CITY OF Painesville

Tiber Creek Drainage Study

August 2008

City of Painesville, Ohio

METCALF & EDDY | AECOM

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Executive Summary

The Tiber Creek and West Tributary Drainage area, located in the southwestern portion of the City, is an area of flooding concern in the City. Metcalf & Eddy (M&E) was hired to perform a drainage study for the Tiber Creek and West Tributary area and recommend improvements to help alleviate areas of drainage restriction.

The major objectives to be accomplished by this study are the following:

- Define the Tiber Creek drainage area;
- Develop a computer model of the drainage system;
- Evaluate the hydraulic capacity of the existing drainage system;
- Determine restrictive drainage areas; and
- Recommend potential improvements and planning-level costs

ES 1.0 Storm Water Model Development

A storm water drainage model was developed using the United States Environmental Protection Agency (USEPA) storm water management model (SWMM) Version 5.0.011 which is freely distributed software and approved by the Federal Emergency Management Agency (FEMA). SWMM is a widely-used program for the analysis of storm drainage systems, planning, and preliminary-design of sewers and drainage systems. All modeling files are included on a compact disc for the City's use with this report. This allows the City to have a working storm sewer model that can be modified, changed, and updated as future development occurs throughout the drainage area.

The Tiber Creek and West Tributary drainage area was modeled for the 5, 10, 50, and 100-year storm events. These are high intensity storm events. Fro example, a 5-year storm is expected to occur once every five years. This means that in a given year a 5-year storm has a 20% chance of occurring. The rainfall data used to define these storms was taken from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 "Precipitation-Frequency Atlas of the United

States, 2004". This document provides the rainfall intensity data in which to create the design storms for the drainage area.

The hydraulic model generated is limited in its use due to the unavailability of field data required to calibrate the model. Model calibration is the process of comparing the model results to data observed in the field and adjusting the input parameters until the model results compare favorably to actual field conditions. Typically, rainfall accumulation and actual measured storm sewer pipe flows during storm events are used for model calibration. Without this calibration process we cannot assume that the model is an entirely accurate representation of flow conditions within the storm sewer system. A storm sewer flow monitoring program must be implemented in order to develop an accurate model that can be used for design making decisions and recommendations. A planning cost for a flow monitoring program is $25,000. This program should be implemented and storm water model calibrated before proceeding with the design improvement phase.

ES 2.0 Critical Areas of Sewer Flow Restriction

After simulating these design storms in the model, areas of storm sewer flow restriction were found within the drainage system. The depth of flow within the sewer pipes was observed; and in some cases, the sewer flow depths overtopped manhole rim elevations. From the results of the model simulations, several areas were determined critical areas of flow restriction:

- Cedarbrook Drive
- Chestnut Street
- Mentor Avenue
- Nelson Street
- Gingerbread Apartments
- Jackson Street

ES 3.0 Storm Drainage Recommendations

M&E analyzed several methods to alleviate the areas of flow restriction within the drainage area including the enlargement of existing sewer pipes and channels, diverting restricted sewer flow to other areas, relief sewers, and additional retention or detention ponds. Since the recommendations are based upon an uncalibrated storm sewer model, they are provided for the City's planning purposes only. They should not be used as a basis for design for any drainage system improvements. The recommendations for improvements to the Tiber Creek drainage area are as follows:

Storm Sewer Improvements

Storm sewer improvements are recommended for the critical areas identified from the model results. These improvements involve upsizing the existing storm sewer pipe sizes to convey flows for up to a 10-year storm event. The storm sewer improvements are listed below in Table ES-1 in an order of priority for the City.

Table ES-1. Recommended Improvements and Planning-Level Costs

Priority	Project	Planning Cost
1	Chestnut Street and Cedarbrook Drive Storm Sewer Improvements	$1,198,,000
2	Mentor Avenue and Jackson Street Storm Sewer Improvements	$1,174,000
3	Gingerbread Apartments Storm Sewer Improvements	$640,000
4	Nelson Street Storm Sewer Improvements	$606,000

Many of the costs identified in Table ES-1 are based upon available record information, recent construction project bids, and project team experience. They are presented in Year 2008 U.S.

Dollars. Detailed storm water model calibration will be required in order to more accurately pinpoint these critical areas and the required pipe sizes for improvements.

Section 1
Introduction

1. INTRODUCTION

The City of Painesville, Ohio (City) is located along the Grand River in Lake County (see Figure 1-1; for a large system map, see Appendix A). The Tiber Creek drainage area, situated to the southwest of downtown, provides conveyance for local storm drainage in this area of the City.

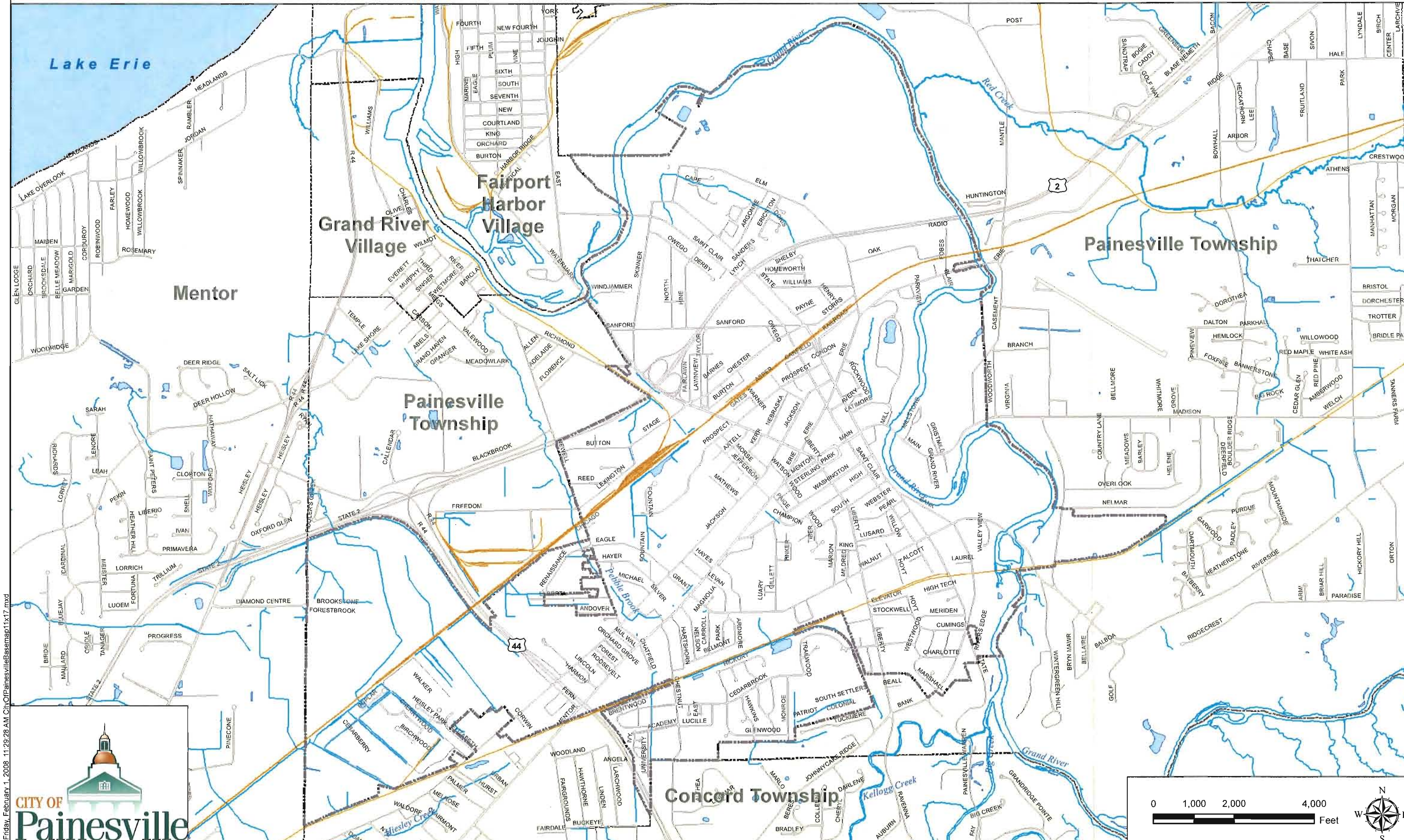
Tiber Creek rises near Walnut Street and Marion Avenue and follows a meandering course to Newell and Jackson Streets. From this point, the creek runs parallel with Newell Street north to Grand River. Storm water runoff in the southwest portions of the City is conveyed by storm sewers or creeks, particularly Tiber Creek. Sanitary sewers provide conveyance of wastewater flows.

1.1 Background & History

After a two-month wet period, two separate weather systems produced more than 11 inches of rain in Lake County on July 27-28, 2006. The intense rains, thunderstorms, and existing saturated conditions caused extensive flooding along the Grand River, affecting three northeast Ohio counties: Lake, Geauga, and Ashtabula (United States Geological Survey (USGS) Open File Report 2007-1164). These counties were declared Federal and State disaster areas (FEMA-1656-DR, State on August 1, 2006).

Near the City at the USGS streamflow-gaging station on the Grand River, the water level rose more than ten feet in a 12-hour period to a record peak stage of 19.35 feet. A peak streamflow of 35,000 cubic feet per second (cfs) was associated with this peak stage. The flooding exceeded the National Weather Service 8-foot flood stage and the Grand River near Painesville did not recede below the flood stage until July 31. This record peak streamflow had an estimated recurrence interval of 500 years. This storm rainfall event was estimated to have a recurrence interval of 1000 years.

Figure 1-1. City of Painesville



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This storm event triggered the city to further evaluate the existing storm drainage system. The Tiber Creek Drainage Study is a part of this initiative to improve the storm drainage.

1.2 Project Purpose

The City contracted with Metcalf & Eddy, Inc. of Ohio (M&E) in 2007 to perform a drainage study of the Tiber Creek and West Tributary drainage area.

The following are the major objectives to be undertaken as a part of this drainage study:

- Define the Tiber Creek drainage area;
- Develop a computer model of the drainage system;
- Evaluate the hydraulic capacity of the existing drainage system;
- Determine restrictive drainage areas; and
- Recommend potential improvements and planning-level costs.

