STORM WATER MANAGEMENT CALCULATIONS

Glenn Ridge Apartments
Morgantown, West Virginia

Prepared for:

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April 30, 2015

Project No. 13-053

Cheat Road Engineering, Inc.

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STORM WATER MANAGEMENT CALCULATIONS
GLENN STREET APARTMENTS

1.0 Purpose

The purpose of the included calculations is to provide a storm water management (SWM) system design that meets or exceeds the requirements of the Morgantown Utility Board (MUB) for the proposed Glenn Street Apartment complex in Morgantown, WV. (See Attachment A for a project location map). For new developments MUB requires that the 2-year, 10-year, and 50-year storms are controlled so that the post development discharge rates are equal to the pre-development discharge rates for the same return interval storm for redevelopment activities. Included with this report are the design calculations for the proposed SWM system. Appendix A shows the project location map, drainage area, site plan, and SWM system construction details.

2.0 Calculations

The SWM system was designed using hydrology program HydroCad. HydroCad utilizes the TR-20 method to determine the storage volumes that are required to control the design storm events. This method of calculation does not account for the time required for water to infiltrate the topsoil and gravel layers, therefore the results provided are conservative in nature. Volumes provided in the calculations are based on a void ratio of 40% within the gravel storage area.

3.0 Results

3.1 SWM System

Shown below are a summary of the results from the SWM system design calculations. Additional SWM system calculations are provided in Appendix B.

Table 1: Summary of SWM System Design Flow Rates

Design Storm	Peak Flow Rate (cfs)				
	Existing Conditions	Allowable Discharge	Uncontrolled Post Development	Controlled Post Development	Peak Discharge Requirement Achieved
2-yr	2.29	2.29	3.90	2.12	Y
10-yr	4.13	4.13	6.34	3.73	Y
50-yr	6.18	6.18	8.87	5.81	Y

The model results show that the proposed SWM system will meet and / or exceed the requirements of MUB with regards to the 2-Year, 10-Year, and 50-Year design storm events. In

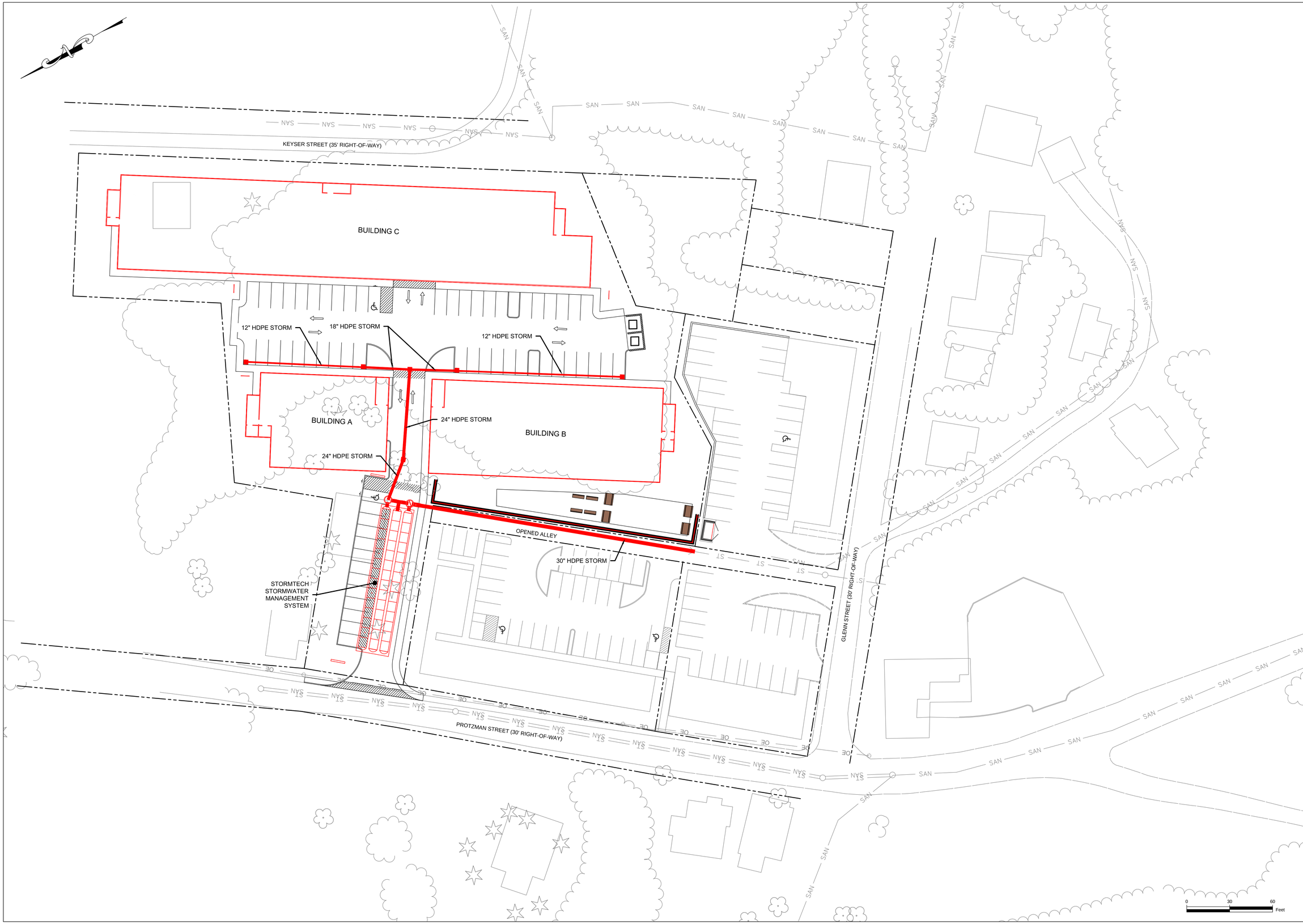
addition, the use of the topsoil and gravel storage area provides the necessary water quality treatment as required by MUB.

4.0 Summary of Results and Recommendations

The system, as designed would provide adequate storage to meet MUB's requirements by not increasing the peak discharge from the existing site for the 2-Year, 10-Year, and 50-Year design storm events. Without this stormwater system, the peak discharge coming off of the proposed development would be increased by approximately 40 percent. That is why it is CRE's recommendation that the system be installed as per the plans and construction details provided in the attached appendices.

APPENDIX A

Site Location Map, Bypass Culvert Drainage Area Map, Site Plan, SWM System Details



REV #	DATE	DESCRIPTION	BY

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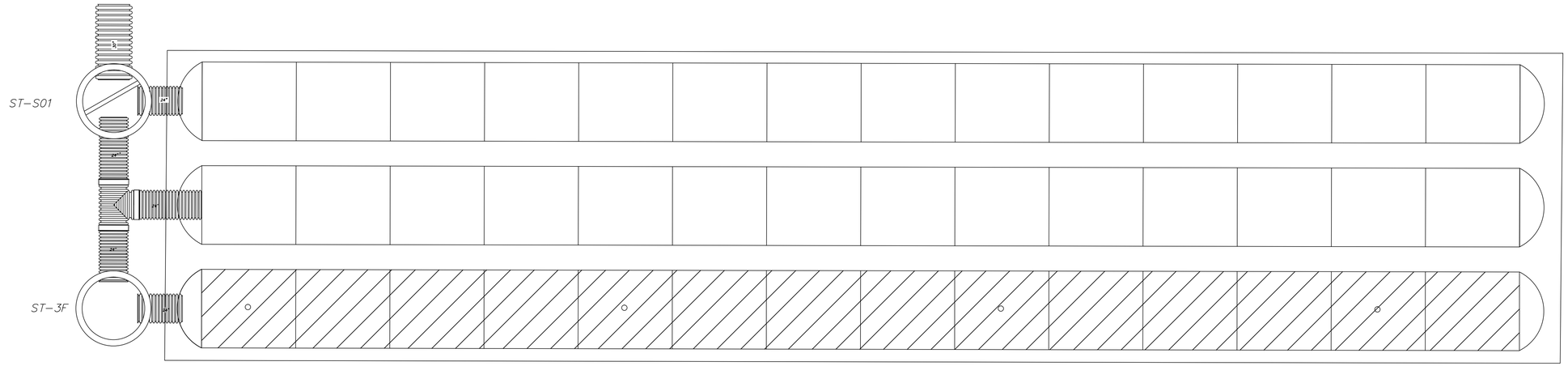
STAN CORP
GLENN RIDGE APARTMENTS
(OUTLINE PLAN)
MORGANTOWN, WV

