



Fellowship Baptist Church Drainage Calculations

3733 Snook Road South
Lebanon Warren County, Ohio
S-32, T-5, R-3
5.6740 Acres July 21, 2015

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The Fellowship Baptist Church Facility site is located at the crest of a hill with storm water draining in three principal directions (see Pre-development Drainage Map). Due to the existing development, terrain and heavily wooded areas the storm water collection, detention and conveyance system is designed to address the proposed addition only.

Presently 1.06 acres of the 5.674 acre site is impervious surface, 2.37 acres is grassed area, and 2.24 acres is heavily wooded. With the proposed building addition and new dock area the total paved area will be 1.22 acres, the grass area will be 2.21 acres and the wooded area will remain 2.24 acres.

A dry pond with 0.13 acres surface area is proposed to detain storm water from the proposed addition. The outlet structure is designed to provide 48 hours of detention for the first 0.75" of rainfall. This draw down time is achieved through the use of a perforated stand pipe with an outlet orifice of 0.5".

The outlet structure is also designed to restrict the flow from the pond such that, for design year storms 1, 2, 5, 10, 25, 50, and 100, total flow peak from each principal drainage area is less after development than it was prior to development. The outlet structure also provides emergency discharge of 9.60 cfs, or 192% of the 100 year storm flow to the pond.

Hydrograph Return Period Recap

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	-----	0.075	0.131	-----	0.207	0.271	0.368	0.457	0.563	Area A
2	SCS Runoff	-----	1.676	2.740	-----	4.136	5.314	7.069	8.688	10.61	Area B
3	SCS Runoff	-----	2.313	3.708	-----	5.530	7.090	9.402	11.48	13.95	Area C
5	SCS Runoff	-----	0.075	0.131	-----	0.207	0.271	0.368	0.457	0.563	Area A
6	SCS Runoff	-----	1.306	2.185	-----	3.346	4.331	5.798	7.154	8.778	Area B
7	SCS Runoff	-----	2.063	3.307	-----	4.932	6.323	8.384	10.24	12.44	Area C
8	SCS Runoff	-----	1.607	2.096	-----	2.678	3.138	3.787	4.352	5.004	To Pond
10	Reservoir	8	0.009	0.010	-----	0.011	0.031	0.115	0.282	0.832	Detention Pond
13	Combine	1, 2, 3,	3.667	5.997	-----	9.054	11.64	15.56	19.09	23.30	Combine All Existing
14	Combine	5, 6, 7, 8,	4.551	7.055	-----	10.31	13.03	17.07	20.69	24.99	Combined Developed
15	Combine	5, 6, 7, 10,	3.118	5.143	-----	7.807	10.06	13.41	16.50	20.17	Routed Through Pond + Direct
17	SCS Runoff	-----	2.313	3.708	-----	5.530	7.090	9.402	11.48	13.95	Area C
18	Combine	7, 10,	2.070	3.315	-----	4.941	6.333	8.395	10.25	12.70	C+Through Pond

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	0.075	2	730	331	----	-----	-----	Area A
2	SCS Runoff	1.676	2	720	4,060	----	-----	-----	Area B
3	SCS Runoff	2.313	2	726	7,896	----	-----	-----	Area C
5	SCS Runoff	0.075	2	730	331	----	-----	-----	Area A
6	SCS Runoff	1.306	2	720	3,216	----	-----	-----	Area B
7	SCS Runoff	2.063	2	726	7,042	----	-----	-----	Area C
8	SCS Runoff	1.607	2	718	3,737	----	-----	-----	To Pond
10	Reservoir	0.009	2	1446	2,423	8	734.88	3,331	Detention Pond
13	Combine	3.667	2	722	12,288	1, 2, 3,	-----	-----	Combine All Existing
14	Combine	4.551	2	720	14,326	5, 6, 7, 8,	-----	-----	Combined Developed
15	Combine	3.118	2	722	13,013	5, 6, 7, 10,	-----	-----	Routed Through Pond + Direct
17	SCS Runoff	2.313	2	726	7,896	----	-----	-----	Area C
18	Combine	2.070	2	726	9,465	7, 10,	-----	-----	C+Through Pond
1809.gpw					Return Period: 1 Year			Wednesday, Aug 26, 2015	

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

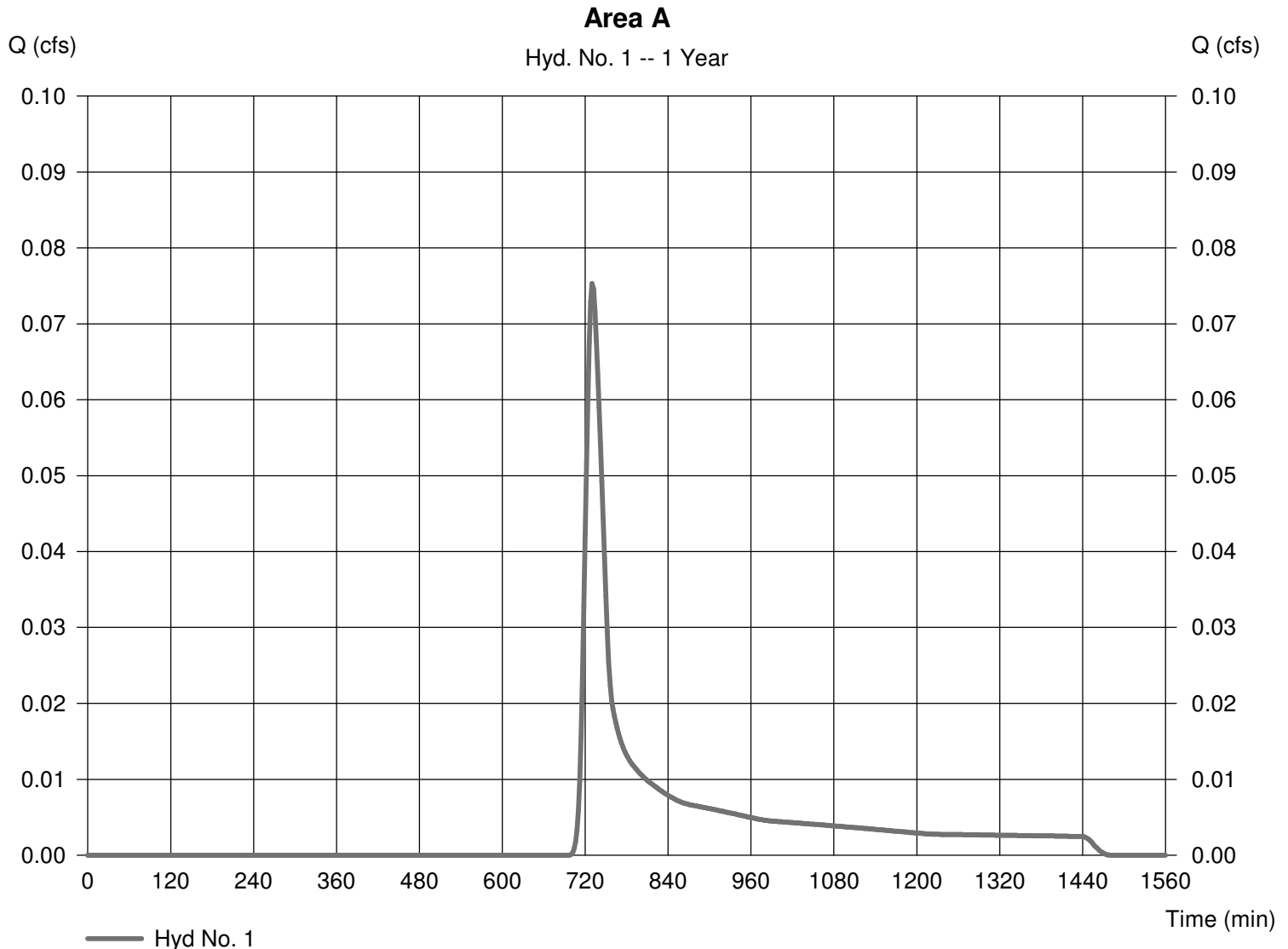
Hyd. No. 1

Area A

Hydrograph type = SCS Runoff
 Storm frequency = 1 yrs
 Time interval = 2 min
 Drainage area = 0.180 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.33 in
 Storm duration = 24 hrs

Peak discharge = 0.075 cfs
 Time to peak = 730 min
 Hyd. volume = 331 cuft
 Curve number = 74*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 25.70 min
 Distribution = Type II
 Shape factor = 484

* Composite (Area/CN) = [(0.180 x 74)] / 0.180



TR55 Tc Worksheet

Hyd. No. 1

Area A

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.240	0.011	
Flow length (ft)	= 100.0	66.0	0.0	
Two-year 24-hr precip. (in)	= 2.86	2.86	0.00	
Land slope (%)	= 4.00	1.00	0.00	
Travel Time (min)	= 11.44	+ 14.28	+ 0.00	= 25.72
Shallow Concentrated Flow				
Flow length (ft)	= 0.00	0.00	0.00	
Watercourse slope (%)	= 0.00	0.00	0.00	
Surface description	= Paved	Paved	Paved	
Average velocity (ft/s)	= 0.00	0.00	0.00	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				25.70 min

