JONES
ENGINEERS, INCORPORATED

HYDROLOGIC ANALYSIS

Single Oak Estates

Tentative Map _____
Log No. _____

Submitted to:
The County of San Diego
Department of Public Works

March, 2006

For:

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1 PURPOSE AND OBJECTIVES

The purpose of this report is to determine the peak runoff volumes and to design an adequate drainage system to handle the flow according to the requirements of the County of San Diego without subjecting the project or adjacent properties to significant flooding impacts during a design flood event.

2 EXISTING CONDITIONS

The proposed development is located approximately one-quarter mile East of Wintergardens Boulevard, between Rockcrest Road and Lemon Crest Drive in Lakeside, California. The site is 4.35 acres in area and is accessed from Single Oak Drive. There is an existing single family home located on the site. Vegetation on the site consists of ornamental landscaping and areas of open field. The topography of the site is characterized by an upland area gently sloping from the east to west. See Figures 1 and 2.

The *USDA's Soil Survey of San Diego Area, California* identifies the soil on the subject property as predominately Hydrologic Group B, consisting of Vista Coarse Sandy Loam with 15 to 30 percent slopes, (VsE).

The site is located within the San Diego Basin Hydraulic Unit Number 7.12 as designated in the California Water Quality Control Plan.

Runoff from the majority of the site drains westerly across Single Oak Drive, into an existing storm drain inlet located on the western edge of Single Oak Drive. The drainage then discharges into an existing ditch which runs westerly approximately 500 feet through private property. The ditch flow is then conveyed through an existing subdivision (Tract 5072) which directs the drainage to Lemon Crest Drive where it enters a roadside ditch and runs westerly down to Wintergardens Boulevard, entering the existing storm drain pipe system carrying runoff northerly approximately three thousand feet to the San Diego River.

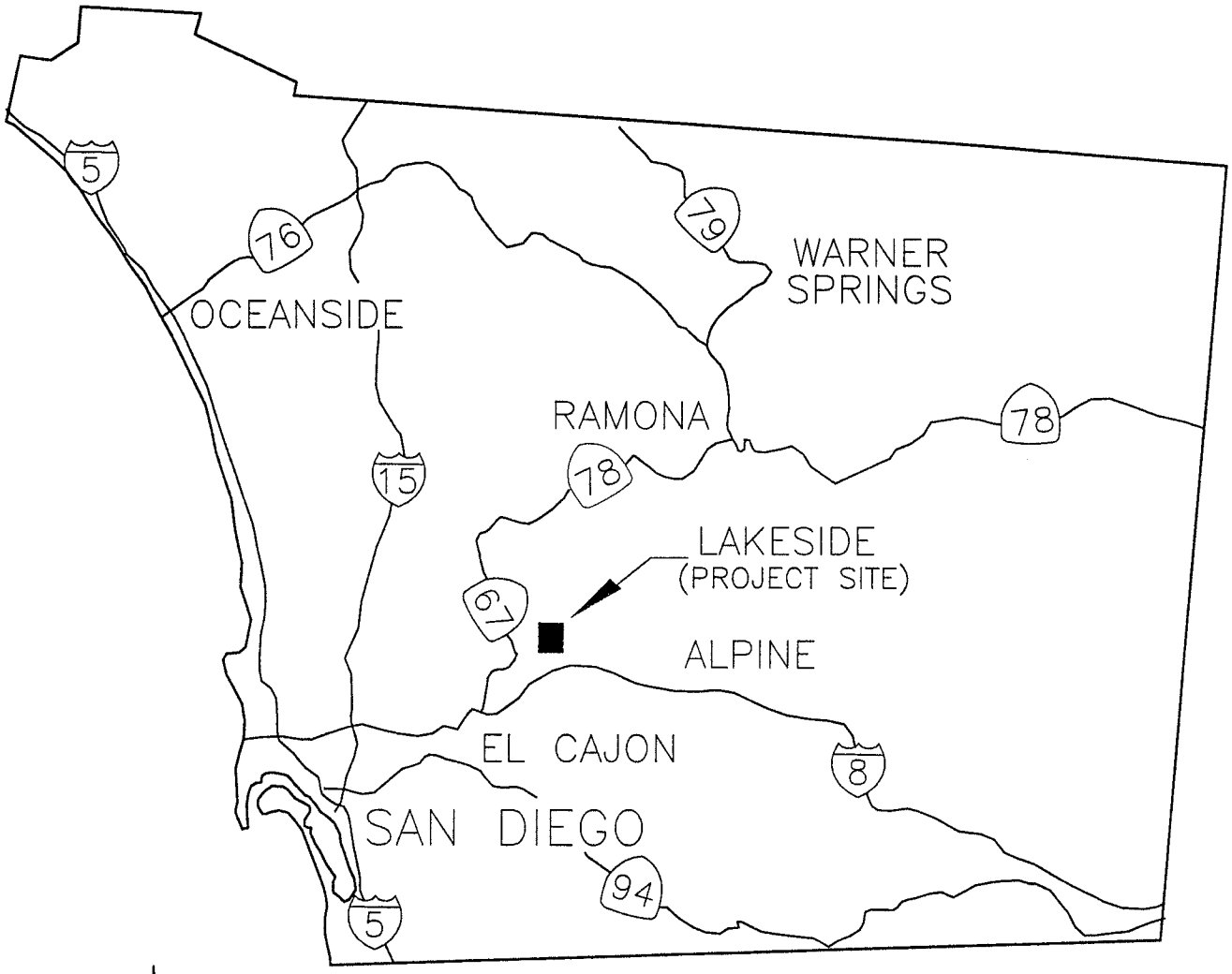
Runoff from the northerly portion of the site drains westerly to Single Oak Drive, then runs northerly along Single Oak Drive three hundred feet to Lemon Crest Drive where it enters a roadside ditch and runs westerly 1100 feet down to Wintergardens Boulevard, entering the storm drain pipe system carrying runoff northerly approximately three thousand feet to the San Diego River.

Elevations within the property range from a low of 453 along the westerly boundary, to a high of 510 along the easterly boundary of the site.

3 PROPOSED DEVELOPMENT

Proposed development includes 14 single-family residential lots (including one existing home site) over 4.35 acres. Proposed lot sizes range from 10,000 to 14,000 square feet in area. Graded pad sizes range in area from between approximately 6,300 to 13,500 square feet. Each building site will be graded individually to allow stormwater drainage to traverse existing natural routes. Drainage facilities for the home site pads, driveways, and private road include storm drains, landscaped earthen berms and swales, and concrete spillways and ditches. Riprap energy dissipaters will be placed at all outlets to reduce the potential for erosion.

Proposed roadway frontage improvements along Rockcrest Road and Single Oak Drive will intercept runoff from offsite sources around the project site and will convey the offsite drainage into the existing storm runoff system.



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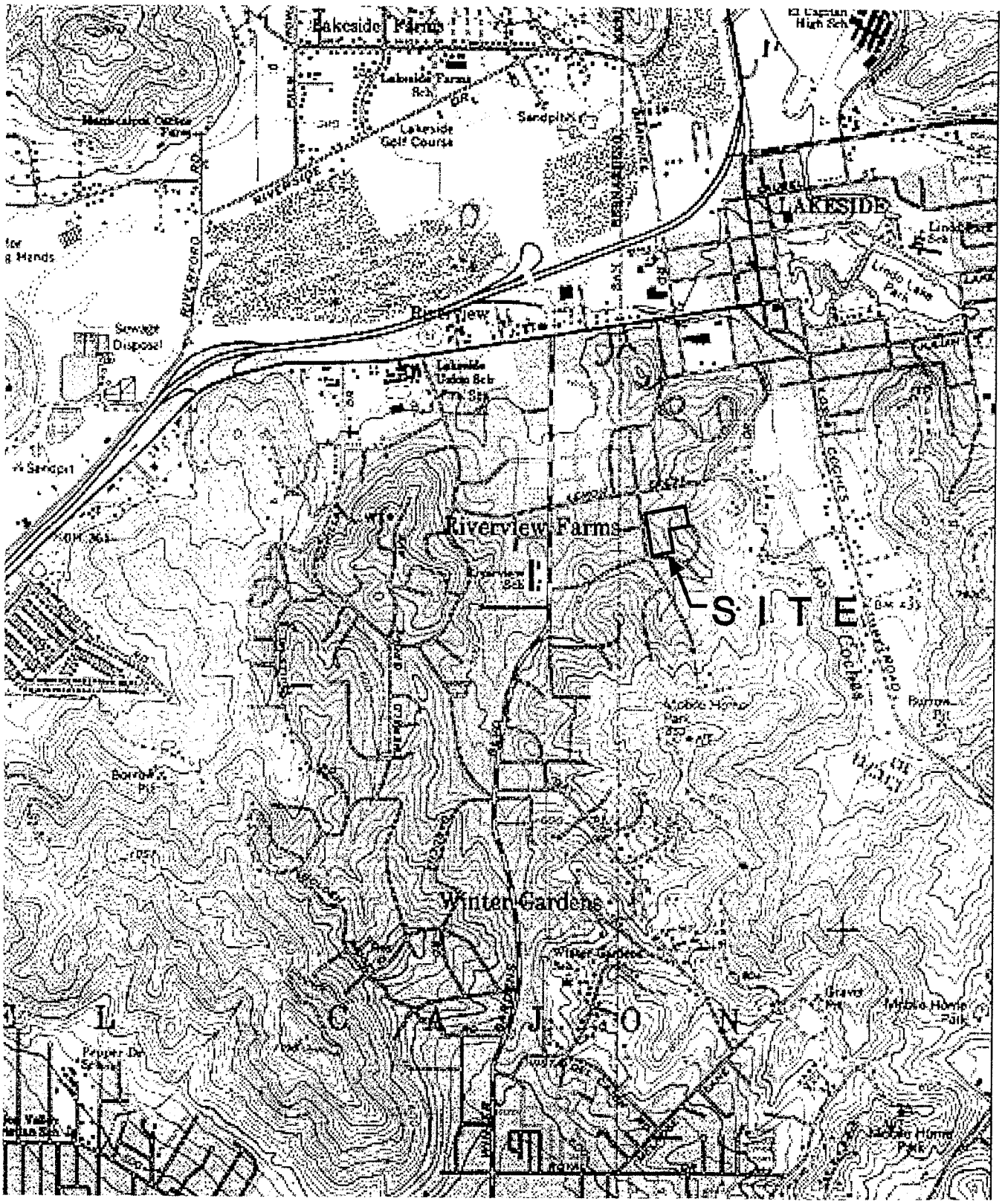
NORTH
NOT TO SCALE

