ATTACHMENT B
DRAINAGE REPORT
FAI 80 & IL RTE 178
SECTION (50-3)HBK

LaSalle County

Prepared by:

GREENE & BRADFORD, INC.
of Springfield
Consulting Engineers
3501 Constitution Drive
Springfield, Illinois 62707
217/793-8844
G&B# 02317
November, 2004

TABLE OF CONTENTS

VOLUME 1

SECTION 1 - CROSS ROAD CULVERT ANALYSIS
SECTION 2 - ROADSIDE DITCH CAPACITY ANALYSIS & ROADSIDE DITCH LINING ANALYSIS
SECTION 3 - CHARTS AND GRAPHS
SECTION 4 - REVIEW COMMENTS

Proposed Improvements

This project is the reconstruction of the I-80 interchange with IL Route 178. The westbound ramps will be reconstructed due to increased traffic and Structure 050-0084 carrying IL Route 178 (C.H. 43) over 1-80 will be removed and replaced. The proposed cross section over I-80 will consist of one 14' through lane in each direction with a 12' left turn lane and a 6' raised median.

SECTION 1

CROSS ROAD CULVERT ANALYSIS

Cross Road Culvert Analysis

There are 8 cross road culverts within the study limits. Two of the culverts will be removed and replaced to meet the proposed alignment changes for the two north ramps.

We have contacted the Bureau of Operations and have received no information with respect to flooding problems, debris problems, channel erosion, complaints, etc. within the study limits. We have also received no information with respect to sensitive flood receptors within the project limits.

If the culvert inspections determined the culvert is in good condition and could remain in place, then the capacity of the existing culvert was checked to determine if the existing culvert could handle the proposed storm water.

The drainage areas were determined using contours created from survey data. The rational method was used to determine the flowrates for all drainage areas.

The runoff coefficient, C, was determined from a field site visit in the summer of 2003. We utilized several charts and graphs (See Section 6) and Flow Master (A software created by Haestad Methods) to determine the time of concentration, Tc. The drainage areas, runoff coefficient and time of concentration was input into a program called Hydra Flow Hydrographs 2002 and was used to check the size of the existing culverts.

The allowable headwater was determined by evaluating ditch summit elevations and proposed edge of shoulder.

The existing culvert flowlines and lengths were taken from our initial survey data. The proposed culvert flowlines and lengths were determined from our proposed cross sections.

The existing cross road culverts will be replaced with circular, concrete pipe culverts, if possible, with flared end sections.

Each cross road culvert outlet was analyzed and a recommendation has been included in this report. Two soil borings were taken near the bridge at Sta. 995+96. The soil borings indicated the existing soil at the surface was a silty loam. Table 9-503a shows that if the outlet velocity is less than 2.5 fps, no outlet protection is required; if the outlet velocity is between 2.5 fps and 6.0 fps, then a ditch lining is required until the grass has grown; and if the outlet velocity is greater than 6.0 fps, riprap should be placed at the end of the end section.

The created head was calculated for each cross road culvert. Since there were no reports of existing flooding within the project limits, we tried to maintain the existing

headwater elevation. The Culvert Hydraulics Information table shows the comparison between the created head, existing headwater elevations and proposed headwater elevations.

Summary Table for Culvert Rehabilitation Diagram

Culvert #	Station	Existing/	Culvert Barrel Description					Control
		Proposed	Dia.	Material	Type	Length	Slope	
Culvert E1	317+21 (Ramp J)	Existing	18"	RCCP	1	109	0.42%	Outlet
Culvert E2	897+00 (I-80)	Existing	24"	RCCP	1	47	0.51%	Outlet
Culvert E3	114+27 (IL 178)	Existing	24"	RCCP	1	107	0.46%	Outlet
Culvert E4	411+15 (Ramp K)	Existing	24"	RCCP	1	47	1.00%	Inlet
Culvert E5	883+00 (I-80)	Existing	24"	RCCP	1	69	1.49%	Outlet
Culvert E6	872+00 (I-80)	Existing	24"	RCCP	1	53	0.45%	Outlet
Culvert E7	115+65 (IL 178)	Existing	24"	RCCP	1	131	0.32%	Outlet
Culvert E8	210+00 (Ramp I)	Existing	24"	RCCP	1	47	1.02%	Inlet
Culvert E9	100+25, RT. (P.E.)	Existing	15"	CMP	1	32	0.78%	Outlet
Culvert E10	101+53, RT. (P.E.)	Existing	15"	CMP	1	44	0.43%	Outlet
Culvert E11	101+76, LT. (C.E.)	Existing	24"	RCCP	1	88	0.94%	Outlet
Culvert E12	102+00 (IL RTE 178)	Existing	24"	RCCP	1	82	0.40%	Outlet
Culvert E13	102+89, RT. (F.E.)	Existing	24"	CMP	1	35	0.11%	Outlet
Culvert E14	102+85, LT. (C.E.)	Existing	24"	RCP	1	129	0.26%	Outlet
Culvert E15	103+68, RT. (F.E.)	Existing	24"	CMP	1	41	1.00%	Outlet
Culvert E16	126+42, RT. (F.E.)	Existing	15"	CMP	1	35	0.49%	Outlet
Culvert E17	127+48, RT. (F.E.)	Existing	15"	CMP	1	36	0.28%	Outlet
Culvert E18	129+56, RT. (F.E.)	Existing	15"	CMP	1	24	0.38%	Outlet
Culvert E19	132+53 (IL RTE 178)	Existing	4x3	RCB	1	55	0.68%	Outlet
Culvert E20	133+07, LT. (C.E.)	Existing	15"	CMP	1	60	0.70%	Outlet
Culvert E21	103+84, LT. (C.E.)	Existing	15"	CMP	1	37	1.86%	Outlet
Culvert 1	114+27 (IL 178)							
Culvert 2	411+15 (Ramp K)	Proposed	24"	RCCP	1	50	1.00%	Inlet
Culvert 3	115+65 (IL 178)							
Culvert 4	212+00 (Ramp I)	Proposed	24"	RCCP	1	50	1.02%	Inlet
Culvert 5	100+25, RT. (P.E.)	Proposed	15"	CMP	1	32	0.78%	Outlet
Culvert 6	101+53, RT. (P.E.)	Proposed	15"	CMP	1	44	0.43%	Outlet
Culvert 7	102+89, RT. (F.E.)	Proposed	24"	CMP	1	35	0.11%	Outlet
Culvert 8	103+68, RT. (F.E.)	Proposed	24"	CMP	1	41	1.00%	Outlet
Culvert 9	103+84, LT. (C.E.)	Proposed	15"	CMP	1	37	1.86%	Outlet
Culvert 10	126+42, RT. (F.E.)	Proposed	15"	RCCP	1	35	0.49%	Outlet
Culvert 11	127+48, RT. (F.E.)	Proposed	15"	RCCP	1	36	0.28%	Outlet
Culvert 12	129+56, RT. (F.E.)	Proposed	15"	RCCP	1	24	0.38%	Outlet

DRAINAGE AREAS

LOCATION	AREA (SQ FT)	AREA (ACRES)
1	61988	1.42
2	43840	1.01
3	22232	0.51
4	94165	2.16
5	215949	4.96
6	78657	1.81
7	85920	1.97
8	327392	7.52
9	203212	4.67
10	7882	0.18
11	13574	0.31
12	12811	0.29
13	26818	0.62
14	31818	0.73
15	64159	1.47
16	25111	0.58
17	45736	1.05
18	661358	15.18
19	284137	6.52
20	94001	2.16
21	393897	9.04
22	383832	8.81
23	187930	4.31
24	80820	1.86
25	112040	2.57
26	68404	1.57

GREENE & BRADFORD CONSULTING ENGINEERS

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 10/01/03
CHECKED BY: _____ DATE: _____
SHEET: 1 OF: _____

DRAINAGE CALCULATIONS

AREA # ~~X~~ 5

$Area_{TOTAL} = 186{,}373.6\ ft^2 / (43560\ ft^2/ac) = \cancel{4.28}\ 4.96$ acres

$AREA_{grass} = 155{,}726.5\ ft^2 / (43560\ ft^2/ac.) = 3.57$ acres

$AREA_{paved} = 4.28$ acres $- 3.57$ acres $= 0.71$ acres

$$C_W = \frac{(3.57\ ac.)(0.20) + (0.71\ ac.)(0.90)}{4.28} = \boxed{0.316}$$

$T_c = ?$

$L_1 = 18'$ $\quad S_1 = 2.08\%$ (Sheet flow)

$L_2 = 250'$ $\quad S_2 = (4'/225')(100) = 1.78\%$ (Shallow Conc. Flow)

$L_3 = 587.5'$ $\quad S_3 = (3.98'/587.5')(100) = 0.68\%$ (Channel Flow)

$Q_{50} = \cancel{11.46}\ 13.28$ cfs

$Q_{100} = \cancel{13.44}\ 15.57$ cfs

TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve

Hyd. No. 1

Area #1
Storm frequency = yrs

Sheet Flow

Manning's n-value	= 0.011
Flow length	= 18.0 ft
Two-year 24-hr precip.	= 3.04 in
Land slope	= 2.1 %

Travel Time ..... = 0.3 min

Shallow Concentrated Flow

Flow length	= 250 ft
Watercourse slope	= 1.8 %
Surface description	= Unpaved
Average velocity	= 2.15 ft/s

Travel Time ..... = 1.9 min

Channel Flow

Cross section flow area	= 6.8 sqft
Wetted perimeter	= 12.0 ft
Channel slope	= 0.7 %
Manning's n-value	= 0.050
Velocity	= 1.68 ft/s
Flow length	= 587.5 ft

Travel Time ..... = 5.8 min

Total Travel Time, Tc ..... = 8.1 min

Hydrograph Plot

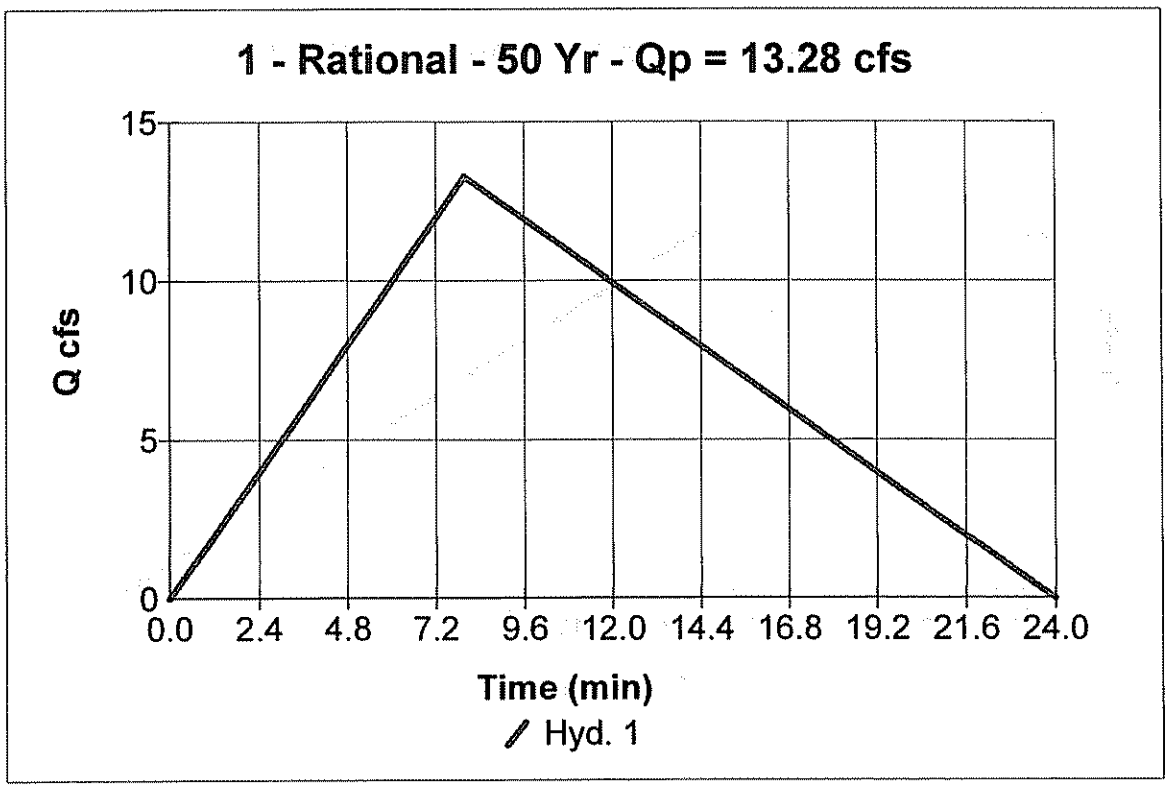
Hydraflow Hydrographs by Intelisolve

Hyd. No. 1

Area #5

Hydrograph type	= Rational	Peak discharge	= 13.28 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 5.0 ac	Runoff coeff.	= 0.32
Intensity	= 8.367 in/hr	Time of conc. (Tc)	= 8 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 9,561 cuft



Hydrograph Plot

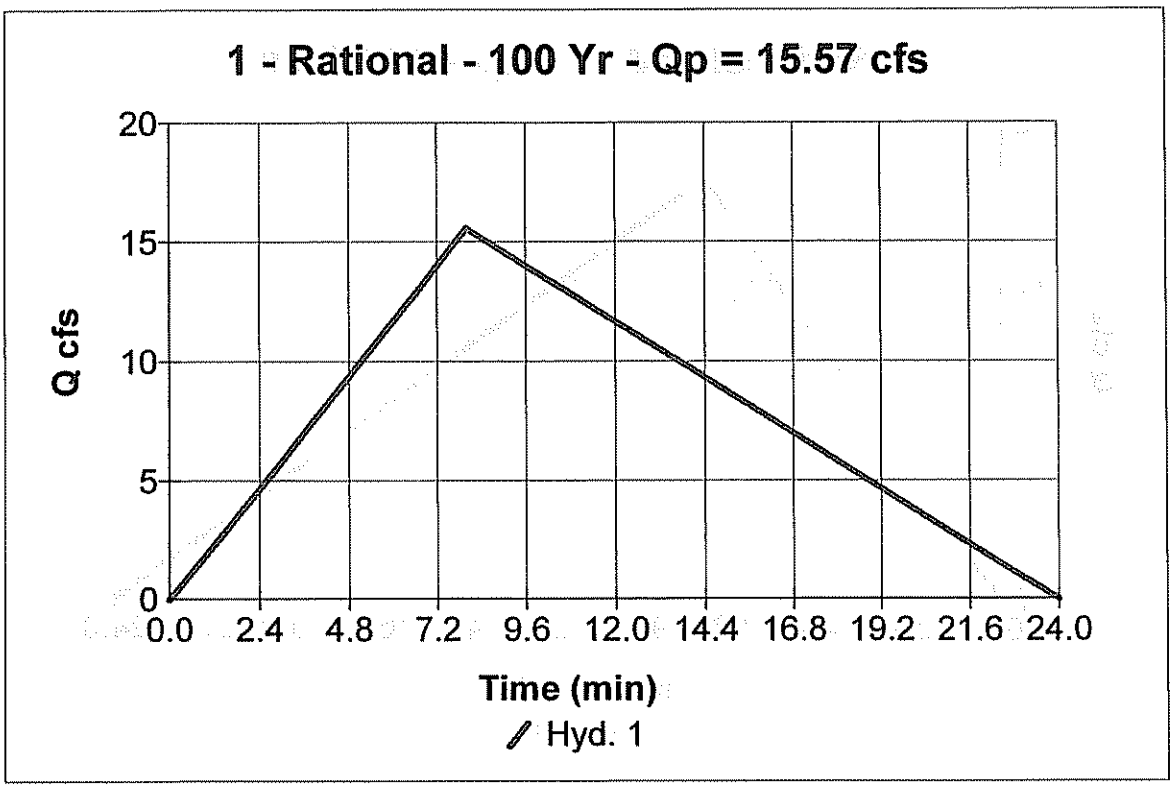
Hydraflow Hydrographs by Intelisolve

Hyd. No. 1

Area #5

Hydrograph type	= Rational	Peak discharge	= 15.57 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 5.0 ac	Runoff coeff.	= 0.32
Intensity	= 9.811 in/hr	Time of conc. (Tc)	= 8 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 11,212 cuft



US PIPE CULVERT NO. E1
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.006800	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	13.28	ft^3/s

Results		
Depth	0.93	ft
Flow Area	7.59	ft^2
Wetted Perimeter	12.58	ft
Top Width	12.35	ft
Critical Depth	0.56	ft
Critical Slope	0.050215	ft/ft
Velocity	1.75	ft/s
Velocity Head	0.05	ft
Specific Energy	0.98	ft
Froude Number	0.39	
Flow is subcritical.		

US PIPE CULVERT NO. E1
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.006800	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	15.57	ft^3/s

Results		
Depth	1.00	ft
Flow Area	8.53	ft^2
Wetted Perimeter	13.27	ft
Top Width	13.02	ft
Critical Depth	0.61	ft
Critical Slope	0.049050	ft/ft
Velocity	1.83	ft/s
Velocity Head	0.05	ft
Specific Energy	1.05	ft
Froude Number	0.40	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E1

Analysis Component			
Storm Event	Design	Discharge	13.28 cfs

Peak Discharge Method: User-Specified			
Design Discharge	13.28 cfs	Check Discharge	15.57 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.020000 ft/ft	Mannings Coefficient	0.040
Depth	0.58 ft	Left Side Slope	5 H : V
Right Side Slope	5 H : V	Bottom Width	5.00 ft

Tailwater conditions for Design Storm.			
Discharge	13.28 cfs	Bottom Elevation	617.56 ft
Depth	0.58 ft	Velocity	2.93 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	13.28 cfs	621.80 ft	7.88 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E1

_ omponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	621.80	ft	Discharge	13.28	cfs
Inlet Control HW Elev	620.78	ft	Tailwater Elevation	618.14	ft
Outlet Control HW Elev	621.80	ft	Control Type	Outlet Control	
Headwater Depth/ Height	2.52				

Grades					
Upstream Invert	618.02	ft	Downstream Invert	617.56	ft
Length	109.00	ft	Constructed Slope	0.004220	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.36	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.36	ft
Velocity Downstream	7.88	ft/s	Critical Slope	0.013991	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	621.80	ft	Upstream Velocity Head	0.88	ft
Ke	0.20		Entrance Loss	0.18	ft

Inlet Control Properties					
Inlet Control HW Elev	620.78	ft	Flow Control	Submerged	
Inlet Type	Groove end w/headwall		Area Full	1.8	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E1

Analysis Component			
Storm Event	Check	Discharge	15.57 cfs

Peak Discharge Method: User-Specified			
Design Discharge	13.28 cfs	Check Discharge	15.57 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.020000 ft/ft	Mannings Coefficient	0.040
Depth	0.62 ft	Left Side Slope	5 H : V
Right Side Slope	5 H : V	Bottom Width	5.00 ft

Tailwater conditions for Check Storm.			
Discharge	15.57 cfs	Bottom Elevation	617.56 ft
Depth	0.62 ft	Velocity	3.07 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	15.57 cfs	622.87 ft	9.01 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low point on
I-80 westbound
station 896+00 elevation 624.45 ft

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E1

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	622.87	ft	Discharge	15.57	cfs
Inlet Control HW Elev	621.39	ft	Tailwater Elevation	618.18	ft
Outlet Control HW Elev	622.87	ft	Control Type	Outlet Control	
Headwater Depth/ Height	3.23				

Grades					
Upstream Invert	618.02	ft	Downstream Invert	617.56	ft
Length	109.00	ft	Constructed Slope	0.004220	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.42	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.42	ft
Velocity Downstream	9.01	ft/s	Critical Slope	0.019001	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

ɔutlet Control Properties					
Outlet Control HW Elev	622.87	ft	Upstream Velocity Head	1.21	ft
Ke	0.20		Entrance Loss	0.24	ft

Inlet Control Properties					
Inlet Control HW Elev	621.39	ft	Flow Control	Submerged	
Inlet Type	Groove end w/headwall		Area Full	1.8	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County- Utica
CALCULATED BY: WCB DATE: 10/01/03
CHECKED BY: DATE:
SHEET: 2 OF:

DRAINAGE CALCULATIONS

AREA # ~~2~~ 7

$AREA_{TOTAL} = 84,672.0\ ft^2 / (43560\ ft^2/ac.) = \cancel{1.94}\ 1.97$ acres

$AREA_{grass} = 46,171.3\ ft^2 / (43560\ ft^2/ac.) = 1.06$ acres

$AREA_{paved} = 1.94$ acres $- 1.06$ acres $= 0.88$ acres

$$C_W = \frac{(1.06\ ac.)(0.20) + (0.88\ ac.)(0.90)}{1.94} = 0.518$$

$T_C = ?$

$L_1 = 18'$ $S_1 = 2.08\%$ (Sheet Flow)

$L_2 = 237.5'$ $S_2 = (2.50'/237.5')(100) = 1.05\%$ (Shallow Conc. Flow)

$L_3 = 812.5'$ $S_3 = (1.98'/812.5)(100) = 0.24\%$ (Channel Flow)

$Q_{50} = \cancel{6.61}\ 6.65$ cfs

$Q_{100} = \cancel{7.78}\ 7.84$ cfs

TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve

Hyd. No. 2

Area #2
Storm frequency = yrs

Sheet Flow

Manning's n-value	= 0.011
Flow length	= 18.0 ft
Two-year 24-hr precip.	= 3.04 in
Land slope	= 2.1 %

Travel Time ..... = 0.3 min

Shallow Concentrated Flow

Flow length	= 238 ft
Watercourse slope	= 1.1 %
Surface description	= Unpaved
Average velocity	= 1.65 ft/s

Travel Time ..... = 2.4 min

Channel Flow

Cross section flow area	= 6.7 sqft
Wetted perimeter	= 11.9 ft
Channel slope	= 0.2 %
Manning's n-value	= 0.050
Velocity	= 0.99 ft/s
Flow length	= 812.5 ft

Travel Time ..... = 13.7 min

Total Travel Time, Tc ..... = 16.4 min

Hydrograph Plot

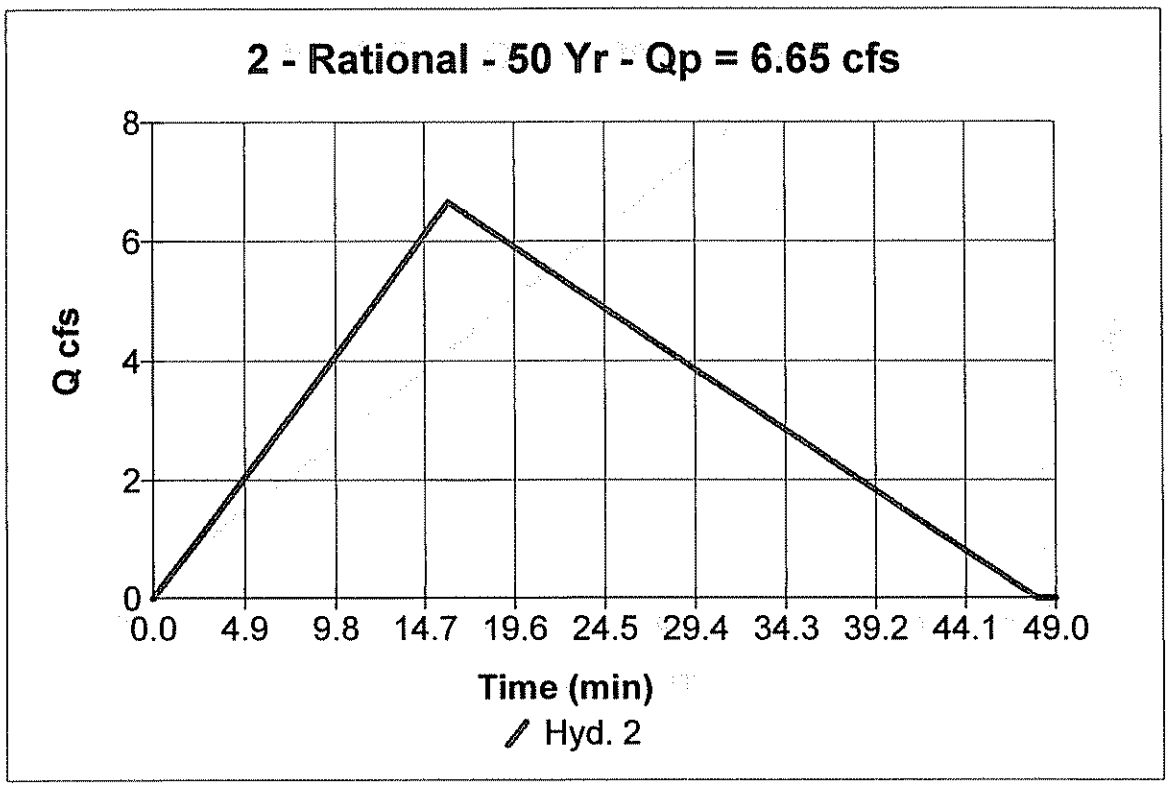
Hydraflow Hydrographs by Intelisolve

Hyd. No. 2

Area #7

Hydrograph type	= Rational	Peak discharge	= 6.65 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 2.0 ac	Runoff coeff.	= 0.52
Intensity	= 6.496 in/hr	Time of conc. (Tc)	= 16.3 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 9,762 cuft



Hydrograph Plot

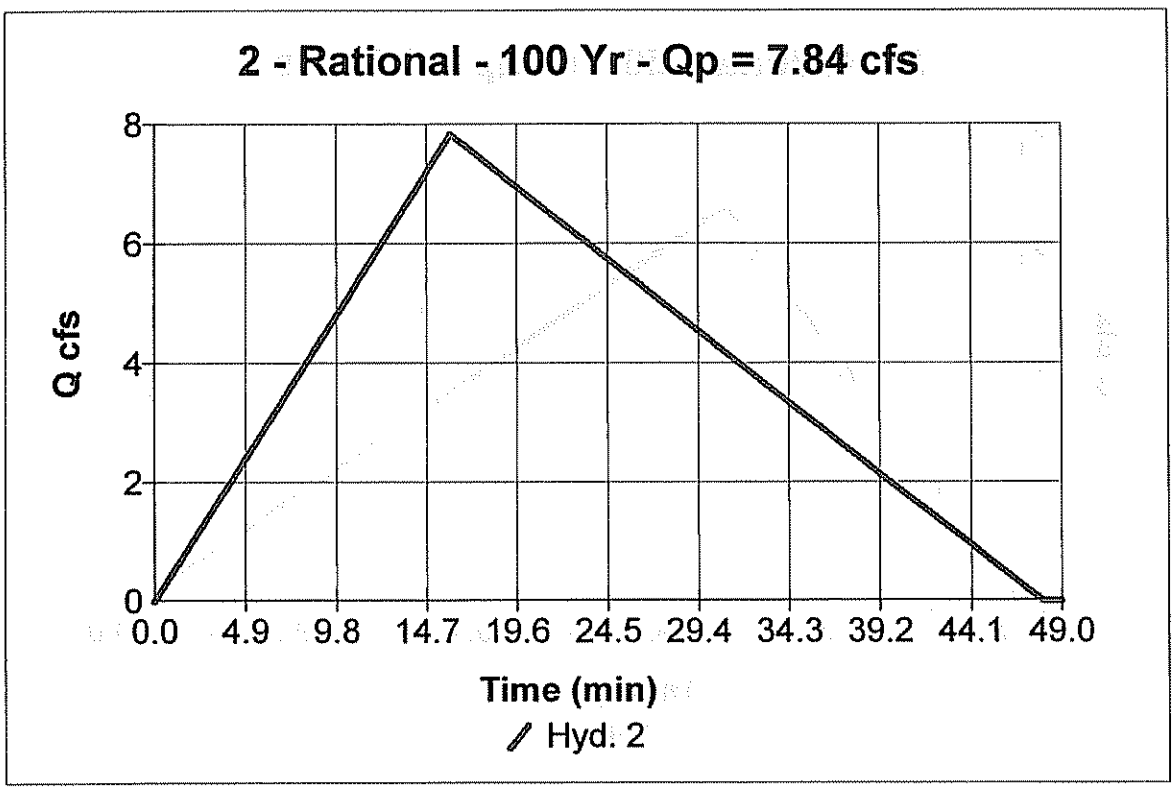
Hydraflow Hydrographs by Intelisolve

Hyd. No. 2

Area #7

Hydrograph type	= Rational	Peak discharge	= 7.84 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 2.0 ac	Runoff coeff.	= 0.52
Intensity	= 7.653 in/hr	Time of conc. (Tc)	= 16.3 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 11,501 cuft



US PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.002400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	6.65	ft^3/s

Results		
Depth	0.98	ft
Flow Area	6.71	ft^2
Wetted Perimeter	11.95	ft
Top Width	11.76	ft
Critical Depth	0.48	ft
Critical Slope	0.054831	ft/ft
Velocity	0.99	ft/s
Velocity Head	0.02	ft
Specific Energy	0.99	ft
Froude Number	0.23	
Flow is subcritical.		

US PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.002400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	7.84	ft^3/s

Results		
Depth	1.05	ft
Flow Area	7.59	ft^2
Wetted Perimeter	12.69	ft
Top Width	12.48	ft
Critical Depth	0.52	ft
Critical Slope	0.053585	ft/ft
Velocity	1.03	ft/s
Velocity Head	0.02	ft
Specific Energy	1.06	ft
Froude Number	0.23	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E2

Analysis Component			
Storm Event	Design	Discharge	6.65 cfs

Peak Discharge Method: User-Specified			
Design Discharge	6.65 cfs	Check Discharge	7.84 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	0.75 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	6.65 cfs	Bottom Elevation	620.78 ft
Depth	0.75 ft	Velocity	1.20 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	6.65 cfs	622.36 ft	4.89 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E2

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	622.36	ft	Discharge	6.65	cfs
Inlet Control HW Elev	622.31	ft	Tailwater Elevation	621.53	ft
Outlet Control HW Elev	622.36	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.67				

Grades					
Upstream Invert	621.02	ft	Downstream Invert	620.78	ft
Length	47.00	ft	Constructed Slope	0.005106	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.89	ft
Slope Type	Steep		Normal Depth	0.89	ft
Flow Regime	Supercritical		Critical Depth	0.91	ft
Velocity Downstream	4.89	ft/s	Critical Slope	0.004715	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	622.36	ft	Upstream Velocity Head	0.35	ft
Ke	0.20		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev	622.31	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E2

Analysis Component			
Storm Event	Check	Discharge	7.84 cfs

Peak Discharge Method: User-Specified			
Design Discharge	6.65 cfs	Check Discharge	7.84 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	0.82 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	7.84 cfs	Bottom Elevation	620.78 ft
Depth	0.82 ft	Velocity	1.25 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	7.84 cfs	622.49 ft	5.11 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low point elevation 624.45 ft.
@ Station 897+00 (I-80)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E2

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	622.49	ft	Discharge	7.84	cfs
Inlet Control HW Elev	622.45	ft	Tailwater Elevation	621.60	ft
Outlet Control HW Elev	622.49	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.73				

Grades					
Upstream Invert	621.02	ft	Downstream Invert	620.78	ft
Length	47.00	ft	Constructed Slope	0.005106	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.98	ft
Slope Type	Steep		Normal Depth	0.98	ft
Flow Regime	Supercritical		Critical Depth	1.00	ft
Velocity Downstream	5.11	ft/s	Critical Slope	0.004865	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

ɔutlet Control Properties					
Outlet Control HW Elev	622.49	ft	Upstream Velocity Head	0.39	ft
Ke	0.20		Entrance Loss	0.08	ft

Inlet Control Properties					
Inlet Control HW Elev	622.45	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 10/01/03
CHECKED BY: _____ DATE: _____
SHEET: 3 OF: _____

DRAINAGE CALCULATIONS

AREA #~~3~~ 9

$AREA_{TOTAL} = (257{,}068.8\ ft^2)/(43560\ ft^2/ac.) =$ ~~5.90~~ 7.52 acres

$AREA_{gross} = 213{,}865.9\ ft^2/(43560\ ft^2/ac.) = 4.91$ acres

$AREA_{parcel} = 5.90$ acres $- 4.91$ acres $= 0.99$ acres

$$C_w = \frac{(\cancel{4.91}\ 6.53\ ac.)(0.20) + (0.99\ ac.)(0.90)}{\cancel{5.90}\ 7.52} = \cancel{0.317}\ 0.29$$

$T_c = ?$

$L_1 = 18$ ft $\quad s_1 = 2.08\%$ (Sheet Flow)

$L_2 = 200$ ft $\quad s_2 = (3'/100')(100) = 2.00\%$ (Shallow Conc. Flow)

$L_3 = 750$ ft $\quad s_3 = (3'/750')(100) = 0.40\%$ (Channel Flow)

$Q_{50} =$ ~~14.76~~ 16.94 cfs

$Q_{100} =$ ~~17.35~~ 19.91 cfs

TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve

Hyd. No. 3

Area #3
Storm frequency = yrs

Sheet Flow

Manning's n-value	= 0.011
Flow length	= 18.0 ft
Two-year 24-hr precip.	= 3.04 in
Land slope	= 2.1 %

Travel Time ..... = 0.3 min

Shallow Concentrated Flow

Flow length	= 200 ft
Watercourse slope	= 2.0 %
Surface description	= Unpaved
Average velocity	= 2.28 ft/s

Travel Time ..... = 1.5 min

Channel Flow

Cross section flow area	= 10.1 sqft
Wetted perimeter	= 14.6 ft
Channel slope	= 0.4 %
Manning's n-value	= 0.050
Velocity	= 1.47 ft/s
Flow length	= 750.0 ft

Travel Time ..... = 8.5 min

Total Travel Time, Tc ..... = 10.3 min

Hydrograph Plot

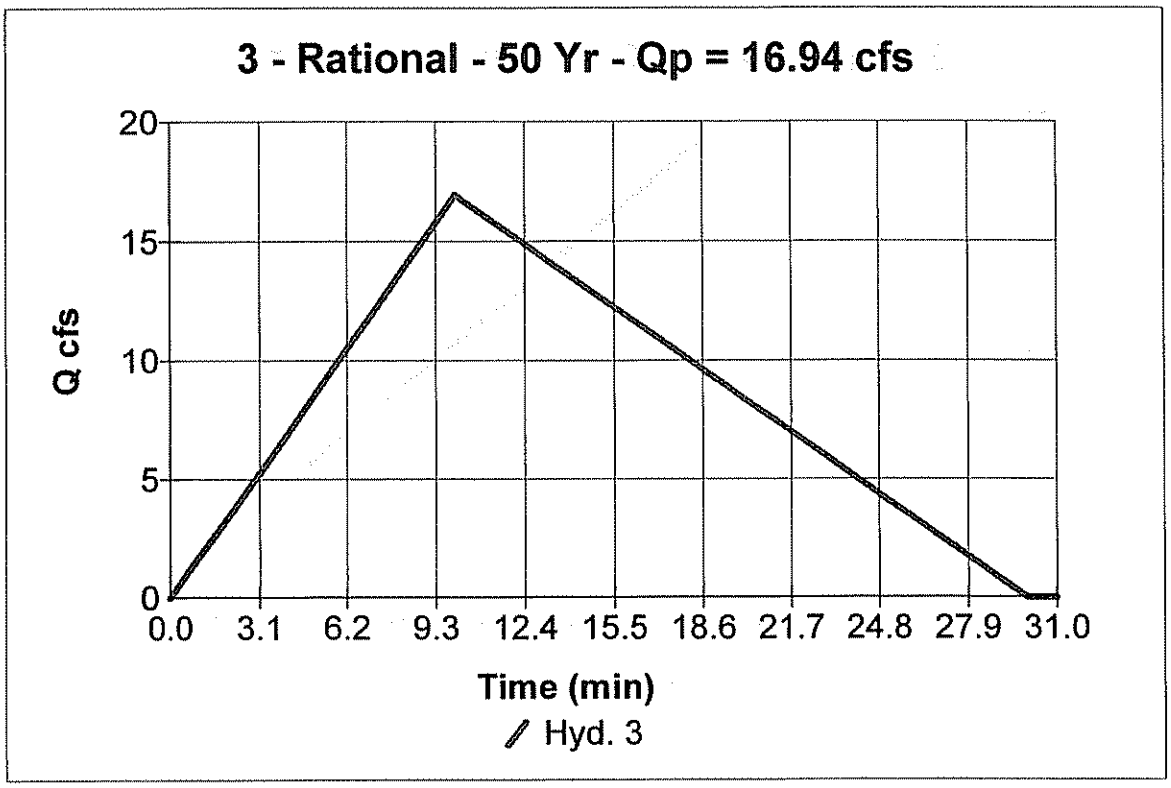
Hydraflow Hydrographs by Intelisolve

Hyd. No. 3

Area #8

Hydrograph type	= Rational	Peak discharge	= 16.94 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 7.5 ac	Runoff coeff.	= 0.29
Intensity	= 7.768 in/hr	Time of conc. (Tc)	= 10.2 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 15,552 cuft



Hydrograph Plot

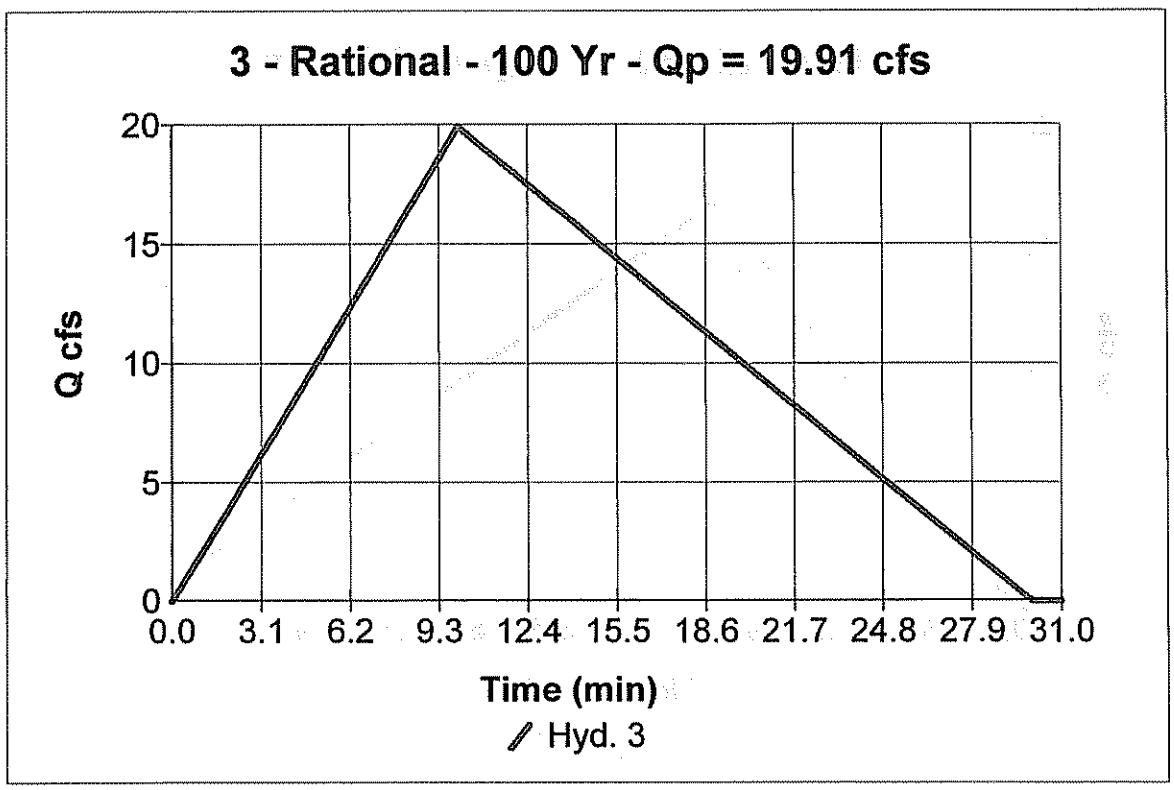
Hydraflow Hydrographs by Intelisolve

Hyd. No. 3

Area #8

Hydrograph type	= Rational	Peak discharge	= 19.91 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 7.5 ac	Runoff coeff.	= 0.29
Intensity	= 9.131 in/hr	Time of conc. (Tc)	= 10.2 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 18,280 cuft



US DITCH @ DS PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	16.94	ft^3/s

Results		
Depth	1.18	ft
Flow Area	11.03	ft^2
Wetted Perimeter	14.94	ft
Top Width	14.65	ft
Critical Depth	0.64	ft
Critical Slope	0.048450	ft/ft
Velocity	1.54	ft/s
Velocity Head	0.04	ft
Specific Energy	1.22	ft
Froude Number	0.31	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	19.91	ft^3/s

Results		
Depth	1.28	ft
Flow Area	12.43	ft^2
Wetted Perimeter	15.80	ft
Top Width	15.48	ft
Critical Depth	0.70	ft
Critical Slope	0.047329	ft/ft
Velocity	1.60	ft/s
Velocity Head	0.04	ft
Specific Energy	1.32	ft
Froude Number	0.32	
Flow is subcritical.		

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 10/01/03
CHECKED BY: _____ DATE: _____
SHEET: 4 OF: _____

DRAINAGE CALCULATIONS

AREA #~~2~~ 7 + #~~3~~ 8

$Area_{TOTAL}$ = 1.94 acres + ~~5.90~~ 7.52 acres = ~~7.84~~ 9.46 acres

$AREA_{grass}$ = 1.06 acres + ~~4.91~~ 6.53 acres = ~~5.97~~ 7.59 acres

$AREA_{paved}$ = 0.88 acres + 0.99 acres = 1.87 acres

$$C_w = \frac{(\cancel{5.97}\ 7.59\ ac.)(0.20) + (1.87\ ac.)(0.90)}{\cancel{7.84}\ 9.46} = \cancel{0.367}\ 0.34$$

Tc (~~Area #2~~) = ~~16~~ min.

Tc (~~Area #3~~) = 10 min.

Tc = 16 min. + 50 ft / 1.58 ft/sec / 60 sec/m. = 16.5 min.

Q_{50} = ~~18.50~~ cfs 21.10

Q_{100} = ~~21.79~~ cfs 24.81

Hydrograph Plot

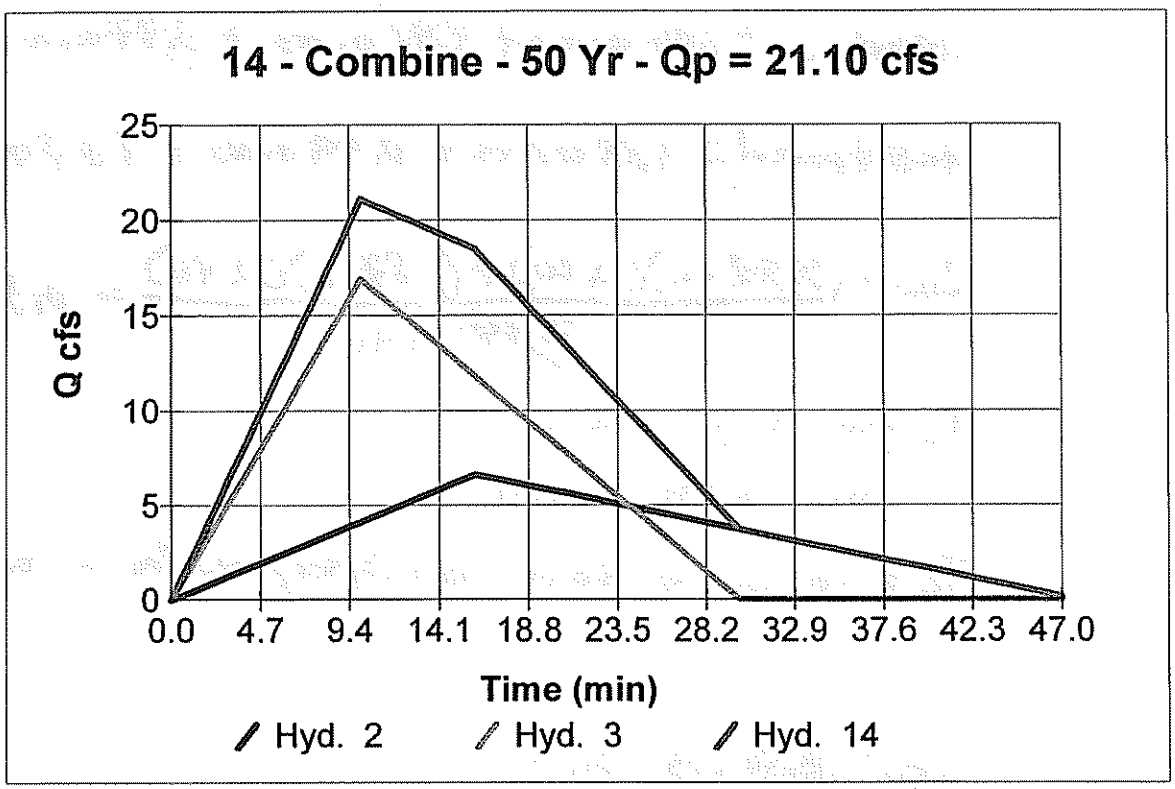
Hydraflow Hydrographs by Intelisolve

Hyd. No. 14

AREA #7 + #8

Hydrograph type	= Combine	Peak discharge	= 21.10 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 2, 3		

Hydrograph Volume = 24,829 cuft



Hydrograph Plot

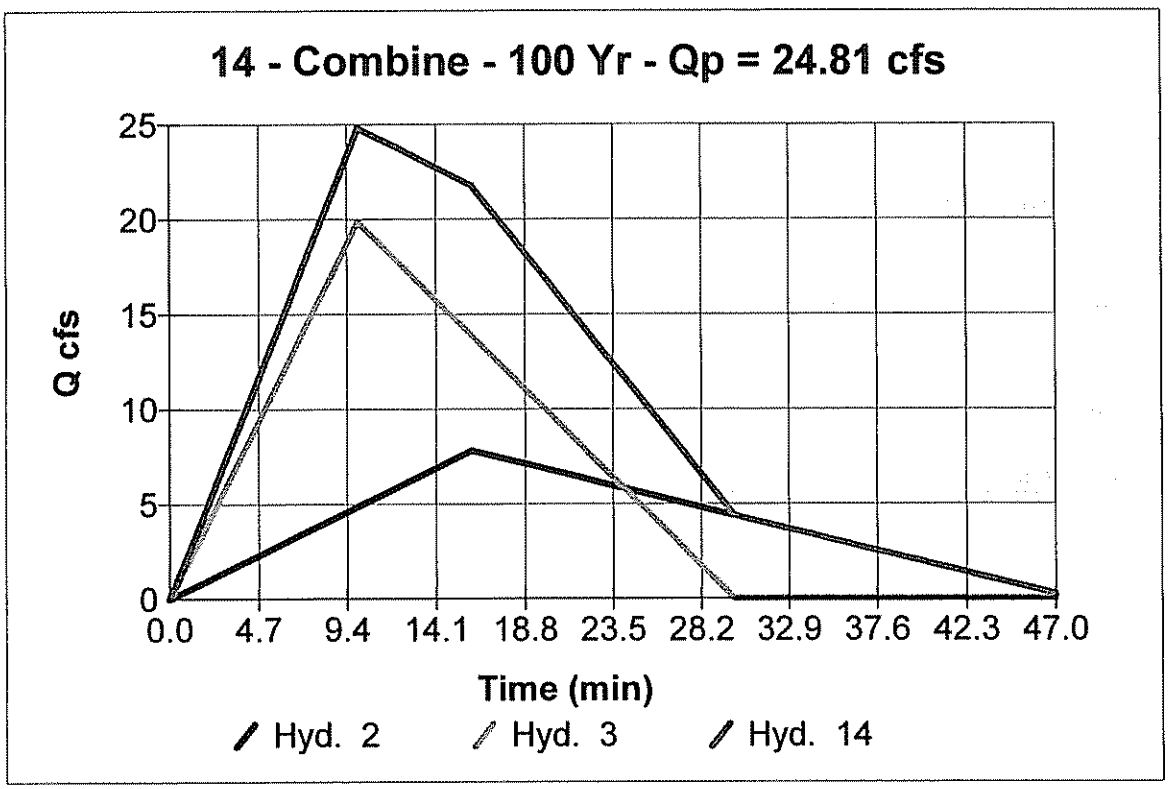
Hydraflow Hydrographs by Intelisolve

Hyd. No. 14

AREA #7 + #8

Hydrograph type	= Combine	Peak discharge	= 24.81 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 2, 3		

Hydrograph Volume = 29,210 cuft



DS DITCH @ DS PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	21.10	ft^3/s

Results		
Depth	1.31	ft
Flow Area	12.97	ft^2
Wetted Perimeter	16.12	ft
Top Width	15.80	ft
Critical Depth	0.72	ft
Critical Slope	0.046934	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.35	ft
Froude Number	0.32	
Flow is subcritical.		

DS DITCH @ DS PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	24.81	ft^3/s

Results		
Depth	1.41	ft
Flow Area	14.63	ft^2
Wetted Perimeter	17.06	ft
Top Width	16.71	ft
Critical Depth	0.79	ft
Critical Slope	0.045857	ft/ft
Velocity	1.70	ft/s
Velocity Head	0.04	ft
Specific Energy	1.46	ft
Froude Number	0.32	
Flow is subcritical.		

US PIPE CULVERT NO. E3
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E3
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	21.10	ft^3/s

Results		
Depth	1.31	ft
Flow Area	12.97	ft^2
Wetted Perimeter	16.12	ft
Top Width	15.80	ft
Critical Depth	0.72	ft
Critical Slope	0.046934	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.35	ft
Froude Number	0.32	
Flow is subcritical.		

US PIPE CULVERT NO. E3
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E3
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	24.81	ft^3/s

Results		
Depth	1.41	ft
Flow Area	14.63	ft^2
Wetted Perimeter	17.06	ft
Top Width	16.71	ft
Critical Depth	0.79	ft
Critical Slope	0.045857	ft/ft
Velocity	1.70	ft/s
Velocity Head	0.04	ft
Specific Energy	1.46	ft
Froude Number	0.32	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E3

Analysis Component			
Storm Event	Design	Discharge	21.10 cfs

Peak Discharge Method: User-Specified			
Design Discharge	21.10 cfs	Check Discharge	24.81 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	1.31 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	21.10 cfs	Bottom Elevation	620.78 ft
Depth	1.31 ft	Velocity	1.63 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	21.10 cfs	623.85 ft	6.82 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point elevation 624.51 ft
@ Station 896+00 (I-80)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E3

ɹmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	623.85	ft	Discharge	21.10	cfs
Inlet Control HW Elev	623.46	ft	Tailwater Elevation	622.09	ft
Outlet Control HW Elev	623.85	ft	Control Type	Outlet Control	
Headwater Depth/ Height	1.59				

Grades					
Upstream Invert	620.67	ft	Downstream Invert	620.18	ft
Length	105.00	ft	Constructed Slope	0.004667	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.91	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.65	ft
Velocity Downstream	6.82	ft/s	Critical Slope	0.008646	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	623.85	ft	Upstream Velocity Head	0.70	ft
Ke	0.20		Entrance Loss	0.14	ft

Inlet Control Properties					
Inlet Control HW Elev	623.46	ft	Flow Control	Submerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E3

Analysis Component			
Storm Event	Check	Discharge	24.81 cfs

Peak Discharge Method: User-Specified			
Design Discharge	21.10 cfs	Check Discharge	24.81 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	1.41 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	24.81 cfs	Bottom Elevation	620.78 ft
Depth	1.41 ft	Velocity	1.70 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	24.81 cfs	624.62 ft	7.90 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E3

omponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	624.62 ft	Discharge	24.81 cfs
Inlet Control HW Elev	623.97 ft	Tailwater Elevation	622.19 ft
Outlet Control HW Elev	624.62 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.97		

Grades			
Upstream Invert	620.67 ft	Downstream Invert	620.18 ft
Length	105.00 ft	Constructed Slope	0.004667 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	2.01 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.76 ft
Velocity Downstream	7.90 ft/s	Critical Slope	0.010844 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	624.62 ft	Upstream Velocity Head	0.97 ft
Ke	0.20	Entrance Loss	0.19 ft

Inlet Control Properties			
Inlet Control HW Elev	623.97 ft	Flow Control	Submerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

GREENE & BRADFORD CONSULTING ENGINEERS

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02 317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 10/01/02
CHECKED BY: _____ DATE: _____
SHEET: 5 OF: _____

DRAINAGE CALCULATIONS

AREA #~~4~~ 14

6.52

$AREA_{TOTAL} = 267{,}433.9\ ft^2 / (43560\ ft^2/acre) = 6.14$ acres

$AREA_{grass} = 221{,}308.9\ ft^2 / (43560\ ft^2/acre) = 5.08$ acres

$AREA_{paved} = 6.14$ acres $- 5.08$ acres $= 1.06$ acres

C = 0.31

AREA # 2 + # 3 + #4

$AREA_{TOTAL} = 7.84$ acres $+ 6.14$ acres $= 13.98$ acres

$AREA_{grass} = 5.97$ acres $+ 5.08$ acres $= 11.05$ acres

$AREA_{paved} = 1.87$ acres $+ 1.06$ acres $= 2.93$ acres

$T_c = 16.5\ min + (750\ ft / 1.60\ ft/sec / 60\ s/min) = 24.3\ min$

$Q_{50} =$ ~~26.42~~ cfs 28.29

$Q_{100} =$ ~~31.06~~ cfs 33.50

Hydrograph Plot

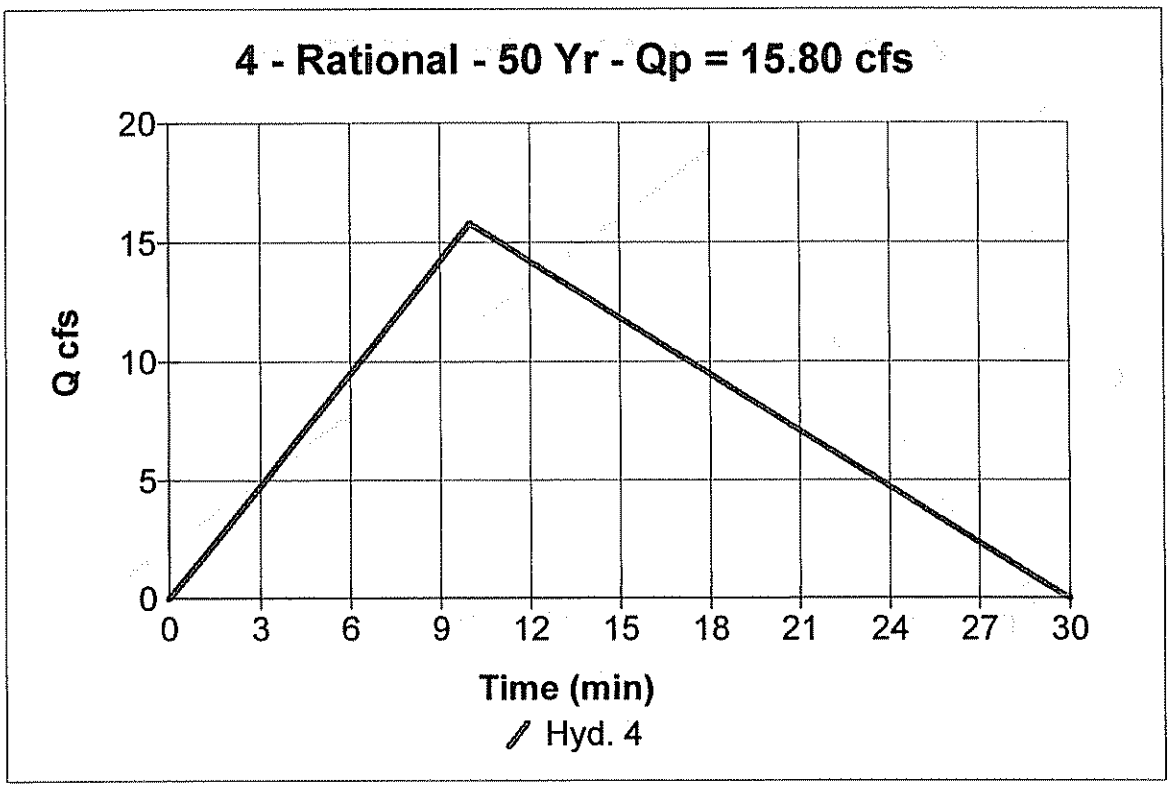
Hydraflow Hydrographs by Intelisolve

Hyd. No. 4

Area #19

Hydrograph type	= Rational	Peak discharge	= 15.80 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 6.5 ac	Runoff coeff.	= 0.31
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 14,223 cuft



Hydrograph Plot

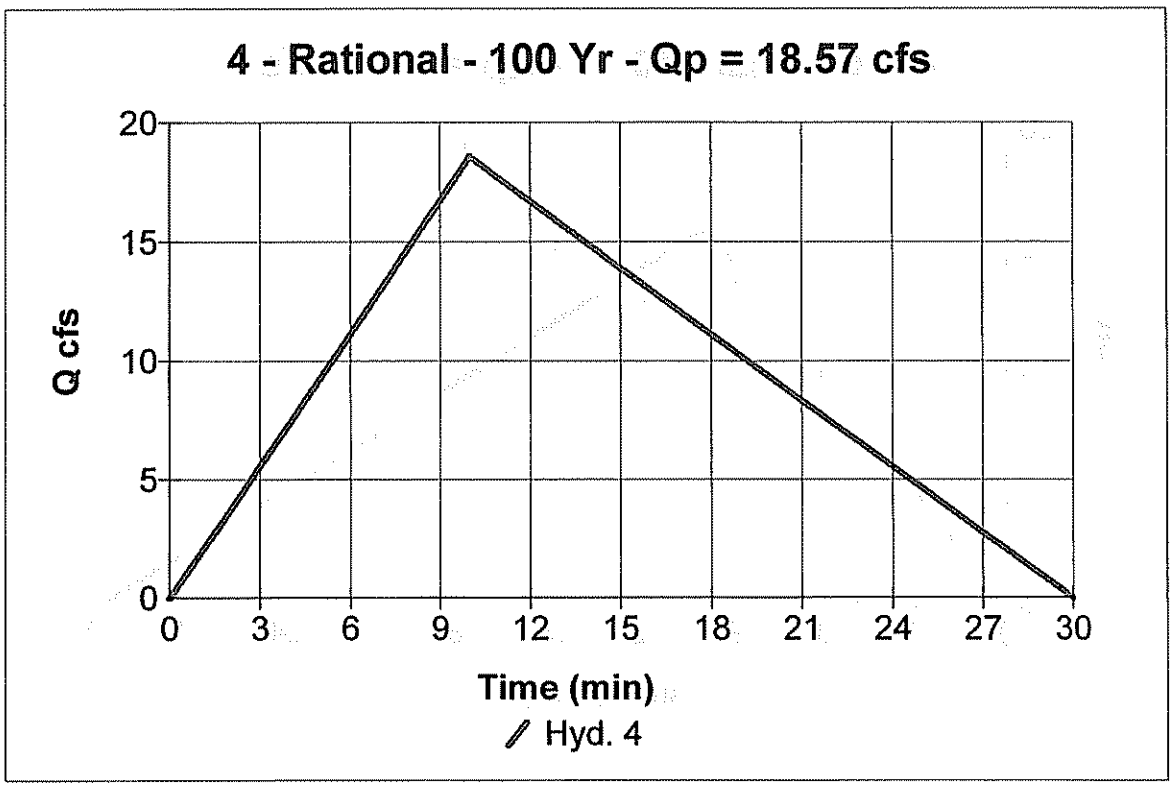
Hydraflow Hydrographs by Intelisolve

Hyd. No. 4

Area #19

Hydrograph type	= Rational	Peak discharge	= 18.57 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 6.5 ac	Runoff coeff.	= 0.31
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 16,715 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

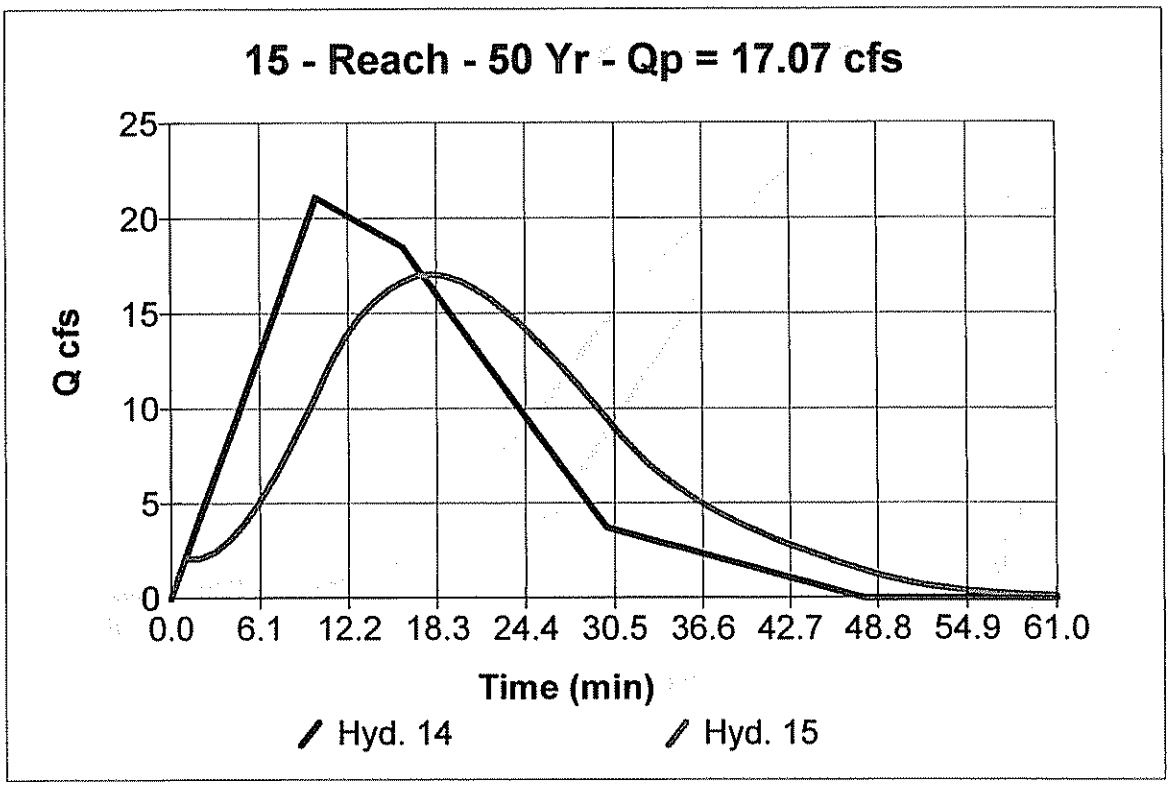
Hyd. No. 15

DITCH FLOW

Hydrograph type	= Reach	Peak discharge	= 17.07 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 14	Section type	= Trapezoidal
Reach length	= 750.0 ft	Channel slope	= 0.4 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.644	Rating curve m	= 1.282
Ave. velocity	= 1.73 ft/s	Routing coeff.	= 0.1630

Modified Att-Kin routing method used.

