Town of West Hartford, Connecticut

Drainage System Evaluations in the Trout Brook Watershed

FINAL REPORT

Phase 2

Area 4: North Main Street

Area 5: St. Joseph's Tributary

Area 6: East Branch Trout Brook at Asylum Avenue

WEST HARTFORD

1854

September 2021

CDM Smith

Table of Contents

List of Figures

List of Tables

Appendices

Section 1
Introduction

The Town of West Hartford (Town) identified six sub-watersheds tributary to Trout Brook (**Figure 1-1**) that were evaluated with respect to flooding and drainage system capacity in a two-phased project. The first phase of this project included Areas 1, 2, and 3, and was completed June 2020. This study includes the watersheds within Phase 2: Areas 4, 5, and 6. CDM Smith performed an assessment of the existing storm drainage system to identify existing drainage system deficiencies, provide alternatives to improve the drainage system, and provide recommended improvements to mitigate flooding within the project area.

1.1 Phase 2 Project Area

The original focus of the analysis as part of the Phase 1 study was the flood prone areas located within Area 1, between Frederick Road (south), Elizabeth Park (east), Asylum Avenue (north), and Trout Brook Drive (west). Phase 1 was expanded to include Area 2 directly south (Fern Street and Milton Street) and Area 3 to the west that is bound by Clifford Drive (north), Linwold Drive (west), and Loomis Drive (south). After the Phase 1 study was completed, the Town initiated the study of Phase 2 that includes areas to the north and west of Phase 1 as shown in **Figure 1-1**. The Phase 2 project area is divided into three study areas: Area 4 – North Main Street Area, Area 5 – St. Joseph's Tributary Area, and Area 6 – East Branch Trout Brook at Asylum Avenue Area.

During heavy rainstorms, streets in the Town experience flooding that impacts the residents, businesses, and visitors, including periodically requiring the Town to close sections of roads. The Town Engineering Division receives notifications from residents, public works staff, and fire department staff on flooding locations and the severity of the impact. The Town engineers performed field visits during rainstorms and summarized the reports for CDM Smith to utilize in the drainage system evaluation. A summary of the reported flooding locations are shown on **Figures 1-2, 1-3,** and **1-4**. This information was used to validate the model performance of the drainage system.

On June 6, 2019 and October 21, 2020, the Town and CDM Smith held public meetings to provide information on the drainage system evaluation to keep stakeholders informed on the project status. The presentations emphasized that the solutions to address drainage problems will have three key participants: Town, Metropolitan District Commission (MDC), and property owners. The Town owns the public storm drainage system and is responsible for maintaining the drainage system to limit the extent and duration of street flooding caused by storm events. The MDC owns the sanitary sewer system and is responsible for maintenance of the sewer system and abating sanitary sewer overflows (SSOs). Individual property owners are responsible for private sewer service laterals and stormwater management on their property.

Phase 2

Area #5
St. Joseph's Tributary
211 Acres

Phase 2

Area #6
East Branch Trout Brook
at Asylum Ave
183 Acres

Phase 2

Area #4
North Main Street
246 Acres

Phase 1

Area #1
FEAT Area
287 Acres

Phase 1

Area #3
East Branch and
Trout Confluence
174 Acres

Phase 1

Area #2 Milton Street and
Fern Street
195 Acres

Legend

Study Areas

- Area 1
- Area 2
- Area 3

Phase 1

- Area 4
- Area 5
- Area 6

Phase 2

- Buildings
- Water Bodies
- Vegetation

N

1"=1,000'

0 500 1,000 Feet

West Hartford, CT
West Hartford Phase 2 Drainage Study
Study Area Overview
Figure 1-1

CDM Smith

Pioneer Dr
Harvest Ln
Brenway Dr
Mountain View Dr
Blue Ridge Ln
Lawler Rd
Westmoreland Dr
Lincoln Ave
Brighton Rd
Sunny Slope Dr
Shady Ln
Asylum Ave
Hatheway Dr
Hathaway Dr
High Point Ln
Craigmoor Rd
Ranger Ln
Hickory Ln
Duffield Dr
Clifford Dr
Clifford Ln
Fulton Pl
Porter Dr
Brookside Pl
Brookside Blvd
Hammick Rd
Fox Meadow Ln
Montclair Dr
Brookfield Rd
North Main St
Brookside Dr
Fox Chase Ln
Banbury Ln
OF-3836-4
OF-3836-5
OF-3836-3
OF-3231-1
Linbrook Rd
Linnard Rd
Timrod Rd
Timrod Ln
Flagstad Rd
Wyndwood Rd
Middlefield Dr
Brookline Dr
Trout Brook Dr
Ballard Dr
Cliffmore Rd
American School For The Deaf
Main St
Linwold Dr
Hilltop Dr
Trout Brook
East Normandy Dr Dr
Rustic Ln
Maxwell East Maxwell Dr Dr
Fern St
Keeney Ave
Hawthorne Rd
Fernbel Ln
Fernridge Rd
Cobbs Rd
Clifton Ave
Brunswick Ave
Arundel Ave
Sylvan Ave
Warwick St
Loomis Dr
Milton St
Arnold Way
Robin Rd
Fernbrook
Whitman Ave
Argyle Ave
Walden St
Grennan Rd
Arlington Rd
Farmington Ave
Brace Rd
Pleasant St
Stanley St
Dale St
Wells Rd
Staples Pl
Four Mile Rd
Woodrow St
Lasalle Rd
Isham Rd
New St
Raymond Rd
Memorial Rd
Arapahoe Rd

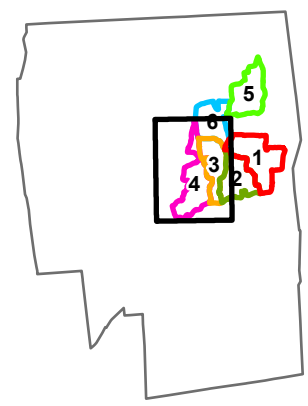
Legend

- Study Area 4
- Outfalls
- Storm Manhole
- Catch Basin
- Storm Drain
- April 2018 Flooding
- August 2019 Flooding

N

1"=600'

0 300 600 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 4 Flooding
Figure 1-2

CDM Smith

Lyman Rd
Seminole Cir
Mohawk Dr
Mohegan Dr
Stoneham Dr
Iroquois Rd
Brewster Rd
Grenhart St
Pontiac Rd
Seneca Rd
Miamis Rd
Sequin Rd
Brainard Rd
Pilgrim Rd
Colony Rd
Norwood Rd
Westwood Rd
North Steele Rd
Ledyard Rd
Albany Ave
Sioux Ln
Vandervere Rd
Nursery Dr
Sherwood Rd
Haynes Rd
Wiltshire Ln
Lawler Rd
OF-3141-3
OF-3141-4
US Hwy 44
Steele Rd
Driveway
Stratford Rd
Whetton Rd
Whetten Rd

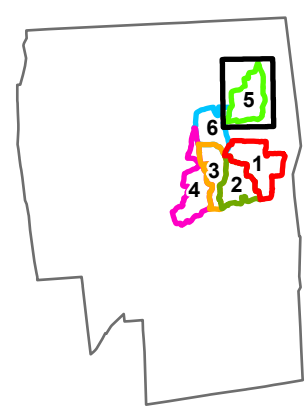
Legend

- Study Area 5
- Outfalls
- Storm Manhole
- Catch Basin
- Storm Drain
- August 2019 Flooding

N

1"=400'

0 200 400 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 5 Flooding
Figure 1-3

CDM Smith

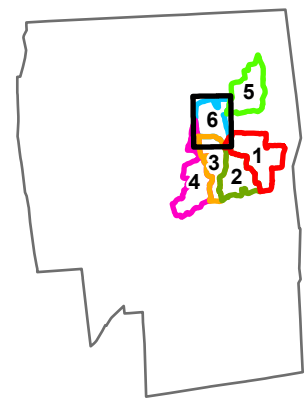
Legend

- Study Area 6
- Outfalls
- Storm Manhole
- Catch Basin
- Storm Drain
- April 2018 Flooding
- September 2011 Flooding
- September 2018 Flooding
- August 2019 Flooding

N

1"= 300'

0 300 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 6 Flooding
Figure 1-4

CDM Smith

This report provides recommendations for improvements to the storm drainage system in the Phase 2 study area to decrease the intensity and frequency of street flooding. The recommendations are prioritized and suitable for inclusion in the Town's capital improvement program planning.

1.2 Purpose and Scope

The purpose of this study is to assess the existing storm drainage system and develop solutions to lessen street flooding. The first task in the project was to collect, review, and analyze existing data which was performed through discussions with the Town, evaluation of existing data, and a desktop analysis. In order to supplement this information, CDM Smith contracted with a surveyor to confirm connectivity of the drainage system and obtain rim and invert elevations on key manholes and structures within the project area.

The data collected in the first task was used to develop a model of the existing storm drainage system. The model was developed to represent existing conditions and alternative scenarios for reducing street flooding. Alternatives to improve the existing storm drainage system were developed for those systems with system capacity deficiencies within each of the three project areas. The drainage solutions were designed to minimize street flooding during a 10-year storm. The 10-year storm is the industry standard design storm for drainage systems in each of the three project areas. Within West Hartford, the 10-year design storm is a storm resulting in 5.1 inches of rainfall in a 24-hour period. This storm has a 10 percent chance of occurring in any given year and would potentially occur once every 10 years.

1.3 System Description

The project study area is approximately 716 acres in a densely populated section of West Hartford, which is primarily residential properties with commercial buildings on the arterial roads. The Phase 2 drainage study area is approximately 5 percent of the total land area in the Town. A summary of the project areas existing drainage system is presented in **Table 1-1**.

Table 1-1: Existing Drainage System Statistics

Area Name	Area (acres)	Number of Properties	Pipe Length (ft)	Pipe Size Range (in)	Drainage Systems
4 – North Main Street	246	736	32,000	10 – 60	4
5 – St. Joseph's Tributary	183	386	23,000	10 – 48	1
6 – East Branch Trout Brook at Asylum Avenue	287	391	18,000	10 - 60	10
Total	**716**	**1,513**	**73,000**		**15**

The existing Geographic Information System (GIS) data used for this report is the version that was available in the fall of 2020.

1.4 MDC Sanitary Sewer System

During a storm event, the flow in the Town-wide sanitary sewer system in West Hartford can increase from an average dry weather flow of 2.3 million gallons per day (mgd) to a peak flow of 65 mgd (based on the MDC's permanent flow meter data). For the sewershed in the Phase 2 study area, the average dry weather flow is about 0.2 mgd and can peak to as high as 6.5 mgd during

heavy rain events. This increased flow is comprised of stormwater and groundwater, with the majority of this increase in flow from stormwater. The MDC is working to remove this extraneous flow from the sanitary sewer system to abate SSOs. SSO abatement is required by a Consent and Decree with the United States Environmental Protection Agency (EPA) and has benefits for human health and the environment.

Stormwater and groundwater currently conveyed through the sanitary sewer system is primarily from private property connections (such as foundation drains, sump pumps, roof leaders, and yard drains) and will need to be transferred to an existing or new Town storm drainage system, the street, or watercourse. The MDC sewer ordinance (S2l) specifies that sanitary sewers shall be used only for conveyance and disposal of sanitary sewage; flow from stormwater, surface water, and subsoil drainage are not allowed into the MDC sanitary sewer system.

Section 2

Model Development and Calibration

2.1 Approach

The drainage system model was developed using the EPA Stormwater Management Model (SWMM). The model was calibrated based on temporary flow metering data from five meters deployed in fall 2019 in Area 1 and validated against reported street flooding during historical events in 2011, 2018, and 2019. The calibrated model represents the drainage system's responses to storm events and was used to assess the flooding during historical storm events and during a 10-year, 24-hour National Resources Conservation Service (NRCS) Type III design storm. A full summary of the development and calibration of a hydrologic and hydraulic model of the drainage system in the study area is provided in CDM Smith's Phase 1 Report dated June 8, 2020.

2.2 Model Development

The West Hartford drainage system model of Areas 4, 5, and 6 consists of 15 drainage systems, 18 outfalls, 213 structures (manholes, junction chambers and catch basins), and 231 pipes. The drain model dynamically simulates rainfall-runoff, groundwater infiltration, evaporation, snow accumulation and melting, and groundwater inflow into drains from pipe defects and sump pumps. Contributing areas to each outfall were subdivided into individual sub-catchments based on topography and the Town's drainage network. Drain pipe configuration was derived from the Town's GIS and supplemented with survey. Data sources used in the model development can be found in the Phase 1 Report.

2.2.1 2019 Flow Metering Program

During fall 2019, CDM Smith deployed five area-velocity flow meters in Area 1. The meter program was implemented because initial model runs did not show good agreement with observed flooding during historical events in Area 1, which was noted as a high-priority area within the Town for existing flooding. Once calibrated, the hydrologic parameters identified during calibration were transferred to the unmetered areas in Areas 4, 5, and 6. Further detail regarding the meter locations, velocity, flow, and depths is provided in the Phase 1 report.

2.2.2 Groundwater Contributions

High groundwater within the West Hartford study area can have a significant impact on flooding with groundwater entering through defects in the pipes or through foundation drain connections from building basements. Currently, many foundation drains are connected to the sanitary sewer system. However, the MDC is working with the Town to disconnect foundation drains from the sanitary sewer and redirect them to the Town's existing or new drainage system. To represent the potential impact of foundation drains and groundwater on drainage system capacity, the model representation of groundwater infiltration was transferred from the calibrated MDC sanitary sewer model for West Hartford to the drainage system model developed for this project. This drainage system model dynamically simulates groundwater elevation in each sub-catchment based on soil parameters and was calibrated to the observed groundwater response in the sewer

system based on metering data, therefore incorporating existing groundwater within the MDC sewer system into the drainage system model for this project. The groundwater portion of the MDC sewer model includes foundation drain discharges. All alternatives were run using the dynamic groundwater model to evaluate the cumulative impact of foundation drain discharges and groundwater infiltration on drainage pipe capacity.

The modeled peak groundwater inflow (10-year recurrence interval) is presented in **Table 2-1** along with the percentage of the peak discharge for the design storm. These results indicate that during the 10-year design storm, the groundwater contribution is much less than the peak discharge. The groundwater was found to be a small part of the flow during the design storm.

Table 2-1: Peak 10-Year Groundwater Flow and Percentage as Part of the Design Storm

Area	Location	Peak 10-year Groundwater Flow (cfs)	Percentage of NRCS Design Storm Peak Flow
Area 4	North Main Street (North)	0.04	0.4%
Area 4	North Main Street (South)	0.04	0.5%
Area 4	Arundel Avenue	1.92	0.4%
Area 5	St. Joseph's Tributary	2.04	0.7%
Area 6	Lindy Lane	0.06	0.5%
Area 6	Trout Brook Drive at UConn	0.90	0.6%
Area 6	Asylum Avenue at Trout Brook Drive	0.35	0.6%
Area 6	Craigmoor Road	0.20	0.6%

As shown in **Table 2-1,** the groundwater contributions are a very small percentage of the stormwater runoff contributions.

2.2.3 Model Calibration and Validation

The drain model hydrology and hydraulics were calibrated based on observed flow, depth, and velocity at each of the five meters that were installed within Area 1 as part of the Phase 1 study. Hydrologic parameters in the unmetered Areas 4, 5, and 6 were inferred based on calibrated hydrologic parameters in Area 1. Model calibration focused on matching simulated and observed flows, velocities, and depths. The simulated flow peaks, volume, and depth demonstrated good calibration to the observed data at all five meters during 2019 metering period. Additional information on the model calibration and metering program can be found in the Phase 1 Report.

2.3 Historical Storm Events and Validation

The calibrated model was validated using historical flooding reports from the Town occurring September 5, 2011, April 17, 2018, September 12, 2018, and August 7, 2019. The rainfall statistics of these events are summarized in **Table 2-2**. The study area maps of reported flooding locations during the historical storm events were used to validate modeled results.

Table 2-2: Rainfall Statistics from the Four Historical Storms Used for Model Validation

Storm	Total Rainfall (in)	5-Minute Peak Intensity (in/hr)	Maximum Average Recurrence Interval (ARI)
September 5, 2011 (Tropical Storm Lee)	5.65	1.80	10-year, 2-, 3-, 6-, and 12-hour
April 17, 2018	3.42	1.84	2-year, 6-hour
September 12, 2018	3.92	2.48	9-year, 3-hour
August 7, 2019	2.64	2.02	21-year, 1-hour

The model predicts flooding in many of the reported flooding locations during these four events. The model and actual accounts do not match exactly because the flooding reports do not differentiate between flooding caused by drain capacity limitations or by other flooding sources in the area. The observed flooding could be related to local flooding caused by high groundwater, maintenance problems, poor drainage, SSOs from the MDC sanitary sewer system, or other flooding causes not related to the drainage network. The model's predicted flooding extents match many of the reported flooding areas contained in the Town's records, suggesting that the model adequately represents existing conditions and flood risk in each area.

Section 3
Collection System Pipe Capacity Assessment

The drainage system capacity assessment was performed for 15 drainage systems tributary to Trout Brook, East Branch of Trout Brook, and St. Joseph's Tributary. Existing conditions were assessed using the model for each of the 15 drainage systems. For systems where flooding occurred, the model was used to develop preliminary design alternatives with adequate capacity for the 10-year, 24-hour design storm.

The following sections describe the collection system capacity analysis that was performed to evaluate the capacity of the existing drainage systems, alternatives that were evaluated to address system deficiencies and proposed recommendations to alleviate flooding and address system capacity concerns.

3.1 Historical Flooding Extent

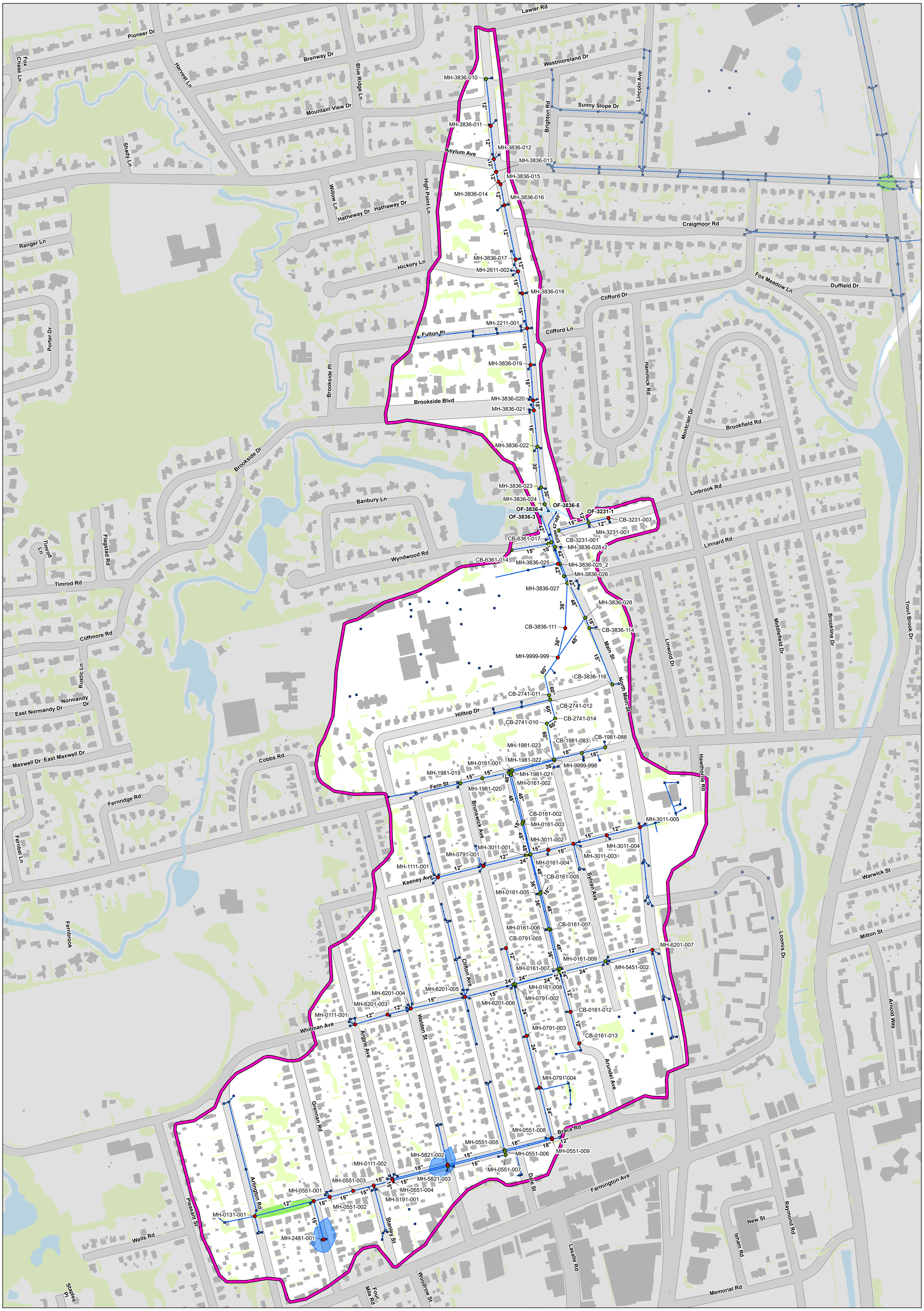
The Town has records of flooding during Tropical Storm Lee (September 5, 2011), as well as events on April 17, 2018, September 12, 2018, and August 7, 2019. Recorded flooding locations from the Town for these events are shown in **Figure 3-1**, **Figure 3-2**, and **Figure 3-3**. In these figures, the orange shading indicates flooding complaints during Hurricane Lee, blue shading indicates flooding complaints during April 17, 2018, pink shading indicates flooding complaints during September 12, 2018, and green shading indicates flooding complaints during August 7, 2019. Rainfall statistics from each of these historical storms are presented in **Table 2-6**. These events were all characterized by intense periods of rainfall, especially for short durations. These short duration, high intensity rainfall events are particularly important for urban flooding due to the short time of concentration in most of the study area.

3.2 Existing System Pipe Capacity

Model simulations were performed to identify capacity issues within the 15 existing drainage systems in Areas 4, 5, and 6 during both historical events and during the 10-year, 24-hour NRCS Type III design storm. This section provides an overview of existing conditions for the design storm for each area. Profiles for each system were generated and are presented under the respective sub-sections in Section 3.3. The figures show manhole flooding as red dots and the simulated hydraulic grade line as a solid blue line.

