

DRAINAGE AND STORM WATER QUALITY PLAN AND SUPPORTING CALCULATIONS

FOR

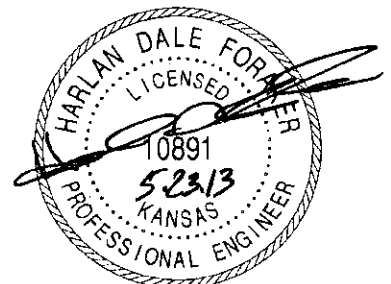
**QT #0345R
MACARTHUR RD AND MERIDIAN AVE
WICHITA, KANSAS**

**PREPARED FOR:
QUIKTRIP CORPORATION
4705 SOUTH 129TH EAST AVENUE
TULSA, OK 74134**

MAY 23RD, 2013

PREPARED BY:

**CERTIFIED ENGINEERING DESIGN, P.A.
1935 WEST MAPLE
WICHITA, KANSAS 67213-3311
(316)262-8808 PHONE
(316)262-1669 FAX**



Mr. Scott Lindebak, P.E., (Con't)
QT #0345R
May 23rd, 2013

CERTIFIED ENGINEERING DESIGN, P.A

1935 West Maple
Wichita, KS 67213-3311
(316)262-8808 Office
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LETTER OF TRANSMITTAL

DATE: May 23rd, 2013

TO: Mr. Scott Lindebak, P.E.
Engineering Division
City of Wichita
8th Floor, City Hall
455 N. Main
Wichita, KS 67202

RE: Drainage Plan
QT #0345R
Wichita, KS

FROM: Harlan D. Foraker, P.E. *HDF*

cc: Joe Kim, Real Estate Project Manager, QuikTrip Corporation

I. TAB 1 – PROJECT NARRATIVE:

Discussion of Development

The goal of this report is to analyze the existing drainage patterns and design the proposed drainage system to serve the QT #345R site in Wichita, KS. This site is located northwest of the intersection of MacArthur Rd and Meridian Ave. This site is currently undeveloped and consists of a crop field.

The SCS soil type present on the site is the Canadian Fine Sandy Loam. This soil is a SCS type B soil. The proposed improvements include adding a 6,000 S.F. building with concrete pavement parking and gas canopy area. A proposed dry detention pond will be used to control runoff. The estimated disturbed area is around 5.95 acres. Proposed conditions will cause an increase in the amount of impervious area by 1.66 acres within the site property area. The total area of the property is 2.68 acres. An aerial photograph of the proposed plat site is located in the Appendix.

Offsite Conditions

There are no off-site areas that drain onto the site. The site is elevated enough to keep offsite drainage from entering. Therefore the design does not need to incorporate off-site drainage.

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Description of Best Management Practices

A stormwater pollution prevention plan (SWPPP) has been developed for erosion control purposes. The disturbed area of the QT #0345R site will be surrounded with silt fence, and the existing curb inlets located on the surrounding streets will have curb inlet protection. A construction entrance is located on site. The proposed curb inlets located on site will also have curb inlet protection. An erosion control plan has been sent and approved by KDHE.

Hydrologic Calculations

Hydrologic Calculations were computed by using both the SCS and rational method. Time of concentration values were estimated using the TR-55 method. The rational method was used to compute peak discharge values to design the proposed storm sewer system. The SCS method was used to analyze the dry detention pond and compare existing versus developed runoff. Soil Types were determined from the Natural Resource Conservation Soil Survey website. The SCS soil type present on the site is the Canadian Fine Sandy Loam, which is a SCS type B soil.

Summary of Runoff Calculations

Detention is required since the increase in impervious area is more than 1 acre. The SCS Method was used to compare existing versus developed runoff calculations. Table 1 shows existing and developed runoff calculations with detention.

Existing & Developed Peak Runoff w/ Detention	
Description	Q (cfs)
Existing Runoff (2 yr.)	3.12
Existing Runoff (5 yr.)	5.31
Existing Runoff (10 yr.)	7.00
Existing Runoff (25 yr.)	9.26
Existing Runoff (100 yr.)	13.76
Developed Runoff (2 yr.)	3.02
Developed Runoff (5 yr.)	4.52
Developed Runoff (10 yr.)	5.74
Developed Runoff (25 yr.)	7.18
Developed Runoff (100 yr.)	9.96

TABLE 1 – EXISTING AND DEVELOPED SCS RUNOFF CALCULATIONS WITH DETENTION

II. TAB 2 – EXISTING CONDITIONS RUNOFF CALCULATIONS

Existing Conditions

The existing site has been divided into two sub-basins. Currently the site is a crop field and most of the runoff sheet flows off of the site. A summary of the existing drainage calculations can be seen in Table 2. The existing drainage basins can be seen on the Existing Drainage map located in the Appendix.

Existing Peak Runoff - SCS Method					
Description	CN	Percent Impervious (%)	Tc (min.)	Area (acres)	Q (cfs)
Existing Basin A (2 yr.)	71	0	20	1.83	2.12
Existing Basin A (5 yr.)					3.61
Existing Basin A (10 yr.)					4.76
Existing Basin A (25 yr.)					6.30
Existing Basin A (100 yr.)					9.36
Existing Basin B (2 yr.)	71	0	17	0.86	1.00
Existing Basin B (5 yr.)					1.70
Existing Basin B (10 yr.)					2.24
Existing Basin B (25 yr.)					2.96
Existing Basin B (100 yr.)					4.40

Table 2 – Existing Runoff Calculations

The combined 100-yr peak discharge for the existing site is 13.76 cfs.

Ground Water Elevations

According to the Kansas Geological Survey's Kansas Water Well Database, the static water surface elevation of the ground water in this area is around 14 ft below the existing ground.

III. TAB 3 – DEVELOPED CONDITIONS RUNOFF CALCULATIONS

Hydraulic Analysis

The proposed storm sewer system was designed with the rational method. The 10-yr design storm was selected to size the storm sewer system. The spreadsheet used in the design of the system is shown in the Appendix.

The 100 yr hydraulic grade line was calculated for this storm sewer system through the use of a program called Storm and Sanitary Analysis an extension of AutoCad Civil 3D. An assumed tailwater elevation of 1282 was set at the outlet end of the proposed storm sewer system to more accurately model the 100-yr hydraulic grade line. The 100-yr hydraulic grade line calculations are shown in the Appendix.

Developed Conditions

The proposed plat site is divided into twelve sub-basins. The proposed drainage of the site incorporates a storm sewer system that drains sub-basins C, F, H, I, J. All of the sub-basins drain to and are detained by the proposed pond except for sub-basins A, G, and K.

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A summary of the developed rational method drainage calculations can be seen in Table 3. The developed drainage basins can be seen on the Developed Drainage Map located in the Appendix.

Developed Peak Runoff - Rational Method						
Description	Percent Impervious (%)	C	Tc	I (in./hr)	Area (acres)	Q (cfs)
Developed Sub-basin A (2 yr.)	44	0.49	15	3.83	0.18	0.34
Developed Sub-basin A (5 yr.)		0.51	15	4.56	0.18	0.42
Developed Sub-basin A (10 yr.)		0.54	15	5.22	0.18	0.51
Developed Sub-basin A (25 yr.)		0.56	15	6.06	0.18	0.61
Developed Sub-basin A (100 yr.)		0.62	15	7.37	0.18	0.82
Developed Sub-basin B (2 yr.)	0	0.20	15	3.83	0.57	0.44
Developed Sub-basin B (5 yr.)		0.22	15	4.56	0.57	0.57
Developed Sub-basin B (10 yr.)		0.28	15	5.22	0.57	0.83
Developed Sub-basin B (25 yr.)		0.30	15	6.06	0.57	1.04
Developed Sub-basin B (100 yr.)		0.41	15	7.37	0.57	1.72
Developed Sub-basin C (2 yr.)	100	0.87	15	3.83	0.19	0.63
Developed Sub-basin C (5 yr.)		0.87	15	4.56	0.19	0.75
Developed Sub-basin C (10 yr.)		0.88	15	5.22	0.19	0.87
Developed Sub-basin C (25 yr.)		0.88	15	6.06	0.19	1.01
Developed Sub-basin C (100 yr.)		0.89	15	7.37	0.19	1.25
Developed Sub-basin D (2 yr.)	100	0.87	15	3.83	0.04	0.13
Developed Sub-basin D (5 yr.)		0.87	15	4.56	0.04	0.16
Developed Sub-basin D (10 yr.)		0.88	15	5.22	0.04	0.18
Developed Sub-basin D (25 yr.)		0.88	15	6.06	0.04	0.21
Developed Sub-basin D (100 yr.)		0.89	15	7.37	0.04	0.26
Developed Sub-basin E (2 yr.)	100	0.87	15	3.83	0.07	0.23
Developed Sub-basin E (5 yr.)		0.87	15	4.56	0.07	0.28
Developed Sub-basin E (10 yr.)		0.88	15	5.22	0.07	0.32
Developed Sub-basin E (25 yr.)		0.88	15	6.06	0.07	0.37
Developed Sub-basin E (100 yr.)		0.89	15	7.37	0.07	0.46
Developed Sub-basin F (2 yr.)	100	0.87	15	3.83	0.13	0.43
Developed Sub-basin F (5 yr.)		0.87	15	4.56	0.13	0.52
Developed Sub-basin F (10 yr.)		0.88	15	5.22	0.13	0.60
Developed Sub-basin F (25 yr.)		0.88	15	6.06	0.13	0.69
Developed Sub-basin F (100 yr.)		0.89	15	7.37	0.13	0.85
Developed Sub-basin G (2 yr.)	0	0.20	15	3.83	0.20	0.15
Developed Sub-basin G (5 yr.)		0.22	15	4.56	0.20	0.20
Developed Sub-basin G (10 yr.)		0.28	15	5.22	0.20	0.29
Developed Sub-basin G (25 yr.)		0.30	15	6.06	0.20	0.36
Developed Sub-basin G (100 yr.)		0.41	15	7.37	0.20	0.60

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Developed Sub-basin H (2 yr.)	100	0.87	15	3.83	0.12	0.40
Developed Sub-basin H (5 yr.)		0.87	15	4.56	0.12	0.48
Developed Sub-basin H (10 yr.)		0.88	15	5.22	0.12	0.55
Developed Sub-basin H (25 yr.)		0.88	15	6.06	0.12	0.64
Developed Sub-basin H (100 yr.)		0.89	15	7.37	0.12	0.79
Developed Sub-basin I (2 yr.)	82	0.75	15	3.83	0.45	1.29
Developed Sub-basin I (5 yr.)		0.75	15	4.56	0.45	1.54
Developed Sub-basin I (10 yr.)		0.77	15	5.22	0.45	1.81
Developed Sub-basin I (25 yr.)		0.78	15	6.06	0.45	2.13
Developed Sub-basin I (100 yr.)		0.80	15	7.37	0.45	2.65
Developed Sub-basin J (2 yr.)	100	0.87	15	3.83	0.50	1.67
Developed Sub-basin J (5 yr.)		0.87	15	4.56	0.50	1.98
Developed Sub-basin J (10 yr.)		0.88	15	5.22	0.50	2.30
Developed Sub-basin J (25 yr.)		0.88	15	6.06	0.50	2.67
Developed Sub-basin J (100 yr.)		0.89	15	7.37	0.50	3.28
Developed Sub-basin K (2 yr.)	22	0.35	15	3.83	0.09	0.12
Developed Sub-basin K (5 yr.)		0.36	15	4.56	0.09	0.15
Developed Sub-basin K (10 yr.)		0.41	15	5.22	0.09	0.19
Developed Sub-basin K (25 yr.)		0.43	15	6.06	0.09	0.23
Developed Sub-basin K (100 yr.)		0.52	15	7.37	0.09	0.34
Developed Sub-basin R1 (2 yr.)	100	0.87	15	3.83	0.13	0.43
Developed Sub-basin R1 (5 yr.)		0.87	15	4.56	0.13	0.52
Developed Sub-basin R1 (10 yr.)		0.88	15	5.22	0.13	0.60
Developed Sub-basin R1 (25 yr.)		0.88	15	6.06	0.13	0.69
Developed Sub-basin R1 (100 yr.)		0.89	15	7.37	0.13	0.85

Table 3 – Rational Method Developed Runoff Calculations

Stormwater Quantity

Detention is required since the increase in impervious area is more than 1 acre. Hydraflow Hydrographs, an extension of AutoCad Civil 3D, was used to model the proposed dry detention pond. The SCS method was used to compare existing versus developed drainage calculations. A proposed 20 degree v-notch weir is planned at the outlet end of the pond to control runoff for the 2 through 100 year SCS design storms. Table 4 shows existing versus developed SCS method drainage calculations with detention. The proposed Hydraflow Hydrograph model can be seen in the Appendix.

Existing & Developed Peak Runoff w/ Detention	
Description	Q (cfs)
Existing Runoff (2 yr.)	3.12
Existing Runoff (5 yr.)	5.31
Existing Runoff (10 yr.)	7.00
Existing Runoff (25 yr.)	9.26
Existing Runoff (100 yr.)	13.76
Developed Runoff (2 yr.)	3.02
Developed Runoff (5 yr.)	4.52
Developed Runoff (10 yr.)	5.74
Developed Runoff (25 yr.)	7.18
Developed Runoff (100 yr.)	9.96

Table 4 – Existing vs Developed SCS Method Drainage Calculations with Detention

Stormwater Quality

Since the proposed land disturbance will be greater than 1 acre, stormwater quality is required for this site. The proposed storm water quality calculations were computed to meet the regulations in the City of Wichita "Storm Water Manual". The computed water quality peak flow calculations can be seen in Table 5 below.

Water Quality Peak Flow Calculation (Qwq)			
$Qwq = qu \cdot A \cdot Qwv \cdot Fp$			
Data			
Drainage Area, A =	2.68	acres	
Time of Conc., Tc =	0.25	hrs	
WQ Rainfall Depth, P =	1.2	inches	
Runoff Coeff., Rv =	0.66		
Calculation			
WQ Prot. Volume, WQv =	0.792	inches	
Calculated CN =	95.7		
S =	0.45	inches	
la =	0.09	inches	
la/P =	0.07		
qu =	740	cfs/sq. mi/in	
Water Quality Peak Flow Rate, Qwq =	2.45	cfs	

Table 5 – Water Quality Peak Flow Calculations

The calculated water quality peak flow rate from the calculations above is 2.45 cfs. A hydrodynamic separator will be selected to treat the water quality flow rate of 2.45 cfs at a %TSS removal rate of 80% or greater.

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The responsible party for maintenance of the hydrodynamic separator will be the property owner of this QuikTrip site.

Channel Protection

Channel protection is not required because the total increase in impervious area is less than 5 acres.

IV. TAB 4 – FLOODPLAIN SUBMITTAL

FEMA Floodplain Boundary

There is no FEMA floodplain located on this property. A copy of the FEMA floodplain map is attached for review in the Appendix.

