

Special Permit Application

Alexandria Real Estate Equities, Inc.

*3000 Minuteman Road
Andover, Massachusetts*

January 26, 2022

Prepared by
SMMA
1000 Massachusetts Avenue
Cambridge, Massachusetts

Alexandria Real Estate Equities, Inc.
Special Permit Application – Buildings 1 & 1A

Prepared by

SMMA
1000 Massachusetts Avenue
Cambridge, Massachusetts

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Special Permit Application

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Project Narrative

Project Narrative

Introduction

The campus at 3000 Minuteman Road in Andover, MA consists of four existing buildings, an amenities building, and 2,348 parking spaces. The square footage of the four existing buildings are as follows:

- Building 1 = 86,000 sf
- Building 2 = 164,100 sf
- Building 3 = 171,200 sf
- Building 4 = 256,700 sf
- Link & Amenities = 48,200 sf
- Total = 726,200 sf

The Applicant submitted an Approval Not Required (ANR) dividing the campus into three lots. The ANR was endorsed by the Andover Planning Board on June 24, 2021 and was recorded in the Northern Essex Registry of Deeds on July 12, 2021. Lot 1 includes the existing Building 1 and land adjacent the Merrimack River, Lot 2 includes the existing Buildings 2, 3, 4, and the Amenity Building.

The proposed project consists of renovations and addition to the existing Building 1. The new construction addition to Building 1 (1A) expands to the north with a 100,000 sf structure housing cGMP suites, warehouse, labs, and office environments. The addition is situated on a sloped site and positioned between setbacks and wetland buffer zones. Parking, landscape islands, and plaza spaces are located at the front of the building and a service road to the loading docks loops around the rear of the building, providing emergency access to all sides of the building.

The proposed project complies with the Town of Andover Wetlands Protection By-Law and Regulations and Town of Andover Stormwater Management & Erosion Control Bylaw and Regulations. The Applicant will submit the appropriate permit filings to the Town of Andover Conservation Commission.

Compliance with Zoning

Parking

Parking is dispersed around the existing Building 1 and 1A addition with handicap parking provided at the existing Building 1 entrance and proposed 1A entrance. The existing Building 1 loading dock will remain and the proposed 1A addition will include six loading docks.

In December 2021 the Town of Andover Zoning Board of Appeals (ZBA) granted a Variance from Article VIII of the Zoning Code to allow the Planning Board flexibility in approving parking requirements for the campus.

Refer to drawing C-121: Layout and Materials Plan for the Parking Summary table.

Dimensional Requirements

The existing Building 1 and proposed 1A addition are in compliance with the Dimension Requirements of the Industrial D2 (ID2) Zoning District. Refer to drawing C-121: Layout and Materials Plan for the Zoning Summary table.

Stormwater Narrative

Introduction

The existing stormwater collection system at the site discharges to the Merrimack River with no treatment, detention, or infiltration prior to discharge. The proposed stormwater management plan provides treatment, detention, and infiltration of stormwater in accordance with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Standards. Best Management Practices (BMPs), including Low Impact Development (LID) BMPs, are designed in accordance with the MassDEP Stormwater Handbook. The proposed development does not alter the tributary area that drains to the Merrimack River and no new discharge points into the river are proposed.

Hydrologic Conditions

The hydrology of existing (pre-development) and proposed (post-development) conditions were modeled using HydroCAD 10. Curve numbers were selected for grass and paved surfaces with hydrologic soil group A and B soils, based on tables provided from the SCS/NRCS TR-55 publication. The hydrologic soil group delineations and estimated Rawls rates are based on the NRCS web soil survey and are supported by onsite geotechnical investigation. Rainfall events used in the hydrology models were obtained from the NOAA Precipitation Frequency Estimates for a Type II 24-hour event at the project location. Detailed HydroCAD reports and drainage area maps for existing and proposed conditions are included in Appendix 3.1.

Existing Drainage System

Under existing conditions, stormwater within the project site flows overland or via a piped network northwest to a discharge endwall at the Merrimack River. It is unknown whether all or some of the catch basins have deep sumps or hoods which would meet the current Stormwater Handbook Standards for catch basin design. There are no known proprietary treatment devices (e.g. hydrodynamic separators) treating the collected stormwater prior to discharge. There are no detention or infiltration BMPs managing stormwater within the project site.

Proposed Drainage System

Under the proposed conditions, stormwater will be directed into deep-sump, hooded catch basins or infiltrated via porous pavement. All stormwater collected via the piped network within the limit of work will be intercepted and pretreated via hydrodynamic separation prior to discharge. The proposed 1a addition roof and a portion of the new parking lot will be routed to subsurface infiltration systems, located under the new parking lot. Additional discharge from the loading docks and adjacent parking areas will be routed to a lined subsurface detention system, which will provide peak flow attenuation.

Stormwater will ultimately discharge to the Merrimack River using the existing endwall. No new discharge point to the river, or to another resource area, is proposed.

Erosion Control and Construction Sequencing

The erosion and sedimentation control program minimizes the risk of impacts to resource areas and adjacent properties during construction of the Project. The program incorporates BMPs specified in the guidelines developed by MassDEP and the United States Environmental Protection Agency (US EPA) and complies with the requirements of the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Construction Activities. These measures include the installation of temporary erosion and sedimentation controls and construction sequencing. Areas of exposed soil will be kept to a minimum, and permanent vegetative cover (or binder coat of pavement) will be established after final grading or as soon as practicable. Erosion and sediment control measures proposed for the Project can be found in the Site Preparation Plan, sheet C-111.

Consistency with MassDEP Stormwater Management Policy

Standard 1 – Untreated Stormwater

Standard 1 states: No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

The project utilizes the existing endwall to the Merrimack River. Therefore, the project is in compliance with Standard 1.

Standard 2 – Post-Development Peak Discharge Rates

Standard 2 states: Stormwater management systems must be designed so that post-development peak rate discharge rates do not exceed pre-development peak discharge rates.

The proposed project is designed so that post-development peak discharge rates do not exceed the pre-development rates for the 2-, 10-, 25-, and 100-year storm events. Peak flow attenuation is achieved through use of porous pavement to reduce impervious areas, as well as three subsurface systems. Two of the systems provide recharge as well as peak flow reduction, while the third system provides detention only. The existing and proposed hydrologic conditions were modeled using HydroCAD to compare existing and proposed conditions. A summary table of pre-development and post-development peak discharge rates as well as hydrology maps and the full HydroCAD reports are included in Appendix 3.1.

The current proposal is in compliance with Standard 2.

Standard 3 – Recharge to Groundwater

Standard 3 states: Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types.

The required recharge volume calculations are based on the existing hydrological soil groups of the site and the increase in impervious surfaces proposed by the project. The site is composed of hydrological soil group A and B soils, based on the NRCS soil survey and geotechnical analysis. The division between A and B soils is highlighted on the attached hydrology maps, and the NRCS web soil survey map is included in Appendix 3.6. The HSG A soils are primarily in the northern portion of the site. The subsurface systems have been located within this portion of the site to ensure maximum infiltration rates.

The two subsurface recharge systems have been sized to infiltrate more than 0.60 inches of runoff over 72 hours, with an infiltration rate of 1.02 in/hour (Rawls rate for sandy loam). The combined contributing impervious area to the recharge systems exceeds the net increased impervious area from existing to proposed conditions.

Geotechnical investigations indicated seasonal high groundwater levels 3-4 feet below existing grades. The two systems have therefore been located in areas of maximum fill within the parking lot footprint to maintain a minimum two feet of separation to ESHGW, per regulation. The resulting high invert elevations of the recharge systems limited the areas of the site that could be routed to the recharge systems. Due to the feasibility limitations associated with the high groundwater levels and the redevelopment design constraints, recharge is provided only to the maximum extent practicable.

Recharge sizing and draw-down calculations can be found Appendix 3.2. The project's provided required recharge volume is in compliance with Standard 3 for redevelopment projects.

Standard 4 – Removal of Total Suspended Solids

Standard 4 states: For new development, stormwater management systems must be designed to remove 80% of the average annual load (post-development conditions) of Total Suspended Solids (TSS). It is presumed that this standard is met when: (a) Suitable nonstructural practices for source control and pollution prevention are implemented; (b) Stormwater management best practices (BMPs) are sized to capture the prescribed runoff volume; and (c) Stormwater management BMPs are maintained as designed.

Removal of Total Suspended Solids (TSS) at the site is accomplished through Contech Cascade CS-4 treatment devices, or approved equal, which have been sized to achieve minimum 80% TSS removal where used as standalone treatment practices. The subsurface infiltration systems provide 80% TSS removal when combined with pretreatment that achieves minimum 44% TSS removal. Therefore, the proprietary treatment devices used in tandem with the subsurface system are sized to provide minimum 44% TSS removal. Porous Pavement also provides 80% TSS removal. TSS removal rate spreadsheets for each treatment train as well as sizing and removal efficiency calcs for the proprietary treatment units have been provided in Appendix 3.3.

The current proposal is in compliance with Standard 4.

Standard 5 – Land Uses with Higher Potential Pollutant Loads

Standard 5 states: Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs. The use of infiltration practices without pretreatment is prohibited.

The Andover town stormwater regulations require that all treatment devices shall be sized to treat 1 inch of runoff; therefore, the proposed pretreatment units have been sized to meet the requirements for a Land Use with Higher Potential Pollutant Loads.

The proposal is in compliance with Standard 5.

Standard 6 – Critical Areas

Standard 6 states: Stormwater discharges within Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Management Handbook.

The site not within a critical area. The proposal is in compliance with Standard 6.

Standard 7 – Redevelopment Projects

Standard 7 states: A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

The majority of the project site qualifies as a redevelopment project, therefore the site has been designed to meet Standards 2-6 only to the maximum extent practicable. The entire site has been designed to achieve peak flow attenuation from existing to proposed conditions, and hydrodynamic separators are proposed where other BMPs are not feasible to ensure 80% TSS removal is achieved within the entire limit of work. Therefore Standards 2 and 4 are fully met. Recharge is provided for the increased impervious area on site, and the systems are sized to exceed the minimum recharge volume to the maximum extent practicable.

The proposal is in compliance with Standard 6.

Standard 8 – Erosion and Sedimentation Controls

Standard 8 states: Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities.

The following erosion and sediment controls will be implemented to prevent impacts during construction or land disturbance activities:

- Silt fence barriers
- Straw bales
- Vegetative slope stabilization
- Temporary swales and sedimentation basins
- Construction entrances

A Stormwater Pollution Prevention Plan (SWPPP) will be prepared for this project and will be submitted as part of the National Pollutant Discharge Elimination System (NPDES) permit process.

The current proposal is in compliance with Standard 8.

Standard 9 – Operation and Maintenance Plan

Standard 9 states: All stormwater management systems must have an operation and maintenance plan to ensure that systems function as designed.

A post-construction operation and maintenance plan is provided for the proposed development. The current proposal is in compliance with Standard 9.

Standard 10 – Illicit Discharges

Standard 10 states: All illicit discharges to the stormwater management system are prohibited.

There are no known or suspected illicit discharges to the stormwater management system at the project site. The project complies with Standard 10.

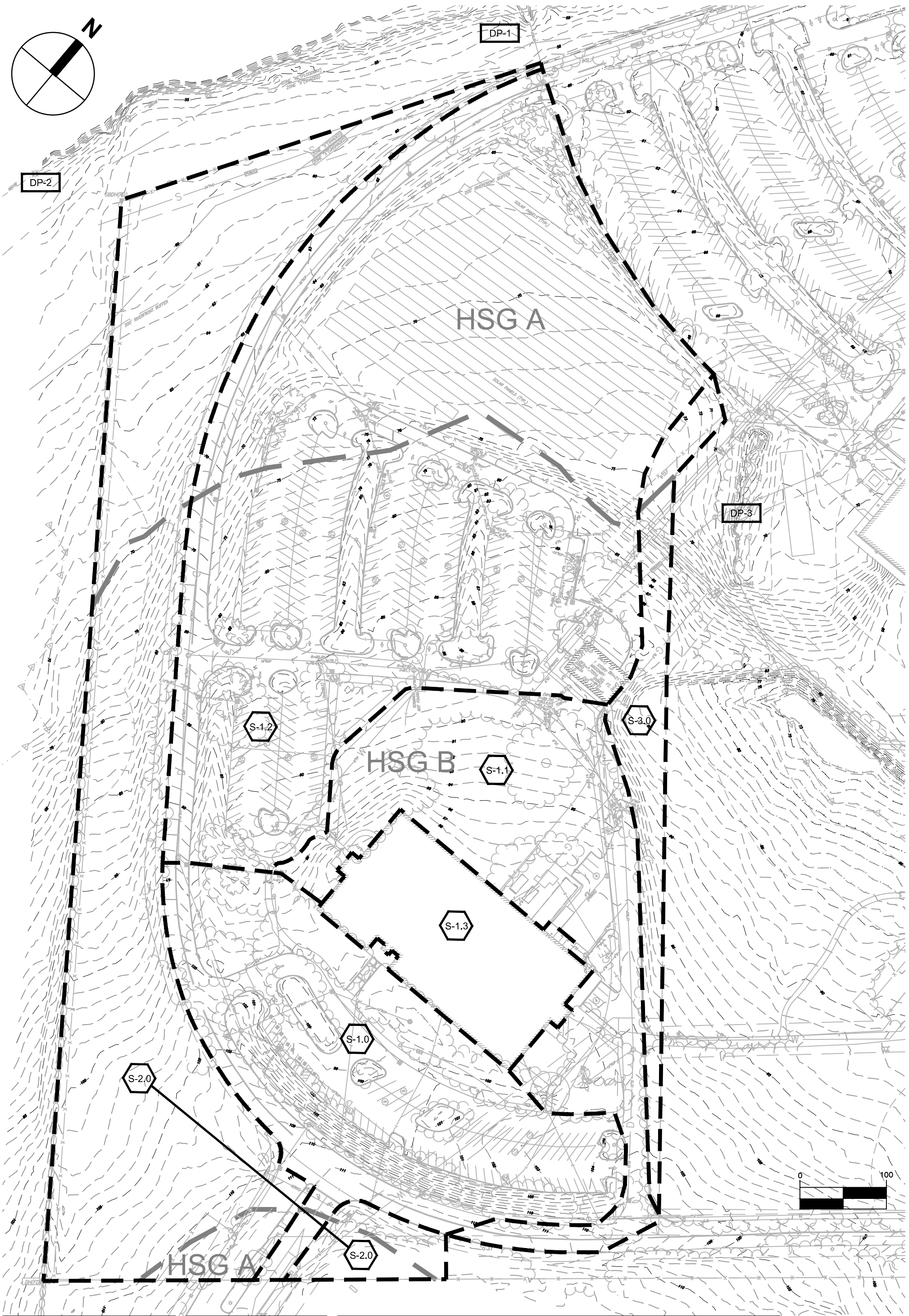
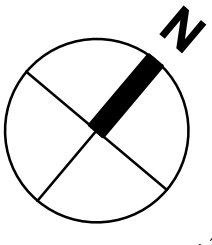
Consistency with Andover Town Stormwater Regulations

The project site has been designed in accordance with the Andover Town Stormwater Regulations. The design implements LID strategies, including porous pavement and subsurface recharge systems, as well as proprietary treatment practices, all of which meet the town's intent for climate change resiliency in stormwater design. In addition to the MassDEP Stormwater Standards above, the Andover town regulations include additional requirements for pollutant removal. In accordance with the requirements for a redevelopment project, the site has been designed to achieve minimum 50% phosphorus removal from the total proposed impervious area within the limit of work. Phosphorus removal is achieved through the two subsurface infiltration systems, porous pavement, and non-structural practices such as street sweeping and catch basin cleaning. Calculations demonstrating the phosphorus loads, removal rates, and overall phosphorus reduction are provided in Appendix 3.4.



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Figures



**EXISTING CONDITIONS
HYDROLOGY MAP**

DATE: 01/23/2022
ISSUE:
SCALE: 1"=100'
REF:
DR BY: MF
CK BY: WWP

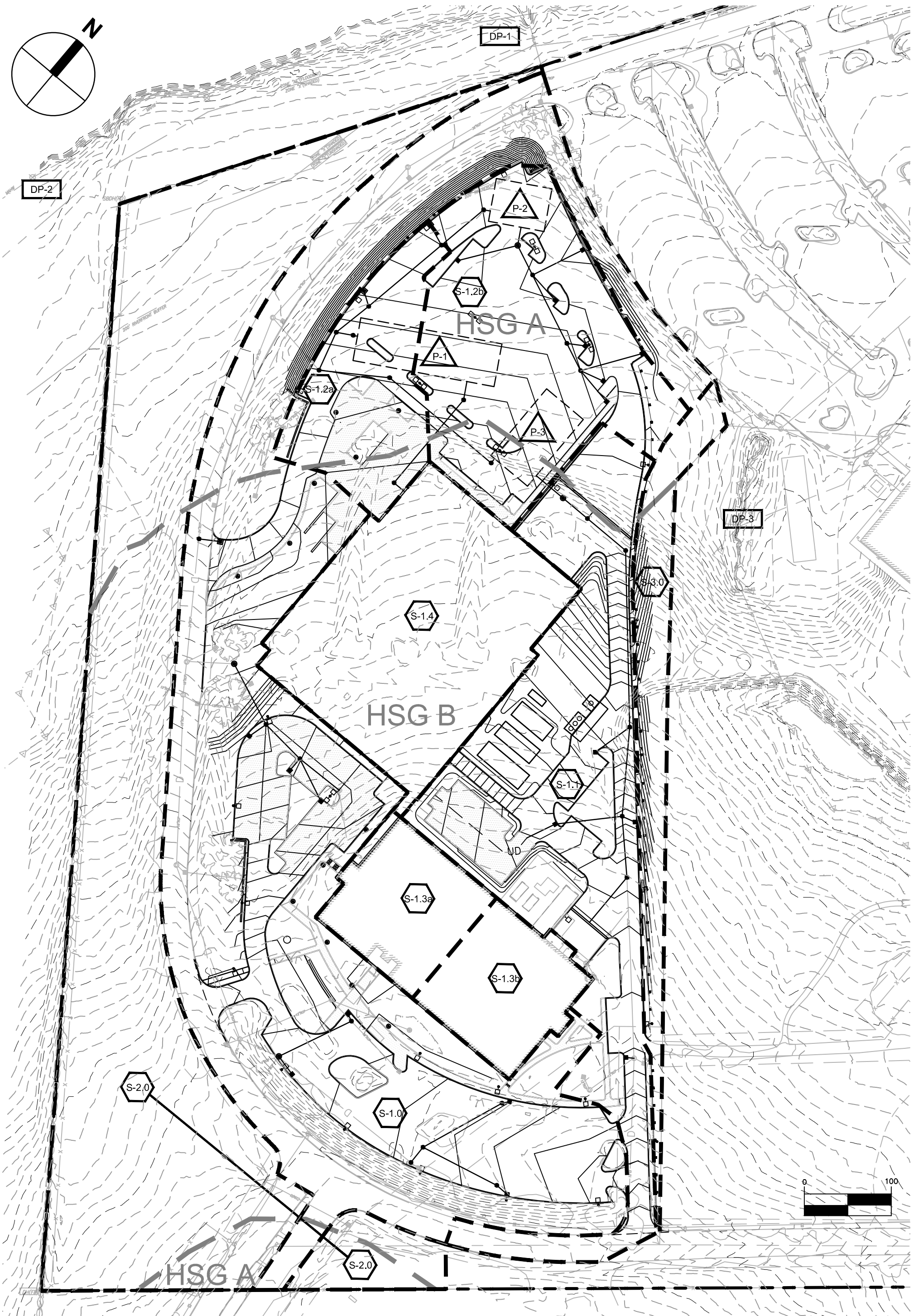
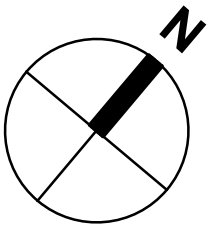
ARE Andover Building 1

