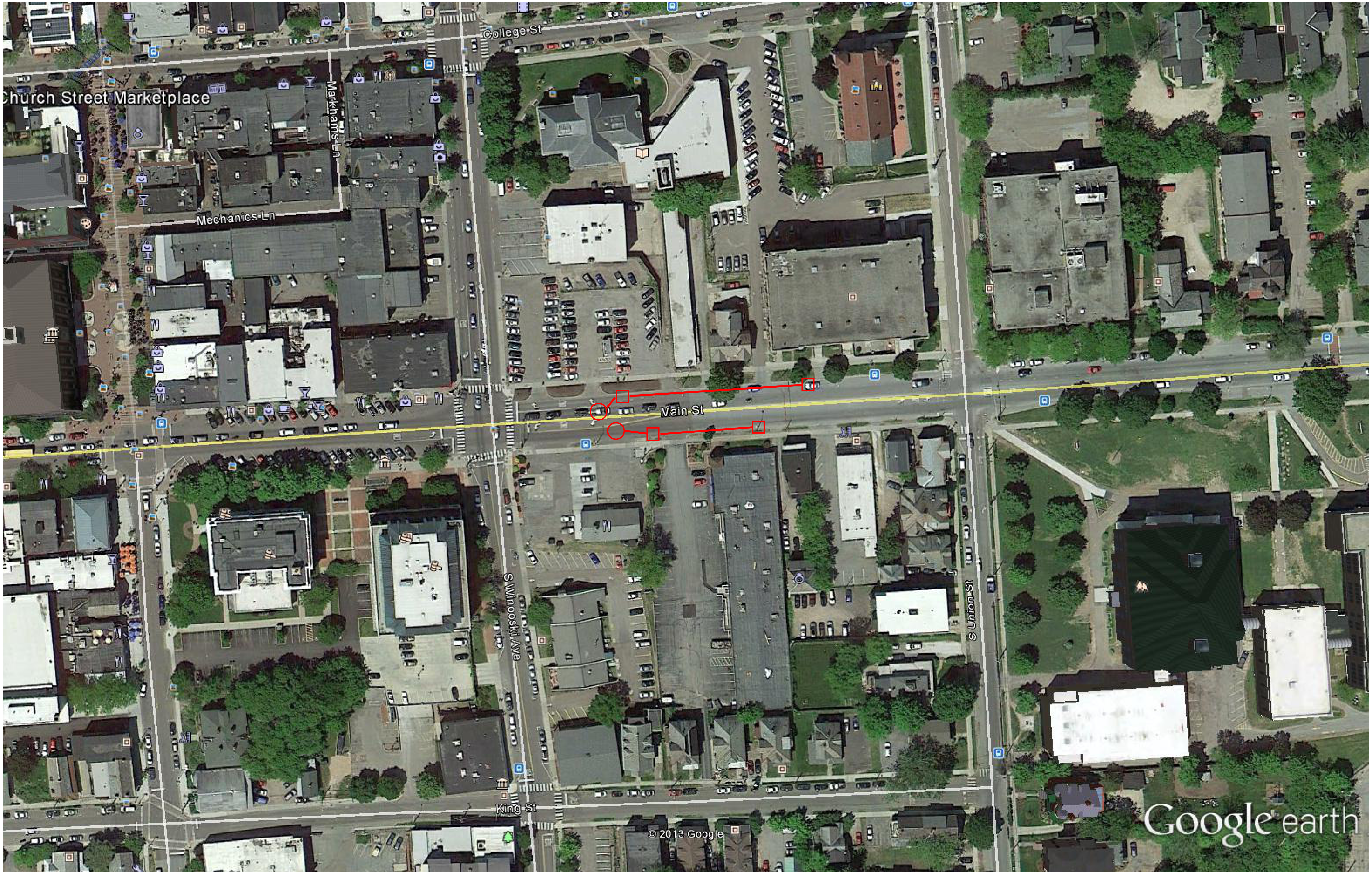
APPENDIX A

FIGURES

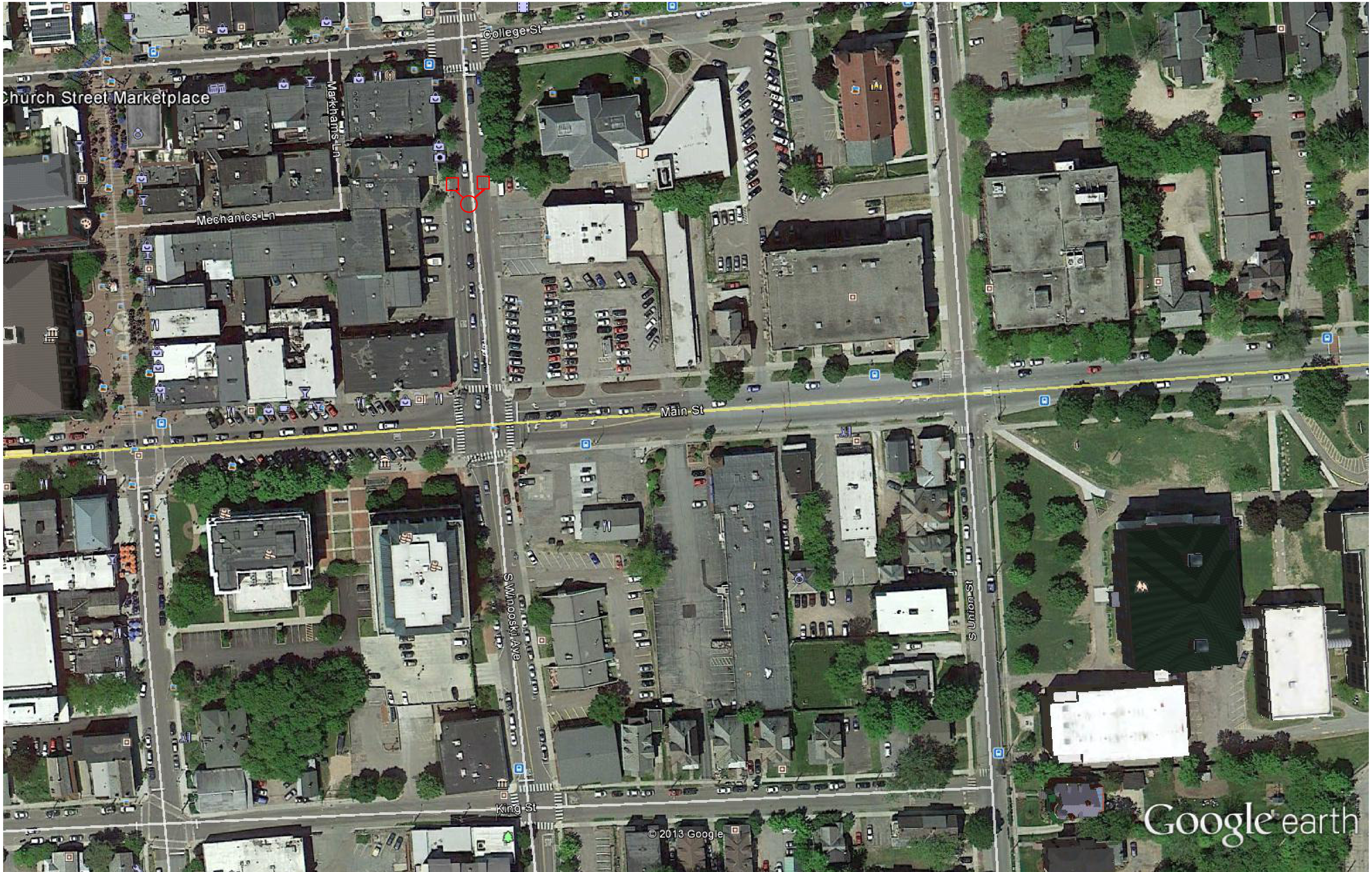


Google earth

feet 1000
meters 300

MAIN STREET - 4 STRUCTURES (CURBLINE CONSTRUCTION)

A+E
JJD
5-9-14



Google earth

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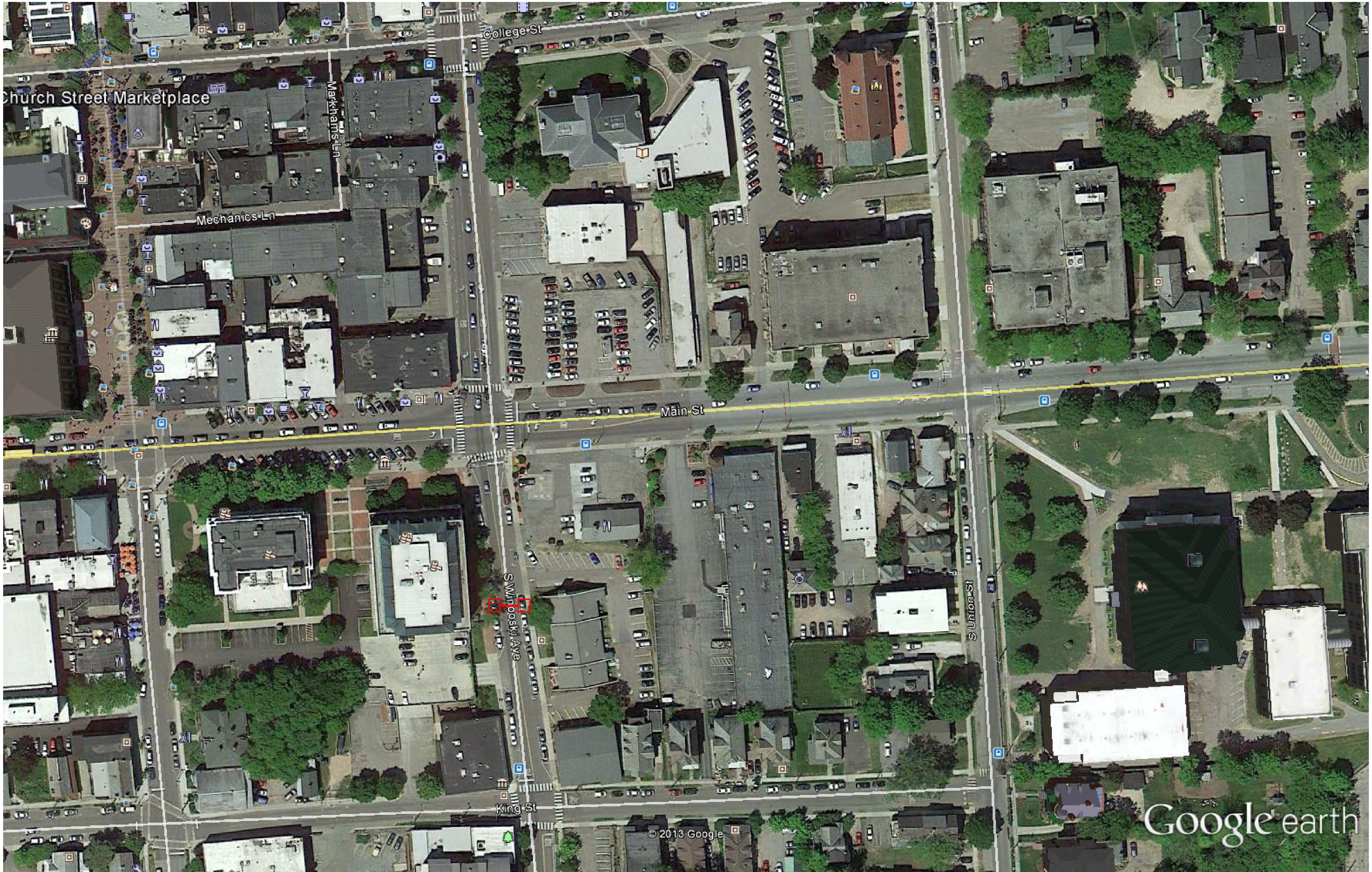
SOUTH WINOOSKI AT FIRE DEPARTMENT - 2 BASINS STRAIGHT TO RAVINE SEWER

A+E
JJD
5-9-14

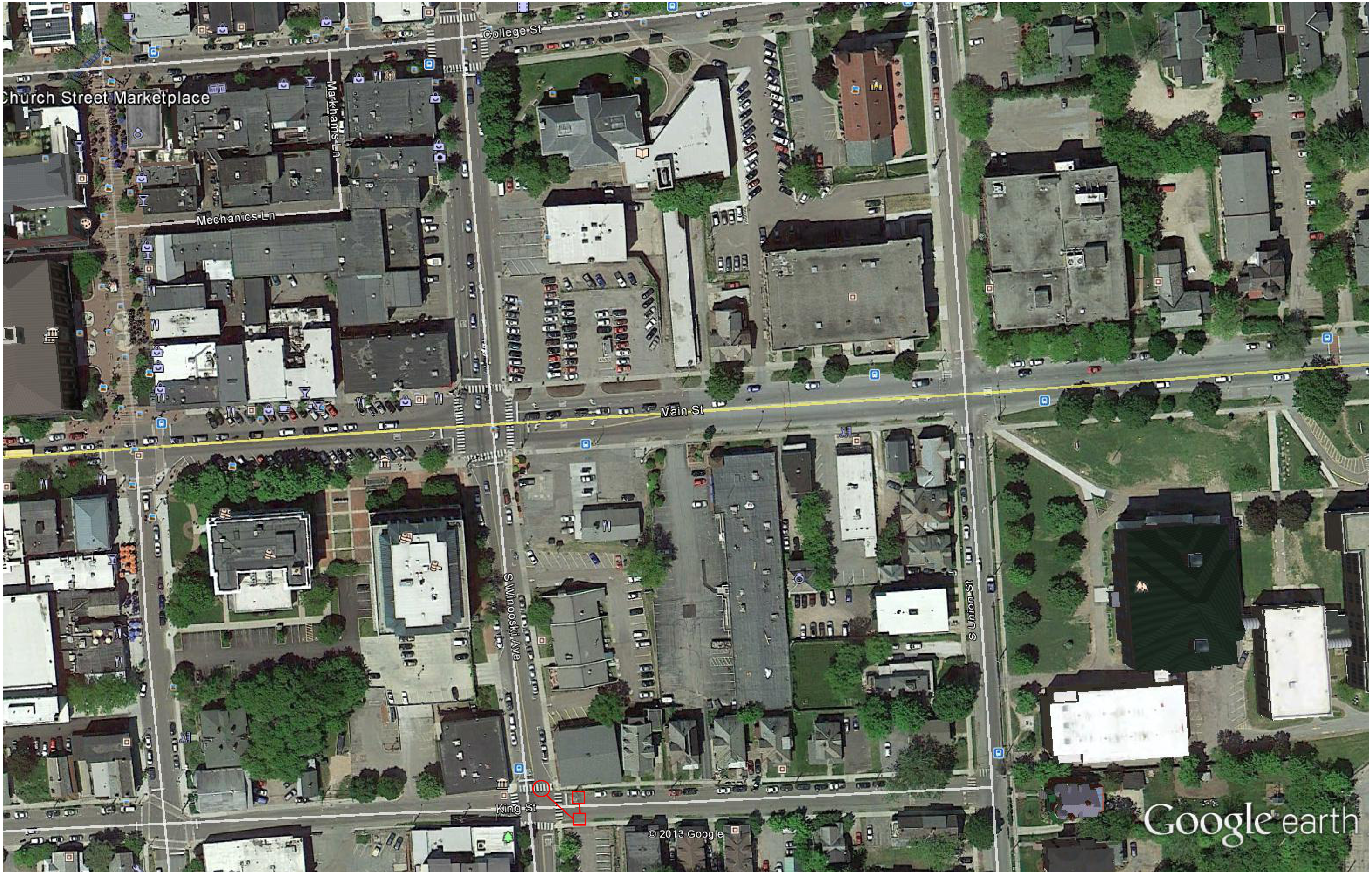


Google earth

feet 1000
meters 300

SOUTH WINOOSKI AVENUE AT COURTHOUSE - 2 BASINS STRAIGHT INTO RAVINE SEWER

A+E
JJD
5-9-14



Google earth

feet 1000
meters 300

KING STREET - 2 BASINS AT THE BOTTOM

A+E
JJD
5-9-14

APPENDIX B

COST ESTIMATES

Table No. 2
Priority Ranking for Stormwater Improvements

Priority	Location	Stormwater Runoff (gallons)	Estimated Construction Cost
1	Main Street	105,900	$107,000
2	So. Winooski at Fire House	28,700	$32,000
3	So. Winooski at Courthouse	98,400	$32,000
4	King Street	94,200	$39,000

In terms of schedule, the recommendation is to implement the above stormwater improvements as soon as financially possible. Since larger stormwater events typically occur during the summer months, the best case scenario would be to complete as much of these projects this spring and summer.

City of Burlington, Vermont

Main Street Stormwater Improvements

Opinion of Probable Construction Costs - Main Street - 4 Structures (Curbline Construction)

As of March 18, 2014

Description of Item		Estimated Quantity	Unit	Unit Price	Total Cost
A - Storm Drain Lines					
A- 1	15" SDR 35 Storm Drain	0	L.F.	$70	$0
A- 2	18" SDR 35 Storm Drain	330	L.F.	$75	$24,750
A- 3	24" SDR 35 Storm Drain	65	L.F.	$85	$5,525
A- 4	36" SDR 35 Storm Drain	0	L.F.	$90	$0
B - Stormwater Appurtenances					
B- 1	Catch Basin 3' Diameter	0	V.F.	$400	$0
B- 2	Catch Basin 4' Diameter	32	V.F.	$450	$14,400
B- 3	Catch Basin 5' Diameter	0	V.F.	$500	$0
B- 4	Catch Basin 6' Diameter	0	V.F.	$550	$0
B- 5	Connection to Existing Ravine SDMH	2	EA.	$1,500	$3,000
C - Earthwork					
C- 1	Rock Excavation	10	C.Y.	$125	$1,250
C- 2	Boulder Excavation	10	C.Y.	$50	$500
C- 3	Misc. Extra. Below Grade Excavation	50	C.Y.	$40	$2,000
C- 4	Exc. & Replac. Unsuitable	50	C.Y.	$40	$2,000
D - Roadwork and Appurtenances					
D- 1	Bituminous Pavement Repair - Roads	250	S.Y.	$65	$16,250
D- 2	Concrete Sidewalk	20	L.F.	$50	$1,000
D- 3	Concrete Curb Replacement	290	L.F.	$30	$8,700
E - Incidental Work					
E- 1	Temporary Inlet Protection	8	EA.	$50	$400
E- 2	Uniformed Traffic Control	100	HRS	$65	$6,500
F - Lump Sum					
F- 1	Prep of Site and Misc Work (10%)	1	L.S.	$8,700	$8,700
F- 2	Bonds (2%)	1	L.S.	$1,900	$1,900
				SUBTOTAL	$96,875
				10% CONTINGENCY	$9,688
				TOTAL	$106,563
				USE	**$107,000**

Notes:

1. ENR 9700 = March 2014

City of Burlington, Vermont

Main Street Stormwater Improvements

Opinion of Probable Construction Costs - South Winooski at Fire Station - 2 Basins to Ravine Sewer

As of March 18, 2014

Description of Item		Estimated Quantity	Unit	Unit Price	Total Cost
A - Storm Drain Lines					
A- 1	6" SDR 35 Storm Drain	0	L.F.	$55	$0
A- 2	15" SDR 35 Storm Drain	0	L.F.	$70	$0
A- 3	18" SDR 35 Storm Drain	50	L.F.	$75	$3,750
A- 4	24" SDR 35 Storm Drain	0	L.F.	$80	$0
B - Stormwater Appurtenances					
B- 1	Catch Basin 3' Diameter	0	V.F.	$400	$0
B- 2	Catch Basin 4' Diameter	16	V.F.	$450	$7,200
B- 3	6,500 Gallon Precast Concrete Tank	0	EA.	$18,000	$0
B- 4	Connection to Existing Ravine SDMH	2	EA.	$1,500	$3,000
C - Earthwork					
C- 1	Rock Excavation	5	C.Y.	$125	$625
C- 2	Boulder Excavation	5	C.Y.	$50	$250
C- 3	Misc. Extra. Below Grade Excavation	20	C.Y.	$40	$800
C- 4	Exc. & Replac. Unsuitable	10	C.Y.	$40	$400
D - Roadwork and Appurtenances					
D- 1	Bituminous Pavement Repair - Roads	60	S.Y.	$65	$3,900
D- 2	Concrete Sidewalk	30	L.F.	$50	$1,500
D- 3	Concrete Curb Replacement	30	L.F.	$30	$900
E - Incidental Work					
E- 1	Temporary Inlet Protection	4	EA.	$50	$200
E- 2	Uniformed Traffic Control	50	HRS	$65	$3,250
F - Lump Sum					
F- 1	Prep of Site and Misc Work (10%)	1	L.S.	$2,600	$2,600
F- 2	Bonds (2%)	1	L.S.	$600	$600
				SUBTOTAL	$28,975
				10% CONTINGENCY	$2,898
				TOTAL	$31,873
				USE	**$32,000**

Notes:

1. ENR 9700 = March 2014

City of Burlington, Vermont

Main Street Stormwater Improvements

Opinion of Probable Construction Costs - South Winooski at Courthouse - 2 Basins to Ravine Sewer

As of March 18, 2014

	Description of Item	Estimated Quantity	Unit	Unit Price	Total Cost
A - Storm Drain Lines					
A- 1	15" SDR 35 Storm Drain	0	L.F.	$70	$0
A- 2	18" SDR 35 Storm Drain	50	L.F.	$75	$3,750
A- 3	24" SDR 35 Storm Drain	0	L.F.	$80	$0
B - Stormwater Appurtenances					
B- 1	Catch Basin 4' Diameter	16	V.F.	$450	$7,200
B- 3	Connection to Existing Ravine SDMH	2	EA.	$1,500	$3,000
C - Earthwork					
C- 1	Rock Excavation	5	C.Y.	$125	$625
C- 2	Boulder Excavation	5	C.Y.	$50	$250
C- 3	Misc. Extra. Below Grade Excavation	20	C.Y.	$40	$800
C- 4	Exc. & Replac. Unsuitable	20	C.Y.	$40	$800
D - Roadwork and Appurtenances					
D- 1	Bituminous Pavement Repair - Roads	60	S.Y.	$65	$3,900
D- 2	Concrete Sidewalk	20	L.F.	$50	$1,000
D- 3	Concrete Curb Replacement	20	L.F.	$30	$600
E - Incidental Work					
E- 1	Temporary Inlet Protection	2	EA.	$50	$100
E- 2	Uniformed Traffic Control	50	HRS	$65	$3,250
F - Lump Sum					
F- 1	Prep of Site and Misc Work (10%)	1	L.S.	$2,600	$2,600
F- 2	Bonds (2%)	1	L.S.	$600	$600
				SUBTOTAL	$28,475
				10% CONTINGENCY	$2,848
				TOTAL	$31,323
				USE	**$32,000**

Notes:

1. ENR 9700 = March 2014

City of Burlington, Vermont

Main Street Stormwater Improvements

Opinion of Probable Construction Costs - King Street - 2 Basins at the Bottom

As of March 18, 2014

Description of Item		Estimated Quantity	Unit	Unit Price	Total Cost
A - Storm Drain Lines					
A- 1	15" HDPE Storm Drain	28	L.F.	$70	$1,960
A- 2	24" HDPE Storm Drain	65	L.F.	$80	$5,200
B - Stormwater Appurtenances					
B- 1	Catch Basin 3' Diameter	6	V.F.	$400	$2,400
B- 2	Catch Basin 4' Diameter	8	V.F.	$450	$3,600
B- 5	Connection to Existing Ravine SDMH	1	EA.	$1,500	$1,500
C - Earthwork					
C- 1	Rock Excavation	10	C.Y.	$125	$1,250
C- 2	Boulder Excavation	10	C.Y.	$50	$500
C- 3	Misc. Extra. Below Grade Excavation	50	C.Y.	$40	$2,000
C- 4	Exc. & Replac. Unsuitable	20	C.Y.	$40	$800
D - Roadwork and Appurtenances					
D- 1	Bituminous Pavement Repair - Roads	110	S.Y.	$65	$7,150
D- 2	Concrete Sidewalk	20	L.F.	$50	$1,000
D- 3	Concrete Curb Replacement	20	L.F.	$30	$600
E - Incidental Work					
E- 1	Temporary Inlet Protection	4	EA.	$50	$200
E- 2	Uniformed Traffic Control	50	HRS	$65	$3,250
F - Lump Sum					
F- 1	Prep of Site and Misc Work (10%)	1	L.S.	$3,200	$3,200
F- 2	Bonds (2%)	1	L.S.	$700	$700
				SUBTOTAL	$35,310
				10% CONTINGENCY	$3,531
				TOTAL	$38,841
				USE	**$39,000**

Notes:

1. ENR 9700 = March 2014

APPENDIX C

HYDROLOGIC ANALYSIS

13059 – Burlington Main Street Stormwater Study
March 18, 2014

Aldrich + Elliott
WATER RESOURCE ENGINEERS

Alternatives Summary

Alternative	Description
Main – 4 Structures	4 CBs installed on Lower Main Street discharge to Ravine Sewer
So. Winooski at Fire House	2 CBs on So. Winooski at Fire House discharge to Ravine Sewer Bypass
So. Winooski at Courthouse	2 CBs on So. Winooski at Courthouse capture flow from So. Winooski and Main St. south side and discharge to Ravine Bypass Sewer
King Street	2 CBs on King Street near So. Winooski that discharge to Ravine Sewer Bypass

Catch Basin Inlet Grates

- Bicycle, plow, ice/snow buildup and debris considerations
- Creating gutter flow is critical to enhance capture
- Hydraulic efficiency – vane versus standard bar

Other Considerations

- City is retaining consultant to prepare hydraulic model of sewer/storm system
- Something needs to be done now to minimize potential flooding however hydraulic model may give insight as to best long term approach

Recommendations

- Construct 4 CBs on Main Street between South Union and entrance to Champlain Farms and discharge flow into existing Ravine Sewer manholes
- Construct 2 CBs on So. Winooski at Fire House and discharge into existing Ravine Sewer Bypass manhole
- Construct 2 CBs on So. Winooski at Court House to capture flow from So. Winooski and Main St. south side and discharge directly into Ravine Bypass Sewer pipeline
- Construction of the King Street improvements is not recommended at this time. It is recommended that the Main Street and two South Winooski Avenue improvements be constructed first to evaluate their impact on the flooding that occurs at the low point on King Street

6 Market Place, Suite 2
Essex Junction, VT 05452
802.879.7733
www.AEengineers.com

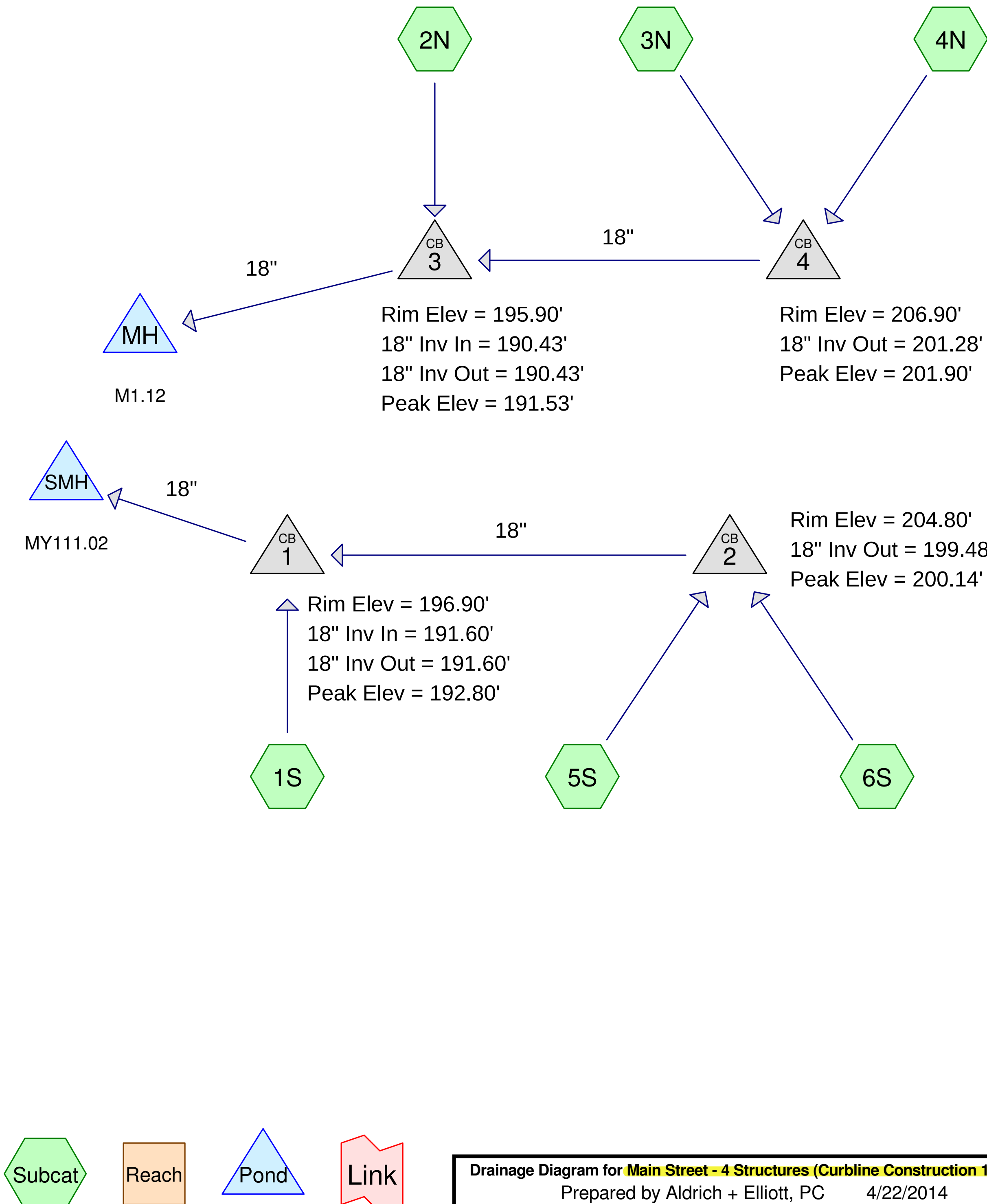
Table No. 1
Stormwater Runoff by Drainage Area

Location	Drainage Area (Acres)	Stormwater Runoff		Total Gallons
		Acre-feet	Gallons	
Main Street	4.280	0.325	105,900	134,600
So. Winooski at Fire House	1.033	0.088	28,700	
So. Winooski at Court House	3.190	0.302	98,400	192,600
King Street	4.923	0.289	94,200	

Notes:
1. Runoff was calculated using a 1.42", 30 minute, constant-intensity rainfall event in HydroCAD.

The Main Street and South Winooski Avenue at Fire House drainage areas contribute to the flooding in front of Mr. Mike's, and the South Winooski Avenue at Courthouse and King Street drainage areas contribute to the flooding in the Courthouse parking lot that ultimately reaches the Hood Plant. The resulting totals are an additional 134,600 gallons of stormwater runoff that could be kept from flooding the Main Street / South Winooski Avenue intersection, and 192,600 gallons that could be kept from flooding the Courthouse and Hood Plant parking lots. This confirms that the potential for stormwater improvements in these areas is significant.

