Con Com, IL
PB, NL
P. Mann
D. Nadeau

DOCUMENT INTAKE FORM

Date 5/17/16

Name David Martin

Property Address (Street, City, Zip) _____

If not the Property Owner, then state your relation to the Property Owner
Applicant's Representative

Name Brian Kuchar

Name of Firm Horsley Witten Group

Your Address (Street, City, Zip) _____

Email Address _____

Telephone _____ Fax _____

City of Amesbury **Board/Committee/Permit Granting Authority - PGA** *(Choose That Apply)*

- [x] Planning Board + N. JAIN + M. Leach
- [x] Conservation Commission
- [ ] Zoning Board of Appeals
- [ ] Other _____
- [ ] Historical Commission
- [ ] Tree Board
- [ ] Design Review Committee

Project Name: 77 Elm St.

Materials Submitted *(Choose That Apply)*

- [ ] Permit Application - NEW
- [ ] Supplemental Information
- [ ] Information Requested by PGA
- [ ] Responses to Peer Review
- [ ] Responses to Technical Assistant Group
- [ ] Other _____

Have you already filed an Application with PGA

If Yes, then List ALL Permits
Permit Type _____

Date Originally Submitted _____

Materials	Description	Original Date	Revision Date		No. of Copies
Plans					
Technical Documents					
Other	Stormwater Analysis & Drainage Report - DATED/REVISED APRIL 2016				

Purpose of Submission / Requested Action	Copy sent to M. Leach from Horsley Witten.

Acknowledgement
Signature _____

Office Use Only

Office of Community & Economic Development, 62 Friend Street Amesbury MA 01913

Received By BFoley Date 5/17/16

Form # AD-001

Last Revised - 02/01/2015

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Sandwich, MA • 02563
Phone - 508-833-6600 • Fax - 508-833-3150 • *www.horsleywitten.com*

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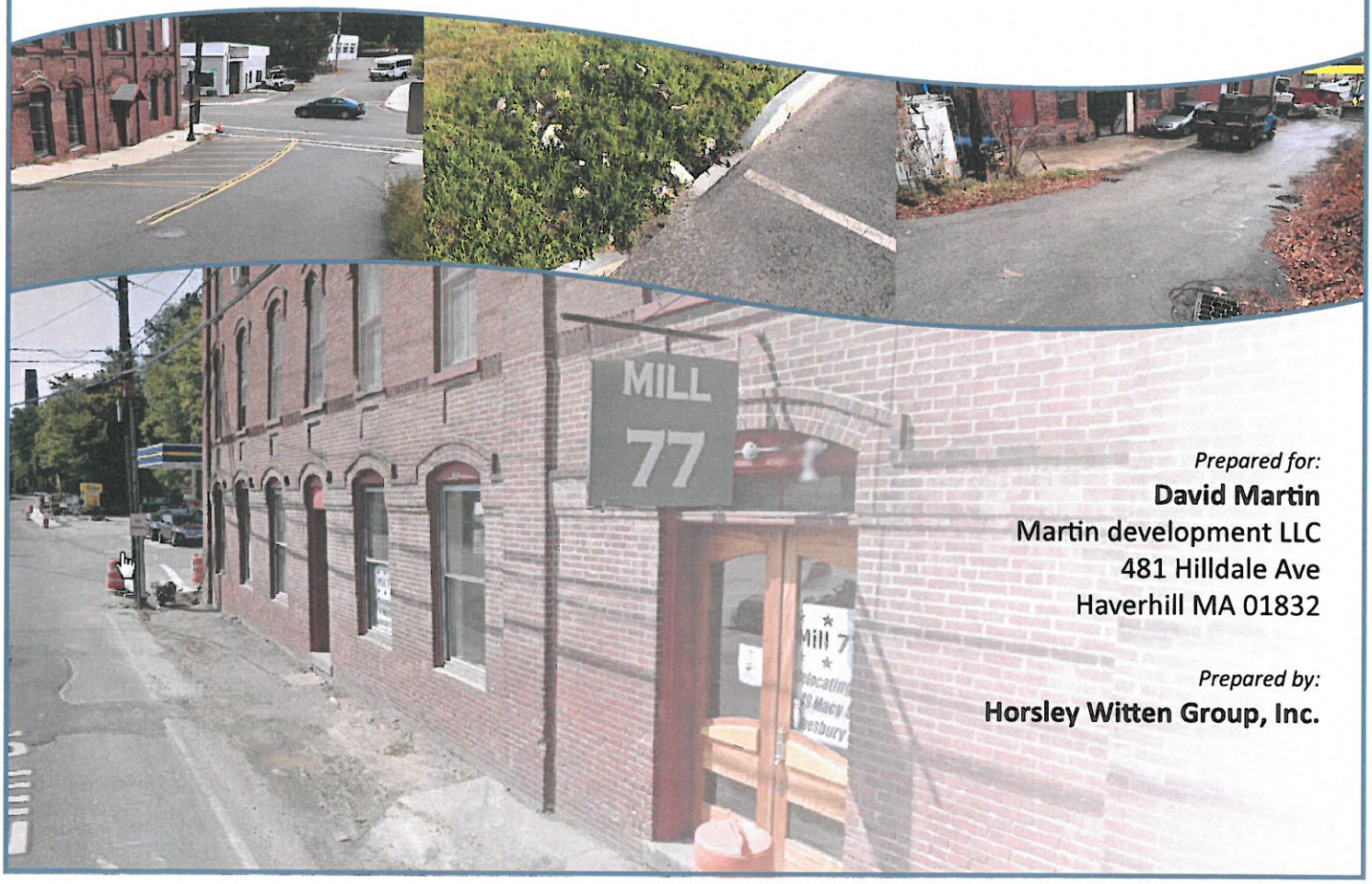
Stormwater Analysis and Drainage Report

Mill 77
77 Elm Street
Amesbury, MA

November 2015
Revised March 2016
Revised April 2016



Prepared for:
David Martin
Martin development LLC
481 Hilldale Ave
Haverhill MA 01832

Prepared by:
Horsley Witten Group, Inc.

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1.0 STORMWATER AND DRAINAGE NARRATIVE

This Stormwater Analysis and Drainage Report provides a summary of the stormwater management system for the proposed site improvements located at 77 Elm Street Amesbury, Massachusetts. The purpose of this report is to describe the pre- and post-development site conditions as well as the practices to be used to reduce pollutants in stormwater discharges during and after construction. The proposed stormwater management system has been designed to incorporate "low-impact-development" (LID) elements and minimizes site disturbance where possible.

Although the Back River is located just north and south of the project site, the river enters a culvert, which runs under Elm Street and the existing building at 77 Elm Street prior to reaching the project site. Due to the culvert, the site is outside of the 200' Riverfront Area. Therefore, only a portion of the site (southeast corner of the existing mill building) is located within the 100' wetland buffer and most of the proposed site improvements are outside the wetland buffer. As part of the overall site design the Massachusetts Stormwater Standards (MASWMS) (revised in February, 2008) were applied to the stormwater management system for the proposed site improvements. In order to promote smart, environmentally friendly development, the proposed concept treats at a minimum the first inch of stormwater runoff. The pre and post peak flows (cfs) have been analyzed for the 2, 10, 25, and 100-year storm events. The proposed stormwater controls will be operated and maintained appropriately during regular operation of the site in the post-construction period as well as during the construction phase.

1.1 Existing Conditions

The project area is located in downtown Amesbury at the intersection of Elm Street and Clark Street (Figure 1 &2). The project consists of Lot 38 A.P. 53 and Lot 139A A.P. 40. The lot areas are 18,008 sq. ft. and 8,734 sq. ft., respectively, with a combined total area of 26,742 sq. ft. (0.61 acres). The project site is located at approximately Latitude: 42° 51' 32.56" N Longitude: -70° 55' 41.0" W.

Lot 38 is located at 77 Elm Street ad consists mainly of an existing brick mill building, paved road/parking areas and a paved "courtyard".

Existing Building (sf):	8,971
Existing Paved Road/Parking (sf):	5,521
Existing Pave Courtyard (sf):	1,578
Pervious cover (sf):	1,938

The general topography of the Lot 38 is very steep and slopes from northwest to southeast with the steepest grades along the northern portion of the lot and access drive. The elevation across the property area varies from 32 feet in the rear to 14 feet at the front of the building.

The surrounding properties to the north south and west are highly developed with a mix of residential and commercial uses. The Back River is located to both the north and the south and crosses under the property via an existing brick/stone culvert (Figure 3). The river enters the culvert to the north and exit southeast of the site across Elm Street. A portion of the southeast corner of the property is located within the 100 foot wetland buffer associated with the Back River (Figure 3).

Lot 139A is located at 9 ½ Fruit place and consists of an existing residential dwelling, paved driveway and lawn.

Existing Building (sf):	1,117
Existing Paved Road/Parking (sf):	750
Existing lawn (sf):	6,867

The general topography of the Lot 139A is moderate and slopes from west to east with the steepest grades along the eastern portion of the lot, which abuts Lot 38. The elevation across the property varies from 50 to 36 feet. The surrounding properties to the north south and west are highly developed and are a mix of residential and commercial uses.

Stormwater Management

Most of the site surface runoff from Lot 38 currently drains via overland flow along the access drive at the rear of the property to an existing town maintained closed pipe drainage system located within the rear access drive. The drainage system is connected to existing town drainage located in the Clark Street Right-of-Way. A small portion of the lot, the "courtyard" area in the northeast corner, currently drains to two existing drain grates, which discharge directly to the culvert below.

Based upon site observations, it is assumed that the roof is pitched to the rear of the property and collected in downspouts, which discharge directly onto the paved parking and access drive along the rear of the property.

The site surface and roof runoff from Lot 139A currently drains untreated west to east via overland flow to the existing drainage system located in the access drive along the western and northern portions of Lot 38.

Soils

According to the 2012 NRCS-Certified Soils MassGIS the soils underlying Lot 139A are Merrimac 254D. Merrimac soils are classified as very deep, somewhat excessively drained soils formed in outwash. Depth to bedrock is typically greater than 60 inches and the water table is normally more than 6 feet below the surface. Merrimac soils are classified as hydrologic soil group C.

Lot 38 is split between Merrimac 254D and 230C Unadilla. Unadilla soils are classified as well drained soils formed in silty, lacustrine sediments or old alluvial deposits. Depth to bedrock is

typically greater than 60 inches and the water table is normally more than 6 feet below the surface. Unadilla soils are classified as hydrologic group C. See Soils Map Figure 4.

Five test pits were excavated on October 9, 2008 by Atlantic Engineering & Survey Consultants, Inc. in the area of the proposed drainage practices on Lot 139A. The test pits identified the underlying soil in this area as a loam, silty loam and glacial till. The five test pits were excavated to depths of 72-101 inches below grade. Presence of groundwater or groundwater seepage was not observed in any of the test pits. (**Appendix A**).The soil strata indicated mottling at shallow depths of 21-38 inches. This is most likely the result of water trapped in the "tight" poorly drained soils found near the surface. Based upon conversations with the site soil evaluator, the layer is dense hardpan, which traps surface runoff just below the surface. It is also noted a significant steep slope caused by a "cut" to construct the existing road exists along the eastern boundary of Lot 139A with a difference in elevation greater than 10' between test pit #1 and the down-slope grade. Groundwater seepage has not been observed anywhere along this slope during site visits in both the spring and fall seasons. HW has also opened all of the existing block and brick catch basins located in both Fruit Place and "Fruit Place Extension" and groundwater seepage was not observed in any of the structures or incoming pipes. Based upon the available data and on site observations, we do not anticipate encountering groundwater entering the underground detention chambers.

Flood Zones

The project site is located within Flood Insurance Rate Map (FIRM) zone A as indicated on community panel No. 250075 0106F dated July 3, 2012 (**Appendix B**). Lot 139A is situated in an area of minimal flood hazard (Zone X). The southern and eastern portions of Lot 38 are located within the 1% annual flood hazard, (Zone A). See Figure 5.

1.2 Proposed Conditions

The proposed project includes the following proposed site improvements on both Lots 139A and 38:

- Conversion of the existing mill building into commercial and retail space (Lot 38);
- Demolition of existing accessory building and stairwell in the area of the "courtyard" (Lot 38) and the removal of the existing residential dwelling (Lot 139A)
- Reconfiguration of the rear access drive and parking (Lot 139A);
- Construction of block retailing walls (Lot 139A):
- New sidewalk and building entrance at the rear of the property (Lot 38);
- A new handicap access ramp to provide ADA accessibility at the rear of building (Lot 38); and
- Construction of a 6,700 square foot parking lot (Lot 139A).

A total of 24 parking spaces is provided on the two lots. The proposed parking lot will provide 19 - 18' long x 9' wide spaces. An additional five spaces are proposed as street side parking off Fruit Place Street. Two of the five street parking spaces are reserved for ADA handicap accessibility with an aisle.

Lot 38

Proposed Building (sf):	7,650
Proposed Paved Road/Parking (sf):	5,550
Proposed Pedestal Paver "Courtyard" 75% impervious cover (sf):	1,900
Proposed Planters "Courtyard" 25% impervious cover (sf):	652
Proposed landscape/pervious cover (sf):	2,256

The total proposed impervious area on Lot 38 (including both the building and paved surfaces will be decreased by 6.4% from the existing conditions.

Lot 139A

Proposed Building (sf):	0
Proposed Parking (sf):	6,132
Proposed Wall (sf):	418
Proposed landscape/pervious cover (sf):	2,183

The total limit of disturbance associated with construction is 31,171 sf and includes work on both lots and proposed roadway improvements within the Fruit Place Right-of-Way. All disturbed areas will be revegetated and/or loam and seeded as indicated on the plans. The area of disturbance within the 100' wetland buffer is 1,464 sf and includes exterior building façade improvements only. Additional lot coverage calculations are provided in **Appendix C.**

Stormwater Management

The proposed redevelopment of Lot 38 results in a reduction of impervious cover. The redevelopment of Lot 139A, which includes the conversion of the residential dwelling into the proposed parking lot, contains two bioretention areas designed to capture and treat stormwater runoff generated by the Lot 139A. The two bioretention areas, 1 and 2, are located in the northeast and southeast corners of the parking lot respectively and sized to treat the first 1" of runoff. Each area is designed to receive approximately 50% of the parking surface runoff. Sediment forebays are provided for pretreatment to capture sediment prior to entering the planted area. Both bioretention cells direct overflow runoff to subsurface storage chambers proposed beneath the parking lot. An isolator row has also been provided as part of the underground storage system to capture any additional sediment and allow for proper maintenance and cleaning.

The Stormwater Management System has been designed to accomplish the following major objectives:

- To capture, treat at a minimum the "first flush" (first 1 inch of stormwater runoff) from the impervious surfaces in order to maintain or improve water quality conditions when compared to existing conditions;
- To provide groundwater recharge to the greatest extent practicable in conformance with the Massachusetts Department of Environmental Protection groundwater recharge criteria through the reduction of impervious cover; and

- To minimize runoff from the post developed conditions at the study points located along the periphery of the site.

These objectives are met through the use of the following stormwater management measures:

- Reduction of site impervious cover on Lot 38 by utilizing the minimum roadway, parking and driveway widths acceptable to local safety officials (i.e., Fire and Police Department).
- Bioretention areas sized to treat the first 1 inch of runoff for water quality treatment of proposed new impervious cover in the proposed parking lot (**Appendix D**). The shallow landscape within the bioretention area is designed to filter runoff sediment and facilitate pollutant uptake through vegetation that will be planted within the bioretention areas. The systems are equipped with an overflow structure to convey runoff from larger storm events to the proposed underground storage system and eventually the existing drainage system.

Stormwater runoff quality was evaluated to ensure that pollutant export from the project site was minimized to the maximum extent practicable. The stormwater management system for the site was designed in accordance with the MassDEP Stormwater Management Policy and the applicable criteria within the town regulations

1.3 Drainage Design Methodology and Analysis

The drainage design was completed by performing a series of tasks that included:

- Excavating soil test pits;
- Determining site drainage areas and sub catchments;
- Sizing the bioretention areas and underground storage chambers; and
- Modeling the proposed drainage network with HydroCAD®.

Due to the poor underlying soils, infiltration is not accounted for in the stormwater management design. The underground storage system is underdrained and designed for detention storage only.

Based upon additional field observations, MassGIS data and aerial images the existing project contributing drainage area has been slightly modified to 2.56 acres (formerly 2.69 acres) to more accurately depict the contributing subcatchment and clarify the pipe sizing for the existing stormwater network located within Fruit Place and "Fruit Place Extension". The area has been divided into seven smaller subcatchments (DA1, DA2, DA3, DA4, DA5, DA6, and DA7). The increase in the number of subcatchments is due to the division of Fruit Place and "Fruit Place Extension" corridor into five subcatchments.

DA1 includes the up-gradient portion of Fruit Place from the intersection with Market Street to the first catchbasin (CB1) on Fruit Place. The contributing drainage area includes the

surrounding homes, portions of the associated driveways, parking lots and front yards. DA1 is approximately 83% impervious.

DA2 includes the down-gradient portion of Fruit Place from CB1 to CB2 and a small portion of Lot 139A A.P. 40. The contributing drainage area includes the surrounding homes, portions of the associated driveways and front yards. DA2 is approximately 62% impervious.

DA3 includes the up-gradient portion of "Fruit Place Extension" from CB2 to CB3. The contributing drainage area includes the building and driveway from Lot 268 A.P. 40 and a portion of "Fruit Place Extension". DA3 is 100% impervious.

DA4 includes a small middle portion of "Fruit Place Extension" located on Lot 38 A.P. 53 from CB3 to CB4. The contributing drainage area includes the paved surface at the rear entrance to the 77 Elm Street. DA4 is 100% impervious.

DA5 includes the down-gradient portion of "Fruit Place Extension" from CB4 to CB5, Study Point 1 (SP1), located at the intersection of Clarke Street. The contributing drainage area includes the paved road portion, 77 Elm Street Mill roof runoff, a portion of the roof runoff from the building on Lot 37 A.P. 53 and runoff from the up-gradient woods and lawn area located on Lot 139A A.P. 40. DA5 is 55% impervious.

DA6 includes the contributing drainage area for Clarke Street (outside of the project area) from the intersection of Market Street to CB5. There are three up-gradient catch basins located along Clarke Street. DA6 drains to SP1, via overland flow and a closed piped drainage system. DA6 includes the surrounding neighborhood within the subcatchment with over a half a dozen buildings and associated roads, driveways and parking lots. DA6 is 61% impervious.

DA7 (formerly DA2) is located in the "courtyard" area and includes the existing pavement and accessory building structures. DA7 is 100% impervious and drains the two catchbasins near the entrance which are both directly connected to the below grade culvert.

The proposed project drainage area is 2.56 acres (formerly 2.69 acres) and comprised of nine subcatchments. DA1 will remain unchanged and continue to drain to CB1 in accordance with the existing conditions. The remaining six drainage areas (2 thru 7) will maintain similar drainage patterns consistent with the existing conditions. Minor modifications will occur within each drainage area, due to the proposed improvements along both Fruit Place and "Fruit Place Extension". The most significant change occurs within DA5, which is subdivided into two additional subcatchments DA-1A and DA-1B to account for the proposed parking lot to be constructed on Lot 139A A.P. 40. The proposed parking lot and stormwater management system divides Lot 139A into the two smaller subcatchments and is directed to underground storage chambers to manage peak flows. All three subcatchments will continue to drain to SP1.

DA-1A is approximately 0.07 acres and includes a portion of the proposed parking lot, associated walls and landscaping. The subcatchment WqV will be treated by a bioretention area. Larger storm events will overflow into underground storage chambers to manage the peak flows. DA2 is 87% impervious

DA-1B is approximately 0.11 acres and includes a portion of the proposed parking lot, associated walls and landscaping. The subcatchment WqV will be treated by a bioretention area. Larger storm events will overflow into underground storage chambers to manage the peak flows. DA2 is 83% impervious

DA2 includes the down-gradient portion of Fruit Place from CB1 to the new CB100. The contributing drainage area includes the surrounding homes, portions of the associated driveways and front yards. DA2 is approximately 77% impervious.

DA3 includes the up-gradient portion of "Fruit Place Extension" from the new CB100 to the existing CB3. The contributing drainage area still includes the home and driveway from Lot 268 A.P. 40 and a portion of "Fruit Place Extension". DA3 remains 100% impervious.

DA4 includes a small middle portion of "Fruit Place Extension" located on Lot 38 A.P. 53 from CB3 to the new CB300. The contributing drainage area includes the paved and landscaped entrance area and the newly created handicapped parking at the rear entrance to the 77 Elm Street. DA4 is 76% impervious.

DA5 is smaller and comprised of a large portion of the area included in the existing DA5 from CB300 to CB5. The contributing drainage area includes the paved road, associated parking at the rear of 77 Elm Street and landscaped area. DA5 is 77% impervious.

DA6 will remain unchanged and continue to drain in accordance with the existing conditions.

DA7 will continue to drain in accordance with the existing conditions. The accessory buildings will be removed from the courtyard area and will be replaced with pavers and landscape planters. It is anticipated that 25% of the paver courtyard surface will be landscaped planters. This represents an improvement from the current conditions. See **Appendix E** for both the revised "Pre" and "Post" developed" Drainage Area Maps.

The proposed Stormwater Management System was designed to accommodate pre-development site hydrologic conditions as well as to eliminate stormwater pollution from the proposed site improvements. Stormwater runoff quantity was evaluated for the 2-year, 10-year, 25-year and 100-year Type III, 24-hour storm for both pre-development and post-development conditions. The stormwater management system was sized to treat the first inch of runoff from the site. Pre-development and post-development conditions were modeled using HydroCAD software, which combines USDA Soil Conservation Service hydrology and hydraulic techniques (commonly known as SCS TR-55 and TR-20) to generate hydrographs

(**Appendix F**). The rainfall amounts used for calculating runoff for the storm events were obtained from the Rainfall Frequency Atlas of the United States (TP40) (**Appendix G**). Pre and post peak flow and volume comparisons are provided in Table 1 below.

Table 1: Peak Flow and Volume Comparisons

STUDY POINT 1

DESIGN STORM	PRE-DEVELOPMENT		POST-DEVELOPMENT		PERCENT REDUCTION	
	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW	VOLUME
2 YR	4.58	0.445	4.49	0.461	2%	-4%
10 YR	7.36	0.725	7.06	0.744	4%	-3%
25 YR	9.14	0.910	8.72	0.930	5%	-2%
100 YR	11.32	1.138	10.71	1.159	5%	-2%

STUDY POINT 2

DESIGN STORM	PRE-DEVELOPMENT		POST-DEVELOPMENT		PERCENT REDUCTION	
	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW	VOLUME
2 YR	0.18	0.014	0.17	0.012	6%	14%
10 YR	0.26	0.021	0.25	0.019	4%	10%
25 YR	0.31	0.025	0.30	0.024	3%	4%
100 YR	0.38	0.031	0.37	0.029	3%	6%

Pipe Sizing (Fruit Place and "Fruit Place Extension")

As demonstrated in Table 1, the stormwater management provides a slight peak flows reduction for the post development conditions, therefore an increase in the existing drainage network capacity would not be anticipated. As part of the Stormwater Analysis, a site visit was performed on March 14, 2016 to confirm the assumed conditions of the existing drain pipes and catch basins located on Fruit Place and "Fruit Place Extension" were correct. Inconsistencies were found between the pipe sizes indicated on the existing conditions survey plan (provided by others) and the actual field conditions. During the site visit, pipe size and material for all pipes were confirmed to be 12" HDPE. The catch basin and manhole structures included both block and brick structures. Following the site visit, the contributing drainage subcatchments for each structure were delineated based upon the existing conditions survey plan, GIS data, aerial images, on site observations made during the March 14th visit and the proposed improvements plans. Using the rational method, pipe sizing calculations were performed for the 25-yr storm event and then cross referenced with the revised stormwater analysis as described above. As anticipated, based upon the peak flows comparison provided in Table 2, the existing Fruit Place and "Fruit Place Extension" drainage network has sufficient pipe capacity for both the current and improved site conditions. The revised pipe sizing calculations are provided in **Appendix H.**

Table 2: Fruit Place and "Fruit Place Extension" Flow Comparisons

DESIGN STORM	PRE-DEVELOPMENT		POST-DEVELOPMENT		PERCENT REDUCTION	
	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW	VOLUME
2 YR	2.98	0.219	2.96	0.244	1%	-11%
10 YR	4.71	3.510	4.47	0.381	5%	89%
25 YR	5.82	0.437	5.43	0.469	7%	-7%

2.0 COMPLIANCE WITH MassDEP STORMWATER STANDARDS

The Massachusetts Stormwater Standards were revised in February 2008 to include ten stormwater management standards, established jointly by the DEP and the Office of Coastal Zone Management and published in the 2008 update of the Stormwater Management Handbook. Projects that are within the jurisdiction of the Wetlands Protection Act Regulations, 310 CMR 10.00 are subjected to these Stormwater Management Standards. For this project, strict adherence to the Handbook is not mandatory because the project is classified as a redevelopment; therefore, the project meets the standards to the greatest extent practicable. In addition, the stormwater management system was designed in accordance with the Town of Amesbury Regulations and Bylaws.

The following is a list of Stormwater Management Standards and accompanying description of compliance for the Mill redevelopment project.

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

No new untreated stormwater runoff outfalls will be created or discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

2. Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

Discharge rates for pre and post-development were calculated using HydroCAD® 2015, a SCS-TR20 based stormwater modeling computer program (**Appendix F**). Post-development peak discharge rates for the 2-year, 10-year, 25-year and 100-year storms are equal to or less than the pr-development conditions. A comparison summary table of the peak flows and volumes is shown in **Table 1**.

3. Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This

Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

Overall, impervious cover is being reduced on Lot 38 in the post condition; therefore, the lot recharge amounts will be greater than pre conditions. The increase of impervious cover on Lot 139A is managed by subsurface storage chambers. Due to the poor soils and observed mottling, recharge of the proposed impervious cover will be minimal on Lot 139A. This standard is met to the greatest extent practicable.

4. Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

- **Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;**
- **Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and**
- **Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.**

The stormwater management treatment system for the site has been selected and sized to equal or exceed the required 80% average annual load of TSS, as follows:

Sediment Forebays:	Recommended design rate:	25%
Bioretention Filter:	Recommended design rate:	90%
Total TSS Removal:		93%

TSS removal calculations are provided in **Appendix I.**

5. For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

No area on the proposed site is designated as a land use with higher potential pollutant loads.

6. Stormwater discharges within the 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 Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

The site is not located within a Zone II or Interim Wellhead Protection Area of a public water supply.

7. 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 project is classified as redevelopment and meets the standards to the maximum extent practicable. Due to the existing development present on site, steep slopes, limited space and poor soils make stormwater management a challenge on Lot 38; therefore, the proposed design reduces the impervious cover by 6.4%. The proposed parking lot on Lot 139A includes two bioretention areas to treat any new stormwater runoff prior to discharge to the underground storage system.

8. A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

Silt sacks will be used at all existing and proposed catch basin structures within the limit of work to prevent sedimentation during construction activities. Silt fence will be placed at all down-sloping areas to prevent sediment from reaching the adjacent wetland and/or discharging off-site.

9. A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

An Operations & Maintenance Manual will be provided under separate cover.

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

The Long-Term Pollution Prevention Plan will be provided in the Operations & Maintenance Manual. There will be no illicit discharges to the stormwater management system. An illicit discharge compliance statement will be submitted prior to the discharge of any stormwater to post-construction BMPs.

3.0 POST-CONSTRUCTION STORMWATER MANAGEMENT

Stormwater treatment and conveyance for the newly constructed areas will be provided by the following proposed BMPs.

3.1. Bioretention Facilities

The bioretention facilities (also referred to as a "rain garden" or a "biofilter") is a stormwater management practice to manage and treat stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants. The system consists of an inflow component, a pretreatment element, an overflow structure, an underdrain, a shallow ponding area (less than nine inches deep), a surface organic layer of mulch, a planting soil bed, and plant materials.

4.0 POLLUTANT CONTROLS

A phased approach will be used to reduce erosion and increase sediment controls during the construction period. Perimeter controls and sediment settling devices will be installed during construction to minimize sediment movement in stormwater and to protect the adjacent wetland and any associated buffers on the property.

4.1. Structural Practices

The following are the structural practices that will be implemented as part of the construction activity.

- Silt Fence & Haybales and/or Sediment Silt Sock Barrier will be installed prior to commencement of construction. This type of practice creates erosion control barriers to intercept sediment in diffuse runoff. The Town will be informed upon installation so that they may inspect these barriers prior to construction. Portions of the erosion control barriers will be replaced and/or repaired as necessary to prevent erosion. Barriers will be installed parallel to land slope at the perimeter of the work site. In

addition, silt sock barriers will be installed around the bioretention areas during construction.

- Silt Sacks (or approved equivalent) will be installed at identified existing catch basins and following construction of the proposed catch basins to prevent sedimentation during the any additional construction. The Silt Sack will be replaced and disposed of off-site if damage is observed.

