K&S ENGINEERING, INC.
Planning Engineering Surveying

HYDROLOGY STUDY

FOR

TM 5517-RPL 1
PEPPER VILLA SUBDIVISION

IN

COUNTY OF SAN DIEGO, CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
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Exp. 6/30/2010
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JN 06-011

August 16, 2008

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7/18/08
DATE

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1.0 INTRODUCTION

The proposed project is located in the County of San Diego, California. This drainage report is prepared to support the Tentative Map for the Pepper Villa Subdivision, (APN 388-072-03) on Pepper Villa Road and Pepper Drive. The proposed project is for the development of a 1.93 Acre lot into an 7-lot subdivision. This drainage study was conducted to ensure that the planned development provides adequate drainage within the parcel and that potential adverse effects to downstream properties are mitigated. According to the Soil Hydrologic Groups table of the County of San Diego, the type of soil at the site is Group C. Also, this report provides detention basins in every individual lot to assure that there will be no increase in flow from existing to developed condition. Therefore, now further downstream analysis was conducted as part of this study.

2.0 EXISTING CONDITIONS

The site is currently developed. There is a single family residence and a swimming pool on the lot. There is an existing storm drain inlet at the southwest corner of the site (corner of Pepper Villa and Pepper Drive). This inlet receives the runoff from the site and tributary area and conveys the flows under the road (pepper drive) to a curb outlet structure to the South. The existing onsite Q_{100} flow at node 42 is 2.96 CFS which is intercepted by an existing curb inlet located at the NW corner of the intersection of Pepper Drive and Pepper Villa Road.

The offsite drainage area tributary to the site is 3.41 Acres. It extends from the northerly extension of Somermont Drive to the northerly site property line. It is important to note that drainage from north of Somermont Drive is intercepted by an existing AC berm located at the southerly site of this street which directs the flow to Pepper Villa Drive and Clove Street bypassing the site.

3.0 PROPOSED CONDITIONS

The proposed project includes the grading for 11 SFR lots. Detention basins for each individual lot is being provided to mitigate the onsite flow increase. Also, brow ditches on the North and East property lines are provided to capture the off-site runoff and discharge it into the street. . The proposed onsite Q_{100} flow at node 42 is 4.81 cfs.

4.0 SUMMARY

- The proposed project was analyzed using Rational Method.
- There will be no diversion of flows, since all the flows will ultimately drain into the same storm drain system.
- There is a slight increase in flows at node 42 which will be mitigated with the provision of detention basins for each individual lot.
- The proposed development will not impact the existing storm drain system.
- Onsite flows are being treated by means of detention facilities and biofiltration through a proposed vegetated swale.

NODE NUMBER	EXISTING CONDITION	PROPOSED CONDITION
98	4.47 CFS	4.42 CFS
42	2.96 CFS	4.81 CFS
72	0.98 CFS	1.45 CFS

5. HYDROLOGY DESIGN MODELS

A. *DESIGN METHODS*

THE RATIONAL METHOD IS USED IN THIS HYDROLOGY STUDY; THE RATIONAL FORMULA IS AS FOLLOWS:

Q = CIA, WHERE : Q= PEAK DISCHARGE IN CUBIC FEET/SECOND *

C = RUNOFF COEFFICIENT (DIMENSIONLESS)

I = RAINFALL INTENSITY IN INCHES/HOUR

A = TRIBUTARY DRAINAGE AREA IN ACRES

*1 ACRE INCHES/HOUR = 1.008 CUBIC FEET/SEC

THE NATURAL WATERSHEDS FLOW METHOD IS ALSO USED IN THIS HYDROLOGY STUDY; THE NATURAL WATERSHEDS FLOW FORMULA IS AS FOLLOWS:

$T_C=[11.9\ L^3/H]^{.385}$

H = DIFFERENCE IN ELEVATION FROM FURTHERMOST POINT OF DESIGN

L = LENGTH OF DRAINAGE COURSE IN MILES

T_C= TIME OF CONCENTRATION IN MINUTES

B. *DESIGN CRITERIA*

- FREQUENCY, 100 YEAR STORM.

- LAND USE PER 2003 COUNTY OF SAN DIEGO HYDROLOGY MANUAL.

- RAIN FALL INTENSITY PER COUNTY OF SAN DIEGO 2003 HYDROLOGY MANUAL.

C. *REFERENCES*

- COUNTY OF SAN DIEGO, HYDROLOGY MANUAL OF JUNE 2003

- COUNTY OF SAN DIEGO 2000 REGIONAL STANDARD DRAWING.

- HAND BOOK OF HYDRAULICS BY BRATER & KING, SIXTH EDITION.

6.- APPENDIX A

(HYDROLOGIC CALCULATIONS)

San Diego County Rational Hydrology Program
EXISTING CONDITION

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CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2006 Version 7.7

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
      Rational Hydrology Study        Date: 08/16/08
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 *********   Hydrology Study Control Information **********

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Program License Serial Number 4035

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Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour,  precipitation(inches) =  2.300
24 hour precipitation(inches) =  6.000
P6/P24 =    38.3%
Adjusted 6 hour precipitation (inches) =  2.700
Adjusted P6/P24 =    45.0%
San Diego hydrology manual 'C' values used


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Process from Point/Station       95.000 to Point/Station       96.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  565.000(Ft.)
Lowest elevation =  555.000(Ft.)
Elevation difference =   10.000(Ft.) Slope = 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*( 100.000^.5)/(  10.000^(1/3)]=   6.18
Rainfall intensity (I) =      6.203(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff =      0.916(CFS)
Total initial stream area =        0.410(Ac.)


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Process from Point/Station       96.000 to Point/Station       98.000
**** IMPROVED CHANNEL TRAVEL TIME ****
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Upstream point elevation =   555.000(Ft.)
Downstream point elevation =   506.000(Ft.)
Channel length thru subarea  =   730.000(Ft.)
Channel base width  =   50.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      2.733(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.733(CFS)
Depth of flow =   0.033(Ft.), Average velocity =   1.534(Ft/s)
Channel flow top width =   56.681(Ft.)
Flow Velocity =    1.53(Ft/s)
Travel time  =    7.93 min.
Time of concentration =   14.12 min.
Critical depth =      0.044(Ft.)
 Adding area flow to channel
Rainfall intensity (I) =      3.642(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      3.642(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      1.228
Subarea runoff =      3.556(CFS) for      3.000(Ac.)
Total runoff =      4.471(CFS)   Total area =      3.410(Ac.)
Depth of flow =   0.045(Ft.), Average velocity =   1.839(Ft/s)
Critical depth =      0.061(Ft.)