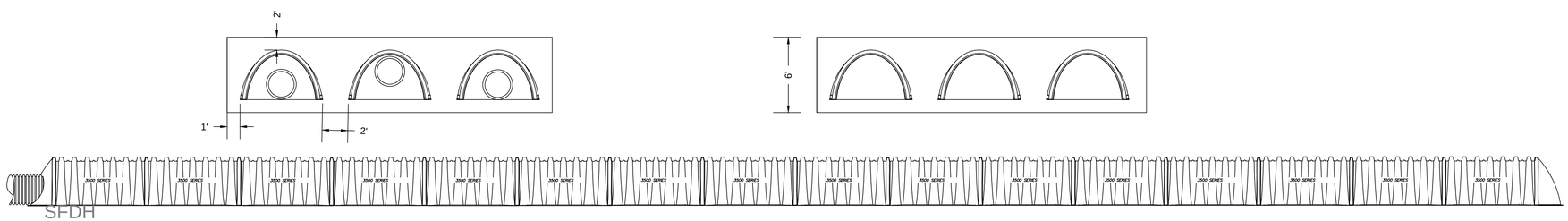
PROJECT NO: 13-053
DRAWING FILE: 13-053_DESIGN_REV.DWG

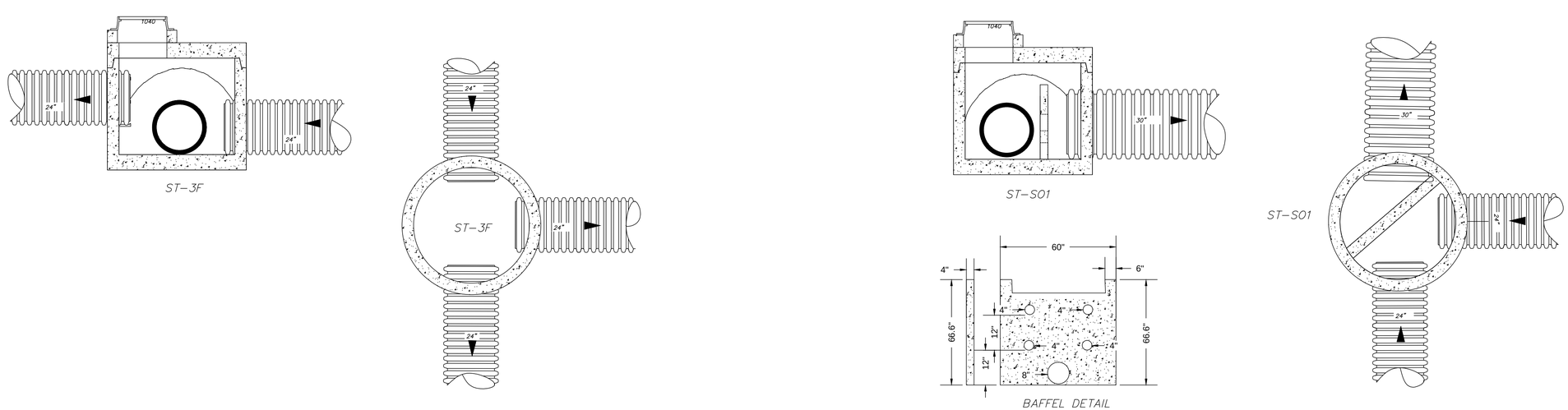
DRAWN BY: A.LINGER
CHECKED BY: B.BOWES
DRAWING SCALE: 1" = 30'
DRAWING DATE: APRIL 30, 2015

STORMWATER PLAN

SHEET NUMBER:
C-07







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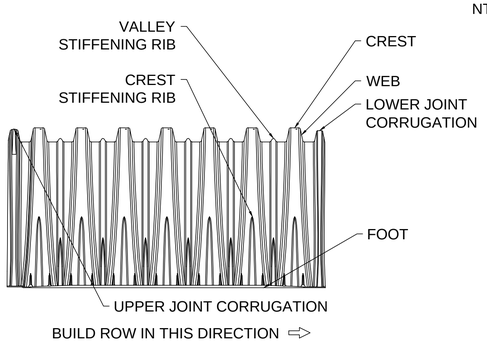
DRAWN BY:	G. SEPP
CHECKED BY:	S.COPEN
DRAWING SCALE:	N.T.S
DRAWING DATE:	April 30, 2015

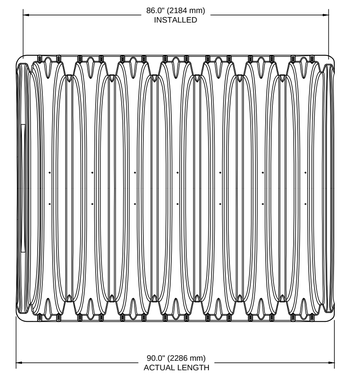
SWM DETAILS

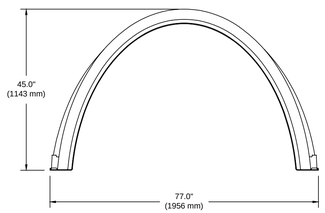
SHEET NUMBER:
C-900

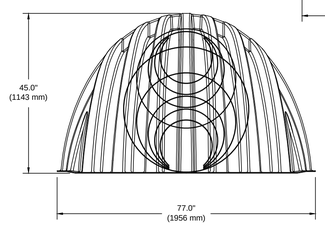
MC-3500 TECHNICAL SPECIFICATION

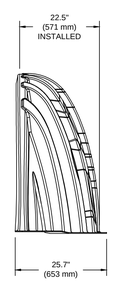
NTS











NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	77.0" X 45.0" X 86.0"	(1956 mm X 1143 mm X 2184 mm)
CHAMBER STORAGE	109.9 CUBIC FEET	(3.11 m³)
MINIMUM INSTALLED STORAGE*	178.9 CUBIC FEET	(5.06 m³)
WEIGHT	135.0 lbs.	(61.2 kg)

NOMINAL END CAP SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	77.0" X 45.0" X 22.5"	(1956 mm X 1143 mm X 571 mm)
END CAP STORAGE	14.9 CUBIC FEET	(0.42 m³)
MINIMUM INSTALLED STORAGE*	46.0 CUBIC FEET	(1.30 m³)
WEIGHT	50.0 lbs.	(22.7 kg)

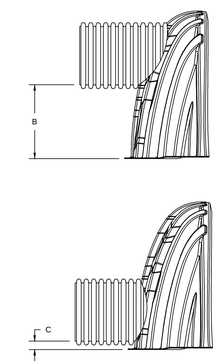
*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS, 12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY

STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"

PART #	STUB	B	C
MC3500IEPP06T	6" (150 mm)	33.21" (844 mm)	---
MC3500IEPP06B		---	0.66" (17 mm)
MC3500IEPP08T	8" (200 mm)	31.16" (791 mm)	---
MC3500IEPP08B		---	0.81" (21 mm)
MC3500IEPP10T	10" (250 mm)	29.04" (738 mm)	---
MC3500IEPP10B		---	0.93" (24 mm)
MC3500IEPP12T	12" (300 mm)	26.36" (670 mm)	---
MC3500IEPP12B		---	1.35" (34 mm)
MC3500IEPP15T	15" (375 mm)	23.39" (594 mm)	---
MC3500IEPP15B		---	1.50" (38 mm)
MC3500IEPP18TC	18" (450 mm)	20.03" (509 mm)	---
MC3500IEPP18BC		---	1.77" (45 mm)
MC3500IEPP24TC	24" (600 mm)	14.48" (368 mm)	---
MC3500IEPP24BC		---	2.06" (52 mm)
MC3500IEPP30BC	30" (750 mm)	---	

NOTE: ALL DIMENSIONS ARE NOMINAL

CUSTOM PRECORED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS.
CUSTOM INVERT LOCATIONS ON THE MC-3500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm)
THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHTEST POSSIBLE FOR THE PIPE SIZE.



