WALSH ENGINEERING
& SURVEYING, INC.

CEQA PRELIMINARY DRAINAGE STUDY
For
Montemar Estates
APN 504-242-41

TM 5316

REGISTERED PROFESSIONAL ENGINEER
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46316
EXP. 12-31-06
CIVIL
STATE OF CALIFORNIA

Signature of Preparer: Lawrence Walsh — Date: 11/3/03

Prepared for:

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(Walsh Engineering Job No 02329)

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San Diego County
DEPT. OF PLANNING & LAND USE

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INTRODUCTION

This Drainage Study is prepared for TM 5316, a major subdivision proposing 13 half-acre lots. The site is located on the south side of Montemar Drive west of Austin Drive in Spring Valley. See the attached Vicinity Map.

1. Existing Conditions, Basins and Drainage Facilities

There is one existing drainage basin (Basin A) contributing to the project. Basin A is 41.6 acres in size and contributes 54.8 cfs, during the 100-year storm, to the existing swale in the southeast corner of the project at the southerly boundary. See the attached Drainage Map 1 and Drainage Basin Calculations.

There is an existing 18" CMP storm-drain pipe underneath Montemar Drive in the northwest corner of the project. Basin B contributes 6.26 cfs during the 100-year storm to the existing pipe, which then flows onto the project. See the attached Drainage Map 1 and Drainage Calculations.

2. Proposed Conditions, Basins and Drainage Facilities

In the proposed condition, the runoff coefficient for Basin A will change due to the proposed development. Subsequently, there is a 0.4 cfs increase in peak runoff when measured at the "Point of Comparison". The "Point of Comparison" is the point at which Basin A is concentrated in the existing swale and the runoff exits the project. See the attached Drainage Map 2 and Drainage Calculations.

The proposed drainage facilities will have rip rap outlet protection / velocity reduction. Each drainage system will be outlet into vegetated swales, which return the runoff to the existing swale in the southeast corner of the proposed subdivision. The proposed storm-drain systems are analyzed herein. See the attached Drainage Map 2 and 3 and Drainage Calculations. This drainage study determined the proposed facilities to have adequate capacity during the 100-year storm event.

All of the proposed drainage facilities will outlet the stormwater runoff into existing swales before leaving the project boundary. The overall drainage characteristics for this project will ultimately remain unchanged.

3. Pre-Development vs. Post-Development

The peak runoff rates for the pre-development and post-development conditions have been analyzed herein. This study has determined a 0.4 cfs increase in peak runoff due to the proposed development, which equates to a 0.7 % increase from the existing condition. The increase is considered insignificant and the proposed development will have no adverse impacts, since the peak runoff rates and velocities will virtually remain unchanged from their existing condition.

a. Erosion / Siltation

The proposed rip rap outlet protection will reduce the runoff velocity to a non-erosive value.

The proposed development does not intend to create or cause a change in existing conditions, which would promote any erosion or siltation on-site or off-site the subject property.

b. Concentration / Diversion

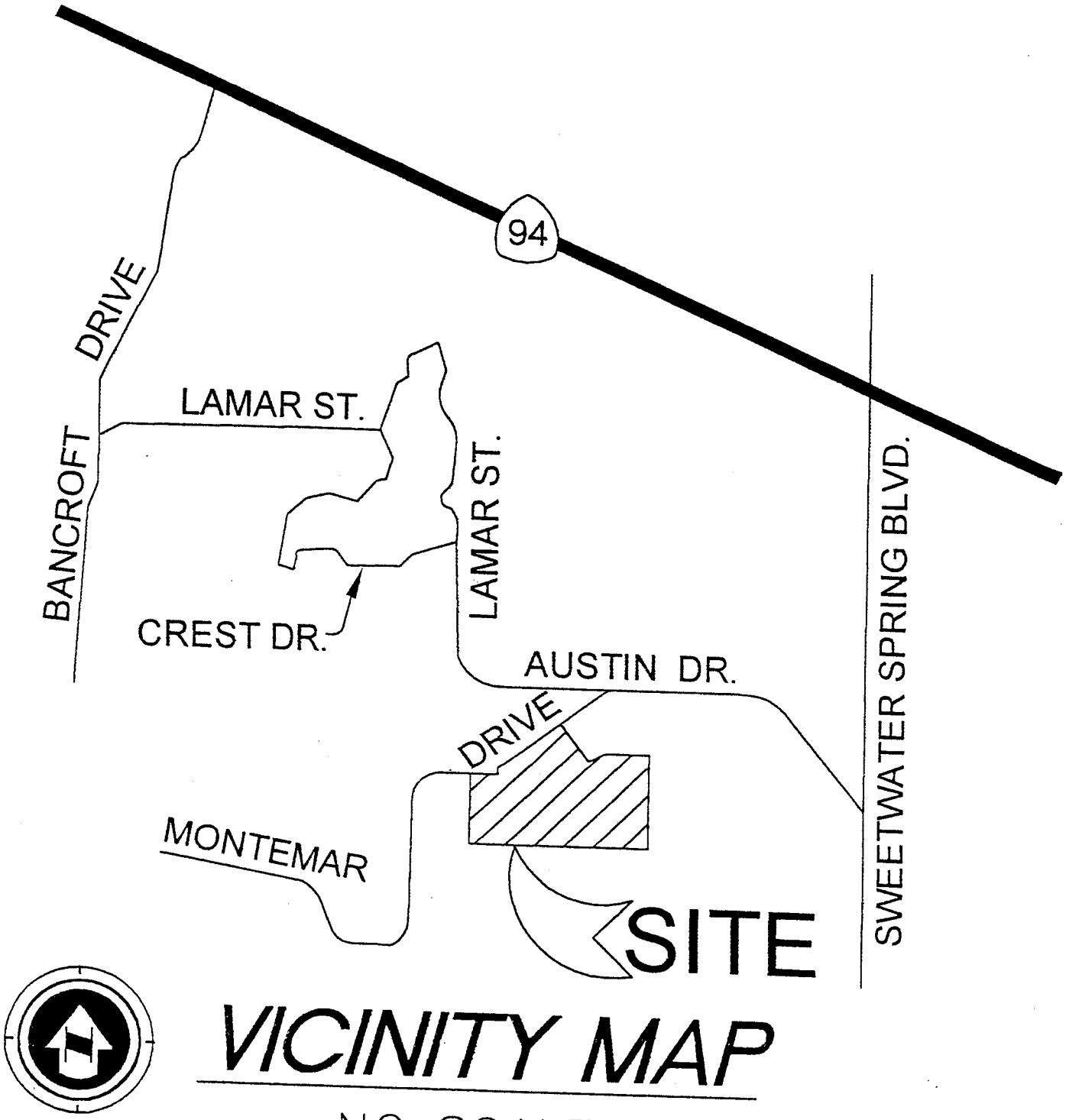
The proposed development will not significantly alter the existing drainage patterns. The proposed development does not propose concentration of any existing drainage basin. The proposed development does not propose diversion of any existing drainage basin area or alteration of the coarse of a stream or river.

4. Flood Plain

The County of San Diego has not studied this area; therefore County floodplain maps do not exist for this area.

FEMA flood plain maps do exist for this area; however, the FEMA map does not provide information pertaining to flood waters in close proximity to this project.

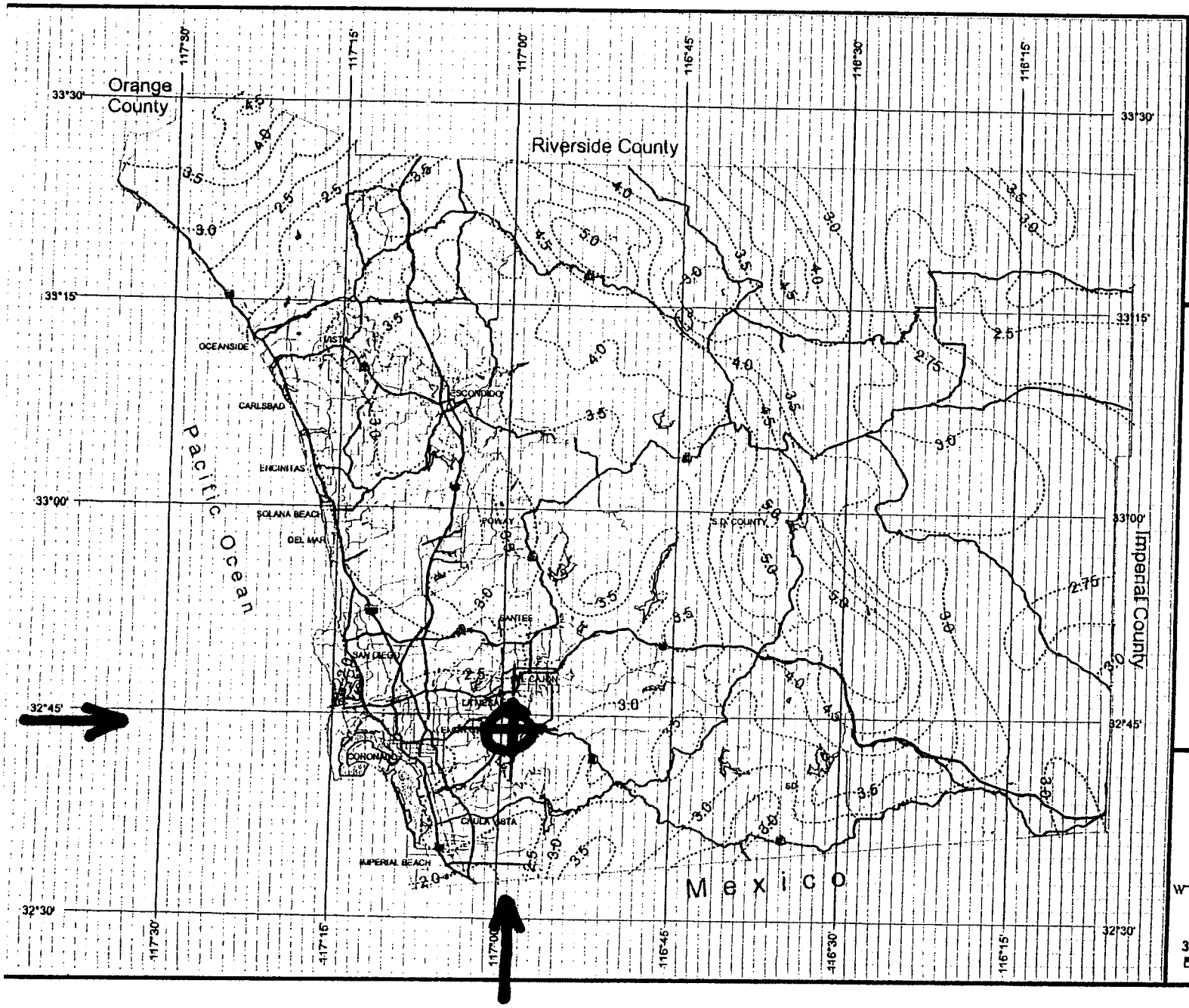
There exists a contributing drainage basin, greater than 25 acres and the location and width of the 100-year lines of inundation are shown on the Tentative Map. See the attached Drainage Map 4 and calculations for the width of the 100-year storm lines of inundation at the point of comparison.



