

DECOULOS & COMPANY

ENVIRONMENTAL ENGINEERING & LAND PLANNING

VIA EMAIL

Monday, January 10, 2022

Mr. Daniel J. Pasquarello, Acting Chairman
Wenham Planning Board
138 Main Street
Wenham, MA 01984

RE: 60 Arbor Street, Wenham;
Wenham Assessor Map 13, Parcels 84 and 84A

Dear Chairman Pasquarello and members of the Board:

On behalf of Susan M. Hamilton and Jeffrey R. Hamilton, Decoulos & Company, LLC is pleased to submit this revised Stormwater Management Report for the subdivision of the above referenced property. The supporting documentation and calculations follow the requirements of Sections 3.3.3.18.1 and 4.7.7.1 of the Rules and Regulations Governing the Subdivision of Land, Wenham, Massachusetts, dated 1984.

The revisions address changes to the proposed design of the subdivision and full compliance with the Rules and Regulations. The stormwater modeling has been changed from the NRCS TR-20 methodology to the Rational Method, as the Rules and Regulations require. Both modeling methods show sufficient capacity for the proposed stormwater management system.

Please feel free to contact us if you have any questions or concerns. Thank you.

Very truly yours,



James J. Decoulos, PE, LSP
jamesj@decoulos.com

cc: Donald R. Pinto, Jr., Esq., Pierce
Susan M. Hamilton and Jeffrey R. Hamilton

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1.0 PURPOSE AND SCOPE

This Stormwater Management Report has been prepared for property located at 60 Arbor Street in the town of Wenham (the “Town”) and is described by the Wenham Assessors on Map 13 as Parcels 84 and 84A. It is further described as two parcels in a deed recorded at the Essex South Registry of Deeds in Book 31953, Page 274; and, as Lot 3 on Land Court Plan 20396C (the “Site”). Lot 3 was formerly part of a larger parcel that Susan purchased from Kimberly Ross Smith as described in Land Court Document No. 340808. The purpose of the Report is to demonstrate that the proposed development of the Site will mitigate peak runoff rates.

The subdivision of the Site is shown on a ten-sheet set of plans entitled “Definitive Subdivision at 60 Arbor Street; Property of Susan M. Hamilton and Jeffrey R. Hamilton, Wenham, Massachusetts; dated January 5, 2022; prepared by Decoulos & Company, LLC” (the “Subdivision Plans”).

The design of stormwater management controls for the subdivision requires compliance with the Massachusetts Wetlands Protection Act, General Laws Chapter 131, Section 40 and the associated regulations generated by the Massachusetts Department of Environmental Protection (“DEP”) at 310 CMR 10.00; the Massachusetts Stormwater Handbook issued from DEP; the Rules and Regulations Governing the Subdivision of Land dated 1984 (the “Planning Board Rules”); and, the Wenham Planning Board Administrative Rules and Regulations, as amended June 6, 2019 (the “Administrative Rules”).

The activities undertaken to prepare the Report included researching the Site history; reviewing reports from the U.S. Geological Survey (USGS), the Natural Resources Conservation Service (NRCS) and DEP; historic permitting and construction files from the Town’s records; a test pit investigation and reviewing environmentally sensitive areas on the Site and surrounding properties; total station and dual-frequency geographic position system (GPS) surveys; a review of the Town’s compliance under the Municipal Separate Storm Sewer System (MS4) general permit issued by the U.S. Environmental Protection Agency and how the Site interacts within the existing MS4 system; and, the analysis of existing and post-development conditions using the computer modeling program HydroCAD™.

The summary of existing and post-development stormwater flows are as follows:

SUMMARY OF EXISTING AND PROPOSED PEAK STORMWATER FLOWS

Table 1
(units in cubic feet per second)

	10 year		50 year	
	Existing	Post-Dev	Existing	Post-Dev
Total Discharge	3.80	3.39	5.18	4.63

2.0 STORMWATER MANAGEMENT DESIGN AND OBJECTIVES

2.1 Existing Stormwater Controls

The existing Site contains approximately 136,677 square feet or 3.14 acres of land which is improved by a single-family house with an attached garage. Vehicular access to the house and garage occurs through a bituminous asphalt driveway that contains two access points onto Arbor Street as shown on Sheet C1 of the Subdivision Plans.

The horizontal Site coordinates are 4,719,465 meters north and 345,182 meters east in Zone 19 (NAD 83) of the Universal Transverse Mercator (UTM) system; latitude north is 42 degrees 36 minutes 43 seconds and longitude west is 70 degrees 53 minutes 16 seconds.

The underlying surficial soils are highly permeable and accept a significant portion of existing stormwater runoff. Soil logs for two test pits are provided in Appendix A. Additionally, a site specific soil report was generated for the Site from the Natural Resources Conservation Service (NRCS) web site and is provided in Appendix A of the Environmental Assessment.

Stormwater that does not immediately infiltrate into the pervious landscaped areas surrounding the house and driveway overflows onto Arbor Street. Arbor Street is a public way owned by the Town with a paved width of approximately 24 feet. There is no curbing along Arbor Street.

Stormwater flows along Arbor Street run to the south, to the intersection with Juniper Street. At the intersection, two catch basins collect localized runoff from surrounding residences, driveways and the paved surfaces of Arbor and Juniper Streets.

The Wenham Department of Public Works (DPW) is responsible for cleaning and maintaining the two catch basins at Arbor and Juniper Streets. The basins are part of the Municipal Separate Storm Sewer System (MS4) maintained by DPW. The most recent annual report to EPA dated September 19, 2019 is posted at

<https://www3.epa.gov/region1/npdes/stormwater/ma/reports/2019/wenham-ma-ar19.pdf>

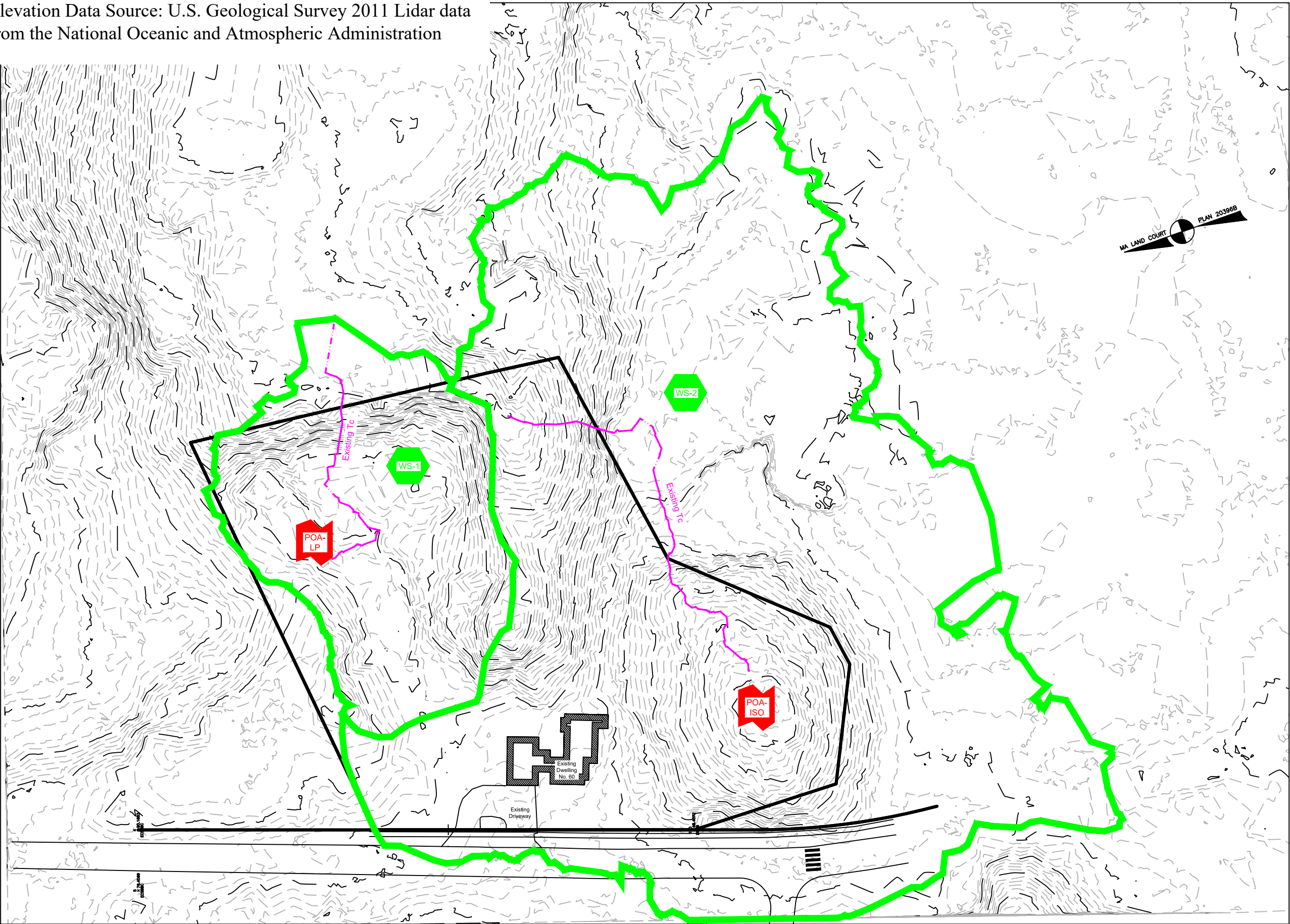
The basins and their outlet are shown on the Stormwater System Map layer of the Town's Geographic Information System (GIS). See <https://www.axisgis.com/WenhamMa/> During a detailed survey and evaluation of the localized catchment at Arbor and Juniper Streets on June 25, 2020, an additional inlet from Juniper Street was found discharging into the easterly catch basin on Arbor Street. The detailed observations, piping and elevations are presented on Sheet C1 of the Subdivision Plans.

Photographs of existing conditions and the interior of the stormwater structures are posted on a Google Photo album at <https://photos.app.goo.gl/7S1uJes2Dki6caVV6>

The outfall from the easterly catch basin on Arbor Street discharges onto the property of Marc Liphardt of 58 Arbor Street (Assessor Map 13, Parcel 142) and flows steeply onto the Site before discharging into an isolated wetlands on Site as shown on Sheet C1 of the Subdivision Drawings. A heavily eroded stormwater channel has formed on the Site before discharging into the wetland resource. There is no record of any stormwater easement that the Town holds to permit flows onto the properties of Mr. Liphardt or the Hamiltons.

The two existing watersheds that discharge into the subsurface on Site are shown on attached Figure 1 and the hydrologic analysis of surface flows is provided in Appendix B.

Elevation Data Source: U.S. Geological Survey 2011 Lidar data
from the National Oceanic and Atmospheric Administration



EXISTING WATERSHED PLAN
60 ARBOR STREET
WENHAM, MASSACHUSETTS

DECOULOS & COMPANY LLC

185 ALEWIFE BROOK PARKWAY
CAMBRIDGE, MA 02138
DECOULOS.COM
617.489.7795

DATE
9-3-20

SCALE
1"=60'

DRWN TCG

DES TCG

CHKD JDD

APRVD JDD

FIGURE

1

2.2 Proposed Stormwater Controls

The proposed project involves the construction of a new 100 foot diameter paved cul-de-sac with a 20 foot paved surface leading to a 12 foot paved driveway that will service a new four-bedroom single family house as shown on the Subdivision Plans.

The purpose of the stormwater management system is to reduce runoff rates and volumes leaving the Site for all design storms and to promote groundwater recharge from the new bituminous asphalt way. The revised design uses deep sump catch basins and stormwater infiltration chambers as shown on Sheet C4 of the Subdivision Plans.

The stormwater system shall collect stormwater runoff from three catch basins as shown on Sheet C4 and discharge runoff into a subsurface stormwater chamber system. Details of the stormwater controls are provided on Sheet C8.

Due to the excellent permeability of the underlying soils, subsurface infiltration of all design years is expected to dissipate underground. The stormwater model for the proposed project has been designed with a hydrologic analysis using the Rational Method in the commercial program HydroCAD™.

The four watersheds that will be formed from the proposed project are shown on attached Figure 2 and the proposed hydrologic analysis is provided in Appendix C.

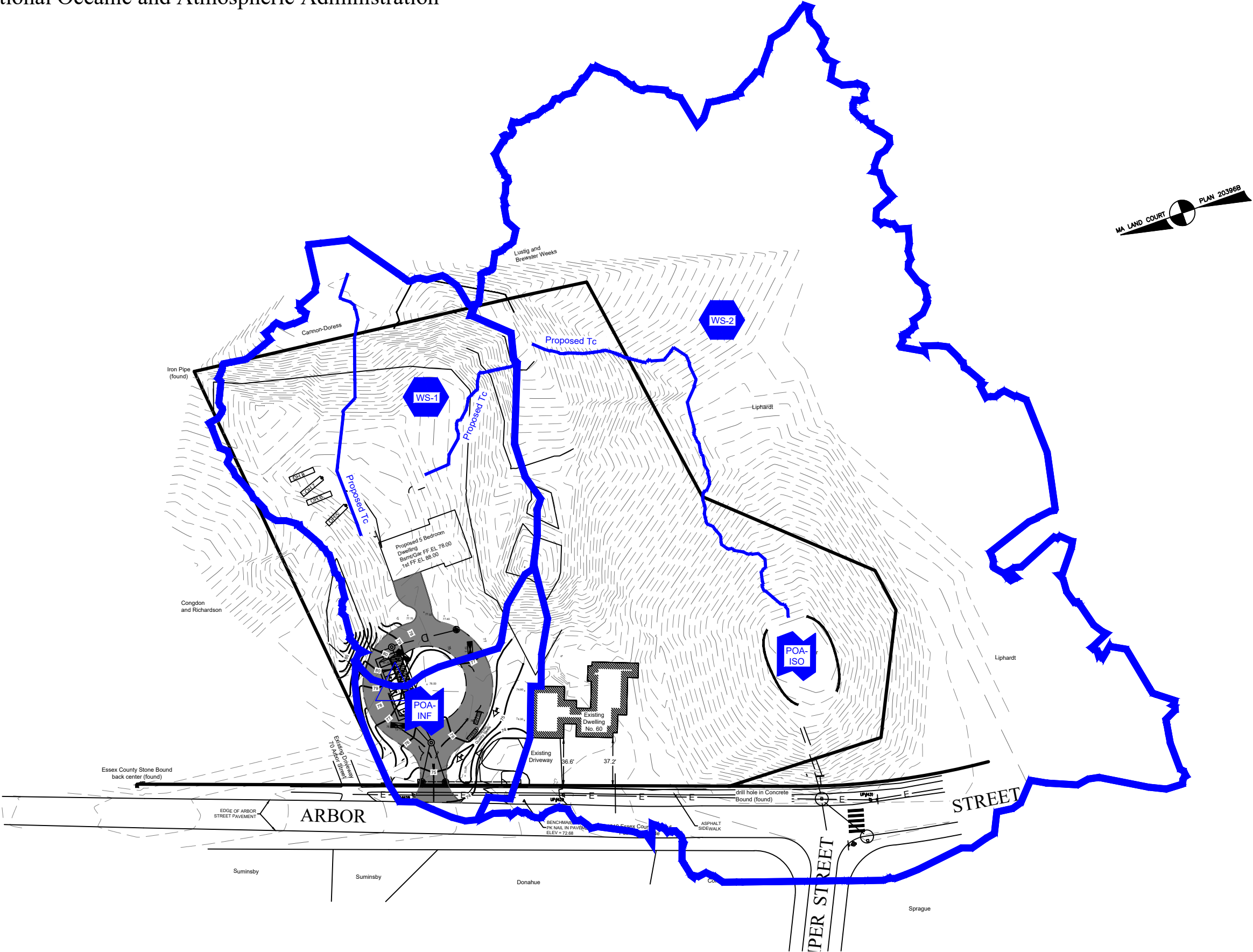
3.0 OPERATION AND MAINTENANCE

3.1 Maintenance Requirements

The stormwater management and treatment system is designed to collect and treat stormwater so that all discharges from the system are in compliance with laws and regulations adopted by the Wenham Planning Board, the Wenham Conservation Commission and DEP. Periodic routine inspection and maintenance of the stormwater treatment system is critical to the continuing performance standards mandated by these agencies.