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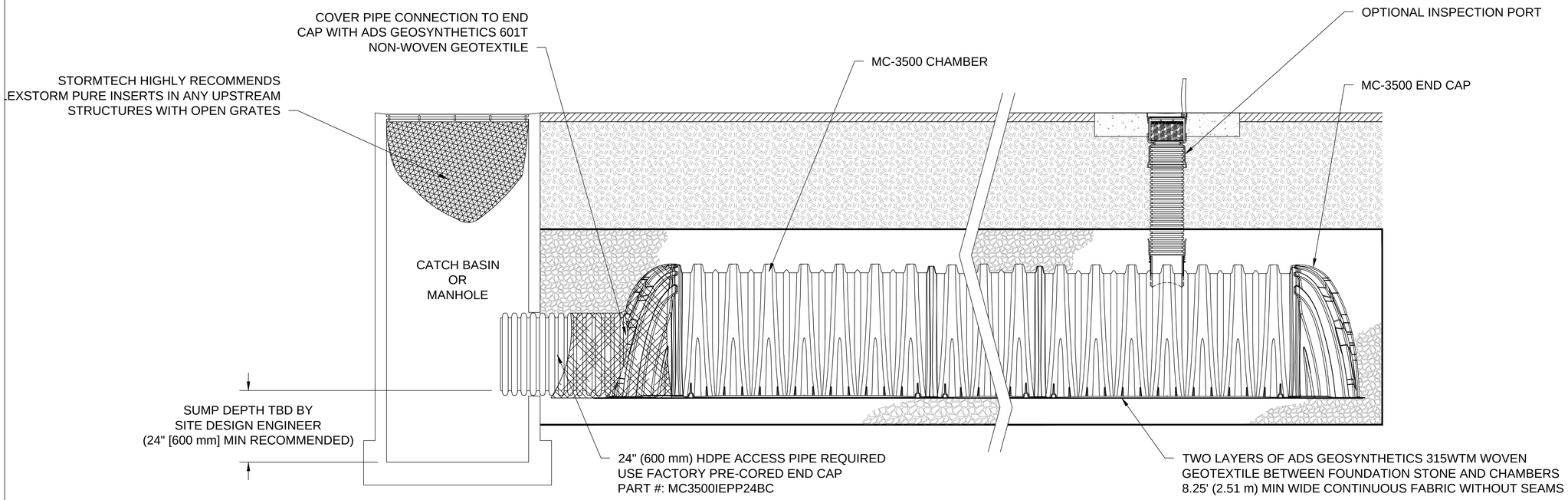
PROJECT NO: 13-053
DRAWING FILE: 13-053_DESIGN.DWG

DRAWN BY: G. SEPP
CHECKED BY: S.COPEN
DRAWING SCALE: N.T.S
DRAWING DATE: April 30, 2015

SWM DETAILS

SHEET NUMBER:
C-901



MC-3500 ISOLATOR ROW DETAIL

NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

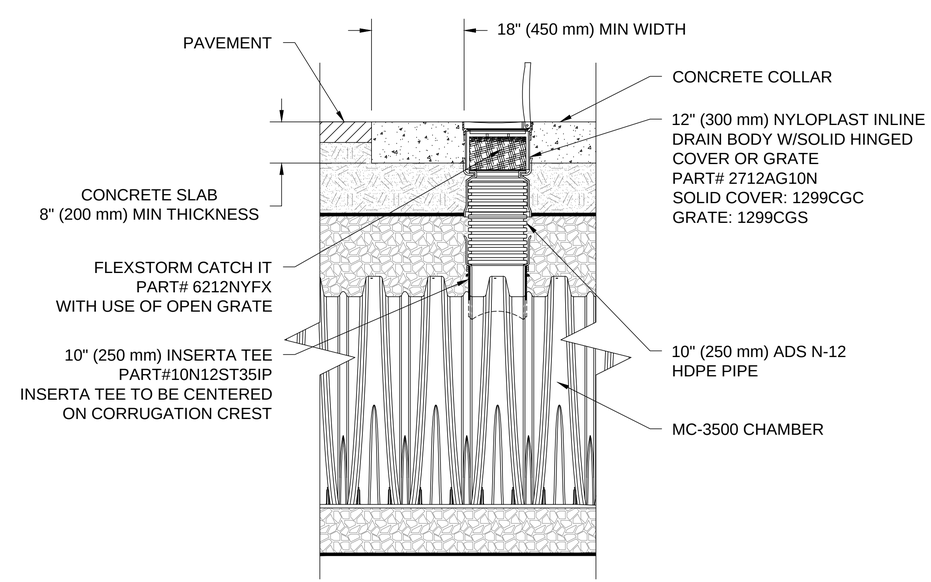
STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.

2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.



MC-3500 INSPECTION PORT DETAIL

NTS

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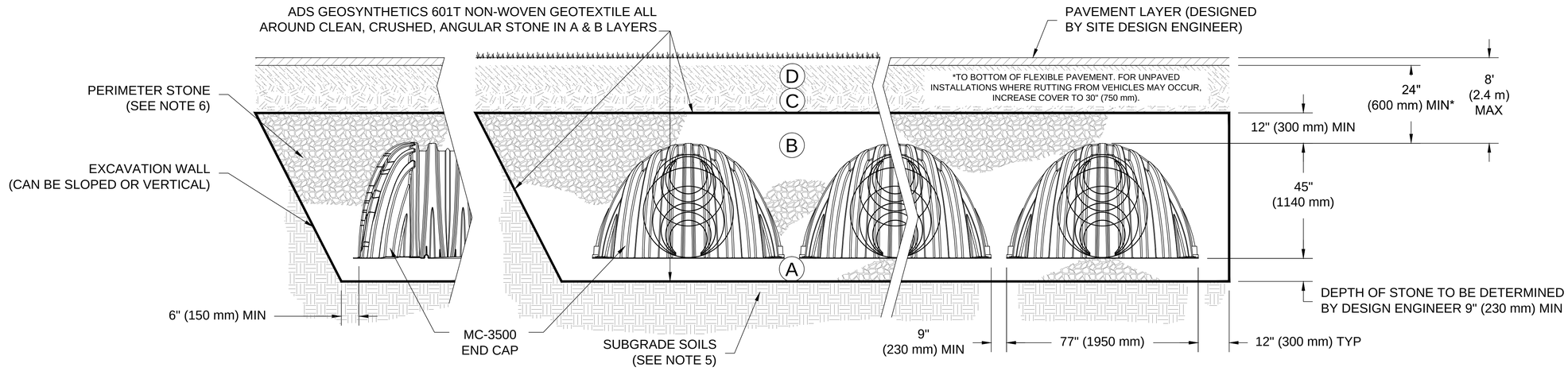
SWM DETAILS

SHEET NUMBER:
C-902

ACCEPTABLE FILL MATERIALS: STORMTECH MC-3500 CHAMBER SYSTEMS

MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE, NOMINAL SIZE DISTRIBUTION BETWEEN 3/4-2 INCH (20-50 mm)	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. [2] [3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



NOTES:

1. MC-3500 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE "SITE DESIGN ENGINEER" REFERS TO THE ENGINEER RESPONSIBLE FOR THE DESIGN AND LAYOUT OF THE STORMTECH CHAMBERS FOR THIS PROJECT.
5. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
6. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
7. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.

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DRAWN BY: G. SEPP
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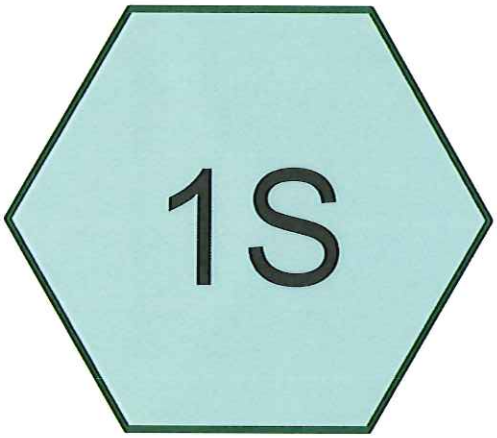
DRAWING SCALE: N.T.S
DRAWING DATE: April 30, 2015

SWM DETAILS

SHEET NUMBER:
C-903

APPENDIX B

SWM System Calculations



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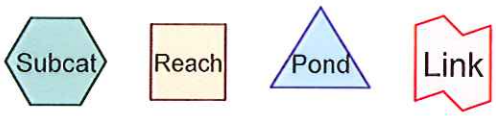