Hydrograph Volume = 25,602 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

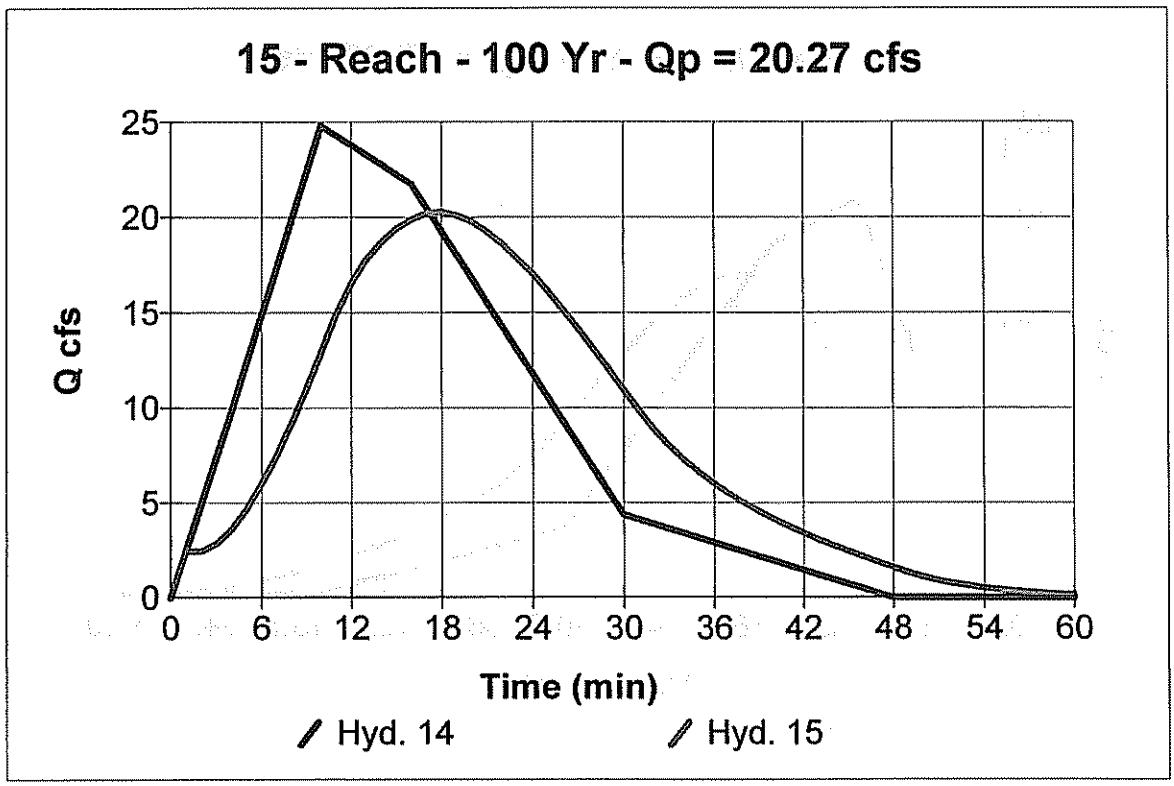
Hyd. No. 15

DITCH FLOW

Hydrograph type	= Reach	Peak discharge	= 20.27 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 14	Section type	= Trapezoidal
Reach length	= 750.0 ft	Channel slope	= 0.4 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.644	Rating curve m	= 1.282
Ave. velocity	= 1.81 ft/s	Routing coeff.	= 0.1700

Modified Att-Kin routing method used.

Hydrograph Volume = 30,083 cuft



Hydrograph Plot

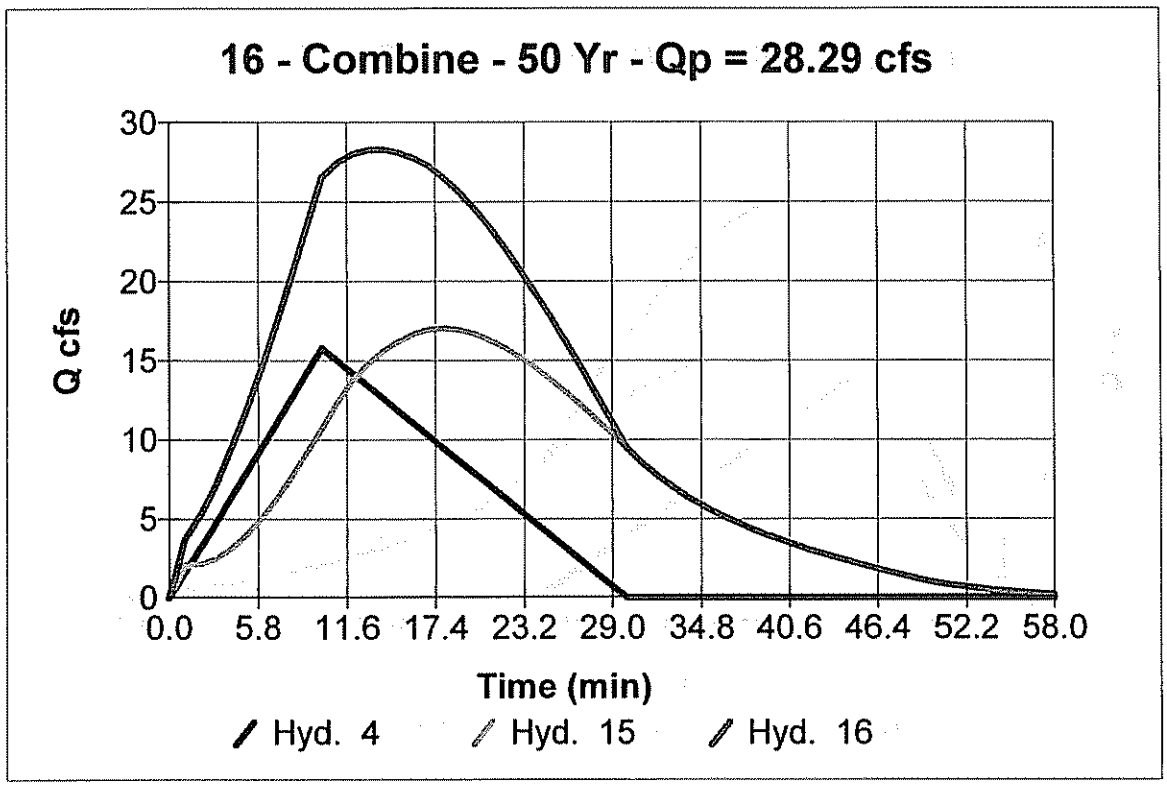
Hydraflow Hydrographs by Intelisolve

Hyd. No. 16

CULVERT 2

Hydrograph type	= Combine	Peak discharge	= 28.29 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 4, 15		

Hydrograph Volume = 39,825 cuft



Hydrograph Plot

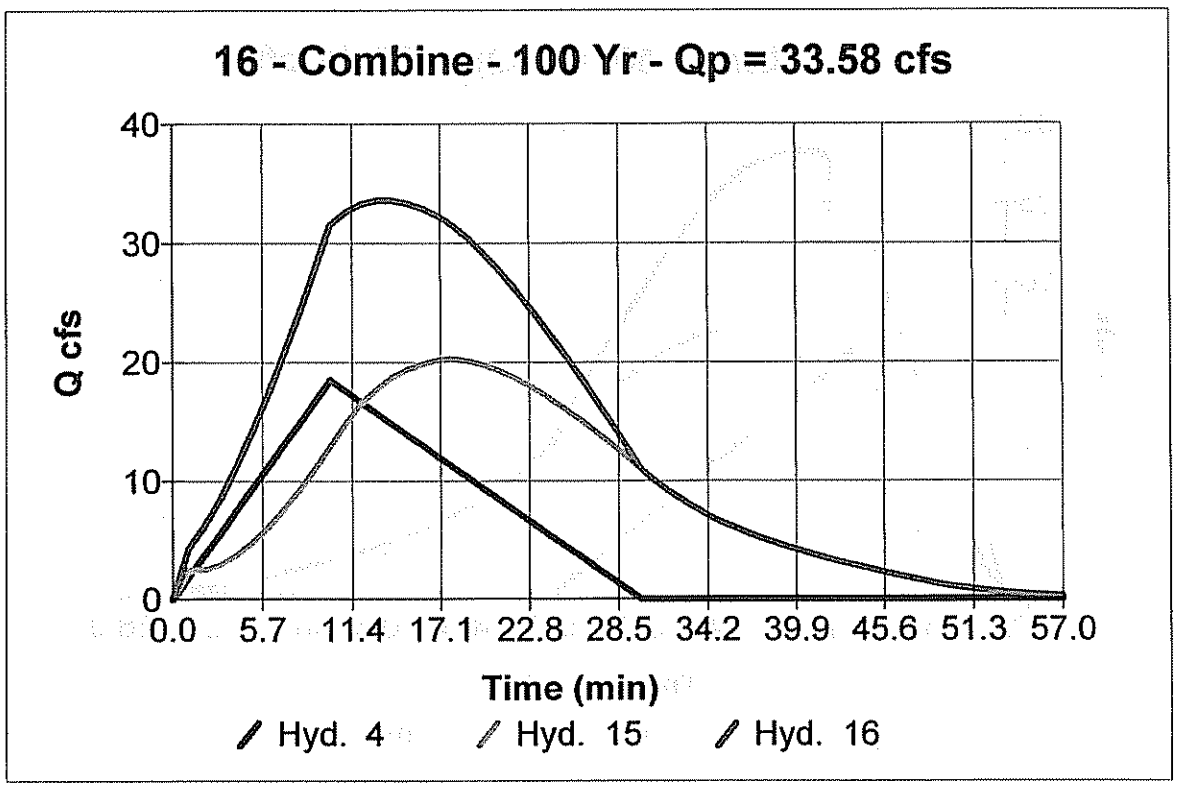
Hydraflow Hydrographs by Intelisolve

Hyd. No. 16

CULVERT 2

Hydrograph type	= Combine	Peak discharge	= 33.58 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 4, 15		

Hydrograph Volume = 46,798 cuft



US PIPE CULVERT NO. 2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	21.10	ft^3/s

Results		
Depth	1.31	ft
Flow Area	12.97	ft^2
Wetted Perimeter	16.12	ft
Top Width	15.80	ft
Critical Depth	0.72	ft
Critical Slope	0.046934	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.35	ft
Froude Number	0.32	
Flow is subcritical.		

US PIPE CULVERT NO. 2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	24.81	ft^3/s

Results		
Depth	1.41	ft
Flow Area	14.63	ft^2
Wetted Perimeter	17.06	ft
Top Width	16.71	ft
Critical Depth	0.79	ft
Critical Slope	0.045857	ft/ft
Velocity	1.70	ft/s
Velocity Head	0.04	ft
Specific Energy	1.46	ft
Froude Number	0.32	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 2

Analysis Component			
Storm Event	Design	Discharge	28.29 cfs

Peak Discharge Method: User-Specified			
Design Discharge	28.29 cfs	Check Discharge	33.58 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	1.50 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	28.29 cfs	Bottom Elevation	617.12 ft
Depth	1.50 ft	Velocity	1.76 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	28.29 cfs	621.40 ft	9.38 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 623.06 ft.
@ Station 088+00 eastbound (I-80)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 2

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	621.40 ft	Discharge	28.29 cfs
Inlet Control HW Elev	621.40 ft	Tailwater Elevation	618.62 ft
Outlet Control HW Elev	621.24 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.92		

Grades			
Upstream Invert	617.56 ft	Downstream Invert	617.12 ft
Length	44.00 ft	Constructed Slope	0.010000 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.83 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.83 ft
Velocity Downstream	9.38 ft/s	Critical Slope	0.013599 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	621.24 ft	Upstream Velocity Head	1.26 ft
Ke	0.20	Entrance Loss	0.25 ft

Inlet Control Properties			
Inlet Control HW Elev	621.40 ft	Flow Control	Submerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 2

Analysis Component			
Storm Event	Check	Discharge	33.58 cfs

Peak Discharge Method: User-Specified			
Design Discharge	28.29 cfs	Check Discharge	33.58 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	1.62 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	33.58 cfs	Bottom Elevation	617.12 ft
Depth	1.62 ft	Velocity	1.83 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	33.58 cfs	622.37 ft	10.87 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 2

_ omponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	622.37	ft	Discharge	33.58	cfs
Inlet Control HW Elev	622.37	ft	Tailwater Elevation	618.74	ft
Outlet Control HW Elev	622.18	ft	Control Type	Inlet Control	
Headwater Depth/ Height	2.40				

Grades					
Upstream Invert	617.56	ft	Downstream Invert	617.12	ft
Length	44.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.91	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.91	ft
Velocity Downstream	10.87	ft/s	Critical Slope	0.019117	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	622.18	ft	Upstream Velocity Head	1.78	ft
Ke	0.20		Entrance Loss	0.36	ft

Inlet Control Properties					
Inlet Control HW Elev	622.37	ft	Flow Control	Submerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 11/5/09
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

Area #18

$Area_{TOTAL} = 15.18$ acres

$AREA_{paved/gravel} = 7.50$ acres $c = 0.60$

$AREA_{grass} = 7.68$ acres $c = 0.20$

$$c = \frac{(7.50)(0.60) + (7.68)(0.20)}{15.18} = 0.40$$

Assumption $T_c = 20$ min.

$Q_{10} = 35.92$ cfs

$Q_{100} = 42.30$ cfs

AREA #7 + #8 + #18 + #19

$Q_{10} = 60.52$ cfs

$Q_{100} = 71.34$ cfs

Peak $T_c = 20$ min.

Hydrograph Plot

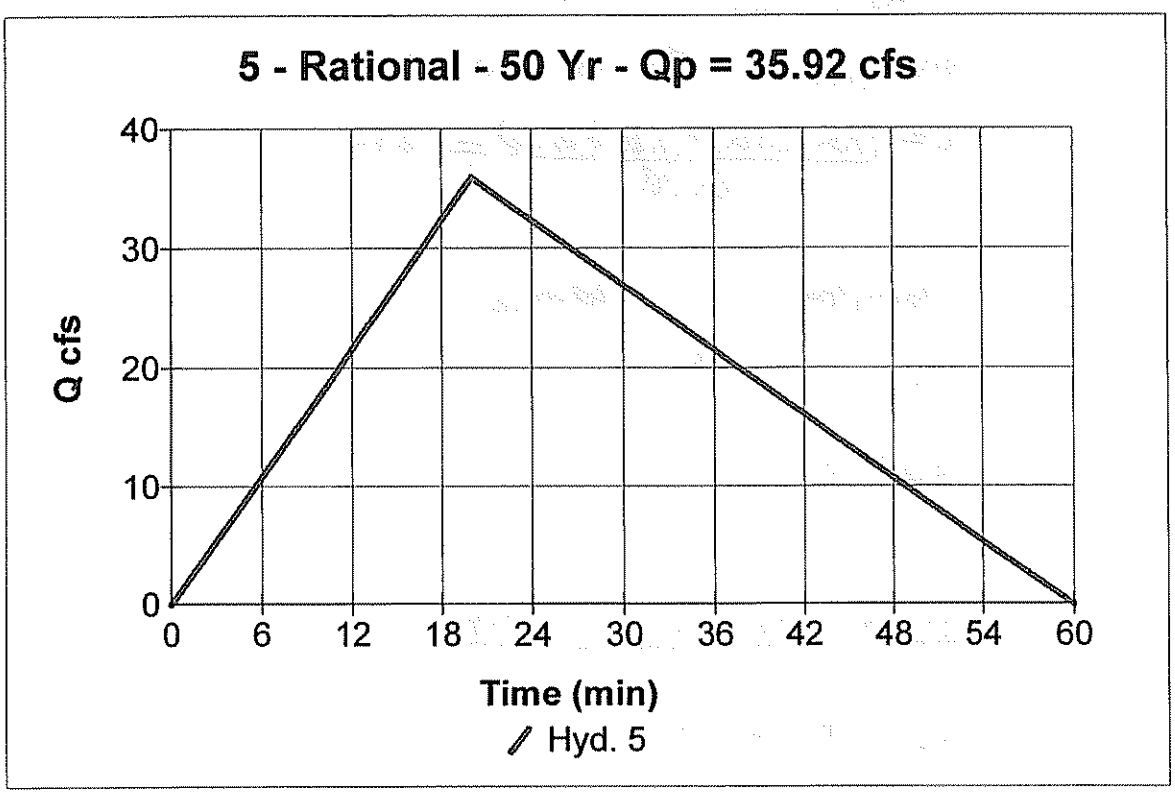
Hydraflow Hydrographs by Intelisolve

Hyd. No. 5

Area #18

Hydrograph type	= Rational	Peak discharge	= 35.92 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 15.2 ac	Runoff coeff.	= 0.4
Intensity	= 5.916 in/hr	Time of conc. (Tc)	= 20 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 64,658 cuft



Hydrograph Plot

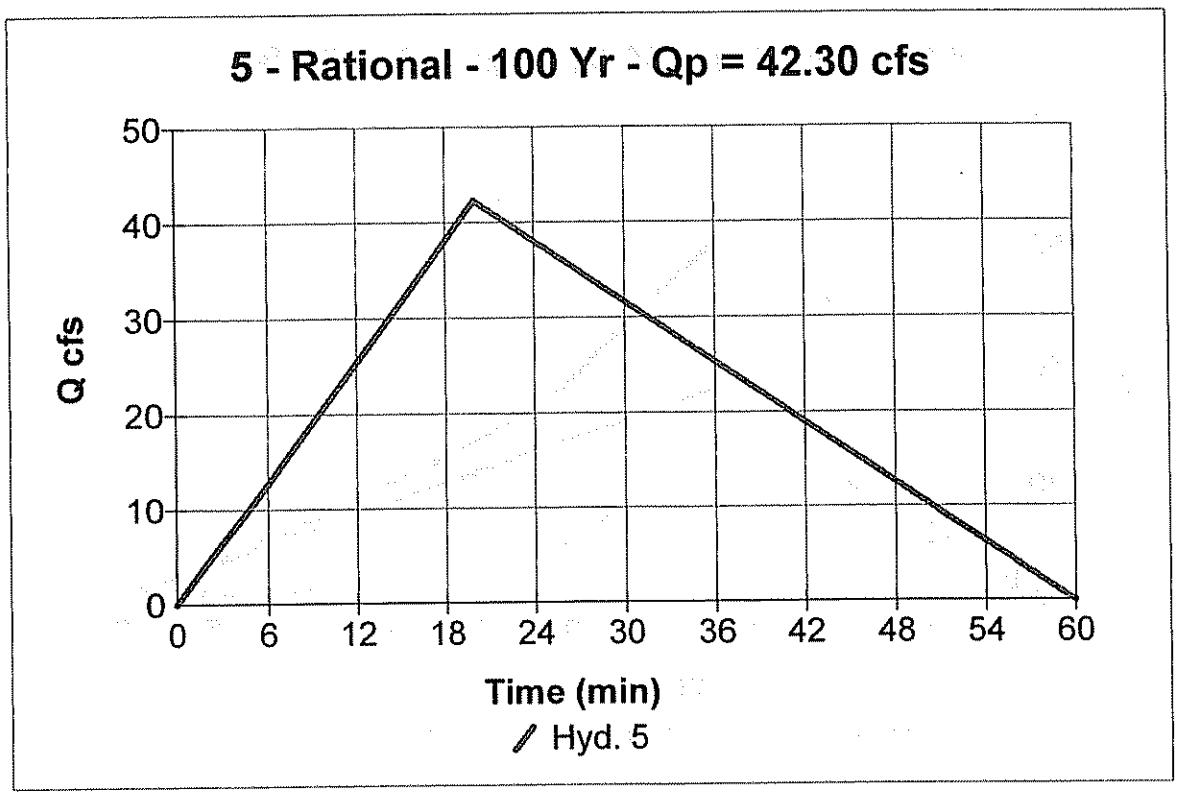
Hydraflow Hydrographs by Intelisolve

Hyd. No. 5

Area #18

Hydrograph type	= Rational	Peak discharge	= 42.30 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 15.2 ac	Runoff coeff.	= 0.4
Intensity	= 6.966 in/hr	Time of conc. (Tc)	= 20 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 76,135 cuft



Hydrograph Plot

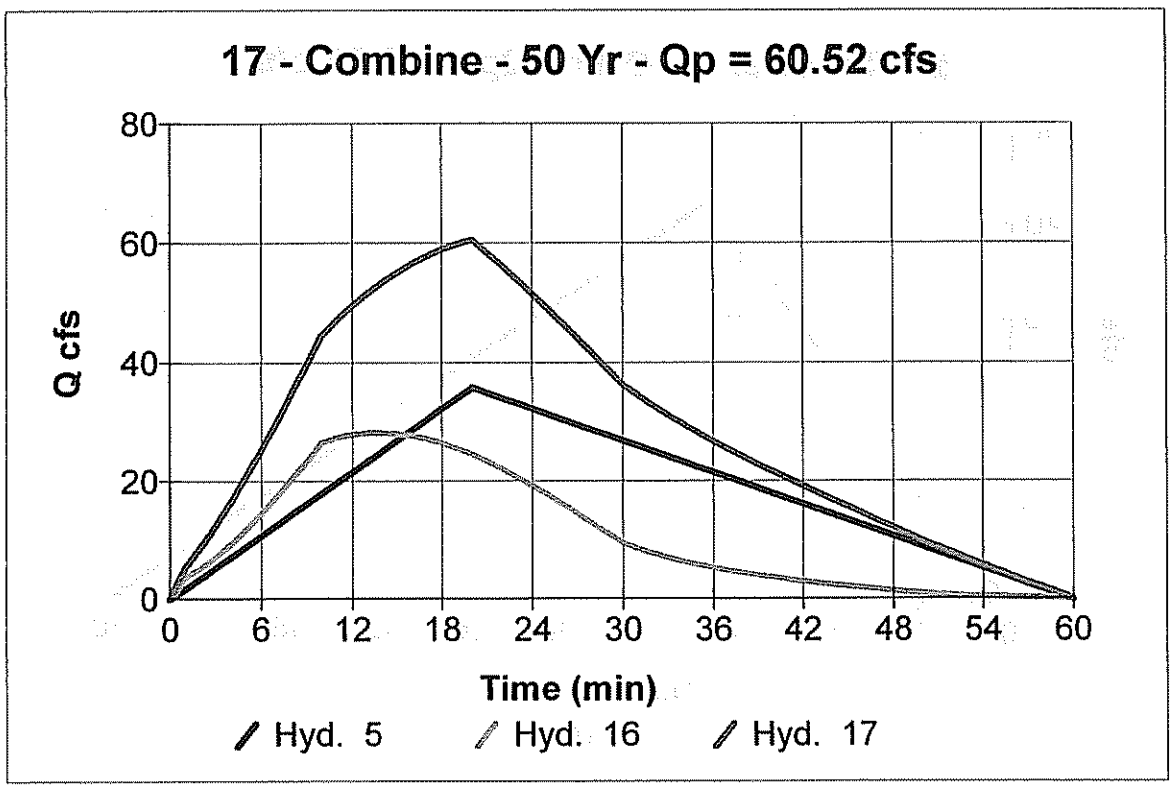
Hydraflow Hydrographs by Intelisolve

Hyd. No. 17

DS CULVERT 2

Hydrograph type	= Combine	Peak discharge	= 60.52 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 5, 16		

Hydrograph Volume = 104,483 cuft



Hydrograph Plot

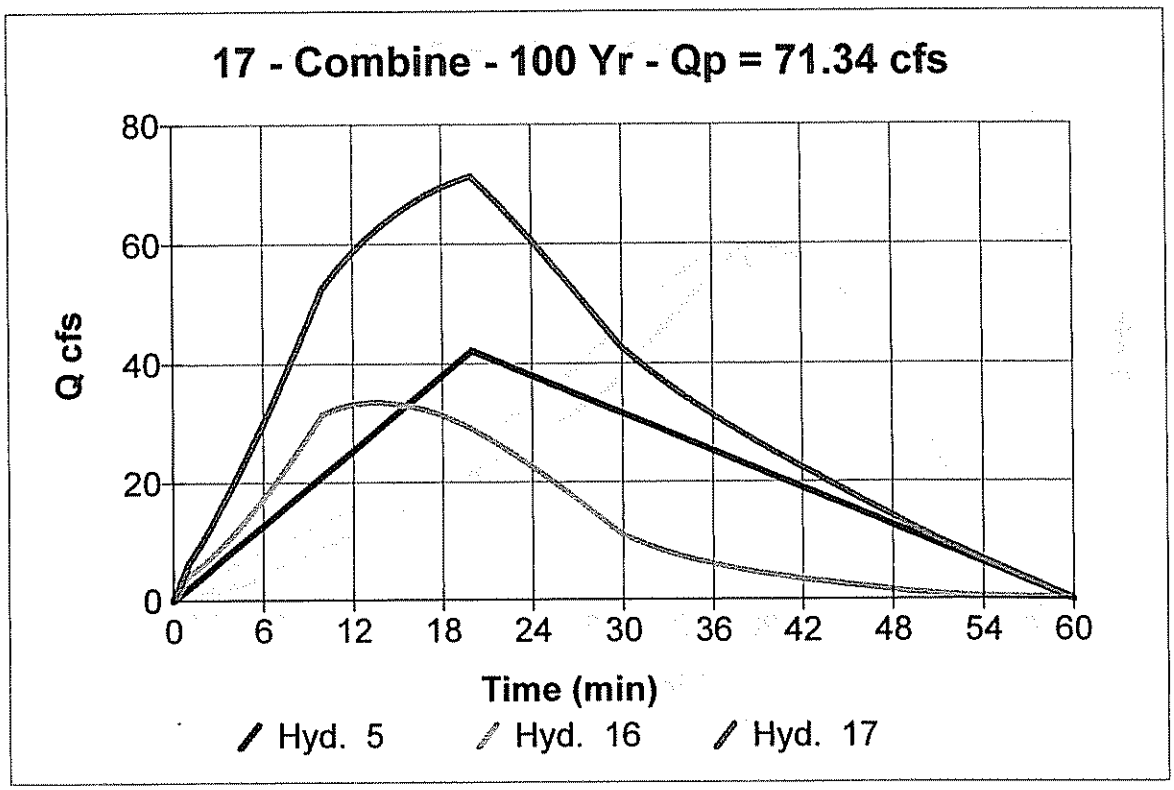
Hydraflow Hydrographs by Intelisolve

Hyd. No. 17

DS CULVERT 2

Hydrograph type	= Combine	Peak discharge	= 71.34 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 5, 16		

Hydrograph Volume = 122,933 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

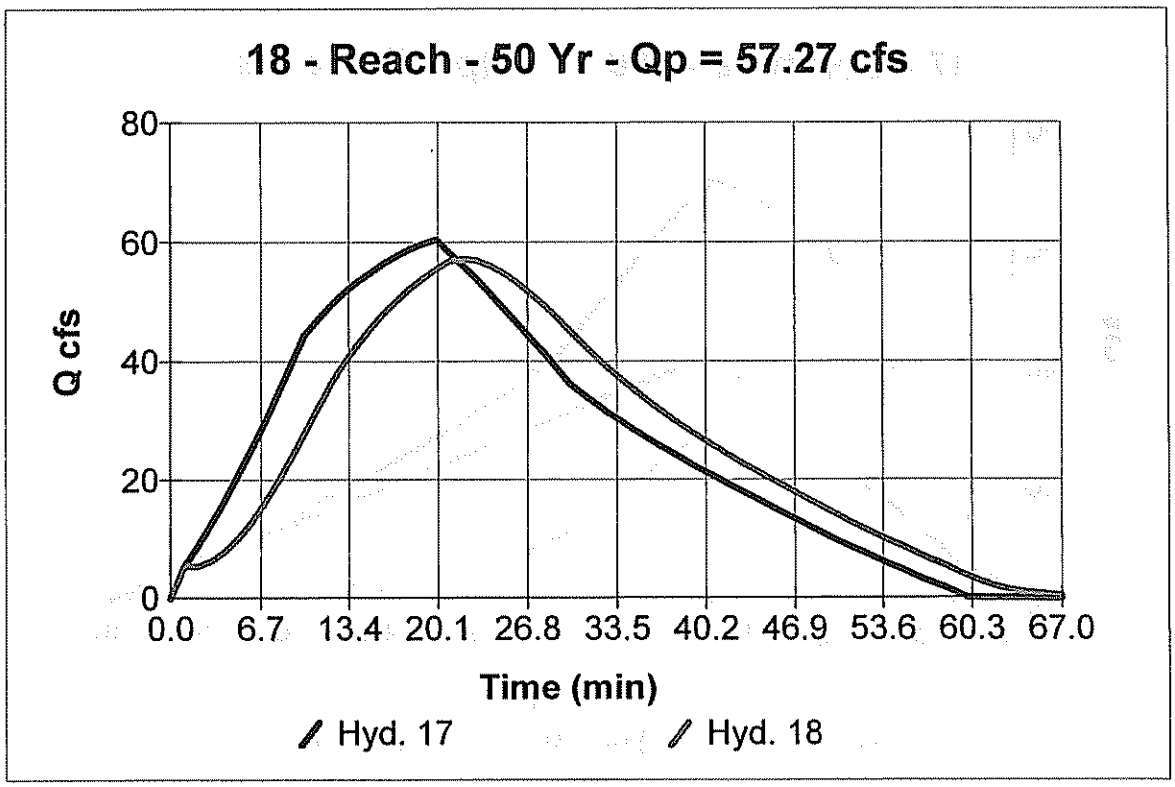
Hyd. No. 18

DITCH CULV 2 & CULV E5

Hydrograph type	= Reach	Peak discharge	= 57.27 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 17	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 0.1 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.381	Rating curve m	= 1.282
Ave. velocity	= 1.77	Routing coeff.	= 0.2633

Modified Att-Kin routing method used.

Hydrograph Volume = 105,732 cuft



Channel Depth ≈ 2.2 ft.

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

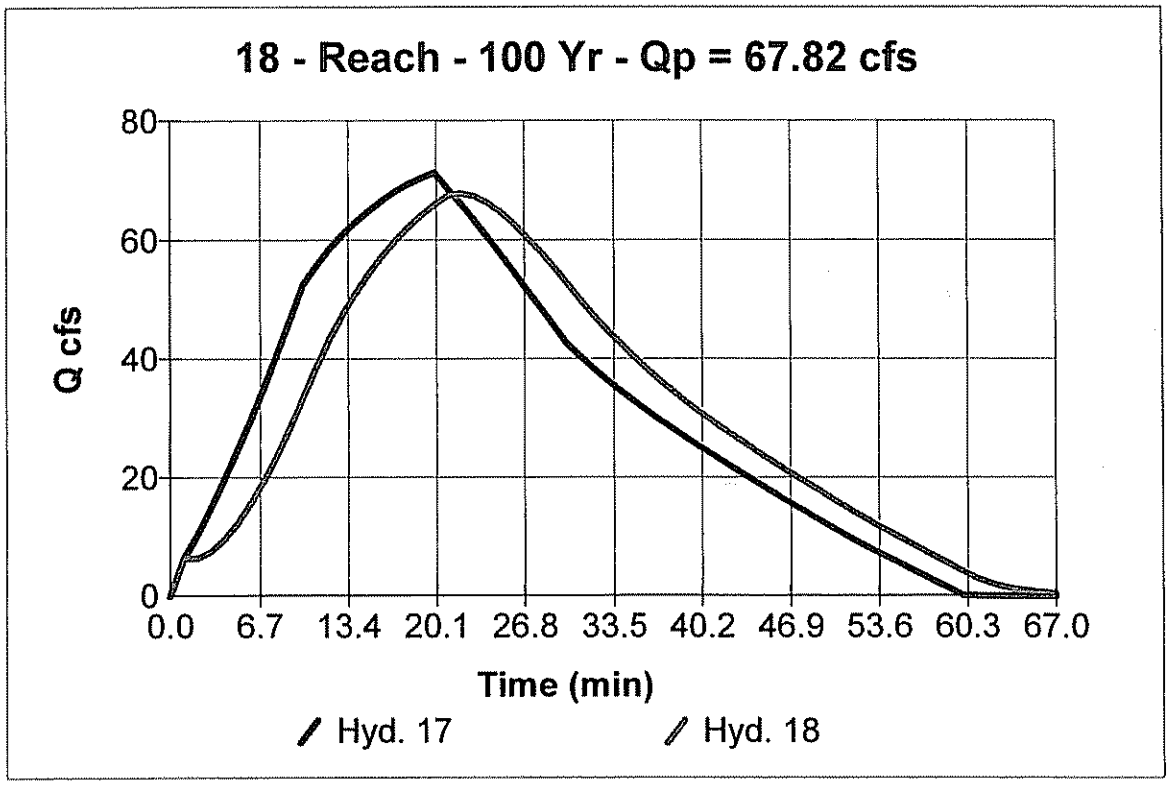
Hyd. No. 18

DITCH CULV 2 & CULV E5

Hydrograph type	= Reach	Peak discharge	= 67.82 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 17	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 0.1 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.381	Rating curve m	= 1.282
Ave. velocity	= 1.86	Routing coeff.	= 0.2740

Modified Att-Kin routing method used.

Hydrograph Volume = 124,344 cuft



Channel Depth ≈ 2.35 ft.

Channel Depth @ Station 886+00 . 2.35' + 617.12 = 619.47'

Low point Elev. @ Station 886+00 622.71'

Channel Depth @ Station 883+00 2.35' + 615.74' = 618.09'

Low Point Elev. @ Station 886+00 621.86'

US DITCH @ DS PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.001400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	57.27	ft^3/s

Results		
Depth	2.58	ft
Flow Area	40.28	ft^2
Wetted Perimeter	27.85	ft
Top Width	27.22	ft
Critical Depth	1.22	ft
Critical Slope	0.040801	ft/ft
Velocity	1.42	ft/s
Velocity Head	0.03	ft
Specific Energy	2.61	ft
Froude Number	0.21	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.001400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	67.82	ft^3/s

Results		
Depth	2.77	ft
Flow Area	45.70	ft^2
Wetted Perimeter	29.64	ft
Top Width	28.96	ft
Critical Depth	1.32	ft
Critical Slope	0.039867	ft/ft
Velocity	1.48	ft/s
Velocity Head	0.03	ft
Specific Energy	2.81	ft
Froude Number	0.21	
Flow is subcritical.		

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 10/01/03
CHECKED BY: _____ DATE: _____
SHEET: 7 OF: _____

DRAINAGE CALCULATIONS

AREA # ~~16~~ 20

$AREA_{TOTAL} = 96{,}739.2\ ft^2 / 43560\ ft^2/acre = \cancel{2.22}\ 2.16\ acres$

$AREA_{grass} = 52{,}781.2\ ft^2 / 43560\ ft^2/acre = 1.21\ acres$

$AREA_{paved} = 2.22\ acres - 1.21\ acres = 1.01\ acres$

$$C_w = \frac{(1.21\ ac.)(0.20) + (1.01\ ac.)(0.90)}{2.22} = 0.518$$

$T_c = ?$

$L_1 = 18\ ft$ $S_1 = 2.08\%$ (Sheet Flow)

$L_2 = 162.5\ ft$ $S_2 = 1.33\%$ (Shallow Conc. Flow)

$L_3 = 1125\ ft$ $S_3 = 0.46\%$ (Channel Flow)

$Q_{50} = \cancel{7.56}\ cfs$ 7.35

$Q_{100} = \cancel{8.91}\ cfs$ 8.66

Hydrograph Plot

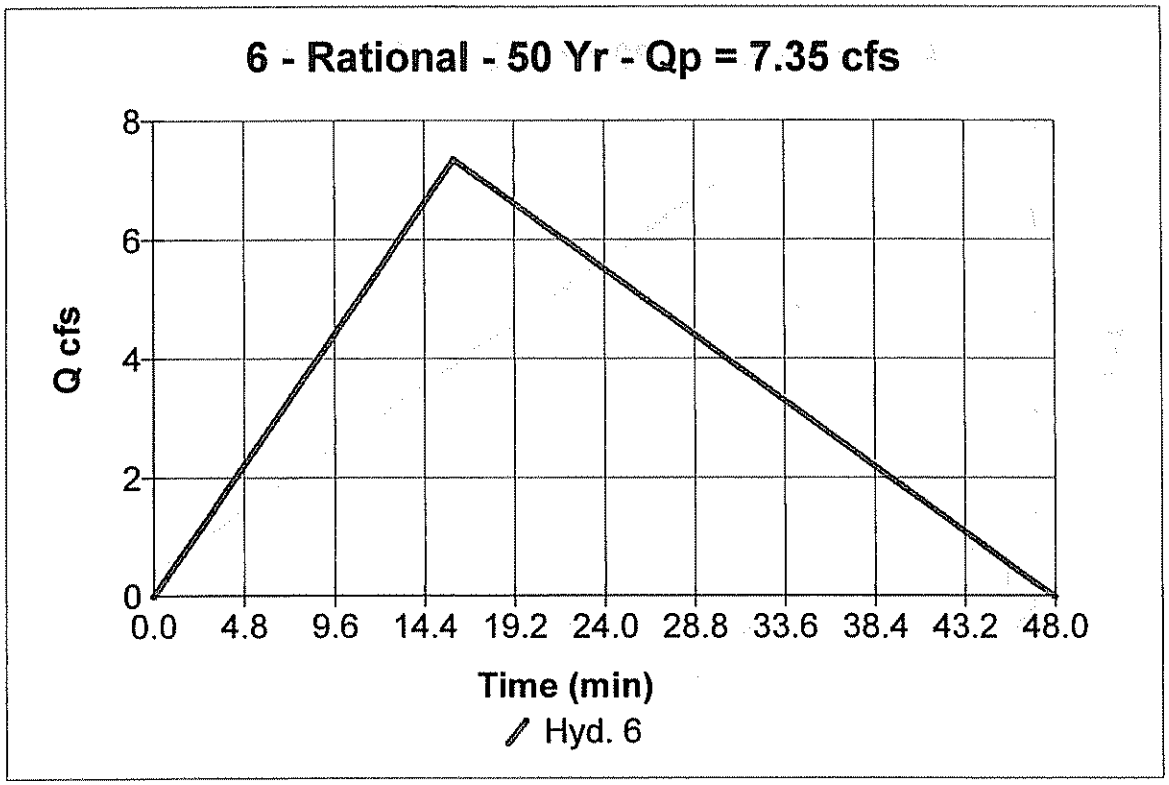
Hydraflow Hydrographs by Intelisolve

Hyd. No. 6

Area #20

Hydrograph type	= Rational	Peak discharge	= 7.35 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 2.2 ac	Runoff coeff.	= 0.52
Intensity	= 6.548 in/hr	Time of conc. (Tc)	= 16 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 10,591 cuft



Hydrograph Plot

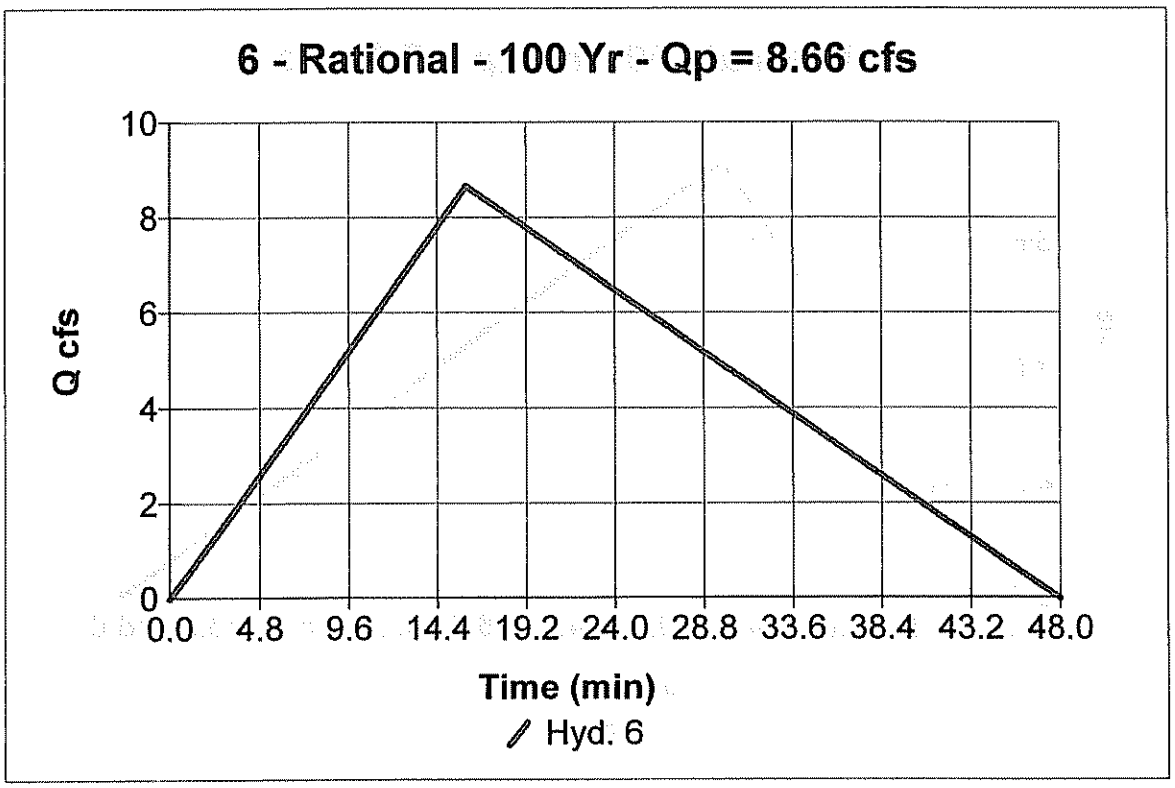
Hydraflow Hydrographs by Intelisolve

Hyd. No. 6

Area #20

Hydrograph type	= Rational	Peak discharge	= 8.66 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 2.2 ac	Runoff coeff.	= 0.52
Intensity	= 7.715 in/hr	Time of conc. (Tc)	= 16 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 12,478 cuft



US PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004600	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	7.35	ft^3/s

Results		
Depth	0.88	ft
Flow Area	5.67	ft^2
Wetted Perimeter	11.01	ft
Top Width	10.84	ft
Critical Depth	0.50	ft
Critical Slope	0.054067	ft/ft
Velocity	1.30	ft/s
Velocity Head	0.03	ft
Specific Energy	0.91	ft
Froude Number	0.32	
Flow is subcritical.		

US PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004600	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	8.66	ft^3/s

Results		
Depth	0.95	ft
Flow Area	6.41	ft^2
Wetted Perimeter	11.69	ft
Top Width	11.50	ft
Critical Depth	0.55	ft
Critical Slope	0.052854	ft/ft
Velocity	1.35	ft/s
Velocity Head	0.03	ft
Specific Energy	0.98	ft
Froude Number	0.32	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E5

Analysis Component			
Storm Event	Design	Discharge	7.35 cfs

Peak Discharge Method: User-Specified			
Design Discharge	7.35 cfs	Check Discharge	8.66 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	0.76 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	7.35 cfs	Bottom Elevation	615.74 ft
Depth	0.76 ft	Velocity	1.29 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	7.35 cfs	618.18 ft	7.38 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E5

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	618.18	ft	Discharge	7.35	cfs
Inlet Control HW Elev	618.14	ft	Tailwater Elevation	616.50	ft
Outlet Control HW Elev	618.18	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.71				

Grades					
Upstream Invert	616.77	ft	Downstream Invert	615.74	ft
Length	69.00	ft	Constructed Slope	0.014928	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.71	ft
Slope Type	Steep		Normal Depth	0.70	ft
Flow Regime	Supercritical		Critical Depth	0.96	ft
Velocity Downstream	7.38	ft/s	Critical Slope	0.004801	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

ɔutlet Control Properties					
Outlet Control HW Elev	618.18	ft	Upstream Velocity Head	0.37	ft
Ke	0.20		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev	618.14	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E5

Analysis Component			
Storm Event	Check	Discharge	8.66 cfs

Peak Discharge Method: User-Specified			
Design Discharge	7.35 cfs	Check Discharge	8.66 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	0.83 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	8.66 cfs	Bottom Elevation	615.74 ft
Depth	0.83 ft	Velocity	1.35 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	8.66 cfs	618.32 ft	7.68 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 621.86
@ Station 883+00. eastbound I-80

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E5

omponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	618.32	ft	Discharge	8.66	cfs
Inlet Control HW Elev	618.28	ft	Tailwater Elevation	616.57	ft
Outlet Control HW Elev	618.32	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.78				

Grades					
Upstream Invert	616.77	ft	Downstream Invert	615.74	ft
Length	69.00	ft	Constructed Slope	0.014928	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.78	ft
Slope Type	Steep		Normal Depth	0.77	ft
Flow Regime	Supercritical		Critical Depth	1.05	ft
Velocity Downstream	7.68	ft/s	Critical Slope	0.004980	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	618.32	ft	Upstream Velocity Head	0.42	ft
Ke	0.20		Entrance Loss	0.08	ft

Inlet Control Properties					
Inlet Control HW Elev	618.28	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 03217.09
DESCRIPTION: La Salle County - Vitra
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA #26

~~1.56~~ OK

$AREA_{TOTAL}$ = ~~1.57~~ acres

~~$AREA_{paved}$ = 0.21 acres~~ OK

~~$AREA_{grass}$ = 1.57 ac. − 0.21 ac. = 1.36 acres~~ OK

~~$C = \frac{(1.36\ ac.)(0.20) + (0.21\ ac.)(0.90)}{1.57} = 0.29$~~ OK

Assume T_c = 10 minutes

Q_{10} = 3.56 cfs ✓

Q_{100} = 4.18 cfs ✓

DITCH BETWEEN E5 & E6 (#5 + #7 + #8 + #18 + #19 + #20 + #26)

Q_{10} = 64.67 cfs

Q_{100} = 96.62 cfs

Hydrograph Plot

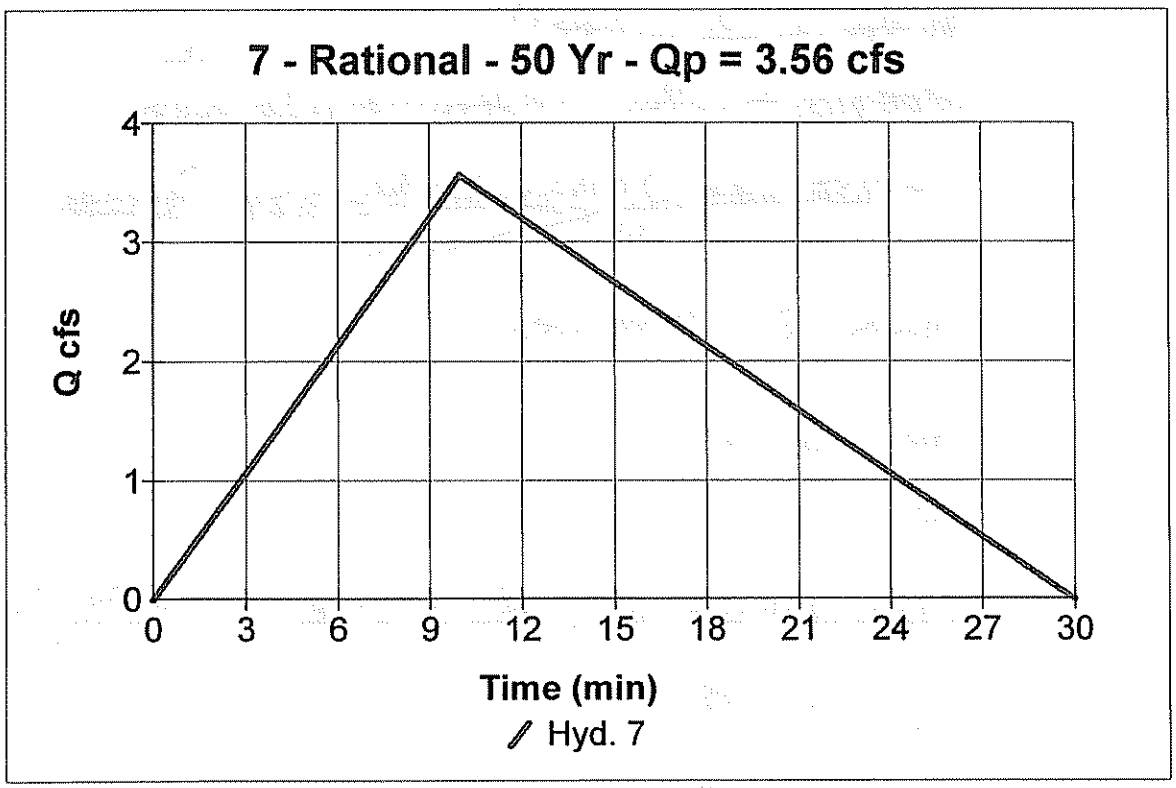
Hydraflow Hydrographs by Intelisolve

Hyd. No. 7

Area #26

Hydrograph type	= Rational	Peak discharge	= 3.56 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 1.6 ac	Runoff coeff.	= 0.29
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 3,204 cuft



Hydrograph Plot

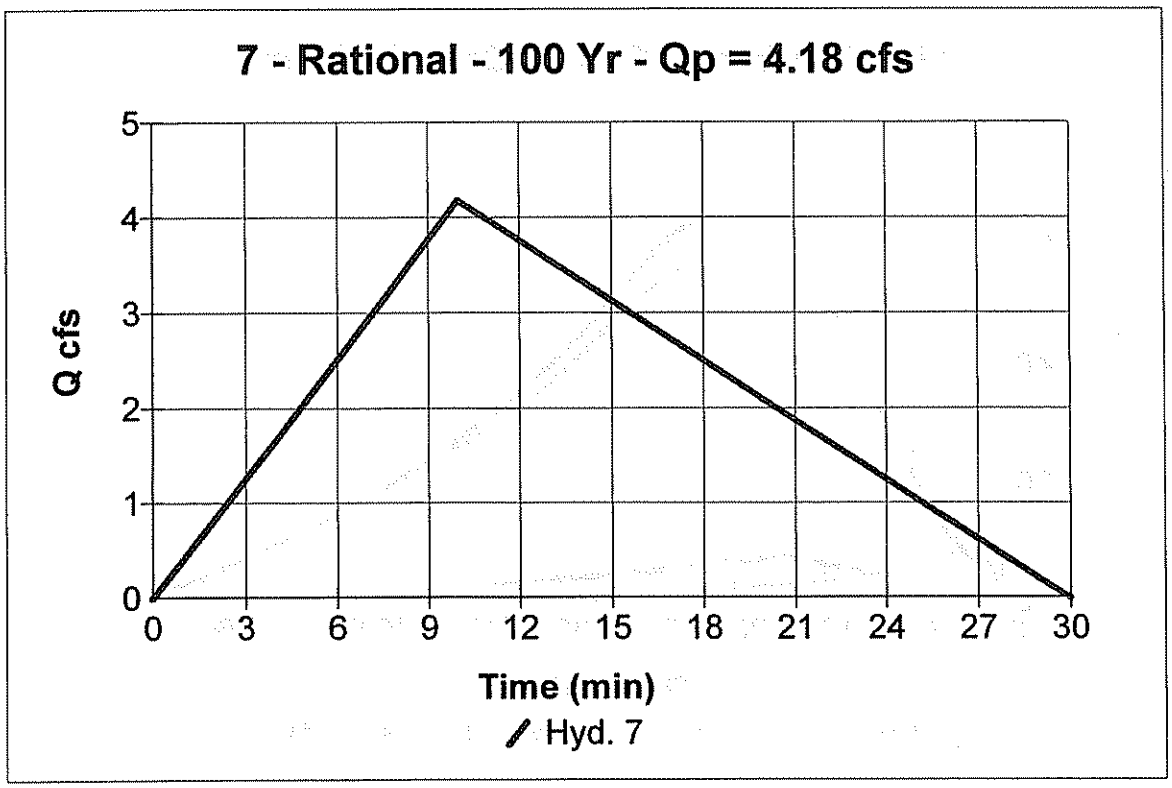
Hydraflow Hydrographs by Intelisolve

Hyd. No. 7

Area #26

Hydrograph type	= Rational	Peak discharge	= 4.18 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.6 ac	Runoff coeff.	= 0.29
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 3,765 cuft



Hydrograph Plot

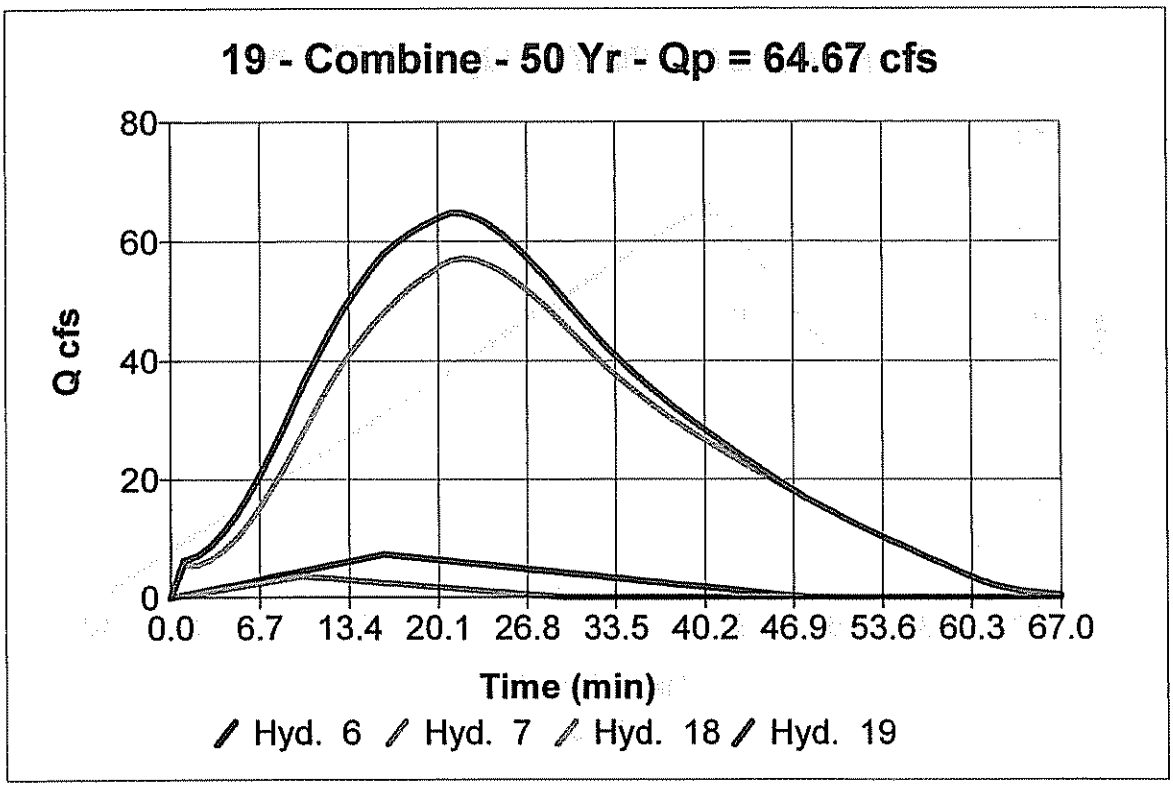
Hydraflow Hydrographs by Intelisolve

Hyd. No. 19

DS CULVERT E5

Hydrograph type	= Combine	Peak discharge	= 64.67 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 6, 7, 18		

Hydrograph Volume = 119,527 cuft



Hydrograph Plot

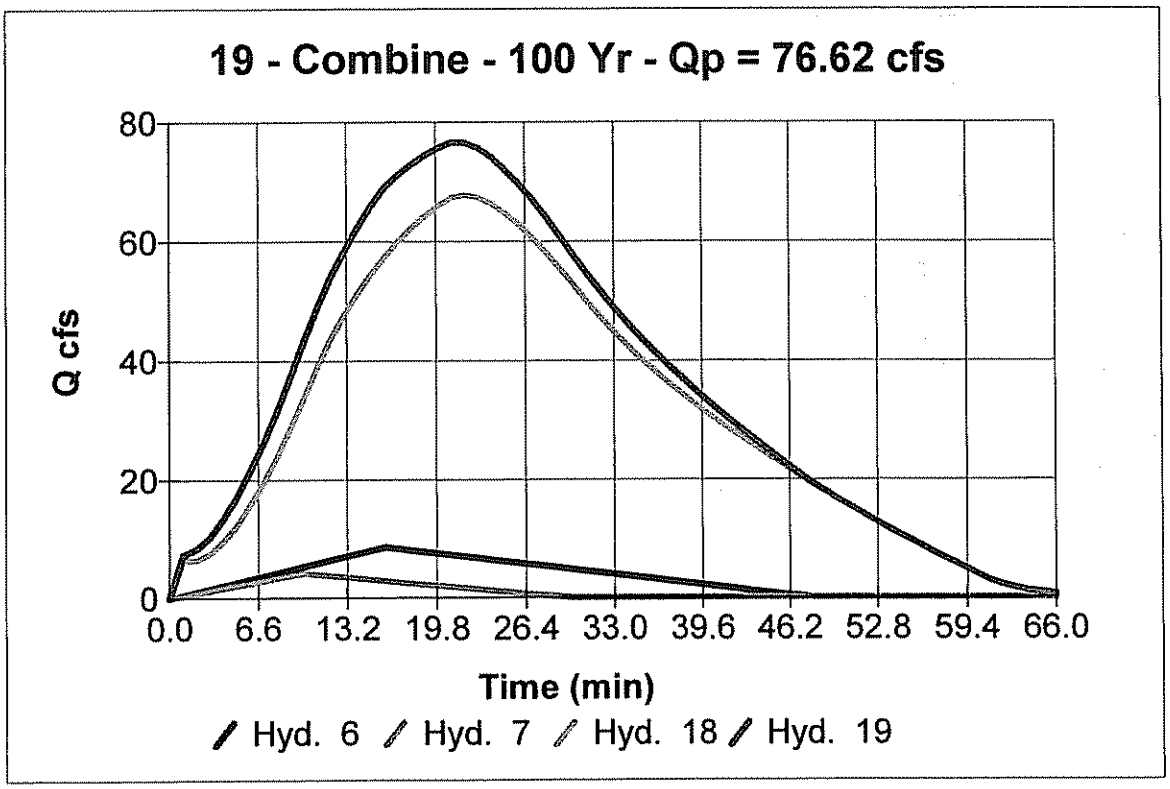
Hydraflow Hydrographs by Intelisolve

Hyd. No. 19

DS CULVERT E5

Hydrograph type	= Combine	Peak discharge	= 76.62 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 6, 7, 18		

Hydrograph Volume = 140,587 cuft



DS DITCH @ DS PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.001400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	64.67	ft^3/s

Results		
Depth	2.72	ft
Flow Area	44.10	ft^2
Wetted Perimeter	29.12	ft
Top Width	28.46	ft
Critical Depth	1.29	ft
Critical Slope	0.040128	ft/ft
Velocity	1.47	ft/s
Velocity Head	0.03	ft
Specific Energy	2.75	ft
Froude Number	0.21	
Flow is subcritical.		