Main Street – 4 Structures



Drainage Diagram for Main Street - 4 Structures (Curbline Construction 18-inch)
Prepared by Aldrich + Elliott, PC 4/22/2014

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
0.544	68	<50% Grass cover, Poor, HSG A (1S,2N,3N,4N,6S)
3.737	98	Paved parking & roofs (1S,2N,3N,4N,5S,6S)
4.280		

Time span=0.00-2.00 hrs, dt=0.01 hrs, 201 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Runoff Area=61,663 sf Runoff Depth=1.02"
Flow Length=552' Tc=10.5 min CN=96 Runoff=3.61 cfs 0.120 af

Subcatchment 2N: Runoff Area=61,497 sf Runoff Depth=0.62"
Flow Length=508' Slope=0.0433 '/' Tc=2.6 min CN=90 Runoff=3.00 cfs 0.073 af

Subcatchment 3N: Runoff Area=26,792 sf Runoff Depth=1.02"
Flow Length=169' Tc=2.6 min CN=96 Runoff=1.65 cfs 0.052 af

Subcatchment 4N: Runoff Area=3,961 sf Runoff Depth=0.80"
Flow Length=271' Slope=0.0080 '/' Tc=3.7 min CN=93 Runoff=0.22 cfs 0.006 af

Subcatchment 5S: Runoff Area=27,511 sf Runoff Depth=1.20"
Flow Length=307' Slope=0.0420 '/' Tc=1.9 min CN=98 Runoff=1.77 cfs 0.063 af

Subcatchment 6S: Runoff Area=5,023 sf Runoff Depth=1.11"
Flow Length=339' Slope=0.0110 '/' Tc=3.7 min CN=97 Runoff=0.32 cfs 0.011 af

Pond 1: Peak Elev=192.80' Inflow=5.66 cfs 0.194 af
18.0" x 39.0' Culvert Outflow=5.66 cfs 0.194 af

Pond 2: Peak Elev=200.14' Inflow=2.09 cfs 0.074 af
18.0" x 133.5' Culvert Outflow=2.09 cfs 0.074 af

Pond 3: Peak Elev=191.53' Inflow=4.87 cfs 0.131 af
18.0" x 39.0' Culvert Outflow=4.87 cfs 0.131 af

Pond 4: Peak Elev=201.90' Inflow=1.87 cfs 0.058 af
18.0" x 192.5' Culvert Outflow=1.87 cfs 0.058 af

Pond MH: M1.12 Inflow=4.87 cfs 0.131 af
Primary=4.87 cfs 0.131 af

Pond SMH: MY111.02 Inflow=5.66 cfs 0.194 af
Primary=5.66 cfs 0.194 af

Total Runoff Area = 4.280 ac Runoff Volume = 0.325 af Average Runoff Depth = 0.91"
12.70% Pervious Area = 0.544 ac 87.30% Impervious Area = 3.737 ac

Subcatchment 1S:

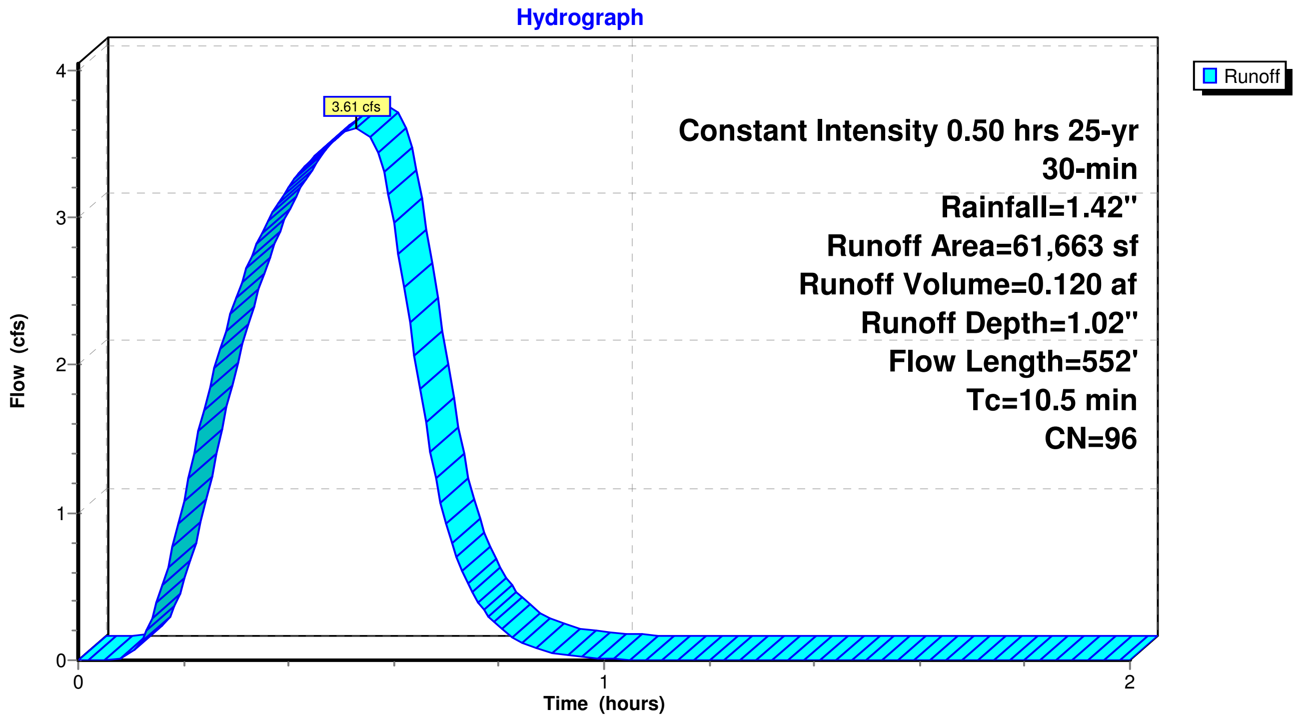
Runoff = 3.61 cfs @ 0.53 hrs, Volume= 0.120 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
3,770	68	<50% Grass cover, Poor, HSG A
57,893	98	Paved parking & roofs
61,663	96	Weighted Average
3,770		Pervious Area
57,893		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	100	0.0500	0.21		**Sheet Flow, Flows over short grass** Grass: Short n= 0.150 P2= 2.30"
0.9	82	0.0500	1.57		**Shallow Concentrated Flow, Flows over grass** Short Grass Pasture Kv= 7.0 fps
1.6	370	0.0380	3.96		**Shallow Concentrated Flow, Flows over pavement** Paved Kv= 20.3 fps
10.5	552	Total			

Subcatchment 1S:



Subcatchment 2N:

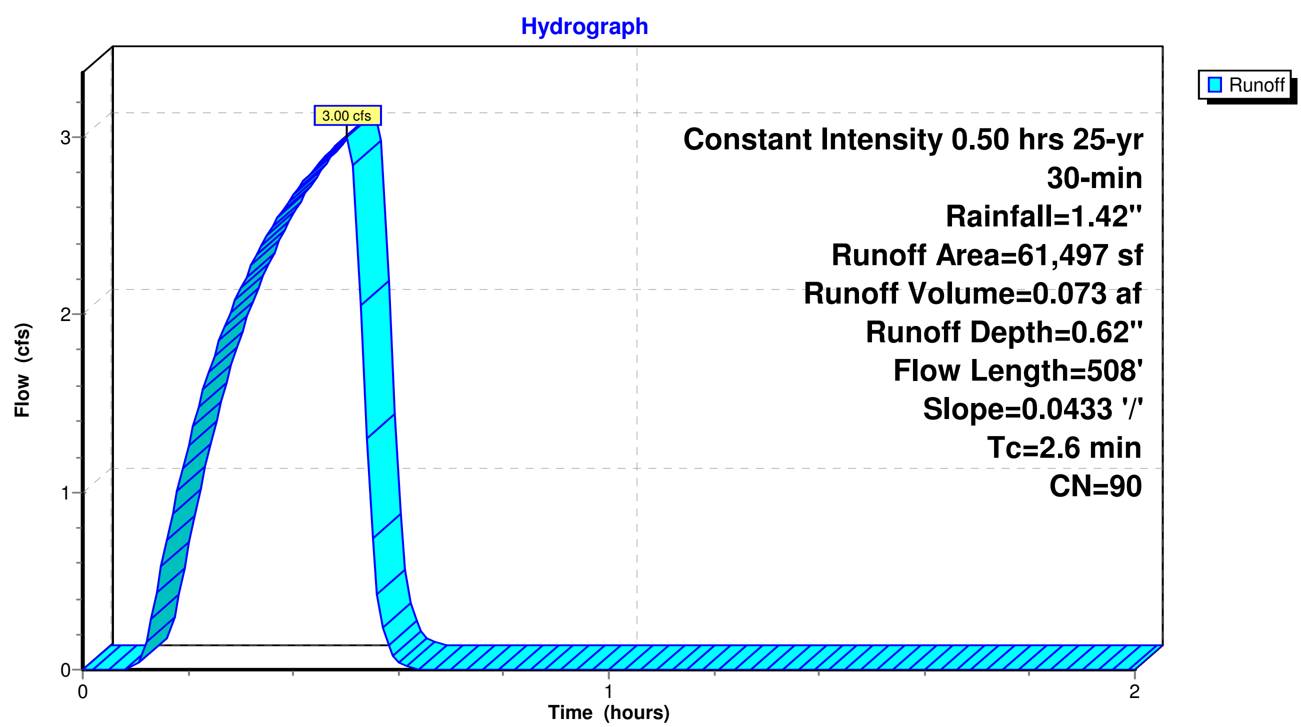
Runoff = 3.00 cfs @ 0.50 hrs, Volume= 0.073 af, Depth= 0.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
17,143	68	<50% Grass cover, Poor, HSG A
44,354	98	Paved parking & roofs
61,497	90	Weighted Average
17,143		Pervious Area
44,354		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0433	1.59		**Sheet Flow, Flows over pavement.** Smooth surfaces n= 0.011 P2= 2.30"
1.6	408	0.0433	4.22		**Shallow Concentrated Flow, Flows over pavement** Paved Kv= 20.3 fps
2.6	508	Total			

Subcatchment 2N:



Subcatchment 3N:

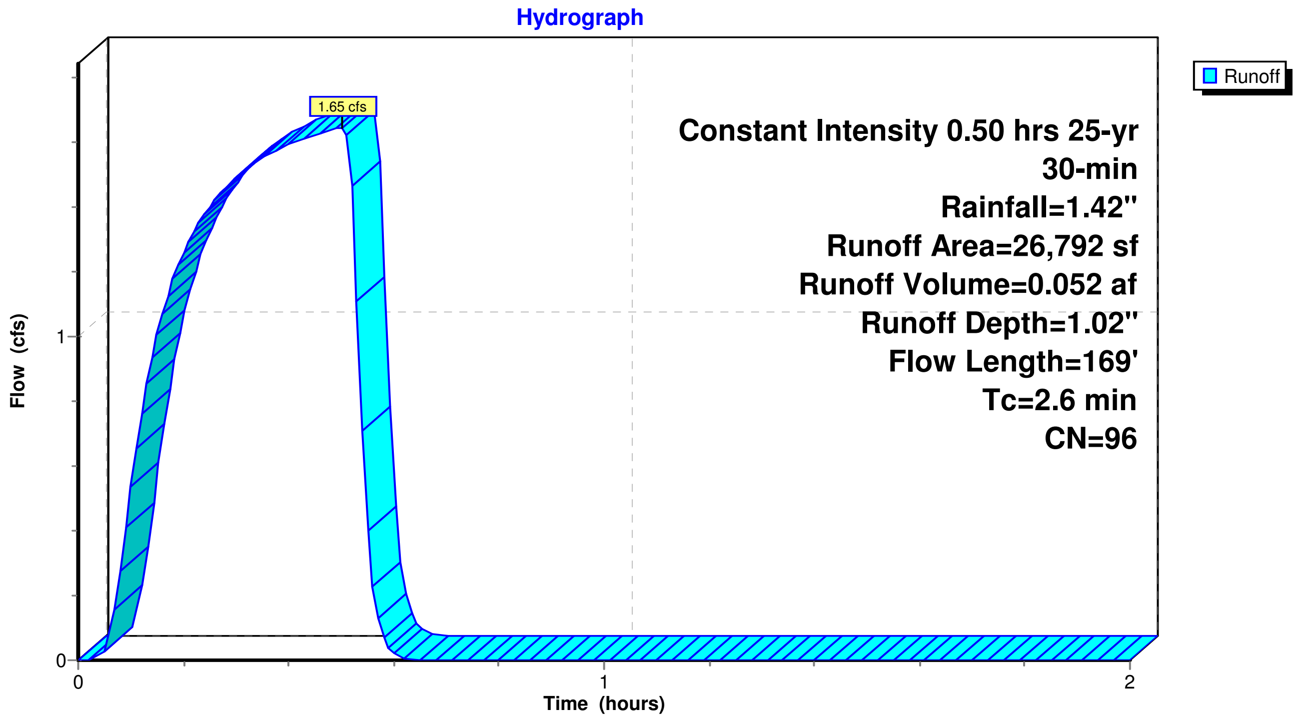
Runoff = 1.65 cfs @ 0.50 hrs, Volume= 0.052 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
1,822	68	<50% Grass cover, Poor, HSG A
24,970	98	Paved parking & roofs
26,792	96	Weighted Average
1,822		Pervious Area
24,970		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	19	0.1050	0.20		**Sheet Flow, Flows over grass** Grass: Short n= 0.150 P2= 2.30"
0.8	81	0.0600	1.74		**Sheet Flow, Flow over concrete sidewalk** Smooth surfaces n= 0.011 P2= 2.30"
0.2	69	0.0600	4.97		**Shallow Concentrated Flow, Flows over concrete sidewalk.** Paved Kv= 20.3 fps
2.6	169	Total			

Subcatchment 3N:



Subcatchment 4N:

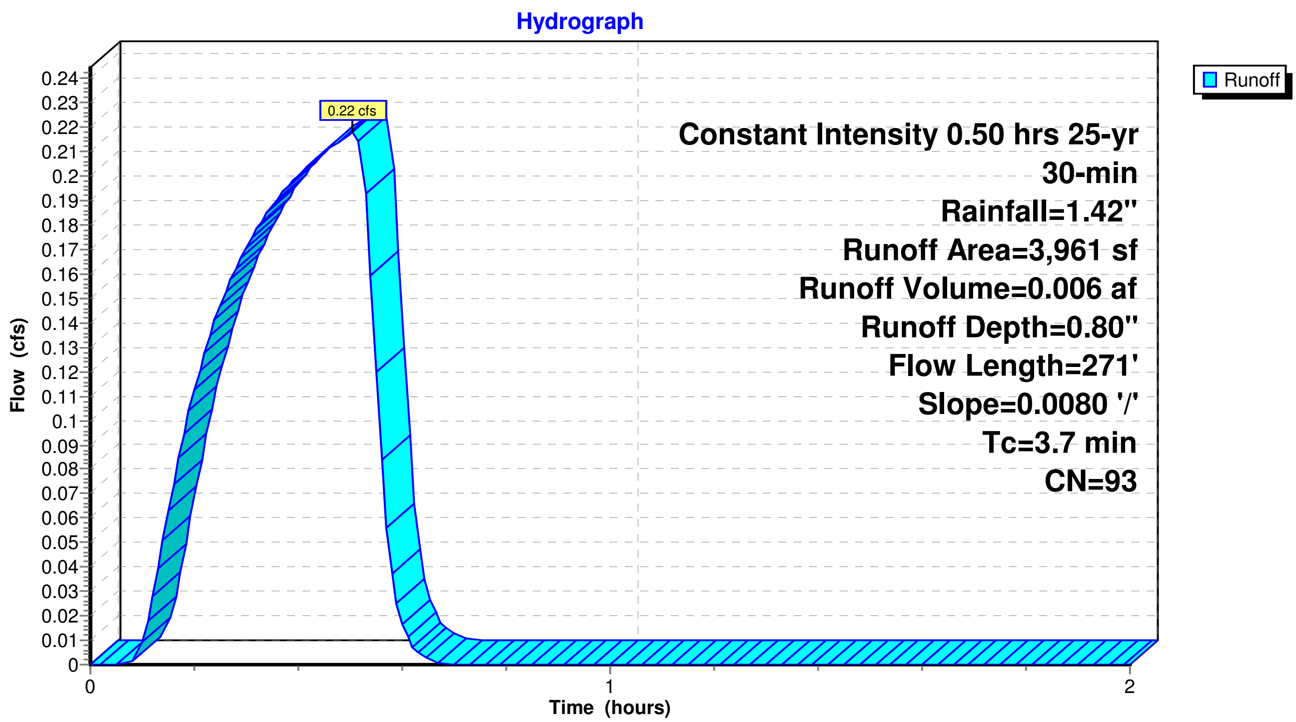
Runoff = 0.22 cfs @ 0.51 hrs, Volume= 0.006 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
720	68	<50% Grass cover, Poor, HSG A
3,241	98	Paved parking & roofs
3,961	93	Weighted Average
720		Pervious Area
3,241		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	100	0.0080	0.81		**Sheet Flow, Flow over pavement.** Smooth surfaces n= 0.011 P2= 2.30"
1.6	171	0.0080	1.82		**Shallow Concentrated Flow, Flow over pavement.** Paved Kv= 20.3 fps
3.7	271	Total			

Subcatchment 4N:



Subcatchment 5S:

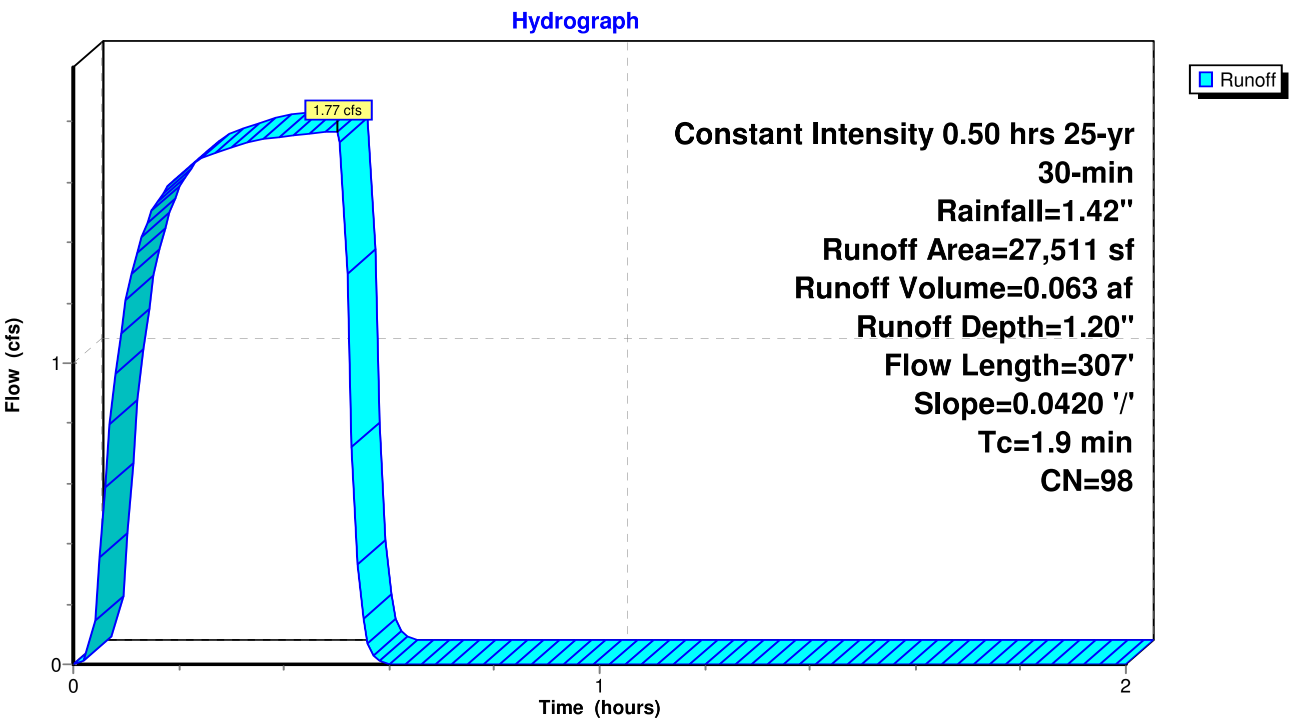
Runoff = 1.77 cfs @ 0.50 hrs, Volume= 0.063 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
27,511	98	Paved parking & roofs
27,511		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	100	0.0420	1.57		**Sheet Flow, Flows over pavement** Smooth surfaces n= 0.011 P2= 2.30"
0.8	207	0.0420	4.16		**Shallow Concentrated Flow, Flows over pavement** Paved Kv= 20.3 fps
1.9	307	Total			

Subcatchment 5S:



Subcatchment 6S:

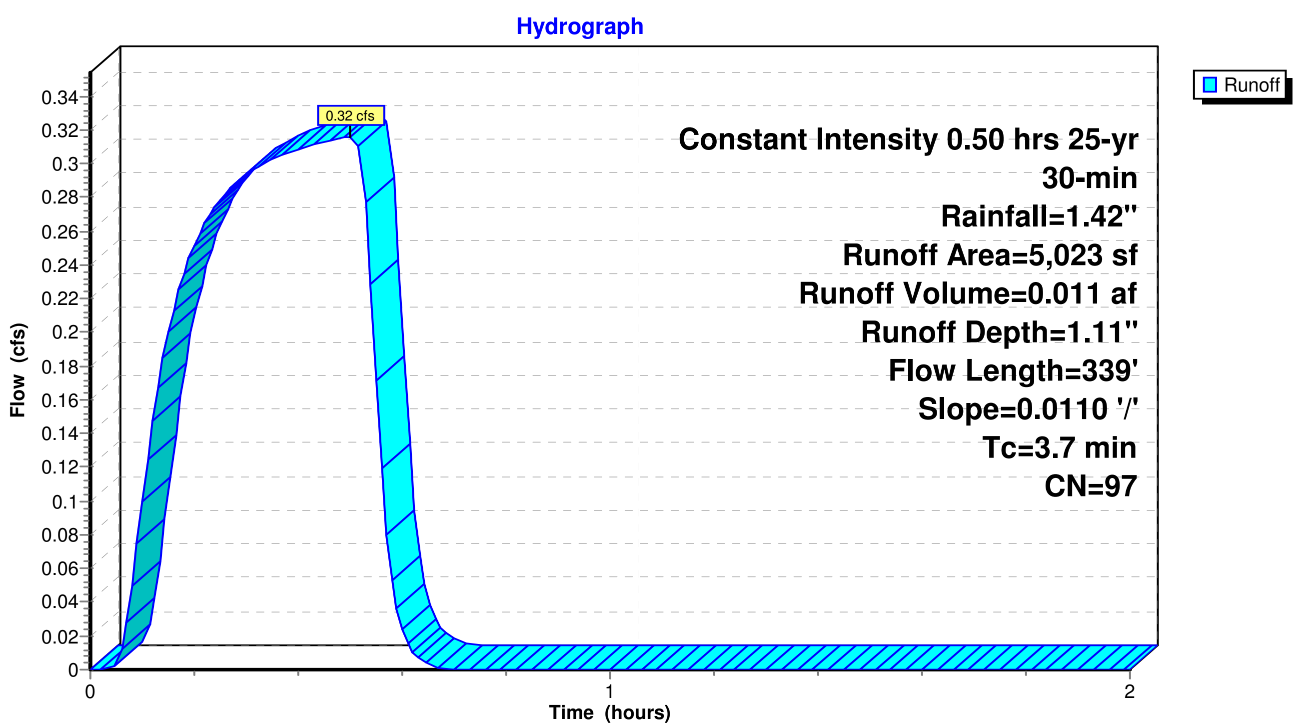
Runoff = 0.32 cfs @ 0.50 hrs, Volume= 0.011 af, Depth= 1.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
225	68	<50% Grass cover, Poor, HSG A
4,798	98	Paved parking & roofs
5,023	97	Weighted Average
225		Pervious Area
4,798		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	100	0.0110	0.92		**Sheet Flow, Flow over concrete sidewalk** Smooth surfaces n= 0.011 P2= 2.30"
1.9	239	0.0110	2.13		**Shallow Concentrated Flow, Flows over concrete sidewalk and do** Paved Kv= 20.3 fps
3.7	339	Total			

Subcatchment 6S:



Pond 1:

4' Diameter Catch Basin

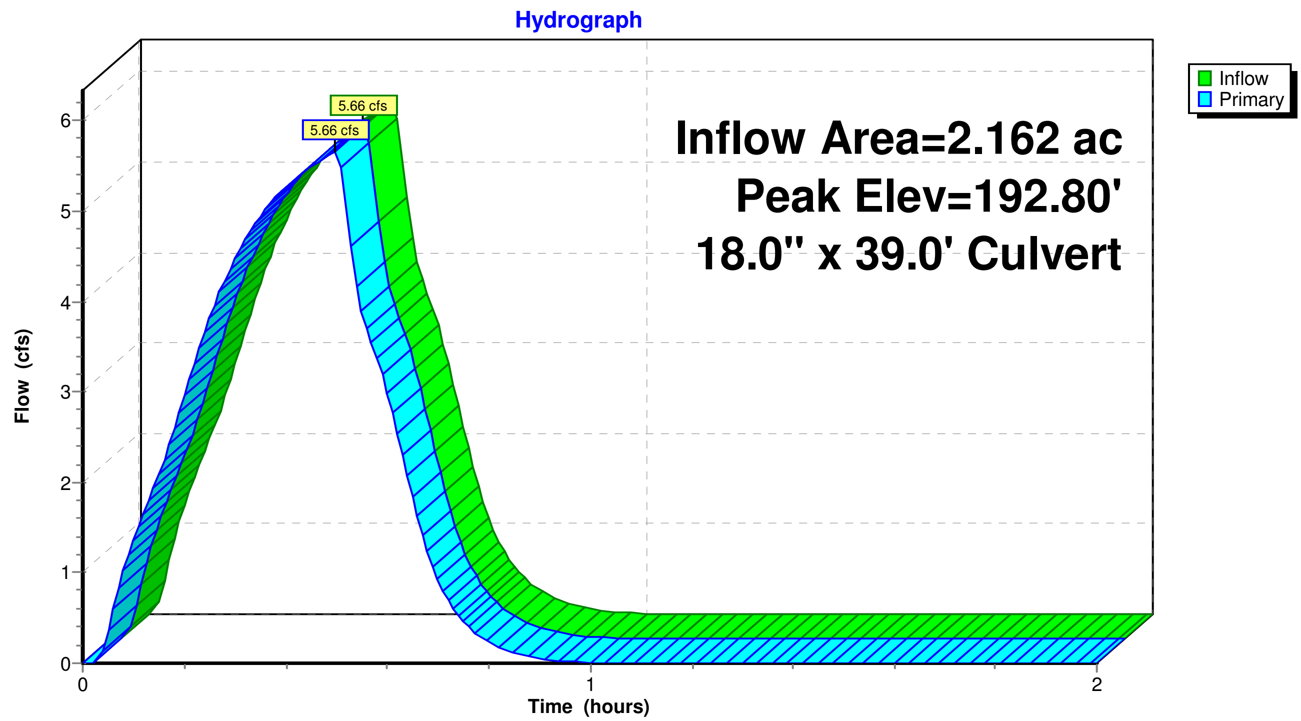
Inflow Area =	2.162 ac, Inflow Depth = 1.08"	for 25-yr, 30-min event	
Inflow =	5.66 cfs @ 0.50 hrs, Volume=	0.194 af	
Outflow =	5.66 cfs @ 0.50 hrs, Volume=	0.194 af,	Atten= 0%, Lag= 0.0 min
Primary =	5.66 cfs @ 0.50 hrs, Volume=	0.194 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Peak Elev= 192.80' @ 0.50 hrs
Flood Elev= 196.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	191.60'	**18.0" x 39.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 189.73' S= 0.0479 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=5.65 cfs @ 0.50 hrs HW=192.80' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 5.65 cfs @ 3.73 fps)

Pond 1:



Pond 2:

4' Diameter Catch Basin

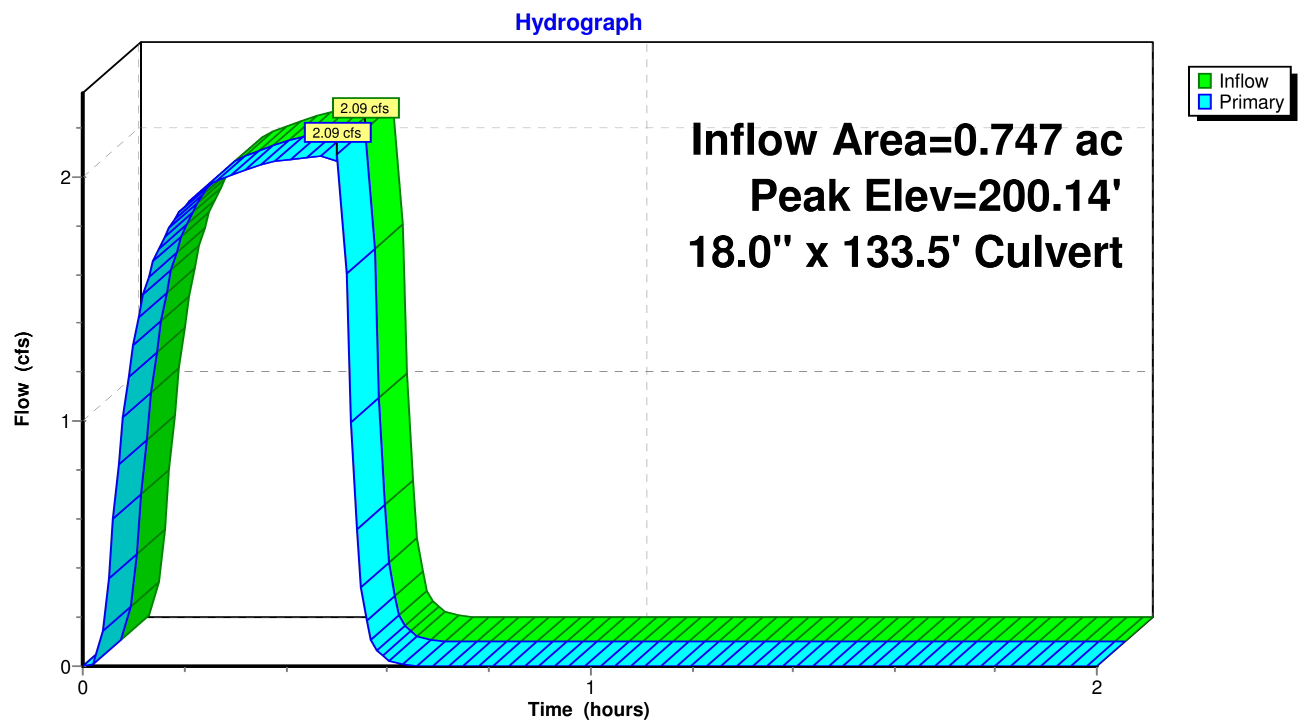
Inflow Area =	0.747 ac,	Inflow Depth = 1.19"	for 25-yr, 30-min event	
Inflow =	2.09 cfs @	0.50 hrs, Volume=	0.074 af	
Outflow =	2.09 cfs @	0.50 hrs, Volume=	0.074 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.09 cfs @	0.50 hrs, Volume=	0.074 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Peak Elev= 200.14' @ 0.50 hrs
Flood Elev= 204.80'

Device	Routing	Invert	Outlet Devices
#1	Primary	199.48'	**18.0" x 133.5' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 191.60' S= 0.0590 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=2.09 cfs @ 0.50 hrs HW=200.14' TW=192.80' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.09 cfs @ 2.77 fps)

Pond 2:



Pond 3:

4' Diameter Catch Basin

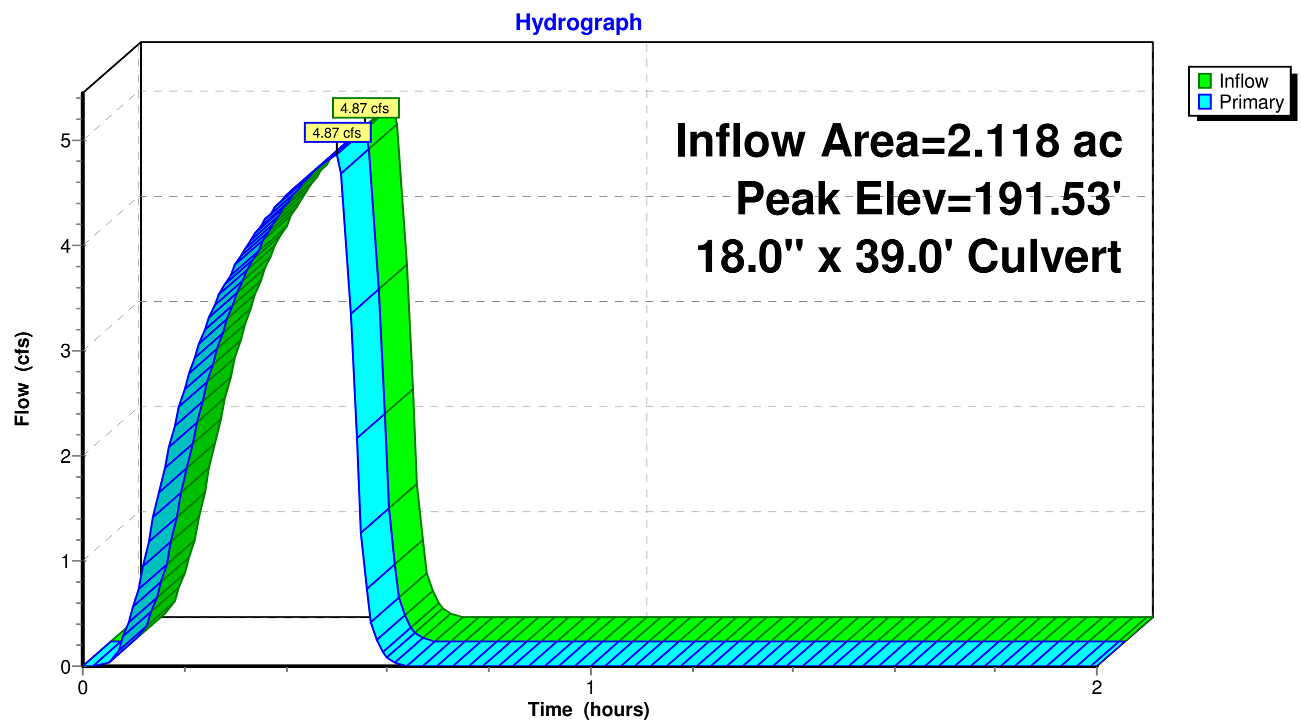
Inflow Area =	2.118 ac, Inflow Depth = 0.74"	for 25-yr, 30-min event	
Inflow =	4.87 cfs @ 0.50 hrs, Volume=	0.131 af	
Outflow =	4.87 cfs @ 0.50 hrs, Volume=	0.131 af,	Atten= 0%, Lag= 0.0 min
Primary =	4.87 cfs @ 0.50 hrs, Volume=	0.131 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Peak Elev= 191.53' @ 0.50 hrs
Flood Elev= 195.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	190.43'	**18.0" x 39.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 190.00' S= 0.0110 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=4.87 cfs @ 0.50 hrs HW=191.53' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 4.87 cfs @ 4.90 fps)

Pond 3:



Pond 4:

4' Diameter Catch Basin

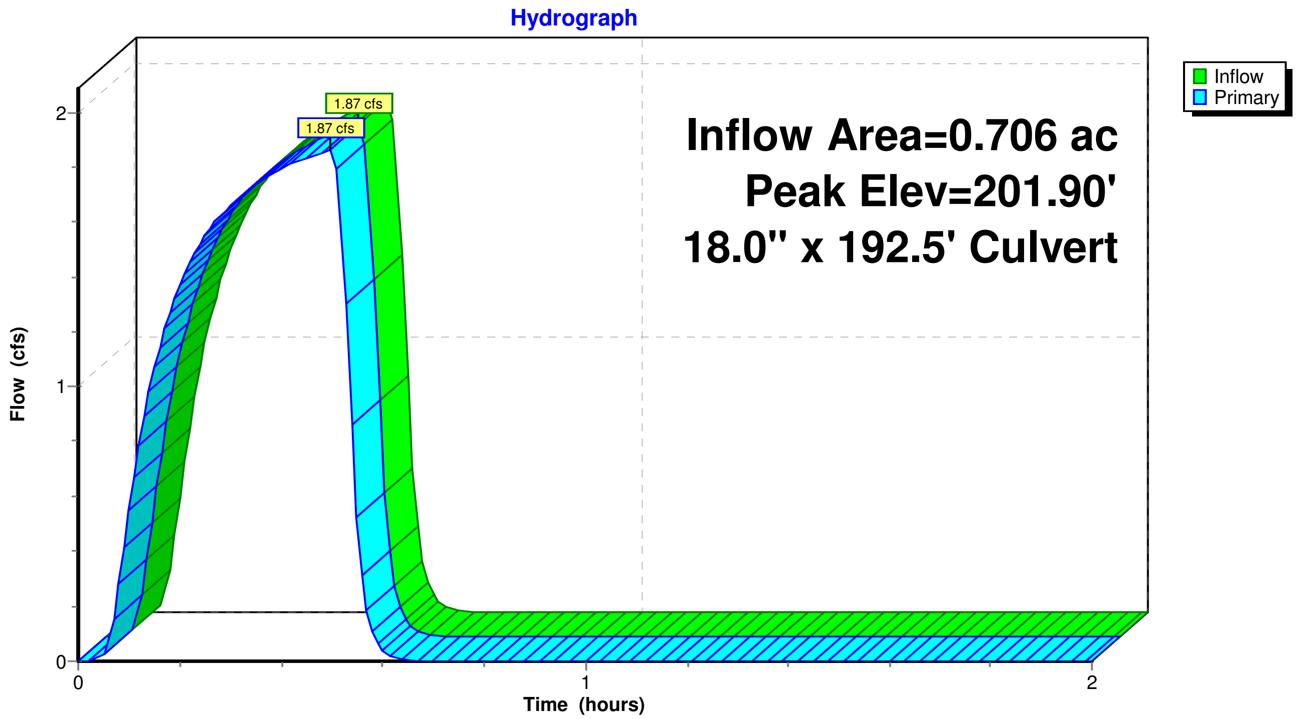
Inflow Area =	0.706 ac, Inflow Depth = 0.99"	for 25-yr, 30-min event
Inflow =	1.87 cfs @ 0.50 hrs, Volume=	0.058 af
Outflow =	1.87 cfs @ 0.50 hrs, Volume=	0.058 af, Atten= 0%, Lag= 0.0 min
Primary =	1.87 cfs @ 0.50 hrs, Volume=	0.058 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Peak Elev= 201.90' @ 0.50 hrs
Flood Elev= 206.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	201.28'	**18.0" x 192.5' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 190.43' S= 0.0564 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=1.86 cfs @ 0.50 hrs HW=201.90' TW=191.53' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.86 cfs @ 2.69 fps)

Pond 4:



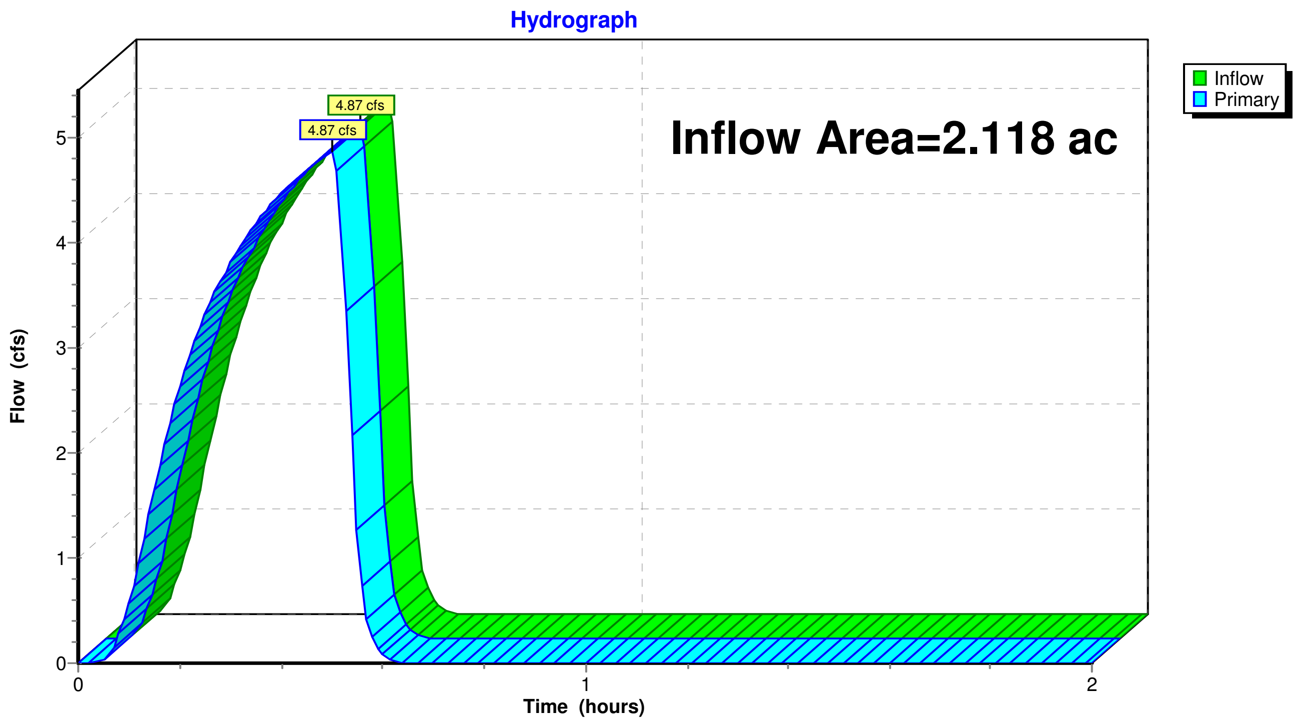
Pond MH: M1.12

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

Inflow Area =	2.118 ac,	Inflow Depth = 0.74"	for 25-yr, 30-min event		
Inflow =	4.87 cfs @	0.50 hrs,	Volume=	0.131 af	
Primary =	4.87 cfs @	0.50 hrs,	Volume=	0.131 af,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs

Pond MH: M1.12



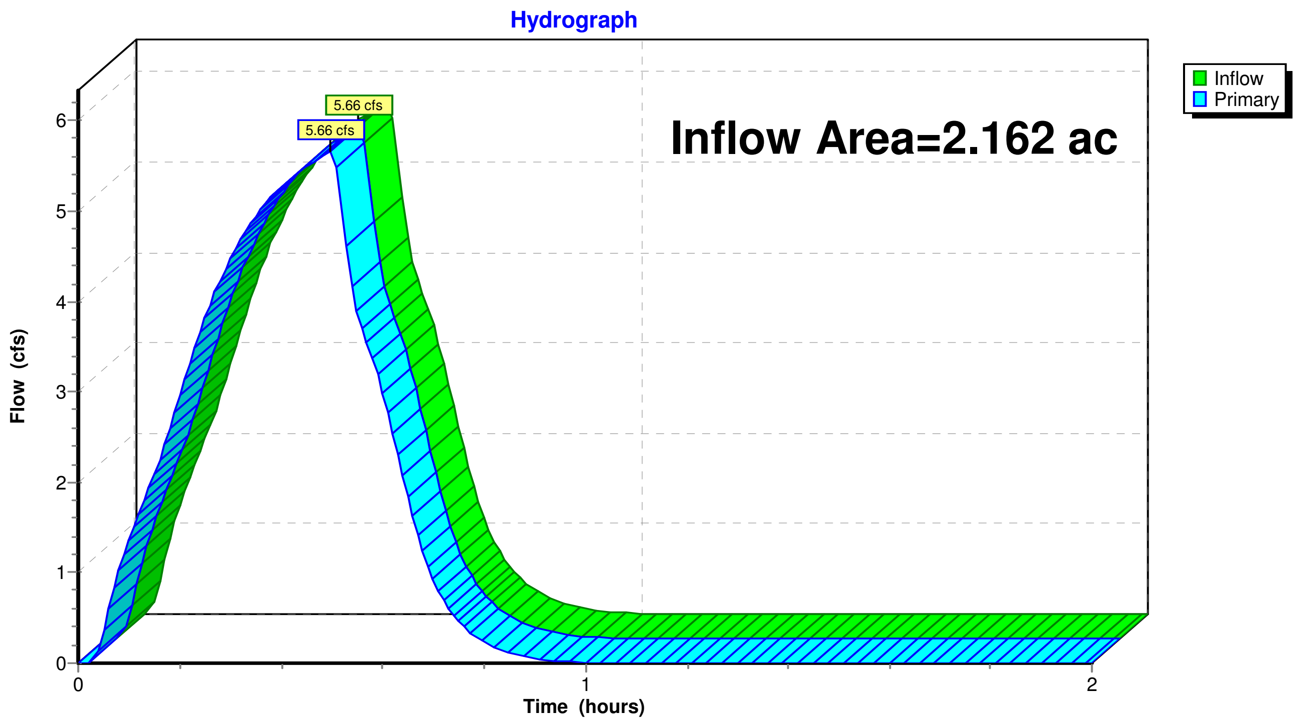
Pond SMH: MY111.02

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

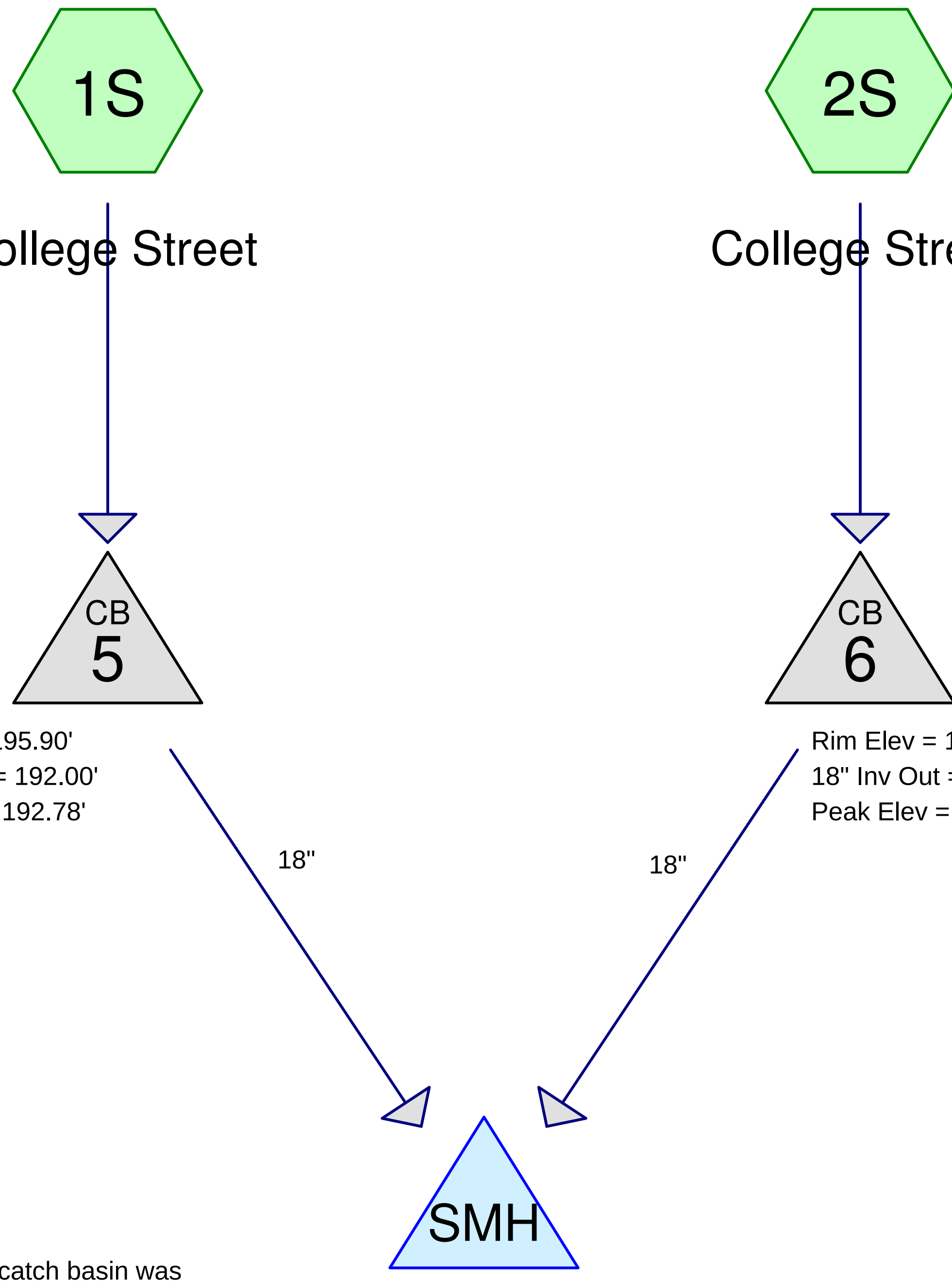
Inflow Area = 2.162 ac, Inflow Depth = 1.08" for 25-yr, 30-min event
Inflow = 5.66 cfs @ 0.50 hrs, Volume= 0.194 af
Primary = 5.66 cfs @ 0.50 hrs, Volume= 0.194 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs

Pond SMH: MY111.02

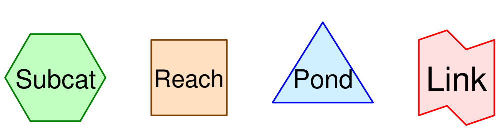


South Winooski at Fire House



MX110.05

Note: Each catch basin was conservatively modeled as if it receives flow from the entire subcatchment. It is because of this duplication that the actual flow into the ravine sewer should be half of what is shown in this model.



Drainage Diagram for South Winooski at Fire Station - 2 Basins Straight to Ravine
Prepared by Aldrich + Elliott, PC 4/22/2014
HydroCAD® 8.00 s/n 004053 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
0.512	89	<50% Grass cover, Poor, HSG D (1S,2S)
1.554	98	Paved roads w/curbs & sewers (1S,2S)
2.066		

Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: College Street Runoff Area=45,000 sf Runoff Depth=1.02"
Flow Length=377' Tc=2.1 min CN=96 Runoff=2.77 cfs 0.088 af

Subcatchment 2S: College Street Runoff Area=45,000 sf Runoff Depth=1.02"
Flow Length=377' Tc=2.1 min CN=96 Runoff=2.77 cfs 0.088 af

Pond 5: Peak Elev=192.78' Inflow=2.77 cfs 0.088 af
18.0" x 18.9' Culvert Outflow=2.77 cfs 0.088 af

Pond 6: Peak Elev=194.18' Inflow=2.77 cfs 0.088 af
18.0" x 20.4' Culvert Outflow=2.77 cfs 0.088 af

Pond SMH: MX110.05 Inflow=5.54 cfs 0.175 af
Primary=5.54 cfs 0.175 af

Total Runoff Area = 2.066 ac Runoff Volume = 0.175 af Average Runoff Depth = 1.02"
24.78% Pervious Area = 0.512 ac 75.22% Impervious Area = 1.554 ac

Subcatchment 1S: College Street

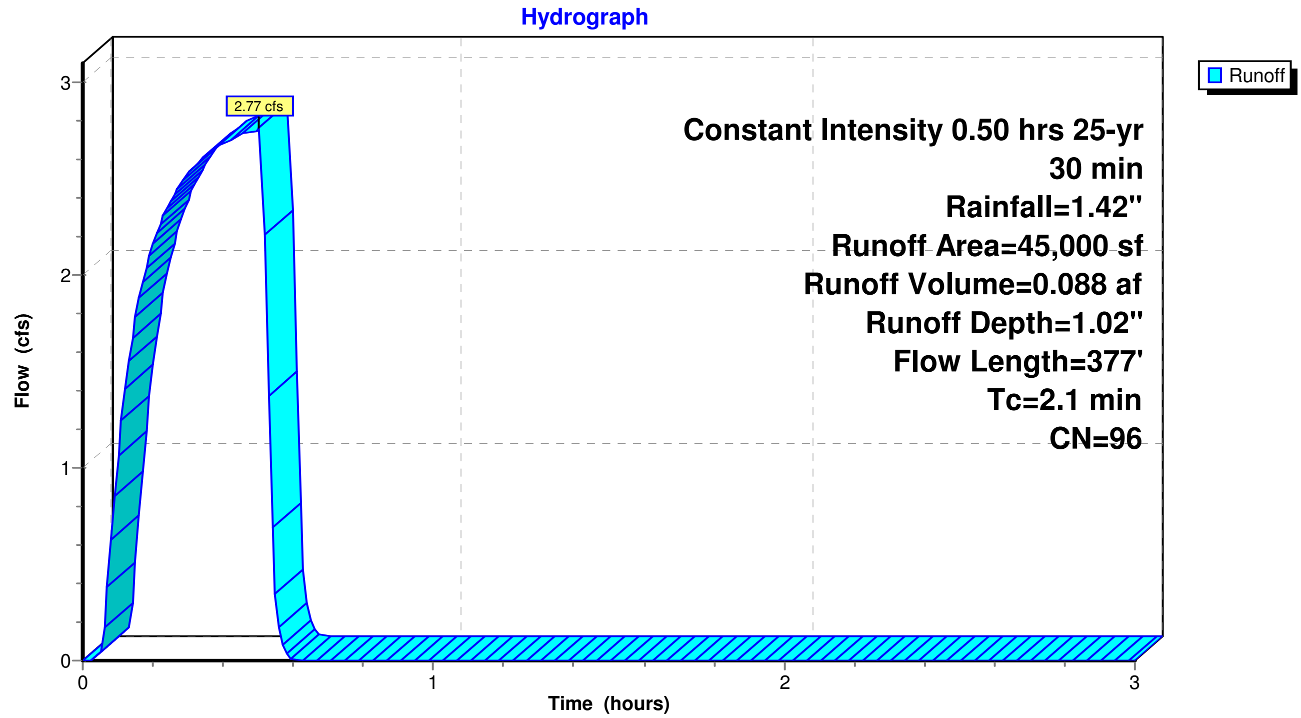
Runoff = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30 min Rainfall=1.42"

Area (sf)	CN	Description
11,150	89	<50% Grass cover, Poor, HSG D
33,850	98	Paved roads w/curbs & sewers
45,000	96	Weighted Average
11,150		Pervious Area
33,850		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	277	0.0300	3.52		**Shallow Concentrated Flow, Flows west down College Street in pa** Paved Kv= 20.3 fps
0.8	100	0.0100	2.03		**Shallow Concentrated Flow, Flow south down North Winooski on** Paved Kv= 20.3 fps
2.1	377	Total			

Subcatchment 1S: College Street



Subcatchment 2S: College Street

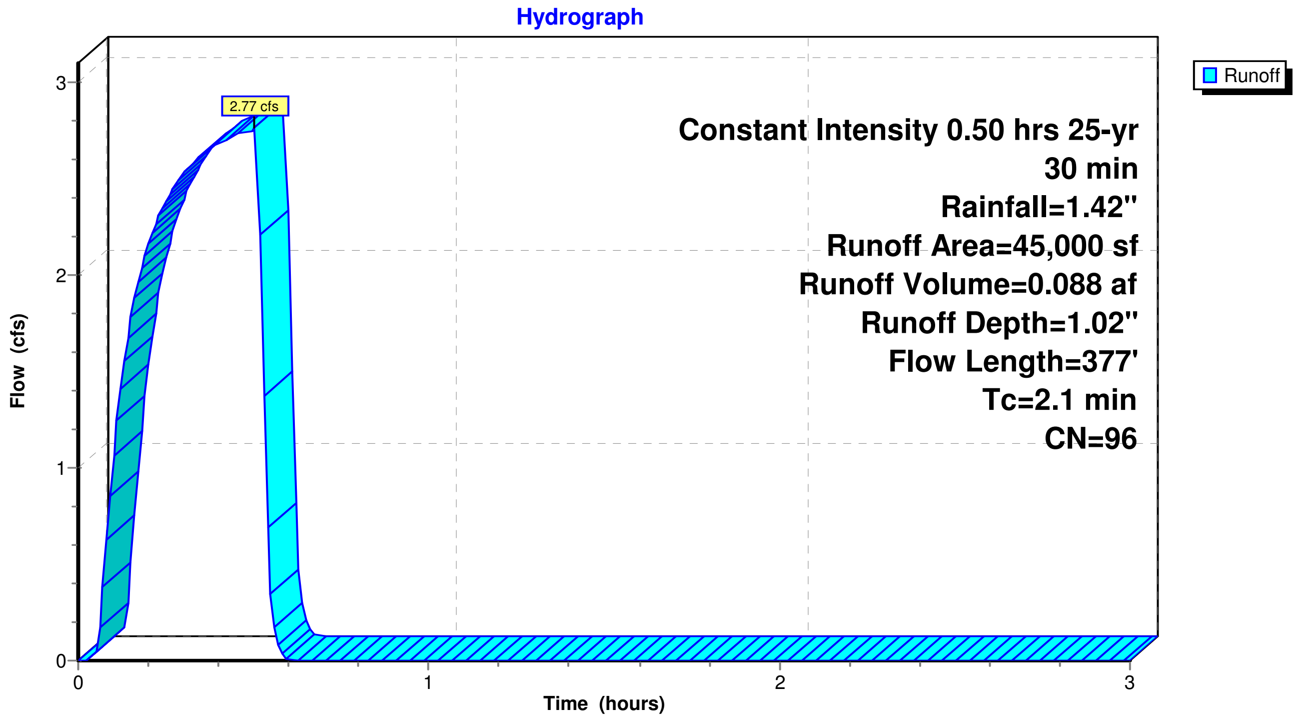
Runoff = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30 min Rainfall=1.42"

Area (sf)	CN	Description
11,150	89	<50% Grass cover, Poor, HSG D
33,850	98	Paved roads w/curbs & sewers
45,000	96	Weighted Average
11,150		Pervious Area
33,850		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	277	0.0300	3.52		**Shallow Concentrated Flow, Flows west down College Street in pa** Paved Kv= 20.3 fps
0.8	100	0.0100	2.03		**Shallow Concentrated Flow, Flow south down North Winooski on** Paved Kv= 20.3 fps
2.1	377	Total			

Subcatchment 2S: College Street



Pond 5:

4' Diameter Catch Basin

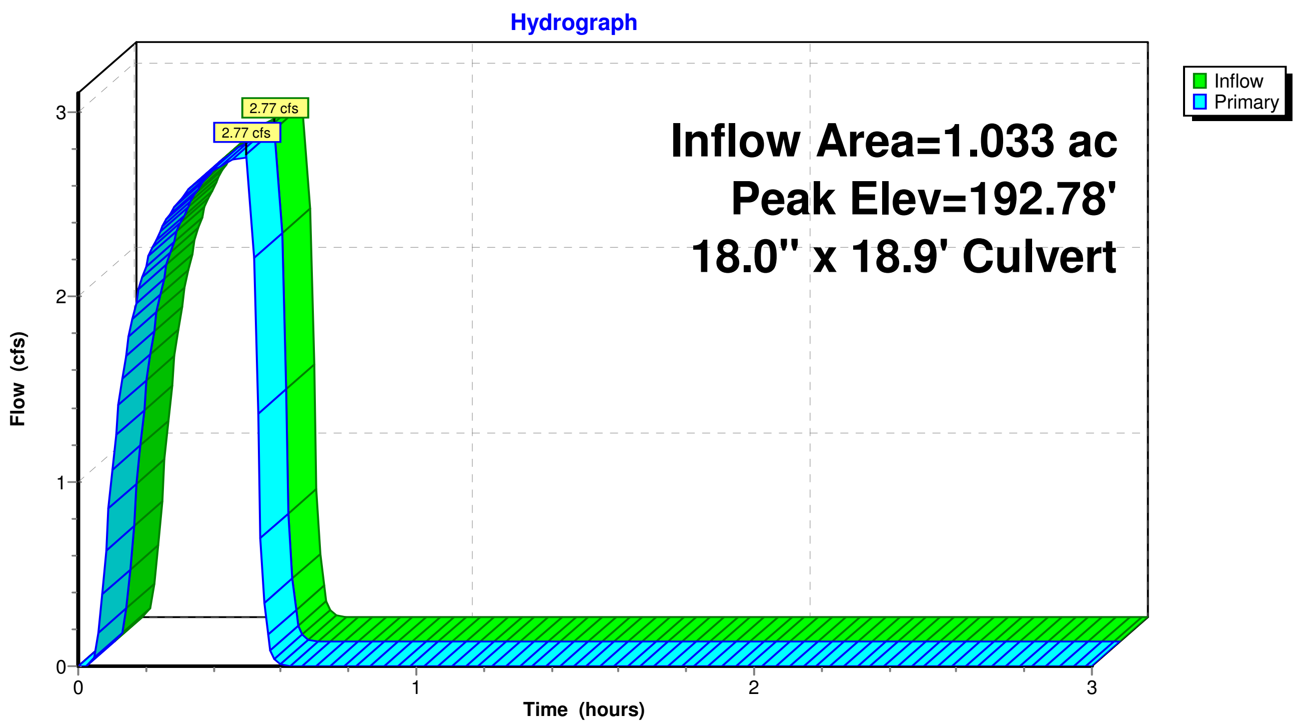
Inflow Area = 1.033 ac, Inflow Depth = 1.02" for 25-yr, 30 min event
Inflow = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af
Outflow = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af, Atten= 0%, Lag= 0.0 min
Primary = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 192.78' @ 0.50 hrs
Flood Elev= 195.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	192.00'	**18.0" x 18.9' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 190.91' S= 0.0577 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=2.77 cfs @ 0.50 hrs HW=192.78' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.77 cfs @ 3.00 fps)

Pond 5:



Pond 6:

4' Diameter Catch Basin

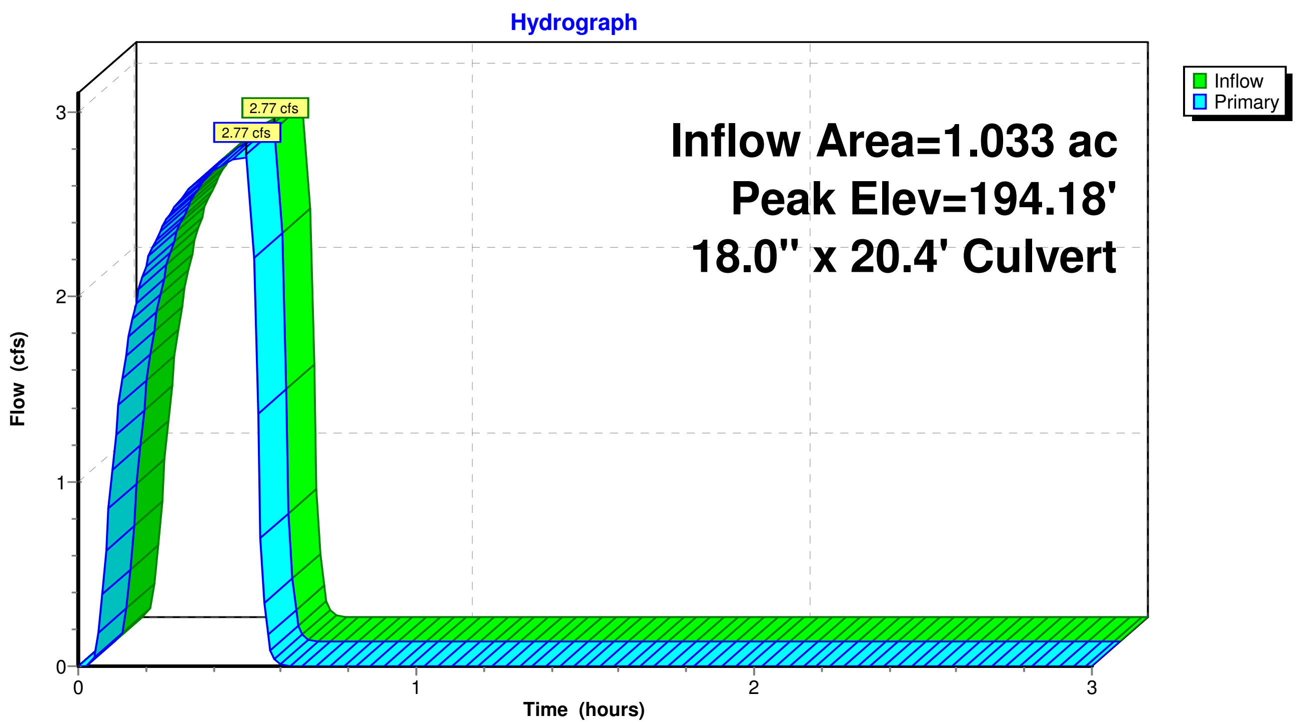
Inflow Area = 1.033 ac, Inflow Depth = 1.02" for 25-yr, 30 min event
Inflow = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af
Outflow = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af, Atten= 0%, Lag= 0.0 min
Primary = 2.77 cfs @ 0.50 hrs, Volume= 0.088 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 194.18' @ 0.50 hrs
Flood Elev= 196.92'