3.2.1 Summary of Existing Pipe Capacity by Outfall

The model was used to evaluate whether flooding is predicted for the 10-year design storm as well as for the historical events considered in this study. **Table 3-1** presents a summary of each of the 15 systems with an indication of whether the model predicts flooding under the different storm events. A check mark indicates that flooding is predicted in the model. Systems without any check marks did not have flooding during the model runs and the existing drainage system has adequate capacity, therefore not requiring replacement pipes.



CDM Smith

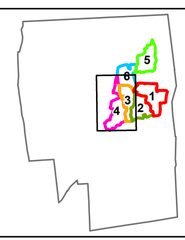
Legend

- Study Area 4
- 10-Year Storm - Flooding
- 10-Year Storm - No Flooding
- Outfalls
- Storm Manhole
- Catch Basin
- Storm Drain
- April 2018 Flooding
- August 2019 Flooding

1"=250'

N

0 250 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 4 Modeling Data
Figure 3-1

CDM Smith

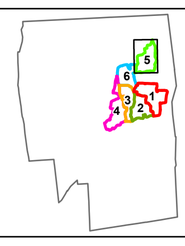
Legend

- Study Area 5
- 10-Year Storm - Flooding
- 10-Year Storm - No Flooding
- Outfalls
- Storm Manhole
- Catch Basin
- Storm Drain
- August 2019 Flooding

1"=150'

N

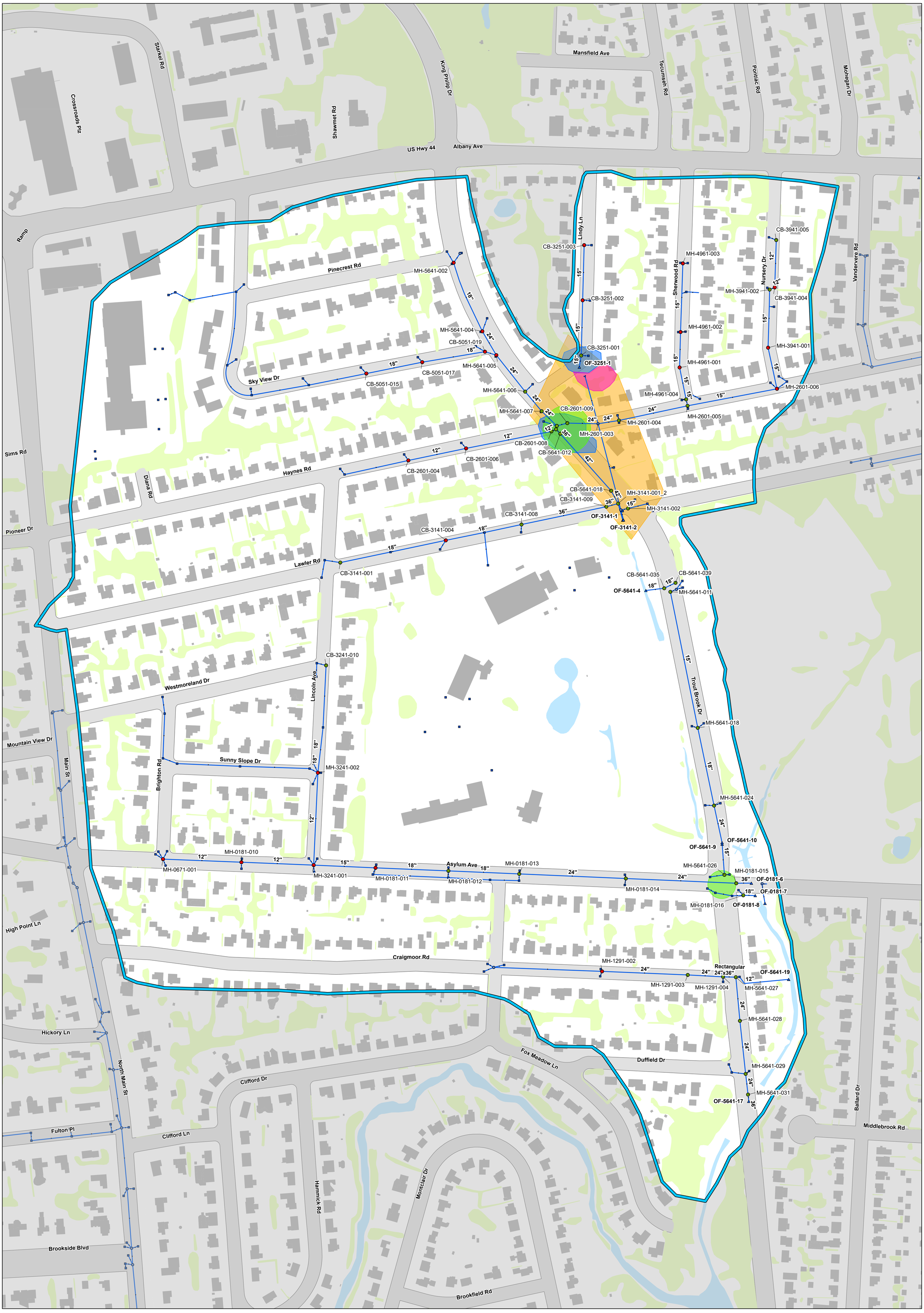
0 150 Feet



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 5 Modeling Data
Figure 3-2

CDM Smith



CDM Smith

Legend

- Study Area 5
- 10-Year Storm - Flooding
- 10-Year Storm - No Flooding
- Outfalls
- Storm Manhole
- Catch Basin
- Storm Drain
- April 2018 Flooding
- September 2011 Flooding
- September 2018 Flooding
- August 2019 Flooding

1"=150'

0 150 Feet

N

West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 6 Modeling Data
Figure 3-3

CDM Smith

Table 3-1: Drainage Systems with Modeled Flooding Summary

Area	Outfall	Location	10-yr 24-hr Type III Design Storm	Tropical Storm Lee	2018 Storms	August 2019 Storm
4	OF-3836-4	North Main Street (North)	√	√	√	√
4	OF-3836-5	North Main Street (South)				
4	OF-3232-1	Linbrook Road (West)	√			
4	OF-3836-3	Arundel Avenue	√	√	√	√
5	OF-3141-3 OF-3141-4	St. Joseph's Tributary	√	√	√	√
6	OF-3251-1	Lindy Lane	√			
6	MH-2601-003	Haynes Road (East)	√			√
6	OF-3141-1	Lawler Road (West)	√	√	√	√
6	MH-3141-001	Lawler Road (East)				
6	OF-5641-4	Trout Brook Drive at UConn (North)				
6	OF-5641-9	Trout Brook Drive at UConn (Middle)				
6	OF-5641-10	Trout Brook Drive at UConn (South)				
6	OF-0181-6	Asylum Avenue and Lincoln Avenue	√	√	√	√
6	OF-0181-7	Asylum Avenue at Trout Brook Drive				
6	OF-5641-17 OF-5641-19	Craigmoor Road	√			

Conceptual layouts were developed for those systems where modeled flooding occurred during either the design storm or historical storm events (nine systems in **Table 3-1**). Recommendations were not developed for those systems that sufficient capacity during the design storm (six systems in **Table 3-1**) and therefore have been omitted from Section 3.3.

3.3 Design Approach

The drainage system's performance was evaluated for the historical storm events and the NRCS rainfall distribution for the 10-year, 24-hour design storm. The design storm rainfall distribution was developed using the site-specific National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall-duration-frequency data, which has a total rainfall depth of 5.1 inches for the 10-year design storm. The objectives of the collection system pipe capacity assessment were:

- Evaluate the existing drainage system performance for a 10-year, 24-hour design storm and the historical storm events.
- Use the historical storm events to prioritize the recommended improvements.
- Identify and characterize hydraulic capacity constraints.

The following summarizes the existing conditions analysis for the nine systems that had modeled flooding during the design storm and/or historical storm events.

3.3.1 Area 4 – North Main Street

Area 4 includes the drainage area that discharges through four outfalls located where North Main Street crosses Trout Brook near Wynwood Road. This area included 32,000 feet of pipe ranging in size from 10- to 60 inches. Three of the four systems had modeled flooding during historical storms and/or the design storm. The following summarizes the existing conditions for each of the four systems.

North Main Street (North)

The North Main Street (North) system is located predominately within North Main Street in the northern part of Area 4. The drainage system starts at the intersection of North Main Street and Westmoreland Drive conveying flows in a southerly direction to the 30-inch outfall to Trout Brook just north of Linbrook Road. This system has several surcharged manholes during the 10-year design storm as shown as red manholes on **Figure 3-1** and on the existing conditions profile (**Figure 3-4**). This area does not have any documented flooding locations.

North Main Street (South)

The North Main Street (South) is a smaller drainage system that conveys flow from the intersection of North Main Street and Hilltop Drive in a northerly direction to the outfall with Trout Brook Drive near Linbrook Road. This system has sufficient capacity to convey the 10-year design storm, and therefore does not have any surcharged manholes on **Figure 3-1** or on the existing conditions profile (**Figure 3-5**). This area does not have any documented flooding locations.

Since this system has sufficient capacity to convey the 10-year design storm within the drainage system, this system does not have any recommendations and has been excluded from Section 4.

Linbrook Road (West)

The small system within Linbrook Road includes three pipe segments that convey flow from Linbrook Road to a 12-inch outfall pipe just east of North Main Street. The system has one surcharged manhole as shown in red on **Figure 3-1** and in the existing conditions profile (**Figure 3-6**). This area does not have any documented flooding locations.

Arundel Avenue

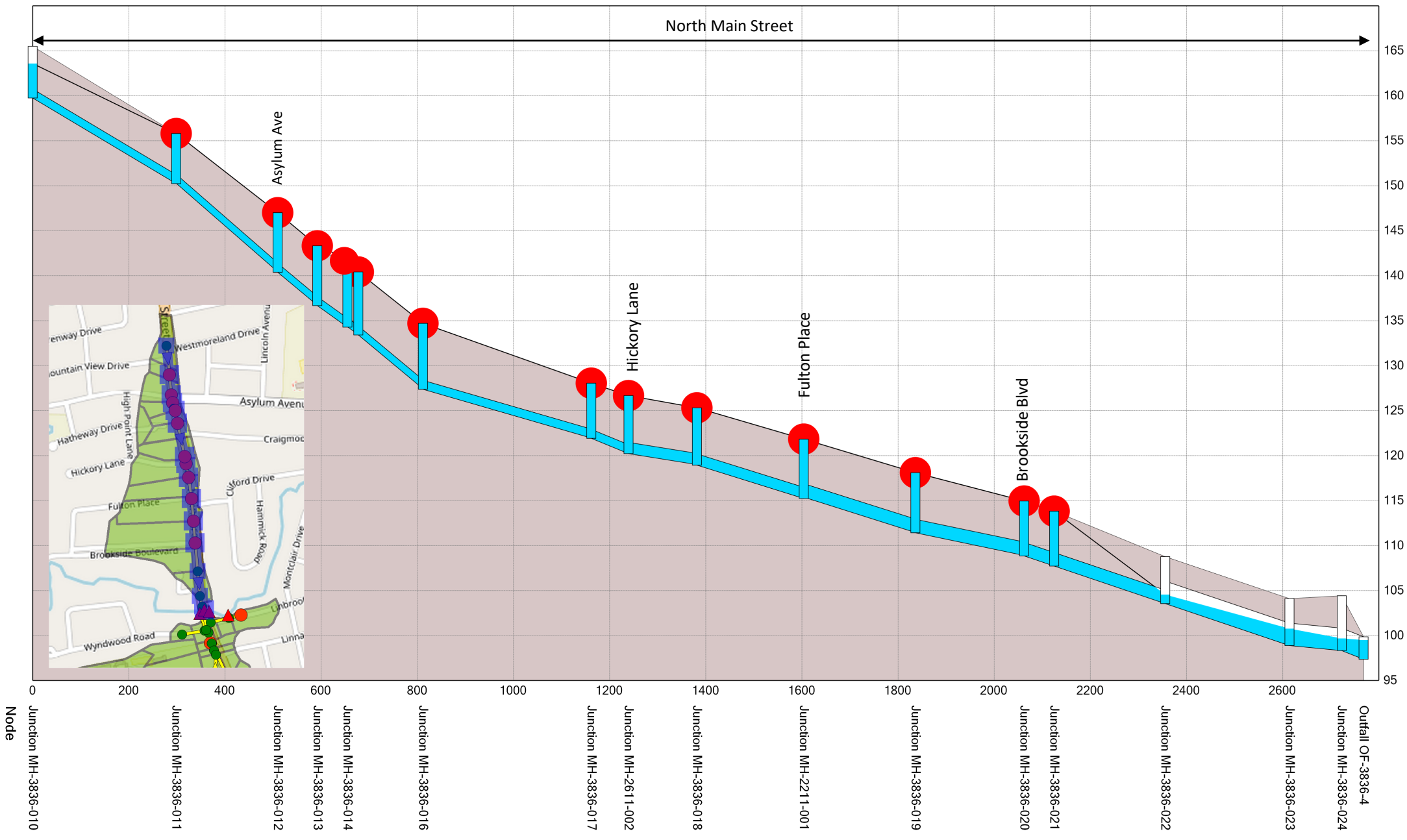
The Arundel Avenue is the largest system within Area 4 as shown on **Figure 3-1**. This system conveys flow in a northerly direction, from Brace Road, down Brunswick Avenue to Whitman Avenue, then down Arundel Avenue to Fern Street, then through private property (including the School for the Deaf) to North Main Street and to the 42-inch outfall at Trout Brook.

The Arundel Avenue system does have several manholes that are surcharged during the 10-year design storm as shown as red manholes on **Figure 3-1** and on the existing conditions profile (**Figure 3-7**). The majority of the flooding from the surcharged manholes does occur on the smaller drainage systems that tie into the main trunkline of the system. The documented flooding within this area occurs on Brace Road and was reported during the April 2018 (blue shading) and the August 2019 (green shading) storm events.

Modeled Flooding

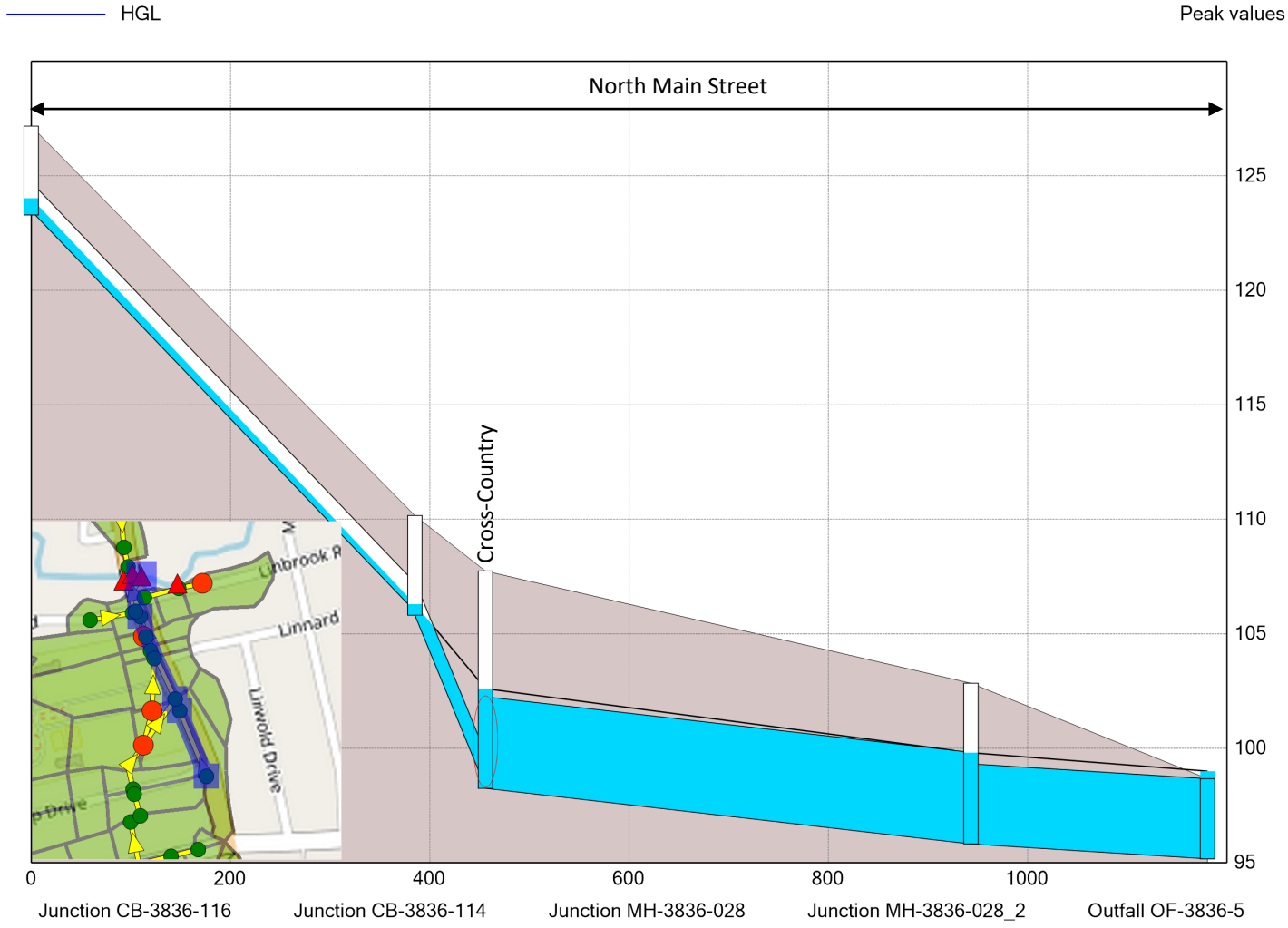
HGL

Peak values

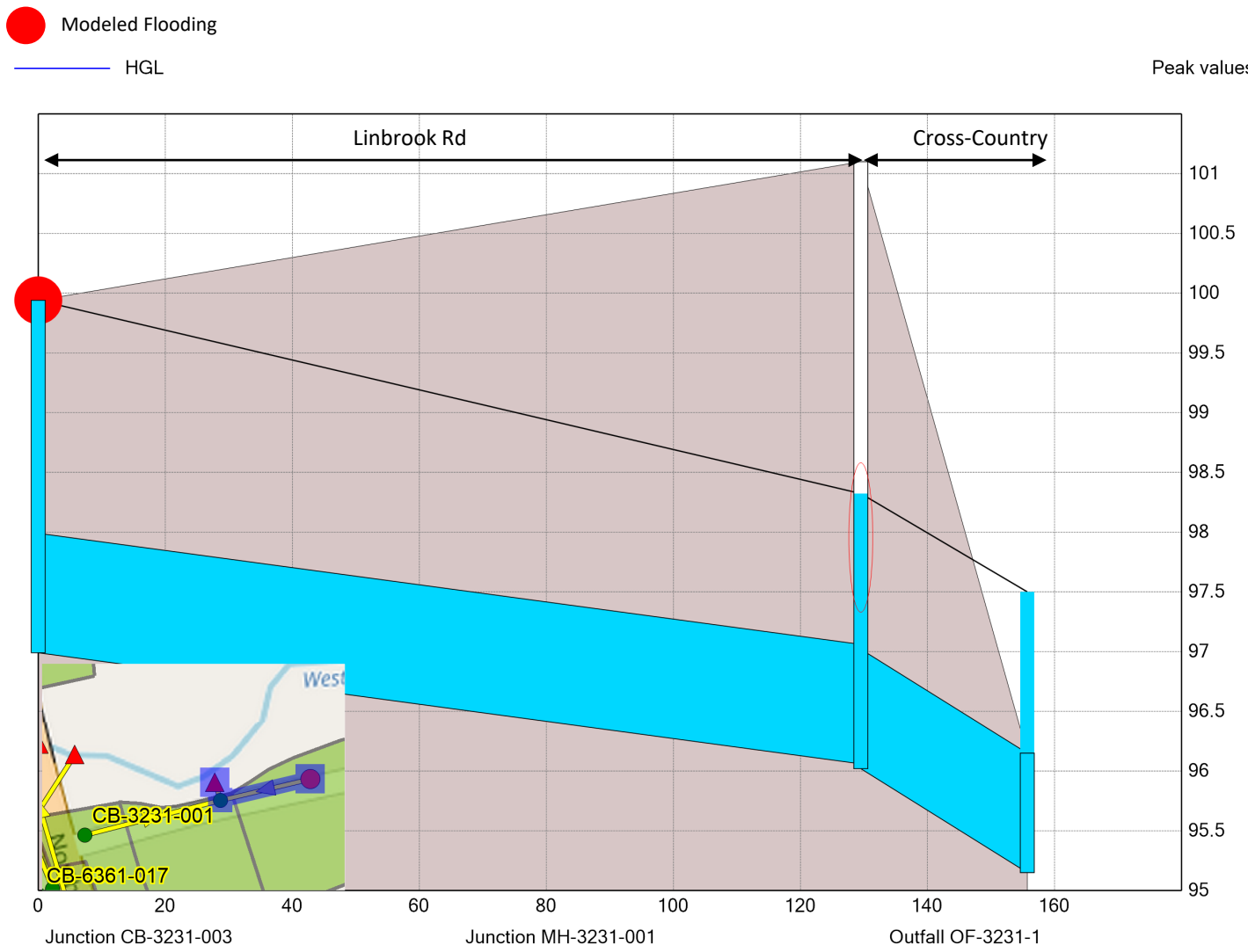


CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: North Main Street (North)
Figure 3-4



West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: North Main Street (South)
Figure 3-5