- Bioretention Area(s) will be graded to within one foot of design elevations until site is fully stabilized to capture sediment during construction. Heavy equipment will not be allowed to operate on the surface location where the systems are planned because soil compaction would adversely impact their long-term performance. Sediment silt sock will be utilized around the perimeter of the bioretention systems during construction. Light earth-moving equipment will be used for excavation and construction of the systems. All excavated materials from the area will be removed and disposed of in an approved location. All bioretention areas will be inspected at least once every seven calendar days and immediately after storm events by the Construction Manager.

- Slope Stabilization will be installed immediately upon obtaining final grades as shown on the project site plans. Areas that fail to stabilize will be re-graded to final grade and stabilized as necessary. Amount of land disturbed will be minimized to reduce potential for erosion and sedimentation. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site and as soon as practicable.

The entire stormwater management system including system inlets, outlets, piping, bioretention facilities and subsurface storage chambers will be inspected upon completion of construction. Sediment will be removed from all elements of the stormwater management system. All control measures must be installed and maintained in accordance with manufacturer's specifications, good engineering practices, and in accordance with this report (every seven-calendar days and after storm events). If inspections show that a control has failed or been installed incorrectly, the Contractor must replace or modify it within 24 hours.

4.2. Stabilization Practices

The amount of land disturbed during construction will be minimized to reduce the potential for erosion and sedimentation. Prompt surface stabilization will be practiced to control erosion in areas where disturbances cannot be avoided during construction. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site. Exceptions to this requirement are allowable when snow cover prevents the initiation of stabilization within 14 days, in which case such measures shall be undertaken as soon as possible.

Stabilization measures that will be, or may be, used during construction are described below:

- Temporary Seeding – Temporary seeding of disturbed surfaces with fast-growing grasses (annual rye) to provide greater resistance to stormwater runoff and/or wind erosion for areas where construction has temporarily ceased.

- Permanent Seeding – Permanent seeding of surfaces with vegetation, including but not limited to grass, trees, bushes, and shrubs, to stabilize the soil. Establishing a permanent and sustainable ground cover at a site stabilizes the soil while reducing the sediment content in runoff.

- Permanent Planting –install and adequately establish all planting as required at the completion of the project.

- Mulching – materials, including but not limited to hay, grass, woodchips, straw, and gravel will be placed on the soil surface to cover and hold in place the disturbed soils.

Temporary seeding or other soil stabilization measures will be provided where construction activities have ceased at the site. Dormant topsoil stockpiles will be temporarily seeded to prevent erosion, and will be surrounded with silt fence. When the site's final grade has been established, permanent vegetation will be planted on the disturbed areas. The vegetation will consist of grass, shrubs, bushes, and trees.

4.3. Other Types of Controls

Additional controls/practices will be undertaken to reduce pollution in stormwater runoff flows which include, but are not limited to, control of off-site mud tracking from construction site, dust suppression, proper sanitary waste disposal, earthwork procedures timed and conducted in manners aimed to minimize erosion and sedimentation, snow removal plans, proper management of waste materials, proper management of hazardous waste, proper material stockpiling, and spill prevention and control measures.

- Dust Suppression – Water sprays shall be used to control dust during extended dry periods during construction.

- Sanitary Wastes – All sanitary wastes will be collected from the portable units by a licensed sanitary waste management contractor (as required by local regulations).

- Earthwork – The exposure of disturbed surfaces to stormwater and potential stormwater erosion will be minimized by well-organized earthwork procedures. Stabilization procedures shall be undertaken in accordance with this report. Grubbing during wet seasons will be avoided if feasible.

- Snow Removal Plan – Plowed snow collected from the parking areas will be deposited onto free draining, pervious surfaces, away from the site's drainage conveyance structures to maximize infiltration. Snowmelt runoff that is not infiltrated will be directed to the site's stormwater management system. Snow is not to be plowed or piled onto the stormwater management facility or wetlands.

- Waste Materials – Dumpsters rented from a licensed solid waste management company will be used to store solid waste and debris that cannot be recycled, reused or salvaged. The dumpsters will meet all local and state solid waste management regulations. Dumpsters will be covered when refuse is not being directly deposited or withdrawn from them. Potentially hazardous wastes will be separated from normal wastes, including segregation of storage areas and proper labeling of containers. Removal of all waste from the site will be performed by licensed contractors in accordance with applicable regulatory requirements and disposed of at either local or regional approved facilities. Waste materials will not be buried on-site. All site personnel will be instructed regarding the correct procedures for waste disposal. Notices stating these procedures will be posted at the site. Solvents and flushing materials used during construction and pre-operational cleaning will be provided, handled, managed, and removed by the contractor for appropriate off-site disposal.

- Hazardous Waste Materials – Any disposal of hazardous materials will be completed using the required paperwork. Copies will be provided to the Engineer and to the Town.

- Spill Prevention and Control Measures – To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management practices will be used throughout the project:

    - An effort will be made to store only enough products required to do the job.
    - All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
    - Products will be kept in their original containers with the original manufacturer's label.
    - Substances will not be mixed with one another unless recommended by the manufacturer.
    - Whenever possible, the maximum amount of a product will be used before disposing of the container.
    - Manufacturers' recommendations for proper use and disposal will be followed.
    - The site superintendent will conduct daily inspections to ensure proper use and disposal of materials.

  To reduce the risk associated with hazardous materials used on the site, the following practices will be used:

- Products will be kept in original containers unless they are not resealable.
- Original labels and material safety data sheets will be retained and kept on-site; they contain important product information.
- If surplus product must be disposed of, manufacturers' or local and state recommended methods for proper disposal will be followed.

- Materials List - Materials or substances listed below are expected to be present on-site during construction:

- Concrete	- Fertilizers
- Asphalt	- Petroleum Based Products
- Paints (enamel and latex)	- Cleaning Solvents
- Metal Studs	- Wood
- Concrete	- Tar
- Sealants	- Adhesives

The following product-specific practices will be followed on-site:

Petroleum Products - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers which area clearly labeled. Any asphalt substances used on-site will be applied according to the manufacturers' recommendations.

Fertilizers – Fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to stormwater. Products will be stored in a covered shed. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.

Paints – All containers will be tightly sealed and stored indoors when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to the manufacturers' instructions or state and local regulations.

Concrete Trucks – Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted, and site personnel will be made aware of the procedures and location of the information and cleanup supplies.

- Materials and equipment necessary for spill cleanup will be kept in the material storage area on-site. Equipment and materials will include, but not be limited to, brooms, dustpans, mops, rags, gloves, goggles, speedi-dry, sand, sawdust, and plastic and metal trash containers specifically for this purpose.

- All spills will be cleaned up immediately after discovery. Spills large enough to reach the storm water system will be reported to the National Response Center at 1-800-424-8802.

- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.

- Spills of toxic or hazardous material will be reported to the appropriate state or local government agency, regardless of the size.

- The site superintendent responsible for the day-to-day site operations will be the spill prevention and clean-up coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage area and in the on-site office trailer.

5.0 CONSTRUCTION STORMWATER OPERATION AND MAINTENANCE PLAN

All stormwater management and controls identified in **Section 3.0** of this Drainage Report shall be operated and maintained appropriately during the construction phase of the project and during regular operation of the site in the post-construction period. The Contractor shall provide, inspect, and maintain all control measures. The stormwater controls will be inspected at least once every seven days and within 24 hours of storm events of 0.5 inches or greater, to prevent deficiencies in the effectiveness of the systems due to sediment build-up, damage, or deterioration. A summary of the maintenance plan is presented below.

The stormwater control system will be regularly inspected to ensure proper performance. The following operation and maintenance provisions will be provided:

- Silt fences will be inspected for depth of sediment, tears, to determine if the fabric is securely attached to the fence posts, and to determine if the fence posts are firmly in the ground. Silt fence will be replaced when necessary.

- Hay bales shall be inspected for depth of sediment and any breaches will promptly be repaired or replaced when necessary.

- Silt Socks shall be inspected for depth of sediment and any breaches will promptly be repaired or replaced when necessary.

- Sediment shall be removed where accumulation reaches one-third the above ground height of any barrier.

- Once each workday structural control measures receiving flows from areas that have not been stabilized by established permanent seeding shall be inspected.

- Remedial action shall be taken in areas where temporary and permanent seeding is deemed inefficient through weekly inspections to establish a stabilized surface.

- All BMP's will be cleared of accumulated foreign debris, including leaves and lawn cuttings.

- All BMP's will be inspected for slope integrity and erosion.

- A snow removal plan will be followed and if necessary on site snow removal will be provided.

- All control measures will be inspected at least once every seven-calendar days and within 24 hours after storm events of 0.5 inches or more.

- A maintenance inspection report will be made after each inspection.

- All measures will be maintained in good working order, if a repair is necessary, it will be initiated within 24 hours of discovery.

REFERENCES

1. ASTM (American Society of Testing and Materials). 2003. ASTM D3385-03 Standard test method for field measurement of infiltration rate of soils in field using double-ring infiltrometer.

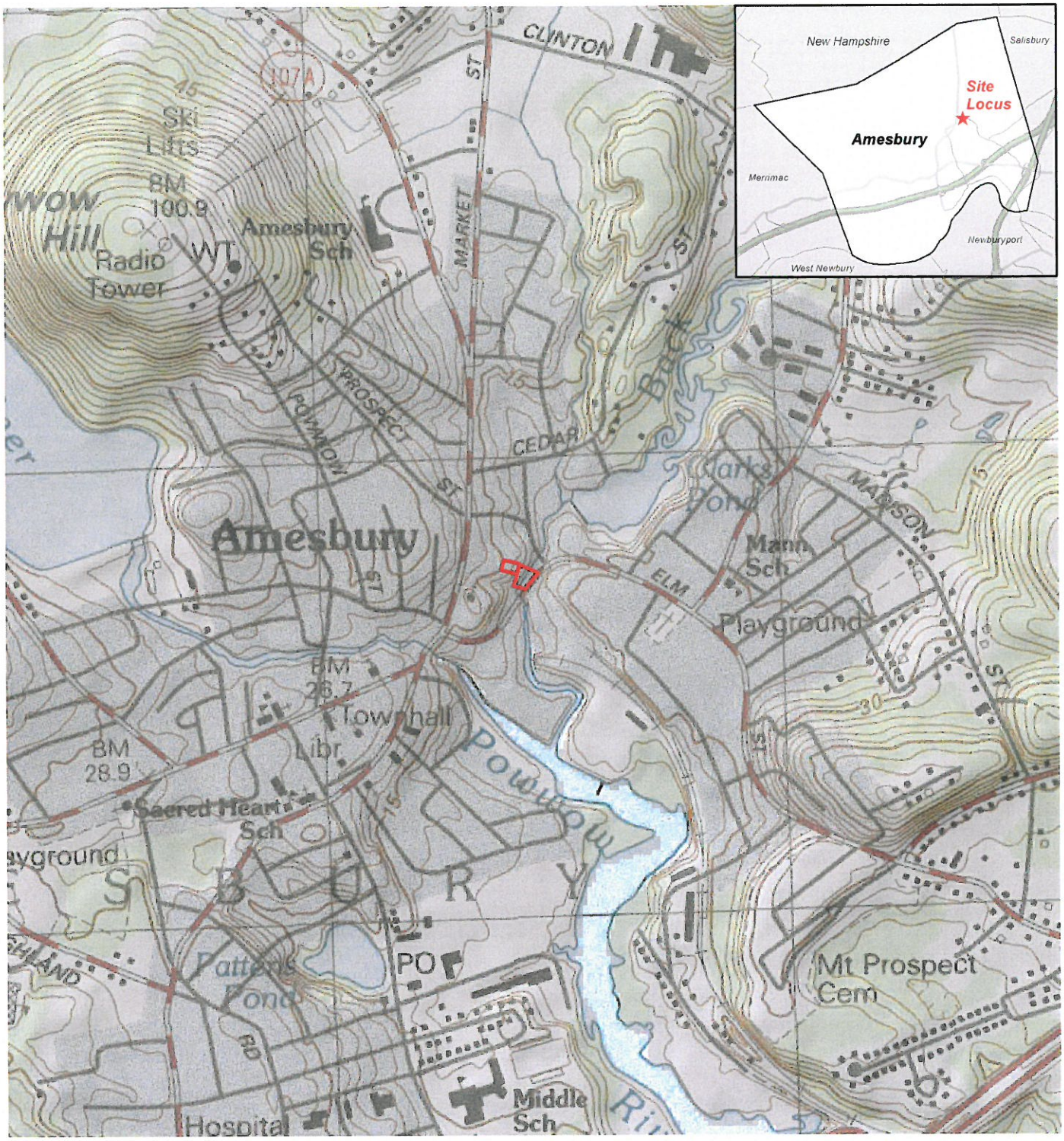
2. Federal Emergency Management Agency (FEMA). See their homepage at: http://www.fema.gov/

3. Massachusetts Department of Environmental Protection. See their homepage at www.state.ma.gov/dep

4. Massachusetts Department of Environmental Protection. 2008. Massachusetts Stormwater Standards Manual.

5. Massachusetts Office of Geographic and Environmental Information (MassGIS). See their homepage at: http://www.mass.gov/mgis/.

Figures



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*Newburyport West Topographic Quadrangle

Legend

Site Parcels

N

0 1,000

1" = 1,000 feet

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Sandwich, MA • 02563
Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com

USGS Topographic Quadrangle
77 Elm Street
Amesbury, MA

Date: 9/11/2015 Figure 1

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*Aerial - MassGIS 2013

Legend

Site Parcels

N

0 200

1" = 200 feet

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Aerial Photo
77 Elm Street
Amesbury, MA

Date: 9/11/2015 Figure 2

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Legend

- Site Parcels
- Parcels
- MassDEP Oil and/or Hazardous Material Sites with Activity and Use Limitations
- Underground Storage Tanks

2012 Integrated List Data - 305(b)/303(d)

- Impaired - TMDL required

DEP Wetlands

- Marsh/Bog

*Aerial - MassGIS 2013

N

0 — 200

1" = 200 feet

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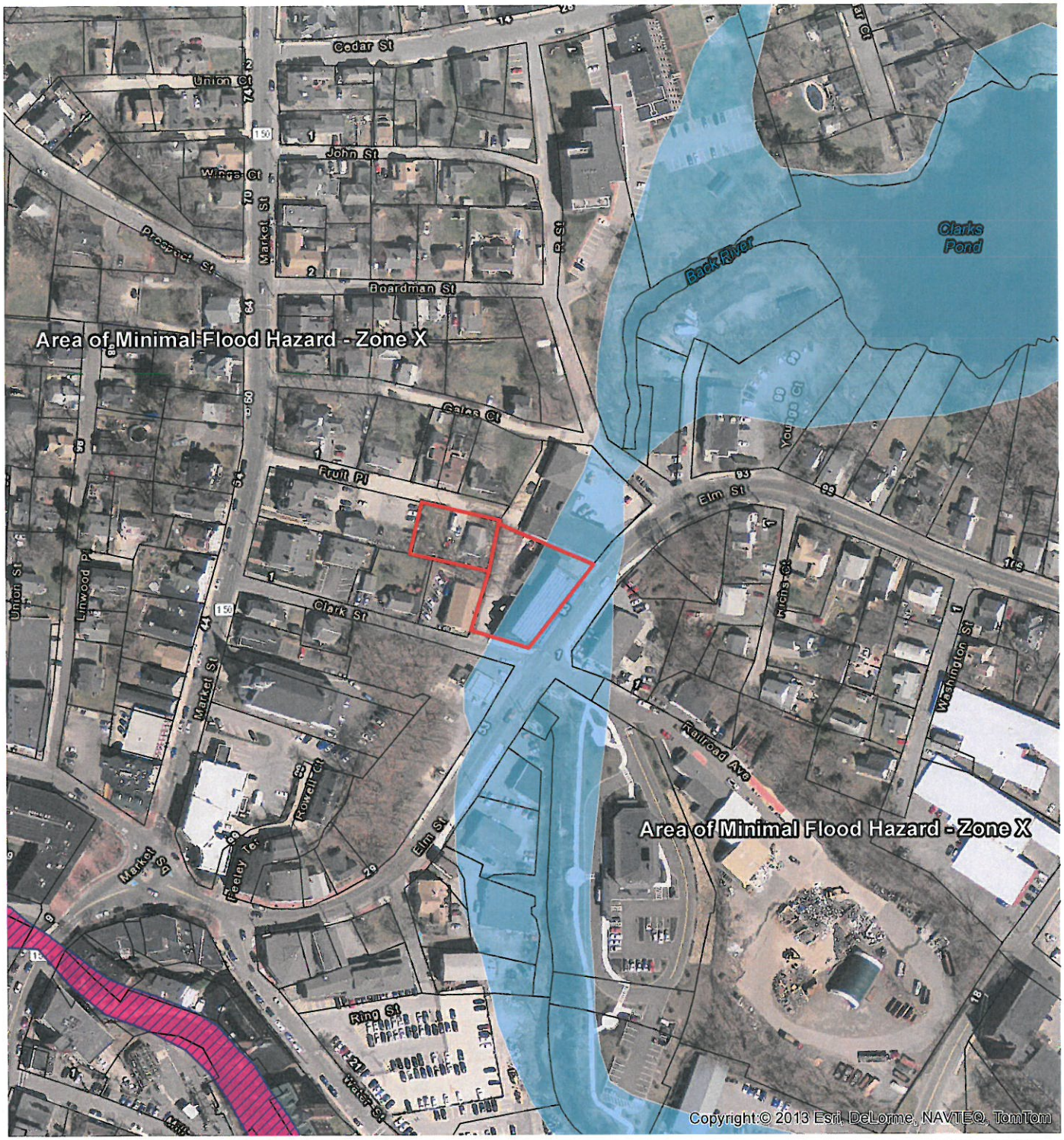
90 Route 6A • Sandwich, MA • 02563
Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com

Existing Constraints
77 Elm Street
Amesbury, MA

Date: 9/11/2015

Figure 3



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Legend

**FEMA's National Flood Hazard Layer - 2012*

- Site Parcels
- Parcels
- Zone A - 1% Annual Chance Flood Hazard
- Zone AE
- Regulatory Floodway

N

0 200

1" = 200 feet

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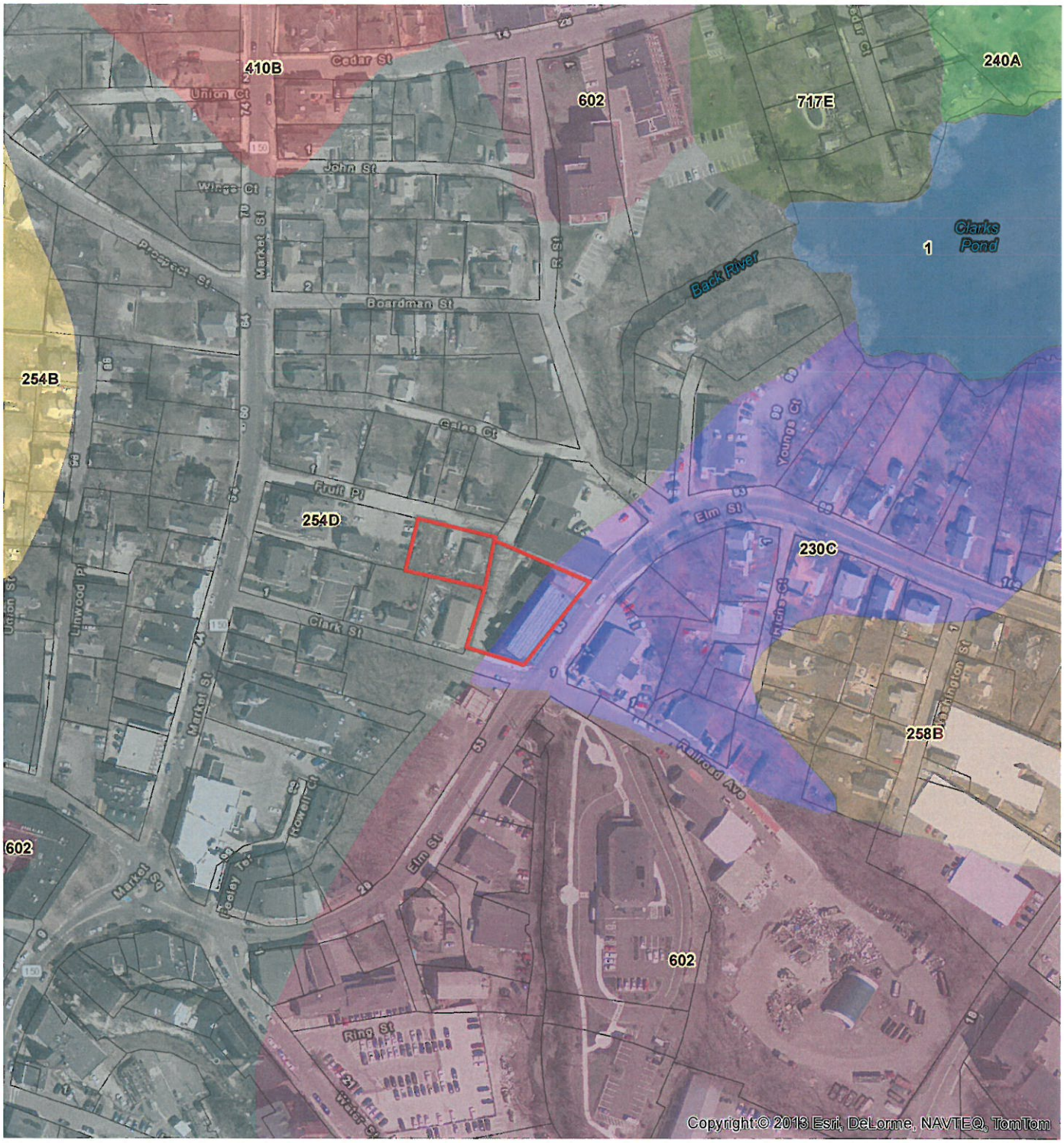
Sustainable Environmental Solutions
90 Route 6A • Sandwich, MA • 02563
Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com

FEMA's National Flood Hazard Layer
77 Elm Street
Amesbury, MA

Date: 9/11/2015

Figure 4



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Legend

- Site Parcels
- Parcels
- 1, Water
- 230C, Unadilla
- 240A, Elmwood
- 254B, Merrimac
- 254D, Merrimac
- 258B, Amostown
- 410B, Sutton
- 602, Urban land
- 607, Water
- 717E, Rock outcrop

*NRCS SSURGO-Certified Soils - MassGIS 2012

N

0 200

1" = 200 feet

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NRCS SSURGO-Certified Soils
Essex County
77 Elm Street
Amesbury, MA

Date: 9/11/2015

Figure 5

Appendix A

Site Soil Evaluation

Atlantic Engineering & Survey Consultants, Inc.
97 Tenney Street • Georgetown, MA 01833
978-352-7870 • 978-352-9940 (fax) • atlantic84@cs.com

John B. Paulson, P.L.S. President
George J. Zambouras, P.E.

October 9, 2008

John Manchester
Back River Ventures, LLC
77 Elm Street
Amesbury, MA 01913

SITE: 9.5 Fruit Street, Amesbury
Soil Evaluation for Drainage Design

Dear Mr. Manchester,

This report documents the results of the subsurface soil exploration and evaluation for the above referenced site. This report has been prepared for the purpose of facilitating a drainage design system for a proposed parking lot on the site. This report is subject to the limitation of use for the purpose for which it was prepared.

Soil evaluations were performed on October 9, 2008. The testing consisted of excavating 5 test pits to depths from 72 inches to 101 inches. These pits were examined for soil types, thickness of layers, textural classification, hydrologic group and depth to groundwater by soils mottling. The test pits are indicated as TP-1 through TP-5 as shown in the following tables and on the attached sketch of the site. The soil colors are taken from the Munsell Charts and the description and textures reflect USDA terminology as utilized by the Commonwealth of Massachusetts for Soils Evaluation.

SOIL LOG INFORMATION

Test Pit 1 (TP-1) October 9, 2008				
Soil Horizon	Soil Depth (inches)	Soil Color (Munsell Chart)	Soil Texture	Notes
A	0 to 22	10YR 3/2	L	topsoil, loam
B	22 to 38	10YR 3/2	L	subsoil, loam
C	38 to 72	10Y 5/2	SiL	substratum, silty loam, glacial till
mottles @ 38 inches				

Test Pit 2 (TP-2) October 9, 2008				
Soil Horizon	Soil Depth (inches)	Soil Color (Munsell Chart)	Soil Texture	Notes

Test Pit 2 (TP-2) October 9, 2008				
F	0 to 38	10YR 3/2	L	topsoil, loam
No A or B				
C	38 to 73	10Y 5/2	SiL	substratum, silty loam, glacial till
mottles @ 38 inches				

Test Pit 3 (TP-3) October 9, 2008				
Soil Horizon	Soil Depth (inches)	Soil Color (Munsell Chart)	Soil Texture	Notes
A	0 to 12	10YR 3/2	L	topsoil, loam
B	12 to 19	10YR 3/2	L	subsoil, loam
C	19 to 96	10Y 5/2	SiL	substratum, silty loam, glacial till
mottles @ 21 inches				

Test Pit 4 (TP-4) October 9, 2008				
Soil Horizon	Soil Depth (inches)	Soil Color (Munsell Chart)	Soil Texture	Notes
A	0 to 16	10YR 3/2	L	topsoil, loam
B	16 to 26	10YR 3/2	L	subsoil, loam
C	26 to 100	10Y 5/2	SiL	substratum, silty loam, glacial till
mottles @ 25 inches				

Test Pit 5 (TP-5) October 9, 2008				
Soil Horizon	Soil Depth (inches)	Soil Color (Munsell Chart)	Soil Texture	Notes
A	0 to 14	10YR 3/2	L	topsoil, loam
B	14 to 21	10YR 3/2	L	subsoil, loam
C	21 to 101	10Y 5/2	SiL	substratum, silty loam, glacial till
mottles @ 21 inches				

This soils on this site are classified as follows:

Massachusetts DEP Standards rate this soils as a poor Class III soil.

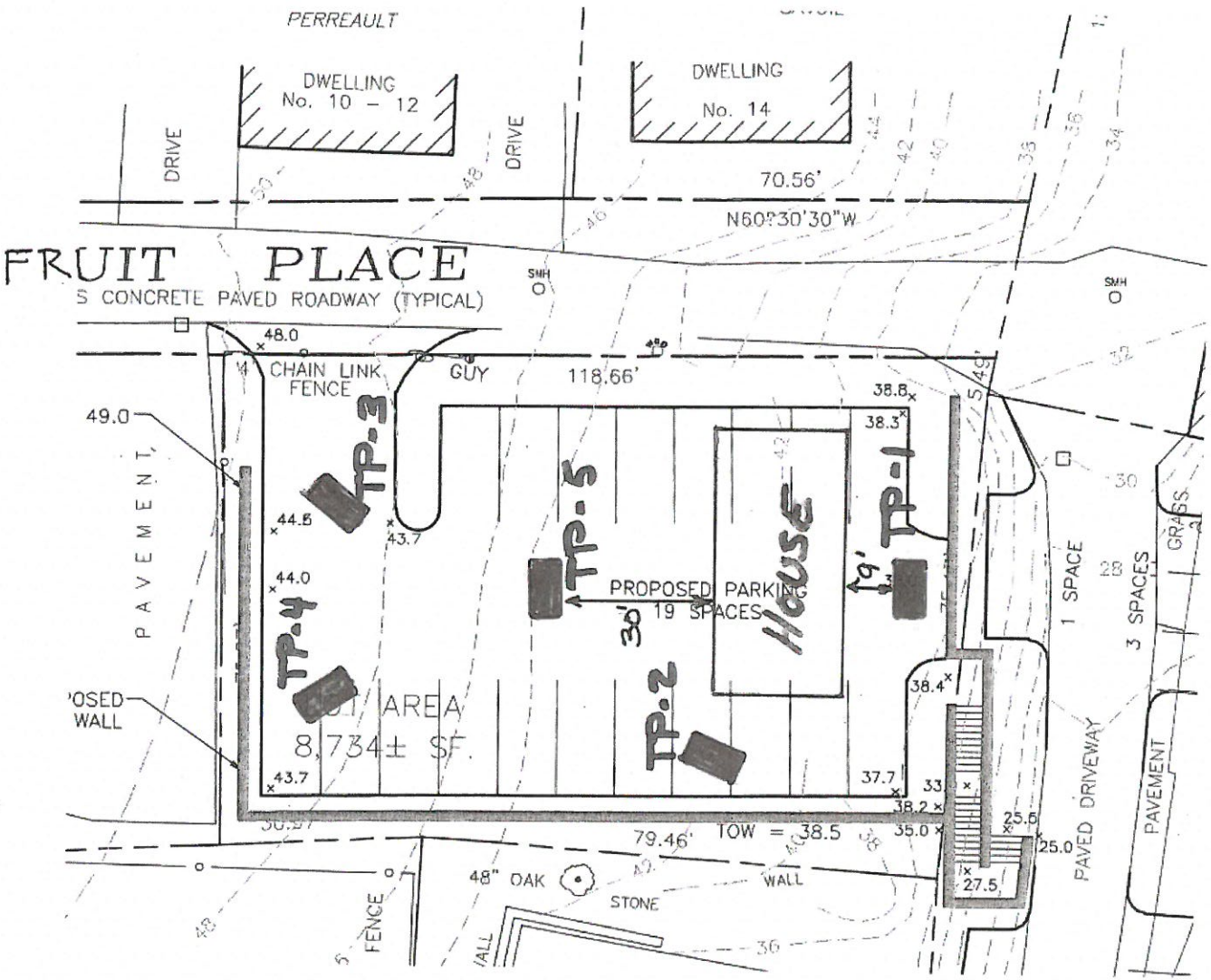
The Handbook on Hydrology rates this soil as a NRCS Soil Group "C" with a design infiltration rate of 0.27 inches per hour.