DS DITCH @ DS PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.001400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	76.62	ft^3/s

Results		
Depth	2.92	ft
Flow Area	50.06	ft^2
Wetted Perimeter	31.00	ft
Top Width	30.28	ft
Critical Depth	1.40	ft
Critical Slope	0.039209	ft/ft
Velocity	1.53	ft/s
Velocity Head	0.04	ft
Specific Energy	2.96	ft
Froude Number	0.21	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.006200	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	64.67	ft^3/s

Results		
Depth	1.97	ft
Flow Area	25.32	ft^2
Wetted Perimeter	22.20	ft
Top Width	21.72	ft
Critical Depth	1.29	ft
Critical Slope	0.040126	ft/ft
Velocity	2.55	ft/s
Velocity Head	0.10	ft
Specific Energy	2.07	ft
Froude Number	0.42	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.006200	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	76.62	ft^3/s

Results		
Depth	2.12	ft
Flow Area	28.73	ft^2
Wetted Perimeter	23.61	ft
Top Width	23.09	ft
Critical Depth	1.40	ft
Critical Slope	0.039208	ft/ft
Velocity	2.67	ft/s
Velocity Head	0.11	ft
Specific Energy	2.23	ft
Froude Number	0.42	
Flow is subcritical.		

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

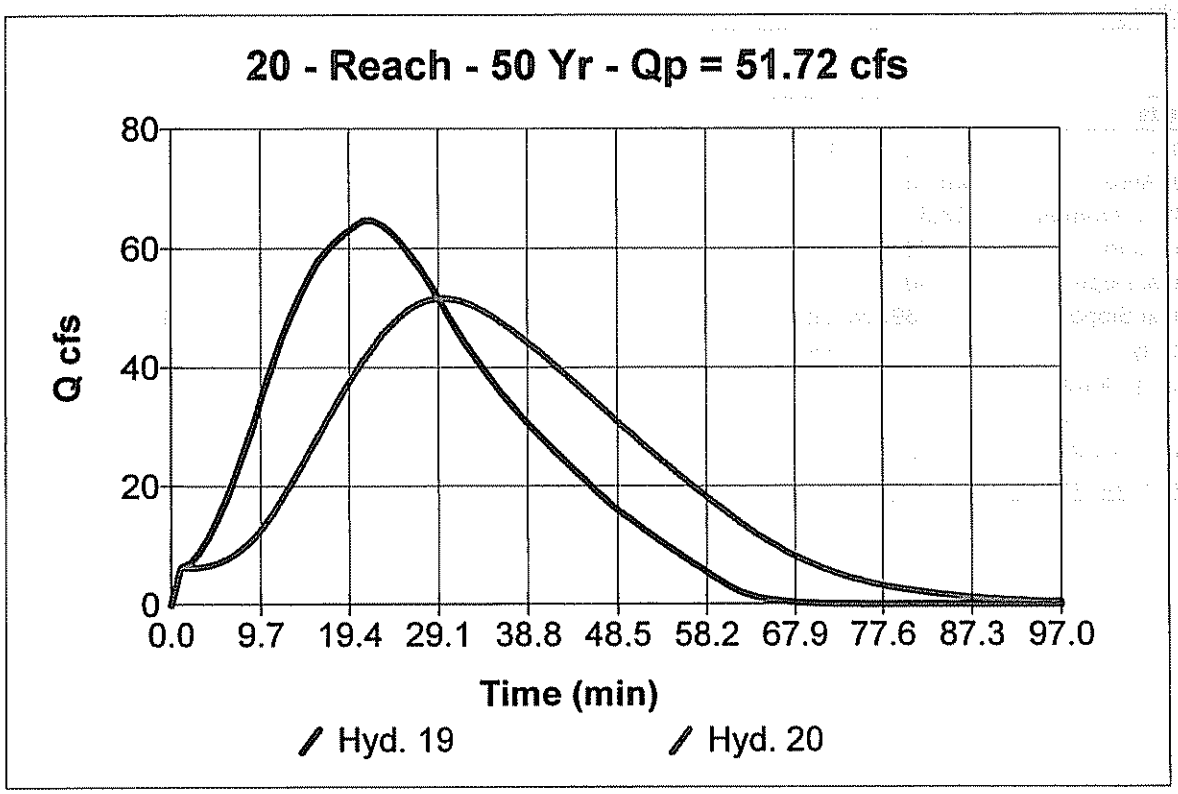
Hyd. No. 20

DITCH CULV E5 TO CULV E6

Hydrograph type	= Reach	Peak discharge	= 51.72 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 19	Section type	= Trapezoidal
Reach length	= 1112.5 ft	Channel slope	= 0.1 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.381	Rating curve m	= 1.282
Ave. velocity	= 1.43	Routing coeff.	= 0.0940

Modified Att-Kin routing method used.

Hydrograph Volume = 123,541 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

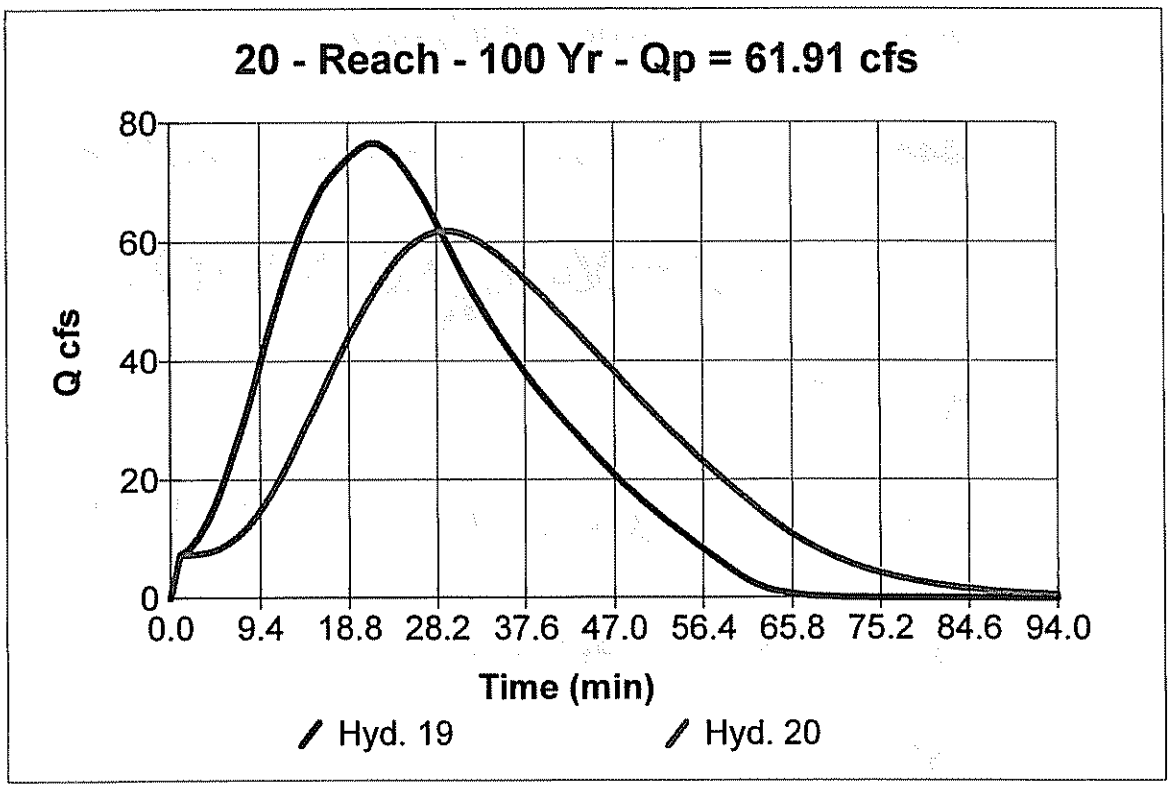
Hyd. No. 20

DITCH CULV E5 TO CULV E6

Hydrograph type	= Reach	Peak discharge	= 61.91 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 19	Section type	= Trapezoidal
Reach length	= 1112.5 ft	Channel slope	= 0.1 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.381	Rating curve m	= 1.282
Ave. velocity	= 1.49	Routing coeff.	= 0.0982

Modified Att-Kin routing method used.

Hydrograph Volume = 145,109 cuft



Depth at Station 883+00 → 615.74' + 2.55' = 618.29'

℄ Elevation 621.86 ft. (eastbound I-80)

Depth at Station 872+00 → 608.80' + 2.55' = 611.35'

℄ Elevation 614.00 ft. (Eastbound I-80)

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 10/01/03
CHECKED BY: DATE:
SHEET: 10 OF:

DRAINAGE CALCULATIONS

AREA #8

$AREA_{total} = 80,238.2\ ft^2 / (43560\ ft^2/acre) = \cancel{1.84}\ 1.86$ acres

$AREA_{grass} = 44,345.0\ ft^2 / (43560\ ft^2/acre) = 1.02$ acres

$AREA_{paved} = 1.84$ acres $- 1.02$ acres $= 0.82$ acres

$$C_w = \frac{(1.02\ acre)(0.20) + (0.82)(0.90)}{1.84} = 0.512$$ ✓

$T_c = ?$

$L_1 = 18$ ft $\quad S_1 = 2.08\%$ (Sheet Flow)

$L_2 = 1062.5$ ft $\quad S_2 = 0.84\%$ (Channel Flow)

$L_3 =$ None

$Q_{50} = \cancel{9.11}$ cfs 7.12

$Q_{100} = \cancel{8.36}$ cfs 8.37

TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve

Hyd. No. 9

Area #8
Storm frequency = yrs

Sheet Flow

Manning's n-value	= 0.011
Flow length	= 18.0 ft
Two-year 24-hr precip.	= 3.25 in
Land slope	= 2.1 %

Travel Time ..... = 0.3 min

Shallow Concentrated Flow

Flow length	= 0 ft
Watercourse slope	= 0.0 %
Surface description	= Paved
Average velocity	= 0.00 ft/s

Travel Time ..... = 0.0 min

Channel Flow

Cross section flow area	= 4.4 sqft
Wetted perimeter	= 9.8 ft
Channel slope	= 0.8 %
Manning's n-value	= 0.050
Velocity	= 1.61 ft/s
Flow length	= 1062.5 ft

Travel Time ..... = 11.0 min

Total Travel Time, Tc ..... = 11.3 min

Hydrograph Plot

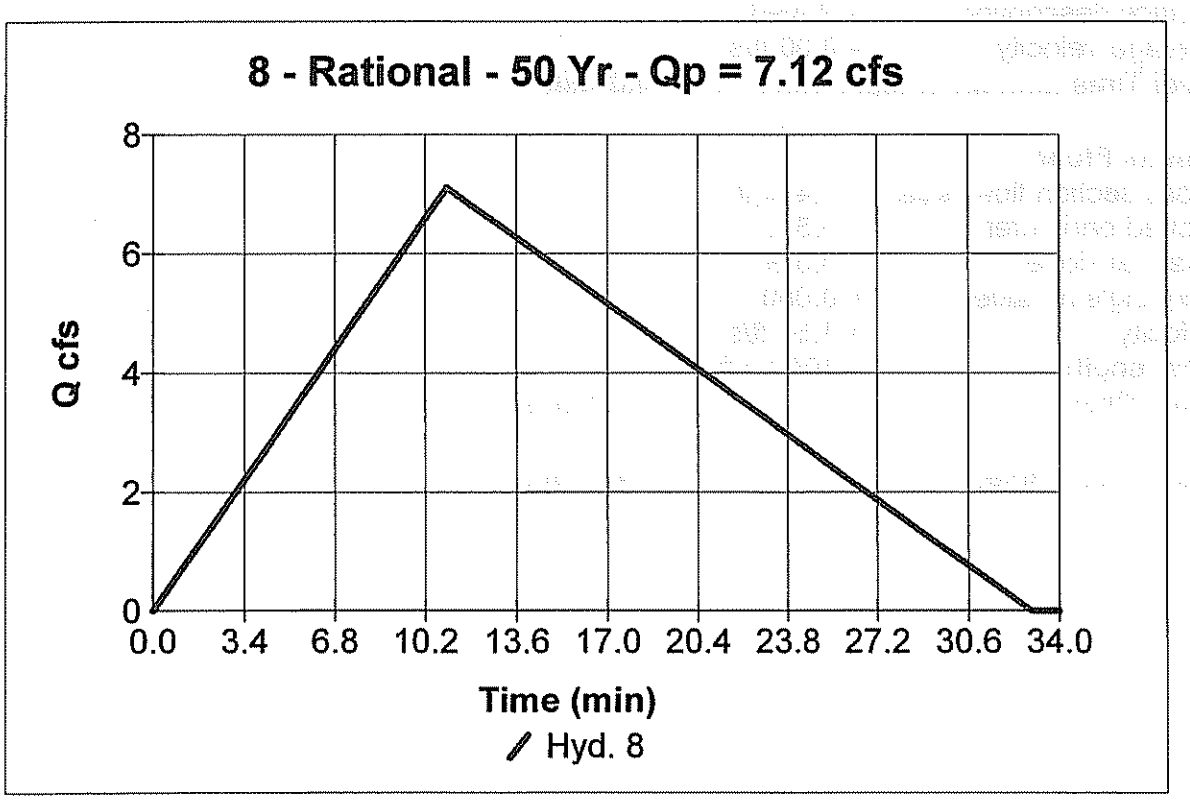
Hydraflow Hydrographs by Intelisolve

Hyd. No. 8

Area #24

Hydrograph type	= Rational	Peak discharge	= 7.12 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 1.9 ac	Runoff coeff.	= 0.51
Intensity	= 7.501 in/hr	Time of conc. (Tc)	= 11.3 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 7,237 cuft



Hydrograph Plot

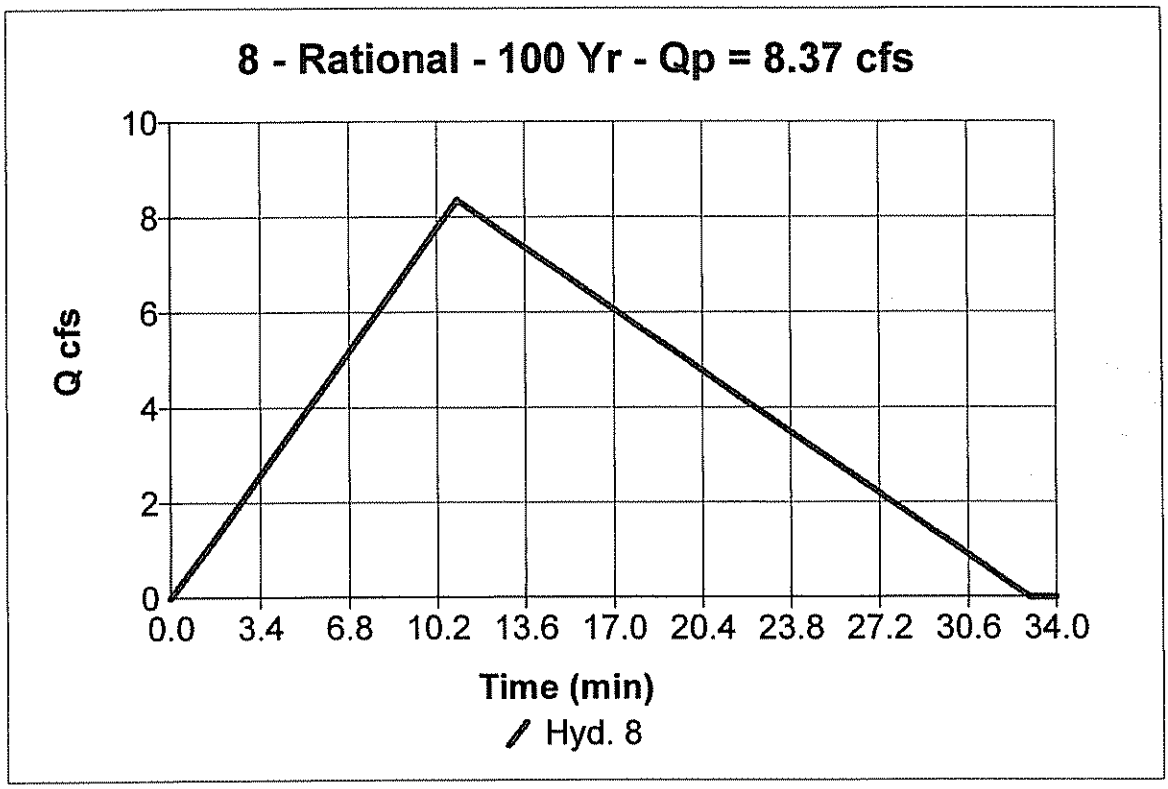
Hydraflow Hydrographs by Intelisolve

Hyd. No. 8

Area #24

Hydrograph type	= Rational	Peak discharge	= 8.37 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.9 ac	Runoff coeff.	= 0.51
Intensity	= 8.824 in/hr	Time of conc. (Tc)	= 11.3 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 8,513 cuft



US PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.008400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	7.12	ft^3/s

Results		
Depth	0.76	ft
Flow Area	4.43	ft^2
Wetted Perimeter	9.77	ft
Top Width	9.62	ft
Critical Depth	0.50	ft
Critical Slope	0.054311	ft/ft
Velocity	1.61	ft/s
Velocity Head	0.04	ft
Specific Energy	0.80	ft
Froude Number	0.42	
Flow is subcritical.		

US PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.008400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	8.37	ft^3/s

Results		
Depth	0.82	ft
Flow Area	5.00	ft^2
Wetted Perimeter	10.36	ft
Top Width	10.19	ft
Critical Depth	0.54	ft
Critical Slope	0.053100	ft/ft
Velocity	1.68	ft/s
Velocity Head	0.04	ft
Specific Energy	0.86	ft
Froude Number	0.42	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E6

Analysis Component			
Storm Event	Design	Discharge	7.12 cfs

Peak Discharge Method: User-Specified			
Design Discharge	7.12 cfs	Check Discharge	8.37 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	0.75 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	7.12 cfs	Bottom Elevation	608.80 ft
Depth	0.75 ft	Velocity	1.28 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	7.12 cfs	610.43 ft	4.86 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E6

.omponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	610.43 ft	Discharge	7.12 cfs
Inlet Control HW Elev	610.39 ft	Tailwater Elevation	609.55 ft
Outlet Control HW Elev	610.43 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.69		

Grades			
Upstream Invert	609.04 ft	Downstream Invert	608.80 ft
Length	53.00 ft	Constructed Slope	0.004528 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.95 ft
Slope Type	Mild	Normal Depth	0.96 ft
Flow Regime	Subcritical	Critical Depth	0.95 ft
Velocity Downstream	4.86 ft/s	Critical Slope	0.004773 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	610.43 ft	Upstream Velocity Head	0.35 ft
Ke	0.20	Entrance Loss	0.07 ft

Inlet Control Properties			
Inlet Control HW Elev	610.39 ft	Flow Control	Unsubmerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E6

Analysis Component			
Storm Event	Check	Discharge	8.37 cfs

Peak Discharge Method: User-Specified			
Design Discharge	7.12 cfs	Check Discharge	8.37 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	0.81 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	8.37 cfs	Bottom Elevation	608.80 ft
Depth	0.81 ft	Velocity	1.34 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	8.37 cfs	610.56 ft	5.13 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 614.00 ft @
Station 872+00 eastbound I-80

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E6

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	610.56	ft	Discharge	8.37	cfs
Inlet Control HW Elev	610.53	ft	Tailwater Elevation	609.61	ft
Outlet Control HW Elev	610.56	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.76				

Grades					
Upstream Invert	609.04	ft	Downstream Invert	608.80	ft
Length	53.00	ft	Constructed Slope	0.004528	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.03	ft
Slope Type	Mild		Normal Depth	1.06	ft
Flow Regime	Subcritical		Critical Depth	1.03	ft
Velocity Downstream	5.13	ft/s	Critical Slope	0.004939	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	610.56	ft	Upstream Velocity Head	0.38	ft
Ke	0.20		Entrance Loss	0.08	ft

Inlet Control Properties					
Inlet Control HW Elev	610.53	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA #25

$AREA_{TOTAL} = 2.57$ acres

$AREA_{grass} = 0.55$ acres

$AREA_{paved} = 2.57$ ac. $- 0.55$ ac $= 2.02$ acres

$$C = \frac{(0.55\,ac)(0.20) + (2.02\,ac)(0.90)}{2.57} = 0.75$$

$T_c = 10$ min.

$Q_{10} = 1.03$ cfs

$Q_{100} = 8.27$ cfs

DOWNSTREAM CULVERT E6 (Area #5 + #7 + #8 + #18 + #19 + #20 + #24 + #25 + #26)

$Q_{10} = 53.77$ cfs

$Q_{100} = 64.60$ cfs

Hydrograph Plot

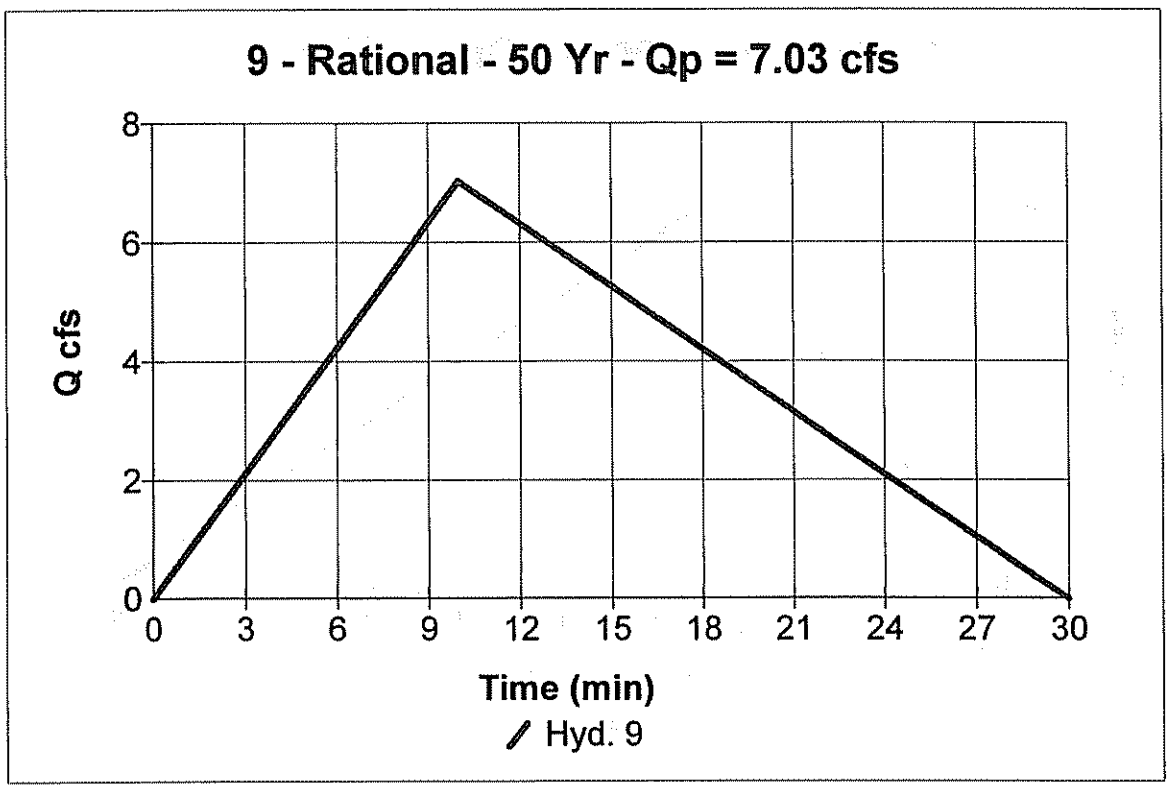
Hydraflow Hydrographs by Intelisolve

Hyd. No. 9

Area #25

Hydrograph type	= Rational	Peak discharge	= 7.03 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 2.6 ac	Runoff coeff.	= 0.35
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 6,330 cuft



Hydrograph Plot

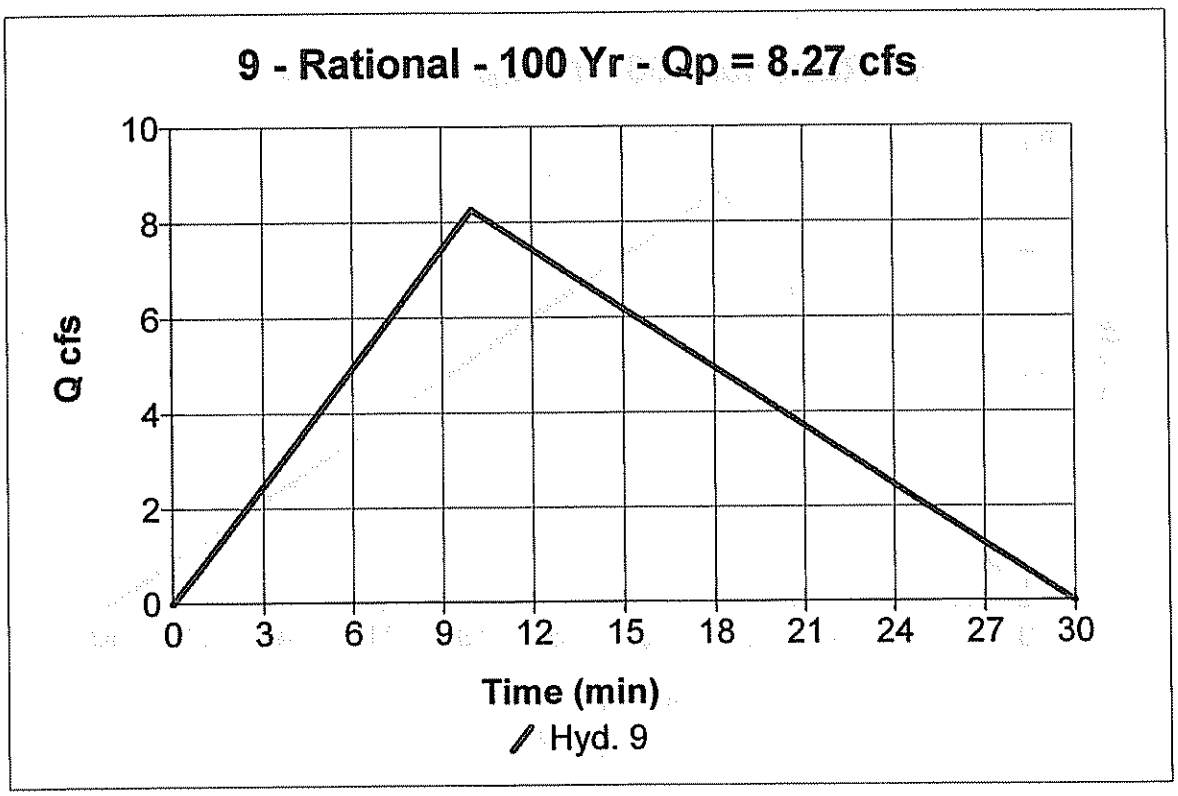
Hydraflow Hydrographs by Intelisolve

Hyd. No. 9

Area #25

Hydrograph type	= Rational	Peak discharge	= 8.27 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 2.6 ac	Runoff coeff.	= 0.35
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 7,439 cuft



Hydrograph Plot

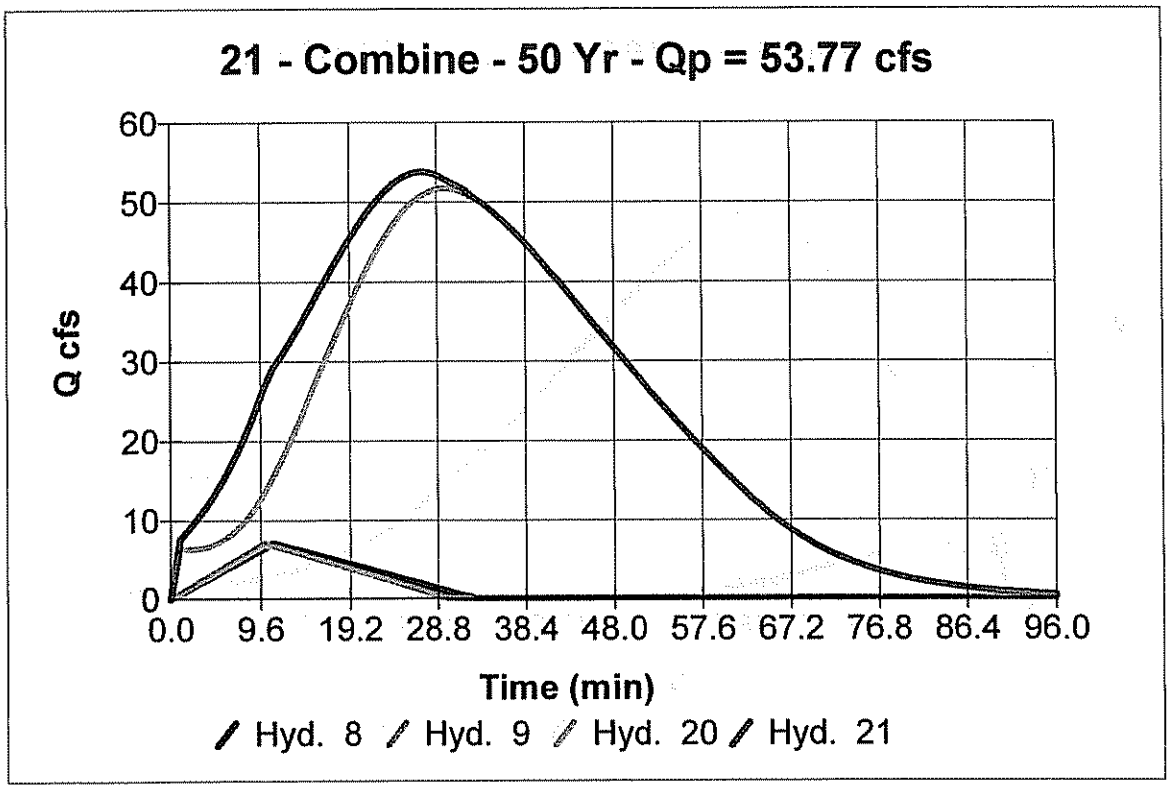
Hydraflow Hydrographs by Intelisolve

Hyd. No. 21

DS CULVERT E6

Hydrograph type	= Combine	Peak discharge	= 53.77 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 8, 9, 20		

Hydrograph Volume = 136,915 cuft



Hydrograph Plot

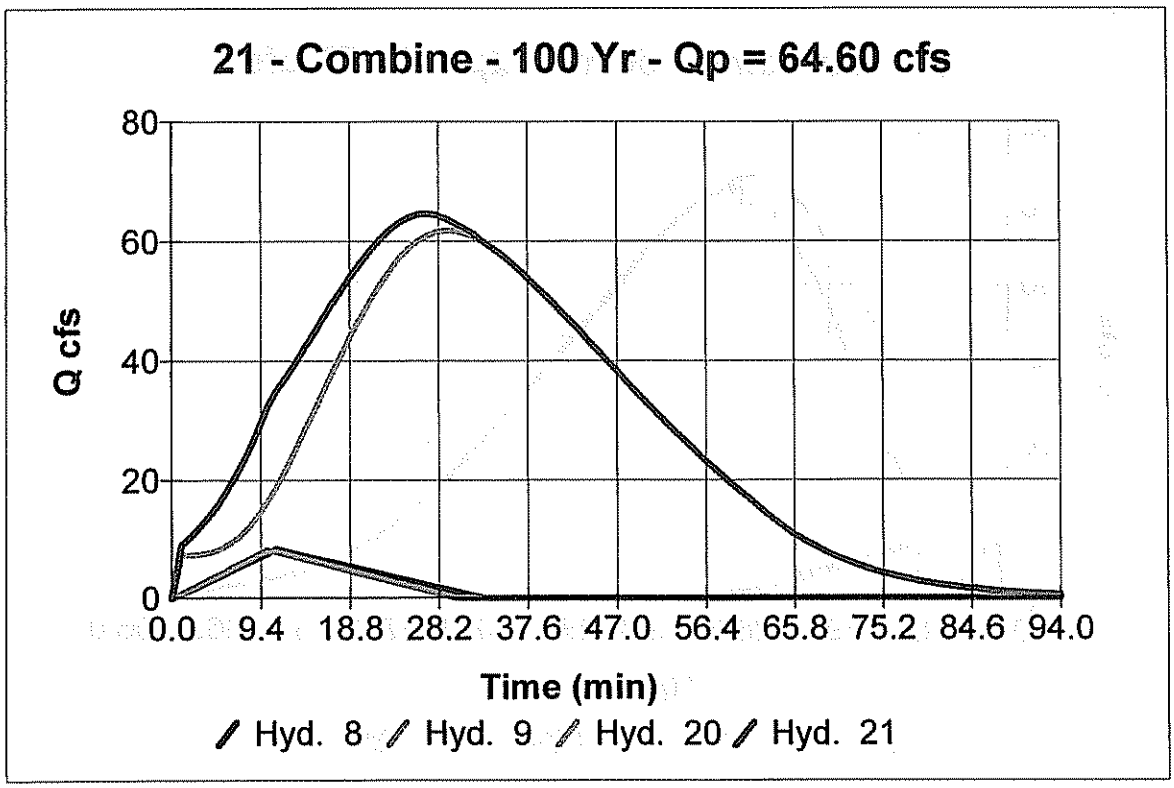
Hydraflow Hydrographs by Intelisolve

Hyd. No. 21

DS CULVERT E6

Hydrograph type	= Combine	Peak discharge	= 64.60 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 8, 9, 20		

Hydrograph Volume = 160,835 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

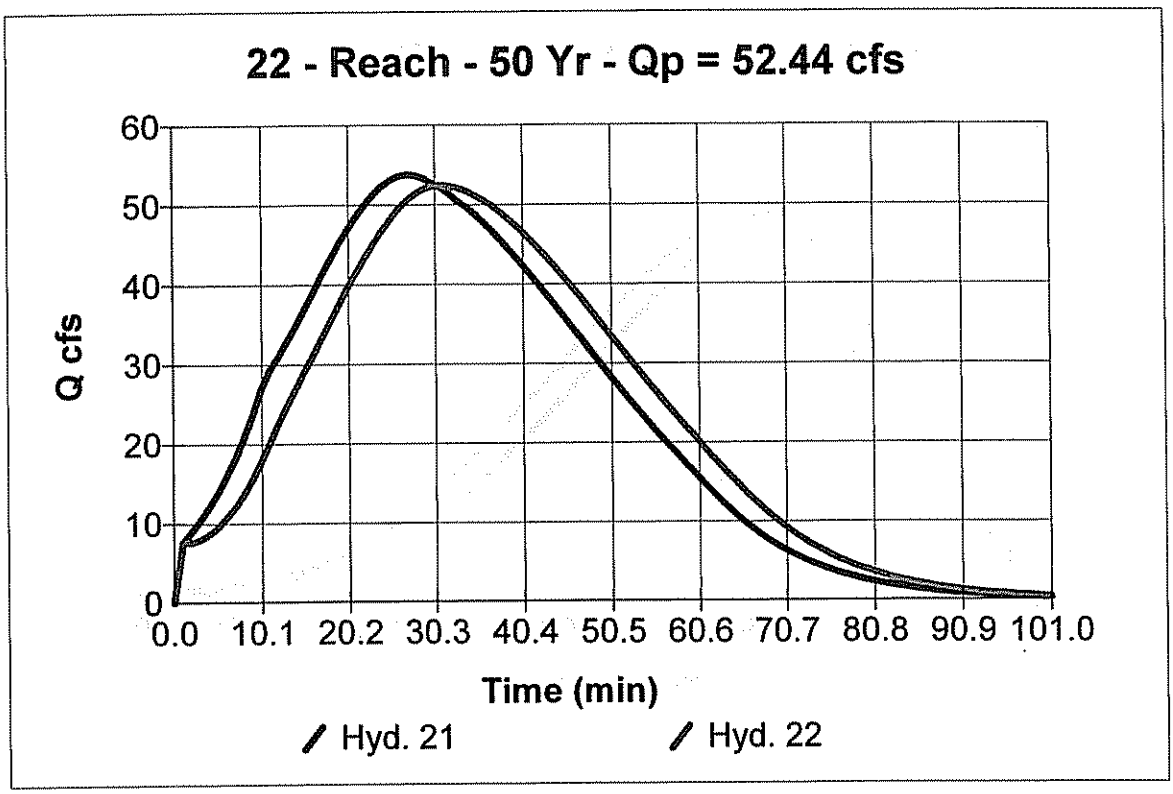
Hyd. No. 22

DITCH DS CULV E6

Hydrograph type	= Reach	Peak discharge	= 52.44 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 21	Section type	= Trapezoidal
Reach length	= 1000.0 ft	Channel slope	= 0.8 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 5.0:1	Max. depth	= 4.0 ft
Rating curve x	= 0.934	Rating curve m	= 1.293
Ave. velocity	= 3.94	Routing coeff.	= 0.2650

Modified Att-Kin routing method used.

Hydrograph Volume = 138,646 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

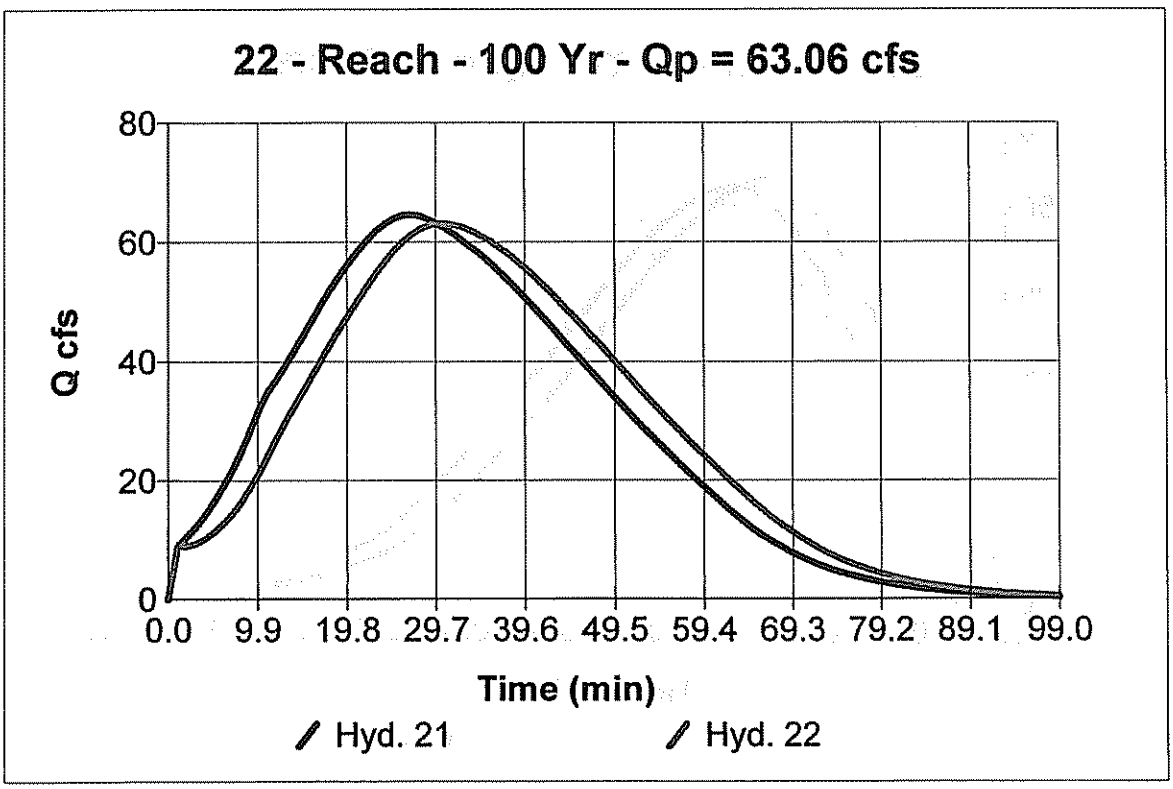
Hyd. No. 22

DITCH DS CULV E6

Hydrograph type	= Reach	Peak discharge	= 63.06 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 21	Section type	= Trapezoidal
Reach length	= 1000.0 ft	Channel slope	= 0.8 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 5.0:1	Max. depth	= 4.0 ft
Rating curve x	= 0.934	Rating curve m	= 1.293
Ave. velocity	= 4.13	Routing coeff.	= 0.2761

Modified Att-Kin routing method used.

Hydrograph Volume = 162,789 cuft



Check Depth

@ station 872+00 ℄ Elev. 614.00ft (Eastbound I-80)

Elevation 1.3' + 608.80' = 610.10 ft.

DS Ditch @ DS PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.008400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	53.77	ft^3/s

Results		
Depth	1.81	ft
Flow Area	20.03	ft^2
Wetted Perimeter	20.47	ft
Top Width	20.12	ft
Critical Depth	1.30	ft
Critical Slope	0.041264	ft/ft
Velocity	2.68	ft/s
Velocity Head	0.11	ft
Specific Energy	1.92	ft
Froude Number	0.47	
Flow is subcritical.		

DS Ditch @ DS PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.008400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	64.60	ft^3/s

Results		
Depth	1.95	ft
Flow Area	22.98	ft^2
Wetted Perimeter	21.92	ft
Top Width	21.53	ft
Critical Depth	1.41	ft
Critical Slope	0.040265	ft/ft
Velocity	2.81	ft/s
Velocity Head	0.12	ft
Specific Energy	2.08	ft
Froude Number	0.48	
Flow is subcritical.		

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 10/01/03
CHECKED BY: _____ DATE: _____
SHEET: 12 OF: _____

DRAINAGE CALCULATIONS

AREA # ~~4~~ 6

$AREA_{TOTAL} = 78{,}549.7\ ft^2 / (43560\ ft^2/acre) = \cancel{1.82}\ 1.81$ acres

$AREA_{grass} = 65{,}509.2\ ft^2 / (43560\ ft^2/acre) = 1.50$ acres

$AREA_{paved} = 1.80$ acres $- 1.50$ acres $= 0.30$ acres

$$C_w = \frac{(1.50\ ac.)(0.20) + (0.30)(0.90)}{1.80\ ac.} = 0.317 \checkmark$$

$T_c = ?$

$L_1 = 125$ ft $\quad S_1 = (1'/100')(100) = 1.00\%$ (Sheet Flow)

$L_2 = 219$ ft $\quad S_2 = (1.28'/219')(100) = 0.58\%$ (Channel Flow)

$Q_{50} = \cancel{3.99}$ cfs 4.00

$Q_{100} = \cancel{4.70}$ cfs 4.71

TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve

Hyd. No. 11

Area #9
Storm frequency = yrs

Sheet Flow

Manning's n-value	= 0.100
Flow length	= 125.0 ft
Two-year 24-hr precip.	= 3.25 in
Land slope	= 1.0 %

Travel Time ..... = 11.1 min

Shallow Concentrated Flow

Flow length	= 0 ft
Watercourse slope	= 0.0 %
Surface description	= Paved
Average velocity	= 0.00 ft/s

Travel Time ..... = 0.0 min

Channel Flow

Cross section flow area	= 3.4 sqft
Wetted perimeter	= 8.9 ft
Channel slope	= 0.6 %
Manning's n-value	= 0.050
Velocity	= 1.19 ft/s
Flow length	= 219.0 ft

Travel Time ..... = 3.1 min

Total Travel Time, Tc ..... = 14.2 min

Hydrograph Plot

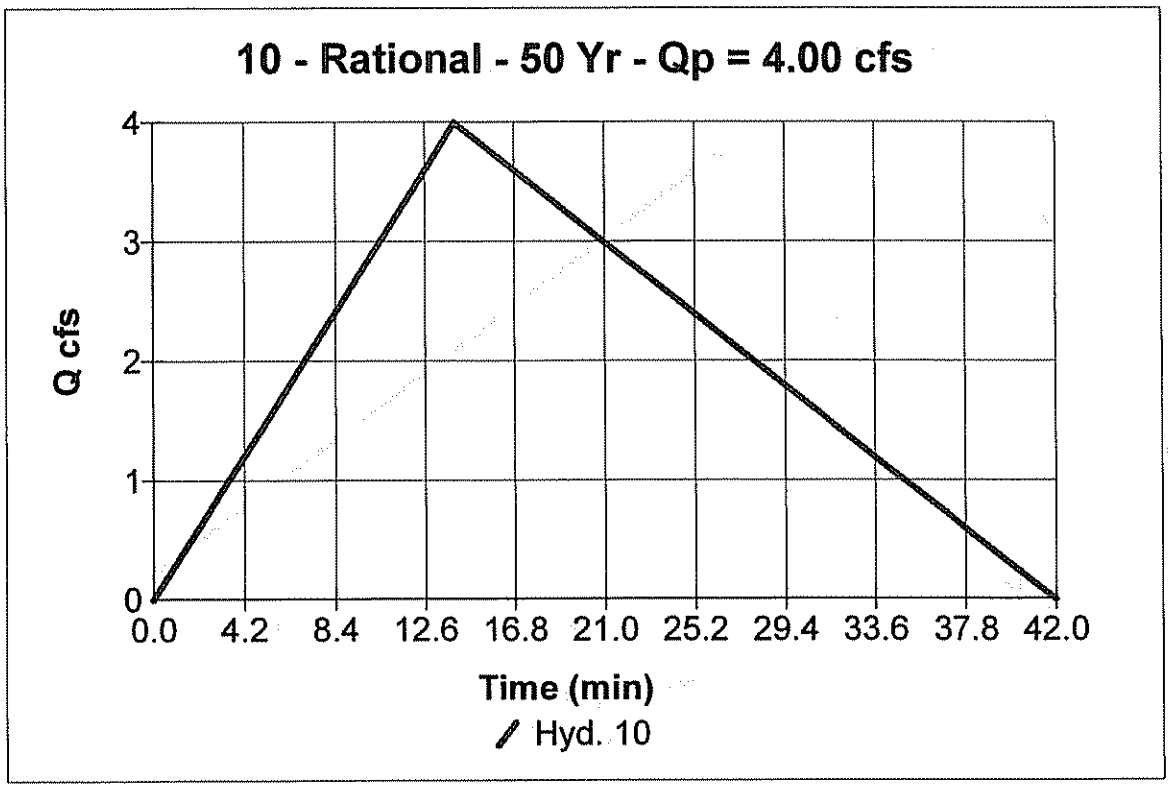
Hydraflow Hydrographs by Intelisolve

Hyd. No. 10

Area #6

Hydrograph type	= Rational	Peak discharge	= 4.00 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 1.8 ac	Runoff coeff.	= 0.32
Intensity	= 6.901 in/hr	Time of conc. (Tc)	= 14.1 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 5,072 cuft



Hydrograph Plot

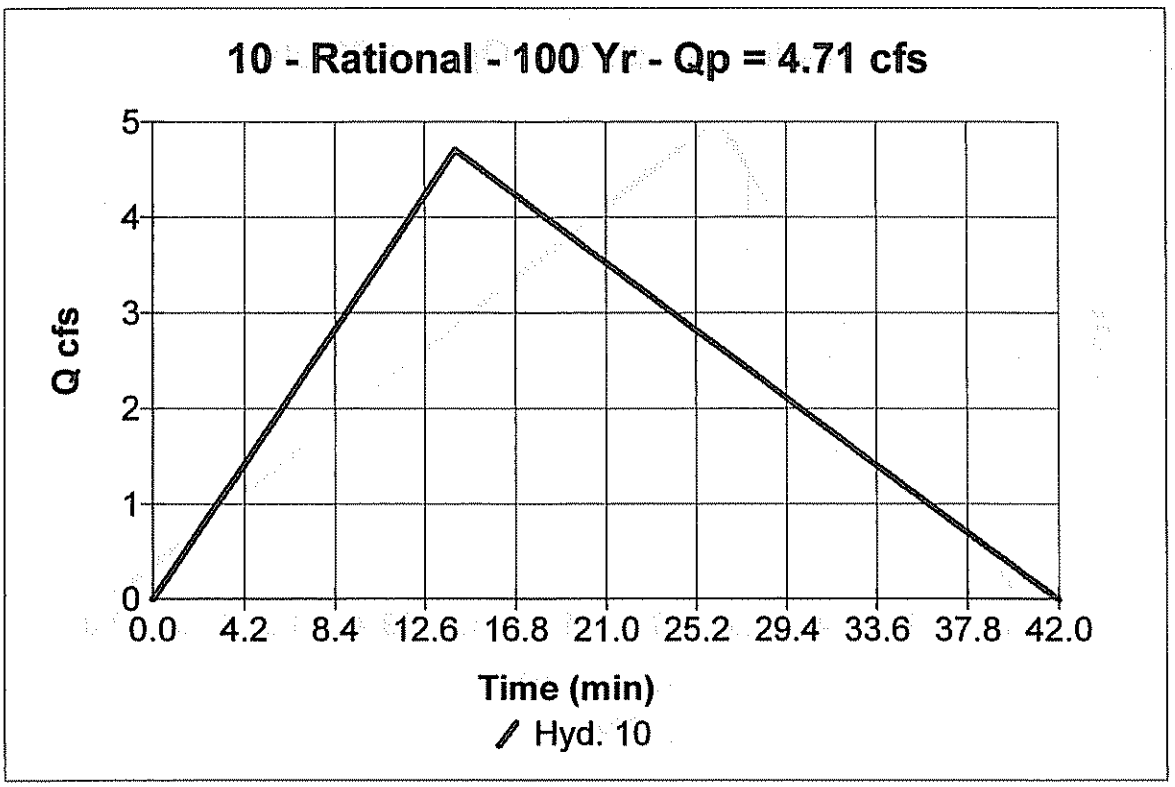
Hydraflow Hydrographs by Intelisolve

Hyd. No. 10

Area #6

Hydrograph type	= Rational	Peak discharge	= 4.71 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.8 ac	Runoff coeff.	= 0.32
Intensity	= 8.128 in/hr	Time of conc. (Tc)	= 14.1 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 5,974 cuft



US PIPE CULVERT NO. E7
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E7
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.005800	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	4.00	ft^3/s

Results		
Depth	0.53	ft
Flow Area	3.37	ft^2
Wetted Perimeter	8.89	ft
Top Width	8.76	ft
Critical Depth	0.28	ft
Critical Slope	0.060587	ft/ft
Velocity	1.19	ft/s
Velocity Head	0.02	ft
Specific Energy	0.55	ft
Froude Number	0.34	
Flow is subcritical.		

US PIPE CULVERT NO. E7
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E7
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.005800	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	4.71	ft^3/s

Results		
Depth	0.58	ft
Flow Area	3.79	ft^2
Wetted Perimeter	9.32	ft
Top Width	9.18	ft
Critical Depth	0.31	ft
Critical Slope	0.058980	ft/ft
Velocity	1.24	ft/s
Velocity Head	0.02	ft
Specific Energy	0.60	ft
Froude Number	0.34	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E7

ıalysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	4.71 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.005800 ft/ft	Mannings Coefficient	0.050
Depth	0.53 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	4.00 cfs	Bottom Elevation	620.30 ft
Depth	0.53 ft	Velocity	1.19 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	4.00 cfs	621.73 ft	4.07 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E7

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	621.73	ft	Discharge	4.00	cfs
Inlet Control HW Elev	621.69	ft	Tailwater Elevation	620.83	ft
Outlet Control HW Elev	621.73	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.50				

Grades					
Upstream Invert	620.72	ft	Downstream Invert	620.30	ft
Length	131.00	ft	Constructed Slope	0.003206	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.70	ft
Slope Type	Mild		Normal Depth	0.77	ft
Flow Regime	Subcritical		Critical Depth	0.70	ft
Velocity Downstream	4.07	ft/s	Critical Slope	0.004481	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	621.73	ft	Upstream Velocity Head	0.20	ft
Ke	0.20		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev	621.69	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E7

Analysis Component			
Storm Event	Check	Discharge	4.71 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	4.71 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.005800 ft/ft	Mannings Coefficient	0.050
Depth	0.58 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	4.71 cfs	Bottom Elevation	620.30 ft
Depth	0.58 ft	Velocity	1.24 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	4.71 cfs	621.82 ft	4.27 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 624.60 Ft @
Station 896+50 (Westbound I-80)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E7

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	621.82	ft	Discharge	4.71	cfs
Inlet Control HW Elev	621.78	ft	Tailwater Elevation	620.88	ft
Outlet Control HW Elev	621.82	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.55				

Grades					
Upstream Invert	620.72	ft	Downstream Invert	620.30	ft
Length	131.00	ft	Constructed Slope	0.003206	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.76	ft
Slope Type	Mild		Normal Depth	0.84	ft
Flow Regime	Subcritical		Critical Depth	0.76	ft
Velocity Downstream	4.27	ft/s	Critical Slope	0.004533	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

ɔutlet Control Properties					
Outlet Control HW Elev	621.82	ft	Upstream Velocity Head	0.22	ft
Ke	0.20		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev	621.78	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

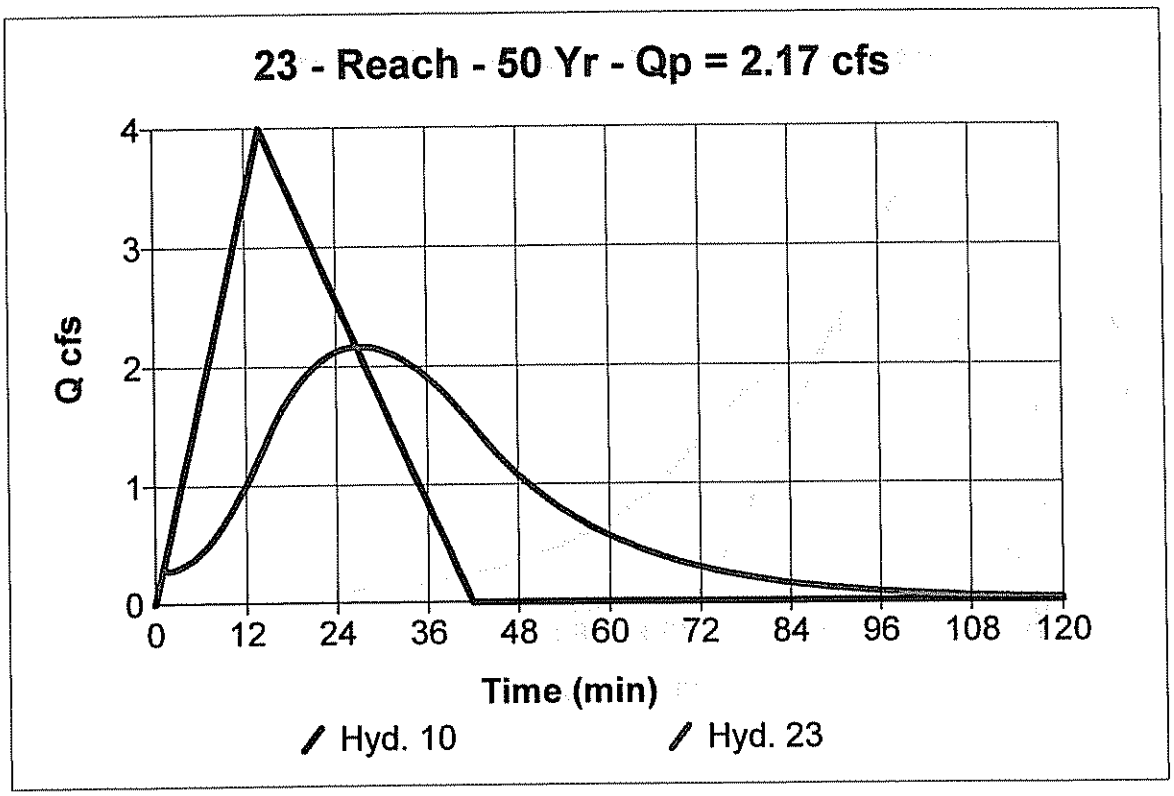
Hyd. No. 23

DITCH CULV 3 TO CULV 4

Hydrograph type	= Reach	Peak discharge	= 2.17 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 10	Section type	= Trapezoidal
Reach length	= 1050.0 ft	Channel slope	= 0.2 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.467	Rating curve m	= 1.282
Ave. velocity	= 0.75	Routing coeff.	= 0.0534

Modified Att-Kin routing method used.

Hydrograph Volume = 5,346 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

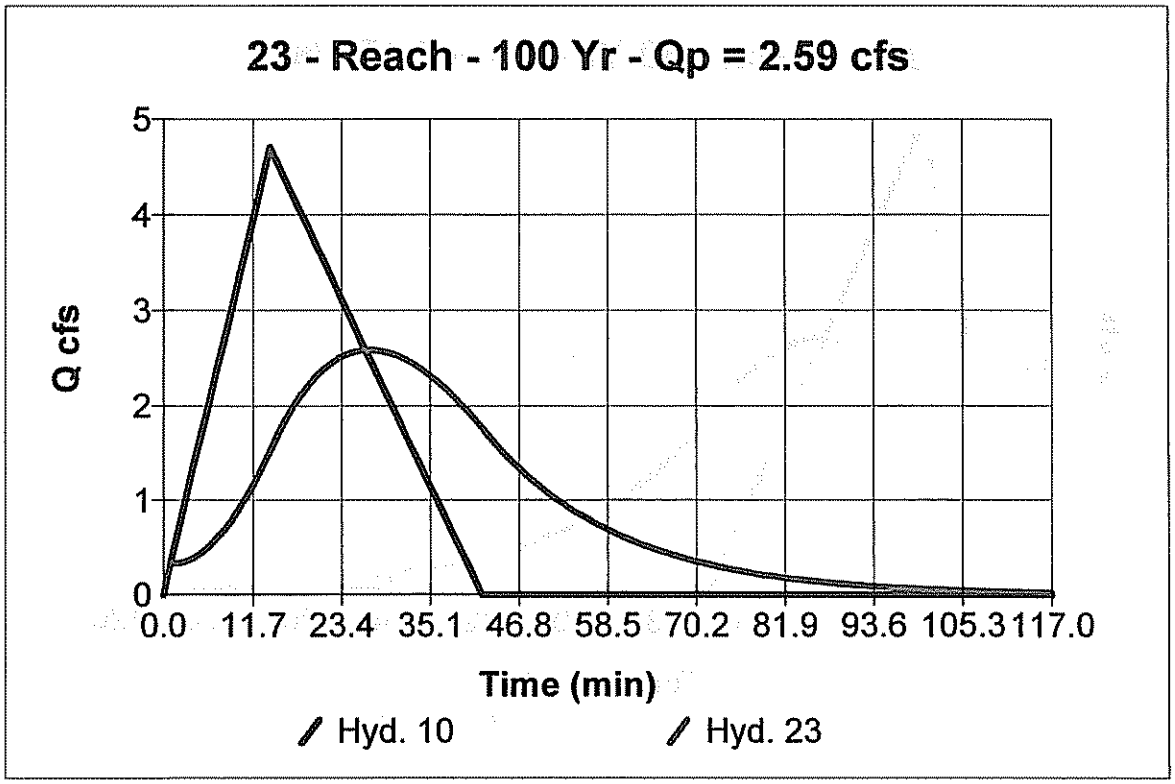
Hyd. No. 23

DITCH CULV 3 TO CULV 4

Hydrograph type	= Reach	Peak discharge	= 2.59 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 10	Section type	= Trapezoidal
Reach length	= 1050.0 ft	Channel slope	= 0.2 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.467	Rating curve m	= 1.282
Ave. velocity	= 0.78	Routing coeff.	= 0.0553

Modified Att-Kin routing method used.

