WALSH ENGINEERING
& SURVEYING, INC.

CEQA PRELIMINARY DRAINAGE STUDY
for
West Lilac Farms
Tentative Map 5276

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

Lawrence W. Walsh, RCE 46316 — 11/1/05 Date

Prepared for:
James D. Pardee, Jr.
267 Stonecreek Court
Westlake Village, CA 91361
(Walsh Engineering Job No 01246)

1870 Cordell Court, Suite 102 • El Cajon CA 92020 • Phone (619) 588-6747 • Fax (619) 448-7132
www.walsh-engineering.com

INTRODUCTION / BACKGROUND

This CEQA Preliminary Drainage Study is a combination of two previously approved Drainage Studies:

- *Drainage Study - West Lilac Farms Tentative Map 5276* signed May 24, 2004. This study is for the onsite portion of the project.
- *Drainage Study for Aqueduct Road & Via Ararat Drive in connection with West Lilac Farms Tentative Map 5276* signed May 25, 2005. This study is for the offsite portion of the project.

The County of San Diego letter dated October 5, 2005 (attached) requests one Drainage Study which encompasses both previously approved Drainage Studies. See Item B on page 2 of the above-mentioned County letter which is on the following pages. This CEQA Preliminary Drainage Study has been compiled to satisfy said County request.

GARY L. PRYOR
DIRECTOR

County of San Diego

DEPARTMENT OF PLANNING AND LAND USE

5201 RUFFIN ROAD, SUITE B, SAN DIEGO, CALIFORNIA 92123-1666
INFORMATION (858) 694-2960
TOLL FREE (800) 411-0017

SAN MARCOS OFFICE
338 VIA VERA CRUZ - SUITE 201
SAN MARCOS, CA 92069-2620
(760) 471-0730

EL CAJON OFFICE
200 EAST MAIN ST. - SIXTH FLOOR
EL CAJON, CA 92020-3912
(619) 441-4030

October 5, 2005

Mr. James D. Pardee, Jr.
2419 Swanfield Court
Thousand Oaks, CA 91361

RE: West Lilac, TM5276RPL^3, Log No. 02-02-002; Seventh Iteration Review of Initial Studies/Information

Dear Mr. Pardee,

The Department of Planning and Land Use (DPLU) has completed the review of your Extended Initial Study/Information and determined it to be "incomplete" as defined by the California Environmental Quality Act (CEQA). At this time, additional information or revisions will be required to determine your project's potential impacts on the environment and complete the CEQA Environmental Initial Study. The reasons for this determination and the revisions/information required are as follows:

Revisions And Additional Information:

A. **Biological Resources**

DPLU staff needs information regarding the availability of off-site mitigation for non-native grassland. If the project has identified available grasslands, please provide information about the formation of this mitigation site in the form of a letter from the manager/coordinator of the site. Describe whether the site will be a mitigation bank that will sell habitat credits or an environmental subdivision that will sell mitigation parcels. Include the following information: assessor parcel numbers, number of acres, estimated time of completion, proposed type of conservation (including all proposed grantees), proposed owner of land in fee title, and proposed habitat manager.

B. **Department of Environmental Health (DEH)**

It appears that the attached letter from DEH dated February 16, 2005 has not been addressed. Please update the project's septic report and preliminary grading plan for DEH review.

Minor Revisions

A. **Preliminary Grading Plan**
DPLU and the Department of Public Works (DPW) staff have reviewed the revised Preliminary Grading Plan submitted on May 25, 2005. The conceptual grading plan shown on preliminary grading plan (4 sheets) addresses the previous comments and is accepted, provided however, that the grading and paving shown thereon is changed to reflect the approved exception request for Via Ararat Drive.

B. **Preliminary Drainage Study**
Drainage studies for the project have been reviewed and no further revisions to the content are needed. However, please provide one CEQA drainage study, which encompasses both on- and off-site portion of the project, for Department of Public Works CEQA review.

C. **Traffic**
DPLU and the Department of Public Works (DPW) staff have reviewed the revised Traffic Study submitted on May 25, 2005. The report itself is acceptable provided that the disposition of the exception request submitted for Via Ararat Drive is addressed in the final CEQA file versions of the Traffic Study.

The Following Studies Do Not Require Any Revisions At This Time:

- Stormwater Management Plan (SWMP)

If you have any specific questions regarding these CEQA comments, please contact Mindy Fogg, Project Environmental Analyst at (858) 694-3831 or by e-mail at mindy.fogg@sdcounty.ca.gov.

Project Schedule: An updated copy of your project schedule is attached showing an estimated hearing/decision date of May 3, 2006.

Submittal Requirements: Unless other agreements have been made with County staff, you must comply with the following submittal requirements in order to make adequate progress and to minimize the time and cost in the processing of your application:

1. Submit a copy of this letter.
2. The County of San Diego's environmental review guidelines require that the requested environmental technical studies be prepared by a California Licensed professional (i.e., engineer, geologist) qualified to complete the study or a consultant from the County's List of Environmental Consultants.
3. The following information and/or document(s) with the requested number of copies as specified. **The Project Number and Environmental Log Number must be clearly and visibly labeled on all submitted documents. All changes to any previously submitted document(s) must be in strikeout/underline format.**

Information/Document	No. Of Copies	Lead Review Dept./Section
Biology: Information regarding proposed mitigation bank	2	Planner (1), Analyst (1)
Revised Traffic	4	Planner (1), Analyst (1), DPW (2)
Revised Drainage	3	Planner (1), Analyst (1), DPW (1)
Revised Preliminary Grading	4	Planner (1), Analyst (1), DPW (1), DEH (1)
DEH Septic Report	4	Planner (1), Analyst (1), DPW (1), DEH (1)
The staff turnaround goal for review of the requested information/document is **7 days**.		

* *Please contact me in advance for a Special Handling Form if you wish to submit other documents.

Resubmittal Due Date: In order to maintain adequate progress in processing of your project, the DPLU requires that all of the revisions/information requested in this letter be submitted in conformance with the above submittal requirements by **November 3, 2005**. Please note that an extension of this date may be granted at the discretion of the Director of the DPLU. To request an extension, submit a written request, signed and dated by the project applicant. The request must include the proposed new submittal date and a brief reasoning for the extension request. If the revised document(s) are not received, or an approved extension request is not granted by the Director by the above date, the Department may make a recommendation for denial of your project to the appropriate decision-making authority based upon inadequate progress pursuant to CEQA Guidelines Section 15109.

Project Issue Resolution Process: If you have disagreements with the requirements within this letter you may, after trying to resolve issues with project staff, have these issues referred to the Project Issue Resolution process to provide you with an opportunity to quickly and inexpensively have issues considered by senior County management. Issues considered under this procedure can include disagreements with staff interpretations of codes or ordinances, requests for additional information or studies, or disagreements regarding project related processing requirements. This process does not replace any other appeal mechanisms such as those for CEQA determinations or administrative appeals. Please contact me to learn more about this process, the limitations, or to request an application form.

If you have any questions or need additional information, please contact me at (858) 495-5375.

Sincerely,

Stella Caldwell, Project Manager
Regulatory Planning

SC:mf

Attachments:
Project Schedule
DEH Letter dated February 16, 2005

cc: Larry Walsh, Walsh Engineering and Surveying, Inc., 1870 Cordell Court, Suite 102, El Cajon, CA 92020
Jerry Hemme, 6256 Greenwich Drive Suite 500, San Diego, CA 92122
Nael Areigat, Project Manager, Department of Public Works, M.S. 0336
Mindy Fogg, Project Analyst, DPLU, M.S. O650
David Hulse, Planning Manager, DPLU, M.S. O650
Marette Esperance, Planning Manager, DPLU, M.S. O650

OFFSITE

WALSH ENGINEERING
& SURVEYING, INC.

DRAINAGE STUDY
West Lilac Farms Tentative Map 5276

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Lawrence W. Walsh, RCE 46316 — 5/24/04 Date

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INTRODUCTION

This report presents a Drainage Study for the West Lilac Farms Tentative Map (TM) 5276. The project site encompasses approximately 93 acres located westerly of Interstate 15 (I-15) and southerly of West Lilac Road between Via Ararat Drive and Aquaduct Road in the Community of Bonsall, County of San Diego (see Vicinity Map).

In its existing condition, the site is by characterized rolling hills, approximately 80 percent of which is primarily land uses of irrigated citrus and avocado groves with occasional orchard weeds. The two main roads, Via Ararat Drive and Aquaduct Road, which parallel the westerly and easterly project boundaries will remain. Several existing homes and grove areas surround the project. Land use for the 28-lot subdivision is rural-residential with a minimum lot size of 2.0 acres.

The project is designed to minimize the use of impervious areas. Streets are designed to meet the County of San Diego's minimum width criteria and multiple access points are provided through the use of cul-de-sacs, thereby reducing the lengths of the streets. The streets will have a paved width of 24-feet; on-street parking is not allowed. To the maximum extent practicable, future driveways will be designed to drain to landscaped areas to promote pollutant removal prior to discharging.

There are no proposed underground stormwater conduits other than short reaches for pad drainage and culvert undercrossings. Rip rap energy dissipaters will be located at all storm drain and spillway outfalls. No culverts, rip rap energy dissipaters, storm drain facilities, landscaping or stormwater facilities will be located within the proposed biological open space areas. The wetlands within the open space are to remain in the natural condition.

The proposed single-family residences will be setback from the impervious streets to provide opportunities to drain rooftops into landscaped areas, thereby minimizing the directly connected impervious areas. The increased impervious areas will be minimized to the maximum extend practicable for single-family developments. As soon as cuts or embankments are completed, all slopes will be stabilized with a hydromulch mixture, or an equivalent protection measure.

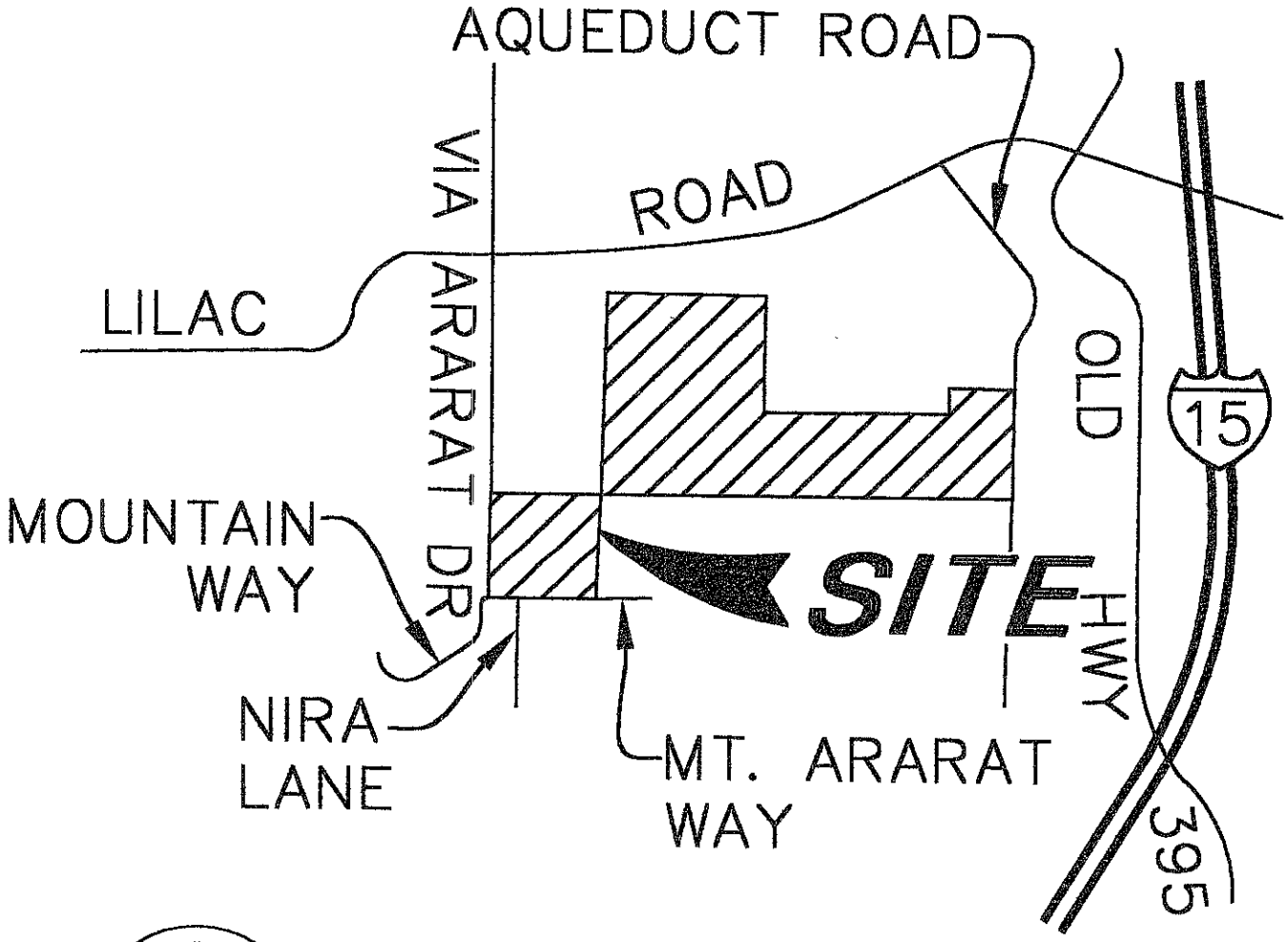
Storm runoff from approximately one-half of the project site drains in a general north-northwesterly direction. Storm runoff from this portion of the site is collected in a well-defined, maturely vegetated swale. The swale flows northwesterly approximately 1.5 miles to its confluence with the San Luis Rey River. Storm runoff from the remaining portion of the project site drains in a general south-southwesterly direction. Storm runoff from this portion of the site is collected in a well-defined swale which flows southwesterly through the lower portion of the site. The swale continues off site to its confluence with Moosa Canyon approximately 1.5 miles southwesterly of the project boundary. Moosa Canyon ultimately discharges to the San Luis Rey River approximately 2.5 miles westerly of the project boundary. The proposed project will not significantly alter the onsite drainage patterns and will not divert storm runoff from its existing ultimate receiving waters.

