

EASTSIDE COMMUNITY CHURCH ADDITION
(Southeast corner of 21st St. N. and Greenwich Rd.)

Stormwater Drainage Study
Tributary Basin to the
West Branch of Four Mile Creek

Y&A Project No. 97-041-115

September, 1997

Prepared by:



Young & Associates, P.A.
100 South Georgie, Derby, Kansas 67037
Tele: (316)788-2552, Fax: (316)788-4408

EASTSIDE COMMUNITY CHURCH ADDITION
Sedgwick County, Kansas

TABLE OF CONTENTS

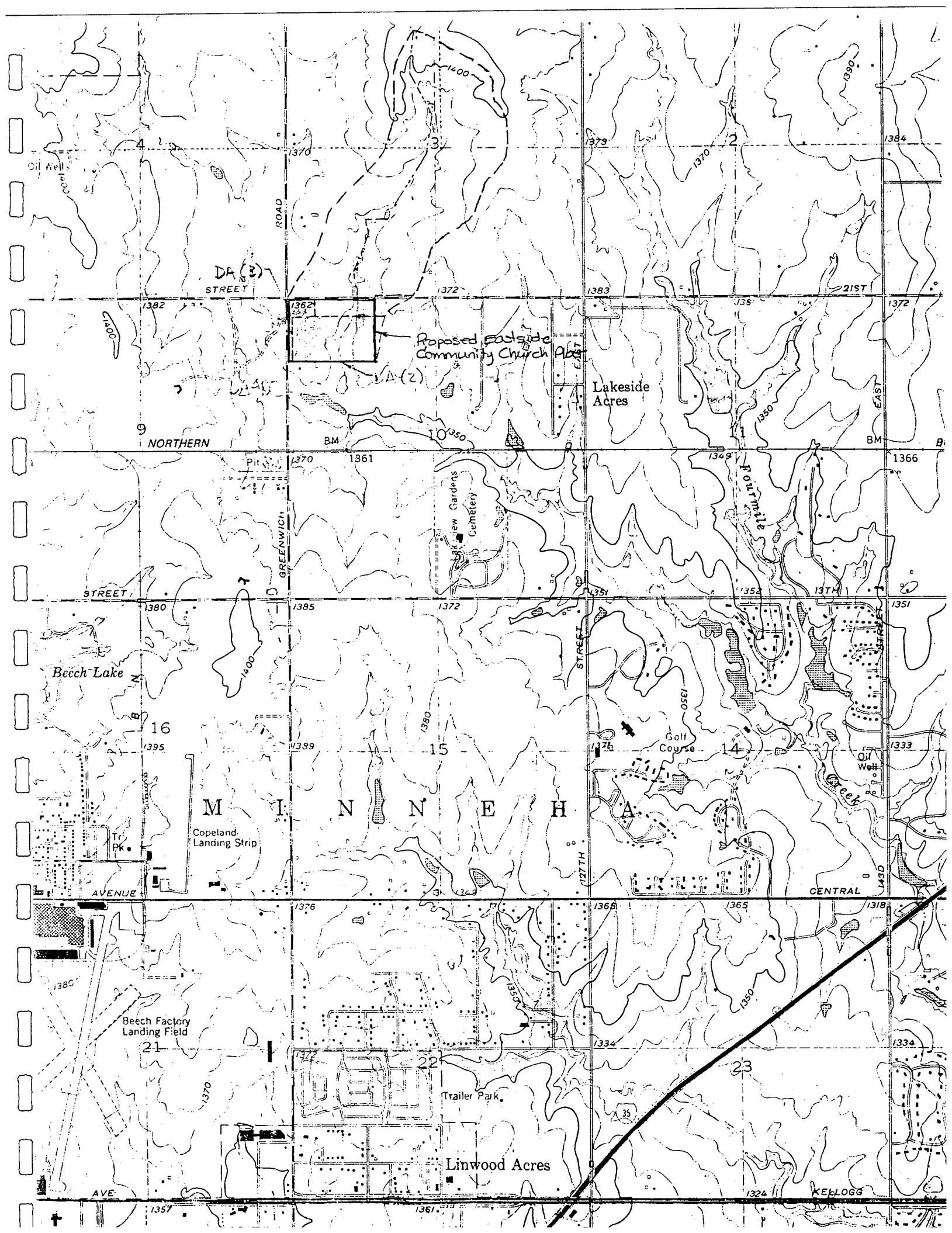


1. Drainage Basin Characteristics
2. Discharge Computations
3. HEC2 Computer Analysis
4. Appendix
5. Topographic Survey

EASTSIDE COMMUNITY CHURCH ADDITION
Sedgwick County, Kansas

1. Drainage Basin Characteristics





DA (2)
STREET

Proposed Eastside
Community Church

Lakeside
Acres

9
NORTHERN

STREET

Beech Lake

M I N N E A P O L I S

Copeland
Landing Strip

AVENUE

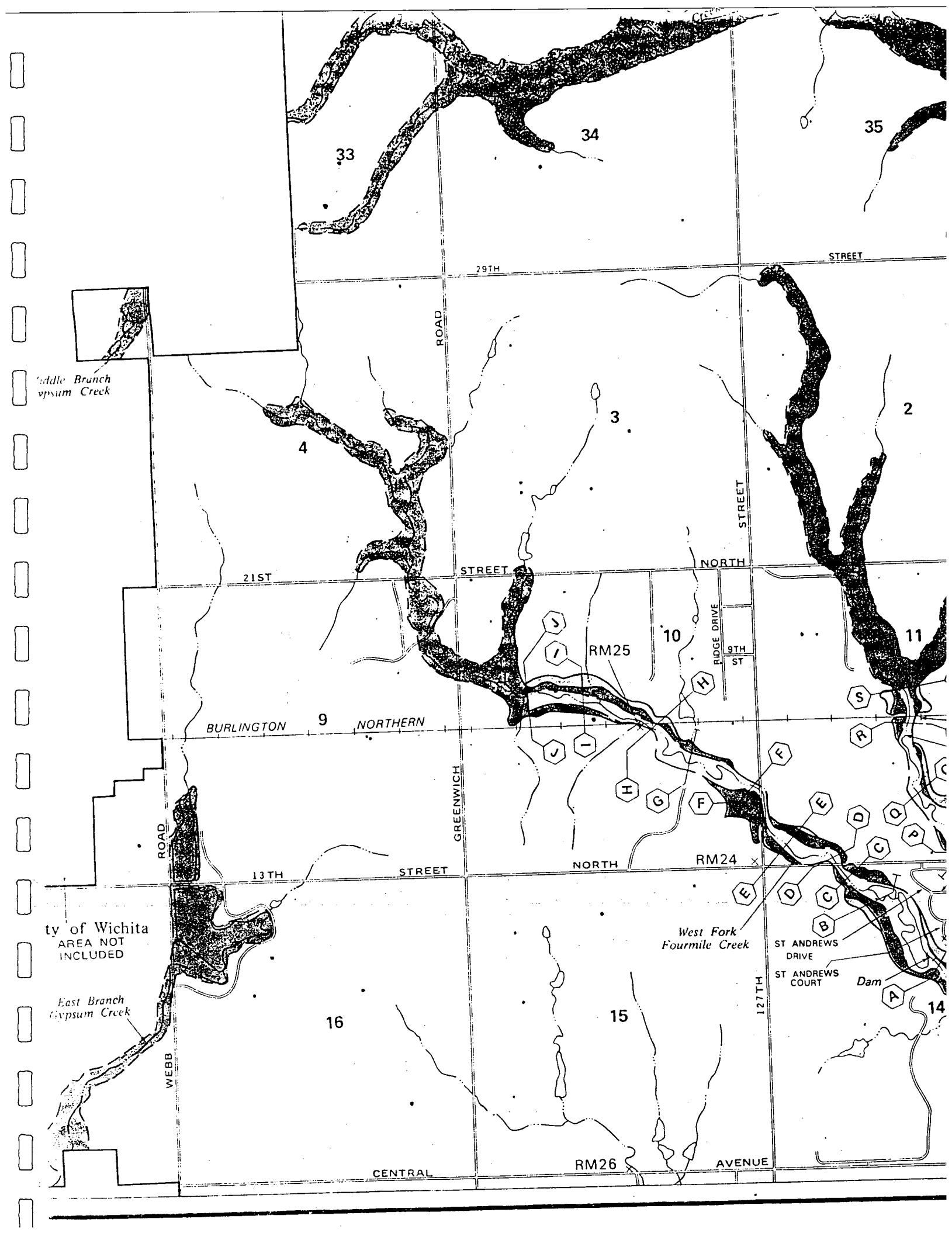
Beech Factory
Landing Field

Trailer Park

Linwood Acres

CENTRAL

KEELOGG



EASTSIDE COMMUNITY CHURCH ADDITION
Sedgwick County, Kansas

2. Discharge Computations



1. Design Criteria :

1.1 For drainage areas larger than 100 acres,
use TR-55 "Graphical Peak Discharge" method

$$Q_p = Q_u A_m Q$$

For small drainage areas use Rational Method

$$Q = ciA$$

1.2 Refer to attached USGS map for drainage area
limits, and general basin characteristics.

Soil types per SCS data for Sedgewick Co., KS.

1.3 Discharge computations are included for two
locations along the proposed drainage reserve.
Additional discharge is computed at the NW
and SW corners of the proposed plat

2. Discharge Computations :

2.1 Drainage Area (1), refer to attached "Drainage
Basin Map", USGS map, and TR-55 "Graphical
Peak Discharge" worksheets,

Worksheet #2, CN = 85

$$Q = 6.02 \text{ in}$$

Worksheet #3, $T_c = 1.25 \text{ hrs}$

Worksheet #4, $Q_{100} = 555 \text{ cfs}$

2.2 Drainage Area (2)

Worksheet #2, CN = 85

$$Q = 6.02 \text{ in}$$

Worksheet #3, $T_c = 1.35 \text{ hrs}$

