Project Prioritization Cover Sheet | Town of West Warwick

RI SPP

Transportation Improvement Program

CONTACT

Contact Information

Contact Person Mark Carruolo Title Town Planner

Mailling Address 1170 Main Street

City West Warwick Zip Code 02893

Phone (401) 827-9025 Email mcarruolo@westwarwickri.org

PROJECT PRIORITIZATION

Project Prioritization *(please use an additional sheet if necessary)*

Priority	Listed in TIP 2013-2016 Yes	No	Project Name
	✓		Arterial Traffic Signal Improvements to Route 1 and Route 3
		✓	Resurfacing Rt 117, Centerville and Legris Ave (Rt 33 to Quaker Ln)
		✓	Resurfacing Rt 3, Cowesett Ave and Tiogue Ave (Pilgrim Ave to Rt 2)
		✓	Resurfacing Rt 33, Providence St (Tollgate Rd to East Ave)
		✓	West Natick Road NB, I-295 NB at Washington Secondary Bike Path and W Natick Rd
		✓	Providence Street Bridget at I-295 NB & SB
		✓	Pulaski Street Bridge at Pawtuxet River
		✓	Red Brook Bridge, RI 3 Tiogue Ave
		✓	Fairview Ave Bridge at Pawtuxet River
		✓	West Natick Road SB, I-295 SB
		✓	Royal Mills Bridge, RI 33 Providence St at Pawtuxet River
		✓	Clyde Bridge, RI 115 Main St at Pawtuxet River
3		✓	Artic Mill Bridge, Factory St at Mill Tail Race
2		✓	Centerville Bridge, RI 117 Main St at Pawtuxet River
		✓	Quidnick RR Bridge, RI 117 Centerville Rd at Washington Secondary Bike Path
		✓	Francis J. LaChapelle Bridge, Factory St at Pawtuxet River S Branch
1		X	Main Street & Brayton Street Drainage Improvements
4		X	East Greenwich Ave. & Quaker Ln. Intersection Improvements

PROJECT PRIORITIZATION

Project Prioritization *(continued)*

Priority	Listed in TIP 2013-2016		Project Name
	Yes	No	

CERTIFICATION

Required Public Hearing

The required public hearing was held on January 4, 2016

Applicant Certification

The information provided on this application is in accordance with local regulations and ordinances.

Mark Carruolo — Applicant

Town Planner — Title

[signature] — Chief Executive Officer Signature

1/6/2016 — Date

CHECKLIST

Submittal Checklist

- ☑ 3 collated copies of complete TIP submittal package
  - ☑ Project Prioritization Cover Sheet
  - ☑ New Project Application Form for each new project
    - ☑ 2-page narrative on evaluation criteria
    - ☑ 8.5" x 11" PDF map of project location
- ☑ Email a copy of complete TIP submittal package to Kimberly.Crabill@doa.ri.gov or provide on a CD
- ☑ Submit complete TIP submittal package to:

Rhode Island Statewide Planning Program
ATTN: Kimberly Crabill
One Capitol Hill
Providence, RI 02908

ALL APPLICATIONS ARE DUE BY 3:00PM ON FRIDAY, JANUARY 8, 2016

AD IN KENT COUNTY DAILY TIMES (KCDT) ON 12/30/15

THE PLANNING BOARD OF THE TOWN OF WEST WARWICK RHODE ISLAND NOTICE OF PUBLIC HEARING

Notice is hereby given that a public hearing will be held in the West Warwick Town Hall, Town Council Chambers, 1170 Main Street, West Warwick, RI, on Monday, January 4, 2016, beginning at 6:00 P.M. The purpose of the public hearing is to consider the Town of West Warwick submission of proposed transportation improvement projects for submission to the State Planning Council for inclusion in the Transportation Improvement Plan (TIP) for Federal Fiscal Years 2017 - 2025.

The projects under consideration in order of priority include:

1. Main Street & Brayton Street Drainage Improvements.
2. Centerville Bridge, RI 117 Main Street at the Pawtuxet River.
3. Arctic Mill Bridge, Factory Street at Mill Tail Race.
4. East Greenwich Avenue & Quaker Lane RI 2, Intersection Improvements.
5. East Main Street Resurfacing.

All persons interested in the above are respectfully requested to be present at the time and place to be heard thereon. For any questions or to review Development Plans, please contact the Town Planning Office at 827-9025. The West Warwick Town Hall is handicapped accessible. Anyone requiring TDD services or other assistance to handicapped individuals is requested to notify the Town Clerk's Office at 822-9201 at least 72 hours in advance of the hearing date.

New Project Application

Transportation Improvement Program

RI SPP

CONTACT

Contact Information

Agency/Organization: Town of West Warwick

Contact Person: Mark Carruolo   Title: Town Planner

Mailling Address: 1170 Main Street

City: West Warwick   Zip Code: 02893

Phone: (401) 827-9025   Email: mcarruolo@westwarwickri.org

PROJECT INFORMATION

Type of Project *select all that apply*

- [ ] Bridge
- [ ] Pavement
- [x] Drainage
- [ ] Planning
- [ ] Traffic
- [ ] Transit
- [ ] Bicycle
- [ ] Pedestrian
- [ ] Transportation Enhancement
- [ ] Other ______

Project Description

Project Title: Main Street and Brayton Street Drainage Improvements

Location by Street Name: Main Street

Project Limits - From: Main Street from Bradley Court   To: East Main Street

Please include an 8.5" x 11" map of the site, indicating project limits.

Provide a brief description of the proposed project:

Upgrade existing undersized drainage system installed in approximately1939 to meet current standards and capacity requirements. Drainage upgrade along Main Street from approximately Bradley Court in a northerly direction to the East Main Street intersection.

PROJECT INFORMATION

Describe need for proposed project:

Existing drainage system along Main Street was constructed in 1939 and is severely undersized resulting in flooding conditions on Main Street, Brayton Street and throughout the Brayton Street area. The Town hired Fuss & O'Neill, engineers, to perform a drainage study of the area and to develop a solution to the flooding conditions. The engineers determined that due to an inadequately-sized drainage system along Main Street, the drainage system was experiencing surcharging and flooding conditions during 10-year, 24 hour storm events. As a result the excess flows are conveyed via overland flow down grade from Main Street to the Brayton Street area.

Describe anticipated municipal or state transportation network or economic development benefits:

Upgrading the Main Street drainage system will alleviate regular hazardous driving conditions resulting from routine flooding in the area. Main Street is one of the main north/south transportation routes in the Town and a major commercial roadway. During regular storm events, traffic becomes congested and driving conditions dangerous along this heavily traveled roadway. Also, during these flood conditions commerce is adversely effected for the businesses located along and in proximity to this section of Main Street.

Correcting this condition will greatly improve traffic circulation in the area and will allow regular commerce to continue unaffected.

Is the project consistent with the local Comprehensive Plan? ☑ Yes ☐ No

Is the project on the Federal Aid System? ☑ Yes ☐ No

Is the project on the National Highway System? ☐ Yes ☑ No

CRITERIA

Evaluation Criteria

Please address the following topics as they relate to the project. Refer to "An Overview of TIP Guiding Principles" for more information. Submission **must not exceed** 2 pages, single-spaced, 12-point font.

1. Mobility Benefits
2. Cost Effectiveness
3. Economic Development
4. Environmental Impact
5. Supports Local and State Goals
6. Safety and Security
7. Equity

PROJECT ESTIMATES

Project Estimates

	ROW	Study	Design	Construction	Total
Estimated Project Costs	N/A	$0 complete	$375,000	$2,500,000	$2,875,000
				Total Cost	$2,875,000
				Amount Requested through TIP Process	$2,875,000

Is there funding from other sources committed to this project? ☑ Yes ☐ No

Source	Amount
Town of West Warwick Drainage Study for Main Street & Brayton Street	$26,000
Total	$26,000

Estimated date of construction Spring 2017

CERTIFICATION

Applicant Certification

I attest that the information provided on this application is in true and accurate.

Mark Carmody (signature) — 1/6/16

Applicant's Signature — Date

Frederick J. Presley (signature) — 1/6/16

Chief Executive Officer's Signature — Date

ALL APPLICATIONS ARE DUE BY 3:00PM ON FRIDAY, JANUARY 8, 2016

Evaluation Criteria

Main Street Drainage Improvements

Mobility Benefits:

Main Street is a heavily travelled commercially developed roadway, experiencing between 12,600 and 13,800 vehicle trips per day, located centrally within the Town of West Warwick. Main Street passes directly through Arctic Village. Arctic Village is the historical center of government and commerce in the Town and is home to approximately 133 business establishments employing in excess of 1000 workers. The existing drainage system along Main Street was constructed in 1939 and is woefully undersized resulting in regular severe flooding. During these frequent flood conditions, it is extremely difficult to travel over this section of Main Street adversely effecting commuter and travel times as well as passenger safety - upgrading the drainage system will eliminate these hazardous conditions.

Cost Effectiveness:

The Town contracted with the engineering firm of Fuss & O'Neill to perform a drainage stude of the existing condition so the study phase of the project has been completed. The Fuss & O'Neill study provides the solution to this untenable condition. The Town is now requesting support for the state for the design and construction phase of the project only. With State assistance, the Town will be able to resolve a major drainage problem that is regularly disrupting vehicular travel and commerce for area businesses in the Town.

Economic Development:

As stated earlier, Main Street and the Arctic Village area is the center of government and commerce in the Town of West Warwick. This area is home to approximately 133 business establishments employing in excess of 1000 workers. The Arctic area accounts for approximately 16% of the business in West Warwick and in excess of $100 million dollars in annual sales.

Environmental Impact

Upgrading drainage in the area will alleviate regular flooding conditions as well as bring the antiquated system up to current standards. The new system will be designed under current regulations and will provide best practices for improving water quality to runoff that eventually deposits into the Pawtuxet River.

Supports Local and State Goals

The proposed project is consistent with the West Warwick Comprehensive Plan and the State Guide Plan Transportation Element 611.

Local Plan – WW Transportation Element Goal 1 states: "Provide West Warwick with a ***safe, convenient***, integrated full service transportation system sufficient to meet the daily travel needs of the Town's residents..." Transportation Element Goal 2 states: "Provide a network of state and local streets and roadways that are ***well maintained*, *safe*, *convenient*, *uncongested***, and ***pleasant to travel***..." Transportation Element Goal 5 states: "Enhance access to municipal offices and commercial businesses in the Arctic Business District..."

State Guide Plan – The proposed project is consistent with the following objectives of the State Guide Plan:

D.1.a Improve safety for all users.
D.1.c Improve air and water quality. (See Environmental Section)
D.1.d Improve appearance, community livability and business viability.
ED.1.a Move people efficiently to and from work and school.
ED.1.c Revitalize and maintain economically healthy "street centric" downtown areas and village centers.
EN.1.b Manage stormwater runoff from roadways to improve quality of receiving waters.
EQ.1.b Provide equitable distribution of transportation projects and improvements."
H.1.a Maintain infrastructure
H.1.b Improve deficiencies
H.1.e Increase safety.
LU.1.a Emphasize growth in existing or planned centers of development.
LU.1.c Preserve functionality to transportation corridors.

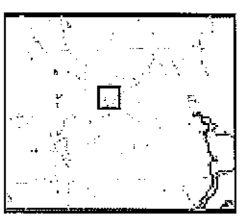
The West Warwick Town Council passed a resolution in support of this TIP submission following a Public Hearing held by the planning Board.

Safety and Security

This project enhances safety by eliminating a hazardous flooding condition on a main roadway within the Town.

Equity

The Town of West Warwick is a diverse community with substantial elderly and minority populations and low income population. The project area has between a 10% and 15% minority population. As a result, this project conforms to the State Guide Plan Equity Objective EQ.1.b "Provide equitable distribution of transportation projects and improvements."



N

1 in = 485.97 ft

This map is for informational purposes only. It is not for appraisal of, description of, or conveyance of land. The Town of West Warwick, Rhode Island and MainStreetGIS assume no legal responsibility for the information contained herein.

MainStreetGIS

MainStreetGIS, LLC
www.mainstreetgis.com

Printed on 12/16/2015
Last update: Property information 7/1/2015, GIS parcel lines 12/31/2014

Drainage Study for Brayton Street and Main Street

Town of West Warwick

West Warwick, RI

June 2013

FUSS & O'NEILL

317 Iron Horse Way, Suite 204
Providence, RI 02908

2011098.D10

Table of Contents

Drainage Study for Brayton Street and Main Street
Town of West Warwick

Table of Contents

Drainage Study for Brayton Street and Main Street
Town of West Warwick

1 Introduction

1.1 Purpose of Study

The purpose of this study is to assist the Town of West Warwick in identifying solutions to address the current flooding issue on Brayton Street. The Brayton Street neighborhood experiences severe flooding during significant rainfall events. Hydrologic analyses of the Brayton Street and surrounding watershed areas, in combination with hydraulic analyses of the existing storm drain/infrastructure system within Main Street, has revealed that flooding experienced within the Brayton Street neighborhood is largely due to the inadequately-sized storm drainage system along Main Street. During significant rainfall events, stormwater generated by the watersheds contributing runoff to Main Street exceeds the conveyance capacity of the roadway's drainage system and the system surcharges. As a result, excess runoff (which cannot be collected by the Main Street drainage system) is ultimately conveyed via overland flow to the adjoining and low-lying Brayton Street neighborhood. The properties within the Brayton Street neighborhood that are primarily impacted by flooding include Lots 32, 33 and 37 of Assessor's Plat 18.

1.2 Objective of Study

As a result of our hydrologic and hydraulic analyses of the Main Street and Brayton Street watersheds and drainage systems, Fuss & O'Neill has identified two potential alternatives to address flooding within the Brayton Street neighborhood. The first alternative involves managing runoff at Main Street before it reaches the Brayton Street properties. The second alternative involves managing runoff locally within the Brayton Street neighborhood.

The objective of this study is to identify the improvements that are necessary to manage runoff generated by the Main Street and Brayton Street Watersheds during the 10-year,24-hour design frequency storm; and to identify their construction costs, advantages, disadvantages, and implementation issues such that the Town can determine which approach offers the most cost-effective, feasible solution to addressing flooding.

2 Existing Conditions

In order to complete this study, a number of existing materials and data sources were utilized to assess existing conditions within the Main Street and Brayton Street Watersheds. Such information was used to delineate contributing watershed areas and identify drainage patterns, to determine the amount of runoff generated by each watershed area, to assess the current conveyance capacity of the existing Main Street drainage system, and to analyze the adequacy of the existing storm drain system on Lots 33, 39, and 103 of Assessor's Plat 18 within the Brayton Street neighborhood.

2.1 Existing Materials and Data Sources

2.1.1 Field Visit

Fuss & O'Neill conducted a field visit to the Brayton Street neighborhood on March 19, 2013. During this field visit, we met with the Town of West Warwick and the current Brayton Street property owner of Lots 32, 33 and 37 of Assessor's Plat 18 to discuss current flooding problems and identify how runoff was entering these properties. Based on our discussion and site observations, it was determined that runoff generated by upgradient properties was a major contributor to on-site flooding and was entering the properties as follows:

- via channelized flow from an existing 12" RCP outfall that conveys runoff from Walker Street;
- via overland flow from the driveway opening to the subject properties along Brayton Street;
- via a swale that conveys flow from the top of Walker Street near the intersection of Main Street; and
- via other general overland flow paths from Main Street.

During this site visit, Fuss & O'Neill was also provided an existing feature and property line survey plan of the subject site. This plan provided the locations of on-site catch basins and drainage structures.

2.1.2 Field Surveys

National Land Surveyors Inc. (NLS) conducted two field surveys. The first survey consisted of a field survey of Lots 32, 33, and 37 of Assessor's Plat 18 along Brayton Street, referred to herein as the subject site, in addition to the properties to the north that lie between the subject site and the North Branch of the Pawtuxet River. The second survey consisted of a field survey of the existing catch basins, manholes, and pipe network associated with the Main Street drainage system between Ellison Street and East Main Street.

The field survey of the subject site and downstream storm drain network was performed on April 1-2, April 15 and April 30, 2013. This survey not only included a survey of existing features, topographical information, and property line information; but also the layout, size, and rim/invert elevations of drainage pipes and structures both on-site and off-site to the north. It is important to note that the surveyor could not determine how exactly runoff collected at the subject site is conveyed to the North Branch of the Pawtuxet River. As reflected on the *Alternative Improvement Plans* that are included within *Appendix D*, the location of the 24-inch CMP storm drain that crosses East Main could not be determined. There are no visible drainage structures downstream of the pipe that are located in the direction at which the drain exits Lot 103 of Assessor's Plat 18. Although there is an 18-inch RCP drain running parallel to the northern side of East Main Street and a drainage structure to the west; it is unclear if the 24-inch CMP connects into this system (i.e. since the manhole to the west does not have a third pipe entering the structure from Lot 103. For the purposes of this study, it was assumed that runoff discharged from the subject site is conveyed through the pipe network that traverses Lots 39 and 103 and ultimately is discharged to the North Branch of the Pawtuxet River through the 24-inch RCP outfall that runs along the western property line of Lot 63. In order to determine the actual connectivity of this existing storm drain network, additional field work would be required where dye or water (from hydrant) could be flushed through the system and traced.

The field survey of the existing catch basins, manholes, and pipe network associated with the Main Street drainage system between Ellison Street and East Main Street. This survey was performed on Main Street on April 18-19, 2013.