Device	Routing	Invert	Outlet Devices
#1	Primary	193.40'	**18.0" x 20.4' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 190.91' S= 0.1221 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=2.77 cfs @ 0.50 hrs HW=194.18' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.77 cfs @ 3.00 fps)

Pond 6:

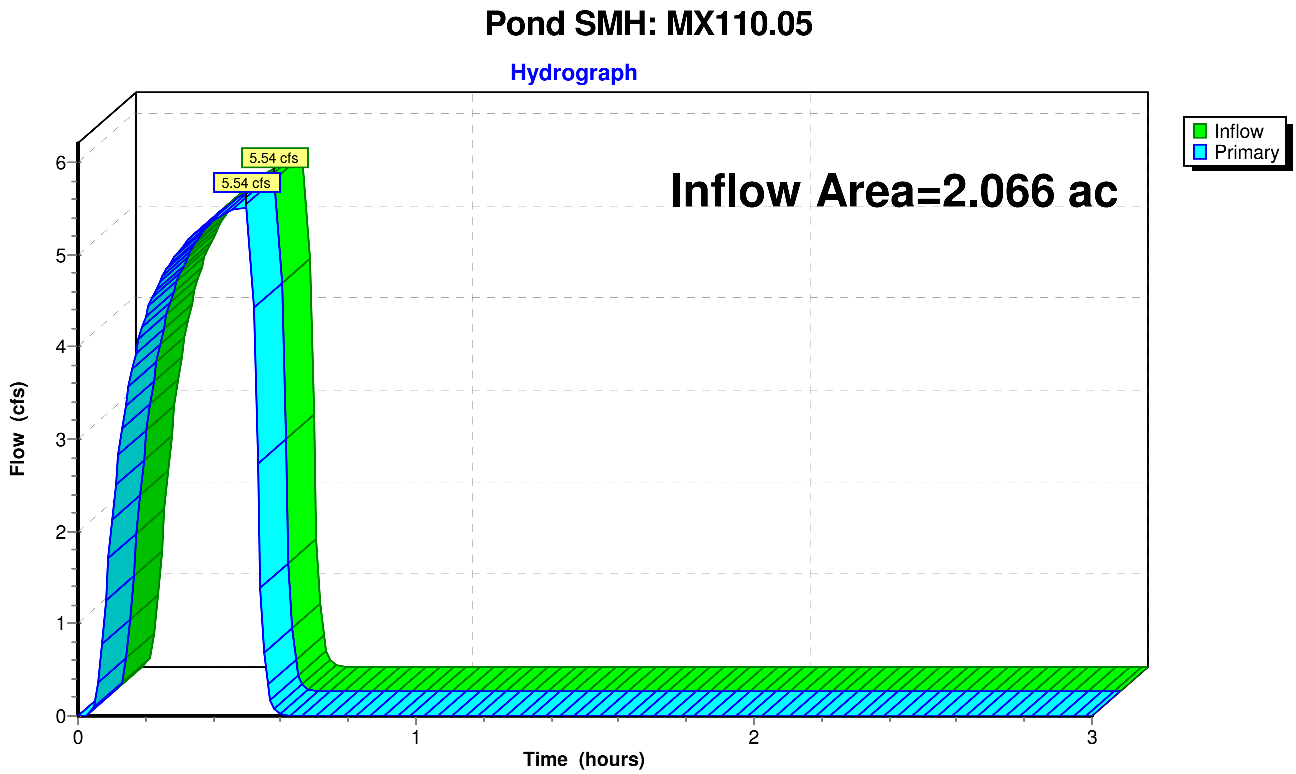


Pond SMH: MX110.05

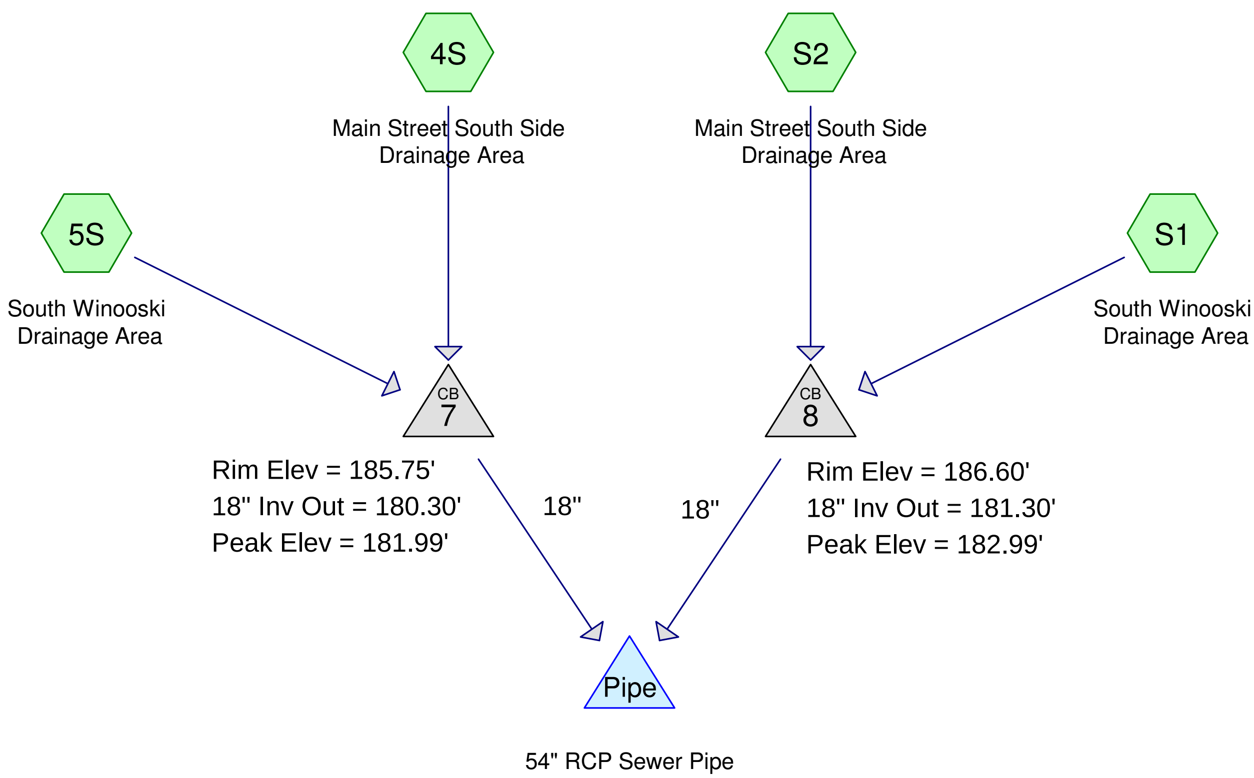
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	2.066 ac,	Inflow Depth = 1.02"		for 25-yr, 30 min event
Inflow =	5.54 cfs @	0.50 hrs,	Volume=	0.175 af
Primary =	5.54 cfs @	0.50 hrs,	Volume=	0.175 af, Atten= 0%, Lag= 0.0 min

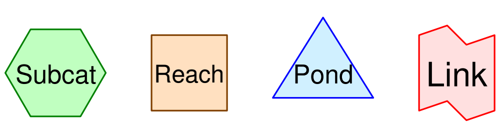
Routing by Dyn-Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs



South Winooski at Courthouse



Note: Each catch basin was conservatively modeled as if it receives flow from the entire subcatchment. It is because of this duplication that the actual flow into the ravine sewer should be half of what is shown in this model.



Drainage Diagram for So Winooski at Courthouse - 2 Basins Straight to Ravine
Prepared by Aldrich + Elliott, PC 4/22/2014
HydroCAD® 8.00 s/n 004053 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
0.183	68	<50% Grass cover, Poor, HSG A (4S,S2)
4.142	98	Paved parking & roofs (4S,S2)
1.632	98	Paved roads w/curbs & sewers (5S,S1)
5.957		

Time span=0.00-1.00 hrs, dt=0.01 hrs, 101 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 4S: Main Street South Side Drainage Area Runoff Area=94,197 sf Runoff Depth=1.11"
Flow Length=450' Tc=2.2 min CN=97 Runoff=5.95 cfs 0.199 af

Subcatchment 5S: South Winooski Drainage Area Runoff Area=35,552 sf Runoff Depth=1.20"
Flow Length=343' Slope=0.0350 '/' Tc=2.2 min CN=98 Runoff=2.29 cfs 0.082 af

Subcatchment S1: South Winooski Drainage Area Runoff Area=35,552 sf Runoff Depth=1.20"
Flow Length=343' Slope=0.0350 '/' Tc=2.2 min CN=98 Runoff=2.29 cfs 0.082 af

Subcatchment S2: Main Street South Side Drainage Area Runoff Area=94,197 sf Runoff Depth=1.11"
Flow Length=450' Tc=2.2 min CN=97 Runoff=5.95 cfs 0.199 af

Pond 7: Peak Elev=181.99' Inflow=8.24 cfs 0.281 af
18.0" x 15.8' Culvert Outflow=8.24 cfs 0.281 af

Pond 8: Peak Elev=182.99' Inflow=8.24 cfs 0.281 af
18.0" x 19.5' Culvert Outflow=8.24 cfs 0.281 af

Pond Pipe: 54" RCP Sewer Pipe Inflow=16.49 cfs 0.562 af
Primary=16.49 cfs 0.562 af

Total Runoff Area = 5.957 ac Runoff Volume = 0.562 af Average Runoff Depth = 1.13"
3.08% Pervious Area = 0.183 ac 96.92% Impervious Area = 5.774 ac

Subcatchment 4S: Main Street South Side Drainage Area

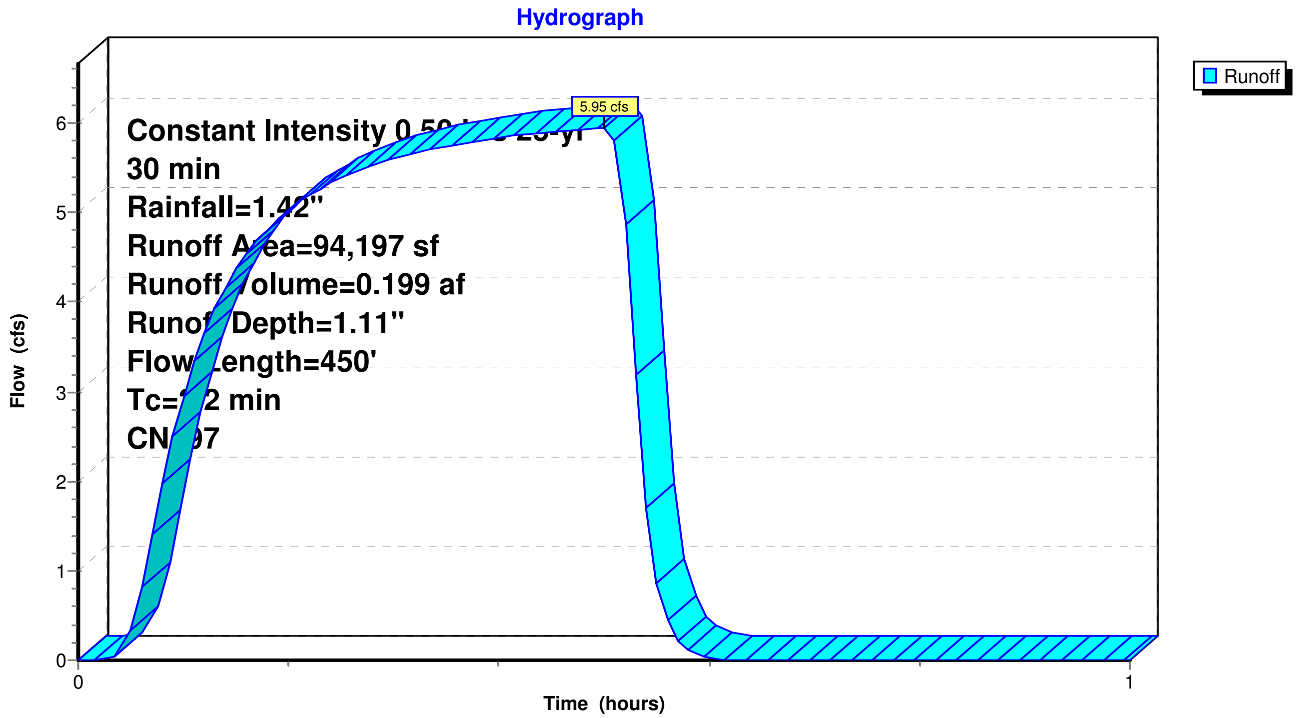
Runoff = 5.95 cfs @ 0.50 hrs, Volume= 0.199 af, Depth= 1.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30 min Rainfall=1.42"

Area (sf)	CN	Description
3,995	68	<50% Grass cover, Poor, HSG A
90,202	98	Paved parking & roofs
94,197	97	Weighted Average
3,995		Pervious Area
90,202		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0500	1.68		**Sheet Flow, Flow over sidewalk and pavement** Smooth surfaces n= 0.011 P2= 2.30"
0.8	220	0.0500	4.54		**Shallow Concentrated Flow, Flow over pavement** Paved Kv= 20.3 fps
0.4	130	0.0600	4.97		**Shallow Concentrated Flow, Flow down Main Street** Paved Kv= 20.3 fps
2.2	450	Total			

Subcatchment 4S: Main Street South Side Drainage Area



Subcatchment 5S: South Winooski Drainage Area

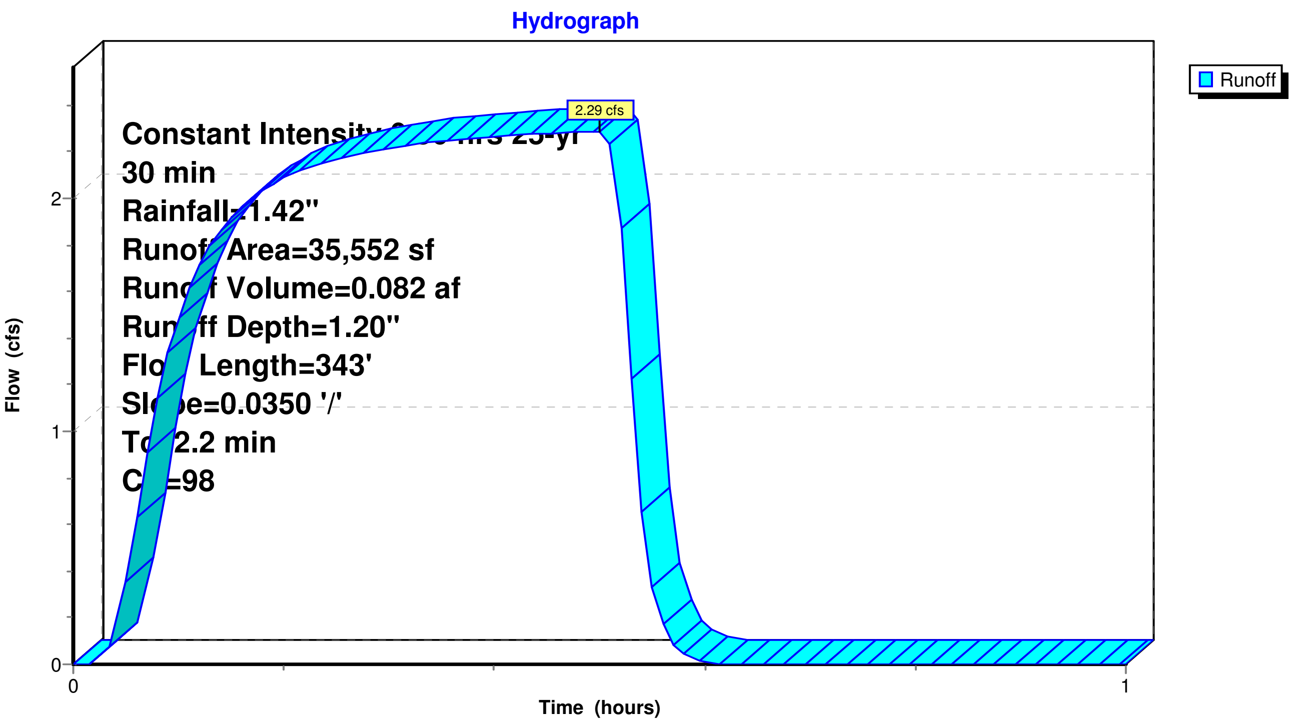
Runoff = 2.29 cfs @ 0.50 hrs, Volume= 0.082 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30 min Rainfall=1.42"

Area (sf)	CN	Description
35,552	98	Paved roads w/curbs & sewers
35,552		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	100	0.0350	1.46		**Sheet Flow, Flow over Gas Station P-lot** Smooth surfaces n= 0.011 P2= 2.30"
1.1	243	0.0350	3.80		**Shallow Concentrated Flow, Flowing down Main and South WInoo** Paved Kv= 20.3 fps
2.2	343	Total			

Subcatchment 5S: South Winooski Drainage Area



Subcatchment S1: South Winooski Drainage Area

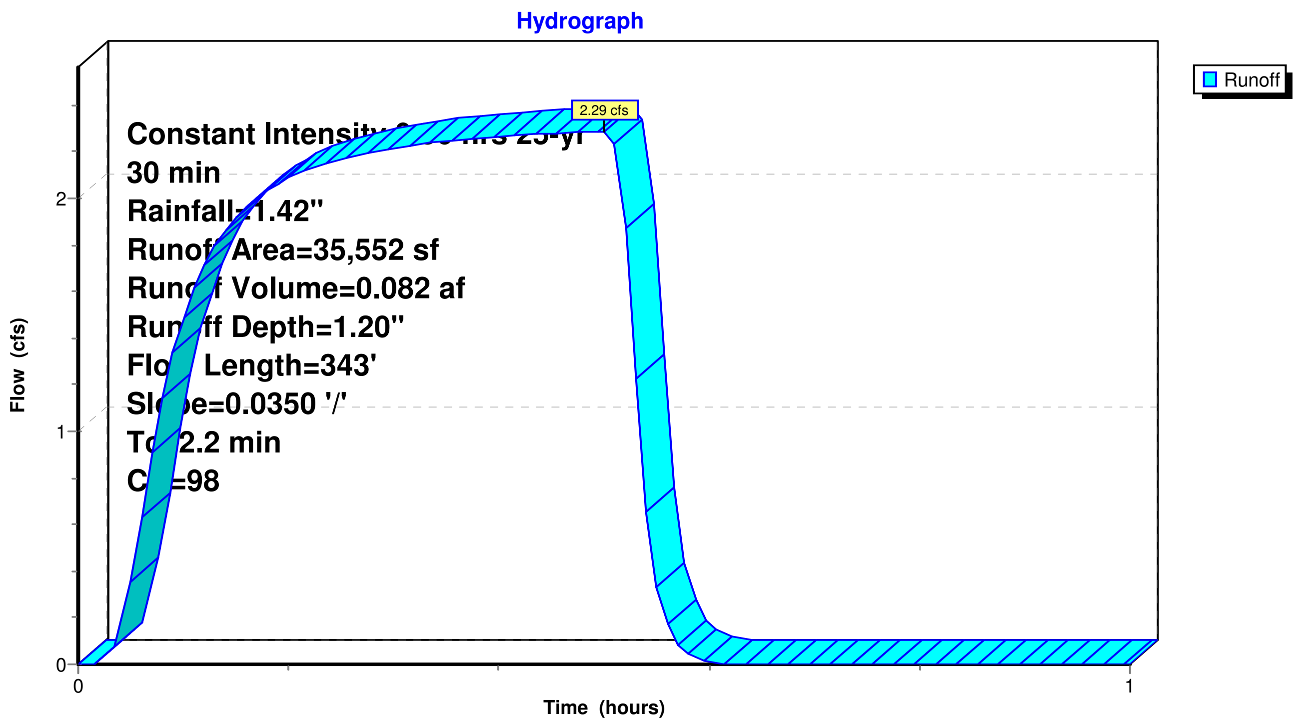
Runoff = 2.29 cfs @ 0.50 hrs, Volume= 0.082 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30 min Rainfall=1.42"

Area (sf)	CN	Description
35,552	98	Paved roads w/curbs & sewers
35,552		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	100	0.0350	1.46		**Sheet Flow, Flow over Gas Station P-lot** Smooth surfaces n= 0.011 P2= 2.30"
1.1	243	0.0350	3.80		**Shallow Concentrated Flow, Flowing down Main and South WInoo** Paved Kv= 20.3 fps
2.2	343	Total			

Subcatchment S1: South Winooski Drainage Area



Subcatchment S2: Main Street South Side Drainage Area

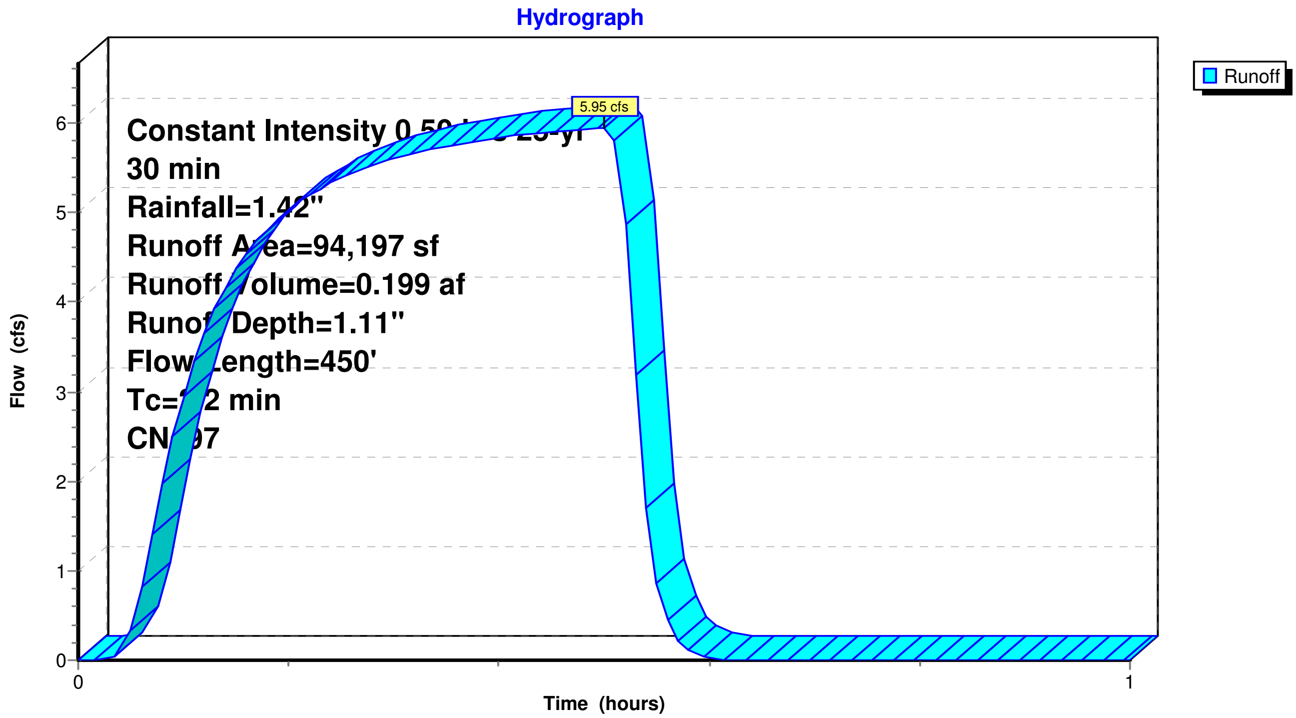
Runoff = 5.95 cfs @ 0.50 hrs, Volume= 0.199 af, Depth= 1.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30 min Rainfall=1.42"

Area (sf)	CN	Description
3,995	68	<50% Grass cover, Poor, HSG A
90,202	98	Paved parking & roofs
94,197	97	Weighted Average
3,995		Pervious Area
90,202		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0500	1.68		**Sheet Flow, Flow over sidewalk and pavement** Smooth surfaces n= 0.011 P2= 2.30"
0.8	220	0.0500	4.54		**Shallow Concentrated Flow, Flow over pavement** Paved Kv= 20.3 fps
0.4	130	0.0600	4.97		**Shallow Concentrated Flow, Flow down Main Street** Paved Kv= 20.3 fps
2.2	450	Total			

Subcatchment S2: Main Street South Side Drainage Area



Pond 7:

4' Diameter Catch Basin.

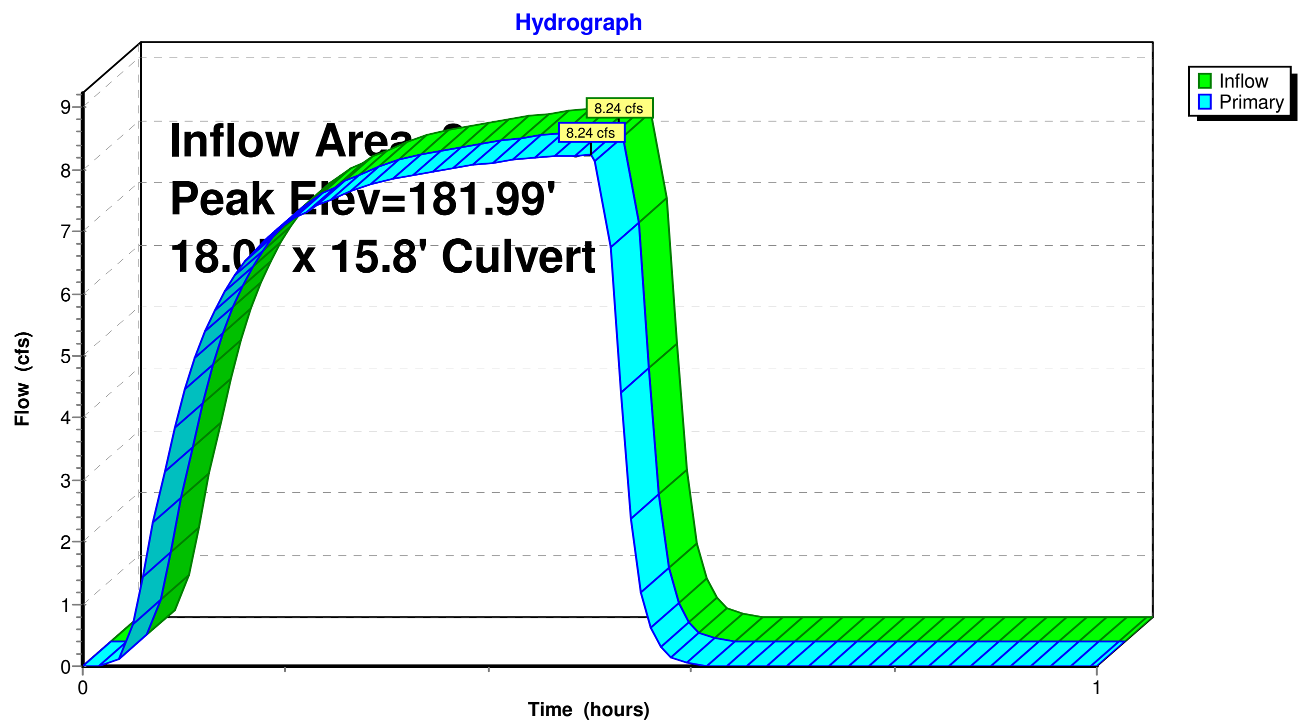
Inflow Area =	2.979 ac,	Inflow Depth = 1.13"	for 25-yr, 30 min event	
Inflow =	8.24 cfs @	0.50 hrs, Volume=	0.281 af	
Outflow =	8.24 cfs @	0.50 hrs, Volume=	0.281 af,	Atten= 0%, Lag= 0.0 min
Primary =	8.24 cfs @	0.50 hrs, Volume=	0.281 af	

Routing by Dyn-Stor-Ind method w/Net Flows, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Peak Elev= 181.99' @ 0.50 hrs
Flood Elev= 185.75'

Device	Routing	Invert	Outlet Devices
#1	Primary	180.30'	**18.0" x 15.8' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 177.82' S= 0.1570 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=8.24 cfs @ 0.50 hrs HW=181.99' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 8.24 cfs @ 4.67 fps)

Pond 7:



Pond 8:

4' Diameter Catch Basin.