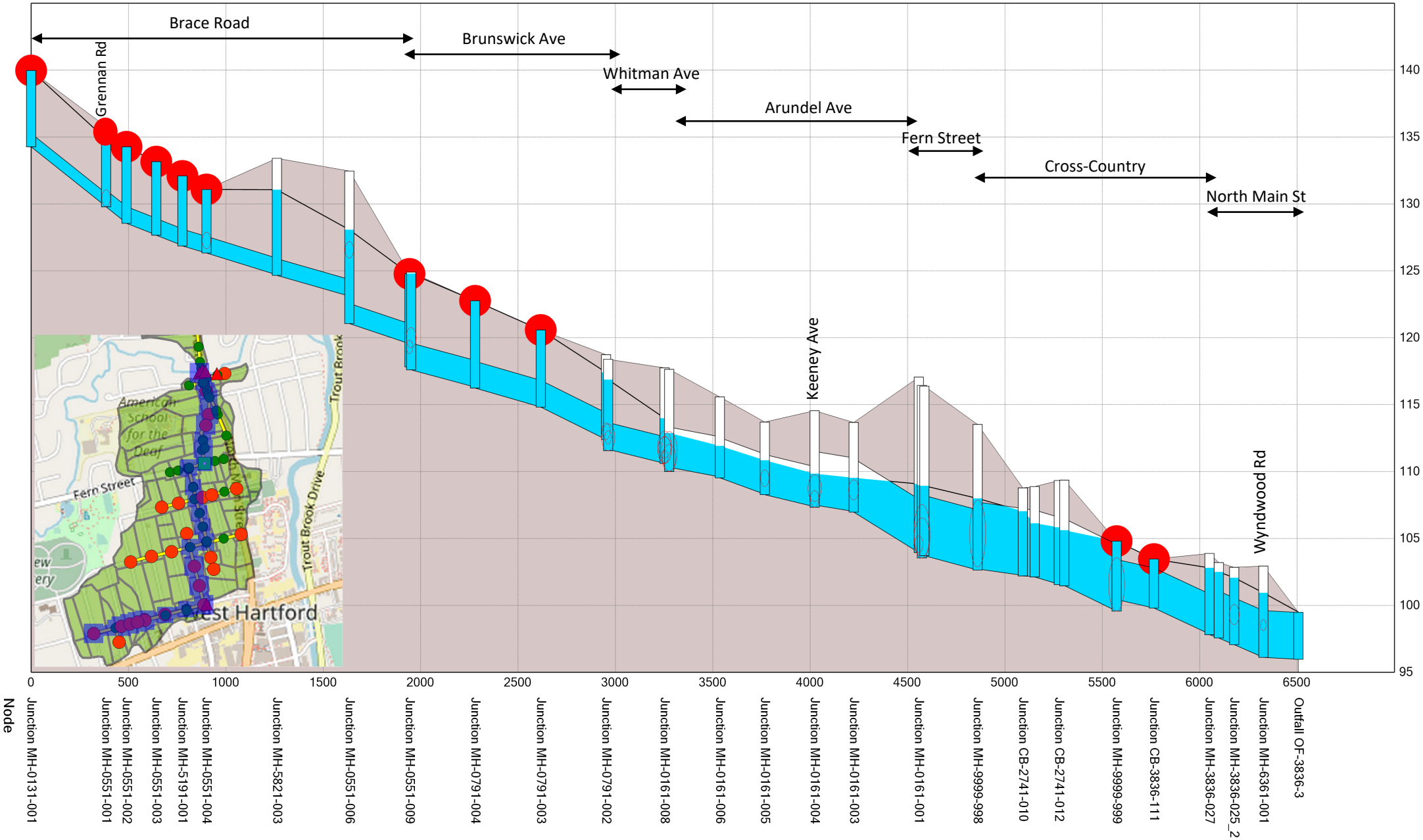
CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Linbrook Road (West)
Figure 3-6

Modeled Flooding

HGL

Peak values



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Arundel Avenue
Figure 3-7

3.3.2 Area 5 – St. Joseph's Tributary

The St. Joseph's Tributary system includes a complex drainage system starting in the northeastern portion of the Area 5 watershed near Mohawk Drive and Norwood Road ending at the twin 42-inch outfalls just south of Lawler Road and Wiltshire Lane. This system has several surcharged manholes within the upper portion of the watershed, mostly north and east of Albany Avenue during the 10-year design storm. Model results showed that the main trunkline south of Albany Avenue has sufficient capacity during the design storm as shown as red manholes on **Figure 3-1** and on the existing conditions profile (**Figure 3-8** and **Figure 3-9**). Documented flooding within Area 5 during the 2019 storm event occurs at the intersections of Colony Road and Brainard Road and Colony Road and Sequin Road (shown as green shading on **Figure 3-1**).

3.3.3 Area 6 – East Branch Trout Brook at Asylum Avenue

Area 6 includes ten smaller drainage systems that discharge to the East Branch of Trout Brook (see **Table 3-1**). The following describes the existing conditions associated with each of the ten systems.

Lindy Lane

Starting in the northern area of Area 6, the Lindy Lane drainage system conveys flows from Lindy Lane to the East Branch of Trout Brook at Lindy Lane. This small system does include surcharged manholes during the 10-year design storm as shown as red manholes on **Figure 3-1** and on the existing conditions profile (**Figure 3-10**). There is documented flooding at Lindy Lane and the East Branch of Trout Brook that is associated with the Lindy Lane culvert that conveys the East Branch of Trout Brook under Lindy Lane. This documented flooding is not attributed to the small drainage system within Lindy Lane.

Haynes Road (East)

The Haynes Road (East) system conveys flow from Sherwood Road and Nursery Drive to the system within Haynes Road, discharging to the East Branch of Trout Brook at a manhole that is within the Lindy Lane culvert. This small drainage system does include surcharged manholes during the 10-year design storm in Sherwood Road and Nursery Drive as shown as red manholes on **Figure 3-1** and on the existing conditions profile (**Figure 3-11**).

There is documented flooding at Haynes Road and the culvert portion of the East Branch of Trout Brook that is associated with insufficient capacity within the Lindy Lane culvert that conveys the East Branch of Trout Brook from Lindy Lane to just south of Lawler Road. Based on the Milone & McBroom Study of Trout Brook, this documented flooding is not attributed to the small drainage system within Haynes Road that discharges to the Lindy Lane culvert.

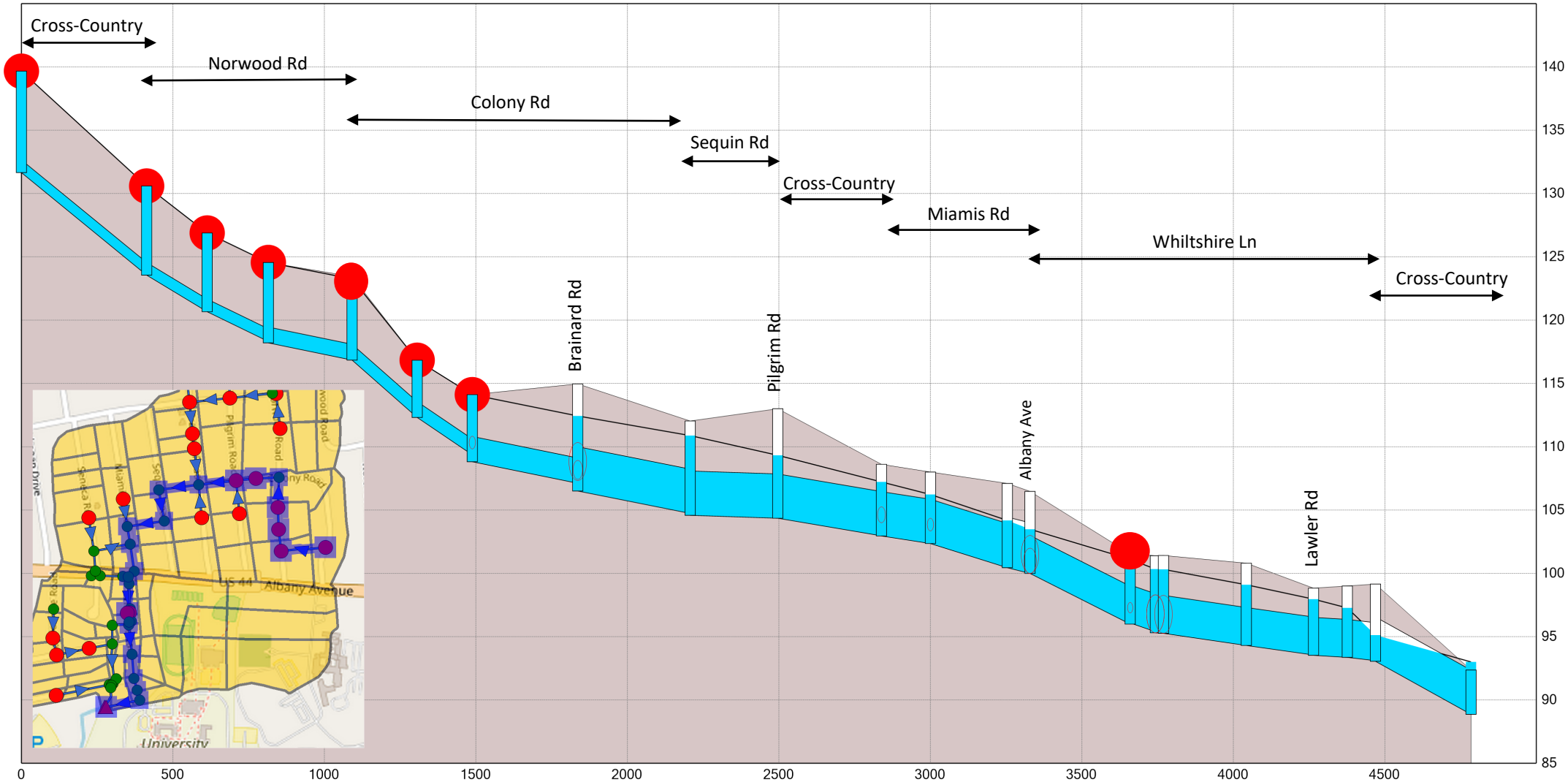
Lawler Road (West)

The Lawler Road (West) system is a medium size system that conveys flows down Trout Brook Drive starting at Pinecrest Road and discharging to the East Branch of Trout Brook just south of Lawler Road. This system has an overflow pipe that conveys flow from the main trunkline at the intersection of Haynes Road and Trout Brook Drive to the Lindy Lane culvert. This medium drainage system does include surcharged manholes predominantly within the side road drainage systems, Sky View Drive, Haynes Road, and Lawler Road, during the 10-year design storm as shown as red manholes on **Figure 3-1** and on the existing conditions profile (**Figure 3-12**).

Modeled Flooding

HGL

Peak values



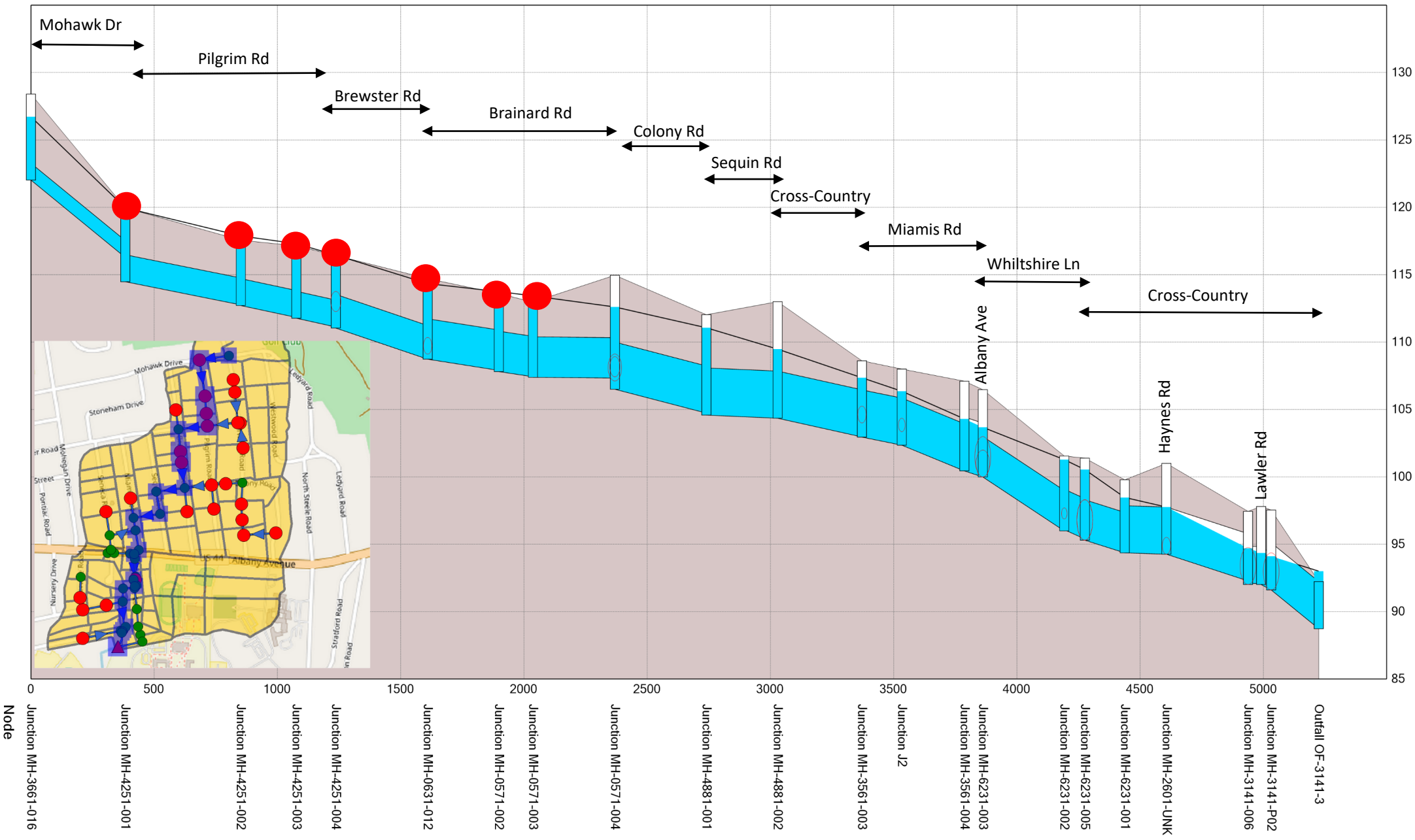
CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: St. Joseph's Tributary
Figure 3-8

Modeled Flooding

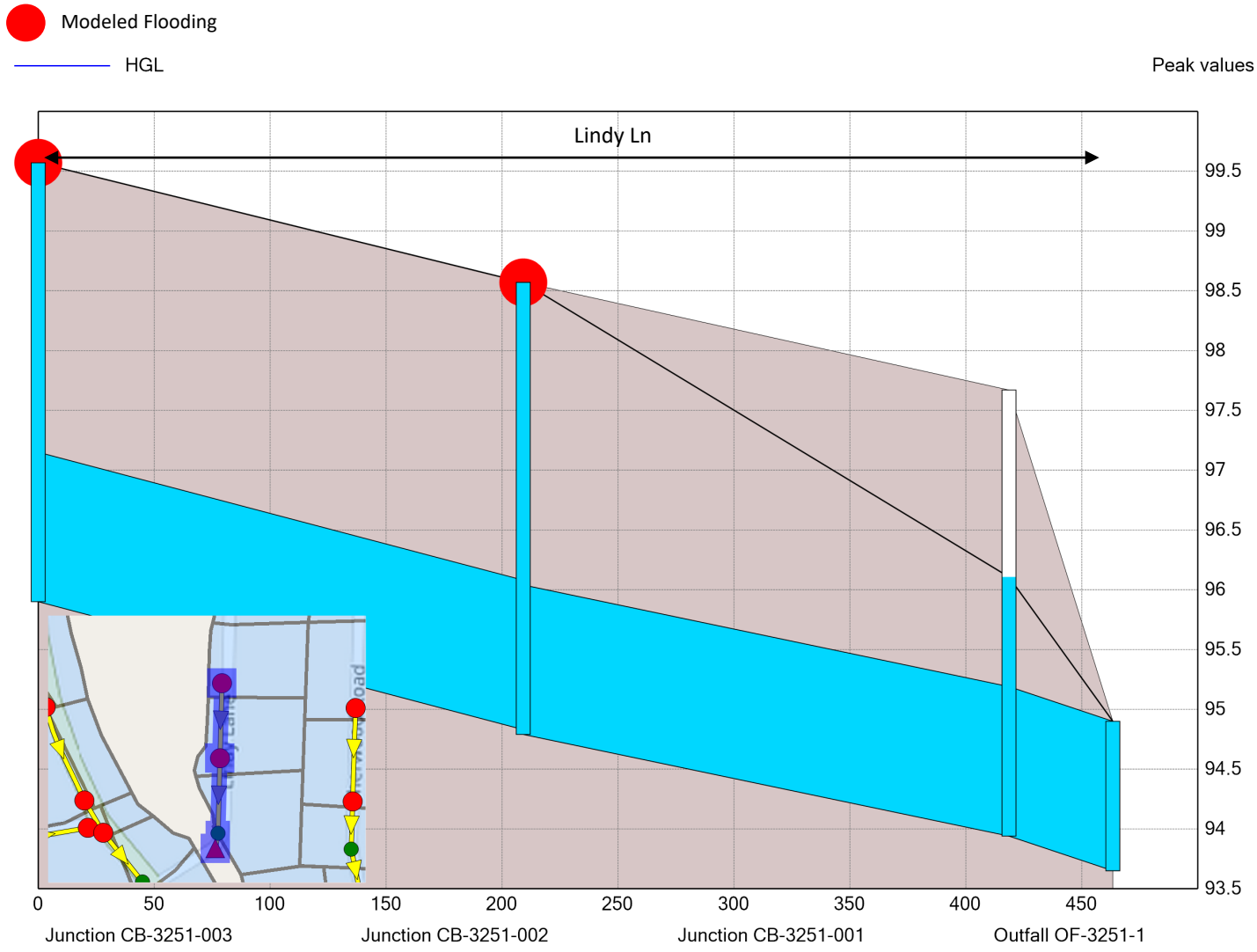
HGL

Peak values

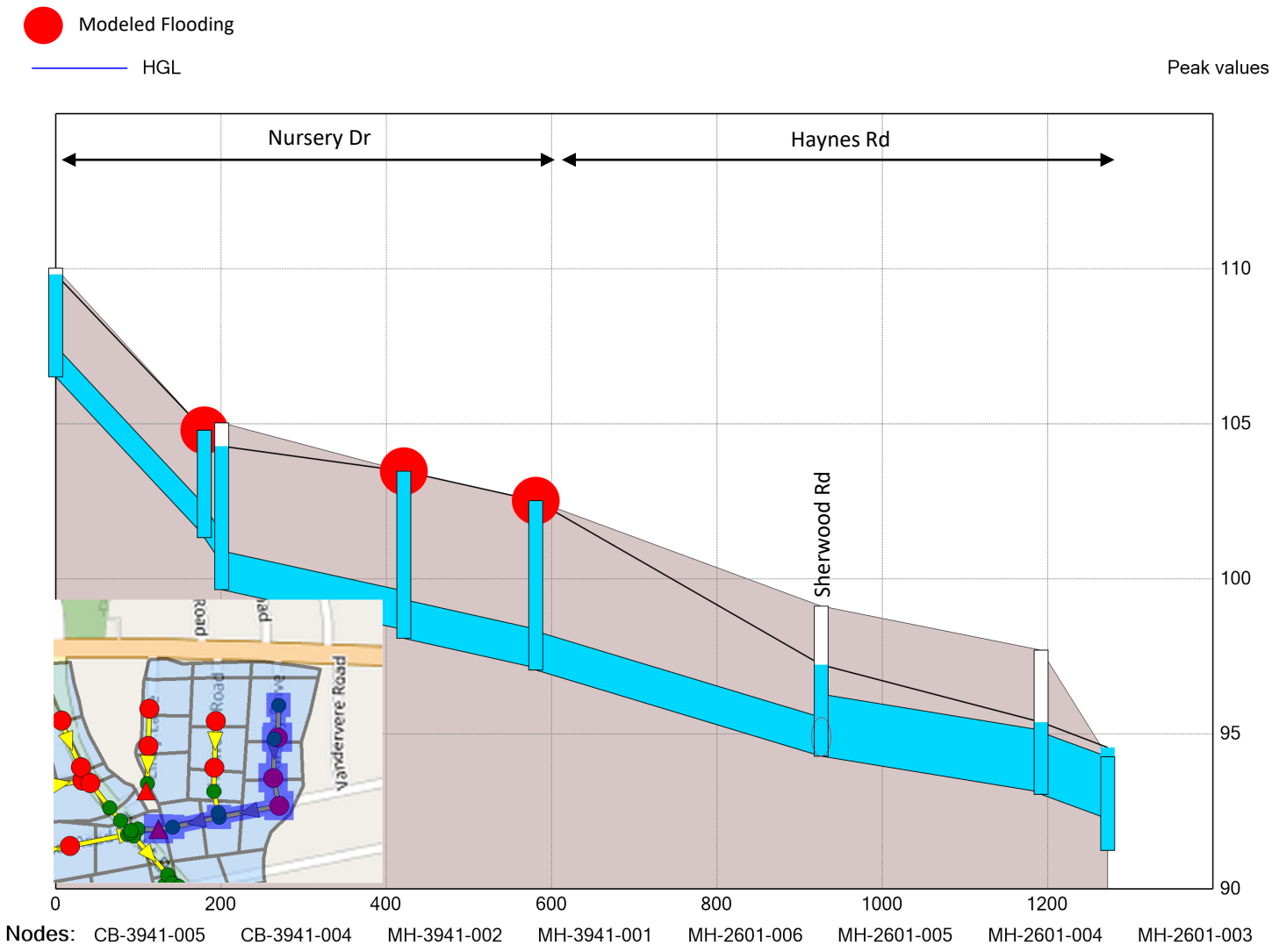


CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: St. Joseph's Tributary
Figure 3-9

