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STORMWATER MANAGEMENT REPORT

Stafford Street Substation

Leicester, MA

March 10, 2022, Rev. 1
File No. 15.0166857.00



PREPARED FOR:
nationalgrid

GZA GeoEnvironmental, Inc.

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TABLE OF CONTENTS

1.0 INTRODUCTION1

1.1 PROJECT DESCRIPTION..... 1

1.2 EXISTING LAND USES, TOPOGRAPHY, HYDROLOGY, AND SOILS 1

2.0 STORMWATER MANAGEMENT STANDARDS2

2.1 STANDARD #1 NO NEW UNTREATED DISCHARGES 2

2.2 STANDARD #2 PEAK RATE ATTENUATION 2

2.2.1 Pre-Development Conditions..... 3

2.2.2 Post-Development Conditions 4

2.3 STANDARD #3 GROUNDWATER RECHARGE 5

2.4 STANDARD #4 WATER QUALITY..... 6

2.5 STANDARD #5 LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS (LUHPPLS) 6

2.6 STANDARD #6 CRITICAL AREAS..... 6

2.7 STANDARD #7 REDEVELOPMENT..... 6

2.8 STANDARD #8 CONSTRUCTION PERIOD SEDIMENT AND EROSION CONTROL..... 6

2.9 STANDARD #9 OPERATION AND MAINTENANCE PLAN 8

2.9.1 Sediment Forebays 8

2.9.2 Infiltration Basin..... 8

2.9.3 Porous Pavement..... 8

2.10 STANDARD #10 ILLICIT DISCHARGES..... 8

FIGURES

- FIGURE 1 LOCUS MAP
- FIGURE 2 SOILS MAP
- FIGURE 3 EXISTING CONDITIONS DRAINAGE MAP
- FIGURE 4 PROPOSED CONDITIONS DRAINAGE MAP
- FIGURE 5 EXPLORATION LOCATION PLAN



TABLE OF CONTENTS

APPENDICES

APPENDIX A	PRE-DEVELOPMENT 2-, 10-, & 100-YEAR 24-HOUR STORM EVENT CALCULATIONS
APPENDIX B	POST-DEVELOPMENT 2-, 10-, & 100-YEAR 24-HOUR STORM EVENT CALCULATIONS
APPENDIX C	RECHARGE TO GROUNDWATER CALCULATIONS & TEST BORING LOGS
APPENDIX D	TSS REMOVAL WORKSHEETS & WATER QUALITY CALCULATIONS
APPENDIX E	LONG TERM POLLUTION PREVENTION PLAN
APPENDIX F	ILLICIT DISCHARGE COMPLIANCE STATEMENT
APPENDIX G	CHECKLIST FOR STORMWATER REPORT



1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

National Grid (NGRID) is proposing to construct a new electrical substation at 408 Stafford Street, Leicester, MA (Site), a 45-acre parcel located northwest of the intersection of Stafford Street and Sunrise Avenue (See Figure 1: Locus Map). The Site is partially developed, with a ground-mounted photovoltaic system in the southwest quadrant, and a 250-ft wide maintained electrical transmission right-of-way bisecting the Site.

The proposed work includes construction of a new 750-foot-long access road leading to a 1.45-acre fenced substation yard located within an existing National Grid transmission line right-of-way. The access road will be paved along with a circular drive aisle within the substation yard. The proposed access and circulation drives will include areas of impervious bituminous pavement and porous bituminous pavement. The remainder of the substation yard surface will be crushed stone, except for the proposed control building and exterior electrical equipment. Proposed cut and fill slopes will be rip-rap covered or vegetated.

The proposed stormwater management design mitigates potential increases in stormwater runoff by lengthening times of concentration. Water quality treatment and groundwater recharge are provided via the proposed porous pavement, the crushed stone yard, and two infiltration basins proposed downstream of the paved driveway apron. Stormwater runoff from unaltered upgradient areas will be routed around the proposed substation yard via perimeter drainage swales, and beneath the new access road via a new culvert.

1.2 EXISTING LAND USES, TOPOGRAPHY, HYDROLOGY, AND SOILS

The area proposed for the new electrical substation and associated access driveway is currently maintained by National Grid as an electrical transmission right-of-way. Ground cover is a mix of grasses and shrubs, coupled with an existing unpaved access drive. Existing grade along the proposed alignment of the access driveway varies from Elev. 800 at Stafford Street (Sta 0+00), down to Elev. 762 at approximately STA 4+25, then up again to Elev. 824 at approximately STA 12+25. The subject area generally drains to the northeast to two existing wetland systems. The average slope of the Site (as previously defined) is approximately eight percent (8%), and there is approximately one-hundred twenty-eight feet (128') of vertical relief between the Site apex and the low-lying wetlands.

The following subsurface information was obtained from GZA's October 8, 2021 "Geotechnical Engineering Report" for the proposed access road:

- Surficial Materials to a depth of approximately 0 to 2 feet consisted of very loose to loose relative density, surficial Forest Mat, Topsoil, and/or Subsoil predominantly sand with varying silt, gravel, and organic content (USCS: SM, OL).
- Sand and Gravel glacial deposits immediately beneath the surficial materials consisting of medium to very dense relative density, fine to coarse Sand with 10% to 50+% gravel, and 5% to 30% Silt (USCS: SM, SP-SM, SW-SM, GM) with cobbles and/or boulders. Based on gradation testing, the D10 of the tested Sand and Gravel samples varied between approximately 0.01 and 0.06 mm.
- Bedrock or possible bedrock immediately beneath the Sand and Gravel at depths ranging from 7.5 to 33 feet bgs.

Based on a review of the United States Department of Agriculture (USDA) Soil Survey of Worcester County, Massachusetts (Southern Part), on-site soils are Whitman fine sandy loam (73A) and Canton fine sandy loam (420 B, 422B, 422C). The USDA defines groups of soils into Hydrologic Soil Groups (HSG) according to their runoff-producing characteristics. Soils are assigned to four groups (A, B, C, and D). Group A soils have a high rate of infiltration and therefore a low runoff potential. They typically



are deep, well drained, and sandy or gravelly. In Group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They may have a hardpan or clay layer at or near the surface, or have a permanent high water table, or are shallow over nearly impervious bedrock or other nearly impervious material. The on-site soils have an HSG classification of:

- Whitman fine sandy loam (73A) D
- Canton fine sandy loam (420B, 422B, 422C) B

See Figure 2: Soils Map

2.0 STORMWATER MANAGEMENT STANDARDS

2.1 STANDARD #1 NO NEW UNTREATED DISCHARGES

The Massachusetts Department of Environmental Protection’s Stormwater Management Standards (SMS) state that “No new Stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.” Stormwater is considered to be treated when Standards 2 through 9 are met. The project complies with standards 2 through 9 and will not discharge untreated stormwater.

2.2 STANDARD #2 PEAK RATE ATTENUATION

To meet Standard #2, stormwater controls must be developed for the 2-year and 10-year 24-hour storm events. In addition, the 100-year 24-hour storm must be evaluated, and the applicant must demonstrate that there will be no increased flooding impact offsite. The potential stormwater impacts of this project were evaluated for the 2-year, 10-year, and 100-year 24-hour storm events. Peak stormwater flows for the indicated recurrence intervals were computed using HydroCAD® (a proprietary stormwater modeling program) for each of the sub-catchment areas within the proposed Project Site under both pre- and post-development conditions. The resulting calculations demonstrate that the subject Project does not increase peak flow rates for the 2-year, 10-year, and 100-year 24-hour storm events (Ref. Appendix A, Appendix B, and Table 7).

To determine the peak flow rates, the following information provided in Tables 1 & 2, and the hydrologic parameters of each subcatchment under pre- and post-development conditions are required:

Table 1: 24-hour Rainfall Depths

24-Hour Rainfall (in)			
Design Storm / Recurrence Interval	2-Year	10-Year	100-Year
Precipitation (inches)	3.15	4.90	7.67

Rainfall depths were derived from Atlas 14 published by the National Oceanographic and Atmospheric Administration (NOAA).



Table 2: Pre- and Post-Development Runoff Curve Numbers (RCN)

Land Use	Hydrologic Soil Group	RCN
>75% Grass Cover, Good	B	61
Brush, Fair	B	56
Crushed Stone	B	62
Gravel surface	B	96
Meadow, non-grazed	B	58
Paved parking	B	98
Porous Pavement	B	55
Riprap	B	50
Roofs	B	98
Woods, Good	B	55
Woods, Good	D	77

The computation of the runoff curve number is based on a combination of soil type and land use. The land use categories and corresponding RCNs listed in Table 2 were identified for use in computing the pre- and post-development runoff from the Site.

2.2.1 Pre-Development Conditions

The existing conditions (pre-development) stormwater evaluation separates the subject property into three (3) subcatchments totaling approximately 26.8 acres, each draining to one of two (2) Design Points (see Figure 3: Existing Conditions Drainage Map). The locations of the Design Points are as follows:

- DP-1: The existing wetland east of the transmission right-of-way (Wetland W-GR-1).
- DP-2: The existing wetland north of the transmission right-of way (Wetland W-GR-2).

Subcatchment E-1 is comprised of a section of the existing transmission right-of-way and represents the portion of the Site draining directly to Wetland W-GR-1. Subcatchment E-2 is located to the north and west of Subcatchment E-1, and includes portions of the transmission right-of-way, and a section of the existing photovoltaic facility. This subcatchment drains to the northeast to Wetland W-GR-2. Subcatchment E-3 represents the western portion of the Site and is a combination of the photovoltaic facility with associated access drive, and the wooded area surrounding the photovoltaic facility. This subcatchment drains to Wetland W-GR-4 before continuing to drain overland to Design Point DP-1

The times of concentration were determined based on a variety of flow paths. In general, typical flow paths consisted of sheet flow, followed by shallow concentrated flow, and channelized flow discharging to the Design Point. The aforementioned flow path is the longest hydrologic path within the subcatchment. The times of concentration calculations are provided in the attached drainage computations (Ref. Appendix A).

The results of the stormwater management pre-development analysis are summarized in the following Tables 3 and 4:



Table 3: Pre-Development Hydrologic Parameters

Design Area	Drainage Areas, Square Feet	Weighted Runoff Curve No.	Time of Concentration, Min.
Subcatchment E-1	294,990	56	15.3
Subcatchment E-2	372,115	59	12.9
Subcatchment E-3	501,975	57	18.7
Total	1,169,080		

Ref. Appendix A and Figure 3: Existing Conditions Drainage Map

Table 4: Pre-Development Peak Flow Rates per Storm Event

Design Point	Peak Flow Rates: 24-hour Storm Event (cfs)		
	2-Year	10-Year	100-Year
DP-1	2.04	12.54	39.06
DP-2	1.50	8.11	23.01

Ref. Appendix A

2.2.2 Post-Development Conditions

The proposed (post-development) watershed is approximately 27.4 acres and drains to the same two Design Points used in the pre-development analysis. As in the pre-development analysis, the contributing watershed was divided into three (3) subcatchments draining to one of the two (2) Design Points as described in pre-development analysis.

Subcatchment P-1 drains to Design Point DP-1 and includes 780 linear feet of the proposed 20-ft wide paved access driveway from Stafford Street to the proposed substation. Additionally, Subcatchment P-1 includes the riprap-armored slopes adjacent to the access driveway, and the grassed area southwest of the substation’s fenced enclosure. Subcatchment P-2 is comprised of the proposed substation yard, 9,100 SF control building, and proposed loop access/circulation drive. Subcatchment P-2 drains to Design Point DP-2. Lastly, Subcatchment P-3 remains largely unchanged from pre-development conditions apart from a slight reduction (2,675 SF) in drainage area due to proposed grading. Subcatchment P-3 drains to Wetland W-GR-4 before draining through the proposed 36-inch diameter CMP culvert beneath the proposed access drive and continuing to drain to Design Point DP-1.

The times of concentration for the proposed subcatchments were determined based on a variety of flow paths. In general, the typical flow path was similar, and in some cases identical, to that used in the existing conditions analysis (i.e., sheet flow followed by shallow concentrated flow, and then channelized flow). Time of concentration calculations are provided in the attached drainage computations (Ref. Appendix B).

The results of the stormwater management post-development analysis are summarized in the following Tables 5 and 6:



Table 5: Post-Development Hydrologic Parameters

Design Area	Drainage Areas, Square Feet	Weighted Runoff Curve No.	Time of Concentration, Min.
Subcatchment P-1	319,875	56	22.1
Subcatchment P-2	376,155	60	25.3
Subcatchment P-3	499,300	57	18.7
Total	1,195,330		

Ref. Appendix B and Figure 4: Proposed Conditions Drainage Map

Table 6: Post-Development Peak Flow Rates per Storm Event

Design Point	Peak Flow Rates: 24-hour Storm Event (cfs)		
	2-Year	10-Year	100-Year
DP-1	2.03	12.41	38.49
DP-2	1.50	6.80	18.62

Ref. Appendix B

The following Table 7 summarizes the Pre- and Post-Development conditions for the proposed project.

Table 7: Summary of Peak Flow Rates (cfs) per Storm Event

Storm Event	DP-1		DP-2	
	Pre-	Post-	Pre-	Post-
2-Year	2.04	2.03	1.50	1.50
10-Year	12.54	12.41	8.11	6.80
100-Year	39.06	38.49	23.01	18.62

2.3 STANDARD #3 GROUNDWATER RECHARGE

In accordance with the MassDEP Stormwater Management Standards (SMS), the Required Recharge Volume for infiltration to groundwater must be provided for the HSG "A", "B", "C", and "D" type soils equal to 0.60", 0.35", 0.25" and 0.10" of runoff, respectively, over the total impervious area of the proposed development. In other terms, the SMS require a volume of stormwater to be recharged as a function of impervious area.

Table 8: Recharge to Groundwater

Required Recharge to Groundwater (C.F.)	Proposed Recharge to Groundwater (C.F.)
1,310	8,930

Refer to Appendix C for calculations and test boring logs.



The proposed recharge volume is provided in the reservoir course of the proposed porous pavement, the storage volume of the crushed stone yard, and in the storage volume of the proposed infiltration basins.

2.4 STANDARD #4 WATER QUALITY

The MassDEP SMS require the applicant to remove at least 80% of the total suspended solids (TSS) contained in the stormwater runoff draining from the proposed site to wetland resource areas. The BMPs proposed for this Project are two small infiltration basins and porous pavement (see Appendix D for TSS Removal Worksheets). These BMPs are sized based on a water quality volume determined by multiplying 1 inch of runoff by the total impervious area of the post-development Project Site (Ref. Appendix D).

2.5 STANDARD #5 LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS (LUHPPLS)

The proposed Stafford Street Substation is not subject to this requirement, as an electrical substation is not a land use with higher potential pollutant loads, as defined by the MassDEP Stormwater Management Standards.

2.6 STANDARD #6 CRITICAL AREAS

The MassDEP SMS require the applicant to treat 1.0 inches of runoff for projects that are located within a "Critical Area," a term that includes Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold water fisheries, or a recharge area for public water supplies. It is our understanding that the Site and its immediate environs do not include any "Critical Areas" as described under the MassDEP Stormwater Management Standards.

2.7 STANDARD #7 REDEVELOPMENT

This Project is not being treated as a redevelopment project; therefore, all the stormwater management standards apply.

2.8 STANDARD #8 CONSTRUCTION PERIOD SEDIMENT AND EROSION CONTROL

A Sediment and Erosion Control Plan has been prepared for this Project and is included in the Project plans attached. The Project is likely to disturb 1 acre or greater of land; thus, will be subject to the Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges from Construction Activities (CGP). A Stormwater Pollution Prevention Plan (SWPPP) in accordance with the requirements of the NPDES CGP will be prepared for this Project as needed and will be submitted to the Leicester Conservation Commission prior to the initiation of land disturbance associated with construction of the stormwater management system.

The Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan information provided below includes the minimum requirements for satisfying Standard #8 and will be incorporated into the SWPPP.

Parties Responsible for Implementing the Construction Period Sediment and Erosion Control Plan:

- National Grid



The construction phase of the proposed project requires the installation of erosion and sediment controls and their maintenance. During the construction phase the following major activities and their sequence in the construction phase will be as follows:

1. Mobilization.
2. Installation of construction entrance.
3. Installation of temporary erosion control measures.
4. Removal and stockpiling of topsoil.
5. Rough grading per construction plans.
6. Installation of storm drainage features.
7. Final grading followed by loam and seeding with general landscaping.
8. Removal of temporary erosion controls upon final stabilization of disturbed areas.

In the following practices, the specified activities and controls are minimums only. They should be increased as needed to ensure proper functioning and that their intent to control erosion and sedimentation is met.

Specific controls and practices include:

1. Erosion Control Barrier and inlet protection.
2. Temporary Stabilization - Soil stockpiles which remain in place for at least 6 months shall be stabilized with temporary seed and mulch no later than 30 days from the last construction activity in that area.
3. Construction Entrance - A stabilized construction entrance shall be installed at all points of access to the site utilized by construction related traffic to help reduce vehicle tracking of sediments onto adjacent streets. Paved streets adjacent to the site entrance(s) will be swept weekly to remove any excess mud, dirt, or rock tracked from the site.
4. Permanent Stabilization - Disturbed portions of the site where construction activities permanently cease shall be stabilized with permanent seeding no later than 14 days after the last construction activity. The permanent seed mix shall be in accordance with the design plans.
5. Trench Dewatering Activities and Line Flushing Discharge Analysis Points – All water discharges shall be directed into fiber mats, netting, rip rap or naturally occurring ground cover to minimize erosion.

Miscellaneous other Controls:

1. Waste Materials - All waste will be collected and stored in a securely covered metal dumpster as provided from a licensed solid waste management company. The dumpster shall meet all local and state regulations. The dumpster will be emptied as necessary. No construction waste materials shall be buried on-site.
2. Hazardous Waste - All hazardous waste materials will be disposed of in a manner specified by local or state regulations or by the manufacturer.
3. Sanitary Waste - All sanitary waste will be collected from the portable units as required by local regulation.

Maintenance and Inspections during Construction:

The following are the minimum requirements for maintenance and inspection of the above controls to ensure they are functioning as intended and to ensure that additional measures are installed, if and when the need arises.

1. All control measures will be inspected at least once each week and following any storm event of 0.5 inches or greater.
2. All measures will be maintained in good working order; if a repair is necessary, it will be initiated within 24 hours of report. Sufficient stockpiles of erosion control material shall be kept on-site in reserve in the event that immediate repair is required.



3. Accumulated sediment will be removed from perimeter erosion controls when it has reached one-third the height of the control.
4. Perimeter erosion controls will be inspected for depth of sediment, tears, gaps, etc., to see if the controls are secure and properly installed.
5. Temporary and permanent seeding and planting will be inspected for bare spots, washouts, and healthy growth until fully established.

2.9 STANDARD #9 OPERATION AND MAINTENANCE PLAN

The operation and maintenance plan (O&M Plan) that follows is to ensure that the criteria of the MassDEP Stormwater Management Standards are met after construction is completed.

The Party Responsible for Inspection and Maintenance: National Grid

2.9.1 Sediment Forebays

The sediment forebays will be inspected monthly, and the accumulated sediment removed as necessary.

2.9.2 Infiltration Basin

The infiltration basin will be inspected at least twice per year. The inspection will include looking for signs of differential settlement, cracking, erosion, leakage in the embankments, tree growth on the embankments, condition of riprap, and sediment accumulation. Accumulated trash will be removed from the basin during inspection. Sediment will be removed from the basin as necessary, using light equipment when the basin bottom is thoroughly dry, so as not to compact the underlying soil.

2.9.3 Porous Pavement

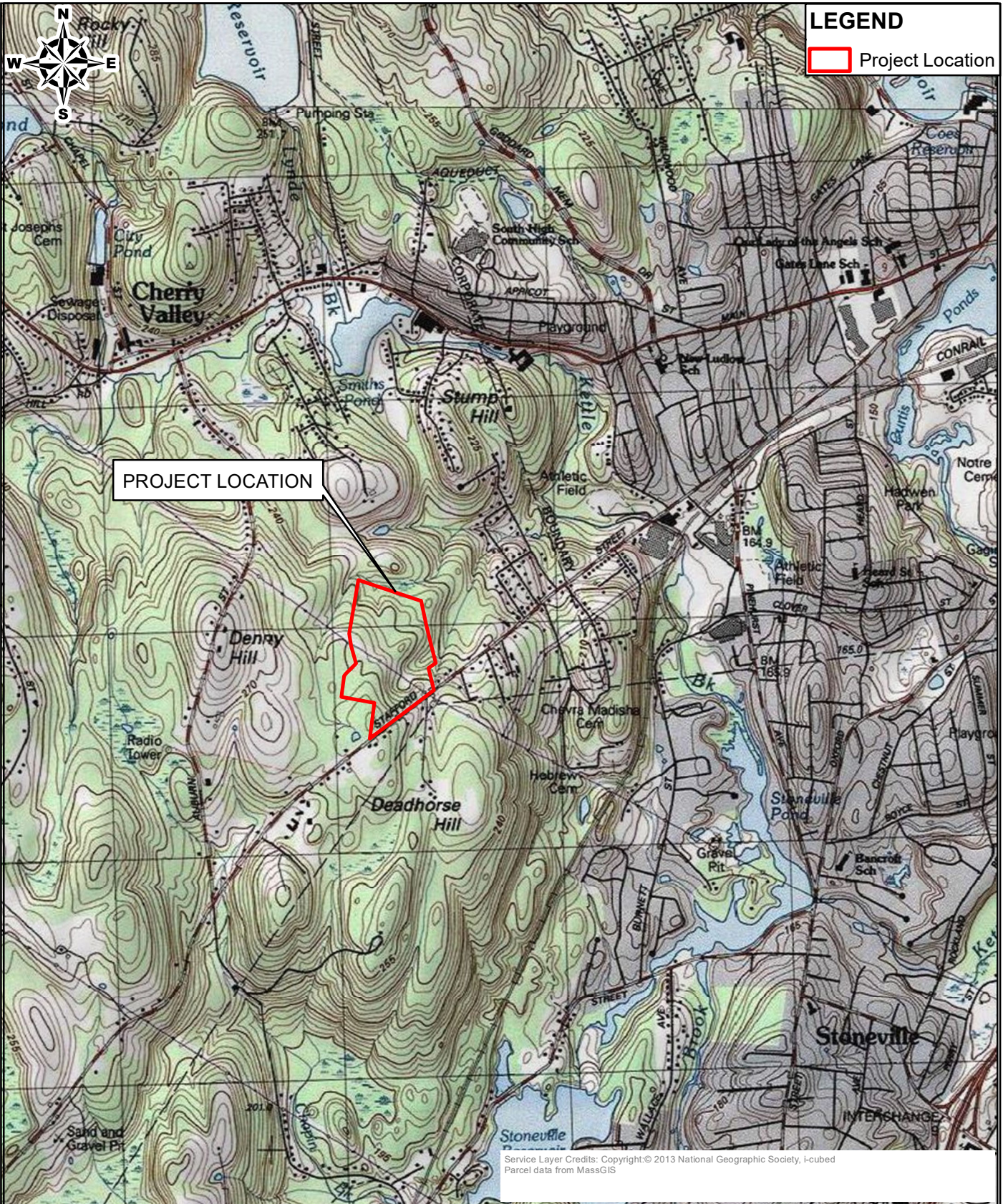
Signs identifying porous pavement areas will be posted. The porous pavement will be inspected no less than quarterly for evidence of sediment accumulation, ponding, or other indications of insufficient infiltration. Excessive sediment from vehicle tracking, run-on, etc., will be removed as needed using pavement vacuum methods annually in the spring following the last snow melt. Excessive leaves will be removed by vacuum or blower annually in the fall following leaf drop and prior to the first significant snow fall and long duration freezing. Snow will not be stockpiled on porous pavement. Road salt will be applied for traction control in winter months in lieu of sand. Sand or other non-soluble traction enhancement materials will not be applied to the areas of porous pavement. Adjacent landscaped areas will be kept well maintained to prevent soil from being transported onto the pavement. The paving surface will be monitored regularly to confirm it drains properly during and after storms. The porous pavement will never be resealed or repaved with impermeable materials. The surface will be inspected annually for deterioration or spalling.

2.10 STANDARD #10 ILLICIT DISCHARGES

No Illicit Discharge Compliance Statement is attached; however, one will be submitted to the Leicester Conservation Commission prior to the discharge of any stormwater to post-development best management practices. Once provided, the Illicit Discharge Compliance Statement can be inserted into this document under Appendix F.

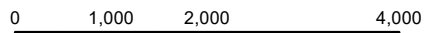


Figures



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 Engineers and Scientists
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PREPARED FOR:
 NATIONAL GRID
 40 SYLVAN RD
 WALTHAM, MA 02451

LOCUS MAP

PROJ MGR: STD	REVIEWED BY: GRM	CHECKED BY: TEJ	FIGURE 1
DESIGNED BY: CCO	DRAWN BY: CCO	SCALE: 1 in = 2,000 ft	
DATE: 02/23/2022	PROJECT NO: 15.0166857.00	REVISION NO:	



LEGEND

- Project Location
- Soil Map Units

PROJECT LOCATION



Soil Map Unit	Soil Name
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony
422B	Canton fine sandy loam, 0 to 8 percent slopes, extremely stony
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony
420B	Canton fine sandy loam, 3 to 8 percent slopes

Service Layer Credits:
 Soils data from U.S. Department of Agriculture, Natural Resources Conservation Service
 Parcel data from MassGIS

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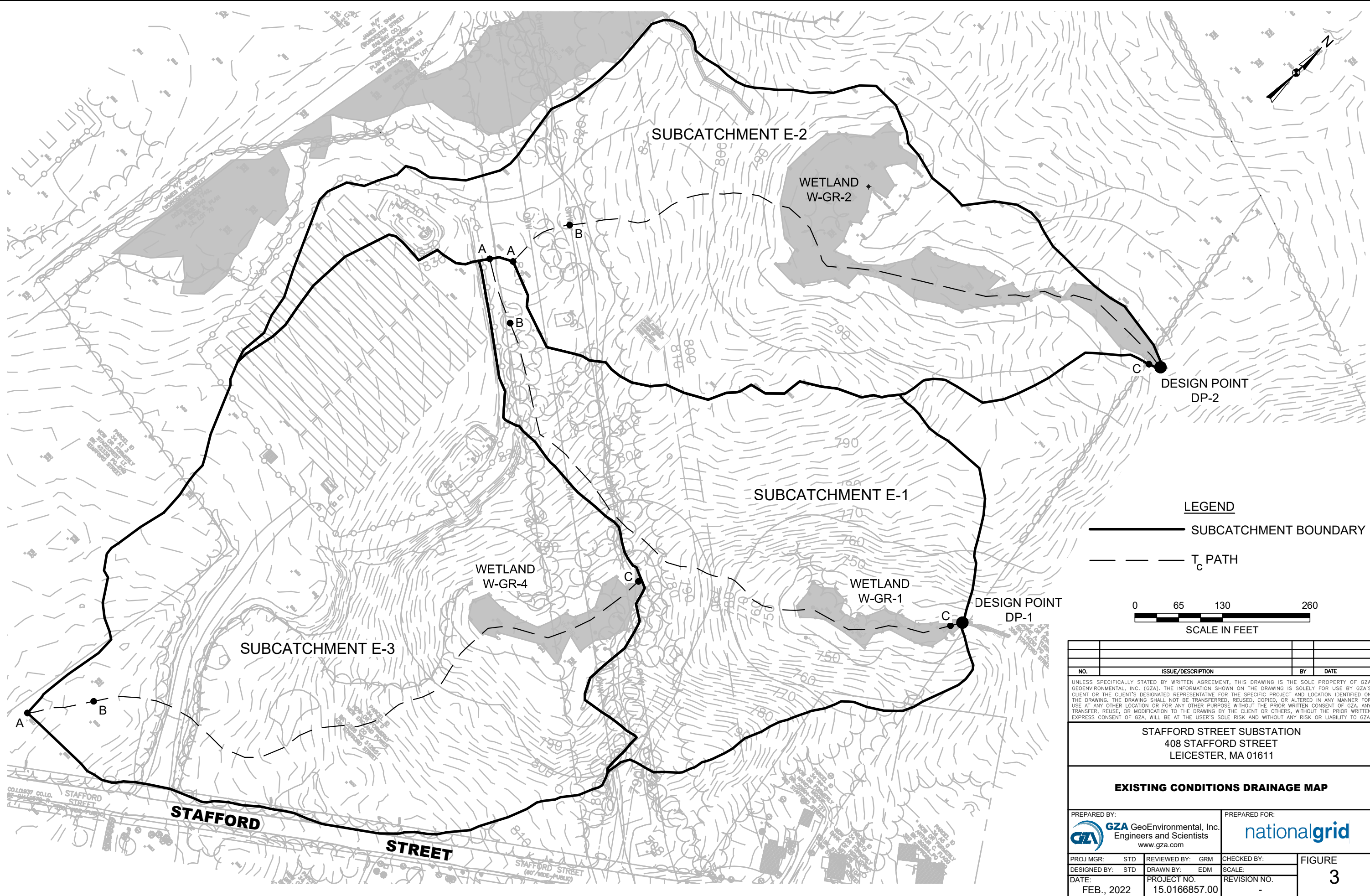
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SOILS MAP

PROJ MGR: STD	REVIEWED BY: GRM	CHECKED BY: TEJ	FIGURE 2
DESIGNED BY: CCO	DRAWN BY: CCO	SCALE: 1 in = 300 ft	
DATE: 02/23/2022	PROJECT NO: 15.0166857.00	REVISION NO:	

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————— SUBCATCHMENT BOUNDARY

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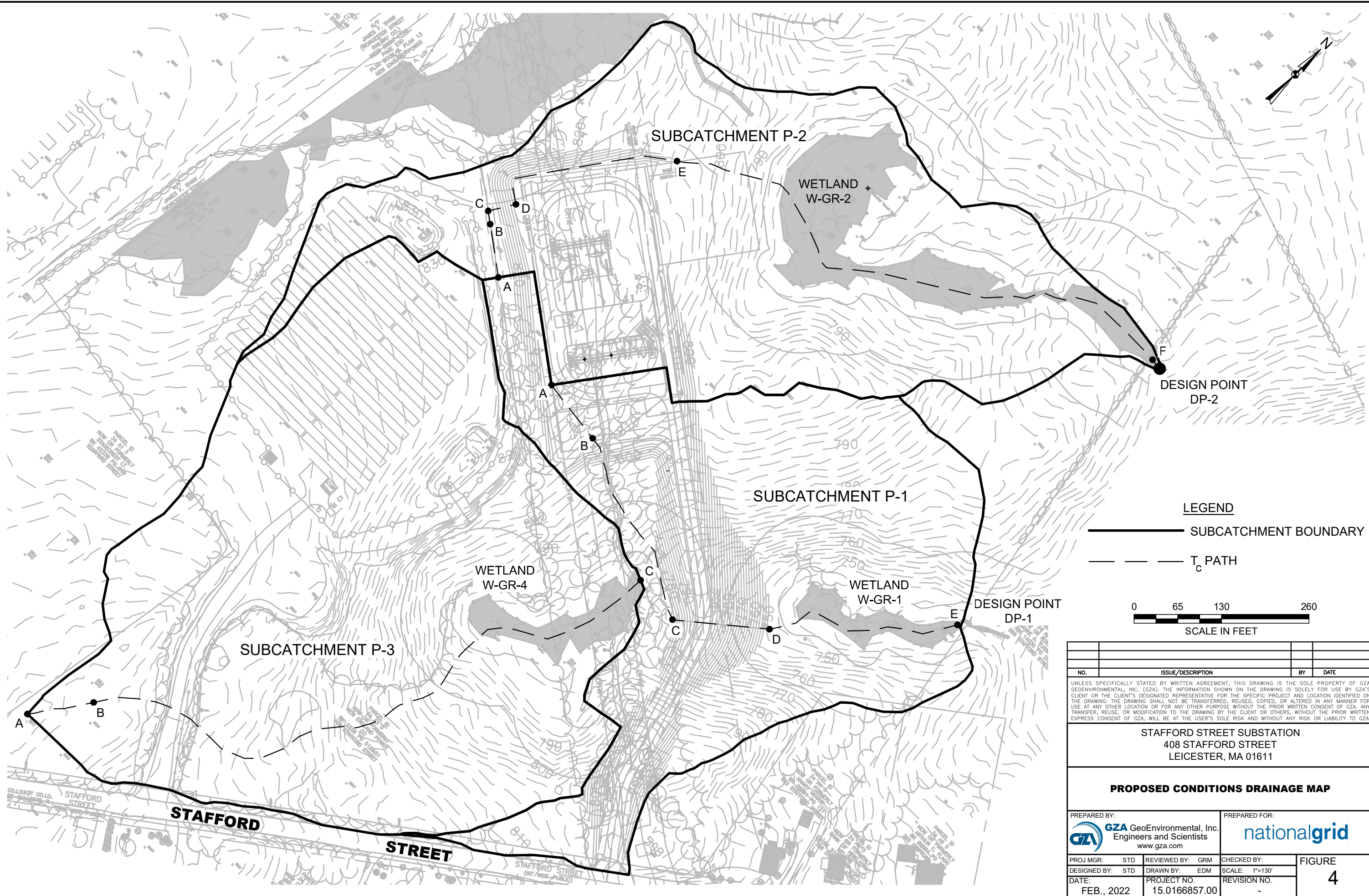
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EXISTING CONDITIONS DRAINAGE MAP