Worksheet #4, $Q_{100} = 590 \text{ cfs}$

2.3 Drainage Area (3), Using Rational Method

$$DA = 4.9 \text{ ac.}$$

$$\begin{aligned} T_c, \text{ sheet flow } & n = 0.15 \\ & L = 300' \\ & P_2 = 3.6 \\ & S = 1.0\% \\ \Rightarrow T_t &= 0.49 \text{ hrs} \end{aligned}$$

$$\begin{aligned} \text{Channel flow } & V = 2.0 \text{ fps} \\ & L = 520' \\ \Rightarrow T_t &= 0.07 \text{ hrs} \end{aligned}$$

$$T_c = 0.56 \text{ hrs (34 min)}$$

$$i_{100} = 5.07 \text{ in/hr}$$

$$C = 0.68 \text{ (Undefined Urban land use)}$$

$$Q_{100} = 0.68 \times 5.07 \times 4.9 = 16.9 \text{ cfs}$$

2.4 Drainage Area (4), Using Rational Method

$$DA = 1.5 \text{ ac.}$$

$$\begin{aligned} T_c, \text{ sheet flow } & n = 0.15 \\ & L = 150' \\ & P_2 = 3.6 \\ & S = 2.0\% \\ T_t &= 0.21 \text{ hrs} \end{aligned}$$

$$\begin{aligned} \text{channel flow } & V = 2.0 \text{ fps} \\ & L = 430' \\ T_t &= 0.06 \text{ hrs.} \end{aligned}$$

$$T_c = 0.27 \text{ hrs (16 min)}$$

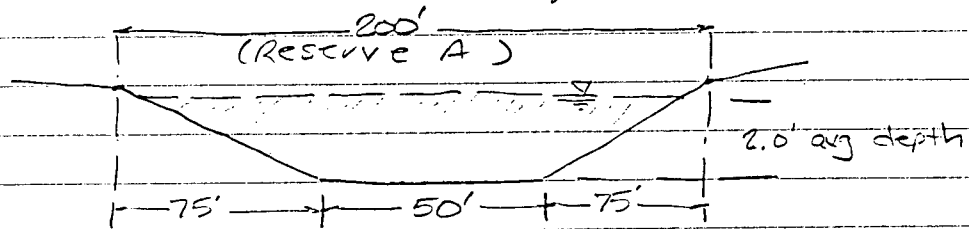
$$I_{100} = 7.18 \text{ in/hr}$$

$$C = 0.68$$

$$Q_{100} = 0.68 \times 7.18 \times 1.5 = 7.3 \text{ cfs}$$

3. Hydraulic Design

3.1 Drainage Area (1), Check typical channel section,



$$\text{Cross-sectional Area, } A = 250 \text{ ft}^2$$

$$P_w = 200 \text{ ft}$$

$$R_h = 1.25 \text{ ft}$$

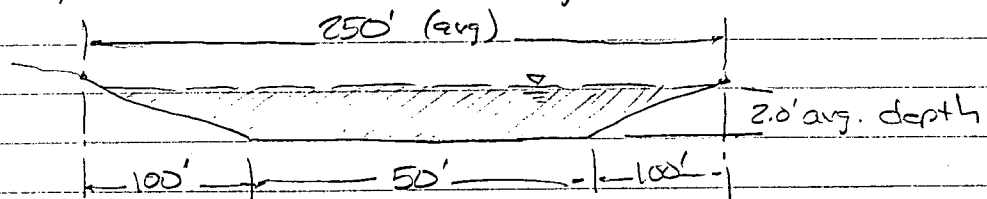
$$S_{\text{avg}} = 0.25 \%$$

$$n = 0.035$$

$$Q = 1.49 (250) (1.25)^{2/3} (0.0025)^{1/2} / 0.035 = 617 \text{ cfs}$$

> 555 cfs OK

3.2 Drainage Area (2), Check typical Channel Section,



$$\text{Cross-Sectional Area, } A = 300 \text{ ft}^2$$

$$P_w = 250 \text{ ft}$$

$$D = 120 \text{ ft}$$

$$Q = 1.49(300)(1.20)^{2/3}(0.0025)^{1/2}/0.035 = 721 \text{ cfs}$$

> 590 cfs $\frac{ok}{5}$

3.3 Drainage Area (3), check existing 29" x 18" CMPPE using Design Data 18 "ACPA"

For $Q = 16.9 \text{ cfs}$, $L = 75'$

Inlet Control Curve, $HW = 2.65'$

Outlet Control Curve, $HW + S_o L = 4.2'$

where $S_o = 0.75\%$ (est.)