V. TAB 5 – FEDERAL, STATE, AND LOCAL PERMITS

A. US Army Corps of Engineers

Not Applicable

B. Kansas Department of Agriculture

Not Applicable

C. Federal Emergency Management Agency (FEMA)

Not Applicable

D. Kansas Department of Transportation

Not Applicable

E. Sedgwick County Right-of-way Permit

Not Applicable

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APPENDIX

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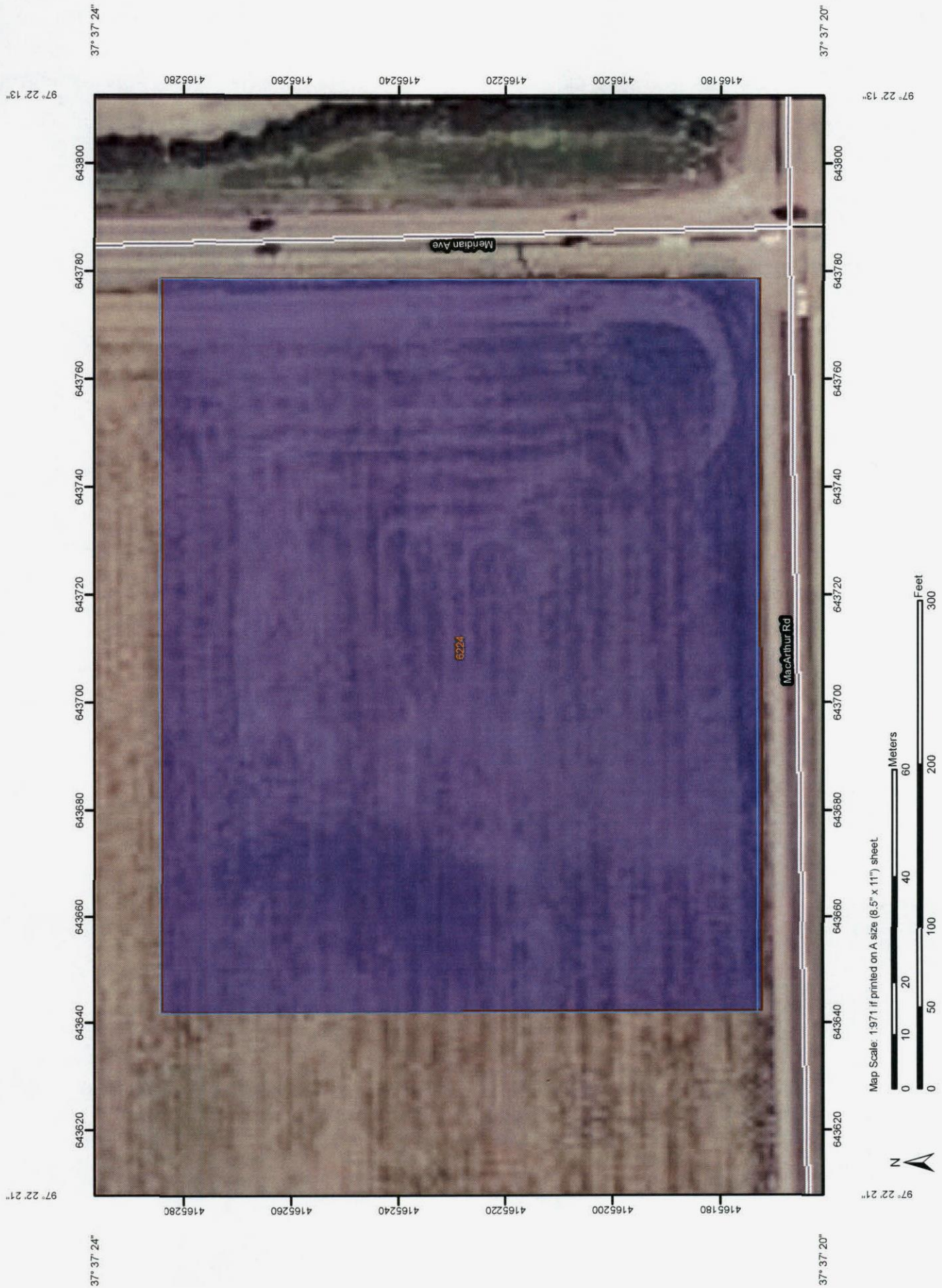
GENERAL MAPS

Aerial Photo

QT #345R
MacArthur Rd and Meridian Ave
Wichita, Kansas
CED Job # 20132108



Hydrologic Soil Group—Sedgwick County, Kansas



MAP LEGEND

Area of Interest (AOI)
 Area of Interest (AOI)

Soils
 Soil Map Units

Soil Ratings

A

A/D

B

B/D

C

C/D


D

Not rated or not available

Political Features


 Cities

Water Features


 Streams and Canals


Transportation

 Rails

 Interstate Highways

 US Routes

 Major Roads

 Local Roads

MAP INFORMATION

Map Scale: 1:971 if printed on A size (8.5" x 11") sheet.
 The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.
 Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: UTM Zone 14N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Sedgwick County, Kansas
 Survey Area Data: Version 8, Sep 20, 2012

Date(s) aerial images were photographed: 6/20/2006

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Sedgwick County, Kansas (KS173)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6224	Canadian fine sandy loam, rarely flooded	B	3.8	100.0%
Totals for Area of Interest			3.8	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

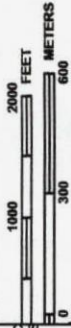
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

MAP SCALE 1" = 1000'



PANEL 0505E

FIRM
FLOOD INSURANCE RATE MAP
SEDGWICK COUNTY,
KANSAS
AND INCORPORATED AREAS

PANEL 505 OF 700

SEE MAP INDEX FOR FIRM PANEL LAYOUT)

NUMBER	PANEL	SUFFIX
200324	0505	E
200324	0505	E
200328	0505	E

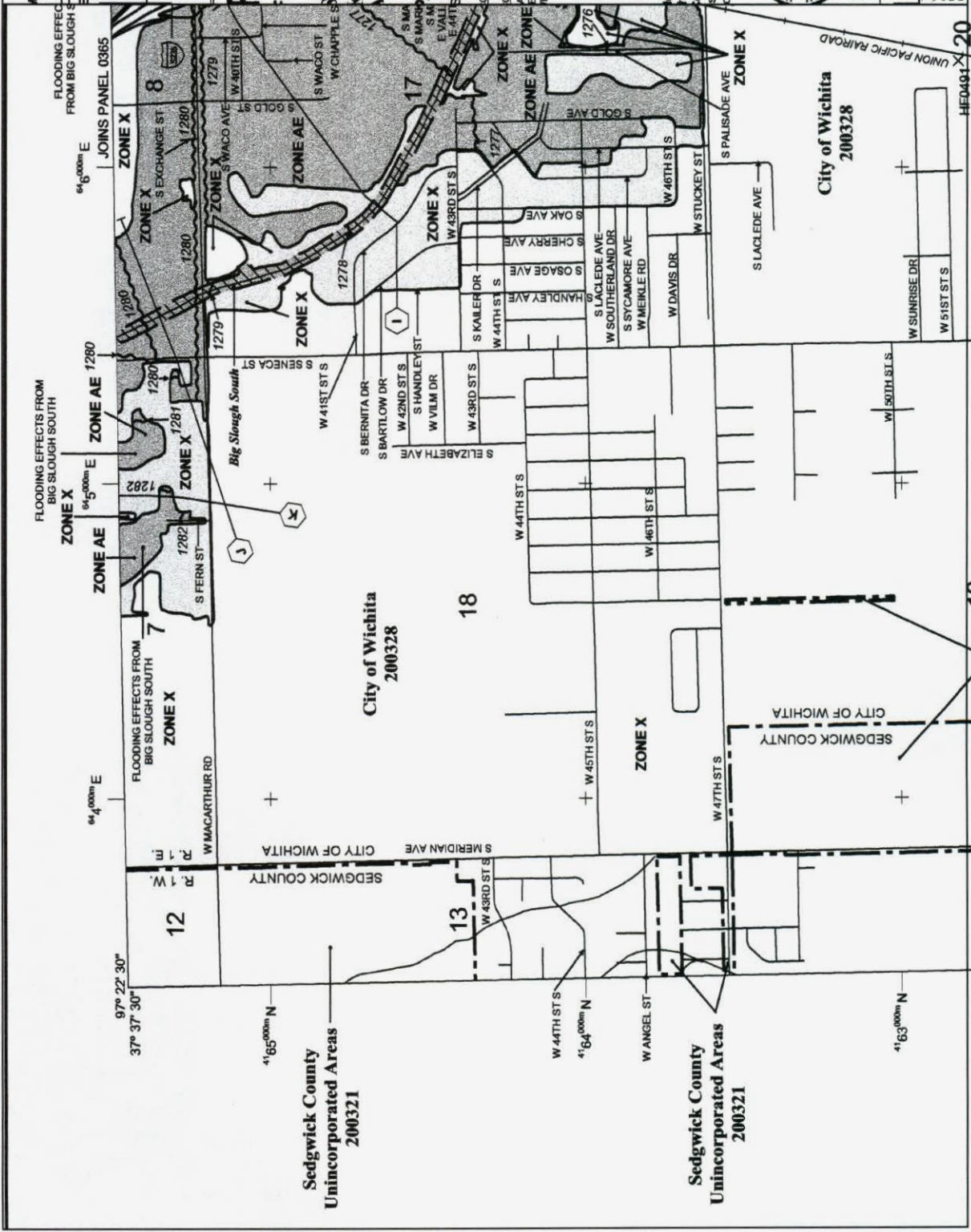
Notice to User: The Map Number shown below would be used when placing map orders; the community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
20173C0505E

EFFECTIVE DATE
FEBRUARY 2, 2007
Federal Emergency Management Agency



This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes to the flood insurance rate schedule since the date of the last published map in this block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



HE0491 X 20

Mr. Scott Lindebak, P.E., (Con't)
QT #0345R
May 23rd, 2013

EXISTING AND DEVELOPED DRAINAGE MAPS

ALAN DALE TOWES
PROFESSIONAL ENGINEER
NO. 5219
STATE OF KANSAS

PROJECT NO. 20131018

CED
CERTIFIED ENGINEERING DESIGN, P.A.
1935 W. MAPLE STREET
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PH: (316) 262-2888
FAX: (316) 262-1868

MACARTHUR ROAD & MERIDIAN AVENUE
WICHITA, KS

QuickTrip No. 0345R

GTL
A. CONSULTING GROUP ASSOCIATION, INC.
1000 W. CENTRAL AVENUE, SUITE 200
WICHITA, KS 67202-1000
PHONE: (316) 262-2888

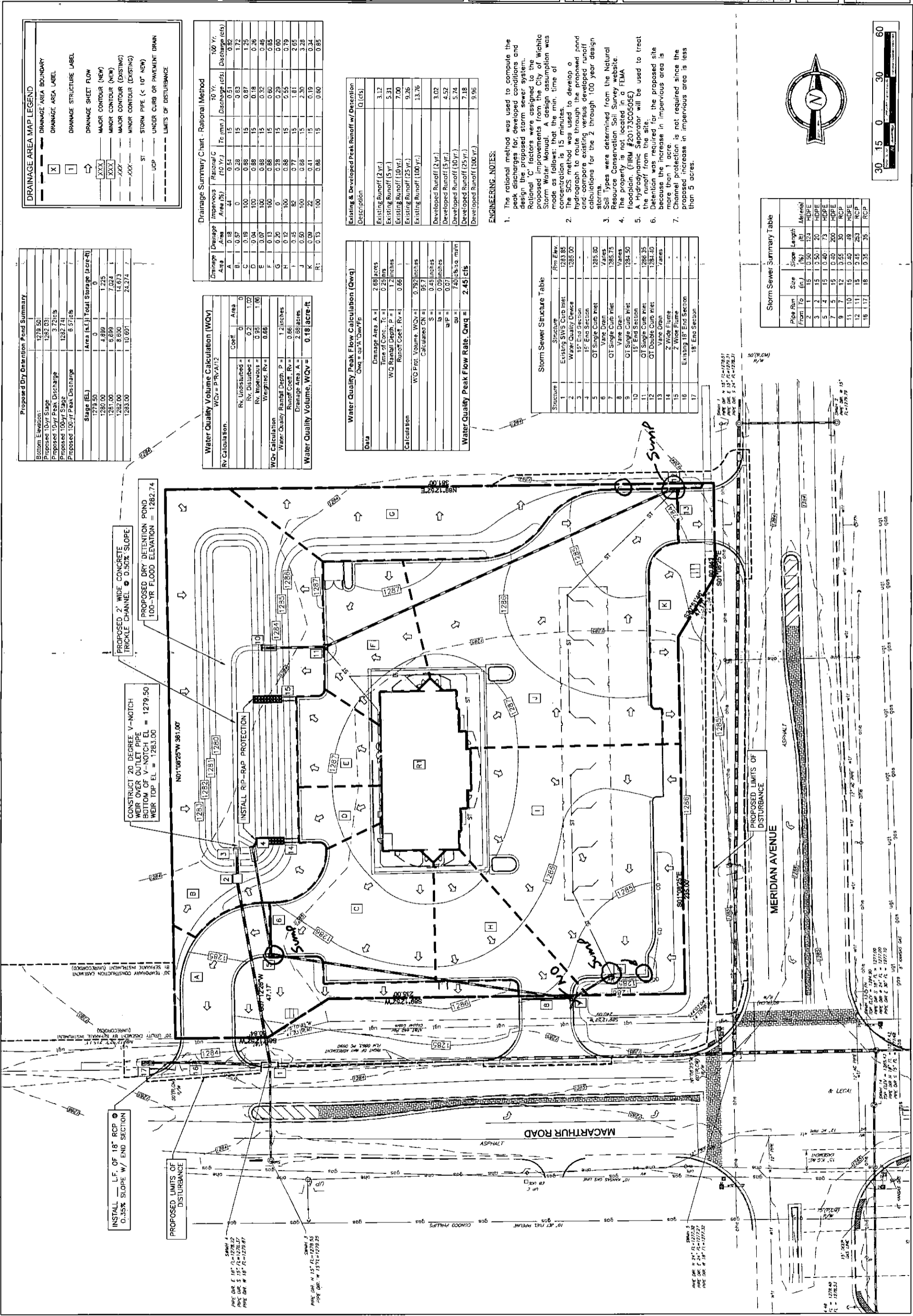
PROTOTYPE: P-25 (05/01/13)
DIVISION: WICHITA
VERSION: 001
DESIGNED BY: CWV
DRAWN BY: CWV
REVIEWED BY: NDF

REV	DATE	DESCRIPTION

ORIGINAL ISSUE DATE: _____

SHEET TITLE:
POST-DEVELOPED
DRAINAGE MAP

SHEET NUMBER:
2



Proposed Dry Detention Pond Summary

Bottom Elevation:	Area (sq. ft.)	Total Storage (acre-ft)
1278.50	0	0
Proposed 100yr Stage	4,889	1.225
Proposed 100yr Peak Discharge	1,281,000	7,824
Proposed 100yr Stage	8,609	14,673
Proposed 100-yr Peak Discharge	1,283,000	24,274
Proposed 100-yr Stage	10,691	17,274

Water Quality Volume Calculation (WQV)
WQV = P x R x A x I

Area (sq. ft.)	Area (acres)	WQV (cu ft)
0	0	0
4,889	0.112	1,225
1,281,000	29.3	7,824
8,609	0.196	5,265
1,283,000	29.4	8,115
10,691	0.243	6,115

Water Quality Volume, WQV = 0.18 acre-ft

Water Quality Peak Flow Calculation (Qwq)
Qwq = q_u x A_u x C_u x P_u

Structure	Structure	Runoff Coef.	Area (sq. ft.)	Peak Flow (cfs)
1	Existing SWS Curb Inlet	0.25	123,85	1.23
2	Water Quality Device	0.12	1,200	0.12
3	18" End Section	0.06	1,200	0.06
4	18" End Section	0.06	1,200	0.06
5	OT Single Curb Inlet	0.792	1,200	7.92
6	Vane Drain	0.09	1,200	0.09
7	Vane Drain	0.07	1,200	0.07
8	OT Single Curb Inlet	0.792	1,200	7.92
9	Vane Drain	0.09	1,200	0.09
10	OT Single Curb Inlet	0.792	1,200	7.92
11	OT Single Curb Inlet	0.792	1,200	7.92
12	OT Double Curb Inlet	0.792	1,200	7.92
13	Vane Drain	0.09	1,200	0.09
14	2" Wide Flume	0.07	1,200	0.07
15	2" Wide Flume	0.07	1,200	0.07
16	Existing 18" End Section	0.06	1,200	0.06
17	18" End Section	0.06	1,200	0.06

Water Quality Peak Flow Rate, Qwq = 2.45 cfs

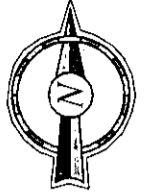
- ENGINEERING NOTES:**
- The rational method was used to compute the peak discharges for developed conditions and design the proposed storm sewer system. Rational "C" factors were assigned to the Storm Water Manual A and the City of Wichita Storm Water Manual A. The time of concentration was 15 minutes. The SCS method was used to develop a hydrograph to route through the proposed pond and compare existing versus developed runoff calculations for the 2 through 100 year design storms.
 - Soil Types were determined from the Natural Resource Conservation Soil Survey website. The property is not located in a FEMA floodplain. (FIRM #201730050E)
 - A Hydrodynamic Separator will be used to treat the runoff from the site.
 - Detention was required for the proposed area because the increase in impervious area is more than 1 acre.
 - Channel protection is not required since the proposed increase in impervious area is less than 5 acres.

