

CROSS POINTE
Wichita, Sedgwick County, Kansas
Revised 03/07/05

Cross Pointe is a 59.2 acre commercial development within the City of Wichita in Sedgwick County, Kansas. The development consists of pavement, storm sewer and two detention ponds. This report contains a drawing of the drainage plan, supporting calculations and data for the Cross Pointe Drainage Plan.

Hydrology

The proposed plat lies in the NW 1/4, Section 10, T27S, R2E. The soil on-site is comprised of Goessel silty clay and Irwin silty clay loam, which are both classified in hydrologic group D. The land is currently open pasture with some trees and one pond. The site is bordered to the north by 21st Street North, to the east by 96 Highway, to the south by pasture, and to the west by Greenwich Road.

The site generally drains to the south to the West Fork of Fourmile Creek. A tributary of the West Fork of Fourmile Creek cuts through this site from the north property line, through the existing pond, to the south property line. Approximately 225 acres drains to the existing 8' x 5' RCB under 21st Street North at the north property line of this site.

Part of the site is in the FEMA defined 100-year floodplain. The tributary that runs through this site was not included in the detailed study but is classified as a Zone A floodplain. This information is included in the "Design Aids" section.

Proposed Basins 1, 2 and 5 all drain away from the site to Greenwich Road, 21st Street North and K-96, respectively. All paved areas within these three basins will be routed to the ponds via storm sewer with no concentrated flows directed to the adjacent streets. Under proposed conditions, the existing 8' x 5' RCB under 21st Street North will be extended south to Pond #1 where it combines with runoff from Proposed Basin 3. The

100-year storm discharge from Pond #1 will be 225 CFS which is approximately the same as the existing conditions runoff at this location (Existing Basin B). This area will need to be heavily armored to protect the adjacent property. Proposed Basin 4 drains to Pond #2 in the southeast corner of the development. The 100-year storm discharge from this pond will be 25 CFS which is slightly less than the existing conditions runoff at this location (Basin C).

The Rational Method was used to calculate runoff quantities. Runoff coefficients were estimated based on tables presented in the Design Aids section of this report using fully developed conditions. Time of concentration was based on slope, flow velocity and length of flow through each basin and was not allowed to be less than 15 minutes. The HEC-1 computer program was used to route the runoff through the ponds and determine the pre- and post-development conditions leaving the site.

The analysis was made based on the available site data which includes the following: 1" = 100' topographic map with 1' contours of the site, a Sedgwick County Soil Survey Map and noted references.

Culvert Design

The Federal Highway Administration's culvert program, HY8 Version 6.1, was used to aid in the design of the RCB. The program output is included in the Proposed Conditions section.

Design Aids

This section includes material used to assist in designing the drainage system. A 1" = 100' scale Drainage Plan map is enclosed in the pocket.

References

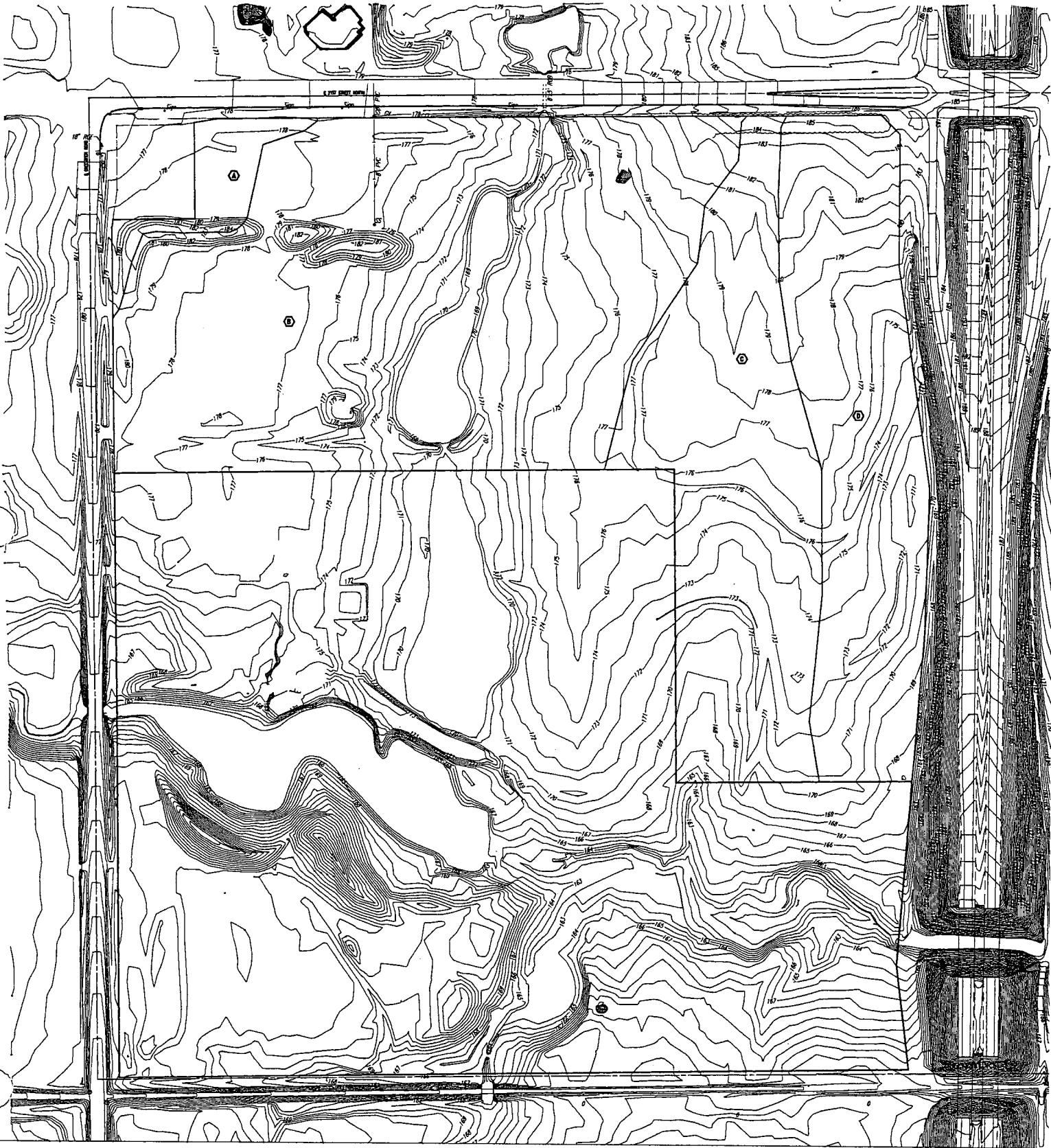
Design of Urban Highway Drainage – The State of the Art, by Reitz & Jens, Inc., April 1980.

Drainage of Highway Pavements, Hydraulic Engineering Circular #12, by Tye Engineering, Inc., March 1984.

Interim Drainage and Storm Sewer Policy for Design Criteria and Documentation, City of Wichita, Kansas, 1985.

Soil Survey of Sedgwick County, Kansas, US Department of Agriculture, Soil Conservation Service, 1979.

EXISTING BASINS



Project: Cross Pointe
 Date: 12/28/2004
 Prep. By: BLB

Manual Input

OFFSITE

Total Area 225.00 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	225.00	225.00

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Existing	20%	0%	0%	0%	0%	80%
Acres	45.00	0.00	0.00	0.00	0.00	180.00

Length of Flow Existing 5650 ft
 Slope 0.84 %
 Waterflow Desc bare / short grass
 Avg Velocity 0.35 ft/sec
 Tc 4.48 hours

15 min <= Tc <= 24 hrs

Runoff Coefficients * Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Existing Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.57	0.58	225.00	74.12
5	0.59	0.78	225.00	102.84
10	0.63	0.91	225.00	129.81
25	0.66	1.06	225.00	157.89
50	0.69	1.21	225.00	187.85
100	0.72	1.36	225.00	218.70

Project: Cross Pointe
 Date: 12/28/2004
 Prep. By: BLB

Manual Input

Basin A

Total Area 1.72 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	1.72	1.72

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Existing	0%	0%	0%	0%	0%	100%
Acres	0.00	0.00	0.00	0.00	0.00	1.72

Length of Flow Existing 300 ft
 Slope 2.17 %
 Waterflow Desc bare / short grass
 Avg Velocity 0.30 ft/sec
 Tc 0.28 hours
 15 min <= Tc <= 24 hrs

Runoff Coefficients * Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Existing Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.54	3.61	1.72	3.35
5	0.56	4.31	1.72	4.15
10	0.61	4.95	1.72	5.19
25	0.64	5.75	1.72	6.33
50	0.67	6.44	1.72	7.42
100	0.70	7.00	1.72	8.43

Project: **Cross Pointe**
 Date: **12/28/2004**
 Prep. By: **BLB**

Manual Input

Basin B

Total Area **30.36** Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	30.36	30.36

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Existing	0%	0%	0%	0%	0%	100%
Acres	0.00	0.00	0.00	0.00	0.00	30.36

Existing
 Length of Flow **1300** ft
 Slope **2.67** %
 Waterflow Desc **bare / short grass**
 Avg Velocity **0.30** ft/sec
 Tc **1.20** hours

15 min <= Tc <= 24 hrs

Runoff Coefficients * Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Existing Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.54	1.47	30.36	24.10
5	0.56	1.92	30.36	32.64
10	0.61	2.26	30.36	41.85
25	0.64	2.67	30.36	51.88
50	0.67	3.02	30.36	61.43
100	0.70	3.36	30.36	71.41

Project: Cross Pointe
 Date: 12/28/2004
 Prep. By: BLB

Manual Input

Basin C

Total Area 14.57 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	14.57	14.57

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Existing	0%	0%	0%	0%	0%	100%
Acres	0.00	0.00	0.00	0.00	0.00	14.57

Length of Flow Existing 1850 ft
 Slope 1.17 %
 Waterflow Desc bare / short grass
 Avg Velocity 0.30 ft/sec
 Tc 1.71 hours

15 min <= Tc <= 24 hrs

Runoff Coefficients * Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Existing Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.54	1.12	14.57	8.81
5	0.56	1.50	14.57	12.24
10	0.61	1.74	14.57	15.46
25	0.64	2.04	14.57	19.02
50	0.67	2.33	14.57	22.75
100	0.70	2.59	14.57	26.42

Project: **Cross Pointe**
 Date: 12/28/2004
 Prep. By: BLB

Manual Input

Basin D

Total Area 12.55 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	12.55	12.55

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Existing	0%	0%	0%	0%	0%	100%
Acres	0.00	0.00	0.00	0.00	0.00	12.55

Length of Flow Existing 1840 ft
 Slope 1.06 %
 Waterflow Desc bare / short grass
 Avg Velocity 0.30 ft/sec
 Tc 1.70 hours
 15 min <= Tc <= 24 hrs

Runoff Coefficients * Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Existing Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.54	1.13	12.55	7.66
5	0.56	1.51	12.55	10.61
10	0.61	1.75	12.55	13.40
25	0.64	2.05	12.55	16.47
50	0.67	2.35	12.55	19.76
100	0.70	2.61	12.55	22.93

Circular Pond Sizing with Elevations

Floor Area (Acres)	1.63
Floor Elevation (ft)	160.90
Static Pool Elevation (ft)	168.90
Side Slopes to Static (_ :1)	2
Side Slopes beyond Static (_ :1)	4

Elevation (ft)	Radius (ft)	Area (ft ²)	Area (Acres)	Storage (ft ³)	Storage (C.Y.)	Storage (Ac-ft)
160.90	150.34	71002.80	1.63	0.00	0.00	0.00
161.70	151.94	72522.18	1.66	57409.99	2126.30	1.32
162.50	153.54	74057.65	1.70	116048.36	4298.09	2.66
163.30	155.14	75609.21	1.74	175934.41	6516.09	4.04
164.10	156.74	77176.85	1.77	237087.43	8781.02	5.44
164.90	158.34	78760.57	1.81	299526.74	11093.58	6.88
165.70	159.94	80360.38	1.84	363271.63	13454.50	8.34
166.50	161.54	81976.27	1.88	428341.40	15864.50	9.83
167.30	163.14	83608.25	1.92	494755.37	18324.27	11.36
168.10	164.74	85256.32	1.96	562532.82	20834.55	12.91
Static Pool 168.90	166.34	86920.46	2.00	631693.06	23396.04	14.50
169.90	170.34	91151.21	2.09	729693.03	27025.67	16.75
170.90	174.34	95482.48	2.19	832426.41	30830.61	19.11
171.90	178.34	99914.29	2.29	940043.98	34816.44	21.58
172.90	182.34	104446.62	2.40	1052696.54	38988.76	24.17
173.90	186.34	109079.49	2.50	1170534.89	43353.14	26.87
174.90	190.34	113812.89	2.61	1293709.83	47915.18	29.70
175.90	194.34	118646.82	2.72	1422372.14	52680.45	32.65
176.90	198.34	123581.28	2.84	1556672.63	57654.54	35.74