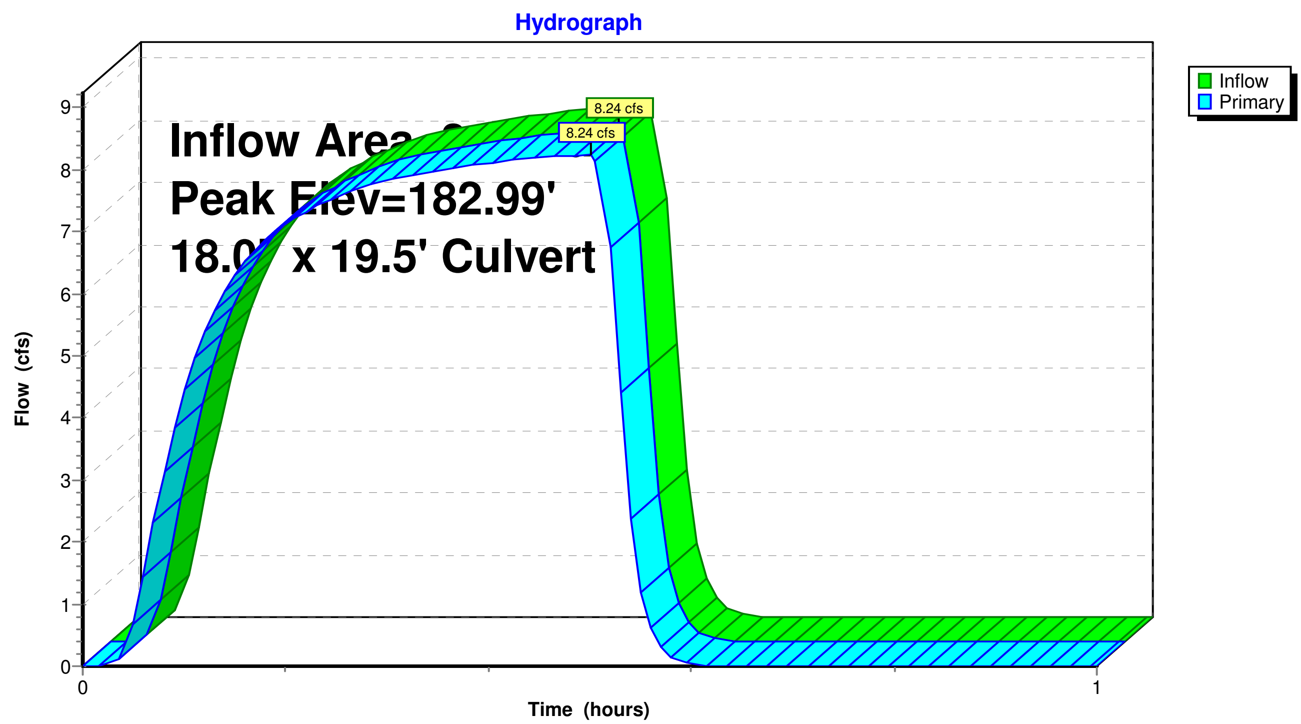
Inflow Area =	2.979 ac,	Inflow Depth = 1.13"	for 25-yr, 30 min event	
Inflow =	8.24 cfs @	0.50 hrs, Volume=	0.281 af	
Outflow =	8.24 cfs @	0.50 hrs, Volume=	0.281 af,	Atten= 0%, Lag= 0.0 min
Primary =	8.24 cfs @	0.50 hrs, Volume=	0.281 af	

Routing by Dyn-Stor-Ind method w/Net Flows, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Peak Elev= 182.99' @ 0.50 hrs
Flood Elev= 186.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	181.30'	**18.0" x 19.5' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 177.80' S= 0.1795 '/' Cc= 0.900 n= 0.010 PVC, smooth interior

Primary OutFlow Max=8.24 cfs @ 0.50 hrs HW=182.99' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 8.24 cfs @ 4.67 fps)

Pond 8:



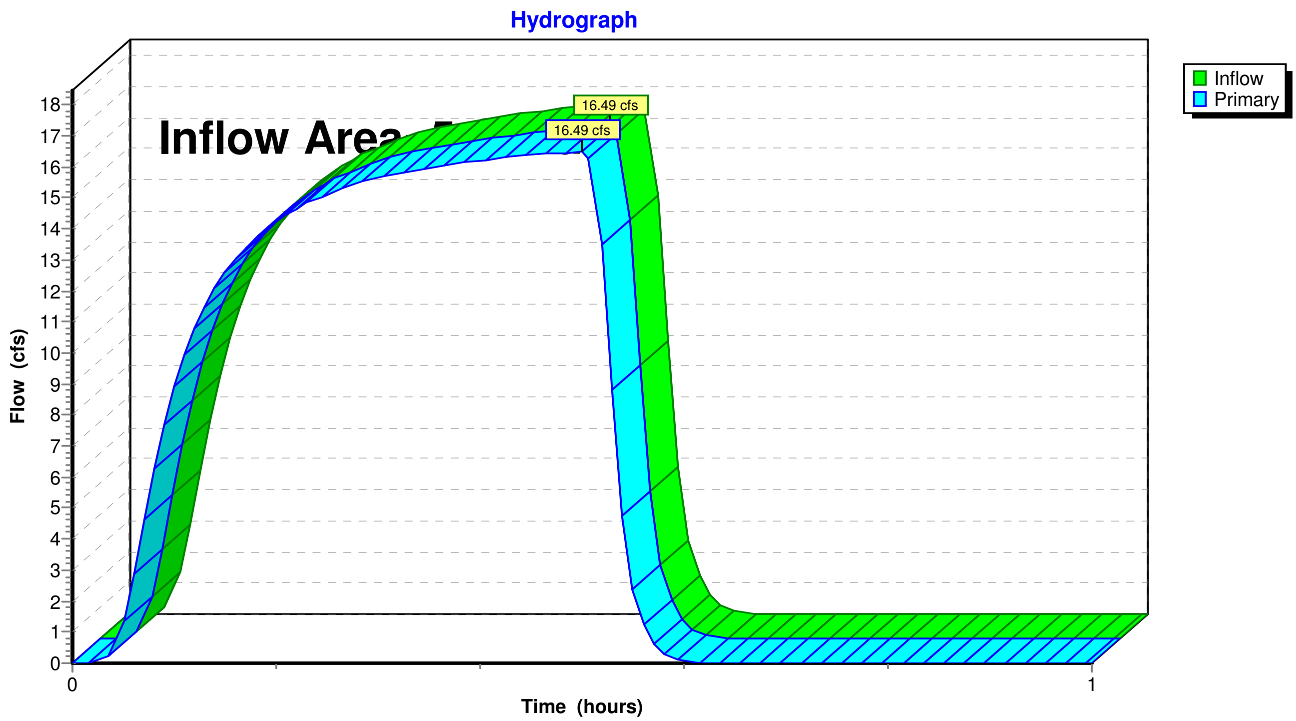
Pond Pipe: 54" RCP Sewer Pipe

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

Inflow Area =	5.957 ac,	Inflow Depth = 1.13"	for 25-yr, 30 min event		
Inflow =	16.49 cfs @	0.50 hrs,	Volume=	0.562 af	
Primary =	16.49 cfs @	0.50 hrs,	Volume=	0.562 af,	Atten= 0%, Lag= 0.0 min

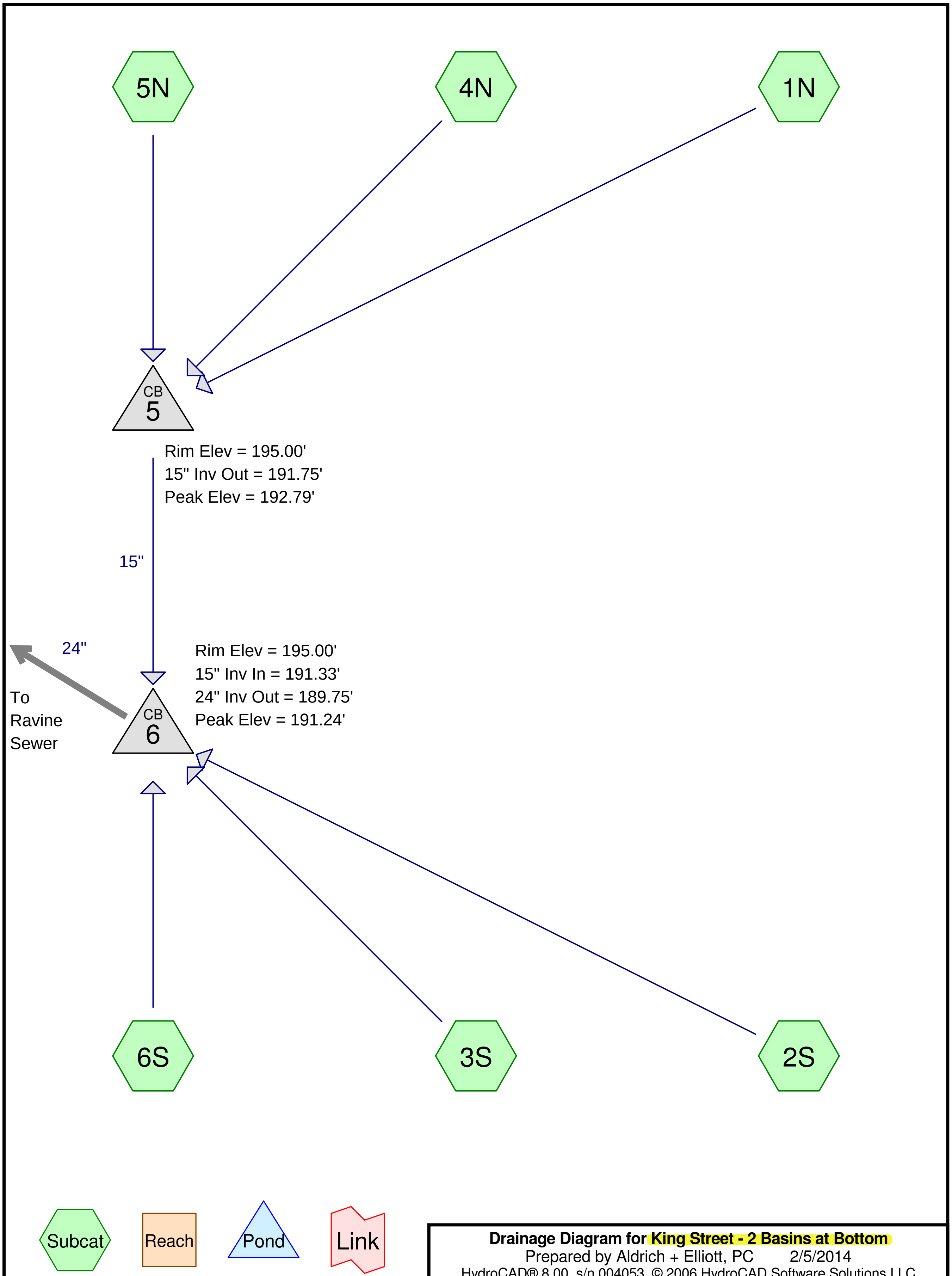
Routing by Dyn-Stor-Ind method w/Net Flows, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs

Pond Pipe: 54" RCP Sewer Pipe



King Street –

2 Basins at the Bottom



Drainage Diagram for King Street - 2 Basins at Bottom
Prepared by Aldrich + Elliott, PC 2/5/2014
HydroCAD® 8.00 s/n 004053 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
1.219	68	<50% Grass cover, Poor, HSG A (1N,2S,3S,4N,5N,6S)
3.704	98	Paved parking & roofs (1N,2S,3S,4N,5N,6S)
4.923		

Time span=0.00-1.00 hrs, dt=0.01 hrs, 101 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1N: Runoff Area=36,354 sf Runoff Depth=0.52"
Flow Length=924' Tc=4.8 min CN=88 Runoff=1.56 cfs 0.036 af

Subcatchment 2S: Runoff Area=41,534 sf Runoff Depth=0.44"
Flow Length=935' Tc=5.1 min CN=86 Runoff=1.60 cfs 0.035 af

Subcatchment 3S: Runoff Area=49,791 sf Runoff Depth=1.11"
Flow Length=984' Tc=5.5 min CN=97 Runoff=3.12 cfs 0.105 af

Subcatchment 4N: Runoff Area=18,119 sf Runoff Depth=0.57"
Flow Length=472' Tc=2.4 min CN=89 Runoff=0.85 cfs 0.020 af

Subcatchment 5N: Runoff Area=20,982 sf Runoff Depth=1.11"
Flow Length=335' Tc=1.4 min CN=97 Runoff=1.33 cfs 0.044 af

Subcatchment 6S: Runoff Area=47,664 sf Runoff Depth=0.52"
Flow Length=536' Tc=3.6 min CN=88 Runoff=2.09 cfs 0.048 af

Pond 5: Peak Elev=192.79' Inflow=3.73 cfs 0.101 af
15.0" x 28.0' Culvert Outflow=3.73 cfs 0.101 af

Pond 6: Peak Elev=191.24' Inflow=10.47 cfs 0.289 af
24.0" x 65.0' Culvert Outflow=10.47 cfs 0.289 af

Total Runoff Area = 4.923 ac Runoff Volume = 0.289 af Average Runoff Depth = 0.70"
24.77% Pervious Area = 1.219 ac 75.23% Impervious Area = 3.704 ac

Subcatchment 1N:

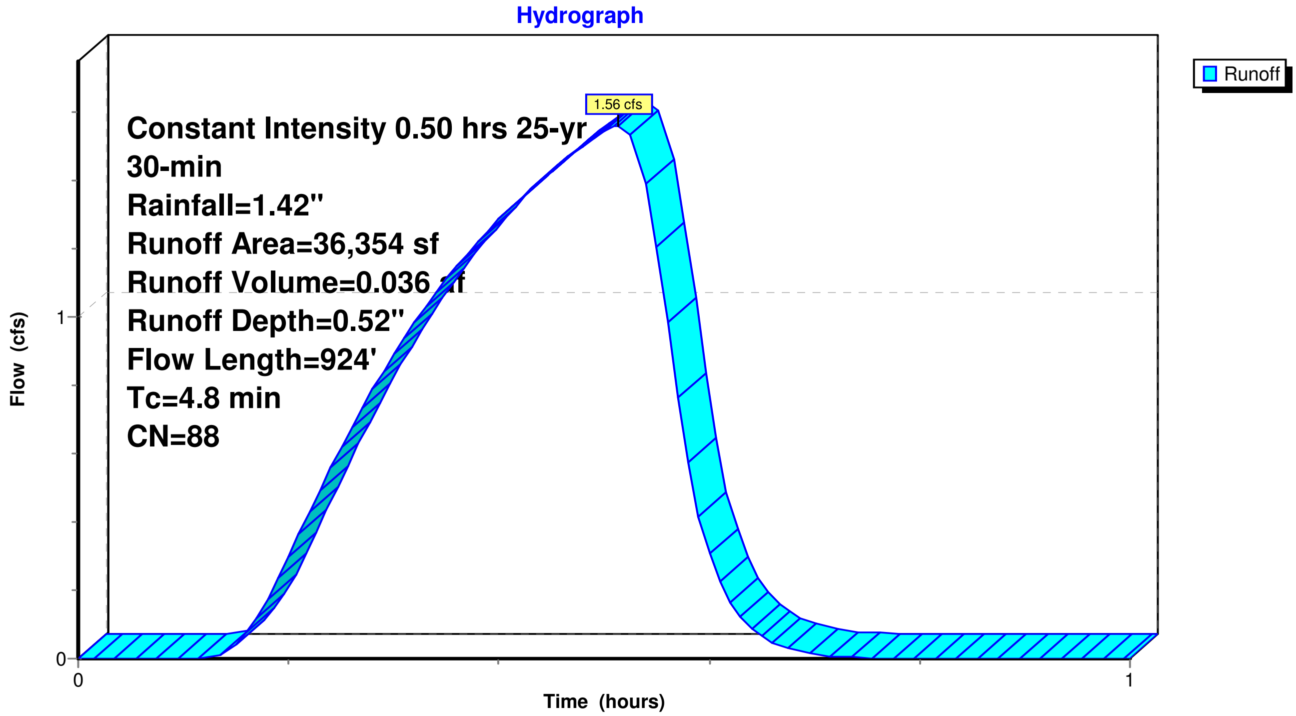
Runoff = 1.56 cfs @ 0.51 hrs, Volume= 0.036 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
11,547	68	<50% Grass cover, Poor, HSG A
24,807	98	Paved parking & roofs
36,354	88	Weighted Average
11,547		Pervious Area
24,807		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0170	1.09		**Sheet Flow, Flow over pavement in parking lot of Champlain Colle** Smooth surfaces n= 0.011 P2= 2.30"
1.4	216	0.1300	2.52		**Shallow Concentrated Flow, Flow over grass behind houses on So** Short Grass Pasture Kv= 7.0 fps
0.6	188	0.0630	5.10		**Shallow Concentrated Flow, Flow over pavement to CB 1** Paved Kv= 20.3 fps
1.3	420	0.0700	5.37		**Shallow Concentrated Flow, Flow over pavement** Paved Kv= 20.3 fps
4.8	924	Total			

Subcatchment 1N:



Subcatchment 2S:

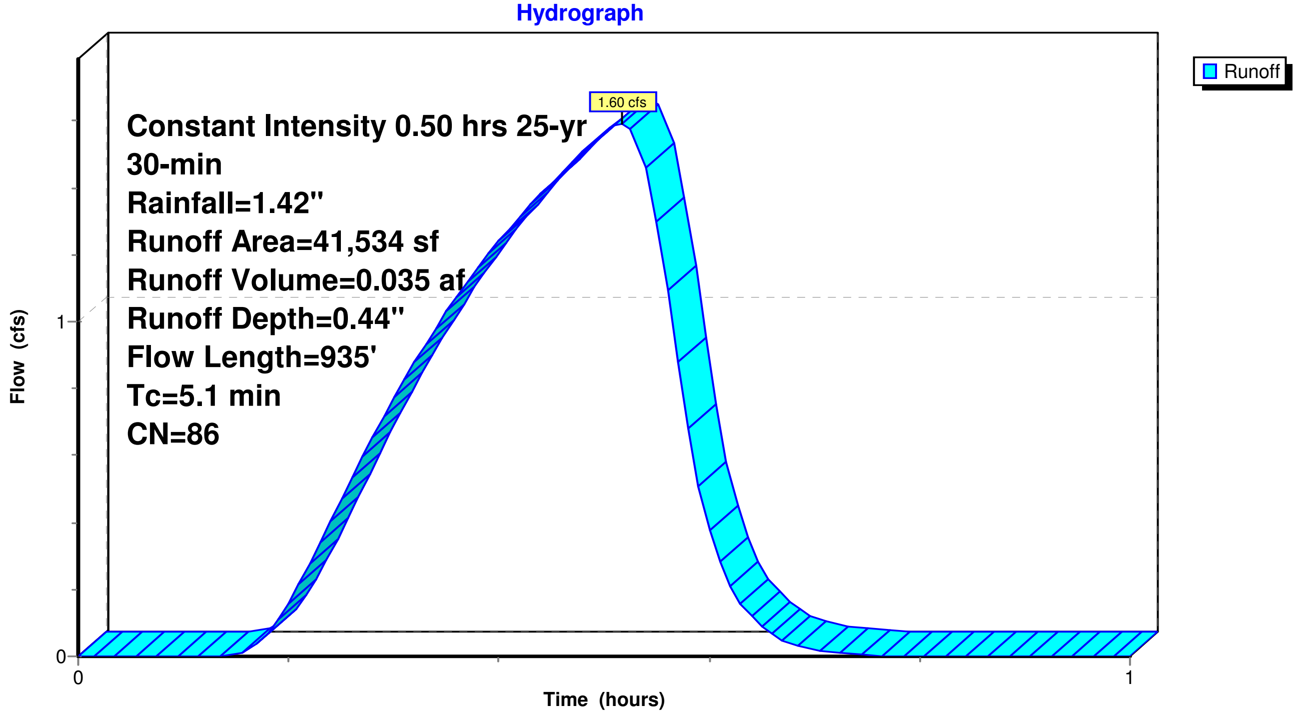
Runoff = 1.60 cfs @ 0.52 hrs, Volume= 0.035 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
17,145	68	<50% Grass cover, Poor, HSG A
24,389	98	Paved parking & roofs
41,534	86	Weighted Average
17,145		Pervious Area
24,389		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0170	1.09		**Sheet Flow, Sheet flow over parking lot at Champlain College** Smooth surfaces n= 0.011 P2= 2.30"
0.3	15	0.0170	0.91		**Shallow Concentrated Flow, Flow over grass behind houses on So** Short Grass Pasture Kv= 7.0 fps
1.3	200	0.1400	2.62		**Shallow Concentrated Flow, Flow over grass behind houses on So** Short Grass Pasture Kv= 7.0 fps
0.7	200	0.0600	4.97		**Shallow Concentrated Flow, Flow over pavement to CB 2** Paved Kv= 20.3 fps
1.3	420	0.0700	5.37		**Shallow Concentrated Flow, Flow over pavement** Paved Kv= 20.3 fps
5.1	935	Total			

Subcatchment 2S:



Subcatchment 3S:

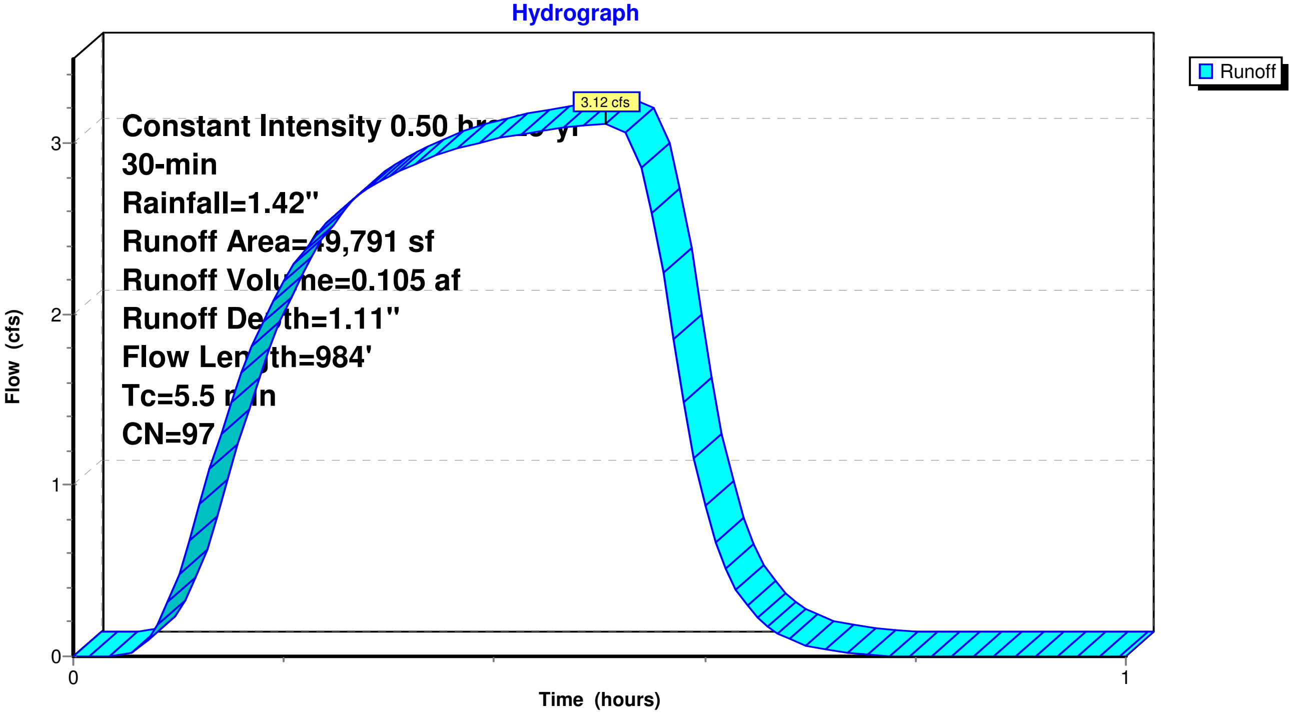
Runoff = 3.12 cfs @ 0.51 hrs, Volume= 0.105 af, Depth= 1.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
47,396	98	Paved parking & roofs
2,395	68	<50% Grass cover, Poor, HSG A
49,791	97	Weighted Average
2,395		Pervious Area
47,396		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0200	1.17		**Sheet Flow, Flow over pavement and down driveways on South Ur** Smooth surfaces n= 0.011 P2= 2.30"
1.7	252	0.1300	2.52		**Shallow Concentrated Flow, Flow over grass behind houses on Ki** Short Grass Pasture Kv= 7.0 fps
0.4	144	0.0830	5.85		**Shallow Concentrated Flow, Flow down driveway and on roadway** Paved Kv= 20.3 fps
0.8	98	0.0100	2.03		**Shallow Concentrated Flow, Flow down driveway and onto roadwa** Paved Kv= 20.3 fps
0.5	180	0.0900	6.09		**Shallow Concentrated Flow, Flow down King Street to CB 3** Paved Kv= 20.3 fps
0.7	210	0.0700	5.37		**Shallow Concentrated Flow, Flow over pavement** Paved Kv= 20.3 fps
5.5	984	Total			

Subcatchment 3S:



Subcatchment 4N:

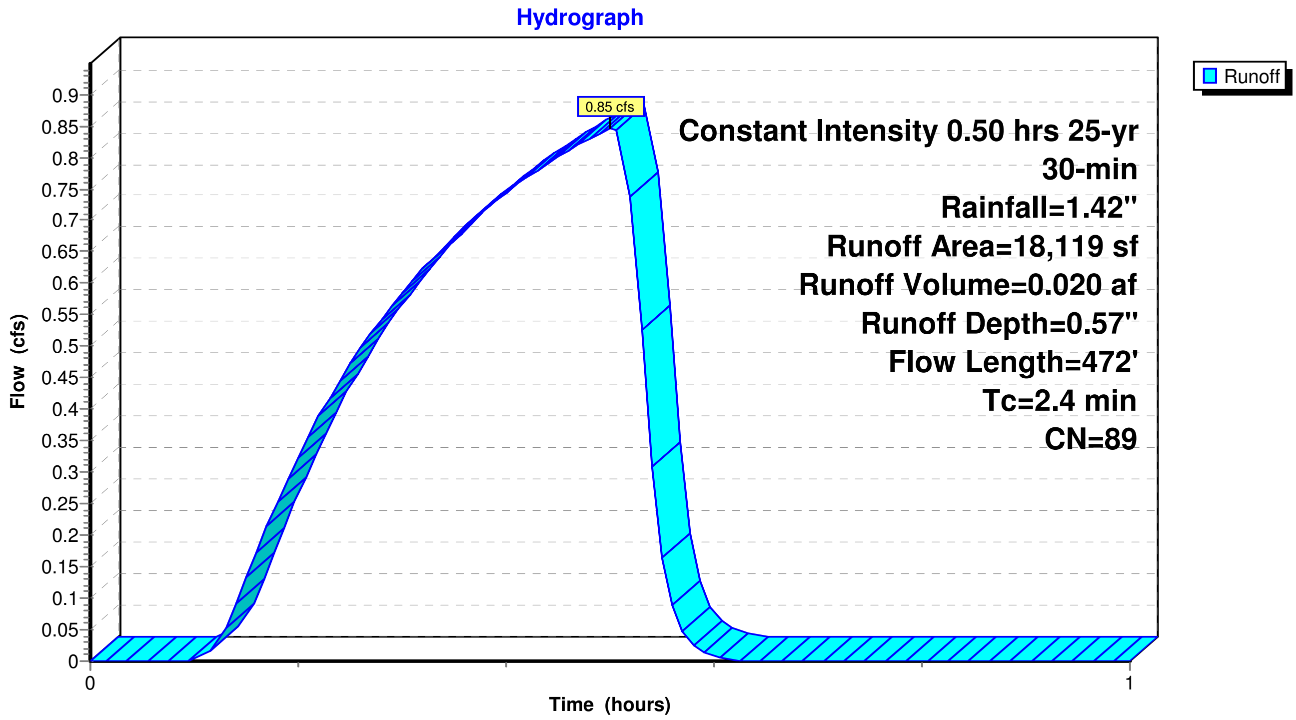
Runoff = 0.85 cfs @ 0.50 hrs, Volume= 0.020 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
5,454	68	<50% Grass cover, Poor, HSG A
12,665	98	Paved parking & roofs
18,119	89	Weighted Average
5,454		Pervious Area
12,665		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	155	0.0700	1.85		**Shallow Concentrated Flow, Flowing behind houses on King Stree** Short Grass Pasture Kv= 7.0 fps
0.3	107	0.0750	5.56		**Shallow Concentrated Flow, Flow over pavement to CB 4** Paved Kv= 20.3 fps
0.7	210	0.0700	5.37		**Shallow Concentrated Flow, Flow over pavement** Paved Kv= 20.3 fps
2.4	472	Total			

Subcatchment 4N:



Subcatchment 5N:

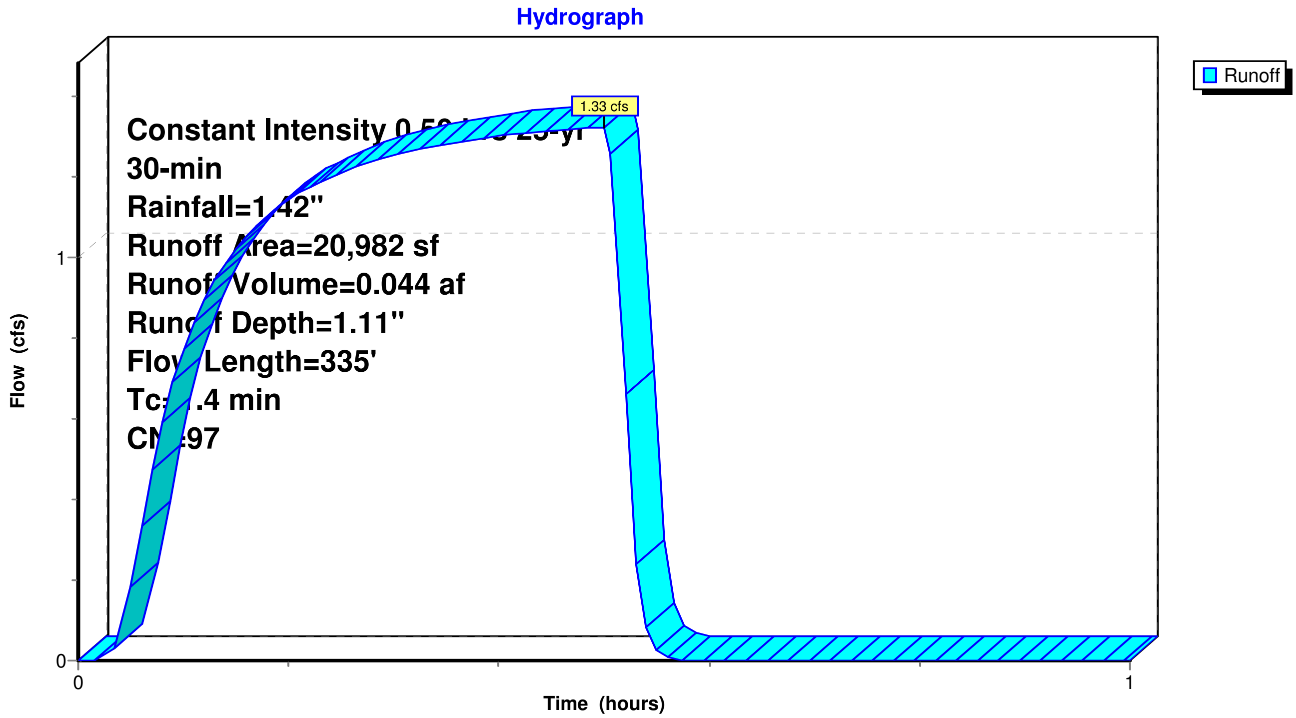
Runoff = 1.33 cfs @ 0.50 hrs, Volume= 0.044 af, Depth= 1.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
566	68	<50% Grass cover, Poor, HSG A
20,416	98	Paved parking & roofs
20,982	97	Weighted Average
566		Pervious Area
20,416		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	84	0.0950	2.16		**Shallow Concentrated Flow, Flow over grass behind houses on Ki** Short Grass Pasture Kv= 7.0 fps
0.8	251	0.0720	5.45		**Shallow Concentrated Flow, Flow down driveways and over roadw** Paved Kv= 20.3 fps
1.4	335	Total			

Subcatchment 5N:



Subcatchment 6S:

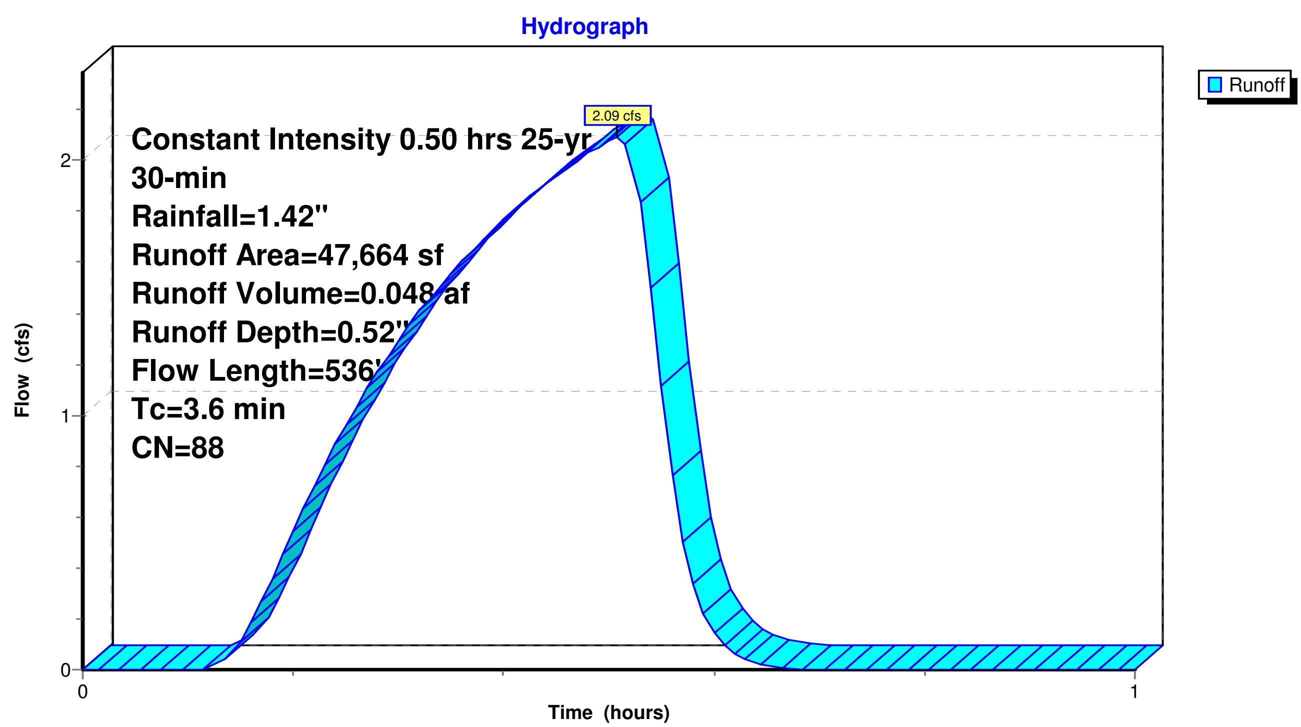
Runoff = 2.09 cfs @ 0.51 hrs, Volume= 0.048 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Constant Intensity 0.50 hrs 25-yr, 30-min Rainfall=1.42"

Area (sf)	CN	Description
16,009	68	<50% Grass cover, Poor, HSG A
31,655	98	Paved parking & roofs
47,664	88	Weighted Average
16,009		Pervious Area
31,655		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	284	0.0600	1.71		**Shallow Concentrated Flow, Flow over grass behind houses on Ki** Short Grass Pasture Kv= 7.0 fps
0.8	252	0.0700	5.37		**Shallow Concentrated Flow, Flow over pavement to CB 5** Paved Kv= 20.3 fps
3.6	536	Total			

Subcatchment 6S:



Pond 5:

3' Diameter Catch Basin.