FIGURE 1 - REGIONAL LOCATION MAP



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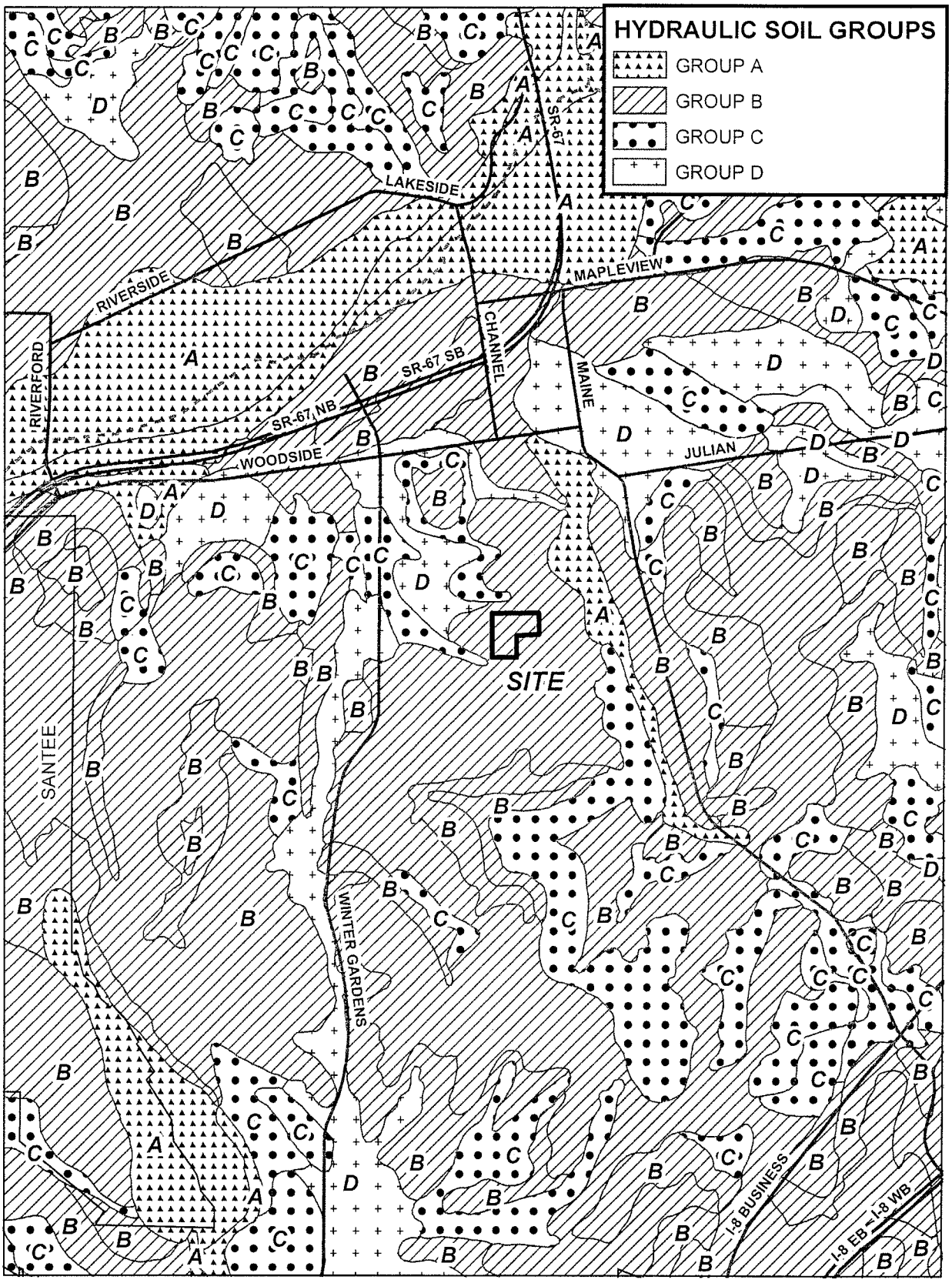
1"= 2,000 FT

FIGURE 2 - USGS QUAD SHEET



-N-

1"= 2,000 FT

FIGURE 3 - SOILS MAP

SOURCE: NRCS SOILS MAPPPING &
SAN DIEGO COUNTY GIS BASEMAPS

-N-

1"= 1,000 FT

SOURCE: SAN DIEGO COUNTY GIS BASEMAPS

FIGURE 4 - LAND USE

8 METHOD OF ANALYSIS

The hydrologic analysis for this project is consistent with current engineering standards and the requirements of San Diego County Department of Public Works. The rational method was used to determine the maximum flow rate resulting from the 100-yr, 6-hour design storm event and the 100-yr, 24-hour design storm event using the current *County of San Diego Drainage Manual's* isopluvial map data (Appendix I).

Peak flow rates were computed for the undeveloped and developed conditions. Two drainage basins (Basin "A" and "B") were identified for both the pre and post development hydrologic analysis and times of concentration were calculated from the hydraulically most distant point of the basin to the point of concentration. Basins "A" and "B" are developed with rural residential density. The majority of the site is situtated within Basin "A". The existing residential home found on the site is situated within Basin "B".

The amounts of impervious and pervious areas were incorporated with land usage and soils to calculate weighted runoff coefficients ("C" values) for each drainage basin.

A weighted runoff coefficient was calculated for each basin, Hydrologic Soils Group "B" occurs over the entirety of each basin.

9 ANALYSIS

9.1 Pre-Development Analysis

Two points of concentration were identified in the pre-development analysis. A runoff coefficient as recommended for undeveloped hydrologic group B soils per the *San Diego County Department of Public Works Flood Control Division's Flood Control and Drainage Manual* (Appendix I) was used to determine Q_{100} (peak flow for 100-yr design storm). Intensity was calculated using the precipitation maps found in the *Drainage Manual* for each basin using the following equation:

$$I = 7.44 P_6 D^{-0.645}$$

Where P6 = 2.7 inches (Appendix I)

D = varies with basin size and travel path.

The time of concentration (T_c) is the addition of initial time (T_i) and time of flow travel (T_f) based on the path drainage takes from the most distant point in the watershed to the point of concentration (POC).

The following equation was used to analyze travel times for overland flow:

$$Tc = \left(\frac{11.9L^3}{h} \right)^{0.385} + T_{\text{initial}}$$

Where *L* = travel length and *h* = beginning minus ending elevations (E_1-E_2).

The attached Pre-Development Hydrology Map illustrates the basin delineations and travel paths. Table 3 contains flow rates (Q_{100}) for the 100 year, 24 hour, rainfall event.

The Pre-Development runoff coefficients are based on a C_p value of 0.32 for Low Density Residential (LDR 1du/ac) for Basin "A" and a C_p value of 0.41 for Low Density Residential (MDR 2.9 du/ac) for Basin "B".

9.1.1 Table 1: Basin "A" Runoff Coefficient – Pre-Development

Hydrologic Soil Group	Area	Land Use	C	A x C
	(acres)			
B	6.23	LDR (1 DU/AC)	0.32	1.99
	6.23			1.99
		Mean Runoff Coefficient		0.32

9.1.2 Table 2: Basin "B" Runoff Coefficient – Pre-Development

Hydrologic Soil Group	Area	Land Use	C	A x C
	(acres)			
B	4.52	LDR (2.9 DU/AC)	0.41	1.85
	4.52			1.85
		Mean Runoff Coefficient		0.41

9.1.3 Table 3: Pre-Development Analysis

Basins A & B:

Run	Sub Basin	Area (acres)	C	CxA	Sum CxA	Flowpath Desc.	Flow Length	E1 (ft)	E2 (ft)	h (ft)	Slope (ft/ft)	V (ft/s)	T_f (min)	I_{100} (in/hr)	Q_{100} (cfs)
	A	6.23	0.32	1.99		initial time	100				0.10		6.40		
L1						overland flow	555	505	454	51	0.09		2.54		
L2						gutter flow	100	454	452	2	0.02	4.00	0.42		
					1.99						*total =*		*9.36*	4.75	9.47
	B	4.52	0.41	1.85		initial time	100				0.10		6.40		
L1						overland flow	255	521	482	39	0.15		1.15		
L2						gutter flow	200	482	472	10	0.05	4.50	0.74		
L3						gutter flow	400	472	446	26	0.07	6.30	1.06		
					1.85						*total =*		*9.35*	4.75	8.81

The T_c for Basin A was determined to be 9.36 minutes with a corresponding Q_{100} equal to 9.47 cfs.