DRAINAGE AREA MAP LEGEND

- DRAINAGE AREA BOUNDARY
- DRAINAGE AREA LABEL
- DRAINAGE STRUCTURE LABEL
- DRAINAGE SHEET FLOW
- MAJOR CONTOUR (NEW)
- MINOR CONTOUR (NEW)
- MAJOR CONTOUR (EXISTING)
- MINOR CONTOUR (EXISTING)
- ST
- STORM PIPE (< 10" NEW)
- UNDER CURB OR PAVEMENT DRAIN
- LIMITS OF DISTURBANCE

Storm Sewer Summary Table

Pipe Run From To	Size (in)	Length (ft)	Material
1	18	123	PIPE
2	18	123	PIPE
3	18	123	PIPE
4	18	123	PIPE
5	18	123	PIPE
6	18	123	PIPE
7	18	123	PIPE
8	18	123	PIPE
9	18	123	PIPE
10	18	123	PIPE
11	18	123	PIPE
12	18	123	PIPE
13	18	123	PIPE
14	18	123	PIPE
15	18	123	PIPE
16	18	123	PIPE
17	18	123	PIPE



Mr. Scott Lindebak, P.E., (Con't)

QT #0345R

May 23rd, 2013

STORM SEWER DESIGN SIZING AND 100-YR HYDRAULIC GRADE LINE CALCULATIONS

Storm Drain Computation Sheet

Project: OT #345R
 Computed By: Logan Mills
 Checked By: Harlan Foraker
 Date: 5/20/2013

Str ID	From	To	Length		Drainage Area		Runoff Coefficient	Area "C"		Time of Concentration		Rainfall (in/hr)	Runoff (cfs)	Pipe Diameter (in)	Q Full (cfs)	Velocity		Sec. Time (min)	Manning's n	Pipe Material	Min. Slope (%)
			(ft)	(in)	(Ac)	Total (Ac)		Inlet (Ac)	Total (Ac)	Inlet (min)	System (min)					Full (ft/s)	Design (ft/s)				
12	11	10	250	38	0.5	0.5	0.44	0.44	15	15.00	5.22	2.30	15	4.33	3.53	3.58	1.16	0.013	RCP	0.45	
11	10	7	38	0.26	0.76	0.88	0.23	0.67	15	16.16	5.08	3.40	15	4.43	3.61	3.98	0.16	0.012	HDPE	0.40	
9	7	5	28	0.45	0.45	0.77	0.35	0.35	15	15.00	5.22	1.81	12	2.64	3.36	3.62	0.13	0.013	RCP	0.55	
7	5	4	198	0.12	0.57	0.88	0.11	0.45	15	15.13	5.22	2.36	15	4.43	3.61	3.66	0.90	0.012	HDPE	0.40	
5	4	67	67	0.19	0.76	0.88	0.17	0.62	15	16.03	5.08	3.15	15	4.43	3.61	3.91	0.29	0.012	HDPE	0.40	

Project Description

File Name: OF #3458 - 100% - HSL - SPF

Project Options

Flow Units: CFS
 Elevation Type: Elevation
 Hydrology Method: Rational
 Time of Concentration (TOC) Method: User-Defined
 Link Rating Method: Hydrodynamic
 Enable Overflow Reading at Nodes: NO
 Stop Steady State Analysis Time Period: NO

Analysis Options

Start Analysis On: May 21, 2013 10:00:00
 End Analysis On: May 21, 2013 00:00:00
 Start Reporting On: May 21, 2013 00:00:00
 Antecedent Dry Days: 0 days
 Runoff (Dry Weather) Time Step: 0.010000 days (60 min)
 Runoff (Wet Weather) Time Step: 0.005000 days (30 min)
 Reporting Time Step: 0.000800 days (12 min)
 Routing Time Step: 30 seconds

Number of Elements

Rain Gauges: 1
 Subbasins: 5
 Nodes: 6
 Junctions: 7
 Outlets: 2
 Flow Dividers: 0
 Inlets: 0
 Storage Nodes: 0
 Links: 8
 Channels: 8
 Pipes: 8
 Pumps: 0
 Orifices: 0
 Weirs: 0
 Orifices: 0
 Pumps: 0
 Land Loss: 0

Rainfall Details

Return Period: 100 years

Subbasin Summary

Subbasin ID	Area Coefficient	Weighted Runoff	Total Runoff	Total Runoff	Peak Runoff	Time of Concentration
	(sq ft)	(cfs)	(cfs)	(cfs)	(cfs)	(minutes)
1 Developed L	0.10	0.8000	1.84	1.54	0.31	1.25
2 Developed P and R1	0.26	0.8000	1.84	1.64	0.43	1.71
3 Developed H	0.12	0.8000	1.84	1.64	0.20	0.78
4 Developed I	0.46	0.8000	1.84	1.47	0.60	2.45
5 Developed J	0.50	0.8000	1.84	1.64	0.32	1.28

Node Summary

SN Element ID	Element Type	Invert Elevation	Groundwater Elevation	Initial Water Elevation	Surcharge	Flow Area	Peak Flow	Min. Elevation	Max. Elevation	Surcharge Depth	Freeboard	Time of Peak	Total Time	Total Time
		(ft)	(ft)	(ft)	(ft)	(sq ft)	(cfs)	(ft)	(ft)	(ft)	(ft)	(min)	(min)	(min)
1.5	Junction	1280.37	1280.30	0.00	0.00	5.10	1287.69	0.00	2.52	0.0000	0.00	0.00	0.00	0.00
2.7	Junction	1281.26	1281.26	0.00	0.00	0.40	1283.11	0.00	2.14	0.0000	0.00	0.00	0.00	0.00
3.9	Junction	1281.51	1284.00	0.00	0.00	2.84	1283.44	0.00	0.56	0.0000	0.00	0.00	0.00	0.00
4.11	Junction	1280.30	1281.86	0.00	0.00	6.98	1283.13	0.00	2.72	0.0000	0.00	0.00	0.00	0.00
8.12	Junction	1281.64	1283.90	0.00	0.00	3.27	1283.22	0.00	0.68	0.0000	0.00	0.00	0.00	0.00
9.4	Outlet	1280.10					1282.00							
7.10	Outlet	1280.20					1282.00							

Link Summary

SN Element ID	Element Type	Material	From Elevation	To Elevation	Length	Inlet Invert	Outlet Invert	Average Slope	Diameter	Manhole	Peak Flow	Depth	Flow	Peak Flow	Peak Flow	Peak Flow	Peak Flow	Time Reported
			(ft)	(ft)	(ft)	(ft)	(ft)	(%)	(in)	(ft)	(cfs)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(min)
1 Link 01	Pipe	3	4	81.00	1280.37	1280.30	0.4000	15.000	0.120	5.74	4.44	1.76	6.88	1.2	1.0	29.00	SURCHARGED	
2 Link 02	Pipe	7	9	180.00	1281.26	1280.10	0.4000	15.000	0.020	3.41	4.42	0.17	2.78	1.2	1.0	9.10	SURCHARGED	
3 Link 03	Pipe	9	7	27.00	1281.51	1281.36	0.5000	12.000	0.020	2.47	2.61	1.01	1.34	1.0	1.0	12.00	SURCHARGED	
4 Link 04	Pipe	11	10	38.00	1280.30	1280.20	0.3000	15.000	0.020	5.05	4.40	1.30	5.03	1.5	1.0	29.00	SURCHARGED	
5 Link 05	Pipe	12	11	250.00	1281.54	1280.45	0.4000	15.000	0.020	3.23	4.34	0.75	2.97	1.5	1.0	4.10	SURCHARGED	

Subbasin Hydrology

Subbasin : Developed C

Input Data

Area (ac) 0.19
 Weighted Runoff Coefficient 0.8900

Runoff Coefficient

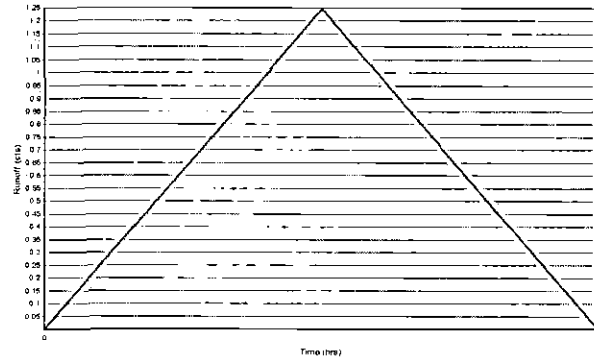
Soil/Surface Description	Area (ac)	Soil Group	Runoff Coeff.
.....	0.18	0.92
Composite Area & Weighted Runoff Coeff.	1.19		0.92

Subbasin Runoff Results

Total Rainfall (in) 1.84
 Total Runoff (in) 1.64
 Peak Runoff (cfs) 1.25
 Rainfall Intensity 7.370
 Weighted Runoff Coefficient 0.8900
 Time of Concentration (days/h/miles) 0.92/15.30

Subbasin : Developed C

Runoff Hydrograph



Subbasin : Developed F and R1

Input Data

Area (ac) 0.78
 Weighted Runoff Coefficient 0.8900

Runoff Coefficient

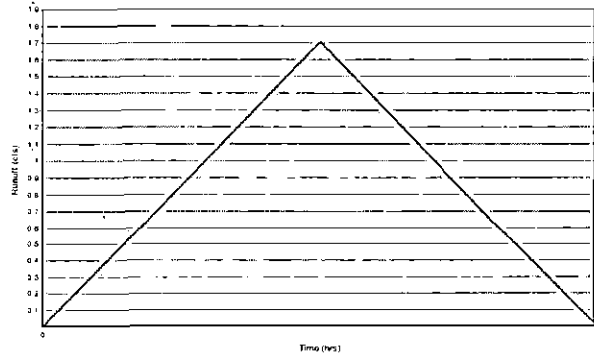
Soil/Surface Description	Area (ac)	Soil Group	Runoff Coeff.
.....	0.78	0.89
Composite Area & Weighted Runoff Coeff.	0.78		0.89

Subbasin Runoff Results

Total Rainfall (in) 1.84
 Total Runoff (in) 1.64
 Peak Runoff (cfs) 1.71
 Rainfall Intensity 7.370
 Weighted Runoff Coefficient 0.8900
 Time of Concentration (days/h/miles) 0.92/15.30

Subbasin : Developed F and R1

Runoff Hydrograph



Subbasin : Developed H

Input Data

Area (ac) 2.12
 Weighted Runoff Coefficient 0.8900

Runoff Coefficient

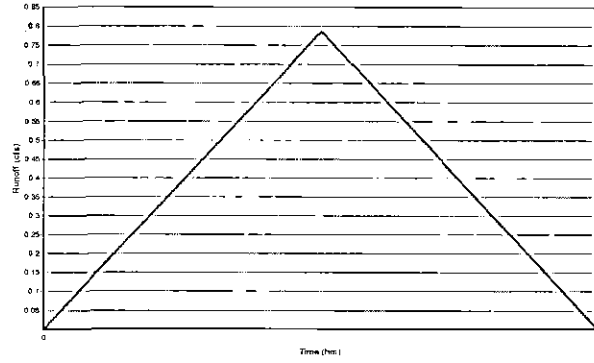
Soil/Surface Description	Area (ac)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	2.12		0.89

Subbasin Runoff Results

Total Rainfall (in) 1.84
 Total Runoff (in) 1.64
 Peak Runoff (cfs) 0.79
 Rainfall Intensity 7.370
 Weighted Runoff Coefficient 0.8900
 Time of Concentration (days hours min sec) 0:00:15.30

Subbasin : Developed H

Runoff Hydrograph



Subbasin : Developed I

Input Data

Area (ac) 2.46
 Weighted Runoff Coefficient 0.8900

Runoff Coefficient

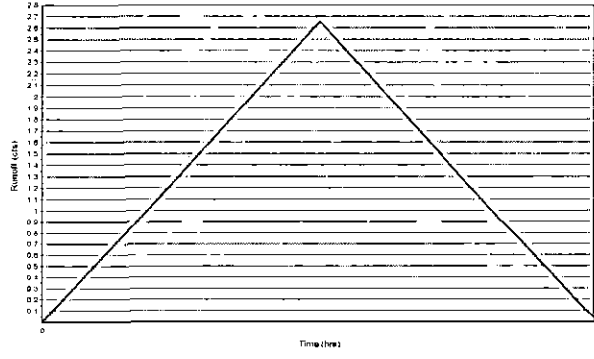
Soil/Surface Description	Area (ac)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	2.46		0.89

Subbasin Runoff Results

Total Rainfall (in) 1.84
 Total Runoff (in) 1.64
 Peak Runoff (cfs) 2.98
 Rainfall Intensity 7.370
 Weighted Runoff Coefficient 0.8900
 Time of Concentration (days hours min sec) 0:00:15.30