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PROJ MGR: STD	REVIEWED BY: GRM	CHECKED BY:	FIGURE
DESIGNED BY: STD	DRAWN BY: EDM	SCALE:	3
DATE: FEB., 2022	PROJECT NO. 15.0166857.00	REVISION NO. -	



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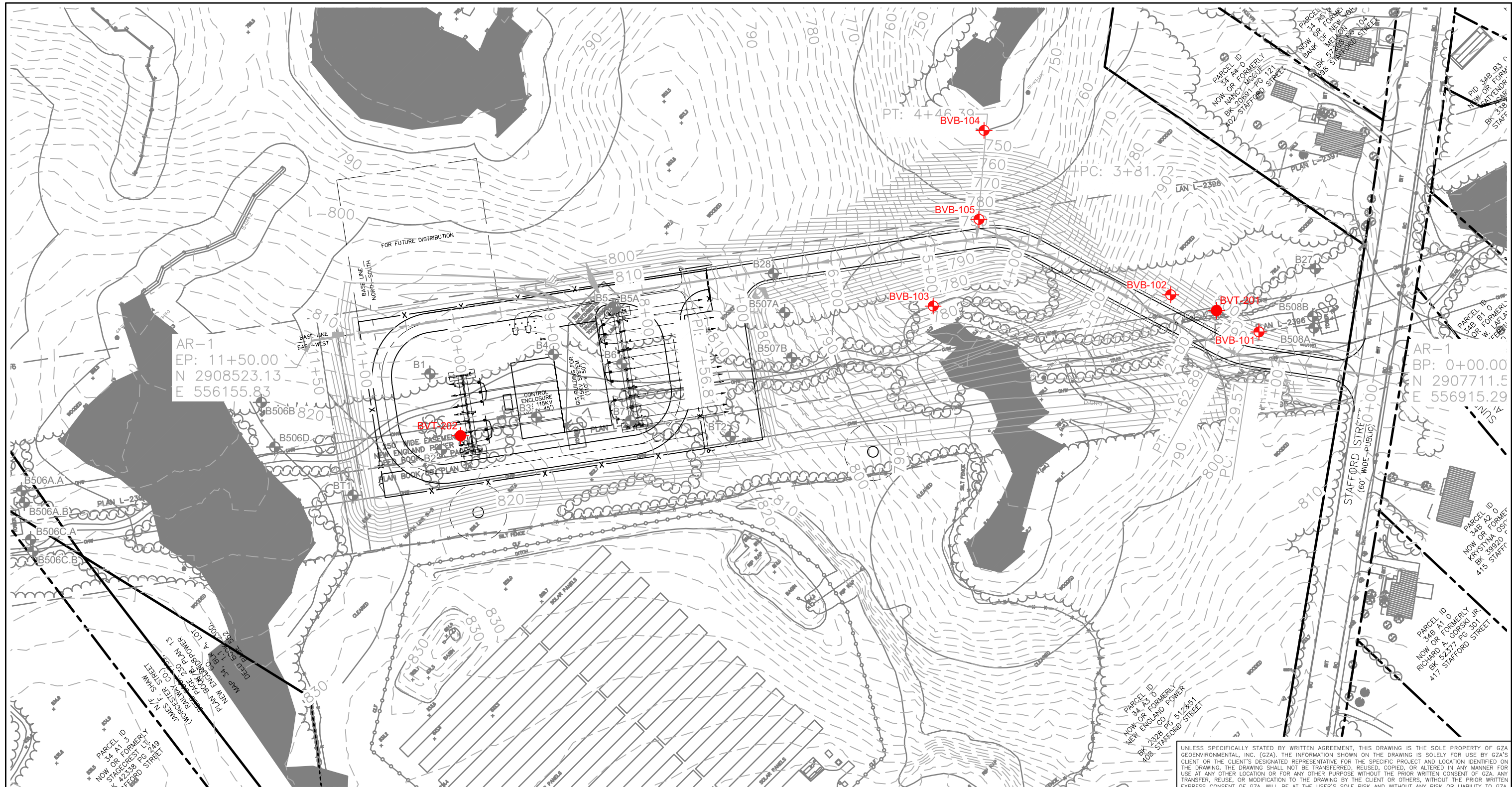
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LEICESTER, MA 01611

PROPOSED CONDITIONS DRAINAGE MAP




PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: nationalgrid	
PROJ MGR: STD	REVIEWED BY: GRM	CHECKED BY:	FIGURE 4
DESIGNED BY: STD	DRAWN BY: EDM	SCALE: 1"=130'	
DATE: FEB., 2022	PROJECT NO. 15.0166857.00	REVISION NO. -	



AR-1
 EP: 11+50.00
 N 2908523.13
 E 556155.83

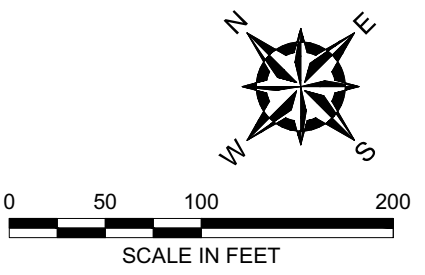
AR-1
 BP: 0+00.00
 N 2907711.5
 E 556915.29

LEGEND

-  **BVB-101** APPROXIMATE GZA BORING LOCATIONS AND DESIGNATION.
-  **BVT-201** APPROXIMATE GZA PROBE LOCATIONS AND DESIGNATION.
-  **B1** APPROXIMATE CDM SMITH BORING LOCATIONS AND DESIGNATION.

SOURCE:

1. THE BASE PLAN WAS DEVELOPED FROM AUTOCAD ELECTRONIC BASE PLAN "GRADING & DRAINING PLAN" PROVIDED BY NATIONAL GRID DATED 2/7/19.
2. B AND BT SERIES BORINGS WERE PERFORMED BY CRAWFORD DRILLING SERVICES, LLC OF GARDNER, MASSACHUSETTS DURING THE PERIOD FROM FEBRUARY 3, 2021 TO APRIL 22, 2021 AND WERE OBSERVED AND LOGGED BY CDM SMITH.
3. BORINGS BVB-101 THROUGH BVB-105 AND PROBES BVT-201 THROUGH BVT-202 WERE PERFORMED BY DRILEX ENVIRONMENTAL OF AUBURN, MASSACHUSETTS DURING THE PERIOD FROM AUGUST 30, 2021 TO SEPTEMBER 1, 2021 AND WERE OBSERVED AND LOGGED BY GZA.
4. GZA BORING LOCATIONS WERE STAKED IN THE FIELD BY TAUPER SURVEY AS NOTED ON "BORING STACKING, A-127 & B-128 LINES, LEICESTER TO AUBURN, MASSACHUSETTS", DATED JUNE 17, 2021. TEST BORINGS WERE COMPLETED WITHIN APPROXIMATELY 1-FOOT OFF THE STAKED LOCATIONS.



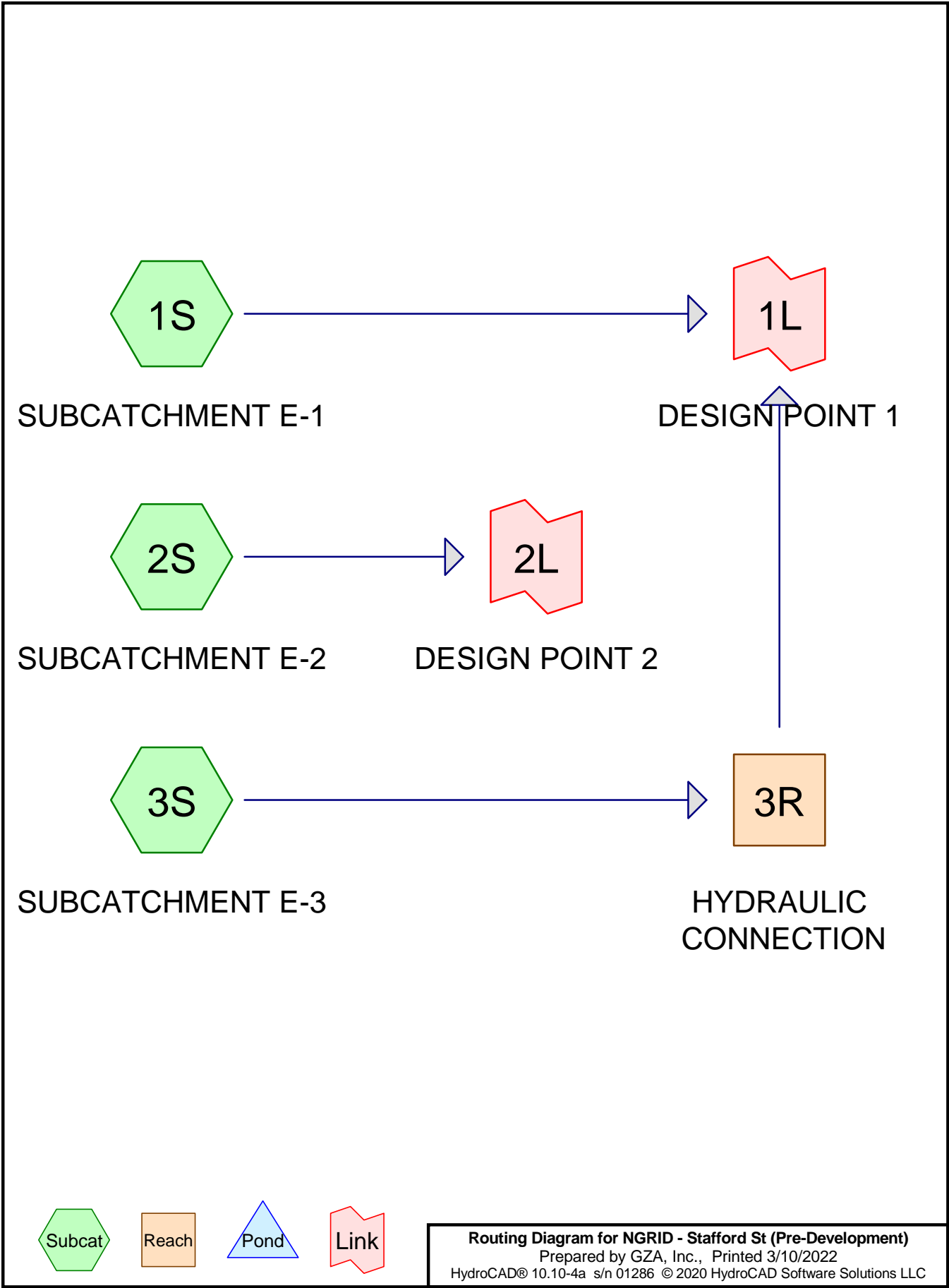
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NATIONAL GRID			
STAFFORD STREET SUBSTATION ACCESS ROAD 408 STAFFORD STREET, LEICESTER, MASSACHUSETTS			
EXPLORATION LOCATION PLAN			
PREPARED BY:	GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: nationalgrid
PROJ MGR: JTS	REVIEWED BY: JTS	CHECKED BY: GRM	FIGURE
DESIGNED BY: JYS	DRAWN BY: AJP	SCALE: AS SHOWN	5
DATE: SEPTEMBER 2021	PROJECT NO. 04.0191281.00	REVISION NO. -	



Appendix A

Pre-Development 2-, 10-, & 100-Year 24-Hour Storm Event Calculations



NGRID - Stafford St (Pre-Development)

Prepared by GZA, Inc.

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Page 2

Project Notes

Rainfall events imported from "Atlas-14-Rain.txt" for 6691 MD Worcester South

Rainfall events imported from "Atlas-14-Rain.txt" for 6682 MA Worcester South

NGRID - Stafford St (Pre-Development)

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Page 3

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.15	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.90	2
3	100-Year	Type III 24-hr		Default	24.00	1	7.67	2

NGRID - Stafford St (Pre-Development)

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Page 4

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.258	56	Brush, Fair, HSG B (1S, 2S, 3S)
0.496	96	Gravel surface, HSG B (1S, 2S, 3S)
3.477	58	Meadow, non-grazed, HSG B (2S, 3S)
16.109	55	Woods, Good, HSG B (1S, 2S, 3S)
1.499	77	Woods, Good, HSG D (1S, 2S, 3S)
26.838	58	TOTAL AREA

NGRID - Stafford St (Pre-Development)

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Page 5

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
25.339	HSG B	1S, 2S, 3S
0.000	HSG C	
1.499	HSG D	1S, 2S, 3S
0.000	Other	
26.838		TOTAL AREA

NGRID - Stafford St (Pre-Development)

Prepared by GZA, Inc.

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Page 6

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	5.258	0.000	0.000	0.000	5.258	Brush, Fair	1S, 2S, 3S
0.000	0.496	0.000	0.000	0.000	0.496	Gravel surface	1S, 2S, 3S
0.000	3.477	0.000	0.000	0.000	3.477	Meadow, non-grazed	2S, 3S
0.000	16.109	0.000	1.499	0.000	17.609	Woods, Good	1S, 2S, 3S
0.000	25.339	0.000	1.499	0.000	26.838	TOTAL AREA	

NGRID - Stafford St (Pre-Development)

Type III 24-hr 2-Year Rainfall=3.15"

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Page 7

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SUBCATCHMENT E-1 Runoff Area=294,990 sf 0.00% Impervious Runoff Depth>0.22"
Flow Length=1,010' Tc=15.3 min CN=56 Runoff=0.70 cfs 0.125 af

Subcatchment 2S: SUBCATCHMENT E-2 Runoff Area=372,115 sf 0.00% Impervious Runoff Depth>0.31"
Flow Length=1,100' Tc=12.9 min CN=59 Runoff=1.50 cfs 0.217 af

Subcatchment 3S: SUBCATCHMENT E-3 Runoff Area=501,975 sf 0.00% Impervious Runoff Depth>0.25"
Flow Length=1,140' Tc=18.7 min CN=57 Runoff=1.37 cfs 0.237 af

Reach 3R: HYDRAULIC CONNECTION Avg. Flow Depth=0.06' Max Vel=2.28 fps Inflow=1.37 cfs 0.237 af
n=0.035 L=240.0' S=0.1292 '/' Capacity=170.43 cfs Outflow=1.36 cfs 0.236 af

Link 1L: DESIGN POINT 1 Inflow=2.04 cfs 0.361 af
Primary=2.04 cfs 0.361 af

Link 2L: DESIGN POINT 2 Inflow=1.50 cfs 0.217 af
Primary=1.50 cfs 0.217 af

Total Runoff Area = 26.838 ac Runoff Volume = 0.580 af Average Runoff Depth = 0.26"
100.00% Pervious = 26.838 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: SUBCATCHMENT E-1

Runoff = 0.70 cfs @ 12.46 hrs, Volume= 0.125 af, Depth> 0.22"

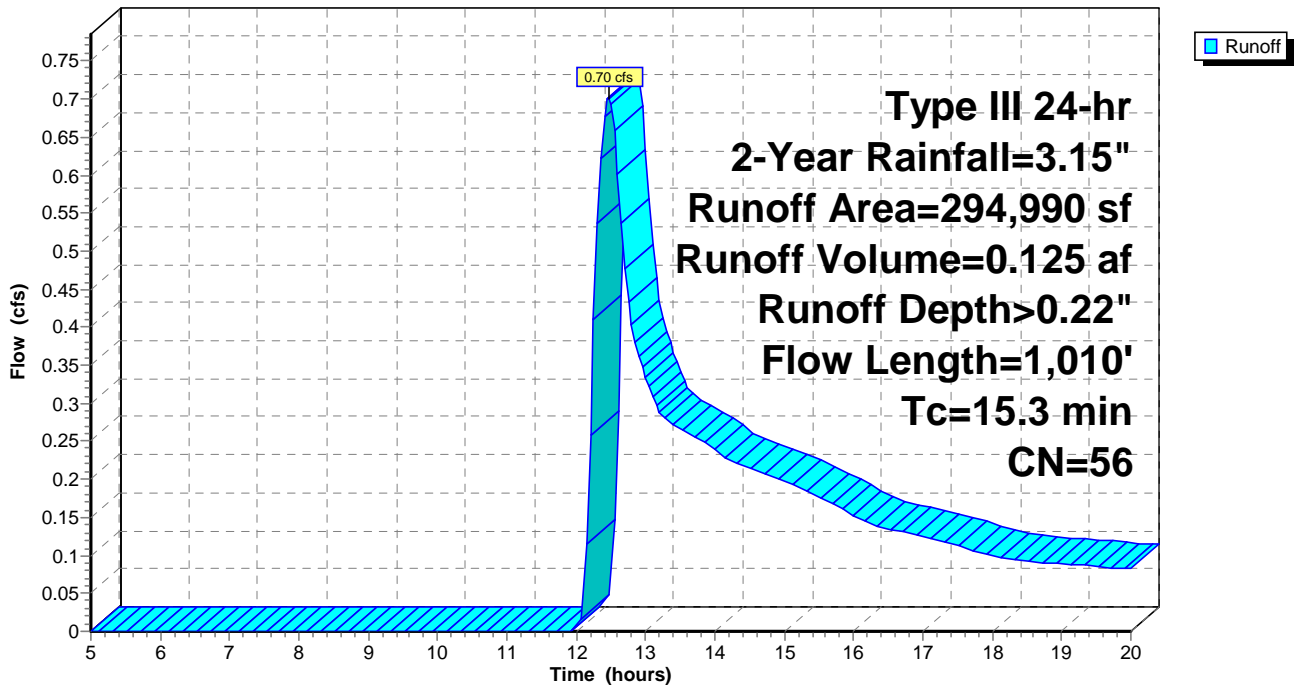
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
174,595	55	Woods, Good, HSG B
108,745	56	Brush, Fair, HSG B
8,290	77	Woods, Good, HSG D
3,360	96	Gravel surface, HSG B
294,990	56	Weighted Average
294,990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	100	0.0300	0.14		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
3.1	910	0.0900	4.83		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
15.3	1,010	Total			

Subcatchment 1S: SUBCATCHMENT E-1

Hydrograph



Summary for Subcatchment 2S: SUBCATCHMENT E-2

Runoff = 1.50 cfs @ 12.34 hrs, Volume= 0.217 af, Depth> 0.31"

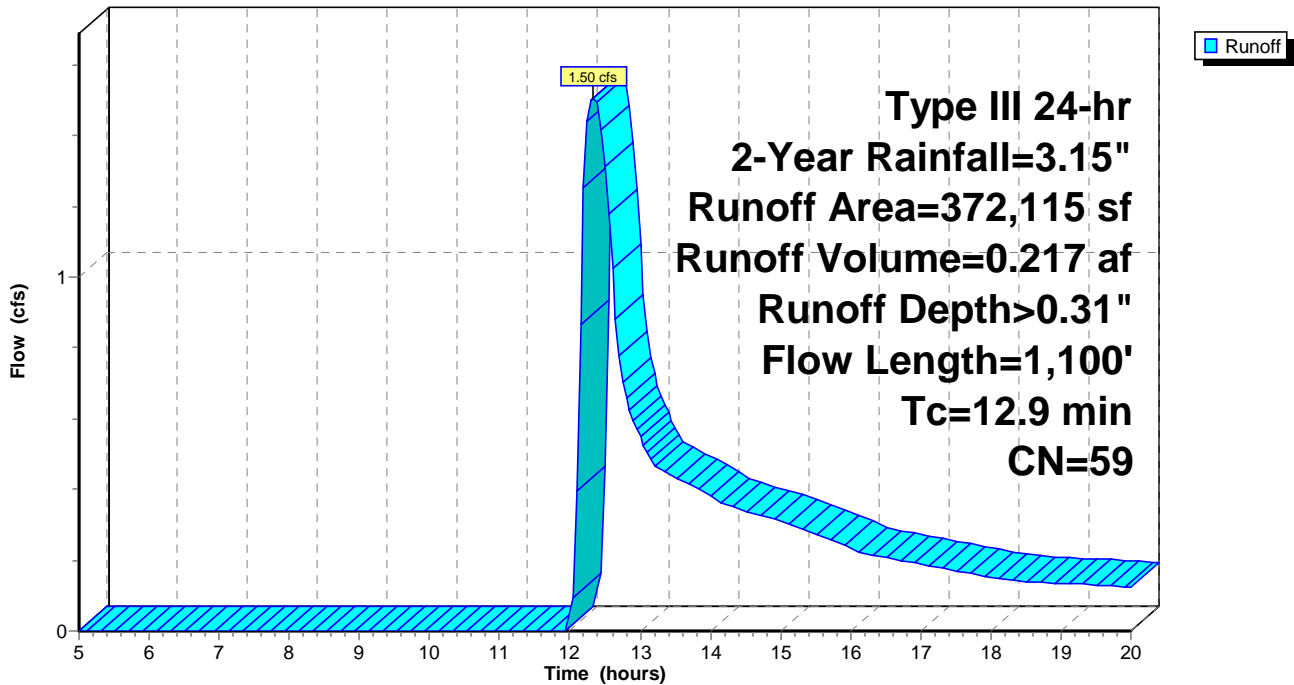
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
209,885	55	Woods, Good, HSG B
85,305	56	Brush, Fair, HSG B
45,030	77	Woods, Good, HSG D
27,210	58	Meadow, non-grazed, HSG B
4,685	96	Gravel surface, HSG B
372,115	59	Weighted Average
372,115		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	100	0.0700	0.19		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
4.2	1,000	0.0620	4.01		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
12.9	1,100	Total			

Subcatchment 2S: SUBCATCHMENT E-2

Hydrograph



Summary for Subcatchment 3S: SUBCATCHMENT E-3

Runoff = 1.37 cfs @ 12.49 hrs, Volume= 0.237 af, Depth> 0.25"

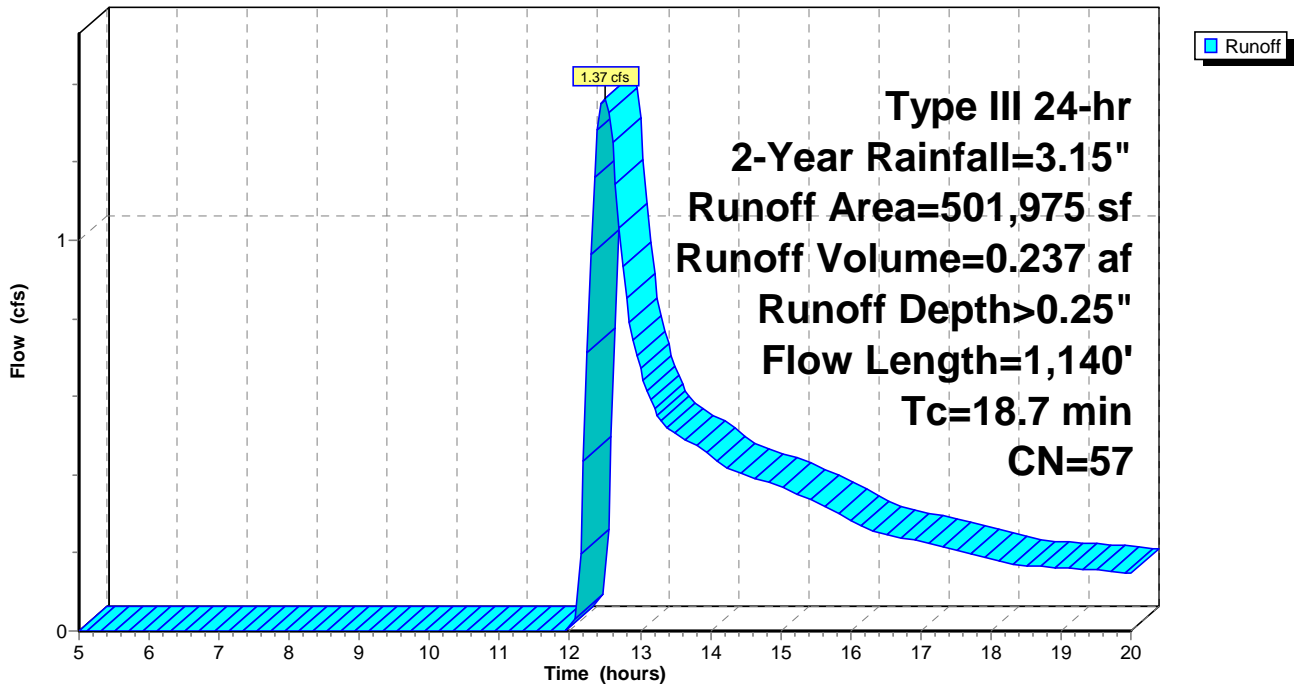
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
317,240	55	Woods, Good, HSG B
34,970	56	Brush, Fair, HSG B
11,990	77	Woods, Good, HSG D
124,235	58	Meadow, non-grazed, HSG B
13,540	96	Gravel surface, HSG B
501,975	57	Weighted Average
501,975		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	100	0.0500	0.11		Sheet Flow, Segment AB
					Woods: Light underbrush n= 0.400 P2= 3.15"
3.7	1,040	0.0830	4.64		Shallow Concentrated Flow, Segment BC
					Unpaved Kv= 16.1 fps
18.7	1,140	Total			

Subcatchment 3S: SUBCATCHMENT E-3

Hydrograph



Summary for Reach 3R: HYDRAULIC CONNECTION

Inflow Area = 11.524 ac, 0.00% Impervious, Inflow Depth > 0.25" for 2-Year event
 Inflow = 1.37 cfs @ 12.49 hrs, Volume= 0.237 af
 Outflow = 1.36 cfs @ 12.54 hrs, Volume= 0.236 af, Atten= 1%, Lag= 2.9 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 2.28 fps, Min. Travel Time= 1.8 min
 Avg. Velocity = 1.30 fps, Avg. Travel Time= 3.1 min

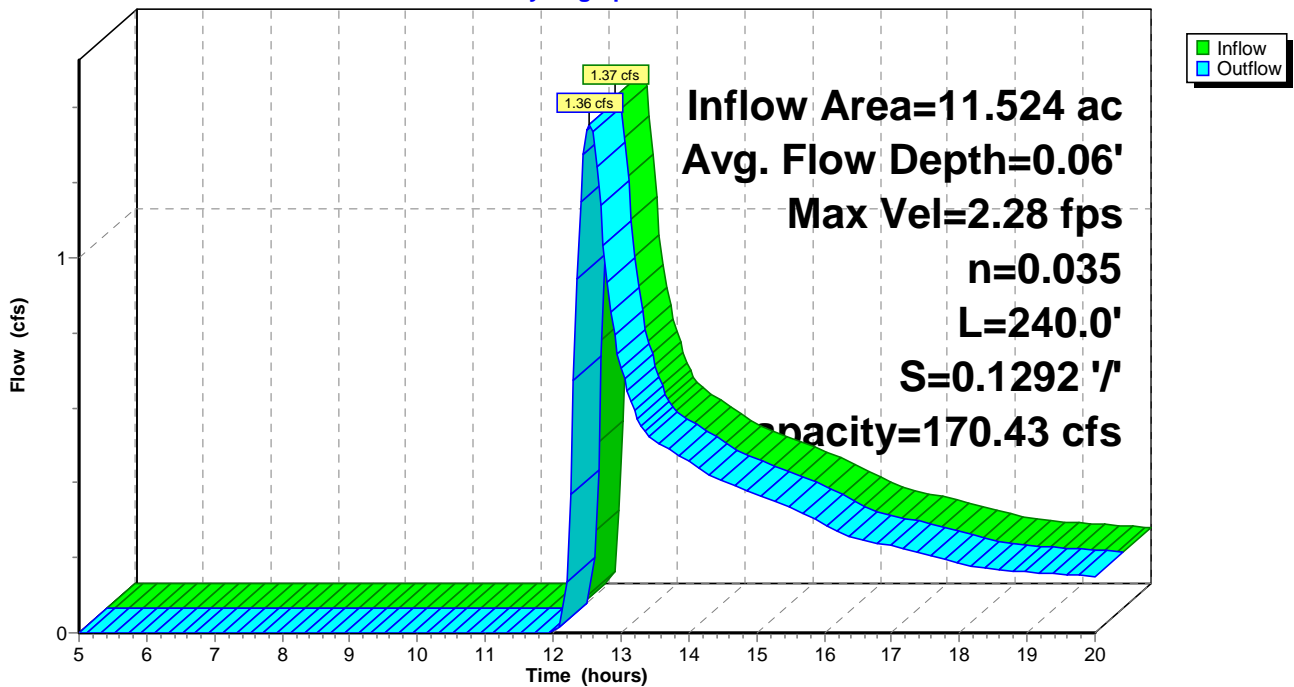
Peak Storage= 143 cf @ 12.51 hrs
 Average Depth at Peak Storage= 0.06' , Surface Width= 10.35'
 Bank-Full Depth= 1.00' Flow Area= 13.0 sf, Capacity= 170.43 cfs

10.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
 Side Slope Z-value= 3.0 ' / ' Top Width= 16.00'
 Length= 240.0' Slope= 0.1292 ' / '
 Inlet Invert= 777.00', Outlet Invert= 746.00'



Reach 3R: HYDRAULIC CONNECTION

Hydrograph

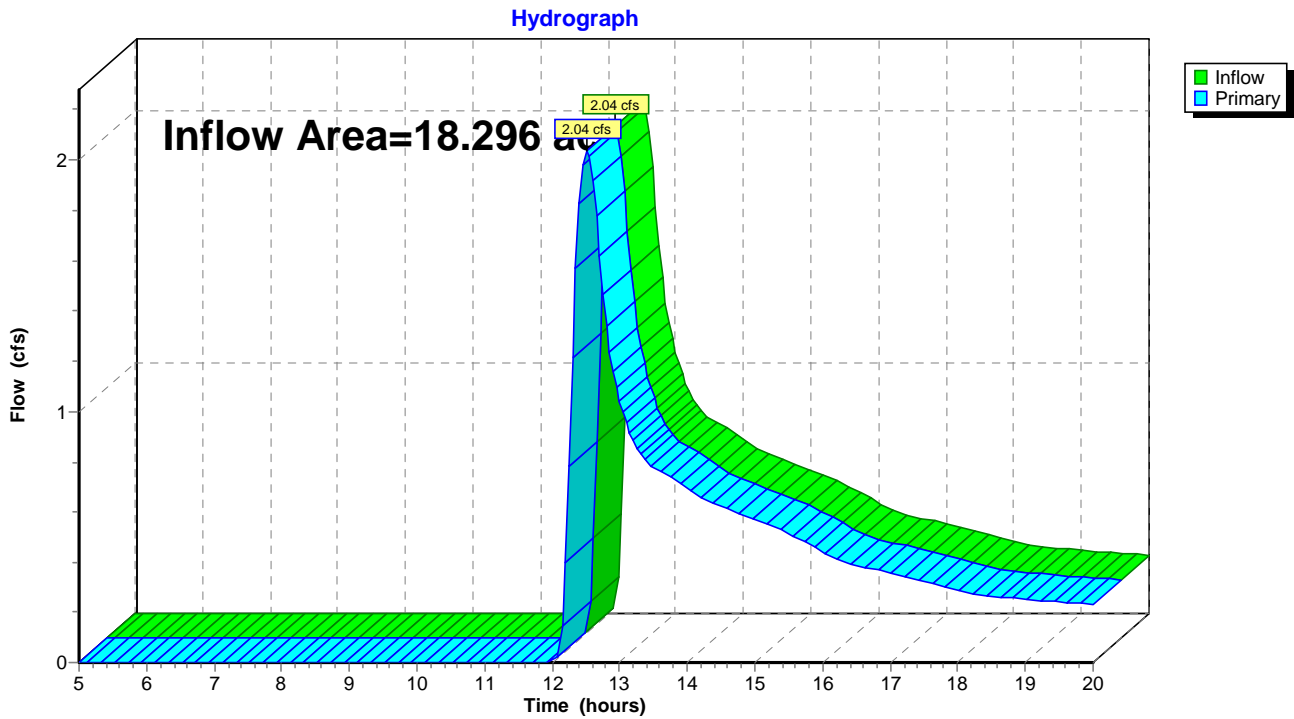


Summary for Link 1L: DESIGN POINT 1

Inflow Area = 18.296 ac, 0.00% Impervious, Inflow Depth > 0.24" for 2-Year event
Inflow = 2.04 cfs @ 12.51 hrs, Volume= 0.361 af
Primary = 2.04 cfs @ 12.51 hrs, Volume= 0.361 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 1L: DESIGN POINT 1