2.1.3 RIDOT Files

Fuss & O'Neill also reviewed RIDOT drawings files associated with the construction of Main Street and the adjacent Bike Path to confirm the presence of existing storm drain networks and refine watershed delineations. A number of files from the area surrounding the subject site were collected. For example, a drawing set entitled "Plan, Profile, and Sections of Proposed State Highway Main Street, West Warwick, Kent County, F.A. Project No. 87 (dated 1936)" showed the storm drain system within Main Street as it was installed at that time.

2.2 Base Mapping and Watershed Delineation

In order to determine the amount of runoff that is discharged to the subject site during storm events, contributing watershed areas had to be delineated and their hydrologic parameters/characteristics had to be identified. The soil types, topography, and hydrologic cover conditions within the contributing watershed areas have a significant effect on the flow generated. These parameters/characteristics were then used in the development of our hydrologic model that was used to estimate peak flow rates and volumes generated by the contributing watershed areas.

2.2.1 Data

The following data sources, in conjunction with the field surveys, were used to delineate contributing watershed areas and identify their respective hydrologic characteristics/parameters:

- **Aerial Mapping/Imagery**: 2011 Rhode Island Department of Environmental Management (RIDEM) Multipsectral Orthophotograpy from the Rhode Island Geographic Information System (RIGIS) database.
- **Soils**: 2013 United Stated States Department of Agriculture (USDA) and Natural Resource Conservation Service (NRCS) soil boundaries from the RIGIS database.
- **Impervious Surface**: 2003-2004 impervious surface data that was developed by RIGIS based off of 2003-2004 aerial imagery from the RIGIS database.
- **Topography**: Spring 2011Light, Imaging, Detection and Ranging system (LiDAR) data from the RIGIS database.

2.2.2 Watershed Delineation

Using the LiDAR data, 1-foot contours for the project area were mapped and watersheds draining to each series of catch basins on Main Street were delineated. These delineations were verified and adjusted based on observations made during the field visit performed on March 19, 2013. *Figure 1* shows a map of the watershed delineations and on-site soils. In summary, approximately 174.2 acres of land drain to the Main Street storm drain system (Subwatersheds 1 through 15) while approximately 13.8 acres of land drain directly to the subject site along Brayton Street (Subwatershed 16).

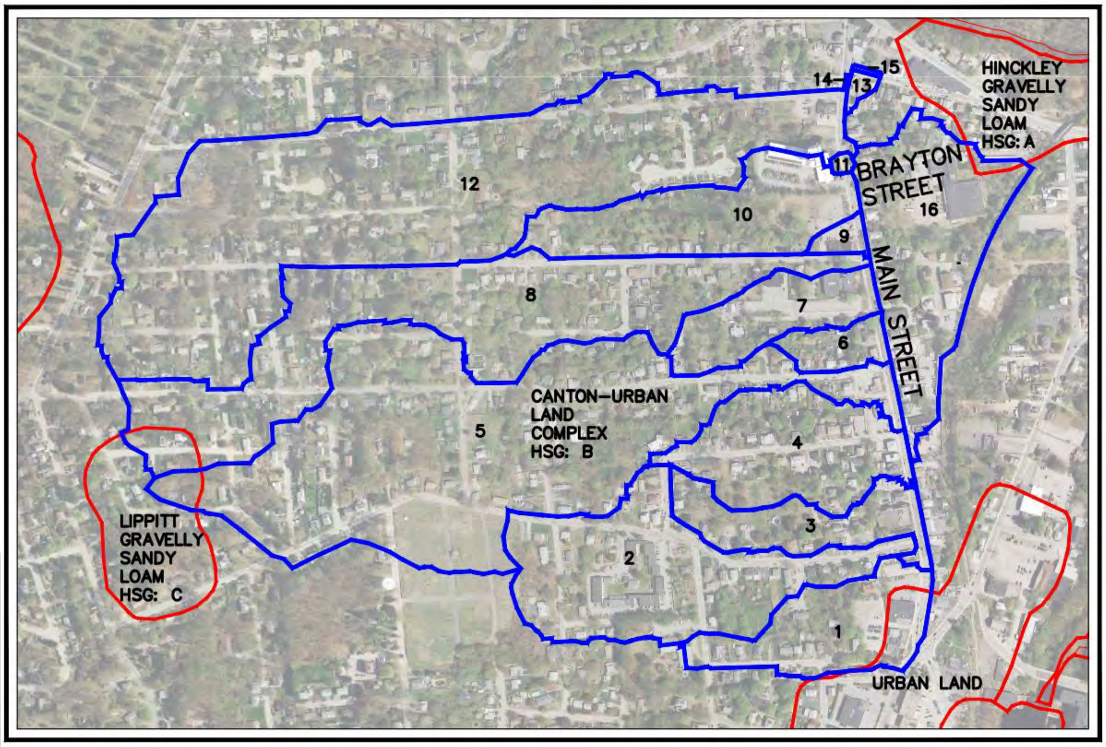


Figure 1—Watershed Delineation and Soils Map

2.3 Summary of Watershed Hydrologic Characteristics

The amount of surface runoff generated by a watershed is the amount of water flow that occurs when the soil is infiltrated to full capacity and excess water from rain, meltwater, or other sources flows over the land. In order to compute the amount of infiltration that occurs within each subwatershed analyzed, the Green-Ampt Infiltration method was utilized. This method requires that the slope of the watershed in addition to its percent imperviousness, general soil characteristics, and percentage of area available for depression storage be approximated.

- The percent slope and average width of each subwatershed was calculated using LiDAR data. In order to calculate these values, multiple flow paths for each subwatershed were delineated. The width of each subwatershed was then determined by dividing subwatershed area by the average flow path length. The percent slope was then determined by dividing the average rise of the flow paths by the average flow path length.

- The percent of imperviousness for each subwatershed was determined by applying 2003-2004 impervious surface data (obtained from RIGIS) to each subwatershed area. The spatial analyst zonal histogram tool in GIS was then used to extract the number of impervious surface pixels in each watershed. Because each pixel represents a two-foot by two-foot square, the number of pixels was multiplied by four square feet to determine an area of impervious surface, which was used to determine the percent area impervious of each watershed.

The following table, *Table 1*, summarizes the area, average flow path length, average width, percent slope, and percent imperviousness of each subwatershed contributing storm flow to the Main Street and Brayton Street:

Table 1
Specific Subwatershed Parameter Inputs

Subwatershed Number	Area (Acres)	Average Flow Path Length (Feet)	Average Width (Feet)	Percent Slope (%)	Percent Impervious by Area (%)
1	7.92	1296	266	4.87	61.60
2	16.79	1959	373	6.53	58.08
3	5.97	1286	173	6.94	52.87
4	10.28	1073	452	7.96	46.96
5	41.24	3066	586	5.32	41.94
6	2.09	685	133	4.09	51.92
7	5.71	1180	211	6.95	52.38
8	26.00	2785	496	5.36	47.85
9	0.77	293	114	4.78	92.44
10	10.49	1703	268	5.36	37.58
11	0.19	115	72	3.48	78.00
12	46.27	3799	531	4.61	45.12
13	0.38	238	69	4.20	88.46
14	0.03	67	18	7.46	96.76
15	0.06	154	18	1.95	100.00
16	13.77	1224	490	2.87	60.94

The soil characteristics (i.e. the soil's ability to infiltrate rainfall) also play an important role in determining how much runoff is generated by each watershed. As reflected within *Figure 1*, the majority of soils within the watersheds contributing flow to Main Street and Brayton Street consist of Canton-Urban land complex. This complex has a "Type B" hydrologic soil group classification and consists of well-drained Canton soils and areas of Urban land. According to the Soil Survey of Rhode Island (July 1981), Canton soils typically have surface and subsoil layers consisting of loamy sand. As a result, it was assumed that the entire area draining to Main Street and Brayton Street contains "Type B" soils and that soil within the limits of analysis exhibit characteristics analogous with loamy sand. As a result, the following typical values for the soil's suction head, saturated hydraulic conductivity, and initial soil moisture deficit were used in the analysis as recommended within *Table A.2* of *EPA's Storm Water Management Model User's Manual , Version 5.0 (November 2004)* for loamy sand:

Table 2
General Study Soil Parameter Inputs

Suction Head (Inches)	Saturated Hydraulic Conductivity (inches/hour)	Initial Soil Moisture Deficit (vol. voids/ vol. total)
4.33	0.43	0.2

The amount of runoff generated by a subwatershed is also impacted by how quickly water flows across its surface (which is partly a function of the watershed's surficial roughness or Manning's 'n' coefficient) and how much area within the subwatershed is available for limited storage (i.e. depressions within the subwatershed that temporarily store water). For purposes of this analysis, values utilized for Manning's 'n' coefficients, the depths of depression storage provided by both impervious and pervious surfaces, and the percentage of impervious area with no depression storage are included in *Table 3*. These values were obtained from suggested values listed within *Tables A.5* and *A.6* of *EPA's Storm Water Management Model User's Manual , Version 5.0 (November 2004)* based on typical values for residential areas.

Table 3
General Subwatershed Parameter Inputs

Manning's n Impervious	Manning's n Pervious	Impervious Depression Storage (Inches)	Pervious Depression Storage (Inches)	Percent of Impervious with No Depression Storage (%)
0.011	0.2	0.08	0.08	25

2.4 Hydrologic Analysis

Using the specific hydrologic characteristics obtained for each subwatershed in addition to the general soil and subwatershed parameters applied on an overall modeling basis, the EPA Storm Water Management Model (SWMM) was used to develop runoff hydrographs for each subwatershed. EPA SWMM is a dynamic 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 of SWMM operates on a collection of subwatershed areas on which rain falls and runoff is generated. For purposes of this analysis, the 10-year, 24-hour storm event was selected as the design frequency storm event. According to the *Rhode Island Stormwater Design and Installation Standards Manual (2010)*, open drainage and pipe conveyance systems must be designed to provide adequate passage for flows leading to, from, and through stormwater management facilities for at least the peak flow generated during the 10-year, 24-hour Type III design storm event. Precipitation values for the ten year storm event were entered in fifteen minute increments based upon the total precipitation rainfall amount of 4.8 inches as obtained for Kent County as documented within the *Rhode Island Stormwater Design and Installation Standards Manual.*

The following table summarizes the approximate runoff rates and volumes generated by each subwatershed during the 10-year, 24-hour storm event:

Table 4
Runoff Rate and Volume Summary Table

Subwatershed Number	Peak Runoff Rate (cfs)	Runoff Volume (cf)
1	18.49	97,600
2	36.58	196,500
3	12.95	66,800
4	23.00	106,900
5	65.62	379,700
6	4.88	22,800
7	12.83	62,800
8	48.06	266,000
9	2.12	12,000
10	17.99	93,600
11	0.51	2,700
12	73.32	439,900
13	1.04	5,300
14	0.08	700
15	0.17	1,300
16	31.11	167,100

As reflected within the table above, the total volume of runoff generated by subwatersheds contributing runoff to the Main Street drainage system (Subwatersheds 1 through 15) is approximately 1,754,600 cubic feet. The volume of runoff generated by the Brayton Street subwatershed (Subwatershed 16) is approximately 167,100 cubic feet.

2.5 Existing Conditions Hydraulic Analyses

2.5.1 Main Street Drainage System

Based on drainage structure and topographical information obtained from survey for the Main Street drainage system, an existing conditions hydraulic model of the Main Street trunk line was developed using EPA's SWMM (Version 5.0.022). Runoff generated by the Main Street subwatersheds (Subwatersheds 1 through 15) was routed through the drainage system. SWMM tracks the quantity of runoff generated within each subwatershed, and the flow rate and flow depth of water in each pipe during a simulation period comprised of multiple time steps. Existing pipe diameters, lengths, pipe material, and inverts for each segment of the Main Street drainage system trunk line were entered into SWMM from data obtained from the survey. Where survey information was not available, inverts were approximated based on other nearby structures or interpolated based on surrounding values and LiDar elevations.

The hydraulic model of the Main Street drainage system was developed not only with conduits, but also with channels designed to convey excess runoff from surcharged/flooded conduits (as gutter and overland flow) to the Brayton Street subwatershed when flooding depths within Main Street exceeded six inches (which is equivalent to the standard reveal for curbing). Additionally, there were three locations at street crossings where gutter/overland flow along Main Street was allowed to flow onto the subject site along Brayton Street. These locations included the curb openings at the two intersections of Walker Street and Main Street and the curb opening at the intersection of Main Street and Brayton Street.

The results of the existing conditions hydraulic analysis of the Main Street drainage system indicated that entire system experienced either surcharging or flooding during the 10-year, 24-hour storm event and that an approximate peak runoff rate of 203 cubic feet per second (cfs) of excess flow from Main Street was discharged to the subject site along Brayton Street. *Figure 2* (below) illustrates the profile of the existing drainage structures on Main Street. In this figure, stormwater flows left to right (in a northerly direction along Main Street) and discharges into the River which would be located at the right extreme of this depiction. Consequently, the upstream (or southernmost) section of the Main Street drainage network is represented by the first structure on the left. The solid blue shading represents the peak water level within the drainage system during the 10-year storm event. Flooding within a structure is represented when the hydraulic grade line (in black) matches the ground surface elevation (in red). As reflected within this profile, the majority of the manholes and catch basins within the Main Street drainage system are surcharging and overflowing/flooding during the 10-year, 24-hour storm event.

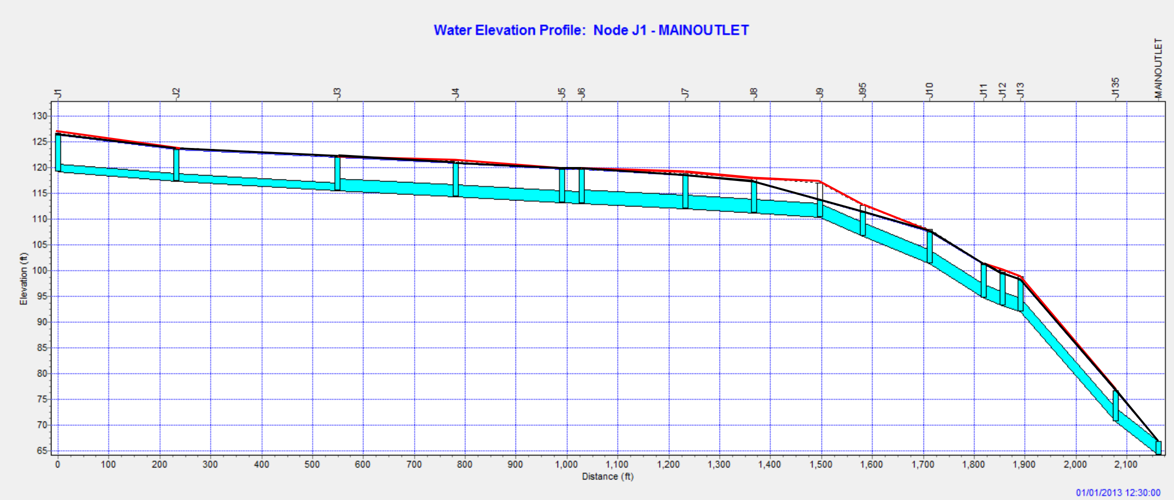


Figure 2—Peak Flow in Storm Drain System on Main Street under Existing Conditions

The existing conditions SWMM model status report has been attached as *Appendix A*.

2.5.2 Brayton Street Drainage System

Lots 32, 33, and 37 of Assessor's Plat 18 are located within a topographically low area within the Brayton Street neighborhood. As a result, runoff generated by Brayton Street Watershed (Subwatershed 16) in combination with excess flow from the Main Street Watershed either discharges to and/or collects within the on-site drainage system that consists of a drainage ditch and closed-conduit drainage system. The outlet to the on-site drainage system consists of a double catch basin that is located within the northeastern corner of the property. Outflow from this structure is then conveyed towards the East Main Street drainage system via a combination of 15-inch cast iron and 24-inch corrugated metal pipes. It should be noted that survey was unable to locate how flow from this system is hydraulically connected to the East Main Street drainage system or the 24-inch outfall that conveys flow to the North Branch Pawtuxet River.

In order to compute the total flow discharged to the on-site drainage system, hydrographs for the Brayton Street Watershed (Subwatershed 16) and overflow from Main Street as developed using EPA SWMM were input as manual-entry hydrographs into Hydraflow Hydrographs Extension for AutoCAD Civil 3D (Hydraflow Hydrographs). Hydraflow Hydrographs is a program that is utilized to perform hydrologic analyses of contributing subwatershed areas and to model/size flood control measures. The results of the analysis revealed that a total peak runoff rate of approximately 198.8 cubic feet per second is discharged to the on-site drainage system during the 10-year, 24-hour storm event. This rate of runoff exceeds the conveyance capacity of the outlet of the on-site drainage system. As a result, flooding occurs on-site during significant rainfall events including the 10-year, 24-hour storm event.

3 Drainage System Improvement Alternatives

This analysis revealed that flooding experienced within the Brayton Street subject site is largely due to the inadequately-sized storm drainage system along Main Street. During significant rainfall events, stormwater generated by Main Street Watershed exceeds the conveyance capacity of the roadway's drainage system and excess flows are conveyed via overland flow to the subject site. As a result, there are two approaches or alternatives to addressing flooding of the subject site. The first approach (referred to herein as Alternative 1) involves increasing the capacity of the Main Street drainage system to accommodate runoff generated by the Main Street Watershed for the 10-year storm event. This will eliminate overflow from being discharged to the subject site from the Main Street drainage system. The second approach (referred to herein as Alternative 2) involves improvements to the drainage system located on the subject site including the installation of a new outfall system that will convey outflow from the on-site drainage system to the North Branch Pawtuxet River.

3.1 Main Street Improvements

The existing infrastructure was installed in 1939 and no longer can handle the amount of runoff that is generated by the contributing watersheds likely as a result of further development of the watershed and increased impervious surface coverage. The existing drain pipes are composed of vitrified clay and brick; and it can be assumed that due to their age, the pipes' capacity may be reduced.