VICINITY MAP

NO SCALE

THOMAS BRO MAP NO. 1271, C-7



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

32° 44'

116° 59'

2.85

DPW GIS

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N W E S

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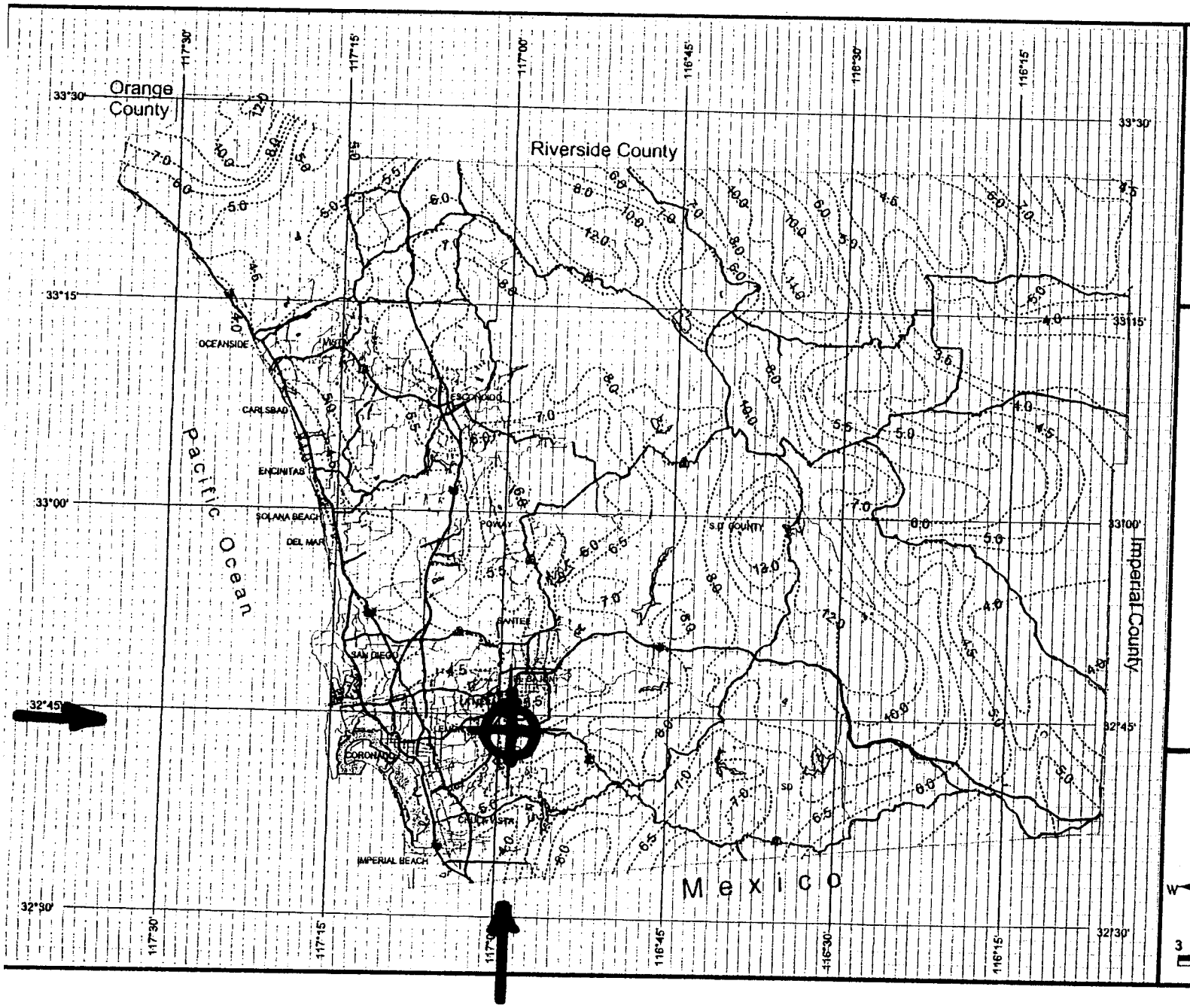

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

32° 44'

116° 59'

6.0

DPW GIS

SanGIS
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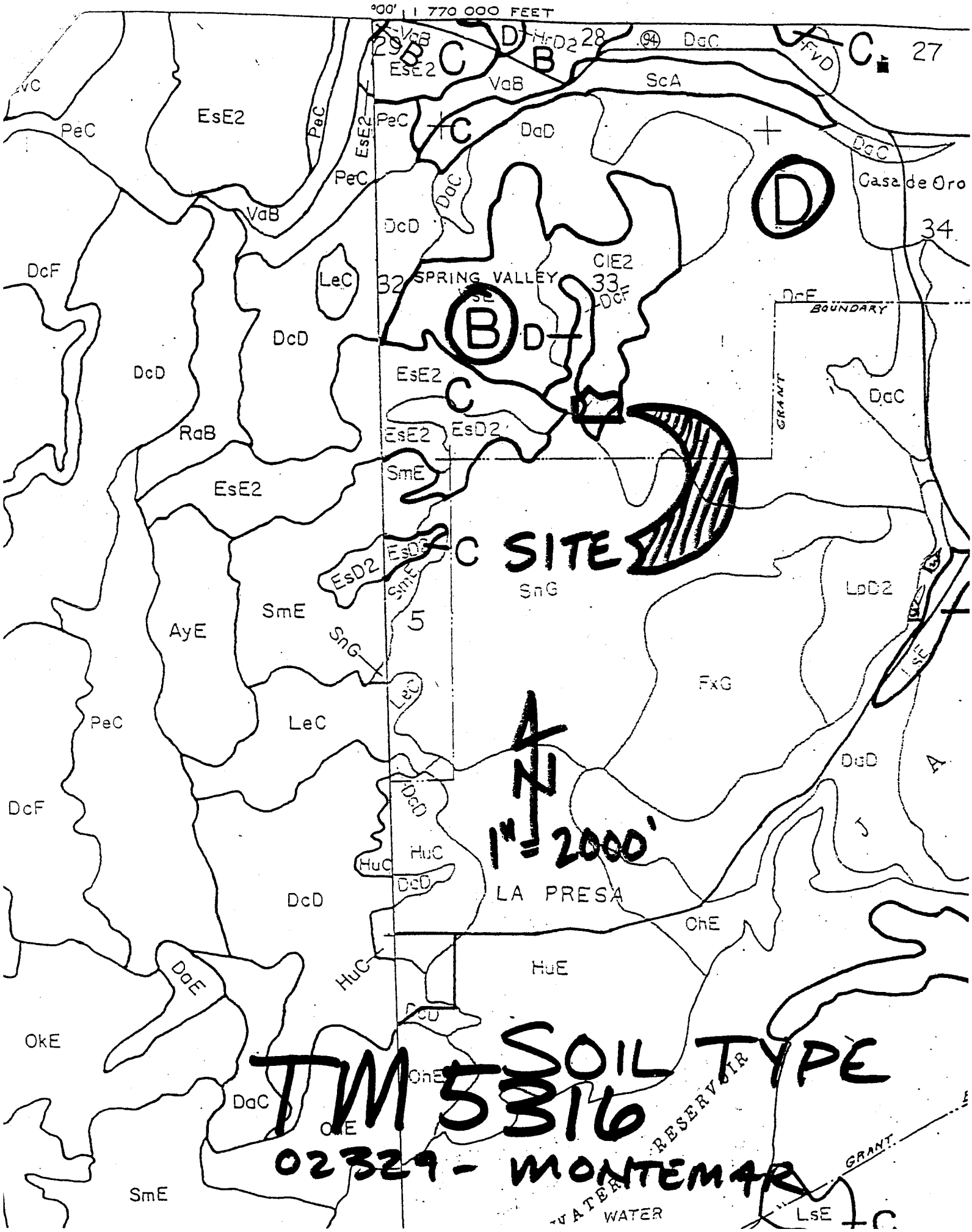
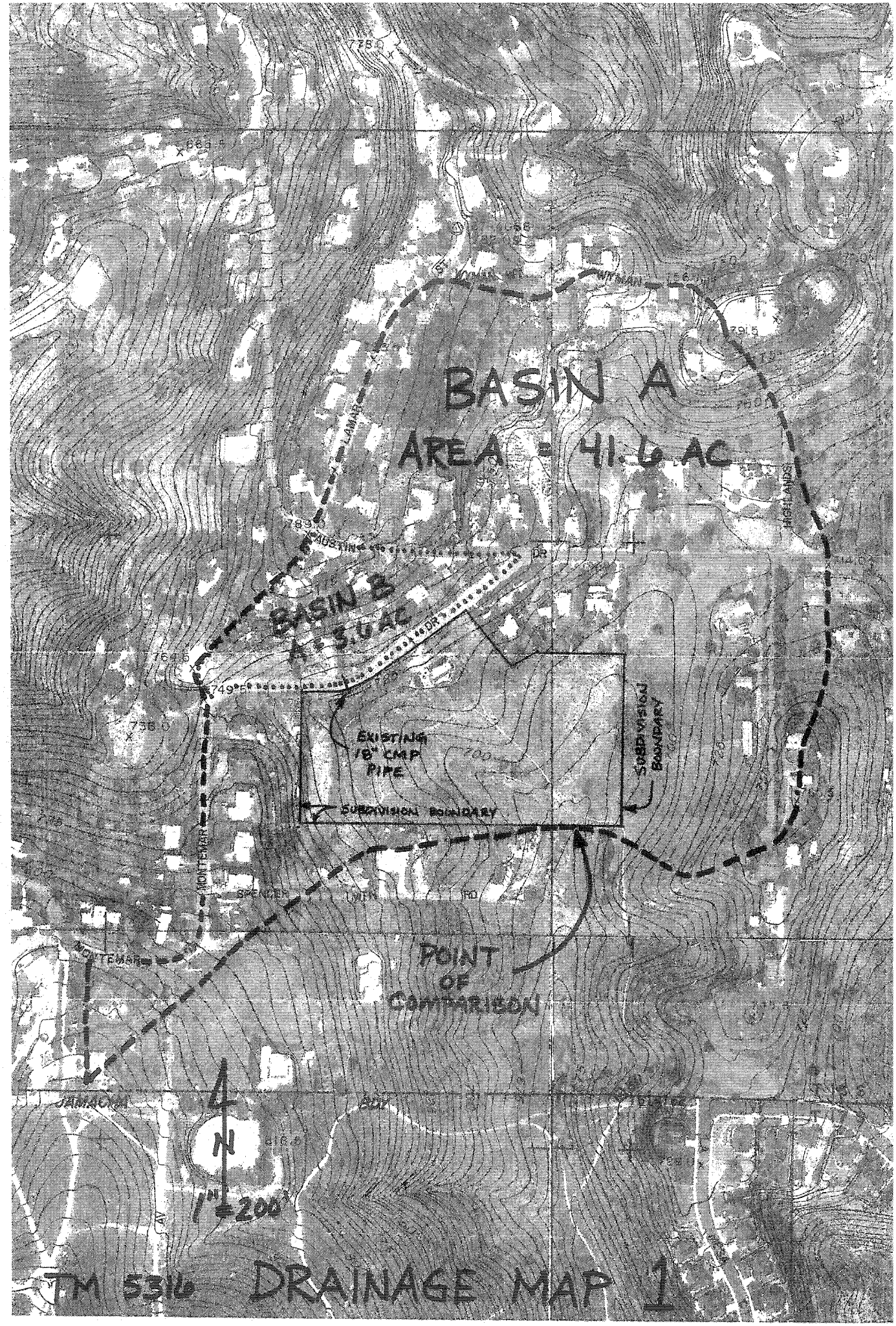


TM 5316
02329 - MONTEMAR
SOIL TYPE

EXISTING CONDITIONS



TM 5316 DRAINAGE MAP 1

DRAINAGE BASIN CALCULATIONS

[EXISTING]

BASIN A:

AREA = 41.6 AC (See Drainage Map 1)

TIME OF CONCENTRATION = $T_c = T_i + T_t$

T_i = 10.5 min (see Table 3-2)

T_t = 6.7 min (see Figure 3-4)

$T_c = 10.5 + 6.7 = 17.2$ min

$T_c = 17.2$ min

INTENSITY = I = 3.38 IN/HR (see Figure 3-1)

RUNOFF COEFFICIENT = C

SOIL TYPE "B" = 21.9 AC (see Table 3-1) → 17.3 AC Developed C = 0.38; 4.6 AC Natural C = 0.25

SOIL TYPE "D" = 19.7 AC (see Table 3-1) → 14.5 AC Developed C = 0.46; 5.2 AC Natural C = 0.35

WEIGHTED C-VALUE:

B: $\frac{0.38(17.3)}{21.9} + \frac{0.25(4.6)}{21.9} = 0.353$

D: $\frac{0.46(14.5)}{19.7} + \frac{0.35(5.2)}{19.7} = 0.431$

$\frac{0.353(21.9)}{41.6} + \frac{0.431(19.7)}{41.6} = 0.39$

$C = 0.39$

$Q = CIA = 0.39(3.38)(41.6) = 54.8$ cfs

$Q_{100} = 54.8$ cfs (EXISTING) ←

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

BASIN A

EQUATION

$$T_c = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

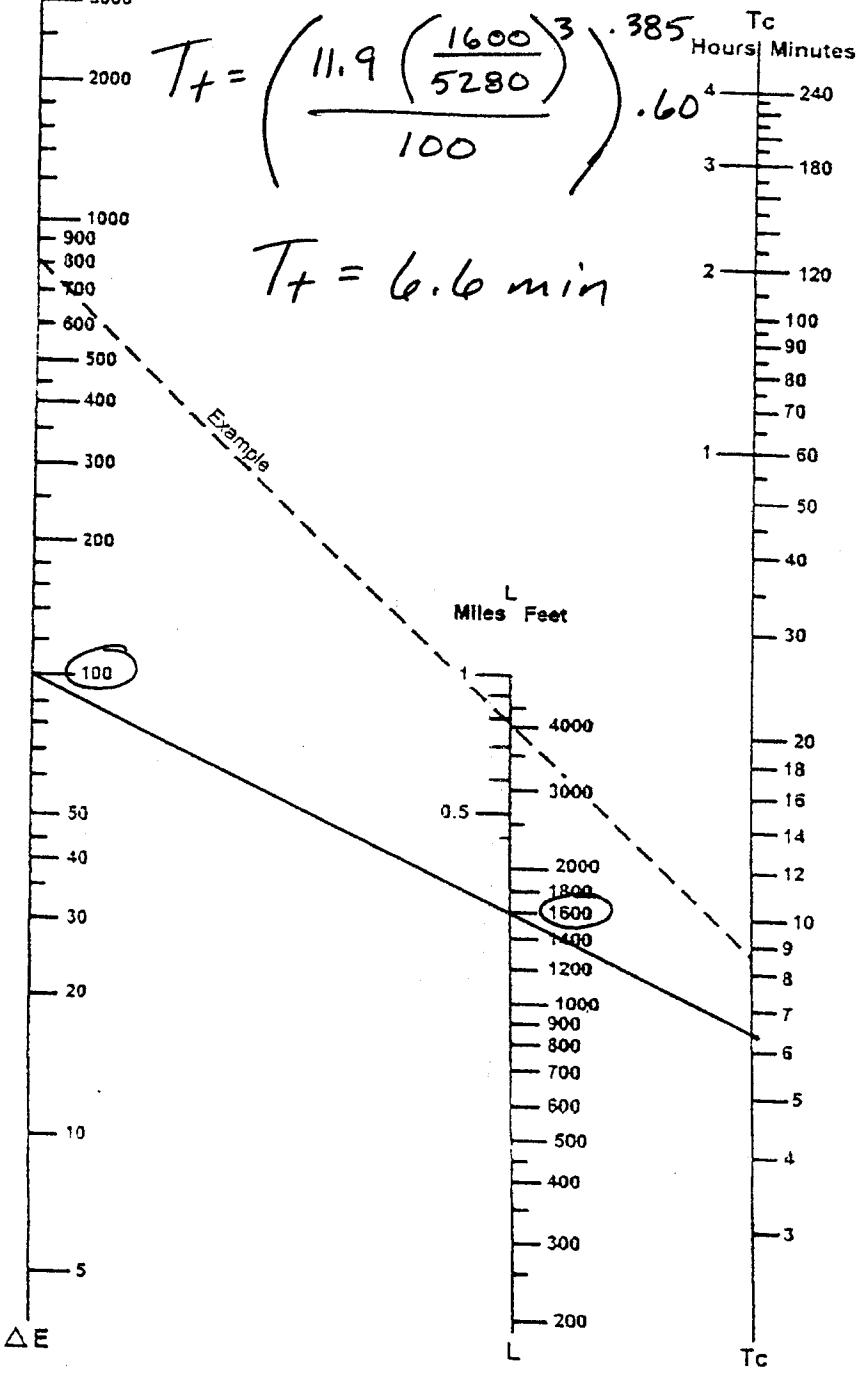
T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$$T_t = \left(\frac{11.9\left(\frac{1600}{5280}\right)^3}{100}\right)^{.385} .60$$

$T_t = 6.6$ min

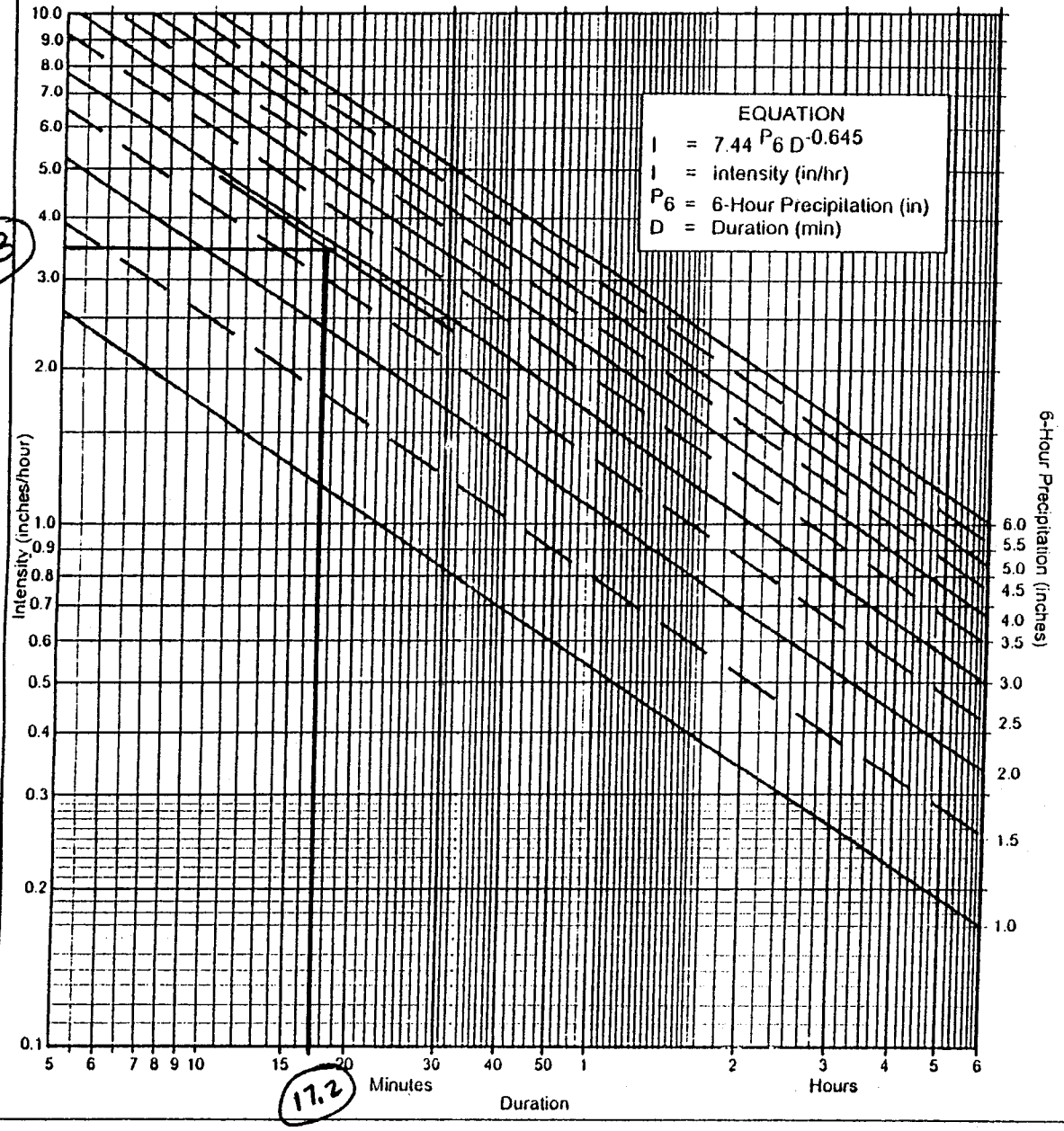


SOURCE: California Division of Highways (1941) and Kirpich (1940)

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

FIGURE 3-4

BASIN A



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.85 in., P_{24} = 6 , $\frac{P_6}{P_{24}}$ = 48 %(2)

(c) Adjusted P_6(2) = 2.85 in.

(d) t_x = 17.2 min.

(e) I = 3.38 in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

BASIN A

Intensity-Duration Design Chart - Template

BASIN A

FIGURE 3-1

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

BASIN A

BASIN A

DRAINAGE BASIN CALCULATIONS

BASIN B: (OFFSITE EXISTING & PROPOSED)

AREA = 3.6 AC (See Drainage Map 1)

TIME OF CONCENTRATION = $T_c = T_i + T_t$

T_i = 7.4 min (see Table 3-2)

T_t = 4.7 min (see Figure 3-4)

$T_c = 7.4 + 4.7 = 12.1$ min

$T_c = 12.1$ min

INTENSITY = I = 4.24 IN/HR (See Figure 3-1)

RUNOFF COEFFICIENT = C

SOIL TYPE "B" = 2.3 AC Developed C = 0.38

SOIL TYPE "D" = 1.3 AC Developed C = 0.46

(See Table 3-1)

WEIGHTED C-VALUE:

$$\frac{0.38(2.3)}{3.6} + \frac{0.46(1.3)}{3.6} = 0.41$$

$C = 0.41$

$Q = CIA = 0.41(4.24)(3.6) = 6.26$ cfs

$Q_{100} = 6.26$ cfs

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/ Acre	.5%		1%		2%		3%		5%		10%	
		L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

BASIN B

EQUATION

$$T_c = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

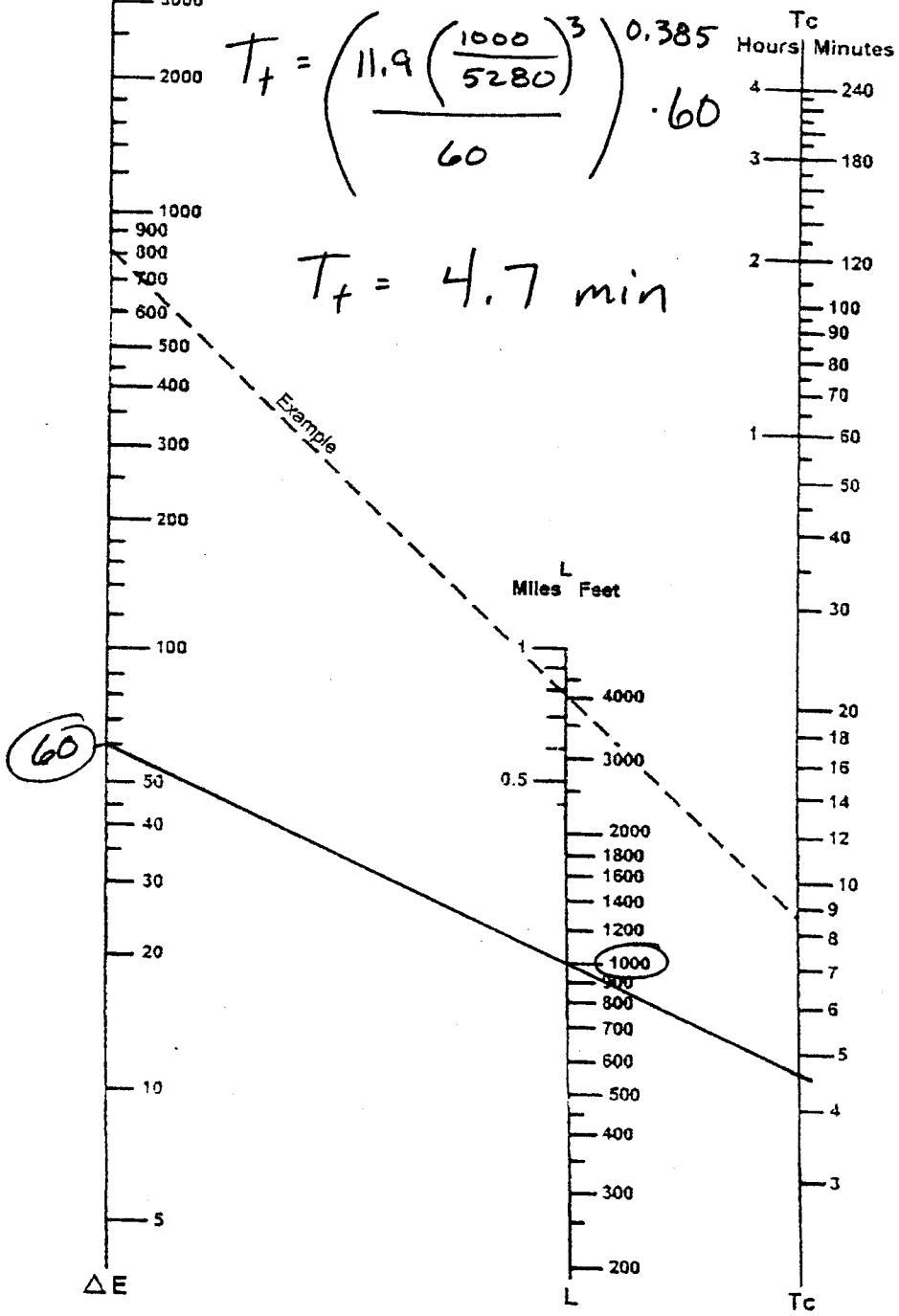
T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$$T_t = \left(\frac{11.9\left(\frac{1000}{5280}\right)^3}{60}\right)^{0.385} \cdot 60$$