250.0 Maximum Q (cfs)
65.000 Weir Width (feet)
168.90 Weir Elevation

<u>Q</u> (cfs)	<u>Weir</u> <u>Width</u> (feet)	<u>Weir</u> <u>Elevation</u>	<u>q</u>	<u>Critical</u> <u>Depth</u> (feet)	<u>Energy</u> <u>Head</u> (feet)	<u>Water</u> <u>Surface</u> <u>Elevation</u>
0.0	65.000	168.90	0.0	0.00	0.00	168.90
25.0	65.000	168.90	0.4	0.17	0.25	169.15
50.0	65.000	168.90	0.8	0.26	0.40	169.30
75.0	65.000	168.90	1.2	0.35	0.52	169.42
100.0	65.000	168.90	1.5	0.42	0.63	169.53
125.0	65.000	168.90	1.9	0.49	0.73	169.63
150.0	65.000	168.90	2.3	0.55	0.82	169.72
175.0	65.000	168.90	2.7	0.61	0.91	169.81
200.0	65.000	168.90	3.1	0.66	1.00	169.90
225.0	65.000	168.90	3.5	0.72	1.08	169.98
250.0	65.000	168.90	3.8	0.77	1.16	170.06

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1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*   JUN 1998                       *
*   VERSION 4.1                     *
*
* RUN DATE 29DEC04 TIME 15:47:30 *
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*
* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
*   609 SECOND STREET          *
*   DAVIS, CALIFORNIA 95616   *
*   (916) 756-1104            *
*
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

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1 ID Cross Pointe 36-04658-5703
2 ID Existing Drainage to through Pond
3 ID 2, 5, 10, 25, 50 & 100 Yr Storms
4 ID By BLB DATE 12-29-04

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*** LIST ***
 *** FREE ***

*DIAGRAM

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5 IT 15 27SEP99 1200 0 28SEP99 2000
6 IN 15 27SEP99 1200
7 IO 0 5
8 JR PREC 3.5 4.5 5.3 6.1 7.0 7.8
*
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*