Hydrograph Volume = 6,286 cuft



GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA # 21

$AREA_T = 9.04$ acres

$AREA_{paved} = 1.03$ acres

$AREA_{grass} = 9.04\ ac. - 1.03\ ac. = 8.01\ ac$

$$C = \frac{(1.03\ ac)(0.90) + (8.01\ ac)(0.20)}{9.04\ ac.} = 0.28$$

Assumed $T_c = 15$ minutes

$Q_{10} = 17.03$ cfs

$Q_{100} = 20.06$ cfs

CULVERT 4

$Q_{10} = 18.45$ cfs

$Q_{100} = 21.77$ cfs

Hydrograph Plot

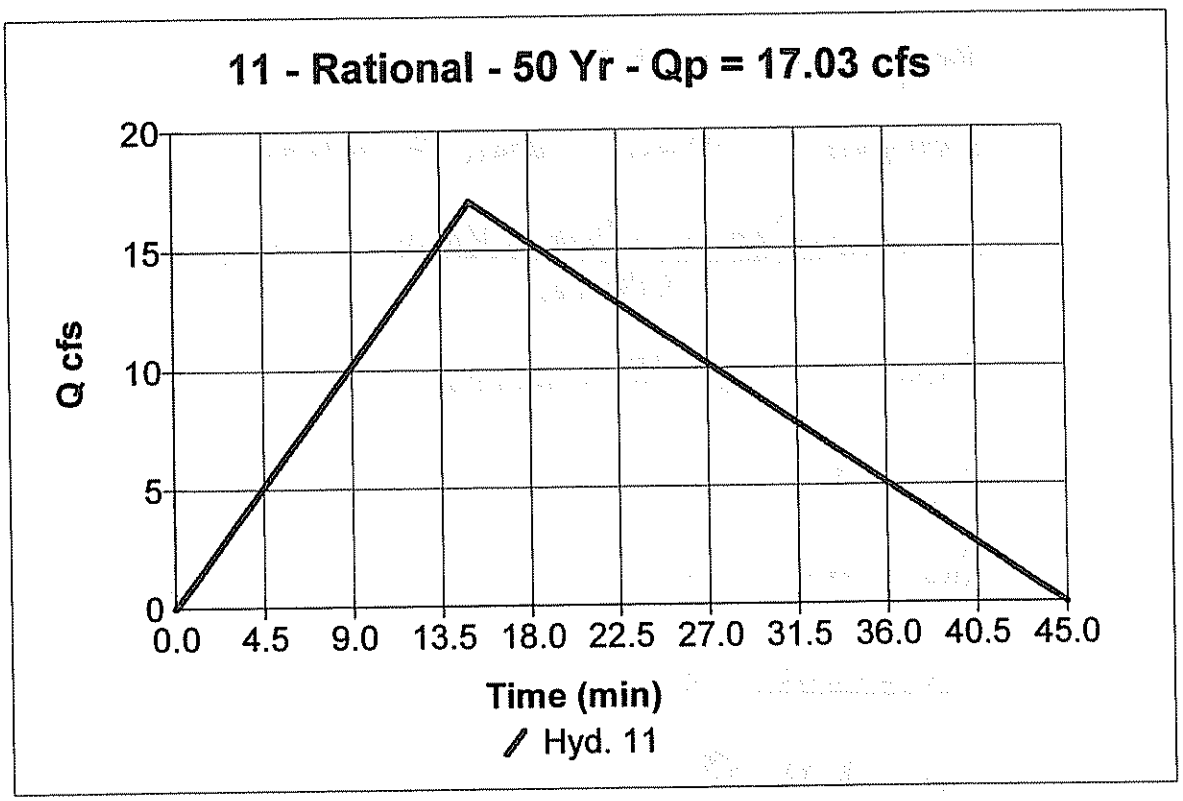
Hydraflow Hydrographs by Intelisolve

Hyd. No. 11

Area #21

Hydrograph type	= Rational	Peak discharge	= 17.03 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 9.0 ac	Runoff coeff.	= 0.28
Intensity	= 6.729 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 22,994 cuft



Hydrograph Plot

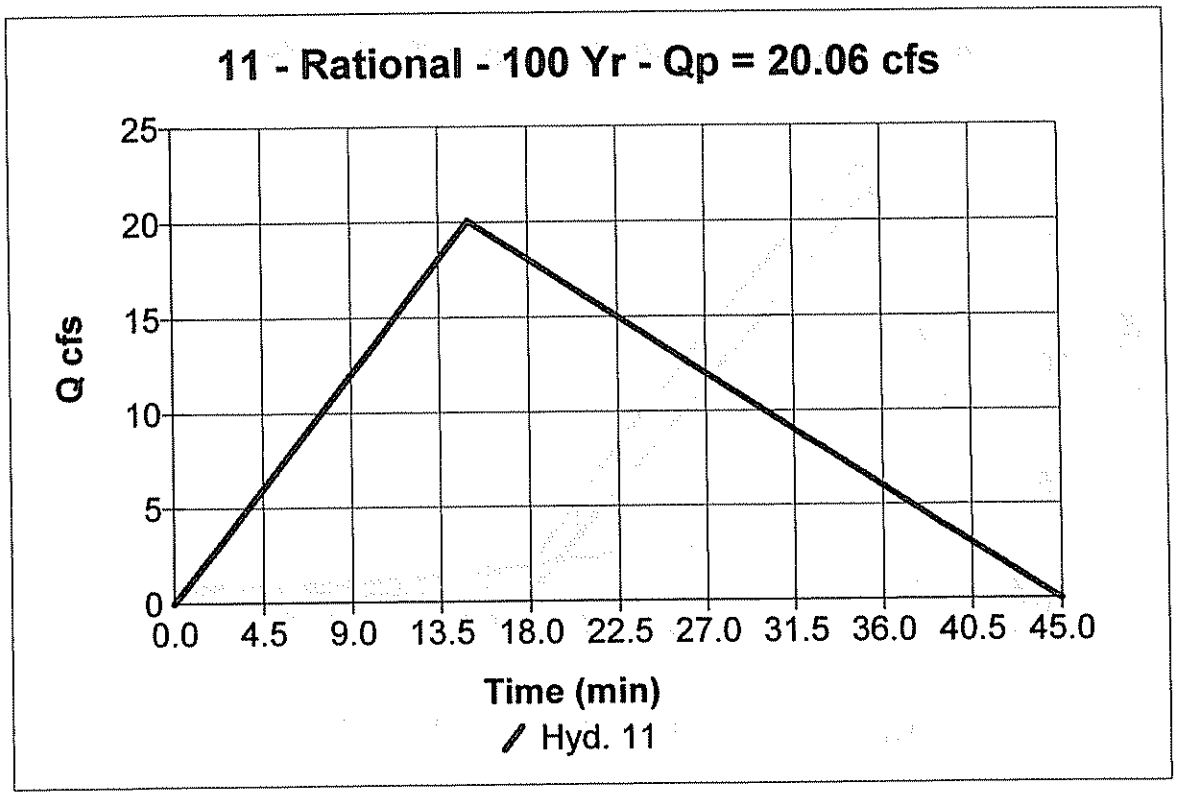
Hydraflow Hydrographs by Intelisolve

Hyd. No. 11

Area #21

Hydrograph type	= Rational	Peak discharge	= 20.06 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 9.0 ac	Runoff coeff.	= 0.28
Intensity	= 7.927 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 27,088 cuft



Hydrograph Plot

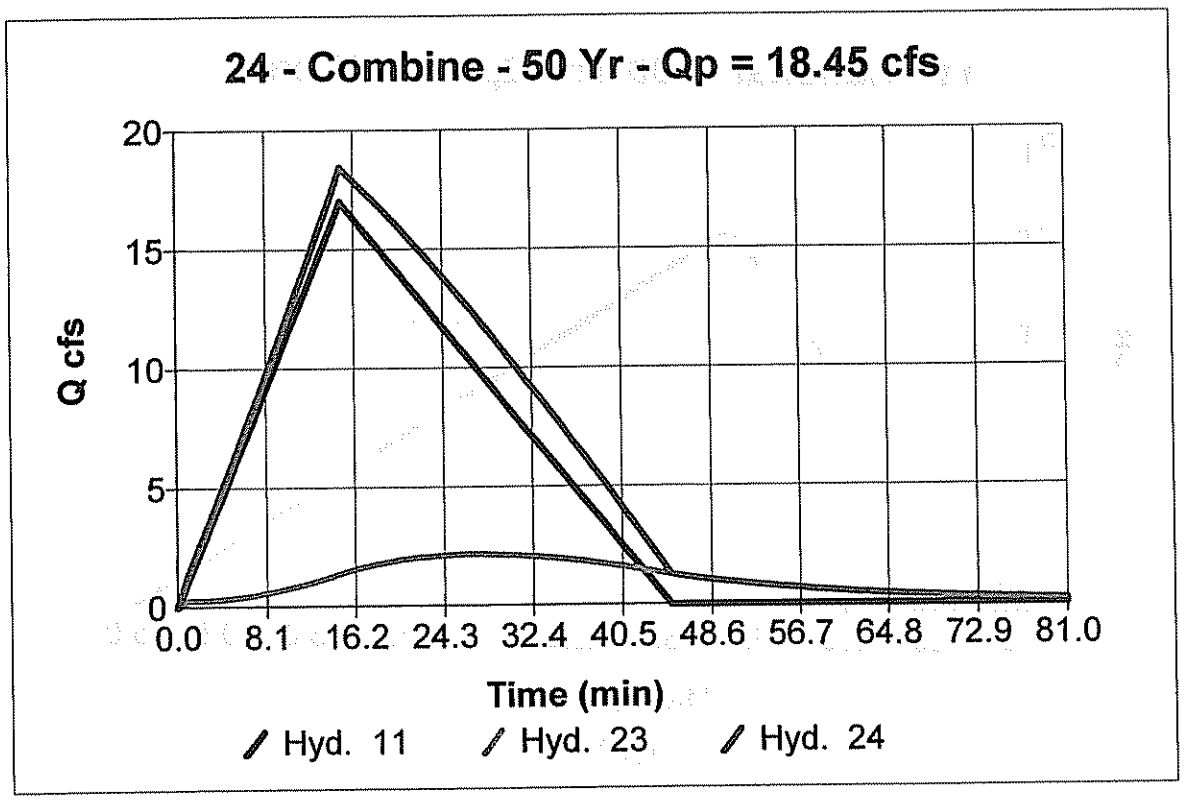
Hydraflow Hydrographs by Intelisolve

Hyd. No. 24

CULVERT 4

Hydrograph type	= Combine	Peak discharge	= 18.45 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 11, 23		

Hydrograph Volume = 28,341 cuft



Hydrograph Plot

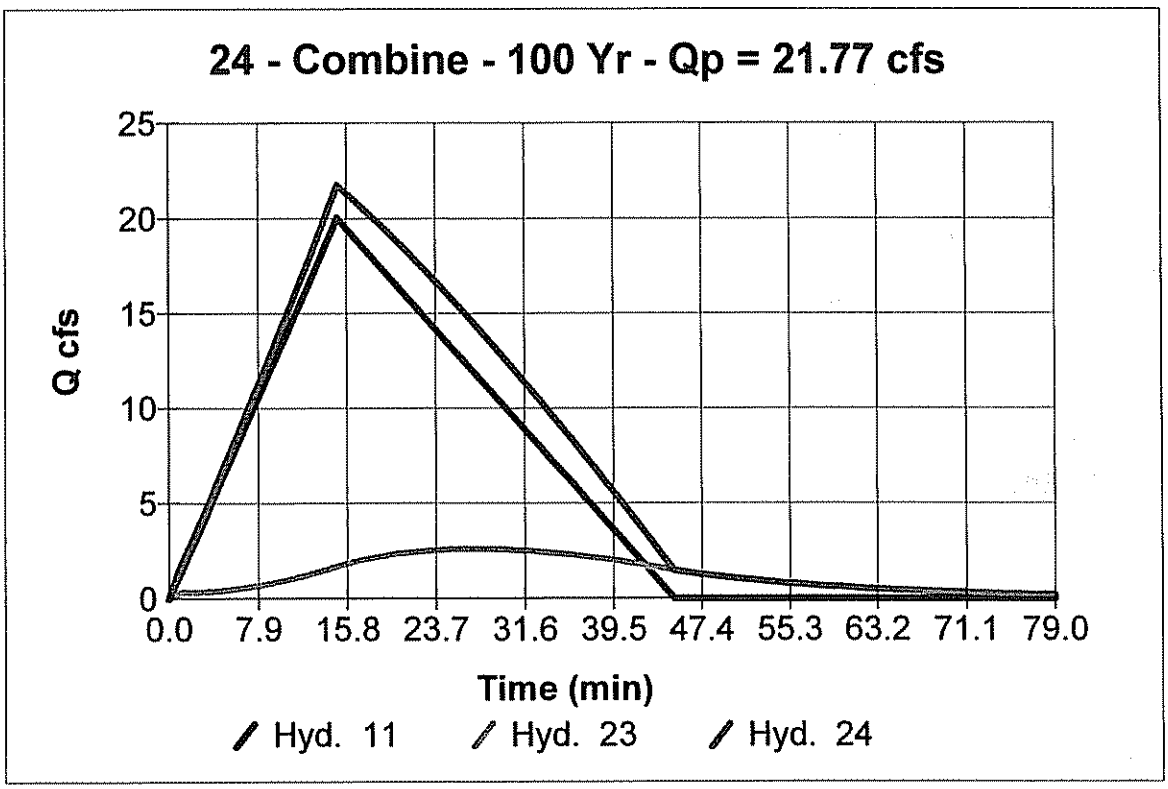
Hydraflow Hydrographs by Intelisolve

Hyd. No. 24

CULVERT 4

Hydrograph type	= Combine	Peak discharge	= 21.77 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 11, 23		

Hydrograph Volume = 33,374 cuft



US PIPE CULVERT NO. 4
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 4
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.002100	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	18.45	ft^3/s

Results		
Depth	1.43	ft
Flow Area	14.91	ft^2
Wetted Perimeter	17.21	ft
Top Width	16.86	ft
Critical Depth	0.67	ft
Critical Slope	0.047851	ft/ft
Velocity	1.24	ft/s
Velocity Head	0.02	ft
Specific Energy	1.45	ft
Froude Number	0.23	
Flow is subcritical.		

US PIPE CULVERT NO. 4
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 4
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.002100	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	21.77	ft^3/s

Results		
Depth	1.54	ft
Flow Area	16.86	ft^2
Wetted Perimeter	18.25	ft
Top Width	17.87	ft
Critical Depth	0.74	ft
Critical Slope	0.046724	ft/ft
Velocity	1.29	ft/s
Velocity Head	0.03	ft
Specific Energy	1.57	ft
Froude Number	0.23	
Flow is subcritical.		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 4

Analysis Component			
Storm Event	Design	Discharge	18.45 cfs

Peak Discharge Method: User-Specified			
Design Discharge	18.45 cfs	Check Discharge	21.77 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.002100 ft/ft	Mannings Coefficient	0.050
Depth	1.43 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	18.45 cfs	Bottom Elevation	618.12 ft
Depth	1.43 ft	Velocity	1.24 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	18.45 cfs	621.08 ft	7.99 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 4

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	621.08 ft	Discharge	18.45 cfs
Inlet Control HW Elev	621.08 ft	Tailwater Elevation	619.55 ft
Outlet Control HW Elev	621.08 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.24		

Grades			
Upstream Invert	618.60 ft	Downstream Invert	618.12 ft
Length	47.00 ft	Constructed Slope	0.010213 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.38 ft
Slope Type	Steep	Normal Depth	1.36 ft
Flow Regime	Supercritical	Critical Depth	1.55 ft
Velocity Downstream	7.99 ft/s	Critical Slope	0.007467 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	621.08 ft	Upstream Velocity Head	0.78 ft
Ke	0.20	Entrance Loss	0.16 ft

Inlet Control Properties			
Inlet Control HW Elev	621.08 ft	Flow Control	Submerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 4

Analysis Component			
Storm Event	Check	Discharge	21.77 cfs

Peak Discharge Method: User-Specified			
Design Discharge	18.45 cfs	Check Discharge	21.77 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.002100 ft/ft	Mannings Coefficient	0.050
Depth	1.54 ft	Left Side Slope	6 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	21.77 cfs	Bottom Elevation	618.12 ft
Depth	1.54 ft	Velocity	1.29 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	21.77 cfs	621.47 ft	8.26 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 622.57 ft.
@ Station 885+00 (westbound I-80)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 4

ɔmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	621.47 ft	Discharge	21.77 cfs
Inlet Control HW Elev	621.47 ft	Tailwater Elevation	619.66 ft
Outlet Control HW Elev	621.40 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.44		

Grades			
Upstream Invert	618.60 ft	Downstream Invert	618.12 ft
Length	47.00 ft	Constructed Slope	0.010213 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.56 ft
Slope Type	Steep	Normal Depth	1.56 ft
Flow Regime	Supercritical	Critical Depth	1.67 ft
Velocity Downstream	8.26 ft/s	Critical Slope	0.008990 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

ɔutlet Control Properties			
Outlet Control HW Elev	621.40 ft	Upstream Velocity Head	0.94 ft
Ke	0.20	Entrance Loss	0.19 ft

Inlet Control Properties			
Inlet Control HW Elev	621.47 ft	Flow Control	Submerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02 317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA #22

$AREA_T = 8.81$ acres

$AREA_{paved} = 1.96$ acres

$AREA_{grass} = 8.81 ac. - 1.96 ac. = 6.85$ acres

$$C = \frac{(6.85 ac.)(0.20) + (1.96 ac.)(0.90)}{8.81 ac.} = 0.36$$

$Q_{10} = 21.34$ cfs

$Q_{100} = 25.14$ cfs

AREA #6 + #21 + #22

$Q_{10} = 39.19$ cfs

$Q_{100} = 46.91$ cfs

Hydrograph Plot

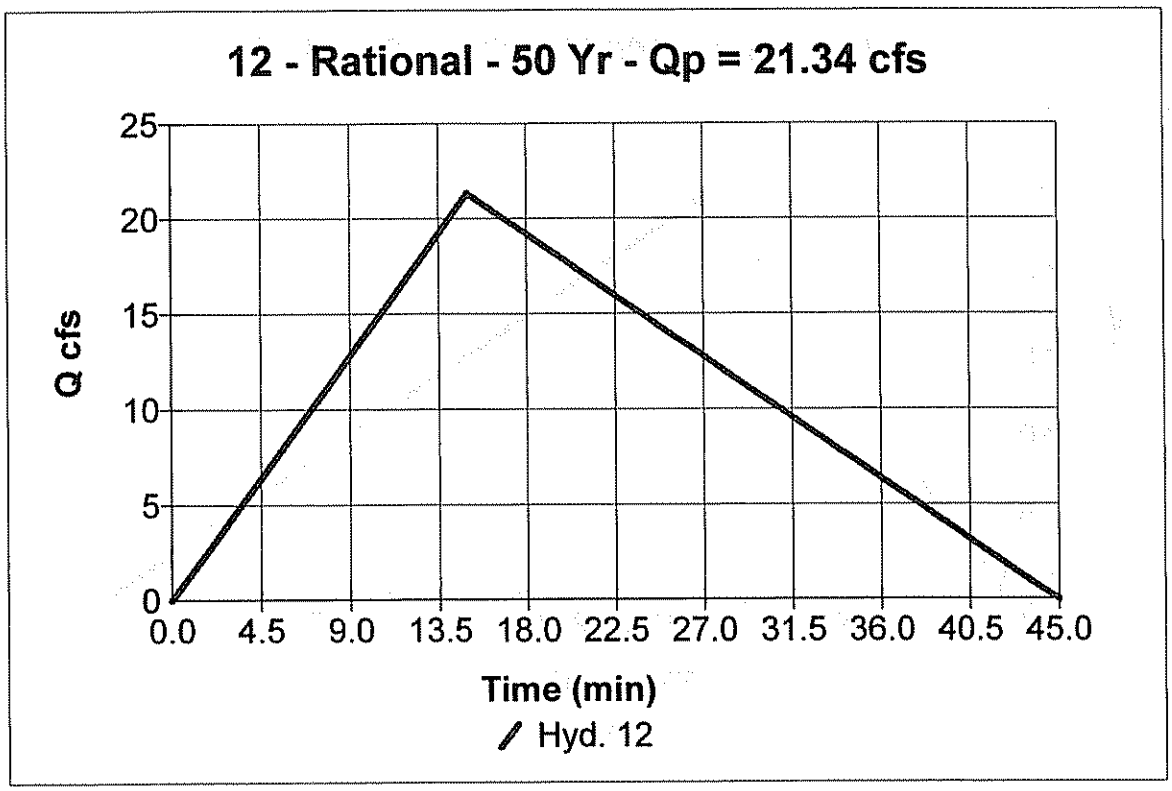
Hydraflow Hydrographs by Intelisolve

Hyd. No. 12

Area #22

Hydrograph type	= Rational	Peak discharge	= 21.34 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 8.8 ac	Runoff coeff.	= 0.36
Intensity	= 6.729 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 28,812 cuft



Hydrograph Plot

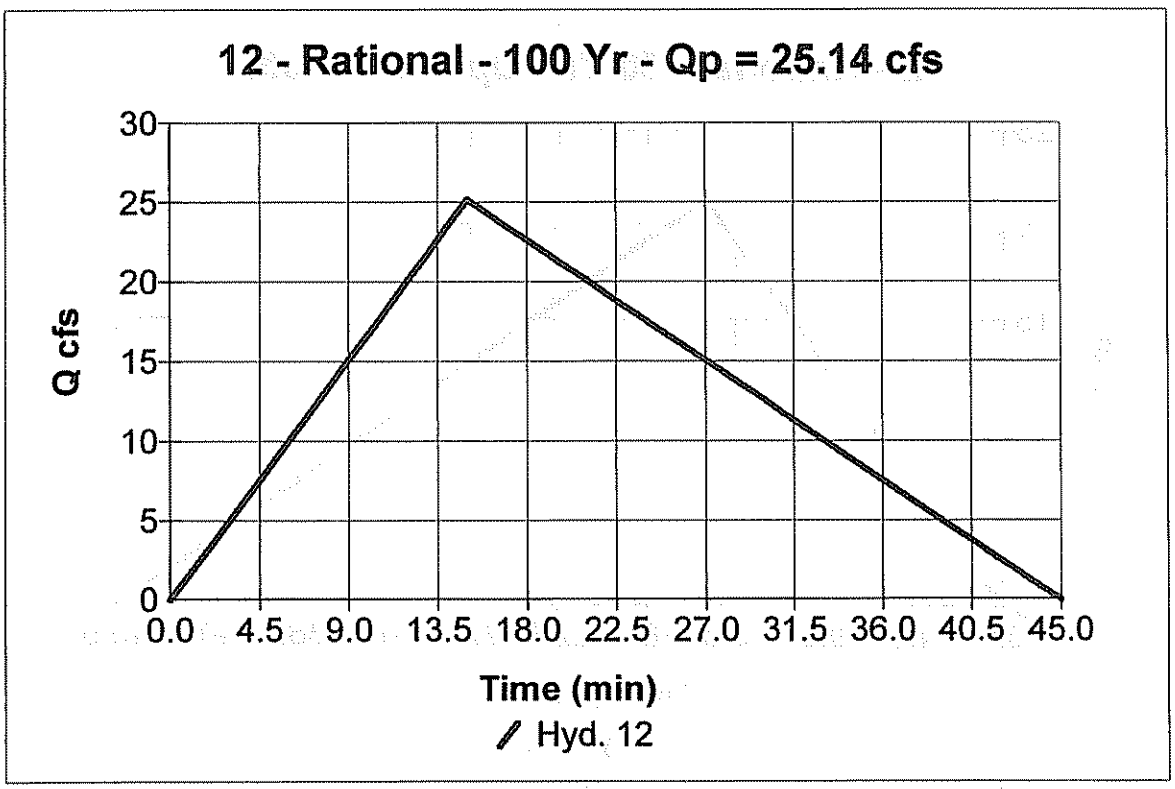
Hydraflow Hydrographs by Intelisolve

Hyd. No. 12

Area #22

Hydrograph type	= Rational	Peak discharge	= 25.14 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 8.8 ac	Runoff coeff.	= 0.36
Intensity	= 7.927 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 33,941 cuft



Hydrograph Plot

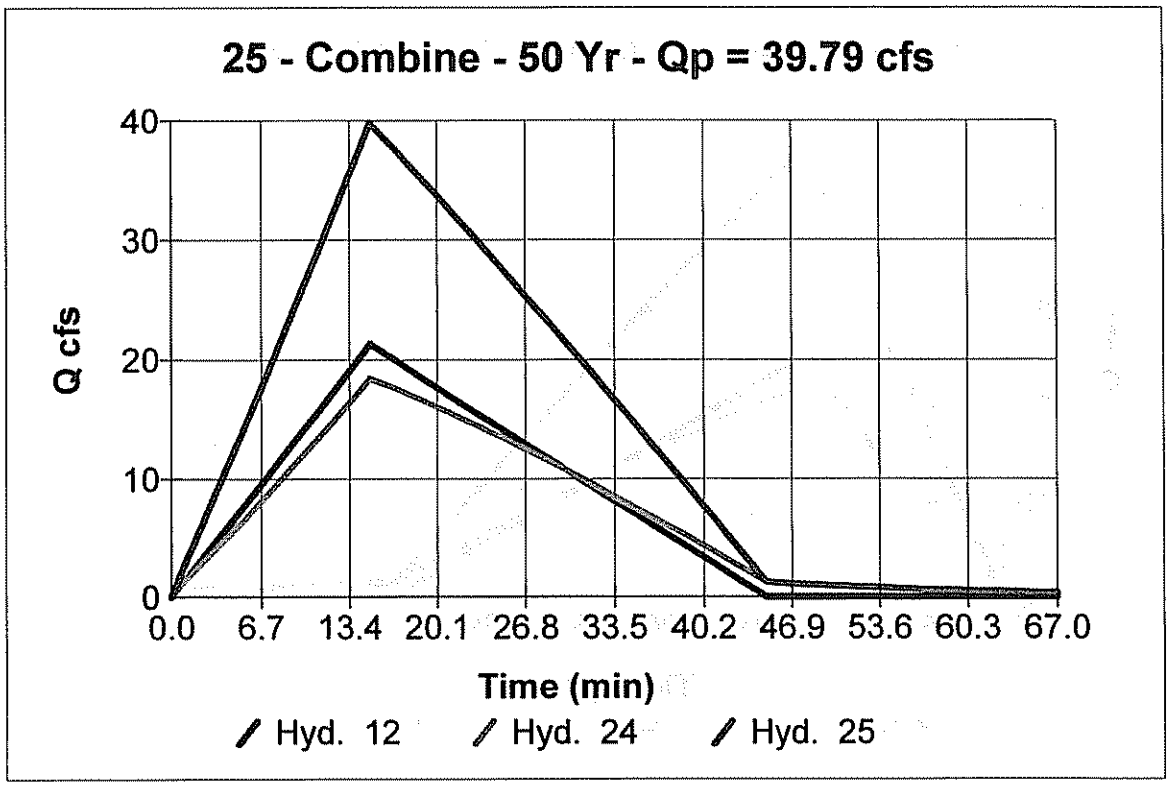
Hydraflow Hydrographs by Intelisolve

Hyd. No. 25

DS CULVERT 4

Hydrograph type	= Combine	Peak discharge	= 39.79 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 12, 24		

Hydrograph Volume = 57,152 cuft



Hydrograph Plot

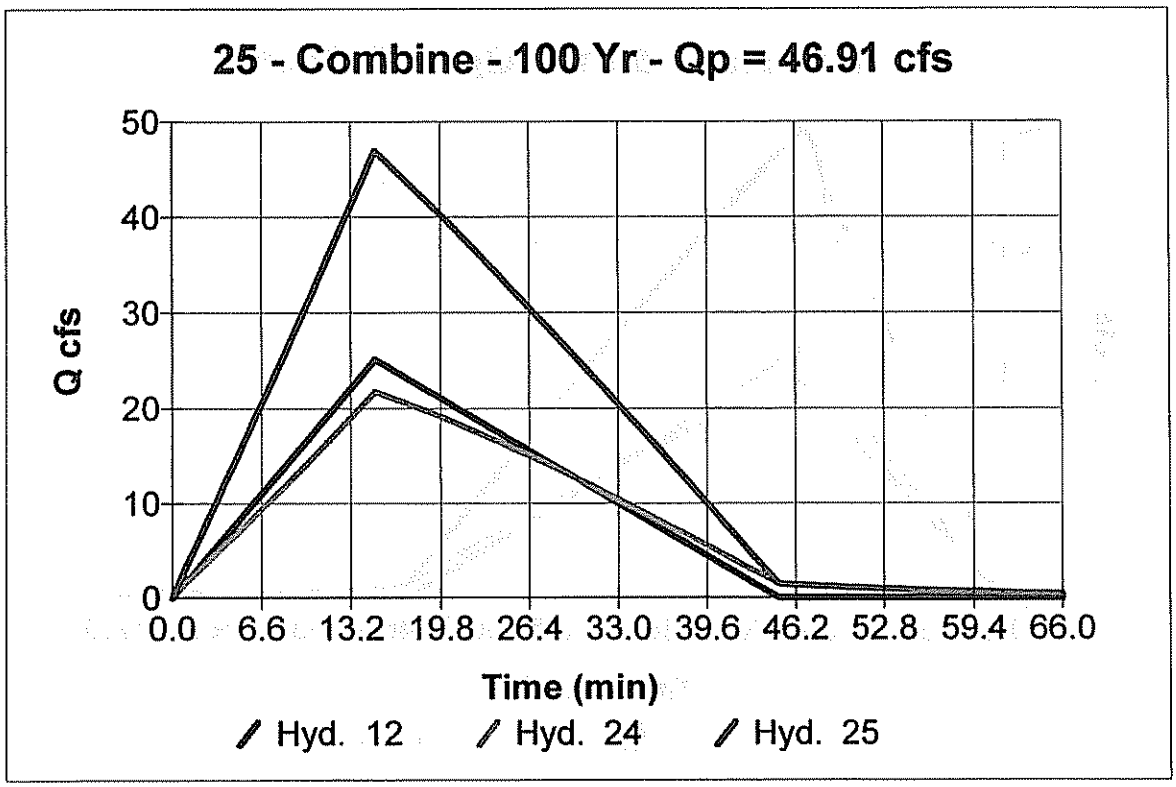
Hydraflow Hydrographs by Intelisolve

Hyd. No. 25

DS CULVERT 4

Hydrograph type	= Combine	Peak discharge	= 46.91 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 12, 24		

Hydrograph Volume = 67,315 cuft



DITCH SECTION
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DITCH SECTION
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.011400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	39.79	ft^3/s

Results		
Depth	1.38	ft
Flow Area	14.08	ft^2
Wetted Perimeter	16.75	ft
Top Width	16.41	ft
Critical Depth	1.01	ft
Critical Slope	0.042909	ft/ft
Velocity	2.83	ft/s
Velocity Head	0.12	ft
Specific Energy	1.50	ft
Froude Number	0.54	
Flow is subcritical.		

DITCH SECTION
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DITCH SECTION
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.011400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	46.91	ft^3/s

Results		
Depth	1.49	ft
Flow Area	15.91	ft^2
Wetted Perimeter	17.75	ft
Top Width	17.39	ft
Critical Depth	1.10	ft
Critical Slope	0.041940	ft/ft
Velocity	2.95	ft/s
Velocity Head	0.14	ft
Specific Energy	1.62	ft
Froude Number	0.54	
Flow is subcritical.		

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

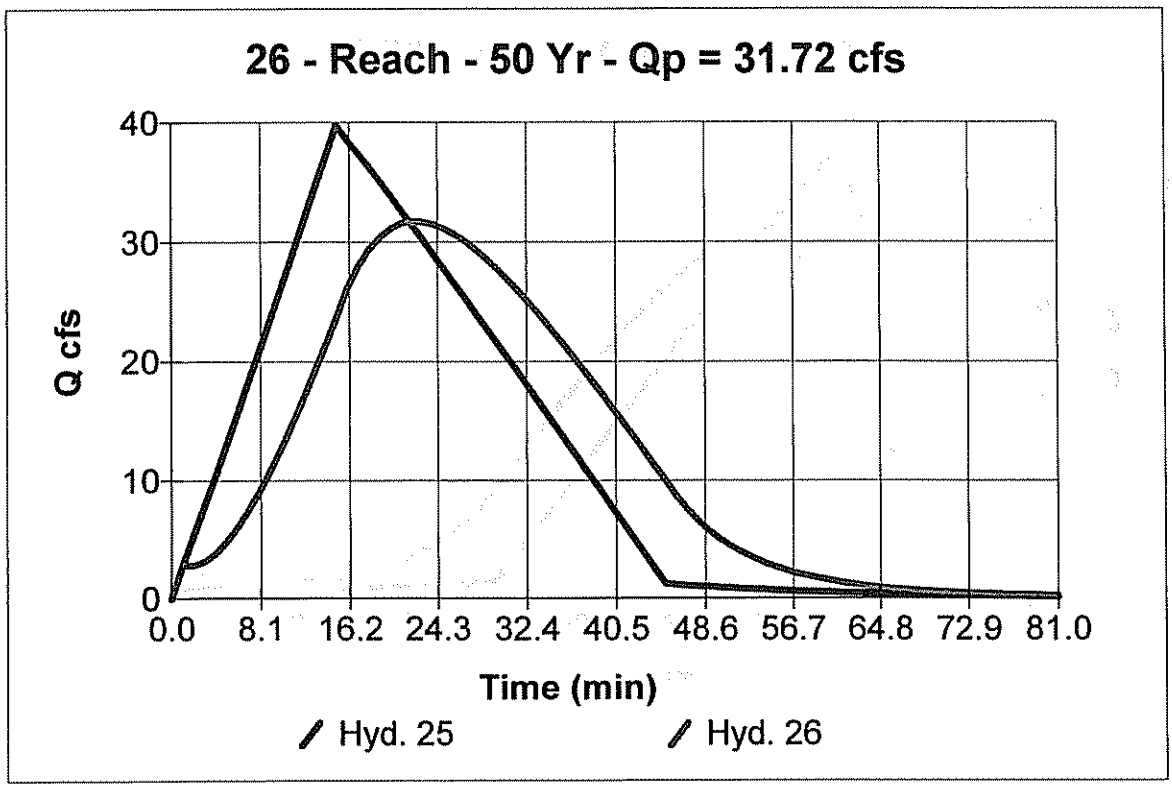
Hyd. No. 26

DITCH DS CULV 4

Hydrograph type	= Reach	Peak discharge	= 31.72 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 25	Section type	= Trapezoidal
Reach length	= 1250.0 ft	Channel slope	= 0.8 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.888	Rating curve m	= 1.282
Ave. velocity	= 2.61	Routing coeff.	= 0.1488

Modified Att-Kin routing method used.

Hydrograph Volume = 58,295 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

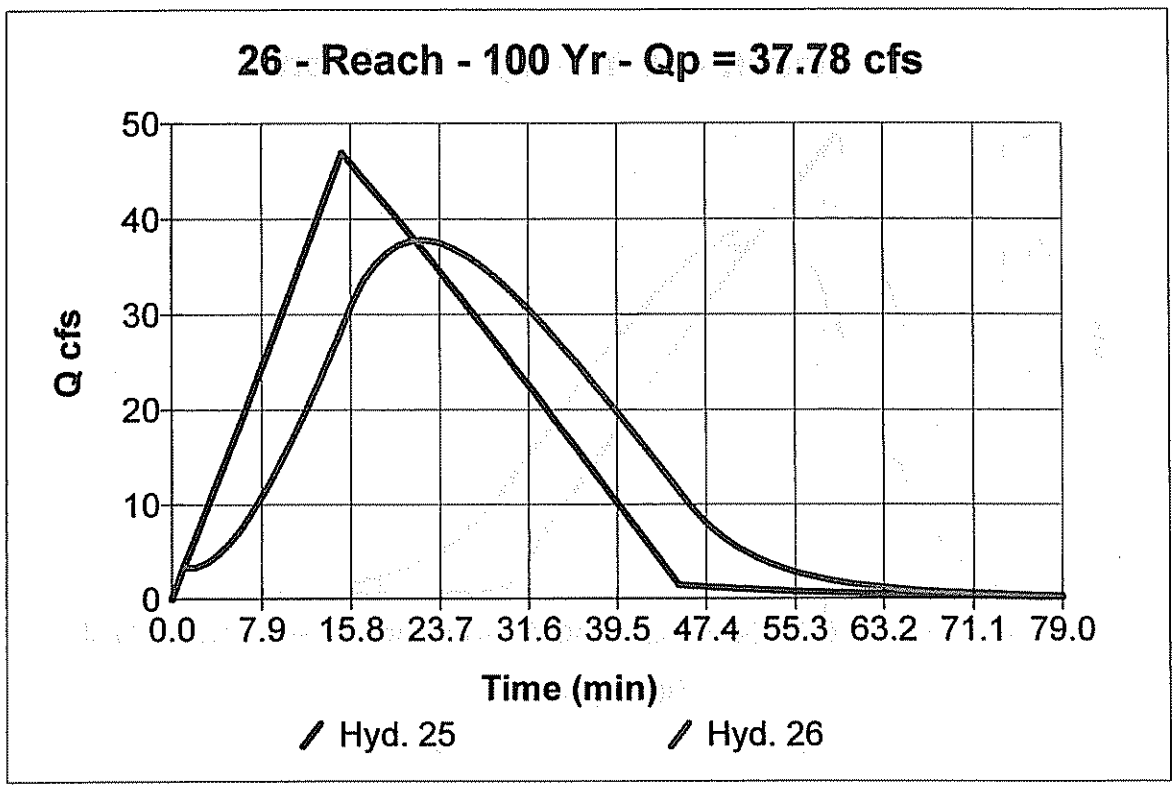
Hyd. No. 26

DITCH DS CULV 4

Hydrograph type	= Reach	Peak discharge	= 37.78 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 25	Section type	= Trapezoidal
Reach length	= 1250.0 ft	Channel slope	= 0.8 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 4.5:1	Max. depth	= 3.0 ft
Rating curve x	= 0.888	Rating curve m	= 1.282
Ave. velocity	= 2.74	Routing coeff.	= 0.1553

Modified Att-Kin routing method used.

Hydrograph Volume = 68,605 cuft



GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA #23

$AREA_T = 4.31$ acres

$AREA_{paved} = 0.60$ acres

$AREA_{grass} = 4.31 \text{ acres} - 0.60 \text{ ac.} = 3.71$ acres

$$C = \frac{(3.71 \text{ ac.})(0.20) + (0.60 \text{ ac.})(0.90)}{4.31 \text{ ac.}} = 0.30$$

$T_c = 15$ minutes

$Q_{10} = 8.70$ cfs

$Q_{100} = 10.25$ cfs

DITCH @ Station 874+00, Lt

$Q_{10} = 38.51$ cfs

$Q_{100} = 45.84$ cfs

Hydrograph Plot

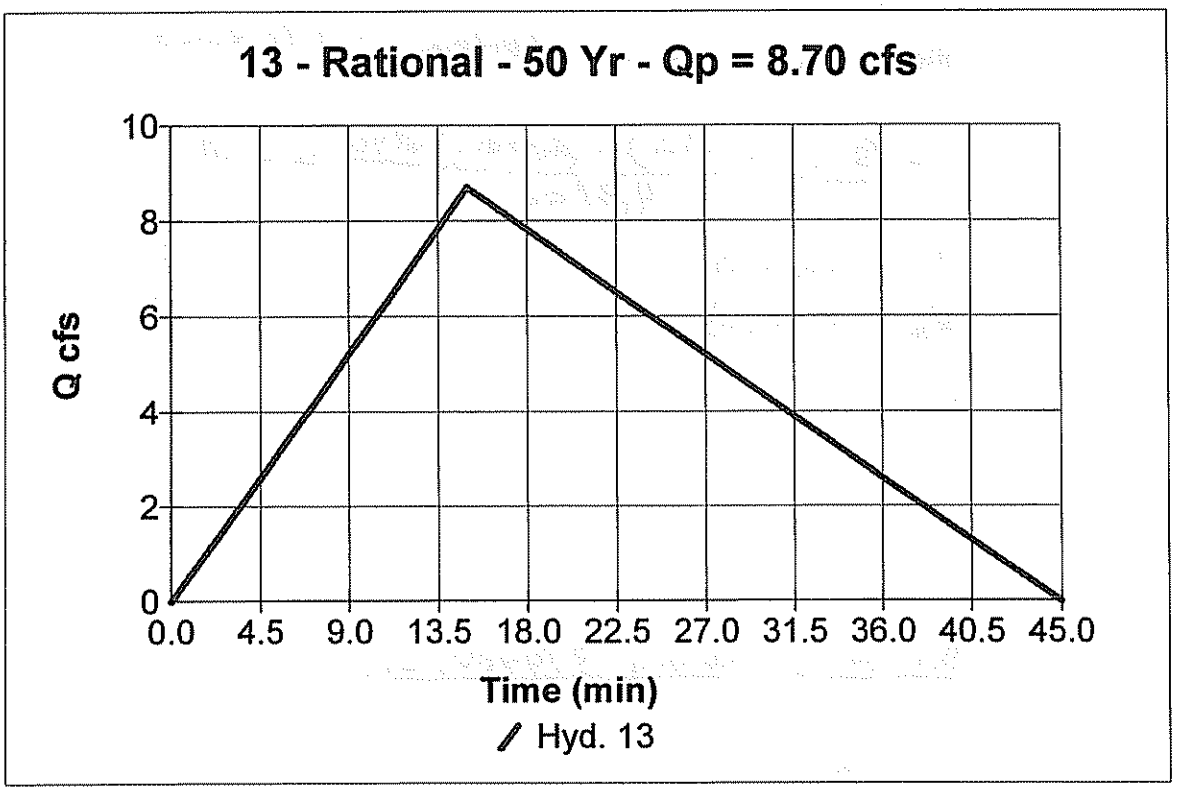
Hydraflow Hydrographs by Intelisolve

Hyd. No. 13

Area #23

Hydrograph type	= Rational	Peak discharge	= 8.70 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 4.3 ac	Runoff coeff.	= 0.3
Intensity	= 6.729 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 11,746 cuft



Hydrograph Plot

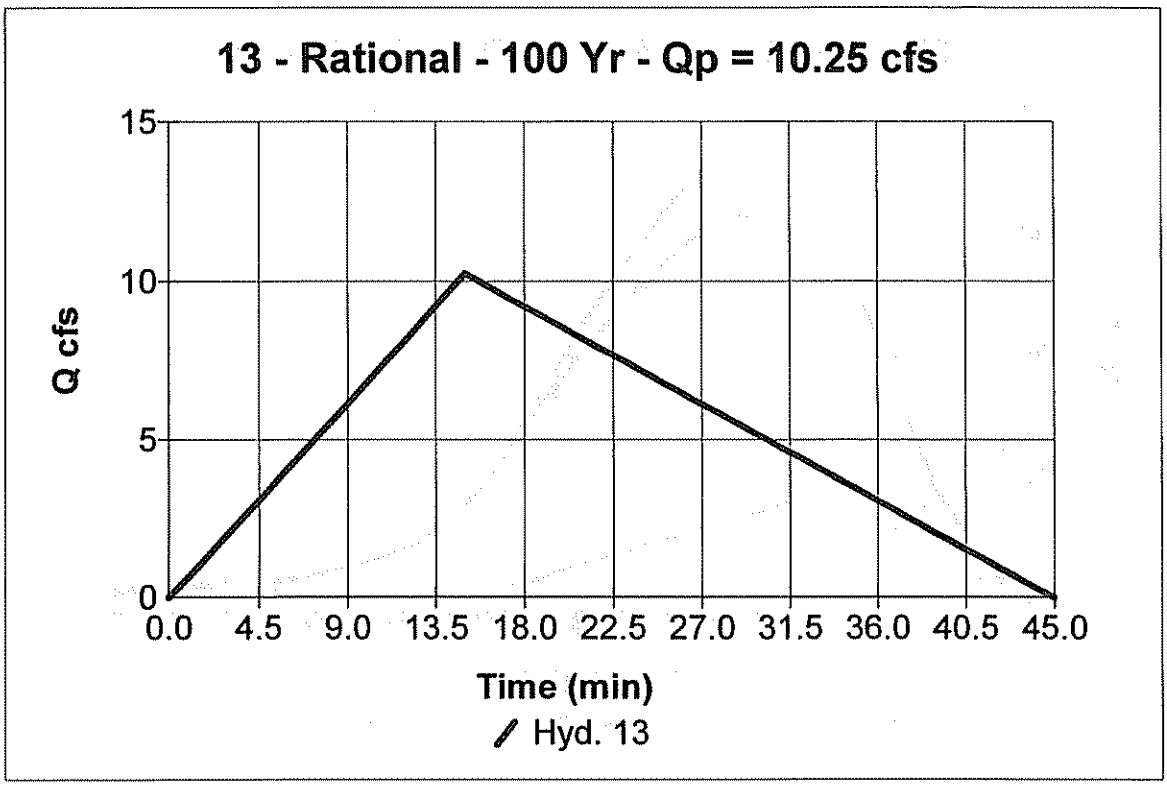
Hydraflow Hydrographs by Intelisolve

Hyd. No. 13

Area #23

Hydrograph type	= Rational	Peak discharge	= 10.25 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 4.3 ac	Runoff coeff.	= 0.3
Intensity	= 7.927 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 13,837 cuft



Hydrograph Plot

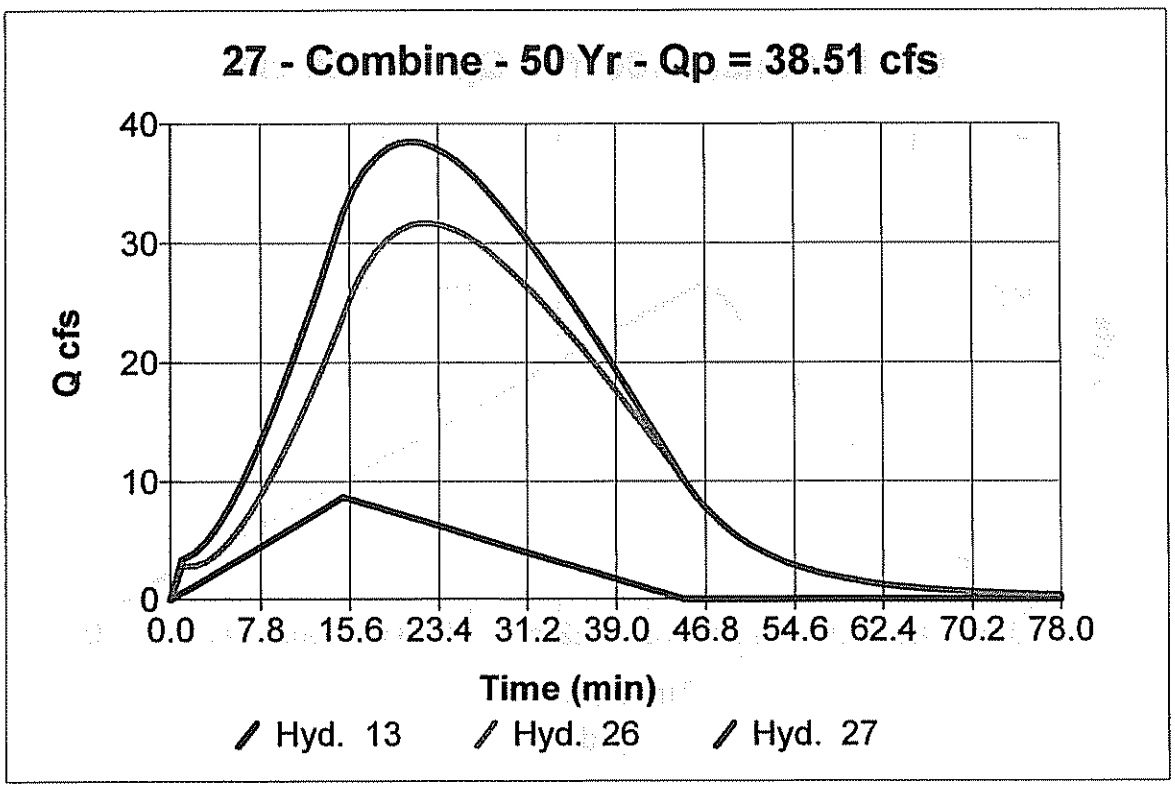
Hydraflow Hydrographs by Intelisolve

Hyd. No. 27

DITCH AT STA 874+00

Hydrograph type	= Combine	Peak discharge	= 38.51 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 13, 26		

Hydrograph Volume = 70,041 cuft



Hydrograph Plot

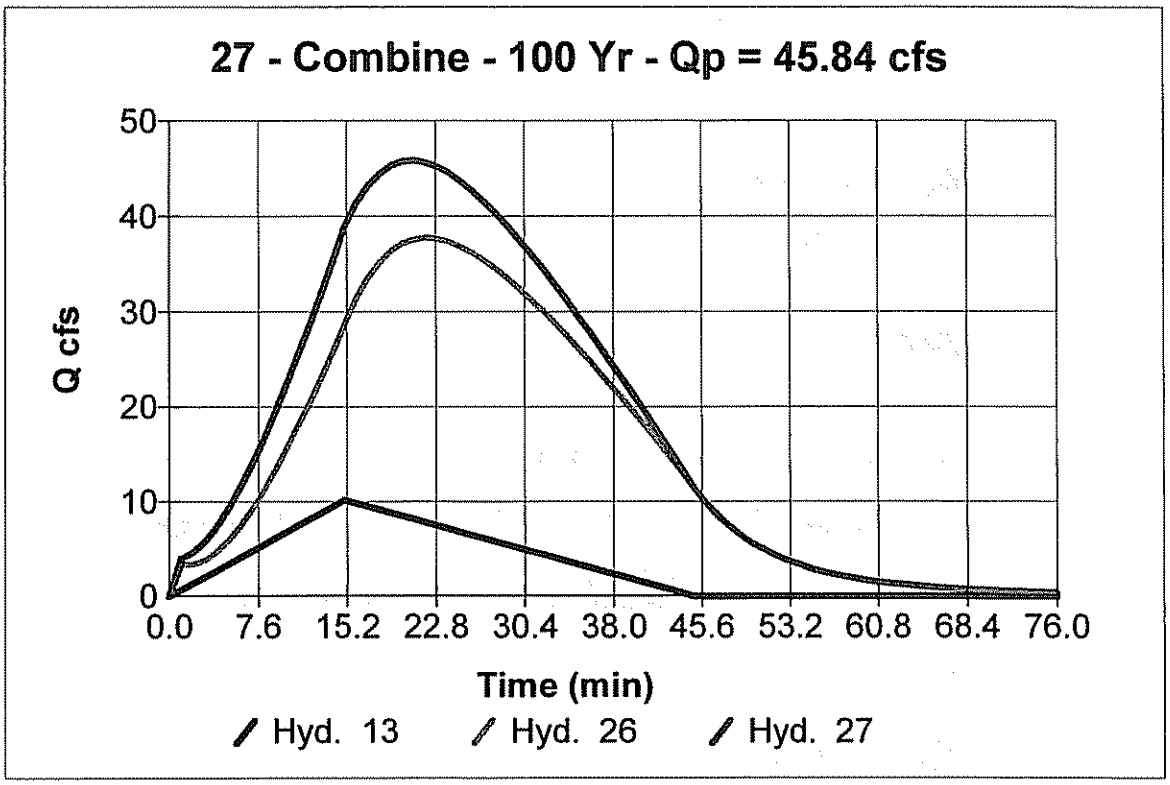
Hydraflow Hydrographs by Intelisolve

Hyd. No. 27

DITCH AT STA 874+00

Hydrograph type	= Combine	Peak discharge	= 45.84 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 13, 26		

Hydrograph Volume = 82,442 cuft



Depth Flow Left Ditch @ Station 872+00 (I-80)

℄ Elevation 613.97

Depth = 608.80 ft + 1.45 ft = 610.25 ft.

GREENE & BRADFORD CONSULTING ENGINEERS

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Vitco
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: _____ DATE: _____
SHEET: _____ OF: _____

DRAINAGE CALCULATIONS

AREA #4

$AREA_T = 2.16$ acres

$AREA_{paved} = 0.40$ acres

$AREA_{grass} = 1.76$ acres

$$c = \frac{(1.76\,ac.)(0.20) + (0.40)(0.90)}{2.16\,ac.} = 0.33$$

$T_c = 10$ minutes

$Q_{10} = 5.51$ cfs

$Q_{100} = 6.55$ cfs

AREA #3

$AREA_T = 0.51$ acres

$AREA_{paved} = 0.07$ acres

$AREA_{grass} = 0.51$ acres $- 0.07$ acres $= 0.44$ acres

$$c = \frac{(0.44\,ac.)(0.20) + (0.07\,ac.)(0.90)}{0.51\,ac.} = 0.30$$

$T_c = 10$ minutes

$Q_{10} = 1.20$ cfs

$Q_{10} = 1.41$ cfs

AREA #3 + #4

$Q_{10} = 6.69$ cfs

$Q_{100} = 7.89$ cfs

Depth $\approx 621.61' + 0.55' = 622.16'$
℄ Rte 178 Elevation $= 624.88$
℄ Station 127+50

Hydrograph Plot

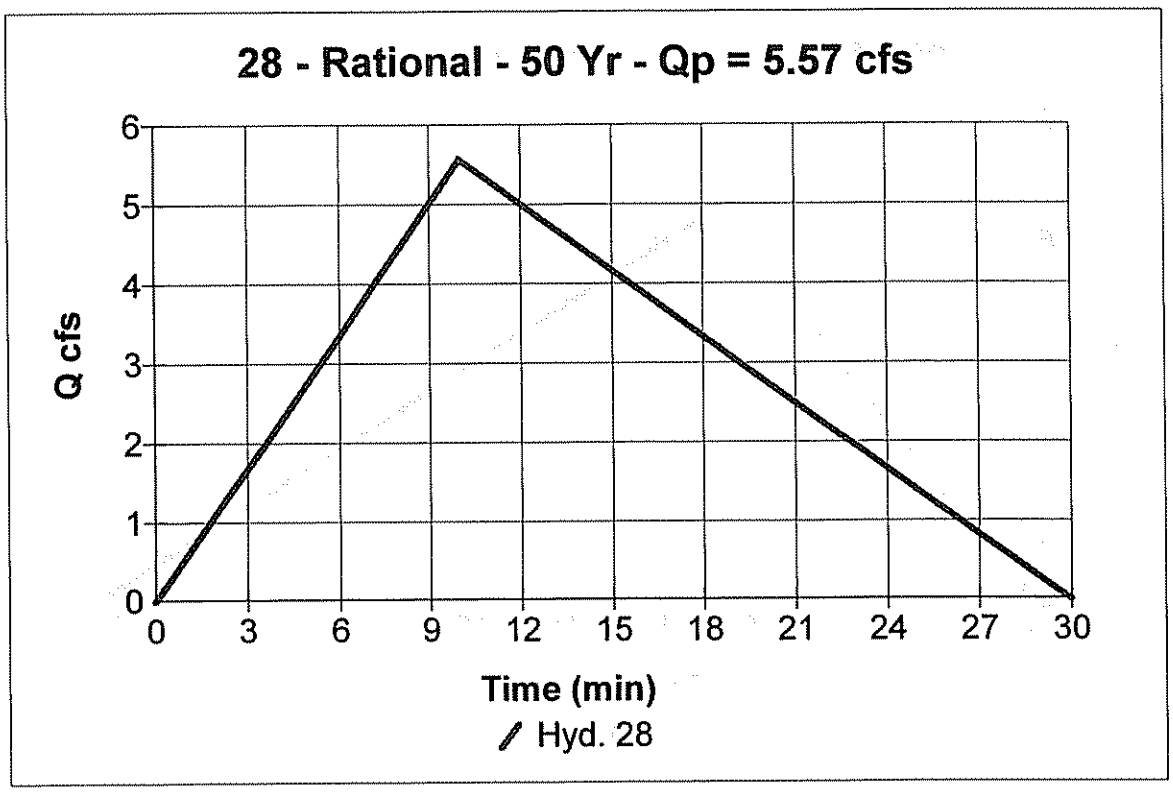
Hydraflow Hydrographs by Intelisolve

Hyd. No. 28

AREA #4

Hydrograph type	= Rational	Peak discharge	= 5.57 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 2.2 ac	Runoff coeff.	= 0.33
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 5,016 cuft



Hydrograph Plot

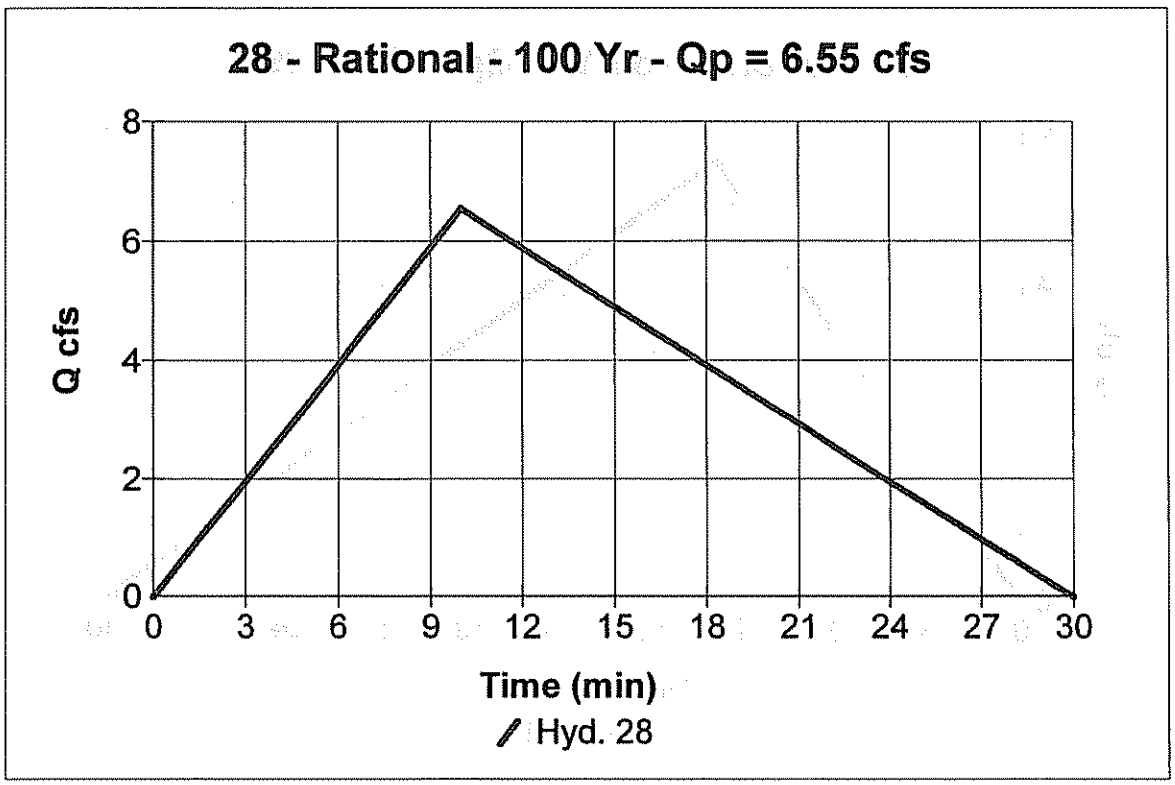
Hydraflow Hydrographs by Intelisolve

Hyd. No. 28

AREA #4

Hydrograph type	= Rational	Peak discharge	= 6.55 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 2.2 ac	Runoff coeff.	= 0.33
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 5,895 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 10

Analysis Component			
Storm Event	Check	Discharge	6.55 cfs

Peak Discharge Method: User-Specified			
Design Discharge	5.57 cfs	Check Discharge	6.55 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	0.77 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	6.55 cfs	Bottom Elevation	621.95 ft
Depth	0.77 ft	Velocity	1.35 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	6.55 cfs	624.11 ft	6.05 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 625.61 ft @
Station 126+50 (IL Rte 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 10

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	624.11	ft	Discharge	6.55	cfs
Inlet Control HW Elev	624.09	ft	Tailwater Elevation	622.72	ft
Outlet Control HW Elev	624.11	ft	Control Type	Outlet Control	
Headwater Depth/ Height	1.59				

Grades					
Upstream Invert	622.12	ft	Downstream Invert	621.95	ft
Length	35.00	ft	Constructed Slope	0.004857	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.03	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.03	ft
Velocity Downstream	6.05	ft/s	Critical Slope	0.010177	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

ɔutlet Control Properties					
Outlet Control HW Elev	624.11	ft	Upstream Velocity Head	0.44	ft
Ke	0.50		Entrance Loss	0.22	ft

Inlet Control Properties					
Inlet Control HW Elev	624.09	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	1.2	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 10

Analysis Component			
Storm Event	Design	Discharge	5.57 cfs

Peak Discharge Method: User-Specified			
Design Discharge	5.57 cfs	Check Discharge	6.55 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	0.71 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	5.57 cfs	Bottom Elevation	621.95 ft
Depth	0.71 ft	Velocity	1.29 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	5.57 cfs	623.79 ft	5.53 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 10

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	623.79	ft	Discharge	5.57	cfs
Inlet Control HW Elev	623.77	ft	Tailwater Elevation	622.66	ft
Outlet Control HW Elev	623.79	ft	Control Type	Outlet Control	
Headwater Depth/ Height	1.34				

Grades					
Upstream Invert	622.12	ft	Downstream Invert	621.95	ft
Length	35.00	ft	Constructed Slope	0.004857	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.96	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	0.96	ft
Velocity Downstream	5.53	ft/s	Critical Slope	0.008554	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	623.79	ft	Upstream Velocity Head	0.34	ft
Ke	0.50		Entrance Loss	0.17	ft

Inlet Control Properties					
Inlet Control HW Elev	623.77	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	1.2	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

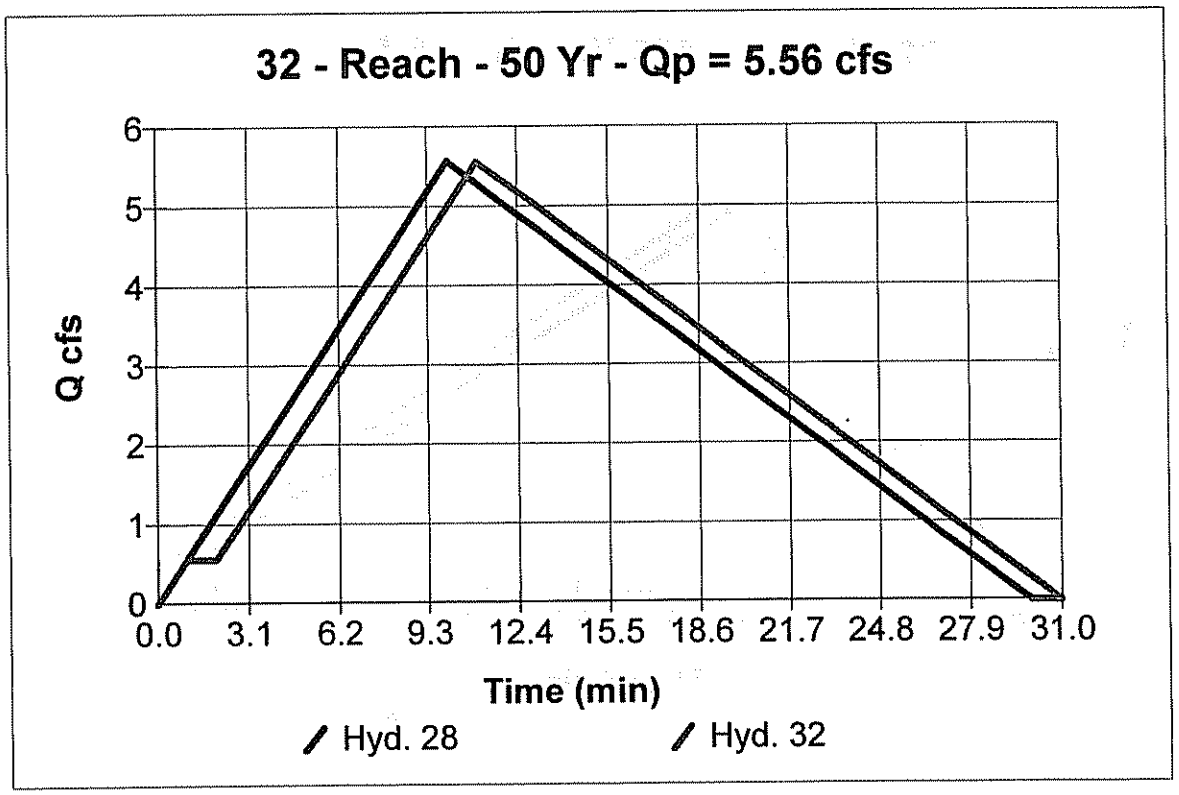
Hyd. No. 32

DITCH CULV 10 TO CULV 11

Hydrograph type	= Reach	Peak discharge	= 5.56 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 28	Section type	= Trapezoidal
Reach length	= 101.0 ft	Channel slope	= 0.5 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.691	Rating curve m	= 1.321
Ave. velocity	= 2.42	Routing coeff.	= 0.9738

Modified Att-Kin routing method used.