Alternative 1 proposes to relieve flooding within the Brayton Street neighborhood via improvements to the existing storm drain system on Main Street. Increasing the size of the trunk line of the drainage system, as well as increasing the capacities of inlets and connection pipes within Main Street and at intersection locations, will substantially relieve the flooding problems on Main Street as well as flooding on the Brayton Street subject site.

However, our analysis also revealed that segments of the Brayton Street drainage system are inadequate to convey flows generated by the Brayton Street Watershed during the 10-year storm. Therefore, improvements to the Main Street drainage system will also require improvements to the Brayton Street outlet system to the River. Since the hydraulic connectivity of the Brayton Street subject site outlet system/network to the River is unknown, Fuss & O'Neill cannot determine the full extent of improvements that would be required to effectively convey outflow from the Brayton Street drainage system to the River. We recommend that dye testing or flushing be performed to determine the actual connectivity of this such that a more accurate assessment of the Brayton Street drainage system can be performed and the extent of improvements quantified.

3.1.1 Hydraulic Analysis Summary and Results

In order to determine the improvements to the Main Street drainage system that are required to eliminate the flooding during the 10-year storm event, the existing trunk line pipe sizes were increased using SWMM until flooding of the system was eliminated and surcharging of the system was reduced to acceptable limits. For this analysis, surcharge within the system was allowed to within one inch of the rim of the trunk line manholes/structures. The following table, *Table 5*, provides a comparison between the existing diameter of each pipe within the trunk line system and the proposed diameter of each segment that is required to alleviate flooding of the Main Street system.

Table 5
Existing and Proposed Pipe Segments

Segment	Existing Composition	Existing Diameter	Proposed Composition	Proposed Diameter
1	Vitrified Clay	18"	RCP	36"
2	Vitrified Clay	18"	RCP	42"
3	Brick	28"	RCP	54"
4	Brick	28"	RCP	54"
5	Brick	28"	RCP	60"
6	Brick	32"	RCP	60"
7	Brick	32"	RCP	54"
8	Brick	32"	RCP	60"
9	Brick	32"	RCP	48"
10	Brick	32"	RCP	48"
11	Brick	32"	RCP	48"
12	Brick	32"	RCP	42"

13	Brick	32"	RCP	48"
14	Brick	32"	RCP	42"
15	Brick	32"	RCP	48"

Figure 3 (below) shows that peak flow during the 10-year, 24-hour storm event is completely contained within the Main Street drainage system under the proposed conditions. This figure is set up similar to *Figure 2* where the solid blue shading represents the peak water level within the drainage system during the 10-year storm event. As reflected within this profile, the hydraulic grade line (in black) is always below the ground surface elevation (in red). Consequently, flooding does not occur at any location within the system (although surcharging is allowed to within an inch of the structure's rim elevation).

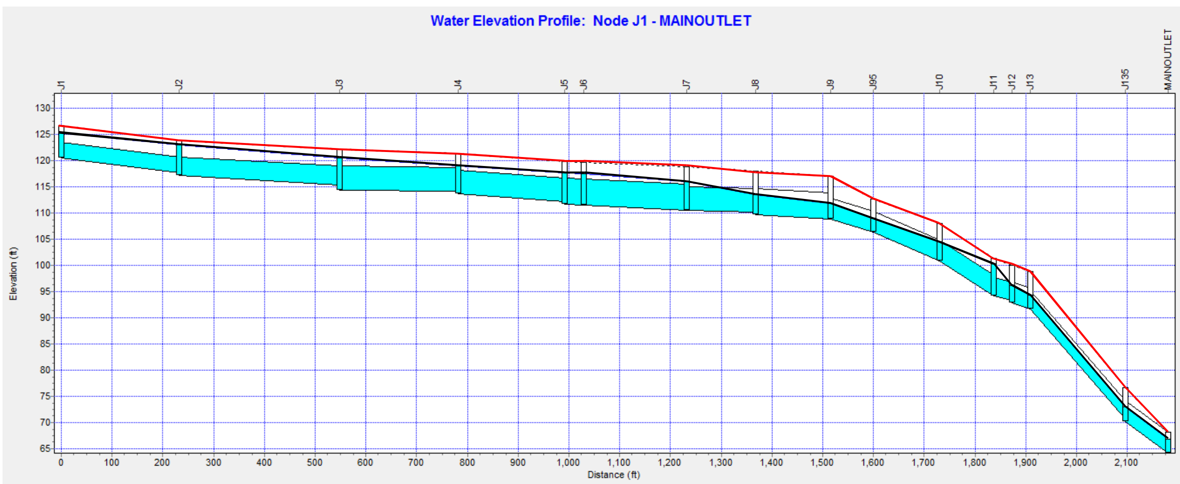


Figure 3—Peak Flow in Storm Drain System on Main Street under Proposed Conditions

The proposed conditions SWMM model status report has been attached as *Appendix B*. Refer to *Appendix D* for the plan (*Sheet CS-101: Main Street Alternative Improvement Plans*) that depicts the major improvements proposed to the Main Street drainage system as part of Alternative 1.

3.1.2 Order-of-Magnitude Opinion of Cost

Based on the results of our analysis at this preliminary stage of the design, Fuss & O'Neill approximates that the order-of magnitude opinion of cost for this alternative is $1.36 million based on this conceptual design with a 25% contingency. Final construction costs would likely range between $949,000 and $2.03 million. A detailed breakdown is presented in the following table. It must be noted that this opinion of cost represents the cost to improve flooding within the Main Street drainage system (only) and eliminate excess flow from being discharged to the Brayton Street subject site. Although this will significantly reduce the amount of flow discharged to Brayton Street (from approximately 199 cubic feet per second to approximately 31 cubic feet per second) during the 10-year storm, segments of the Brayton Street drainage system do not have the capacity to effectively convey the 10-year flow to the River without flooding. Once the actual layout of this system can be determined through additional dye-testing or flushing, the extent of this system that will require replacement can be determined as well the cost to construct such improvements.

Table 6
Order-of Magnitude Opinion of Cost for Main Street Improvements

ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	TOTAL COST
Site Construction				
Remove and Dispose Manhole	EA	16	$500.00	$8,000
Remove and Dispose Clay and Brick Drain Pipe	LF	2,220	$20.00	$44,400
Remove, Handle, Haul, and Reset Curb	LF	1,440	$20.00	$28,800
Remove and Dispose Sidewalks	SY	480	$7.00	$3,400
Remove and Dispose Flexible Pavement	SY	2,470	$5.00	$12,400
Full Depth Sawcut Bituminous Pavement	LF	4,450	$2.00	$8,900
36-Inch RCP - Including Excavation and Gaskets	LF	230	$155.00	$35,700
42-Inch RCP - Including Excavation and Gaskets	LF	500	$190.00	$98,800
48-Inch RCP - Including Excavation and Gaskets	LF	370	$250.00	$107,500
54-Inch RCP - Including Excavation and Gaskets	LF	520	$310.00	$173,600
60-Inch RCP - Including Excavation and Gaskets	LF	480	$365.00	$131,400
5' Diameter Manhole with Frame and Cover	EA	1	$3,500.00	$3,500
6' Diameter Manhole with Frame and Cover	EA	1	$5,000.00	$5,000
8' Diameter Manhole with Frame and Cover	EA	14	$10,000.00	$140,000
Portland Cement Concrete Sidewalk	CY	53	$300.00	$16,000
Bituminous Surface Course, Type I-1	TON	214	$100.00	$21,400
Bituminous Base Course	TON	356	$100.00	$35,600
Gravel Borrow Base Course (Excavated, Stockpiled, and Re-installed)	CY	931	$25.00	$23,300
Fine Grading and Compaction	SY	2,950	$3.00	$8,900
Increase Capacity of Catch Basins/Inlets to the Trunk Line System	LS	1	$125,000	$125,000
Construction Subtotal				$1,031,600
Construction Incidentals				
Erosion and Sedimentation Controls (Assume 0.5% of Total Construction Cost)	L.S.	1	$5,000	$5,000
Maintenance and Movement of Traffic Protection (Assume 1% of Total Construction Cost)	L.S.	1	$12,000	$12,000
Mobilization & Demobilization (Assume 4% of Total Construction Cost)	L.S.	1	$36,000	$36,000
Construction Incidentals Subtotal				$53,000
OVERALL SUBTOTAL				**$1,084,600**
CONTINGENCY (25%)				$271,200
OVERALL TOTAL INCLUDING CONTINGENCY*				**$1,356,000**

Note:
* Indicates that this value excludes the cost to replace undersized segments of the Brayton Street drainage system.

3.1.3 Advantages and Disadvantages

The main advantage to addressing flooding issues by proposing improvements to the Main Street drainage system (instead of at the Brayton Street subject site) is that this solution would not only address flooding of the Brayton Street site but would also address flooding that occurs along Main Street during storm events up to, and including, the 10-year, 24-hour storm event. Improvements proposed as part of this alternative would address flooding at its source, whereas the second would only address flooding issues locally on Brayton Street. Other advantages and disadvantages to this alternative are summarized in the following table.

Table 7
Main Street Improvements Advantages and Disadvantages

Advantages	Disadvantages
Addresses flooding issues on Main Street as well as significantly reduces flooding on Brayton Street.	Will cost more money to install than Alternative 2.
Along with solving flooding problems on Main Street, addresses issue of outdated and potentially inadequate storm drain infrastructure on Main Street.	Will impact traffic more significantly than Alternative 2 resulting in more lengthy pedestrian and roadway closures/diversions along Main Street throughout construction.
Avoids doing work on private property and requiring need for easements.	Increasing the size of the trunk line may result in conflicts with other existing underground utilities on Main Street. Sections of adjacent utility mains may need replaced if damaged or supported during construction.
	Does not eliminate flooding at the Brayton Street subject site. This alternative will still require improvements to the drainage system that conveys flow from the Brayton Street subject site to the East Main Street drainage system and/or River.

3.1.4 Implementation Issues

Implementation issues associated with constructing the Alternative 1 Improvements include, but are not limited to, the following.

- In order to increase the sizes of the Main Street trunk line system, roadway and pedestrian closures/diversions will be necessary throughout construction.
- Due to the necessity to replace several sections of the trunk line system with 48-inch and 60-inch diameter pipes, new manholes (several of which will have 8-foot diameters) will be required at the junctions of pipe segments. Since these manholes will need to accommodate existing pipe connections from adjacent structures or will be installed adjacent to other existing utilities, the manholes will need to be carefully installed adding time and cost to construction.
- Increasing the size of the trunk line system without improving the inlet capacities of the structures along Main Street and at intersecting roadways would result in minimal benefits in

terms of flooding. As a result, this alternative would require improvements to the inlet structures and cross-connection pipe sizes within Main Street at intersecting roadways.

- Based on our review of RIDOT plans, there are existing sewer, gas, telecom, and water mains within Main Street. The system must be carefully designed to avoid and/or minimize impacts to such utilities. There is the potential that sections of these existing utilities could be damaged and require replacement during construction.

3.2 Brayton Site Improvements

The second approach (referred to herein as Alternative 2) to addressing flooding within the Brayton Street neighborhood involves improvements to the drainage system located on the subject site (only) along with the installation of a new outfall system that will convey outflow from the on-site drainage system to the North Branch Pawtuxet River. This alternative assumes that the Main Street drainage system will continue to surcharge and flood and that this excess flow (approximately 168 cubic feet per second) will continue to flow overland to the drainage system located within the subject site.

3.2.1 Hydraulic Analysis Summary and Results

Using the hydrographs generated by SWMM for the Main Street and Brayton Street Watersheds, Hydraflow Hydrographs was utilized to route these hydrographs through the existing drainage ditch/swale located within the subject site. It was determined through analysis that the existing drainage ditch/swale had to be increased in size and that a new outlet system would need to be constructed in order to accommodate the total peak runoff rate of approximately 198.8 cubic feet per second that is discharged to the on-site drainage system during the 10-year, 24-hour storm event. Consequently, the following improvements are proposed as part of Alternative 2 to substantially relieve or eliminate the flooding problems at the Brayton Street subject site:

- The expansion of the site's existing drainage ditch into two detention areas that will be hydraulically connected by an eight-foot wide by four-foot high box culvert.
  - It was determined that Detention Area No. 1 must detain approximately 46,570 cubic feet of runoff; and that Detention Area No. 2 must detain approximately 31, 250 cubic feet of runoff.
  - The two detention areas were hydraulically connected with a box culvert due to space limitiations between the corner of the on-site building and an existing 12-inch diameter sewer main. The box culvert also allows the two detention areas to be connected while providing the property owner with the ability to maintain access around the structure. Detention Basin No. 2 will also be constructed with an eight-foot diameter outlet structure.
  - A stone diaphragm is also proposed along the down-gradient perimeter of the site's paved parking area to provide for the pretreatment of parking lot runoff.
- The installation of a new outlet system that will convey flow from the Brayton Street subject site beneath adjacent properties and East Main Street prior to being discharged to the North Branch Pawtuxet River via a new headwall structure and stone energy dissipator. This outlet system will consist of 54-inch diameter HDPE (ADS N-12) piping with exception to the segment of this

system that will convey flow beneath East Main Street. To minimize disruption to existing utilities within the roadway, this segment will consist of a 3-foot high by 5-foot wide precast concrete box culvert. Regardless, sections of the 12-inch diameter asbestos cement and 6-inch diameter cast-iron water mains will still require replacement and the amount of cover over these mains will be reduced to approximately two feet. Consequently, approval from the water authority will be required in addition to additional measures to protect the water mains from freezing.

Refer to *Appendix C* for a report that summarizes input and output supporting the sizing of the Brayton Street stormwater management improvements. Additionally, refer to *Appendix D* for the plan *(Sheet CS-102: Brayton Street Alternative Improvement Plans*) that depicts the major improvements proposed as part of Alternative 2.

It should be noted that the installation of the proposed outlet system pipe network will require approval from other property owners as well. As a potential alternate option, the proposed route of the 54-inch outlet network could be revised to more closely follow the existing system's outlet network to the North Branch Pawtuxet River. However, the actual connectivity of this system to the East Main Street drainage system would need to be verified/confirmed via additional dye testing or flushing (since survey could not determine). This alternate pipe network layout could also be designed to eliminate flow beneath the structure on Lot 39 and to potentially replace the existing 24-inch system within drainage easements that may currently exist.

On-site soil investigations will also be required to confirm the depths to high seasonal groundwater to ensure that the bottom of the proposed detention areas will not intercept groundwater.

3.2.2 Order-of-Magnitude Opinion of Cost

Based on the results of our analysis at this preliminary stage of the design, Fuss & O'Neill approximates that the order-of magnitude opinion of cost for Alternative 1 would be $660,000 at this conceptual design phase with a 25% contingency. Final costs would likely range between $462,000 and $990,000. A detailed breakdown is presented in the following table.

Table 8
Order-of Magnitude Opinion of Cost for Brayton Street Improvements

ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	TOTAL COST
Site Construction				
Clearing and Grubbing	AC	1.3	$12,500.00	$16,300
Remove and Dispose Sidewalks	SY	150	$7.00	$1,100
Remove and Dispose Flexible Pavement	SY	225	$5.00	$1,100
Remove, Handle, Haul, and Reset Curb	LF	20	$20.00	$400
Earth Excavation (Stockpiled and Re-used or Hauled Off-Site) for Detention Basin Construction	CY	6,400	$15.00	$96,000
Protect and Support Utility Pole	EA	1	$5,000.00	$5,000

ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	TOTAL COST
Support and Protect and/or Replace Sections of Gas, Telecom, and Water Mains	LS	1	$20,000.00	$20,000
Fine Grading and Compaction	SY	6,695	$3.00	$20,100
Gravel Borrow Base Course (Excavated, Stockpiled, and Re-installed)	CY	75	$25.00	$1,900
Bituminous Surface Course, Type I-1	TON	20	$100.00	$2,000
Bituminous Base Course	TON	32	$100.00	$3,200
Full Depth Sawcut Bituminous Pavement	LF	100	$2.00	$200
Remove and Reset/Replace 1 1/8" PE Gas Line	LF	25	$35.00	$900
54-Inch HDPE (ADS N-12) Storm Drain - Including Excavation	LF	230	$175.00	$40,300
36-Inch x 60-Inch RCP Box Culvert	LF	60	$750.00	$45,000
60-Inch HDPE (ADS N-12) Storm Drain - Including Excavation	LF	225	$200.00	$45,000
96"x48" Box Culvert (Including Excavation)	LF	150	$500.00	$75,000
8' Diameter Manhole with Frame and Cover	EA	3	$10,000	$30,000
Convert DCB to DMH	EA	1	$700.00	$700
Concrete Headwall	CY	20	$1,000.00	$20,000
8' Diameter Overflow Structure with Orifice and Trashrack	EA	1	$10,000	$10,000
Portland Cement Concrete Sidewalk	CY	3	$300	$900
Crushed Stone Diaphragm	CY	20	$35.00	$700
Stone Riprap R-3, R-4, R-5	CY	200	$75.00	$15,000
Bedding for Riprap FS-2 Standard	CY	50	$75.00	$3,800
Filter Fabric for Riprap and Stone Diaphragm	SY	295	$2.50	$700
Loam Borrow - 4 Inches Deep	SY	6,320	$4.50	$28,400
General Highway / Residential Seeding	SY	6,320	$1.00	$6,300
Construction Subtotal				$490,000
Construction Incidentals				
Erosion and Sedimentation Controls (Assume 1% of Total Construction Cost)	LS	1	$5,000	$5,000
Maintenance and Movement of Traffic Protection (Assume 1% of Total Construction Cost)	LS	1	$5,000	$5,000
Property Line Survey and Easement Descriptions (incl. Attorney Fees)	EA	1	$10,000	$10,000
Mobilization & Demobilization (Assume 4% of Total Construction Cost)	LS	1	$18,000	$18,000
Engineering and Construction Administration Subtotal				$38,000
OVERALL SUBTOTAL				**$528,000**
CONTINGENCY (25%)				$132,000
OVERALL TOTAL INCLUDING CONTINGENCY				**$660,000**

3.2.3 Advantages and Disadvantages

The main advantage to addressing flooding issues by proposing improvements to the Brayton Street drainage system (instead of at Main Street) is primarily associated with cost. Improvements proposed as part of this alternative would address flooding within the Brayton Street neighborhood for slightly more than half the cost of improvements associated with Alternative 1. Other advantages and disadvantages to this alternative are summarized in the following table.