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9 KK OFFST
* Area North of 21st Street North
10 KO 5
11 BA 0.3516
12 PB 1.00
13 PC 0.000 0.003 0.006 0.008 0.011 0.014 0.017 0.019 0.022 0.025
14 PC 0.029 0.032 0.035 0.038 0.042 0.045 0.048 0.052 0.056 0.060

```

15	PC	0.064	0.068	0.072	0.076	0.080	0.085	0.090	0.095	0.100	0.105
16	PC	0.110	0.115	0.120	0.127	0.134	0.140	0.147	0.155	0.163	0.172
17	PC	0.181	0.193	0.204	0.220	0.235	0.259	0.283	0.387	0.663	0.699
18	PC	0.735	0.754	0.772	0.786	0.799	0.810	0.820	0.828	0.835	0.843
19	PC	0.850	0.858	0.865	0.873	0.880	0.885	0.889	0.894	0.898	0.903
20	PC	0.907	0.912	0.916	0.921	0.925	0.929	0.934	0.938	0.943	0.947
21	PC	0.952	0.955	0.958	0.961	0.964	0.967	0.970	0.973	0.976	0.979
22	PC	0.982	0.985	0.988	0.991	0.994	0.997	1.000			
23	LS	0	80	10							
24	UD	2.780									
	*										
	*										
	*										
25	KK	ROUTE									
26	KO	5									
27	RT	0	0	1							
	*										
	*										
	*										
28	KK	BASB									
29	KO	5									
30	BA	0.0474									
31	PB	1.00									
32	PC	0.000	0.003	0.006	0.008	0.011	0.014	0.017	0.019	0.022	0.025
33	PC	0.029	0.032	0.035	0.038	0.042	0.045	0.048	0.052	0.056	0.060
34	PC	0.064	0.068	0.072	0.076	0.080	0.085	0.090	0.095	0.100	0.105
35	PC	0.110	0.115	0.120	0.127	0.134	0.140	0.147	0.155	0.163	0.172
36	PC	0.181	0.193	0.204	0.220	0.235	0.259	0.283	0.387	0.663	0.699
37	PC	0.735	0.754	0.772	0.786	0.799	0.810	0.820	0.828	0.835	0.843
38	PC	0.850	0.858	0.865	0.873	0.880	0.885	0.889	0.894	0.898	0.903
39	PC	0.907	0.912	0.916	0.921	0.925	0.929	0.934	0.938	0.943	0.947

HEC-1 INPUT

PAGE 2

LINE	ID	1	2	3	4	5	6	7	8	9	10
40	PC	0.952	0.955	0.958	0.961	0.964	0.967	0.970	0.973	0.976	0.979
41	PC	0.982	0.985	0.988	0.991	0.994	0.997	1.000			
42	LS	0	80	0							
43	UD	0.720									
	*										
	*										
	*										
44	KK	OFF&B									
45	KO	5									
46	HC	2	0								
	*										
	*										
	*										
47	KK	POND									
	*	Runoff at South Property Line									
48	KO	5									
49	RS	1	ELEV	168.9							
50	SA	2.00	2.09	2.19	2.29	2.40					
51	SE	168.9	169.9	170.9	171.9	172.9					
52	SQ	0.0	25.0	50.0	75.0	100.0	125.0	150.0	175.0	200.0	225.0
53	SQ	250.0									

54 SE 168.9 169.15 169.30 169.42 169.53 169.63 169.72 169.81 169.90 170.0
 55 SE 170.06
 *
 *
 *
 56 ZZ

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT
 LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
 NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

9 OFFST
 V
 V
 25 ROUTE
 .
 .
 28 . BASB
 .
 .
 44 OFF&B.....
 V
 V
 47 POND

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

 * FLOOD HYDROGRAPH PACKAGE (HEC-1) *
 * JUN 1998 *
 * VERSION 4.1 *
 * RUN DATE 29DEC04 TIME 15:47:30 *
 * *****

 * U.S. ARMY CORPS OF ENGINEERS *
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 * (916) 756-1104 *
 * *****

Cross Pointe 36-04658-5703
 Existing Drainage to through Pond
 2, 5, 10, 25, 50 & 100 Yr Storms
 By BLB DATE 12-29-04

7 IO OUTPUT CONTROL VARIABLES
 IPRNT 0 PRINT CONTROL
 IPLOT 5 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
 NMIN 15 MINUTES IN COMPUTATION INTERVAL
 IDATE 27SEP99 STARTING DATE
 ITIME 1200 STARTING TIME
 NQ 129 NUMBER OF HYDROGRAPH ORDINATES
 NDDATE 28SEP99 ENDING DATE
 NDTIME 2000 ENDING TIME
 ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .25 HOURS

TOTAL TIME BASE 32.00 HOURS

ENGLISH UNITS

DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-FEET
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
3.50 4.50 5.30 6.10 7.00 7.80

*** **

* *
9 KK * OFFST *
* *

10 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

* *
25 KK * ROUTE *
* *

26 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

* *
28 KK * BASB *

* *

29 KO

OUTPUT CONTROL VARIABLES

IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

44 KK

* *
* OFF&B *
* *

45 KO

OUTPUT CONTROL VARIABLES

IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

47 KK

* *
* POND *
* *

48 KO

OUTPUT CONTROL VARIABLES

IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION						
				RATIO 1 3.50	RATIO 2 4.50	RATIO 3 5.30	RATIO 4 6.10	RATIO 5 7.00	RATIO 6 7.80	
HYDROGRAPH AT										
+	OFFST	.35	1	FLOW	68.	101.	129.	157.	190.	219.
				TIME	15.00	15.00	14.75	14.75	14.75	14.75
ROUTED TO										
	ROUTE	.35	1	FLOW	68.	101.	129.	157.	190.	219.
				TIME	15.25	15.25	15.00	15.00	15.00	15.00
HYDROGRAPH AT										
+	BASB	.05	1	FLOW	21.	32.	41.	51.	62.	72.

TIME 12.75 12.50 12.50 12.50 12.50 12.50

2 COMBINED AT

OFF&B .40 1 FLOW 71. 106. 135. 164. 198. 228.
TIME 15.25 15.00 15.00 15.00 15.00 15.00

ROUTED TO

+ POND .40 1 FLOW 71. 106. 134. 164. 197. 228.
TIME 15.25 15.25 15.25 15.00 15.00 15.00

** PEAK STAGES IN FEET **

1 STAGE 169.40 169.55 169.66 169.77 169.89 170.01
TIME 15.25 15.25 15.25 15.00 15.00 15.00

*** NORMAL END OF HEC-1 ***

Project: **Cross Pointe**
 Date: 3/7/2005
 Prep. By: BLB

Manual Input

Basin 1

Total Area 1.57 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0.00	0.00	0.00	1.57	1.57
	0%	0%	0%	100%	100%

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Future	100%	0%	0%	0%	0%	0%
Acres	1.57	0.00	0.00	0.00	0.00	0.00

Length of Flow 100 ft
 Slope 0.50 %
 Waterflow Desc pavement / lawn
 Avg Velocity 0.50 ft/sec
 Tc 0.06 hours
 15 min <= Tc <= 24 hrs

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Future Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.68	3.83	1.57	4.09
5	0.69	4.56	1.57	4.94
10	0.73	5.22	1.57	5.98
25	0.75	6.06	1.57	7.14
50	0.77	6.78	1.57	8.20
100	0.80	7.37	1.57	9.26

Project: **Cross Pointe**
 Date: 3/7/2005
 Prep. By: BLB

Manual Input

Basin 2

Total Area 4.28 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	4.28	4.28

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Future	100%	0%	0%	0%	0%	0%
Acres	4.28	0.00	0.00	0.00	0.00	0.00

Length of Flow 100 ft
 Slope 0.50 %
 Waterflow Desc pavement / lawn
 Avg Velocity 0.50 ft/sec
 Tc 0.06 hours
 15 min <= Tc <= 24 hrs

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Future Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.68	3.83	4.28	11.15
5	0.69	4.56	4.28	13.47
10	0.73	5.22	4.28	16.31
25	0.75	6.06	4.28	19.45
50	0.77	6.78	4.28	22.34
100	0.80	7.37	4.28	25.23

Project: **Cross Pointe**
 Date: 3/7/2005
 Prep. By: BLB

Manual Input

Basin 3

Total Area 29.74 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	29.74	29.74

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Future	90%	0%	0%	10%	0%	0%
Acres	26.77	0.00	0.00	2.97	0.00	0.00

Length of Flow 1440 ft
 Slope 0.70 %
 Waterflow Desc pavement / sws
 Avg Velocity 0.55 ft/sec
 Tc 0.73 hours
 15 min <= Tc <= 24 hrs

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Future Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.66	2.11	29.74	41.48
5	0.67	2.61	29.74	52.16
10	0.71	3.05	29.74	64.67
25	0.73	3.57	29.74	77.93
50	0.76	4.03	29.74	90.49
100	0.79	4.43	29.74	103.55

Project: **Cross Pointe**
 Date: 3/7/2005
 Prep. By: BLB

Manual Input

Basin 4

Total Area 20.27 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	20.27	20.27

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Future	90%	0%	0%	10%	0%	0%
Acres	18.24	0.00	0.00	2.03	0.00	0.00

Length of Flow 1965 ft
 Slope 1.00 %
 Waterflow Desc pavement / sws
 Avg Velocity 0.50 ft/sec
 Tc 1.09 hours

15 min <= Tc <= 24 hrs

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Future Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.66	1.59	20.27	21.30
5	0.67	2.05	20.27	27.92
10	0.71	2.41	20.27	34.83
25	0.73	2.84	20.27	42.25
50	0.76	3.22	20.27	49.28
100	0.79	3.57	20.27	56.88

Project: **Cross Pointe**
 Date: 3/7/2005
 Prep. By: BLB

Manual Input

Basin 5

Total Area 3.33 Acres

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	0%	0%	100%	100%
Acres	0.00	0.00	0.00	3.33	3.33

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
Future	100%	0%	0%	0%	0%	0%
Acres	3.33	0.00	0.00	0.00	0.00	0.00

Length of Flow 100 ft
 Slope 0.50 %
 Waterflow Desc pavement / lawn
 Avg Velocity 0.50 ft/sec
 Tc 0.06 hours

15 min <= Tc <= 24 hrs

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.54
5	0.69	0.69	0.73	0.51	0.54	0.56
10	0.73	0.73	0.79	0.56	0.62	0.61
25	0.75	0.75	0.81	0.59	0.66	0.64
50	0.77	0.77	0.83	0.62	0.70	0.67
100	0.80	0.80	0.86	0.66	0.76	0.70

Future Conditions

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.68	3.83	3.33	8.67
5	0.69	4.56	3.33	10.48
10	0.73	5.22	3.33	12.69
25	0.75	6.06	3.33	15.13
50	0.77	6.78	3.33	17.38
100	0.80	7.37	3.33	19.63

Circular Pond Sizing with Elevations

Floor Area (Acres)	2.09
Floor Elevation (ft)	161.60
Static Pool Elevation (ft)	169.60
Side Slopes to Static (_:1)	2
Side Slopes beyond Static (_:1)	4

Static Pool

Elevation (ft)	Radius (ft)	Area (ft ²)	Area (Acres)	Storage (ft ³)	Storage (C.Y.)	Storage (Ac-ft)
161.60	170.23	91040.40	2.09	0.00	0.00	0.00
162.40	171.83	92759.80	2.13	73520.08	2722.97	1.69
163.20	173.43	94495.29	2.17	148428.56	5497.35	3.41
164.00	175.03	96246.87	2.21	224744.72	8323.88	5.16
164.80	176.63	98014.53	2.25	302487.89	11203.26	6.94
165.60	178.23	99798.27	2.29	381677.35	14136.20	8.76
166.40	179.83	101598.10	2.33	462332.41	17123.42	10.61
167.20	181.43	103414.02	2.37	544472.37	20165.64	12.50
168.00	183.03	105246.02	2.42	628116.54	23263.58	14.42
168.80	184.63	107094.10	2.46	713284.21	26417.93	16.37
169.60	186.23	108958.27	2.50	799994.69	29629.43	18.37
170.60	190.23	113689.07	2.61	921282.60	34121.58	21.15
171.60	194.23	118520.39	2.72	1047803.97	38807.55	24.05
172.60	198.23	123452.25	2.83	1179709.58	43692.95	27.08
173.60	202.23	128484.64	2.95	1317150.24	48783.34	30.24
174.60	206.23	133617.56	3.07	1460276.73	54084.32	33.52
175.60	210.23	138851.01	3.19	1609239.86	59601.48	36.94
176.60	214.23	144184.99	3.31	1764190.43	65340.39	40.50
177.60	218.23	149619.50	3.43	1925279.22	71306.64	44.20

228.0 Maximum Q (cfs)
25.000 Weir Width (feet)
169.60 Weir Elevation

<u>Q</u> (cfs)	<u>Weir</u> <u>Width</u> (feet)	<u>Weir</u> <u>Elevation</u>	<u>q</u>	<u>Critical</u> <u>Depth</u> (feet)	<u>Energy</u> <u>Head</u> (feet)	<u>Water</u> <u>Surface</u> <u>Elevation</u>
0.0	25.000	169.60	0.0	0.00	0.00	169.60
22.8	25.000	169.60	0.9	0.30	0.44	170.04
45.6	25.000	169.60	1.8	0.47	0.70	170.30
68.4	25.000	169.60	2.7	0.61	0.92	170.52
91.2	25.000	169.60	3.6	0.74	1.12	170.72
114.0	25.000	169.60	4.6	0.86	1.30	170.90
136.8	25.000	169.60	5.5	0.98	1.46	171.06
159.6	25.000	169.60	6.4	1.08	1.62	171.22
182.4	25.000	169.60	7.3	1.18	1.77	171.37
205.2	25.000	169.60	8.2	1.28	1.92	171.52
228.0	25.000	169.60	9.1	1.37	2.06	171.66

Circular Pond Sizing with Elevations

Floor Area (Acres)	2.09
Floor Elevation (ft)	157.60
Static Pool Elevation (ft)	165.60
Side Slopes to Static (_:1)	2
Side Slopes beyond Static (_:1)	4

Elevation (ft)	Radius (ft)	Area (ft ²)	Area (Acres)	Storage (ft ³)	Storage (C.Y.)	Storage (Ac-ft)
157.60	170.23	91040.40	2.09	0.00	0.00	0.00
158.40	171.83	92759.80	2.13	73520.08	2722.97	1.69
159.20	173.43	94495.29	2.17	148428.56	5497.35	3.41
160.00	175.03	96246.87	2.21	224744.72	8323.88	5.16
160.80	176.63	98014.53	2.25	302487.89	11203.26	6.94
161.60	178.23	99798.27	2.29	381677.35	14136.20	8.76
162.40	179.83	101598.10	2.33	462332.41	17123.42	10.61
163.20	181.43	103414.02	2.37	544472.37	20165.64	12.50
164.00	183.03	105246.02	2.42	628116.54	23263.58	14.42
164.80	184.63	107094.10	2.46	713284.21	26417.93	16.37
Static Pool	165.60	108958.27	2.50	799994.69	29629.43	18.37
166.60	190.23	113689.07	2.61	921282.60	34121.58	21.15
167.60	194.23	118520.39	2.72	1047803.97	38807.55	24.05
168.60	198.23	123452.25	2.83	1179709.58	43692.95	27.08
169.60	202.23	128484.64	2.95	1317150.24	48783.34	30.24
170.60	206.23	133617.56	3.07	1460276.73	54084.32	33.52
171.60	210.23	138851.01	3.19	1609239.86	59601.48	36.94
172.60	214.23	144184.99	3.31	1764190.43	65340.39	40.50
173.60	218.23	149619.50	3.43	1925279.22	71306.64	44.20

57.0 Maximum Q (cfs)
3.000 Weir Width (feet)
165.60 Weir Elevation

<u>Q</u> (cfs)	<u>Weir</u> <u>Width</u> (feet)	<u>Weir</u> <u>Elevation</u>	<u>q</u>	<u>Critical</u> <u>Depth</u> (feet)	<u>Energy</u> <u>Head</u> (feet)	<u>Water</u> <u>Surface</u> <u>Elevation</u>
0.0	3.000	165.60	0.0	0.00	0.00	165.60
5.7	3.000	165.60	1.9	0.48	0.72	166.32
11.4	3.000	165.60	3.8	0.77	1.15	166.75
17.1	3.000	165.60	5.7	1.00	1.50	167.10
22.8	3.000	165.60	7.6	1.22	1.82	167.42
28.5	3.000	165.60	9.5	1.41	2.11	167.71
34.2	3.000	165.60	11.4	1.59	2.39	167.99
39.9	3.000	165.60	13.3	1.76	2.65	168.25
45.6	3.000	165.60	15.2	1.93	2.89	168.49
51.3	3.000	165.60	17.1	2.09	3.13	168.73
57.0	3.000	165.60	19.0	2.24	3.36	168.96

CURRENT DATE: 03-07-2005

FILE DATE: 03-07-2005

START TIME: 07:22:31

FILE NAME: RCB

FHWA CULVERT ANALYSIS
 HY-8, VERSION 6.1
 ° C ° SITE DATA ° CULVERT SHAPE, MATERIAL, INLET °
 ° U ° INLET OUTLET CULVERT ° BARRELS °
 ° L ° ELEV. ELEV. LENGTH ° SHAPE SPAN RISE MANNING INLET °
 ° NO. ° (ft) (ft) (ft) ° MATERIAL (ft) (ft) n TYPE °
 ° 1 ° 170.33 169.60 950.00 ° 1 RCB 8.00 5.00 .012 CONVENTIONAL °
 ° 2 ° ° ° ° ° ° ° ° ° °
 ° 3 ° ° ° ° ° ° ° ° ° °
 ° 4 ° ° ° ° ° ° ° ° ° °
 ° 5 ° ° ° ° ° ° ° ° ° °
 ° 6 ° ° ° ° ° ° ° ° ° °

SUMMARY OF CULVERT FLOWS (cfs) FILE: RCB DATE: 03-07-2005

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
171.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
171.80	21.9	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
172.23	43.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
172.72	65.7	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
173.16	87.6	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
173.60	109.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
174.02	131.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
174.41	153.3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
174.79	175.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
175.15	197.1	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
175.50	219.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RCB DATE: 03-07-2005

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
171.60	0.000	0.00	0.00	0.00
171.80	0.000	21.90	0.00	0.00
172.23	0.000	43.80	0.00	0.00
172.72	0.000	65.70	0.00	0.00
173.16	0.000	87.60	0.00	0.00
173.60	0.000	109.50	0.00	0.00
174.02	0.000	131.40	0.00	0.00
174.41	0.000	153.30	0.00	0.00
174.79	0.000	175.20	0.00	0.00
175.15	0.000	197.10	0.00	0.00
175.50	0.000	219.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010
 <2> TOLERANCE (%) = 1.000

PRINT DATE: 03-07-2005

FILE DATE: 03-07-2005

PRINT TIME: 07:22:31

FILE NAME: RCB

Performance curve data separator line

PERFORMANCE CURVE FOR CULVERT 1 - 1(8.00 (ft) BY 5.00 (ft)) RCB

Performance curve data separator line

DIS-CHARGE FLOW (cfs)	HEAD- ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	171.60	0.00	1.27	0-NF	0.00	0.00	0.00	2.00	0.00	0.00
21.90	171.80	1.06	1.47	3-M1t	0.93	0.62	2.00	2.00	1.37	0.00
43.80	172.23	1.68	1.90	3-M1t	1.48	0.98	2.00	2.00	2.74	0.00
65.70	172.72	2.20	2.39	3-M1t	1.95	1.28	2.00	2.00	4.11	0.00
87.60	173.16	2.65	2.83	3-M2t	2.38	1.55	2.00	2.00	5.47	0.00
109.50	173.60	3.06	3.27	3-M2t	2.79	1.80	2.00	2.00	6.84	0.00
131.40	174.02	3.45	3.69	2-M2c	3.19	2.04	2.04	2.00	8.07	0.00
153.30	174.41	3.81	4.08	2-M2c	3.57	2.26	2.26	2.00	8.50	0.00
175.20	174.79	4.16	4.46	2-M2c	3.95	2.47	2.47	2.00	8.88	0.00
197.10	175.15	4.50	4.82	2-M2c	4.31	2.67	2.67	2.00	9.24	0.00
219.00	175.50	4.84	5.17	2-M2c	5.00	2.86	2.86	2.00	9.57	0.00

Performance curve data separator line

El. inlet face invert 170.33 ft El. outlet invert 169.60 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

Performance curve data separator line

* SITE DATA ***** CULVERT INVERT *****

INLET STATION 0.00 ft
INLET ELEVATION 170.33 ft
OUTLET STATION 950.00 ft
OUTLET ELEVATION 169.60 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0008
CULVERT LENGTH ALONG SLOPE 950.00 ft

***** CULVERT DATA SUMMARY *****

BARREL SHAPE BOX
BARREL SPAN 8.00 ft
BARREL RISE 5.00 ft
BARREL MATERIAL CONCRETE
BARREL MANNING'S n 0.012
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION NONE

Performance curve data separator line

PRINT DATE: 03-07-2005
PRINT TIME: 07:22:31

FILE DATE: 03-07-2005
FILE NAME: RCB

TAILWATER #####
#####

CONSTANT WATER SURFACE ELEVATION
171.60

ROADWAY OVERTOPPING DATA #####
#####

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	50.00 ft
CREST LENGTH	50.00 ft
OVERTOPPING CREST ELEVATION	177.62 ft

#####



```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*   JUN 1998                       *
*   VERSION 4.1                     *
*
* RUN DATE 07MAR05 TIME 13:26:46 *
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
*   609 SECOND STREET          *
* DAVIS, CALIFORNIA 95616     *
*   (916) 756-1104            *
*
*****

```

```

X   X  XXXXXXX  XXXXX      X
X   X X      X   X      XX
X   X X      X           X
XXXXXXX XXXX  X           XXXXX X
X   X X      X           X
X   X X      X   X      X
X   X  XXXXXXX  XXXXX      XXX

```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

PAGE 1

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

```

1 ID Cross Pointe 36-04658-5703
2 ID Proposed Drainage - Revised
3 ID 2, 5, 10, 25, 50 & 100 Yr Storms
4 ID By BLB DATE 3-07-05

```

*** LIST ***
 *** FREE ***

*DIAGRAM