3000 Minuteman Road
Andover MA

JOB NO.: 21141.00



SYMMES MAINI & McKEE ASSOCIATES
1000 Massachusetts Avenue
Cambridge, Massachusetts 02138
P:617.547.5400 F:617.648.4920



DATE: 01/23/2022
 ISSUE:
 SCALE: 1"=100'
 REF:
 DR BY: MF
 CK BY: WWP

ARE Andover Building 1
 3000 Minuteman Road
 Andover MA
 JOB NO.: 21141.00



**PROPOSED CONDITIONS
 HYDROLOGY MAP**

SYMMES MAINI & MCKEE ASSOCIATES
 1000 Massachusetts Avenue
 Cambridge, Massachusetts 02138
 P:617.547.5400 F:617.648.4920



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Appendices



Appendix 3.1

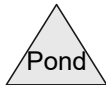
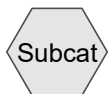
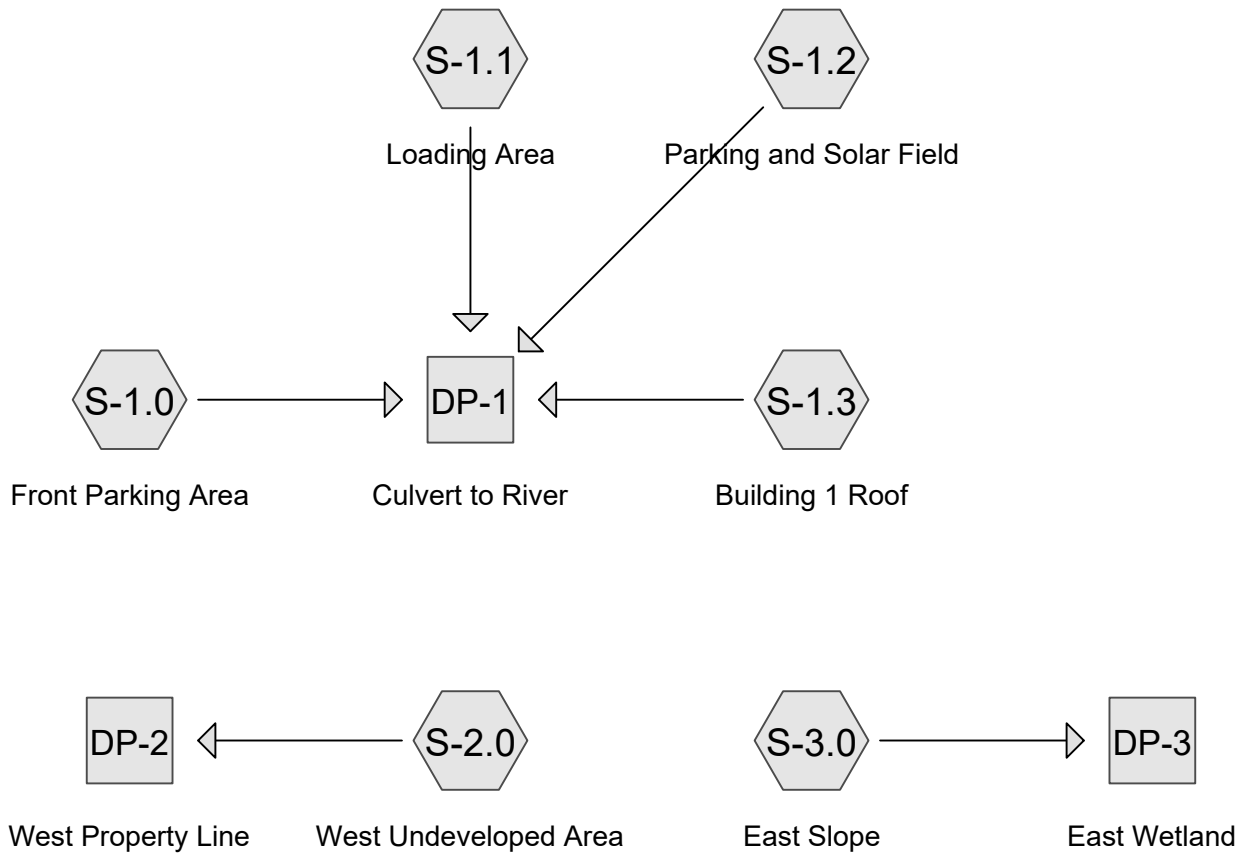
Hydrology Modeling

1000 MASSACHUSETTS AVENUE
 CAMBRIDGE, MASSACHUSETTS 02138
 T: 617.547.5400

ARE - Buildings 1 & 1A
 3000 Minuteman Road, Andover, MA
 SMMA Job No. 21141
 Date: 1/24/2022
 Calc by: MF
 Check by: WWP

Peak Discharge Rate Summary [cfs]

Design Point	2-year (3.11")		10-year (4.91")		25-year (6.03")		100-year (7.76")	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
DP-1	19.81	19.02	48.17	46.68	67.75	65.50	99.43	96.32
DP-2	0.33	0.33	5.37	5.37	10.10	10.10	18.73	18.73
DP-3	0.21	0.19	1.27	1.15	2.13	1.93	3.64	3.29



Routing Diagram for ARE Andover Building 1 - EX
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.590	39	>75% Grass cover, Good, HSG A (S-1.0, S-1.2, S-2.0, S-3.0)
6.300	61	>75% Grass cover, Good, HSG B (S-1.1, S-1.2, S-2.0, S-3.0)
6.160	98	Paved Parking (S-1.0, S-1.1, S-1.2, S-2.0)
1.020	98	Roofs (S-1.3)
20.070	67	TOTAL AREA

ARE Andover Building 1 - EX

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ARE Building 1 - Existing Conditions
Type II 24-hr 2 yr Storm Rainfall=3.11"

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking Area Runoff Area=2.870 ac 55.05% Impervious Runoff Depth=0.82"
Flow Length=1,816' Tc=6.0 min CN=71 Runoff=4.10 cfs 0.197 af

SubcatchmentS-1.1: Loading Area Runoff Area=2.460 ac 39.43% Impervious Runoff Depth=1.09"
Flow Length=1,527' Tc=9.1 min CN=76 Runoff=4.22 cfs 0.223 af

SubcatchmentS-1.2: Parking and Solar Runoff Area=7.910 ac 44.25% Impervious Runoff Depth=0.73"
Flow Length=843' Tc=10.1 min CN=69 Runoff=8.16 cfs 0.481 af

SubcatchmentS-1.3: Building 1 Roof Runoff Area=1.020 ac 100.00% Impervious Runoff Depth=2.88"
Tc=6.0 min CN=98 Runoff=4.48 cfs 0.245 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=0.18"
Flow Length=580' Tc=9.6 min CN=53 Runoff=0.33 cfs 0.074 af

SubcatchmentS-3.0: East Slope Runoff Area=0.720 ac 0.00% Impervious Runoff Depth=0.28"
Tc=6.0 min CN=57 Runoff=0.21 cfs 0.017 af

Reach DP-1: Culvert to River Inflow=19.81 cfs 1.146 af
Outflow=19.81 cfs 1.146 af

Reach DP-2: West Property Line Inflow=0.33 cfs 0.074 af
Outflow=0.33 cfs 0.074 af

Reach DP-3: East Wetland Inflow=0.21 cfs 0.017 af
Outflow=0.21 cfs 0.017 af

Total Runoff Area = 20.070 ac Runoff Volume = 1.237 af Average Runoff Depth = 0.74"
64.23% Pervious = 12.890 ac 35.77% Impervious = 7.180 ac

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ARE Building 1 - Existing Conditions
Type II 24-hr 2 yr Storm Rainfall=3.11"

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Summary for Subcatchment S-1.0: Front Parking Area

Runoff = 4.10 cfs @ 11.98 hrs, Volume= 0.197 af, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
* 1.580	98	Paved Parking
2.870	71	Weighted Average
1.290		44.95% Pervious Area
1.580		55.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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ARE Building 1 - Existing Conditions
Type II 24-hr 2 yr Storm Rainfall=3.11"

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5.1 1,816 Total, Increased to minimum Tc = 6.0 min

Summary for Subcatchment S-1.1: Loading Area

Runoff = 4.22 cfs @ 12.01 hrs, Volume= 0.223 af, Depth= 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
1.490	61	>75% Grass cover, Good, HSG B
* 0.970	98	Paved Parking
2.460	76	Weighted Average
1.490		60.57% Pervious Area
0.970		39.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.0320	0.18		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.7	150	0.0450	1.48		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.3	10	0.0010	0.64		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
0.4	163	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15"
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.3	107	0.0100	7.03	12.41	Pipe Channel, CMP_Round 18"
					18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	154	0.0100	7.79	18.73	Pipe Channel, RCP_Round 21"
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	232	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	67	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

9.1 1,527 Total

ARE Andover Building 1 - EX

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ARE Building 1 - Existing Conditions
Type II 24-hr 2 yr Storm Rainfall=3.11"

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Summary for Subcatchment S-1.2: Parking and Solar Field

Runoff = 8.16 cfs @ 12.03 hrs, Volume= 0.481 af, Depth= 0.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
1.300	61	>75% Grass cover, Good, HSG B
3.110	39	>75% Grass cover, Good, HSG A
* 3.500	98	Paved Parking
7.910	69	Weighted Average
4.410		55.75% Pervious Area
3.500		44.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.0750	0.25		Sheet Flow, A-B Grass: Short n= 0.150 P2= 3.11"
0.8	107	0.0960	2.17		Shallow Concentrated Flow, B-C Short Grass Pasture Kv= 7.0 fps
5.5	423	0.0340	1.29		Shallow Concentrated Flow, C-D Short Grass Pasture Kv= 7.0 fps
0.0	15	0.0100	5.36	4.21	Pipe Channel, CMP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
10.1	843	Total			

Summary for Subcatchment S-1.3: Building 1 Roof

Runoff = 4.48 cfs @ 11.97 hrs, Volume= 0.245 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
* 1.020	98	Roofs
1.020		100.00% Impervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 0.33 cfs @ 12.09 hrs, Volume= 0.074 af, Depth= 0.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

Summary for Subcatchment S-3.0: East Slope

Runoff = 0.21 cfs @ 12.01 hrs, Volume= 0.017 af, Depth= 0.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
0.600	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.720	57	Weighted Average
0.720		100.00% Pervious Area

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Type II 24-hr 2 yr Storm Rainfall=3.11"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.260 ac, 49.58% Impervious, Inflow Depth = 0.96" for 2 yr Storm event
Inflow = 19.81 cfs @ 12.00 hrs, Volume= 1.146 af
Outflow = 19.81 cfs @ 12.00 hrs, Volume= 1.146 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 0.18" for 2 yr Storm event
Inflow = 0.33 cfs @ 12.09 hrs, Volume= 0.074 af
Outflow = 0.33 cfs @ 12.09 hrs, Volume= 0.074 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.720 ac, 0.00% Impervious, Inflow Depth = 0.28" for 2 yr Storm event
Inflow = 0.21 cfs @ 12.01 hrs, Volume= 0.017 af
Outflow = 0.21 cfs @ 12.01 hrs, Volume= 0.017 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

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Type II 24-hr 10 yr Storm Rainfall=4.91"

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking Area Runoff Area=2.870 ac 55.05% Impervious Runoff Depth=2.05"
Flow Length=1,816' Tc=6.0 min CN=71 Runoff=10.54 cfs 0.490 af

SubcatchmentS-1.1: Loading Area Runoff Area=2.460 ac 39.43% Impervious Runoff Depth=2.46"
Flow Length=1,527' Tc=9.1 min CN=76 Runoff=9.65 cfs 0.505 af

SubcatchmentS-1.2: Parking and Solar Runoff Area=7.910 ac 44.25% Impervious Runoff Depth=1.89"
Flow Length=843' Tc=10.1 min CN=69 Runoff=22.86 cfs 1.247 af

SubcatchmentS-1.3: Building 1 Roof Runoff Area=1.020 ac 100.00% Impervious Runoff Depth=4.67"
Tc=6.0 min CN=98 Runoff=7.13 cfs 0.397 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=0.82"
Flow Length=580' Tc=9.6 min CN=53 Runoff=5.37 cfs 0.348 af

SubcatchmentS-3.0: East Slope Runoff Area=0.720 ac 0.00% Impervious Runoff Depth=1.06"
Tc=6.0 min CN=57 Runoff=1.27 cfs 0.063 af

Reach DP-1: Culvert to River Inflow=48.17 cfs 2.639 af
Outflow=48.17 cfs 2.639 af

Reach DP-2: West Property Line Inflow=5.37 cfs 0.348 af
Outflow=5.37 cfs 0.348 af

Reach DP-3: East Wetland Inflow=1.27 cfs 0.063 af
Outflow=1.27 cfs 0.063 af

Total Runoff Area = 20.070 ac Runoff Volume = 3.050 af Average Runoff Depth = 1.82"
64.23% Pervious = 12.890 ac 35.77% Impervious = 7.180 ac

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Summary for Subcatchment S-1.0: Front Parking Area

Runoff = 10.54 cfs @ 11.98 hrs, Volume= 0.490 af, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
* 1.580	98	Paved Parking
2.870	71	Weighted Average
1.290		44.95% Pervious Area
1.580		55.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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5.1 1,816 Total, Increased to minimum Tc = 6.0 min

Summary for Subcatchment S-1.1: Loading Area

Runoff = 9.65 cfs @ 12.01 hrs, Volume= 0.505 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
1.490	61	>75% Grass cover, Good, HSG B
* 0.970	98	Paved Parking
2.460	76	Weighted Average
1.490		60.57% Pervious Area
0.970		39.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.0320	0.18		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.7	150	0.0450	1.48		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.3	10	0.0010	0.64		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
0.4	163	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15"
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.3	107	0.0100	7.03	12.41	Pipe Channel, CMP_Round 18"
					18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	154	0.0100	7.79	18.73	Pipe Channel, RCP_Round 21"
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	232	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	67	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

9.1 1,527 Total

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Summary for Subcatchment S-1.2: Parking and Solar Field

Runoff = 22.86 cfs @ 12.02 hrs, Volume= 1.247 af, Depth= 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
1.300	61	>75% Grass cover, Good, HSG B
3.110	39	>75% Grass cover, Good, HSG A
* 3.500	98	Paved Parking
7.910	69	Weighted Average
4.410		55.75% Pervious Area
3.500		44.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.0750	0.25		Sheet Flow, A-B Grass: Short n= 0.150 P2= 3.11"
0.8	107	0.0960	2.17		Shallow Concentrated Flow, B-C Short Grass Pasture Kv= 7.0 fps
5.5	423	0.0340	1.29		Shallow Concentrated Flow, C-D Short Grass Pasture Kv= 7.0 fps
0.0	15	0.0100	5.36	4.21	Pipe Channel, CMP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
10.1	843	Total			

Summary for Subcatchment S-1.3: Building 1 Roof

Runoff = 7.13 cfs @ 11.97 hrs, Volume= 0.397 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
* 1.020	98	Roofs
1.020		100.00% Impervious Area

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Type II 24-hr 10 yr Storm Rainfall=4.91"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 5.37 cfs @ 12.04 hrs, Volume= 0.348 af, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

Summary for Subcatchment S-3.0: East Slope

Runoff = 1.27 cfs @ 11.99 hrs, Volume= 0.063 af, Depth= 1.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
0.600	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.720	57	Weighted Average
0.720		100.00% Pervious Area

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Type II 24-hr 10 yr Storm Rainfall=4.91"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.260 ac, 49.58% Impervious, Inflow Depth = 2.22" for 10 yr Storm event
Inflow = 48.17 cfs @ 12.00 hrs, Volume= 2.639 af
Outflow = 48.17 cfs @ 12.00 hrs, Volume= 2.639 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 0.82" for 10 yr Storm event
Inflow = 5.37 cfs @ 12.04 hrs, Volume= 0.348 af
Outflow = 5.37 cfs @ 12.04 hrs, Volume= 0.348 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.720 ac, 0.00% Impervious, Inflow Depth = 1.06" for 10 yr Storm event
Inflow = 1.27 cfs @ 11.99 hrs, Volume= 0.063 af
Outflow = 1.27 cfs @ 11.99 hrs, Volume= 0.063 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

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Type II 24-hr 25 yr Storm Rainfall=6.03"

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking Area Runoff Area=2.870 ac 55.05% Impervious Runoff Depth=2.92"
Flow Length=1,816' Tc=6.0 min CN=71 Runoff=15.01 cfs 0.699 af

SubcatchmentS-1.1: Loading Area Runoff Area=2.460 ac 39.43% Impervious Runoff Depth=3.41"
Flow Length=1,527' Tc=9.1 min CN=76 Runoff=13.28 cfs 0.698 af

SubcatchmentS-1.2: Parking and Solar Runoff Area=7.910 ac 44.25% Impervious Runoff Depth=2.74"
Flow Length=843' Tc=10.1 min CN=69 Runoff=33.28 cfs 1.803 af

SubcatchmentS-1.3: Building 1 Roof Runoff Area=1.020 ac 100.00% Impervious Runoff Depth=5.79"
Tc=6.0 min CN=98 Runoff=8.77 cfs 0.492 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=1.38"
Flow Length=580' Tc=9.6 min CN=53 Runoff=10.10 cfs 0.586 af

SubcatchmentS-3.0: East Slope Runoff Area=0.720 ac 0.00% Impervious Runoff Depth=1.69"
Tc=6.0 min CN=57 Runoff=2.13 cfs 0.102 af