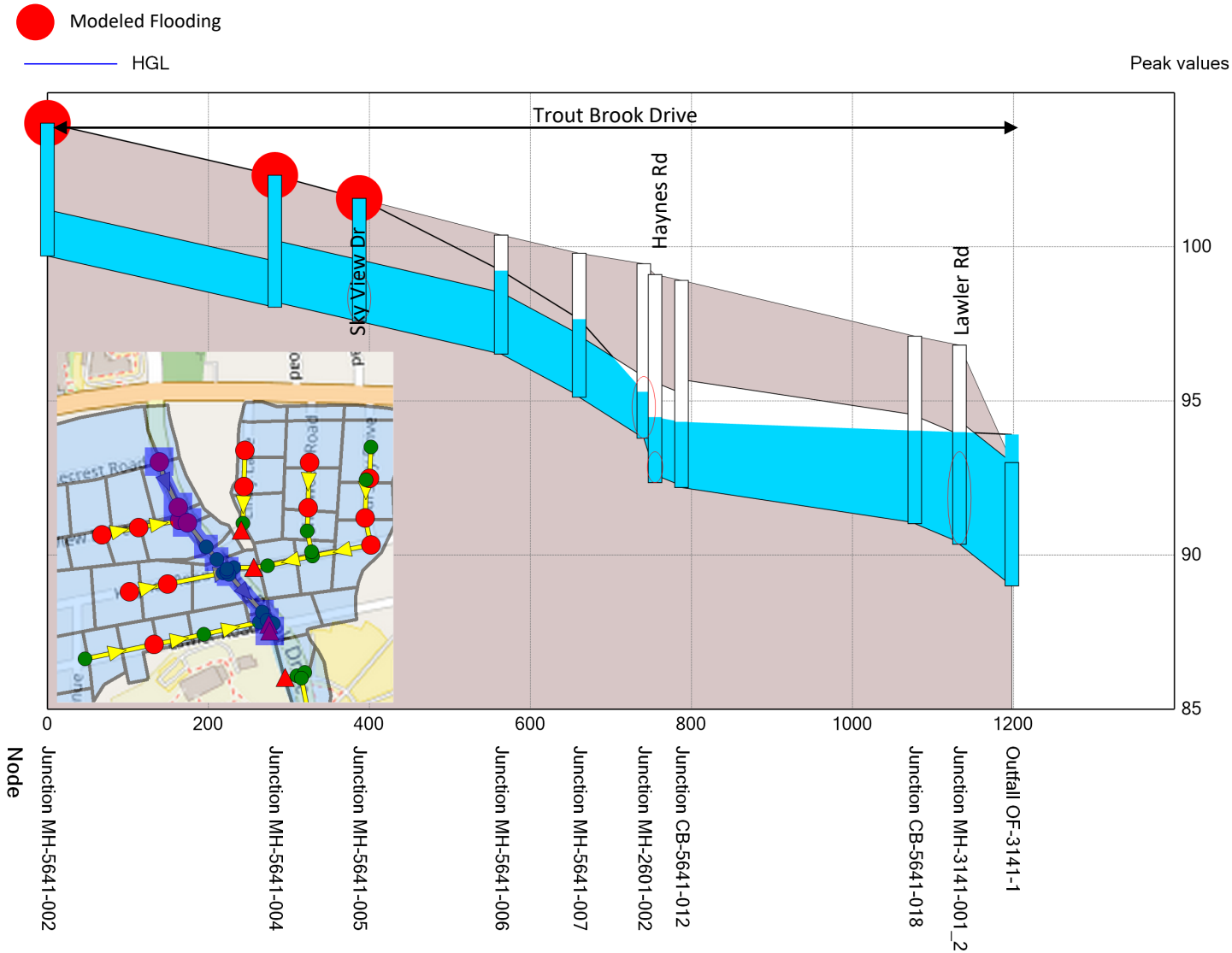


West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Lindy Lane
Figure 3-10



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Haynes Road (East)
Figure 3-11



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Lawler Road (West)
Figure 3-12

There is documented flooding on Trout Brook Drive and Haynes Road from the 2011 (orange shading), 2018 (blue shading), and 2019 (green shading) storm events that is most likely associated with insufficient capacity of the Lindy Lane culvert that conveys the East Branch of Trout Brook from Lindy Lane to just south of Lawler Road. Based on the Milone & McBroom Study of Trout Brook, the documented flooding is most likely not attributed to this medium system but associated with the insufficient culverts that convey the East Branch of Trout Brook.

Lawler Road (East)

The Lawler Road (East) system is a very small system that conveys flow form the intersection of Lawler Road and Trout Brook Drive to the Lindy Lane culvert at the intersection of Lawler Road and Trout Brook Drive. This system does not have any surcharged manholes during the 10-year design storm as shown on the existing conditions profile (**Figure 3-13**). Documented flooding within this area is not associated with the very small drainage system but is associated with the insufficient capacity within the Lindy Land culvert as previously described.

Trout Brook Drive at UConn (North)

The Trout Brook Drive at UConn (North) system is a small system that conveys flows from Trout Brook Drive to the East Branch of Trout Brook via an 18-inch outfall approximately 400 feet south of the intersection of Lawler Road and Trout Brook Drive. This system does not have any surcharged manholes during the 10-year storm event as shown on **Figure 3-1** and on the existing conditions profile (**Figure 3-14**). This system also does not have any documented flooding.

Trout Brook Drive at UConn (Middle)

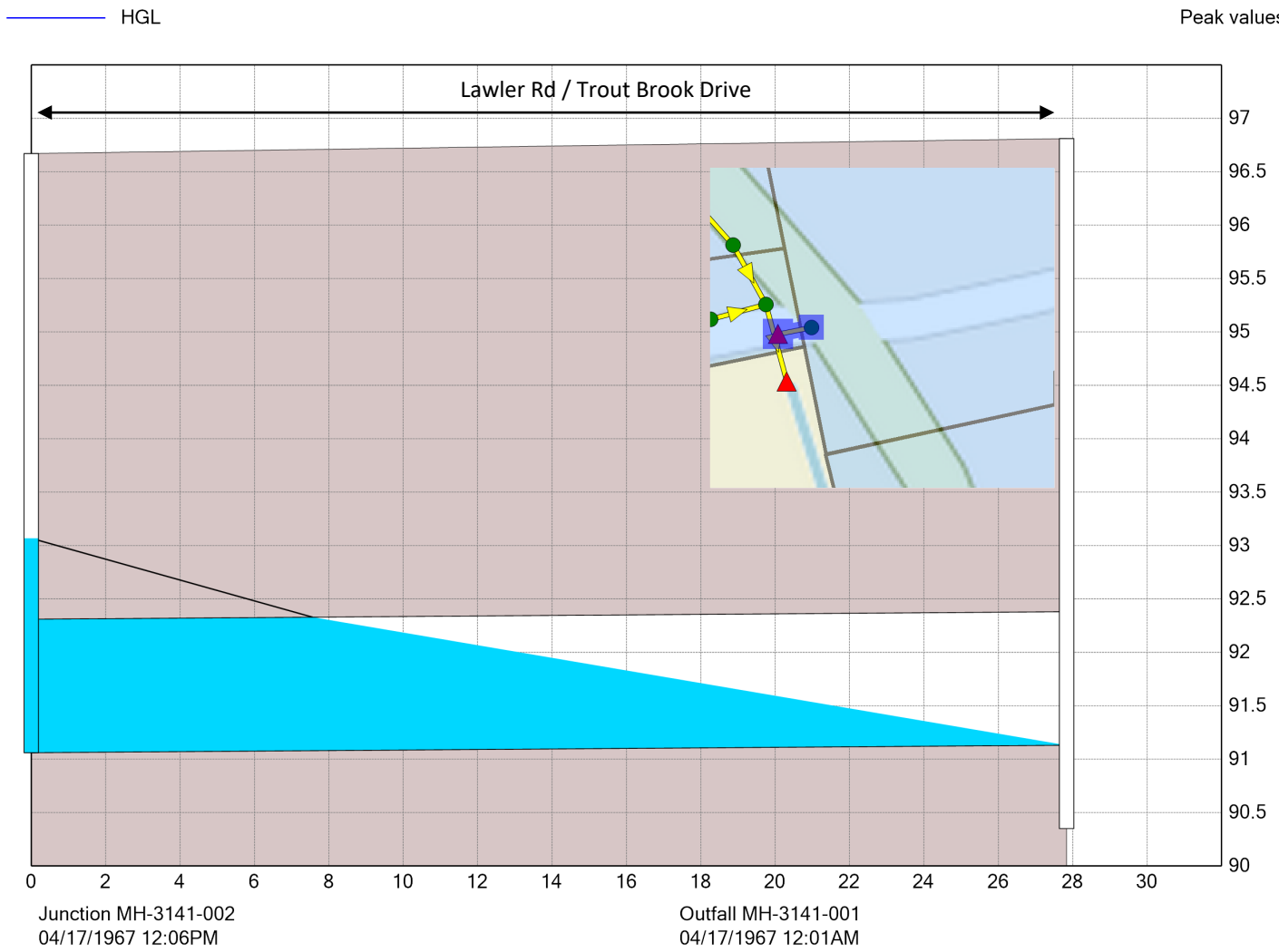
The Trout Brook Drive at UConn (Middle) system conveys flow from Trout Brook Drive between Lawler Road and Asylum Avenue, discharging to the East Branch of Trout Brook via a 24-inch outfall just north of the intersection of Asylum Avenue and Trout Brook Drive. This system does not have any surcharged manholes as shown on **Figure 3-1** and on the existing conditions profile (**Figure 3-15**). This system also does not have any documented flooding.

Trout Brook Drive at UConn (South)

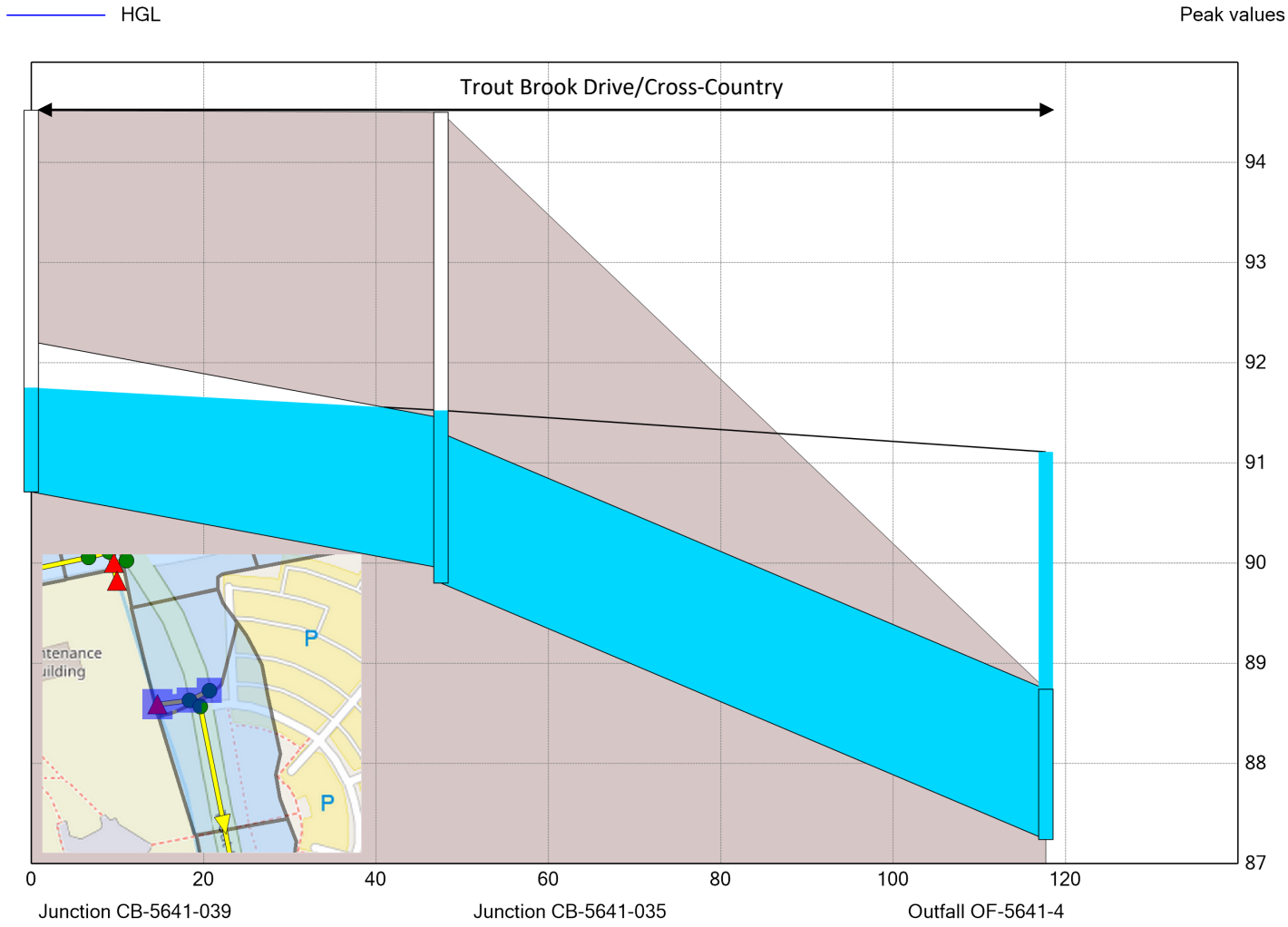
The Trout Brook Drive at UConn (South) system is a very small system that conveys flow from a portion of the intersection of Asylum Avenue and Trout Brook Drive to the East Branch of Trout Brook via a 15-inch outfall just north of the intersection of Asylum Avenue and Trout Brook Drive. This system does not have any surcharged manholes as shown on **Figure 3-1** and on the existing conditions profile (**Figure 3-16**). The documented flooding during the 2019 storm (green shading) at the intersection of Trout Brook Drive and Asylum Avenue is most likely not associated with this very small drainage system.

Asylum Avenue at Lincoln Avenue

The medium size system, Asylum Avenue at Lincoln Avenue, conveys flow from the Sunny Slope Drive area down Asylum Avenue to the East Branch of Trout Brook to a 36-inch outfall just west of the intersection of Trout Brook Drive and Asylum Avenue. This medium drainage system does include surcharged manholes predominantly within the upper portion of the drainage system, Lincoln Avenue and Asylum Avenue, during the 10-year design storm as shown as red manholes on **Figure 3-1**, and on the existing conditions profile (**Figure 3-17**).

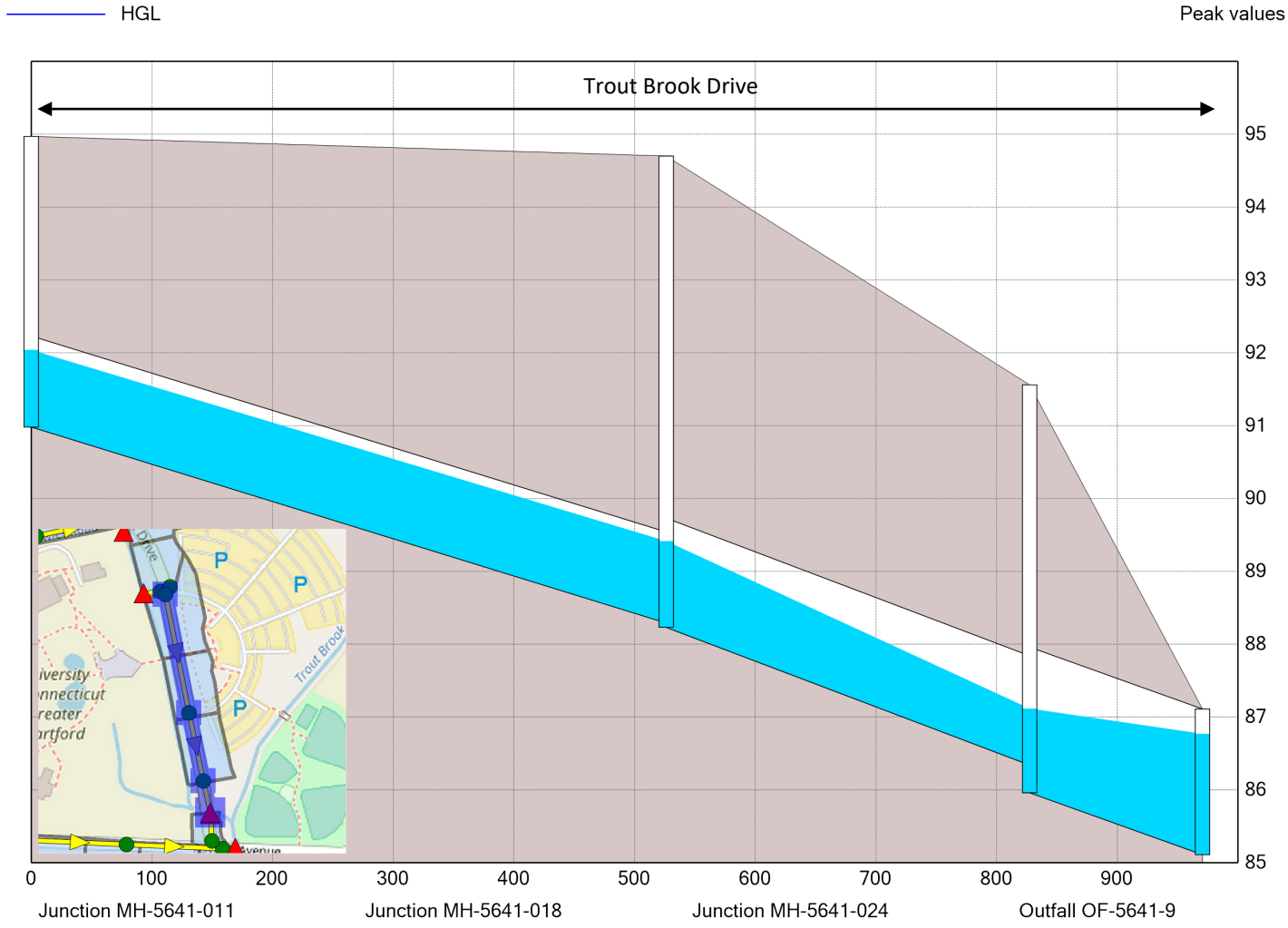


West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Lawler Road (East)
Figure 3-13



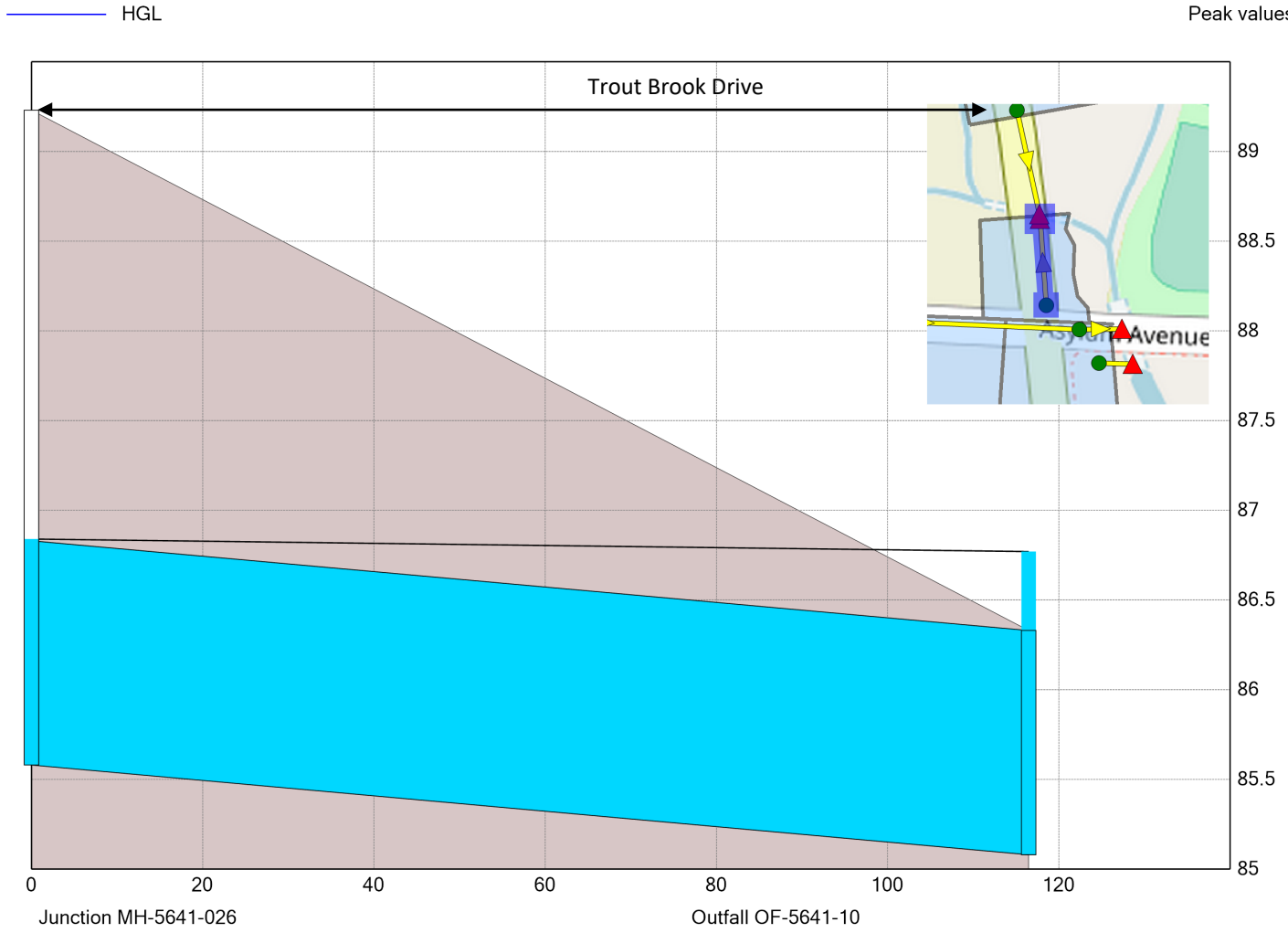
CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Trout Brook Drive at UConn (North)
Figure 3-14



