative:** -New 72" pipe in Nahatan St, approx. 1,000 LF -Flow split vault, approx. 10' x 10' -Drainage improvements on Nahatan St
Class 4 Opinion of Construction Cost	**$967,000**	**$2,210,000**
Scope Contingency (20%)	$194,000	$442,000
Market Factor (20%)	$194,000	$442,000
Subtotal Opinion of Construction Cost	**$1,355,000**	**$3,094,000**
Site Investigation / Geotechnical (7.5%)	$102,000	$233,000
Design Engineering (12.5%)	$170,000	$387,000
Engineering Services During Constr. (5%)	$68,000	$155,000
Construction Management (10%)	$136,000	$310,000
Temporary Easements	$0	$0
Estimated Capital Cost	**$1,831,000**	**$4,179,000**

Figure 26 and Figure 27 show maps of the concepts for Nahatan Street Underpass, proposed and alternative, respectively.



U:\195\150727\4 planninganalysis\GIS\01 mxd\sFigure 26 - Project Concept - Nahatan Street Underpass.mxd Revised: 2022-03-10 By: isartor



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Proposed Structure
- Proposed Work

0 100 200 Feet

1 inch = 200 feet

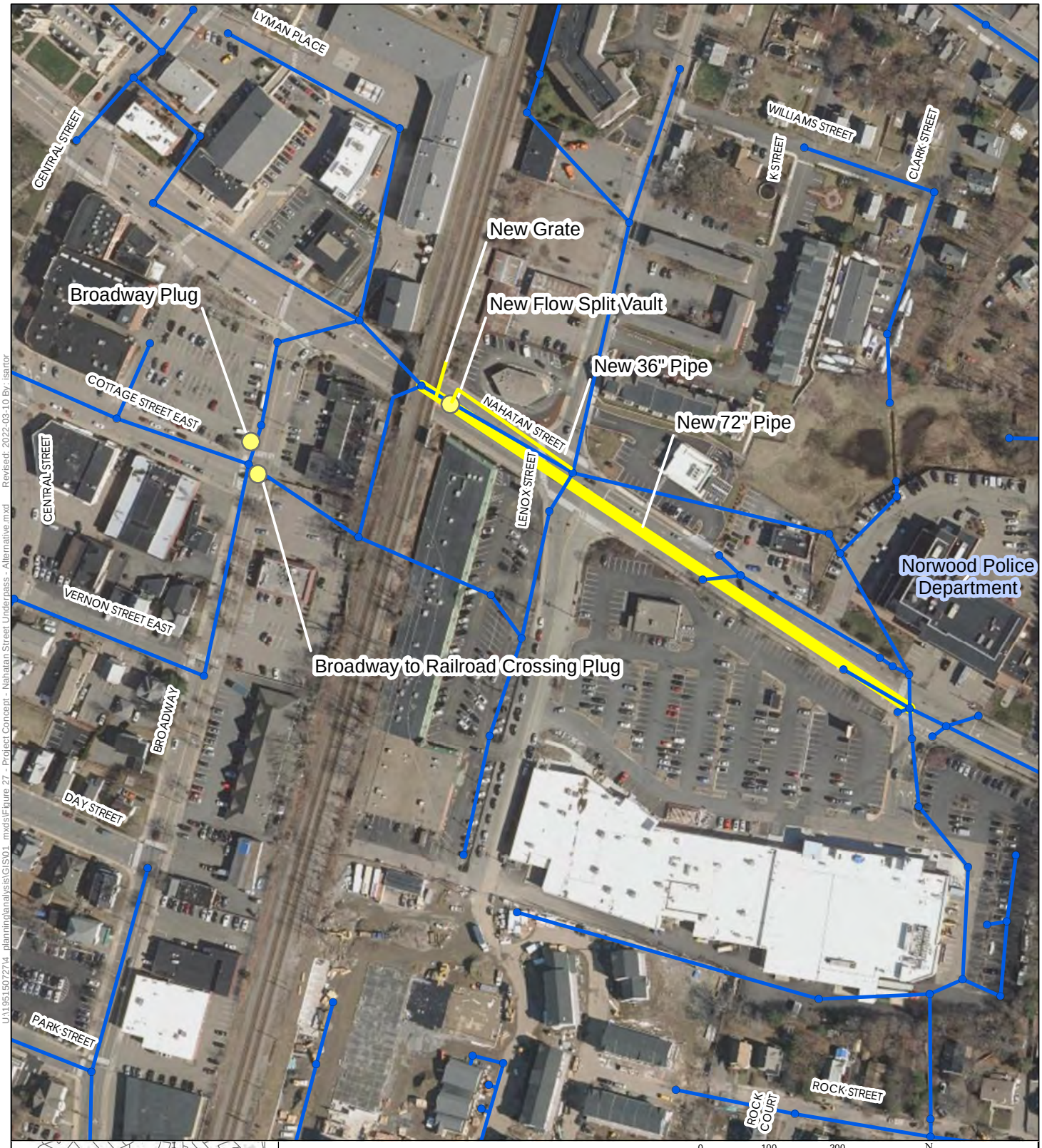
N

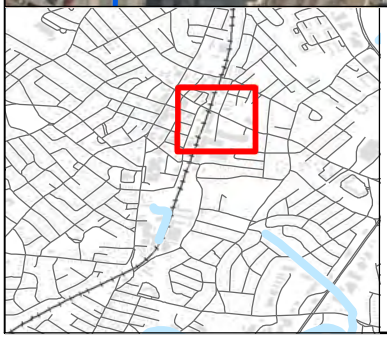
Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
26

Title
Project Concept:
Nahatan Street Underpass





Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Proposed Work

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
27

Title
Project Concept:
Nahatan Street Underpass - Alternative

U:\195\507274 planning\analysis\GIS\01 mxds\Figure 27 - Project Concept - Nahatan Street Underpass - Alternative.mxd Revised: 2022-03-10 By: isantor

6.2 EAST VERNON STREET

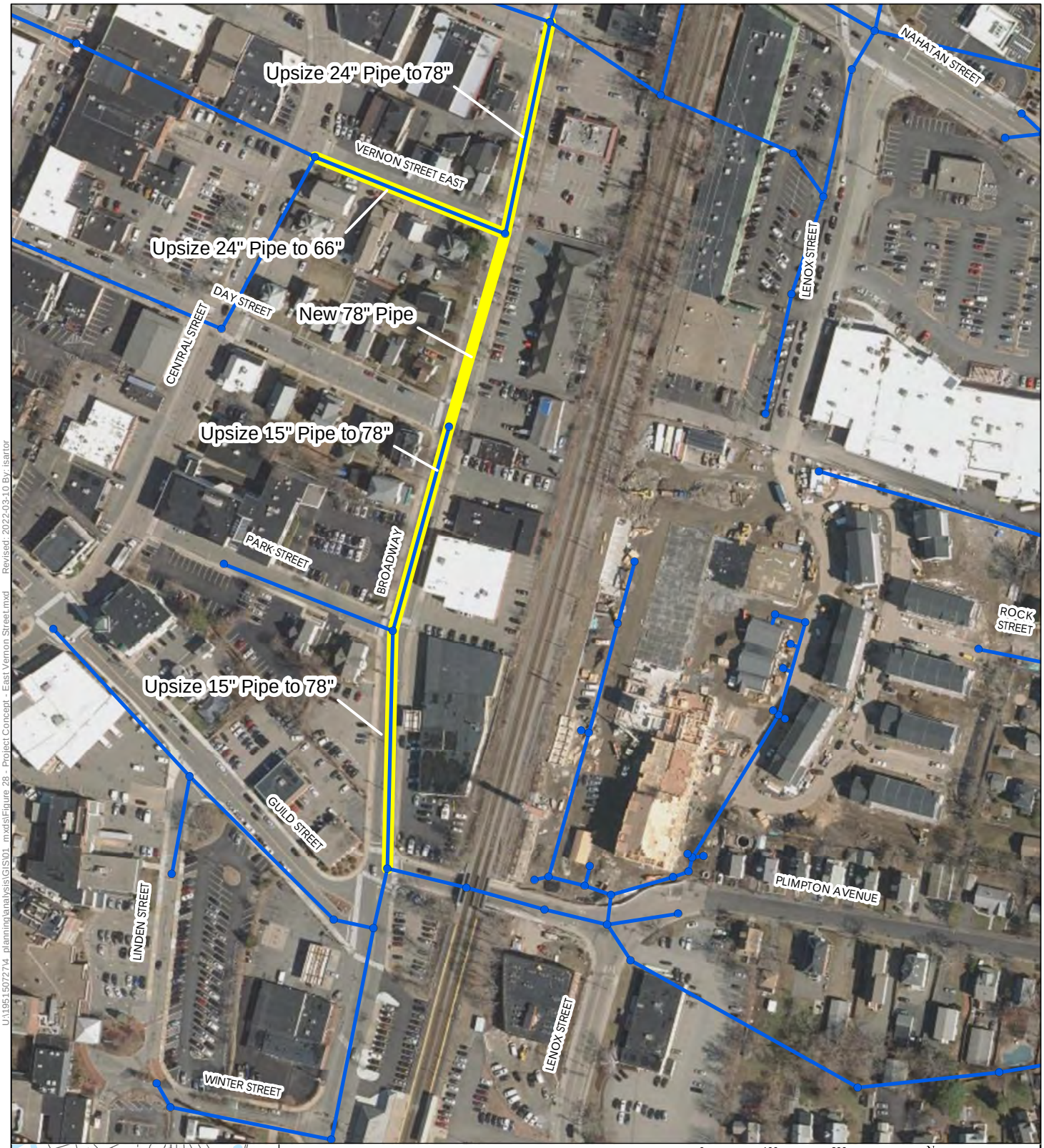
This suite of improvements would connect the drainage system along Broadway Street to serve as the main drainage corridor for all storm flows from the northwest portion of the Meadow Brook watershed, including storm flows from East Vernon Street. The existing 12”-15” local drain pipes would be replaced with a much larger 78” drain pipe. If Nahatan flows are instead routed through the Nahatan corridor (Nahatan alternative concept), then the Broadway Street pipe could be slightly smaller, but a 78” pipe is assumed for the purpose of the planning-level cost estimate.

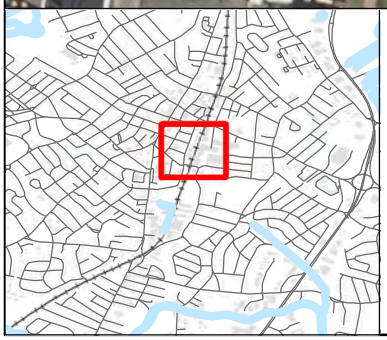
A preliminary estimate of construction duration is approximately 16 weeks, which does not account for Contractor startup/mobilization activities.

Table 13 – East Vernon Drainage Concept – Est. Capital Cost

Major Components:	-New 78” pipe in Broadway St, approx. 665 LF. -New 66” pipe in East Vernon St, approx. 120 LF.
Class 4 Opinion of Construction Cost	**$1,482,000**
Scope Contingency (20%)	$297,000
Market Factor (20%)	$297,000
Subtotal Opinion of Construction Cost	**$2,076,000**
Site Investigation / Geotechnical (7.5%)	$156,000
Design Engineering (12.5%)	$260,000
Engineering Services During Constr. (5%)	$104,000
Construction Management (10%)	$208,000
Temporary Easements	$0
Estimated Capital Cost	**$2,804,000**

Figure 28 shows a map of the concept for East Vernon drainage.





Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Proposed Work

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
28

Title
Project Concept:
East Vernon Street

6.3 WASHINGTON STREET

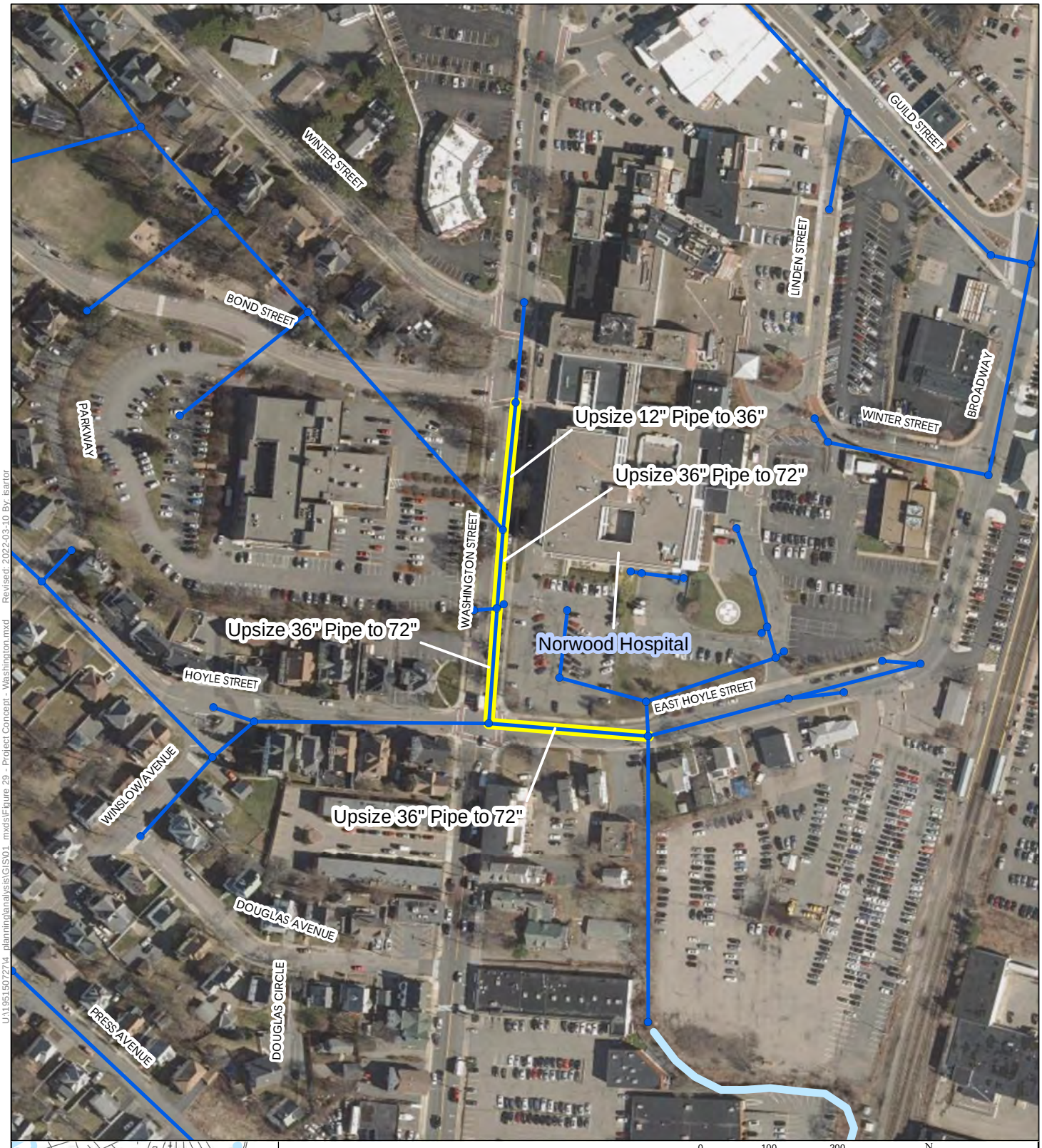
The existing 36” drain pipe in Washington Street cannot manage all of the upstream flows, resulting in flooding west and northwest of the Norwood Hospital, which sheet flows overland and contributes to the flooding in the hospital parking areas and on East Hoyle Street. Upsizing the system in Washington Street to a 78” pipe would reduce sheet flows and convey flows underground in this vicinity.

A preliminary estimate of construction duration is approximately 10 weeks, which does not account for Contractor startup/mobilization activities.

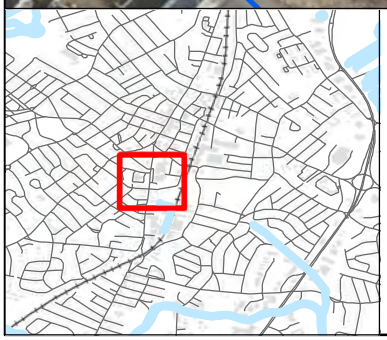
Table 14 – Washington Street Drainage Concept – Est. Capital Cost

Major Components:	-Enlarged 36” and 72” pipe in Washington and East Hoyle Sts, approx. 700 LF
Class 4 Opinion of Construction Cost	**$1,051,000**
Scope Contingency (20%)	$211,000
Market Factor (20%)	$211,000
Subtotal Opinion of Construction Cost	**$1,473,000**
Site Investigation / Geotechnical (7.5%)	$111,000
Design Engineering (12.5%)	$185,000
Engineering Services During Constr. (5%)	$74,000
Construction Management (10%)	$148,000
Temporary Easements	$0
Estimated Capital Cost	**$1,991,000**

Figure 29 shows a map of the concept for Washington Street drainage.



U:\195\507274 planning\analysis\GIS\01 mxds\Figure 29 - Project Concept - Washington.mxd Revised: 2022-03-10 By: lsartor



Notes
1. Coordinate System: GCS WGS 1984

Legend
- Existing Manhole
- Existing Pipe
- Proposed Work
- Open Waterway

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
29

Title
Project Concept:
Washington Street

6.4 EAST HOYLE STREET

East Hoyle Street, just south of Norwood Hospital, is a low-lying area that floods regularly. The local drainage network receives storm flows from upstream pipes, local rainfall, aboveground sheet flow, and pumped drainage from the Norwood Hospital basement drainage pumps. Stormwater runoff from this area currently drains through a 42" pipe in a narrow easement to a small drainage ditch, which conveys flow southerly to an existing 60" pipe crossing below the railroad corridor. From the railroad, the storm drain system extends through an existing easement underneath a warehouse at 349 Lenox Street, which presents challenges to upsizing.

Various scenarios were considered to reduce flooding in the vicinity of East Hoyle Street, and the most feasible was determined to be a new railroad crossing from East Hoyle Street into the MBTA parking lot. This work would involve upsizing the pipe in East Hoyle Street from 12" to 78", increasing the capacity of catch basins to route flows into the enlarged pipe, excavating tunnel shafts adjacent to East Hoyle St and within the MBTA parking lot, jacking a steel casing and 78" drain pipe under the railroad, and laying/upsizing pipe to 84" through the MBTA parking lot and Lenox Street. Permitting processes for the railroad crossing are anticipated to be significant. Approximately half of the construction cost is attributed to the railroad crossing tunnel and associated jacking/receiving shafts.

As discussed in Section 6.7, the MBTA parking lot could be used for up to 3 million gallons of additional stormwater storage. If storage is implemented in the parking lot, the pipe along Lenox Street may be able to be constructed at a smaller diameter.

A preliminary estimate of construction duration is approximately 20 weeks, which does not account for Contractor startup/mobilization activities.

The drainage of this area will be very sensitive to the redesign of the Norwood Hospital site. An early plan for the hospital site renovation indicated that the basement-level parking area and building entrance is planned to be regraded and eliminated, and the drainage pumps are planned for decommissioning. The model's surface mesh currently shows a significant amount of sheet flow across the parking areas west and south of the hospital, so the elevation and grading of that portion of the site will significantly impact how stormwater flows and drains.

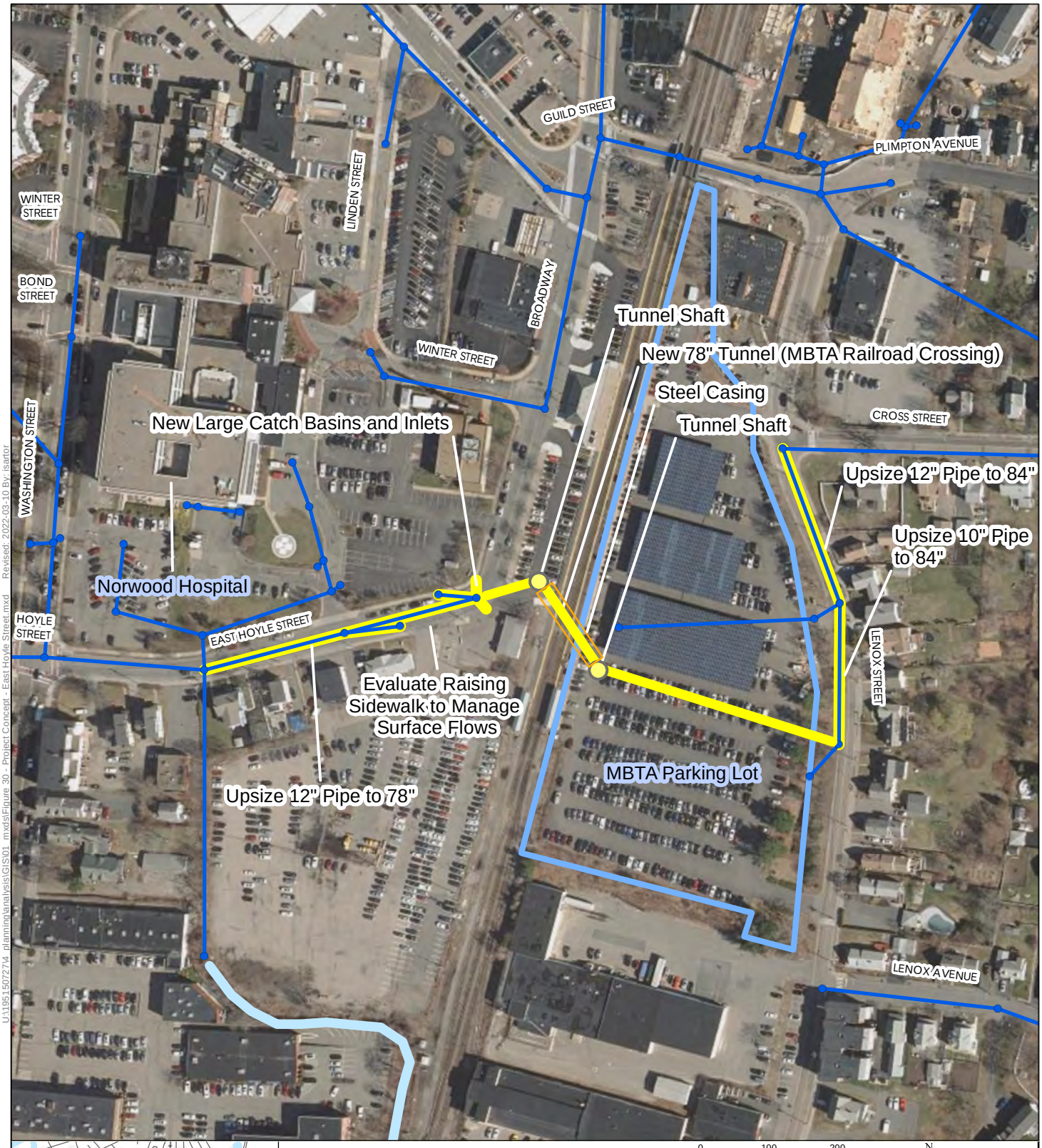
In early discussions with the Town, Norwood Hospital has indicated they are aware of the historic and potential future tendencies for water to pond in this low-lying location.

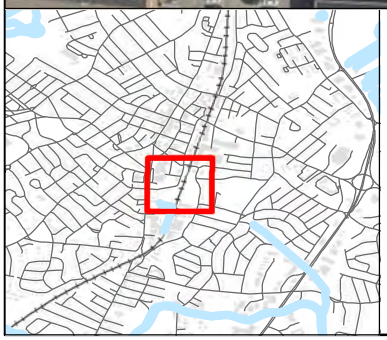
The Town has conducted preliminary modeling analyses indicating that some portion of the storm flows may be re-routed north along Broadway to the Guild Street underpass, or underground storage with pumping could provide some flood relief. However, a full evaluation of these options will require more detailed site information and ongoing collaboration with local property owners such as the Norwood Hospital.

Table 15 – East Hoyle Street Drainage Concept – Est. Capital Cost

Major Components:	-Enlarged 78" pipe in E. Hoyle St, approx. 500 LF. -New 160 LF tunnel crossing under railroad, including jacking/receiving shafts and steel casing. -New /enlarged 84" pipe in MBTA parking lot and Lenox St, approx. 830 LF.
Class 4 Opinion of Construction Cost	**$4,419,000**
Scope Contingency (20%)	$884,000
Market Factor (20%)	$884,000
Subtotal Opinion of Construction Cost	**$6,187,000**
Site Investigation / Geotechnical (7.5%)	$465,000
Design Engineering (12.5%)	$774,000
Engineering Services During Constr. (5%)	$310,000
Construction Management (10%)	$619,000
Temporary Easements	$60,000
Estimated Capital Cost	**$8,415,000**

Figure 30 shows a map of the concept for East Hoyle Street drainage.





Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Proposed Work
- MBTA Parking Lot
- Open Waterway

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
30

Title
Project Concept:
East Hoyle Street

U:\195\1507274\planninganalysis\GIS\01_mxds\Figure 30 - Project Concept - East Hoyle Street.mxd Revised: 2022-03-10 By: isartor

6.5 GUILD STREET

The flows from the East Vernon Street concept that are routed within Broadway Street would be conveyed through the Guild Street underpass. Flows from Guild Street underpass currently flow through the storm drain network east within backyards toward an especially low-lying area of private properties between Plimpton Avenue and Cross Street. When the storm drain network is full, backyard drainage cannot enter the system and deep flooding can occur.

Proposed improvements herein would involve upsizing the pipes under the Guild Street underpass from 30” to 78”, with a new 78” pipe within Lenox Street southward. Additional flows from East Hoyle would be accepted, and all stormwater would be conveyed in a new 84” pipe in Cross Street to Hennessey Field.

This area is subject to significant surface flows, and additional evaluations for improving drainage are recommended during detailed design of this project. Specific improvements that benefit the low-lying backyards, include:

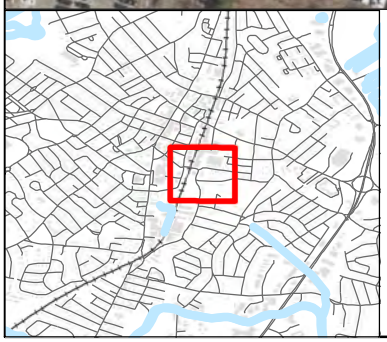
- Surface drainage at the Guild Street underpass (including surface flows from the Avalon Apartments’ southwest driveway),
- Surface drainage on Plimpton Avenue near the intersection with Lenox St (including surface flows from the Avalon Apartments’ southeast driveway),
- Catch basin capacity and configuration on Plimpton Avenue at its lowest location near the existing storm drain from the north,
- Routing and capacity of drains from the parking lot behind Riverside Community Center,
- Surface drainage from Cross Street just north of Hennessey Field, and potential overland flow routing into Hennessey Field, considering pedestrian safety, and
- Additional drainage features within the Town’s easement in the low-lying backyards.

A preliminary estimate of construction duration is approximately 14 weeks, which does not account for Contractor startup/mobilization activities.

Table 16 – Guild Street Drainage Concept – Est. Capital Cost

Major Components:	-Enlarged 78" pipe in Guild and Lenox Sts, and enlarged 84" pipe in Cross St, approx. 1,530 LF. -Drainage improvements throughout
Class 4 Opinion of Construction Cost	**$2,940,000**
Scope Contingency (20%)	$588,000
Market Factor (20%)	$588,000
Subtotal Opinion of Construction Cost	**$4,116,000**
Site Investigation / Geotechnical (7.5%)	$309,000
Design Engineering (12.5%)	$515,000
Engineering Services During Constr. (5%)	$206,000
Construction Management (10%)	$412,000
Temporary Easements	$0
Estimated Capital Cost	**$5,558,000**

Figure 31 shows a map of the concept for Guild Street drainage.



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Proposed Work

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
31

Title
Project Concept:
Guild Street

U:\195\1507274 planninganalysis\GIS\01 mxds\Figure 31 - Project Concept - Guild Street.mxd Revised: 2022-03-10 By: tsartor

6.6 HENNESSEY FIELD STORAGE

All of the drainage improvements upstream of Hennessey Field will route stormwater through the drain network faster. To avoid exacerbating flooding downstream and increasing peak flowrates to the Neponset River, a large detention basin would be needed at Hennessey Field. The storage project would include re-grading a large portion of Hennessey Field into a detention basin. Existing drain pipes through Hennessey Field would be daylighted at/near their existing inverts to channelize flows during small storms (with riprap at base and 2:1-sloped sidewalls). Flows from north of Hennessey field would enter at Cross Street into an engineered open channel and move down through the basin, draining through a grate at the bottom. The grate would be connected to the existing system which conveys flows through Murphy Field to the headwall at Meadowbrook. When flow rates exceed the capacity of the grate and downstream pipe, the basin will detain excess flows.

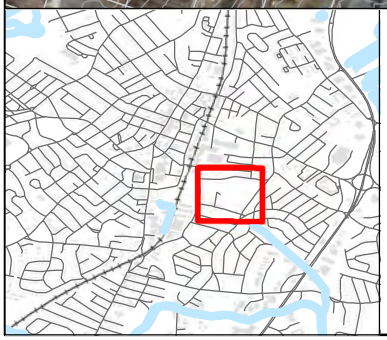
A berm would be constructed at the south-eastern corner of the property, and much of Hennessey Field would be cleared and lowered by several feet to increase detention volume. Although specific dimensions would be refined during design, an excavation volume of approximately 53,000 cubic yards of soil was estimated at this stage to be removed from the site. Town records show areas of what is assumed to be bedrock ledge in the northern portion of the field which could impact the feasible excavation and resulting storage volume. Records also show existing sewer pipes that would need to be reconfigured. With a top of berm at elevation 78', 2:1 side slope, and 2' of freeboard, the storage capacity as shown could be approximately 9.5 million gallons (35 acre-feet). This exceeds the required storage identified in Section 5.6. However, the presence of bedrock ledge could hinder excavation and may reduce the detention volume at this site.

The Hennessey Field Storage project could also provide recreational improvements to the Town of Norwood. Excavation on the site would remove overgrowth in the park, and landscaped areas and recreational trails would be constructed around the basin. A preliminary estimate of construction duration is approximately 30 weeks, which does not account for Contractor startup/mobilization activities.

Table 17 – Hennessey Field Storage Concept – Est. Capital Cost

Major Components:	-New storage basin (9.5 MG, or 29 acre-feet) with new berm along the southern portion. -Daylighted storm drain along the bottom via new riprap channel -Outlet vault with screens and flow control -Recreational features and landscaping
Class 4 Opinion of Construction Cost	**$4,276,000**
Scope Contingency (20%)	$856,000
Market Factor (20%)	$856,000
Subtotal Opinion of Construction Cost	**$5,988,000**
Site Investigation / Geotechnical (7.5%)	$450,000
Design Engineering (12.5%)	$749,000
Engineering Services During Constr. (5%)	$300,000
Construction Management (10%)	$599,000
Temporary Easements	$0
Estimated Capital Cost	**$8,086,000**

Figure 32 shows a map of the concept for Hennessey Field storage.



Notes
1. Coordinate System: GCS WGS 1984

Legend
- Model Nodes - Existing
- Model Conduits - Existing
- Hennessey Field Storage Contours
- Hennesey Trail

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
32

Title
Project Concept:
Hennessey Field Storage

6.7 MBTA STORAGE

Stormwater storage in Hennessey Field is considered a far superior project because it is a large site owned by the Town and located centrally within the drainage system. If, however, feasibility issues are encountered during the design process for Hennessey Field and the necessary amount of storage cannot be achieved, then the MBTA parking lot would be a possible location to investigate building additional storage volume.

Storage at the MBTA parking lot would involve excavating in the area that is not currently topped with solar panels to achieve the desired volume. An example storage basin dimension could be 50,000 square foot area (occupying approximately 60% of the parking lot without solar panels), excavated from the parking lot surface elevation of 112 feet (NAVD-88) down to a floor elevation of 100 feet. This would allow a working volume of approximately eight feet deep, to store up to 3 million gallons of stormwater. Permitting processes for excavation in proximity to the railroad tracks are anticipated to be significant.

6.8 MURPHY FIELD TO MEADOW BROOK

The existing 5’ x 7’ box culvert that drains out of Murphy Field to Meadow Brook is currently undersized and results in localized flooding within Murphy Field. The 2004 Study recommended that a second box culvert be installed to relieve the bottleneck. Investigations during design would determine whether a parallel alignment or an alternate alignment that follows Lenox Avenue and Pleasant Street is a more-feasible option for the new culvert.

East of Pleasant Street, the parallel box culvert could continue to Meadow Brook or could be daylighted and connected with Meadow Brook. Daylighting the Brook would provide aesthetic and recreational amenities to the Town. This daylighting is assumed for the purposes of estimating capital costs. The work would involve installing a pre-cast concrete channel to fit within the Town property line at a depth that matches the invert of the existing box culvert and relocating an existing 24” sewer that runs in a similar alignment. The pre-cast concrete channel downstream along Meadow Brook is 6’ deep and 12’ wide with topsoil overbanks, as shown in Figure 33, and it is assumed a similar sized channel would be required in this daylighting project. A preliminary estimate of construction duration is approximately 12 weeks, which does not account for Contractor startup/mobilization activities.

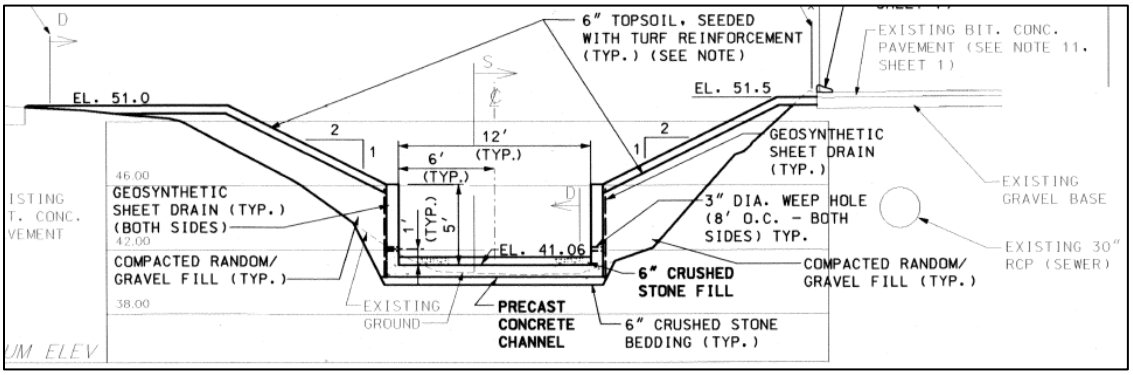
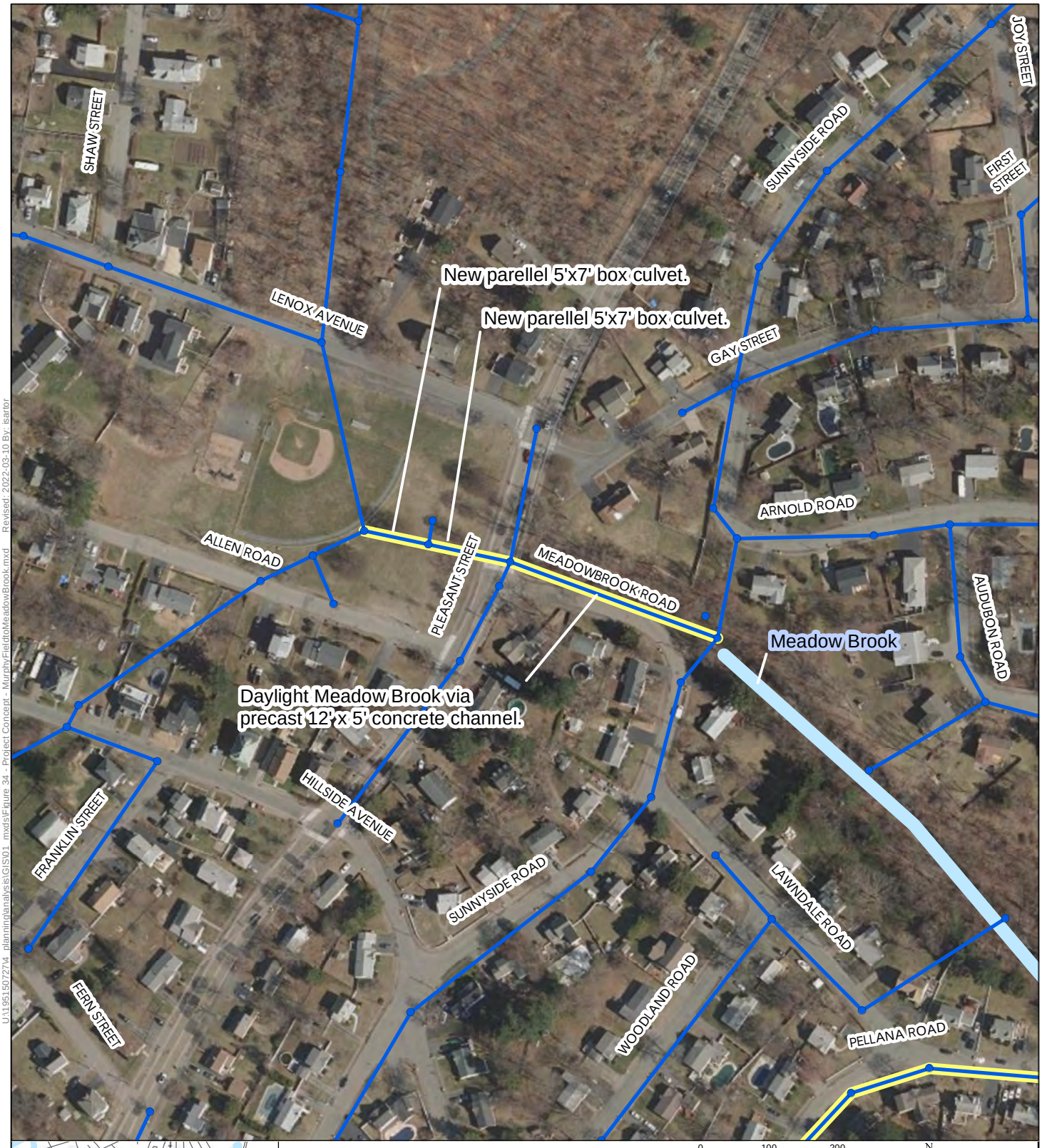


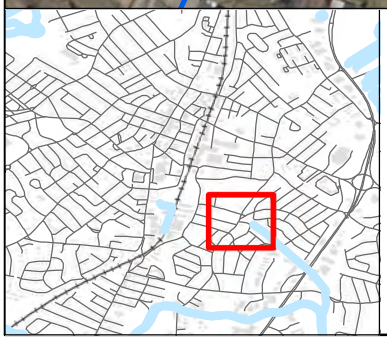
Figure 33 – Meadow Brook Pre-Cast Concrete Channel

Table 18 – Murphy Field to Meadow Brook Drainage Concept – Est. Capital Cost

Major Components:	-New parallel 5' x 7' box culvert, approx. 360 LF. -Daylighted Meadow Brook via precast 12' x 5' concrete channel, approx. 300 LF.
Class 4 Opinion of Construction Cost	**$1,266,000**
Scope Contingency (20%)	$254,000
Market Factor (20%)	$254,000
Subtotal Opinion of Construction Cost	**$1,774,000**
Site Investigation / Geotechnical (7.5%)	$134,000
Design Engineering (12.5%)	$222,000
Engineering Services During Constr. (5%)	$89,000
Construction Management (10%)	$178,000
Temporary Easements	$0
Estimated Capital Cost	**$2,397,000**

Figure 34 shows a map of the concept for Murphy Field to Meadow Brook drainage.





Notes
1. Coordinate System: GCS WGS 1984

Legend
- Model Nodes - Existing
- Model Conduits - Existing
- Proposed Work
- Open Waterway

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
34

Title
Project Concept:
Murphy Field to Meadow Brook

6.9 MEADOW BROOK

In 1997, the USACE dredged, widened, and improved the reach of Meadow Brook downstream (east) of West Sixth Street. This project would be mimic the USACE work in the 1000-foot reach of Meadow Brook from West Sixth Street to Sunnyside Road, resulting in a uniform 10' wide base and a 2:1 sloped side bank as shown in Figure 35. Removal of mature trees and shrubs would be required in some locations.

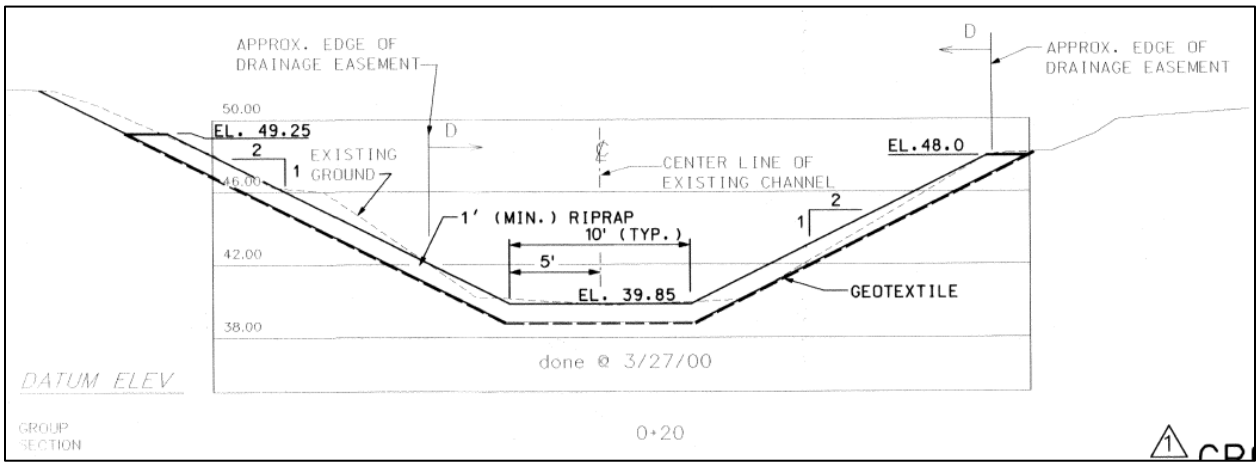


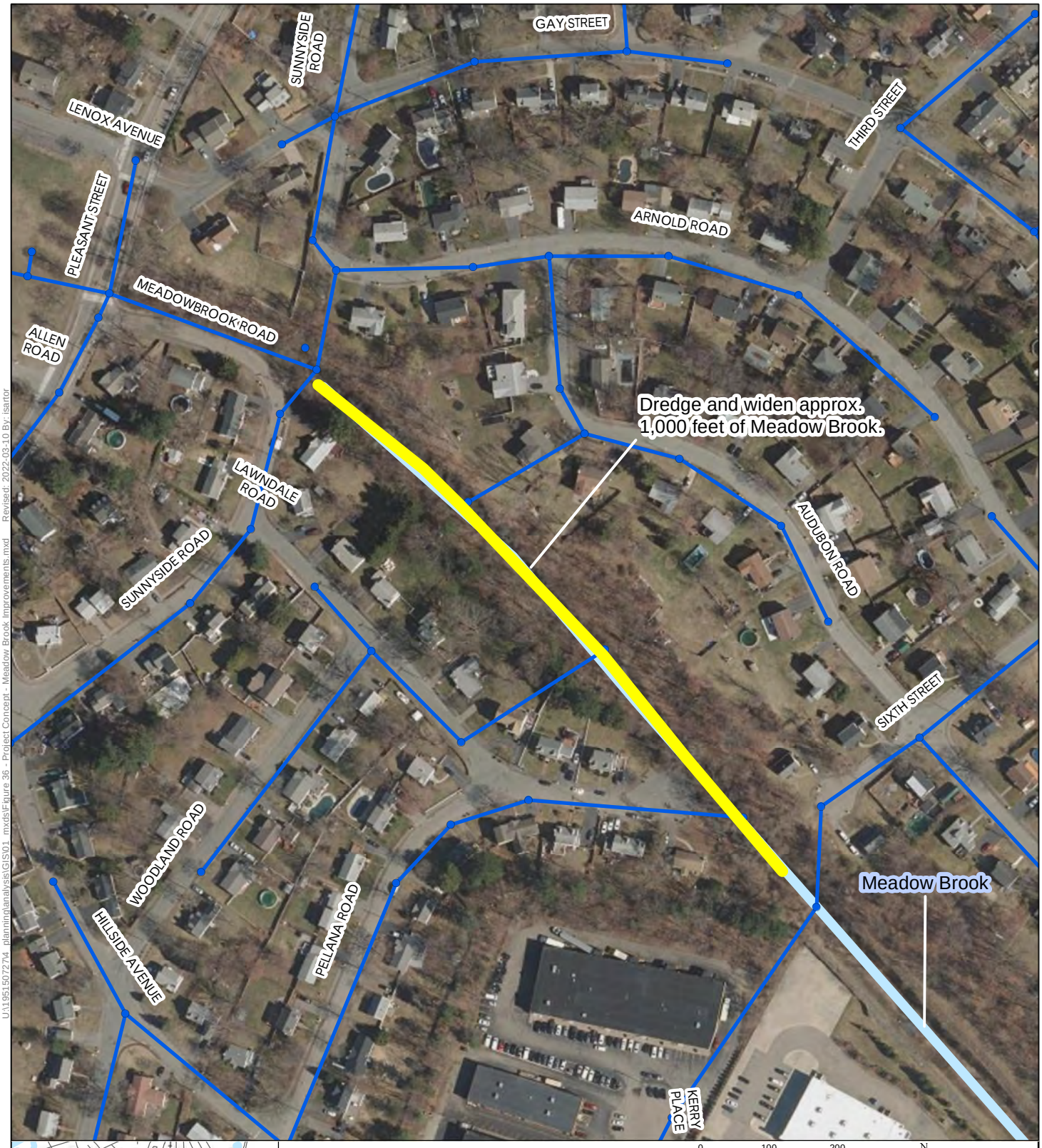
Figure 35 – Meadow Brook 1997 Downstream Improvements

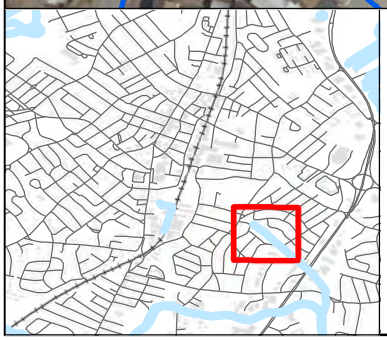
A preliminary estimate of construction duration is approximately 12 weeks, which does not account for Contractor startup/mobilization activities.

Table 19 – Meadow Brook Improvement Concept – Est. Capital Cost

Major Components:	-Dredge and widen Meadow Brook, approx. 1,000 LF.
Class 4 Opinion of Construction Cost	**$743,000**
Scope Contingency (20%)	$149,000
Market Factor (20%)	$149,000
Subtotal Opinion of Construction Cost	**$1,041,000**
Site Investigation / Geotechnical (7.5%)	$79,000
Design Engineering (12.5%)	$131,000
Engineering Services During Constr. (5%)	$53,000
Construction Management (10%)	$105,000
Temporary Easements	$0
Estimated Capital Cost	**$1,409,000**

Figure 35 shows a map of the concept for Meadow Brook improvements.





Notes
1. Coordinate System: GCS WGS 1984

Legend
- Model Nodes - Existing
- Model Conduits - Existing
- Proposed Work
- Open Waterway

0 100 200 Feet

1 inch = 200 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
36

Title
Project Concept:
Meadow Brook Improvements

6.10 JACOBSEN DRIVE

Jacobsen Drive at Redwood Drive has a natural bowl-shaped topography that floods in large storms. Owing to the flat elevation in the vicinity, even after implementation of the proposed flood relief projects, the neighborhood will remain vulnerable to flooding in large storms, although floods will be less deep.

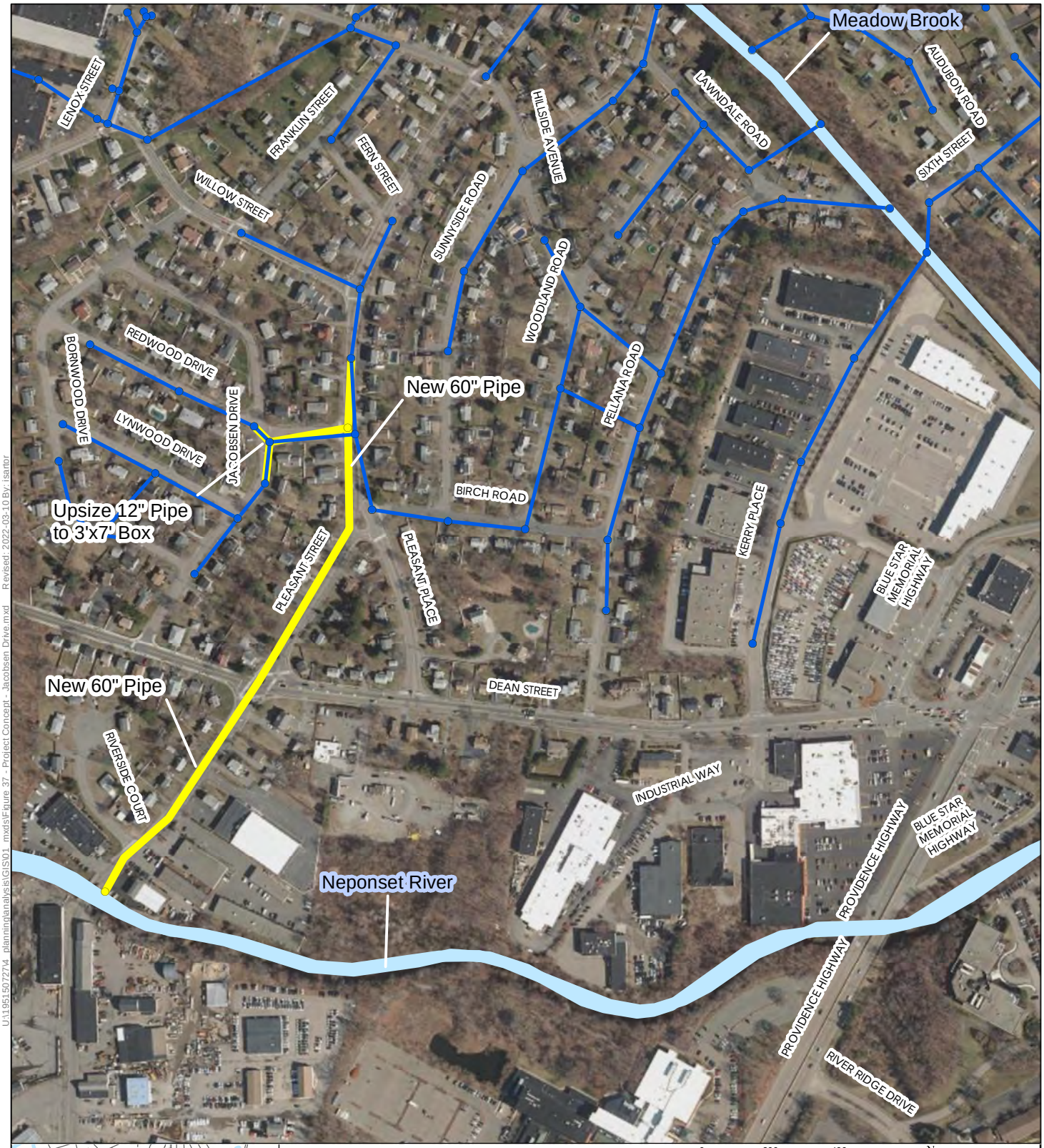
The proposed concept for Jacobsen Drive is shown in Figure 37. This concept carries flows from Jacobsen Drive and Redwood Drive directly to the Neponset River. A new 60" pipe would be routed south along Pleasant Street to discharge stormwater in the vicinity of the existing outfall. Because the existing outfall serves only an 18" pipe, a new outfall would need to be built. As mentioned in Section 5.6, peak flows to the Neponset River cannot be increased. The increased flows to the Neponset at Pleasant Street would need to be offset by decreasing flows from Meadow Brook, which could be achieved through stormwater detention at Hennessey Field. Permitting processes are anticipated to be significant. A preliminary estimate of construction duration is approximately 18 weeks, which does not account for Contractor startup/mobilization activities.

An alternative concept, shown in Figure 38, is similar to the 2004 Study and increases capacity to Meadow Brook by replacing approximately 2,400 feet of existing pipes with a box culvert 3' tall and 7' wide. The non-traditional dimensions of the box culvert accommodate high groundwater, match the shallow invert at Meadow Brook, and provide 2' depth of bury. It is assumed that a wide box would conflict with the sewer main, so the costs assume replacement of the existing sewer mains along the entire alignment with new double-barrel sewers to receive lateral flows from each side of the street. This work would occur in residential neighborhoods and would likely encounter high groundwater, but it would reduce flooding all along the alignment. A preliminary estimate of construction duration is approximately 30 weeks, which does not account for Contractor startup/mobilization activities.