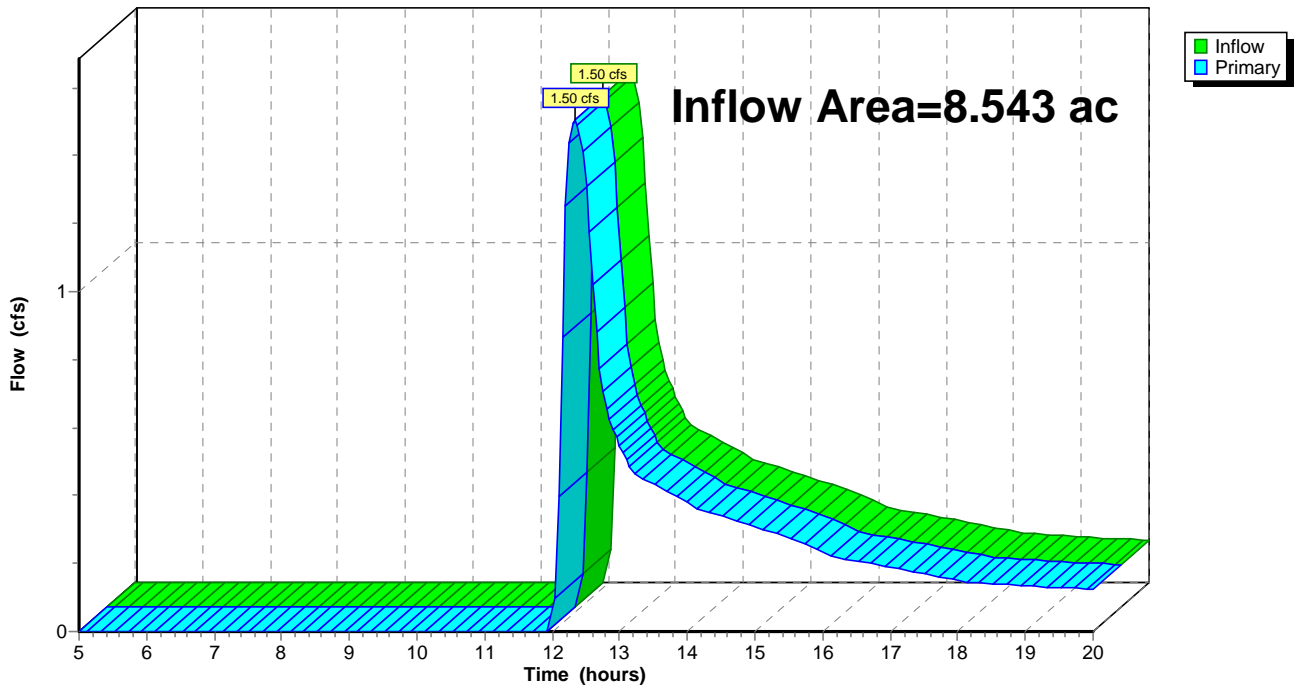
Summary for Link 2L: DESIGN POINT 2

Inflow Area = 8.543 ac, 0.00% Impervious, Inflow Depth > 0.31" for 2-Year event
Inflow = 1.50 cfs @ 12.34 hrs, Volume= 0.217 af
Primary = 1.50 cfs @ 12.34 hrs, Volume= 0.217 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 2L: DESIGN POINT 2

Hydrograph



NGRID - Stafford St (Pre-Development)

Type III 24-hr 10-Year Rainfall=4.90"

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Page 14

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SUBCATCHMENT E-1 Runoff Area=294,990 sf 0.00% Impervious Runoff Depth>0.88"
Flow Length=1,010' Tc=15.3 min CN=56 Runoff=4.71 cfs 0.496 af

Subcatchment 2S: SUBCATCHMENT E-2 Runoff Area=372,115 sf 0.00% Impervious Runoff Depth>1.06"
Flow Length=1,100' Tc=12.9 min CN=59 Runoff=8.11 cfs 0.752 af

Subcatchment 3S: SUBCATCHMENT E-3 Runoff Area=501,975 sf 0.00% Impervious Runoff Depth>0.93"
Flow Length=1,140' Tc=18.7 min CN=57 Runoff=8.13 cfs 0.898 af

Reach 3R: HYDRAULIC CONNECTION Avg. Flow Depth=0.17' Max Vel=4.53 fps Inflow=8.13 cfs 0.898 af
n=0.035 L=240.0' S=0.1292 '/' Capacity=170.43 cfs Outflow=8.06 cfs 0.896 af

Link 1L: DESIGN POINT 1 Inflow=12.54 cfs 1.392 af
Primary=12.54 cfs 1.392 af

Link 2L: DESIGN POINT 2 Inflow=8.11 cfs 0.752 af
Primary=8.11 cfs 0.752 af

Total Runoff Area = 26.838 ac Runoff Volume = 2.145 af Average Runoff Depth = 0.96"
100.00% Pervious = 26.838 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: SUBCATCHMENT E-1

Runoff = 4.71 cfs @ 12.26 hrs, Volume= 0.496 af, Depth> 0.88"

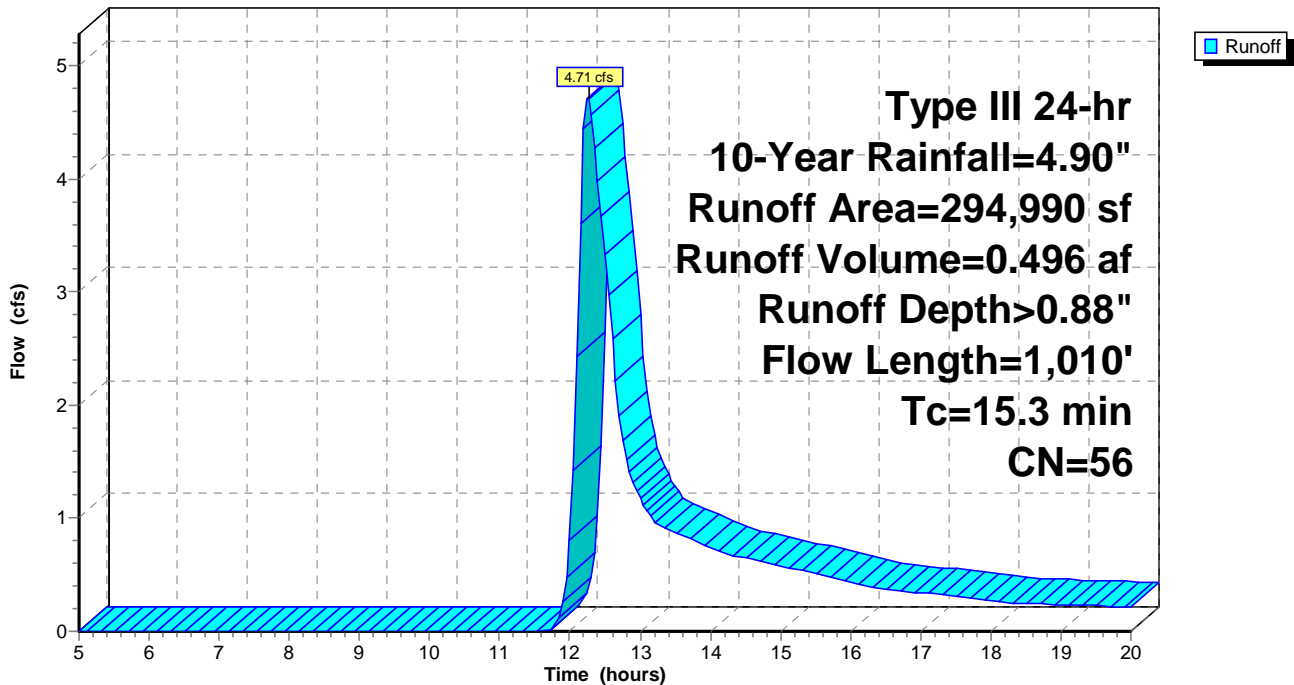
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.90"

Area (sf)	CN	Description
174,595	55	Woods, Good, HSG B
108,745	56	Brush, Fair, HSG B
8,290	77	Woods, Good, HSG D
3,360	96	Gravel surface, HSG B
294,990	56	Weighted Average
294,990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	100	0.0300	0.14		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
3.1	910	0.0900	4.83		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
15.3	1,010	Total			

Subcatchment 1S: SUBCATCHMENT E-1

Hydrograph



Summary for Subcatchment 2S: SUBCATCHMENT E-2

Runoff = 8.11 cfs @ 12.21 hrs, Volume= 0.752 af, Depth> 1.06"

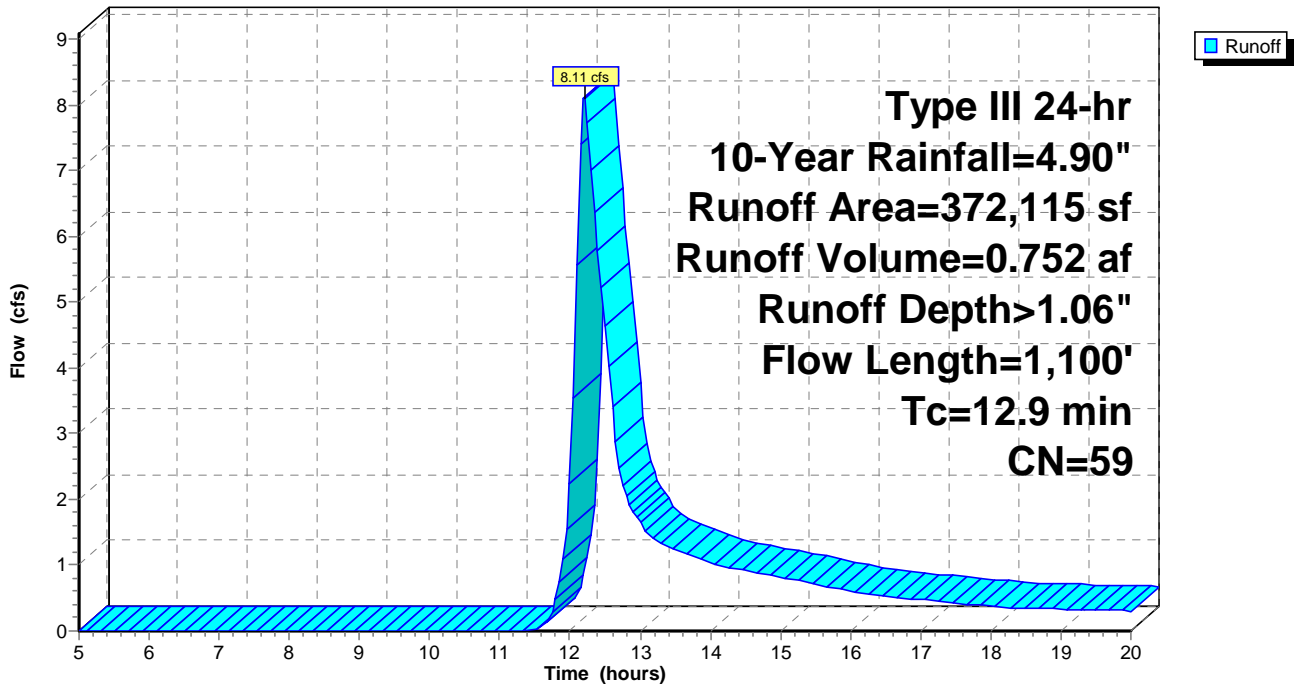
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.90"

Area (sf)	CN	Description
209,885	55	Woods, Good, HSG B
85,305	56	Brush, Fair, HSG B
45,030	77	Woods, Good, HSG D
27,210	58	Meadow, non-grazed, HSG B
4,685	96	Gravel surface, HSG B
372,115	59	Weighted Average
372,115		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	100	0.0700	0.19		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
4.2	1,000	0.0620	4.01		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
12.9	1,100	Total			

Subcatchment 2S: SUBCATCHMENT E-2

Hydrograph



Summary for Subcatchment 3S: SUBCATCHMENT E-3

Runoff = 8.13 cfs @ 12.31 hrs, Volume= 0.898 af, Depth> 0.93"

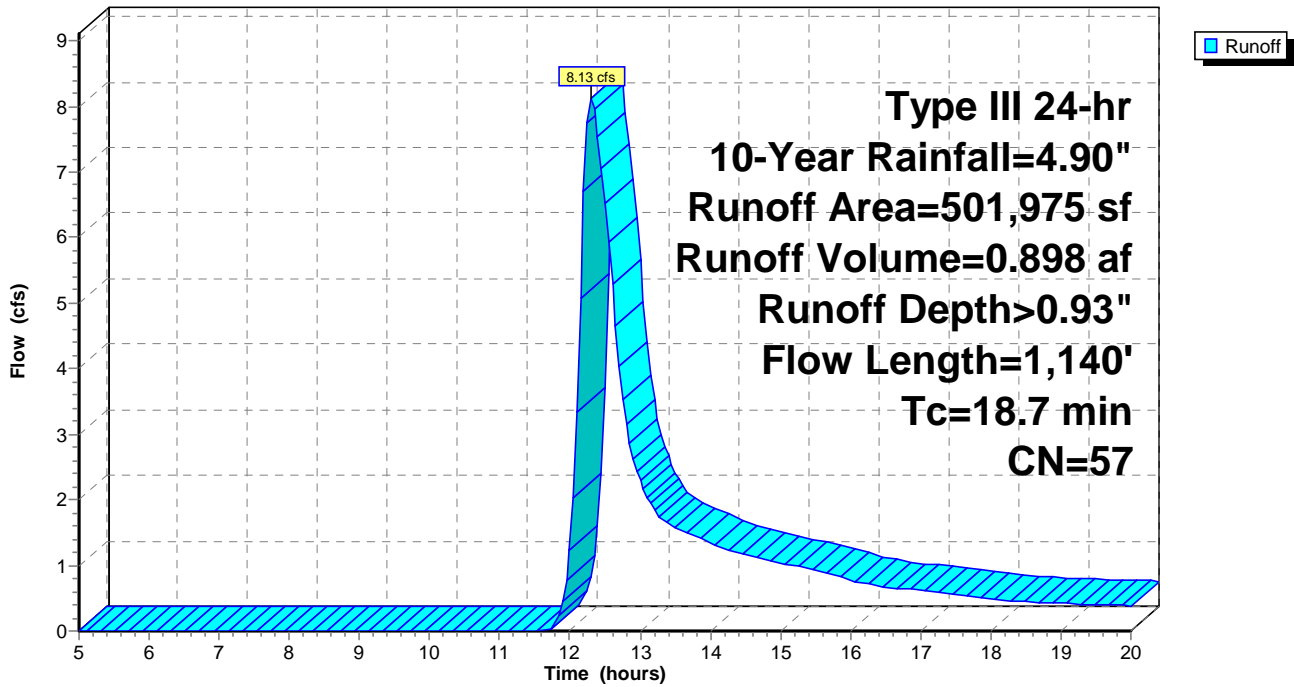
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.90"

Area (sf)	CN	Description
317,240	55	Woods, Good, HSG B
34,970	56	Brush, Fair, HSG B
11,990	77	Woods, Good, HSG D
124,235	58	Meadow, non-grazed, HSG B
13,540	96	Gravel surface, HSG B
501,975	57	Weighted Average
501,975		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	100	0.0500	0.11		Sheet Flow, Segment AB
3.7	1,040	0.0830	4.64		Woods: Light underbrush n= 0.400 P2= 3.15" Shallow Concentrated Flow, Segment BC
18.7	1,140	Total			Unpaved Kv= 16.1 fps

Subcatchment 3S: SUBCATCHMENT E-3

Hydrograph



Summary for Reach 3R: HYDRAULIC CONNECTION

Inflow Area = 11.524 ac, 0.00% Impervious, Inflow Depth > 0.93" for 10-Year event
 Inflow = 8.13 cfs @ 12.31 hrs, Volume= 0.898 af
 Outflow = 8.06 cfs @ 12.34 hrs, Volume= 0.896 af, Atten= 1%, Lag= 1.6 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 4.53 fps, Min. Travel Time= 0.9 min
 Avg. Velocity = 2.01 fps, Avg. Travel Time= 2.0 min

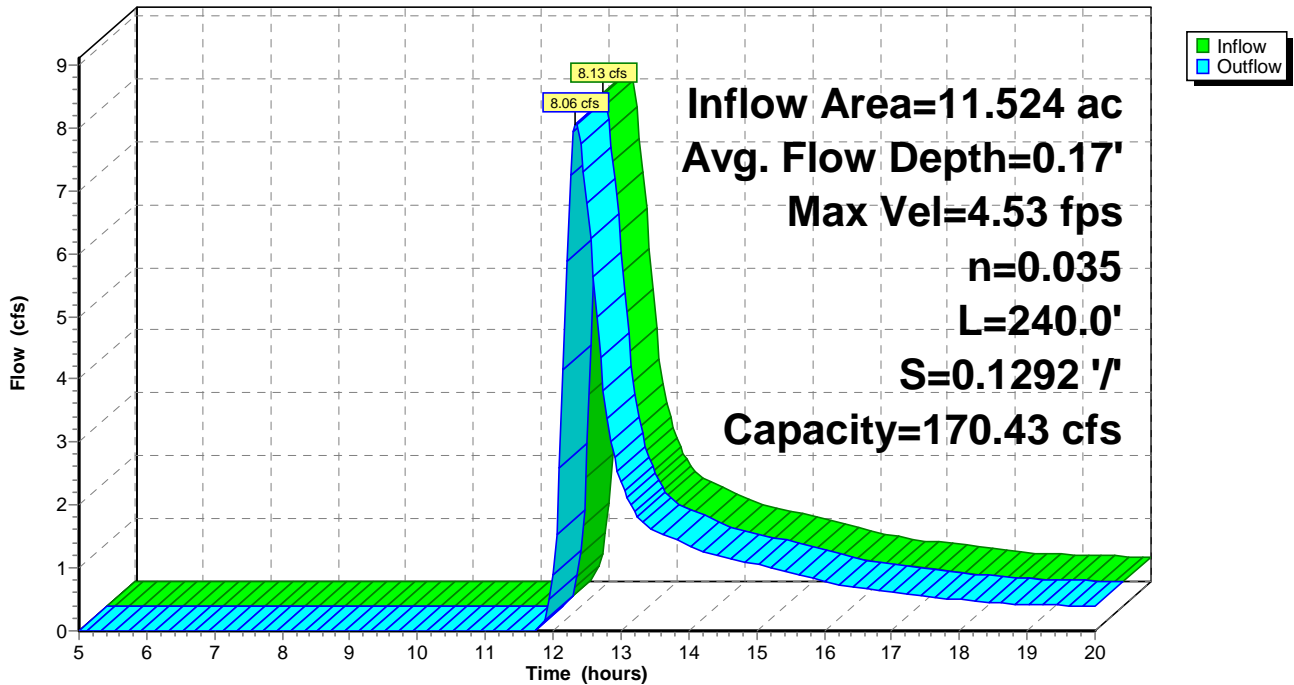
Peak Storage= 431 cf @ 12.32 hrs
 Average Depth at Peak Storage= 0.17' , Surface Width= 11.02'
 Bank-Full Depth= 1.00' Flow Area= 13.0 sf, Capacity= 170.43 cfs

10.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
 Side Slope Z-value= 3.0 ' / ' Top Width= 16.00'
 Length= 240.0' Slope= 0.1292 ' / '
 Inlet Invert= 777.00', Outlet Invert= 746.00'



Reach 3R: HYDRAULIC CONNECTION

Hydrograph



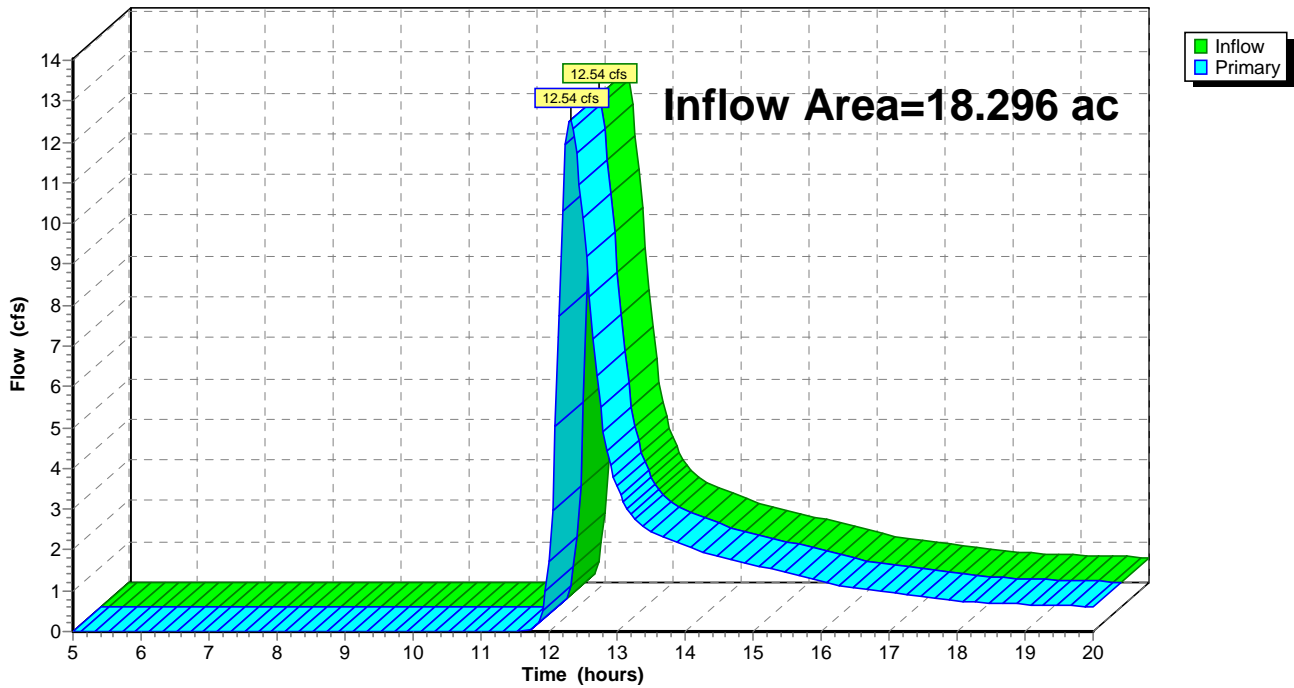
Summary for Link 1L: DESIGN POINT 1

Inflow Area = 18.296 ac, 0.00% Impervious, Inflow Depth > 0.91" for 10-Year event
Inflow = 12.54 cfs @ 12.31 hrs, Volume= 1.392 af
Primary = 12.54 cfs @ 12.31 hrs, Volume= 1.392 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 1L: DESIGN POINT 1

Hydrograph



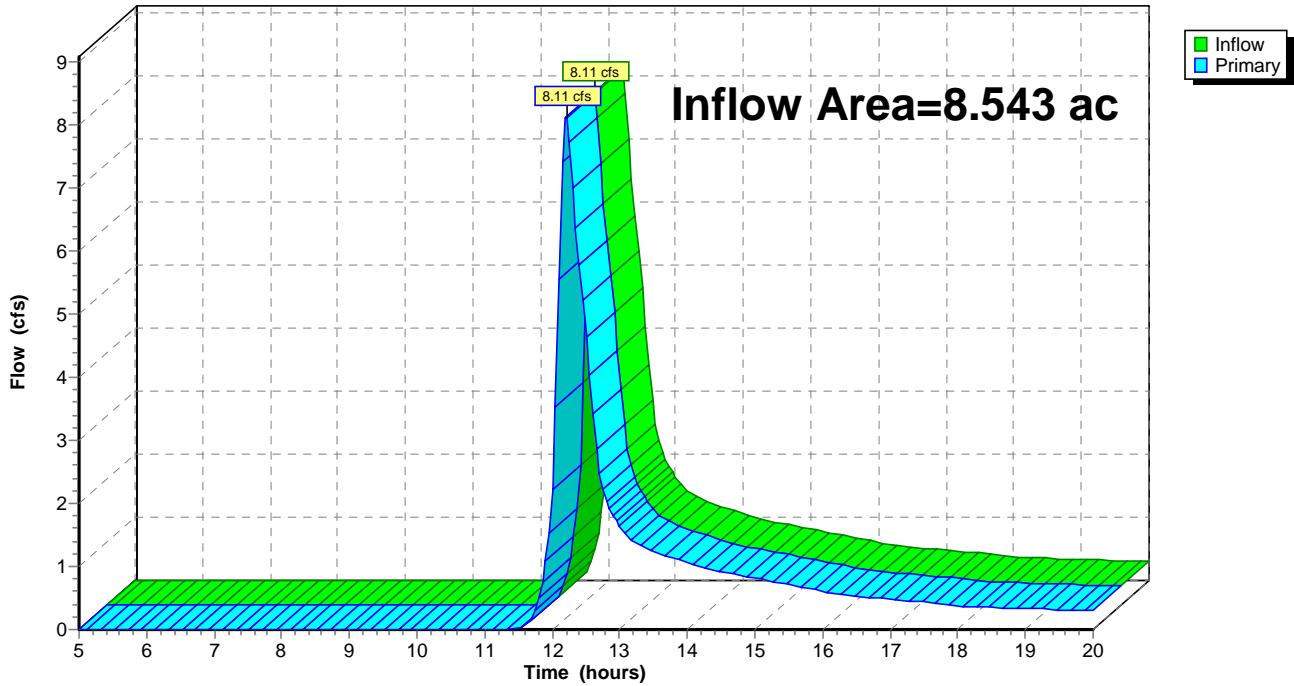
Summary for Link 2L: DESIGN POINT 2

Inflow Area = 8.543 ac, 0.00% Impervious, Inflow Depth > 1.06" for 10-Year event
Inflow = 8.11 cfs @ 12.21 hrs, Volume= 0.752 af
Primary = 8.11 cfs @ 12.21 hrs, Volume= 0.752 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 2L: DESIGN POINT 2

Hydrograph



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SUBCATCHMENT E-1 Runoff Area=294,990 sf 0.00% Impervious Runoff Depth>2.43"
Flow Length=1,010' Tc=15.3 min CN=56 Runoff=15.01 cfs 1.370 af

Subcatchment 2S: SUBCATCHMENT E-2 Runoff Area=372,115 sf 0.00% Impervious Runoff Depth>2.73"
Flow Length=1,100' Tc=12.9 min CN=59 Runoff=23.01 cfs 1.945 af

Subcatchment 3S: SUBCATCHMENT E-3 Runoff Area=501,975 sf 0.00% Impervious Runoff Depth>2.52"
Flow Length=1,140' Tc=18.7 min CN=57 Runoff=24.85 cfs 2.424 af

Reach 3R: HYDRAULIC CONNECTION Avg. Flow Depth=0.33' Max Vel=6.83 fps Inflow=24.85 cfs 2.424 af
n=0.035 L=240.0' S=0.1292 '/ Capacity=170.43 cfs Outflow=24.64 cfs 2.421 af

Link 1L: DESIGN POINT 1 Inflow=39.06 cfs 3.791 af
Primary=39.06 cfs 3.791 af

Link 2L: DESIGN POINT 2 Inflow=23.01 cfs 1.945 af
Primary=23.01 cfs 1.945 af

Total Runoff Area = 26.838 ac Runoff Volume = 5.739 af Average Runoff Depth = 2.57"
100.00% Pervious = 26.838 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: SUBCATCHMENT E-1

Runoff = 15.01 cfs @ 12.23 hrs, Volume= 1.370 af, Depth> 2.43"

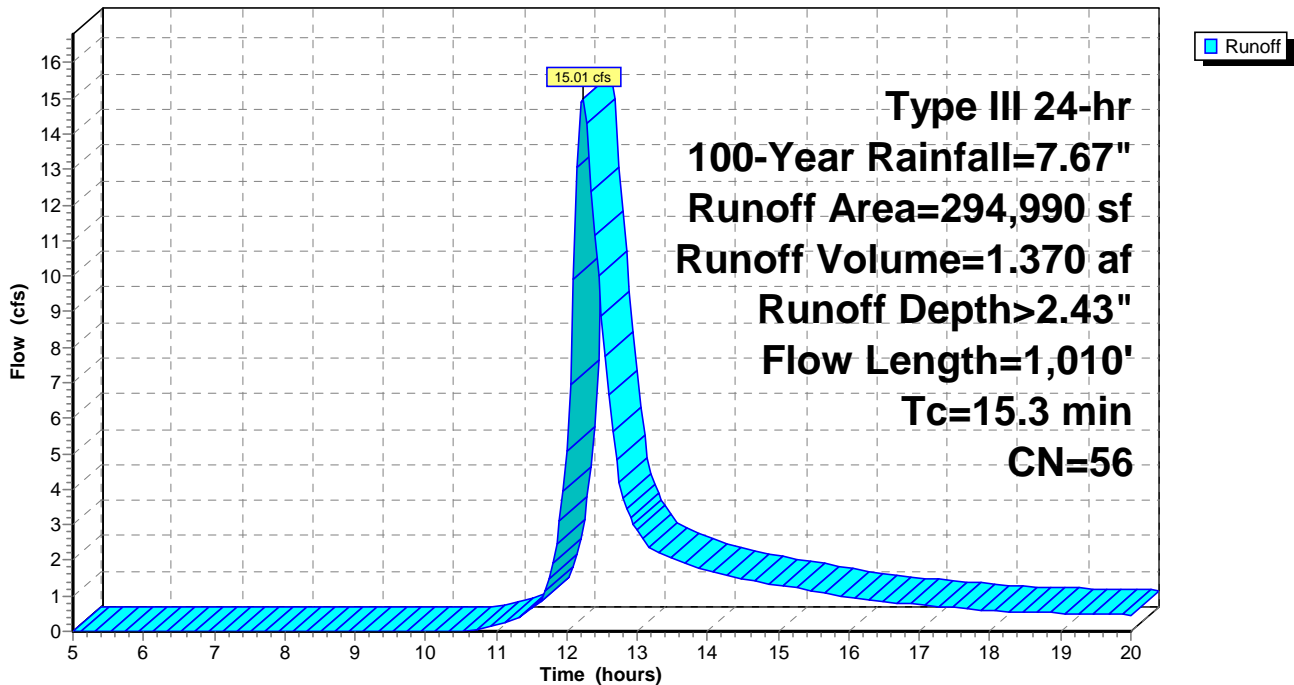
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.67"

Area (sf)	CN	Description
174,595	55	Woods, Good, HSG B
108,745	56	Brush, Fair, HSG B
8,290	77	Woods, Good, HSG D
3,360	96	Gravel surface, HSG B
294,990	56	Weighted Average
294,990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	100	0.0300	0.14		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
3.1	910	0.0900	4.83		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
15.3	1,010	Total			

Subcatchment 1S: SUBCATCHMENT E-1

Hydrograph



Summary for Subcatchment 2S: SUBCATCHMENT E-2

Runoff = 23.01 cfs @ 12.19 hrs, Volume= 1.945 af, Depth> 2.73"