Reach DP-1: Culvert to River Inflow=67.75 cfs 3.693 af
Outflow=67.75 cfs 3.693 af

Reach DP-2: West Property Line Inflow=10.10 cfs 0.586 af
Outflow=10.10 cfs 0.586 af

Reach DP-3: East Wetland Inflow=2.13 cfs 0.102 af
Outflow=2.13 cfs 0.102 af

Total Runoff Area = 20.070 ac Runoff Volume = 4.380 af Average Runoff Depth = 2.62"
64.23% Pervious = 12.890 ac 35.77% Impervious = 7.180 ac

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Type II 24-hr 25 yr Storm Rainfall=6.03"

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Summary for Subcatchment S-1.0: Front Parking Area

Runoff = 15.01 cfs @ 11.97 hrs, Volume= 0.699 af, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
* 1.580	98	Paved Parking
2.870	71	Weighted Average
1.290		44.95% Pervious Area
1.580		55.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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ARE Building 1 - Existing Conditions
Type II 24-hr 25 yr Storm Rainfall=6.03"

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5.1 1,816 Total, Increased to minimum Tc = 6.0 min

Summary for Subcatchment S-1.1: Loading Area

Runoff = 13.28 cfs @ 12.01 hrs, Volume= 0.698 af, Depth= 3.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
1.490	61	>75% Grass cover, Good, HSG B
* 0.970	98	Paved Parking
2.460	76	Weighted Average
1.490		60.57% Pervious Area
0.970		39.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.0320	0.18		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.7	150	0.0450	1.48		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.3	10	0.0010	0.64		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
0.4	163	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15"
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.3	107	0.0100	7.03	12.41	Pipe Channel, CMP_Round 18"
					18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	154	0.0100	7.79	18.73	Pipe Channel, RCP_Round 21"
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	232	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	67	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

9.1 1,527 Total

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Type II 24-hr 25 yr Storm Rainfall=6.03"

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Summary for Subcatchment S-1.2: Parking and Solar Field

Runoff = 33.28 cfs @ 12.02 hrs, Volume= 1.803 af, Depth= 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
1.300	61	>75% Grass cover, Good, HSG B
3.110	39	>75% Grass cover, Good, HSG A
* 3.500	98	Paved Parking
7.910	69	Weighted Average
4.410		55.75% Pervious Area
3.500		44.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.0750	0.25		Sheet Flow, A-B Grass: Short n= 0.150 P2= 3.11"
0.8	107	0.0960	2.17		Shallow Concentrated Flow, B-C Short Grass Pasture Kv= 7.0 fps
5.5	423	0.0340	1.29		Shallow Concentrated Flow, C-D Short Grass Pasture Kv= 7.0 fps
0.0	15	0.0100	5.36	4.21	Pipe Channel, CMP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
10.1	843	Total			

Summary for Subcatchment S-1.3: Building 1 Roof

Runoff = 8.77 cfs @ 11.97 hrs, Volume= 0.492 af, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
* 1.020	98	Roofs
1.020		100.00% Impervious Area

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ARE Building 1 - Existing Conditions
Type II 24-hr 25 yr Storm Rainfall=6.03"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 10.10 cfs @ 12.03 hrs, Volume= 0.586 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

Summary for Subcatchment S-3.0: East Slope

Runoff = 2.13 cfs @ 11.98 hrs, Volume= 0.102 af, Depth= 1.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
0.600	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.720	57	Weighted Average
0.720		100.00% Pervious Area

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ARE Building 1 - Existing Conditions
Type II 24-hr 25 yr Storm Rainfall=6.03"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.260 ac, 49.58% Impervious, Inflow Depth = 3.11" for 25 yr Storm event
Inflow = 67.75 cfs @ 12.00 hrs, Volume= 3.693 af
Outflow = 67.75 cfs @ 12.00 hrs, Volume= 3.693 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 1.38" for 25 yr Storm event
Inflow = 10.10 cfs @ 12.03 hrs, Volume= 0.586 af
Outflow = 10.10 cfs @ 12.03 hrs, Volume= 0.586 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.720 ac, 0.00% Impervious, Inflow Depth = 1.69" for 25 yr Storm event
Inflow = 2.13 cfs @ 11.98 hrs, Volume= 0.102 af
Outflow = 2.13 cfs @ 11.98 hrs, Volume= 0.102 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

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Type II 24-hr 100 yr Storm Rainfall=7.76"

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking Area Runoff Area=2.870 ac 55.05% Impervious Runoff Depth=4.37"
Flow Length=1,816' Tc=6.0 min CN=71 Runoff=22.22 cfs 1.046 af

SubcatchmentS-1.1: Loading Area Runoff Area=2.460 ac 39.43% Impervious Runoff Depth=4.94"
Flow Length=1,527' Tc=9.1 min CN=76 Runoff=19.03 cfs 1.013 af

SubcatchmentS-1.2: Parking and Solar Runoff Area=7.910 ac 44.25% Impervious Runoff Depth=4.15"
Flow Length=843' Tc=10.1 min CN=69 Runoff=50.35 cfs 2.733 af

SubcatchmentS-1.3: Building 1 Roof Runoff Area=1.020 ac 100.00% Impervious Runoff Depth=7.52"
Tc=6.0 min CN=98 Runoff=11.30 cfs 0.639 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=2.41"
Flow Length=580' Tc=9.6 min CN=53 Runoff=18.73 cfs 1.023 af

SubcatchmentS-3.0: East Slope Runoff Area=0.720 ac 0.00% Impervious Runoff Depth=2.83"
Tc=6.0 min CN=57 Runoff=3.64 cfs 0.170 af

Reach DP-1: Culvert to River Inflow=99.43 cfs 5.431 af
Outflow=99.43 cfs 5.431 af

Reach DP-2: West Property Line Inflow=18.73 cfs 1.023 af
Outflow=18.73 cfs 1.023 af

Reach DP-3: East Wetland Inflow=3.64 cfs 0.170 af
Outflow=3.64 cfs 0.170 af

Total Runoff Area = 20.070 ac Runoff Volume = 6.624 af Average Runoff Depth = 3.96"
64.23% Pervious = 12.890 ac 35.77% Impervious = 7.180 ac

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Summary for Subcatchment S-1.0: Front Parking Area

Runoff = 22.22 cfs @ 11.97 hrs, Volume= 1.046 af, Depth= 4.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
* 1.580	98	Paved Parking
2.870	71	Weighted Average
1.290		44.95% Pervious Area
1.580		55.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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5.1 1,816 Total, Increased to minimum Tc = 6.0 min

Summary for Subcatchment S-1.1: Loading Area

Runoff = 19.03 cfs @ 12.00 hrs, Volume= 1.013 af, Depth= 4.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
1.490	61	>75% Grass cover, Good, HSG B
* 0.970	98	Paved Parking
2.460	76	Weighted Average
1.490		60.57% Pervious Area
0.970		39.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.0320	0.18		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.7	150	0.0450	1.48		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.3	10	0.0010	0.64		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
0.4	163	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15"
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.3	107	0.0100	7.03	12.41	Pipe Channel, CMP_Round 18"
					18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	154	0.0100	7.79	18.73	Pipe Channel, RCP_Round 21"
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30"
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	232	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	67	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36"
					36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

9.1 1,527 Total

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Type II 24-hr 100 yr Storm Rainfall=7.76"

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Summary for Subcatchment S-1.2: Parking and Solar Field

Runoff = 50.35 cfs @ 12.02 hrs, Volume= 2.733 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
1.300	61	>75% Grass cover, Good, HSG B
3.110	39	>75% Grass cover, Good, HSG A
* 3.500	98	Paved Parking
7.910	69	Weighted Average
4.410		55.75% Pervious Area
3.500		44.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.0750	0.25		Sheet Flow, A-B Grass: Short n= 0.150 P2= 3.11"
0.8	107	0.0960	2.17		Shallow Concentrated Flow, B-C Short Grass Pasture Kv= 7.0 fps
5.5	423	0.0340	1.29		Shallow Concentrated Flow, C-D Short Grass Pasture Kv= 7.0 fps
0.0	15	0.0100	5.36	4.21	Pipe Channel, CMP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011
0.3	182	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	66	0.0100	11.15	78.83	Pipe Channel, CMP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
10.1	843	Total			

Summary for Subcatchment S-1.3: Building 1 Roof

Runoff = 11.30 cfs @ 11.97 hrs, Volume= 0.639 af, Depth= 7.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
* 1.020	98	Roofs
1.020		100.00% Impervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 18.73 cfs @ 12.02 hrs, Volume= 1.023 af, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

Summary for Subcatchment S-3.0: East Slope

Runoff = 3.64 cfs @ 11.98 hrs, Volume= 0.170 af, Depth= 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
0.600	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.720	57	Weighted Average
0.720		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.260 ac, 49.58% Impervious, Inflow Depth = 4.57" for 100 yr Storm event
Inflow = 99.43 cfs @ 12.00 hrs, Volume= 5.431 af
Outflow = 99.43 cfs @ 12.00 hrs, Volume= 5.431 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 2.41" for 100 yr Storm event
Inflow = 18.73 cfs @ 12.02 hrs, Volume= 1.023 af
Outflow = 18.73 cfs @ 12.02 hrs, Volume= 1.023 af, Atten= 0%, Lag= 0.0 min

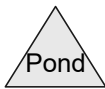
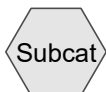
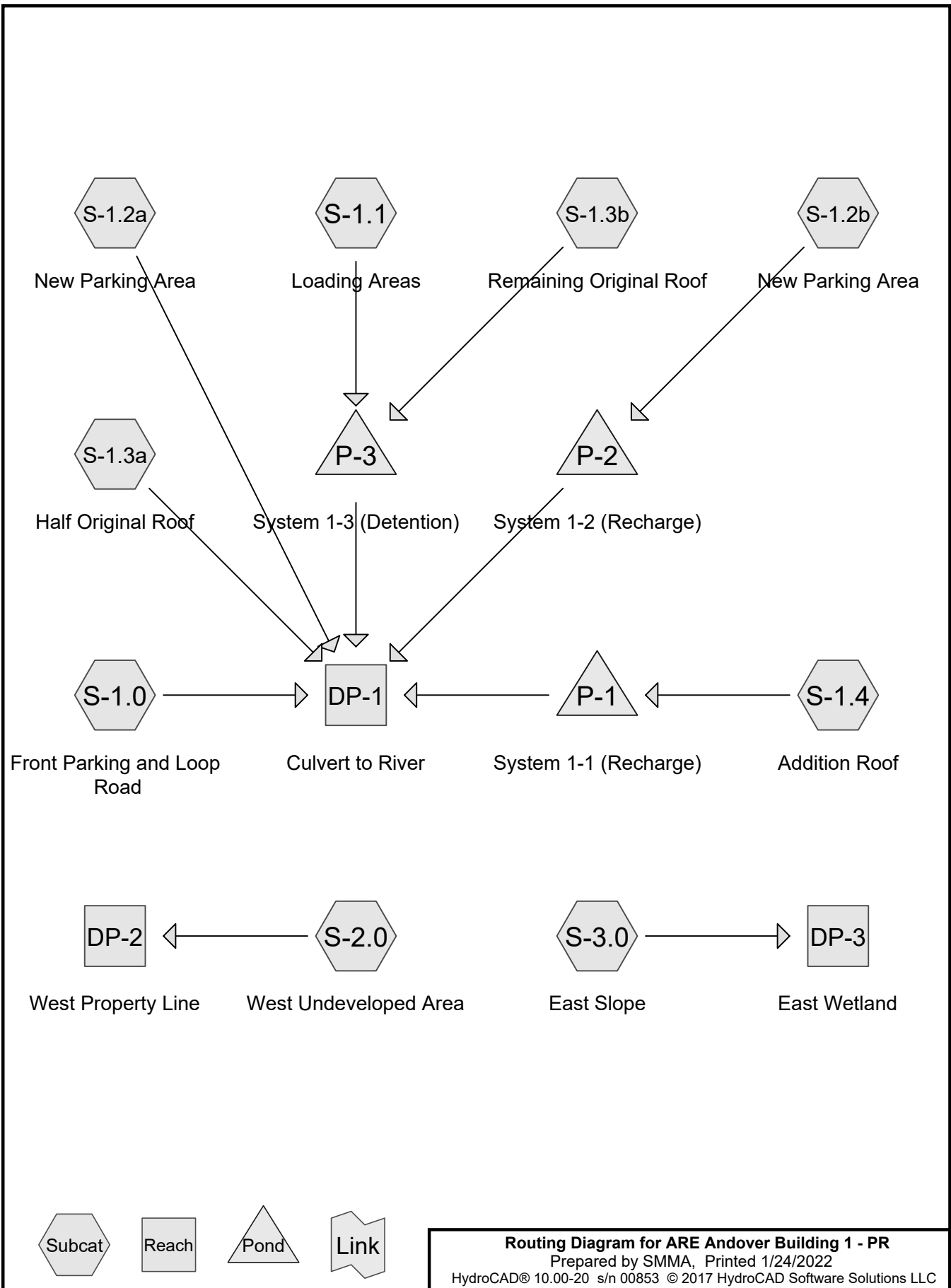
Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.720 ac, 0.00% Impervious, Inflow Depth = 2.83" for 100 yr Storm event
Inflow = 3.64 cfs @ 11.98 hrs, Volume= 0.170 af
Outflow = 3.64 cfs @ 11.98 hrs, Volume= 0.170 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



Routing Diagram for ARE Andover Building 1 - PR
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.410	39	>75% Grass cover, Good, HSG A (S-1.0, S-1.2a, S-1.2b, S-2.0, S-3.0)
6.680	61	>75% Grass cover, Good, HSG B (S-1.0, S-1.1, S-2.0, S-3.0)
6.300	98	Paved Parking (S-1.0, S-1.1, S-1.2a, S-1.2b, S-2.0)
0.600	50	Porous Pavement (S-1.0, S-1.1)
0.300	50	Porous Pavers (S-1.0, S-1.2a, S-1.2b)
2.780	98	Roofs (S-1.3a, S-1.3b, S-1.4)
20.070	74	TOTAL AREA

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Type II 24-hr 2 yr Storm Rainfall=3.11"

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking and Runoff Area=6.340 ac 41.48% Impervious Runoff Depth=0.87"
Flow Length=1,816' Tc=6.0 min CN=72 Runoff=9.69 cfs 0.462 af

SubcatchmentS-1.1: Loading Areas Runoff Area=2.630 ac 57.41% Impervious Runoff Depth=1.47"
Tc=9.1 min CN=82 Runoff=6.15 cfs 0.321 af

SubcatchmentS-1.2a: New Parking Area Runoff Area=0.790 ac 63.29% Impervious Runoff Depth=1.27"
Tc=6.0 min CN=79 Runoff=1.80 cfs 0.084 af

SubcatchmentS-1.2b: New Parking Area Runoff Area=1.790 ac 86.59% Impervious Runoff Depth=2.09"
Tc=6.0 min CN=90 Runoff=6.45 cfs 0.311 af

SubcatchmentS-1.3a: Half Original Roof Runoff Area=0.530 ac 100.00% Impervious Runoff Depth=2.88"
Tc=6.0 min CN=98 Runoff=2.33 cfs 0.127 af

SubcatchmentS-1.3b: Remaining Original Runoff Area=0.520 ac 100.00% Impervious Runoff Depth=2.88"
Tc=9.1 min CN=98 Runoff=2.07 cfs 0.125 af

SubcatchmentS-1.4: Addition Roof Runoff Area=1.730 ac 100.00% Impervious Runoff Depth=2.88"
Tc=6.0 min CN=98 Runoff=7.60 cfs 0.415 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=0.18"
Flow Length=580' Tc=9.6 min CN=53 Runoff=0.33 cfs 0.074 af

SubcatchmentS-3.0: East Slope Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=0.28"
Tc=6.0 min CN=57 Runoff=0.19 cfs 0.015 af

Reach DP-1: Culvert to River Inflow=19.02 cfs 1.310 af
Outflow=19.02 cfs 1.310 af

Reach DP-2: West Property Line Inflow=0.33 cfs 0.074 af
Outflow=0.33 cfs 0.074 af

Reach DP-3: East Wetland Inflow=0.19 cfs 0.015 af
Outflow=0.19 cfs 0.015 af

Pond P-1: System 1-1 (Recharge) Peak Elev=71.81' Storage=8,437 cf Inflow=7.60 cfs 0.415 af
Discarded=0.19 cfs 0.373 af Primary=0.29 cfs 0.042 af Outflow=0.48 cfs 0.415 af

Pond P-2: System 1-2 (Recharge) Peak Elev=68.92' Storage=4,777 cf Inflow=6.45 cfs 0.311 af
Discarded=0.08 cfs 0.162 af Primary=3.76 cfs 0.150 af Outflow=3.84 cfs 0.311 af

Pond P-3: System 1-3 (Detention) Peak Elev=67.40' Storage=5,231 cf Inflow=8.21 cfs 0.446 af
Outflow=3.58 cfs 0.446 af

Total Runoff Area = 20.070 ac Runoff Volume = 1.934 af Average Runoff Depth = 1.16"
54.76% Pervious = 10.990 ac 45.24% Impervious = 9.080 ac

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Type II 24-hr 2 yr Storm Rainfall=3.11"

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Summary for Subcatchment S-1.0: Front Parking and Loop Road

Runoff = 9.69 cfs @ 11.98 hrs, Volume= 0.462 af, Depth= 0.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
0.900	39	>75% Grass cover, Good, HSG A
2.290	61	>75% Grass cover, Good, HSG B
* 2.630	98	Paved Parking
* 0.090	50	Porous Pavers
* 0.430	50	Porous Pavement
6.340	72	Weighted Average
3.710		58.52% Pervious Area
2.630		41.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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0.1	66	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
-----	----	--------	-------	-------	---

5.1 1,816 Total, Increased to minimum Tc = 6.0 min

Summary for Subcatchment S-1.1: Loading Areas

Runoff = 6.15 cfs @ 12.01 hrs, Volume= 0.321 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
0.950	61	>75% Grass cover, Good, HSG B
* 0.170	50	Porous Pavement
* 1.510	98	Paved Parking
2.630	82	Weighted Average
1.120		42.59% Pervious Area
1.510		57.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Roof Tc

Summary for Subcatchment S-1.2a: New Parking Area

Runoff = 1.80 cfs @ 11.98 hrs, Volume= 0.084 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
* 0.190	50	Porous Pavers
0.100	39	>75% Grass cover, Good, HSG A
* 0.500	98	Paved Parking
0.790	79	Weighted Average
0.290		36.71% Pervious Area
0.500		63.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