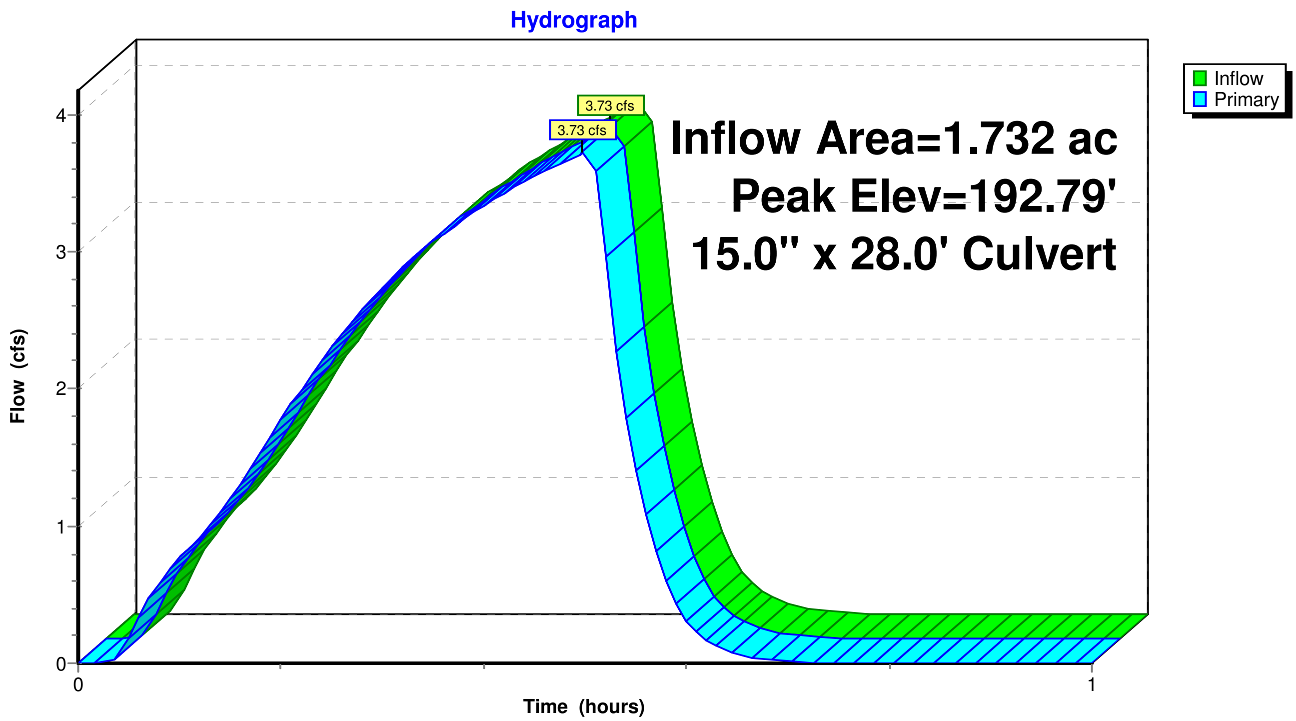
Inflow Area =	1.732 ac,	Inflow Depth = 0.70"	for 25-yr, 30-min event	
Inflow =	3.73 cfs @	0.50 hrs, Volume=	0.101 af	
Outflow =	3.73 cfs @	0.50 hrs, Volume=	0.101 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.73 cfs @	0.50 hrs, Volume=	0.101 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Peak Elev= 192.79' @ 0.50 hrs
Flood Elev= 195.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	191.75'	**15.0" x 28.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 191.33' S= 0.0150 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=3.71 cfs @ 0.50 hrs HW=192.79' TW=191.24' (Dynamic Tailwater)
1=Culvert (Barrel Controls 3.71 cfs @ 4.62 fps)

Pond 5:



Pond 6:

4' Diameter Catch Basin

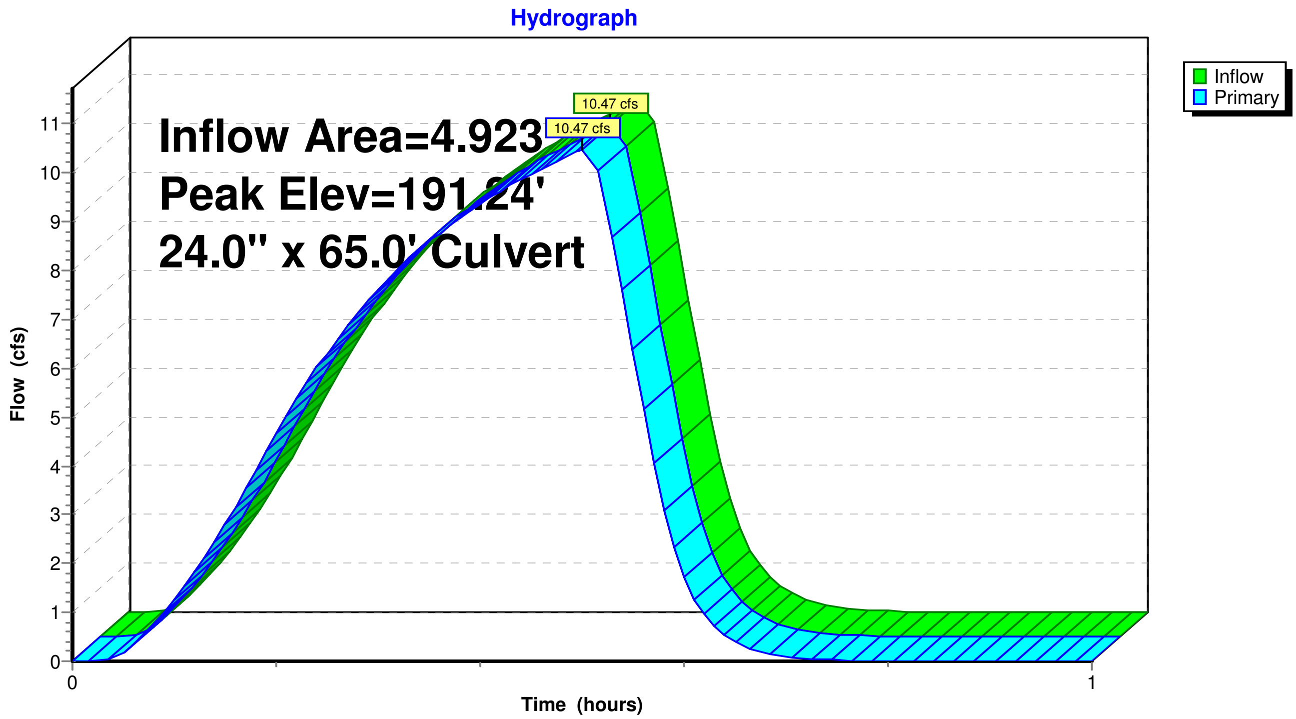
Inflow Area =	4.923 ac,	Inflow Depth = 0.70"	for 25-yr, 30-min event	
Inflow =	10.47 cfs @	0.50 hrs, Volume=	0.289 af	
Outflow =	10.47 cfs @	0.50 hrs, Volume=	0.289 af,	Atten= 0%, Lag= 0.0 min
Primary =	10.47 cfs @	0.50 hrs, Volume=	0.289 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-1.00 hrs, dt= 0.01 hrs
Peak Elev= 191.24' @ 0.50 hrs
Flood Elev= 195.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	189.75'	**24.0" x 65.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 188.78' S= 0.0149 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

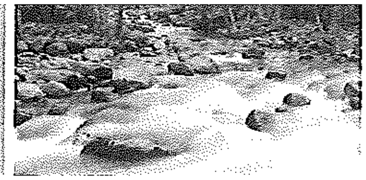
Primary OutFlow Max=10.47 cfs @ 0.50 hrs HW=191.24' (Free Discharge)
↑**1=Culvert** (Inlet Controls 10.47 cfs @ 4.16 fps)

Pond 6:



APPENDIX D

CUT SHEETS – CATCH BASIN GRATES & CURB INLETS



FLOW CAPACITIES OF INLET GRATES

Selecting and specifying the proper type of inlet grates for drainage is an important part of a stormwater management design plan. East Jordan Iron Works manufactures many different types and sizes of inlet drainage grates to meet your design needs. See a listing of EJIW drainage tables for round grates and catch basins in the back of this catalog.

The flow capacity of any inlet grate in a sump or ponded condition is a function of the depth of water over the grate and the open area of the grate. For this calculation, the orifice equation is used. The orifice equation can be used to determine the flow through a grate.

$Q = CA\sqrt{(2gd)}$ where Q = flow
C = orifice coefficient
A = open area of grate (ft^2)
g = acceleration due to gravity (32.2 ft/sec^2)
d = depth of water over grate (feet)

Using an orifice coefficient of 0.67 and correcting open area from square feet to square inches and depth of water from feet to inches, this equation simplifies to:

$Q = 0.0108\, A\sqrt{d}$ where Q = flow (CFS, cubic feet per second)
A = open area of grate (in^2)
d = depth of water over grate (inches)

Note: This equation is valid for inlet grates in a sump condition where water depths are 4 inches or greater. At water depths less than 4 inches an inlet grate acts as a weir to incoming flow and requires different analysis to determine flow capacity. The weir equation used is listed below and it is used to determine how much water flows to the grate:

$Q = 3.33\, L(H)^{3/2}$ where Q = flow (CFS)
L = perimeter of grate where flow is present (in feet)
H = depth of water above grate (in feet)

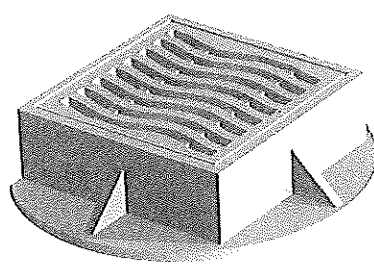
It is important to note that the orifice or weir calculations listed above do not compensate for any reduction in flow capacity due to clogging by debris. This adjustment may vary and is left up to the discretion of the specifying engineer. In traveled portions of roadways, inlets should be placed at low points and along slopes. The inlets placed along slopes are intended to reduce inlet bypass and to reduce or eliminate ponding which can be a hazard to traffic. Maximum allowable ponding varies between specifying bodies.

Example 1:
Calculate the flow capacity of an EJIW model 5105 TYPE M1 Inlet Grate with 6 inches of water over it. Since depth exceeds 4" the orifice equation is applicable.

Recall: $Q = 0.0108\, A\sqrt{d}$ $A = 175\ in^2$
$d = 6$ inches

$Q = 0.0108 \times 175 \times \sqrt{6}$

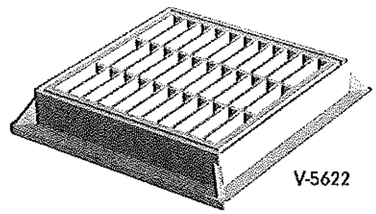
$Q = 4.6$ CFS



5105M1

Example 2A:
Select a suitable EJIW manhole catch basin unit with a grate to handle 6 CFS. Depth of water is 5 inches.

Recall: $Q = 0.0108\,A\sqrt{d}$ $\quad Q = 6$ CFS, $d = 5$ inches


V-5622

Solve for A:

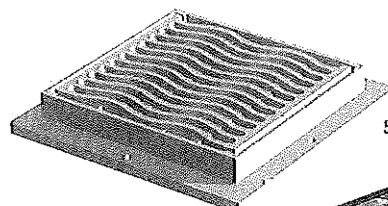
$$A = Q/(0.0108\sqrt{d})$$

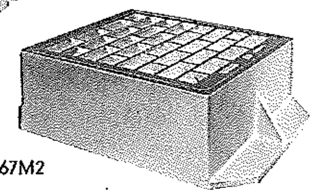
$$A = 6/(0.0108\sqrt{5})$$

$$A = 249\ \text{in}^2$$

Choose EJIW model V-5622 Grate with 266 sq. in. open area.

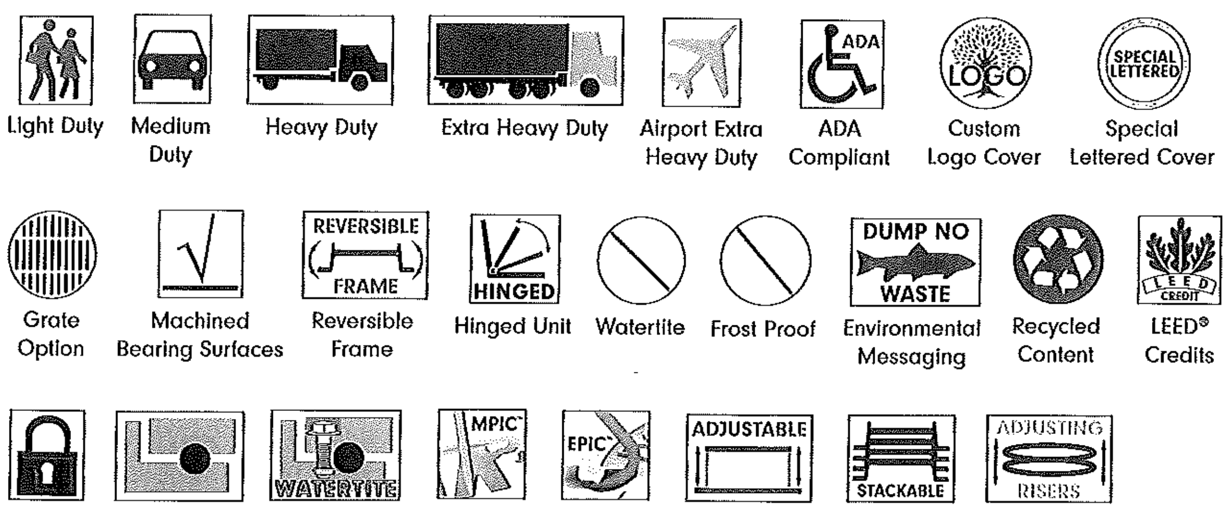
Sinusoidal and Vane grate flow characteristics
It is generally accepted that vane grates are more efficient than standard bar grates when capturing water that is moving across them. Sinusoidal and vane grates have greater efficiency due to better directional flow characteristics. Sinusoidal and vane grates typically allow less water to bypass the grate. Please note that if a vane grate is installed improperly (i.e. backwards) the grate will have poor flow characteristics, while sinusoidal grates accept water equally in either direction.


5416


7467M2

CATALOG ICONS

The icons throughout this product catalog aid as a quick reference to help identify the features and options in each product series.



Light Duty | Medium Duty | Heavy Duty | Extra Heavy Duty | Airport Extra Heavy Duty | ADA Compliant | Custom Logo Cover | Special Lettered Cover

Grate Option | Machined Bearing Surfaces | Reversible Frame | Hinged Unit | Watertite | Frost Proof | Environmental Messaging | Recycled Content | LEED® Credits

Security | Gasket Seal | Watertite Bolting | MPIC™ Pick slot | EPIC™ Pick slot | Adjustable Unit | Stackable Frame | Adjusting Risers

DRAINAGE TABLES — CATCH BASIN GRATES (CONTINUED)

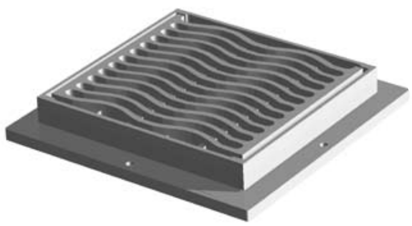
Grate Option	Sq. In. Opening	3-Sided Perimeter	4-Sided Perimeter	Grate Description	Frame Option
5416M2	1040	126	192	Two grate unit	5417, 5418
V-4880-6	1080	119	179	Two grate unit	V4880, V4881
7567M2	1110	164	283	Three grate unit, Concave, DNW	7568L & 7568R & 7568C
V-5648	1176	152	202	1/2 grate assy	V5758
V-4880-2	1260	119	179	Two grate unit, Non-traffic-Heavy duty	V4881, V4883
5400M	1500	148	238	Two grate unit	5405

* 2-sided perimeter suggested for vane grate calculation

Note: All dimensions are in inches.

SINUSOIDAL AND VANE GRATE FLOW CHARACTERISTICS

It is generally accepted that sinusoidal and vane grates are more efficient than standard bar grates when capturing water that is moving across them. Sinusoidal and vane grates have greater efficiency due to better directional flow characteristics. Sinusoidal and vane grates typically allow less water to bypass the grate. Please note that if a vane grate is installed improperly (i.e. backwards) the grate could have poor flow characteristics, while sinusoidal grates accept water equally in either direction. See page 28 for calculating flow capacities of inlet grates.



Illustrating 5416

Illustrating 7466M2

Illustrating V-5622

DRAINAGE TABLES — ROUND GRATES (CONTINUED)

Grate Option	Manhole Grate Dia.	Catch Basin Grate Thk.	Sq. In. Opening	Grate Wier Perimeter	Grate Description	Frame Series
1266M	31 9/16	1 1/8	182	99		1266
1811M	31 11/16	1 5/16	240	100		1230, 1232, 1234, 1820, 1825, V-1600-4, V-1700-4, V-7032
V-3600-4	31 7/8	1 3/8	350	100		1230, 1232, 1234, 1820, 1825, V-1600-4, V-1700-4, V-7032
8025MVH	31 15/16	1 3/8	209	100	ADA	8027
1480M1	31 15/16	1 1/2	262	101	ADA, DNW	1320, 1322, 1480, 2810, V-1419, V-1420, V-1432
1320M	32	1 1/2	360	101	Cross bar	1320, 1322, 1480, 2810, V-1419, V-1420, V-1432
1322M	32	1 1/2	240	101		1320
1480M	32	1 1/2	275	101	Non-Traffic	1320, 1322, 1480, 2810, V-1419, V-1420, V-1432
8028MVH	32 1/4	1 3/8	209	101	ADA	8027
2880M	32 3/4	2	2419	103		2880Z TF
V-7069	33 3/4	1 3/8	236	106	ADA	V-7069-1
V-3610-6	33 7/8	1 1/2	350	106		V-1610-6
1330M	35	2	375	110		1330
1585M	36	1 1/2	400	113		1585, 1586
8029MVH	37 1/4	1 1/2	308	117	ADA	
V-3600-5	38	2	480	119		V-1600-5, V-1700-5
1580M	38 1/2	1 1/2	468	121	Heavy duty & Extra Heavy duty	1581, 1821, 2815
1580M2	38 1/2	1 1/2	304	121	ADA	1581, 1821, 2815
V-3610-7	39 5/8	1 1/2	516	125		V-1610-7
1843M1	44 1/8	2	639	139		1843, 1845
V-3610-8	45 5/8	1 1/2	810	143		V-1610-8
V-3600-6	50 1/4	2	760	158		V-1600-6, V-1700-6

DRAINAGE TABLES — CATCH BASIN GRATES

EJIW is continually adding new construction castings and drainage grates to our product offering. Please consult with your EJIW representative or email us at ejiwsales@ejiw.com to request a sales drawing not shown in this catalog.

Grate Option	Sq. In. Opening	3-Sided Perimeter	4-Sided Perimeter	Grate Description	Frame Option
5000M3	10	58	81	Restricted Flow, DNW	5000, 5020, 5080
V-5708	33	28	38		V-5708
8201M	50	41	55	ADA	8201, 8301
5100M2	50	66 3/8	88 1/2	Restricted Flow (variable)	5100, 5125
V-5713	55	40	54		V-5613, V-5713
V-5712	66	36	48		V-5712
7797M	70	41	54		7797
V-5714	76	44	58		V-5714
V-5716	90	48	64		V-5716
7720M	100	48	68		7720
7700M2*	100	59	83	Vane, DNW	7700
7700M3*	100	59	83	Bi-directional Vane, DNW	7700
V-5720-80	105	59	79	ADA	V-5620, V-5720
5800M1	112	51	73		5150

Note: All dimensions are in inches.

DRAINAGE TABLES — CATCH BASIN GRATES (CONTINUED)

Grate Option	Sq. In. Opening	3-Sided Perimeter	4-Sided Perimeter	Grate Description	Frame Option
7700M1	128	59	83	Diagonal, DNW	7700
5800M2	130	51	73		5150
7463M2*	130	57	81	Vane	7464
7700M4	135	59	83	ADA, Diagonal, DNW	7700
5031M	140	56	78	Concave	5030, 5031
5030M	140	56	79	Concave,	5030
5090M	144	54	72		5090
5120M	148	54	77		5120
5110M5	148	83	110	ADA	5110
5190M2	150	59	89	Sinusoidal, two grate unit available	5190, 5191, 5192, 5193
V5718	152	54	72		V-5718
V4274	155	54	81		V-4274
8205M	155	65	86		8205, 8305
V-5622-80	156	71	95	ADA, DNW, Two grate unit available	5235, 5236, 5250, V-4875, V-5622
V-5751	158	54	80		V-5751
5000M1	160	58	81	DNW	5000, 5020, 5080
5000M2	160	58	81	Sinusoidal, DNW	5000, 5020, 5080
V-5724-80	164	72	96	ADA	V-5724
V-5720	175	59	79		V-5620, V-5720
5105M1	175	66	89	Sinusoidal, DNW	5100, 5125
5344M*	175	71	95	Vane	5342, 5344, 5370, V-5324-1
V-4410	195	66	88	Valley Gutter	V-4410-1, V-4410-2, V-4410-3
5391M	180	71	94		5391
8222M	185	62	87		8222, 8322
7750M1	185	64	88	Herringbone, DNW	7750
5340M	185	65	87	DNW	5340
V-5752	188	60	84		V-5752
7765M*	189	63	94	Vane	7765, 7766
V-5726-80	194	77	103	ADA	V-5626, V-5726
V-5624-80	194	77	103	ADA, DNW	V-5624
V-4873-1	195	86	123	ADA	V-4873
V-4230-2*	195	66	97	Vane	V-4230, V-4231
5335M	200	63	93	Concave	5335
V-4246	200	66	96	DNW	V-4246
5250M	200	71	95	DNW	5250, 5235, V-4875, V-5622
7569M1	205	67	94		7569
7569M2	205	67	94	Concave	7569
5130M2	210	66	93	DNW	5130
5245M	210	71	107	DNW	5245
5370M	215	71	95		5370
7750M2*	216	64	88	Vane, DNW	7750
7750M3*	216	64	88	Bi-directional Vane, DNW	7750
7600M*	220	65	95	Vane, DNW	7600, 5460
8206M	220	71	94		8206, 8306
V-4275	220	71	100		V-4275
7075M1	220	72	96	Sinusoidal	7076
7466M2*	225	69	93	Vane	7466, 7467
7030M5	225	71	107	Diagonal	5245, 7030, 7031, 7032, 7035, 7037

* 2-sided perimeter suggested for vane grate calculation

Note: All dimensions are in inches.

DRAINAGE TABLES — CATCH BASIN GRATES (CONTINUED)

Grate Option	Sq. In. Opening	3-Sided Perimeter	4-Sided Perimeter	Grate Description	Frame Option
7750-0	229	64	88	Beehive	7750
5130M1	235	66	93		5130
7535M*	235	68	90	Vane, Two grate unit available	7535
5410M	239	69	107	Concave	5410
V-4243-1	240	63	93	DNW	V-4240, V-4241, V-4854
5130M3	240	66	93	Diagonal	5130
V5324	243	72	96	Concave	V-5324
5050M	245	78	104		5050
5380M*	250	68	90	Vane	5380
V-4435	251	78	108	Valley Gutter — Slight	V-4435
V-4280-2*	255	77	111	Vane	V-4280
5360M	256	68	104	Sloped	5360
V-4230-1	260	66	97	DNW	V-4230, V-4231
7030M2	260	71	106		5245, 7030, 7031, 7032, 7035, 7037
7030M6*	260	71	107	Vane	5245, 7030, 7031, 7032, 7035, 7037
5395M1	260	81	117		5395
5395M2	260	81	117	Depressed Cross Bars	5395
V-5660-80	260	83	119	ADA, DNW	V-5660
V-4430	265	78	108	Valley Gutter	V-4430
V-5622	266	71	95	DNW, Two grate unit available	5250, 5235, V-4875, V-5622
7075M2	266	72	96	Sinusoidal, Expressway use	7076
V-5724-1	268	72	96	DNW	V-5724
V-5622-5	269	71	95	Two grate unit available	5250, 5235, V-4875, V-5622
8208M	270	77	103		8208, 8308
V-4530	272	76	98	Valley Gutter — Sloped, DNW	V-4530-1, V-4530-2
7030M4*	272	71	107	Vane	5245, 7030, 7031, 7032, 7035, 7037
5345M1	276	78	104	Parallel Bar, Two grate unit available	5345, 5346
5055M2	280	71	106		5055
5385M	280	74	104		5385
5055M	283	71	106	M1	5055
V-4880	283	89	119	ADA, Two grate unit available	4595, V-4880, V-4882
V-5732-80	283	96	128	ADA	V-5632, V-5732
V-5630-80	283	96	128	ADA	V-5630
V-4410	290	88	132	Two grate unit, Valley Gutter	V-4410-2
V-5655	293	71	103		V-5655
8105M3	295	76	112	DNW	8105
V-5624	295	77	103		V-5624
5110M4	295	83	110	Medium duty, DNW	5110
5355M6	298	101	149	ADA, Non-slip, 1/2 grate	5355, 5356, 5357
5230M	300	72	96		5230
5115M2	300	81	108	DNW	5115
5110M3	300	83	110	Sinusoidal, DNW	5110
V-5664	300	83	115		V-5664
5190M2	300	89	148	Two grate unit, Sinusoidal	5191, 5192
V-4510-1	310	83	119	Valley Gutter, DNW	V-4510
V-5622-80	312	95	142	Two grate unit, ADA, DNW	5236L & 5236R
7030M3	315	71	107	Diagonal, Medium duty	5245
8105M1	320	76	112	Diagonal	8105

* 2-sided perimeter suggested for vane grate calculation

Note: All dimensions are in inches.

DRAINAGE TABLES — CATCH BASIN GRATES (CONTINUED)

Grate Option	Sq. In. Opening	3-Sided Perimeter	4-Sided Perimeter	Grate Description	Frame Option
5345M2	320	78	104	Two grate unit available	5345, 5346
V-5726	321	77	103		V-5626, V-5726
V-5775	326	84	112		V-5775
8228M	328	83	114		8228, 8328
V-4855-1	332	72	110	High Capacity	V-4855
5450M	335	77	107		5450
5420M	335	90	120	Steel angle frame, DNW	5420
7590M1	338	91	139	DNW, Two grate unit available	7593
7567M	340	85	125	Vane, Two and three grate units available	7568
V-4215-2	346	73	109	Medium duty, Two grate unit available	V-4215
5110M2	350	83	110	DNW	5110
5344M	350	95	143	Two grate unit, Vane	5344
V-4880-4	350	89	119	Two grate unit available	4595, V-4880, V-4882
V-5736-80	356	115	153	ADA	V-5736
V-4280-1	361	77	111		V-4280
V-4280-3	363	77	111		V-4280
V-4215-1	365	73	109	Two grate unit available	V-4215
5416M3*	365	93	126	Vane, DNW, Two grate unit available	5416
8105M2	370	76	112	Parallel Bar	8105
V-5728	370	84	112		V-5728
7567M2	370	85	125	Concave, DNW, Two & three grate unit available	7568
5110M1	375	83	110	Non-Traffic, DNW	5110
7034M	380	83	119	Sloped, two grate unit available	7034
V-4067-1	383	83	119		V-4867-1
5115M1	390	81	108		5115, 5116
V-5662	390	83	115		V-5662
V-5660	390	83	119	DNW	V-5660
V-4230-2*	390	97	157	Two grate unit, Vane	V-4232L & V-4232R
V-5666	397	90	128		V-5666
5250M	400	95	142	Two grate unit, DNW	5236L & 5236R
V-5763	402	84	116		V-5763
V-5360	405	84	120	Concave	V-5360-1
7590M	415	91	139	DNW, Two grate unit available	7593
7595M	415	99	147		7595
5355M3	416	101	149	DNW, 1/2 grate	5355, 5356, 5357
V-5760	413	84	120		V-5760
8213M	426	95	127		8213, 8313
5425M2*	440	90	135	Two grate unit, Vane	5425
7600M*	440	97	158	Two grate unit, Vane, DNW	7600L & 7600R
V-4880-3	442	89	119	Two grate unit available	4595, V-4880, V-4882
V-4520-1	458	89	125	Valley Gutter	V-4520
V-5665	463	89	127		V-5665
5355M1	465	101	149	Diagonal	5355, 5356, 5357
7535M*	470	90	135	Two grate unit, Vane, barrier wall	7536
V-4880-1	473	89	119	DNW, two grate unit available	4595, V-4880, V-4882
V-5630	474	95	127	DNW	V-5630
V-4243-1	480	93	152	Two grate unit, DNW	V-4243L & V-4243R
5416M1	490	93	126	Sinusoidal, two grate unit available	5416

* 2-sided perimeter suggested for vane grate calculation

Note: All dimensions are in inches.