The T_c for Basin B was determined to be 9.35 minutes with a corresponding Q_{100} equal to 8.81 cfs.

9.2 Post-Development Analysis

Each basin was analyzed by assigning a travel path routed through the post-development condition. In the cases where drainage begins on a pad, the initial time was calculated using Table 3-2 from the San Diego County Hydrology Manual. Channel flow analysis was performed using Haestad Methods Open Channel Flow Module, Version 3.3 (c) 1991 (Appendix I).

A weighted runoff coefficient was calculated for each basin, Hydrologic Soils Group "B" occurs over the entirety of each basin. The Post-Development runoff coefficients are based on a C_p value of 0.45 for Medium Density Residential (MDR 4.3 du/ac) and a C_p value of 0.32 for Low Density Residential (LDR 1.0 du/ac) for Basin "A" and a C_p value of 0.41 for Low Density Residential (MDR 2.9 du/ac) for Basin "B".

9.2.1 Table 4: Basin "A" Post-Development Runoff Coefficient

Hydrologic Class	Area	Land Use	C	A x C
	(acres)			
B	2.22	LDR (1DU/AC)	0.32	0.71
B	3.24	MDR (4.3 DU/AC)	0.45	1.46
	5.46			2.17
		Mean Runoff Coefficient		0.40

9.2.2 Table 5: Basin "B" Post Development Runoff Coefficient

Hydrologic Class	Area	Land Use	C	A x C
	(acres)			
B	5.29	LDR (2.9DU/AC)	0.41	2.17
	5.29			2.17
		Mean Runoff Coefficient		0.41

9.2.3 Table 6: Post-Development Analysis

Run	Sub Basin	Area (acres)	C	CxA	Sum CxA	Flowpath Desc.	Flow Length (ft)	E1 (ft)	E2 (ft)	h (ft)	Slope (ft/ft)	V (ft/s)	T_f (min)	I_{100} (in/hr)	Q_{100} (cfs)
	A	5.46	0.40	2.18		initial time	70				0.010		9.60		
L1						ditch	175	497	478	19	0.109	9.45	0.31		
L2						bioswale	150	478	476	2	0.013	2.42	1.03		
L3						ditch	110	476	455	21	0.191	15.27	0.12		
L4						bioswale	85	455	454	1	0.012	2.84	0.50		
L5						pipe	80	454	452	2	0.025	10.45	0.13		
					2.18						*total =*		*11.69*	4.11	8.98
	B	5.29	0.41	2.17		initial time	70				0.01		9.60		
L1						ditch	75	494.3	493.5	0.8	0.01	2.92	0.43		
L2						gutter	346	493.5	463.5	30	0.09	7.10	0.81		
L3						gutter	320	463.5	446	17.5	0.05	5.80	0.92		
					2.17						*total =*		*11.76*	4.10	8.89

The T_c for Basin A was determined to be 11.69 minutes with a corresponding Q_{100} equal to 8.98 cfs.

The T_c for Basin B1 was determined to be 11.76 minutes with a corresponding Q_{100} equal to 8.89 cfs.

10 CONCLUSION

The peak runoff rate during the 100 year storm event will result in an decrease of 0.49 cfs in Basin "A" and will result in an increase of 0.08 cfs in Basin "B". Based upon the 100 year storm calculations, the proposed drainage facilities with this development will adequately handle the 100-year peak storm without significantly impacting the proposed residential lots or offsite property.

Appendix I:

Calculations:

PRE-DEVELOPMENT
BASIN "A"
INITIAL TIME

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.

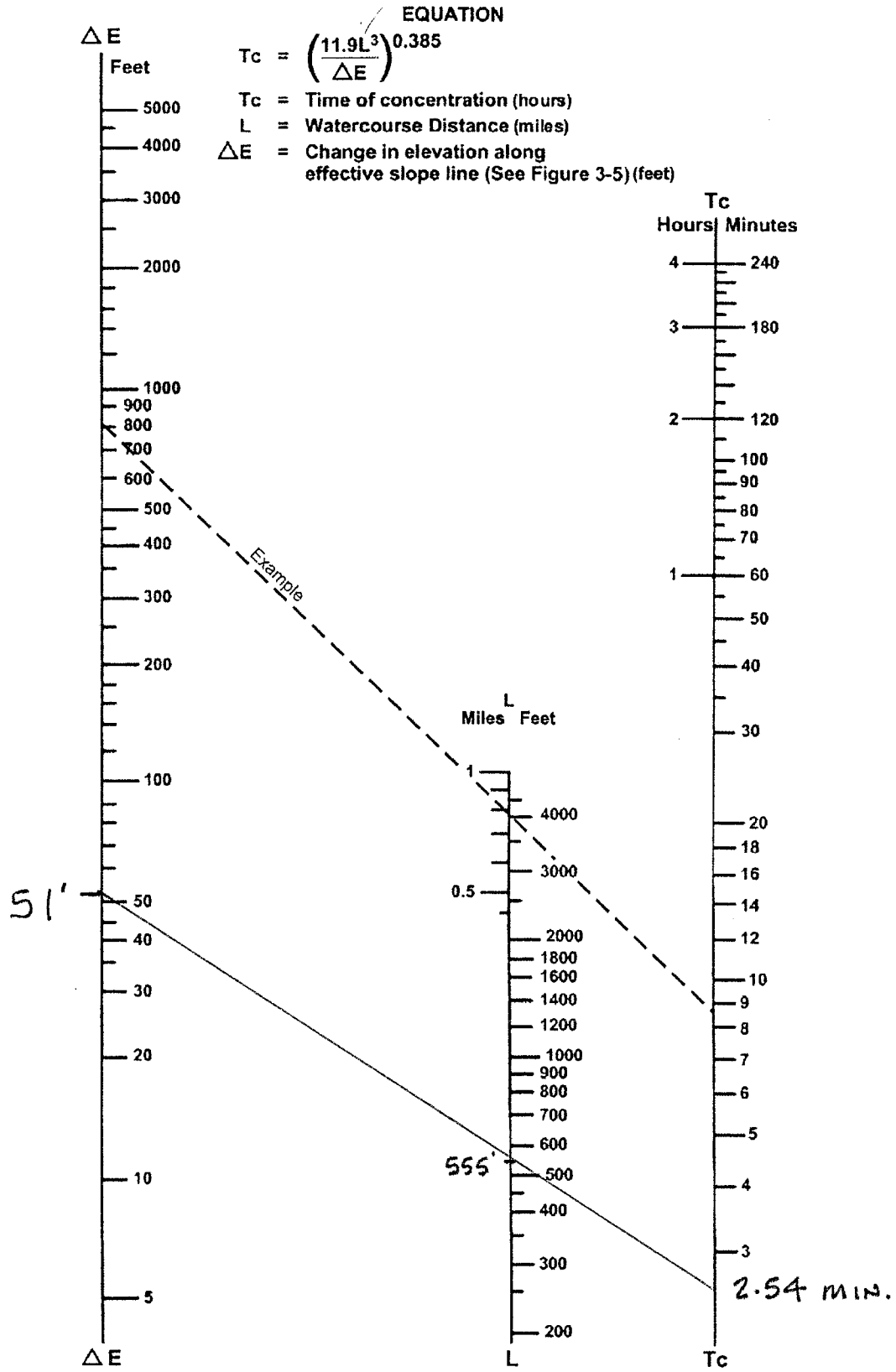
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved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



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

BASIN "A"

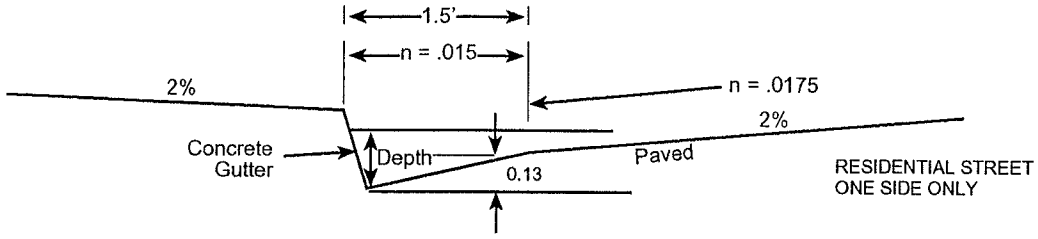
Nomograph for Determination of Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