Summary for Subcatchment 1S: EXISTING

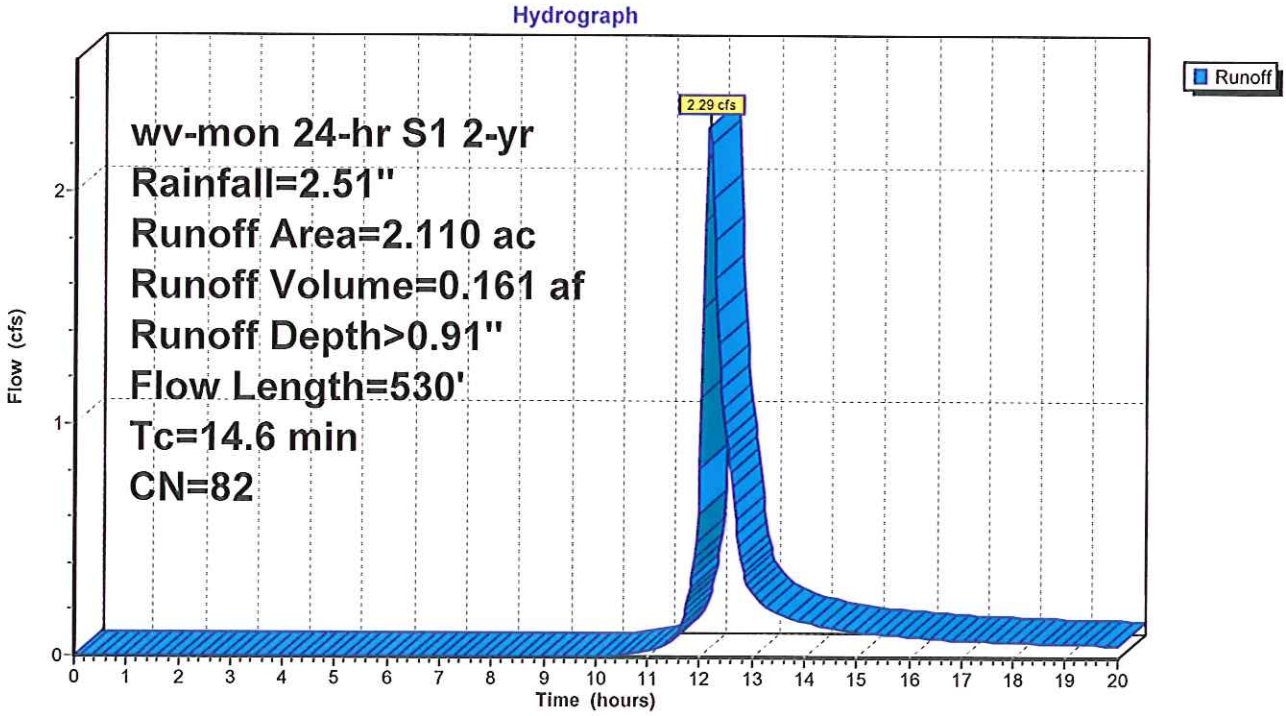
Runoff = 2.29 cfs @ 12.16 hrs, Volume= 0.161 af, Depth> 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
wv-mon 24-hr S1 2-yr Rainfall=2.51"

Area (ac)	CN	Description
2.110	82	Woods/grass comb., Poor, HSG C
2.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	150	0.2300	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.51"
1.8	250	0.2200	2.35		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	130	0.0900	12.69	38.06	**Channel Flow,** Area= 3.0 sf Perim= 5.0' r= 0.60' n= 0.025 Earth, clean & winding
14.6	530	Total			

Subcatchment 1S: EXISTING



Summary for Subcatchment 1S: EXISTING

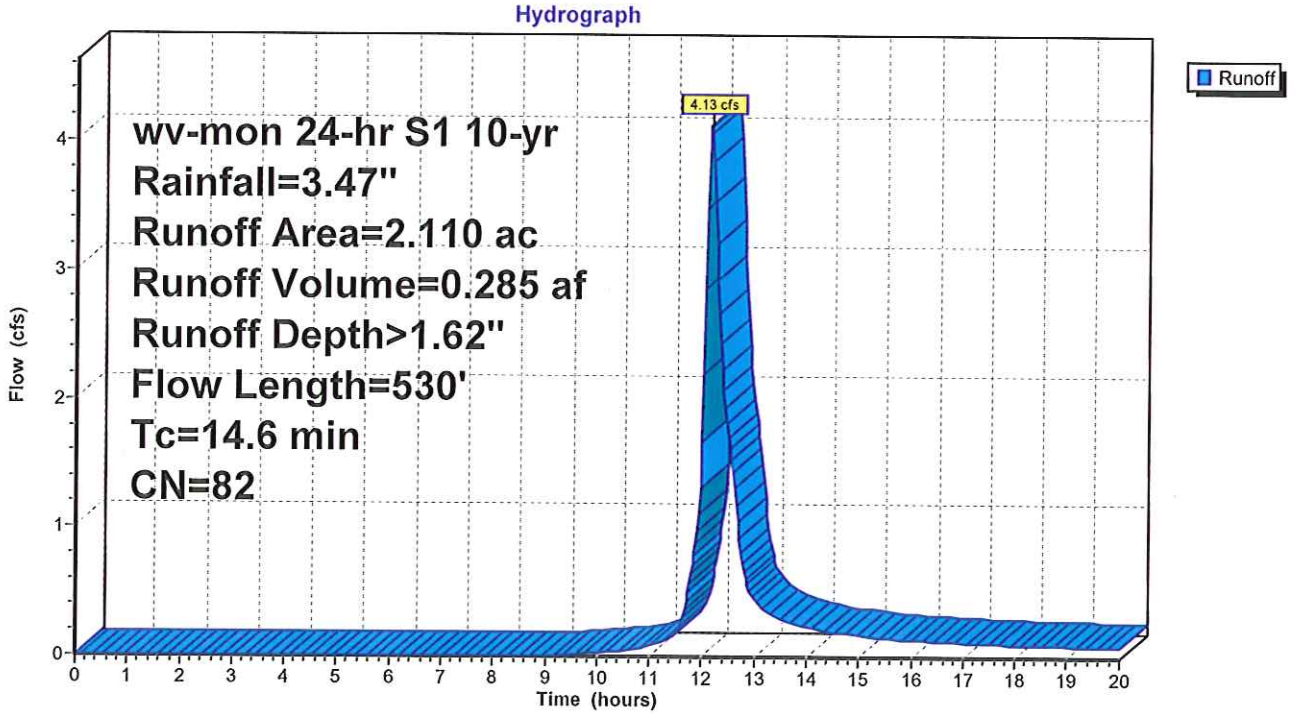
Runoff = 4.13 cfs @ 12.16 hrs, Volume= 0.285 af, Depth> 1.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
wv-mon 24-hr S1 10-yr Rainfall=3.47"

Area (ac)	CN	Description
2.110	82	Woods/grass comb., Poor, HSG C
2.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	150	0.2300	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.51"
1.8	250	0.2200	2.35		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	130	0.0900	12.69	38.06	**Channel Flow,** Area= 3.0 sf Perim= 5.0' r= 0.60' n= 0.025 Earth, clean & winding
14.6	530	Total			

Subcatchment 1S: EXISTING



Summary for Subcatchment 1S: EXISTING

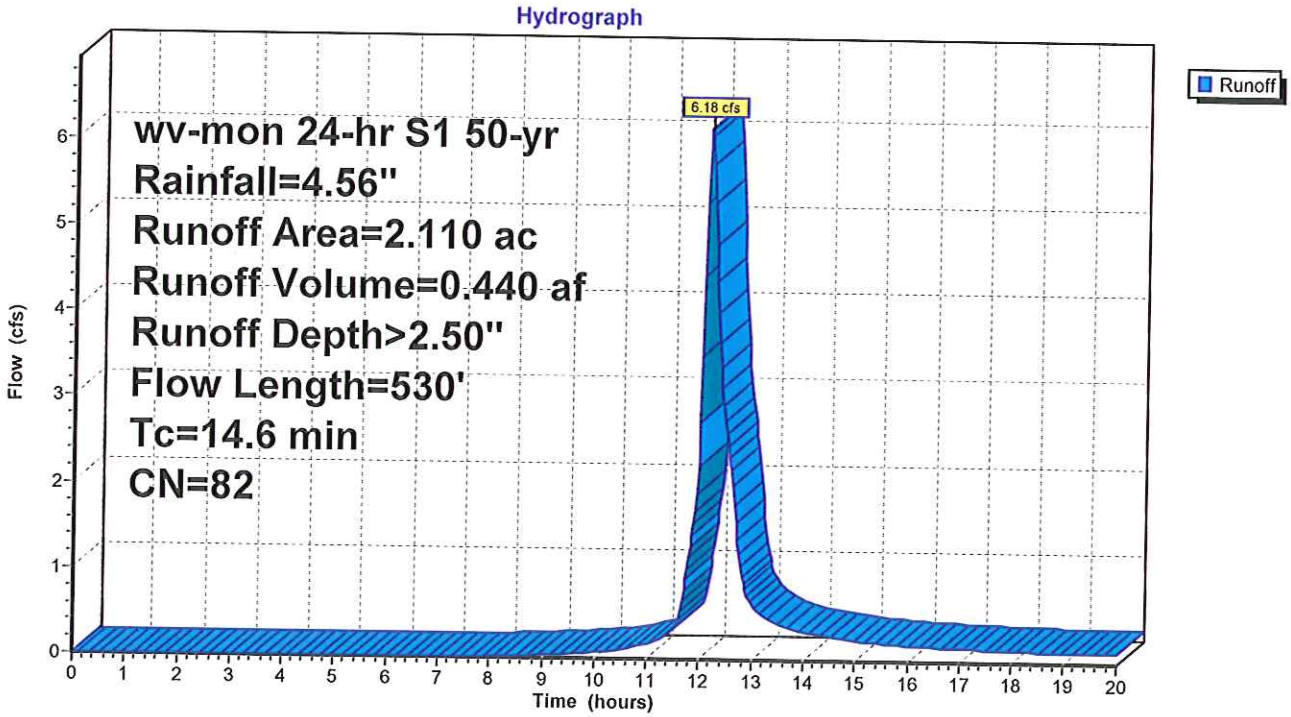
Runoff = 6.18 cfs @ 12.16 hrs, Volume= 0.440 af, Depth> 2.50"