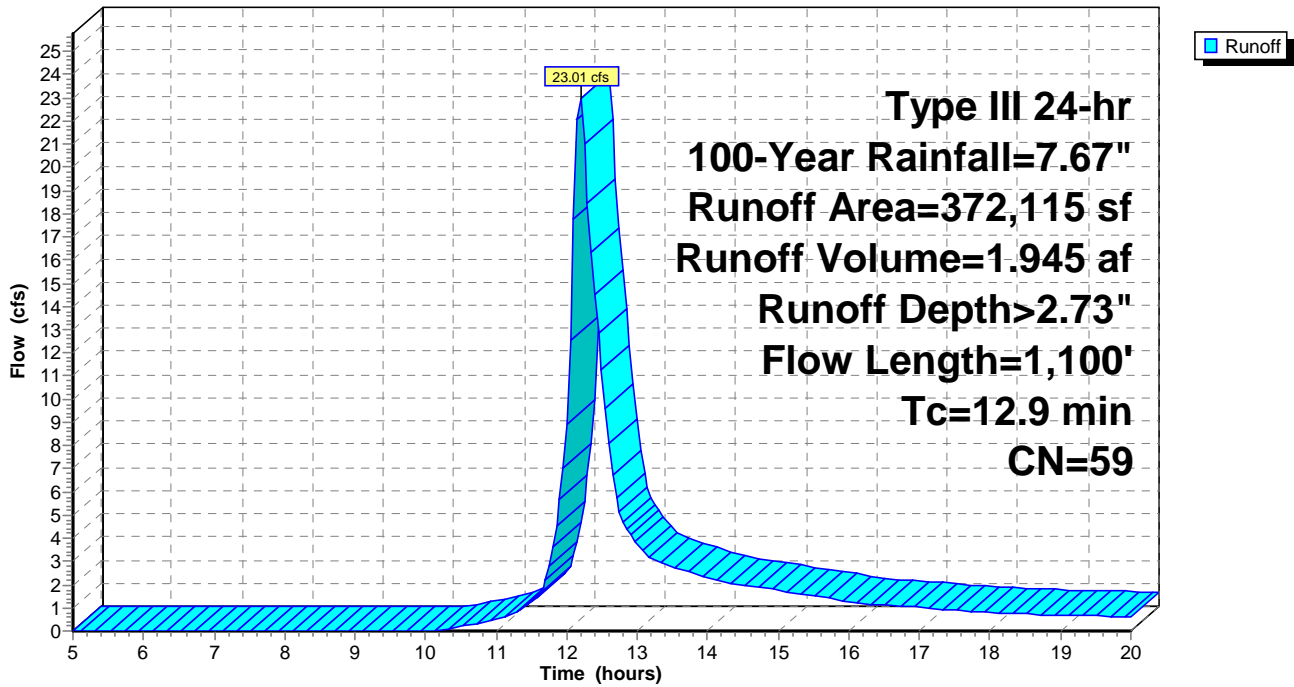
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-Year Rainfall=7.67"

Area (sf)	CN	Description
209,885	55	Woods, Good, HSG B
85,305	56	Brush, Fair, HSG B
45,030	77	Woods, Good, HSG D
27,210	58	Meadow, non-grazed, HSG B
4,685	96	Gravel surface, HSG B
372,115	59	Weighted Average
372,115		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	100	0.0700	0.19		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
4.2	1,000	0.0620	4.01		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
12.9	1,100	Total			

Subcatchment 2S: SUBCATCHMENT E-2

Hydrograph



Summary for Subcatchment 3S: SUBCATCHMENT E-3

Runoff = 24.85 cfs @ 12.27 hrs, Volume= 2.424 af, Depth> 2.52"

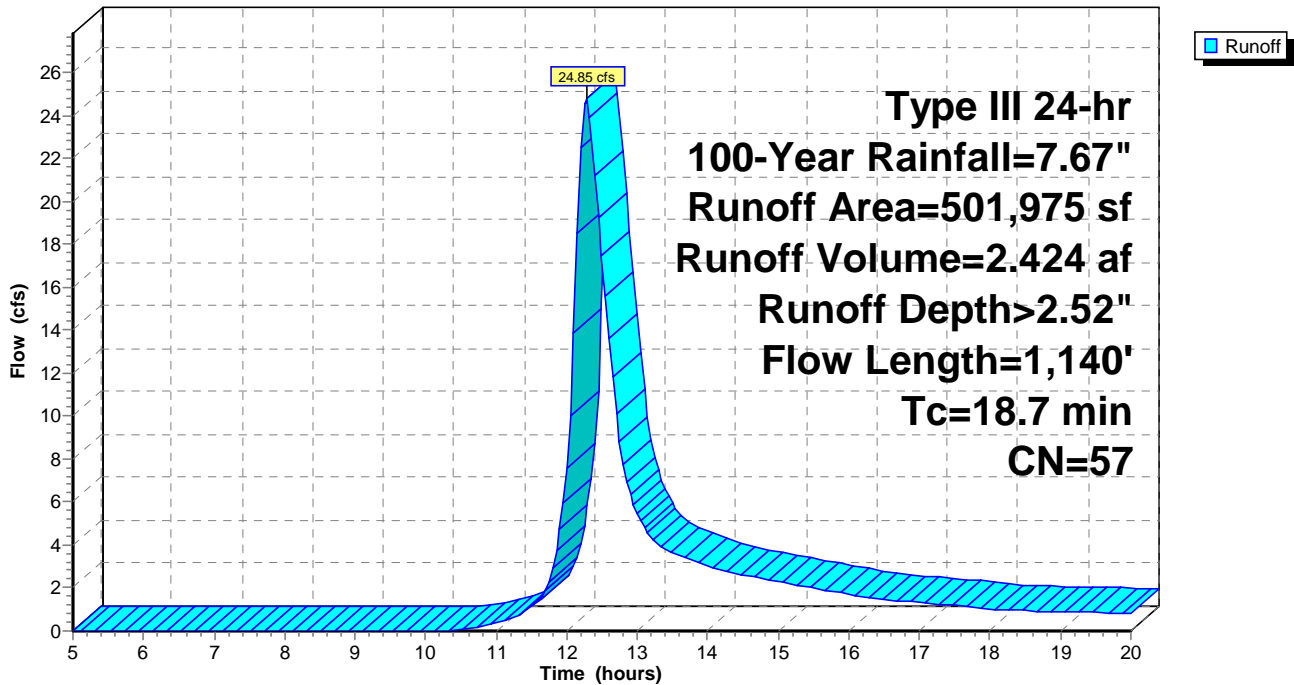
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.67"

Area (sf)	CN	Description
317,240	55	Woods, Good, HSG B
34,970	56	Brush, Fair, HSG B
11,990	77	Woods, Good, HSG D
124,235	58	Meadow, non-grazed, HSG B
13,540	96	Gravel surface, HSG B
501,975	57	Weighted Average
501,975		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	100	0.0500	0.11		Sheet Flow, Segment AB
					Woods: Light underbrush n= 0.400 P2= 3.15"
3.7	1,040	0.0830	4.64		Shallow Concentrated Flow, Segment BC
					Unpaved Kv= 16.1 fps
18.7	1,140	Total			

Subcatchment 3S: SUBCATCHMENT E-3

Hydrograph



Summary for Reach 3R: HYDRAULIC CONNECTION

Inflow Area = 11.524 ac, 0.00% Impervious, Inflow Depth > 2.52" for 100-Year event
 Inflow = 24.85 cfs @ 12.27 hrs, Volume= 2.424 af
 Outflow = 24.64 cfs @ 12.29 hrs, Volume= 2.421 af, Atten= 1%, Lag= 1.2 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 6.83 fps, Min. Travel Time= 0.6 min
 Avg. Velocity = 2.65 fps, Avg. Travel Time= 1.5 min

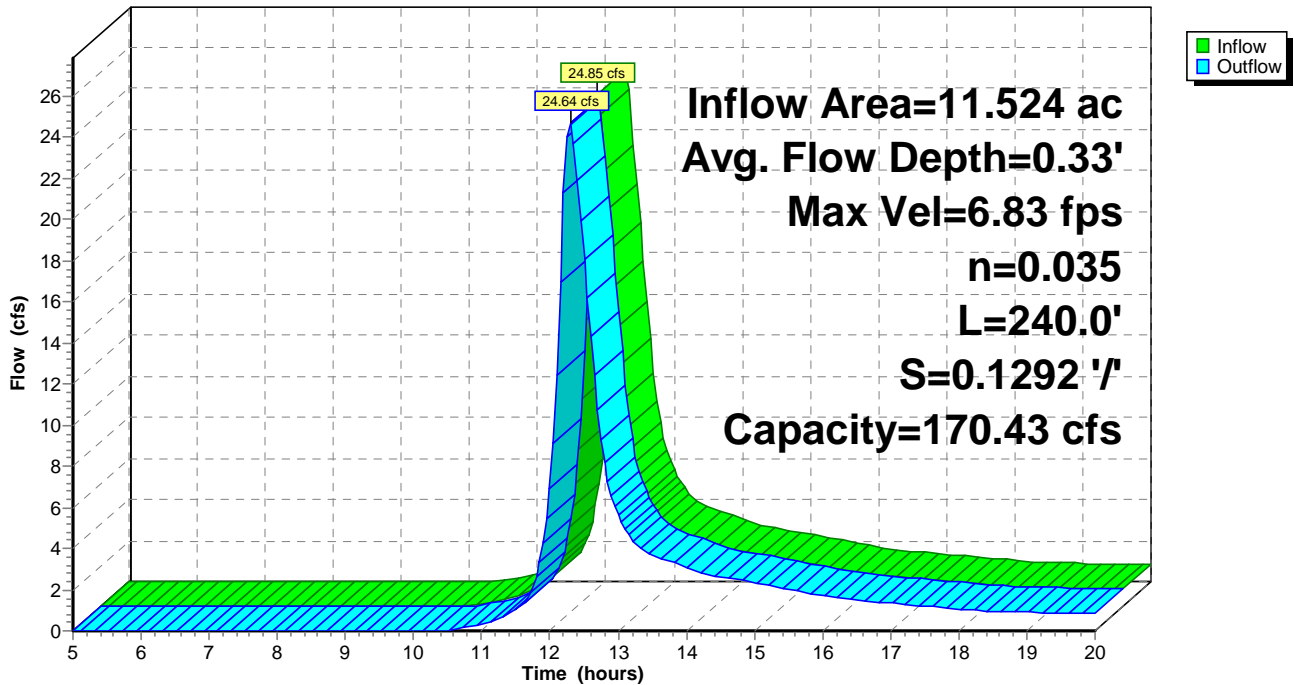
Peak Storage= 870 cf @ 12.28 hrs
 Average Depth at Peak Storage= 0.33' , Surface Width= 11.98'
 Bank-Full Depth= 1.00' Flow Area= 13.0 sf, Capacity= 170.43 cfs

10.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
 Side Slope Z-value= 3.0 ' / ' Top Width= 16.00'
 Length= 240.0' Slope= 0.1292 ' / '
 Inlet Invert= 777.00', Outlet Invert= 746.00'



Reach 3R: HYDRAULIC CONNECTION

Hydrograph



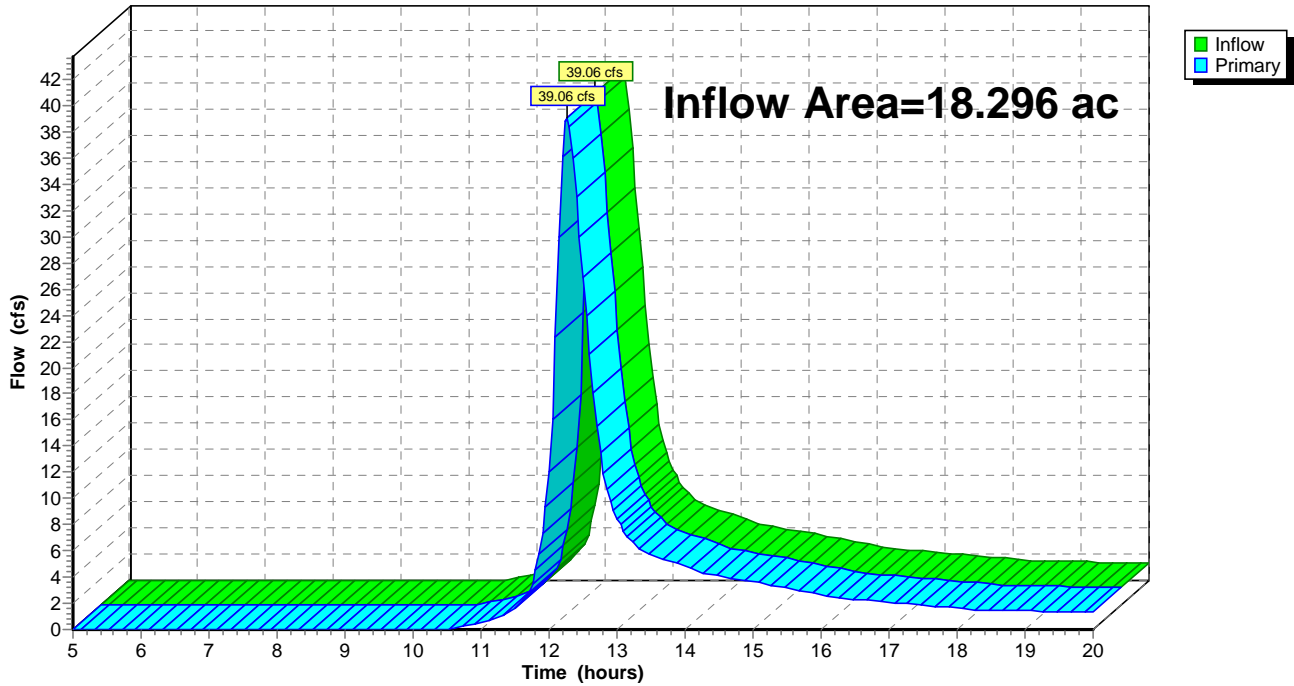
Summary for Link 1L: DESIGN POINT 1

Inflow Area = 18.296 ac, 0.00% Impervious, Inflow Depth > 2.49" for 100-Year event
Inflow = 39.06 cfs @ 12.27 hrs, Volume= 3.791 af
Primary = 39.06 cfs @ 12.27 hrs, Volume= 3.791 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 1L: DESIGN POINT 1

Hydrograph



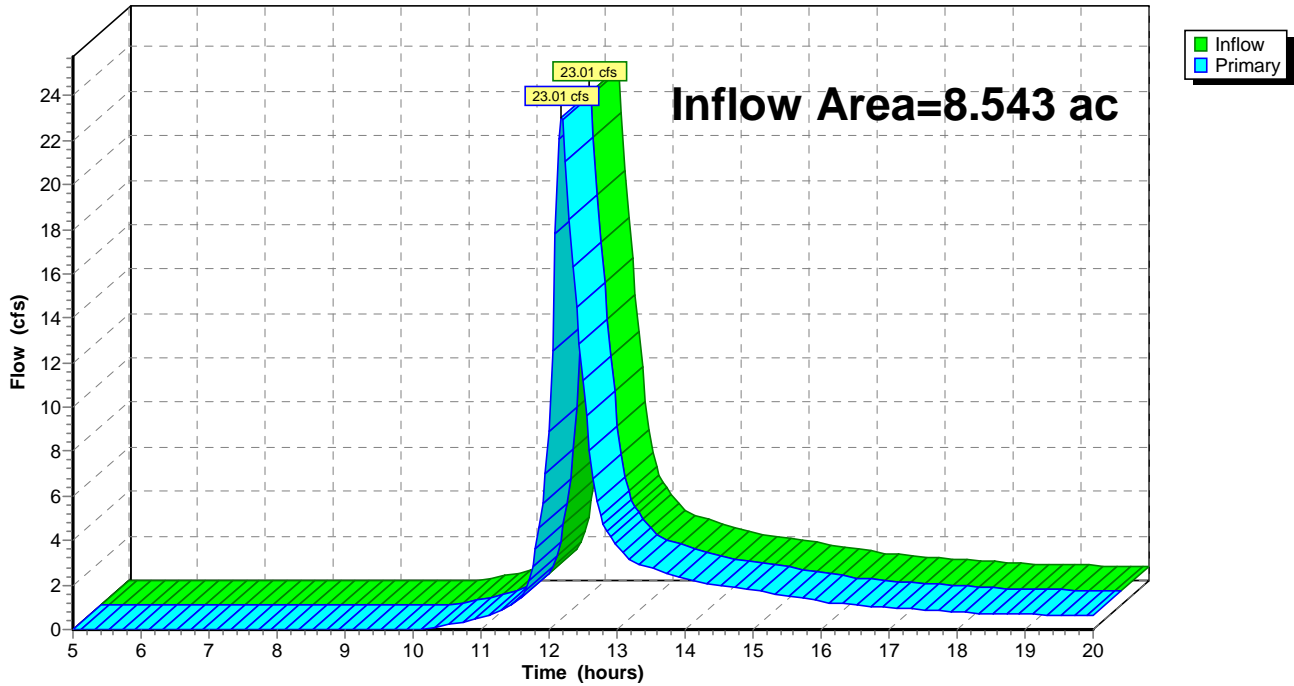
Summary for Link 2L: DESIGN POINT 2

Inflow Area = 8.543 ac, 0.00% Impervious, Inflow Depth > 2.73" for 100-Year event
Inflow = 23.01 cfs @ 12.19 hrs, Volume= 1.945 af
Primary = 23.01 cfs @ 12.19 hrs, Volume= 1.945 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 2L: DESIGN POINT 2

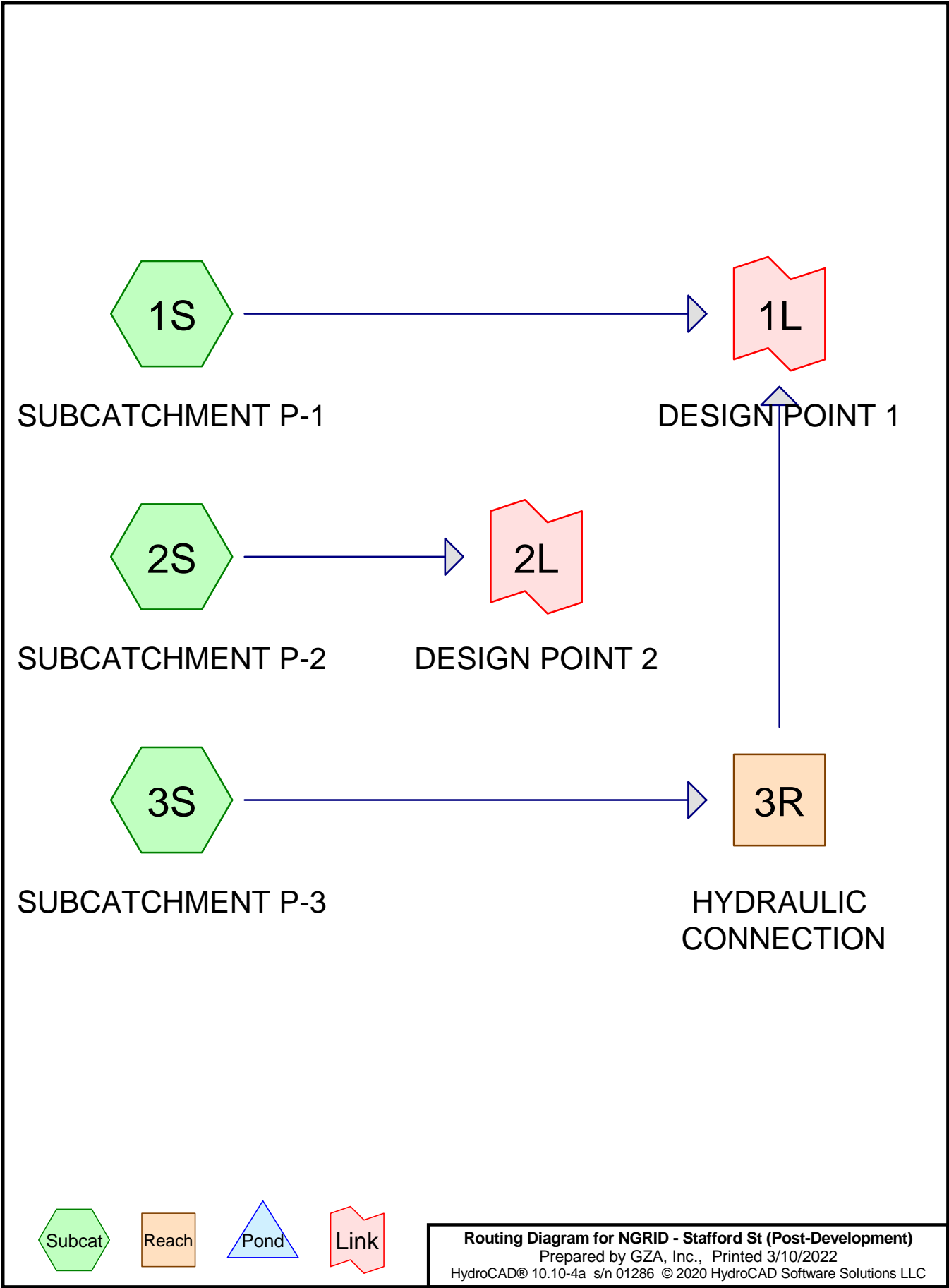
Hydrograph





Appendix B

Post-Development 2-, 10-, & 100-Year 24-Hour Storm Event Calculations



NGRID - Stafford St (Post-Development)

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Page 2

Project Notes

Rainfall events imported from "Atlas-14-Rain.txt" for 6691 MD Worcester South

Rainfall events imported from "Atlas-14-Rain.txt" for 6682 MA Worcester South

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Page 3

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.15	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.90	2
3	100-Year	Type III 24-hr		Default	24.00	1	7.67	2

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Page 4

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.197	61	>75% Grass cover, Good, HSG B (1S)
2.178	56	Brush, Fair, HSG B (1S, 2S, 3S)
0.920	62	Crushed Stone, HSG B (1S, 2S)
0.320	96	Gravel surface, HSG B (2S, 3S)
3.477	58	Meadow, non-grazed, HSG B (2S, 3S)
0.308	98	Paved parking, HSG B (1S, 2S)
0.510	55	Porous Pavement, HSG B (1S, 2S)
1.712	50	Riprap, HSG B (1S, 2S)
0.209	98	Roofs, HSG B (2S)
16.110	55	Woods, Good, HSG B (1S, 2S, 3S)
1.499	77	Woods, Good, HSG D (1S, 2S, 3S)
27.441	58	TOTAL AREA

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Page 5

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
25.942	HSG B	1S, 2S, 3S
0.000	HSG C	
1.499	HSG D	1S, 2S, 3S
0.000	Other	
27.441		TOTAL AREA

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.197	0.000	0.000	0.000	0.197	>75% Grass cover, Good	1S
0.000	2.178	0.000	0.000	0.000	2.178	Brush, Fair	1S, 2S, 3S
0.000	0.920	0.000	0.000	0.000	0.920	Crushed Stone	1S, 2S
0.000	0.320	0.000	0.000	0.000	0.320	Gravel surface	2S, 3S
0.000	3.477	0.000	0.000	0.000	3.477	Meadow, non-grazed	2S, 3S
0.000	0.308	0.000	0.000	0.000	0.308	Paved parking	1S, 2S
0.000	0.510	0.000	0.000	0.000	0.510	Porous Pavement	1S, 2S
0.000	1.712	0.000	0.000	0.000	1.712	Riprap	1S, 2S
0.000	0.209	0.000	0.000	0.000	0.209	Roofs	2S
0.000	16.110	0.000	1.499	0.000	17.610	Woods, Good	1S, 2S, 3S
0.000	25.942	0.000	1.499	0.000	27.441	TOTAL AREA	

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Page 7

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	1S	0.00	0.00	138.0	0.1880	0.025	36.0	0.0	0.0
2	3R	776.00	750.00	138.0	0.1884	0.025	36.0	0.0	0.0

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Type III 24-hr 2-Year Rainfall=3.15"

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Page 8

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SUBCATCHMENT P-1 Runoff Area=319,875 sf 1.38% Impervious Runoff Depth>0.22"
Flow Length=848' Tc=22.1 min CN=56 Runoff=0.69 cfs 0.135 af

Subcatchment 2S: SUBCATCHMENT P-2 Runoff Area=376,155 sf 4.82% Impervious Runoff Depth>0.33"
Flow Length=1,275' Tc=25.3 min CN=60 Runoff=1.50 cfs 0.240 af

Subcatchment 3S: SUBCATCHMENT P-3 Runoff Area=499,300 sf 0.00% Impervious Runoff Depth>0.25"
Flow Length=1,140' Tc=18.7 min CN=57 Runoff=1.36 cfs 0.236 af

Reach 3R: HYDRAULIC CONNECTION Avg. Flow Depth=0.20' Max Vel=6.64 fps Inflow=1.36 cfs 0.236 af
36.0" Round Pipe n=0.025 L=138.0' S=0.1884 1/1' Capacity=150.54 cfs Outflow=1.36 cfs 0.236 af

Link 1L: DESIGN POINT 1 Inflow=2.03 cfs 0.371 af
Primary=2.03 cfs 0.371 af

Link 2L: DESIGN POINT 2 Inflow=1.50 cfs 0.240 af
Primary=1.50 cfs 0.240 af

Total Runoff Area = 27.441 ac Runoff Volume = 0.610 af Average Runoff Depth = 0.27"
98.11% Pervious = 26.924 ac 1.89% Impervious = 0.517 ac

NGRID - Stafford St (Post-Development)

Type III 24-hr 2-Year Rainfall=3.15"

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Page 9

Summary for Subcatchment 1S: SUBCATCHMENT P-1

Runoff = 0.69 cfs @ 12.56 hrs, Volume= 0.135 af, Depth> 0.22"

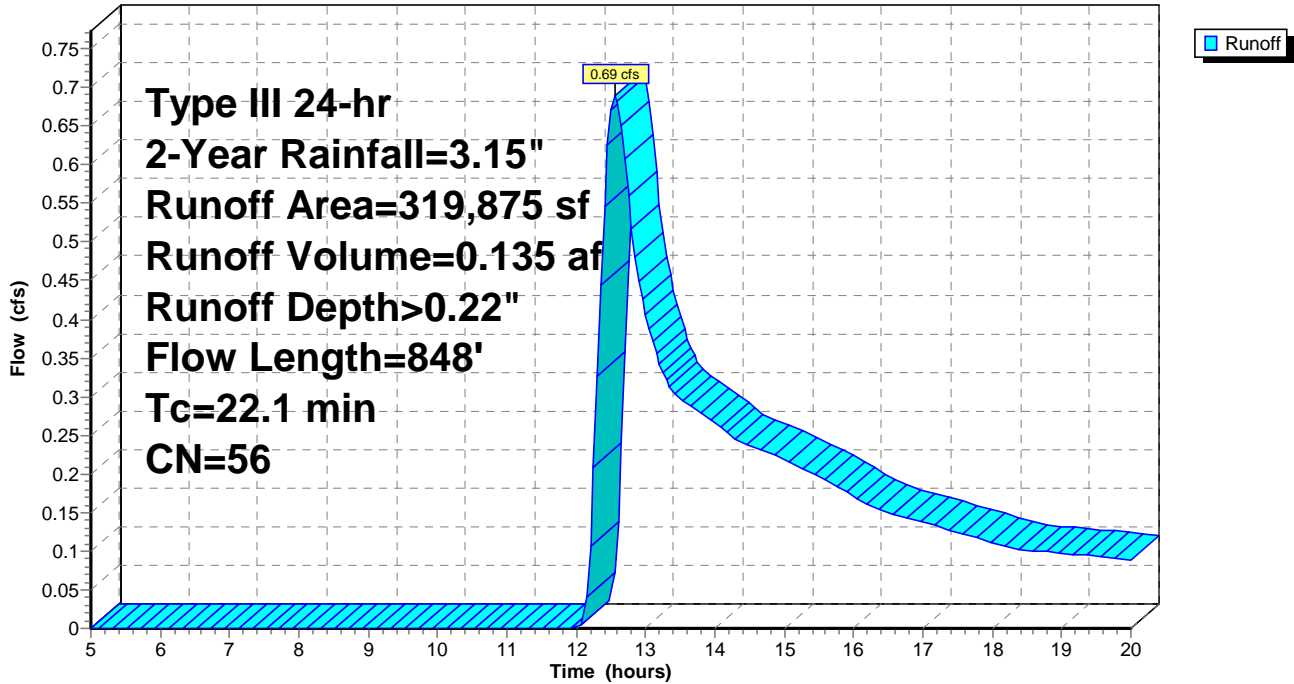
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
177,595	55	Woods, Good, HSG B
42,815	56	Brush, Fair, HSG B
8,290	77	Woods, Good, HSG D
* 57,765	50	Riprap, HSG B
* 5,915	62	Crushed Stone, HSG B
8,580	61	>75% Grass cover, Good, HSG B
* 14,510	55	Porous Pavement, HSG B
* 4,405	98	Paved parking, HSG B
319,875	56	Weighted Average
315,470		98.62% Pervious Area
4,405		1.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0100	0.09		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
0.9	300	0.1130	5.41		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
0.1	138	0.1880	21.27	150.38	Pipe Channel, Segment CD 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.025 Corrugated metal
2.1	310	0.0226	2.42		Shallow Concentrated Flow, Segment DE Unpaved Kv= 16.1 fps
22.1	848	Total			

Subcatchment 1S: SUBCATCHMENT P-1

Hydrograph



NGRID - Stafford St (Post-Development)

Type III 24-hr 2-Year Rainfall=3.15"

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Page 11

Summary for Subcatchment 2S: SUBCATCHMENT P-2

Runoff = 1.50 cfs @ 12.52 hrs, Volume= 0.240 af, Depth> 0.33"

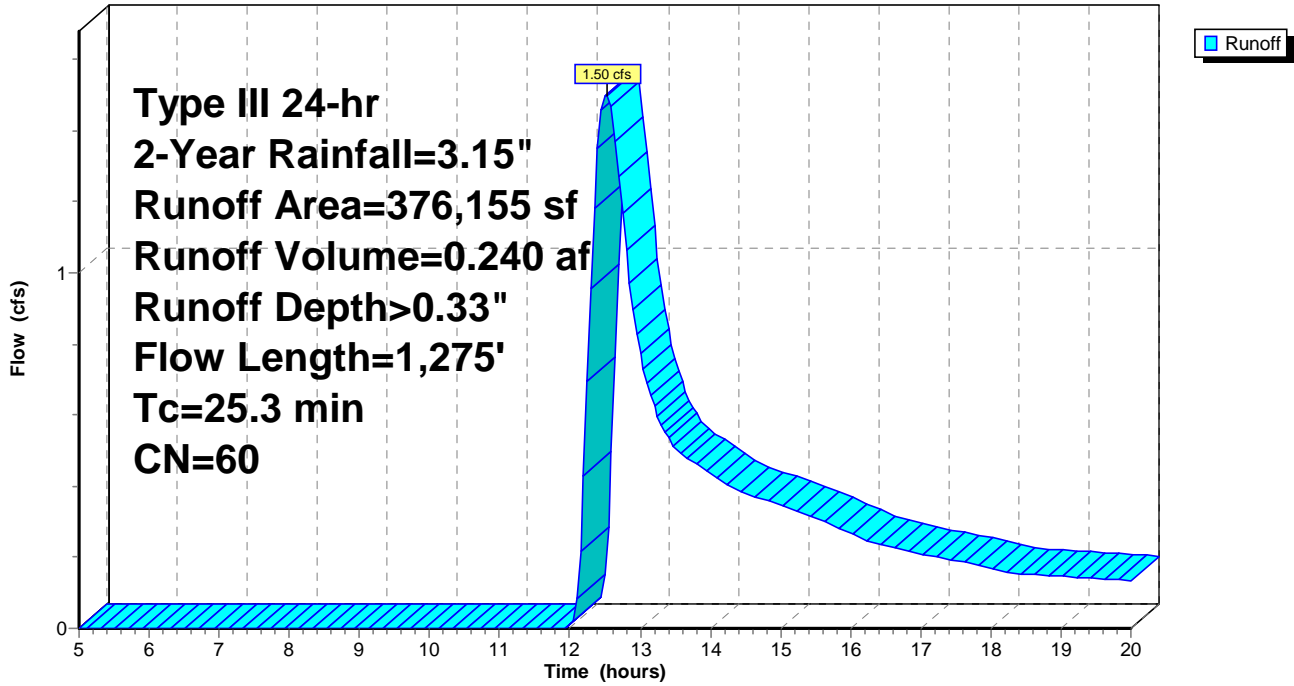
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
209,605	55	Woods, Good, HSG B
17,080	56	Brush, Fair, HSG B
45,030	77	Woods, Good, HSG D
27,210	58	Meadow, non-grazed, HSG B
415	96	Gravel surface, HSG B
* 16,795	50	Riprap, HSG B
* 34,170	62	Crushed Stone, HSG B
9,030	98	Paved parking, HSG B
9,100	98	Roofs, HSG B
* 7,720	55	Porous Pavement, HSG B
376,155	60	Weighted Average
358,025		95.18% Pervious Area
18,130		4.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.7	80	0.0088	0.08		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
2.8	20	0.0500	0.12		Sheet Flow, Segment BC Grass: Dense n= 0.240 P2= 3.15"
0.1	45	0.3488	9.51		Shallow Concentrated Flow, Segment CD Unpaved Kv= 16.1 fps
1.9	275	0.0145	2.44	29.27	Trap/Vee/Rect Channel Flow, Segment DE Bot.W=2.00' D=2.00' Z= 2.0 '/' Top.W=10.00' n= 0.078 Riprap, 12-inch
3.8	855	0.0550	3.78		Shallow Concentrated Flow, Segment EF Unpaved Kv= 16.1 fps
25.3	1,275	Total			