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Process from Point/Station       69.000 to Point/Station       70.000
**** INITIAL AREA EVALUATION ****
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                     ]
(4.3 DU/A or Less        )
Impervious value, Ai = 0.300
Sub-Area C Value = 0.480
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  517.000(Ft.)
Lowest elevation =  512.000(Ft.)
Elevation difference =    5.000(Ft.) Slope =  5.000 %
Top of Initial Area Slope adjusted by User to 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
 4.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*( 100.000^.5)/(  10.000^(1/3)]=   5.18
Rainfall intensity (I) =      6.953(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
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Subarea runoff =       0.200(CFS)
Total initial stream area =        0.060(Ac.)


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Process from Point/Station       70.000 to Point/Station       72.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =   512.000(Ft.)
Downstream point elevation =   495.000(Ft.)
Channel length thru subarea  =   378.000(Ft.)
Channel base width  =   50.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      0.625(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      0.625(CFS)
Depth of flow =   0.016(Ft.), Average velocity =   0.773(Ft/s)
Channel flow top width =   53.132(Ft.)
Flow Velocity =    0.77(Ft/s)
Travel time  =    8.15 min.
Time of concentration =   13.33 min.
Critical depth =      0.017(Ft.)
 Adding area flow to channel
Rainfall intensity (I) =      3.780(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                    ]
(4.3 DU/A or Less        )
Impervious value, Ai = 0.300
Sub-Area C Value = 0.480
Rainfall intensity =      3.780(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =      0.259
Subarea runoff =      0.780(CFS) for      0.480(Ac.)
Total runoff =      0.980(CFS)   Total area =      0.540(Ac.)
Depth of flow =   0.020(Ft.), Average velocity =   0.919(Ft/s)
Critical depth =      0.022(Ft.)


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Process from Point/Station       55.000 to Point/Station       56.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                       ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  510.000(Ft.)
Lowest elevation =  504.000(Ft.)
Elevation difference =    6.000(Ft.) Slope =  6.000 %
Top of Initial Area Slope adjusted by User to 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
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 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*( 100.000^.5)/(  10.000^(1/3)]=   6.18
Rainfall intensity (I) =      6.203(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff =      0.402(CFS)
Total initial stream area =        0.180(Ac.)


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Process from Point/Station       56.000 to Point/Station       42.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =   504.000(Ft.)
Downstream point elevation =   490.000(Ft.)
Channel length thru subarea  =   306.000(Ft.)
Channel base width  =   50.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      1.730(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      1.730(CFS)
Depth of flow =   0.029(Ft.), Average velocity =   1.146(Ft/s)
Channel flow top width =   55.709(Ft.)
Flow Velocity =    1.15(Ft/s)
Travel time  =    4.45 min.
Time of concentration =   10.63 min.
Critical depth =      0.033(Ft.)
 Adding area flow to channel
Rainfall intensity (I) =      4.373(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      4.373(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      0.677
Subarea runoff =      2.558(CFS) for      1.700(Ac.)
Total runoff =      2.960(CFS)   Total area =       1.880(Ac.)
Depth of flow =   0.039(Ft.), Average velocity =   1.400(Ft/s)
Critical depth =      0.046(Ft.)
End of computations, total study area =          5.830 (Ac.)
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PROPOSED CONDITION

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              San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2006 Version 7.7

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
      Rational Hydrology Study        Date: 08/16/08
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 *********   Hydrology Study Control Information **********

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Program License Serial Number 4035

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Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour,  precipitation(inches) =  2.300
24 hour precipitation(inches) =  6.000
P6/P24 =    38.3%
Adjusted 6 hour precipitation (inches) =  2.700
Adjusted P6/P24 =    45.0%
San Diego hydrology manual 'C' values used


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Process from Point/Station       95.000 to Point/Station       96.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  565.000(Ft.)
Lowest elevation =  555.000(Ft.)
Elevation difference =   10.000(Ft.) Slope = 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*( 100.000^.5)/(  10.000^(1/3)]=   6.18
Rainfall intensity (I) =      6.203(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff =      0.916(CFS)
Total initial stream area =        0.410(Ac.)


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Process from Point/Station       96.000 to Point/Station       97.000
**** IMPROVED CHANNEL TRAVEL TIME ****
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Upstream point elevation =   555.000(Ft.)
Downstream point elevation =   510.000(Ft.)
Channel length thru subarea  =   730.000(Ft.)
Channel base width  =   50.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      2.709(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.709(CFS)
Depth of flow =   0.034(Ft.), Average velocity =   1.489(Ft/s)
Channel flow top width =   56.816(Ft.)
Flow Velocity =    1.49(Ft/s)
Travel time  =    8.17 min.
Time of concentration =   14.36 min.
Critical depth =      0.044(Ft.)
 Adding area flow to channel
Rainfall intensity (I) =      3.603(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      3.603(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      1.228
Subarea runoff =      3.507(CFS) for      3.000(Ac.)
Total runoff =      4.423(CFS)   Total area =      3.410(Ac.)
Depth of flow =   0.045(Ft.), Average velocity =   1.783(Ft/s)
Critical depth =      0.060(Ft.)


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Process from Point/Station       97.000 to Point/Station       98.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
______________________________________________________________________
Upstream point/station elevation =   509.000(Ft.)
Downstream point/station elevation =   505.000(Ft.)
Pipe length  =   280.00(Ft.) Slope =   0.0143  Manning's N = 0.015
No. of pipes = 1  Required pipe flow  =     4.423(CFS)
Given pipe size =     24.00(In.)
Calculated individual pipe flow  =     4.423(CFS)
Normal flow depth in pipe =    7.07(In.)
Flow top width inside pipe =   21.88(In.)
Critical Depth =    8.87(In.)
Pipe flow velocity =      5.73(Ft/s)
Travel time through pipe =    0.81 min.
Time of concentration (TC) =    15.17 min.


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Process from Point/Station       98.000 to Point/Station       99.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =   504.810(Ft.)
Downstream point elevation =   504.610(Ft.)
Channel length thru subarea  =    10.000(Ft.)
Channel base width  =    5.000(Ft.)
Slope or 'Z' of left channel bank =   0.000
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Slope or 'Z' of right channel bank =   0.000
Manning's 'N'     = 0.015
Maximum depth of channel  =    0.250(Ft.)
Flow(q) thru subarea =      4.423(CFS)
Depth of flow =   0.196(Ft.), Average velocity =   4.502(Ft/s)
Channel flow top width =    5.000(Ft.)
Flow Velocity =    4.50(Ft/s)
Travel time  =    0.04 min.
Time of concentration =   15.21 min.
Critical depth =      0.289(Ft.)