The owner shall be responsible for all maintenance and repair activities at the Site relating to roof runoff, maintenance of the paved road, minimizing and eliminating debris and organic matter that will collect in the gutters and drains, and, ensuring that the deep sumps of the catch basins are periodically cleaned and performing as designed.

Elevation Data Source: U.S. Geological Survey 2011 Lidar data
from the National Oceanic and Atmospheric Administration



PROPOSED WATERSHED PLAN
60 ARBOR STREET
WENHAM, MASSACHUSETTS

DECOULOS & COMPANY LLC

185 ALEWIFE BROOK PARKWAY
CAMBRIDGE, MA 02138
DECOULOS.COM
617.489.7795

DATE
01-10-22
SCALE
1"=80'

DRWN TCG
DES TCG
CHKD JDD
APRVD JDD

FIGURE
PR-WS

Grounds

All grassed and landscaped areas shall be continuously covered and any exposed areas or other areas that are temporarily altered and subject to erosion shall be immediately stabilized with mulch, sod, seed, stone or other suitable materials. All grass clippings, leaves, brush and other natural materials shall be transported to an approved composting facility. No clippings or leaves shall be deposited in wooded areas or on abutting properties.

Roof Gutters and Downspouts

All roof gutters shall be cleaned twice per year, in the spring and fall. Leaves, pine needles and similar materials shall be removed from the gutters and disposed of by a landscaping contractor.

Private Way and Driveway

The private way and new driveway shall be cleared by hand sweeping and pickup, vacuum sweeper or leaf blowers during the spring, summer and fall periods. During winter months, de-icing materials shall be applied only during extreme conditions and at minimal application rates. All sand or de-icing agents shall be removed in early spring by either hand sweeping and pickup, or by a vacuum sweeper. Any sediment removed shall be disposed of in accordance with DEP policy and guidance.

Catch Basins and Stormwater Chamber System

The catch basin sumps shall be cleaned once per year, preferably in late fall, by an independent contractor certified by the water quality manufacturer. All debris from the sumps shall be removed and disposed of in accordance with DEP policy and guidance.

A written report of the inspection and maintenance of the paved surfaces and catch basins shall be provided to DPW Director Bill Tyack within 30 days of the maintenance work.

APPENDIX A

SOIL BORING LOGS

SOIL LOGS FOR STORMWATER SYSTEM

Date: July 24, 2013

By: Gregory P. Bernard, RS, Soil Evaluator

OH9

Surface Elevation.....	70.2
0-19" Gravelly Fill.....	68.62
19-46 C1 Coarse Sand.....	66.37
46-60 C2 Fine Sand.....	65.20
60-81 C3 Coarse Sand.....	63.45

No Refusal

No Observed Groundwater

No Redox Features

Estimated Seasonal High Groundwater > 81"

OH10

Surface Elevation.....	70.1
0-15" Gravelly Fill.....	68.85
15-45 C1 Coarse Sand.....	66.35
45-54 C2 Very Fine Sand.....	65.60
54-80 C3 Sand.....	63.43

No Refusal

No Observed Groundwater

No Redox Features

Estimated Seasonal High Groundwater > 80"

OH11

Surface Elevation.....	72.5
0-10" A Sandy Loam.....	71.67
10-22 B Sandy Loam.....	70.67
22-84 C Sand.....	65.50

No Refusal

No Observed Groundwater

No Redox Features

Estimated Seasonal High Groundwater > 84"

Date: November 10, 2021
Observed by: James J. Decoulos, PE

Depth (inches)	Elevations (survey feet) (NAVD88)
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TP 1

Surface.....	77.90
0-12 A Sandy Loam 10 YR 3/4.....	76.90
12-28 B Gravelly Sandy Loam 10 YR 5/6.....	74.57
28-132 C Coarse Sand & Gravel 10 YR 5/6.....	66.90

No Refusal
No Observed Groundwater
No Redox Features
Estimated Seasonal High Groundwater > 132

TP 2

Surface	76.30
0-20 A Loam 10 YR 3/4.....	74.63
20-32 B Sandy Loam 10 YR 5/6.....	73.63
32-72 C1 Gravelly Sand 2.5 Y 5/3.....	70.30
72-128 C2 Gravel & Coarse Sand 2.5 Y 5/3.....	65.63

No Refusal
No Observed Groundwater
No Redox Features
Estimated Seasonal High Groundwater >128

TP 3

Surface	76.50
0-9 A Sandy Loam 10 YR 3/4.....	75.75
9-96 C1 Sandy Loam with Pockets of Sand 10 YR 5/4.....	68.50
96-132 C2 Gravelly Sand 2.5 Y 5/3.....	65.50

No Refusal
No Observed Groundwater
at 60 inches, Redox was greater than 5 percent
Estimated Seasonal High Groundwater > 132

APPENDIX B
EXISTING CONDITIONS
HYDROLOGIC ANALYSIS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

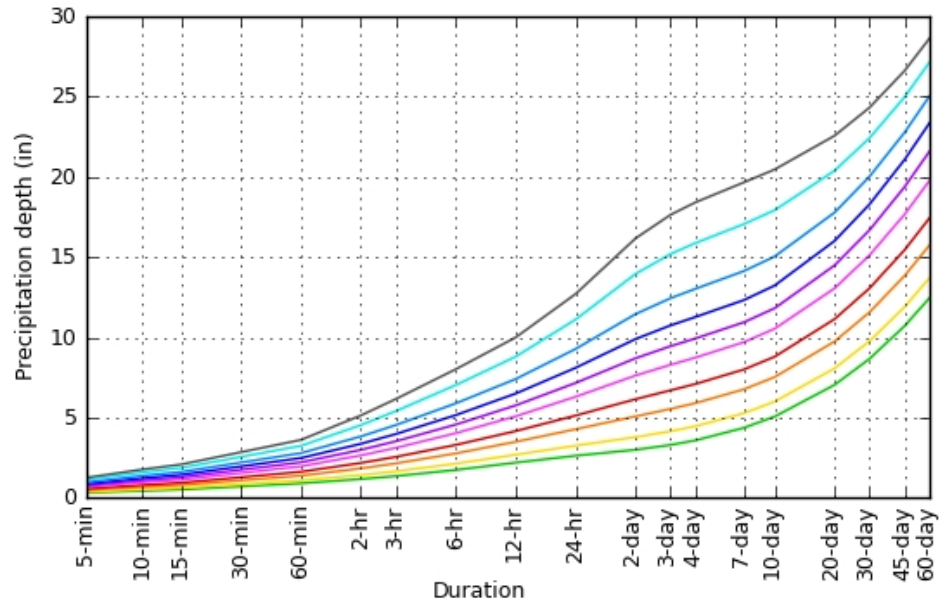
PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.307 (0.237-0.386)	0.371 (0.286-0.467)	0.475 (0.364-0.599)	0.562 (0.428-0.713)	0.680 (0.504-0.900)	0.769 (0.558-1.04)	0.862 (0.610-1.21)	0.968 (0.650-1.39)	1.12 (0.725-1.66)	1.25 (0.789-1.88)
10-min	0.435 (0.336-0.547)	0.525 (0.405-0.661)	0.672 (0.516-0.848)	0.795 (0.607-1.01)	0.963 (0.713-1.28)	1.09 (0.792-1.47)	1.22 (0.865-1.71)	1.37 (0.921-1.96)	1.59 (1.03-2.35)	1.77 (1.12-2.67)
15-min	0.512 (0.395-0.644)	0.618 (0.476-0.778)	0.791 (0.607-0.999)	0.935 (0.714-1.19)	1.13 (0.839-1.50)	1.28 (0.931-1.73)	1.44 (1.02-2.02)	1.61 (1.08-2.31)	1.87 (1.21-2.77)	2.08 (1.32-3.14)
30-min	0.707 (0.545-0.888)	0.850 (0.654-1.07)	1.08 (0.832-1.37)	1.28 (0.976-1.62)	1.55 (1.15-2.05)	1.75 (1.27-2.36)	1.96 (1.39-2.75)	2.20 (1.48-3.15)	2.55 (1.65-3.78)	2.84 (1.80-4.29)
60-min	0.901 (0.694-1.13)	1.08 (0.833-1.36)	1.38 (1.06-1.74)	1.62 (1.24-2.06)	1.96 (1.45-2.60)	2.21 (1.61-2.99)	2.48 (1.76-3.48)	2.78 (1.87-3.99)	3.23 (2.09-4.79)	3.61 (2.28-5.45)
2-hr	1.17 (0.906-1.46)	1.42 (1.10-1.77)	1.83 (1.42-2.29)	2.17 (1.67-2.74)	2.64 (1.98-3.49)	2.99 (2.20-4.04)	3.36 (2.42-4.74)	3.82 (2.58-5.44)	4.53 (2.94-6.66)	5.13 (3.26-7.69)
3-hr	1.35 (1.06-1.68)	1.65 (1.29-2.06)	2.14 (1.67-2.68)	2.55 (1.97-3.20)	3.11 (2.34-4.10)	3.52 (2.61-4.76)	3.97 (2.87-5.60)	4.53 (3.06-6.43)	5.40 (3.51-7.92)	6.16 (3.92-9.20)
6-hr	1.73 (1.37-2.14)	2.13 (1.67-2.63)	2.76 (2.17-3.43)	3.30 (2.57-4.11)	4.03 (3.05-5.28)	4.56 (3.40-6.13)	5.15 (3.75-7.22)	5.88 (3.99-8.29)	7.02 (4.58-10.2)	8.01 (5.11-11.9)
12-hr	2.19 (1.74-2.69)	2.68 (2.13-3.30)	3.49 (2.76-4.30)	4.16 (3.27-5.15)	5.08 (3.88-6.61)	5.76 (4.31-7.67)	6.50 (4.74-9.02)	7.40 (5.05-10.4)	8.79 (5.76-12.7)	9.99 (6.40-14.7)
24-hr	2.62 (2.10-3.20)	3.25 (2.60-3.97)	4.27 (3.41-5.23)	5.12 (4.07-6.31)	6.30 (4.85-8.15)	7.16 (5.40-9.49)	8.10 (5.97-11.2)	9.28 (6.35-12.9)	11.1 (7.30-16.0)	12.7 (8.15-18.6)
2-day	2.99 (2.42-3.62)	3.78 (3.06-4.59)	5.07 (4.09-6.17)	6.14 (4.92-7.52)	7.62 (5.92-9.84)	8.69 (6.64-11.5)	9.89 (7.38-13.7)	11.4 (7.86-15.8)	14.0 (9.20-19.9)	16.2 (10.4-23.5)
3-day	3.29 (2.68-3.97)	4.15 (3.37-5.01)	5.54 (4.49-6.72)	6.70 (5.39-8.16)	8.29 (6.48-10.7)	9.45 (7.25-12.5)	10.7 (8.05-14.9)	12.4 (8.57-17.1)	15.2 (10.0-21.6)	17.6 (11.4-25.5)
4-day	3.58 (2.92-4.31)	4.46 (3.64-5.37)	5.90 (4.79-7.13)	7.09 (5.73-8.62)	8.73 (6.85-11.2)	9.93 (7.64-13.1)	11.3 (8.47-15.5)	13.0 (8.99-17.9)	15.9 (10.5-22.5)	18.4 (11.9-26.6)
7-day	4.36 (3.59-5.22)	5.27 (4.33-6.31)	6.76 (5.53-8.13)	7.99 (6.50-9.66)	9.70 (7.64-12.3)	10.9 (8.45-14.3)	12.3 (9.28-16.8)	14.1 (9.79-19.3)	17.1 (11.3-24.1)	19.7 (12.7-28.2)
10-day	5.06 (4.18-6.03)	5.99 (4.95-7.16)	7.52 (6.18-9.01)	8.79 (7.18-10.6)	10.5 (8.33-13.3)	11.8 (9.14-15.3)	13.2 (9.96-17.9)	15.0 (10.5-20.4)	17.9 (11.9-25.2)	20.5 (13.3-29.3)
20-day	7.04 (5.87-8.33)	8.06 (6.72-9.56)	9.74 (8.08-11.6)	11.1 (9.18-13.3)	13.1 (10.4-16.3)	14.5 (11.2-18.5)	16.0 (12.0-21.2)	17.8 (12.5-23.9)	20.4 (13.6-28.4)	22.6 (14.7-32.1)
30-day	8.66 (7.27-10.2)	9.77 (8.18-11.5)	11.6 (9.65-13.7)	13.1 (10.8-15.6)	15.1 (12.0-18.7)	16.7 (12.9-21.0)	18.3 (13.6-23.8)	20.0 (14.1-26.8)	22.4 (15.1-31.1)	24.3 (15.8-34.4)
45-day	10.7 (9.03-12.6)	11.9 (10.0-14.0)	13.8 (11.6-16.3)	15.4 (12.9-18.3)	17.7 (14.1-21.7)	19.4 (15.0-24.2)	21.1 (15.7-27.1)	22.8 (16.1-30.4)	25.0 (16.8-34.5)	26.6 (17.4-37.5)
60-day	12.5 (10.5-14.6)	13.7 (11.6-16.1)	15.7 (13.3-18.5)	17.4 (14.6-20.6)	19.8 (15.8-24.1)	21.6 (16.8-26.8)	23.4 (17.4-29.9)	25.0 (17.7-33.3)	27.1 (18.3-37.3)	28.6 (18.7-40.2)
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.										