The 100-year floodplains limits of the San Luis Rey River and Moosa Canyon have been determined and are shown on the County of San Diego's floodplain maps. This project is not encumbered by the San Luis Rey River or Moosa Canyon floodplains.

The proposed project is comprised of rural residential homes with minimum lot sizes of two acres. With the exception of the access roads and residential pads, the majority of the existing orchards and vegetation will be preserved. Storm runoff from the access roads will surface flow to proposed spillways. Storm runoff will be conveyed under the access roads through culvert undercrossings. Rip rap energy dissipators will be located at the outfalls of the proposed spillways and at the culvert undercrossings to provide runoff velocity reduction. Street runoff will then be routed overland through landscaped and vegetated areas prior to entering the existing vegetated swales.

Roof drains on all homes to be constructed will deposit into landscaped areas and the runoff will be required to flow overland through the landscaping prior to entering the swales. Recognizing that pollutants from all onsite runoff from the lots will have been adequately filtered through the landscape and the natural swales, potential pollutants will be minimal. In addition, the approximately 65% of the site is characterized by Hydrologic Soil Group Types "B" and "C" which will naturally promote infiltration.

The increase in impervious areas attributed to the construction of the homes will be offset by depositing the roof drains into the landscaped areas which will be located adjacent to the homes, thereby slowing the rate of stormwater runoff and enhancing opportunities for filtration and infiltration.



VICINITY MAP

NO SCALE

THOMAS BRO MAP NO. 1048, G–7 & H–7
AND NO. 1068, G–1 & H–1

HYDROLOGIC RESULTS

The Hydrologic Results indicate that the total storm peak discharge from the project site in the proposed condition will not significantly alter the drainage characteristics. The weighted runoff coefficient used for both the existing and proposed conditions is 0.41, for residential-rural (lots greater than 0.5 acres) land uses, as presented in the County of San Diego Hydrology Manual.

Theoretically, the development of any site will cause an increase in runoff due to the increase in impervious surfaces. However, the potential increase in runoff attributed to this development is not measurable because the runoff coefficient and characteristics will not be significantly altered. In addition, storm runoff from the proposed paved street areas will flow rapidly in the pavement and will typically peak and pass sooner than the overland surface runoff from the residential pads and landscaped and grove areas. The reason for the differences in the time for the storm peak flows is attributed to the difference in times of concentration, which is defined as the time required for runoff to flow from the most remote part of the watershed to the outlet point under consideration. Recognizing that runoff flows faster over paved surfaces than it does through vegetation and landscaping, the hydrologic results are reasonable in the indication that there are only slight, localized increased storm peak discharges attributed to this proposed development and the runoff velocities within the swales will not be significantly impacted by the proposed project.

The estimated 100-year storm peak discharges are summarized in the following Table.

TABLE: 100-YEAR STORM EVENT

	EXISTING CONDITION		PROPOSED CONDITION	
DRAINAGE BASIN NO.	DRAINAGE BASIN AREA (AC.)	Q (CFS)	DRAINAGE BASIN AREA (AC.)	Q (CFS)
1	16	34	16	34
2	57	115	57	117
3	6	16	6	17
4	5	13	5	13
5	4	11	4	11
6	7	18	7	18
7	43	97	43	100

The estimated 100-year storm peak discharge in the existing northerly swale is 100 CFS. The estimated 100-year storm peak discharge in the existing southerly swale is 117 CFS. The 100-year Flood Lines of Inundation in the two existing swales are shown on the Proposed Condition Drainage Map.

The hydrologic calculations, references and Drainage Maps are located in the Appendix.

HYDROLOGIC METHODOLOGY AND CRITERIA

The hydrologic methodology and criteria utilized herein is in accordance with the County of San Diego Hydrology Manual. The Rational Method and the County of San Diego Intensity-Duration Design Charts and Nomograph for Determination of Time of Concentration (Tc) for Natural Watersheds were used to estimate the storm peak discharge from the proposed project site.

The storm peak discharges in the street drainage areas were determined using a weighted runoff coefficient for industrial land uses. Drainage Basins Nos. 1, 2, 4, 5 and 7 collect and convey street runoff.

The modified Rational Method based was used to combine the estimated storm peak discharges from the paved areas and rural residential lots to determine the total storm peak discharges for the proposed condition drainage basins.

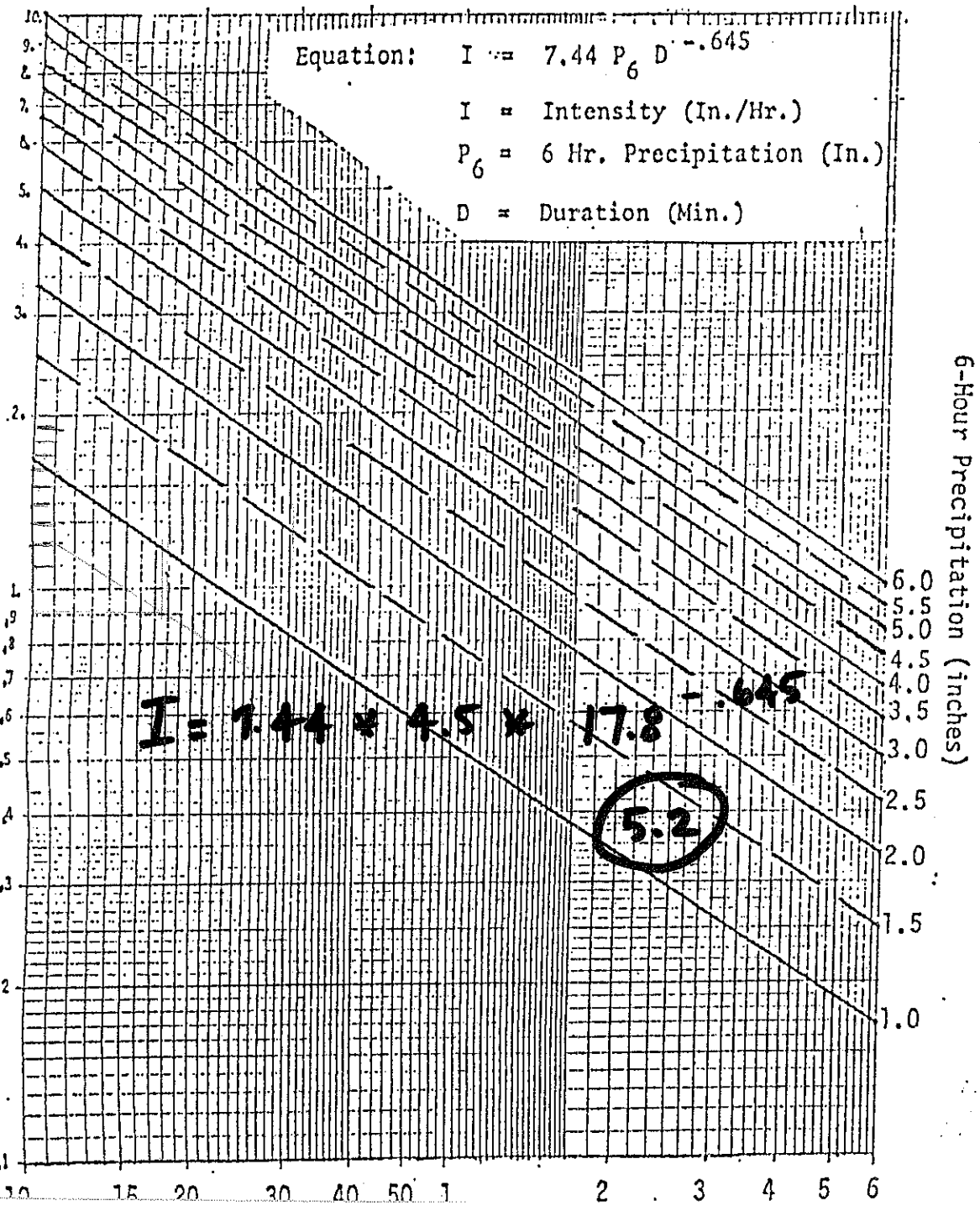
The On-site hydrologic criteria used is as follows:

Design Storm	100-year event, 6-hour duration
Precipitation	4.5-inches
Soil Type	"B" (15%) "C" (50%) "D" (35%)
Weighted Runoff Coefficient ("C" value)	0.41 (existing and proposed conditions) 0.91 (proposed paved streets)

The Off-site hydrologic criteria used is as follows:

Design Storm	100-year event, 6-hour duration
Precipitation	4.5-inches
Soil Type	"B" = 0.32 "C" = 0.36
Weighted Runoff Coefficient ("C" value)	varies 0.9 (for developed areas)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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.

BASIN 1

Application Form:

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^*P_6}{P_{24}}$ = 56 %*

2) Adjusted $^*P_6$ = 4.5 in.

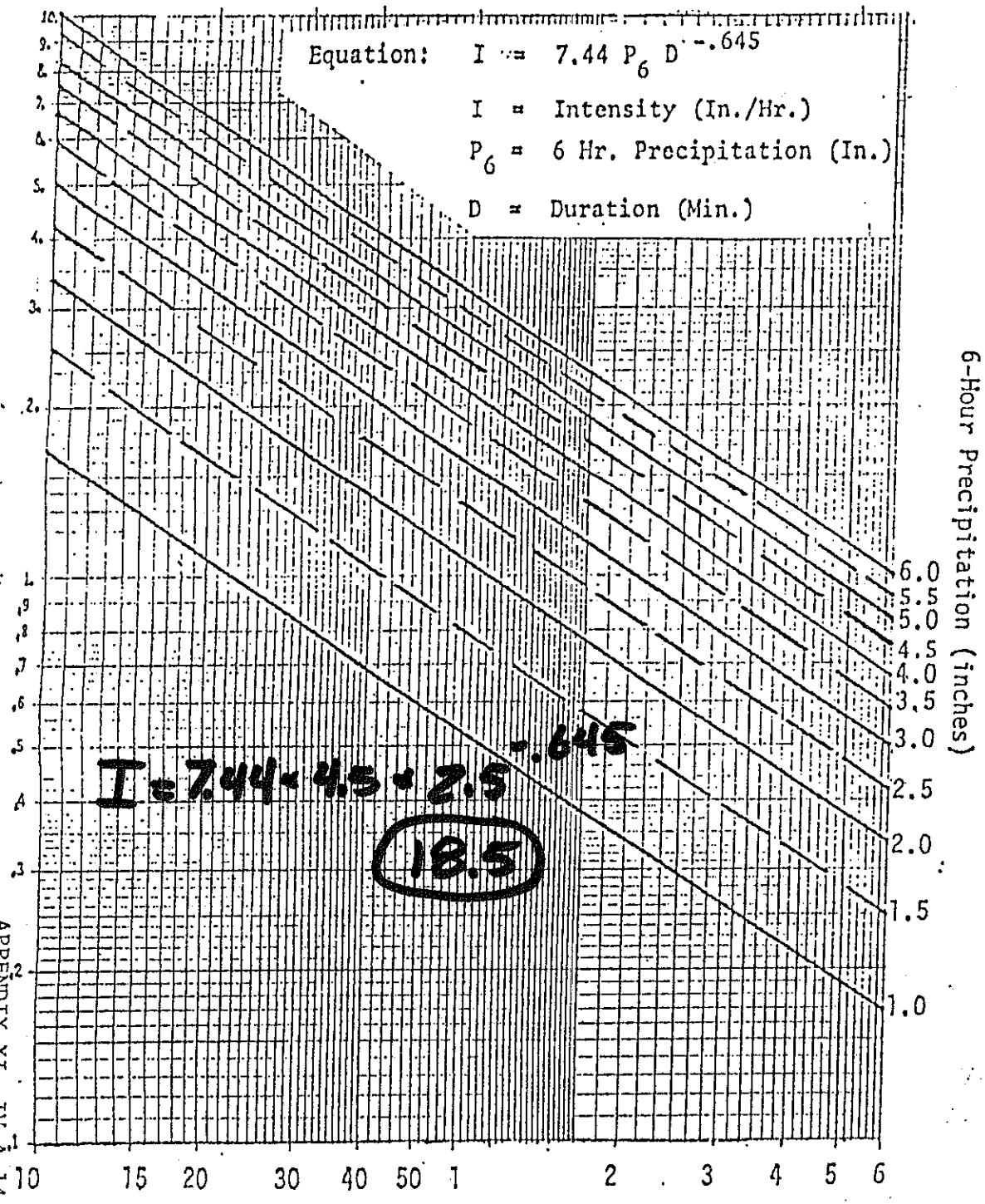
3) t_c = 17.8 min. $A_{EXIST} = A_{PROP} = 16$ AC

4) I = 5.2 in/hr.

*Not Applicable to Desert Region

Q = 0.41 (5.2)(16) = 34 CFS (EXIST)
Q = 0.41 (5.2)(15.1) = 33 CFS (PROP)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

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

BASIN 1

Application Form:

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^{*}P_6}{P_{24}}$ = 56 %*

2) Adjusted $^{*}P_6$ = 4.5 in.

3) t_c = 2.5 min.