Subcatchment 2S: SUBCATCHMENT P-2

Hydrograph



Summary for Subcatchment 3S: SUBCATCHMENT P-3

Runoff = 1.36 cfs @ 12.49 hrs, Volume= 0.236 af, Depth> 0.25"

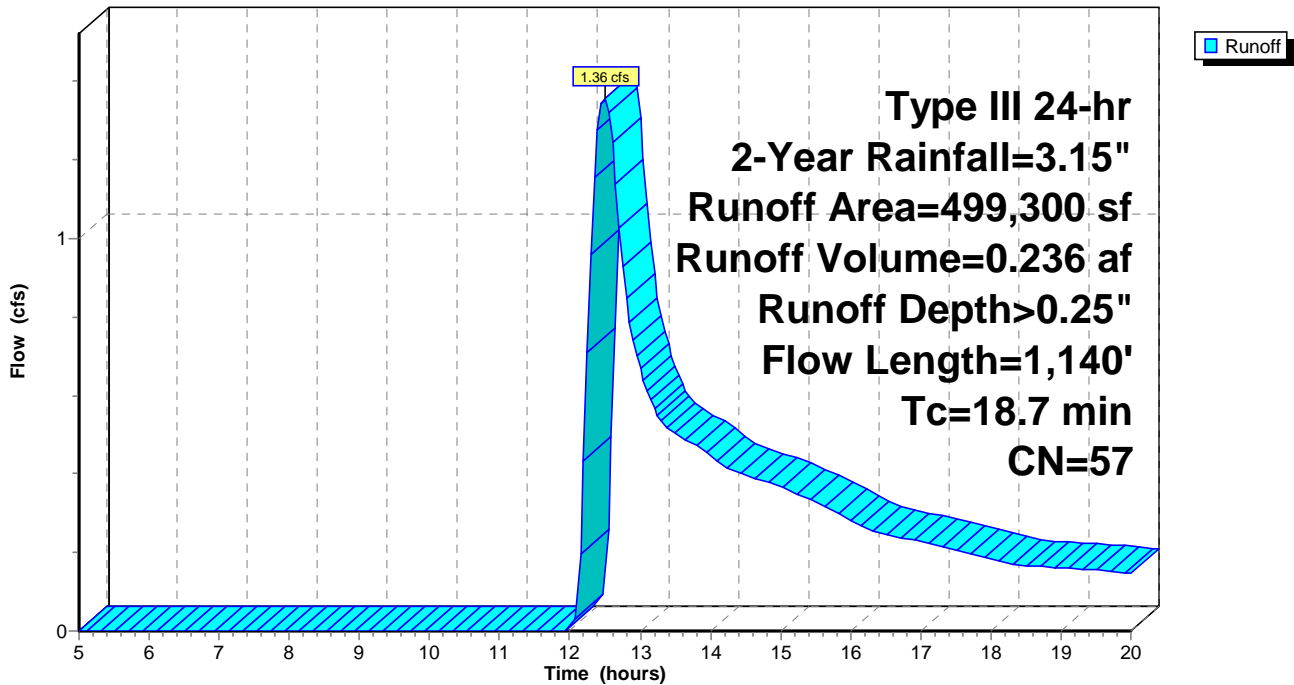
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
314,565	55	Woods, Good, HSG B
34,970	56	Brush, Fair, HSG B
11,990	77	Woods, Good, HSG D
124,235	58	Meadow, non-grazed, HSG B
13,540	96	Gravel surface, HSG B
499,300	57	Weighted Average
499,300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	100	0.0500	0.11		Sheet Flow, Segment AB
					Woods: Light underbrush n= 0.400 P2= 3.15"
3.7	1,040	0.0830	4.64		Shallow Concentrated Flow, Segment BC
					Unpaved Kv= 16.1 fps
18.7	1,140	Total			

Subcatchment 3S: SUBCATCHMENT P-3

Hydrograph



Summary for Reach 3R: HYDRAULIC CONNECTION

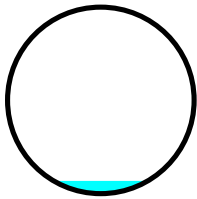
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 11.462 ac, 0.00% Impervious, Inflow Depth > 0.25" for 2-Year event
 Inflow = 1.36 cfs @ 12.49 hrs, Volume= 0.236 af
 Outflow = 1.36 cfs @ 12.50 hrs, Volume= 0.236 af, Atten= 0%, Lag= 0.6 min

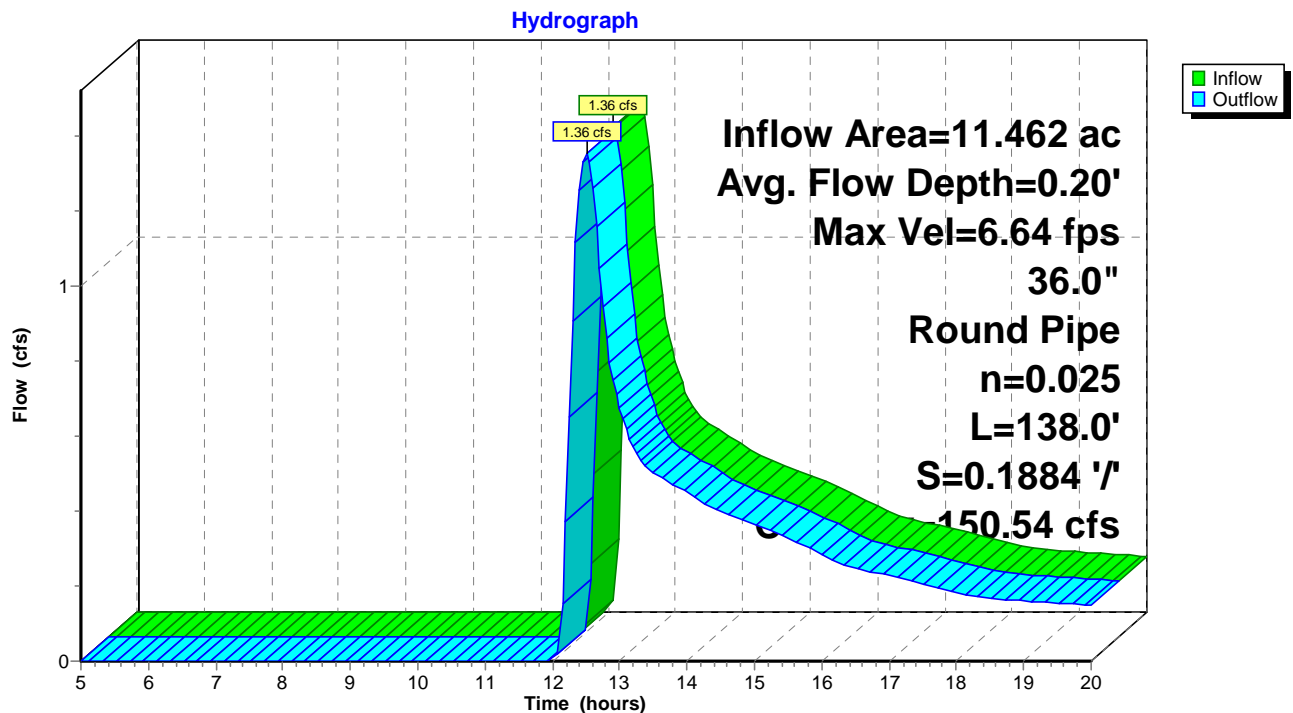
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 6.64 fps, Min. Travel Time= 0.3 min
 Avg. Velocity = 4.26 fps, Avg. Travel Time= 0.5 min

Peak Storage= 28 cf @ 12.49 hrs
 Average Depth at Peak Storage= 0.20' , Surface Width= 1.50'
 Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 150.54 cfs

36.0" Round Pipe
 n= 0.025 Corrugated metal
 Length= 138.0' Slope= 0.1884 1/1
 Inlet Invert= 776.00', Outlet Invert= 750.00'



Reach 3R: HYDRAULIC CONNECTION

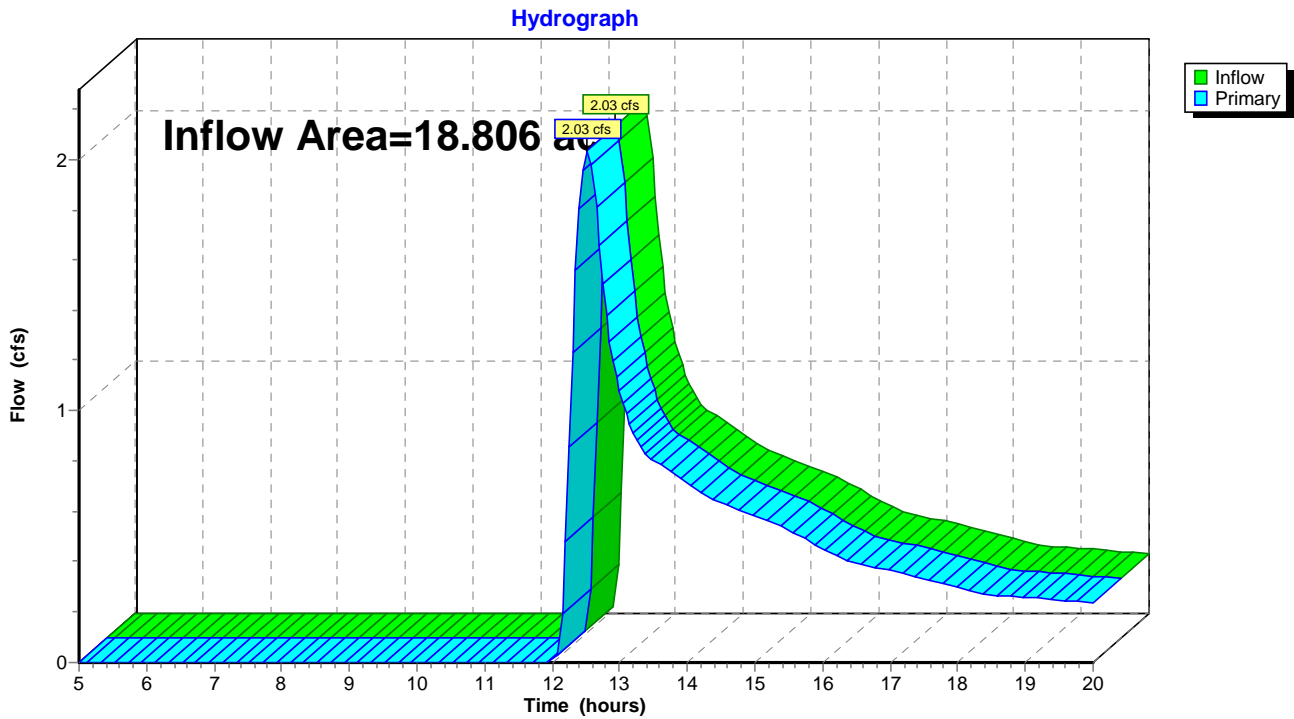


Summary for Link 1L: DESIGN POINT 1

Inflow Area = 18.806 ac, 0.54% Impervious, Inflow Depth > 0.24" for 2-Year event
Inflow = 2.03 cfs @ 12.52 hrs, Volume= 0.371 af
Primary = 2.03 cfs @ 12.52 hrs, Volume= 0.371 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 1L: DESIGN POINT 1



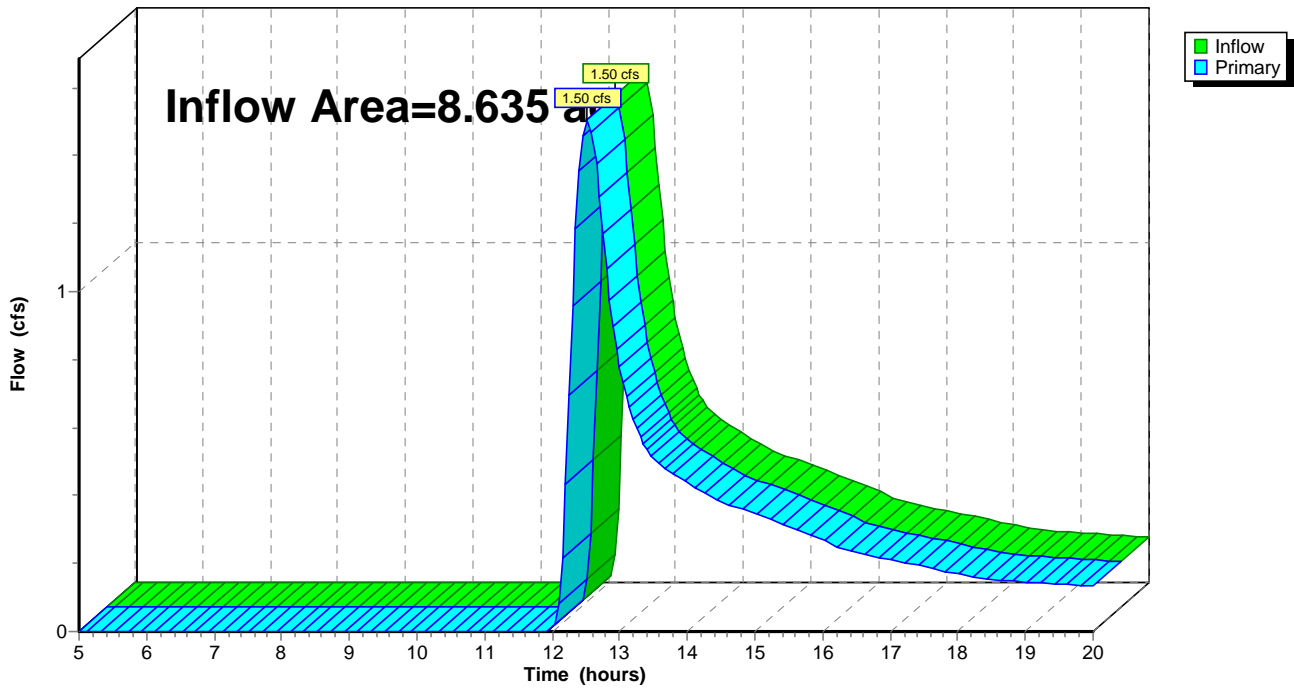
Summary for Link 2L: DESIGN POINT 2

Inflow Area = 8.635 ac, 4.82% Impervious, Inflow Depth > 0.33" for 2-Year event
Inflow = 1.50 cfs @ 12.52 hrs, Volume= 0.240 af
Primary = 1.50 cfs @ 12.52 hrs, Volume= 0.240 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 2L: DESIGN POINT 2

Hydrograph



NGRID - Stafford St (Post-Development)

Type III 24-hr 10-Year Rainfall=4.90"

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Page 17

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SUBCATCHMENT P-1 Runoff Area=319,875 sf 1.38% Impervious Runoff Depth>0.88"
Flow Length=848' Tc=22.1 min CN=56 Runoff=4.47 cfs 0.536 af

Subcatchment 2S: SUBCATCHMENT P-2 Runoff Area=376,155 sf 4.82% Impervious Runoff Depth>1.11"
Flow Length=1,275' Tc=25.3 min CN=60 Runoff=6.80 cfs 0.799 af

Subcatchment 3S: SUBCATCHMENT P-3 Runoff Area=499,300 sf 0.00% Impervious Runoff Depth>0.93"
Flow Length=1,140' Tc=18.7 min CN=57 Runoff=8.09 cfs 0.893 af

Reach 3R: HYDRAULIC CONNECTION Avg. Flow Depth=0.47' Max Vel=11.34 fps Inflow=8.09 cfs 0.893 af
36.0" Round Pipe n=0.025 L=138.0' S=0.1884 1/1' Capacity=150.54 cfs Outflow=8.08 cfs 0.892 af

Link 1L: DESIGN POINT 1 Inflow=12.41 cfs 1.428 af
Primary=12.41 cfs 1.428 af

Link 2L: DESIGN POINT 2 Inflow=6.80 cfs 0.799 af
Primary=6.80 cfs 0.799 af

Total Runoff Area = 27.441 ac Runoff Volume = 2.228 af Average Runoff Depth = 0.97"
98.11% Pervious = 26.924 ac 1.89% Impervious = 0.517 ac

NGRID - Stafford St (Post-Development)

Type III 24-hr 10-Year Rainfall=4.90"

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Page 18

Summary for Subcatchment 1S: SUBCATCHMENT P-1

Runoff = 4.47 cfs @ 12.37 hrs, Volume= 0.536 af, Depth> 0.88"

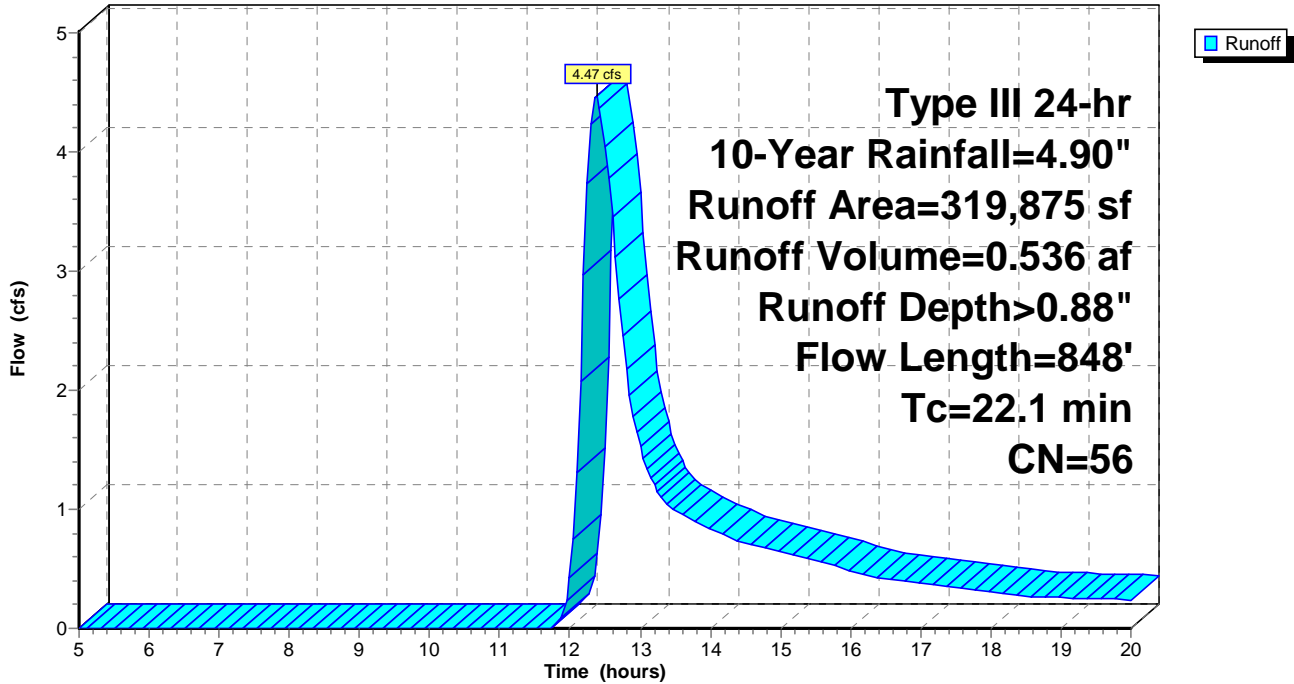
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.90"

Area (sf)	CN	Description
177,595	55	Woods, Good, HSG B
42,815	56	Brush, Fair, HSG B
8,290	77	Woods, Good, HSG D
* 57,765	50	Riprap, HSG B
* 5,915	62	Crushed Stone, HSG B
8,580	61	>75% Grass cover, Good, HSG B
* 14,510	55	Porous Pavement, HSG B
* 4,405	98	Paved parking, HSG B
319,875	56	Weighted Average
315,470		98.62% Pervious Area
4,405		1.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0100	0.09		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
0.9	300	0.1130	5.41		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
0.1	138	0.1880	21.27	150.38	Pipe Channel, Segment CD 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.025 Corrugated metal
2.1	310	0.0226	2.42		Shallow Concentrated Flow, Segment DE Unpaved Kv= 16.1 fps
22.1	848	Total			

Subcatchment 1S: SUBCATCHMENT P-1

Hydrograph



NGRID - Stafford St (Post-Development)

Type III 24-hr 10-Year Rainfall=4.90"

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Page 20

Summary for Subcatchment 2S: SUBCATCHMENT P-2

Runoff = 6.80 cfs @ 12.40 hrs, Volume= 0.799 af, Depth> 1.11"

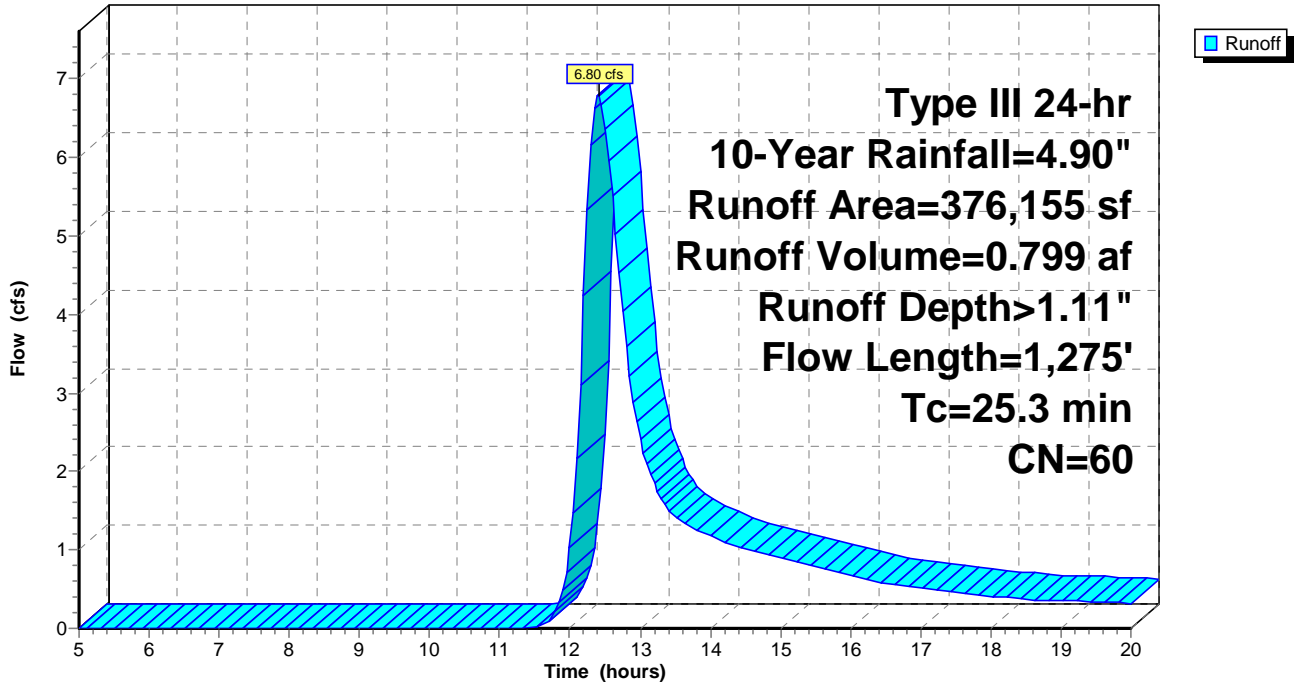
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.90"

Area (sf)	CN	Description
209,605	55	Woods, Good, HSG B
17,080	56	Brush, Fair, HSG B
45,030	77	Woods, Good, HSG D
27,210	58	Meadow, non-grazed, HSG B
415	96	Gravel surface, HSG B
* 16,795	50	Riprap, HSG B
* 34,170	62	Crushed Stone, HSG B
9,030	98	Paved parking, HSG B
9,100	98	Roofs, HSG B
* 7,720	55	Porous Pavement, HSG B
376,155	60	Weighted Average
358,025		95.18% Pervious Area
18,130		4.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.7	80	0.0088	0.08		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
2.8	20	0.0500	0.12		Sheet Flow, Segment BC Grass: Dense n= 0.240 P2= 3.15"
0.1	45	0.3488	9.51		Shallow Concentrated Flow, Segment CD Unpaved Kv= 16.1 fps
1.9	275	0.0145	2.44	29.27	Trap/Vee/Rect Channel Flow, Segment DE Bot.W=2.00' D=2.00' Z= 2.0 '/' Top.W=10.00' n= 0.078 Riprap, 12-inch
3.8	855	0.0550	3.78		Shallow Concentrated Flow, Segment EF Unpaved Kv= 16.1 fps
25.3	1,275	Total			

Subcatchment 2S: SUBCATCHMENT P-2

Hydrograph



Summary for Subcatchment 3S: SUBCATCHMENT P-3

Runoff = 8.09 cfs @ 12.31 hrs, Volume= 0.893 af, Depth> 0.93"

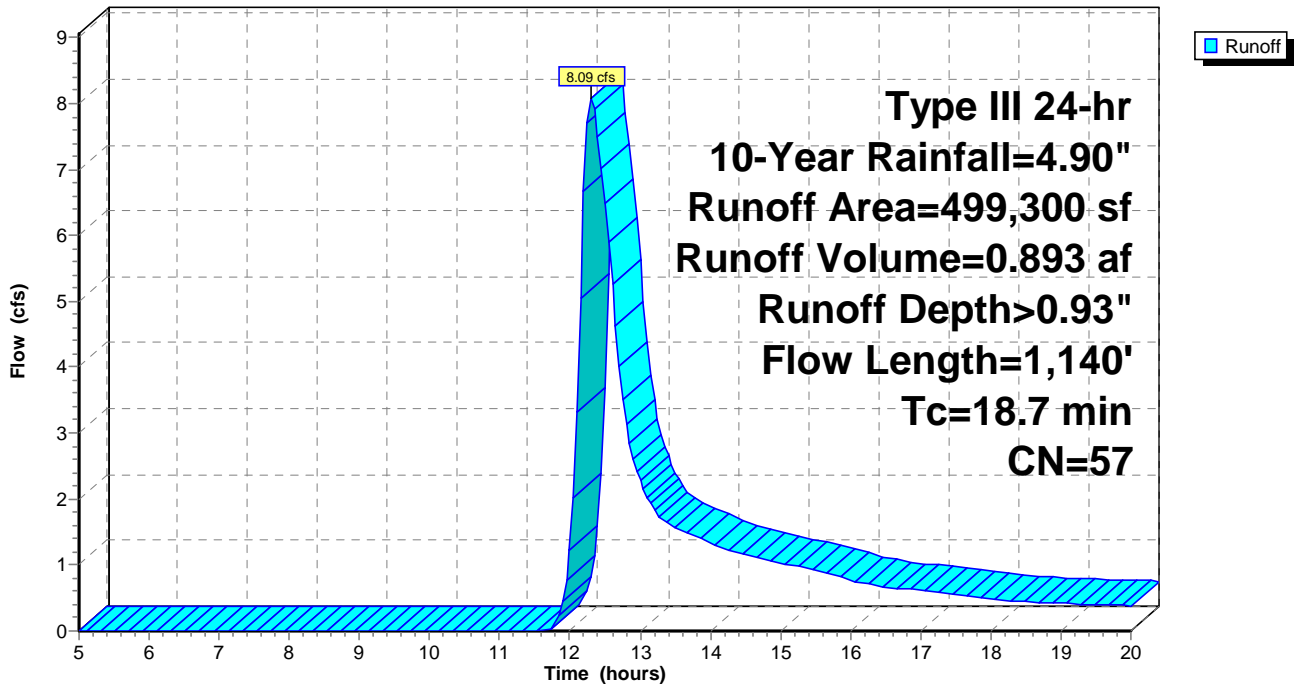
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.90"

Area (sf)	CN	Description
314,565	55	Woods, Good, HSG B
34,970	56	Brush, Fair, HSG B
11,990	77	Woods, Good, HSG D
124,235	58	Meadow, non-grazed, HSG B
13,540	96	Gravel surface, HSG B
499,300	57	Weighted Average
499,300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	100	0.0500	0.11		Sheet Flow, Segment AB
					Woods: Light underbrush n= 0.400 P2= 3.15"
3.7	1,040	0.0830	4.64		Shallow Concentrated Flow, Segment BC
					Unpaved Kv= 16.1 fps
18.7	1,140	Total			

Subcatchment 3S: SUBCATCHMENT P-3

Hydrograph



Summary for Reach 3R: HYDRAULIC CONNECTION

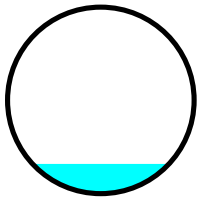
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area =	11.462 ac,	0.00% Impervious,	Inflow Depth > 0.93"	for 10-Year event
Inflow =	8.09 cfs @	12.31 hrs,	Volume=	0.893 af
Outflow =	8.08 cfs @	12.32 hrs,	Volume=	0.892 af, Atten= 0%, Lag= 0.3 min

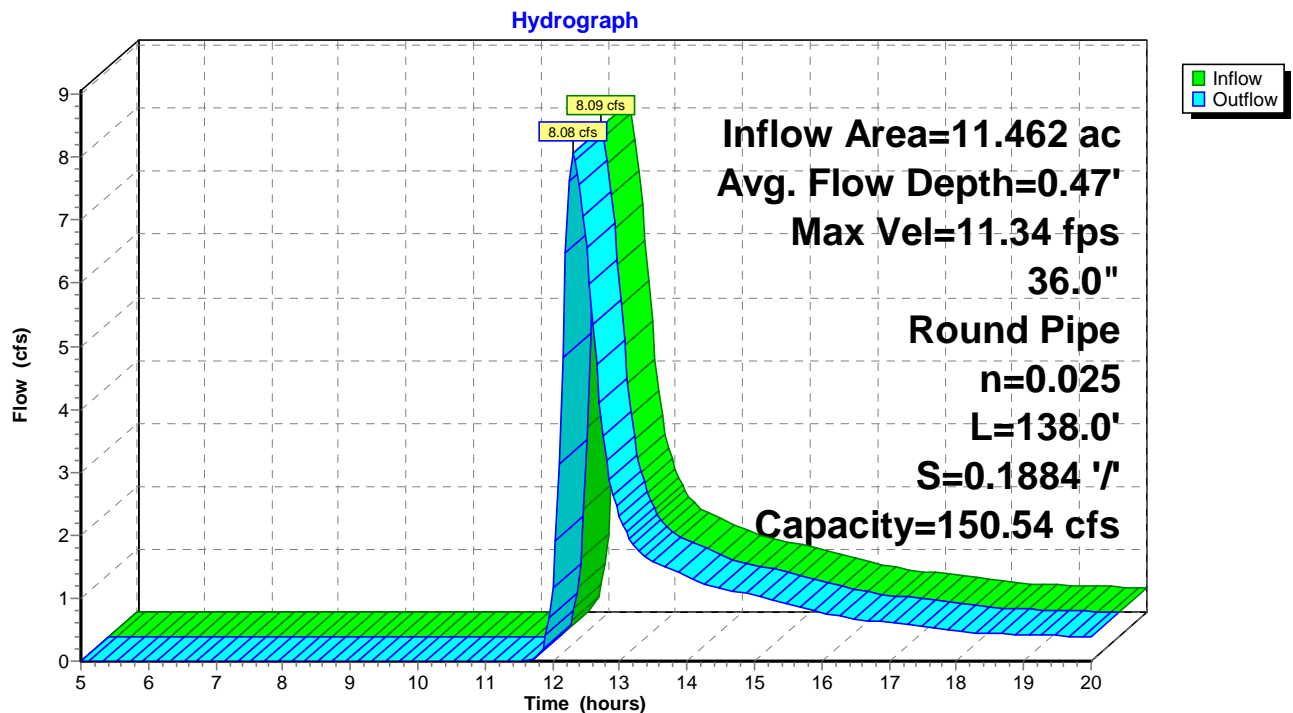
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 11.34 fps, Min. Travel Time= 0.2 min
 Avg. Velocity = 5.95 fps, Avg. Travel Time= 0.4 min

Peak Storage= 98 cf @ 12.31 hrs
 Average Depth at Peak Storage= 0.47' , Surface Width= 2.19'
 Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 150.54 cfs