Please feel free to call me should you need any additional information.

Sincerely,

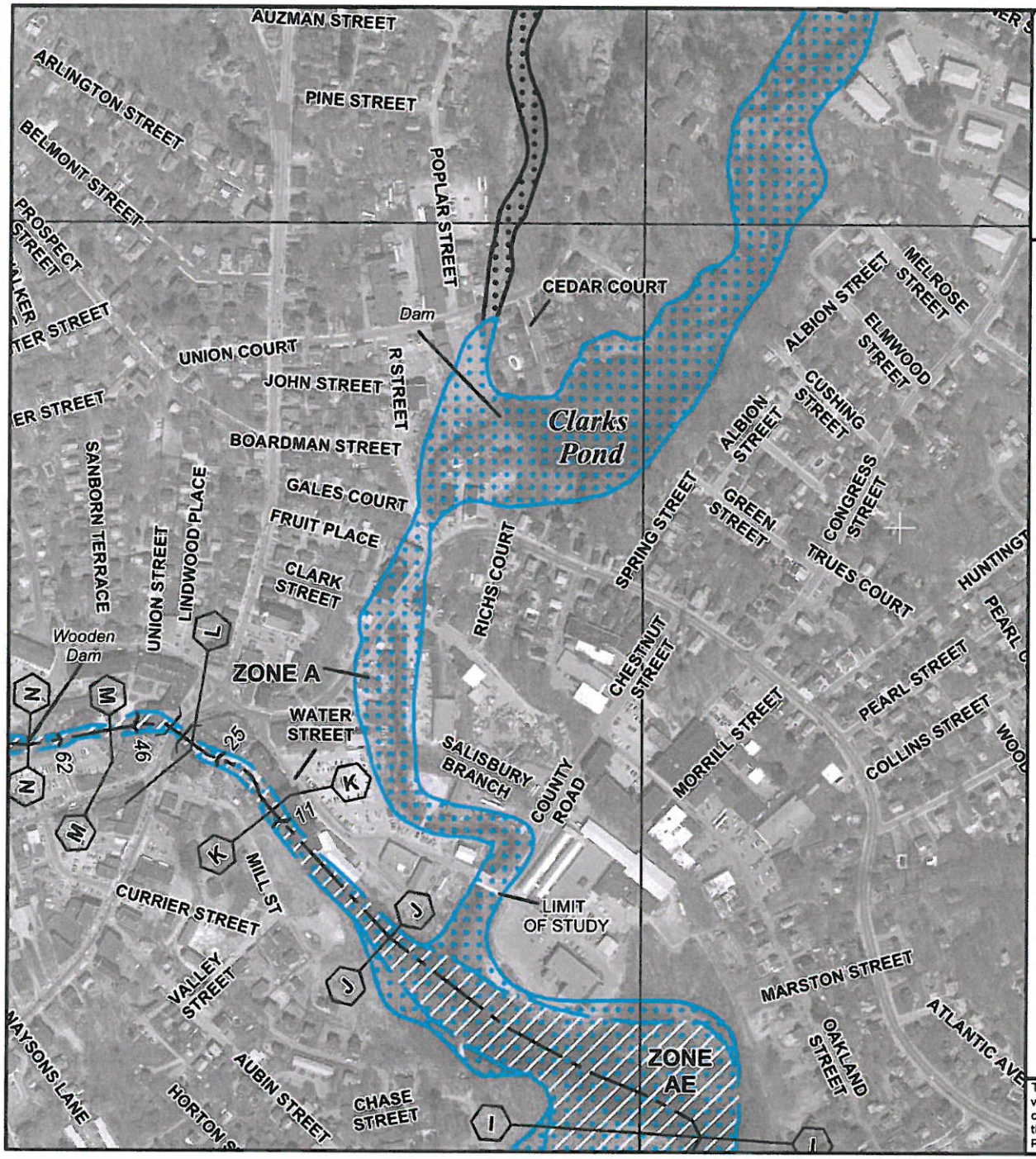
John B. Paulson,, SE1871

I:\Win2008Files\BackRiverVentures-9FruitSt-Amesbury-SoilEvaluation-10-09-08.wpd


PERREAULT
DWELLING
No. 10 – 12
DWELLING
No. 14
DRIVE
DRIVE
70.56'
N60°30'30"W
FRUIT PLACE
S CONCRETE PAVED ROADWAY (TYPICAL)
SMH
SMH
48.0
CHAIN LINK FENCE
GUY
118.66'
49.0
PAVEMENT
TP-3
TP-5
TP-1
TP-4
TP-2
44.5
43.7
44.0
43.7
PROPOSED PARKING
19 SPACES
30'
19'
House
AREA
8,734± SF.
38.8
38.3
38.4
37.7
38.2
35.0
33
25.5
25.0
27.5
1 SPACE
3 SPACES
GRASS
PAVED DRIVEWAY
PAVEMENT
79.46'
TOW = 38.5
48" OAK
STONE
WALL
FENCE
WALL
OSED
WALL

Appendix B

Flood Insurance Rate Map (FIRM)



MAP SCALE 1" = 500'

250 0 500 1000

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0106F

FIRM

FLOOD INSURANCE RATE MAP

ESSEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 106 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
AMESBURY, CITY OF	250075	0106	F
SALISBURY, TOWN OF	250103	0106	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25009C0106F

EFFECTIVE DATE
JULY 3, 2012

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix C

Lot Area Calculations

Horsley Witten Group
Sustainable Environmental Solutions

Project Name:	77 Elm Street	Project No.:	15123
Prepared by:	Horsley Witten Group, Inc.	Date.:	3/17/2016
Reviewed by:	Brian Kuchar	Date.:	3/17/2016

Lot Area Calculations

Lot 38 Area (sf)	18008		
	Existing	Proposed	% Reduction
Building (sf)	8971	7650	14.7%
Pavement (sf)			
Road/Parking	5521	5550	
Courtyard (75% impervious)	1578	1900	
Impervious Lot Coverage -Building and Pavement (sf)	16070	15100	6.0%
Pervious Lot Coverage (sf)	1938	2908	
% Building Lot Coverage	50%	42%	
% Lot coverage	89%	84%	
% Open space	11%	16%	
Lot 139A Area (sf)	8733		
Building (sf)	1117	0	
Pavement (sf)	748	6132	
Walls (sf)	0	418	
Impervious Lot Coverage - Building and Pavement (sf)	1865	6550	
Pervious Lot Coverage (sf)	6868	2183	
% Building Lot Coverage	13%	0%	
% Lot coverage	21%	75%	
% Open space	79%	25%	
Combined Lot Area	26741		
Combined building (sf)	10088	7650	24.2%
Impervious Lot Coverage-Building and Pavement (sf)	17935	21232	
Pervious Lot Coverage (sf)	8806	5509	
Total (sf)	26741	26741	
% Building Lot Coverage	37.72%	28.61%	
% Lot coverage	104.79%	108.01%	
% Open space	32.93%	20.60%	

Appendix D

Bioretention Sizing Calculations

Horsley Witten Group
Sustainable Environmental Solutions

Project: Mill 77 **Project No:** 15123
Project Location: 77 Elm Street, Amesbury, MA
Calculated By: MJC
Checked By: BRK
Date : 3/17/2016
Revised 4/27/2016

Instructions: Enter values in [ ] cells only.
All other cells are formulas or links and do not need to be edited.
See cell comments for descriptions and formulas used.

Water Quality Volume (WQv)

Based upon 1-inch of rainfall times the contributing impervious area contributing impervious area

WQv (cf) = (1" rainfall/12) * Imp. Area (sf)

Storm Type: 1 ***Inch***

DA	Description	% Imp.	Drainage Area		Imp. Area		WQv Required*	WQv required
		%	sf	ac	sf	ac	cf	af
DA-1A		87%	4,008	0.09	3,500	0.08	292	0.007
DA-1B		83%	3,991	0.09	3,300	0.08	275	0.006
	TOTALS		7999	0.18	6,800	0.16	0	

Sizing Equations: Bioretention

Required Surface Area (sf) = (WQv) (df) / [(k) (hf + df) (tf)]

Where: df = Filter bed depth (ft) k = Coefficient of permeability of filter media (ft/day)
hf = Ave. height of water above filter bed (ft) tf = Design filter bed drain time (days)

BIORETENTION SIZING:

Bio Area	Drainage Area Name	WQv Required (af)	df (ft)	K (ft/day)	hmax-Height of water above filter (in.)	hf=avg of above (ft)	tf (days)	Surface Area Required (sf)	Surface Area Provided (sf)	Sediment Forebay Required 10% WQv (cf)	Sediment Forebay Provided (cf)	WQV Treatment Provided (af)
1	DA-1A	0.007	1.50	2	6	0.25	1.67	75	109	29.17	27	0.010
2	DA-1B	0.006	1.50	2	6	0.25	1.67	71	77	27.50	27	0.007
	TOTALS	0.013						145	186	56.67	54	0.017
					Percentage of Treatment Provided				**128%**		**95%**	**128%**

Appendix E

Drainage Area Maps

LEGEND

DRAINAGE AREA BOUNDARY

WOODS, GOOD, HSG C

HOUSES GRASS, HSG C

DA-1 PAVEMENT

SP1 STUDY POINT

TIME OF CONCENTRATION FLOW PATH

10' CONTOURS (MASS GIS)

1' COUNTOURS (HW SURVEY)

0 40

SCALE IN FEET

SOIL TYPES

254 D - MERIMAC (HSG C)

230 C - UNADILLA (HSG A)

Revisions

Rev.	Date	By	Appr.	Description
1	03/27/18	BRK	BRK	Revised Boundaries
2	04/27/18	BRK	BRK	Revised Boundaries

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A
Sandwich, MA 02563
508-833-6600 voice
508-833-3150 fax

Date: 04/27/18 Design By: Drawn By: BRK Checked By: BRK

Plan Set

MILL 77
77 ELM STREET
AMESBURY MASSACHUSETTS

Plan Title

PROPOSED DRAINAGE MAP

Prepared For:
Martin Development LLC.
77 Elm Street
Amesbury, MA 01913
Phone:(978) 834-0069 x 101
Fax: ---

Survey Provided By:
Eastern Land Survey Assoc., Inc.
104 Lowell Street
Phone:(978) 531-8121
Fax:(508) 833-3150
Dated: ---

Registration:

Project Number: 15123

Sheet Number: 2 of 2

last modified: 04/26/18 printed: 04/26/18 by bk H:\Projects\2015\15123 77 Elm St-Amesbury\Drawings\MISC\15123-EX-DA-PIPES.dwg

LEGEND

DRAINAGE AREA BOUNDARY

- WOODS, GOOD, HSG C
- HOUSES GRASS, HSG C
- DA-1 PAVEMENT

SP1 STUDY POINT

- TIME OF CONCENTRATION FLOW PATH
- 10' CONTOURS (MASS GIS)
- 1' COUNTOURS (HW SURVEY)

0 40
SCALE IN FEET

SOIL TYPES

254 D - MERIMAC (HSG C)

230 C - UNADILLA (HSG A)

Revisions

Rev.	Date	By	Appr.	Description
1	03/17/16	BPK	SPK	Revised Sourcebook

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A
Sandwich, MA 02563
508-833-6600 voice
508-833-3150 fax

Date: 4/31/16 Design By: BW Drawn By: BW Checked By: CW/RC

Plan Set: MILL 77
77 ELM STREET
AMESBURY MASSACHUSETTS

Plan Title: PROPOSED DRAINAGE MAP

Proposed For: Martin Development LLC.
77 Elm Street
Amesbury, MA 01913
Phone:(978) 834-0965 x 101
Fax: ---

Survey Provided By: Eastern Land Survey Assoc., Inc.
104 Lowell Street
Phone:(978) 531-6121
Fax:(508) 833-3150
Dated: ---

Registration:

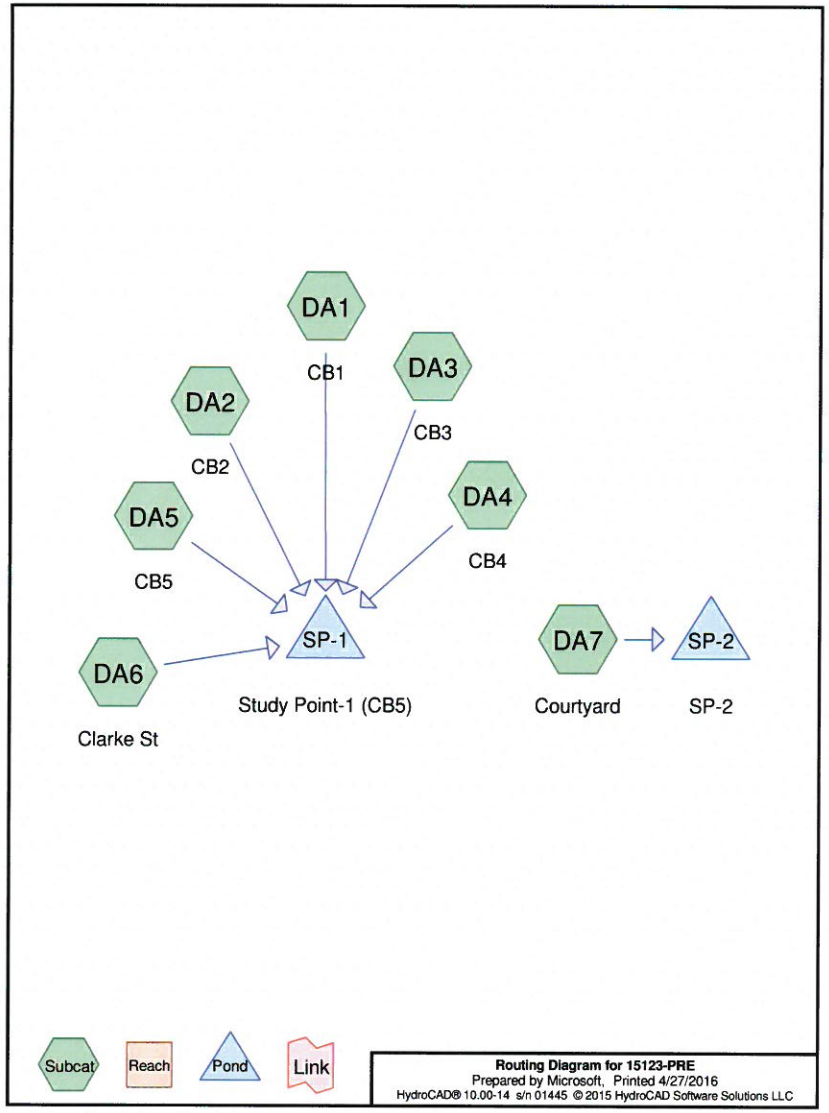
Project Number: 15123

Sheet Number: 2 of 2

last modified: 04/26/16 printed: 04/26/16 by bk H:\Projects\2015\15123 77 Elm St-Amesbury\Drawings\MISC\15123-PR DA-PIPES.dwg

Appendix F

HydroCAD® Drainage Calculations



Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.635	74	>75% Grass cover, Good, HSG C (DA1, DA5, DA6)
0.007	65	Brush, Good, HSG C (DA2)
0.058	74	Landscaped planters, Good, HSG C (DA2)
0.035	98	Paved parking & roofs (DA7)
0.536	98	Paved parking, HSG C (DA6)
0.262	98	Paved parking/Roof, HSG C (DA5)
0.298	98	Paved slab, HSG C (DA2, DA3, DA4)
0.298	98	Road/Roof, HSG C (DA1)
0.024	98	Roofs, HSG A (DA7)
0.296	98	Roofs, HSG C (DA6)
0.171	72	Woods/grass comb., Good, HSG C (DA5, DA6)
2.620	**90**	**TOTAL AREA**

Summary for Subcatchment DA1: CB1

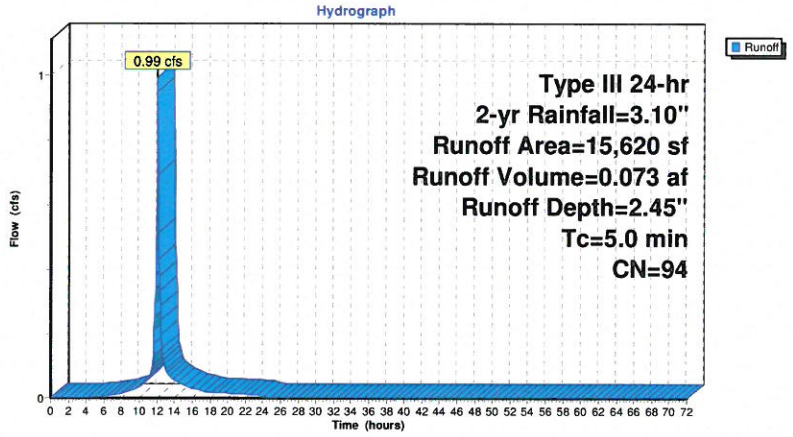
Runoff = 0.99 cfs @ 12.07 hrs, Volume= 0.073 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	12,960	98	Road/Roof, HSG C
	2,660	74	>75% Grass cover, Good, HSG C
	15,620	94	Weighted Average
	2,660		17.03% Pervious Area
	12,960		82.97% Impervious Area

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

Subcatchment DA1: CB1



Summary for Subcatchment DA2: CB2

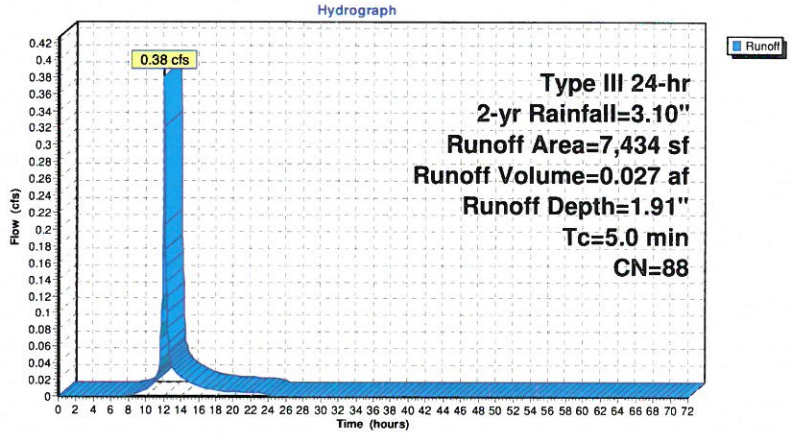
Runoff = 0.38 cfs @ 12.08 hrs, Volume= 0.027 af, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	4,590	98	Paved slab, HSG C
*	2,526	74	Landscaped planters, Good, HSG C
	318	65	Brush, Good, HSG C
	7,434	88	Weighted Average
	2,844		38.26% Pervious Area
	4,590		61.74% Impervious Area

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

Subcatchment DA2: CB2



Summary for Subcatchment DA3: CB3

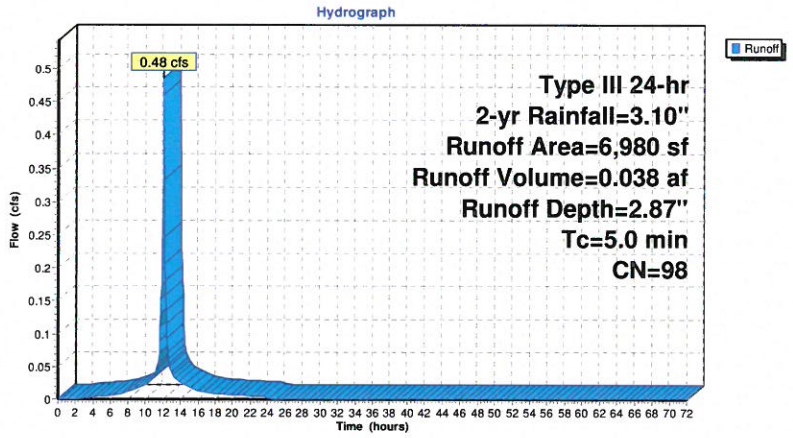
Runoff = 0.48 cfs @ 12.07 hrs, Volume= 0.038 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	6,980	98	Paved slab, HSG C
	6,980		100.00% Impervious Area

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

Subcatchment DA3: CB3



Summary for Subcatchment DA4: CB4

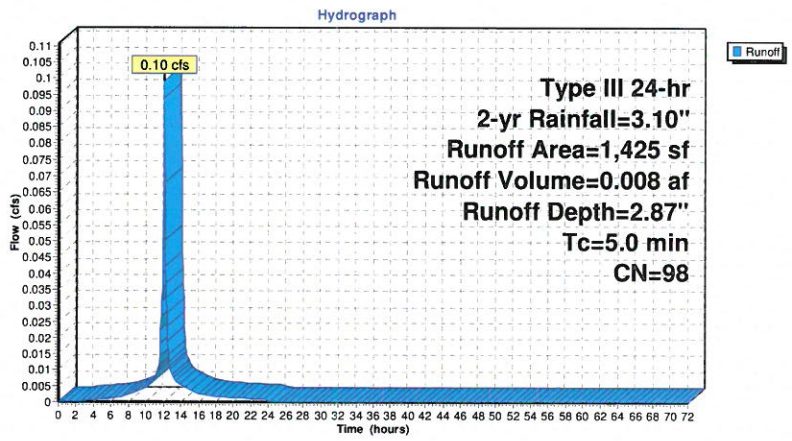
Runoff = 0.10 cfs @ 12.07 hrs, Volume= 0.008 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	1,425	98	Paved slab, HSG C
	1,425		100.00% Impervious Area

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

Subcatchment DA4: CB4



Summary for Subcatchment DA5: CB5

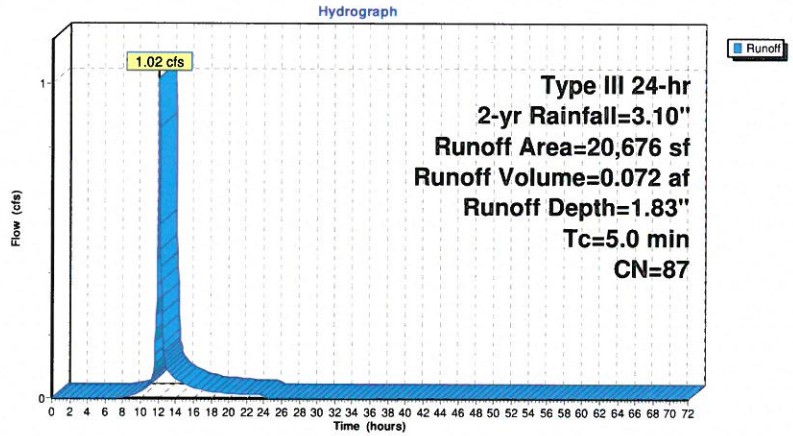
Runoff = 1.02 cfs @ 12.08 hrs, Volume= 0.072 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	11,401	98	Paved parking/Roof, HSG C
	5,065	74	>75% Grass cover, Good, HSG C
	4,210	72	Woods/grass comb., Good, HSG C
	20,676	87	Weighted Average
	9,275		44.86% Pervious Area
	11,401		55.14% Impervious Area

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

Subcatchment DA5: CB5



Summary for Subcatchment DA6: Clarke St

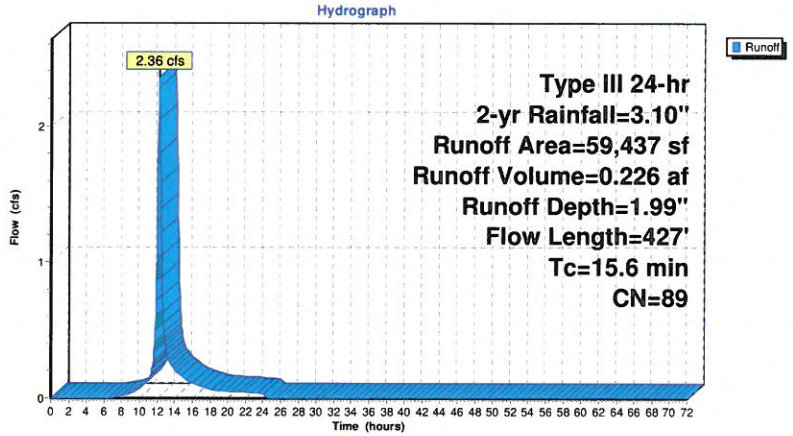
Runoff = 2.36 cfs @ 12.21 hrs, Volume= 0.226 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
12,879	98	Roofs, HSG C
23,361	98	Paved parking, HSG C
3,254	72	Woods/grass comb., Good, HSG C
19,943	74	>75% Grass cover, Good, HSG C
59,437	89	Weighted Average
23,197		39.03% Pervious Area
36,240		60.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	120	0.0830	2.60		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
3.3	62	0.1100	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
11.1	97	0.0900	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.2	74	0.0900	6.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	74	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.6	427	Total			

Subcatchment DA6: Clarke St



Summary for Subcatchment DA7: Courtyard

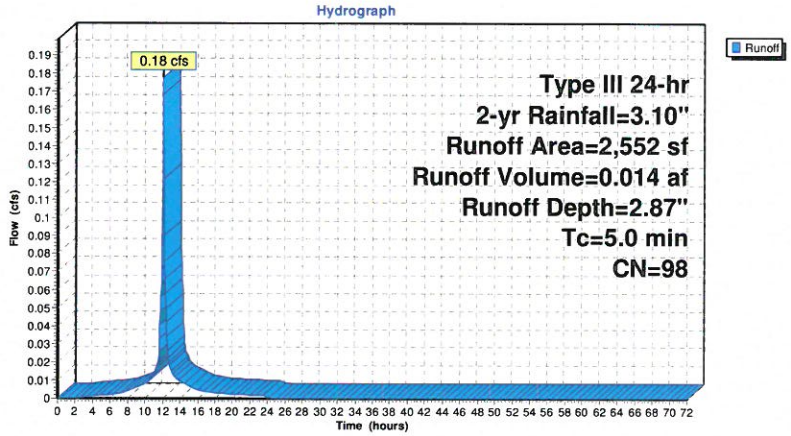
Runoff = 0.18 cfs @ 12.07 hrs, Volume= 0.014 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
1,515	98	Paved parking & roofs
1,037	98	Roofs, HSG A
2,552	98	Weighted Average
2,552		100.00% Impervious Area

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

Subcatchment DA7: Courtyard

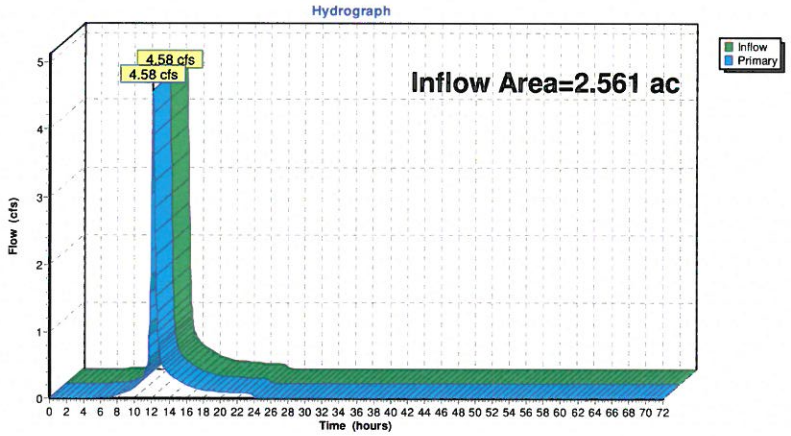


Summary for Pond SP-1: Study Point-1 (CB5)

Inflow Area = 2.561 ac, 65.96% Impervious, Inflow Depth = 2.08" for 2-yr event
Inflow = 4.58 cfs @ 12.10 hrs, Volume= 0.445 af
Primary = 4.58 cfs @ 12.10 hrs, Volume= 0.445 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-1: Study Point-1 (CB5)

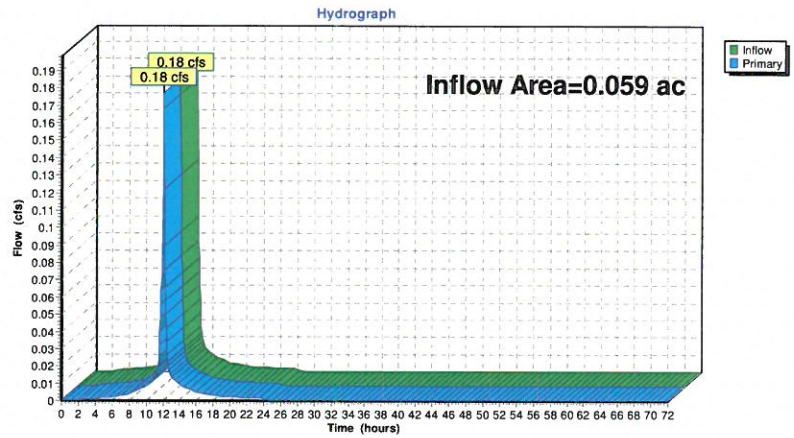


Summary for Pond SP-2: SP-2

Inflow Area = 0.059 ac,100.00% Impervious, Inflow Depth = 2.87" for 2-yr event
Inflow = 0.18 cfs @ 12.07 hrs, Volume= 0.014 af
Primary = 0.18 cfs @ 12.07 hrs, Volume= 0.014 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-2: SP-2