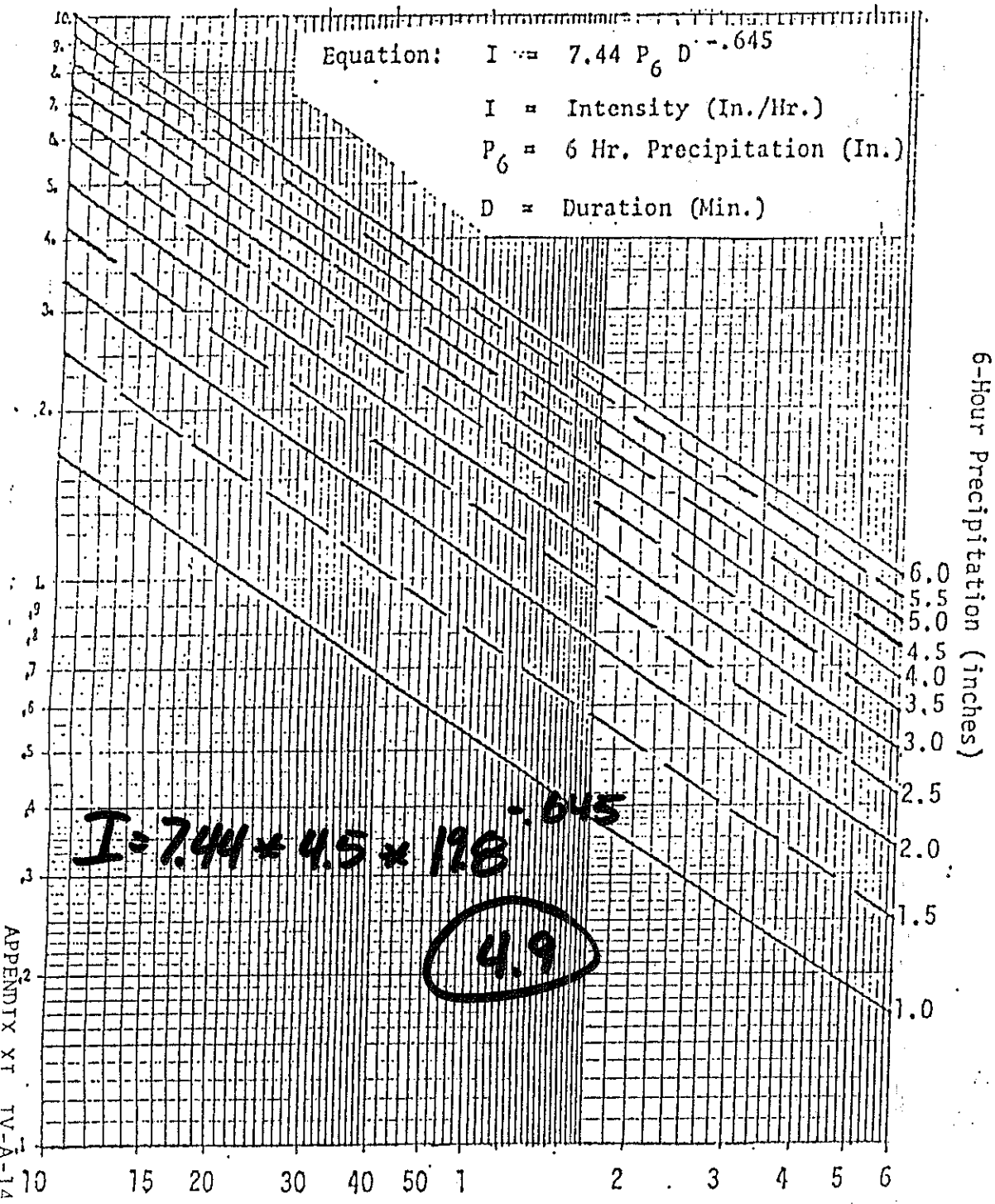
4) I = 18.5 in/hr.

*Not Applicable to Desert Region

A = 0.3 AC

Q = 0.91(18.5)(0.3) = 5 CFS (PROP. STREET)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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: BASIN 2

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^*P_6}{P_{24}}$ = 56 %*

2) Adjusted $^*P_6$ = 4.5 in.

3) t_c = 19.8 min. $A_{EXIST} = A_{PROP} = 57$ AC

4) I = 4.9 in/hr.

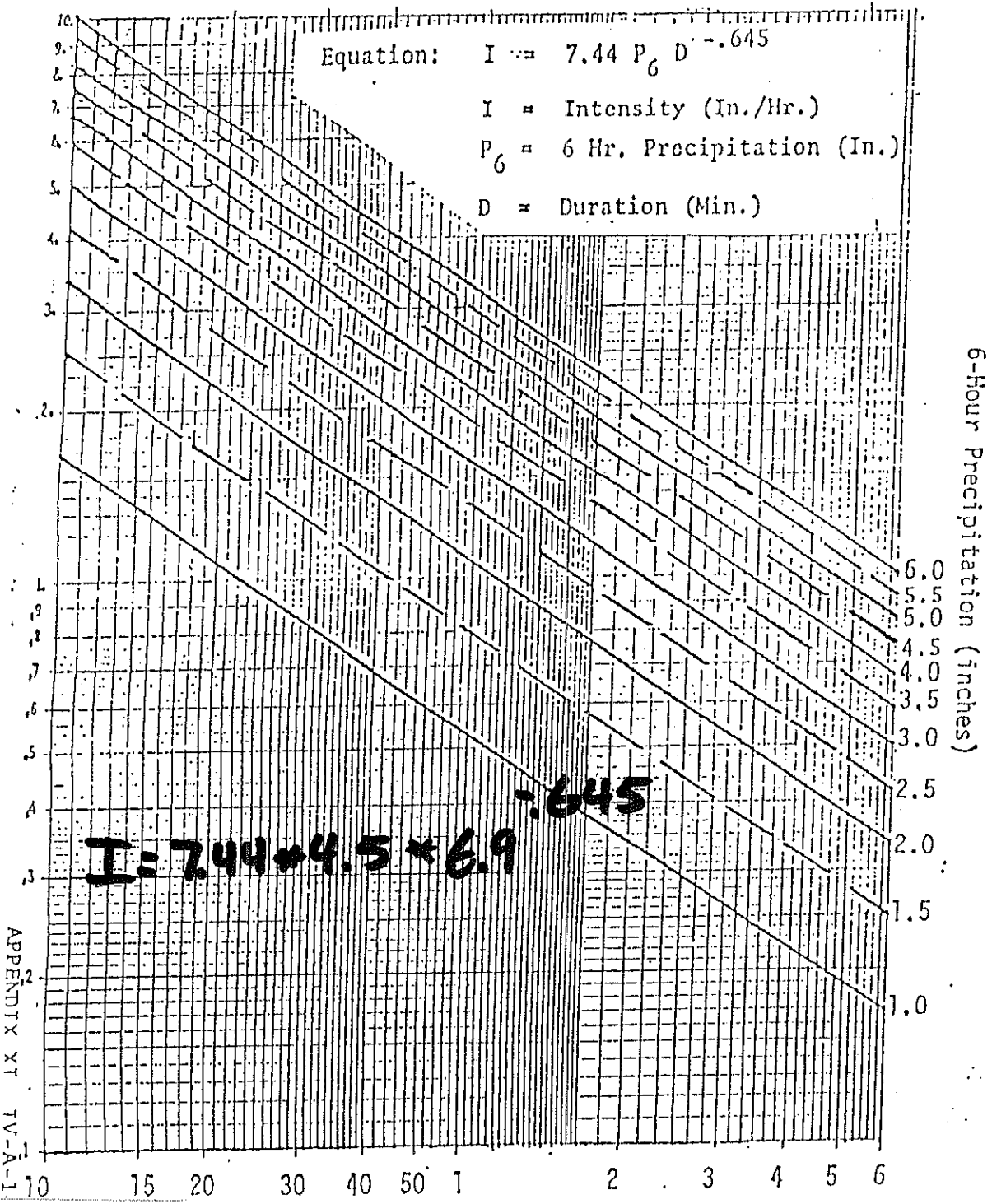
*Not Applicable to Desert Region

$Q = 0.41(4.9)(57) = 115$ CFS (EXIST)

$Q = 0.41(4.9)(56) = 112$ CFS (PROP)

APPENDIX XI IV-A-14

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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.

BASIN 2

Application Form:

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{*P_6}{P_{24}}$ = 56 %*

2) Adjusted $*P_6$ = 4.5 in.

3) t_c = 6.9 min.

4) I = 9.6 in/hr.

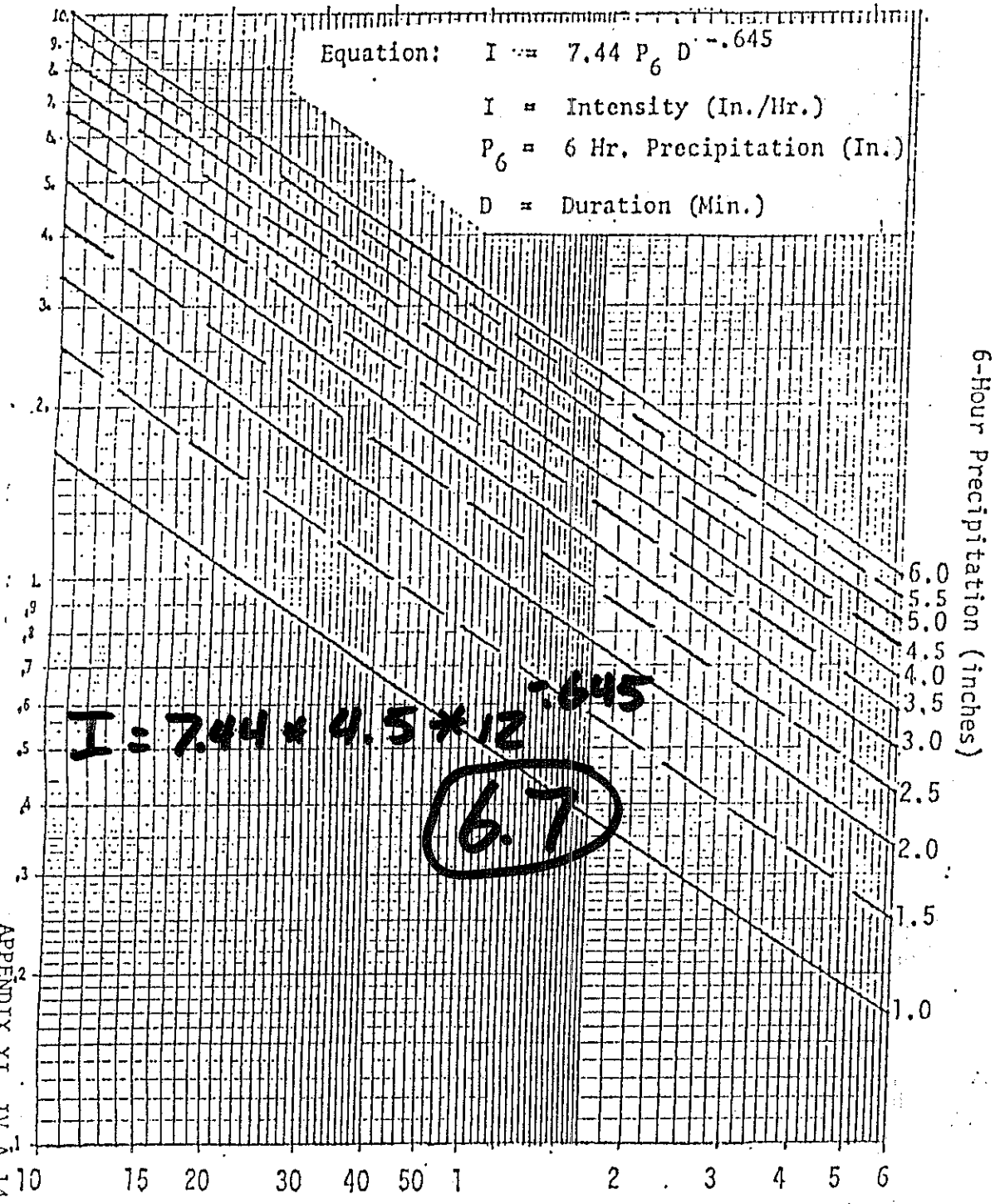
*Not Applicable to Desert Region

A = 1.0

Q = 0.91 (9.6)(1.0) = 9 CFS

(PROP. STREET)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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: BASIN 3

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^*P_6}{P_{24}}$ = 56 %*

2) Adjusted $^*P_6$ = 4.5 in.

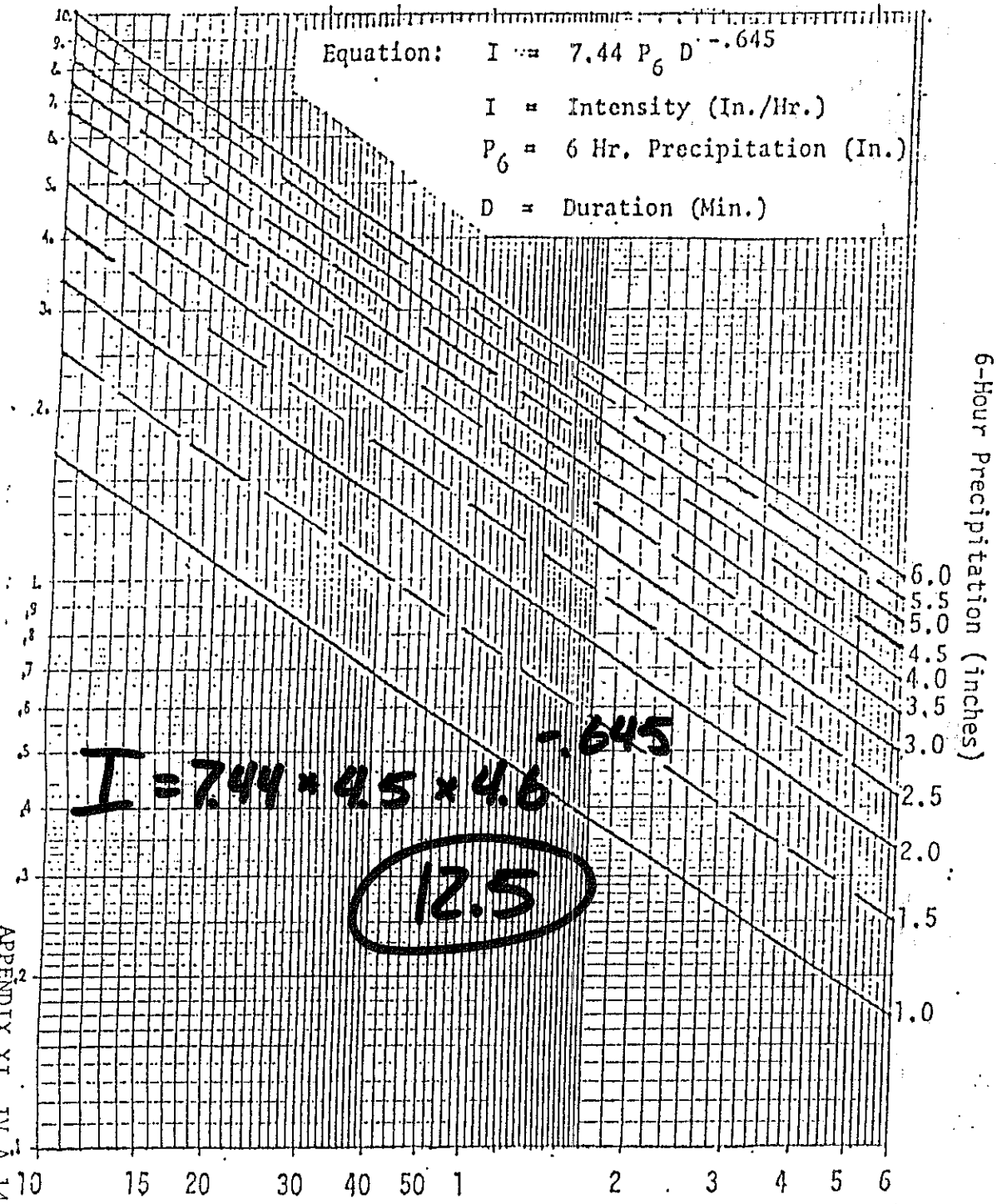
3) t_c = 12 min. $A_{EXIST} = A_{PROP} = 6$ AC

4) I = 6.7 in/hr.