Hydrograph Volume = 5,050 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

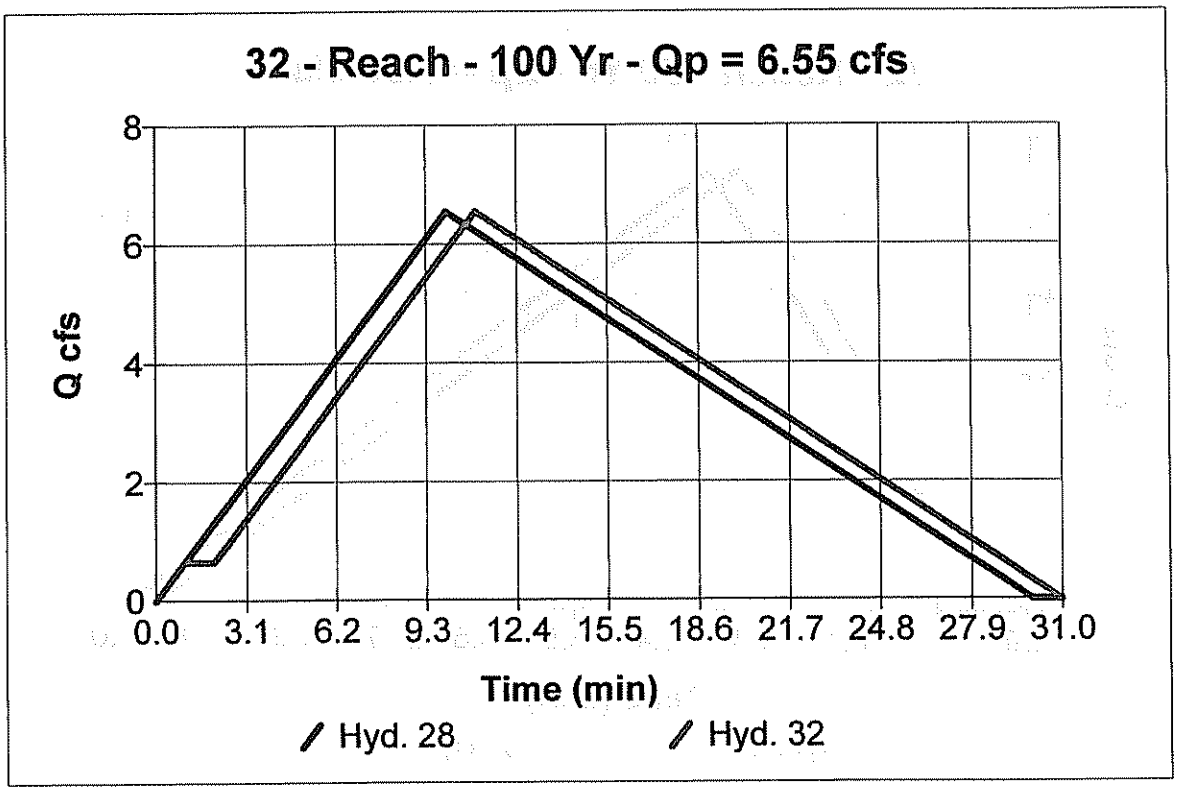
Hyd. No. 32

DITCH CULV 10 TO CULV 11

Hydrograph type	= Reach	Peak discharge	= 6.55 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 28	Section type	= Trapezoidal
Reach length	= 101.0 ft	Channel slope	= 0.5 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.691	Rating curve m	= 1.321
Ave. velocity	= 2.55	Routing coeff.	= 0.9996

Modified Att-Kin routing method used.

Hydrograph Volume = 5,934 cuft



Hydrograph Plot

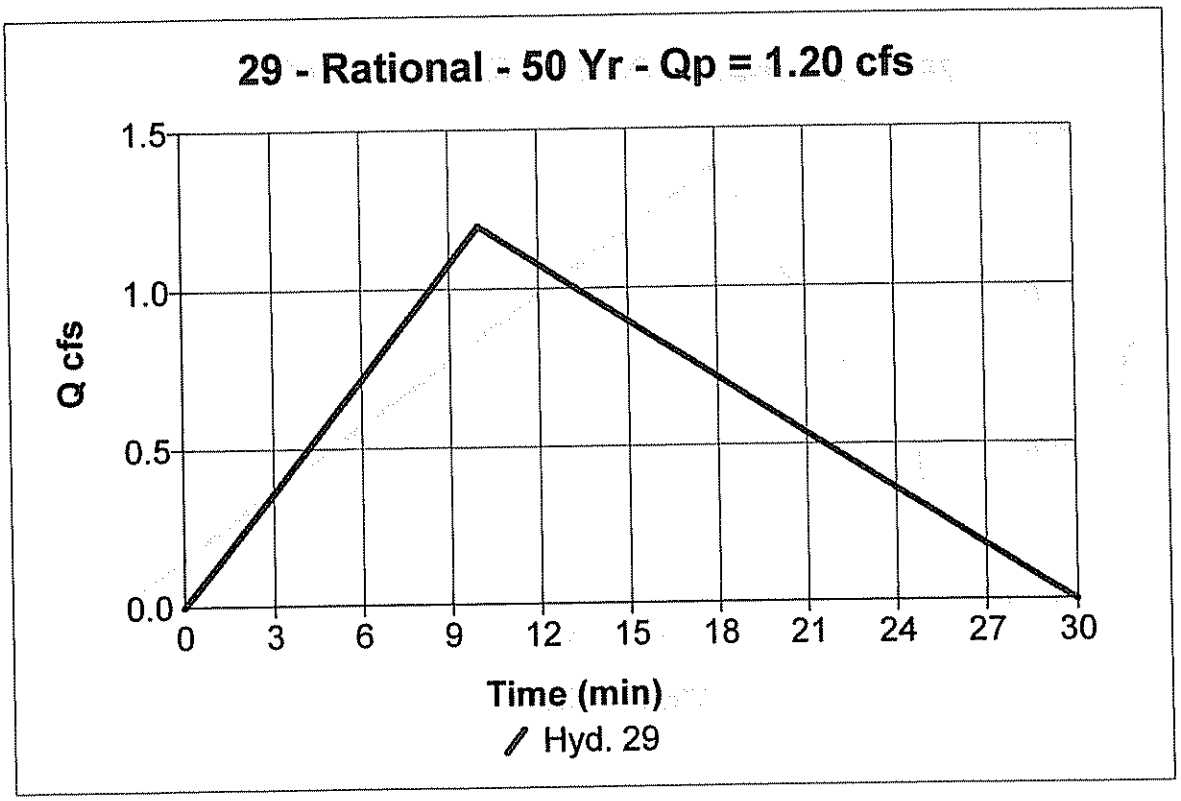
Hydraflow Hydrographs by Intelisolve

Hyd. No. 29

AREA #3

Hydrograph type	= Rational	Peak discharge	= 1.20 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 0.5 ac	Runoff coeff.	= 0.3
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 1,077 cuft



Hydrograph Plot

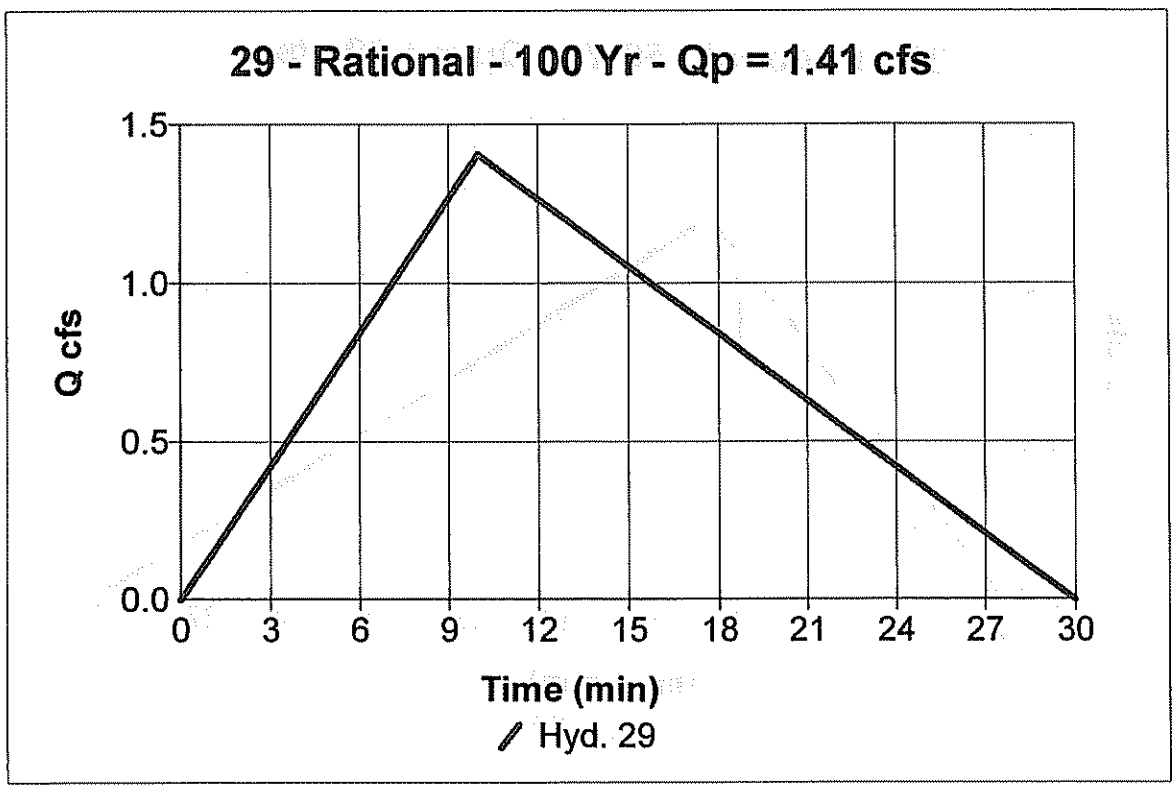
Hydraflow Hydrographs by Intelisolve

Hyd. No. 29

AREA #3

Hydrograph type	= Rational	Peak discharge	= 1.41 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.5 ac	Runoff coeff.	= 0.3
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 1,265 cuft



Hydrograph Plot

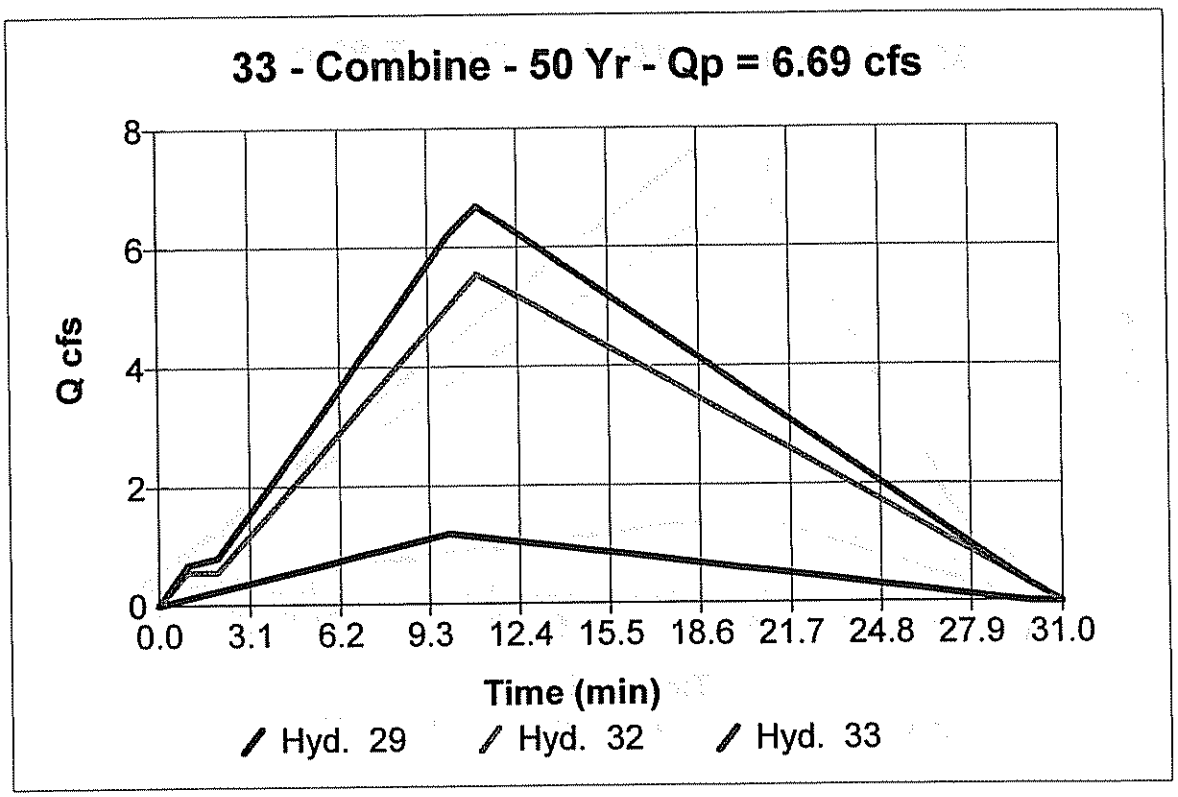
Hydraflow Hydrographs by Intelisolve

Hyd. No. 33

US CULVERT 11

Hydrograph type	= Combine	Peak discharge	= 6.69 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 29, 32		

Hydrograph Volume = 6,126 cuft



Hydrograph Plot

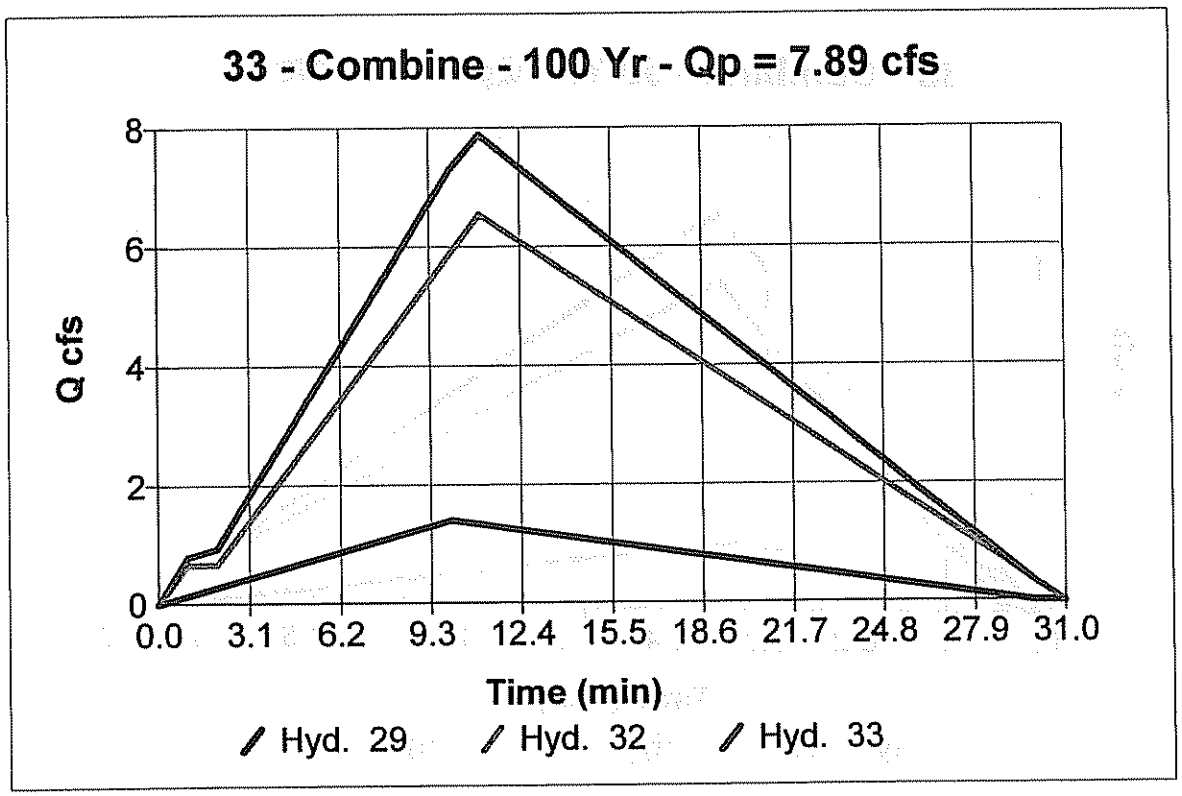
Hydraflow Hydrographs by Intelisolve

Hyd. No. 33

US CULVERT 11

Hydrograph type	= Combine	Peak discharge	= 7.89 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 29, 32		

Hydrograph Volume = 7,199 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 11

Analysis Component			
Storm Event	Design	Discharge	6.69 cfs

Peak Discharge Method: User-Specified			
Design Discharge	6.69 cfs	Check Discharge	7.89 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.005800 ft/ft	Mannings Coefficient	0.050
Depth	0.73 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	6.69 cfs	Bottom Elevation	621.51 ft
Depth	0.73 ft	Velocity	1.47 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	6.69 cfs	623.74 ft	6.13 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 624.88 ft.
@ Station 127+50 (IL Rte 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 11

omponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	623.74 ft	Discharge	6.69 cfs
Inlet Control HW Elev	623.63 ft	Tailwater Elevation	622.24 ft
Outlet Control HW Elev	623.74 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.70		

Grades			
Upstream Invert	621.61 ft	Downstream Invert	621.51 ft
Length	36.00 ft	Constructed Slope	0.002778 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.04 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.04 ft
Velocity Downstream	6.13 ft/s	Critical Slope	0.010451 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	623.74 ft	Upstream Velocity Head	0.46 ft
Ke	0.50	Entrance Loss	0.23 ft

Inlet Control Properties			
Inlet Control HW Elev	623.63 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	1.2 ft^2
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 11

Analysis Component			
Storm Event	Check	Discharge	7.89 cfs

Peak Discharge Method: User-Specified			
Design Discharge	6.69 cfs	Check Discharge	7.89 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.005800 ft/ft	Mannings Coefficient	0.050
Depth	0.80 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	7.89 cfs	Bottom Elevation	621.51 ft
Depth	0.80 ft	Velocity	1.55 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	7.89 cfs	624.20 ft ✓	6.85 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 11

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	624.20	ft	Discharge	7.89	cfs
Inlet Control HW Elev	624.09	ft	Tailwater Elevation	622.31	ft
Outlet Control HW Elev	624.20	ft	Control Type	Outlet Control	
Headwater Depth/ Height	2.07				

Grades					
Upstream Invert	621.61	ft	Downstream Invert	621.51	ft
Length	36.00	ft	Constructed Slope	0.002778	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.11	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.11	ft
Velocity Downstream	6.85	ft/s	Critical Slope	0.013300	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	624.20	ft	Upstream Velocity Head	0.64	ft
Ke	0.50		Entrance Loss	0.32	ft

Inlet Control Properties					
Inlet Control HW Elev	624.09	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	1.2	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

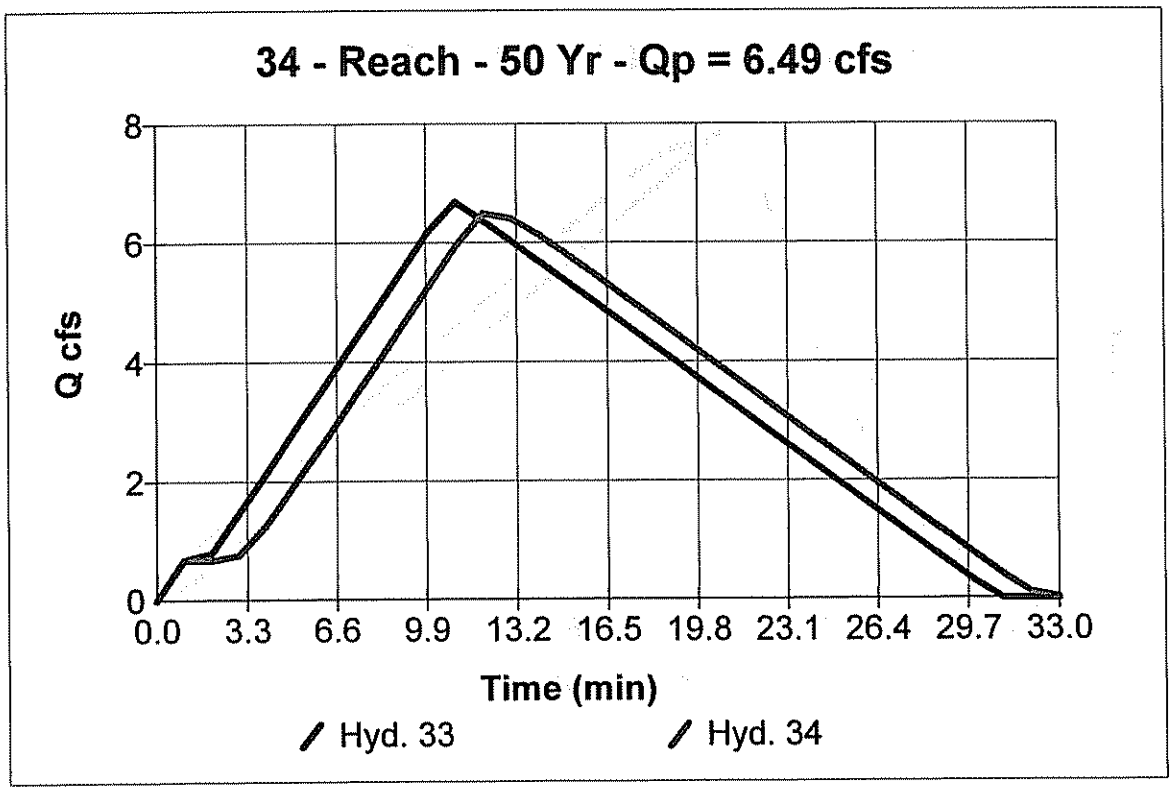
Hyd. No. 34

DITCH CULV 10 TO CULV 11

Hydrograph type	= Reach	Peak discharge	= 6.49 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 33	Section type	= Trapezoidal
Reach length	= 170.0 ft	Channel slope	= 0.6 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.776	Rating curve m	= 1.321
Ave. velocity	= 2.45	Routing coeff.	= 0.7270

Modified Att-Kin routing method used.

Hydrograph Volume = 6,182 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

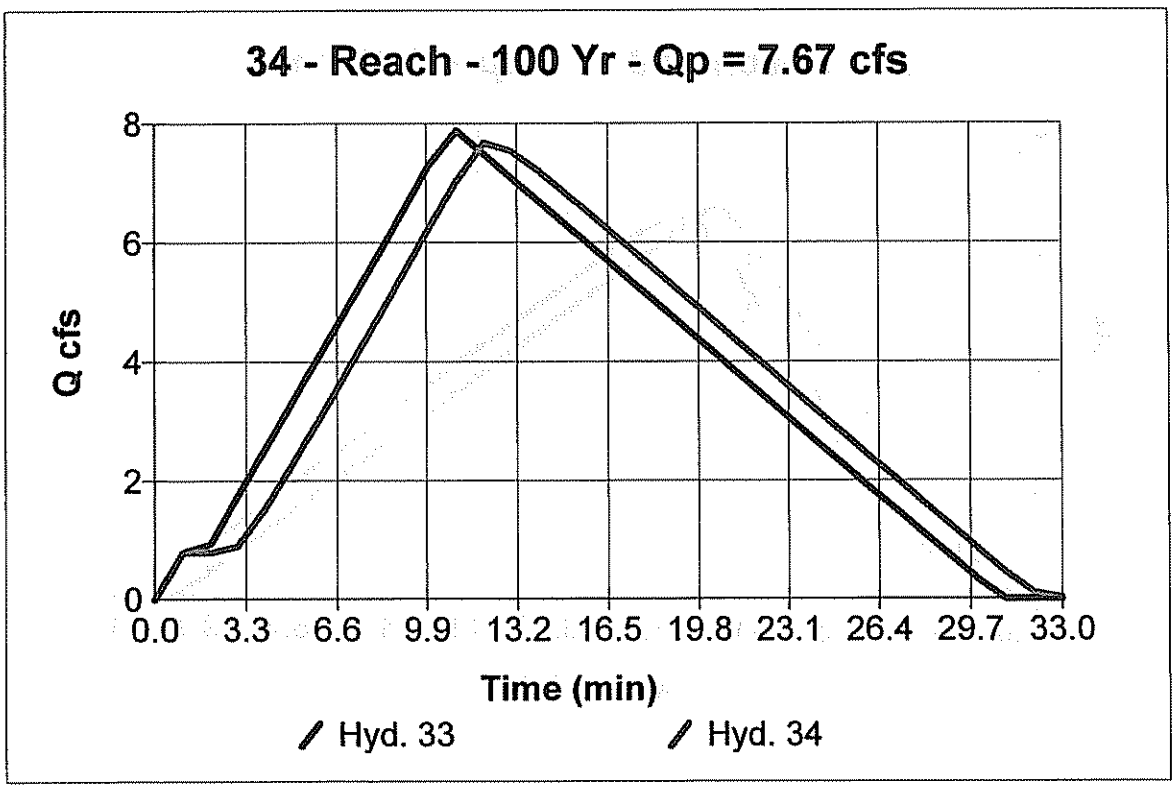
Hyd. No. 34

DITCH CULV 10 TO CULV 11

Hydrograph type	= Reach	Peak discharge	= 7.67 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 33	Section type	= Trapezoidal
Reach length	= 170.0 ft	Channel slope	= 0.6 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.776	Rating curve m	= 1.321
Ave. velocity	= 2.58	Routing coeff.	= 0.7511

Modified Att-Kin routing method used.

Hydrograph Volume = 7,262 cuft



GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WEB DATE: 11/3/04
CHECKED BY: _____ DATE: _____
SHEET: _____ OF: _____

DRAINAGE CALCULATIONS

AREA #2

$AREA_T = 1.01$ acres

$A_{paved} = 0.11$ acres

$AREA_{grass} = 1.01$ ac. $- 0.11$ ac. $= 0.90$ ac.

$$C = \frac{(0.90\,ac.)(0.20) + (0.11\,ac.)(0.90)}{1.01} = 0.28$$

$T_c = 10$ minutes (assumed)

$Q_{10} = 2.21$ cfs

$Q_{100} = 2.60$ cfs

AREA #2 + #3 + #4

$Q_{10} = 8.48$ cfs

$Q_{100} = 10.01$ cfs

Channel Depth = 0.65' + 620.52 = 621.17'

℄ Elevation 624.22' @ Station 129+50 (IL17B)

AREA #1

$AREA_T = 1.42$ acres

$AREA_{grass} = 0.17$ acres

$AREA_{paved} = 1.42$ ac. $- 0.17$ ac. $= 1.25$ acres

$$C = \frac{(1.25\,ac.)(0.20) + (0.17\,ac.)(0.90)}{1.42\,ac.} = 0.28$$

$T_c = 10$ minutes (assumed)

$Q_{10} = 3.11$ cfs

$Q_{100} = 3.65$ cfs

AREA #1 + #2 + #3 + #4

$Q_{10} = 9.86$ cfs

$Q_{100} = 11.72$ cfs

Channel Depth = 0.75' + 620.10' = 620.85'

℄ Elevation 623.80 ft. @ Station 132+50 (IL17B)

Hydrograph Plot

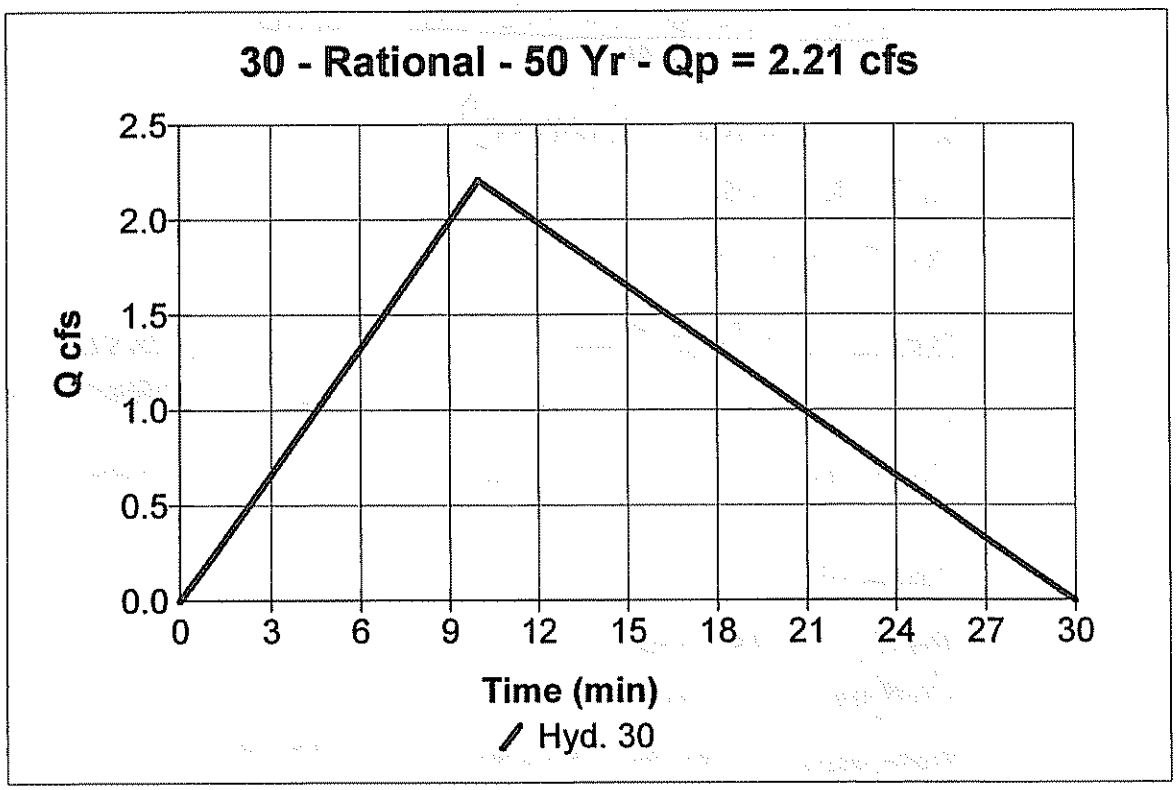
Hydraflow Hydrographs by Intelisolve

Hyd. No. 30

AREA # 2

Hydrograph type	= Rational	Peak discharge	= 2.21 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 1.0 ac	Runoff coeff.	= 0.28
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 1,990 cuft



Hydrograph Plot

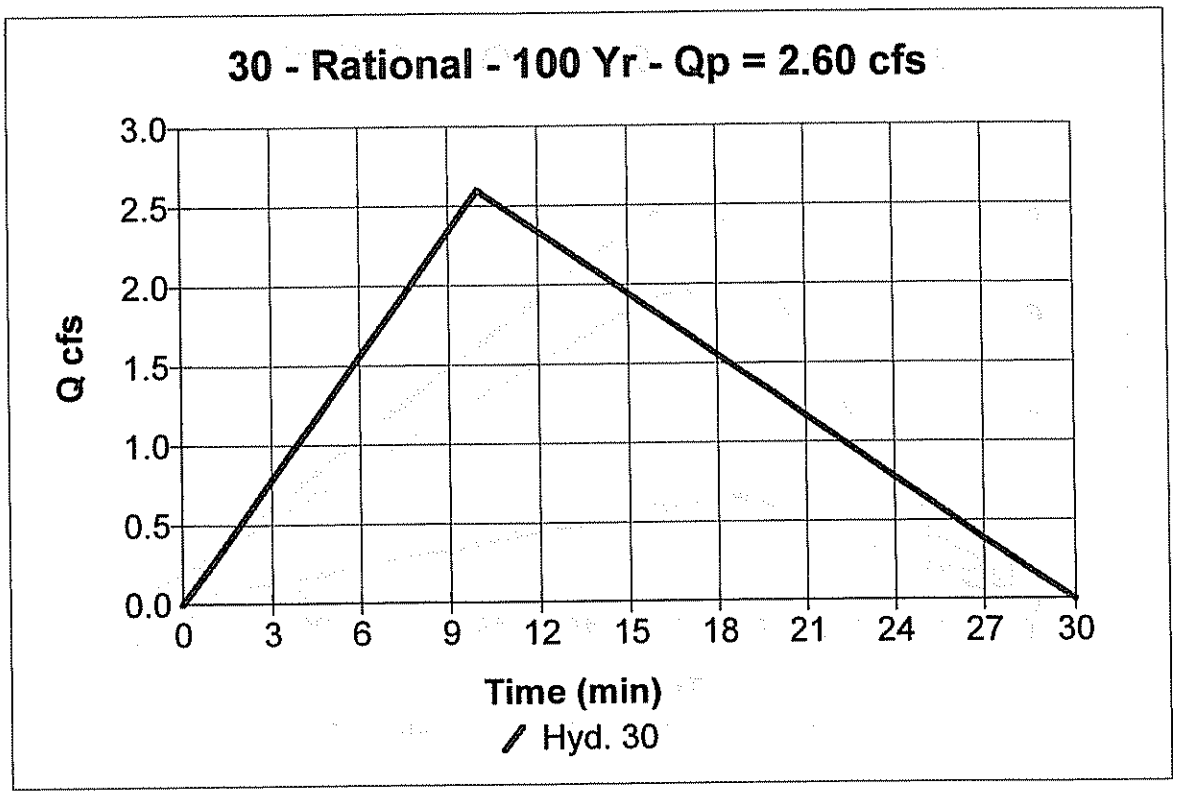
Hydraflow Hydrographs by Intelisolve

Hyd. No. 30

AREA # 2

Hydrograph type	= Rational	Peak discharge	= 2.60 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.0 ac	Runoff coeff.	= 0.28
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 2,339 cuft



Hydrograph Plot

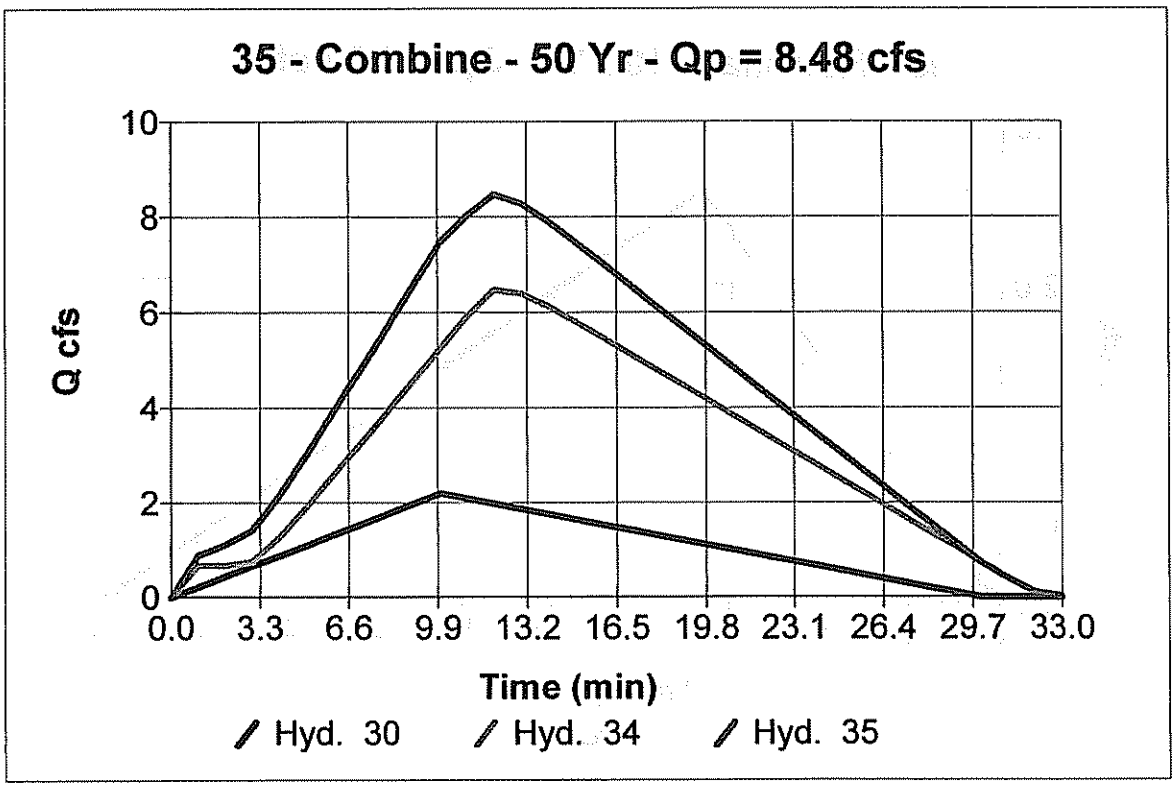
Hydraflow Hydrographs by Intelisolve

Hyd. No. 35

US CULVERT 12

Hydrograph type	= Combine	Peak discharge	= 8.48 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 30, 34		

Hydrograph Volume = 8,172 cuft



Hydrograph Plot

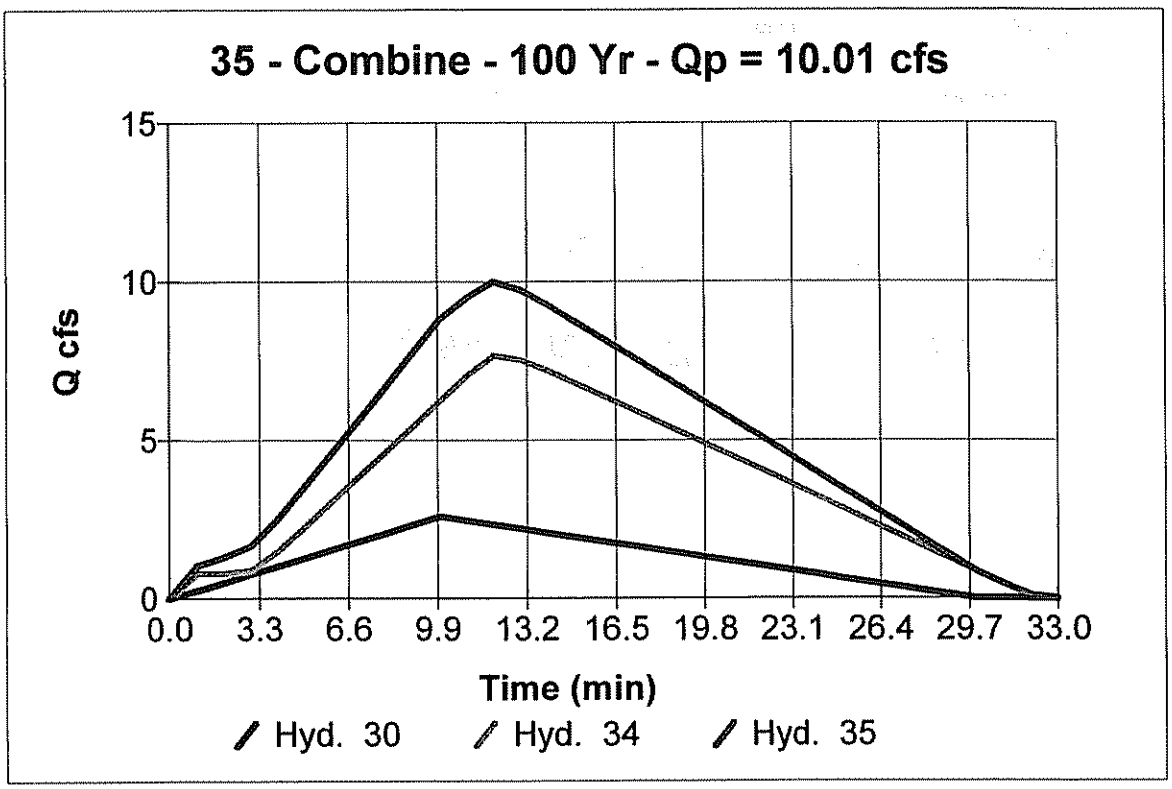
Hydraflow Hydrographs by Intelisolve

Hyd. No. 35

US CULVERT 12

Hydrograph type	= Combine	Peak discharge	= 10.01 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 30, 34		

Hydrograph Volume = 9,601 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 12

Analysis Component			
Storm Event	Design	Discharge	8.48 cfs

Peak Discharge Method: User-Specified			
Design Discharge	8.48 cfs	Check Discharge	10.01 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.002100 ft/ft	Mannings Coefficient	0.050
Depth	1.07 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	8.48 cfs	Bottom Elevation	620.43 ft
Depth	1.07 ft	Velocity	1.09 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	8.48 cfs	623.26 ft	7.24 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 624.22 ft @
Station 129+50 (IL Rte 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 12

ɔmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	623.26 ft	Discharge	8.48 cfs
Inlet Control HW Elev	623.26 ft	Tailwater Elevation	621.50 ft
Outlet Control HW Elev	623.16 ft	Control Type	Inlet Control
Headwater Depth/ Height	2.19		

Grades			
Upstream Invert	620.52 ft	Downstream Invert	620.43 ft
Length	24.00 ft	Constructed Slope	0.003750 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.14 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.14 ft
Velocity Downstream	7.24 ft/s	Critical Slope	0.015063 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	623.16 ft	Upstream Velocity Head	0.74 ft
Ke	0.50	Entrance Loss	0.37 ft

Inlet Control Properties			
Inlet Control HW Elev	623.26 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	1.2 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 12

Analysis Component			
Storm Event	Check	Discharge	10.01 cfs

Peak Discharge Method: User-Specified			
Design Discharge	8.48 cfs	Check Discharge	10.01 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.002100 ft/ft	Mannings Coefficient	0.050
Depth	1.17 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	10.01 cfs	Bottom Elevation	620.43 ft
Depth	1.17 ft	Velocity	1.14 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	10.01 cfs	624.00 ft ✓	8.33 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 12

ɔmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	624.00 ft	Discharge	10.01 cfs
Inlet Control HW Elev	624.00 ft	Tailwater Elevation	621.60 ft
Outlet Control HW Elev	623.78 ft	Control Type	Inlet Control
Headwater Depth/ Height	2.79		

Grades			
Upstream Invert	620.52 ft	Downstream Invert	620.43 ft
Length	24.00 ft	Constructed Slope	0.003750 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.18 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.18 ft
Velocity Downstream	8.33 ft/s	Critical Slope	0.020781 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		

ɔutlet Control Properties			
Outlet Control HW Elev	623.78 ft	Upstream Velocity Head	1.03 ft
Ke	0.50	Entrance Loss	0.52 ft

Inlet Control Properties			
Inlet Control HW Elev	624.00 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	1.2 ft^2
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

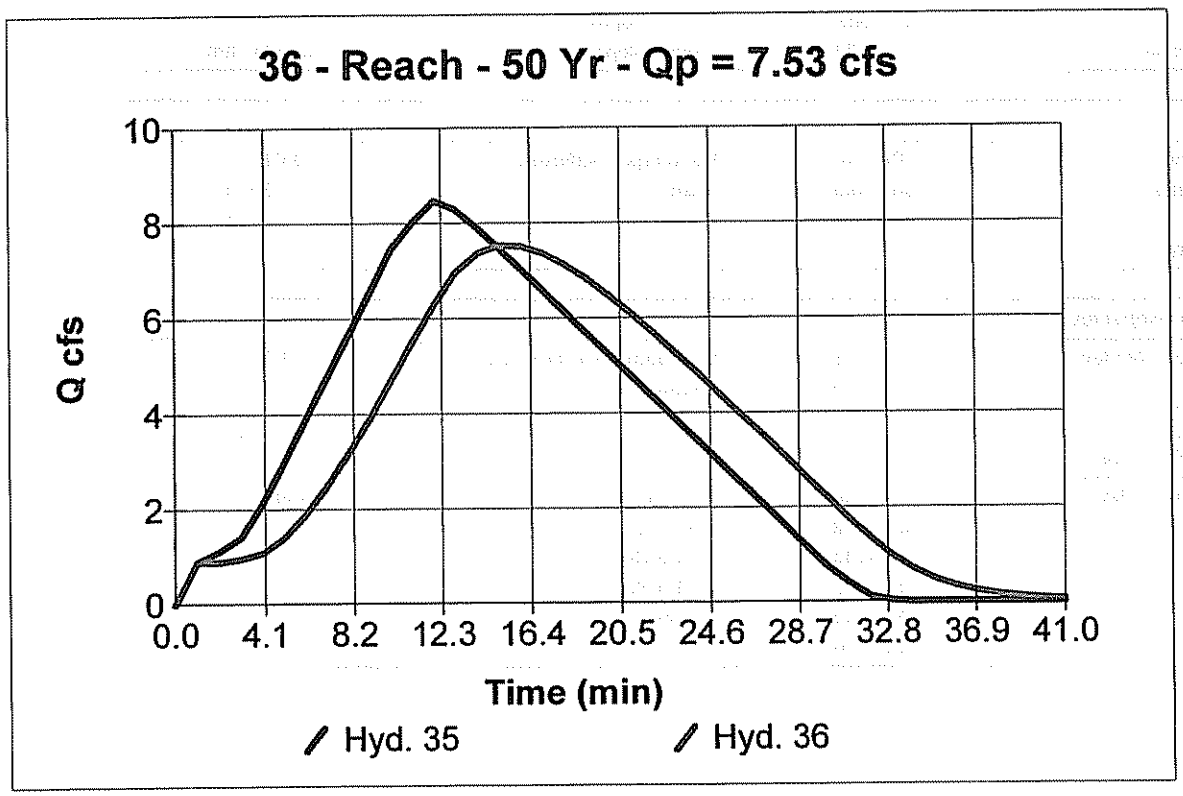
Hyd. No. 36

DITCH DS CULVERT 12

Hydrograph type	= Reach	Peak discharge	= 7.53 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 35	Section type	= Trapezoidal
Reach length	= 300.0 ft	Channel slope	= 0.2 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.467	Rating curve m	= 1.321
Ave. velocity	= 1.35	Routing coeff.	= 0.3022

Modified Att-Kin routing method used.

Hydrograph Volume = 8,348 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

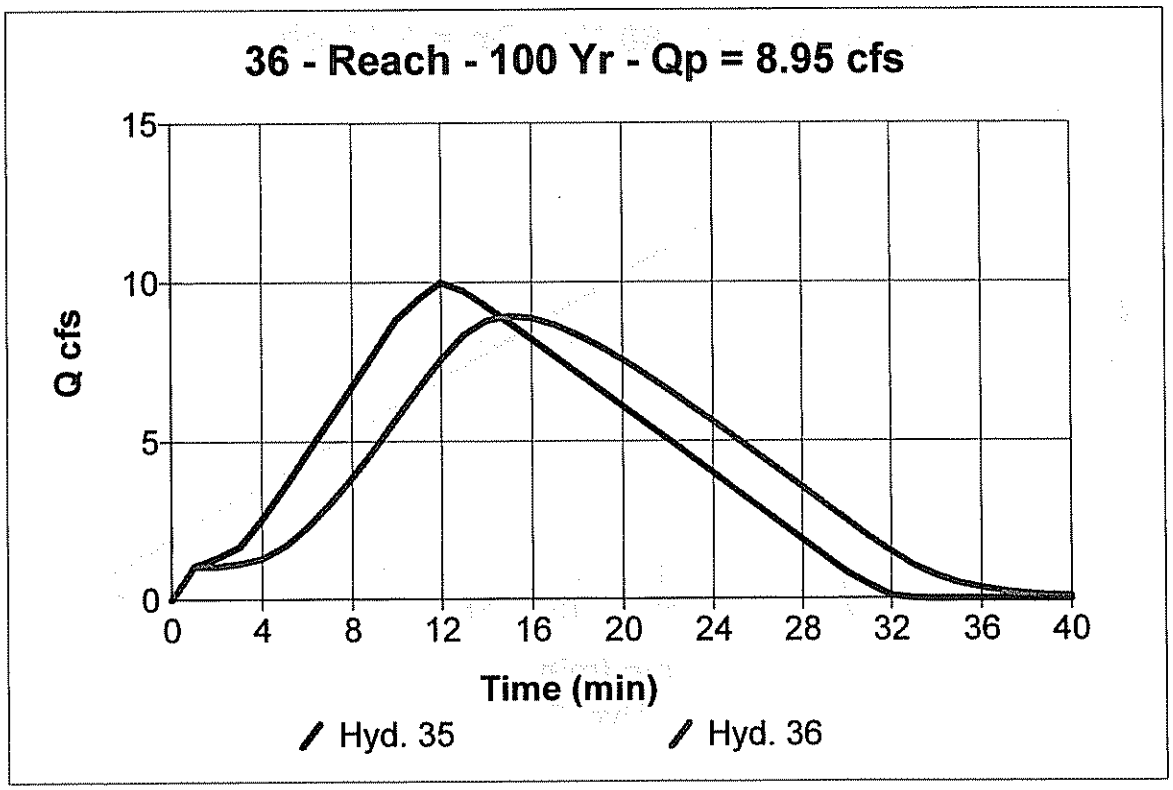
Hyd. No. 36

DITCH DS CULVERT 12

Hydrograph type	= Reach	Peak discharge	= 8.95 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 35	Section type	= Trapezoidal
Reach length	= 300.0 ft	Channel slope	= 0.2 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.467	Rating curve m	= 1.321
Ave. velocity	= 1.42	Routing coeff.	= 0.3157

Modified Att-Kin routing method used.

Hydrograph Volume = 9,800 cuft



Hydrograph Plot

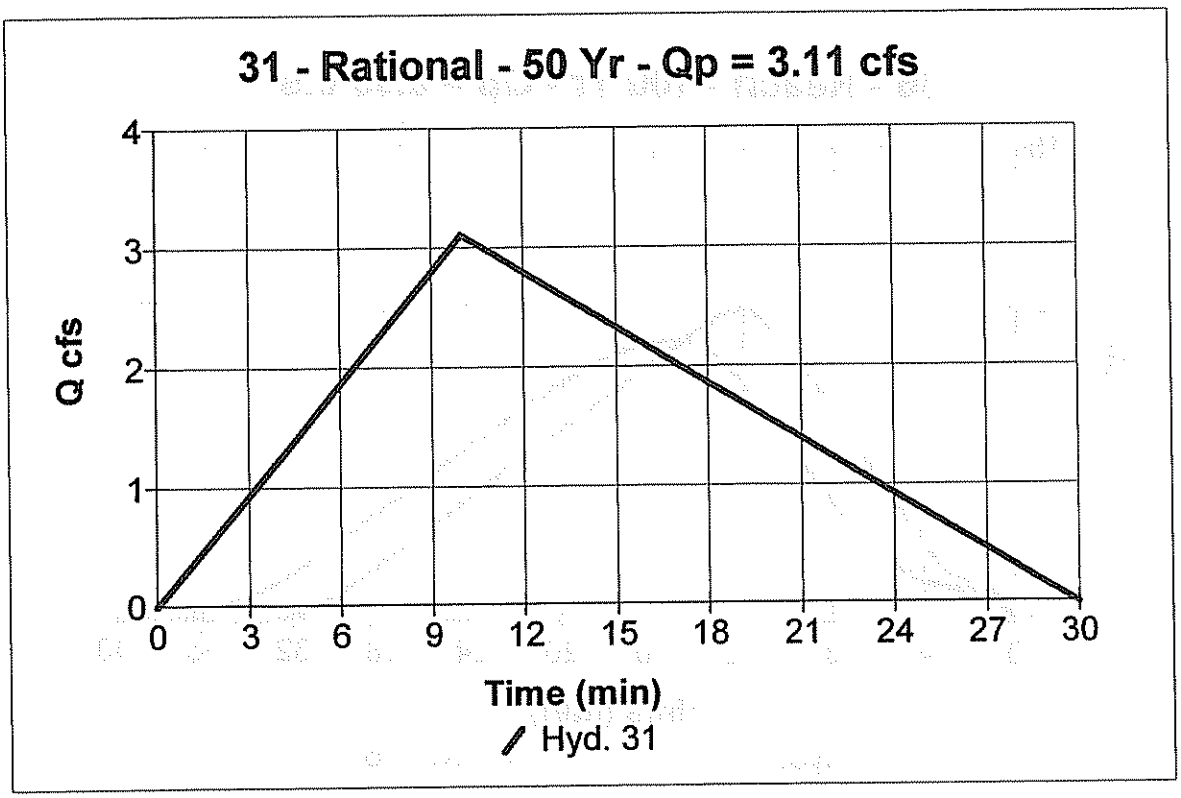
Hydraflow Hydrographs by Intelisolve

Hyd. No. 31

AREA #1

Hydrograph type	= Rational	Peak discharge	= 3.11 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 1.4 ac	Runoff coeff.	= 0.28
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 2,798 cuft



Hydrograph Plot

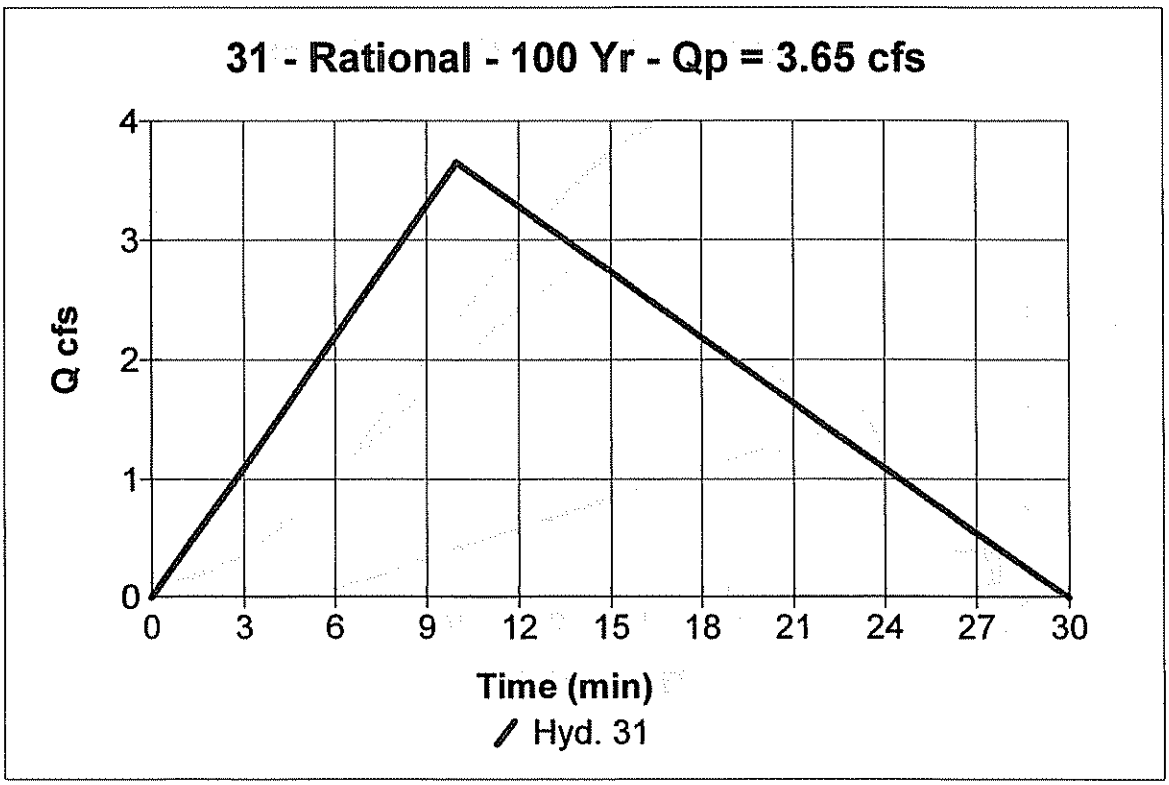
Hydraflow Hydrographs by Intelisolve

Hyd. No. 31

AREA #1

Hydrograph type	= Rational	Peak discharge	= 3.65 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.4 ac	Runoff coeff.	= 0.28
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 3,288 cuft



Hydrograph Plot

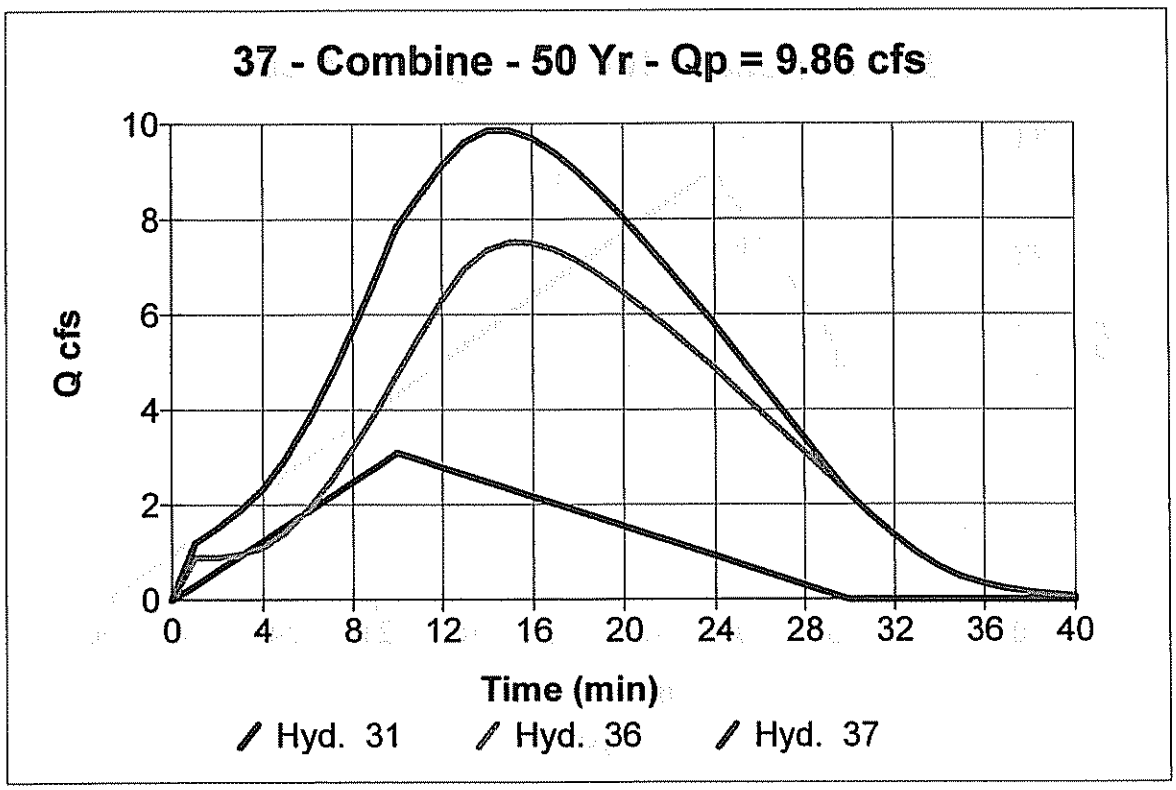
Hydraflow Hydrographs by Intelisolve

Hyd. No. 37

DITCH STATAION 100+00

Hydrograph type	= Combine	Peak discharge	= 9.86 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 31, 36		

Hydrograph Volume = 11,146 cuft



Hydrograph Plot

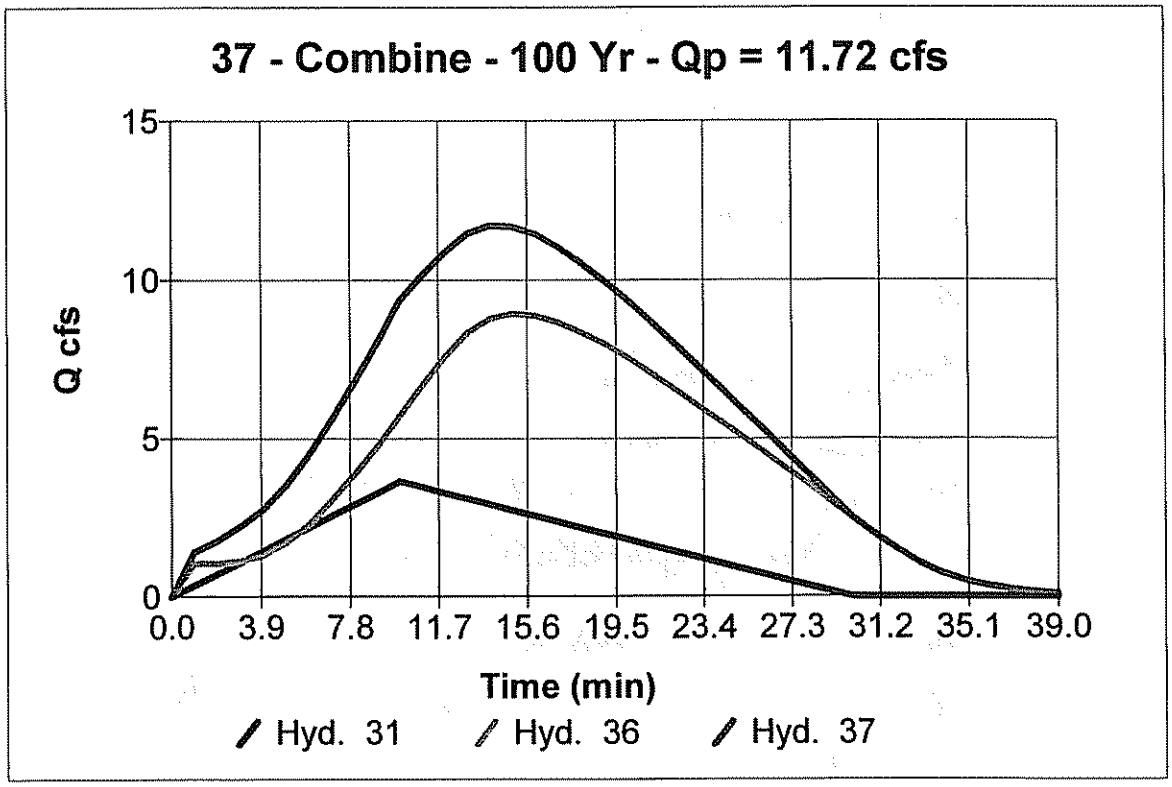
Hydraflow Hydrographs by Intelisolve

Hyd. No. 37

DITCH STATAION 100+00

Hydrograph type	= Combine	Peak discharge	= 11.72 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 31, 36		

Hydrograph Volume = 13,088 cuft



GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA #9

$AREA_{TOTAL} = 4.67$ acres

$AREA_{grass} = 4.67$ ac. $- 0.60$ ac. $= 4.07$ acres

$AREA_{paved} = 0.60$ acres

$$C = \frac{(4.07)(0.20) + (0.60)(0.90)}{4.67} = 0.29$$

Assumed $T_C = 15$ minutes

$Q_{10} = 9.11$ cfs

$Q_{100} = 10.94$ cfs

AREA #10

$AREA_{TOTAL} = 0.18$ acres

$AREA_{paved} = 0.06$ acres

$AREA_{grass} = 0.18$ ac. $- 0.06$ ac. $= 0.12$ acres

$$C = \frac{(0.12)(0.20) + (0.06)(0.90)}{0.18} = 0.43$$

Assumed $T_C = 10$ minutes

$Q_{10} = 0.61$ cfs $\qquad Q_{100} = 0.71$ cfs

AREA #9 + #10

$Q_{10} = 9.52$ cfs

$Q_{100} = 11.23$ cfs

Low Point Elevation 623.39 ft @ Station 103+00 IL 178

Channel Depth = 618.02' + 0.05' ≈ 618.67 ft.