$T_t = 4.7$ min

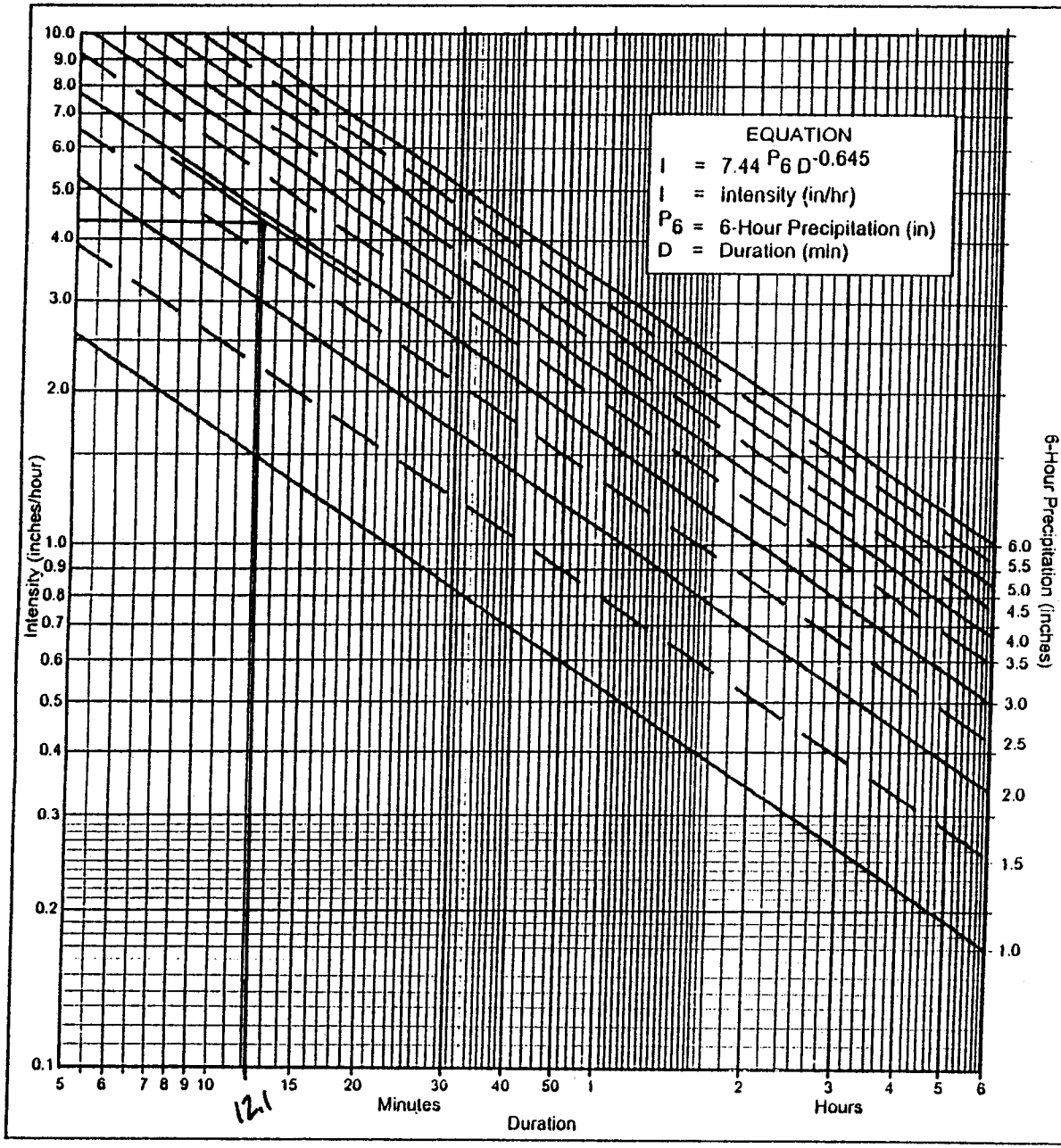


SOURCE: California Division of Highways (1941) and Kirpich (1940)

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

FIGURE 3-4

BASIN B



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.85 in., P_{24} = 6 , $\frac{P_6}{P_{24}}$ = 48 %(2)

(c) Adjusted P_6(2) = 2.85 in.

(d) t_x = 12.1 min.

(e) I = 4.24 in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

BASIN B

FIGURE **3-1**

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

BASIN B

BASIN B

DRAINAGE FACILITY CALCULATIONS

Existing 18" storm drain pipe (CMP): (See Drainage Map 1)

$Q_{100} = 6.26$ cfs

$n = 0.02$

$d = 1.5'$

$s = 0.02$ (assumed minimum)

$D = ?$

$$* \; Q = \frac{K'}{n}(d)^{8/3}(s)^{1/2}$$

$$6.26 = \frac{K'}{0.02}(1.5)^{8/3}(0.02)^{1/2}$$

$$K' = 0.30 \rightarrow \frac{D}{d} = 0.59$$

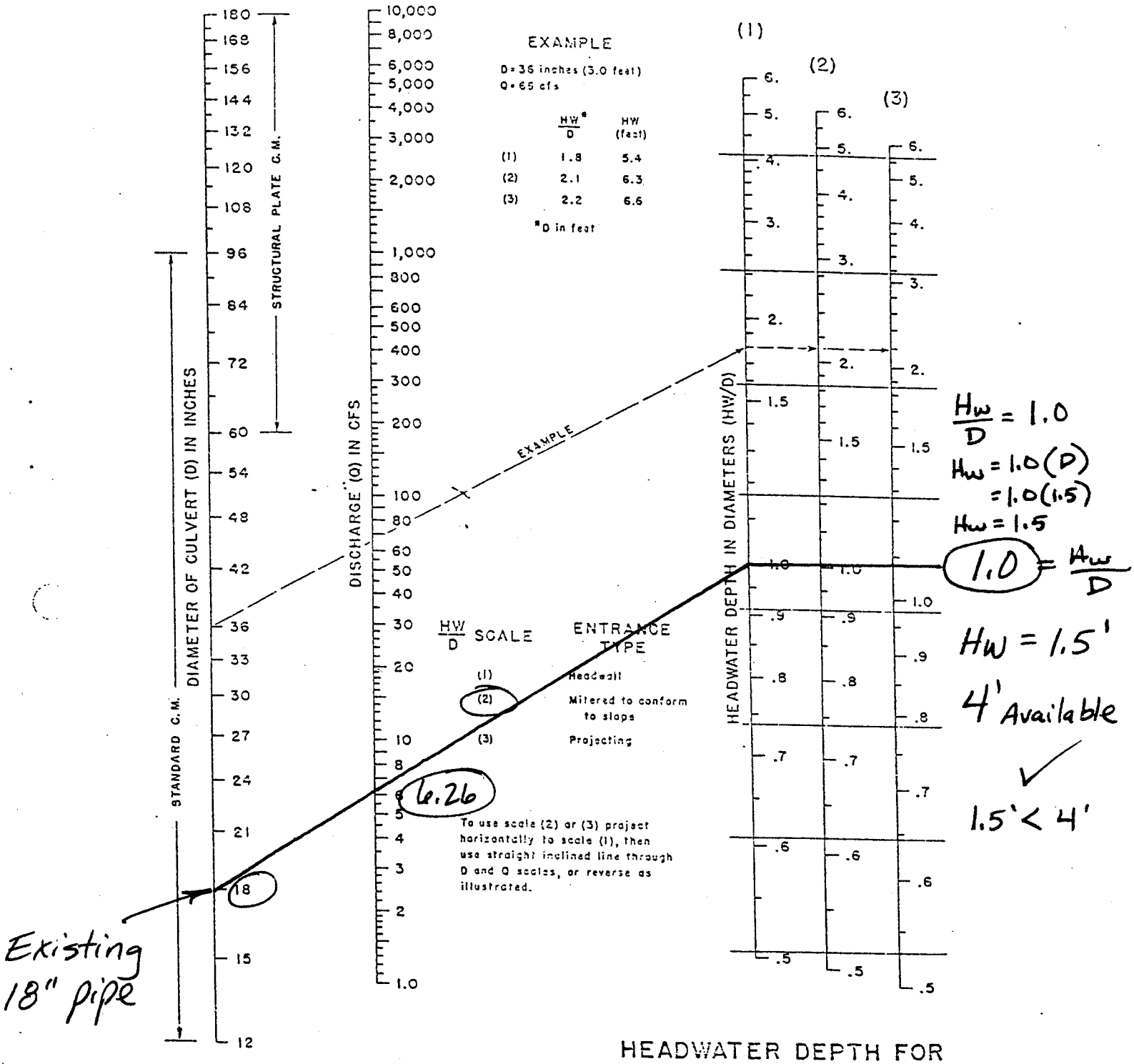
$$D = 0.9' < 1.5' \checkmark$$

∴ Capacity is Sufficient.

See attached chart for headwater depth.

* Per Brater & Kings "Handbook of Hydraulics"

CHART 5

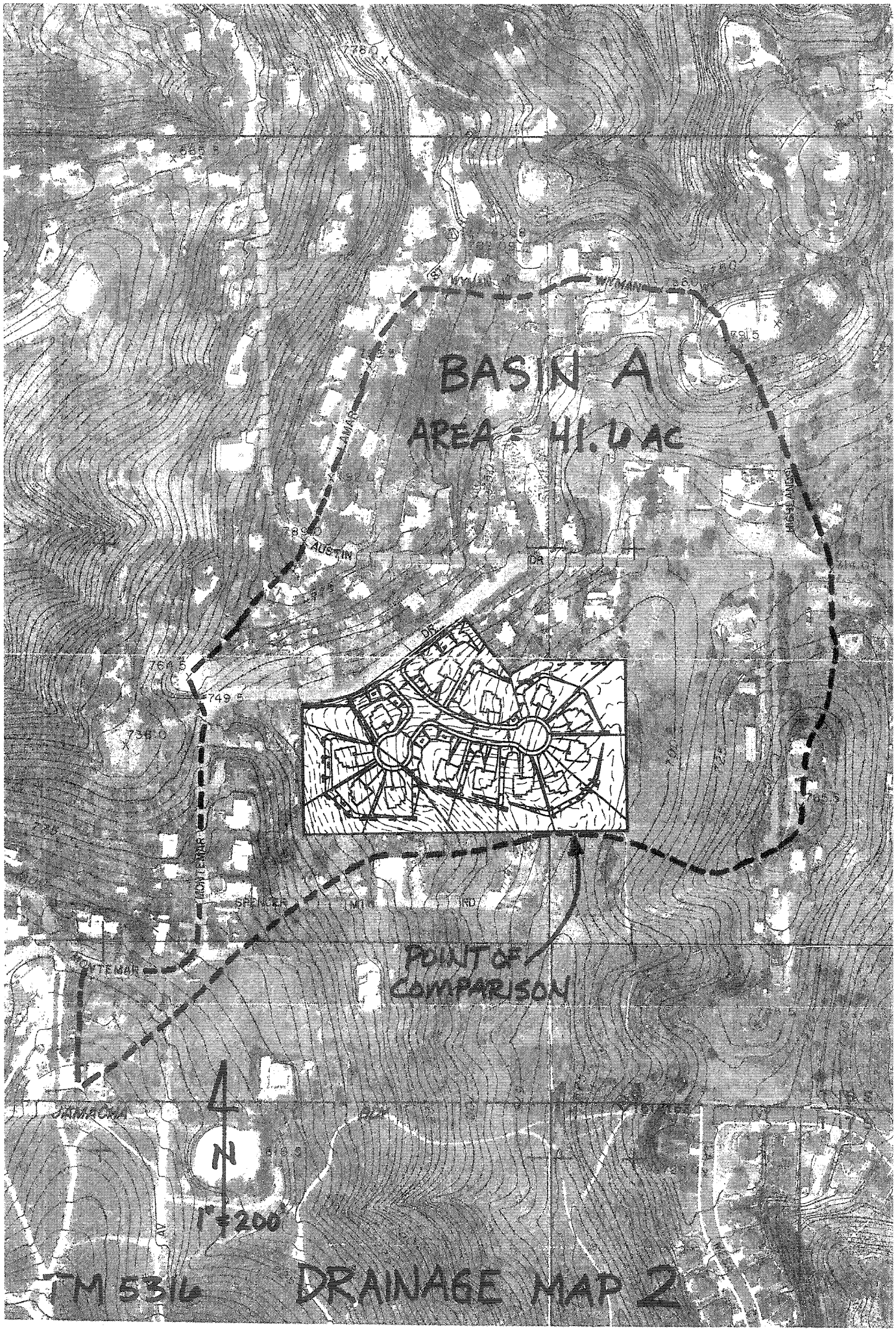


HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

BASIN B
EXISTING 18" PIPE (CMP)

PROPOSED CONDITIONS



M 5316 DRAINAGE MAP 2

DRAINAGE BASIN CALCULATIONS

[PROPOSED]

BASIN A:

AREA = 41.6 AC (See Drainage Map 2)

TIME OF CONCENTRATION = $T_c = T_i + T_t$

T_i = 10.5 min (see Table 3-2)

T_t = 6.7 min (see Figure 3-4)

$T_c = 10.5 + 6.7 = 17.2$ min

$T_c = 17.2$ min

INTENSITY = I = 3.38 IN/HR (See Figure 3-1)