$L = 75'$

$$HW = 4.2 - (0.0075 \times 75) = 3.6'$$

\therefore Outlet Control

$\frac{ok}{5}$

Check, $Q = 1.49 A R_h^{2/3} S^{1/2} / n$

$$A = 2.90 \text{ ft}^2$$

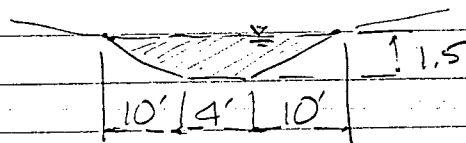
$$P_w = 6.2832 \text{ ft}$$

$$Q = 17.2 \text{ cfs} \quad \frac{ok}{5}$$

$$R_h = 0.4615 \text{ ft}$$

$$n = 0.013$$

3.4 Drainage Area (4), check typical channel section



Cross-sectional Area, $A = 21 \text{ ft}^2$

$$P_w = 24.2237 \text{ ft}$$

$$R_h = 0.8669 \text{ ft}$$

$$S = 0.50\%$$

$$n = 0.035$$

$$Q = 1.49(21)(0.8669)^{2/3}(0.005)^{1/2}/0.035 = 57 \text{ cfs}$$

$\frac{ok}{5}$

Worksheet 2: Runoff curve number and runoff

Project Eastside Community Church By CEY Date 6-5-97

Location DA (1) reference Drainage Map Checked _____ Date _____

Circle one: Present Developed

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN ^{1/}			Area <input checked="" type="checkbox"/> acres <input type="checkbox"/> mi ² <input type="checkbox"/> %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
D	Cemeteries	89			40	3360
D	Pastures, grassland.	84			175	14,700
D	Urban Commercial	95			20	1,900

^{1/} Use only one CN source per line.

Totals = 235 19,960

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____

Use CN = 85

2. Runoff

Frequency yr
 Rainfall, P (24-hour) in
 Runoff, Q in
 (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)

Storm #1	Storm #2	Storm #3
100		
7.8		
6.02		

Worksheet 2: Runoff curve number and runoff

Project Eastside Community Church By CKY Date 6-5-97

Location DA (2) reference attached map Checked _____ Date _____

Circle one: Present Developed

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN \checkmark			Area <input checked="" type="checkbox"/> acres <input type="checkbox"/> mi ² <input type="checkbox"/> %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
D	Urban Commercial	95			25	2375
D	Open Space	80			12	960
D	Residential (1/4 ac. lots)	87			6	522
D	Cemeteries	84			40	3360
D	Pastures, grassland	84			175	14,700
					Totals =	258 21,917

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____; Use CN = 85

2. Runoff

Frequency yr
 Rainfall, P (24-hour) in
 Runoff, Q in
 (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)

Storm #1	Storm #2	Storm #3
100		
7.8		
6.02		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Eastside Community Church By CRY Date 6-5-97

Location DA(1) reference attached map Checked _____ Date _____

Circle one: Present Developed
 Circle one: T_c T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

<u>Sheet flow</u> (Applicable to T _c only)	Segment ID	(1)	
1. Surface description (table 3-1)		Grass	
2. Manning's roughness coeff., n (table 3-1) ..		0.15	
3. Flow length, L (total L ≤ 300 ft) ft		300	
4. Two-yr 24-hr rainfall, P ₂ in		3.5	
5. Land slope, s ft/ft		0.015	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr		0.42	+ [] = []

<u>Shallow concentrated flow</u>	Segment ID	(1)	
7. Surface description (paved or unpaved)		unpaved	
8. Flow length, L ft		1500	
9. Watercourse slope, s ft/ft		0.015	
10. Average velocity, V (figure 3-1) ft/s		2.0	
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr		0.21	+ [] = []

<u>Channel flow</u>	Segment ID	(1)	
12. Cross sectional flow area, a ft ²			
13. Wetted perimeter, p _w ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft			
15. Channel slope, s ft/ft			
16. Manning's roughness coeff., n			
17. $v = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft/s		2.0	
18. Flow length, L ft		4500	
19. $T_t = \frac{L}{3600 v}$ Compute T _t hr		0.62	+ [] = []
20. Watershed or subarea T _c or T _t (add T _t in steps 6, 11, and 19) hr			[1.25]

Worksheet 4: Graphical Peak Discharge method

Project Eastside Community Church By CRY Date 6-5-97

Location DA(1) reference attached map Checked _____ Date _____

Circle one: Present Developed _____

1. Data:

Drainage area $A_m = \underline{0.3672}$ mi² (acres/640)
 Runoff curve number CN = 85 (From worksheet 2)
 Time of concentration .. $T_c = \underline{1.25}$ hr (From worksheet 3)
 Rainfall distribution type = II (I, IA, II, III)
 Pond and swamp areas spread throughout watershed = 2% percent of A_m (5 acres or mi² covered)

2. Frequency yr

3. Rainfall, P (24-hour) in

4. Initial abstraction, I_a in
 (Use CN with table 4-1.)

5. Compute I_a/P

6. Unit peak discharge, q_u csm/in
 (Use T_c and I_a/P with exhibit 4-II)

7. Runoff, Q in
 (From worksheet 2).

8. Pond and swamp adjustment factor, F_p
 (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)

9. Peak discharge, q_p cfs
 (Where $q_p = q_u A_m Q F_p$)

Storm #1	Storm #2	Storm #3
100		
7.8		
0.353		
0.0453		
310		
6.02		
0.81		
555		

(685 cfs w/o pond adjustment)

Worksheet 4: Graphical Peak Discharge method

Project Eastside Community Church By CRY Date 6-5-97

Location DA(2) reference attached map Checked _____ Date _____

Circle one: Present Developed

1. Data:

Drainage area $A_m = \underline{24030}$ mi^2 (acres/640)
 Runoff curve number CN = 85 (From worksheet 2)
 Time of concentration .. $T_c = \underline{1.35}$ hr (From worksheet 3)
 Rainfall distribution type = II (I, IA, II, III)
 Pond and swamp areas spread throughout watershed = 29% percent of A_m (5 acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency yr	100		
3. Rainfall, P (24-hour) in	7.8		
4. Initial abstraction, I_a in (Use CN with table 4-1.)	0.353		
5. Compute I_a/P	0.0453		
6. Unit peak discharge, q_u csm/in (Use T_c and I_a/P with exhibit 4- <u>II</u>)	300		
7. Runoff, Q in (From worksheet 2).	6.02		
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)	0.81		
9. Peak discharge, q_p cfs (Where $q_p = q_u A_m Q F_p$)	590.		