Upon defining the drainage area, M&E determined a representative coefficient of runoff based upon the existing site conditions and City ordinance requirements for evaluation utilizing the United States Environmental Protection Agency (USEPA) Storm Water Management Model (SWMM) version 5.0.011 computer software modeling program. Stormwater flows were developed for the 5, 10, 50, and 100-year storm events; additionally, M&E indicated the design year rain event that could be passed through the City's drainage system without causing manholes to overtop with stormwater. The hydraulic capacity of the channels and storm sewer pipes through the drainage area were evaluated to identify critical hydraulic restrictions within the system. Based on this analysis, potential improvements and their associated planning costs were developed to increase the system capacity to handle larger rainfall events.

2. STORM SEWER MODELING

A hydraulic model was developed to evaluate the City's stormwater drainage capacity for the 5, 10, 50, and 100-year design storms and to determine the critical (current) system capacity. The USEPA SWMM Version 5.0.011 was selected for this analysis, which is freely distributed and approved by the Federal Emergency Management Agency (FEMA). A compact disc (CD) containing the hydraulic model files is included with this report. The hydraulic model files can be uploaded onto a computer for use with the SWMM software. This model can be expanded and modified to account for additional City development or changes to the existing storm sewers.

2.1 Model Development

The USEPA SWMM is a rainfall runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff component operates on a collection of sub-basin areas that receive precipitation and generate runoff. The routing portion of the software can transport the runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. In addition to the runoff quantity and quality, SWMM tracks the flow rate and flow depth of water in each pipe and channel during the simulation period. Furthermore, SWMM effectively integrates hydrologic and hydraulic predictions, accounting for time variations and the effect of storage components.

SWMM is a widely-used software for planning, analysis, and preliminary design of sewers and drainage systems. Developed originally in 1971 and completely re-written for the Version 5 release, SWWM Version 5.0.011 is an update to Version 5.0 and a Windows program with several key functions:

- Editing study area input data
- Running hydrologic, hydraulic, and water quality simulations

- Viewing results in conveyance system maps, profile plots, graphs, tables, and other various formats (see Figure 2-1).

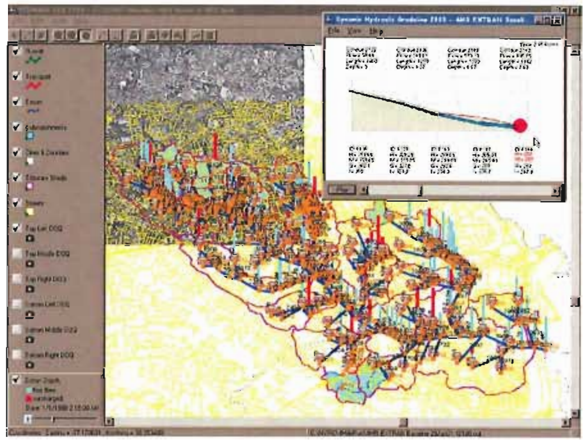
Figure 2-1. SWMM Program

M&E recommended using the USEPA SWMM Version 5.0 software because it integrates hydrologic and hydraulic predictions, accounts for time variations in rainfall, and can take into account the effect of storage. SWMM Version 5.0 is a free, downloadable, FEMA-approved storm modeling software that the City can use. This software allows the City to incorporate future developments into the model and observe their effects to the downstream drainage area.

2.1.1 Purpose

The development of a hydraulic model of the City's stormwater conveyance system is a helpful tool to evaluate the system's capacity for the 5, 10, 50, and 100-year design storms and identify improvements to make within the drainage system. A calibrated hydraulic model can also be used to determine the critical, or current, capacity of the drainage system in terms of the design-year rain event that can be passed without flooding. Any proposed improvements, including the upsizing of storm sewer pipes and detention/retention basins, can be incorporated into a calibrated hydraulic model to analyze the benefits to the drainage system.

2.1.2 Model Extent & Boundary Conditions

The approximate drainage area for this study is illustrated in Figure 2-2. The Geographic Information Systems (GIS) map of the City's storm sewer infrastructure was developed as part of the GASB-34 Data Development Project.

The southeastern edge of the drainage area follows State Route 84, with the southernmost tip approximately at the onramps to State Route 44 and the easternmost extent near Liberty Street. The eastern boundary crosses Kensington Avenue, the Norfolk Southern railroad, and East Walnut Avenue at Marion Avenue with its northernmost extent near Mentor Avenue. The northern border of the drainage area runs along Mentor Avenue and West Jackson Street except for a small extent between Newell Street and Fountain Avenue. The western border approximately follows State Route 44, with the exception of the developments along Brentwood Drive and Ivy Lane.

2.1.3 Assumptions & Limiting Conditions

Some assumptions were made in the development of the storm sewer system model. The roughness coefficients for the various pipe materials and surfaces were assumed and are summarized in Table 2-1.

Table 2-1. Manning's 'n' roughness coefficients.

Description	Roughness Coefficient
Reinforced Concrete Pipe (RCP)	0.013
Vitrified Clay Pipe (VCP)	0.013
Corrugated Metal Pipe (CMP)	0.025
Overland Flow – Streets	0.014
Overland Flow – Grass	0.030
Open Channel Flow	0.030 – 0.125

Additionally, the software assumes that the sewer system is clear of sediment and debris and that the full pipe depth is available for storm water transport. However, field visits and manhole inspections have indicated that many pipes within the City's storm sewer system contain sediment and debris which partially obstructs the pipe; therefore, the volume of water that can flow through these pipes is limited during any given storm event. This assumption impacts the analysis of the critical design storm, as the model is not representative of the actual pipe conditions.

A sewer profile view showing how pipe sediment can adversely affect its capacity can be found in Appendix E. A sample pipe section was selected for this example, Storm Manhole 304 to Storm Manhole 301 along Mentor Avenue. This sewer section along Mentor Avenue reaches from 870 feet northeast of West Washington Street to 300 feet southwest of Levan Drive. The first profile shows the water level in a clean pipe section carrying a 10-year design storm flow. The second profile shows the water level in the pipe section with sediment filling 33% of its volume. In this profile, the water level for a 10-year design storm overtops the manhole rim elevations.

2.1.4 Model Calibration

Model calibration is the process of comparing the model results to data observed in the field and adjusting the input parameters until the model results compare favorably to actual field conditions. Field data used for calibration in this case would be rainfall accumulation and actual measured sewer flows during storms events. This hydraulic model is limited in its use for design decision-related activities because model calibration data was not available for input. Even though the required storm sewer data was gathered and entered into the model, we cannot assume that the model is an entirely accurate representation of flow conditions in the storm sewer system. The model can be used to identify problem areas within the system, however final design decisions should not be made from an uncalibrated model.

2.1.5 Data Development

Data used in the preparation of this report was gathered in part from City records, field investigations, existing studies and reports, and data generated by government agencies such as the USGS and National Oceanic and Atmospheric Administration (NOAA). All of this data was then entered into the SWMM model (see Appendix A).

The storm sewer connectivity and sewer pipe diameters were taken from the City's GIS map as developed for the GASB-34 Data Development Project. The City's construction plans and reports from within the drainage area were reviewed and the hydraulic model was modified where appropriate. M&E personnel inspected accessible manholes within the study area and measured the storm sewer pipe inverts. Approximate rim elevations for each manhole were obtained based upon the two-foot contours from Lake County's GIS database. With this data, approximate storm sewer slopes were determined. Sewer pipe diameters were determined from the City's storm sewer map. The pipe slopes and diameters were necessary elements for the development of the model.

Some sections of the drainage study consisted of open channels and Tiber Creek. For these regions, the cross-sectional area was either approximated from the topographic contours or taken from field measurements acquired by M&E personnel.

2.1.6 Model Hydrology & Hydraulics

- Forty-three sub-basins were delineated for the Tiber Creek and West Tributary area based on two-foot contour topographic data as shown in Figure 2-3. Details regarding the characteristics of

