VISTA
DESIGN INC. Landscape Architects, Land Planning Consultants, Engineers & Surveyors

BRYANS ROAD SHOPPING CENTER

STORMWATER MANAGEMENT COMPUTATIONS FOR

NPDES PROGRAM:
STORMWATER MANAGEMET RETROFIT

CHARLES COUNTY, MARYLAND
PGM# VCI 09-0078

TAX MAP 5
PARCELS:
100, 265, 396, 602, 628, 631, 633, 672, 673, 682, 719, 733, & 734

February 16, 2011

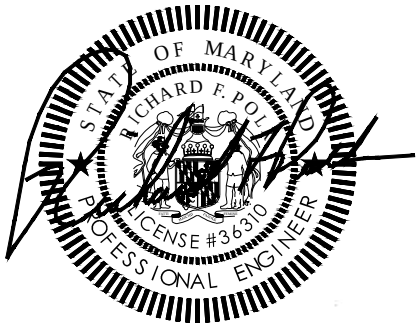

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TABLE OF CONTENTS

DESIGN NARRATIVE 3

DRY SWALES 5

INLET DESIGN 15

FILTERRA DESIGN 18

STORMFILTER DESIGN 20

SOILS REPORT 79

DRY SWALE DESIGN

TR-55 PEAK RUNOFF CALCULATION (GRAPHICAL METHOD)

Project:	Acton-Hamilton	DSN BY:	RFB
County:	Charles	CHK BY:	RFP
Date:	2/16/2011	Watershed ID#	Dry Swale - "A"

Total Drainage Area	0.599105	Acres
Runoff Curve Number	82	
Time of Concentration	0.193	Hours

Frequency	yrs	1	2	10	100
24-Hr Rainfall, P	in	2.7	3.3	5.3	7.5
Ia/P Ratio		0.162	0.132	0.082	0.058
Runoff	in	1.15	1.63	3.36	5.40
Unit Peak Discharge	cfs/ac/in	1.215	1.239	1.282	1.303
Initial Abstraction, Ia	in	1.175	1.175	1.175	1.175
Peak Discharge	cfs	**0.8**	**1.2**	**2.58**	**4.2**

TR-55 Curve Numbers for Hydrologic Soil Type

Watershed # Dry Swale - "A"
Date: 2/16/2011

Fully Developed Urban Areas	Veg Stab	A	B		C		D
Grass Cover > 75%	Good	39	61	**12038**	74	**7006**	80
Paved parking lots, roof, driveways		98	98	**7053**	98		98
Total Area for Each Hydrologic Soil Type		**0.000**	**0.000**	**0.438**		**0.161**	
			TOTAL ACRES	**0.599**			
WEIGHTED RUNOFF CURVE NUMBER (RCN)				**82**			

TIME OF CONCENTRATION AND TRAVEL TIME

Project:	Acton-Hamilton	DSN BY:	RFB
County:	Charles	CHK BY:	RFP
Date:	2/16/2011	Watershed ID#	Dry Swale - "A"

Flow Type	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE (A-J)	MANNINGS "N"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./dev.)	TRAVEL TIME
Sheet Flow	100	0.03	E	**0.15**	n/a	n/a	n/a	0.137 hours
Sheet Flow				------	n/a	n/a	n/a	hours
Shallow Concentrated Flow	238	0.0106	U	n/a	n/a	n/a	**1.66**	0.040 hours
Shallow Concentrated Flow	52	0.0167	P	n/a	n/a	n/a	**2.63**	0.005 hours
Shallow Concentrated Flow	110	0.0285	U	n/a	n/a	n/a	**2.72**	0.011 hours
Open Channel			n/a				-------	hours
Open Channel			n/a				-------	hours
Open Channel			n/a				-------	hours
						Time of Concentration		**0.193 hours**

Sheet Flow Surface Codes

A Smooth Surface
B Fallow (no Residue)
C Cultivated < 20% Res.
D Cultivated > 20% Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Bermuda
H Woods, Light
I Woods, Dense
J Range, Natural

Shallow Concentrated Surface Codes

U Unpaved Surface
P Paved Surface

Dry Swale Design Guidelines

Site: Acton-Hamilton Date: 2/16/2011

Swale ID# Dry Swale - "A"

Specific Site Data

Drainage Area =	0.599	Acres	
Impervious Area =	0.162	Acres	
Underlying Soils =	HSG D	S = 0.06	
Site Location =	Eastern Zone	P = 1	

Step 1. Compute WQv

Compute Volumetric Runoff Coefficient (Rv) Rv = 0.05 + 0.009 (I)

Rv = 0.293 I = 0.27 or 27.03%

Compute WQv WQv =[(P) (Rv) (A)] / 12

WQv = 0.0146 ac-ft or 637.7 cf

Step 2. Compute Rev

Compute Rev Using Percent Volume Method Rev = [(S) (Rv) (A)] / 12

Rev = 0.0009 ac-ft or 38.3 cf.

Compute Rev Using Percent Area Method Rev = (S) (Ai)

Rev = 0.00971488 ac-ft or 423 cf.

Swale Design Data (input)

Slope = s =	0.010	or 0.98%			
Side Slope (z) =	3	Invert U/S =	178.60	Invert D/S	177.50
Length = l =	112 ft				
Ponding Depth =	0.475 ft				
Rev Material =	Sand	n =	0.4		
10-year Flow = Q10 =	2.58 cfs				

Swale Design Data (output)

Pretreatment Area for Dry Swale Vp = (10%) (WQv) 0.025

Vp = 63.77 cf

Swale treatment value: WQv - Vp = w x l x dmid

Width of storage surface = w = 10.79 ft

Width of bottom = wb = 7.94 ft Use Bottom width = 8 ft

Determine stone-filled reservoir depth = d = d = V / (l x wb x n)

Stone depth = d = 0.11 ft

Q10 = 2.58 Determine depth of Flow in Channel = 0.15

V10 = 1.58

The cross-sectional area of the channel (A) needed to safely pass Q10 =

A = Q10 / V10 A = 1.63 Actual A = 2.04417403 **DRY SWALE OK**

The minimum depth of the channel dc = dmax + d10 + dfree

max depth 0.95

Free Board 0.25

dc = 1.35 ft

TR-55 PEAK RUNOFF CALCULATION (GRAPHICAL METHOD)

Project: Acton-Hamilton
County: Charles
Date: 2/16/2011

DSN BY: RFB
CHK BY: RFP
Watershed ID# Dry Swale - "B"

Total Drainage Area	1.011364	Acres
Runoff Curve Number	89	
Time of Concentration	0.193	Hours

Frequency	yrs	1	2	10	100
24-Hr Rainfall, P	in	2.7	3.3	5.3	7.5
Ia/P Ratio		0.091	0.074	0.046	0.033
Runoff	in	1.64	2.18	4.07	6.21
Unit Peak Discharge	cfs/ac/in	1.274	1.288	1.313	1.325
Initial Abstraction, Ia	in	1.175	1.175	1.175	1.175
Peak Discharge	cfs	2.1	2.8	5.40	8.3

TR-55 Curve Numbers for Hydrologic Soil Type

Watershed # Dry Swale - "B"
Date: 2/16/2011

Fully Developed Urban Areas	Veg Stab	A		B		C		D	
Grass Cover > 75%	Good	39		61	**7135**	74	**12330**	80	
Paved parking lots, roof, driveways		98		98	**24590**	98		98	
Total Area for Each Hydrologic Soil Type		**0.000**		**0.000**	**0.728**		**0.283**		
				TOTAL ACRES	**1.011**				
WEIGHTED RUNOFF CURVE NUMBER (RCN)					**89**				

TIME OF CONCENTRATION AND TRAVEL TIME

Project: Acton-Hamilton
County: Charles
Date: 2/16/2011

DSN BY: RFB
CHK BY: RFP
Watershed ID# Dry Swale - "B"

Flow Type	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE (A-J)	MANNINGS "N"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./dev.)	TRAVEL TIME
Sheet Flow	100	0.03	E	**0.15**	n/a	n/a	n/a	0.137 hours
Sheet Flow				------	n/a	n/a	n/a	hours
Shallow Concentrated Flow	238	0.0106	U	n/a	n/a	n/a	**1.66**	0.040 hours
Shallow Concentrated Flow	52	0.0167	P	n/a	n/a	n/a	**2.63**	0.005 hours
Shallow Concentrated Flow	110	0.0285	U	n/a	n/a	n/a	**2.72**	0.011 hours
Open Channel			n/a				-------	hours
Open Channel			n/a				-------	hours
Open Channel			n/a				-------	hours
						Time of Concentration		**0.193 hours**

Sheet Flow Surface Codes

A Smooth Surface
B Fallow (no Residue)
C Cultivated < 20% Res.
D Cultivated > 20% Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Bermuda
H Woods, Light
I Woods, Dense
J Range, Natural

Shallow Concentrated Surface Codes

U Unpaved Surface
P Paved Surface

Dry Swale Design Guidelines

Site: Acton-Hamilton Date: 2/16/2011

Swale ID# Dry Swale - "B"

Specific Site Data

Drainage Area =	1.011	Acres	
Impervious Area =	0.565	Acres	
Underlying Soils =	HSG D	S = 0.06	
Site Location =	Eastern Zone	P = 1	

Step 1. Compute WQv

Compute Volumetric Runoff Coefficient (Rv) Rv = 0.05 + 0.009 (I)

Rv = 0.552 I = 0.56 or 55.82%

Compute WQv WQv =[(P) (Rv) (A)] / 12

WQv = 0.0466 ac-ft or 2027.8 cf

Step 2. Compute Rev

Compute Rev Using Percent Volume Method Rev = [(S) (Rv) (A)] / 12

Rev = 0.0028 ac-ft or 121.7 cf.

Compute Rev Using Percent Area Method Rev = (S) (Ai)

Rev = 0.03387052 ac-ft or 1475 cf.

Swale Design Data (input)

Slope = s =	0.007	or 0.67%			
Side Slope (z) =	3	Invert U/S =	177.00	Invert D/S	175.00
Length = l =	297 ft				
Ponding Depth =	0.55 ft				
Rev Material =	Sand	n =	0.4		
10-year Flow = Q10 =	5.40 cfs				

Swale Design Data (output)

Pretreatment Area for Dry Swale Vp = (10%) (WQv) 0.025

Vp = 202.78 cf

Swale treatment value: WQv - Vp = w x l x dmid

Width of storage surface = w = 11.17 ft

Width of bottom = wb = 7.87 ft Use Bottom width = 8 ft

Determine stone-filled reservoir depth = d = d = V / (l x wb x n)

Stone depth = d = 0.13 ft

Q10 = 5.40 Determine depth of Flow in Channel = 0.25

V10 = 1.84

The cross-sectional area of the channel (A) needed to safely pass Q10 =

A = Q10 / V10 A = 2.94 Actual A = 3.75602881 **DRY SWALE OK**

The minimum depth of the channel dc = dmax + d10 + dfree

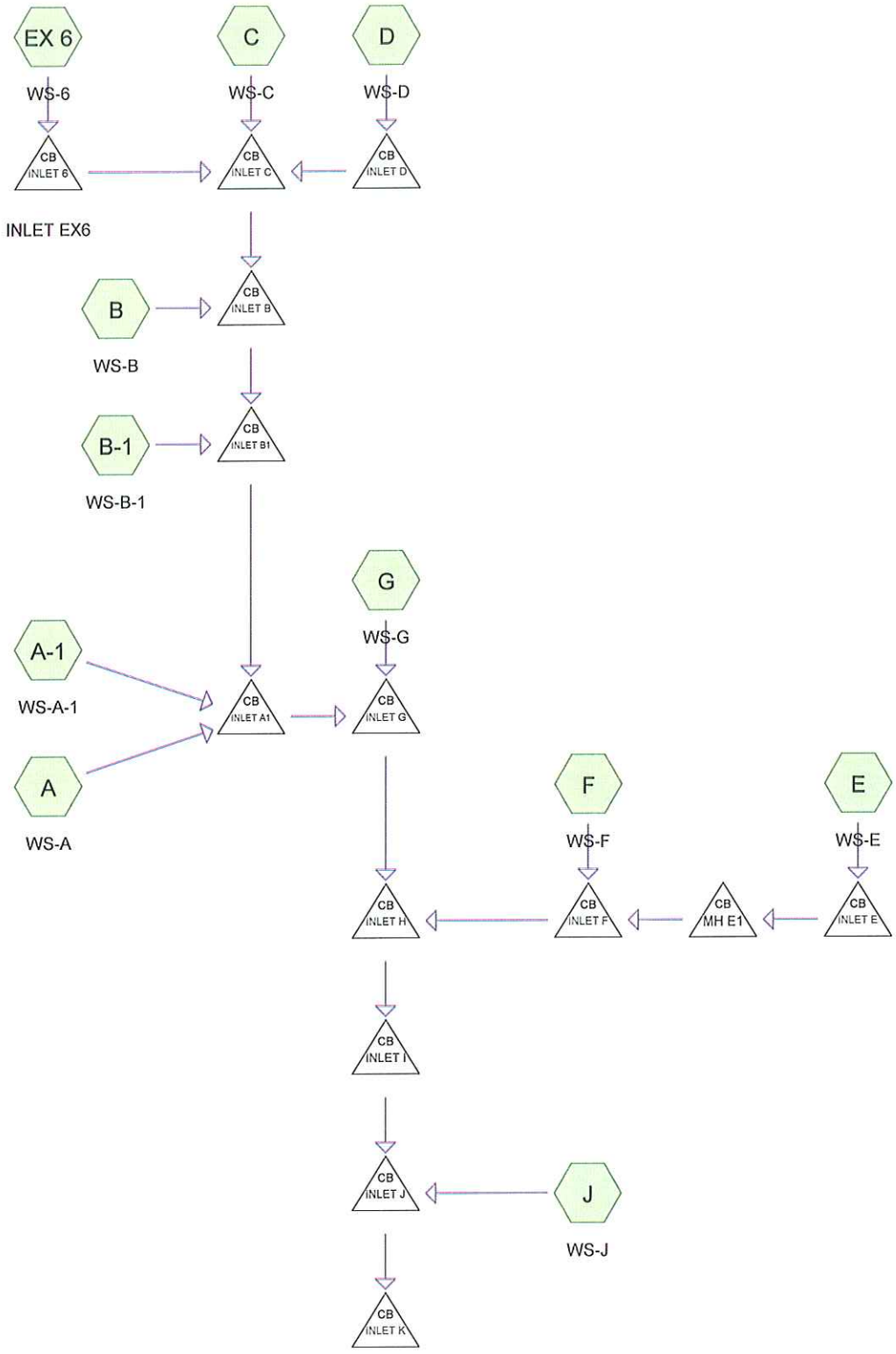
max depth 1.10

Free Board 0.25

dc = 1.60 ft

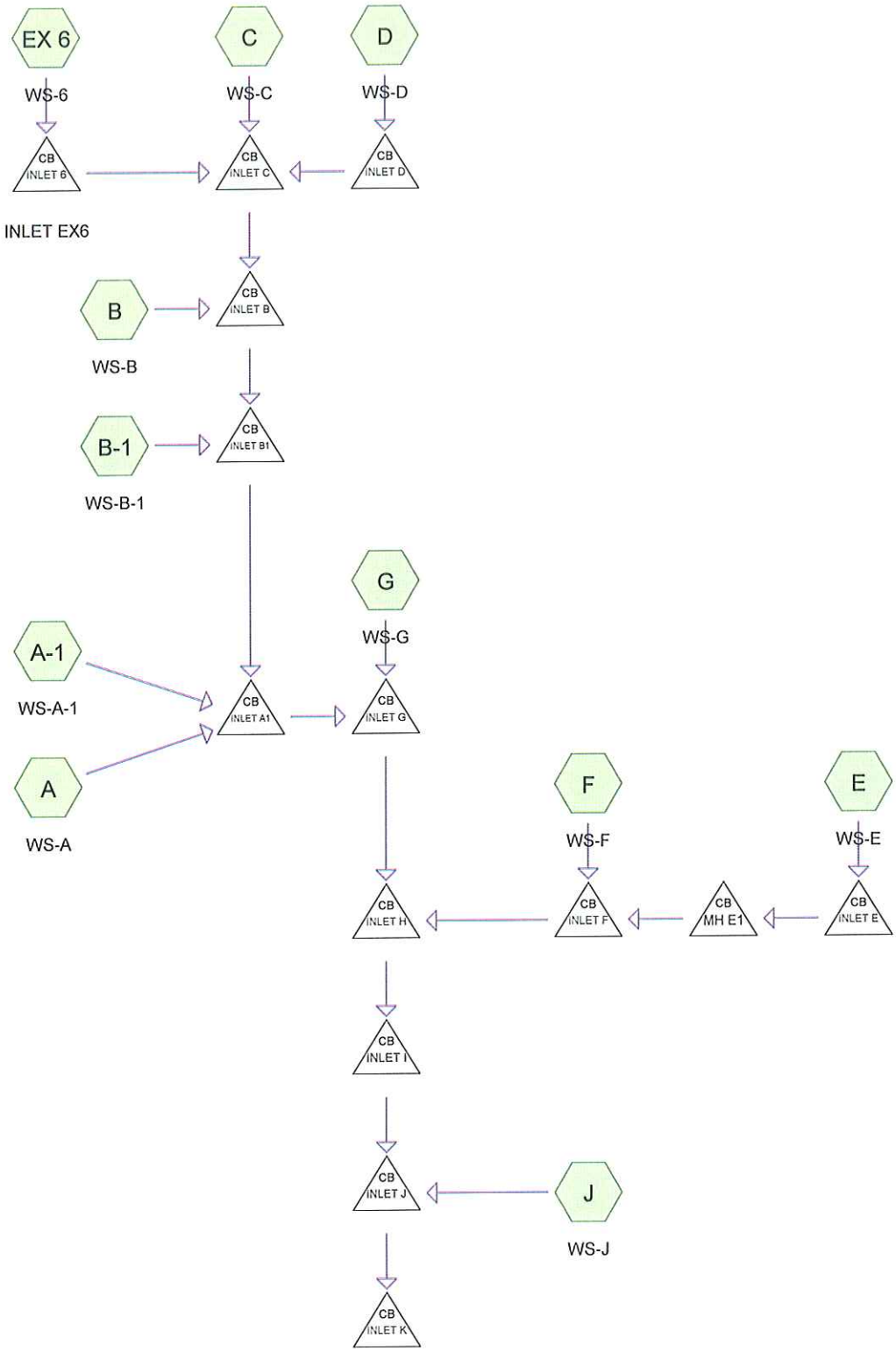
	A	B	C	D	E	F	G	H	I	J	K	L	M
Sub-Watershed	Rd STA Up Stream	Rd STA Down Stream	Swale Length	Invert Up Stream	Invert Down Stream	Swale Slope	Swale Side Slope	Swale Bottom Width	Ponding Depth	Stone Depth	Q10 Flow	Swale Depth	Swale Width
Dry Swale - "A"	N/A	N/A	112	178.60	177.50	0.98%	3	8.0	11.40	2	2.58	1.35	16.07

STORMFILTER DESIGN



Subcat Reach Pond Link

Drainage Diagram for Q-10
Prepared by {enter your company name here} 2/16/2011
HydroCAD® 8.00 s/n 001700 © 2006 HydroCAD Software Solutions LLC



Subcat Reach Pond Link

Drainage Diagram for Q-10
Prepared by {enter your company name here} 2/16/2011
HydroCAD® 8.00 s/n 001700 © 2006 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcats)
0.050	61	>75% Grass cover, Good, HSG B (F)
0.429	80	>75% Grass cover, Good, HSG D (C,D,E,G,J)
9.288	98	Paved parking & roofs (A,A-1,B,B-1,C,D,E,EX 6,F,G,J)
9.766		

Subcatchment A: WS-A

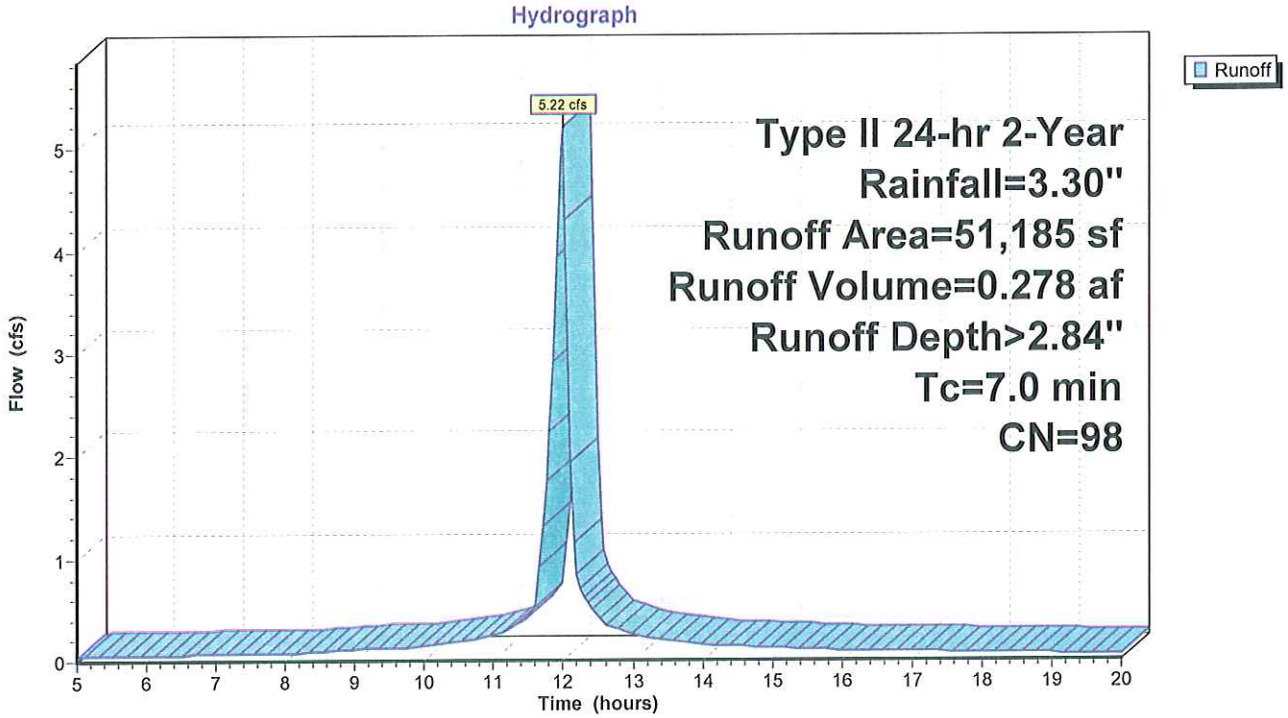
Runoff = 5.22 cfs @ 11.98 hrs, Volume= 0.278 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
51,185	98	Paved parking & roofs
51,185		Impervious Area

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

Subcatchment A: WS-A



Subcatchment A-1: WS-A-1

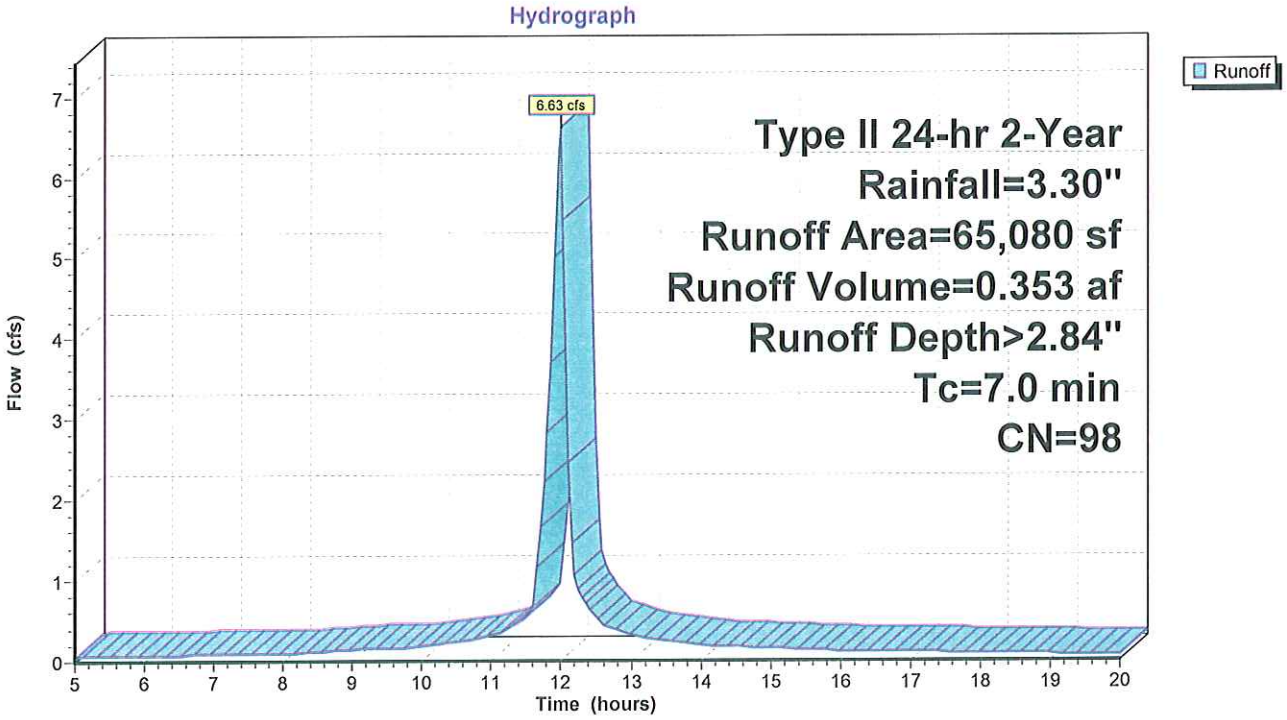
Runoff = 6.63 cfs @ 11.98 hrs, Volume= 0.353 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
65,080	98	Paved parking & roofs
65,080		Impervious Area

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

Subcatchment A-1: WS-A-1



Subcatchment B: WS-B

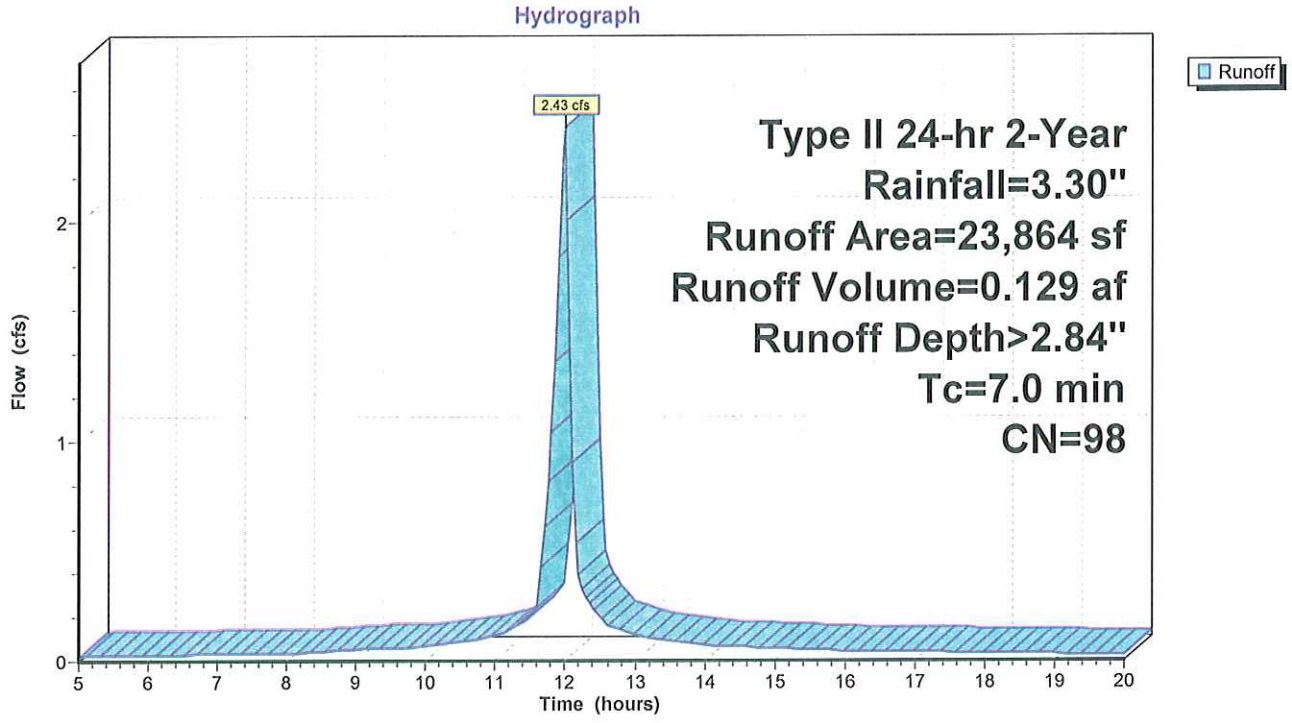
Runoff = 2.43 cfs @ 11.98 hrs, Volume= 0.129 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
23,864	98	Paved parking & roofs
23,864		Impervious Area

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

Subcatchment B: WS-B



Subcatchment B-1: WS-B-1

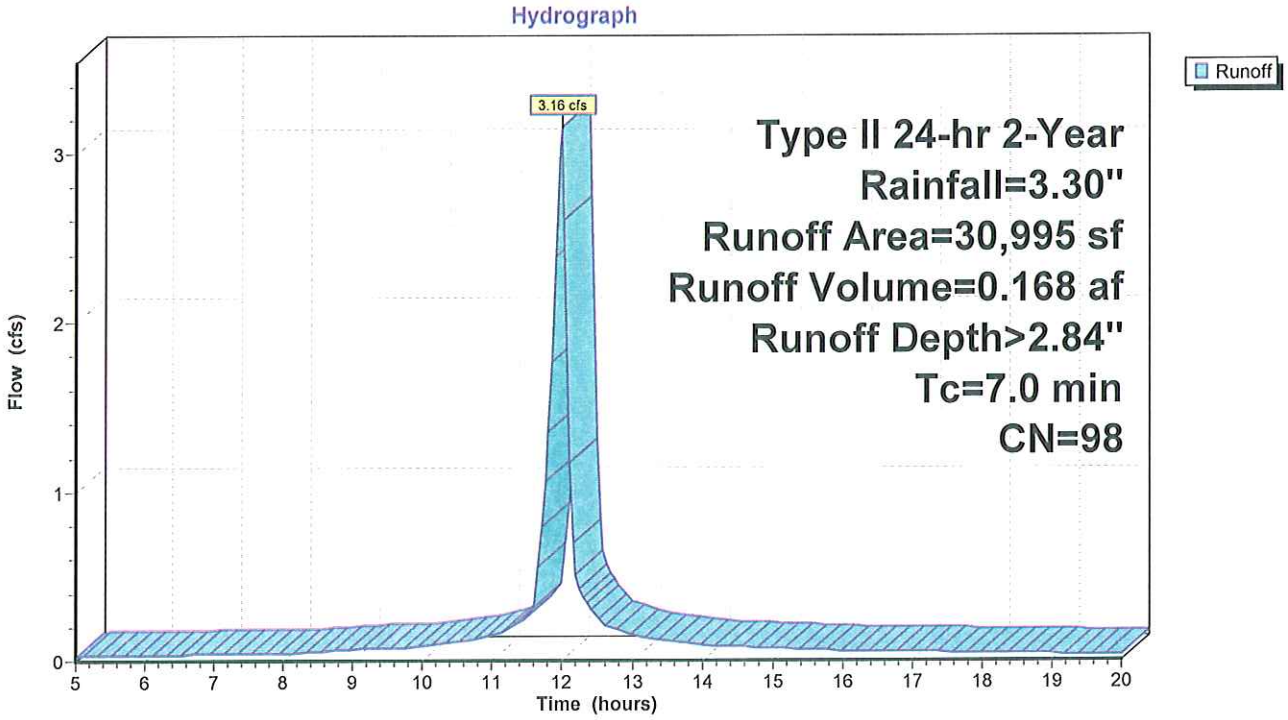
Runoff = 3.16 cfs @ 11.98 hrs, Volume= 0.168 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
30,995	98	Paved parking & roofs
30,995		Impervious Area