Table 20 – Jacobsen Drive Drainage Concepts – Est. Capital Cost

Major Components:	**Proposed:** -New 60" pipe in Pleasant St, approx. 2,000 LF. -New outfall at Neponset River.	**Alternative:** -New 3' x 7' box culvert in various streets, approx. 3,000 LF.
Class 4 Opinion of Construction Cost	**$2,589,000**	**$5,548,000**
Scope Contingency (20%)	$518,000	$1,110,000
Market Factor (20%)	$518,000	$1,110,000
Subtotal Opinion of Construction Cost	**$3,625,000**	**$7,768,000**
Site Investigation / Geotechnical (7.5%)	$272,000	$583,000
Design Engineering (12.5%)	$454,000	$971,000
Engineering Services During Constr. (5%)	$182,000	$389,000
Construction Management (10%)	$363,000	$777,000
Temporary Easements	$0	$0
Estimated Capital Cost	**$4,896,000**	**$10,488,000**

Figure 37 and Figure 38 show maps of the concepts for Jacobsen Drive, proposed and alternative, respectively.



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Existing Manhole
- Existing Pipe
- Proposed Work
- Open Waterway

0 200 400 Feet

1 inch = 400 feet

N

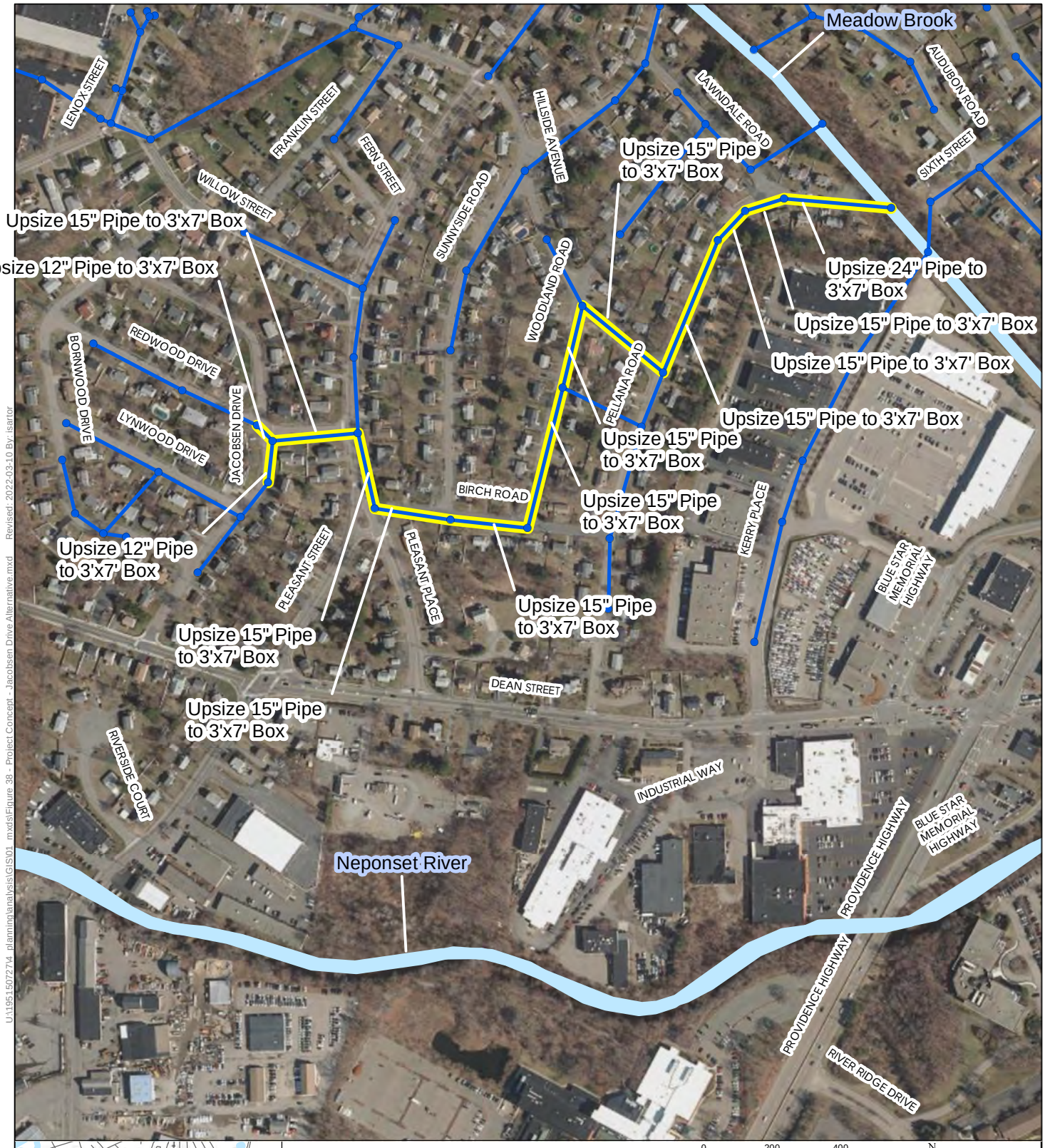
Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

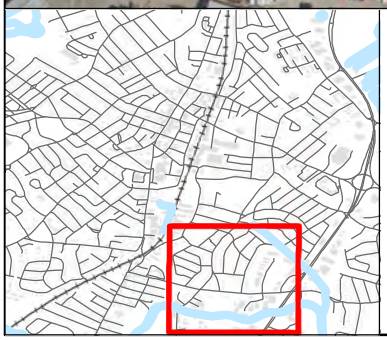
Figure No.
37

Title
Project Cocept:
Jacobsen Drive

U:\195\507274 planninganalysis\GIS\01 mxds\Figure 37 - Project Concept - Jacobsen Drive.mxd Revised: 2022-03-10 By: lsartor



U:\195\507274 planninganalysis\GIS\01 mxd\sFigure 38 - Project Concept - Jacobsen Drive Alternative.mxd Revised: 2022-03-10 By: isartor



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Legend
- Model Nodes - Existing
- Model Conduits - Existing
- Proposed Work
- Open Waterway

0 200 400 Feet

1 inch = 400 feet

N

Stantec

Client: Town of Norwood
Project: Meadow Brook Drainage Study

Figure No.
38

Title
Project Concept:
Jacobsen Drive - Alternative

6.11 PHASING APPROACH

When implementing capital projects for drainage, downstream improvements must be implemented prior to upstream improvements, so as not to create conditions where increased flows conveyed to areas that have insufficient capacity will experience increased flooding. In this case, the proposed phasing shown in Table 21 would allow for improvements to be implemented as funding becomes available, starting with the downstream-most projects.

Hennessey Field Storage would need to be constructed first, to store and control flows to Meadow Brook. As the Hennessey Field project is anticipated to be a complex and lengthy design undertaking Meadow Brook improvements could be implemented simultaneously. The new box culvert and creek daylighting from Murphy Field to Meadow Brook would be next, followed by the Guild Street project. The upstream projects (Phases 4A, 4B, and 4C) could be implemented in the Town's order of preference as funds become available.

Table 21 – Potential Phasing Approach for Proposed Capital Improvements

Phase	Project Concept	Planning-Level Opinion of Probable Capital Cost	
1	Hennessey	$ 8,086,000	$ 9,495,000
	Meadow Brook	$ 1,409,000	
2	Murphy to Meadow Brook	$ 2,397,000	$ 2,397,000
3	Guild St	$ 5,558,000	$ 5,558,000
4A	E. Vernon	$ 2,804,000	$ 4,635,000
	Nahatan Underpass	$ 1,831,000	
4B	E. Hoyle	$ 8,415,000	$ 10,406,000
	Washington St	$ 1,991,000	
4C	Jacobsen	$ 4,896,000	$ 4,896,000

7.0 GRANT FUNDING OPPORTUNITIES

Flood infrastructure projects can be eligible for funding from programs such as MVP, FEMA, and ARPA. Additionally, where multiple improvements are needed in one vicinity, stormwater improvements bundled with surface improvements such as transportation improvements may be eligible for funding from MassDOT Complete Streets, MassWorks, and USDOT BUILD.

The grant application requirements vary significantly. Most Federal grant applications require a FEMA benefit-cost analysis to determine project benefits (long-term risk reduction) and costs (life cycle) using specific methodologies and tools.

Most public grants have a funding match requirement and require strict reporting throughout the duration of the project.

Appendix A FLOW METER INSTALLATION LOGS

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NorwoodMA

Final Report Submitted to **NorwoodMA**
June 23, 2021

ADS ENVIRONMENTAL SERVICES

340 The Bridge Street, Suite 204
Huntsville, AL 35806

800-633-7246
www.adsenv.com

June 23, 2021

Stefani Harrison Senior Associate
Norwood, MA
Stantec
65 Network Drive, 2nd Floor
Burlington, MA 01803

SUBJECT: NorwoodMA

Dear Stefani Harrison,

ADS is pleased to submit the report for the NorwoodMA completed on behalf of NorwoodMA. The metering was conducted at six (6) locations. The study was conducted during the period of Tuesday, March 23, 2021 to Sunday, June 13, 2021.

The report contains depth, velocity, and quantity hydrographs as well as daily long tables for the metering period. An Excel file containing depth, quantity, and velocity entities for the monitoring location in 5-minute format was provided previously.

In addition, we would be happy to further explain any details about the report that may seem unclear. Should you have any questions or comments, you may contact the Project Manager, Mike Armes at 914-290-3093 .

It has been our pleasure to be of service to you in the performance of this project. Thank you for choosing ADS products and services to meet your flow monitoring needs.

Sincerely,
ADS ENVIRONMENTAL SERVICES

Melissa Hygom
Data Analyst III, Londonderry NH

NorwoodMA

Prepared For:

Stefani Harrison Senior Associate
Norwood, MA
Stantec 65 Network Drive, 2nd
FloorBurlington, MA 01803

Prepared By:

ADS, LLC
340 The Bridge Street, Suite 204
Huntsville, AL 35806

EastHoyleSt

Site Commentary

SITE INFORMATION

Pipe	Round (36 in H)
Silt	0.00 (in)

OBSERVATIONS

Average flow depth, velocity, and quantity data observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021**, along with observed minimum and maximum data, are provided in the following table.

Observed Flow Conditions			
Item	**DFINAL (in)**	**VFINAL (ft/s)**	**QFINAL (MGD - Total MG)**
Average	2.50	1.55	0.253
Minimum	1.70	0.80	0.063
Maximum	15.28	7.65	13.763
Min Time	05/26/2021 01:45:00	05/26/2021 02:55:00	05/26/2021 02:55:00
Max Time	04/21/2021 17:45:00	04/21/2021 17:40:00	04/21/2021 17:40:00

Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Values in the Observed Flow Conditions and data on the graphical reports are based on the none average.

DATA UPTIME

Data uptime observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021** is provided in the following table:

Percent Uptime	
DFINAL (in)	100
VFINAL (ft/s)	100
QFINAL (MGD - Total MG)	100

Norwood, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

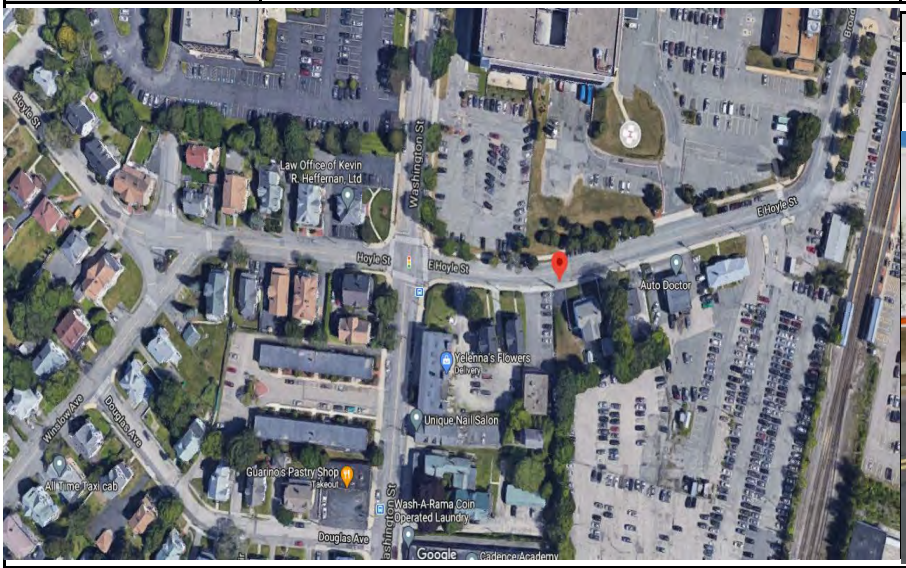
Site I.D.

EastHoyleSt

Site Address / Location:	15 East Hoyle St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
36x36	Circular

Manhole #	System Characteristics
	Commercial
Access	Traffic
Drive	None



ADS Project Name:	Norwood
ADS Project Number:	32685.11.325

Installation Information

Installation Date:	Installation Type:
Monday, March 22, 2021	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV Gated (CS7)	0 - 30 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:38am	60.75x60.75
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.00"	34.0
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
0.8	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
60.75	
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	24
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

42.187618, -71.201955 S/N:61771 IP:166.219.48.166

Hydrograph Report

EastHoyleSt

Flow Monitor

EastHoyleSt

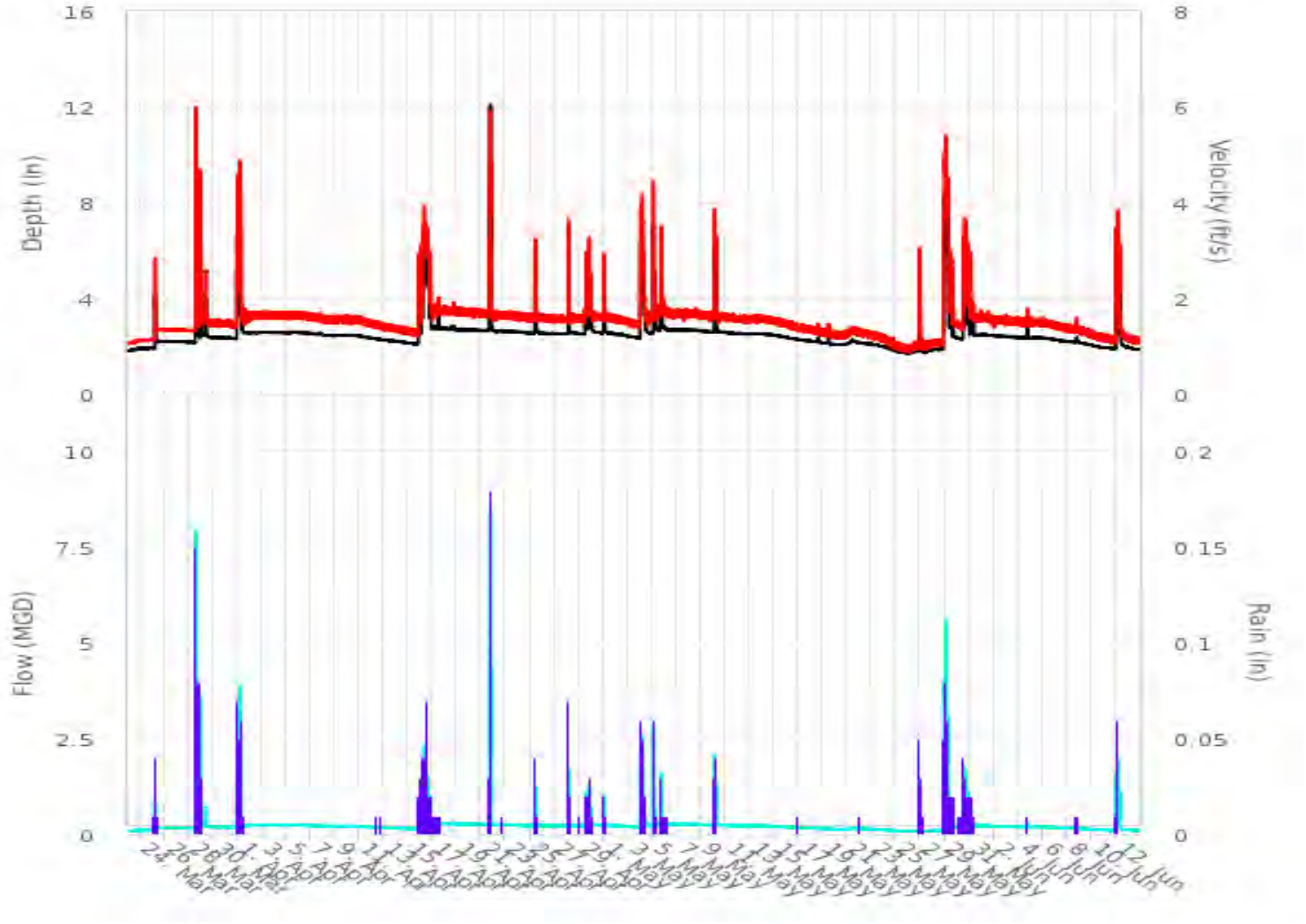
Pipe Height
36.00
in

Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL
- VFINAL
- QFINAL
- RAIN FINAL



ENVIRONMENTAL SERVICES

340 The Bridge Street, Suite 204
Huntsville, AL 35806

800-633-7246
www.adsenv.com

Scattergraph Report

EastHoyleSt

Flow Monitor

EastHoyleSt

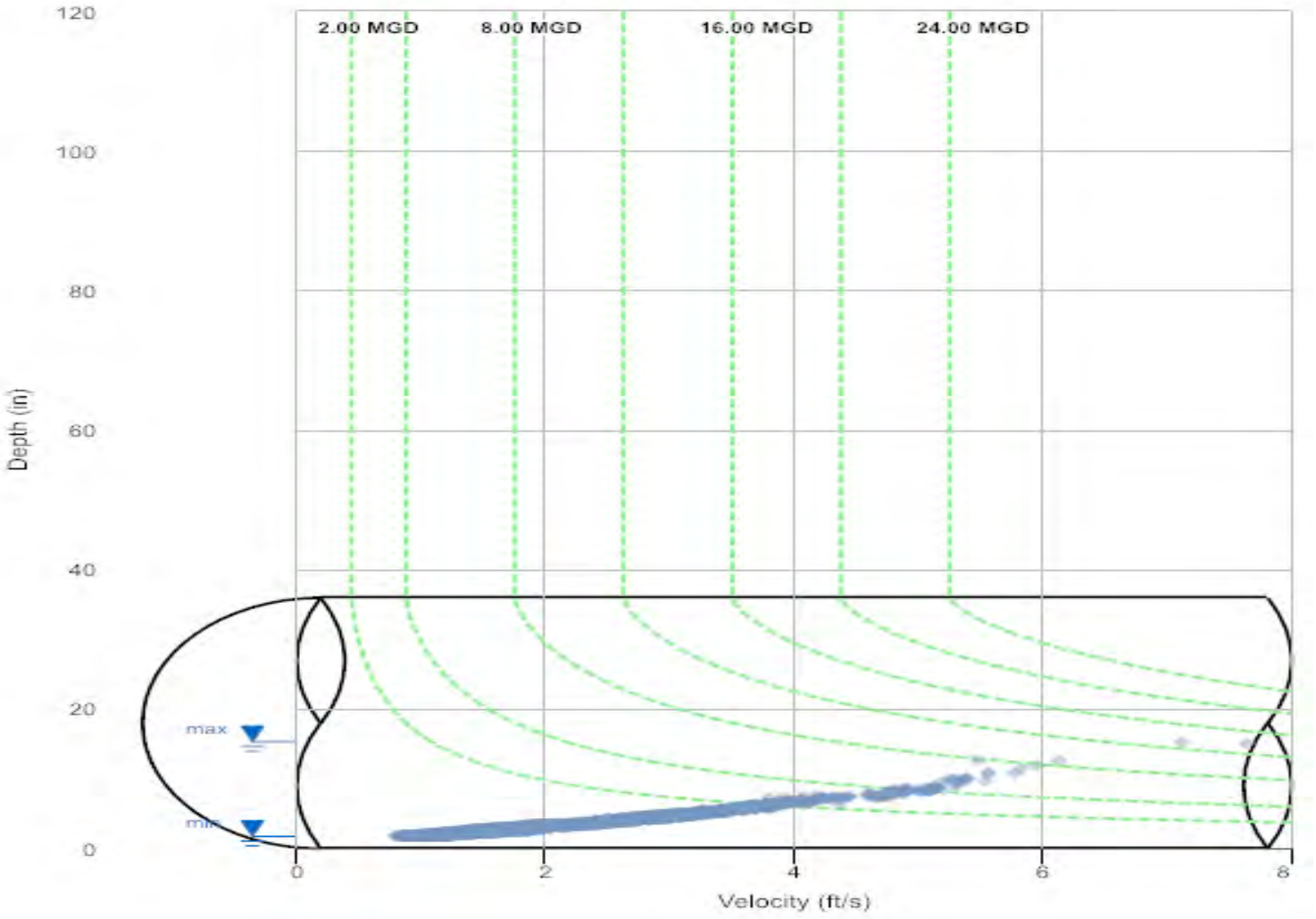
Pipe Height
36.00
in

Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL - VFINAL
- Iso-Q™
- Min-Max Depth



340 The Bridge Street, Suite 204
Huntsville, AL 35806

800-633-7246
www.adsenv.com

Daily Tabular Report

03/23/2021 00:00 - 06/13/2021 23:55
EastHoyleStPipe: Round (36 in H), Silt0.00 in

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
03/23/2021	03:20	1.81	23:50	1.93	1.86	03:20	1.05	23:50	1.14	1.09	03:20	0.090	23:50	0.108	0.097	0.097	-
03/24/2021	09:20	1.88	21:35	1.95	1.91	09:20	1.10	21:35	1.16	1.13	09:20	0.100	21:35	0.112	0.105	0.105	-
03/25/2021	05:55	1.87	06:25	4.21	2.20	05:55	1.10	06:10	2.96	1.34	05:55	0.099	06:10	0.881	0.163	0.163	0.11
03/26/2021	16:00	2.16	08:50	2.22	2.19	16:00	1.31	08:50	1.36	1.34	16:00	0.147	08:50	0.159	0.153	0.153	-
03/27/2021	22:20	2.15	08:55	2.22	2.19	22:20	1.31	08:55	1.36	1.34	22:20	0.145	08:55	0.159	0.152	0.152	-
03/28/2021	06:55	2.13	14:30	12.62	3.01	06:55	1.29	14:30	6.14	1.84	06:55	0.141	14:30	8.760	0.546	0.546	0.78
03/29/2021	22:00	2.33	00:40	4.89	2.67	02:20	1.34	00:35	3.17	1.69	19:35	0.175	00:40	1.175	0.287	0.287	0.06
03/30/2021	21:00	2.33	00:55	2.39	2.35	23:30	1.34	08:25	1.62	1.47	23:30	0.168	08:25	0.206	0.187	0.187	-
03/31/2021	21:15	2.29	23:10	5.68	2.44	17:35	1.33	23:10	3.66	1.53	17:35	0.165	23:10	1.689	0.226	0.226	0.17
04/01/2021	20:45	2.52	04:25	8.48	3.51	19:50	1.39	04:30	4.93	2.20	12:25	0.198	04:25	4.031	0.677	0.677	0.76
04/02/2021	13:05	2.54	02:15	2.60	2.56	12:20	1.41	01:20	1.88	1.64	03:25	0.203	01:20	0.270	0.237	0.237	-
04/03/2021	18:15	2.55	23:50	2.60	2.57	20:20	1.52	15:45	1.78	1.65	20:20	0.219	05:55	0.259	0.238	0.238	-
04/04/2021	04:50	2.54	02:40	2.60	2.56	04:35	1.52	14:45	1.79	1.64	04:35	0.217	14:45	0.261	0.237	0.237	-
04/05/2021	03:50	2.54	13:10	2.63	2.57	23:55	1.51	17:40	1.81	1.65	08:30	0.215	17:40	0.269	0.238	0.238	-
04/06/2021	21:45	2.50	09:20	2.63	2.55	22:15	1.50	02:55	1.77	1.63	22:15	0.211	09:25	0.258	0.234	0.234	-
04/07/2021	23:45	2.44	18:55	2.59	2.51	23:30	1.46	16:40	1.75	1.60	23:30	0.197	19:00	0.248	0.223	0.223	-
04/08/2021	19:50	2.42	01:10	2.47	2.44	20:55	1.41	00:55	1.70	1.55	20:55	0.188	00:55	0.231	0.208	0.208	-
04/09/2021	12:25	2.43	23:50	2.48	2.45	19:55	1.43	14:40	1.69	1.56	19:15	0.193	14:40	0.229	0.211	0.211	-
04/10/2021	21:45	2.41	05:10	2.49	2.45	00:50	1.35	08:45	1.71	1.55	00:50	0.183	08:45	0.234	0.209	0.209	-
04/11/2021	23:10	2.33	01:00	2.45	2.38	22:50	1.34	02:50	1.67	1.50	22:50	0.169	02:50	0.222	0.194	0.194	-
04/12/2021	19:55	2.23	02:35	2.35	2.30	21:50	1.27	01:50	1.61	1.43	21:50	0.150	01:50	0.204	0.176	0.176	0.02
04/13/2021	23:00	2.19	00:00	2.28	2.23	15:55	1.24	00:50	1.55	1.38	15:55	0.145	00:50	0.186	0.163	0.163	-
04/14/2021	23:25	2.12	00:15	2.23	2.17	19:50	1.18	04:45	1.49	1.33	19:50	0.131	04:45	0.171	0.150	0.150	-
04/15/2021	16:55	2.08	21:50	4.50	2.36	13:55	1.14	21:55	2.97	1.46	13:55	0.122	21:55	0.966	0.216	0.216	0.25
04/16/2021	01:35	2.51	07:40	6.76	4.31	01:50	1.38	07:40	3.97	2.75	01:45	0.195	07:40	2.361	0.932	0.932	1.47
04/17/2021	17:40	2.70	12:05	3.29	2.78	18:40	1.53	12:10	2.07	1.75	18:40	0.242	12:10	0.429	0.286	0.286	0.10
04/18/2021	22:40	2.67	14:15	2.87	2.73	18:00	1.53	16:10	1.97	1.75	20:45	0.243	16:10	0.324	0.277	0.277	-
04/19/2021	22:15	2.65	15:10	2.75	2.68	14:10	1.54	04:40	1.89	1.71	14:10	0.235	04:40	0.301	0.263	0.263	-
04/20/2021	23:00	2.62	12:45	2.72	2.66	09:45	1.49	03:40	1.84	1.69	09:45	0.227	06:00	0.283	0.257	0.257	-
04/21/2021	14:45	2.62	17:45	15.28	3.15	23:10	1.51	17:40	7.65	1.95	23:10	0.229	17:40	13.763	0.555	0.555	0.49
04/22/2021	05:40	2.54	09:55	2.68	2.63	14:50	1.46	13:15	1.85	1.64	06:15	0.213	13:15	0.282	0.245	0.245	0.01
04/23/2021	23:25	2.56	00:10	2.67	2.61	20:40	1.48	00:40	1.78	1.63	20:40	0.215	00:40	0.267	0.240	0.240	-
04/24/2021	23:40	2.53	01:50	2.64	2.56	19:40	1.45	04:35	1.73	1.60	19:40	0.205	02:00	0.256	0.230	0.230	-
04/25/2021	02:15	2.53	09:45	5.16	2.76	16:15	1.41	09:50	3.29	1.73	16:15	0.204	09:45	1.321	0.304	0.304	0.22
04/26/2021	14:40	2.49	07:30	2.59	2.52	17:40	1.43	02:35	1.72	1.57	17:40	0.199	07:30	0.247	0.221	0.221	-
04/27/2021	00:35	2.48	08:45	2.53	2.51	11:45	1.43	06:30	1.71	1.56	11:45	0.198	06:30	0.242	0.219	0.219	-
04/28/2021	00:15	2.50	03:25	5.87	2.74	18:00	1.31	03:20	3.74	1.70	18:00	0.187	03:20	1.813	0.297	0.297	0.20
04/29/2021	08:55	2.48	20:40	5.27	2.99	04:50	1.43	20:40	3.36	1.86	04:50	0.198	20:40	1.392	0.374	0.374	0.40
04/30/2021	23:25	2.51	00:00	3.42	2.61	04:00	1.42	00:00	2.20	1.63	23:30	0.203	00:00	0.483	0.242	0.242	0.04
05/01/2021	22:35	2.46	01:05	4.62	2.68	22:20	1.43	00:55	2.94	1.68	22:20	0.197	01:05	1.004	0.271	0.271	0.12
05/02/2021	21:35	2.40	00:45	2.53	2.48	14:35	1.29	11:50	1.71	1.54	14:35	0.176	11:50	0.239	0.211	0.211	-
05/03/2021	23:35	2.32	00:00	2.43	2.37	20:20	1.33	10:50	1.61	1.47	20:20	0.168	00:05	0.213	0.190	0.190	-
05/04/2021	00:10	2.32	04:40	7.12	3.46	16:30	1.35	04:45	4.22	2.17	00:15	0.178	04:45	2.697	0.603	0.603	0.80
05/05/2021	02:00	2.52	02:40	7.46	3.10	05:45	1.44	02:40	4.72	1.95	02:10	0.218	02:40	3.227	0.423	0.423	0.42
05/06/2021	21:05	2.66	00:35	2.82	2.69	16:35	1.49	00:20	1.97	1.69	22:35	0.232	00:20	0.325	0.262	0.262	0.01
05/07/2021	19:10	2.63	14:40	2.75	2.66	15:20	1.46	19:45	1.86	1.67	17:45	0.223	19:45	0.290	0.255	0.255	-
05/08/2021	20:45	2.62	01:50	2.71	2.65	18:55	1.42	12:55	1.90	1.66	18:55	0.213	12:55	0.294	0.251	0.251	-
05/09/2021	22:35	2.56	03:40	2.68	2.60	18:30	1.41	09:45	1.78	1.63	18:30	0.207	03:45	0.266	0.240	0.240	-
05/10/2021	23:35	2.56	03:30	6.30	3.05	12:45	1.42	03:35	3.92	1.91	12:45	0.210	03:35	2.095	0.424	0.424	0.42
05/11/2021	21:45	2.51	04:10	2.62	2.55	22:50	1.45	02:50	1.74	1.59	22:50	0.205	02:50	0.252	0.227	0.227	-
05/12/2021	15:45	2.49	02:35	2.59	2.51	16:55	1.43	01:50	1.71	1.56	16:55	0.198	01:50	0.242	0.218	0.218	-
05/13/2021	01:25	2.48	21:55	2.54	2.51	20:50	1.43	05:45	1.71	1.56	20:50	0.199	05:45	0.241	0.218	0.218	-
05/14/2021	22:05	2.43	04:00	2.54	2.49	10:20	1.40	04:45	1.69	1.54	14:55	0.191	04:45	0.236	0.213	0.213	-
05/15/2021	22:40	2.37	00:00	2.48	2.42	23:45	1.34	08:40	1.65	1.50	23:45	0.173	08:40	0.221	0.198	0.198	-
05/16/2021	23:55	2.25	00:00	2.39	2.32	17:50	1.27	02:45	1.59	1.42	17:50	0.155	02:45	0.203	0.177	0.177	0.01
05/17/2021	17:05	2.21	03:15	2.29	2.25	16:50	1.21	01:45	1.53	1.36	16:50	0.142	01:45	0.186	0.162	0.162	-
05/18/2021	23:05	2.13	15:15	2.41	2.19	20:45	1.16	15:30	1.55	1.32	20:45	0.130	15:05	0.197	0.150	0.150	-
05/19/2021	23:40	2.07	10:35	2.48	2.12	19:45	1.12	10:45	1.52	1.27	19:45	0.119	10:15	0.199	0.138	0.138	-
05/20/2021	14:50	2.06	23:00	2.11	2.07	13:50	1.10	23:20	1.38	1.23	13:50	0.115	23:20	0.148	0.130	0.130	-
05/21/2021	01:10	2.09	09:55	2.32	2.17	02:20	1.16	12:30	1.47	1.30	02:20	0.126	09:55	0.175	0.146	0.146	-
05/22/2021	16:30	2.06	00:35	2.18	2.11	16:45	1.10	01:40	1.43	1.26	16:45	0.115	01:40	0.160	0.137	0.137	0.01
05/23/2021	22:30	1.96	01:15	2.08	2.03	20:40	1.03	00:40	1.35	1.19	20:40	0.102	00:40	0.140	0.122	0.122	-
05/24/2021	23:55	1.77	00:25	1.99	1.89	19:40	0.89	04:35	1.29	1.08	19:40	0.077	04:35	0.126	0.100	0.100	-
05/25/2021	23:50	1.70	02:25	1.81	1.75	23:35	0.81	03:35	1.13	0.97	23:35	0.064	03:35	0.094	0.079	0.079	-
05/26/2021	01:45	1.70	21:55	4.87	1.97	02:55	0.80	21:55	3.18	1.13	02:55	0.063	21:55	1.175	0.146	0.146	0.18
05/27/2021	09:25	1.71	00:00	2.60	1.84	08:25	0.87	00:05	1.53	1.04	10:30	0.070	00:00	0.217	0.092	0.092	0.03
05/28/2021	12:40	1.80	23:10	8.41	2.54	00:55	0.93	23:45	5.12	1.48	12:35	0.082	23:45	4.116	0.428	0.428	0.74
05/29/2021	23:10	2.33	01:40	10.02	4.27	19:35	1.35	01:35	5.41	2.65	23:15	0.173	01:35	5.617	1.183	1.183	1.43

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
05/30/2021	08:15	2.26	14:45	5.94	3.22	08:05	1.27	14:45	3.76	2.06	08:05	0.153	14:45	1.854	0.505	0.505	0.57
05/31/2021	11:20	2.42	02:35	4.46	2.68	16:40	1.39	02:35	3.00	1.73	16:40	0.190	02:35	0.975	0.284	0.284	0.14
06/01/2021	21:15	2.43	07:00	2.52	2.47	22:45	1.38	14:00	1.78	1.59	22:45	0.185	07:00	0.243	0.216	0.216	-
06/02/2021	21:05	2.38	00:05	2.46	2.42	23:10	1.33	23:05	1.69	1.54	22:30	0.175	23:05	0.227	0.204	0.204	-
06/03/2021	15:25	2.34	03:05	2.44	2.38	00:05	1.33	00:20	1.75	1.52	00:05	0.174	00:20	0.228	0.197	0.197	-
06/04/2021	23:25	2.31	17:30	2.88	2.37	19:55	1.31	18:00	1.80	1.52	19:55	0.165	17:35	0.303	0.196	0.196	0.05
06/05/2021	00:05	2.32	08:35	2.41	2.35	13:25	1.37	08:50	1.65	1.50	13:25	0.172	08:50	0.213	0.190	0.190	-
06/06/2021	19:50	2.27	00:35	2.37	2.31	22:55	1.31	00:25	1.69	1.47	22:55	0.160	00:25	0.215	0.182	0.182	-
06/07/2021	21:35	2.19	00:10	2.29	2.23	21:55	1.24	01:55	1.56	1.40	21:55	0.143	01:00	0.187	0.165	0.165	-
06/08/2021	16:40	2.14	19:40	2.38	2.19	20:55	1.23	19:35	1.60	1.37	15:20	0.138	19:40	0.208	0.156	0.156	0.04
06/09/2021	22:50	2.04	00:00	2.18	2.10	19:55	1.13	04:50	1.46	1.29	19:55	0.117	04:50	0.161	0.139	0.139	-
06/10/2021	21:30	1.93	00:00	2.08	1.99	23:50	1.04	03:50	1.37	1.20	23:50	0.100	01:15	0.141	0.119	0.119	-
06/11/2021	20:30	1.89	00:15	1.96	1.92	17:55	0.99	02:50	1.29	1.14	17:55	0.092	00:30	0.123	0.107	0.107	0.03
06/12/2021	21:40	1.94	04:50	6.03	2.72	21:50	1.04	04:50	3.85	1.71	21:50	0.101	04:50	1.938	0.363	0.363	0.14
06/13/2021	18:35	1.87	00:05	1.97	1.90	15:55	0.98	00:50	1.29	1.13	15:55	0.089	00:50	0.123	0.104	0.104	-

03/23/2021 00:00 - 06/13/2021 23:55

	DFINAL (in)	VFINAL (ft/s)	QFINAL (MGD - Total MG)	Rain (in)
Total			20.989	10.22
Average	2.50	1.55	0.253	

GuildSt

Site Commentary

SITE INFORMATION

Pipe	Round (36 in H)
Silt	0.00 (in)

OBSERVATIONS

Average flow depth, velocity, and quantity data observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021**, along with observed minimum and maximum data, are provided in the following table.

REPLACE OTHER SITE OBSERVATIONS HERE

Observed Flow Conditions			
Item	**DFINAL (in)**	**VFINAL (ft/s)**	**QFINAL (MGD - Total MG)**
Average	2.03	1.23	0.144
Minimum	1.46	0.74	0.052
Maximum	14.63	3.81	6.338
Min Time	05/26/2021 21:40:00	05/28/2021 15:40:00	05/28/2021 15:40:00
Max Time	03/28/2021 14:25:00	04/01/2021 04:25:00	03/28/2021 14:25:00

Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Values in the Observed Flow Conditions and data on the graphical reports are based on the none average.

DATA UPTIME

Data uptime observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021** is provided in the following table:

Percent Uptime	
DFINAL (in)	100
VFINAL (ft/s)	100
QFINAL (MGD - Total MG)	100

Norwood, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

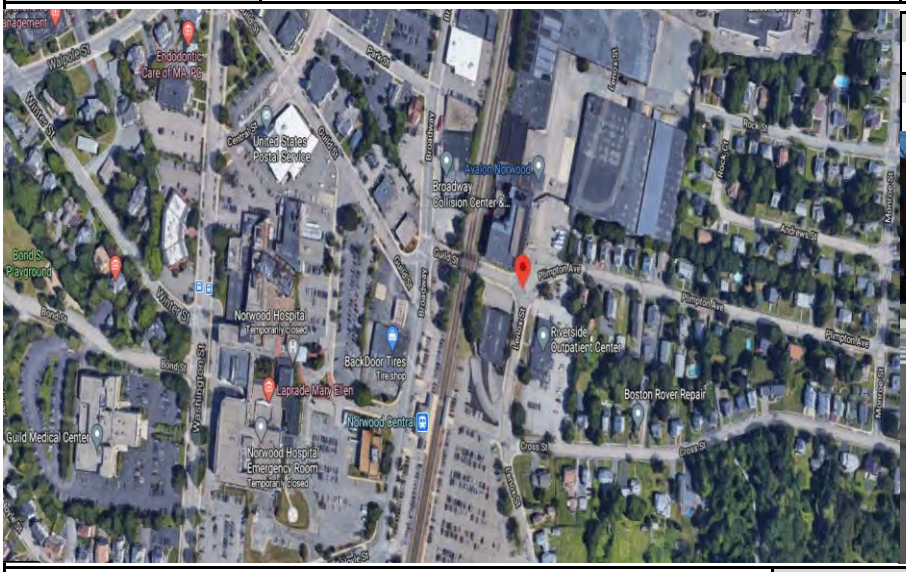
Site I.D.

GuildSt

Site Address / Location:	Guild St at Lenox St (see coordinates)
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
36x36	Circular

Manhole #	System Characteristics
	Commercial
Access	Traffic
Drive	None



Installation Information

Installation Date:	Installation Type:
Monday, March 22, 2021	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV Gated (CS7)	0 - 30 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:38am	30"x30"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.00"	28.00"
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
0.25	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
132.88	
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	24
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

42.189515, -71.198622 S/N:51557 IP:166.219.48.195

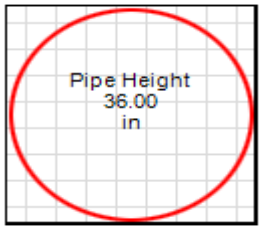
ADS Project Name:	Norwood
ADS Project Number:	32685.11.325

Hydrograph Report

GuildSt

Flow Monitor

GuildSt



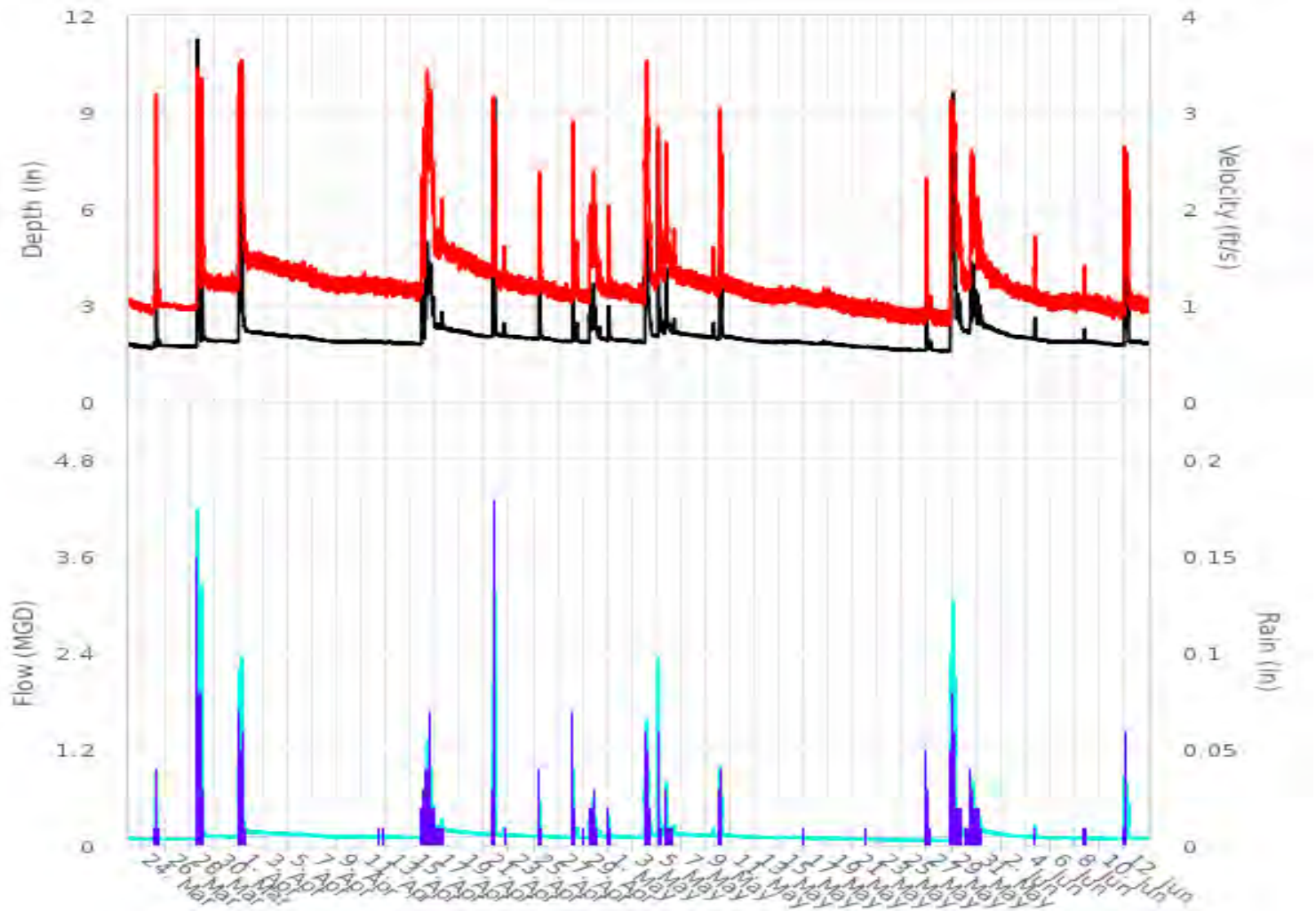
Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL
- VFINAL
- QFINAL
- RAIN FINAL

ADS ENVIRONMENTAL SERVICES



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Huntsville, AL 35806

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Scattergraph Report

GuildSt

Flow Monitor

GuildSt

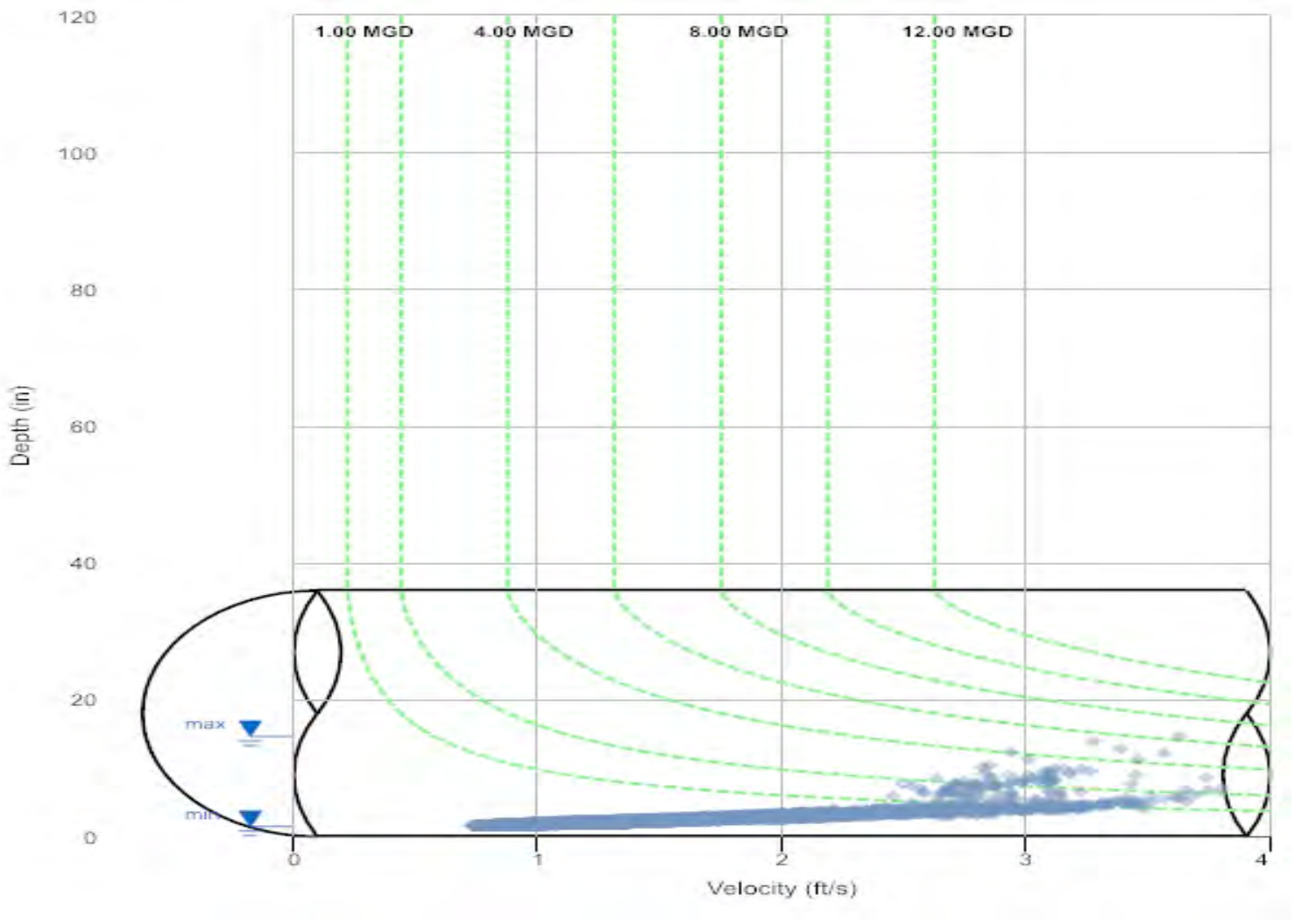
Pipe Height
36.00
in

Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL - VFINAL
- Iso-Q™
- Min-Max Depth