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Process from Point/Station       69.000 to Point/Station       70.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                    ]
(4.3 DU/A or Less       )
Impervious value, Ai = 0.300
Sub-Area C Value = 0.480
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  517.000(Ft.)
Lowest elevation =  512.000(Ft.)
Elevation difference =    5.000(Ft.) Slope =  5.000 %
Top of Initial Area Slope adjusted by User to 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
 4.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*( 100.000^.5)/(  10.000^(1/3)]=   5.18
Rainfall intensity (I) =      6.953(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
Subarea runoff =      0.200(CFS)
Total initial stream area =        0.060(Ac.)


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Process from Point/Station       70.000 to Point/Station       71.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =   512.000(Ft.)
Downstream point elevation =   505.000(Ft.)
Channel length thru subarea  =   110.000(Ft.)
Channel base width  =   20.000(Ft.)
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =  50.000
Estimated mean flow rate at midpoint of channel =      0.391(CFS)
Manning's 'N'     = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      0.391(CFS)
Depth of flow =   0.018(Ft.), Average velocity =   1.016(Ft/s)
Channel flow top width =   21.841(Ft.)
Flow Velocity =    1.02(Ft/s)
Travel time  =    1.81 min.
Time of concentration =    6.99 min.
Critical depth =      0.022(Ft.)
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 Adding area flow to channel
Rainfall intensity (I) =      5.734(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      5.734(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.391  CA =      0.090
Subarea runoff =      0.316(CFS) for      0.170(Ac.)
Total runoff =      0.516(CFS)   Total area =      0.230(Ac.)
Depth of flow =   0.022(Ft.), Average velocity =   1.128(Ft/s)
Critical depth =      0.027(Ft.)


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Process from Point/Station       70.000 to Point/Station       71.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      5.734(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(4.3 DU/A or Less       )
Impervious value, Ai = 0.300
Sub-Area C Value = 0.480
Time of concentration =     6.99 min.
Rainfall intensity =      5.734(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.444  CA =      0.253
Subarea runoff =      0.936(CFS) for      0.340(Ac.)
Total runoff =      1.452(CFS)   Total area =      0.570(Ac.)


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Process from Point/Station       71.000 to Point/Station       72.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
______________________________________________________________________
Upstream point/station elevation =   508.610(Ft.)
Downstream point/station elevation =   495.000(Ft.)
Pipe length  =   297.00(Ft.) Slope =   0.0458  Manning's N = 0.015
No. of pipes = 1  Required pipe flow  =     1.452(CFS)
Given pipe size =     24.00(In.)
Calculated individual pipe flow  =     1.452(CFS)
Normal flow depth in pipe =    3.06(In.)
Flow top width inside pipe =   16.00(In.)
Critical Depth =    4.99(In.)
Pipe flow velocity =      6.24(Ft/s)
Travel time through pipe =    0.79 min.
Time of concentration (TC) =     7.78 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       72.000 to Point/Station       73.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Covered channel
```

```
Upstream point elevation =   495.000(Ft.)
Downstream point elevation =   494.800(Ft.)
Channel length thru subarea  =    20.000(Ft.)
Channel base width  =    3.000(Ft.)
Slope or 'Z' of left channel bank =   0.000
Slope or 'Z' of right channel bank =   0.000
Manning's 'N'    = 0.015
Maximum depth of channel  =    0.250(Ft.)
Flow(q) thru subarea =      1.452(CFS)
Depth of flow =   0.171(Ft.), Average velocity =   2.836(Ft/s)
Channel flow top width =    3.000(Ft.)
Flow Velocity =    2.84(Ft/s)
Travel time  =    0.12 min.
Time of concentration =    7.90 min.
Critical depth =      0.193(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       55.000 to Point/Station       56.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                    ]
(7.3 DU/A or Less        )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.540
Initial subarea total flow distance  =   65.000(Ft.)
Highest elevation =  507.600(Ft.)
Lowest elevation =  506.650(Ft.)
Elevation difference =    0.950(Ft.) Slope =  1.462 %
Top of Initial Area Slope adjusted by User to  1.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 65.00 (Ft)
for the top area slope value of   1.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   8.13 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5400)*(  65.000^.5)/(   1.000^(1/3)]=   8.13
Rainfall intensity (I) =      5.200(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.540
Subarea runoff =      0.618(CFS)
Total initial stream area =        0.220(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       56.000 to Point/Station       57.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
______________________________________________________________________
Top of street segment elevation =   506.000(Ft.)
End of street segment elevation =   493.000(Ft.)
Length of street segment  =   222.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  24.000(Ft.)
Distance from crown to crossfall grade break  =  22.500(Ft.)
Slope from gutter to grade break (v/hz) =   0.080
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =   0.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
```

```
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0200
 Manning's N from grade break to crown =  0.0200
Estimated mean flow rate at midpoint of street =      2.084(CFS)
Depth of flow =   0.240(Ft.), Average velocity =   3.507(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =   7.232(Ft.)
Flow velocity =   3.51(Ft/s)
Travel time =    1.05 min.     TC =    9.18  min.
 Adding area flow to street
Rainfall intensity (I) =      4.807(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                    ]
(7.3 DU/A or Less        )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.540
Rainfall intensity =      4.807(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.540  CA =      0.724
Subarea runoff =      2.860(CFS) for      1.120(Ac.)
Total runoff =      3.478(CFS)    Total area =       1.340(Ac.)
Street flow at end of street =      3.478(CFS)
Half street flow at end of street =      3.478(CFS)
Depth of flow =   0.276(Ft.), Average velocity =   3.918(Ft/s)
Flow width (from curb towards crown)=   9.036(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       57.000 to Point/Station       42.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =   492.640(Ft.)
Downstream point elevation =   490.500(Ft.)
Channel length thru subarea  =   130.000(Ft.)
Channel base width  =    4.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Manning's 'N'    = 0.020
Maximum depth of channel  =    0.500(Ft.)
Flow(q) thru subarea =      3.478(CFS)
Depth of flow =   0.234(Ft.), Average velocity =   3.334(Ft/s)
Channel flow top width =    4.934(Ft.)
Flow Velocity =    3.33(Ft/s)
Travel time  =    0.65 min.
Time of concentration =    9.83 min.
Critical depth =      0.273(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       57.000 to Point/Station       42.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      1.340(Ac.)
Runoff from this stream =      3.478(CFS)
Time of concentration =    9.83 min.
Rainfall intensity =     4.599(In/Hr)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       40.000 to Point/Station       41.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                    ]
(7.3 DU/A or Less        )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.540
Initial subarea total flow distance  =   75.000(Ft.)
Highest elevation =  505.600(Ft.)
Lowest elevation =  504.400(Ft.)
Elevation difference =    1.200(Ft.) Slope =  1.600 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   1.60 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   7.71 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5400)*(  80.000^.5)/(   1.600^(1/3)]=   7.71
Rainfall intensity (I) =      5.381(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.540
Subarea runoff =      0.378(CFS)
Total initial stream area =        0.130(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       41.000 to Point/Station       42.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =   504.400(Ft.)
Downstream point elevation =   492.140(Ft.)
Channel length thru subarea  =   215.000(Ft.)
Channel base width  =    4.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =      0.935(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      0.935(CFS)
Depth of flow =   0.085(Ft.), Average velocity =   2.649(Ft/s)
Channel flow top width =    4.339(Ft.)
Flow Velocity =    2.65(Ft/s)
Travel time  =    1.35 min.
Time of concentration =    9.06 min.
Critical depth =      0.117(Ft.)
 Adding area flow to channel
Rainfall intensity (I) =      4.848(In/Hr) for a   100.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                    ]
(7.3 DU/A or Less        )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.540
Rainfall intensity =      4.848(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
```