*Not Applicable to Desert Region

$Q = 0.41(6.7)(6) = 16$ CFS (EXIST)
$Q = 0.41(6.7)(5.6) = 15$ CFS (PROP.)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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.

BASIN 3

Application Form:

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^*P_6}{P_{24}}$ = 56 %*

2) Adjusted $^*P_6$ = 4.5 in.

3) t_c = 4.6 min.

4) I = 12.5 in/hr.

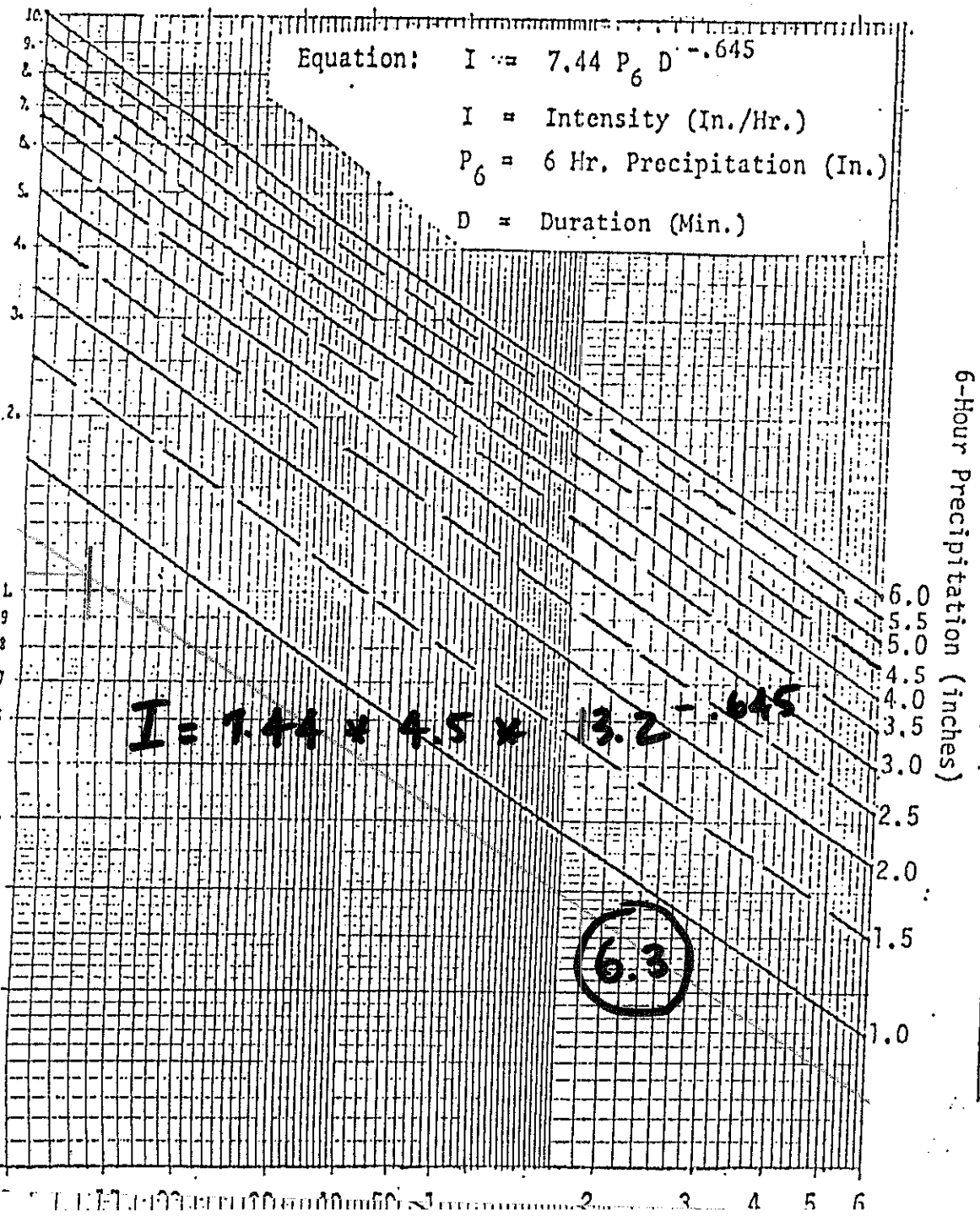
*Not Applicable to Desert Region

A=0.4 AC

Q=0.91(12.5)(0.4) = 4 CFS

(PROP. STREET)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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: BASIN 4

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^*P_6}{P_{24}}$ = 56 %*

2) Adjusted $^*P_6$ = 4.5 in.

3) t_c = 13.2 min. $A_{EXIST} = A_{PROP} = 5$ AC

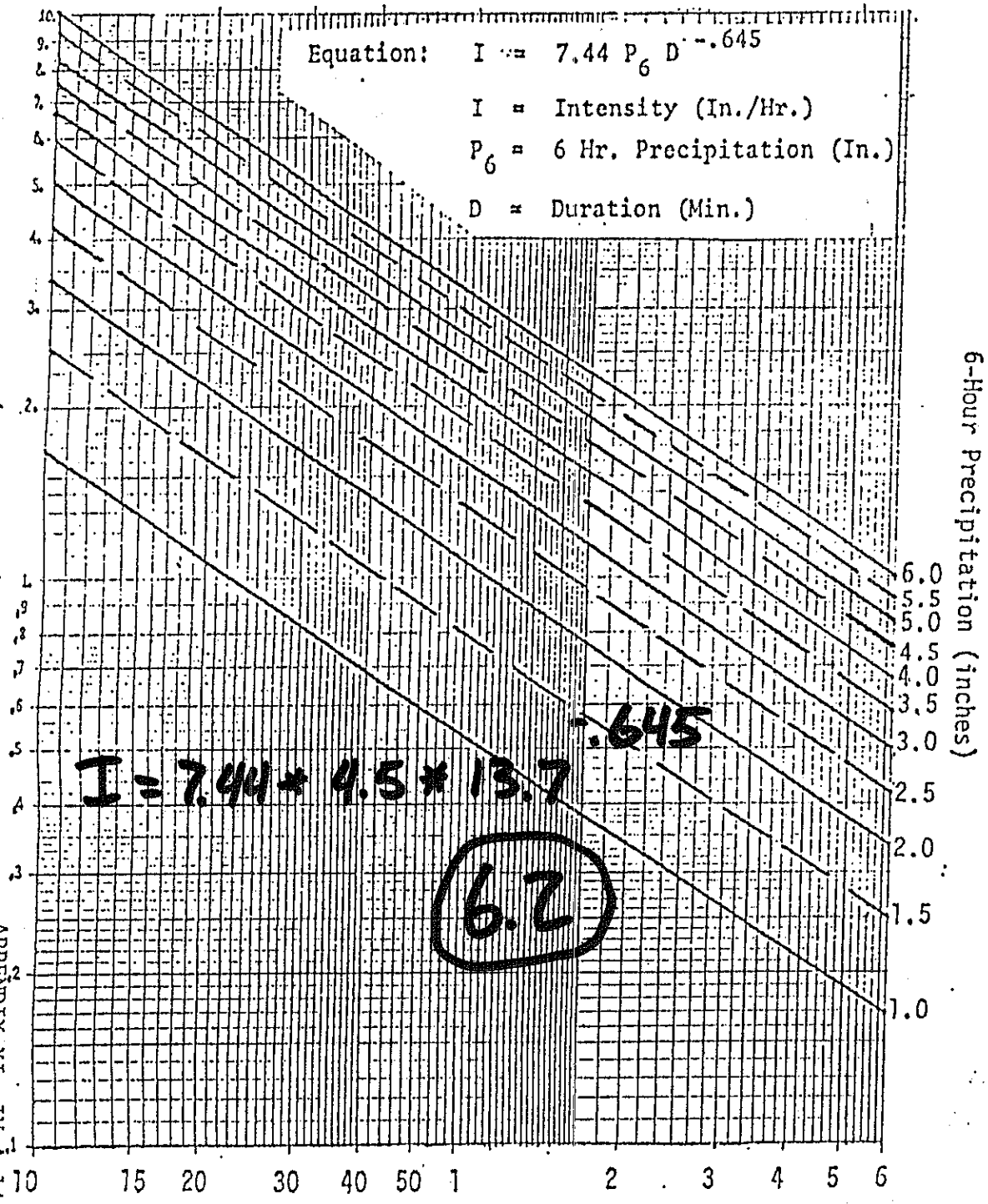
4) I = 6.3 in/hr.

*Not Applicable to Desert Region

Q = 0.41 (6.3) (5) = 13 CFS

Q_F = 0.42 (6.3) (5) 13 CFS (PROP)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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: BASIN 6

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^{*}P_6}{P_{24}}$ = 56 %*

2) Adjusted $^{*}P_6$ = 4.5 in.

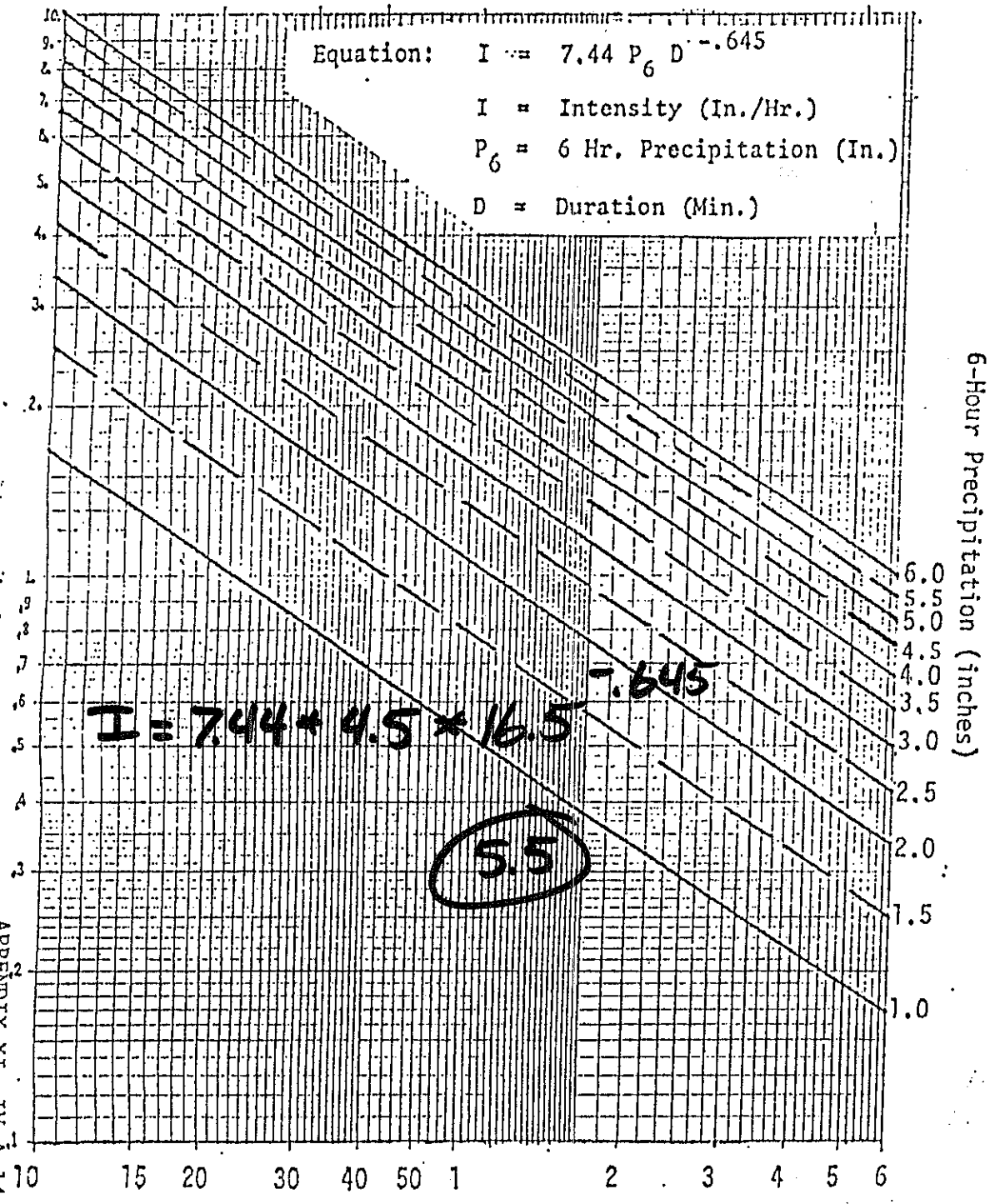
3) t_c = 13.7 min. $A_{EXIST} = A_{PROP} = 7AC$

4) I = 6.2 in/hr.

*Not Applicable to Desert Region

$Q = 0.41(6.2)(7) = 18$ CFS (EXIST. & PROP.)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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.

BASIN 7

Application Form:

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^*P_6}{P_{24}}$ = 56 %*

2) Adjusted $^*P_6$ = 4.5 in.