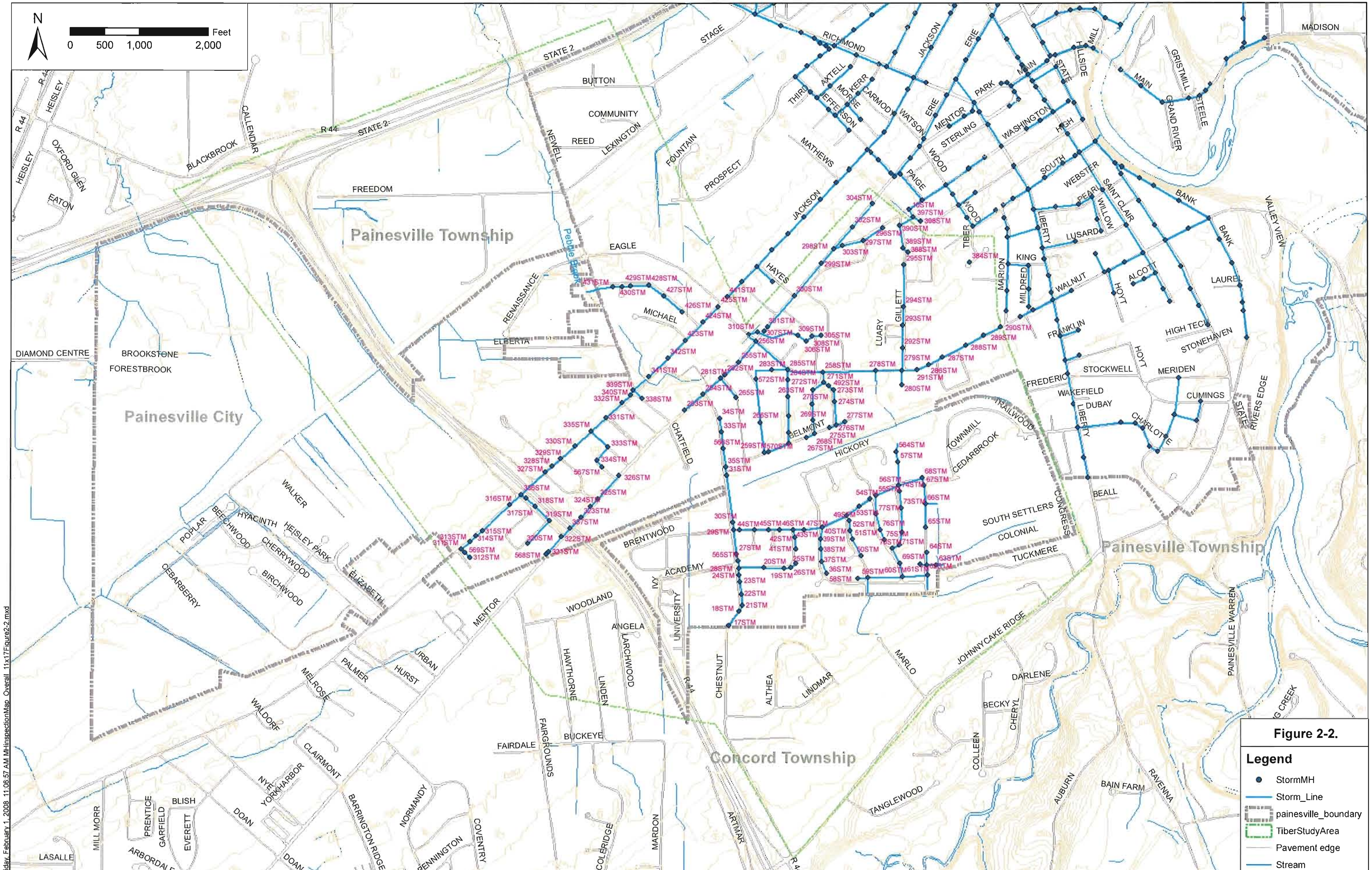

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Figure 2-3 Sub Basin Map
Tiber Creek Study Area

these sub-basins are shown in the SWMM input file (Appendix B). The sub-basin characteristics were determined as follows:

- ***Area***: The area for each sub-basin was calculated using ESRI ArcMap Version 9.2, software used for mapping and editing tasks as well as for map-based analysis.

- ***Soil Type***: Soil types were derived from the Natural Resources Conservation Service Custom Soil Resource Report for Lake County, Ohio, Painesville Tiber Creek (see Appendix C). Thus, the soil composition of each sub-basin was mapped according to its boundaries. Each soil type was then classified into one or a dual hydrologic soil group (A, B, C, D, A/D, B/D, or C/D).
- ***Average Slope***: The average slope for each sub-basin was calculated by dividing the average ground elevation by the length of flow for each sub-basin.
- ***Sub-basin Length***: The length of each sub-basin was assumed to be the flow path from the furthest point in the sub-basin to the sewer entry.
- ***Land Cover***: The percent impervious was determined by using data provided by the National Land Cover Database (see Appendix D). Land cover includes both the land use e.g., agricultural or urban, and the percents of tree canopy cover and impervious surface. The database was developed by the USGS Land Cover Institute based on data from 2001.

2.2 Design Storm Events

This analysis considered the 5, 10, 50, and 100-year storm events. It was decided to use the 24-hour design storms based on data from the NOAA Atlas 14 ("Precipitation-Frequency Atlas of the United States", 2004 available online at the NOAA website). The NOAA Atlas 14 provides rainfall intensity curves on which to create the design storms for the study area.

The Huff & Angel time distribution based on sub-basin area was applied (Rainfall Frequency Atlas of the Midwest, Floyd A. Huff & James R. Angel, 1992). It was assumed that the precipitation was a heavy storm rainfall at a point, thus implying a front-loaded storm. The design storms input into the model were comprised of the following characteristics:

	5-Year Storm	10-Year Storm	50-Year Storm	100-Year Storm
Avg. Intensity (in/hr)	0.147	0.171	0.234	0.264
Peak Intensity (in/hr)	0.4998	0.5814	0.7956	0.8976
Depth (in)	2.94	3.42	4.68	5.28

Chapter 3 explains the modeling results from these storm events and identifies the critical areas that were observed.

Section 3
Critical Drainage Areas

3. CRITICAL DRAINAGE AREAS

Critical areas were identified as those areas in which storm water manholes overtopped their rims during the 5 and 10-year design storm model simulation. Overall, these areas were found to generally correlate with areas mentioned by the City as having previous reports of surface water problems. Although the 5, 10, 50, and 100-year storm events were simulated, the 5 and 10-year events were considered most critical for identification and alternative analysis due to their frequency. Additionally, improvements made for the 5 and 10-year events would have some impact on the system capacity for the 50 and 100-year events.

3.1 Model Simulation Summary

The storm sewer model was then run to simulate the 5, 10, 50, and 100-year storm events. Graphical results of each storm may be seen in Figures 3-1 through 3-4. In each figure, the circles represent storm sewer manholes, culvert inlets/outlets, or catch basins. The color gradient indicates the depth of the storm water within the structure relative to the ground surface. Negative numbers indicate depth of the storm water below the manhole rims (ground surface); positive numbers indicate the depth that the storm water has overtopped their manhole rims.

Figure 3-1 Depth of Storm Water at Drainage Structures
5-Year Design Storm
Baseline Conditions

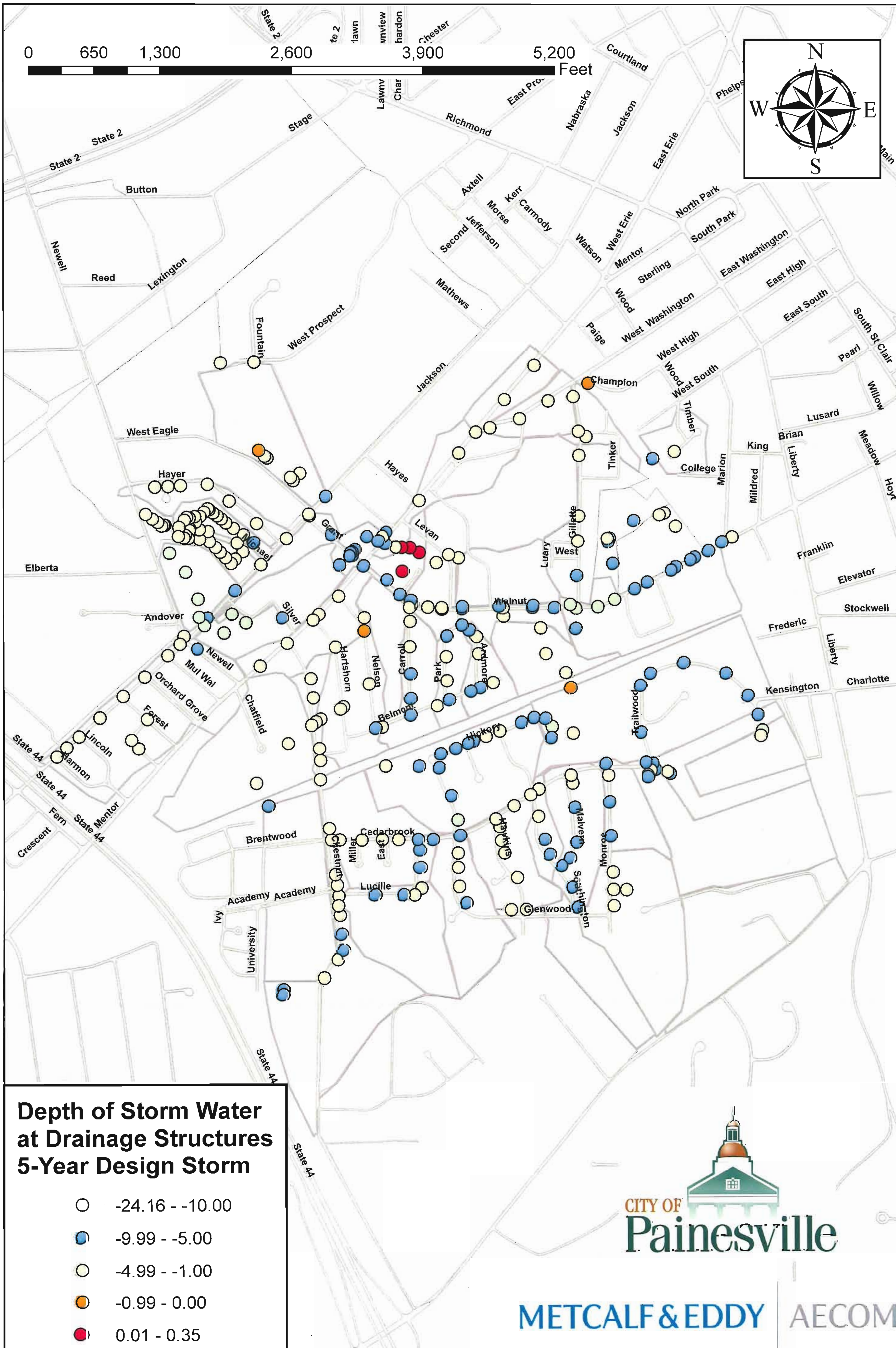


Figure 3-2 Depth of Storm Water at Drainage Structures
10-Year Design Storm
Baseline Conditions