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Summary for Subcatchment S-1.2b: New Parking Area

Runoff = 6.45 cfs @ 11.97 hrs, Volume= 0.311 af, Depth= 2.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
* 0.020	50	Porous Pavers
0.220	39	>75% Grass cover, Good, HSG A
* 1.550	98	Paved Parking
1.790	90	Weighted Average
0.240		13.41% Pervious Area
1.550		86.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3a: Half Original Roof

Runoff = 2.33 cfs @ 11.97 hrs, Volume= 0.127 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
* 0.530	98	Roofs
0.530		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3b: Remaining Original Roof

Runoff = 2.07 cfs @ 12.00 hrs, Volume= 0.125 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
* 0.520	98	Roofs
0.520		100.00% Impervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Min Tc

Summary for Subcatchment S-1.4: Addition Roof

Runoff = 7.60 cfs @ 11.97 hrs, Volume= 0.415 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
* 1.730	98	Roofs
* 0.000	98	Paved Parking
1.730	98	Weighted Average
1.730		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 0.33 cfs @ 12.09 hrs, Volume= 0.074 af, Depth= 0.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

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Type II 24-hr 2 yr Storm Rainfall=3.11"

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Summary for Subcatchment S-3.0: East Slope

Runoff = 0.19 cfs @ 12.01 hrs, Volume= 0.015 af, Depth= 0.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2 yr Storm Rainfall=3.11"

Area (ac)	CN	Description
0.530	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.650	57	Weighted Average
0.650		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.330 ac, 62.60% Impervious, Inflow Depth = 1.10" for 2 yr Storm event
Inflow = 19.02 cfs @ 12.00 hrs, Volume= 1.310 af
Outflow = 19.02 cfs @ 12.00 hrs, Volume= 1.310 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 0.18" for 2 yr Storm event
Inflow = 0.33 cfs @ 12.09 hrs, Volume= 0.074 af
Outflow = 0.33 cfs @ 12.09 hrs, Volume= 0.074 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.650 ac, 0.00% Impervious, Inflow Depth = 0.28" for 2 yr Storm event
Inflow = 0.19 cfs @ 12.01 hrs, Volume= 0.015 af
Outflow = 0.19 cfs @ 12.01 hrs, Volume= 0.015 af, Atten= 0%, Lag= 0.0 min

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Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Pond P-1: System 1-1 (Recharge)

Inflow Area = 1.730 ac, 100.00% Impervious, Inflow Depth = 2.88" for 2 yr Storm event
Inflow = 7.60 cfs @ 11.97 hrs, Volume= 0.415 af
Outflow = 0.48 cfs @ 12.60 hrs, Volume= 0.415 af, Atten= 94%, Lag= 37.8 min
Discarded = 0.19 cfs @ 10.72 hrs, Volume= 0.373 af
Primary = 0.29 cfs @ 12.60 hrs, Volume= 0.042 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 71.81' @ 12.60 hrs Surf.Area= 8,250 sf Storage= 8,437 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 307.3 min (1,060.4 - 753.1)

Volume	Invert	Avail.Storage	Storage Description
#1	70.00'	6,024 cf	50.00'W x 165.00'L x 3.50'H Prismaoid 28,875 cf Overall - 11,663 cf Embedded = 17,212 cf x 35.0% Voids
#2	70.50'	11,663 cf	36.0" Round Pipe Storage (10 rows by 165lf) Inside #1 L= 1,650.0'
		17,687 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	71.60'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	70.00'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.19 cfs @ 10.72 hrs HW=70.04' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=0.29 cfs @ 12.60 hrs HW=71.81' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 0.29 cfs @ 1.58 fps)

Summary for Pond P-2: System 1-2 (Recharge)

Inflow Area = 1.790 ac, 86.59% Impervious, Inflow Depth = 2.09" for 2 yr Storm event
Inflow = 6.45 cfs @ 11.97 hrs, Volume= 0.311 af
Outflow = 3.84 cfs @ 12.05 hrs, Volume= 0.311 af, Atten= 41%, Lag= 4.6 min
Discarded = 0.08 cfs @ 10.44 hrs, Volume= 0.162 af
Primary = 3.76 cfs @ 12.05 hrs, Volume= 0.150 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 68.92' @ 12.05 hrs Surf.Area= 3,250 sf Storage= 4,777 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 223.2 min (1,028.1 - 804.9)

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Volume	Invert	Avail.Storage	Storage Description
#1	66.50'	2,942 cf	50.00'W x 65.00'L x 4.00'H Prismaoid 13,000 cf Overall - 4,595 cf Embedded = 8,405 cf x 35.0% Voids
#2	67.00'	4,595 cf	36.0" Round Pipe Storage (10 rows by 65lf) Inside #1 L= 650.0'
		7,536 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	68.10'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	66.50'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.08 cfs @ 10.44 hrs HW=66.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=3.75 cfs @ 12.05 hrs HW=68.92' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 3.75 cfs @ 3.09 fps)

Summary for Pond P-3: System 1-3 (Detention)

Inflow Area = 3.150 ac, 64.44% Impervious, Inflow Depth = 1.70" for 2 yr Storm event
Inflow = 8.21 cfs @ 12.01 hrs, Volume= 0.446 af
Outflow = 3.58 cfs @ 12.13 hrs, Volume= 0.446 af, Atten= 56%, Lag= 7.4 min
Primary = 3.58 cfs @ 12.13 hrs, Volume= 0.446 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 67.40' @ 12.13 hrs Surf.Area= 5,500 sf Storage= 5,231 cf

Plug-Flow detention time= 39.6 min calculated for 0.446 af (100% of inflow)
Center-of-Mass det. time= 39.8 min (854.3 - 814.6)

Volume	Invert	Avail.Storage	Storage Description
#1	66.00'	4,264 cf	100.00'W x 55.00'L x 4.50'H Prismaoid 24,750 cf Overall - 12,566 cf Embedded = 12,184 cf x 35.0% Voids
#2	66.00'	12,566 cf	48.0" Round Pipe Storage (10 rows x 100lf) Inside #1 L= 1,000.0'
		16,831 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	66.00'	12.0" Vert. Orifice/Grate C= 0.600
#2	Primary	69.10'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=3.58 cfs @ 12.13 hrs HW=67.40' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 3.58 cfs @ 4.56 fps)
↑**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking and Runoff Area=6.340 ac 41.48% Impervious Runoff Depth=2.13"
Flow Length=1,816' Tc=6.0 min CN=72 Runoff=24.20 cfs 1.125 af

SubcatchmentS-1.1: Loading Areas Runoff Area=2.630 ac 57.41% Impervious Runoff Depth=3.00"
Tc=9.1 min CN=82 Runoff=12.41 cfs 0.657 af

SubcatchmentS-1.2a: New Parking Area Runoff Area=0.790 ac 63.29% Impervious Runoff Depth=2.72"
Tc=6.0 min CN=79 Runoff=3.82 cfs 0.179 af

SubcatchmentS-1.2b: New Parking Area Runoff Area=1.790 ac 86.59% Impervious Runoff Depth=3.79"
Tc=6.0 min CN=90 Runoff=11.31 cfs 0.565 af

SubcatchmentS-1.3a: Half Original Roof Runoff Area=0.530 ac 100.00% Impervious Runoff Depth=4.67"
Tc=6.0 min CN=98 Runoff=3.70 cfs 0.206 af

SubcatchmentS-1.3b: Remaining Original Runoff Area=0.520 ac 100.00% Impervious Runoff Depth=4.67"
Tc=9.1 min CN=98 Runoff=3.29 cfs 0.203 af

SubcatchmentS-1.4: Addition Roof Runoff Area=1.730 ac 100.00% Impervious Runoff Depth=4.67"
Tc=6.0 min CN=98 Runoff=12.09 cfs 0.674 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=0.82"
Flow Length=580' Tc=9.6 min CN=53 Runoff=5.37 cfs 0.348 af

SubcatchmentS-3.0: East Slope Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=1.06"
Tc=6.0 min CN=57 Runoff=1.15 cfs 0.057 af

Reach DP-1: Culvert to River Inflow=46.68 cfs 2.983 af
Outflow=46.68 cfs 2.983 af

Reach DP-2: West Property Line Inflow=5.37 cfs 0.348 af
Outflow=5.37 cfs 0.348 af

Reach DP-3: East Wetland Inflow=1.15 cfs 0.057 af
Outflow=1.15 cfs 0.057 af

Pond P-1: System 1-1 (Recharge) Peak Elev=72.41' Storage=12,066 cf Inflow=12.09 cfs 0.674 af
Discarded=0.19 cfs 0.443 af Primary=3.68 cfs 0.230 af Outflow=3.87 cfs 0.674 af

Pond P-2: System 1-2 (Recharge) Peak Elev=69.52' Storage=6,122 cf Inflow=11.31 cfs 0.565 af
Discarded=0.08 cfs 0.182 af Primary=9.72 cfs 0.383 af Outflow=9.80 cfs 0.565 af

Pond P-3: System 1-3 (Detention) Peak Elev=68.65' Storage=10,843 cf Inflow=15.70 cfs 0.860 af
Outflow=5.54 cfs 0.860 af

Total Runoff Area = 20.070 ac Runoff Volume = 4.014 af Average Runoff Depth = 2.40"
54.76% Pervious = 10.990 ac 45.24% Impervious = 9.080 ac

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Type II 24-hr 10 yr Storm Rainfall=4.91"

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Summary for Subcatchment S-1.0: Front Parking and Loop Road

Runoff = 24.20 cfs @ 11.98 hrs, Volume= 1.125 af, Depth= 2.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
0.900	39	>75% Grass cover, Good, HSG A
2.290	61	>75% Grass cover, Good, HSG B
* 2.630	98	Paved Parking
* 0.090	50	Porous Pavers
* 0.430	50	Porous Pavement
6.340	72	Weighted Average
3.710		58.52% Pervious Area
2.630		41.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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0.1	66	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
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5.1	1,816	Total, Increased to minimum Tc = 6.0 min			
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Summary for Subcatchment S-1.1: Loading Areas

Runoff = 12.41 cfs @ 12.01 hrs, Volume= 0.657 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
0.950	61	>75% Grass cover, Good, HSG B
* 0.170	50	Porous Pavement
* 1.510	98	Paved Parking
2.630	82	Weighted Average
1.120		42.59% Pervious Area
1.510		57.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Roof Tc

Summary for Subcatchment S-1.2a: New Parking Area

Runoff = 3.82 cfs @ 11.97 hrs, Volume= 0.179 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
* 0.190	50	Porous Pavers
0.100	39	>75% Grass cover, Good, HSG A
* 0.500	98	Paved Parking
0.790	79	Weighted Average
0.290		36.71% Pervious Area
0.500		63.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

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Summary for Subcatchment S-1.2b: New Parking Area

Runoff = 11.31 cfs @ 11.97 hrs, Volume= 0.565 af, Depth= 3.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
* 0.020	50	Porous Pavers
0.220	39	>75% Grass cover, Good, HSG A
* 1.550	98	Paved Parking
1.790	90	Weighted Average
0.240		13.41% Pervious Area
1.550		86.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3a: Half Original Roof

Runoff = 3.70 cfs @ 11.97 hrs, Volume= 0.206 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
* 0.530	98	Roofs
0.530		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3b: Remaining Original Roof

Runoff = 3.29 cfs @ 12.00 hrs, Volume= 0.203 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
* 0.520	98	Roofs
0.520		100.00% Impervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Min Tc

Summary for Subcatchment S-1.4: Addition Roof

Runoff = 12.09 cfs @ 11.97 hrs, Volume= 0.674 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
* 1.730	98	Roofs
* 0.000	98	Paved Parking
1.730	98	Weighted Average
1.730		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 5.37 cfs @ 12.04 hrs, Volume= 0.348 af, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

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Summary for Subcatchment S-3.0: East Slope

Runoff = 1.15 cfs @ 11.99 hrs, Volume= 0.057 af, Depth= 1.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 yr Storm Rainfall=4.91"

Area (ac)	CN	Description
0.530	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.650	57	Weighted Average
0.650		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.330 ac, 62.60% Impervious, Inflow Depth = 2.50" for 10 yr Storm event
Inflow = 46.68 cfs @ 11.99 hrs, Volume= 2.983 af
Outflow = 46.68 cfs @ 11.99 hrs, Volume= 2.983 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 0.82" for 10 yr Storm event
Inflow = 5.37 cfs @ 12.04 hrs, Volume= 0.348 af
Outflow = 5.37 cfs @ 12.04 hrs, Volume= 0.348 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.650 ac, 0.00% Impervious, Inflow Depth = 1.06" for 10 yr Storm event
Inflow = 1.15 cfs @ 11.99 hrs, Volume= 0.057 af
Outflow = 1.15 cfs @ 11.99 hrs, Volume= 0.057 af, Atten= 0%, Lag= 0.0 min

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Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Pond P-1: System 1-1 (Recharge)

Inflow Area = 1.730 ac, 100.00% Impervious, Inflow Depth = 4.67" for 10 yr Storm event
Inflow = 12.09 cfs @ 11.97 hrs, Volume= 0.674 af
Outflow = 3.87 cfs @ 12.09 hrs, Volume= 0.674 af, Atten= 68%, Lag= 7.3 min
Discarded = 0.19 cfs @ 9.17 hrs, Volume= 0.443 af
Primary = 3.68 cfs @ 12.09 hrs, Volume= 0.230 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 72.41' @ 12.09 hrs Surf.Area= 8,250 sf Storage= 12,066 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 239.4 min (983.6 - 744.2)

Volume	Invert	Avail.Storage	Storage Description
#1	70.00'	6,024 cf	50.00'W x 165.00'L x 3.50'H Prismaoid 28,875 cf Overall - 11,663 cf Embedded = 17,212 cf x 35.0% Voids
#2	70.50'	11,663 cf	36.0" Round Pipe Storage (10 rows by 165lf) Inside #1 L= 1,650.0'
			17,687 cf Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	71.60'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	70.00'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.19 cfs @ 9.17 hrs HW=70.04' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=3.67 cfs @ 12.09 hrs HW=72.41' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 3.67 cfs @ 3.07 fps)

Summary for Pond P-2: System 1-2 (Recharge)

Inflow Area = 1.790 ac, 86.59% Impervious, Inflow Depth = 3.79" for 10 yr Storm event
Inflow = 11.31 cfs @ 11.97 hrs, Volume= 0.565 af
Outflow = 9.80 cfs @ 12.01 hrs, Volume= 0.565 af, Atten= 13%, Lag= 2.4 min
Discarded = 0.08 cfs @ 8.60 hrs, Volume= 0.182 af
Primary = 9.72 cfs @ 12.01 hrs, Volume= 0.383 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 69.52' @ 12.01 hrs Surf.Area= 3,250 sf Storage= 6,122 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 141.2 min (929.3 - 788.1)

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Volume	Invert	Avail.Storage	Storage Description
#1	66.50'	2,942 cf	50.00'W x 65.00'L x 4.00'H Prismaoid 13,000 cf Overall - 4,595 cf Embedded = 8,405 cf x 35.0% Voids
#2	67.00'	4,595 cf	36.0" Round Pipe Storage (10 rows by 65lf) Inside #1 L= 650.0'
		7,536 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	68.10'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	66.50'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.08 cfs @ 8.60 hrs HW=66.54' (Free Discharge)
 ↳ **2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=9.72 cfs @ 12.01 hrs HW=69.52' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Orifice/Grate** (Orifice Controls 9.72 cfs @ 4.06 fps)

Summary for Pond P-3: System 1-3 (Detention)

Inflow Area = 3.150 ac, 64.44% Impervious, Inflow Depth = 3.28" for 10 yr Storm event
 Inflow = 15.70 cfs @ 12.00 hrs, Volume= 0.860 af
 Outflow = 5.54 cfs @ 12.15 hrs, Volume= 0.860 af, Atten= 65%, Lag= 8.8 min
 Primary = 5.54 cfs @ 12.15 hrs, Volume= 0.860 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 68.65' @ 12.15 hrs Surf.Area= 5,500 sf Storage= 10,843 cf

Plug-Flow detention time= 35.4 min calculated for 0.860 af (100% of inflow)
 Center-of-Mass det. time= 35.3 min (835.7 - 800.4)

Volume	Invert	Avail.Storage	Storage Description
#1	66.00'	4,264 cf	100.00'W x 55.00'L x 4.50'H Prismaoid 24,750 cf Overall - 12,566 cf Embedded = 12,184 cf x 35.0% Voids
#2	66.00'	12,566 cf	48.0" Round Pipe Storage (10 rows x 100lf) Inside #1 L= 1,000.0'
		16,831 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	66.00'	12.0" Vert. Orifice/Grate C= 0.600
#2	Primary	69.10'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=5.54 cfs @ 12.15 hrs HW=68.65' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Orifice/Grate** (Orifice Controls 5.54 cfs @ 7.06 fps)
 ↳ **2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking and Runoff Area=6.340 ac 41.48% Impervious Runoff Depth=3.02"
Flow Length=1,816' Tc=6.0 min CN=72 Runoff=34.18 cfs 1.594 af

SubcatchmentS-1.1: Loading Areas Runoff Area=2.630 ac 57.41% Impervious Runoff Depth=4.01"
Tc=9.1 min CN=82 Runoff=16.43 cfs 0.880 af

SubcatchmentS-1.2a: New Parking Area Runoff Area=0.790 ac 63.29% Impervious Runoff Depth=3.71"
Tc=6.0 min CN=79 Runoff=5.13 cfs 0.244 af

SubcatchmentS-1.2b: New Parking Area Runoff Area=1.790 ac 86.59% Impervious Runoff Depth=4.88"
Tc=6.0 min CN=90 Runoff=14.31 cfs 0.727 af

SubcatchmentS-1.3a: Half Original Roof Runoff Area=0.530 ac 100.00% Impervious Runoff Depth=5.79"
Tc=6.0 min CN=98 Runoff=4.56 cfs 0.256 af

SubcatchmentS-1.3b: Remaining Original Runoff Area=0.520 ac 100.00% Impervious Runoff Depth=5.79"
Tc=9.1 min CN=98 Runoff=4.05 cfs 0.251 af

SubcatchmentS-1.4: Addition Roof Runoff Area=1.730 ac 100.00% Impervious Runoff Depth=5.79"
Tc=6.0 min CN=98 Runoff=14.87 cfs 0.835 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=1.38"
Flow Length=580' Tc=9.6 min CN=53 Runoff=10.10 cfs 0.586 af

SubcatchmentS-3.0: East Slope Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=1.69"
Tc=6.0 min CN=57 Runoff=1.93 cfs 0.092 af

Reach DP-1: Culvert to River Inflow=65.50 cfs 4.121 af
Outflow=65.50 cfs 4.121 af