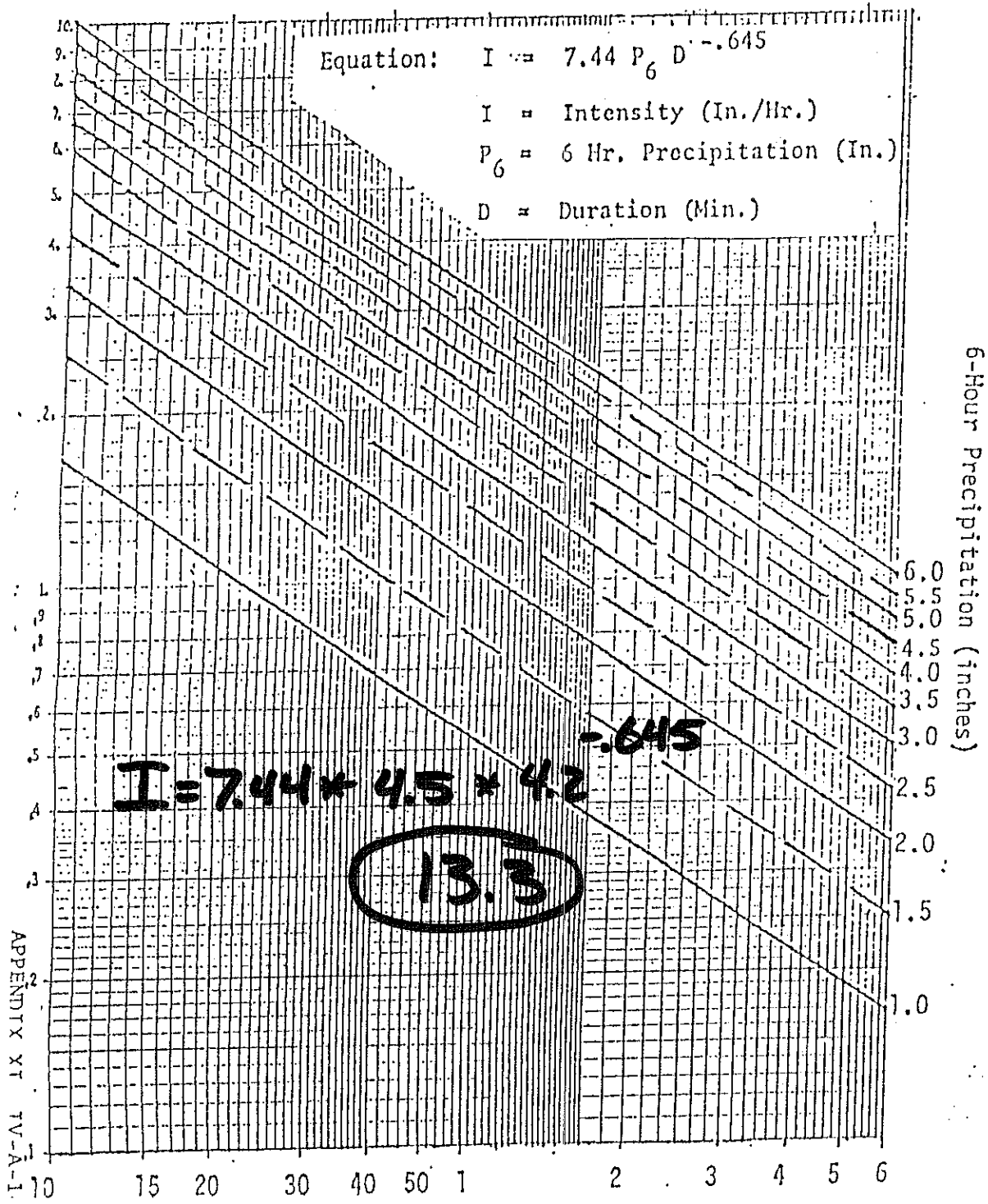
3) t_c = 16.5 min. $A_{EXIST} = A_{PROP} = 43$ AC

4) I = 5.5 in/hr.

*Not Applicable to Desert Region

Q = 0.41(5.5) 43 = 97 CFS (EXIST.)
Q = 0.41(5.5) 42 = 95 CFS (PROP.)

INTENSITY-DURATION DESIGN CHART



Directions for Application:

1) From precipitation maps determine 6 hr. and 24 hr. amounts for the selected frequency. These maps are printed 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 applicable 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.

BASIN 7

Application Form:

0) Selected Frequency 100 yr.

1) P_6 = 4.5 in., P_{24} = 8, $\frac{{}^*P_6}{P_{24}}$ = 56 %*

2) Adjusted $^*P_6$ = 4.5 in.

3) t_c = 4.2 min.

4) I = 13.3 in/hr.

*Not Applicable to Desert Region

A = 1 AC

Q = 0.91(13.3)(1) = 12 CFS

(PROP. STREET)

MODIFIED RATIONAL METHOD:

COMBINED STREET AND REMAINING DRAINAGE BASIN AREAS

BASIN 1

$Q_1 = 5$ CFS @ $T_c = 2.5$ MIN, $I = 18.5$ IN/HR

$Q_2 = 33$ CFS @ $T_c = 17.8$ MIN, $I = 5.2$ IN/HR

$Q_{T1} = 5 + \frac{2.5}{17.8}(33) = 9.6$ @ 2.5 MIN

$Q_{T2} = 33 + \frac{5.2}{18.5}(5) = 34$ CFS @ 17.8 MIN ← USE THIS

SAME AS EXISTING

BASIN 2

$Q_1 = 9$ CFS @ $T_c = 6.9$ MIN , $I = 9.6$ IN/HR
$Q_2 = 110$ @ $T_c = 19.8$ MIN , $I = 4.9$ IN/HR

$Q_{T1} = 9 + \frac{6.9}{19.8}(112) = 48$ CFS @ $T_c = 6.9$ MIN
$Q_{T2} = 112 + \frac{4.9}{9.6}(9) = 117$ @ $T_c = 19.8$ MIN. ← USE THIS

BASIN 3

$Q_1 = 4\,CFS$ @ $T_C = 4.6\,MIN$, $I = 12.5\ IN/HR$
$Q_2 = 15\,CFS$ @ $T_C = 12\,MIN$, $I = 6.7\ IN/HR$

$Q_{T1} = 4 + \frac{4.6}{12}(15) = 10\ CFS$ @ $4.6\,MIN$
$Q_{T2} = 15 + \frac{6.7}{12.5}(4) = 17\ CFS$ @ $T_C = 12\,MIN$ ← USE THIS

BASIN 5

$Q_1 = 1 \text{ CFS}$ @ $T_c = 5$ MIN, $I = 11.9$ IN/HR
$Q_2 = 11 \text{ CFS}$ @ $T_c = 12$ MIN, $I = 6.7$ IN/HR

$Q_{T1} = 1 + \frac{5}{12}(11) = 6$ CFS @ $T_c = 5$ MIN
$Q_{T2} = 11 + \frac{6.7}{11.9}(1) = 12$ CFS @ $T_c = 12$ MIN ← USE THIS

BASIN 7

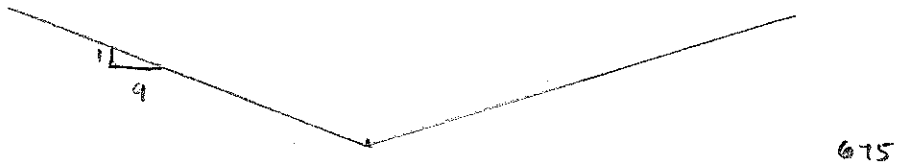
$Q_1 = 12 \text{ CFS} \ @ \ T_c = 4.2 \text{ MIN}, \quad I = 13.3 \text{ IN/HR}$

$Q_2 = 95 \text{ CFS} \ @ \ T_c = 16.5 \text{ MIN}, \quad I = 5.5 \text{ IN/HR}$

$Q_{T1} = 12 + \frac{4.2}{16.5}(95) = 36 \text{ CFS} \ @ \ 4.2 \text{ MIN}$

$Q_{T2} = 95 + \frac{5.5}{13.3}(12) = 100 \text{ CFS} \ @ \ 16.5 \text{ MIN}$ ←

NORTHERLY SWALE - EXISTING AND PROPOSED CONDITIONS



Q= 97 CFS (EXIST), Q= 100 CFS (PROP.)

n= .05

S ≈ 0.10

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Assume d	A	Pw	R	Q	y
1'	9	18	.5	53	5.9
1.2'	10.8	21.6	.5	64	
1.5'	13.5	27.2	.5	80	
1.9'	17.1	34.4	.5	101	5.9 ←

SOUTHERLY SWALE - EXISTING & PROPOSED CONDITIONS

Q = 115 CFS (EXIST.), Q = 117 CFS (PROP) $Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

n = .03

S = .025

Assume d	A	P_w	R	Q	V
2	14	28.2	.49	68	
2.5	17.5	35.4	.49	86	
3	21	42.4	.49	103	
3.2	22.4	45.3	.49	110	
3.3	23.1	46.7	.49	113	
3.4	23.8	48.1	.49	117	4.9 ←

(EXISTING & PROPOSED)

TABLE 2

RUNOFF COEFFICIENTS (RATIONAL METHOD)

DEVELOPED AREAS (URBAN)

Land Use	Coefficient, C Soil Group (1) A	B	C	D
Residential:				
Single Family	.40	.45	.50	.55
Multi-Units	.45	.50	.60	.70
Mobile homes	.45	.50	.55	.65
Rural (lots greater than 1/2 acre)	.30	.35	.40	.45
Commercial (2) 80% Impervious	.70	.75	.80	.85
Industrial (2) 90% Impervious	.80	.85	.90	.95

$C_{WEIGHTED} = .35(.15) + .4(.5) + .45(.35) = .41$

NOTES:

(1) Soil Group maps are available at the offices of the Department of Public Works.

(2) Where actual conditions deviate significantly from the tabulated imperviousness values of 80% or 90%, the values given for coefficient C, may be revised by multiplying 80% or 90% by the ratio of actual imperviousness to the tabulated imperviousness. However, in no case shall the final coefficient be less than 0.50. For example: Consider commercial property on D soil group.

Actual imperviousness = 50%

Tabulated imperviousness = 80%

Revised $C = \frac{50}{80} \times 0.85 = 0.53$

TABLE 2

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Commercial (2) 80% Impervious	.70	.75	.80	.85
Industrial (2) 90% Impervious	.80	.85	.90	.95

$C_{WEIGHTED} = .85(.15) + .9(.5) + .95(.35) = 0.91$

NOTES:

(1) Soil Group maps are available at the offices of the Department of Public Works.

(2) Where actual conditions deviate significantly from the tabulated imperviousness values of 80% or 90%, the values given for coefficient C, may be revised by multiplying 80% or 90% by the ratio of actual imperviousness to the tabulated imperviousness. However, in no case shall the final coefficient be less than 0.50. For example: Consider commercial property on D soil group.