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

Subcatchment B-1: WS-B-1



Subcatchment C: WS-C

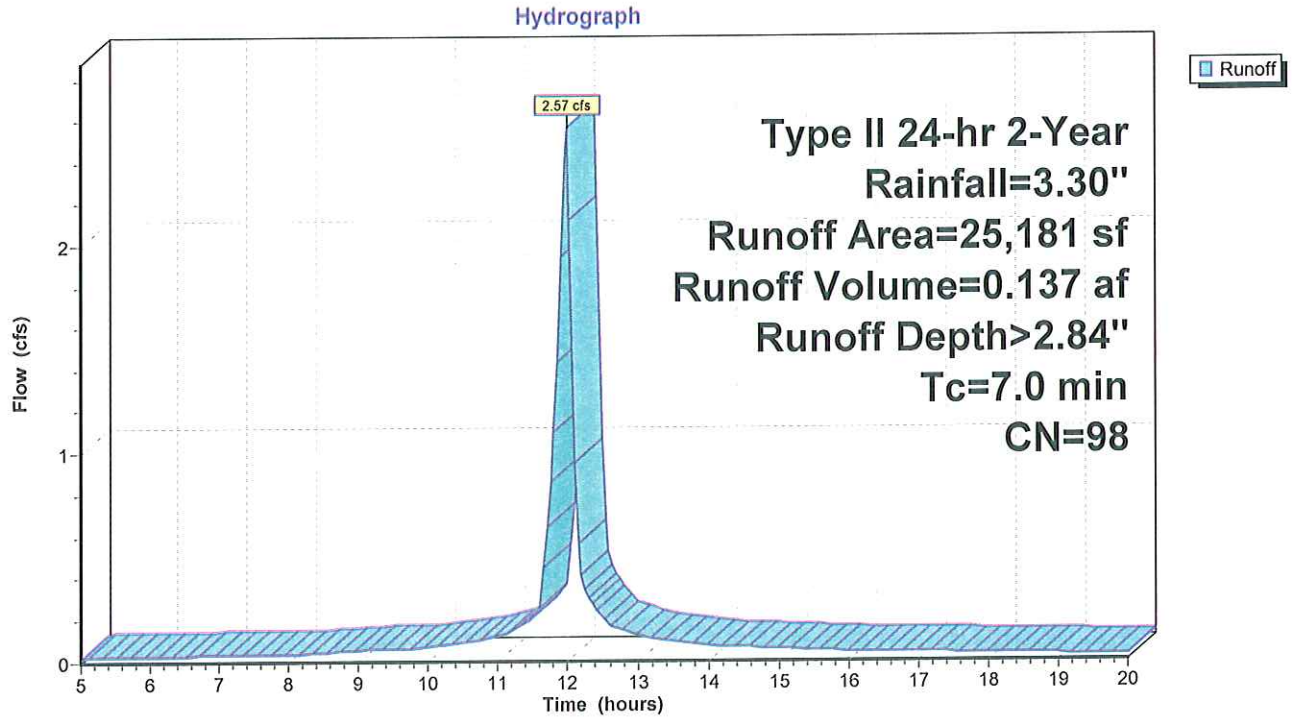
Runoff = 2.57 cfs @ 11.98 hrs, Volume= 0.137 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
24,931	98	Paved parking & roofs
250	80	>75% Grass cover, Good, HSG D
25,181	98	Weighted Average
250		Pervious Area
24,931		Impervious Area

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

Subcatchment C: WS-C



Subcatchment D: WS-D

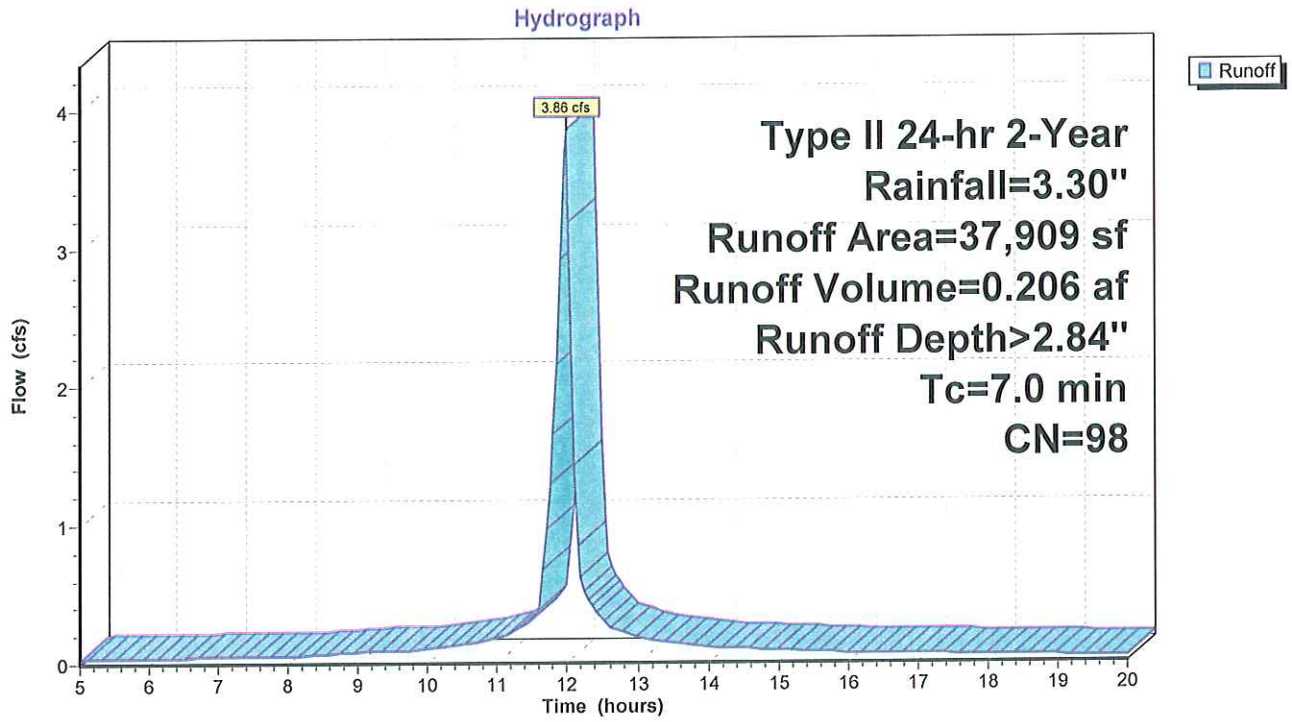
Runoff = 3.86 cfs @ 11.98 hrs, Volume= 0.206 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
37,313	98	Paved parking & roofs
596	80	>75% Grass cover, Good, HSG D
37,909	98	Weighted Average
596		Pervious Area
37,313		Impervious Area

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

Subcatchment D: WS-D



Subcatchment E: WS-E

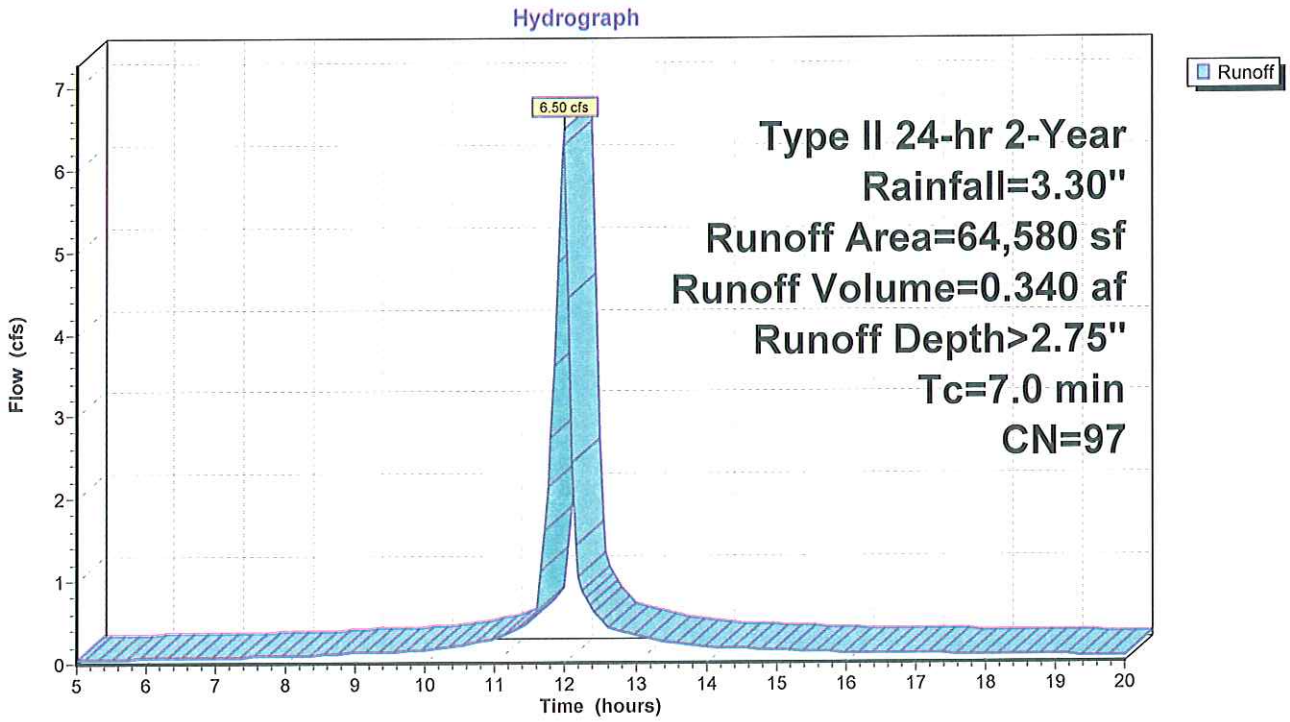
Runoff = 6.50 cfs @ 11.98 hrs, Volume= 0.340 af, Depth> 2.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
59,598	98	Paved parking & roofs
4,982	80	>75% Grass cover, Good, HSG D
64,580	97	Weighted Average
4,982		Pervious Area
59,598		Impervious Area

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

Subcatchment E: WS-E



Subcatchment EX 6: WS-6

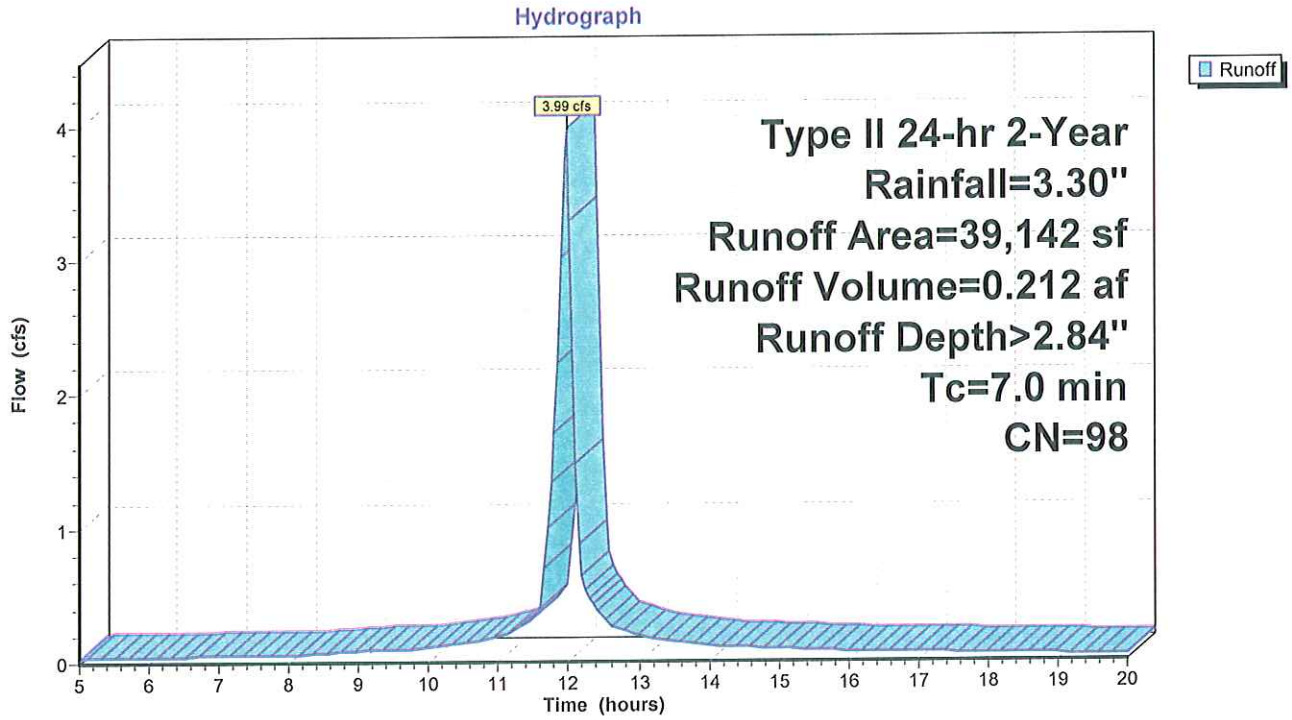
Runoff = 3.99 cfs @ 11.98 hrs, Volume= 0.212 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
39,142	98	Paved parking & roofs
39,142		Impervious Area

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

Subcatchment EX 6: WS-6



Subcatchment F: WS-F

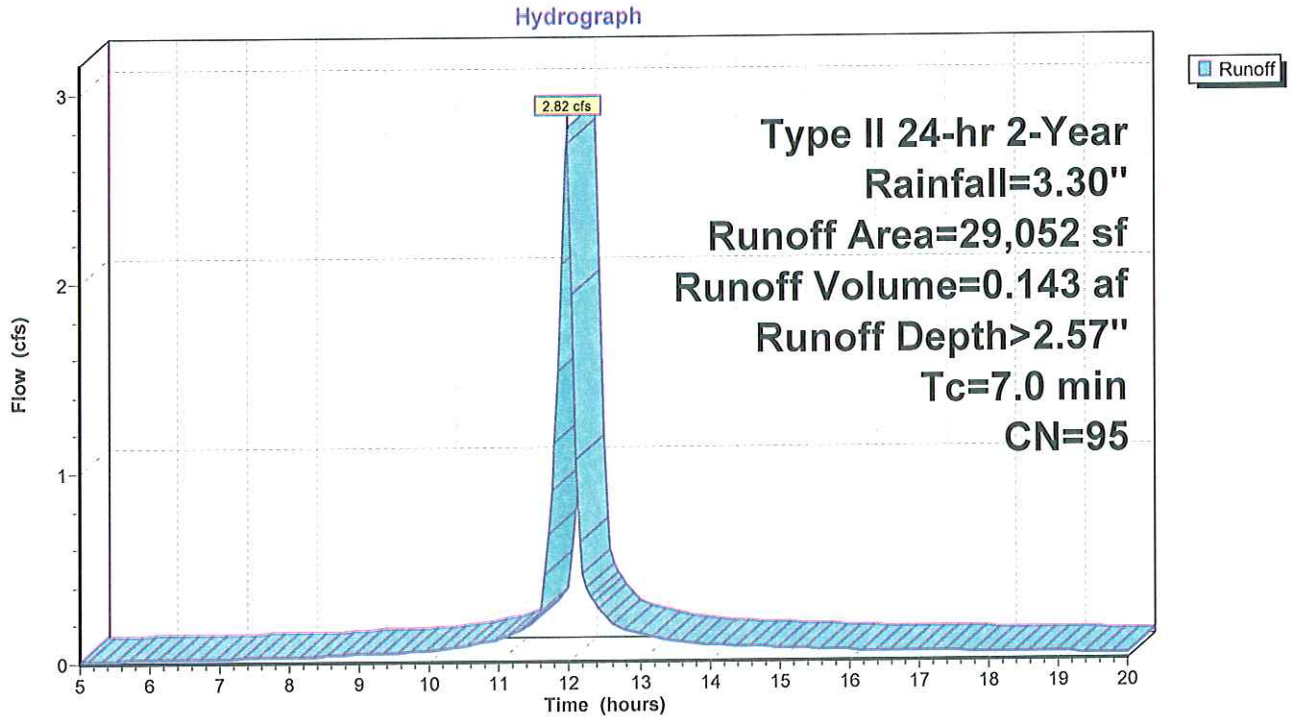
Runoff = 2.82 cfs @ 11.98 hrs, Volume= 0.143 af, Depth> 2.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
26,892	98	Paved parking & roofs
2,160	61	>75% Grass cover, Good, HSG B
29,052	95	Weighted Average
2,160		Pervious Area
26,892		Impervious Area

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

Subcatchment F: WS-F



Subcatchment G: WS-G

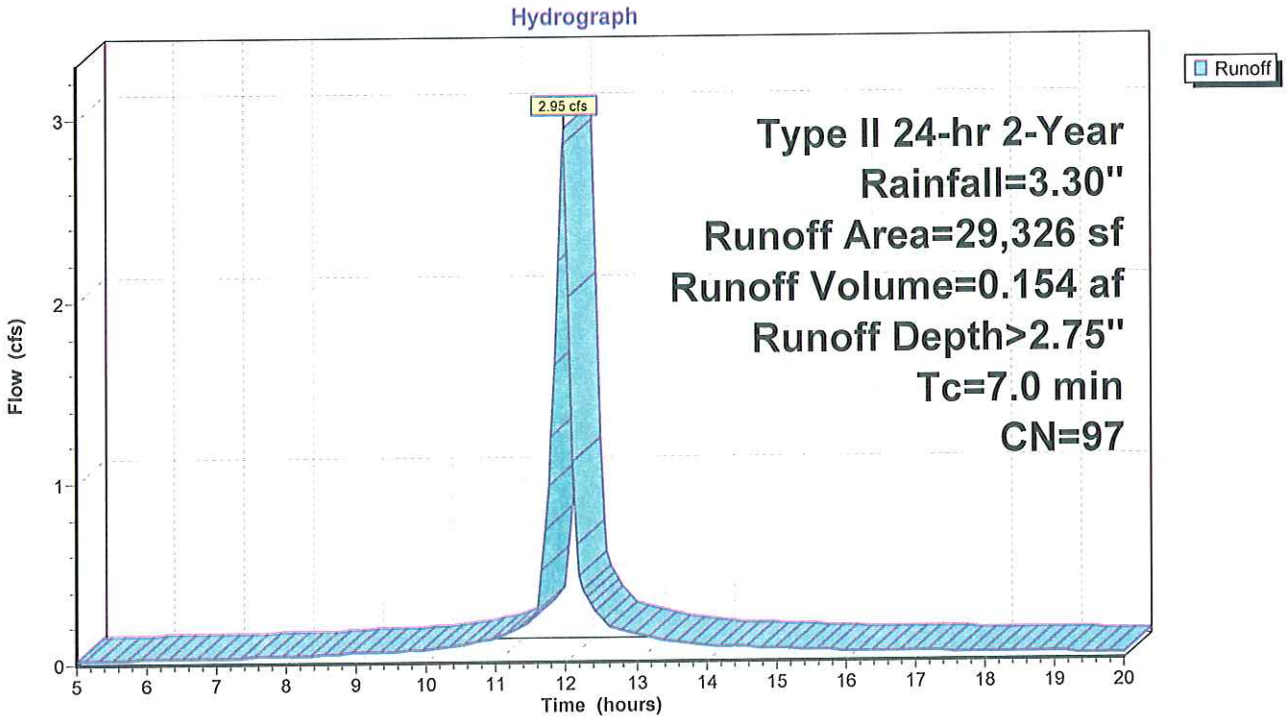
Runoff = 2.95 cfs @ 11.98 hrs, Volume= 0.154 af, Depth> 2.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
28,366	98	Paved parking & roofs
960	80	>75% Grass cover, Good, HSG D
29,326	97	Weighted Average
960		Pervious Area
28,366		Impervious Area

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

Subcatchment G: WS-G



Subcatchment J: WS-J

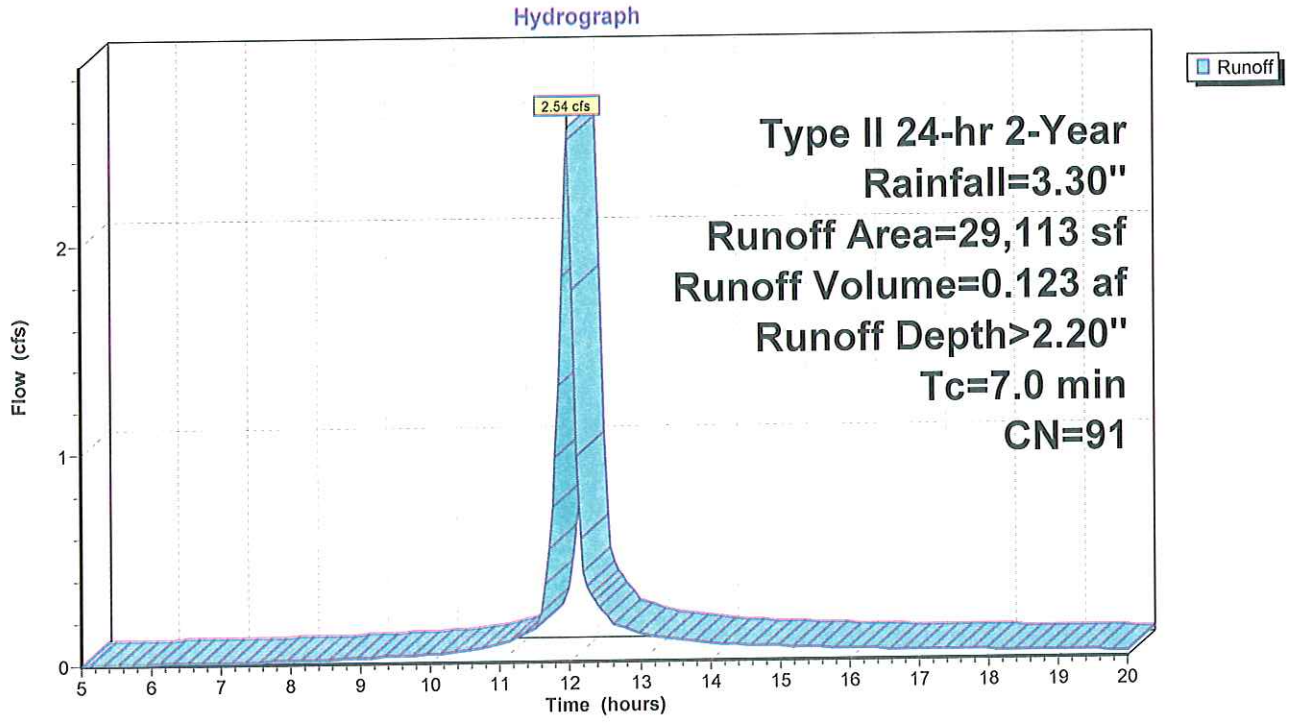
Runoff = 2.54 cfs @ 11.98 hrs, Volume= 0.123 af, Depth> 2.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
17,235	98	Paved parking & roofs
11,878	80	>75% Grass cover, Good, HSG D
29,113	91	Weighted Average
11,878		Pervious Area
17,235		Impervious Area

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

Subcatchment J: WS-J



Pond INLET 6: INLET EX6

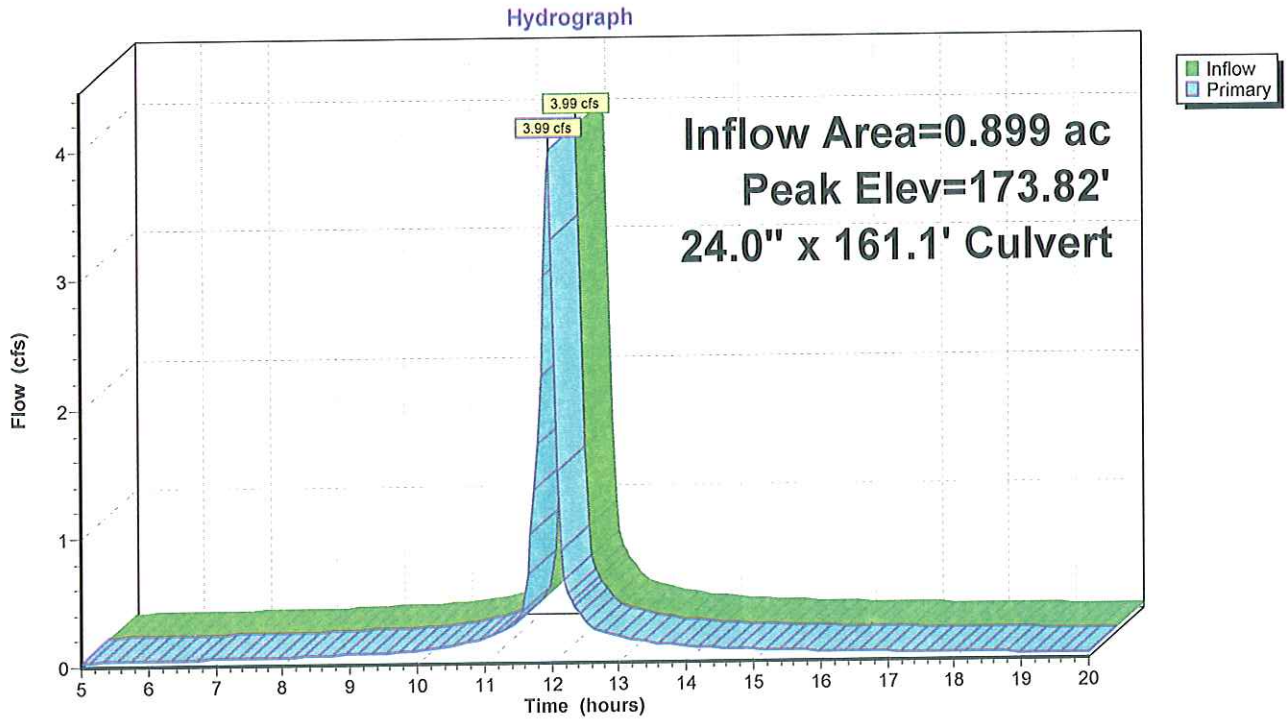
Inflow Area = 0.899 ac, Inflow Depth > 2.84" for 2-Year event
Inflow = 3.99 cfs @ 11.98 hrs, Volume= 0.212 af
Outflow = 3.99 cfs @ 11.98 hrs, Volume= 0.212 af, Atten= 0%, Lag= 0.0 min
Primary = 3.99 cfs @ 11.98 hrs, Volume= 0.212 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 173.82' @ 11.98 hrs
Flood Elev= 175.94'

Device	Routing	Invert	Outlet Devices
#1	Primary	172.80'	**24.0" x 161.1' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 172.29' S= 0.0032 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished

Primary OutFlow Max=3.84 cfs @ 11.98 hrs HW=173.79' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 3.84 cfs @ 3.60 fps)

Pond INLET 6: INLET EX6



Pond INLET A1:

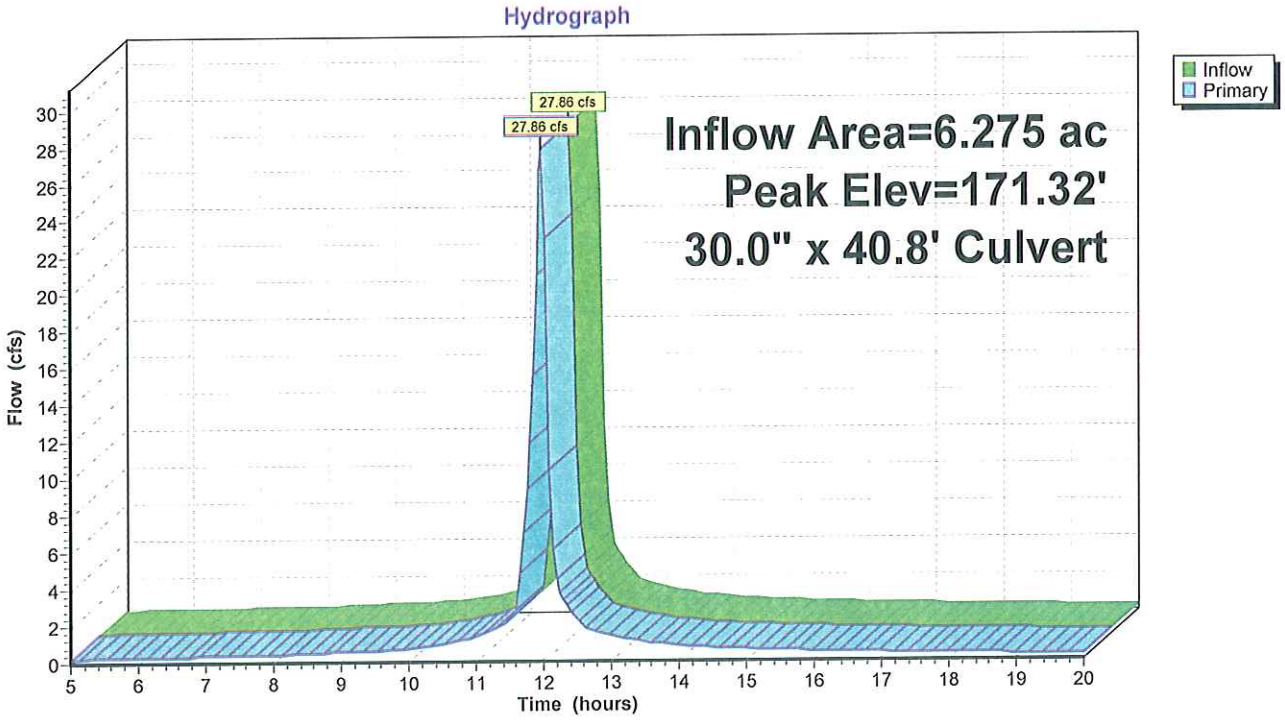
Inflow Area = 6.275 ac, Inflow Depth > 2.84" for 2-Year event
Inflow = 27.86 cfs @ 11.98 hrs, Volume= 1.483 af
Outflow = 27.86 cfs @ 11.98 hrs, Volume= 1.483 af, Atten= 0%, Lag= 0.0 min
Primary = 27.86 cfs @ 11.98 hrs, Volume= 1.483 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.32' @ 11.98 hrs
Flood Elev= 173.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.34'	**30.0" x 40.8' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.13' S= 0.0051 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=26.84 cfs @ 11.98 hrs HW=171.23' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 26.84 cfs @ 5.93 fps)

Pond INLET A1:



Pond INLET B:

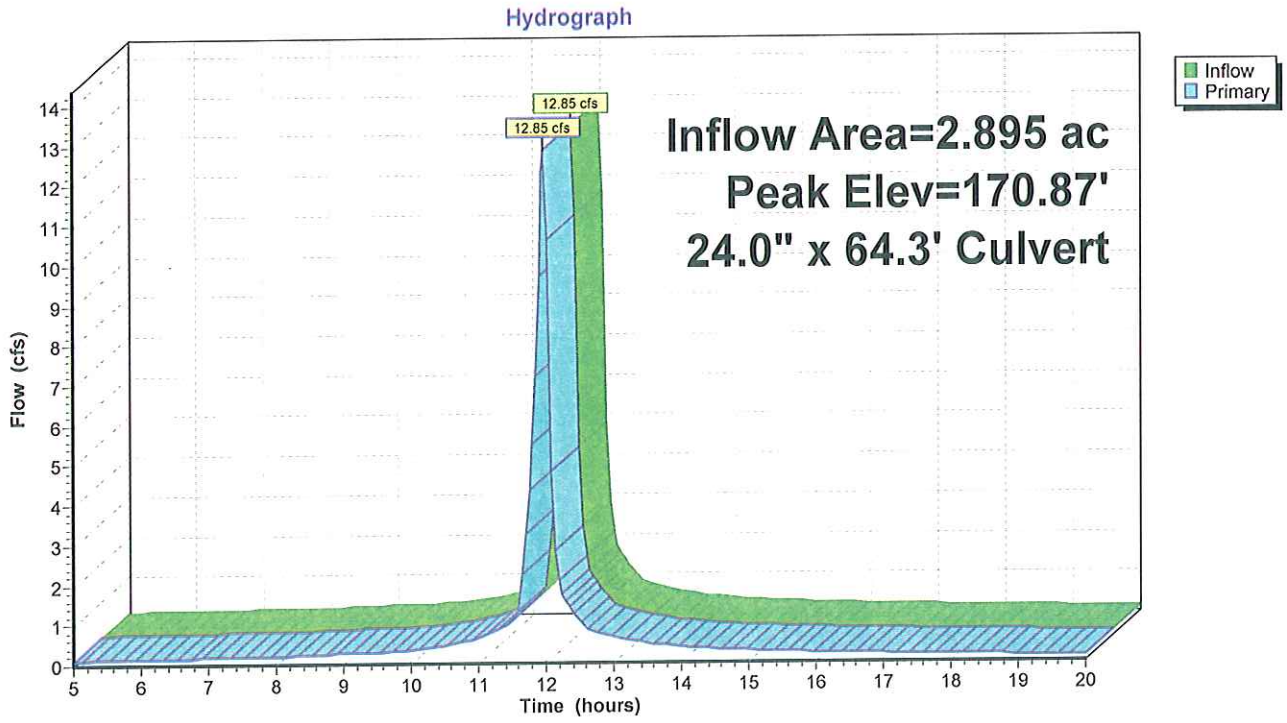
Inflow Area = 2.895 ac, Inflow Depth > 2.84" for 2-Year event
Inflow = 12.85 cfs @ 11.98 hrs, Volume= 0.684 af
Outflow = 12.85 cfs @ 11.98 hrs, Volume= 0.684 af, Atten= 0%, Lag= 0.0 min
Primary = 12.85 cfs @ 11.98 hrs, Volume= 0.684 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 170.87' @ 11.98 hrs
Flood Elev= 174.19'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.91'	**24.0" x 64.3' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.59' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=12.38 cfs @ 11.98 hrs HW=170.82' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 12.38 cfs @ 5.13 fps)

Pond INLET B:



Pond INLET B1:

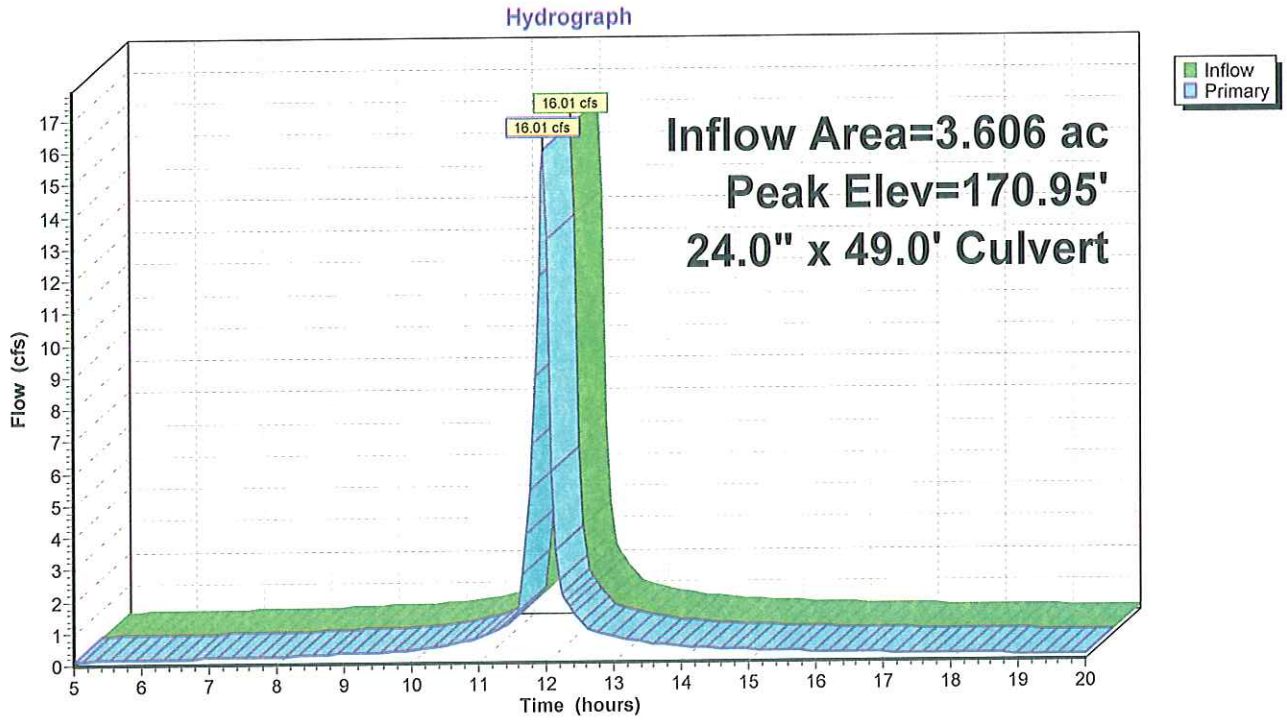
Inflow Area = 3.606 ac, Inflow Depth > 2.84" for 2-Year event
Inflow = 16.01 cfs @ 11.98 hrs, Volume= 0.852 af
Outflow = 16.01 cfs @ 11.98 hrs, Volume= 0.852 af, Atten= 0%, Lag= 0.0 min
Primary = 16.01 cfs @ 11.98 hrs, Volume= 0.852 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 170.95' @ 11.98 hrs
Flood Elev= 174.19'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.59'	**24.0" x 49.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.34' S= 0.0051 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=15.42 cfs @ 11.98 hrs HW=170.88' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 15.42 cfs @ 5.37 fps)

Pond INLET B1:



Pond INLET C:

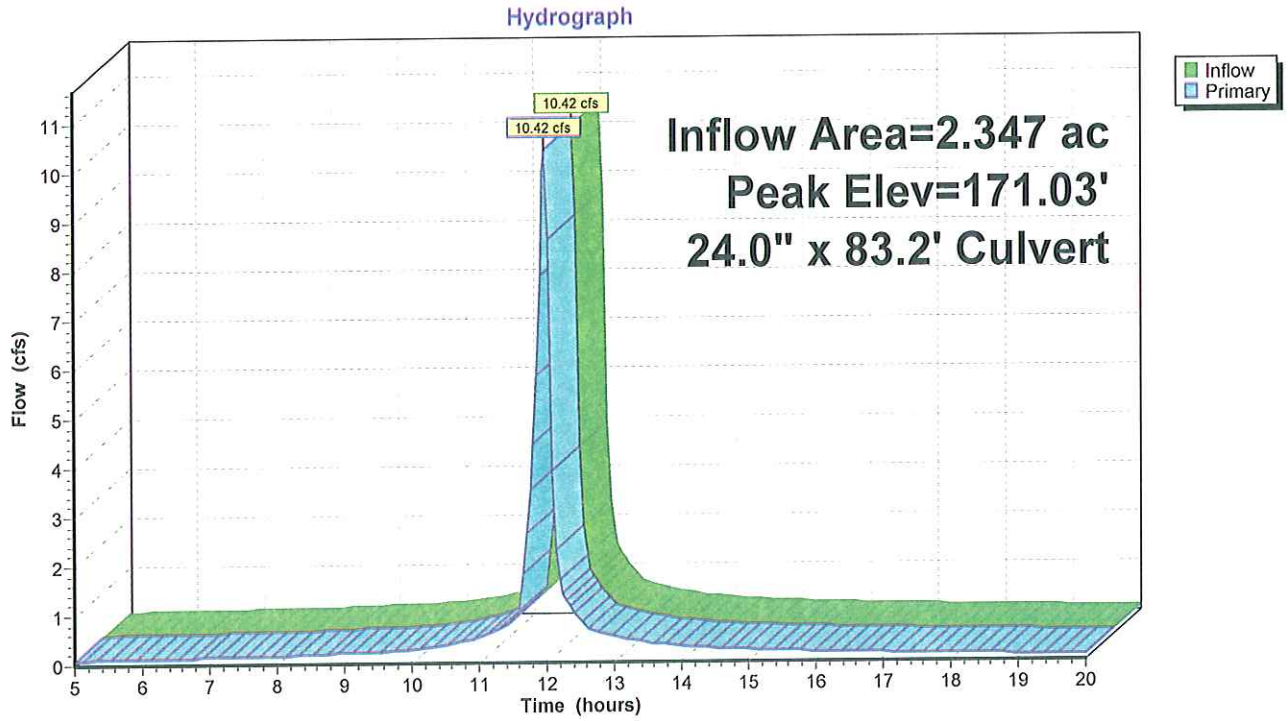
Inflow Area = 2.347 ac, Inflow Depth > 2.84" for 2-Year event
Inflow = 10.42 cfs @ 11.98 hrs, Volume= 0.555 af
Outflow = 10.42 cfs @ 11.98 hrs, Volume= 0.555 af, Atten= 0%, Lag= 0.0 min
Primary = 10.42 cfs @ 11.98 hrs, Volume= 0.555 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.03' @ 11.98 hrs
Flood Elev= 174.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	169.32'	**24.0" x 83.2' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.91' S= 0.0049 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished

Primary OutFlow Max=10.04 cfs @ 11.98 hrs HW=170.98' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 10.04 cfs @ 4.86 fps)

Pond INLET C:



Pond INLET D:

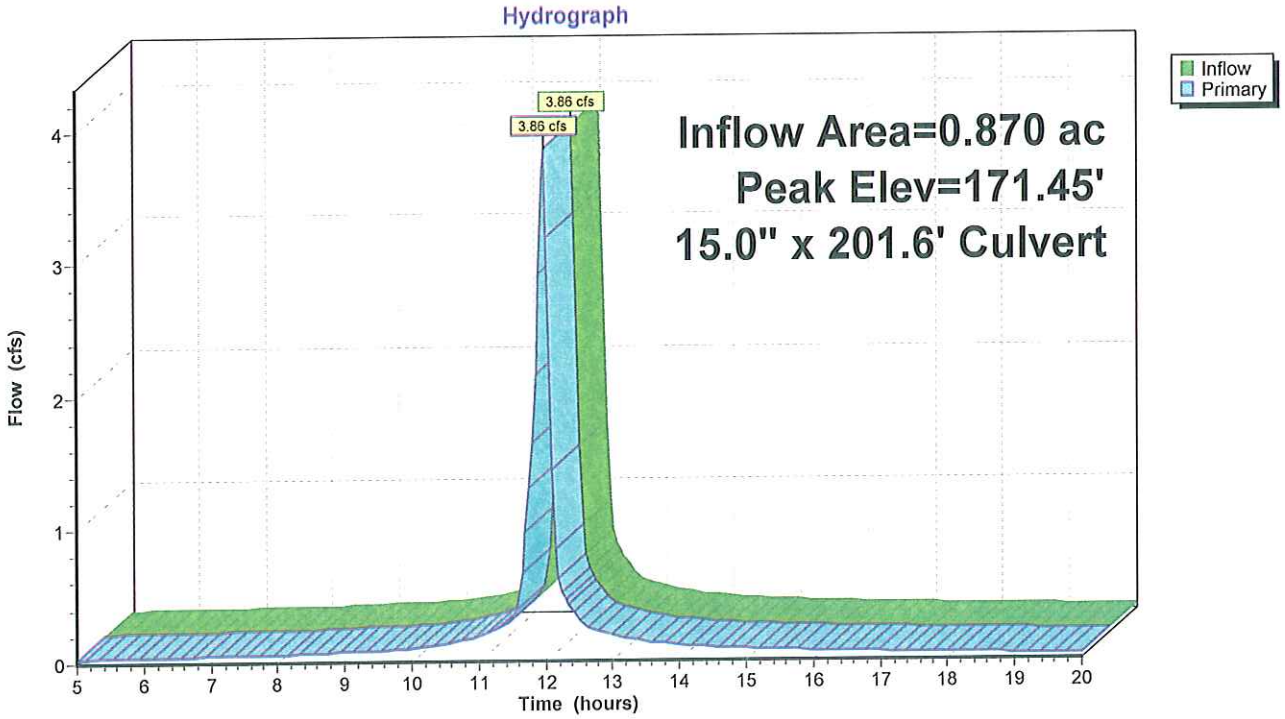
Inflow Area = 0.870 ac, Inflow Depth > 2.84" for 2-Year event
Inflow = 3.86 cfs @ 11.98 hrs, Volume= 0.206 af
Outflow = 3.86 cfs @ 11.98 hrs, Volume= 0.206 af, Atten= 0%, Lag= 0.0 min
Primary = 3.86 cfs @ 11.98 hrs, Volume= 0.206 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.45' @ 11.98 hrs
Flood Elev= 174.55'

Device	Routing	Invert	Outlet Devices
#1	Primary	170.33'	**15.0" x 201.6' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 169.32' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=3.72 cfs @ 11.98 hrs HW=171.42' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 3.72 cfs @ 4.39 fps)

Pond INLET D:



Pond INLET E:

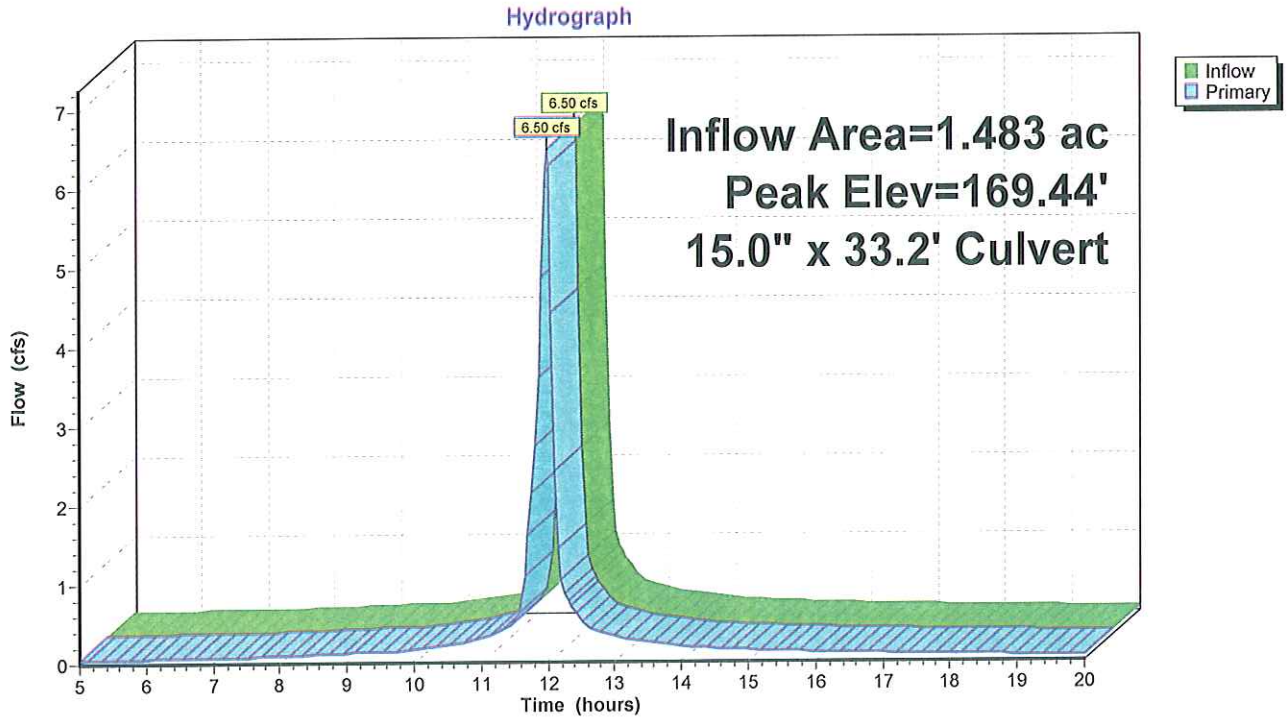
Inflow Area = 1.483 ac, Inflow Depth > 2.75" for 2-Year event
Inflow = 6.50 cfs @ 11.98 hrs, Volume= 0.340 af
Outflow = 6.50 cfs @ 11.98 hrs, Volume= 0.340 af, Atten= 0%, Lag= 0.0 min
Primary = 6.50 cfs @ 11.98 hrs, Volume= 0.340 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 169.44' @ 11.98 hrs
Flood Elev= 173.03'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.62'	**15.0" x 33.2' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 167.27' S= 0.0105 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=6.26 cfs @ 11.98 hrs HW=169.37' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 6.26 cfs @ 5.10 fps)

Pond INLET E:



Pond INLET F:

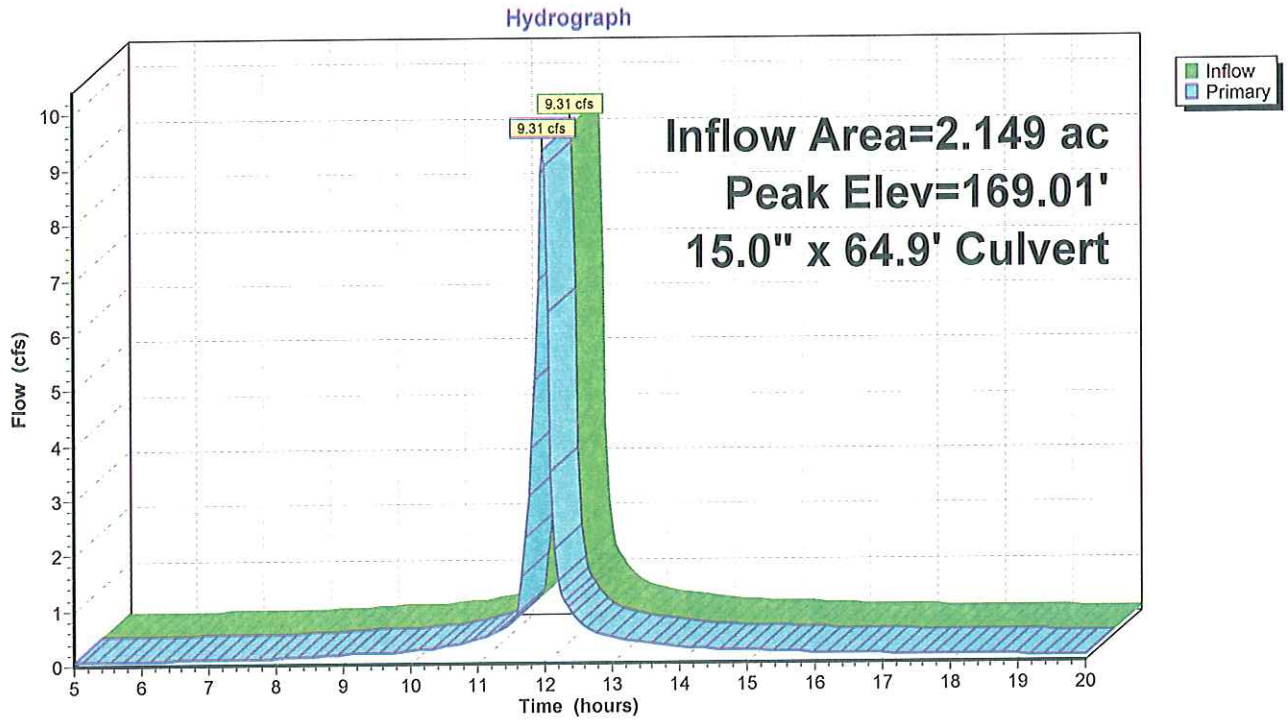
Inflow Area = 2.149 ac, Inflow Depth > 2.70" for 2-Year event
Inflow = 9.31 cfs @ 11.98 hrs, Volume= 0.483 af
Outflow = 9.31 cfs @ 11.98 hrs, Volume= 0.483 af, Atten= 0%, Lag= 0.0 min
Primary = 9.31 cfs @ 11.98 hrs, Volume= 0.483 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 169.01' @ 11.98 hrs
Flood Elev= 172.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	165.93'	**15.0" x 64.9' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 165.29' S= 0.0099 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=8.97 cfs @ 11.98 hrs HW=168.86' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 8.97 cfs @ 7.31 fps)

Pond INLET F:



Pond INLET G:

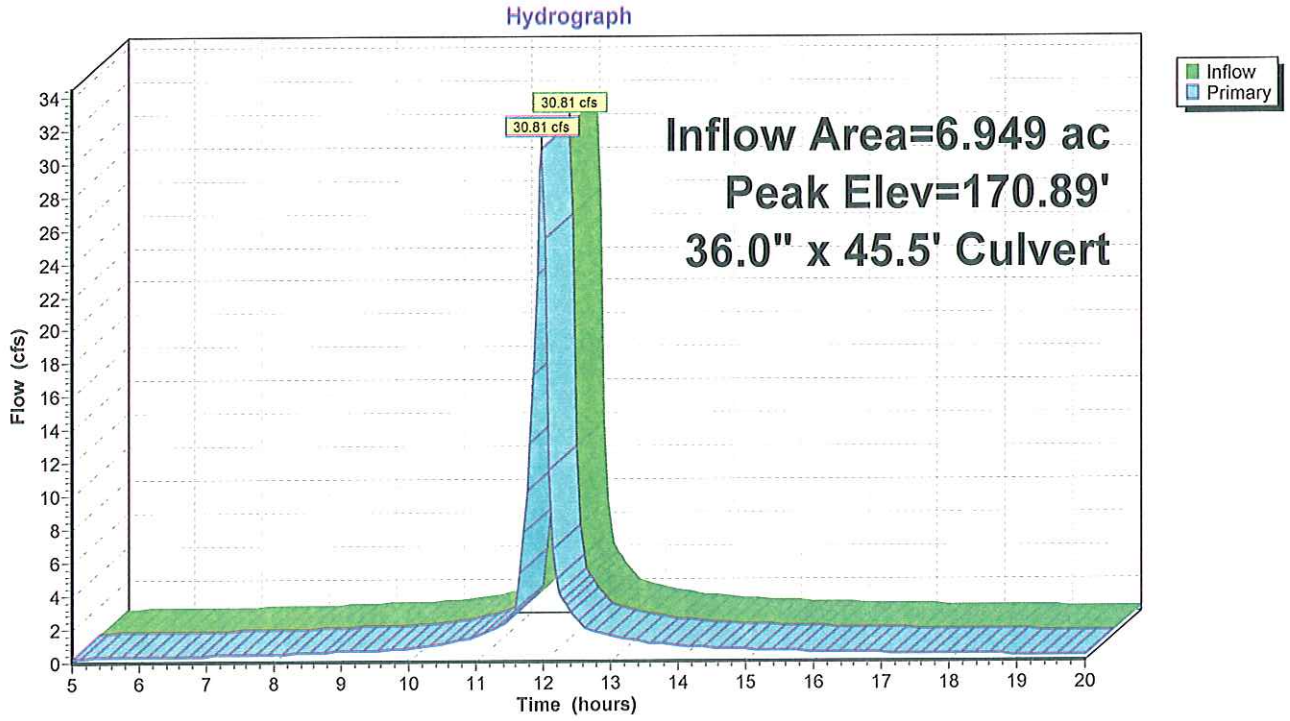
Inflow Area = 6.949 ac, Inflow Depth > 2.83" for 2-Year event
Inflow = 30.81 cfs @ 11.98 hrs, Volume= 1.637 af
Outflow = 30.81 cfs @ 11.98 hrs, Volume= 1.637 af, Atten= 0%, Lag= 0.0 min
Primary = 30.81 cfs @ 11.98 hrs, Volume= 1.637 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 170.89' @ 11.98 hrs
Flood Elev= 173.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.13'	**36.0" x 45.5' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 167.90' S= 0.0051 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=29.68 cfs @ 11.98 hrs HW=170.82' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 29.68 cfs @ 5.86 fps)

Pond INLET G:



Pond INLET H:

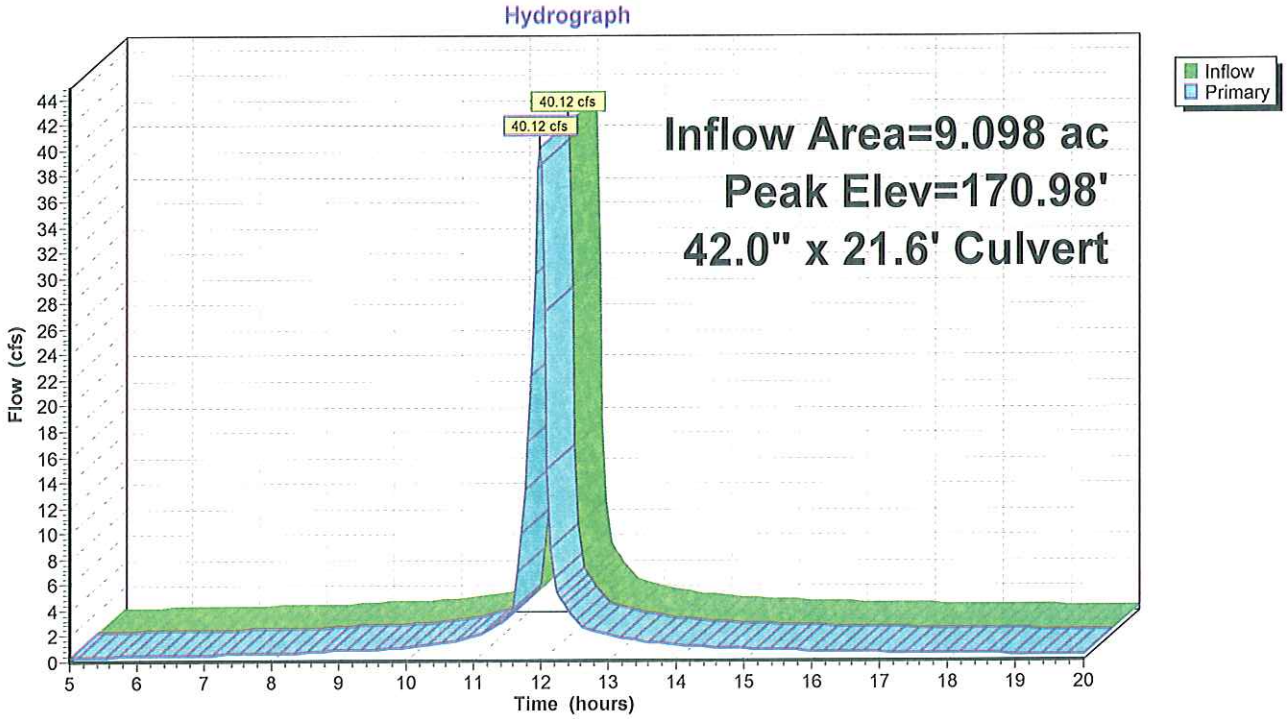
Inflow Area = 9.098 ac, Inflow Depth > 2.80" for 2-Year event
Inflow = 40.12 cfs @ 11.98 hrs, Volume= 2.120 af
Outflow = 40.12 cfs @ 11.98 hrs, Volume= 2.120 af, Atten= 0%, Lag= 0.0 min
Primary = 40.12 cfs @ 11.98 hrs, Volume= 2.120 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 170.98' @ 11.98 hrs
Flood Elev= 172.39'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.90'	**42.0" x 21.6' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 167.80' S= 0.0046 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=38.64 cfs @ 11.98 hrs HW=170.91' (Free Discharge)
↑**1=Culvert** (Barrel Controls 38.64 cfs @ 5.90 fps)

Pond INLET H:



Pond INLET I:

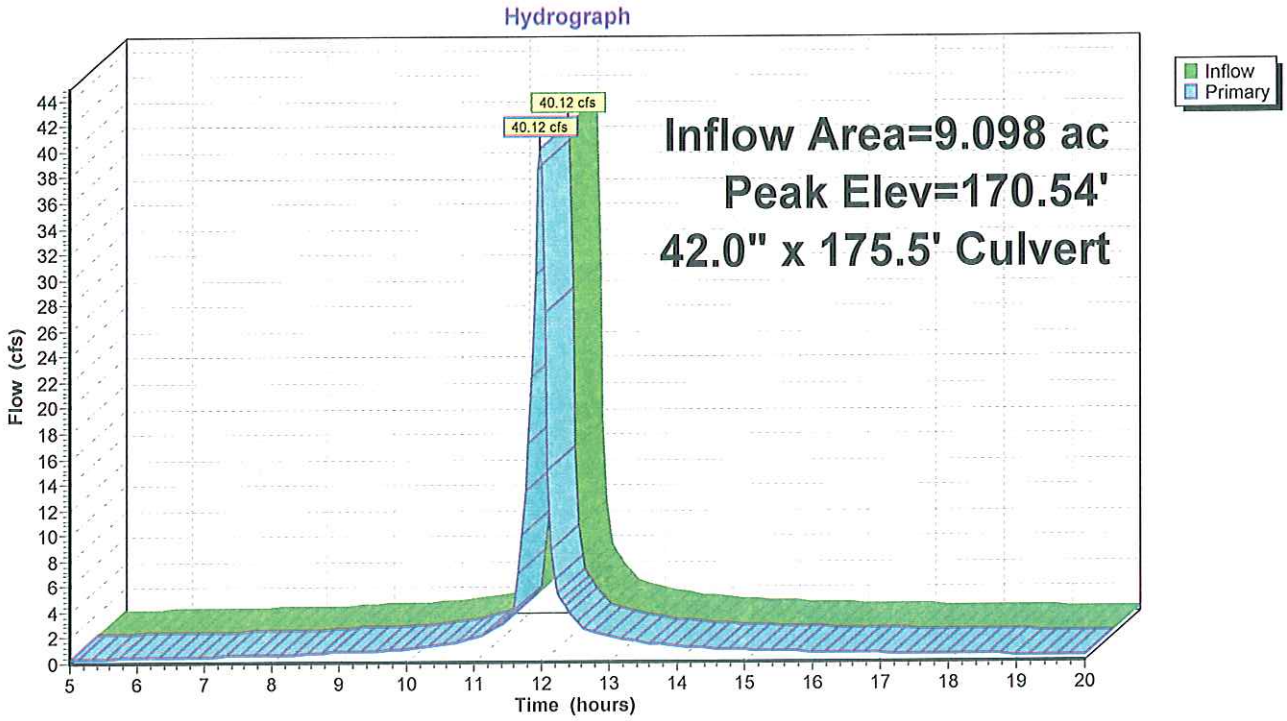
Inflow Area = 9.098 ac, Inflow Depth > 2.80" for 2-Year event
Inflow = 40.12 cfs @ 11.98 hrs, Volume= 2.120 af
Outflow = 40.12 cfs @ 11.98 hrs, Volume= 2.120 af, Atten= 0%, Lag= 0.0 min
Primary = 40.12 cfs @ 11.98 hrs, Volume= 2.120 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 170.54' @ 11.98 hrs
Flood Elev= 172.42'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.80'	**42.0" x 175.5' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 166.92' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=38.64 cfs @ 11.98 hrs HW=170.47' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 38.64 cfs @ 6.78 fps)