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

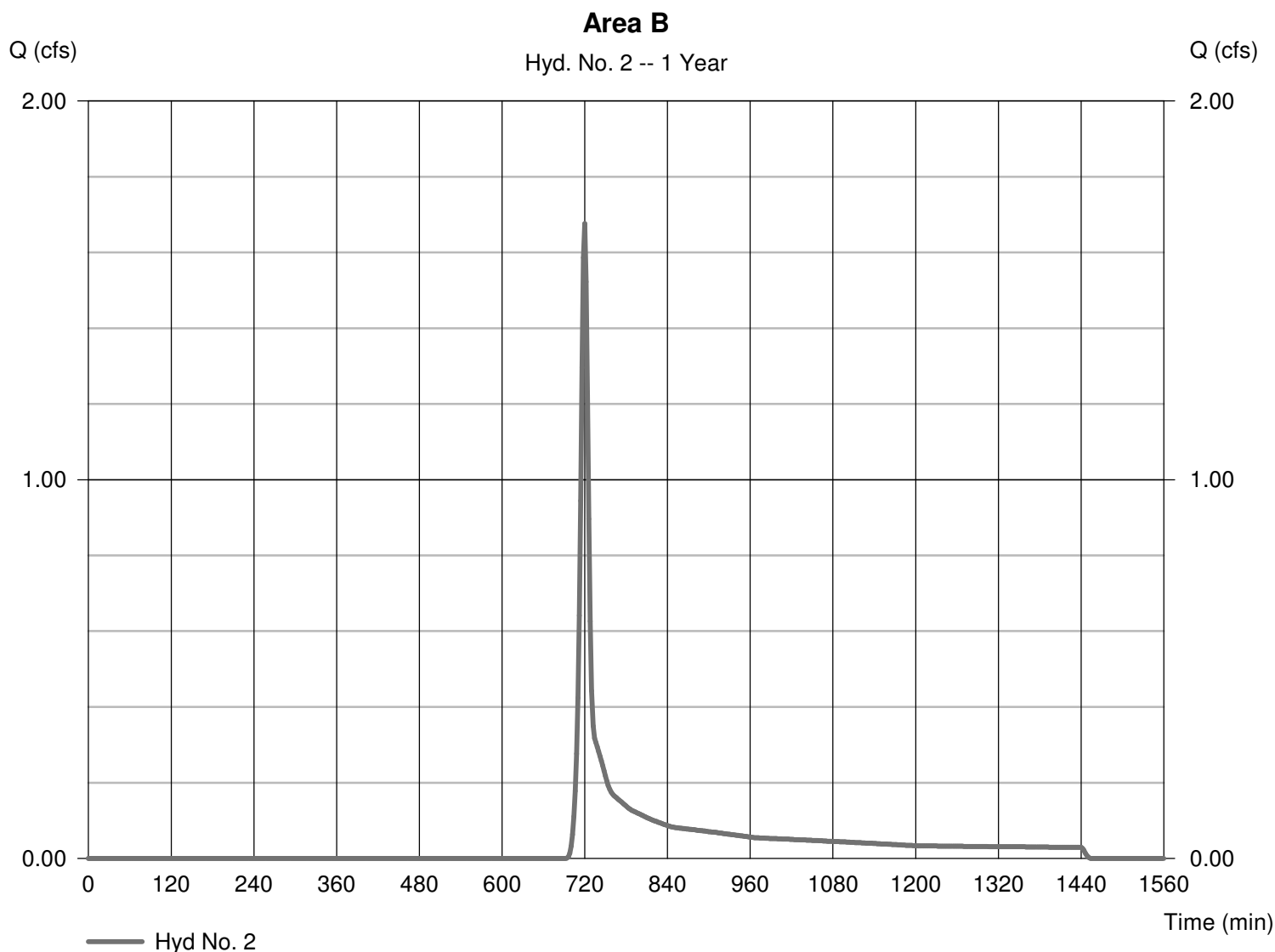
Hyd. No. 2

Area B

Hydrograph type = SCS Runoff
 Storm frequency = 1 yrs
 Time interval = 2 min
 Drainage area = 2.020 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.33 in
 Storm duration = 24 hrs

Peak discharge = 1.676 cfs
 Time to peak = 720 min
 Hyd. volume = 4,060 cuft
 Curve number = 75*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 9.80 min
 Distribution = Type II
 Shape factor = 484

* Composite (Area/CN) = $[(0.190 \times 98) + (1.010 \times 70) + (0.680 \times 74) + (0.140 \times 89)] / 2.020$



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No. 2

Area B

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 85.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.86	0.00	0.00	
Land slope (%)	= 4.70	0.00	0.00	
Travel Time (min)	= 9.42	+	0.00	+
				0.00
				= 9.42
Shallow Concentrated Flow				
Flow length (ft)	= 177.00	0.00	0.00	
Watercourse slope (%)	= 20.90	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 7.38	0.00	0.00	
Travel Time (min)	= 0.40	+	0.00	+
				0.00
				= 0.40
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
				0.00
				= 0.00
Total Travel Time, Tc				9.80 min

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

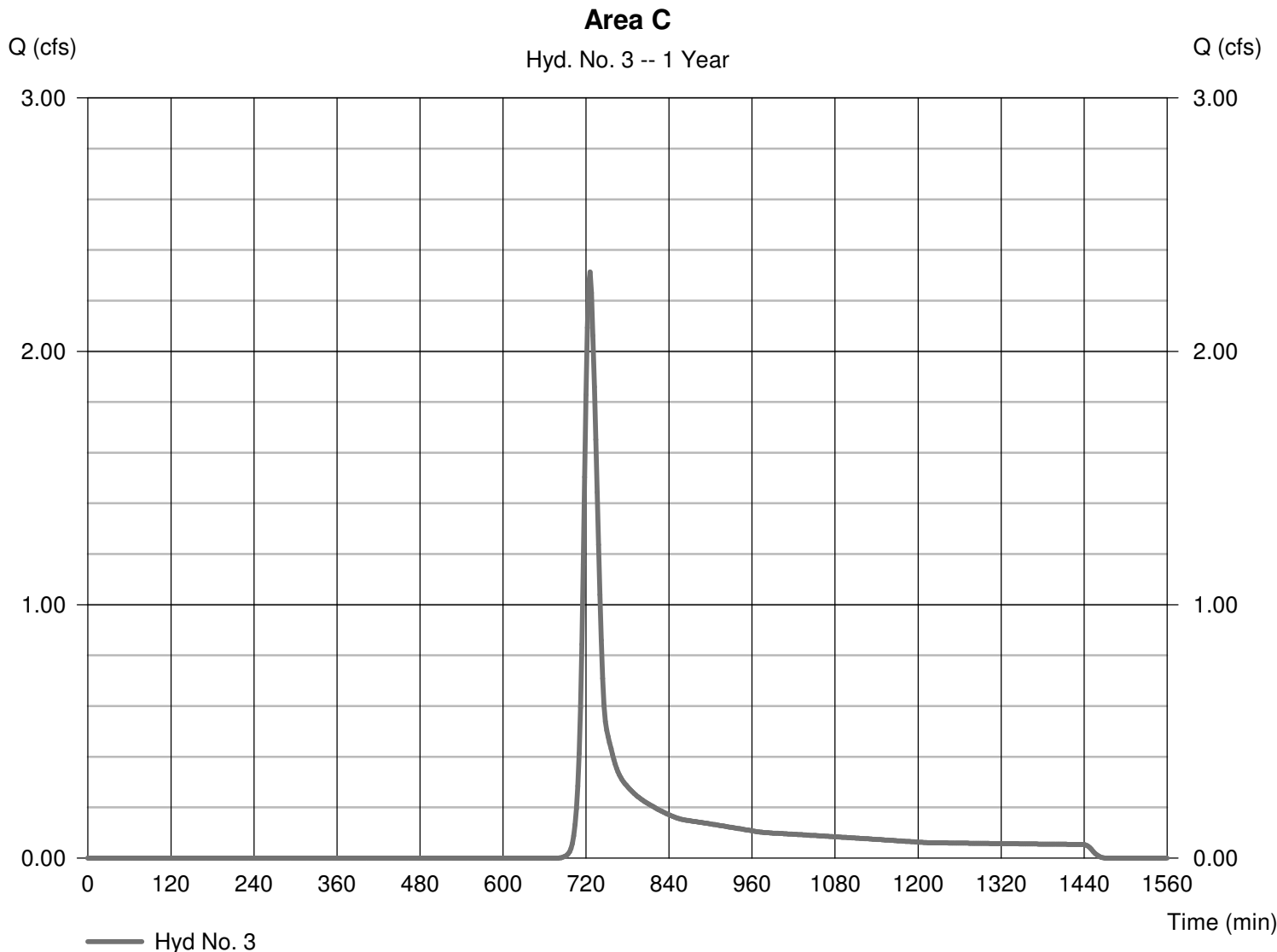
Hyd. No. 3

Area C

Hydrograph type = SCS Runoff
 Storm frequency = 1 yrs
 Time interval = 2 min
 Drainage area = 3.420 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.33 in
 Storm duration = 24 hrs

Peak discharge = 2.313 cfs
 Time to peak = 726 min
 Hyd. volume = 7,896 cuft
 Curve number = 77*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 18.70 min
 Distribution = Type II
 Shape factor = 484

* Composite (Area/CN) = [(0.600 x 98) + (1.230 x 70) + (1.460 x 74) + (0.130 x 89)] / 3.420