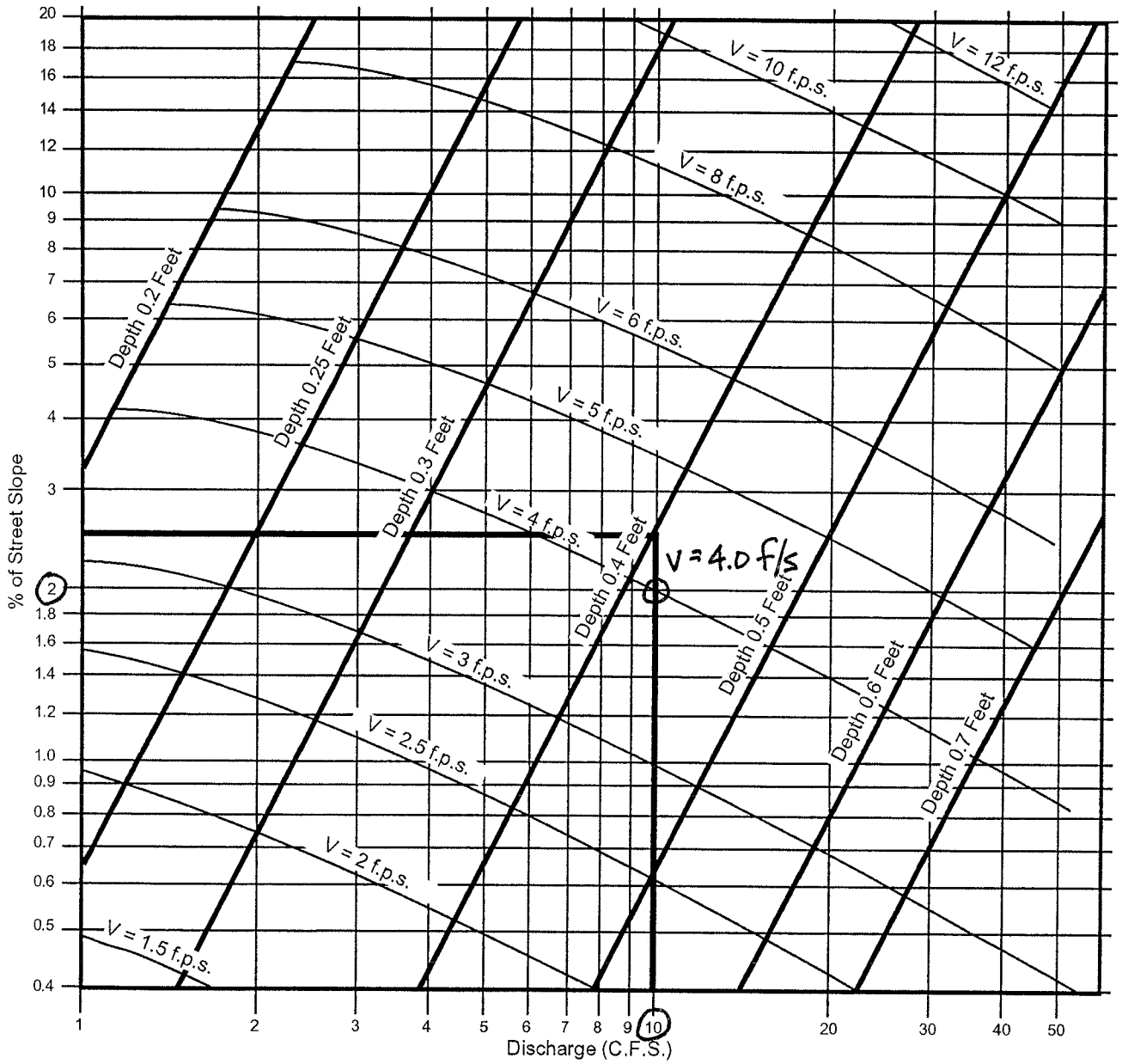
PRE-DEVELOPMENT

L-1

FIGURE

3-4





EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

BASIN "A"

Gutter and Roadway Discharge - Velocity Chart

PRE - DEVELOPMENT

L-2

FIGURE

3-6

PRE-DEVELOPMENT
BASIN "B"
INITIAL TIME

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.

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	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
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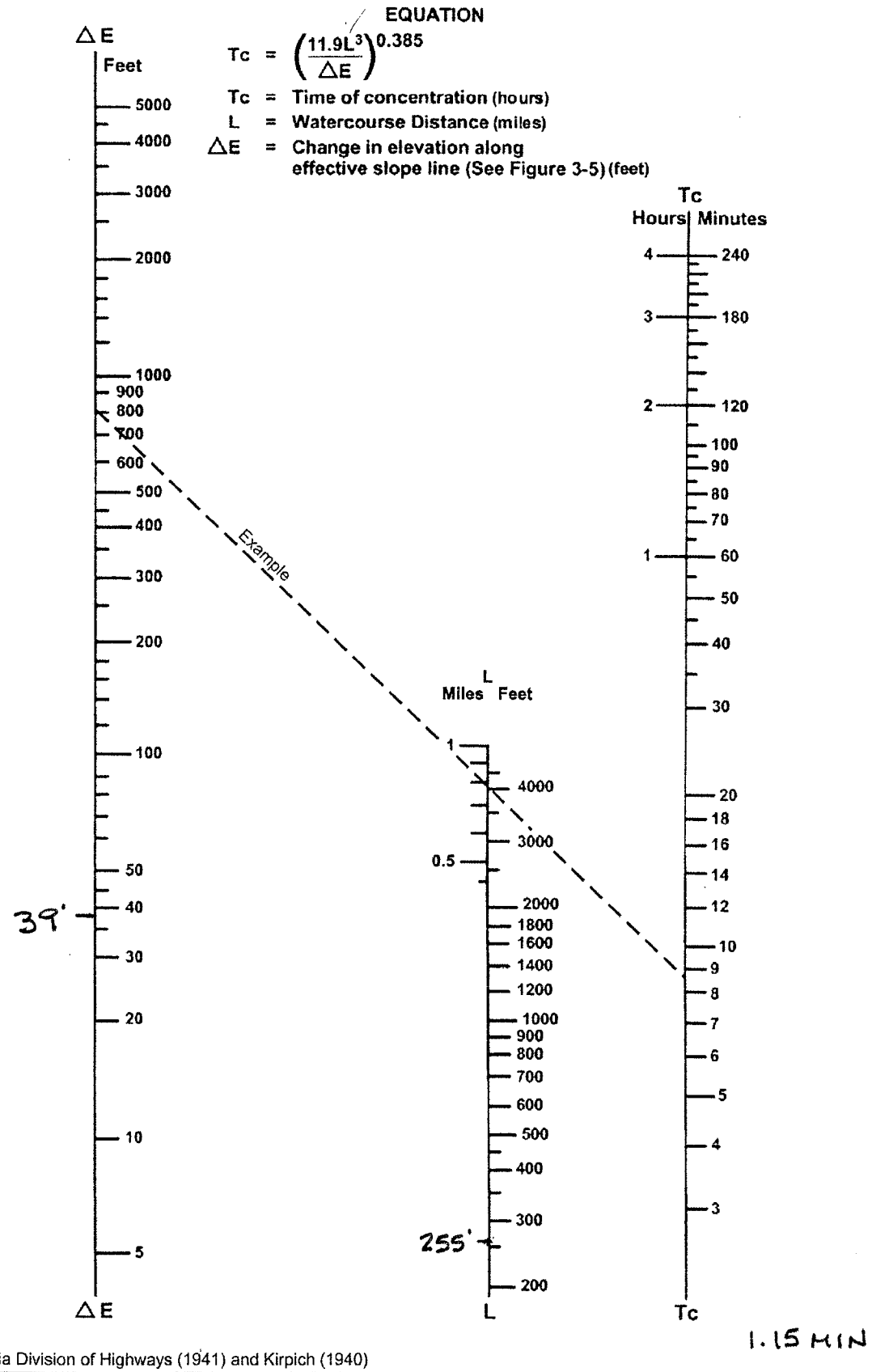


SOURCE: California Division of Highways (1941) and Kirpich (1940)

BASIN "B"

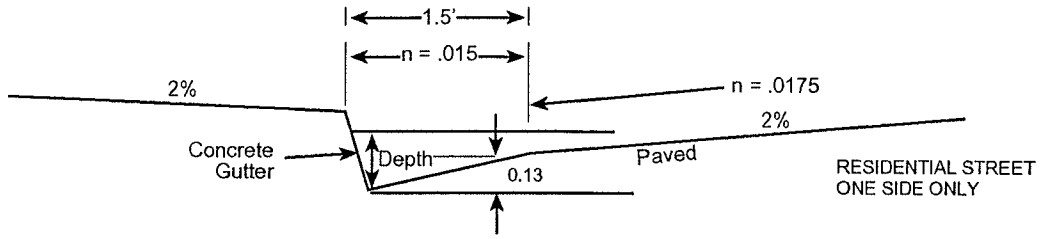
Nomograph for Determination of Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