```
(Q=KCIA) is C = 0.540  CA =      0.292
Subarea runoff =      1.036(CFS) for      0.410(Ac.)
Total runoff =      1.414(CFS)   Total area =      0.540(Ac.)
Depth of flow =   0.108(Ft.), Average velocity =   3.095(Ft/s)
Critical depth =      0.152(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       41.000 to Point/Station       42.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.540(Ac.)
Runoff from this stream =      1.414(CFS)
Time of concentration =    9.06 min.
Rainfall intensity =     4.848(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                (In/Hr)


1        3.478      9.83            4.599
2        1.414      9.06            4.848
Qmax(1) =
         1.000 *    1.000 *     3.478) +
         0.949 *    1.000 *     1.414) + =       4.819
Qmax(2) =
         1.000 *    0.922 *     3.478) +
         1.000 *    1.000 *     1.414) + =       4.619

Total of 2 streams to confluence:
Flow rates before confluence point:
       3.478       1.414
Maximum flow rates at confluence using above data:
        4.819       4.619
Area of streams before confluence:
        1.340       0.540
Results of confluence:
Total flow rate =      4.819(CFS)
Time of concentration =     9.832 min.
Effective stream area after confluence =      1.880(Ac.)
End of computations, total study area =          5.860 (Ac.)
```

DETENTION BASIN CALCULATIONS

GIVEN:

$P_6 = 2.3$ IN

$C_{EX} = 0.48$

$C_{PROP} = 0.54$

DEVELOPED AREA = 2.0 AC

PROP. BASIN VOL PER LOT = 1,500 CF

FIND:

REQUIRED DETENTION VOLUME PER LOT.

$$\text{VOL/LOT} = \frac{\text{EX. VOL} - \text{PROP. VOL}}{11 \text{ LOTS}}$$

$$= (C_{EX})(P_6)A_{DEV} - (C_{PROP})(P_6)A_{DEV.} / 11 \text{ LOTS}$$

$$= (0.48)(2.3)(2) - (0.54)(2.3)(2.0) / 11 \text{ LOTS}$$

$$= 0.27 \text{ AC-IN} / 11$$

$$= 0.18 \text{ AC-IN} \times \frac{43560 \text{ FT}^2}{1 \text{ AC}} \times \frac{1 \text{ FT}}{12 \text{ IN}}$$

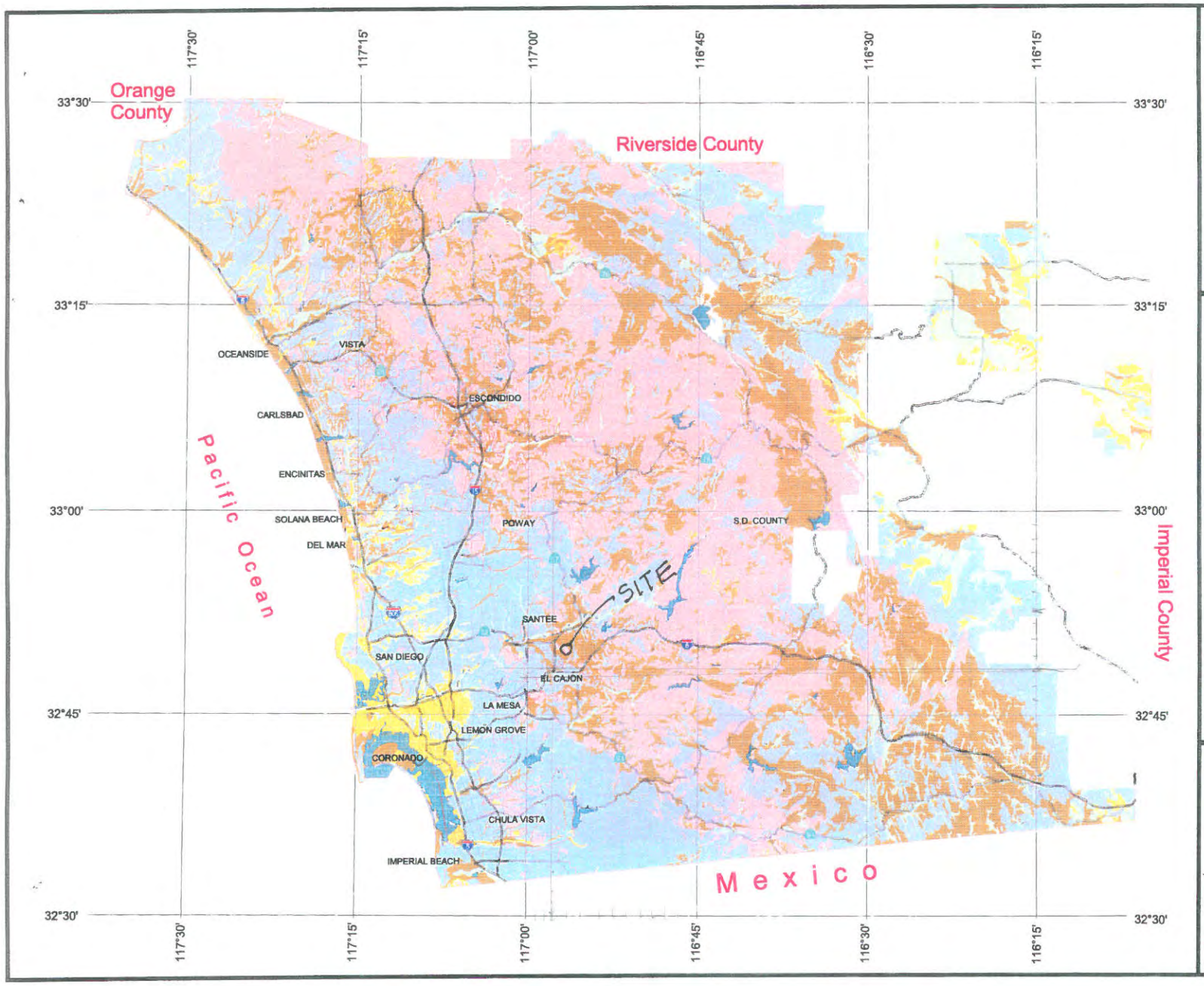