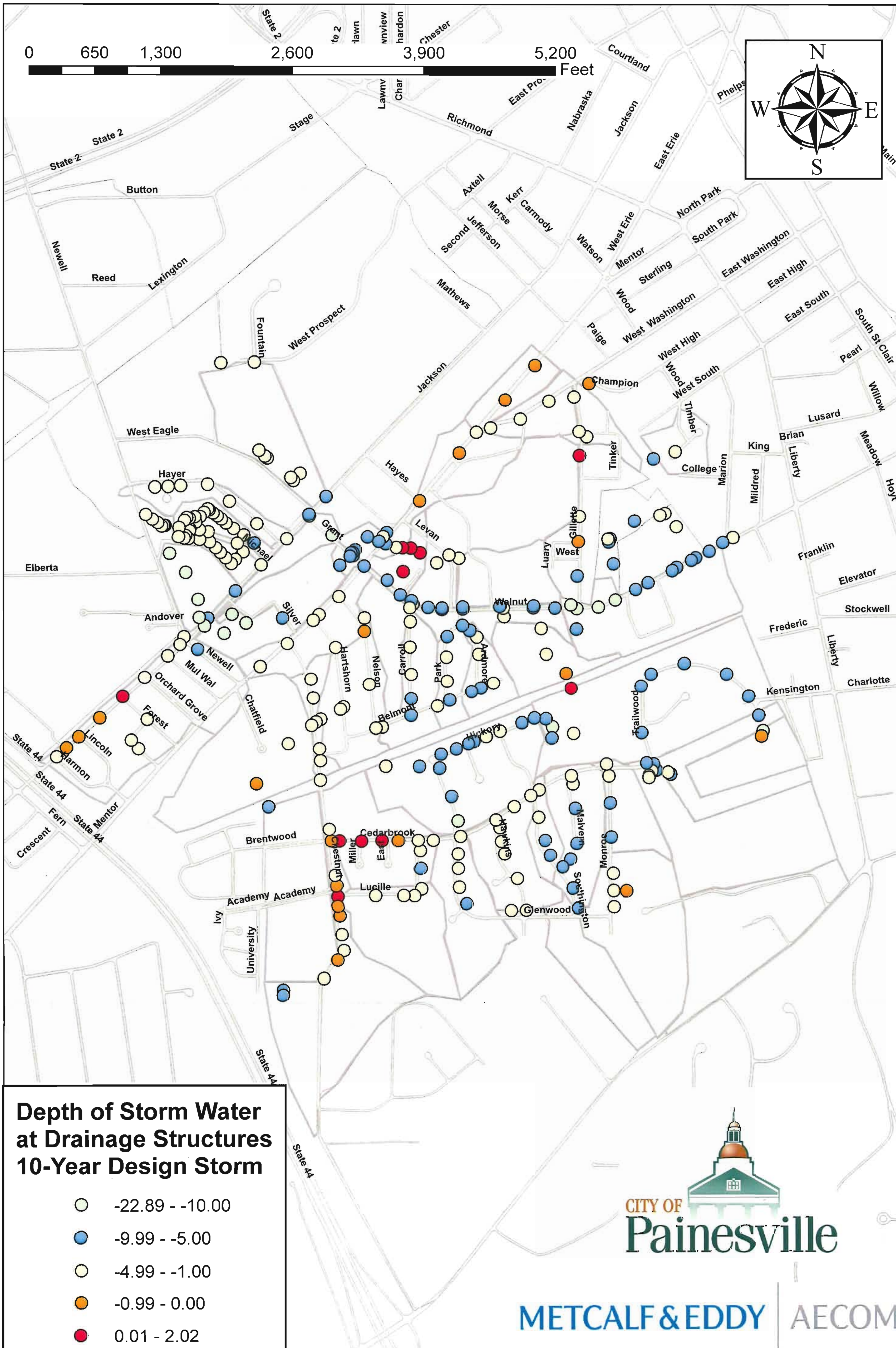


Figure 3-3 Depth of Storm Water at Drainage Structures
50-Year Design Storm
Baseline Conditions

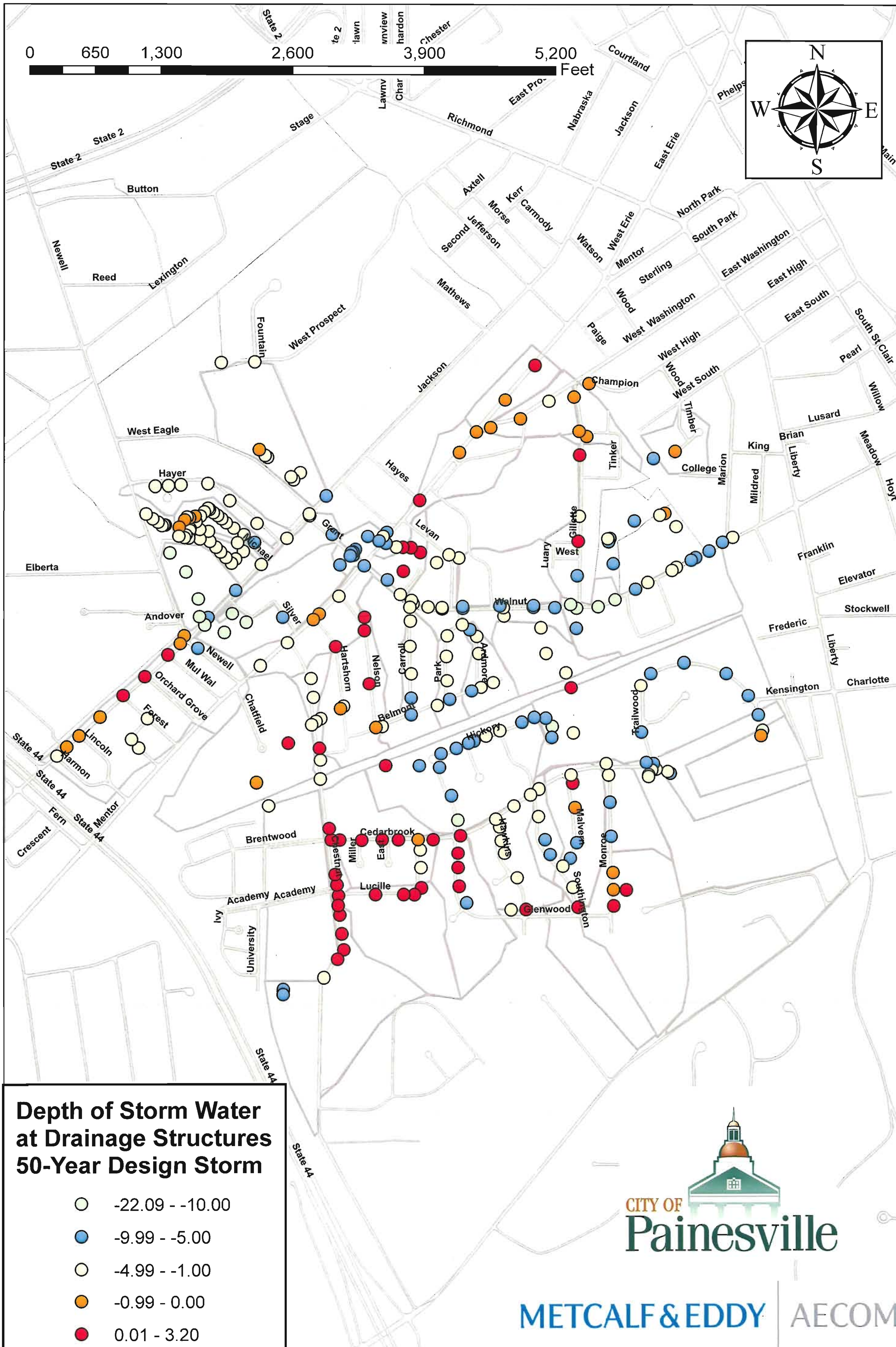
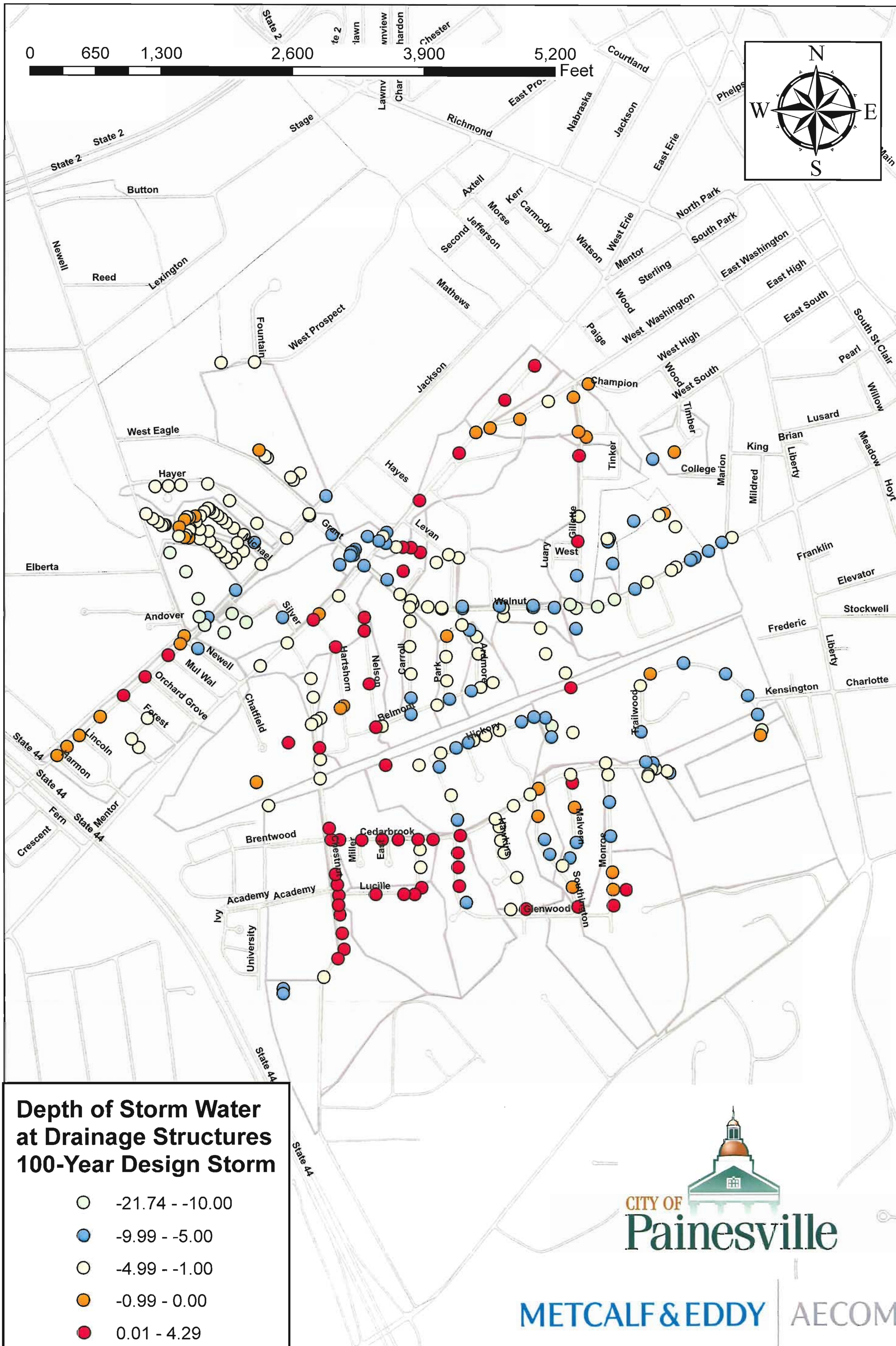


Figure 3-4 Depth of Storm Water at Drainage Structures
100-Year Design Storm
Baseline Conditions



3.3 Critical Areas

From the results of the model simulation, some sections of the following streets were defined as being critical areas:

- Cedarbrook Drive
- Chestnut Street
- Gingerbread Apartments Property
- Gillette Street
- Mentor Avenue
- Nelson Street
- Jackson Street

Data for the existing sewers in the critical areas can be found in Table 3-1. Sewer pipe profiles of the critical areas with storm water depths for each design storm event may be found in Appendix E.