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Huntsville, AL 35806

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Daily Tabular Report

03/23/2021 00:00 - 06/13/2021 23:55
GuildStPipe: Round (36 in H), Silt0.00 in

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
03/23/2021	23:35	1.66	01:15	1.83	1.75	23:35	0.92	01:15	1.08	1.00	23:35	0.070	01:15	0.094	0.082	0.082	-
03/24/2021	19:35	1.63	01:00	1.77	1.70	19:35	0.89	01:00	1.02	0.96	19:35	0.066	01:00	0.085	0.075	0.075	-
03/25/2021	00:40	1.66	06:05	4.29	1.81	00:40	0.92	06:00	3.25	1.07	00:40	0.070	06:05	0.976	0.100	0.100	0.11
03/26/2021	11:40	1.71	03:40	1.78	1.73	11:40	0.97	03:40	1.03	0.99	11:40	0.076	03:40	0.087	0.080	0.080	-
03/27/2021	17:00	1.67	04:00	1.76	1.71	17:00	0.94	04:00	1.02	0.97	17:00	0.072	04:00	0.084	0.077	0.077	-
03/28/2021	06:10	1.68	14:25	14.63	2.47	06:10	0.94	22:25	3.74	1.50	06:10	0.073	14:25	6.338	0.330	0.330	0.78
03/29/2021	15:35	1.86	00:35	3.66	2.01	19:35	1.11	00:30	2.84	1.34	19:35	0.102	00:30	0.684	0.144	0.144	0.06
03/30/2021	00:35	1.85	05:50	1.93	1.89	03:10	1.09	23:10	1.37	1.22	03:10	0.098	23:10	0.127	0.112	0.112	-
03/31/2021	11:35	1.84	23:05	4.52	1.96	02:50	1.08	23:00	3.46	1.28	12:00	0.096	23:00	1.145	0.136	0.136	0.17
04/01/2021	20:25	2.14	00:25	12.18	2.87	17:00	1.31	04:25	3.81	1.97	17:00	0.148	00:25	4.868	0.421	0.421	0.76
04/02/2021	20:45	2.08	13:20	2.21	2.14	13:45	1.29	11:50	1.62	1.46	20:45	0.141	11:50	0.185	0.161	0.161	-
04/03/2021	22:20	2.04	00:05	2.16	2.10	20:20	1.30	00:05	1.58	1.42	12:45	0.136	00:05	0.178	0.153	0.153	-
04/04/2021	13:50	1.99	02:35	2.12	2.05	14:25	1.25	02:35	1.51	1.38	13:50	0.125	02:35	0.165	0.143	0.143	-
04/05/2021	17:15	1.98	15:15	2.07	2.02	08:30	1.22	23:35	1.50	1.35	08:30	0.123	23:35	0.154	0.138	0.138	-
04/06/2021	22:15	1.93	00:50	2.08	1.99	22:15	1.15	02:55	1.47	1.32	22:15	0.109	00:50	0.152	0.131	0.131	-
04/07/2021	23:05	1.87	01:20	1.98	1.92	21:55	1.12	01:55	1.43	1.26	21:15	0.104	01:55	0.139	0.118	0.118	-
04/08/2021	23:35	1.83	02:05	1.92	1.88	20:15	1.09	00:55	1.37	1.22	20:15	0.098	00:55	0.127	0.111	0.111	-
04/09/2021	12:40	1.82	22:55	1.91	1.86	19:55	1.06	04:50	1.34	1.20	19:55	0.094	22:10	0.122	0.108	0.108	-
04/10/2021	21:35	1.82	03:35	1.92	1.87	23:50	1.08	13:40	1.35	1.21	18:15	0.096	10:00	0.124	0.109	0.109	-
04/11/2021	11:40	1.83	05:35	1.95	1.87	17:55	1.06	12:40	1.36	1.21	17:55	0.094	05:35	0.130	0.109	0.109	-
04/12/2021	22:00	1.80	02:15	1.90	1.85	21:50	1.02	01:50	1.35	1.19	21:50	0.088	01:50	0.123	0.106	0.106	0.02
04/13/2021	19:00	1.79	04:50	1.89	1.84	15:55	1.05	20:30	1.33	1.18	00:30	0.091	20:30	0.119	0.104	0.104	-
04/14/2021	22:45	1.77	03:25	1.87	1.81	19:50	1.02	19:30	1.31	1.16	19:50	0.088	19:30	0.115	0.100	0.100	-
04/15/2021	08:05	1.75	21:30	3.23	1.96	13:55	0.99	22:15	2.39	1.29	13:55	0.082	21:30	0.461	0.138	0.138	0.25
04/16/2021	01:40	1.94	07:30	5.03	3.26	01:35	1.25	07:30	3.48	2.40	01:35	0.119	07:30	1.348	0.530	0.530	1.47
04/17/2021	22:40	2.21	11:45	2.81	2.34	22:40	1.34	11:40	2.12	1.63	22:40	0.154	11:40	0.347	0.207	0.207	0.10
04/18/2021	21:20	2.14	01:25	2.30	2.21	20:50	1.29	10:35	1.67	1.52	20:50	0.147	08:15	0.199	0.177	0.177	-
04/19/2021	23:55	2.06	05:15	2.23	2.14	02:55	1.27	03:00	1.64	1.46	19:45	0.138	03:00	0.187	0.161	0.161	-
04/20/2021	22:05	2.00	06:25	2.11	2.06	18:45	1.23	03:40	1.53	1.39	18:45	0.125	06:15	0.164	0.145	0.145	-
04/21/2021	17:40	1.73	18:20	12.74	2.38	17:40	1.14	16:50	3.64	1.54	17:40	0.092	18:20	4.915	0.251	0.251	0.49
04/22/2021	22:05	1.99	12:35	2.45	2.08	21:40	1.08	12:40	1.81	1.27	21:40	0.107	12:40	0.242	0.135	0.135	0.01
04/23/2021	18:35	1.97	04:10	2.05	2.01	10:50	1.09	10:30	1.36	1.22	20:00	0.108	10:30	0.137	0.123	0.123	-
04/24/2021	23:20	1.93	17:20	2.02	1.98	19:40	1.04	19:20	1.34	1.19	19:40	0.100	19:20	0.134	0.116	0.116	-
04/25/2021	08:10	1.92	09:45	3.62	2.12	08:10	1.04	09:45	2.40	1.31	08:10	0.097	09:45	0.575	0.154	0.154	0.22
04/26/2021	20:50	1.86	04:40	1.99	1.92	17:40	1.01	02:35	1.34	1.15	17:40	0.094	02:35	0.132	0.108	0.108	-
04/27/2021	19:40	1.85	13:40	1.95	1.88	06:50	0.97	01:35	1.27	1.11	06:50	0.087	01:35	0.118	0.101	0.101	-
04/28/2021	23:35	1.84	03:15	4.99	2.07	20:35	0.97	03:15	3.32	1.27	00:55	0.088	03:15	1.271	0.150	0.150	0.20
04/29/2021	02:30	1.83	20:35	3.71	2.28	09:45	0.97	20:40	2.41	1.45	09:45	0.087	20:35	0.594	0.195	0.195	0.40
04/30/2021	23:15	1.89	00:00	2.71	2.02	23:30	1.00	00:00	2.02	1.23	23:30	0.092	00:00	0.316	0.127	0.127	0.04
05/01/2021	21:45	1.86	00:55	3.00	2.04	17:25	1.03	01:05	2.16	1.25	21:45	0.093	01:05	0.387	0.135	0.135	0.12
05/02/2021	22:05	1.85	08:25	1.95	1.90	21:20	0.99	11:50	1.29	1.13	21:20	0.089	11:50	0.122	0.105	0.105	-
05/03/2021	20:20	1.81	13:40	1.93	1.86	20:20	0.95	13:25	1.24	1.10	20:20	0.082	13:25	0.116	0.099	0.099	-
05/04/2021	00:15	1.84	04:30	5.51	2.67	00:15	1.07	04:35	3.63	1.73	00:15	0.094	04:35	1.601	0.316	0.316	0.80
05/05/2021	02:00	2.00	02:30	11.30	2.53	00:55	1.14	02:30	3.02	1.62	00:55	0.115	02:30	3.703	0.256	0.256	0.42
05/06/2021	23:15	2.05	09:30	2.63	2.18	04:20	1.09	09:15	1.86	1.36	22:55	0.120	09:30	0.269	0.156	0.156	0.01
05/07/2021	23:30	2.03	01:50	2.15	2.09	21:55	1.13	01:55	1.45	1.28	21:55	0.118	01:55	0.160	0.136	0.136	-
05/08/2021	23:05	1.98	09:15	2.08	2.03	20:55	1.08	15:40	1.39	1.24	20:55	0.109	15:40	0.145	0.127	0.127	-
05/09/2021	21:35	1.92	15:00	2.45	2.03	21:30	1.06	13:45	1.74	1.24	21:30	0.100	15:00	0.228	0.128	0.128	-
05/10/2021	00:10	1.94	03:25	4.50	2.33	23:50	1.09	03:25	3.14	1.47	01:00	0.107	03:25	1.037	0.214	0.214	0.42
05/11/2021	23:35	1.91	01:20	2.03	1.97	22:50	1.03	17:35	1.32	1.18	22:50	0.098	04:30	0.131	0.115	0.115	-
05/12/2021	22:00	1.86	06:30	1.96	1.91	21:50	0.97	01:50	1.27	1.13	21:50	0.087	04:25	0.122	0.105	0.105	-
05/13/2021	17:55	1.84	04:40	1.91	1.87	15:55	0.96	05:45	1.26	1.10	15:55	0.086	05:45	0.116	0.100	0.100	-
05/14/2021	19:25	1.81	14:30	1.92	1.85	19:50	0.94	14:35	1.27	1.09	19:50	0.082	14:35	0.118	0.097	0.097	-
05/15/2021	11:00	1.79	23:45	1.91	1.86	18:50	0.96	18:30	1.25	1.09	10:50	0.084	18:30	0.114	0.098	0.098	-
05/16/2021	17:55	1.81	01:45	1.92	1.86	17:50	0.93	02:45	1.26	1.09	17:50	0.081	02:45	0.116	0.097	0.097	0.01
05/17/2021	19:20	1.78	04:45	1.87	1.82	16:10	0.91	01:45	1.22	1.05	16:10	0.077	01:45	0.108	0.091	0.091	-
05/18/2021	04:25	1.77	12:55	1.95	1.81	10:55	0.91	13:10	1.20	1.05	10:55	0.077	12:55	0.110	0.091	0.091	-
05/19/2021	23:30	1.71	05:55	1.83	1.78	14:50	0.88	09:35	1.19	1.02	23:25	0.073	09:35	0.103	0.086	0.086	-
05/20/2021	23:00	1.69	00:45	1.79	1.74	23:00	0.84	03:40	1.16	0.99	23:00	0.065	03:40	0.097	0.080	0.080	-
05/21/2021	23:55	1.68	00:10	1.75	1.70	07:55	0.82	12:30	1.11	0.96	07:55	0.063	12:30	0.087	0.076	0.076	-
05/22/2021	12:50	1.65	02:45	1.73	1.69	21:40	0.81	01:40	1.11	0.95	21:40	0.061	01:40	0.088	0.074	0.074	0.01
05/23/2021	23:35	1.61	01:30	1.73	1.67	20:40	0.78	05:35	1.09	0.93	20:00	0.057	05:35	0.086	0.071	0.071	-
05/24/2021	21:50	1.59	23:25	1.66	1.62	09:50	0.76	04:35	1.04	0.89	09:50	0.055	04:35	0.077	0.065	0.065	-
05/25/2021	22:00	1.59	10:15	1.64	1.61	08:50	0.74	23:15	1.02	0.88	08:50	0.053	23:15	0.075	0.064	0.064	-
05/26/2021	21:40	1.46	22:15	3.43	1.73	17:40	0.74	22:15	2.36	0.98	17:40	0.053	22:15	0.524	0.091	0.091	0.18
05/27/2021	23:45	1.56	00:00	1.97	1.64	16:40	0.74	00:00	1.20	0.91	11:05	0.053	00:00	0.117	0.068	0.068	0.03
05/28/2021	17:05	1.56	23:35	8.60	2.18	15:40	0.74	22:40	3.23	1.16	15:40	0.052	23:35	2.538	0.248	0.248	0.74
05/29/2021	22:15	2.18	01:15	9.82	3.76	19:15	1.11	01:40	3.19	1.95	19:15	0.132	01:15	3.154	0.654	0.654	1.43
05/30/2021	08:55	2.12	15:35	4.43	2.70	06:40	1.10	15:40	2.66	1.64	08:45	0.122	15:35	0.849	0.279	0.279	0.57
05/31/2021	19:15	2.27	02:30	3.39	2.47	17:10	1.16	02:30	2.18	1.50	18:50	0.146	02:30	0.473	0.209	0.209	0.14

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	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
06/01/2021	22:35	2.12	01:40	2.38	2.23	20:25	0.99	01:10	1.67	1.30	20:25	0.113	01:10	0.208	0.153	0.153	-
06/02/2021	22:50	2.01	06:45	2.19	2.09	16:25	1.05	06:55	1.37	1.20	22:30	0.108	06:55	0.152	0.128	0.128	-
06/03/2021	15:50	1.96	06:20	2.05	2.01	15:25	1.01	10:50	1.28	1.14	15:25	0.101	10:50	0.130	0.114	0.114	-
06/04/2021	22:35	1.90	17:20	2.65	2.00	19:20	0.97	17:20	1.83	1.14	21:35	0.091	17:20	0.276	0.114	0.114	0.05
06/05/2021	20:40	1.84	00:00	1.96	1.90	23:55	0.92	17:55	1.20	1.05	20:35	0.082	17:55	0.113	0.097	0.097	-
06/06/2021	10:15	1.82	18:20	1.90	1.86	04:50	0.91	22:35	1.17	1.03	04:50	0.079	22:35	0.106	0.092	0.092	-
06/07/2021	11:50	1.82	16:20	1.92	1.87	21:15	0.90	16:40	1.19	1.03	21:15	0.079	16:40	0.111	0.093	0.093	-
06/08/2021	23:40	1.82	19:15	2.34	1.88	20:55	0.89	19:15	1.47	1.04	20:55	0.079	19:15	0.185	0.095	0.095	0.04
06/09/2021	21:05	1.80	02:50	1.91	1.85	19:55	0.88	04:50	1.16	1.01	19:55	0.077	02:40	0.104	0.090	0.090	-
06/10/2021	12:05	1.76	05:20	1.88	1.80	18:55	0.83	03:50	1.12	0.98	18:55	0.069	02:10	0.099	0.084	0.084	-
06/11/2021	22:45	1.72	23:55	1.90	1.77	22:50	0.79	02:50	1.10	0.95	22:50	0.064	23:55	0.098	0.079	0.079	0.03
06/12/2021	23:55	1.81	00:45	4.67	2.31	21:50	0.89	00:50	2.69	1.35	21:50	0.080	00:50	0.925	0.201	0.201	0.14
06/13/2021	22:05	1.77	03:20	1.90	1.84	20:50	0.87	00:50	1.16	1.00	17:30	0.077	00:50	0.105	0.088	0.088	-

03/23/2021 00:00 - 06/13/2021 23:55

	DFINAL (in)	VFINAL (ft/s)	QFINAL (MGD - Total MG)	Rain (in)
Total			11.928	10.22
Average	2.03	1.23	0.144	

MurphyField

Site Commentary

SITE INFORMATION

Pipe	Elliptical (54 in H x 53.5 in W)
Silt	0.00 (in)

OBSERVATIONS

Average flow depth, velocity, and quantity data observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021**, along with observed minimum and maximum data, are provided in the following table.

Observed Flow Conditions			
Item	**DFINAL (in)**	**VFINAL (ft/s)**	**QFINAL (MGD - Total MG)**
Average	3.38	2.54	0.905
Minimum	2.02	1.36	0.174
Maximum	32.12	9.98	31.474
Min Time	05/28/2021 08:10:00	05/28/2021 10:05:00	05/28/2021 10:05:00
Max Time	04/21/2021 17:50:00	03/28/2021 14:40:00	04/21/2021 17:50:00

Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Values in the Observed Flow Conditions and data on the graphical reports are based on the none average.

DATA UPTIME

Data uptime observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021** is provided in the following table:

Percent Uptime	
DFINAL (in)	100
VFINAL (ft/s)	100
QFINAL (MGD - Total MG)	100

Norwood, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

Site I.D.

MurphyField_MP1

Site Address / Location:	Pleasant Park
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
54.0" X 53.50"	Elliptical

Manhole #	System Characteristics
	Other
Access	**Traffic**
Drive	None

ADS Project Name:	Norwood, MA
ADS Project Number:	32685.11.325

Installation Information

Installation Date:	Installation Type:
Thursday, March 18, 2021	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 5-10 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV Gated (CS7)	

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
1.25"	
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
Silt (in)	**Silt Type**
0	

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
88.25"	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
Manhole Cover	**Manhole Frame**
Unbolted	Normal
Active Drop Connections	**Air Quality:**
No	
Pipe Material	**Pipe Condition:**
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

42.185053,-71.195834, S/N:60956, IP:166.219.185.138 MP1 is to the right if you are looking at both incoming lines.

Hydrograph Report

MurphyField

Flow Monitor

MurphyField

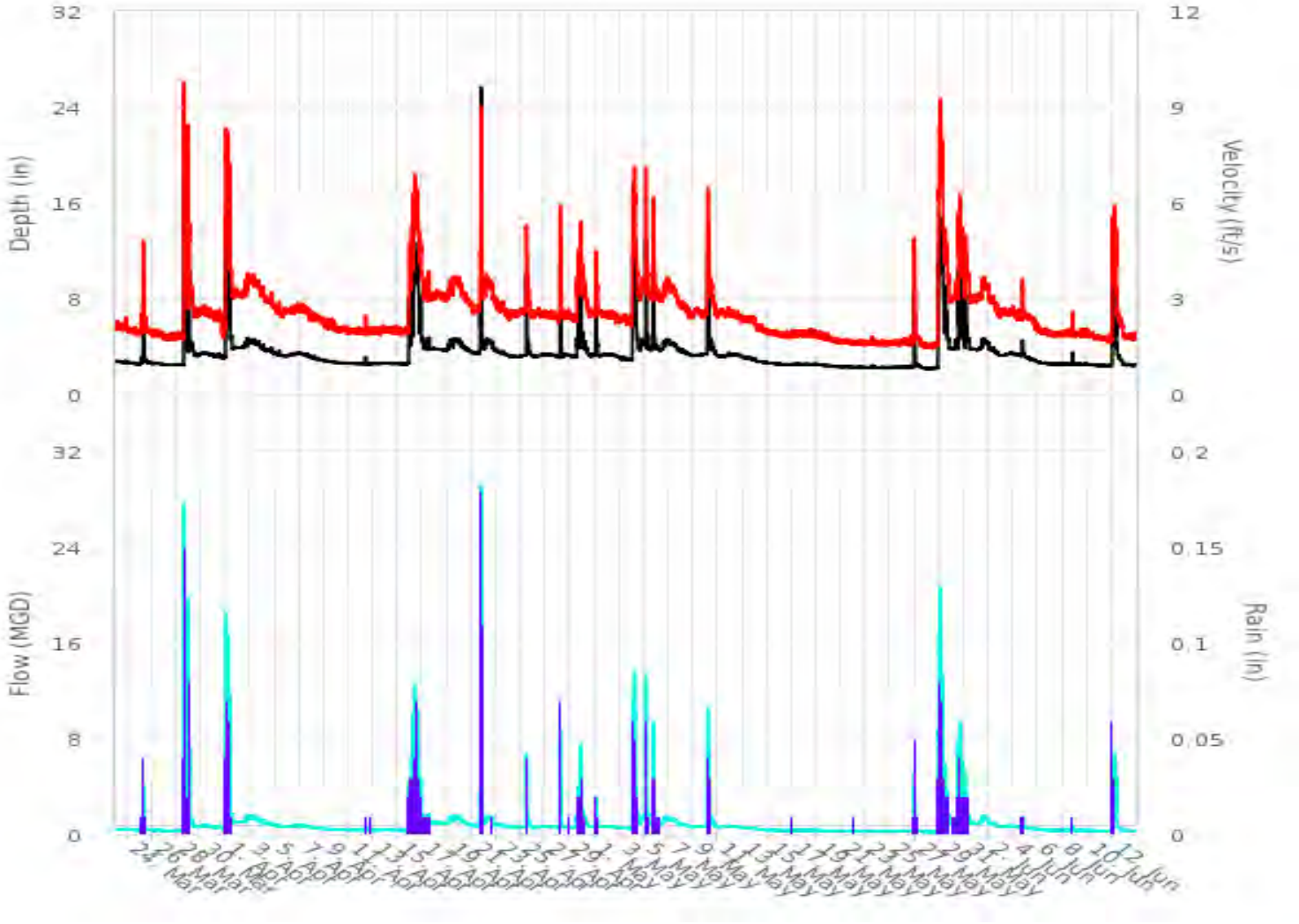
Pipe Height
54.00
in

Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL
- VFINAL
- QFINAL
- RAIN FINAL



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Scattergraph Report

MurphyField

Flow Monitor

MurphyField

Pipe Height
54.00
in

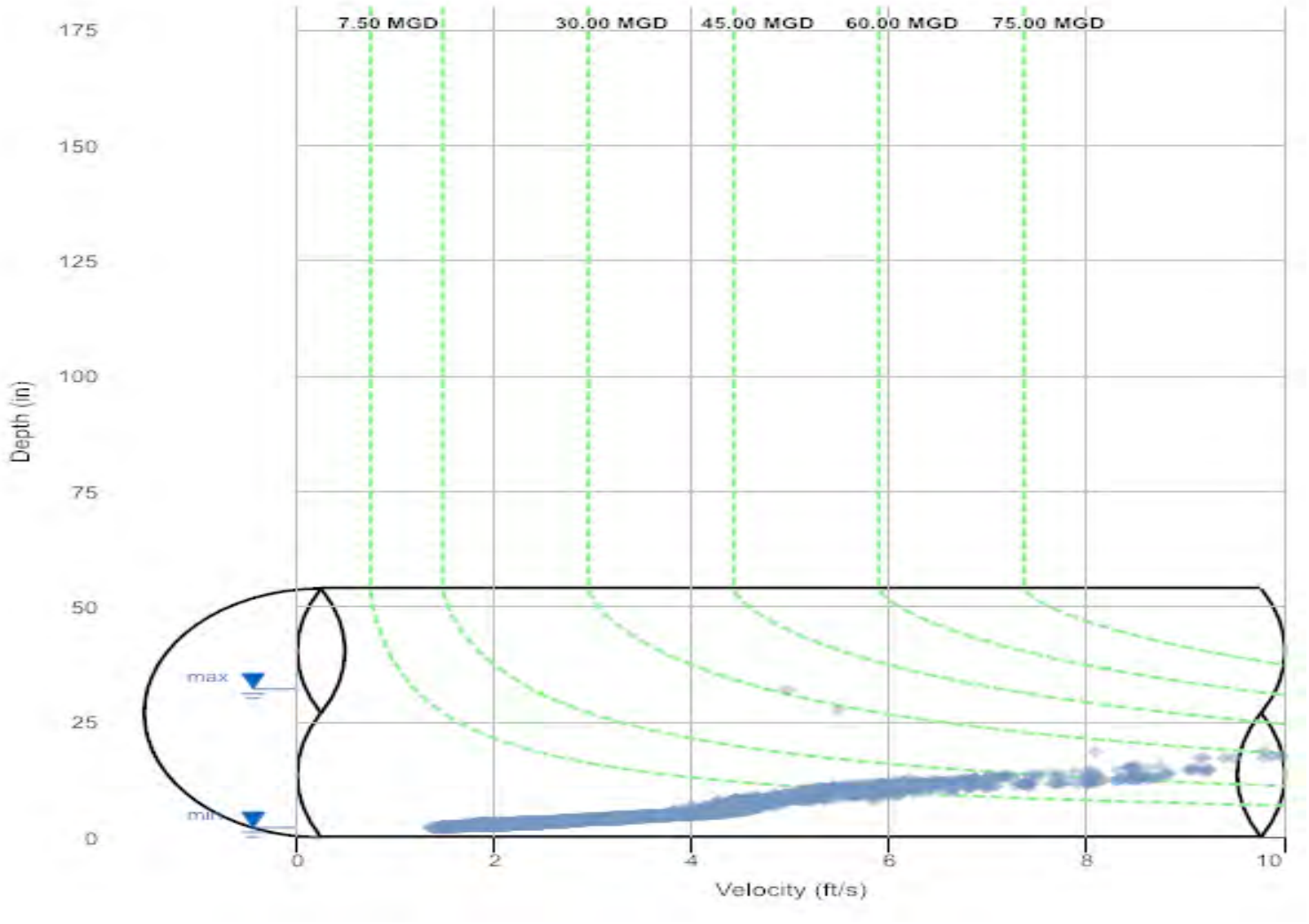
Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL - VFINAL
- Iso-Q™
- Min-Max Depth

ADS ENVIRONMENTAL SERVICES



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Daily Tabular Report

03/23/2021 00:00 - 06/13/2021 23:55
MurphyFieldPipe: Elliptical (54 in H x 53.5 in W), Silt0.00 in

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
03/23/2021	22:50	2.59	20:15	2.83	2.69	15:45	1.94	20:30	2.41	2.11	13:35	0.356	20:30	0.483	0.401	0.401	-
03/24/2021	18:50	2.49	12:55	2.67	2.57	14:45	1.81	15:15	2.24	1.97	19:40	0.310	03:10	0.399	0.349	0.349	-
03/25/2021	00:15	2.48	06:20	8.34	2.94	23:55	1.75	06:25	5.01	2.24	23:55	0.295	06:20	5.002	0.554	0.554	0.11
03/26/2021	23:50	2.39	01:45	2.66	2.54	22:55	1.70	01:05	2.19	1.88	22:55	0.276	01:05	0.407	0.327	0.327	-
03/27/2021	18:20	2.38	13:20	2.49	2.43	06:50	1.67	11:10	2.02	1.78	18:20	0.266	11:10	0.331	0.290	0.290	-
03/28/2021	01:35	2.38	14:45	18.53	4.51	10:45	1.69	14:40	9.98	3.03	12:35	0.268	14:45	30.286	2.434	2.434	0.78
03/29/2021	15:55	3.13	00:45	10.38	3.84	14:15	2.29	00:50	5.38	2.90	14:15	0.547	00:45	7.363	1.086	1.086	0.06
03/30/2021	23:55	3.13	05:25	3.55	3.37	23:45	2.27	03:30	2.82	2.59	19:10	0.561	03:30	0.786	0.687	0.687	-
03/31/2021	18:25	2.90	23:55	10.31	3.36	17:25	1.70	23:15	5.84	2.39	18:20	0.390	23:55	7.282	0.736	0.736	0.17
04/01/2021	14:35	3.74	00:40	15.11	6.04	14:45	2.98	04:40	8.46	4.17	14:45	0.920	00:40	19.677	3.553	3.553	0.76
04/02/2021	02:05	3.81	18:45	4.76	4.12	10:40	2.93	18:25	3.83	3.32	10:40	0.943	18:45	1.662	1.191	1.191	-
04/03/2021	23:05	3.72	06:15	4.64	4.18	20:20	2.96	06:20	3.78	3.40	20:20	0.938	06:20	1.603	1.241	1.241	-
04/04/2021	22:35	3.33	01:20	4.22	3.62	21:50	2.66	01:20	3.42	2.93	21:55	0.704	01:20	1.260	0.864	0.864	-
04/05/2021	21:05	3.12	08:20	3.74	3.25	13:20	2.32	08:25	3.03	2.58	16:20	0.561	08:25	0.929	0.648	0.648	-
04/06/2021	04:35	3.16	21:35	3.49	3.33	03:45	2.41	22:35	2.87	2.64	03:45	0.601	21:50	0.789	0.687	0.687	-
04/07/2021	22:35	2.98	02:40	3.46	3.26	20:10	2.19	01:00	2.86	2.59	21:55	0.504	01:00	0.781	0.654	0.654	-
04/08/2021	23:30	2.71	04:25	3.23	2.92	14:30	2.11	00:00	2.62	2.37	23:40	0.421	00:00	0.635	0.507	0.507	-
04/09/2021	23:20	2.57	04:35	2.83	2.69	23:35	1.96	14:30	2.40	2.12	23:20	0.348	04:35	0.488	0.403	0.403	-
04/10/2021	18:25	2.52	05:40	2.71	2.59	21:45	1.83	14:40	2.25	2.01	23:15	0.325	14:40	0.401	0.361	0.361	-
04/11/2021	13:00	2.49	00:35	2.61	2.55	17:55	1.84	19:50	2.20	1.98	17:55	0.320	19:50	0.397	0.345	0.345	-
04/12/2021	07:35	2.47	08:15	3.17	2.55	11:20	1.81	08:30	2.51	1.98	07:35	0.304	08:15	0.598	0.346	0.346	0.02
04/13/2021	12:35	2.45	11:35	2.63	2.56	12:35	1.80	18:45	2.24	1.99	12:35	0.296	18:45	0.405	0.349	0.349	-
04/14/2021	19:55	2.48	03:45	2.62	2.55	19:50	1.82	18:20	2.21	2.00	19:50	0.305	17:35	0.392	0.350	0.350	-
04/15/2021	07:00	2.46	21:50	8.06	2.97	13:15	1.79	21:45	4.75	2.28	05:40	0.306	21:50	4.491	0.636	0.636	0.25
04/16/2021	01:25	4.02	07:45	12.80	8.12	01:30	3.04	07:50	6.89	4.91	01:30	1.043	07:45	12.697	5.292	5.292	1.47
04/17/2021	10:40	3.67	12:55	4.75	3.93	16:50	2.86	12:40	3.85	3.16	10:40	0.862	12:50	1.689	1.057	1.057	0.10
04/18/2021	21:00	3.62	05:35	3.81	3.71	20:45	2.83	03:30	3.28	3.08	20:45	0.840	03:25	1.027	0.939	0.939	-
04/19/2021	02:25	3.67	15:45	4.71	4.31	01:35	2.85	17:55	3.77	3.42	01:35	0.901	17:55	1.618	1.308	1.308	-
04/20/2021	22:55	3.46	00:05	4.58	3.82	23:40	2.61	00:00	3.70	3.03	23:40	0.727	00:05	1.543	0.969	0.969	-
04/21/2021	10:25	3.29	17:50	32.12	4.65	03:45	2.45	17:45	9.80	3.27	08:15	0.640	17:50	31.474	2.122	2.122	0.49
04/22/2021	21:05	3.57	06:45	4.68	4.11	23:15	2.77	04:15	3.75	3.27	21:05	0.798	06:45	1.594	1.173	1.173	0.01
04/23/2021	23:20	3.17	01:35	3.65	3.41	20:50	2.30	05:35	2.98	2.66	22:45	0.572	05:35	0.872	0.716	0.716	-
04/24/2021	07:30	3.08	02:30	3.31	3.14	11:40	2.23	02:40	2.76	2.54	11:40	0.529	02:40	0.692	0.606	0.606	-
04/25/2021	00:40	3.10	10:00	10.02	3.80	22:10	2.24	10:25	5.32	2.91	22:10	0.540	09:55	6.809	1.085	1.085	0.22
04/26/2021	02:25	3.07	23:55	3.41	3.22	02:15	2.30	09:45	2.74	2.53	02:15	0.538	23:55	0.717	0.626	0.626	-
04/27/2021	23:45	3.05	02:50	3.36	3.24	23:50	2.18	01:35	2.72	2.46	23:50	0.501	01:35	0.699	0.616	0.616	-
04/28/2021	00:50	2.99	03:30	11.32	3.72	00:50	2.18	03:30	6.22	2.74	00:50	0.484	03:30	9.647	1.031	1.031	0.20
04/29/2021	06:30	3.00	20:45	10.51	4.15	11:05	2.23	20:50	5.50	3.09	06:30	0.507	20:50	7.670	1.326	1.326	0.40
04/30/2021	17:10	3.10	00:00	5.06	3.51	12:15	2.30	00:00	4.07	2.78	17:05	0.574	00:00	1.964	0.799	0.799	0.04
05/01/2021	08:00	3.15	01:05	6.66	3.56	13:40	2.34	01:20	4.53	2.77	12:20	0.577	01:05	3.168	0.844	0.844	0.12
05/02/2021	23:55	3.04	08:50	3.37	3.23	21:10	2.18	08:20	2.69	2.43	23:20	0.504	08:20	0.695	0.606	0.606	-
05/03/2021	22:15	2.77	07:05	3.17	2.93	22:50	2.06	01:35	2.55	2.33	22:50	0.410	09:00	0.583	0.501	0.501	-
05/04/2021	00:05	2.80	04:50	13.19	5.90	00:15	2.16	04:45	7.18	4.00	00:15	0.437	04:50	13.819	3.033	3.033	0.80
05/05/2021	12:05	3.60	02:45	13.41	4.73	12:00	2.87	02:45	7.44	3.57	12:00	0.843	02:45	14.666	1.860	1.860	0.42
05/06/2021	06:35	3.60	17:05	4.65	4.03	06:05	2.83	20:00	3.71	3.24	06:40	0.829	20:00	1.565	1.129	1.129	0.01
05/07/2021	23:45	3.45	00:15	4.56	3.99	23:45	2.65	00:15	3.69	3.14	23:45	0.727	00:15	1.525	1.073	1.073	-
05/08/2021	22:10	3.15	01:40	3.78	3.39	22:00	2.32	00:55	2.95	2.63	22:35	0.567	01:40	0.924	0.704	0.704	-
05/09/2021	00:50	3.16	15:25	3.42	3.27	19:30	2.34	07:20	2.75	2.55	00:05	0.575	14:40	0.712	0.647	0.647	-
05/10/2021	22:50	3.16	03:45	11.74	4.68	22:00	2.28	03:45	6.56	3.32	23:50	0.566	03:45	10.719	1.880	1.880	0.42
05/11/2021	10:20	3.09	20:35	3.47	3.19	08:15	2.25	08:20	2.74	2.57	02:55	0.551	20:30	0.750	0.627	0.627	-
05/12/2021	23:55	3.05	01:30	3.37	3.25	23:50	2.18	01:40	2.67	2.45	23:50	0.504	01:40	0.696	0.616	0.616	-
05/13/2021	23:15	2.78	02:15	3.20	2.98	14:55	2.00	10:40	2.56	2.34	23:45	0.438	10:40	0.617	0.518	0.518	-
05/14/2021	22:20	2.54	00:05	3.01	2.70	19:50	1.86	00:10	2.39	2.05	21:40	0.333	00:10	0.527	0.390	0.390	-
05/15/2021	16:00	2.48	10:45	2.65	2.56	18:50	1.73	14:45	2.14	1.91	18:50	0.294	04:25	0.382	0.335	0.335	-
05/16/2021	14:50	2.42	22:55	2.53	2.48	12:55	1.72	13:00	2.05	1.85	14:45	0.282	22:35	0.352	0.309	0.309	0.01
05/17/2021	00:30	2.43	08:00	2.60	2.49	11:55	1.72	17:40	2.09	1.88	11:55	0.282	03:15	0.355	0.317	0.317	-
05/18/2021	11:05	2.42	04:15	2.54	2.49	15:50	1.70	17:45	2.10	1.89	11:05	0.282	23:50	0.359	0.319	0.319	-
05/19/2021	23:50	2.31	00:35	2.54	2.42	14:50	1.64	00:35	2.05	1.79	23:50	0.250	00:35	0.357	0.290	0.290	-
05/20/2021	23:45	2.24	01:45	2.40	2.31	23:40	1.51	03:40	1.83	1.68	23:40	0.218	03:40	0.285	0.254	0.254	-
05/21/2021	23:10	2.19	12:50	2.35	2.27	23:10	1.52	12:30	1.79	1.64	23:10	0.212	12:30	0.273	0.242	0.242	-
05/22/2021	00:35	2.19	15:45	2.33	2.24	21:40	1.46	16:25	1.74	1.60	21:00	0.207	16:25	0.259	0.231	0.231	0.01
05/23/2021	19:25	2.18	11:55	2.43	2.24	20:40	1.45	12:10	1.81	1.61	19:25	0.206	11:55	0.292	0.232	0.232	-
05/24/2021	14:05	2.16	07:30	2.31	2.22	14:05	1.43	14:25	1.72	1.59	14:05	0.196	07:30	0.256	0.227	0.227	-
05/25/2021	01:30	2.17	22:10	2.33	2.24	03:55	1.47	03:35	1.77	1.60	18:00	0.209	03:35	0.267	0.231	0.231	-
05/26/2021	06:40	2.17	22:45	8.82	2.68	07:50	1.47	22:45	4.98	1.89	07:50	0.205	22:45	5.395	0.532	0.532	0.18
05/27/2021	21:45	2.10	00:00	4.14	2.32	21:35	1.40	00:00	3.34	1.69	21:35	0.185	00:00	1.200	0.270	0.270	0.03
05/28/2021	08:10	2.02	22:55	13.82	3.35	10:05	1.36	23:15	8.55	2.24	10:05	0.174	23:10	17.329	1.598	1.598	0.74
05/29/2021	23:40	3.69	01:30	14.82	6.99	23:40	2.82	01:55	9.25	4.89	23:40	0.852	01:45	20.869	5.097	5.097	1.43

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	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
05/30/2021	00:25	3.69	15:00	11.23	5.74	06:00	2.76	14:45	6.28	3.94	00:25	0.857	14:50	9.450	2.709	2.709	0.57
05/31/2021	23:45	3.66	02:40	8.48	4.28	12:00	2.81	02:40	5.03	3.35	12:00	0.852	02:40	5.148	1.343	1.343	0.14
06/01/2021	02:35	3.63	13:55	4.66	4.12	02:40	2.80	14:05	3.72	3.28	02:40	0.826	14:05	1.588	1.178	1.178	-
06/02/2021	23:55	3.18	08:45	3.93	3.53	20:30	2.30	00:20	3.16	2.76	21:10	0.564	00:20	1.039	0.785	0.785	-
06/03/2021	01:45	3.19	22:35	3.48	3.33	06:35	2.37	15:45	2.80	2.57	00:00	0.588	22:15	0.761	0.667	0.667	-
06/04/2021	23:45	3.06	17:40	4.54	3.36	15:50	2.26	17:45	3.63	2.55	15:50	0.527	17:45	1.480	0.682	0.682	0.05
06/05/2021	20:45	2.67	00:25	3.13	2.89	23:55	1.90	02:05	2.54	2.29	23:55	0.355	00:25	0.591	0.484	0.484	-
06/06/2021	19:10	2.49	00:10	2.69	2.59	22:55	1.76	00:45	2.22	1.95	22:55	0.300	00:45	0.411	0.348	0.348	-
06/07/2021	20:15	2.46	18:05	2.58	2.51	01:35	1.75	22:30	2.09	1.88	01:35	0.294	22:30	0.358	0.321	0.321	-
06/08/2021	18:45	2.45	19:35	3.50	2.57	21:25	1.78	19:30	2.59	1.94	18:45	0.293	19:30	0.718	0.347	0.347	0.04
06/09/2021	10:50	2.43	09:25	2.58	2.51	14:20	1.73	21:10	2.12	1.90	22:40	0.289	21:10	0.371	0.323	0.323	-
06/10/2021	21:30	2.34	01:30	2.52	2.44	23:50	1.65	02:35	2.02	1.81	23:50	0.260	03:30	0.336	0.298	0.298	-
06/11/2021	16:25	2.30	19:50	2.47	2.36	17:55	1.55	19:30	1.96	1.73	17:55	0.234	19:30	0.320	0.270	0.270	0.03
06/12/2021	23:40	2.44	06:05	9.31	4.18	23:40	1.75	05:00	6.10	3.08	23:40	0.286	05:00	6.994	1.523	1.523	0.14
06/13/2021	17:45	2.34	07:35	2.53	2.43	15:55	1.65	13:45	2.00	1.80	17:45	0.255	07:30	0.331	0.292	0.291	-

03/23/2021 00:00 - 06/13/2021 23:55

	DFINAL (in)	VFINAL (ft/s)	QFINAL (MGD - Total MG)	Rain (in)
Total			75.143	10.22
Average	3.38	2.54	0.905	

MurphyField(2)

Site Commentary

SITE INFORMATION

Pipe	Elliptical (48.25 in H x 48 in W)
Silt	0.00 (in)

OBSERVATIONS

Average flow depth, velocity, and quantity data observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021**, along with observed minimum and maximum data, are provided in the following table.

Observed Flow Conditions			
Item	**DFINAL (in)**	**VFINAL (ft/s)**	**QFINAL (MGD - Total MG)**
Average	2.07	2.26	0.413
Minimum	1.48	1.29	0.096
Maximum	24.71	11.43	46.450
Min Time	05/26/2021 18:40:00	05/26/2021 17:00:00	05/26/2021 17:00:00
Max Time	04/21/2021 17:50:00	03/28/2021 14:40:00	04/21/2021 17:50:00

Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Values in the Observed Flow Conditions and data on the graphical reports are based on the none average.

DATA UPTIME

Data uptime observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021** is provided in the following table:

Percent Uptime	
DFINAL (in)	100
VFINAL (ft/s)	100
QFINAL (MGD - Total MG)	100

Norwood, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

Site I.D.

MurphyField_MP2

Site Address / Location:	Pleasant Park
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
48.25" X 48.0"	Elliptical

Manhole #	System Characteristics
	Other
Access	**Traffic**
Drive	None

ADS Project Name:	Norwood, MA
ADS Project Number:	32685.11.325

Installation Information

Installation Date:	Installation Type:
Thursday, March 18, 2021	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 5-10 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV Gated (CS7)	

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
1.50"	
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
Silt (in)	**Silt Type**
0	

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
88.25"	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
Manhole Cover	**Manhole Frame**
Unbolted	Normal
Active Drop Connections	**Air Quality:**
No	
Pipe Material	**Pipe Condition:**
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

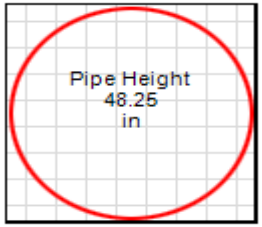
42.185053,-71.195834, S/N:60956, IP:166.219.185.138 MP2 is to the left if you are looking at both incoming lines.

Hydrograph Report

MurphyField(2)

Flow Monitor

MurphyField(2)



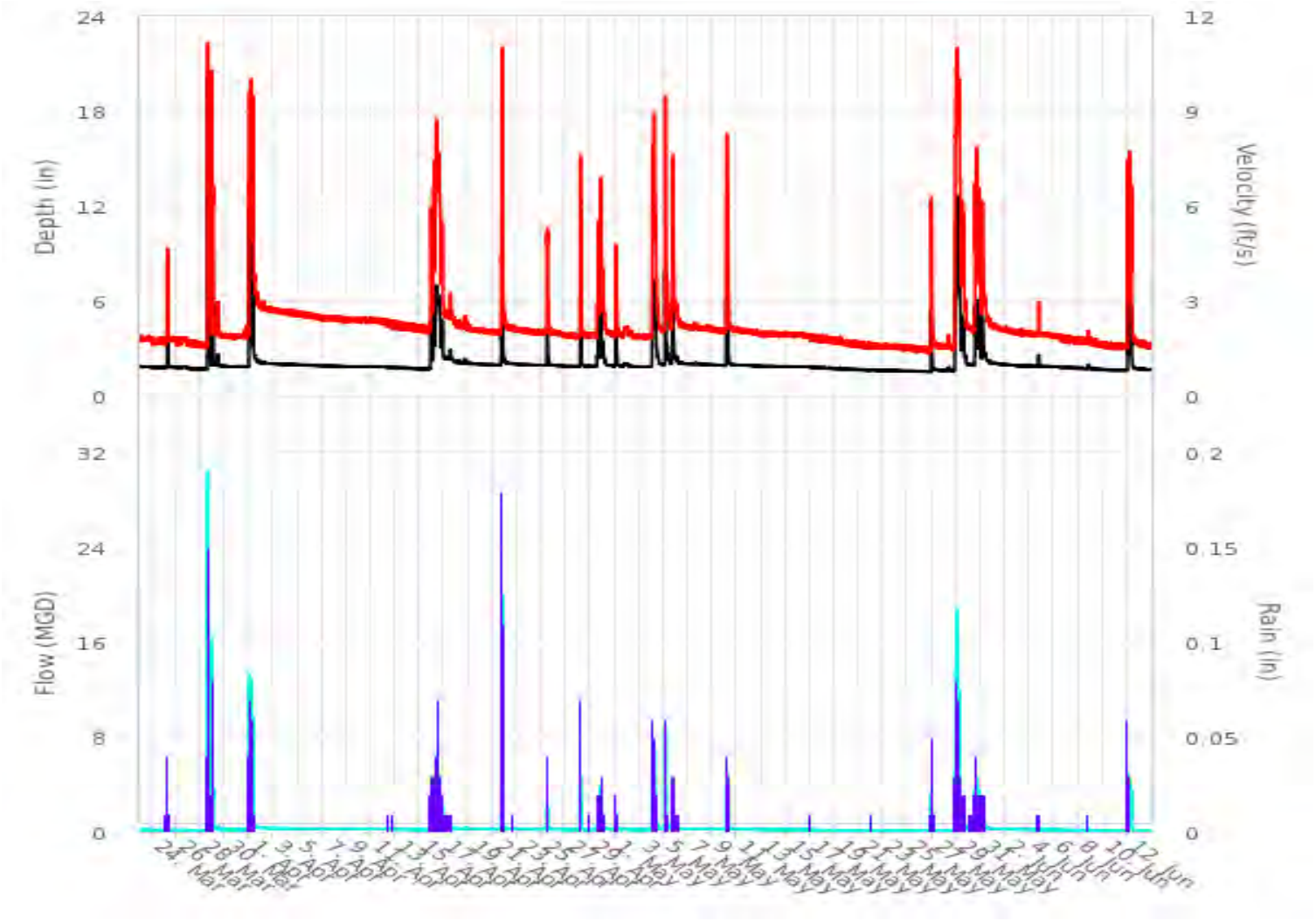
Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL
- VFINAL
- QFINAL
- RAIN FINAL

ADS ENVIRONMENTAL SERVICES



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Scattergraph Report

MurphyField(2)

Flow Monitor

MurphyField(2)

Pipe Height
48.25
in

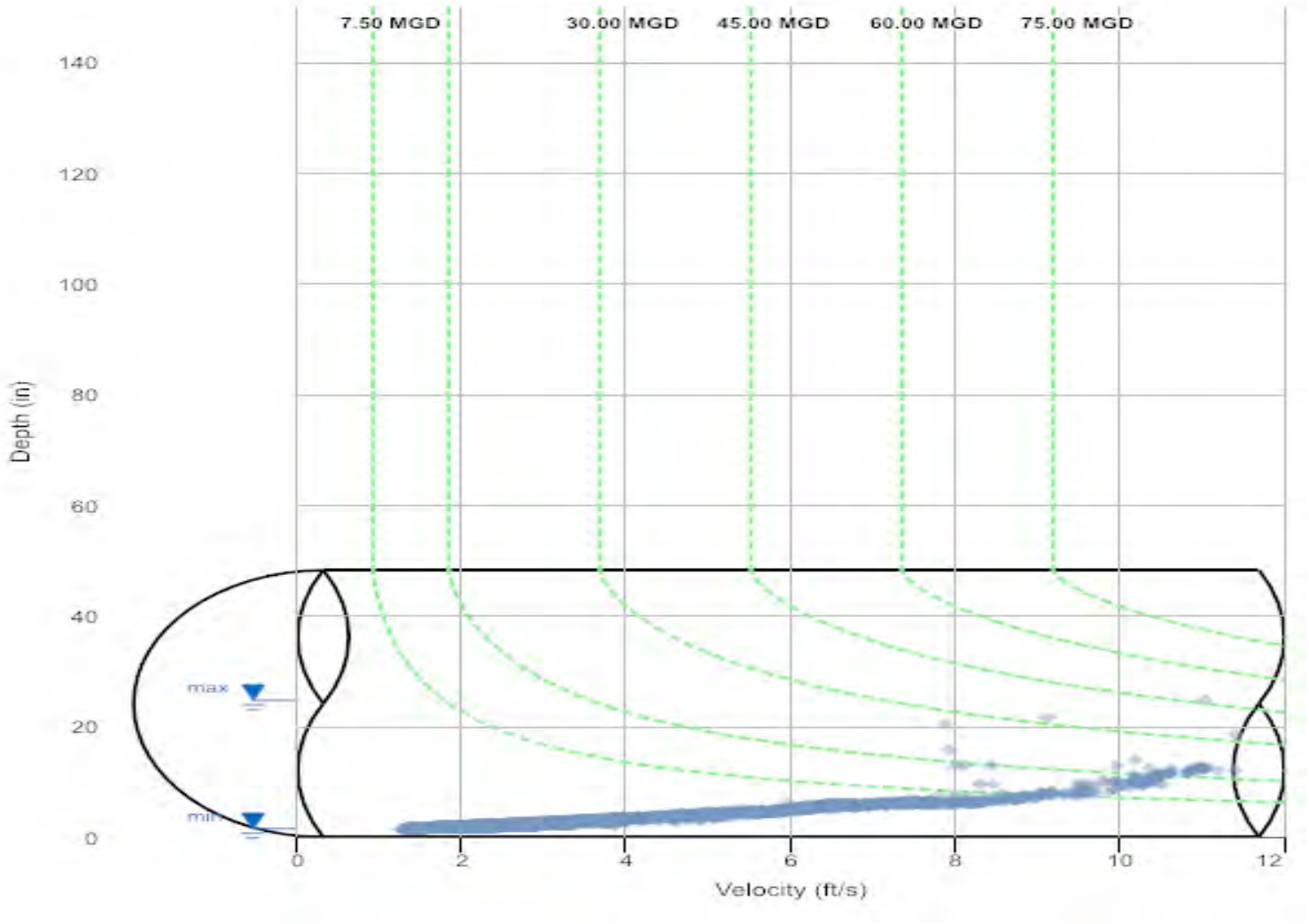
Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL - VFINAL
- Iso-Q™
- Min-Max Depth

ADS ENVIRONMENTAL SERVICES



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Daily Tabular Report

03/23/2021 00:00 - 06/13/2021 23:55
MurphyField(2)Pipe: Elliptical (48.25 in H x 48 in W), Silt0.00 in

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
03/23/2021	23:35	1.74	02:55	1.86	1.82	05:55	1.67	20:20	1.94	1.80	23:35	0.157	20:20	0.199	0.181	0.181	-
03/24/2021	05:10	1.70	17:30	1.84	1.77	04:55	1.56	14:25	1.88	1.72	04:55	0.144	16:05	0.189	0.166	0.166	-
03/25/2021	00:45	1.71	06:35	4.13	1.92	00:35	1.58	06:35	4.68	1.94	00:35	0.146	06:35	1.583	0.236	0.236	0.11
03/26/2021	22:40	1.69	16:15	1.83	1.78	07:50	1.53	12:25	1.91	1.74	22:35	0.139	12:25	0.194	0.170	0.170	-
03/27/2021	21:40	1.65	01:25	1.79	1.71	21:35	1.47	01:35	1.82	1.64	21:35	0.128	01:35	0.176	0.150	0.150	-
03/28/2021	05:25	1.65	14:35	21.54	2.99	05:10	1.46	14:40	11.43	2.97	05:15	0.128	14:40	32.861	1.605	1.605	0.78
03/29/2021	20:45	1.86	00:55	5.82	2.22	20:05	1.82	00:50	6.68	2.36	20:05	0.189	00:50	3.713	0.429	0.429	0.06
03/30/2021	15:50	1.82	01:15	1.90	1.86	15:15	1.77	03:30	1.99	1.87	15:15	0.178	01:20	0.210	0.194	0.194	-
03/31/2021	00:40	1.82	23:15	5.92	1.99	19:50	1.37	23:15	6.75	2.09	19:50	0.139	23:15	3.873	0.313	0.313	0.17
04/01/2021	23:30	2.05	04:25	12.98	3.61	23:40	2.71	04:20	10.86	4.56	23:30	0.326	04:20	16.483	2.001	2.001	0.76
04/02/2021	23:05	1.99	05:20	2.18	2.04	22:40	2.62	05:15	2.99	2.75	22:40	0.301	05:15	0.391	0.328	0.328	-
04/03/2021	22:50	1.96	06:55	2.07	2.00	22:50	2.55	09:10	2.81	2.67	22:50	0.285	09:10	0.337	0.309	0.309	-
04/04/2021	21:55	1.92	01:15	2.03	1.97	21:50	2.50	04:55	2.76	2.62	21:55	0.272	01:15	0.323	0.297	0.297	-
04/05/2021	22:00	1.89	09:50	2.01	1.94	23:55	2.45	06:15	2.69	2.56	22:00	0.261	00:45	0.309	0.283	0.283	-
04/06/2021	23:15	1.84	16:40	1.96	1.91	23:25	2.32	00:35	2.64	2.50	23:25	0.238	00:25	0.293	0.269	0.269	-
04/07/2021	01:20	1.84	00:00	1.95	1.88	02:55	2.34	21:35	2.59	2.45	02:55	0.240	00:00	0.283	0.258	0.258	-
04/08/2021	20:15	1.82	06:35	1.91	1.87	20:15	2.26	15:40	2.55	2.42	20:15	0.227	00:55	0.272	0.252	0.252	-
04/09/2021	05:35	1.82	00:45	1.88	1.85	05:40	2.29	14:40	2.52	2.40	05:40	0.231	02:40	0.261	0.247	0.247	-
04/10/2021	18:05	1.81	07:55	1.88	1.85	18:15	2.26	23:30	2.50	2.39	18:15	0.227	00:35	0.260	0.245	0.245	-
04/11/2021	20:20	1.79	02:15	1.88	1.84	14:35	2.26	07:45	2.52	2.37	19:30	0.227	07:45	0.260	0.242	0.242	-
04/12/2021	20:30	1.71	07:55	1.85	1.79	18:30	2.06	06:45	2.48	2.29	18:30	0.189	04:25	0.252	0.225	0.225	0.02
04/13/2021	17:05	1.69	00:50	1.83	1.75	20:50	2.02	00:50	2.45	2.20	20:50	0.184	00:50	0.247	0.208	0.208	-
04/14/2021	16:25	1.67	15:00	1.80	1.72	19:50	1.98	07:20	2.35	2.15	16:30	0.177	07:20	0.230	0.199	0.199	-
04/15/2021	15:20	1.64	21:55	4.68	1.96	15:30	1.91	21:30	6.00	2.47	15:30	0.164	21:55	2.375	0.355	0.355	0.25
04/16/2021	01:50	2.20	07:45	7.07	4.64	01:50	2.54	07:50	8.83	5.53	01:50	0.338	07:50	6.516	2.596	2.596	1.47
04/17/2021	22:10	2.08	12:20	2.94	2.33	22:15	2.15	12:20	3.26	2.53	22:15	0.265	12:20	0.669	0.369	0.369	0.10
04/18/2021	22:50	2.00	15:15	2.30	2.12	20:45	2.03	15:30	2.56	2.25	22:35	0.238	15:30	0.359	0.284	0.284	-
04/19/2021	21:50	1.96	02:50	2.14	2.01	20:15	1.99	03:00	2.26	2.09	20:15	0.226	02:50	0.280	0.243	0.243	-
04/20/2021	22:20	1.93	03:40	2.05	1.97	23:00	1.93	03:40	2.22	2.04	22:25	0.214	03:40	0.266	0.231	0.231	-
04/21/2021	07:35	1.91	17:50	24.71	2.72	07:55	1.90	18:35	11.06	2.86	07:55	0.207	17:50	46.450	1.117	1.117	0.49
04/22/2021	22:45	1.96	00:20	2.23	2.03	22:20	2.03	00:25	2.43	2.14	22:20	0.231	00:25	0.327	0.252	0.252	0.01
04/23/2021	14:45	1.92	04:40	2.03	1.97	20:00	1.94	01:05	2.17	2.06	20:00	0.214	01:05	0.254	0.233	0.233	-
04/24/2021	23:00	1.88	07:40	2.01	1.94	09:50	1.90	14:25	2.13	2.01	09:50	0.204	07:30	0.247	0.221	0.221	-
04/25/2021	00:35	1.89	10:50	4.75	2.18	00:35	1.89	10:50	5.64	2.35	00:35	0.200	10:50	2.342	0.365	0.365	0.22
04/26/2021	22:15	1.84	02:50	1.98	1.90	22:35	1.82	10:15	2.07	1.95	22:35	0.188	02:50	0.235	0.208	0.208	-
04/27/2021	16:55	1.81	06:25	1.90	1.86	21:35	1.77	06:30	2.05	1.89	18:15	0.179	06:30	0.219	0.196	0.196	-
04/28/2021	20:30	1.81	03:35	6.29	2.18	20:35	1.78	03:30	7.78	2.32	20:35	0.179	03:30	4.818	0.429	0.429	0.20
04/29/2021	11:15	1.84	21:00	5.90	2.56	09:45	1.80	20:50	6.95	2.83	11:20	0.185	20:50	3.957	0.620	0.620	0.40
04/30/2021	22:30	1.82	00:00	3.34	2.04	22:40	1.82	00:00	3.94	2.15	22:40	0.185	00:00	0.972	0.267	0.267	0.04
05/01/2021	15:00	1.82	01:15	4.14	2.13	14:45	1.81	01:20	4.80	2.27	14:55	0.184	01:15	1.602	0.323	0.323	0.12
05/02/2021	13:20	1.82	00:55	2.05	1.87	23:35	1.78	01:05	2.23	1.92	23:35	0.180	01:05	0.263	0.201	0.201	-
05/03/2021	09:55	1.81	04:40	1.87	1.84	15:25	1.76	20:40	1.99	1.87	10:35	0.177	20:40	0.205	0.191	0.191	-
05/04/2021	00:15	1.83	04:50	7.38	3.32	00:15	1.86	04:50	9.01	3.85	00:15	0.189	04:50	7.123	1.425	1.425	0.80
05/05/2021	01:40	1.95	02:40	11.59	2.81	00:55	2.01	02:40	10.85	3.21	00:10	0.229	02:40	16.351	0.890	0.890	0.42
05/06/2021	23:00	1.98	00:50	2.54	2.10	22:55	2.07	00:55	2.95	2.30	22:55	0.236	00:50	0.484	0.288	0.288	0.01
05/07/2021	03:40	1.96	15:20	2.16	2.00	11:25	2.05	15:25	2.36	2.16	11:25	0.231	15:25	0.301	0.249	0.249	-
05/08/2021	19:25	1.92	13:40	2.03	1.97	19:40	2.01	13:30	2.25	2.12	19:40	0.220	13:40	0.265	0.240	0.240	-
05/09/2021	22:10	1.88	04:55	1.99	1.94	16:50	1.96	04:50	2.21	2.06	16:50	0.209	04:50	0.252	0.227	0.227	-
05/10/2021	00:25	1.89	03:40	6.26	2.62	23:50	1.96	03:40	8.37	2.99	00:25	0.212	03:40	5.202	0.821	0.821	0.42
05/11/2021	23:25	1.89	00:20	1.98	1.93	17:55	1.94	00:30	2.18	2.05	23:30	0.207	00:30	0.246	0.224	0.224	-
05/12/2021	21:35	1.84	03:35	1.95	1.89	21:10	1.87	01:50	2.15	1.99	21:15	0.192	01:50	0.237	0.212	0.212	-
05/13/2021	03:05	1.81	21:50	1.90	1.86	15:55	1.82	10:40	2.07	1.95	06:40	0.183	10:40	0.220	0.203	0.203	-
05/14/2021	11:20	1.81	05:10	1.89	1.85	11:35	1.82	14:35	2.05	1.94	11:35	0.183	14:35	0.216	0.200	0.200	-
05/15/2021	19:15	1.81	05:25	1.88	1.85	18:50	1.81	13:35	2.06	1.93	19:20	0.183	05:25	0.214	0.198	0.198	-
05/16/2021	23:40	1.77	00:00	1.87	1.83	23:15	1.78	22:25	2.03	1.91	23:15	0.176	04:00	0.208	0.194	0.194	0.01
05/17/2021	11:10	1.70	00:20	1.85	1.77	16:50	1.61	11:35	2.00	1.81	16:50	0.147	11:35	0.201	0.174	0.174	-
05/18/2021	22:30	1.69	16:05	1.83	1.74	20:45	1.58	00:45	2.00	1.77	20:45	0.143	00:45	0.201	0.166	0.166	-
05/19/2021	21:10	1.62	11:25	1.82	1.70	21:20	1.53	11:20	1.90	1.70	21:20	0.131	11:20	0.191	0.154	0.154	-
05/20/2021	22:30	1.59	02:05	1.72	1.65	23:40	1.45	13:30	1.84	1.63	08:55	0.122	13:30	0.168	0.142	0.142	-
05/21/2021	17:50	1.58	10:45	1.72	1.63	17:45	1.42	02:40	1.77	1.59	17:45	0.117	10:45	0.156	0.135	0.135	-
05/22/2021	10:45	1.57	01:55	1.68	1.61	06:55	1.43	11:30	1.73	1.56	06:55	0.118	01:55	0.151	0.130	0.130	0.01
05/23/2021	23:30	1.57	07:30	1.65	1.60	05:55	1.40	00:40	1.67	1.55	05:55	0.114	08:10	0.142	0.128	0.128	-
05/24/2021	21:10	1.55	01:35	1.64	1.58	14:45	1.37	04:35	1.68	1.52	21:15	0.110	02:15	0.140	0.125	0.125	-
05/25/2021	20:30	1.51	11:20	1.60	1.56	18:40	1.32	03:35	1.67	1.49	20:15	0.103	03:35	0.136	0.119	0.119	-
05/26/2021	18:40	1.48	22:35	5.49	1.79	17:00	1.29	22:35	6.31	1.80	17:00	0.096	22:35	3.239	0.287	0.287	0.18
05/27/2021	20:00	1.59	00:00	2.86	1.66	21:35	1.43	00:00	3.49	1.65	21:35	0.118	00:00	0.684	0.149	0.149	0.03
05/28/2021	17:10	1.54	23:45	11.30	2.41	17:15	1.38	23:50	10.53	2.51	17:15	0.108	23:50	15.312	1.132	1.132	0.74
05/29/2021	23:45	1.95	01:40	12.75	4.74	23:40	2.10	01:50	11.07	5.30	23:40	0.235	01:40	18.962	3.734	3.734	1.43