(728 cfs w/o pond adjustment)

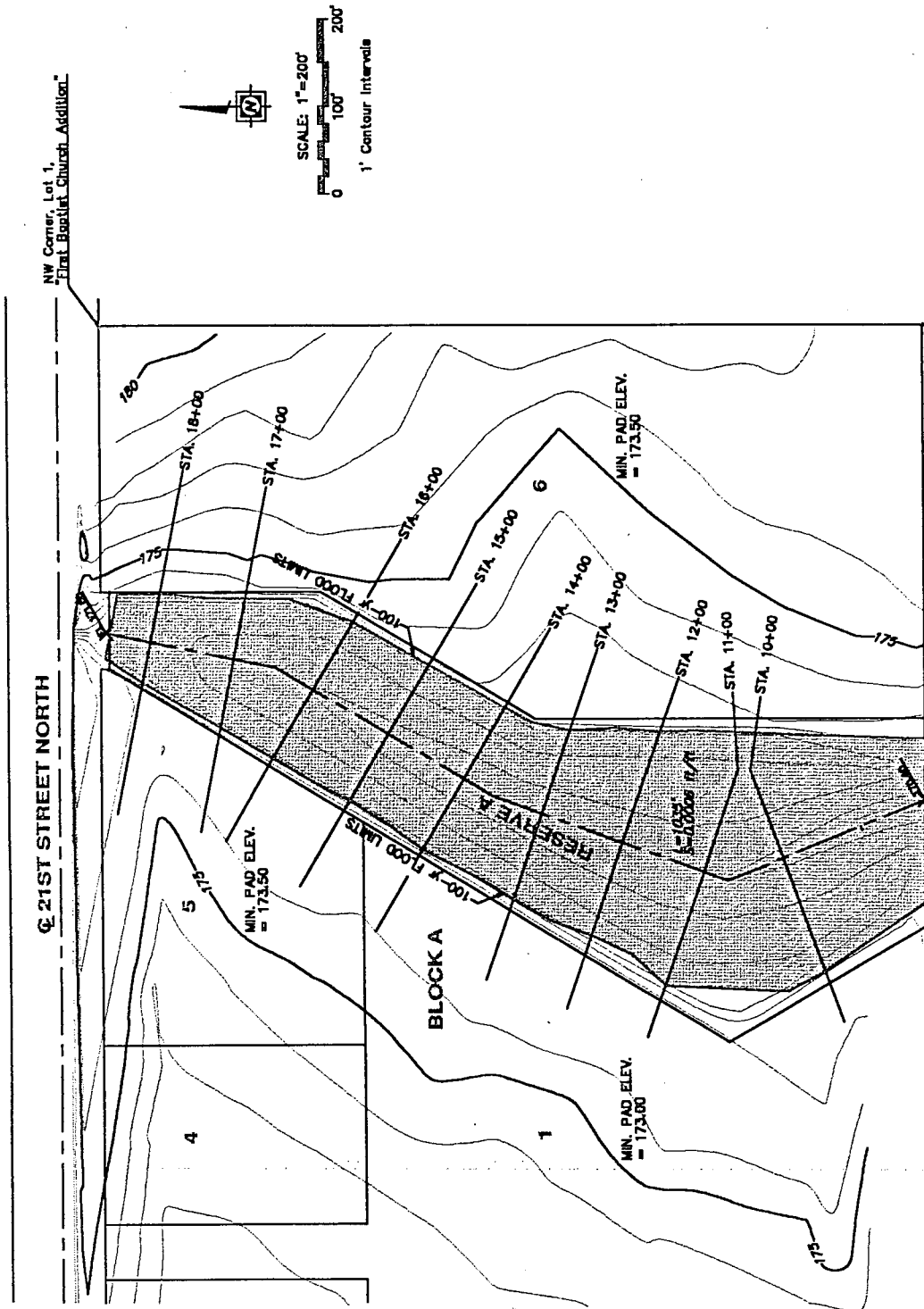
EASTSIDE COMMUNITY CHURCH ADDITION
Sedgwick County, Kansas