Table 3-1. Critical Areas - Existing Sewer Data

Critical Area Location	Extent	Pipe Diameter (in.)	Pipe Slope Range (%)
Cedarbrook Drive	Between Chestnut Street and Hawkins Drive	15	0.15–0.81
Chestnut Street	Upstream of Academy Court	12	0.30–1.58
	Between Academy Court and Cedarbrook Drive	18	0.93–1.68
Mentor Avenue	Upstream of West Washington Street	12	0.07–0.39
	Between Levan Drive and West Washington Street	18	0.09–0.43
Nelson Street	Open Channel between Nelson and Carroll	Open Channel	0.25
Jackson Street	Between Harmon Avenue and Mulwal Drive	15	0.17–0.45
Gingerbread Apartments Property	Between Levan and Mentor Avenue	36, 48, and Open Channel	Varies

Cedarbrook Drive

Cedarbrook Drive does not show any structures overtopping their rims during the 5-year design storm. However, the downstream section of Cedarbrook Drive between Lucille Avenue and Chestnut Street show flow overtopping manhole rims during the 10, 50, and 100-year design storms in the model simulation. In addition, there is flow overtopping manhole rims along the west end of Glenwood Road. The critical section of pipe is shown in Figure 3-5. This section of the storm sewer network located near Chestnut Street is characterized by a 15-inch diameter vitrified clay pipe. This region is primarily residential development. There is a small storm water detention basin in the undeveloped land between the Norfolk Southern railroad tracks and Cedarbrook Drive. Proposed sewer pipe sizes for both the 5-year and 10-year design storms are shown in Table 3-2.

Table 3-2. Cedarbrook Drive Critical Areas - Storm Sewer Upsizing

Street	Manhole	Manhole	Existing Diameter (in)	5-Year Storm Proposed Diameter (in)	10-Year Storm Proposed Diameter (in)
Cedarbrook Street	44 STM	493 STM	15	24	24
Cedarbrook Street	493 STM	29 STM	15	18	24

Chestnut Street

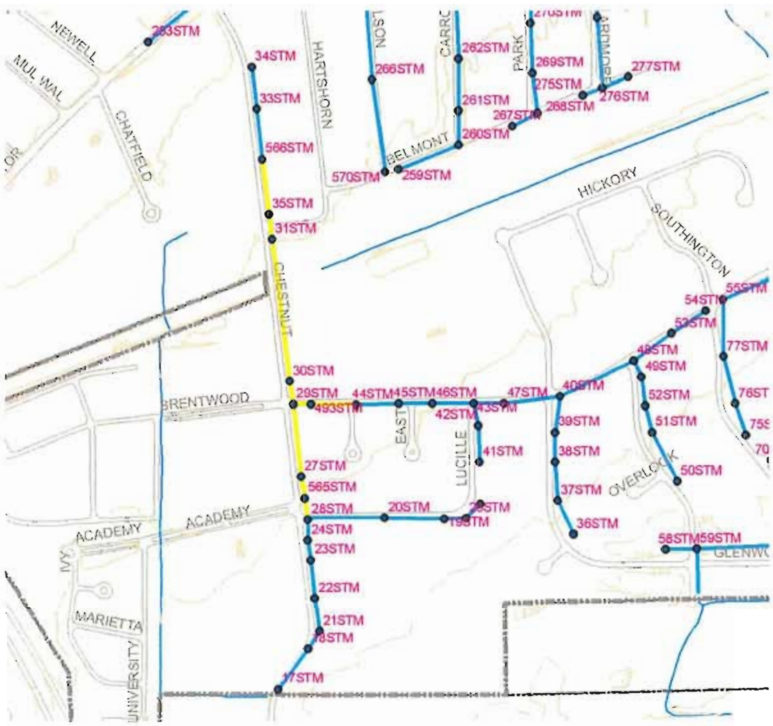
Chestnut Street does not show any structures overtopping their rims during the 5-year design storm. However, the section of Chestnut Street located south of the Norfolk Southern railroad tracks around the intersection with Cedarbrook Drive and Lucille Avenue show manholes overtopping their rims during the 10, 50, and 100-year design storms in the model simulation. The critical section of pipe is shown in Figure 3-5. There are two sections of the storm sewer network. The pipe segment upstream of Academy Court is characterized by a 12-inch diameter pipe flowing at slopes between 0.30% and 1.58%. The second section, between Cedarbrook

Drive and Academy Court, consists of an 18-inch diameter pipe at slopes between 0.93% and 1.68%. These pipes are made of vitrified clay, reinforced concrete, and corrugated plastic. This region is primarily residential development. Proposed sewer pipe sizes for both the 5-year and 10-year design storms are shown in Table 3-3.

Table 3-3. Chestnut Street Critical Areas - Storm Sewer Upsizing

Street	Manhole	Manhole	Existing Diameter (in)	5-Year Storm Proposed Diameter (in)	10-Year Storm Proposed Diameter (in)
Chestnut Street	28 STM	565 STM	12	18	18
Chestnut Street	565 STM	27 STM	12	24	24
Chestnut Street	27 STM	29 STM	18	24	24
Chestnut Street	29 STM	30 STM	18	24	24
Chestnut Street	30 STM	31 STM	21	24	24
Chestnut Street	31 STM	35 STM	21	24	24
Chestnut Street	35 STM	32 STM	21	24	24

Figure 3-5. Cedarbrook Drive and Chestnut Street Critical Areas (Critical Area in Yellow)



Mentor Avenue

Mentor Avenue does not have flow overtopping manhole rims during the 5-year storm. However, sections of Mentor Avenue upstream of Levan Drive and sections to the west of Walnut Street show manholes overtopping their rims during the 10, 50, and 100-year design storms in the model simulation. The section of pipe between Levan Drive and West Washington Street, is characterized by an 18-inch diameter vitrified clay pipe at slopes between 0.09% and 0.43%. This region includes commercial and residential development. This 18-inch pipe is reduced to a 12-inch pipe to the west of Levan Drive. Proposed sewer pipe sizes for both the 5-year and 10-year design storms are shown in Table 3-5.

Table 3-5. Mentor Avenue Storm Sewer Upsizing

Street	Manhole	Manhole	Existing Diameter (in)	5-Year Storm Proposed Diameter (in)	10-Year Storm Proposed Diameter (in)
Mentor Avenue	255 STM	256 STM	12	18	18
Mentor Avenue	300 STM	301 STM	12	18	18

Nelson Street

A portion of Nelson Street floods shows manholes overtopping their rims during the 5, 10, 50, and 100-year design storms in model simulation. The critical section of pipe is shown in Figure 3-6. The storm sewer along Nelson Street is characterized by 24-inch and 27-inch pipes at slopes between 0.3 and 0.08%. This sewer is then diverted to the east by an open channel between Nelson Street and Carroll Avenue. This region is primarily residential development. The restriction in flow along Nelson Street during the large storm events can be relieved by enclosing the open channel with a 42-inch circular pipe. The proposed pipe enclosure size is shown in Table 3-6.

Table 3-6. Nelson Street Open Channel Enclosure

Street	Manhole	Manhole	Existing Diameter (in)	5-Year Storm Proposed Diameter (in)	10-Year Storm Proposed Diameter (in)
Nelson Street	572 STM	285 STM	Open Channel	42	42

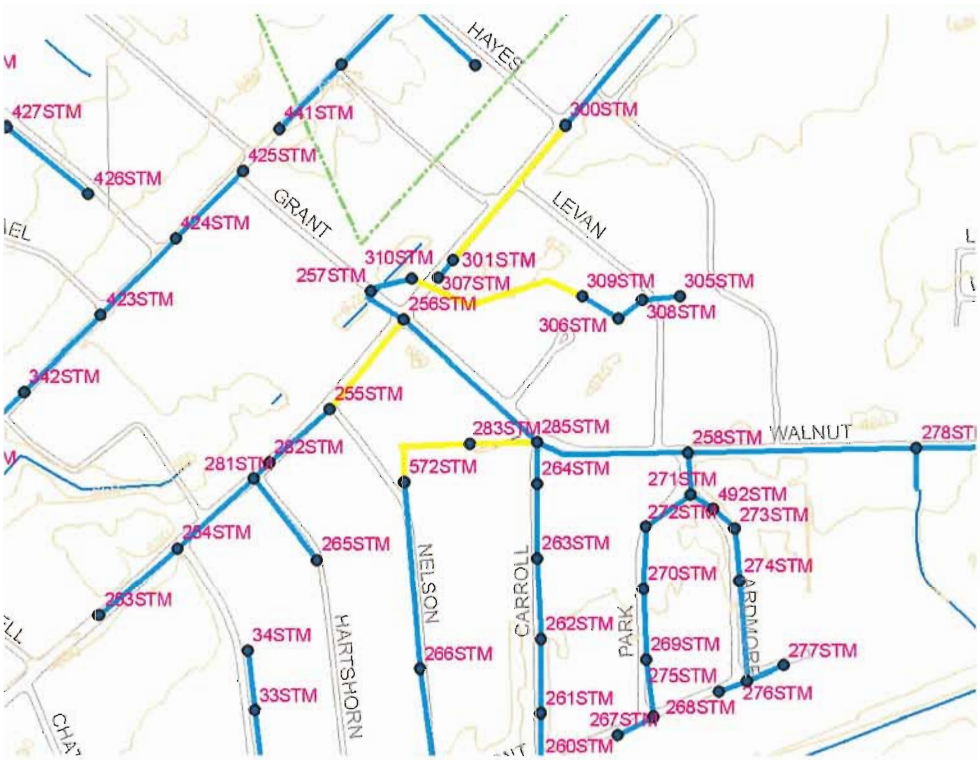
Gingerbread Apartments Property

The storm sewer that travels through the Gingerbread Apartments property has three small portions of open channeled storm sewer that span portions of the apartment complex. The critical drainage area is shown in Figure 3-6. These open channeled portions of storm sewer show surface flooding on the property for the 5, 10, 50, and 100-year design storm events. It is recommended to enclose these open channel sections with new re-sloped pipe as shown in Table 3-7.