Table 9
Brayton Site Improvement Advantages and Disadvantages

Advantages	Disadvantages
Will cost less money to address flooding at the Brayton Street subject site than Alternative 1.	Will not address flooding currently experienced along Main Street.
Construction of improvements will not impact traffic as much as the construction of the Alternative 1 improvements would.	Construction of new outlet system network will impact traffic and result in road closures along East Main Street during construction.
Will increase the capacity of the existing 24-inch outlet system via the elimination of flow discharged from the Brayton Site's existing drainage ditch/swale.	Requires doing work on private property requiring need for easements.
	Requires the construction of a new outfall within freshwater wetlands which will likely increase permitting time and costs

3.2.4 Implementation Issues

Implementation issues associated with constructing the Alternative 2 Improvements include, but are not limited to, the following.

- In order to construct the new outlet system network that will discharge flow from the Brayton Street site to the River, permissions and easements will be required from the owners of Lots 39, 101, and 102; and Lot 64 in addition to RIDOT and RIDEM.
- Due to the presence of existing utilities within East Main Street, the segment of the new outlet system that will convey flow beneath the roadway must be a 3-foot high by 5-foot wide box culvert. Although this will minimize disruption to existing utilities, sections of the 12-inch and 6-inch water mains must be replaced with new piping that will have approximately two feet of cover. Since this is less than the standard cover depths for water mains (for freeze protection), approval will be required by the water authority and additional measures to protect both pipes from freezing will likely be required.
- A section of the existing gas service to the structure located on Lot 39 must be removed and replaced when constructing the new outlet system network.
- Based on our review of RIDOT plans, there are existing sewer, gas, telecom, drainage, and water mains within East Main Street. The new outlet system must be carefully installed to avoid

and/or minimize impacts to such utilities. There is the potential that sections of these existing utilities could be damaged and require replacement during construction.

- The installation of a new headwall and outfall system will require a more intensive review process by RIDEM due to the construction of this system within freshwater wetlands and the potential increase of peak flows discharged to the River.

4 Conclusions/Recommendations

The primary reason for flooding at the Brayton Street subject site is related to the Main Street drainage system's inability to effectively capture and convey runoff during significant rainfall events. Because the system is undersized, the system floods and excess flows (of approximately 167.7 cfs) are conveyed via overland flow to the adjoining and low-lying Brayton Street neighborhood. The two options for improving the drainage issues on Brayton Street include:

- addressing flooding at its source by upgrading the storm drain network on Main Street to eliminate system surcharging/flooding ; or
- addressing flooding at the "end of pipe" by increasing the storage volume of the open drainage system on the Brayton Street subject site and providing a larger outlet pipe network to more effectively convey outflow to the River.

"End of pipe" solutions are generally not recommended when there is the opportunity to address problems at its source. In this case, however, addressing flooding at its source may be cost prohibitive for the Town. The main advantage to addressing flooding at the "end of pipe" (at the Brayton Street property) is that it will cost approximately half as much as the cost of improving the Main Street storm drain network (though it should be noted that construction of the new outlet system network will require approvals and easements from other property owners).

Although addressing flooding at its source (at Main Street) is more cost prohibitive, this alternative does potentially significantly reduce flooding at two locations: Main Street and Brayton Street. It must be noted, however, that increasing the size of the Main Street trunk line system without improving the inlet capacities of the structures along Main Street and at intersecting roadways would result in minimal benefits in terms of flooding. As a result, this alternative also requires improvements to the inlet structures and cross-connection pipe sizes within Main Street at intersecting roadways. It has also been determined that sections of the existing outlet system from the Brayton Street site do not have the capacity required to effectively convey flow generated by the 10-year storm to the River subsequent to improvements to the Main Street drainage system. As a result, it is likely that localized flooding at the Brayton site will still occur although it would occur at a much lesser scale unless segments of the Brayton Street drainage system are also improved. Our surveyor was unable to locate the discharge of the system or its hydraulic connection to the East Main Street drainage system. As a result, we recommend that the Town further investigate the connectivity of this system (via flushing or dye testing) such that the layout of the Brayton Street property's current outlet system can be determined and the required improvements (and associated costs) can be quantified. This testing should be performed prior to making any firm decision.

Appendix A

Existing Conditions SWMM Status Report (for Main Street Drainage System)

Main Street SWMM

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------

Main Street SWMM

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... DYNWAVE
Starting Date ............ JAN-01-2013 00:00:00
Ending Date .............. JAN-10-2013 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:00:05
Dry Time Step ............ 00:00:05
Routing Time Step ........ 5.00 sec


WARNING 02: maximum depth increased for Node J1

WARNING 02: maximum depth increased for Node J2

WARNING 02: maximum depth increased for Node J3

WARNING 02: maximum depth increased for Node J4

WARNING 02: maximum depth increased for Node J5

WARNING 02: maximum depth increased for Node J6

WARNING 02: maximum depth increased for Node J7

WARNING 02: maximum depth increased for Node J8

WARNING 02: maximum depth increased for Node J9

WARNING 02: maximum depth increased for Node J10

WARNING 02: maximum depth increased for Node J11

WARNING 02: maximum depth increased for Node J12

WARNING 02: maximum depth increased for Node J13

WARNING 02: maximum depth increased for Node OBJ2

WARNING 02: maximum depth increased for Node OBEND

*********************
Control Actions Taken
*********************


**************************        Volume         Depth
Runoff Quantity Continuity      acre-feet        inches
**************************      ---------       -------
```

Total Precipitation	75.292	4.800
Evaporation Loss	0.000	0.000
Infiltration Loss	30.611	1.951
Surface Runoff	44.226	2.819
Final Surface Storage	0.455	0.029
Continuity Error (%)	0.000	

************************* Flow Routing Continuity *************************	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	44.226	14.412
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	43.271	14.100
Internal Outflow	0.000	0.000
Storage Losses	0.000	0.000
Initial Stored Volume	0.003	0.001
Final Stored Volume	1.830	0.596
Continuity Error (%)	-1.971	

****
Highest Continuity Errors
****

Node DUMMY (-133175.92%)
Node OBJ6 (30.42%)
Node OBJ2 (16.61%)

****
Time-Step Critical Elements
****

Link 32Brick7 (3.08%)

****
Highest Flow Instability Indexes
****

All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	0.50 sec
Average Time Step	:	4.95 sec
Maximum Time Step	:	5.00 sec
Percent in Steady State	:	1.32
Average Iterations per Step	:	1.99

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
S3	4.80	0.00	0.00	1.71	3.06	0.50	12.95	0.638
S4	4.80	0.00	0.00	1.89	2.88	0.80	23.00	0.600
S5	4.80	0.00	0.00	2.24	2.54	2.84	65.62	0.528
S6	4.80	0.00	0.00	1.71	3.06	0.17	4.88	0.638
S7	4.80	0.00	0.00	1.71	3.06	0.47	12.83	0.638
S8	4.80	0.00	0.00	1.96	2.81	1.99	48.06	0.586
S9	4.80	0.00	0.00	0.26	4.49	0.09	2.12	0.935
S10	4.80	0.00	0.00	2.33	2.45	0.70	17.99	0.510
S11	4.80	0.00	0.00	0.75	4.00	0.02	0.51	0.834

S12	4.80	0.00	0.00	2.15	2.62	3.29	73.32	0.546
S14	4.80	0.00	0.00	0.11	4.63	0.00	0.08	0.965
S13	4.80	0.00	0.00	0.39	4.35	0.04	1.04	0.907
S15	4.80	0.00	0.00	0.00	4.74	0.01	0.17	0.988
S16	4.80	0.00	0.00	1.42	3.34	1.25	31.11	0.697
S17	4.80	0.00	0.00	1.38	3.39	0.02	0.70	0.706
S1	4.80	0.00	0.00	1.38	3.38	0.73	18.49	0.705
S2	4.80	0.00	0.00	1.53	3.23	1.47	36.58	0.673

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
J1	JUNCTION	0.16	7.12	126.28	0 12:29
J2	JUNCTION	0.16	6.25	123.50	0 12:30
J3	JUNCTION	0.18	6.45	121.85	0 12:30
J4	JUNCTION	0.16	6.43	120.70	0 12:30
J5	JUNCTION	0.17	6.46	119.51	0 12:30
J6	JUNCTION	0.17	6.61	119.49	0 12:30
J7	JUNCTION	0.15	6.43	118.39	0 12:30
J8	JUNCTION	0.14	6.19	117.28	0 12:30
J9	JUNCTION	0.08	3.38	113.60	0 12:30
J95	JUNCTION	0.09	4.52	111.17	0 12:30
J10	JUNCTION	0.11	6.19	107.39	0 12:30
J11	JUNCTION	0.12	6.49	101.02	0 12:30
J12	JUNCTION	0.11	6.49	99.61	0 12:30
J13	JUNCTION	0.08	6.10	98.09	0 12:30
J135	JUNCTION	0.09	5.97	76.53	0 12:30
OBJ6	JUNCTION	0.00	0.01	91.81	0 13:20
OBJ2	JUNCTION	0.45	1.12	89.12	0 14:30
OBEND	JUNCTION	0.22	0.48	79.13	0 14:30
Building	JUNCTION	0.23	0.50	78.49	0 14:30
DCB	JUNCTION	0.21	0.45	77.77	0 14:30
DMH	JUNCTION	0.22	0.45	76.71	0 14:30
CB	JUNCTION	0.18	0.37	76.37	0 13:45
ASSUMED	JUNCTION	0.23	0.50	73.40	0 13:45
DMH2	JUNCTION	0.13	0.27	72.24	0 13:45
DUMMY	JUNCTION	0.00	0.00	62.10	0 12:31
J35	JUNCTION	0.00	0.10	121.10	0 12:30
J55	JUNCTION	0.00	0.12	118.12	0 12:30
J85	JUNCTION	0.00	0.03	113.03	0 12:30
MAINOUTLET	OUTFALL	0.08	2.66	66.77	0 12:10
4OUTLET	OUTFALL	0.00	0.02	116.02	0 12:29
ROUTLET	OUTFALL	0.00	0.00	62.00	1 04:23
BOUTLET	OUTFALL	0.13	0.27	54.58	0 13:45

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
J1	JUNCTION	68.00	68.00	0 12:29	2.697	2.699
J2	JUNCTION	23.00	70.68	0 12:29	0.804	3.369
J3	JUNCTION	65.60	97.07	0 12:29	2.839	5.622
J4	JUNCTION	4.87	30.92	0 11:52	0.174	4.199
J5	JUNCTION	12.83	38.36	0 12:29	0.474	4.679
J6	JUNCTION	48.05	55.24	0 12:29	1.986	6.284
J7	JUNCTION	2.12	55.82	0 12:17	0.094	6.380
J8	JUNCTION	17.99	73.37	0 12:29	0.698	7.082
J9	JUNCTION	0.51	71.22	0 12:29	0.021	7.100

J95	JUNCTION	0.00	71.21	0	12:30	0.000	7.101
J10	JUNCTION	73.30	144.51	0	12:29	3.293	10.397
J11	JUNCTION	0.08	144.47	0	12:30	0.004	10.403
J12	JUNCTION	1.04	145.30	0	12:30	0.045	10.450
J13	JUNCTION	0.17	144.30	0	12:30	0.008	10.459
J135	JUNCTION	0.00	142.38	0	12:30	0.000	10.461
OBJ6	JUNCTION	0.00	2.58	0	12:30	0.000	0.007
OBJ2	JUNCTION	31.10	176.19	0	12:29	1.251	3.851
OBEND	JUNCTION	0.00	2.11	0	14:30	0.000	3.211
Building	JUNCTION	0.00	2.11	0	14:30	0.000	3.211
DCB	JUNCTION	0.00	2.11	0	14:30	0.000	3.211
DMH	JUNCTION	0.00	2.11	0	14:30	0.000	3.211
CB	JUNCTION	0.70	2.15	0	13:44	0.025	3.236
ASSUMED	JUNCTION	0.00	2.15	0	13:45	0.000	3.236
DMH2	JUNCTION	0.00	2.15	0	13:45	0.000	3.236
DUMMY	JUNCTION	0.00	0.71	0	12:30	0.000	0.000
J35	JUNCTION	0.00	20.59	0	12:30	0.000	0.710
J55	JUNCTION	0.00	31.09	0	12:30	0.000	0.386
J85	JUNCTION	0.00	2.59	0	12:30	0.000	0.005
MAINOUTLET	OUTFALL	0.00	142.39	0	12:30	0.000	10.463
4OUTLET	OUTFALL	0.00	20.21	0	12:29	0.000	0.139
ROUTLET	OUTFALL	0.00	1.06	1	04:23	0.000	0.262
BOUTLET	OUTFALL	0.00	2.15	0	13:45	0.000	3.236

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
J95	JUNCTION	0.52	1.858	1.482
J135	JUNCTION	0.41	3.306	0.034

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
MAINOUTLET	23.08	10.87	142.39	10.463
4OUTLET	0.40	11.41	20.21	0.139
ROUTLET	7.83	0.57	1.06	0.262
BOUTLET	99.72	0.57	2.15	3.236
System	32.76	23.42	163.50	14.099

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth

18Clay1	CONDUIT	11.63	0	11:48	6.58	1.22	1.00
18Clay2	CONDUIT	12.85	0	11:48	7.27	1.60	1.00
28Brick1	CONDUIT	29.77	0	11:52	6.98	1.45	1.00
28Brick2	CONDUIT	29.98	0	13:29	7.03	1.33	1.00
28Brick3	CONDUIT	32.06	0	13:26	7.52	1.63	1.00
32Brick1	CONDUIT	47.91	0	12:02	8.62	1.70	1.00
32Brick2	CONDUIT	53.29	0	12:12	9.59	1.58	1.00
32Brick3	CONDUIT	70.71	0	12:30	13.04	2.06	1.00
32Brick4	CONDUIT	71.21	0	12:30	16.78	0.82	1.00
DUM	CONDUIT	71.21	0	12:30	15.14	0.83	1.00
32Brick5	CONDUIT	112.78	0	12:09	20.29	1.07	1.00
32Brick6	CONDUIT	124.47	0	12:35	22.40	1.51	1.00
32Brick7	CONDUIT	141.90	0	12:26	25.92	1.90	1.00
32Brick8	CONDUIT	142.38	0	12:30	26.14	1.00	1.00
DUM2	CONDUIT	142.39	0	12:30	25.62	1.23	1.00
18Clay1Gut	CONDUIT	36.19	0	12:30	5.79	0.99	1.00
18Clay2Gut	CONDUIT	23.88	0	12:06	3.82	1.00	1.00
28Brick1Gut	CONDUIT	20.59	0	12:30	9.03	0.95	0.60
28Brick2Gut	CONDUIT	3.29	0	12:30	1.13	0.12	0.68
28Brick3Gut	CONDUIT	31.09	0	12:30	15.18	0.57	0.57
32Brick1Gut	CONDUIT	22.53	0	12:30	3.61	1.01	1.00
32Brick2Gut	CONDUIT	17.39	0	12:30	3.82	0.66	0.85
32Brick3Gut	CONDUIT	2.59	0	12:30	8.54	0.04	0.22
32Brick4Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.39
32Brick5Gut	CONDUIT	41.82	0	12:30	10.62	0.51	0.88
32Brick6Gut	CONDUIT	60.96	0	12:30	10.25	0.94	0.98
32Brick7Gut	CONDUIT	54.36	0	12:30	9.26	0.92	0.97
32Brick8Gut	CONDUIT	0.71	0	12:30	13.47	0.01	0.10
18Clay1Over	CONDUIT	20.21	0	12:29	2.86	0.01	0.07
18Clay2Over	CONDUIT	38.87	0	12:30	1.09	0.07	0.60
28Brick1Over	CONDUIT	54.94	0	12:30	1.13	0.06	0.60
28Brick2Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
28Brick3Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
32Brick1Over	CONDUIT	0.61	0	12:30	0.28	0.07	0.22
32Brick2Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.02
32Brick3Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.02
32Brick4Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick5Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick6Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick7Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick8Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
SWALE1	CONDUIT	0.00	0	13:20	0.00	0.00	0.50
SWALE2	CONDUIT	2.11	0	14:30	2.07	0.23	0.40
15CIP	CONDUIT	2.11	0	14:30	4.77	0.31	0.39
24CMP	CONDUIT	2.11	0	14:30	3.73	0.13	0.24
24CMP2	CONDUIT	2.11	0	14:30	4.00	0.11	0.22
24CMP3	CONDUIT	2.11	0	14:30	4.53	0.12	0.21
24CMP4	CONDUIT	2.15	0	13:45	4.27	0.08	0.22
18RCP	CONDUIT	2.15	0	13:45	4.19	0.24	0.33
24RCP	CONDUIT	2.15	0	13:45	8.69	0.04	0.13
DUMMY	CONDUIT	1.06	1	04:23	0.00	0.00	0.00
J35S	CONDUIT	20.59	0	12:30	4.66	0.21	0.71
J55S	CONDUIT	30.97	0	12:30	4.31	0.25	0.73
J85S	CONDUIT	1.98	0	12:30	3.34	0.02	0.08

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
18Clay1	1.00	0.00	0.00	0.00	0.92	0.08	0.00	0.00	0.27	0.0000
18Clay2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.22	0.0000
28Brick1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.29	0.0000
28Brick2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.29	0.0000
28Brick3	1.75	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.26	0.0000
32Brick1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.32	0.0000
32Brick2	1.00	0.00	0.00	0.00	0.90	0.09	0.00	0.00	0.32	0.0000

32Brick3	1.00	0.00	0.00	0.00	0.85	0.15	0.00	0.00	0.45	0.0000
32Brick4	1.47	0.00	0.00	0.00	0.61	0.39	0.00	0.00	0.67	0.0000
DUM	1.00	0.00	0.00	0.00	0.81	0.19	0.00	0.00	0.65	0.0000
32Brick5	1.32	0.00	0.00	0.00	0.55	0.45	0.00	0.00	0.80	0.0000
32Brick6	3.31	0.00	0.00	0.00	0.78	0.22	0.00	0.00	0.76	0.0000
32Brick7	3.20	0.00	0.00	0.00	0.43	0.57	0.00	0.00	0.93	0.0000
32Brick8	1.00	0.00	0.06	0.00	0.51	0.43	0.00	0.00	1.12	0.0000
DUM2	1.78	0.00	0.00	0.00	0.63	0.37	0.00	0.00	0.96	0.0000
18Clay1Gut	1.00	0.98	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.0000
18Clay2Gut	1.00	0.98	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.0000
28Brick1Gut	1.00	0.97	0.02	0.00	0.00	0.01	0.00	0.00	0.05	0.0000
28Brick2Gut	1.00	0.99	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.0000
28Brick3Gut	1.53	0.98	0.01	0.00	0.00	0.01	0.00	0.00	0.05	0.0000
32Brick1Gut	1.00	0.99	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.0000
32Brick2Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick3Gut	1.00	0.98	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.0000
32Brick4Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick5Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.0000
32Brick6Gut	1.82	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.0000
32Brick7Gut	1.73	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick8Gut	1.00	0.92	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
18Clay1Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.0000
18Clay2Over	1.00	0.00	0.99	0.00	0.01	0.00	0.00	0.00	0.00	0.0000
28Brick1Over	1.00	0.00	0.99	0.00	0.01	0.00	0.00	0.00	0.00	0.0000
28Brick2Over	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28Brick3Over	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick1Over	1.00	0.06	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick2Over	1.00	0.06	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick3Over	1.00	0.06	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick4Over	1.00	0.92	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick5Over	1.00	0.92	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick6Over	1.00	0.92	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick7Over	1.00	0.92	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick8Over	1.00	0.92	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
SWALE1	1.00	0.00	0.06	0.00	0.94	0.00	0.00	0.00	0.00	0.0000
SWALE2	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.42	0.0000
15CIP	1.01	0.00	0.00	0.00	0.04	0.95	0.00	0.00	1.27	0.0000
24CMP	1.10	0.01	0.00	0.00	0.27	0.72	0.00	0.00	1.02	0.0000
24CMP2	1.14	0.01	0.00	0.00	0.05	0.94	0.00	0.00	1.09	0.0000
24CMP3	3.79	0.00	0.01	0.00	0.05	0.94	0.00	0.00	1.27	0.0000
24CMP4	1.03	0.00	0.00	0.00	0.02	0.98	0.00	0.00	1.26	0.0000
18RCP	1.95	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.16	0.0000
24RCP	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	3.19	0.0000
DUMMY	93460.50	0.92	0.00	0.00	0.01	0.07	0.00	0.00	2.28	0.0000
J35S	1.00	0.00	0.97	0.00	0.02	0.01	0.00	0.00	0.02	0.0000
J55S	1.00	0.00	0.98	0.00	0.02	0.01	0.00	0.00	0.01	0.0000
J85S	1.00	0.06	0.92	0.00	0.02	0.00	0.00	0.00	0.01	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
18Clay1	2.33	2.33	2.33	1.73	1.73
18Clay2	2.55	2.55	2.55	1.11	0.92
28Brick1	2.02	2.02	2.02	2.11	2.02
28Brick2	2.01	2.01	2.01	1.68	1.64
28Brick3	1.99	1.99	1.99	1.84	1.44
32Brick1	1.62	1.62	1.62	2.14	1.62
32Brick2	1.18	1.18	1.18	1.94	1.18
32Brick3	0.32	0.32	0.32	2.01	0.32
32Brick4	0.32	0.32	0.32	0.01	0.01
DUM	0.52	0.52	0.53	0.01	0.01
32Brick5	0.69	0.69	0.69	0.26	0.26
32Brick6	0.72	0.72	0.72	0.91	0.70
32Brick7	0.13	0.13	0.14	1.07	0.13
32Brick8	0.13	0.13	0.14	0.01	0.01

DUM2	0.01	0.01	0.01	0.48	0.01
18Clay1Gut	0.46	0.46	0.46	0.01	0.01
18Clay2Gut	0.94	0.94	0.94	0.57	0.57
32Brick1Gut	0.01	0.01	0.01	0.28	0.01