3. HEC2 Computer Analysis
(AutoCivil v.7.0)



EASTSIDE COMMUNITY CHURCH ADDITION TO SEDGWICK COUNTY, KANSAS

FLOODWAY ANALYSIS



1900 South Georgia, Berks, KS 67527
 Tulsa (318) 755-2803
 Ft. Worth (318) 755-4400

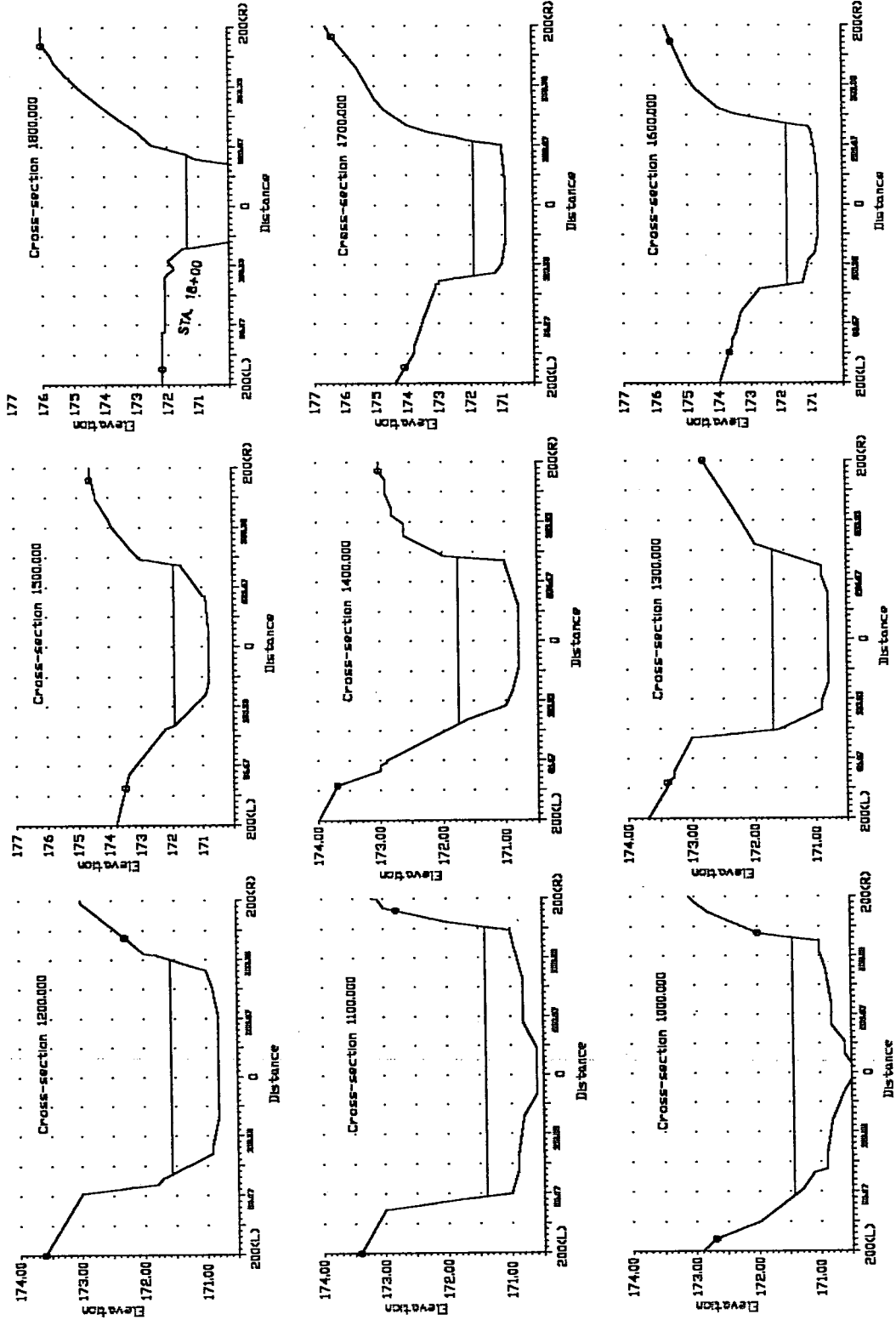


YOUNG & ASSOCIATES, P.A.
 Civil and Environmental Engineers

July 12, 1997

EASTSIDE COMMUNITY CHURCH ADDITION TO SEDGWICK COUNTY, KANSAS

CHANNEL CROSS-SECTIONS



1*****

* HEC-2 WATER SURFACE PROFILES *

* U.S. ARMY

CORPS OF ENGINEERS *

* HYDROLOGIC ENGINEERING

* *

CENTER *

* Version 4.6.2; May 1991 *

* 609 SECOND STREET,

SUITE D *

* DAVIS, CALIFORNIA 95616-4687

* *

* RUN DATE 11JUL97 TIME 17:18:41 *

* (916) 756-1104

```

X X XXXXXXXX XXXXX XXXXX
X X X X X X X X
X X X X X
XXXXXXXX XXXX X XXXXX XXXXX
X X X X X
X X X X X X
X X XXXXXXXX XXXXX XXXXXXXX

```

1

11JUL97 17:18:41

PAGE 1

THIS RUN EXECUTED 11JUL97 17:18:41

HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991

T1 AUTOHEC2
T2 97-041-118
T3 FMC TRIBUTARY PROFILE 1: FLOW 800

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
-10	0	0	1	0	0	0	800.00	170.50	1.00	

1

11JUL97 17:18:41

PAGE 2

SECNO DEPTH CWSEL CRIWS WSELK EG HV HL OLOSS L-BANK
 ELEV
 Q QLOB QCH QROB ALOB ACH AROB VOL TWA R-BANK
 ELEV
 TIME VLOB VCH VROB XNL XNCH XNR WTN ELMIN SSTA
 SLOPE XLOBL XLCH XLOBR ITRIAL IDC ICONT CORAR TOPWID
 ENDST

*PROF 1
0

CCHV= .100 CEHV= .300

*SECNO 1000.000

3720 CRITICAL DEPTH ASSUMED

1000.000	.93	171.43	171.43	170.50	171.74	.31	.00	.00	172.70
800.0	.0	800.0	.0	.0	178.3	.0	.0	.0	172.00
.00	.00	4.49	.00	.000	.035	.000	.000	170.50	82.44
.021518	0.	0.	0.	0	19	0	.00	291.64	374.08

*SECNO 1050.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1050.000	.87	171.37	171.37	.00	171.67	.30	1.09	.64	172.60
800.0	.0	800.0	.0	.0	183.0	.0	.2	.3	172.10
.00	.00	4.37	.00	.000	.035	.000	.000	170.50	77.24
.022025	51.	50.	55.	20	11	0	.00	316.83	394.06

*SECNO 1100.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1100.000	.79	171.39	171.39	.00	171.70	.30	1.09	.56	173.40
800.0	.0	800.0	.0	.0	181.1	.0	.4	.7	172.80
.01	.00	4.42	.00	.000	.035	.000	.000	170.60	83.14
.021682	185.	50.	81.	20	11	0	.00	304.87	388.01

*SECNO 1150.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1150.000	.72	171.52	171.52	.00	171.84	.33	1.06	.46	173.50
800.0	.0	800.0	.0	.0	173.9	.0	.6	1.0	172.00
.01	.00	4.60	.00	.000	.035	.000	.000	170.80	104.49
.020914	50.	50.	58.	20	11	0	.00	268.13	372.62

SECNO DEPTH CWSEL CRIWS WSELK EG HV HL OLOSS L-BANK
 ELEV
 Q QLOB QCH QROB ALOB ACH AROB VOL TWA R-BANK
 ELEV
 TIME VLOB VCH VROB XNL XNCH XNR WTN ELMIN SSTA
 SLOPE XLOBL XLCH XLOBR ITRIAL IDC ICONT CORAR TOPWID
 ENDST

*SECNO 1200.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1200.000	.79	171.59	171.59	.00	171.94	.35	1.03	.45	173.60
800.0	.0	800.0	.0	.0	168.8	.0	.8	1.3	172.30
.01	.00	4.74	.00	.000	.035	.000	.000	170.80	109.26
.020406	50.	50.	50.	20	8	0	.00	244.33	353.58

*SECNO 1250.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1250.000	.81	171.61	171.61	.00	171.97	.36	1.02	.42	173.60
800.0	.0	800.0	.0	.0	165.6	.0	1.0	1.6	172.50
.02	.00	4.83	.00	.000	.035	.000	.000	170.80	109.11
.020267	50.	50.	51.	20	8	0	.00	231.82	340.94

*SECNO 1300.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1300.000	.90	171.70	171.70	.00	172.10	.39	1.00	.42	173.40
800.0	.0	800.0	.0	.0	158.7	.0	1.2	1.9	172.80
.02	.00	5.04	.00	.000	.035	.000	.000	170.80	117.82
.019560	62.	50.	61.	20	8	0	.00	202.78	320.60

*SECNO 1350.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1350.000	.91	171.71	171.71	.00	172.12	.42	.97	.40	173.40
800.0	.0	800.0	.0	.0	154.7	.0	1.4	2.1	173.00
.02	.00	5.17	.00	.000	.035	.000	.000	170.80	127.58
.019157	50.	50.	50.	20	5	0	.00	187.15	314.72

*SECNO 1400.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

1

11JUL97 17:18:41

PAGE 4

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	L-BANK	
ELEV	Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK
ELEV	TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
ENDST	SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	