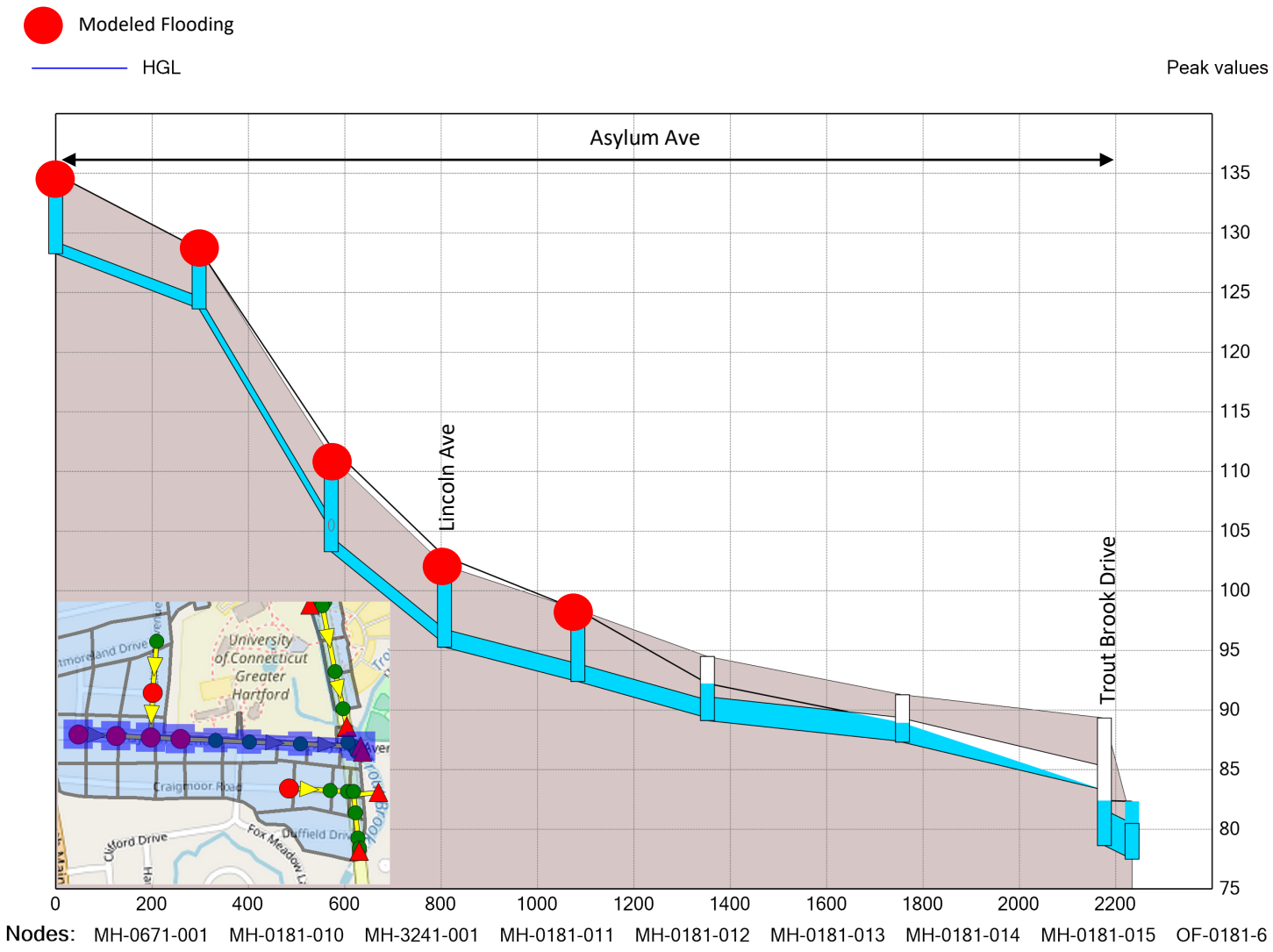
CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Trout Brook Drive at UConn (Middle)
Figure 3-15



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Trout Brook Drive at UConn (South)
Figure 3-16



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Asylum Avenue at Lincoln Avenue
Figure 3-17

There is documented flooding at the intersection of Asylum Avenue and Trout Brook Drive during the 2019 storm event (green shading). Based on the Milone & McBroom Study of Trout Brook, this documented flooding most likely is not attributed to the medium drainage system within Asylum Avenue but associated with the Asylum Avenue culvert for the East Branch of Trout Brook.

Asylum Avenue at Trout Brook Drive

The Asylum Avenue at Trout Brook Drive system conveys flows from the intersection of Trout Brook Drive and Asylum Avenue via an 18-inch outfall just south of Asylum Avenue. This system does not have any surcharged manholes as shown on **Figure 3-1** and on the existing conditions profile (**Figure 3-18**). The documented flooding during the 2019 storm (green shading) at the intersection of Trout Brook Drive and Asylum Avenue is most likely not associated with this very small drainage system.

Craigmoor Road

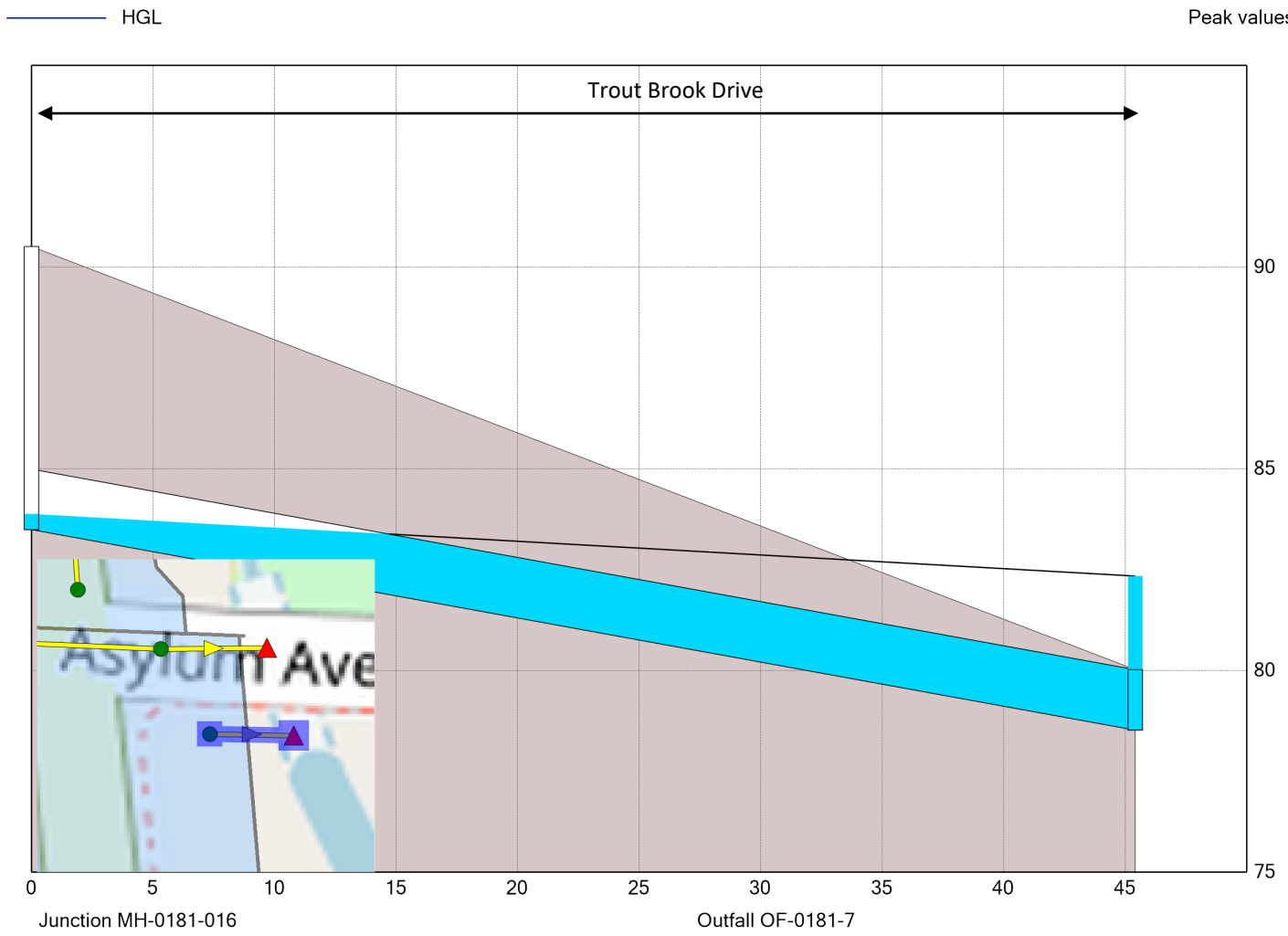
The Craigmoor Road system starts at the intersection of Craigmoor Road and Fox Meadow Lane, conveys flows down Craigmoor Road and Trout Brook Drive to the 36-inch outfall just south of the intersection of Duffield Drive and Tour Brook Drive. This system has one surcharged manhole during the 10-year design storm as shown as a red manhole on **Figure 3-1** and on the existing conditions profile (**Figure 3-19**). This system does not have any documented flooding.

3.4 Private Inflow and Collector Drainage System

The study area includes private inflow connections to the sanitary sewer system that have been confirmed through building inspections and dye testing performed by the MDC over the past decade. The most prevalent sources of private inflow in all three areas are foundation drains and sump pumps that connect to the sanitary sewer service inside the building. Most residential homes in West Hartford built prior to 1959 were constructed with an internal sump or access pit which was typically installed to accept flow from foundation drains. Many of the access pits in these homes still have active connections to the sanitary sewer service that can contribute during wet weather or dry weather when groundwater levels are high.

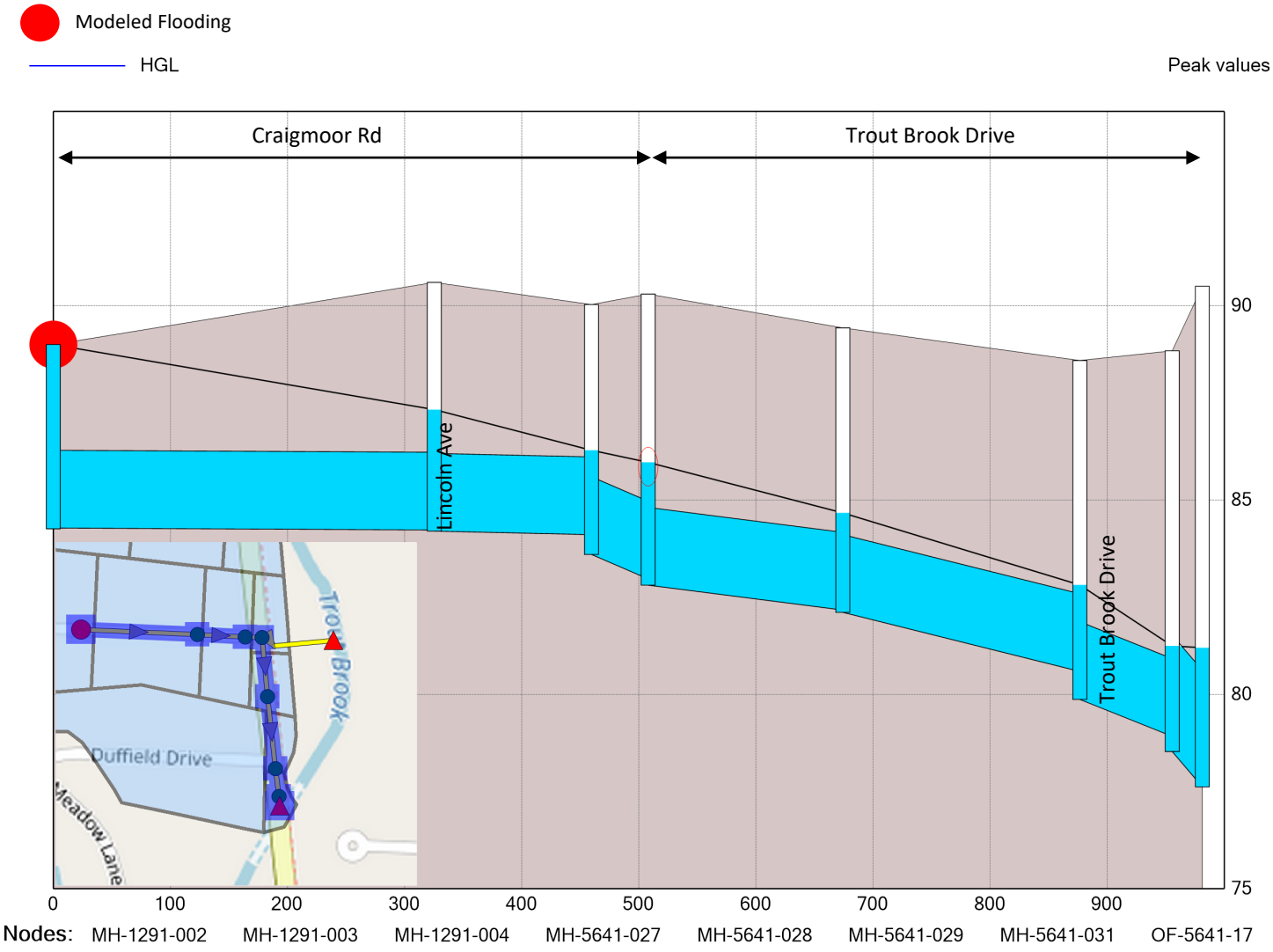
The drainage study area overlaps with four sewer subareas (WH11, WH17, WH30, and WH31) that have been identified as problem areas by the MDC and prioritized for sewer system improvements. The improvements include sewer main, manhole and lateral rehabilitation, and disconnecting private inflow sources from the sanitary sewer system as part of a comprehensive rehabilitation program to address the problems in the area.

The conceptual layouts for private inflow removal that were developed by CDM Smith for the MDC in 2018-19 in the study area were further evaluated using the latest West Hartford storm drain GIS data (February 2020) and the existing drain system recommendations. The conceptual layouts were limited to areas where building inspection were previously conducted by the MDC. This includes all buildings in Area 6 but only certain streets in Area 4 and Area 5.



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Asylum Avenue at Trout Brook Drive
Figure 3-18



CDM Smith

West Hartford, CT
West Hartford Phase 2 Drainage Study
Existing Profile: Craigmoor Road
Figure 3-19

The general approach to disconnect most private inflow sources is through installation of pre-fabricated sump pits, sump pumps, and discharge piping inside the home with the pumped discharge connecting to a 6-inch PVC gravity drain service outside the home. The drain service on private property would ultimately connect to a 6-inch PVC collector drain in the public right-of-way. The collector drains will connect to the Town drainage system at the nearest manhole or catch basin. This is the same approach required by the Town for private inflow removal developed under the Four Mile Road Area project constructed in 2012-2013 and Greenhurst Road Area project constructed in 2015-2017. The collector drain system recommendations for the Phase 2 study areas are further evaluated in **Section 4** and the collector drainage system costs are summarized for each outfall in the study area in **Section 5**.

Section 4

Summary and Recommended Improvements

This section presents recommended drainage system improvements to mitigate flooding during the 10-year design storm. All alternatives consider redirecting foundation drains and sump pump discharges from the MDC sewer system to the Town's existing or new drainage system using the calibrated representation of infiltration/inflow in the MDC sewer model.

4.1 Prioritization of Drainage Improvements

The existing conditions evaluation described in Section 3 shows capacity constraints within most drainage systems in Areas 4, 5, and 6. While the NRCS Type III design storm was used to evaluate existing pipe capacity and to size the recommended preliminary drainage system design, this design storm is conservative and may overestimate the likelihood of flooding especially during smaller more frequent storm events. Therefore, recommended improvements were prioritized using modeled smaller storm events and the Town's records of flooding during historical storm events. The following describes the tiers that were developed to prioritize improvements based on drainage system capacity deficiencies:

Tier 1 - High Priority Areas has flooding under the following scenarios:

- Model predicated flooding during 10-year 24-hour design storm
- Model predicted flooding during historical storms
- Reported flooding complaints from Town

Tier 2 - Moderate Priority has flooding under the following scenarios:

- Model predicated flooding during 10-year 24-hour design storm
- Model predicted flooding during historical storms

Tier 3 – Low Priority has flooding under the following scenarios:

- Model predicted flooding during 10-year 24-hour design storm

Recommended improvements within systems ranked in the Tier 2 and 3 categories are likely not necessary and should be addressed last or if flooding conditions change in the future.

The model domain included all 15 drainage systems, emphasizing areas with the least system capacity and systems with known and documented historical flooding concerns. Drains not explicitly represented in the model are located away from the main trunk lines and do not contain any areas of documented flooding. Therefore, this study assumes that these small drainage systems tributary to the major drainage systems have adequate capacity for the 10-year event, and consequently no improvements are recommended.

Table 4-1: Drainage Improvements – Prioritized Tiers

Area	Outfall	Location	Tier
4	OF-3836-4	North Main Street (North)	2
4	OF-3232-1	Linbrook Road (West)	3
4	OF-3836-3	Arundel Avenue	1
5	OF-3141-3 and OF-3141-4	St. Joseph's Tributary	1
6	OF-3251-1	Lindy Lane	3
6	MH-2601-003	Haynes Road (East)	2
6	OF-3141-1	Lawler Road (West)	1
6	OF-0181-6	Asylum Avenue and Lincoln Avenue	2
6	OF-5641-17 and OF-5641-19	Craigmoor Road	3

4.2 Recommended Drainage Improvements

Recommended improvements were developed for the nine drainage systems that showed flooding during the design storm and/or historical events. The following summarizes the analysis and recommendations for each outfall. See **Appendix A** for a complete list of the hydraulic improvements for the various alternatives considered in Areas 4, 5, and 6.

4.2.1 Area 4 – North Main Street

The North Main Street Area (Area 4) includes recommendations for three drainage systems: North Main Street (North) (OF-3836-4), Linbrook Road (West) (OF-3232-1), and Arundel Avenue (OF-3836-3). The following summarizes the analysis and recommendations within each system.

North Main Street (North) – OF-3836-4

The model results show that the main trunkline within North Main Street system has insufficient capacity to convey flows for the 10-year design storm. To increase capacity, replacement pipes are proposed from the intersection of Asylum Avenue and North Main Street to the outfall at Trout Brook. This area does not have documented flooding locations, and based on the roadway topography, the excess flow that cannot enter the drainage system due to insufficient capacity bypasses the catch basins and is conveyed down the gutter line to Trout Brook. Pipes recommended for replacement are shown on **Figure 4-1** and **Table 4-2** is a summary of the proposed pipe replacement quantities.

Table 4-2: Hydraulic Improvements Summary – North Main Street (North)

Proposed Pipe Size (in)	Pipe Length (lf)
15	150
18	160
24	430
30	1,370
36	110
Total	***2,220***

MH-3836-010
12"
MH-3836-011
12"
Asylum Ave
MH-3836-012
12" to 15"
MH-3836-013
MH-3836-014
12" to 15"
MH-3836-015
12" to 18"
12" to 18"
MH-3836-016
12" to 24"
MH-3836-017
12" to 24"
MH-2611-002
15" to 30"
MH-3836-018
15" to 30"
MH-2211-001
18" to 30"
MH-3836-019
18" to 30"
MH-3836-020
18" to 30"
MH-3836-021
18" to 30"
MH-3836-022
30" to 30"
MH-3836-023
30" to 36"
MH-3836-024
30" to 36"
OF-3836-4
Mountain View Dr
Blue Ridge Ln
Hickory Ln
Fulton Pl
Brookside Pl
Brookside Blvd
Banbury Ln
Willow Ln
Hathaway Dr
Hatheway Dr
High Point Ln
Brighton Rd
Sunny Slope Dr
MH-3241-002
Lincoln Ave
MH-0671-001
MH-0181-010
MH-3241-001
Craigmoor Rd
Clifford Ln
Clifford Dr
Hammick Rd
North Main St
Linbrook Rd

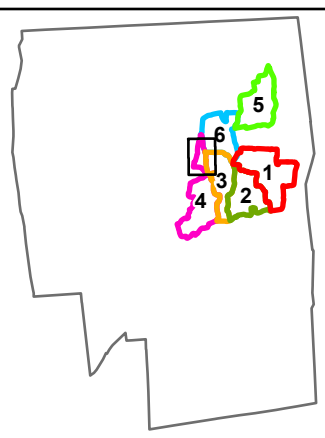
Legend

- Study Area 4
- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Proposed Storm Drain
- Proposed Storm Manhole
- 18" Proposed Storm Drain Size

N

1"=200'

0 200 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
North Main Street (North)
Recommended Improvements
Figure 4-1

CDM Smith

Linbrook Road (West) – OF-3232-1

There is only one pipe segment within the Linbrook Road (West) system that does not have sufficient capacity to convey the 10-year design storm (see **Figure 3-6**). In order to provide sufficient capacity, the deficient 12-inch pipe and downstream 12-inch outfall pipe are being replaced with approximately 160 feet of 15-inch pipe as shown on **Figure 4-2**. Since this area does not have any documented flooding, it is recommended as a Tier 3 priority.

Arundel Avenue – OF-3836-3

The Arundel Avenue system is the most complex system within the project area. Model results show that most of the main trunkline has sufficient capacity to convey flows for the 10-year design storm, but the systems that tie in from the side streets tend to have insufficient capacity and surcharged manholes (see **Figure 3-1**). Once the capacity of the side street systems is increased, the additional flow to the trunkline causes deficiencies within the trunkline and additional surcharging. In order to address the surcharged manholes on the side streets and minimize impacts to the trunkline system, three alternatives were evaluated to address the documented flooding locations.