36.0" Round Pipe
 n= 0.025 Corrugated metal
 Length= 138.0' Slope= 0.1884 '/'
 Inlet Invert= 776.00', Outlet Invert= 750.00'



Reach 3R: HYDRAULIC CONNECTION



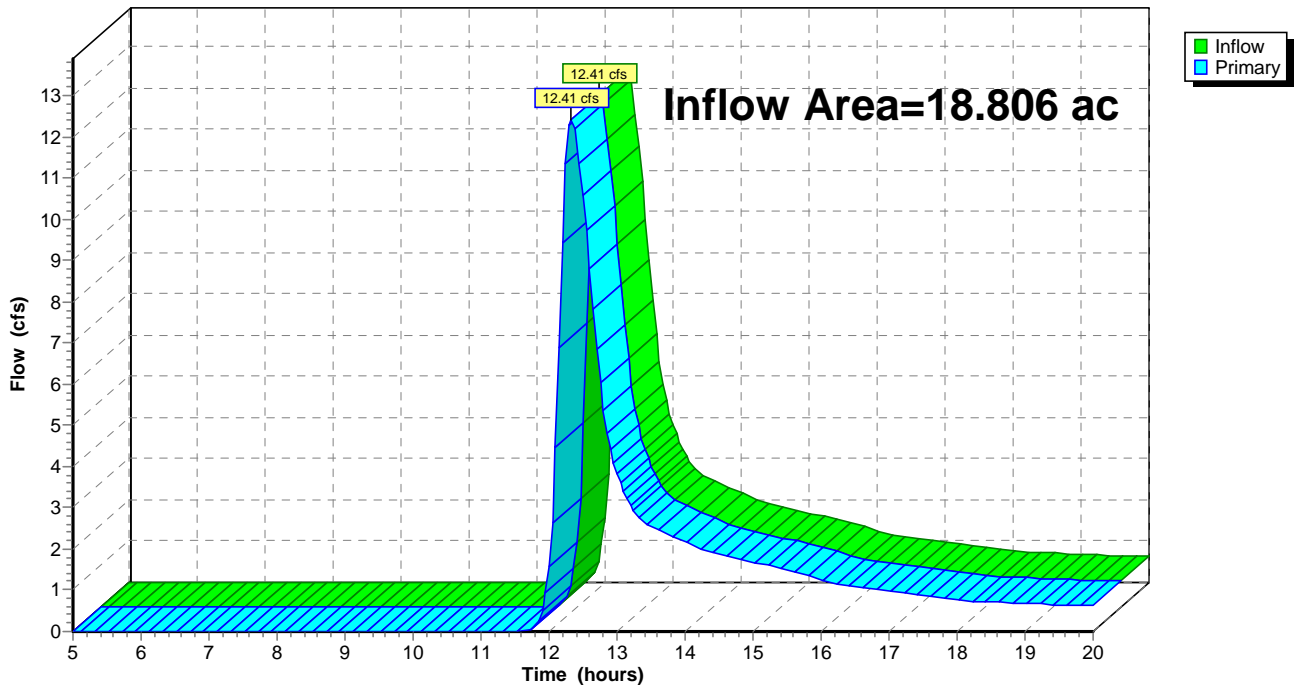
Summary for Link 1L: DESIGN POINT 1

Inflow Area = 18.806 ac, 0.54% Impervious, Inflow Depth > 0.91" for 10-Year event
Inflow = 12.41 cfs @ 12.34 hrs, Volume= 1.428 af
Primary = 12.41 cfs @ 12.34 hrs, Volume= 1.428 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 1L: DESIGN POINT 1

Hydrograph



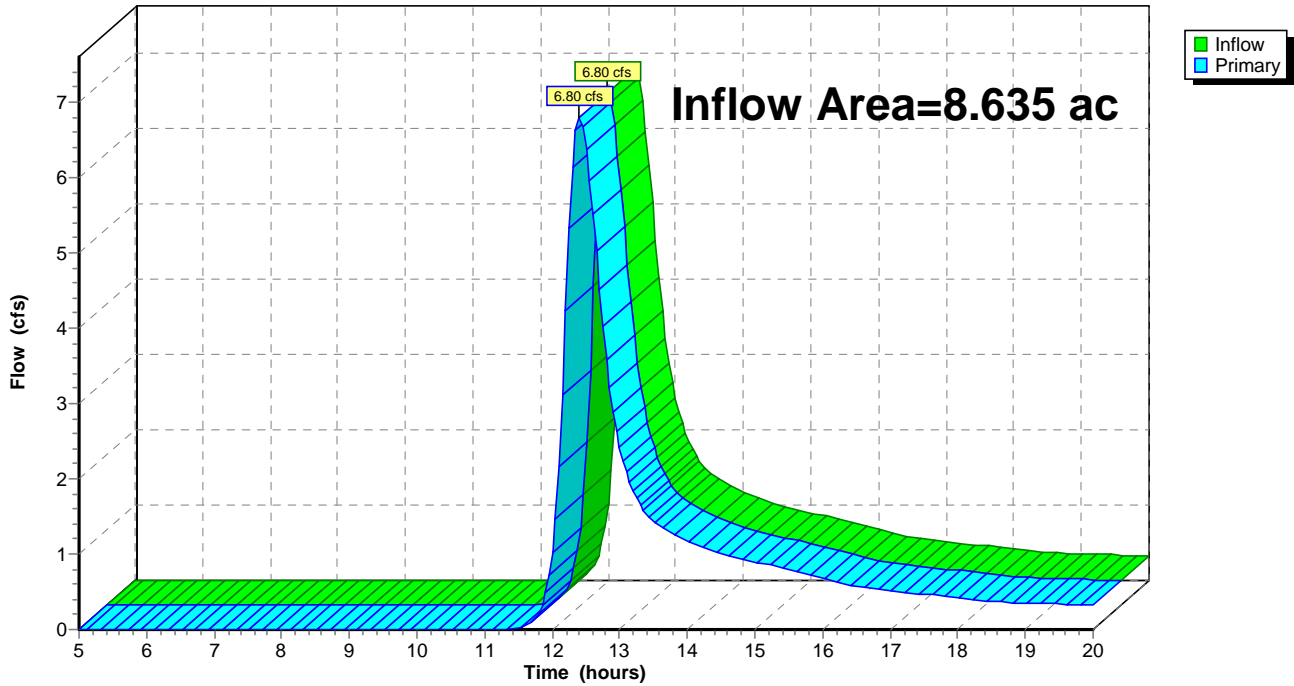
Summary for Link 2L: DESIGN POINT 2

Inflow Area = 8.635 ac, 4.82% Impervious, Inflow Depth > 1.11" for 10-Year event
Inflow = 6.80 cfs @ 12.40 hrs, Volume= 0.799 af
Primary = 6.80 cfs @ 12.40 hrs, Volume= 0.799 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 2L: DESIGN POINT 2

Hydrograph



NGRID - Stafford St (Post-Development)

Type III 24-hr 100-Year Rainfall=7.67"

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Page 26

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SUBCATCHMENT P-1 Runoff Area=319,875 sf 1.38% Impervious Runoff Depth>2.42"
Flow Length=848' Tc=22.1 min CN=56 Runoff=14.11 cfs 1.481 af

Subcatchment 2S: SUBCATCHMENT P-2 Runoff Area=376,155 sf 4.82% Impervious Runoff Depth>2.82"
Flow Length=1,275' Tc=25.3 min CN=60 Runoff=18.62 cfs 2.029 af

Subcatchment 3S: SUBCATCHMENT P-3 Runoff Area=499,300 sf 0.00% Impervious Runoff Depth>2.52"
Flow Length=1,140' Tc=18.7 min CN=57 Runoff=24.72 cfs 2.411 af

Reach 3R: HYDRAULIC CONNECTION Avg. Flow Depth=0.82' Max Vel=15.68 fps Inflow=24.72 cfs 2.411 af
36.0" Round Pipe n=0.025 L=138.0' S=0.1884 1/1' Capacity=150.54 cfs Outflow=24.60 cfs 2.410 af

Link 1L: DESIGN POINT 1 Inflow=38.49 cfs 3.892 af
Primary=38.49 cfs 3.892 af

Link 2L: DESIGN POINT 2 Inflow=18.62 cfs 2.029 af
Primary=18.62 cfs 2.029 af

Total Runoff Area = 27.441 ac Runoff Volume = 5.922 af Average Runoff Depth = 2.59"
98.11% Pervious = 26.924 ac 1.89% Impervious = 0.517 ac

Summary for Subcatchment 1S: SUBCATCHMENT P-1

Runoff = 14.11 cfs @ 12.33 hrs, Volume= 1.481 af, Depth> 2.42"

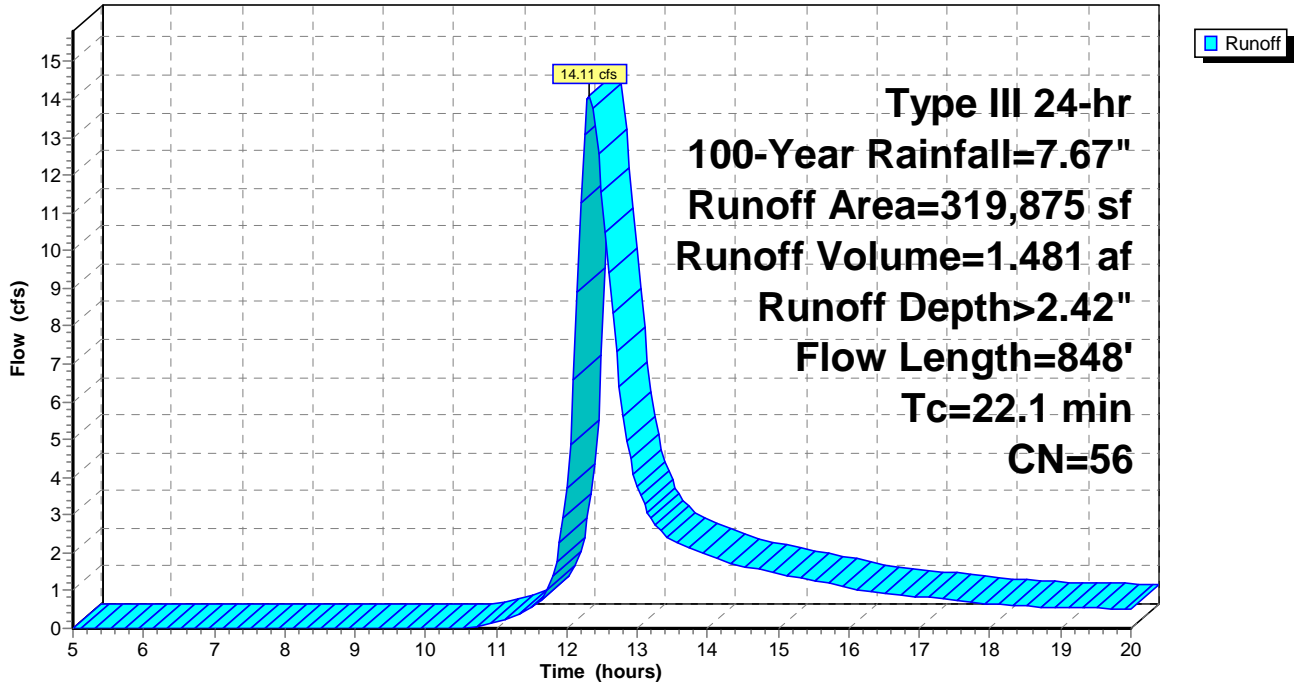
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.67"

Area (sf)	CN	Description
177,595	55	Woods, Good, HSG B
42,815	56	Brush, Fair, HSG B
8,290	77	Woods, Good, HSG D
* 57,765	50	Riprap, HSG B
* 5,915	62	Crushed Stone, HSG B
8,580	61	>75% Grass cover, Good, HSG B
* 14,510	55	Porous Pavement, HSG B
* 4,405	98	Paved parking, HSG B
319,875	56	Weighted Average
315,470		98.62% Pervious Area
4,405		1.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0100	0.09		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
0.9	300	0.1130	5.41		Shallow Concentrated Flow, Segment BC Unpaved Kv= 16.1 fps
0.1	138	0.1880	21.27	150.38	Pipe Channel, Segment CD 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.025 Corrugated metal
2.1	310	0.0226	2.42		Shallow Concentrated Flow, Segment DE Unpaved Kv= 16.1 fps
22.1	848	Total			

Subcatchment 1S: SUBCATCHMENT P-1

Hydrograph



NGRID - Stafford St (Post-Development)

Type III 24-hr 100-Year Rainfall=7.67"

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Page 29

Summary for Subcatchment 2S: SUBCATCHMENT P-2

Runoff = 18.62 cfs @ 12.37 hrs, Volume= 2.029 af, Depth> 2.82"

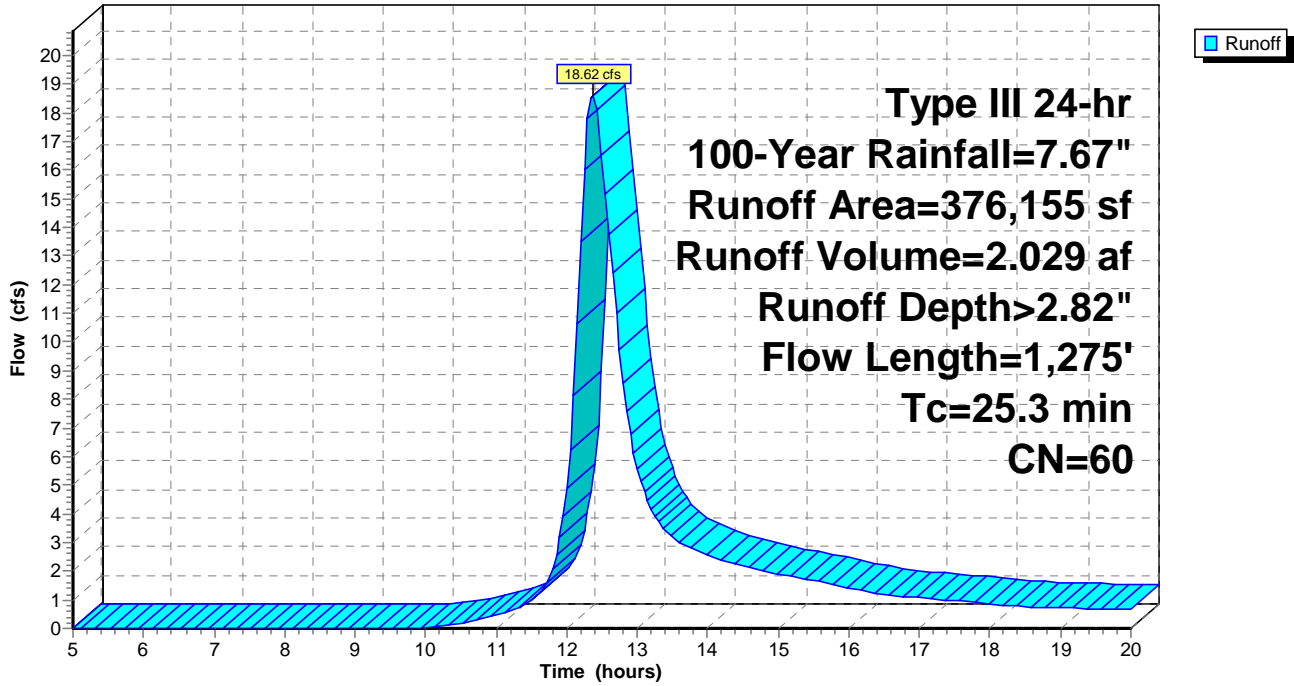
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.67"

Area (sf)	CN	Description
209,605	55	Woods, Good, HSG B
17,080	56	Brush, Fair, HSG B
45,030	77	Woods, Good, HSG D
27,210	58	Meadow, non-grazed, HSG B
415	96	Gravel surface, HSG B
* 16,795	50	Riprap, HSG B
* 34,170	62	Crushed Stone, HSG B
9,030	98	Paved parking, HSG B
9,100	98	Roofs, HSG B
* 7,720	55	Porous Pavement, HSG B
376,155	60	Weighted Average
358,025		95.18% Pervious Area
18,130		4.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.7	80	0.0088	0.08		Sheet Flow, Segment AB Grass: Dense n= 0.240 P2= 3.15"
2.8	20	0.0500	0.12		Sheet Flow, Segment BC Grass: Dense n= 0.240 P2= 3.15"
0.1	45	0.3488	9.51		Shallow Concentrated Flow, Segment CD Unpaved Kv= 16.1 fps
1.9	275	0.0145	2.44	29.27	Trap/Vee/Rect Channel Flow, Segment DE Bot.W=2.00' D=2.00' Z= 2.0 '/' Top.W=10.00' n= 0.078 Riprap, 12-inch
3.8	855	0.0550	3.78		Shallow Concentrated Flow, Segment EF Unpaved Kv= 16.1 fps
25.3	1,275	Total			

Subcatchment 2S: SUBCATCHMENT P-2

Hydrograph



Summary for Subcatchment 3S: SUBCATCHMENT P-3

Runoff = 24.72 cfs @ 12.27 hrs, Volume= 2.411 af, Depth> 2.52"

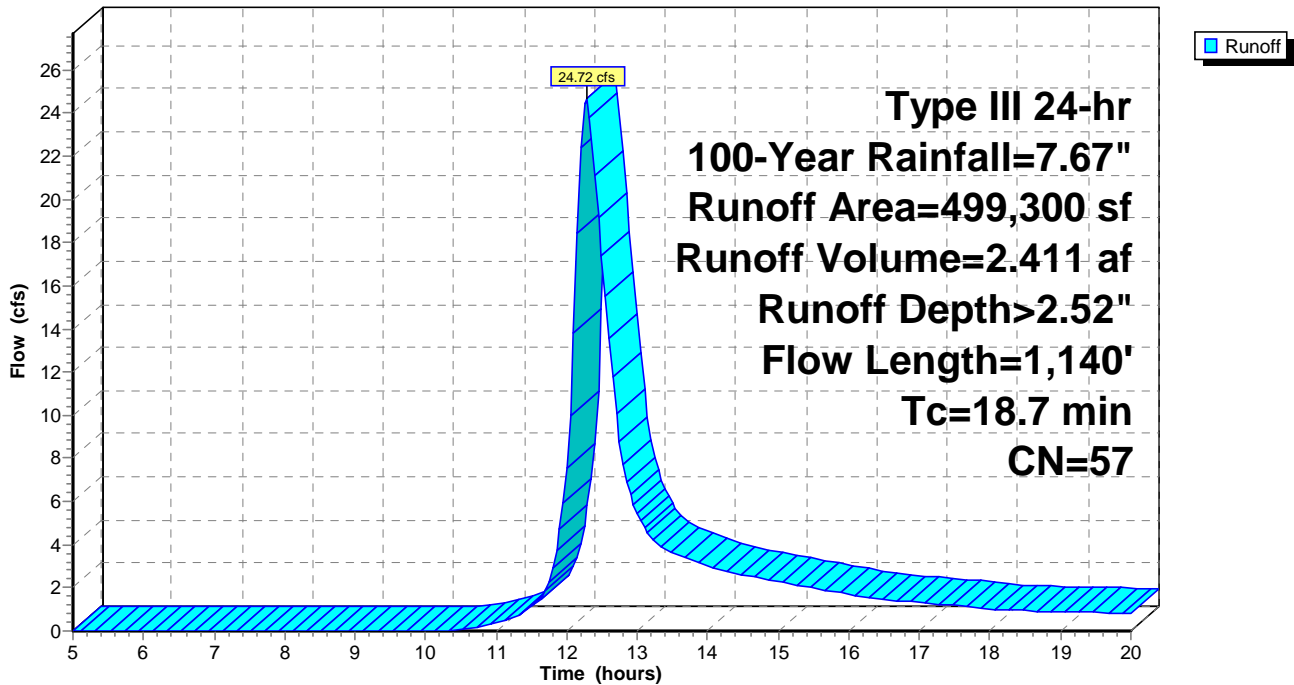
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.67"

Area (sf)	CN	Description
314,565	55	Woods, Good, HSG B
34,970	56	Brush, Fair, HSG B
11,990	77	Woods, Good, HSG D
124,235	58	Meadow, non-grazed, HSG B
13,540	96	Gravel surface, HSG B
499,300	57	Weighted Average
499,300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	100	0.0500	0.11		Sheet Flow, Segment AB
3.7	1,040	0.0830	4.64		Woods: Light underbrush n= 0.400 P2= 3.15" Shallow Concentrated Flow, Segment BC
					Unpaved Kv= 16.1 fps
18.7	1,140	Total			

Subcatchment 3S: SUBCATCHMENT P-3

Hydrograph



Summary for Reach 3R: HYDRAULIC CONNECTION

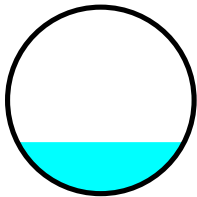
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area =	11.462 ac,	0.00% Impervious,	Inflow Depth > 2.52"	for 100-Year event
Inflow =	24.72 cfs @	12.27 hrs,	Volume=	2.411 af
Outflow =	24.60 cfs @	12.28 hrs,	Volume=	2.410 af, Atten= 0%, Lag= 0.3 min

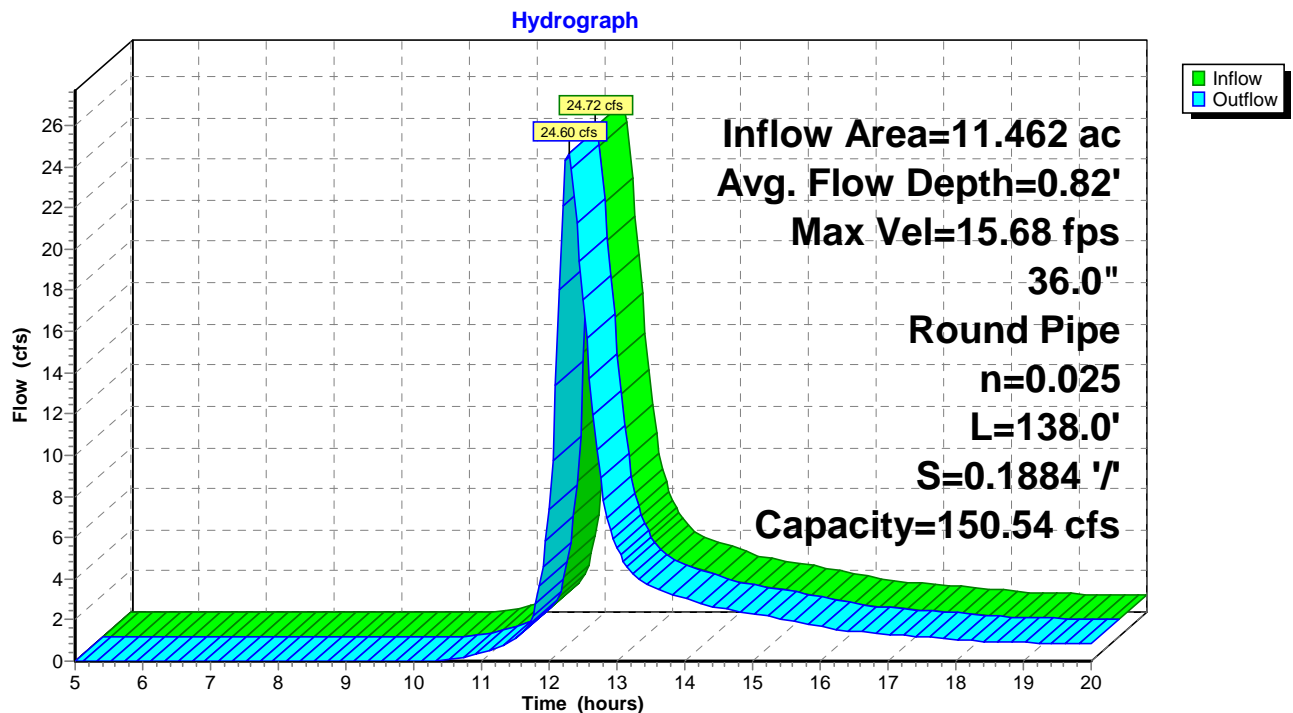
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 15.68 fps, Min. Travel Time= 0.1 min
 Avg. Velocity = 7.32 fps, Avg. Travel Time= 0.3 min

Peak Storage= 216 cf @ 12.28 hrs
 Average Depth at Peak Storage= 0.82' , Surface Width= 2.67'
 Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 150.54 cfs

36.0" Round Pipe
 n= 0.025 Corrugated metal
 Length= 138.0' Slope= 0.1884 '/'
 Inlet Invert= 776.00', Outlet Invert= 750.00'



Reach 3R: HYDRAULIC CONNECTION



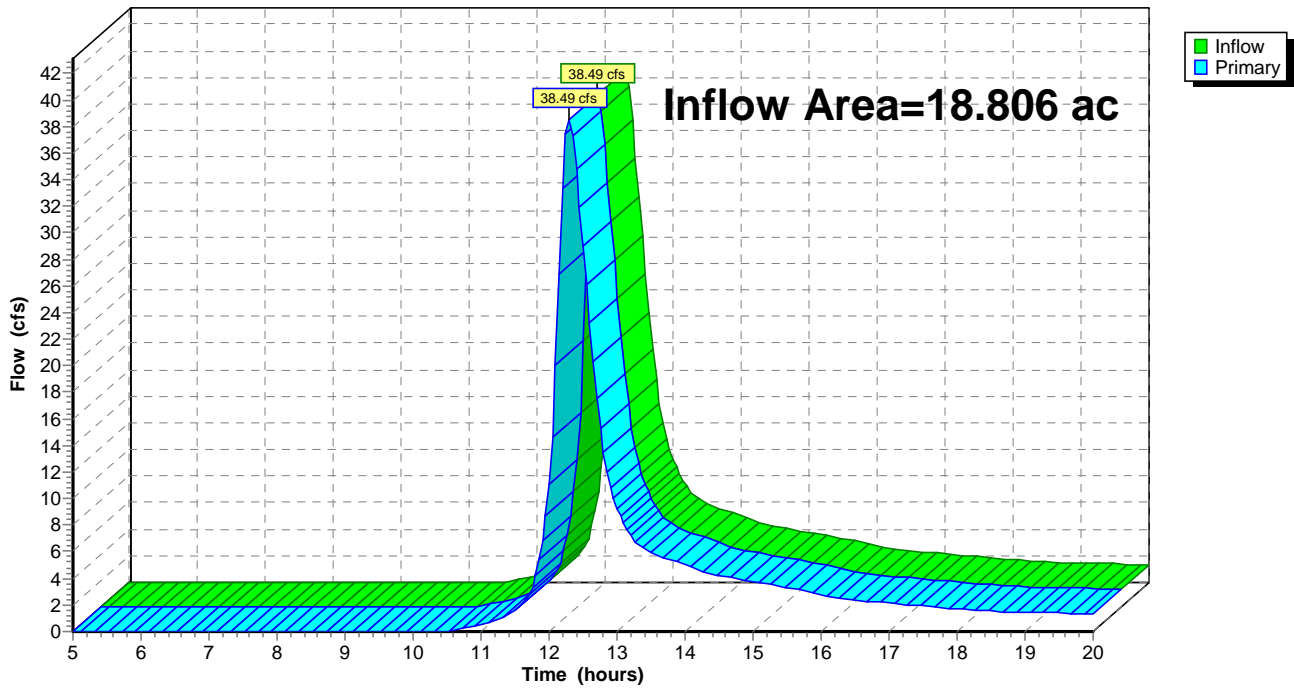
Summary for Link 1L: DESIGN POINT 1

Inflow Area = 18.806 ac, 0.54% Impervious, Inflow Depth > 2.48" for 100-Year event
Inflow = 38.49 cfs @ 12.30 hrs, Volume= 3.892 af
Primary = 38.49 cfs @ 12.30 hrs, Volume= 3.892 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 1L: DESIGN POINT 1

Hydrograph



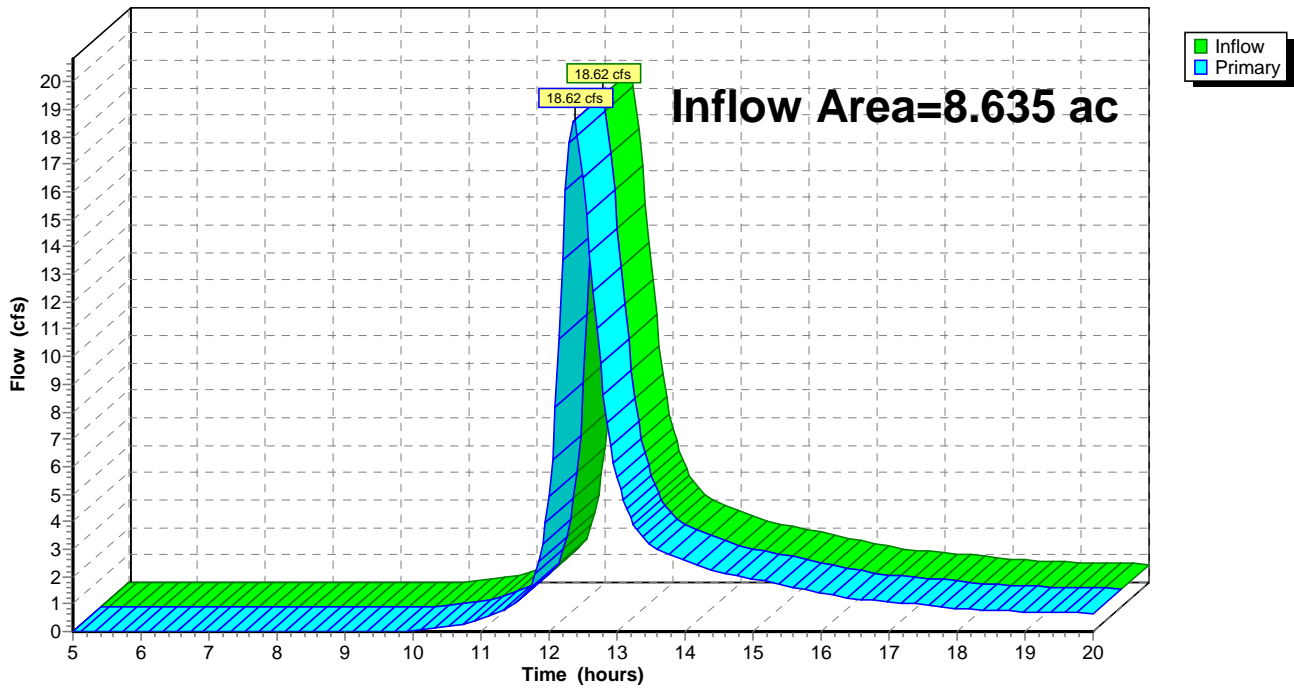
Summary for Link 2L: DESIGN POINT 2

Inflow Area = 8.635 ac, 4.82% Impervious, Inflow Depth > 2.82" for 100-Year event
Inflow = 18.62 cfs @ 12.37 hrs, Volume= 2.029 af
Primary = 18.62 cfs @ 12.37 hrs, Volume= 2.029 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 2L: DESIGN POINT 2