3720 CRITICAL DEPTH ASSUMED

1400.000	.95	171.75	171.75	.00	172.17	.42	.96	.39	173.70
800.0	.0	800.0	.0	.0	154.2	.0	1.6	2.3	173.00
.02	.00	5.19	.00	.000	.035	.000	.000	170.80	127.12
.019313	81.	50.	13.	20	8	0	.00	186.99	314.11

*SECNO 1450.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1450.000	.93	171.73	171.73	.00	172.16	.43	.97	.40	173.80
800.0	.0	800.0	.0	.0	152.0	.0	1.7	2.5	173.80
.03	.00	5.26	.00	.000	.035	.000	.000	170.80	131.71
.019447	59.	50.	50.	20	5	0	.00	181.38	313.10

*SECNO 1500.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1500.000	1.09	171.89	171.89	.00	172.31	.42	.96	.44	173.50
800.0	.0	800.0	.0	.0	153.0	.0	1.9	2.7	174.60
.03	.00	5.23	.00	.000	.035	.000	.000	170.80	132.14
.018860	60.	50.	50.	20	8	0	.00	180.07	312.21

*SECNO 1550.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1550.000	1.02	171.82	171.82	.00	172.25	.43	.95	.46	173.60
800.0	.0	800.0	.0	.0	152.7	.0	2.1	2.9	175.00
.03	.00	5.24	.00	.000	.035	.000	.000	170.80	129.39
.019232	52.	50.	51.	20	11	0	.00	181.83	311.21

*SECNO 1600.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1600.000	.98	171.78	171.78	.00	172.20	.42	.95	.42	173.70
800.0	.0	800.0	.0	.0	153.2	.0	2.3	3.1	175.50
.03	.00	5.22	.00	.000	.035	.000	.000	170.80	129.45
.018877	50.	50.	50.	20	8	0	.00	180.83	310.28

1

11JUL97 17:18:41

PAGE 5

SECNO DEPTH CWSEL CRIWS WSELK EG HV HL GLOSS L-BANK
 ELEV
 Q QLOB QCH QROB ALOB ACH AROB VOL TWA R-BANK
 ELEV
 TIME VLOB VCH VROB XNL XNCH XNR WTN ELMIN SSTA
 SLOPE XLOBL XLCH XLOBR ITRIAL IDC ICONT CORAR TOPWID
 ENDST

*SECNO 1650.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

1650.000	1.05	171.85	171.85	.00	172.29	.43	.95	.39	173.80
800.0	.0	800.0	.0	.0	151.4	.0	2.4	3.3	176.00
.04	.00	5.28	.00	.000	.035	.000	.000	170.80	123.08
.019130	19.	50.	107.	20	8	0	.00	177.36	300.44

*SECNO 1700.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

1700.000	1.02	171.92	171.92	.00	172.40	.48	.93	.38	174.10
800.0	.0	800.0	.0	.0	144.2	.0	2.6	3.5	176.40
.04	.00	5.55	.00	.000	.035	.000	.000	170.90	139.74
.018231	51.	50.	57.	20	8	0	.00	151.35	291.09

*SECNO 1750.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

1750.000	1.15	172.05	172.05	.00	172.59	.54	.90	.37	175.00
800.0	.0	800.0	.0	.0	135.8	.0	2.8	3.7	176.30
.04	.00	5.89	.00	.000	.035	.000	.000	170.90	155.78
.017582	50.	50.	51.	20	8	0	.00	126.57	282.35

*SECNO 1800.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

EASTSIDE COMMUNITY CHURCH ADDITION

Sedgwick County, Kansas

4. Appendix



Table 2-2a.—Runoff curve numbers for urban areas¹

Cover description	Average percent impervious area ²	Curve numbers for hydrologic soil group—			
		A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ³ :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%).....		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way).....		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ⁴ ...		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business.....	85	89	92	94	95
Industrial.....	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses).....	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
<i>Developing urban areas</i>					
Newly graded areas (pervious areas only, no vegetation) ⁵					
Idle lands (CN's are determined using cover types similar to those in table 2-2c).		77	86	91	94

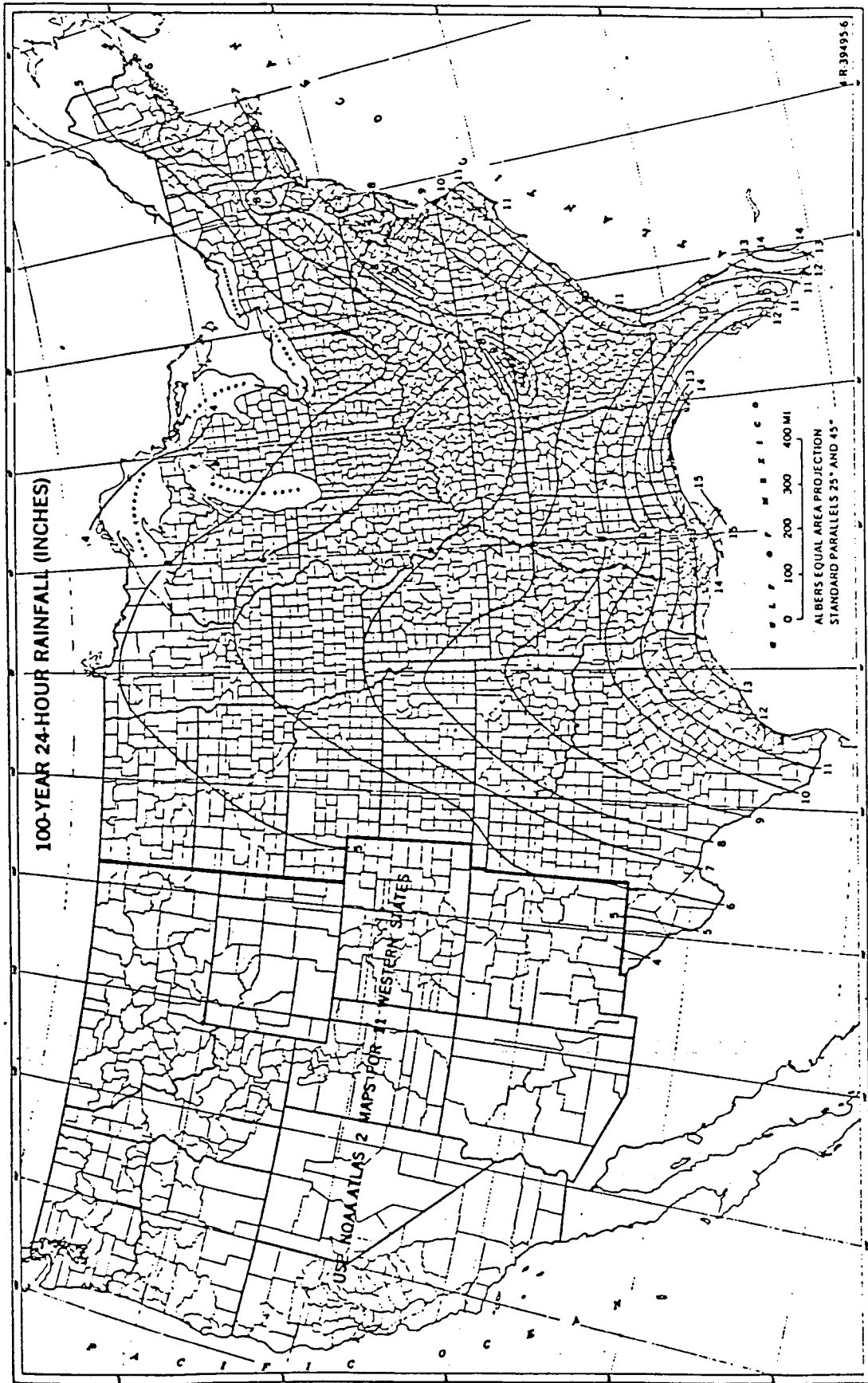
¹Average runoff condition, and $I_p = 0.2S$.