TR55 Tc Worksheet

Hyd. No. 3

Area C

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 132.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.86	2.86	0.00	
Land slope (%)	= 3.80	0.00	0.00	
Travel Time (min)	= 14.58	+ 0.00	+ 0.00	= 14.58
Shallow Concentrated Flow				
Flow length (ft)	= 104.00	152.00	0.00	
Watercourse slope (%)	= 1.90	18.40	0.00	
Surface description	= Paved	Unpaved	Paved	
Average velocity (ft/s)	= 2.80	6.92	0.00	
Travel Time (min)	= 0.62	+ 0.37	+ 0.00	= 0.98
Channel Flow				
X sectional flow area (sqft)	= 12.00	0.00	0.00	
Wetted perimeter (ft)	= 12.00	0.00	0.00	
Channel slope (%)	= 18.40	0.00	0.00	
Manning's n-value	= 0.800	0.015	0.015	
Velocity (ft/s)	= 0.80	0.00	0.00	
Flow length (ft)	= 152.0	0.0	0.0	
Travel Time (min)	= 3.17	+ 0.00	+ 0.00	= 3.17
Total Travel Time, Tc				18.70 min

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

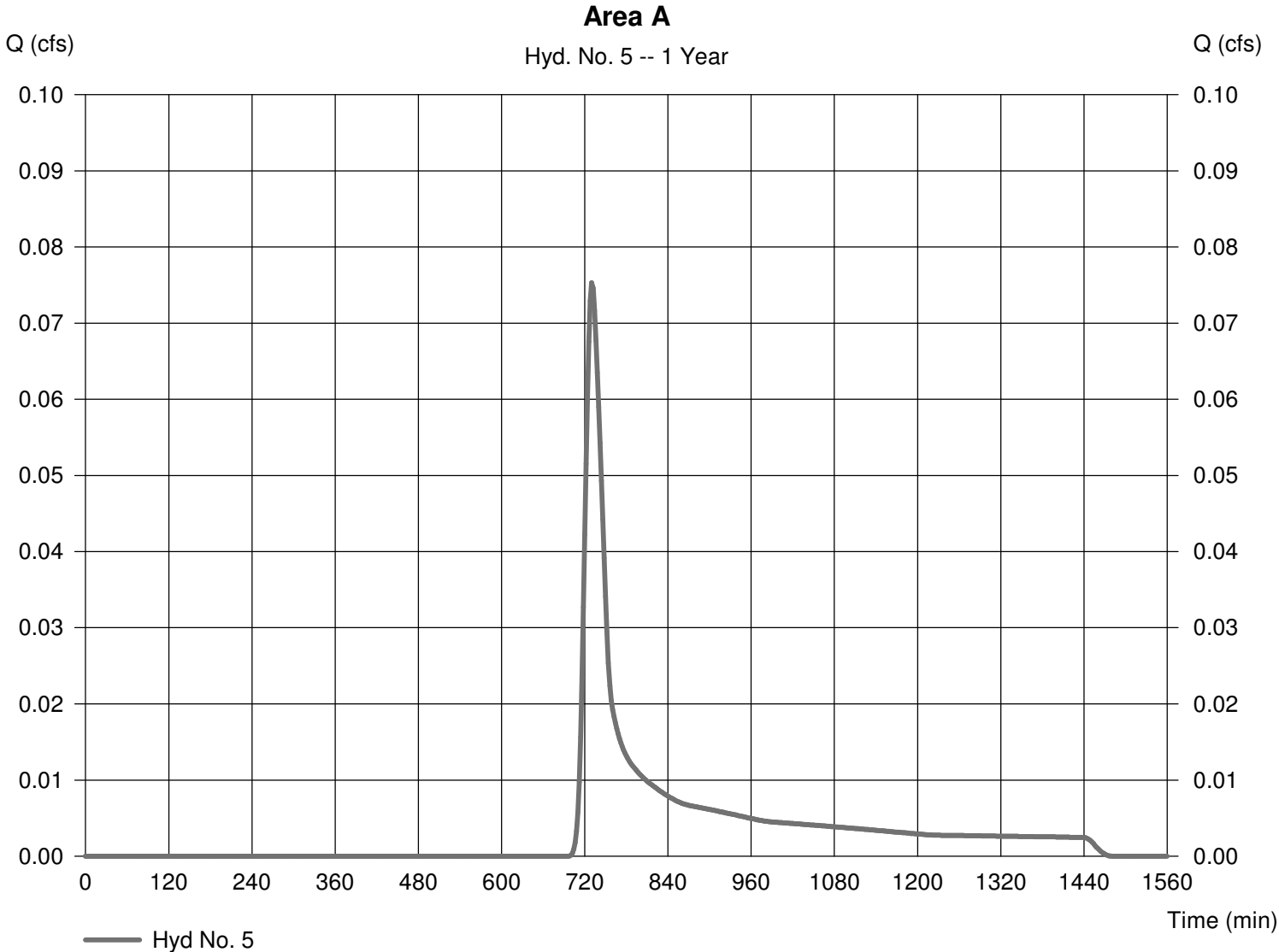
Hyd. No. 5

Area A

Hydrograph type = SCS Runoff
Storm frequency = 1 yrs
Time interval = 2 min
Drainage area = 0.180 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 2.33 in
Storm duration = 24 hrs

Peak discharge = 0.075 cfs
Time to peak = 730 min
Hyd. volume = 331 cuft
Curve number = 74*
Hydraulic length = 0 ft
Time of conc. (Tc) = 25.70 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = [(0.180 x 74)] / 0.180



TR55 Tc Worksheet

Hyd. No. 5

Area A

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.240	0.011	
Flow length (ft)	= 100.0	66.0	0.0	
Two-year 24-hr precip. (in)	= 2.86	2.86	0.00	
Land slope (%)	= 4.00	1.00	0.00	
Travel Time (min)	= 11.44	+ 14.28	+ 0.00	= 25.72
Shallow Concentrated Flow				
Flow length (ft)	= 0.00	0.00	0.00	
Watercourse slope (%)	= 0.00	0.00	0.00	
Surface description	= Paved	Paved	Paved	
Average velocity (ft/s)	= 0.00	0.00	0.00	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				25.70 min

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

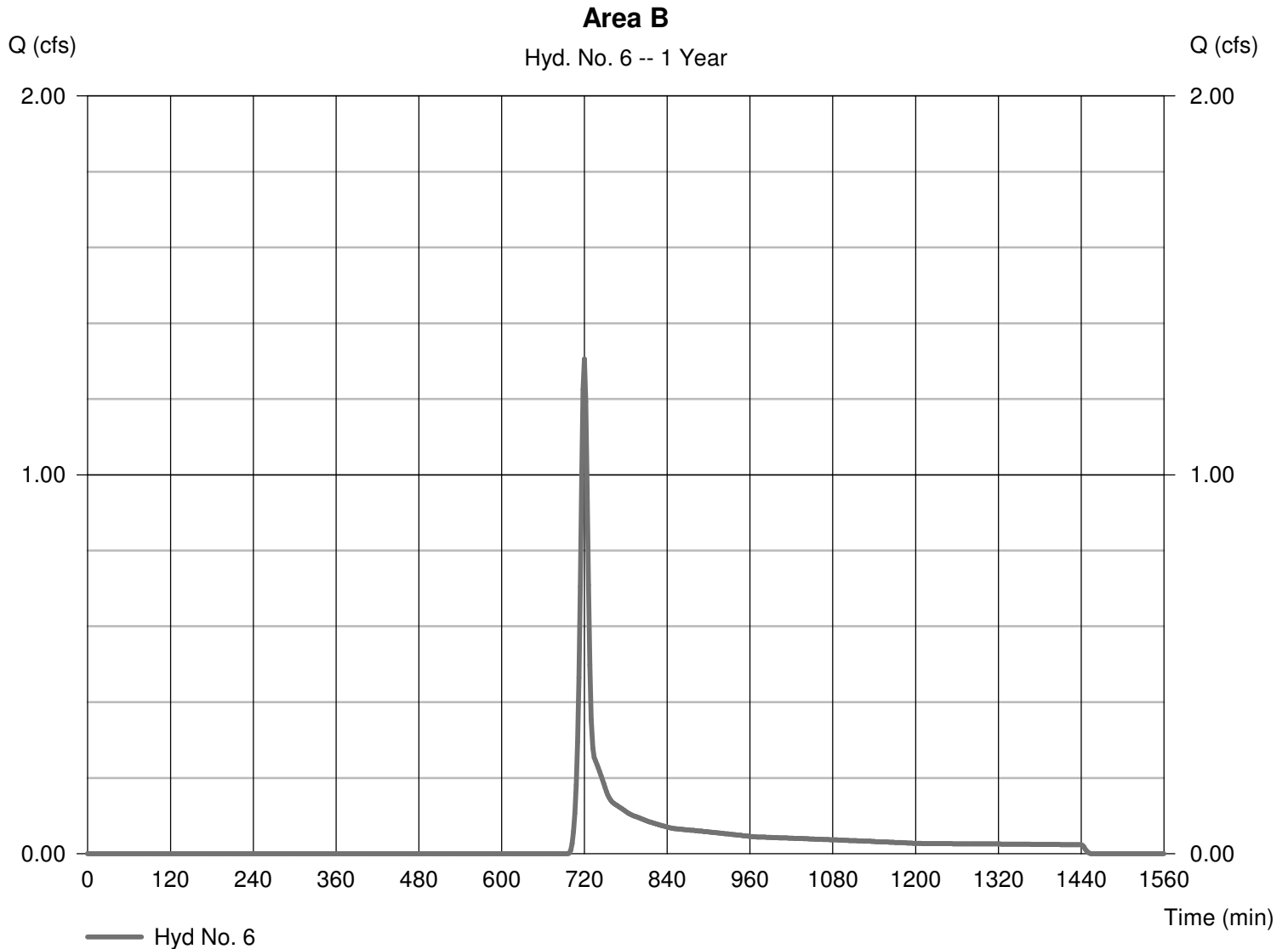
Hyd. No. 6

Area B

Hydrograph type = SCS Runoff
Storm frequency = 1 yrs
Time interval = 2 min
Drainage area = 1.720 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 2.33 in
Storm duration = 24 hrs