```

5 IT 15 27SEP99 1200 0 28SEP99 2000
6 IN 15 27SEP99 1200
7 IO 0 5
8 JR PREC 3.5 4.5 5.3 6.1 7.0 7.8

```

*
 *
 *

```

9 KK OFFST
* Area North of 21st Street North
10 KO 5
11 BA 0.3516
12 PB 1.00
13 PC 0.000 0.003 0.006 0.008 0.011 0.014 0.017 0.019 0.022 0.025
14 PC 0.029 0.032 0.035 0.038 0.042 0.045 0.048 0.052 0.056 0.060

```

15	PC	0.064	0.068	0.072	0.076	0.080	0.085	0.090	0.095	0.100	0.105
16	PC	0.110	0.115	0.120	0.127	0.134	0.140	0.147	0.155	0.163	0.172
17	PC	0.181	0.193	0.204	0.220	0.235	0.259	0.283	0.387	0.663	0.699
18	PC	0.735	0.754	0.772	0.786	0.799	0.810	0.820	0.828	0.835	0.843
19	PC	0.850	0.858	0.865	0.873	0.880	0.885	0.889	0.894	0.898	0.903
20	PC	0.907	0.912	0.916	0.921	0.925	0.929	0.934	0.938	0.943	0.947
21	PC	0.952	0.955	0.958	0.961	0.964	0.967	0.970	0.973	0.976	0.979
22	PC	0.982	0.985	0.988	0.991	0.994	0.997	1.000			
23	LS	0	80	10							
24	UD	2.780									

*
*
*

25	KK	ROUTE									
26	KO	5									
27	RT	0	0	1							

*
*
*

28	KK	BAS3									
29	KO	5									
30	BA	0.0465									
31	PB	1.00									
32	PC	0.000	0.003	0.006	0.008	0.011	0.014	0.017	0.019	0.022	0.025
33	PC	0.029	0.032	0.035	0.038	0.042	0.045	0.048	0.052	0.056	0.060
34	PC	0.064	0.068	0.072	0.076	0.080	0.085	0.090	0.095	0.100	0.105
35	PC	0.110	0.115	0.120	0.127	0.134	0.140	0.147	0.155	0.163	0.172
36	PC	0.181	0.193	0.204	0.220	0.235	0.259	0.283	0.387	0.663	0.699
37	PC	0.735	0.754	0.772	0.786	0.799	0.810	0.820	0.828	0.835	0.843
38	PC	0.850	0.858	0.865	0.873	0.880	0.885	0.889	0.894	0.898	0.903
39	PC	0.907	0.912	0.916	0.921	0.925	0.929	0.934	0.938	0.943	0.947

HEC-1 INPUT

1

PAGE 2

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

40	PC	0.952	0.955	0.958	0.961	0.964	0.967	0.970	0.973	0.976	0.979
41	PC	0.982	0.985	0.988	0.991	0.994	0.997	1.000			
42	LS	0	80	80							
43	UD	0.510									

*
*
*

44	KK	COMB									
45	KO	5									
46	HC	2	0								

*
*
*

47	KK	POND1									
	*	Runoff at South Property Line									
	*	20 Weir at Elevation 169.60									

48	KO	5									
49	RS	1	ELEV	169.6							
50	SA	2.50	2.61	2.72	2.83	2.95					
51	SE	169.6	170.6	171.6	172.6	173.6					
52	SQ	0.0	22.8	45.6	68.4	91.2	114.0	136.8	159.6	182.4	205.2

53	SQ	228.0									
54	SE	169.6	170.04	170.30	170.52	170.72	170.90	171.06	171.22	171.37	171.5
55	SE	171.66									
	*										
	*										
	*										
56	KK	BAS5									
57	KO	5									
58	BA	0.0317									
59	PB	1.00									
60	PC	0.000	0.003	0.006	0.008	0.011	0.014	0.017	0.019	0.022	0.025
61	PC	0.029	0.032	0.035	0.038	0.042	0.045	0.048	0.052	0.056	0.060
62	PC	0.064	0.068	0.072	0.076	0.080	0.085	0.090	0.095	0.100	0.105
63	PC	0.110	0.115	0.120	0.127	0.134	0.140	0.147	0.155	0.163	0.172
64	PC	0.181	0.193	0.204	0.220	0.235	0.259	0.283	0.387	0.663	0.699
65	PC	0.735	0.754	0.772	0.786	0.799	0.810	0.820	0.828	0.835	0.843
66	PC	0.850	0.858	0.865	0.873	0.880	0.885	0.889	0.894	0.898	0.903
67	PC	0.907	0.912	0.916	0.921	0.925	0.929	0.934	0.938	0.943	0.947
68	PC	0.952	0.955	0.958	0.961	0.964	0.967	0.970	0.973	0.976	0.979
69	PC	0.982	0.985	0.988	0.991	0.994	0.997	1.000			
70	LS	0	80	80							
71	UD	0.740									
	*										
	*										
	*										

1

HEC-1 INPUT

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

72	KK	POND2									
	*	Runoff at Southeast Corner of Site									
	*	3 Weir at Elevation 165.60									
73	KO	5									
74	RS	1	ELEV	165.6							
75	SA	2.50	2.61	2.72	2.83	2.95					
76	SE	165.6	166.6	167.6	168.6	169.6					
77	SQ	0.0	5.7	11.4	17.1	22.8	28.5	34.2	39.9	45.6	51.3
78	SQ	57.0									
79	SE	165.6	166.32	166.75	167.10	167.42	167.71	167.99	168.25	168.49	168.7
80	SE	168.96									
	*										
	*										
	*										
81	ZZ										

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (---->) DIVERSION OR PUMP FLOW

NO. (.) CONNECTOR (<----) RETURN OF DIVERTED OR PUMPED FLOW

9 OFFST
V
V

25 ROUTE
.
.

28 . BAS3



44 COMB.....
 V
 V
 47 POND1
 .
 .
 56 . BAS5
 . V
 . V
 72 . POND2

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

 * *
 * FLOOD HYDROGRAPH PACKAGE (HEC-1) *
 * JUN 1998 *
 * VERSION 4.1 *
 * *
 * RUN DATE 07MAR05 TIME 13:26:46 *
 * *

 * *
 * U.S. ARMY CORPS OF ENGINEERS *
 * HYDROLOGIC ENGINEERING CENTER *
 * 609 SECOND STREET *
 * DAVIS, CALIFORNIA 95616 *
 * (916) 756-1104 *
 * *

Cross Pointe 36-04658-5703
 Proposed Drainage - Revised
 2, 5, 10, 25, 50 & 100 Yr Storms
 By BLB DATE 3-07-05

7 IO OUTPUT CONTROL VARIABLES
 IPRNT 0 PRINT CONTROL
 IPLOT 5 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
 NMIN 15 MINUTES IN COMPUTATION INTERVAL
 IDATE 27SEP99 STARTING DATE
 ITIME 1200 STARTING TIME