Subbasin : Developed I

Runoff Hydrograph



Subbasin : Developed J

Input Data

Area (ac) ----- 0.50
 Weighted Runoff Coefficient ----- 0.8900

Runoff Coefficient

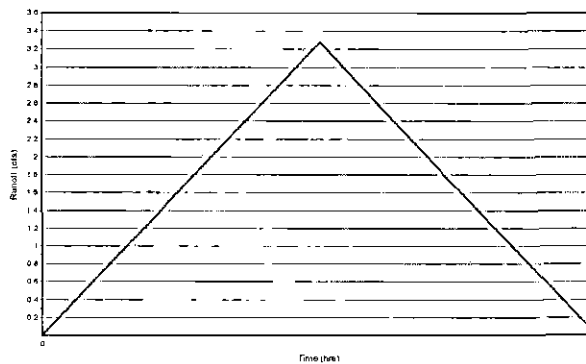
Soil/Surface Description	Area (Acres)	Soil Group	Runoff Coeff.
-----	0.60	-----	0.89
Composite Area & Weighted Runoff Coeff.	0.50	-----	0.89

Subbasin Runoff Results

Total Rainfall (in) ----- 1.84
 Total Runoff (in) ----- 1.64
 Peak Runoff (cfs) ----- 526
 Peak Intensity ----- 7.372
 Weighted Runoff Coefficient ----- 0.8900
 Time of Concentration (days/hh:mm:ss) ----- 0:00:15.00

Subbasin : Developed J

Runoff Hydrograph



Junction Input

SN Element ID	Invert Elevation (ft)	Groundline Elevation (ft)	Groundwater Elevation (ft)	Inlet Water Depth (ft)	Water Elevation (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Flow Area (sq ft)	Minimum Pipe Cover (ft)
1.6	1280.37	1285.30	4.93	0.00	1280.37	0.00	-1285.30	0.00	0.00
2.7	1281.25	1285.05	3.80	0.00	1281.25	0.00	-1285.05	0.00	0.00
3.9	1281.51	1284.30	2.79	0.00	1281.51	0.00	-1284.00	0.00	0.00
4.11	1280.36	1285.85	5.50	0.00	1280.36	0.00	-1285.85	0.00	0.00
5.12	1281.98	1283.90	2.02	0.00	1281.98	0.00	-1283.90	0.00	0.00

Junction Results

SN Element ID	Peak Inflow (cfs)	Peak Inflow (cfs)	Peak Elevation (ft)	Max HGL (ft)	Max HGL Depth (ft)	Max Surge Depth (ft)	Min Surge Depth (ft)	Average Surge (ft)	Average HGL Elevation (ft)	Average HGL Depth (ft)	Time of Max HGL Occurrence (days/hh:mm)	Time of Peak Flooding Occurrence (days/hh:mm)	Total Time Flooded (hours)	Total Time Flooded (hours)
1.6	5.18	124	1282.68	2.31	2.00	2.62	1282.06	1.72	0.00:00	0.00:00	0.00:00	0.00	0.00	
2.7	3.00	0.78	1283.11	1.85	0.00	2.14	1283.23	0.96	0.00:15	0.00:00	0.00:00	0.00	0.00	
3.9	2.86	2.64	1283.44	1.93	0.00	0.58	1283.34	0.83	0.00:15	0.00:00	0.00:00	0.00	0.00	
4.11	6.98	1.00	1283.13	2.38	0.00	2.12	1283.08	1.72	0.00:00	0.00:00	0.00:00	0.00	0.00	
5.12	3.27	3.27	1283.22	1.84	0.00	0.58	1283.28	1.07	0.00:15	0.00:00	0.00:00	0.00	0.00	

Mr. Scott Lindebak, P.E., (Con't)

QT #0345R

May 23rd, 2013

TIME OF CONCENTRATION CALCS

Project: CT-#0345R
 Feature: Time of Concentration Calcs
 Analyst: Logan Mills
 Version: 3/14/2013
 Notes:

Sheet	Subbasin	Number of Segments	Sheet Flow (mins)	Shallow Concentrated Flow (mins)	Open Channel Ditch Flow (mins)	Open Channel Pipe Flow (mins)	Open Channel General Flow (mins)	Other (mins)	Total Tc (mins)	Length (feet)	Drop (feet)	Avg. Slope (%)	Avg. Vel. (fps)	Lag (mins)	Lag (hours)	Area (acres)
1	Existing A	2	17.1	2.9	0.0	0.0	0.0	0.0	20.0	254	2	0.83	0.21	12.0	0.200	1.83
2	Existing B	1	16.9	0.0	0.0	0.0	0.0	0.0	16.9	92	0	0.50	0.09	10.1	0.169	1.04
3	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
4	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
5	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
6	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
7	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
8	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
9	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
10	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
11	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
12	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
13	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
14	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	0.00	0.82	16.4	0.273	500
15	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
16	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
17	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
18	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
19	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
20	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
21	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
22	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
23	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
24	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
25	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500
26	0	6	20.3	2.4	0.1	0.2	0.1	4.2	27.3	1350	47	3.48	0.82	16.4	0.273	500

Mr. Scott Lindebak, P.E., (Con't)

QT #0345R

May 23rd, 2013

2' WIDE FLUME CALCULATIONS

2' WIDE FLUME @ 1% SLOPE

Project Description

Friction Method Manning Formula
Solve For Discharge

Input Data

Roughness Coefficient 0.016
Channel Slope 0.01000 ft/ft
Normal Depth 0.25 ft
Bottom Width 2.00 ft

Results

Discharge 1.59 ft³/s
Flow Area 0.50 ft²
Wetted Perimeter 2.50 ft
Hydraulic Radius 0.20 ft
Top Width 2.00 ft
Critical Depth 0.27 ft
Critical Slope 0.00794 ft/ft
Velocity 3.18 ft/s
Velocity Head 0.16 ft
Specific Energy 0.41 ft
Froude Number 1.12
Flow Type Supercritical

GVF Input Data

Downstream Depth 0.00 ft
Length 0.00 ft
Number Of Steps 0

GVF Output Data

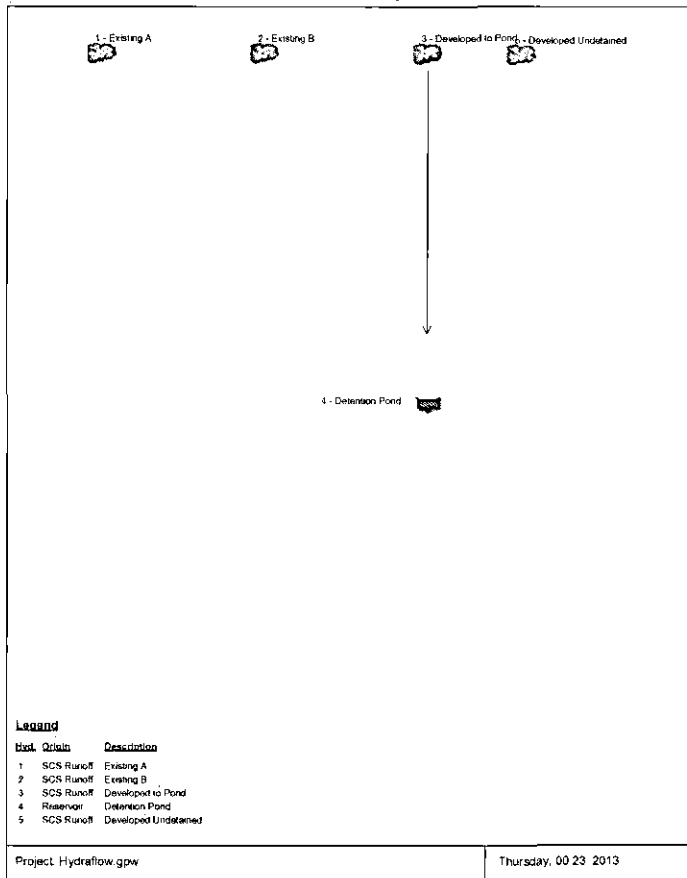
Upstream Depth 0.00 ft
Profile Description
Profile Headloss 0.00 ft
Downstream Velocity Infinity ft/s
Upstream Velocity Infinity ft/s
Normal Depth 0.25 ft
Critical Depth 0.27 ft
Channel Slope 0.01000 ft/ft
Critical Slope 0.00794 ft/ft

Mr. Scott Lindebak, P.E., (Con't)
QT #0345R
May 23rd, 2013

HYDRAFLOW HYDROGRAPHS CALCULATIONS

Watershed Model Schematic

HydroFlow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9



Hydrograph Return Period Recap

HydroFlow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)							Hydrograph Description	
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr		100-yr
1	SCS Runoff	---	---	2,121	---	3,612	4,755	6,303	---	9,362	Existing A
2	SCS Runoff	---	---	0,997	---	1,608	2,235	2,982	---	4,400	Existing B
3	SCS Runoff	---	---	7,323	---	9,782	11,46	13,62	---	17,69	Developed to Pond
4	Reservoir	3	---	1,871	---	2,851	3,718	4,684	---	6,571	Detention Pond
5	SCS Runoff	---	---	1,149	---	1,863	2,028	2,406	---	3,380	Developed Undrainable

Proj. file: Hydroflow.gpw Thursday, 00 23, 2013

Hydrograph Summary Report

HydroFlow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total storage used (cuft)	Hydrograph Description
1	SCS Runoff	2,121	2'	726	7,066	---	---	---	Existing A
2	SCS Runoff	0,997	2	726	3,321	---	---	---	Existing B
3	SCS Runoff	7,323	2	722	21,392	---	---	---	Developed to Pond
4	Reservoir	1,871	2	738	21,168	3	1281.39	10,920	Detention Pond
5	SCS Runoff	1,149	2	722	3,221	---	---	---	Developed Undrainable

Hydroflow.gpw Return Period: 2 Year Thursday, 00 23 2013

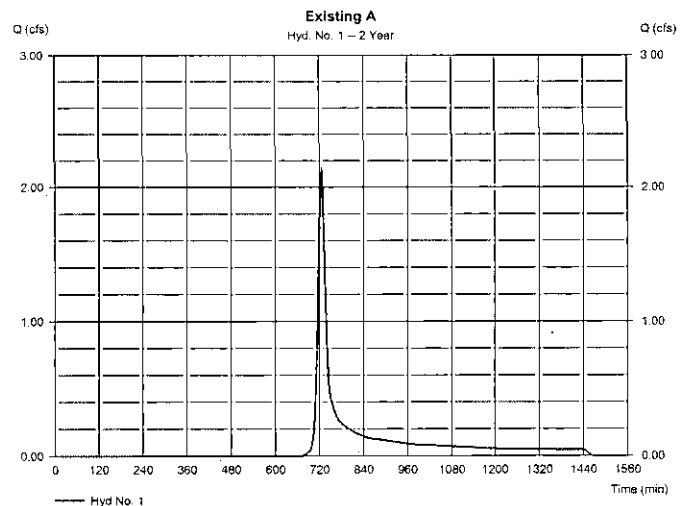
Hydrograph Report

HydroFlow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9 Thursday, 00 23, 2013

Hyd. No. 1

Existing A

Hydrograph type	= SCS Runoff	Peak discharge	= 2,121 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 7,066 cuft
Drainage area	= 1.830 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

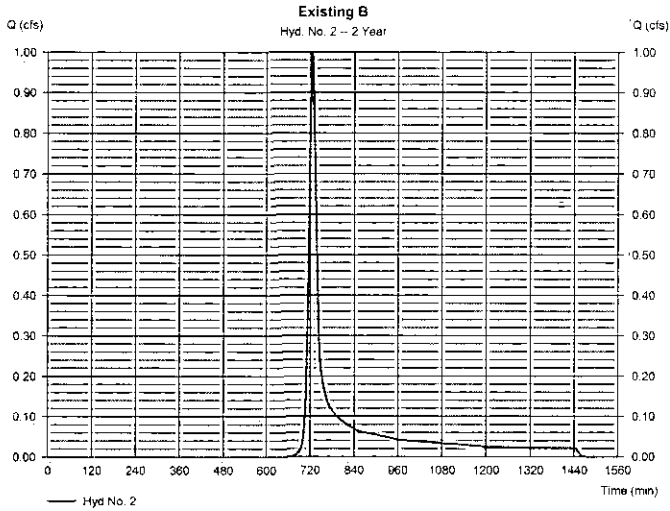


Hydrograph Report

Hyd. No. 2

Existing B

Hydrograph type	= SCS Runoff	Peak discharge	= 0.997 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 3,321 cuft
Drainage area	= 0.860 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.00 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



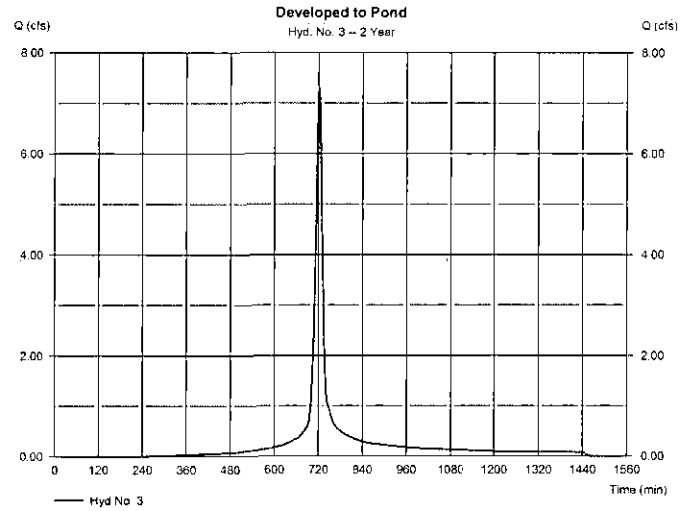
Hydrograph Report

Hyd. No. 3

Developed to Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 7.323 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 21,392 cuft
Drainage area	= 2,210 ac	Curve number	= 93
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1,550 * 94) + (0,660 * 80)] / 2,210



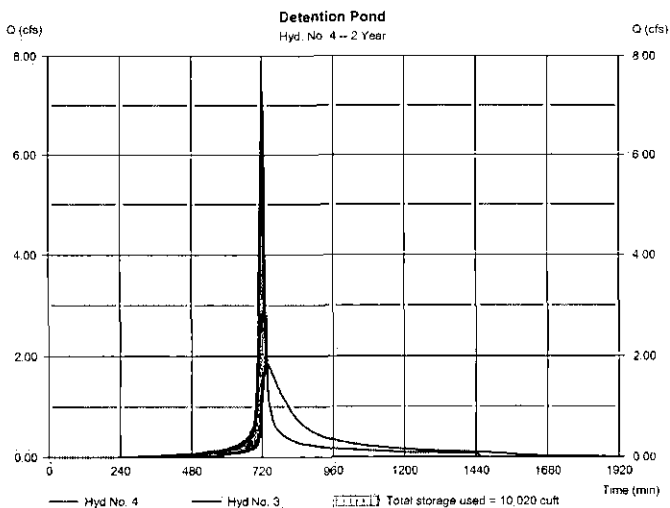
Hydrograph Report

Hyd. No. 4

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 1.871 cfs
Storm frequency	= 2 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 21,188 cuft
Inflow hyd. No.	= 3 - Developed to Pond	Max. Elevation	= 1281.39 ft
Reservoir name	= Detention Pond	Max. Storage	= 10,020 cuft

Storage Inflection method used



Pond Report

Pond No. 1 - Detention Pond

Pond Data

Contours - User-defined contour area. Average end area method used for volume calculation. Beginning Elevation = 1279.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1279.50	0.00	0	0
0.50	1280.00	4,809	1,225	1,225
1.50	1281.00	8,690	5,796	7,024
2.50	1282.00	8,600	7,850	14,873
3.50	1283.00	10,901	9,901	24,774

Culvert / Orifice Structures

	[A]	[B]	[C]	[Pr/Rsr]
Rise (in)	= 15.00	0.00	0.00	0.00
Span (in)	= 15.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 1279.50	0.00	0.00	0.00
Length (ft)	= 20.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= 0.12	0.13	0.13	n/a
Orifice Coeff.	= 0.80	0.80	0.80	0.80
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len. (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 1279.50	0.00	0.00	0.00
Weir Coeff.	= 0.45	3.33	3.33	3.33
Weir Type	= 20 (sg)	---	---	---
Multi-Stage	= Yes	No	No	No
Exit Elev. (ft)	= 0.000 (by Contour)	---	---	---
TW Elev. (ft)	= 0.00	---	---	---

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Cv A cfs	Cv B cfs	Cv C cfs	Pr/Rsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	1279.50	0.00	---	---	---	---	---	---	---	---	---	0.000
0.50	1,225	1280.00	0.08 c	---	---	---	0.08 s	---	---	---	---	---	0.075
1.50	7,024	1281.00	1.11 c	---	---	---	1.10 s	---	---	---	---	---	1.101
2.50	14,873	1282.00	3.50 c	---	---	---	3.50 s	---	---	---	---	---	3.500
3.50	24,774	1283.00	7.65 c	---	---	---	7.65 s	---	---	---	---	---	7.653

Note: Culvert/Orifice structures are analyzed under wet (w) and dry (d) states. Weir flows checked for orifice conditions and submergence.