```
Analysis begun on:  Thu Jun 13 09:13:14 2013
Analysis ended on:  Thu Jun 13 09:13:25 2013
Total elapsed time: 00:00:11
```

FUSS & O'NEILL

Appendix B

Proposed Conditions SWMM Status Report (for Main Street Drainage System)

Main Street SWMM

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------

Main Street SWMM

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... DYNWAVE
Starting Date ............ JAN-01-2013 00:00:00
Ending Date .............. JAN-10-2013 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:00:05
Dry Time Step ............ 00:00:05
Routing Time Step ........ 5.00 sec


WARNING 03: negative offset ignored for Link 28Brick1Gut

WARNING 02: maximum depth increased for Node J1

WARNING 02: maximum depth increased for Node J2

WARNING 02: maximum depth increased for Node J3

WARNING 02: maximum depth increased for Node J4

WARNING 02: maximum depth increased for Node J5

WARNING 02: maximum depth increased for Node J6

WARNING 02: maximum depth increased for Node J7

WARNING 02: maximum depth increased for Node J8

WARNING 02: maximum depth increased for Node J9

WARNING 02: maximum depth increased for Node J10

WARNING 02: maximum depth increased for Node J11

WARNING 02: maximum depth increased for Node J12

WARNING 02: maximum depth increased for Node J13

WARNING 02: maximum depth increased for Node OBJ2

WARNING 02: maximum depth increased for Node OBEND

*********************
Control Actions Taken
*********************


**************************        Volume         Depth
```

```
Runoff Quantity Continuity     acre-feet      inches
**************************     ---------     -------
Total Precipitation ......        75.292       4.800
Evaporation Loss .........         0.000       0.000
Infiltration Loss ........        30.611       1.951
Surface Runoff ...........        44.226       2.819
Final Surface Storage ....         0.455       0.029
Continuity Error (%) .....         0.000


**************************        Volume      Volume
Flow Routing Continuity        acre-feet    10^6 gal
**************************     ---------   ---------
Dry Weather Inflow .......         0.000       0.000
Wet Weather Inflow .......        44.226      14.412
Groundwater Inflow .......         0.000       0.000
RDII Inflow ..............         0.000       0.000
External Inflow ..........         0.000       0.000
External Outflow .........        43.711      14.244
Internal Outflow .........         0.000       0.000
Storage Losses ...........         0.000       0.000
Initial Stored Volume ....         0.003       0.001
Final Stored Volume ......         1.033       0.337
Continuity Error (%) .....        -1.168


*************************
Highest Continuity Errors
*************************
Node OBJ2 (52.99%)


***************************
Time-Step Critical Elements
***************************
Link 32Brick7 (1.14%)


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     4.98 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     4.48
Average Iterations per Step :     1.96


***************************
Subcatchment Runoff Summary
***************************
```

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
S3	4.80	0.00	0.00	1.71	3.06	0.50	12.95	0.638
S4	4.80	0.00	0.00	1.89	2.88	0.80	23.00	0.600
S5	4.80	0.00	0.00	2.24	2.54	2.84	65.62	0.528
S6	4.80	0.00	0.00	1.71	3.06	0.17	4.88	0.638
S7	4.80	0.00	0.00	1.71	3.06	0.47	12.83	0.638
S8	4.80	0.00	0.00	1.96	2.81	1.99	48.06	0.586
S9	4.80	0.00	0.00	0.26	4.49	0.09	2.12	0.935
S10	4.80	0.00	0.00	2.33	2.45	0.70	17.99	0.510
S11	4.80	0.00	0.00	0.75	4.00	0.02	0.51	0.834

S12	4.80	0.00	0.00	2.15	2.62	3.29	73.32	0.546
S14	4.80	0.00	0.00	0.11	4.63	0.00	0.08	0.965
S13	4.80	0.00	0.00	0.39	4.35	0.04	1.04	0.907
S15	4.80	0.00	0.00	0.00	4.74	0.01	0.17	0.988
S16	4.80	0.00	0.00	1.42	3.34	1.25	31.11	0.697
S17	4.80	0.00	0.00	1.38	3.39	0.02	0.70	0.706
S1	4.80	0.00	0.00	1.38	3.38	0.73	18.49	0.705
S2	4.80	0.00	0.00	1.53	3.23	1.47	36.58	0.673

****

Node Depth Summary

****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min
J1	JUNCTION	0.05	4.85	125.28	0	12:30
J2	JUNCTION	0.07	5.83	122.91	0	12:30
J3	JUNCTION	0.12	6.04	120.38	0	12:30
J4	JUNCTION	0.08	5.43	118.95	0	12:30
J5	JUNCTION	0.10	6.02	117.57	0	12:30
J6	JUNCTION	0.11	6.02	117.40	0	12:30
J7	JUNCTION	0.12	5.50	115.96	0	12:30
J8	JUNCTION	0.10	3.81	113.40	0	12:30
J9	JUNCTION	0.07	3.08	111.80	0	12:30
J95	JUNCTION	0.06	2.78	109.01	0	12:30
J10	JUNCTION	0.07	3.66	104.44	0	12:30
J11	JUNCTION	0.10	6.09	100.20	0	12:30
J12	JUNCTION	0.08	3.35	96.05	0	12:30
J13	JUNCTION	0.06	2.67	94.24	0	12:31
J135	JUNCTION	0.07	2.75	72.89	0	12:31
OBJ6	JUNCTION	0.00	0.00	91.80	0	00:00
OBJ2	JUNCTION	0.17	0.28	88.28	1	00:25
OBEND	JUNCTION	0.10	0.15	78.80	1	00:25
Building	JUNCTION	0.11	0.17	78.16	1	00:26
DCB	JUNCTION	0.10	0.15	77.47	1	00:26
DMH	JUNCTION	0.10	0.16	76.42	1	00:31
CB	JUNCTION	0.08	0.24	76.24	0	12:30
ASSUMED	JUNCTION	0.11	0.31	73.21	0	12:30
DMH2	JUNCTION	0.06	0.17	72.14	0	12:30
DUMMY	JUNCTION	0.00	0.00	62.10	0	00:00
J35	JUNCTION	0.00	0.00	121.00	0	00:00
J55	JUNCTION	0.00	0.00	118.00	0	00:00
J85	JUNCTION	0.00	0.00	113.00	0	00:00
MAINOUTLET	OUTFALL	0.07	2.74	66.85	0	12:31
4OUTLET	OUTFALL	0.00	0.00	116.00	0	00:00
ROUTLET	OUTFALL	0.00	0.00	62.00	0	00:00
BOUTLET	OUTFALL	0.06	0.17	54.48	0	12:30

****

Node Inflow Summary

****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
J1	JUNCTION	68.01	68.01	0	12:30	2.698	2.709
J2	JUNCTION	23.00	90.49	0	12:30	0.804	3.529
J3	JUNCTION	65.62	155.04	0	12:30	2.839	6.406
J4	JUNCTION	4.88	159.03	0	12:30	0.174	6.641
J5	JUNCTION	12.83	171.50	0	12:30	0.475	7.151
J6	JUNCTION	48.06	218.80	0	12:30	1.986	9.164
J7	JUNCTION	2.12	220.71	0	12:30	0.094	9.303
J8	JUNCTION	17.99	238.24	0	12:30	0.698	10.073
J9	JUNCTION	0.51	238.87	0	12:30	0.021	10.110

J95	JUNCTION	0.00	239.05	0	12:30	0.000	10.133
J10	JUNCTION	73.31	311.27	0	12:30	3.293	13.458
J11	JUNCTION	0.08	310.98	0	12:30	0.004	13.488
J12	JUNCTION	1.04	312.13	0	12:30	0.045	13.576
J13	JUNCTION	0.17	312.43	0	12:30	0.008	13.595
J135	JUNCTION	0.00	312.47	0	12:31	0.000	13.618
OBJ6	JUNCTION	0.00	0.00	0	00:00	0.000	0.000
OBJ2	JUNCTION	31.11	31.11	0	12:30	1.251	1.256
OBEND	JUNCTION	0.00	0.22	1	00:25	0.000	0.590
Building	JUNCTION	0.00	0.22	1	00:25	0.000	0.590
DCB	JUNCTION	0.00	0.22	1	00:26	0.000	0.590
DMH	JUNCTION	0.00	0.22	1	00:26	0.000	0.590
CB	JUNCTION	0.70	0.84	0	12:30	0.025	0.615
ASSUMED	JUNCTION	0.00	0.84	0	12:30	0.000	0.615
DMH2	JUNCTION	0.00	0.83	0	12:30	0.000	0.615
DUMMY	JUNCTION	0.00	0.00	0	00:00	0.000	0.000
J35	JUNCTION	0.00	0.00	0	00:00	0.000	0.000
J55	JUNCTION	0.00	0.00	0	00:00	0.000	0.000
J85	JUNCTION	0.00	0.00	0	00:00	0.000	0.000
MAINOUTLET	OUTFALL	0.00	312.61	0	12:31	0.000	13.628
4OUTLET	OUTFALL	0.00	0.00	0	00:00	0.000	0.000
ROUTLET	OUTFALL	0.00	0.00	0	00:00	0.000	0.000
BOUTLET	OUTFALL	0.00	0.83	0	12:30	0.000	0.615

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
MAINOUTLET	22.55	13.43	312.61	13.628
4OUTLET	0.00	0.00	0.00	0.000
ROUTLET	0.00	0.00	0.00	0.000
BOUTLET	99.72	0.11	0.83	0.615
System	30.57	13.53	313.42	14.243

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min		Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
18Clay1	CONDUIT	67.51	0	12:30	10.21	0.91	1.00
18Clay2	CONDUIT	89.76	0	12:30	9.33	1.20	1.00
28Brick1	CONDUIT	154.30	0	12:30	9.70	2.09	1.00
28Brick2	CONDUIT	160.44	0	12:31	10.09	0.97	1.00
28Brick3	CONDUIT	173.99	0	12:31	8.86	1.00	1.00
32Brick1	CONDUIT	218.71	0	12:30	11.14	1.25	1.00
32Brick2	CONDUIT	220.85	0	12:30	14.07	2.15	0.96

32Brick3	CONDUIT	238.42	0	12:30	16.71	1.19	0.69
32Brick4	CONDUIT	239.05	0	12:30	24.52	0.97	0.73
DUM	CONDUIT	239.37	0	12:31	23.99	0.82	0.80
32Brick5	CONDUIT	310.92	0	12:30	25.26	0.86	0.96
32Brick6	CONDUIT	311.25	0	12:30	32.35	1.96	1.00
32Brick7	CONDUIT	312.32	0	12:31	31.40	1.22	0.75
32Brick8	CONDUIT	312.47	0	12:31	39.85	0.93	0.76
DUM2	CONDUIT	312.61	0	12:31	34.04	0.81	0.69
18Clay1Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
18Clay2Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
28Brick1Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
28Brick2Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
28Brick3Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick1Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick2Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick3Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick4Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick5Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick6Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick7Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick8Gut	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
18Clay1Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
18Clay2Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
28Brick1Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
28Brick2Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
28Brick3Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
32Brick1Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick2Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick3Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick4Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick5Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick6Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick7Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
32Brick8Over	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
SWALE1	CONDUIT	0.00	0	00:00	0.00	0.00	0.14
SWALE2	CONDUIT	0.22	1	00:25	1.04	0.02	0.10
15CIP	CONDUIT	0.22	1	00:25	2.37	0.03	0.13
24CMP	CONDUIT	0.22	1	00:26	1.88	0.01	0.08
24CMP2	CONDUIT	0.22	1	00:26	1.97	0.01	0.08
24CMP3	CONDUIT	0.22	1	00:27	2.22	0.01	0.09
24CMP4	CONDUIT	0.84	0	12:30	3.27	0.03	0.14
18RCP	CONDUIT	0.83	0	12:30	3.20	0.09	0.21
24RCP	CONDUIT	0.83	0	12:30	6.53	0.01	0.08
DUMMY	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
J35S	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
J55S	CONDUIT	0.00	0	00:00	0.00	0.00	0.50
J85S	CONDUIT	0.00	0	00:00	0.00	0.00	0.00