Reach DP-2: West Property Line Inflow=10.10 cfs 0.586 af
Outflow=10.10 cfs 0.586 af

Reach DP-3: East Wetland Inflow=1.93 cfs 0.092 af
Outflow=1.93 cfs 0.092 af

Pond P-1: System 1-1 (Recharge) Peak Elev=72.76' Storage=14,075 cf Inflow=14.87 cfs 0.835 af
Discarded=0.19 cfs 0.476 af Primary=6.89 cfs 0.359 af Outflow=7.09 cfs 0.835 af

Pond P-2: System 1-2 (Recharge) Peak Elev=69.80' Storage=6,663 cf Inflow=14.31 cfs 0.727 af
Discarded=0.08 cfs 0.190 af Primary=12.68 cfs 0.537 af Outflow=12.76 cfs 0.727 af

Pond P-3: System 1-3 (Detention) Peak Elev=69.48' Storage=14,253 cf Inflow=20.48 cfs 1.131 af
Outflow=8.79 cfs 1.131 af

Total Runoff Area = 20.070 ac Runoff Volume = 5.465 af Average Runoff Depth = 3.27"
54.76% Pervious = 10.990 ac 45.24% Impervious = 9.080 ac

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Summary for Subcatchment S-1.0: Front Parking and Loop Road

Runoff = 34.18 cfs @ 11.97 hrs, Volume= 1.594 af, Depth= 3.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
0.900	39	>75% Grass cover, Good, HSG A
2.290	61	>75% Grass cover, Good, HSG B
* 2.630	98	Paved Parking
* 0.090	50	Porous Pavers
* 0.430	50	Porous Pavement
6.340	72	Weighted Average
3.710		58.52% Pervious Area
2.630		41.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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0.1 66 0.0100 11.15 78.83 **Pipe Channel, RCP_Round 36"**
 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75'
 n= 0.011

5.1 1,816 Total, Increased to minimum Tc = 6.0 min

Summary for Subcatchment S-1.1: Loading Areas

Runoff = 16.43 cfs @ 12.00 hrs, Volume= 0.880 af, Depth= 4.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
0.950	61	>75% Grass cover, Good, HSG B
* 0.170	50	Porous Pavement
* 1.510	98	Paved Parking
2.630	82	Weighted Average
1.120		42.59% Pervious Area
1.510		57.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Roof Tc

Summary for Subcatchment S-1.2a: New Parking Area

Runoff = 5.13 cfs @ 11.97 hrs, Volume= 0.244 af, Depth= 3.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
* 0.190	50	Porous Pavers
0.100	39	>75% Grass cover, Good, HSG A
* 0.500	98	Paved Parking
0.790	79	Weighted Average
0.290		36.71% Pervious Area
0.500		63.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

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Summary for Subcatchment S-1.2b: New Parking Area

Runoff = 14.31 cfs @ 11.97 hrs, Volume= 0.727 af, Depth= 4.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
* 0.020	50	Porous Pavers
0.220	39	>75% Grass cover, Good, HSG A
* 1.550	98	Paved Parking
1.790	90	Weighted Average
0.240		13.41% Pervious Area
1.550		86.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3a: Half Original Roof

Runoff = 4.56 cfs @ 11.97 hrs, Volume= 0.256 af, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
* 0.530	98	Roofs
0.530		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3b: Remaining Original Roof

Runoff = 4.05 cfs @ 12.00 hrs, Volume= 0.251 af, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
* 0.520	98	Roofs
0.520		100.00% Impervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Min Tc

Summary for Subcatchment S-1.4: Addition Roof

Runoff = 14.87 cfs @ 11.97 hrs, Volume= 0.835 af, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
* 1.730	98	Roofs
* 0.000	98	Paved Parking
1.730	98	Weighted Average
1.730		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 10.10 cfs @ 12.03 hrs, Volume= 0.586 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

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Summary for Subcatchment S-3.0: East Slope

Runoff = 1.93 cfs @ 11.98 hrs, Volume= 0.092 af, Depth= 1.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Storm Rainfall=6.03"

Area (ac)	CN	Description
0.530	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.650	57	Weighted Average
0.650		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.330 ac, 62.60% Impervious, Inflow Depth = 3.45" for 25 yr Storm event
Inflow = 65.50 cfs @ 11.99 hrs, Volume= 4.121 af
Outflow = 65.50 cfs @ 11.99 hrs, Volume= 4.121 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 1.38" for 25 yr Storm event
Inflow = 10.10 cfs @ 12.03 hrs, Volume= 0.586 af
Outflow = 10.10 cfs @ 12.03 hrs, Volume= 0.586 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.650 ac, 0.00% Impervious, Inflow Depth = 1.69" for 25 yr Storm event
Inflow = 1.93 cfs @ 11.98 hrs, Volume= 0.092 af
Outflow = 1.93 cfs @ 11.98 hrs, Volume= 0.092 af, Atten= 0%, Lag= 0.0 min

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Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Pond P-1: System 1-1 (Recharge)

Inflow Area = 1.730 ac, 100.00% Impervious, Inflow Depth = 5.79" for 25 yr Storm event
Inflow = 14.87 cfs @ 11.97 hrs, Volume= 0.835 af
Outflow = 7.09 cfs @ 12.06 hrs, Volume= 0.835 af, Atten= 52%, Lag= 5.6 min
Discarded = 0.19 cfs @ 8.47 hrs, Volume= 0.476 af
Primary = 6.89 cfs @ 12.06 hrs, Volume= 0.359 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 72.76' @ 12.06 hrs Surf.Area= 8,250 sf Storage= 14,075 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 213.3 min (954.3 - 740.9)

Volume	Invert	Avail.Storage	Storage Description
#1	70.00'	6,024 cf	50.00'W x 165.00'L x 3.50'H Prismaoid 28,875 cf Overall - 11,663 cf Embedded = 17,212 cf x 35.0% Voids
#2	70.50'	11,663 cf	36.0" Round Pipe Storage (10 rows by 165lf) Inside #1 L= 1,650.0'
			17,687 cf Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	71.60'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	70.00'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.19 cfs @ 8.47 hrs HW=70.04' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=6.89 cfs @ 12.06 hrs HW=72.76' TW=0.00' (Dynamic Tailwater)

↑**1=Orifice/Grate** (Orifice Controls 6.89 cfs @ 3.66 fps)

Summary for Pond P-2: System 1-2 (Recharge)

Inflow Area = 1.790 ac, 86.59% Impervious, Inflow Depth = 4.88" for 25 yr Storm event
Inflow = 14.31 cfs @ 11.97 hrs, Volume= 0.727 af
Outflow = 12.76 cfs @ 12.00 hrs, Volume= 0.727 af, Atten= 11%, Lag= 2.2 min
Discarded = 0.08 cfs @ 7.37 hrs, Volume= 0.190 af
Primary = 12.68 cfs @ 12.00 hrs, Volume= 0.537 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 69.80' @ 12.00 hrs Surf.Area= 3,250 sf Storage= 6,663 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 116.8 min (898.0 - 781.2)

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Volume	Invert	Avail.Storage	Storage Description
#1	66.50'	2,942 cf	50.00'W x 65.00'L x 4.00'H Prismaoid 13,000 cf Overall - 4,595 cf Embedded = 8,405 cf x 35.0% Voids
#2	67.00'	4,595 cf	36.0" Round Pipe Storage (10 rows by 65lf) Inside #1 L= 650.0'
		7,536 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	68.10'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	66.50'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.08 cfs @ 7.37 hrs HW=66.54' (Free Discharge)
 ↳ **2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=12.66 cfs @ 12.00 hrs HW=69.80' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Orifice/Grate** (Orifice Controls 12.66 cfs @ 4.44 fps)

Summary for Pond P-3: System 1-3 (Detention)

Inflow Area = 3.150 ac, 64.44% Impervious, Inflow Depth = 4.31" for 25 yr Storm event
 Inflow = 20.48 cfs @ 12.00 hrs, Volume= 1.131 af
 Outflow = 8.79 cfs @ 12.13 hrs, Volume= 1.131 af, Atten= 57%, Lag= 7.6 min
 Primary = 8.79 cfs @ 12.13 hrs, Volume= 1.131 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 69.48' @ 12.13 hrs Surf.Area= 5,500 sf Storage= 14,253 cf

Plug-Flow detention time= 33.8 min calculated for 1.131 af (100% of inflow)
 Center-of-Mass det. time= 34.0 min (828.1 - 794.2)

Volume	Invert	Avail.Storage	Storage Description
#1	66.00'	4,264 cf	100.00'W x 55.00'L x 4.50'H Prismaoid 24,750 cf Overall - 12,566 cf Embedded = 12,184 cf x 35.0% Voids
#2	66.00'	12,566 cf	48.0" Round Pipe Storage (10 rows x 100lf) Inside #1 L= 1,000.0'
		16,831 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	66.00'	12.0" Vert. Orifice/Grate C= 0.600
#2	Primary	69.10'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=8.79 cfs @ 12.13 hrs HW=69.48' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Orifice/Grate** (Orifice Controls 6.53 cfs @ 8.32 fps)
 ↳ **2=Sharp-Crested Rectangular Weir** (Weir Controls 2.26 cfs @ 2.02 fps)

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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.0: Front Parking and Runoff Area=6.340 ac 41.48% Impervious Runoff Depth=4.48"
Flow Length=1,816' Tc=6.0 min CN=72 Runoff=50.23 cfs 2.369 af

SubcatchmentS-1.1: Loading Areas Runoff Area=2.630 ac 57.41% Impervious Runoff Depth=5.63"
Tc=9.1 min CN=82 Runoff=22.66 cfs 1.234 af

SubcatchmentS-1.2a: New Parking Area Runoff Area=0.790 ac 63.29% Impervious Runoff Depth=5.28"
Tc=6.0 min CN=79 Runoff=7.19 cfs 0.348 af

SubcatchmentS-1.2b: New Parking Area Runoff Area=1.790 ac 86.59% Impervious Runoff Depth=6.57"
Tc=6.0 min CN=90 Runoff=18.90 cfs 0.980 af

SubcatchmentS-1.3a: Half Original Roof Runoff Area=0.530 ac 100.00% Impervious Runoff Depth=7.52"
Tc=6.0 min CN=98 Runoff=5.87 cfs 0.332 af

SubcatchmentS-1.3b: Remaining Original Runoff Area=0.520 ac 100.00% Impervious Runoff Depth=7.52"
Tc=9.1 min CN=98 Runoff=5.22 cfs 0.326 af

SubcatchmentS-1.4: Addition Roof Runoff Area=1.730 ac 100.00% Impervious Runoff Depth=7.52"
Tc=6.0 min CN=98 Runoff=19.17 cfs 1.084 af

SubcatchmentS-2.0: West Undeveloped Runoff Area=5.090 ac 2.16% Impervious Runoff Depth=2.41"
Flow Length=580' Tc=9.6 min CN=53 Runoff=18.73 cfs 1.023 af

SubcatchmentS-3.0: East Slope Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=2.83"
Tc=6.0 min CN=57 Runoff=3.29 cfs 0.153 af

Reach DP-1: Culvert to River Inflow=96.32 cfs 5.966 af
Outflow=96.32 cfs 5.966 af

Reach DP-2: West Property Line Inflow=18.73 cfs 1.023 af
Outflow=18.73 cfs 1.023 af

Reach DP-3: East Wetland Inflow=3.29 cfs 0.153 af
Outflow=3.29 cfs 0.153 af

Pond P-1: System 1-1 (Recharge) Peak Elev=73.23' Storage=16,583 cf Inflow=19.17 cfs 1.084 af
Discarded=0.19 cfs 0.511 af Primary=11.95 cfs 0.574 af Outflow=12.14 cfs 1.084 af

Pond P-2: System 1-2 (Recharge) Peak Elev=70.37' Storage=7,393 cf Inflow=18.90 cfs 0.980 af
Discarded=0.08 cfs 0.198 af Primary=17.07 cfs 0.782 af Outflow=17.15 cfs 0.980 af

Pond P-3: System 1-3 (Detention) Peak Elev=70.42' Storage=16,685 cf Inflow=27.88 cfs 1.560 af
Outflow=21.12 cfs 1.560 af

Total Runoff Area = 20.070 ac Runoff Volume = 7.851 af Average Runoff Depth = 4.69"
54.76% Pervious = 10.990 ac 45.24% Impervious = 9.080 ac

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Summary for Subcatchment S-1.0: Front Parking and Loop Road

Runoff = 50.23 cfs @ 11.97 hrs, Volume= 2.369 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
0.900	39	>75% Grass cover, Good, HSG A
2.290	61	>75% Grass cover, Good, HSG B
* 2.630	98	Paved Parking
* 0.090	50	Porous Pavers
* 0.430	50	Porous Pavement
6.340	72	Weighted Average
3.710		58.52% Pervious Area
2.630		41.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.39		Sheet Flow, A-B Smooth surfaces n= 0.011 P2= 3.11"
1.1	170	0.0176	2.69		Shallow Concentrated Flow, B-C Paved Kv= 20.3 fps
0.6	206	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.2	52	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12" 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.011 Concrete pipe, bends & connections
0.6	213	0.0100	6.22	7.63	Pipe Channel, RCP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011
0.5	196	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.1	38	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011
0.3	190	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.4	222	0.0100	9.88	48.47	Pipe Channel, RCP_Round 30" 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011
0.3	233	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.3	180	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011

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0.1	66	0.0100	11.15	78.83	Pipe Channel, RCP_Round 36" 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
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5.1	1,816	Total, Increased to minimum Tc = 6.0 min			
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Summary for Subcatchment S-1.1: Loading Areas

Runoff = 22.66 cfs @ 12.00 hrs, Volume= 1.234 af, Depth= 5.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
0.950	61	>75% Grass cover, Good, HSG B
* 0.170	50	Porous Pavement
* 1.510	98	Paved Parking
2.630	82	Weighted Average
1.120		42.59% Pervious Area
1.510		57.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Roof Tc

Summary for Subcatchment S-1.2a: New Parking Area

Runoff = 7.19 cfs @ 11.97 hrs, Volume= 0.348 af, Depth= 5.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
* 0.190	50	Porous Pavers
0.100	39	>75% Grass cover, Good, HSG A
* 0.500	98	Paved Parking
0.790	79	Weighted Average
0.290		36.71% Pervious Area
0.500		63.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

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Summary for Subcatchment S-1.2b: New Parking Area

Runoff = 18.90 cfs @ 11.97 hrs, Volume= 0.980 af, Depth= 6.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
* 0.020	50	Porous Pavers
0.220	39	>75% Grass cover, Good, HSG A
* 1.550	98	Paved Parking
1.790	90	Weighted Average
0.240		13.41% Pervious Area
1.550		86.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3a: Half Original Roof

Runoff = 5.87 cfs @ 11.97 hrs, Volume= 0.332 af, Depth= 7.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
* 0.530	98	Roofs
0.530		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-1.3b: Remaining Original Roof

Runoff = 5.22 cfs @ 12.00 hrs, Volume= 0.326 af, Depth= 7.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
* 0.520	98	Roofs
0.520		100.00% Impervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1					Direct Entry, Min Tc

Summary for Subcatchment S-1.4: Addition Roof

Runoff = 19.17 cfs @ 11.97 hrs, Volume= 1.084 af, Depth= 7.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
* 1.730	98	Roofs
* 0.000	98	Paved Parking
1.730	98	Weighted Average
1.730		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min Tc

Summary for Subcatchment S-2.0: West Undeveloped Area

Runoff = 18.73 cfs @ 12.02 hrs, Volume= 1.023 af, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
2.910	61	>75% Grass cover, Good, HSG B
2.070	39	>75% Grass cover, Good, HSG A
* 0.110	98	Paved Parking
5.090	53	Weighted Average
4.980		97.84% Pervious Area
0.110		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		Sheet Flow, A-B
					Grass: Short n= 0.150 P2= 3.11"
1.8	180	0.0560	1.66		Shallow Concentrated Flow, B-C
					Short Grass Pasture Kv= 7.0 fps
0.8	77	0.0520	1.60		Shallow Concentrated Flow, C-D
					Short Grass Pasture Kv= 7.0 fps
2.7	273	0.0590	1.70		Shallow Concentrated Flow, D-E
					Short Grass Pasture Kv= 7.0 fps
9.6	580	Total			

ARE Andover Building 1 - PR

Prepared by SMMA

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Type II 24-hr 100 yr Storm Rainfall=7.76"

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Summary for Subcatchment S-3.0: East Slope

Runoff = 3.29 cfs @ 11.98 hrs, Volume= 0.153 af, Depth= 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr Storm Rainfall=7.76"

Area (ac)	CN	Description
0.530	61	>75% Grass cover, Good, HSG B
0.120	39	>75% Grass cover, Good, HSG A
* 0.000	98	Paved Parking
0.650	57	Weighted Average
0.650		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Summary for Reach DP-1: Culvert to River

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14.330 ac, 62.60% Impervious, Inflow Depth = 5.00" for 100 yr Storm event
Inflow = 96.32 cfs @ 11.99 hrs, Volume= 5.966 af
Outflow = 96.32 cfs @ 11.99 hrs, Volume= 5.966 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-2: West Property Line

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.090 ac, 2.16% Impervious, Inflow Depth = 2.41" for 100 yr Storm event
Inflow = 18.73 cfs @ 12.02 hrs, Volume= 1.023 af
Outflow = 18.73 cfs @ 12.02 hrs, Volume= 1.023 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Reach DP-3: East Wetland

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.650 ac, 0.00% Impervious, Inflow Depth = 2.83" for 100 yr Storm event
Inflow = 3.29 cfs @ 11.98 hrs, Volume= 0.153 af
Outflow = 3.29 cfs @ 11.98 hrs, Volume= 0.153 af, Atten= 0%, Lag= 0.0 min

ARE Andover Building 1 - PR

Prepared by SMMA

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ARE Building 1 - Proposed Conditions
Type II 24-hr 100 yr Storm Rainfall=7.76"

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Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Pond P-1: System 1-1 (Recharge)

Inflow Area = 1.730 ac, 100.00% Impervious, Inflow Depth = 7.52" for 100 yr Storm event
Inflow = 19.17 cfs @ 11.97 hrs, Volume= 1.084 af
Outflow = 12.14 cfs @ 12.04 hrs, Volume= 1.084 af, Atten= 37%, Lag= 4.4 min
Discarded = 0.19 cfs @ 6.42 hrs, Volume= 0.511 af
Primary = 11.95 cfs @ 12.04 hrs, Volume= 0.574 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 73.23' @ 12.04 hrs Surf.Area= 8,250 sf Storage= 16,583 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 185.9 min (923.3 - 737.4)