Hydrograph Report

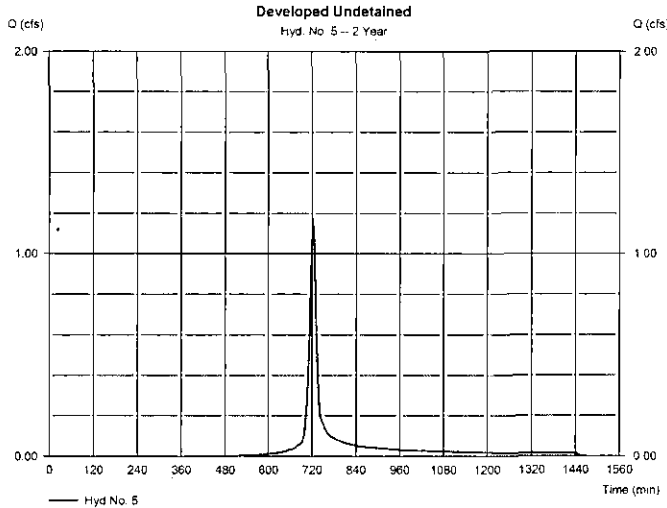
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9 Thursday, 00 23, 2013

Hyd. No. 5

Developed Undetained

Hydrograph type	= SCS Runoff	Peak discharge	= 1,149 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 3,221 cuft
Drainage area	= 0.470 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 98) + (0.370 x 80)] / 0.470



Hydrograph Summary Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

Hyd No.	Hydrograph type (origin)	Peak flow (cfs)	Time Interval (min)	Time to Peak (min)	Hyd volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.612	2	726	11,601	----	----	----	Existing A
2	SCS Runoff	1.866	2	726	5,452	----	----	----	Existing B
3	SCS Runoff	9.762	2	722	29,002	----	----	----	Developed to Pond
4	Reservoir	2.861	2	736	26,768	3	1261.79	13,073	Detention Pond
5	SCS Runoff	1.663	2	722	4,985	----	----	----	Developed Undetained

Hydroflow.gvw Return Period: 5 Year Thursday, 00 23, 2013

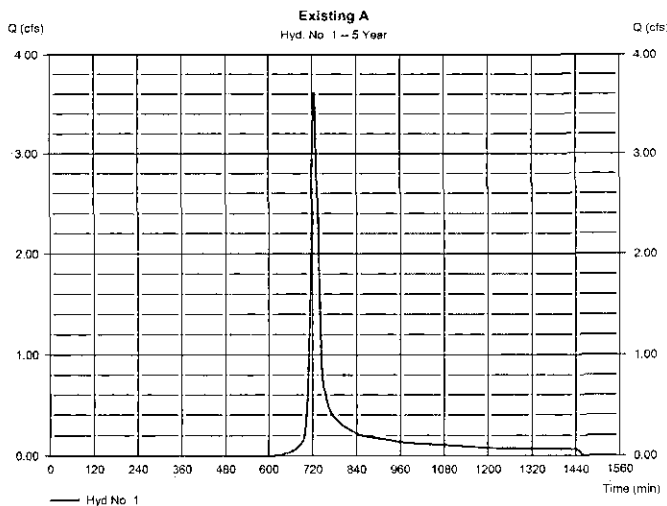
Hydrograph Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9 Thursday, 00 23, 2013

Hyd. No. 1

Existing A

Hydrograph type	= SCS Runoff	Peak discharge	= 3,612 cfs
Storm frequency	= 5 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 11,601 cuft
Drainage area	= 1.830 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 4.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



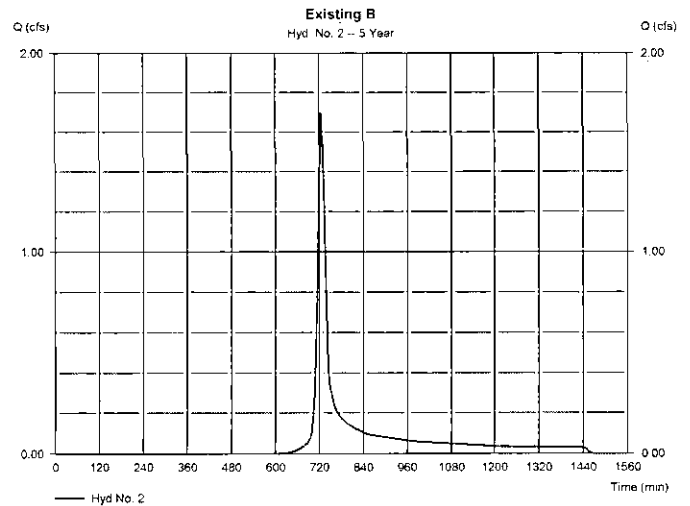
Hydrograph Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9 Thursday, 00 23, 2013

Hyd. No. 2

Existing B

Hydrograph type	= SCS Runoff	Peak discharge	= 1,698 cfs
Storm frequency	= 5 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 5,452 cuft
Drainage area	= 0.860 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.00 min
Total precip.	= 4.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

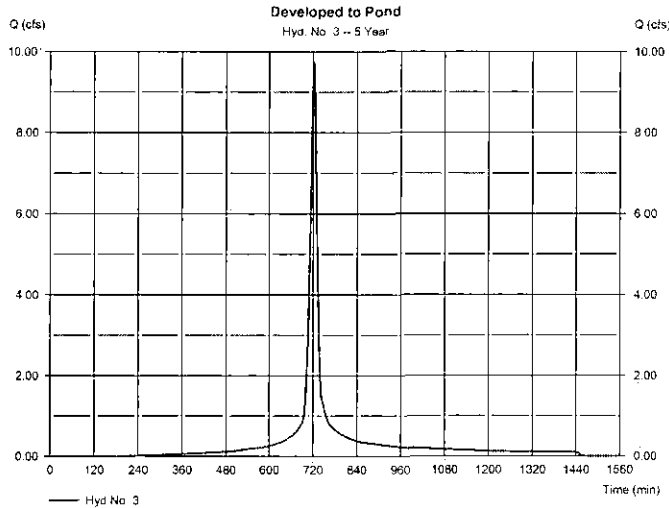
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9 Thursday, 09/23/2013

Hyd. No. 3

Developed to Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 9.762 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 29.002 cuft
Drainage area	= 2.210 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 4.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.550 x 98) + (0.060 x 80)] / 2.210



Hydrograph Report

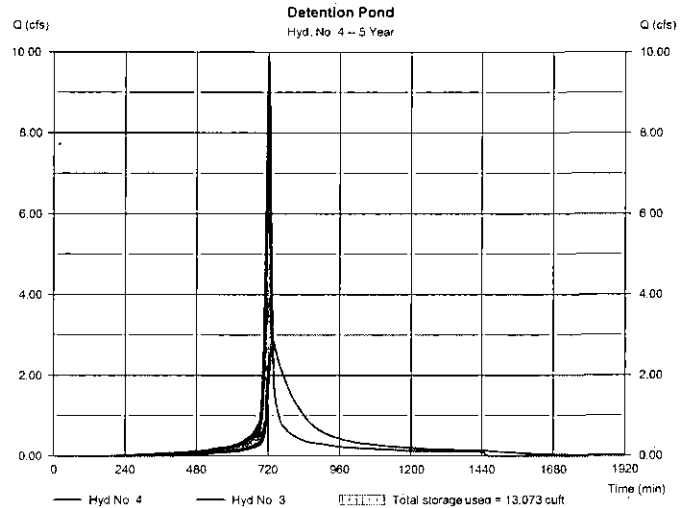
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9 Thursday, 09/23/2013

Hyd. No. 4

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 2.861 cfs
Storm frequency	= 5 yrs	Time to peak	= 736 min
Time interval	= 2 min	Hyd. volume	= 28.798 cuft
Inflow hyd. No.	= 3 - Developed to Pond	Max. Elevation	= 1281.79 ft
Reservoir name	= Detention Pond	Max. Storage	= 13,073 cuft

Storage Indication method used



Hydrograph Report

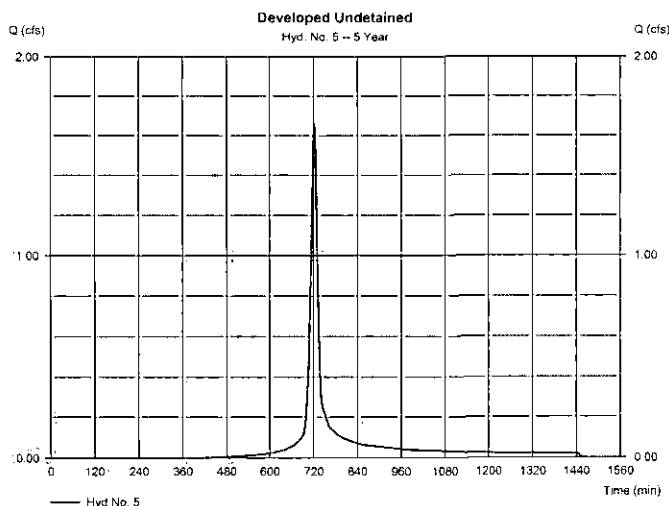
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9 Thursday, 09/23/2013

Hyd. No. 5

Developed Undetained

Hydrograph type	= SCS Runoff	Peak discharge	= 1.663 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 4.685 cuft
Drainage area	= 0.470 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 4.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 88) + (0.370 x 80)] / 0.470



Hydrograph Summary Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	4.755	2	724	15.072	---	---	---	Existing A
2	SCS Runoff	2.235	2	724	7.063	---	---	---	Existing B
3	SCS Runoff	11.46	2	722	34.372	---	---	---	Developed to Pond
4	Reservoir	3.718	2	736	34.169	3	1282.04	13,004	Detention Pond
5	SCS Runoff	2.028	2	722	5.745	---	---	---	Developed Undetained
Hydroflow gww						Return Period: 10 Year		Thursday, 09/23/2013	

Hydrograph Report

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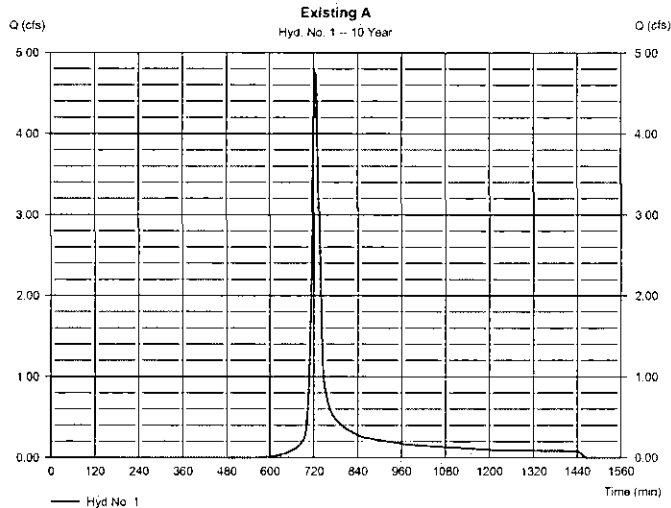
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

Thursday, 09/23/2013

Hyd. No. 1

Existing A

Hydrograph type	= SCS Runoff	Peak discharge	= 4.756 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 15,072 cuft
Drainage area	= 1.830 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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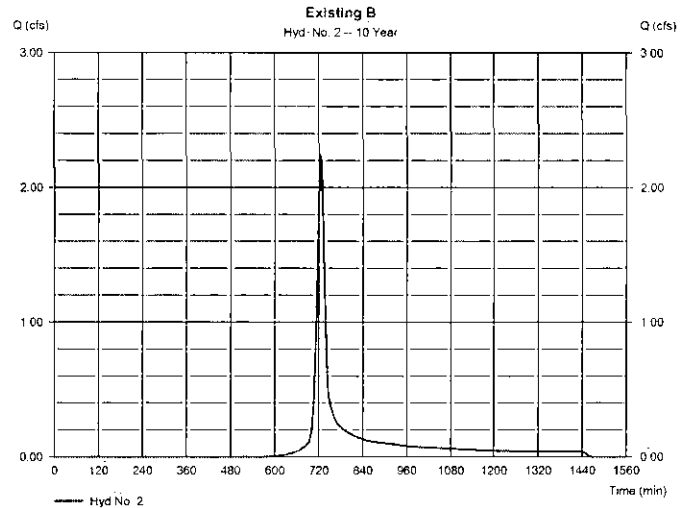
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

Thursday, 09/23/2013

Hyd. No. 2

Existing B

Hydrograph type	= SCS Runoff	Peak discharge	= 2.235 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 7,083 cuft
Drainage area	= 0.860 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

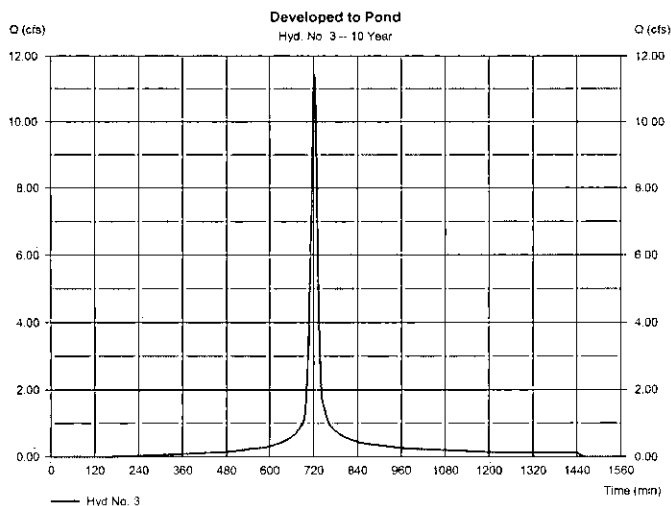
Thursday, 09/23/2013

Hyd. No. 3

Developed to Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 11.46 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 34,372 cuft
Drainage area	= 2.210 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/Cn) = [(1.550 x 98) + (0.000 x 0)] / 2.210