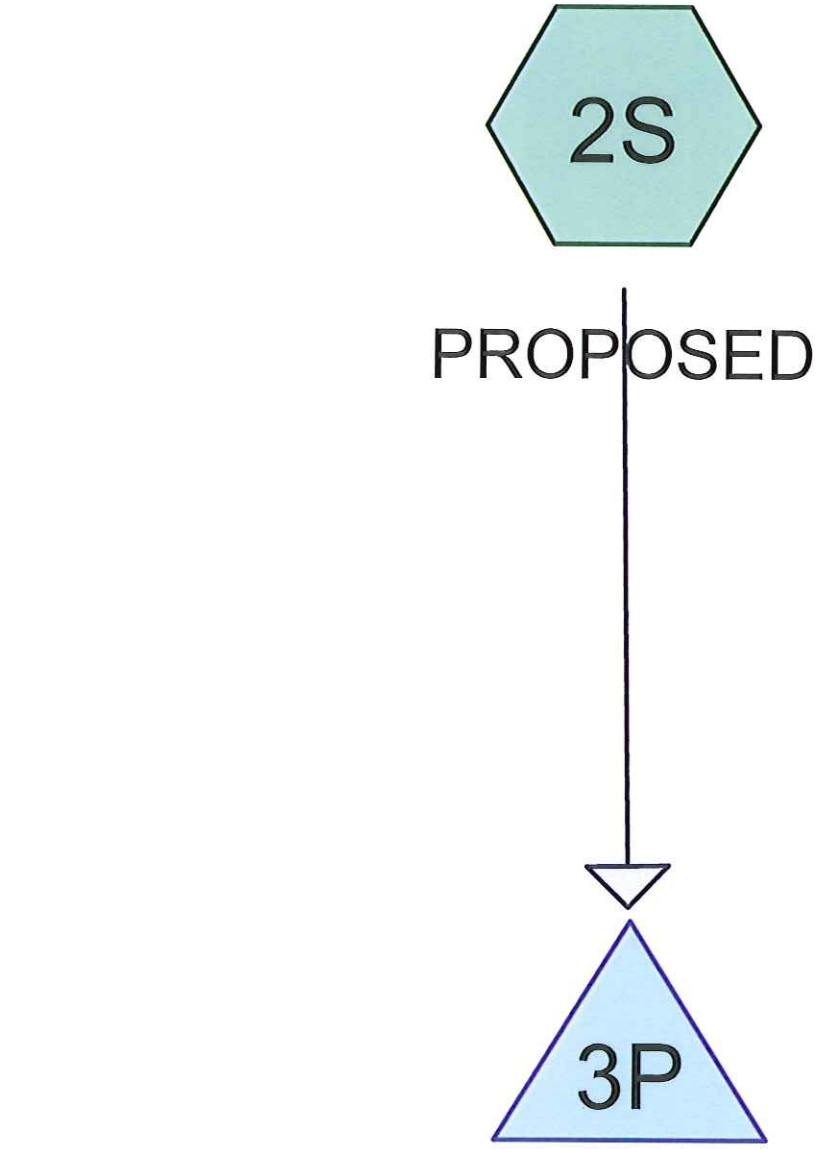
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
wv-mon 24-hr S1 50-yr Rainfall=4.56"

Area (ac)	CN	Description
2.110	82	Woods/grass comb., Poor, HSG C
2.110		100.00% Pervious Area

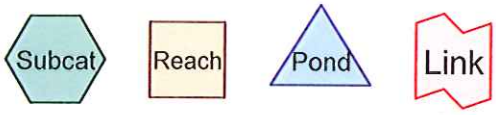
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	150	0.2300	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.51"
1.8	250	0.2200	2.35		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	130	0.0900	12.69	38.06	**Channel Flow,** Area= 3.0 sf Perim= 5.0' r= 0.60' n= 0.025 Earth, clean & winding
14.6	530	Total			

Subcatchment 1S: EXISTING





PROPOSED STORM TECH



Routing Diagram for STORM DESIGN
Prepared by {enter your company name here}, Printed 4/30/2015
HydroCAD® 10.00-13 s/n 08689 © 2014 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.600	61	>75% Grass cover, Good, HSG B (2S)
1.500	98	Paved parking, HSG C (2S)
2.100	**87**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.600	HSG B	2S
1.500	HSG C	2S
0.000	HSG D	
0.000	Other	
2.100		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.600	0.000	0.000	0.000	0.600	>75% Grass cover, Good	2S
0.000	0.000	1.500	0.000	0.000	1.500	Paved parking	2S
0.000	**0.600**	**1.500**	**0.000**	**0.000**	**2.100**	**TOTAL AREA**	

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	2S	0.00	0.00	125.0	0.0500	0.013	12.0	0.0	0.0
2	3P	1,001.00	998.50	30.0	0.0833	0.013	30.0	0.0	0.0

Time span=0.00-20.00 hrs, dt=0.03 hrs, 668 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: PROPOSED Runoff Area=2.100 ac 71.43% Impervious Runoff Depth>1.22"
Flow Length=475' Tc=8.7 min CN=87 Runoff=3.90 cfs 0.213 af

Pond 3P: PROPOSED STORM TECH Peak Elev=1,002.39' Storage=0.064 af Inflow=3.90 cfs 0.213 af
Outflow=2.12 cfs 0.187 af

Total Runoff Area = 2.100 ac Runoff Volume = 0.213 af Average Runoff Depth = 1.22"
28.57% Pervious = 0.600 ac 71.43% Impervious = 1.500 ac

Summary for Subcatchment 2S: PROPOSED

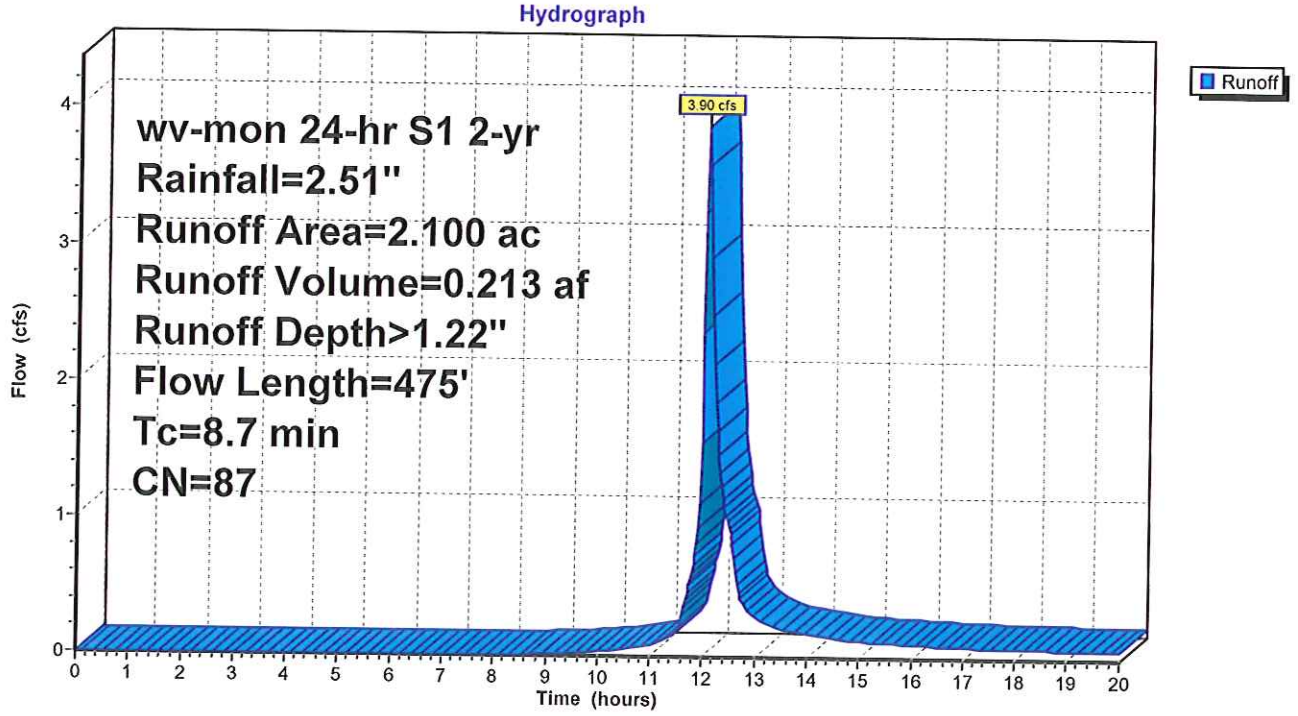
Runoff = 3.90 cfs @ 12.07 hrs, Volume= 0.213 af, Depth> 1.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
wv-mon 24-hr S1 2-yr Rainfall=2.51"