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	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
05/30/2021	08:45	1.89	16:00	6.08	3.21	08:45	1.95	14:55	7.96	3.77	08:45	0.206	14:55	4.641	1.257	1.257	0.57
05/31/2021	23:30	2.01	02:50	5.08	2.47	23:00	2.12	02:55	6.19	2.79	23:30	0.248	02:50	2.815	0.499	0.499	0.14
06/01/2021	19:00	1.94	03:30	2.14	2.00	18:45	2.00	03:25	2.30	2.13	18:45	0.222	03:25	0.293	0.247	0.247	-
06/02/2021	22:40	1.88	01:00	2.01	1.94	22:40	1.91	01:05	2.22	2.03	22:40	0.201	01:05	0.258	0.224	0.224	-
06/03/2021	09:35	1.84	08:15	1.98	1.89	07:50	1.85	08:30	2.13	1.97	09:55	0.193	08:15	0.241	0.210	0.210	-
06/04/2021	12:20	1.85	17:55	2.59	1.92	01:55	1.84	18:00	2.99	2.01	01:55	0.190	18:00	0.507	0.221	0.221	0.05
06/05/2021	23:20	1.82	07:15	1.90	1.86	23:15	1.80	13:45	2.05	1.93	23:20	0.181	13:45	0.216	0.201	0.201	-
06/06/2021	21:55	1.72	03:30	1.87	1.81	19:50	1.67	02:00	1.98	1.85	19:50	0.154	02:00	0.203	0.184	0.184	-
06/07/2021	13:05	1.69	05:15	1.84	1.75	21:55	1.58	01:55	1.96	1.76	21:55	0.144	05:10	0.199	0.167	0.167	-
06/08/2021	15:30	1.66	20:10	1.99	1.75	15:20	1.58	20:10	2.11	1.75	15:25	0.140	20:10	0.242	0.166	0.166	0.04
06/09/2021	16:15	1.63	05:05	1.80	1.69	14:20	1.51	02:15	1.85	1.67	19:20	0.131	02:15	0.179	0.151	0.151	-
06/10/2021	19:10	1.58	01:10	1.70	1.63	18:55	1.42	01:15	1.75	1.57	18:55	0.116	01:15	0.158	0.134	0.134	-
06/11/2021	10:15	1.58	03:15	1.69	1.62	17:55	1.40	12:40	1.72	1.55	17:55	0.116	03:15	0.152	0.131	0.131	0.03
06/12/2021	21:35	1.65	00:55	7.33	2.64	23:25	1.54	00:55	8.38	2.96	23:25	0.134	00:55	6.551	0.876	0.876	0.14
06/13/2021	17:45	1.60	00:00	1.77	1.65	20:50	1.42	10:40	1.81	1.61	20:50	0.118	05:20	0.171	0.141	0.140	-

03/23/2021 00:00 - 06/13/2021 23:55

	DFINAL (in)	VFINAL (ft/s)	QFINAL (MGD - Total MG)	Rain (in)
Total			34.267	10.22
Average	2.07	2.26	0.413	

PoliceStation

Site Commentary

SITE INFORMATION

Pipe	Round (30 in H)
Silt	0.00 (in)

OBSERVATIONS

Average flow depth, velocity, and quantity data observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021**, along with observed minimum and maximum data, are provided in the following table.

Observed Flow Conditions			
Item	**DFINAL (in)**	**VFINAL (ft/s)**	**QFINAL (MGD - Total MG)**
Average	3.09	0.11	0.035
Minimum	2.49	0.01	0.001
Maximum	15.56	1.87	2.941
Min Time	05/26/2021 17:15:00	05/24/2021 11:00:00	05/24/2021 11:00:00
Max Time	04/21/2021 17:45:00	05/29/2021 01:30:00	04/21/2021 17:45:00

Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Values in the Observed Flow Conditions and data on the graphical reports are based on the none average.

DATA UPTIME

Data uptime observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021** is provided in the following table:

Percent Uptime	
DFINAL (in)	100
VFINAL (ft/s)	100
QFINAL (MGD - Total MG)	100

Norwood, MA

Flow Monitoring
Site Installation Report

Site I.D.

PoliceStation

Site Address / Location:	137 Nahatan St. Norwood, MA (Police Station)
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
30"x30"	Circular
Manhole #	**System Characteristics**
Access	**Traffic**
Drive	None

Installation Information

Installation Date:	Installation Type:
Thursday, March 18, 2021	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV Gated (CS7)	

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:38am	30"x30"
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
2.75"	27.25"
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
0.1	
Silt (in)	**Silt Type**
0	

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
105.13"	
Manhole Material:	**Manhole Condition:**
Concrete	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
Manhole Cover	**Manhole Frame**
Concealed	Normal
Active Drop Connections	**Air Quality:**
No	
Pipe Material	**Pipe Condition:**
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

42.192992, -71.195418 S/N:64050 IP:166.219.172.77

ADS Project Name:	Norwood
ADS Project Number:	32685.11.325

Hydrograph Report

PoliceStation

Flow Monitor

PoliceStation

Pipe Height
30.00
in

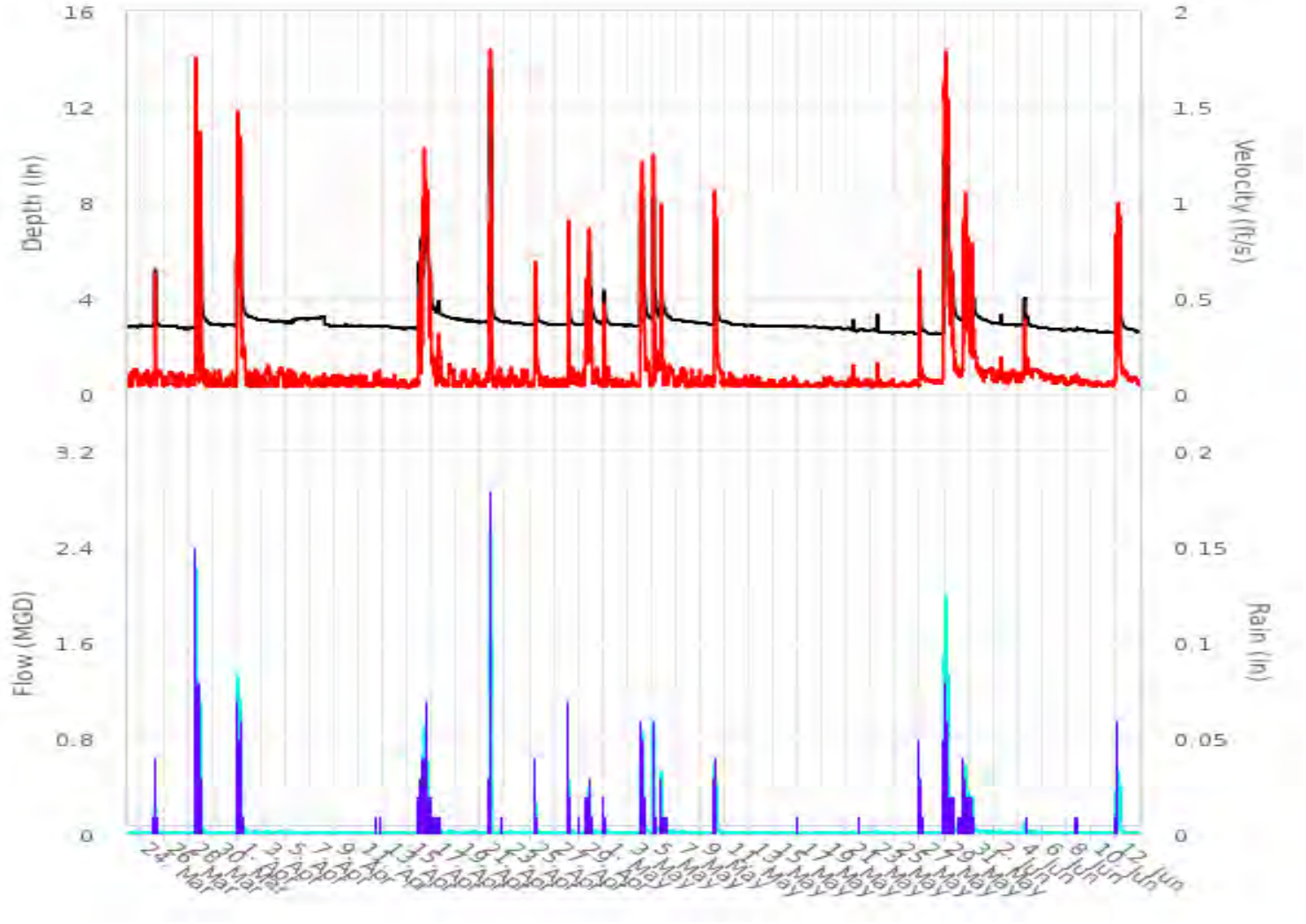
Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL
- VFINAL
- QFINAL
- RAIN FINAL

ADS ENVIRONMENTAL SERVICES



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Scattergraph Report

PoliceStation

Flow Monitor

PoliceStation

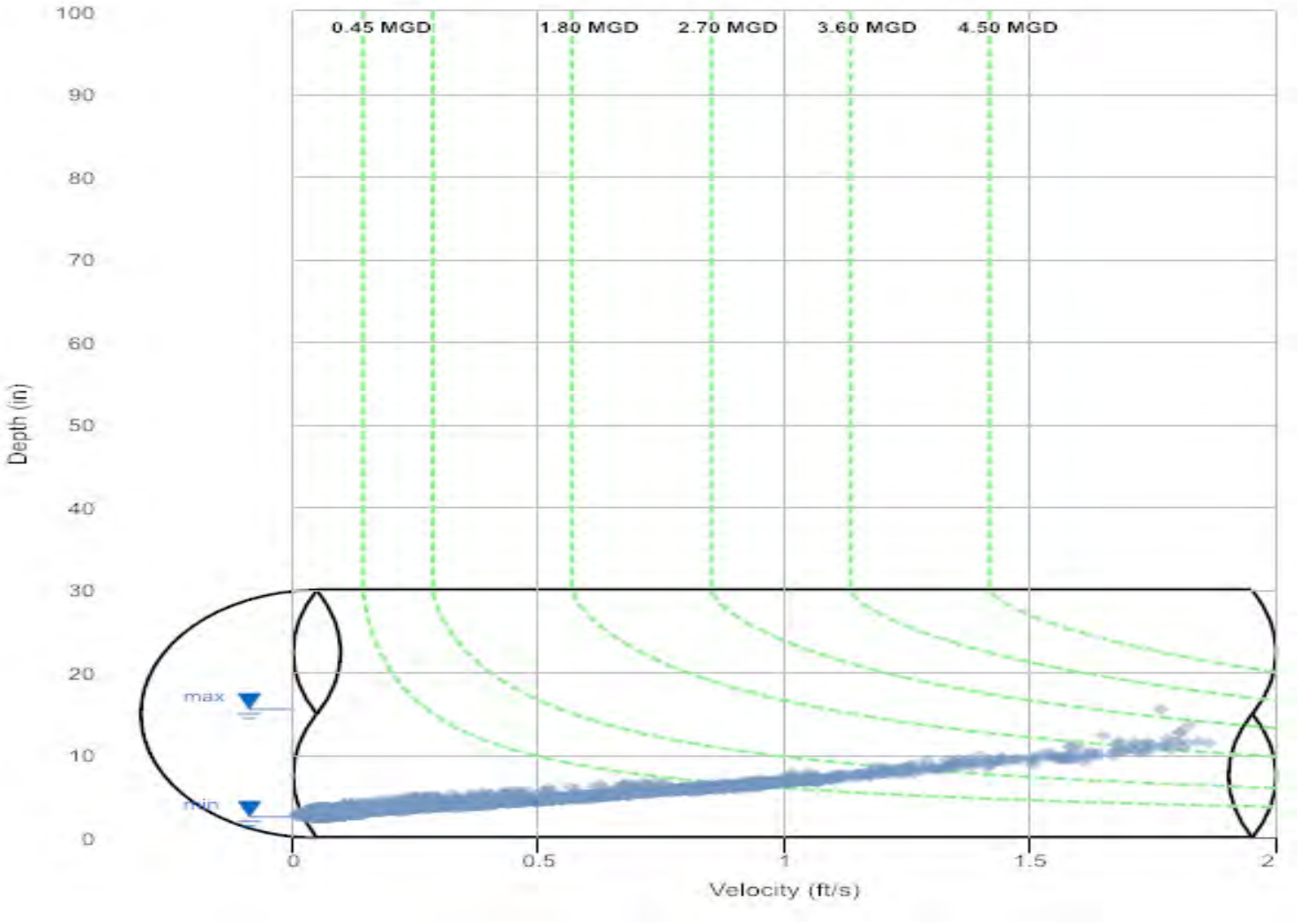
Pipe Height
30.00
in

Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL - VFINAL
- Iso-Q™
- Min-Max Depth



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Daily Tabular Report

03/23/2021 00:00 - 06/13/2021 23:55
PoliceStationPipe: Round (30 in H), Silt0.00 in

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
03/23/2021	03:45	2.78	23:00	2.88	2.82	02:20	0.04	17:00	0.14	0.08	02:35	0.005	17:00	0.021	0.012	0.012	-
03/24/2021	20:35	2.82	05:20	2.89	2.84	20:35	0.03	15:25	0.13	0.08	20:35	0.004	15:25	0.019	0.012	0.012	-
03/25/2021	00:30	2.83	06:15	5.42	2.97	02:20	0.04	06:15	0.70	0.10	02:20	0.005	06:15	0.273	0.019	0.019	0.11
03/26/2021	22:30	2.82	23:40	2.87	2.85	23:50	0.02	13:20	0.12	0.07	23:50	0.004	13:45	0.018	0.011	0.011	-
03/27/2021	22:45	2.74	00:00	2.86	2.77	00:10	0.03	00:50	0.13	0.07	00:10	0.004	00:50	0.020	0.010	0.010	-
03/28/2021	02:00	2.73	14:30	12.68	3.90	11:45	0.04	14:30	1.81	0.28	11:50	0.006	14:30	2.309	0.158	0.158	0.78
03/29/2021	22:50	2.92	00:40	6.38	3.30	07:05	0.03	00:40	0.89	0.13	14:00	0.005	00:40	0.437	0.037	0.037	0.06
03/30/2021	17:15	2.87	09:45	2.93	2.90	08:35	0.03	03:15	0.14	0.05	08:35	0.005	03:15	0.022	0.008	0.008	-
03/31/2021	18:35	2.86	23:55	6.29	2.98	15:25	0.03	23:55	0.92	0.08	20:35	0.005	23:55	0.445	0.020	0.020	0.17
04/01/2021	23:55	3.22	00:35	9.78	4.60	18:40	0.04	00:30	1.54	0.43	18:40	0.008	00:30	1.377	0.211	0.211	0.76
04/02/2021	23:40	3.10	00:55	3.25	3.16	20:20	0.03	14:05	0.14	0.07	20:20	0.005	14:05	0.024	0.012	0.012	-
04/03/2021	17:10	3.04	09:50	3.12	3.08	20:35	0.03	12:05	0.17	0.08	20:35	0.005	12:05	0.030	0.013	0.013	-
04/04/2021	23:40	3.00	09:30	3.07	3.03	20:25	0.03	12:55	0.14	0.08	20:25	0.005	12:55	0.024	0.013	0.013	-
04/05/2021	12:25	2.97	17:25	3.16	3.05	20:55	0.03	04:55	0.14	0.07	20:55	0.005	15:40	0.024	0.012	0.012	-
04/06/2021	18:00	3.12	08:20	3.17	3.14	07:30	0.03	03:35	0.12	0.07	07:30	0.006	03:35	0.021	0.012	0.012	-
04/07/2021	15:55	3.14	22:00	3.24	3.17	14:40	0.03	19:50	0.12	0.05	14:40	0.005	19:50	0.021	0.010	0.010	-
04/08/2021	17:50	2.85	02:55	3.24	2.92	06:20	0.03	06:25	0.12	0.06	21:40	0.005	03:20	0.019	0.009	0.009	-
04/09/2021	16:05	2.82	20:15	2.95	2.85	04:05	0.04	07:35	0.11	0.06	04:05	0.005	07:35	0.017	0.009	0.009	-
04/10/2021	16:35	2.84	09:25	2.87	2.86	00:05	0.03	10:05	0.10	0.06	00:05	0.005	10:05	0.016	0.009	0.009	-
04/11/2021	11:20	2.81	02:40	2.87	2.83	13:55	0.03	02:10	0.12	0.06	13:55	0.005	02:10	0.018	0.008	0.008	-
04/12/2021	11:30	2.81	06:00	2.87	2.83	02:25	0.03	15:55	0.12	0.07	20:05	0.005	15:55	0.019	0.011	0.011	0.02
04/13/2021	21:45	2.77	09:50	2.83	2.80	16:30	0.02	20:15	0.12	0.05	16:30	0.003	20:15	0.018	0.008	0.008	-
04/14/2021	15:45	2.72	04:05	2.77	2.75	02:45	0.02	11:10	0.08	0.05	02:45	0.004	11:10	0.012	0.007	0.007	-
04/15/2021	13:35	2.74	21:40	5.61	3.04	03:10	0.03	21:40	0.52	0.09	08:10	0.004	21:40	0.215	0.022	0.022	0.25
04/16/2021	23:55	3.69	07:35	8.17	5.59	01:30	0.11	07:40	1.32	0.65	01:45	0.027	07:40	0.920	0.307	0.307	1.47
04/17/2021	23:55	3.27	12:05	3.89	3.45	17:00	0.04	12:05	0.34	0.14	23:20	0.007	12:05	0.083	0.028	0.028	0.10
04/18/2021	19:15	3.13	00:00	3.27	3.19	07:45	0.04	09:40	0.16	0.08	20:00	0.007	09:40	0.028	0.014	0.014	-
04/19/2021	21:15	3.06	00:00	3.14	3.10	19:55	0.03	13:45	0.13	0.06	19:55	0.006	13:45	0.023	0.011	0.011	-
04/20/2021	22:10	3.00	03:10	3.07	3.03	02:55	0.03	08:40	0.14	0.06	02:55	0.006	09:10	0.023	0.011	0.011	-
04/21/2021	14:00	2.98	17:45	15.56	3.77	04:40	0.04	17:50	1.83	0.23	04:45	0.006	17:45	2.941	0.126	0.126	0.49
04/22/2021	21:00	3.01	00:00	3.32	3.09	00:05	0.03	05:50	0.16	0.07	00:05	0.006	05:50	0.028	0.012	0.012	0.01
04/23/2021	18:45	2.94	05:10	3.01	2.98	15:20	0.01	08:50	0.14	0.07	15:20	0.002	08:50	0.023	0.012	0.012	-
04/24/2021	15:00	2.90	04:45	2.95	2.93	05:10	0.04	09:35	0.13	0.07	08:20	0.006	09:35	0.022	0.011	0.011	-
04/25/2021	07:15	2.91	09:50	5.42	3.21	05:50	0.04	09:50	0.70	0.13	05:50	0.006	09:50	0.274	0.032	0.032	0.22
04/26/2021	14:40	2.89	00:25	3.00	2.93	11:00	0.02	22:20	0.13	0.05	11:00	0.004	22:20	0.021	0.009	0.009	-
04/27/2021	14:55	2.89	09:00	2.92	2.91	12:55	0.03	17:40	0.10	0.05	12:55	0.005	21:25	0.016	0.008	0.008	-
04/28/2021	20:15	2.89	03:20	6.56	3.16	07:25	0.04	03:25	0.92	0.13	19:05	0.006	03:20	0.472	0.032	0.032	0.20
04/29/2021	04:15	2.90	20:40	6.19	3.50	00:50	0.04	20:45	0.89	0.22	00:50	0.006	20:40	0.420	0.059	0.059	0.40
04/30/2021	21:20	2.93	00:00	4.10	3.15	16:40	0.03	00:00	0.40	0.09	16:40	0.005	00:00	0.104	0.018	0.018	0.04
05/01/2021	18:10	2.90	01:00	4.36	3.11	06:30	0.04	01:00	0.47	0.10	23:45	0.006	01:00	0.135	0.021	0.021	0.12
05/02/2021	17:50	2.87	03:25	2.93	2.90	23:05	0.03	01:00	0.13	0.05	23:05	0.005	01:00	0.020	0.008	0.008	-
05/03/2021	14:40	2.83	08:30	2.88	2.86	00:05	0.03	08:45	0.11	0.05	00:05	0.005	08:45	0.017	0.008	0.008	-
05/04/2021	00:00	2.86	04:45	8.32	4.23	22:20	0.04	04:40	1.22	0.36	22:20	0.006	04:50	0.870	0.148	0.148	0.80
05/05/2021	01:40	3.11	02:35	9.33	3.86	00:35	0.04	02:40	1.46	0.24	00:35	0.007	02:40	1.229	0.083	0.083	0.42
05/06/2021	19:10	3.08	00:35	3.63	3.21	18:40	0.04	00:25	0.18	0.09	18:40	0.006	00:25	0.039	0.017	0.017	0.01
05/07/2021	18:20	3.03	02:50	3.09	3.06	00:40	0.03	09:10	0.14	0.08	00:40	0.005	09:10	0.024	0.013	0.013	-
05/08/2021	22:30	2.97	03:45	3.05	3.01	06:35	0.03	05:25	0.14	0.06	06:35	0.005	05:25	0.023	0.010	0.010	-
05/09/2021	22:40	2.91	02:20	2.98	2.95	03:25	0.03	17:15	0.12	0.05	07:30	0.005	17:15	0.019	0.009	0.009	-
05/10/2021	00:00	2.92	03:40	6.96	3.61	00:45	0.04	03:40	1.07	0.24	00:45	0.006	03:40	0.598	0.079	0.079	0.42
05/11/2021	17:30	2.89	00:00	3.01	2.95	14:45	0.03	01:05	0.13	0.06	14:45	0.004	01:05	0.022	0.010	0.010	-
05/12/2021	16:15	2.86	08:15	2.91	2.88	02:25	0.04	23:45	0.11	0.06	02:25	0.006	23:45	0.017	0.009	0.009	-
05/13/2021	16:25	2.84	08:25	2.88	2.86	11:55	0.04	04:25	0.11	0.05	11:55	0.005	04:25	0.017	0.008	0.008	-
05/14/2021	13:50	2.82	08:20	2.86	2.84	08:40	0.03	10:10	0.09	0.05	08:40	0.005	10:10	0.014	0.007	0.007	-
05/15/2021	12:15	2.81	07:40	2.85	2.83	11:40	0.03	21:05	0.09	0.05	11:40	0.004	21:05	0.013	0.007	0.007	-
05/16/2021	15:25	2.81	07:10	2.85	2.83	16:35	0.03	13:30	0.11	0.05	16:35	0.004	13:30	0.016	0.008	0.008	0.01
05/17/2021	18:45	2.78	08:15	2.86	2.82	07:45	0.04	15:30	0.08	0.05	20:10	0.005	15:30	0.012	0.007	0.007	-
05/18/2021	18:40	2.77	08:25	2.82	2.80	14:00	0.01	22:10	0.07	0.04	14:00	0.002	22:10	0.010	0.007	0.007	-
05/19/2021	17:25	2.72	01:50	2.80	2.76	07:20	0.02	12:45	0.09	0.06	07:20	0.003	12:45	0.014	0.008	0.008	-
05/20/2021	16:30	2.71	08:40	2.77	2.74	00:25	0.03	10:40	0.07	0.05	00:25	0.004	10:40	0.011	0.007	0.007	-
05/21/2021	17:30	2.61	11:15	3.12	2.70	07:50	0.03	11:15	0.16	0.06	07:50	0.005	11:15	0.029	0.009	0.009	-
05/22/2021	09:30	2.64	03:35	2.69	2.67	07:50	0.02	16:40	0.08	0.06	07:50	0.003	16:40	0.011	0.008	0.008	0.01
05/23/2021	18:55	2.56	11:20	3.32	2.67	02:35	0.01	10:35	0.16	0.06	02:35	0.002	10:35	0.031	0.008	0.008	-
05/24/2021	17:50	2.54	08:35	2.59	2.57	11:00	0.01	17:30	0.08	0.05	11:00	0.001	17:30	0.011	0.007	0.007	-
05/25/2021	17:00	2.54	08:00	2.59	2.57	06:20	0.02	03:50	0.06	0.05	06:20	0.003	03:50	0.008	0.006	0.006	-
05/26/2021	17:15	2.49	22:40	5.13	2.72	03:00	0.02	22:40	0.66	0.09	03:00	0.003	22:40	0.238	0.019	0.019	0.18
05/27/2021	17:35	2.53	00:00	3.27	2.61	18:15	0.06	00:00	0.19	0.08	18:15	0.008	00:00	0.035	0.011	0.011	0.03
05/28/2021	14:50	2.51	23:50	10.02	3.24	05:10	0.04	23:10	1.67	0.22	05:10	0.005	23:50	1.525	0.120	0.120	0.74
05/29/2021	23:55	3.23	01:55	11.51	5.66	20:20	0.09	01:30	1.87	0.68	20:20	0.019	01:55	2.071	0.450	0.450	1.43

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
05/30/2021	10:15	3.07	15:45	7.09	4.14	05:40	0.08	15:40	1.10	0.37	05:40	0.014	15:45	0.630	0.133	0.133	0.57
05/31/2021	23:55	3.15	05:05	5.57	3.64	23:30	0.08	05:00	0.82	0.23	23:30	0.014	05:05	0.328	0.057	0.057	0.14
06/01/2021	22:35	2.97	00:00	3.15	3.05	04:30	0.06	17:10	0.14	0.11	23:30	0.010	08:50	0.024	0.018	0.018	-
06/02/2021	22:50	2.90	14:45	3.35	2.96	03:45	0.05	14:40	0.21	0.10	03:45	0.008	14:40	0.041	0.016	0.016	-
06/03/2021	22:00	2.87	08:45	2.92	2.90	04:15	0.05	12:50	0.13	0.09	04:15	0.007	12:50	0.021	0.014	0.014	-
06/04/2021	15:35	2.86	13:10	4.03	3.01	06:25	0.06	13:25	0.39	0.14	06:25	0.009	13:25	0.099	0.025	0.025	0.05
06/05/2021	21:20	2.76	00:00	2.87	2.82	20:15	0.08	08:40	0.14	0.12	20:15	0.011	08:40	0.021	0.018	0.018	-
06/06/2021	18:40	2.70	04:45	2.77	2.74	20:25	0.05	01:50	0.11	0.09	20:25	0.007	04:50	0.016	0.013	0.013	-
06/07/2021	18:35	2.66	06:35	2.73	2.70	23:40	0.03	15:40	0.10	0.07	23:40	0.004	15:40	0.014	0.010	0.010	-
06/08/2021	14:35	2.65	20:00	2.79	2.69	00:05	0.04	19:10	0.11	0.07	00:05	0.005	19:25	0.015	0.010	0.010	0.04
06/09/2021	17:05	2.62	05:45	2.70	2.66	06:15	0.04	07:30	0.08	0.06	06:30	0.005	07:30	0.012	0.008	0.008	-
06/10/2021	18:45	2.58	05:05	2.64	2.61	12:25	0.02	10:35	0.09	0.05	12:25	0.003	10:35	0.012	0.007	0.007	-
06/11/2021	15:00	2.57	08:40	2.61	2.59	16:45	0.03	23:20	0.09	0.05	16:45	0.003	23:20	0.012	0.007	0.007	0.03
06/12/2021	00:00	2.60	06:00	6.83	3.57	21:50	0.08	05:55	1.07	0.28	21:50	0.012	05:55	0.581	0.088	0.088	0.14
06/13/2021	19:15	2.60	00:00	2.73	2.67	23:15	0.03	01:35	0.10	0.07	23:15	0.005	01:35	0.014	0.010	0.010	-

03/23/2021 00:00 - 06/13/2021 23:55

	DFINAL (in)	VFINAL (ft/s)	QFINAL (MGD - Total MG)	Rain (in)
Total			2.885	10.22
Average	3.09	0.11	0.035	

RG01

Site Commentary

SITE INFORMATION

Rain Gauge	Rain Gauge (0 H x 0 W)
Silt	0.00 (in)

OBSERVATIONS

Average flow depth, velocity, and quantity data observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021**, along with observed minimum and maximum data, are provided in the following table.

Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Values in the Observed Flow Conditions and data on the graphical reports are based on the none average.

DATA UPTIME

Data uptime observed during **Tuesday, March 23, 2021 to Sunday, June 13, 2021** is provided in the following table:

Percent Uptime	
Rainfall (in)	100

Norwood, MA

Flow Monitoring
Site Installation Report

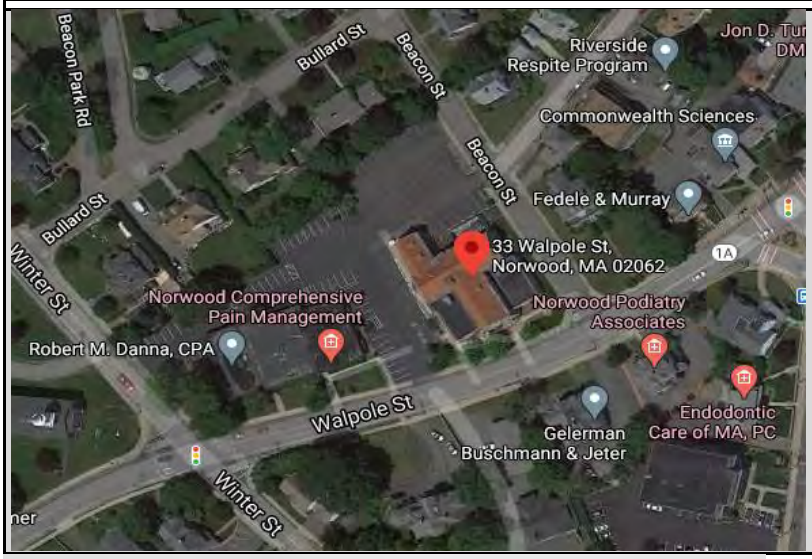
ADS ENVIRONMENTAL SERVICES®

Site I.D.

RG01

Site Address / Location:	33 Walpole St, Norwood, MA
Site Access:	Drive (Roof Access through Library)

Monitor Series	Location Type
Rain Alert III	Temporary
Pipe Size (H x W)	Pipe Shape



Manhole #	System Characteristics
Access	**Traffic**
Drive	None

Installation Information

Installation Date:	Installation Type:
Thursday, March 18, 2021	Rain Gauge
Monitoring Location (Sensors):	Monitor Location:
Rooftop	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
Downlooker Physical Offset (in)	Measurement Confidence (in)
Peak Velocity (fps)	Velocity Sensor Offset (in)
Silt (in)	Silt Type

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
Manhole Material:	Manhole Condition:
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
Manhole Cover	Manhole Frame
Active Drop Connections	Air Quality:
Pipe Material	Pipe Condition:

Communication Information:

Communication Type	Antenna Location
Wireless	Cabinet

Additional Site Info. / Comments:

42.191113, -71.203895 S/N:4191 IP: 10.4.3.78 VZ

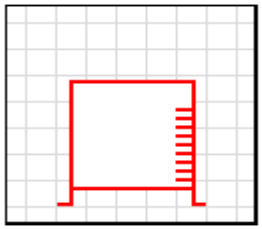
ADS Project Name:	Norwood, MA
ADS Project Number:	32685.11.325

Hydrograph Report

RG01

Rain Gauge

RG01



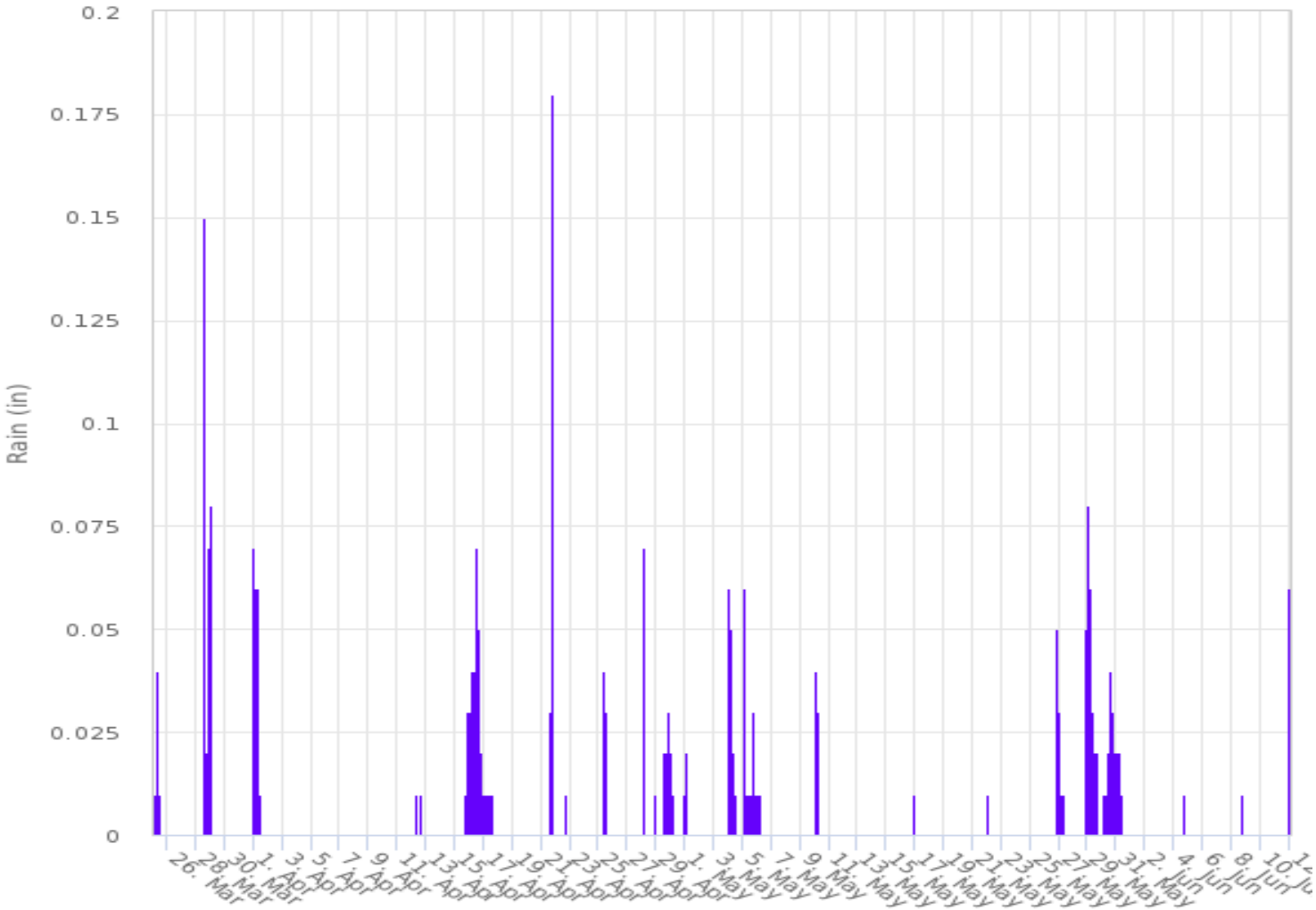
Report Period

03/23/2021
To
06/13/2021

Legend

- DFINAL
- VFINAL
- QFINAL
- RAIN FINAL

ADS ENVIRONMENTAL SERVICES



340 The Bridge Street, Suite 204
Huntsville, AL 35806

800-633-7246
www.adsenv.com

Daily Tabular Report

03/23/2021 00:00 - 06/13/2021 23:55
RG01Rain Gauge: Rain Gauge (0 H x 0 W), Silt0.00

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
03/23/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/24/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/25/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11
03/26/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/27/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/28/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.78
03/29/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06
03/30/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/31/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.17
04/01/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.76
04/02/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/03/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/04/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/05/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/06/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/07/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/08/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/09/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/10/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/11/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/12/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02
04/13/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/14/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/15/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25
04/16/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.47
04/17/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
04/18/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/19/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/20/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/21/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.49
04/22/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
04/23/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/24/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/25/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22
04/26/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/27/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/28/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20
04/29/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.40
04/30/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04
05/01/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.12
05/02/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/03/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/04/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.80
05/05/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.42
05/06/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
05/07/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/08/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/09/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/10/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.42
05/11/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/12/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/13/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/14/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/15/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/16/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
05/17/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/18/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/19/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/20/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/21/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/22/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
05/23/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/24/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/25/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/26/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.18
05/27/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
05/28/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.74
05/29/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.43
05/30/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.57

	DFINAL (in)					VFINAL (ft/s)					QFINAL (MGD - Total MG)						Rain (in)
Date	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
05/31/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14
06/01/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/02/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/03/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/04/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
06/05/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/06/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/07/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/08/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04
06/09/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/10/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/11/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
06/12/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14
06/13/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

03/23/2021 00:00 - 06/13/2021 23:55

	DFINAL (in)	VFINAL (ft/s)	QFINAL (MGD - Total MG)	Rain (in)
Total				10.22
Average				

Appendix B MODEL CALIBRATION PLOTS

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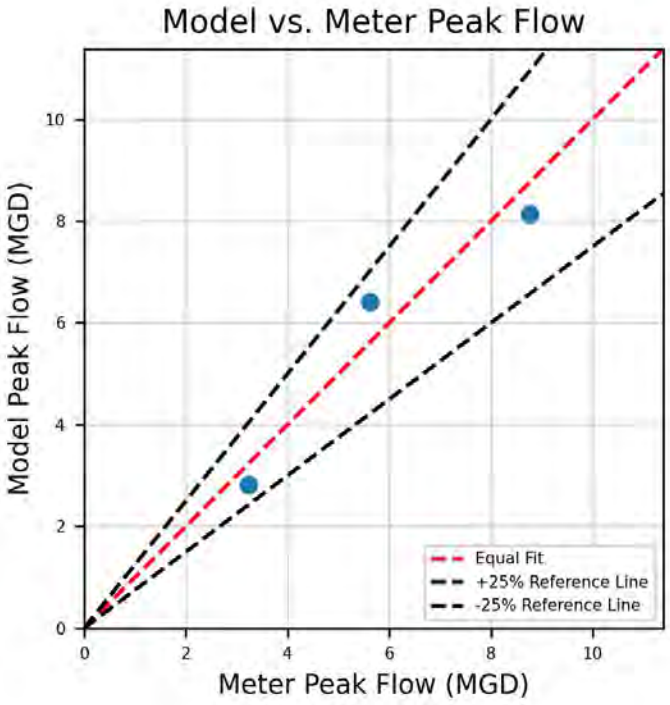
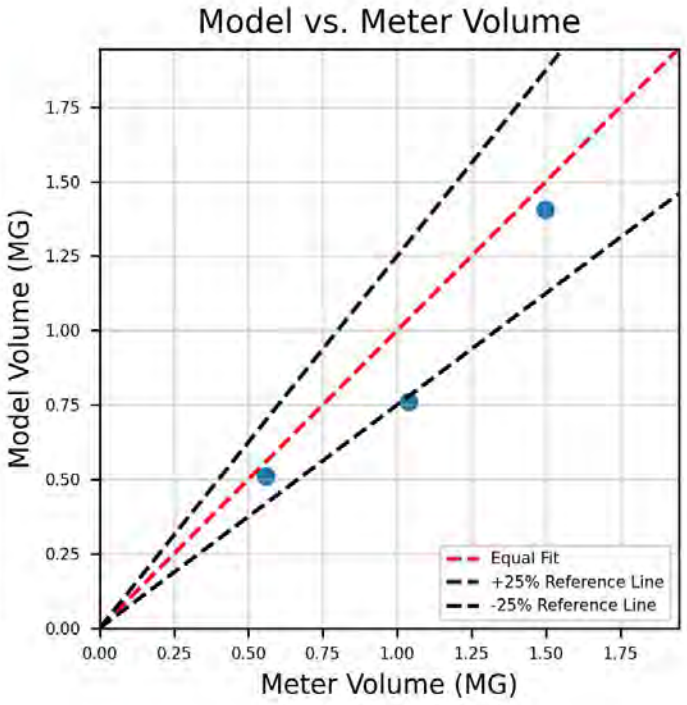
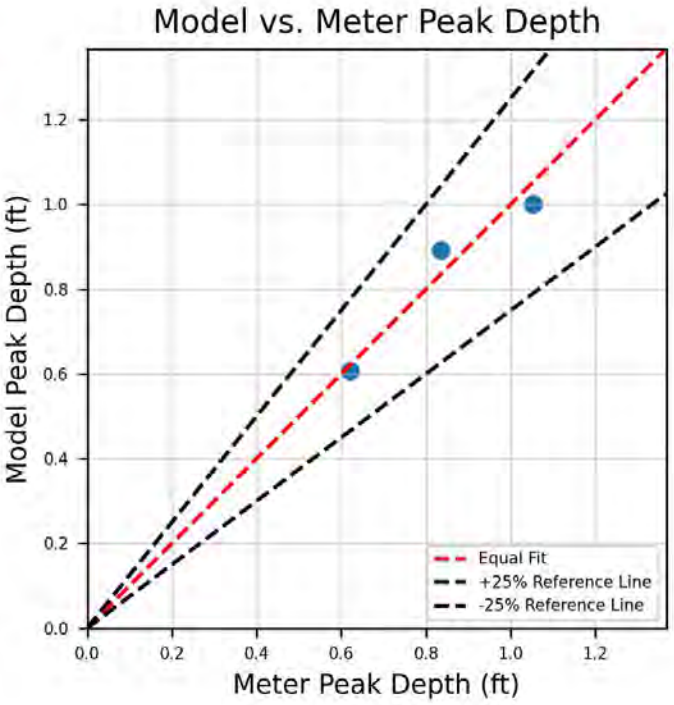
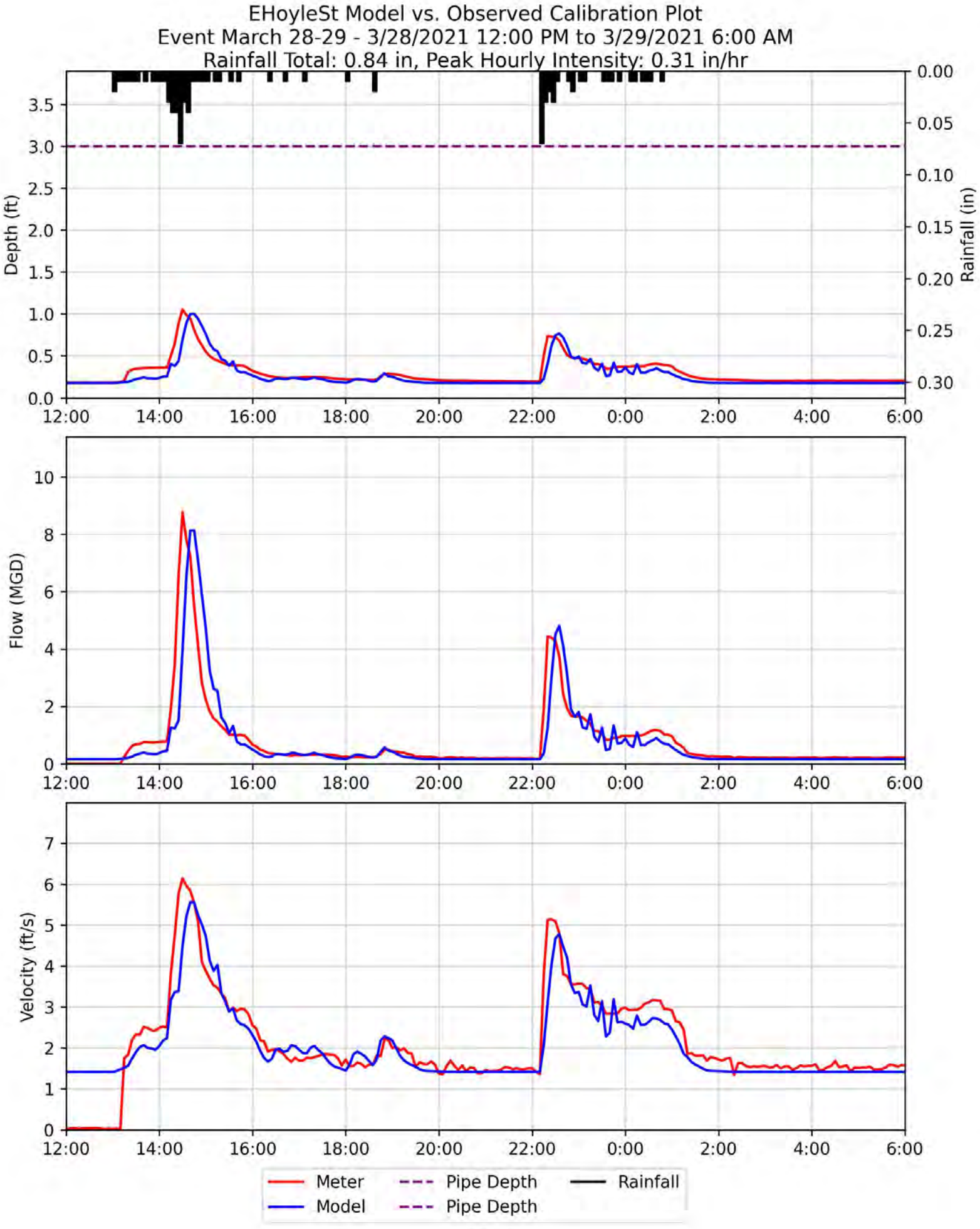
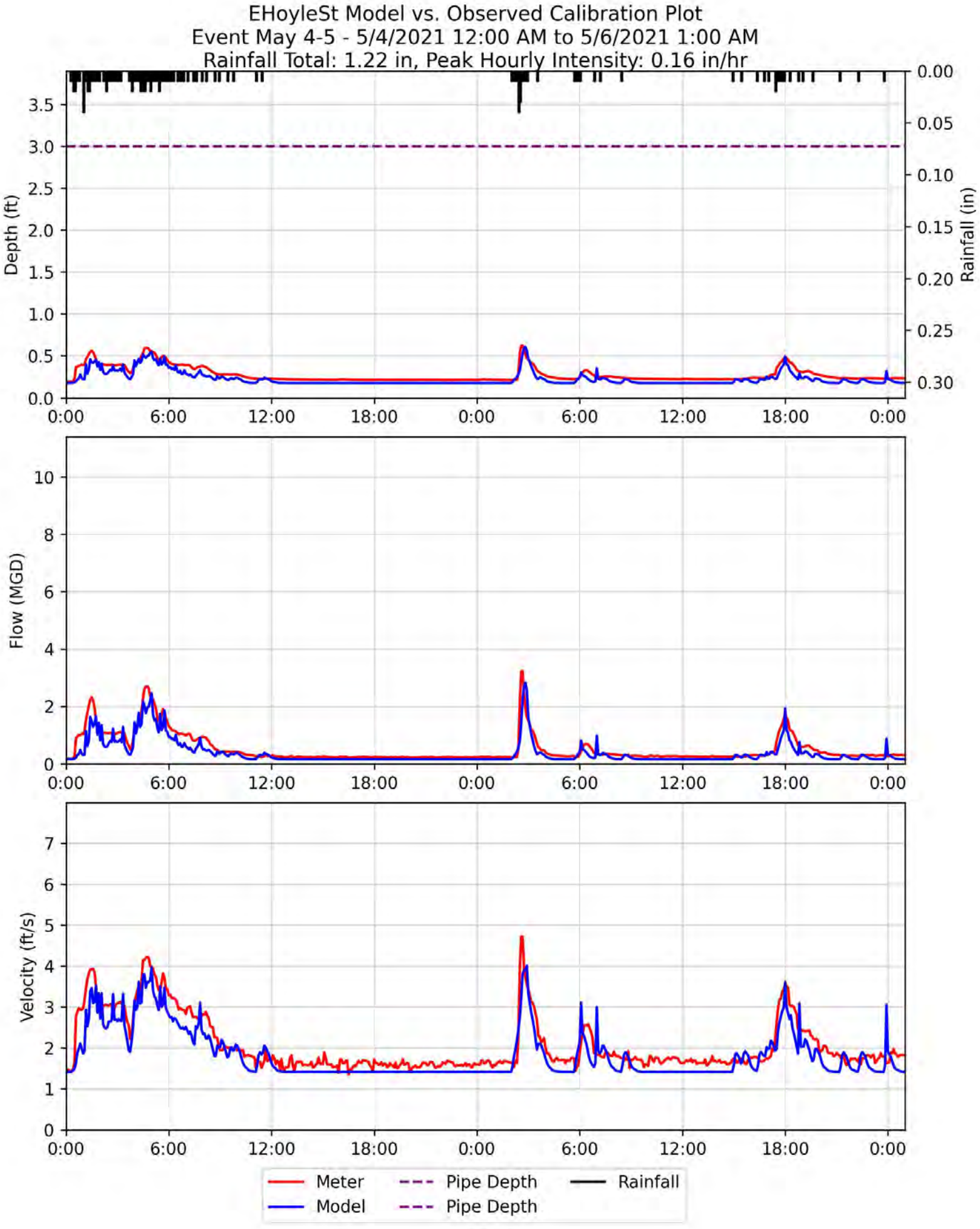
EHoyleSt (Model ID: 5400.1) - Regression Plots