Table 3-7. Gingerbread Apartments Storm Sewer Enclosure

Area	Manhole	Manhole	Existing Diameter (in)	5-Year Storm Proposed Diameter (in)	10-Year Storm Proposed Diameter (in)
Gingerbread Apts.	-	-	36	36	36
Gingerbread Apts.	-	-	Open Channel	36	36
Gingerbread Apts.	-	-	36	36	36
Gingerbread Apts.	-	-	Open Channel	36	36
Gingerbread Apts.	-	-	48	48	48
Gingerbread Apts.	-	-	Open Channel	48	48
Gingerbread Apts.	-	-	48	48	48

Figure 3-6. Mentor Avenue, Nelson Street, and Gingerbread Apartments Critical Areas (Critical Areas in Yellow)



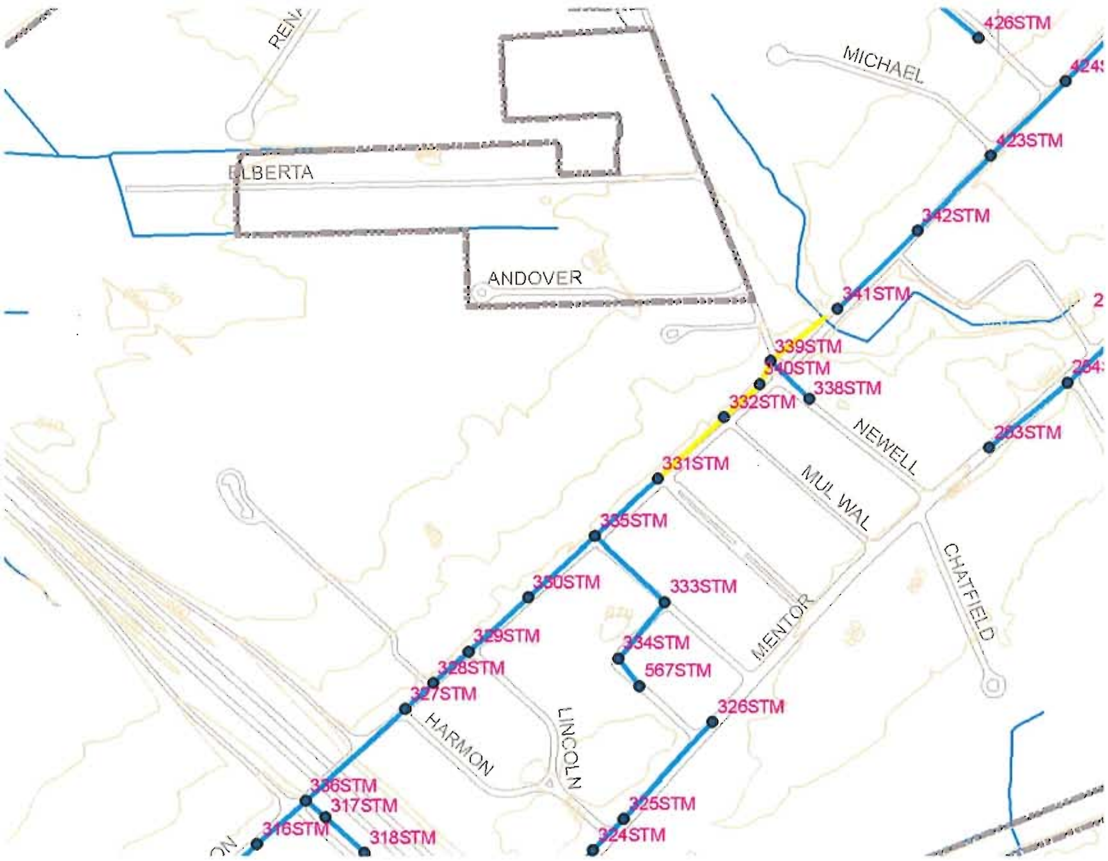
Jackson Street

A section of Jackson Street shows manholes overtopping their rims during the 10, 50, and 100-year design storms in the model simulation. The critical section of pipe is shown in Figure 3-7. The storm sewer between Harmon Avenue and Newell Street is characterized by a 15-inch diameter vitrified clay pipe at slopes between 0.17% and 0.45%. This region is primarily residential development. Proposed sewer pipe sizes for both the 5-year and 10-year design storms are shown in Table 3-8.

Table 3-8. Jackson Street Storm Sewer Upsizing

Street	Manhole	Manhole	Existing Diameter (in)	5-Year Storm Proposed Diameter (in)	10-Year Storm Proposed Diameter (in)
Jackson Street	331 STM	332 STM	15	24	24
Jackson Street	332 STM	340 STM	15	24	24
Jackson Street	340 STM	339 STM	12	18	18
Jackson Street	341 STM	339 STM	12	18	18

Figure 3-7. Jackson Street Critical Area (Critical Area in Yellow)

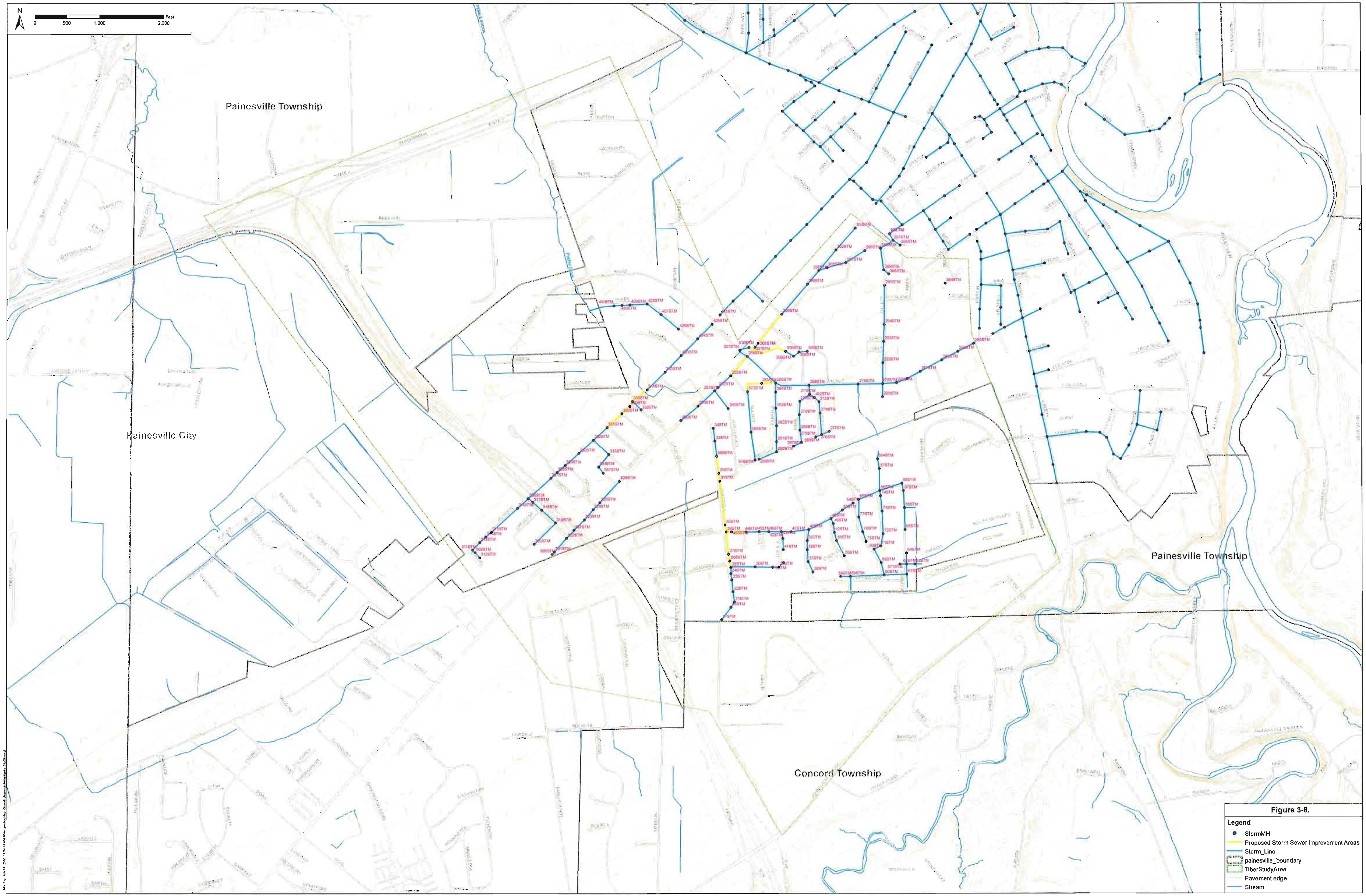


Gillette Street

Gillette Street does not show any flow overtopping manhole rims during the 5-year storm event. However, there are two structures that show flow overtopping their rims during the 10, 50, and 100-year storm events. One structure is located at the intersection of Luary Street and Gillette Street and another is located near the intersection of Tinker Avenue and Gillette Street. Based upon field observations, it is believed that there are negatively sloped pipes along Gillette Street. A detailed survey should be completed in order to verify pipe slopes and sewer construction.