Summary for Subcatchment DA1: CB1

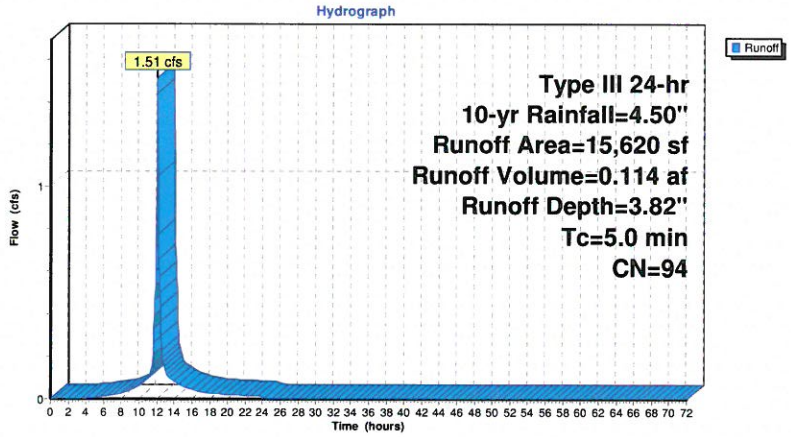
Runoff = 1.51 cfs @ 12.07 hrs, Volume= 0.114 af, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	12,960	98	Road/Roof, HSG C
	2,660	74	>75% Grass cover, Good, HSG C
	15,620	94	Weighted Average
	2,660		17.03% Pervious Area
	12,960		82.97% Impervious Area

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

Subcatchment DA1: CB1



Summary for Subcatchment DA2: CB2

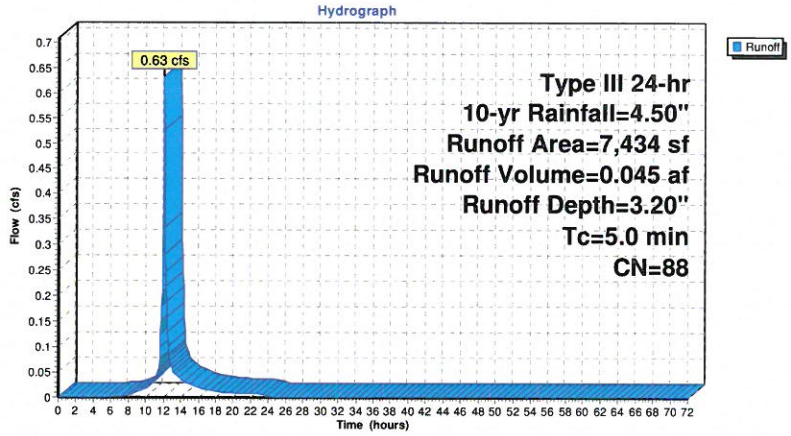
Runoff = 0.63 cfs @ 12.07 hrs, Volume= 0.045 af, Depth= 3.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	4,590	98	Paved slab, HSG C
*	2,526	74	Landscaped planters, Good, HSG C
	318	65	Brush, Good, HSG C
	7,434	88	Weighted Average
	2,844		38.26% Pervious Area
	4,590		61.74% Impervious Area

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

Subcatchment DA2: CB2



Summary for Subcatchment DA3: CB3

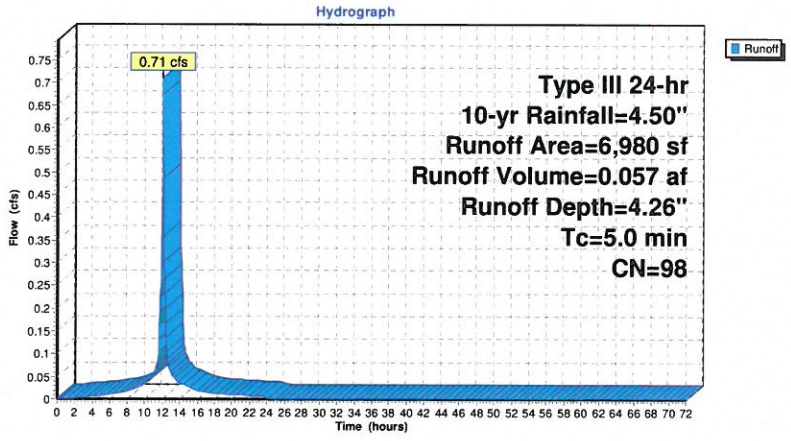
Runoff = 0.71 cfs @ 12.07 hrs, Volume= 0.057 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	6,980	98	Paved slab, HSG C
	6,980		100.00% Impervious Area

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

Subcatchment DA3: CB3



Summary for Subcatchment DA4: CB4

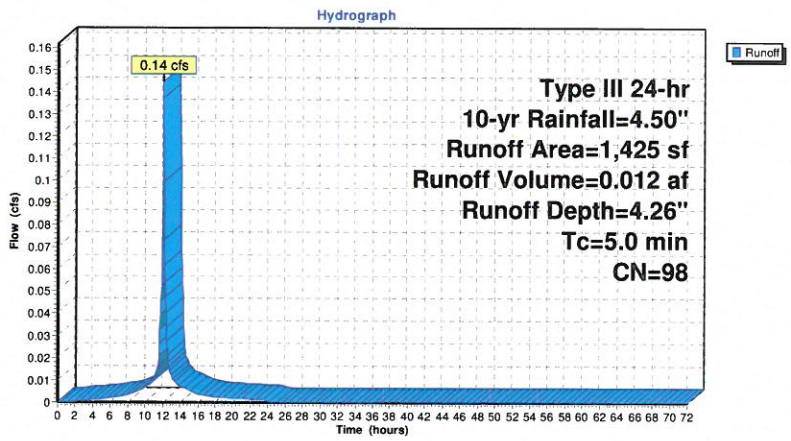
Runoff = 0.14 cfs @ 12.07 hrs, Volume= 0.012 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	1,425	98	Paved slab, HSG C
	1,425		100.00% Impervious Area

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

Subcatchment DA4: CB4



Summary for Subcatchment DA5: CB5

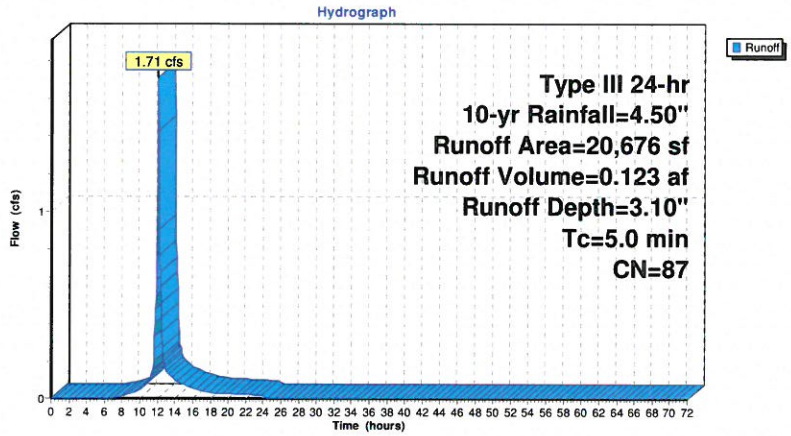
Runoff = 1.71 cfs @ 12.07 hrs, Volume= 0.123 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	11,401	98	Paved parking/Roof, HSG C
	5,065	74	>75% Grass cover, Good, HSG C
	4,210	72	Woods/grass comb., Good, HSG C
	20,676	87	Weighted Average
	9,275		44.86% Pervious Area
	11,401		55.14% Impervious Area

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

Subcatchment DA5: CB5



Summary for Subcatchment DA6: Clarke St

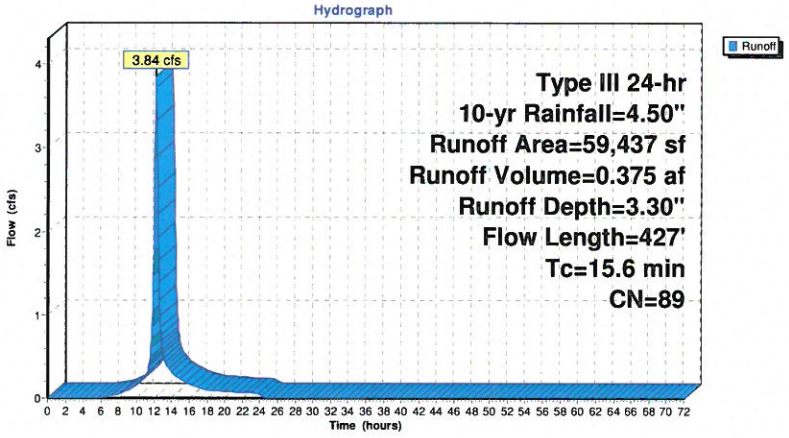
Runoff = 3.84 cfs @ 12.21 hrs, Volume= 0.375 af, Depth= 3.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

Area (sf)	CN	Description
12,879	98	Roofs, HSG C
23,361	98	Paved parking, HSG C
3,254	72	Woods/grass comb., Good, HSG C
19,943	74	>75% Grass cover, Good, HSG C
59,437	89	Weighted Average
23,197		39.03% Pervious Area
36,240		60.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	120	0.0830	2.60		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
3.3	62	0.1100	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
11.1	97	0.0900	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.2	74	0.0900	6.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	74	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.6	427	Total			

Subcatchment DA6: Clarke St



Summary for Subcatchment DA7: Courtyard

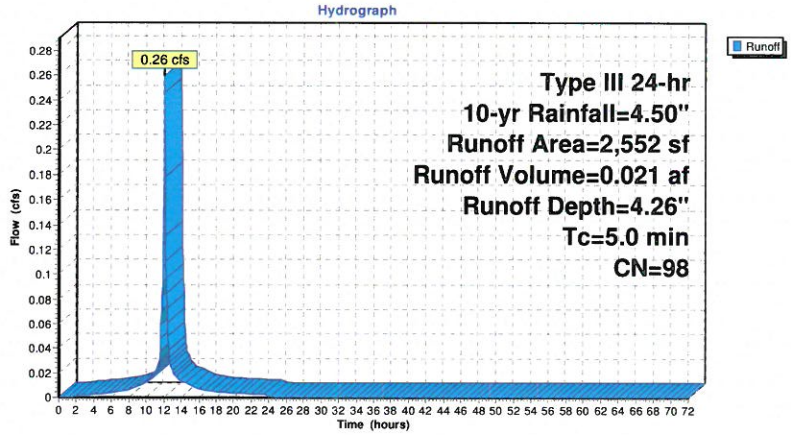
Runoff = 0.26 cfs @ 12.07 hrs, Volume= 0.021 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

Area (sf)	CN	Description
1,515	98	Paved parking & roofs
1,037	98	Roofs, HSG A
2,552	98	Weighted Average
2,552		100.00% Impervious Area

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

Subcatchment DA7: Courtyard

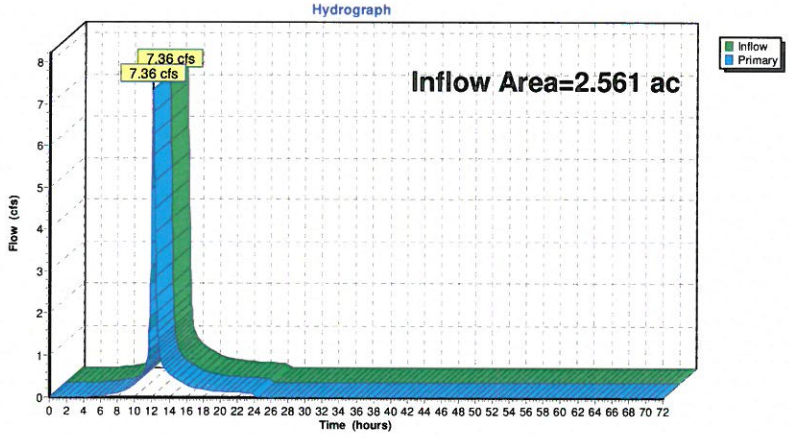


Summary for Pond SP-1: Study Point-1 (CB5)

Inflow Area = 2.561 ac, 65.96% Impervious, Inflow Depth = 3.40" for 10-yr event
Inflow = 7.36 cfs @ 12.10 hrs, Volume= 0.725 af
Primary = 7.36 cfs @ 12.10 hrs, Volume= 0.725 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-1: Study Point-1 (CB5)

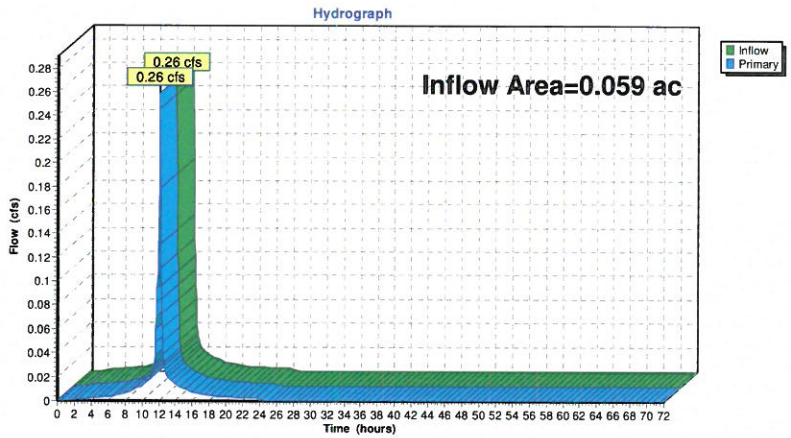


Summary for Pond SP-2: SP-2

Inflow Area = 0.059 ac,100.00% Impervious, Inflow Depth = 4.26" for 10-yr event
Inflow = 0.26 cfs @ 12.07 hrs, Volume= 0.021 af
Primary = 0.26 cfs @ 12.07 hrs, Volume= 0.021 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-2: SP-2



Summary for Subcatchment DA1: CB1

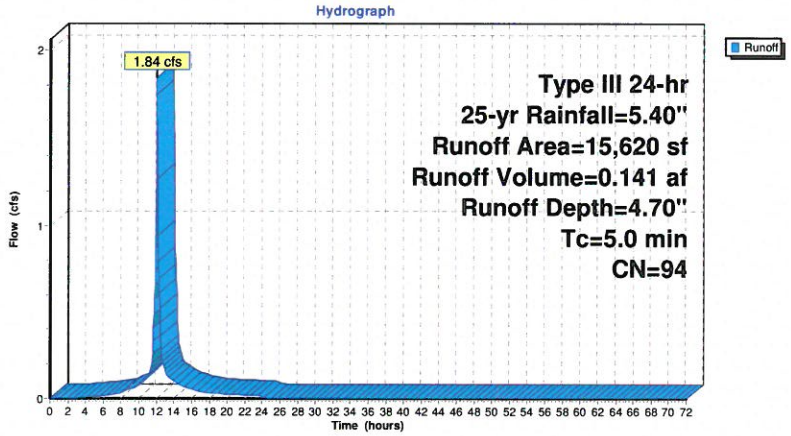
Runoff = 1.84 cfs @ 12.07 hrs, Volume= 0.141 af, Depth= 4.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	12,960	98	Road/Roof, HSG C
	2,660	74	>75% Grass cover, Good, HSG C
	15,620	94	Weighted Average
	2,660		17.03% Pervious Area
	12,960		82.97% Impervious Area

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

Subcatchment DA1: CB1



Summary for Subcatchment DA2: CB2

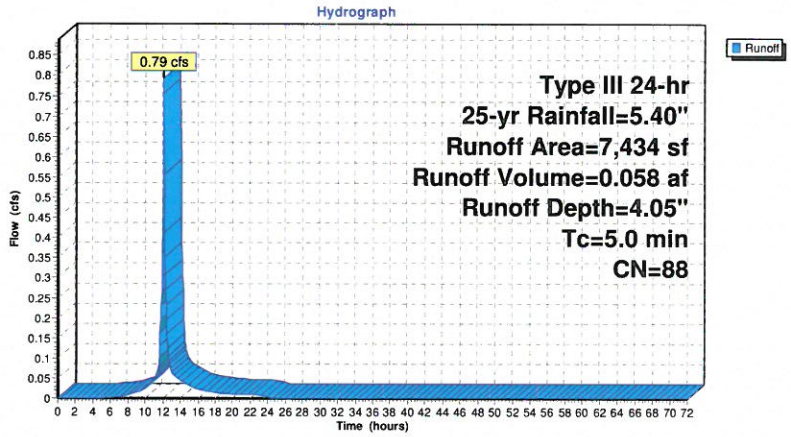
Runoff = 0.79 cfs @ 12.07 hrs, Volume= 0.058 af, Depth= 4.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	4,590	98	Paved slab, HSG C
*	2,526	74	Landscaped planters, Good, HSG C
	318	65	Brush, Good, HSG C
	7,434	88	Weighted Average
	2,844		38.26% Pervious Area
	4,590		61.74% Impervious Area

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

Subcatchment DA2: CB2



Summary for Subcatchment DA3: CB3

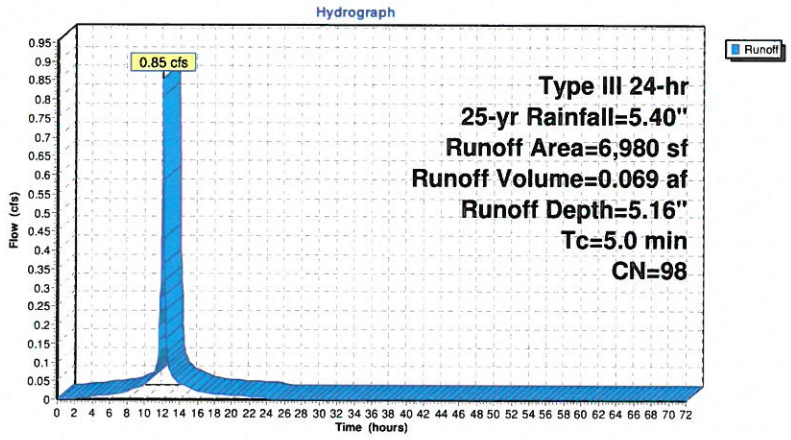
Runoff = 0.85 cfs @ 12.07 hrs, Volume= 0.069 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	6,980	98	Paved slab, HSG C
	6,980		100.00% Impervious Area

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

Subcatchment DA3: CB3



Summary for Subcatchment DA4: CB4

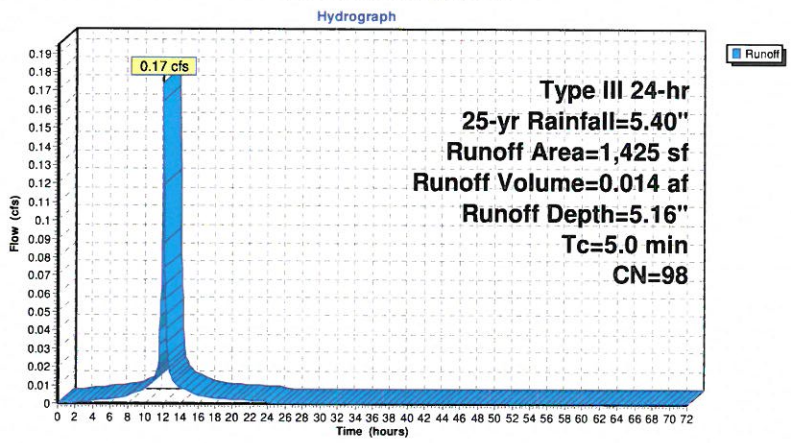
Runoff = 0.17 cfs @ 12.07 hrs, Volume= 0.014 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	1,425	98	Paved slab, HSG C
	1,425		100.00% Impervious Area

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

Subcatchment DA4: CB4



Summary for Subcatchment DA5: CB5

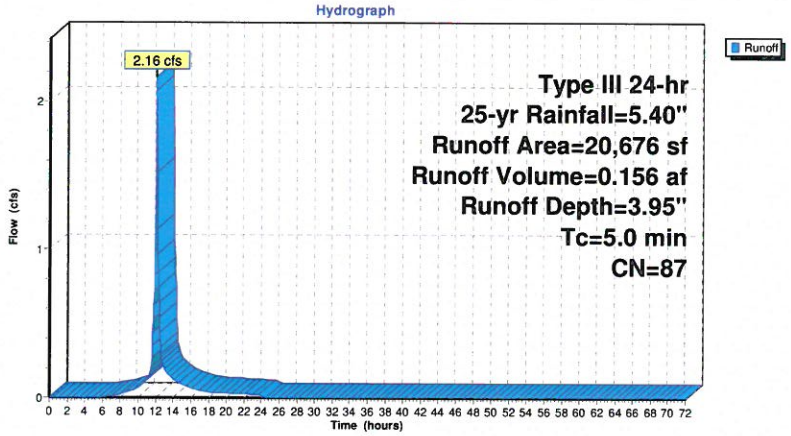
Runoff = 2.16 cfs @ 12.07 hrs, Volume= 0.156 af, Depth= 3.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	11,401	98	Paved parking/Roof, HSG C
	5,065	74	>75% Grass cover, Good, HSG C
	4,210	72	Woods/grass comb., Good, HSG C
	20,676	87	Weighted Average
	9,275		44.86% Pervious Area
	11,401		55.14% Impervious Area

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

Subcatchment DA5: CB5



Summary for Subcatchment DA6: Clarke St

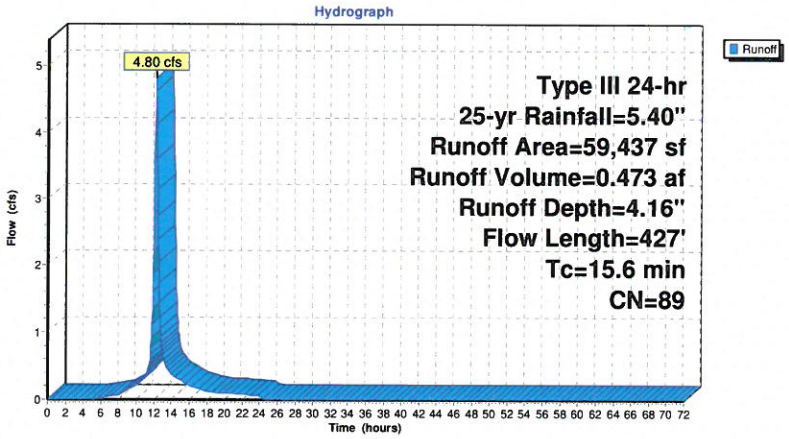
Runoff = 4.80 cfs @ 12.21 hrs, Volume= 0.473 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

Area (sf)	CN	Description
12,879	98	Roofs, HSG C
23,361	98	Paved parking, HSG C
3,254	72	Woods/grass comb., Good, HSG C
19,943	74	>75% Grass cover, Good, HSG C
59,437	89	Weighted Average
23,197		39.03% Pervious Area
36,240		60.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	120	0.0830	2.60		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
3.3	62	0.1100	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
11.1	97	0.0900	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.2	74	0.0900	6.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	74	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.6	427	Total			

Subcatchment DA6: Clarke St



Summary for Subcatchment DA7: Courtyard

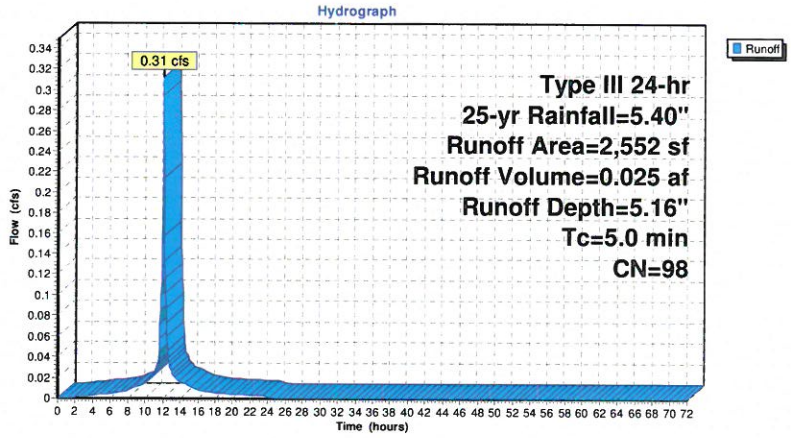
Runoff = 0.31 cfs @ 12.07 hrs, Volume= 0.025 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

Area (sf)	CN	Description
1,515	98	Paved parking & roofs
1,037	98	Roofs, HSG A
2,552	98	Weighted Average
2,552		100.00% Impervious Area

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

Subcatchment DA7: Courtyard

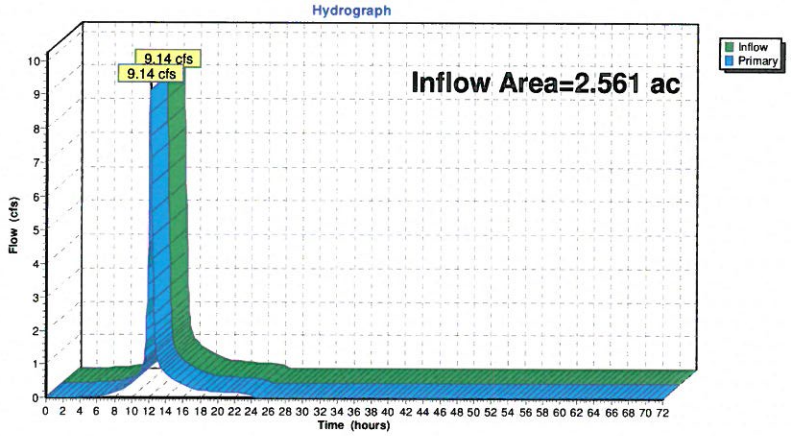


Summary for Pond SP-1: Study Point-1 (CB5)

Inflow Area = 2.561 ac, 65.96% Impervious, Inflow Depth = 4.26" for 25-yr event
Inflow = 9.14 cfs @ 12.10 hrs, Volume= 0.910 af
Primary = 9.14 cfs @ 12.10 hrs, Volume= 0.910 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-1: Study Point-1 (CB5)

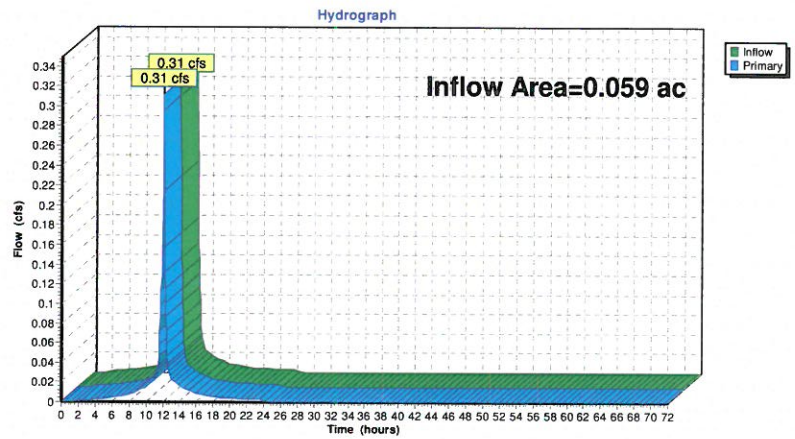


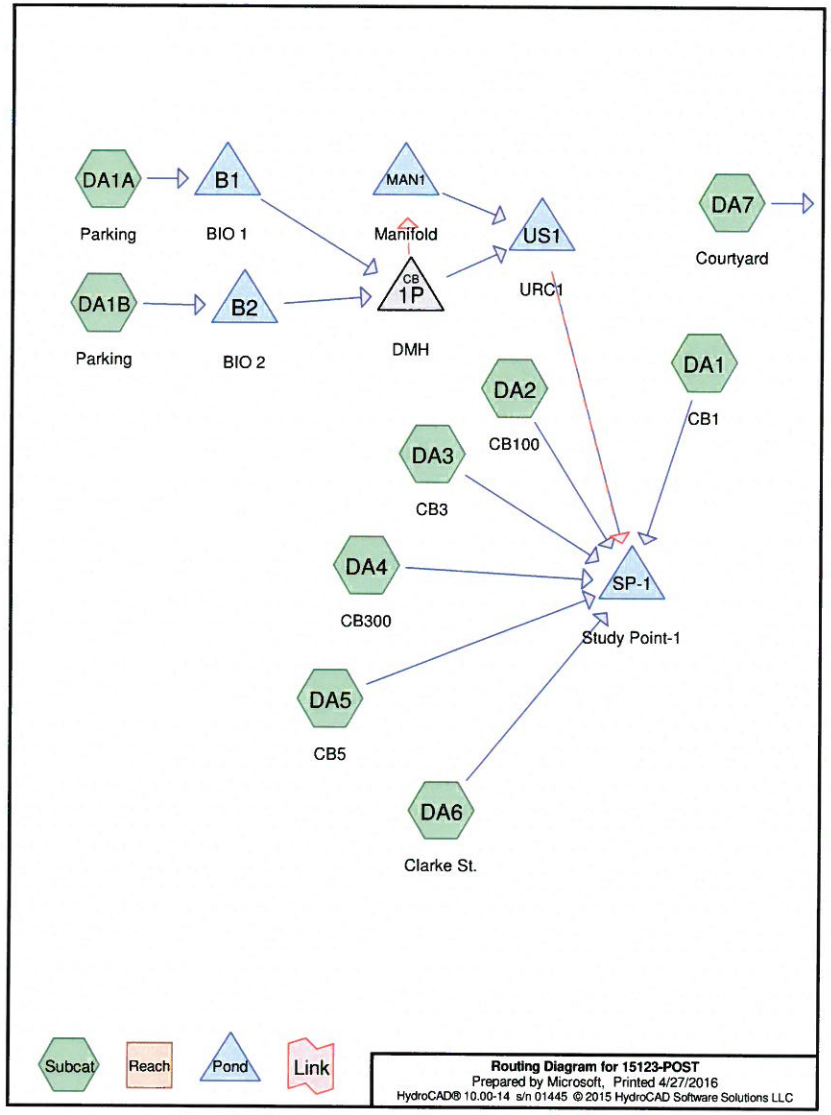
Summary for Pond SP-2: SP-2

Inflow Area = 0.059 ac,100.00% Impervious, Inflow Depth = 5.16" for 25-yr event
Inflow = 0.31 cfs @ 12.07 hrs, Volume= 0.025 af
Primary = 0.31 cfs @ 12.07 hrs, Volume= 0.025 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-2: SP-2





Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.484	74	>75% Grass cover, Good, HSG C (DA1, DA1A, DA1B, DA4, DA5, DA6)
0.045	74	Landscaped planters, Good, HSG C (DA2, DA7)
0.692	98	Paved parking, HSG C (DA1A, DA1B, DA6)
0.220	98	Paved parking/Roof, HSG C (DA5)
0.344	98	Paved slab, HSG C (DA2, DA3, DA4, DA7)
0.025	98	Pavers, HSG C (DA7)
0.298	98	Road/Roof, HSG C (DA1)
0.296	98	Roofs, HSG C (DA6)
0.006	98	Water Surface, HSG C (DA1A, DA1B)
0.210	72	Woods/grass comb., Good, HSG C (DA5, DA6)
2.621	**91**	**TOTAL AREA**

Summary for Subcatchment DA1: CB1

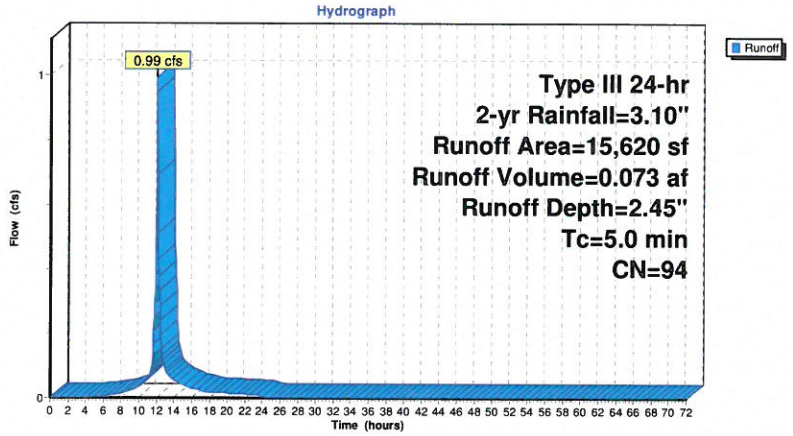
Runoff = 0.99 cfs @ 12.07 hrs, Volume= 0.073 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	12,960	98	Road/Roof, HSG C
	2,660	74	>75% Grass cover, Good, HSG C
	15,620	94	Weighted Average
	2,660		17.03% Pervious Area
	12,960		82.97% Impervious Area

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

Subcatchment DA1: CB1



Summary for Subcatchment DA1A: Parking

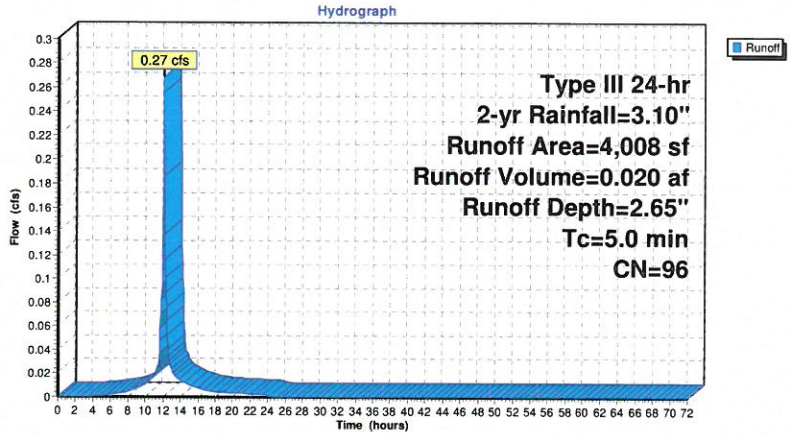
Runoff = 0.27 cfs @ 12.07 hrs, Volume= 0.020 af, Depth= 2.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
3,500	98	Paved parking, HSG C
152	98	Water Surface, HSG C
356	74	>75% Grass cover, Good, HSG C
4,008	96	Weighted Average
356		8.88% Pervious Area
3,652		91.12% Impervious Area

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

Subcatchment DA1A: Parking



Summary for Subcatchment DA1B: Parking

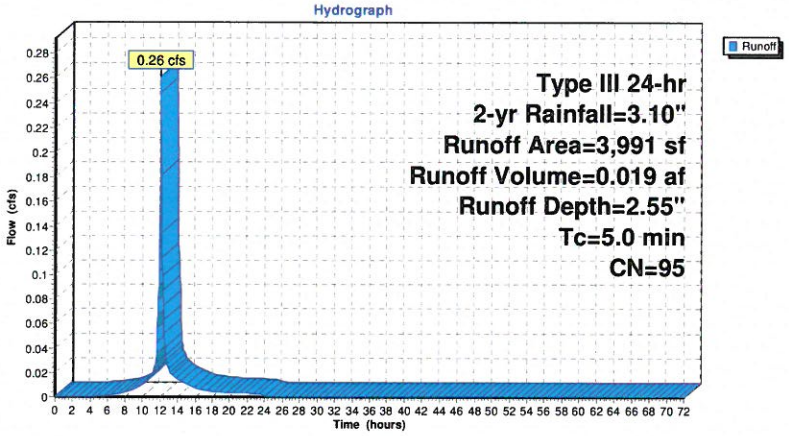
Runoff = 0.26 cfs @ 12.07 hrs, Volume= 0.019 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
3,300	98	Paved parking, HSG C
114	98	Water Surface, HSG C
577	74	>75% Grass cover, Good, HSG C
3,991	95	Weighted Average
577		14.46% Pervious Area
3,414		85.54% Impervious Area

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

Subcatchment DA1B: Parking



Summary for Subcatchment DA2: CB100

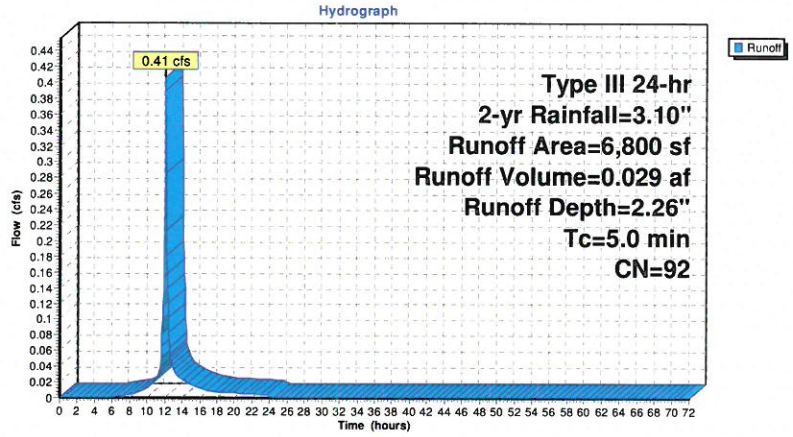
Runoff = 0.41 cfs @ 12.07 hrs, Volume= 0.029 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	5,200	98	Paved slab, HSG C
*	1,600	74	Landscaped planters, Good, HSG C
	6,800	92	Weighted Average
	1,600		23.53% Pervious Area
	5,200		76.47% Impervious Area

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

Subcatchment DA2: CB100



Summary for Subcatchment DA3: CB3

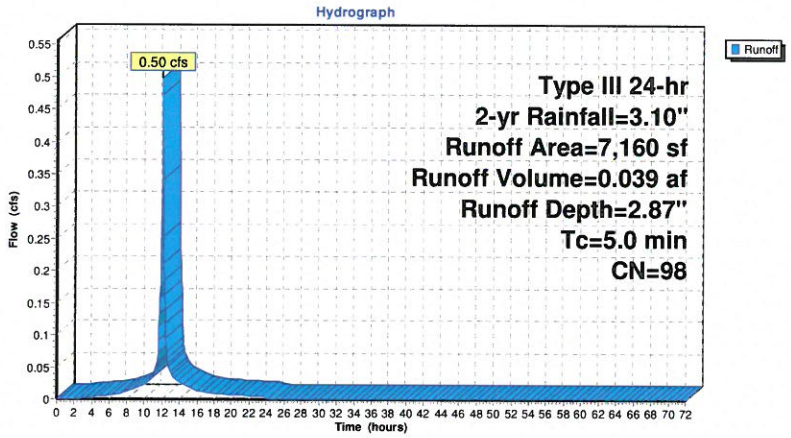
Runoff = 0.50 cfs @ 12.07 hrs, Volume= 0.039 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	7,160	98	Paved slab, HSG C
	7,160		100.00% Impervious Area

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

Subcatchment DA3: CB3



Summary for Subcatchment DA4: CB300

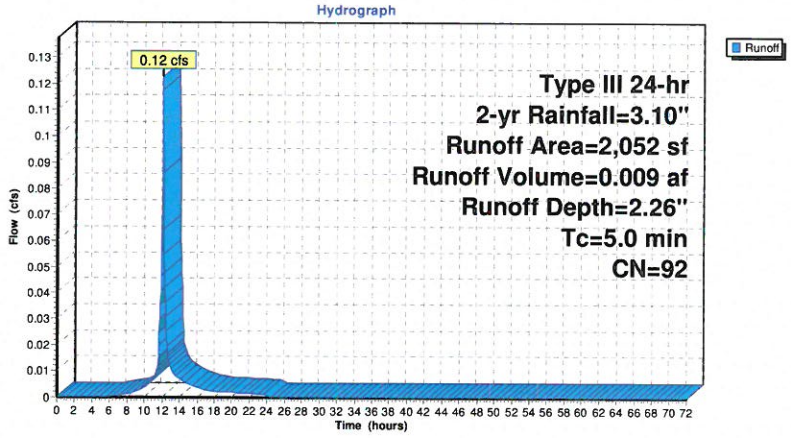
Runoff = 0.12 cfs @ 12.07 hrs, Volume= 0.009 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	1,552	98	Paved slab, HSG C
	500	74	>75% Grass cover, Good, HSG C
	2,052	92	Weighted Average
	500		24.37% Pervious Area
	1,552		75.63% Impervious Area

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

Subcatchment DA4: CB300



Summary for Subcatchment DA5: CB5

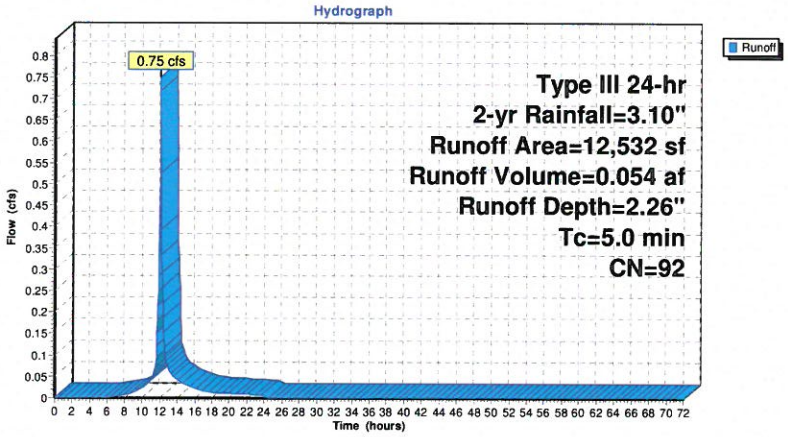
Runoff = 0.75 cfs @ 12.07 hrs, Volume= 0.054 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	9,600	98	Paved parking/Roof, HSG C
	2,032	74	>75% Grass cover, Good, HSG C
	900	72	Woods/grass comb., Good, HSG C
	12,532	92	Weighted Average
	2,932		23.40% Pervious Area
	9,600		76.60% Impervious Area

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

Subcatchment DA5: CB5



Summary for Subcatchment DA6: Clarke St.

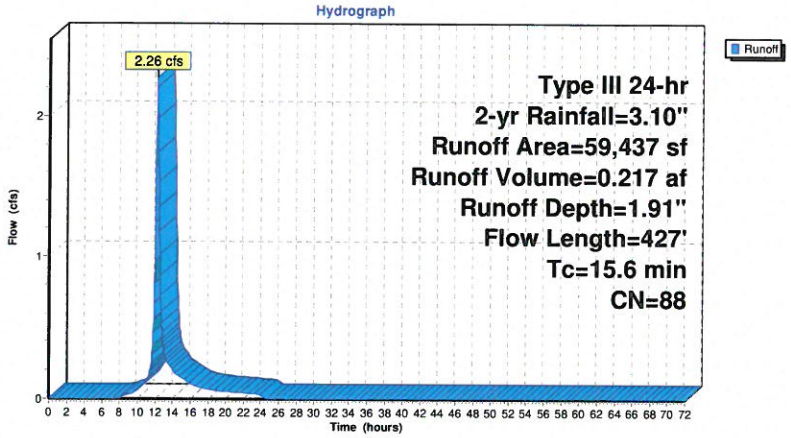
Runoff = 2.26 cfs @ 12.21 hrs, Volume= 0.217 af, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
12,879	98	Roofs, HSG C
23,361	98	Paved parking, HSG C
8,237	72	Woods/grass comb., Good, HSG C
14,960	74	>75% Grass cover, Good, HSG C
59,437	88	Weighted Average
23,197		39.03% Pervious Area
36,240		60.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	120	0.0830	2.60		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
3.3	62	0.1100	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
11.1	97	0.0900	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.2	74	0.0900	6.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	74	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.6	427	Total			

Subcatchment DA6: Clarke St.



Summary for Subcatchment DA7: Courtyard

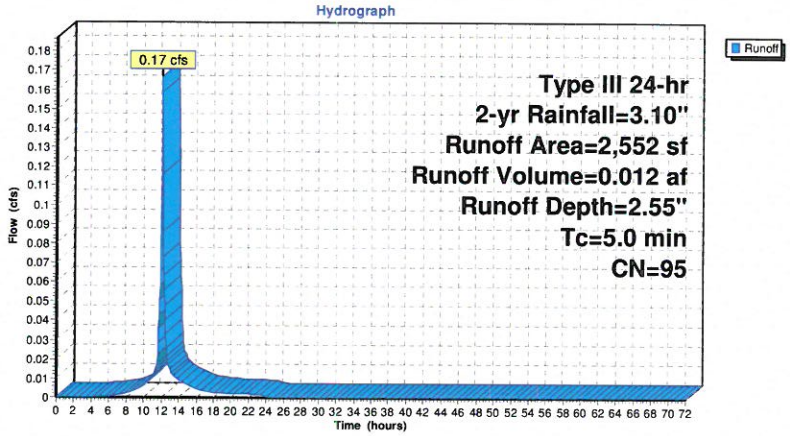
Runoff = 0.17 cfs @ 12.07 hrs, Volume= 0.012 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
*	1,084	98	Paved slab, HSG C
*	1,096	98	Pavers, HSG C
*	372	74	Landscaped planters, Good, HSG C
	2,552	95	Weighted Average
	372		14.58% Pervious Area
	2,180		85.42% Impervious Area

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

Subcatchment DA7: Courtyard



Summary for Pond 1P: DMH

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 2.60" for 2-yr event
Inflow = 0.53 cfs @ 12.08 hrs, Volume= 0.040 af
Outflow = 0.53 cfs @ 12.08 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min
Primary = 0.53 cfs @ 12.08 hrs, Volume= 0.040 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

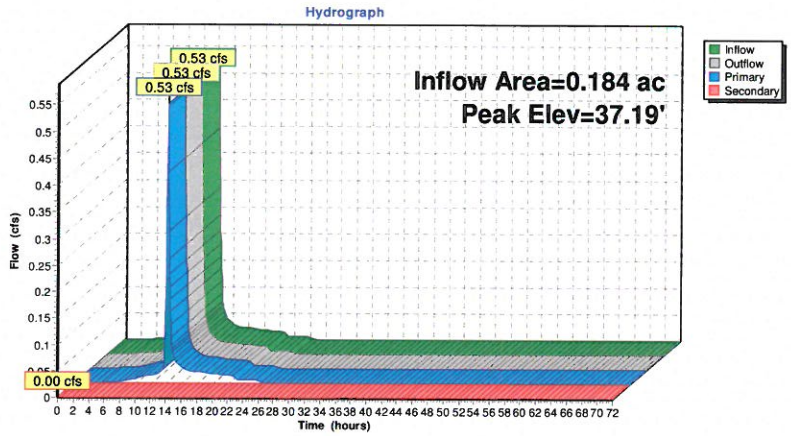
Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 37.19' @ 12.08 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	36.79'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 36.79' / 36.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Device 3	39.29'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	37.00'	**24.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.51 cfs @ 12.08 hrs HW=37.19' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.51 cfs @ 1.73 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=36.79' (Free Discharge)
└**3=Orifice/Grate** (Controls 0.00 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: DMH



Summary for Pond B1: BIO 1

Inflow Area = 0.092 ac, 91.12% Impervious, Inflow Depth = 2.65" for 2-yr event
Inflow = 0.27 cfs @ 12.07 hrs, Volume= 0.020 af
Outflow = 0.27 cfs @ 12.08 hrs, Volume= 0.020 af, Atten= 1%, Lag= 0.7 min
Primary = 0.27 cfs @ 12.08 hrs, Volume= 0.020 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.55' @ 12.08 hrs Surf.Area= 189 sf Storage= 95 cf

Plug-Flow detention time= 42.0 min calculated for 0.020 af (100% of inflow)
Center-of-Mass det. time= 42.0 min (816.0 - 774.0)

Volume	Invert	Avail.Storage	Storage Description
#1	41.00'	125 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

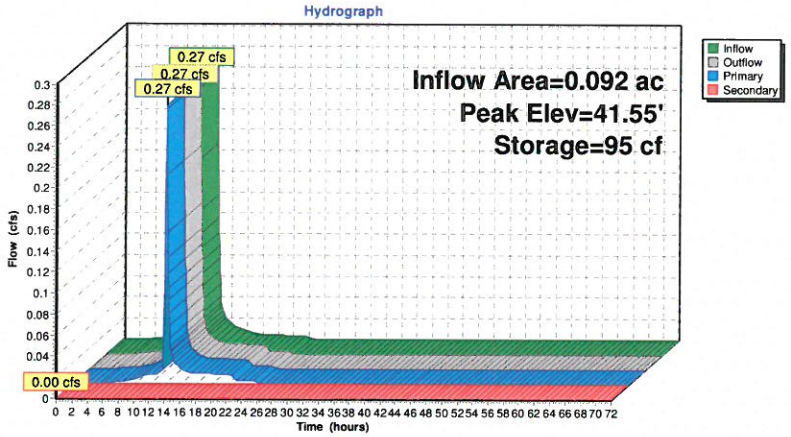
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
41.00	152	0	0
41.71	200	125	125

Device	Routing	Invert	Outlet Devices
#1	Primary	38.00'	**12.0" Round Culvert** L= 16.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.00' / 37.84' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	38.13'	**4.0" Round Culvert** L= 8.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.13' / 38.09' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	41.00'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.70'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.26 cfs @ 12.08 hrs HW=41.55' (Free Discharge)
└**1=Culvert** (Passes 0.26 cfs of 5.22 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.25 cfs @ 0.75 fps)
└**3=Culvert** (Passes 0.01 cfs of 0.60 cfs potential flow)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=41.00' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B1: BIO 1



Summary for Pond B2: BIO 2

Inflow Area =	0.092 ac,	85.54% Impervious,	Inflow Depth =	2.55"	for 2-yr event
Inflow =	0.26 cfs @	12.07 hrs,	Volume=	0.019 af	
Outflow =	0.26 cfs @	12.09 hrs,	Volume=	0.019 af,	Atten= 1%, Lag= 0.9 min
Primary =	0.26 cfs @	12.09 hrs,	Volume=	0.019 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.25' @ 12.09 hrs Surf.Area= 248 sf Storage= 92 cf

Plug-Flow detention time= 38.5 min calculated for 0.019 af (100% of inflow)
Center-of-Mass det. time= 38.5 min (819.5 - 781.0)

Volume	Invert	Avail.Storage	Storage Description
#1	40.70'	135 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

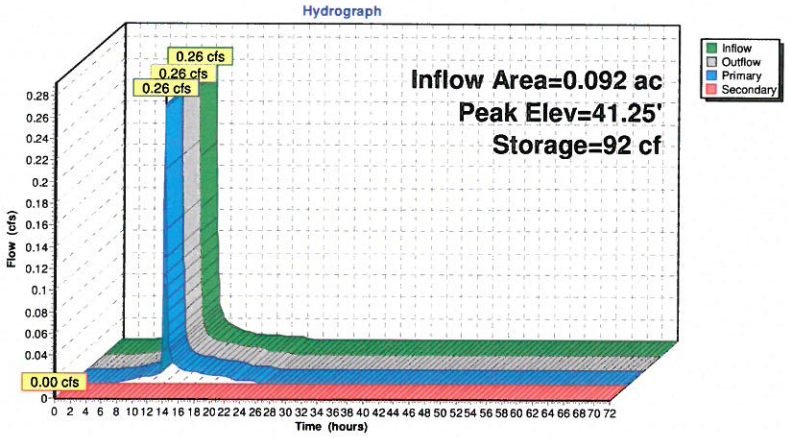
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.70	114	0	0
41.00	157	41	41
41.41	305	95	135

Device	Routing	Invert	Outlet Devices
#1	Primary	37.67'	**12.0" Round Culvert** L= 9.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.67' / 37.63' S= 0.0044 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.20'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	37.83'	**4.0" Round Culvert** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.83' / 37.77' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	40.70'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.40'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.25 cfs @ 12.09 hrs HW=41.25' (Free Discharge)
↑—**1=Culvert** (Passes 0.25 cfs of 5.24 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 0.24 cfs @ 0.74 fps)
↑—**3=Culvert** (Passes 0.01 cfs of 0.60 cfs potential flow)
↑—**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=40.70' (Free Discharge)
↑—**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B2: BIO 2



Summary for Pond MAN1: Manifold

Inflow	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af
Outflow	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af, Atten= 0%, Lag= 0.0 min
Primary	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 37.00' @ 0.00 hrs Surf.Area= 0 sf Storage= 0 cf

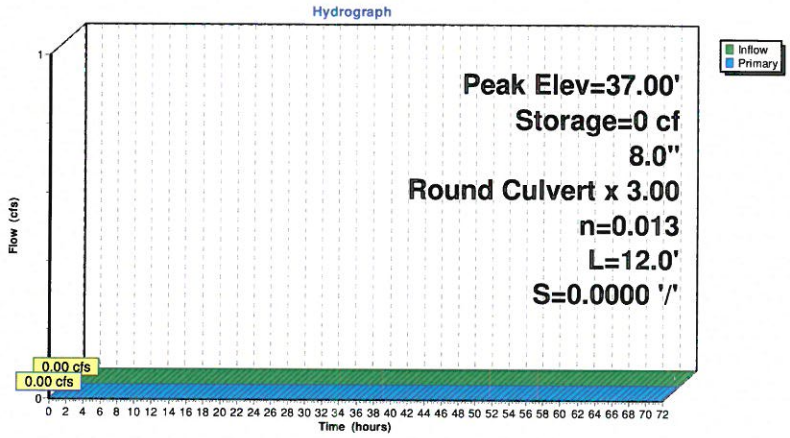
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	38 cf	**24.0" Round Pipe Storage** L= 12.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	38.33'	**8.0" Round Culvert X 3.00** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.33' / 38.33' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=37.00' (Free Discharge)
↑**1=Culvert** (Controls 0.00 cfs)

Pond MAN1: Manifold

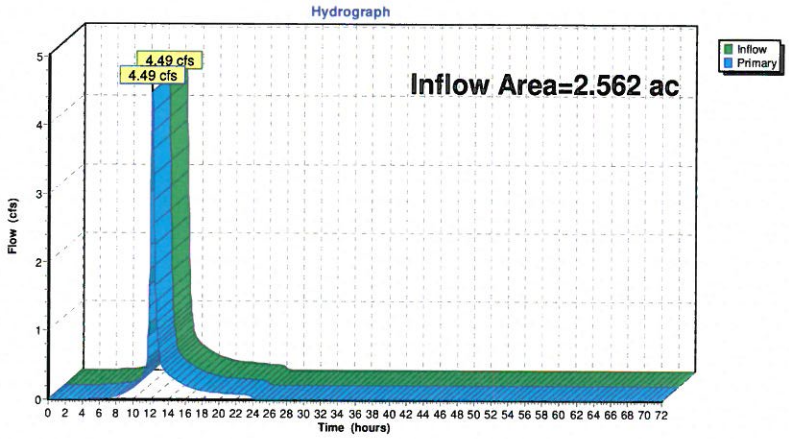


Summary for Pond SP-1: Study Point-1

Inflow Area = 2.562 ac, 71.49% Impervious, Inflow Depth = 2.16" for 2-yr event
Inflow = 4.49 cfs @ 12.10 hrs, Volume= 0.461 af
Primary = 4.49 cfs @ 12.10 hrs, Volume= 0.461 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-1: Study Point-1



Summary for Pond US1: URC1

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 2.60" for 2-yr event
Inflow = 0.53 cfs @ 12.08 hrs, Volume= 0.040 af
Outflow = 0.23 cfs @ 12.27 hrs, Volume= 0.040 af, Atten= 56%, Lag= 10.9 min
Primary = 0.23 cfs @ 12.27 hrs, Volume= 0.040 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 36.43' @ 12.27 hrs Surf.Area= 926 sf Storage= 236 cf

Plug-Flow detention time= 6.2 min calculated for 0.040 af (100% of inflow)
Center-of-Mass det. time= 6.2 min (823.9 - 817.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	35.79'	1,221 cf	**20.50'W x 45.16'L x 4.50'H Field A** 4,166 cf Overall - 1,114 cf Embedded = 3,052 cf x 40.0% Voids
#2A	36.79'	1,114 cf	**StormTech SC-740** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,335 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Secondary	38.79'	**6.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.79' / 38.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	35.45'	**4.0" Round Culvert** L= 46.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 35.45' / 35.22' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf

Primary OutFlow Max=0.23 cfs @ 12.27 hrs HW=36.42' (Free Discharge)
↑—**2=Culvert** (Barrel Controls 0.23 cfs @ 2.62 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=35.79' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond US1: URC1 - Chamber Wizard Field A

Chamber Model = StormTech SC-740 (StormTech® SC-740)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

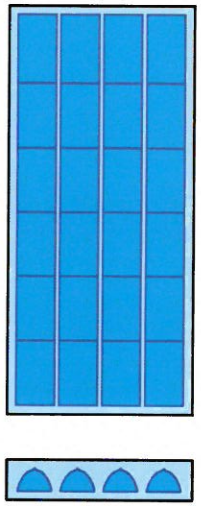
6 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 43.16' Row Length +12.0" End Stone x 2 = 45.16' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

24 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,113.9 cf Chamber Storage

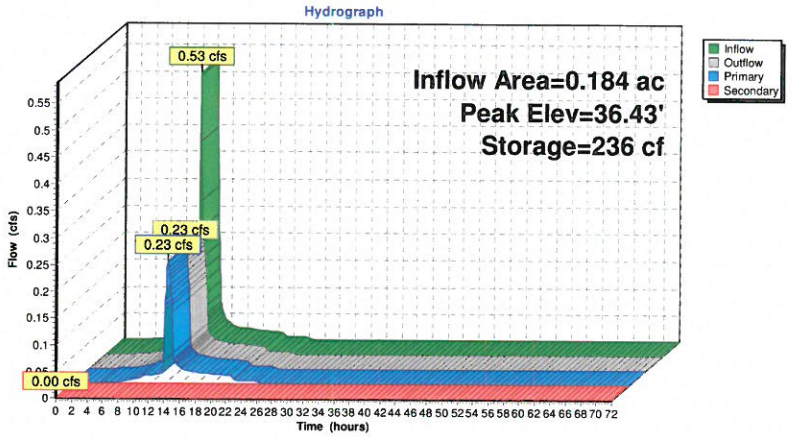
4,165.9 cf Field - 1,113.9 cf Chambers = 3,052.0 cf Stone x 40.0% Voids = 1,220.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,334.7 cf = 0.054 af
Overall Storage Efficiency = 56.0%