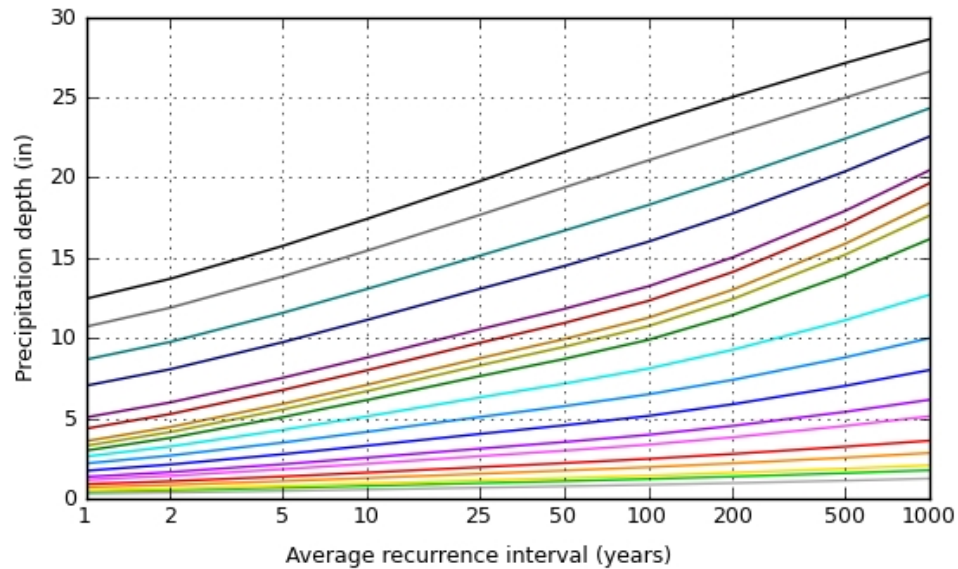
[Back to Top](#)

PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 42.6122°, Longitude: -70.8875°



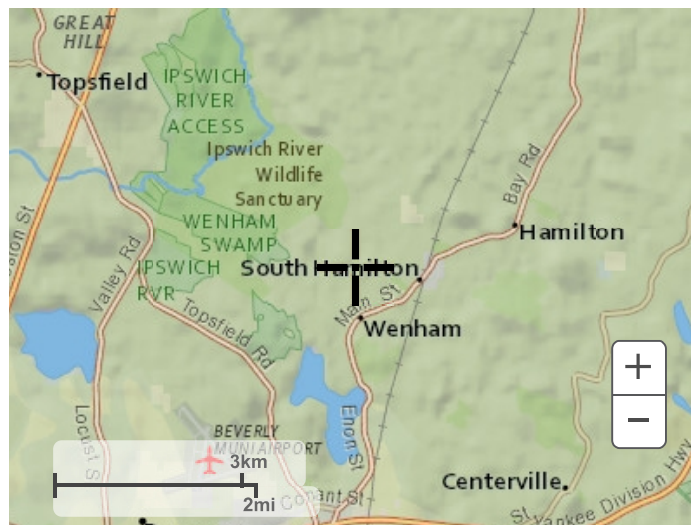
Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000



Duration	
5-min	2-day
10-min	3-day
15-min	4-day
30-min	7-day
60-min	10-day
2-hr	20-day
3-hr	30-day
6-hr	45-day
12-hr	60-day
24-hr	

Maps & aerals

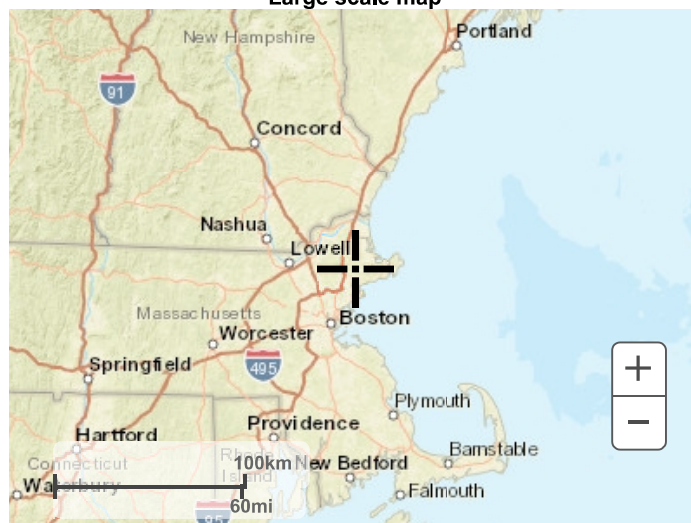
Small scale terrain



Large scale terrain

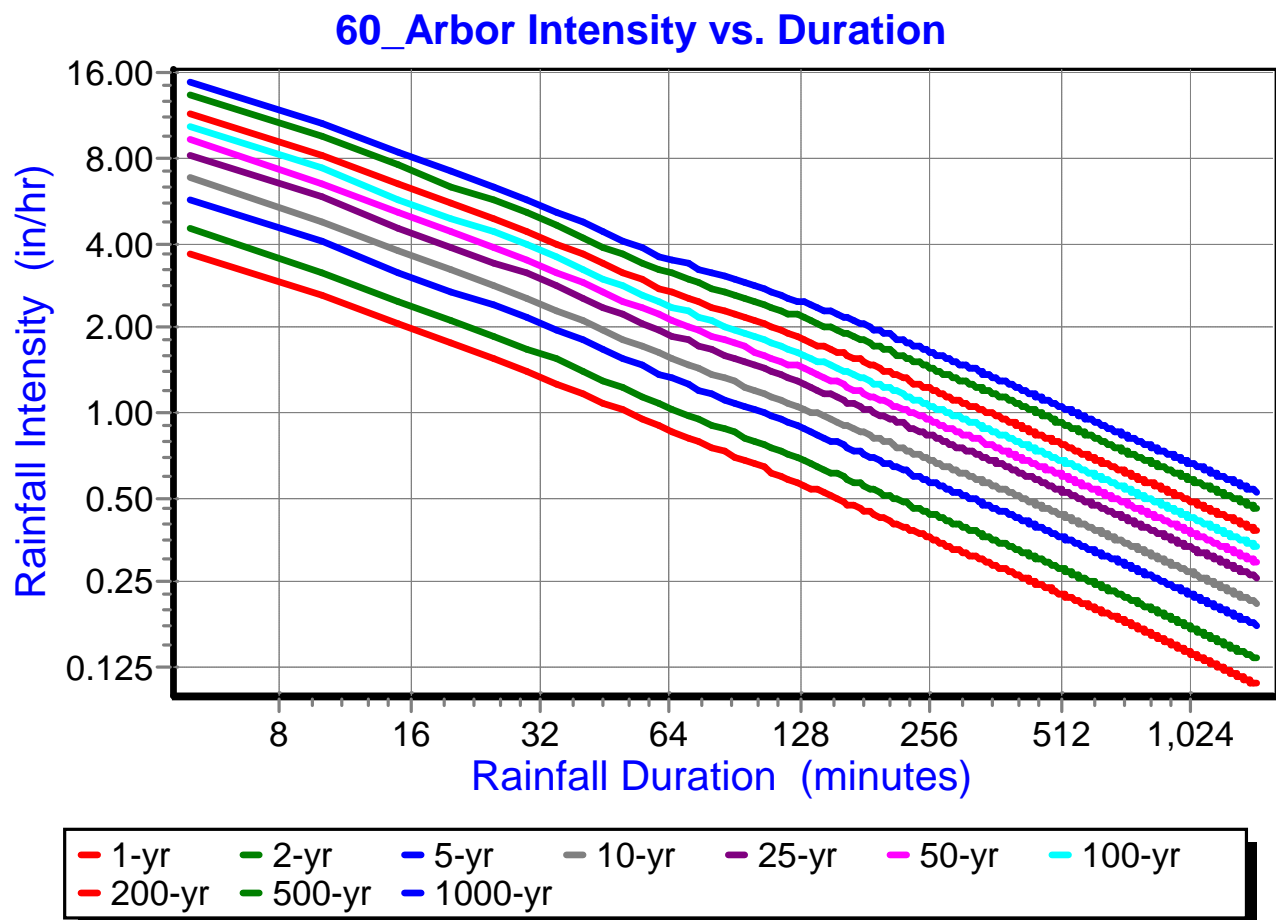


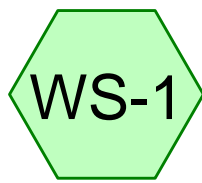
Large scale map



Large scale aerial

IDF Curve Report

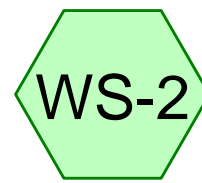




WS-1



POA-LP



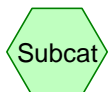
WS-2



POA- ISO WETLANDS



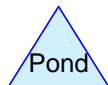
TOTAL



Subcat



Reach



Pond



Link

Routing Diagram for 60 Arbor Street EX 9-3-20

Prepared by Decoulos & Company, LLC, Printed 1/9/2022

HydroCAD® 10.10-7a s/n 09833 © 2021 HydroCAD Software Solutions LLC

60 Arbor Street EX 9-3-20

Prepared by Decoulos & Company, LLC

Printed 1/9/2022

HydroCAD® 10.10-7a s/n 09833 © 2021 HydroCAD Software Solutions LLC

Page 2

Area Listing (all nodes)

Area (sq-ft)	C	Description (subcatchment-numbers)
2,016	0.80	Paved parking, HSG A (WS-2)
16,329	0.90	Paved roads w/curbs & sewers, HSG A (WS-2)
3,080	0.85	Roofs, HSG A (WS-2)
220,470	0.30	Woods, Fair, HSG A (WS-2)
55,134	0.30	Woods/grass comb., Fair, HSG A (WS-1)
297,029	0.34	TOTAL AREA

60 Arbor Street EX 9-3-20

Prepared by Decoulos & Company, LLC

Printed 1/9/2022

HydroCAD® 10.10-7a s/n 09833 © 2021 HydroCAD Software Solutions LLC

Page 3

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
297,029	HSG A	WS-1, WS-2
0	HSG B	
0	HSG C	
0	HSG D	
0	Other	
297,029		TOTAL AREA

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Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
2,016	0	0	0	0	2,016	Paved parking
16,329	0	0	0	0	16,329	Paved roads w/curbs & sewers
3,080	0	0	0	0	3,080	Roofs
220,470	0	0	0	0	220,470	Woods, Fair
55,134	0	0	0	0	55,134	Woods/grass comb., Fair
297,029	0	0	0	0	297,029	TOTAL AREA

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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment WS-1: WS-1Runoff Area=55,134 sf 0.00% Impervious Runoff Depth=0.49"
Flow Length=255' Tc=15.3 min C=0.30 Runoff=0.62 cfs 2,233 cf**Subcatchment WS-2: WS-2**Runoff Area=241,895 sf 0.00% Impervious Runoff Depth=0.57"
Flow Length=388' Tc=9.7 min C=0.35 Runoff=3.17 cfs 11,430 cf**Link POA-ISO: POA- ISO WETLANDS**Inflow=3.17 cfs 11,430 cf
Primary=3.17 cfs 11,430 cf**Link POA-LP: POA-LP**Inflow=0.62 cfs 2,233 cf
Primary=0.62 cfs 2,233 cf**Link TOTAL: TOTAL**Inflow=3.80 cfs 13,662 cf
Primary=3.80 cfs 13,662 cf**Total Runoff Area = 297,029 sf Runoff Volume = 13,662 cf Average Runoff Depth = 0.55"**
100.00% Pervious = 297,029 sf 0.00% Impervious = 0 sf

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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Summary for Subcatchment WS-1: WS-1

Runoff = 0.62 cfs @ 0.26 hrs, Volume= 2,233 cf, Depth= 0.49"
 Routed to Link POA-LP : POA-LP

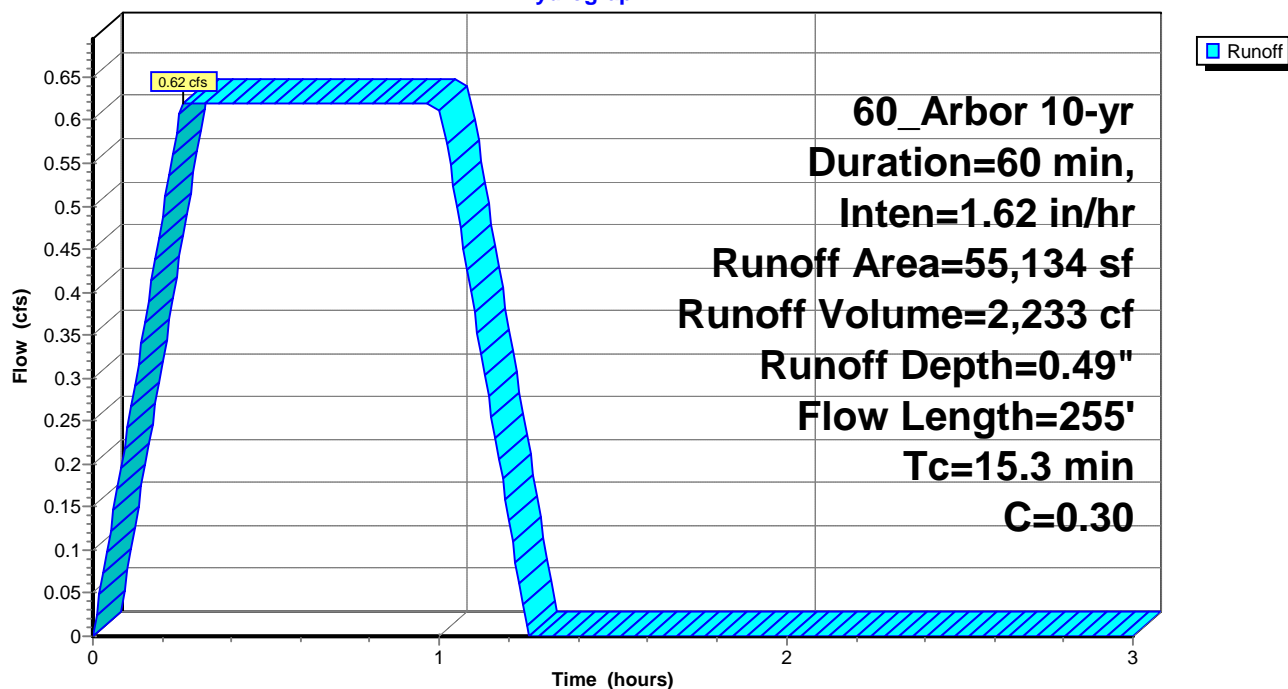
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

Area (sf)	C	Description
55,134	0.30	Woods/grass comb., Fair, HSG A
55,134		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.0180	0.06		Sheet Flow, Sheet Flow
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.3	54	0.3700	3.04		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.1	151	0.0570	1.19		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
15.3	255	Total			

Subcatchment WS-1: WS-1

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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Summary for Subcatchment WS-2: WS-2

Runoff = 3.17 cfs @ 0.17 hrs, Volume= 11,430 cf, Depth= 0.57"
 Routed to Link POA-ISO : POA- ISO WETLANDS

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

Area (sf)	C	Description
220,470	0.30	Woods, Fair, HSG A
3,080	0.85	Roofs, HSG A
2,016	0.80	Paved parking, HSG A
16,329	0.90	Paved roads w/curbs & sewers, HSG A
241,895	0.35	Weighted Average
241,895		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.2200	0.18		Sheet Flow, Sheet Flow
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.2	41	0.5200	3.61		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.8	87	0.0110	0.52		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.0	210	0.1239	1.76		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
9.7	388	Total			

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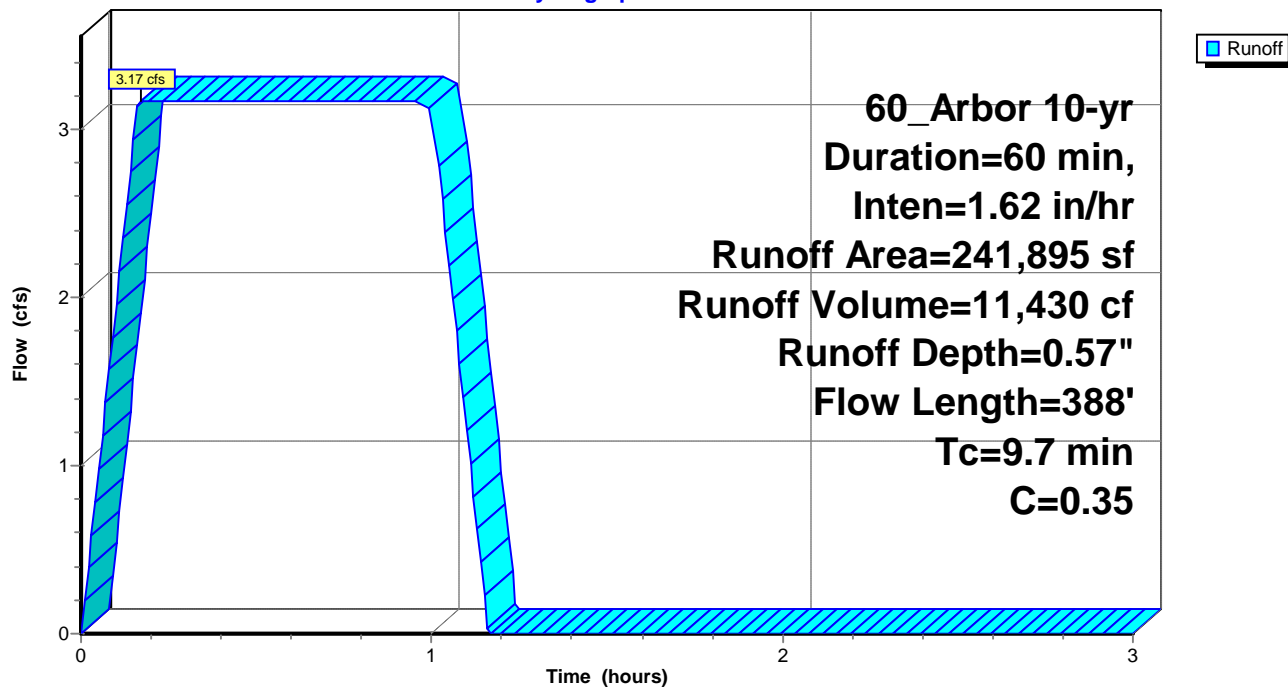
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Subcatchment WS-2: WS-2