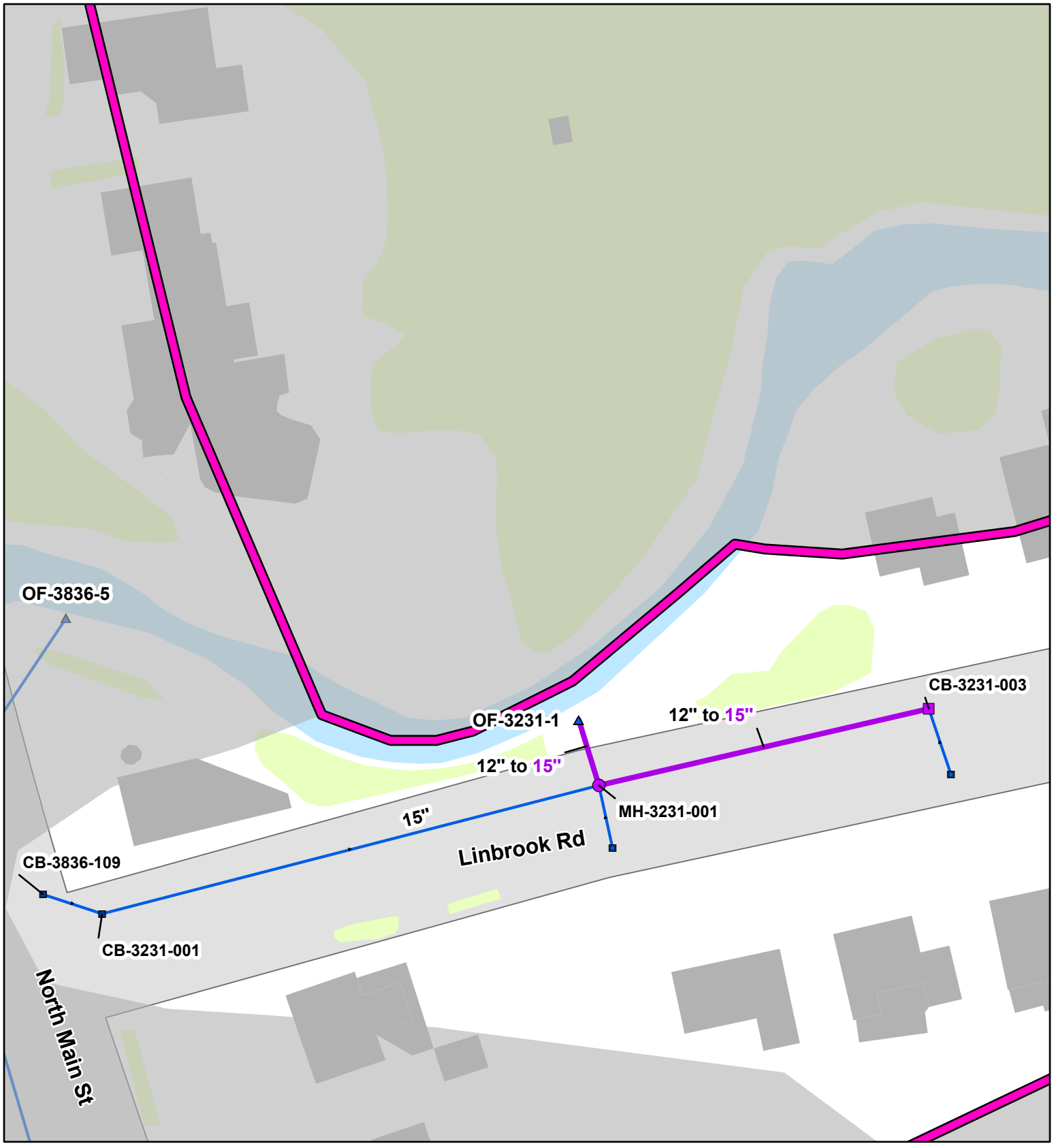
- *Alternative 1:* Existing pipe replacements to address insufficient capacity
- *Alternative 2:* Subsurface storage and replace existing under capacity pipes
- *Alternative 3:* Diversion pipe to divert flow away from the Arundel Avenue system (recommended alternative)

Arundel Avenue – Alternative 1

This alternative considered replacement of pipes so that the entire system has sufficient capacity during the 10-year design storm. **Table 4-3** and **Figure 4-3** summarize proposed improvements for Alternative 1.

Table 4-3: Hydraulic Improvements Summary – Arundel Avenue Alternative 1

Proposed Pipe Size (in)	Pipe Length (lf)
12	200
15	300
18	900
24	1,800
30	900
36	2,700
42	100
48x48	1,000
48x60	200
48x72	300
48x84	2,000
60x96	1,000
Total	***11,400***



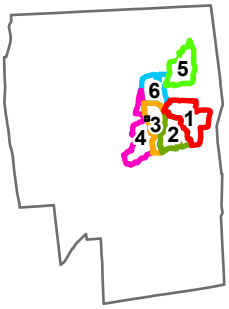
Legend

- Study Area 4
- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Recommended Improvement
- Proposed Storm Manhole
- Proposed Storm Catch Basin
- 18" Proposed Storm Drain Size

N

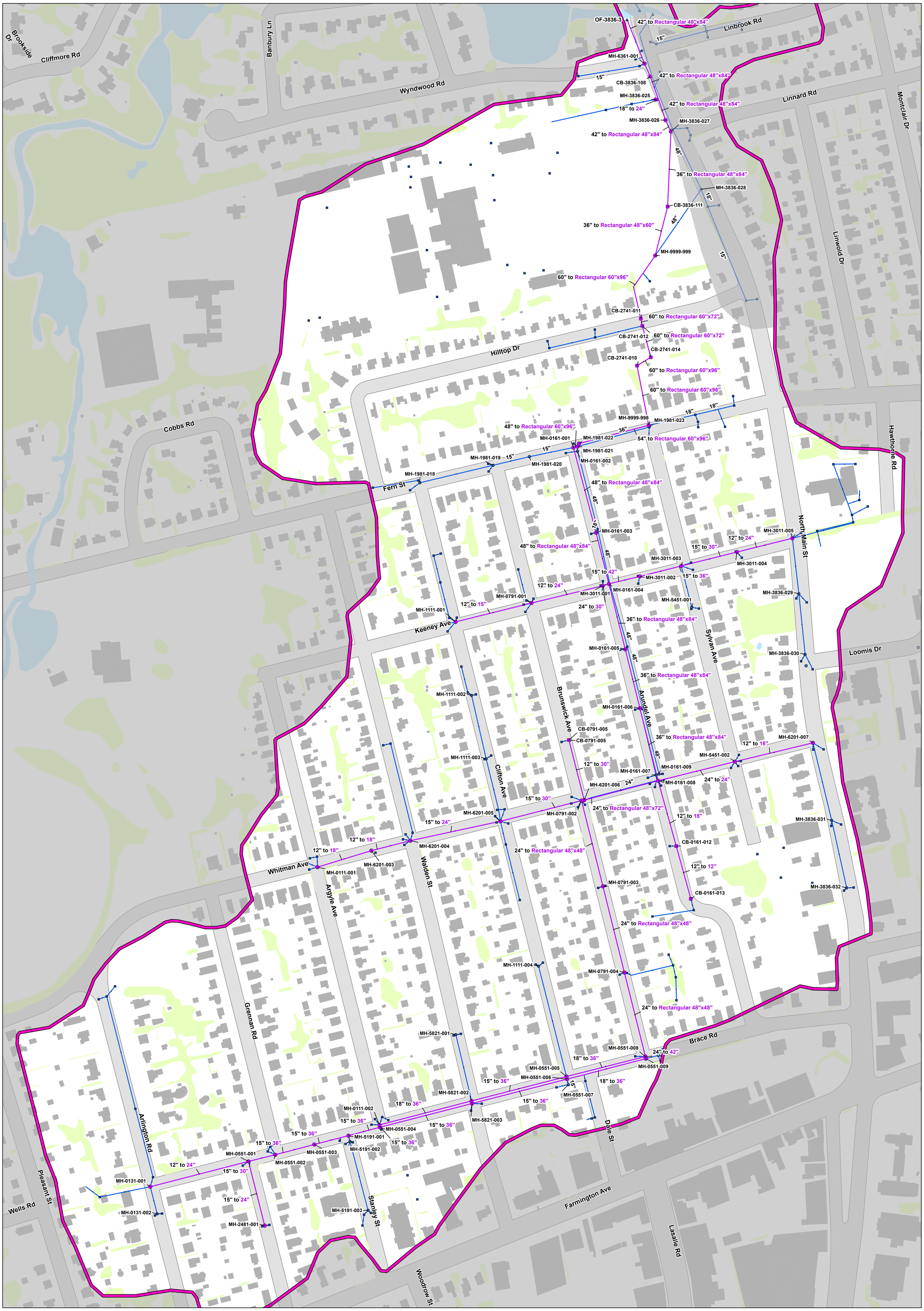
1"=50'

0 50 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Linbrook Road (West)
Recommended Improvements
Figure 4-2

CDM Smith



Legend

- Study Area 4
- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Alternative 1 Labeled Circular
- Proposed Storm Manhole
- Proposed Storm Catch Basin
- 18" Proposed Storm Drain Size

1"=150'

N

0 150 300 450 600 Feet

West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 4 Arundel Avenue Alternative 1
Figure 4-3

Arundel Avenue – Alternative 2

This alternative considered storage within the upper portion of the watershed to minimize impacts to the downstream trunkline. A parking lot at the intersection of Brunswick Avenue and Brace Road was chosen for the subsurface storage location. Based on the modeling results, approximately 6.14 acre-feet of storage is required to decrease surcharged manholes downstream and minimize pipe replacements. The storage design assumes subsurface storage without accounting for infiltration. If subsurface conditions are favorable and infiltration is included in the future, the subsurface storage volume could be reduced. The design also assumes that the storage unit drains via gravity back to the drainage system. **Table 4-4** and **Figure 4-4** summarize proposed improvements for Alternative 2.

Table 4-4: Hydraulic Improvements Summary – Arundel Avenue Alternative 2

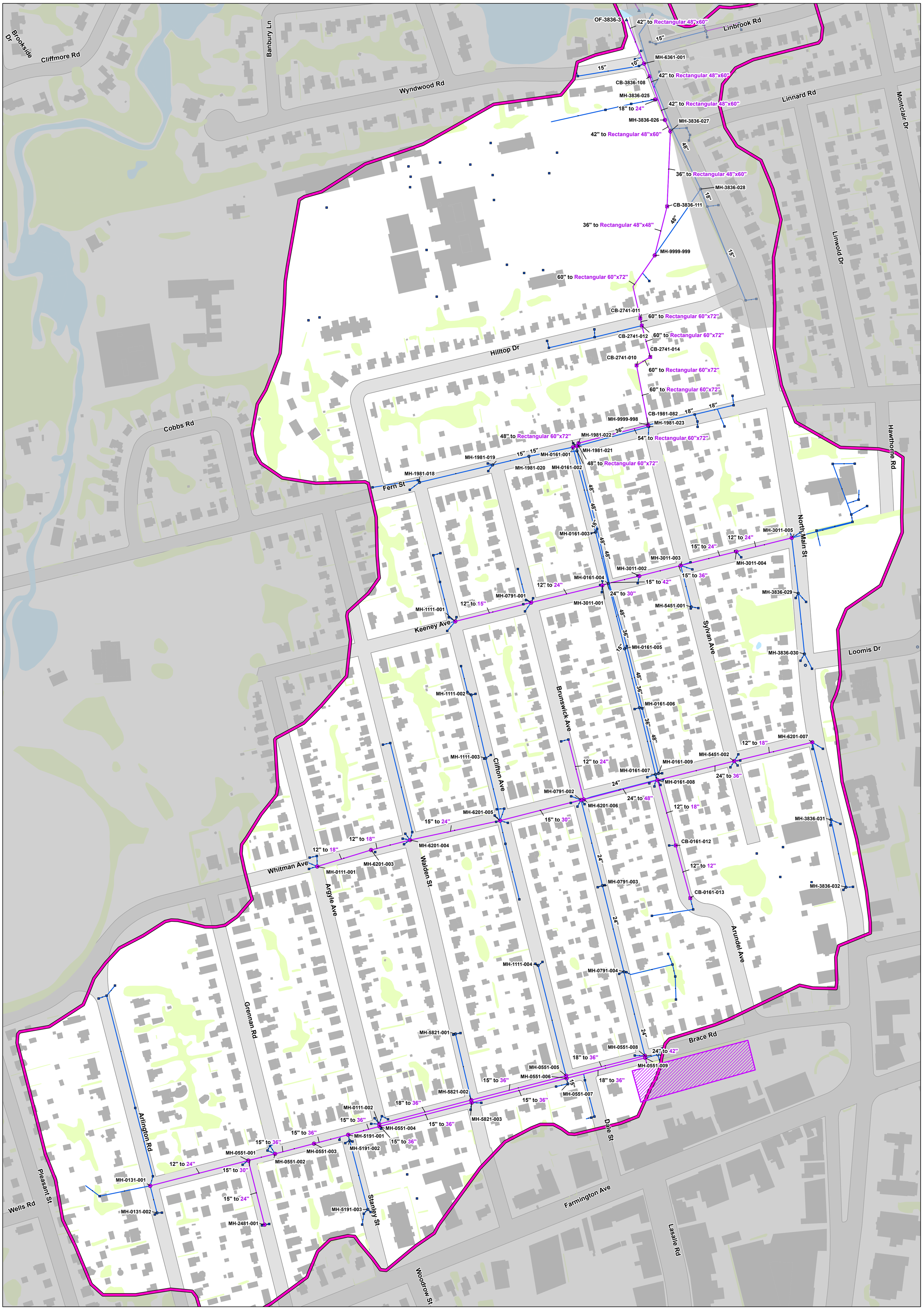
Proposed Pipe Size (in)	Pipe Length (lf)
12	200
15	300
18	900
24	1,800
30	300
36	500
42	100
48	300
48x48	300
48x60	1,500
60x72	1,700
Total	***8,100***

Arundel Avenue – Alternative 3

This alternative includes installation of a 60-inch diversion pipe from the intersection of Whitman Avenue and Arundel Avenue to an existing outfall on Loomis Drive. Based on the modeling results, the diversion is required to decrease surcharged manholes downstream and minimize pipe replacements. **Table 4-5** and **Figure 4-5** summarize proposed improvements for Alternative 3. Based on constructability, community impacts, and cost this is the recommended alternative.

Table 4-5: Hydraulic Improvements Summary – Arundel Avenue Alternative 3

Proposed Pipe Size (in)	Pipe Length (lf)
15	500
18	600
24	1,400
30	800
36	2,900
42	300
48	700
54	1,600
60	1,200
Total	***10,000***



CDM Smith

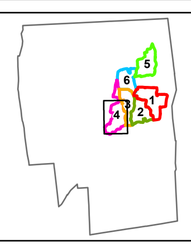
Legend

- Study Area 4
- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Alternative 1 Labeled Circular
- Proposed Storm Manhole
- Proposed Storm Catch Basin
- 18" Proposed Storm Drain Size
- Proposed Underground Storage

1"=150'

N

0 150 300 450 600 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 4 Arundel Avenue Alternative 2
Figure 4-4

CDM Smith

CDM Smith

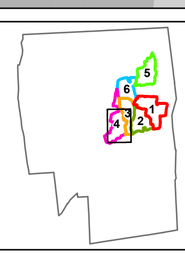
Legend

- Study Area 4
- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Alternative 1 Labeled Circular
- Proposed Storm Manhole
- Proposed Storm Catch Basin
- 18" Proposed Storm Drain Size

1"=150'

N

0 150 300 450 600 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 4 Arundel Avenue Alternative 3
Figure 4-5

CDM Smith

4.2.2 Area 5 – St. Joseph's Tributary

The St. Joseph's Tributary Area (Area 5) includes recommendations for one drainage system with two outfalls, OF-3141-3 and OF-3141-4. This system is complex, consisting of a large drainage network that splits just south of Albany Avenue and discharges to two separate 42-inch outfalls. Model results show that most of the main trunkline has sufficient capacity to convey flows for the 10-year design storm, but the systems that tie in from the side streets tend to have insufficient capacity and surcharged manholes (see **Figure 3-2**). Once the capacity of the side street systems is increased, the additional flow to the trunkline causes deficiencies within the trunkline and additional surcharging. To address the surcharged manholes on the side streets and minimize impacts to the trunkline system, two alternatives were evaluated to address the documented flooding locations.

- *Alternative 1:* Existing pipe replacements to address insufficient capacity
- *Alternative 2:* Subsurface storage and replace existing under capacity pipes (recommended alternative)

St. Joseph's Tributary – Alternative 1

This alternative considered replacement of pipes so that the entire system has sufficient capacity during the 10-year design storm. The storage design assumes subsurface storage without accounting for infiltration. If subsurface conditions are favorable and infiltration is included in the future, the subsurface storage volume could be reduced. The design also assumes that the storage unit drains via gravity back to the drainage system. **Table 4-6** and **Figure 4-6** summarize proposed improvements for Alternative 1.

Table 4-6: Hydraulic Improvements Summary – St. Joseph's Tributary Alternative 1

Proposed Pipe Size (in)	Pipe Length (lf)
18	1,200
24	2,100
30	1,800
36	300
42	400
48	800
54	3,300
Total	***9,900***

St. Joseph's Tributary – Alternative 2

This alternative considered storage within the upper portion of the watershed to minimize impacts to the downstream trunkline. The tennis courts at the University of St. Joseph on Albany Avenue was chosen for the subsurface storage location. Based on the modeling results, approximately 3.1 acre-feet of storage is needed to decrease surcharged manholes downstream and minimize pipe replacements. **Table 4-7** and **Figure 4-7** summarize proposed improvements for Alternative 2. Based on constructability, community impacts, and cost this is the recommended alternative.

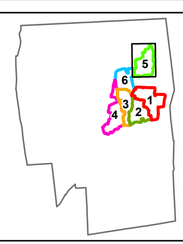
Legend

- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Alternative 1 Labeled Circular
- Proposed Storm Catch Basin
- Proposed Storm Manhole
- 18" Proposed Storm Drain Size

1"=150'

N

0 150 300 450 600 Feet



West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 5 Alternative 1
Figure 4-6

Legend

- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Alternative 1 Labeled Circular
- Proposed Storm Catch Basin
- Proposed Storm Manhole
- 18" Proposed Storm Drain Size
- Proposed Underground Storage

1"=150'

N

0 150 300 450 600 Feet

West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 5 Alternative 2
Figure 4-7

Table 4-7: Hydraulic Improvements Summary – St. Joseph's Tributary Alternative 2

Proposed Pipe Size (in)	Pipe Length (lf)
12	200
18	1,000
24	2,100
30	2,100
36	300
42	1,500
48	800
Total	***8,000***

4.2.3 Area 6 – East Branch Trout Brook at Asylum Avenue

The East Branch Trout Brook at Asylum Avenue Area (Area 6) includes recommendations for five drainage systems: Lindy Lane (OF-3251-1), Haynes Road (East) (MH-2601-003), Lawler Road (West) (OF-3141-1), Asylum Avenue and Lincoln Avenue (OF-0181-6), and Craigmoor Road (OF-5641-17 and OF-5641-19). This area experiences riverine flooding along Trout Brook due to undersized culverts, which causes roadway flooding. The Town is evaluating culvert improvements separate from this analysis to address the riverine flooding. The following summarizes the analysis and recommendations for each of the drainage systems.

Lindy Lane – OF-3251-1

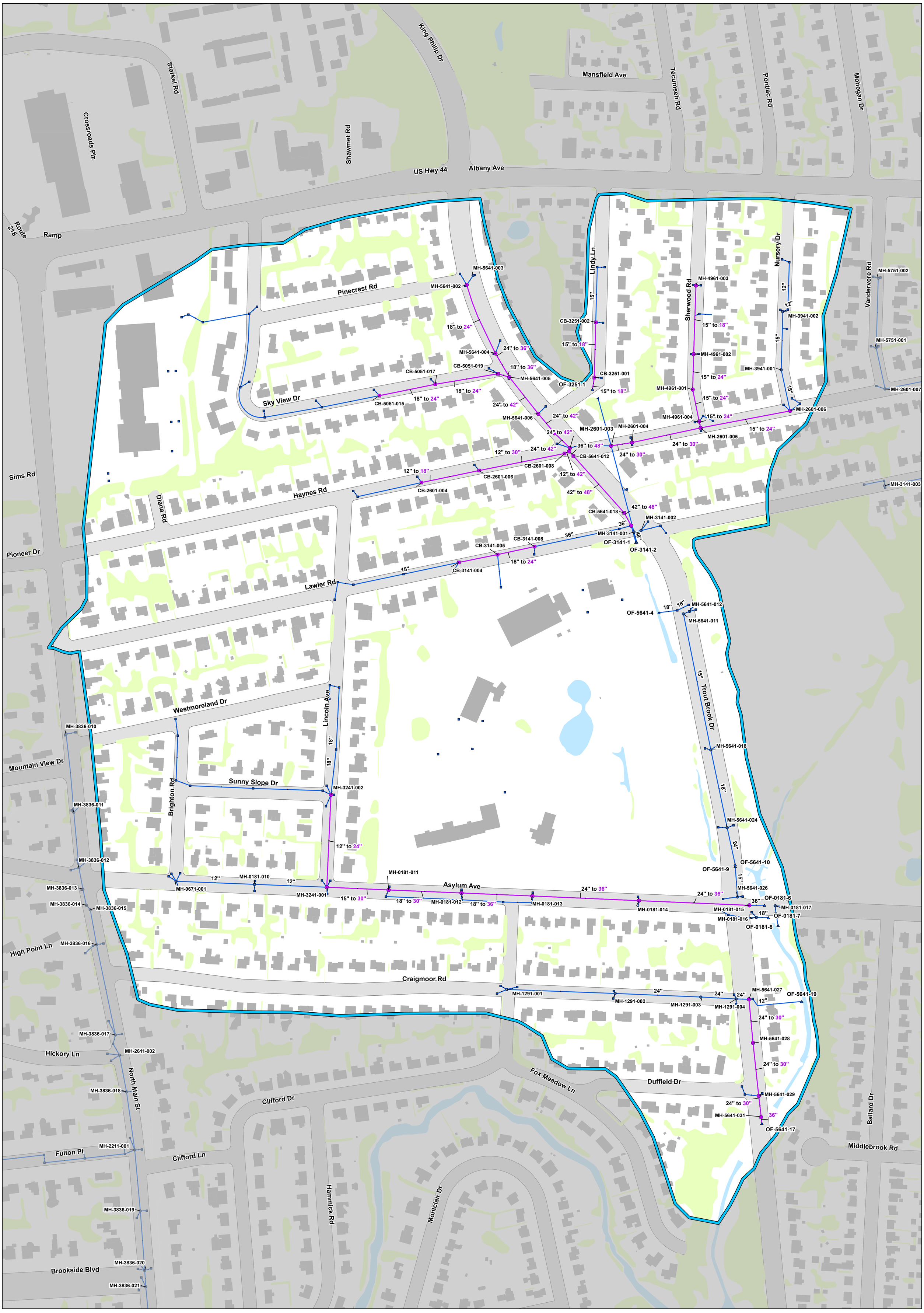
The model results show that the storm drain on Lindy Lane has insufficient capacity to convey flows for the 10-year design storm. To increase capacity, replacement pipes are proposed for the entire system. There is documented flooding at Lindy Lane and the East Branch of Trout Brook that is associated with the Lindy Lane culvert that conveys the East Branch of Trout Brook under Lindy Lane and not related to this small drainage system. It is recommended that approximately 300 feet of 15-inch pipe be replaced with 18-inch pipe as shown on **Figure 4-8**.