RUNOFF COEFFICIENT = C

EXISTING C = 0.39 A = 34.1 AC

PROPOSED C = 2.5 AC - SOIL TYPE "D" DEVELOPED = 0.46

5 AC - Soil Type "B" Developed = 0.38

WEIGHTED C-VALUE

$$\frac{0.38(5)}{7.5} + \frac{0.46(2.5)}{7.5} = 0.406$$

$$\frac{0.406(7.5)}{41.6} + \frac{0.39(34.1)}{41.6} = 0.393$$

$$C = 0.393$$

$$Q = CIA = 0.393(3.38)(41.6) = 55.2 \text{ cfs}$$

$$Q_{100} = 55.2 \text{ cfs (PROPOSED)}$$

Q_{100} = 54.8 cfs Existing

Q_{100} = 55.2 cfs Proposed

$$> \frac{0.4}{54.8}(100) = 0.7\% \text{ increase}$$

∴ There is a 0.4 cfs increase in runoff at the point of comparison. (

DRAINAGE CALCULATIONS:

EXISTING SWALE @ the POINT OF COMPARISON:

(See BASIN A CALCULATIONS EXISTING & PROPOSED)

Q_{100} = 54.8 cfs (EXISTING)

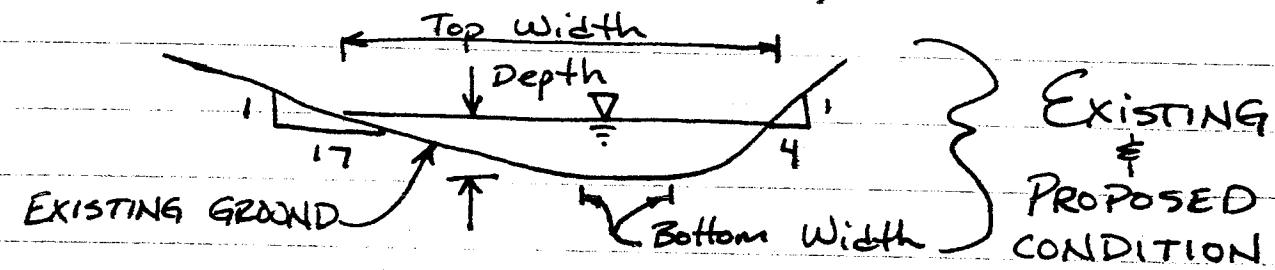
Q_{100} = 55.2 cfs (PROPOSED)

BOTTOM WIDTH = b = 5' (approximate value)

ROUGHNESS COEFFICIENT = n = 0.035

SLOPE = 5%

SIDE SLOPE = Z = Z_1 = 1/17 , Z_2 = 1/4



Channel Calculator

[EXISTING]

Given Input Data:

Shape	Trapezoidal
Flowrate	54.8000 cfs
Slope	0.0500 ft/ft
Manning's n	0.0350
Bottom width	5.0000 ft
Left slope	0.0588 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	0.7496 ft
Velocity	5.6785 fps
Top width	20.7472 ft

Channel Calculator

[PROPOSED]

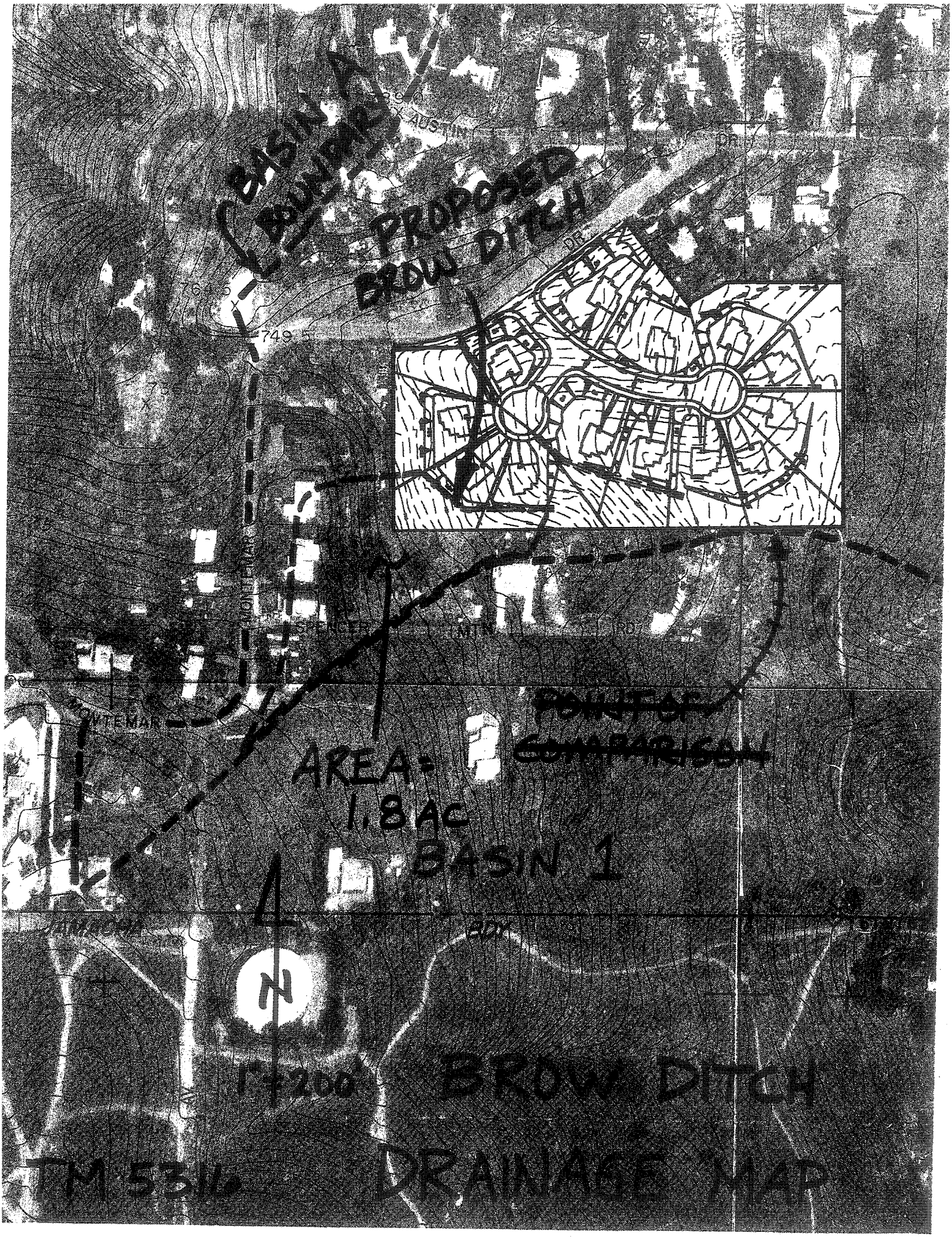
Given Input Data:

Shape	Trapezoidal
Flowrate	55.2000 cfs
Slope	0.0500 ft/ft
Manning's n	0.0350
Bottom width	5.0000 ft
Left slope	0.0588 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	0.7521 ft
Velocity	5.6893 fps
Top width	20.7999 ft

∴ the above calculations compare the existing and proposed conditions and show the difference between them is virtually nothing.


BASIN A
BOUNDARY
PROPOSED
BROW DITCH
AUSTIN
DR
749.5
MONTEMAR
SPENCER
MTN
RD
MONTEMAR
~~POINT OF~~
~~COMPARISON~~
AREA=
1.8 AC
BASIN 1
JAMACHA
BDY
N
1"=200'
BROW DITCH
TM 5316
DRAINAGE MAP

DRAINAGE BASIN CALCULATIONS:

BASIN 1: [PROPOSED]

AREA = 1.8 AC (See Brow Ditch Basin Map)

TIME OF CONCENTRATION: $T_c = T_i + T_t$

T_i = 10.5 min (See Table 3-2)

T_t = 3.3 min (See Figure 3-4)

$T_c = 10.5 + 3.3 = 13.8$ min

$T_c = 13.8$ min

INTENSITY = I = 4.0 IN/HR (See Figure 3-1)

RUNOFF COEFFICIENT = C

SOIL TYPE "D" → DEVELOPED C = 0.46

C = 0.46

$$Q = CIA = 0.46(4.0)(1.8) = 3.3 \text{ cfs}$$

$$Q_{100} = 3.3 \text{ cfs} \longleftarrow$$

The Q_{100} shown above is the highest peak flow that any of the proposed brow ditches will receive. Therefore, the calculation shown above is considered the worst case scenario and is the only brow ditch calculation provided.

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

BASIN 1

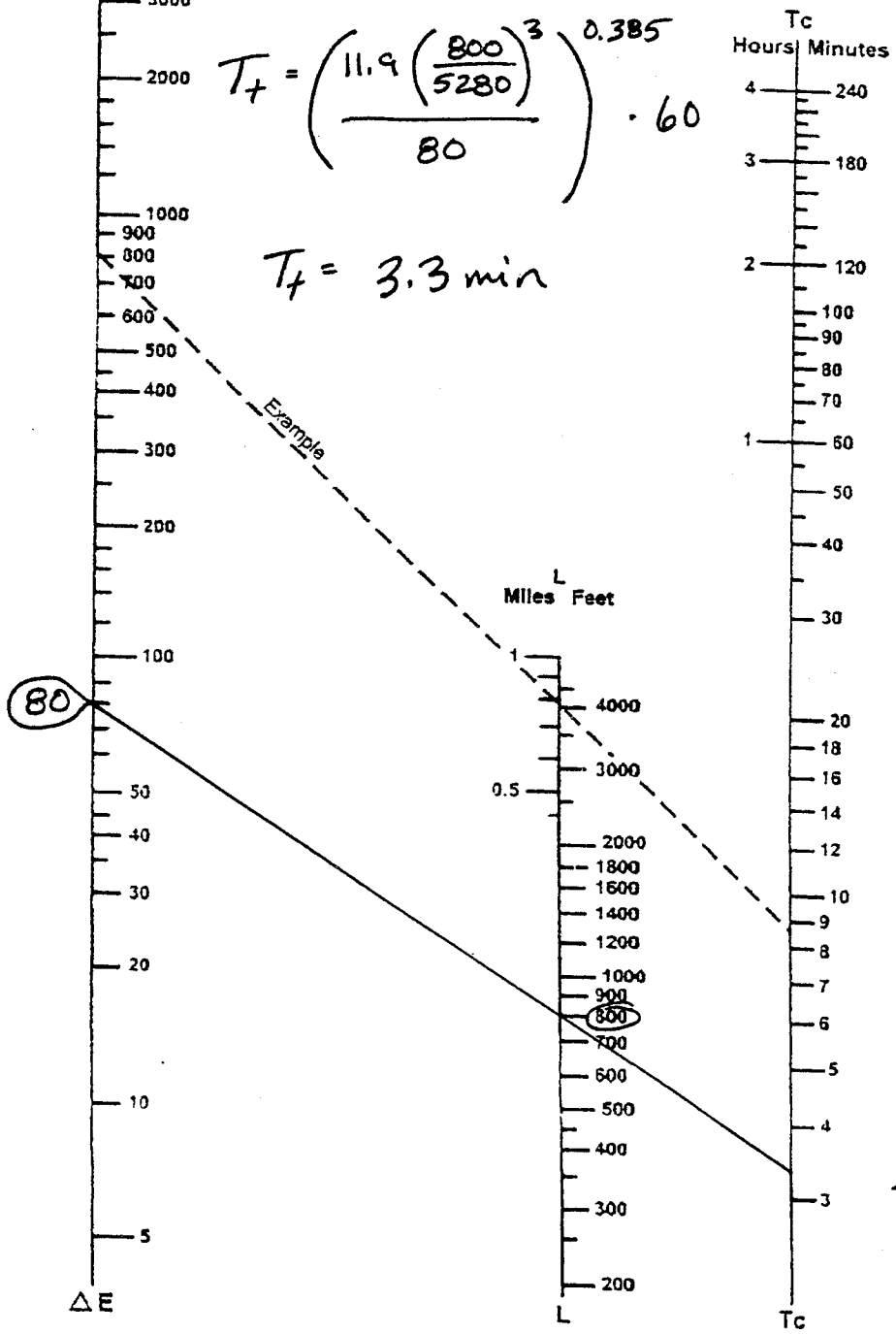
EQUATION

$$T_c = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

T_c = Time of concentration (hours)
L = Watercourse Distance (miles)
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$$T_t = \left(\frac{11.9\left(\frac{800}{5280}\right)^3}{80}\right)^{0.385} \cdot 60$$