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
		--- Fraction of Time in Flow Class ----								
18Clay1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.35	0.0000
18Clay2	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.30	0.0000
28Brick1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.21	0.0000
28Brick2	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.34	0.0000
28Brick3	2.84	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.27	0.0000
32Brick1	1.00	0.00	0.29	0.00	0.71	0.00	0.00	0.00	0.24	0.0000
32Brick2	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.29	0.0000
32Brick3	1.00	0.00	0.00	0.00	0.87	0.13	0.00	0.00	0.42	0.0000
32Brick4	1.84	0.00	0.14	0.00	0.50	0.36	0.00	0.00	0.73	0.0000
DUM	1.32	0.00	0.00	0.00	0.63	0.37	0.00	0.00	0.67	0.0000
32Brick5	1.88	0.00	0.34	0.00	0.45	0.21	0.00	0.00	0.73	0.0000
32Brick6	3.72	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.82	0.0000
32Brick7	4.47	0.00	0.10	0.00	0.51	0.39	0.00	0.00	0.92	0.0000
32Brick8	1.22	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.17	0.0000

DUM2	2.48	0.00	0.00	0.00	0.58	0.41	0.00	0.00	1.23	0.0000
18Clay1Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
18Clay2Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28Brick1Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28Brick2Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28Brick3Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick1Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick2Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick3Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick4Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick5Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick6Gut	1.82	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick7Gut	1.73	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick8Gut	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
18Clay1Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
18Clay2Over	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28Brick1Over	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28Brick2Over	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28Brick3Over	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick1Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick2Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick3Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick4Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick5Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick6Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick7Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32Brick8Over	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
SWALE1	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
SWALE2	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.40	0.0000
15CIP	1.01	0.00	0.00	0.00	0.04	0.95	0.00	0.00	1.16	0.0000
24CMP	1.10	0.01	0.00	0.00	0.88	0.10	0.00	0.00	0.92	0.0000
24CMP2	1.14	0.01	0.00	0.00	0.54	0.45	0.00	0.00	0.98	0.0000
24CMP3	3.79	0.00	0.01	0.00	0.05	0.94	0.00	0.00	1.13	0.0000
24CMP4	1.03	0.00	0.00	0.00	0.02	0.98	0.00	0.00	1.16	0.0000
18RCP	1.95	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.09	0.0000
24RCP	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	2.92	0.0000
DUMMY	93460.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
J35S	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
J55S	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
J85S	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000

****
Conduit Surcharge Summary
****

Conduit	--------- Hours Full Both Ends	Upstream	-------- Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
18Clay1	0.15	0.15	0.15	0.01	0.01
18Clay2	0.22	0.22	0.22	0.32	0.22
28Brick1	0.10	0.10	0.10	0.75	0.10
28Brick2	0.17	0.17	0.17	0.01	0.01
28Brick3	0.26	0.26	0.26	0.01	0.01
32Brick1	0.24	0.24	0.24	0.35	0.24
32Brick2	0.01	0.01	0.01	0.76	0.01
32Brick3	0.01	0.01	0.01	0.30	0.01
32Brick6	0.71	0.71	0.71	0.74	0.71
32Brick7	0.01	0.01	0.01	0.32	0.01

Analysis begun on: Thu Jun 13 09:27:21 2013
Analysis ended on: Thu Jun 13 09:27:32 2013
Total elapsed time: 00:00:11

Appendix C

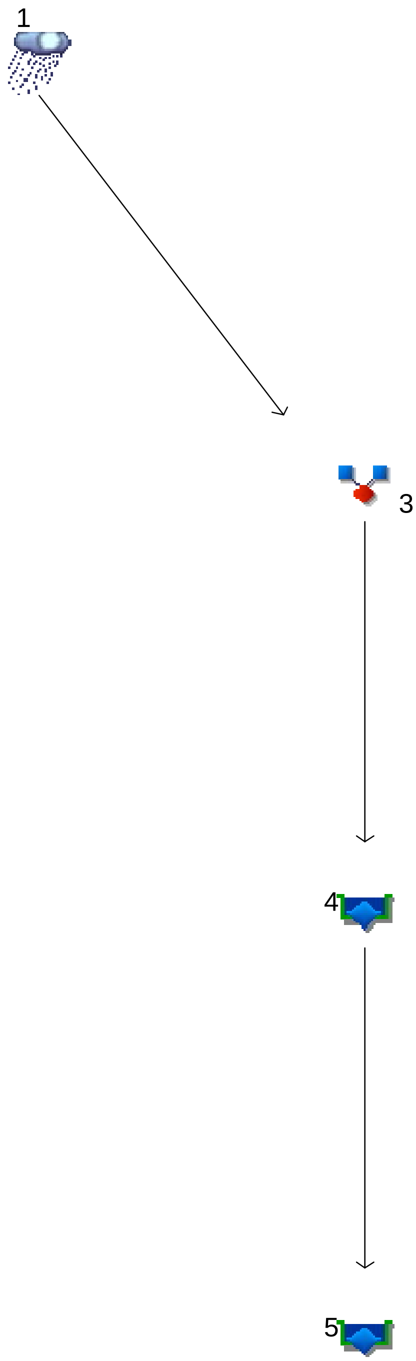
Brayton Site Hydraulic Analysis Report (Hydraflow Hydrographs)

Hydraflow Table of Contents

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Tuesday, Jun 18, 2013

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8



Legend

Hyd.	Origin	Description
1	Manual	Brayton Street Runoff
2	Manual	Overflow from Main Street
3	Combine	Total Flow to Brayton Site
4	Reservoir	Basin No. 1 Sizing
5	Reservoir	Basin No. 2 Sizing

Project: SDA_BraytonREV_20130530.gpw

Tuesday, Jun 18, 2013

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Manual	31.11	15	750	168,201	------	------	------	Brayton Street Runoff
2	Manual	167.72	15	750	384,489	------	------	------	Overflow from Main Street
3	Combine	198.83	15	750	552,690	1, 2	------	------	Total Flow to Brayton Site
4	Reservoir	196.58	15	750	552,682	3	89.86	43,206	Basin No. 1 Sizing
5	Reservoir	194.33	15	750	552,669	4	87.97	29,966	Basin No. 2 Sizing

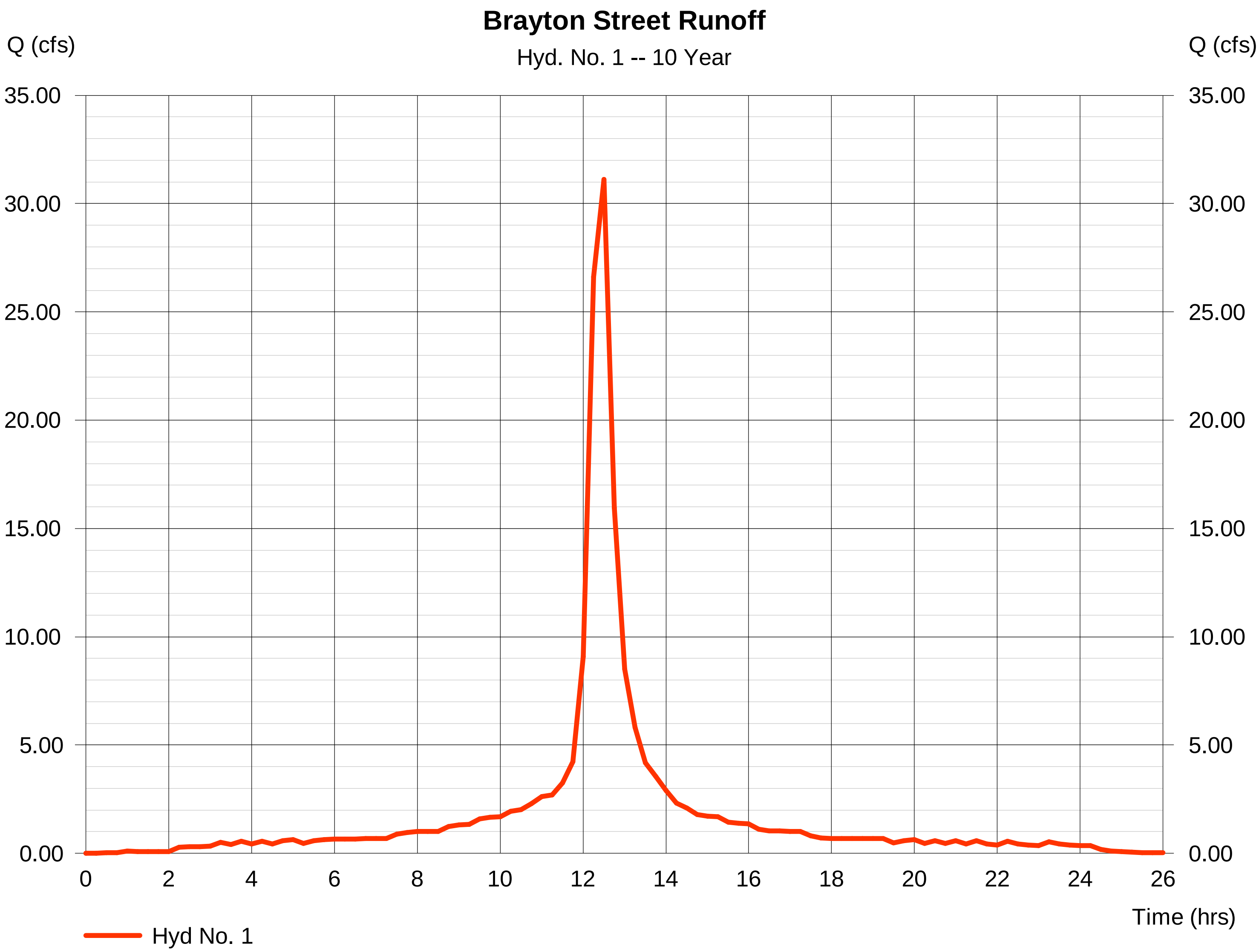
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Tuesday, Jun 18, 2013

Hyd. No. 1

Brayton Street Runoff

Hydrograph type	= Manual	Peak discharge	= 31.11 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.50 hrs
Time interval	= 15 min	Hyd. volume	= 168,201 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Tuesday, Jun 18, 2013

Hyd. No. 2

Overflow from Main Street

Hydrograph type	= Manual	Peak discharge	= 167.72 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.50 hrs
Time interval	= 15 min	Hyd. volume	= 384,489 cuft

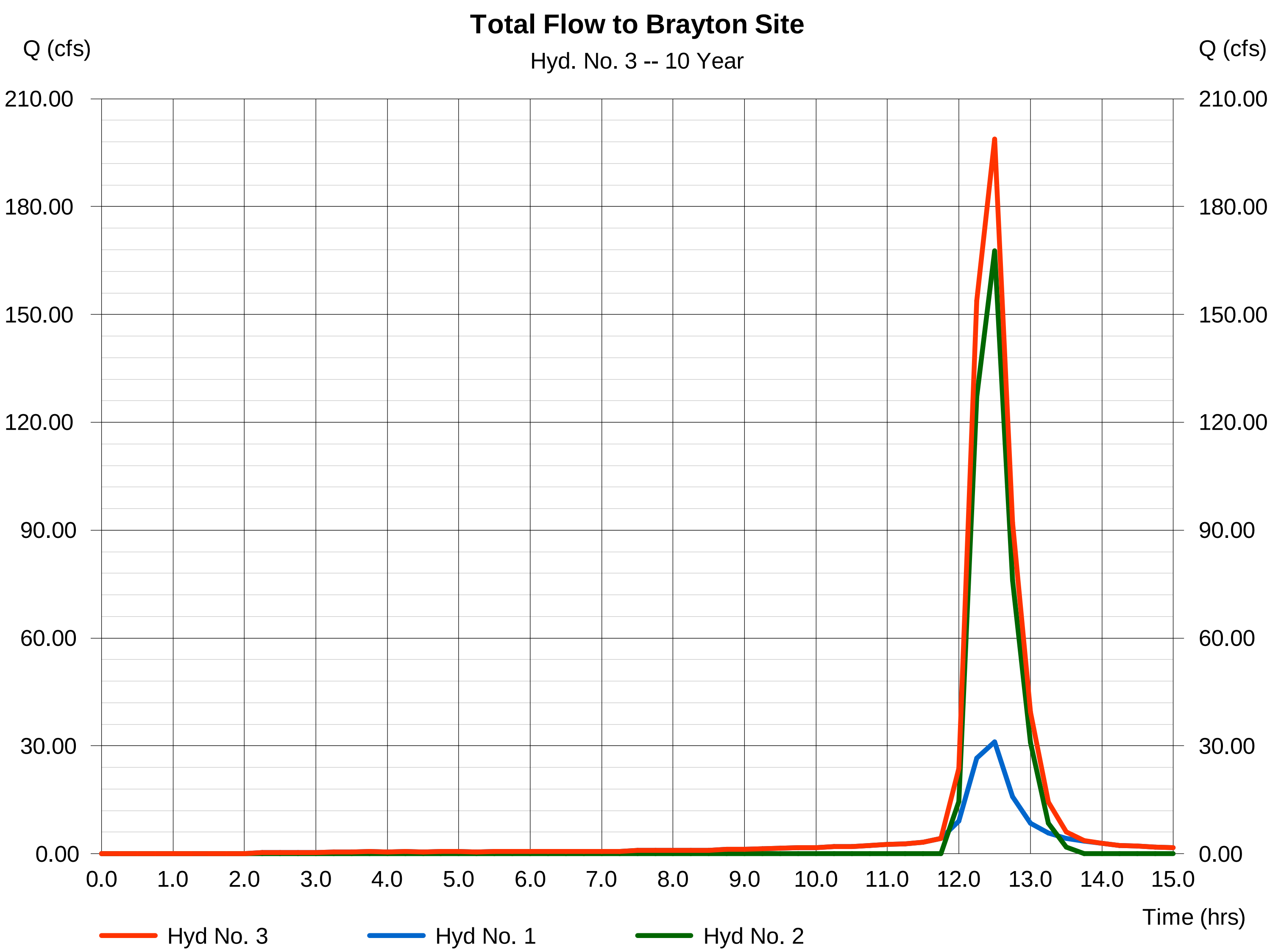
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Tuesday, Jun 18, 2013

Hyd. No. 3

Total Flow to Brayton Site

Hydrograph type	= Combine	Peak discharge	= 198.83 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.50 hrs
Time interval	= 15 min	Hyd. volume	= 552,690 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 0.000 ac



Hydrograph Report

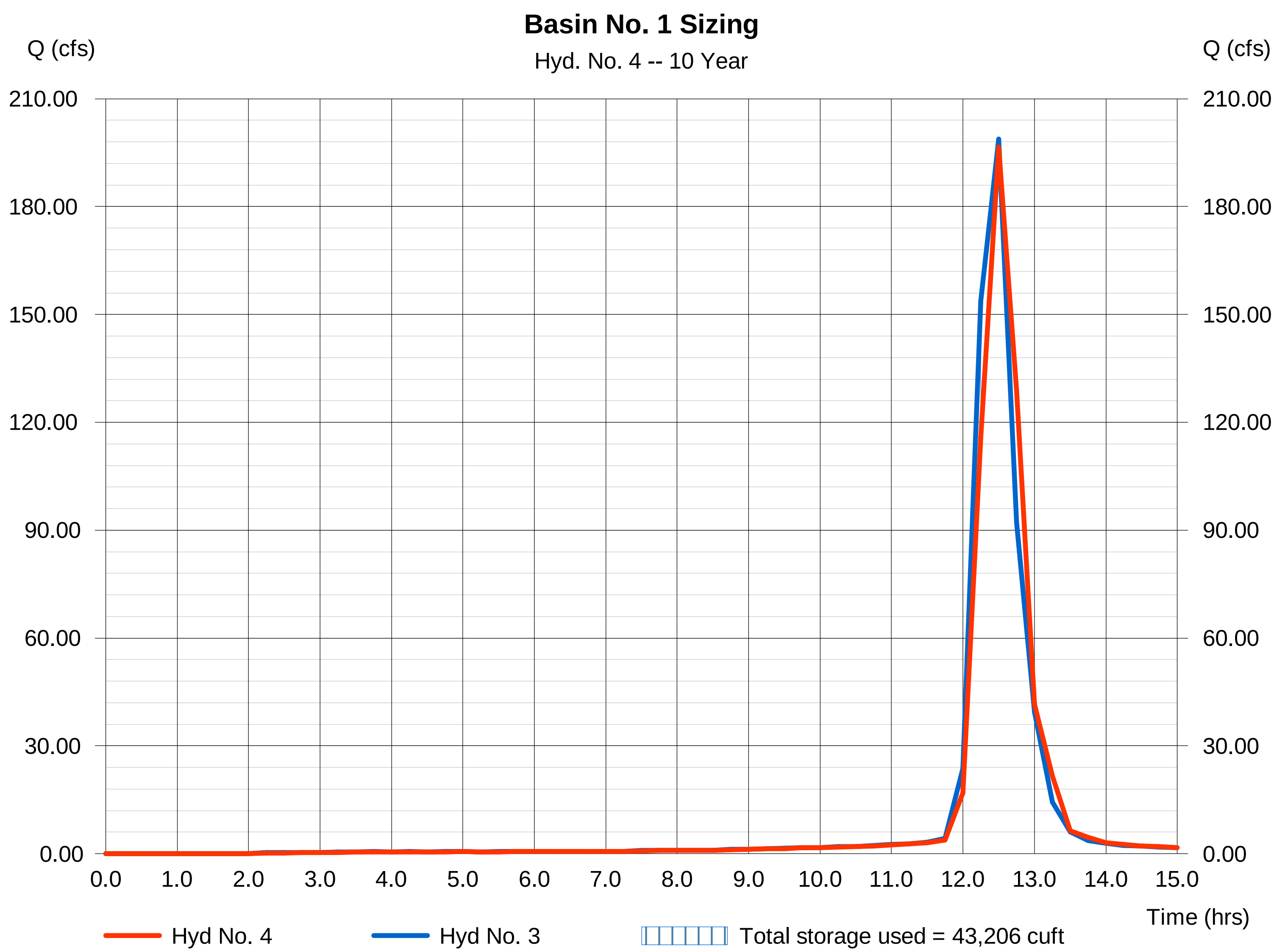
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Tuesday, Jun 18, 2013