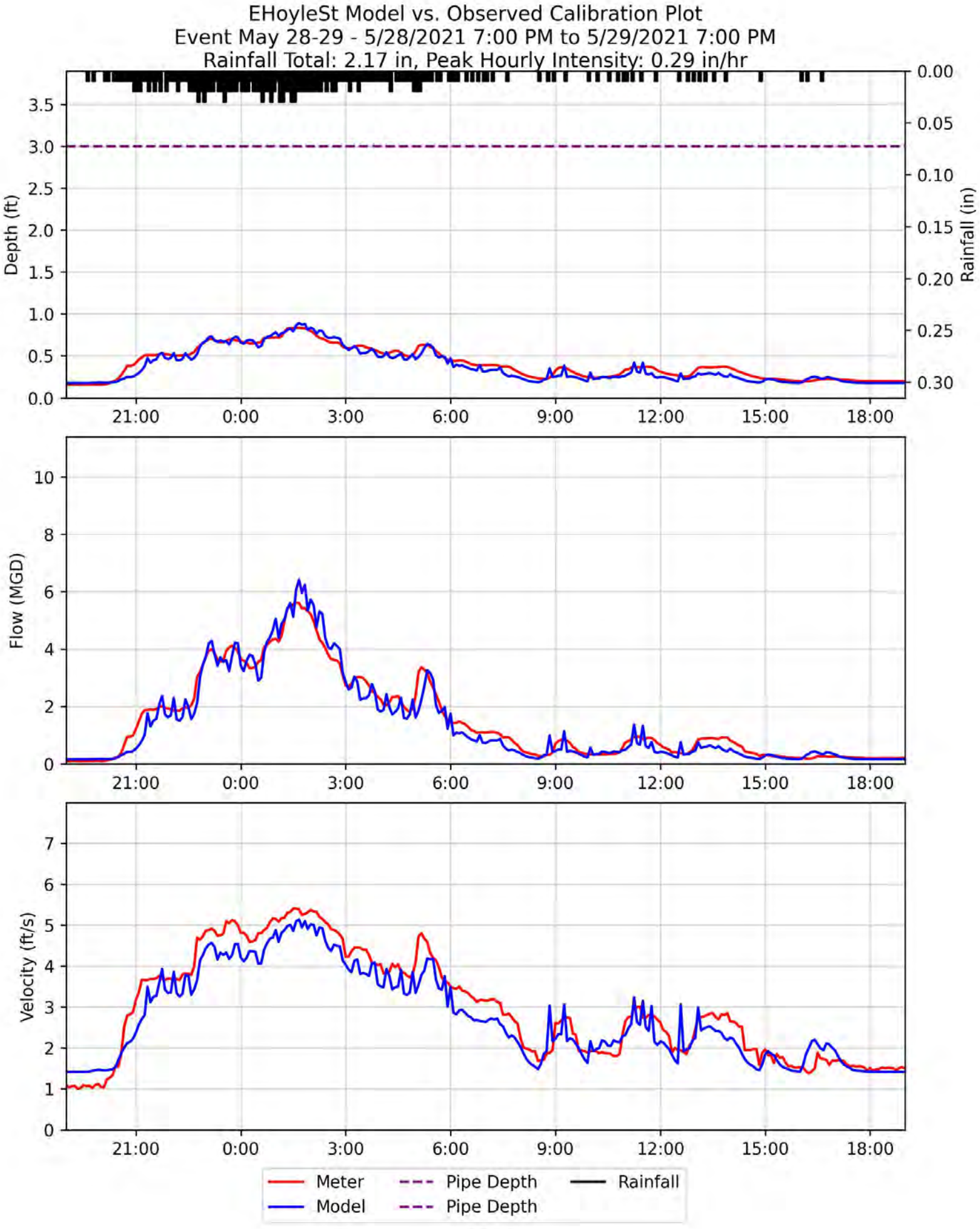




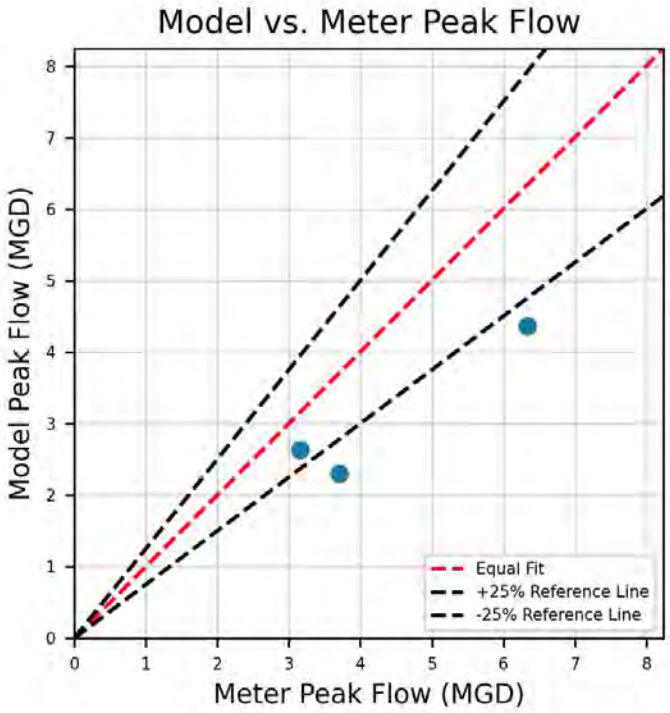


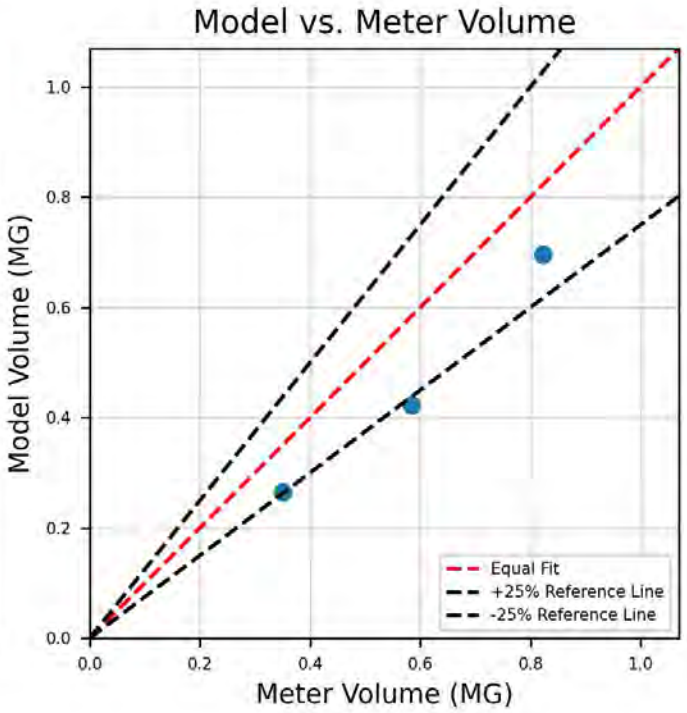

EHoyleSt Model vs. Observed Calibration Plot
Event March 28-29 - 3/28/2021 12:00 PM to 3/29/2021 6:00 AM
Rainfall Total: 0.84 in, Peak Hourly Intensity: 0.31 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

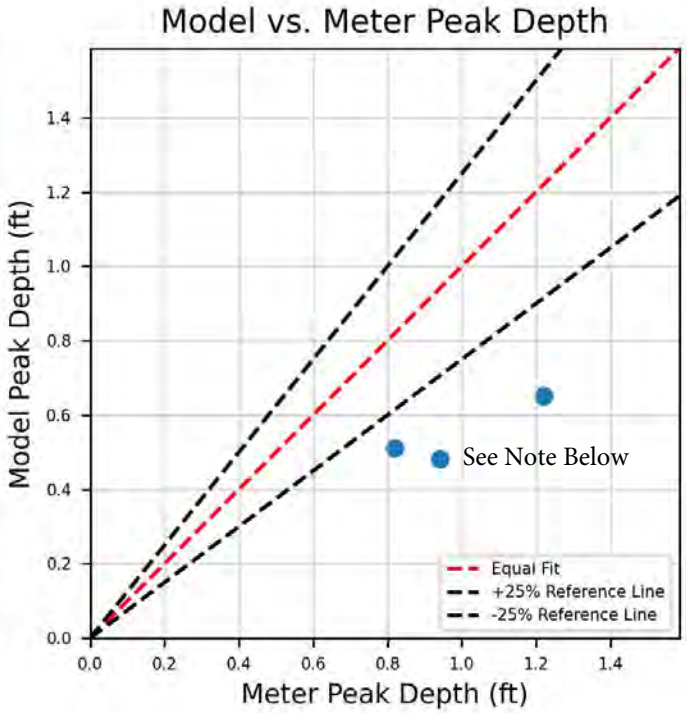

EHoyleSt Model vs. Observed Calibration Plot
Event May 4-5 - 5/4/2021 12:00 AM to 5/6/2021 1:00 AM
Rainfall Total: 1.22 in, Peak Hourly Intensity: 0.16 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
0:00
6:00
12:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall


EHoyleSt Model vs. Observed Calibration Plot
Event May 28-29 - 5/28/2021 7:00 PM to 5/29/2021 7:00 PM
Rainfall Total: 2.17 in, Peak Hourly Intensity: 0.29 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
21:00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

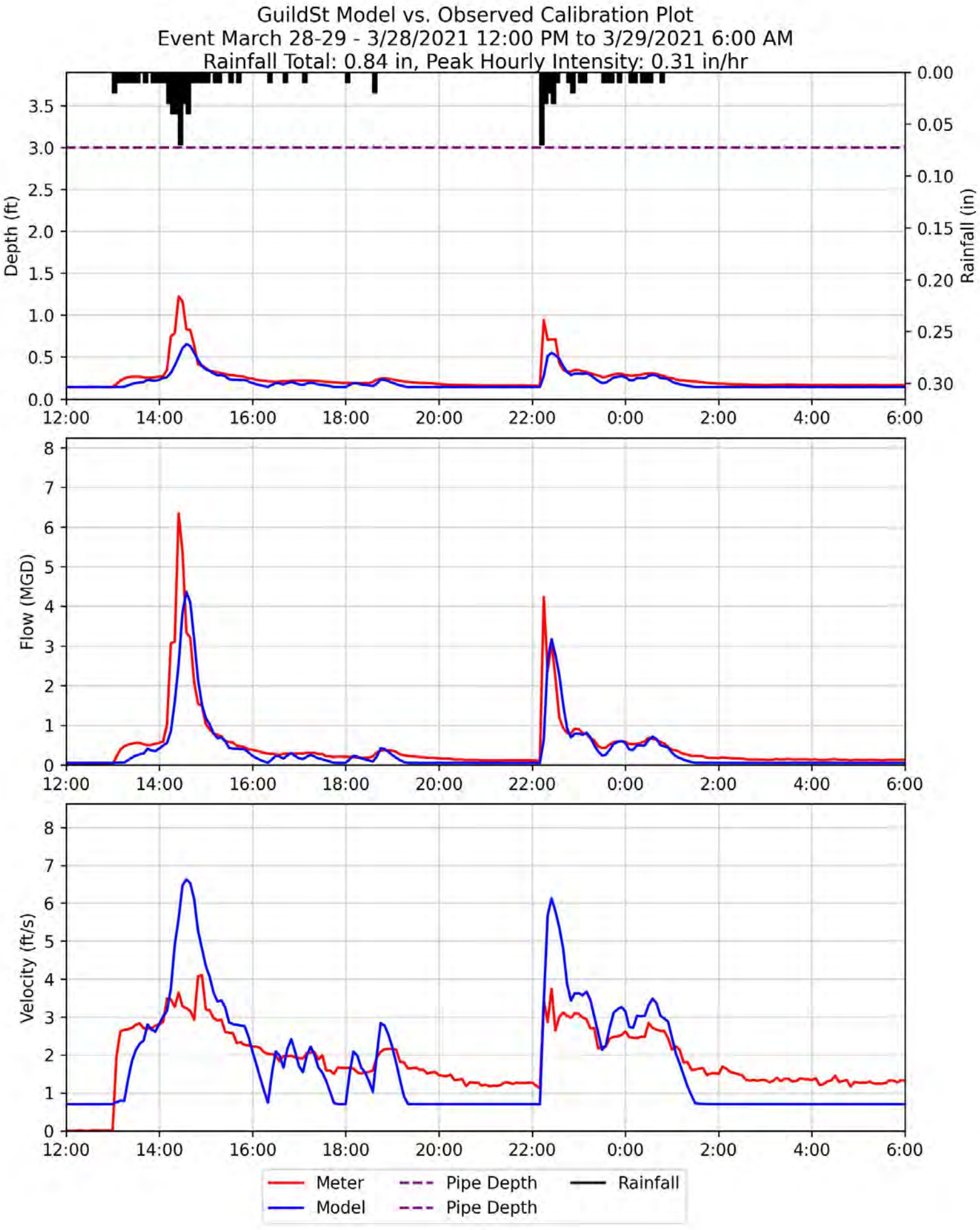
GuildSt (Model ID: 10446.1) - Regression Plots

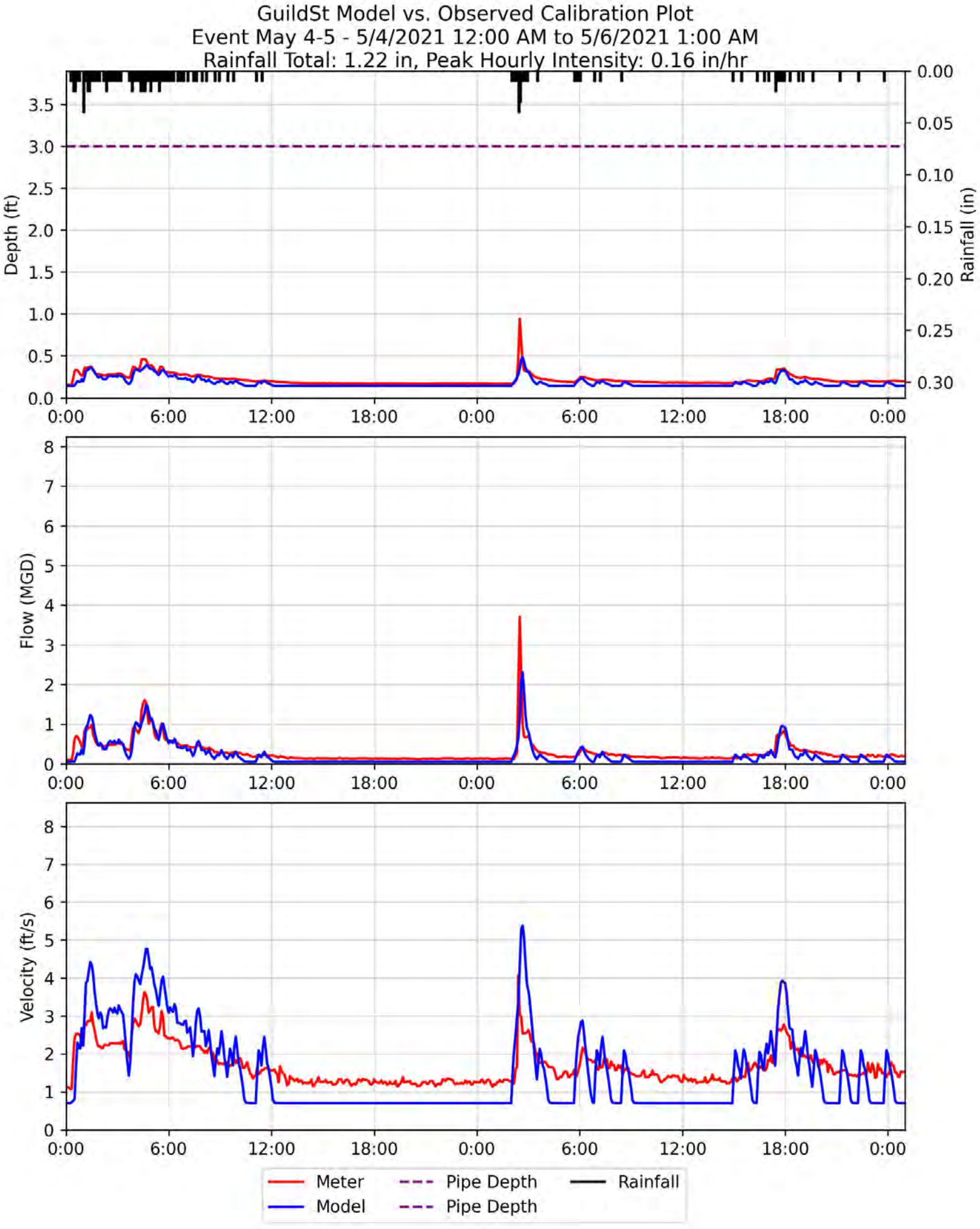


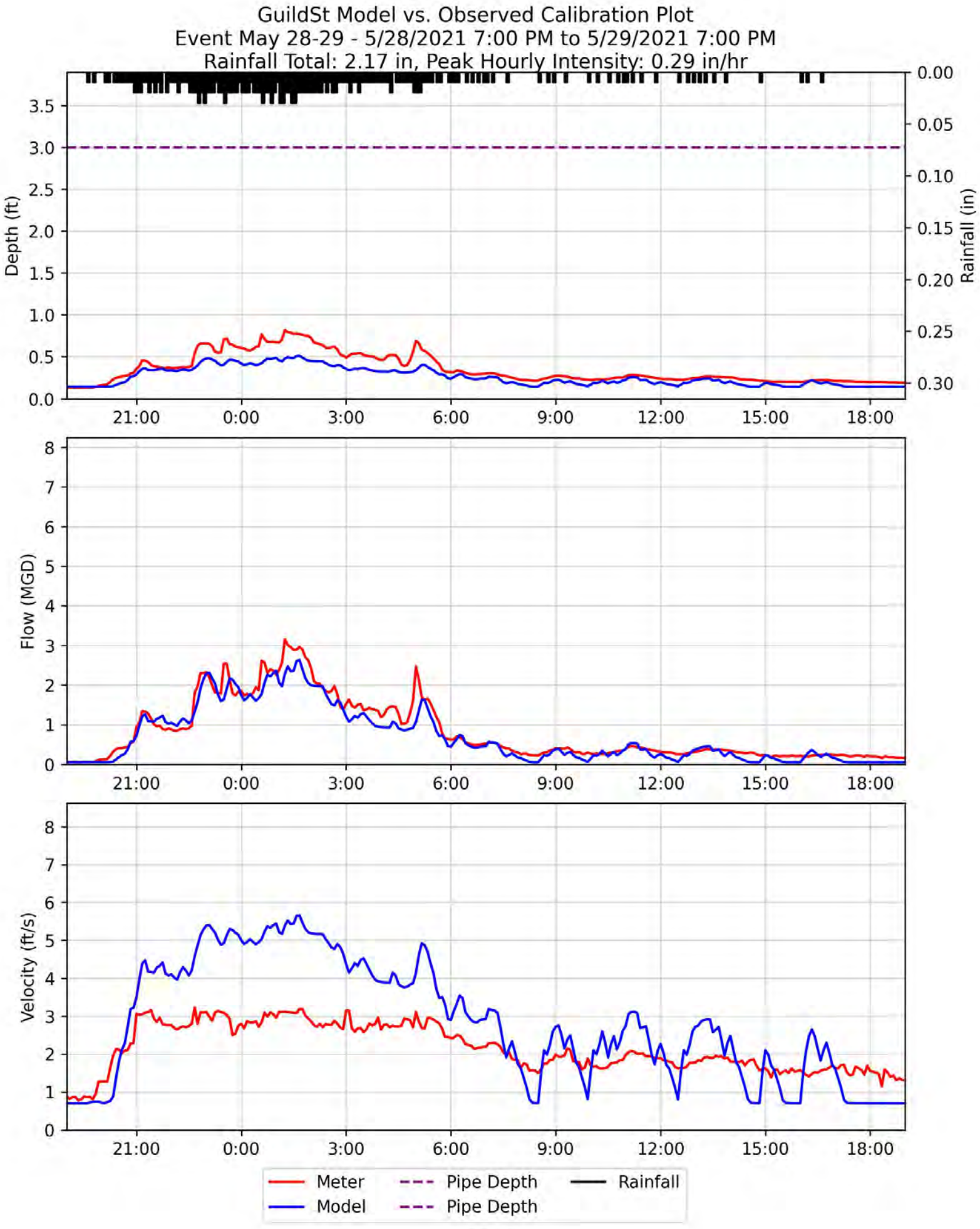




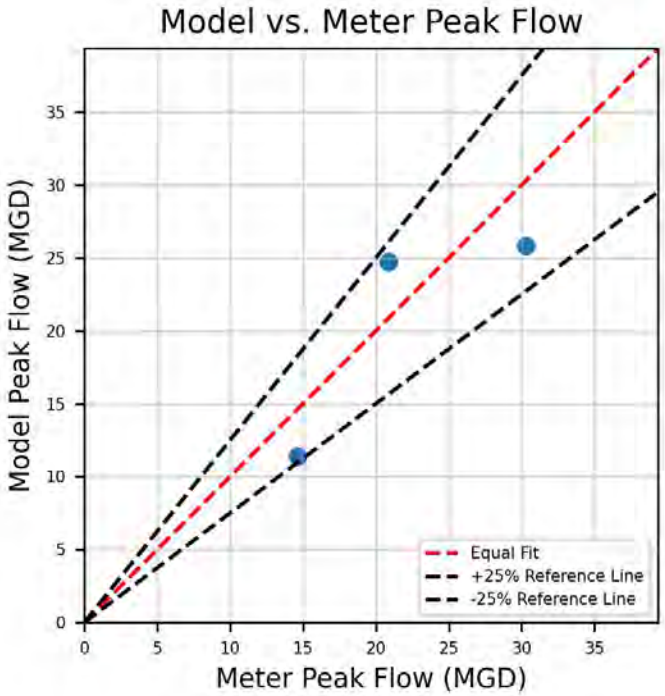
Note: Peak flow and volume correlation are critical for system recommendations and performance assessments, and are the primary calibration parameters. Meter vs modeled depth correlation is considered acceptable given the close match of the peak flow and total volume and the overall intent of the model. The depth vs velocity relationship at this meter appears to be influenced by surface catch-basins connected directly to the access manhole that are creating turbulence and suspect meter readings during intense rainfall conditions.

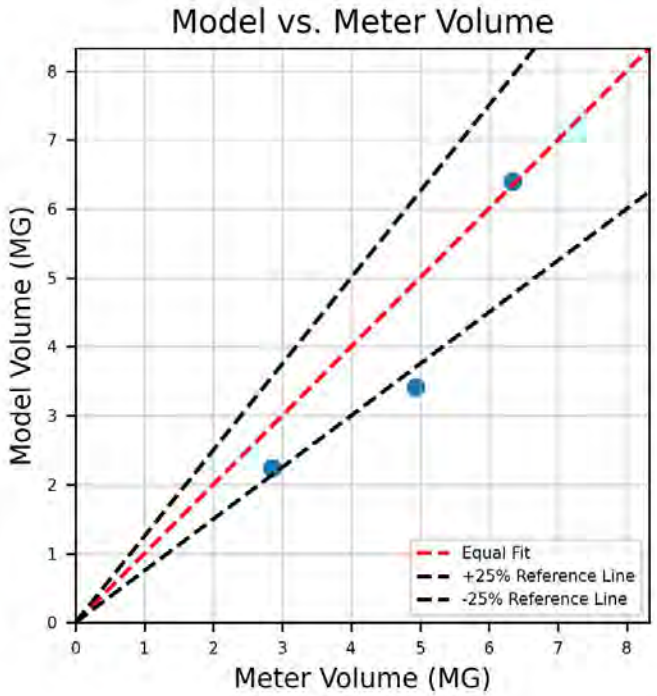

GuildSt Model vs. Observed Calibration Plot
Event March 28-29 - 3/28/2021 12:00 PM to 3/29/2021 6:00 AM
Rainfall Total: 0.84 in, Peak Hourly Intensity: 0.31 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

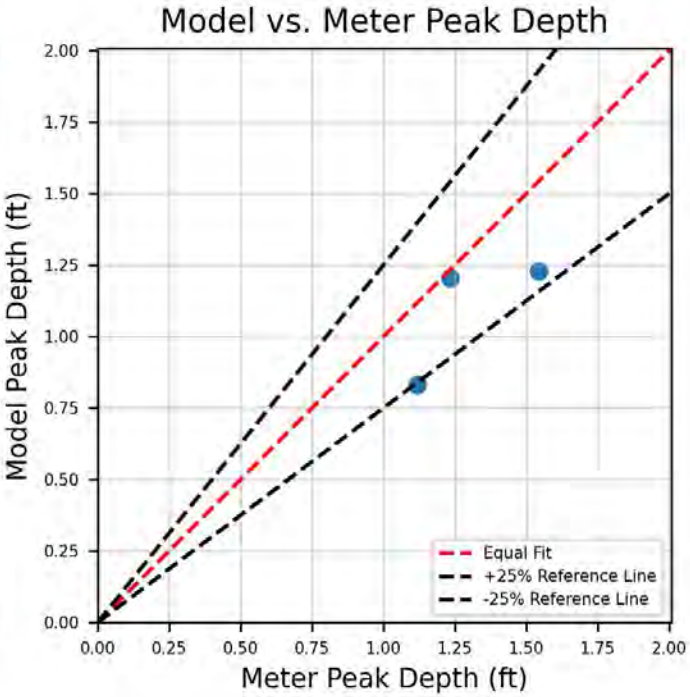

GuildSt Model vs. Observed Calibration Plot
Event May 4-5 - 5/4/2021 12:00 AM to 5/6/2021 1:00 AM
Rainfall Total: 1.22 in, Peak Hourly Intensity: 0.16 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
0:00
6:00
12:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

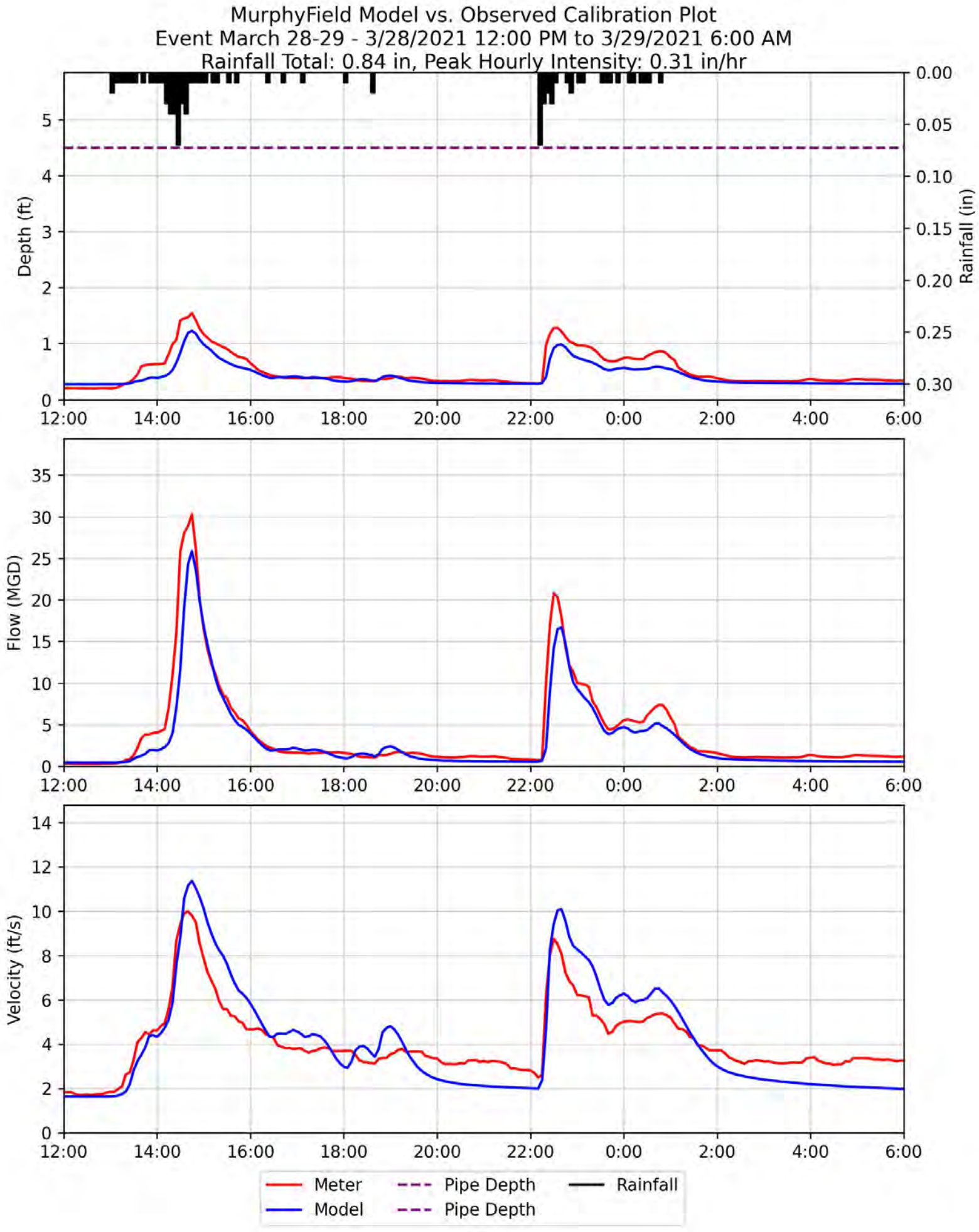

GuildSt Model vs. Observed Calibration Plot
Event May 28-29 - 5/28/2021 7:00 PM to 5/29/2021 7:00 PM
Rainfall Total: 2.17 in, Peak Hourly Intensity: 0.29 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
21:00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

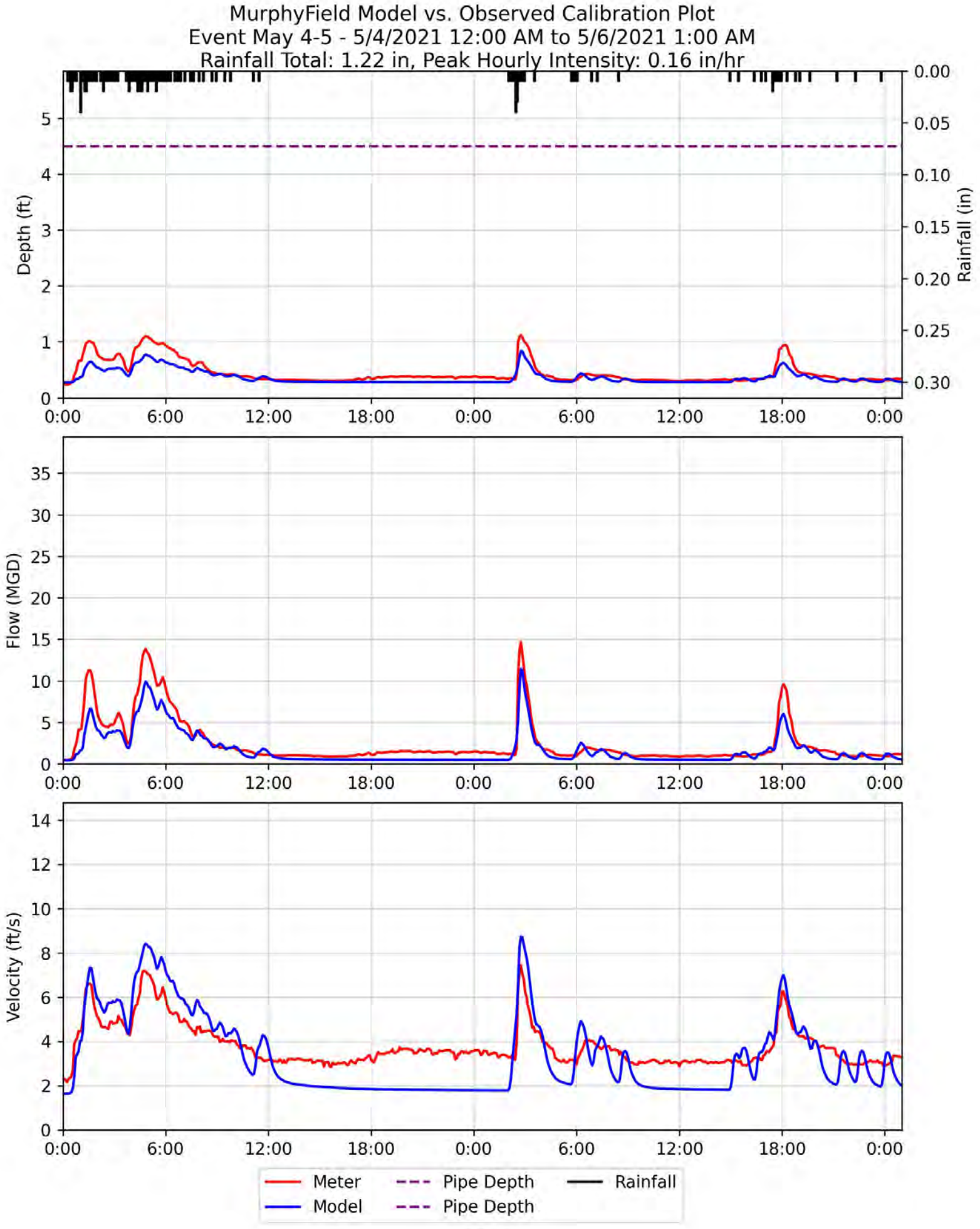
MurphyField (Model ID: 10270.1) - Regression Plots

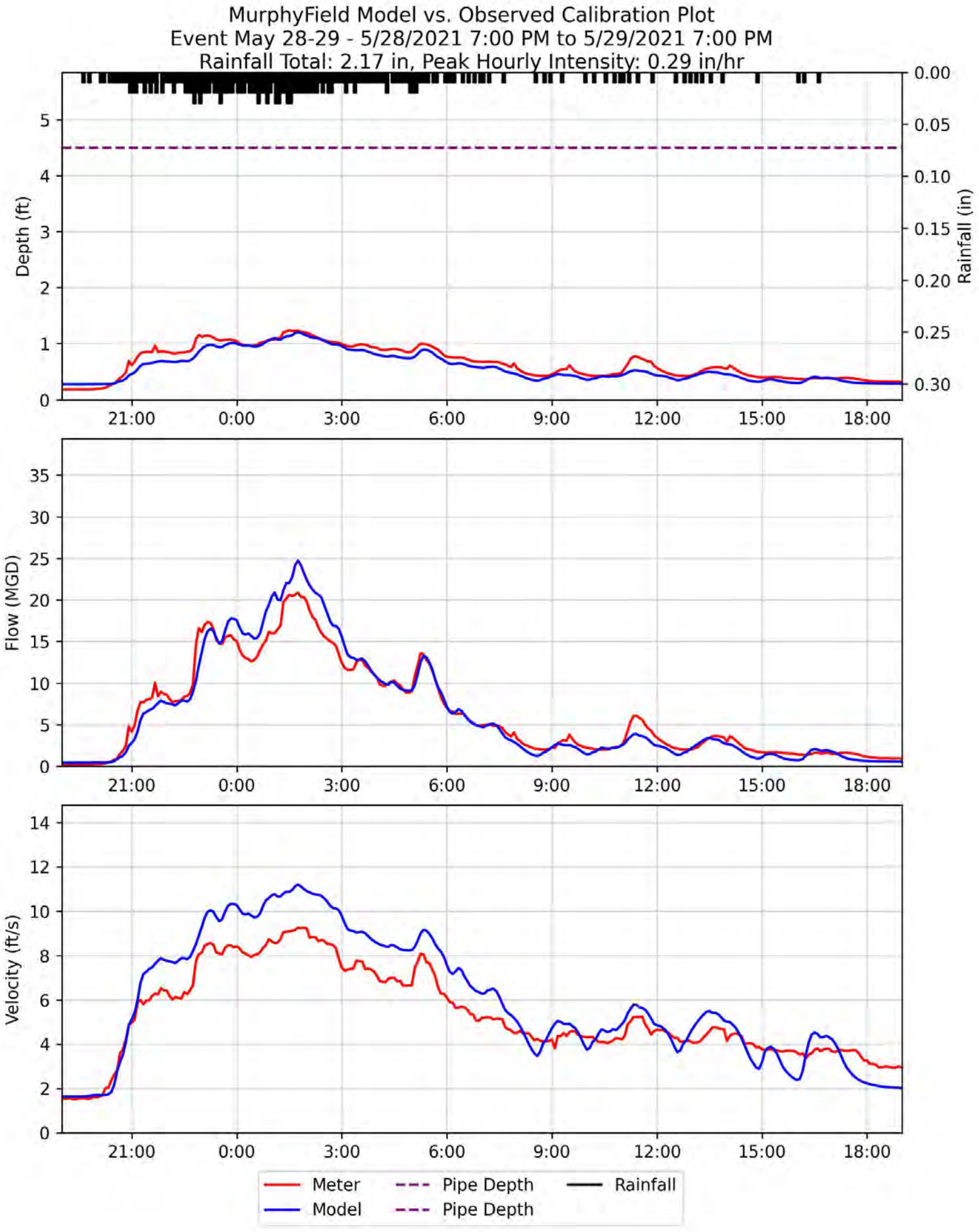




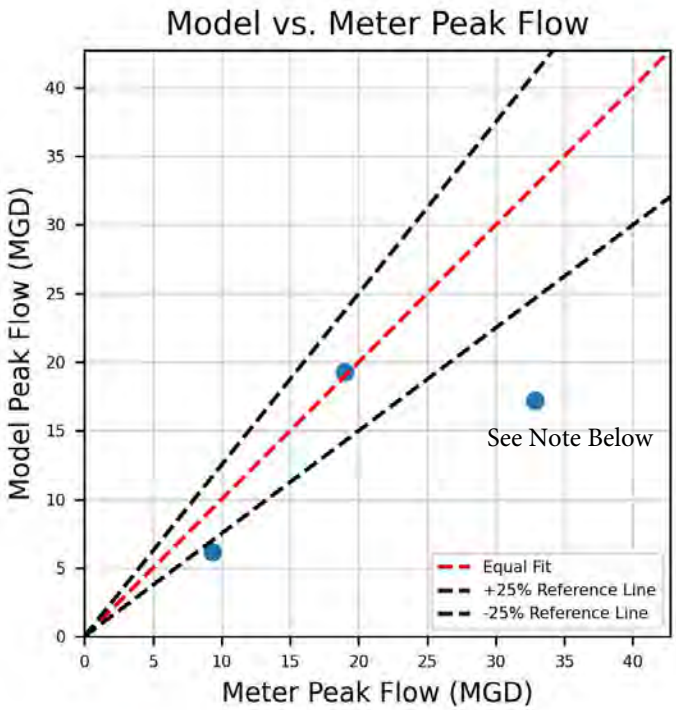


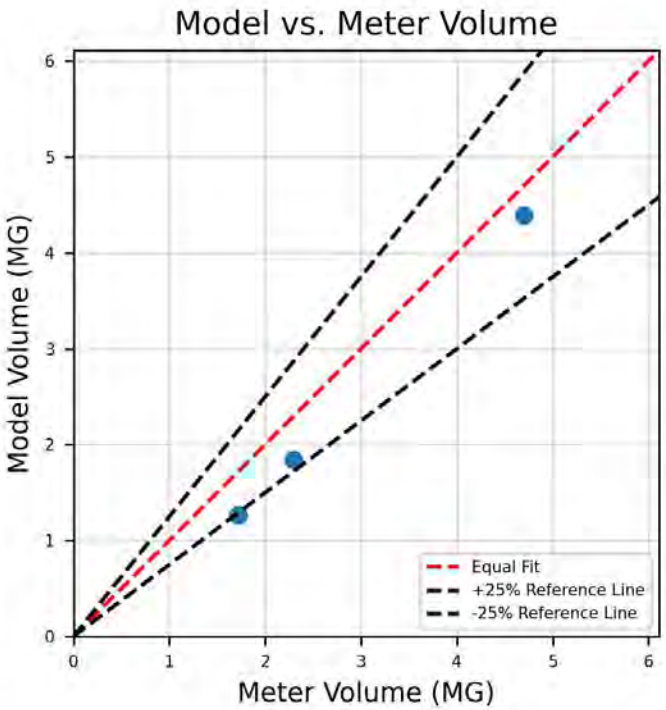

MurphyField Model vs. Observed Calibration Plot
Event March 28-29 - 3/28/2021 12:00 PM to 3/29/2021 6:00 AM
Rainfall Total: 0.84 in, Peak Hourly Intensity: 0.31 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

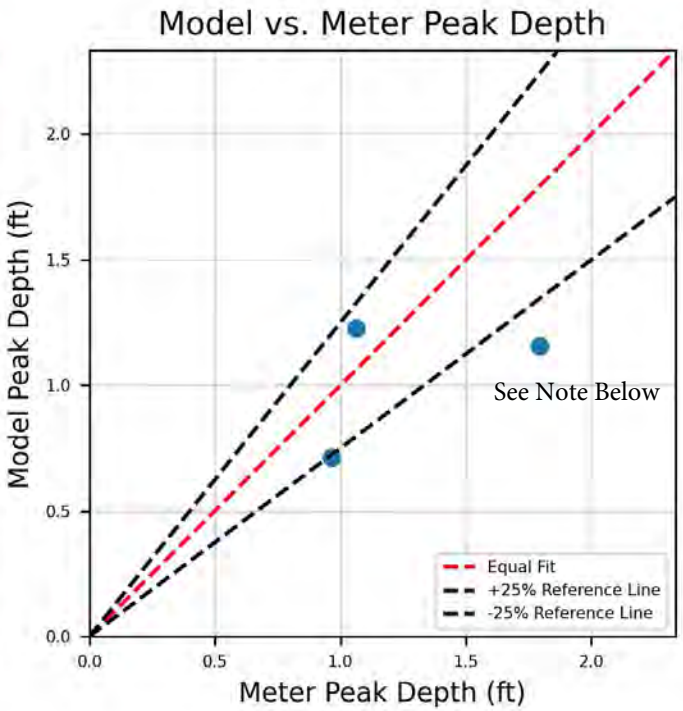

MurphyField Model vs. Observed Calibration Plot
Event May 4-5 - 5/4/2021 12:00 AM to 5/6/2021 1:00 AM
Rainfall Total: 1.22 in, Peak Hourly Intensity: 0.16 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
0:00
6:00
12:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall


MurphyField Model vs. Observed Calibration Plot
Event May 28-29 - 5/28/2021 7:00 PM to 5/29/2021 7:00 PM
Rainfall Total: 2.17 in, Peak Hourly Intensity: 0.29 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
21:00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

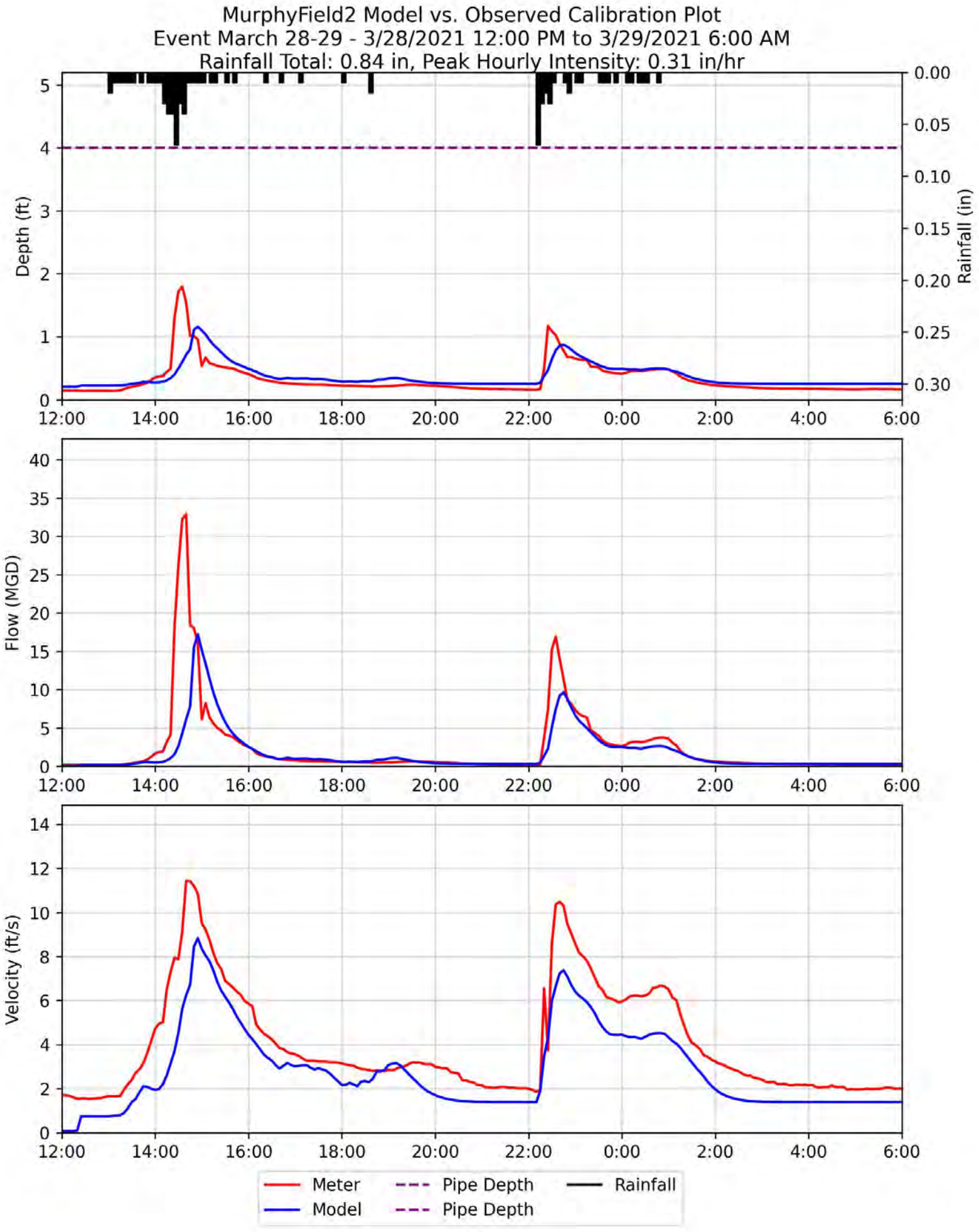
MurphyField2 (Model ID: 10265.1) - Regression Plots

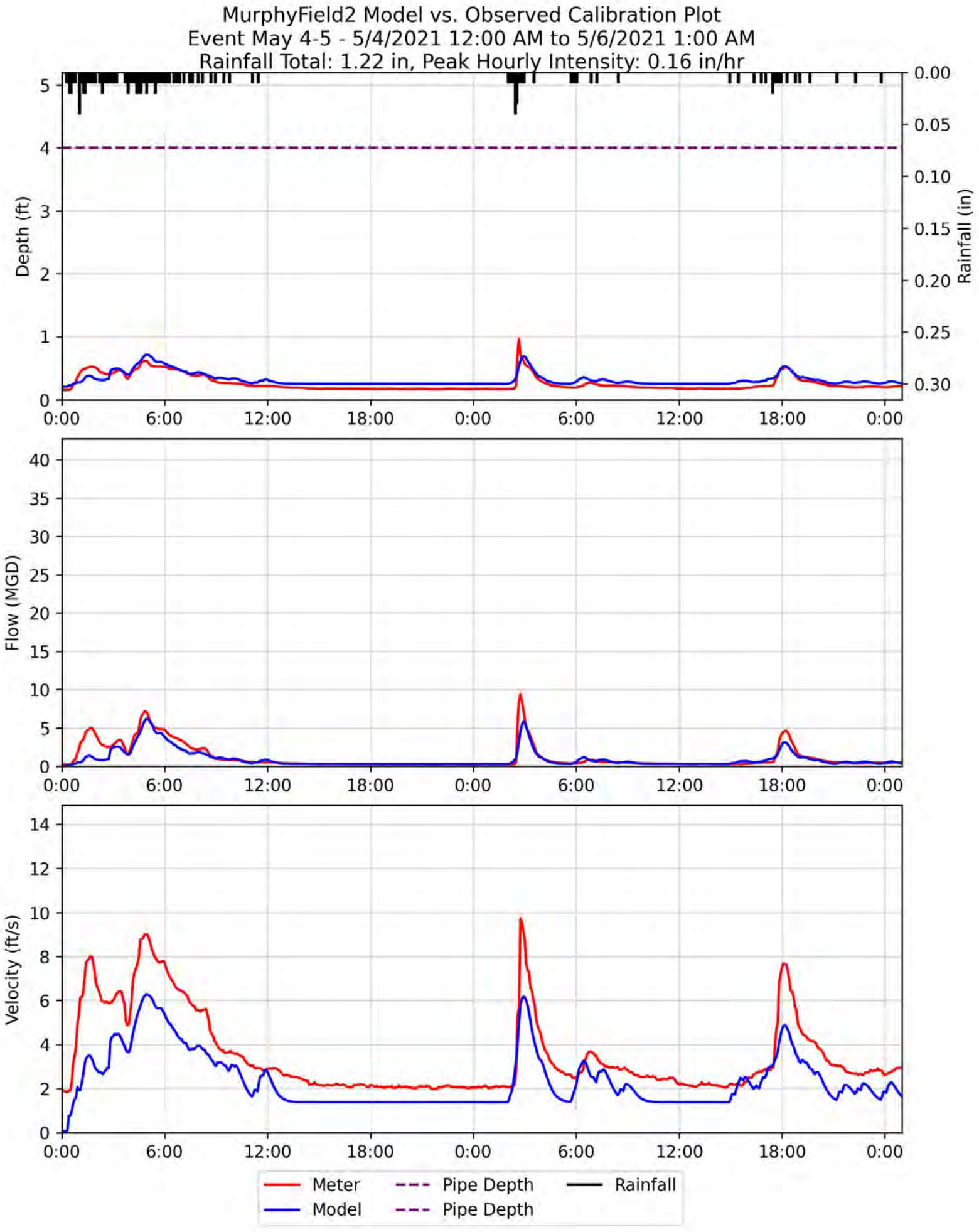


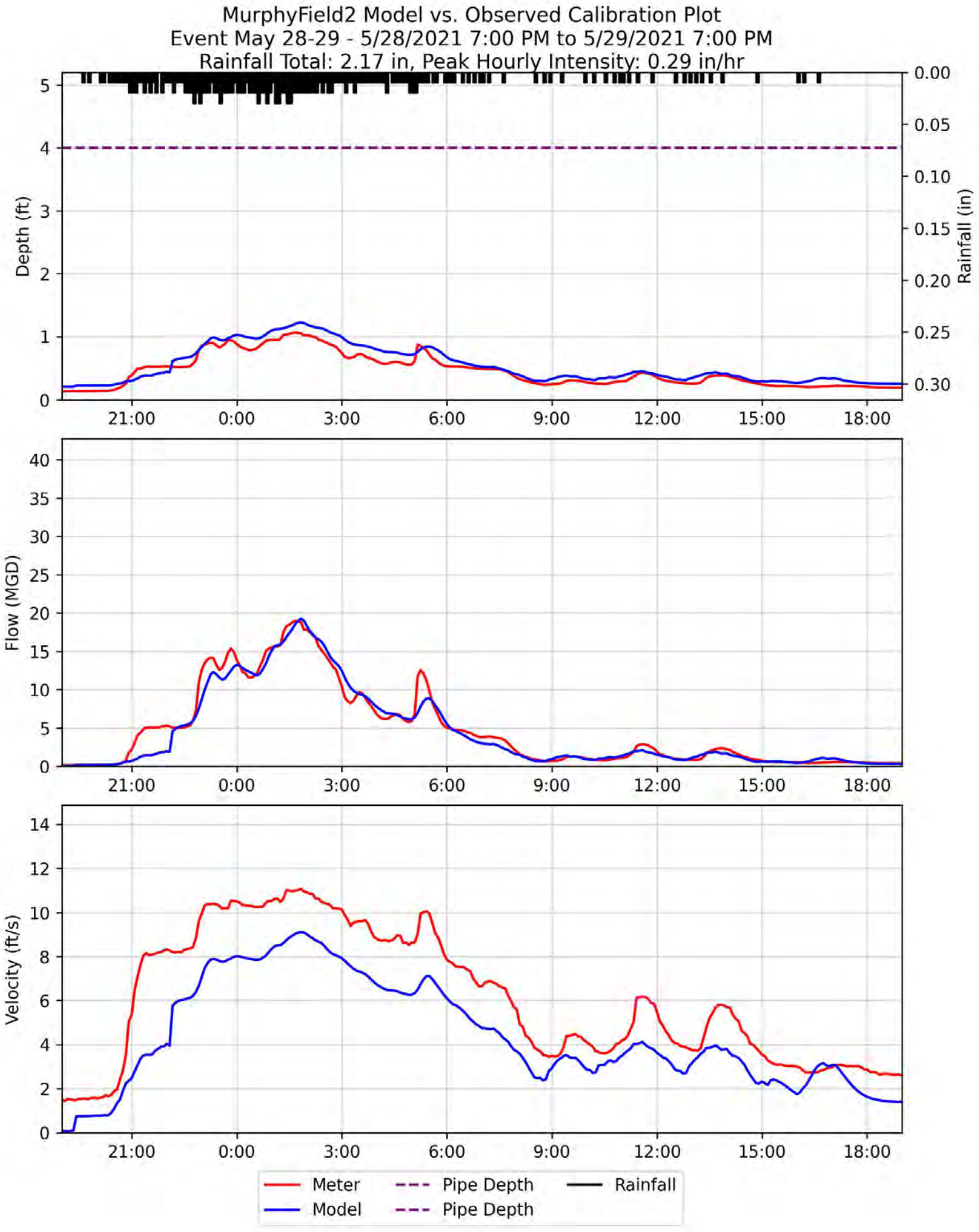




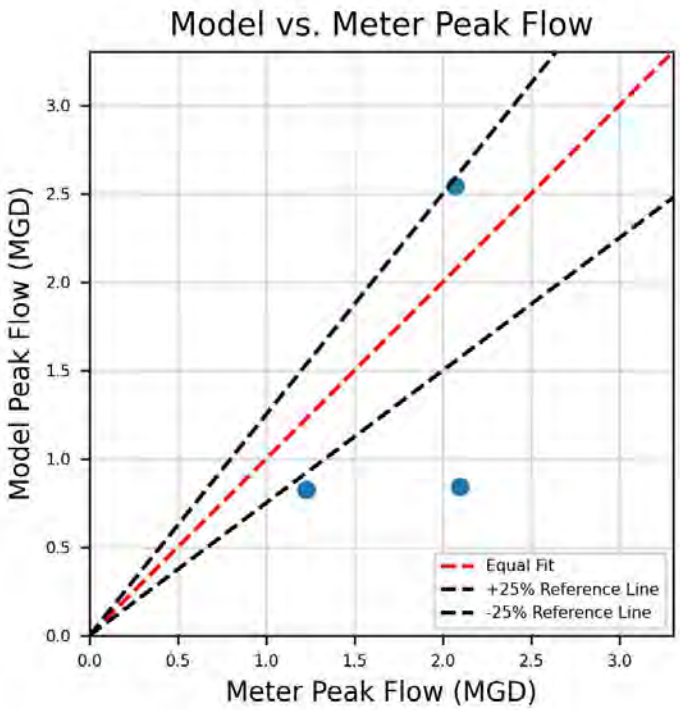
Note: This structure experiences a hydraulic jump during high flow conditions due to the steep slope of the incoming pipe where the meter's velocity sensor is located and the comparatively flat slope of the outgoing pipe. During these conditions, the meter's depth sensor in the access manhole does not reflect the depth of flow at the velocity sensor and cannot accurately measure flow. The event on March 28-29 was one of these events and the correlation is considered acceptable given the intent of this model.