$$= 653 \text{ FT}^3 < \text{PROP. VOL} = 1{,}500 \text{ CF}$$

$\therefore$ O.K

7.- APPENDIX B

(TABLES & CHARTS)

32° 49'
116° 56



County of San Diego Hydrology Manual

Soil Hydrologic Groups

Legend

Soil Groups

- Group A
- Group B
- Group C ← USE
- Group D
- Undetermined
- Data Unavailable

DPW GIS
Department of Public Works
Geographic Information Services

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N
W E
S

3 0 3 Miles

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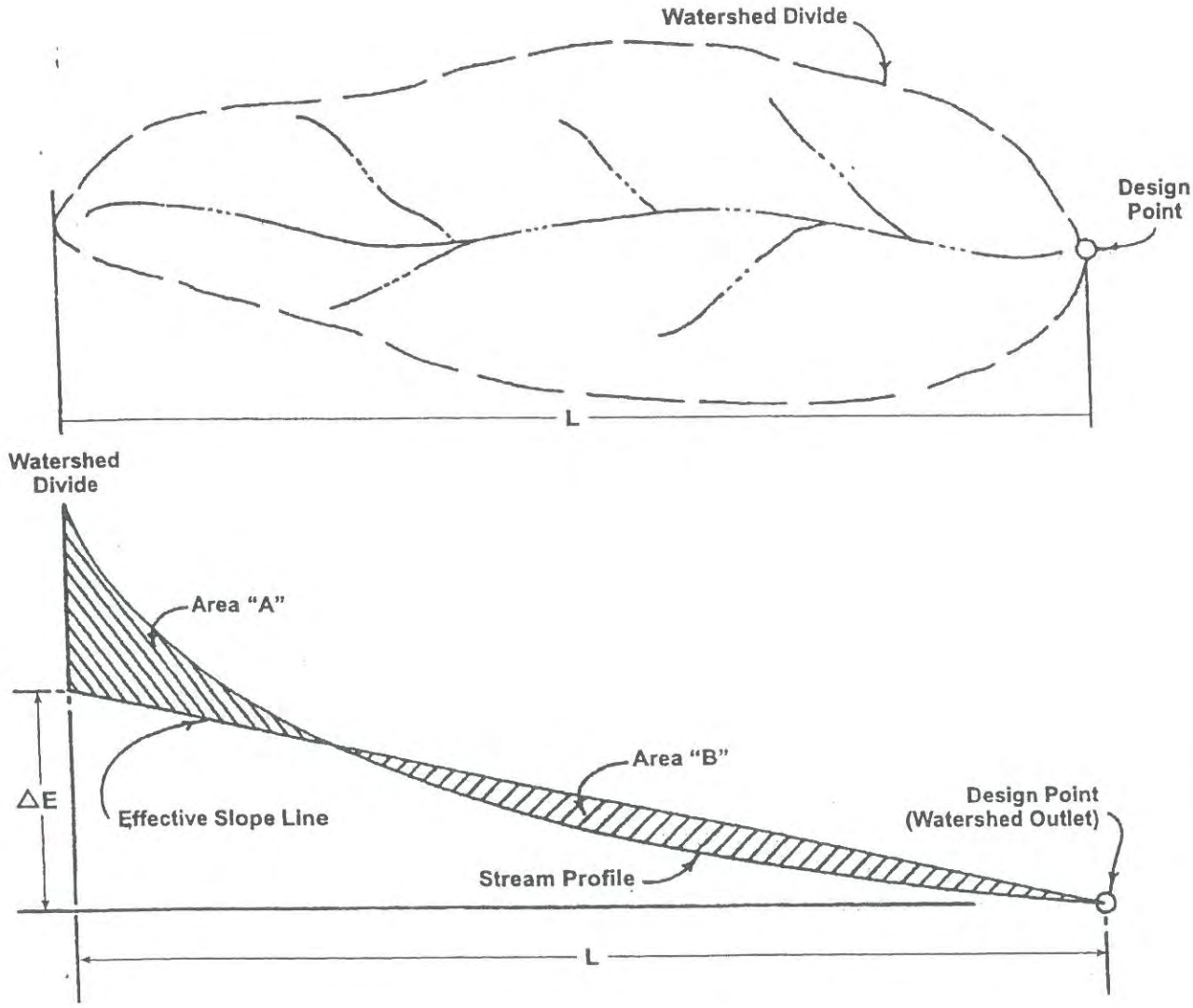
Average Values of Roughness Coefficient (Manning's n)

Type of Waterway	Roughness Coefficient (n)
1. Closed Conduits (1)	
Steel (not lined)	0.015
Cast Iron	0.015
Aluminum	.021
Corrugated Metal (not lined)	0.024
Corrugated Metal (2) (smooth asphalt quarterlining)	0.021
Corrugated Metal (2) (smooth asphalt half lining)	0.018
Corrugated Metal (smooth asphalt full lining)	0.012
Concrete RCP	0.012
Clay (sewer)	0.013
Asbestos Cement & PVC	0.011