Actual imperviousness = 50%

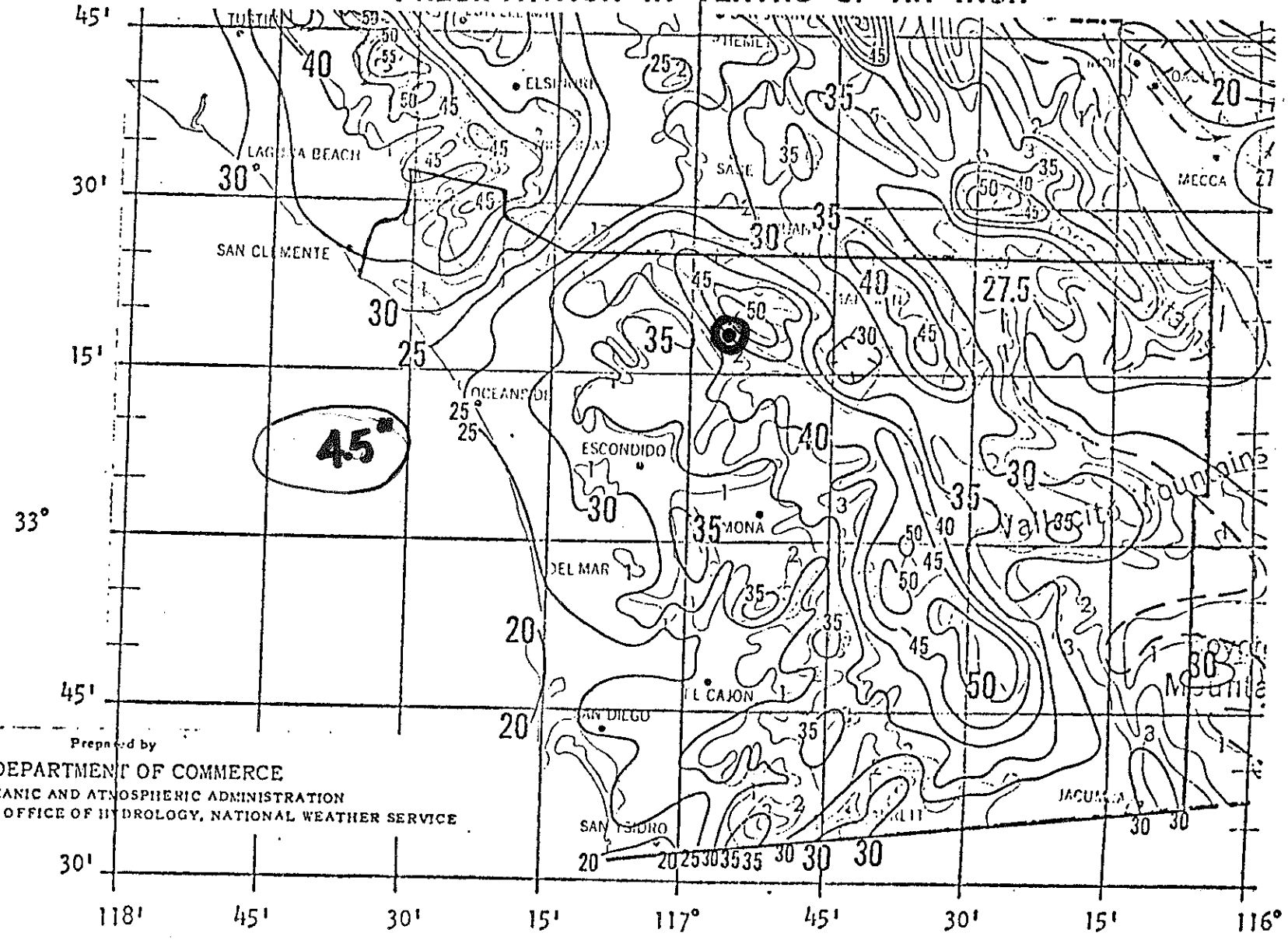
Tabulated imperviousness = 80%

Revised $C = \frac{50}{80} \times 0.85 = 0.53$

COUNTY OF SAN DIEGO
DEPARTMENT OF SANITATION &
FLOOD CONTROL

100-YEAR 6-HOUR PRECIPITATION

~20~ ISOPLUVIALS OF 100-YEAR 6-HOUR PRECIPITATION IN TENTHS OF AN INCH

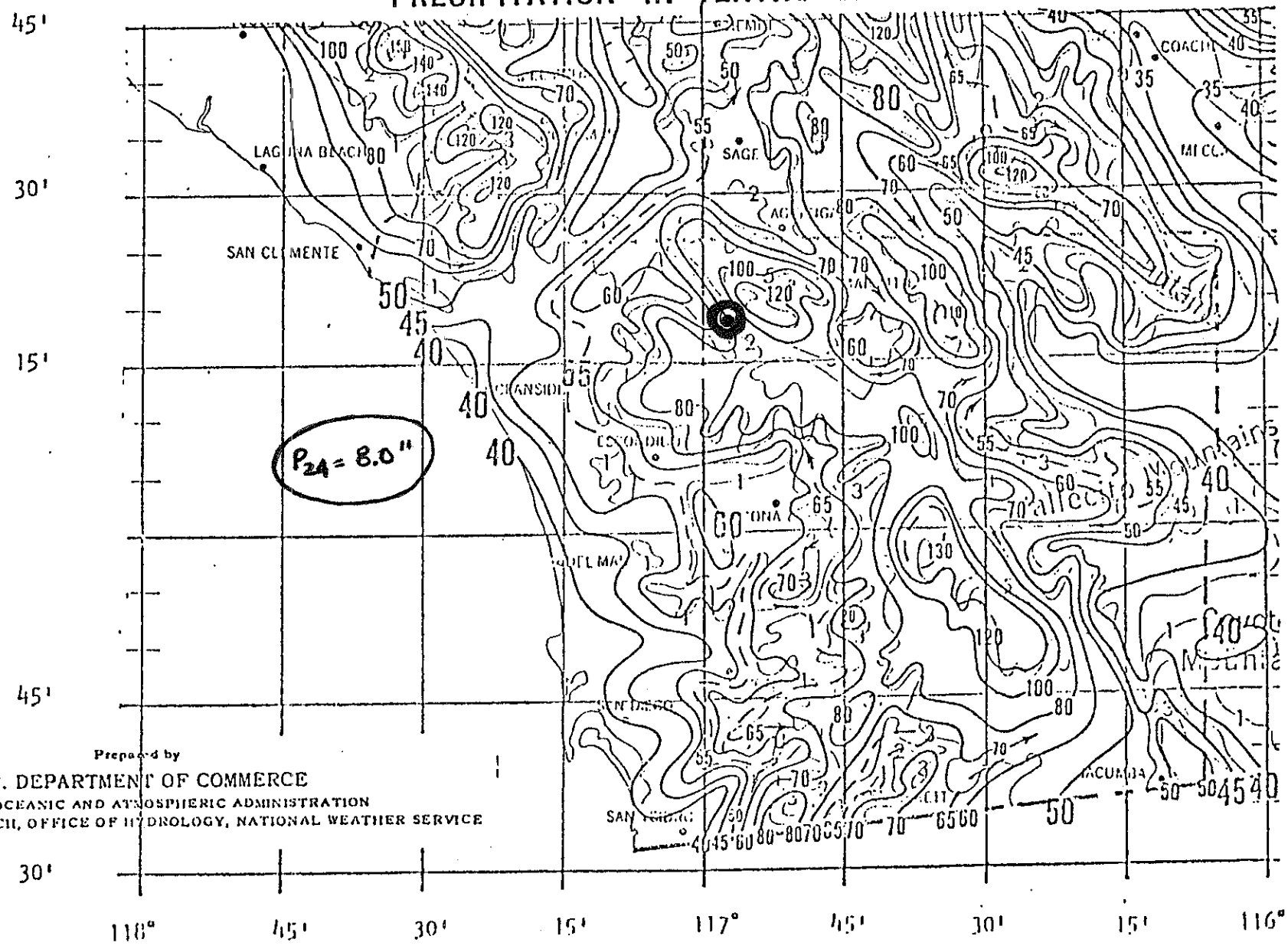


Prepared by
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SPECIAL STUDIES BRANCH, OFFICE OF HYDROLOGY, NATIONAL WEATHER SERVICE

COUNTY OF SAN DIEGO
DEPARTMENT OF SANITATION &
FLOOD CONTROL

100-YEAR 24-HOUR PRECIPITATION

(20) ISOPLUVIALS OF 100-YEAR 24-HOUR PRECIPITATION IN TENTHS OF AN INCH



Prepared by
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SPECIAL STUDIES BRANCH, OFFICE OF HYDROLOGY, NATIONAL WEATHER SERVICE

BASIN 1

~~RESID~~ EXIST AND PROP.

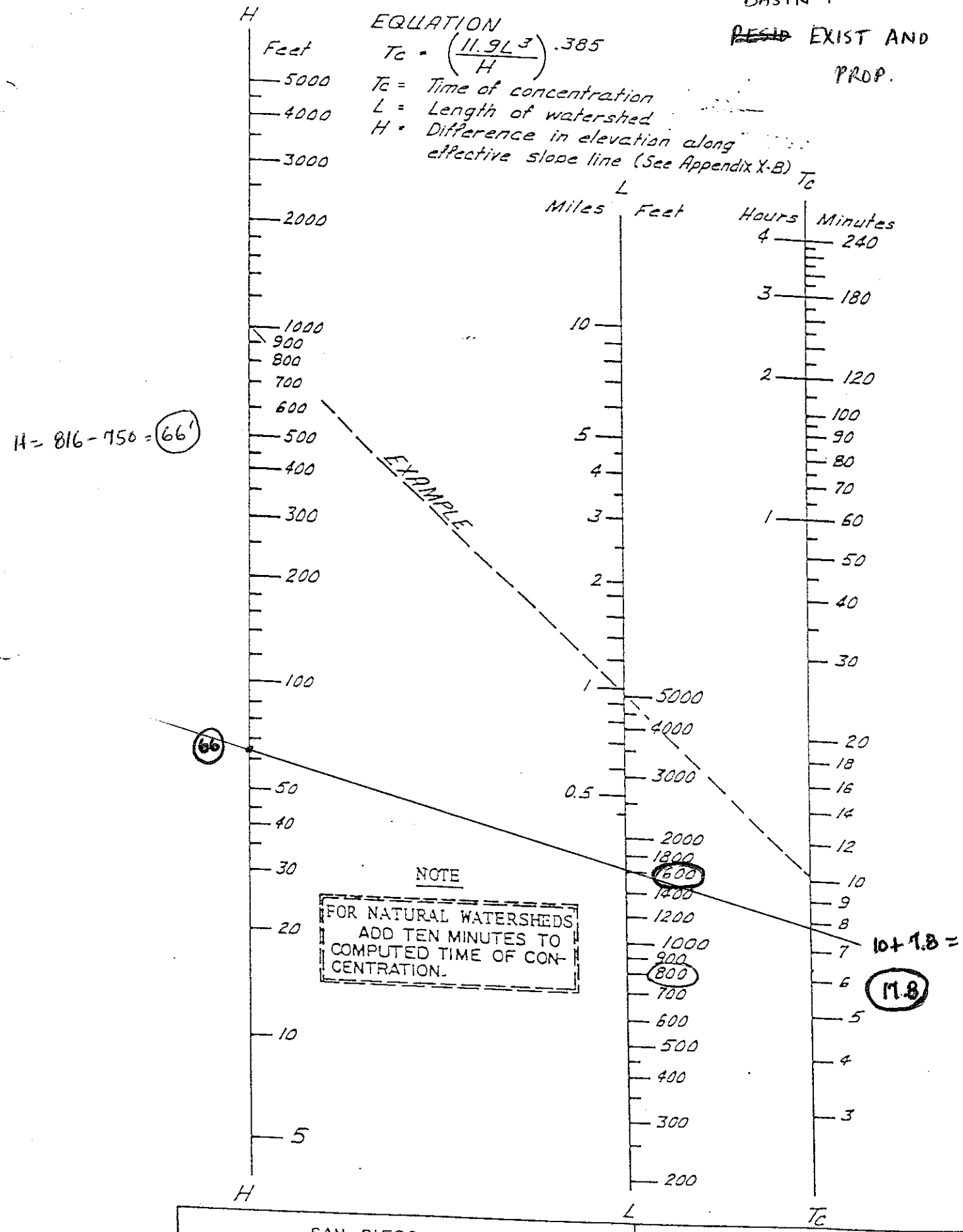
EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration

L = Length of watershed

H = Difference in elevation along effective slope line (See Appendix X-B)



SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B. H. Hoffmaster	NOMOGRAPH FOR DETERMINATION OF TIME OF CONCENTRATION (Tc) FOR NATURAL WATERSHEDS
	DATE 12/1/69 — APPENDIX X-

BASIN 1

PROPOSED STREET

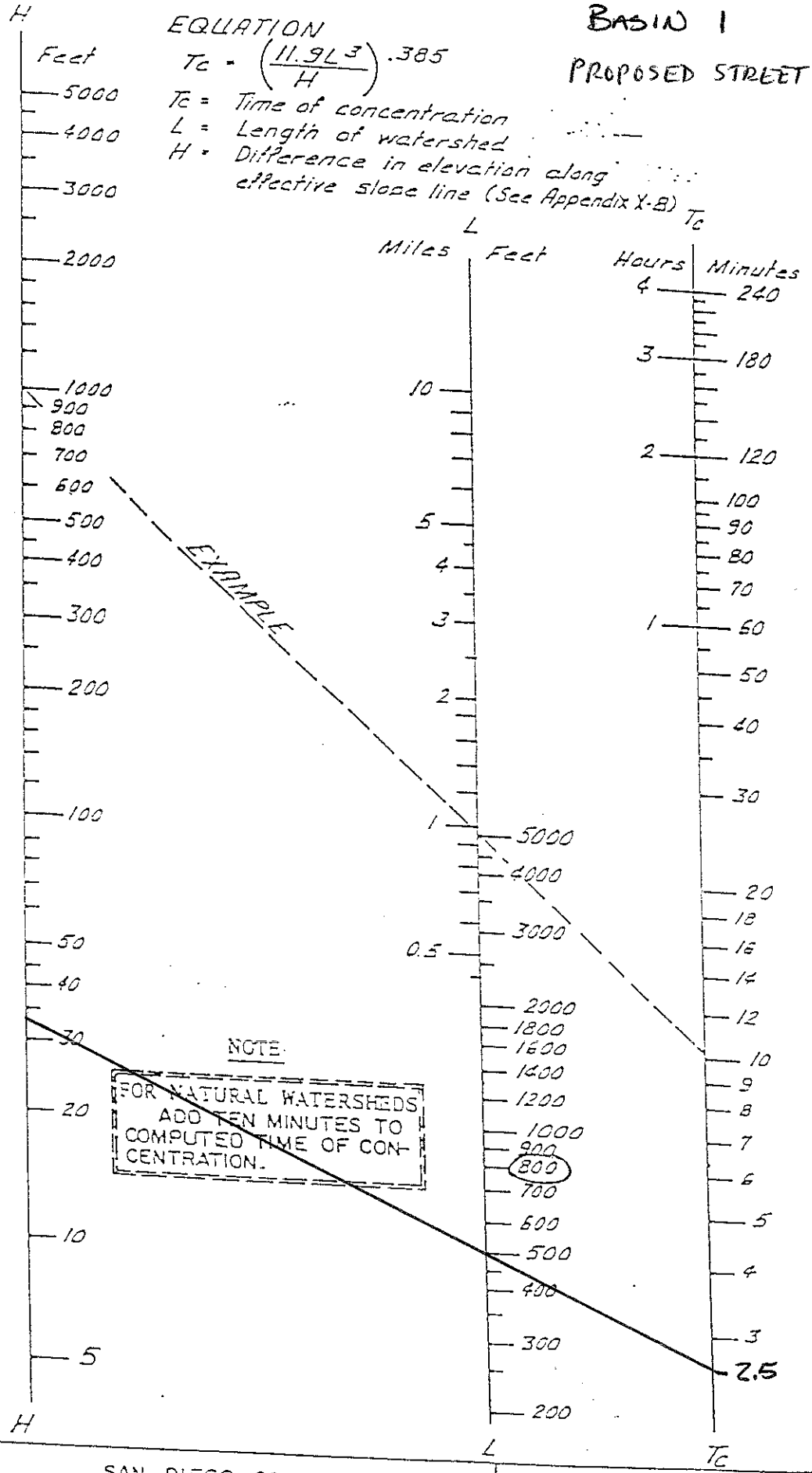
EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration

L = Length of watershed

H = Difference in elevation along effective slope line (See Appendix X-B)



SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B.H. Holmes	NOMOGRAPH FOR DETERMINATIO OF TIME OF CONCENTRATION (T FOR NATURAL WATERSHEDS
	DATE 12/1/69

BASIN 2

EXIST. & PROP.