Hyd. No. 4

Basin No. 1 Sizing

Hydrograph type	= Reservoir	Peak discharge	= 196.58 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.50 hrs
Time interval	= 15 min	Hyd. volume	= 552,682 cuft
Inflow hyd. No.	= 3 - Total Flow to Brayton Site	Max. Elevation	= 89.86 ft
Reservoir name	= Upper Basin	Max. Storage	= 43,206 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Tuesday, Jun 18, 2013

Pond No. 1 - Upper Basin

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 86.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	86.00	5,976	0	0
1.00	87.00	8,209	7,062	7,062
2.00	88.00	11,603	9,856	16,919
3.00	89.00	14,842	13,188	30,107
4.00	90.00	18,138	16,461	46,567

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 48.00	0.00	0.00	0.00
Span (in)	= 96.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 86.00	0.00	0.00	0.00
Length (ft)	= 146.00	0.00	0.00	0.00
Slope (%)	= 0.80	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	86.00	0.00	---	---	---	---	---	---	---	---	---	0.000
0.10	706	86.10	0.86 ic	---	---	---	---	---	---	---	---	---	0.861
0.20	1,412	86.20	2.44 ic	---	---	---	---	---	---	---	---	---	2.436
0.30	2,119	86.30	4.48 ic	---	---	---	---	---	---	---	---	---	4.475
0.40	2,825	86.40	6.89 ic	---	---	---	---	---	---	---	---	---	6.890
0.50	3,531	86.50	9.63 ic	---	---	---	---	---	---	---	---	---	9.630
0.60	4,237	86.60	12.66 ic	---	---	---	---	---	---	---	---	---	12.66
0.70	4,944	86.70	15.95 ic	---	---	---	---	---	---	---	---	---	15.95
0.80	5,650	86.80	19.49 ic	---	---	---	---	---	---	---	---	---	19.49
0.90	6,356	86.90	23.26 ic	---	---	---	---	---	---	---	---	---	23.26
1.00	7,062	87.00	27.24 ic	---	---	---	---	---	---	---	---	---	27.24
1.10	8,048	87.10	31.42 ic	---	---	---	---	---	---	---	---	---	31.42
1.20	9,034	87.20	35.80 ic	---	---	---	---	---	---	---	---	---	35.80
1.30	10,019	87.30	40.37 ic	---	---	---	---	---	---	---	---	---	40.37
1.40	11,005	87.40	45.12 ic	---	---	---	---	---	---	---	---	---	45.12
1.50	11,990	87.50	50.04 ic	---	---	---	---	---	---	---	---	---	50.04
1.60	12,976	87.60	55.12 ic	---	---	---	---	---	---	---	---	---	55.12
1.70	13,962	87.70	60.37 ic	---	---	---	---	---	---	---	---	---	60.37
1.80	14,947	87.80	65.78 ic	---	---	---	---	---	---	---	---	---	65.78
1.90	15,933	87.90	71.33 ic	---	---	---	---	---	---	---	---	---	71.33
2.00	16,919	88.00	77.04 ic	---	---	---	---	---	---	---	---	---	77.04
2.10	18,237	88.10	82.89 ic	---	---	---	---	---	---	---	---	---	82.89
2.20	19,556	88.20	88.88 ic	---	---	---	---	---	---	---	---	---	88.88
2.30	20,875	88.30	95.01 ic	---	---	---	---	---	---	---	---	---	95.01
2.40	22,194	88.40	101.27 ic	---	---	---	---	---	---	---	---	---	101.27
2.50	23,513	88.50	107.67 ic	---	---	---	---	---	---	---	---	---	107.67
2.60	24,831	88.60	114.19 ic	---	---	---	---	---	---	---	---	---	114.19
2.70	26,150	88.70	120.84 ic	---	---	---	---	---	---	---	---	---	120.84
2.80	27,469	88.80	127.62 ic	---	---	---	---	---	---	---	---	---	127.62
2.90	28,788	88.90	134.51 ic	---	---	---	---	---	---	---	---	---	134.51
3.00	30,107	89.00	141.53 ic	---	---	---	---	---	---	---	---	---	141.53
3.10	31,753	89.10	148.67 ic	---	---	---	---	---	---	---	---	---	148.67
3.20	33,399	89.20	155.92 ic	---	---	---	---	---	---	---	---	---	155.92
3.30	35,045	89.30	163.28 ic	---	---	---	---	---	---	---	---	---	163.28
3.40	36,691	89.40	170.76 ic	---	---	---	---	---	---	---	---	---	170.76
3.50	38,337	89.50	178.35 ic	---	---	---	---	---	---	---	---	---	178.35
3.60	39,983	89.60	185.87 oc	---	---	---	---	---	---	---	---	---	185.87
3.70	41,629	89.70	191.34 oc	---	---	---	---	---	---	---	---	---	191.34

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Upper Basin

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.80	43,275	89.80	196.81 oc	---	---	---	---	---	---	---	---	---	196.81
3.90	44,921	89.90	202.28 oc	---	---	---	---	---	---	---	---	---	202.28
4.00	46,567	90.00	196.83 oc	---	---	---	---	---	---	---	---	---	196.83

...End

Hydrograph Report

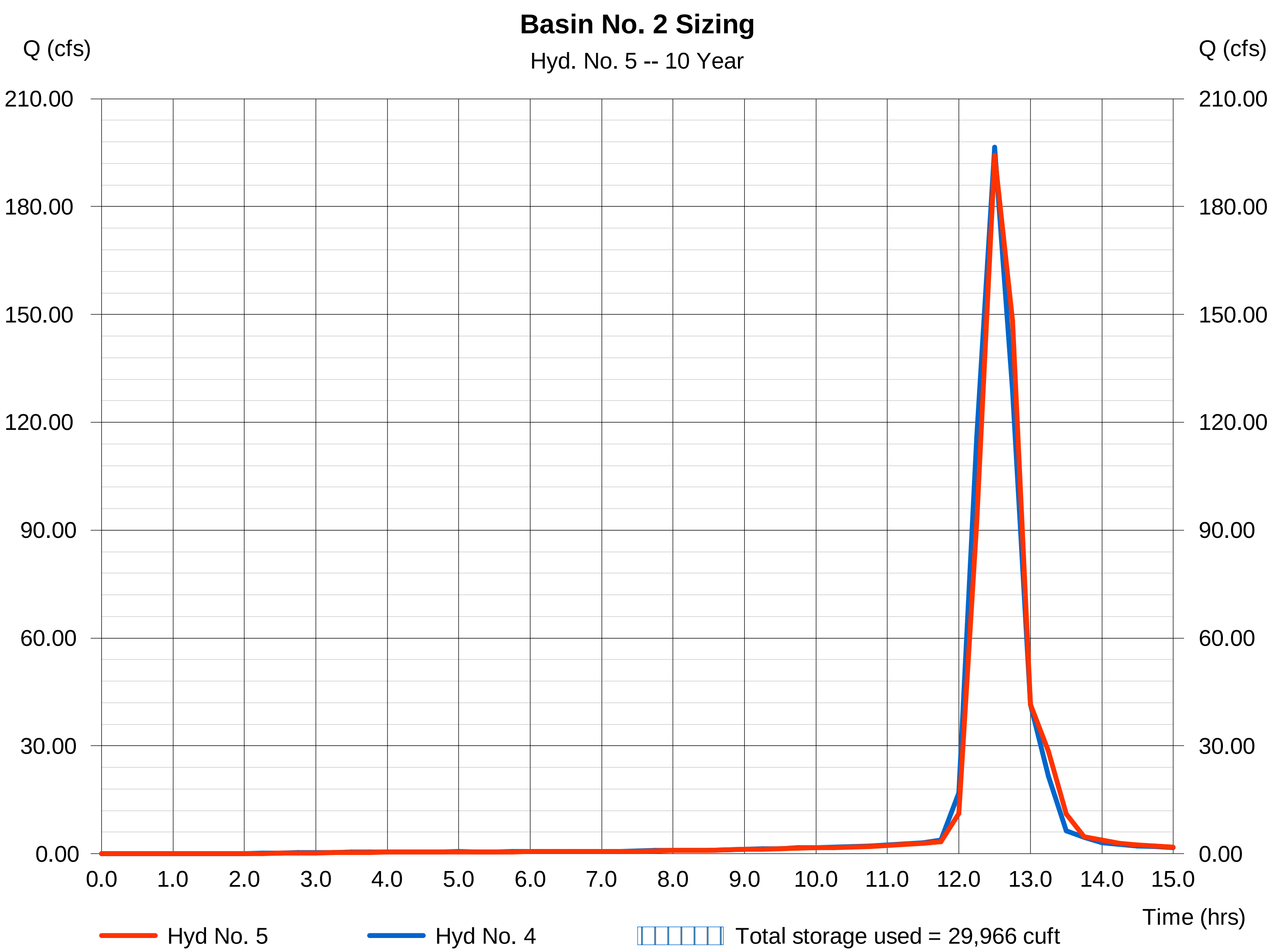
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Tuesday, Jun 18, 2013

Hyd. No. 5

Basin No. 2 Sizing

Hydrograph type	= Reservoir	Peak discharge	= 194.33 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.50 hrs
Time interval	= 15 min	Hyd. volume	= 552,669 cuft
Inflow hyd. No.	= 4 - Basin No. 1 Sizing	Max. Elevation	= 87.97 ft
Reservoir name	= Lower Basin	Max. Storage	= 29,966 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Tuesday, Jun 18, 2013

Pond No. 2 - Lower Basin

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 84.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	84.00	5,109	0	0
1.00	85.00	6,432	5,757	5,757
2.00	86.00	7,785	7,097	12,854
3.00	87.00	9,193	8,478	21,333
4.00	88.00	10,659	9,916	31,249

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 54.00	24.00	0.00	0.00
Span (in)	= 54.00	48.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 78.50	84.00	0.00	0.00
Length (ft)	= 160.00	0.00	0.00	0.00
Slope (%)	= 0.40	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 25.13	0.00	0.00	0.00
Crest El. (ft)	= 86.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	84.00	0.00	0.00	---	---	0.00	---	---	---	---	---	0.000
0.10	576	84.10	113.55 oc	0.43 ic	---	---	0.00	---	---	---	---	---	0.431
0.20	1,151	84.20	113.55 oc	1.22 ic	---	---	0.00	---	---	---	---	---	1.218
0.30	1,727	84.30	113.55 oc	2.24 ic	---	---	0.00	---	---	---	---	---	2.238
0.40	2,303	84.40	113.55 oc	3.45 ic	---	---	0.00	---	---	---	---	---	3.445
0.50	2,879	84.50	113.55 oc	4.81 ic	---	---	0.00	---	---	---	---	---	4.815
0.60	3,454	84.60	113.55 oc	6.33 ic	---	---	0.00	---	---	---	---	---	6.329
0.70	4,030	84.70	113.55 oc	7.98 ic	---	---	0.00	---	---	---	---	---	7.976
0.80	4,606	84.80	113.55 oc	9.74 ic	---	---	0.00	---	---	---	---	---	9.745
0.90	5,182	84.90	113.55 oc	11.63 ic	---	---	0.00	---	---	---	---	---	11.63
1.00	5,757	85.00	113.55 oc	13.62 ic	---	---	0.00	---	---	---	---	---	13.62
1.10	6,467	85.10	113.55 oc	15.71 ic	---	---	0.00	---	---	---	---	---	15.71
1.20	7,177	85.20	113.55 oc	17.90 ic	---	---	0.00	---	---	---	---	---	17.90
1.30	7,886	85.30	113.55 oc	20.19 ic	---	---	0.00	---	---	---	---	---	20.19
1.40	8,596	85.40	113.55 oc	22.56 ic	---	---	0.00	---	---	---	---	---	22.56
1.50	9,306	85.50	113.55 oc	25.02 ic	---	---	0.00	---	---	---	---	---	25.02
1.60	10,015	85.60	113.55 oc	27.56 ic	---	---	0.00	---	---	---	---	---	27.56
1.70	10,725	85.70	113.55 oc	30.19 ic	---	---	0.00	---	---	---	---	---	30.19
1.80	11,435	85.80	113.55 oc	32.89 ic	---	---	0.00	---	---	---	---	---	32.89
1.90	12,145	85.90	113.55 oc	35.67 ic	---	---	0.00	---	---	---	---	---	35.67
2.00	12,854	86.00	113.55 oc	38.52 ic	---	---	0.00	---	---	---	---	---	38.52
2.10	13,702	86.10	113.55 oc	40.40 ic	---	---	2.65	---	---	---	---	---	43.05
2.20	14,550	86.20	113.55 oc	42.20 ic	---	---	7.48	---	---	---	---	---	49.68
2.30	15,398	86.30	113.55 oc	43.92 ic	---	---	13.75	---	---	---	---	---	57.67
2.40	16,246	86.40	113.55 oc	45.58 ic	---	---	21.17	---	---	---	---	---	66.75
2.50	17,093	86.50	113.55 oc	47.18 ic	---	---	29.59	---	---	---	---	---	76.76
2.60	17,941	86.60	113.55 oc	48.72 ic	---	---	38.89	---	---	---	---	---	87.62
2.70	18,789	86.70	113.55 oc	50.22 ic	---	---	49.01	---	---	---	---	---	99.23
2.80	19,637	86.80	113.55 oc	51.68 ic	---	---	59.88	---	---	---	---	---	111.56
2.90	20,485	86.90	124.55 oc	53.10 ic	---	---	71.45	---	---	---	---	---	124.54
3.00	21,333	87.00	138.16 oc	54.48 ic	---	---	83.68	---	---	---	---	---	138.16
3.10	22,324	87.10	149.57 oc	53.02 ic	---	---	96.54	---	---	---	---	---	149.57
3.20	23,316	87.20	159.06 oc	49.06 ic	---	---	110.00	---	---	---	---	---	159.06
3.30	24,307	87.30	168.47 oc	44.43 ic	---	---	124.04	---	---	---	---	---	168.46
3.40	25,299	87.40	175.20 oc	41.06 ic	---	---	134.14 s	---	---	---	---	---	175.19
3.50	26,291	87.50	180.33 oc	38.59 ic	---	---	141.74 s	---	---	---	---	---	180.33
3.60	27,282	87.60	184.79 oc	36.47 ic	---	---	148.32 s	---	---	---	---	---	184.79
3.70	28,274	87.70	188.80 oc	34.59 ic	---	---	154.20 s	---	---	---	---	---	188.79

Continues on next page...

Lower Basin

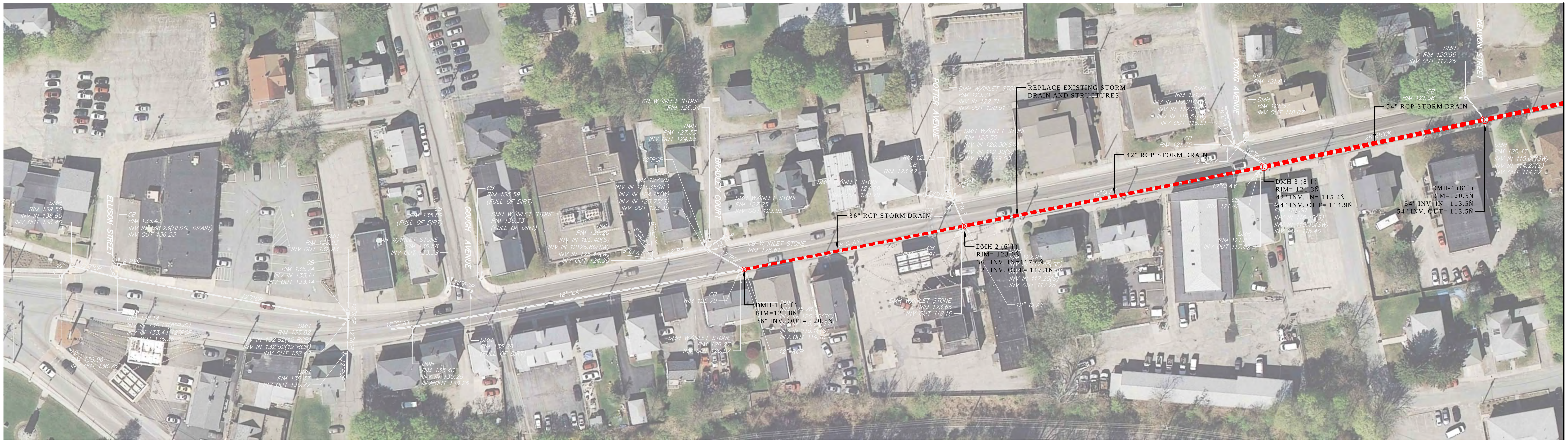
Stage / Storage / Discharge Table

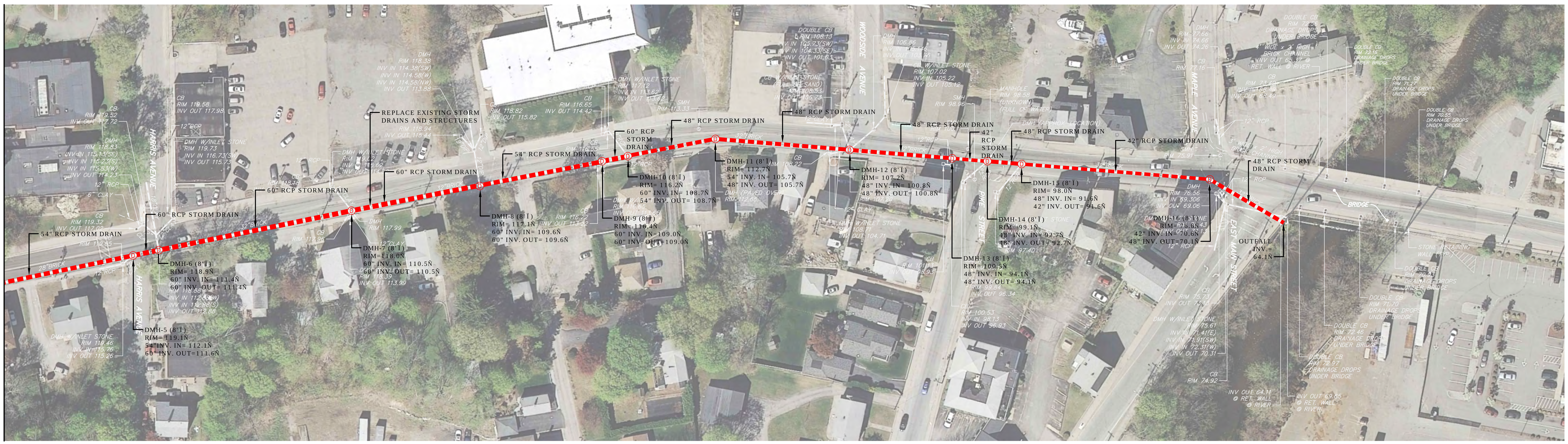
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.80	29,265	87.80	192.45 oc	32.90 ic	---	---	159.55 s	---	---	---	---	---	192.44
3.90	30,257	87.90	195.12 ic	31.20 ic	---	---	163.91 s	---	---	---	---	---	195.11
4.00	31,249	88.00	197.56 ic	29.66 ic	---	---	167.89 s	---	---	---	---	---	197.55

...End

Appendix D

Main Street and Brayton Street Alternative Improvement Plans





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LAYER STATE:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.				