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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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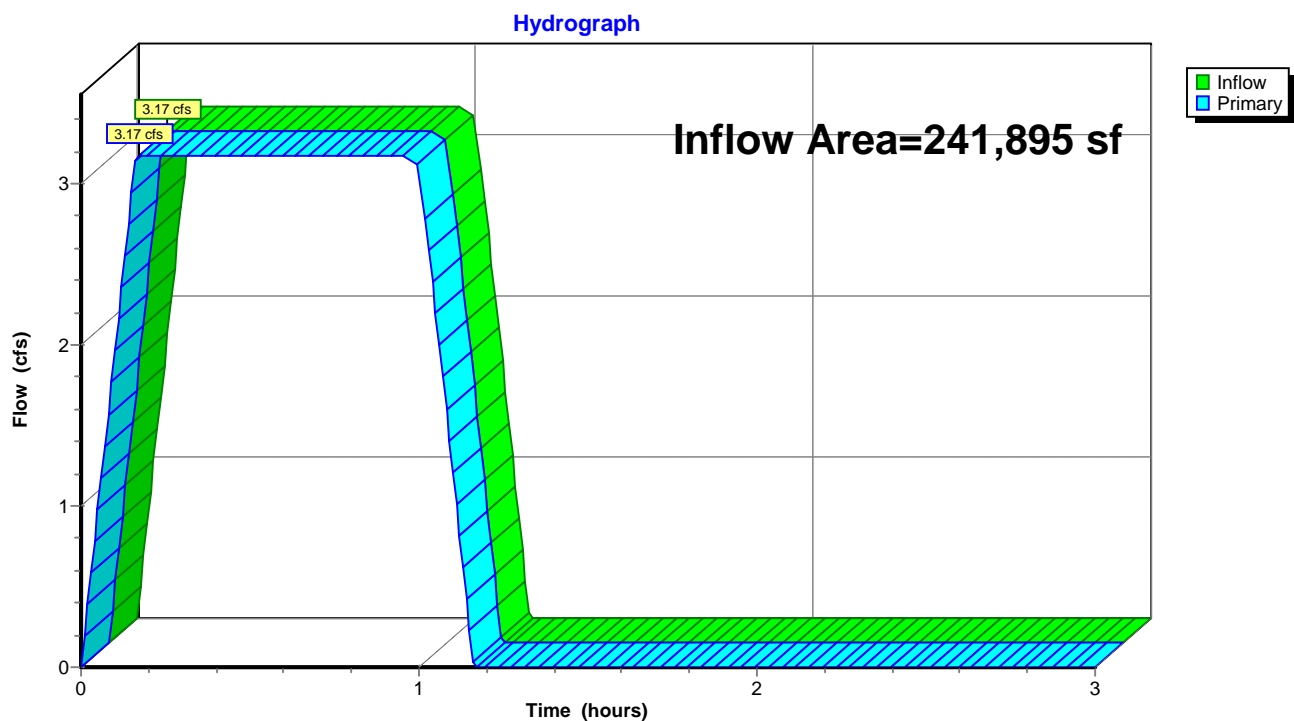
Page 9

Summary for Link POA-ISO: POA- ISO WETLANDS

Inflow Area = 241,895 sf, 0.00% Impervious, Inflow Depth = 0.57" for 10-yr event
Inflow = 3.17 cfs @ 0.17 hrs, Volume= 11,430 cf
Primary = 3.17 cfs @ 0.17 hrs, Volume= 11,430 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link POA-ISO: POA- ISO WETLANDS



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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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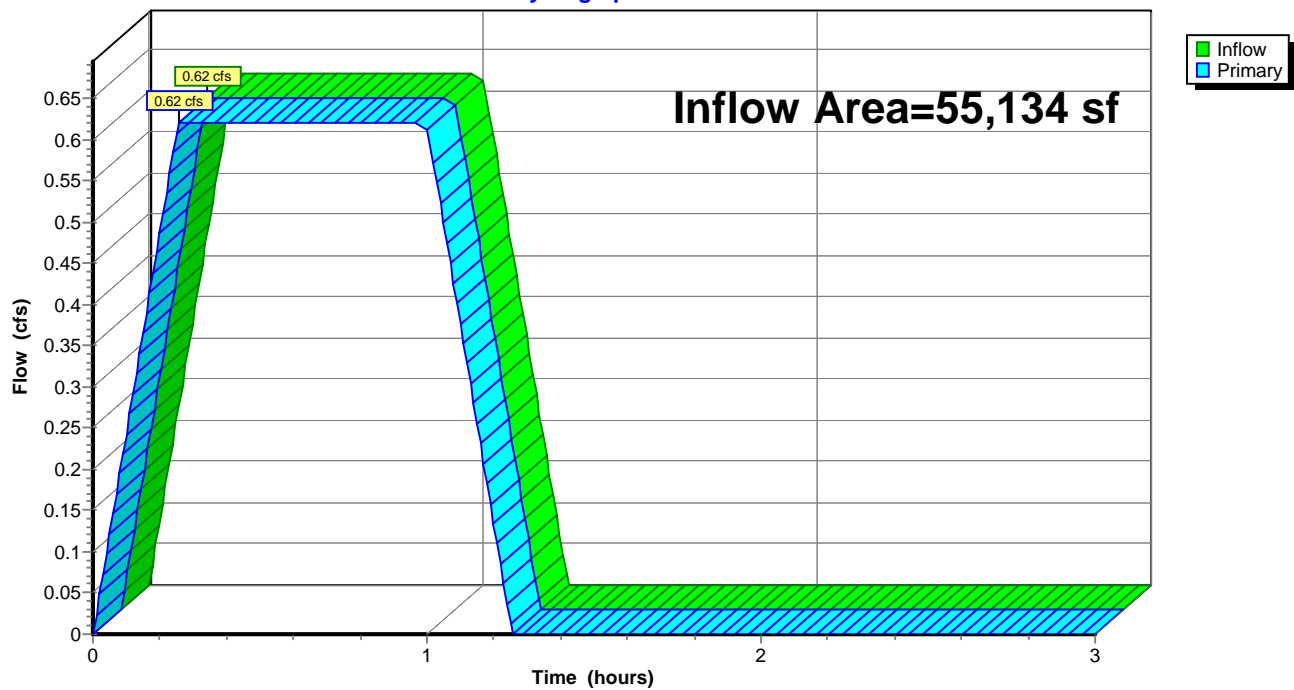
Summary for Link POA-LP: POA-LP

Inflow Area = 55,134 sf, 0.00% Impervious, Inflow Depth = 0.49" for 10-yr event
Inflow = 0.62 cfs @ 0.26 hrs, Volume= 2,233 cf
Primary = 0.62 cfs @ 0.26 hrs, Volume= 2,233 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link POA-LP: POA-LP

Hydrograph



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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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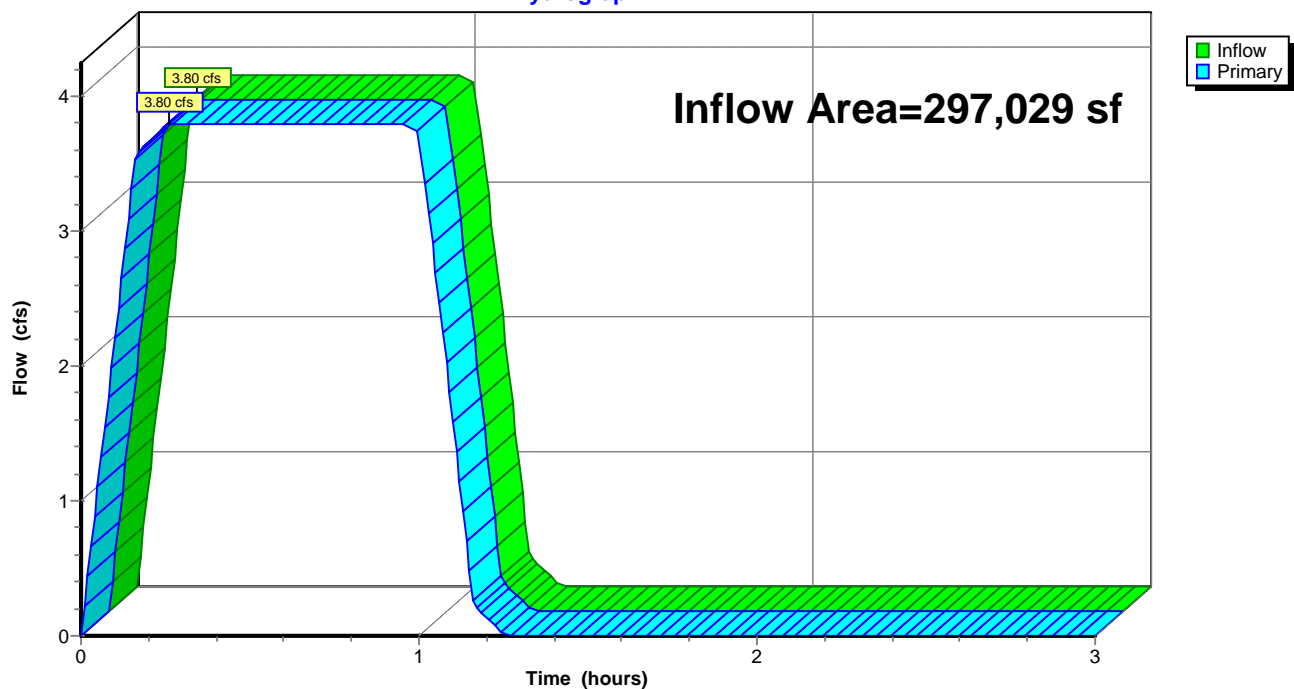
Summary for Link TOTAL: TOTAL

Inflow Area = 297,029 sf, 0.00% Impervious, Inflow Depth = 0.55" for 10-yr event
Inflow = 3.80 cfs @ 0.26 hrs, Volume= 13,662 cf
Primary = 3.80 cfs @ 0.26 hrs, Volume= 13,662 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link TOTAL: TOTAL

Hydrograph



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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment WS-1: WS-1Runoff Area=55,134 sf 0.00% Impervious Runoff Depth=0.66"
Flow Length=255' Tc=15.3 min C=0.30 Runoff=0.85 cfs 3,046 cf**Subcatchment WS-2: WS-2**Runoff Area=241,895 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=388' Tc=9.7 min C=0.35 Runoff=4.33 cfs 15,592 cf**Link POA-ISO: POA- ISO WETLANDS**Inflow=4.33 cfs 15,592 cf
Primary=4.33 cfs 15,592 cf**Link POA-LP: POA-LP**Inflow=0.85 cfs 3,046 cf
Primary=0.85 cfs 3,046 cf**Link TOTAL: TOTAL**Inflow=5.18 cfs 18,638 cf
Primary=5.18 cfs 18,638 cf**Total Runoff Area = 297,029 sf Runoff Volume = 18,638 cf Average Runoff Depth = 0.75"**
100.00% Pervious = 297,029 sf 0.00% Impervious = 0 sf

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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Summary for Subcatchment WS-1: WS-1

Runoff = 0.85 cfs @ 0.26 hrs, Volume= 3,046 cf, Depth= 0.66"
 Routed to Link POA-LP : POA-LP

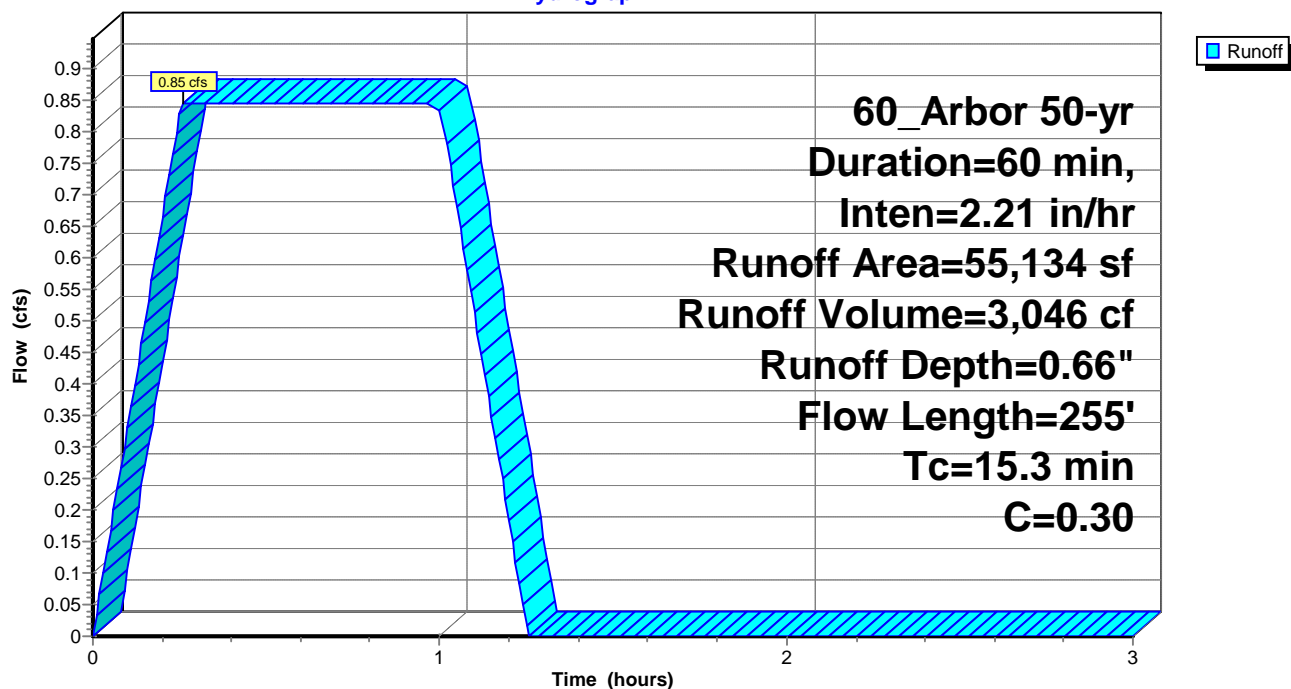
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

Area (sf)	C	Description
55,134	0.30	Woods/grass comb., Fair, HSG A
55,134		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.0180	0.06		Sheet Flow, Sheet Flow
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.3	54	0.3700	3.04		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.1	151	0.0570	1.19		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
15.3	255	Total			

Subcatchment WS-1: WS-1

Hydrograph



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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Summary for Subcatchment WS-2: WS-2

Runoff = 4.33 cfs @ 0.17 hrs, Volume= 15,592 cf, Depth= 0.77"
 Routed to Link POA-ISO : POA- ISO WETLANDS

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

Area (sf)	C	Description
220,470	0.30	Woods, Fair, HSG A
3,080	0.85	Roofs, HSG A
2,016	0.80	Paved parking, HSG A
16,329	0.90	Paved roads w/curbs & sewers, HSG A
241,895	0.35	Weighted Average
241,895		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.2200	0.18		Sheet Flow, Sheet Flow
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.2	41	0.5200	3.61		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.8	87	0.0110	0.52		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.0	210	0.1239	1.76		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
9.7	388	Total			