Hydrograph





Appendix C

Recharge to Groundwater Calculations & Test Boring Logs



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CHECKED BY DATE
SCALE

REQUIRED RECHARGE VOLUME CALCULATIONS

$$\text{PROPOSED IMPERVIOUS COVER} = 44,765 \text{ ft}^2$$

$$\text{PROPOSED IMPERVIOUS COVER DIRECTED TO RECHARGE BMPs} = 44,765 \text{ ft}^2$$

$$\text{HYDROLOGIC SOIL GROUP} = B \Rightarrow \text{TARGET DEPTH FACTOR} = 0.35 \text{ IN}$$

$$\begin{aligned} \text{REQUIRED RECHARGE VOLUME \#1 (RV}_1) &= (0.35 \text{ IN})(22,230 \text{ ft}^2 + 12,445 \text{ ft}^2) \left(\frac{1 \text{ FT}}{12 \text{ IN}}\right) \\ &= 1015 \text{ ft}^3 \end{aligned}$$

$$\text{VOLUME PROVIDED IN RESERVOIR COURSE OF POROUS PAVEMENT} = 3,665 \text{ ft}^3$$

$$\boxed{3,665 \text{ ft}^3 > 1,015 \text{ ft}^3} \checkmark$$

$$\text{RV}_2 = (0.35 \text{ IN})(990 \text{ ft}^2) \left(\frac{1 \text{ FT}}{12 \text{ IN}}\right) = 30 \text{ ft}^3$$

$$\text{VOLUME PROVIDED IN PROPOSED INFILTRATION BASINS} = 133.5 \text{ ft}^3$$

$$\boxed{133.5 \text{ ft}^3 > 30 \text{ ft}^3} \checkmark$$

$$\text{RV}_3 = (0.35 \text{ IN})(9,100 \text{ ft}^2) \left(\frac{1 \text{ FT}}{12 \text{ IN}}\right) = 265 \text{ ft}^3$$

$$\text{VOLUME PROVIDED IN CRUSHED STONE YARD} = 5,135 \text{ ft}^3$$

$$\boxed{5,135 \text{ ft}^3 > 265 \text{ ft}^3}$$

SUMMARY: TOTAL REQUIRED RECHARGE VOLUME = 1,310 ft³
TOTAL VOLUME PROVIDED FOR RECHARGE = 8,930 ft³

$$\boxed{8,930 \text{ ft}^3 > 1,310 \text{ ft}^3} \checkmark$$



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INFILTRATION BMP DRAWDOWN TIME

$$\text{TIME DRAWDOWN} = \frac{RV}{(K)(\text{BOTTOM AREA})}$$

WHERE: RV = STORAGE VOLUME

K = SATURATED HYDRAULIC CONDUCTIVITY (RAWLS RATES)

BOTTOM AREA = BOTTOM AREA OF RECHARGE PRACTICE

POROUS PAVEMENT:

$$RV = 3,665 \text{ ft}^3$$

$$K = 0.52 \text{ IN/HR (RAWLS RATE FOR HSG B "LOAM")}$$

$$\text{BOTTOM AREA} = 22,230 \text{ ft}^2$$

$$\text{TIME DRAWDOWN} = \frac{3,665 \text{ ft}^3}{(0.52 \text{ IN/HR})(22,230 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}})} = 3.8 \text{ HRS}$$

$$3.8 \text{ HRS} < 72 \text{ HRS} \quad \checkmark$$

INFILTRATION BASIN:

$$RV = 66.75 \text{ ft}^3$$

$$K = 0.52 \text{ IN/HR}$$

$$\text{BOTTOM AREA} = 25 \text{ ft}^2$$

$$\text{TIME DRAWDOWN} = \frac{66.75 \text{ ft}^3}{(0.52 \text{ IN/HR})(25 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}})} = 61.6 \text{ HRS}$$

$$61.6 \text{ HRS} < 72 \text{ HRS} \quad \checkmark$$

CRUSHED STONE:

$$RV = 5,135 \text{ ft}^3$$

$$K = 0.52 \text{ IN/HR}$$

$$\text{BOTTOM AREA} = 31,130 \text{ ft}^2$$

$$\text{TIME DRAWDOWN} = \frac{5,135 \text{ ft}^3}{(0.52 \text{ IN/HR})(31,130 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}})} = 3.8 \text{ HRS}$$

$$3.8 \text{ HRS} < 72 \text{ HRS} \quad \checkmark$$

TABLE 1 - SUMMARY OF SUBSURFACE CONDITIONS

**Stafford Street Access Road
Leicester, Massachusetts
GZA Project No. 04.0191281.00**

Test Boring	Station (Approx.)	Northing (ft)	Easting (ft)	Approximate Existing Ground Surface Elevation (2)	Soil and Groundwater Conditions (1, 3, 4)						Bottom of Exploration (ft)	
					Bottom of Topsoil / Subsoil (ft)		Top of Bedrock (ft)		Groundwater (ft)			
					Depth BGS	ELEV	Depth BGS	ELEV	Depth BGS	ELEV	BGS	ELEV
BVB-101	150	2907829	556868	801	NE	NE	20.1	781	18.2	783	20.1	781
BVB-102	240	2907917	556829	798	2.0	796	17.6	780	NE	NE	17.6	780
BVB-103	510	2908085	556648	774	1.5	773	10.0	764	0.1	774	10.0	764
BVB-104	440	2908181	556812	748	0.3	748	12.5	736	0.4	748	12.5	736
BVB-105	450	2908110	556730	763	0.6	762	7.5	756	5.7	757	7.5	756
BVT-201	190	2907870	556847	805	0.5	805	12.9	792	NE	NE	12.9	792
BVT-202	1010	2908320	556202	824	0.5	824	17.0	807	NE	NE	17.0	807
B5	830	2908325	556404	802	1.5	801	19.1	783	13.9	788	29.1	773
B28	670	2908231	556547	789	0.7	788	14.0	775	11.7	777	24.0	765
B507A	660	2908194	556527	793	2.0	791	20.0	773	20.2	773	29.5	764
B507B	650	2908155	556498	795	0.7	794	18.0	777	15.4	780	33.0	762
B508.A	50	2907791	556906	798	0.6	797	20.7	777	13.8	784	30.7	767
B508.B	60	2907801	556914	798	1.7	796	19.5	779	15.7	782	29.5	769

NOTES:

- 1 All depths are measured in feet below ground surface (bgs). Depths were estimated to the nearest 0.1 feet during drilling as presented on the boring logs. The accuracy of these values depends on drilling conditions and sample recovery and is on the order of ±1 foot. Elevations are rounded to the nearest 1 foot.
- 2 Coordinates and ground surface elevation at GZA boring locations were surveyed by Tauper Land Survey referencing NAD83 and NAVD88. Coordinates and ground surface elevation at CDM boring locations were obtained from CDM Report.
- 3 "NE" indicates stratum or groundwater not encountered in exploration, "NM" indicates groundwater not measured.
- 4 See test boring logs in Appendix B for additional information.



Boring Number: B5

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA **Project Number:** 257372

Drilling Contractor/Driller: Crawford Drilling Services, LLC/J. Martinelli/E. Ainsorth

Surface Elevation (ft): 802.4

Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.

Total Depth (ft): 29.1

Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.

Depth to Initial Water Level (ft):

Bore Hole Location:

Depth	Date	Time
13.9	4/2/2021	9:05

N: 2908325.13

E: 556403.55

Abandonment Method: Backfilled with cement grout and soil cuttings.

Drilling Date: Start: 3/31/2021 **End:** 4/2/2021

Logged By: Hamza Al-Qudah

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	0	SS	S-1	12	6 20	5	>20		SUBSOIL	Top 2": Moist, dark brown, FOREST MAT, some silt, (roots and leaves). Bottom 2": Moist, dark brown, fine to coarse GRAVEL, some fine to coarse sand, trace silt, (GP).	Sample S-1 terminated early due to angle of penetration. Drill rig chattering between 1 and 3.4 ft bgs. Possible boulder.
	5	SS	S-2	24	24 53 53 40	13	106		SAND AND GRAVEL	Moist, very dense, light brown, fine to coarse SAND and fine to coarse GRAVEL, little silt, (SM).	
	10	SS	S-3	24	42 27 26 35	8	53			Moist to wet, very dense, light brown, fine to coarse SAND and fine to coarse GRAVEL, some silt, (SM).	Drill rig chattering between 12 and 12.8 ft bgs.
	15	SS	S-4	18	15 20 60 50/0"	9	80			Moist to wet, very dense, light brown, fine to coarse SAND, some fine to coarse gravel, some silt, (SM).	

Sample Types		Consistency vs Blowcount/Foot				Burmister Classification	
AS - Auger/Grab Sample	HP - Hydro Punch	Granular (Sand):		Fine Grained (Clay):		and	35-50%
CS - California Sampler	SS - Split Spoon	V. Loose: 0-4	Dense: 30-50	V. Soft: <2	Stiff: 8-15	some	20-35%
NQ - 1.9" Rock Core	ST - Shelby Tube	Loose: 4-10	V. Dense: >50	Soft: 2-4	V. Stiff: 15-30	little	10-20%
NX - 2.2" Rock Core	WS - Wash Sample	M. Dense: 10-30		M. Stiff: 4-8	Hard: >30	trace	<10%
	GP - Geoprobe					moisture, density, color	

Reviewed by: A. Smith

Date: 4/19/2021

Boring Number: B5



Boring Number: B5

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and
Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
15									SAND AND GRAVEL	Moist to wet, very dense, light brown, fine to coarse SAND, some fine to coarse gravel, some silt, (SM).	Driller indicated top of rock at 16 ft bgs. Observed rock cuttings in wash.
783.0		SS	S-5	1	50/0.5"	0	>50			Moist, very dense, grey, fine to coarse GRAVEL, little fine to coarse sand, (SM). <i>See next page for rock material descriptions.</i>	Sample S-5 appears to be highly weathered rock.
20											
778.0											
25											
773.0											
30											
768.0											



Boring Number: B5

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks	
	15										See previous page for soil material descriptions.		
783.0	20	NX	C-1	60	100	51	3.1	NR		SCHIST	moderately hard, slightly weathered, extremely fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: low angle, partly open, smooth, planar, fresh, open; secondary joint set: moderately dipping, open, rough, planar, discolored, open.		
							4.9	NR					
							3.0	NR					
							3.9	NR					
778.0	25	NX	C-2	60	90	68	3.0	NR		GRA NITE	very hard, fresh, slightly fractured, light grey, coarse grained GRANITE; primary joint set: low angle, partly open, rough, undulating, fresh, open.		
							2.0	NR		SCHIST	moderately hard, slightly weathered, extremely fractured to moderately fractured, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: moderately dipping, open, smooth, planar, discolored, open.		
							2.0	NR					
							3.8	NR				moderately hard, slightly weathered to fresh, extremely fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, partly open, smooth, planar, fresh, open.	
							1.5	NR					
							1.9	NR					
773.0	30										Test boring terminated at 29.1 feet bgs.		
768.0													



Boring Number: B28

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA **Project Number:** 257372

Drilling Contractor/Driller: Crawford Drilling Services, LLC/J. Martinelli/E. Ainsorth/J. Thibault **Surface Elevation (ft):** 788.7

Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.

Total Depth (ft): 24.0

Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.

Depth to Initial Water Level (ft):

Bore Hole Location:

Depth	Date	Time
11.7	3/5/2021	9:10

N: 2908231.48

E: 556546.94

Abandonment Method: Backfilled with cement grout and soil cuttings.

Drilling Date: Start: 3/4/2021 **End:** 3/5/2021

Logged By: Hamza Al-Qudah

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	0	SS	S-1	24	1 13 23 16	12	36		Top 2": Moist, dense, dark brown, ORGANIC SILT and fine to medium SAND, (leaves), (OL). Middle 5": Moist, dense, orangish brown, SILT and fine SAND, little fine gravel, trace organics, (roots), (ML). Bottom 5": Moist, dense, light brown, fine to coarse GRAVEL, little fine to medium sand, trace silt, (GP). Dry, very dense, light brown, fine to coarse GRAVEL, some fine to coarse sand, trace silt, (GP). Moist, very dense, light brown, fine to coarse SAND and fine GRAVEL, little silt, (SM).		
		SS	S-2	24	20 32 46 44	13	78				
784.0	5	SS	S-3	24	14 40 56 51	12	96				
		SS	S-4	6	83/5.5"	2	>83				
779.0	10								Moist, very dense, light brown, fine to coarse GRAVEL and fine to medium SAND, little silt, (GM).		
774.0											See next page for rock material descriptions.

Sample Types		Consistency vs Blowcount/Foot				Burmister Classification	
AS - Auger/Grab Sample	HP - Hydro Punch	Granular (Sand):		Fine Grained (Clay):		and	35-50%
CS - California Sampler	SS - Split Spoon	V. Loose: 0-4	Dense: 30-50	V. Soft: <2	Stiff: 8-15	some	20-35%
NQ - 1.9" Rock Core	ST - Shelby Tube	Loose: 4-10	V. Dense: >50	Soft: 2-4	V. Stiff: 15-30	little	10-20%
NX - 2.2" Rock Core	WS - Wash Sample	M. Dense: 10-30		M. Stiff: 4-8	Hard: >30	trace	<10%
	GP - Geoprobe					moisture, density, color	

Reviewed by: A. Smith

Date: 4/19/2021

Boring Number: B28



Boring Number: B28

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
	0										See previous page for soil material descriptions.	
784.0	5											
779.0	10											
774.0	15	NX	C-1	60	87	82	4.6	NR		SCHIST	moderately hard, fresh, extremely fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, tight, smooth, planar, fresh, tight.	Quartz intrusion at approximately 14.6 ft bgs.
							2.7	NR				
							1.9	NR				
							1.5	NR				
							1.3	NR				
769.0	20						2.2	NR			moderately hard, fresh, slightly fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, tight to partly open, smooth, planar, fresh, open.	



Boring Number: B28

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
		NX	C-2	60	92	87	1.9	NR		SCHIST	moderately hard, fresh, slightly fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, tight to partly open, smooth, planar, fresh, open.	
						2.0	NR					
						1.5	NR					
						1.3	NR					
764.0	25										Test boring terminated at 24.0 feet bgs.	
759.0	30											
754.0	35											
749.0	40											



Boring Number: B507A

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA **Project Number:** 257372

Drilling Contractor/Driller: Crawford Drilling Services, LLC/J. Martinelli/E. Ainsorth/ M. Martinelli

Surface Elevation (ft): 793.2

Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.

Total Depth (ft): 29.5

Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.

Depth to Initial Water Level (ft):

Bore Hole Location:

Depth	Date	Time
20.2	3/9/2021	8:25

N: 2908194.18

E: 556526.50

Abandonment Method: Backfilled with cement grout and soil cuttings.

Drilling Date: Start: 3/5/2021 **End:** 3/9/2021

Logged By: Hamza Al-Qudah

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
0		SS	S-1	24	2 2 2	6	4		SUBSOIL	Top 1": Moist, loose, dark brown, SILT, little fine sand, (frozen and roots), (ML). Bottom 5": Moist, loose, orangish brown, SILT, some fine to medium sand, trace organics, (roots), (ML).	
789.0		SS	S-2	24	5 5 28 35	4	33		SAND AND GRAVEL	Moist, medium dense, brown, fine to coarse GRAVEL and fine to medium SAND, little silt, (GM).	
5		SS	S-3	24	23 45 63 42	13	108		SAND AND GRAVEL	Moist to wet, very dense, light brown, fine to coarse GRAVEL, some fine to coarse sand, little silt, (roots), (GM).	Drill rig chattering between 7 and 8 ft bgs.
784.0	10								SAND AND GRAVEL		Driller indicated possible rock at 9 ft bgs. Observed rock cuttings in wash. Boulder encountered and cored between 10 feet and 15 feet bgs. Approximate diameter 1.8 ft bgs.
779.0									SAND AND GRAVEL		

Sample Types		Consistency vs Blowcount/Foot				Burmister Classification	
AS - Auger/Grab Sample	HP - Hydro Punch	Granular (Sand):		Fine Grained (Clay):		and	35-50%
CS - California Sampler	SS - Split Spoon	V. Loose: 0-4	Dense: 30-50	V. Soft: <2	Stiff: 8-15	some	20-35%
NQ - 1.9" Rock Core	ST - Shelby Tube	Loose: 4-10	V. Dense: >50	Soft: 2-4	V. Stiff: 15-30	little	10-20%
NX - 2.2" Rock Core	WS - Wash Sample	M. Dense: 10-30		M. Stiff: 4-8	Hard: >30	trace	<10%
	GP - Geoprobe					moisture, density, color	

Reviewed by: A. Smith

Date: 4/19/2021

Boring Number: B507A



Boring Number: B507A

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and
Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	15	SS	S-4	24	15 43 58 77	10	101		SAND AND GRAVEL	Moist to wet, very dense, light brown, fine to coarse SAND, some fine to coarse gravel, some silt, (SM).	
774.0	20									See next page for rock material descriptions.	
769.0	25										
764.0	30										
759.0											



Boring Number: B507A

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
	15										See previous page for soil material descriptions.	
774.0	20	NX	C-1	54	81	48	3.5	NR		GRANITE	very hard, moderately weathered, moderately fractured, light grey with black (mottled), coarse grained GRANITE; primary joint set: moderately dipping, wide, rough, undulating, discolored, open.	Quartz intrusion between approximately 21.5 and 21.75 ft. bgs.
769.0	25	NX	C-2	60	92	84	1.6	NR		SCHIST	moderately hard, highly weathered to slightly weathered, extremely fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, tight, smooth, planar, disintegrated to fresh; secondary joint set: moderately dipping, partly open to wide, smooth, planar, disintegrated to decomposed, open.	
764.0	30						1.5	NR			moderately hard, slightly weathered to fresh, moderately fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, tight to partly open, smooth, planar, discolored to fresh.	Granite intrusion between approximately 27.3 and 27.9 ft. bgs.
759.0	30										Test boring terminated at 29.5 feet bgs.	



Boring Number: B507B

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA **Project Number:** 257372

Drilling Contractor/Driller: Crawford Drilling Services, LLC/J. Martinelli / M. Martinelli

Surface Elevation (ft): 795.3

Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.

Total Depth (ft): 33.0

Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.

Depth to Initial Water Level (ft):

Bore Hole Location:

Depth	Date	Time
15.4	3/11/2021	9:04

N: 2908155.45

E: 556498.15

Abandonment Method: Backfilled with cement grout and soil cuttings.

Drilling Date: Start: 3/10/2021 **End:** 3/11/2021

Logged By: Hamza Al-Qudah

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	0	SS	S-1	24	5 6 4 5	10	10		SAND AND GRAVEL	Top 3": Moist, medium dense, dark brown, fine to medium SAND and ORGANIC SILT, (roots), (SM). Middle 4": Moist, medium dense, orangish brown, fine to medium SAND, some silt, little fine gravel, trace organics, (roots), (SM). Bottom 3": Moist, medium dense, light brown, fine to coarse SAND, some fine gravel, some silt, (roots), (SM).	
	791.0	SS	S-2	24	4 36 28 33	16	64			Moist, very dense, light brown, fine to coarse SAND and fine to coarse GRAVEL, little silt, (SM).	
	5	SS	S-3	24	27 48 56 45	16	104			Moist to wet, very dense, light brown, fine to coarse GRAVEL and fine to coarse SAND, little silt, (GM).	Drill rig chattering between approximately 7 and 8.5 ft bgs.
	786.0	SS	S-4	24	21 29 41 41	9	70			Wet, very dense, light brown, fine to coarse GRAVEL, some fine to coarse sand, little silt, (GM).	Drill rig chattering between approximately 11 and 12 ft bgs.
	781.0	SS	S-5	12	13 13 50/0"	6	>63			Top 3": Moist, very dense, light brown, fine to medium SAND, trace silt, (SP-SM). Bottom 3": Moist, very dense, grey to light brown, SILT, some fine sand, (ML).	

Sample Types		Consistency vs Blowcount/Foot				Burmister Classification	
AS - Auger/Grab Sample	HP - Hydro Punch	Granular (Sand):		Fine Grained (Clay):		and	35-50%
CS - California Sampler	SS - Split Spoon	V. Loose: 0-4	Dense: 30-50	V. Soft: <2	Stiff: 8-15	some	20-35%
NQ - 1.9" Rock Core	ST - Shelby Tube	Loose: 4-10	V. Dense: >50	Soft: 2-4	V. Stiff: 15-30	little	10-20%
NX - 2.2" Rock Core	WS - Wash Sample	M. Dense: 10-30		M. Stiff: 4-8	Hard: >30	trace	<10%
	GP - Geoprobe					moisture, density, color	

Reviewed by: A. Smith

Date: 4/19/2021

Boring Number: B507B



Boring Number: B507B

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and
Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	15								SAND AND GRAVEL	Bottom 3": Moist, very dense, grey to light brown, SILT, some fine sand, (ML).	Driller indicated rock at 15 ft bgs. Drill rig chattering between 15 and 18 ft bgs.
776.0	20									See next page for rock material descriptions.	
771.0	25										
766.0	30										
761.0											



Boring Number: B507B

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
	15										See previous page for soil material descriptions.	
776.0	20	NX	C-1	60	100	67	2.8	NR		GRANITE	very hard, moderately weathered to slightly weathered, extremely fractured to sound, light grey with black, coarse grained GRANITE; primary joint set: low angle, wide, rough, undulating, discolored, open.	Losing water at approximately 20.7 ft bgs.
	2.7						NR		SCHIST			
	3.6						NR		GRANITE			
	2.5						NR		SCHIST			
771.0	25	NX	C-2	60	98	60	2.3	NR		GRANITE	very hard, slightly weathered, extremely fractured to sound, light grey with black, coarse grained GRANITE; primary joint set: horizontal, open, smooth, planar, discolored, open.	Quartz intrusion between 28.6 and 28.9 ft bgs.
	2.0						NR		SCHIST			
	2.9						NR		SCHIST			
	1.7						NR		SCHIST			
766.0	30	NX	C-3	60	100	82	1.9	NR		SCHIST	moderately hard, slightly weathered, sound, light grey with black (mottled), coarse grained GRANITE.	Quartz intrusion between 29.6 and 29.8 ft bgs.
	1.5						NR		SCHIST			
	1.5						NR		SCHIST			
	1.5						NR		SCHIST			
761.0							1.7	NR		SCHIST	moderately hard, moderately weathered to fresh, extremely fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, wide, smooth, planar, decomposed, open; secondary joint set: moderately dipping, open, smooth, planar, decomposed, open.	Quartz intrusion between 30.75 and 31 ft bgs. Quartz intrusion between 31.2 and 31.4 ft bgs. Quartz intrusion at 31.5 ft bgs.

Test boring terminated at 33.0 feet bgs.

Boring Number: B507B



Boring Number: B508.A

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA **Project Number:** 257372

Drilling Contractor/Driller: Crawford Drilling Services, LLC/J. Martinelli/E. Ainsworth

Surface Elevation (ft): 798.3

Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.

Total Depth (ft): 30.7

Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.

Depth to Initial Water Level (ft):

Bore Hole Location:

Depth	Date	Time
13.8	3/1/2021	11:59

N: 2907791.33

E: 556906.39

Abandonment Method: Backfilled with cement grout and soil cuttings.

Drilling Date: Start: 2/26/2021 **End:** 3/1/2021

Logged By: Hamza Al-Qudah

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	0	SS	S-1	7	28 100/1"	2	>100		TOP SOIL	Moist to wet, very dense, dark brown, fine to coarse SAND and coarse GRAVEL, little organic silt, (frozen, roots and leaves), (SM).	Rock in tip of spoon. Drill rig chattering between 0.7 and 3 ft bgs. possible boulder.
	794.0	SS	S-2	24	7 12 11 13	5	23		SAND AND GRAVEL	Moist to wet, medium dense, light brown, fine to coarse GRAVEL, some fine to coarse sand, little silt, (GM).	
	789.0	SS	S-3	24	18 18 20 36	5	38			Moist, dense, light brown, fine to coarse SAND, some fine to coarse gravel, little silt, (SM).	
	784.0	SS	S-4	16	16 29 100/4"	4	>129			Wet, very dense, brown, fine to coarse GRAVEL and fine to coarse SAND, little silt, (GM).	Drill rig chattering between 11.5 and 13.5 ft bgs. Possible boulder.

Sample Types		Consistency vs Blowcount/Foot				Burmister Classification	
AS - Auger/Grab Sample	HP - Hydro Punch	Granular (Sand):		Fine Grained (Clay):		and	35-50%
CS - California Sampler	SS - Split Spoon	V. Loose: 0-4	Dense: 30-50	V. Soft: <2	Stiff: 8-15	some	20-35%
NQ - 1.9" Rock Core	ST - Shelby Tube	Loose: 4-10	V. Dense: >50	Soft: 2-4	V. Stiff: 15-30	little	10-20%
NX - 2.2" Rock Core	WS - Wash Sample	M. Dense: 10-30		M. Stiff: 4-8	Hard: >30	trace	<10%
	GP - Geoprobe					moisture, density, color	

Reviewed by: A. Smith

Date: 4/19/2021

Boring Number: B508.A



Boring Number: B508.A

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and
Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	15								SAND AND GRAVEL	Wet, very dense, brown, fine to coarse GRAVEL and fine to coarse SAND, little silt, (GM).	Drill rig chattering between 17 and 19 ft bgs.
779.0		SS	S-5	8	52 100/2"	4	>100			Moist, very dense, light brown, fine to coarse SAND, some fine to coarse gravel. some silt, (SM).	
	20									<i>See next page for rock material descriptions.</i>	
774.0											
	25										
769.0											
	30										
764.0											



Boring Number: B508.A

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
779.0	15										See previous page for soil material descriptions.	
774.0	20	NX	C-1	60	97	94	3.0	NR		GRANITE	very hard, slightly weathered to fresh, extremely fractured to sound, light grey with black (mottled), coarse grained GRANITE; primary joint set: horizontal, tight to partly open, rough, undulating, fresh, tight to open.	
							3.5	NR				
							3.3	NR				
							4.0	NR				
769.0	25						2.1	NR		SCHIST	moderately hard, fresh, moderately fractured to sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, moderately wide, smooth, planar, fresh, open.	
							3.3	NR		GRANITE	very hard, fresh, sound, light grey with black, coarse grained GRANITE.	
							1.5	NR		SCHIST	very hard, slightly weathered to fresh, moderately fractured to slightly fractured, light grey with black (mottled), coarse grained GRANITE; primary joint set: low angle, tight, rough, undulating, fresh, tight.	
		NX	C-2	60	100	94	1.8	NR		GRANITE	medium hard to moderately hard, slightly weathered, extremely fractured to sound, dark grey to light grey, medium grained SCHIST; foliation low angle; primary joint set: low angle, tight, smooth, planar, fresh, tight.	
							2.5	NR				
							2.0	NR		SCHIST	very hard, slightly weathered to fresh, extremely fractured to sound, light grey with black (mottled), coarse grained GRANITE; primary joint set: horizontal, partly open to open, rough, undulating, fresh, open.	
764.0	30										moderately hard, fresh, sound, dark grey, medium grained SCHIST; foliation horizontal;	

Test boring terminated at 30.7 feet bgs.

Boring Number: B508.A



Boring Number: B508.B

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA **Project Number:** 257372

Drilling Contractor/Driller: Crawford Drilling Services, LLC/J. Martinelli/E. Ainsworth/J. Thibault

Surface Elevation (ft): 798.2

Drilling Method/Bore Hole Diameter: Drive and Wash/4 in.

Total Depth (ft): 29.5

Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.

Depth to Initial Water Level (ft):

Bore Hole Location:

Depth	Date	Time
15.7	2/25/2021	13:27

N: 2907800.74 E: 556914.12

Abandonment Method: Backfilled with cement grout and soil cuttings.

Drilling Date: Start: 2/25/2021 **End:** 2/25/2021

Logged By: Hamza Al-Qudah

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
	0	SS	S-1	24	4 5 5 8	3	10		TOPSOIL	Wet, medium dense, dark brown, coarse GRAVEL, little fine to coarse sand, trace silt, trace organics, (GP).	
		SS	S-2	8	45 100/2"	7	>100		SUBSOIL	Wet, very dense, orangish brown, fine to coarse SAND, some silt, little fine gravel, (roots), (SM).	
794.0	5	SS	S-3	24	10 10 9 10	3	19		SAND AND GRAVEL	Wet, medium dense, light brown, fine to coarse GRAVEL, little fine to coarse sand, trace silt, (GP).	
		SS	S-4	24	9 14 16 12	9	30			Wet, dense, light brown, fine to coarse GRAVEL, some fine to coarse sand, little silt, (GP-GM).	
789.0	10	SS	S-5	24	9 10 13 25	7	23			Moist, medium dense, light brown, fine to coarse SAND, some fine to coarse gravel, little silt, (SM).	
										Moist, very dense, light brown, fine to coarse GRAVEL and fine to coarse SAND, little silt, (GM).	Drill rig chattering between 12 and 14 ft bgs.

Sample Types		Consistency vs Blowcount/Foot				Burmister Classification	
AS - Auger/Grab Sample	HP - Hydro Punch	Granular (Sand):		Fine Grained (Clay):		and	35-50%
CS - California Sampler	SS - Split Spoon	V. Loose: 0-4	Dense: 30-50	V. Soft: <2	Stiff: 8-15	some	20-35%
NQ - 1.9" Rock Core	ST - Shelby Tube	Loose: 4-10	V. Dense: >50	Soft: 2-4	V. Stiff: 15-30	little	10-20%
NX - 2.2" Rock Core	WS - Wash Sample	M. Dense: 10-30		M. Stiff: 4-8	Hard: >30	trace	<10%
	GP - Geoprobe					moisture, density, color	

Reviewed by: A. Smith

Date: 4/16/2021

Boring Number: B508.B



Boring Number: B508.B

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
15	▼	SS	S-6	24	17 37 86 67	13	123		SAND AND GRAVEL	Moist, very dense, light brown, fine to coarse GRAVEL and fine to coarse SAND, little silt, (GM).	
779.0	20									See next page for rock material descriptions.	
774.0	25										
769.0	30										
764.0											



Boring Number: B508.B

Client: National Grid

Project Name: A127/B128 & Z126 - Stafford Street

Project Location: Leicester, Worcester, and Auburn, MA

Project Number: 257372

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Recovery (%)	RQD (%)	Drill Rate (min/ft)	Down Press. (psi)	Graphic Log	Strata	Material Description	Remarks
779.0	15										See previous page for soil material descriptions.	
	20	NX	C-1	60	98		5.1	NR		GRANITE	very hard, slightly weathered, extremely fractured to sound, light grey with black (mottled), coarse grained GRANITE; primary joint set: horizontal, open, rough, undulating, fresh, open.	Quartz intrusion between 21.2 and 21.6 ft bgs.
						81	3.7	NR		SCHIST	moderately hard, fresh, sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, very tight, smooth, planar, fresh, open.	
							5.0	NR		GRANITE	very hard, fresh, sound, light grey with black (mottled), coarse grained GRANITE; primary joint set: horizontal, partly open, rough, undulating, fresh, tight.	
							5.8	NR		GRANITE	very hard, fresh, slightly fractured to sound, light grey with black (mottled), coarse grained GRANITE; primary joint set: horizontal, partly open, rough, undulating, fresh, open.	
774.0	25						2.5	NR		SCHIST	moderately hard, fresh, sound, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, tight, smooth, planar, fresh.	Granite intrusion between 26.8 and 27 ft bgs.
		NX	C-2	60	95	91	1.5	NR		SCHIST	very hard, fresh, sound, light grey with black (mottled), coarse grained GRANITE.	
							1.8	NR		GRANITE	very hard, fresh, sound, light grey with black (mottled), coarse grained GRANITE.	
769.0	30						1.5	NR		SCHIST	moderately hard, slightly weathered, extremely fractured, dark grey, medium grained SCHIST; foliation horizontal; primary joint set: horizontal, tight, smooth, planar, fresh, tight.	Test boring terminated at 29.5 feet bgs.
764.0												

TEST BORING LOG



GZA
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Engineers and Scientists

National Grid
Stafford Street Access Road
Leicester, Massachusetts

EXPLORATION NO.: BVB-101
SHEET: 1 of 1
PROJECT NO: 04.0191281.00
REVIEWED BY: J. Szmyt

Logged By: Dylan Shaffer
Drilling Co.: Drilex Environmental
Foreman: Jamie Hastings

Type of Rig: CME55LC
Rig Model: ATV
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 801
Final Boring Depth (ft.): 20.1
Date Start - Finish: 8/30/2021 - 8/30/2021

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic
Hammer Weight (lb.): 140 lbs
Hammer Fall (in.): 30"
Auger or Casing O.D./I.D Dia (in.): 4.25"

Sampler Type: Split Spoon
Sampler O.D. (in.): 2"
Sampler Length (in.): 24"
Rock Core Size: NA

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
8/30/21	11:24	18.20 ft.	15 min.