Pond INLET I:



Pond INLET J:

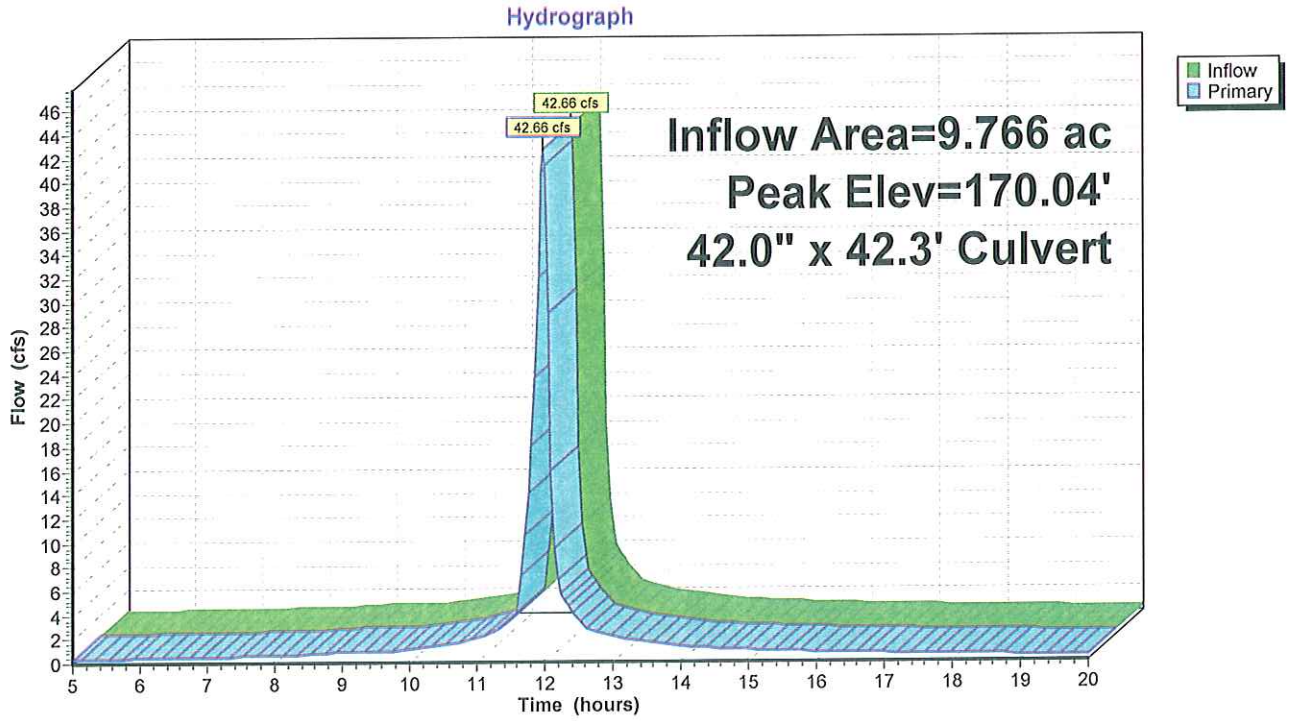
Inflow Area = 9.766 ac, Inflow Depth > 2.76" for 2-Year event
Inflow = 42.66 cfs @ 11.98 hrs, Volume= 2.242 af
Outflow = 42.66 cfs @ 11.98 hrs, Volume= 2.242 af, Atten= 0%, Lag= 0.0 min
Primary = 42.66 cfs @ 11.98 hrs, Volume= 2.242 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 170.04' @ 11.98 hrs
Flood Elev= 171.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	166.92'	**42.0" x 42.3' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 166.70' S= 0.0052 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=41.09 cfs @ 11.98 hrs HW=169.96' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 41.09 cfs @ 6.19 fps)

Pond INLET J:



Pond INLET K:

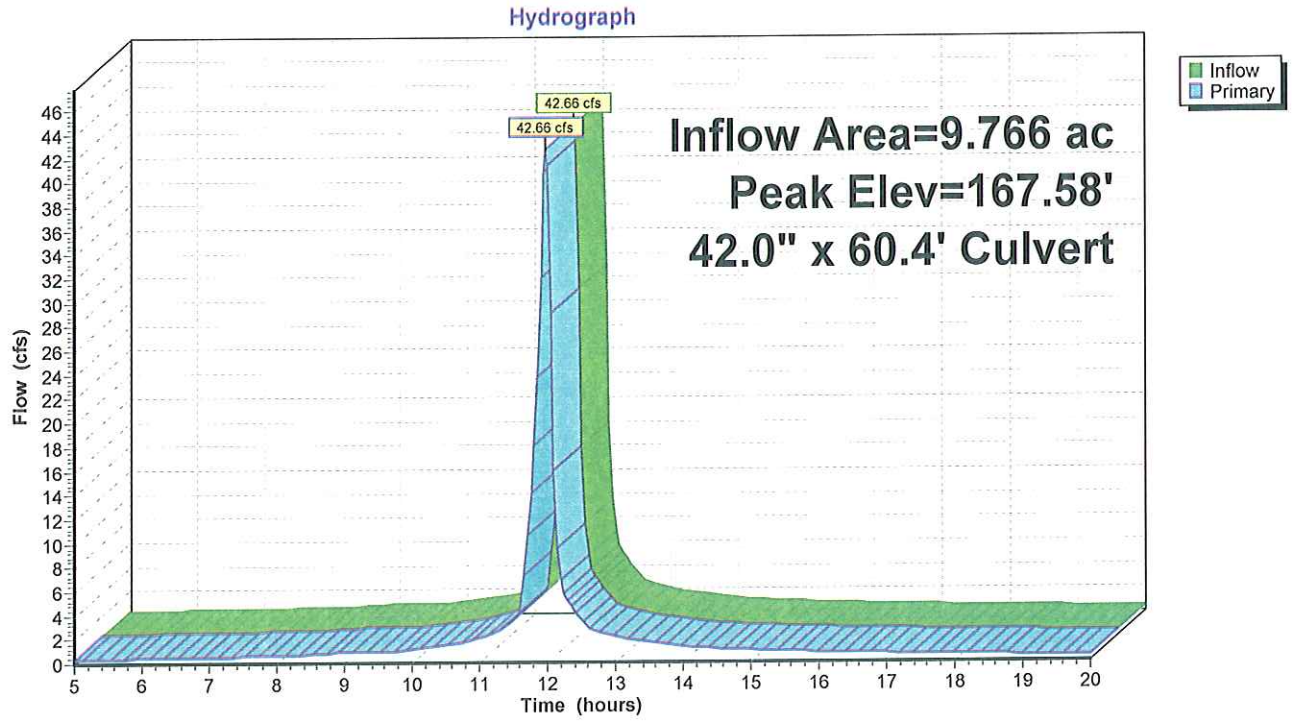
Inflow Area = 9.766 ac, Inflow Depth > 2.76" for 2-Year event
Inflow = 42.66 cfs @ 11.98 hrs, Volume= 2.242 af
Outflow = 42.66 cfs @ 11.98 hrs, Volume= 2.242 af, Atten= 0%, Lag= 0.0 min
Primary = 42.66 cfs @ 11.98 hrs, Volume= 2.242 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 167.58' @ 11.98 hrs
Flood Elev= 170.23'

Device	Routing	Invert	Outlet Devices
#1	Primary	164.50'	**42.0" x 60.4' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 164.20' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=41.09 cfs @ 11.98 hrs HW=167.50' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 41.09 cfs @ 6.28 fps)

Pond INLET K:



Pond MH E1:

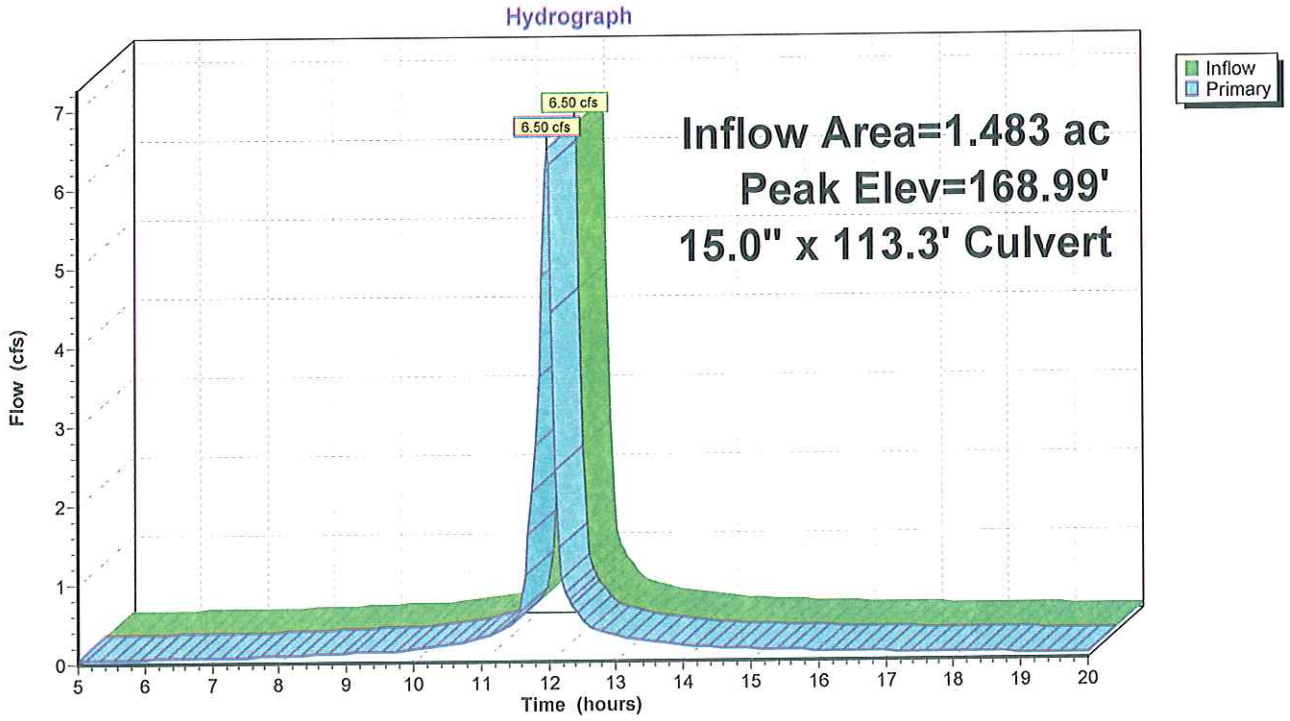
Inflow Area = 1.483 ac, Inflow Depth > 2.75" for 2-Year event
Inflow = 6.50 cfs @ 11.98 hrs, Volume= 0.340 af
Outflow = 6.50 cfs @ 11.98 hrs, Volume= 0.340 af, Atten= 0%, Lag= 0.0 min
Primary = 6.50 cfs @ 11.98 hrs, Volume= 0.340 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 168.99' @ 11.98 hrs
Flood Elev= 173.01'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.17'	**15.0" x 113.3' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 166.03' S= 0.0101 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=6.26 cfs @ 11.98 hrs HW=168.92' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 6.26 cfs @ 5.10 fps)

Pond MH E1:



Subcatchment A: WS-A

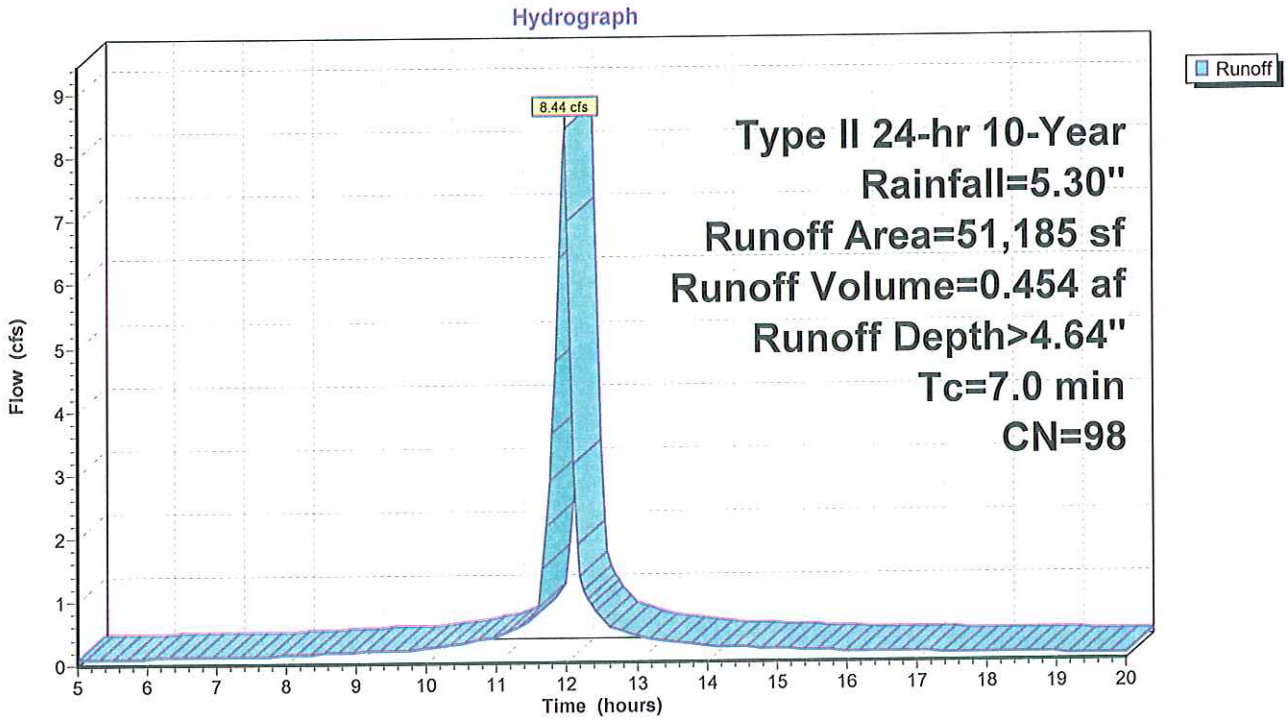
Runoff = 8.44 cfs @ 11.98 hrs, Volume= 0.454 af, Depth> 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
51,185	98	Paved parking & roofs
51,185		Impervious Area

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

Subcatchment A: WS-A



Subcatchment A-1: WS-A-1

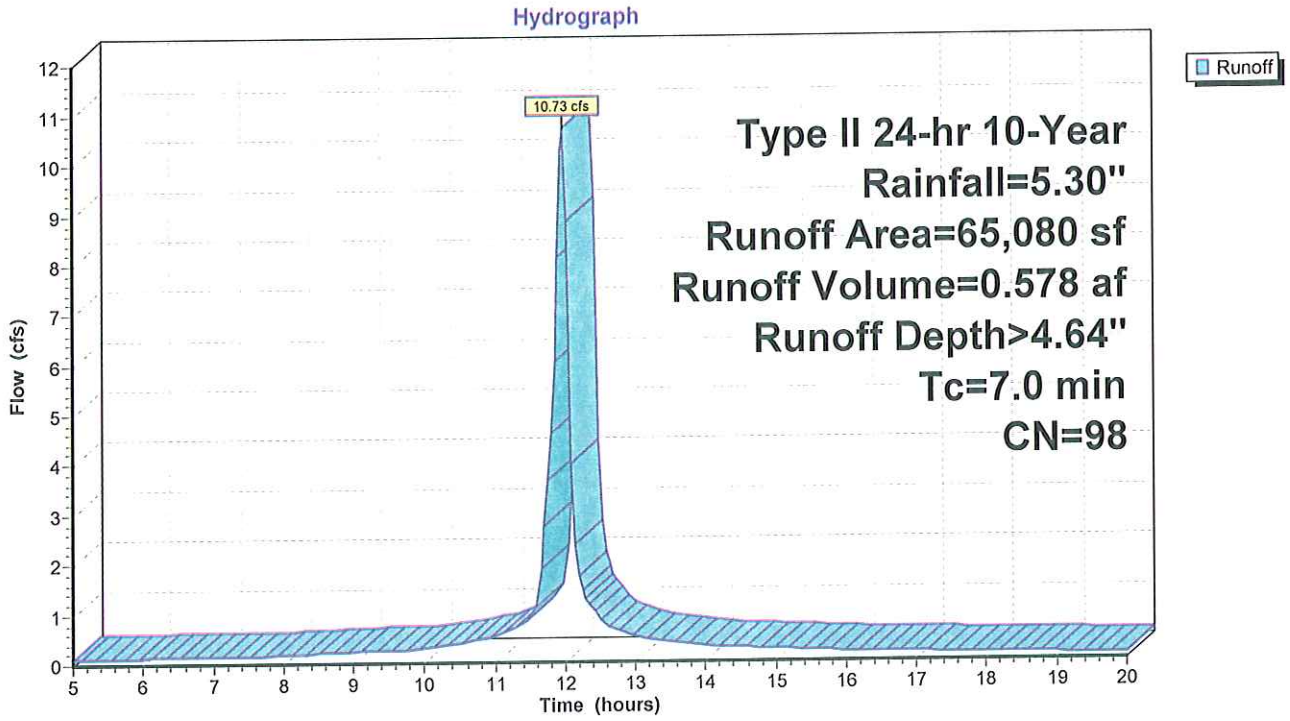
Runoff = 10.73 cfs @ 11.98 hrs, Volume= 0.578 af, Depth> 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
65,080	98	Paved parking & roofs
65,080		Impervious Area

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

Subcatchment A-1: WS-A-1



Subcatchment B: WS-B

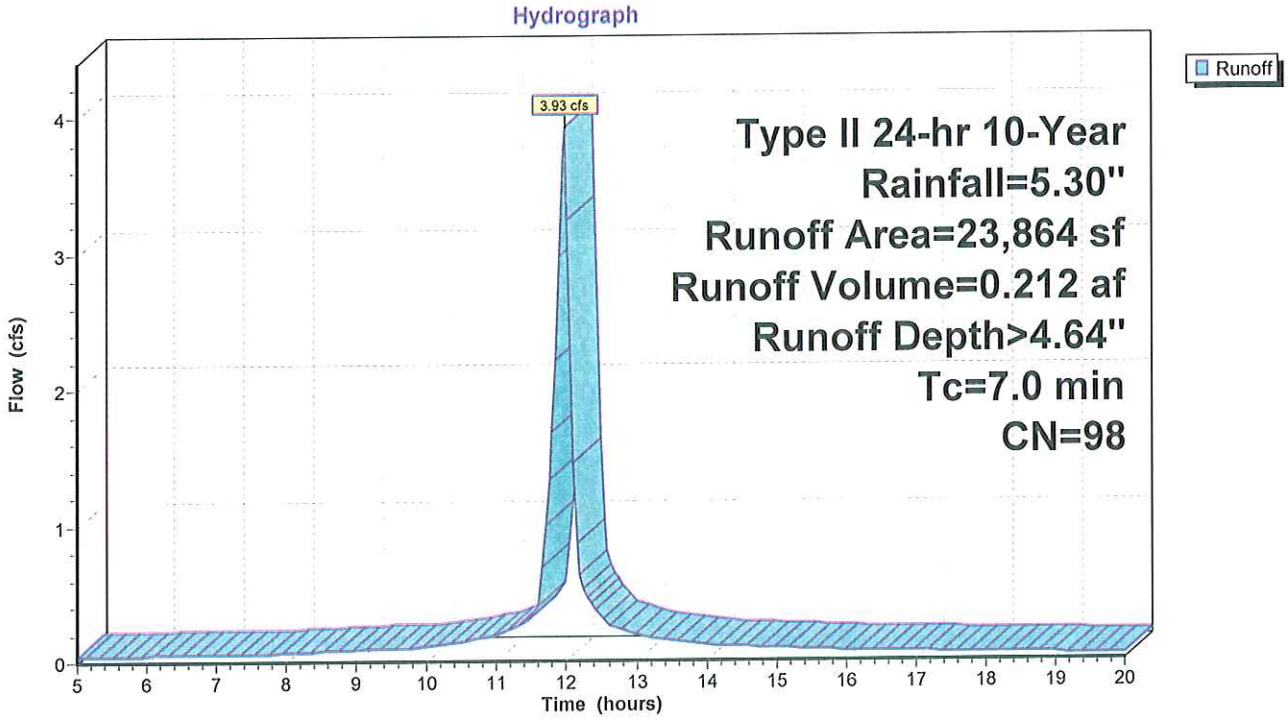
Runoff = 3.93 cfs @ 11.98 hrs, Volume= 0.212 af, Depth> 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
23,864	98	Paved parking & roofs
23,864		Impervious Area

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

Subcatchment B: WS-B



Subcatchment B-1: WS-B-1

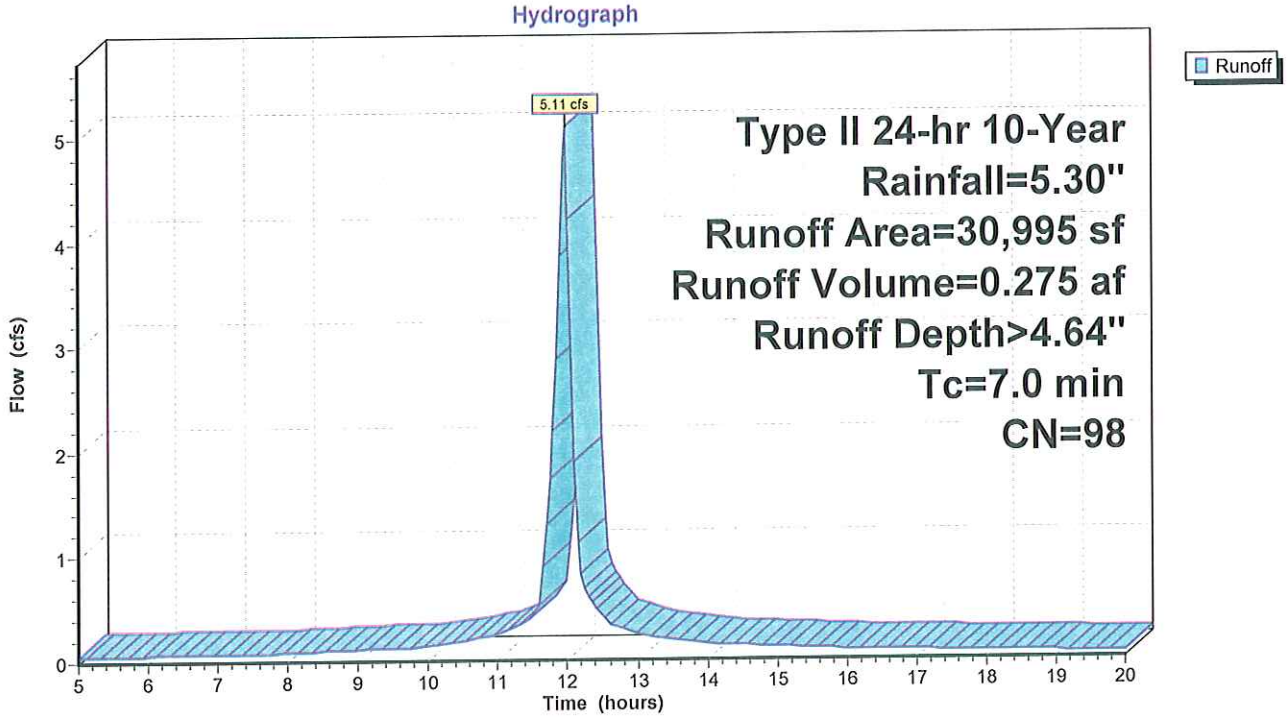
Runoff = 5.11 cfs @ 11.98 hrs, Volume= 0.275 af, Depth> 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
30,995	98	Paved parking & roofs
30,995		Impervious Area

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

Subcatchment B-1: WS-B-1



Subcatchment C: WS-C

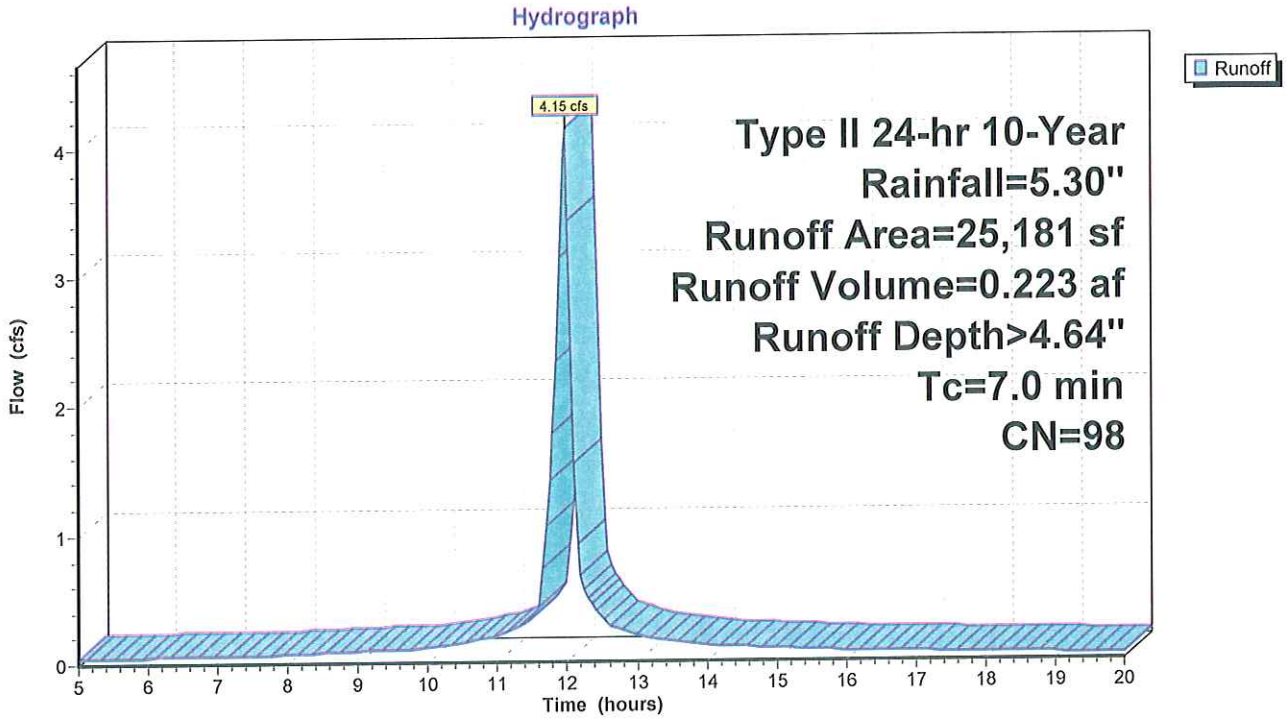
Runoff = 4.15 cfs @ 11.98 hrs, Volume= 0.223 af, Depth> 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
24,931	98	Paved parking & roofs
250	80	>75% Grass cover, Good, HSG D
25,181	98	Weighted Average
250		Pervious Area
24,931		Impervious Area

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

Subcatchment C: WS-C



Subcatchment D: WS-D

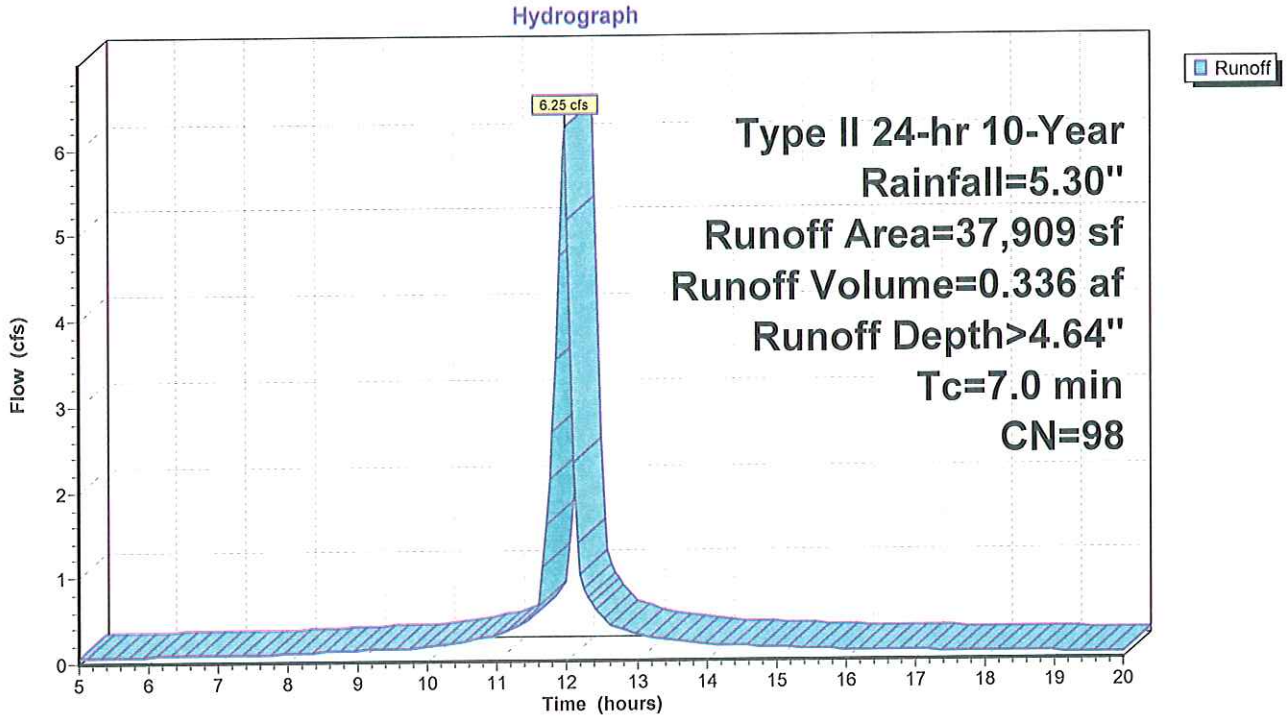
Runoff = 6.25 cfs @ 11.98 hrs, Volume= 0.336 af, Depth> 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
37,313	98	Paved parking & roofs
596	80	>75% Grass cover, Good, HSG D
37,909	98	Weighted Average
596		Pervious Area
37,313		Impervious Area