DRAINAGE TABLES — CATCH BASIN GRATES (CONTINUED)

Grate Option	Sq. In. Opening	3-Sided Perimeter	4-Sided Perimeter	Grate Description	Frame Option
V-5732	490	96	128		V-5632, V-5732
V-4873	492	86	123		V-4873
5355M5*	514	101	149	Vane, 1/2 grate	5355, 5356, 5357
V-4230-1	520	97	157	Two grate unit, DNW	V-4232L & V-4232R
5380M*	500	90	135	Two grate unit, Vane	5375, 5376
8315M	500	112	150	Two grate unit	8315
5240M	510	96	132	DNW	5240
5416M2	520	92	125	Two grate unit available	5416
V-4410	585	110	176	Three grate unit, Valley Gutter	V-4410-3
V-5622	536	96	143	Two grate unit, DNW	5236L & 5236R
V-5622-5	538	96	143	Two grate unit,	5236L & 5236R
V-4880-6	540	89	119	Two grate unit available	4595, V-4880, V-4882
5355M4	540	101	149	Diagonal, 1/2 grate	5355, 5356, 5357
V-4530	544	98	151	Two grate unit, Sloped grate	V-4530-2
5345M1	552	104	156	Two grate unit, Parallel Bar	5350
V-5668	562	101	139		V-5668, V-5768
V-4880	566	119	179	Two grate unit, ADA	V-4881, V-4883
7585M	575	109	159	DNW	7585
V-4230-2*	585	127	217	Three grate unit, Vane	V-4232L & V-4232R & V-4233C
V-5667	598	101	151	1/2 frame & grate unit	V-5667, V-5767
V-4880-2	630	89	119	Non-Traffic, two grate unit available	4595, V-4880, V-4882
5345M2	640	104	156	Two grate unit	5350
8233M	640	114	164	Two grate unit	8233, 8333
V-5636	651	113	150	DNW	V-5636
V-5736	652	115	153		V-5736
7600M*	660	303	393	Three grate unit, Vane, DNW	7600L & 7600R & 7600C
7590M1	676	135	183	Two grate unit, DNW	7592
7567M*	680	125	204	Two grate unit, Vane	7568L & 7568R
V-4215-2	692	111	147	Two grate unit, Medium duty	V-4216L & V-4216R
V-4880-4	700	119	179	Two grate unit	V-4881, V-4883
V-5669	724	113	163		V-5669, V-5769
V-4215-1	730	111	147	Two grate Unit	V-4216L & V-4216R
5416M3*	730	126	192	Two grate unit, Vane, DNW	5417, 5418
7567M2	740	125	204	Two grate unit, Concave, DNW	7568L & 7568R
5355M2	750	101	149	Directional	5355, 5356, 5357
5400M	750	103	148	Two grate unit available	5400
7034M	760	119	190	Two grate unit, Sloped	7034L & 7034R
V-4230-2*	780	132	192	Four grate unit, Vane	(2) V-4232L & (2) V-4232R
V-4230-1	780	126	216	Three grate unit	V-4232L & V-4232R & V-4233C
7590M	830	135	183	Two grate unit, DNW	7592
V-5742	868	131	175	1/2 grate assy	V-5642, V-5742
V-4880-3	884	119	179	Two grate unit	V-4881, V-4883
V-5670	708	125	174	1/2 frame & grate unit	V-5670, V-5770
V-4880-1	946	119	179	Two grate unit, DNW	V-4881, V-4883
5390M	908	121	161	One piece frame with two piece grate	5390
5416M1	980	126	192	Two grate unit, Sinusoidal	5417, 5418
7567M*	1020	164	283	Three grate unit, Vane, Concave	7568L & 7568R & 7568C
V-4230-1	1040	132	192	Four grate unit	(2) V-4232L & (2) V-4232R

* 2-sided perimeter suggested for vane grate calculation

Note: All dimensions are in inches.

CHOOSING THE PROPER INLET GRATE

Adopting an inlet grate design requires an analysis of the functions the grate should perform. A designer must review the drainage requirements and then specify which functions will be necessary for satisfactory grate and all other performance requirements of each application. For example, if the only consideration is for the grate to efficiently intercept large quantities of storm water from the gutter, then a grate with the proper geometry and flow-through area is the one to choose. Although capacity is an important function, there are other considerations that must be evaluated to satisfy the requirements of a functional, correctly located, safe grate. Designers must note that there may be other considerations in addition to those listed below that should be evaluated prior to making a choice. **SEE, ESPECIALLY, "IMPORTANT INFORMATION ON CHOOSING THE RIGHT CASTING FOR YOUR APPLICATION," BEGINNING ON PAGE 7 OF THIS CATALOG, INCLUDING THE MATERIAL THERE CONCERNING HANDICAPPED PERSON, PEDESTRIAN AND BICYCLE SAFETY CONCERNS.**

CONSIDERATIONS FOR HANDICAPPED PERSONS, BICYCLES AND PEDESTRIANS
Design and placement of the grate must be suitable for use in areas where handicapped persons, bicycles and pedestrians may be present.

The adoption of the Americans with Disabilities Act (ADA), the prominence of narrow-tired bicycles and concern for pedestrian safety dictates that designers carefully consider the safety of the type of grating selected for various applications. If the installation is changed in concept, scope or usage pattern at some future date, designers must at that time reconsider the types of gratings used and determine if they still meet their safety requirements. If not, designers must replace these existing grates with more appropriate styles.

GRATES FOR BICYCLES
The designer must determine the appropriate grate design and inlet location for safe use by bicycle traffic, having in mind the specific details of location and foreseeable use. The following are some important considerations:

1. The style of grate employed should allow bicycle travel from all accessible directions. Grates located in open areas, or adjacent to driveways, or in other locations where they are not adjacent to barrier curbs require special attention in this regard.

2. In general, we suggest consideration of our Type L vane style grates. Certain grates shown in our catalog are generally not suitable for use where bicycle traffic is a consideration. The designer is responsible for making the appropriate grate selection.

3. If slotted grates or vane-type grates other than our Type L are considered, they should have sufficiently narrow openings and/or should have appropriately spaced transverse (cross) bars to ensure that any foreseeable width and diameter of bicycle tire cannot drop down into openings to an unsafe extent.

4. Gutter slopes should not be substantially swaled into the curb so as to create a disturbance in the roadway which might affect the ability of bicycles or other traffic to traverse them.

GRATES FOR PEDESTRIANS AND HANDICAPPED
Various regulations or customs may dictate the use of specific types of grates, such as gratings with longitudinal slope openings no greater than 1/4” or 1/2”. Designers must carefully evaluate the location and placement of grates against applicable specifications to be sure they are using grates that will satisfy the specification’s requirement and provide a pathway (accessible route) for pedestrians and handicapped persons. The Americans with Disabilities Act (ADA) provides grating specification guidelines that can be used in creating accessible routes for handicapped individuals.

HYDRAULIC EFFICIENCY
The ability of a grate to intercept storm water or its hydraulic efficiency is an important function. The main considerations in design are the geometry and the flow-through area of the openings for each individual grate. NEENAH has recognized the designers need for hydraulic information on individual grates. We studied individual grate performance by establishing our own hydraulic testing program and are now capable of supplying grate capacity information on the grates shown in this catalog. Please contact us for specific charts and information.

SCREENING OUT HARMFUL DEBRIS

An inlet grate must act as a strainer and prevent harmful debris from entering sewer lines. Objects such as branches, large sheets of semi rigid material, sticks, chunks of wood, etc. which are easily passed by large curb openings (open throat) are conveniently prevented from entering the catch basin by a well chosen grate.

If large debris gets into the catch basin, it can often float or wash into the lines, clogging them at inaccessible locations and making the drainage system ineffective.

Should clogging of the grate occur at the upstream end, grates of longer lengths usually provide the extra flow-through capacity necessary to accommodate the gutter flow as well as some of the side flow.

ABILITY TO PASS UNOBJECTIONABLE DEBRIS

Organic material such as grass clippings, leaves, small stones, scraps of paper and even small twigs should be passed into the catch basin. Because of their size and configuration they are not a hazard for the sewer lines.

Grates designed with closely spaced bars for strength and safety become easily clogged from very small but always present debris. The problem is magnified even more as this debris is packed into the openings by passing traffic creating a hard, semi-solid surface. If the velocity of the gutter flow is insufficient to dislodge the packed debris, the grate becomes ineffective.

The answer then is to provide grate openings wide enough, of suitable length or of special design to pass this debris and still meet the other requirements. NEENAH has many sizes and styles that can be implemented into your designs.

STRENGTH

Inlet grates placed in roadways must be designed to withstand heavy traffic loads. A common designation for standard highway loads is described as H20-44 loading for single axle trucks and HS20-44 for tandem axle trucks (tractor semi-trailer units) The maximum axle loading in both cases is 32,000 lbs, or 16,000 lbs. for each set of dual wheels. There may be cases where more extreme design loads are necessary such as airports, commercial applications, industrial sites or installations where extra heavy loads and/or extremely hard tires are present. Refer to page 5, **Castings for Different Traffic Conditions** for additional information.

DURABILITY

A gutter inlet grate should be designed to match or exceed the expected life of the installation. The inherent rust-resisting properties of unpainted cast iron and its time-tested performance insures long life. The strength of cast iron grates resists earth and pavement pressures - qualities one should question in other non-cast iron materials.

■ Note: When specifying/ordering grates, refer to “Choosing the proper inlet grate” on pages 117-118.
For a complete listing of FREE OPEN AREAS and WEIR PERIMETERS of all NEENAH grates, refer to pages 306-311.

STORM WATER MANAGEMENT WITH NEENAH GRATES

An important consideration in any storm water management plan is the proper selection and use of drainage grates. The NEENAH line of inlet, area and drainage grates offers hundreds and hundreds of choices. Different shapes, sizes and geometry provide varying capacities which can match your inlet and outlet control requirements.

When runoff conditions overtax sewer lines or treatment capacity, engineers frequently detain excess storm water by temporarily impounding storm water in suitable depressed open space areas, parking lots or other available basin type structures. With NEENAH capacity rated grates, ponded water can be slowly released at a controlled rate as sewer lines and treatment facilities are able to accept new discharges.

SEE "IMPORTANT INFORMATION ON CHOOSING THE RIGHT CASTING FOR YOUR APPLICATION," BEGINNING ON PAGE 7 OF THIS CATALOG, INCLUDING THE MATERIAL THERE CONCERNING HANDICAPPED PERSON, PEDESTRIAN AND BICYCLE SAFETY CONCERNS.

Specific applications of NEENAH drainage grate products include:

MEDIAN DRAIN AND FREEWAY DRAINAGE

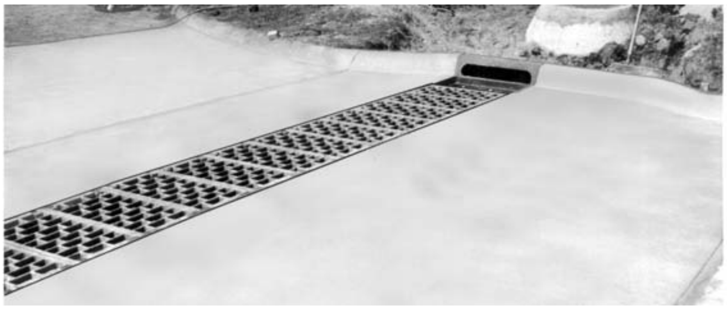
Stormwater management on freeways is important so that roads are safe for motorists during wet weather. NEENAH offers a variety of choices for inlet boxes, median inlets or ditch checks.

TRENCH FRAME AND GRATE

For draining large impervious areas, many designers specify NEENAH trench drains. Sizes range from 6” to 48” widths. Drains can be installed in any length with direction changes to suit the area and drainage conditions.

HIGH CAPACITY VANE STYLE TYPE “L”

NEENAH’s high capacity vane style grates offer designers the best combination of hydraulic efficiency and safety for triangular gutter slope applications.



SHEET FLOW INTERCEPTING GRATES

There are numerous occasions when designers desire to remove sheet flow from streets or parking lots. NEENAH has addressed this need with specialized castings suited for various situations.

■ Note: When specifying/ordering grates, refer to "Choosing the proper inlet grate" on pages 117-118.
For a complete listing of FREE OPEN AREAS and WEIR PERIMETERS of all NEENAH grates, refer to pages 306-311.

TYPE "L" VANE STYLE GRATES

CAPACITY

An important function of an inlet grate is capacity - the ability to intercept the storm water from the gutter. Hydraulic tests prove the Type "L" Vane Style Grates will accept more water than any of the conventional grate styles under virtually all flow conditions. Even with extremely high volume and velocity conditions in the gutter, there will be very little if any water that the grate will not capture, providing the water passes over it. The efficiency of these grates can be as much as 20% greater than conventional designs. For this reason, an ever increasing number of states, counties and municipalities have adopted the Type "L" Vane Style Grate as a standard.

Cross section of Vane Style Grate in testing flume showing hydraulic performance at 2 cfs.

GRATE PLACEMENT

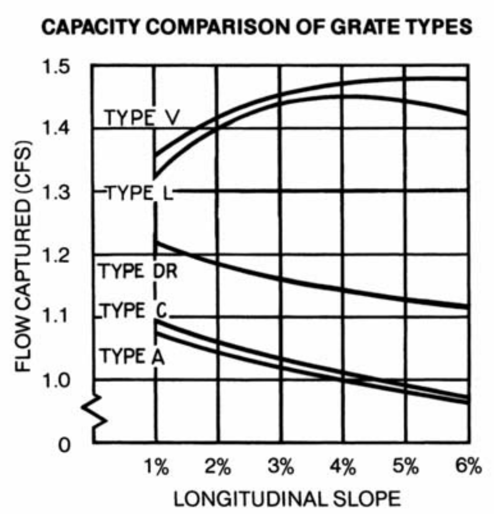
Type "L" Vane Style Grates are being used in grate replacement programs in many cities throughout the country, not only because of their storm water capacity features but also because they are more likely to be safe for bicycles than many other styles of grates. A replacement high capacity Type "L" grate can be dimensioned to fit most catch basin inlets. Our Product Engineering and Sales Departments are available to assist you in developing your grate replacement program.

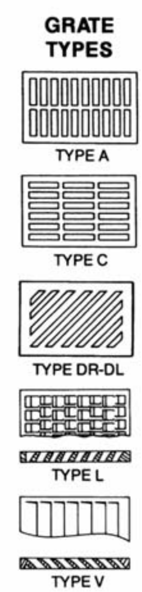
BICYCLE GRATES

Please read in its entirety "Pedestrian, Bicycle and Handicap Considerations" on page 7, in which we suggest consideration of Type "L" vane style grates where bicycles are a factor in the choice of a casting.

DEBRIS

A properly functioning inlet grate such as the Type "L" Vane Style Grate must screen out the larger harmful debris and prevent it from entering and clogging the sewer pipe. Small debris, which can be easily handled by the underground portions of the storm sewer, are allowed to pass through the grate openings to prevent blockage on the surface of the grate.

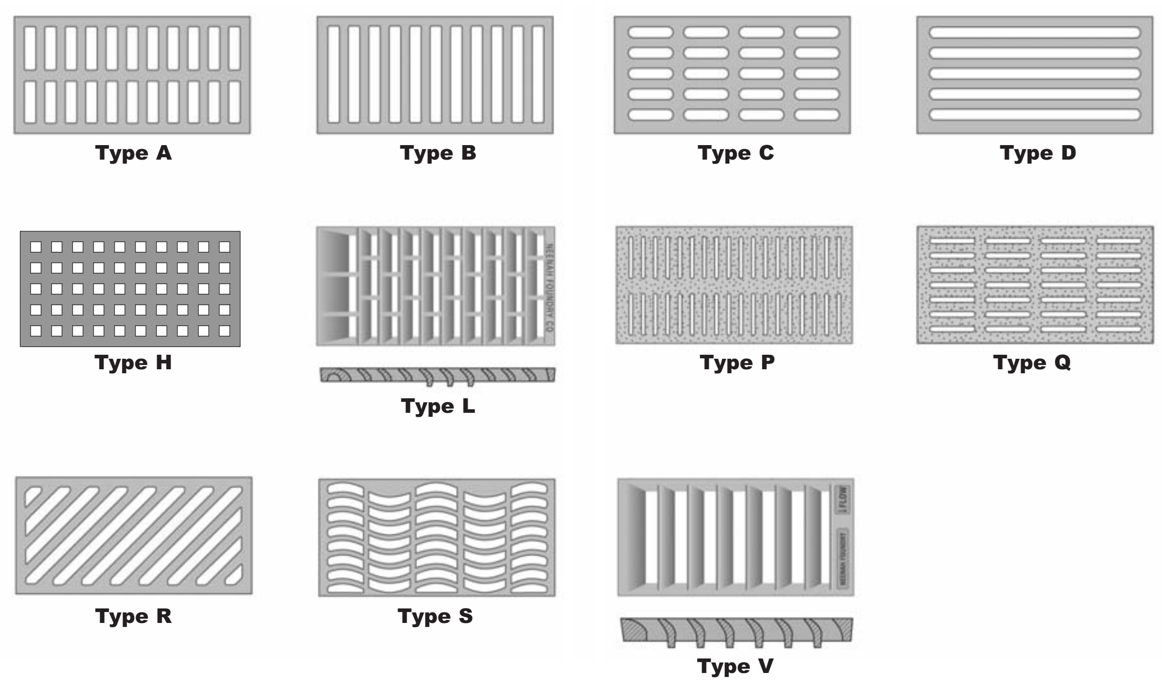




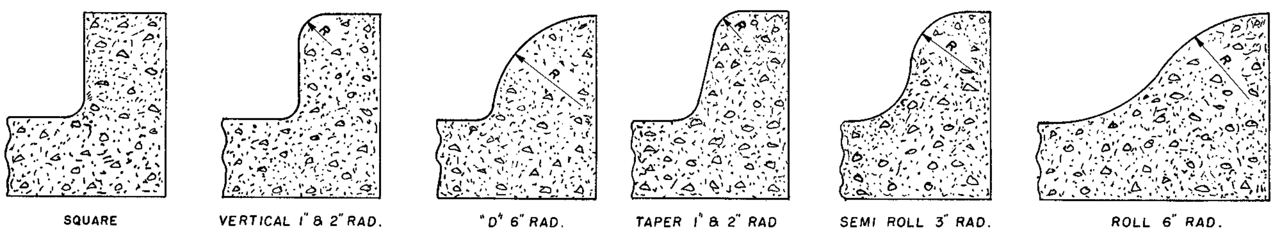
The above chart shows flume test results using 17" x 20" full size grates in the types detailed top right. A constant transverse or gutter slope of 6% was used to contain more water over the grate. The gutter flow in the channel was set at 2 cfs. Note the improved performance of the Type "L" and "V" Vane Grates.

■ **Note: When specifying/ordering grates, refer to "Choosing the proper inlet grate" on pages 117-118.**
For a complete listing of FREE OPEN AREAS and WEIR PERIMETERS of all NEENAH grates, refer to pages 306-311.

INLET GRATE TYPES
CURB FACE TYPES

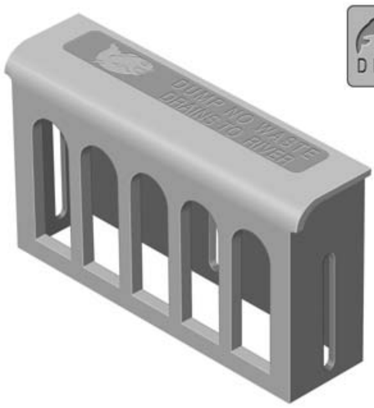


The templates shown illustrate a few of the many types of curb sections which can be properly matched with the catch basin inlets shown on the following pages. As noted, curb boxes can be adjusted to match concrete curb heights.

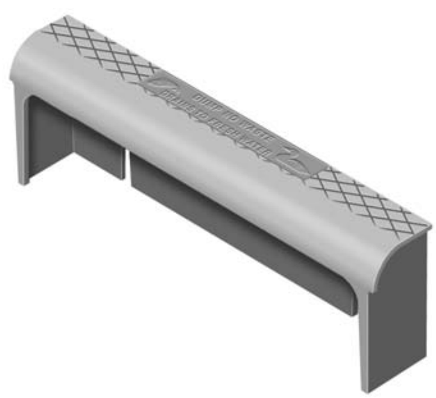


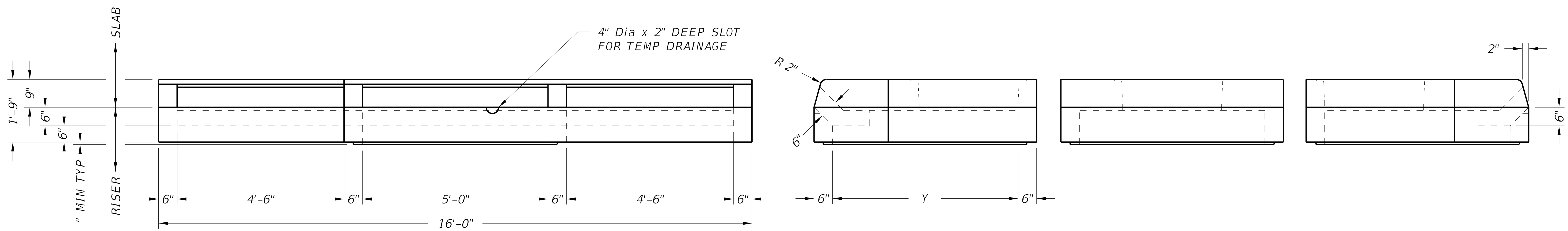
ENVIRO-CURB LOGOS

As noted on the following catalog items, our curb boxes and curb plates can be furnished with Environmental Notices which address specific drainage situations. If your installation requires such a notice, please contact NEENAH for specific availability and needs.



Illustrating R-3000-A





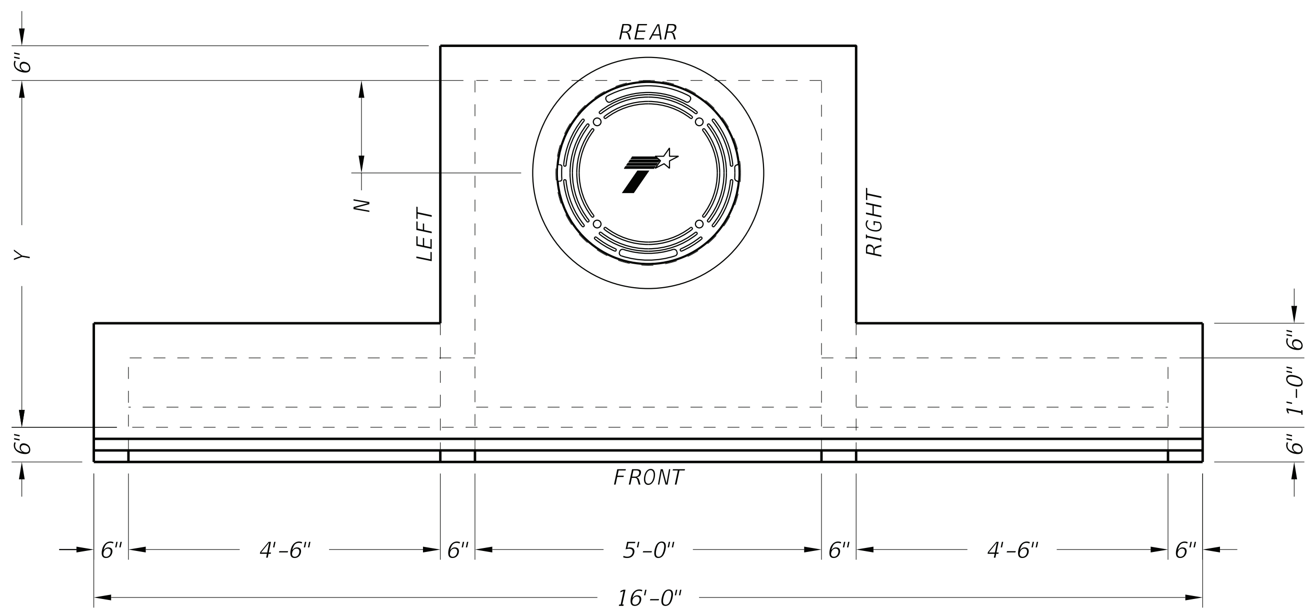
FRONT VIEW

RIGHT VIEW

REAR VIEW

(EXTENSIONS NOT SHOWN)

LEFT VIEW



PLAN VIEW

DISCLAIMER:
The use of this standard is governed by the "Texas Engineering Practice Act". No warranty of any kind is made by TxDOT for any purpose whatsoever. TxDOT assumes no responsibility for the conversion of this standard to other formats or for incorrect results or damages resulting from its use.

DATE:
FILE:

HS20 LOADING

SHEET 1 OF 2

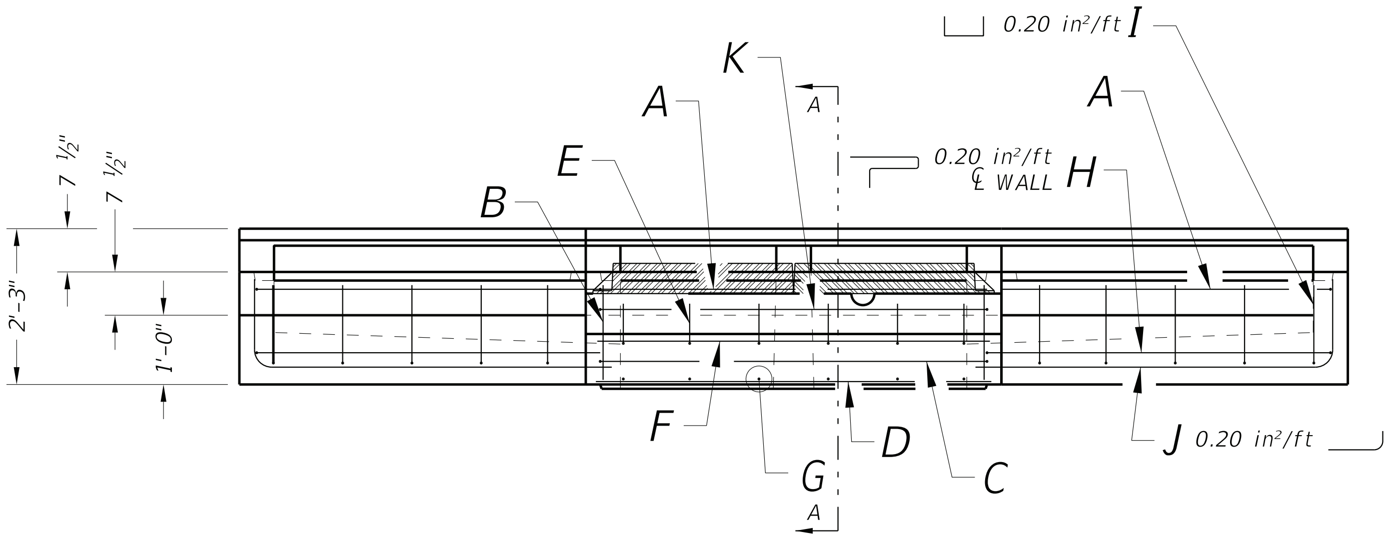
Texas Department of Transportation

Bridge Division Standard

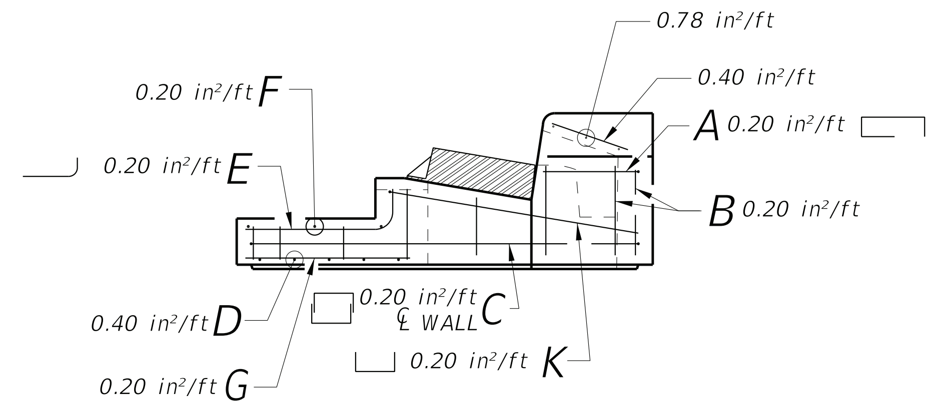
PRECAST CURB INLET OUTSIDE ROADWAY

TYPE PCO

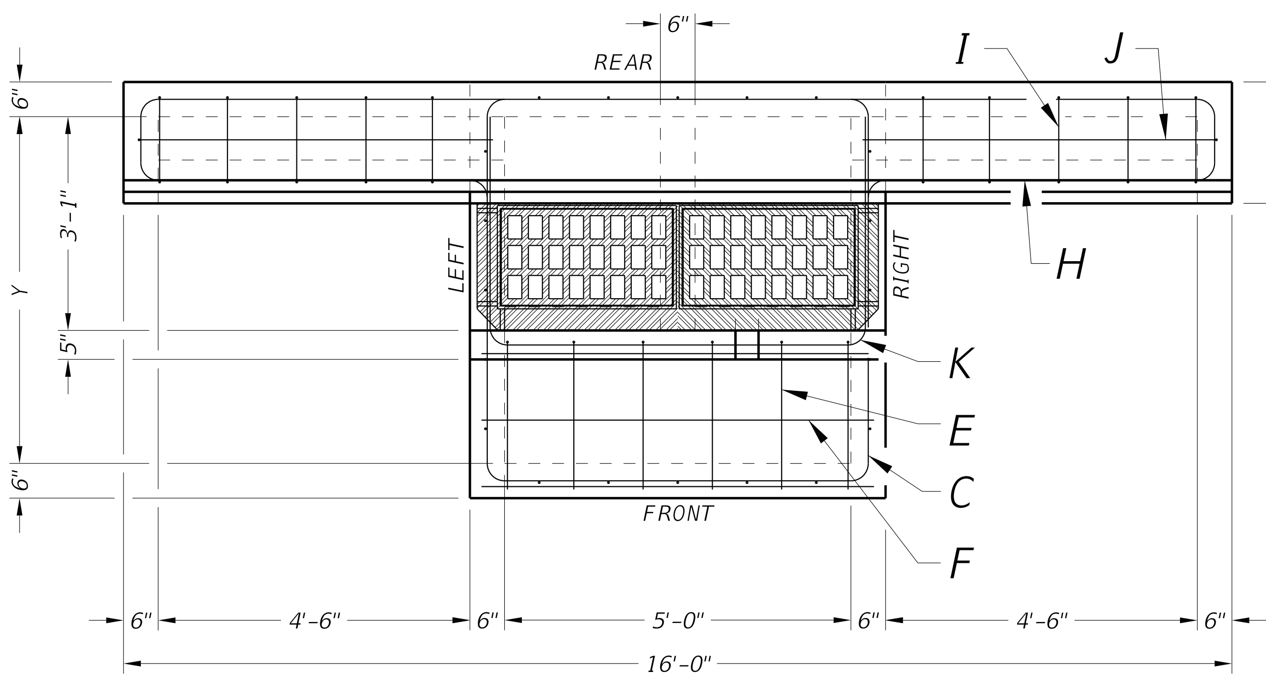
FILE: prestd03.dgn	DN: TxDOT	CK: TxDOT	DW: TxDOT	CK: TxDOT
©TxDOT August 2013	CONT	SECT	JOB	HIGHWAY
REVISIONS	DIST	COUNTY		SHEET NO.