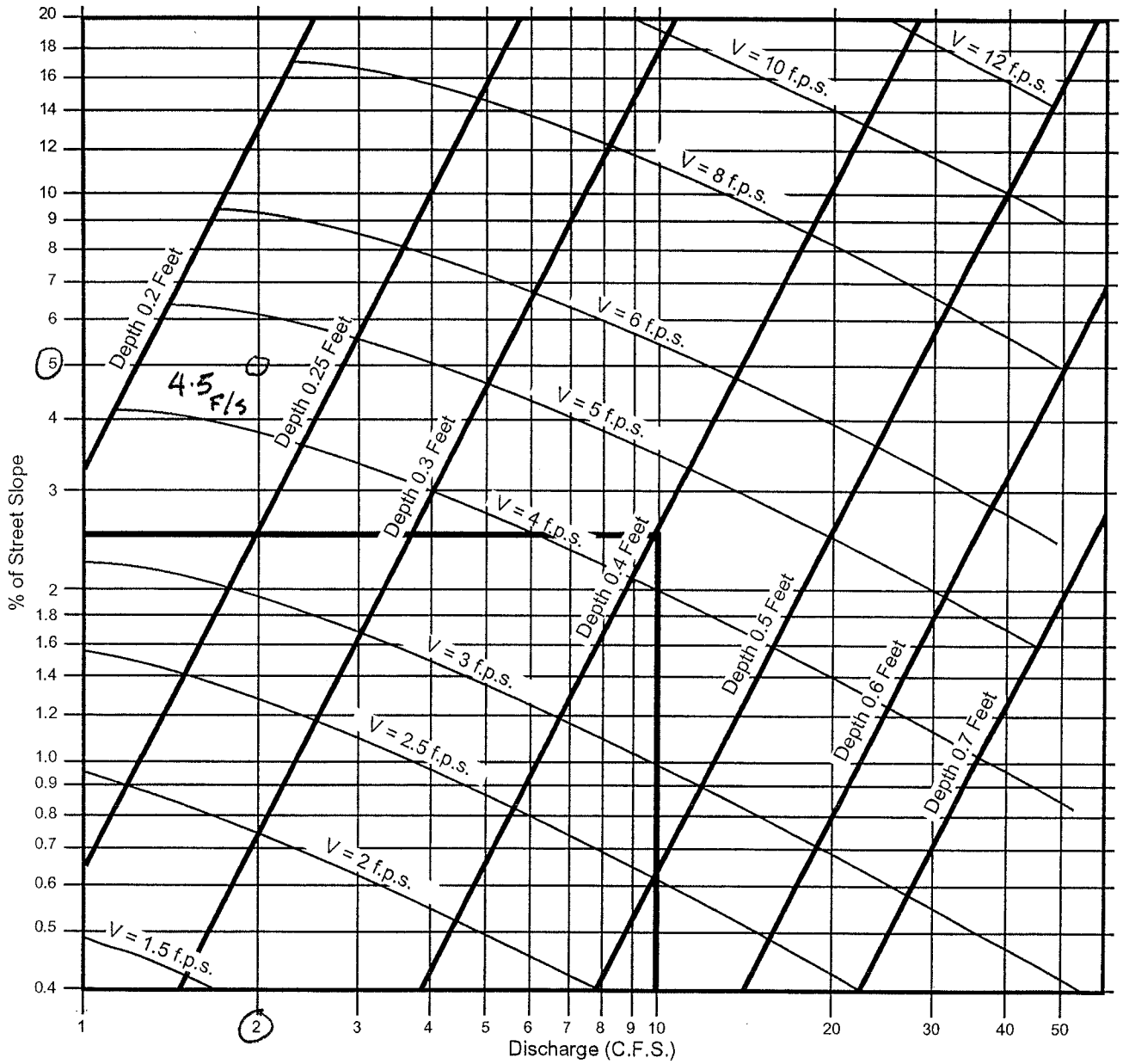
PRE-DEVELOPMENT

L-1

FIGURE

3-4





EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

BASIN "B"

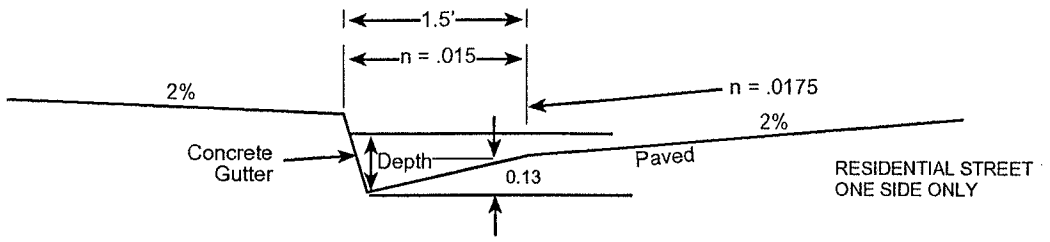
Gutter and Roadway Discharge - Velocity Chart

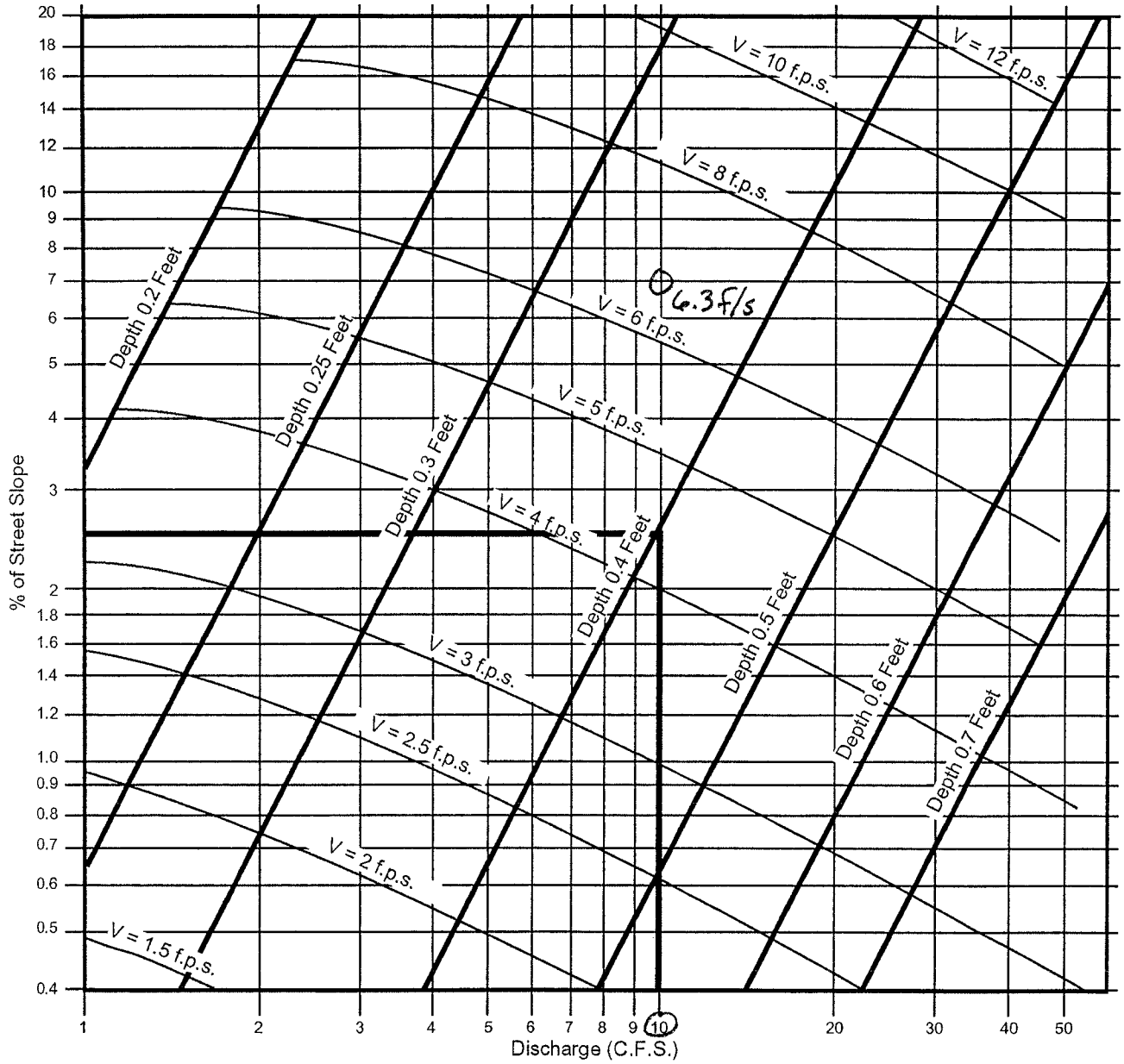
PRE-DEVELOPMENT

L-2

FIGURE

3-6





EXAMPLE:
Given: Q = 10 S = 2.5%
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SOURCE: San Diego County Department of Special District Services Design Manual

BASIN "B"

Gutter and Roadway Discharge - Velocity Chart

PRE-DEVELOPMENT

L-3

FIGURE

3-6

POST-DEVELOPMENT
BASIN "A"
INITIAL TIME

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.

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	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

Triangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POST-DEVELOPMENT 1-1

Comment: BASIN "A" L-1 DITCH

Solve For Depth

Given Input Data:

Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.1100 ft/ft
Discharge.....	3.00 cfs

Computed Results:

Depth.....	0.33 ft
Velocity.....	9.45 fps
Flow Area.....	0.32 sf
Flow Top Width...	1.95 ft
Wetted Perimeter.	2.06 ft
Critical Depth...	0.57 ft
Critical Slope...	0.0053 ft/ft
Froude Number....	4.13 (flow is Supercritical)

Open Channel Flow Module, Version 3.3 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POST - L-2

Comment: BASIN "A: POST DEVELOPMENT L-2 BIOSWALE

Solve For Depth

Given Input Data:

Bottom Width.....	3.00 ft
Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0133 ft/ft
Discharge.....	5.00 cfs

Computed Results:

Depth.....	0.47 ft
Velocity.....	2.42 fps
Flow Area.....	2.07 sf
Flow Top Width...	5.82 ft
Wetted Perimeter.	5.97 ft
Critical Depth...	0.39 ft
Critical Slope...	0.0275 ft/ft
Froude Number....	0.71 (flow is Subcritical)

Open Channel Flow Module, Version 3.3 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Triangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POST L-3

Comment: BASIN "A" POST DEVELOPMENT L-3 DITCH

Solve For Depth

Given Input Data:

Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.1900 ft/ft
Discharge.....	9.00 cfs

Computed Results:

Depth.....	0.44 ft
Velocity.....	15.27 fps
Flow Area.....	0.59 sf
Flow Top Width...	2.66 ft
Wetted Perimeter.	2.80 ft
Critical Depth...	0.89 ft
Critical Slope...	0.0046 ft/ft
Froude Number....	5.72 (flow is Supercritical)

Open Channel Flow Module, Version 3.3 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POST - L4