Area (ac)	CN	Description
0.600	61	>75% Grass cover, Good, HSG B
1.500	98	Paved parking, HSG C
2.100	87	Weighted Average
0.600		28.57% Pervious Area
1.500		71.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	200	0.2000	0.43		**Sheet Flow, GRASS SHEET FLOW** Grass: Short n= 0.150 P2= 2.51"
0.8	150	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	125	0.0500	10.14	7.97	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
8.7	475	Total			

Subcatchment 2S: PROPOSED



Summary for Pond 3P: PROPOSED STORM TECH

Inflow Area =	2.100 ac, 71.43% Impervious, Inflow Depth > 1.22" for 2-yr event			
Inflow =	3.90 cfs @ 12.07 hrs, Volume=	0.213 af		
Outflow =	2.12 cfs @ 12.22 hrs, Volume=	0.187 af, Atten= 45%, Lag= 8.5 min		
Primary =	2.12 cfs @ 12.22 hrs, Volume=	0.187 af		

Routing by Stor-Ind method, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
Peak Elev= 1,002.39' @ 12.22 hrs Surf.Area= 0.055 ac Storage= 0.064 af

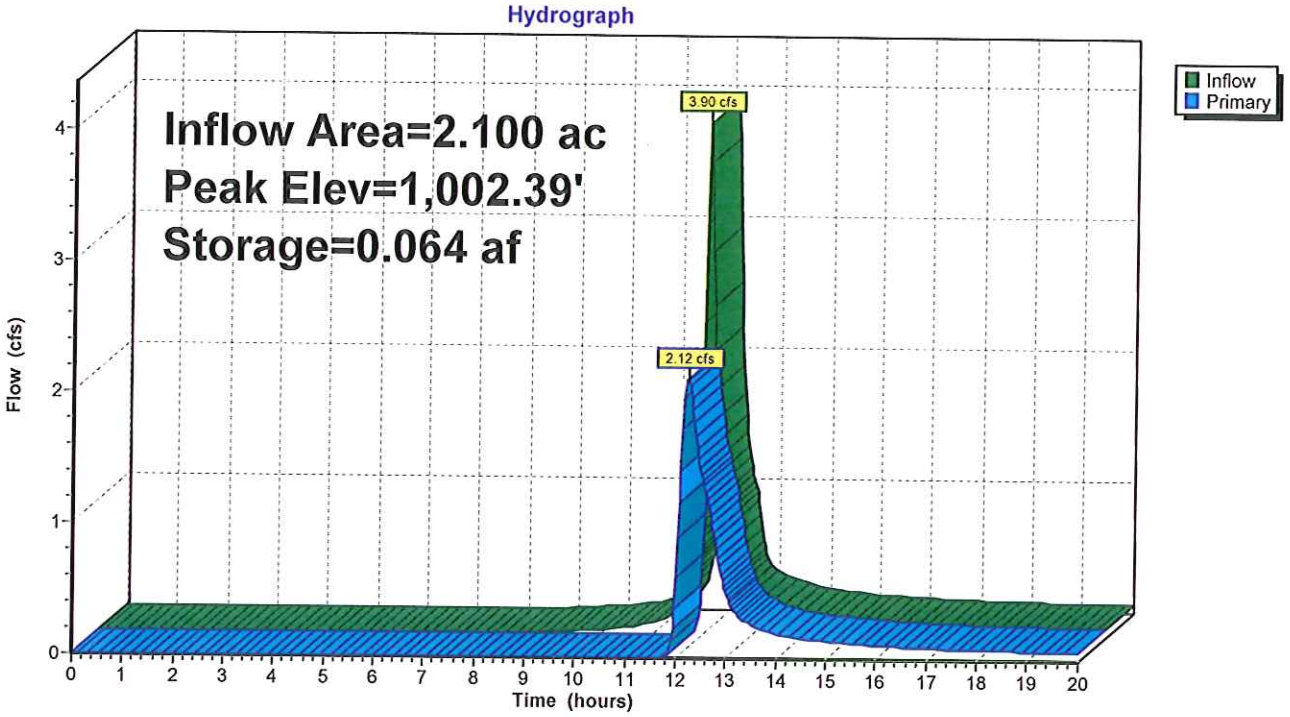
Plug-Flow detention time= 66.4 min calculated for 0.187 af (88% of inflow)
Center-of-Mass det. time= 27.8 min (818.8 - 791.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,000.00'	0.105 af	**22.80'W x 105.10'L x 5.50'H Prismatoid** 0.303 af Overall - 0.039 af Embedded = 0.264 af x 40.0% Voids
#2	1,001.00'	0.039 af	**ADS_StormTech MC-3500 d +Cap @ 105.10' L** Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 105.10'L = 1,611.7 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 3 Rows of 0 Chambers Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
		0.144 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	1,001.00'	**30.0" Round Culvert** L= 30.0' Ke= 0.900 Inlet / Outlet Invert= 1,001.00' / 998.50' S= 0.0833 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Device 1	1,001.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	1,002.00'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	1,003.00'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600
#5	Device 1	1,004.00'	**1.0' long x 4.0' 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 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=2.12 cfs @ 12.22 hrs HW=1,002.39' (Free Discharge)
└─**1=Culvert** (Passes 2.12 cfs of 8.87 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.73 cfs @ 4.95 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.40 cfs @ 2.27 fps)
  ├─**4=Orifice/Grate** (Controls 0.00 cfs)
  └─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: PROPOSED STORM TECH



Time span=0.00-20.00 hrs, dt=0.03 hrs, 668 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: PROPOSED Runoff Area=2.100 ac 71.43% Impervious Runoff Depth>2.01"
Flow Length=475' Tc=8.7 min CN=87 Runoff=6.34 cfs 0.352 af

Pond 3P: PROPOSED STORM TECH Peak Elev=1,003.39' Storage=0.093 af Inflow=6.34 cfs 0.352 af
Outflow=3.73 cfs 0.325 af

Total Runoff Area = 2.100 ac Runoff Volume = 0.352 af Average Runoff Depth = 2.01"
28.57% Pervious = 0.600 ac 71.43% Impervious = 1.500 ac