FRONT VIEW



SECTION A-A



PLAN VIEW

GENERAL NOTES:

1. Designed according to ASTM C913.
2. Inlet throat is placed under roadway and intended for direct traffic. Inlet lid is not for direct traffic. Do not place Inlet lid in roadway.
3 Provide Class "H" concrete in accordance with Item 421 and having a minimum compressive strength of 5,000 psi.
4. Provide Grade 60 reinforcing steel or equivalent area of WWR.
5. Provide typical clear cover of 1 ½" to reinforcing steel from surface of concrete.
6. Extensions may be right, left, both or none.
7. Open area of main throat = 324 sq in. Open area of one extension throat = 324 sq in. Refer to iron detail for open area of grate.
8. Design tongue and groove joints for full closure on both shoulders. Minimum spigot depth is ¾". Top slab may employ a butt joint with dowels at the Contractor's option.
9. Seal tongue and groove joints and butt joints with preformed or bulk mastic in conformance with Manufacturer's recommendations. Tongue and groove joints may be grouted no more than 1" between each section, or ½ the joint depth, whichever is greater.
10. Do not grout rubber gasket joints without Manufacturer's recommendation.
11. Provide lifting devices in conformance with Manufacturer's recommendations.
12. See approved industry Cast Iron Product Standards for details of castings.
13. See Standard Inlet and Manhole Program Guide for information not shown.
14. Payment for inlet is per Item 465, "Manholes and Inlets" by type and size.

SIZE	Y
3'x5'	3'
4'x5'	4'
5'x5'	5'
5'x6'	6'

HS20 LOADING

Texas Department of Transportation

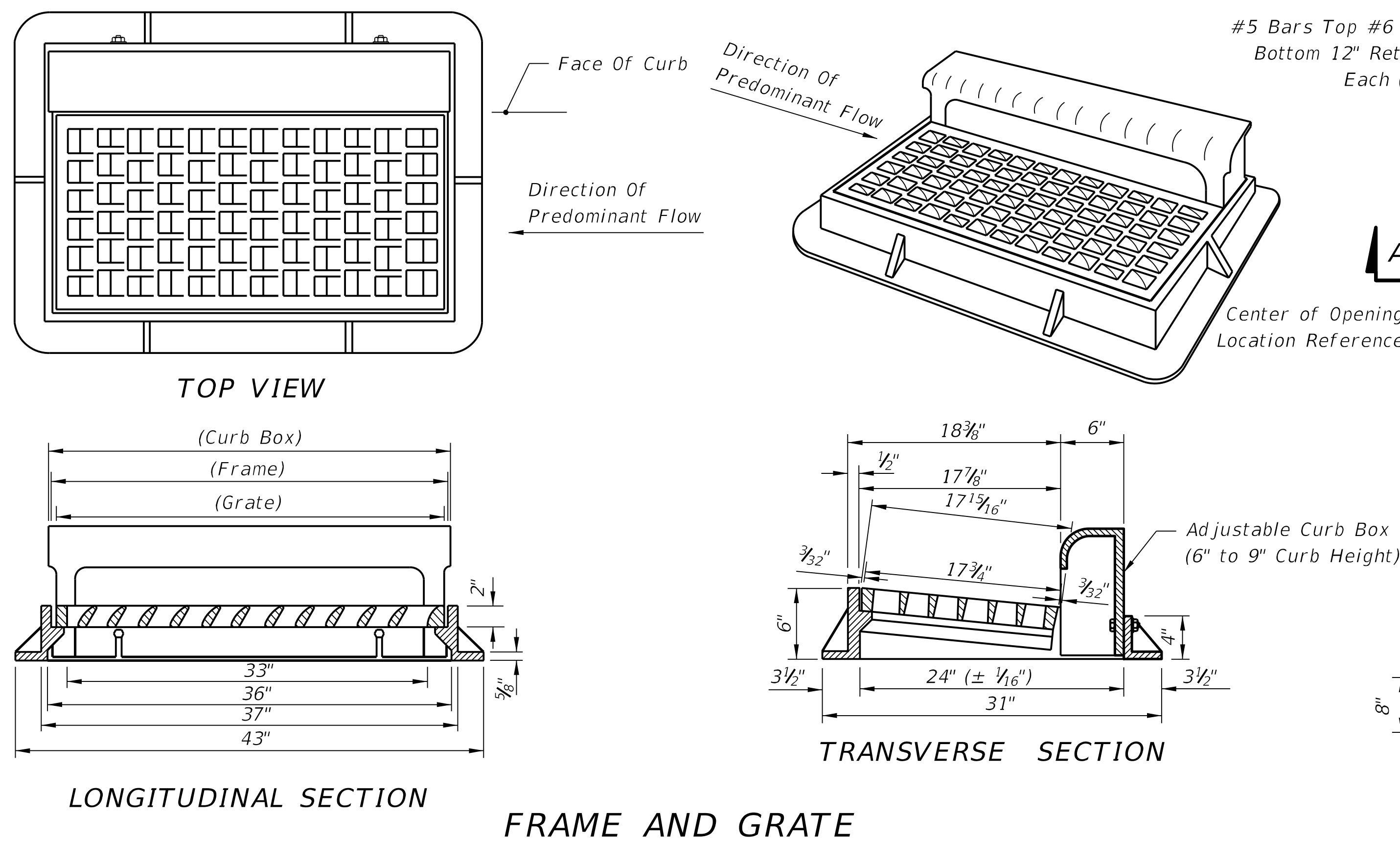
Bridge Division Standard

PRECAST CURB INLET UNDER ROADWAY

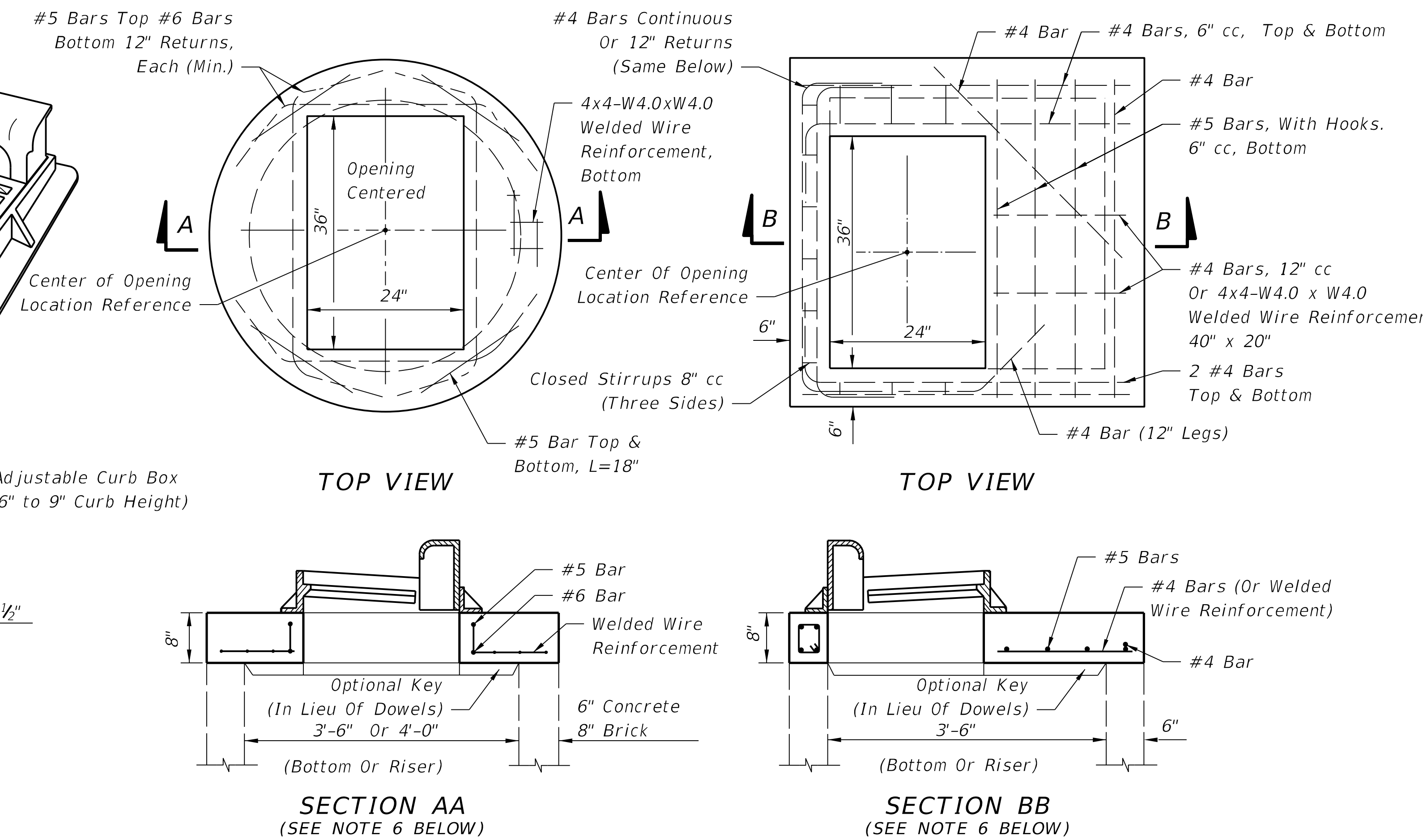
TYPE PCU

FILE: prestd04.dgn	DN: TxDOT	CK: TxDOT	DW: TxDOT	CK: TxDOT
©TxDOT August 2013	CONT	SECT	JOB	HIGHWAY
REVISIONS	DIST		COUNTY	SHEET NO.

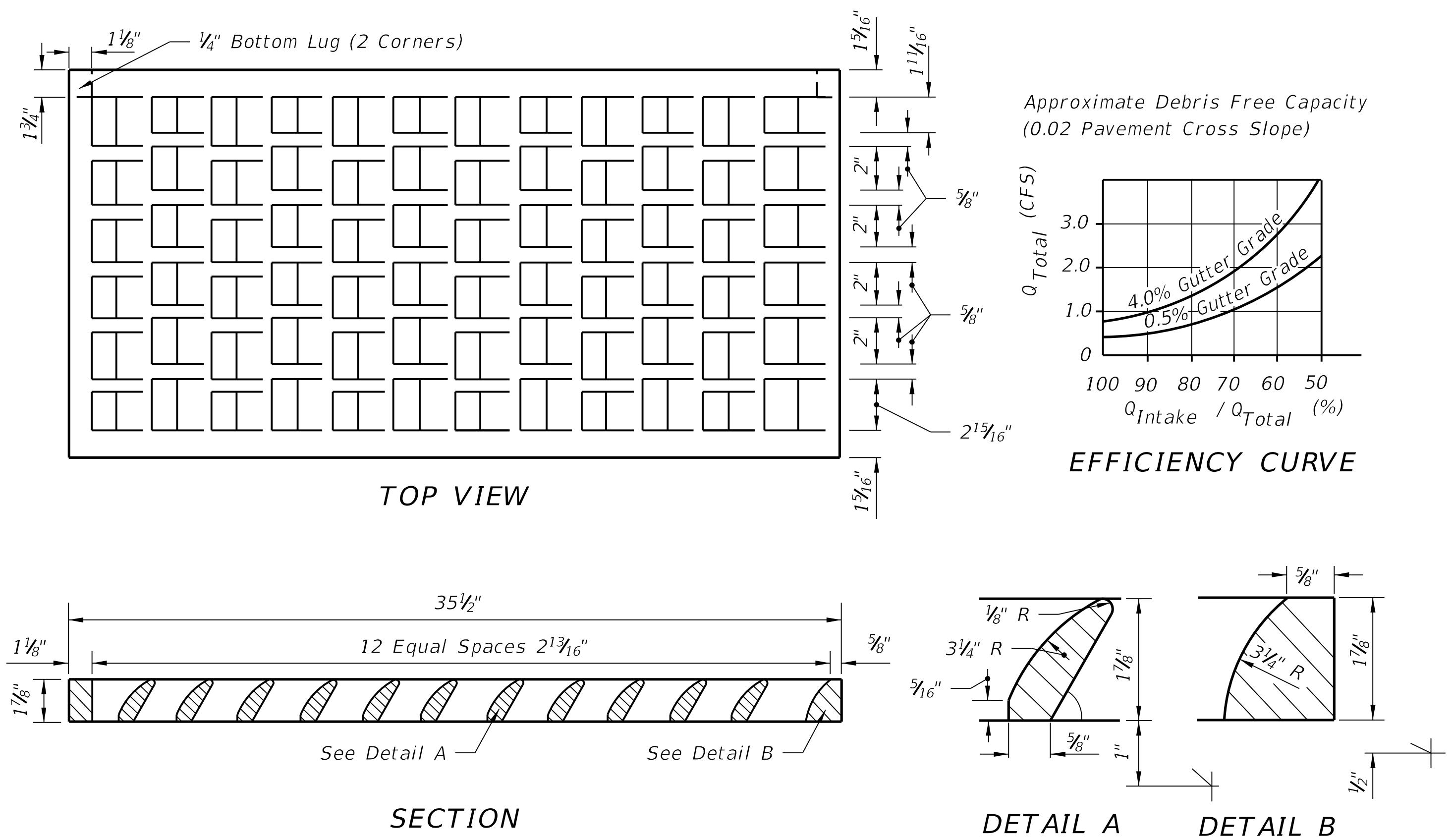
DATE:
FILE:



FRAME AND GRATE



TOP SLABS



GRATE DETAIL

GENERAL NOTES

1. This inlet is primarily intended for locations with light to moderate flows where right of way does not permit the use of throated Curb Inlets Types 1 through 6. The typical application is on curb returns to city streets. The inlet grate is suitable for pedestrian and bicycle traffic.

2. This inlet to be located outside of curb ramp area in vertical faced curbs such as Curb and Gutter Type F. Grate shall be oriented with vanes directed toward Predominant flow.

3. For structure bottoms see Index No. 200. For supplemental details see Index No. 201.

4. All steel in slab tops shall have 1¼" minimum cover unless otherwise shown. Tops shall be either cast-in-place or precast concrete.

5. For Alternate B applications, top slab openings shall be placed such that 2 edges of inlet frame will be located directly above bottom wall or riser wall.

6. When used on a structure with dimensions larger than those detailed above and risers are not applied, the top slab shall be constructed using Index No. 200 with the slab opening adjusted to 24"x36". The "Special Top Slab" on Index No. 200 is not permitted.

7. Frame may be adjusted with one to six courses of brick.

8. Vaned grates with approximately equal openings will be permitted that satisfy AASHTO HL-93 loading. Grates shall be reversible, right or left.

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LAST REVISION	REVISION	DESCRIPTION:	FDOT 2014 DESIGN STANDARDS	CURB INLET TOP TYPE 9	INDEX NO.	SHEET NO.
07/01/13					214	1 of 1

APPENDIX E

CITY OF BURLINGTON MEMO

MAIN STREET AREA COMBINED SEWER MODEL

BURLINGTON, VT PUBLIC WORKS

Memorandum

To: Interested Parties

From: Steve Roy

Date: December 19, 2013

Re: Main Street Area Combined Sewer Model **DRAFT**

INTRODUCTION

As a result of increasing flooding issues in the Main/S. Winooski/King Street area, we've contracted with a local engineering firm (Aldrich & Elliott) to develop short term options to capture and attenuate any stormwater before introducing it into our combined sewer system. Even though a calibrated SWMM (Storm Water Management Model) of our system is not expected until summer/fall of next year, we thought it would be prudent to see whether or not our current pipe network can take additional storm flows without creating new problems for neighbors downstream of the flooding area.

I constructed our pipe network in PCSWMM for the old ravine sewer as well as bypass projects completed approximately 20 years ago (Contracts 2, 3 and 6). The intent here is to identify any <u>hydraulic</u> restrictions that could be aggravated by additional flows.

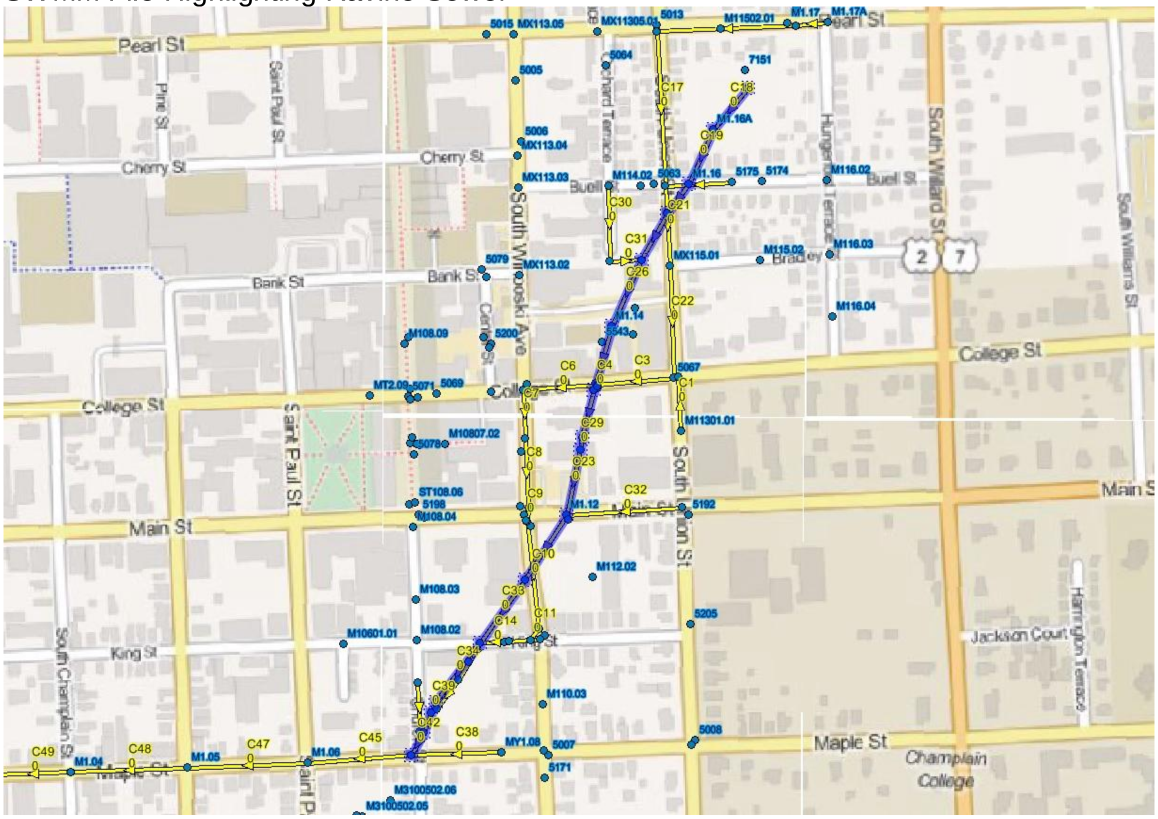
After constructing this pipe network, I input increasing baseflows in various pipes depending on estimated collection area with the intent to have combined flowrates going down the 5' diameter pipe on Maple Street equivalent to peak flows seen at Main Plant. It is important to note that Maple Street is one of three major feeds into Main Plant, with the others being Battery Street and Pine Street.

RESULTS

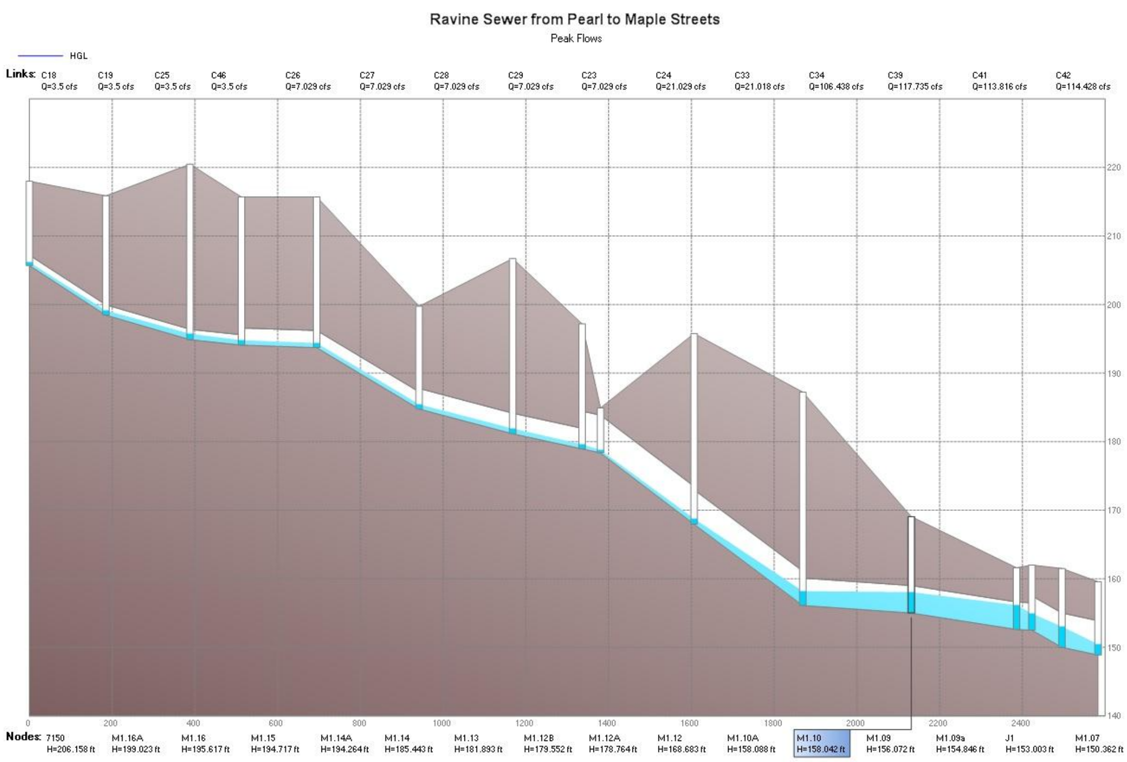
As seen in the screenshots below, there doesn't appear to be any hydraulic restrictions that would preclude introducing more surface flow into the ravine sewer bypass. For most storms, the ponding issue at the intersection of Main and S. Winooski, flooding on S. Winooski at the courthouse plaza entrance and flooding on King Street at the entrance to the Hood plant parking lot is most likely a function of an inadequate number of catch basins to capture stormwater runoff as opposed to surcharge issues from our pipe network. However, the introduction of uncontrolled peak flows can and will cause problems further downstream where the collection system feeds come together and at the wastewater plant. Preliminary concepts from Aldrich & Elliott that include storage with the additional catch basin inlets are warranted.

When completed and calibrated, next year's SWMM model of the entire combined sewer system will allow us the tool to both analyze our existing system for deficiencies and run what-if scenarios.

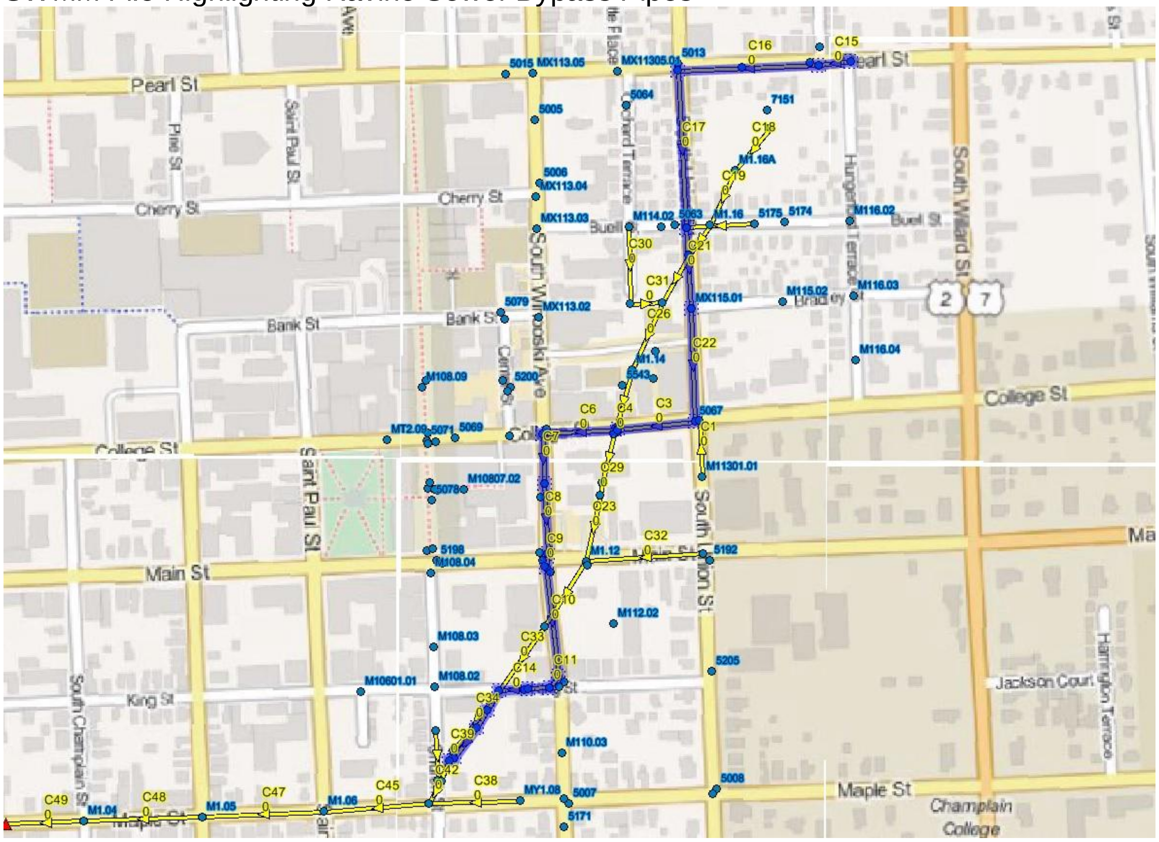
SWMM File Highlighting Ravine Sewer



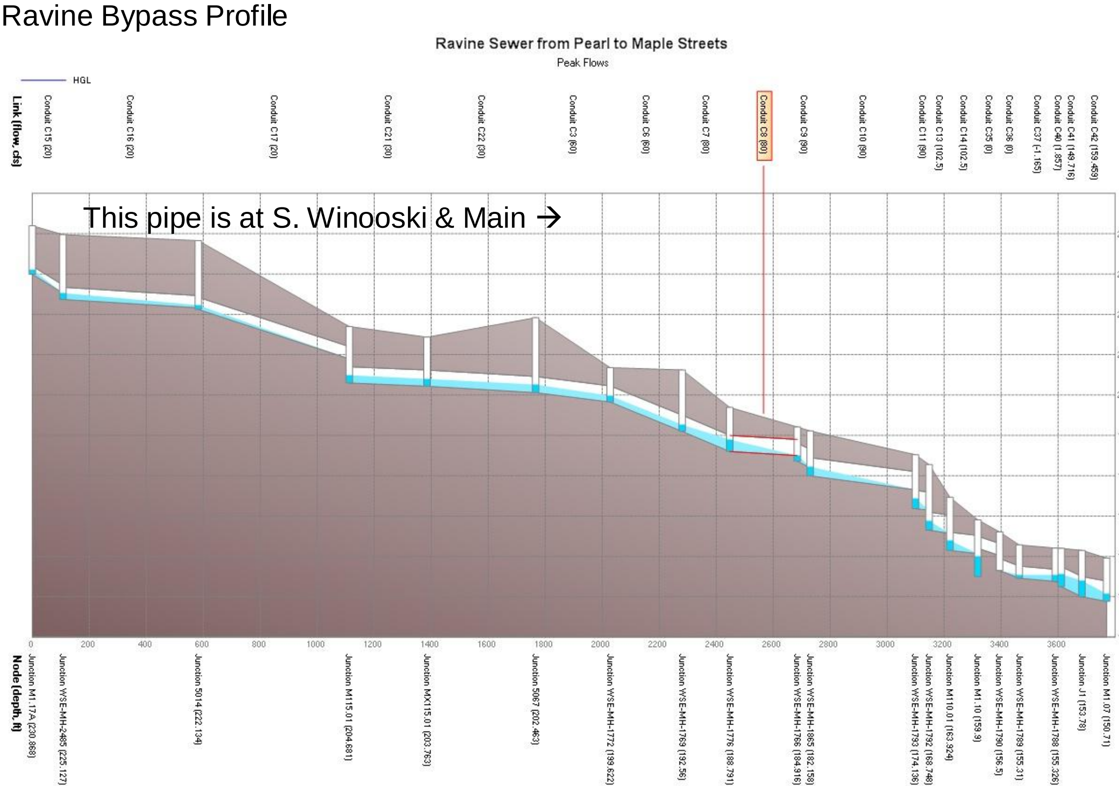
Ravine Sewer Peak Flows



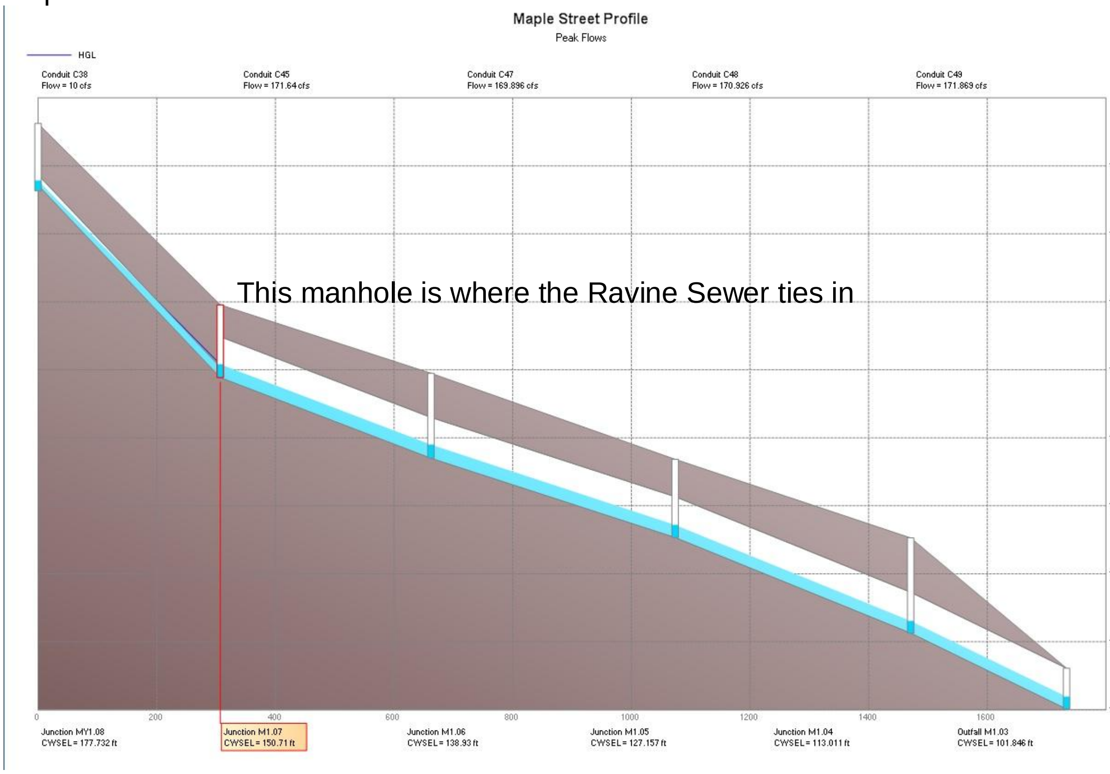
SWMM File Highlighting Ravine Sewer Bypass Pipes



Ravine Bypass Profile



Maple Street Profile



Flooding at Main & S. Winooski (courtesy Burlington Free Press)

Flooding on King Street (courtesy Amber Thibault, Burlington Telecom)

Flooding in Hood Plant Parking Lot (courtesy Hugo Martinez)