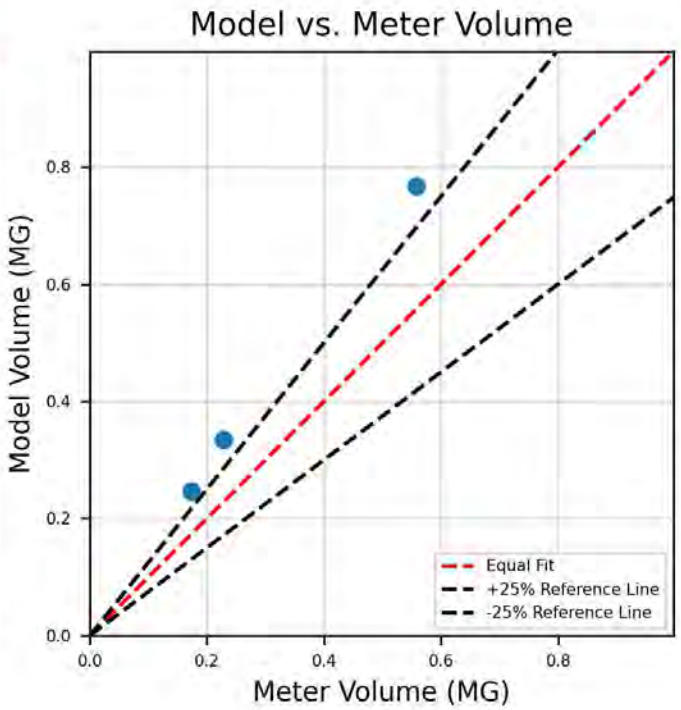

MurphyField2 Model vs. Observed Calibration Plot
Event March 28-29 - 3/28/2021 12:00 PM to 3/29/2021 6:00 AM
Rainfall Total: 0.84 in, Peak Hourly Intensity: 0.31 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

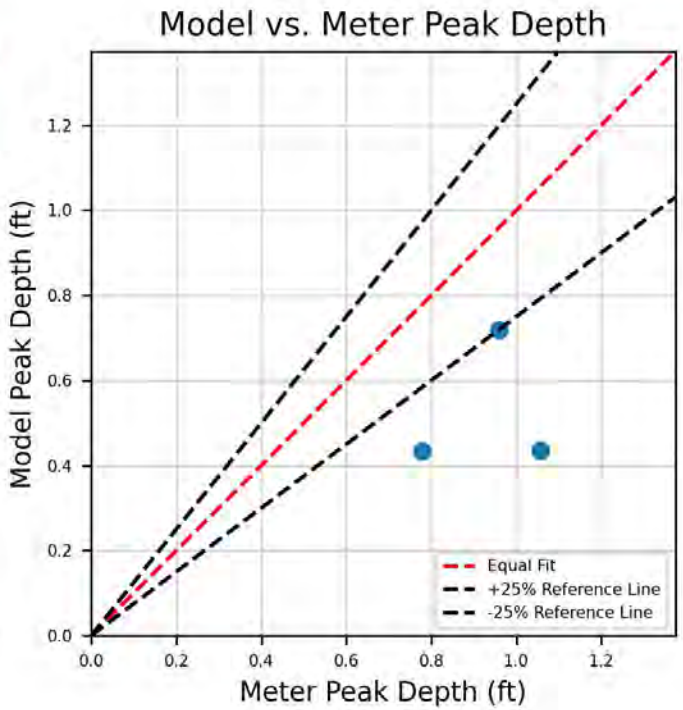

MurphyField2 Model vs. Observed Calibration Plot
Event May 4-5 - 5/4/2021 12:00 AM to 5/6/2021 1:00 AM
Rainfall Total: 1.22 in, Peak Hourly Intensity: 0.16 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
0:00
6:00
12:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall


MurphyField2 Model vs. Observed Calibration Plot
Event May 28-29 - 5/28/2021 7:00 PM to 5/29/2021 7:00 PM
Rainfall Total: 2.17 in, Peak Hourly Intensity: 0.29 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
21:00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

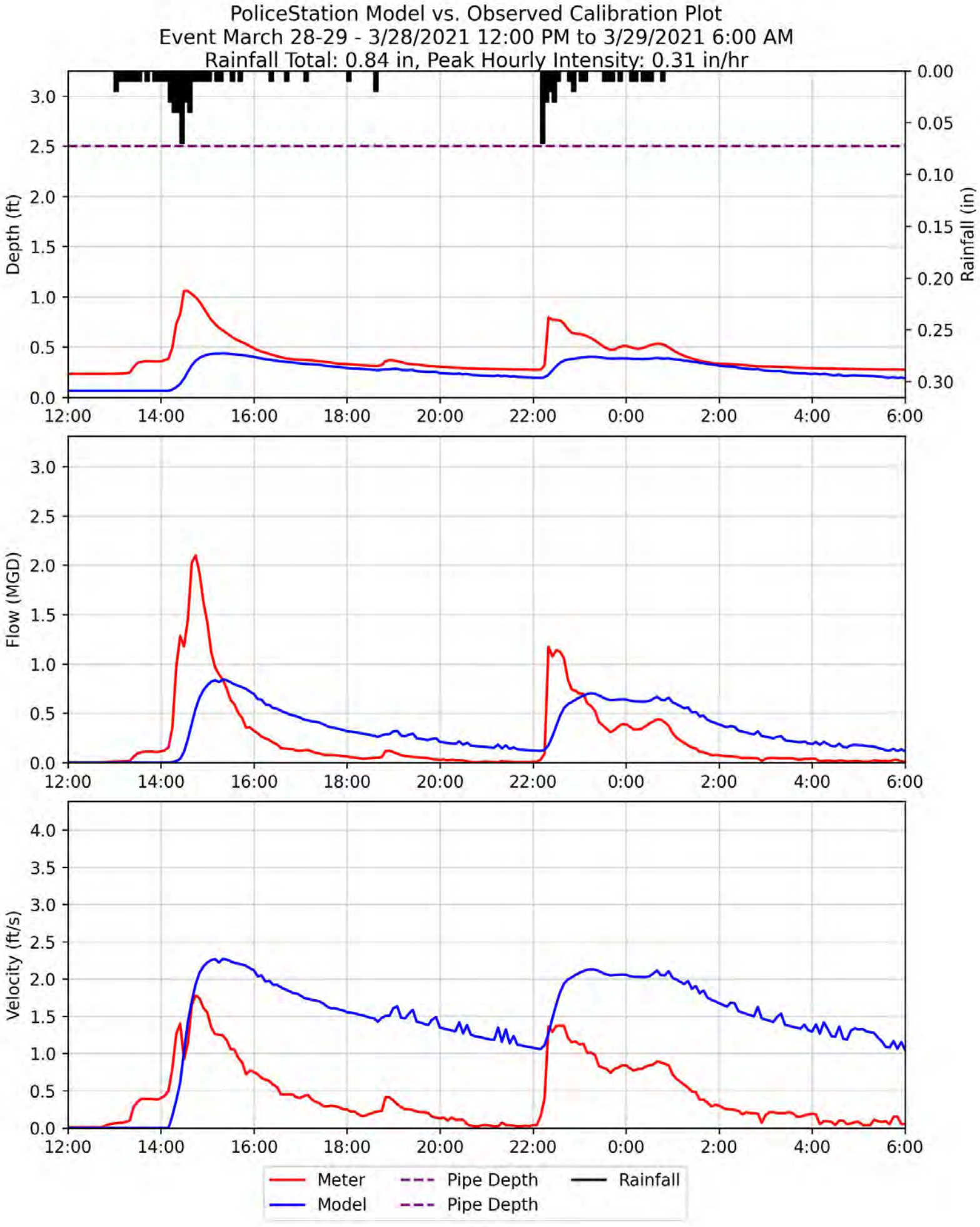
PoliceStation (Model ID: DryPondOutlet.1) - Regression Plots

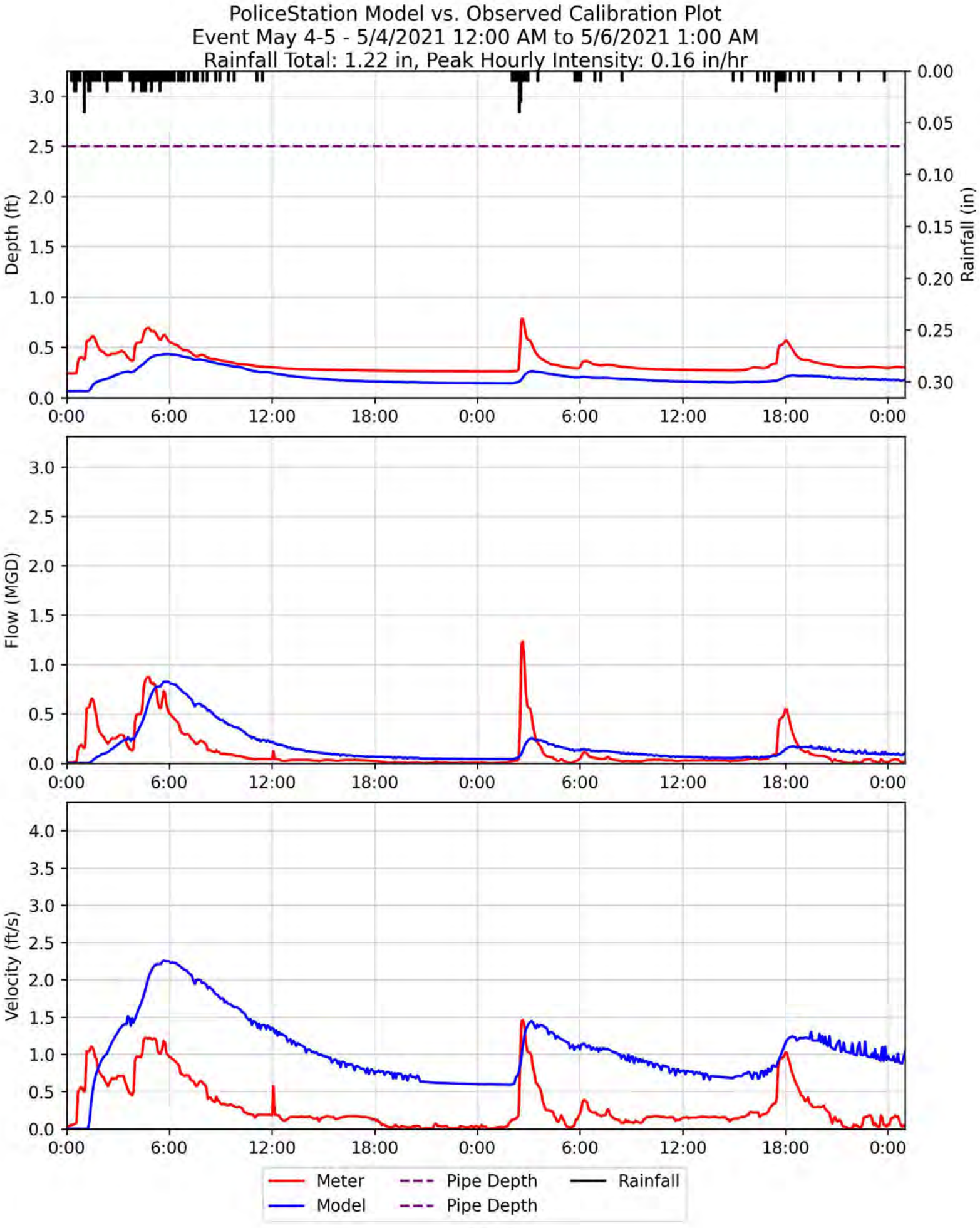


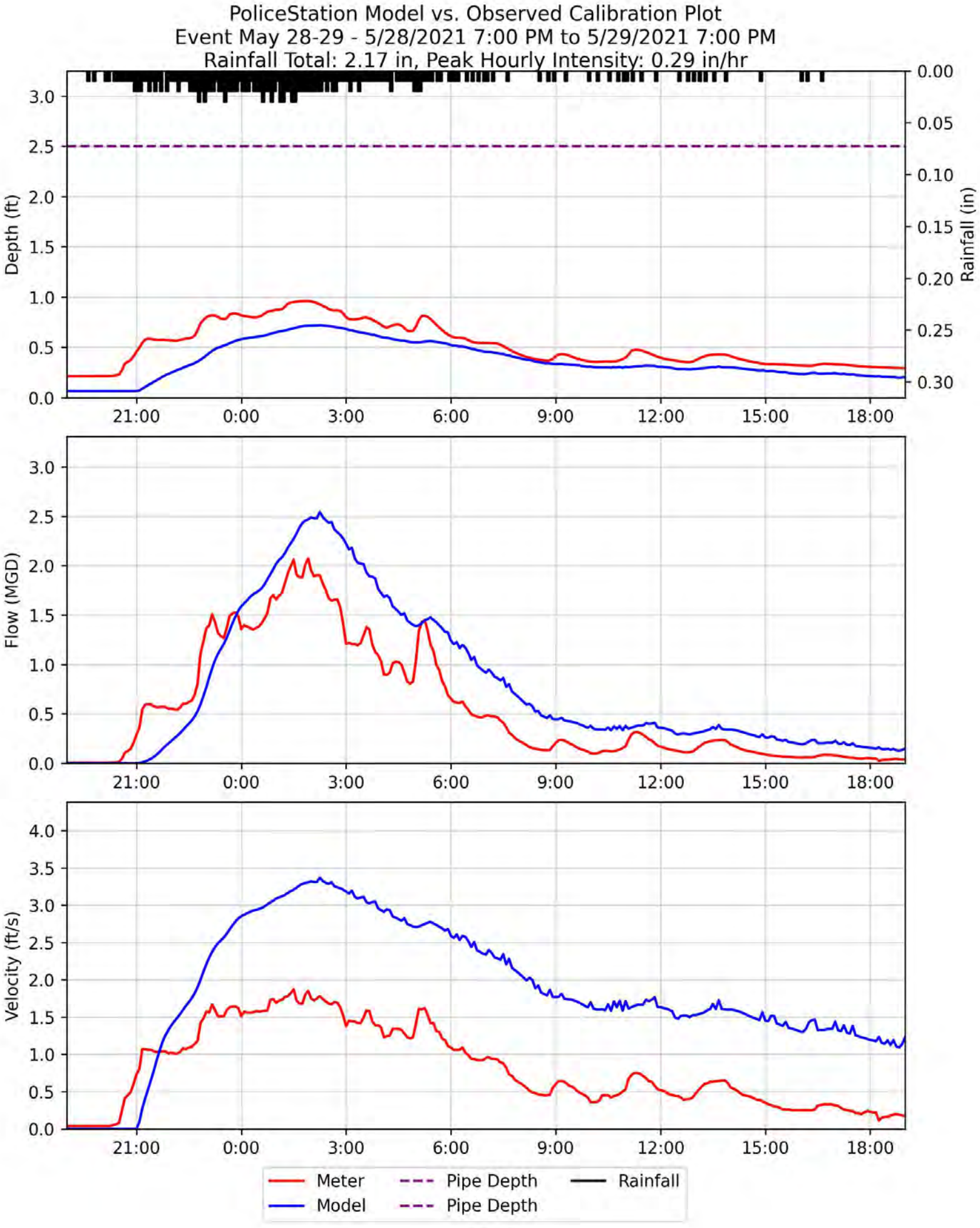




Note: This meter is located immediately downstream of the storage retention pond near the Police Station. The outlet pipe of that pond appears to be susceptible to partial blockages which significantly affect peak discharge rates. Because the model is assuming an outlet completely free of blockage and the total volume is conservatively overpredicting, the metered vs modeled correlations are considered acceptable given the intent of this model.


PoliceStation Model vs. Observed Calibration Plot
Event March 28-29 - 3/28/2021 12:00 PM to 3/29/2021 6:00 AM
Rainfall Total: 0.84 in, Peak Hourly Intensity: 0.31 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall


PoliceStation Model vs. Observed Calibration Plot
Event May 4-5 - 5/4/2021 12:00 AM to 5/6/2021 1:00 AM
Rainfall Total: 1.22 in, Peak Hourly Intensity: 0.16 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
0:00
6:00
12:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall


PoliceStation Model vs. Observed Calibration Plot
Event May 28-29 - 5/28/2021 7:00 PM to 5/29/2021 7:00 PM
Rainfall Total: 2.17 in, Peak Hourly Intensity: 0.29 in/hr
Depth (ft)
Rainfall (in)
Flow (MGD)
Velocity (ft/s)
21:00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
Meter
Model
Pipe Depth
Pipe Depth
Rainfall

Appendix C MODEL SIMULATED FLOOD RESULTS

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731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-1

Existing System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Existing
- Model Conduits - Existing

Exisitng Conditions 2YR 24HR Storm (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

Stantec

TOWN OF NORWOOD MASS · INC. FEB 23 1872 ·

U:\195150727\4_planninganalysis\GIS\01_mxd\sfC-1_C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: lsartor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-2

Existing System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Existing
- Model Conduits - Existing

Exisitng Conditions 2YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

Stantec

TOWN OF NORWOOD MASS · INC. FEB 23 1872 ·

U:\195150727\4_planninganalysis\GIS\01_mxd\sfC-1, C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: lsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

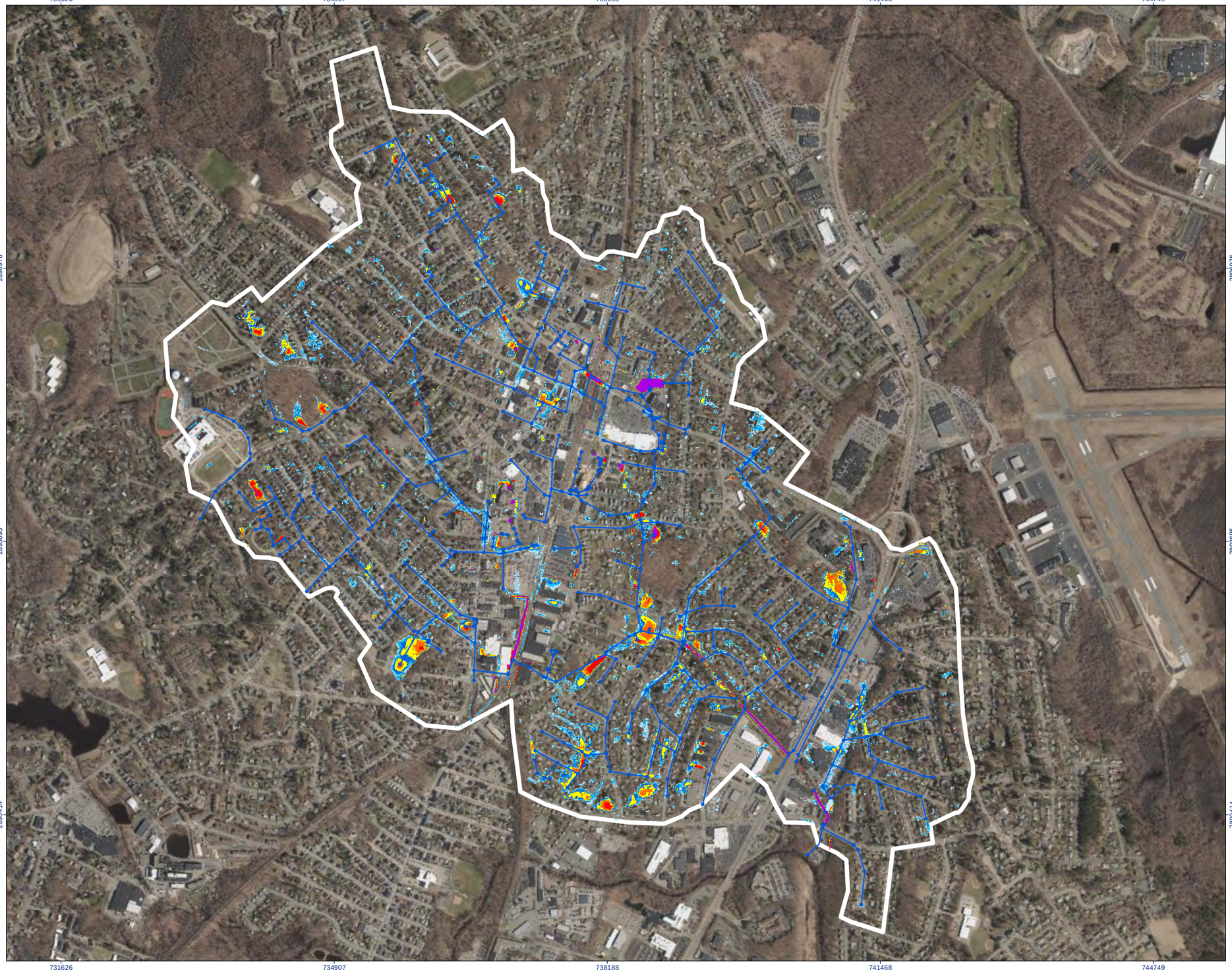

Figure No.
C-3

Existing System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Existing
- Model Conduits - Existing

Exisitng Conditions 5YR 24HR Storm (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

Stantec

TOWN OF NORWOOD MASS · INC. FEB 23 1872 ·

U:\195150727\4_planninganalysis\GIS\01_mxd\sfC-1_C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: lsartor

731626 734907 738188 741468 744749

2896976 2893695 2890414

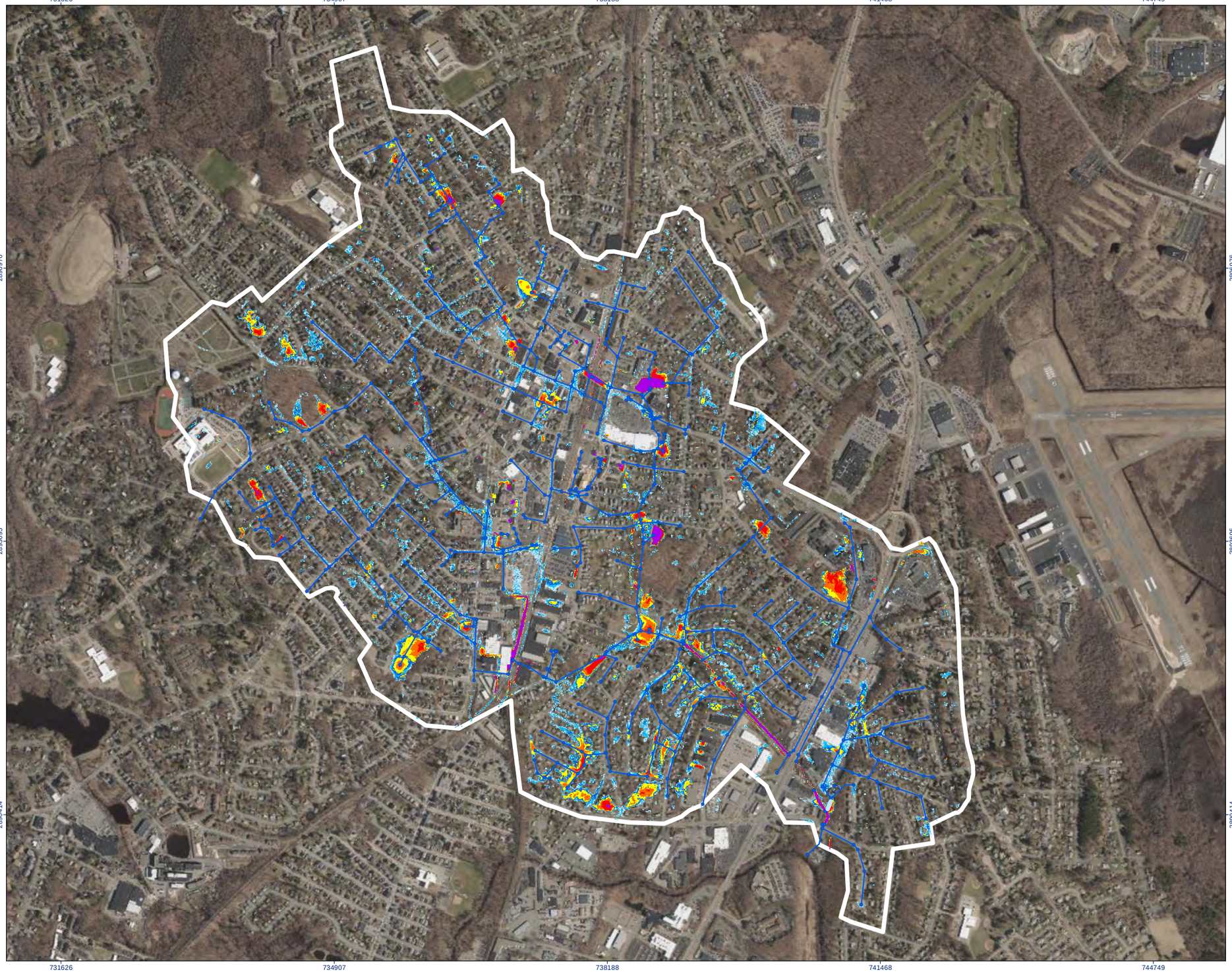

Figure No.
C-4

Existing System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Existing
- Model Conduits - Existing

Exisitng Conditions 5YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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TOWN OF NORWOOD MASS · INC. FEB 23 1872 ·

U:\195150727\4_planninganalysis\GIS\01_mxd\sfC-1_C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: lsartor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-5

Existing System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Existing
- Model Conduits - Existing

Exisitng Conditions 10YR 24HR Storm (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-6

Existing System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Existing
- Model Conduits - Existing

Exisitng Conditions 10YR 24HR Storm 2070 (NRCC)

Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes

1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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TOWN OF NORWOOD MASS INC. FEB 23 1872

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731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-7

2004 Recommendations Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - 2004 Recommendations
- Model Conduits - 2004 Recommendations

2004 Rec 2YR 24HR Storm (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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TOWN OF NORWOOD MASS · INC. FEB 23 1872 ·

U:\195150727\4_planning\analysis\GIS\01_mxd\stC-1_C-18_Norwood Model Results.mxd Revised: 2022-01-31 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-8

2004 Recommendations Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - 2004 Recommendations
- Model Conduits - 2004 Recommendations

2004 Rec 2YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planninganalysis\GIS\01_mxd\GC-1_C-18_Norwood Model Results.mxd Revised: 2022-01-31 By: lsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-9

2004 Recommendations Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - 2004 Recommendations
- Model Conduits - 2004 Recommendations

2004 Rec 5YR 24HR Storm (NRCC)

Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes

1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planninganalysis\GIS\01_mxd\sfC-1_C-18_Norwood Model Results.mxd Revised: 2022-01-31 By: lsartor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-10

2004 Recommendations Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - 2004 Recommendations
- Model Conduits - 2004 Recommendations

2004 Rec 5YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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TOWN OF NORWOOD MASS · INC. FEB 23 1872 ·

U:\195150727\4_planning\analysis\GIS\01_mxd\stC-1_C-10_Norwood Model Results.mxd Revised: 2022-01-31 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

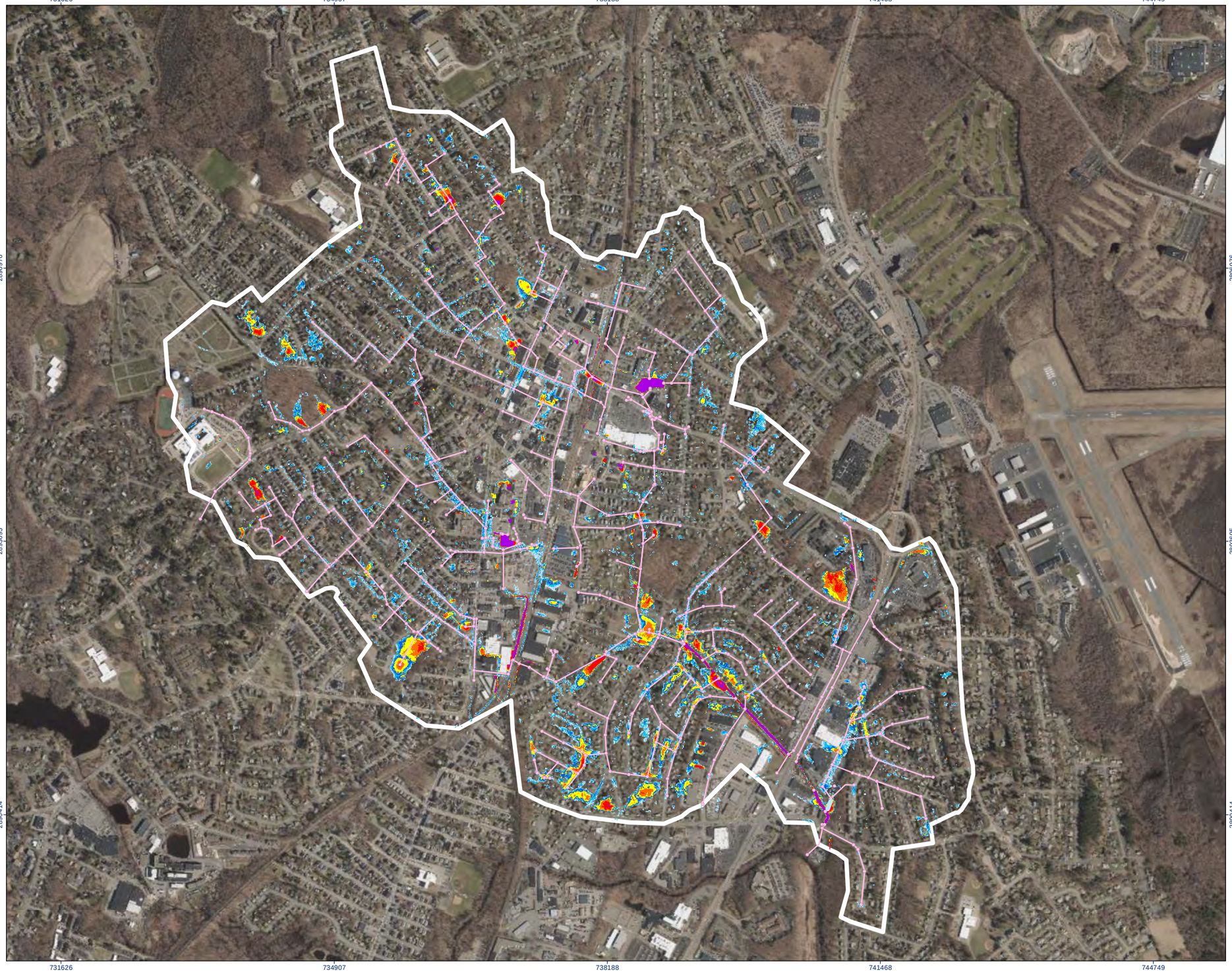

Figure No.
C-11

2004 Recommendations Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - 2004 Recommendations
- Model Conduits - 2004 Recommendations

2004 Rec 10YR 24HR Storm (NRCC)

Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes

1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planning\analysis\GIS\01_mxds\C-1_C-18_Norwood Model Results.mxd Revised: 2022-01-31 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-12

2004 Recommendations Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - 2004 Recommendations
- Model Conduits - 2004 Recommendations

2004 Rec 10YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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TOWN OF NORWOOD MASS INC. FEB 23 1872

U:\195150727\4_planning\analysis\GIS\01_mxd\stC.1_C-18_Norwood Model Results.mxd Revised: 2022-01-31 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

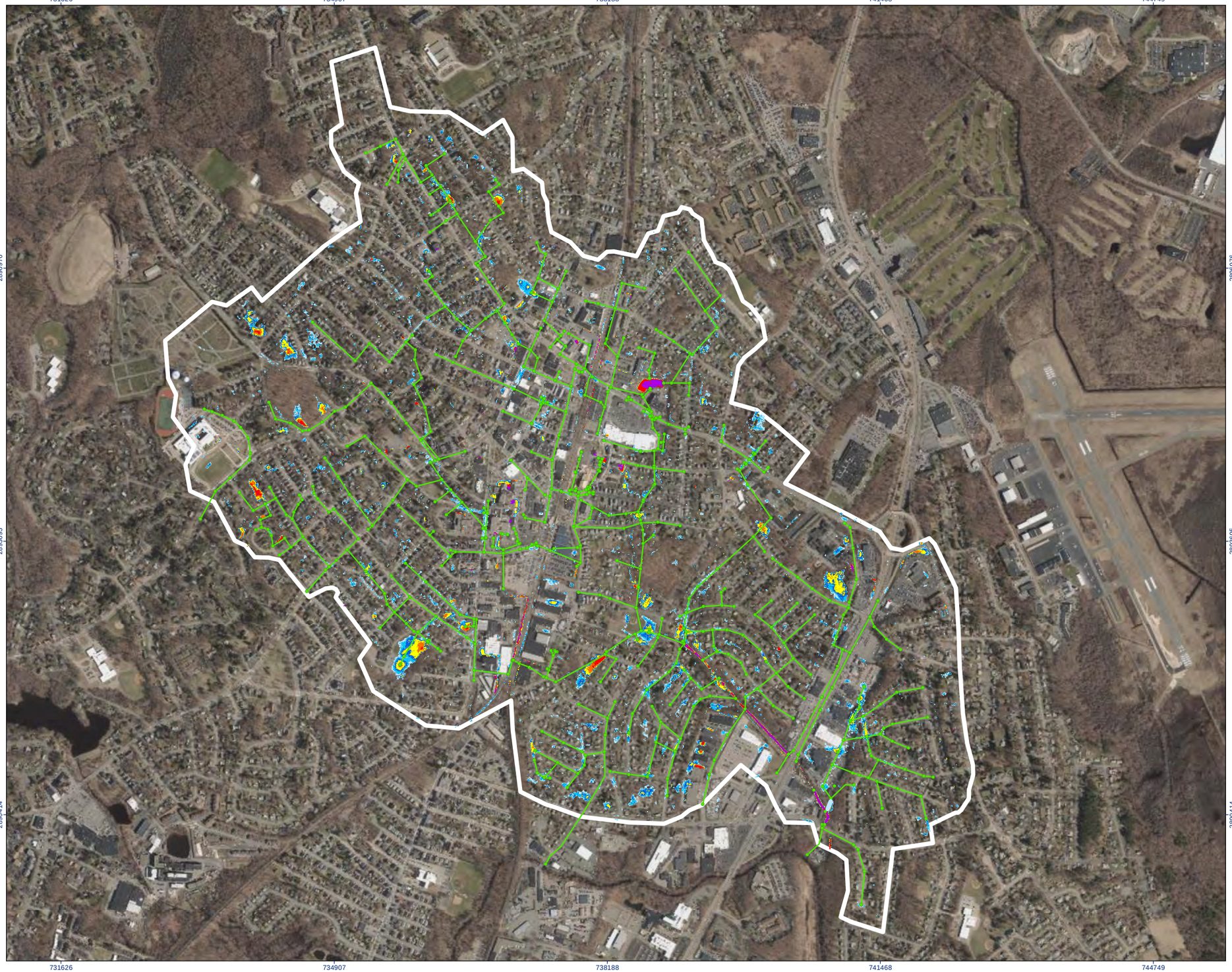

Figure No.
C-13

Proposed System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Proposed
- Model Conduits - Proposed

Proposed System 2YR 24HR Storm (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planning\analysis\GIS\01_mxd\stC-1_C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-14

Proposed System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Proposed
- Model Conduits - Proposed

Proposed System 2YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planning\analysis\GIS\01_mxds\C-1_C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-15

Proposed System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Proposed
- Model Conduits - Proposed

Proposed System 5YR 24HR Storm (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planning\analysis\GIS\01_mxd\stC-1_C-15_Norwood Model Results.mxd Revised: 2022-02-24 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

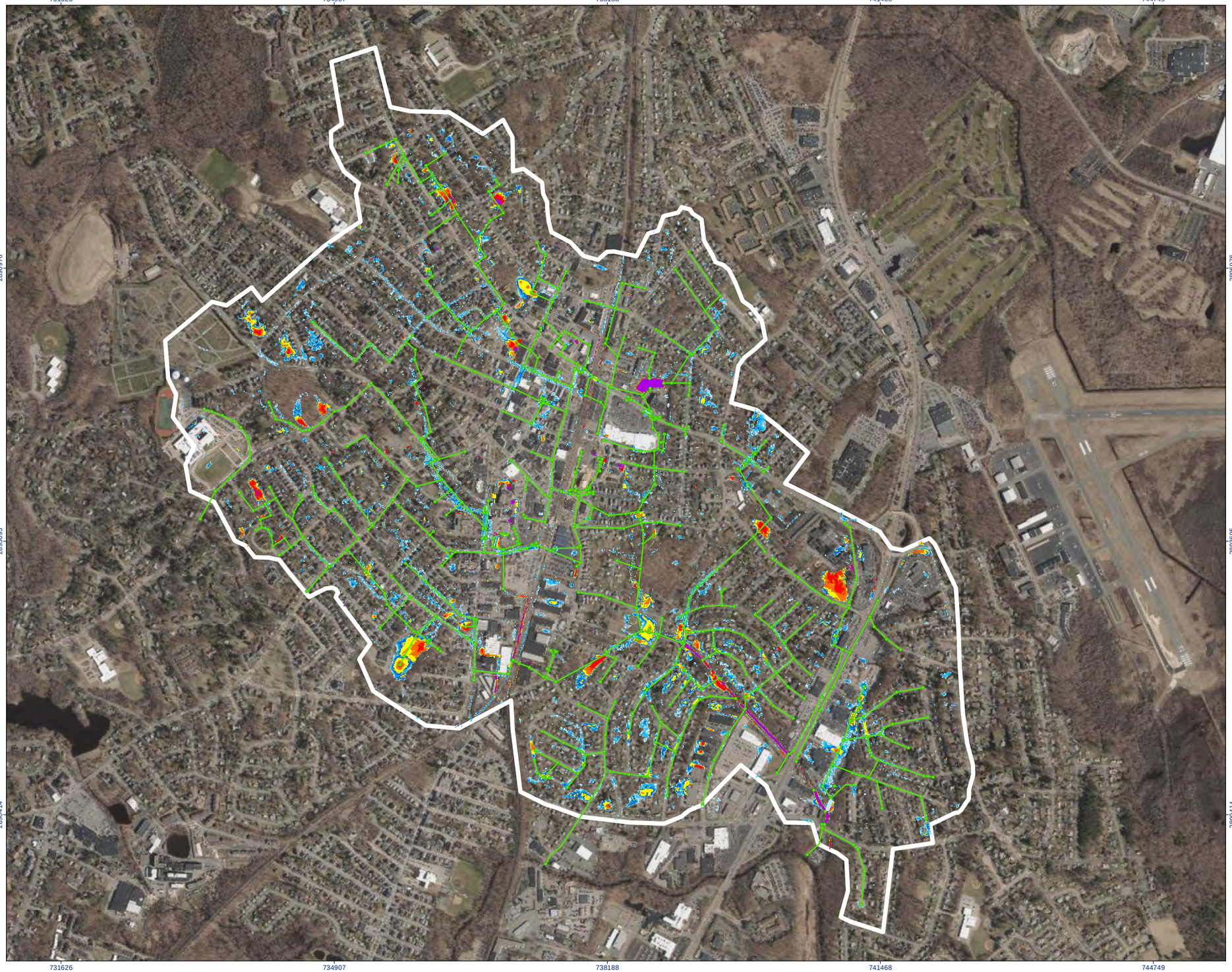

Figure No.
C-16

Proposed System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Proposed
- Model Conduits - Proposed

Proposed System 5YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planning\analysis\GIS\01_mxd\stC.1_C-16_Norwood Model Results.mxd Revised: 2022-02-24 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-17

Proposed System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Proposed
- Model Conduits - Proposed

Proposed System 10YR 24HR Storm (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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U:\195150727\4_planning\analysis\GIS\01_mxd\stC.1_C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: tsantor

731626 734907 738188 741468 744749

2896976 2893695 2890414

Figure No.
C-18

Proposed System Model Results

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 1,200 2,400 Feet

(At original document size of 11x17)
1:14,400

Legend

- Model Nodes - Proposed
- Model Conduits - Proposed

Proposed System 10YR 24HR Storm 2070 (NRCC)
Flooding Depth

- 3"
- 6"
- 9"
- 1'
- 1' 6"
- 2'
- 3'

Notes
1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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TOWN OF NORWOOD MASS · INC. FEB 23 1872 ·

U:\195150727\4_planning\analysis\GIS\01_mxd\stC.1_C-18_Norwood Model Results.mxd Revised: 2022-02-24 By: tsantor

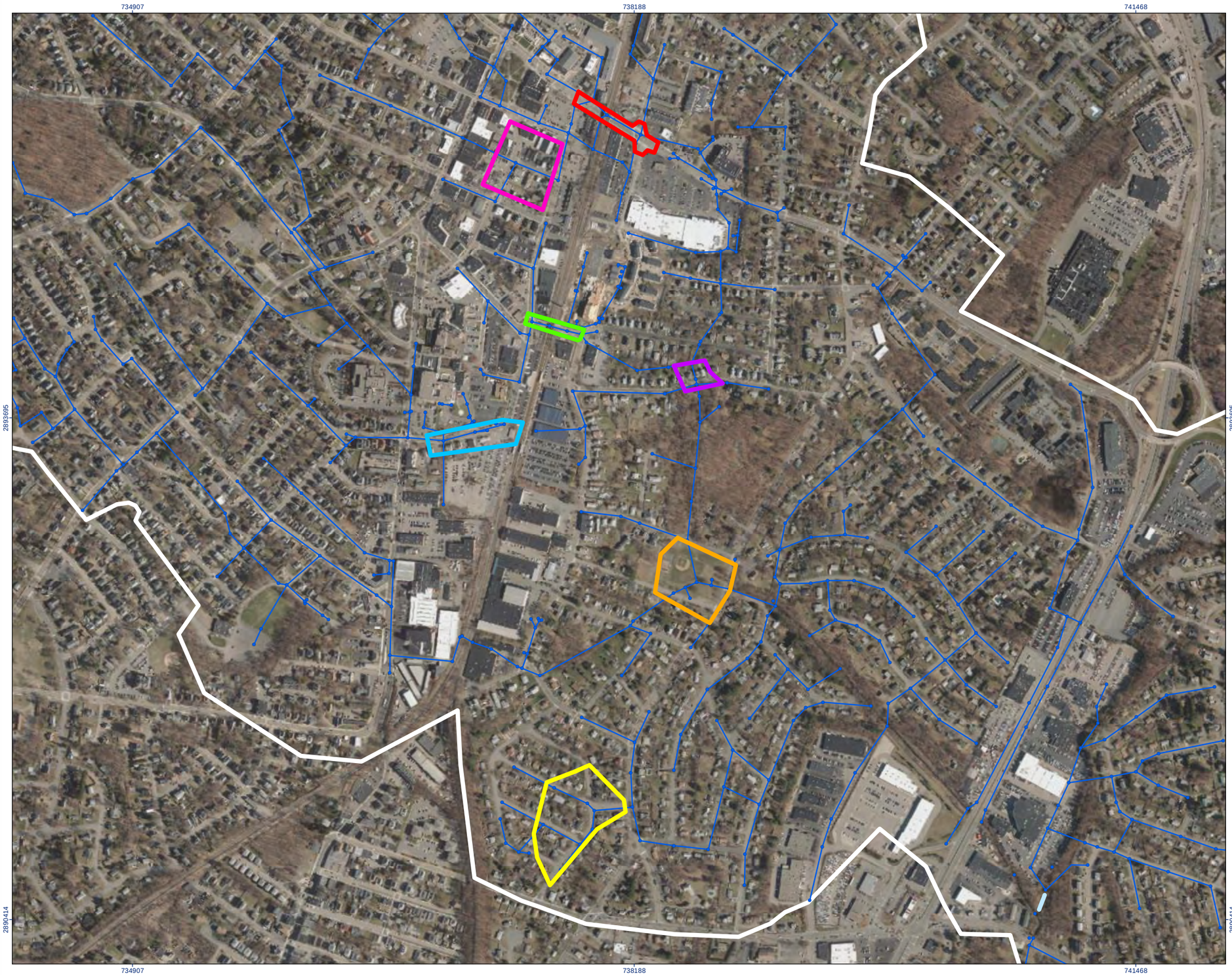

Figure No.
C-19

Delineations of Key Locations to Determine Flooded Area

Client: Town of Norwood
Project: Meadow Brook Drainage Sudy

N

0 650 1,300 Feet

(At original document size of 11x17)
1:7,800

Legend

- Model Nodes - Existing
- Model Conduits - Existing

Delineations

- Central St at East Vernon St
- Cross St
- East Hoyle St at Broadway
- Guild St Underpass
- Jacobsen Dr at Redwood Dr
- Murphy Field
- Nahatan St Undepass

Notes

1. Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet
2. Data Sources:
3. Background:

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TOWN OF NORWOOD MASS · INC · FEB 23 · 87 ·

U:\1961507274_planning\analysis\GIS\01_mxds\C-19_Norwood Flood Area.mxd Revised: 2022-03-10 By: isartor

2 Year							
Location / Event Recurrence		Flooded Area[1]		Flood Depths		Flood Duration (min)	
	Ground Elev (ft)	6"	18"	WSEL.	Depth (ft)	≥ 6"	≥ 18"
Central St at East Vernon St	115.60						
2-year, Existing System		0.83	0.09	116.98	1.38	70	0
2-year, Proposed System		0.20	0.00	116.11	0.51	5	0
% Reduction		76%	99%		63%	93%	N/A
2-year 2070, Existing System		1.07	0.23	117.17	1.57	85	15
2-year 2070, Proposed System		0.32	0.00	116.25	0.65	20	0
% Reduction		71%	100%		59%	76%	100%
Nahatan St Underpass	107.83						
2-year, Existing System		0.19	0.01	109.28	1.45	45	0
2-year, Proposed System		0.10	0.00	108.74	0.90	30	0
% Reduction		47%	100%		38%	33%	N/A
2-year 2070, Existing System		1.07	0.33	111.41	3.58	60	40
2-year 2070, Proposed System		0.32	0.00	108.94	1.10	40	0
% Reduction		71%	100%		69%	33%	100%
Guild St Underpass	104.15						
2-year, Existing System		0.05	0.00	104.69	0.54	5	0
2-year, Proposed System[2]		0.05	0.00	104.62	0.47	0	0
% Reduction		0%			13%	100%	N/A
2-year 2070, Existing System		0.12	0.01	105.29	1.14	10	0
2-year 2070, Proposed System		0.09	0.00	104.77	0.62	10	0
% Reduction		26%	48%		46%	0%	N/A
Cross St[3]	84.87						
2-year, Existing System		0.37	0.12	86.80	1.93	>12 hours	15
2-year, Proposed System		0.17	0.01	86.20	1.33	>12 hours	0
% Reduction		53%	93%		31%	N/A	100%
2-year 2070, Existing System		0.71	0.22	87.35	2.48	>12 hours	45
2-year 2070, Proposed System		0.19	0.03	86.34	1.47	>12 hours	0
% Reduction		73%	87%		41%	N/A	100%
Murphy Field	55.04						
2-year, Existing System		1.80	0.37	56.70	1.65	140	20
2-year, Proposed System		1.01	0.01	56.08	1.04	125	0
% Reduction		44%	98%		37%	11%	100%
2-year 2070, Existing System		2.06	0.71	56.93	1.88	160	45
2-year 2070, Proposed System		1.34	0.04	56.30	1.26	140	0
% Reduction		35%	95%		33%	13%	100%
East Hoyle St at Broadway	115.43						
2-year, Existing System		0.40	0.00	116.19	0.76	35	0
2-year, Proposed System		0.03	0.00	115.67	0.24	0	0
% Reduction		92%	100%		69%	100%	N/A
2-year 2070, Existing System		0.68	0.00	116.30	0.87	45	0
2-year 2070, Proposed System		0.18	0.00	115.89	0.46	0	0
% Reduction		74%	100%		47%	100%	N/A
Jacobsen Dr at Redwood Dr	56.17						
2-year, Existing System		1.28	0.11	57.84	1.67	380	165
2-year, Proposed System		0.20	0.00	56.66	0.49	0	0
% Reduction		84%	100%		71%	100%	100%
2-year 2070, Existing System		2.49	0.36	58.27	2.10	440	240
2-year 2070, Proposed System		0.31	0.00	56.78	0.61	10	0
% Reduction		88%	100%		71%	98%	100%

5 Year							
Location / Event Recurrence		Flooded Area[1]		Flooded Area*		Flood Duration (min)	
	Ground Elev (ft)	6"	18"	WSEL.	Depth (ft)	≥ 6"	≥ 18"
Central St at East Vernon St	115.60						
5-year, Existing System		1.07	0.23	117.17	1.57	90	20
5-year, Proposed System		0.31	0.00	116.24	0.64	20	0
% Reduction		71%	100%		59%	78%	100%
5-year 2070, Existing System		1.30	0.36	117.43	1.83	110	35
5-year 2070, Proposed System		0.46	0.00	116.43	0.83	30	0
% Reduction		65%	100%		55%	73%	73%
Nahatan St Underpass	107.83						
5-year, Existing System		0.47	0.33	111.43	3.60	65	40
5-year, Proposed System		0.14	0.00	108.93	1.10	40	0
% Reduction		70%	100%		69%	38%	100%
5-year 2070, Existing System		0.68	0.41	112.12	4.29	85	55
5-year 2070, Proposed System		0.21	0.01	109.20	1.37	55	0
% Reduction		70%	98%		68%	35%	100%
Guild St Underpass	104.15						
5-year, Existing System		0.11	0.01	105.24	1.09	10	0
5-year, Proposed System		0.08	0.00	104.74	0.59	10	0
% Reduction		25%	50%		45%	0%	N/A
5-year 2070, Existing System		0.24	0.06	105.80	1.65	15	5
5-year 2070, Proposed System		0.12	0.01	104.78	0.63	10	0
% Reduction		51%	91%		62%	33%	N/A
Cross St[3]	84.87						
5-year, Existing System		0.71	0.22	87.34	2.47	>12 hours	45
5-year, Proposed System		0.19	0.03	86.34	1.47	>12 hours	0
% Reduction		73%	87%		40%	N/A	100%
5-year 2070, Existing System		0.91	0.27	87.55	2.68	>12 hours	80
5-year 2070, Proposed System		0.21	0.05	86.47	1.60	>12 hours	10
% Reduction		77%	81%		40%	N/A	88%
Murphy Field	55.04						
5-year, Existing System		2.07	0.72	56.94	1.90	160	50
5-year, Proposed System		1.35	0.04	56.31	1.27	145	0
% Reduction		35%	95%		33%	9%	100%
5-year 2070, Existing System		2.20	0.89	57.06	2.02	190	75
5-year 2070, Proposed System		1.75	0.13	56.50	1.46	170	0
% Reduction		20%	85%		28%	11%	100%
East Hoyle St at Broadway	115.43						
5-year, Existing System		0.68	0.00	116.30	2.12	45	0
5-year, Proposed System		0.18	0.00	115.90	0.61	0	0
% Reduction		74%	100%		71%	100%	N/A
5-year 2070, Existing System		0.83	0.00	116.39	2.34	60	0
5-year 2070, Proposed System		0.39	0.00	116.11	0.72	15	0
% Reduction		53%	100%		69%	75%	N/A
Jacobsen Dr at Redwood Dr	56.17						
5-year, Existing System		2.54	0.38	58.29	2.12	445.00	240
5-year, Proposed System		0.31	0.00	56.78	0.61	15.00	0
% Reduction		88%	100%		71%	97%	100%
5-year 2070, Existing System		3.18	0.69	58.51	2.34	490	275
5-year 2070, Proposed System		0.47	0.00	56.89	0.72	25	0
% Reduction		85%	100%		69%	95%	100%

10 Year							
Location / Event Recurrence		Flooded Area[1]		Flood Depths		Flood Duration (min)	
	Ground Elev (ft)	6"	18"	WSEL.	Depth (ft)	≥ 6"	≥ 18"
Central St at East Vernon St	115.60						
10-year, Existing System		1.24	0.33	117.37	1.77	105	30
10-year, Proposed System		0.40	0.00	116.36	0.77	30	0
% Reduction		67%	100%		57%	71%	100%
10-year 2070, Existing System		1.46	0.51	117.66	2.07	125	45
10-year 2070, Proposed System		0.66	0.01	116.66	1.06	40	0
% Reduction		55%	99%		49%	68%	100%
Nahatan St Underpass	107.83						
10-year, Existing System		0.64	0.40	112.00	4.17	80	50
10-year, Proposed System		0.19	0.01	109.16	1.33	55	0
% Reduction		70%	98%		68%	31%	100%
10-year 2070, Existing System		0.87	0.45	112.48	4.65	105	65
10-year 2070, Proposed System		0.34	0.16	110.12	2.29	70	15
% Reduction		61%	64%		51%	33%	77%
Guild St Underpass	104.15						
10-year, Existing System		0.20	0.03	105.62	1.47	15	0
10-year, Proposed System		0.11	0.00	104.98	0.83	10	0
% Reduction		48%	87%		43%	33%	N/A
10-year 2070, Existing System		0.29	0.09	106.03	1.88	25	15
10-year 2070, Proposed System		0.13	0.01	105.06	0.91	15	0
% Reduction		55%	92%		52%	40%	100%
Cross St[3]	84.87						
10-year, Existing System		0.80	0.26	87.52	2.65	>12 hours	70
10-year, Proposed System		0.21	0.05	86.61	1.74	>12 hours	10
% Reduction		74%	82%		34%	N/A	86%
10-year 2070, Existing System		1.06	0.40	87.76	2.89	>12 hours	105
10-year 2070, Proposed System		0.25	0.07	86.72	1.85	>12 hours	20
% Reduction		77%	82%		36%	N/A	81%
Murphy Field	55.04						
10-year, Existing System		2.17	0.86	57.04	1.99	185	70
10-year, Proposed System		1.60	0.10	56.51	1.46	165	0
% Reduction		26%	89%		27%	11%	100%
10-year 2070, Existing System		2.41	1.14	57.23	2.19	225	100
10-year 2070, Proposed System		2.77	1.30	57.34	2.30	200	40
% Reduction		-15%	-14%		-5%	11%	60%
East Hoyle St at Broadway	115.43						
10-year, Existing System		0.78	0.00	116.37	0.94	60	0
10-year, Proposed System		0.31	0.00	116.11	0.68	15	0
% Reduction		61%	100%		27%	75%	N/A
10-year 2070, Existing System		1.08	0.08	116.46	1.03	85	0
10-year 2070, Proposed System		0.56	0.00	116.39	0.96	20	0
% Reduction		48%	99%		7%	76%	N/A
Jacobsen Dr at Redwood Dr	56.17						
10-year, Existing System		3.08	0.66	58.49	2.31	485	270
10-year, Proposed System		0.43	0.00	56.87	0.69	25	0
% Reduction		86%	100%		70%	95%	100%
10-year 2070, Existing System		3.31	0.83	58.62	2.45	545	305
10-year 2070, Proposed System		0.62	0.00	57.02	0.85	35	0
% Reduction		81%	100%		65%	94%	100%

[1]The delineation of each location, from which flooded area is calculated, is shown in Figure C-19.
[2]Guild Street underpass, Proposed System: minor variations in the surface mesh caused irregularities in the 2-year present day design storm. In this sole instance, Proposed System flooded area results were set equal to Existing System.
[3]Simulated flooding greater than 6" deep in the Cross Street backyards extended beyond the end of the simulation period, so exact durations were not derived.