Summary for Subcatchment 2S: PROPOSED

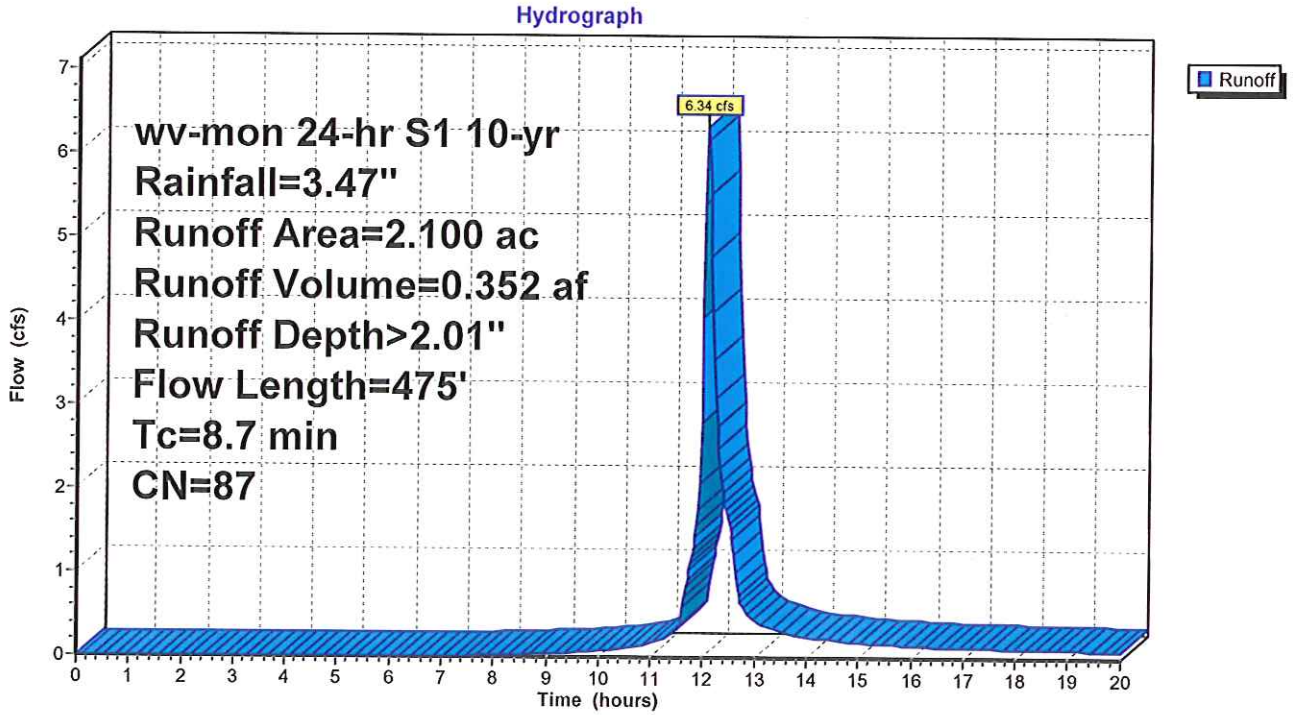
Runoff = 6.34 cfs @ 12.07 hrs, Volume= 0.352 af, Depth> 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
wv-mon 24-hr S1 10-yr Rainfall=3.47"

Area (ac)	CN	Description
0.600	61	>75% Grass cover, Good, HSG B
1.500	98	Paved parking, HSG C
2.100	87	Weighted Average
0.600		28.57% Pervious Area
1.500		71.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	200	0.2000	0.43		**Sheet Flow, GRASS SHEET FLOW** Grass: Short n= 0.150 P2= 2.51"
0.8	150	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	125	0.0500	10.14	7.97	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
8.7	475	Total			

Subcatchment 2S: PROPOSED



Summary for Pond 3P: PROPOSED STORM TECH

Inflow Area =	2.100 ac, 71.43% Impervious, Inflow Depth > 2.01" for 10-yr event			
Inflow =	6.34 cfs @ 12.07 hrs, Volume=	0.352 af		
Outflow =	3.73 cfs @ 12.20 hrs, Volume=	0.325 af, Atten= 41%, Lag= 7.8 min		
Primary =	3.73 cfs @ 12.20 hrs, Volume=	0.325 af		

Routing by Stor-Ind method, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
Peak Elev= 1,003.39' @ 12.20 hrs Surf.Area= 0.055 ac Storage= 0.093 af

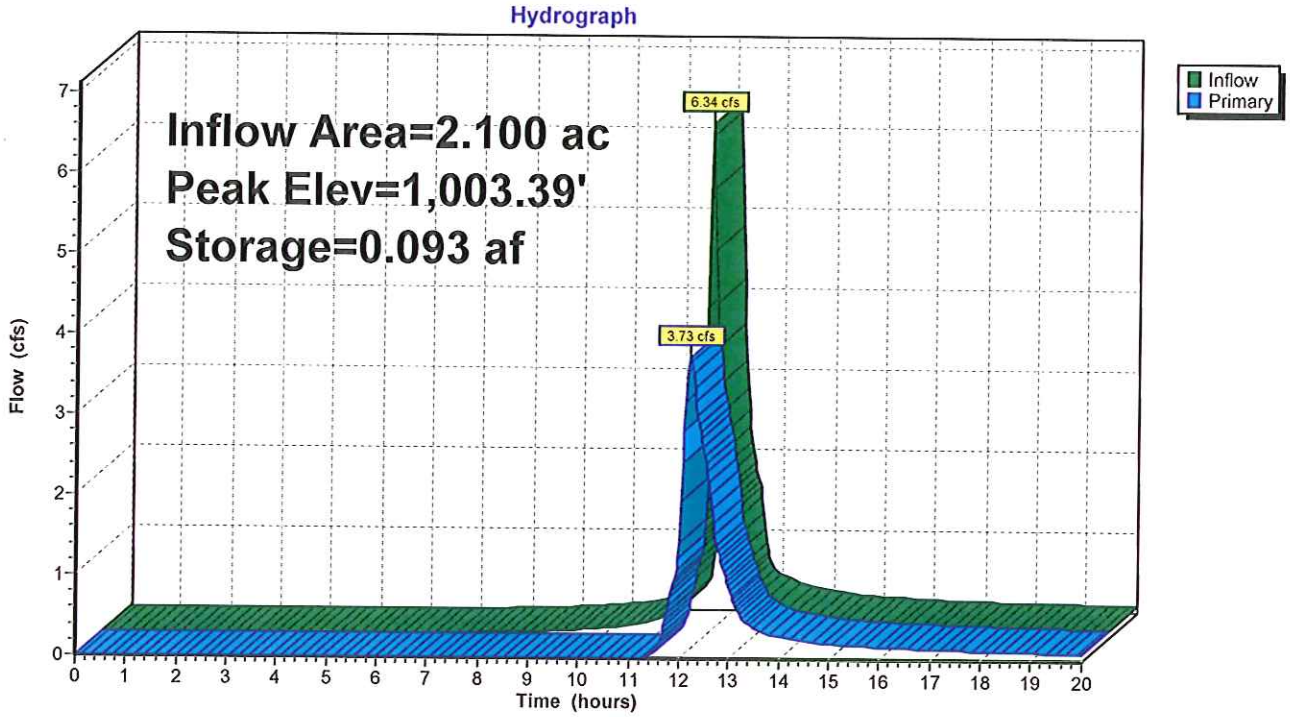
Plug-Flow detention time= 50.8 min calculated for 0.325 af (92% of inflow)
Center-of-Mass det. time= 24.2 min (803.0 - 778.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,000.00'	0.105 af	**22.80'W x 105.10'L x 5.50'H Prismatoid** 0.303 af Overall - 0.039 af Embedded = 0.264 af x 40.0% Voids
#2	1,001.00'	0.039 af	**ADS_StormTech MC-3500 d +Cap @ 105.10' L** Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 105.10'L = 1,611.7 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 3 Rows of 0 Chambers Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
		0.144 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	1,001.00'	**30.0" Round Culvert** L= 30.0' Ke= 0.900 Inlet / Outlet Invert= 1,001.00' / 998.50' S= 0.0833 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Device 1	1,001.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	1,002.00'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	1,003.00'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600
#5	Device 1	1,004.00'	**1.0' long x 4.0' 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 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=3.72 cfs @ 12.20 hrs HW=1,003.38' (Free Discharge)
└─**1=Culvert** (Passes 3.72 cfs of 20.02 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 2.41 cfs @ 6.89 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.93 cfs @ 5.31 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.39 cfs @ 2.24 fps)
  └─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: PROPOSED STORM TECH



Time span=0.00-20.00 hrs, dt=0.03 hrs, 668 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: PROPOSED Runoff Area=2.100 ac 71.43% Impervious Runoff Depth>2.96"
Flow Length=475' Tc=8.7 min CN=87 Runoff=8.87 cfs 0.518 af

Pond 3P: PROPOSED STORM TECH Peak Elev=1,004.41' Storage=0.120 af Inflow=8.87 cfs 0.518 af
Outflow=5.81 cfs 0.491 af

Total Runoff Area = 2.100 ac Runoff Volume = 0.518 af Average Runoff Depth = 2.96"
28.57% Pervious = 0.600 ac 71.43% Impervious = 1.500 ac