Drain Tile (terra cotta)	0.015
Cast-in-place Pipe	0.015
Reinforced Concrete Box	0.014
2. Open Channels (1)	
a. Unlined	
Clay Loam	0.023
Sand	0.020
b. Revetted	
Gravel	0.030
Rock	0.040
Pipe and Wire	0.025
Sacked Concrete	0.025
c. Lined	
Concrete (poured)	0.014
Air Blown Mortar (3)	0.016
Asphaltic Concrete or Bituminous Plant Mix	0.018
d. Vegetated (5)	
Grass lined, maintained	.035
Grass and Weeds	.045
Grass lined with concrete low flow channel	.032
3. Pavement and Gutters (1)	
Concrete	0.015
Bituminous (plant-mixed)	0.016



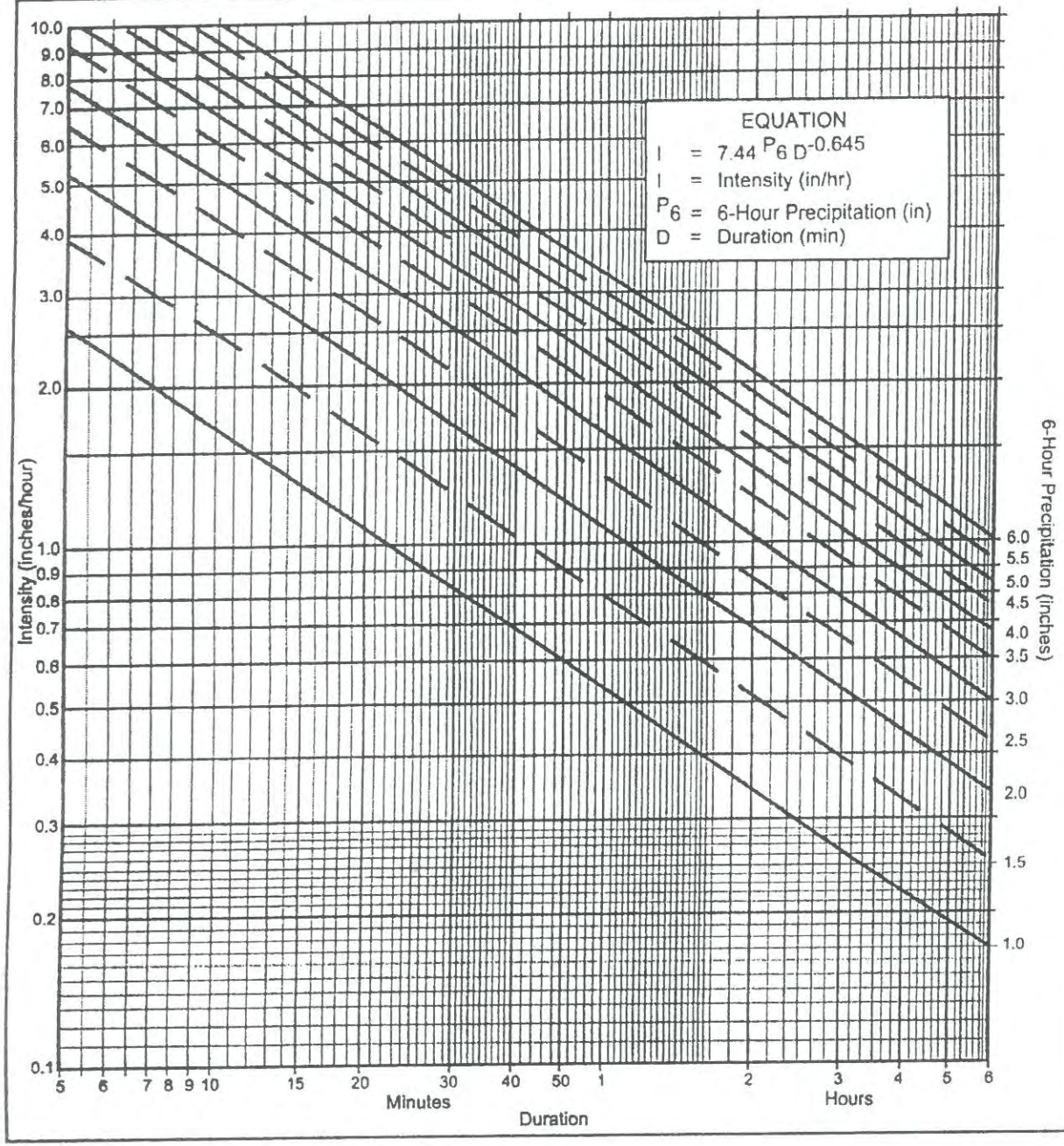
Area "A" = Area "B"

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

FIGURE

Computation of Effective Slope for Natural Watersheds

3-5



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 _____ year

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

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

(d) t_x = _____ min.

(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