Hydrograph Report

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Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

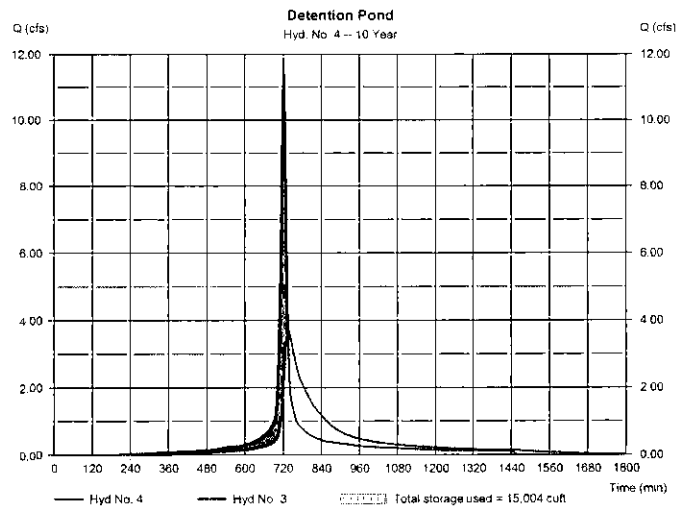
Thursday, 09/23/2013

Hyd. No. 4

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 3.718 cfs
Storm frequency	= 10 yrs	Time to peak	= 736 min
Time interval	= 2 min	Hyd. volume	= 34,169 cuft
Inflow hyd. No.	= 3 - Developed to Pond	Max. Elevation	= 1282.04 ft
Reservoir name	= Detention Pond	Max. Storage	= 15,004 cuft

Storage indication method used:



Hydrograph Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v8

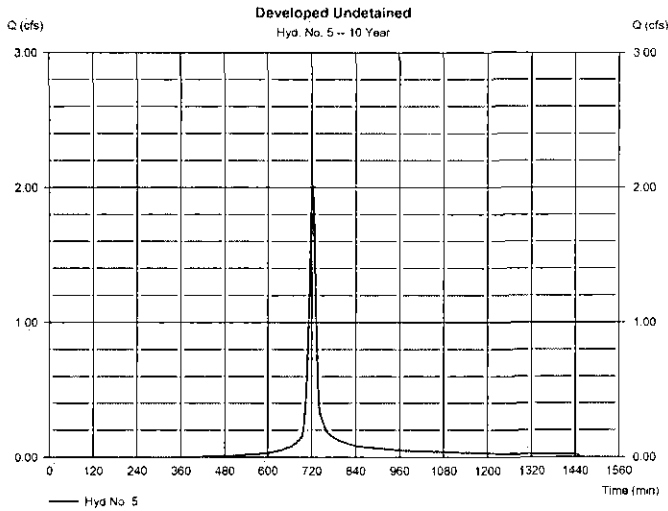
Thursday, 09/23, 2013

Hyd. No. 5

Developed Undetained

Hydrograph type	= SCS Runoff	Peak discharge	= 2.028 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 5,745 cuft
Drainage area	= 0.470 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (AreaCN) = [(0.100 x 28) + (0.370 x 26)] / 0.170



Hydrograph Summary Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total stage used (cuft)	Hydrograph Description
1	SCS Runoff	9.303	2	724	19,793	---	---	---	Existing A
2	SCS Runoff	2.902	2	724	0.302	---	---	---	Existing B
3	SCS Runoff	13.62	2	722	41,306	---	---	---	Developed to Pond
4	Reservoir	4.884	2	738	41,106	3	1282.29	17,415	Detention Pond
5	SCS Runoff	2.496	2	722	7,136	---	---	---	Developed Undetained

Hydroflow.gpw Return Period: 25 Year Thursday, 09/23, 2013

Hydrograph Report

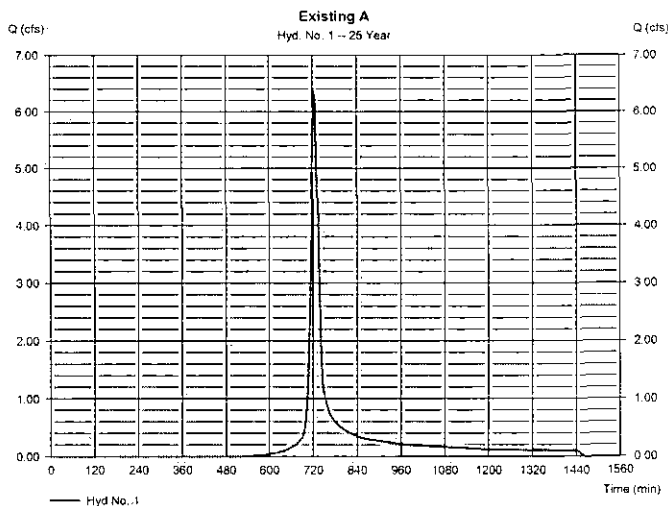
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v8

Thursday, 09/23, 2013

Hyd. No. 1

Existing A

Hydrograph type	= SCS Runoff	Peak discharge	= 6.303 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 19,793 cuft
Drainage area	= 1.830 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 6.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

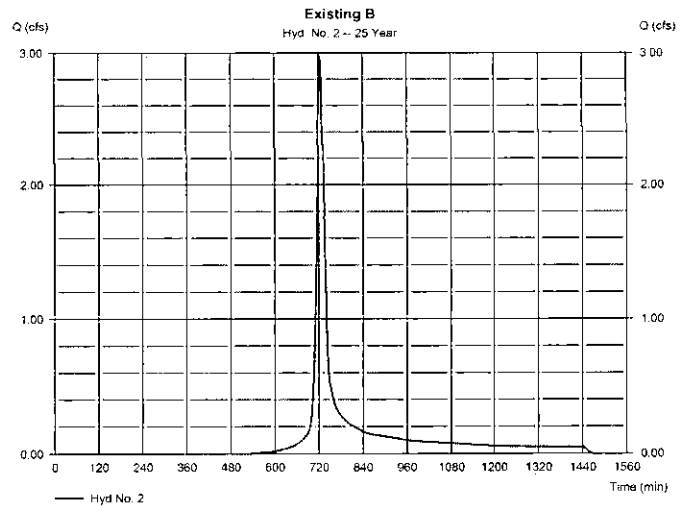
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v8

Thursday, 09/23, 2013

Hyd. No. 2

Existing B

Hydrograph type	= SCS Runoff	Peak discharge	= 2.962 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 9,302 cuft
Drainage area	= 0.860 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.00 min
Total precip.	= 6.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

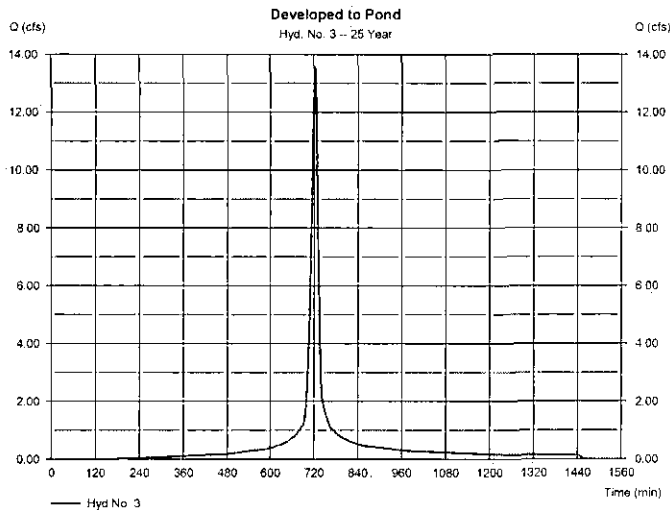
Thursday, 09/23/2013

Hyd. No. 3

Developed to Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 13.62 cfs
Storm frequency	= 25 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 41,309 cuft
Drainage area	= 2.210 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 6.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.550 * 98) + (0.000 * 80)] / 2.210



Hydrograph Report

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Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

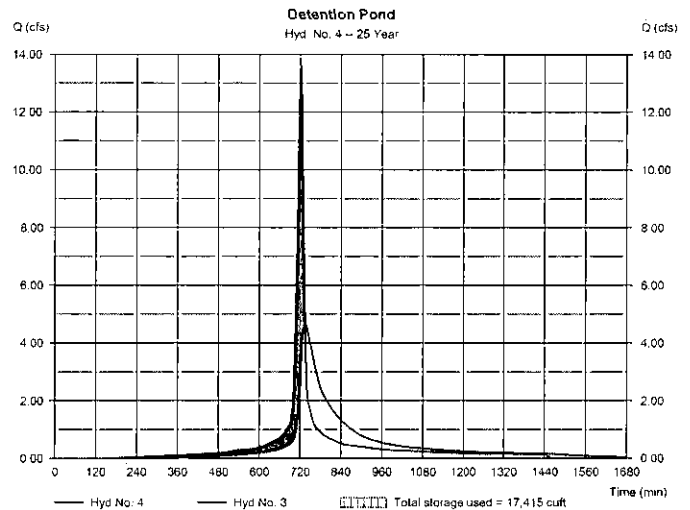
Thursday, 09/23/2013

Hyd. No. 4

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 4.684 cfs
Storm frequency	= 25 yrs	Time to peak	= 736 min
Time interval	= 2 min	Hyd. volume	= 41,106 cuft
Inflow hyd. No.	= 3 - Developed to Pond	Max. Elevation	= 1282.29 ft
Reservoir name	= Detention Pond	Max. Storage	= 17,415 cuft

Storage Indication method used



Hydrograph Report

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Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

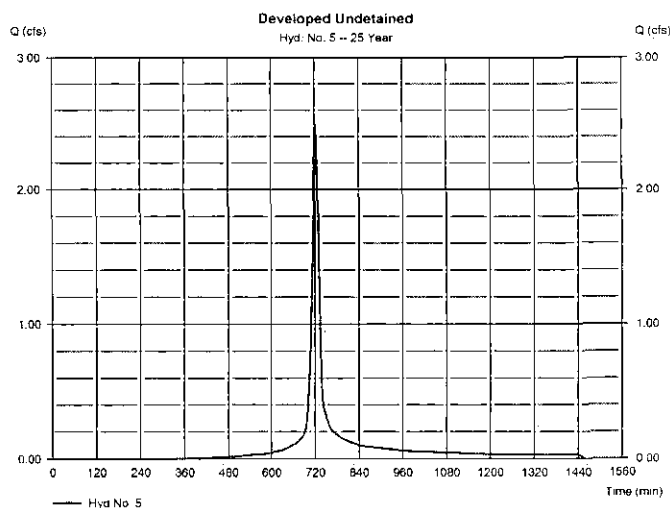
Thursday, 09/23/2013

Hyd. No. 5

Developed Undetained

Hydrograph type	= SCS Runoff	Peak discharge	= 2.499 cfs
Storm frequency	= 25 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 7,136 cuft
Drainage area	= 0.470 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 6.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 * 98) + (0.370 * 80)] / 0.470



Hydrograph Summary Report

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Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. v9

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total storage used (cuft)	Hydrograph Description
1	SCS Runoff	9.382	2	724	20,298	----	----	----	Existing A
2	SCS Runoff	4.400	2	724	13,755	----	----	----	Existing B
3	SCS Runoff	17.68	2	722	54,472	----	----	----	Developed to Pond
4	Reservoir	6.571	2	734	54,269	3	1282.74	21,781	Detention Pond
5	SCS Runoff	3.388	2	722	9,820	----	----	----	Developed Undetained

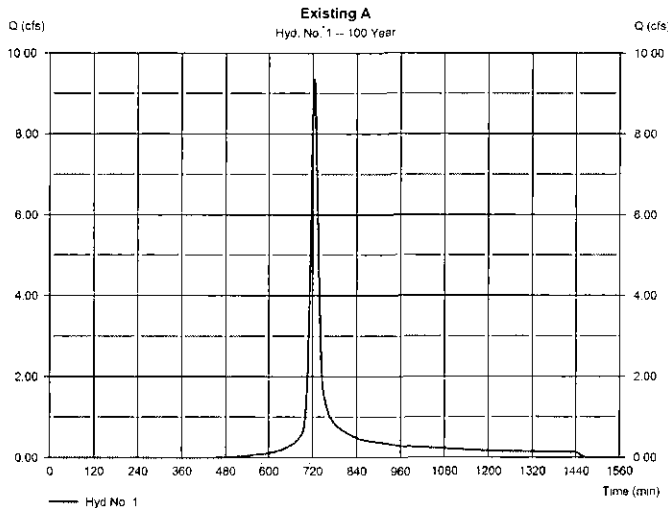
Hydroflow.gpw Return Period: 100 Year Thursday, 09/23/2013

Hydrograph Report

Hyd. No. 1

Existing A

Hydrograph type	= SCS Runoff	Peak discharge	= 9.362 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 29,268 cuft
Drainage area	= 1.830 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 7.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

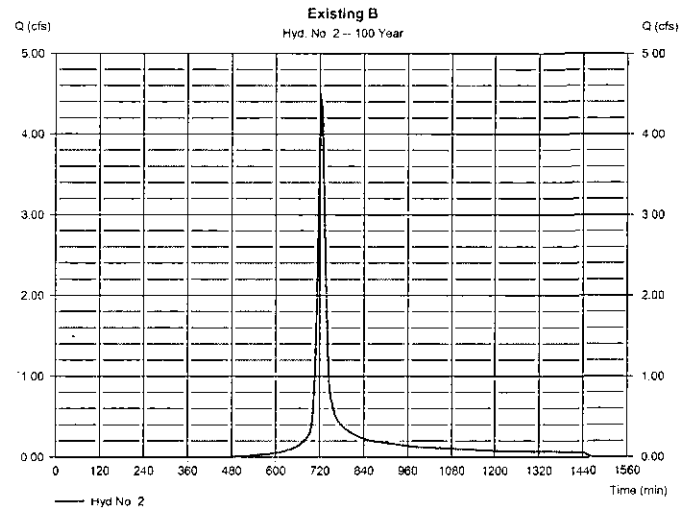


Hydrograph Report

Hyd. No. 2

Existing B

Hydrograph type	= SCS Runoff	Peak discharge	= 4.400 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 13,755 cuft
Drainage area	= 0.860 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.00 min
Total precip.	= 7.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



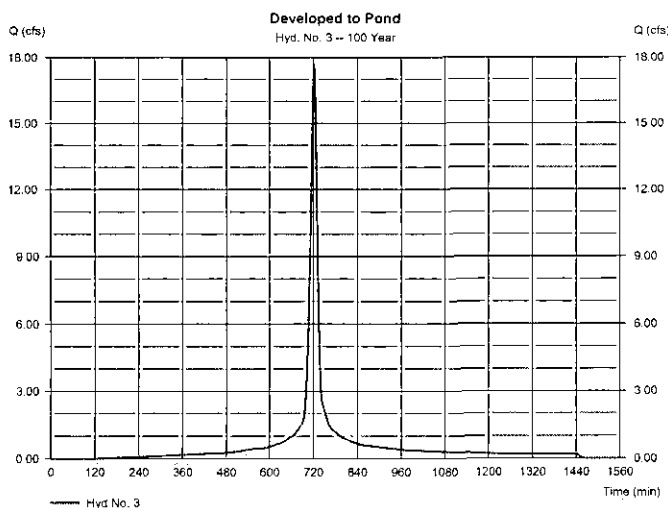
Hydrograph Report

Hyd. No. 3

Developed to Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 17.69 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 54,472 cuft
Drainage area	= 2.210 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 7.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.550 x 98) + (0.660 x 80)] / 2.210