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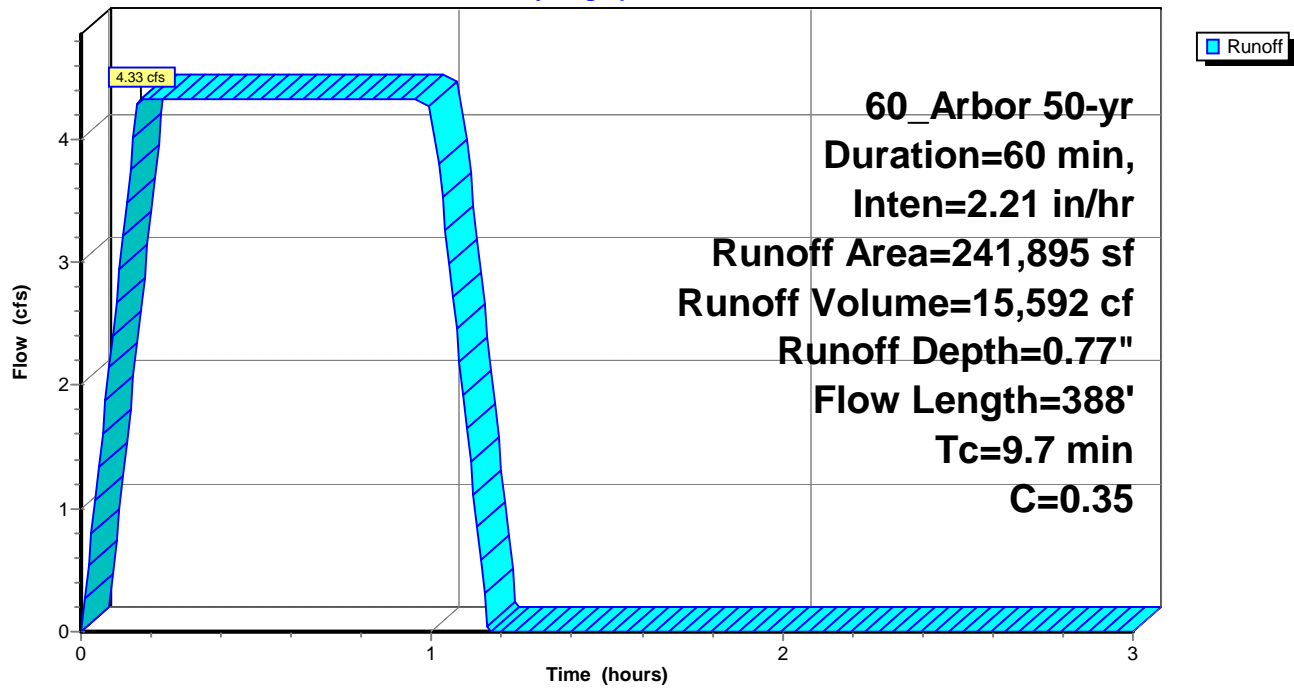
60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Subcatchment WS-2: WS-2

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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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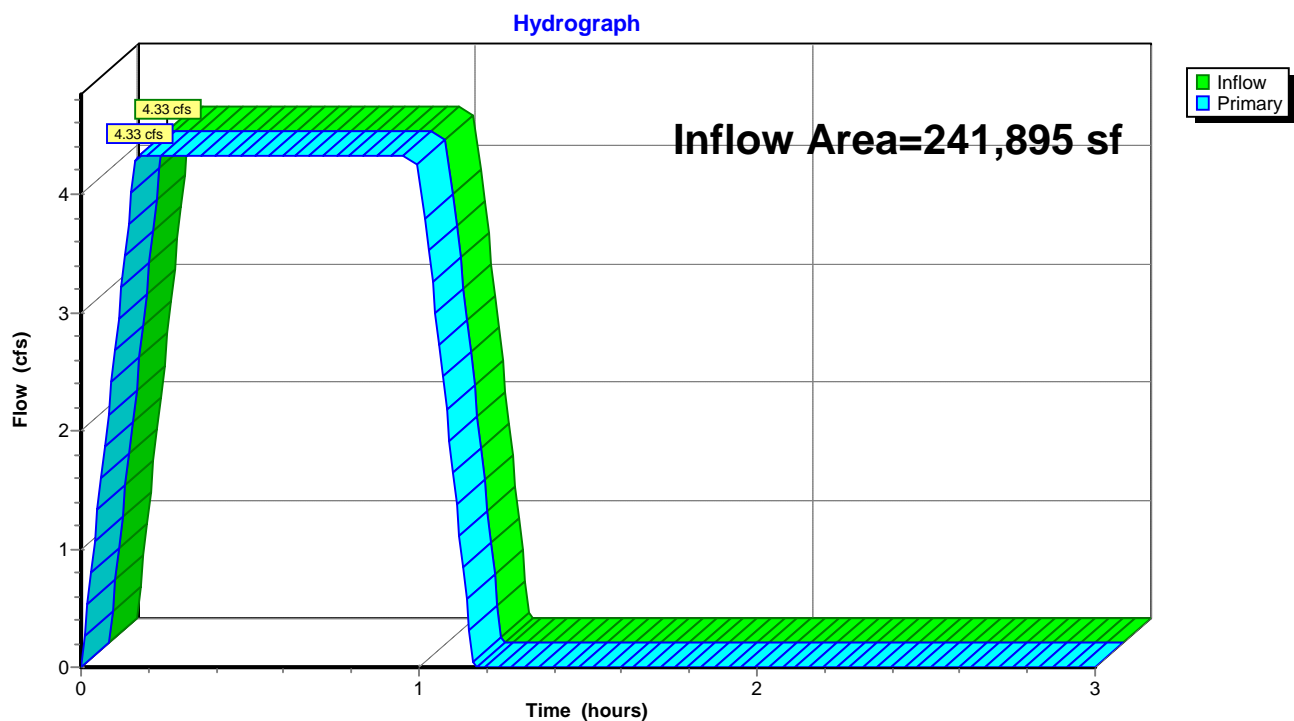
Page 16

Summary for Link POA-ISO: POA- ISO WETLANDS

Inflow Area = 241,895 sf, 0.00% Impervious, Inflow Depth = 0.77" for 50-yr event
Inflow = 4.33 cfs @ 0.17 hrs, Volume= 15,592 cf
Primary = 4.33 cfs @ 0.17 hrs, Volume= 15,592 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link POA-ISO: POA- ISO WETLANDS



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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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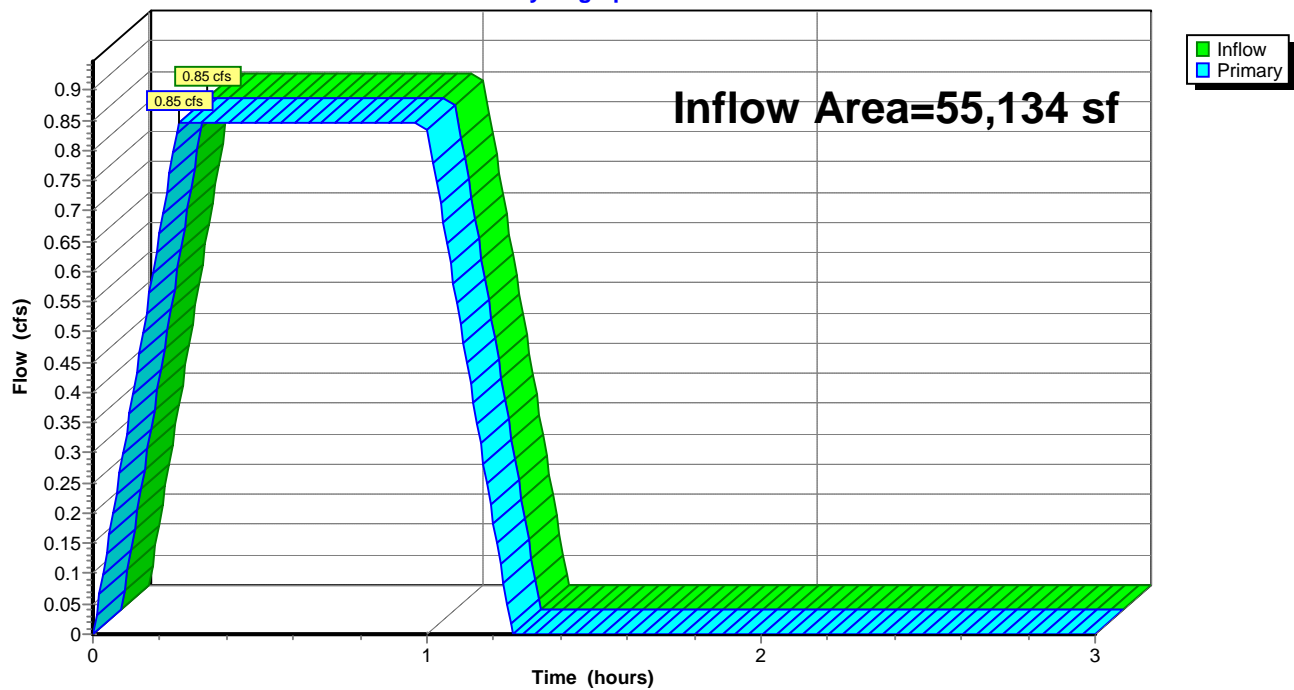
Summary for Link POA-LP: POA-LP

Inflow Area = 55,134 sf, 0.00% Impervious, Inflow Depth = 0.66" for 50-yr event
Inflow = 0.85 cfs @ 0.26 hrs, Volume= 3,046 cf
Primary = 0.85 cfs @ 0.26 hrs, Volume= 3,046 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link POA-LP: POA-LP

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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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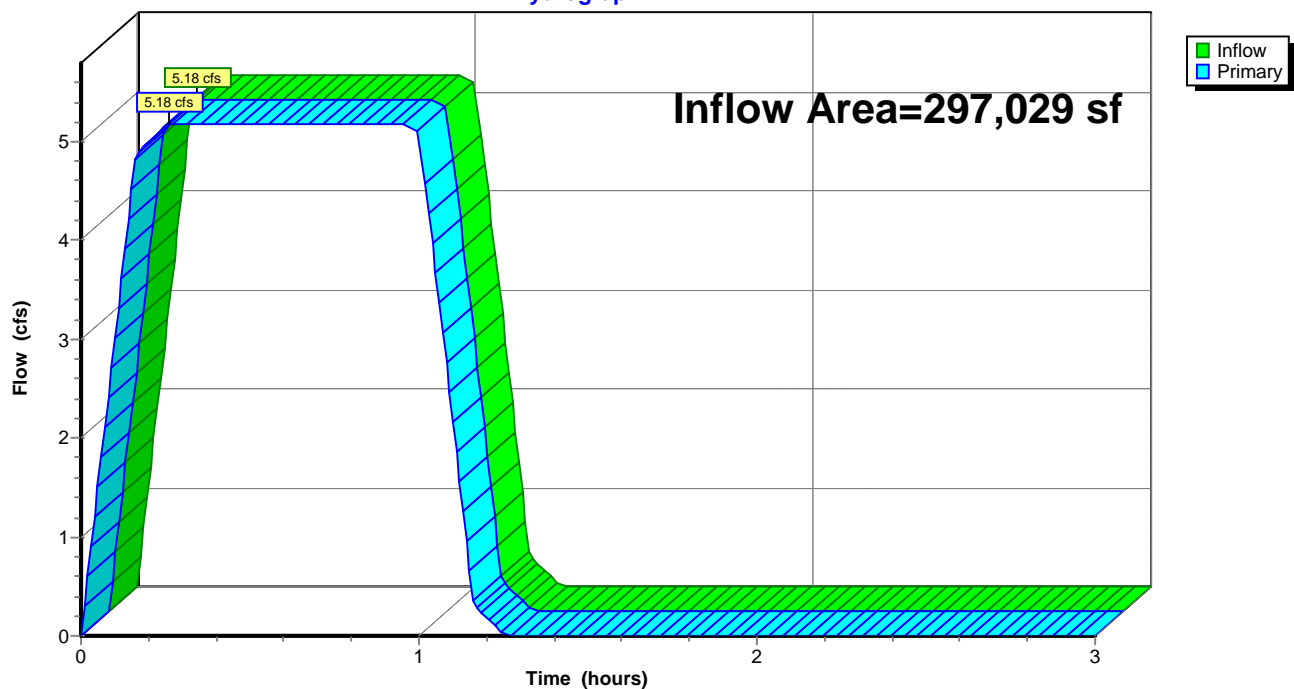
Summary for Link TOTAL: TOTAL

Inflow Area = 297,029 sf, 0.00% Impervious, Inflow Depth = 0.75" for 50-yr event
Inflow = 5.18 cfs @ 0.26 hrs, Volume= 18,638 cf
Primary = 5.18 cfs @ 0.26 hrs, Volume= 18,638 cf, Atten= 0%, Lag= 0.0 min

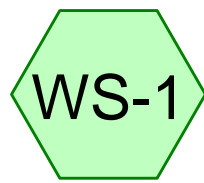
Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link TOTAL: TOTAL

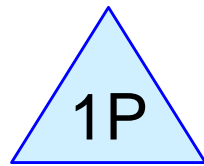
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APPENDIX C
POST-DEVELOPMENT CONDITIONS
HYDROLOGIC ANALYSIS



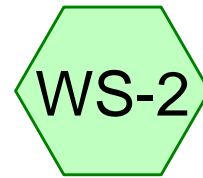
WS-1



PND #1



POA- INF



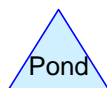
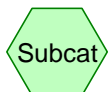
WS-2



POA- ISO WETLANDS



POA- TOTAL



Routing Diagram for 60 Arbor Street PR 10-28-20

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Area Listing (all nodes)

Area (sq-ft)	C	Description (subcatchment-numbers)
2,827	0.30	>75% Grass cover, Good, HSG A (WS-1)
7,606	0.80	Paved parking, HSG A (WS-1)
1,009	0.85	Paved parking, HSG A (WS-2)
14,894	0.90	Paved roads w/curbs & sewers, HSG A (WS-2)
2,202	0.85	Roofs, HSG A (WS-1)
3,080	0.90	Roofs, HSG A (WS-2)
207,036	0.35	Woods, Fair, HSG A (WS-2)
58,375	0.35	Woods/grass comb., Fair, HSG A (WS-1)
297,029	0.40	TOTAL AREA

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Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
297,029	HSG A	WS-1, WS-2
0	HSG B	
0	HSG C	
0	HSG D	
0	Other	
297,029		TOTAL AREA

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Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
2,827	0	0	0	0	2,827	>75% Grass cover, Good
8,615	0	0	0	0	8,615	Paved parking
14,894	0	0	0	0	14,894	Paved roads w/curbs & sewers
5,282	0	0	0	0	5,282	Roofs
207,036	0	0	0	0	207,036	Woods, Fair
58,375	0	0	0	0	58,375	Woods/grass comb., Fair
297,029	0	0	0	0	297,029	TOTAL AREA

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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment WS-1: WS-1Runoff Area=71,010 sf 0.00% Impervious Runoff Depth=0.66"
Flow Length=388' Tc=40.3 min C=0.41 Runoff=1.09 cfs 3,930 cf**Subcatchment WS-2: WS-2**Runoff Area=226,019 sf 0.00% Impervious Runoff Depth=0.65"
Flow Length=388' Tc=9.7 min C=0.40 Runoff=3.39 cfs 12,205 cf**Pond 1P: PND #1**Peak Elev=71.85' Storage=2,926 cf Inflow=1.09 cfs 3,930 cf
Discarded=0.21 cfs 2,065 cf Primary=0.00 cfs 0 cf Outflow=0.21 cfs 2,065 cf**Link POA-INF: POA- INF**Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf**Link POA-ISO: POA- ISO WETLANDS**Inflow=3.39 cfs 12,205 cf
Primary=3.39 cfs 12,205 cf**Link TOTAL: POA- TOTAL**Inflow=3.39 cfs 12,205 cf
Primary=3.39 cfs 12,205 cf**Total Runoff Area = 297,029 sf Runoff Volume = 16,135 cf Average Runoff Depth = 0.65"**
100.00% Pervious = 297,029 sf 0.00% Impervious = 0 sf

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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Summary for Subcatchment WS-1: WS-1

Runoff = 1.09 cfs @ 0.68 hrs, Volume= 3,930 cf, Depth= 0.66"
 Routed to Pond 1P : PND #1