 NQ 129 NUMBER OF HYDROGRAPH ORDINATES
 NDDATE 28SEP99 ENDING DATE
 NDTIME 2000 ENDING TIME
 ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .25 HOURS
 TOTAL TIME BASE 32.00 HOURS

ENGLISH UNITS

DRAINAGE AREA SQUARE MILES
 PRECIPITATION DEPTH INCHES
 LENGTH, ELEVATION FEET
 FLOW CUBIC FEET PER SECOND
 STORAGE VOLUME ACRE-FEET
 SURFACE AREA ACRES
 TEMPERATURE DEGREES FAHRENHEIT

NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
3.50 4.50 5.30 6.10 7.00 7.80

*** **

9 KK * OFFST *

10 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

25 KK * ROUTE *

26 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

28 KK * BAS3 *

29 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

44 KK * COMB *

45 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

47 KK * POND1 *

48 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

56 KK * BASS *

57 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

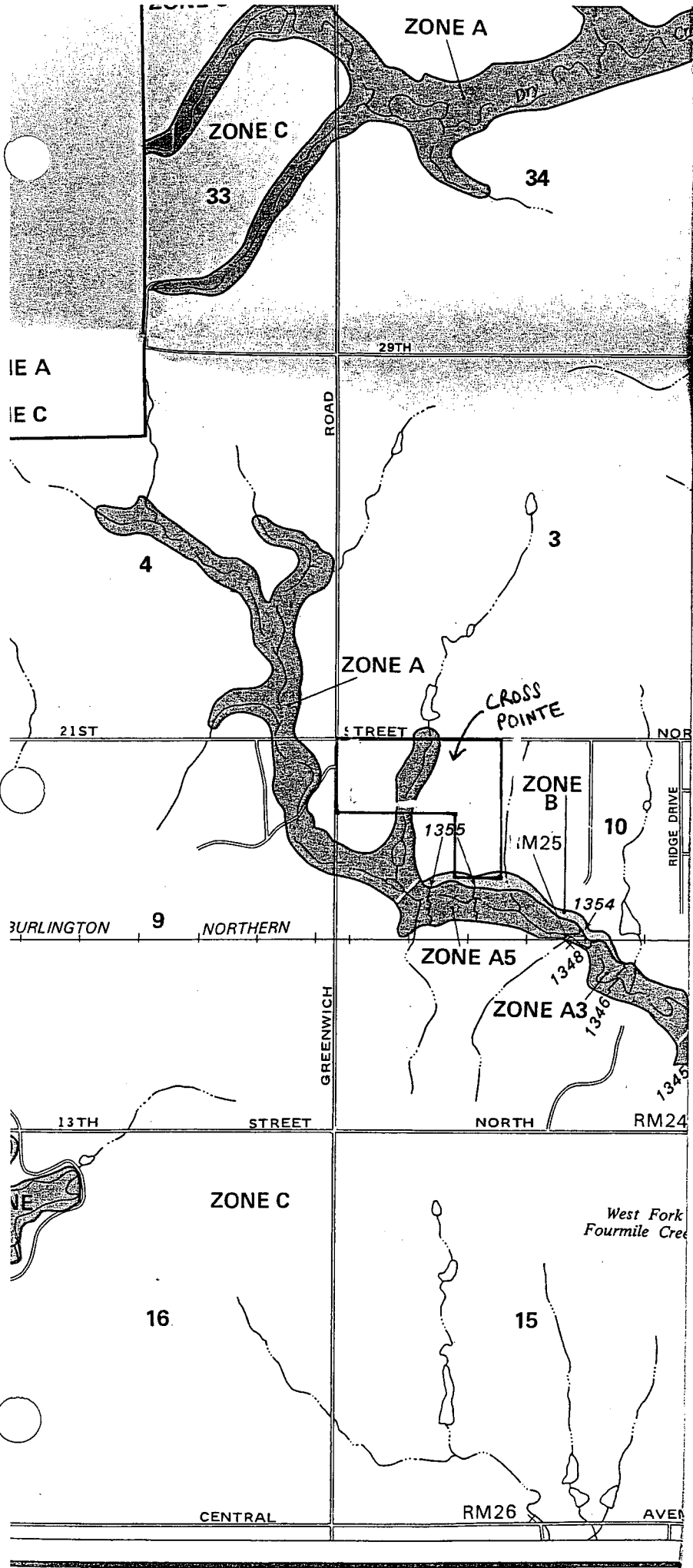
72 KK * POND2 *

73 KO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 5 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

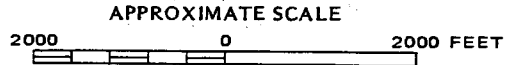
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION						
				RATIO 1 3.50	RATIO 2 4.50	RATIO 3 5.30	RATIO 4 6.10	RATIO 5 7.00	RATIO 6 7.80	
HYDROGRAPH AT										
+	OFFST	.35	1	FLOW	68.	101.	129.	157.	190.	219.
				TIME	15.00	15.00	14.75	14.75	14.75	14.75
ROUTED TO										
+	ROUTE	.35	1	FLOW	68.	101.	129.	157.	190.	219.
				TIME	15.25	15.25	15.00	15.00	15.00	15.00
HYDROGRAPH AT										
+	BAS3	.05	1	FLOW	43.	57.	68.	79.	92.	103.
				TIME	12.25	12.25	12.25	12.25	12.25	12.25
2 COMBINED AT										
+	COMB	.40	1	FLOW	71.	105.	134.	163.	197.	226.
				TIME	15.25	15.00	15.00	15.00	15.00	15.00
ROUTED TO										
+	POND1	.40	1	FLOW	70.	104.	133.	162.	196.	225.
				TIME	15.50	15.25	15.25	15.25	15.25	15.25
				** PEAK STAGES IN FEET **						
			1	STAGE	170.54	170.82	171.03	171.24	171.45	171.64
				TIME	15.50	15.25	15.25	15.25	15.25	15.25
HYDROGRAPH AT										
+	BAS5	.03	1	FLOW	24.	32.	38.	44.	51.	57.
				TIME	12.50	12.50	12.50	12.50	12.50	12.50
ROUTED TO										
+	POND2	.03	1	FLOW	8.	12.	15.	18.	21.	25.
				TIME	13.75	13.75	13.75	13.50	13.50	13.50
				** PEAK STAGES IN FEET **						
			1	STAGE	166.51	166.76	166.94	167.13	167.33	167.51
				TIME	13.75	13.75	13.75	13.50	13.50	13.50

*** NORMAL END OF HEC-1 ***



To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

**FIRM
FLOOD INSURANCE RATE MAP**

**SEDGWICK
COUNTY,
KANSAS**
(UNINCORPORATED AREAS)

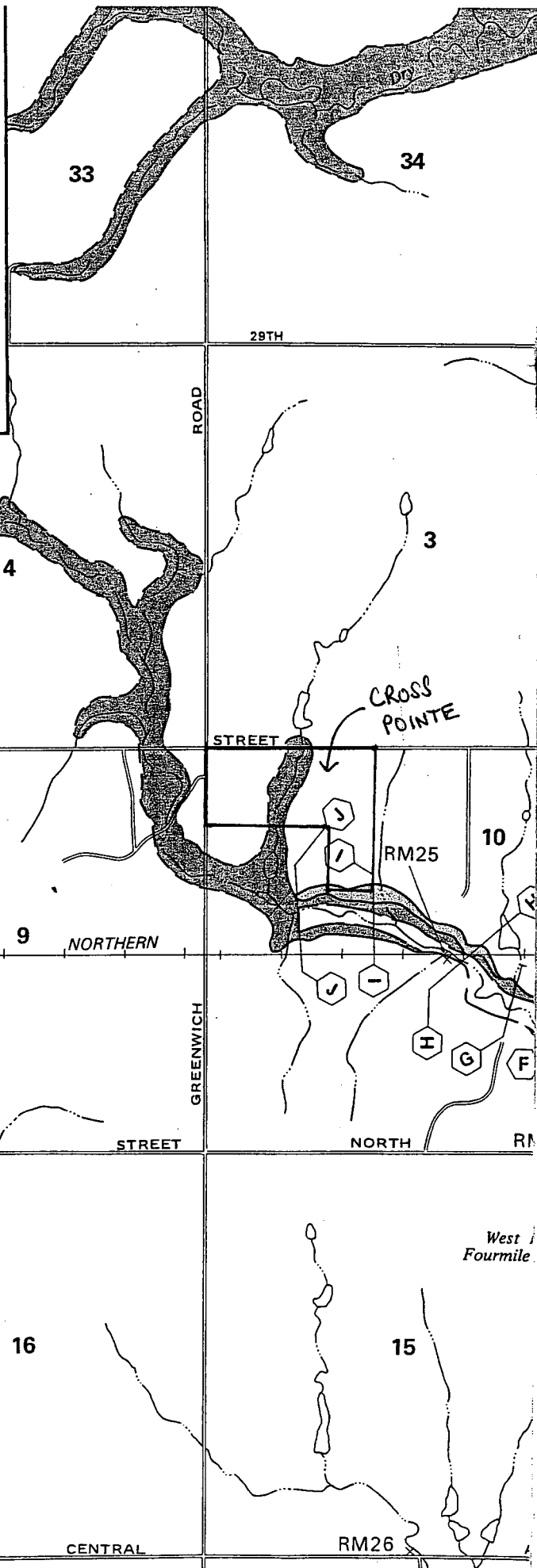
PANEL 150 OF 300

**COMMUNITY-PANEL NUMBER
200321 0150 A**

**EFFECTIVE DATE:
JUNE 3, 1986**



Federal Emergency Management Agency



APPROXIMATE SCALE



NATIONAL FLOOD INSURANCE PROGRAM

**FLOODWAY
FLOOD BOUNDARY AND
FLOODWAY MAP**

**SEDGWICK
COUNTY,
KANSAS**
(UNINCORPORATED AREAS)

PANEL 150 OF 300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
200321 0150

EFFECTIVE DATE:
JUNE 3, 1986



Federal Emergency Management Agency

FLOODING SOURCE		FLOODWAY				BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)	
WEST FORK FOURMILE CREEK									
A	1110	100	412	8.7	1327.3	1327.3	1327.3	0.0	
B	2800	500	1984	1.8	1334.9	1334.9	1335.6	0.7	
C	3870	197	904	4.0	1335.4	1335.4	1336.0	0.6	
D	4256	250	1402	2.6	1337.5	1337.5	1337.9	0.4	
E	5436	253	953	3.8	1338.1	1338.1	1338.8	0.7	
F	6741	120	891	4.2	1345.1	1345.1	1345.1	0.0	
G	8661	300	1283	3.0	1345.7	1345.7	1346.7	1.0	
H	10,291	250	1078	3.5	1348.0	1348.0	1348.6	0.6	
I	11,776	210	1385	2.7	1354.9	1354.9	1355.1	0.2	
J	12,986	300	1661	2.3	1355.3	1355.3	1355.8	0.5	
BROOKHAVEN CREEK									
A	2980	400 ²	1359	3.1	1293.5	1293.5	1294.3	0.8	
B	4512	400	1472	3.0	1296.6	1296.6	1297.3	0.7	
C	5005	350	2086	2.1	1301.4	1301.4	1301.5	0.1	
D	6306	400	2452	1.8	1303.4	1303.4	1304.3	0.9	
E	9106	141	607	7.3	1308.7	1308.7	1309.4	0.7	
F	10,376	300	1594	2.8	1313.8	1313.8	1314.4	0.6	
G	11,056	200	1233	3.6	1315.2	1315.2	1315.7	0.5	
H	13,091	250	1278	3.0	1319.3	1319.3	1320.3	1.0	
I	13,359	200	2566	1.5	1328.7	1328.7	1328.7	0.0	
J	14,149	200	1949	1.9	1328.7	1328.7	1328.8	0.1	
K	15,729	450	2177	1.7	1330.0	1330.0	1330.6	0.6	
L	17,359	250	671	5.6	1331.5	1331.5	1332.4	0.9	

¹FEET ABOVE MOUTH

²THIS WIDTH EXTENDS BEYOND COUNTY BOUNDARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

SEDGWICK COUNTY, KS
(UNINCORPORATED AREAS)

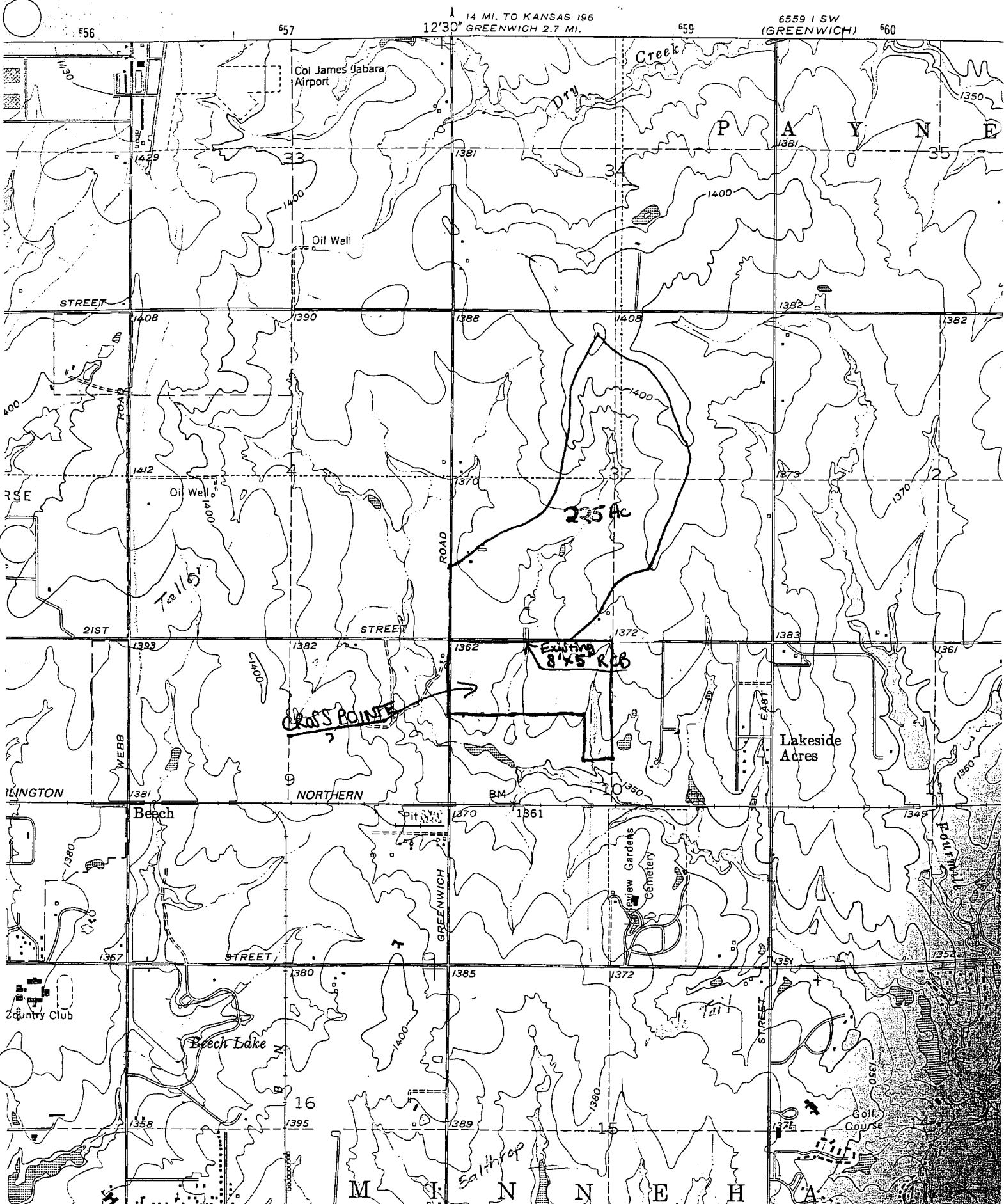
FLOODWAY DATA

WEST FORK FOURMILE CREEK -- BROOKHAVEN CREEK

TABLE 3

RIOR

STATE OF KANSAS



14 MI. TO KANSAS 196
GREENWICH 2.7 MI.

6559 1 SW
(GREENWICH)

CROSS POINT