Comment: BASIN "A" POST-DEVELOPMENT L-4 BIOSWALE

Solve For Depth

Given Input Data:

Bottom Width.....	3.00 ft
Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0120 ft/ft
Discharge.....	10.00 cfs

Computed Results:

Depth.....	0.69 ft
Velocity.....	2.84 fps
Flow Area.....	3.52 sf
Flow Top Width...	7.16 ft
Wetted Perimeter.	7.39 ft
Critical Depth...	0.57 ft
Critical Slope...	0.0248 ft/ft
Froude Number....	0.71 (flow is Subcritical)

Open Channel Flow Module, Version 3.3 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: POSTDEVELOPMENT L-5

Comment: BASIN "A" POST DEVELOPMENT L-5 18" CONC. PIPE

Solve For Actual Depth

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.0250 ft/ft
Manning's n.....	0.012
Discharge.....	10.00 cfs

Computed Results:

Depth.....	0.80 ft
Velocity.....	10.45 fps
Flow Area.....	0.96 sf
Critical Depth....	1.22 ft
Critical Slope....	0.0078 ft/ft
Percent Full.....	53.26 %
Full Capacity.....	17.99 cfs
QMAX @.94D.....	19.36 cfs
Froude Number.....	2.30 (flow is Supercritical)

Open Channel Flow Module, Version 3.3 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

POST DEVELOPMENT
BASIN "B"
INITIAL TIME

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

Triangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: POST-DEVELOPMENT

Comment: BASIN "B" L-1 DITCH

Solve For Depth

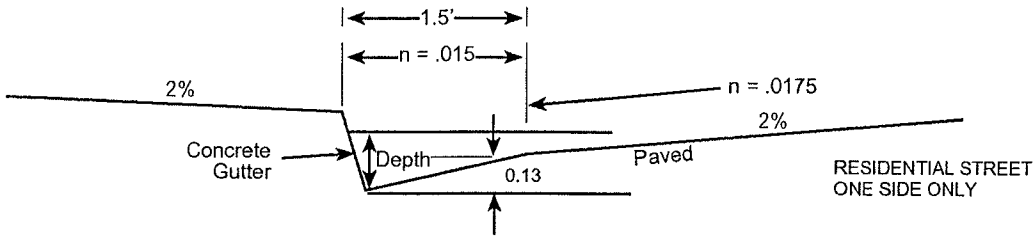
Given Input Data:

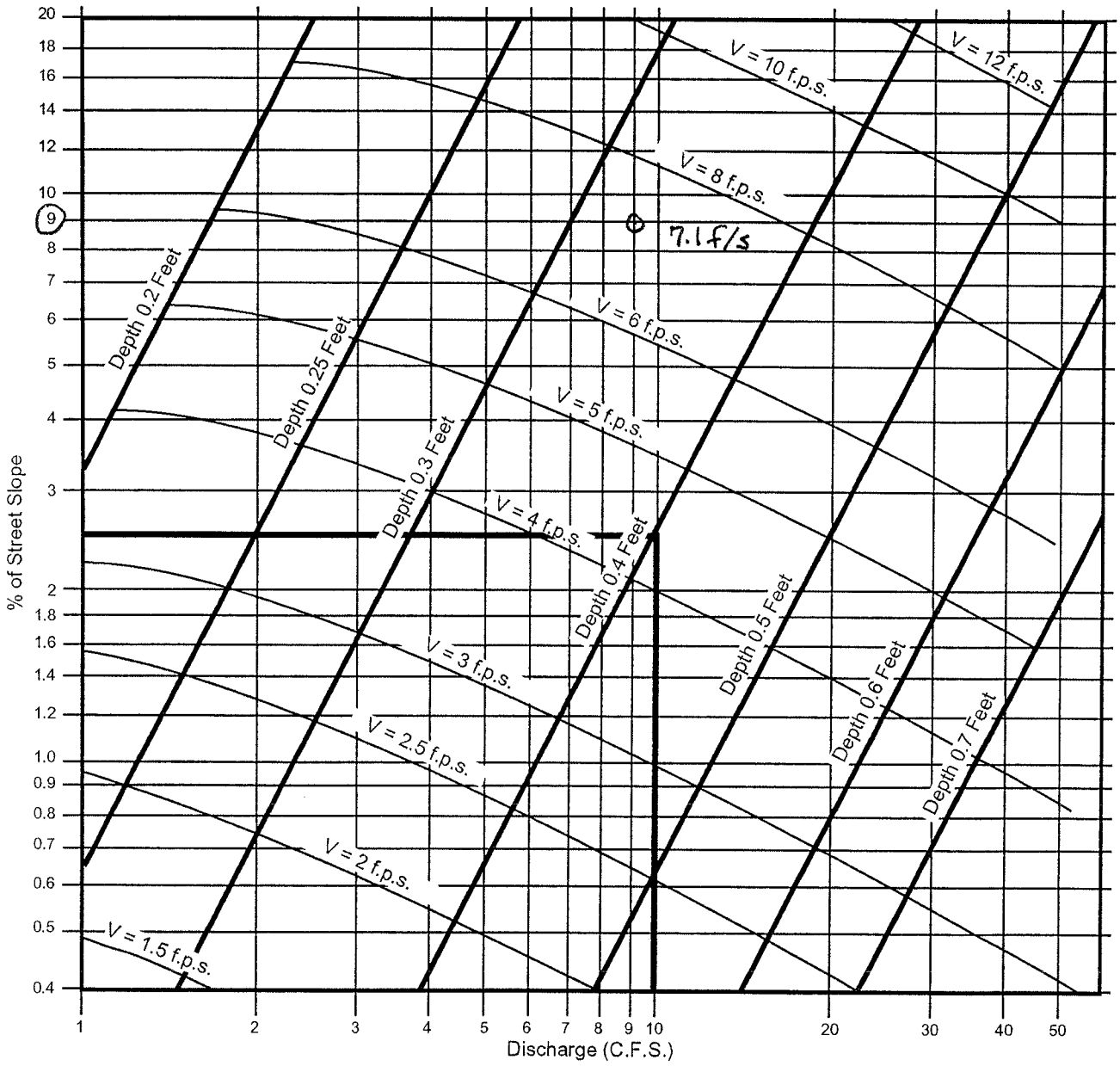
Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.015
Channel Slope....	0.0100 ft/ft
Discharge.....	1.00 cfs

Computed Results:

Depth.....	0.34 ft
Velocity.....	2.92 fps
Flow Area.....	0.34 sf
Flow Top Width...	2.03 ft
Wetted Perimeter.	2.14 ft
Critical Depth...	0.37 ft
Critical Slope...	0.0062 ft/ft
Froude Number....	1.25 (flow is Supercritical)

Open Channel Flow Module, Version 3.3 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708





EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

BASIN "B"

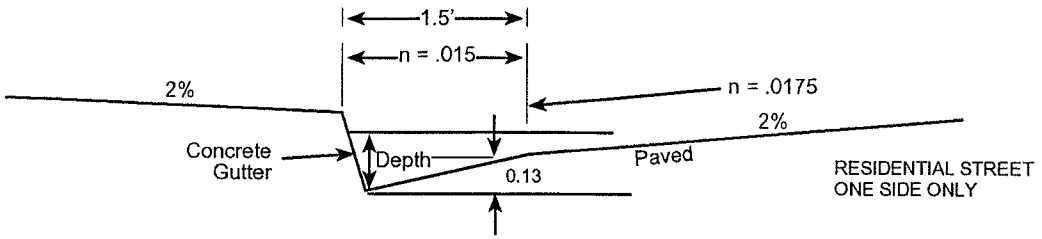
Gutter and Roadway Discharge - Velocity Chart