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

Area (sf)	C	Description
7,606	0.80	Paved parking, HSG A
2,202	0.85	Roofs, HSG A
2,827	0.30	>75% Grass cover, Good, HSG A
58,375	0.35	Woods/grass comb., Fair, HSG A
71,010	0.41	Weighted Average
71,010		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.0	200	0.0720	0.09		Sheet Flow, Sheet
					Woods: Dense underbrush n= 0.800 P2= 3.20"
0.2	47	0.4680	3.42		Shallow Concentrated Flow, Shallow
					Woodland Kv= 5.0 fps
0.6	57	0.0578	1.68		Shallow Concentrated Flow, Shallow
					Short Grass Pasture Kv= 7.0 fps
0.5	84	0.0357	2.83		Shallow Concentrated Flow, Shallow
					Grassed Waterway Kv= 15.0 fps
40.3	388	Total			

60 Arbor Street PR 10-28-20

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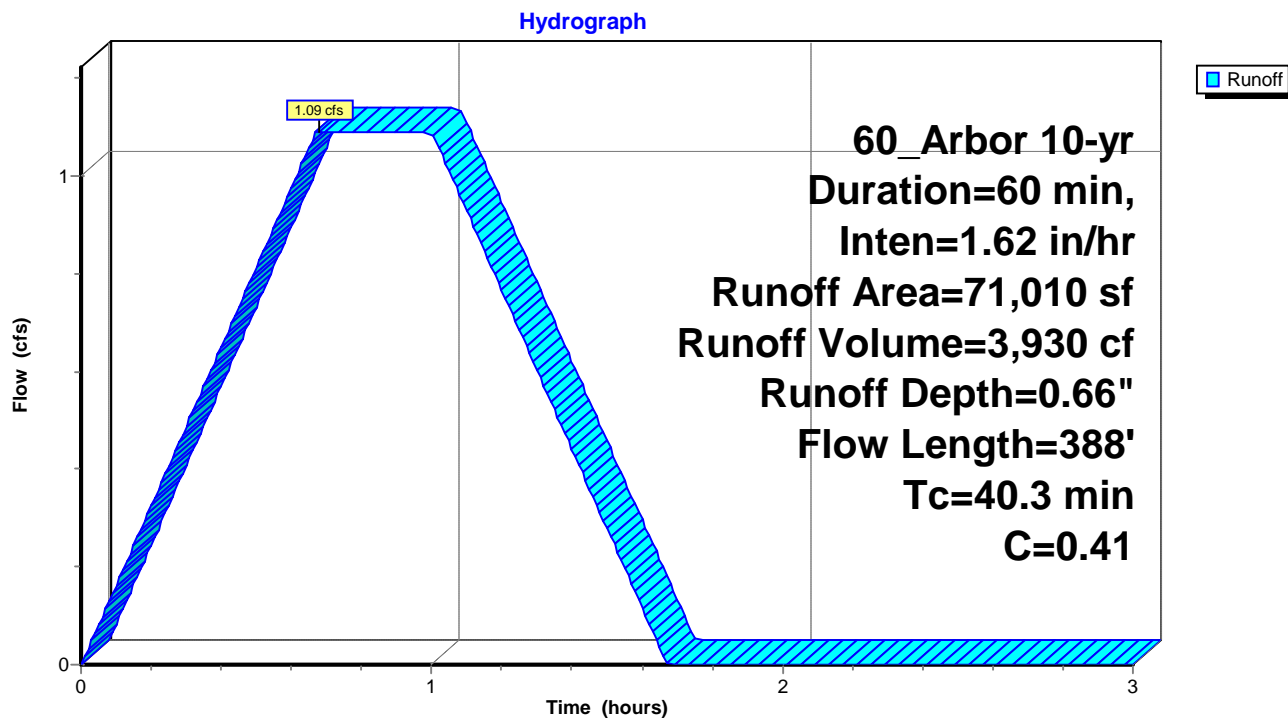
60 Arbor Street, Wenham

60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Subcatchment WS-1: WS-1



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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Summary for Subcatchment WS-2: WS-2

Runoff = 3.39 cfs @ 0.17 hrs, Volume= 12,205 cf, Depth= 0.65"
 Routed to Link POA-ISO : POA- ISO WETLANDS

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

Area (sf)	C	Description
207,036	0.35	Woods, Fair, HSG A
3,080	0.90	Roofs, HSG A
1,009	0.85	Paved parking, HSG A
14,894	0.90	Paved roads w/curbs & sewers, HSG A
226,019	0.40	Weighted Average
226,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.2200	0.18		Sheet Flow, Sheet Flow
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.2	41	0.5200	3.61		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.8	87	0.0110	0.52		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.0	210	0.1239	1.76		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
9.7	388	Total			

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60 Arbor Street, Wenham

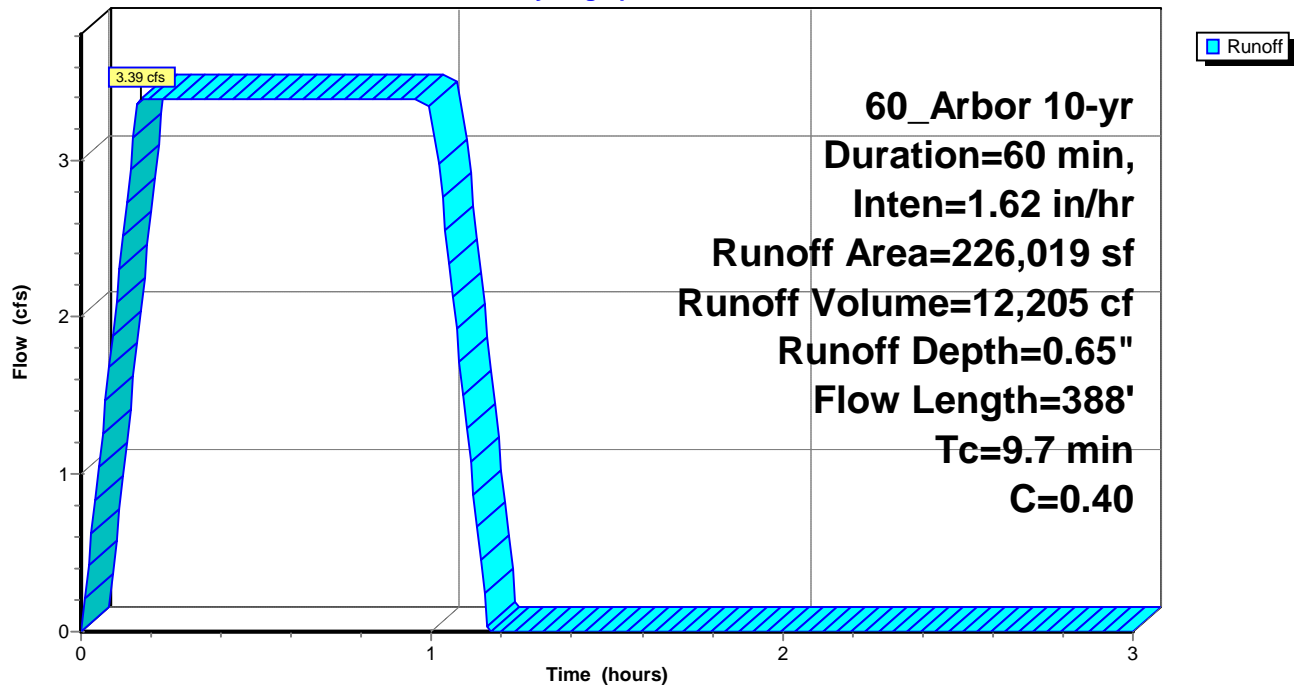
60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Subcatchment WS-2: WS-2

Hydrograph



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60 Arbor Street, Wenham

60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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Summary for Pond 1P: PND #1

Inflow Area = 71,010 sf, 0.00% Impervious, Inflow Depth = 0.66" for 10-yr event
 Inflow = 1.09 cfs @ 0.68 hrs, Volume= 3,930 cf
 Outflow = 0.21 cfs @ 0.44 hrs, Volume= 2,065 cf, Atten= 81%, Lag= 0.0 min
 Discarded = 0.21 cfs @ 0.44 hrs, Volume= 2,065 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
 Routed to Link POA-INF : POA- INF

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Peak Elev= 71.85' @ 1.54 hrs Surf.Area= 1,101 sf Storage= 2,926 cf

Plug-Flow detention time= 64.7 min calculated for 2,065 cf (53% of inflow)
 Center-of-Mass det. time= 48.3 min (98.5 - 50.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	67.81'	2,088 cf	21.42'W x 51.39'L x 7.00'H Field A 7,704 cf Overall - 2,486 cf Embedded = 5,219 cf x 40.0% Voids
#2A	68.81'	2,486 cf	ADS_StormTech MC-4500 +Cap x 22 Inside #1 Effective Size= 90.4"W x 60.0"H => 26.46 sf x 4.02'L = 106.5 cf Overall Size= 100.0"W x 60.0"H x 4.33'L with 0.31' Overlap 22 Chambers in 2 Rows Cap Storage= 35.7 cf x 2 x 2 rows = 142.8 cf
		4,573 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	74.00'	4.0" Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Discarded	67.81'	8.270 in/hr Exfiltration over Surface area Phase-In= 1.00'

Discarded OutFlow Max=0.21 cfs @ 0.44 hrs HW=68.82' (Free Discharge)
 ↑ **2=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=67.81' (Free Discharge)
 ↑ **1=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: PND #1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech MC-4500 +Cap (ADS StormTech® MC-4500 with cap, use MC-4500 b for new designs)

Effective Size= 90.4"W x 60.0"H => 26.46 sf x 4.02'L = 106.5 cf

Overall Size= 100.0"W x 60.0"H x 4.33'L with 0.31' Overlap

Cap Storage= 35.7 cf x 2 x 2 rows = 142.8 cf

100.0" Wide + 9.0" Spacing = 109.0" C-C Row Spacing

11 Chambers/Row x 4.02' Long +2.56' Cap Length x 2 = 49.39' Row Length +12.0" End Stone x 2 = 51.39' Base Length

2 Rows x 100.0" Wide + 9.0" Spacing x 1 + 24.0" Side Stone x 2 = 21.42' Base Width

12.0" Stone Base + 60.0" Chamber Height + 12.0" Stone Cover = 7.00' Field Height

22 Chambers x 106.5 cf + 35.7 cf Cap Volume x 2 x 2 Rows = 2,485.6 cf Chamber Storage

7,704.5 cf Field - 2,485.6 cf Chambers = 5,218.9 cf Stone x 40.0% Voids = 2,087.6 cf Stone Storage

Chamber Storage + Stone Storage = 4,573.1 cf = 0.105 af

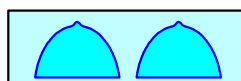
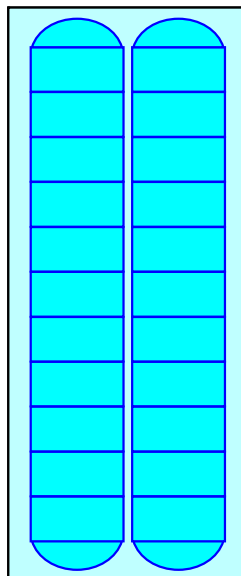
Overall Storage Efficiency = 59.4%

Overall System Size = 51.39' x 21.42' x 7.00'

22 Chambers

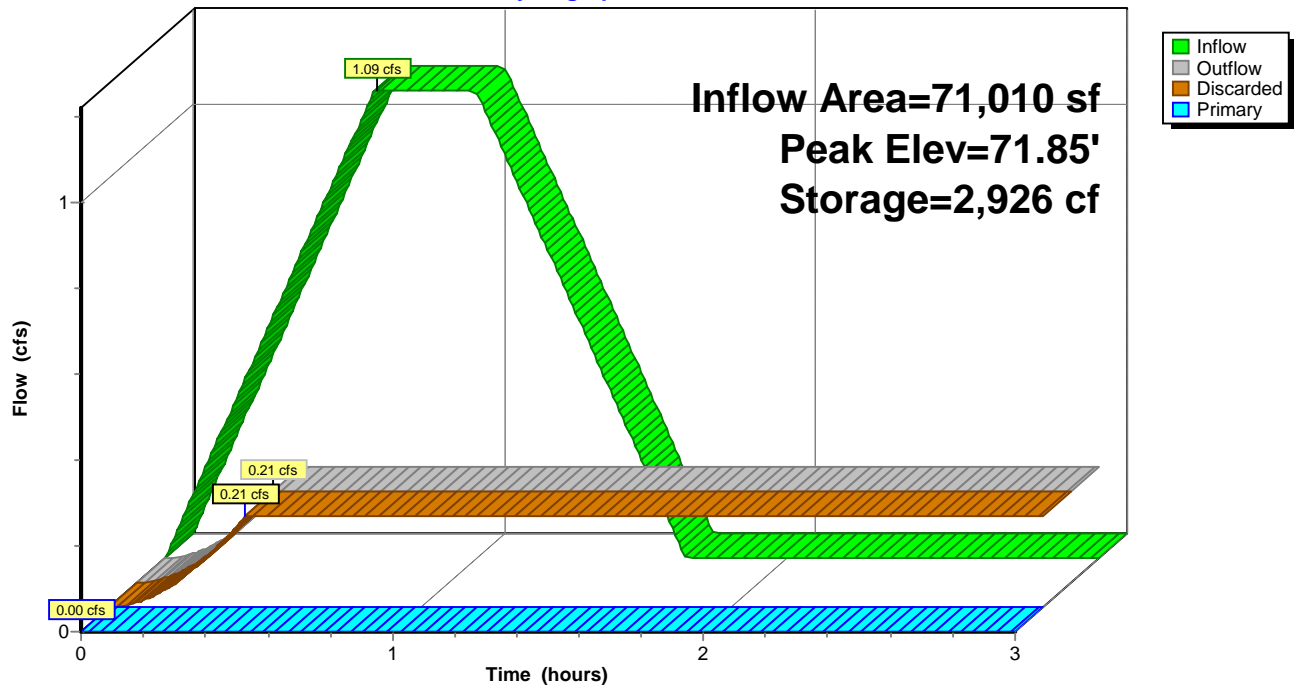
285.4 cy Field

193.3 cy Stone



Pond 1P: PND #1

Hydrograph



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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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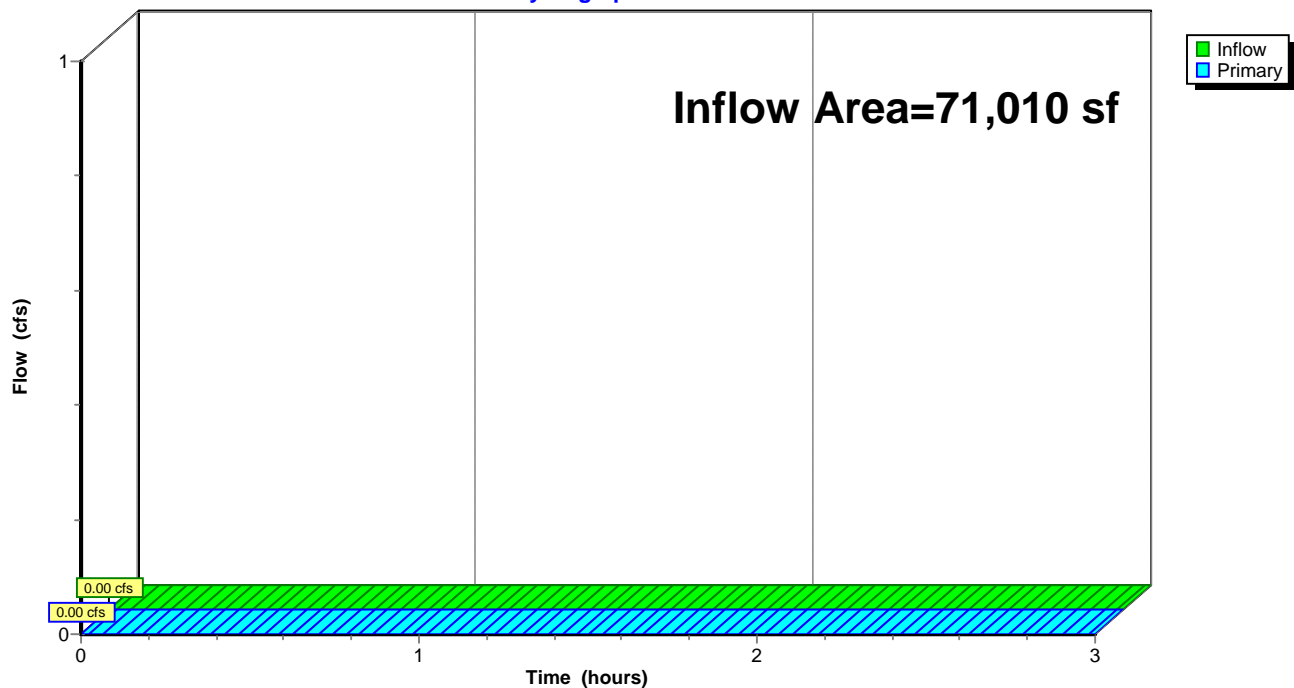
Summary for Link POA-INF: POA- INF