Existing 84x5 ROB

235 Ac

Lakeside Acres

WILKINSON

NORTHERN

Beech

Country Club

Beech Lake

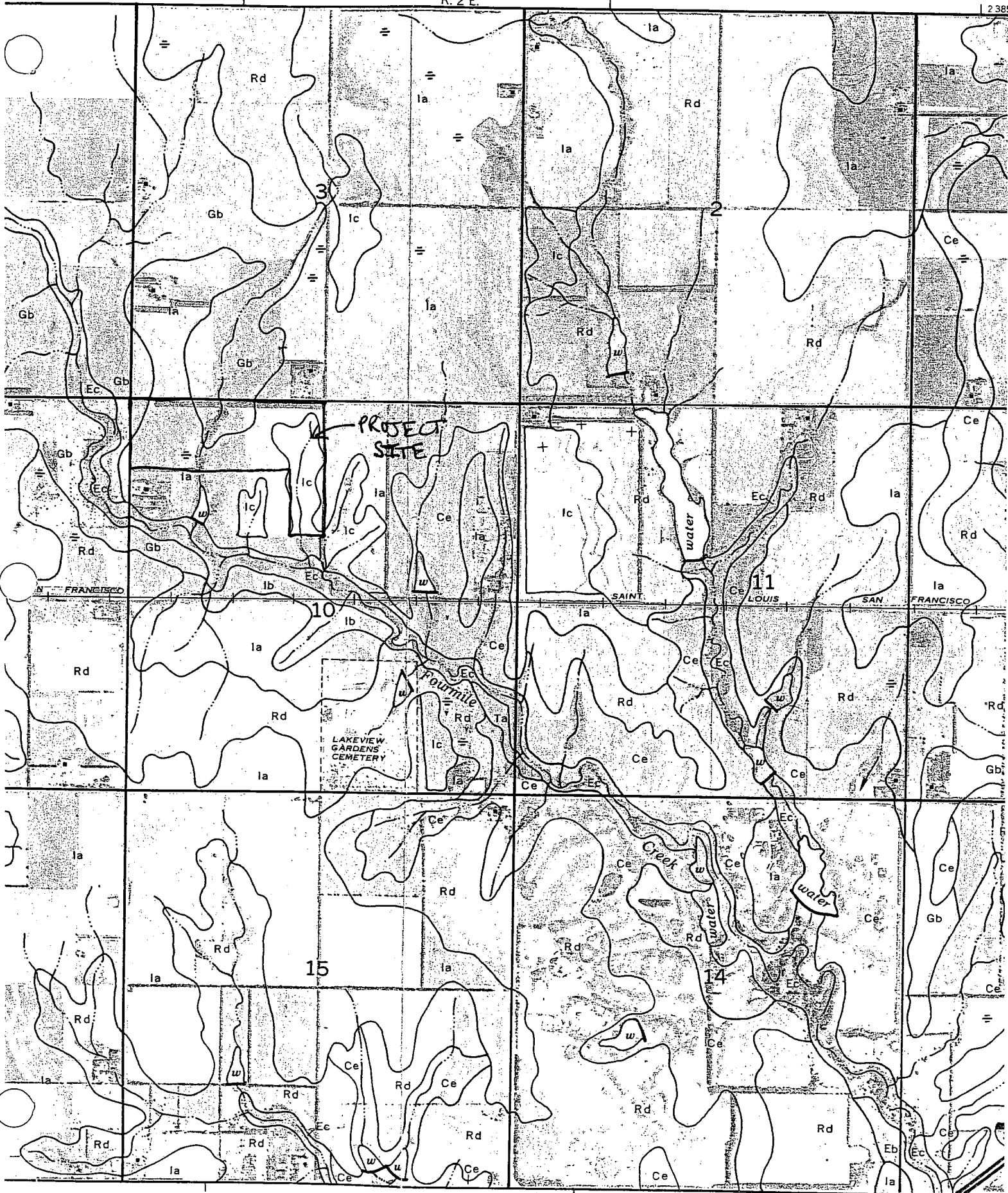
Eulew Gardens Cemetery

Golf Course

M I N N E H A

R. 2 E.

238



KS-2-5

County	Expected 24-hour Storm Rainfall in Inches						Normal Annual Precipitation Inches
	Storm Frequency in Years						
	100	50	25	10	5	2	
Pawnee	6.6	6.0	5.2	4.5	3.7	2.8	23.3
Phillips	6.0	5.5	4.8	4.1	3.4	2.5	23.6
Pottawatomie	7.5	6.6	5.9	5.1	4.3	3.4	33.6
Pratt	7.2	6.4	5.6	4.8	4.1	3.0	24.6
Rawlins	5.5	5.0	4.3	3.6	3.1	2.3	21.0
Reno	7.4	6.6	5.8	5.0	4.2	3.2	27.7
Republic	6.8	6.0	5.4	4.6	3.9	2.9	28.6
Rice	7.3	6.4	5.6	4.8	4.1	3.0	26.6
Riley	7.4	6.5	5.8	5.1	4.3	3.3	33.5
Rooks	6.1	5.7	4.9	4.1	3.4	2.5	23.9
Rush	6.5	5.9	5.0	4.3	3.6	2.7	23.3
Russell	6.7	5.9	5.2	4.4	3.7	2.8	26.8
Saline	7.3	6.4	5.7	4.9	4.1	3.1	28.4
Scott	5.7	5.3	4.5	3.8	3.2	2.4	20.2
Sedgwick	7.8	7.0	6.1	5.3	4.5	3.5	30.6
Seward	6.0	5.7	4.8	4.2	3.5	2.6	19.8
Shawnee	7.8	6.8	6.1	5.3	4.5	3.5	34.7
Sheridan	5.7	5.3	4.5	3.8	3.2	2.4	21.3
Sherman	5.3	4.8	4.2	3.5	3.0	2.2	16.7
Smith	6.3	5.7	5.0	4.2	3.5	2.6	24.4
Stafford	7.1	6.2	5.5	4.7	4.0	2.9	25.1
Stanton	5.6	5.2	4.5	3.8	3.2	2.4	15.8
Stevens	5.9	5.5	4.7	4.1	3.4	2.5	19.7
Sumner	8.0	7.1	6.2	5.4	4.6	3.6	34.0

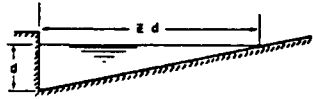
$x\text{-slope} = \frac{3}{8} \frac{1}{4} = 0.03125\%$

$z = \frac{1}{x\text{-slope}} = \frac{1}{0.03125} = 32$

$n = 0.016$

$\frac{z}{n} = \frac{32}{0.016} = 2000$

always



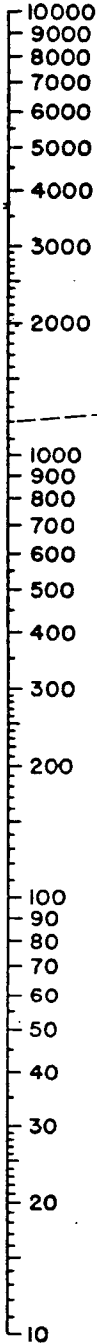
EQUATION: $Q = 0.58 \left(\frac{z}{n}\right)^{3/2} d^{5/2}$
 n IS ROUGHNESS COEFFICIENT IN MANNING FORMULA APPROPRIATE TO MATERIAL IN BOTTOM OF CHANNEL
 z IS RECIPROCAL OF CROSS SLOPE
 REFERENCE: H. R. B. PROCEEDINGS 1948, PAGE 150, EQUATION (14)

EXAMPLE (SEE INSTRUCTION 1)

GIVEN: $s = 0.03$
 $z = 24$
 $n = .02$
 $Q = 2.0\text{CFS}$
 $z/n = 1200$

FIND: $d = 0.22$ BY FOLLOWING DASHED LINES

RATIO z/n

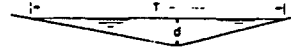


TURNING LINE

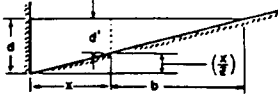
INSTRUCTIONS

1. CONNECT z/n RATIO WITH SLOPE (S) AND CONNECT DISCHARGE (Q) WITH POINT WHERE LINE CROSSES TURNING LINE READ DEPTH AT CURB (d) Q CAN BE FOUND FROM d BY CONNECTING d WITH CROSSING OF TURNING LINE

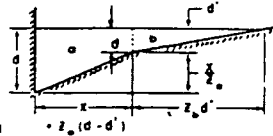
2. FOR SHALLOW V-SHAPED CHANNEL AS SHOWN USE NOMOGRAPH AS EXPLAINED IN INSTRUCTION 1 BUT WITH $z = \frac{T}{d}$



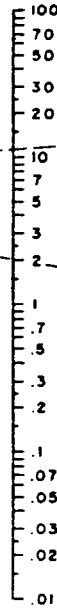
3. TO DETERMINE DISCHARGE Q_0 IN PORTION OF CHANNEL HAVING WIDTH x : DETERMINE DEPTH d FOR TOTAL DISCHARGE IN ENTIRE SECTION AS EXPLAINED IN 1. THEN USE NOMOGRAPH TO DETERMINE Q_b IN SECTION OF WIDTH b FOR DEPTH $d' = d - (\frac{x}{z})$. THEN $Q_0 = Q - Q_b$.



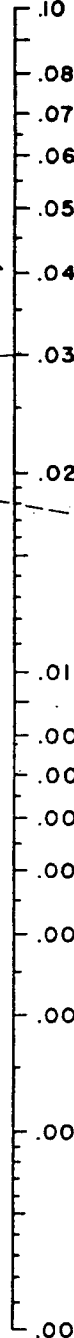
4. TO DETERMINE DISCHARGE (Q_0) IN COMPOSITE SECTION: FOLLOW INSTRUCTION 3. TO OBTAIN DISCHARGE (Q_0) IN SECTION a AT ASSUMED DEPTH d' BASED ON AN EXTENSION OF SLOPE z_0 TO INTERSECT WATER SURFACE; OBTAIN Q_b FOR SLOPE RATIO z_b AND DEPTH d' ; $d' = d - \frac{x}{z_0}$. THEN $Q_1 = Q_0 + Q_b$.



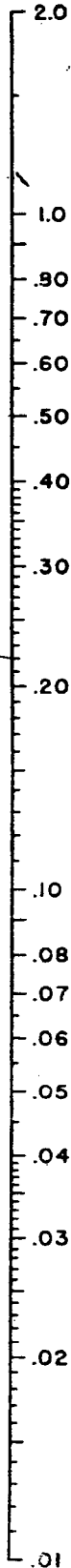
DISCHARGE (Q) IN CFS



SLOPE OF CHANNEL (S) IN FT./FT.



DEPTH AT CURB OR DEEPEST POINT (d) IN FT.



$$L_T = 0.6Q^{0.42} S^{0.3} (1/nS_x)^{0.6}$$

FOR COMPOSITE CROSS SLOPES, USE S_e FOR S_x .

$$S_e = S_x + S'_w E_o \quad ; \quad S'_w = a/W$$

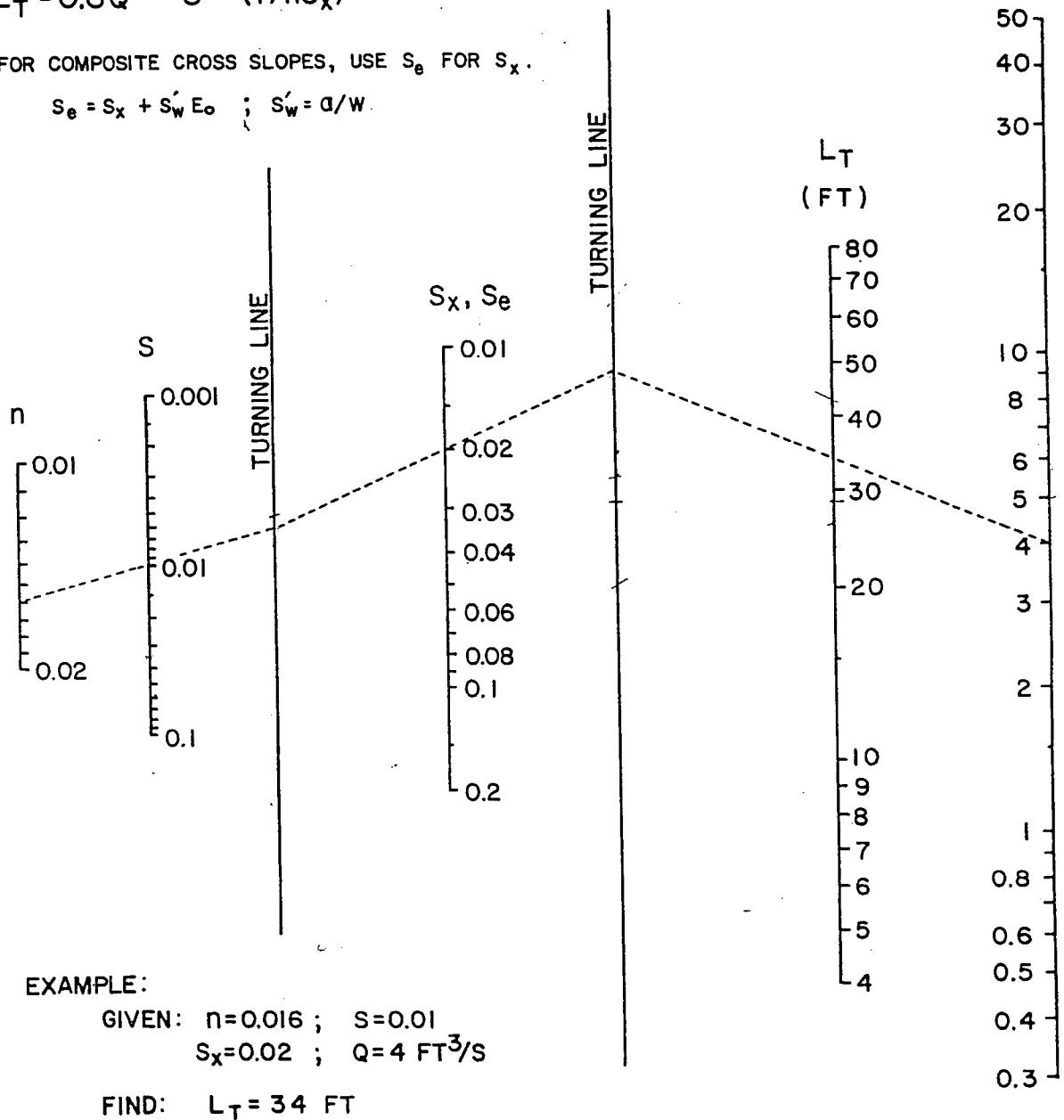
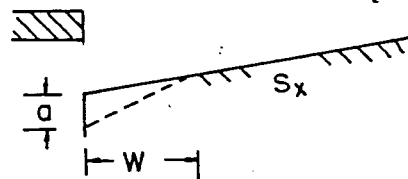


CHART 9. Curb-opening and slotted drain inlet length for total interception.

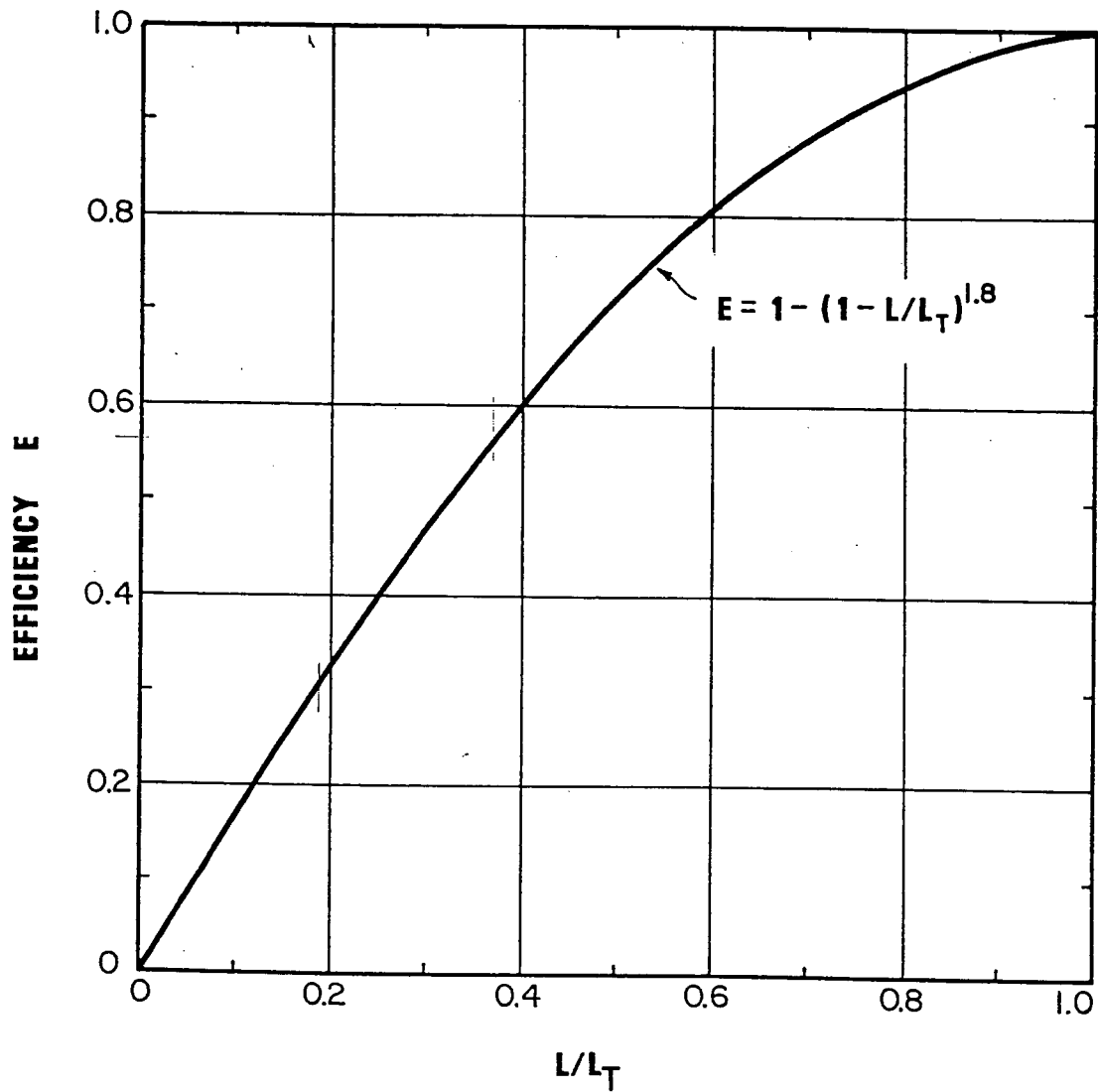


CHART 10. Curb-opening and slotted drain inlet interception efficiency.

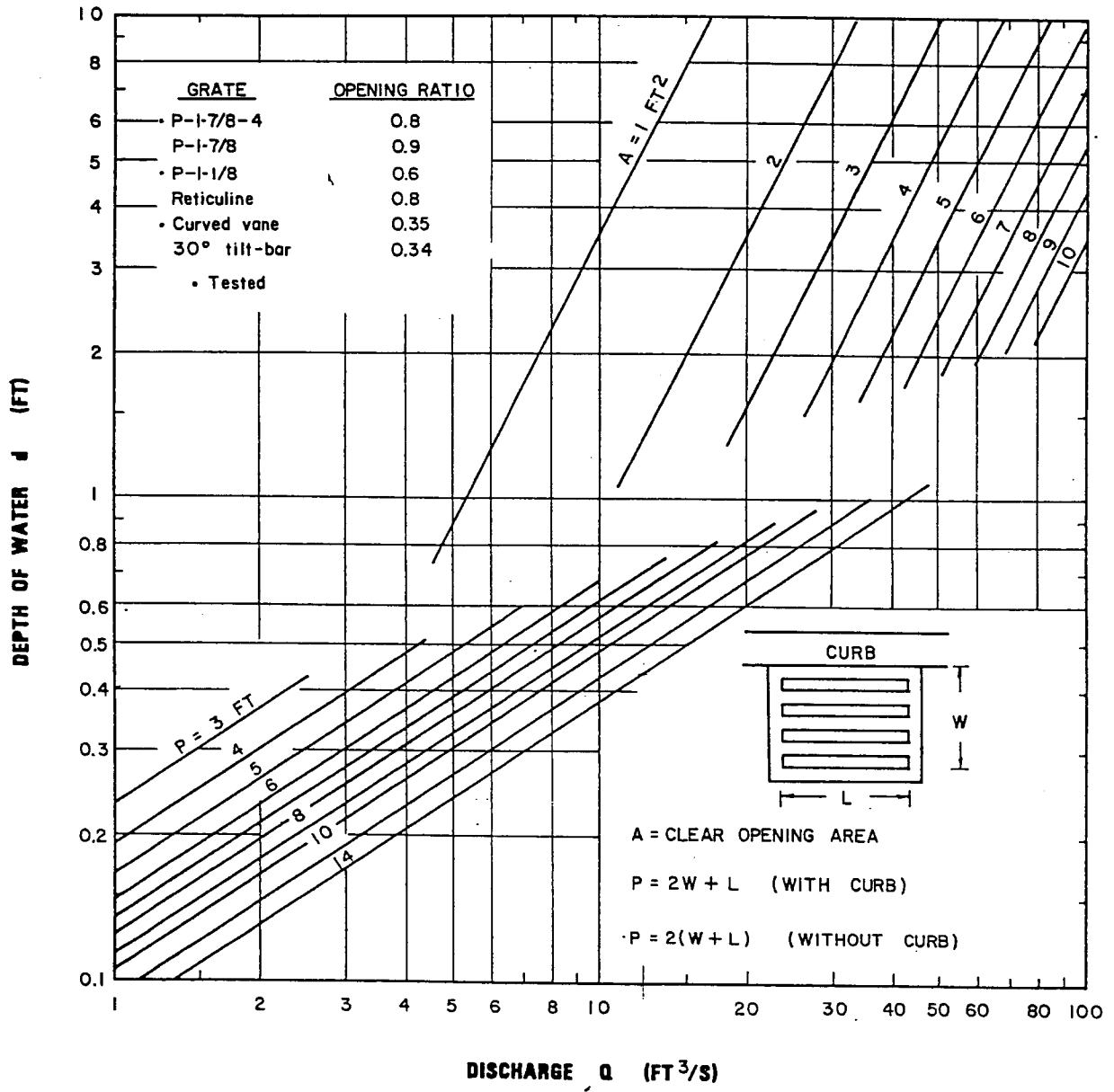


CHART 11. Grate inlet capacity in sump conditions.

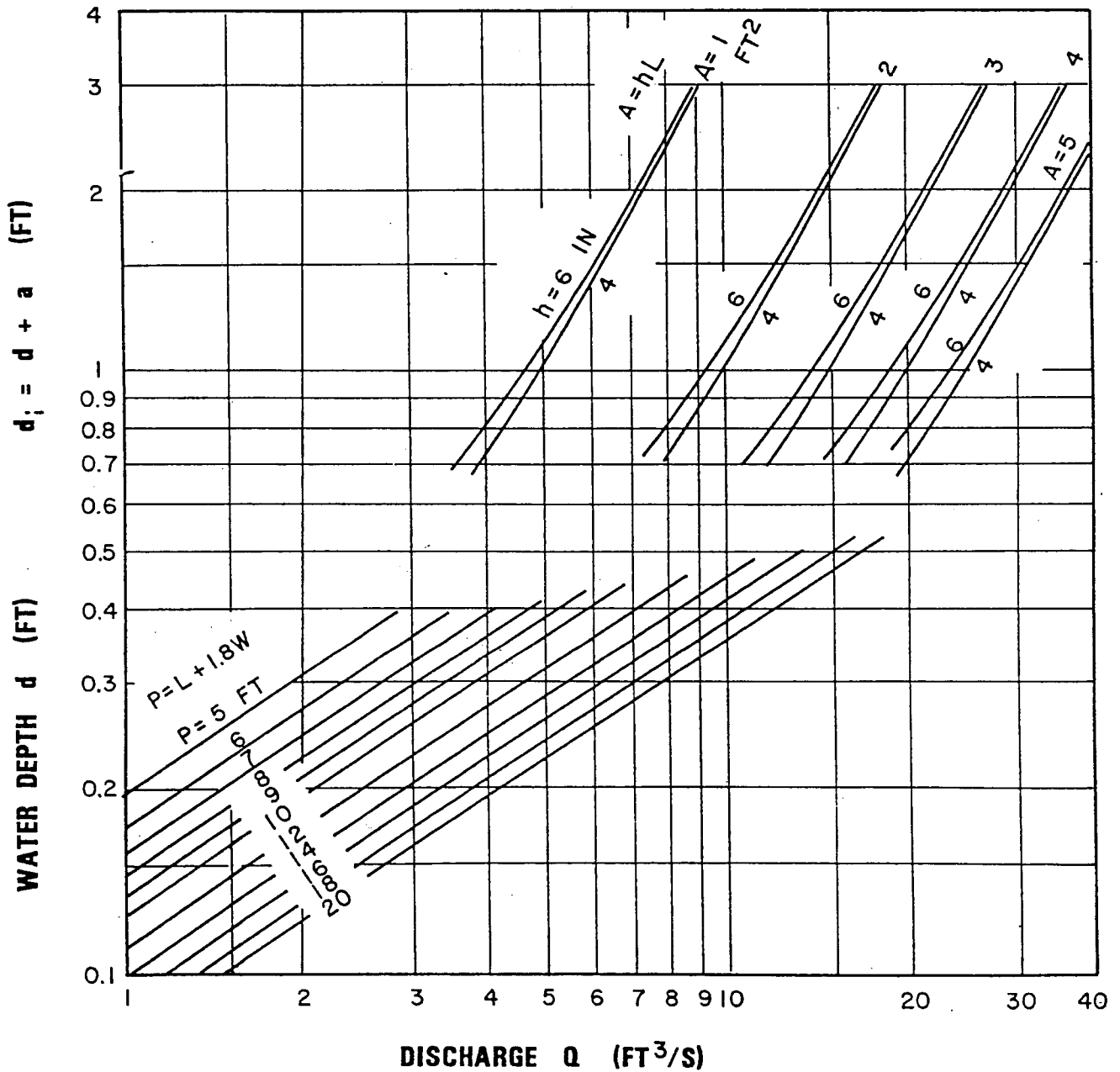
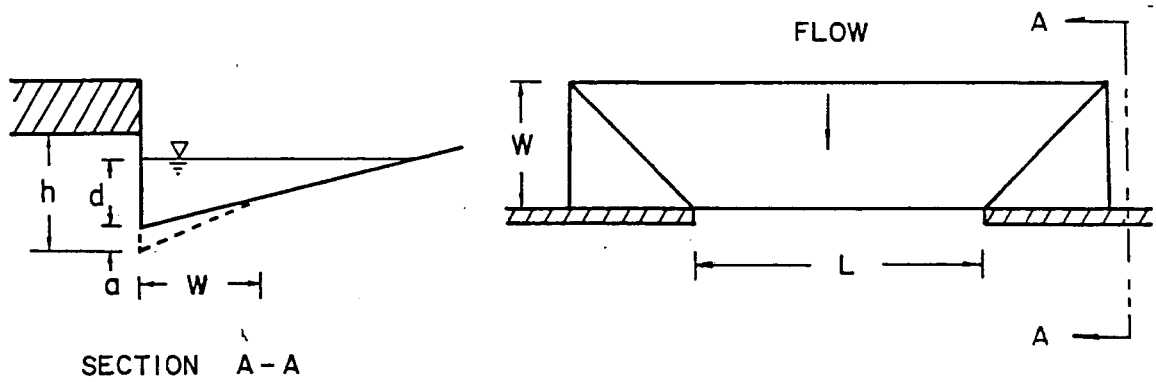


CHART 12. Depressed curb-opening inlet capacity in sump locations.

ATTACHMENT A
DRAINAGE CRITERIA MANUAL

RAINFALL INTENSITY TABLE FOR SEDGWICK COUNTY, KANSAS

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

DURATION IN MINUTES ($\frac{1}{2}$)	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	$i = 4.18$	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
44	1.75	2.11	2.61	3.05	3.57	4.03	4.43
45	1.73	2.08	2.57	3.01	3.52	3.98	4.38

ATTACHMENT A CONTINUED
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<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>.5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
46	1.70	2.05	2.54	2.97	3.48	3.93	4.33
47	1.67	2.02	2.50	2.93	3.44	3.88	4.28
48	1.66	2.00	2.47	2.90	3.39	3.84	4.23
49	1.64	1.97	2.44	2.86	3.35	3.79	4.18