²The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

³CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

⁴Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

⁵Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.



100 yr, 24 hr 7.5 in

Figure B-8.—One-hundred-year, 24-hour rainfall.

texture is given in appendix A for determining the HSG classification for disturbed soils.

Hydrologic condition

Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Cover type

Table 2-2 addresses most cover types, such as vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

Treatment

Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

Table 2-1.—Runoff depth for selected CN's and rainfall amounts¹

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

¹Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

Curves on this sheet are for
the case $I_a = 0.2S$, so that

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S}$$

Curve number = 100
95
90
85
80
75
70
65
60
55
50
45
40

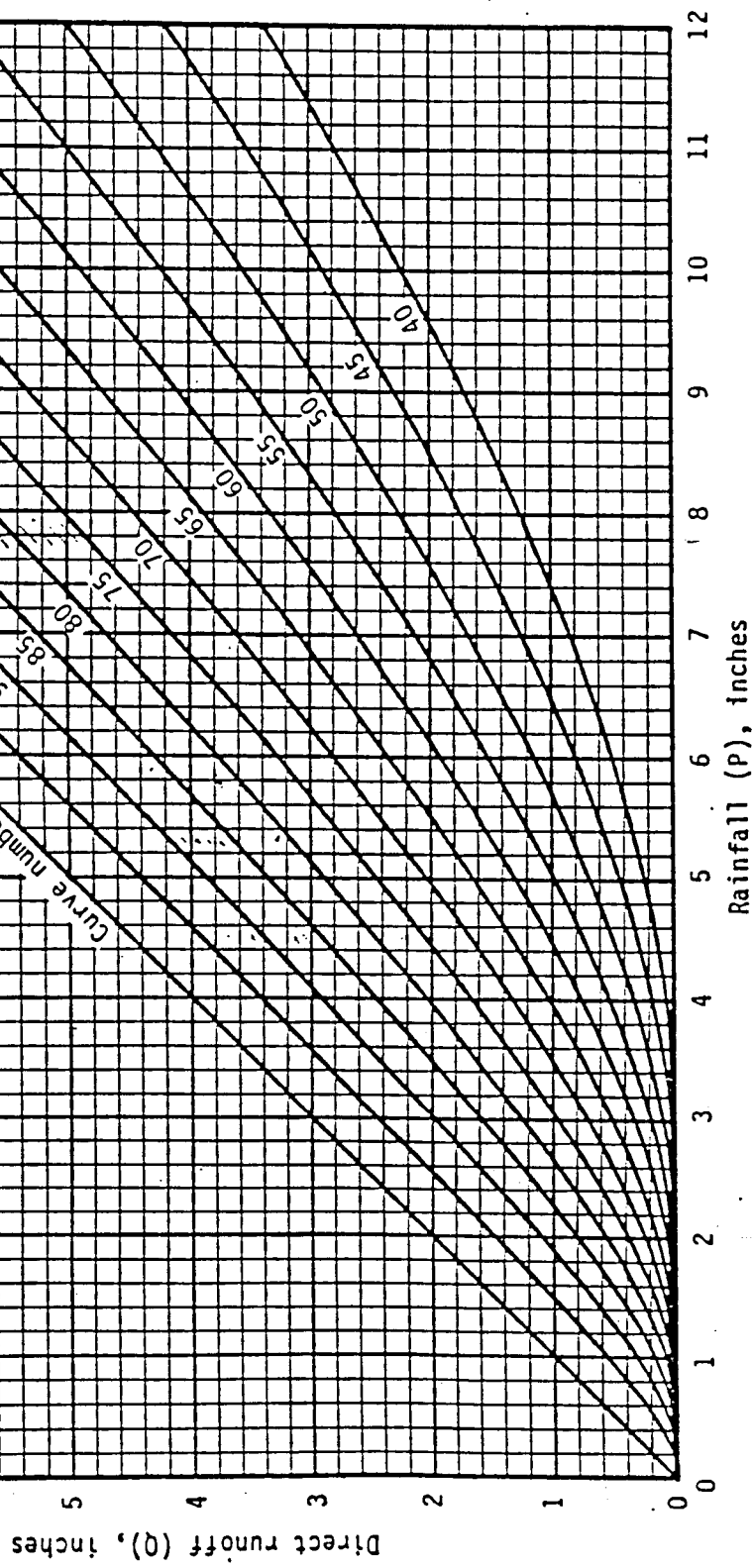


Figure 2-1.—Solution of runoff equation.

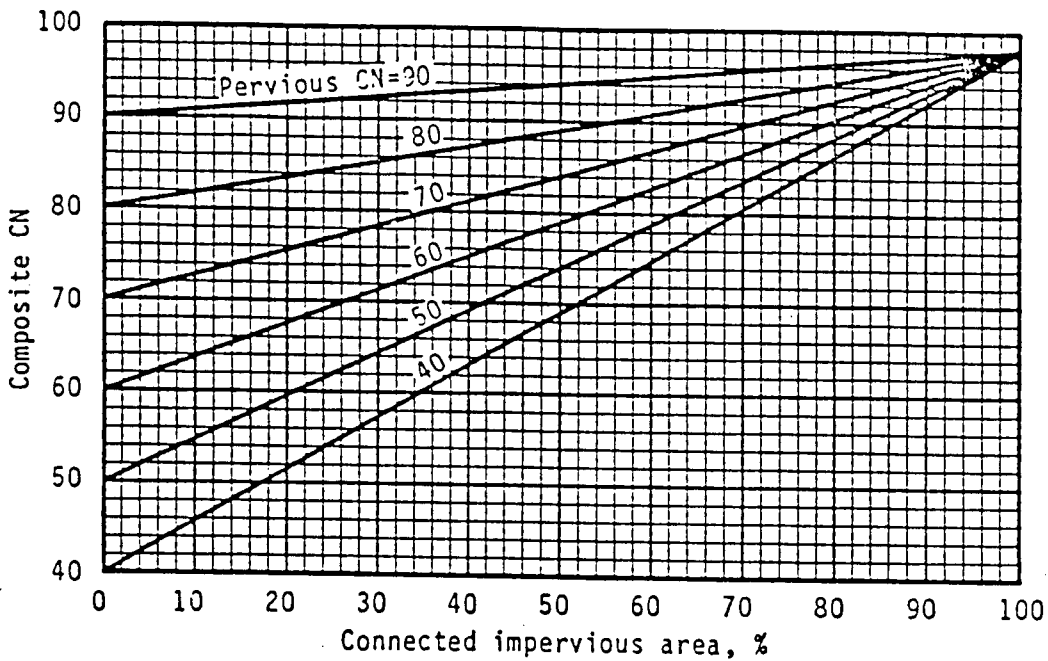


Figure 2-3.—Composite CN with connected impervious area.