Peak discharge = 1.306 cfs
Time to peak = 720 min
Hyd. volume = 3,216 cuft
Curve number = 74*
Hydraulic length = 0 ft
Time of conc. (Tc) = 9.80 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = [(0.140 x 98) + (1.010 x 70) + (0.570 x 74)] / 1.720



TR55 Tc Worksheet

Hyd. No. 6

Area B

<u>Description</u>	<u>A</u>		<u>B</u>		<u>C</u>	<u>Totals</u>
Sheet Flow						
Manning's n-value	= 0.240		0.011		0.011	
Flow length (ft)	= 85.0		0.0		0.0	
Two-year 24-hr precip. (in)	= 2.86		0.00		0.00	
Land slope (%)	= 4.70		0.00		0.00	
Travel Time (min)	= 9.42	+	0.00	+	0.00	= 9.42
Shallow Concentrated Flow						
Flow length (ft)	= 177.00		0.00		0.00	
Watercourse slope (%)	= 20.90		0.00		0.00	
Surface description	= Unpaved		Paved		Paved	
Average velocity (ft/s)	= 7.38		0.00		0.00	
Travel Time (min)	= 0.40	+	0.00	+	0.00	= 0.40
Channel Flow						
X sectional flow area (sqft)	= 0.00		0.00		0.00	
Wetted perimeter (ft)	= 0.00		0.00		0.00	
Channel slope (%)	= 0.00		0.00		0.00	
Manning's n-value	= 0.015		0.015		0.015	
Velocity (ft/s)	= 0.00		0.00		0.00	
Flow length (ft)	= 0.0		0.0		0.0	
Travel Time (min)	= 0.00	+	0.00	+	0.00	= 0.00
Total Travel Time, Tc						9.80 min

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

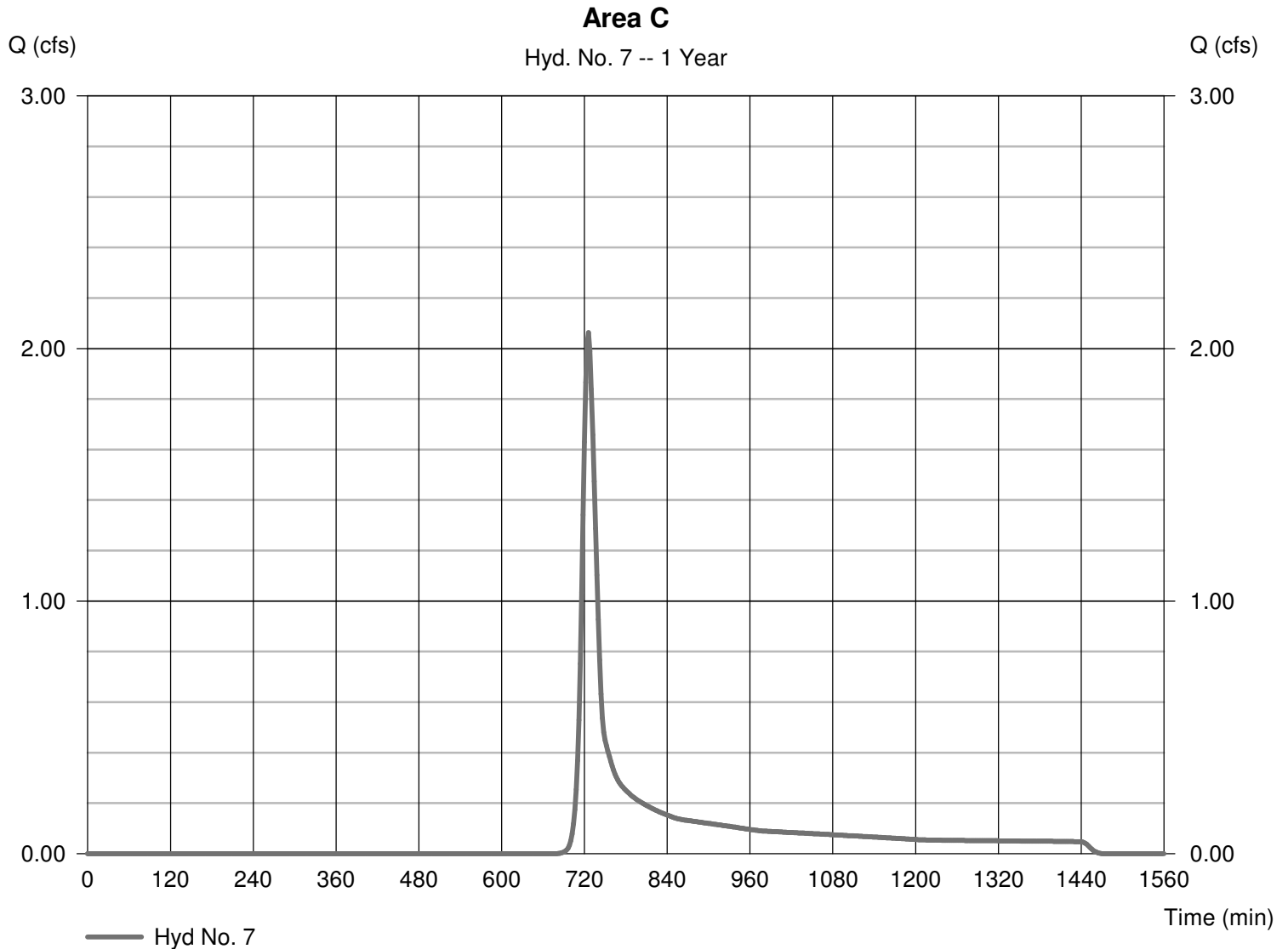
Hyd. No. 7

Area C

Hydrograph type = SCS Runoff
Storm frequency = 1 yrs
Time interval = 2 min
Drainage area = 3.050 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 2.33 in
Storm duration = 24 hrs

Peak discharge = 2.063 cfs
Time to peak = 726 min
Hyd. volume = 7,042 cuft
Curve number = 77*
Hydraulic length = 0 ft
Time of conc. (Tc) = 18.70 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = [(0.590 x 98) + (1.230 x 70) + (1.230 x 74)] / 3.050



TR55 Tc Worksheet

Hyd. No. 7

Area C

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 132.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.86	2.86	0.00	
Land slope (%)	= 3.80	0.00	0.00	
Travel Time (min)	= 14.58	+ 0.00	+ 0.00	= 14.58
Shallow Concentrated Flow				
Flow length (ft)	= 104.00	152.00	0.00	
Watercourse slope (%)	= 1.90	18.40	0.00	
Surface description	= Paved	Unpaved	Paved	
Average velocity (ft/s)	= 2.80	6.92	0.00	
Travel Time (min)	= 0.62	+ 0.37	+ 0.00	= 0.98
Channel Flow				
X sectional flow area (sqft)	= 12.00	0.00	0.00	
Wetted perimeter (ft)	= 12.00	0.00	0.00	
Channel slope (%)	= 18.40	0.00	0.00	
Manning's n-value	= 0.800	0.015	0.015	
Velocity (ft/s)	= 0.80	0.00	0.00	
Flow length (ft)	= 152.0	0.0	0.0	
Travel Time (min)	= 3.17	+ 0.00	+ 0.00	= 3.17
Total Travel Time, Tc				18.70 min