$T_t = 3.3$ min



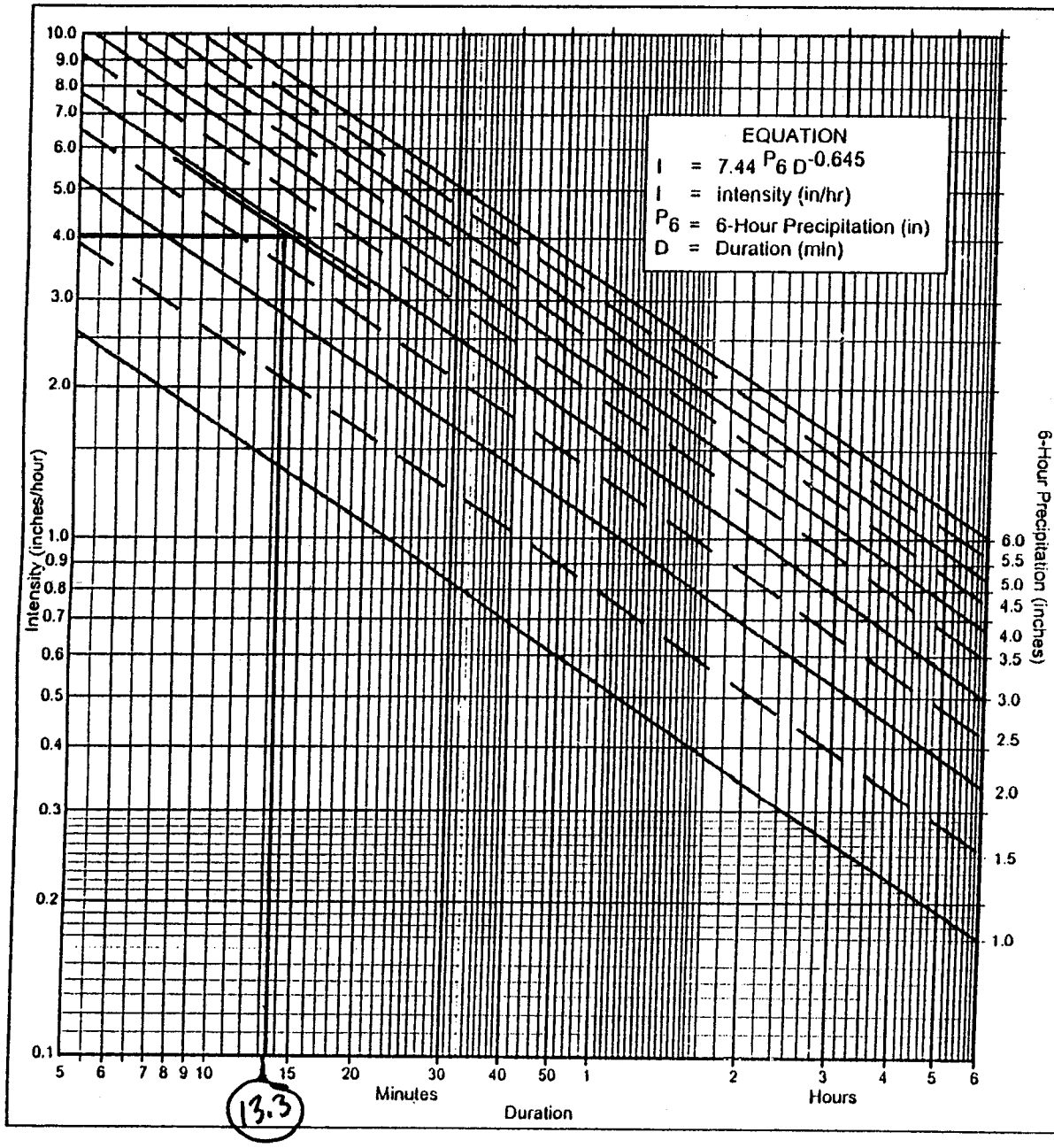
$T_t = 3.3$ min

SOURCE: California Division of Highways (1941) and Kirpich (1940)

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

FIGURE
3-4

BASIN 1



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.85 in., P_{24} = 6 , $\frac{P_6}{P_{24}}$ = 48 %(2)

(c) Adjusted P_6(2) = 2.85 in.

(d) t_x = 13.8 min.

(e) I = 4.0 in./hr. = $7.44(2.85)(13.3)^{-.645}$

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

FIGURE

3-1

BASIN 1

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

BASIN 1

BASIN 1

DRAINAGE FACILITY CALCULATIONS:

PROPOSED CONCRETE BROW DITCH: (WORST CASE)

$Q_{100} = 3.3$ cfs

$n = 0.02$

$d = 2'$

$s = 2\%$ (min.)

$$* \; Q = \frac{K'}{n}(d)^{8/3}(s)^{1/2}$$

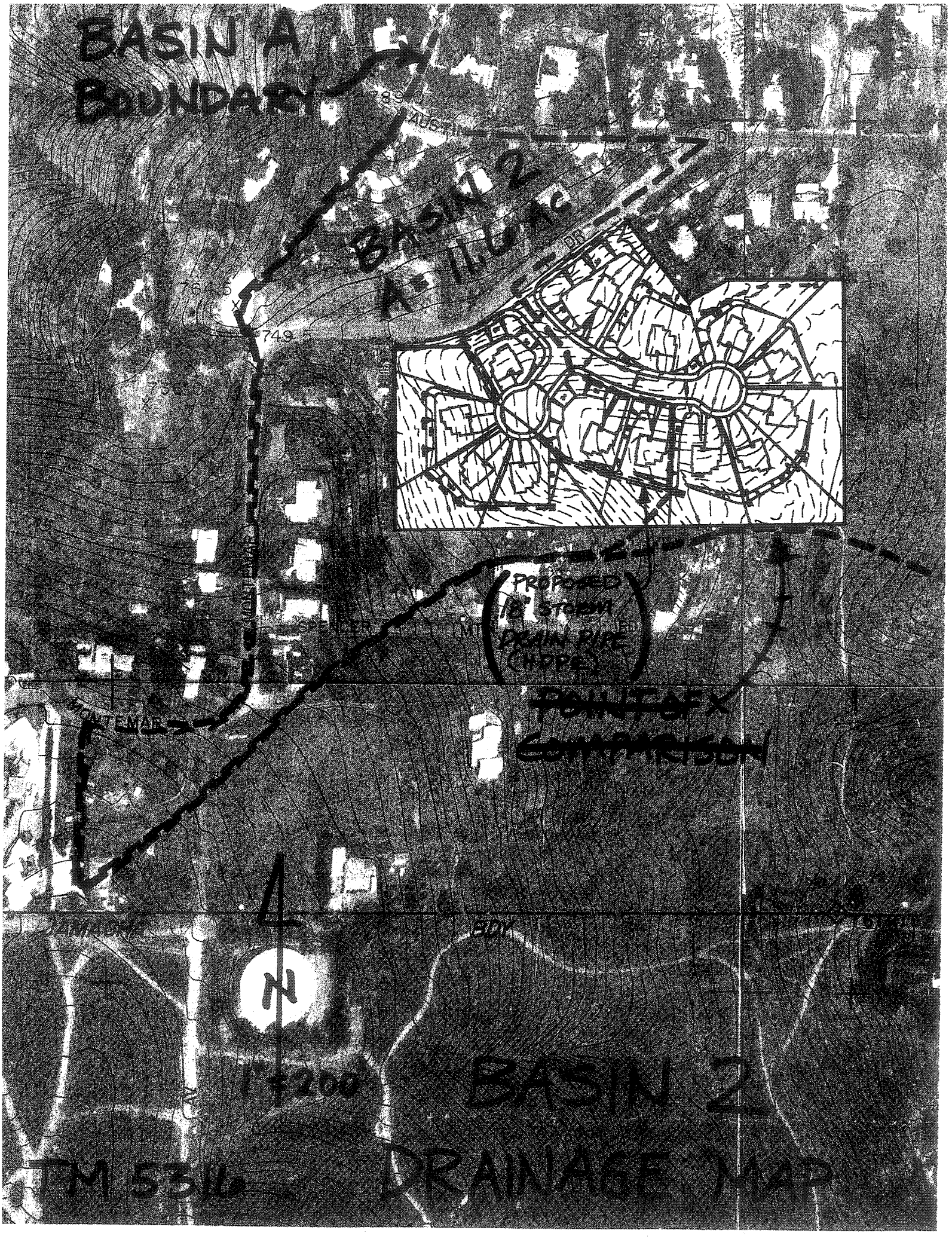
* Per Brater & King

$$3.3 = \frac{K'}{0.02}(2)^{8/3}(0.02)^{1/2} \longrightarrow K' = 0.0735$$

$$K' \rightarrow \frac{D}{d} = 0.27 \longrightarrow D = 0.54'$$

$$D = 0.54' \leq 1.0' \checkmark$$

∴ the capacity of the proposed Brow Ditches is sufficient.


BASIN A
BOUNDARY
BASIN 2
A = 11.6 AC
PROPOSED
18" STORM
DRAIN PIPE
(HDPE)
POINT OF
COMPARISON
MONTEMAR
SPENCER
JAMACHA
BDY
N
1" = 200'
BASIN 2
TM 5316
DRAINAGE MAP

DRAINAGE BASIN CALCULATIONS:

BASIN 2: [PROPOSED]

AREA: 11.6 AC (See BASIN 2 DRAINAGE MAP)

TIME OF CONCENTRATION = $T_c = T_i + T_t$

T_i = 10.5 min (See Table 3-2)

T_t = 7.2 min (See Figure 3-4)

$T_c = 10.5 + 7.2 = 17.7$ min

$T_c = 17.7$ min

INTENSITY = I = 3.32 IN/HR (See Figure 3-1)

RUNOFF COEFFICIENT = C

SOIL TYPE "B" = 4.1 AC Developed $C = 0.38$

SOIL TYPE "D" = 7.5 AC Developed $C = 0.46$

WEIGHTED C-VALUE: (See Table 3-1)

$$\frac{0.38(4.1)}{11.6} + \frac{0.46(7.5)}{11.6} = 0.43$$

$C = 0.43$ (Proposed)

$Q = CIA = 0.43(3.32)(11.6) = 16.6$ cfs

$Q_{100} = 16.6$ cfs ←

The Q_{100} shown above is the highest peak flow that any of the proposed storm drain pipes will receive. Therefore, the calculation shown above is considered the worst case scenario and is the only storm drain system calculation provided.

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

BASIN 2

EQUATION

$$T_c = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

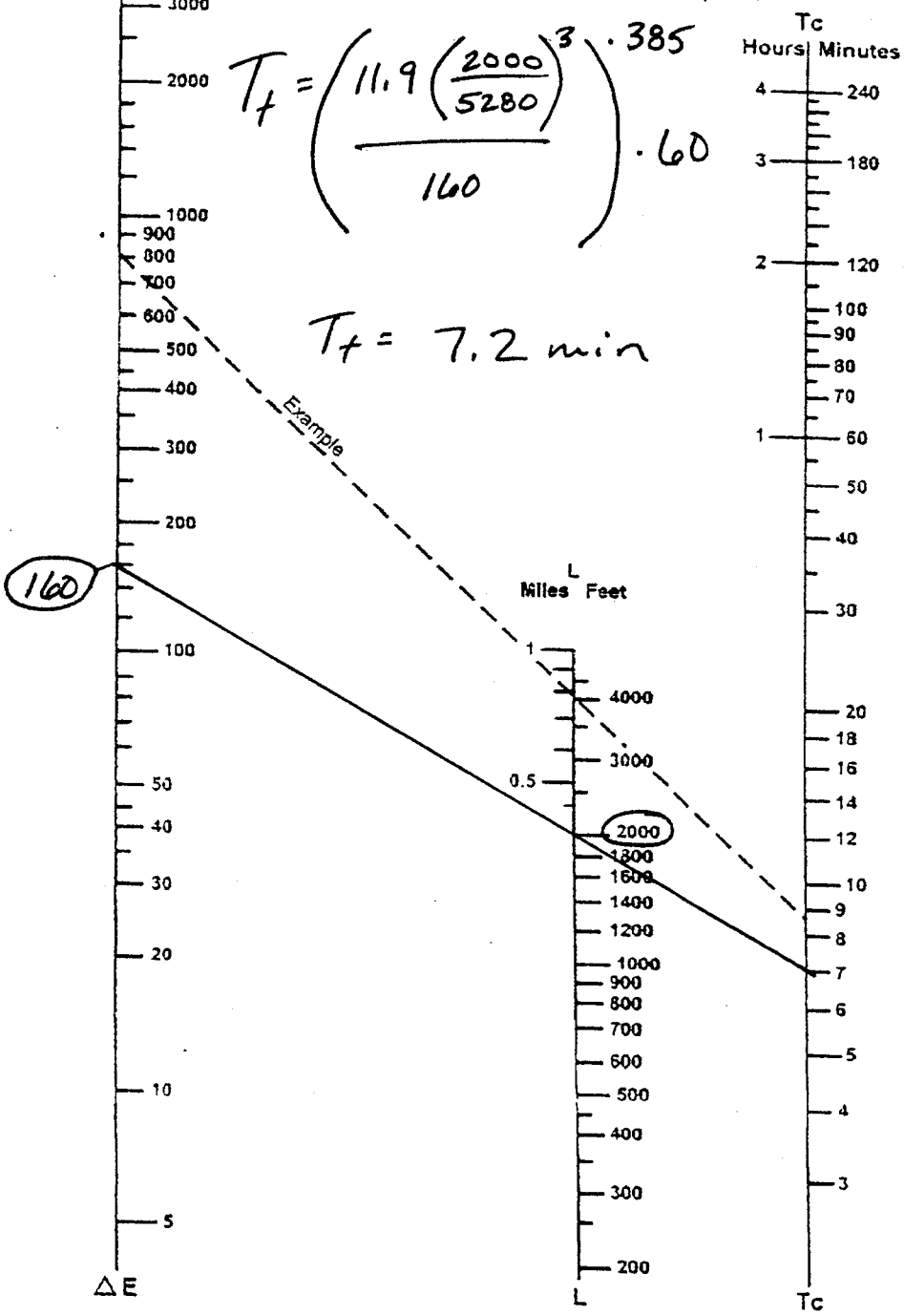
T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$$T_t = \left(\frac{11.9\left(\frac{2000}{5280}\right)^3}{160}\right)^{.385} \cdot 60$$