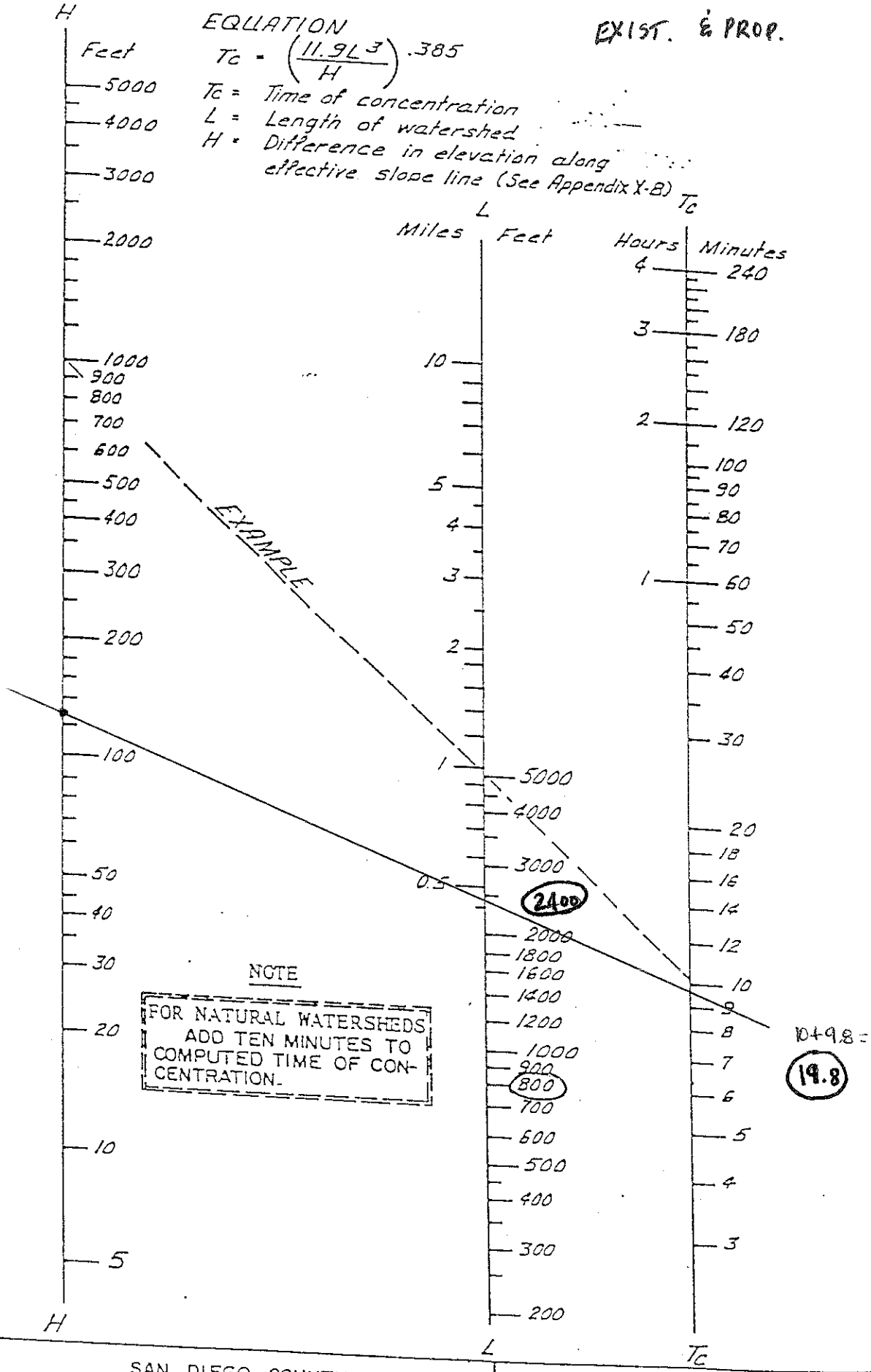
EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration

L = Length of watershed

H = Difference in elevation along effective slope line (See Appendix X-B)



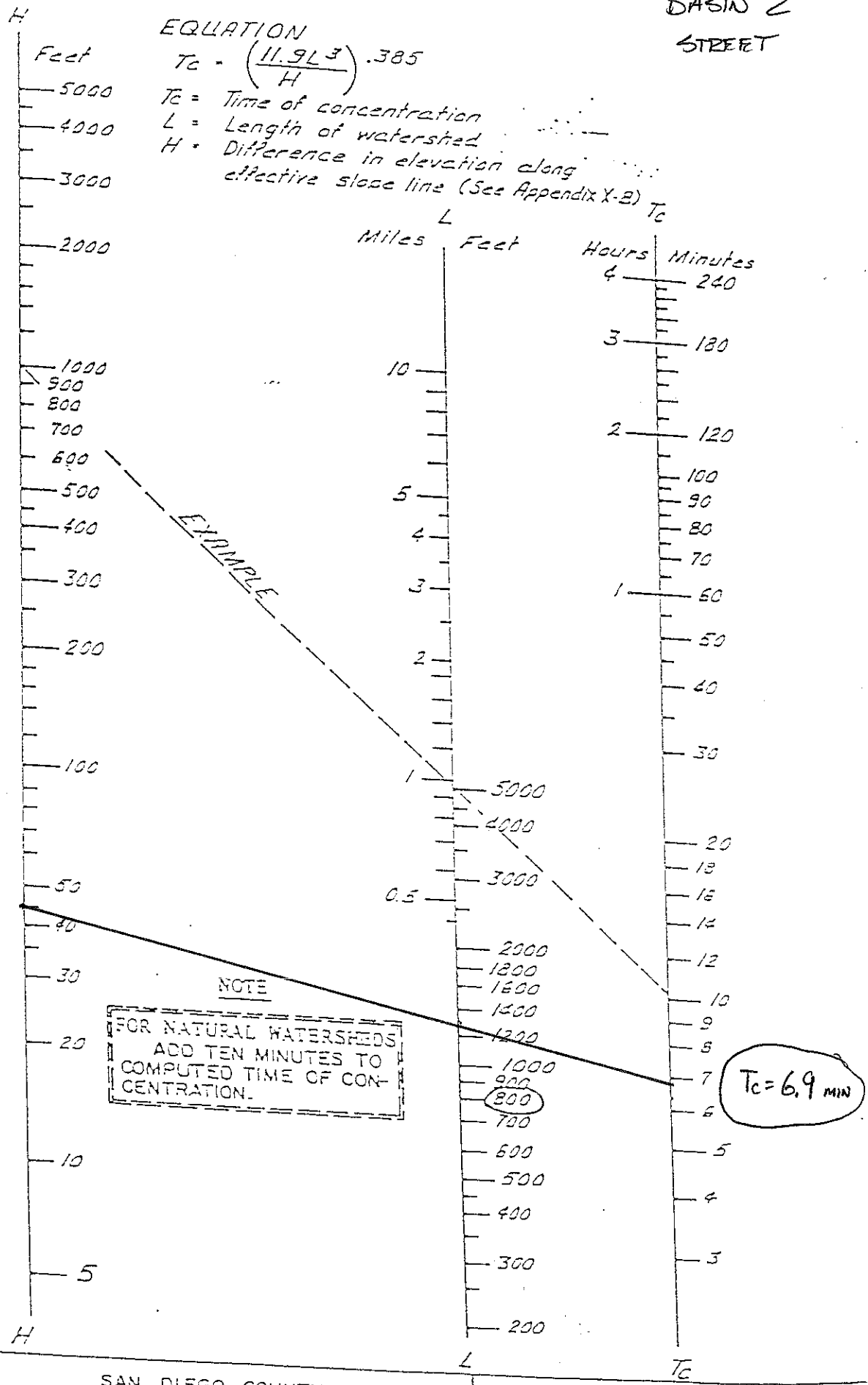
SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B. H. Hofmeister	NOMOGRAPH FOR DETERMINATION OF TIME OF CONCENTRATION (Tc) FOR NATURAL WATERSHEDS
	DATE 12/1/69

BASIN 2
STREET

EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-B)



SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED D. H. Hohmuth	NOMOGRAPH FOR DETERMINAT OF TIME OF CONCENTRATION (FOR NATURAL WATERSHEDS
	DATE 12/1/69

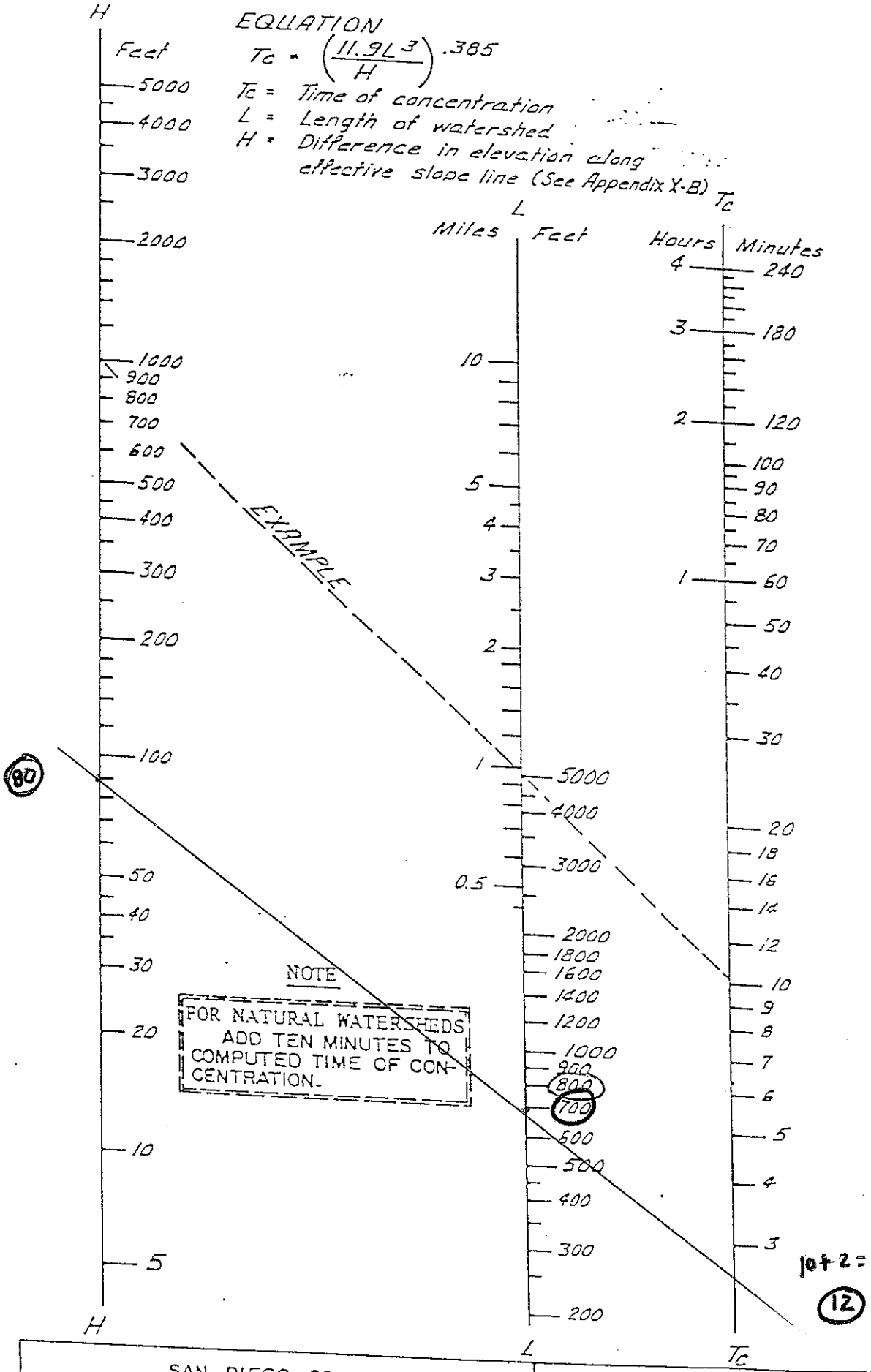
BASIN 3

EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-B)

H = 895 - 795



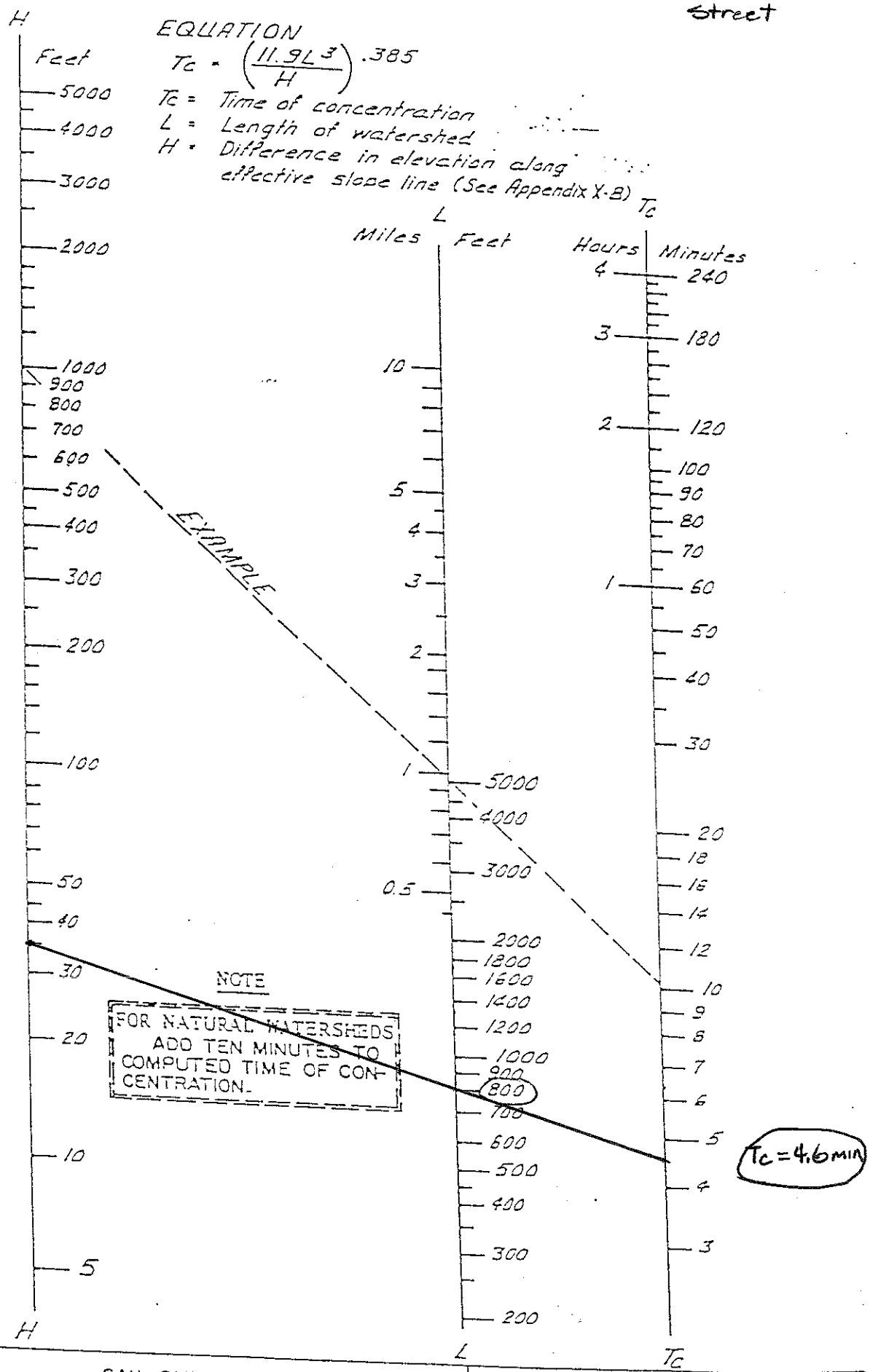
SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B.H. Holmacker	NOMOGRAPH FOR DETERMINATIO OF TIME OF CONCENTRATION (T FOR NATURAL WATERSHEDS
	DATE 12/1/67 — APPENDIX