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

Subcatchment D: WS-D



Subcatchment E: WS-E

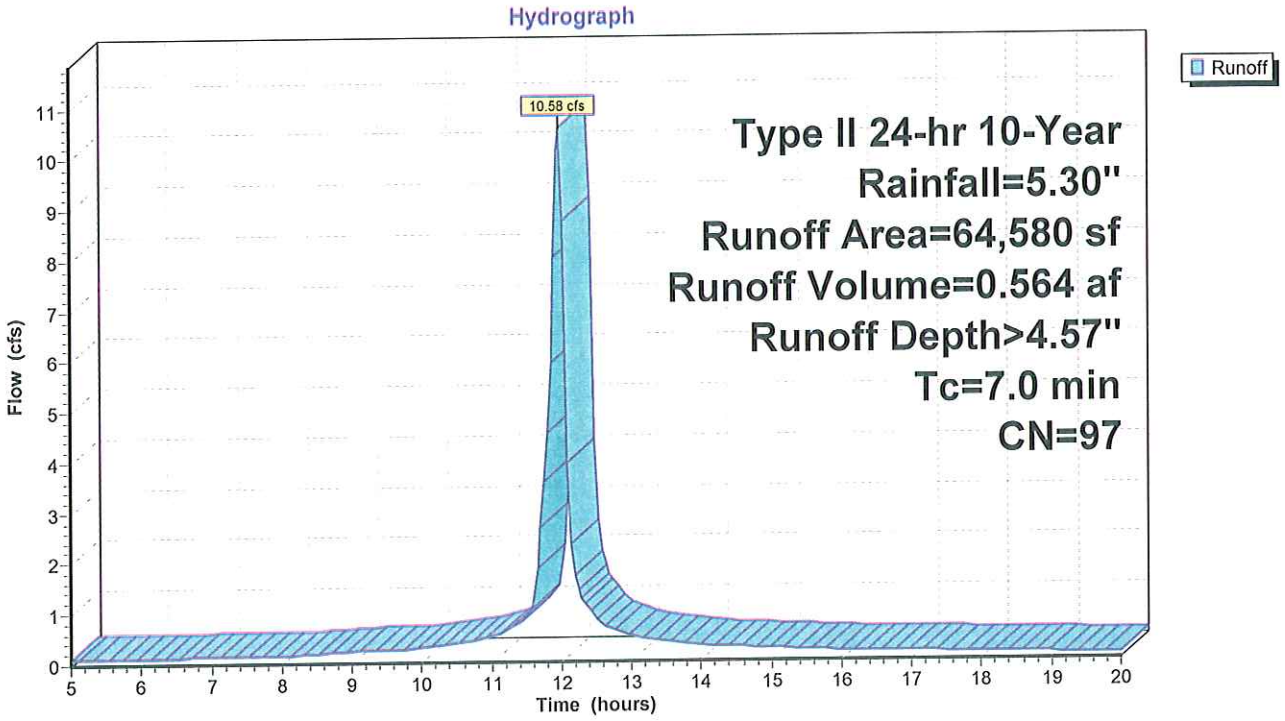
Runoff = 10.58 cfs @ 11.98 hrs, Volume= 0.564 af, Depth> 4.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
59,598	98	Paved parking & roofs
4,982	80	>75% Grass cover, Good, HSG D
64,580	97	Weighted Average
4,982		Pervious Area
59,598		Impervious Area

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

Subcatchment E: WS-E



Subcatchment EX 6: WS-6

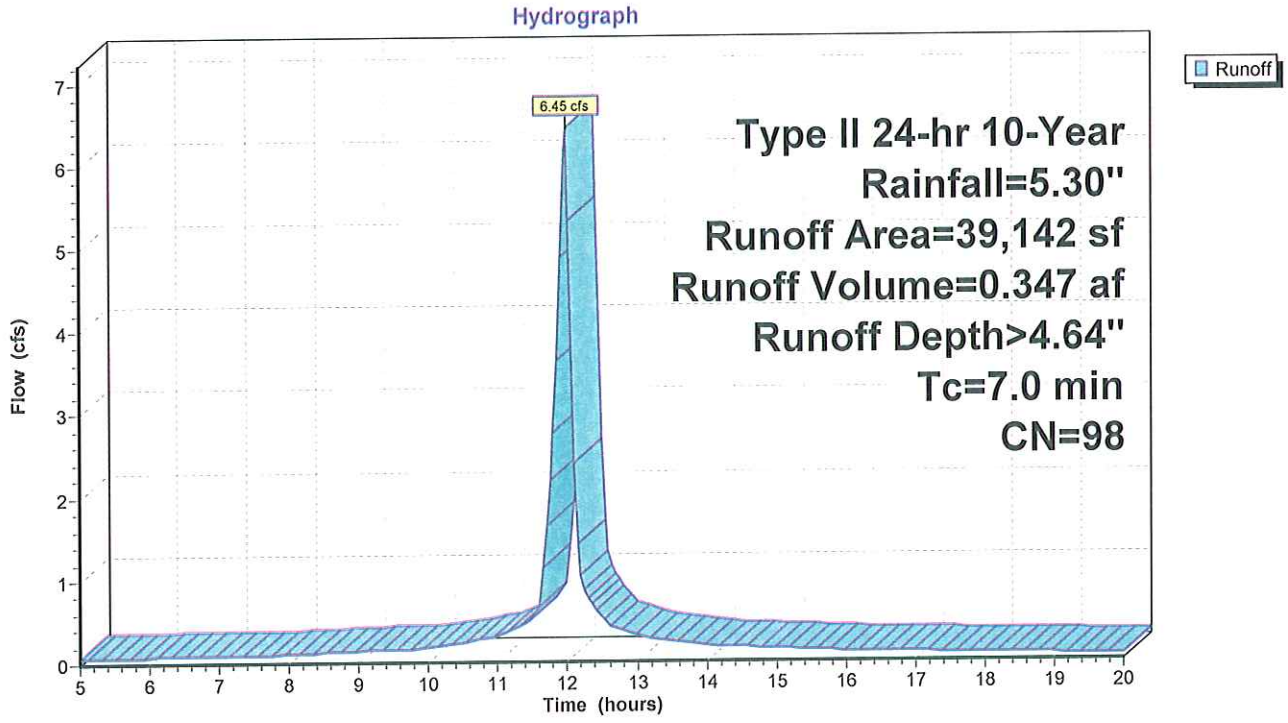
Runoff = 6.45 cfs @ 11.98 hrs, Volume= 0.347 af, Depth> 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
39,142	98	Paved parking & roofs
39,142		Impervious Area

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

Subcatchment EX 6: WS-6



Subcatchment F: WS-F

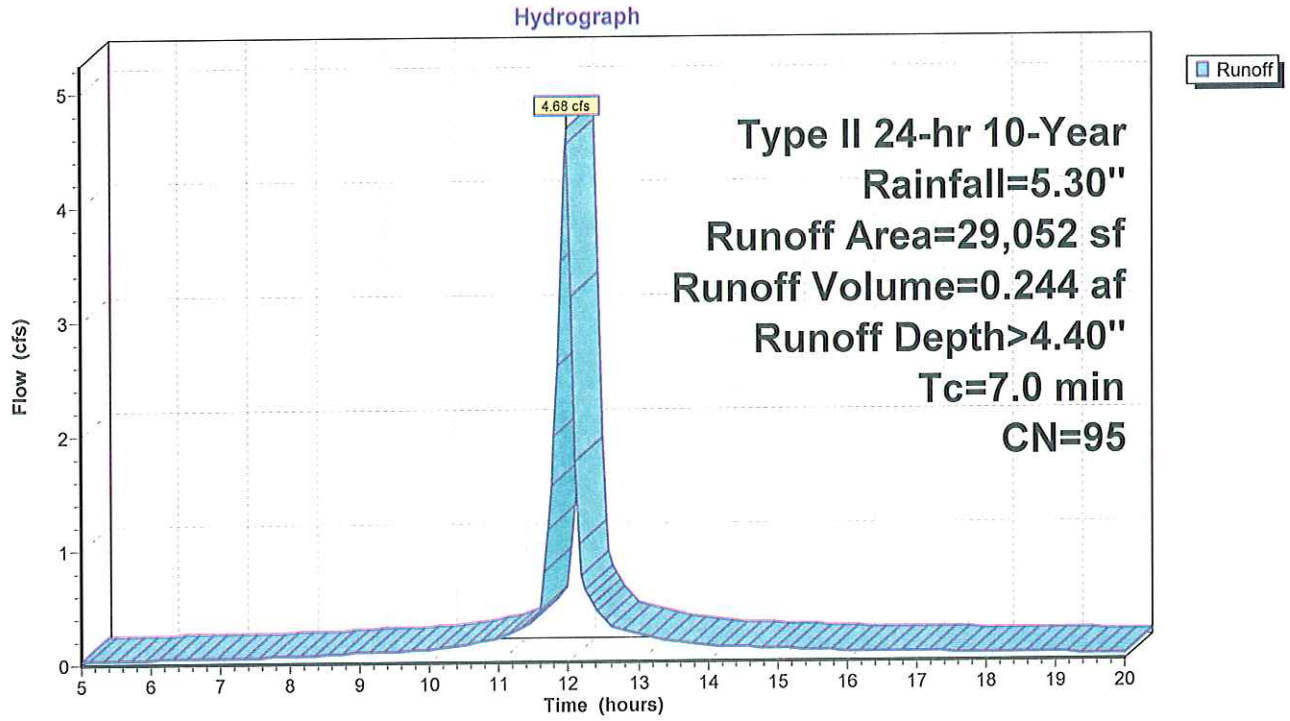
Runoff = 4.68 cfs @ 11.98 hrs, Volume= 0.244 af, Depth> 4.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
26,892	98	Paved parking & roofs
2,160	61	>75% Grass cover, Good, HSG B
29,052	95	Weighted Average
2,160		Pervious Area
26,892		Impervious Area

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

Subcatchment F: WS-F



Subcatchment G: WS-G

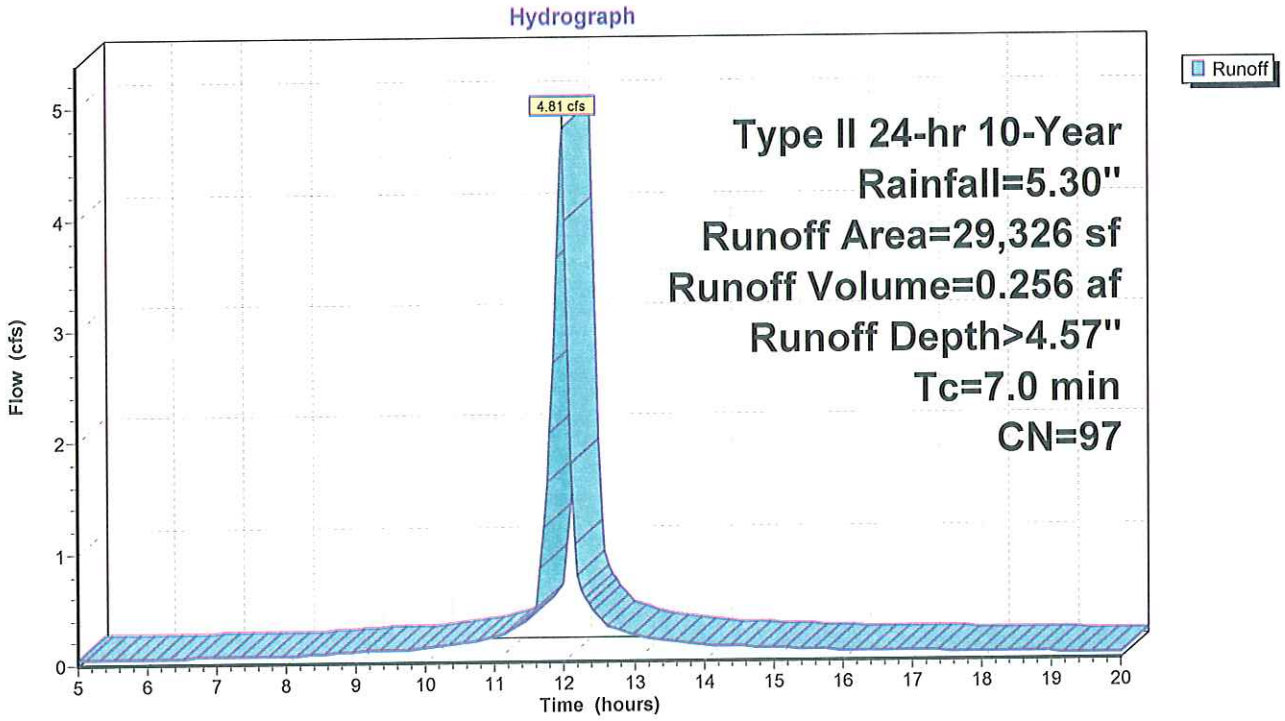
Runoff = 4.81 cfs @ 11.98 hrs, Volume= 0.256 af, Depth> 4.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
28,366	98	Paved parking & roofs
960	80	>75% Grass cover, Good, HSG D
29,326	97	Weighted Average
960		Pervious Area
28,366		Impervious Area

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

Subcatchment G: WS-G



Subcatchment J: WS-J

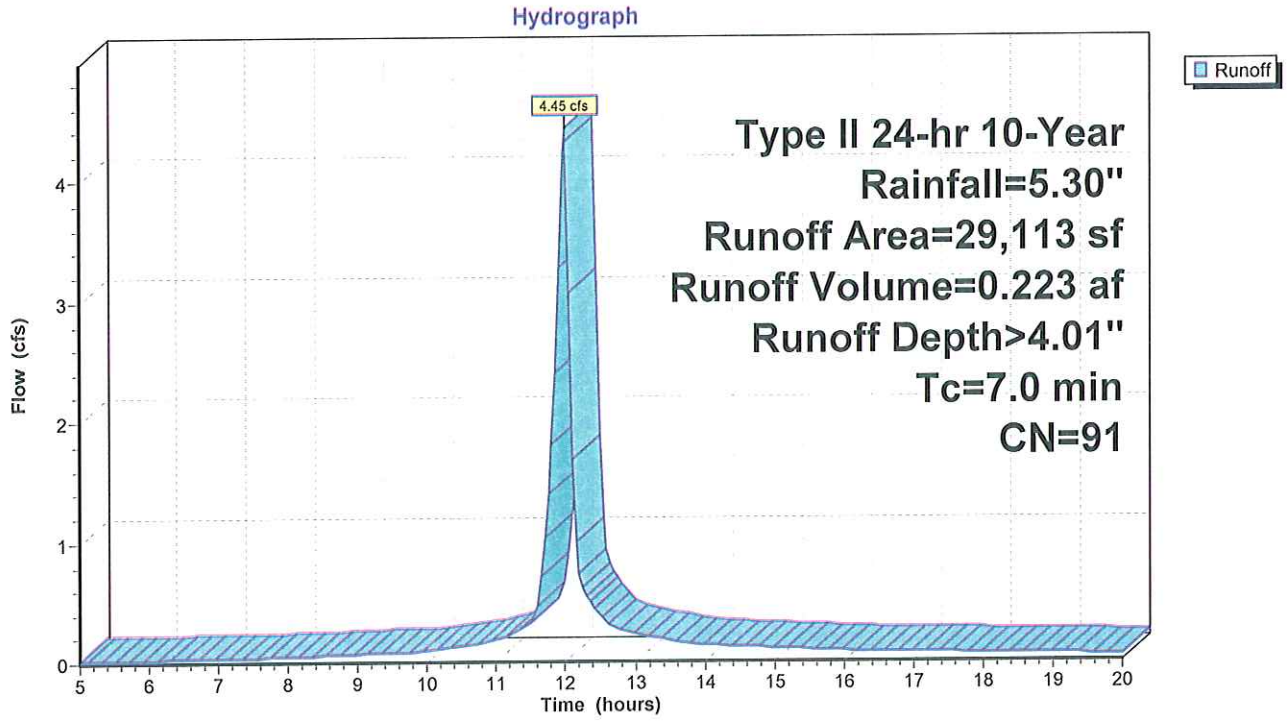
Runoff = 4.45 cfs @ 11.98 hrs, Volume= 0.223 af, Depth> 4.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.30"

Area (sf)	CN	Description
17,235	98	Paved parking & roofs
11,878	80	>75% Grass cover, Good, HSG D
29,113	91	Weighted Average
11,878		Pervious Area
17,235		Impervious Area

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

Subcatchment J: WS-J



Pond INLET 6: INLET EX6

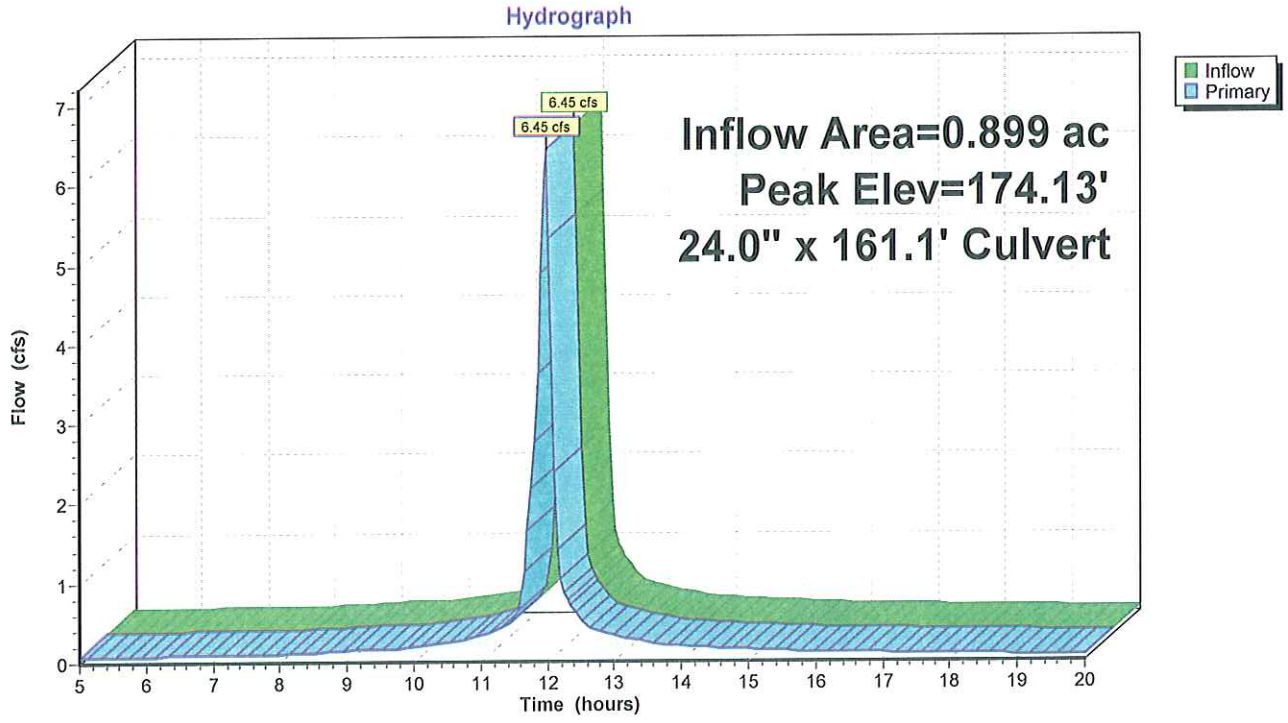
Inflow Area = 0.899 ac, Inflow Depth > 4.64" for 10-Year event
Inflow = 6.45 cfs @ 11.98 hrs, Volume= 0.347 af
Outflow = 6.45 cfs @ 11.98 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min
Primary = 6.45 cfs @ 11.98 hrs, Volume= 0.347 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 174.13' @ 11.98 hrs
Flood Elev= 175.94'

Device	Routing	Invert	Outlet Devices
#1	Primary	172.80'	**24.0" x 161.1' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 172.29' S= 0.0032 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished

Primary OutFlow Max=6.21 cfs @ 11.98 hrs HW=174.10' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 6.21 cfs @ 4.07 fps)

Pond INLET 6: INLET EX6



Pond INLET A1:

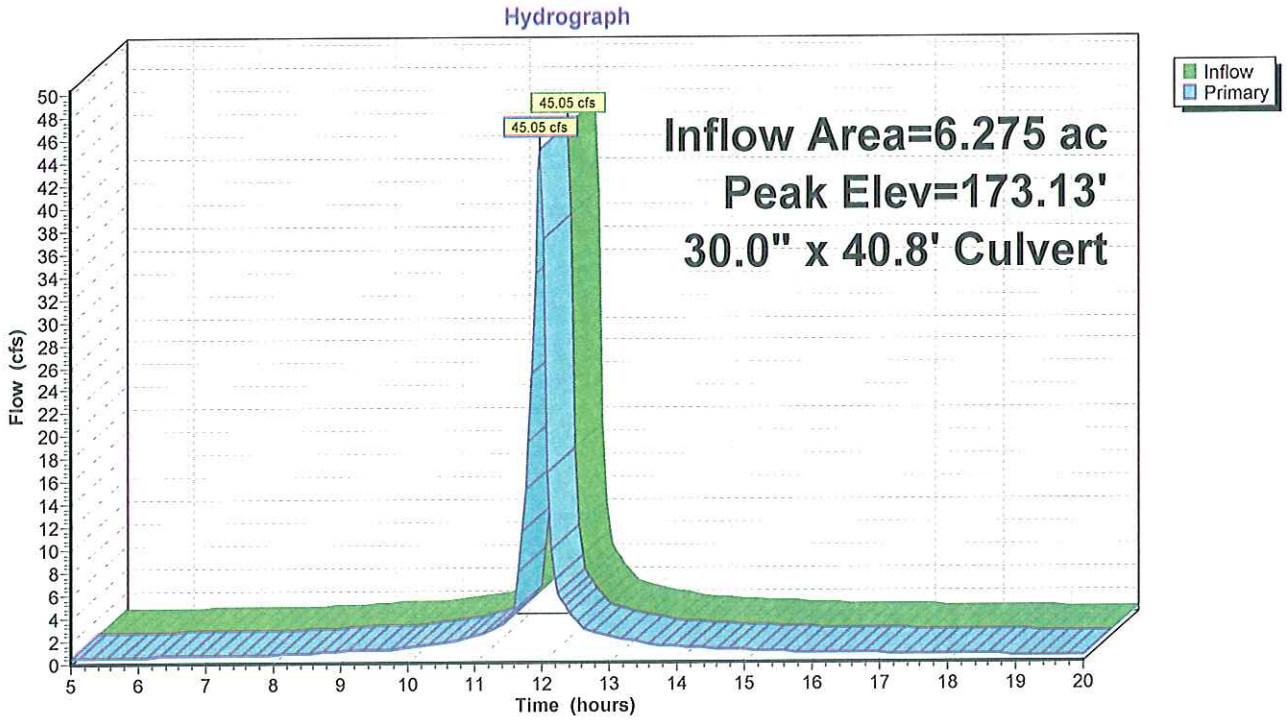
Inflow Area = 6.275 ac, Inflow Depth > 4.64" for 10-Year event
Inflow = 45.05 cfs @ 11.98 hrs, Volume= 2.426 af
Outflow = 45.05 cfs @ 11.98 hrs, Volume= 2.426 af, Atten= 0%, Lag= 0.0 min
Primary = 45.05 cfs @ 11.98 hrs, Volume= 2.426 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 173.13' @ 11.98 hrs
Flood Elev= 173.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.34'	**30.0" x 40.8' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.13' S= 0.0051 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=43.40 cfs @ 11.98 hrs HW=172.96' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 43.40 cfs @ 8.84 fps)

Pond INLET A1:



Pond INLET B:

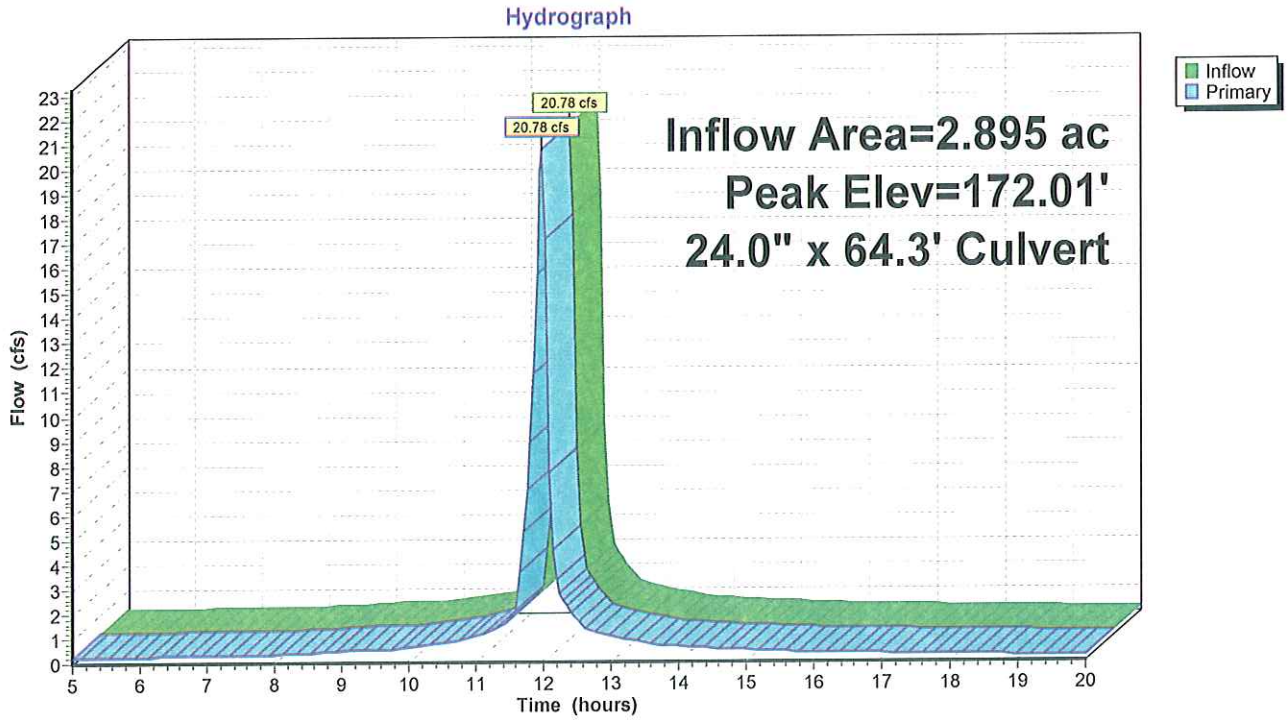
Inflow Area = 2.895 ac, Inflow Depth > 4.64" for 10-Year event
Inflow = 20.78 cfs @ 11.98 hrs, Volume= 1.119 af
Outflow = 20.78 cfs @ 11.98 hrs, Volume= 1.119 af, Atten= 0%, Lag= 0.0 min
Primary = 20.78 cfs @ 11.98 hrs, Volume= 1.119 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 172.01' @ 11.98 hrs
Flood Elev= 174.19'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.91'	**24.0" x 64.3' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.59' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=20.02 cfs @ 11.98 hrs HW=171.90' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 20.02 cfs @ 6.37 fps)

Pond INLET B:



Pond INLET B1:

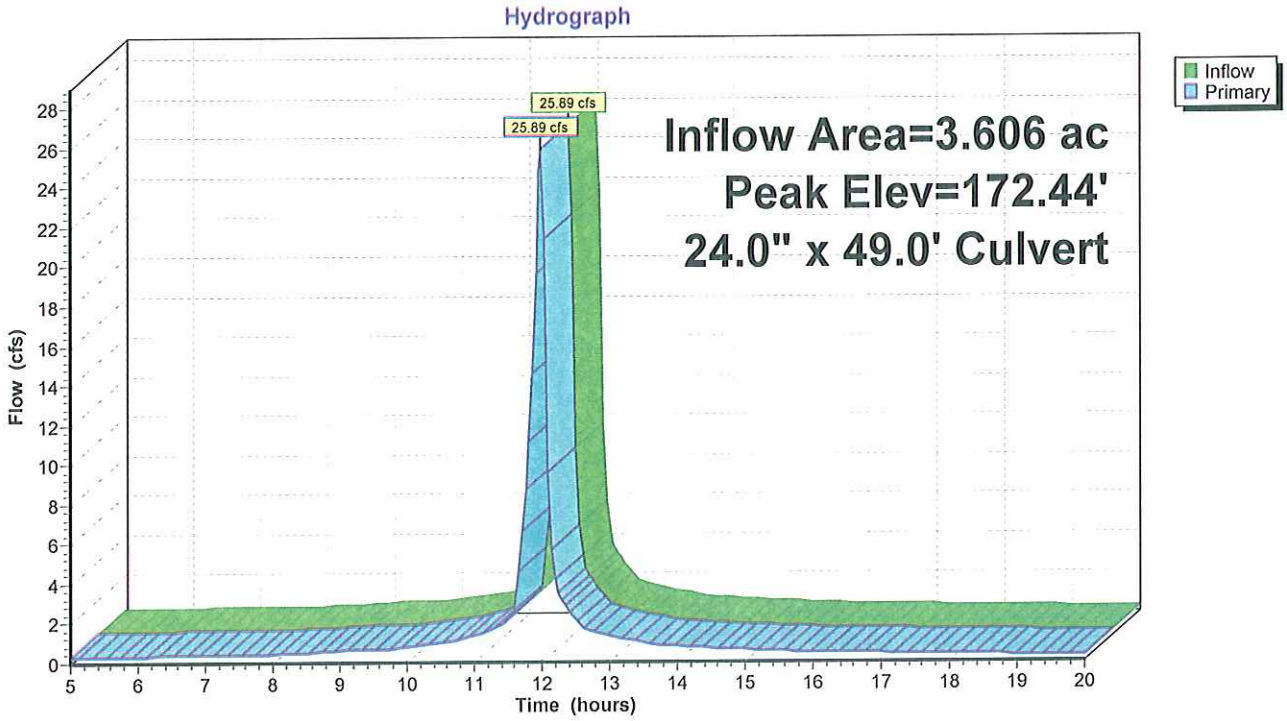
Inflow Area = 3.606 ac, Inflow Depth > 4.64" for 10-Year event
Inflow = 25.89 cfs @ 11.98 hrs, Volume= 1.394 af
Outflow = 25.89 cfs @ 11.98 hrs, Volume= 1.394 af, Atten= 0%, Lag= 0.0 min
Primary = 25.89 cfs @ 11.98 hrs, Volume= 1.394 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 172.44' @ 11.98 hrs
Flood Elev= 174.19'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.59'	**24.0" x 49.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.34' S= 0.0051 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=24.94 cfs @ 11.98 hrs HW=172.31' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 24.94 cfs @ 7.94 fps)

Pond INLET B1:



Pond INLET C:

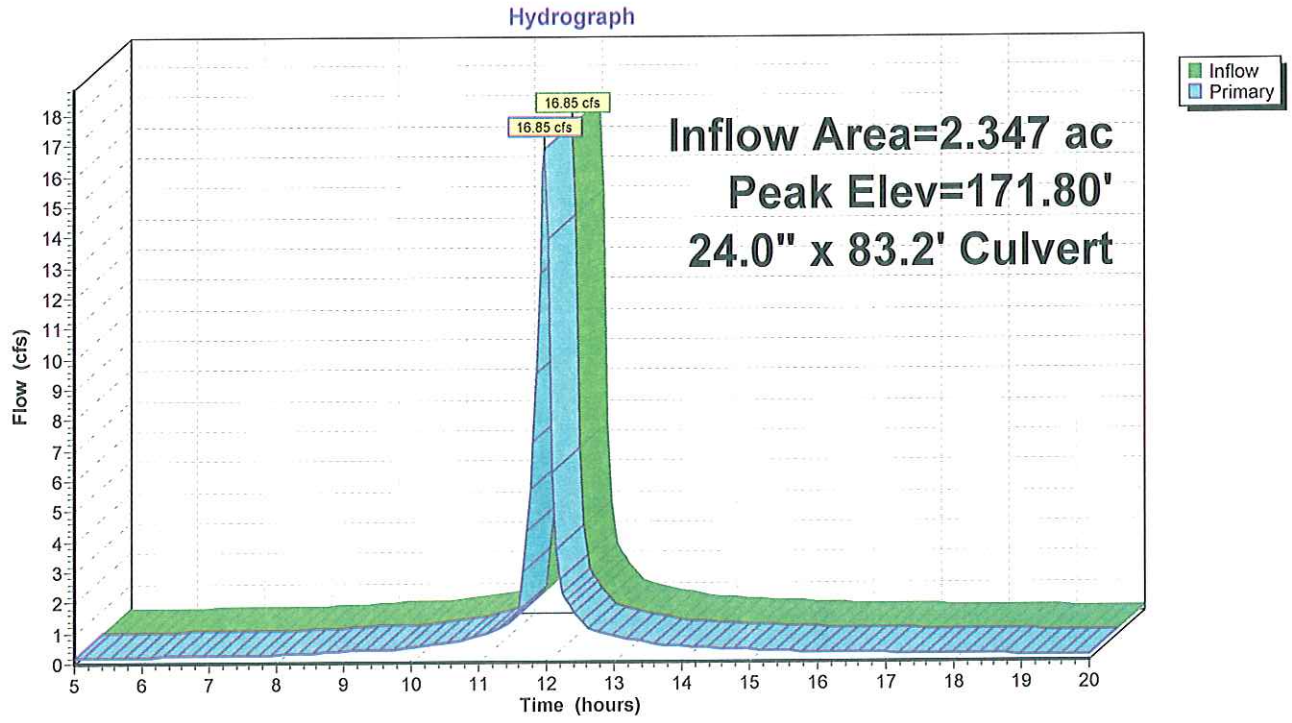
Inflow Area = 2.347 ac, Inflow Depth > 4.64" for 10-Year event
Inflow = 16.85 cfs @ 11.98 hrs, Volume= 0.907 af
Outflow = 16.85 cfs @ 11.98 hrs, Volume= 0.907 af, Atten= 0%, Lag= 0.0 min
Primary = 16.85 cfs @ 11.98 hrs, Volume= 0.907 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.80' @ 11.98 hrs
Flood Elev= 174.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	169.32'	**24.0" x 83.2' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 168.91' S= 0.0049 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished

Primary OutFlow Max=16.23 cfs @ 11.98 hrs HW=171.73' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 16.23 cfs @ 5.44 fps)

Pond INLET C:



Pond INLET D:

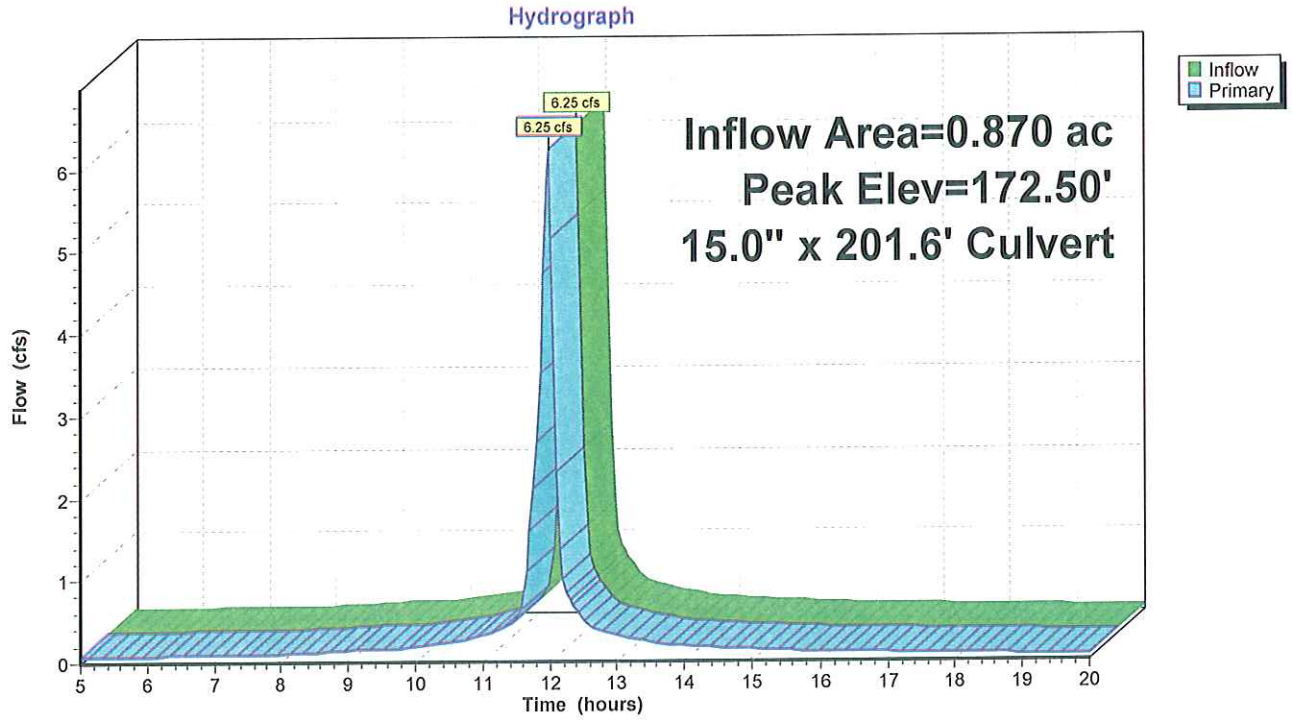
Inflow Area = 0.870 ac, Inflow Depth > 4.64" for 10-Year event
Inflow = 6.25 cfs @ 11.98 hrs, Volume= 0.336 af
Outflow = 6.25 cfs @ 11.98 hrs, Volume= 0.336 af, Atten= 0%, Lag= 0.0 min
Primary = 6.25 cfs @ 11.98 hrs, Volume= 0.336 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 172.50' @ 11.98 hrs
Flood Elev= 174.55'

Device	Routing	Invert	Outlet Devices
#1	Primary	170.33'	**15.0" x 201.6' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 169.32' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=6.02 cfs @ 11.98 hrs HW=172.39' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 6.02 cfs @ 4.90 fps)

Pond INLET D:



Pond INLET E:

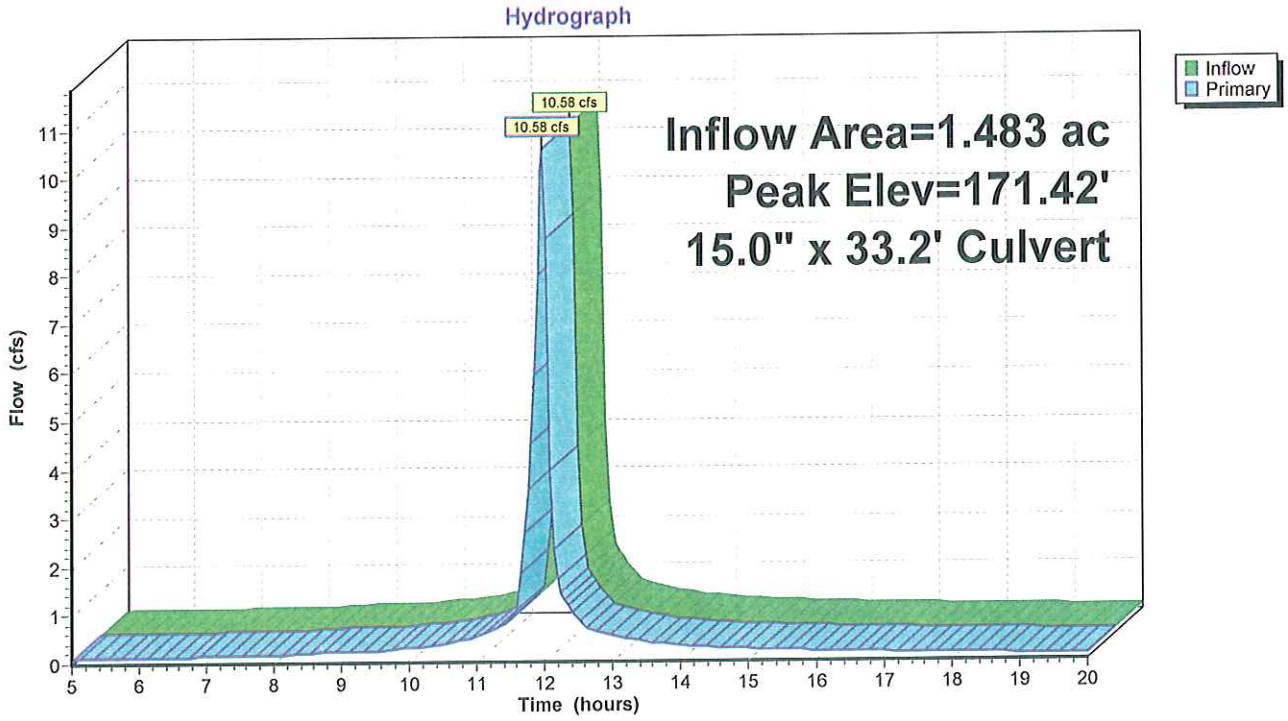
Inflow Area = 1.483 ac, Inflow Depth > 4.57" for 10-Year event
Inflow = 10.58 cfs @ 11.98 hrs, Volume= 0.564 af
Outflow = 10.58 cfs @ 11.98 hrs, Volume= 0.564 af, Atten= 0%, Lag= 0.0 min
Primary = 10.58 cfs @ 11.98 hrs, Volume= 0.564 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.42' @ 11.98 hrs
Flood Elev= 173.03'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.62'	**15.0" x 33.2' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 167.27' S= 0.0105 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=10.19 cfs @ 11.98 hrs HW=171.22' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 10.19 cfs @ 8.31 fps)

Pond INLET E:



Pond INLET F:

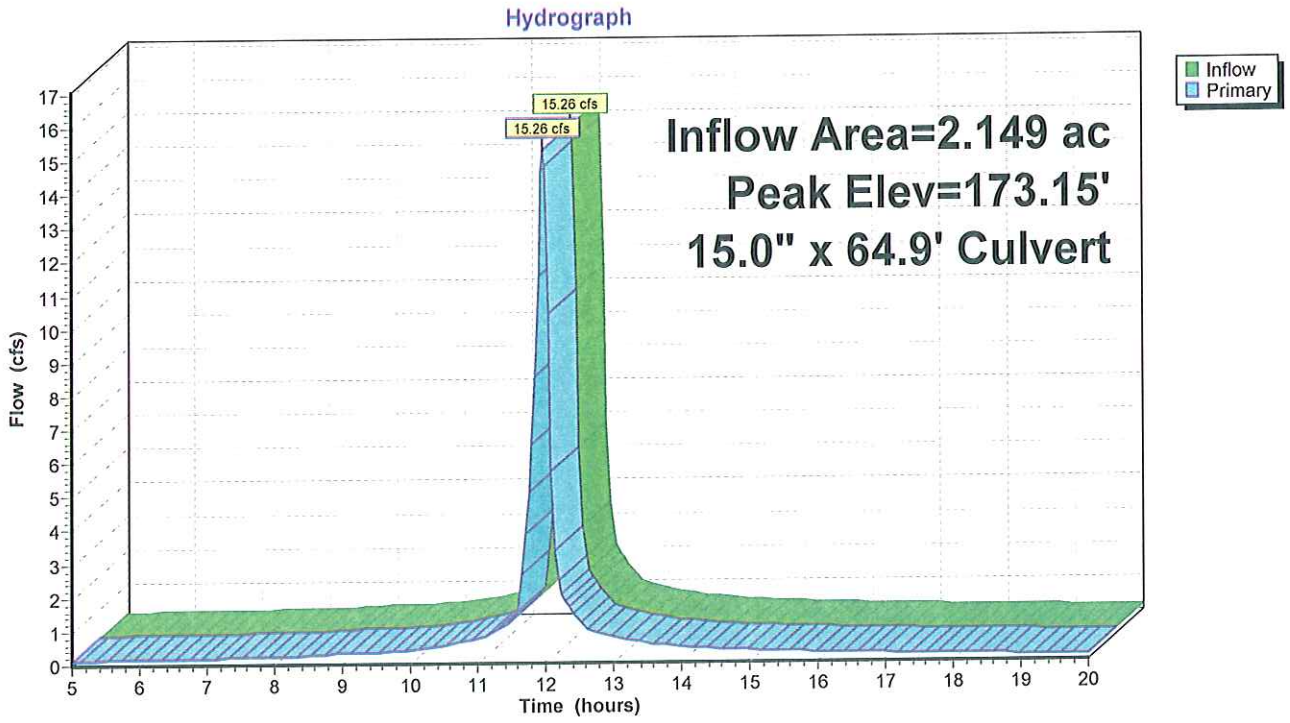
Inflow Area = 2.149 ac, Inflow Depth > 4.51" for 10-Year event
Inflow = 15.26 cfs @ 11.98 hrs, Volume= 0.809 af
Outflow = 15.26 cfs @ 11.98 hrs, Volume= 0.809 af, Atten= 0%, Lag= 0.0 min
Primary = 15.26 cfs @ 11.98 hrs, Volume= 0.809 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 173.15' @ 11.98 hrs
Flood Elev= 172.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	165.93'	**15.0" x 64.9' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 165.29' S= 0.0099 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=14.70 cfs @ 11.98 hrs HW=172.75' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 14.70 cfs @ 11.98 fps)

Pond INLET F:



Pond INLET G:

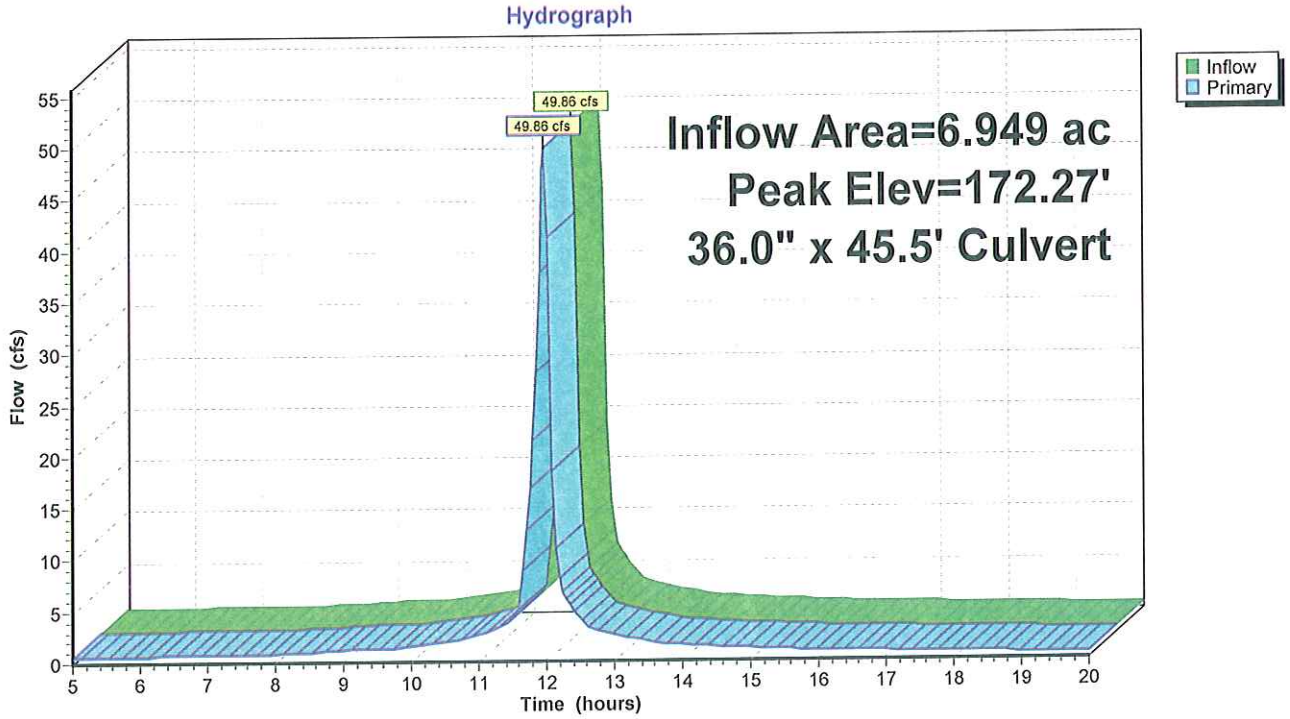
Inflow Area = 6.949 ac, Inflow Depth > 4.63" for 10-Year event
Inflow = 49.86 cfs @ 11.98 hrs, Volume= 2.682 af
Outflow = 49.86 cfs @ 11.98 hrs, Volume= 2.682 af, Atten= 0%, Lag= 0.0 min
Primary = 49.86 cfs @ 11.98 hrs, Volume= 2.682 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 172.27' @ 11.98 hrs
Flood Elev= 173.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	168.13'	**36.0" x 45.5' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 167.90' S= 0.0051 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=47.88 cfs @ 11.98 hrs HW=172.14' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 47.88 cfs @ 6.77 fps)

Pond INLET G:



Pond INLET H:

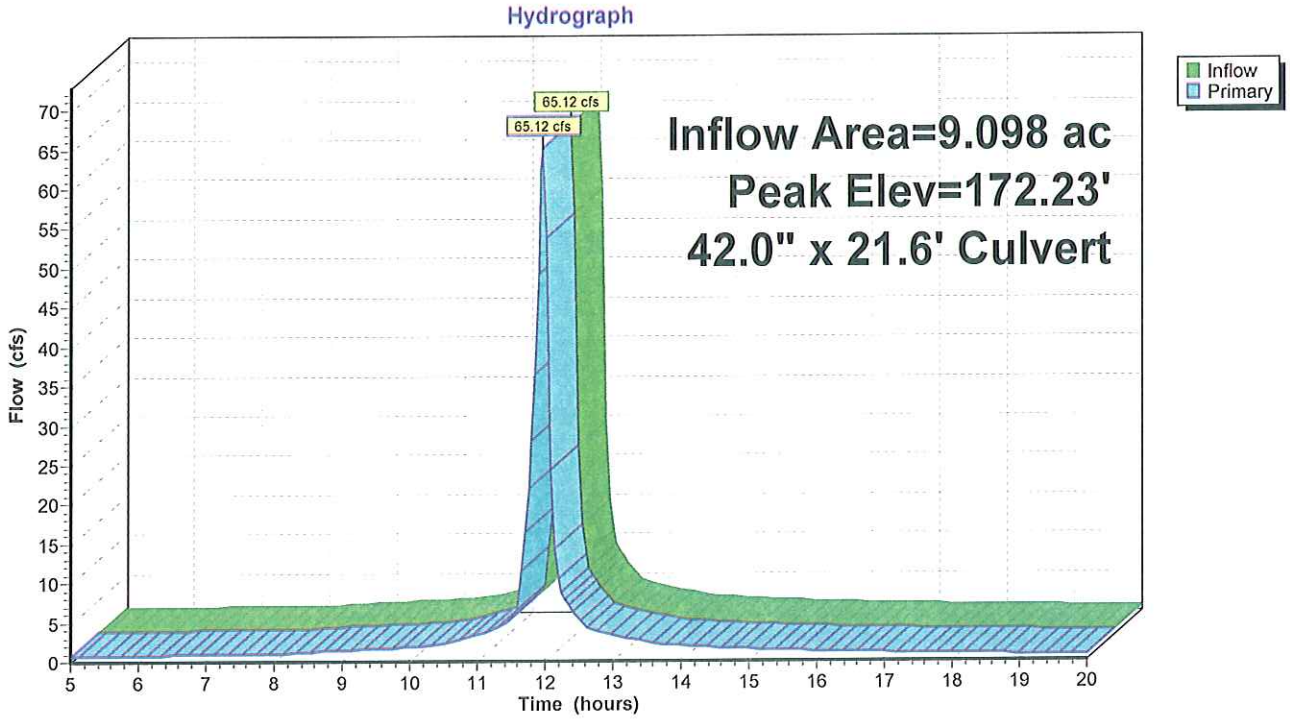
Inflow Area = 9.098 ac, Inflow Depth > 4.60" for 10-Year event
Inflow = 65.12 cfs @ 11.98 hrs, Volume= 3.491 af
Outflow = 65.12 cfs @ 11.98 hrs, Volume= 3.491 af, Atten= 0%, Lag= 0.0 min
Primary = 65.12 cfs @ 11.98 hrs, Volume= 3.491 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 172.23' @ 11.98 hrs
Flood Elev= 172.39'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.90'	**42.0" x 21.6' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 167.80' S= 0.0046 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=62.73 cfs @ 11.98 hrs HW=172.11' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 62.73 cfs @ 6.87 fps)

Pond INLET H:



Pond INLET I:

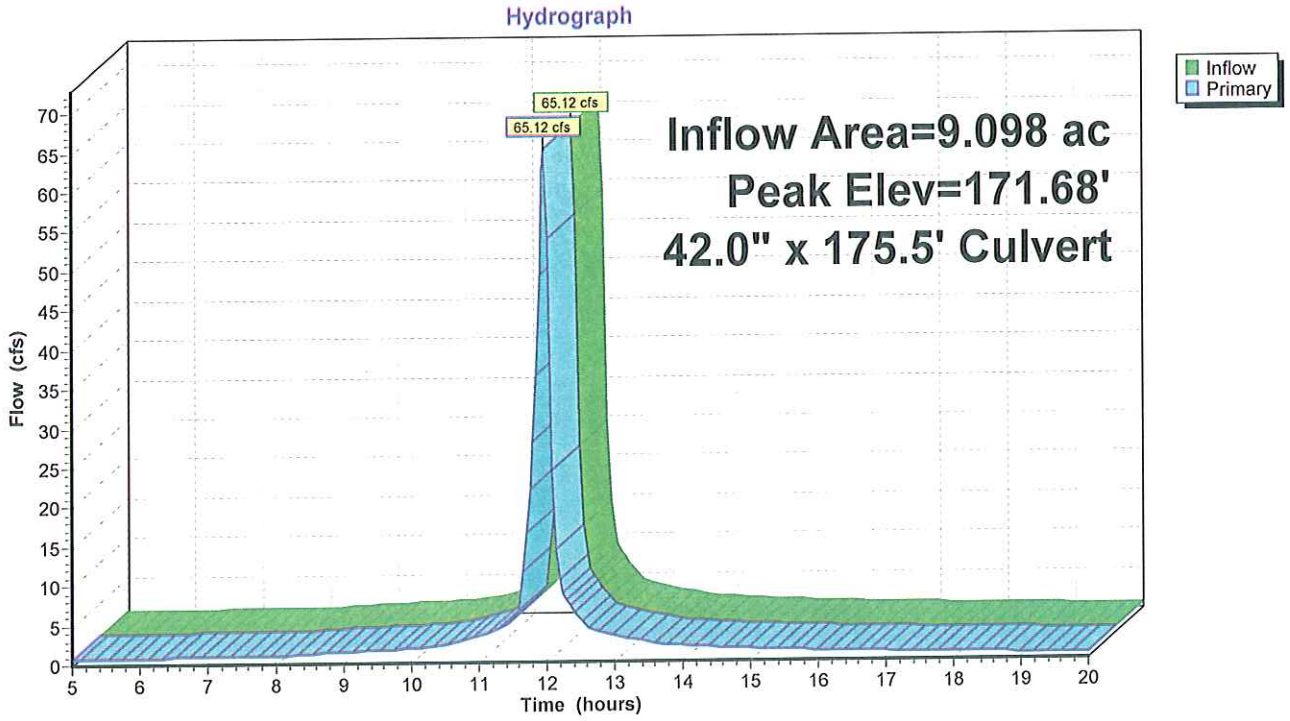
Inflow Area = 9.098 ac, Inflow Depth > 4.60" for 10-Year event
Inflow = 65.12 cfs @ 11.98 hrs, Volume= 3.491 af
Outflow = 65.12 cfs @ 11.98 hrs, Volume= 3.491 af, Atten= 0%, Lag= 0.0 min
Primary = 65.12 cfs @ 11.98 hrs, Volume= 3.491 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.68' @ 11.98 hrs
Flood Elev= 172.42'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.80'	**42.0" x 175.5' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 166.92' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=62.73 cfs @ 11.98 hrs HW=171.57' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 62.73 cfs @ 7.53 fps)

Pond INLET I:



Pond INLET J:

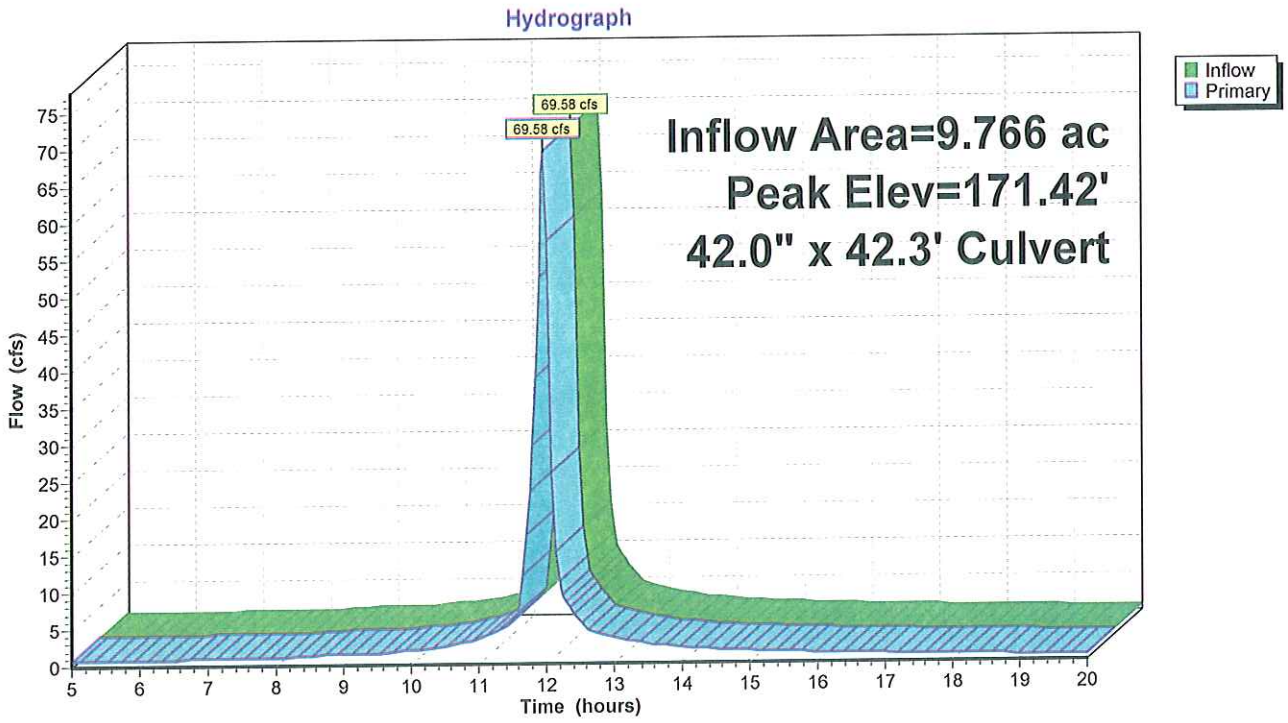
Inflow Area = 9.766 ac, Inflow Depth > 4.56" for 10-Year event
Inflow = 69.58 cfs @ 11.98 hrs, Volume= 3.714 af
Outflow = 69.58 cfs @ 11.98 hrs, Volume= 3.714 af, Atten= 0%, Lag= 0.0 min
Primary = 69.58 cfs @ 11.98 hrs, Volume= 3.714 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.42' @ 11.98 hrs
Flood Elev= 171.46'

Device	Routing	Invert	Outlet Devices
#1	Primary	166.92'	**42.0" x 42.3' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 166.70' S= 0.0052 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=67.02 cfs @ 11.98 hrs HW=171.29' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 67.02 cfs @ 7.16 fps)

Pond INLET J:



Pond INLET K:

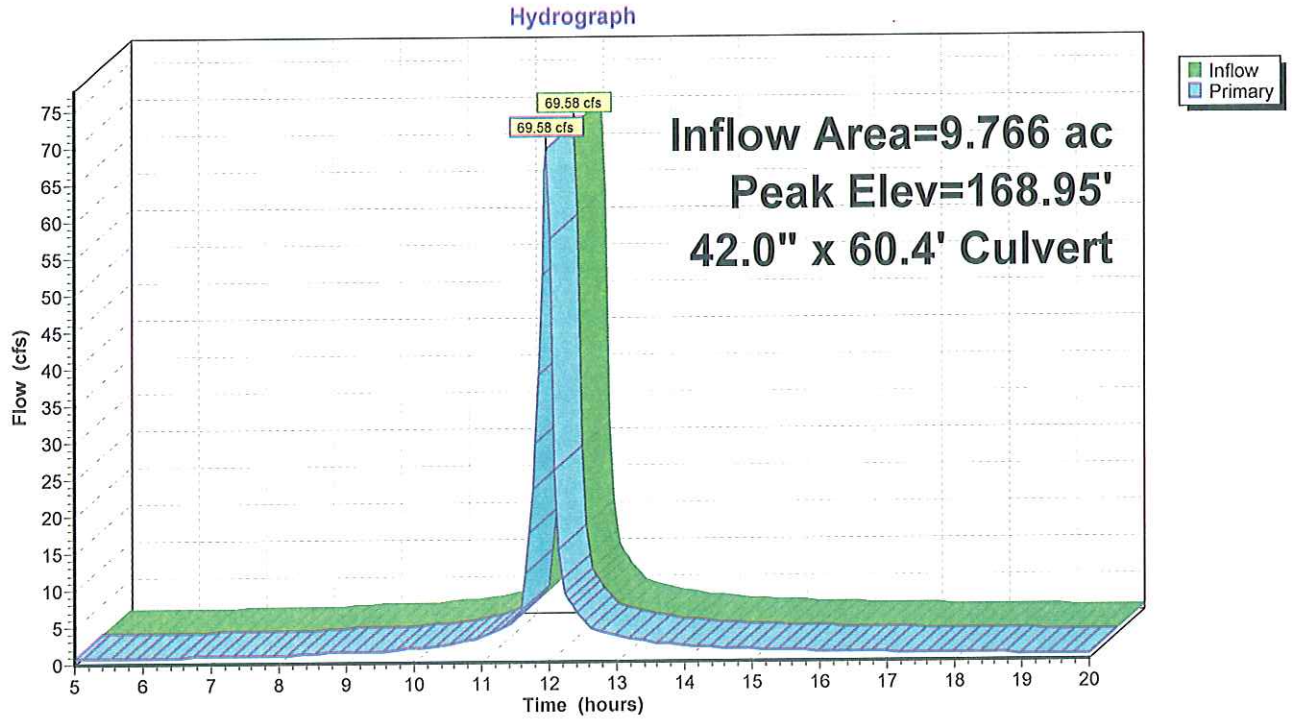
Inflow Area = 9.766 ac, Inflow Depth > 4.56" for 10-Year event
Inflow = 69.58 cfs @ 11.98 hrs, Volume= 3.714 af
Outflow = 69.58 cfs @ 11.98 hrs, Volume= 3.714 af, Atten= 0%, Lag= 0.0 min
Primary = 69.58 cfs @ 11.98 hrs, Volume= 3.714 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 168.95' @ 11.98 hrs
Flood Elev= 170.23'

Device	Routing	Invert	Outlet Devices
#1	Primary	164.50'	**42.0" x 60.4' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 164.20' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=67.02 cfs @ 11.98 hrs HW=168.82' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 67.02 cfs @ 7.21 fps)

Pond INLET K:



Pond MH E1:

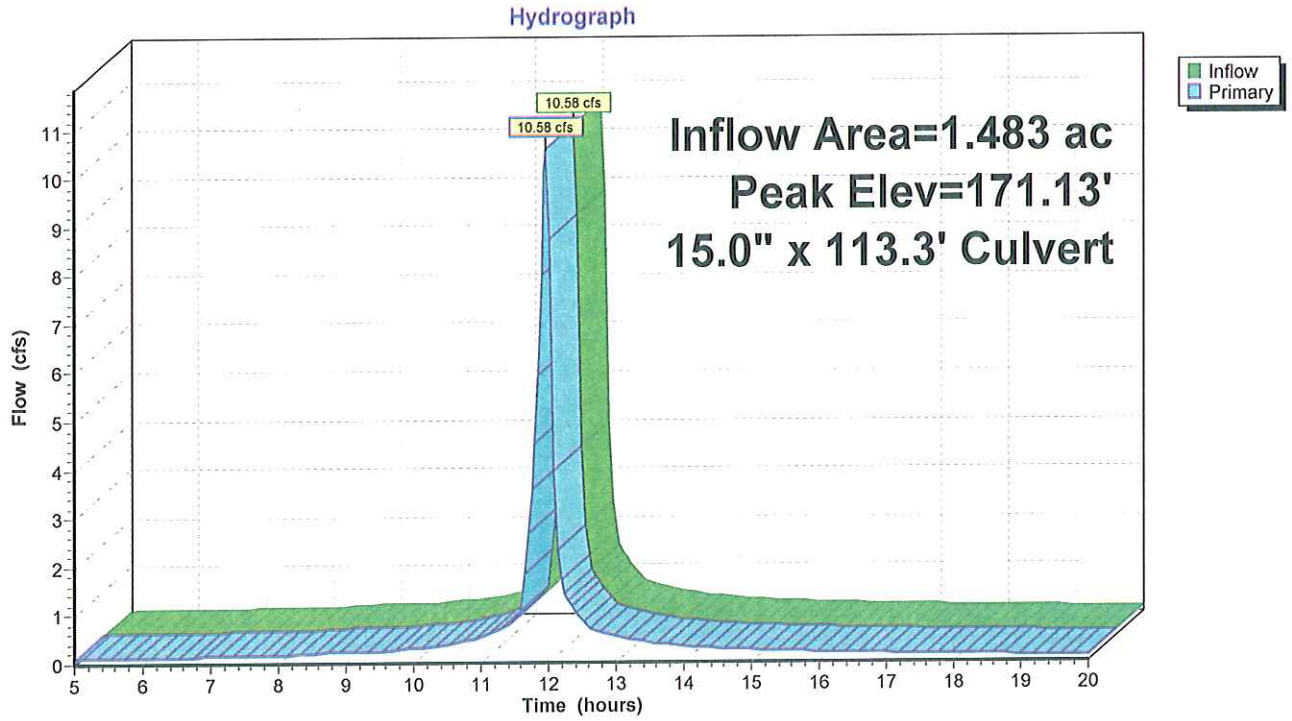
Inflow Area = 1.483 ac, Inflow Depth > 4.57" for 10-Year event
Inflow = 10.58 cfs @ 11.98 hrs, Volume= 0.564 af
Outflow = 10.58 cfs @ 11.98 hrs, Volume= 0.564 af, Atten= 0%, Lag= 0.0 min
Primary = 10.58 cfs @ 11.98 hrs, Volume= 0.564 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 171.13' @ 11.98 hrs
Flood Elev= 173.01'

Device	Routing	Invert	Outlet Devices
#1	Primary	167.17'	**15.0" x 113.3' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 166.03' S= 0.0101 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=10.19 cfs @ 11.98 hrs HW=170.91' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 10.19 cfs @ 8.31 fps)

Pond MH E1:



SOILS REPORT

HARDIN-KIGHT ASSOCIATES, INC.
CONSULTING ENGINEERS

May 18, 2010

Project No.: 09167

Vista Design, Inc.
11634 Worcester Highway
Showell, Maryland 21862

Attention: Mr. Steve Engel, RLA

Reference: Geotechnical Investigation
Bryans Road Town Center
Stormwater Management Retrofits
Charles County, Maryland

Dear Mr. Engel:

As requested, we have completed our exploration of the proposed stormwater management (SWM) retrofit areas at the Bryans Road Town Center, in Charles County, Maryland. Our findings, analysis, and recommendations are enclosed. The purpose of this investigation is to evaluate the subsurface conditions for the design and construction of the retrofits of the stormwater management facilities for the existing commercial area.