$T_t = 7.2$ min

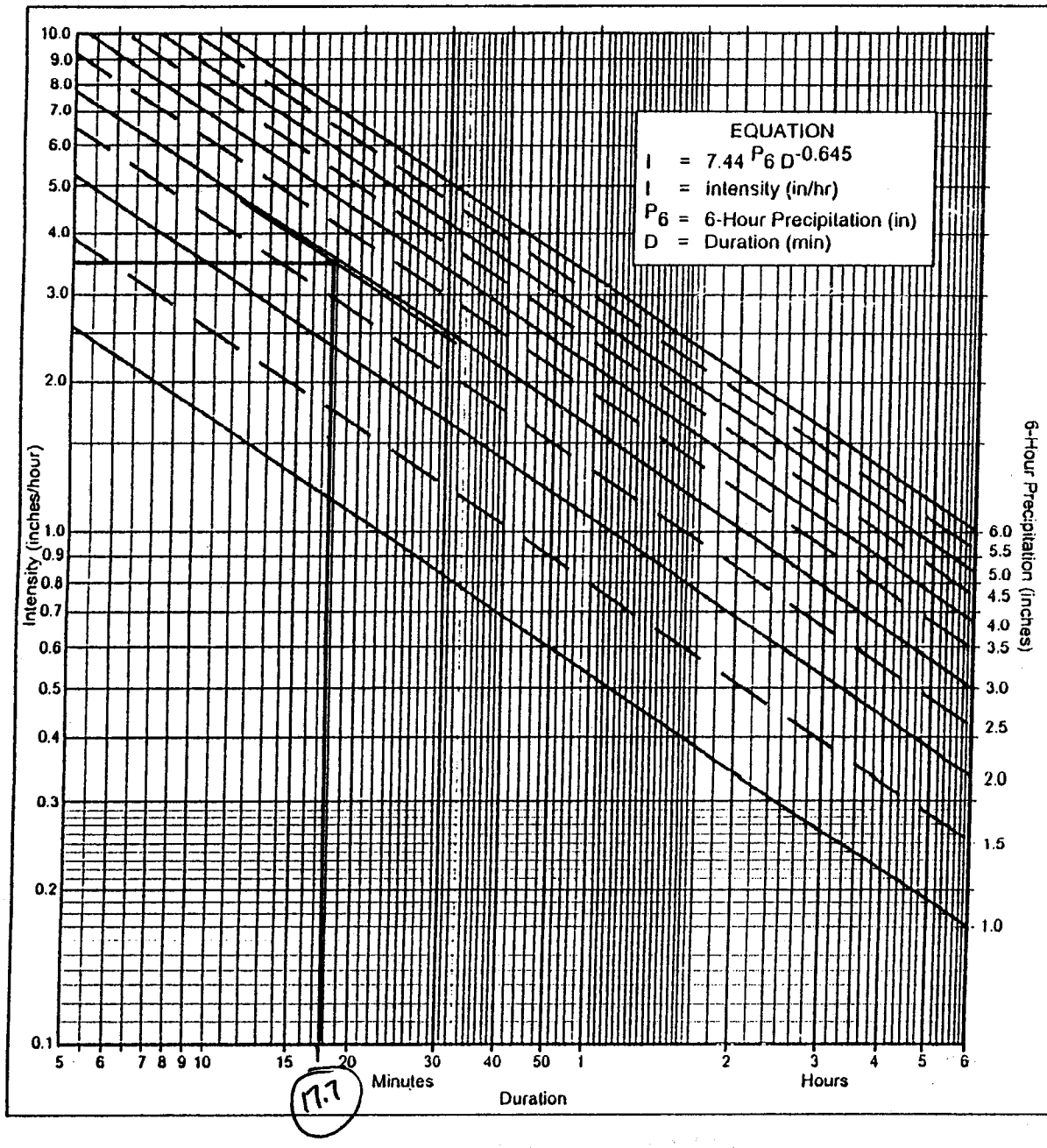


SOURCE: California Division of Highways (1941) and Kirpich (1940)

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

FIGURE 3-4

BASIN 2



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.85 in., P_{24} = 6 $\frac{P_6}{P_{24}}$ = 48 %(2)

(c) Adjusted P_6(2) = 2.85 in.

(d) t_x = 17.7 min.

(e) I = 3.32 in./hr. = $7.44(2.85)(17.7)^{-.645}$

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

BASIN 7

Intensity-Duration Design Chart - Template

BASIN 2

FIGURE **3-1**

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

BASIN 2

BASIN 2

DRAINAGE FACILITY CALCULATIONS:

PROPOSED STORM DRAIN SYSTEM: (WORST CASE)

$Q_{100} = 16.6$ cfs

$n = 0.013$

$d = 1.5'$

$D = 0.93$ (MOST EFFICIENT DEPTH)

$K' = 0.498$

$s = ?$ (Minimum)

$$Q = \frac{K'}{n}(d)^{8/3}(s)^{1/2}$$

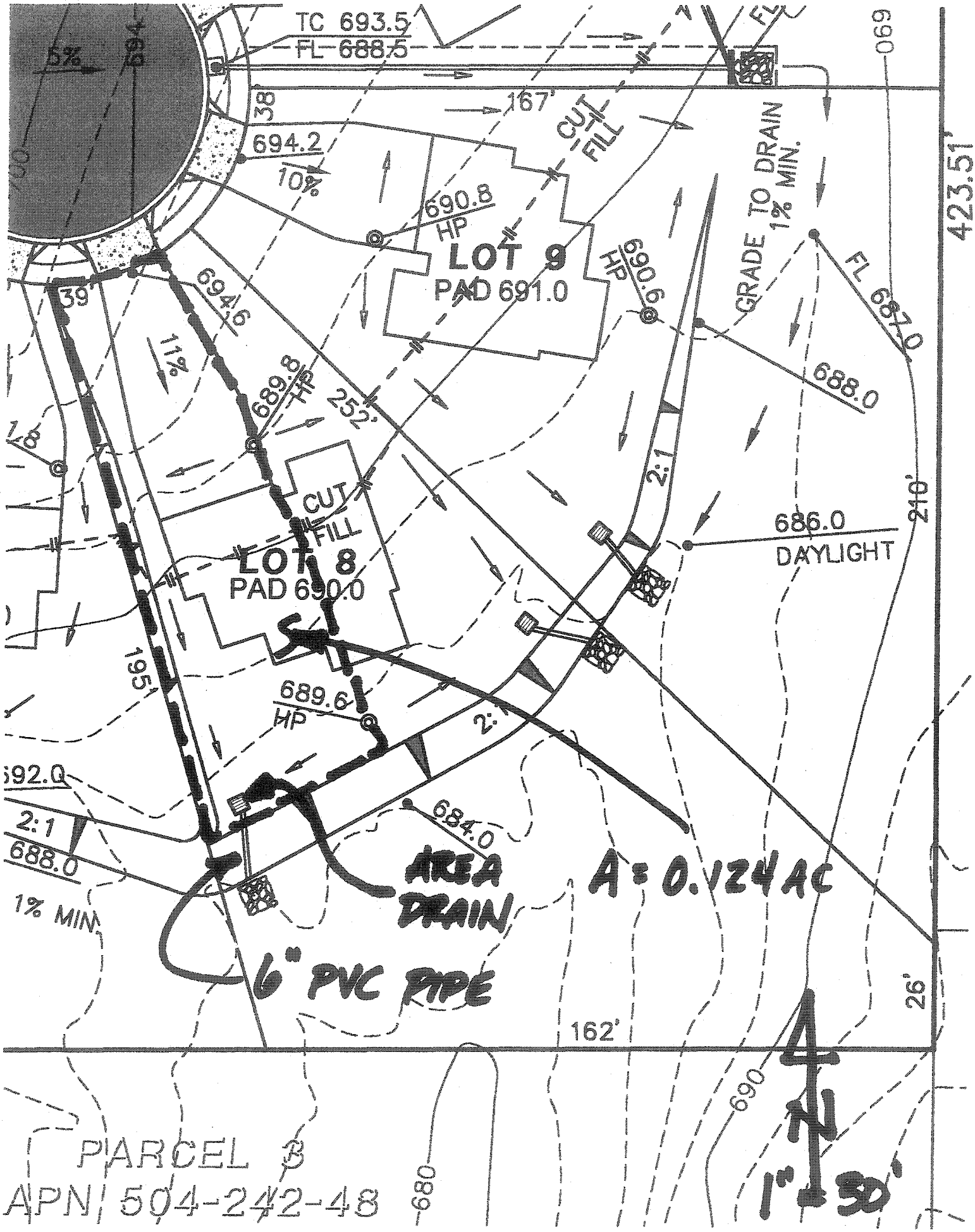
* Per Brater & King

$$16.6 = \frac{0.498}{0.013}(1.5)^{8/3}(s)^{1/2}$$

$$S_{min.} = 0.022$$

∴ The proposed storm drain system is sufficient as long as the minimum slope of the pipes are 2.2%.

The proposed minimum slope in the storm drain system is 5%; therefore, the proposed storm drain system is sufficient.



LOT DRAINAGE MAP

DRAINAGE BASIN CALCULATIONS:

PROPOSED LOT DRAINAGE: (Typical)

AREA = 0.124 AC (See Lot Drainage Map)

TIME OF CONCENTRATION = $T_c = T_i + T_t$

T_i = 10.5 min (See Table 3-2)

T_c = 10.5 min

INTENSITY = I = 4.65 IN/HR (See Figure 3-1)

RUNOFF COEFFICIENT = C = 0.46 (See Table 3-1)

$$Q = CIA = 0.46(4.65)(0.124) = 0.27 \text{ cfs}$$

$$Q_{100} = 0.27 \text{ cfs} \longleftarrow$$

∴ The Q_{100} above represents the maximum amount of runoff that the area drain (proposed) will receive during a 100-year storm.

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

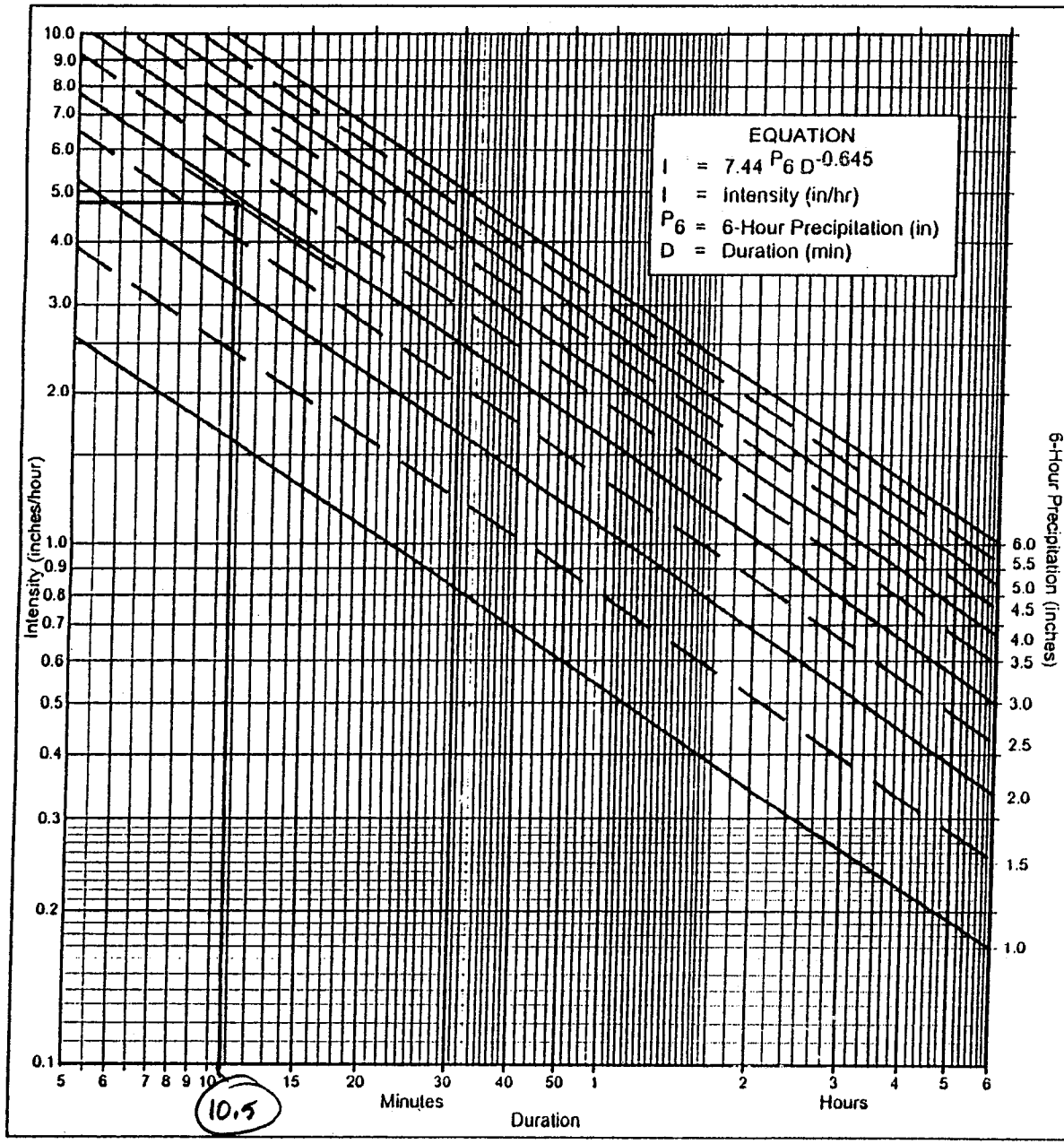
Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