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0-2	24	10	15 13 17 21	30	S-1: Dense, brown, fine to coarse SAND, some Gravel, little Silt, trace Roots, moist. (SM)						
		S-2	2-4	24	17	26 31 41 38	72	S-2: Very dense, light brown/gray, GRAVEL, some fine to medium Sand, little Silt, dry. (GM)	1					
		S-3	5-7	24	13	32 34 23 27	57	S-3: Very dense, light brown/gray, fine to coarse SAND, and Gravel, little Silt, dry. (SM)						
		S-4	7-9	24	12	61 34 32 58	66	S-4: Very dense, light brown/gray, GRAVEL and fine to coarse Sand, little Silt, dry. (GM)						
		S-5	10-12	24	12	9 18 24 37	42	S-5: Dense, brown, fine to coarse SAND, and Gravel, little Silt, moist. (SM-GM)						
		S-6	15-17	24	15	5 41 27 15	68	S-6: Very dense, brown with gray, GRAVEL, some fine Sand, little Silt, moist. (GM)						
20		S-7	20-20.1	1	1	25/1"	R	S-7: Very dense, brown, GRAVEL, some fine to coarse Sand, some Silt, wet. Potential cuttings. (GM)	3		20.1	780.9	BOULDER OR BEDROCK	
								End of exploration at 20.1 feet.	4					

REMARKS

- 1 - Very difficult drilling at 2 feet below ground surface (bgs).
- 2 - Auger refusal at approximately 20 feet bgs on probable bedrock or boulder.
- 3 - Split spoon refusal at approximately 20.1 feet bgs on boulder or bedrock.
- 4 - Test boring backfilled to ground surface with drill spoils.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.:
BVB-101

TEST BORING LOG



GZA
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Engineers and Scientists

National Grid
Stafford Street Access Road
Leicester, Massachusetts

EXPLORATION NO.: BVB-102
SHEET: 1 of 1
PROJECT NO: 04.0191281.00
REVIEWED BY: J. Szmyt

Logged By: Dylan Shaffer
Drilling Co.: Drilex Environmental
Foreman: Jamie Hastings

Type of Rig: CME55LC
Rig Model: ATV
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 798
Final Boring Depth (ft.): 17.6
Date Start - Finish: 8/31/2021 - 8/31/2021

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic
Hammer Weight (lb.): 140 lbs
Hammer Fall (in.): 30"
Auger or Casing O.D./I.D Dia (in.): 4.25"

Sampler Type: Split Spoon
Sampler O.D. (in.): 2"
Sampler Length (in.): 24"
Rock Core Size: NA

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
8/31/21	9:25	Dry	15 min.

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0-2	24	10	1 2 1 4	3	S-1: Top 3": Very loose, dark brown, fine to medium SAND, some Silt, little Roots, little Gravel, moist. (SM) Bottom 7": Very loose, orange/brown, fine to medium SAND, some Silt, little Gravel, trace Roots, moist. (SM)	1		0.2	TOPSOIL	797.8	
		S-2	2-4	24	15	32 33 31 41	64	S-2: Very dense, brown/gray, fine to coarse SAND, and GRAVEL, little Silt, trace Roots, moist. (SM-GM)						
		S-3	5-7	24	16	26 26 24 27	50	S-3: Very dense, brown/gray, fine to coarse SAND, and GRAVEL, little Silt, moist. (SM-GM)						
		S-4	7-9	24	18	30 38 46 48	84	S-4: Very dense, brown/gray, fine to coarse SAND, and GRAVEL, little Silt, moist. (SM-GM)						
		S-5	10-10.4	11	6	8 60/5"	R	S-5: Very dense, brown, fine to coarse SAND, some Silt, little Gravel, moist. (SM)						
		S-6	15-16.2	15	10	38 24 50/3"	R	S-6: Very dense, light brown/gray, fine to coarse SAND, and GRAVEL, some Silt, moist. (SM-GM)						
								End of exploration at 17.6 feet.	5		17.6	BOULDER OR BEDROCK	780.4	

- REMARKS**
- 1 - Very difficult drilling at 2 feet below ground surface (bgs).
 - 2 - Split spoon refusal at approximately 10.9 feet bgs.
 - 3 - Split spoon refusal at approximately 16.2 feet bgs.
 - 4 - Auger refusal at approximately 17.6 feet bgs on boulder or bedrock.
 - 5 - Test boring backfilled to ground surface with drill spoils.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.:
BVB-102

TEST BORING LOG



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National Grid
Stafford Street Access Road
Leicester, Massachusetts

EXPLORATION NO.: BVB-103
SHEET: 1 of 1
PROJECT NO: 04.0191281.00
REVIEWED BY: J. Szmyt

Logged By: Dylan Shaffer
Drilling Co.: Drilex Environmental
Foreman: Jamie Hastings

Type of Rig: CME55LC
Rig Model: ATV
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 774
Final Boring Depth (ft.): 10
Date Start - Finish: 9/1/2021 - 9/1/2021

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic
Hammer Weight (lb.): 140 lbs
Hammer Fall (in.): 30"
Auger or Casing O.D./I.D Dia (in.): 4.25"

Sampler Type: Split Spoon
Sampler O.D. (in.): 2"
Sampler Length (in.): 24"
Rock Core Size: NA

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
09/01/21	12:00	0.1 ft.	30 min.

Depth (ft)	Casing Blows/ Core Rate	Sample						SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0-1.9	23	7	WOH 1 3 60/5"	4	S-1: Top 3": Very loose, dark brown/black, SILT, some Organics, little Wood/Roots, trace fine to coarse Sand, wet. (OL) Bottom 4": Very loose, brown, GRAVEL, little fine to coarse Sand, little Silt, wet. (GM)	1 2		0.2	PEAT	773.8	
		S-2	4-6	24	18	8 20 30 23	50	S-2: Very dense, brown, fine to coarse SAND, some Gravel, some Silt, moist, with 2.5-inch-thick layer of predominantly Gravel. (SM)				SAND AND GRAVEL		
		S-3	6-8	24	13	49 35 52 72	87	S-3: Very dense, brown, fine to coarse SAND, and GRAVEL, some Silt, moist. (SM-GM)						
		S-4	8-9.7	21	12	38 24 48 50/3"	72	S-4: Top 11": Very dense, brown, fine to coarse SAND, some Gravel, some Silt, moist. (SM) Bottom 1": Very dense, gray, GRAVEL, some fine to coarse SAND, little Silt, moist. (GM)	3 4		10	BOULDER OR BEDROCK	764.0	
10								End of exploration at 10 feet.	5 6					

REMARKS

- 1 - Split spoon refusal at approximately 1.9 feet below ground surface (bgs).
- 2 - Very difficult drilling at approximately 1 foot bgs.
- 3 - Split spoon refusal at approximately 9.7 feet bgs.
- 4 - Auger refusal at approximately 10 feet bgs on boulder or bedrock.
- 5 - Driller noted numerous cobbles throughout length of boring.
- 6 - Test boring backfilled to ground surface with drill spoils.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.:
BVB-103

TEST BORING LOG



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GeoEnvironmental, Inc.
Engineers and Scientists

National Grid
Stafford Street Access Road
Leicester, Massachusetts

EXPLORATION NO.: BVB-104
SHEET: 1 of 1
PROJECT NO: 04.0191281.00
REVIEWED BY: J. Szmyt

Logged By: Dylan Shaffer
Drilling Co.: Drilex Environmental
Foreman: Jamie Hastings

Type of Rig: CME55LC
Rig Model: ATV
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 748
Final Boring Depth (ft.): 12.5
Date Start - Finish: 8/31/2021 - 9/1/2021

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic
Hammer Weight (lb.): 140 lbs
Hammer Fall (in.): 30"
Auger or Casing O.D./I.D Dia (in.): 4.25"

Sampler Type: Split Spoon
Sampler O.D. (in.): 2"
Sampler Length (in.): 24"
Rock Core Size: NA

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
9/1/21	7:45	0.4 ft.	15 hrs.

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)	
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)								
5		S-1	0-0.9	11	6	4 50/5"	R	S-1: Top 3": Very dense, dark brown/black, SILT, some Organics, little Roots, trace fine to medium Sand, trace Gravel, wet. (OL) Bottom 3": Very dense, light brown/gray, GRAVEL, little fine to coarse Sand, little Silt, wet. (GM)	1		0.3	TOPSOIL	747.7	
		S-2	4-6	24	19	7 8 17 20	25	S-2: Medium dense, gray/orange, fine to medium SAND, and SILT, trace Gravel, moist. (SM) Medium dense, orange/brown, fine to coarse SAND, some Gravel, some Silt, moist. (SM)	2			SAND AND GRAVEL		
		S-3	6-8	24	17	14 16 35 37	51	S-3: Very dense, brown, fine to coarse SAND, some Gravel, some Silt, moist. (SM)						
		S-4	8-10	24	15	18 40 58 52	98	S-4: Very dense, brown with white/gray, GRAVEL, some fine to coarse Sand, little Silt, wet. (GM)				8		740.0
		S-5	10-11.9	23	14	21 56 70 60/5"	>100	S-5: Very dense, brown with white/gray, GRAVEL, some fine to coarse Sand, little Silt, wet. (GM)	3				WEATHERED ROCK	
15							End of exploration at 12.5 feet.	4		12.5		BOULDER OR BEDROCK	735.5	
								5						
								6						

REMARKS

- 1 - Split spoon refusal at approximately 0.9 feet below ground surface (bgs).
- 2 - Difficult drilling at approximately 1 foot bgs.
- 3 - Split spoon refusal at approximately 11.9 feet bgs.
- 4 - Auger refusal at approximately 12.5 feet bgs on boulder or bedrock.
- 5 - Driller noted numerous cobbles throughout length of boring.
- 6 - Test boring backfilled to ground surface with drill spoils.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.:
BVB-104

TEST BORING LOG



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National Grid
Stafford Street Access Road
Leicester, Massachusetts

EXPLORATION NO.: BVB-105
SHEET: 1 of 1
PROJECT NO: 04.0191281.00
REVIEWED BY: J. Szmyt

Logged By: Dylan Shaffer
Drilling Co.: Drilex Environmental
Foreman: Jamie Hastings

Type of Rig: CME55LC
Rig Model: ATV
Drilling Method:HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 763
Final Boring Depth (ft.): 7.5
Date Start - Finish: 9/1/2021 - 9/1/2021

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic
Hammer Weight (lb.): 140 lbs
Hammer Fall (in.): 30"
Auger or Casing O.D./I.D Dia (in.): 4.25"

Sampler Type: Split Spoon
Sampler O.D. (in.): 2"
Sampler Length (in.): 24"
Rock Core Size: NA

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
9/1/21	9:52	5.7 ft.	30 min.

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)		
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)									
5		S-1	0-2	24	7	2 5 4 7	9	S-1: Top 2": Loose, dark brown, fine SAND, some Silt, little Roots, trace Gravel, moist. (SM) Bottom 5": Loose, dark brown/orange, fine to medium SAND, some Silt, trace Roots, trace Gravel, moist. (SM)	1		0.1	FOREST MAT	762.9		
		S-2	2-2.8	10	10	12 50/4"	R	S-2: Very dense, brown, fine to coarse SAND, some Gravel, little Silt, moist. (SM)			2				
		S-3	5-5.8	10	4.5	10 50/4"	R	S-3: Very dense, white/gray with brown, fine to coarse SAND, and Gravel, little Silt, moist. (SM)							
		S-4	7.1-7.5	4	3	25/4"	R	S-4: No Sample, cuttings consisted of: GRAVEL, little fine to coarse Sand, little Silt, wet. (GM)							
7.5							End of exploration at 7.5 feet.	3		7.5	BOULDER OR BEDROCK	755.5			

REMARKS

- 1 - Difficult drilling at approximately 3 feet below ground surface (bgs).
- 2 - Very difficult drilling at approximately 5 feet bgs.
- 3 - Auger refusal at approximately 7.5 ft bgs on boulder or bedrock.
- 4 - Driller noted numerous cobbles throughout length of boring.
- 5 - Test boring backfilled to ground surface with drill spoils.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.:
BVB-105

TEST BORING LOG



GZA
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Engineers and Scientists

National Grid
Stafford Street Access Road
Leicester, Massachusetts

EXPLORATION NO.: BVT-201
SHEET: 1 of 1
PROJECT NO: 04.0191281.00
REVIEWED BY: J. Szmyt

Logged By: Dylan Shaffer
Drilling Co.: Drilex Environmental
Foreman: Jamie Hastings

Type of Rig: CME55LC
Rig Model: ATV
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 805
Final Boring Depth (ft.): 12.9
Date Start - Finish: 8/30/2021 - 8/30/2021

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic
Hammer Weight (lb.): 140 lbs
Hammer Fall (in.): 30"
Auger or Casing O.D./I.D Dia (in.): 4.25"

Sampler Type: Split Spoon
Sampler O.D. (in.): 2"
Sampler Length (in.): 24"
Rock Core Size: NA

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
8/30/21	13:45	Dry	30 min.

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
5		S-1	0-0.5					S-1: Orange/dark brown, fine SAND, little Silt, little Roots/Organics, trace Gravel, moist. (SM)	1		0.5	TOPSOIL	804.5
		S-2	5-8					S-2: Brown, GRAVEL, some coarse Sand, little Silt, moist. (GM)	2			SAND AND GRAVEL	
		S-3	8-11					S-3: Brown, GRAVEL, some fine to coarse Sand, little Silt, moist. (GM)	3				
15								End of exploration at 12.9 feet.	4		12.9	BOULDER OR BEDROCK	792.1
									5				

REMARKS

- 1 - Boulder observed on sidewall of probe at approximately 0.5 feet below ground surface (bgs).
- 2 - Difficult drilling encountered at approximately 1 foot bgs.
- 3 - Auger refusal at approximately 12.9 bgs on boulder or bedrock.
- 4 - Boring was a probe, SPT sampling not performed. Samples from soil cuttings obtained from the approximate depth interval noted.
- 5 - Test probe backfilled to ground surface with drill spoils.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.:
BVT-201

TEST BORING LOG



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Engineers and Scientists

National Grid
Stafford Street Access Road
Leicester, Massachusetts

EXPLORATION NO.: BVT-202
SHEET: 1 of 1
PROJECT NO: 04.0191281.00
REVIEWED BY: J. Szmyt

Logged By: Dylan Shaffer
Drilling Co.: Drilex Environmental
Foreman: Jamie Hastings

Type of Rig: CME55LC
Rig Model: ATV
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 824
Final Boring Depth (ft.): 17
Date Start - Finish: 8/30/2021 - 8/30/2021

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic
Hammer Weight (lb.): 140 lbs
Hammer Fall (in.): 30"
Auger or Casing O.D./I.D Dia (in.): 4.25"

Sampler Type: Split Spoon
Sampler O.D. (in.): 2"
Sampler Length (in.): 24"
Rock Core Size: NA

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
8/30/21	11:30	Dry (Collapse)	15 min.

Depth (ft)	Casing Blows/ Core Rate	Sample					SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Depth (ft.)	Stratum Description	Elev. (ft.)
		No.	Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)							
		S-1	1-2					S-1: Brown/orange, fine to medium SAND, some Silt, little Gravel, trace Roots/Organics, moist. (SM)			0.5	TOPSOIL	823.5
		S-2	3-5					S-2: Brown, fine to coarse SAND, some Gravel, some Silt, moist. (SM)	1		2.5	SAND	821.5
5		S-3	7-9					S-3: Brown, GRAVEL, some fine to coarse Sand, little Silt, moist. (GM)				GLACIAL TILL	
10		S-4	11-14					S-4: Brown, fine to coarse SAND, some Silt, some Gravel, moist. (SM)	2				
15									3				
									4				
17								End of exploration at 17 feet.			17	BOULDER OR BEDROCK	807.0
20									5				
									6				

REMARKS

- 1 - Difficult drilling at 4 feet below ground surface (bgs).
- 2 - Borehole collapse at approximately 10.5 feet bgs during HSA removal.
- 3 - Driller noted evidence of water on auger flights at approximately 16.5 feet bgs.
- 4 - Auger refusal at approximately 17 feet bgs on boulder or bedrock.
- 5 - Boring was a probe, SPT sampling not performed. Samples from soil cuttings obtained from the approximate depth interval noted.
- 6 - Test probe backfilled to ground surface with drill spoils.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.:
BVT-202



Appendix D

TSS Removal Worksheets & Water Quality Calculations

INSTRUCTIONS:

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location:

	B	C	D	E	F
	BMP ¹	TSS Removal Rate ¹	Starting TSS Load*	Amount Removed (C*D)	Remaining Load (D-E)
TSS Removal Calculation Worksheet	Sediment Forebay	0.25	1.00	0.25	0.75
		0.00	0.75	0.00	0.75
		0.00	0.75	0.00	0.75
		0.00	0.75	0.00	0.75
		0.00	0.75	0.00	0.75

Total TSS Removal =

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project:
 Prepared By:
 Date:

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
 1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location:

	B	C	D	E	F
	BMP ¹	TSS Removal Rate ¹	Starting TSS Load*	Amount Removed (C*D)	Remaining Load (D-E)
TSS Removal Calculation Worksheet	Infiltration Basin	0.80	1.00	0.80	0.20
		0.00	0.20	0.00	0.20
		0.00	0.20	0.00	0.20
		0.00	0.20	0.00	0.20
		0.00	0.20	0.00	0.20

Total TSS Removal =

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project:
 Prepared By:
 Date:

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
 1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location:

	B	C	D	E	F
	BMP ¹	TSS Removal Rate ¹	Starting TSS Load*	Amount Removed (C*D)	Remaining Load (D-E)
TSS Removal Calculation Worksheet	Porous Pavement	0.80	1.00	0.80	0.20
		0.00	0.20	0.00	0.20
		0.00	0.20	0.00	0.20
		0.00	0.20	0.00	0.20
		0.00	0.20	0.00	0.20

Total TSS Removal =

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project:
 Prepared By:
 Date:

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
 1. From MassDEP Stormwater Handbook Vol. 1



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Fax (413) 732-1249
http://www.gza.com

Engineers and
Scientists

JOB 15.0166857.00 STAFFORD ST.
SHEET NO. 1 OF 3
CALCULATED BY STD DATE 3/10/22
CHECKED BY _____ DATE _____
SCALE _____

WATER QUALITY VOLUME CALCULATIONS

$$WQV = (1.0 \text{ INCH})(\text{TOTAL IMPERVIOUS AREA})$$

$$\text{AREA OF PROPOSED POROUS BIT. CONC. PAVEMENT} = 22,230 \text{ ft}^2$$

AREA OF PROPOSED BIT. CONC. PAVEMENT

$$\text{UPGRADIENT OF PROPOSED POROUS BIT. CONC. PAVEMENT} = 12,445 \text{ ft}^2$$

$$\text{AREA OF PROPOSED BIT. CONC. DRIVEWAY APRON @ STAFFORD ST.} = 990 \text{ ft}^2$$

$$\text{AREA OF PROPOSED CONTROL BUILDING} = 9,100 \text{ ft}^2$$

$$\begin{aligned} WQV_1 &= (1.0 \text{ IN})(22,230 \text{ ft}^2 + 12,445 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}}) \\ &= 2890 \text{ ft}^3 \end{aligned}$$

$$\begin{aligned} WQV_2 &= (1.0 \text{ IN})(990 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}}) \\ &= 82.5 \text{ ft}^3 \end{aligned}$$

$$\begin{aligned} WQV_3 &= (1.0 \text{ IN})(9,100 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}}) \\ &= 760 \text{ ft}^3 \end{aligned}$$

SIZE RESERVOIR LAYER BENEATH POROUS PAVEMENT TO TREAT WQV₁

$$\text{POROSITY OF RESERVOIR LAYER} = 0.33$$

$$\begin{aligned} \text{DEPTH OF RESERVOIR LAYER} &= WQV_1 / (\text{AREA OF POROUS PAVEMENT} \times 0.33) \\ &= (2,890 \text{ ft}^3) / [(22,230 \text{ ft}^2)(0.33)] \\ &= 0.4 \text{ ft} \\ &= 4.8 \text{ IN} \end{aligned}$$

SET RESERVOIR DEPTH TO 6 IN. TO ACCOUNT FOR DRIVEWAY SLOPES BEING SLIGHTLY STEEPER THAN THE SUGGESTED 5% MAXIMUM.

$$\text{RESULTANT WQV PROVIDED} = (22,230 \text{ ft}^2)(0.5 \text{ ft})(0.33) = \boxed{3665 \text{ ft}^3} > 2890 \text{ ft}^3 \checkmark$$



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SHEET NO. 2 OF 3

CALCULATED BY STD DATE 3/10/22

CHECKED BY _____ DATE _____

SCALE _____

WATER QUALITY VOLUME CALCULATIONS (CONT.)

SIZE INFILTRATION BASINS TO TREAT WQV₂

SEDIMENT FOREBAY

SEDIMENT FOREBAY MUST STORE A VOLUME =
(0.1 IN) (CONTRIBUTING IMPERVIOUS AREA)

$$\begin{aligned}\text{CONTRIBUTING IMPERVIOUS AREA} &= \frac{1}{2} \text{ THE DRIVEWAY APRON} \\ &= \frac{1}{2} (990 \text{ ft}^2) \\ &= 495 \text{ ft}^2\end{aligned}$$

$$\text{REQUIRED FOREBAY VOLUME} = (0.1 \text{ IN}) (495 \text{ ft}^2) \left(\frac{1 \text{ FT}}{12 \text{ IN}}\right) = 4.1 \text{ ft}^3$$

$$\begin{aligned}\text{PROPOSED FOREBAY VOLUME} &= 3 \text{ FT} \times 3 \text{ FT BOTTOM, } 0.5 \text{ FT DEEP} \\ &\quad \text{W/ } 2:1 \text{ SIDE SLOPES} \\ &= 6.25 \text{ ft}^3\end{aligned}$$

$$6.25 \text{ ft}^3 > 4.1 \text{ ft}^3 \quad \checkmark$$

INFILTRATION BASIN

$$\text{SIZE EACH BASIN TO TREAT } \frac{1}{2} \text{ WQV}_2 = \frac{1}{2} (82.5 \text{ ft}^3) = 41.25 \text{ ft}^3$$

$$\begin{aligned}\text{PROPOSED INFILTRATION BASIN VOLUME} &= 5 \text{ FT} \times 5 \text{ FT BOTTOM, } 1.5 \text{ FT DEEP} \\ &\quad \text{W/ } 2:1 \text{ SIDE SLOPES} \\ &= 66.75 \text{ ft}^3\end{aligned}$$

$$66.75 \text{ ft}^3 > 41.25 \text{ ft}^3 \quad \checkmark$$



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JOB 15.0166857.00 STAFFORD ST.

SHEET NO. 3 OF 3

CALCULATED BY STD DATE 3/10/22

CHECKED BY DATE

SCALE

WATER QUALITY VOLUME CALCULATIONS (CONT.)

USE CRUSHED STONE YARD TO TREAT WQV₃

ASSUME 2,745 ft² OF CONTROL BUILDING DRAINS TO
CRUSHED STONE YARD #1 (SE OF CONTROL BUILDING)

ASSUME 6,355 ft² OF CONTROL BUILDING DRAINS TO
CRUSHED STONE YARD #2 (NW OF CONTROL BUILDING)

$$WQV_{3A} = (1.0 \text{ IN})(2,745 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}}) = 230 \text{ ft}^3$$

$$\text{YARD \#1 AREA} = 8330 \text{ ft}^2$$

$$\text{DEPTH OF CRUSHED STONE} = 0.5 \text{ ft}$$

$$\text{POROSITY OF CRUSHED STONE} = 0.33$$

$$\text{STORAGE VOLUME} = (8330 \text{ ft}^2)(0.5 \text{ ft})(0.33) = 1,375 \text{ ft}^3$$

$$1,375 \text{ ft}^3 > 230 \text{ ft}^3 \quad \checkmark$$

$$WQV_{3B} = (1.0 \text{ IN})(6,355 \text{ ft}^2)(\frac{1 \text{ FT}}{12 \text{ IN}}) = 530 \text{ ft}^3$$

$$\text{YARD \#2 AREA} = 22,800 \text{ ft}^2$$

$$\text{DEPTH OF CRUSHED STONE} = 0.5 \text{ ft}$$

$$\text{POROSITY OF CRUSHED STONE} = 0.33$$

$$\text{STORAGE VOLUME} = (22,800 \text{ ft}^2)(0.5 \text{ ft})(0.33) = 3,760 \text{ ft}^3$$

$$3,760 \text{ ft}^3 > 530 \text{ ft}^3 \quad \checkmark$$

SUMMARY: TOTAL TARGET WQV = 3,735 ft³
TOTAL VOLUME PROVIDED FOR WQ = 8,930 ft³

$$8,930 \text{ ft}^3 > 3,735 \text{ ft}^3 \quad \checkmark$$



Appendix E

Long Term Pollution Prevention Plan



Long-Term Pollution Prevention Plan: Stafford Street Substation, Leicester, MA

The Long-Term Pollution Prevention Plan that follows is a guideline for source control and pollution prevention to help maintain stormwater quality:

1.1 STORING MATERIALS AND WASTE PRODUCTS INSIDE OR UNDER COVER

1.1.1 Waste Materials

All waste materials shall be collected and stored in a manner that will prevent materials from entering watercourses, wetlands, or other offsite areas. Material shall be regularly collected and disposed of offsite in a manner consistent with all federal, state and local regulations.

1.1.2 Hazardous Waste:

All hazardous waste materials shall be disposed of in a manner specified by State and Federal regulations and/or in accordance with the manufacturer's recommendations.

1.1.3 Sanitary Waste:

The proposed substation will not have sanitary facilities. The Project as proposed will not generate sanitary waste.

1.2 VEHICLE WASHING

Not applicable—no vehicle washing will take place at the facility.

1.3 ROUTINE INSPECTIONS AND MAINTENANCE OF STORMWATER BMPS

Please refer to the Operation and Maintenance Plan.

1.4 SPILL PREVENTION AND RESPONSE PLAN

The following good housekeeping and material management practices shall be followed to reduce the risk of spills or other accidental exposure of hazardous materials to stormwater runoff:



- Store quantities of materials required for the project and not more,
- Store materials onsite in a neat, orderly manner in appropriate labeled containers,
- Store materials indoors or under cover,
- Follow manufacturers' recommendations for proper use and disposal of excess or used materials.

If an emergency spill or release occurs, the Leicester Department of Public Works, Leicester Fire Department, and the Leicester Local Emergency Planning Committee should be contacted immediately.

1.5 MAINTENANCE OF LAWNS, GARDENS, & OTHER LANDSCAPED AREAS

Nearly all of the developed space will consist of either paved areas, areas surfaced by crushed stone, or areas surfaced by riprap. As such, turfed areas requiring maintenance at the Site will be minimal. Regardless, areas maintained as lawn or otherwise vegetated shall be kept free of bare spots or erosion with proper mulching and seeding.

1.6 STORAGE AND USE OF FERTILIZERS, HERBICIDES, AND PESTICIDES

Nearly all of the developed Site will consist of either paved areas, areas surfaced by crushed stone, or areas surfaced by riprap. As such, vegetated areas at the Site requiring maintenance will be minimal. Occasional use of herbicides and pesticides may be required with regard to invasive plant species or dangerous pests such as wasps and hornets. To the extent they may be required, fertilizers, herbicides, and pesticides shall be used in accordance with manufacturer's requirements and in accordance with all applicable regulations. Such materials shall be stored indoors or under cover. Partially used bags of fertilizers should be stored in sealable plastic bins.

1.7 PET WASTE MANAGEMENT

Not applicable.

1.8 PROPER MANAGEMENT OF DEICING CHEMICALS AND SNOW

The Site is not within a water supply protection area; however, the following best management practices for salt storage shall be adhered to the maximum extent practical:

- Salt and deicing chemicals shall be stored on an impervious surface and under cover, and



- Runoff from salt/deicing chemical storage piles shall be collected and contained.

1.9 PROVISIONS FOR PREVENTION OF ILLICIT DISCHARGES TO THE STORMWATER MANAGEMENT SYSTEM

No chemicals, litter, trash or other illicit materials shall be dumped into or otherwise allowed to enter the stormwater drainage system. Only stormwater and the following non-stormwater discharges may enter the storm drainage system. (Note: This comprehensive listing was sourced from the federal NPDES program and generally applies to all site and all discharges to stormwater drainage systems. The listing is provided here in its entirety, although the subject Site is likely to encounter few, if any, of these.)

Allowable Non-Stormwater Discharges:

- a. Water line flushing,
- b. Landscape irrigation,
- c. Diverted stream flows,
- d. Rising ground water,
- e. Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)),
- f. Uncontaminated pumped ground water,
- g. Discharge from potable water sources,
- h. Foundation drains,
- i. Air conditioning condensation,
- j. Irrigation water, springs,
- k. Water from crawl space pumps,
- l. Footing drains,
- m. Lawn watering,
- n. Flow from riparian habitats and wetlands,
- o. Street wash waters,
- p. Residential building wash waters without detergents

1.10 CONTACT INFORMATION

- National Grid

Richard Costa
(781) 907-3149
Richard.Costa@nationalgrid.com



Appendix F

Illicit Discharge Compliance Statement



Appendix G

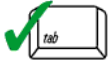
Checklist for Stormwater Report



Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the [Massachusetts Stormwater Handbook](#). The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.¹ This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

¹ The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

² For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.



Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Steven T. D'Ambrosio 03/10/22
Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

- New development
- Redevelopment
- Mix of New Development and Redevelopment



Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- No disturbance to any Wetland Resource Areas
- Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- Reduced Impervious Area (Redevelopment Only)
- Minimizing disturbance to existing trees and shrubs
- LID Site Design Credit Requested:
 - Credit 1
 - Credit 2
 - Credit 3
- Use of "country drainage" versus curb and gutter conveyance and pipe
- Bioretention Cells (includes Rain Gardens)
- Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- Treebox Filter
- Water Quality Swale
- Grass Channel
- Green Roof
- Other (describe): Porous Pavement

Standard 1: No New Untreated Discharges

- No new untreated discharges
- Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.



Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

- Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

- Soil Analysis provided.
- Required Recharge Volume calculation provided.
- Required Recharge volume reduced through use of the LID site Design Credits.
- Sizing the infiltration, BMPs is based on the following method: Check the method used.
 - Static
 - Simple Dynamic
 - Dynamic Field¹
- Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
 - Site is comprised solely of C and D soils and/or bedrock at the land surface
 - M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
 - Solid Waste Landfill pursuant to 310 CMR 19.000
 - Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

¹ 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

- The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
 - Provisions for storing materials and waste products inside or under cover;
 - Vehicle washing controls;
 - Requirements for routine inspections and maintenance of stormwater BMPs;
 - Spill prevention and response plans;
 - Provisions for maintenance of lawns, gardens, and other landscaped areas;
 - Requirements for storage and use of fertilizers, herbicides, and pesticides;
 - Pet waste management provisions;
 - Provisions for operation and management of septic systems;
 - Provisions for solid waste management;
 - Snow disposal and plowing plans relative to Wetland Resource Areas;
 - Winter Road Salt and/or Sand Use and Storage restrictions;
 - Street sweeping schedules;
 - Provisions for prevention of illicit discharges to the stormwater management system;
 - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
 - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
 - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
 - Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
 - is within the Zone II or Interim Wellhead Protection Area
 - is near or to other critical areas
 - is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
 - involves runoff from land uses with higher potential pollutant loads.
 - The Required Water Quality Volume is reduced through use of the LID site Design Credits.
 - Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.



Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

- The BMP is sized (and calculations provided) based on:
 - The ½" or 1" Water Quality Volume or
 - The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

- The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted **prior to** the discharge of stormwater to the post-construction stormwater BMPs.
- The NPDES Multi-Sector General Permit does **not** cover the land use.
- LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- All exposure has been eliminated.
- All exposure has **not** been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

- The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- Critical areas and BMPs are identified in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

- The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
 - Limited Project
 - Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
 - Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
 - Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
 - Bike Path and/or Foot Path
 - Redevelopment Project
 - Redevelopment portion of mix of new and redevelopment.
- Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
 - Construction Period Operation and Maintenance Plan;
 - Names of Persons or Entity Responsible for Plan Compliance;
 - Construction Period Pollution Prevention Measures;
 - Erosion and Sedimentation Control Plan Drawings;
 - Detail drawings and specifications for erosion control BMPs, including sizing calculations;
 - Vegetation Planning;
 - Site Development Plan;
 - Construction Sequencing Plan;
 - Sequencing of Erosion and Sedimentation Controls;
 - Operation and Maintenance of Erosion and Sedimentation Controls;
 - Inspection Schedule;
 - Maintenance Schedule;
 - Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

- The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has **not** been included in the Stormwater Report but will be submitted **before** land disturbance begins.
- The project is **not** covered by a NPDES Construction General Permit.
- The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

- The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
 - Name of the stormwater management system owners;
 - Party responsible for operation and maintenance;
 - Schedule for implementation of routine and non-routine maintenance tasks;
 - Plan showing the location of all stormwater BMPs maintenance access areas;
 - Description and delineation of public safety features;
 - Estimated operation and maintenance budget; and
 - Operation and Maintenance Log Form.
- The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
 - A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
 - A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

- The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- An Illicit Discharge Compliance Statement is attached;
- NO Illicit Discharge Compliance Statement is attached but will be submitted **prior to** the discharge of any stormwater to post-construction BMPs.



GZA GeoEnvironmental, Inc.