24 Chambers
154.3 cy Field
113.0 cy Stone



Pond US1: URC1



Summary for Subcatchment DA1: CB1

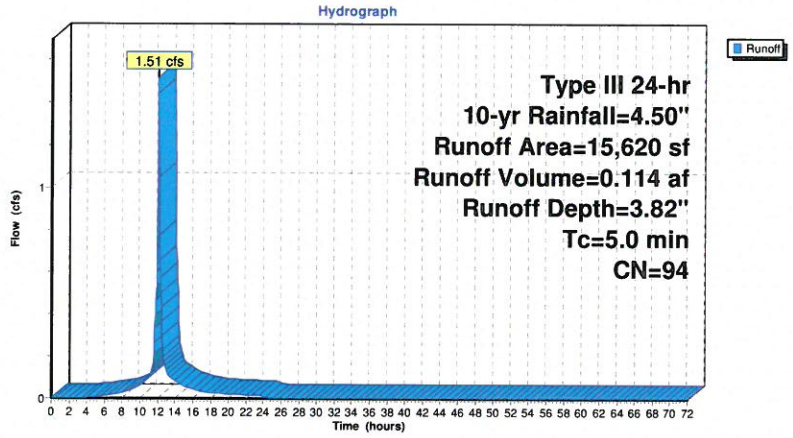
Runoff = 1.51 cfs @ 12.07 hrs, Volume= 0.114 af, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	12,960	98	Road/Roof, HSG C
	2,660	74	>75% Grass cover, Good, HSG C
	15,620	94	Weighted Average
	2,660		17.03% Pervious Area
	12,960		82.97% Impervious Area

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

Subcatchment DA1: CB1



Summary for Subcatchment DA1A: Parking

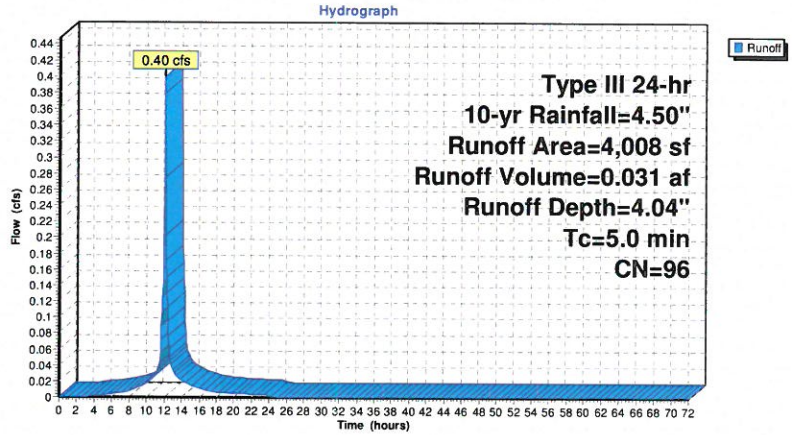
Runoff = 0.40 cfs @ 12.07 hrs, Volume= 0.031 af, Depth= 4.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

Area (sf)	CN	Description
3,500	98	Paved parking, HSG C
152	98	Water Surface, HSG C
356	74	>75% Grass cover, Good, HSG C
4,008	96	Weighted Average
356		8.88% Pervious Area
3,652		91.12% Impervious Area

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

Subcatchment DA1A: Parking



Summary for Subcatchment DA1B: Parking

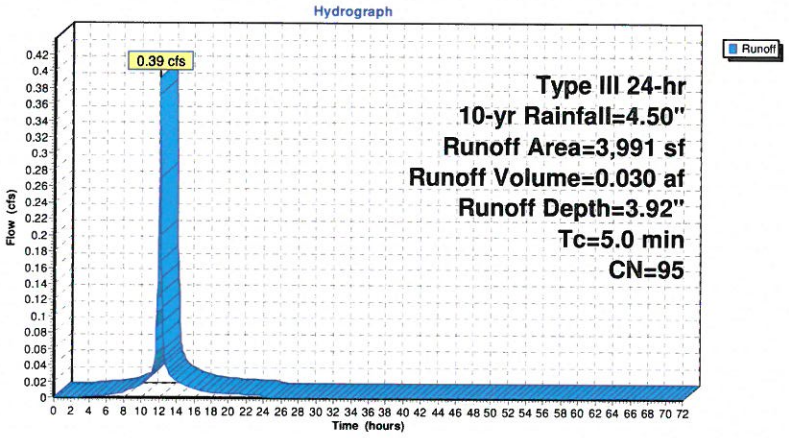
Runoff = 0.39 cfs @ 12.07 hrs, Volume= 0.030 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

Area (sf)	CN	Description
3,300	98	Paved parking, HSG C
114	98	Water Surface, HSG C
577	74	>75% Grass cover, Good, HSG C
3,991	95	Weighted Average
577		14.46% Pervious Area
3,414		85.54% Impervious Area

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

Subcatchment DA1B: Parking



Summary for Subcatchment DA2: CB100

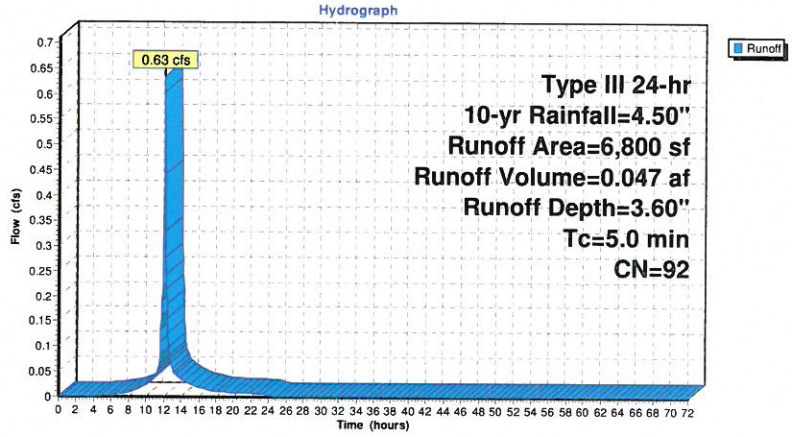
Runoff = 0.63 cfs @ 12.07 hrs, Volume= 0.047 af, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	5,200	98	Paved slab, HSG C
*	1,600	74	Landscaped planters, Good, HSG C
	6,800	92	Weighted Average
	1,600		23.53% Pervious Area
	5,200		76.47% Impervious Area

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

Subcatchment DA2: CB100



Summary for Subcatchment DA3: CB3

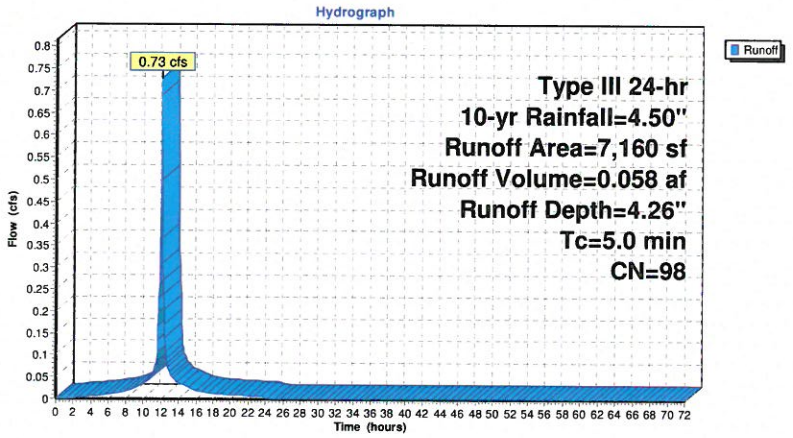
Runoff = 0.73 cfs @ 12.07 hrs, Volume= 0.058 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	7,160	98	Paved slab, HSG C
	7,160		100.00% Impervious Area

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

Subcatchment DA3: CB3



Summary for Subcatchment DA4: CB300

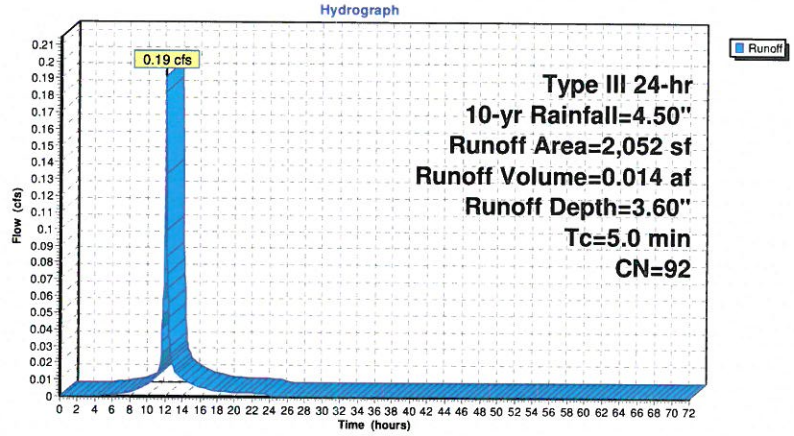
Runoff = 0.19 cfs @ 12.07 hrs, Volume= 0.014 af, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	1,552	98	Paved slab, HSG C
	500	74	>75% Grass cover, Good, HSG C
	2,052	92	Weighted Average
	500		24.37% Pervious Area
	1,552		75.63% Impervious Area

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

Subcatchment DA4: CB300



Summary for Subcatchment DA5: CB5

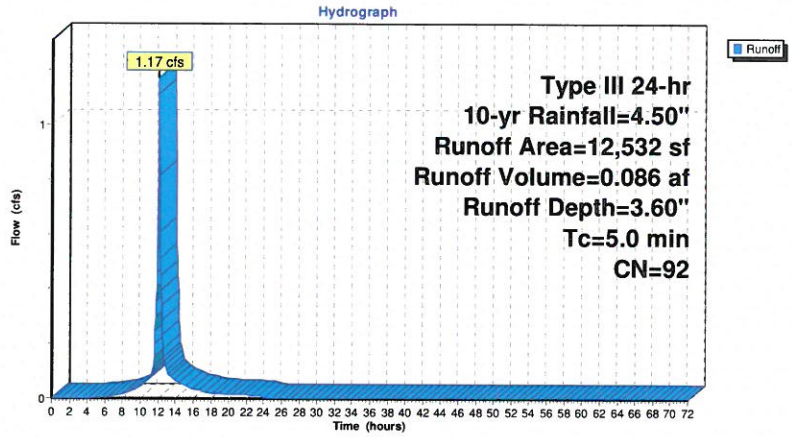
Runoff = 1.17 cfs @ 12.07 hrs, Volume= 0.086 af, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	9,600	98	Paved parking/Roof, HSG C
	2,032	74	>75% Grass cover, Good, HSG C
	900	72	Woods/grass comb., Good, HSG C
	12,532	92	Weighted Average
	2,932		23.40% Pervious Area
	9,600		76.60% Impervious Area

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

Subcatchment DA5: CB5



Summary for Subcatchment DA6: Clarke St.

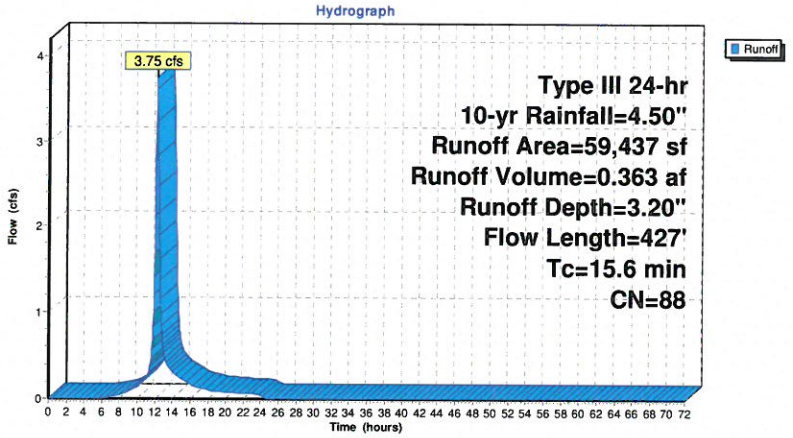
Runoff = 3.75 cfs @ 12.21 hrs, Volume= 0.363 af, Depth= 3.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

Area (sf)	CN	Description
12,879	98	Roofs, HSG C
23,361	98	Paved parking, HSG C
8,237	72	Woods/grass comb., Good, HSG C
14,960	74	>75% Grass cover, Good, HSG C
59,437	88	Weighted Average
23,197		39.03% Pervious Area
36,240		60.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	120	0.0830	2.60		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
3.3	62	0.1100	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
11.1	97	0.0900	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.2	74	0.0900	6.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	74	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.6	427	Total			

Subcatchment DA6: Clarke St.



Summary for Subcatchment DA7: Courtyard

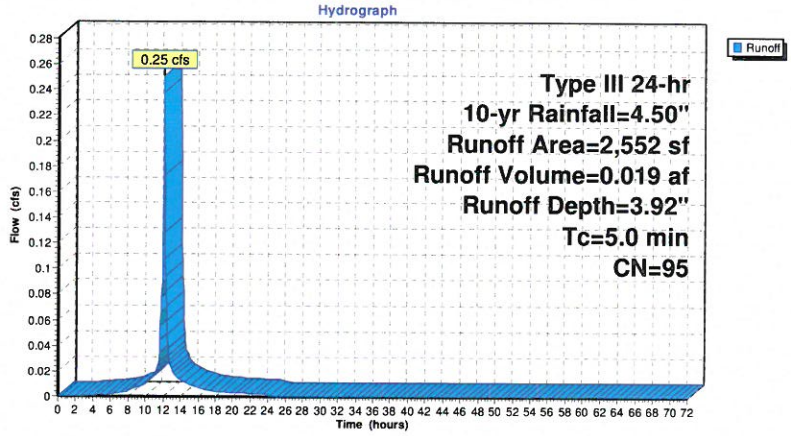
Runoff = 0.25 cfs @ 12.07 hrs, Volume= 0.019 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.50"

	Area (sf)	CN	Description
*	1,084	98	Paved slab, HSG C
*	1,096	98	Pavers, HSG C
*	372	74	Landscaped planters, Good, HSG C
	2,552	95	Weighted Average
	372		14.58% Pervious Area
	2,180		85.42% Impervious Area

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

Subcatchment DA7: Courtyard



Summary for Pond 1P: DMH

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 3.98" for 10-yr event
Inflow = 0.79 cfs @ 12.08 hrs, Volume= 0.061 af
Outflow = 0.79 cfs @ 12.08 hrs, Volume= 0.061 af, Atten= 0%, Lag= 0.0 min
Primary = 0.79 cfs @ 12.08 hrs, Volume= 0.061 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

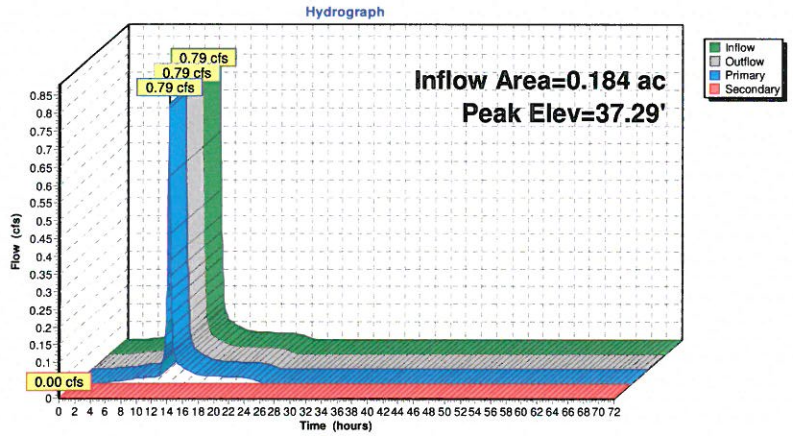
Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 37.29' @ 12.08 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	36.79'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 36.79' / 36.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Device 3	39.29'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	37.00'	**24.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.76 cfs @ 12.08 hrs HW=37.28' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.76 cfs @ 1.94 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=36.79' (Free Discharge)
└**3=Orifice/Grate** (Controls 0.00 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: DMH



Summary for Pond B1: BIO 1

Inflow Area = 0.092 ac, 91.12% Impervious, Inflow Depth = 4.04" for 10-yr event
Inflow = 0.40 cfs @ 12.07 hrs, Volume= 0.031 af
Outflow = 0.40 cfs @ 12.08 hrs, Volume= 0.031 af, Atten= 1%, Lag= 0.6 min
Primary = 0.40 cfs @ 12.08 hrs, Volume= 0.031 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.57' @ 12.08 hrs Surf.Area= 191 sf Storage= 98 cf

Plug-Flow detention time= 38.2 min calculated for 0.031 af (100% of inflow)
Center-of-Mass det. time= 38.2 min (802.2 - 764.0)

Volume	Invert	Avail.Storage	Storage Description
#1	41.00'	125 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

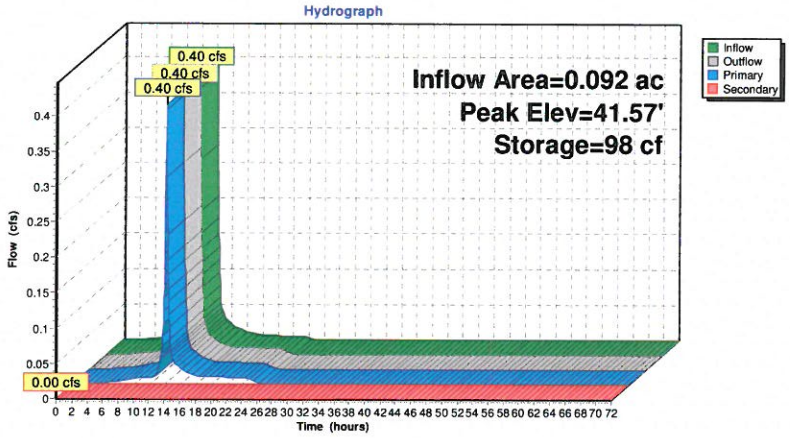
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
41.00	152	0	0
41.71	200	125	125

Device	Routing	Invert	Outlet Devices
#1	Primary	38.00'	**12.0" Round Culvert** L= 16.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.00' / 37.84' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	38.13'	**4.0" Round Culvert** L= 8.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.13' / 38.09' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	41.00'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.70'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.38 cfs @ 12.08 hrs HW=41.57' (Free Discharge)
└**1=Culvert** (Passes 0.38 cfs of 5.23 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.37 cfs @ 0.86 fps)
└**3=Culvert** (Passes 0.01 cfs of 0.60 cfs potential flow)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=41.00' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B1: BIO 1



Summary for Pond B2: BIO 2

Inflow Area = 0.092 ac, 85.54% Impervious, Inflow Depth = 3.92" for 10-yr event
Inflow = 0.39 cfs @ 12.07 hrs, Volume= 0.030 af
Outflow = 0.39 cfs @ 12.08 hrs, Volume= 0.030 af, Atten= 1%, Lag= 0.8 min
Primary = 0.39 cfs @ 12.08 hrs, Volume= 0.030 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.27' @ 12.08 hrs Surf.Area= 254 sf Storage= 96 cf

Plug-Flow detention time= 35.3 min calculated for 0.030 af (100% of inflow)
Center-of-Mass det. time= 35.2 min (805.4 - 770.1)

Volume	Invert	Avail.Storage	Storage Description
#1	40.70'	135 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

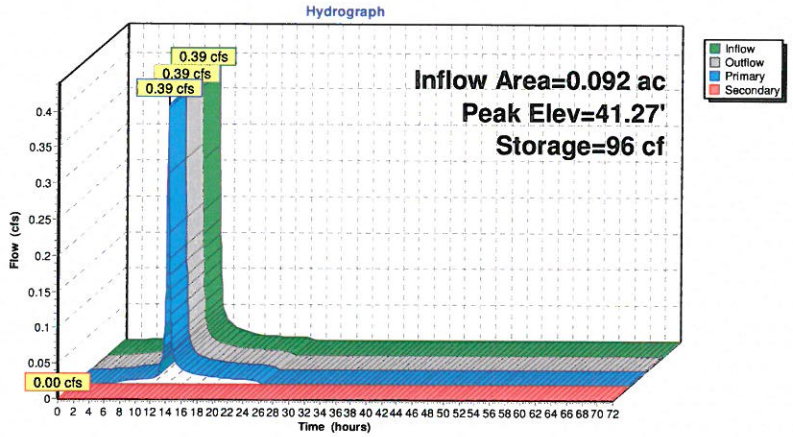
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.70	114	0	0
41.00	157	41	41
41.41	305	95	135

Device	Routing	Invert	Outlet Devices
#1	Primary	37.67'	**12.0" Round Culvert** L= 9.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.67' / 37.63' S= 0.0044 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.20'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	37.83'	**4.0" Round Culvert** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.83' / 37.77' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	40.70'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.40'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.38 cfs @ 12.08 hrs HW=41.27' (Free Discharge)
↑**1=Culvert** (Passes 0.38 cfs of 5.25 cfs potential flow)
↑**2=Orifice/Grate** (Weir Controls 0.36 cfs @ 0.85 fps)
↑**3=Culvert** (Passes 0.01 cfs of 0.60 cfs potential flow)
↑**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=40.70' (Free Discharge)
↑**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B2: BIO 2



Summary for Pond MAN1: Manifold

Inflow	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af
Outflow	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af, Atten= 0%, Lag= 0.0 min
Primary	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 37.00' @ 0.00 hrs Surf.Area= 0 sf Storage= 0 cf

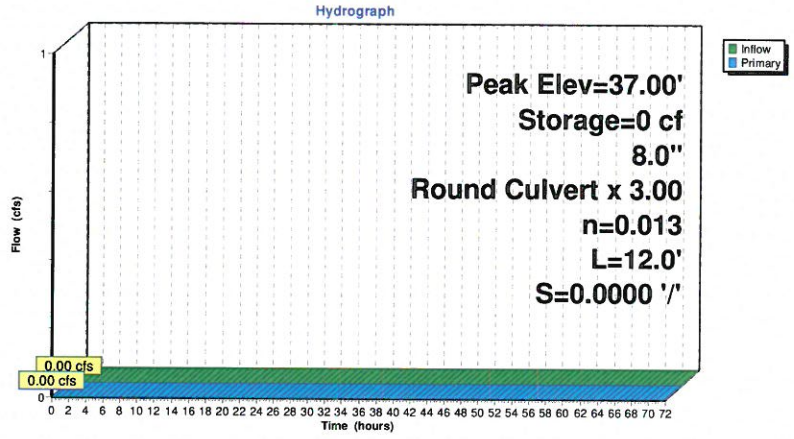
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	38 cf	**24.0" Round Pipe Storage** L= 12.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	38.33'	**8.0" Round Culvert X 3.00** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.33' / 38.33' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=37.00' (Free Discharge)
1=Culvert (Controls 0.00 cfs)

Pond MAN1: Manifold

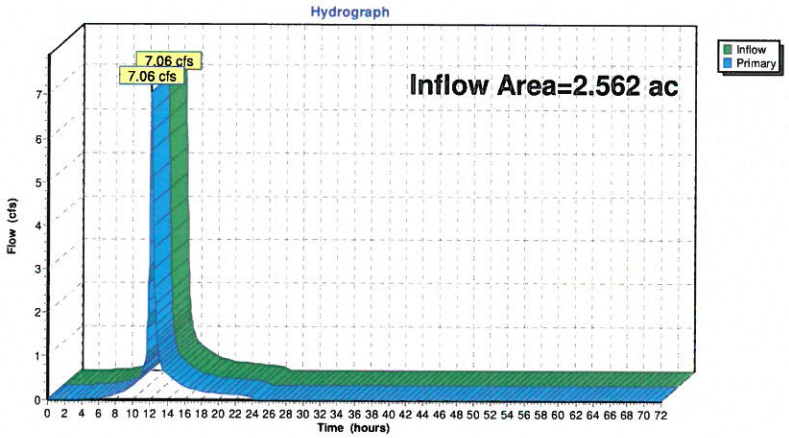


Summary for Pond SP-1: Study Point-1

Inflow Area = 2.562 ac, 71.49% Impervious, Inflow Depth = 3.49" for 10-yr event
Inflow = 7.06 cfs @ 12.10 hrs, Volume= 0.744 af
Primary = 7.06 cfs @ 12.10 hrs, Volume= 0.744 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-1: Study Point-1



Summary for Pond US1: URC1

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 3.98" for 10-yr event
Inflow = 0.79 cfs @ 12.08 hrs, Volume= 0.061 af
Outflow = 0.29 cfs @ 12.33 hrs, Volume= 0.061 af, Atten= 64%, Lag= 14.6 min
Primary = 0.29 cfs @ 12.33 hrs, Volume= 0.061 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 36.91' @ 12.33 hrs Surf.Area= 926 sf Storage= 463 cf

Plug-Flow detention time= 9.8 min calculated for 0.061 af (100% of inflow)
Center-of-Mass det. time= 9.8 min (813.5 - 803.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	35.79'	1,221 cf	**20.50'W x 45.16'L x 4.50'H Field A** 4,166 cf Overall - 1,114 cf Embedded = 3,052 cf x 40.0% Voids
#2A	36.79'	1,114 cf	**StormTech SC-740** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,335 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Secondary	38.79'	**6.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.79' / 38.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	35.45'	**4.0" Round Culvert** L= 46.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 35.45' / 35.22' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf

Primary OutFlow Max=0.29 cfs @ 12.33 hrs HW=36.91' (Free Discharge)
↑—**2=Culvert** (Barrel Controls 0.29 cfs @ 3.28 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=35.79' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond US1: URC1 - Chamber Wizard Field A

Chamber Model = StormTech SC-740 (StormTech® SC-740)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

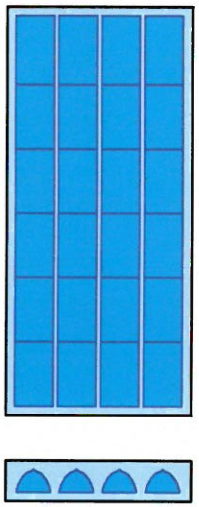
6 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 43.16' Row Length +12.0" End Stone x 2 = 45.16' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

24 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,113.9 cf Chamber Storage

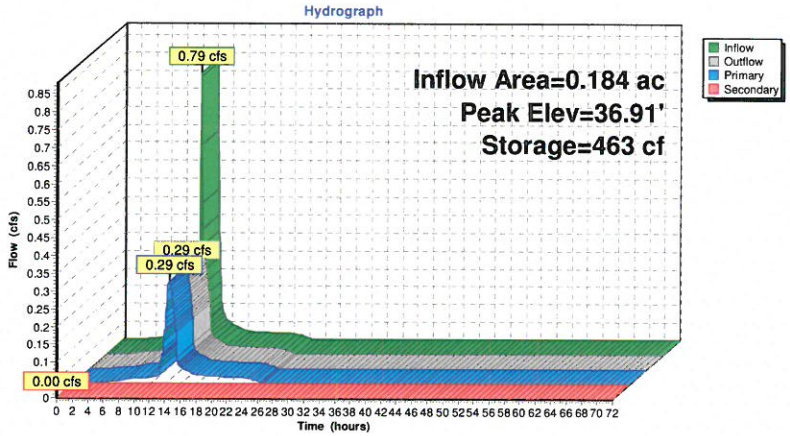
4,165.9 cf Field - 1,113.9 cf Chambers = 3,052.0 cf Stone x 40.0% Voids = 1,220.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,334.7 cf = 0.054 af
Overall Storage Efficiency = 56.0%

24 Chambers
154.3 cy Field
113.0 cy Stone



Pond US1: URC1



Summary for Subcatchment DA1: CB1

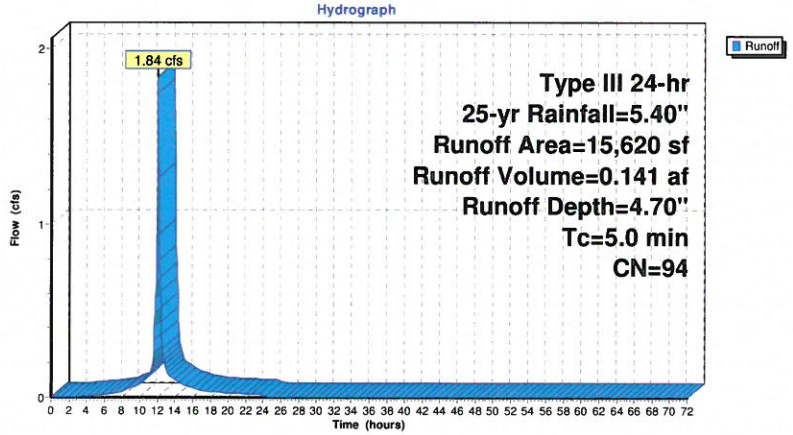
Runoff = 1.84 cfs @ 12.07 hrs, Volume= 0.141 af, Depth= 4.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	12,960	98	Road/Roof, HSG C
	2,660	74	>75% Grass cover, Good, HSG C
	15,620	94	Weighted Average
	2,660		17.03% Pervious Area
	12,960		82.97% Impervious Area