SEAL

SEAL

SCALE:
HORZ.: 1"=50'
VERT.:
DATUM:
HORZ.:
VERT.:

50 25 0 50
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

TOWN OF WEST WARWICK

ALTERNATIVE IMPROVEMENT PLAN No. 1
BRAYTON STREET IMPROVEMENTS

BRAYTON STREET DRAINAGE IMPROVEMENTS

WEST WARWICK RHODE ISLAND

PROJ. No.: 20111098D10
DATE: MAY 2013

CS-101

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.				

SEAL

SEAL

SCALE:
HORZ.: 1" = 30'
VERT.:
DATUM:
HORZ.:
VERT.:
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

TOWN OF WEST WARWICK

ALTERNATIVE IMPROVEMENT PLAN No. 2
BRAYTON STREET IMPROVEMENTS

BRAYTON STREET DRAINAGE IMPROVEMENTS

WEST WARWICK RHODE ISLAND

PROJ. No.: 20111098D10
DATE: MAY 2013

CS-102

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Plotter: NONE CTB File: FO.STB
MS VIEW:
LAYER STATE:

FUSS & O'NEILL, INC.

317 Iron Horse Way, Suite 204

Providence RI, 02908

OPINION OF COST

DATE UPDATED : 9/8/2014 | SHEET 1 OF 1

PROJECT : **Brayton Street Drainage Study**

LOCATION : **West Warwick, Rhode Island**

BASIS : 2014 RIDOT Weighted Average Unit Prices and Experience Based Upon Previous Construction Projects.

DESCRIPTION: **Order of Magnitude Opinion of Cost for Main Street Drainage Improvements Including Full Street Repav**

DRAWING NO.: CS-101 | ESTIMATOR : MKF | CHECKED BY : DEA

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor's)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM NO.	ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	TOTAL COST
1	**Site Construction**				
	Remove and Dispose Manhole	EA	16	$300	$4,800
	Remove and Dispose Clay and Brick Drain Pipe	LF	2,220	$20	$44,400
	Remove, Handle, Haul, and Reset Curb	LF	1,440	$20	$28,800
	Remove and Dispose Sidewalks	SY	480	$8	$3,800
	Remove and Dispose Flexible Pavement	SY	7,100	$6	$42,600
	Full Depth Sawcut Bituminous Pavement	LF	1,000	$2	$2,000
	36-Inch RCP - Including Excavation and Gaskets	LF	230	$160	$36,800
	42-Inch RCP - Including Excavation and Gaskets	LF	520	$200	$104,000
	48-Inch RCP - Including Excavation and Gaskets	LF	430	$250	$107,500
	54-Inch RCP - Including Excavation and Gaskets	LF	560	$310	$173,600
	60-Inch RCP - Including Excavation and Gaskets	LF	360	$370	$133,200
	5' Diameter Manhole with Frame and Cover	EA	1	$3,500	$3,500
	6' Diameter Manhole with Frame and Cover	EA	1	$5,000	$5,000
	8' Diameter Manhole with Frame and Cover	EA	14	$10,000	$140,000
	Portland Cement Concrete Sidewalk	CY	53	$310	$16,500
	Bituminous Surface Course, Type I-1	TON	820	$110	$90,200
	Bituminous Base Course	TON	2,500	$110	$275,000
	Gravel Borrow Base Course (Excavated, Stockpiled, and Re-installed)	CY	4,020	$25	$100,500
	Fine Grading and Compaction	SY	7,600	$3	$22,800
	Increase Capacity of Catch Basins/Inlets to the Trunk Line System	LS	1	$130,000	$130,000
	Construction Subtotal				$1,465,000
2	**Construction Incidentals**				
	Erosion and Sedimentation Controls (Assume 0.5% of Total Construction Cost)	L.S.	1	$25,000	$20,000
	Maintenance and Movement of Traffic Protection (Assume 1% of Total Construction Cost)	L.S.	1	$70,000	$50,000
	Mobilization & Demobilization (Assume 4% of Total Construction Cost)	L.S.	1	$42,000	$42,000
	Construction Incidentals Subtotal				$112,000
	OVERALL SUBTOTAL				**$1,577,000**
	2 YEARS INFLATION AT 3% PER YEAR				$48,729
	CONTINGENCY (25%)				$394,300
	ENGINEERING AND PERMITTING (15%)				$236,600
	ALLOWANCE FOR UTILITY CONFLICTS				$150,000
	ALLOWANCE FOR BEST MANAGEMENT PRACTICES				$100,000
	OVERALL TOTAL INCLUDING CONTINGENCY				**$2,507,000**

New Project Application

Transportation Improvement Program

RI SPP

CONTACT

Contact Information

Agency/Organization: Town of West Warwick

Contact Person: Mark Carruolo Title: Town Planner

Mailling Address: 1170 Main Street

City: West Warwick Zip Code: 02893

Phone: (401) 827-9025 Email: mcarruolo@westwarwick.org

PROJECT INFORMATION

Type of Project *select all that apply*

- ☐ Bridge
- ☐ Pavement
- ☐ Drainage
- ☐ Planning
- ☐ Traffic
- ☐ Transit
- ☐ Bicycle
- ☐ Pedestrian
- ☐ Transportation Enhancement
- ☑ Other: Intersection Improvement

Project Description

Project Title: East Greenwich Avenue/Quaker Lane (RI-2) Intersection Improvements

Location by Street Name: East Greenwich Avenue/Quaker Lane

Project Limits - From: East Greenwich Avenue To: Quaker Lane

Please include an 8.5" x 11" map of the site, indicating project limits.

Provide a brief description of the proposed project:

Reconfigure the intersection of East Greenwich Avenue and Quaker Lane to include a dedicated right turn lane allowing additional right turn capacity for vehicles turning southerly onto Quaker Lane (RI-2).

PROJECT INFORMATION

Describe need for proposed project:

The current intersection is over capacity resulting in substantial delay times for vehicles accessing Quaker Lane traveling both southerly and northerly directions. Vehicles are experiencing multiple light change cycles before being able to access Route 2/Quaker Lane. Adding a right hand turning lane would alleviate these extended wait times.

Describe anticipated municipal or state transportation network or economic development benefits:

Reconstructing the intersection will result in improved traffic flows allowing vehicles to access Route 2/Quaker Lane more efficiently. This will reduce wait time, reduce congestion, and allow individuals to get to work quicker and/or allow smoother more efficient access to Route 2, Rhode Island's major regional shopping corridor. Reduces wait times with also reduce fuel consumption and air pollution through by eliminating prolonged vehicle idling time.

Is the project consistent with the local Comprehensive Plan? ☑ Yes ☐ No

Is the project on the Federal Aid System? ☑ Yes ☐ No

Is the project on the National Highway System? ☐ Yes ☑ No

CRITERIA

Evaluation Criteria

Please address the following topics as they relate to the project. Refer to "An Overview of TIP Guiding Principles" for more information. Submission **must not exceed** 2 pages, single-spaced, 12-point font.

1. Mobility Benefits
2. Cost Effectiveness
3. Economic Development
4. Environmental Impact
5. Supports Local and State Goals
6. Safety and Security
7. Equity

PROJECT ESTIMATES

Project Estimates

	ROW	Study	Design	Construction	Total
Estimated Project Costs	$70,000	$10,000	$20,000	$200,000	$300,000
				Total Cost	$300,000
				Amount Requested through TIP Process	$300,000

Is there funding from other sources committed to this project? ☐ Yes ☑ No

Source	Amount
Total	

Estimated date of construction Spring 2017

CERTIFICATION

Applicant Certification

I attest that the information provided on this application is in true and accurate.

Applicant's Signature [signature] Date 1/6/16

Chief Executive Officer's Signature [signature] Date 1/6/16

ALL APPLICATIONS ARE DUE BY 3:00PM ON FRIDAY, JANUARY 8, 2016

Evaluation Criteria

East Greenwich Avenue/Quaker Lane (RI-2) Intersection Improvements

Mobility Benefits:

That section of Quaker Lane in proximity to its intersection with East Greenwich Avenue experiences in excess of 29,000 trips per day. There are no formal intersection counts along East Greenwich Avenue but it is estimated this intersection experiences approximately 12,000 vehicle trips per day. This intersection provides a direct link from medium to high density residential areas on East Greenwich and Greenbush Road to Quaker Lane (RI-2) and Interstate Route 95 via Route 2. This project will result in improved traffic flow making it more convenient for travelers who desire to access Route 2 a major activity center and the largest retail corridor in the State as well as improved access to Interstate Route 95 for individuals travelling to and from work.

Cost Effectiveness:

For a fairly modest investment, of a little over $300,000, this intersection can be improved providing great benefit in reduced waiting time (with idling vehicles) thereby reducing emissions and conserving fuel two contributing factors to climate change. This project is necessary presently but with continued development along Route 2 these improvements will become imperative for the proper access and circulation of vehicles accessing and exiting this heavily travelled commercial corridor.

Economic Development:

As previously stated, this intersection of East Greenwich Avenue and Quaker Lane (RI-2) provides direct access for a major portion of residences located in the southerly section of West Warwick to Route 2 a major employment center as well as the largest retail corridor in the State. It is also a major intersection providing thousands West Warwick residents access to Interstate Route 95 via Quaker Lane for those travelling to and from work.

Environmental Impact

As stated earlier, reconstruction of this heavily traveled intersection will enable a freer flow of traffic thereby eliminating substantial delays for vehicles (idling). The improved vehicle circulation will result in lower fuel consumption, promoting energy conservation, and lower emissions thereby improving air quality.

Supports Local and State Goals

The proposed project is consistent with the West Warwick Comprehensive Plan and the State Guide Plan Transportation Element 611.

Local Plan – The project is located in the Crompton section of West Warwick, this section is identified in the local plan as an area with the most potential for residential development. The plan designated residential development as the land use with the highest traffic generation resulting in traffic congestion. WW Transportation Element Goal 2 states: "Provide a network of state and local streets and roadways that are well maintained, safe, ***convenient***, ***uncongested***, and pleasant to travel…" Implementation action 2 states: Work with RIDOT to expedite TIP projects programmed for West Warwick. In addition to the current TIP projects recommended for inclusion in the TIP are… (2) East Greenwich Avenue…"

State Guide Plan – The proposed project is consistent with the following objectives of the State Guide Plan:

D.1.c Improve air and water quality. (See Environmental Section)
ED.1.a Move people efficiently to and from work and school.
EN.1.a Improve air quality.
EN.1.c Conserve energy.
EQ.1.b Provide equitable distribution of transportation projects and improvements."
H.1.b Improve deficiencies
H.1.c Minimize congestion
H.1.d Manage growth in vehicular demand
H.1.e Increase safety.

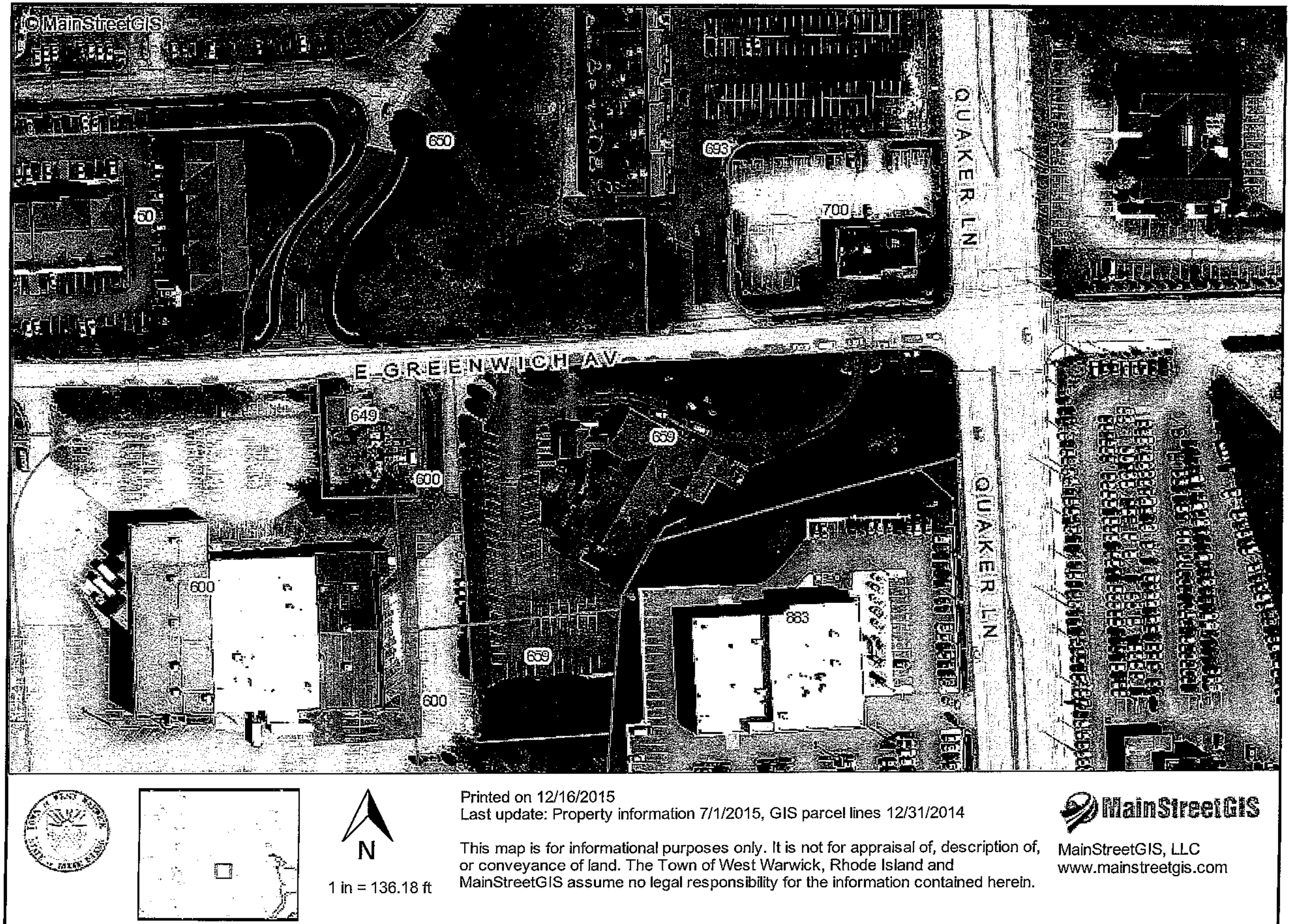
This project has substantial public support from the residents who live in the area and regularly access Route 2 for commerce and travel to and from work. At recent public meeting for a proposed development project in the area, a common theme from the area residents was the congestion at the Greenbush Road/Quaker Lane intersection and need for a dedicated right turn lane.

Safety and Security

This project enhances safety in that it provides a dedicated right turn lane for vehicles attempting to proceed southerly on Route 2 from East Greenwich Avenue. Currently there is only one lane of travel to accommodate three potential turning movements at the intersection. The additional turn lane will remove vehicles desiring to proceed southerly and place them in a protected right turn lane thereby improving and enhancing passenger and traffic safety.

Equity

The Town of West Warwick is a diverse community with substantial elderly and minority populations and low income population. The project area has approximately a 9% minority population. As a result, this project conforms to the State Guide Plan Equity Objective EQ.1.b "Provide equitable distribution of transportation projects and improvements."



Printed on 12/16/2015
Last update: Property information 7/1/2015, GIS parcel lines 12/31/2014

This map is for informational purposes only. It is not for appraisal of, description of, or conveyance of land. The Town of West Warwick, Rhode Island and MainStreetGIS assume no legal responsibility for the information contained herein.

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