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)

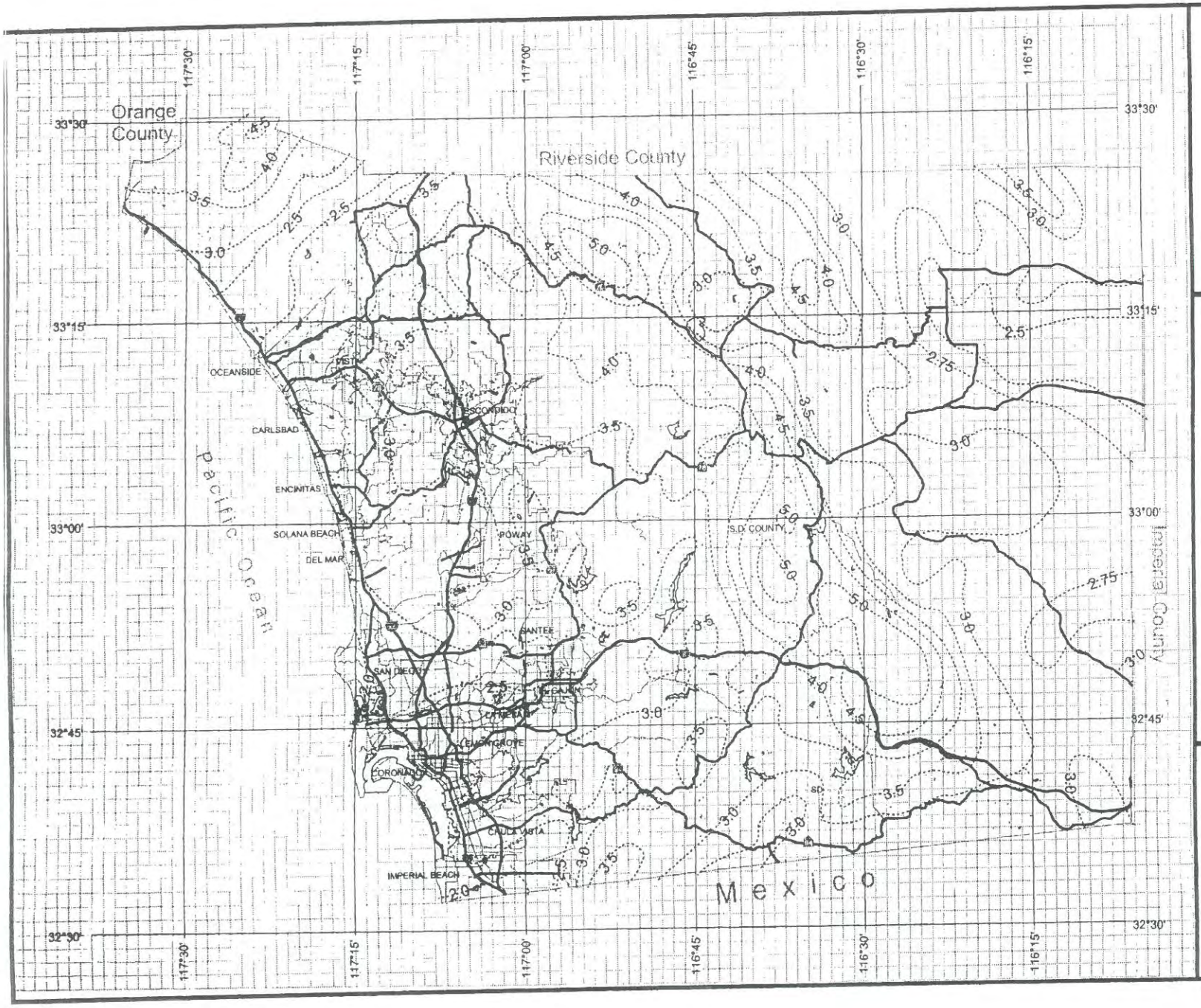
Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	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

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



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

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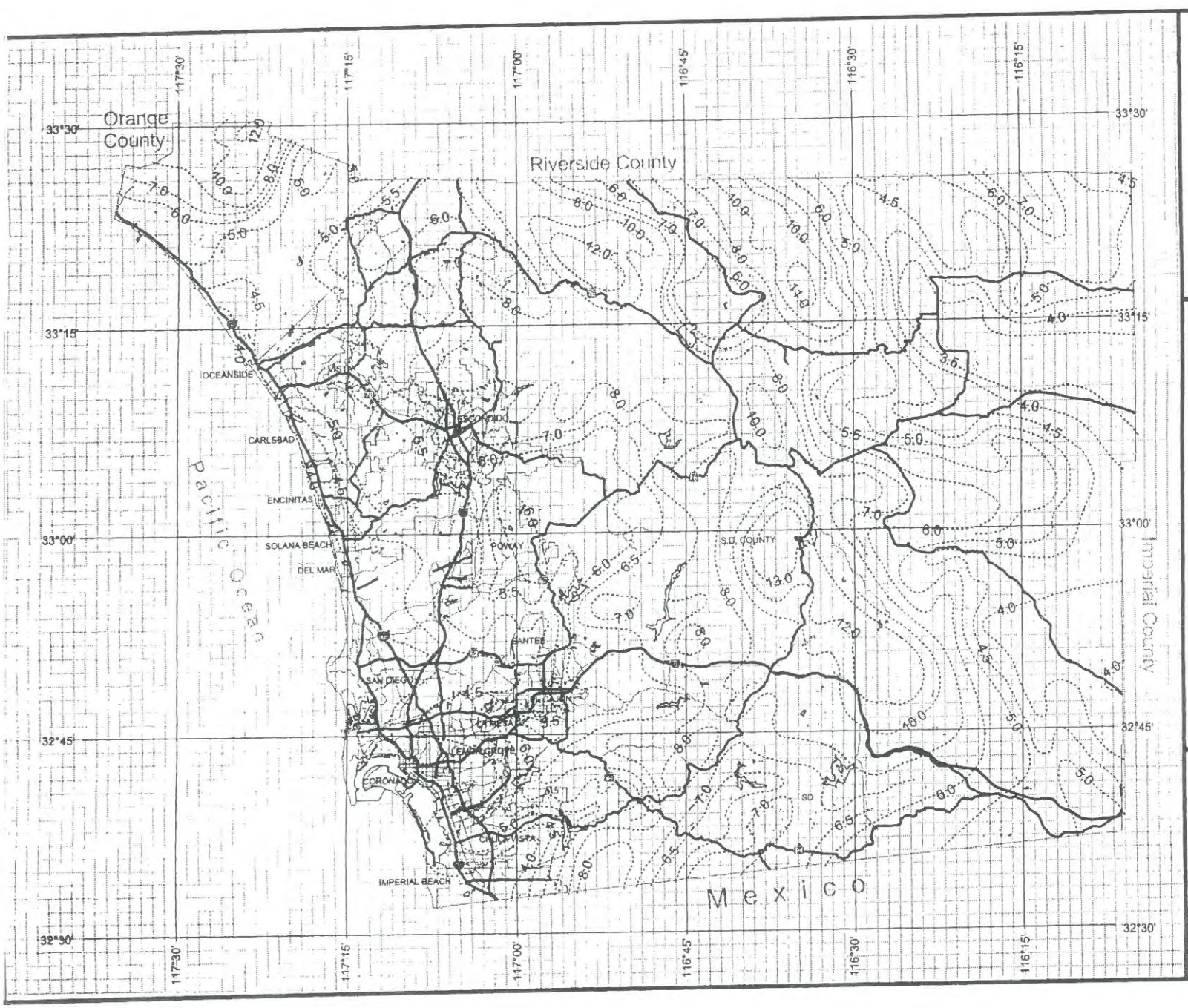
N W E S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

DPW GIS

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N W E S

3 0 3 Miles

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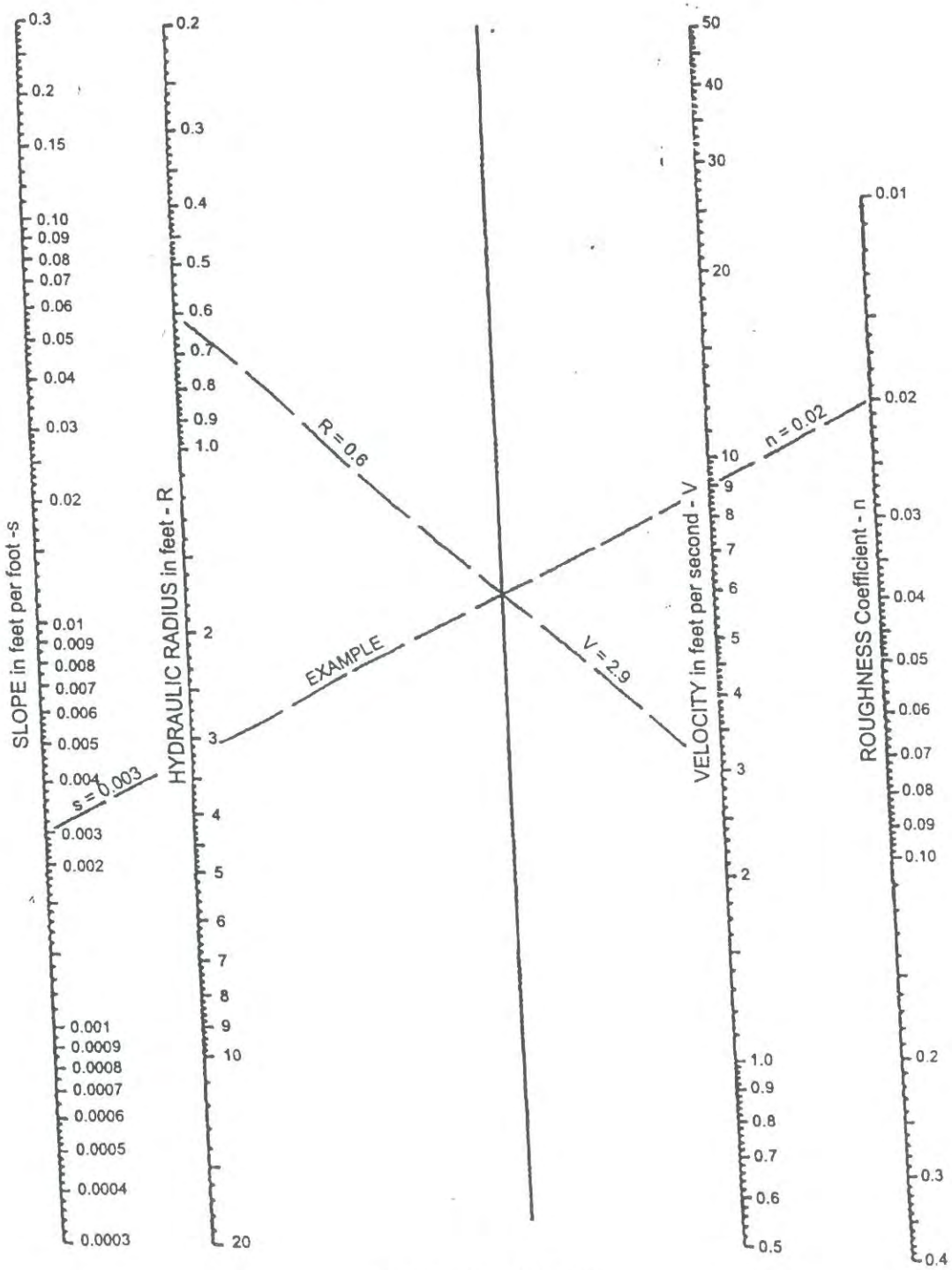
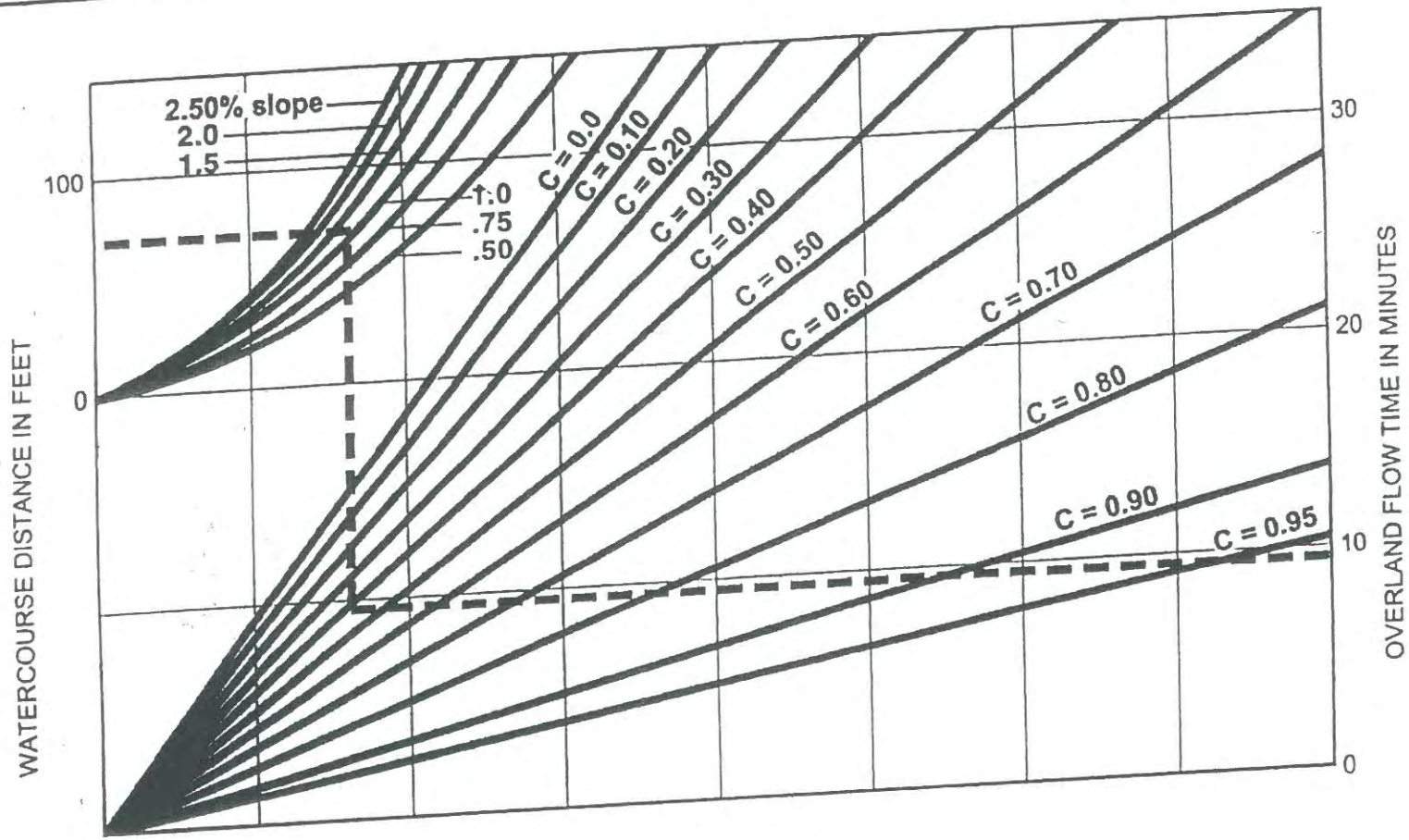
EQUATION: $V = \frac{1.49}{n} R^{2/3} s^{1/2}$



SOURCE: USDOT, FHWA, HDS-3 (1961)

FIGURE 3-7

Manning's Equation Nomograph



EXAMPLE:
Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE

3-3

Rational Formula - Overland Time of Flow Nomograph

8.- APPENDIX C

(HYDROLOGY MAPS)