Appendix D OPINION OF PROBABLE CONSTRUCTION COST

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Opinion of Probable Construction Cost

Town of Norwood

Meadow Brook Drainage Study

Norwood, MA

January 13, 2022

Opinion of Probable Construction Cost

Basis of Estimate Report

Client: **Norwood, MA**	**Date Issued: 13Jan2022**
Project Name: Meadow Brook Drain	**Revision No.: 1**
Project Contact: S. Harrison	**Stantec Class: 4**
Design Definition: Pre-Design	**Currency: USD**

Prepared by:	Stantec Estimating, D Polla Lead Estimator	Date:	13-Jan-2022
Reviewed by:	Stantec Estimating, T. Zavala QA/QC Reviewer	Date:	13-Jan-2022
Reviewed by:		Date:	
Accepted by:		Date:	

Any opinions of probable construction costs (OPCC) prepared by Stantec, including evaluations of the Client's project budget, and/or funding, represent Stantec's best judgment as a design professional familiar with the Construction industry. Unless and to the extent otherwise indicated by Stantec, such opinions or evaluations are based on upon current market rates for labor, material and equipment. The Client acknowledges that Stantec has no control over the costs of said labor, materials, or equipment, construction contractor's methods of determining bid prices, competitive bidding environments, unidentified field conditions, market conditions, hyper-inflationary or deflationary price cycles, or any other factors that may affect the OPCC, the project budget or negotiating conditions at the time of project execution. Client further acknowledges that the OPCC is a "snapshot" in time and that the reliability of the OPCC will degrade over time. Accordingly Stantec does not warrant or represent that construction bids or negotiated prices will not vary from the Client's project budget or Stantec's good faith OPCC.

TABLE OF CONTENTS

Blue Text – Project Specific
Black Text – General Report

1 BASIS OF ESTIMATE

1.1 Introduction

The intent of this OPCC for the Town of Norwood, Meadow Brook Drainage Study is to describe, in sufficient detail, the methodology, assumptions, exclusions, allowances, exceptions and any other information used to develop the estimate.

1.2 Project Scope

The project is located in Norwood, Massachusetts. The project scope of work includes:

- **Storm drain improvements**
- **Nahatan Underpass Alternative 1 – new 72" and 36" storm drains, grate inlet, and flow splitter box**
- **Nahatan Underpass Alternative 2 – new 78" and 24" storm drains, grate inlet, and flow splitter box**
- **East Vernon Street – new 78" storm drain, upsize 24" to 66", and upsize 15" to 78"**
- **Guild Street – new 84" storm drain and upsize 12/18/30/54" to 84"**
- **Washington Street – upsize 12" to 36" and upsize 36" to 72"**
- **East Hoyle Street – Upsize 12" to 78", upsize 10/12" to 84", new 78", and new 78" tunnel under railroad tracks**
- **Hennessey Field Storage – conversion of Hennessey Field into a storage basin**
- **Murphy Field to Meadow Brook – Add a second 7' x 5' box culvert for drainage to Meadow Brook. Also cost to daylight 300 feet of drainage in Meadow Brook**
- **Meadow Brook – open channel improvements and rip rap to improve flow**
- **Jacobsen Street Alternative 1 – upsize 12/15/24" to 3' x7' box culvert and relocate sewer as needed**
- **Jacobsen Street Alternative 2 – upsize 12/15/18" to 60", new outfall at river, and relocate sewer as needed**
- **Reconnection of existing inlets and storm drains**
- **Add new inlets allowance**
- **Repair roadways and landscaping**

1.3 Organization

The project is broken down into a work breakdown structure (WBS) as identified in the attached estimate summary. Major category is by Work Area.

1.4 Class of Estimate

This OPCC estimate is considered a Class 4 according to the Stantec Cost Estimate Classification System. A Cost Estimate Classification Matrix including Accuracy Ranges and Typical Contingencies along with detailed description of each Estimate Class can be found in the Attachments under Estimate Classification Matrix/Estimate Classification Descriptions.

A 20% contingency is included.

A 20% market conditions factor is also included to cover the extreme conditions for

- **Material price escalation and shortages**
- **Skilled labor shortages**
- **Lack of contractor availability**

Contingency specifically includes:

- Errors and omissions in the estimating process
- Variability associated with the quantification effort
- Design that may not be complete enough to determine final quantities
- Some items that may define precise quantification but are required to be estimated
- Some items to be quantified that are generally computed by factoring
- Labor productivity variability
- Labor availability, skills, and productivity that may vary from that assumed
- Weather impact which may affect productivity
- Normal wage rate variability
- Composite wage rates varying from those assumed due to crew make-up, market conditions, and labor availability
- Material and equipment costs that may vary from those in the estimate due to inflationary reasons and market conditions.
- Changes in the actual quantities that may change schedules from that assumed in the estimate.

Contingency specifically excludes:

- Significant changes in scope
- Major unexpected work stoppages (strikes, etc.)
- Disasters (hurricanes, tornados, etc.)
- Excessive, unexpected inflation
- Excessive, unexpected currency fluctuations

1.5 Reference Documents

The following reference documents serve as the estimating basis:

No.	Date	Description
1	January 2022	Partial option sketches
2	January 2022	Options spreadsheet
3	January 2022	Draft Meadow Brook Drainage Study

1.6 Estimating Team

The estimating team is made up of the following individuals:

Name	Role and Responsibility
Estimating, T. Zavala	QA / QC Reviewer
Estimating, D. Polla	Estimators

1.7 Labor Assumptions

The following labor assumptions are incorporated into the OPCC:

Parameter	OPCC Assumption
Local Wage Determination	2022 Norfolk County MA
Productivity Adjustment to U.S.	None
Shift Basis | Shifts/Day | Days/Week	8 hrs | 1 Shifts/day
Living Per diems or Camp Costs	None
FICA | SUI |Workers Compensation	Included in hourly rate

1.8 Equipment Assumptions

The following equipment assumptions are incorporated into the OPCC:

Parameter	OPCC Assumption
Equipment Rate Basis	**Norfolk County MA ave. rates**
Rate Adjustment to U.S. Avg.	**None**
Fuel Rates : Gasoline |Diesel Compensation	**$3.60/Gal. | $3.50/Gal.**

1.9 Escalation

Estimated costs reflect current price levels consistent with the OPCC publish date. **Escalation to the mid-point of construction has not been added to the OPCC.**

1.10 Assumptions

The following assumptions are incorporated into the OPCC:

Project specific assumptions/comments/clarifications:

General:

- **Priced as neutral market with three plus competitive bids**
- **No budget quotes obtained, all pricing per database and online pricing**
- **Demoed asphalt hauled to recycle**
- **No special coating for manholes, catch basins, or RCP pipe included**
- **No special joints included for piping**
- **Import pipe bedding - $27.50/cy delivery**
- **Rigid pipe bedding – 10" below to springline with minimum of 1' each side**
- **Native backfill above import bedding. If import structural fill is required, will add significant cost for haul off and import**
- **Trench box shoring included**
- **Wellpoint and in trench dewatering included**
- **No storm drain bypass pumping included**
- **No pricing for hazardous material included**
- **No street, curb, sidewalk, grade improvements included**
- **Allowances provided are identified**
  - **Relocation of sewers**
  - **Police details for traffic control**

Nahatan Street Underpass Alternative 1:

- **Included new storm drain, manholes, reconnect of inlets, flow splitter vault, and trench drains as shown**
- **Included tie ins to existing**
- **Assumed lane closures during construction**

- Trench patch repair of asphalt only
- Assumed 5 new inlets added
- Estimator's assumed construction duration – 12 weeks

Nahatan Street Underpass Alternative 2:

- Included new storm drain, manholes, reconnect of inlets, flow splitter vault, and trench drains as shown
- Included tie ins to existing
- Assumed lane closures during construction in Nahatan Street and full road closure of Broadway
- Trench patch repair of asphalt only
- Estimator's assumed construction duration – 8 weeks

East Vernon Street:

- Included new storm drain, manholes, and reconnect of inlets as shown
- Included tie ins to existing
- Assumed full road closures during construction
- Trench patch repair of asphalt only
- Assumed 6 new inlets added
- Estimator's assumed construction duration – 9 weeks

Guild Street:

- Included new storm drain, manholes, and reconnect of inlets as shown
- Included tie ins to existing
- Assumed full road closures during construction
- Trench patch repair of asphalt only
- Assumed 8 new inlets added
- Assumed sewer relocation in Cross St.
- Estimator's assumed construction duration – 14 weeks

Washington Street:

- Included new storm drain, manholes, and reconnect of inlets as shown
- Included tie ins to existing
- Assumed full road closures during construction
- Trench patch repair of asphalt only
- Assumed 2 new inlets added
- Estimator's assumed construction duration – 7 weeks

East Hoyle Street:

- Included new storm drain, manholes, and reconnect of inlets as shown
- Included tie ins to existing
- Assumed full road closures during construction
- Trench patch repair of asphalt only
- Assumed 8 new inlets added
- Included jacking/receiving shafts and trenchless crossing of railroad tracks with permanent steel casing
- Estimator's assumed construction duration – 13 weeks

Hennessey Field Storage:

- Included clear & grub, excavation, backfill, and haul off of spoils
- Assumed 10% rock blasting of excavated material
- Included rip rap channel through storage basin for minor flows
- Included pricing for outlet structure
- Assumed gravel path along basin berm
- Removed/replaced topsoil and seeded basin area
- Estimator's assumed construction duration – 24 weeks

Murphy Field to Meadow Brook:

- Included new storm drain, manholes, and reconnect of inlets as shown
- Included tie ins to existing
- Included outfall structure
- Assumed full road closures during construction
- Trench patch repair of asphalt only
- Assumed 4 new inlets added
- Included option for open box culvert for 300 feet in Meadow Brook
- Estimator's assumed construction duration – 6 weeks, 7 weeks for open channel option

Meadow Brook:

- Included clear & grub, excavation, backfill, and haul off of spoils
- Included rip rap channel
- Estimator's assumed construction duration – 9 weeks

Jacobsen Alternative 1:

- Included new storm drain, manholes, and reconnect of inlets as shown
- Included tie ins to existing
- Included relocation of sewer
- Assumed full road closures during construction
- Trench patch repair of asphalt only
- Option appears to need significant work including grading, curbing, road improvements to allow for effective drainage to storm drain. Pricing not included
- Assumed 12 new inlets added
- Estimator's assumed construction duration – 22 weeks

Jacobsen Alternative 2:

- Included new storm drain, manholes, and reconnect of inlets as shown
- Included tie ins to existing
- Included minor relocation of sewer
- Assumed full road closures during construction
- Trench patch repair of asphalt only
- Assumed 5 new inlets added
- Estimator's assumed construction duration – 14 weeks

Exclusions / Exceptions

The developed estimate excludes the following:

- Non-conventional environmental mitigation measures
- Non-conventional heritage and cultural mitigation measures
- All owner costs and owner's contingency such as but not limited to pre-construction activities, management and support of field construction activities, interest during construction, allowances for change orders and claims, engineering services during construction, and owner's contingency
- Removal of unforeseen underground obstructions
- Hazardous material remediation or disposal
- Utility costs for power connects or incoming transmission
- Permits beyond those normally needed for the type of project
- Facility O&M costs
- Special inspections and testing not listed
- CM fees
- Engineering Design Fees
- Geotechnical investigation

1.12 Allowances

The developed estimate includes the following allowances:

- As indicated in estimate

1.13 Project Risks / Opportunities

The following standard project risks can influence bid results:

- Specification requiring special phasing constraints
- Onerous contract terms and conditions

Attachment

Estimate Classification

Estimate Classification

The Class of Estimate given to this estimate is based on the Association for the Advancement of Cost Engineering (AACE) Recommended Practice No. 18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement and Construction for the Process Industries. This AACE Recommended Practice has been adapted and expanded to the specific needs and characteristics for Stantec Design Projects and Programs. A copy of this Practice can be obtained from the AACE website at: https://www.costengineering.eu/Downloads/articles/AACE_CLASSIFICATION_SYSTEM.pdf

Stantec Estimating Framework utilizes a five level Class System (5, 4, 3, 2, and 1) which corresponds to estimate types prepared at various stages of project development. Class 5 cost estimates are developed a project conception when little project information or scope has been developed. Class 2 estimates are complete detailed unit cost and take off estimates with complete or near complete scope definition.

ESTIMAING FRAMEWORK

SUMMARY OF OPCC COST ESTIMATE CLASSIFICATIONS APPLIED TO DESIGN AND CONSTRUCTION PROJECTS

ESTIMATE CHARACTERISTICS					
AACE Estimate Class	Class 5	Class 4	Class 3	Class 2	Class 1
Estimate Methodology	Parametric or Capacity Factored	Equipment Factored or Parametric	Semi-Detailed Unit Costs with Assembly Level Line Items	Detailed Unit Cost with Forced Detailed Take-off	Detailed Unit Cost with Detailed Take-off
Expected Level of Accuracy	-50% to +100%	-30% to +50%	-20% to +30%	-15% to +20%	-10% to +15%
Key Content Requirements ***(Scope Content Examples)***	0 to 25% *Hydraulic Capacity*	25 to 30% *Process Flow Diagram* *Design Criteria* *General Site Layout* *Pipeline Corridors* *Prelim. Equipment Lists* *Prelim. Electrical Loads*	45 to 60% *Final Equipment Lists* *Site Layout (Earthwork)* *Building/Facility Plans* *Major Sections* *Concrete Quantities* *Final P&IDs* *Electrical Single Lines*	70 to 90% *Preliminary to Advanced Drawings* *Major Specifications*	95 to 100% *Complete Annotated Drawings* *Complete Specifications*

Attachment

Detailed Cost Estimates by Option

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA001 Nahatan Street Underpass - Alt 1									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	3.00	mon	-	-	36,098	-	-	36,098
Site Supervision	1500.050	12.00	wk	78,012	1,260	-	43,834	602	123,708
Surveyor Services	1700.400	1.00	ls	6,191	-	-	974	-	7,166
Potholing	2100.300	29.00	ea	7,922	1,015		4,729	-	13,666
Weekly Cleanup	2150.300	12.00	wk	20,868	-	-	2,702	-	23,570
e041 General Conditions		*1.00*	*ls*	112,994	2,274	36,098	52,239	602	204,207
e061 Traffic Control									
Traffic Control, Labor	2750.400	50.00	day	11,432	-		1,126	-	12,558
Traffic Control, Material	2750.400	50.00	day		3,499			-	3,499
Traffic Control, Setup	2750.400	50.00	day	11,432	-		1,126	-	12,558
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	50.00	day		-	72,864		-	72,864
e061 Traffic Control		*1.00*	*ls*	22,864	3,499	72,864	2,251		101,479
WP100 General		**1.00**	**ls**	135,858	5,773	108,962	54,491	602	305,686
WP150 Demolition									
d201 Demolition									
Demo AC Paving	2150.050	17,040.00	sf	13,168	-	-	8,609		21,777
Demo Storm Drain Pipe	2150.100	180.00	lf	2,318	-	-	1,516		3,834
Haul Asphalt to Off-Site Disposal	2316.515	316.00	cy	5,681	-	-	7,124	2,428	15,233
Haul Debris to Off-Site Disposal	2316.515	21.00	cy	378	-	-	473	516	1,367
Plug 3'x4' Pipe	2650.250	1.00	ea	915	287	-	87	345	1,634
Plug 24" Pipe	2650.250	1.00	ea	915	75	-	87	91	1,167
Saw Cut Asphalt 4" Thick	2750.200	2,840.00	lf	6,129	-	-	784	-	6,912
d201 Demolition		*1,420.00*	*lf*	29,502	362		18,679	3,381	51,925
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	1,420.00	lf	24,916	9,492	-	7,956	-	42,365
d206 Allowance for Utility Relocations		*1.00*	*ls*	24,916	9,492		7,956		42,365
WP150 Demolition		**1.00**	**ls**	54,418	9,855		26,636	3,381	94,290
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	1,420.00	ls	2,160	1,093	-	120	-	3,374
e051 Erosion Control		*1.00*	*ls*	2,160	1,093		120		3,374
e201 Storm Drain									
Utility Crossing Material	1850.100	29.00	ea	-	7,754		-	-	7,754
Import Bedding	2200.100	811.00	cy	-	18,975	-	-	21,686	40,660
Trench Box	2200.750	216.00	hr	-	-	-	8,454	-	8,454
Haul Trench Spoils to Off-Site Disposal	2316.515	1,987.00	cy	35,722	-	-	44,793	12,216	92,731
RCP Class IV O-Ring Joint Pipe, 24"	2650.204	60.00	lf		3,770	-	-	-	3,770
RCP Class IV O-Ring Joint Pipe, 36"	2650.204	180.00	lf		24,246	-	-	-	24,246
Concrete Box Culvert, 4' x 3', Purchase	2650.204	194.00	lf		103,748	-	-	-	103,748

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain									
RCP Class IV O-Ring Joint Pipe, 72"	2650.204	986.00	lf		487,948	-	-	-	487,948
Concrete Pipe, 72", Specials/Bends, Fab Charge	2650.250	4.00	ea		6,417	-	-	-	6,417
Pipe Crew	21000.275	216.00	hr	253,428	-	-	133,006	-	386,435
e201 Storm Drain		*1,420.00*	*lf*	289,151	652,859		186,253	33,901	1,162,165
e203 Dewatering									
Filter Bags	2250.050	54.00	ea	5,827	3,779	-	1,409	-	11,014
In Trench Dewatering	2250.050	216.00	hr	1,457	3,627	-	4,509	-	9,593
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	40.00	ea		1,959	-		-	1,959
Set Well Points, Up to 15', 3" dia., Install	2250.100	95.00	ea	8,289		-	179	-	8,468
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,349	-	4,349
Operate Pumps and Equipment	2250.100	54.00	day	-	14,018	-	14,090	-	28,108
Maintenance of Wellpoint System Pumps	2250.100	54.00	day	74,154	-	-	7,302	-	81,456
e203 Dewatering		*1,420.00*	*lf*	89,727	23,384		31,837		144,947
e206 Manholes									
Box Base Manhole, Purchase	2700.050	5.00	ea		58,158	-		-	58,158
Box Base Manhole, Install	2700.050	5.00	ea	28,075	1,337	-	8,965	-	38,376
e206 Manholes		*5.00*	*ea*	28,075	59,495		8,965		96,534
e208 Flow Split Vault									
Crane Placement	1850.100	1.00	ls	3,168	-		641	-	3,809
Import Bedding	2200.100	8.00	cy	-	187	-	-	214	401
Trench Box	2200.750	16.00	hr	-	-	-	626	-	626
Haul Trench Spoils to Off-Site Disposal	2316.515	57.00	cy	1,025	-	-	1,285	350	2,660
Pre-Cast Concrete Flow Split Vault w/ Cover, 10'x10', Purchase	2700.200	1.00	ea		56,152	-		-	56,152
Pre-Cast Concrete Flow Split Vault w/ Cover, 10'x10', Install	2700.200	1.00	ea	11,230	267	-	3,586	-	15,083
e208 Flow Split Vault		*1.00*	*ls*	15,422	56,607		6,138	564	78,732
e211 New Inlets									
New Inlets, Purchase	2700.150	5.00	ea		21,391	-		-	21,391
New Inlets, Install	2700.150	5.00	ea	28,075	1,671	-	8,965	1,337	40,048
e211 New Inlets		*5.00*	*ea*	28,075	23,063		8,965	1,337	61,439
e212 Linear Drainage Grates									
Linear Drainage Grates, Material Purchase, Ductile Iron	2700.150	50.00	lf		15,656	-		-	15,656
Linear Drainage Grates, Install	2700.150	50.00	lf	5,615	5,014	-	1,793	334	12,756
e212 Linear Drainage Grates		*50.00*	*lf*	5,615	20,669		1,793	334	28,412
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	150.00	lf	14,037	3,670	2,005	4,482	3,008	27,203
e213 Reconnect Existing Inlets		*15.00*	*ea*	14,037	3,670	2,005	4,482	3,008	27,203
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,337	-	-	1,337
Aggregate Base, 8"	2750.050	1,893.00	sy	-	-	59,602	-	-	59,602
Asphalt Pavement, 6"	2750.050	1,893.00	sy	-	-	134,105	-	-	134,105

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e216 Pavement Restoration									
Pavement Markings	2750.150	1.00	ls	-	-	3,797	-	-	3,797
e216 Pavement Restoration		*1,893.00*	*sy*			198,840			198,840
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	7,594	-	-	7,594
e221 Surface Restoration		*1.00*	*ls*			7,594			7,594
WP200 Civil		**1.00**	**ls**	472,262	840,840	208,440	248,554	39,145	1,809,240
WA001 Nahatan Street Underpass - Alt 1		***1.00***	***ls***	662,538	856,467	317,402	329,680	43,127	2,209,215

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	662,538		5,848.478 hrs				21.42%	
Material	856,467						27.69%	
Subcontract	317,402						10.26%	
Equipment	329,680		2,792.367 hrs				10.66%	
Other	43,127						1.39%	
Subtotal	**2,209,214**	**2,209,214**					**71.43%**	**71.43%**
Scope Contingency	441,843			20.000 %	T		14.29%	
Market Conditions	441,843			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**883,686**	**3,092,900**					**28.57%**	**100.00%**
Partial Total		***3,092,900***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA002 Nahatan Street Underpass - Alt 2									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	2.00	mon	-	-	24,065	-	-	24,065
Site Supervision	1500.050	8.00	wk	52,008	840	-	29,223	401	82,472
Surveyor Services	1700.400	1.00	ls	6,191	-	-	974	-	7,166
Residents Support	1850.100	20.00	day	9,146	-		901	-	10,046
Potholing	2100.300	8.00	ea	2,185	280		1,305	-	3,770
Weekly Cleanup	2150.300	8.00	wk	13,912	-	-	1,801	-	15,713
e041 General Conditions		*1.00*	*ls*	83,443	1,120	24,065	34,203	401	143,232
e061 Traffic Control									
Traffic Control, Labor	2750.400	40.00	day	9,146	-		901	-	10,046
Traffic Control, Material	2750.400	40.00	day		2,799			-	2,799
Traffic Control, Setup	2750.400	40.00	day	9,146	-		901	-	10,046
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	40.00	day		-	58,292		-	58,292
e061 Traffic Control		*1.00*	*ls*	18,291	2,799	58,292	1,801		81,183
WP100 General		**1.00**	**ls**	101,734	3,918	82,357	36,004	401	224,415
WP150 Demolition									
d201 Demolition									
Demo AC Paving	2150.050	5,664.00	sf	4,377	-	-	2,862		7,239
Demo Storm Drain Pipe	2150.100	122.00	lf	1,571	-	-	1,027		2,599
Haul Asphalt to Off-Site Disposal	2316.515	105.00	cy	1,888	-	-	2,367	807	5,062
Haul Debris to Off-Site Disposal	2316.515	14.00	cy	252	-	-	316	344	912
Plug 3'x4' Pipe	2650.250	1.00	ea	915	287	-	87	345	1,634
Plug 24" Pipe	2650.250	1.00	ea	915	75	-	87	91	1,167
Saw Cut Asphalt 4" Thick	2750.200	1,566.00	lf	3,379	-	-	432	-	3,812
d201 Demolition		*397.00*	*lf*	13,296	362		7,177	1,587	22,423
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	397.00	lf	6,966	2,654	-	2,224	-	11,844
d206 Allowance for Utility Relocations		*1.00*	*ls*	6,966	2,654		2,224		11,844
WP150 Demolition		**1.00**	**ls**	20,262	3,016		9,402	1,587	34,267
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	397.00	ls	604	306	-	34	-	943
e051 Erosion Control		*1.00*	*ls*	604	306		34		943
e201 Storm Drain									
Utility Crossing Material	1850.100	8.00	ea	-	2,139		-	-	2,139
Import Bedding	2200.100	221.00	cy	-	5,171	-	-	5,909	11,080
Trench Box	2200.750	64.00	hr	-	-	-	2,505	-	2,505
Haul Trench Spoils to Off-Site Disposal	2316.515	569.00	cy	10,229	-	-	12,827	3,498	26,555
RCP Class IV O-Ring Joint Pipe, 24"	2650.204	92.00	lf		5,781	-	-	-	5,781
RCP Class IV O-Ring Joint Pipe, 78"	2650.204	275.00	lf		145,963	-	-	-	145,963

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain									
Concrete Pipe, 78", Specials/Bends, Fab Charge	2650.250	2.00	ea		4,278	-	-	-	4,278
Pipe Crew	21000.275	64.00	hr	75,090	-	-	39,409	-	114,499
e201 Storm Drain		*367.00*	*lf*	85,319	163,332		54,741	9,408	312,800
e203 Dewatering									
Filter Bags	2250.050	26.00	ea	2,805	1,819	-	678	-	5,303
In Trench Dewatering	2250.050	64.00	hr	432	1,075	-	1,336	-	2,842
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	26.00	ea		1,274	-		-	1,274
Set Well Points, Up to 15', 3" dia., Install	2250.100	26.00	ea	2,269		-	49	-	2,318
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,349	-	4,349
Operate Pumps and Equipment	2250.100	26.00	day	-	6,750	-	6,784	-	13,534
Maintenance of Wellpoint System Pumps	2250.100	26.00	day	35,704	-	-	3,516	-	39,220
e203 Dewatering		*367.00*	*lf*	41,210	10,917		16,712		68,838
e206 Manholes									
Box Base Manhole, Purchase	2700.050	6.00	ea		69,789	-		-	69,789
Box Base Manhole, Install	2700.050	6.00	ea	33,689	1,604	-	10,758	-	46,052
e206 Manholes		*6.00*	*ea*	33,689	71,394		10,758		115,841
e208 Flow Split Vault									
Crane Placement	1850.100	1.00	ls	3,168	-		641	-	3,809
Import Bedding	2200.100	12.00	cy	-	281	-	-	321	602
Trench Box	2200.750	16.00	hr	-	-	-	626	-	626
Haul Trench Spoils to Off-Site Disposal	2316.515	95.00	cy	1,708	-	-	2,142	584	4,434
Pre-Cast Concrete Flow Split Vault w/ Cover, 15'x12', Purchase	2700.200	1.00	ea		54,815	-		-	54,815
Pre-Cast Concrete Flow Split Vault w/ Cover, 15'x12', Install	2700.200	1.00	ea	11,230	267	-	3,586	-	15,083
e208 Flow Split Vault		*1.00*	*ls*	16,106	55,364		6,995	905	79,369
e212 Linear Drainage Grates									
Linear Drainage Grates, Material Purchase, Ductile Iron	2700.150	150.00	lf		46,968	-		-	46,968
Linear Drainage Grates, Install	2700.150	150.00	lf	16,845	15,041	-	5,379	1,003	38,267
e212 Linear Drainage Grates		*150.00*	*lf*	16,845	62,008		5,379	1,003	85,235
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	30.00	lf	2,807	734	401	896	602	5,441
e213 Reconnect Existing Inlets		*3.00*	*ea*	2,807	734	401	896	602	5,441
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,337	-	-	1,337
Aggregate Base, 8"	2750.050	630.00	sy	-	-	19,836	-	-	19,836
Asphalt Pavement, 6"	2750.050	630.00	sy	-	-	44,631	-	-	44,631
Pavement Markings	2750.150	1.00	ls	-	-	1,003	-	-	1,003
e216 Pavement Restoration		*630.00*	*sy*			66,806			66,806
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	2,123	-	-	2,123

Spreadsheet Level	Phase	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e221 Surface Restoration		*1.00 ls*			2,123			2,123
WP200 Civil		**1.00 ls**	196,580	364,055	69,330	95,514	11,917	737,396
WA002 Nahatan Street Underpass - Alt 2		***1.00 ls***	318,577	370,989	151,687	140,920	13,905	996,079

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	318,577		2,811.360 hrs				22.85%	
Material	370,989						26.60%	
Subcontract	151,687						10.88%	
Equipment	140,920		1,433.282 hrs				10.11%	
Other	13,905						1.00%	
Subtotal	**996,078**	**996,078**					**71.43%**	**71.43%**
Scope Contingency	199,216			20.000 %	T		14.29%	
Market Conditions	199,216			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**398,432**	**1,394,510**					**28.57%**	**100.00%**
Partial Total		***1,394,510***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA003 East Vernon Street									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	2.00	mon	-	-	24,121	-	-	24,121
Site Supervision	1500.050	9.00	wk	58,626	947	-	32,934	452	92,960
Surveyor Services	1700.400	1.00	ls	6,204	-	-	976	-	7,180
Residents Support	1850.100	45.00	day	20,619	-		2,030	-	22,649
Potholing	2100.300	16.00	ea	4,380	561		2,614	-	7,554
Weekly Cleanup	2150.300	9.00	wk	15,683	-	-	2,030	-	17,712
e041 General Conditions		*1.00*	*ls*	105,511	1,508	24,121	40,584	452	172,176
e061 Traffic Control									
Traffic Control, Labor	2750.400	45.00	day	10,310	-		1,015	-	11,324
Traffic Control, Material	2750.400	45.00	day		3,156			-	3,156
Traffic Control, Setup	2750.400	45.00	day	10,310	-		1,015	-	11,324
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	45.00	day		-	65,730		-	65,730
e061 Traffic Control		*1.00*	*ls*	20,619	3,156	65,730	2,030		91,535
WP100 General		**1.00**	**ls**	126,131	4,664	89,851	42,613	452	263,711
WP150 Demolition									
d201 Demolition									
Demo AC Paving	2150.050	9,396.00	sf	7,275	-	-	4,756		12,031
Demo Storm Drain Pipe	2150.100	503.00	lf	6,491	-	-	4,243		10,734
Haul Asphalt to Off-Site Disposal	2316.515	116.00	cy	2,089	-	-	2,619	893	5,602
Haul Debris to Off-Site Disposal	2316.515	33.00	cy	594	-	-	745	813	2,153
Saw Cut Asphalt 4" Thick	2750.200	1,566.00	lf	3,386	-	-	433	-	3,819
d201 Demolition		*783.00*	*lf*	19,836			12,796	1,706	34,339
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	783.00	lf	6,883	2,623	-	2,198	-	11,704
d206 Allowance for Utility Relocations		*1.00*	*ls*	6,883	2,623		2,198		11,704
WP150 Demolition		**1.00**	**ls**	26,719	2,623		14,994	1,706	46,042
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	783.00	ls	1,194	604	-	66	-	1,864
e051 Erosion Control		*1.00*	*ls*	1,194	604		66		1,864
e201 Storm Drain									
Utility Crossing Material	1850.100	16.00	ea	-	4,288		-	-	4,288
Import Bedding	2200.100	552.00	cy	-	12,945	-	-	14,794	27,739
Trench Box	2200.750	144.00	hr	-	-	-	5,646	-	5,646
Haul Trench Spoils to Off-Site Disposal	2316.515	1,473.00	cy	26,529	-	-	33,259	9,074	68,862
RCP Class IV O-Ring Joint Pipe, 66"	2650.204	119.00	lf		50,934	-	-	-	50,934
RCP Class IV O-Ring Joint Pipe, 78"	2650.204	664.00	lf		353,251	-	-	-	353,251
Concrete Pipe, 78", Specials/Bends, Fab Charge	2650.250	3.00	ea		6,432	-	-	-	6,432
Pipe Crew	21000.275	144.00	hr	169,291	-	-	88,829	-	258,120

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain		*783.00*	*lf*	195,819	427,851		127,734	23,868	775,272
e203 Dewatering									
Filter Bags	2250.050	40.00	ea	4,325	2,805	-	1,046	-	8,175
In Trench Dewatering	2250.050	144.00	hr	973	2,424	-	3,011	-	6,408
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	40.00	ea		1,964	-		-	1,964
Set Well Points, Up to 15', 3" dia., Install	2250.100	52.00	ea	4,546		-	98	-	4,645
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,356	-	4,356
Operate Pumps and Equipment	2250.100	40.00	day	-	10,407	-	10,455	-	20,862
Maintenance of Wellpoint System Pumps	2250.100	40.00	day	55,039	-	-	5,418	-	60,457
e203 Dewatering		*783.00*	*lf*	64,883	17,599		24,385		106,867
e206 Manholes									
Box Base Manhole, Purchase	2700.050	6.00	ea		69,951	-		-	69,951
Box Base Manhole, Install	2700.050	6.00	ea	33,757	1,608	-	10,777	-	46,142
e206 Manholes		*6.00*	*ea*	33,757	71,559		10,777		116,093
e211 New Inlets									
New Inlets, Purchase	2700.150	6.00	ea		25,729	-		-	25,729
New Inlets, Install	2700.150	6.00	ea	33,757	2,010	-	10,777	1,608	48,152
e211 New Inlets		*6.00*	*ea*	33,757	27,739		10,777	1,608	73,881
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	90.00	lf	8,439	2,207	1,206	2,694	1,809	16,356
e213 Reconnect Existing Inlets		*9.00*	*ea*	8,439	2,207	1,206	2,694	1,809	16,356
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,340	-	-	1,340
Aggregate Base, 6"	2750.050	1,044.00	sy	-	-	24,710	-	-	24,710
Asphalt Pavement, 4"	2750.050	1,044.00	sy	-	-	49,421	-	-	49,421
Pavement Markings	2750.150	1.00	ls	-	-	2,104	-	-	2,104
e216 Pavement Restoration		*1,044.00*	*sy*			77,575			77,575
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	4,197	-	-	4,197
e221 Surface Restoration		*1.00*	*ls*			4,197			4,197
WP200 Civil		**1.00**	**ls**	337,849	547,560	82,978	176,434	27,286	1,172,106
WA003 East Vernon Street		***1.00***	***ls***	490,699	554,846	172,829	234,041	29,444	1,481,859

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	490,699		4,317.988 hrs				23.65%	
Material	554,846						26.74%	
Subcontract	172,829						8.33%	
Equipment	234,041		2,049.151 hrs				11.28%	
Other	29,444						1.42%	
Subtotal	**1,481,859**	**1,481,859**					**71.43%**	**71.43%**
Scope Contingency	296,372			20.000 %	T		14.29%	
Market Conditions	296,372			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**592,744**	**2,074,603**					**28.57%**	**100.00%**
Partial Total		***2,074,603***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA005 Washington Street									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	1.60	mon	-	-	19,311	-	-	19,311
Site Supervision	1500.050	7.00	wk	45,626	737	-	25,630	352	72,345
Surveyor Services	1700.400	1.00	ls	6,208	-	-	976	-	7,184
Residents Support	1850.100	25.00	day	11,462	-		1,128	-	12,590
Potholing	2100.300	15.00	ea	4,108	526		2,452	-	7,087
Weekly Cleanup	2150.300	7.00	wk	12,205	-	-	1,580	-	13,785
e041 General Conditions		*1.00*	*ls*	79,610	1,263	19,311	31,766	352	132,301
e061 Traffic Control									
Traffic Control, Labor	2750.400	25.00	day	5,731	-		564	-	6,295
Traffic Control, Material	2750.400	35.00	day		2,456			-	2,456
Traffic Control, Setup	2750.400	35.00	day	8,023	-		790	-	8,813
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	25.00	day		-	36,543		-	36,543
e061 Traffic Control		*1.00*	*ls*	13,755	2,456	36,543	1,354		54,107
WP100 General		**1.00**	**ls**	93,364	3,719	55,853	33,120	352	186,409
WP150 Demolition									
d201 Demolition									
Demo AC Paving	2150.050	7,040.00	sf	5,454	-	-	3,565		9,020
Demo Storm Drain Pipe	2150.100	704.00	lf	9,091	-	-	5,942		15,033
Haul Asphalt to Off-Site Disposal	2316.515	87.00	cy	1,568	-	-	1,965	670	4,203
Haul Debris to Off-Site Disposal	2316.515	184.00	cy	3,316	-	-	4,157	4,537	12,009
Saw Cut Asphalt 4" Thick	2750.200	1,408.00	lf	3,046	-	-	389	-	3,436
d201 Demolition		*704.00*	*lf*	22,475			16,019	5,207	43,701
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	704.00	lf	12,385	4,720	-	3,954	-	21,059
d206 Allowance for Utility Relocations		*1.00*	*ls*	12,385	4,720		3,954		21,059
WP150 Demolition		**1.00**	**ls**	34,860	4,720		19,972	5,207	64,760
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	704.00	ls	1,074	543	-	60	-	1,677
e051 Erosion Control		*1.00*	*ls*	1,074	543		60		1,677
e201 Storm Drain									
Utility Crossing Material	1850.100	14.00	ea	-	3,755		-	-	3,755
Import Bedding	2200.100	404.00	cy	-	9,481	-	-	10,835	20,316
Trench Box	2200.750	104.00	hr	-	-	-	4,080	-	4,080
Haul Trench Spoils to Off-Site Disposal	2316.515	995.00	cy	17,930	-	-	22,477	6,133	46,540
RCP Class IV O-Ring Joint Pipe, 36"	2650.204	187.00	lf		25,265	-	-	-	25,265
RCP Class IV O-Ring Joint Pipe, 72"	2650.204	517.00	lf		256,627	-	-	-	256,627
Concrete Pipe, 72", Specials/Bends, Fab Charge	2650.250	2.00	ea		3,218	-	-	-	3,218
Pipe Crew	21000.275	104.00	hr	122,341	-	-	64,189	-	186,530

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain		*704.00*	*lf*	140,270	298,347		90,747	16,969	546,332
e203 Dewatering									
Filter Bags	2250.050	19.00	ea	2,055	1,333	-	497	-	3,886
In Trench Dewatering	2250.050	104.00	hr	703	1,752	-	2,176	-	4,631
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	40.00	ea		1,965	-		-	1,965
Set Well Points, Up to 15', 3" dia., Install	2250.100	47.00	ea	4,112		-	89	-	4,201
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,359	-	4,359
Operate Pumps and Equipment	2250.100	19.00	day	-	4,947	-	4,969	-	9,916
Maintenance of Wellpoint System Pumps	2250.100	19.00	day	26,160	-	-	2,575	-	28,735
e203 Dewatering		*704.00*	*lf*	33,030	9,997		14,665		57,691
e206 Manholes									
Box Base Manhole, Purchase	2700.050	5.00	ea		58,334	-		-	58,334
Box Base Manhole, Install	2700.050	5.00	ea	28,148	1,341	-	8,986	-	38,475
e206 Manholes		*5.00*	*ea*	28,148	59,675		8,986		96,809
e211 New Inlets									
New Inlets, Purchase	2700.150	2.00	ea		8,583	-		-	8,583
New Inlets, Install	2700.150	2.00	ea	11,259	671	-	3,594	536	16,060
e211 New Inlets		*2.00*	*ea*	11,259	9,253		3,594	536	24,643
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	50.00	lf	4,691	1,227	671	1,498	1,006	9,092
e213 Reconnect Existing Inlets		*5.00*	*ea*	4,691	1,227	671	1,498	1,006	9,092
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,341	-	-	1,341
Aggregate Base, 6"	2750.050	783.00	sy	-	-	18,546	-	-	18,546
Asphalt Pavement, 4"	2750.050	783.00	sy	-	-	37,092	-	-	37,092
Pavement Markings	2750.150	1.00	ls	-	-	1,888	-	-	1,888
e216 Pavement Restoration		*783.00*	*sy*			58,867			58,867
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	3,776	-	-	3,776
e221 Surface Restoration		*1.00*	*ls*			3,776			3,776
WP200 Civil		**1.00**	**ls**	218,473	379,042	63,314	119,549	18,511	798,888
WA005 Washington Street		***1.00***	***ls***	346,697	387,482	119,167	172,641	24,070	1,050,057

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	346,697		3,044.600 hrs				23.58%	
Material	387,482						26.36%	
Subcontract	119,167						8.11%	
Equipment	172,641		1,445.103 hrs				11.74%	
Other	24,070						1.64%	
Subtotal	**1,050,057**	**1,050,057**					**71.43%**	**71.43%**
Scope Contingency	210,011			20.000 %	T		14.29%	
Market Conditions	210,011			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**420,022**	**1,470,079**					**28.57%**	**100.00%**
Partial Total		***1,470,079***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA006 East Hoyle Street									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	3.00	mon	-	-	35,956	-	-	35,956
Site Supervision	1500.050	13.00	wk	84,226	1,359	-	47,344	649	133,579
Surveyor Services	1700.400	1.00	ls	6,170	-	-	971	-	7,142
Residents Support	1850.100	30.00	day	13,672	-		1,347	-	15,019
Potholing	2100.300	26.00	ea	7,079	906		4,227	-	12,212
Weekly Cleanup	2150.300	13.00	wk	22,531	-	-	2,918	-	25,448
e041 General Conditions		*1.00*	*ls*	133,678	2,266	35,956	56,807	649	229,356
e061 Traffic Control									
Traffic Control, Labor	2750.400	30.00	day	6,836	-		673	-	7,509
Traffic Control, Material	2750.400	65.00	day		4,531			-	4,531
Traffic Control, Setup	2750.400	65.00	day	14,811	-		1,459	-	16,270
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	30.00	day		-	43,547		-	43,547
e061 Traffic Control		*1.00*	*ls*	21,647	4,531	43,547	2,132		71,858
WP100 General		**1.00**	**ls**	155,325	6,797	79,503	58,939	649	301,213
WP150 Demolition									
d201 Demolition									
Demo AC Paving	2150.050	15,024.00	sf	11,570	-	-	7,568		19,138
Demo Storm Drain Pipe	2150.100	860.00	lf	11,038	-	-	7,220		18,258
Haul Asphalt to Off-Site Disposal	2316.515	186.00	cy	3,334	-	-	4,182	1,425	8,940
Haul Debris to Off-Site Disposal	2316.515	25.00	cy	448	-	-	562	613	1,623
Saw Cut Asphalt 4" Thick	2750.200	2,504.00	lf	5,385	-	-	689	-	6,074
d201 Demolition		*1,330.00*	*lf*	31,776			20,220	2,037	54,034
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	1,330.00	lf	11,629	4,428	-	3,715	-	19,772
d206 Allowance for Utility Relocations		*1.00*	*ls*	11,629	4,428		3,715		19,772
WP150 Demolition		**1.00**	**ls**	43,405	4,428		23,935	2,037	73,805
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	1,330.00	ls	2,017	1,020	-	112	-	3,149
e051 Erosion Control		*1.00*	*ls*	2,017	1,020		112		3,149
e121 Jacking/Receiving Shafts									
Import Bedding	2200.100	45.00	cy	-	1,199	-	-	1,199	2,397
Purchase Controlled Low Strength Material (CLSM)	2200.100	30.00	cy	-	3,995	-	-	-	3,995
Excavation	2200.200	667.00	cy	7,155	-	-	9,298	-	16,452
Structural Backfill	2200.250	507.00	cy	9,235	-	-	10,257	-	19,492
Steel Sheeting, 38 #/sf, Rental	2200.800	4,000.00	sf	-	-	55,142	-	-	55,142
Steel Sheeting, 38 #/sf, Install/Removal	2200.800	4,000.00	sf	71,203	-		114,888	-	186,091
Whaler & Bracing for Sheeting	2200.800	4,000.00	sf	15,311	6,377		3,563	-	25,251
Dewatering	2250.050	1,248.00	ch	7,484	13,920	-	34,629	-	56,033