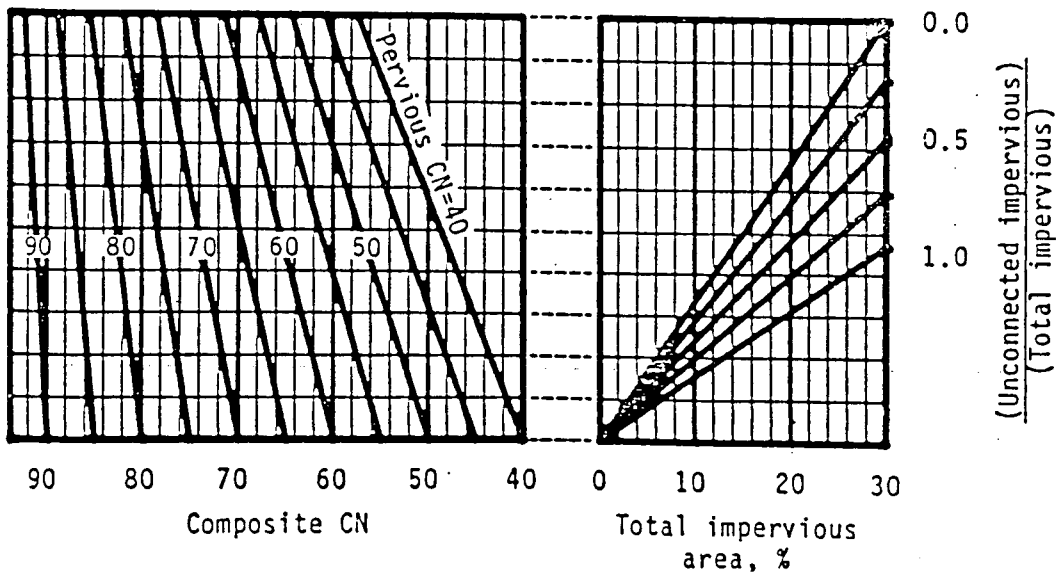


Figure 2-4.—Composite CN with unconnected impervious areas and total impervious area less than 30%.

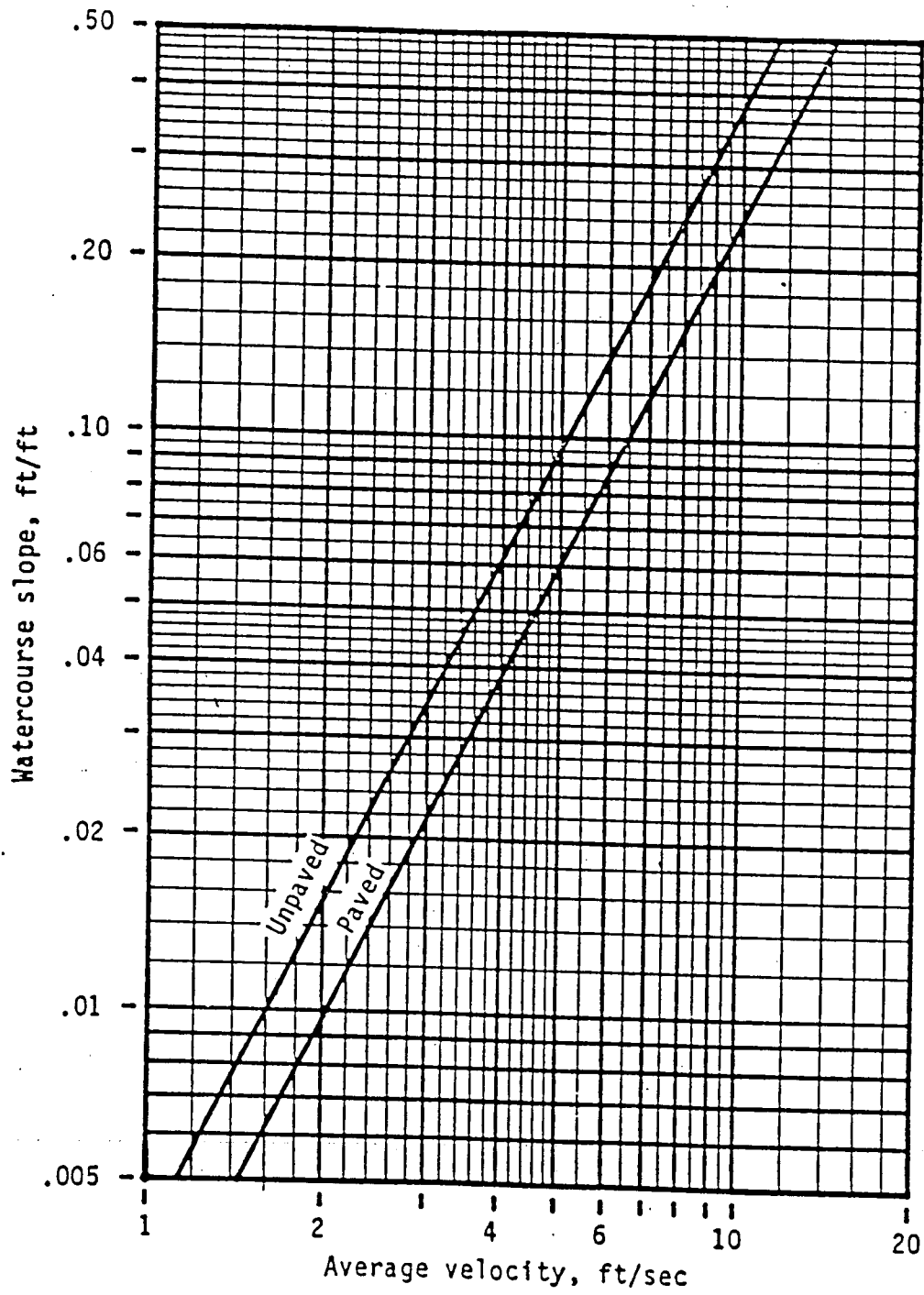


Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Exhibit 4-II: Unit peak discharge (q_u) for SCS type II rainfall distribution