Tiber Creek Drainage Area – Critical Areas Map

An overall map of the critical storm sewer sections in the Tiber Creek Drainage Area is provided in Figure 3-8 on the following page.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0
500
1,000
2,000
Feet
Painesville Township
Painesville City
Painesville Township
Concord Township
Figure 3-8.
Legend
StormMH
Proposed Storm Sewer Improvement Areas
Storm_Line
painesville_boundary
TiberStudyArea
Pavement edge
Stream

Section 4
Recommended Drainage Improvements

4. RECOMMENDED DRAINAGE IMPROVEMENTS

M&E proposed the following recommendations on conveyance of the 10-year storm event to relieve the critical areas. In sizing the sewer pipes to convey both the 5-year and 10-year storms, a majority of the proposed pipe sizes were the same. Therefore, improving the sewers to convey a 10-year storm is approximately the same cost as improving to convey a 5-year storm. Improving to a 10-year storm would allow more frequent events to be conveyed; the flooding caused by larger storms would be mitigated to some degree, and the implementation costs would be less than if the system was improved to handle a large but less-frequent storm.

It is important to note that these recommendations are being made on an uncalibrated hydraulic model. That being the case, these proposed recommendations are not to be considered for a final design; however they are useful for future storm sewer improvement planning purposes.

4.1 Improvement Considerations

Several types of drainage improvements were considered to help relieve the system, including:

- enlarging pipes and open channels;
- diverting restricted sewer flow to areas of less restriction;
- construction of relief sewers; and
- construction or expansion of detention or retention basins

Enlarged sewer pipes and open channels were modeled in the storm sewer model. This solution utilizes existing easements and right-of-ways and generally keeps land acquisition costs to a minimum. Creating a diversion sewer to transfer storm flows from an area of restriction to an area of less restriction is usually a cost-effective solution. However, in this case the transfer of flows from the upstream drainage area south of the Norfolk-Southern railroad tracks to an area in the downstream drainage area to the north of the Norfolk-Southern railroad tracks would create flow restrictions in this area. The construction or expansion of detention basins is a method that stores peak flows and attenuates the storm flow within the system. This solution can have a major impact on a drainage system.

4.1.1 Planning Level Basis of Cost

Preliminary planning level cost estimates were developed for the proposed improvements. These costs are the opinion of the Engineer based on available pricing information for labor, equipment and materials, unit prices, and general knowledge of similar projects. Costs are presented in Year 2008 U.S. Dollars, and are for comparison purposes. Costs were calculated based on 2007 Means Heavy Construction Cost Data and escalated to 2008 dollars, recent construction project bids, and project team experience. Calculations do not include operations and maintenance costs and are strictly construction costs only. A 30% contingency is included in the final cost to represent fluctuations in prices, contractor overhead and profit, and various fees. As for engineering costs, a 15% contingency is added for engineering and design fees and construction services.

4.2 Recommendations

The following recommendations are proposed in an order of priority for the City.

4.2.1 Detailed Storm Water Modeling and Calibration

The storm water model developed as part of this report is limited in accuracy due to the lack of existing flow and rainfall data needed to properly calibrate the model. Experience has shown that an uncalibrated model is not entirely reliable and should not be used to make final design recommendations. Two factors for drainage models in suburban areas that are difficult to account for accurately are that the entire drainage area is not connected to the drainage system (some areas pond in backyards, for example, and that the pervious area contribution is difficult to estimate based upon soils data).

Section 4
Recommended Drainage Improvements

A calibrated model is essential for model accuracy and final design recommendations. Therefore, a flow monitoring program should be implemented on site for a period of at least three months. This should include six (6) to ten (10) flow monitors and two (2) rain gauges placed at strategic points within the drainage system. A successful flow monitoring program should occur during the spring months (April, May, June) or fall months (September, October, November) in order to observe the best flow data for modeling purposes. A typical flow monitoring program of this size will cost approximately $25,000.

4.2.2 Chestnut Street and Cedarbrook Drive Storm Sewer Improvements

It is recommended to enlarge the storm sewer pipe sizes along Chestnut Street and Cedarbrook Drive as identified in Section 3. Table 4-1 shows the costs associated with upgrading the Chestnut Street and Cedarbrook Drive storm sewers to convey flows for up to a 10-year storm. In addition, it was noted during field observations that a heavy amount of debris was present in the storm sewer along Cedarbrook Drive. This debris should be removed to alleviate any blockages.

Table 4-1. Chestnut St. and Cedarbrook Dr. Storm Sewer Improvements – 10-Year Storm

Item	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	1	$200,000	$200,000
2	Conditon Survey	LS	1	$50,000	$50,000
3	Storm Sewer Pipe Removed	LF	1770	$20	$35,400
4	24" Storm Sewer Pipe	LF	1660	$100	$166,000
5	18" Storm Sewer Pipe	LF	110	$80	$8,800
6	Storm Sewer Manholes	EA	13	$2,500	$32,500
7	Asphalt Replacement	SY	4720	$60	$283,200
8	Traffic Control	MO	3	$10,000	$30,000
9	Landscape Repair	SY	3940	$5	$19,700
	Subtotal				$825,600
	Contingency (30%)				$247,680
	Engineering and CA Services (15%)				$123,840
	Total				**$1,198,000**

4.2.3 Mentor Avenue and Jackson Street Storm Sewer Improvements

It is recommended to enlarge the storm sewer pipe sizes along Mentor Avenue and Jackson Street as identified in Section 3. Table 4-2 shows the costs associated with upgrading the Mentor Avenue and Jackson Street storm sewers to convey flows for up to a 10-year storm.

Table 4-2. Mentor Avenue and Jackson Street Storm Sewer Improvements – 10-Year Storm

Item	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	1	$200,000	$200,000
2	Conditon Survey	LS	1	$50,000	$50,000
3	Storm Sewer Pipe Removed	LF	1800	$20	$36,000
4	24" Storm Sewer Pipe	LF	810	$100	$81,000
5	18" Storm Sewer Pipe	LF	990	$80	$79,200
6	Storm Sewer Manholes	EA	10	$2,500	$25,000
7	Asphalt Replacement	SY	4800	$60	$288,000
8	Traffic Control	MO	3	$10,000	$30,000
9	Landscape Repair	SY	4000	$5	$20,000
	Subtotal				$809,200
	Contingency (30%)				$242,760
	Engineering/CA Services (15%)				$121,380
	Total				**$1,174,000**

4.2.4 Gingerbread Apartments Storm Sewer Improvements

The Gingerbread Apartments property experiences parking lot flooding during the 5, 10, 50, and 100-year storm events. A 36-inch storm sewer opens to an open channel on the west end of the Gingerbread Apartments complex then a 36-inch pipe carries flow under the parking lot. There is a small portion of open channel in the parking lot in which a 48-inch pipe carries flow on the downstream end. This 48-inch invert is higher than the upstream 36-inch pipe, thus backing up storm sewer flow. The 48-inch pipe opens into another small section of open channel on the east end of the parking lot, which allows storm sewer flow to surcharge into the parking lot. It is recommended to replace and enclose the entire storm sewer conveyance through the property.

Table 4-3 shows the costs associated with renovating the Gingerbread Apartments storm sewer to convey a 10-year storm.

Table 4-3. Gingerbread Storm Sewer Improvements – 10-Year Storm

Item	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	1	$200,000	$200,000
2	Conditon Survey	LS	1	$50,000	$50,000
3	36" Storm Sewer Pipe	LF	225	$150	$33,750
4	48" Storm Sewer Pipe	LF	225	$200	$45,000
5	Asphalt Replacement	SY	1200	$60	$72,000
6	Storm Sewer Manhole	EA	2	$2,500	$5,000
7	Traffic Control	MO	2	$10,000	$20,000
8	Landscape Repair	SY	3000	$5	$15,000
	Subtotal				$440,750
	Contingency (30%)				$132,225
	Engineering and CA Services (15%)				$66,113
	Total				**$640,000**

4.2.5 Nelson Street Storm Sewer Improvements

It is recommended to enclose the storm sewer open channel located between Nelson Street and Carroll Street with a 42-inch pipe. This will alleviate the flow restriction that results in manholes overtopping their rims along Nelson Street. Table 4-4 shows the costs associated with constructing a 42-inch pipe along this open channel section.

Table 4-4. Nelson Street Storm Sewer Improvements – 10-Year Storm

Item	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	1	$200,000	$200,000
2	Conditon Survey	LS	1	$50,000	$50,000
3	42" Storm Sewer Pipe	LF	450	$200	$90,000
4	Backfill	CY	850	$50	$42,500
5	Traffic Control	MO	2	$10,000	$20,000
6	Landscape Repair	SY	3000	$5	$15,000
	Subtotal				$417,500
	Contingency (30%)				$125,250
	Engineering and CA Services (15%)				$62,625
	Total				**$606,000**

Graphical results of the 5-year and 10-year storms with the above recommendations can be seen in Figures 4-3 through 4-4. In each figure, the circles represent storm sewer manholes, culvert inlets/outlets, or catch basins. The color gradient indicates the depth of the storm water within the structure relative to the ground surface. Negative numbers indicate depth of the storm water below the manhole rims (ground surface); positive numbers indicate the depth that the storm water has overtopped their manhole rims.

4.2.6 Graphical Model – Recommended Plan

The storm sewer model was run simulating the 5 and 10-year storm events with the recommended pipe sizes. Graphical results of each storm may be seen in Figures 4-1 and Figure 4-2. In each figure, the circles represent storm sewer manholes, culvert inlets/outlets, or catch basins. The color gradient indicates the depth of the storm water within the structure relative to the ground surface. Negative numbers indicate depth of the storm water below the manhole rims (ground surface); positive numbers indicate the depth that the storm water has overtopped their manhole rims.