The overall Bryans Road Town Center site is located on the western side of Marshall Hall Road, north of its intersection with Indian Head Highway (Maryland Route 210) and south of its intersection with Matthews Road. The portion of the site labeled as Parcel 261 consists of an existing wooded area that is located approximately 500 feet west of the intersection of Marshall Hall Road and Indian Head Highway. A subsurface water quality and extended detention system, with possible infiltration, is being considered for Parcel 261. In addition, the installation of dry swales is being considered north of the shopping center, along Matthews Road.

We were provided with a site plan entitled *Proposed Stormwater*, dated August 26, 2009, by Vista Design, Inc. (Vista). In addition, we were provided with an electronic version of the site plan. The site plan indicates the layout of the proposed SWM facility for Parcel 261, as well as existing topography for the entire site. Proposed grades are not provided on the site plan. However, based on conversations with Vista, we understand that the bottom of the proposed infiltration facility is to be at El. 164. Based on the site plan, Parcel 261 slopes down gently from the northwest to the southeast. Ground surface elevations range from a low elevation of approximately 165 feet above

Mean Sea Level (MSL), at the southeastern portion of the parcel, to a high elevation of approximately 173 feet above MSL, at the northwestern portion of the parcel. In the area of the proposed dry swale, adjacent to Matthews Road, the existing grades slope down slightly from approximately El. 178, at the northwestern portion the swale, to El. 176, at the southeastern portion of the proposed dry swale.

Our study included a review of the geological and soils literature and performance of a field investigation and laboratory testing. The field investigation included drilling 6 Standard Penetration Test (SPT) borings at the locations indicated on the Boring Location Plan, included as Figure 1 within Appendix A. Also included in the investigation were 3 hand-auger probes that were advanced at the locations indicated on the Hand-Auger Probe Location Plan, included as Figure 2 within Appendix A. The Boring Location Plan and Hand-Auger Location Plan are versions of the electronic site plan provided by Vista, altered to show the boring and hand-auger probe locations. We selected the proposed boring and hand-auger probe locations. The borings and hand-auger probes were located in the field using existing site features. Therefore, they should be considered approximate. The ground surface elevations on the logs were estimated from the topographic map provided on the site plan, and should also be considered approximate.

The borings labeled B-1 through B-6 were drilled in the area of the proposed SWM facility for Parcel 261. Each of the borings was drilled to a depth of 15 feet below the existing surface. The hand auger probes are labeled as AP-1 through AP-3 and were advanced at the location of the proposed dry swale, adjacent to Matthews Road. The hand-auger probes were advanced to depths ranging from 6 to 8 feet below existing grade.

Standard Penetration Testing was performed in the borings as per ASTM Test Designation D 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils,* and soil samples were retrieved at 2.5-foot intervals to 10 feet and at 5-foot intervals, thereafter. Standard Penetration Testing involves driving a 2-inch O.D., 1 ⅜ -inch I.D. split-spoon sampler with a 140-pound hammer free-falling 30 inches. The SPT N-value, given as blows per foot (bpf), is defined as the total number of blows required to drive the sampler from the 6 to 18 inches.

The soils have been visually classified in general accordance with the Unified Soil Classification System (ASTM D 2488). Samples were returned to the laboratory for selective laboratory testing. Descriptions as provided on the logs are visual, supplemented by available laboratory test results. The boring and hand-auger probe logs are included in Appendix B and the laboratory test results are included in Appendix C.

Groundwater levels were generally recorded On the borings and hand-auger probes during drilling and at the completion of the soil sampling. In addition, groundwater monitoring pipes were installed in each of the borings and hand-auger probes upon the completion of drilling to prevent caving and allow for long term water level monitoring. The water levels were also recorded at approximately 24 hours after the completion of drilling.

SUBSURFACE CONDITIONS

Geology

According to the *Geologic Map of Charles County* (McCartan, 1989), the site is located within the Coastal Plain Physiographic Province. Coastal Plain sediments were deposited in a marine and alluvial environment. More specifically, the Bryans Road site is underlain by Upland Gravel 3 (TUG_3). The Upland Gravel 3 is described as predominantly interbedded medium sand and gravel, with a coarse sand matrix and pebbles floating in a poorly sorted sandy silt cap at the top. The thickness is as much as 55 feet. For a more detailed description of the geologic unit, please refer to the above publication.

Soil Survey

The USDA Soil Conservation Service Soil (SCS) *Survey Map for Charles County, Maryland* indicates the presence of Urban Land (Uk) soils through the Bryans Road Town Center site. The following is a brief summary of the SCS information:

Urban Land

Urban land consists of areas that have been graded, cut, filled, or otherwise disturbed during urbanization. A soils investigation is required to determine the characteristics in any given location.

Conditions Encountered

The soils encountered are consistent with the Geological and Soil Survey literature. Three (3) to 6 inches of topsoil was encountered at the boring and hand-auger probe locations. Existing fill was encountered in Borings B-5 and B-6 to a depth of approximately 9.5 feet below the existing surface. The existing fill generally consists of interbedded layers of lean clay, silt and sand, with varying amounts of gravel. The SPT

"N" values in the fill ranged from 8 blows per foot (bpf) to 50 blows for 5 inches of penetration.

Possible fill soils consisting of clayey sand were encountered in Boring B-6 from 9.5 to 14.6 feet below the existing surface. The SPT "N" values in the clayey, possible fill soils ranged from 7 bpf to 12 bpf.

Below the existing fill, the natural soils consist primarily of fine-grained silts and clays overlying more-coarse grained silty sand and gravel. The SPT "N" values in the fine-grained natural soils ranged from 10 bpf to 50 blows for 5 inches of penetration. The fine-grained natural soils were not encountered in Borings B-5 and B-6. The coarse-grained natural soils were encountered through the remaining depth of each of the borings and hand-auger probes. The SPT "N" values in the coarse-grained soils ranged from 36 bpf to 50 blows for 1 inch of penetration.

Auger refusal was not encountered in the borings and hand-auger probes. However, very dense materials were encountered in each of the boring locations, with the exception of Boring B-6, at depths ranging from 2.5 to 8 feet, corresponding to El. 163 to El. 169. Very dense materials are described as having an SPT "N" value of 50 bpf or more.

Groundwater was observed at 24 hours after the completion of drilling, in each of the borings in Parcel 261, at depths ranging from 4.1 to 6.9 feet, corresponding to El. 164.1 to El. 166. Groundwater was encountered in each of the hand-auger probes adjacent to Matthews Road, at 24 hours after the completion of drilling, at depths ranging from 3 to 7.5 feet, corresponding to El. 169.3 to El. 173.3. Each boring and hand-auger probe had a 1-inch diameter, slotted pvc pipe installed to prevent caving of the borehole.

The fine-grained soils are visually classified as CL and ML, and the coarse-grained soils are classified as SM, SP-SM, SC and GP, in accordance with the Unified Soil Classification System (USCS). These classifications are indicated on the attached hand-auger probe logs. The USCS visual descriptions were generally confirmed by laboratory tests on representative samples. The fine-grained soil was found to have a liquid limit ranging from 35 to 39 and a plastic index ranging from 11 to 21. The moisture contents for the near surface samples ranged from 3.4% to 19.6%. The average moisture content was 13.4%.

Detailed descriptions of conditions encountered are presented on the attached boring and hand-auger probe logs. The laboratory test results are included in Appendix C. The boring and hand-auger probe logs may be found in Appendix B.

ANALYSIS AND CONCLUSIONS

Parcel 261

We understand that a subsurface water quality and extended detention system, with possible infiltration, is being considered for Parcel 261. We understand that the bottom of the proposed facility is to be at approximately El. 164. Existing fill was encountered in Borings B-5 and B-6, which are located towards the southern portion of Parcel 261. The existing fill was encountered from the existing ground surface to a depth of approximately 9.5 feet. Existing fill was not encountered on the central and northern portions of the site. Groundwater was encountered in each of the borings from 4.1 to 6.9 feet, corresponding to El. 164.1 to El. 166. Very dense materials were encountered at a depth ranging from 2.5 to 8 feet, corresponding to El. 163 to El. 169.

According to the Maryland Stormwater Design Manual, the seasonal groundwater table cannot be located within 4 feet of the bottom of an infiltration facility. Therefore, due to the shallow water table and the fine-grained near surface soils, infiltration is not feasible for the proposed Parcel 261 SWM facility. The facility must be designed as a detention facility that is water tight and completely separated from the existing groundwater. Conventional sump and pump dewatering techniques will be required during construction of the facility. Difficult excavations must be anticipated during the construction of the facility. However, we do not anticipate that blasting will be required.

Dry Swale (Adjacent to Matthews Road)

Hand-Auger Probes AP-1 through AP-3 were advanced at the proposed dry swale location, adjacent to Matthews Road. According to the Maryland Stormwater Design Manual, the bottom of a dry swale facility may not be located within 4 feet of the seasonally high groundwater table. Water was encountered in each of the probes at depths ranging from 3 to 7.5 feet below existing grades, corresponding to El. 169.3 to El. 173.3. At the southeastern portion of the proposed dry swale, the water was observed at a depth of 3 feet below the surface. Therefore, a dry swale is likely not feasible at the southeastern end of the proposed facility. However, at the central and northwestern portions of the proposed dry swale, the water was observed from 5.7 to 7.5 feet below the surface (El. 169.3 to El. 171.5). The dry swale may be feasible at the central and northwestern portions of the currently planned facility location, depending on the dimensions of the proposed swale. Also, consideration may be given to accepting a 2-foot buffer above the water level, rather than the currently required 4-foot buffer zone. It should be noted that the water encountered in this investigation is likely perched, in view of the layered nature of the near-surface soils.

RECOMMENDATIONS

These preliminary recommendations are provided as a guide to assist in consideration of the stormwater management facility design. Final recommendations must be prepared based on the final proposed design.

1. Due to the shallow depth to groundwater and fine-grained soils located towards the surface, infiltration is not feasible at the location of Parcel 261. We recommend that the facility be designed as a detention facility and be water tight and completely separated from the groundwater.

2. Due to the shallow depth to groundwater, the proposed dry swale located adjacent to Matthews Road is not feasible at the southeastern side of the proposed facility. However, the dry swale may be feasible at the central and northwestern portions of the proposed facility. We recommend that the proposed dry swale be given further consideration once the approximate dimensions are known, and using the water levels observed in the monitoring pipes. Water was observed at 5.7 feet (El. 171.5) at the northwestern portion and at 7.5 feet (El. 169.3) at the central portion of the facility.

3. We recommend that consideration be given to reducing the currently required 4-foot buffer zone to a 2-foot buffer zone between the seasonally high water table and the bottom of facility elevation for the proposed dry swale, in light of the layered soils creating "perched" water conditions. This would increase the feasibility of the currently proposed dry swale.

4. We recommend that an additional investigation be conducted at other proposed dry swale areas if more specific groundwater information is required.

5. We recommend that the contractor be prepared for difficult excavations during SWM facility construction.

6. We recommend that the foundations for any proposed structures be proportioned for an allowable soil pressure of 2,000 psf and that foundation soils be tested and confirmed during construction.

7. We recommend that the earth slopes be constructed to a maximum gradient of 2H:1V or flatter. Flatter slopes are recommended where possible to facilitate maintenance and to reduce the potential for erosion.

8 We recommend that the earth pressure against structures be computed based on an angle of internal friction of 20 degrees, unit weight of 120 pounds per cubic foot, and cohesion equal to 1,000 psf, if the clayey soils are used as backfill. We recommend the computations be based on a friction angle of 30 degrees and a unit weight of 120 pounds per cubic foot if the sandy soils are used as backfill.

9. We recommend that the existing ground surface in fill areas be compacted after stripping topsoil but prior to placement of fill. We recommend that the existing ground surface be compacted to a minimum of 95% based on the standard moisture density relationship test (ASTM D-698) in the areas of any proposed structures. In green areas the surface can be compacted to a minimum of 90%.

10. We recommend that fill in structural areas be compacted to a minimum of 95% based on ASTM D-698 and to a minimum of 90% in green areas.

11. We recommend that the contract documents include provisions for temporary dewatering of excavations. We recommend that the findings of this investigation be made available to prospective contractors. We recommend that prospective contractors be given the opportunity to conduct their own subsurface investigation to evaluate soil and ground water conditions.

12. We recommend that the contractor be prepared to dry the on-site soils in order to achieve compaction.

13. We recommend that the proposed final stormwater management design be reviewed by this office. A final review with modified final recommendations, if deemed necessary, will be prepared.

14. We recommend that the stormwater management facility construction be monitored by the geotechnical engineer, in addition to the certifying engineer to confirm the satisfactory completion of geotechnical aspects of the installation and to modify these recommendations, if necessary.

LIMITATIONS

This report was prepared in accordance with generally accepted practice for geotechnical engineering in this area. It is intended for the use of the client for the specific site, as shown on the attached sketches. The soil and water conditions represent the conditions encountered at the locations of the exploratory borings and hand-auger probes as shown on the Boring and Hand-Auger Probe Location Plans. Variations in the soils between the boring and hand-auger probe locations and below the depths explored should be anticipated.

If you have any questions or if you require additional service, please contact our office.

Very truly yours,

HARDIN-KIGHT ASSOCIATES, INC.

Justin Frizzell, P.E.

Stephen E. Kight, P.E.

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APPENDIX B

BORING & HAND AUGER PROBES

Hardin-Kight Associates, Inc.
7524 WB&A Road, Suite 100
Glen Burnie, Maryland 21061

Office: (410) 553-0802
Fax #: (410) 553-0808

Record of Soil Exploration

Project Name: Bryans Road Town Center SWM
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland
Boring Location: N: E:

BORING NO. B-1
JOB NO. 09167
Page 1 of 1

Surf. Elev.: 172.0±
Elev. from(4): Topo
Offset Elev:
Offset Dist.:

Hammer Wt. 140 lbs.
Hammer Drop: 30"
Sampler Size: 2"
Offset Direction:

Rock Core Dia.: ---
Hole Diameter: 6"
Boring Method: HSA

Foreman: TM
Inspector: MC
Date Started: 05/11/10
Date Finished: 05/11/10

Elev.	Soil Description (Color, Moisture, Density, Plasticity, Size Proportions)	Depth	Sample Data: Type	Blow Counts	#	Recovery	Condition	Boring & Sample Notes
172.0	0.0 – 6" of Topsoil	0						
	0.4 – Tan, slightly moist, stiff, medium plastic, lean CLAY with sand, trace gravel USC: (CL)*			4 4 6	1	9	I	
171	2.0 – Gray, moist, hard, medim plastic, lean CLAY with sand, trace gravel USC: (CL)*	3		12 22 22	2	16	I	
168	4.5 – Brown, mottled gray, moist, hard, medium plastic, sandy lean CLAY, trace fine gravel USC: (CL)*	6		17 50/5"	3	8	I	
165		9		16 25 21	4	11	I	
162	9.5 – Gray, moist, very dense, medium plastic, clayey GRAVEL USC: (GP)*	12		12 16 20	5	6	I	
159	---, wet 14.0 – Orange brown, wet, non-plastic, GRAVEL with sand USC: (GP)*	15		22 24 28	6	9"	I	1" water monitoring pipe installed to 15.0'
	15.0 – Boring Terminated at 15 Ft.	18						
156								
153								

* Visual Description - in general accordance with ASTM D 2488

Notes: Surface Elevation estimated from topographic map provided by Vista.

Water	Caved
Encountered 12.0'	
Completion 8.6'	Pipe
On at	
On 05/12 at 24 hrs. 6.0'	

Hardin-Kight Associates, Inc.
7524 WB&A Road, Suite 100
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Office: (410) 553-0802
Fax #: (410) 553-0808

Record of Soil Exploration

Project Name: Bryans Road Town Center SWM
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland
Boring Location: N: E:

BORING NO. B-2
JOB NO. 09167
Page 1 of 1

Surf. Elev.: 171.5±
Elev. from(4): Topo
Offset Elev:
Offset Dist.:

Hammer Wt. 140 lbs.
Hammer Drop: 30"
Sampler Size: 2"
Offset Direction:

Rock Core Dia.: ---
Hole Diameter: 6"
Boring Method: HSA

Foreman: TM
Inspector: MC
Date Started: 05/11/10
Date Finished: 05/11/10

Elev. 171.5	Soil Description (Color, Moisture, Density Plasticity, Size Proportions)	Depth	Sample Data: Type	Blow Counts	#	Recovery	Condition	Boring & Sample Notes
171	0.0 – 5" of Topsoil – 0.4 – Tan, slightly moist, stiff, medium plastic, lean CLAY with sand USC: (CL)*	0		3 5 7	1	9	I	
	---, very stiff, trace grave, – 3.0 – Gray, moist, hard, medium plastic, sandy lean CLAY USC: (CL)*	3		16 26 28	2	11	I	
168	---, trace gravel	6		14 22 24	3	11	I	
165		9		12 25 32	4	8	I	
162	9.5 – Light gray, moist, very dense to dense, non-plastic, SAND with silt and gravel USC: (SP-SM)*	12		12 18 32	5	9	I	
159		15		16 17 20	6	10	I	1" water monitoring pipe installed to 15.0'
156	15.0 – Boring Terminated at 15 Ft.	18						
153								

* Visual Description - In general accordance with ASTM D 2488

Notes: Surface Elevation estimated from topographic map provided by Vista.

Water	Caved
Encountered 11.0'	
Completion 8.3'	Pipe
On at	
On 05/12 at 24 hrs. 6.9'	Pipe

Hardin-Kight Associates, Inc.
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Office: (410) 553-0802
Fax #: (410) 553-0808

Record of Soil Exploration

Project Name: Bryans Road Town Center SWM
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland
Boring Location: N: E:

BORING NO. B-3
JOB NO. 09167
Page 1 of 1

Surf. Elev.: 171.0±
Elev. from(4): Topo
Offset Elev:
Offset Dist.:

Hammer Wt. 140 lbs.
Hammer Drop: 30"
Sampler Size: 2"
Offset Direction:

Rock Core Dia.: ---
Hole Diameter: 6"
Boring Method: HSA

Foreman: TM
Inspector: MC
Date Started: 05/11/10
Date Finished: 05/11/10

Elev. 171.0	Soil Description (Color, Moisture, Density, Plasticity, Size Proportions)	Depth	Sample Data: Type	Blow Counts	#	Recovery	Condition	Boring & Sample Notes
171	0.0 6" of Topsoil	0						
	0.5 Red brown, slightly moist, stiff, non-plastic, sandy SILT, trace organics USC: (ML)*			5 6 4	1	2	I	
168		3		9 6 10	2	2	I	
	----, hard, trace gravel			18 22 23	3	11	I	
165	6.0 Gray, slightly moist, dense, low plastic, silty SAND with gravel USC: (SM)* 7.0	6		21 47 50	4	10	I	
162	Orange brown, moist, hard, medium plastic, sandy lean CLAY with gravel USC: (CL)* 9.5	9		19 50/5"	5		I	
159	Orange brown, moist, very dense, non-plastic, sandy GRAVEL USC: (GP)* 12.5	12		28 50/3"	6	3	I	1" water monitoring pipe installed to 14.0'
156	Orange brown, moist, very dense, medium plastic, clayey SAND, trace gravel USC: (SC)* 14.3 Boring Terminated at 14.3 Ft.	15						
153		18						

* Visual Description - In general accordance with ASTM D 2488

Notes: Surface Elevation estimated from topographic map provided by Vista.

Water	Caved
Encountered 11.0'	
Completion 9.5'	Pipe
On at	
On 05/12 at 5.6'	

Hardin-Kight Associates, Inc.
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Office: (410) 553-0802
Fax #: (410) 553-0808

Record of Soil Exploration

Project Name: Bryans Road Town Center SWM
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland
Boring Location: N: E:

BORING NO. B-4
JOB NO. 09167
Page 1 of 1

Surf. Elev.: 170.5±
Elev. from(4): Topo
Offset Elev:
Offset Dist.:

Hammer Wt. 140 lbs.
Hammer Drop: 30"
Sampler Size: 2"
Offset Direction:

Rock Core Dia.: ""
Hole Diameter: 6"
Boring Method: HSA

Foreman: TM
Inspector: MC
Date Started: 05/11/10
Date Finished: 05/11/10

Elev. 170.5	Soil Description (Color, Moisture, Density, Plasticity, Size Proportions)	Depth	Sample Data: Type	Blow Counts	#	Recovery	Condition	Boring & Sample Notes
171	0.0 5" of Topsoil 0.4 Brown, moist, very stiff, medium plastic, lean CLAY with sand USC: (CL)*	0		7 9 10	1	10	I	
168	3.2 Tan, slightly moist, very dense, non-plastic, sandy GRAVEL with silt 4.6 USC: (GP)*	3		6 34 50/5"	2	10	I	
165	Tan, moist, very dense, non-plastic, silty SAND with gravel USC: (SM)*	6		50/5"	3	5	I	
				31 50/1"	4	0	L	
162	8.6 Tan, very moist, very dense, medium plastic, clayey SAND with gravel USC: (SC)*	9		17 23 28	5	8	I	
159	12.5 Tan, moist, very dense, non-plastic, silty SAND, trace gravel USC: (SM)*	12		13 22 28	6	10	I	
156	15.0 Boring Terminated at 15 Ft.	15						1" water monitoring pipe installed to 15.0'
153		18						

* Visual Description - In general accordance with ASTM D 2488

Notes: Surface Elevation estimated from topographic map provided by Vista.

Water	Caved
Encountered 7.5'	
Completion 8.5'	Pipe
On at	
On 05/12 at 5.4'	Pipe

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Office: (410) 553-0802
Fax #: (410) 553-0808

Record of Soil Exploration

Project Name: Bryans Road Town Center SWM
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland
Boring Location: N: E:

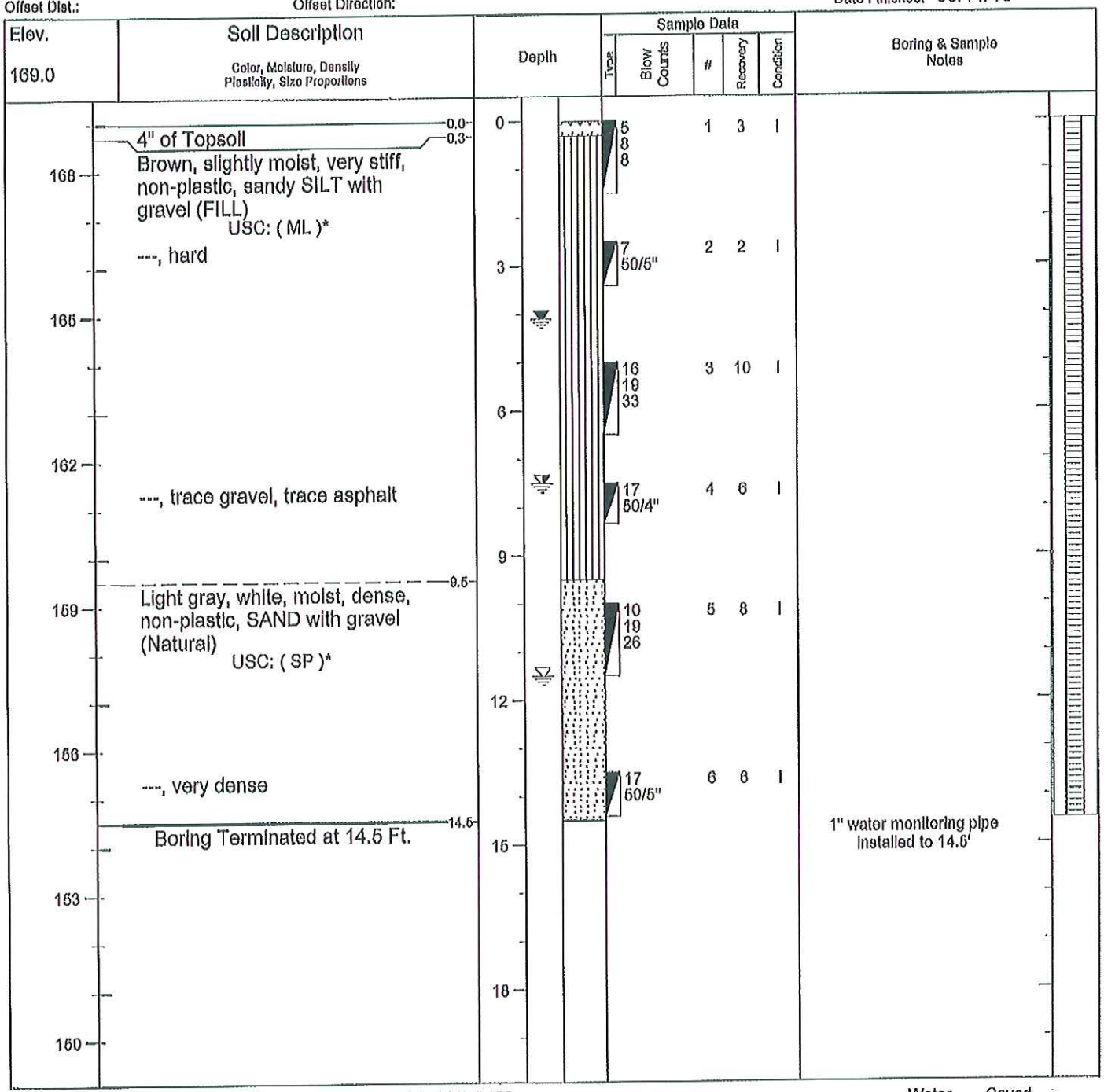
BORING NO. B-5
JOB NO. 09167
Page 1 of 1

Surf. Elev.: 169.0±
Elev. from(4): Topo
Offset Elev:
Offset Dist.:

Hammer Wt. 140 lbs.
Hammer Drop: 30"
Sampler Size: 2"
Offset Direction:

Rock Core Dia.: ---
Hole Diameter: 6"
Boring Method: HSA

Foreman: TM
Inspector: MC
Date Started: 05/11/10
Date Finished: 05/11/10



* Visual Description - In general accordance with ASTM D 2488

Notes: Surface Elevation estimated from topographic map provided by Vista

	Water	Caved
Encountered	11.5'	
Completion	7.5'	Pipe
On	at	
On 05/12	at 4.1'	

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Record of Soil Exploration

Project Name: Bryans Road Town Center SWM
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland
Boring Location: N: E:

BORING NO. B-6
JOB NO. 09167
Page 1 of 1

Surf. Elev.: 170.0±
Elev. from(4): Topo
Offset Elev:
Offset Dist.:

Hammer Wt. 140 lbs.
Hammer Drop: 30"
Sampler Size: 2"
Offset Direction:

Rock Core Dia.: ---
Hole Diameter: 6"
Boring Method: HSA

Foreman: TM
Inspector: MC
Date Started: 05/11/10
Date Finished: 05/11/10

Elev.	Soil Description (Color, Moisture, Density Plasticity, Size Proportions)	Depth	Sample Data: Type	Blow Counts	#	Recovery	Condition	Boring & Sample Notes
170.0								
	0.0 6" of Topsoil	0						Boring offset 15' North due to gas and electric lines
	0.5 Tan, mottled brown, slightly moist, very stiff, medium plastic, lean CLAY with sand (FILL) USC: (CL)*			7 9 11	1	9	I	
168	---, hard	3		29 27 16	2	10	I	
	3.3 Orange brown, slightly moist, very dense, low plastic, clayey SAND with gravel (FILL)							
	4.5 USC: (SC)*							
165	Light brown, moist, medium stiff, medium plastic, lean CLAY with sand (FILL) USC: (CL)*	6		6 6 3	3	6	I	
	7.5 Orange brown, moist, medium dense, non-plastic, silty SAND (FILL) USC: (SM)*			10 8 4	4	7	I	
162	9.5 Tan, very moist, loose, medium plastic, clayey SAND, trace gravel (Possible FILL) USC: (SC)*	9		3 3 4	5	7	I	
159		12		5 7 5	6	18	I	
156	14.0							
	15.0 Tan, wet, medium dense, non-plastic, SAND with gravel (Natural) USC: (SP)*	15						1" water monitoring pipe installed at 15.0'
	Boring Terminated at 15 Ft.							
153		18						

* Visual Description - In general accordance with ASTM D 2488

Notes: Surface Elevation estimated from topographic map provided by Vista.