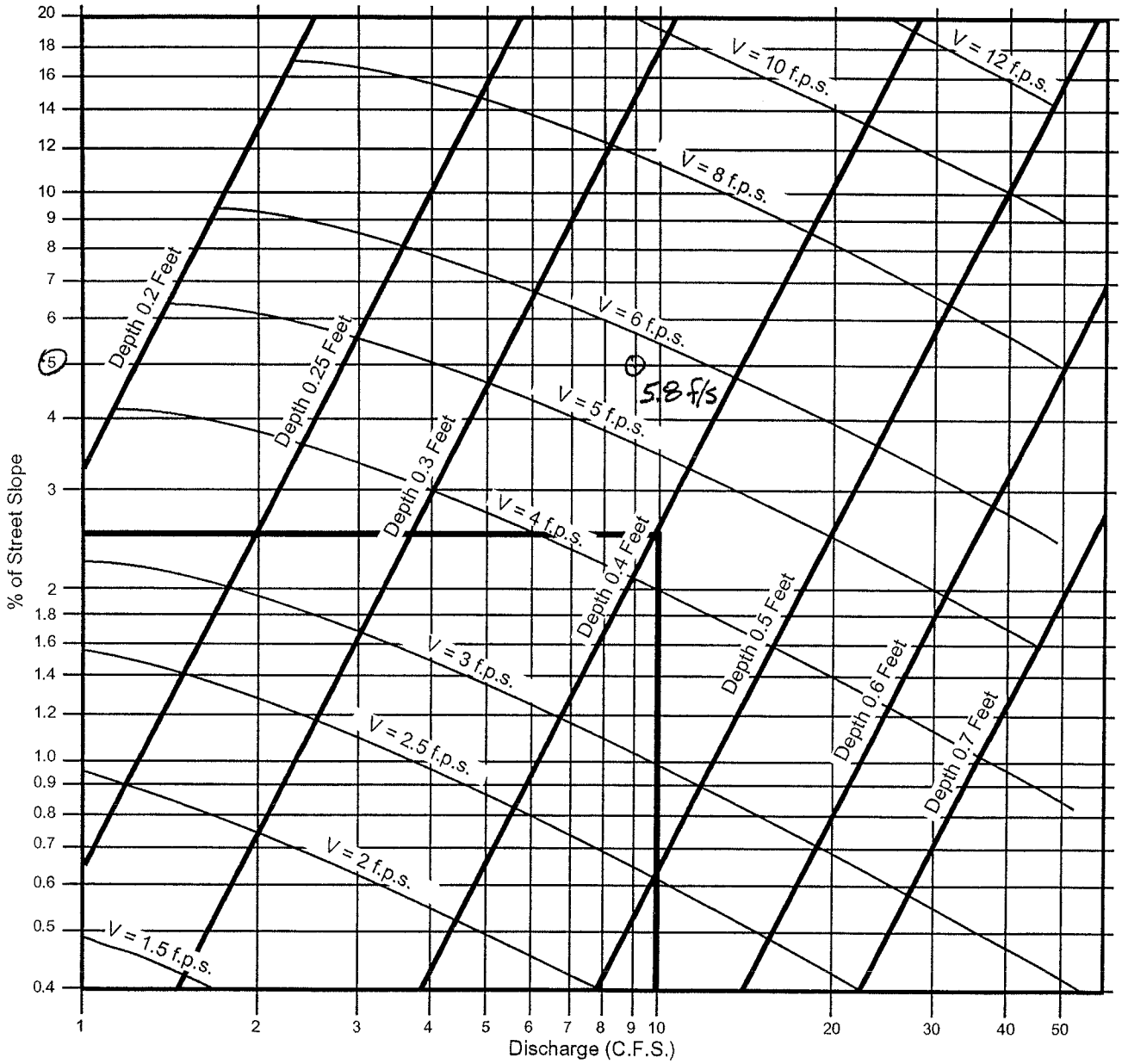
POST-DEVELOPMENT

L-2

FIGURE

3-6





EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

BASIN "B"

Gutter and Roadway Discharge - Velocity Chart

POST-DEVELOPMENT

L-3

FIGURE

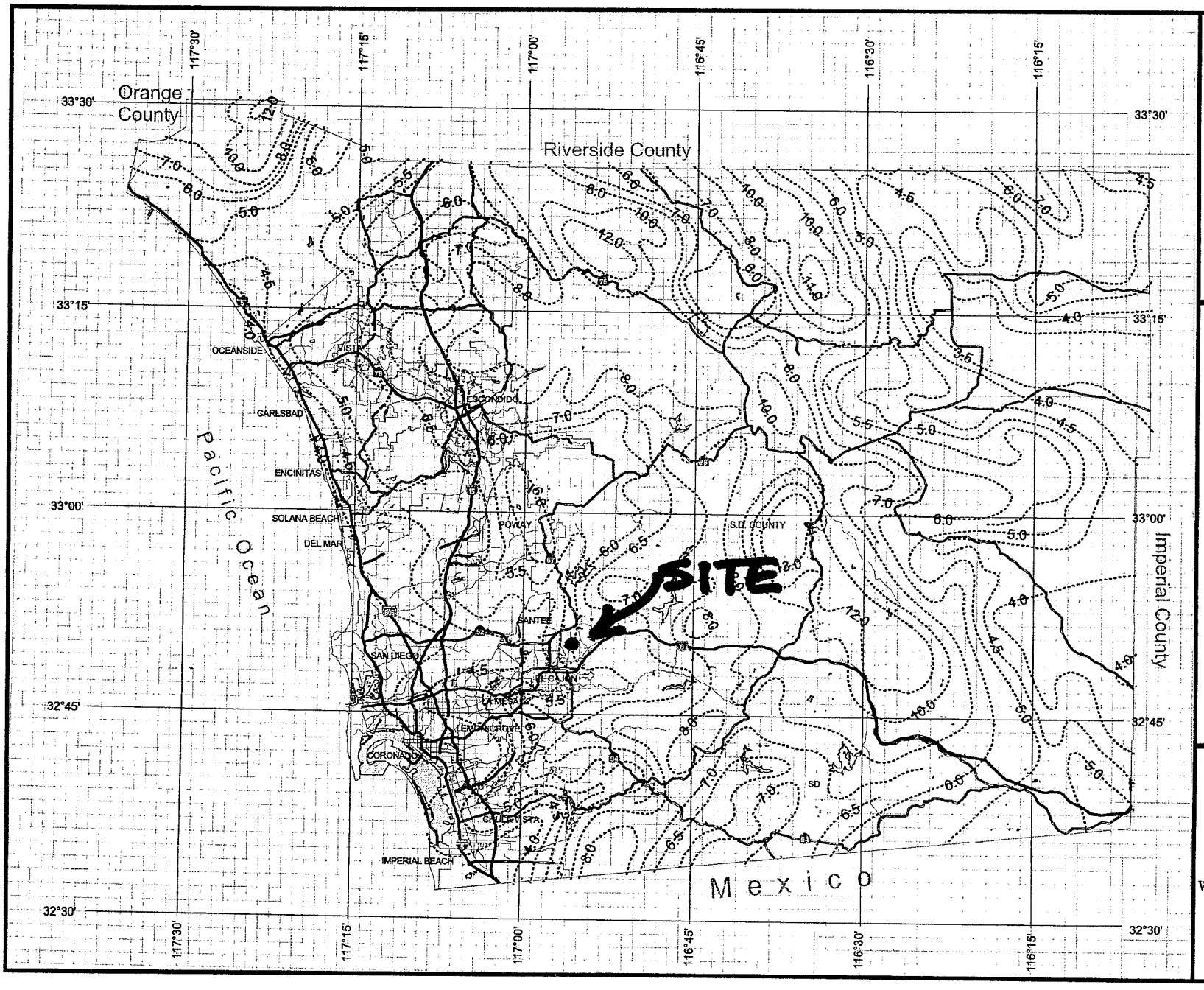
3-6

Appendix II:

Isopluvial Maps

Runoff Coefficients

Intensity-Duration Design Chart



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

i = 6.0 IN/HR.

DPW GIS
Department of Public Works
Geographic Information Services

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3 0 3 Miles

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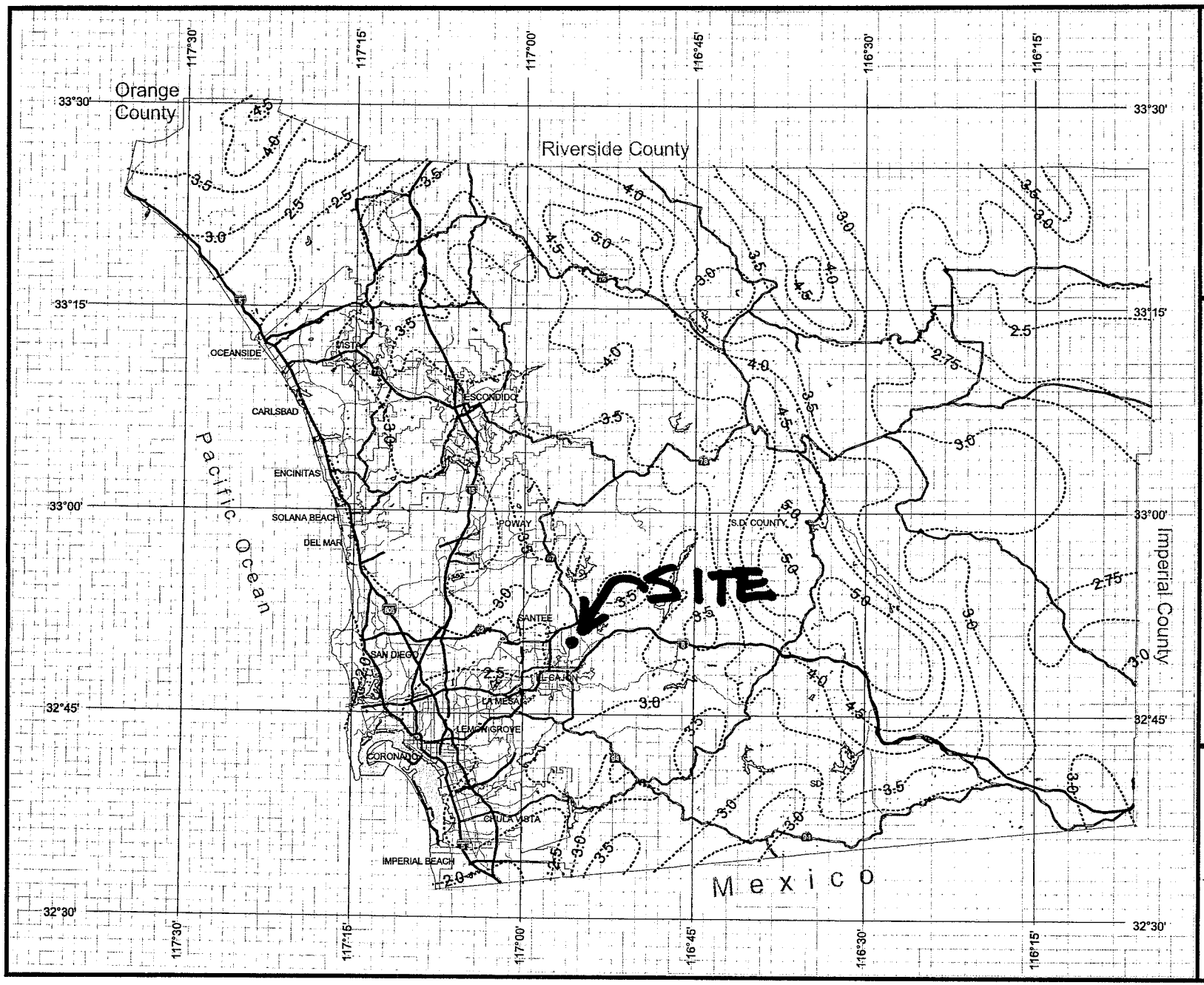

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

i = 2.7 IN/HR.