Inflow Area = 71,010 sf, 0.00% Impervious, Inflow Depth = 0.00" for 10-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : POA- TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link POA-INF: POA- INF

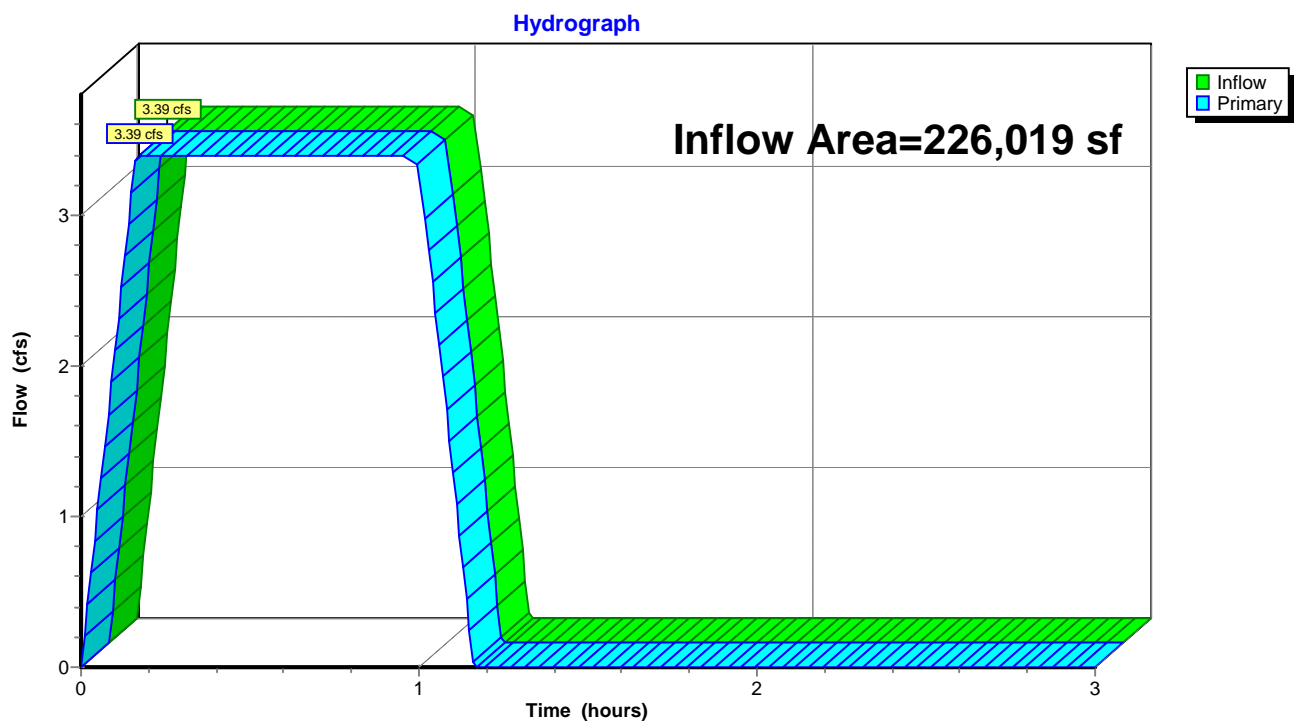
Hydrograph



Summary for Link POA-ISO: POA- ISO WETLANDS

Inflow Area = 226,019 sf, 0.00% Impervious, Inflow Depth = 0.65" for 10-yr event
Inflow = 3.39 cfs @ 0.17 hrs, Volume= 12,205 cf
Primary = 3.39 cfs @ 0.17 hrs, Volume= 12,205 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : POA- TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link POA-ISO: POA- ISO WETLANDS

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60_Arbor 10-yr Duration=60 min, Inten=1.62 in/hr

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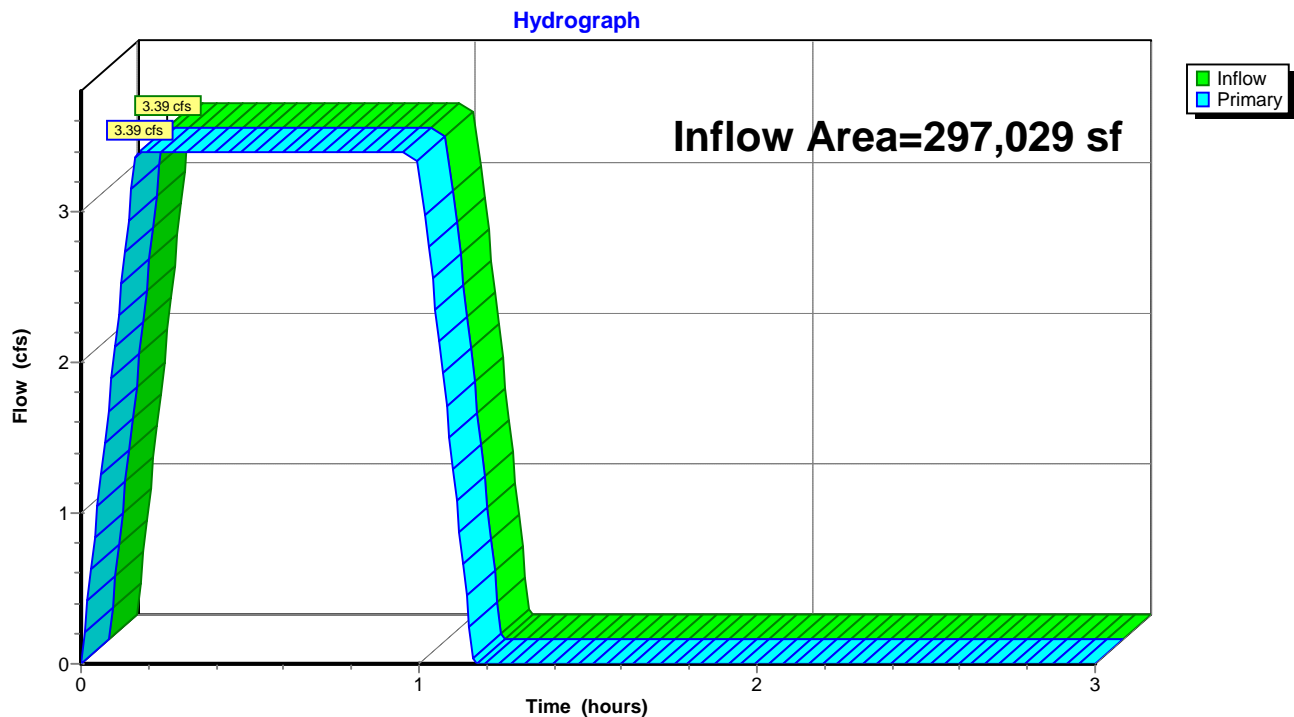
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Summary for Link TOTAL: POA- TOTAL

Inflow Area = 297,029 sf, 0.00% Impervious, Inflow Depth = 0.49" for 10-yr event
Inflow = 3.39 cfs @ 0.17 hrs, Volume= 12,205 cf
Primary = 3.39 cfs @ 0.17 hrs, Volume= 12,205 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link TOTAL: POA- TOTAL



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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment WS-1: WS-1Runoff Area=71,010 sf 0.00% Impervious Runoff Depth=0.91"
Flow Length=388' Tc=40.3 min C=0.41 Runoff=1.49 cfs 5,362 cf**Subcatchment WS-2: WS-2**Runoff Area=226,019 sf 0.00% Impervious Runoff Depth=0.88"
Flow Length=388' Tc=9.7 min C=0.40 Runoff=4.63 cfs 16,650 cf**Pond 1P: PND #1**Peak Elev=74.17' Storage=4,291 cf Inflow=1.49 cfs 5,362 cf
Discarded=0.21 cfs 2,098 cf Primary=0.06 cfs 35 cf Outflow=0.27 cfs 2,134 cf**Link POA-INF: POA- INF**Inflow=0.06 cfs 35 cf
Primary=0.06 cfs 35 cf**Link POA-ISO: POA- ISO WETLANDS**Inflow=4.63 cfs 16,650 cf
Primary=4.63 cfs 16,650 cf**Link TOTAL: POA- TOTAL**Inflow=4.63 cfs 16,685 cf
Primary=4.63 cfs 16,685 cf**Total Runoff Area = 297,029 sf Runoff Volume = 22,012 cf Average Runoff Depth = 0.89"**
100.00% Pervious = 297,029 sf 0.00% Impervious = 0 sf

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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Summary for Subcatchment WS-1: WS-1

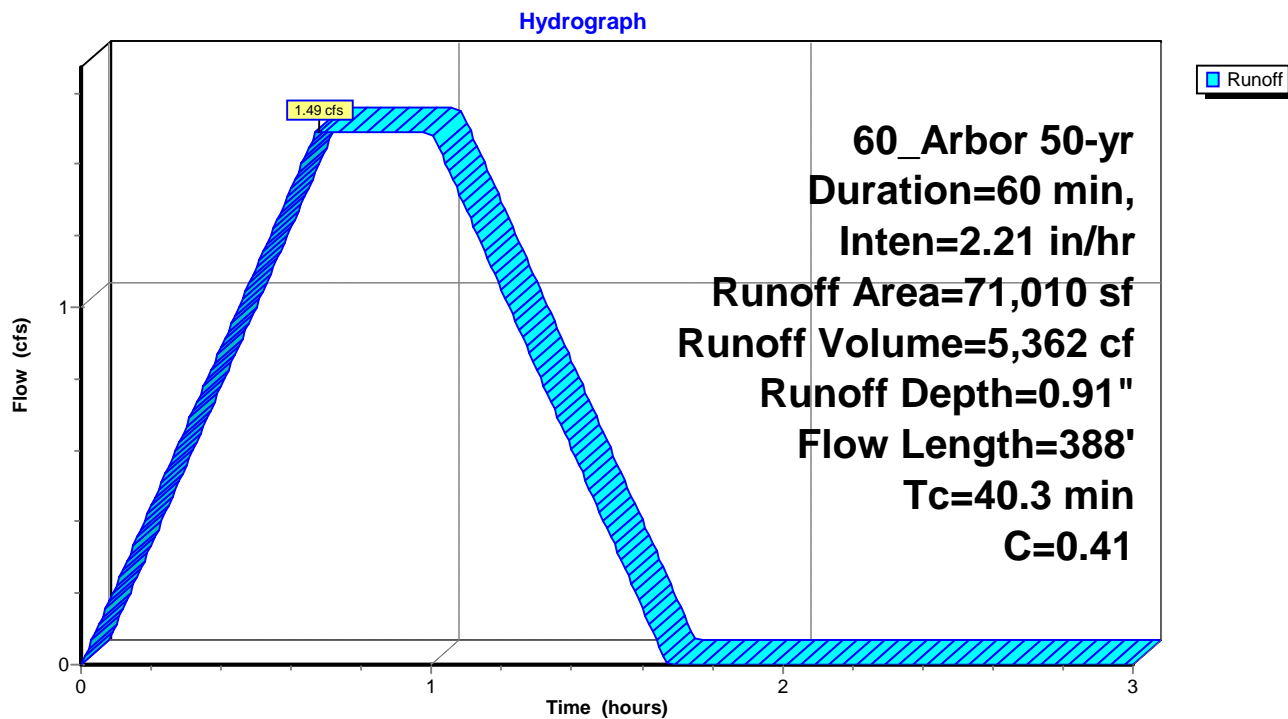
Runoff = 1.49 cfs @ 0.68 hrs, Volume= 5,362 cf, Depth= 0.91"
 Routed to Pond 1P : PND #1

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

Area (sf)	C	Description
7,606	0.80	Paved parking, HSG A
2,202	0.85	Roofs, HSG A
2,827	0.30	>75% Grass cover, Good, HSG A
58,375	0.35	Woods/grass comb., Fair, HSG A
71,010	0.41	Weighted Average
71,010		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.0	200	0.0720	0.09		Sheet Flow, Sheet
					Woods: Dense underbrush n= 0.800 P2= 3.20"
0.2	47	0.4680	3.42		Shallow Concentrated Flow, Shallow
					Woodland Kv= 5.0 fps
0.6	57	0.0578	1.68		Shallow Concentrated Flow, Shallow
					Short Grass Pasture Kv= 7.0 fps
0.5	84	0.0357	2.83		Shallow Concentrated Flow, Shallow
					Grassed Waterway Kv= 15.0 fps
40.3	388	Total			

Subcatchment WS-1: WS-1



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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Summary for Subcatchment WS-2: WS-2

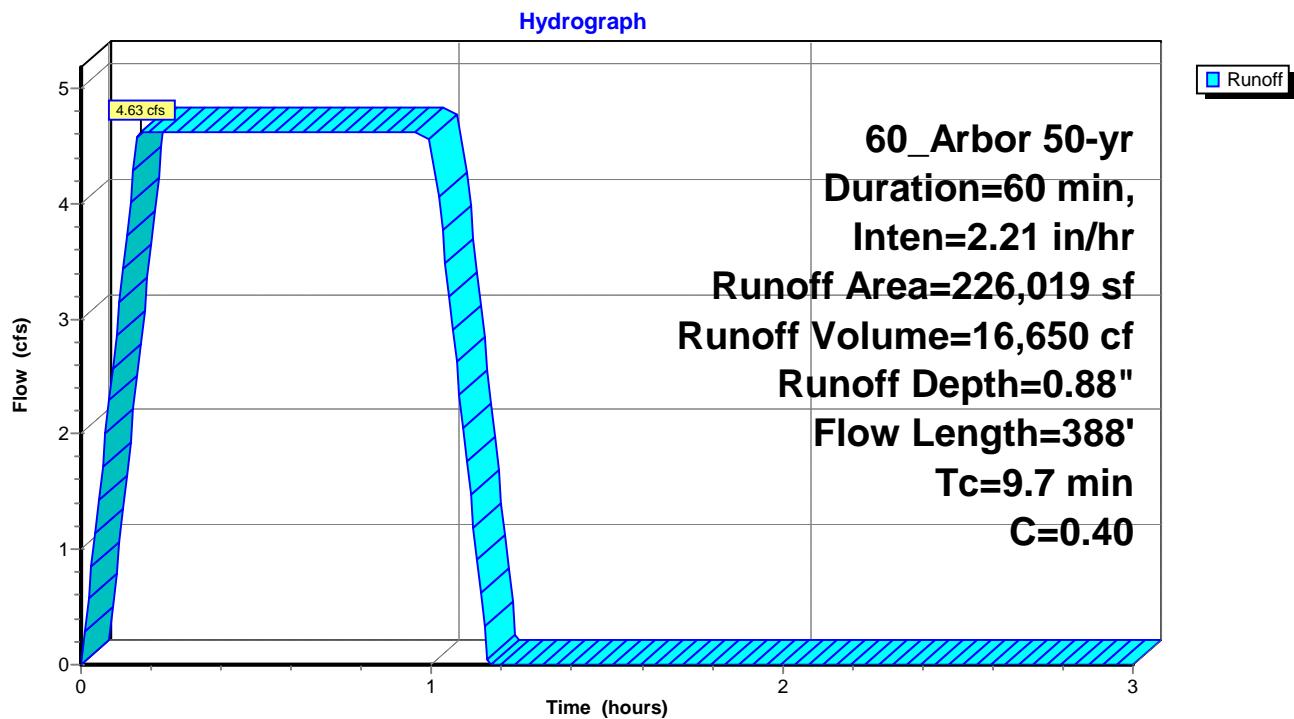
Runoff = 4.63 cfs @ 0.17 hrs, Volume= 16,650 cf, Depth= 0.88"
 Routed to Link POA-ISO : POA- ISO WETLANDS