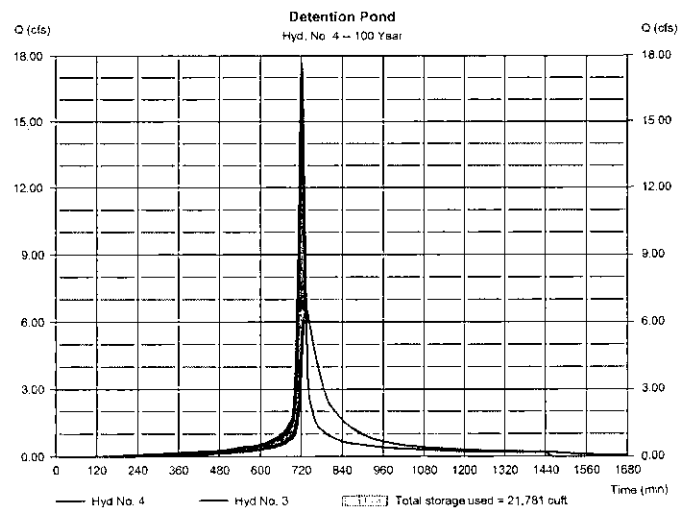
Hydrograph Report

Hyd. No. 4

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 6.571 cfs
Storm frequency	= 100 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 54,269 cuft
Inflow hyd. No.	= 3 - Developed to Pond	Max. Elevation	= 1282.74 ft
Reservoir name	= Detention Pond	Max. Storage	= 21,781 cuft

Storage Indication method used



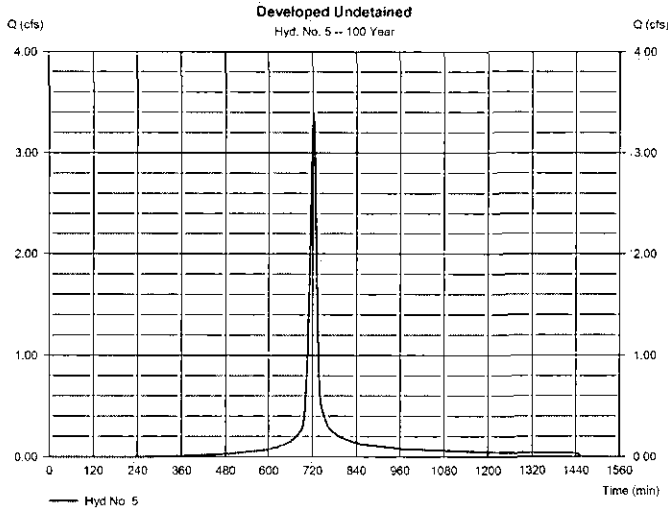
Hydrograph Report

Hyd. No. 5

Developed Undetained

Hydrograph type	= SCS Runoff	Peak discharge	= 3.389 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 9,820 cuft
Drainage area	= 0.470 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft.
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 7.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite [Area/CN] = [(0.100 * 98) + (0.370 * 80)] / 0.470



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (IDF)			
	B	D	E	(N/A)
1	42.7057	9.9000	0.8062	---
2	51.0205	10.8000	0.7866	---
3	6.0000	0.0000	0.0000	---
5	96.0163	12.7000	0.7593	---
10	81.2026	14.5000	0.8074	---
25	100.2580	15.8000	0.8129	---
50	107.3112	16.1000	0.8010	---
100	128.7870	17.2000	0.8131	---

File name: City of Wichita IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.01	3.89	3.21	2.70	2.43	2.18	1.98	1.82	1.68	1.56	1.47	1.36
2	5.83	4.52	3.81	3.30	2.93	2.64	2.41	2.22	2.06	1.92	1.80	1.70
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	9.94	5.40	4.08	4.09	3.65	3.31	3.03	2.80	2.61	2.44	2.30	2.17
10	7.38	6.14	5.28	4.95	4.17	3.79	3.48	3.22	3.00	2.81	2.64	2.50
25	8.47	7.12	6.17	5.43	4.81	4.47	4.11	3.81	3.55	3.33	3.14	2.97
50	8.33	7.87	6.84	6.07	5.47	4.99	4.59	4.28	3.98	3.74	3.53	3.34
100	10.19	8.64	7.53	6.70	6.05	5.52	5.08	4.72	4.41	4.14	3.91	3.70

Tc = time in minutes. Values may exceed 90.

Project file name: S:\Logan's CED Documents\Hydraflow\City of Wichita.ppt

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.80	3.50	0.00	4.50	5.20	6.10	6.90	7.80
SCS 6-hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-5th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Mr. Scott Lindebak, P.E., (Con't)
QT #0345R
May 23rd, 2013

MISCELLANEOUS DRAINAGE INFORMATION

1988 Drainage Criteria Manual
City of Wichita, Kansas
Rainfall Intensity Table for Sedgwick County, KS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour.

Table 1 Rainfall Intensity Table (Duration 15 min – 120 min)

DURATION, in hours	DURATION, in minutes	RETURN PERIOD						
		1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0.0833	5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
0.1000	6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
0.1167	7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
0.1333	8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
0.1500	9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
0.1667	10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
0.1833	11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
0.2000	12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
0.2167	13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
0.2333	14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
0.2500	15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
0.2667	16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
0.2833	17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
0.3000	18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
0.3167	19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
0.3333	20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
0.3500	21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
0.3667	22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
0.3833	23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
0.4000	24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
0.4167	25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
0.4333	26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
0.4500	27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
0.4667	28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
0.4833	29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
0.5000	30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
0.5167	31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
0.5333	32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
0.5500	33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
0.5667	34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
0.5833	35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
0.6000	36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
0.6167	37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
0.6333	38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
0.6500	39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
0.6667	40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
0.6833	41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
0.7000	42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
0.7167	43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
0.7333	44	1.75	2.11	2.61	3.05	3.57	4.03	4.43

Appendix B

DURATION in hours	DURATION in minutes	RETURN PERIOD						
		1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
0.7500	45	1.73	2.08	2.57	3.01	3.52	3.98	4.38
0.7667	46	1.70	2.05	2.54	2.97	3.48	3.93	4.33
0.7833	47	1.67	2.02	2.50	2.93	3.44	3.88	4.28
0.8000	48	1.66	2.00	2.47	2.90	3.39	3.84	4.23
0.8167	49	1.64	1.97	2.44	2.86	3.35	3.79	4.18
0.8333	50	1.61	1.95	2.41	2.83	3.32	3.75	4.13
0.8500	51	1.59	1.92	2.38	2.79	3.28	3.71	4.09
0.8667	52	1.56	1.89	2.35	2.76	3.24	3.67	4.05
0.8833	53	1.54	1.86	2.33	2.73	3.20	3.63	4.00
0.9000	54	1.52	1.84	2.30	2.70	3.17	3.59	3.96
0.9167	55	1.50	1.81	2.27	2.67	3.14	3.55	3.92
0.9333	56	1.47	1.79	2.25	2.64	3.10	3.51	3.88
0.9500	57	1.45	1.76	2.22	2.61	3.07	3.48	3.84
0.9667	58	1.43	1.74	2.20	2.59	3.04	3.44	3.81
0.9833	59	1.42	1.72	2.18	2.56	3.01	3.41	3.77
1.0000	60	1.40	1.69	2.15	2.53	2.98	3.37	3.73
1.0167	61	1.38	1.67	2.13	2.51	2.95	3.34	3.70
1.0333	62	1.36	1.65	2.11	2.48	2.92	3.31	3.67
1.0500	63	1.34	1.63	2.09	2.46	2.89	3.28	3.63
1.0667	64	1.33	1.61	2.07	2.44	2.86	3.25	3.60
1.0833	65	1.31	1.59	2.05	2.41	2.84	3.22	3.57
1.1000	66	1.30	1.57	2.03	2.39	2.81	3.19	3.54
1.1167	67	1.28	1.56	2.01	2.37	2.79	3.16	3.51
1.1333	68	1.26	1.54	1.99	2.35	2.76	3.13	3.48
1.1500	69	1.25	1.52	1.97	2.33	2.74	3.10	3.45
1.1667	70	1.24	1.50	1.95	2.31	2.71	3.08	3.42
1.1833	71	1.22	1.49	1.93	2.28	2.69	3.05	3.39
1.2000	72	1.21	1.47	1.92	2.26	2.67	3.02	3.36
1.2167	73	1.20	1.46	1.90	2.25	2.64	3.00	3.34
1.2333	74	1.18	1.44	1.88	2.23	2.63	2.98	3.31
1.2500	75	1.17	1.43	1.86	2.21	2.61	2.95	3.29
1.2667	76	1.16	1.41	1.85	2.19	2.58	2.93	3.26
1.2833	77	1.15	1.40	1.83	2.17	2.55	2.90	3.24
1.3000	78	1.13	1.38	1.82	2.15	2.53	2.88	3.22
1.3167	79	1.12	1.37	1.80	2.14	2.50	2.86	3.19
1.3333	80	1.11	1.36	1.79	2.12	2.48	2.84	3.16
1.3500	81	1.10	1.34	1.77	2.10	2.46	2.82	3.13
1.3667	82	1.09	1.33	1.76	2.08	2.43	2.79	3.10
1.3833	83	1.08	1.32	1.74	2.06	2.41	2.76	3.07
1.4000	84	1.07	1.31	1.73	2.04	2.39	2.74	3.04
1.4167	85	1.07	1.30	1.72	2.02	2.37	2.71	3.01
1.4333	86	1.05	1.28	1.70	2.00	2.34	2.69	2.99
1.4500	87	1.04	1.27	1.69	1.99	2.32	2.66	2.96
1.4667	88	1.03	1.26	1.68	1.97	2.30	2.64	2.93
1.4833	89	1.02	1.25	1.68	1.95	2.28	2.62	2.91
1.5000	90	1.01	1.24	1.66	1.93	2.26	2.59	2.88
1.5167	91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
1.5333	92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
1.5500	93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
1.5667	94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
1.5833	95	0.97	1.19	1.59	1.85	2.17	2.49	2.76

DURATION in hours	DURATION in minutes	RETURN PERIOD						
		1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
1.6000	96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
1.6167	97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
1.6333	98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
1.6500	99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
1.6667	100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
1.6833	101	0.93	1.13	1.52	1.77	2.08	2.39	2.65
1.7000	102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
1.7167	103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
1.7333	104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
1.7500	105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
1.7667	106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
1.7833	107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
1.8000	108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
1.8167	109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
1.8333	110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
1.8500	111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
1.8667	112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
1.8833	113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
1.9000	114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
1.9167	115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
1.9333	116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
1.9500	117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
1.9667	118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
1.9833	119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
2.0000	120	0.81	0.99	1.33	1.55	1.81	2.07	2.30

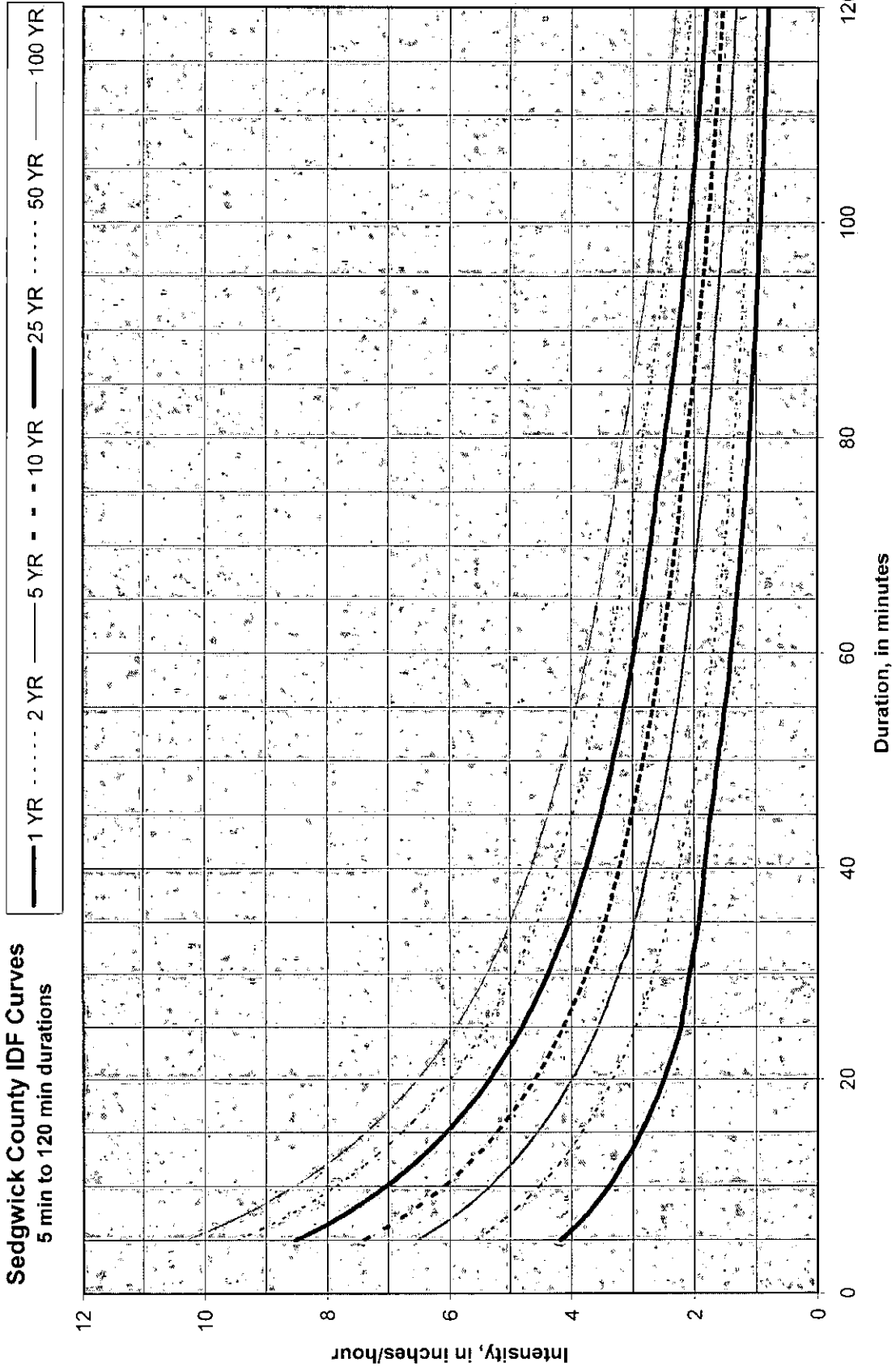


Table C-1 Rational C Values

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
<u>Business</u>					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
<u>Residential Single Family (Soil Group D)</u>					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
<u>Residential Multi-Family (Soil Group D)</u>					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
<u>Residential Single Family (Soil Group C)</u>					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
<u>Residential Multi-Family (Soil Group C)</u>					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
<u>Residential Single Family (Soil Group B)</u>					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
<u>Residential Multi-Family (Soil Group B)</u>					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80
<u>Single Family (Soil Group A)</u>					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44