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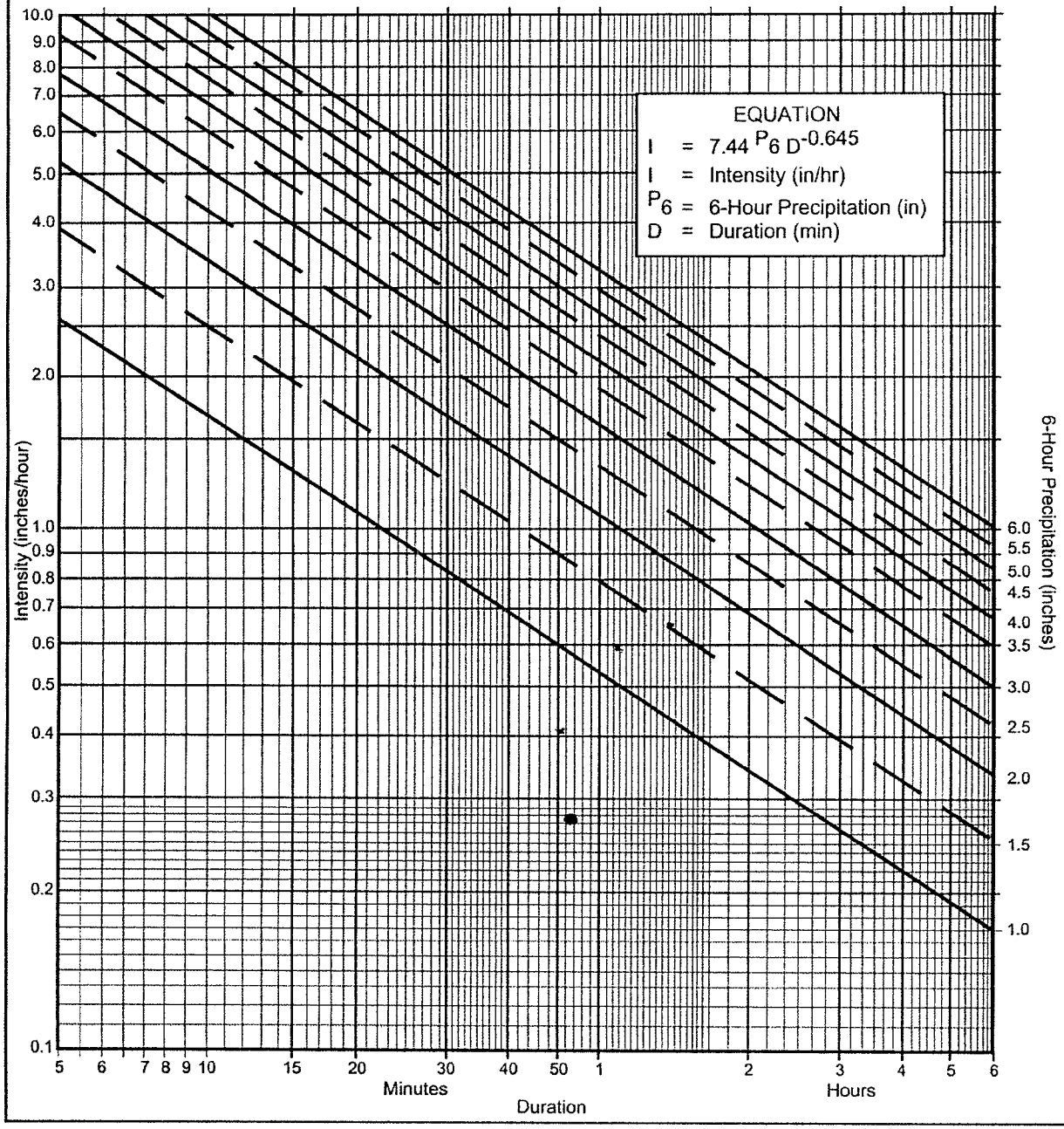
Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

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



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 = 2.7 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 45 %(2)

(c) Adjusted P_6(2) = 2.7 in.

(d) t_x = _____ min. • VARIES • SEE REPORT

(e) I = _____ in./hr.

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

P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	I	I	I	I	I	I	I	I	I	I	I
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

Appendix III:

Tentative Map

Hydrology Maps

POST- DEVELOPMENT HYDROLOGY

SAN DIEGO COUNTY TRACT NO. _____

SINGLE OAK ESTATES

N

1"= 100'

MARCH, 2006

JONES
ENGINEERS, INCORPORATED
535 N. HWY. 101 SUITE "J"
SOLANA BEACH, CA. 92075
(858) 847-0011

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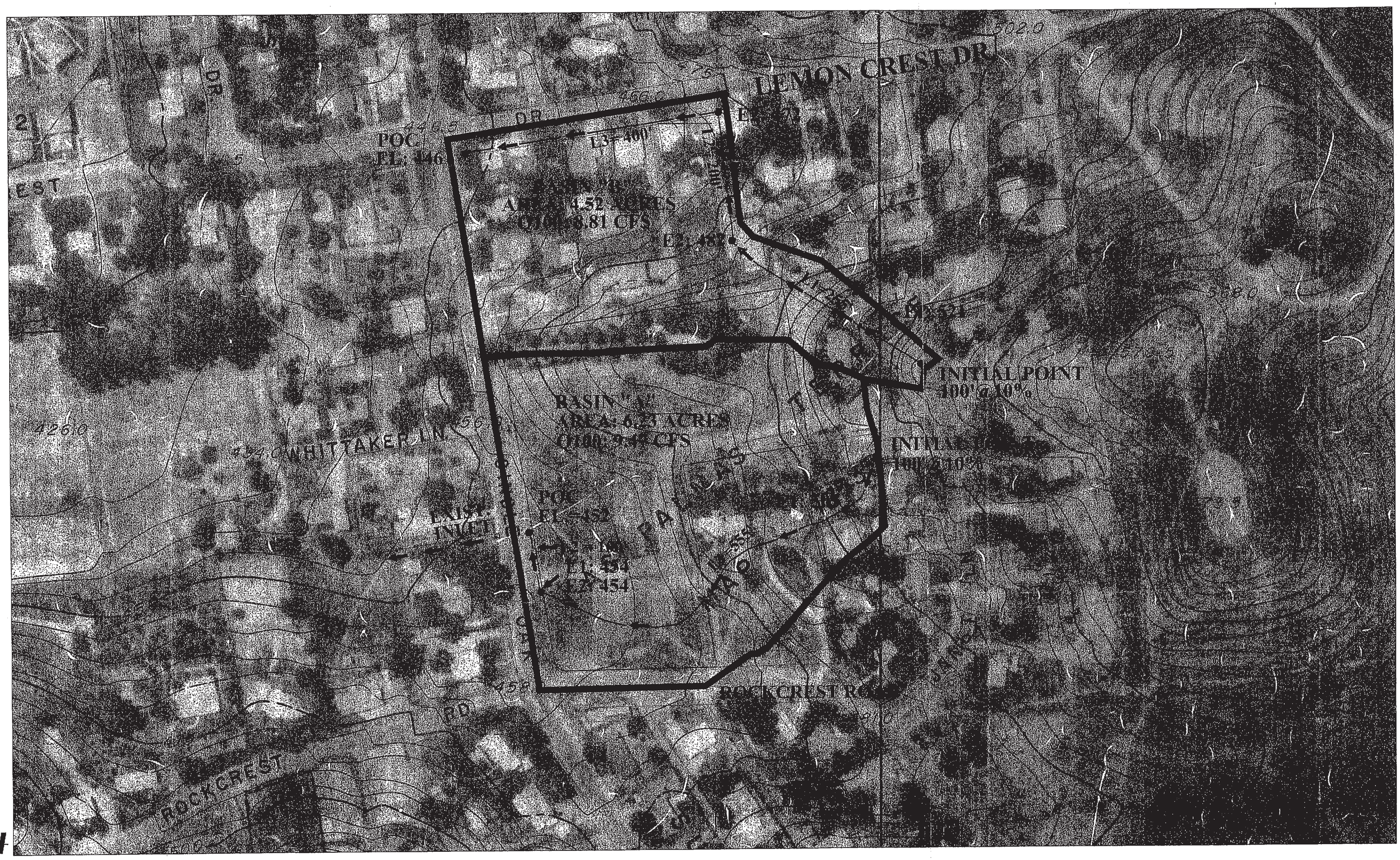
PRE-DEVELOPMENT HYDROLOGY

SAN DIEGO COUNTY TRACT NO. _____

SINGLE OAK ESTATES



N

1"= 100'

MARCH, 2006

JONES
ENGINEERS, INCORPORATED
535 N. HWY. 101 SUITE "J"
SOLANA BEACH, CA. 92075
(858) 847-0011

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