Summary for Subcatchment 2S: PROPOSED

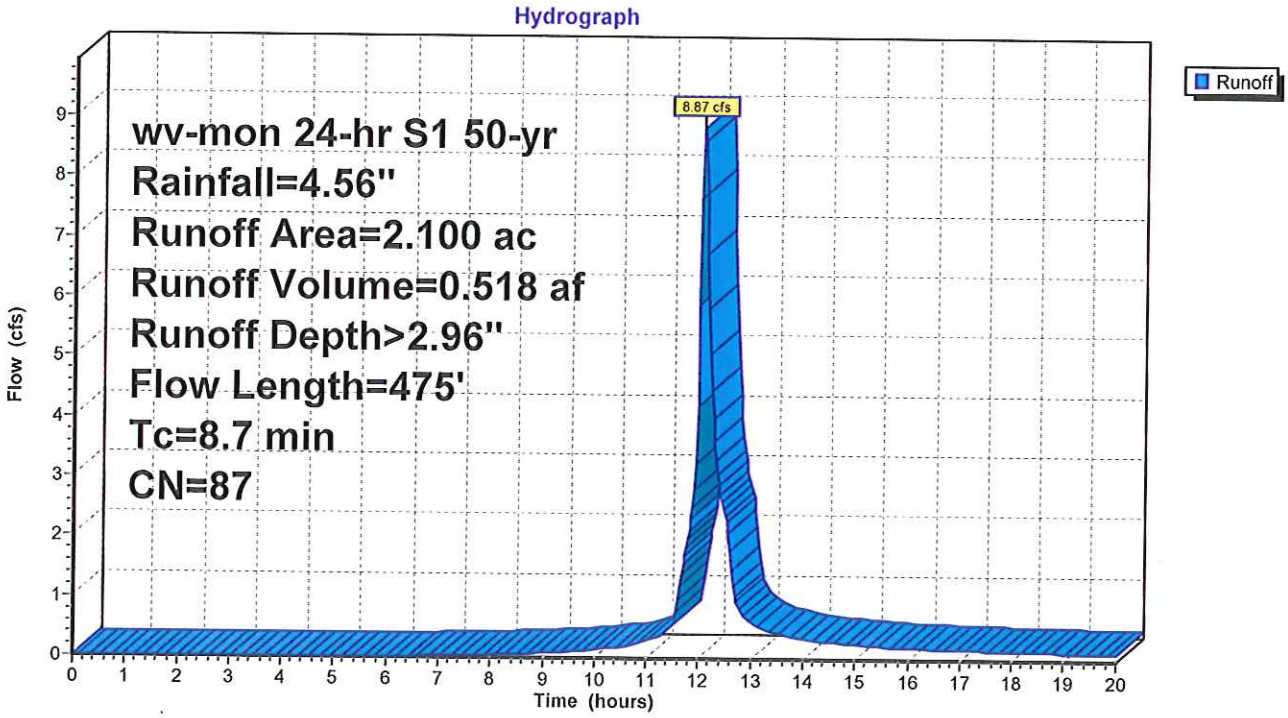
Runoff = 8.87 cfs @ 12.07 hrs, Volume= 0.518 af, Depth> 2.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
wv-mon 24-hr S1 50-yr Rainfall=4.56"

Area (ac)	CN	Description
0.600	61	>75% Grass cover, Good, HSG B
1.500	98	Paved parking, HSG C
2.100	87	Weighted Average
0.600		28.57% Pervious Area
1.500		71.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	200	0.2000	0.43		**Sheet Flow, GRASS SHEET FLOW** Grass: Short n= 0.150 P2= 2.51"
0.8	150	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	125	0.0500	10.14	7.97	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
8.7	475	Total			

Subcatchment 2S: PROPOSED



Summary for Pond 3P: PROPOSED STORM TECH

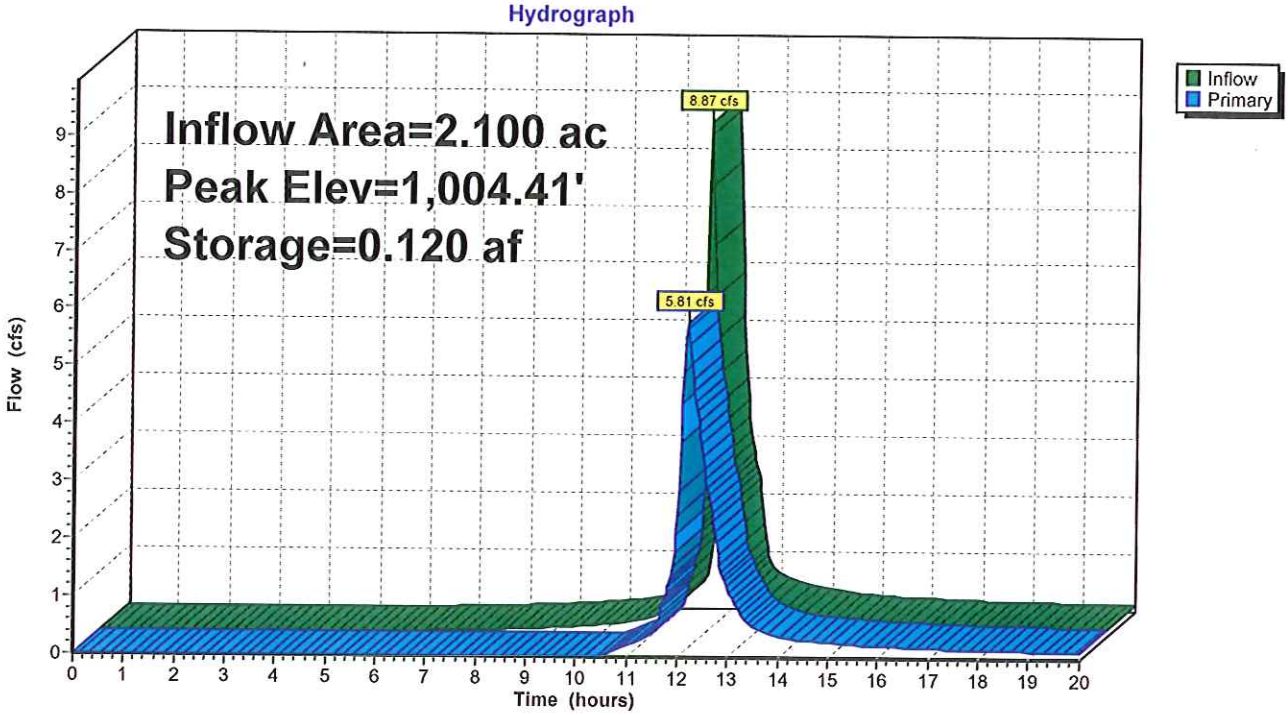
Inflow Area =	2.100 ac, 71.43% Impervious, Inflow Depth > 2.96" for 50-yr event				
Inflow =	8.87 cfs @ 12.07 hrs, Volume=	0.518 af			
Outflow =	5.81 cfs @ 12.19 hrs, Volume=	0.491 af, Atten= 34%, Lag= 6.9 min			
Primary =	5.81 cfs @ 12.19 hrs, Volume=	0.491 af			

Routing by Stor-Ind method, Time Span= 0.00-20.01 hrs, dt= 0.03 hrs
Peak Elev= 1,004.41' @ 12.19 hrs Surf.Area= 0.055 ac Storage= 0.120 af

Plug-Flow detention time= 42.4 min calculated for 0.490 af (94% of inflow)
Center-of-Mass det. time= 22.8 min (793.1 - 770.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,000.00'	0.105 af	**22.80'W x 105.10'L x 5.50'H Prismatoid** 0.303 af Overall - 0.039 af Embedded = 0.264 af x 40.0% Voids
#2	1,001.00'	0.039 af	**ADS_StormTech MC-3500 d +Cap @ 105.10' L** Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 105.10'L = 1,611.7 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 3 Rows of 0 Chambers Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
		0.144 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	1,001.00'	**30.0" Round Culvert** L= 30.0' Ke= 0.900 Inlet / Outlet Invert= 1,001.00' / 998.50' S= 0.0833 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf
#2	Device 1	1,001.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	1,002.00'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	1,003.00'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600
#5	Device 1	1,004.00'	**1.0' long x 4.0' 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 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=5.78 cfs @ 12.19 hrs HW=1,004.40' (Free Discharge)
└─**1=Culvert** (Passes 5.78 cfs of 27.37 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 2.94 cfs @ 8.43 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 1.26 cfs @ 7.20 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.93 cfs @ 5.35 fps)
  └─**5=Broad-Crested Rectangular Weir** (Weir Controls 0.65 cfs @ 1.61 fps)

Pond 3P: PROPOSED STORM TECH