Volume	Invert	Avail.Storage	Storage Description
#1	70.00'	6,024 cf	50.00'W x 165.00'L x 3.50'H Prismaoid 28,875 cf Overall - 11,663 cf Embedded = 17,212 cf x 35.0% Voids
#2	70.50'	11,663 cf	36.0" Round Pipe Storage (10 rows by 165lf) Inside #1 L= 1,650.0'
		17,687 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	71.60'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	70.00'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.19 cfs @ 6.42 hrs HW=70.04' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=11.94 cfs @ 12.04 hrs HW=73.23' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 11.94 cfs @ 4.35 fps)

Summary for Pond P-2: System 1-2 (Recharge)

Inflow Area = 1.790 ac, 86.59% Impervious, Inflow Depth = 6.57" for 100 yr Storm event
Inflow = 18.90 cfs @ 11.97 hrs, Volume= 0.980 af
Outflow = 17.15 cfs @ 12.00 hrs, Volume= 0.980 af, Atten= 9%, Lag= 2.0 min
Discarded = 0.08 cfs @ 5.88 hrs, Volume= 0.198 af
Primary = 17.07 cfs @ 12.00 hrs, Volume= 0.782 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 70.37' @ 12.00 hrs Surf.Area= 3,250 sf Storage= 7,393 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 94.6 min (867.9 - 773.3)

ARE Andover Building 1 - PR

Prepared by SMMA

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ARE Building 1 - Proposed Conditions
Type II 24-hr 100 yr Storm Rainfall=7.76"

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Volume	Invert	Avail.Storage	Storage Description
#1	66.50'	2,942 cf	50.00'W x 65.00'L x 4.00'H Prismaoid 13,000 cf Overall - 4,595 cf Embedded = 8,405 cf x 35.0% Voids
#2	67.00'	4,595 cf	36.0" Round Pipe Storage (10 rows by 65lf) Inside #1 L= 650.0'
		7,536 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	68.10'	24.0" Vert. Orifice/Grate C= 0.600
#2	Discarded	66.50'	1.020 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.08 cfs @ 5.88 hrs HW=66.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=17.06 cfs @ 12.00 hrs HW=70.37' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 17.06 cfs @ 5.43 fps)

Summary for Pond P-3: System 1-3 (Detention)

Inflow Area = 3.150 ac, 64.44% Impervious, Inflow Depth = 5.94" for 100 yr Storm event
Inflow = 27.88 cfs @ 12.00 hrs, Volume= 1.560 af
Outflow = 21.12 cfs @ 12.07 hrs, Volume= 1.560 af, Atten= 24%, Lag= 4.1 min
Primary = 21.12 cfs @ 12.07 hrs, Volume= 1.560 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 70.42' @ 12.07 hrs Surf.Area= 5,500 sf Storage= 16,685 cf

Plug-Flow detention time= 30.0 min calculated for 1.560 af (100% of inflow)
Center-of-Mass det. time= 29.9 min (816.6 - 786.7)

Volume	Invert	Avail.Storage	Storage Description
#1	66.00'	4,264 cf	100.00'W x 55.00'L x 4.50'H Prismaoid 24,750 cf Overall - 12,566 cf Embedded = 12,184 cf x 35.0% Voids
#2	66.00'	12,566 cf	48.0" Round Pipe Storage (10 rows x 100lf) Inside #1 L= 1,000.0'
		16,831 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	66.00'	12.0" Vert. Orifice/Grate C= 0.600
#2	Primary	69.10'	3.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=21.12 cfs @ 12.07 hrs HW=70.42' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 7.49 cfs @ 9.54 fps)
↑**2=Sharp-Crested Rectangular Weir** (Weir Controls 13.63 cfs @ 3.76 fps)



Appendix 3.2

Recharge & Drawdown Calculations

1000 MASSACHUSETTS AVENUE
 CAMBRIDGE, MASSACHUSETTS 02138
 T: 617.547.5400

ARE Andover Building 1

SMMA Job No. 21141
 Date: 1/23/2022
 Calc by: MF
 Check by: WWP

Required recharge volume is calculated utilizing DEP's "static method."
 Hydrologic Soil Group and Rawls Rate based on geotechnical survey of site.

Required Recharge Volume

	Area		Target Depth Factor		Required Volume <i>cf</i>
	<i>sf</i>	<i>ac</i>	<i>HSG</i>	<i>in</i>	
Existing Impervious	312,528	7.17			
Proposed Impervious	395,986	9.09			
Net Increase	83,458	1.92	A	0.6	4,173

Provided Recharge Volume

Recharge System	Contributing Impervious Area	Recharge Provided (volume below outlet)*
	<i>sf</i>	<i>cf</i>
SRS 1-1	75,485	7,139
SRS 1-2	67,592	2,812
Total	143,077	9,951

*volumes calculated using HydroCAD

Drawdown Time

	K (Rawls Rate) <i>in/hr</i>	Depth <i>ft</i>	Time* <i>hr</i>
Subsurface Recharge System	1.02	1.6	18.8

*Time = Recharge Volume / K * Bottom Area



Appendix 3.3

TSS Reduction Calculations

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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.

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	Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
	Proprietary Treatment Practice	0.40	0.75	0.30	0.45
	Subsurface Infiltration Structure	0.80	0.45	0.36	0.09
		0.00	0.09	0.00	0.09
		0.00	0.09	0.00	0.09

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

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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.

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

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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.

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	Proprietary Treatment Practice	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

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQU 1-1

CASCADE SEPARATOR CS-4

Project Information					
Project Name	3000 Minuteman Building 1			Option #	A
Country	UNITED_STATES	State	Massachusetts	City	Andover

Contact Information			
First Name	Marisa	Last Name	Fryer
Company	SMMA	Phone #	617-520-9244
Email	mfryer@smma.com		

Design Criteria					
Site Designation	WQU 1-1			Sizing Method	Net Annual
Screening Required?	No	Drainage Area (ac)	1.67	Peak Flow (cfs)	7.77
Groundwater Depth (ft)	5 - 10	Pipe Invert Depth (ft)	5 - 10	Bedrock Depth (ft)	>15
Multiple Inlets?	Yes	Grate Inlet Required?	No	Pipe Size (in)	18.00
Required Particle Size Distribution?	No	90° between two inlets?	Yes	180° between inlet and outlet?	No
Runoff Coefficient	0.71	Rainfall Station	67 - Groveland, MA	TC (Min)	6

Treatment Selection					
Treatment Unit	CASCADE SEPARATOR	System Model	CS-4		
Target Removal	80%	Particle Size Distribution (PSD)	110	Predicted Net Annual Removal	97.13%

*Treatment flow rate calculated using annualized weighted calculation.

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQU 1-1

CASCADE SEPARATOR CS-4

CASCADE SEPARATOR ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD								
Rainfall Intensity ¹ (in/hr)	% Rainfall Volume ¹	Cumulative Rainfall Volume	Rainfall Volume Treated	Total Flowrate (cfs)	Treated Flowrate (cfs)	Hydraulic Loading Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.0800	41.00%	41.00%	41.00%	0.0900	0.0900	3.21%	100.00%	41.04%
0.1600	23.90%	64.90%	23.90%	0.1900	0.1900	6.78%	100.00%	23.88%
0.2400	11.50%	76.40%	11.50%	0.2800	0.2800	10.00%	100.00%	11.53%
0.3200	7.40%	83.80%	7.40%	0.3800	0.3800	13.57%	99.14%	7.36%
0.4000	4.50%	88.30%	4.50%	0.4700	0.4700	16.78%	96.13%	4.28%
0.4800	2.90%	91.20%	2.90%	0.5700	0.5700	20.35%	92.77%	2.69%
0.5600	1.80%	93.00%	1.80%	0.6600	0.6600	23.57%	89.74%	1.60%
0.6400	1.20%	94.20%	1.20%	0.7600	0.7600	27.14%	86.39%	1.02%
0.7200	1.60%	95.80%	1.60%	0.8500	0.8500	30.35%	83.37%	1.33%
0.8000	0.80%	96.60%	0.80%	0.9500	0.9500	33.92%	80.02%	0.63%
1.0000	0.60%	97.20%	0.60%	1.1900	1.1900	42.49%	71.96%	0.41%
1.4000	1.40%	98.60%	1.40%	1.6600	1.6600	59.27%	56.19%	0.81%
1.8000	0.90%	99.50%	0.85%	2.1300	2.0000	71.41%	42.04%	0.38%
2.2000	0.50%	100.00%	0.38%	2.6100	2.0000	71.41%	34.31%	0.17%
								97.13%
Removal Efficiency Adjustment ² =								
Predicted % Annual Rainfall Treated =								99.83%
Predicted Net Annual Load Removal Efficiency =								97.13%
1 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA								
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.								

*Treatment flow rate calculated using annualized weighted calculation.

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQI 1-1

CASCADE SEPARATOR CS-4

Project Information					
Project Name	3000 Minuteman Building 1			Option #	A
Country	UNITED_STATES	State	Massachusetts	City	Andover

Contact Information			
First Name	Marisa	Last Name	Fryer
Company	SMMA	Phone #	617-520-9244
Email	mfryer@smma.com		

Design Criteria					
Site Designation	WQI 1-1			Sizing Method	Net Annual
Screening Required?	No	Drainage Area (ac)	0.35	Peak Flow (cfs)	1.33
Groundwater Depth (ft)	0 - 5	Pipe Invert Depth (ft)	0 - 5	Bedrock Depth (ft)	>15
Multiple Inlets?	No	Grate Inlet Required?	Yes	Pipe Size (in)	12.00
Required Particle Size Distribution?	No	90° between two inlets?	N/A	180° between inlet and outlet?	No
Runoff Coefficient	0.58	Rainfall Station	67 - Groveland, MA	TC (Min)	6

Treatment Selection					
Treatment Unit	CASCADE SEPARATOR	System Model	CS-4		
Target Removal	80%	Particle Size Distribution (PSD)	110	Predicted Net Annual Removal	99.98%

*Treatment flow rate calculated using annualized weighted calculation.

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQI 1-1

CASCADE SEPARATOR CS-4

CASCADE SEPARATOR ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD								
Rainfall Intensity ¹ (in/hr)	% Rainfall Volume ¹	Cumulative Rainfall Volume	Rainfall Volume Treated	Total Flowrate (cfs)	Treated Flowrate (cfs)	Hydraulic Loading Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.0800	41.00%	41.00%	41.00%	0.0200	0.0200	%	100.00%	41.04%
0.1600	23.90%	64.90%	23.90%	0.0300	0.0300	%	100.00%	23.88%
0.2400	11.50%	76.40%	11.50%	0.0500	0.0500	%	100.00%	11.53%
0.3200	7.40%	83.80%	7.40%	0.0600	0.0600	%	100.00%	7.42%
0.4000	4.50%	88.30%	4.50%	0.0800	0.0800	%	100.00%	4.45%
0.4800	2.90%	91.20%	2.90%	0.1000	0.1000	%	100.00%	2.90%
0.5600	1.80%	93.00%	1.80%	0.1100	0.1100	%	100.00%	1.78%
0.6400	1.20%	94.20%	1.20%	0.1300	0.1300	%	100.00%	1.18%
0.7200	1.60%	95.80%	1.60%	0.1500	0.1500	%	100.00%	1.60%
0.8000	0.80%	96.60%	0.80%	0.1600	0.1600	%	100.00%	0.79%
1.0000	0.60%	97.20%	0.60%	0.2000	0.2000	%	100.00%	0.57%
1.4000	1.40%	98.60%	1.40%	0.2800	0.2800	%	100.00%	1.44%
1.8000	0.90%	99.50%	0.90%	0.3700	0.3700	%	99.48%	0.91%
2.2000	0.50%	100.00%	0.50%	0.4500	0.4500	%	96.79%	0.49%
								99.98%
Removal Efficiency Adjustment ² =								
Predicted % Annual Rainfall Treated =							100.00%	
Predicted Net Annual Load Removal Efficiency =							99.98%	
1 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA								
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.								

*Treatment flow rate calculated using annualized weighted calculation.

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQU 2-1

CASCADE SEPARATOR CS-4

Project Information					
Project Name	3000 Minuteman Building 1			Option #	A
Country	UNITED_STATES	State	Massachusetts	City	Andover

Contact Information			
First Name	Marisa	Last Name	Fryer
Company	SMMA	Phone #	617-520-9244
Email	mfryer@smma.com		

Design Criteria					
Site Designation	WQU 2-1			Sizing Method	Net Annual
Screening Required?	No	Drainage Area (ac)	2.63	Peak Flow (cfs)	10.42
Groundwater Depth (ft)	0 - 5	Pipe Invert Depth (ft)	0 - 5	Bedrock Depth (ft)	>15
Multiple Inlets?	Yes	Grate Inlet Required?	No	Pipe Size (in)	24.00
Required Particle Size Distribution?	No	90° between two inlets?	Yes	180° between inlet and outlet?	No
Runoff Coefficient	0.60	Rainfall Station	67 - Groveland, MA	TC (Min)	6

Treatment Selection					
Treatment Unit	CASCADE SEPARATOR	System Model	CS-4		
Target Removal	80%	Particle Size Distribution (PSD)	110	Predicted Net Annual Removal	95.42%

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQU 2-1

CASCADE SEPARATOR CS-4

CASCADE SEPARATOR ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD								
Rainfall Intensity ¹ (in/hr)	% Rainfall Volume ¹	Cumulative Rainfall Volume	Rainfall Volume Treated	Total Flowrate (cfs)	Treated Flowrate (cfs)	Hydraulic Loading Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.0800	41.00%	41.00%	41.00%	0.1300	0.1300	%	100.00%	41.04%
0.1600	23.90%	64.90%	23.90%	0.2500	0.2500	%	100.00%	23.88%
0.2400	11.50%	76.40%	11.50%	0.3800	0.3800	%	99.14%	11.43%
0.3200	7.40%	83.80%	7.40%	0.5000	0.5000	%	95.12%	7.06%
0.4000	4.50%	88.30%	4.50%	0.6300	0.6300	%	90.75%	4.04%
0.4800	2.90%	91.20%	2.90%	0.7600	0.7600	%	86.39%	2.51%
0.5600	1.80%	93.00%	1.80%	0.8800	0.8800	%	82.37%	1.47%
0.6400	1.20%	94.20%	1.20%	1.0100	1.0100	%	78.00%	0.92%
0.7200	1.60%	95.80%	1.60%	1.1400	1.1400	%	73.63%	1.18%
0.8000	0.80%	96.60%	0.80%	1.2600	1.2600	%	69.61%	0.55%
1.0000	0.60%	97.20%	0.60%	1.5800	1.5800	%	58.87%	0.34%
1.4000	1.40%	98.60%	1.27%	2.2100	2.0000	%	40.52%	0.58%
1.8000	0.90%	99.50%	0.63%	2.8400	2.0000	%	31.53%	0.29%
2.2000	0.50%	100.00%	0.29%	3.4700	2.0000	%	25.81%	0.13%
								95.42%
Removal Efficiency Adjustment ² =								
Predicted % Annual Rainfall Treated =								99.39%
Predicted Net Annual Load Removal Efficiency =								95.42%
1 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA								
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.								

*Treatment flow rate calculated using annualized weighted calculation.

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQU 2-2

CASCADE SEPARATOR CS-4

Project Information					
Project Name	3000 Minuteman Building 1			Option #	A
Country	UNITED_STATES	State	Massachusetts	City	Andover

Contact Information			
First Name	Marisa	Last Name	Fryer
Company	SMMA	Phone #	617-520-9244
Email	mfryer@smma.com		

Design Criteria					
Site Designation	WQU 2-2			Sizing Method	Net Annual
Screening Required?	No	Drainage Area (ac)	1.78	Peak Flow (cfs)	9.93
Groundwater Depth (ft)	0 - 5	Pipe Invert Depth (ft)	0 - 5	Bedrock Depth (ft)	>15
Multiple Inlets?	Yes	Grate Inlet Required?	No	Pipe Size (in)	24.00
Required Particle Size Distribution?	No	90° between two inlets?	Yes	180° between inlet and outlet?	No
Runoff Coefficient	0.84	Rainfall Station	67 - Groveland, MA	TC (Min)	6

Treatment Selection					
Treatment Unit	CASCADE SEPARATOR	System Model	CS-4		
Target Removal	80%	Particle Size Distribution (PSD)	110	Predicted Net Annual Removal	95.78%

*Treatment flow rate calculated using annualized weighted calculation.

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQU 2-2

CASCADE SEPARATOR CS-4

CASCADE SEPARATOR ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD								
Rainfall Intensity ¹ (in/hr)	% Rainfall Volume ¹	Cumulative Rainfall Volume	Rainfall Volume Treated	Total Flowrate (cfs)	Treated Flowrate (cfs)	Hydraulic Loading Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.0800	41.00%	41.00%	41.00%	0.1200	0.1200	4.28%	100.00%	41.04%
0.1600	23.90%	64.90%	23.90%	0.2400	0.2400	8.57%	100.00%	23.88%
0.2400	11.50%	76.40%	11.50%	0.3600	0.3600	12.85%	99.82%	11.51%
0.3200	7.40%	83.80%	7.40%	0.4800	0.4800	17.14%	95.79%	7.11%
0.4000	4.50%	88.30%	4.50%	0.6000	0.6000	21.42%	91.77%	4.08%
0.4800	2.90%	91.20%	2.90%	0.7200	0.7200	25.71%	87.73%	2.54%
0.5600	1.80%	93.00%	1.80%	0.8400	0.8400	29.99%	83.71%	1.49%
0.6400	1.20%	94.20%	1.20%	0.9600	0.9600	34.28%	79.68%	0.94%
0.7200	1.60%	95.80%	1.60%	1.0800	1.0800	38.56%	75.65%	1.21%
0.8000	0.80%	96.60%	0.80%	1.2000	1.2000	42.85%	71.62%	0.57%
1.0000	0.60%	97.20%	0.60%	1.5000	1.5000	53.56%	61.55%	0.35%
1.4000	1.40%	98.60%	1.34%	2.0900	2.0000	71.41%	42.85%	0.62%
1.8000	0.90%	99.50%	0.67%	2.6900	2.0000	71.41%	33.29%	0.30%
2.2000	0.50%	100.00%	0.30%	3.2900	2.0000	71.41%	27.22%	0.14%
								95.78%
Removal Efficiency Adjustment ² =								
Predicted % Annual Rainfall Treated =								99.51%
Predicted Net Annual Load Removal Efficiency =								95.78%
1 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA								
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.								

*Treatment flow rate calculated using annualized weighted calculation.