Figure 4-1 Depth of Storm Water at Drainage Structures
5-Year Design Storm
Recommended Plan

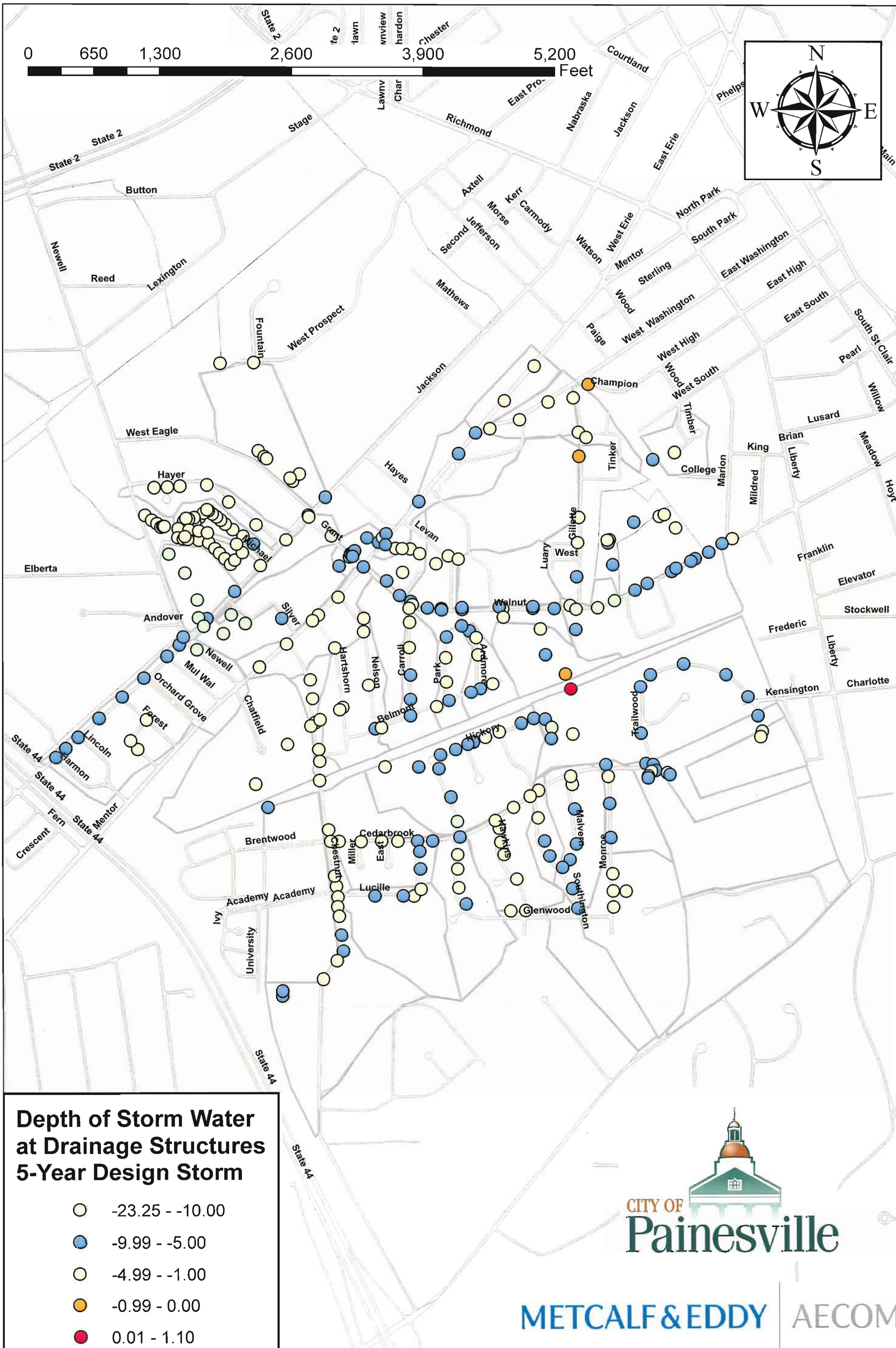
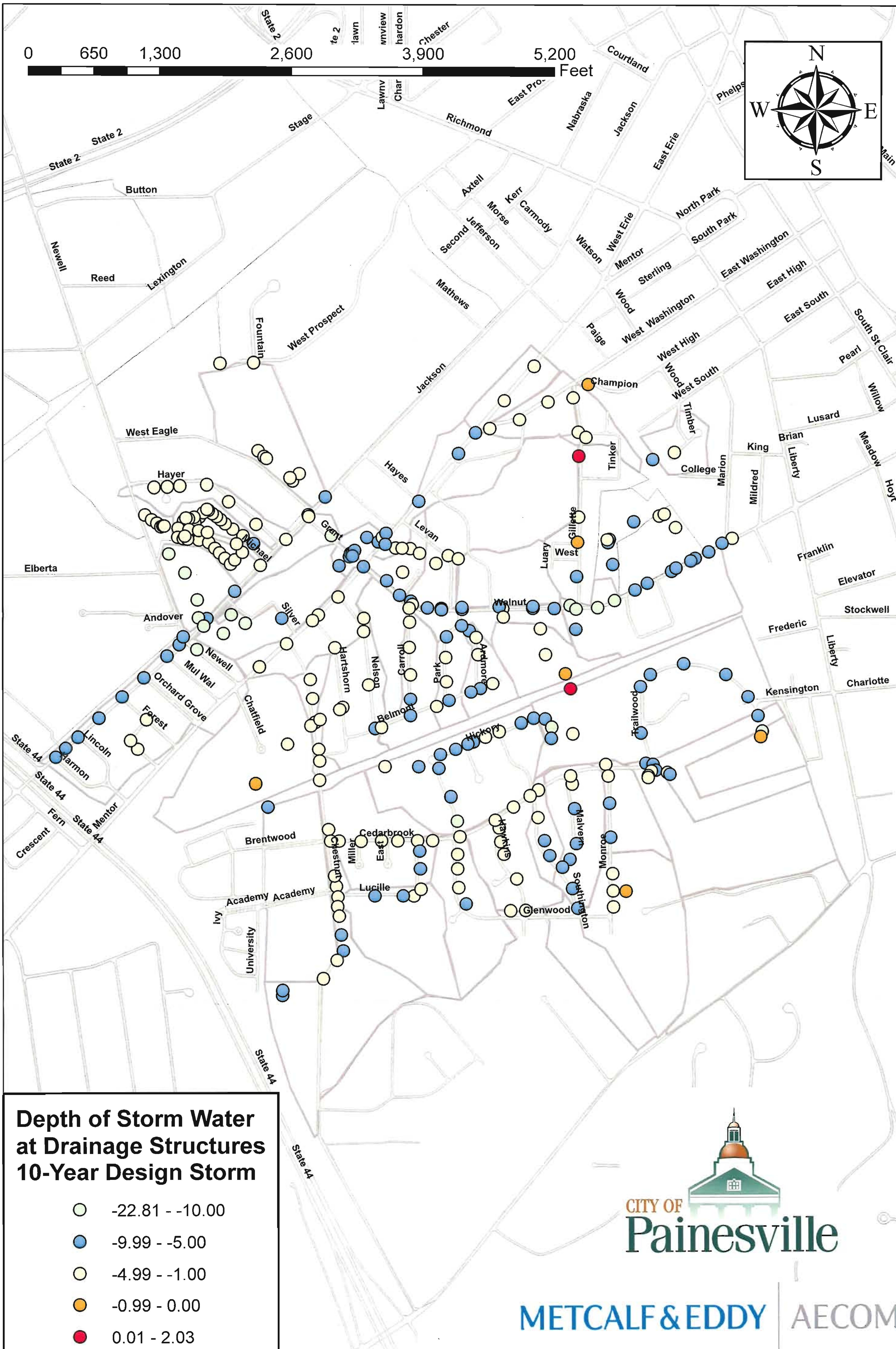


Figure 4-2 Depth of Storm Water at Drainage Structures
10-Year Design Storm
Recommended Plan



Section 5
Summary & Conclusions

The storm sewer model for this project was developed using information provided by the City including storm sewer mapping, construction plans, and various reports. This Section presents a discussion of the storm sewer improvement recommendations and provides a summary of issues that should be considered and evaluated further in working toward design improvements.

The following is a summary of the recommendations for the Tiber Creek Drainage area

5.1 Flow Monitoring Program and Model Calibration

As outlined in Sections 2 and 4, a calibrated model is necessary for model accuracy in order to use the model appropriately for design-related decisions, like sizing new storm sewer pipes. A three-month duration flow monitoring program should be implemented throughout the Tiber Creek drainage area. Several flow monitors shall be placed at strategic storm sewer locations to measure sewer flows. Rain gages should be placed throughout the drainage area as well in order to measure rainfall amounts. The planning cost in 2008 dollars for a flow monitoring program is $25,000.

Project	Planning Cost
Flow Monitoring Program	$25,000

Once the flow monitoring program is complete, the storm water model will need to be calibrated for accuracy using this field data.

5.2 Tiber Creek Storm Sewer Improvements

The following is a summary of the recommended improvements to the Tiber Creek drainage area. They are planning level costs to address the critical drainage areas identified in the storm water model.

Project	Planning Cost
Chestnut Street and Cedarbrook Drive Storm Sewer Improvements	$1,198,000
Mentor Avenue and Jackson Street Storm Sewer Improvements	$1,174,000
Gingerbread Apartments Storm Sewer Improvements	$640,000
Nelson Street Storm Sewer Improvements	$606,000

The following are a few items of consideration when proceeding with storm sewer improvement projects.

Easements and Acquisitions. It may be necessary to research existing information for identification of easements, which may include obtaining record documents, property lines and other data to determine owners and abutters, and to prepare lists for notification. The expansion of the West Pond near Chestnut Street would require temporary and permanent easements for construction and operations/maintenance for the City. These costs were included in the planning estimate for the West Basin Expansion. Any potentially required temporary or permanent easements or necessary acquisitions should be shown on the preliminary drawings.

Project Survey. Topographic and location surveys must be performed at sites in which improvements are proposed. Specific structure locations and elevations, and detailed site contours must be developed before any final drainage design can take place. Existing utilities on each site must be located and recorded. The storm water model developed as part of this study used GIS information available from Lake County, however more specific site conditions must be surveyed for final design and can also be incorporated into the storm water model.

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Summary & Conclusions

Environmental Impacts. Potential environmental and project impacts shall be investigated. This includes both traffic and construction impacts. For each site where impacts are expected, the need for mitigation measures shall be evaluated.

Permitting. Permits for proposed drainage improvements will need to be obtained through the Ohio Environmental Protection Agency (OhioEPA). The following activities will require permitting:

- One or more acres of land disturbance
- Stream Piping/Culverting
- Channelization
- Dredging a wetland to create a pond
- Dredging and filling activities in wetlands

Project Plans and Specifications. Final project plans and specifications will need to be developed for construction.