LOT DRAINAGE



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.85 in., P_{24} = 6. , $\frac{P_6}{P_{24}}$ = 48 %(2)

(c) Adjusted $P_6^{(2)}$ = 2.85 in.

(d) t_x = 10.5 min.

(e) I = 4.65 in./hr. = $7.44(2.85)(10.5)^{-.645}$

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

LOT DRAINAGE

Intensity-Duration Design Chart - Template

LOT DRAINAGE

FIGURE **3-1**

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

LOT DRAINAGE

LOT DRAINAGE

DRAINAGE FACILITY CALCULATIONS:

PROPOSED 6" PVC PIPE: (WORST CASE)
(LOT 8)

$Q_{100} = 0.27$ cfs

$Q(\text{max @ min. slope}) = ?$

$n = 0.013$

$d = 0.5'$

$s_{min} = 0.02$

$$* Q = \frac{K'}{n}(d)^{8/3}(s)^{1/2}$$

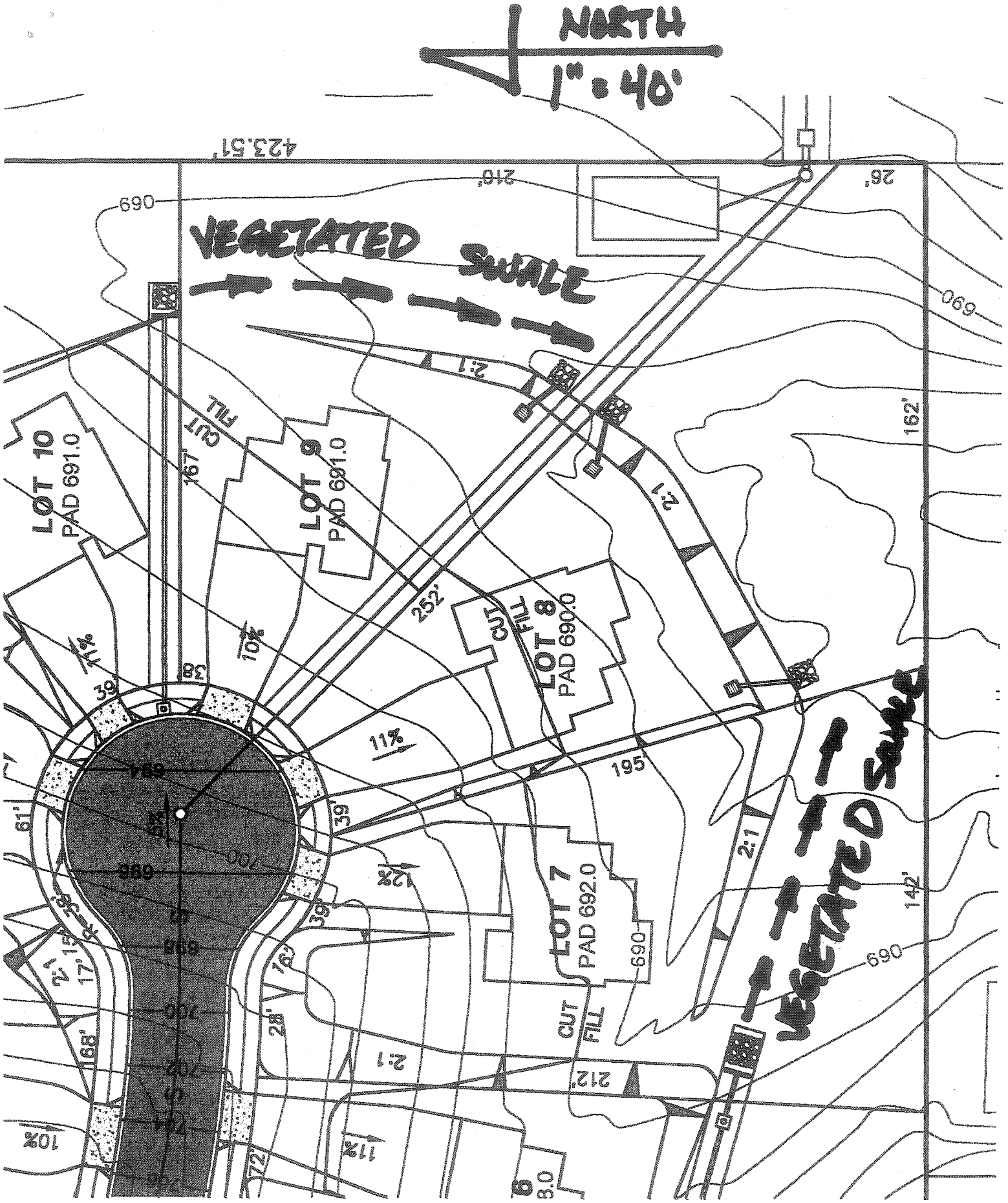
* Per Brater & King

$$Q = \frac{0.498}{0.013}(0.5)^{8/3}(2\%)^{1/2}$$

$Q_{max} = 0.85$ cfs with minimum slope = 2%

∴ The typical slope proposed will be 10%. Subsequently, a pipe at 10% will have adequate capacity during a 100-yr storm.

Therefore, the proposed 6" pvc pipes will have adequate capacity.



DRAINAGE MAP 3

DRAINAGE FACILITY CALCULATIONS:

PROPOSED VEGETATED SWALE: LOT 7
(See Drainage Map 3)

$Q_{100} = 16.6$ cfs
$n = 0.035$
$s = 7\%$
$b = 8'$

$* \; Q = \frac{K'}{n}(b)^{8/3}(s)^{1/2}$

* Per Brater & King

$$16.6 = \frac{K'}{0.035}(8')^{8/3}(0.07)^{1/2} \longrightarrow K' = 0.0086$$

$$K' \longrightarrow \frac{D}{b} = 0.05 \; (z = 2:1) \longrightarrow D = 0.4'$$

∴ The depth of flow in the vegetated swale during a 100-year storm is 0.4 feet.

$$V = \frac{Q}{A} = \frac{16.6}{0.4(8)} \cong 5.2 \text{ fps} < 6 \text{ fps} \checkmark$$

∴ The velocity in the vegetated swale will be 5.2 feet per second.

∴ The proposed velocity is less than 6 feet per second; therefore it is considered non-erosive.

DRAINAGE FACILITY CALCULATIONS:

Proposed Vegetated Swale : Lot 9
(See Drainge Map 3)

$Q_{100} = 55.2 - 16.6 = 38.6$ cfs (maximum)

$n = 0.035$

$b = 8'$

$s = 0.01$ (minimum)

$* \; Q = \frac{K'}{n}(b)^{8/3}(s)^{1/2}$

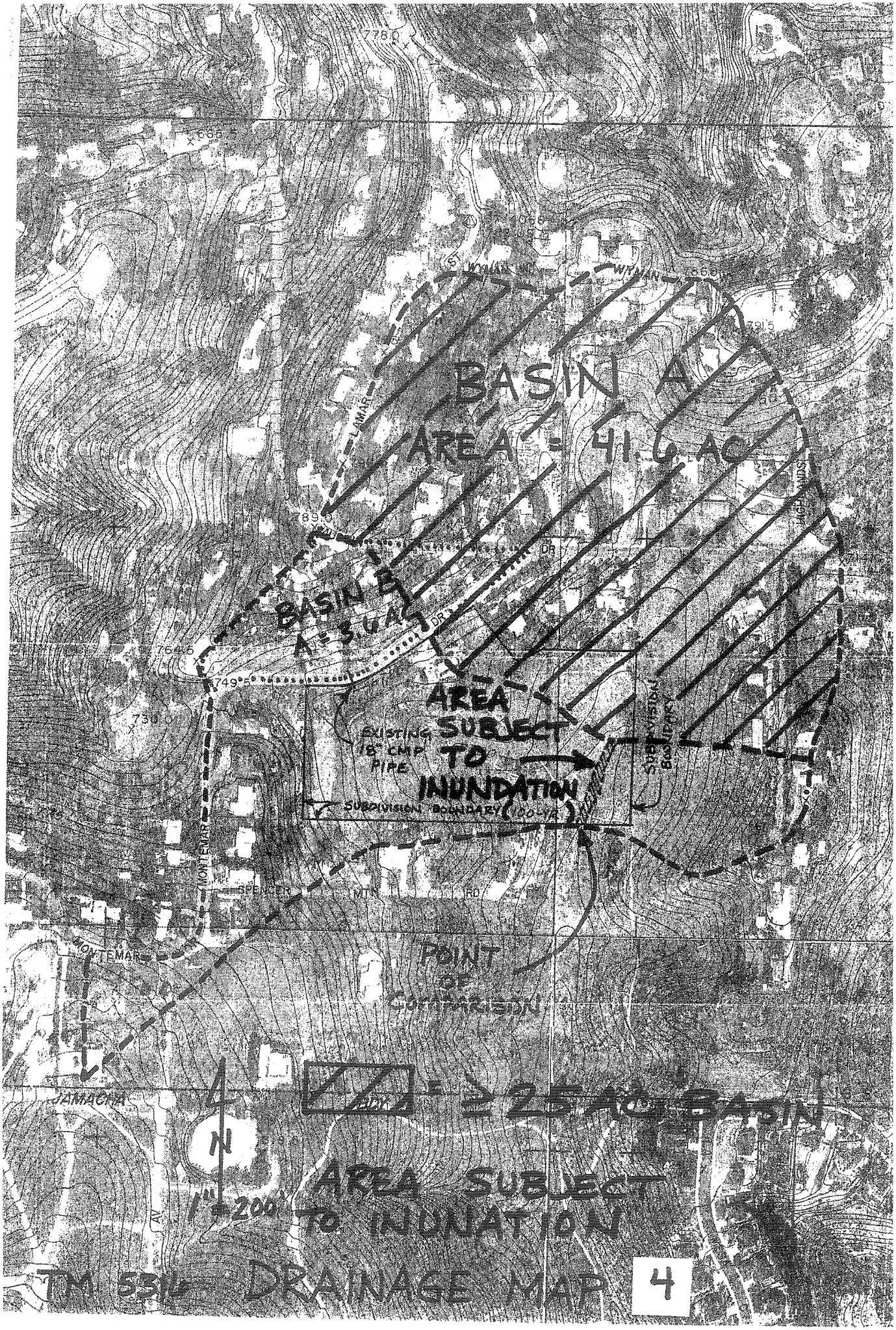
*Per Brater & King

$$38.6 = \frac{K'}{0.035}(8')^{8/3}(0.01)^{1/2} \longrightarrow K' = 0.0528$$

$$K' \rightarrow \frac{D}{b} = 0.13 \rightarrow D = 1.04'$$

$$V = \frac{Q}{A} = \frac{38.6}{1.04(8)} = 4.63 \text{ fps} < 6 \text{fps} \checkmark$$

∴ the velocity in the vegetated swale will be 4.63 feet per second, which is less than 6 feet per second. Therefore, the proposed velocity is considered to be non-erosive.



TM 5316 DRAINAGE MAP

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