Hydrograph Plot

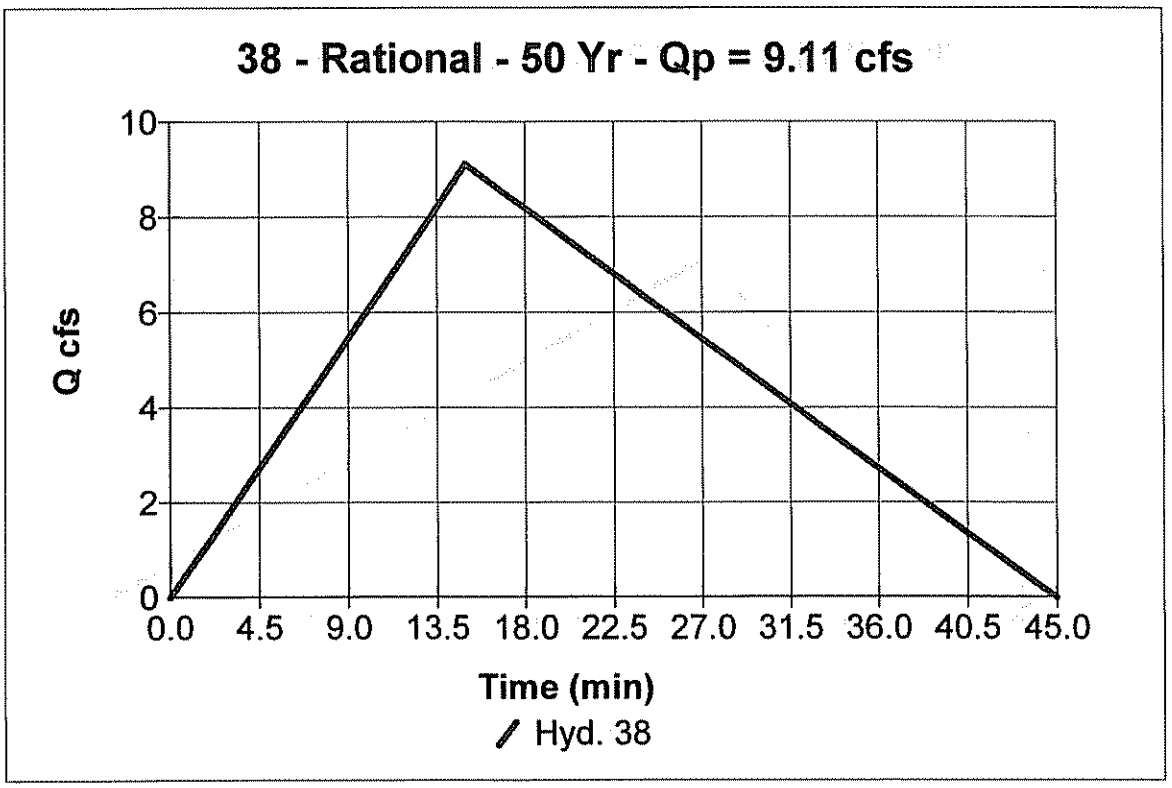
Hydraflow Hydrographs by Intelisolve

Hyd. No. 38

AREA #9

Hydrograph type	= Rational	Peak discharge	= 9.11 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 4.7 ac	Runoff coeff.	= 0.29
Intensity	= 6.729 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 12,303 cuft



Hydrograph Plot

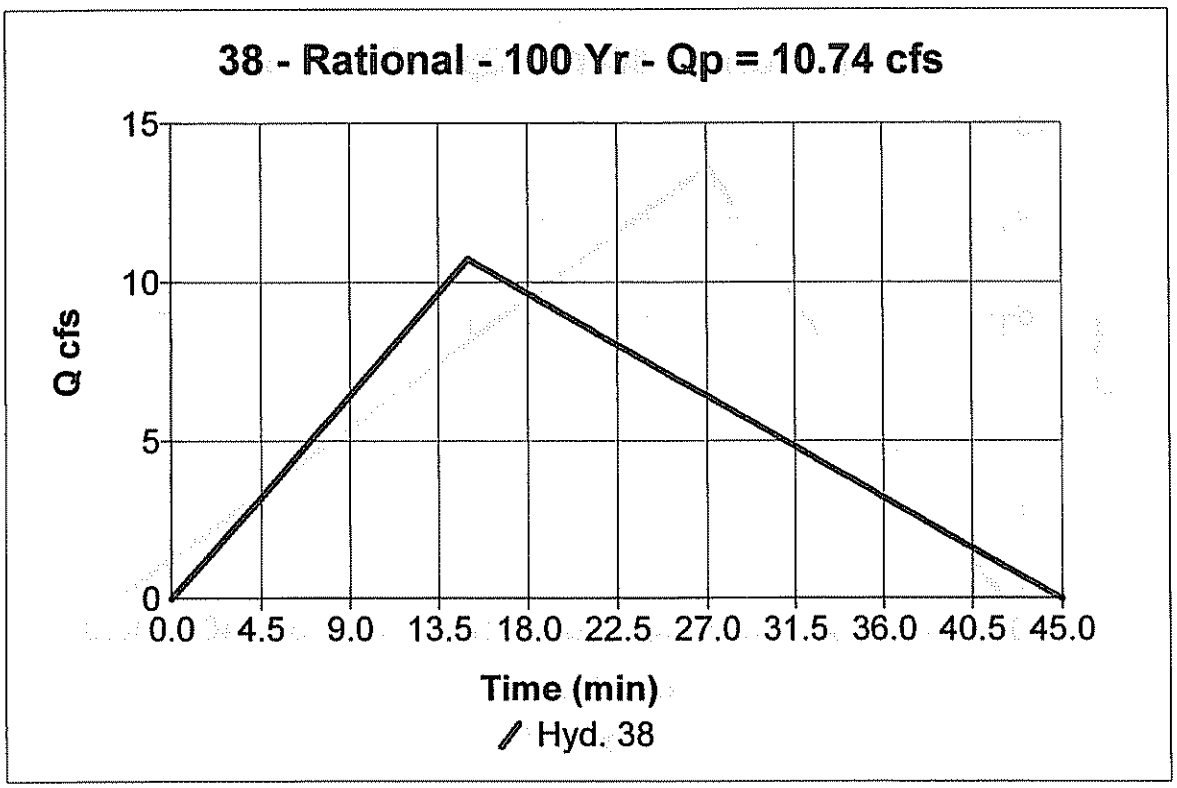
Hydraflow Hydrographs by Intelisolve

Hyd. No. 38

AREA #9

Hydrograph type	= Rational	Peak discharge	= 10.74 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 4.7 ac	Runoff coeff.	= 0.29
Intensity	= 7.927 in/hr	Time of conc. (Tc)	= 15 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 14,493 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 8

Analysis Component			
Storm Event	Design	Discharge	9.11 cfs

Peak Discharge Method: User-Specified			
Design Discharge	9.11 cfs	Check Discharge	10.74 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	0.95 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	9.11 cfs	Bottom Elevation	618.19 ft
Depth	0.95 ft	Velocity	1.41 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 Inch Circular	9.11 cfs	620.31 ft	5.28 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 624.83 ft. @
Station 104+00 (IL Rte. 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 8

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	620.31	ft	Discharge	9.11	cfs
Inlet Control HW Elev	620.17	ft	Tailwater Elevation	619.14	ft
Outlet Control HW Elev	620.31	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.85				

Grades					
Upstream Invert	618.60	ft	Downstream Invert	618.19	ft
Length	41.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.08	ft
Slope Type	Mild		Normal Depth	1.28	ft
Flow Regime	Subcritical		Critical Depth	1.08	ft
Velocity Downstream	5.28	ft/s	Critical Slope	0.017226	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

ɔutlet Control Properties					
Outlet Control HW Elev	620.31	ft	Upstream Velocity Head	0.29	ft
Ke	0.50		Entrance Loss	0.14	ft

Inlet Control Properties					
Inlet Control HW Elev	620.17	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 8

Analysis Component			
Storm Event	Check	Discharge	10.74 cfs

Peak Discharge Method: User-Specified			
Design Discharge	9.11 cfs	Check Discharge	10.74 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	1.03 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	10.74 cfs	Bottom Elevation	618.19 ft
Depth	1.03 ft	Velocity	1.47 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	10.74 cfs	620.49 ft ✓	5.60 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 8

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	620.49	ft	Discharge	10.74	cfs
Inlet Control HW Elev	620.34	ft	Tailwater Elevation	619.22	ft
Outlet Control HW Elev	620.49	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.95				

Grades					
Upstream Invert	618.60	ft	Downstream Invert	618.19	ft
Length	41.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.17	ft
Slope Type	Mild		Normal Depth	1.45	ft
Flow Regime	Subcritical		Critical Depth	1.17	ft
Velocity Downstream	5.60	ft/s	Critical Slope	0.018182	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	620.49	ft	Upstream Velocity Head	0.31	ft
Ke	0.50		Entrance Loss	0.16	ft

Inlet Control Properties					
Inlet Control HW Elev	620.34	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

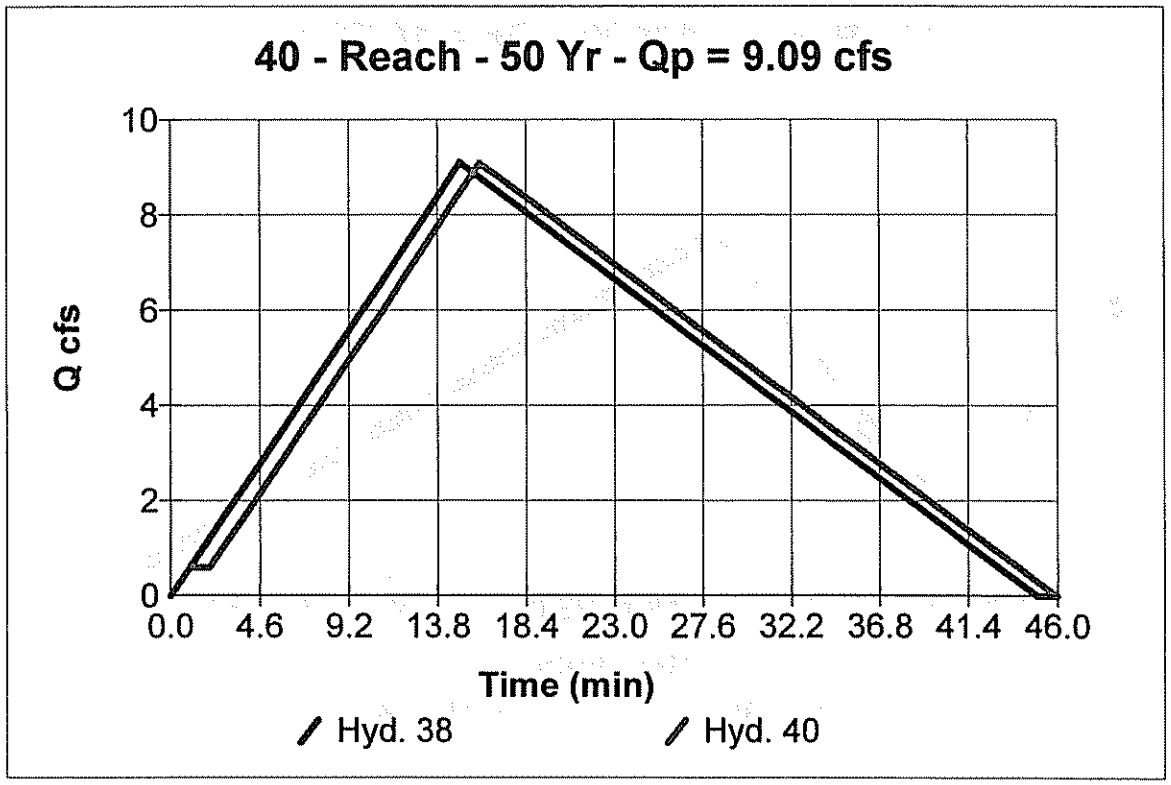
Hyd. No. 40

DITCH CULV 8 TO CULV 7

Hydrograph type	= Reach	Peak discharge	= 9.09 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 38	Section type	= Trapezoidal
Reach length	= 120.0 ft	Channel slope	= 0.4 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.644	Rating curve m	= 1.321
Ave. velocity	= 2.85	Routing coeff.	= 0.9689

Modified Att-Kin routing method used.

Hydrograph Volume = 12,340 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

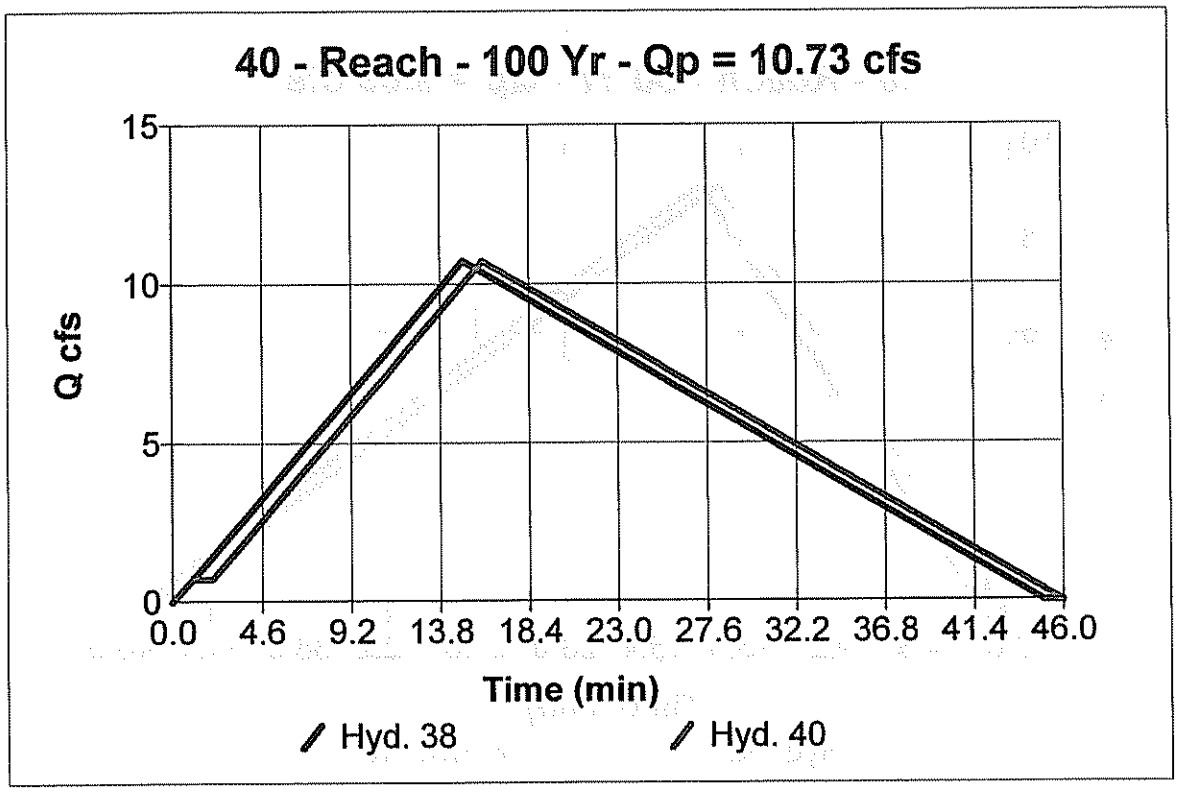
Hyd. No. 40

DITCH CULV 8 TO CULV 7

Hydrograph type	= Reach	Peak discharge	= 10.73 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 38	Section type	= Trapezoidal
Reach length	= 120.0 ft	Channel slope	= 0.4 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.644	Rating curve m	= 1.321
Ave. velocity	= 3.00	Routing coeff.	= 0.9952

Modified Att-Kin routing method used.

Hydrograph Volume = 14,536 cuft



Hydrograph Plot

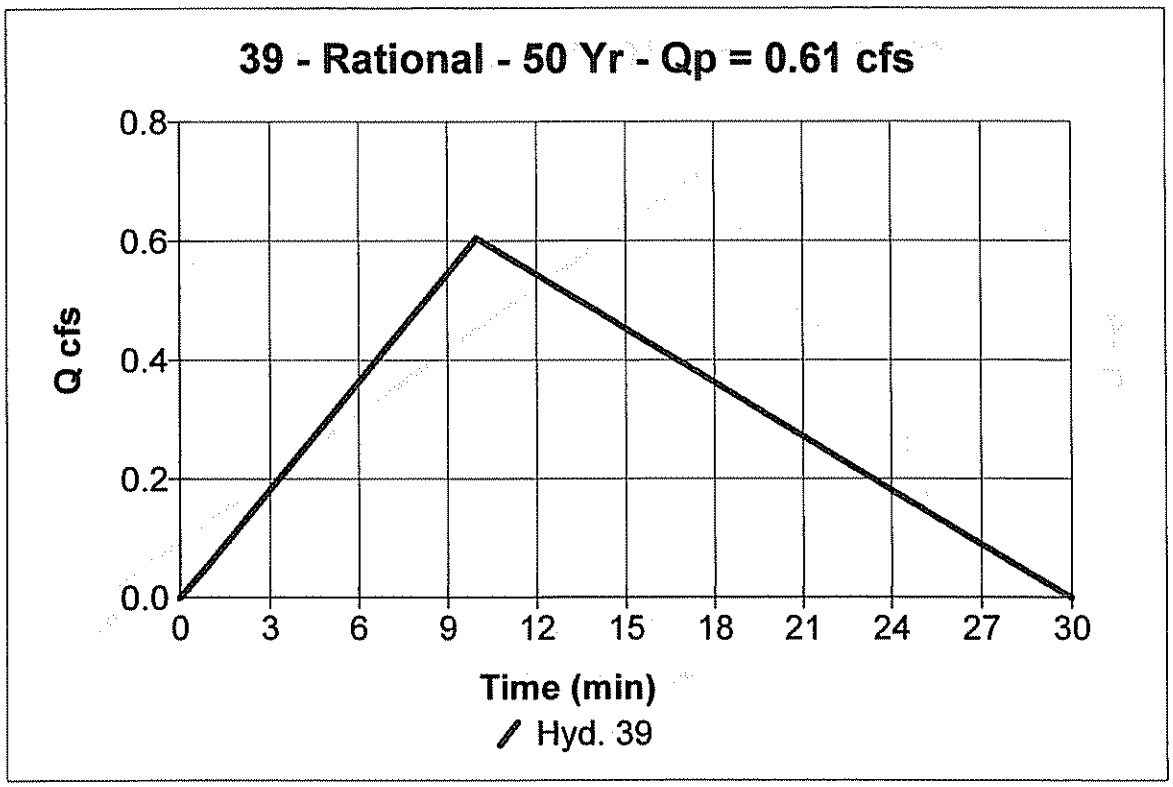
Hydraflow Hydrographs by Intelisolve

Hyd. No. 39

AREA #10

Hydrograph type	= Rational	Peak discharge	= 0.61 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 0.2 ac	Runoff coeff.	= 0.43
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 545 cuft



Hydrograph Plot

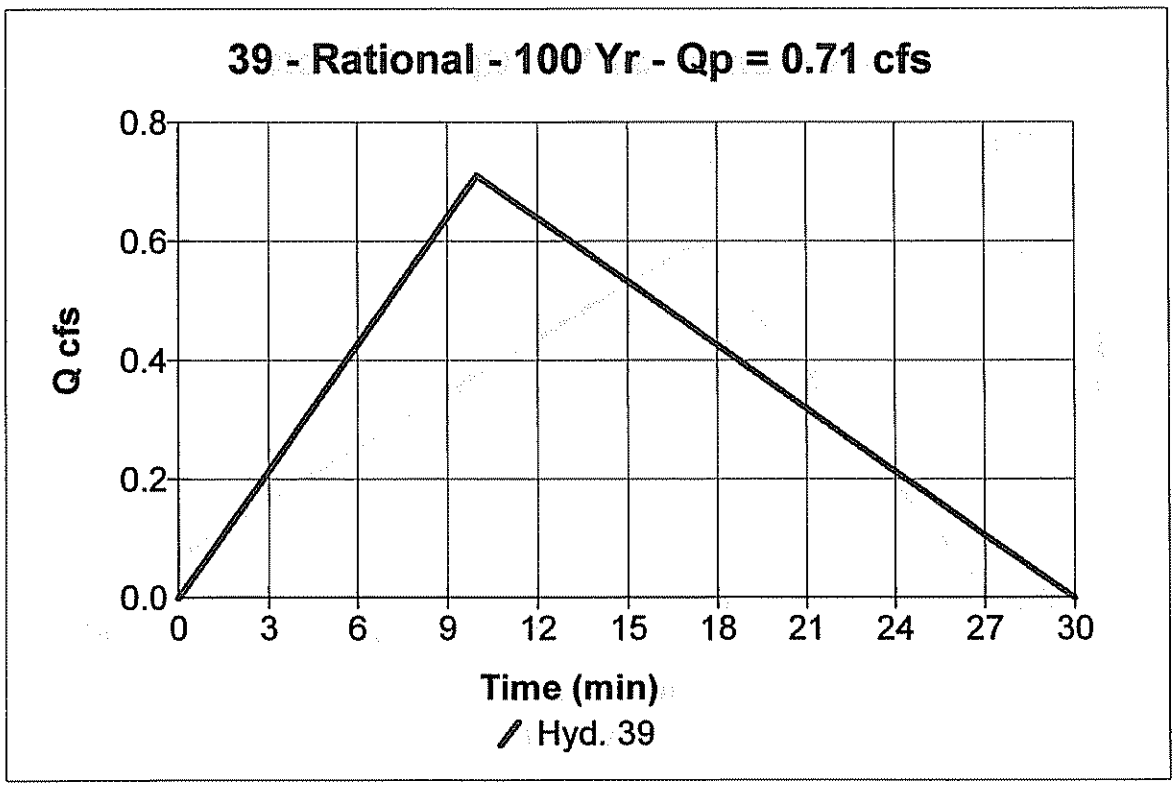
Hydraflow Hydrographs by Intelisolve

Hyd. No. 39

AREA #10

Hydrograph type	= Rational	Peak discharge	= 0.71 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.2 ac	Runoff coeff.	= 0.43
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 640 cuft



Hydrograph Plot

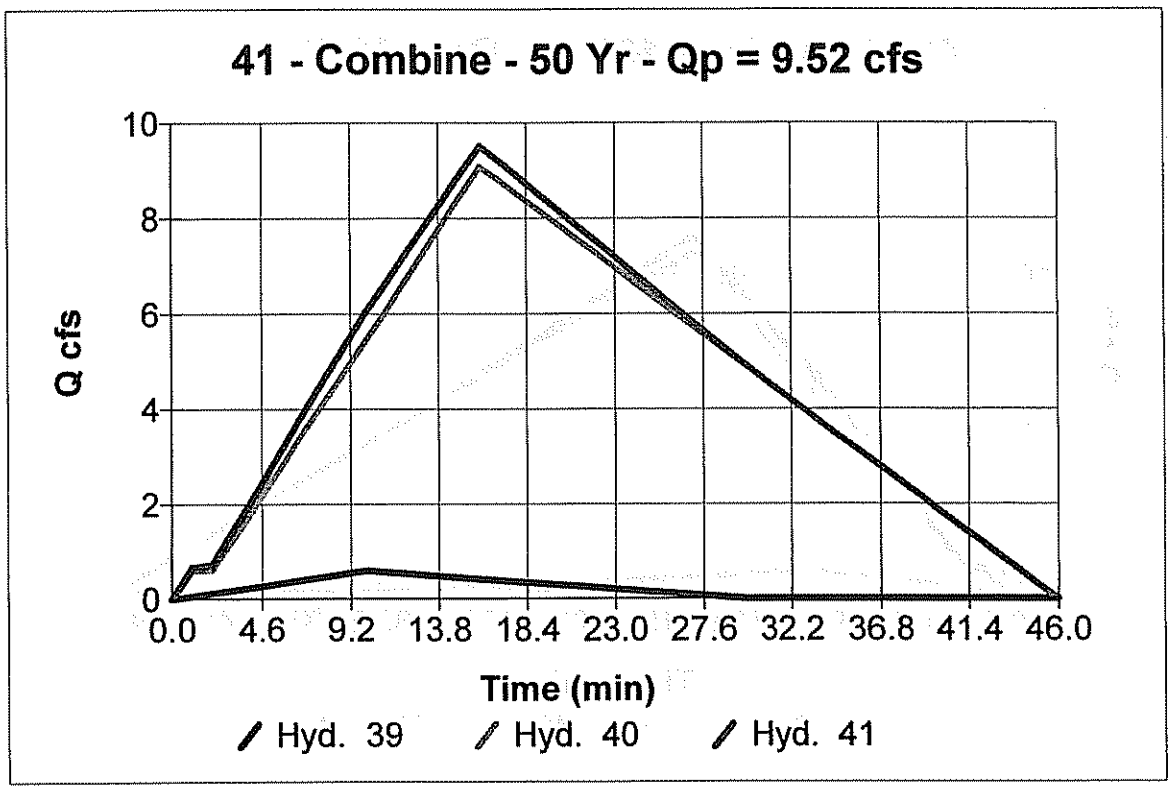
Hydraflow Hydrographs by Intelisolve

Hyd. No. 41

US CULVERT 7

Hydrograph type	= Combine	Peak discharge	= 9.52 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 39, 40		

Hydrograph Volume = 12,885 cuft



Hydrograph Plot

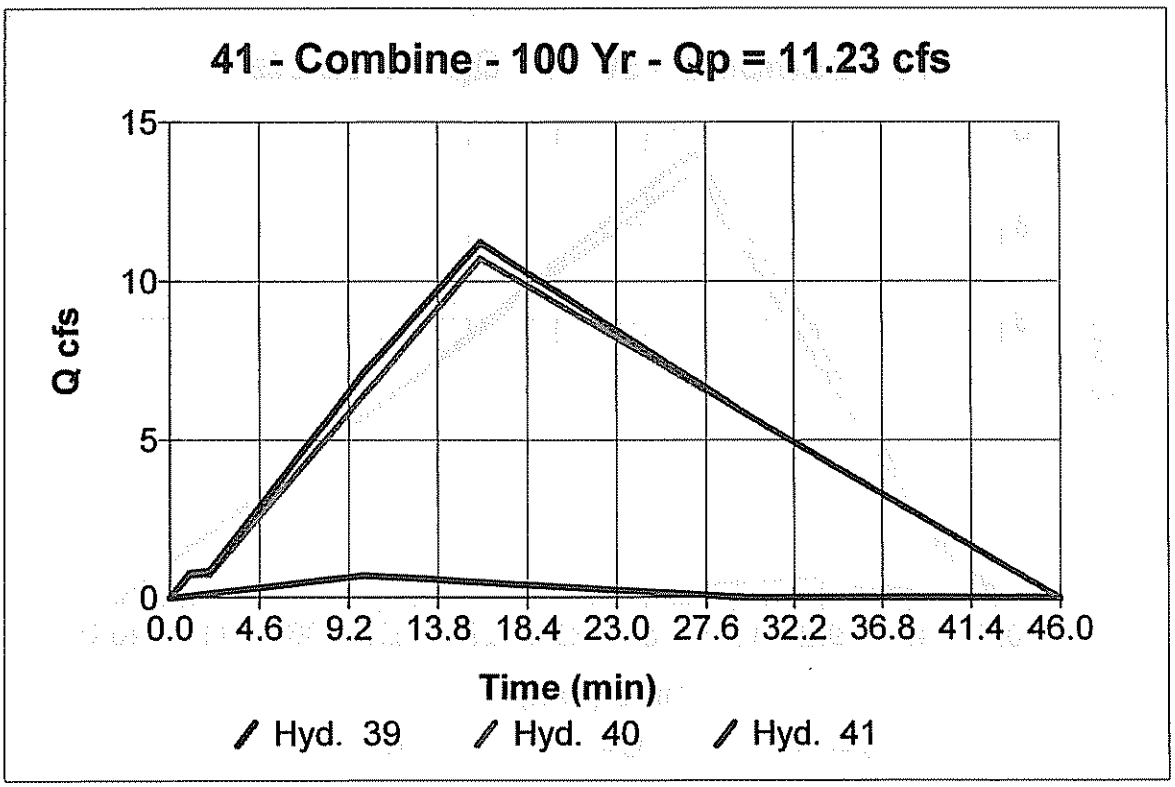
Hydraflow Hydrographs by Intelisolve

Hyd. No. 41

US CULVERT 7

Hydrograph type	= Combine	Peak discharge	= 11.23 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 39, 40		

Hydrograph Volume = 15,176 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 7

Analysis Component			
Storm Event	Design	Discharge	9.52 cfs

Peak Discharge Method: User-Specified			
Design Discharge	9.52 cfs	Check Discharge	11.23 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	0.97 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	9.52 cfs	Bottom Elevation	617.98 ft
Depth	0.97 ft	Velocity	1.42 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	9.52 cfs	619.92 ft	5.36 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 623.39 ft. @
Station 103+00 (ILL Rte. 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 7

ɔmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	619.92 ft	Discharge	9.52 cfs
Inlet Control HW Elev	619.64 ft	Tailwater Elevation	618.95 ft
Outlet Control HW Elev	619.92 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.95		

Grades			
Upstream Invert	618.02 ft	Downstream Invert	617.98 ft
Length	35.00 ft	Constructed Slope	0.001143 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.10 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.10 ft
Velocity Downstream	5.36 ft/s	Critical Slope	0.017452 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	619.92 ft	Upstream Velocity Head	0.19 ft
Ke	0.50	Entrance Loss	0.10 ft

Inlet Control Properties			
Inlet Control HW Elev	619.64 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 7

Analysis Component			
Storm Event	Check	Discharge	11.23 cfs

Peak Discharge Method: User-Specified			
Design Discharge	9.52 cfs	Check Discharge	11.23 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.050
Depth	1.05 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	11.23 cfs	Bottom Elevation	617.98 ft
Depth	1.05 ft	Velocity	1.49 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	11.23 cfs	620.13 ft	5.69 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 7

,omponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	620.13 ft	Discharge	11.23 cfs
Inlet Control HW Elev	619.82 ft	Tailwater Elevation	619.03 ft
Outlet Control HW Elev	620.13 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.06		

Grades			
Upstream Invert	618.02 ft	Downstream Invert	617.98 ft
Length	35.00 ft	Constructed Slope	0.001143 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.20 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.20 ft
Velocity Downstream	5.69 ft/s	Critical Slope	0.018501 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	620.13 ft	Upstream Velocity Head	0.23 ft
Ke	0.50	Entrance Loss	0.11 ft

Inlet Control Properties			
Inlet Control HW Elev	619.82 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

GREENE & BRADFORD CONSULTING ENGINEERS

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: La Salle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA # 13

$AREA_{TOTAL} = 0.62$ acres

$AREA_{paved} = 0.16$ acres

$AREA_{grass} = 0.62\ ac. - 0.16\ ac. = 0.46$ acres

$$C = \frac{(0.46)(0.20) + (0.16\ ac.)(0.90)}{0.62\ ac.} = 0.38$$

Assumed $T_c = 10$ minutes

$Q_{10} = 1.84$ cfs

$Q_{100} = 2.16$ cfs

AREA # 12

$AREA_{TOTAL} = 0.29$ acres

$AREA_{paved} = 0.08$ acres

$AREA_{grass} = 0.29\ ac. - 0.08\ ac. = 0.21$ acres

$$C = \frac{(0.21\ ac.)(0.20) + (0.08\ ac.)(0.90)}{0.29\ ac.} = 0.39$$

Assumed $T_c = 10$ minutes

$Q_{10} = 0.80$ cfs

$Q_{100} = 1.04$ cfs

AREA # 12 + # 13

$Q_{10} = 2.55$ cfs

$Q_{100} = 3.01$ cfs

Channel Depth = 618.69' + 0.55' = 619.24 ft.

Low Point IL. Rte 178 Elevation 622.19 ft @ Sta. 101+00.

Hydrograph Plot

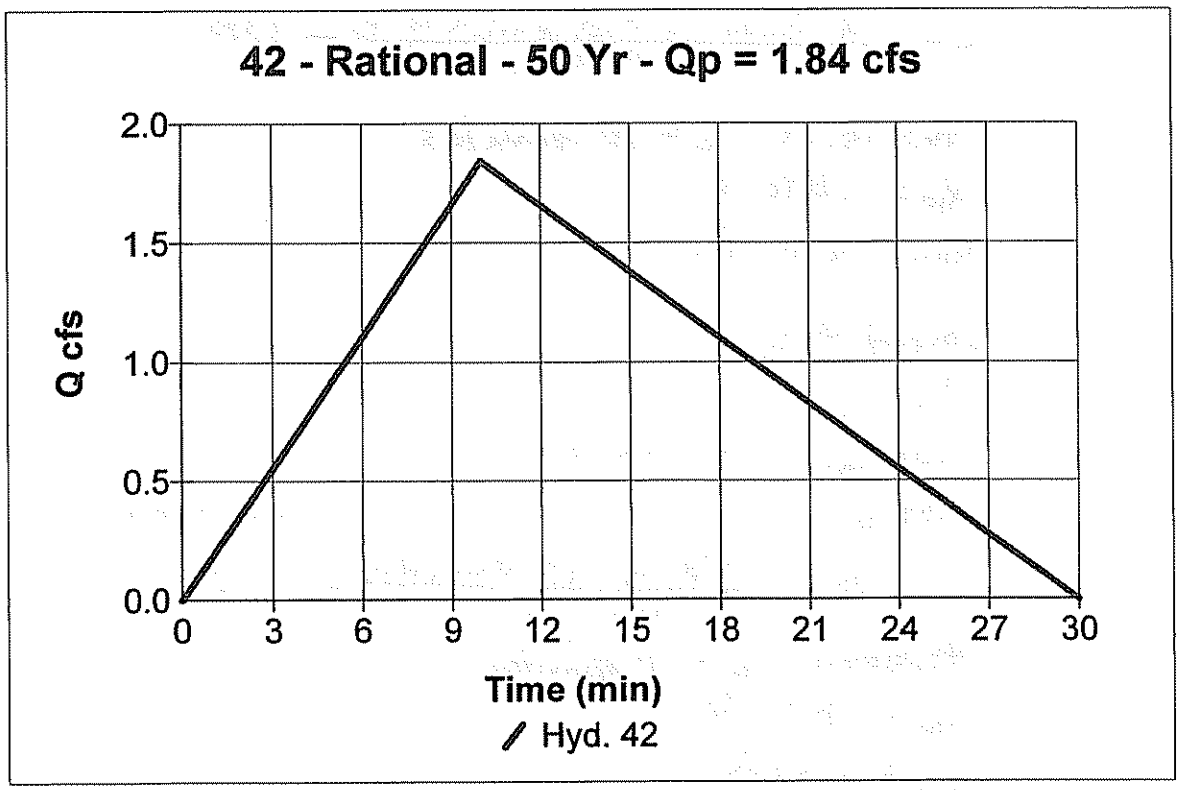
Hydraflow Hydrographs by Intelisolve

Hyd. No. 42

AREA #13

Hydrograph type	= Rational	Peak discharge	= 1.84 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.38
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 1,658 cuft



Hydrograph Plot

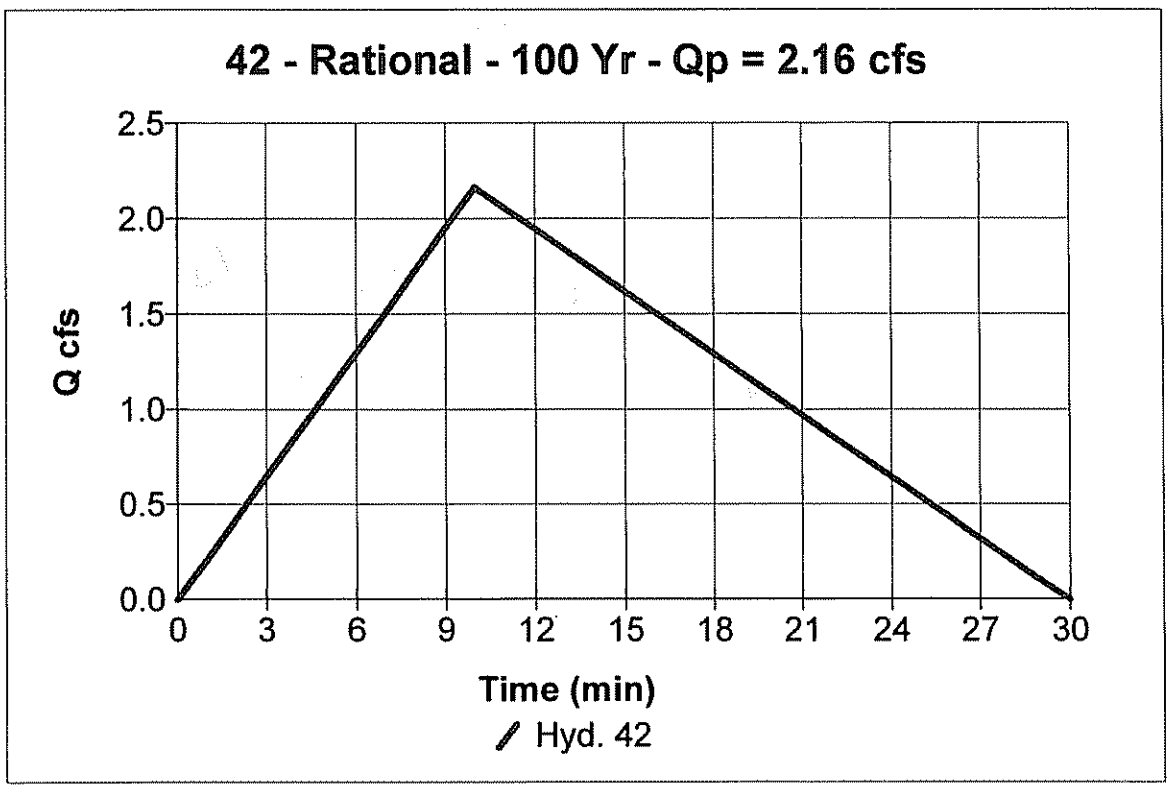
Hydraflow Hydrographs by Intelisolve

Hyd. No. 42

AREA #13

Hydrograph type	= Rational	Peak discharge	= 2.16 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.38
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 1,948 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 5

Analysis Component			
Storm Event	Design	Discharge	1.84 cfs

Peak Discharge Method: User-Specified			
Design Discharge	1.84 cfs	Check Discharge	2.16 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.001400 ft/ft	Mannings Coefficient	0.050
Depth	0.54 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	1.84 cfs	Bottom Elevation	618.82 ft
Depth	0.54 ft	Velocity	0.61 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	1.84 cfs	619.92 ft	3.63 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 621.79 ft. @
Station 100+00 (IL Rte. 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 5

ɔmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	619.92 ft	Discharge	1.84 cfs
Inlet Control HW Elev	619.83 ft	Tailwater Elevation	619.36 ft
Outlet Control HW Elev	619.92 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.68		

Grades			
Upstream Invert	619.07 ft	Downstream Invert	618.82 ft
Length	32.00 ft	Constructed Slope	0.007813 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.54 ft
Slope Type	Mild	Normal Depth	0.69 ft
Flow Regime	Subcritical	Critical Depth	0.54 ft
Velocity Downstream	3.63 ft/s	Critical Slope	0.018520 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		

ɔutlet Control Properties			
Outlet Control HW Elev	619.92 ft	Upstream Velocity Head	0.11 ft
Ke	0.50	Entrance Loss	0.05 ft

Inlet Control Properties			
Inlet Control HW Elev	619.83 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	1.2 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 5

Analysis Component			
Storm Event	Check	Discharge	2.16 cfs

Peak Discharge Method: User-Specified			
Design Discharge	1.84 cfs	Check Discharge	2.16 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.001400 ft/ft	Mannings Coefficient	0.050
Depth	0.59 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	2.16 cfs	Bottom Elevation	618.82 ft
Depth	0.59 ft	Velocity	0.64 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	2.16 cfs	620.01 ft	3.82 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 5

,mponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	620.01 ft	Discharge	2.16 cfs
Inlet Control HW Elev	619.90 ft	Tailwater Elevation	619.41 ft
Outlet Control HW Elev	620.01 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.75		

Grades			
Upstream Invert	619.07 ft	Downstream Invert	618.82 ft
Length	32.00 ft	Constructed Slope	0.007813 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.59 ft
Slope Type	Mild	Normal Depth	0.77 ft
Flow Regime	Subcritical	Critical Depth	0.59 ft
Velocity Downstream	3.82 ft/s	Critical Slope	0.018989 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	620.01 ft	Upstream Velocity Head	0.12 ft
Ke	0.50	Entrance Loss	0.06 ft

Inlet Control Properties			
Inlet Control HW Elev	619.90 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	1.2 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

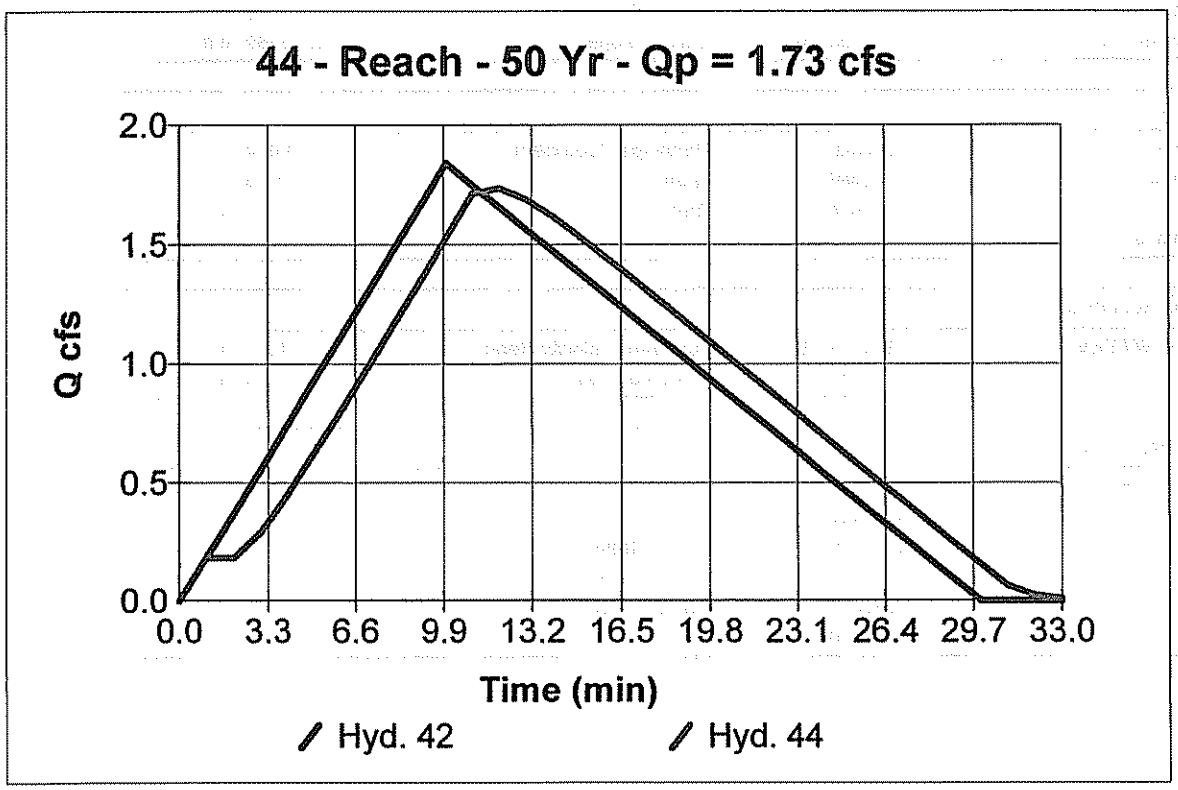
Hyd. No. 44

DITCH CULV 5 TO CULV 6

Hydrograph type	= Reach	Peak discharge	= 1.73 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyd. No.	= 42	Section type	= Trapezoidal
Reach length	= 92.0 ft	Channel slope	= 0.1 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.381	Rating curve m	= 1.321
Ave. velocity	= 0.96	Routing coeff.	= 0.5867

Modified Att-Kin routing method used.

Hydrograph Volume = 1,676 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

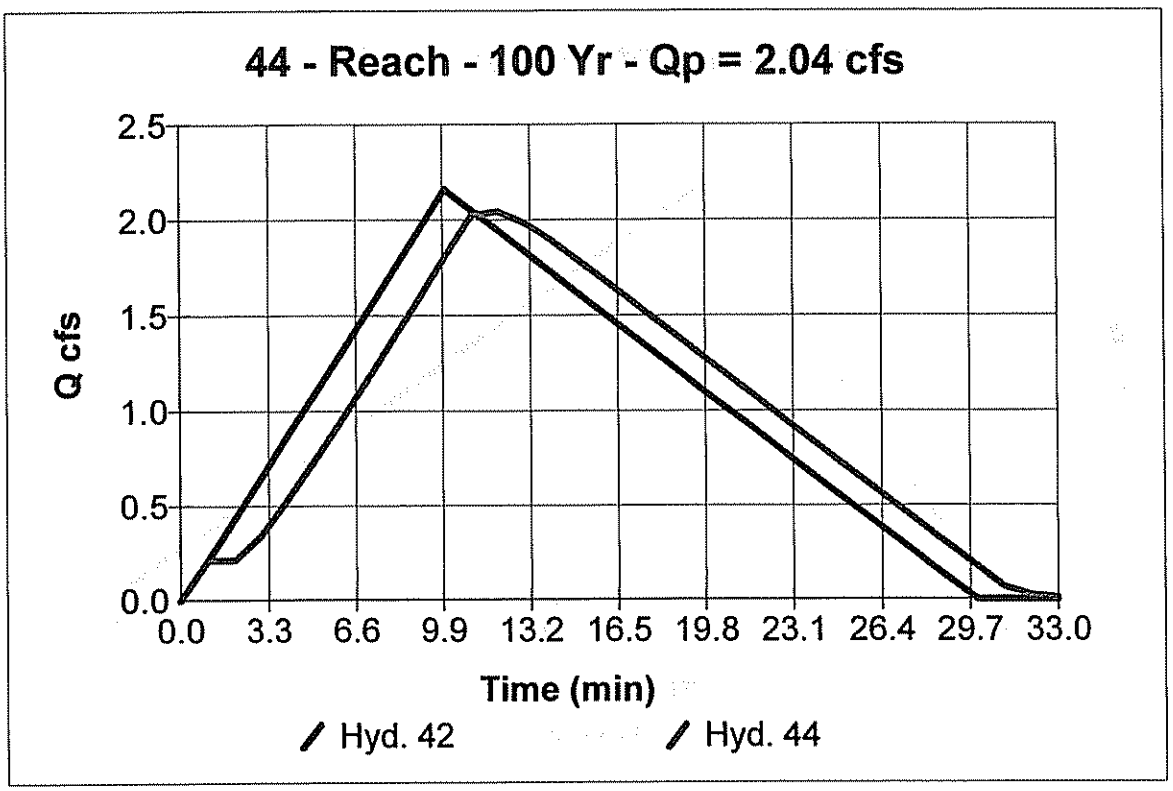
Hyd. No. 44

DITCH CULV 5 TO CULV 6

Hydrograph type	= Reach	Peak discharge	= 2.04 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyd. No.	= 42	Section type	= Trapezoidal
Reach length	= 92.0 ft	Channel slope	= 0.1 %
Manning's n	= 0.050	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 0.381	Rating curve m	= 1.321
Ave. velocity	= 1.02	Routing coeff.	= 0.6084

Modified Att-Kin routing method used.