Appendix C

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
<u>Multi-Family (Soil Group A)</u>					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
<u>Industrial</u>					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
<u>Playgrounds</u>	15	0.33	0.35	0.42	0.55
<u>Schools</u>	40	0.49	0.51	0.56	0.66
<u>Railroad Yard Areas</u>	30	0.43	0.45	0.50	0.62
<u>Undeveloped Urban Areas</u>					
Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
<u>Streets</u>					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
<u>Drive, Parking Lots and Walks:</u>	96	0.87	0.87	0.88	0.89
<u>Roofs</u>	90	0.80	0.85	0.90	0.93
<u>Urban Lawn Areas (Soil Group A)</u>					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
<u>Urban Lawn Areas (Soil Group B)</u>					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
<u>Urban Lawn Areas (Soil Group C)</u>					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55
<u>Urban Lawn Areas (Soil Group D)</u>					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Table A-1 Roughness Coefficients (Manning's n) for Sheet Flow

Surface Description ¹	Manning's n
Smooth surfaces (concrete, asphalt, gravel or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover < 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses ^A	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods ^B	
Light underbrush	0.40
Dense underbrush	0.80

¹ Source: SCS, TR-55, Second Edition, June 1986.
^A Includes species such as bluestem grass, buffalo grass, grama grass, and native grass mixtures.
^B When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Table A-2 Manning's n Values

Street and Pavement Gutters ²		Manning's n
Asphalt pavement		0.016
Concrete gutter		0.016
Concrete pavement		0.018
Culverts and Storm Sewers ³	Roughness or Corrugation	Manning's n
Concrete Pipe	Smooth	0.013
Concrete Boxes	Smooth	0.013
Corrugated Polyethylene	Corrugated	Per manufacturer
Smooth Polyethylene	Smooth	0.011
Polyvinyl chloride (PVC)	Smooth	0.011

Artificial Channels ⁴		Depth Ranges		
Category	Lining Type	0-0.5 ft	0.5-2.0 ft	>2.0 ft
Grassed	Grass	0.050	0.040	0.035
Rigid	Concrete	0.016	0.013	0.013
	Grouted Riprap	0.040	0.030	0.028
	Gabions	0.030	0.030	0.030
	Stone Masonry	0.042	0.032	0.030
	Soil Cement	0.025	0.022	0.020
	Asphalt	0.018	0.016	0.016
Unlined	Bare Soil	0.023	0.020	0.020
	Rock Cut	0.045	0.035	0.025
Temporary*	Woven Paper Net	0.016	0.015	0.015
	Jute Net	0.028	0.022	0.019
	Fiberglass Roving	0.028	0.022	0.019
	Straw with Net	0.065	0.033	0.025
	Curled Wood Mat	0.066	0.035	0.028
	Synthetic Mat	0.036	0.025	0.021
Gravel Riprap	1-inch D ₅₀	0.044	0.033	0.030
	2-inch D ₅₀	0.066	0.041	0.034
Rock Riprap	6-inch D ₅₀	0.104	0.069	0.035
	12-inch D ₅₀	—	0.078	0.040

Natural Channels ⁵	Manning's n
NATURAL STREAMS	
Main Channels	
1. Clean, straight, full, no rifts or deep pools	0.030
2. Same as "1", but more stones and weeds	0.035
3. Clean, winding, some pools and shoals	0.040
4. Same as "3", but some weeds and stones	0.045
5. Same as "4", lower stages, more ineffective slopes and sections	0.048
6. Same as "4" but more stones	0.050
7. Sluggish reaches, weedy, deep pools	0.070
8. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.100
Floodplain – Pasture	
1. Short grass	0.030
2. Tall grass	0.035
Floodplain – Cultivated Areas	
1. No crop	0.030
2. Mature row crops	0.035
3. Mature field crops	0.040
Floodplain – Brush	
1. Heavy weeds scattered brush	0.050
2. Light brush and trees, in winter	0.050
3. Light brush and trees, in summer	0.060
4. Medium to dense brush, in winter	0.070
5. Medium to dense brush in summer	0.100
Floodplain – Trees	
1. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.100
2. Same as "1", but with flow in branches	0.120
3. Dense willows, summer, straight	0.150
<p>1. Lining designed for the interim condition, typically serving the needs of construction sequencing</p> <p>2. Source: HEC-22, 2001</p> <p>3. Source: Typical manufacturer data</p> <p>4. Source: HEC-15, 1988</p> <p>5. Source: HEC-RAS Hydraulic Reference Manual, 2008</p>	

Site plans with subbasin boundaries can be overlain on the hydrologic soil group map to aid in the determination of Curve Numbers. Please note that the map includes a soil group identified as "Urban." These areas should be considered as HSG D soils unless the reviewing authority approves an alternate group classification based on a review of field tests provided by the design engineer.

4.3.3 Required Curve Numbers

The CN values in Table 4-2 shall be used for all pre- and post-development hydrologic calculations. The pre-developed CN values for pervious areas are an equal blending of pasture in fair condition and cultivated small grain in good condition. The City of Wichita and Sedgwick County elect to use this land use as a realistic basis for the condition of local watersheds prior to development. The detrimental effect of grading on infiltration rates is acknowledged in the disturbed pervious land use values. This effect can be reduced through preferred site design practices that minimize the grading footprint. The impervious CN of 98 accounts for the near total runoff of rainfall from impervious surfaces. A CN of 100 is to be used for permanent water surfaces such as lakes and ponds.

Table 4-2 Pre- and Post-Development Curve Numbers

Land Use	Hydrologic Soil Group			
	A	B	C	D
Pre-Developed or Undisturbed Pervious	55	71	80	84
Developed or Disturbed Pervious	71	80	84	88
Impervious	98	98	98	98

4.3.4 Composite Curve Numbers

For a subbasin containing subareas of varying CNs, a composite CN is computed. It should be noted that when composite CNs are used, the analysis does not take into account the location of the specific land uses within the subbasin, but simplifies the drainage area conceptually as a uniform land use represented by the composite CN. The composite CN for a subbasin shall be calculated by using an area-weighted averaging procedure as illustrated in the following example:

Table 4-3 Calculation of a Composite Curve Number

Land Use	Fraction of Total Land Area (1)	CN (2)	Weighted CN (1 x 2)
Disturbed Pervious, "B" Soil	0.30	80	24.0
Undisturbed Pervious, "B" Soil	0.70	71	49.7
Total Weighted Composite Curve Number =			24.0 + 49.7 = 73.7

For some applications, it is necessary to "route" flow through a control structure such as a stormwater pond and outlet. The temporary storage of inflowing water (detention) tends to attenuate the inflow hydrograph, resulting in outflow with a lower peak but increased duration. Thus, routing is fundamental to the design of stormwater storage facilities.

This chapter provides descriptions of the hydrologic methods to be used to implement the requirements of this Manual.

4.2 Rainfall

A rainfall event-based hydrologic analysis requires an estimate of the amount (depth or intensity) of rainfall that will occur on the site during a specified duration for a specified average return period. The average return period (sometimes referred to as average return interval or frequency) is expressed in years. The average annual exceedance probability of the event is the reciprocal of the average return period, and is expressed as the probability that the event will be equalled or exceeded in any given year. (The probability lies between 0 and 1.) For example, an event with an average return interval of 100 years has an average annual probability of being equalled or exceeded of $1/100 = 0.01$, or 1%.

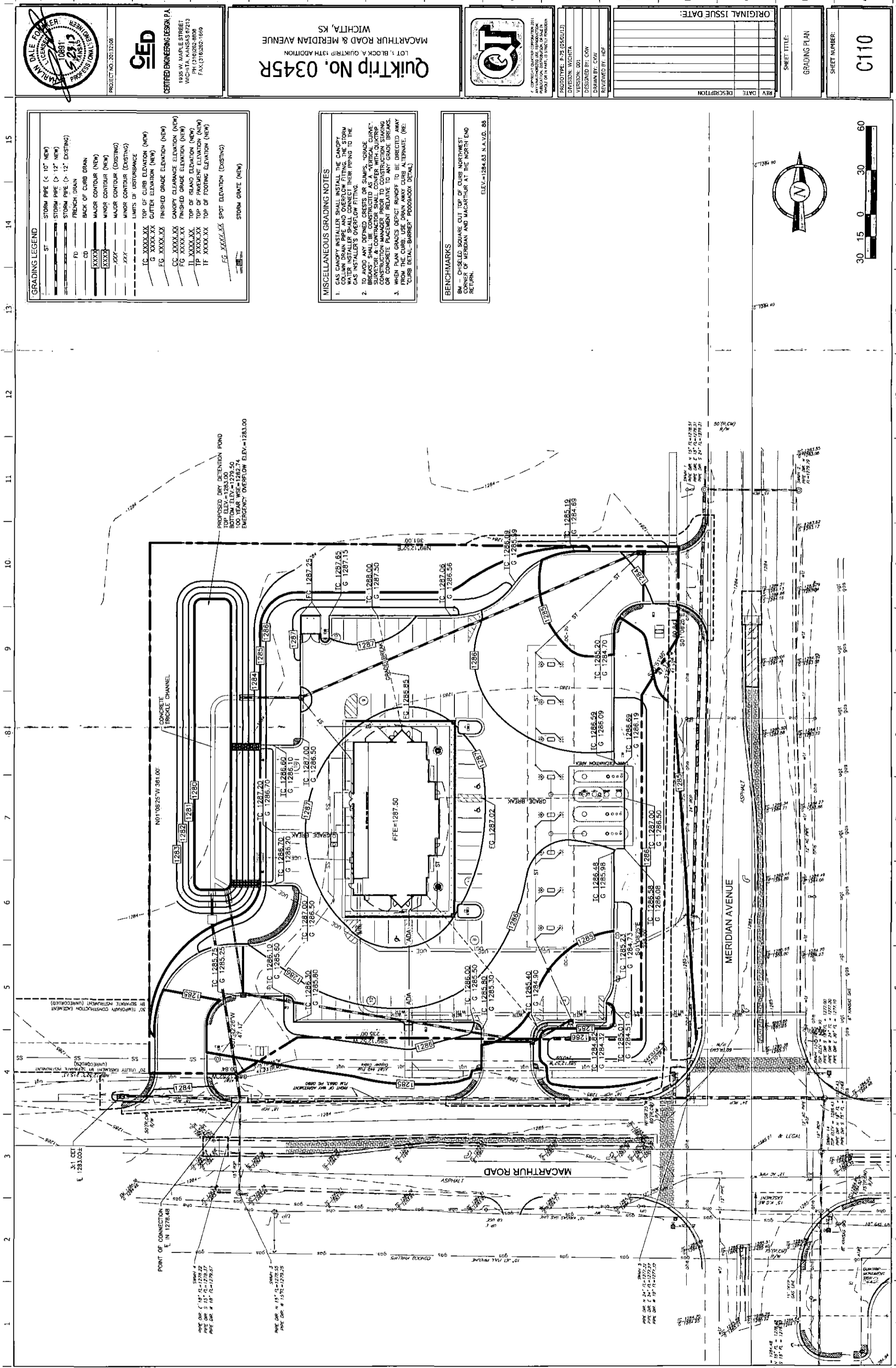
For methods discussed in this Manual requiring a distributed rainfall event, the NRCS 24-hour Type 2 rainfall distribution (Figure 4-1) will be used. Table 4-1 lists the 24-hour point rainfall depths for various frequency storm events. These values were derived from the National Weather Service TP-40 rainfall atlas. (Note that the 1-year through 10-year values are partial duration series depths. For the larger storms, there is no significant difference between the partial duration and annual series.)

Table 4-1 Point Rainfall Depths (inches) for 24-Hour Design Storms

1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2.8	3.5	4.5	5.2	6.1	6.9	7.8	9.4

Mr. Scott Lindebak, P.E., (Con't)
QT #0345R
May 23rd, 2013

GRADING PLAN



GRADING LEGEND

- ST - STORM PIPE (< 10" NEW)
- ST - STORM PIPE (> 12" NEW)
- ST - STORM PIPE (> 12" EXISTING)
- FD - FRENCH DRAIN
- CD - BACK OF CURB DRAIN
- XXXX - MAJOR CONTOUR (NEW)
- XXXX - MINOR CONTOUR (NEW)
- XXX - MINOR CONTOUR (EXISTING)
- XXX - MINOR CONTOUR (EXISTING)
- - LIMITS OF DISTURBANCE
- TC XXXX.XX - TOP OF CURB ELEVATION (NEW)
- G XXXX.XX - GUTTER ELEVATION (NEW)
- FG XXXX.XX - FINISHED GRADE ELEVATION (NEW)
- CC XXXX.XX - CANOPY CLEARANCE ELEVATION (NEW)
- FG XXXX.XX - FINISHED GRADE ELEVATION (NEW)
- IL XXXX.XX - TOP OF ISLAND ELEVATION (NEW)
- TP XXXX.XX - TOP OF PAVEMENT ELEVATION (NEW)
- TF XXXX.XX - TOP OF FOOTING ELEVATION (NEW)
- FG XXXX.XX - SPOT ELEVATION (EXISTING)
- - STORM GRATE (NEW)

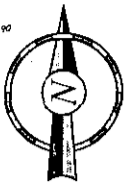
MISCELLANEOUS GRADING NOTES

- GAS CANOPY INSTALLER SHALL INSTALL THE CANOPY COLUMN DRAIN PIPE AND OVERFLOW FITTING. THE STORM WATER SHALL BE DIRECTED TO THEIR PIPING TO THE GAS INSTALLER'S OVERFLOW FITTING.
- TO AVOID ANY DEFINED OBSTACLES OR OBSTRUCTIONS, BREAKS SHALL BE CONSTRUCTED AS A "VERTICAL CURVE". SURVEYOR & CONTRACTOR SHALL CONFER WITH QUIKTRIP CONSTRUCTION MANAGER PRIOR TO CONSTRUCTION STAKING OR CONCRETE PLACEMENT RELATIVE TO ANY GRADE BREAKS.
- WHEN PLAN GRADES DEFECT RUNOFF TO BE DIRECTED AWAY FROM CURB DETAIL, CURB DETAIL SHALL BE ALTERNATE. (SEE CURB DETAIL BARBER PROGRAM DETAIL).

BENCHMARKS

BM - CHISELED SQUARE CUT TOP OF CURB NORTHWEST CORNER OF MERIDIAN AND MACARTHUR AT THE NORTH END RETURN.

ELEV.=1284.63 N.A.V.D. 88

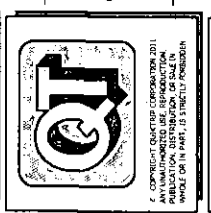


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PROJECT NO. 20131008

QuikTrip No. 0345R
LOT 1, BLOCK A, QUIKTRIP 13TH ADDITION
MACARTHUR ROAD & MERIDIAN AVENUE
WICHITA, KS



PROTOTYPE: P-25 (05/01/13)
DIVISION: WICHITA
VERSION: 003
DESIGNED BY: CRW
DRAWN BY: CRW
REVIEWED BY: HGF

REV	DATE	DESCRIPTION

ORIGINAL ISSUE DATE:

SHEET TITLE:
GRADING PLAN

SHEET NUMBER:
C110