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

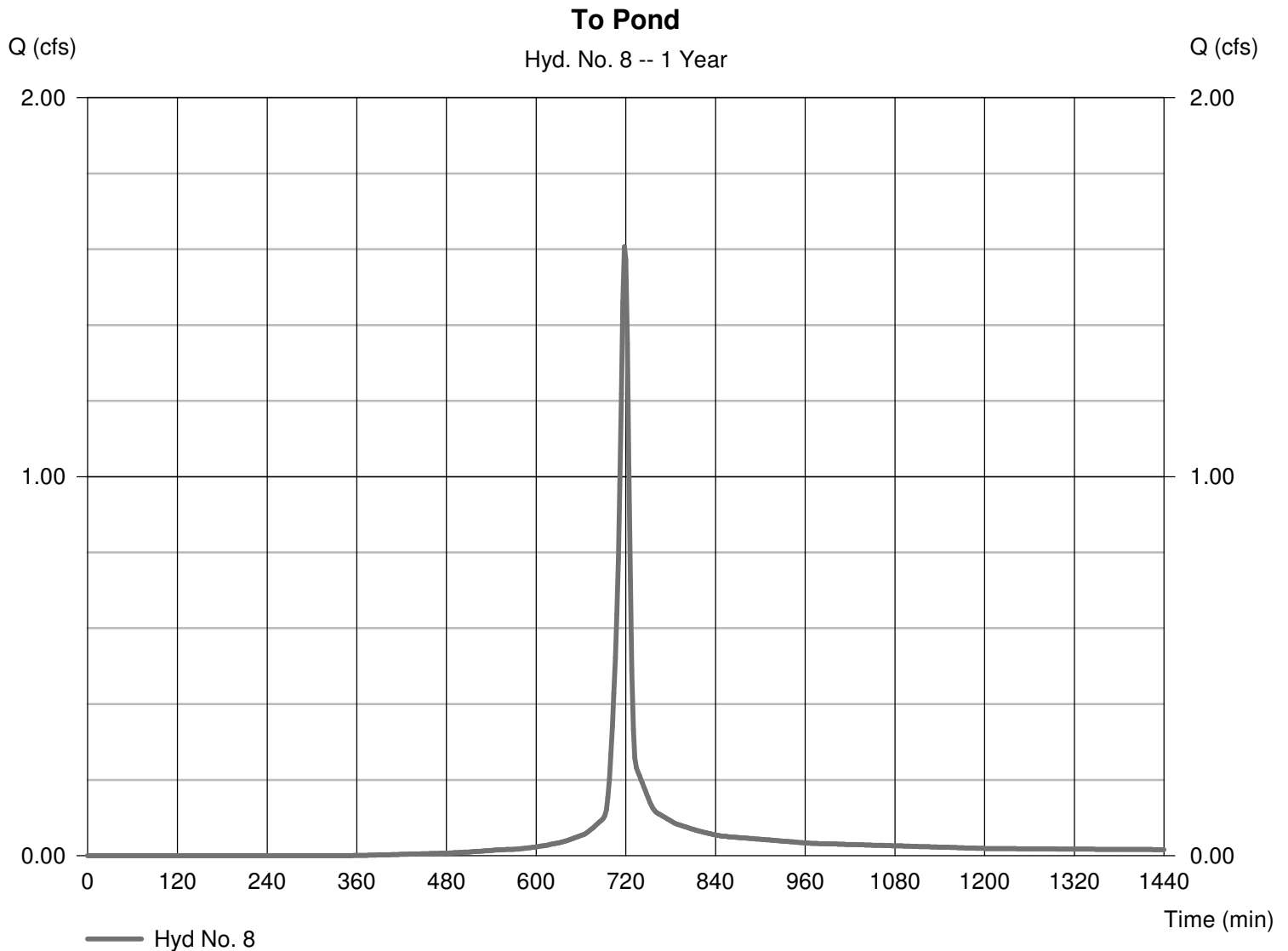
Hyd. No. 8

To Pond

Hydrograph type = SCS Runoff
 Storm frequency = 1 yrs
 Time interval = 2 min
 Drainage area = 0.670 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.33 in
 Storm duration = 24 hrs

Peak discharge = 1.607 cfs
 Time to peak = 718 min
 Hyd. volume = 3,737 cuft
 Curve number = 92*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 7.20 min
 Distribution = Type II
 Shape factor = 484

* Composite (Area/CN) = $[(0.180 \times 74) + (0.490 \times 98)] / 0.670$



TR55 Tc Worksheet

Hyd. No. 8

To Pond

<u>Description</u>	<u>A</u>		<u>B</u>		<u>C</u>	<u>Totals</u>
Sheet Flow						
Manning's n-value	= 0.150		0.011		0.011	
Flow length (ft)	= 100.0		0.0		0.0	
Two-year 24-hr precip. (in)	= 2.86		0.00		0.00	
Land slope (%)	= 5.00		0.00		0.00	
Travel Time (min)	= 7.18	+	0.00	+	0.00	= 7.18
Shallow Concentrated Flow						
Flow length (ft)	= 0.00		0.00		0.00	
Watercourse slope (%)	= 0.00		0.00		0.00	
Surface description	= Paved		Paved		Paved	
Average velocity (ft/s)	= 0.00		0.00		0.00	
Travel Time (min)	= 0.00	+	0.00	+	0.00	= 0.00
Channel Flow						
X sectional flow area (sqft)	= 0.00		0.00		0.00	
Wetted perimeter (ft)	= 0.00		0.00		0.00	
Channel slope (%)	= 0.00		0.00		0.00	
Manning's n-value	= 0.015		0.015		0.015	
Velocity (ft/s)	= 0.00		0.00		0.00	
Flow length (ft)	= 0.0		0.0		0.0	
Travel Time (min)	= 0.00	+	0.00	+	0.00	= 0.00
Total Travel Time, Tc						7.20 min

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

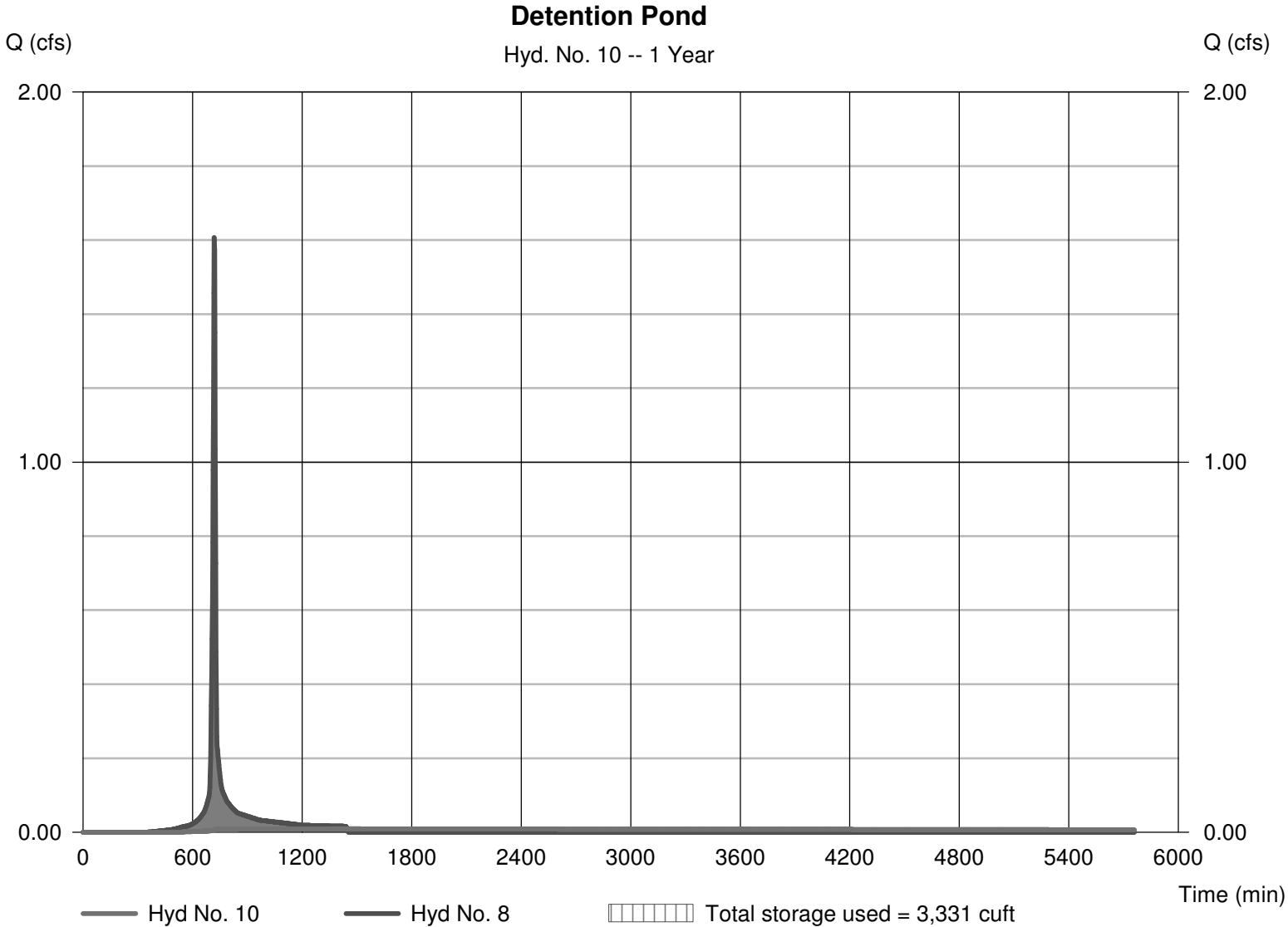
Hyd. No. 10

Detention Pond

Hydrograph type = Reservoir
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyd. No. = 8 - To Pond
Reservoir name = Pond

Peak discharge = 0.009 cfs
Time to peak = 1446 min
Hyd. volume = 2,423 cuft
Max. Elevation = 734.88 ft
Max. Storage = 3,331 cuft

Storage Indication method used.



Pond No. 1 - Pond

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 733.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	733.00	738	0	0
1.00	734.00	1,930	1,287	1,287
2.00	735.00	2,747	2,326	3,613
3.00	736.00	3,630	3,178	6,791
4.00	737.00	4,573	4,092	10,883
5.00	738.00	5,575	5,065	15,949