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

Area (sf)	C	Description
207,036	0.35	Woods, Fair, HSG A
3,080	0.90	Roofs, HSG A
1,009	0.85	Paved parking, HSG A
14,894	0.90	Paved roads w/curbs & sewers, HSG A
226,019	0.40	Weighted Average
226,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.2200	0.18		Sheet Flow, Sheet Flow
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.2	41	0.5200	3.61		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.8	87	0.0110	0.52		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
2.0	210	0.1239	1.76		Shallow Concentrated Flow, Shallow Concentrated Flow
					Woodland Kv= 5.0 fps
9.7	388	Total			

Subcatchment WS-2: WS-2



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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Summary for Pond 1P: PND #1

Inflow Area = 71,010 sf, 0.00% Impervious, Inflow Depth = 0.91" for 50-yr event
 Inflow = 1.49 cfs @ 0.68 hrs, Volume= 5,362 cf
 Outflow = 0.27 cfs @ 1.55 hrs, Volume= 2,134 cf, Atten= 82%, Lag= 52.1 min
 Discarded = 0.21 cfs @ 0.37 hrs, Volume= 2,098 cf
 Primary = 0.06 cfs @ 1.55 hrs, Volume= 35 cf
 Routed to Link POA-INF : POA- INF

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Peak Elev= 74.17' @ 1.55 hrs Surf.Area= 1,101 sf Storage= 4,291 cf

Plug-Flow detention time= 67.9 min calculated for 2,134 cf (40% of inflow)
 Center-of-Mass det. time= 47.0 min (97.2 - 50.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	67.81'	2,088 cf	21.42'W x 51.39'L x 7.00'H Field A 7,704 cf Overall - 2,486 cf Embedded = 5,219 cf x 40.0% Voids
#2A	68.81'	2,486 cf	ADS StormTech MC-4500 +Cap x 22 Inside #1 Effective Size= 90.4"W x 60.0"H => 26.46 sf x 4.02'L = 106.5 cf Overall Size= 100.0"W x 60.0"H x 4.33'L with 0.31' Overlap 22 Chambers in 2 Rows Cap Storage= 35.7 cf x 2 x 2 rows = 142.8 cf
		4,573 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	74.00'	4.0" Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Discarded	67.81'	8.270 in/hr Exfiltration over Surface area Phase-In= 1.00'

Discarded OutFlow Max=0.21 cfs @ 0.37 hrs HW=68.82' (Free Discharge)
 ↑ **2=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=0.06 cfs @ 1.55 hrs HW=74.17' (Free Discharge)
 ↑ **1=Orifice/Grate** (Orifice Controls 0.06 cfs @ 1.40 fps)

Pond 1P: PND #1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech MC-4500 +Cap (ADS StormTech® MC-4500 with cap, use MC-4500 b for new designs)

Effective Size= 90.4"W x 60.0"H => 26.46 sf x 4.02'L = 106.5 cf

Overall Size= 100.0"W x 60.0"H x 4.33'L with 0.31' Overlap

Cap Storage= 35.7 cf x 2 x 2 rows = 142.8 cf

100.0" Wide + 9.0" Spacing = 109.0" C-C Row Spacing

11 Chambers/Row x 4.02' Long +2.56' Cap Length x 2 = 49.39' Row Length +12.0" End Stone x 2 = 51.39' Base Length

2 Rows x 100.0" Wide + 9.0" Spacing x 1 + 24.0" Side Stone x 2 = 21.42' Base Width

12.0" Stone Base + 60.0" Chamber Height + 12.0" Stone Cover = 7.00' Field Height

22 Chambers x 106.5 cf + 35.7 cf Cap Volume x 2 x 2 Rows = 2,485.6 cf Chamber Storage

7,704.5 cf Field - 2,485.6 cf Chambers = 5,218.9 cf Stone x 40.0% Voids = 2,087.6 cf Stone Storage

Chamber Storage + Stone Storage = 4,573.1 cf = 0.105 af

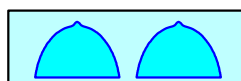
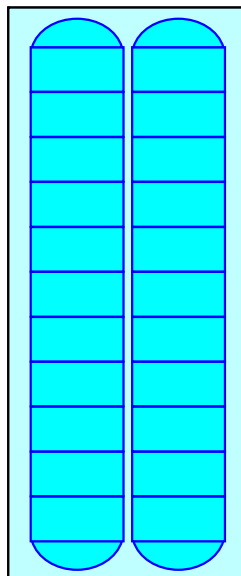
Overall Storage Efficiency = 59.4%

Overall System Size = 51.39' x 21.42' x 7.00'

22 Chambers

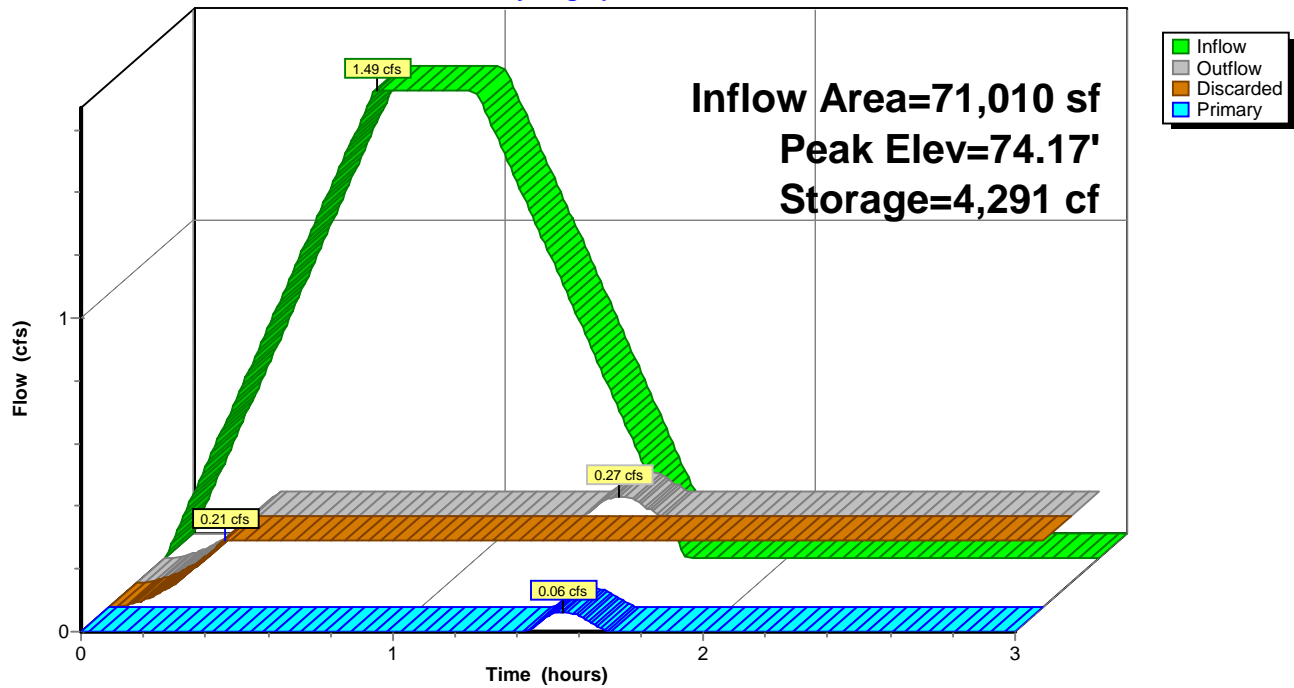
285.4 cy Field

193.3 cy Stone



Pond 1P: PND #1

Hydrograph



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60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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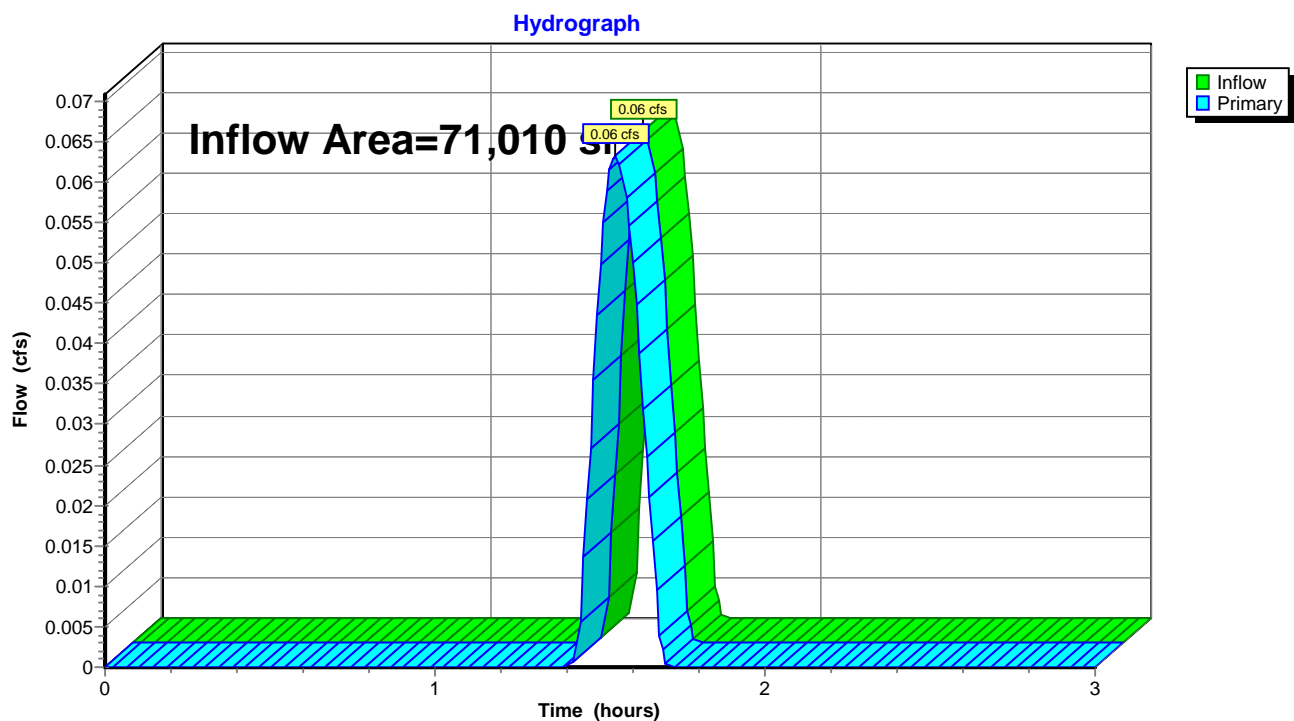
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Summary for Link POA-INF: POA- INF

Inflow Area = 71,010 sf, 0.00% Impervious, Inflow Depth = 0.01" for 50-yr event
Inflow = 0.06 cfs @ 1.55 hrs, Volume= 35 cf
Primary = 0.06 cfs @ 1.55 hrs, Volume= 35 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : POA- TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

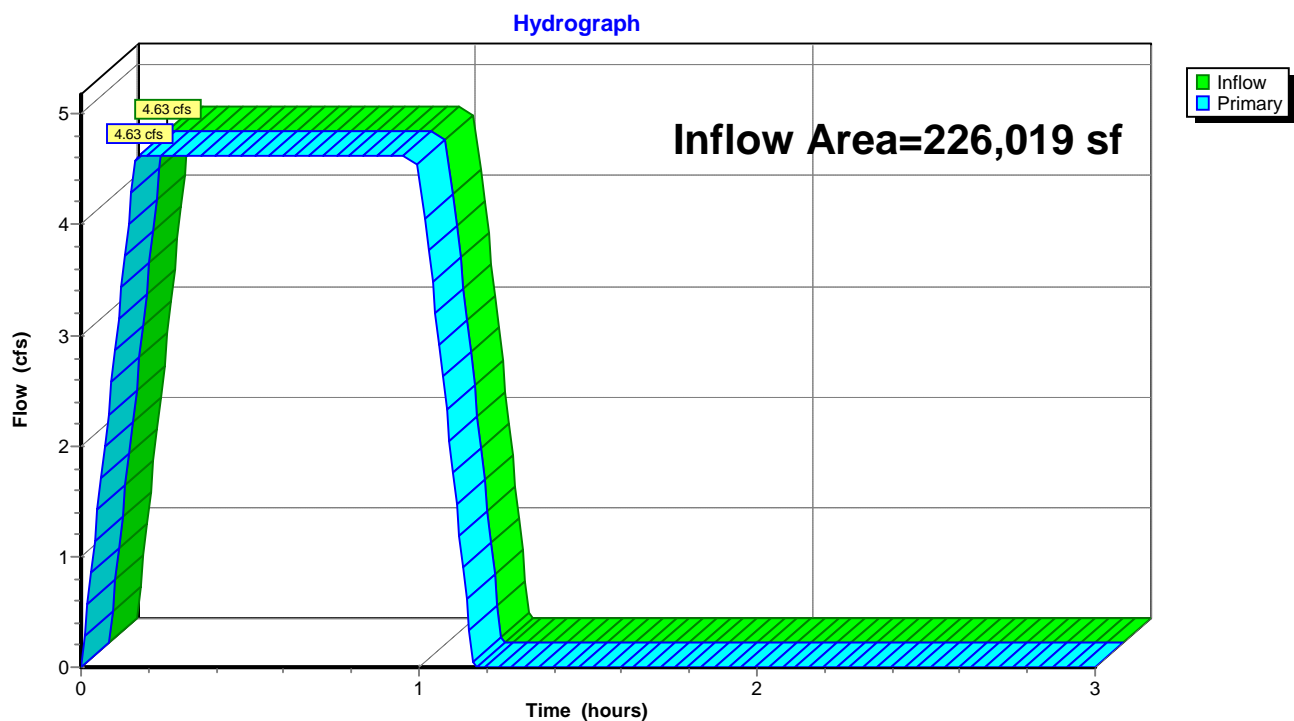
Link POA-INF: POA- INF



Summary for Link POA-ISO: POA- ISO WETLANDS

Inflow Area = 226,019 sf, 0.00% Impervious, Inflow Depth = 0.88" for 50-yr event
Inflow = 4.63 cfs @ 0.17 hrs, Volume= 16,650 cf
Primary = 4.63 cfs @ 0.17 hrs, Volume= 16,650 cf, Atten= 0%, Lag= 0.0 min
Routed to Link TOTAL : POA- TOTAL

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link POA-ISO: POA- ISO WETLANDS

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60 Arbor Street, Wenham

60_Arbor 50-yr Duration=60 min, Inten=2.21 in/hr

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Summary for Link TOTAL: POA- TOTAL

Inflow Area = 297,029 sf, 0.00% Impervious, Inflow Depth = 0.67" for 50-yr event
Inflow = 4.63 cfs @ 0.17 hrs, Volume= 16,685 cf
Primary = 4.63 cfs @ 0.17 hrs, Volume= 16,685 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Link TOTAL: POA- TOTAL