Hydrograph Volume = 1,969 cuft



Hydrograph Plot

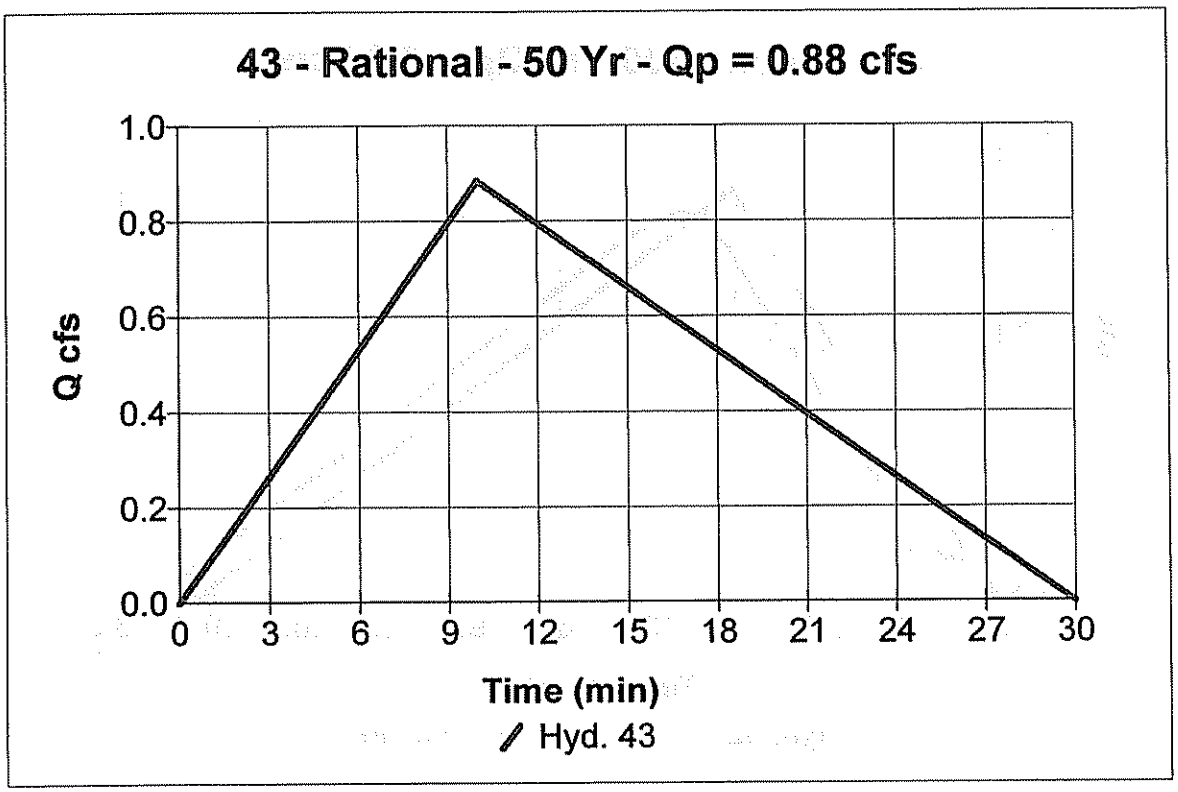
Hydraflow Hydrographs by Intelisolve

Hyd. No. 43

AREA #12

Hydrograph type	= Rational	Peak discharge	= 0.88 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 0.3 ac	Runoff coeff.	= 0.39
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 796 cuft



Hydrograph Plot

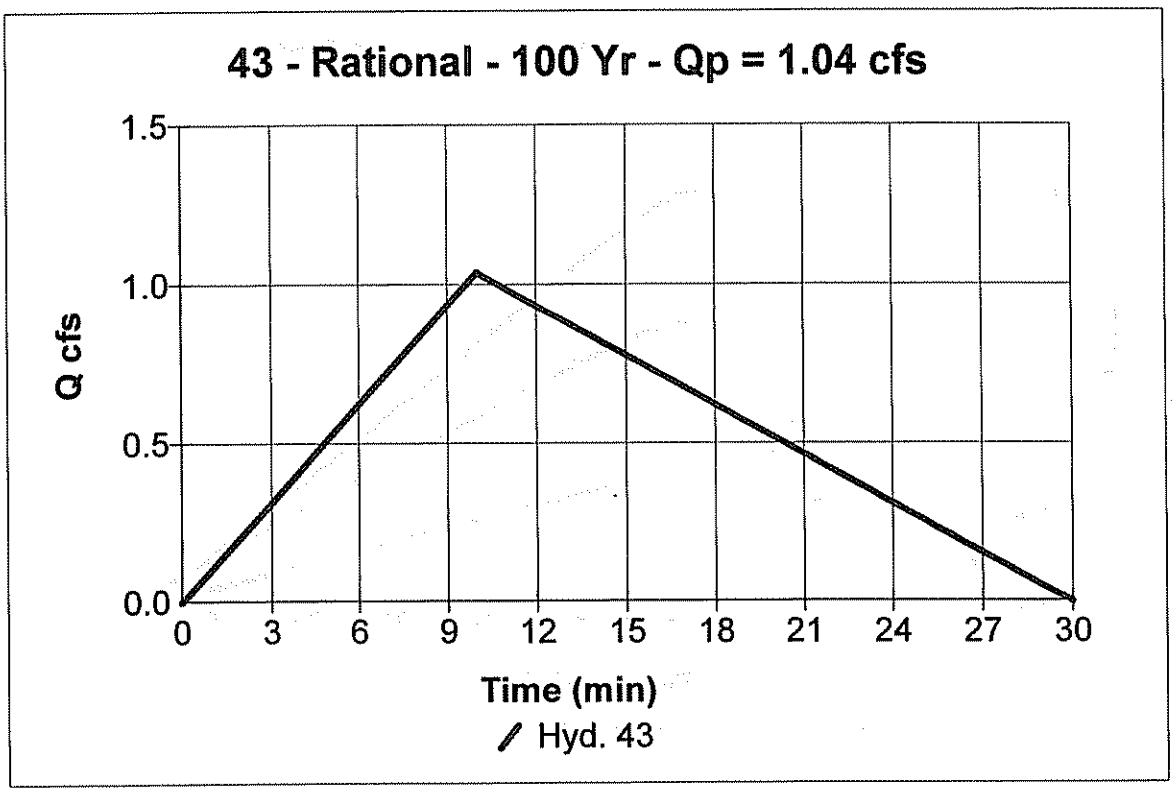
Hydraflow Hydrographs by Intelisolve

Hyd. No. 43

AREA #12

Hydrograph type	= Rational	Peak discharge	= 1.04 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.3 ac	Runoff coeff.	= 0.39
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 935 cuft



Hydrograph Plot

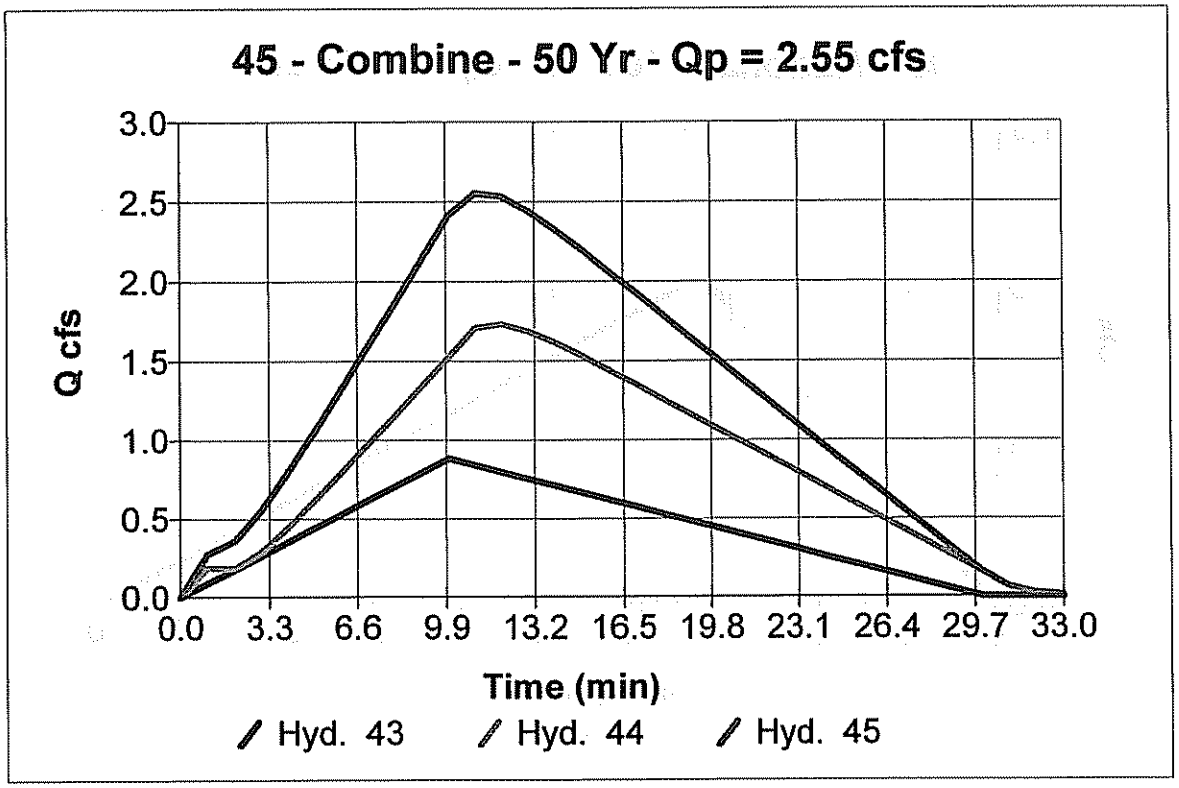
Hydraflow Hydrographs by Intelisolve

Hyd. No. 45

US CULVERT 6

Hydrograph type	= Combine	Peak discharge	= 2.55 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 43, 44		

Hydrograph Volume = 2,472 cuft



Hydrograph Plot

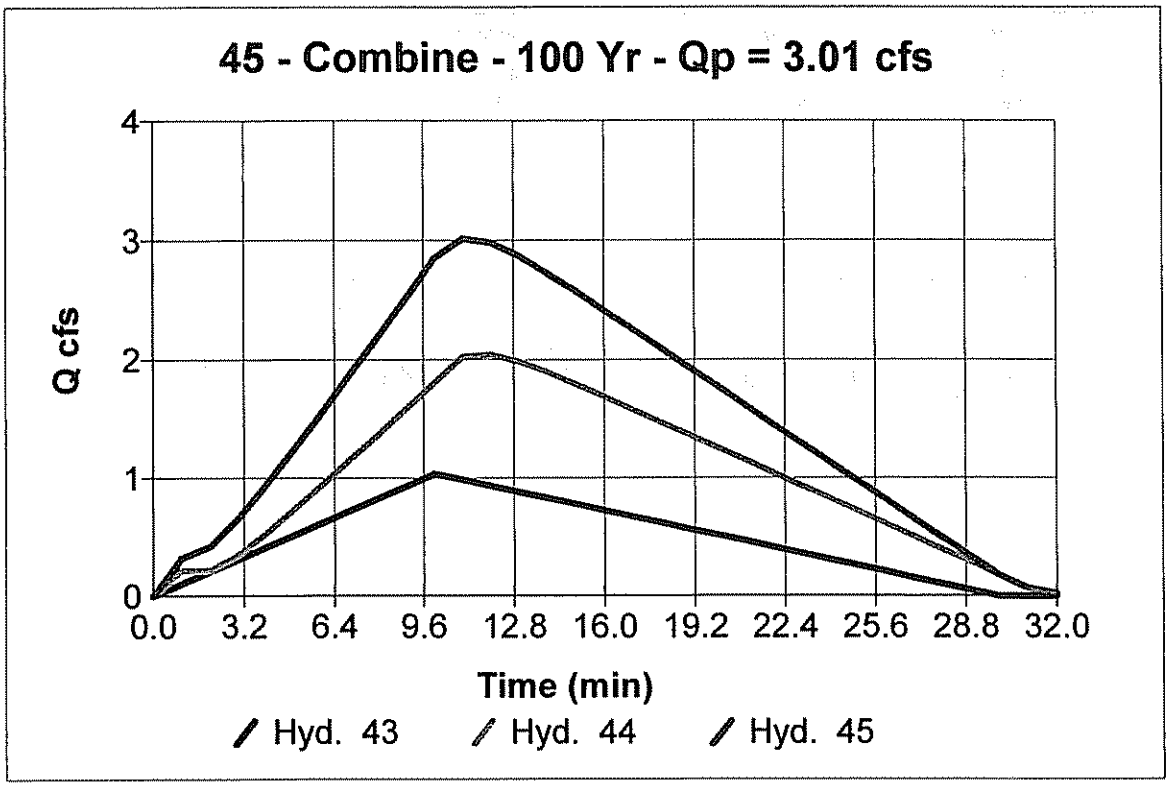
Hydraflow Hydrographs by Intelisolve

Hyd. No. 45

US CULVERT 6

Hydrograph type	= Combine	Peak discharge	= 3.01 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 43, 44		

Hydrograph Volume = 2,905 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 6

Analysis Component			
Storm Event	Design	Discharge	2.65 cfs

Peak Discharge Method: User-Specified			
Design Discharge	2.65 cfs	Check Discharge	3.01 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.001400 ft/ft	Mannings Coefficient	0.050
Depth	0.65 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	2.65 cfs	Bottom Elevation	618.50 ft
Depth	0.65 ft	Velocity	0.68 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	2.65 cfs	619.83 ft	4.08 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 622.19 ft. @
Station 101+00 (Int. Rte. 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 6

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	619.83	ft	Discharge	2.65	cfs
Inlet Control HW Elev	619.64	ft	Tailwater Elevation	619.15	ft
Outlet Control HW Elev	619.83	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.91				

Grades					
Upstream Invert	618.69	ft	Downstream Invert	618.50	ft
Length	44.00	ft	Constructed Slope	0.004318	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.65	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	0.65	ft
Velocity Downstream	4.08	ft/s	Critical Slope	0.019815	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	619.83	ft	Upstream Velocity Head	0.10	ft
Ke	0.50		Entrance Loss	0.05	ft

Inlet Control Properties					
Inlet Control HW Elev	619.64	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	1.2	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 6

. ıalysis Component			
Storm Event	Check	Discharge	3.01 cfs

Peak Discharge Method: User-Specified			
Design Discharge	2.65 cfs	Check Discharge	3.01 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.001400 ft/ft	Mannings Coefficient	0.050
Depth	0.70 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	3.01 cfs	Bottom Elevation	618.50 ft
Depth	0.70 ft	Velocity	0.71 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	3.01 cfs	619.93 ft	4.26 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 6

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	619.93	ft	Discharge	3.01	cfs
Inlet Control HW Elev	619.72	ft	Tailwater Elevation	619.20	ft
Outlet Control HW Elev	619.93	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.99				

Grades					
Upstream Invert	618.69	ft	Downstream Invert	618.50	ft
Length	44.00	ft	Constructed Slope	0.004318	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.70	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	0.70	ft
Velocity Downstream	4.26	ft/s	Critical Slope	0.020545	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	619.93	ft	Upstream Velocity Head	0.11	ft
Ke	0.50		Entrance Loss	0.06	ft

Inlet Control Properties					
Inlet Control HW Elev	619.72	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	1.2	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: DATE:
SHEET: OF:

DRAINAGE CALCULATIONS

AREA #17

$AREA_{TOTAL} = 1.05$ acres

$AREA_{paved} = 0.30$ acres

$AREA_{grass} = 1.05$ ac. $- 0.30$ ac. $= 0.75$ acres

$$c = \frac{(0.75ac)(0.20) + (0.30ac)(0.90)}{1.05\ ac.} = 0.40$$

Assumed $T_c = 10$ minutes

$Q_{10} = 3.28$ cfs

$Q_{10} = 3.86$ cfs

AREA #16

$AREA_{TOTAL} = 0.58$ acres

~~AREA paved =~~

$c = 0.80$

Assumed $T_c = 7$ minutes

$Q_{10} = 4.02$ cfs

$Q_{100} = 4.71$ cfs

AREA #16 + #17

$Q_{10} = 6.45$ cfs

$Q_{100} = 1.56$ cfs

Hydrograph Plot

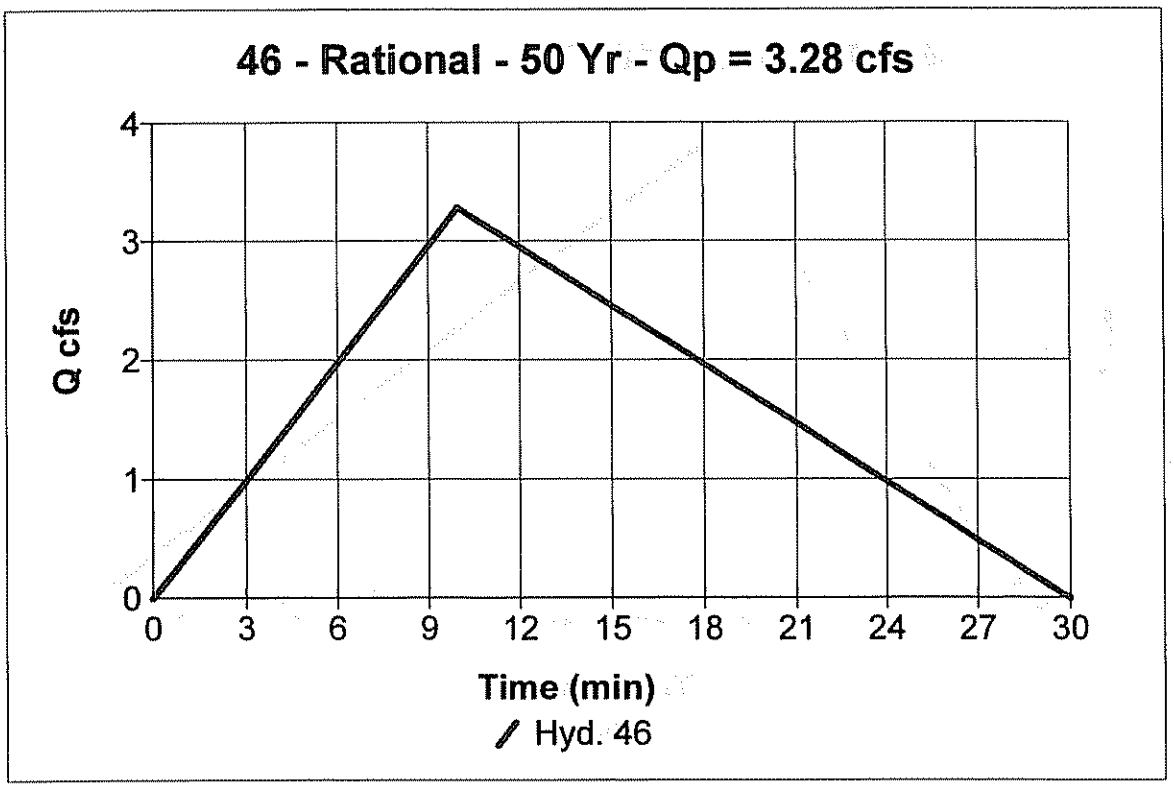
Hydraflow Hydrographs by Intelisolve

Hyd. No. 46

AREA #17

Hydrograph type	= Rational	Peak discharge	= 3.28 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 1.1 ac	Runoff coeff.	= 0.4
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 2,956 cuft



Hydrograph Plot

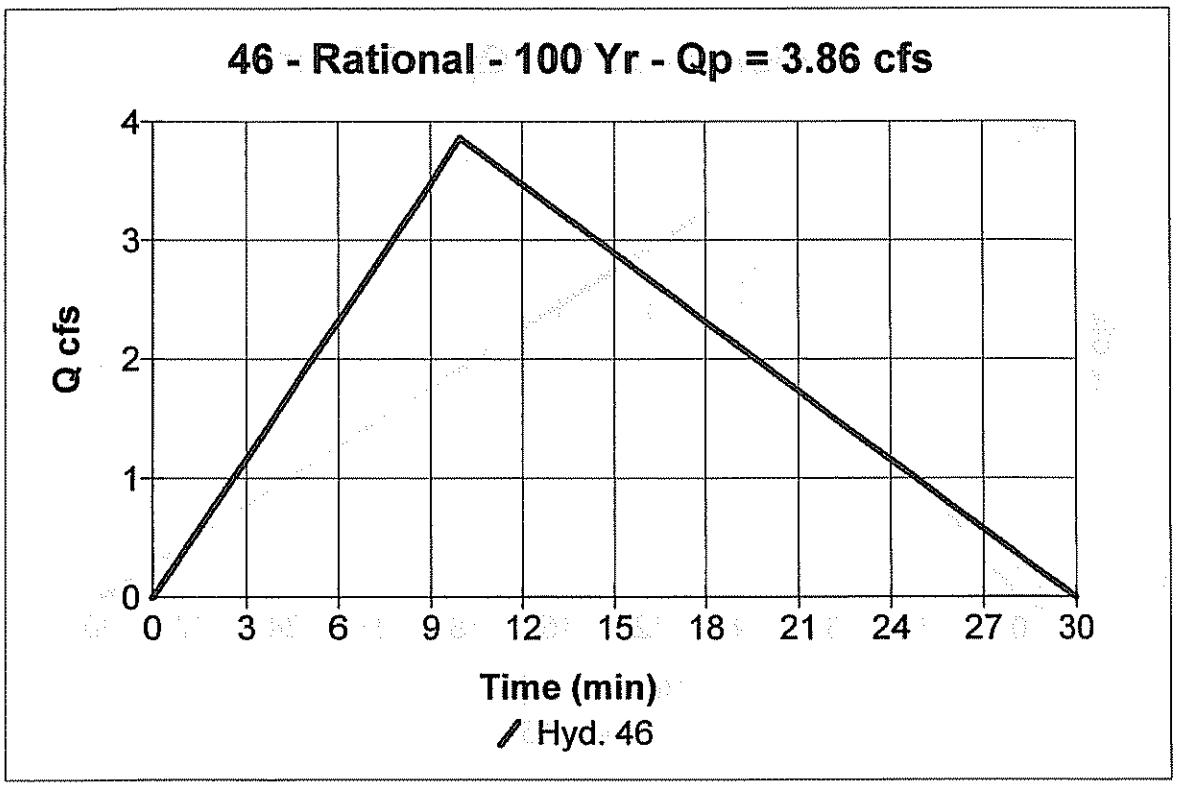
Hydraflow Hydrographs by Intelisolve

Hyd. No. 46

AREA #17

Hydrograph type	= Rational	Peak discharge	= 3.86 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.1 ac	Runoff coeff.	= 0.4
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 3,473 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. 9

Analysis Component			
Storm Event	Design	Discharge	3.28 cfs

Peak Discharge Method: User-Specified			
Design Discharge	3.28 cfs	Check Discharge	3.86 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.056000 ft/ft	Mannings Coefficient	0.050
Depth	0.26 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	3.28 cfs	Bottom Elevation	619.78 ft
Depth	0.26 ft	Velocity	2.59 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	3.28 cfs	621.64 ft	4.41 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 625.83 ft. @
Station 104+50 (Il. Rte. 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 9

ɹmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	621.64 ft	Discharge	3.28 cfs
Inlet Control HW Elev	621.55 ft	Tailwater Elevation	620.04 ft
Outlet Control HW Elev	621.64 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.94		

Grades			
Upstream Invert	620.47 ft	Downstream Invert	619.78 ft
Length	37.00 ft	Constructed Slope	0.018649 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.73 ft
Slope Type	Mild	Normal Depth	0.76 ft
Flow Regime	Subcritical	Critical Depth	0.73 ft
Velocity Downstream	4.41 ft/s	Critical Slope	0.021174 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		

ɔutlet Control Properties			
Outlet Control HW Elev	621.64 ft	Upstream Velocity Head	0.27 ft
Ke	0.50	Entrance Loss	0.14 ft

Inlet Control Properties			
Inlet Control HW Elev	621.55 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	1.2 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 9

Analysis Component			
Storm Event	Check	Discharge	3.86 cfs

Peak Discharge Method: User-Specified			
Design Discharge	3.28 cfs	Check Discharge	3.86 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.056000 ft/ft	Mannings Coefficient	0.050
Depth	0.29 ft	Left Side Slope	3 H : V
Right Side Slope	3 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	3.86 cfs	Bottom Elevation	619.78 ft
Depth	0.29 ft	Velocity	2.73 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-15 inch Circular	3.86 cfs	621.76 ft	4.69 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. 9

ɹmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	621.76	ft	Discharge	3.86	cfs
Inlet Control HW Elev	621.67	ft	Tailwater Elevation	620.07	ft
Outlet Control HW Elev	621.76	ft	Control Type	Outlet Control	
Headwater Depth/ Height	1.03				

Grades					
Upstream Invert	620.47	ft	Downstream Invert	619.78	ft
Length	37.00	ft	Constructed Slope	0.018649	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.79	ft
Slope Type	Mild		Normal Depth	0.85	ft
Flow Regime	Subcritical		Critical Depth	0.79	ft
Velocity Downstream	4.69	ft/s	Critical Slope	0.022677	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

ɔutlet Control Properties					
Outlet Control HW Elev	621.76	ft	Upstream Velocity Head	0.29	ft
Ke	0.50		Entrance Loss	0.15	ft

Inlet Control Properties					
Inlet Control HW Elev	621.67	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	1.2	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Hydrograph Plot

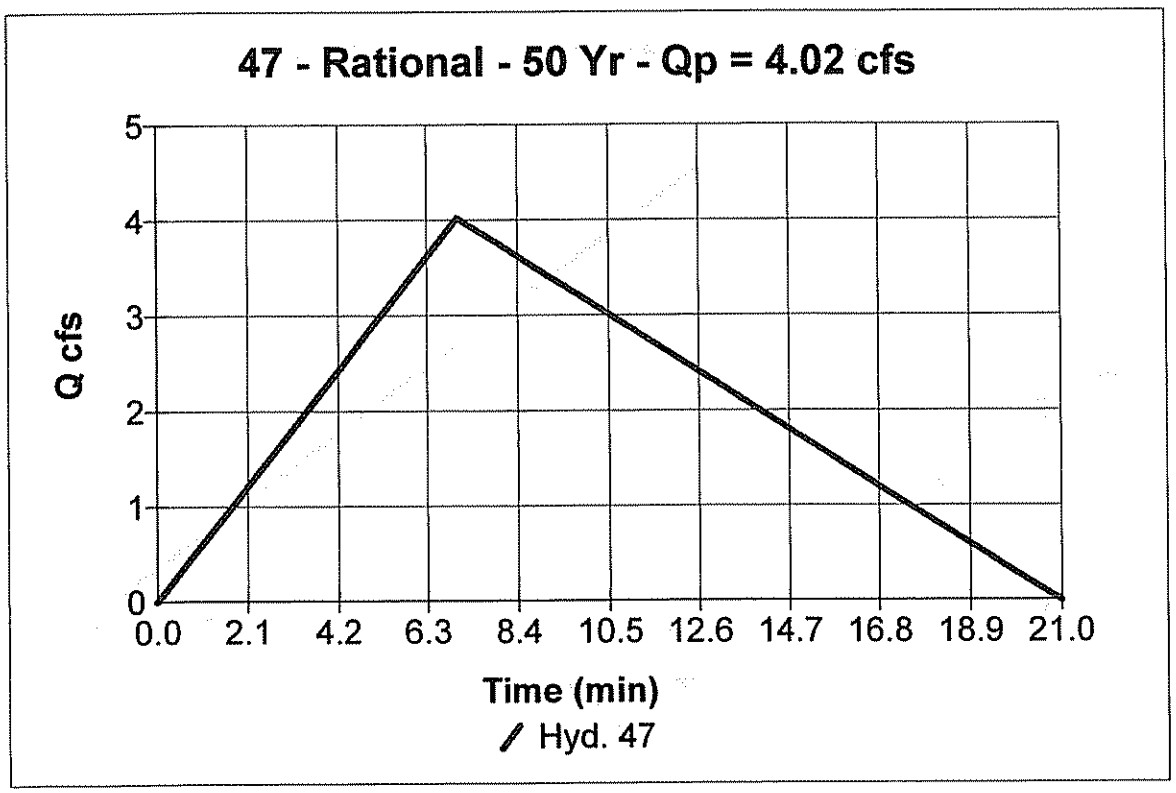
Hydraflow Hydrographs by Intelisolve

Hyd. No. 47

AREA #16

Hydrograph type	= Rational	Peak discharge	= 4.02 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.8
Intensity	= 8.672 in/hr	Time of conc. (Tc)	= 7 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 2,535 cuft



Hydrograph Plot

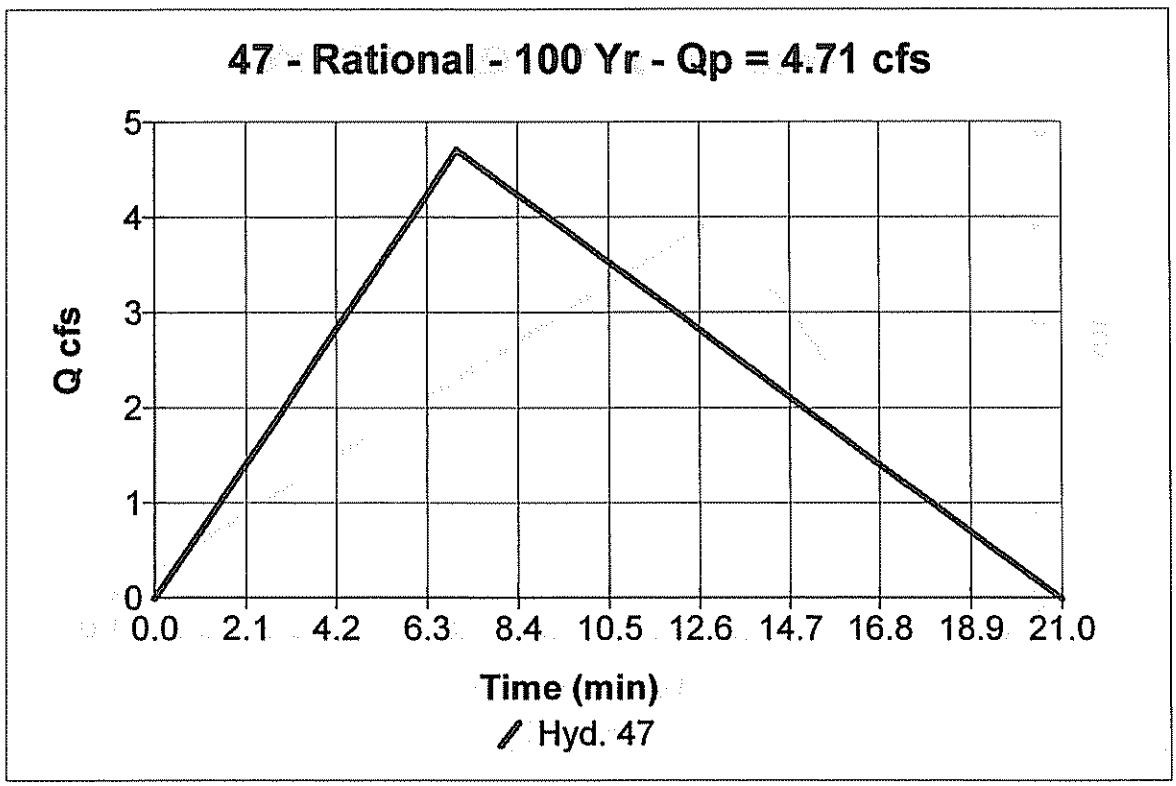
Hydraflow Hydrographs by Intelisolve

Hyd. No. 47

AREA #16

Hydrograph type	= Rational	Peak discharge	= 4.71 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.8
Intensity	= 10.154 in/hr	Time of conc. (Tc)	= 7 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 2,968 cuft



Hydrograph Plot

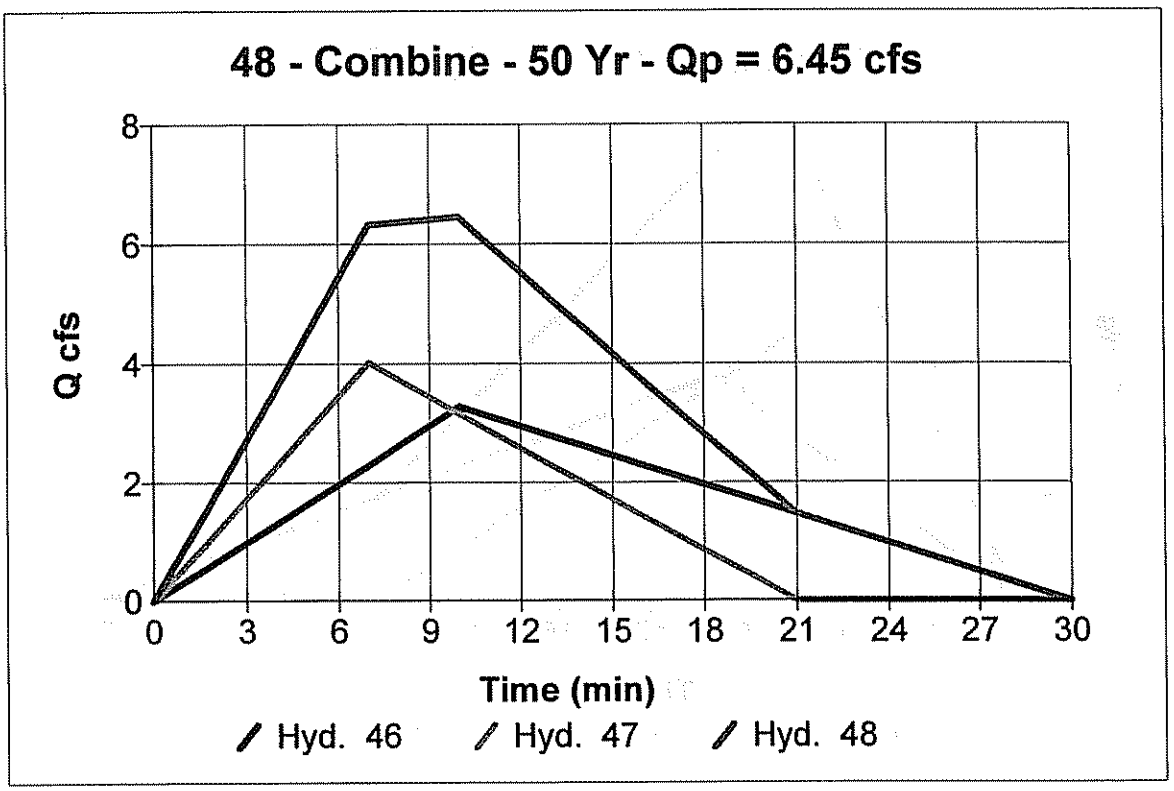
Hydraflow Hydrographs by Intelisolve

Hyd. No. 48

US CULVERT E14

Hydrograph type	= Combine	Peak discharge	= 6.45 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 46, 47		

Hydrograph Volume = 5,491 cuft



Hydrograph Plot

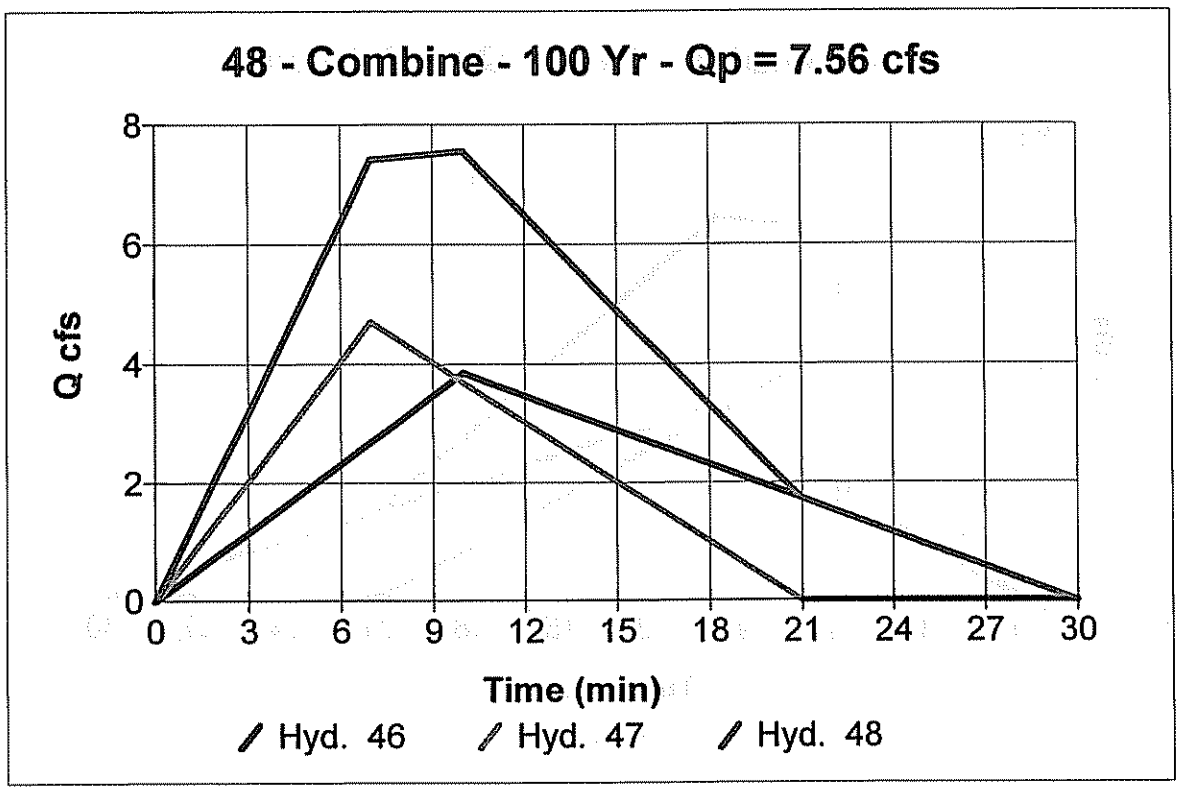
Hydraflow Hydrographs by Intelisolve

Hyd. No. 48

US CULVERT E14

Hydrograph type	= Combine	Peak discharge	= 7.56 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 46, 47		

Hydrograph Volume = 6,442 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. E14

Analysis Component			
Storm Event	Design	Discharge	6.45 cfs

Peak Discharge Method: User-Specified			
Design Discharge	6.45 cfs	Check Discharge	7.56 cfs

Tailwater properties: Rectangular Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.013
Depth	0.87 ft	Bottom Width	1.77 ft

Tailwater conditions for Design Storm.			
Discharge	6.45 cfs	Bottom Elevation	617.48 ft
Depth	0.87 ft	Velocity	4.18 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	6.45 cfs	619.14 ft	4.71 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E14

ɹmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	619.14 ft	Discharge	6.45 cfs
Inlet Control HW Elev	619.08 ft	Tailwater Elevation	618.35 ft
Outlet Control HW Elev	619.14 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.67		

Grades			
Upstream Invert	617.81 ft	Downstream Invert	617.47 ft
Length	129.00 ft	Constructed Slope	0.002636 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.90 ft
Slope Type	Mild	Normal Depth	1.06 ft
Flow Regime	Subcritical	Critical Depth	0.90 ft
Velocity Downstream	4.71 ft/s	Critical Slope	0.004690 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

ɔutlet Control Properties			
Outlet Control HW Elev	619.14 ft	Upstream Velocity Head	0.23 ft
Ke	0.20	Entrance Loss	0.05 ft

Inlet Control Properties			
Inlet Control HW Elev	619.08 ft	Flow Control	Unsubmerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft²
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E14

Analysis Component			
Storm Event	Check	Discharge	7.56 cfs

Peak Discharge Method: User-Specified			
Design Discharge	6.45 cfs	Check Discharge	7.56 cfs

Tailwater properties: Rectangular Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.013
Depth	0.98 ft	Bottom Width	1.77 ft

Tailwater conditions for Check Storm.			
Discharge	7.56 cfs	Bottom Elevation	617.48 ft
Depth	0.98 ft	Velocity	4.34 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	7.56 cfs	619.27 ft	4.85 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 623.39 ft. @
Station 103+00 (IL Rte. 178)

Greene & Bradford, Inc.
© Haestad Methods, Inc. 37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E14

ɔmponent:Culvert-1

Culvert Summary					
Computed Headwater Elevation	619.27	ft	Discharge	7.56	cfs
Inlet Control HW Elev	619.21	ft	Tailwater Elevation	618.46	ft
Outlet Control HW Elev	619.27	ft	Control Type	Outlet Control	
Headwater Depth/ Height	0.73				

Grades					
Upstream Invert	617.81	ft	Downstream Invert	617.47	ft
Length	129.00	ft	Constructed Slope	0.002636	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.99	ft
Slope Type	Mild		Normal Depth	1.18	ft
Flow Regime	Subcritical		Critical Depth	0.98	ft
Velocity Downstream	4.85	ft/s	Critical Slope	0.004828	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	619.27	ft	Upstream Velocity Head	0.25	ft
Ke	0.20		Entrance Loss	0.05	ft

Inlet Control Properties					
Inlet Control HW Elev	619.21	ft	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

GREENE & BRADFORD CONSULTING ENGINEERS

GREENE & BRADFORD, INC.
3501 Constitution Drive
Springfield, Illinois 62707
(217) 793-8844
(217) 793-6227 Fax
www.greeneandbradford.com

PROJECT NUMBER: 02317.09
DESCRIPTION: LaSalle County - Utica
CALCULATED BY: WCB DATE: 11/3/04
CHECKED BY: _____ DATE: _____
SHEET: _____ OF: _____

DRAINAGE CALCULATIONS

AREA #14

$AREA_{TOTAL} = 0.73$ acres

~~$AREA_{paved} =$~~

$C = 0.50$

Assumed $T_c = 10$ minutes.

$Q_{10} = 2.85$ cfs

$Q_{100} = 3.35$ cfs

AREA #15

$AREA_{TOTAL} = 1.47$ acres

$C = 0.80$

Assumed $T_c = 7$ minutes

$Q_{10} = 10.20$ cfs

$Q_{100} = 11.94$ cfs

AREA #14 + #15 + #16 + #17

$Q_{10} = 18.52$ cfs

$Q_{100} = 21.70$ cfs

AREA #14 + #15 + #16 + #17 + #9 + #10 + #12 + #13

$Q_{10} = 25.78$ cfs

$Q_{100} = 30.30$ cfs

Hydrograph Plot

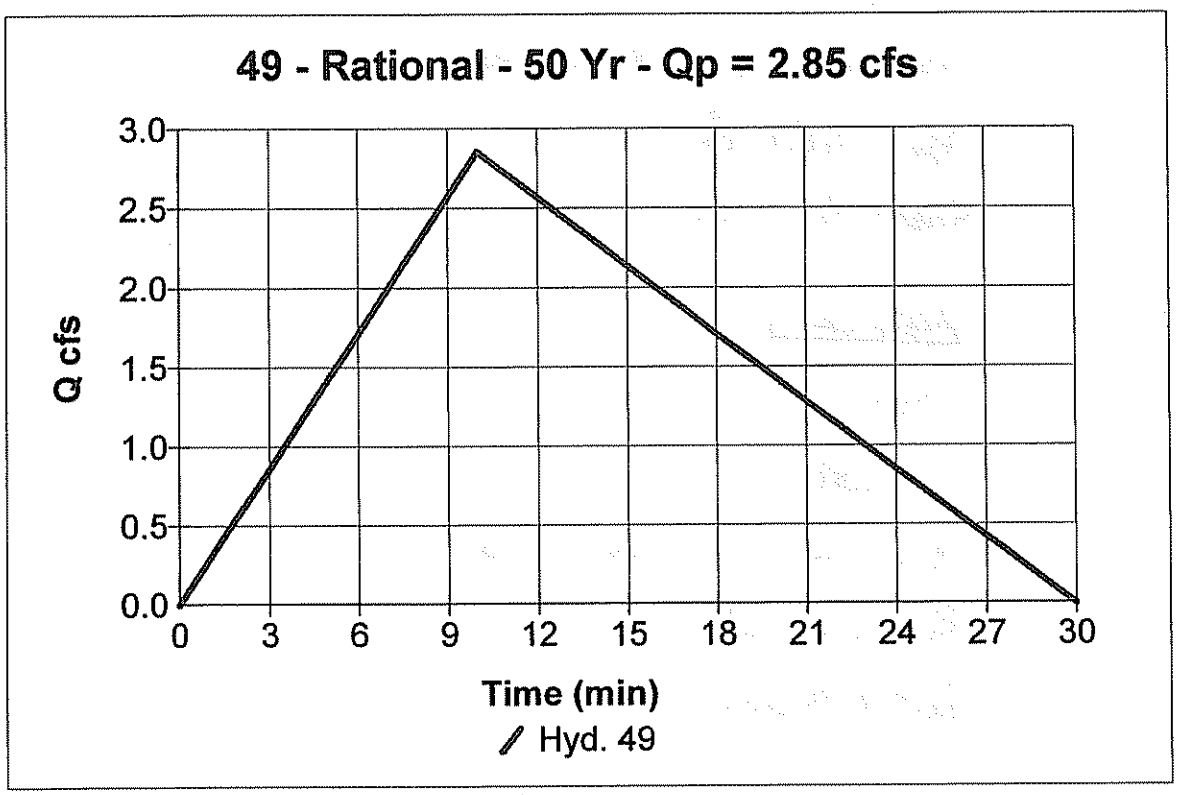
Hydraflow Hydrographs by Intelisolve

Hyd. No. 49

AREA #14

Hydrograph type	= Rational	Peak discharge	= 2.85 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 0.7 ac	Runoff coeff.	= 0.5
Intensity	= 7.819 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 2,568 cuft



Hydrograph Plot

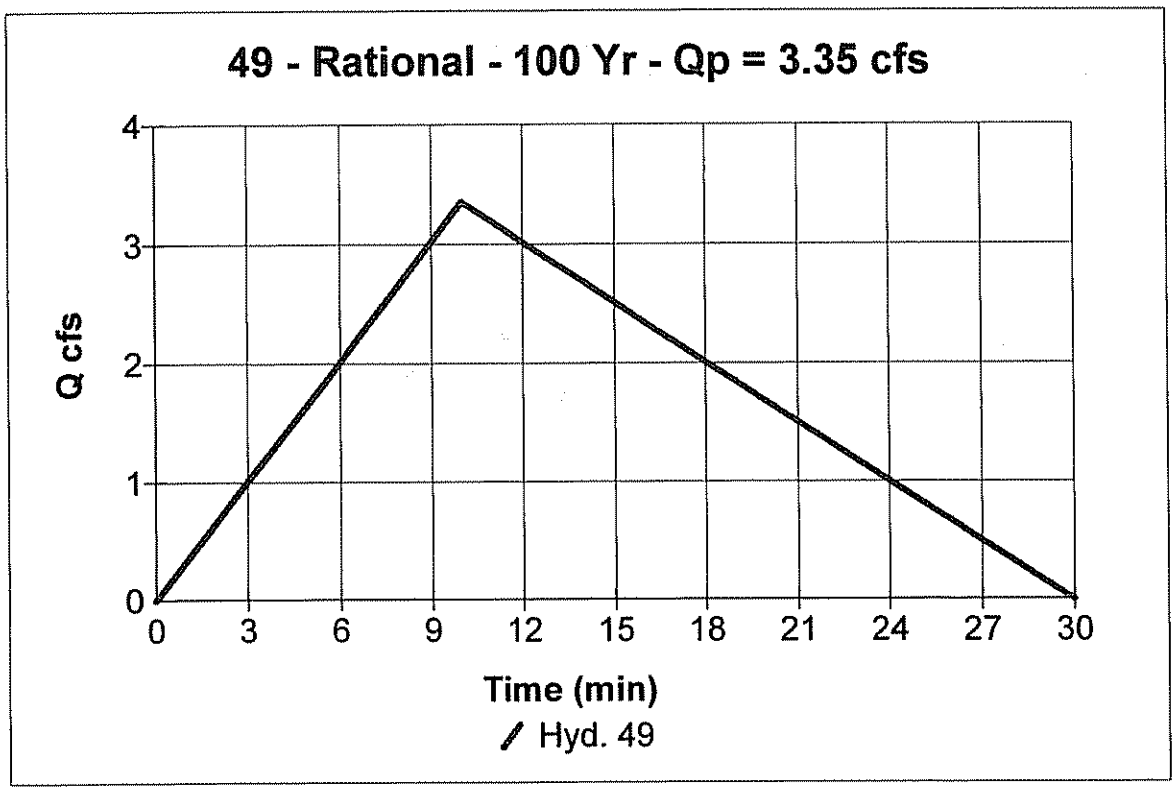
Hydraflow Hydrographs by Intelisolve

Hyd. No. 49

AREA #14

Hydrograph type	= Rational	Peak discharge	= 3.35 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.7 ac	Runoff coeff.	= 0.5
Intensity	= 9.189 in/hr	Time of conc. (Tc)	= 10 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 3,019 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. E11

Analysis Component			
Storm Event	Design	Discharge	2.85 cfs

Peak Discharge Method: User-Specified			
Design Discharge	2.85 cfs	Check Discharge	3.35 cfs

Tailwater properties: Rectangular Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.013
Depth	0.48 ft	Bottom Width	1.77 ft

Tailwater conditions for Design Storm.			
Discharge	2.85 cfs	Bottom Elevation	617.48 ft
Depth	0.48 ft	Velocity	3.33 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	2.85 cfs	619.15 ft ✓	4.82 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 622.19 ft. @
Station 101+00 (IL. Rte. 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E11

mponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	619.15 ft	Discharge	2.85 cfs
Inlet Control HW Elev	619.11 ft	Tailwater Elevation	617.96 ft
Outlet Control HW Elev	619.15 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.42		

Grades			
Upstream Invert	618.31 ft	Downstream Invert	617.48 ft
Length	88.00 ft	Constructed Slope	0.009432 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.49 ft
Slope Type	Steep	Normal Depth	0.49 ft
Flow Regime	Supercritical	Critical Depth	0.59 ft
Velocity Downstream	4.82 ft/s	Critical Slope	0.004451 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	619.15 ft	Upstream Velocity Head	0.21 ft
Ke	0.20	Entrance Loss	0.04 ft

Inlet Control Properties			
Inlet Control HW Elev	619.11 ft	Flow Control	Unsubmerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E11

Analysis Component			
Storm Event	Check	Discharge	3.35 cfs

Peak Discharge Method: User-Specified			
Design Discharge	2.85 cfs	Check Discharge	3.35 cfs

Tailwater properties: Rectangular Channel			
Slope	0.004000 ft/ft	Mannings Coefficient	0.013
Depth	0.54 ft	Bottom Width	1.77 ft

Tailwater conditions for Check Storm.			
Discharge	3.35 cfs	Bottom Elevation	617.48 ft
Depth	0.54 ft	Velocity	3.49 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	3.35 cfs	619.23 ft	5.05 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E11

ɔmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	619.23 ft	Discharge	3.35 cfs
Inlet Control HW Elev	619.18 ft	Tailwater Elevation	618.02 ft
Outlet Control HW Elev	619.23 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.46		

Grades			
Upstream Invert	618.31 ft	Downstream Invert	617.48 ft
Length	88.00 ft	Constructed Slope	0.009432 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.53 ft
Slope Type	Steep	Normal Depth	0.53 ft
Flow Regime	Supercritical	Critical Depth	0.64 ft
Velocity Downstream	5.05 ft/s	Critical Slope	0.004460 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	619.23 ft	Upstream Velocity Head	0.23 ft
Ke	0.20	Entrance Loss	0.05 ft

Inlet Control Properties			
Inlet Control HW Elev	619.18 ft	Flow Control	Unsubmerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft²
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Hydrograph Plot

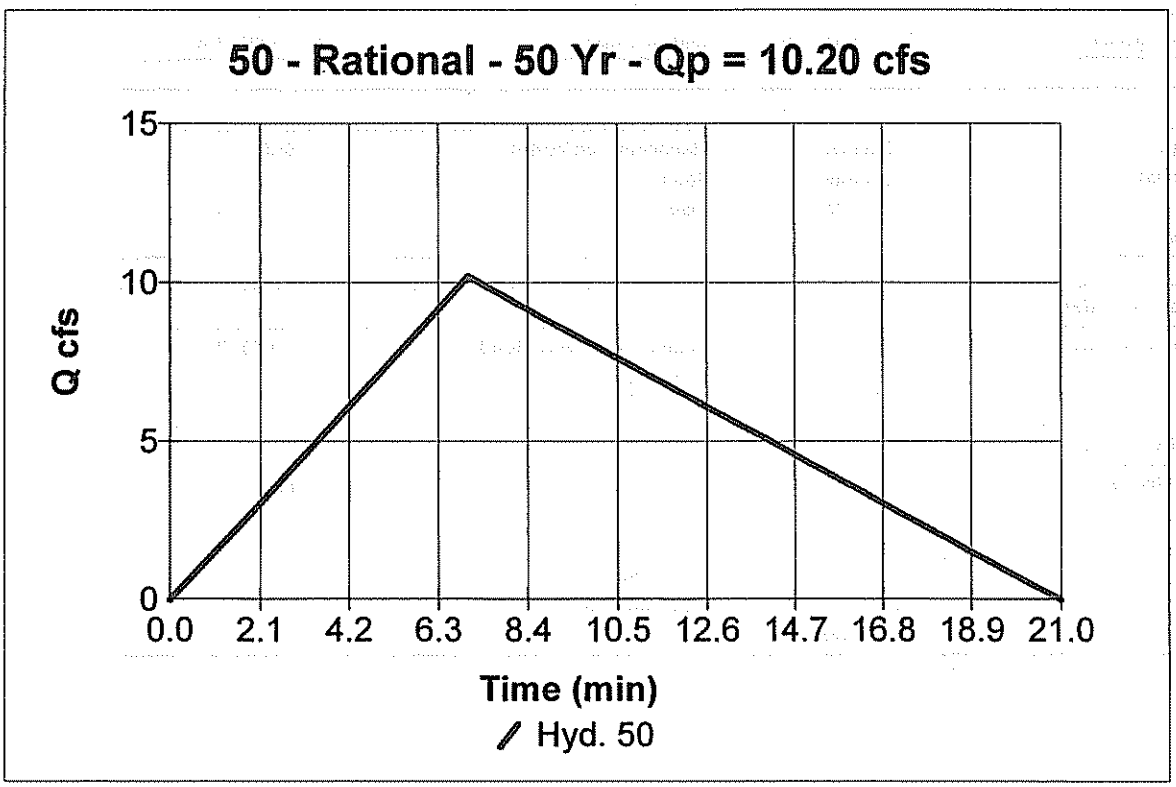
Hydraflow Hydrographs by Intelisolve

Hyd. No. 50

AREA #15

Hydrograph type	= Rational	Peak discharge	= 10.20 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Drainage area	= 1.5 ac	Runoff coeff.	= 0.8
Intensity	= 8.672 in/hr	Time of conc. (Tc)	= 7 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 6,425 cuft



Hydrograph Plot

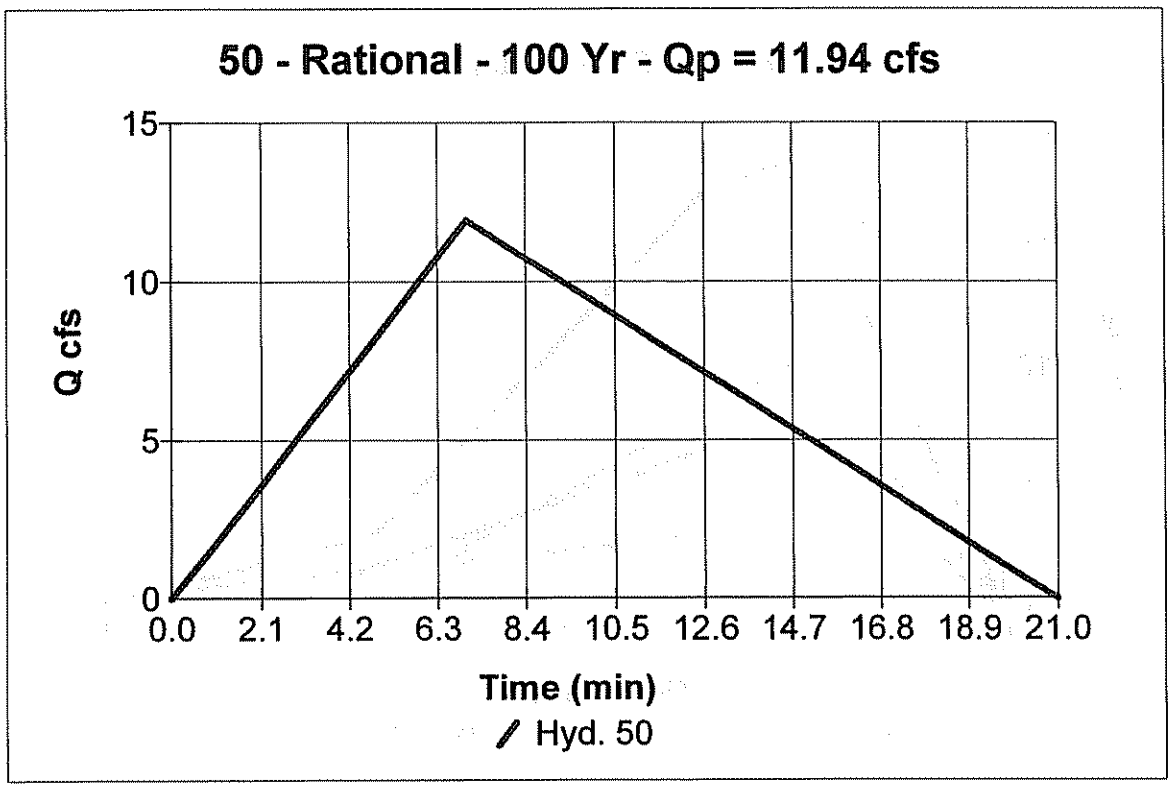
Hydraflow Hydrographs by Intelisolve

Hyd. No. 50

AREA #15

Hydrograph type	= Rational	Peak discharge	= 11.94 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.5 ac	Runoff coeff.	= 0.8
Intensity	= 10.154 in/hr	Time of conc. (Tc)	= 7 min
IDF Curve	= Northeast.idf	Asc/Rec limb fact	= 1/2

Hydrograph Volume = 7,523 cuft



Hydrograph Plot

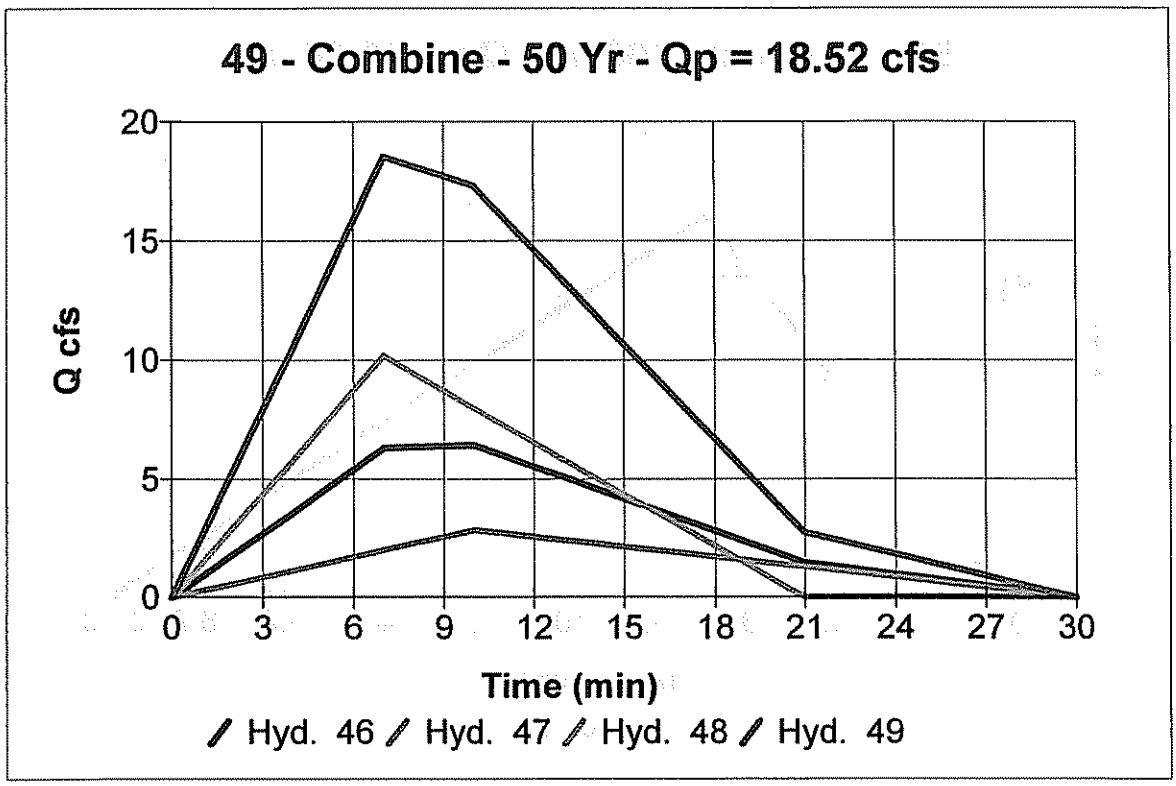
Hydraflow Hydrographs by Intelisolve

Hyd. No. 49

CULVERT E12

Hydrograph type	= Combine	Peak discharge	= 18.52 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 46, 47, 48		

Hydrograph Volume = 14,484 cuft



Hydrograph Plot

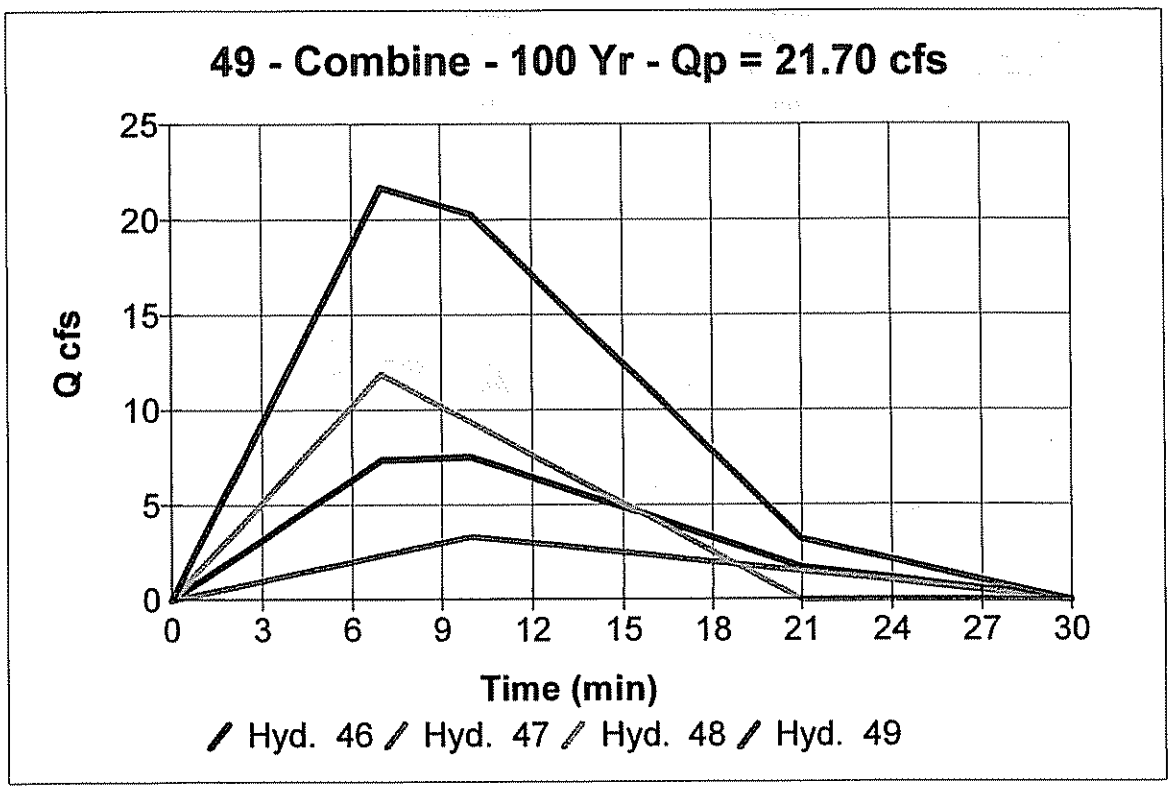
Hydraflow Hydrographs by Intelisolve

Hyd. No. 49

CULVERT E12

Hydrograph type	= Combine	Peak discharge	= 21.70 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 46, 47, 48		

Hydrograph Volume = 16,983 cuft



Culvert Designer/Analyzer Report
PIPE CULVERT NO. E12

Analysis Component			
Storm Event	Check	Discharge	21.70 cfs

Peak Discharge Method: User-Specified			
Design Discharge	18.52 cfs	Check Discharge	21.70 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	1.32 ft	Left Side Slope	4 H : V
Right Side Slope	4 H : V	Bottom Width	4.00 ft

Tailwater conditions for Check Storm.			
Discharge	21.70 cfs	Bottom Elevation	617.15 ft
Depth	1.32 ft	Velocity	1.77 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	21.70 cfs	620.63 ft	7.76 ft/s
Weir	Not Considered	N/A	N/A	N/A

Low Point Elevation 622.93 ft.
@ Station 102+50 (Il. Rte. 178)

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E12

›mponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	620.63 ft	Discharge	21.70 cfs
Inlet Control HW Elev	620.34 ft	Tailwater Elevation	618.47 ft
Outlet Control HW Elev	620.63 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.58		

Grades			
Upstream Invert	617.47 ft	Downstream Invert	617.15 ft
Length	82.00 ft	Constructed Slope	0.003902 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.67 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.67 ft
Velocity Downstream	7.76 ft/s	Critical Slope	0.008953 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	620.63 ft	Upstream Velocity Head	0.74 ft
Ke	0.20	Entrance Loss	0.15 ft

Inlet Control Properties			
Inlet Control HW Elev	620.34 ft	Flow Control	Submerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E12

Analysis Component			
Storm Event	Design	Discharge	18.52 cfs

Peak Discharge Method: User-Specified			
Design Discharge	18.52 cfs	Check Discharge	21.70 cfs

Tailwater properties: Trapezoidal Channel			
Slope	0.004600 ft/ft	Mannings Coefficient	0.050
Depth	1.23 ft	Left Side Slope	4 H : V
Right Side Slope	4 H : V	Bottom Width	4.00 ft

Tailwater conditions for Design Storm.			
Discharge	18.52 cfs	Bottom Elevation	617.15 ft
Depth	1.23 ft	Velocity	1.70 ft/s

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	18.52 cfs	620.08 ft	7.09 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
PIPE CULVERT NO. E12

ɔmponent:Culvert-1

Culvert Summary			
Computed Headwater Elevation	620.08 ft	Discharge	18.52 cfs
Inlet Control HW Elev	619.96 ft	Tailwater Elevation	618.38 ft
Outlet Control HW Elev	620.08 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.31		

Grades			
Upstream Invert	617.47 ft	Downstream Invert	617.15 ft
Length	82.00 ft	Constructed Slope	0.003902 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.55 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.55 ft
Velocity Downstream	7.09 ft/s	Critical Slope	0.007495 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	620.08 ft	Upstream Velocity Head	0.55 ft
Ke	0.20	Entrance Loss	0.11 ft