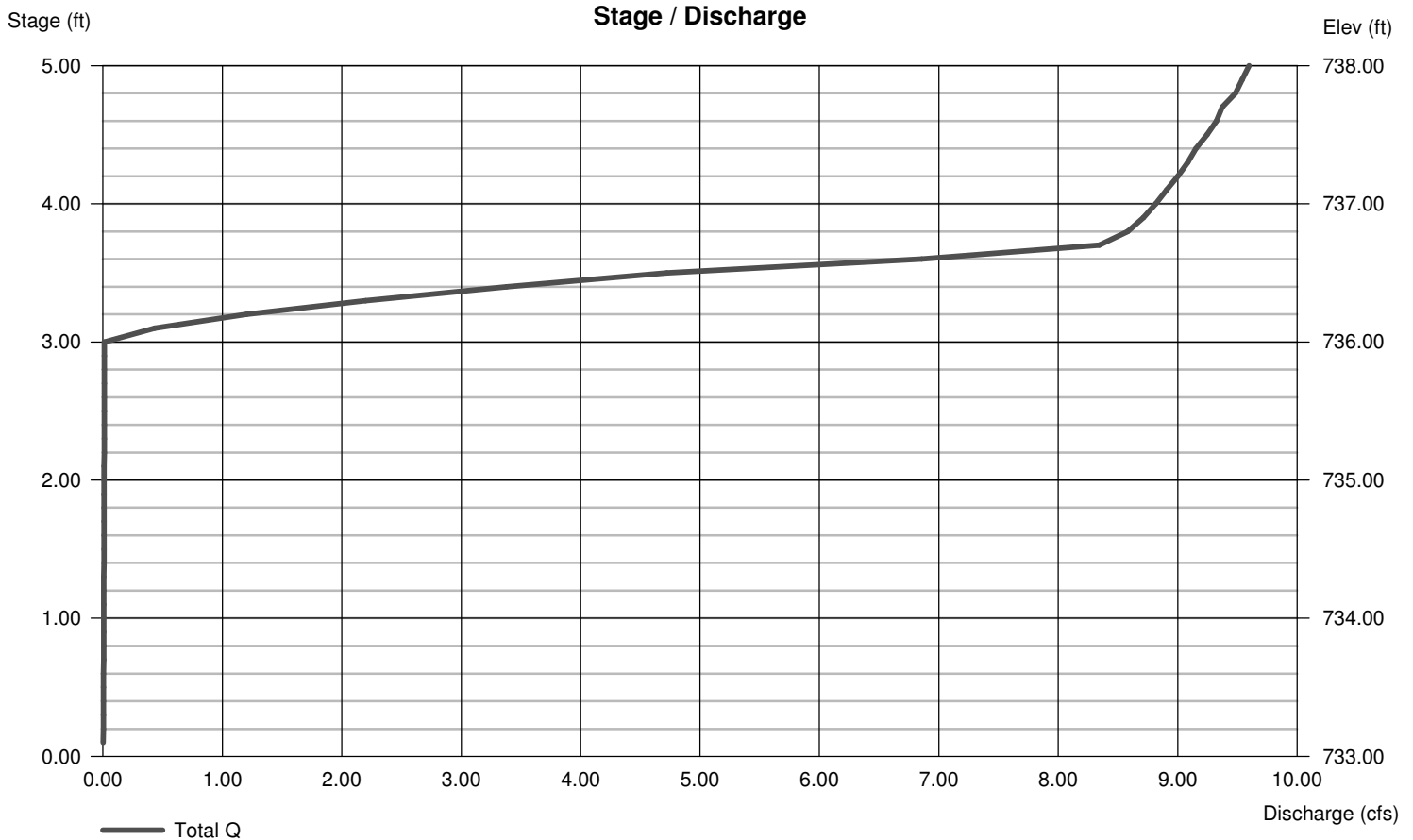
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.50	0.00	Inactive
Span (in)	= 12.00	0.50	0.00	0.50
No. Barrels	= 1	1	0	42
Invert El. (ft)	= 731.00	731.50	0.00	731.50
Length (ft)	= 120.00	0.10	0.00	1.50
Slope (%)	= 22.90	0.01	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.62
Multi-Stage	= n/a	Yes	No	Yes

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 4.00	8.00	Inactive	0.00
Crest El. (ft)	= 736.00	736.50	0.00	0.00
Weir Coeff.	= 3.33	2.60	3.33	3.33
Weir Type	= Rect	Broad	Rect	---
Multi-Stage	= Yes	Yes	Yes	No
Exfil.(in/hr)	= 0.000	(by Wet area)		
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet and outlet control. Weir risers are checked for orifice conditions.



Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

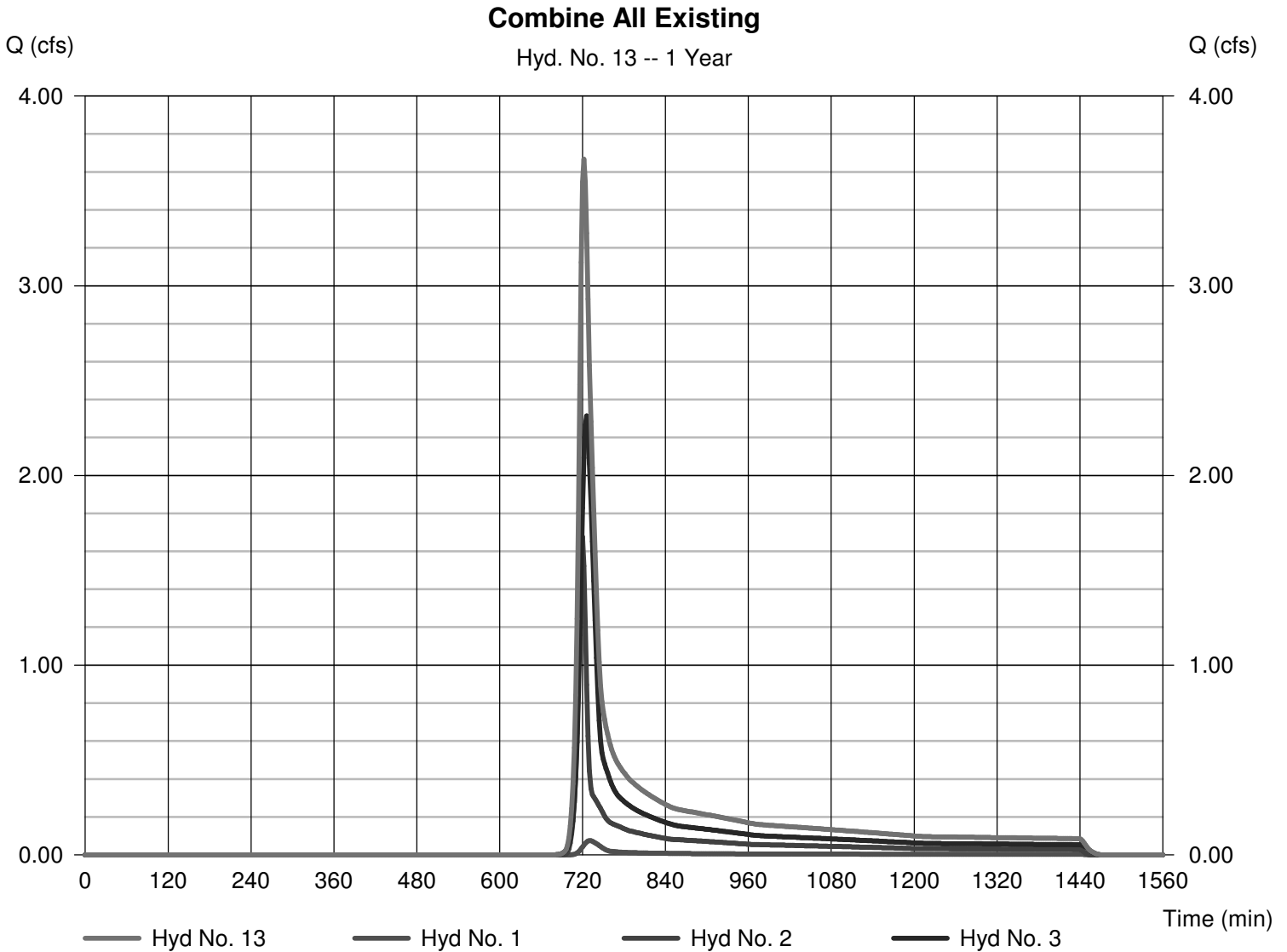
Wednesday, Aug 26, 2015

Hyd. No. 13

Combine All Existing

Hydrograph type = Combine
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyds. = 1, 2, 3

Peak discharge = 3.667 cfs
Time to peak = 722 min
Hyd. volume = 12,288 cuft
Contrib. drain. area = 5.620 ac



Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

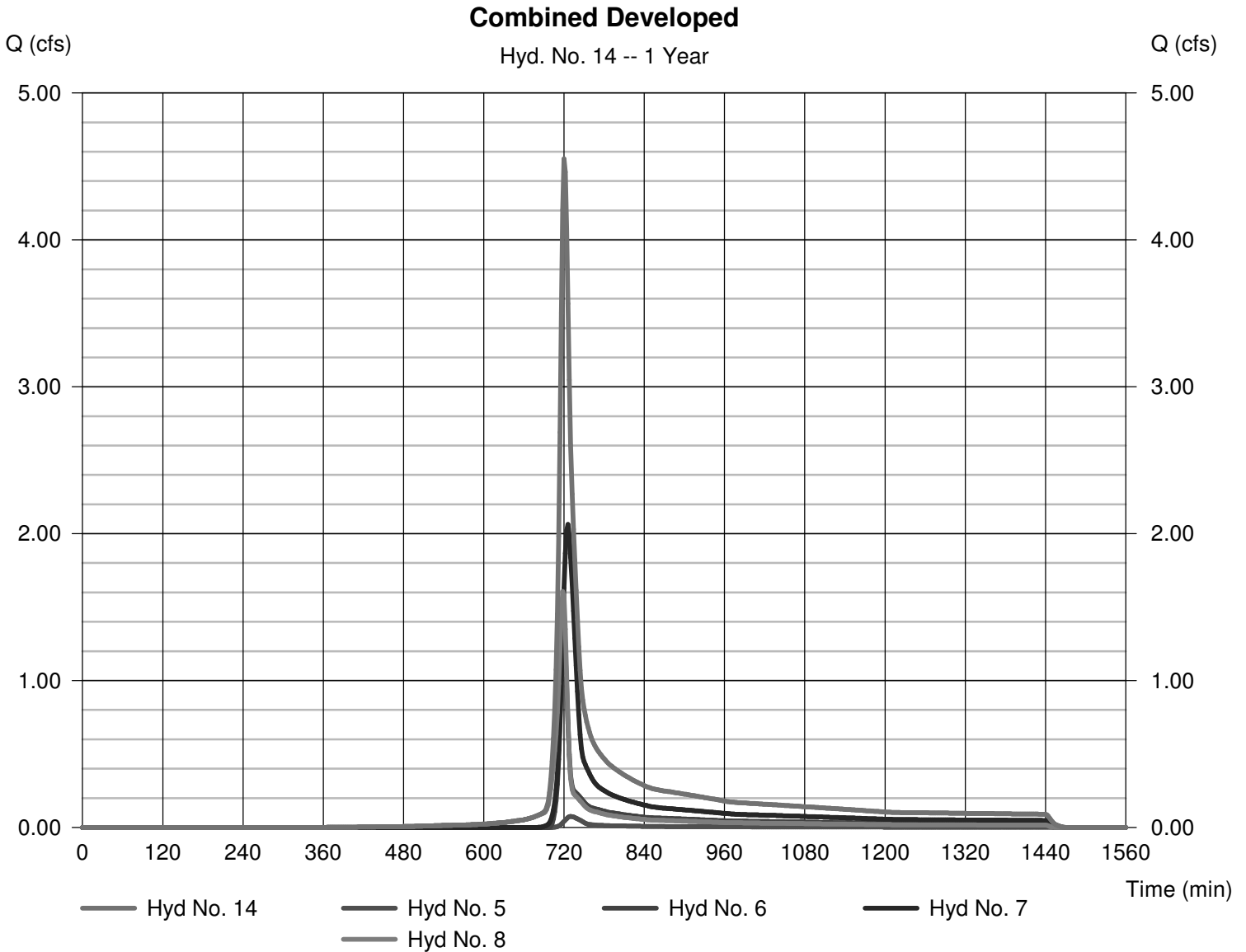
Wednesday, Aug 26, 2015

Hyd. No. 14

Combined Developed

Hydrograph type = Combine
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyds. = 5, 6, 7, 8

Peak discharge = 4.551 cfs
Time to peak = 720 min
Hyd. volume = 14,326 cuft
Contrib. drain. area = 5.620 ac



Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.02

Wednesday, Aug 26, 2015

Hyd. No. 15

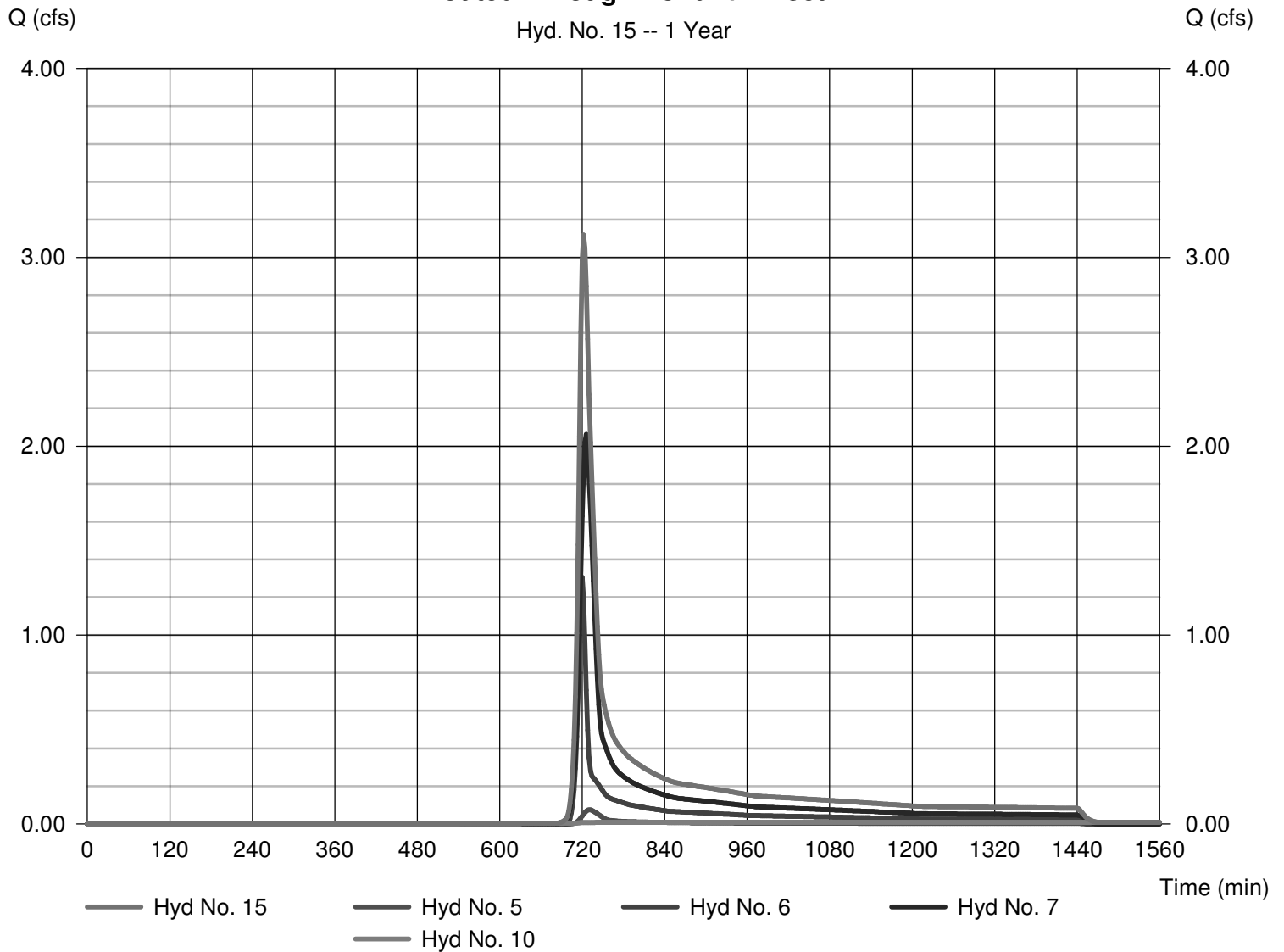
Routed Through Pond + Direct

Hydrograph type = Combine
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyds. = 5, 6, 7, 10

Peak discharge = 3.118 cfs
Time to peak = 722 min
Hyd. volume = 13,013 cuft
Contrib. drain. area = 4.950 ac

Routed Through Pond + Direct

Hyd. No. 15 -- 1 Year



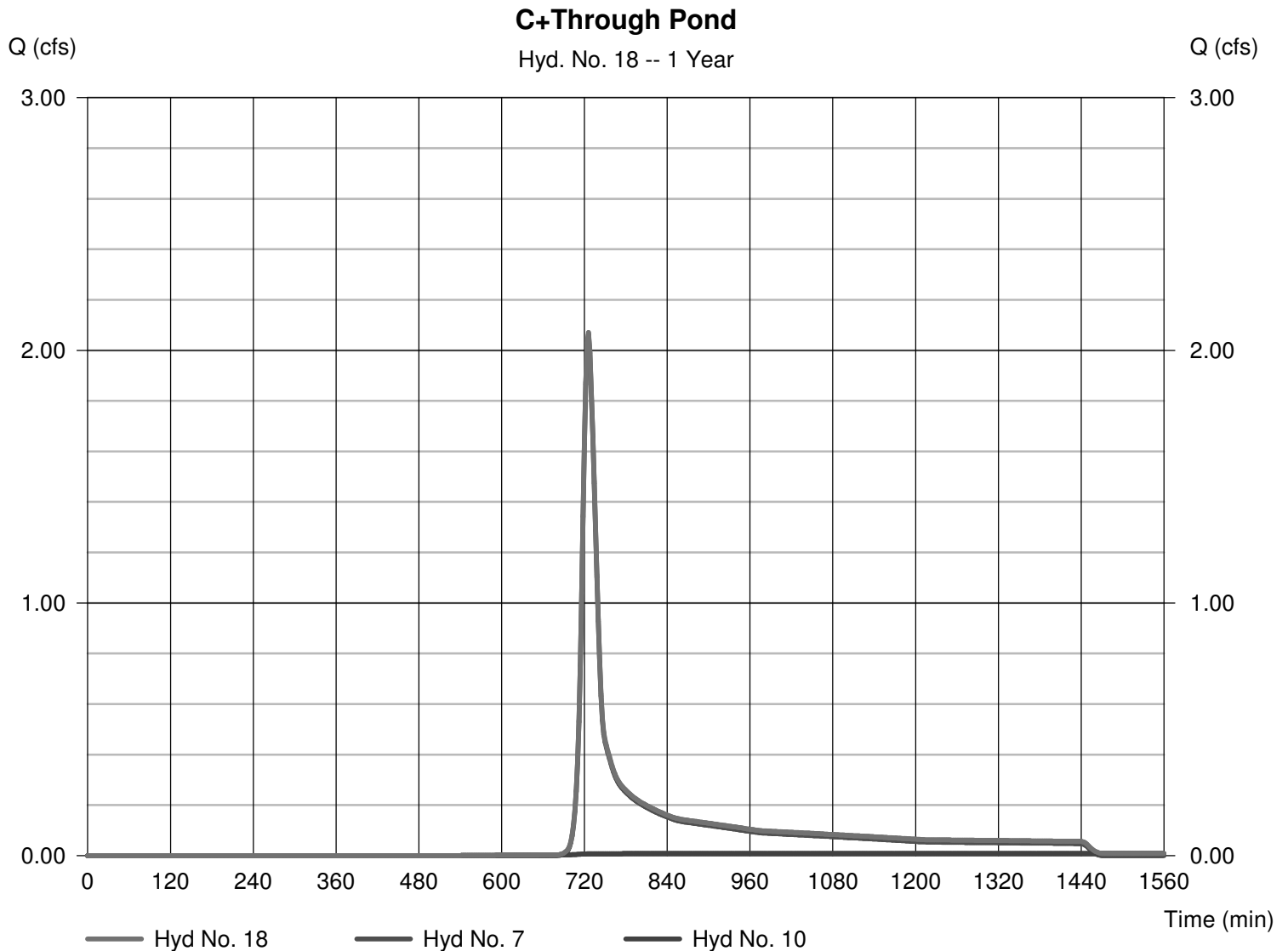
Hydrograph Report

Hyd. No. 18

C+Through Pond

Hydrograph type = Combine
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyds. = 7, 10