Haynes Road (East) – MH-2601-003

The model results show that the storm drain on Sherwood Road and Nursery Drive have insufficient capacity to convey flows for the 10-year design storm. To increase capacity, replacement pipes are proposed for the downstream system on Haynes Road to reduce surcharge and on Sherwood Road. **Table 4-8** and **Figure 4-8** summarize proposed improvements.

Table 4-8: Hydraulic Improvements Summary – Haynes Road (East)

Proposed Pipe Size (in)	Pipe Length (lf)
18	300
24	600
30	300
Total	***1,200***



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Legend

- Outfalls
- Existing Storm Manhole
- Existing Catch Basin
- Existing Storm Drain
- 18" Existing Storm Drain Size
- Alternative 1 Labeled Circular
- Proposed Storm Manhole
- 18" Proposed Storm Drain Size

1"=150'

N

0 150 300 450 600 Feet

West Hartford, CT
West Hartford Phase 2 Drainage Study
Area 6 Recommended Improvements
Figure 4-8

CDM Smith

Lawler Road (West) – OF-3141-1

The model results show that the upstream storm drains on Trout Brook Drive, Sky View Drive, Haynes Road, and Lawler Road have insufficient capacity. To increase capacity, replacement pipes are proposed for the majority of the system. **Table 4-9** and **Figure 4-8** summarize proposed improvements.

Table 4-9: Hydraulic Improvements Summary – Lawler Road (West)

Proposed Pipe (in)	Pipe Length (lf)
18	200
24	1,000
30	300
36	200
42	400
48	400
Total	***2,500***

Asylum Avenue and Lincoln Avenue – OF-0181-6

The model results show surcharged pipes in the upstream portion of the system on Lincoln Avenue and Asylum Avenue that have insufficient capacity to convey flows for the 10-year design storm. To increase capacity, replacement pipes are proposed in the downstream system on Trout Brook Drive to reduce surcharge. **Table 4-10** and **Figure 4-8** summarize proposed improvements.

Table 4-10: Hydraulic Improvements Summary – Asylum Avenue and Lincoln Avenue

Proposed Pipe Size (in)	Pipe Length (lf)
24	400
30	500
36	1,100
Total	***2,000***

Craigmoor Road – OF-5641-17 and OF-5641-19

The model results show a surcharged manhole on Craigmoor Road indicating insufficient capacity to convey flows for the 10-year design storm. To increase capacity, replacement pipes are proposed for the downstream system on Trout Brook Drive to reduce surcharge. Since this area does not have any documented flooding, it is recommended as a Tier 3 priority. **Table 4-11** and **Figure 4-8** summarize proposed improvements.

Table 4-11: Hydraulic Improvements Summary – Craigmoor Road

Proposed Pipe Size (in)	Pipe Length (lf)
30	400
36	30
Total	***430***

4.3 Prioritization Summary

Recommendations were developed for nine drainage systems based on modeled flooding during design storm and/or historical storms. Using the results of the existing conditions assessment, each recommendation was put into one of three priority tiers:

- *Tier 1 – High Priority Areas* has model predicated flooding during the design storm, model predicted flooding during historical storms, and reported flooding complaints from Town.
- *Tier 2 – Moderate Priority* has model predicated flooding during the design storm and historical storms.
- *Tier 3 – Low Priority has m*odel predicted flooding during the design storm.

The model was used to evaluate whether flooding is predicted for the 10-year design storm as well as for the four historical events considered in this study. Documented flooding locations were provided by the Town. In some instances, there was documented flooding along the East Branch of Trout Brook (within Area 6) that was not attributed to the drainage system. At these locations there was documented flooding, but the drainage systems did not have modeled flooding predicted during some of the modeled storm events. When this occurred, the Town was consulted to confirm the type of documented flooding and that the flooding was associated with the river system and not the drainage system. The specific locations where this occurred have been documented in the respective sections under Section 4.2 for each specific drainage system.

Table 4-12 presents a summary of each of the nine outfall systems including the recommended alternative and Tier prioritization.

Table 4-12: Recommendation Summary

			Alternative			
Area	Outfall	Location	1	2	3	Tier
4	OF-3836-4	North Main Street (North)	√			2
4	OF-3232-1	Linbrook Road (West)	√			3
4	OF-3836-3	Arundel Avenue			√	1
5	OF-3141-3 and OF-3141-4	St. Joseph's Tributary	√			1
6	OF-3251-1	Lindy Lane	√			3
6	MH-2601-003	Haynes Road (East)	√			2
6	OF-3141-1	Lawler Road (West)	√			1
6	OF-0181-6	Asylum Avenue and Lincoln Avenue	√			2
6	OF-5641-17 and OF-5641-19	Craigmoor Road	√			3

4.4 Groundwater Evaluation Recommendations

Due to the groundwater concerns within Area 3 under the Phase 1 study, CDM Smith performed an analysis of groundwater within Phase 1 project area and portions of the Phase 2 project area. The results of the groundwater study showed that Area 3 could benefit from additional groundwater investigations. Since groundwater does not seem to be as problematic within the

Phase 2 study area, no additional groundwater assessments were performed in Phase 2. The results of the groundwater study for Areas 1, 2, and 3 are presented in the Phase 1 report.

4.5 Collector Drainage Systems

The collector drainage system recommendations have been evaluated for the drainage study to consider conceptual layouts for redirecting sump pump and foundation discharge to the drainage system and away from the MDC sewer system. There are a significant number of confirmed private inflow connections in the study area that will require new mainline drain extensions, manholes, catch basins, and collector drains in the public right-of-way to facilitate redirection to the drain system. These recommendations are separate from the improvements and recommendations for the existing drainage system and will require coordination with the MDC and private property owners to implement.

Area 4 is located within portions of MDC sewer subareas WH17 and WH30, Area 5 is located within portions of sewer subareas WH11 and WH31, and Area 6 is located within MDC sewer subarea WH31. Both WH30 and WH31 were identified with excessive levels of inflow, infiltration, and rainfall-induced infiltration during prior studies that included building inspections. WH11 and WH17 were also identified with high levels of inflow and infiltration during the studies but building inspections were not conducted in either subarea since rainfall-induced infiltration was not identified at the time.

The estimated number of private inflow removal buildings, collector drains, drain extensions, and new drain structures have been summarized for each area on a street-by-street basis. The totals for Area 4 and Area 5 include some streets with completed building inspections. The remaining streets have been prorated based on the completed inspections in the adjacent areas which show that 40 percent of the buildings require private inflow removal, and 60 feet of collector drains are required per building. The Area 4 and Area 5 totals are considered rough order of magnitude estimates until building inspections are conducted and conceptual layouts can be developed. The Area 6 totals are based on the completed building inspections which have been used to develop the conceptual layout and costs.

Figures have been developed to show the conceptual layouts for collector drainage systems and connections to the existing drainage system in the study areas where building inspections have been conducted and private inflow removal targets have been identified. The figures show the proposed collector drains, new drain extensions, and new drain structures in the public right-of-way that have been used to develop estimated construction costs. The private property layouts were not evaluated since that component requires site visits which are performed during the final design and construction phases.

The conceptual layouts for Area 4 and Area 5 are incomplete due to the lack of building inspections on most streets. The figures for these areas show the inspection targets for streets without building inspections but do not show the private inflow removal buildings or collector drain locations. The proposed drain extensions have been shown for certain streets with no existing drains, but these extensions should be further evaluated based on the building inspection results.

Area 4

The proposed collector drainage system in Area 4 includes 320 buildings identified for I/I removal on 23 streets. The existing storm drains in this area include four different drainage systems (OF-3836-3, OF-3836-4, OF-3836-5, and OF-3232-1) that discharge to Trout Brook near North Main Street and Linbrook Road.

The collector drainage system recommendations for Area 4 have been separated into the streets with building inspections and the streets without building inspections. **Table 4-13** summarizes the Area 4 private inflow removal totals on a street-by-street basis and **Figure 4-9** shows the conceptual layout for new drain extensions, structures, and collector drains.

Table 4-13: Area 4 Collector Drainage System Recommendations

Study Area	Sewer Subarea	Street	I/I Removal Buildings	Collector Drain (Lf)	Drain Extensions (Lf)	Drain Structures
Area 4	**Streets with Building Inspections (Note 1)**					
	WH30	Brookside Boulevard	9	870	630	3
	WH30	Fulton Place	15	910	160	1
	WH30	Hickory Lane	12	585	560	3
	WH30	Linbrook Road	3	215	0	0
	WH30	Mountain View Drive	3	200	150	1
	WH30	North Main Street	30	1,850	0	0
	WH30	Wyndwood Road	2	120	0	0
		Subtotals	**74**	**4,750**	**1,500**	**8**
	Streets without Building Inspections (Note 2)					
	WH17	Argyle Avenue	18	1,080	1,150	4
	WH17	Arlington Road	11	660	260	1
	WH17	Arundel Avenue	22	1,320	360	3
	WH17	Brace Road	13	780	0	0
	WH17	Brunswick Avenue	22	1,320	560	2
	WH17	Clifton Avenue	24	1,440	0	0
	WH17	Dale Street	2	120	0	0
	WH17	Fern Street	18	1,080	0	0
	WH17	Grennan Road	14	840	640	3
	WH17	Hilltop Drive	21	1,260	930	4
	WH17	Keeney Avenue	16	960	0	0
	WH17	North Main Street	15	900	0	0
	WH17	Sylvan Avenue	14	840	730	2
	WH17	Walden Street	25	1,500	600	2
	WH17	Whitman Avenue	16	960	0	0
		Subtotals	**235**	**15,060**	**5,230**	**21**
		Area 4 Totals	**325**	**19,810**	**6,730**	**29**

Note 1: Subtotals are based on completed inspection data and conceptual layout for private inflow removal.

Note 2: Subtotals are prorated based on the completed inspections in the adjacent areas which show that 40% of the buildings require private inflow removal and 60 feet of collector drains per building.

Area 6

Area 4

Note: Building inspection targets indicate inspections not performed on most streets in Area 4. Inspections are necessary to identify the private inflow removal buildings and layout the collector drainage system for the remainder of the area.

Legend

- 24" and Larger Drain Pipe
- 6"-20" Drain Pipe
- Abandoned/Inactive Drain
- Catch Basin
- Drain Manhole
- Drain Outfall

Private Inflow Removal

- Building Inspection Target
- Private Inflow Removal Building
- New Drain Extension
- New Collector Drain
- New Catch Basin
- Drain Manhole

0 300 600
Feet

N

CDM Smith

Town of West Hartford, CT

West Hartford Drainage Study
Figure 4-9
Area 4 Collector Drainage System
July 2021

The conceptual layout for the nine streets with building inspections includes 85 private inflow removal buildings, 5,405 feet of collector drains, 2,515 feet of new storm drain extensions, and 13 new storm drain structures. The remaining fifteen streets without building inspections use the prorated totals that assume an additional 235 private inflow removal buildings, 14,100 feet of collector drains, 5,230 feet of storm drain extensions, and 21 storm drain structures.

Area 5

The proposed collector drainage system in Area 5 includes 164 buildings identified for I/I removal on 18 streets. The existing storm drains are located within the St. Joseph's tributary area that includes two outfalls (OF-3141-3 and OF-3141-4) that discharge to the same general location south of Lawler Road. Like Area 4, collector drainage system recommendations for Area 5 have been separated into streets with building inspections and streets without building inspections. **Table 4-14** summarizes the Area 5 private inflow removal totals on a street-by-street basis and **Figure 4-10** shows the conceptual layout for drain extensions, structures, and collector drains.

Table 4-14: Area 5 Collector Drainage System Recommendations

Study Area	Sewer Subarea	Street	I/I Removal Buildings	Collector Drain (Lf)	Drain Extensions (Lf)	Drain Structures
Area 5	**Streets with Building Inspections (Note 1)**					
	WH31	Haynes Road	4	300	0	0
	WH31	Vandervere Road	4	205	0	0
		Subtotals	**8**	**505**	**0**	**0**
	Streets without Building Inspections (Note 2)					
	WH11	Albany Avenue	7	420	0	0
	WH11	Brainard Road	16	960	0	0
	WH11	Brewster Road	7	420	0	0
	WH11	Colony Road	9	540	620	5
	WH11	Lawler Road	10	600	0	0
	WH11	Miamis Road	13	780	0	0
	WH11	Mohawk Drive	4	240	0	0
	WH11	Mohegan Drive	6	360	0	0
	WH11	North Steele Road	4	240	0	0
	WH11	Norwood Road	18	1,080	0	0
	WH11	Pilgrim Road	16	960	0	0
	WH11	Seneca Road	13	780	0	0
	WH11	Sequin Road	13	780	0	0
	WH31	Sioux Lane	3	180	0	0
	WH11	Westwood Road	8	480	740	3
	WH11	Wiltshire Lane	9	540	0	0
		Subtotals	**156**	**9,360**	**1,360**	**8**
		Area 5 Totals	**164**	**9,865**	**1,360**	**8**

Note 1: Subtotals are based on completed inspection data and conceptual layout for private inflow removal.

Note 2: Subtotals are prorated based on the completed inspections in the adjacent areas which show that 40% of the buildings require private inflow removal and 60 feet of collector drains per building.

Parsons Dr
Lyman Rd
Seminole Cir
Mohawk Dr
Stoneham Dr
Iroquois Rd
Brewster Rd
Seneca Rd
Brainard Rd
Westwood Rd
Ledyard Rd
N Steele Rd
Grenhart St
Mohegan Dr
Colony Rd
Pontiac Rd
Miamis Rd
Sequin Rd
Chesterfield Ln
Pilgrim Rd
Norwood Rd
Albany Ave
US Hwy 44
Nursery Dr
Vanderveer Rd
Sioux Ln
Wiltshire Ln
Haynes Rd
Lawler Rd
Steele Rd
Stratford Rd

Note: Building inspection targets indicate inspections not performed on most streets in Area 4. Inspections are necessary to identify the private inflow removal buildings and layout the collector drainage system for the remainder of the area.

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Legend

- 24" and Larger Drain Pipe
- 6"-20" Drain Pipe
- Abandoned/Inactive Drain
- Catch Basin
- Drain Manhole
- Drain Outfall

Private Inflow Removal

- Building Inspection Target
- Private Inflow Removal Building
- New Drain Extension
- New Collector Drain
- New Catch Basin
- Drain Manhole

0 200 400
Feet

N

Town of West Hartford, CT

West Hartford Drainage Study
Figure 4-10
Area 5 Collector Drainage System
July 2021

The only streets in Area 5 with building inspections are Haynes Road and Vandervere Road in the southwest portion of the area. These two streets include 8 private inflow removal buildings, 505 feet of collector drains, no new storm drain extensions and no new storm drain structures. The remaining 16 streets without building inspections use the prorated totals that assume an additional 156 private inflow removal buildings, 9,360 feet of collector drains, 1,360 feet of new storm drain extensions, and 8 new storm drain structures will be required.

Area 6

The proposed collector drainage system in Area 6 includes 120 buildings identified for I/I removal on 11 streets. As noted, building inspections were conducted on all streets in this area and the results were used to the develop the conceptual layout for I/I removal. The existing storm drains in Area 6 include multiple outfall systems located along Trout Brook Drive. The conceptual layout for Area 6 includes 6,700 feet of collector drain, 3,950 feet of new storm drain extensions, and 14 new storm drain structures.

Table 4-15 summarizes the private inflow removal totals for Area 6 on a street-by-street basis. **Figure 4-11** shows the conceptual layout for new drain extensions, structures and collector drains in Area 6.

Table 4-15: Area 6 Collector Drainage System Recommendations

Study Area	Sewer Subarea	Street	I/I Removal Buildings	Collector Drain (Lf)	Drain Extensions (Lf)	Drain Structures
Area 6	WH31	Duffield Drive	1	20	360	1
	WH31	Haynes Road	22	1,030	900	3
	WH31	Lawler Road	13	1,130	780	3
	WH31	Lindy Lane	2	90	0	0
	WH31	Nursery Drive	5	190	0	0
	WH31	Pinecrest Road	10	500	410	2
	WH31	Sherwood Road	11	500	0	0
	WH31	Sky View Drive	9	510	0	0
	WH31	Sunny Slope Drive	5	220	0	0
	WH31	Trout Brook Drive	8	450	0	0
	WH31	Westmoreland Drive	5	300	260	1
		Totals	**120**	**6,700**	**3,950**	**14**

Note 1: Subtotals are based on completed inspection data and conceptual layout for private inflow removal.

Area 5

Area 6

Area 4

Legend

- 24" and Larger Drain Pipe
- 6"-20" Drain Pipe
- Abandoned/Inactive Drain
- Catch Basin
- Drain Manhole
- Drain Outfall

Private Inflow Removal

- Private Inflow Removal Building
- New Drain Extension
- New Collector Drain
- New Catch Basin
- Drain Manhole

0 200 400
Feet

N

CDM Smith

Town of West Hartford, CT

West Hartford Drainage Study
Figure 4-11
Area 6 Collector Drainage System
July 2021

Section 5
Cost Estimate

This section provides conceptual costs for storm drainage system improvements and collector drainage system improvements for each drain outfall. The recommended improvements to the drainage system are described in **Section 4**.

5.1 Capacity Improvements

Section 4 summarized the recommendations for improving the public drainage system to accommodate at 10-year storm and prioritized the project implementation. **Table 5-1** summarizes the costs for each alternative. If the Town implemented improvements to all areas, the total cost in 2021 dollars is estimated to be in the range of $74 million to $90 million.

Table 5-1: Conceptual Design Costs for Storm Drain System Replacements

Area	Outfall	Location	Alternative 1	Alternative 2	Alternative 3	Tier
4	OF-3836-4	North Main Street (North)	$4,300,000			2
4	OF-3232-1	Linbrook Road (West)	$170,000			3
4	OF-3836-3	Arundel Avenue	$40,400,000	$28,200,000	$33,200,000	1
5	OF-3141-3 OF-3141-4	St. Joseph's Tributary	$27,200,000	$32,400,000		1
6	OF-3251-1	Lindy Lane	$300,000			3
6	MH-2601-003	Haynes Road (East)	$2,100,000			2
6	OF-3141-1	Lawler Road (West)	$5,800,000			1
6	OF-0181-6	Asylum Avenue and Lincoln Avenue	$4,600,000			2
6	OF-5641-17 OF-5641-19	Craigmoor Road	$1,000,000			3

For the drainage system improvements, unit costs based on pipe diameter and length were developed from construction contracts in the greater Hartford area awarded in the last 10 years. Since the alternatives were developed to a conceptual level, costs for engineering and contingency totaling 45 percent were added to the base totals.

The conceptual costs include new drain pipes, manholes, and catch basins installed in the public right-of-way with earthwork, pavement replacement, surface restoration, police, maintenance and protection of traffic, and miscellaneous work. No rock excavation allowance was included.

The age, material, and condition of pipes was not considered in this analysis. Older pipes may need to be lined or replaced due to pipe condition if they are in the construction area. The minimum new drain pipe size is 12-inch diameter, but existing 10-inch diameter pipes will remain if they meet capacity.

5.2 Collector Drainage System

Section 4 summarizes the collector drainage system recommendations for the three study areas on a street-by-street basis. This information has been further developed to identify the collector drainage system costs for each storm drain outfall area as summarized in **Table 5-2**. The collector drainage system cost estimates are based on the following assumptions:

- 6" PVC Collector Drain: $150 per foot
- 12-15" RCP Storm Drain Extensions: $400 per foot
- New Storm Drain Structures: $5,000 each
- Engineering and Contingency: 45 percent

The total conceptual cost estimate, for collector drainage systems in the priority areas listed in **Table 5-2** is $15,264,800, including engineering and contingency totaling 45 percent. The conceptual layout within priority drainage systems includes approximately 36,375 feet of collector drains, 12,040 feet of new storm drain extensions, and 51 new storm drain structures. The estimated collector drainage system costs do not include costs for work on private property (sump pumps/pits, interior discharge pipe, exterior service pipe, etc.). Based on recent construction costs from the Four Mile Road Area and Greenhurst Road Area projects, the cost for work on private property ranges from $13,000 to $15,000 per property.

Table 5-2: Conceptual Design Costs for Collector Drainage Systems

Area	Location	Private I/I Removal Buildings	Collector Drain (Lf)	Drain Extensions (Lf)	Drain Structure (Each)	Total Costs[1, 2]
4	North Main Street (North)	62	3,815	1,500	8	$1,757,800
4	Linbrook Road (West)	3	215	0	0	$46,800
4	Arundel Avenue	260	15,780	5,230	21	$6,617,800
5	St. Joseph's Tributary	164	9,865	1,360	8	$2,992,500
6	Lindy Lane	2	90	0	0	$19,600
6	Haynes Road (East)	39	1,770	1,310	5	$1,181,100
6	Lawler Road (West)	39	2,540	780	3	$1,026,600
6	Asylum Ave and Lincoln Ave	24	1,380	260	1	$458,200
6	Craigmoor Road	16	920	1600	5	$1,164,400
Totals		**609**	**36,375**	**12,040**	**51**	**$15,264,800**

1. Total costs include 45% for engineering and contingency.
2. Total costs do not include work on private property.

The work on private property includes approximately 609 buildings as summarized in **Table 5-2**. This total includes buildings with completed inspections (202) and buildings that have not been inspected (407). As summarized in Section 4, Areas 4 and 5 include over 1,000 properties with incomplete building inspections that may have illicit connections that require private inflow removal. Based on the completed building inspections in the study areas, approximately 40

percent of the buildings with incomplete inspections will require private inflow removal. These buildings should be inspected to determine the actual totals and refine the costs assumptions.

Based on the average cost from past projects ($14,000 per building), the estimated cost for work on private property is $8.5 million. Including engineering and contingency (45 percent), the total project cost for work on private property is $12.4 million as summarized in **Table 5-3**.

5.3 Summary

Recommendations and costs have been developed for the various drainage system deficiencies. The proposed drainage improvements fall into four categories:

- **Pipe Replacements** – Drainage system replacements increase the capacity of the existing pipes in the public right-of-way to convey the 10-year storm.
- **Collector Drains** – These are smaller diameter pipes that collect private property storm drain connections and do not convey street drainage.
- **Drain Extensions** – These are the improvements to the drainage infrastructure (pipes, catch basins, and manholes), typically on side streets, to convey public and private stormwater.
- **Private Disconnects** – Private infrastructure improvements (on private property) to convey storm flow to the public drain, collector drain, or drain extensions.