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQI 2-1, 2-2

CASCADE SEPARATOR CS-4

Project Information					
Project Name	3000 Minuteman Building 1			Option #	A
Country	UNITED_STATES	State	Massachusetts	City	Andover

Contact Information			
First Name	Marisa	Last Name	Fryer
Company	SMMA	Phone #	617-520-9244
Email	mfryer@smma.com		

Design Criteria					
Site Designation	WQI 2-1, 2-2			Sizing Method	Net Annual
Screening Required?	No	Drainage Area (ac)	0.40	Peak Flow (cfs)	1.71
Groundwater Depth (ft)	0 - 5	Pipe Invert Depth (ft)	0 - 5	Bedrock Depth (ft)	>15
Multiple Inlets?	No	Grate Inlet Required?	Yes	Pipe Size (in)	12.00
Required Particle Size Distribution?	No	90° between two inlets?	N/A	180° between inlet and outlet?	No
Runoff Coefficient	0.65	Rainfall Station	67 - Groveland, MA	TC (Min)	6

Treatment Selection					
Treatment Unit	CASCADE SEPARATOR	System Model	CS-4		
Target Removal	80%	Particle Size Distribution (PSD)	110	Predicted Net Annual Removal	99.92%

Hydrodynamic Separation Product Calculator

3000 Minuteman Building 1

WQI 2-1, 2-2

CASCADE SEPARATOR CS-4

CASCADE SEPARATOR ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD								
Rainfall Intensity ¹ (in/hr)	% Rainfall Volume ¹	Cumulative Rainfall Volume	Rainfall Volume Treated	Total Flowrate (cfs)	Treated Flowrate (cfs)	Hydraulic Loading Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.0800	41.00%	41.00%	41.00%	0.0200	0.0200	0.71%	100.00%	41.04%
0.1600	23.90%	64.90%	23.90%	0.0400	0.0400	1.43%	100.00%	23.88%
0.2400	11.50%	76.40%	11.50%	0.0600	0.0600	2.14%	100.00%	11.53%
0.3200	7.40%	83.80%	7.40%	0.0800	0.0800	2.86%	100.00%	7.42%
0.4000	4.50%	88.30%	4.50%	0.1000	0.1000	3.57%	100.00%	4.45%
0.4800	2.90%	91.20%	2.90%	0.1200	0.1200	4.28%	100.00%	2.90%
0.5600	1.80%	93.00%	1.80%	0.1500	0.1500	5.36%	100.00%	1.78%
0.6400	1.20%	94.20%	1.20%	0.1700	0.1700	6.07%	100.00%	1.18%
0.7200	1.60%	95.80%	1.60%	0.1900	0.1900	6.78%	100.00%	1.60%
0.8000	0.80%	96.60%	0.80%	0.2100	0.2100	7.50%	100.00%	0.79%
1.0000	0.60%	97.20%	0.60%	0.2600	0.2600	9.28%	100.00%	0.57%
1.4000	1.40%	98.60%	1.40%	0.3600	0.3600	12.85%	99.82%	1.44%
1.8000	0.90%	99.50%	0.90%	0.4700	0.4700	16.78%	96.13%	0.87%
2.2000	0.50%	100.00%	0.50%	0.5700	0.5700	20.35%	92.77%	0.47%
								99.92%
Removal Efficiency Adjustment ² =								
Predicted % Annual Rainfall Treated =							100.00%	
Predicted Net Annual Load Removal Efficiency =							99.92%	
1 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA								
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.								

*Treatment flow rate calculated using annualized weighted calculation.



Appendix 3.4

Phosphorus Reduction Calculations

1000 MASSACHUSETTS AVENUE
 CAMBRIDGE, MASSACHUSETTS 02138
 T: 617.547.5400

ARE - Buildings 1 & 1A
 3000 Minuteman Road, Andover, MA
 SMMA Job No. 21141
 Date: 1/24/2022
 Calc by: MF
 Check by: DCC

Phosphorus Reduction Calculations

Table 1 - Proposed Avg Annual Distinct P Load Export Rates

	P Load Export Rate* (lb/ac/yr)
Impervious (Industrial)	1.78
Pervious (HSG A)	0.03
Pervious (HSG B)	0.12

*Load rates provided by EPA BMP Accounting and Tracking Tool (BATT)

Table 2 - Untreated Proposed Conditions Phosphorus Load by Area

	Proposed Area (ac)*	P Load Export Rate (lb/ac/yr)	Untreated Project P Load (lb/yr)	Target Reduction (%)**	Target Phosphorus Load (lb/yr)
Impervious (Industrial)	7.5	1.78	13.4	50%	6.7
Porous Pavement	1.2	1.78	2.1	50%	1.1
Pervious (HSG A)	1.3	0.03	0.0	0%	0.0
Pervious (HSG B)	3.2	0.12	0.4	0%	0.4
Total	13.2		15.9		8.2

*Proposed area breakdown only includes areas within limit of work

**Andover Town regs require 50% phosphorus reduction from total proposed impervious area.

Table 3 - Phosphorus Reduction Credits for Selected Enhanced Non-Structural BMPs

Note: PRF = Phosphorus Reduction Factor from EPA BMP Accounting and Tracking Tool (BATT)

	IA being swept (ac)	PLE (lb/yr)	PRF (lb/ac/yr)	Annual Freq. (%)	Credit (lb/yr)
Street Sweeping	7.5	1.78	0.01	100%	0.13

	IA to CBs (ac)	PLE (lb/yr)	PRF (lb/ac/yr)	Credit (lb/yr)
Catch Basin Cleaning	13.2	1.78	0.02	0.47

	Sweeping (lb/yr)	CB Cleaning (lb/yr)	Total (lb/yr)
Non-Structural P Reduction Credits	0.13	0.47	0.60

1000 MASSACHUSETTS AVENUE
 CAMBRIDGE, MASSACHUSETTS 02138
 T: 617.547.5400

Table 4 - Phosphorus Loading to Structural Stormwater BMPs

	Impervious Area (ac)	Pervious Area (ac)	P Load to BMP (lb/yr)
Infiltration System #1	1.73	0.00	3.1
Infiltration System #2	1.55	0.24	2.8
Porous Pavement	1.20	0.00	2.1
Total	3.28	0.24	8.0

Table 5 - Phosphorus Load Reductions per Structural Stormwater BMP

	Infiltration Rate (in/hr)	Design Storm (in)*	Filter/Reservoir Course	P Removal Rate (%)**	P Reduction (lb/yr)
Infiltration System #1	1.02	2.0		100%	3.1
Infiltration System #2	1.02	1.0		96%	2.7
Porous Pavement			12-16"	62%	1.3
Total					7.1

*Design storm capacities calculated using HydroCAD. See attached HydroCAD report.

**See attached BMP Performance Tables.

Table 6 - P Load Export Proposed Conditions

Untreated Project P Load (lb/yr)	Non-Structural P Reduction (lb/yr)	Structural P Reduction (lb/yr)	Proposed P Export (lb/yr)	Target Phosphorus Load (lb/yr)	Target Met?
15.9	0.60	7.1	8.2	8.2	Yes

Table 3- 7: Infiltration Trench (IR = 1.02 in/hr) BMP Performance Table

Infiltration Trench (IR = 1.02 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	26.3%	44.6%	68.2%	81.0%	88.0%	92.1%	96.5%	98.3%
Cumulative Phosphorus Load Reduction	27%	47%	73%	86%	92%	96%	99%	100%

Figure 3- 4: BMP Performance Curve: Infiltration Trench (infiltration rate = 1.02 in/hr)

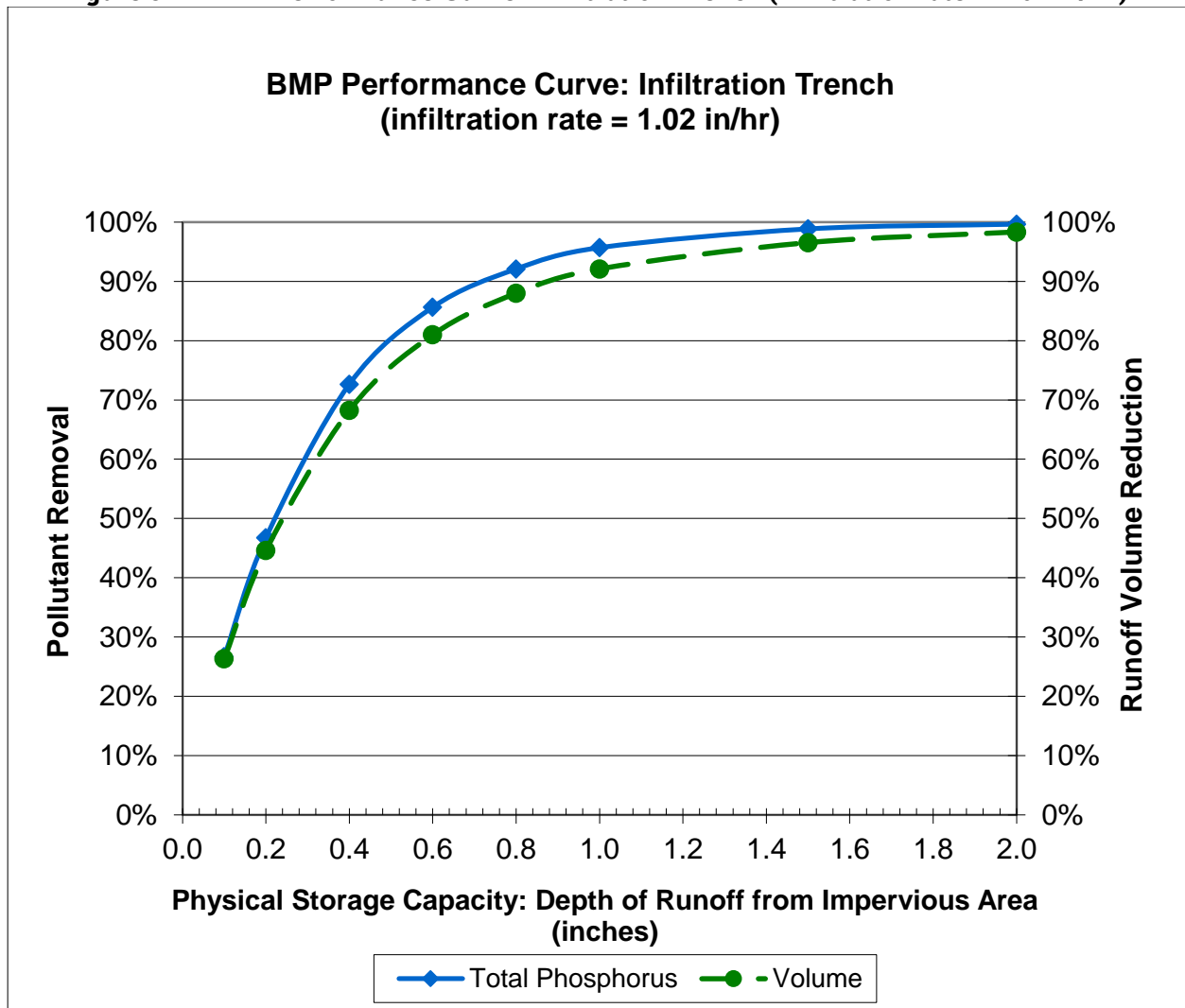
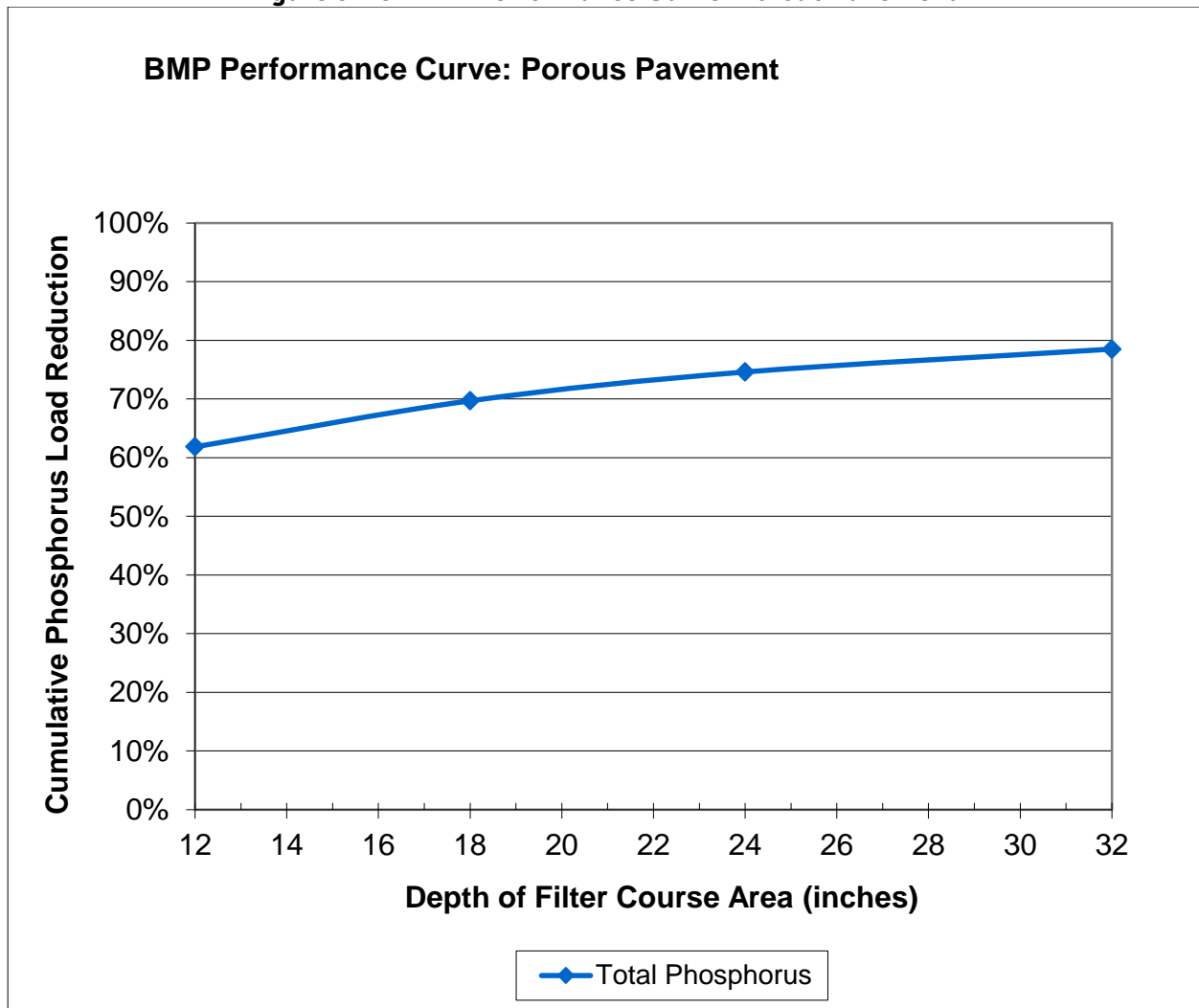


Table 3- 18: Porous Pavement BMP Performance Table

Porous Pavement BMP Performance Table: Long-Term Phosphorus Load Reduction				
BMP Capacity: Depth of Filter Course Area (inches)	12.0	18.0	24.0	32.0
Cumulative Phosphorus Load Reduction	62%	70%	75%	78%

Figure 3- 15: BMP Performance Curve: Porous Pavement



ARE Andover Building 1 - PR

Prepared by SMMA

HydroCAD® 10.00-20 s/n 00853 © 2017 HydroCAD Software Solutions LLC

ARE Building 1 - Water Quality Events

Type II 24-hr 1" Event Rainfall=1.00"

Printed 1/25/2022

Page 3

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.2b: New Parking Area Runoff Area=1.790 ac 86.59% Impervious Runoff Depth=0.32"
Tc=6.0 min CN=90 Runoff=1.02 cfs 0.048 af

SubcatchmentS-1.4: AdditionRoof Runoff Area=1.730 ac 100.00% Impervious Runoff Depth=0.79"
Tc=6.0 min CN=98 Runoff=2.26 cfs 0.114 af

Pond P-1: System 1-1 (Recharge) Peak Elev=70.61' Storage=1,850 cf Inflow=2.26 cfs 0.114 af
Discarded=0.19 cfs 0.114 af Primary=0.00 cfs 0.000 af Outflow=0.19 cfs 0.114 af

Pond P-2: System 1-2 (Recharge) Peak Elev=67.13' Storage=764 cf Inflow=1.02 cfs 0.048 af
Discarded=0.08 cfs 0.048 af Primary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.048 af

Total Runoff Area = 3.520 ac Runoff Volume = 0.162 af Average Runoff Depth = 0.55"
6.82% Pervious = 0.240 ac 93.18% Impervious = 3.280 ac

Subsurface Recharge System 2 retains 100% runoff volume from 1" water quality event.

ARE Andover Building 1 - PR

Prepared by SMMA

HydroCAD® 10.00-20 s/n 00853 © 2017 HydroCAD Software Solutions LLC

ARE Building 1 - Water Quality Events

Type II 24-hr 2" Event Rainfall=2.00"

Printed 1/25/2022

Page 7

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS-1.2b: New Parking Area Runoff Area=1.790 ac 86.59% Impervious Runoff Depth=1.09"
Tc=6.0 min CN=90 Runoff=3.48 cfs 0.163 af

SubcatchmentS-1.4: Addition Roof Runoff Area=1.730 ac 100.00% Impervious Runoff Depth=1.77"
Tc=6.0 min CN=98 Runoff=4.81 cfs 0.256 af

Pond P-1: System 1-1 (Recharge) Peak Elev=71.25' Storage=5,098 cf Inflow=4.81 cfs 0.256 af
Discarded=0.19 cfs 0.256 af Primary=0.00 cfs 0.000 af Outflow=0.19 cfs 0.256 af

Pond P-2: System 1-2 (Recharge) Peak Elev=68.29' Storage=3,273 cf Inflow=3.48 cfs 0.163 af
Discarded=0.08 cfs 0.135 af Primary=0.23 cfs 0.028 af Outflow=0.31 cfs 0.163 af

Total Runoff Area = 3.520 ac Runoff Volume = 0.419 af Average Runoff Depth = 1.43"
6.82% Pervious = 0.240 ac 93.18% Impervious = 3.280 ac

Subsurface Recharge System 1 retains 100% runoff volume from 2" water quality event.



Appendix 3.5

Operation & Maintenance Plan

Operation & Maintenance Plan

Buildings 1 & 1A

Alexandria Real Estate Equities, Inc.

3000 Minuteman Road

Andover, MA

January 26, 2022

Prepared by

SMMA

1000 Massachusetts Avenue

Cambridge, Massachusetts

Operation and Maintenance Plan

This Operation and Maintenance (O&M) Plan has been developed in accordance with Massachusetts DEP Stormwater Management Guidelines Standard No. 9 to ensure that the proposed stormwater management system functions as designed.