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

Subcatchment DA1: CB1



Summary for Subcatchment DA1A: Parking

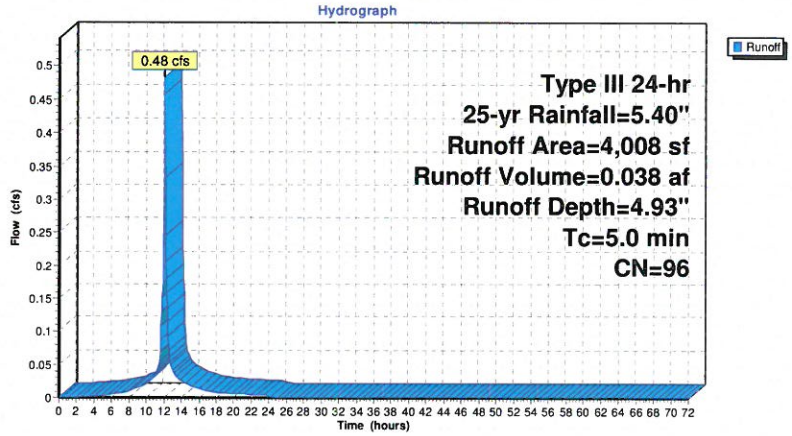
Runoff = 0.48 cfs @ 12.07 hrs, Volume= 0.038 af, Depth= 4.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

Area (sf)	CN	Description
3,500	98	Paved parking, HSG C
152	98	Water Surface, HSG C
356	74	>75% Grass cover, Good, HSG C
4,008	96	Weighted Average
356		8.88% Pervious Area
3,652		91.12% Impervious Area

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

Subcatchment DA1A: Parking



Summary for Subcatchment DA1B: Parking

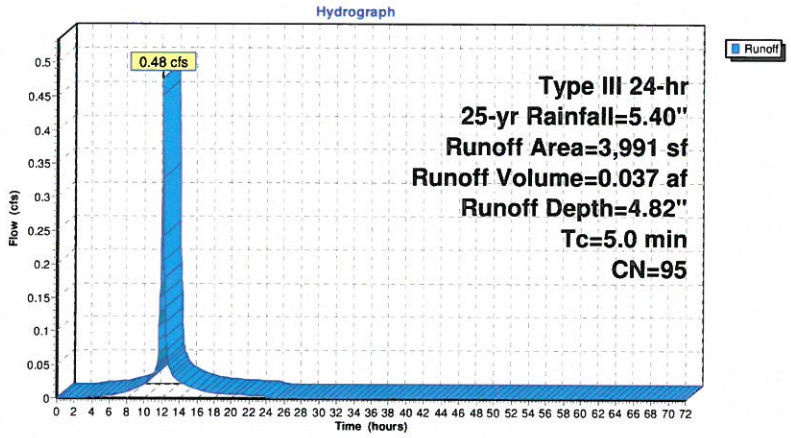
Runoff = 0.48 cfs @ 12.07 hrs, Volume= 0.037 af, Depth= 4.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

Area (sf)	CN	Description
3,300	98	Paved parking, HSG C
114	98	Water Surface, HSG C
577	74	>75% Grass cover, Good, HSG C
3,991	95	Weighted Average
577		14.46% Pervious Area
3,414		85.54% Impervious Area

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

Subcatchment DA1B: Parking



Summary for Subcatchment DA2: CB100

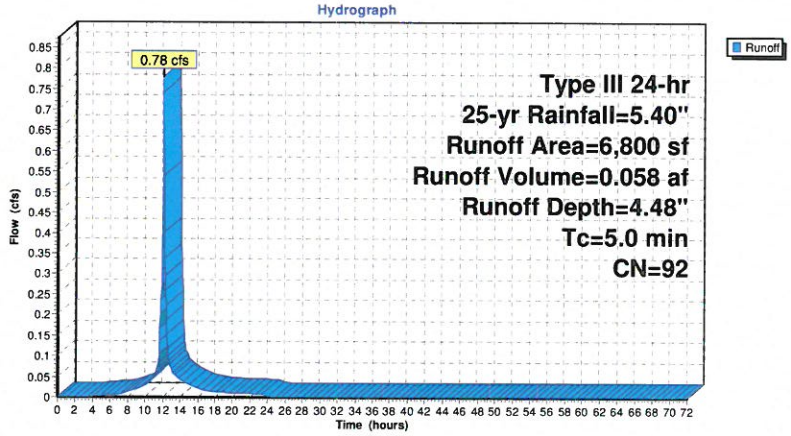
Runoff = 0.78 cfs @ 12.07 hrs, Volume= 0.058 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	5,200	98	Paved slab, HSG C
*	1,600	74	Landscaped planters, Good, HSG C
	6,800	92	Weighted Average
	1,600		23.53% Pervious Area
	5,200		76.47% Impervious Area

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

Subcatchment DA2: CB100



Summary for Subcatchment DA3: CB3

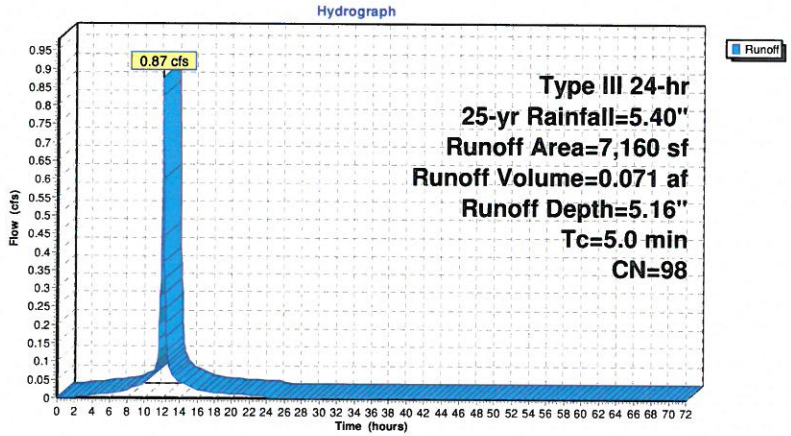
Runoff = 0.87 cfs @ 12.07 hrs, Volume= 0.071 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	7,160	98	Paved slab, HSG C
	7,160		100.00% Impervious Area

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

Subcatchment DA3: CB3



Summary for Subcatchment DA4: CB300

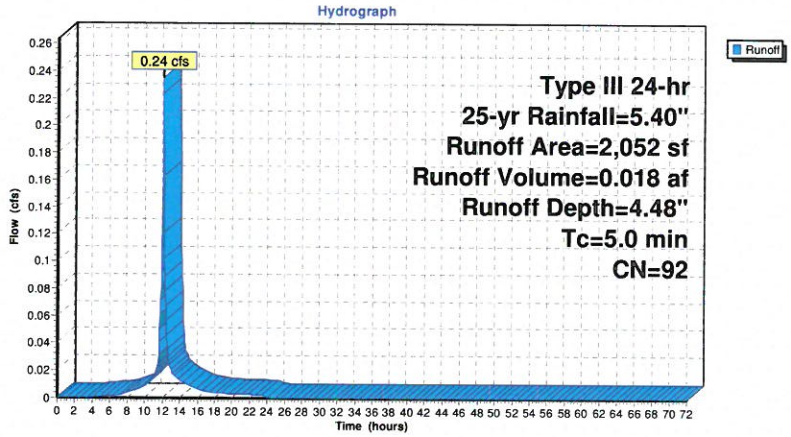
Runoff = 0.24 cfs @ 12.07 hrs, Volume= 0.018 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	1,552	98	Paved slab, HSG C
	500	74	>75% Grass cover, Good, HSG C
	2,052	92	Weighted Average
	500		24.37% Pervious Area
	1,552		75.63% Impervious Area

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

Subcatchment DA4: CB300



Summary for Subcatchment DA5: CB5

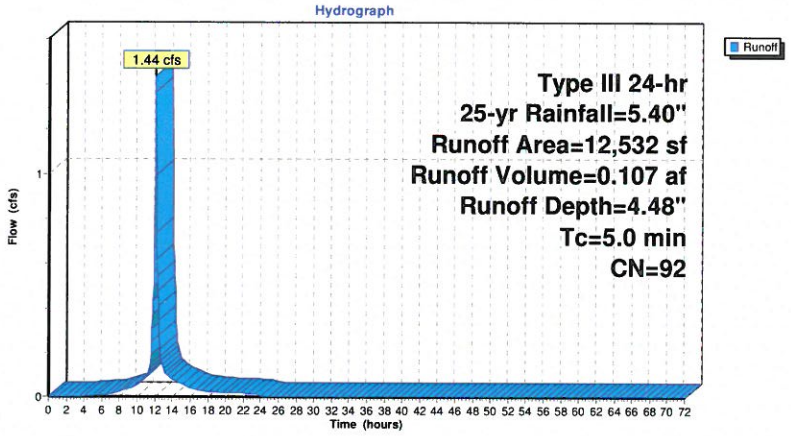
Runoff = 1.44 cfs @ 12.07 hrs, Volume= 0.107 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	9,600	98	Paved parking/Roof, HSG C
	2,032	74	>75% Grass cover, Good, HSG C
	900	72	Woods/grass comb., Good, HSG C
	12,532	92	Weighted Average
	2,932		23.40% Pervious Area
	9,600		76.60% Impervious Area

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

Subcatchment DA5: CB5



Summary for Subcatchment DA6: Clarke St.

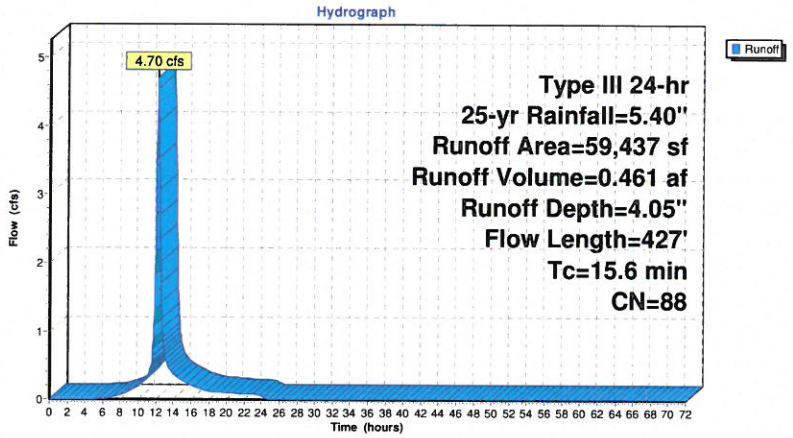
Runoff = 4.70 cfs @ 12.21 hrs, Volume= 0.461 af, Depth= 4.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

Area (sf)	CN	Description
12,879	98	Roofs, HSG C
23,361	98	Paved parking, HSG C
8,237	72	Woods/grass comb., Good, HSG C
14,960	74	>75% Grass cover, Good, HSG C
59,437	88	Weighted Average
23,197		39.03% Pervious Area
36,240		60.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	120	0.0830	2.60		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
3.3	62	0.1100	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
11.1	97	0.0900	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.2	74	0.0900	6.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	74	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.6	427	Total			

Subcatchment DA6: Clarke St.



Summary for Subcatchment DA7: Courtyard

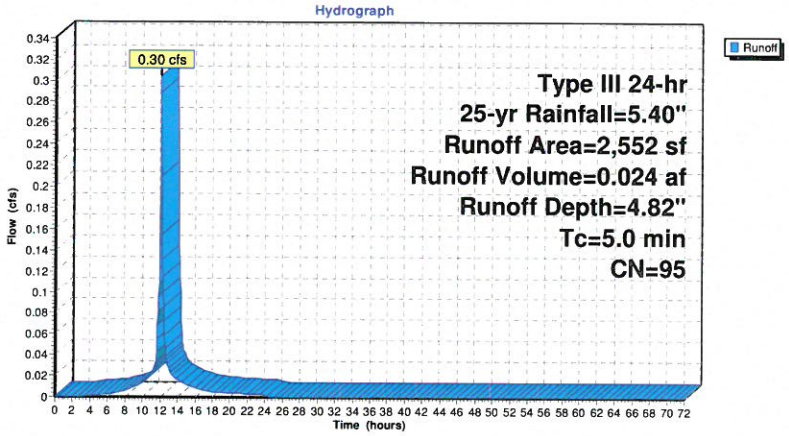
Runoff = 0.30 cfs @ 12.07 hrs, Volume= 0.024 af, Depth= 4.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-yr Rainfall=5.40"

	Area (sf)	CN	Description
*	1,084	98	Paved slab, HSG C
*	1,096	98	Pavers, HSG C
*	372	74	Landscaped planters, Good, HSG C
	2,552	95	Weighted Average
	372		14.58% Pervious Area
	2,180		85.42% Impervious Area

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

Subcatchment DA7: Courtyard



Summary for Pond 1P: DMH

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 4.87" for 25-yr event
Inflow = 0.95 cfs @ 12.08 hrs, Volume= 0.075 af
Outflow = 0.95 cfs @ 12.08 hrs, Volume= 0.075 af, Atten= 0%, Lag= 0.0 min
Primary = 0.95 cfs @ 12.08 hrs, Volume= 0.075 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

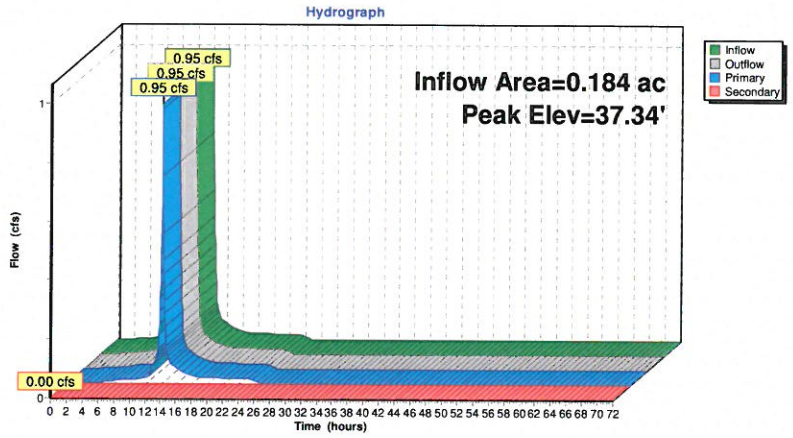
Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 37.34' @ 12.08 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	36.79'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 36.79' / 36.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Device 3	39.29'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	37.00'	**24.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.92 cfs @ 12.08 hrs HW=37.33' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.92 cfs @ 2.04 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=36.79' (Free Discharge)
└**3=Orifice/Grate** (Controls 0.00 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: DMH



Summary for Pond B1: BIO 1

Inflow Area = 0.092 ac, 91.12% Impervious, Inflow Depth = 4.93" for 25-yr event
Inflow = 0.48 cfs @ 12.07 hrs, Volume= 0.038 af
Outflow = 0.48 cfs @ 12.08 hrs, Volume= 0.038 af, Atten= 1%, Lag= 0.6 min
Primary = 0.48 cfs @ 12.08 hrs, Volume= 0.038 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.58' @ 12.08 hrs Surf.Area= 191 sf Storage= 100 cf

Plug-Flow detention time= 36.7 min calculated for 0.038 af (100% of inflow)
Center-of-Mass det. time= 36.6 min (796.3 - 759.7)

Volume	Invert	Avail.Storage	Storage Description
#1	41.00'	125 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

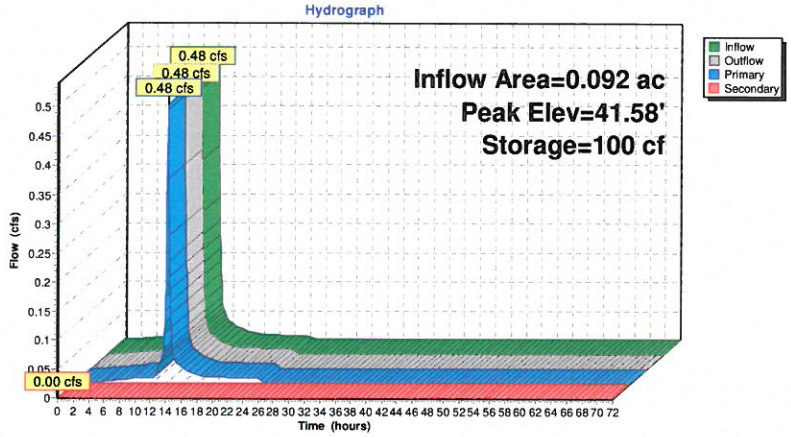
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
41.00	152	0	0
41.71	200	125	125

Device	Routing	Invert	Outlet Devices
#1	Primary	38.00'	**12.0" Round Culvert** L= 16.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.00' / 37.84' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	38.13'	**4.0" Round Culvert** L= 8.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.13' / 38.09' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	41.00'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.70'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.46 cfs @ 12.08 hrs HW=41.58' (Free Discharge)
└**1=Culvert** (Passes 0.46 cfs of 5.24 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.45 cfs @ 0.92 fps)
└**3=Culvert** (Passes 0.01 cfs of 0.60 cfs potential flow)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=41.00' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B1: BIO 1



Summary for Pond B2: BIO 2

Inflow Area =	0.092 ac, 85.54% Impervious, Inflow Depth =	4.82"	for	25-yr event
Inflow =	0.48 cfs @ 12.07 hrs, Volume=	0.037 af		
Outflow =	0.47 cfs @ 12.08 hrs, Volume=	0.037 af,	Atten= 1%,	Lag= 0.8 min
Primary =	0.47 cfs @ 12.08 hrs, Volume=	0.037 af		
Secondary =	0.00 cfs @ 0.00 hrs, Volume=	0.000 af		

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.28' @ 12.08 hrs Surf.Area= 258 sf Storage= 99 cf

Plug-Flow detention time= 33.8 min calculated for 0.037 af (100% of inflow)
Center-of-Mass det. time= 33.8 min (799.2 - 765.3)

Volume	Invert	Avail.Storage	Storage Description
#1	40.70'	135 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

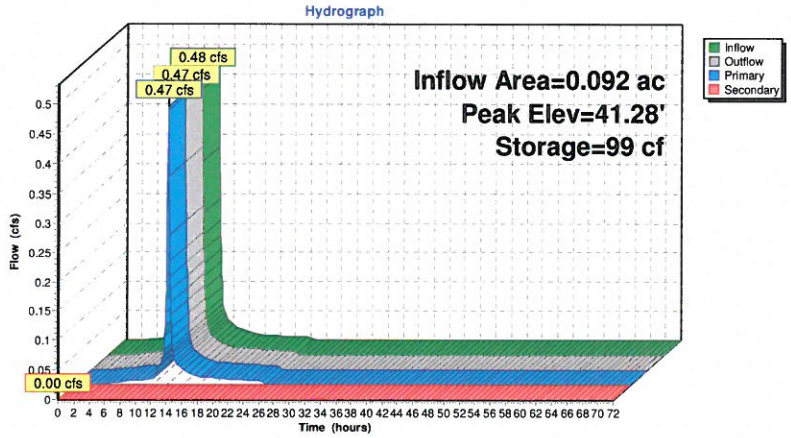
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.70	114	0	0
41.00	157	41	41
41.41	305	95	135

Device	Routing	Invert	Outlet Devices
#1	Primary	37.67'	**12.0" Round Culvert** L= 9.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.67' / 37.63' S= 0.0044 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.20'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	37.83'	**4.0" Round Culvert** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.83' / 37.77' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	40.70'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.40'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.46 cfs @ 12.08 hrs HW=41.28' (Free Discharge)
↑—**1=Culvert** (Passes 0.46 cfs of 5.26 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 0.44 cfs @ 0.91 fps)
↑—**3=Culvert** (Passes 0.01 cfs of 0.60 cfs potential flow)
↑—**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=40.70' (Free Discharge)
↑—**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B2: BIO 2



Summary for Pond MAN1: Manifold

Inflow	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af
Outflow	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af, Atten= 0%, Lag= 0.0 min
Primary	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 37.00' @ 0.00 hrs Surf.Area= 0 sf Storage= 0 cf

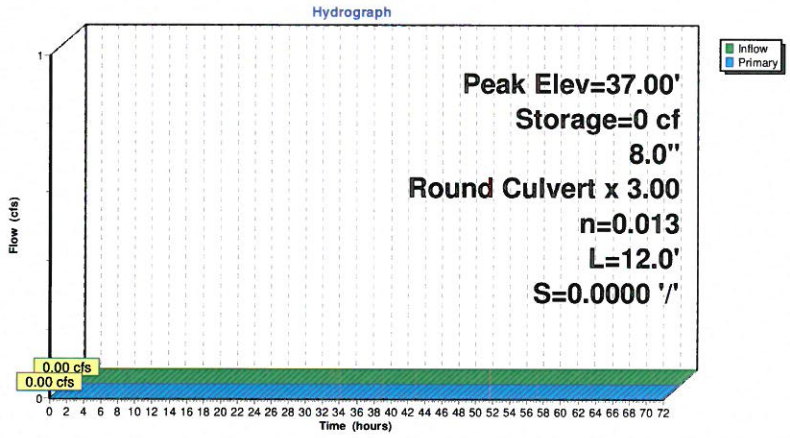
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	38 cf	**24.0" Round Pipe Storage** L= 12.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	38.33'	**8.0" Round Culvert X 3.00** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.33' / 38.33' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=37.00' (Free Discharge)
1=Culvert (Controls 0.00 cfs)

Pond MAN1: Manifold

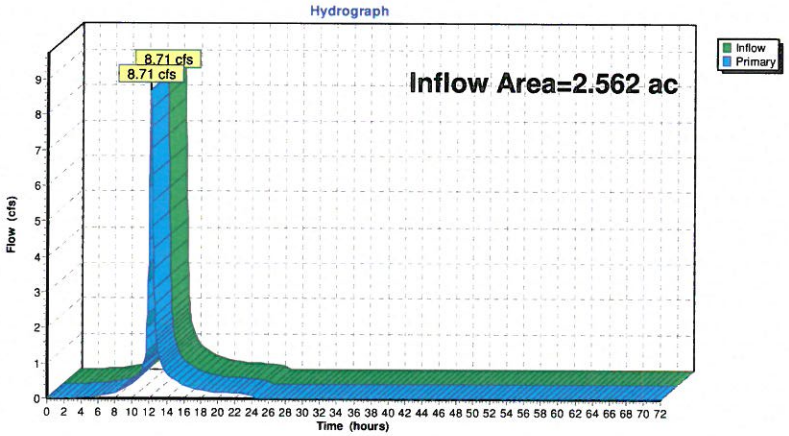


Summary for Pond SP-1: Study Point-1

Inflow Area = 2.562 ac, 71.49% Impervious, Inflow Depth = 4.35" for 25-yr event
Inflow = 8.71 cfs @ 12.10 hrs, Volume= 0.930 af
Primary = 8.71 cfs @ 12.10 hrs, Volume= 0.930 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-1: Study Point-1



Summary for Pond US1: URC1

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 4.87" for 25-yr event
Inflow = 0.95 cfs @ 12.08 hrs, Volume= 0.075 af
Outflow = 0.31 cfs @ 12.37 hrs, Volume= 0.075 af, Atten= 68%, Lag= 17.1 min
Primary = 0.31 cfs @ 12.37 hrs, Volume= 0.075 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 37.14' @ 12.37 hrs Surf.Area= 926 sf Storage= 631 cf

Plug-Flow detention time= 12.3 min calculated for 0.075 af (100% of inflow)
Center-of-Mass det. time= 12.3 min (810.0 - 797.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	35.79'	1,221 cf	**20.50'W x 45.16'L x 4.50'H Field A** 4,166 cf Overall - 1,114 cf Embedded = 3,052 cf x 40.0% Voids
#2A	36.79'	1,114 cf	**StormTech SC-740** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,335 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Secondary	38.79'	**6.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.79' / 38.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	35.45'	**4.0" Round Culvert** L= 46.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 35.45' / 35.22' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf

Primary OutFlow Max=0.31 cfs @ 12.37 hrs HW=37.14' (Free Discharge)
↑—**2=Culvert** (Barrel Controls 0.31 cfs @ 3.54 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=35.79' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond US1: URC1 - Chamber Wizard Field A

Chamber Model = StormTech SC-740 (StormTech® SC-740)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

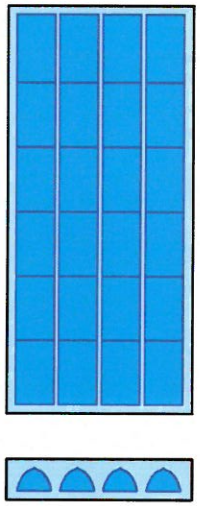
6 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 43.16' Row Length +12.0" End Stone x 2 = 45.16' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

24 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,113.9 cf Chamber Storage

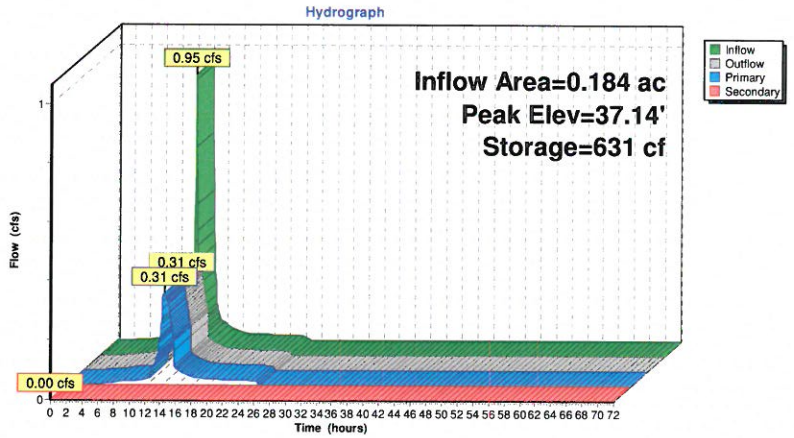
4,165.9 cf Field - 1,113.9 cf Chambers = 3,052.0 cf Stone x 40.0% Voids = 1,220.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,334.7 cf = 0.054 af
Overall Storage Efficiency = 56.0%

24 Chambers
154.3 cy Field
113.0 cy Stone



Pond US1: URC1



Summary for Subcatchment DA1: CB1

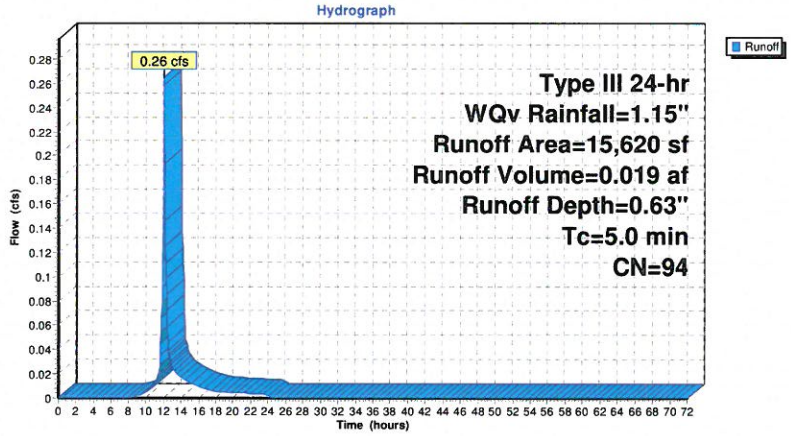
Runoff = 0.26 cfs @ 12.08 hrs, Volume= 0.019 af, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

	Area (sf)	CN	Description
*	12,960	98	Road/Roof, HSG C
	2,660	74	>75% Grass cover, Good, HSG C
	15,620	94	Weighted Average
	2,660		17.03% Pervious Area
	12,960		82.97% Impervious Area

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

Subcatchment DA1: CB1



Summary for Subcatchment DA1A: Parking

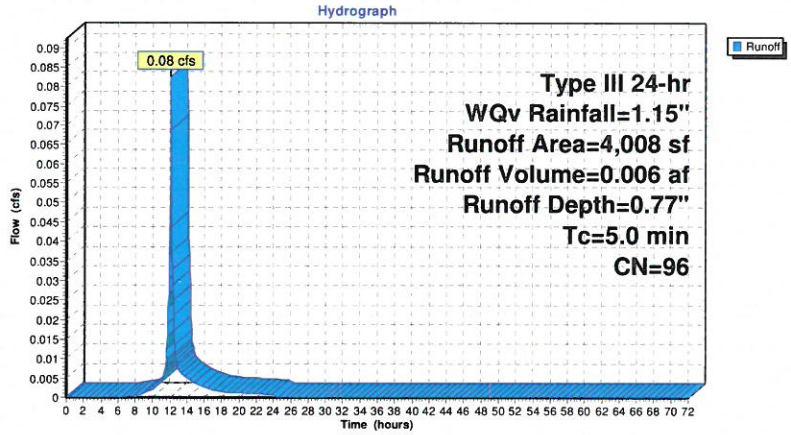
Runoff = 0.08 cfs @ 12.07 hrs, Volume= 0.006 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

Area (sf)	CN	Description
3,500	98	Paved parking, HSG C
152	98	Water Surface, HSG C
356	74	>75% Grass cover, Good, HSG C
4,008	96	Weighted Average
356		8.88% Pervious Area
3,652		91.12% Impervious Area