Table 5-3 provides a summary of costs for each improvement by outfall and prioritization tier. The summation of drainage system improvements, drain extensions, collector drains, and private disconnects are presented in Section 4.

Table 5-3: Conceptual Design Costs for Storm Drain System Replacements

Area	Location	Pipe Replacements	Collector Drains	Drain Extensions	Private Disconnects	Tier
4	North Main Street (North)	$4,300,000	$829,800	$928,000	$1,258,600	2
4	Linbrook Road (West)	$170,000	$46,800	$0	$60,900	3
4	Arundel Avenue	$33,200,000	$3,432,200	$3,185,700	$5,278,000	1
5	St. Joseph's Tributary	$27,200,000	$2,145,700	$846,800	$3,329,200	1
6	Lindy Lane	$300,000	$19,600	$0	$40,600	3
6	Haynes Road (East)	$2,100,000	$385,000	$796,100	$791,700	2
6	Lawler Road (West)	$5,800,000	$552,500	$474,200	$791,700	1
6	Asylum Avenue and Lincoln Avenue	$4,600,000	$300,100	$158,100	$487,200	2
6	Craigmoor Road	$1,000,000	$200,100	$964,300	$324,800	3

1. Costs include 45 percent for engineering and contingency.

Drainage system and collector drainage system improvements should be considered based on the prioritization tier shown in the table above and the available funding. As shown above there is a Tier 1, 2, and 3 recommendation within each of the three project areas.

Appendix A

Pipe Quantities for Hydraulic Improvements

Drainage System Evaluations in the Trout Brook Watershed - Phase 2

Area 4: North Main Street

Pipe Quantities for Hydraulic Improvements in North Main Street (North)

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
North Main Street	MH-3836-012	MH-3836-013	12	15	82
North Main Street	MH-3836-013	MH-3836-014	12	15	63
North Main Street	MH-3836-014	MH-3836-015	12	18	23
North Main Street	MH-3836-015	MH-3836-016	12	18	134
North Main Street	MH-3836-016	MH-3836-017	12	24	350
North Main Street	MH-3836-017	MH-2611-002	12	24	77
North Main Street	MH-2611-002	MH-3836-018	15	30	142
North Main Street	MH-3836-018	MH-2211-001	15	30	222
North Main Street	MH-2211-001	MH-3836-019	18	30	232
North Main Street	MH-3836-019	MH-3836-020	18	30	226
North Main Street	MH-3836-020	MH-3836-021	18	30	62
North Main Street	MH-3836-021	MH-3836-022	18	30	231
North Main Street	MH-3836-022	MH-3836-023	30	30	258
North Main Street	MH-3836-023	MH-3836-024	30	36	109

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 4: North Main Street
Pipe Quantities for Hydraulic Improvements in Linbrook Road (West)

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Recommended Pipe Diameter (in)	Pipe Length (lf)
Linbrook Road	CB-3231-003	MH-3231-001	12	15	130
Linbrook Road	MH-3231-001	OF-3231-1	12	15	26

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 4: North Main Street
Pipe Quantities for Hydraulic Improvements in Arundel Area - Alternative 1 (increase pipe size)

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Arundel Avenue	CB-0161-013	CB-0161-012	12	12	208
Keeney Avenue	MH-1111-001	MH-0791-001	12	15	297
Whitman Avenue	MH-0111-001	MH-6201-003	12	18	214
Whitman Avenue	MH-6201-003	MH-6201-004	12	18	153
Whitman Avenue	MH-6201-007	MH-5451-002	12	18	305
Arundel Avenue	CB-0161-012	MH-0161-008	12	18	257
Brace Road	MH-0131-001	MH-0551-001	12	24	385
Grennan Road	MH-2481-001	MH-0551-001	15	24	251
Whitman Avenue	MH-6201-004	MH-6201-005	15	24	350
Whitman Avenue	MH-5451-002	MH-0161-008	24	24	300
Keeney Avenue	MH-0791-001	MH-3011-001	12	24	278
Keeney Avenue	MH-3011-005	MH-3011-004	12	24	217
North Main Street	MH-3836-025	MH-3836-025_2	18	24	13
Brace Road	MH-0551-001	MH-0551-002	15	30	105
Brunswick Avenue	CB-0791-005	MH-6201-006	12	30	235
Whitman Avenue	MH-6201-005	MH-6201-006	15	30	317
Keeney Avenue	MH-3011-001	MH-0161-004	24	30	24
Keeney Avenue	MH-3011-004	MH-3011-003	15	30	218
Brace Road	MH-0551-002	MH-0551-003	15	36	153
Brace Road	MH-0551-003	MH-5191-001	15	36	134
Brace Road	MH-5191-001	MH-0551-004	15	36	124
Brace Road	MH-0551-004	MH-0111-002	15	36	9
Brace Road	MH-0111-002	MH-5821-002	18	36	361
Brace Road	MH-0551-004	MH-5821-003	15	36	361
Brace Road	MH-5821-002	MH-0551-005	15	36	372
Brace Road	MH-5821-003	MH-0551-006	15	36	372
Brace Road	MH-0551-006	MH-0551-009	18	36	309
Brace Road	MH-0551-005	MH-0551-008	18	36	309
Keeney Avenue	MH-3011-003	MH-3011-002	15	36	163
Brace Road	MH-0551-009	MH-0551-008	24	42	8
Keeney Avenue	MH-3011-002	MH-0161-004_2	15	42	117
Brunswick Avenue	MH-0551-008	MH-0791-004	24	48x48	329
Brunswick Avenue	MH-0791-004	MH-0791-003	24	48x48	337
Brunswick Avenue	MH-0791-003	MH-6201-006	24	48x48	335
Cross-Country	MH-9999-999	CB-3836-111	36	48x60	192
Whitman Avenue	MH-6201-006	MH-0161-008	24	48x72	290
Arundel Avenue	MH-0161-008	MH-0161-006	36	48x84	260
Arundel Avenue	MH-0161-006	MH-0161-005	36	48x84	231
Arundel Avenue	MH-0161-005	MH-0161-004	36	48x84	256
Arundel Avenue	MH-0161-004	MH-0161-003	48	48x84	200

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Arundel Avenue	MH-0161-003	MH-0161-001	48	48x84	334
Cross-Country	CB-3836-111	MH-3836-027	36	48x84	285
North Main Street	MH-3836-027	MH-3836-026	42	48x84	48
North Main Street	MH-3836-026	MH-3836-025_2	42	48x84	79
North Main Street	MH-3836-025_2	MH-6361-001	42	48x84	150
North Main Street	MH-6361-001	OF-3836-3	42	48x84	180
Fern Street	MH-0161-001	MH-1981-021	48	60x96	16
Fern Street	MH-1981-021	MH-1981-022	48	60x96	13
Fern Street	MH-1981-022	MH-9999-998	54	60x96	273
Cross-Country	MH-9999-998	CB-2741-010	60	60x96	232
Cross-Country	CB-2741-010	CB-2741-014	60	60x96	61
Cross-Country	CB-2741-014	CB-2741-012	60	60x96	123
Cross-Country	CB-2741-012	CB-2741-011	60	60x96	28
Cross-Country	CB-2741-011	MH-9999-999	60	60x96	268

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 4: North Main Street
Pipe Quantities for Hydraulic Improvements in Arundel Area - Alternative 2 (Brace Road 2 MG Storage Tank)

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Brace Road	MH-0551-008_ST	MH-0551-008		12	25
Arundel Avenue	CB-0161-013	CB-0161-012	12	12	208
Keeney Avenue	MH-1111-001	MH-0791-001	12	15	297
Whitman Avenue	MH-0111-001	MH-6201-003	12	18	214
Whitman Avenue	MH-6201-003	MH-6201-004	12	18	153
Whitman Avenue	MH-6201-007	MH-5451-002	12	18	305
Arundel Avenue	CB-0161-012	MH-0161-008	12	18	257
Grennan Road	MH-2481-001	MH-0551-001	15	24	251
Brunswick Avenue	CB-0791-005	MH-0791-002	12	24	235
Whitman Avenue	MH-6201-004	MH-6201-005	15	24	350
Keeney Avenue	MH-0791-001	MH-3011-001	12	24	278
Keeney Avenue	MH-3011-005	MH-3011-004	12	24	217
Keeney Avenue	MH-3011-004	MH-3011-003	15	24	218
North Main Street	MH-3836-025	MH-3836-025_2	18	24	13
North Main Street	MH-3836-025	MH-3836-025_2	18	24	192
Whitman Avenue	MH-6201-005	MH-0791-002	15	30	317
Keeney Avenue	MH-3011-001	MH-0161-004	24	30	24
Whitman Avenue	MH-5451-002	MH-0161-008	24	36	300
Keeney Avenue	MH-3011-003	MH-3011-002	15	36	163
Brace Road	MH-0551-009	MH-0551-008_STORAGE	24	42	8
Keeney Avenue	MH-3011-002	MH-0161-004_2	15	42	117
Whitman Avenue	MH-0791-002	MH-0161-008	24	48	290
Cross-Country	MH-9999-999	CB-3836-111	36	48x48	192
Cross-Country	MH-9999-999	CB-3836-111	36	48x48	61
Cross-Country	CB-3836-111	MH-3836-027	36	48x60	285
North Main Street	MH-3836-027	MH-3836-026	42	48x60	48
North Main Street	MH-3836-026	MH-3836-025_2	42	48x60	79
North Main Street	MH-3836-025_2	MH-6361-001	42	48x60	150
North Main Street	MH-6361-001	OF-3836-3	42	48x60	180
Cross-Country	CB-3836-111	MH-3836-027	36	48x60	123
North Main Street	MH-3836-027	MH-3836-026	42	48x60	28
North Main Street	MH-3836-026	MH-3836-025_2	42	48x60	268
North Main Street	MH-3836-025_2	MH-6361-001	42	48x60	285
North Main Street	MH-6361-001	OF-3836-3	42	48x60	48
Fern Street	MH-0161-001	MH-1981-021	48	60x72	16
Fern Street	MH-1981-021	MH-1981-022	48	60x72	13
Fern Street	MH-1981-022	MH-9999-998	54	60x72	273
Cross-Country	MH-9999-998	CB-2741-010	60	60x72	232
Cross-Country	CB-2741-010	CB-2741-014	60	60x72	61

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Cross-Country	CB-2741-014	CB-2741-012	60	60x72	123
Cross-Country	CB-2741-012	CB-2741-011	60	60x72	28
Cross-Country	CB-2741-011	MH-9999-999	60	60x72	268
Cross-Country	MH-9999-998	CB-2741-010	60	60x72	117
Cross-Country	CB-2741-010	CB-2741-014	60	60x72	16
Cross-Country	CB-2741-014	CB-2741-012	60	60x72	13
Cross-Country	CB-2741-012	CB-2741-011	60	60x72	273
Cross-Country	CB-2741-011	MH-9999-999	60	60x72	232

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 4: North Main Street
Pipe Quantities for Hydraulic Improvements in Arundel Area - Alternative 3 (Loomis Drive Diversion)

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Arundel Avenue	CB-0161-013	CB-0161-012	12	15	208
Keeney Avenue	MH-1111-001	MH-0791-001	12	15	297
Whitman Avenue	MH-0111-001	MH-6201-003	12	18	214
Whitman Avenue	MH-6201-003	MH-6201-004	12	18	153
Arundel Avenue	CB-0161-012	MH-0161-008	12	18	257
Brace Road	MH-0131-001	MH-0551-001	12	24	385
Whitman Avenue	MH-6201-004	MH-6201-005	15	24	350
Keeney Avenue	MH-3011-004	MH-3011-003	15	24	218
Keeney Avenue	MH-0791-001	MH-3011-001	12	24	278
Keeney Avenue	MH-3011-005	MH-3011-004	12	24	217
Grennan Road	MH-2481-001	MH-0551-001	15	30	251
Brunswick Avenue	CB-0791-005	MH-0791-002	12	30	235
Keeney Avenue	MH-3011-001	MH-0161-004	24	30	24
Keeney Avenue	MH-3011-003	MH-3011-002	15	30	163
Keeney Avenue	MH-3011-002	MH-0161-004	15	30	117
Brace Road	MH-0551-001	MH-0551-002	15	36	105
Brace Road	MH-0551-002	MH-0551-003	15	36	153
Brace Road	MH-0551-003	MH-5191-001	15	36	134
Brace Road	MH-5191-001	MH-0551-004	15	36	124
Brace Road	MH-0551-004	MH-0111-002	15	36	9
Brace Road	MH-0111-002	MH-5821-002	18	36	361
Brace Road	MH-0551-004	MH-5821-003	15	36	361
Brace Road	MH-5821-002	MH-0551-005	15	36	372
Brace Road	MH-5821-003	MH-0551-006	15	36	372
Brace Road	MH-0551-006	MH-0551-009	18	36	309
Brace Road	MH-0551-005	MH-0551-008	18	36	309
Whitman Avenue	MH-6201-005	MH-0791-002	15	36	317
Brace Road	MH-0551-009	MH-0551-008	24	42	8
Cross-Country (American School for Deaf)	CB-3836-111	MH-3836-027	36	42	285
Brunswick Avenue	MH-0551-008	MH-0791-004	24	48	329
Brunswick Avenue	MH-0791-004	MH-0791-003	24	48	337
Brunswick Avenue	MH-0791-003	MH-0791-002	24	54	335
Whitman Avenue	MH-0791-002	MH-0161-008	24	54	290
Whitman Avenue	MH-0161-008	J2	N/A	54	623
North Main Street	J2	J3	N/A	54	306
Loomis Drive	J3	J4	N/A	60	1141
Loomis Drive	J4	J1	N/A	60	93

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 5: St. Joseph's Tributary
Pipe Quantities for Hydraulic Improvements - Alternative 1 (increase pipe size)

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Pilgrim Road	MH-4251-006	MH-1161-001	12	18	307
Cross-Country	MH-1161-003	MH-3931-006	12	18	413
Norwood Road	MH-3931-006	MH-3931-004	12	18	200
Miamis Road	MH-3561-002	MH-3561-003	15	18	256
Norwood Road	MH-3931-001	MH-3931-002	15	24	160
Norwood Road	CB-3931-019	CB-3931-016	15	24	319
Norwood Road	CB-3931-016	MH-0631-013	15	24	33
Brainard Road	MH-0571-001	MH-0631-012	15	24	250
Brainard Road	MH-0571-005	MH-0571-004	18	24	306
Norwood Road	MH-3931-004	MH-3931-003	12	24	202
Haynes Road	MH-2601-007	MH-2601-008	15	24	308
Lawler Road	MH-3141-003	MH-3141-004	15	24	500
Norwood Road	MH-3931-002	MH-0631-013	15	30	393
Brewster Road	MH-0631-013	MH-4251-004	18	30	395
Pilgrim Road	MH-4251-003	MH-4251-004	24	30	160
Norwood Road	MH-3931-003	MH-3931-005	15	30	276
Colony Road	MH-3931-005	MH-1161-002	15	30	215
Colony Road	MH-1161-002	MH-1161-001	15	30	182
Haynes Road	MH-2601-008	MH-2601-UNK	15	30	218
Wiltshire Lane	MH-6231-003	MH-3261-P01	36	36	64
Wiltshire Lane	MH-3261-P01	MH-3261-P02	36	36	228
Brewster Road	MH-4251-004	MH-0631-012	30	42	373
Brainard Road	MH-0631-012	MH-0571-002	36	48	288
Brainard Road	MH-0571-002	MH-0571-003	36	48	139
Colony Road	MH-1161-001	MH-0571-004	24	48	348
Brainard Road	MH-0571-003	MH-0571-004	36	54	332
Colony Road	MH-0571-004	MH-4881-001	42	54	371
Sequin Road	MH-4881-001	MH-4881-002	42	54	289
Cross-Country	MH-4881-002	MH-3561-003	42	54	342
Miamis Road	MH-3561-003	J2	42	54	162
Miamis Road	J2	MH-3561-004	42	54	254
Albany Avenue	MH-3561-004	MH-6231-003	48	54	75
Wiltshire Lane	MH-6231-003	MH-6231-002	36	54	331
Wiltshire Lane	MH-6231-002	MH-6231-005	36	54	83
Wiltshire Lane	MH-6231-005	MH-6231-004	36	54	27
Wiltshire Lane	MH-6231-004	MH-6231-006	36	54	273
Wiltshire Lane	MH-6231-006	MH-6231-007	36	54	222
Cross-Country	MH-6231-007	CB-6231-008	36	54	112
Cross-Country	CB-6231-008	CB-6231-009	36	54	93
Cross-Country	CB-6231-009	OF-3141-4	42	54	315

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 5: St. Joseph's Tributary
Pipe Quantities for Hydraulic Improvements - Alternative 2 (1 MG Storage Tank)

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Albany Avenue	Underground Storage	MH-4881-003	N/A	12	171
Pilgrim Road	MH-4251-006	MH-1161-001	12	18	307
Brainard Road	MH-0571-001	MH-0631-012	15	18	250
Cross-Country	MH-1161-003	MH-3931-006	12	18	413
Norwood Road	MH-3931-001	MH-3931-002	15	24	160
Norwood Road	CB-3931-019	CB-3931-016	15	24	319
Norwood Road	CB-3931-016	MH-0631-013	15	24	33
Norwood Road	MH-3931-006	MH-3931-004	12	24	200
Norwood Road	MH-3931-004	MH-3931-003	12	24	202
Haynes Road	MH-2601-007	MH-2601-008	15	24	308
Lawler Road	MH-3141-003	MH-3141-004	15	24	500
Albany Avenue	MH-4881-003	MH-3561-004	N/A	24	379
Norwood Road	MH-3931-002	MH-0631-013	15	30	393
Brewster Road	MH-0631-013	MH-4251-004	18	30	395
Pilgrim Road	MH-4251-002	MH-4251-003	24	30	225
Pilgrim Road	MH-4251-003	MH-4251-004	24	30	160
Norwood Road	MH-3931-003	MH-3931-005	15	30	276
Colony Road	MH-3931-005	MH-1161-002	15	30	215
Colony Road	MH-1161-002	MH-1161-001	15	30	182
Haynes Road	MH-2601-008	MH-2601-UNK	15	30	218
Colony Road	MH-1161-001	MH-0571-004	24	36	348
Brewster Road	MH-4251-004	MH-0631-012	30	42	373
Brainard Road	MH-0571-004	MH-0571-005	N/A	42	306
Brainard Road	MH-0571-005	Underground Storage	N/A	42	839
Brainard Road	MH-0631-012	MH-0571-002	36	48	288
Brainard Road	MH-0571-002	MH-0571-003	36	48	139
Brainard Road	MH-0571-003	MH-0571-004	36	48	332

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 6: East Branch Trout Brook at Asylum Avenue
Pipe Quantities for Hydraulic Improvements for OF-3251

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Lindy Lane	CB-3251-002	CB-3251-001	15	18	209
Lindy Lane	CB-3251-001	OF-3251-1	15	18	45

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 6: East Branch Trout Brook at Asylum Avenue
Pipe Quantities for Hydraulic Improvements for MH-2601-003

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Sherwood Road	MH-4961-003	MH-4961-002	15	18	260
Haynes Road	MH-2601-006	MH-2601-005	15	24	345
Sherwood Road	MH-4961-002	MH-4961-001	15	24	134
Sherwood Road	MH-4961-001	MH-4961-004	15	24	124
Sherwood Road	MH-4961-004	MH-2601-005	15	24	25
Haynes Road	MH-2601-005	MH-2601-004	24	30	266
Haynes Road	MH-2601-004	MH-2601-003	24	30	81

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 6: East Branch Trout Brook at Asylum Avenue
Pipe Quantities for Hydraulic Improvements for OF-3141-1

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Haynes Road	CB-2601-004	CB-2601-006	12	18	224
Sky View Drive	CB-5051-015	CB-5051-017	18	24	216
Sky View Drive	CB-5051-017	CB-5051-019	18	24	241
Trout Brook Drive	MH-5641-002	MH-5641-004	18	24	282
Lawler Road	CB-3141-004	CB-3141-008	18	24	293
Haynes Road	CB-2601-006	CB-2601-008	12	30	330
Sky View Drive	CB-5051-019	MH-5641-005	18	36	45
Trout Brook Drive	MH-5641-004	MH-5641-005	24	36	105
Trout Brook Drive	MH-5641-005	MH-5641-006	24	42	176
Trout Brook Drive	MH-5641-006	MH-5641-007	24	42	97
Trout Brook Drive	MH-5641-007	MH-2601-002	24	42	80
Trout Brook Drive	MH-2601-002	MH-2601-001	24	42	13
Haynes Road	CB-2601-008	MH-2601-001	12	42	16
Trout Brook Drive	MH-2601-001	CB-5641-012	36	48	33
Trout Brook Drive	CB-5641-012	CB-5641-018	42	48	290
Trout Brook Drive	CB-5641-018	MH-3141-001_2	42	48	55

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 6: East Branch Trout Brook at Asylum Avenue
Pipe Quantities for Hydraulic Improvements for OF-0181-6

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Lincoln Avenue	MH-3241-002	MH-3241-001	12	24	351
Asylum Avenue	MH-3241-001	MH-0181-011	15	30	235
Asylum Avenue	MH-0181-011	MH-0181-012	18	30	277
Asylum Avenue	MH-0181-012	MH-0181-013	18	36	269
Asylum Avenue	MH-0181-013	MH-0181-014	24	36	405
Asylum Avenue	MH-0181-014	MH-0181-015	24	36	419

Drainage System Evaluations in the Trout Brook Watershed - Phase 2
Area 6: East Branch Trout Brook at Asylum Avenue
Pipe Quantities for Hydraulic Improvements for OF-5641-17

Location	Upstream Structure	Downstream Structure	Existing Pipe Diameter (in)	Proposed Pipe Diameter (in)	Pipe Length (lf)
Trout Brook Drive	MH-5641-027	MH-5641-028	24	30	166
Trout Brook Drive	MH-5641-028	MH-5641-029	24	30	202
Trout Brook Drive	MH-5641-029	MH-5641-031	24	30	79
Trout Brook Drive	MH-5641-031	OF-5641-17	36	36	26


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