50	1.61	1.95	2.41	2.83	3.32	3.75	4.13
51	1.59	1.92	2.38	2.79	3.28	3.71	4.09
52	1.56	1.89	2.35	2.76	3.24	3.67	4.05
53	1.54	1.86	2.33	2.73	3.20	3.63	4.00
54	1.52	1.84	2.30	2.70	3.17	3.59	3.96
55	1.50	1.81	2.27	2.67	3.14	3.55	3.92
56	1.47	1.79	2.25	2.64	3.10	3.51	3.88
57	1.45	1.76	2.22	2.61	3.07	3.48	3.84
58	1.43	1.74	2.20	2.59	3.04	3.44	3.81
59	1.42	1.72	2.18	2.56	3.01	3.41	3.77
60	1.40	1.69	2.15	2.53	2.98	3.37	3.73
61	1.38	1.67	2.13	2.51	2.95	3.34	3.70
62	1.36	1.65	2.11	2.48	2.92	3.31	3.67
63	1.34	1.63	2.09	2.46	2.89	3.28	3.63
64	1.33	1.61	2.07	2.44	2.86	3.25	3.60
65	1.31	1.59	2.05	2.41	2.84	3.22	3.57
66	1.30	1.57	2.03	2.39	2.81	3.19	3.54
67	1.28	1.56	2.01	2.37	2.79	3.16	3.51
68	1.26	1.54	1.99	2.35	2.76	3.13	3.48
69	1.25	1.52	1.97	2.33	2.74	3.10	3.45
70	1.24	1.50	1.95	2.31	2.71	3.08	3.42
71	1.22	1.49	1.93	2.28	2.69	3.05	3.39
72	1.21	1.47	1.92	2.26	2.67	3.02	3.36
73	1.20	1.46	1.90	2.25	2.64	3.00	3.34
74	1.18	1.44	1.88	2.23	2.63	2.98	3.31
75	1.17	1.43	1.86	2.21	2.61	2.95	3.29
76	1.16	1.41	1.85	2.19	2.58	2.93	3.26
77	1.15	1.40	1.83	2.17	2.55	2.90	3.24
78	1.13	1.38	1.82	2.15	2.53	2.88	3.22
79	1.12	1.37	1.80	2.14	2.50	2.86	3.19
80	1.11	1.36	1.79	2.12	2.48	2.84	3.16
81	1.10	1.34	1.77	2.10	2.46	2.82	3.13
82	1.09	1.33	1.76	2.08	2.43	2.79	3.10
83	1.08	1.32	1.74	2.06	2.41	2.76	3.07
84	1.07	1.31	1.73	2.04	2.39	2.74	3.04
85	1.06	1.30	1.72	2.02	2.37	2.71	3.01
86	1.05	1.28	1.70	2.00	2.34	2.69	2.99
87	1.04	1.27	1.69	1.99	2.32	2.66	2.96
88	1.03	1.26	1.68	1.97	2.30	2.64	2.93
89	1.02	1.25	1.68	1.95	2.28	2.62	2.91
90	1.01	1.24	1.66	1.93	2.26	2.59	2.88

ATTACHMENT A CONTINUED
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<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
95	0.97	1.19	1.59	1.85	2.17	2.49	2.76
96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
101	0.93	1.13	1.52	1.77	2.07	2.39	2.65
102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
120	0.81	0.99	1.33	1.55	1.81	2.07	2.30

<u>DURATION IN HOURS</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
2	0.81	0.99	1.33	1.55	1.81	2.07	2.30
3	0.59	0.72	0.97	1.13	1.32	1.51	1.68
4	0.47	0.58	0.78	0.91	1.06	1.21	1.35
5	0.40	0.49	0.66	0.77	0.89	1.02	1.14
6	0.35	0.42	0.57	0.67	0.78	0.89	0.99
8	0.28	0.34	0.46	0.53	0.62	0.71	0.79
10	0.23	0.29	0.39	0.45	0.52	0.60	0.67
12	0.20	0.25	0.33	0.39	0.45	0.52	0.58
18	0.15	0.18	0.24	0.28	0.33	0.38	0.42
24	0.12	0.15	0.20	0.23	0.27	0.31	0.34

ATTACHMENT B
DRAINAGE CRITERIA MANUAL

INCREMENTAL INFILTRATION VALUES IN INCHES

Time Minutes**	SCS Hydrologic Soil Group			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
5	.33	.26	.19	.12
10	.25	.17	.09	.04
15	.18	.11	.05	.02
20	.13	.07	.03	.02
25	.10	.05	.03	.02
30	.08	.05	.03	.02
35	.08	.05	.03	.02
40	.08	.05	.03	.02
45	.08	.05	.03	.02
50	.08	.05	.03	.02
55	.08	.05	.03	.02
60	.08	.05	.03	.02
65	.08	.05	.03	.02
70	.08	.05	.03	.02
75	.08	.05	.03	.02
80	.08	.05	.03	.02
85	.08	.05	.03	.02
90	.08	.05	.03	.02
95	.08	.05	.03	.02
100	.08	.05	.03	.02
105	.08	.05	.03	.02
110	.08	.05	.03	.02
115	.08	.05	.03	.02
120	.08	.05	.03	.02

**Time at end of the time increment

NOTE: Values for 125 minutes and additional 5 minute increments shall be the same as those shown for 120 minutes.

ATTACHMENT C

DRAINAGE CRITERIA MANUAL

DEPRESSION STORAGE LOSSES

<u>Surface Type</u>	<u>Total Loss (Inches)</u>
Impervious:	
Paved Areas	0.1
Flat Roofs	0.1
Sloped Roofs	0.05
Pervious:	
Lawns and Grass	0.3
Wooded Areas and Open Fields	0.4

ATTACHMENT D

DRAINAGE CRITERIA

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD
AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

<u>Land Use or Surface Characteristics</u>	<u>Percent Impervious</u>	<u>Frequency.</u>			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
1. Business:					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
2. Residential:					
<u>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>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>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>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>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>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

Land Use or rface Characteristics	Percènt Impervious	Frequency			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<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
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
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:	15	0.33	0.35	0.42	0.55
5. Schools:	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:	30	0.43	0.45	0.50	0.62
7. Undeveloped Urban Areas:					
Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:	96	0.87	0.87	0.88	0.89
10. Roofs:	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
<u>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>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>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>Land Use or Surface Characteristics</u>	<u>Percent Impervious</u>	<u>Frequency</u>			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>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

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.

ATTACHMENT E

DRAINAGE CRITERIA

AVERAGE OVERLAND FLOW VELOCITY FOR USE WITH URBANIZED AREAS

Surface Type	VELOCITY IN FEET/SECOND FOR SLOPES IN PERCENT SHOWN																			
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	20.0
Forest with Heavy Ground Litter or Meadow	0.03	0.04	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.16	0.21	0.28	0.33	0.39	0.46	0.53	0.60	0.72	1.10
Fallow or Minimum Tillage Cultivation	0.06	0.08	0.10	0.12	0.13	0.14	0.16	0.17	0.18	0.19	0.29	0.40	0.51	0.66	0.78	0.91	1.05	1.20	1.44	2.10
Short Grass Pasture or Lawns	0.09	0.13	0.15	0.18	0.20	0.21	0.23	0.25	0.26	0.28	0.45	0.60	0.77	0.96	1.17	1.33	1.50	1.68	1.98	3.20
Almost Bare Ground	0.16	0.22	0.28	0.31	0.35	0.38	0.41	0.44	0.46	0.49	0.70	0.85	1.05	1.26	1.50	1.75	2.03	2.32	2.79	4.40
Grassed Waterway	0.35	0.48	0.58	0.67	0.77	0.84	0.91	0.98	1.05	1.12	1.54	1.82	2.10	2.38	2.78	3.20	3.66	4.14	4.56	7.00
Paved Areas (Sheet Flow) or Shallow Gutter Flow	0.44	0.62	0.77	0.91	1.05	1.12	1.19	1.26	1.33	1.40	2.00	2.55	3.20	3.83	4.41	5.04	5.70	6.00	6.20	9.00

ATTACHMENT F

DETERMINATION OF DIMENSIONLESS
WATERSHED CONVEYANCE FACTOR (\emptyset)

$$\emptyset = \emptyset_1 + \emptyset_2$$

\emptyset_1	Classification
0.6	Extensive channel improvement and storm sewer system, closed conduit channel system
0.7	Moderate channel improvement and storm sewer system.
0.8	Some channel improvement and storm sewers, mainly cleaning and enlargement of existing channel.
0.9	Little channel improvement and storm sewers.
1.0	Natural channel conditions.
\emptyset_2	Classification
0.0	No channel vegetation.
0.1	Light channel vegetation.
0.2	Moderate channel vegetation.
0.3	Heavy channel vegetation.

EXHIBIT NO. 1

SOIL LEGEND

<u>SYMBOL</u>	<u>HYDROLOGIC GROUP</u>	<u>NAME</u>
Aa	B	Albion-Shellabarger sandy loams, 1 to 4 percent slopes
Ab	B	Albion and Shellabarger sandy loams, 7 to 15 percent slopes
Ba	C	Blanket silt loam, 0 to 1 percent slopes
Bb	C	Blanket silt loam, 1 to 3 percent slopes
Ca	B	Canadian fine sandy loam
Cb	B	Canadian-Waldeck fine sandy loams
Cc	D	Carwile fine sandy loam
Cd	B	Clark-Ost clay loams, 1 to 4 percent slopes
Ce	C	Clime silty clay, 3 to 6 percent slopes
Ea	B	Elandco silt loam
Eb	B	Elandco silt loam, occasionally flooded
Ec	B	Elandco silt loam, frequently flooded
Fa	B	Farnum loam, 0 to 1 percent slopes
Fb	B	Farnum loam, 1 to 3 percent slopes
Fc	B	Farnum loam, sandy substratum, 0 to 1 percent slopes
Ga	D	Goessel silty clay, 0 to 1 percent slopes
Gb	D	Goessel silty clay, 1 to 2 percent slopes
Ia	D	Irwin silty clay loam, 1 to 3 percent slopes
Ib	D	Irwin silty clay loam, 3 to 6 percent slopes
Ic	D	Irwin silty clay loam, 2 to 6 percent slopes, eroded
La	C	Lesho loam
Lb	A	Lincoln soils
Ma	B	Milan loam, 1 to 3 percent slopes
Mb	B	Milan form, 3 to 6 percent slopes
Mc	B	Milan clay loam, 2 to 6 percent slopes, eroded
Na	B	Naron fine sandy loam
Oc	D	Owens clay loam, 1 to 3 percent slopes
Od	D	Owens-Rock outcrop complex, 3 to 10 percent slopes
Pa		Pits
Pb	D	Plevna fine sandy loam
Pc	A	Pratt loamy fine sand, undulating
Pd	A	Pratt-Tivoli complex, rolling
Ra	D	Renfrow silty clay loam, 1 to 3 percent slopes
Rb	D	Renfrow silty clay loam, 3 to 6 percent slopes
Rc	D	Renfrow-Owens clay loams, 1 to 4 percent slopes
Rd	D	Rosehill silty clay, 1 to 3 percent slopes
Sa	B	Shellabarger sandy loam, 1 to 3 percent slopes
Sb	B	Shellabarger sandy loam, 3 to 6 percent slopes
Sc	B	Shellabarger sandy loam, 3 to 6 percent slopes, eroded
Ta	D	Tabler silty clay loam
Tb	D	Tabler-Drummond complex
Ua	B	Urban land-Canadian complex
Ub	B	Urban land-Elandco complex
Uc	B	Urban land-Farnum complex, 0 to 3 percent slopes
Ud	D	Urban land-Irwin complex, 1 to 3 percent slopes
Ue	D	Urban land-Tabler complex
Va	B	Vanoss silt loam, 0 to 1 percent slopes
Vb	B	Vanoss silt loam, 1 to 3 percent slopes
Vc	B	Vanoss silt loam, 3 to 6 percent slopes
Vd	B	Vanoss silt loam, 3 to 6 percent slopes, eroded
Ve	D	Vernon sandy loam, 1 to 3 percent slopes
Vf	D	Vernon sandy loam, 3 to 6 percent slopes
Wa	C	Waldeck sandy loam
Wb	D	Waurika silt loam