Water	Caved
Encountered 11.0'	
Completion 10.0'	Pipe
On at	
On 05/12 at 6.9'	

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Topsoil, rootmat, and saw dust
	Low plasticity clay
	Poorly graded gravel
	Poorly graded sand with silt
	Silt
	Silty sand
	Clayey sand
	Poorly graded sand
Misc. Symbols	
	Water level encountered during drilling
	Water level observed at 24 hours after the completion of drilling
	Water level observed at boring completion
Soil Samplers	
	Standard penetration test

Symbol	Description
Monitor Well Details	
	slotted pipe, no backfill
	no pipe, filler material

Notes:

1. Borings were drilled on 05/11/10.
2. Water level readings from 1"-dia. monitoring pipe are listed on logs.
3. Borings were located in the field using existing site features. Therefore, boring locations should be considered approximate.
4. Surface Elevations were estimated from topographic map provided by Vista Design, Inc. and should be considered approximate.

Hardin-Kight Associates, Inc.
7524 WB&A Road, Suite 100
Glen Burnie, Maryland 21061

Office: (410) 553-0802
Fax #: (410) 553-0808

Record of Soil Exploration

Project Name: Bryan's Road Town Center
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland

AUGER PROBE NO. AP-1
JOB NO. 09167

Surf. Elev.: 177.2
Elev. from(4):

Hammer Wt.
Hammer Drop:
Sampler Size:

Date Started: 8/11/09
Date Finished: 8/11/09

Foreman: MC
Inspector: Ron Wolff

Elev. 177.2	Soil Description (Color, Moisture, Plasticity, Size Proportions)	Depth	Type	#	Condition	Boring & Sample Notes
	3" of Topsoil	0.0 – 0.3				
	Light brown, moist, medium plastic, silty lean CLAY, trace sand USC: (CL-ML)*	0.3 – 1.0				
176	Brown, gray, moist, medium plastic, sandy lean CLAY USC: (CL)*	1.0 – 4.5		1, 2		
174						
	Light gray, tan, moist, medium plastic, silty lean CLAY with embedded sand lenses, trace gravel USC: (CL-ML)*	4.5 – 6.0		3		
172	Auger Probe Terminated at 6 Ft.	6.0				Water monitoring pipe installed to 6.0'
170						
168						
166						
164						

0 2 4 6 8 10 12

* Visual Description - In general accordance with ASTM D 2488

Notes: Surface Elevation & Location provided by Vista Design, Inc.

Water	Caved
Encountered	Dry
Completion	Dry Pipe
On at	
On 8/17 at 144 hrs.	6.7 Pipe

Hardin-Kight Associates, Inc.
7524 WB&A Road, Suite 100
Glen Burnie, Maryland 21061

Office: (410) 553-0802
Fax #: (410) 553-0808

Record of Soil Exploration

Project Name: Bryan's Road Town Center
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland

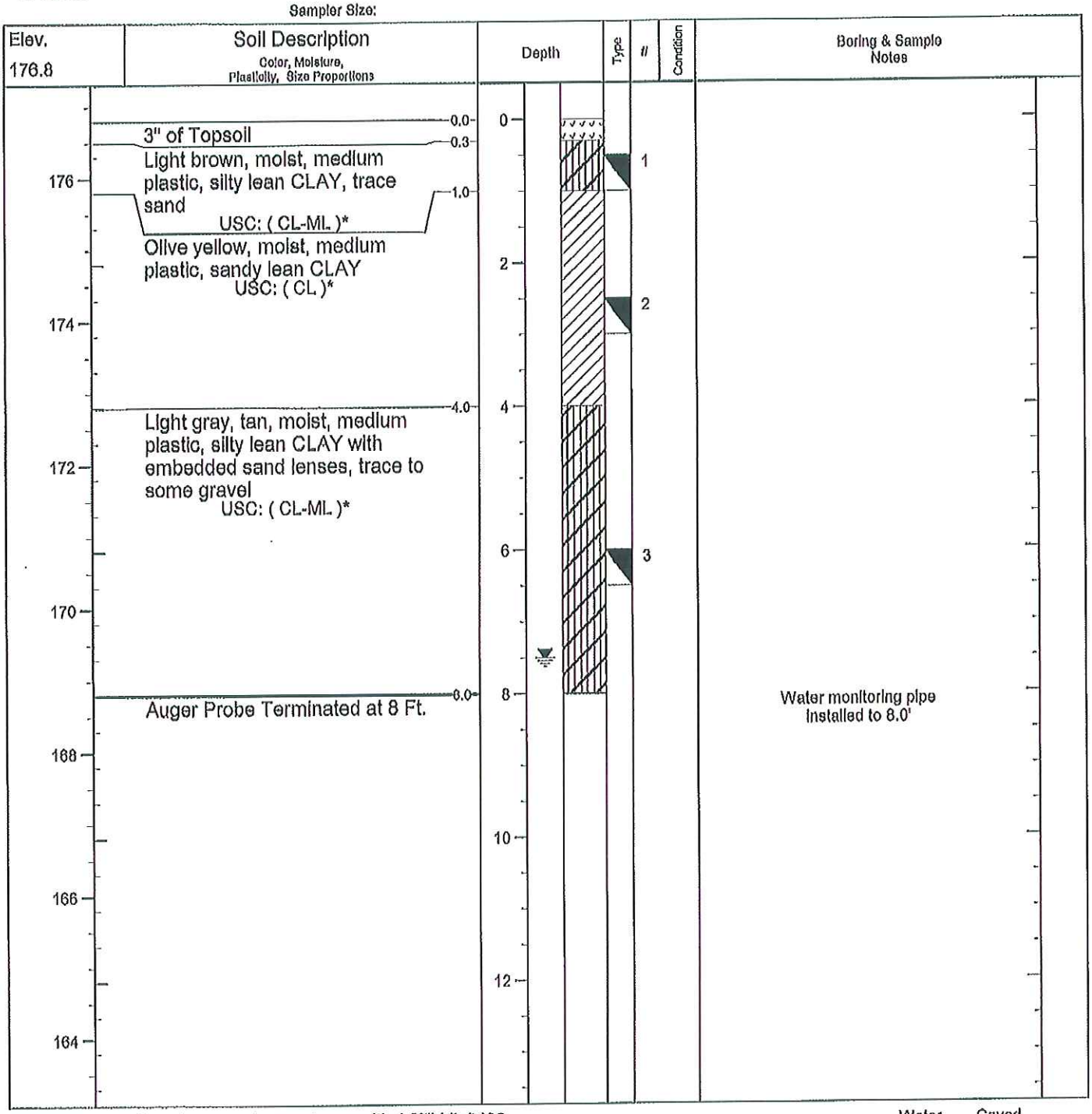
AUGER PROBE NO. AP-2
JOB NO. 09167

Surf. Elev.: 176.8
Elev. from(4):

Hammer Wt.
Hammer Drop:
Sampler Size:

Date Started: 8/11/09
Date Finished: 8/11/09

Foreman: MC
Inspector: Ron Wolff



* Visual Description - in general accordance with ASTM D 2488

Notes: Surface Elevation & Location provided by Vista Design, Inc.

Water	Caved
Encountered Dry	
Completion Dry	Pipe
On at	
On 8/17 at 144 hrs. 7.5'	

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Record of Soil Exploration

Project Name: Bryan's Road Town Center
Contracted With: Vista Design, Inc.
Project Location: Charles County, Maryland

AUGER PROBE NO. **AP-3**
JOB NO. 09167

Surf. Elev.: 176.3
Elev. from(4):

Hammer Wt.
Hammer Drop:
Sampler Size:

Date Started: 8/11/09
Date Finished: 8/11/09

Foreman: MC
Inspector: Ron Wolff

Elev. 176.3	Soil Description (Color, Moisture, Plasticity, Size Proportions)	Depth	Type	#	Condition	Boring & Sample Notes
176	0.0 – 3" of Topsoil	0				
	0.3 – Light brown, moist, medium plastic, sandy lean CLAY USC: (CL)*	2		1		
174	2.5 – Tan, gray, moist, medium plastic, silty lean CLAY with embedded sand lenses USC: (CL-ML)*	4		2		
172	4.5 – Light gray, tan, moist, medium plastic, silty lean CLAY with embedded sand lenses, trace gravel USC: (CL-ML)*	6		3		Water monitoring pipe Installed to 6.0'
170	Auger Probe Terminated at 6 Ft.	8				
168		10				
166		12				
164						

* Visual Description - In general accordance with ASTM D 2488

Notes: Surface Elevation & Location provided by Vista Design, Inc.

	Water	Caved
Encountered	Dry	
Completion	Dry	Pipe
On 8/12 at 24 hrs.	3.0'	Pipe
On 8/17 at 144 hrs.	4.7'	Pipe

KEY TO SYMBOLS

Symbol Description

Strata symbols

Topsoil

Silty low plasticity clay

Low plasticity clay

Misc. Symbols

Water level at 6 days

Soil Samplers

Bulk/Grab sample

Notes:

1. Exploratory hand-auger probes were advanced on 8/11/9.
2. Water levels are indicated on the boring logs.
3. These logs are subject to the limitations, conclusions, and recommendations in the geotechnical report.
4. Results of tests conducted on samples recovered are reported on the logs.

APPENDIX C

LABORATORY TEST RESULTS

Project: Bryan's Road, SWM
Job #: 09167

Report Date: 5/18/2010
Report Status: Final

Auger Probe	Sample	Depth	Moisture Content	Description	USC Class.	Liquid Limit	Plastic Limit	Plastic Index	% Gravel	% Sand	% Fines	Notes
B-1	S-1	0.0'-1.5'	17.2%									
B-1	S-2	2.5'-4.0'	14.9%									
B-1	S-3	5.0'-6.5'	14.8%									
B-1	S-4	7.5'-9.0'	15.2%	Light greenish gray with yellow mottles, fine sandy lean Clay, with fine gravel	CL*	39	18	21	See below	43%	57%	100% passed 3/8"
B-2	S-1	0.0'-1.5'	16.6%									
B-2	S-2	2.5'-4.0'	10.9%									
B-2	S-3	5.0'-6.5'	13.3%									
B-3	S-1	0.0'-1.5'	15.9%									
B-3	S-2	2.5'-4.0'	14.6%									
B-3	S-3	5.0'-6.5'	4.7%									contained ÷3/4"
B-4	S-1	0.0'-1.5'	19.6%									
B-4	S-2	2.5'-4.0'	3.4%									contained ÷3/4"
B-4	S-3	5.0'-6.5'	9.5%									
B-5	S-1	0.0'-1.5'	14.9%									
B-5	S-2	2.5'-4.0'	18.0%									
B-5	S-3/4	5.0'-9.0'	16.6%	Brown, micaceous, medium to fine sandy Silt, with gravel	ML*	37	26	11	See below	48%	52%	100% passed 1"
B-6	S-1	0.0'-1.5'	12.6%									
B-6	S-2	2.5'-4.0'	9.1%									
B-6	S-3	5.0'-6.5'	11.9%									

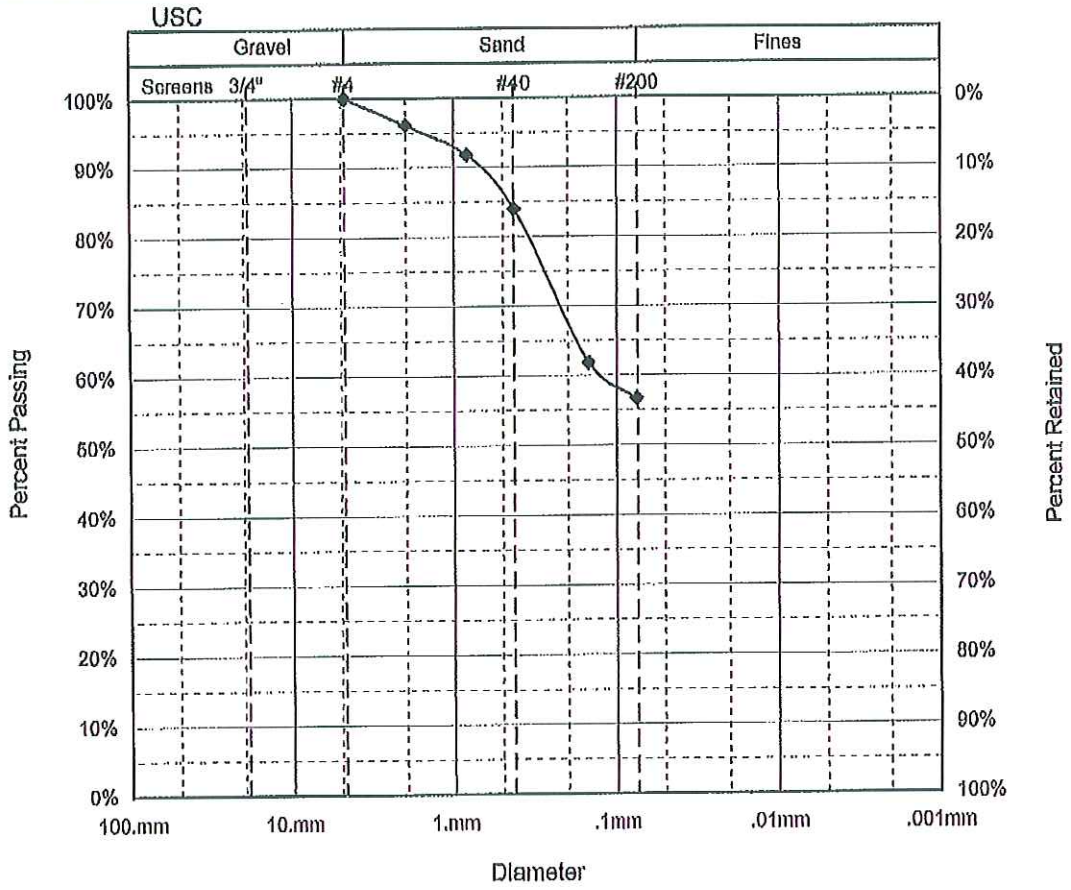
Note: Gradation and classification on -#4 material.
Insufficient sample to run complete gradation

Page 92

Project: Bryan's Road, SWM
Identification: B-1, S-4, 7.5-9.0'
Description: Light greenish gray with yellow mottles, fine sandy lean Clay, with fine gravel
Received: 5/13/2010

Job #: 09167
Lab #: 100232
Report Date: 5/18/2010
Report Status: Final

Laboratory Analysis



Test Methods	Soil Properties
Moisture Content: ASTM D2216 Grain Size Analysis: ASTM D422 Liquid & Plastic Limits: ASTM D4318	Moisture Content 15.2% Liquid Limit: 39 Plastic Limit: 18 Plasticity Index: 21 A-Line: 13.9 Cu: Cc:

Note: Gradation on -#4 material. Insufficient sample to run complete gradation, 7g of 200g sample recieved retained on #4, maximum particle passes 3/8" screen.

Classification
USC: CL*

Checked By:

Tested By:

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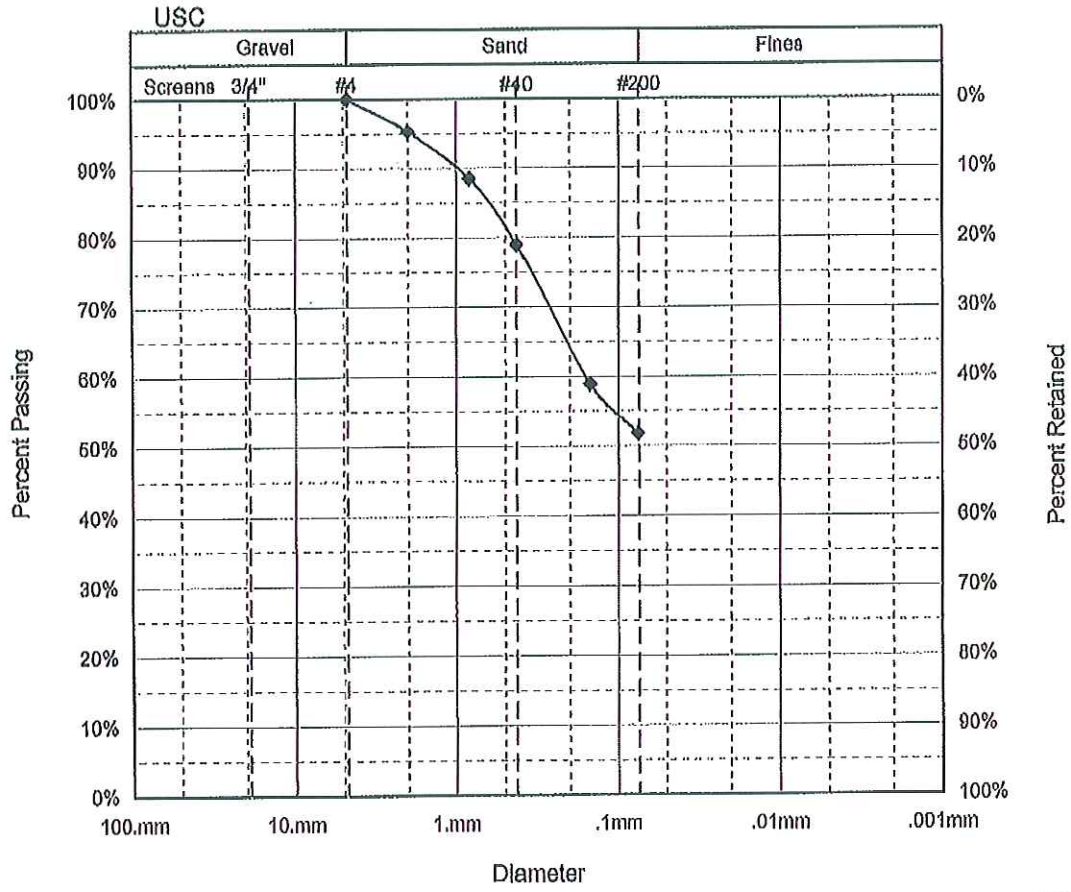
Project: Bryan's Road, SWM
Identification: B-5, S-3/4 5.0'-9.0'
Description: Brown, micaceous, medium to fine sandy Silt, with gravel
Received: 5/13/2010

Job #: 09167
Lab #: 100233
Report Date: 5/18/2010
Report Status: Final

Laboratory Analysis



Test Methods	Soil Properties	
Moisture Content: ASTM D2216 Grain Size Analysis: ASTM D422 Liquid & Plastic Limits: ASTM D4318	Moisture Content 16.6% Liquid Limit: 37 Plastic Limit: 26 Plasticity Index: 11 A-Line: 12.4 Cu: Cc:	
Note: Gradation on -#4 material. Insufficient sample to run complete gradation,57.06g of 236g sample recieved retained on #4, maximum particle passes 1" screen.		Classification USC: ML*
	Checked By:	Tested By:

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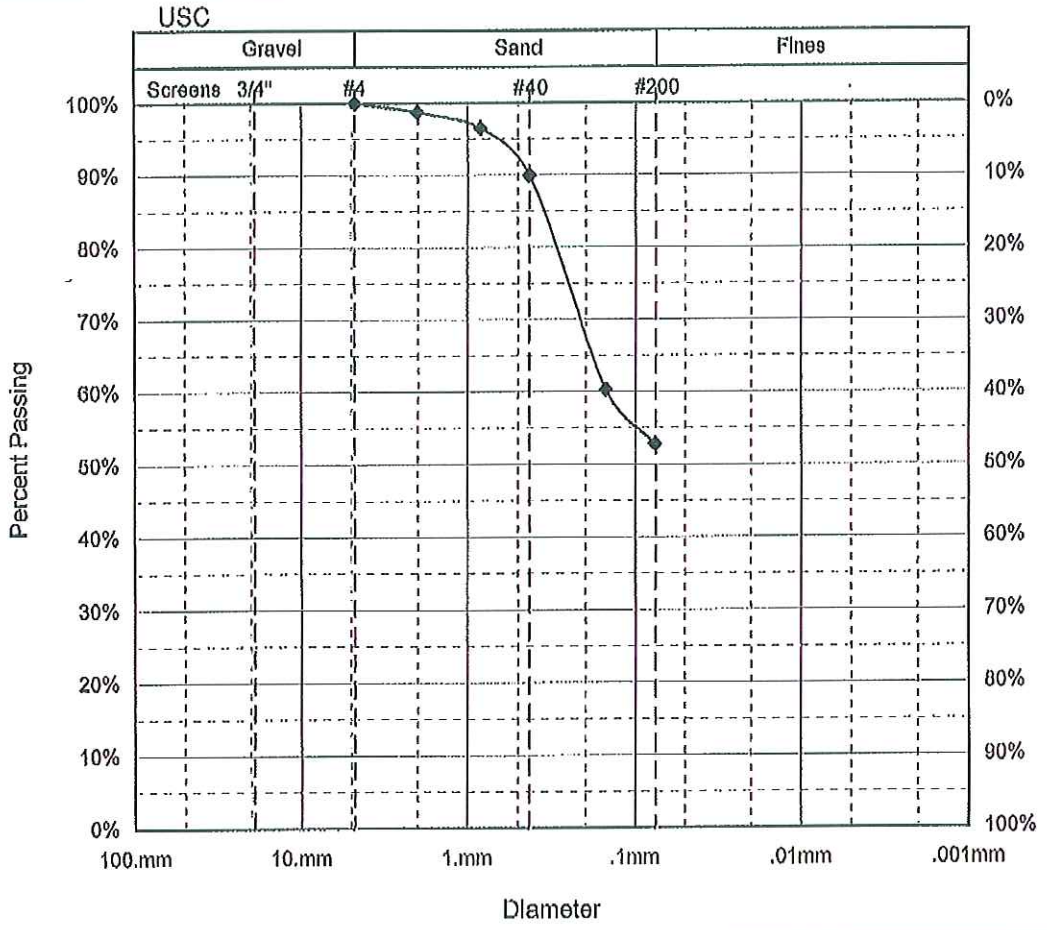
Project: Bryan's Road Town Center
Identification: AP-2, S-2, 1'-4'
Description: Olive yellow sandy Clay

Job #: 09167
Lab #: 090332
Report Date: 8/25/2009
Report Status: Final

Received: 8/11/2009

Laboratory Analysis



Test Methods	Soil Properties	
Moisture Content: ASTM D2216 Grain Size Analysis: ASTM D422 Liquid & Plastic Limits: ASTM D4318	Moisture Content 15.1% Liquid Limit: 35 Plastic Limit: 17 Plastic Index: 18 A Line: 11	
Note:		Classification USC: CL
C:\Lab Testing\09\[090332mal.xls]	Checked By:	Tested By: JGP

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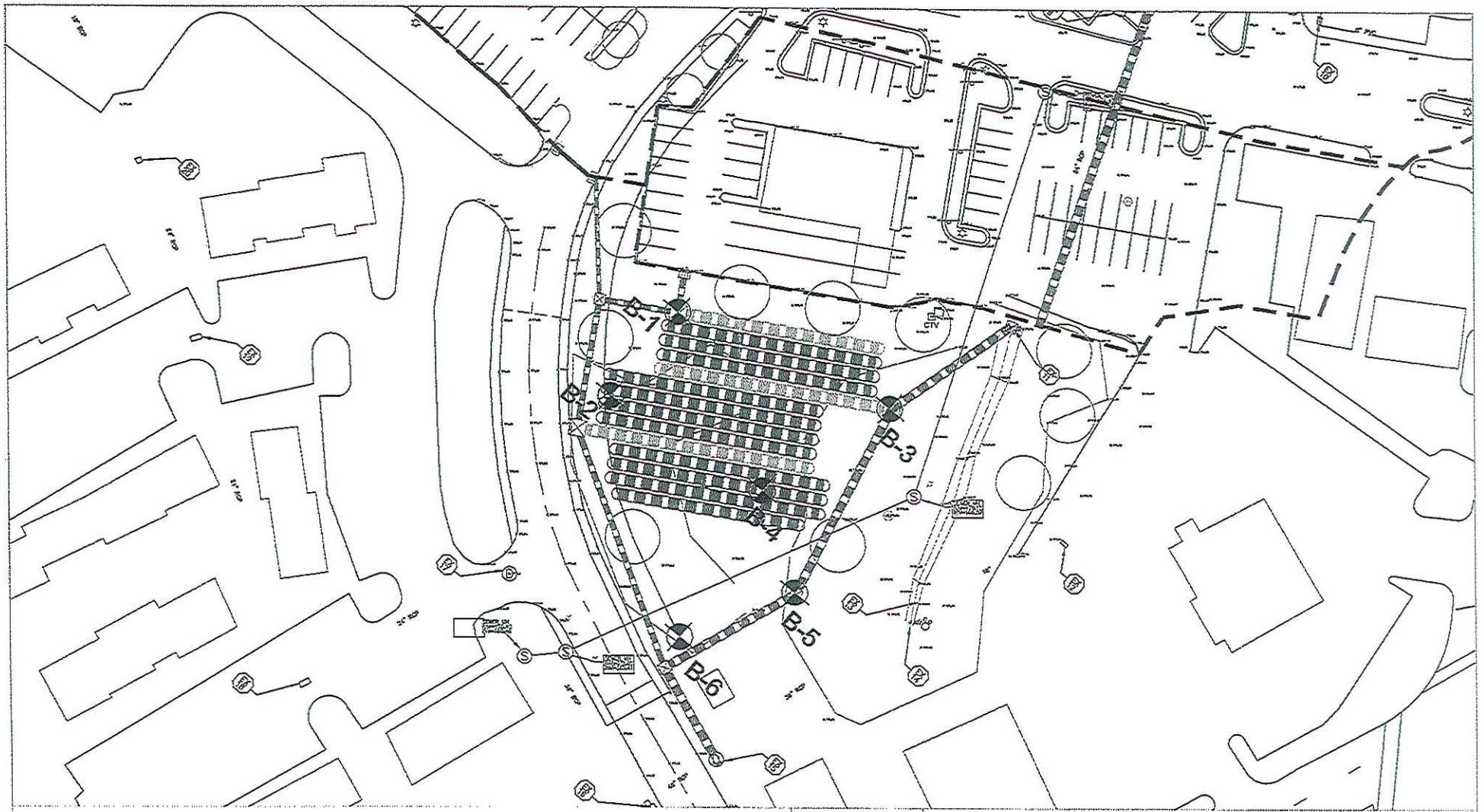
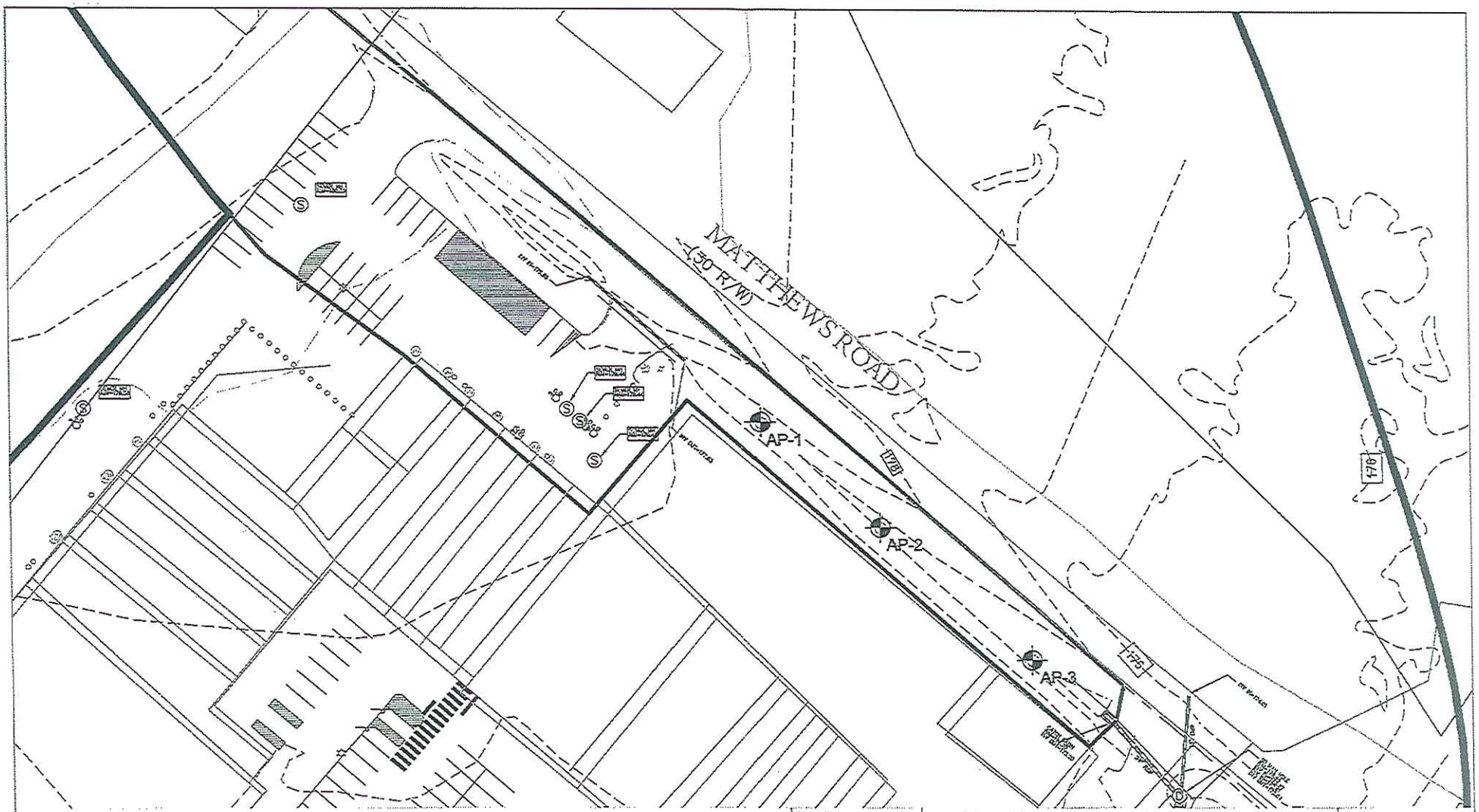
APPENDIX A FIGURES

BORING & HAND AUGER LOCATION PLANS

Page 96



PROJECT: 09157	BRYANS ROAD TOWN CENTER PARCEL 261 BORING LOCATION PLAN		DATE: MAY 2010
SCALE: APPROX. 1"=50'			DRAWN BY:
			CHECKED BY:
FIGURE: 1	FILE: O:\REPORTS\09\09167\BRYANSROADTC	HARDIN-KIGHT ASSOCIATES, INC. CONSULTING ENGINEERS	



PROJECT: 09167	BRYAN'S ROAD TOWN CENTER PROPOSED DRY SWALE LOCATION HAND AUGER PROBE LOCATION PLAN		DATE: AUG. 2009
SCALE: APPROX. 1"=50'			DRAWN BY:
			CHECKED BY:
FIGURE: 2	FILE: O:\REPORTS\09\09167\BRYAN'SROADTC	HARDIN-KIGHT ASSOCIATES, INC. CONSULTING ENGINEERS	