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e121 Jacking/Receiving Shafts									
Haul Trench Spoils to Off-Site Disposal	2316.515	160.00	cy	2,468	-	-	3,225	852	6,546
Pump-Place Concrete, Slab-On-Grade	3300.250	30.00	cy	1,559	-	-	299	559	2,417
Truck Driver, Material Handling	20050.050	160.00	hr	17,154	-	-	-	-	17,154
Pipe Crew	21000.275	24.00	ch	26,397	-	-	16,482	-	42,879
On-Highway Rear Dump, Material Handling	21000.425	160.00	hr	-	-	-	22,576	-	22,576
e121 Jacking/Receiving Shafts		*2.00*	*ea*	157,965	25,490	55,142	215,217	2,610	456,424
e126 Pipe Jacking									
Pipe Jacking, Machine Mob/Setup/Rental/Parts/Demob	2300.300	1.00	ls	-	-	998,781	-	-	998,781
Pipe Jacking, Tunneling/Casing Install	2300.300	160.00	lf	100,726	1,065		35,751	21,307	158,850
Pipe Jacking, Supplies	2300.300	160.00	lf		5,114			-	5,114
Haul Trench Spoils to Off-Site Disposal	2316.515	336.00	cy	5,479	-	-	6,773	2,237	14,490
Pump-Place Grout (Low Production)	3300.750	75.00	cy	6,561	19,976	-	4,219	1,398	32,153
e126 Pipe Jacking		*160.00*	*lf*	112,766	26,155	998,781	46,742	24,943	1,209,387
e131 Pipe Purchase									
Carbon Steel Casing, 102"	2500.584	160.00	lf		383,020	-		-	383,020
RCP Pipe, 78"	2650.204	160.00	lf		119,321	-	-	-	119,321
e131 Pipe Purchase		*160.00*	*lf*		502,341				502,341
e201 Storm Drain									
Utility Crossing Material	1850.100	26.00	ea	-	6,925		-	-	6,925
Import Bedding	2200.100	1,025.00	cy	-	23,888	-	-	27,300	51,188
Trench Box	2200.750	216.00	hr	-	-	-	8,428	-	8,428
Haul Trench Spoils to Off-Site Disposal	2316.515	2,827.00	cy	50,671	-	-	63,557	17,321	131,549
RCP Class IV O-Ring Joint Pipe, 24"	2650.204	40.00	lf		2,504	-	-	-	2,504
RCP Class IV O-Ring Joint Pipe, 78"	2650.204	500.00	lf		264,344	-	-	-	264,344
RCP Class IV O-Ring Joint Pipe, 84"	2650.204	830.00	lf		469,760	-	-	-	469,760
Concrete Pipe, Specials/Bends, Fab Charge	2650.250	6.00	ea		19,976	-	-	-	19,976
Pipe Crew	21000.275	216.00	hr	252,568	-	-	132,604	-	385,173
e201 Storm Drain		*1,330.00*	*lf*	303,239	787,396		204,590	44,621	1,339,845
e203 Dewatering									
Filter Bags	2250.050	34.00	ea	3,656	2,370	-	884	-	6,911
In Trench Dewatering	2250.050	216.00	hr	1,452	3,614	-	4,495	-	9,561
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	40.00	ea		1,952	-		-	1,952
Set Well Points, Up to 15', 3" dia., Install	2250.100	89.00	ea	7,739		-	167	-	7,907
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,336	-	4,336
Operate Pumps and Equipment	2250.100	47.00	day	-	12,155	-	12,226	-	24,382
Maintenance of Wellpoint System Pumps	2250.100	47.00	day	64,323	-	-	6,336	-	70,658
e203 Dewatering		*1,330.00*	*lf*	77,170	20,091		28,445		125,705
e206 Manholes									
Box Base Manhole, Purchase	2700.050	8.00	ea		92,687	-		-	92,687
Box Base Manhole, Install	2700.050	8.00	ea	44,767	2,131	-	14,300	-	61,198
e206 Manholes		*8.00*	*ea*	44,767	94,818		14,300		153,885
e211 New Inlets									
New Inlets, Purchase	2700.150	8.00	ea		34,092	-		-	34,092

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e211 New Inlets									
New Inlets, Install	2700.150	8.00	ea	44,767	2,663	-	14,300	2,131	63,861
e211 New Inlets		*8.00*	*ea*	44,767	36,755		14,300	2,131	97,953
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	120.00	lf	8,394	2,924	1,598	2,681	2,397	17,995
e213 Reconnect Existing Inlets		*12.00*	*ea*	8,394	2,924	1,598	2,681	2,397	17,995
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,332	-	-	1,332
Aggregate Base, 6"	2750.050	1,670.00	sy	-	-	39,281	-	-	39,281
Asphalt Pavement, 4"	2750.050	1,670.00	sy	-	-	78,561	-	-	78,561
Pavement Markings	2750.150	1.00	ls	-	-	6,659	-	-	6,659
e216 Pavement Restoration		*1,670.00*	*sy*			125,832			125,832
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	10,654	-	-	10,654
e221 Surface Restoration		*1.00*	*ls*			10,654			10,654
WP200 Civil		**1.00**	**ls**	751,084	1,496,990	1,192,006	526,388	76,701	4,043,170
WA006 East Hoyle Street		***1.00***	***ls***	949,814	1,508,215	1,271,509	609,262	79,388	4,418,188

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	949,814		9,007.536 hrs				15.36%	
Material	1,508,215						24.38%	
Subcontract	1,271,509						20.56%	
Equipment	609,262		5,483.585 hrs				9.85%	
Other	79,388						1.28%	
Subtotal	**4,418,188**	**4,418,188**					**71.43%**	**71.43%**
Scope Contingency	883,638			20.000 %	T		14.29%	
Market Conditions	883,638			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**1,767,276**	**6,185,464**					**28.57%**	**100.00%**
Partial Total		***6,185,464***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA004 Guild Street									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	3.25	mon	-	-	39,108	-	-	39,108
Site Supervision	1500.050	14.00	wk	91,018	1,470	-	51,142	702	144,332
Surveyor Services	1700.400	1.00	ls	6,192	-	-	974	-	7,166
Residents Support	1850.100	60.00	day	27,438	-		2,702	-	30,140
Potholing	2100.300	32.00	ea	8,742	1,120		5,219	-	15,080
Weekly Cleanup	2150.300	14.00	wk	24,347	-	-	3,152	-	27,499
e041 General Conditions		*1.00*	*ls*	157,738	2,589	39,108	63,189	702	263,326
e061 Traffic Control									
Traffic Control, Labor	2750.400	60.00	day	13,719	-		1,351	-	15,070
Traffic Control, Material	2750.400	60.00	day		4,199			-	4,199
Traffic Control, Setup	2750.400	60.00	day	13,719	-		1,351	-	15,070
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	60.00	day		-	87,442		-	87,442
e061 Traffic Control		*1.00*	*ls*	27,438	4,199	87,442	2,702		121,780
WP100 General		**1.00**	**ls**	185,176	6,788	126,550	65,890	702	385,106
WP150 Demolition									
d201 Demolition									
Clear and Grub Site -Light	2100.250	0.06	ac	474	-	-	103	-	577
Strip Topsoil to Stockpile	2100.250	47.00	cy	33	-	-	68	-	101
Tree Removal	2100.250	25.00	ea	11,433	-	-	1,126	-	12,558
Demo AC Paving	2150.050	18,360.00	sf	14,188	-	-	9,277		23,465
Demo Storm Drain Pipe	2150.100	1,240.00	lf	15,971	-	-	10,442		26,413
Haul Asphalt to Off-Site Disposal	2316.515	227.00	cy	4,081	-	-	5,117	1,745	10,943
Haul Debris to Off-Site Disposal	2316.515	206.00	cy	3,704	-	-	4,644	5,066	13,414
Plug 30" Pipe	2650.250	1.00	ea	915	118	-	87	142	1,261
Saw Cut Asphalt 4" Thick	2750.200	3,060.00	lf	6,604	-	-	844	-	7,448
d201 Demolition		*1,614.00*	*lf*	57,402	118		31,708	6,952	96,180
d206 Allowance for Utility Relocations									
Utility Relocations, Cross St	2650.308	821.00	lf	57,625	21,954	-	18,401	-	97,981
Utility Relocations	2650.308	793.00	lf	6,958	2,651	-	2,222	-	11,830
d206 Allowance for Utility Relocations		*1.00*	*ls*	64,583	24,605		20,623		109,810
d211 Sewer Bypass Pumping Allowance									
Bypass Pumping	2250.050	25.00	day		-	16,713		-	16,713
d211 Sewer Bypass Pumping Allowance		*1.00*	*ls*			16,713			16,713
WP150 Demolition		**1.00**	**ls**	121,985	24,722	16,713	52,331	6,952	222,704
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	1,615.00	ls	2,457	1,243	-	137	-	3,837
e051 Erosion Control		*1.00*	*ls*	2,457	1,243		137		3,837
e201 Storm Drain									
Utility Crossing Material	1850.100	32.00	ea	-	8,557		-	-	8,557

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain									
Import Bedding	2200.100	1,282.00	cy	-	29,996	-	-	34,281	64,278
Trench Box	2200.750	256.00	hr	-	-	-	10,020	-	10,020
Haul Trench Spoils to Off-Site Disposal	2316.515	3,619.00	cy	65,065	-	-	81,587	22,250	168,902
Concrete Box Culvert, 4.5' x 12', Purchase	2650.204	84.00	lf		124,665	-	-	-	124,665
RCP Class IV O-Ring Joint Pipe, 84"	2650.204	1,530.00	lf		869,404	-	-	-	869,404
Concrete Pipe, 84", Specials/Bends, Fab Charge	2650.250	5.00	ea		13,370	-	-	-	13,370
Pipe Crew	21000.275	256.00	hr	300,373	-	-	157,643	-	458,016
e201 Storm Drain		*1,614.00*	*lf*	365,438	1,045,992		249,250	56,532	1,717,211
e203 Dewatering									
Filter Bags	2250.050	47.00	ea	5,072	3,289	-	1,226	-	9,587
In Trench Dewatering	2250.050	256.00	hr	1,727	4,299	-	5,344	-	11,370
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	40.00	ea		1,959	-		-	1,959
Set Well Points, Up to 15', 3" dia., Install	2250.100	108.00	ea	9,424		-	204	-	9,628
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,349	-	4,349
Operate Pumps and Equipment	2250.100	47.00	day	-	12,202	-	12,264	-	24,465
Maintenance of Wellpoint System Pumps	2250.100	47.00	day	64,545	-	-	6,355	-	70,900
e203 Dewatering		*1,614.00*	*lf*	80,766	21,749		29,742		132,258
e206 Manholes									
Box Base Manhole, Purchase	2700.050	10.00	ea		116,322	-		-	116,322
Box Base Manhole, Install	2700.050	10.00	ea	56,151	2,674	-	17,930	-	76,756
e206 Manholes		*10.00*	*ea*	56,151	118,996		17,930		193,078
e211 New Inlets									
New Inlets, Purchase	2700.150	8.00	ea		34,228	-		-	34,228
New Inlets, Install	2700.150	8.00	ea	44,921	2,674	-	14,344	2,139	64,079
e211 New Inlets		*8.00*	*ea*	44,921	36,902		14,344	2,139	98,307
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	150.00	lf	14,038	3,670	2,006	4,483	3,008	27,204
e213 Reconnect Existing Inlets		*15.00*	*ea*	14,038	3,670	2,006	4,483	3,008	27,204
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,337	-	-	1,337
Aggregate Base, 6"	2750.050	2,040.00	sy	-	-	48,175	-	-	48,175
Asphalt Pavement, 4"	2750.050	2,040.00	sy	-	-	96,350	-	-	96,350
Pavement Markings	2750.150	1.00	ls	-	-	4,319	-	-	4,319
e216 Pavement Restoration		*2,040.00*	*sy*			150,181			150,181
e221 Surface Restoration									
Spread Topsoil	2850.250	47.00	cy	220		-	70	-	290
Misc Surface Restoration	2850.250	1.00	ls	-	-	8,632	-	-	8,632
Hydroseeding	2850.250	0.06	acre	-	-	349	-	-	349
e221 Surface Restoration		*1.00*	*ls*	220		8,981	70		9,271
WP200 Civil		**1.00**	**ls**	563,992	1,228,553	161,168	315,956	61,679	2,331,348
WA004 Guild Street		***1.00***	***ls***	871,154	1,260,063	304,431	434,177	69,333	2,939,157

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	871,154		7,655.209 hrs				21.17%	
Material	1,260,063						30.62%	
Subcontract	304,431						7.40%	
Equipment	434,177		3,540.081 hrs				10.55%	
Other	69,333						1.68%	
Subtotal	**2,939,158**	**2,939,158**					**71.43%**	**71.43%**
Scope Contingency	587,831			20.000 %	T		14.29%	
Market Conditions	587,831			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**1,175,662**	**4,114,820**					**28.57%**	**100.00%**
Partial Total		***4,114,820***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA007 Hennessey Field Storage									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	5.50	mon	-	-	68,007	-	-	68,007
Site Supervision	1500.050	24.00	wk	159,746	2,585	-	89,530	1,237	253,098
Surveyor Services	1700.400	1.00	ls	15,848	-	-	2,487	-	18,335
Weekly Cleanup	2150.300	24.00	wk	42,732	-	-	5,518	-	48,250
e041 General Conditions		*1.00*	*ls*	218,326	2,585	68,007	97,534	1,237	387,689
e061 Traffic Control									
Traffic Control, Material	2750.400	110.00	day		7,900			-	7,900
Traffic Control, Setup	2750.400	110.00	day	25,751	-		2,529	-	28,280
e061 Traffic Control		*1.00*	*ls*	25,751	7,900		2,529		36,180
WP100 General		**1.00**	**ls**	244,076	10,486	68,007	100,063	1,237	423,869
WP150 Demolition									
d201 Demolition									
Clear and Grub Site -Medium	2100.250	1.50	ac	9,716	-	-	2,102	309	12,127
Tree Removal	2100.250	300.00	ea	140,458	-	-	13,794	-	154,252
Haul Debris to Off-Site Disposal	2316.515	275.00	cy	5,048	-	-	6,317	6,925	18,291
d201 Demolition		*1.00*	*lf*	155,222			22,214	7,234	184,670
d206 Allowance for Utility Relocations									
Utility Relocations, Sewer	2650.308	800.00	lf	28,744	21,982	-	9,155	-	59,881
d206 Allowance for Utility Relocations		*8.00*	*ls*	28,744	21,982		9,155		59,881
WP150 Demolition		**1.00**	**ls**	183,966	21,982		31,369	7,234	244,551
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	4,600.00	ls	7,166	3,634	-	398	-	11,198
e051 Erosion Control		*1.00*	*ls*	7,166	3,634		398		11,198
e210 Outlet Structure									
Crane Placement	1850.100	1.00	ls	3,243	-		655	-	3,898
Import Bedding	2200.100	8.00	cy	-	192	-	-	220	412
Pre-Cast Concrete Outlet w/ Cover, 10'x10', Purchase	2700.200	1.00	ea		48,086	-		-	48,086
Pre-Cast Concrete Outlet w/ Cover, 10'x10', Install	2700.200	1.00	ea	11,498	275	-	3,662	-	15,434
e210 Outlet Structure		*1.00*	*ls*	14,741	48,553		4,317	220	67,830
e231 Rip Rap									
Purchase Import Bedding	2200.100	445.00	cy	-	9,171	-	-	12,228	21,398
Purchase Rip Rap	2200.100	890.00	cy	-	42,185	-	-	16,874	59,059
Spread, Grade, and Compact Imported Base	2200.250	445.00	cy	3,462	-	-	3,197	-	6,660
Rip Rap Machine Place	2200.550	24,000.00	sf	29,669		-	13,826	-	43,495
Geotextile	99902.750	2,670.00	sy	3,125	8,070	-	307	-	11,502
e231 Rip Rap		*890.00*	*cy*	36,256	59,426		17,331	29,102	142,115
e236 Site Excavation/Backfill									

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e236 Site Excavation/Backfill									
Rough Grade	2200.150	27,040.00	sy	18,369	-	-	14,955	-	33,324
Fine Grade	2200.150	27,040.00	sy	48,241	-	-	13,245	-	61,486
Rock Blasting - Open Area, Allowance	2200.350	6,000.00	cy	-	-	-	-	453,381	453,381
Haul Spoils to Off-Site Disposal	2316.515	53,019.00	cy	567,764	-	-	710,482	333,783	1,612,029
Cut to Fill	21000.225	9,604.00	cy	115,647	-	-	116,041	-	231,687
Excavate, Load for Export	21000.475	53,019.00	cy	309,243	-	-	209,984	-	519,228
e236 Site Excavation/Backfill		*1.00*	*ls*	1,059,264			1,064,707	787,163	2,911,134
e261 Surface Restoration									
Strip Topsoil to Stockpile	2100.250	4,507.00	cy	3,266	-	-	6,617	-	9,882
Gravel Path	2200.100	2,556.00	sy	-		29,769	-	-	29,769
Spread Topsoil	2850.250	4,507.00	cy	21,592		-	6,877	-	28,469
Misc Surface Restoration	2850.250	1.00	ls	-	-	31,599	-	-	31,599
Hydroseeding	2850.250	5.60	acre	-	-	26,811	-	-	26,811
e261 Surface Restoration		*1.00*	*ls*	24,857		88,179	13,494		126,530
e263 Park Recreational Areas									
Landscaping at Recreational Areas	2850.250	4.00	ls	-	-	54,955	-	-	54,955
Site Appurtenances, Benches, Stationary Excersice Equip. 4 Locations, Purchase	2875.150	4.00	ea		229,821	-		-	229,821
Equipment Installation/Setup	2875.150	4.00	ea	45,991	2,873	-	14,133	-	62,996
e263 Park Recreational Areas		*4.00*	*ea*	45,991	232,694	54,955	14,133		347,773
WP200 Civil		**1.00**	**ls**	1,188,275	344,307	143,134	1,114,378	816,485	3,606,580
WA007 Hennessey Field Storage		***1.00***	***ls***	1,616,318	376,774	211,142	1,245,811	824,956	4,275,000

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	1,616,318		13,237.636 hrs				27.01%	
Material	376,774						6.30%	
Subcontract	211,142						3.53%	
Equipment	1,245,811		7,215.508 hrs				20.82%	
Other	824,956						13.78%	
Subtotal	**4,275,001**	**4,275,001**					**71.43%**	**71.43%**
Scope Contingency	855,000			20.000 %	T		14.29%	
Market Conditions	855,000			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**1,710,000**	**5,985,001**					**28.57%**	**100.00%**
Partial Total		***5,985,001***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA008 Murphy Field to Meadow Brook									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	1.50	mon	-	-	17,970	-	-	17,970
Site Supervision	1500.050	6.00	wk	38,858	627	-	21,843	299	61,628
Surveyor Services	1700.400	1.00	ls	6,168	-	-	971	-	7,139
Residents Support	1850.100	10.00	day	4,555	-		449	-	5,004
Potholing	2100.300	12.00	ea	3,266	418		1,950	-	5,634
Weekly Cleanup	2150.300	6.00	wk	10,395	-	-	1,346	-	11,741
e041 General Conditions		*1.00*	*ls*	63,242	1,045	17,970	26,559	299	109,115
e061 Traffic Control									
Traffic Control, Labor	2750.400	10.00	day	2,278	-		224	-	2,502
Traffic Control, Material	2750.400	20.00	day		1,394			-	1,394
Traffic Control, Setup	2750.400	20.00	day	4,555	-		449	-	5,004
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	10.00	day		-	14,509		-	14,509
e061 Traffic Control		*1.00*	*ls*	6,833	1,394	14,509	673		23,409
WP100 General		**1.00**	**ls**	70,075	2,439	32,478	27,232	299	132,524
WP150 Demolition									
d201 Demolition									
Clear and Grub Site -Light	2100.250	0.20	ac	1,576		-	342	-	1,917
Strip Topsoil to Stockpile	2100.250	150.00	cy	106	-	-	215	-	321
Demo AC Paving	2150.050	3,720.00	sf	2,864	-	-	1,873		4,737
Haul Asphalt to Off-Site Disposal	2316.515	46.00	cy	824	-	-	1,034	352	2,210
Haul Debris to Off-Site Disposal	2316.515	12.00	cy	215	-	-	270	294	779
Saw Cut Asphalt 4" Thick	2750.200	620.00	lf	1,333	-	-	171	-	1,503
d201 Demolition		*579.00*	*lf*	6,917			3,904	646	11,467
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	579.00	lf	5,060	1,927	-	1,617	-	8,604
d206 Allowance for Utility Relocations		*1.00*	*ls*	5,060	1,927		1,617		8,604
WP150 Demolition		**1.00**	**ls**	11,977	1,927		5,521	646	20,071
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	580.00	ls	879	445	-	49	-	1,373
e051 Erosion Control		*1.00*	*ls*	879	445		49		1,373
e201 Storm Drain									
Utility Crossing Material	1850.100	12.00	ea	-	3,195		-	-	3,195
Import Bedding	2200.100	456.00	cy	-	10,622	-	-	12,140	22,762
Trench Box	2200.750	80.00	hr	-	-	-	3,120	-	3,120
Haul Trench Spoils to Off-Site Disposal	2316.515	1,281.00	cy	22,952	-	-	28,790	7,845	59,588
Concrete Box Culvert, 5' x 7', Purchase	2650.204	579.00	lf		493,247	-	-	-	493,247
Concrete Box Culvert, 5' x 7', Specials/Bends, Fab Charge	2650.250	2.00	ea		5,324	-	-	-	5,324

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain									
Pipe Crew	21000.275	80.00	hr	93,506	-	-	49,095	-	142,601
e201 Storm Drain		*579.00*	*lf*	116,458	512,387		81,006	19,985	729,836
e203 Dewatering									
Filter Bags	2250.050	12.00	ea	1,290	836	-	312	-	2,438
In Trench Dewatering	2250.050	80.00	hr	537	1,338	-	1,664	-	3,540
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	39.00	ea		1,902	-		-	1,902
Set Well Points, Up to 15', 3" dia., Install	2250.100	39.00	ea	3,390		-	73	-	3,463
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,334	-	4,334
Operate Pumps and Equipment	2250.100	12.00	day	-	3,102	-	3,120	-	6,223
Maintenance of Wellpoint System Pumps	2250.100	12.00	day	16,416	-	-	1,617	-	18,033
e203 Dewatering		*579.00*	*lf*	21,633	7,178		11,121		39,933
e206 Manholes									
Box Base Manhole, Purchase	2700.050	3.00	ea		34,741	-		-	34,741
Box Base Manhole, Install	2700.050	3.00	ea	16,781	799	-	5,361	-	22,940
e206 Manholes		*3.00*	*ea*	16,781	35,540		5,361		57,681
e211 New Inlets									
New Inlets, Purchase	2700.150	4.00	ea		17,038	-		-	17,038
New Inlets, Install	2700.150	4.00	ea	22,374	1,331	-	7,148	1,065	31,918
e211 New Inlets		*4.00*	*ea*	22,374	18,369		7,148	1,065	48,956
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	10.00	lf	699	244	133	223	200	1,499
e213 Reconnect Existing Inlets		*1.00*	*ea*	699	244	133	223	200	1,499
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,331	-	-	1,331
Aggregate Base, 6"	2750.050	414.00	sy	-	-	9,733	-	-	9,733
Asphalt Pavement, 4"	2750.050	414.00	sy	-	-	19,467	-	-	19,467
Pavement Markings	2750.150	1.00	ls	-	-	1,597	-	-	1,597
e216 Pavement Restoration		*414.00*	*sy*			32,128			32,128
e221 Surface Restoration									
Spread Topsoil	2850.250	150.00	cy	699		-	223	-	923
Misc Surface Restoration	2850.250	1.00	ls	-	-	3,088	-	-	3,088
Sod in Place with Soil Prep and Sprinkler Irrigation System	2850.250	8,070.00	sf	-	-	10,742	-	-	10,742
e221 Surface Restoration		*1.00*	*ls*	699		13,830	223		14,753
WP200 Civil		**1.00**	**ls**	179,524	574,163	46,091	105,131	21,249	926,159
WA008 Murphy Field to Meadow Brook		***1.00***	***ls***	261,577	578,528	78,570	137,884	22,195	1,078,754

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	261,577		2,308.566 hrs				17.32%	
Material	578,528						38.31%	
Subcontract	78,570						5.20%	
Equipment	137,884		1,121.266 hrs				9.13%	
Other	22,195						1.47%	
Subtotal	**1,078,754**	**1,078,754**					**71.43%**	**71.43%**
Scope Contingency	215,751			20.000 %	T		14.29%	
Market Conditions	215,751			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**431,502**	**1,510,256**					**28.57%**	**100.00%**
Partial Total		***1,510,256***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA008a Murphy Field to Meadow Brook w/Open Channel									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	1.60	mon	-	-	19,137	-	-	19,137
Site Supervision	1500.050	7.00	wk	45,271	731	-	25,452	349	71,802
Surveyor Services	1700.400	1.00	ls	6,159	-	-	970	-	7,129
Residents Support	1850.100	15.00	day	6,824	-		672	-	7,496
Potholing	2100.300	5.00	ea	1,359	174		812	-	2,344
Weekly Cleanup	2150.300	7.00	wk	12,110	-	-	1,569	-	13,679
e041 General Conditions		*1.00*	*ls*	71,723	904	19,137	29,474	349	121,586
e061 Traffic Control									
Traffic Control, Labor	2750.400	5.00	day	1,137	-		112	-	1,249
Traffic Control, Material	2750.400	35.00	day		2,435			-	2,435
Traffic Control, Setup	2750.400	35.00	day	7,961	-		784	-	8,745
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	5.00	day		-	7,243		-	7,243
e061 Traffic Control		*1.00*	*ls*	9,098	2,435	7,243	896		19,672
WP100 General		**1.00**	**ls**	80,821	3,339	26,379	30,370	349	141,259
WP150 Demolition									
d201 Demolition									
Clear and Grub Site -Light	2100.250	0.15	ac	1,180	-	-	256	-	1,436
Clear and Grub Site -Medium	2100.250	0.27	ac	1,718	-	-	373	54	2,145
Strip Topsoil to Stockpile	2100.250	122.00	cy	86	-	-	175	-	260
Tree Removal	2100.250	60.00	ea	27,295	-	-	2,689	-	29,984
Demo AC Paving	2150.050	900.00	sf	692	-	-	453		1,144
Haul Asphalt to Off-Site Disposal	2316.515	11.00	cy	197	-	-	247	84	528
Haul Debris to Off-Site Disposal	2316.515	64.00	cy	1,145	-	-	1,437	1,566	4,148
Saw Cut Asphalt 4" Thick	2750.200	60.00	lf	129	-	-	16	-	145
d201 Demolition		*579.00*	*lf*	32,441			5,646	1,704	39,791
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	250.00	lf	2,182	831	-	697	-	3,710
d206 Allowance for Utility Relocations		*1.00*	*ls*	2,182	831		697		3,710
WP150 Demolition		**1.00**	**ls**	34,623	831		6,343	1,704	43,501
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	580.00	ls	878	444	-	49	-	1,371
e051 Erosion Control		*1.00*	*ls*	878	444		49		1,371
e201 Storm Drain									
Utility Crossing Material	1850.100	5.00	ea	-	1,329		-	-	1,329
Import Bedding	2200.100	197.00	cy	-	4,581	-	-	5,236	9,817
Trench Box	2200.750	40.00	hr	-	-	-	1,558	-	1,558
Haul Trench Spoils to Off-Site Disposal	2316.515	553.00	cy	9,896	-	-	12,415	3,382	25,693
Concrete Box Culvert, 5' x 7', Purchase	2650.204	250.00	lf		212,628	-	-	-	212,628

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain									
Concrete Box Culvert, 5' x 7', Specials/Bends, Fab Charge	2650.250	1.00	ea		2,658	-	-	-	2,658
Pipe Crew	21000.275	40.00	hr	46,687	-	-	24,517	-	71,204
e201 Storm Drain		*250.00*	*lf*	56,584	221,196		38,490	8,618	324,888
e201a Open Channel									
Import Bedding	2200.100	384.00	cy	-	8,930	-	-	10,206	19,137
Trench Box	2200.750	48.00	hr	-	-	-	1,870	-	1,870
Haul Trench Spoils to Off-Site Disposal	2316.515	384.00	cy	6,872	-	-	8,621	2,348	17,841
Concrete Box Culvert, Open Top, 5' x 12', Purchase	2650.204	361.00	lf		417,376	-	-	-	417,376
Pipe Crew	21000.275	48.00	hr	56,025	-	-	29,420	-	85,445
e201a Open Channel		*361.00*	*lf*	62,897	426,306		39,911	12,555	541,668
e203 Dewatering									
Filter Bags	2250.050	6.00	ea	644	417	-	156	-	1,217
In Trench Dewatering	2250.050	32.00	hr	215	534	-	665	-	1,414
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	17.00	ea		828	-		-	828
Set Well Points, Up to 15', 3" dia., Install	2250.100	17.00	ea	1,476		-	32	-	1,508
Well Point Header Lines	2250.100	250.00	lf	-	-	-	2,164	-	2,164
Operate Pumps and Equipment	2250.100	6.00	day	-	1,549	-	1,558	-	3,107
Maintenance of Wellpoint System Pumps	2250.100	6.00	day	8,197	-	-	808	-	9,004
e203 Dewatering		*250.00*	*lf*	10,531	3,328		5,383		19,242
e206 Manholes									
Box Base Manhole, Purchase	2700.050	2.00	ea		23,123	-		-	23,123
Box Base Manhole, Install	2700.050	2.00	ea	11,172	532	-	3,569	-	15,272
e206 Manholes		*2.00*	*ea*	11,172	23,655		3,569		38,396
e211 New Inlets									
New Inlets, Purchase	2700.150	2.00	ea		8,505	-		-	8,505
New Inlets, Install	2700.150	2.00	ea	11,172	664	-	3,569	532	15,937
e211 New Inlets		*2.00*	*ea*	11,172	9,170		3,569	532	24,442
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	10.00	lf	698	243	133	223	199	1,497
e213 Reconnect Existing Inlets		*1.00*	*ea*	698	243	133	223	199	1,497
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,329	-	-	1,329
Aggregate Base, 6"	2750.050	100.00	sy	-	-	2,347	-	-	2,347
Asphalt Pavement, 4"	2750.050	100.00	sy	-	-	4,694	-	-	4,694
Pavement Markings	2750.150	1.00	ls	-	-	664	-	-	664
e216 Pavement Restoration		*100.00*	*sy*			9,035			9,035
e221 Surface Restoration									
Spread Topsoil	2850.250	122.00	cy	568		-	181	-	749
Misc Surface Restoration	2850.250	1.00	ls	-	-	1,329	-	-	1,329
Sod in Place with Soil Prep and Sprinkler Irrigation System	2850.250	6,600.00	sf	-	-	8,771	-	-	8,771

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e221 Surface Restoration		*1.00*	*ls*	568		10,100	181		10,849
e226 Outfall Concrete									
Concrete Outfall	3075.250	1.00	ls	-	-	42,526	-	-	42,526
e226 Outfall Concrete		*1.00*	*ls*			42,526			42,526
e231 Rip Rap									
Purchase Import Bedding	2200.100	8.00	cy	-	159	-	-	213	372
Purchase Rip Rap	2200.100	20.00	cy	-	917	-	-	367	1,284
Spread, Grade, and Compact Imported Base	2200.250	8.00	cy	60	-	-	56	-	117
Rip Rap Machine Place	2200.550	400.00	sf	480		-	225	-	705
Geotextile	99902.750	45.00	sy	51	132	-	5	-	188
e231 Rip Rap		*20.00*	*cy*	592	1,208		286	579	2,665
e236 Site Excavation/Backfill									
Rough Grade	2200.150	1,445.00	sy	1,369	-	-	1,118	-	2,486
Fine Grade	2200.150	1,445.00	sy	3,594	-	-	990	-	4,584
Excavation, Load for Export	2200.200	500.00	cy	3,530	-	-	4,349	-	7,879
Backfill from On-Site Stockpile	2200.250	50.00	cy	938	-	-	518	-	1,455
Haul Trench Spoils to Off-Site Disposal	2316.515	450.00	cy	8,053	-	-	10,102	2,752	20,907
e236 Site Excavation/Backfill		*1.00*	*ls*	17,484			17,077	2,752	37,313
e241 Open Channel Surface Restoration									
Strip Topsoil to Stockpile	2100.250	167.00	cy	118	-	-	239	-	357
Spread Topsoil	2850.250	167.00	cy	777		-	248	-	1,026
Hydroseeding	2850.250	0.21	acre	-	-	1,823	-	-	1,823
Turf Reinforcement	99902.750	1,000.00	sy	4,549	19,004	-	448	-	24,001
e241 Open Channel Surface Restoration		*1.00*	*ls*	5,444	19,004	1,823	936		27,207
WP200 Civil		**1.00**	**ls**	178,018	704,553	63,617	109,674	25,235	1,081,098
WA008a Murphy Field to Meadow Brook w/Open Channel		***1.00***	***ls***	293,463	708,723	89,996	146,387	27,288	1,265,857

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	293,463		2,574.124 hrs				16.56%	
Material	708,723						39.99%	
Subcontract	89,996						5.08%	
Equipment	146,387		1,144.075 hrs				8.26%	
Other	27,288						1.54%	
Subtotal	**1,265,857**	**1,265,857**					**71.43%**	**71.43%**
Scope Contingency	253,171			20.000 %	T		14.29%	
Market Conditions	253,171			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**506,342**	**1,772,199**					**28.57%**	**100.00%**
Partial Total		***1,772,199***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA009 Meadow Brook									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	2.00	mon	-	-	24,459	-	-	24,459
Site Supervision	1500.050	9.00	wk	59,336	959	-	33,289	459	94,043
Surveyor Services	1700.400	1.00	ls	9,418	-	-	1,480	-	10,898
Weekly Cleanup	2150.300	9.00	wk	15,872	-	-	2,052	-	17,924
e041 General Conditions		*1.00*	*ls*	84,627	959	24,459	36,820	459	147,324
e061 Traffic Control									
Traffic Control, Material	2750.400	45.00	day		3,198			-	3,198
Traffic Control, Setup	2750.400	45.00	day	10,434	-		1,026	-	11,460
e061 Traffic Control		*1.00*	*ls*	10,434	3,198		1,026		14,658
WP100 General		**1.00**	**ls**	95,061	4,157	24,459	37,846	459	161,982
WP150 Demolition									
d201 Demolition									
Clear and Grub Site -Medium	2100.250	1.20	ac	7,699	-	-	1,668	245	9,611
Tree Removal	2100.250	240.00	ea	111,299	-	-	10,942	-	122,241
Haul Debris to Off-Site Disposal	2316.515	220.00	cy	4,005	-	-	5,015	5,487	14,507
d201 Demolition		*1,000.00*	*lf*	123,002			17,625	5,732	146,359
WP150 Demolition		**1.00**	**ls**	123,002			17,625	5,732	146,359
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	2,000.00	ls	3,086	1,563	-	172	-	4,821
e051 Erosion Control		*1.00*	*ls*	3,086	1,563		172		4,821
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	13,588	-	-	13,588
e221 Surface Restoration		*1.00*	*ls*			13,588			13,588
e231 Rip Rap									
Purchase Import Bedding	2200.100	862.00	cy	-	17,570	-	-	23,426	40,996
Purchase Rip Rap	2200.100	1,770.00	cy	-	82,977	-	-	33,191	116,168
Spread, Grade, and Compact Imported Base	2200.250	862.00	cy	6,643	-	-	6,141	-	12,784
Rip Rap Machine Place	2200.550	46,500.00	sf	56,938		-	26,562	-	83,500
Geotextile	99902.750	5,450.00	sy	6,319	17,042	-	621	-	23,981
e231 Rip Rap		*1,770.00*	*cy*	69,899	117,589		33,324	56,617	277,429
e236 Site Excavation/Backfill									
Rough Grade	2200.150	5,170.00	sy	4,992	-	-	4,068	-	9,060
Fine Grade	2200.150	5,170.00	sy	13,110	-	-	3,603	-	16,713
Excavation, Load for Export	2200.200	1,850.00	cy	13,315	-	-	16,370	-	29,685
Backfill from On-Site Stockpile	2200.250	250.00	cy	4,781	-	-	2,632	-	7,413
Haul Trench Spoils to Off-Site Disposal	2316.515	1,600.00	cy	29,125	-	-	36,476	9,977	75,577
e236 Site Excavation/Backfill		*1.00*	*ls*	65,323			63,149	9,977	138,449

Spreadsheet Level	Phase	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WP200 Civil		**1.00 ls**	138,308	119,152	13,588	96,645	66,594	434,287
WA009 Meadow Brook		***1.00 ls***	356,371	123,309	38,047	152,116	72,784	742,628

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	356,371		3,046.344 hrs				34.28%	
Material	123,309						11.86%	
Subcontract	38,047						3.66%	
Equipment	152,116		1,684.880 hrs				14.63%	
Other	72,784						7.00%	
Subtotal	**742,627**	**742,627**					**71.43%**	**71.43%**
Scope Contingency	148,526			20.000 %	T		14.29%	
Market Conditions	148,526			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**297,052**	**1,039,679**					**28.57%**	**100.00%**
Partial Total		***1,039,679***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA010 Jacobsen Alternative 1									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	5.00	mon	-	-	59,974	-	-	59,974
Site Supervision	1500.050	22.00	wk	142,633	2,302	-	80,169	1,100	226,203
Surveyor Services	1700.400	1.00	ls	9,262	-	-	1,458	-	10,720
Residents Support	1850.100	100.00	day	45,604	-		4,492	-	50,096
Potholing	2100.300	60.00	ea	16,346	2,093		9,761	-	28,200
Weekly Cleanup	2150.300	22.00	wk	38,154	-	-	4,941	-	43,095
e041 General Conditions		*1.00*	*ls*	252,000	4,395	59,974	100,819	1,100	418,287
e061 Traffic Control									
Traffic Control, Labor	2750.400	100.00	day	22,802	-		2,246	-	25,048
Traffic Control, Material	2750.400	100.00	day		6,976			-	6,976
Traffic Control, Setup	2750.400	100.00	day	22,802	-		2,246	-	25,048
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	100.00	day		-	145,270		-	145,270
e061 Traffic Control		*1.00*	*ls*	45,604	6,976	145,270	4,492		202,342
WP100 General		**1.00**	**ls**	297,604	11,371	205,243	105,311	1,100	620,629
WP150 Demolition									
d201 Demolition									
Demo AC Paving	2150.050	36,276.00	sf	27,956	-	-	18,284		46,240
Demo Storm Drain Pipe	2150.100	3,023.00	lf	38,827	-	-	25,394		64,222
Haul Asphalt to Off-Site Disposal	2316.515	450.00	cy	8,071	-	-	10,122	3,449	21,642
Haul Debris to Off-Site Disposal	2316.515	200.00	cy	3,587	-	-	4,499	4,905	12,991
Saw Cut Asphalt 4" Thick	2750.200	6,046.00	lf	13,012	-	-	1,664	-	14,676
d201 Demolition		*3,023.00*	*lf*	91,453			59,964	8,353	159,770
d206 Allowance for Utility Relocations									
Utility Relocations, Reroute Sewer	2650.308	3,023.00	lf	211,596	80,578	-	67,588	-	359,761
d206 Allowance for Utility Relocations		*1.00*	*ls*	211,596	80,578		67,588		359,761
d211 Sewer Bypass Pumping Allowance									
Bypass Pumping	2250.050	55.00	day		-	36,651		-	36,651
d211 Sewer Bypass Pumping Allowance		*1.00*	*ls*			36,651			36,651
WP150 Demolition		**1.00**	**ls**	303,048	80,578	36,651	127,551	8,353	556,182
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	3,023.00	ls	4,587	2,320	-	255	-	7,162
e051 Erosion Control		*1.00*	*ls*	4,587	2,320		255		7,162
e201 Storm Drain									
Utility Crossing Material	1850.100	60.00	ea	-	15,993		-	-	15,993
Import Bedding	2200.100	1,644.00	cy	-	38,343	-	-	43,821	82,164
Trench Box	2200.750	432.00	hr	-	-	-	16,867	-	16,867
Haul Trench Spoils to Off-Site Disposal	2316.515	3,642.00	cy	65,318	-	-	81,924	22,329	169,571

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain									
Concrete Box Culvert, 3' x 7', Purchase	2650.204	3,023.00	lf		2,215,896	-	-	-	2,215,896
Concrete Box Culvert, 3' x 7', Specials/Bends, Fab Charge	2650.250	6.00	ea		15,993	-	-	-	15,993
Pipe Crew	21000.275	432.00	hr	505,477	-	-	265,368	-	770,846
e201 Storm Drain		*3,023.00*	*lf*	570,795	2,286,226		364,159	66,150	3,287,330
e203 Dewatering									
Filter Bags	2250.050	124.00	ea	13,343	8,651	-	3,228	-	25,221
In Trench Dewatering	2250.050	432.00	hr	2,905	7,233	-	8,996	-	19,134
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	40.00	ea		1,953	-		-	1,953
Set Well Points, Up to 15', 3" dia., Install	2250.100	202.00	ea	17,577		-	380	-	17,958
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,338	-	4,338
Operate Pumps and Equipment	2250.100	124.00	day	-	32,094	-	32,276	-	64,369
Maintenance of Wellpoint System Pumps	2250.100	124.00	day	169,817	-	-	16,726	-	186,543
e203 Dewatering		*3,023.00*	*lf*	203,643	49,930		65,943		319,516
e206 Manholes									
Box Base Manhole, Purchase	2700.050	14.00	ea		162,329	-		-	162,329
Box Base Manhole, Install	2700.050	14.00	ea	78,395	3,732	-	25,041	-	107,167
e206 Manholes		*14.00*	*ea*	78,395	166,061		25,041		269,496
e211 New Inlets									
New Inlets, Purchase	2700.150	12.00	ea		51,178	-		-	51,178
New Inlets, Install	2700.150	12.00	ea	67,195	3,998	-	21,464	3,199	95,856
e211 New Inlets		*12.00*	*ea*	67,195	55,176		21,464	3,199	147,033
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	200.00	lf	13,999	4,878	2,665	4,472	3,998	30,012
e213 Reconnect Existing Inlets		*20.00*	*ea*	13,999	4,878	2,665	4,472	3,998	30,012
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,333	-	-	1,333
Aggregate Base, 6"	2750.050	4,031.00	sy	-	-	94,888	-	-	94,888
Asphalt Pavement, 4"	2750.050	4,031.00	sy	-	-	189,777	-	-	189,777
Pavement Markings	2750.150	1.00	ls	-	-	8,130	-	-	8,130
e216 Pavement Restoration		*4,031.00*	*sy*			294,128			294,128
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	16,164	-	-	16,164
e221 Surface Restoration		*1.00*	*ls*			16,164			16,164
WP200 Civil		**1.00**	**ls**	938,614	2,564,590	312,957	481,333	73,347	4,370,842
WA010 Jacobsen Alternative 1		***1.00***	***ls***	1,539,266	2,656,539	554,851	714,196	82,800	5,547,652

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	1,539,266		13,571.793 hrs				19.82%	
Material	2,656,539						34.20%	
Subcontract	554,851						7.14%	
Equipment	714,196		6,269.621 hrs				9.20%	
Other	82,800						1.07%	
Subtotal	**5,547,652**	**5,547,652**					**71.43%**	**71.43%**
Scope Contingency	1,109,530			20.000 %	T		14.29%	
Market Conditions	1,109,530			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**2,219,060**	**7,766,712**					**28.57%**	**100.00%**
Partial Total		***7,766,712***						

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
WA011 Jacobsen Alternative 2									
WP100 General									
e041 General Conditions									
Site Facilities	1400.200	3.25	mon	-	-	39,244	-	-	39,244
Site Supervision	1500.050	14.00	wk	91,292	1,474	-	51,279	704	144,750
Surveyor Services	1700.400	1.00	ls	6,210	-	-	977	-	7,187
Residents Support	1850.100	50.00	day	22,934	-		2,257	-	25,191
Potholing	2100.300	40.00	ea	10,960	1,404		6,541	-	18,905
Weekly Cleanup	2150.300	14.00	wk	24,421	-	-	3,160	-	27,581
e041 General Conditions		*1.00*	*ls*	155,817	2,879	39,244	64,214	704	262,859
e061 Traffic Control									
Traffic Control, Labor	2750.400	60.00	day	13,760	-		1,354	-	15,115
Traffic Control, Material	2750.400	70.00	day		4,915			-	4,915
Traffic Control, Setup	2750.400	70.00	day	16,054	-		1,580	-	17,634
Traffic Control, Police Patrol, 2 Each, $720/day Each	2750.400	60.00	day		-	87,746		-	87,746
e061 Traffic Control		*1.00*	*ls*	29,814	4,915	87,746	2,935		125,410
WP100 General		**1.00**	**ls**	185,632	7,793	126,991	67,149	704	388,269
WP150 Demolition									
d201 Demolition									
Demo AC Paving	2150.050	19,930.00	sf	15,448	-	-	10,097		25,545
Demo Storm Drain Pipe	2150.100	1,993.00	lf	25,746	-	-	16,828		42,574
Haul Asphalt to Off-Site Disposal	2316.515	250.00	cy	4,507	-	-	5,650	1,927	12,083
Haul Debris to Off-Site Disposal	2316.515	130.00	cy	2,343	-	-	2,938	3,207	8,488
Plug 15" Pipe	2650.250	1.00	ea	917	34	-	87	40	1,078
Saw Cut Asphalt 4" Thick	2750.200	3,986.00	lf	8,628	-	-	1,103	-	9,731
d201 Demolition		*1,993.00*	*lf*	57,590	34		36,702	5,174	99,499
d206 Allowance for Utility Relocations									
Utility Relocations	2650.308	1,713.00	lf	15,074	5,746	-	4,812	-	25,632
Utility Relocations, Reroute Sewer	2650.308	280.00	lf	19,712	7,513	-	6,292	-	33,518
d206 Allowance for Utility Relocations		*1.00*	*ls*	34,787	13,259		11,104		59,150
d211 Sewer Bypass Pumping Allowance									
Bypass Pumping	2250.050	5.00	day		-	3,354		-	3,354
d211 Sewer Bypass Pumping Allowance		*1.00*	*ls*			3,354			3,354
WP150 Demolition		**1.00**	**ls**	92,376	13,293	3,354	47,807	5,174	162,004
WP200 Civil									
e051 Erosion Control									
Erosion Control Allowance	2200.700	1,993.00	ls	3,042	1,539	-	169	-	4,750
e051 Erosion Control		*1.00*	*ls*	3,042	1,539		169		4,750
e201 Storm Drain									
Utility Crossing Material	1850.100	40.00	ea	-	10,733		-	-	10,733
Import Bedding	2200.100	1,084.00	cy	-	25,452	-	-	29,088	54,540

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e201 Storm Drain									
Trench Box	2200.750	288.00	hr	-	-	-	11,302	-	11,302
Haul Trench Spoils to Off-Site Disposal	2316.515	2,533.00	cy	45,661	-	-	57,241	15,620	118,523
Concrete Pipe, 60", Purchase	2650.204	1,993.00	lf		715,958	-	-	-	715,958
Concrete Pipe, 60", Specials/Bends, Fab Charge	2650.250	6.00	ea		9,660	-	-	-	9,660
Pipe Crew	21000.275	288.00	hr	338,936	-	-	177,823	-	516,759
e201 Storm Drain		*1,993.00*	*lf*	384,597	761,803		246,367	44,708	1,437,475
e203 Dewatering									
Filter Bags	2250.050	75.00	ea	8,117	5,266	-	1,962	-	15,345
In Trench Dewatering	2250.050	288.00	hr	1,948	4,853	-	6,028	-	12,829
Set Well Points, Up to 15', 3" dia., Purchase	2250.100	40.00	ea		1,966	-		-	1,966
Set Well Points, Up to 15', 3" dia., Install	2250.100	133.00	ea	11,640		-	252	-	11,892
Well Point Header Lines	2250.100	500.00	lf	-	-	-	4,360	-	4,360
Operate Pumps and Equipment	2250.100	75.00	day	-	19,536	-	19,622	-	39,158
Maintenance of Wellpoint System Pumps	2250.100	75.00	day	103,306	-	-	10,168	-	113,475
e203 Dewatering		*1,993.00*	*lf*	125,012	31,620		42,393		199,025
e206 Manholes									
Pre-Cast Concrete Manhole, 6' Dia., Purchase	2700.050	10.00	ea		49,642	-		-	49,642
Pre-Cast Concrete Manhole, 6' Dia., Install	2700.050	10.00	ea	28,160	2,013	-	8,989	-	39,162
e206 Manholes		*10.00*	*ea*	28,160	51,655		8,989		88,804
e211 New Inlets									
New Inlets, Purchase	2700.150	5.00	ea		21,467	-		-	21,467
New Inlets, Install	2700.150	5.00	ea	28,160	1,677	-	8,989	1,342	40,168
e211 New Inlets		*5.00*	*ea*	28,160	23,144		8,989	1,342	61,635
e213 Reconnect Existing Inlets									
Reconnect Existing Inlets	2650.203	150.00	lf	10,560	3,683	2,013	3,371	3,019	22,645
e213 Reconnect Existing Inlets		*15.00*	*ea*	10,560	3,683	2,013	3,371	3,019	22,645
e216 Pavement Restoration									
AC Paving, Mob	2750.050	1.00	ls	-	-	1,342	-	-	1,342
Aggregate Base, 6"	2750.050	2,215.00	sy	-	-	52,490	-	-	52,490
Asphalt Pavement, 4"	2750.050	2,215.00	sy	-	-	104,980	-	-	104,980
Pavement Markings	2750.150	1.00	ls	-	-	13,417	-	-	13,417
e216 Pavement Restoration		*2,215.00*	*sy*			172,229			172,229
e221 Surface Restoration									
Misc Surface Restoration	2850.250	1.00	ls	-	-	2,683	-	-	2,683
e221 Surface Restoration		*1.00*	*ls*			2,683			2,683
e226 Outfall Concrete									
Fine Grade SOG	2200.150	104.00	sf	57	-	-		-	57
Rip Rap Machine Place	2200.550	200.00	sf	2,133	1,610	-	681	-	4,424
Outfall Steel Grate	2650.250	1.00	ea	2,816	10,733	-	899	-	14,448
6' Chain Link Fence	2800.150	30.00	lf	-	-	1,409	-	-	1,409
Misc Surface Restoration	2850.250	1.00	ls	-	-	1,610	-	-	1,610
Form Slab-on-Grade Perimeter Edge	3100.150	76.00	sf	980	427	-	238	-	1,645

Spreadsheet Level	Phase	Takeoff Quantity		Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
e226 Outfall Concrete									
Construct Job-Built 3/4", 7-Ply Sanded Plyform Wall Forms 4-8'	3100.250	352.00	sf	4,768	1,977	-	627	-	7,372
Strip & Oil Wall Forms	3100.650	367.00	sf	397	10	-	29	-	437
Strip & Oil Slab Edge Forms	3100.650	76.00	sf	82	2	-	6	-	90
Install Edge Chamfer 1"	3100.800	58.00	lf	111	16	-	138	-	266
Construct Box Out Forms, Door Drops and Windows	3100.850	15.00	sf	484	5	-	59	-	548
Purchase Form Ties, Coil Tie, 12"x1/2", w/ Connecting Rods and Bolts	3100.950	30.00	ea	-	135	-	-	-	135
Install Rebar, Slab-On-Grade (Low Production)	3200.150	0.25	tn	294		-	55	-	348
Purchase Rebar, Slab-On-Grade	3200.150	0.25	tn	-	570	-	-	-	570
Install Rebar, Walls, Straight (Low Production)	3200.250	0.44	tn	640		-	101	-	742
Purchase Rebar, Walls, Straight	3200.250	0.44	tn	-	992	-	-	-	992
Place Rebar/Mesh Support - Bricks	3200.750	30.00	ea	8	10	-	3	-	21
Purchase Ready-Mix Concrete (Pump Mix) - 4,500 psi	3300.050	3.90	cy	-	942	-	-	-	942
Purchase Ready-Mix Concrete (Pump Mix) - 4,500 psi	3300.050	4.90	cy	-	1,183	-	-	-	1,183
Purchase Ready-Mix Concrete (Pump Mix) - 4,500 psi (Waste)	3300.100	0.30	cy	-	72	-	-	-	72
Purchase Ready-Mix Concrete (Pump Mix) - 4,500 psi (Waste)	3300.100	0.30	cy	-	72	-	-	-	72
Pump-Place Concrete, Slab-On-Grade (Low Production)	3300.250	3.90	cy	233	-	-	39	73	346
Trowel Top Surface, Slab-On-Grade	3300.250	104.00	sf	315	-	-	14	-	329
Pump-Place Concrete, Walls (Low Production)	3300.350	4.90	cy	294	-	-	40	92	427
Trowel Top Surface, Walls	3300.350	23.00	sf	276	-	-	3	-	279
Grind Fins and Patch Voids @ Formed Surfaces, Walls	3300.350	367.00	sf	638	26	-		-	664
Sandblast Horizontal Joints Before Placing Walls	3400.025	23.00	sf	90	8	-		-	98
Cure Concrete with Spray-On Liquid Curing Compounds	3400.400	104.00	sf	45	5	-	4	-	54
Cure Concrete with Spray-On Liquid Curing Compounds	3400.400	367.00	sf	159	18	-	15	-	192
Finisher (Concrete)	20050.050	12.00	hr	1,726	-	-	-	-	1,726
Pipe Crew	21000.275	4.00	hr	4,707	-	-	2,470	-	7,177
e226 Outfall Concrete		*1.00*	*ls*	21,254	18,816	3,019	5,423	165	48,676
WP200 Civil		**1.00**	**ls**	600,784	892,260	179,943	315,701	49,234	2,037,922
WA011 Jacobsen Alternative 2		***1.00***	***ls***	878,792	913,346	310,288	430,656	55,112	2,588,195

Partial Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	878,792		7,722.231 hrs				24.25%	
Material	913,346						25.21%	
Subcontract	310,288						8.56%	
Equipment	430,656		3,638.210 hrs				11.89%	
Other	55,112						1.52%	
Subtotal	**2,588,194**	**2,588,194**					**71.43%**	**71.43%**
Scope Contingency	517,639			20.000 %	T		14.29%	
Market Conditions	517,639			20.000 %	T		14.29%	
Escalation					C			
Subtotal	**1,035,278**	**3,623,472**					**28.57%**	**100.00%**
Partial Total		***3,623,472***						

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