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

Subcatchment DA1A: Parking



Summary for Subcatchment DA1B: Parking

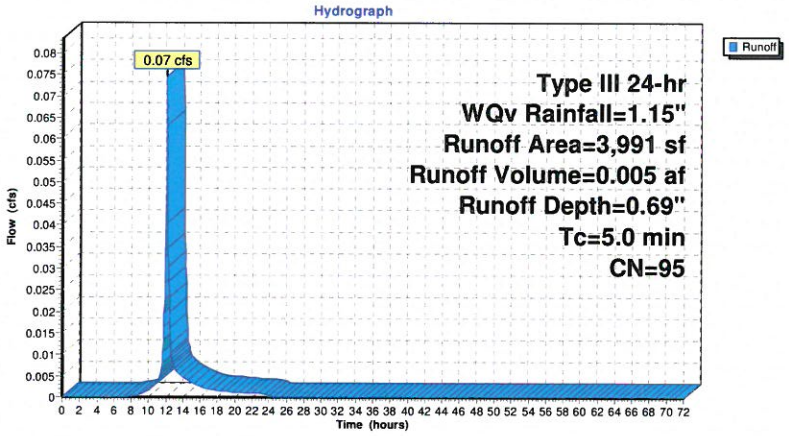
Runoff = 0.07 cfs @ 12.08 hrs, Volume= 0.005 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

Area (sf)	CN	Description
3,300	98	Paved parking, HSG C
114	98	Water Surface, HSG C
577	74	>75% Grass cover, Good, HSG C
3,991	95	Weighted Average
577		14.46% Pervious Area
3,414		85.54% Impervious Area

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

Subcatchment DA1B: Parking



Summary for Subcatchment DA2: CB100

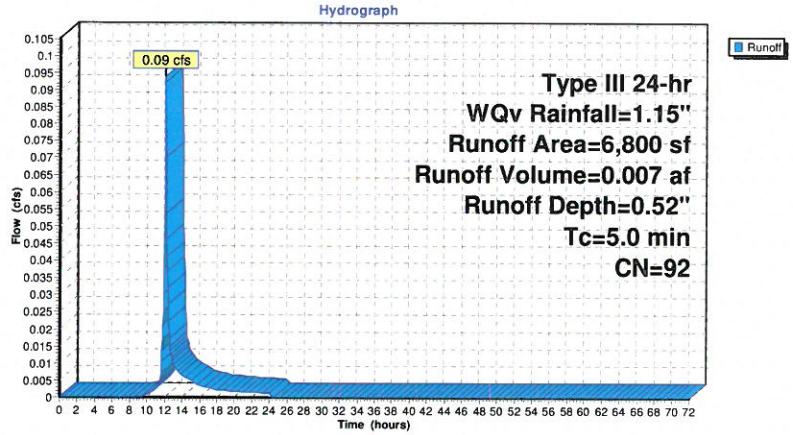
Runoff = 0.09 cfs @ 12.08 hrs, Volume= 0.007 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

	Area (sf)	CN	Description
*	5,200	98	Paved slab, HSG C
*	1,600	74	Landscaped planters, Good, HSG C
	6,800	92	Weighted Average
	1,600		23.53% Pervious Area
	5,200		76.47% Impervious Area

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

Subcatchment DA2: CB100



Summary for Subcatchment DA3: CB3

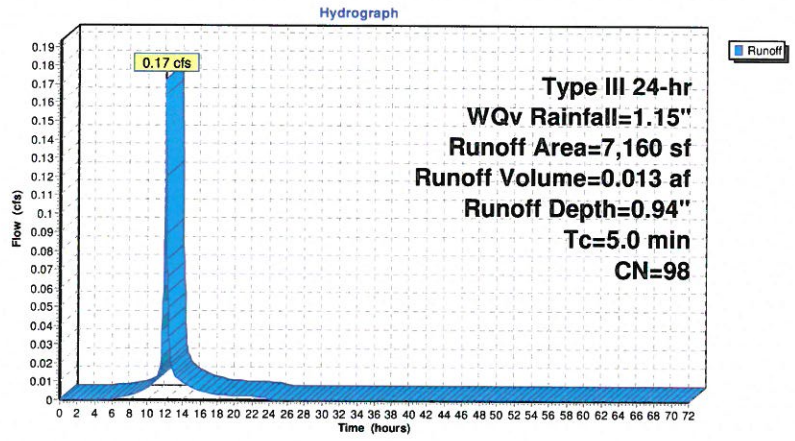
Runoff = 0.17 cfs @ 12.07 hrs, Volume= 0.013 af, Depth= 0.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

	Area (sf)	CN	Description
*	7,160	98	Paved slab, HSG C
	7,160		100.00% Impervious Area

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

Subcatchment DA3: CB3



Summary for Subcatchment DA4: CB300

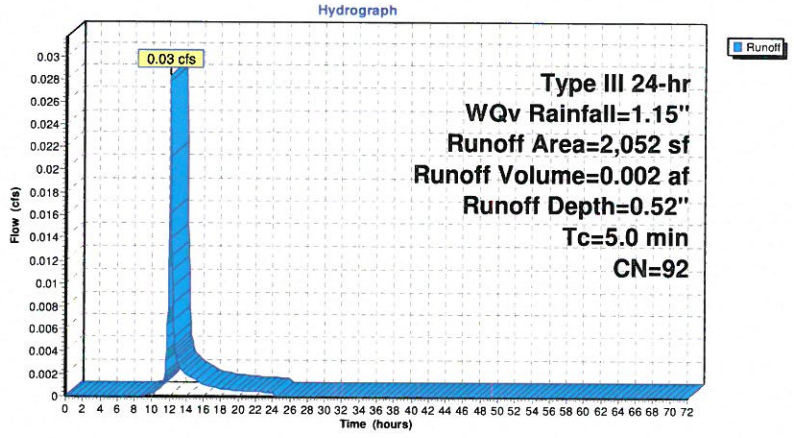
Runoff = 0.03 cfs @ 12.08 hrs, Volume= 0.002 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

	Area (sf)	CN	Description
*	1,552	98	Paved slab, HSG C
	500	74	>75% Grass cover, Good, HSG C
	2,052	92	Weighted Average
	500		24.37% Pervious Area
	1,552		75.63% Impervious Area

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

Subcatchment DA4: CB300



Summary for Subcatchment DA5: CB5

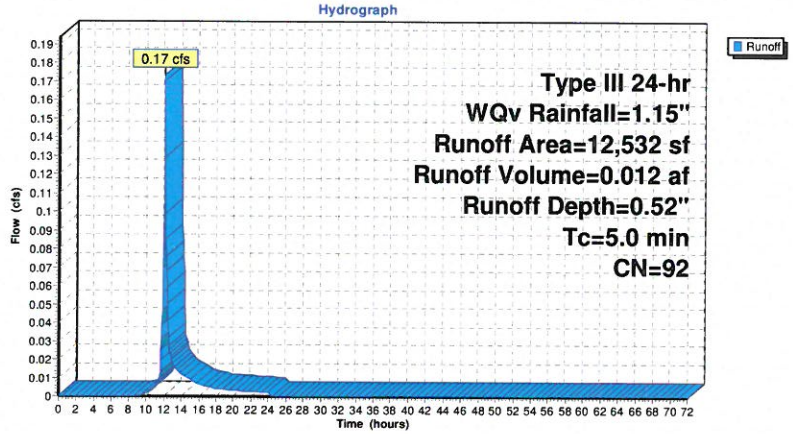
Runoff = 0.17 cfs @ 12.08 hrs, Volume= 0.012 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

	Area (sf)	CN	Description
*	9,600	98	Paved parking/Roof, HSG C
	2,032	74	>75% Grass cover, Good, HSG C
	900	72	Woods/grass comb., Good, HSG C
	12,532	92	Weighted Average
	2,932		23.40% Pervious Area
	9,600		76.60% Impervious Area

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

Subcatchment DA5: CB5



Summary for Subcatchment DA6: Clarke St.

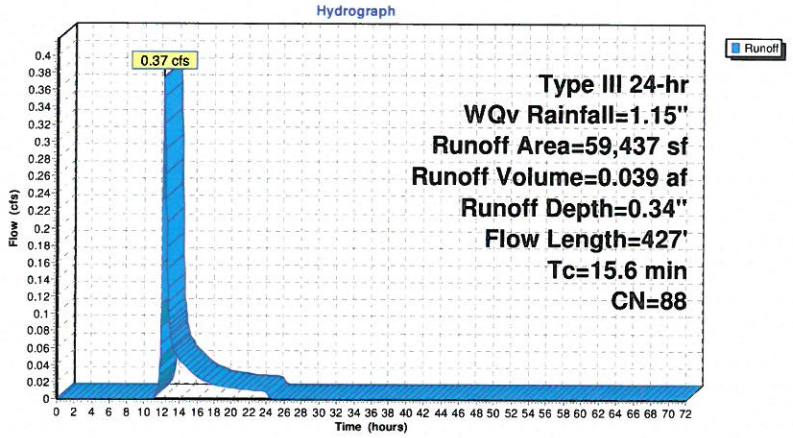
Runoff = 0.37 cfs @ 12.24 hrs, Volume= 0.039 af, Depth= 0.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

Area (sf)	CN	Description
12,879	98	Roofs, HSG C
23,361	98	Paved parking, HSG C
8,237	72	Woods/grass comb., Good, HSG C
14,960	74	>75% Grass cover, Good, HSG C
59,437	88	Weighted Average
23,197		39.03% Pervious Area
36,240		60.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	120	0.0830	2.60		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
3.3	62	0.1100	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
11.1	97	0.0900	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.2	74	0.0900	6.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	74	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.6	427	Total			

Subcatchment DA6: Clarke St.



Summary for Subcatchment DA7: Courtyard

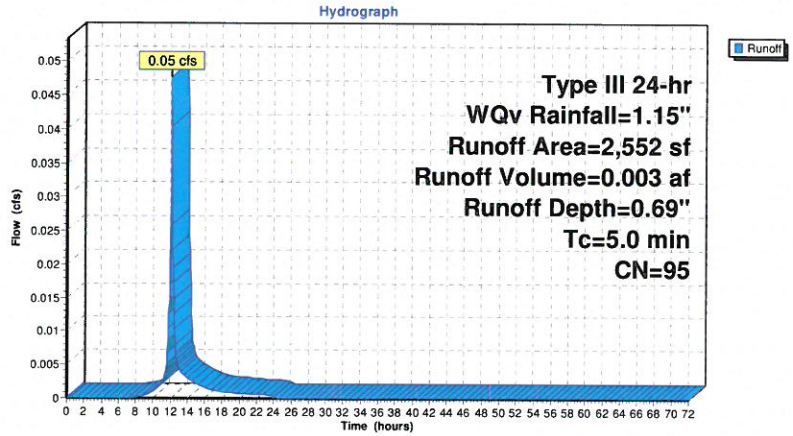
Runoff = 0.05 cfs @ 12.08 hrs, Volume= 0.003 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.15"

	Area (sf)	CN	Description
*	1,084	98	Paved slab, HSG C
*	1,096	98	Pavers, HSG C
*	372	74	Landscaped planters, Good, HSG C
	2,552	95	Weighted Average
	372		14.58% Pervious Area
	2,180		85.42% Impervious Area

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

Subcatchment DA7: Courtyard



Summary for Pond 1P: DMH

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 0.73" for WQv event
Inflow = 0.03 cfs @ 12.52 hrs, Volume= 0.011 af
Outflow = 0.03 cfs @ 12.52 hrs, Volume= 0.011 af, Atten= 0%, Lag= 0.0 min
Primary = 0.03 cfs @ 12.52 hrs, Volume= 0.011 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

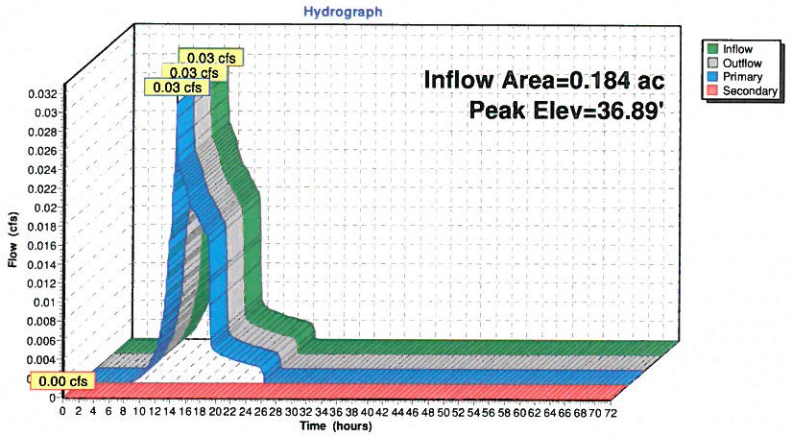
Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 36.89' @ 12.52 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	36.79'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 36.79' / 36.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Device 3	39.29'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	37.00'	**24.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.03 cfs @ 12.52 hrs HW=36.89' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.03 cfs @ 0.72 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=36.79' (Free Discharge)
└**3=Orifice/Grate** (Controls 0.00 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: DMH



Summary for Pond B1: BIO 1

Inflow Area = 0.092 ac, 91.12% Impervious, Inflow Depth = 0.77" for WQv event
Inflow = 0.08 cfs @ 12.07 hrs, Volume= 0.006 af
Outflow = 0.02 cfs @ 12.52 hrs, Volume= 0.006 af, Atten= 79%, Lag= 26.5 min
Primary = 0.02 cfs @ 12.52 hrs, Volume= 0.006 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.50' @ 12.52 hrs Surf.Area= 186 sf Storage= 85 cf

Plug-Flow detention time= 61.8 min calculated for 0.006 af (100% of inflow)
Center-of-Mass det. time= 61.7 min (869.3 - 807.6)

Volume	Invert	Avail.Storage	Storage Description
#1	41.00'	125 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

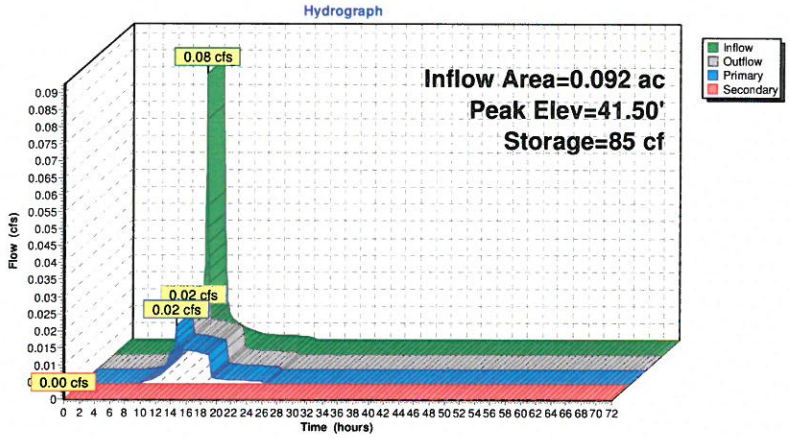
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
41.00	152	0	0
41.71	200	125	125

Device	Routing	Invert	Outlet Devices
#1	Primary	38.00'	**12.0" Round Culvert** L= 16.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.00' / 37.84' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	38.13'	**4.0" Round Culvert** L= 8.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.13' / 38.09' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	41.00'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.70'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.02 cfs @ 12.52 hrs HW=41.50' (Free Discharge)
└**1=Culvert** (Passes 0.02 cfs of 5.17 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.01 cfs @ 0.21 fps)
└**3=Culvert** (Passes 0.01 cfs of 0.59 cfs potential flow)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=41.00' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B1: BIO 1



Summary for Pond B2: BIO 2

Inflow Area = 0.092 ac, 85.54% Impervious, Inflow Depth = 0.69" for WQv event
Inflow = 0.07 cfs @ 12.08 hrs, Volume= 0.005 af
Outflow = 0.01 cfs @ 12.56 hrs, Volume= 0.005 af, Atten= 83%, Lag= 29.0 min
Primary = 0.01 cfs @ 12.56 hrs, Volume= 0.005 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 41.19' @ 12.56 hrs Surf.Area= 224 sf Storage= 76 cf

Plug-Flow detention time= 53.5 min calculated for 0.005 af (100% of inflow)
Center-of-Mass det. time= 53.5 min (870.6 - 817.1)

Volume	Invert	Avail.Storage	Storage Description
#1	40.70'	135 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

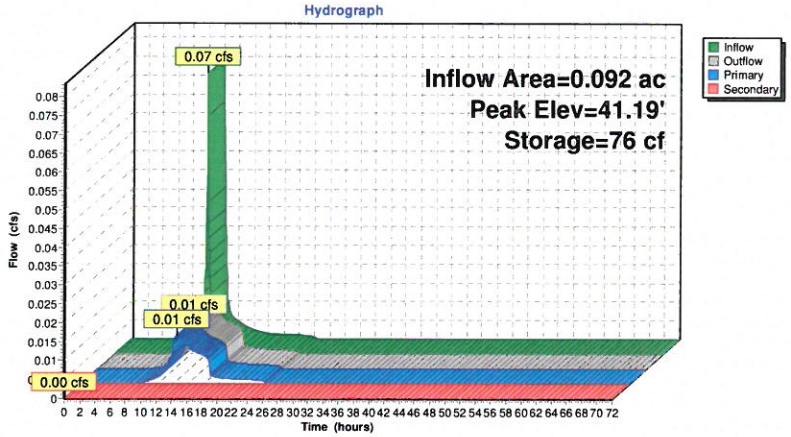
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.70	114	0	0
41.00	157	41	41
41.41	305	95	135

Device	Routing	Invert	Outlet Devices
#1	Primary	37.67'	**12.0" Round Culvert** L= 9.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.67' / 37.63' S= 0.0044 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.20'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	37.83'	**4.0" Round Culvert** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 37.83' / 37.77' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf
#4	Device 3	40.70'	**2.410 in/hr Exfiltration over Surface area**
#5	Secondary	41.40'	**2.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.01 cfs @ 12.56 hrs HW=41.19' (Free Discharge)
↑**1=Culvert** (Passes 0.01 cfs of 5.18 cfs potential flow)
↑**2=Orifice/Grate** (Controls 0.00 cfs)
↑**3=Culvert** (Passes 0.01 cfs of 0.59 cfs potential flow)
↑**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=40.70' (Free Discharge)
↑**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond B2: BIO 2



Summary for Pond MAN1: Manifold

Inflow	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af
Outflow	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af, Atten= 0%, Lag= 0.0 min
Primary	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 37.00' @ 0.00 hrs Surf.Area= 0 sf Storage= 0 cf

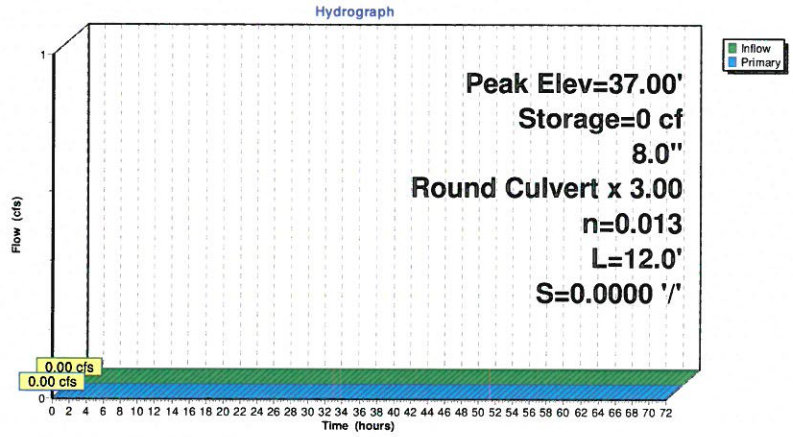
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	38 cf	**24.0" Round Pipe Storage** L= 12.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	38.33'	**8.0" Round Culvert X 3.00** L= 12.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.33' / 38.33' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=37.00' (Free Discharge)
1=Culvert (Controls 0.00 cfs)

Pond MAN1: Manifold

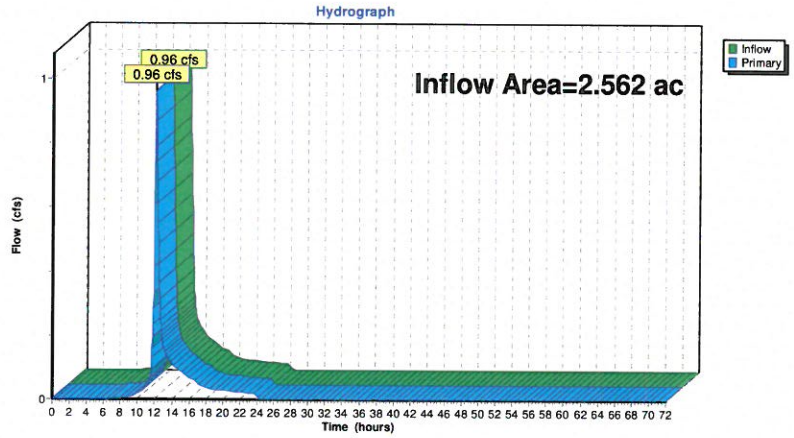


Summary for Pond SP-1: Study Point-1

Inflow Area = 2.562 ac, 71.49% Impervious, Inflow Depth = 0.48" for WQv event
Inflow = 0.96 cfs @ 12.10 hrs, Volume= 0.103 af
Primary = 0.96 cfs @ 12.10 hrs, Volume= 0.103 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond SP-1: Study Point-1



Summary for Pond US1: URC1

Inflow Area = 0.184 ac, 88.34% Impervious, Inflow Depth = 0.73" for WQv event
Inflow = 0.03 cfs @ 12.52 hrs, Volume= 0.011 af
Outflow = 0.03 cfs @ 12.56 hrs, Volume= 0.011 af, Atten= 5%, Lag= 2.5 min
Primary = 0.03 cfs @ 12.56 hrs, Volume= 0.011 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 35.80' @ 12.56 hrs Surf.Area= 926 sf Storage= 3 cf

Plug-Flow detention time= 2.0 min calculated for 0.011 af (100% of inflow)
Center-of-Mass det. time= 2.0 min (871.9 - 869.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	35.79'	1,221 cf	**20.50'W x 45.16'L x 4.50'H Field A** 4,166 cf Overall - 1,114 cf Embedded = 3,052 cf x 40.0% Voids
#2A	36.79'	1,114 cf	**StormTech SC-740** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,335 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Secondary	38.79'	**6.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 38.79' / 38.79' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	35.45'	**4.0" Round Culvert** L= 46.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 35.45' / 35.22' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf

Primary OutFlow Max=0.13 cfs @ 12.56 hrs HW=35.80' (Free Discharge)
↑—**2=Culvert** (Barrel Controls 0.13 cfs @ 1.74 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=35.79' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond US1: URC1 - Chamber Wizard Field A

Chamber Model = StormTech SC-740 (StormTech® SC-740)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

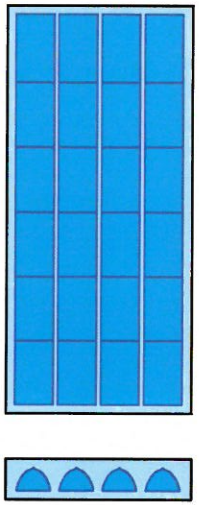
6 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 43.16' Row Length +12.0" End Stone x 2 = 45.16' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

24 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,113.9 cf Chamber Storage

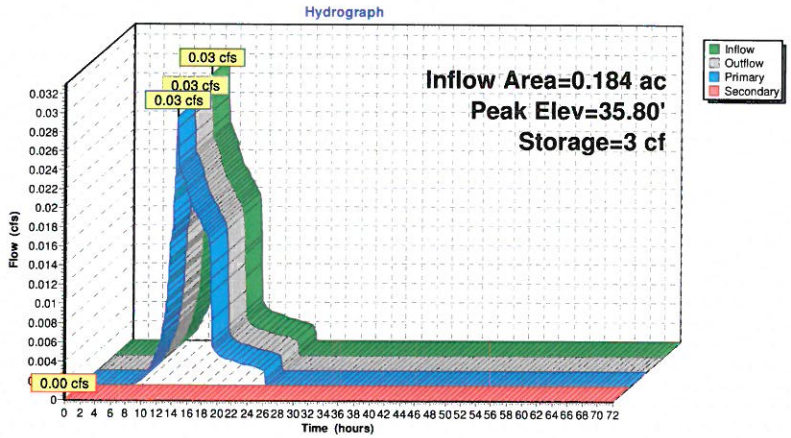
4,165.9 cf Field - 1,113.9 cf Chambers = 3,052.0 cf Stone x 40.0% Voids = 1,220.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,334.7 cf = 0.054 af
Overall Storage Efficiency = 56.0%

24 Chambers
154.3 cy Field
113.0 cy Stone



Pond US1: URC1



Appendix G

U.S. Rainfall Frequency Atlas

F-1. Rainfall Data for Massachusetts from *Rainfall Frequency Atlas of the United States* (TP-40)

- Users of this Handbook should note that current MA DEP written guidance (see DEP Waterlines newsletter -- Fall 2000) requires the use of TP-40 Rainfall Data for calculations under the Wetlands Protection Regulations and the Stormwater Management Policy. More stringent design storms may be used under a local bylaw or ordinance. However, DEP will continue to require the use of TP-40 in any case it reviews under the Wetlands Protection Act and Stormwater Management Policy.

Adjusted Technical Paper 40 Design Storms for 24-hour Event by County

County Name	1-yr 24-hr	2-yr 24-hr	5-yr 24-hr	10-yr 24-hr	25-yr 24-hr	50-yr 24-hr	100-yr 24-hr
Barnstable	2.5	3.6	4.5	4.8	5.7	6.4	7.1
Berkshire	2.5	2.9	3.8	4.4	5.1	5.9	6.4
Bristol	2.5	3.4	4.3	4.8	5.6	6.3	7.0
Dukes	2.5	3.6	4.6	4.9	5.8	6.5	7.2
Essex	2.5	3.1	3.9	4.5	5.4	5.9	6.5
Franklin	2.5	2.9	3.8	4.3	5.1	5.8	6.2
Hampden	2.5	3.0	4.0	4.6	5.3	6.0	6.5
Hampshire	2.5	3.0	3.9	4.5	5.2	5.9	6.4
Middlesex	2.5	3.1	4.0	4.5	5.3	5.9	6.5
Nantucket	2.5	3.6	4.6	4.9	5.8	6.5	7.2
Norfolk	2.5	3.2	4.1	4.7	5.5	6.1	6.7
Plymouth	2.5	3.4	4.3	4.7	5.6	6.2	7.0
Suffolk	2.5	3.2	4.0	4.6	5.5	6.0	6.6
Worcester	2.5	3.0	4.0	4.5	5.3	5.9	6.5

Appendix H

Pipe Sizing Calculations

4/27/2016
PROJECT # 15123

77 ELM STREET

PIPE SIZING CALCULATIONS

Horsley Witten Group
Sustainable Environmental Solutions

Storm Event 25-yr

From	To		A_I (sf) Imperv.	Al (ac) Imperv.	A_p (sf) Perv.	A_p (ac) Perv.	Atotal (acres)	C_I	C_p	C_w weighted	Tc (min)	i (iph)	Q_{actual} (cfs)	L (ft)	Pipe Dia. (in.)	n	U/S Invert (ft)	D/S Invert (ft)	Pipe Slope (ft/ft)	R (hyrdraulic Radius)	$V_{capacity}$ (fps)	$Q_{capacity}$ (cfs)	Q_{actual} from Chamber Outlet	Notes
PIPE RUN 1 - Fruit Place and "Fruit Place Extension"																								
CB1		15620	12960	0.2975	2660.00	0.0611	0.3586	0.90	0.20	0.78	5.00	6.10	1.71											
	DMH 101													80.00	12	0.0130	46.19	33.77	0.1553	0.2500	17.87	14.03		
DMH 101		0	0	0.0000	0.00	0.0000	0.3586	0.90	0.20	0.78	5.04	6.10	2.01										0.3	Discharge from chmabers
	CB2/DMH													46.00	12	0.0130	33.60	24.94	0.1883	0.2500	19.67	15.45		
CB 100		6800	5200	0.1194	1600.00	0.0367	0.5147	0.90	0.20	0.77	5.05	6.10	2.71											
	CB2/DMH													8.00	12	0.0130	24.78	24.70	0.0100	0.2500	4.53	3.56		
CB2/DMH		0	0	0.0000	0.00	0.0000	0.5147	0.90	0.20	0.77	5.11	6.10	2.71											
	CB 3													19.00	12	0.0130	24.11	23.85	0.0137	0.2500	5.30	4.17		
CB 3		7160	7160	0.1644	0.00	0.0000	0.6791	0.90	0.20	0.80	5.22	6.10	3.61											
	CB 300													33.00	12	0.0130	23.77	21.79	0.0600	0.2500	11.11	8.72		
CB 300		2052	1552	0.0356	500.00	0.0115	0.7262	0.90	0.20	0.79	5.37	6.10	3.82											
	CB 5													105.00	12	0.0130	21.79	15.55	0.0594	0.2500	11.05	8.68		
CB5		12532	9600	0.2204	2932.00	0.0673	1.0139	0.90	0.20	0.78	5.37	6.10	5.11											
	TOTALS	44164	23512																					
		1.0137961																						

Appendix I

TSS Removal Worksheet

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

Version 1, Automated: Mar. 4, 2008

Location: Subcatchment DA-1A

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Sediment Forebay	0.25	1.00	0.25	0.75
Bioretention Area	0.90	0.75	0.68	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

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

Project: Mill 77
Prepared By: BRK
Date: 11/10/2015

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

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