Inlet Control Properties			
Inlet Control HW Elev	619.96 ft	Flow Control	Submerged
Inlet Type	Groove end w/headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	2
C	0.02920	Equation Form	1
Y	0.74000		

Hydrograph Plot

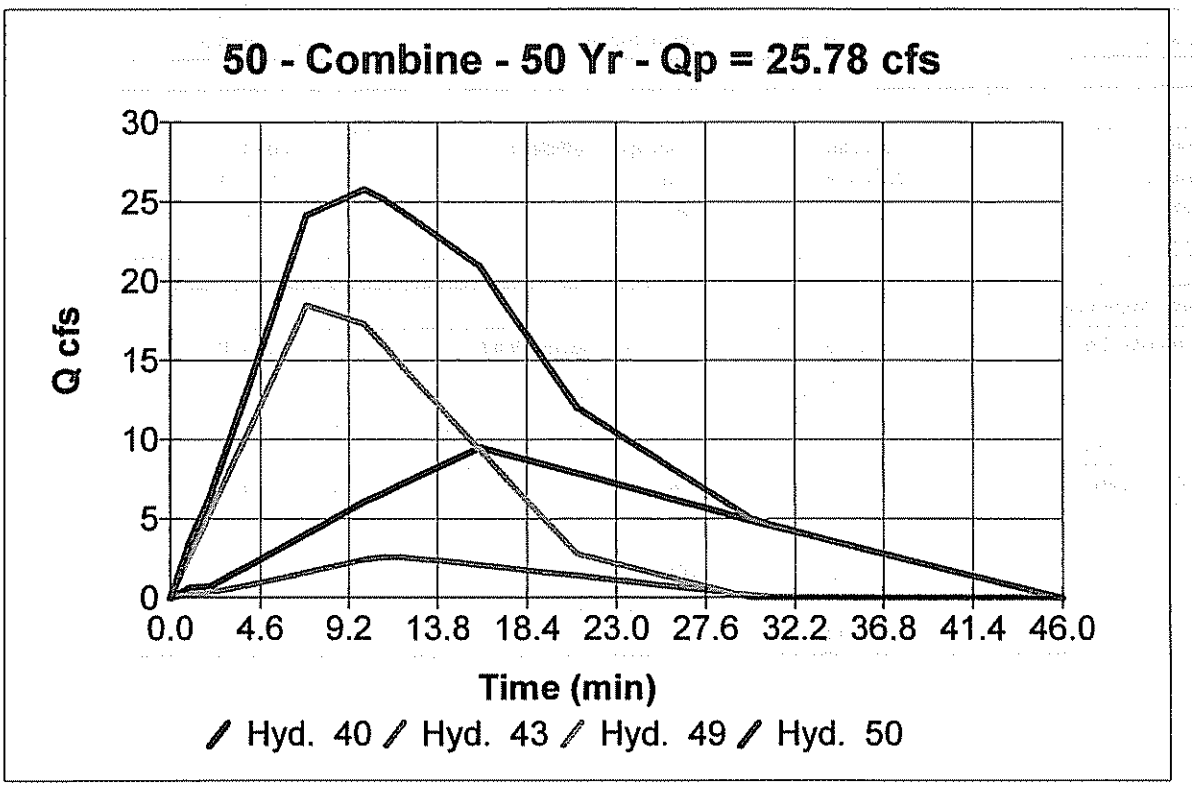
Hydraflow Hydrographs by Intelisolve

Hyd. No. 50

DS CULVERT E12

Hydrograph type	= Combine	Peak discharge	= 25.78 cfs
Storm frequency	= 50 yrs	Time interval	= 1 min
Inflow hyds.	= 40, 43, 49		

Hydrograph Volume = 29,841 cuft



Hydrograph Plot

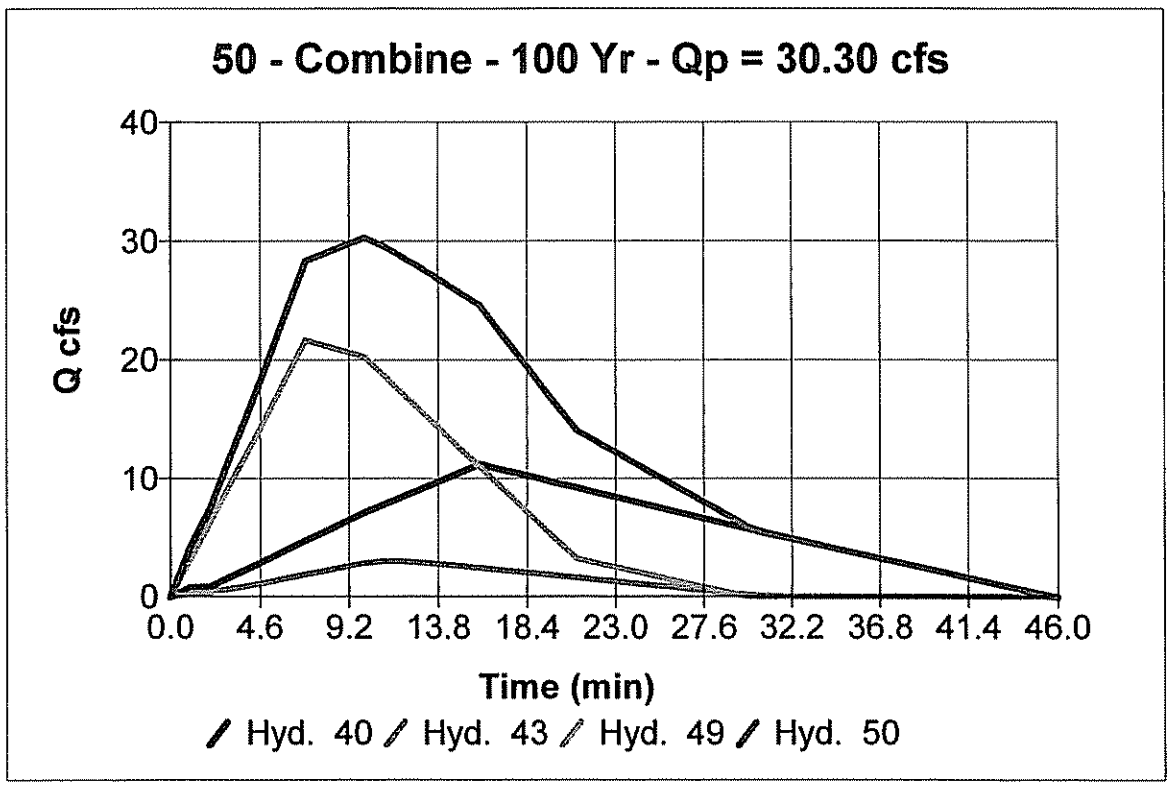
Hydraflow Hydrographs by Intelisolve

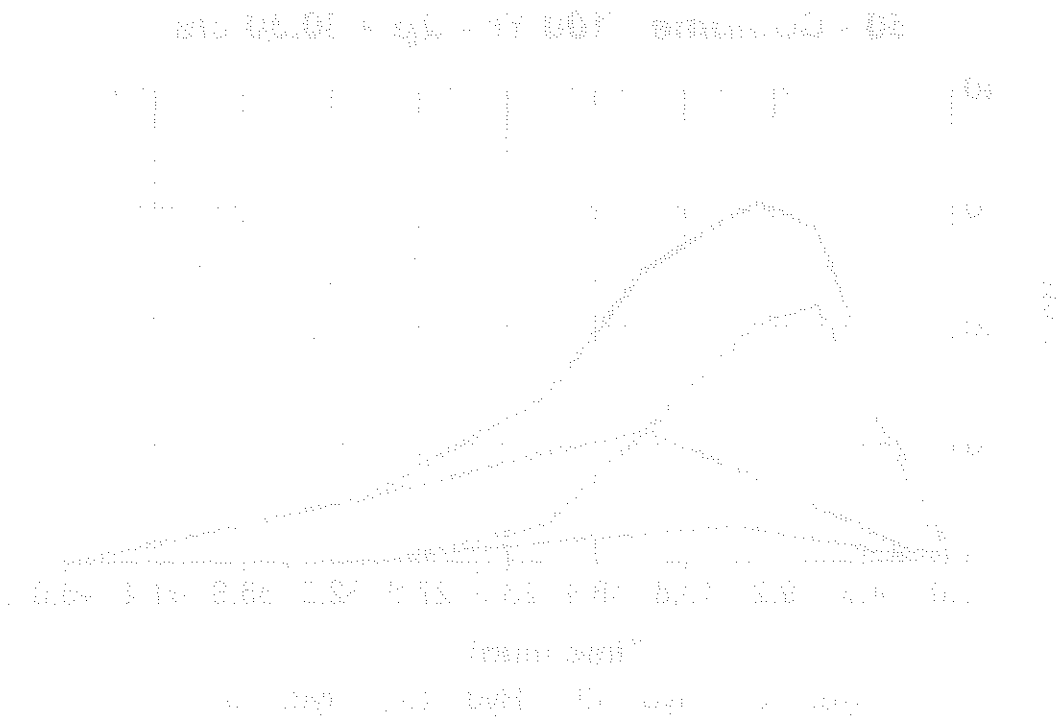
Hyd. No. 50

DS CULVERT E12

Hydrograph type	= Combine	Peak discharge	= 30.30 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 40, 43, 49		

Hydrograph Volume = 35,064 cuft





SECTION 2

ROADSIDE DITCH CAPACITY & ROADSIDE DITCH LINING ANALYSIS

Roadside Ditch Capacity Analysis

All ditches were checked based on a 50 year design frequency. The maximum allowable flow depth will be six inches below the proposed edge of shoulder.

The drainage areas were determined using USGS Quadrangle Maps and our survey data. The rational method was used to determine the flowrates for all drainage areas.

The runoff coefficient, C, was determined from pictures and a video tape taken just after we began this project in 1999. We utilized several charts and graphs (See Section 6) and Flow Master (A software created by Haestad Methods) to determine the 50 year flowrate.

The drainage areas were determined using contours created from survey data. The rational method was used to determine the flowrates for all drainage areas. The run-off coefficient, C, was determined from a field site visit in the summer of 2003.

We utilized several charts and graphs (See Section 3) and Flow Master Sheets to determine the time of concentration, Tc. The drainage areas, run-off coefficient and time of concentration was input into a program called Hydraflow Hydrographs 2002 to determine the 50 year flowrate. Flow Master was used to calculate the flow depth and velocity for a particular section with a given discharge.

Roadside Ditch Lining Analysis

All roadside ditch lining was based on a 50 year design frequency which is larger than the IDOT required 10 year frequency.

Two soil borings were taken near the bridge at Sta. 995+96. The soil borings indicated the existing soil at the surface was a silty loam. Table 9-503a shows that if the ditch velocity is less than 2.5 fps, no protection is required; if the ditch velocity is between 2.5 fps and 6.0 fps, then a ditch lining is required until the grass has grown; and if the ditch velocity is greater than 6.0 fps, riprap should be placed in the bottom of the ditch.

Using these guidelines, it was determined that no additional protection will be required other than seeding the exposed slopes.

ROADSIDE DITCH HYDRAULICS INFORMATION						
DITCH SECTION LOCATION	DRAINAGE AREA (acres)	DESIGN DISCHARGE 50 YEAR cfs	W.S. EL ft.	TOP BANK ELEV. or edge of shoulder	EDGE OF SHOULDER ft.	VELOCITY ft./sec.
Sta. 898+49.50, 376.43' Lt. (U.S. Pipe Culvert No. 1)	4.96	13.28	618.94	624.13	none	1.75
Sta. 896+99.89, 13.98' Rt. (U.S. Pipe Culvert No. 2)	1.97	6.65	621.99	624.46	624.46	0.99
Sta. 897+00, 62.66' Rt. (D.S. Pipe Culvert No. 2)	7.52	16.94	621.97	624.46	none	1.52
Sta. 896+99, 62.66' Rt. (D.S. Pipe Culvert No. 2)	9.46	21.10	622.09	624.46	none	1.63
Sta. 896+38.56, 73.49' Rt. (U.S. Pipe Culvert No. 3)	9.46	21.10	621.98	624.3	none	1.63
Sta. 895+32.24, 72.61' Rt. (D.S. Pipe Culvert No. 3)	9.46	21.10	621.49	624.00	none	1.63
Sta. 887+83.63, 100.79' Rt. (U.S. Pipe Culvert No. 4)	15.98	28.29	619.03	622.48	622.10	1.75
Sta. 887+65, 141' Rt. (D.S. Pipe Culvert No. 4)	31.16	60.52	620.05	620.74	620.91	1.50
Sta. 883+0, 10.75' Rt. (U.S. Pipe Culvert No. 5)	2.16	7.35	617.65	621.65	621.65	1.29
Sta. 883+01, 81.57' Rt. (D.S. Pipe Culvert No. 5)	37.72	57.32	618.19	621.31	618.72	1.43
Sta. 882+99, 81.57' Rt. (D.S. Pipe Culvert No. 5)	39.88	64.67	618.29	621.31	618.72	1.49
Sta. 872+00, 10.82' Rt. (U.S. Pipe Culvert No. 6)	1.86	7.12	609.80	613.38	613.38	1.61
Sta. 872+01, 66.12' Rt. (D.S. Pipe Culvert No. 6)	42.45	46.65	610.05	613.50	611.66	4.00
Sta. 871+99, 66.12' Rt. (D.S. Pipe Culvert No. 6)	44.31	53.77	610.1	613.50	611.66	4.13
Sta. 896+40.05, 71.89' Lt. (U.S. Pipe Culvert No. 7)	1.81	4.00	621.25	624.13	none	1.19
Sta. 895+34.97, 73.44' Lt. (D.S. Pipe Culvert No. 7)	1.81	4.00	620.83	623.85	none	1.19
Sta. 887+25.27, 78.66' Lt. (U.S. Pipe Culvert No. 8)	10.85	18.45	619.85	622.53	623.26	1.20
Sta. 887+10, 116' Lt. (D.S. Pipe Culvert No. 8)	19.66	39.79	619.55	621.55	621.92	2.90

US PIPE CULVERT NO. E1
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.006800	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	13.28	ft^3/s

Results		
Depth	0.93	ft
Flow Area	7.59	ft^2
Wetted Perimeter	12.58	ft
Top Width	12.35	ft
Critical Depth	0.56	ft
Critical Slope	0.050215	ft/ft
Velocity	1.75	ft/s
Velocity Head	0.05	ft
Specific Energy	0.98	ft
Froude Number	0.39	
Flow is subcritical.		

US PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.002400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	6.65	ft^3/s

Results		
Depth	0.98	ft
Flow Area	6.71	ft^2
Wetted Perimeter	11.95	ft
Top Width	11.76	ft
Critical Depth	0.48	ft
Critical Slope	0.054831	ft/ft
Velocity	0.99	ft/s
Velocity Head	0.02	ft
Specific Energy	0.99	ft
Froude Number	0.23	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	16.94	ft^3/s

Results		
Depth	1.18	ft
Flow Area	11.03	ft^2
Wetted Perimeter	14.94	ft
Top Width	14.65	ft
Critical Depth	0.64	ft
Critical Slope	0.048450	ft/ft
Velocity	1.54	ft/s
Velocity Head	0.04	ft
Specific Energy	1.22	ft
Froude Number	0.31	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	16.94	ft^3/s

Results		
Depth	1.18	ft
Flow Area	11.03	ft^2
Wetted Perimeter	14.94	ft
Top Width	14.65	ft
Critical Depth	0.64	ft
Critical Slope	0.048450	ft/ft
Velocity	1.54	ft/s
Velocity Head	0.04	ft
Specific Energy	1.22	ft
Froude Number	0.31	
Flow is subcritical.		

DS DITCH @ DS PIPE CULVERT NO. E2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	21.10	ft^3/s

Results		
Depth	1.31	ft
Flow Area	12.97	ft^2
Wetted Perimeter	16.12	ft
Top Width	15.80	ft
Critical Depth	0.72	ft
Critical Slope	0.046934	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.35	ft
Froude Number	0.32	
Flow is subcritical.		

US PIPE CULVERT NO. E3
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E3
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	21.10	ft^3/s

Results		
Depth	1.31	ft
Flow Area	12.97	ft^2
Wetted Perimeter	16.12	ft
Top Width	15.80	ft
Critical Depth	0.72	ft
Critical Slope	0.046934	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.35	ft
Froude Number	0.32	
Flow is subcritical.		

US PIPE CULVERT NO. 2
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	21.10	ft^3/s

Results		
Depth	1.31	ft
Flow Area	12.97	ft^2
Wetted Perimeter	16.12	ft
Top Width	15.80	ft
Critical Depth	0.72	ft
Critical Slope	0.046934	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.35	ft
Froude Number	0.32	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.001400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	57.27	ft^3/s

Results		
Depth	2.58	ft
Flow Area	40.28	ft^2
Wetted Perimeter	27.85	ft
Top Width	27.22	ft
Critical Depth	1.22	ft
Critical Slope	0.040801	ft/ft
Velocity	1.42	ft/s
Velocity Head	0.03	ft
Specific Energy	2.61	ft
Froude Number	0.21	
Flow is subcritical.		

US PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.004600	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	7.35	ft^3/s

Results		
Depth	0.88	ft
Flow Area	5.67	ft^2
Wetted Perimeter	11.01	ft
Top Width	10.84	ft
Critical Depth	0.50	ft
Critical Slope	0.054067	ft/ft
Velocity	1.30	ft/s
Velocity Head	0.03	ft
Specific Energy	0.91	ft
Froude Number	0.32	
Flow is subcritical.		

DS DITCH @ DS PIPE CULVERT NO. E5
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.001400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	64.67	ft^3/s

Results		
Depth	2.72	ft
Flow Area	44.10	ft^2
Wetted Perimeter	29.12	ft
Top Width	28.46	ft
Critical Depth	1.29	ft
Critical Slope	0.040128	ft/ft
Velocity	1.47	ft/s
Velocity Head	0.03	ft
Specific Energy	2.75	ft
Froude Number	0.21	
Flow is subcritical.		

US DITCH @ DS PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US Ditch @ DS PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.006200	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	64.67	ft^3/s

Results		
Depth	1.97	ft
Flow Area	25.32	ft^2
Wetted Perimeter	22.20	ft
Top Width	21.72	ft
Critical Depth	1.29	ft
Critical Slope	0.040126	ft/ft
Velocity	2.55	ft/s
Velocity Head	0.10	ft
Specific Energy	2.07	ft
Froude Number	0.42	
Flow is subcritical.		

US PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.008400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	7.12	ft^3/s

Results		
Depth	0.76	ft
Flow Area	4.43	ft^2
Wetted Perimeter	9.77	ft
Top Width	9.62	ft
Critical Depth	0.50	ft
Critical Slope	0.054311	ft/ft
Velocity	1.61	ft/s
Velocity Head	0.04	ft
Specific Energy	0.80	ft
Froude Number	0.42	
Flow is subcritical.		

DS Ditch @ DS PIPE CULVERT NO. E6
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DS Ditch @ DS PIPE CULVERT NO. E6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.008400	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	2.00	ft
Discharge	53.77	ft^3/s

Results		
Depth	1.81	ft
Flow Area	20.03	ft^2
Wetted Perimeter	20.47	ft
Top Width	20.12	ft
Critical Depth	1.30	ft
Critical Slope	0.041264	ft/ft
Velocity	2.68	ft/s
Velocity Head	0.11	ft
Specific Energy	1.92	ft
Froude Number	0.47	
Flow is subcritical.		

US PIPE CULVERT NO. E7
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. E7
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.005800	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	4.00	ft^3/s

Results		
Depth	0.53	ft
Flow Area	3.37	ft^2
Wetted Perimeter	8.89	ft
Top Width	8.76	ft
Critical Depth	0.28	ft
Critical Slope	0.060587	ft/ft
Velocity	1.19	ft/s
Velocity Head	0.02	ft
Specific Energy	0.55	ft
Froude Number	0.34	
Flow is subcritical.		

US PIPE CULVERT NO. 4
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 4
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.002100	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	18.45	ft^3/s

Results		
Depth	1.43	ft
Flow Area	14.91	ft^2
Wetted Perimeter	17.21	ft
Top Width	16.86	ft
Critical Depth	0.67	ft
Critical Slope	0.047851	ft/ft
Velocity	1.24	ft/s
Velocity Head	0.02	ft
Specific Energy	1.45	ft
Froude Number	0.23	
Flow is subcritical.		

DITCH SECTION
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	DITCH SECTION
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.011400	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	39.79	ft^3/s

Results		
Depth	1.38	ft
Flow Area	14.08	ft^2
Wetted Perimeter	16.75	ft
Top Width	16.41	ft
Critical Depth	1.01	ft
Critical Slope	0.042909	ft/ft
Velocity	2.83	ft/s
Velocity Head	0.12	ft
Specific Energy	1.50	ft
Froude Number	0.54	
Flow is subcritical.		

US PIPE CULVERT NO. 7
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 7
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.005800	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	3.99	ft^3/s

Results		
Depth	0.53	ft
Flow Area	3.37	ft^2
Wetted Perimeter	8.88	ft
Top Width	8.75	ft
Critical Depth	0.28	ft
Critical Slope	0.060612	ft/ft
Velocity	1.19	ft/s
Velocity Head	0.02	ft
Specific Energy	0.55	ft
Froude Number	0.34	
Flow is subcritical.		

US PIPE CULVERT NO. 8
Worksheet for Trapezoidal Channel

Project Description	
Project File	j:\02317\calcs\project1.fm2
Worksheet	US PIPE CULVERT NO. 8
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.050	
Channel Slope	0.002100	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	4.00	ft
Discharge	13.18	ft^3/s

Results		
Depth	1.22	ft
Flow Area	11.63	ft^2
Wetted Perimeter	15.31	ft
Top Width	15.01	ft
Critical Depth	0.56	ft
Critical Slope	0.050271	ft/ft
Velocity	1.13	ft/s
Velocity Head	0.02	ft
Specific Energy	1.24	ft
Froude Number	0.23	
Flow is subcritical.		

SECTION 3

CHARTS AND GRAPHS

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 5/21/92

ROUTE FAI 80 DESCRIPTION CC IPTION COUNTY HIGHWAY 43 (UTICA ROAD) OVER FAI 80 LOGGED BY L.M.

SECTION 50-2HB-6 LOCATION LOCATION NW 14, SEC. 6, TWP. 33N, RNG. 2E, 3rd PM

COUNTY LASALLE DRILLING METHOD ETHOD Hollow Stem Auger HAMMER TYPE Automatic

STRUCT. NO. 050-0084 EXISTING
Station 695+00.16

BORING NO. 2 SOUTH ABUT.
Station 695+68.16
Offset 110.00ft RT
Ground Surface Elev. 644.71 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter ft
Upon Completion ft
After Hrs. ft

Description	Elev.	Depth (ft)	Blows (6")	UCS Qu (tsf)	Blows (6")	UCS Qu (tsf)	MOIST (%)
AUGERED BITUMINOUS CONCRETE OVER CONCRETE SLAB OVER SAND							
	642.71						
Loose Brown SAND (FILL)			2				
			3	-	2		
			2	-	3	1.3	31.0
					4	B	
		-5	3				
			4	-	2		
			4	-	2	2.0	31.0
					3		19.0
	637.71						
Stiff Mix o GRAY SILTY CLAY TILL; Black SILTY CLAY LOAM & Greenish Gray SILTY CLAY (FILL)			3				
			6	1.5	3		
			7	P	7	4.0	18.0
					8	P	
	635.71						
Stiff Brown SILTY CLAY TILL							
		-10	4				
			4	1.7	5		
			4	B	7	4.5	17.0
					8	B	
	633.21						
Stiff Mix of Brown SILTY CLAY LOAM TILL & Black SILTY CLAY LOAM			3				
			4	1.5	3		
			5	B	8	4.0	14.0
					10	B	
	630.71						
Stiff Brown SILTY CLAY TILL (FILL)							
		-15	2				
			4	1.0	12		
			5	B	22	3.5	10.0
					20	B	
			4				
			9	1.0	12		
			7	P	19	-	6.0
					25	-	
		-20					

Description	Elev.	Depth (ft)	Blows (6")	UCS Qu (tsf)	MOIST (%)
Dense Brown Well graded Medium SAND (continued)			7		
			13	-	6.0
			21	-	
	600.15				
Brown Coarse SAND & GRAVEL			9		
			15	-	6.0
			17	-	
		-25			
			7		
			14	-	6.0
			15	-	
			10		
			9	-	8.0
			13	-	
	593.15	-30			
Dark Brown Fractured LIMESTONE			150		6.0
	592.15		63		6.0
TOP OF ST. PETER SANDSTONE	591.65		100		5.0
End of Boring					
		-35			
		-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 6-89)

nent
on

SOIL BORING LOG

ion
ESCRIPTION COUNTY HIGHWAY 43(UTICA ROAD) OVER FAI 80

Date 3/1/02

LOGGED BY K.W.

LOCATION NW 14, SEC. 5, TWP. 33N, RNG. 2E, 3rd PM

S METHOD Hollow Stem Auger HAMMER TYPE Automatic

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	8		
	19	–	4.0
	27	–	
	15		
	20	–	5.0
	33	–	
-45			
	15		
	18	–	4.0
	23	–	
	11		
	16	–	2.0
	20	–	
-50			
	11		
	11	–	5.0
	12	–	
	12		
	18	–	5.0
	100	–	
-55			
	130/ .75"	–	–
		–	
	100/.5"		
-60			

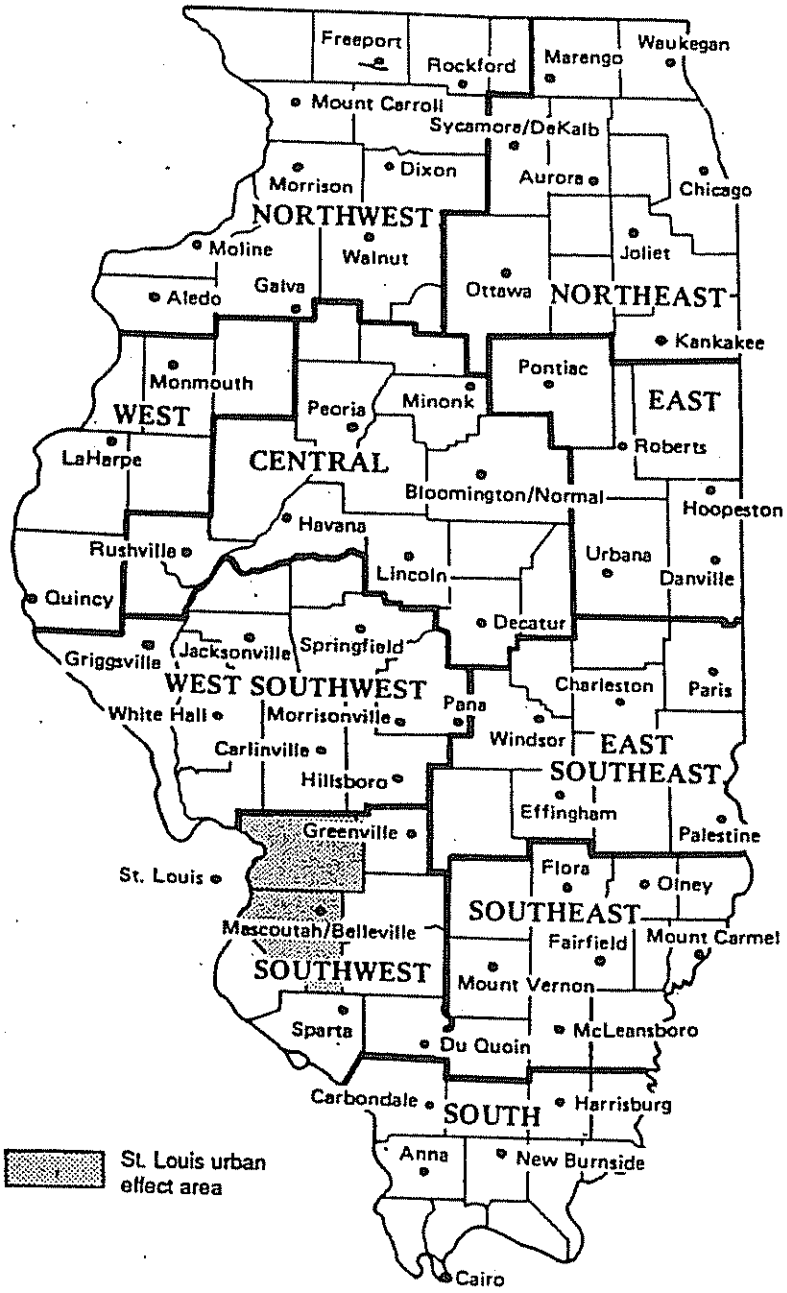
Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encountar ft
Upon Completion ft
After Hrs. ft

UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
ut two blow values in each sampling zone (AASHTO T206)

BBE, from 137 (Rev. 8-99)

BULLETIN 70 SECTION MAP



Precipitation-reporting stations and climatic sections used in developing Illinois frequency relations

Figure 4-202a
Page 1

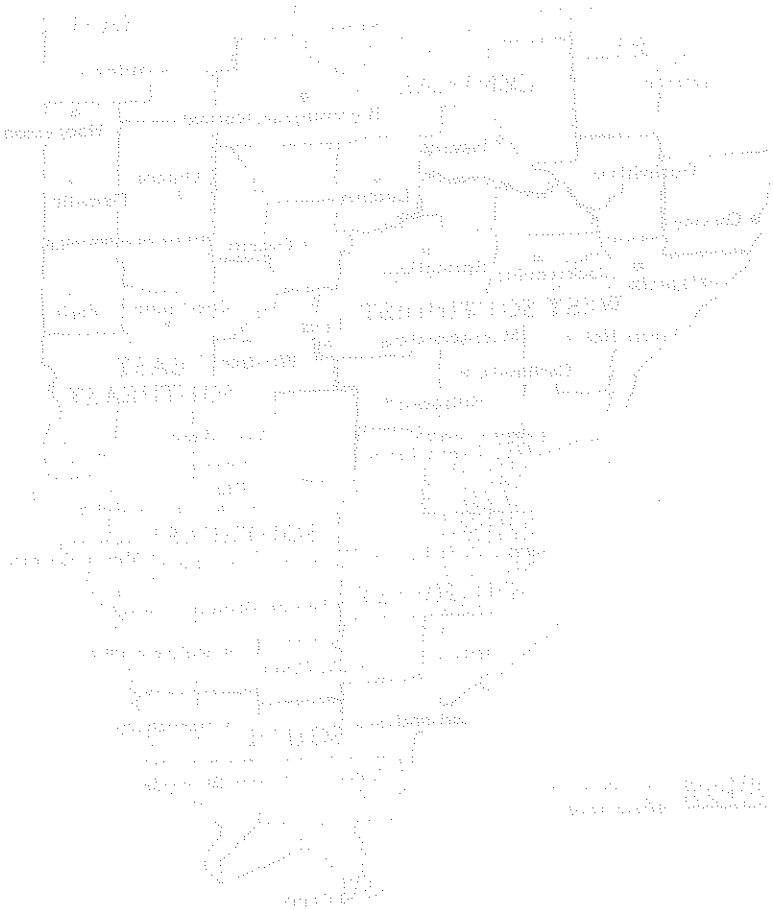


Table 1. Sectional Frequency Distributions for Storm Periods of 5 Minutes to 10 Days and Recurrence Intervals of 2 Months to 100 Years

Storm codes

1 – 10 days
2 – 5 days
3 – 72 hours
4 – 48 hours
5 – 24 hours
6 – 18 hours
7 – 12 hours
8 – 6 hours
9 – 3 hours
10 – 2 hours
11 – 1 hour
12 – 30 minutes
13 – 15 minutes
14 – 10 minutes
15 – 5 minutes

Sectional (zone) codes

1 – Northwest
2 – Northeast
3 – West
4 – Central
5 – East
6 – West Southwest
7 – East Southeast
8 – Southwest
9 – Southeast
10 – South

Rainfall (inches) for given recurrence interval

Storm code	*Zone code*	*2-month*	*3-month*	*4-month*	*6-month*	*9-month*	*1-year*	*2-year*	*5-year*	*10-year*	*25-year*	*50-year*	*100-year*
1	1	2.14	2.60	2.97	3.50	4.02	4.37	5.23	6.30	7.14	8.39	9.64	11.09
1	2	2.02	2.48	2.80	3.30	3.79	4.12	4.95	6.04	6.89	8.18	9.38	11.14
1	3	2.27	2.78	3.13	3.68	4.23	4.60	5.60	6.91	7.89	9.24	10.36	11.90
1	4	2.10	2.58	2.92	3.43	3.93	4.29	5.12	6.27	7.10	8.19	9.10	10.18
1	5	2.13	2.62	2.96	3.48	4.00	4.35	5.15	6.21	6.97	8.04	8.90	9.92
1	6	2.16	2.65	2.99	3.52	4.05	4.40	5.35	6.62	7.45	8.66	9.79	11.26
1	7	2.30	2.80	3.16	3.70	4.27	4.64	5.58	6.80	7.61	8.66	9.70	10.87
1	8	2.22	2.74	3.09	3.63	4.18	4.54	5.54	6.80	7.80	9.20	10.44	11.81
1	9	2.30	2.88	3.23	3.80	4.33	4.75	5.74	7.09	8.07	9.54	10.68	11.79
1	10	2.55	3.15	3.58	4.21	4.84	5.26	6.36	7.81	8.90	10.34	11.36	12.50
2	1	1.76	2.12	2.38	2.76	3.17	3.45	4.13	5.10	5.91	7.21	8.36	9.97
2	2	1.66	1.98	2.24	2.60	2.99	3.25	3.93	4.91	5.70	6.93	8.04	9.96
2	3	1.92	2.30	2.56	2.97	3.41	3.71	4.57	5.80	6.65	7.90	8.95	10.50
2	4	1.77	2.12	2.37	2.78	3.20	3.48	4.17	5.11	5.84	6.96	7.98	9.21
2	5	1.75	2.10	2.37	2.75	3.15	3.42	4.12	4.96	5.67	6.76	7.65	8.78
2	6	1.77	2.13	2.39	2.78	3.19	3.47	4.19	5.32	6.20	7.44	8.53	9.93
2	7	1.85	2.22	2.50	2.90	3.31	3.63	4.34	5.33	6.11	7.28	8.37	9.65
2	8	1.85	2.21	2.49	2.90	3.31	3.62	4.40	5.46	6.34	7.68	8.88	10.68
2	9	1.90	2.29	2.59	3.00	3.45	3.75	4.48	5.57	6.50	7.91	9.16	10.57
2	10	2.09	2.52	2.83	3.29	3.77	4.10	4.99	6.20	7.21	8.45	9.45	10.82
3	1	1.58	1.90	2.11	2.45	2.82	3.06	3.73	4.67	5.42	6.59	7.64	8.87
3	2	1.53	1.83	2.02	2.34	2.70	2.93	3.55	4.44	5.18	6.32	7.41	8.78
3	3	1.72	2.05	2.28	2.64	3.02	3.30	4.08	5.11	5.87	6.97	7.95	9.48
3	4	1.59	1.91	2.12	2.44	2.80	3.05	3.70	4.55	5.26	6.15	7.25	8.16
3	5	1.61	1.93	2.16	2.48	2.85	3.10	3.71	4.57	5.20	6.17	6.97	7.83
3	6	1.63	1.95	2.16	2.50	2.88	3.13	3.81	4.85	5.68	6.84	7.76	8.92
3	7	1.62	1.90	2.15	2.50	2.87	3.12	3.73	4.64	5.32	6.39	7.35	8.54
3	8	1.67	1.97	2.20	2.54	2.93	3.22	3.94	4.92	5.74	6.97	8.12	9.55
3	9	1.73	2.02	2.25	2.62	3.00	3.27	3.92	4.92	5.75	7.05	8.23	9.40
3	10	1.88	2.25	2.49	2.87	3.30	3.59	4.36	5.48	6.34	7.53	8.54	9.52
4	1	1.47	1.74	1.93	2.24	2.58	2.80	3.42	4.28	4.96	6.07	7.02	8.07
4	2	1.44	1.70	1.90	2.18	2.49	2.70	3.30	4.09	4.81	5.88	6.84	8.16
4	3	1.61	1.88	2.09	2.42	2.76	3.01	3.68	4.56	5.50	6.45	7.56	8.80
4	4	1.48	1.76	1.95	2.25	2.58	2.81	3.38	4.19	4.86	5.78	6.62	7.51
4	5	1.51	1.77	1.95	2.26	2.57	2.82	3.40	4.16	4.77	5.66	6.40	7.16
4	6	1.52	1.81	2.00	2.30	2.64	2.87	3.49	4.45	5.21	6.28	7.12	8.19
4	7	1.52	1.78	1.98	2.30	2.64	2.87	3.42	4.26	4.88	5.84	6.75	8.00
4	8	1.57	1.85	2.06	2.38	2.75	2.97	3.59	4.52	5.26	6.43	7.36	8.81
4	9	1.59	1.87	2.07	2.40	2.76	3.00	3.60	4.52	5.28	6.48	7.58	8.62
4	10	1.75	2.08	2.31	2.65	3.02	3.30	4.00	5.03	5.80	6.93	7.86	8.79
5	1	1.40	1.64	1.80	2.08	2.36	2.57	3.11	3.95	4.63	5.60	6.53	7.36
5	2	1.38	1.61	1.76	2.03	2.31	2.51	3.04	3.80	4.47	5.51	6.46	7.58
5	3	1.53	1.77	1.95	2.24	2.56	2.79	3.45	4.29	4.93	6.07	7.04	8.20
5	4	1.39	1.63	1.80	2.04	2.32	2.52	3.02	3.76	4.45	5.32	6.08	6.92
5	5	1.36	1.58	1.75	2.00	2.27	2.47	3.01	3.71	4.26	5.04	5.83	6.61
5	6	1.42	1.66	1.84	2.10	2.38	2.59	3.11	3.93	4.65	5.57	6.46	7.45
5	7	1.40	1.63	1.78	2.07	2.35	2.55	3.03	3.80	4.44	5.37	6.23	7.41
5	8	1.49	1.73	1.90	2.20	2.48	2.71	3.28	4.13	4.76	6.02	7.07	8.21
5	9	1.44	1.68	1.85	2.12	2.41	2.62	3.16	4.00	4.62	5.79	6.71	7.73
5	10	1.63	1.91	2.10	2.41	2.74	2.97	3.62	4.51	5.21	6.23	7.11	8.27

Table 1. Continued

Storm code	Zone code	2-month	3-month	4-month	6-month	9-month	1-year	2-year	5-year	10-year	25-year	50-year	100-year
		Rainfall (inches) for given recurrence interval											
6	1	1.30	1.52	1.66	1.92	2.18	2.37	2.86	3.63	4.26	5.15	6.01	6.92
6	2	1.26	1.47	1.61	1.86	2.12	2.30	2.79	3.50	4.11	5.06	5.95	6.97
6	3	1.41	1.64	1.80	2.07	2.36	2.57	3.18	3.95	4.53	5.59	6.47	7.55
6	4	1.27	1.51	1.66	1.88	2.12	2.28	2.75	3.46	4.09	4.90	5.59	6.37
6	5	1.25	1.47	1.62	1.84	2.09	2.27	2.77	3.41	3.92	4.63	5.37	6.08
6	6	1.31	1.53	1.68	1.93	2.19	2.38	2.86	3.61	4.28	5.12	5.95	6.85
6	7	1.29	1.50	1.64	1.90	2.16	2.35	2.79	3.49	4.08	4.94	5.73	6.81
6	8	1.35	1.59	1.74	2.00	2.29	2.49	3.02	3.80	4.38	5.54	6.51	7.55
6	9	1.33	1.55	1.71	1.95	2.22	2.41	2.91	3.68	4.25	5.33	6.17	7.11
6	10	1.51	1.77	1.95	2.22	2.52	2.74	3.33	4.15	4.79	5.74	6.54	7.61
7	1	1.23	1.43	1.57	1.81	2.06	2.24	2.71	3.43	4.03	4.88	5.66	6.51
7	2	1.20	1.40	1.53	1.77	2.01	2.18	2.64	3.31	3.89	4.79	5.62	6.59
7	3	1.34	1.56	1.70	1.94	2.22	2.43	2.98	3.73	4.29	5.28	6.13	7.14
7	4	1.19	1.40	1.53	1.77	2.01	2.17	2.62	3.27	3.87	4.63	5.29	6.02
7	5	1.18	1.38	1.53	1.74	1.98	2.15	2.62	3.23	3.71	4.38	5.08	5.75
7	6	1.24	1.44	1.57	1.82	2.07	2.25	2.71	3.39	3.97	4.84	5.62	6.48
7	7	1.21	1.42	1.55	1.80	2.04	2.22	2.63	3.30	3.86	4.67	5.42	6.45
7	8	1.28	1.50	1.64	1.88	2.15	2.35	2.86	3.60	4.14	5.24	6.15	7.14
7	9	1.25	1.46	1.60	1.85	2.10	2.28	2.75	3.48	4.02	5.04	5.84	6.72
7	10	1.42	1.66	1.83	2.10	2.38	2.59	3.15	3.93	4.53	5.42	6.19	7.20
8	1	1.06	1.24	1.37	1.56	1.77	1.93	2.33	2.96	3.48	4.20	4.90	5.69
8	2	1.03	1.21	1.32	1.52	1.74	1.88	2.28	2.85	3.35	4.13	4.85	5.68
8	3	1.15	1.34	1.47	1.67	1.91	2.10	2.58	3.22	3.70	4.55	5.28	6.15
8	4	1.03	1.21	1.34	1.53	1.74	1.89	2.26	2.82	3.33	3.99	4.56	5.19
8	5	1.00	1.18	1.32	1.49	1.70	1.85	2.26	2.78	3.20	3.78	4.38	4.96
8	6	1.07	1.24	1.37	1.57	1.78	1.94	2.33	2.95	3.48	4.18	4.85	5.59
8	7	1.06	1.23	1.37	1.55	1.74	1.87	2.27	2.85	3.33	4.03	4.67	5.56
8	8	1.12	1.30	1.44	1.64	1.87	2.03	2.45	3.10	3.57	4.52	5.30	6.16
8	9	1.08	1.27	1.41	1.60	1.81	1.97	2.37	3.00	3.47	4.34	5.03	5.80
8	10	1.23	1.44	1.58	1.71	2.05	2.23	2.73	3.39	3.91	4.68	5.31	6.21
9	1	0.91	1.06	1.16	1.33	1.52	1.65	1.99	2.53	2.97	3.59	4.18	4.90
9	2	0.88	1.02	1.13	1.30	1.47	1.60	1.94	2.43	2.86	3.53	4.14	4.85
9	3	0.98	1.15	1.26	1.44	1.65	1.79	2.21	2.75	3.15	3.89	4.51	5.25
9	4	0.89	1.03	1.13	1.30	1.47	1.61	1.93	2.41	2.85	3.41	3.89	4.43
9	5	0.87	1.02	1.12	1.28	1.46	1.58	1.93	2.37	2.73	3.22	3.74	4.23
9	6	0.91	1.07	1.18	1.34	1.52	1.66	1.99	2.51	2.98	3.56	4.14	4.77
9	7	0.89	1.05	1.15	1.32	1.50	1.63	1.94	2.43	2.84	3.44	3.99	4.74
9	8	0.95	1.12	1.22	1.40	1.59	1.73	2.10	2.63	3.08	3.86	4.52	5.25
9	9	0.92	1.08	1.21	1.37	1.55	1.68	2.02	2.56	2.96	3.71	4.29	4.95
9	10	1.06	1.23	1.35	1.54	1.75	1.90	2.32	2.89	3.33	3.99	4.55	5.29
10	1	0.84	0.97	1.06	1.23	1.40	1.52	1.83	2.33	2.74	3.31	3.86	4.47
10	2	0.81	0.95	1.05	1.20	1.36	1.48	1.79	2.24	2.64	3.25	3.82	4.47
10	3	0.91	1.06	1.17	1.32	1.50	1.65	2.02	2.53	2.91	3.58	4.15	4.84
10	4	0.82	0.95	1.04	1.19	1.37	1.48	1.78	2.22	2.62	3.14	3.59	4.08
10	5	0.79	0.93	1.03	1.17	1.34	1.46	1.78	2.19	2.52	2.97	3.44	3.90
10	6	0.84	0.98	1.08	1.24	1.41	1.53	1.84	2.32	2.74	3.28	3.81	4.39
10	7	0.83	0.97	1.07	1.22	1.38	1.50	1.79	2.24	2.62	3.17	3.67	4.39
10	8	0.88	1.02	1.13	1.28	1.47	1.60	1.94	2.44	2.87	3.55	4.20	4.84
10	9	0.85	1.00	1.12	1.26	1.43	1.55	1.85	2.36	2.72	3.41	3.96	4.56
10	10	0.97	1.13	1.25	1.43	1.62	1.76	2.14	2.66	3.07	3.68	4.20	4.88

Table 1. Concluded

Storm code	Zone code	2-month	3-month	4-month	6-month	9-month	1-year	2-year	5-year	10-year	25-year	50-year	100-year
		Rainfall (inches) for given recurrence interval											
11	1	0.67	0.78	0.86	0.98	1.11	1.21	1.46	1.86	2.18	2.63	3.07	3.51
11	2	0.65	0.76	0.84	0.96	1.09	1.18	1.43	1.79	2.10	2.59	3.04	3.56
11	3	0.72	0.84	0.92	1.06	1.21	1.31	1.60	2.02	2.32	2.86	3.31	3.85
11	4	0.65	0.76	0.83	0.95	1.09	1.18	1.42	1.77	2.09	2.50	2.86	3.25
11	5	0.64	0.74	0.81	0.93	1.07	1.16	1.41	1.74	2.00	2.39	2.74	3.11
11	6	0.67	0.79	0.87	0.99	1.12	1.21	1.46	1.85	2.19	2.62	3.04	3.50
11	7	0.66	0.77	0.85	0.97	1.10	1.20	1.42	1.78	2.09	2.52	2.93	3.48
11	8	0.70	0.81	0.89	1.02	1.15	1.26	1.54	1.93	2.27	2.84	3.32	3.86
11	9	0.68	0.79	0.88	1.00	1.13	1.23	1.49	1.88	2.20	2.72	3.15	3.63
11	10	0.77	0.90	0.99	1.13	1.29	1.40	1.70	2.12	2.45	2.93	3.34	3.89
12	1	0.52	0.61	0.68	0.77	0.87	0.95	1.15	1.46	1.71	2.07	2.42	2.77
12	2	0.51	0.60	0.65	0.75	0.86	0.93	1.12	1.41	1.65	2.04	2.39	2.80
12	3	0.57	0.66	0.73	0.83	0.95	1.03	1.27	1.59	1.82	2.25	2.61	3.03
12	4	0.52	0.60	0.66	0.75	0.86	0.93	1.12	1.39	1.64	1.97	2.25	2.56
12	5	0.50	0.58	0.64	0.74	0.84	0.91	1.11	1.37	1.57	1.87	2.16	2.45
12	6	0.53	0.61	0.68	0.78	0.88	0.96	1.15	1.46	1.72	2.06	2.39	2.75
12	7	0.52	0.60	0.66	0.76	0.86	0.93	1.12	1.41	1.64	1.99	2.31	2.74
12	8	0.55	0.64	0.71	0.81	0.92	1.00	1.22	1.53	1.78	2.25	2.62	3.03
12	9	0.53	0.62	0.68	0.78	0.89	0.97	1.17	1.47	1.73	2.14	2.48	2.86
12	10	0.61	0.70	0.77	0.89	1.01	1.10	1.34	1.66	1.93	2.31	2.63	3.06
13	1	0.38	0.45	0.50	0.57	0.64	0.70	0.84	1.07	1.25	1.51	1.76	1.99
13	2	0.37	0.44	0.48	0.55	0.63	0.68	0.82	1.03	1.21	1.49	1.75	2.05
13	3	0.41	0.48	0.53	0.61	0.69	0.75	0.91	1.16	1.33	1.64	1.90	2.21
13	4	0.37	0.44	0.49	0.56	0.63	0.68	0.81	1.02	1.20	1.44	1.64	1.87
13	5	0.37	0.43	0.47	0.54	0.62	0.67	0.81	1.00	1.14	1.37	1.60	1.85
13	6	0.38	0.45	0.49	0.57	0.64	0.70	0.84	1.06	1.26	1.52	1.75	2.01
13	7	0.38	0.44	0.49	0.56	0.63	0.69	0.82	1.03	1.20	1.45	1.68	2.00
13	8	0.40	0.47	0.52	0.59	0.67	0.73	0.89	1.12	1.29	1.63	1.91	2.22
13	9	0.39	0.46	0.50	0.58	0.65	0.71	0.85	1.08	1.25	1.56	1.81	2.09
13	10	0.43	0.51	0.56	0.65	0.74	0.80	0.98	1.22	1.41	1.68	1.92	2.23
14	1	0.31	0.36	0.40	0.46	0.52	0.57	0.68	0.87	1.02	1.23	1.44	1.62
14	2	0.30	0.35	0.39	0.45	0.51	0.55	0.67	0.84	0.98	1.21	1.42	1.67
14	3	0.34	0.39	0.43	0.49	0.56	0.61	0.74	0.94	1.08	1.33	1.55	1.81
14	4	0.30	0.35	0.39	0.45	0.50	0.55	0.66	0.83	0.98	1.17	1.34	1.52
14	5	0.30	0.35	0.38	0.43	0.49	0.54	0.66	0.81	0.94	1.12	1.28	1.46
14	6	0.31	0.36	0.40	0.46	0.52	0.57	0.68	0.87	1.02	1.22	1.42	1.64
14	7	0.31	0.36	0.40	0.45	0.51	0.56	0.66	0.83	0.98	1.18	1.37	1.63
14	8	0.33	0.38	0.42	0.49	0.55	0.60	0.72	0.91	1.05	1.32	1.55	1.81
14	9	0.32	0.37	0.41	0.47	0.53	0.58	0.70	0.88	1.02	1.27	1.48	1.70
14	10	0.36	0.42	0.46	0.53	0.60	0.65	0.80	0.99	1.14	1.37	1.56	1.82
15	1	0.17	0.20	0.22	0.25	0.29	0.31	0.37	0.47	0.56	0.67	0.78	0.89
15	2	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.46	0.54	0.66	0.78	0.91
15	3	0.18	0.21	0.23	0.26	0.30	0.33	0.40	0.51	0.59	0.73	0.84	0.98
15	4	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.45	0.53	0.64	0.73	0.83
15	5	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.44	0.51	0.61	0.70	0.79
15	6	0.17	0.20	0.22	0.25	0.29	0.31	0.37	0.47	0.56	0.67	0.78	0.89
15	7	0.17	0.20	0.22	0.25	0.29	0.31	0.36	0.46	0.54	0.64	0.75	0.89
15	8	0.18	0.21	0.23	0.26	0.30	0.33	0.40	0.50	0.58	0.72	0.85	0.99
15	9	0.18	0.20	0.22	0.26	0.29	0.32	0.38	0.48	0.55	0.69	0.81	0.93
15	10	0.20	0.23	0.25	0.29	0.33	0.36	0.43	0.54	0.62	0.75	0.85	0.99

RUNOFF COEFFICIENTS

VALUES OF C - $\frac{\text{Runoff}}{\text{Rainfall}}$			RUNOFF COEFFICIENT C	
TYPE OF DRAINAGE AREA SURFACES			MIN.	MAX.
ROOFS, slag to metal			0.75	0.95
PAVEMENTS	Asphalt		0.70	0.95
	Concrete		0.80	0.95
	Gravel, from clean and loose to clayey and compact		0.25	0.70
R.R. YARDS			0.20	0.40
EARTH SURFACES	Sand, from uniform grain size, no fines to well graded some clay or silt	Bare	0.15	0.50
		Light Vegetation	0.10	0.40
		Dense Vegetation	0.05	0.30
	Loam, from sandy or gravelly to clayey	Bare	0.20	0.60
		Light Vegetation	0.10	0.45
		Dense Vegetation	0.05	0.35
	Gravel, from clean gravel and gravel sand mixtures, no silt or clay to high clay or silt content	Bare	0.25	0.65
		Light Vegetation	0.15	0.50
		Dense Vegetation	0.10	0.40
	Clay, from coarse sandy or silty to pure colloidal clays	Bare	0.30	0.75
		Light Vegetation	0.20	0.60
		Dense Vegetation	0.15	0.50
COMPOSITE AREAS	City, business areas		0.70	0.95
	City, dense residential areas, vary as to soil & Vegetation		0.50	0.65
	Suburban residential areas, vary as to soil & vegetation		0.35	0.55
	Rural Districts, vary as to soil & vegetation		0.13	0.25
	Parks, Golf Courses, etc., vary as to soil & vegetation		0.10	0.35
LAWNS	Sandy soil, flat 2%		0.05	0.10
	Sandy soil, average 2% to 7%		0.10	0.15
	Sandy soil, steep, 7%		0.15	0.20
	Heavy soil, flat 2%		0.13	0.17
	Heavy soil, average 2% to 7%		0.18	0.22
	Heavy soil, steep 7%		0.25	0.35

Note: Values of "C" for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.

Table 4-103 a

Fig. 4-103 b
OVERLAND FLOW MANNING'S n VALUES

	Recommended Value	Range of Values
Concrete	.011	.01 - .013
Asphalt	.012	.01 - .015
Bare sand[a]	.010	.010 - .016
Graveled surface[a]	.012	.012 - .030
Bare clay-loam (eroded)[a]	.012	.012 - .033
Fallow (no residue)	.05	.006 - .16
Chisel plow (ϵ1/4 tons/acre residue)	.07	.006 - .17
Chisel plow (1/4 - 1 tons/acre residue)	.18	.07 - .34
Chisel plow (1 - 3 tons/acre residue)	.30	.19 - .47
Chisel plow (∂3 tons/acre residue)	.40	.34 - .46
Disk/Harrow (ϵ1/4 tons acre residue)	.08	.008 - .41
Disk/Harrow (1/4 - 1 tons/acre residue)	.16	.10 - .25
Disk/Harrow (1 - 3 tons/acre residue)	.25	.14 - .53
Disk/Harrow (∂3 tons/acre residue)	.30	-- --
No till (ϵ1/4 tons/acre residue)	.04	.03 - .07
No till (1/4 - 1 tons/acre residue)	.07	.01 - .13
No till (1 - 3 tons/acre residue)	.30	.16 - .47
Plow (Fall)	.06	.02 - .10
Coulter	.10	.05 - .13
Range (natural)	.13	.01 - .32
Range (clipped)	.08	.02 - .24
Grass (bluegrass sod)	.45	.39 - .63
Short grass prairie[a]	.15	.10 - .20
Dense grass [c]	.24	.17 - .30
Bermudagrass[c]	.41	.30 - .48
Woods	.45	-- --

All values are from Engman (1983), unless noted otherwise.

[a]Woolhiser (1975).

[b]Fallow has been idle for one year and is fairly smooth.

[c]Palmer (1946). Weeping lovegrass, bluegrass, buffalo grass, blue gramma grass, native grass mix (OK), alfalfa, lespedeza.

Note: These values were determined specifically for overland flow conditions and are not appropriate for conventional open channel flow calculations. See Chapter 5 of this manual for open channel flow procedures.

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n
(Boldface figures are values generally recommended in design)

Type of channel and description	Minimum	Normal	Maximum
A. CLOSED CONDUITS FLOWING PARTLY FULL			
A-1. Metal			
a. Brass, smooth	0.009	**0.010**	0.013
b. Steel			
1. Lockbar and welded	0.010	0.012	0.014
2. Riveted and spiral	0.013	0.016	0.017
c. Cast iron			
1. Coated	0.010	0.013	0.014
2. Uncoated	0.011	0.014	0.016
d. Wrought iron			
1. Black	0.012	0.014	0.015
2. Galvanized	0.013	0.016	0.017
e. Corrugated metal			
1. Subdrain	0.017	0.019	0.021
2. Storm drain	0.021	**0.024**	0.030
A-2. Nonmetal			
a. Lucite	0.008	0.009	0.010
b. Glass	0.009	**0.010**	0.013
c. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
d. Concrete			
1. Culvert, straight and free of debris	0.010	0.011	0.013
2. Culvert with bends, connections, and some debris	0.011	**0.013**	0.014
3. Finished	0.011	0.012	0.014
4. Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
5. Unfinished, steel form	0.012	0.013	0.014
6. Unfinished, smooth wood form	0.012	**0.014**	0.016
7. Unfinished, rough wood form	0.015	0.017	0.020
e. Wood			
1. Stave	0.010	0.012	0.014
2. Laminated, treated	0.015	0.017	0.020
f. Clay			
1. Common drainage tile	0.011	**0.013**	0.017
2. Vitrified sewer	0.011	0.014	0.017
3. Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
4. Vitrified subdrain with open joint	0.014	0.016	0.018
g. Brickwork			
1. Glazed	0.011	0.013	0.015
2. Lined with cement mortar	0.012	0.015	0.017
h. Sanitary sewers coated with sewage slimes, with bends and connections	0.012	0.013	0.016
i. Paved invert, sewer, smooth bottom	0.016	0.019	0.020
j. Rubble masonry, cemented	0.018	0.025	0.030

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n *(continued)*

Type of channel and description	Minimum	Normal	Maximum
B. LINED OR BUILT-UP CHANNELS			
B-1. Metal			
a. Smooth steel surface			
1. Unpainted	0.011	0.012	0.014
2. Painted	0.012	0.013	0.017
b. Corrugated	0.021	0.025	0.030
B-2. Nonmetal			
a. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
b. Wood			
1. Planed, untreated	0.010	0.012	0.014
2. Planed, creosoted	0.011	0.012	0.015
3. Unplaned	0.011	0.013	0.015
4. Plank with battens	0.012	0.015	0.018
5. Lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. Trowel finish	0.011	**0.013**	0.015
2. Float finish	0.013	0.015	0.016
3. Finished, with gravel on bottom	0.015	0.017	0.020
4. Unfinished	0.014	0.017	0.020
5. Gunite, good section	0.016	0.019	0.023
6. Gunite, wavy section	0.018	0.022	0.025
7. On good excavated rock	0.017	0.020	
8. On irregular excavated rock	0.022	0.027	
d. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
5. Dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone in mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. Glazed	0.011	**0.013**	0.015
2. In cement mortar	0.012	**0.015**	0.018
g. Masonry			
1. Cemented rubble	0.017	0.025	0.030
2. Dry rubble	0.023	0.032	0.035
h. Dressed ashlar	0.013	0.015	0.017
i. Asphalt			
1. Smooth	0.013	0.013	
2. Rough	0.016	0.016	
j. Vegetal lining	0.030	.....	0.500

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
C. EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140
D. NATURAL STREAMS			
D-1. Minor streams (top width at flood stage <100 ft)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Dense willows, summer, straight	0.110	0.150	0.200
2. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.100	0.120	0.160
D-3. Major streams (top width at flood stage >100 ft). The n value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	.....	0.060
b. Irregular and rough section	0.035	.....	0.100

TABLE 9-503a

AVERAGE MAXIMUM PERMISSIBLE VELOCITIES (FT./SEC.)

SOIL TYPE	BARE EARTH	WITH GRASS
Fine Sand (Non-Colloidal)	2.0	4.0
Sandy Loam (Non-Colloidal)	2.0	5.0
Silt Loam (Non-Colloidal)	2.5	6.0
Alluvial Silts (Non-Colloidal)	3.0	6.0
Ordinary Firm Loam	3.0	6.0
Fine Gravel	4.0	-
Alluvial Silts (Colloidal)	4.0	7.0
Stiff Clay (Non-Colloidal)	4.5	8.0
Graded Loam to Cobbles (Non-Colloidal)	4.5	8.0
Graded Silt to Cobbles (Colloidal)	5.0	8.0
Coarse Gravel (Non-Colloidal)	6.0	-
Cobbles and Shingles	7.0	-
Shale and Hard Pans	8.0	-

Note: The type of soil which will line the proposed ditch should be obtained from the soils report. If a soils report is not available, the designer should consult with personnel in the District Bureau of Materials to determine the most appropriate method of establishing the soil types. Their general knowledge of prevailing soils in the area together with any available soils maps, nearby structural borings or other soil data may provide sufficient information. If the need for extensive ditch lining is anticipated, a special soil survey at sample locations or throughout the project may be warranted.

TABLE 9-503b

TRANSITIONAL DITCH LINING

SCOURING SLOPE %*	LENGTH OF TRANSITION, FT.
0-4	25
4-6	50
6-10	75
Over 10	100

*Ditch gradient at the lower end of the section of ditch where lining is required.

SECTION 4

REVIEW COMMENTS