Owner and Responsible Party

The Applicant/Owner shall be the party responsible for adherence to the DEP Stormwater Management Policy after completion of construction. The Applicant/Owner shall designate a Site Supervisor who shall assume responsibility for this post construction maintenance plan, after a CoC has been issued. The Applicant/Owner shall be responsible for financing maintenance activities and both anticipated and emergency repairs of the system.

If the property owner changes, it shall be the responsibility of Applicant/Owner to notify the future owner of the stormwater management system and its components as well as the requirements for operation and maintenance.

Members of the Town of Andover Department of Community Development and Planning shall be allowed to enter the property at reasonable times and in a reasonable manner for the purposes of inspection of the systems.

Stormwater Management Maintenance

The following site maintenance activities are required to maintain the optimal pollutant attenuation by the drainage system. A maintenance schedule follows in this plan.

Catch Basins and Manholes

Proper maintenance includes inspection of all grates, sumps, and outlets. Any debris or obstructions should be removed. Structural damage should be recorded and reported. The amount of sediment in each catch basin should be recorded. The catch basin sumps shall be cleaned when they are half full of sediment or debris (approximately two feet below outlet pipe.)

Water Quality Units

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument.

The water quality system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the

pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine whether the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning of the systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole cover and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Polluted water or sediments removed from the CDS is to be disposed of in accordance with all applicable local, state and federal laws and regulations including M.G.L.c. 21C and 310 CMR 30.00.

Subsurface Detention & Infiltration Systems

The inlet and outlet of each system should be inspected and cleared of any debris that might clog the system. The system should be checked to ensure functionality after installation. The area above and immediately adjacent to the system should be checked for depressions. The area above and adjacent to the system should also be inspected to ensure that no unauthorized modifications have been made.

Porous Pavement

In most porous pavement designs, the pavement itself acts as pretreatment to the stone reservoir below. Consequently, frequent cleaning and maintenance of the pavement surface is critical to prevent clogging. To keep the surface clean, frequent vacuum sweeping along with jet washing of asphalt and concrete pavement is required. No winter sanding shall be conducted on the porous surface. As discussed, designs that include an “overflow edge” provide a backup in case the surface clogs. If the surface clogs, stormwater will flow over the surface and into the trench, where some infiltration and treatment will occur. For proper maintenance:

- Post signs identifying porous pavement areas.
- Minimize salt use during winter months. If drinking water sources are located nearby, porous pavements may not be allowed.
- No winter sanding is allowed.
- Keep landscaped areas well maintained to prevent soil from being transported onto the pavement.
- Clean the surface using vacuum sweeping machines monthly. For paving stones, periodically add joint material (sand) to replace material that has been transported.
- Regularly monitor the paving surface to make sure it drains properly after storms.
- Never reseal or repave with impermeable materials.
- Inspect the surface annually for deterioration or spalling.
- Periodically reseed grass pavers to fill in bare spots.

- Attach rollers to the bottoms of snowplows to prevent them from catching on the edges of grass pavers and some paving stones.

Other Site Maintenance

Pavement and Grass Areas

The pavement areas should be swept to remove solids and reduce the amount of suspended solids in the runoff. All accumulated trash and litter throughout the site should be collected and discarded.

Snow Removal

Maintenance activities during the winter months are primarily limited to snow removal activities and removal of debris and trash throughout the site.

Snow removal operations will adhere to *the Massachusetts Department of Environmental Protection – Bureau of Resource Protection Guidelines (dated March 8, 2001)*. Snow will be stockpiled as far away from resource areas as possible and removed as necessary under larger snow events. Stockpiling snow in this manner will allow meltwater to enter the drainage system and thereby receive pretreatment prior to discharging to receiving resource areas. Snow and ice that has accumulated around catch basin grates will be removed.

Winter Salt and Sand Use

For concrete walkways and plaza areas, no binary chloride compounds shall be applied, i.e. sodium chloride, calcium chloride or magnesium chloride, for a minimum of 6 months after concrete installation is complete. This allows the concrete to cure to its optimal strength. For the first year, an aggressive snow removal process through mechanical means or hand shoveling followed by the use of sand or fine gravel mixtures optimal for the life of the sidewalks and plaza systems.

Maintenance Schedule

Required Action	Frequency
Catch Basins and Manholes	
Inspect for depth of sediment, obstructions, structural damage, or other malfunction	Quarterly in the first year; at least twice per year after
Clean sumps of accumulated sediment	When structures are ½ full of sediment/debris (approximately two feet below outlet pipe) once per year minimum
Pavement and Grass Areas	
Sweep pavement areas	At least twice per year: after final snow melt and after final leaf fall and as necessary in summer months
Remove accumulated litter, debris, and discarded materials throughout the site	Once per week

Subsurface Detention & Infiltration Systems	
Inspect inlets and outlet and remove any debris	Quarterly in first year; at least twice per year after
Inspect system for functionality	After first major rainfall following installation
Check for depressions in areas above and surrounding the system	Once per year
Confirm that no unauthorized modifications have been performed to the site around (including over) the system	Once per year
Inspect interior of system	Once per year
Water Quality Units	
Inspect for depth of sediment, obstructions, structural damage, and other malfunction	Twice per year in spring and fall
Remove sediment and pollutants	When level of sediment in structure's sump reaches 75% of capacity or when appreciable level of hydrocarbons and debris has accumulated; at a minimum of once per year
Porous Pavement	
Monitor to ensure that the paving surface drains properly after storms	As needed
For porous asphalts and concretes, clean the surface using power washer to dislodge trapped particles and then vacuum sweep the area. For paving stones, add joint material (sand) to replace material that has been transported.	As needed
Inspect the surface annually for deterioration	Annually
Assess exfiltration capability at least once a year. When exfiltration capacity is found to decline, implement measures from the Operation and Maintenance Plan to restore original exfiltration capacity.	As needed, but at least once a year
Reseed grass pavers to fill in bare spots.	As needed

Reporting and Documentation

The Site Supervisor for the Applicant/Owner shall be responsible for maintaining an accurate Site Maintenance Log. The Site Maintenance Log shall be located on site and made available to the Town of Andover Department of Community Development and Planning.

The Site Maintenance Log shall:

- Document the completion of planned maintenance tasks
- Identify the person responsible for the completion of tasks
- Identify any outstanding problem, malfunction, or inconsistency identified during the course of routine maintenance

The Site Supervisor shall be responsible for ensuring that the scheduled tasks area appropriately completed as described in this plan and the Site Maintenance Log accurately represents activities carried out as described in this plan.

Site Maintenance Log

A Site Maintenance Log shall be completed as described above and shall, at a minimum, include the following items:

- Completed Inspection Checklist
- Date of activity performed
- Specific maintenance task
- Structural components maintained, as identified on the O&M Plan
- Staff person or contractor performing activity on behalf of the Applicant/Owner
- Supervisor verification of maintenance activity
- Recommended additional maintenance task
- Means to document identified areas of concern, erosion, or system discrepancies requiring attention

Public Safety Features

On-site public safety features include the following:

- Covers and grates on all manholes and catch basins designed to withstand H₂O loading
- Maintain or reduce peak stormwater runoff rates from existing to proposed conditions
- Creation and implementation of an O&M Plan to ensure the ability of the stormwater management system to continue to operate as designed

Inspection Checklist

Date of Inspection _____

Checklist Completed By _____

Reviewed by Supervisor _____

Required Action	Frequency	Comments
Catch Basins and Manholes		
Inspect for depth of sediment, obstructions, structural damage, or other malfunction	Quarterly in the first year; at least twice per year after	
Clean sumps of accumulated sediment	When structures are ½ full of sediment/debris (approximately two feet below outlet pipe) once per year minimum	
Pavement and Grass Areas		
Sweep pavement areas	At least twice per year: after final snow melt and after final leaf fall and as necessary in summer months	
Remove accumulated litter, debris, and discarded materials throughout the site	Once per week	
Subsurface Detention & Infiltration Systems		
Inspect inlets and outlet and remove any debris	Quarterly in first year; at least twice per year after	
Inspect system for functionality	After first major rainfall following installation	
Check for depressions in areas above and surrounding the system	Once per year	
Confirm that no unauthorized modifications have been performed to the site around (including over) the system	Once per year	
Inspect interior of system	Once per year	

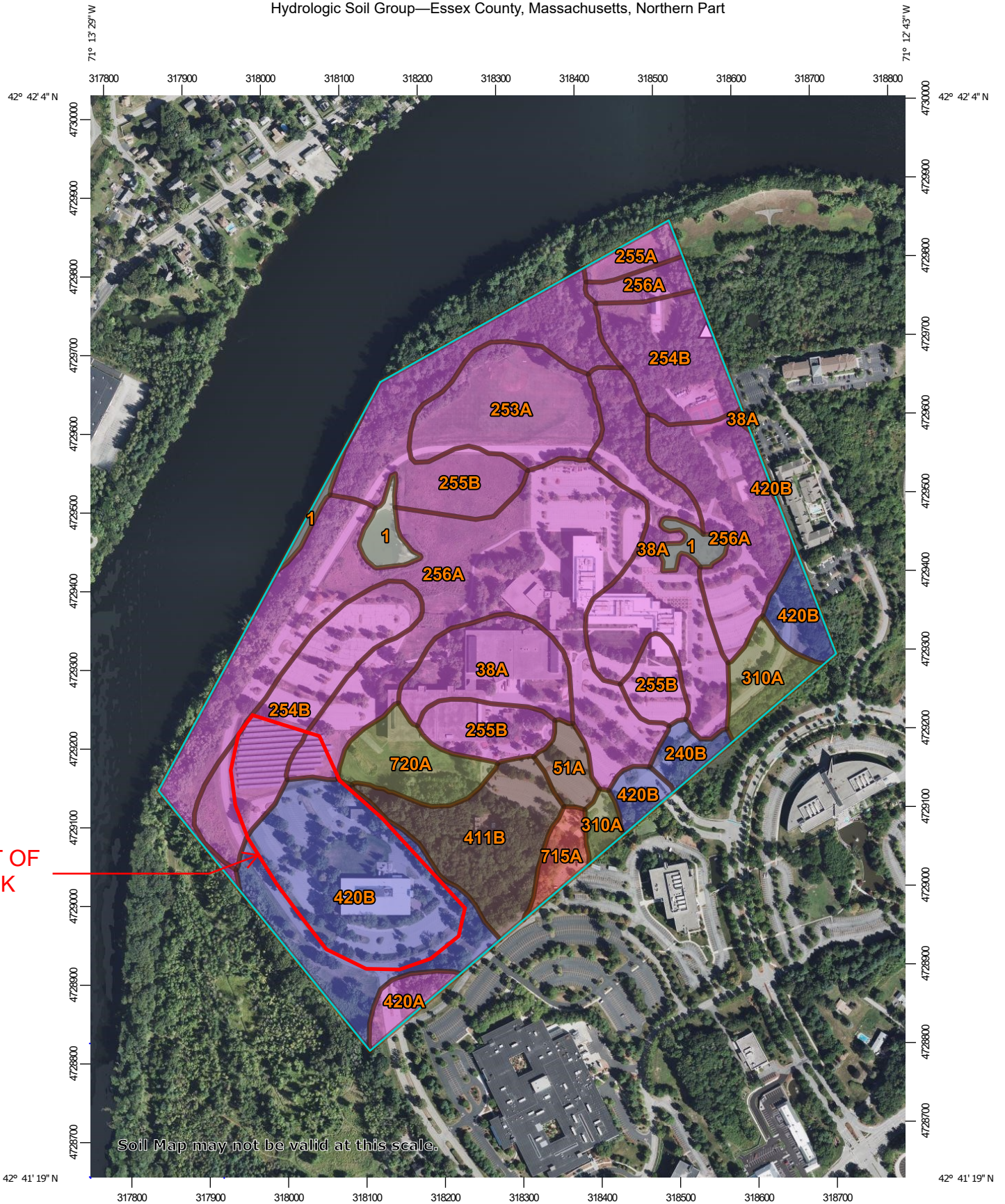
Water Quality Units		
Inspect for depth of sediment, obstructions, structural damage, and other malfunction	Twice per year in spring and fall	
Remove sediment and pollutants	When level of sediment in structure's sump reaches 75% of capacity or when appreciable level of hydrocarbons and debris has accumulated; at a minimum of once per year	
Porous Pavement		
Monitor to ensure that the paving surface drains properly after storms	As needed	
For porous asphalts and concretes, clean the surface using power washer to dislodge trapped particles and then vacuum sweep the area. For paving stones, add joint material (sand) to replace material that has been transported.	As needed	
Inspect the surface annually for deterioration	Annually	
Assess exfiltration capability at least once a year. When exfiltration capacity is found to decline, implement measures from the Operation and Maintenance Plan to restore original exfiltration capacity.	As needed, but at least once a year	
Reseed grass pavers to fill in bare spots.	As needed	

The background of the page is a complex pattern of thin, light blue lines that curve and flow across the page, creating a sense of movement and depth. The lines are more densely packed in some areas and more sparse in others, forming a series of overlapping, wavy bands.

Appendix 3.6

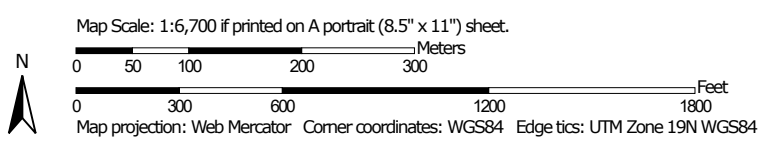
NRCS Web Soil Survey

Hydrologic Soil Group—Essex County, Massachusetts, Northern Part




Soil Map may not be valid at this scale.

LIMIT OF WORK







MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)









Soils

 Soil Survey Areas
 Soil Map Unit Polygons
 Soil Map Unit Lines
 Soil Map Unit Points

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available


















Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available


Soil Rating Points









 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Special Point Features

 Blowout
 Borrow Pit
 Clay Spot
 Closed Depression
 Gravel Pit
 Gravelly Spot
 Landfill
 Lava Flow
 Marsh or swamp
 Mine or Quarry
 Miscellaneous Water
 Perennial Water
 Rock Outcrop
 Saline Spot
 Sandy Spot
 Severely Eroded Spot
 Sinkhole

Background

 Aerial Photography

 Slide or Slip
 Sodic Spot
 Spoil Area
 Stony Spot
 Very Stony Spot
 Wet Spot
 Other
 Special Line Features

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Northern Part
 Survey Area Data: Version 17, Sep 2, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 13, 2020—Sep 15, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		2.2	1.8%
38A	Pipestone loamy sand, 0 to 3 percent slopes	A	14.4	11.9%
51A	Swansea muck, 0 to 1 percent slopes	B/D	1.4	1.1%
240B	Elmwood fine sandy loam, 3 to 8 percent slopes	B	1.2	1.0%
253A	Hinckley loamy sand, 0 to 3 percent slopes	A	6.9	5.7%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	12.7	10.5%
255A	Windsor loamy sand, 0 to 3 percent slopes	A	1.1	0.9%
255B	Windsor loamy sand, 3 to 8 percent slopes	A	13.7	11.3%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	A	34.5	28.4%
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C/D	3.0	2.5%
411B	Sutton fine sandy loam, 0 to 8 percent slopes, very stony	B/D	6.8	5.6%
420A	Canton fine sandy loam, 0 to 3 percent slopes	A	1.2	1.0%
420B	Canton fine sandy loam, 3 to 8 percent slopes	B	17.4	14.4%
715A	Ridgebury and Leicester fine sandy loams, 0 to 3 percent slopes, extremely stony	D	1.4	1.1%
720A	Whately variant fine sandy loam, 0 to 3 percent slopes	C/D	3.5	2.9%
Totals for Area of Interest			121.4	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



Appendix 3.7

Phase 1 Utility Assessment

Phase 1 Utility Assessment

Water and Sewer

Estimated water demand and sanitary discharge for Phase 1 and the anticipated master plan expansion have been prepared by Genesis AEC. The Applicant has presented the projections to Andover Public Works including representatives of the Water, Sewer and Engineering Divisions. For purposes of this utility analysis Phase 1 includes Building 1 and the proposed Addition, Building 3, Building 2 with partial occupancy and the Link/Amenity Building. The Phase 1 data presented below includes chilled water demand. For this analysis the chilled water source for Buildings 2 and 3 is assumed to be from a central utility plant (CUP).

ARE is committed to sustainable technologies to minimize water demand and will work with the town to assess water supply during peak demand conditions. ARE is also committed to conducting a study of a section of the sanitary sewer as discussed with the town.

The peak and average water demands and average sewer discharge profiles for Phase 1 are as follows:

PLUMBING ENGINEERING CALCULATIONS
Domestic Water & Drainage Usage - Phase 1



Project Name: ARE
 Project Number: 21326
 Location: Andover PA
 Plumbing Code: Mass Plumbing Code

Calculated By: J Rowe
 Date: 23-Jan-22
 Revision: 2

BUILDING	Peak Flow (GPM)	Domestic Water GPD	Sanitary GPD	Comments
	Building 1	50	6840	
Building 1 Addition	58.5	8310	4386	
Building 2 - 50%	50	6840	3623	
Building 3	95	14085	7438	
Link	100	4940	4940	
Partial CUP	222.5	77100	30200	
TOTAL FLOW	576	118115	54210	

PARAMETERS

1. Personnel based upon 7.5 GPD per person (8 GPD for Cafeteria)
2. Assume (1) lab sink per 1,000 SF
3. Assume (1) glass washer and (1) autoclave per 25,000 SF of lab space
4. Lab RODI based upon 0.1 gpd/SF & 0.0003 gpm/SF
5. Clean room purified water based upon 0.2 gpd/SF & 0.0006 gpm/SF
6. Lab RODI backwash is based upon 30% of the water make-up on a SF basis
7. Clean room purified water backwash is based upon a 40% of the water make-up on a SF basis

The design team is currently coordinating a series of hydrant flow tests to be conducted in January or early February 2022. The testing will provide input to the water network model and confirm water pressures and flowrates under existing conditions and enable modeling of proposed demand scenarios.

SMMA has prepared analyses of the existing sewer capacity and is designing the new sewer connections to meet peak flow.

The plumbing design for each building is being developed with Genesis AEC. In general, a new lab/process service will be provided for each building complete with an interior neutralization system. After being neutralized, the lab/process waste main will be routed to the main with an exterior test/sampling port installed as required.

Electrical Distribution

The existing site distribution capacity is rated to support approximately 11MVA. However, the site is limited by the utility owned 5000kVA transformers.

The calculated total demand load for the site is approximately 27,735kVA (or 464A at 34.5kV). Based on the electrical load calculation, the existing electrical service to the site is adequate to provide power for Phase 1 of the campus fit-out.