Peak discharge = 2.070 cfs
Time to peak = 726 min
Hyd. volume = 9,465 cuft
Contrib. drain. area = 3.050 ac



Post-Construction Storm Water Quality Orifice Design (Version 9/10/12)

Spreadsheet Created by Chris Barnes, PE, CPESC, CPSWQ, CMS4S - Assistant City Engineer, City of Canton, OH

To be used for sizing of single water quality orifice in applicable structural post-construction Best Management Practices

PROJECT LOCATION: Addition to Fellowship Baptist Church South Lebanon, Ohio

DATE: 8/24/2015
BY: RC

See Ohio EPA Construction General Permit & Post-Construction Q&A Document for details

WATER QUALITY VOLUME (WQv)

WQv = CPA/12
where WQv = Water Quality Volume (acre-ft)
Runoff Coefficient, C = value from table:

Industrial & Commercial	0.8
High Density Residential (>8 dwellings/acre)	0.5
Medium Density Residential (4 to 8 dwellings/acre)	0.4
Low Density Residential (<4 dwellings/acre)	0.3
Open Space and Recreational Areas	0.2

= 0.8 (Use composite C as necessary)

Precipitation Depth, P = 0.75 inches
Drainage Area, A = 0.67 acres
WQv = 0.03 acre-ft
WQv = 1,459 ft³

EXTENDED DETENTION VOLUME (EDv)

EDv = 0.75WQv (for Wet Extended Detention Basins)
= 1,094 ft³
EDv = WQv (for all other structural BMPs)
= 1,459 ft³

DESIGN PARAMETERS

BMP Type =
Draw-down time for selected BMP = 48 hrs (see p.23 in Ohio EPA Permit No. OHC000003)
Per page 22 in Ohio EPA Permit No. OHC000003, "the outlet structure for the post-construction BMP must not discharge more than the first half of the WQv or extended detention volume (EDv) in less than one-third of the drain time."
EDv = 1,459 ft³, as applicable for selected BMP
1/2 of WQv or EDv = 730 ft³, as applicable for selected BMP
1/3 of draw-down time = 16.00 hrs
Maximum Volume Allowed to be discharged in 16.00 hrs = 486 cf
WQ orifice invert elevation = 731.50 ft
EDv elevation = 734.48 ft (this is the elevation corresponding to the EDv, based on BMP configuration)
Maximum Hydraulic Head, H_{max} = 2.98 ft (this is the EDv depth measured from the WQ orifice invert to EDv elevation)
Orifice Coefficient, C = 0.62

OHIO EPA METHOD 1 (using design parameters above)

Average Discharge, Q_{avg} = 0.01 cfs (this is the average discharge corresponding to the draw-down time)
Maximum Discharge, Q_{max} = 0.02 cfs (this is the maximum discharge corresponding to the draw-down time)
Orifice Area, A = Q_{max}/[C(2gH_{max})^{0.5}]
= 0.002 ft²
Orifice Diameter, D = 0.60 in (This is a preliminary estimate only)
(Must route the EDv to ensure design parameters are met and adjust design accordingly...)

OHIO EPA METHOD 2 (using design parameters above)

Average Discharge, Q_{avg} = 0.01 cfs (this is the average discharge corresponding to the draw-down time)
Maximum Hydraulic Head, H_{max} = 2.98 ft (this is the EDv depth measured from the WQ orifice invert to EDv elevation)
Average Hydraulic Head, H_{avg} = 1.49 ft
Orifice Coefficient, C = 0.62
Orifice Area, A = Q_{avg}/[C(2gH_{avg})^{0.5}]
= 0.001 ft²
Orifice Diameter, D = 0.50 in
Volume discharged in 1/3 of draw-down time = 486 cf **Design parameters met. Orifice size OK.**

Manual Estimate of Water Quality Orifice Diameter (using design parameters above)

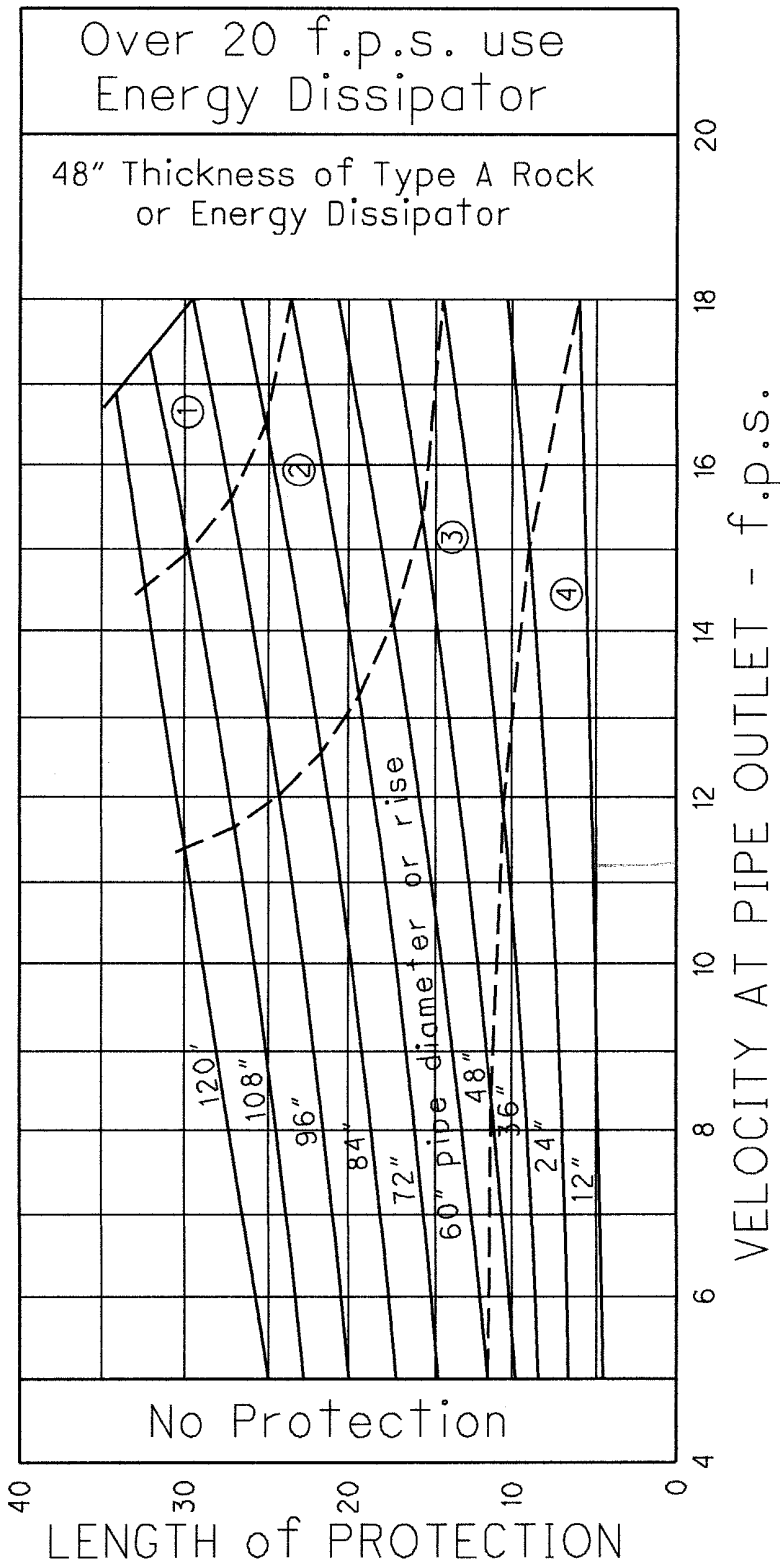
(Calculations based on EDv parameters provided above)
Orifice Diameter, D = 0.5 in
Maximum Hydraulic Head, H_{max} = 2.98 ft (this is the EDv depth measured from the WQ orifice invert to EDv elevation)
Orifice Coefficient, C = 0.62
Average Discharge, Q_{avg} = 0.01 cfs (this is the average discharge corresponding to the draw-down time)
Draw-down time = 48.94 hrs
Volume discharged in 1/3 of draw-down time = 477 cf **Design parameters met. Orifice size OK.**

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1107-1

REFERENCE SECTION

1107.2



ROCK TYPE
A A B C

LEGEND
① 48" of 18" rock
② 36" of 18" rock
③ 30" of 12" rock
④ 18" of 6" rock

NOTES
Rock size (6", 12", 18") indicates the square opening on which 85% of the material, by weight, will be retained.
The width of protection shall be the width of the headwall, with 4' being the minimum.
(Where a stream bed will withstand the calculated velocity without erosion, no rock channel protection will be required.)

$Q = 0.932$
 $V = 11.65 \text{ f.p.s.}$
5' long x 4' wide
18" deep
Type C Rock