BASIN 3
street

EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-B)



SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B.H. [illegible]	NOMOGRAPH FOR DETERMINATIO OF TIME OF CONCENTRATION (T FOR NATURAL WATERSHEDS
	DATE 12/1/69 — APPENDIX

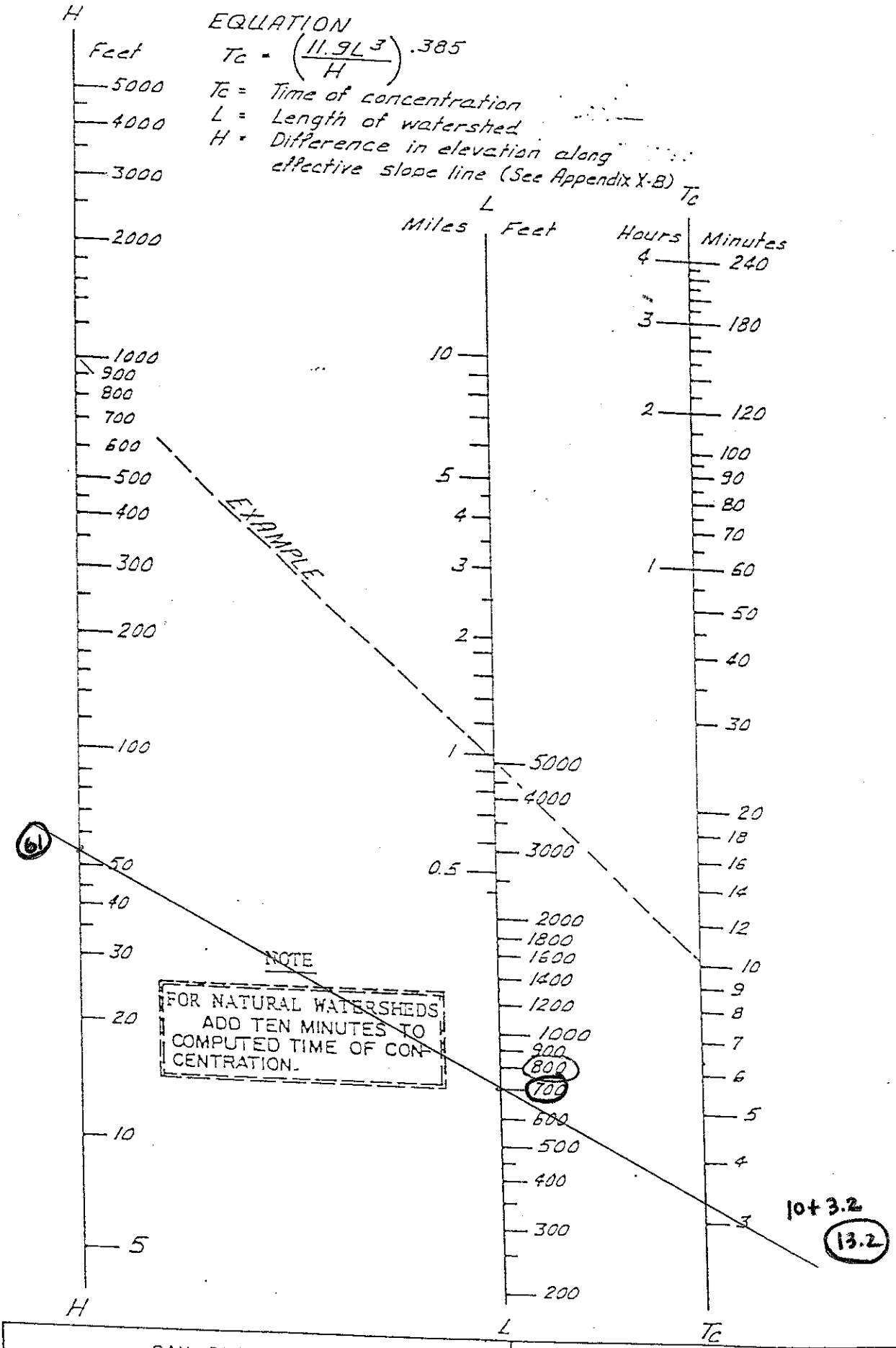
BASIN 4

EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-B)

H= 886-825



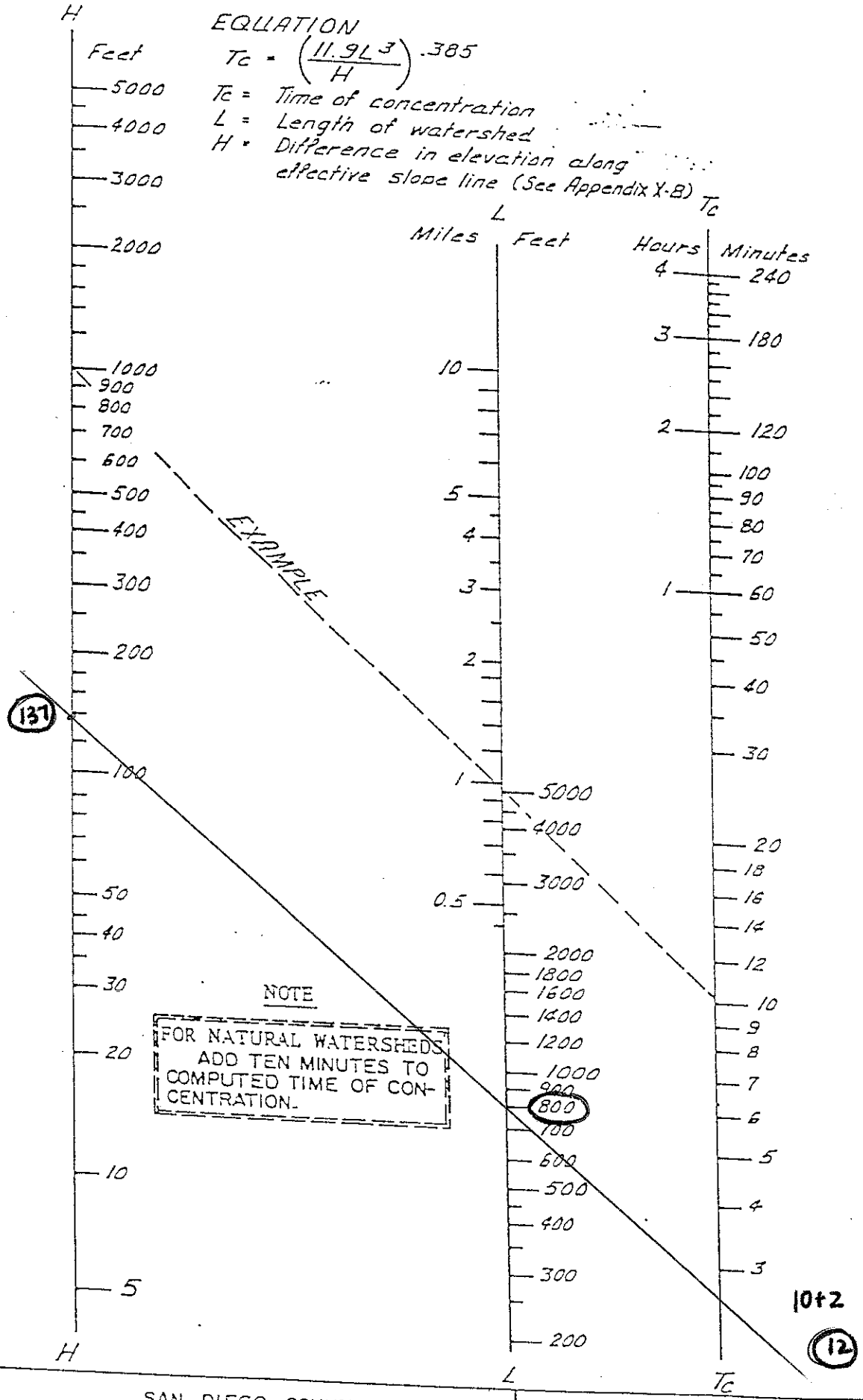
SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B. H. Hoffmacher	NOMOGRAPH FOR DETERMINATION OF TIME OF CONCENTRATION (Tc) FOR NATURAL WATERSHEDS
	DATE 12/1/69 — APPENDIX X

BASIN 5

EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-B)

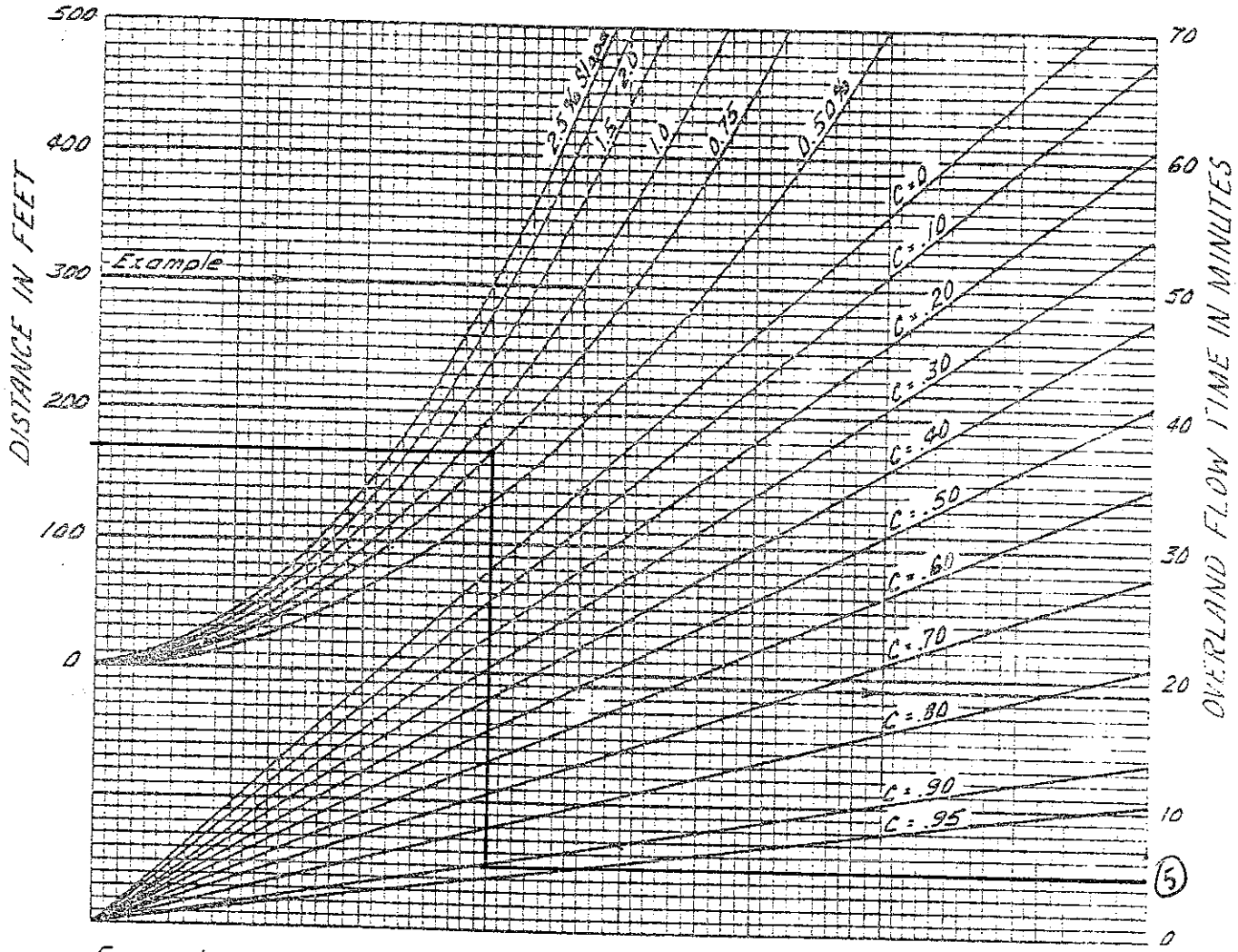


H= 817 - 680

SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B. H. Holmacker	NOMOGRAPH FOR DETERMINATION OF TIME OF CONCENTRATION (Tc) FOR NATURAL WATERSHEDS
	DATE 12/1/69
	APPENDIX

BASIN 5
STREET

URBAN AREAS OVERLAND TIME OF FLOW CURVES



Example:
Given: Length of Flow = 300 ft.
Slope = 1.0 %
Coefficient of Runoff. C = .50
Read: Overland Flowtime = 19 Minutes

L=170
S=1.0%
C=0.91
Tc=5 min.

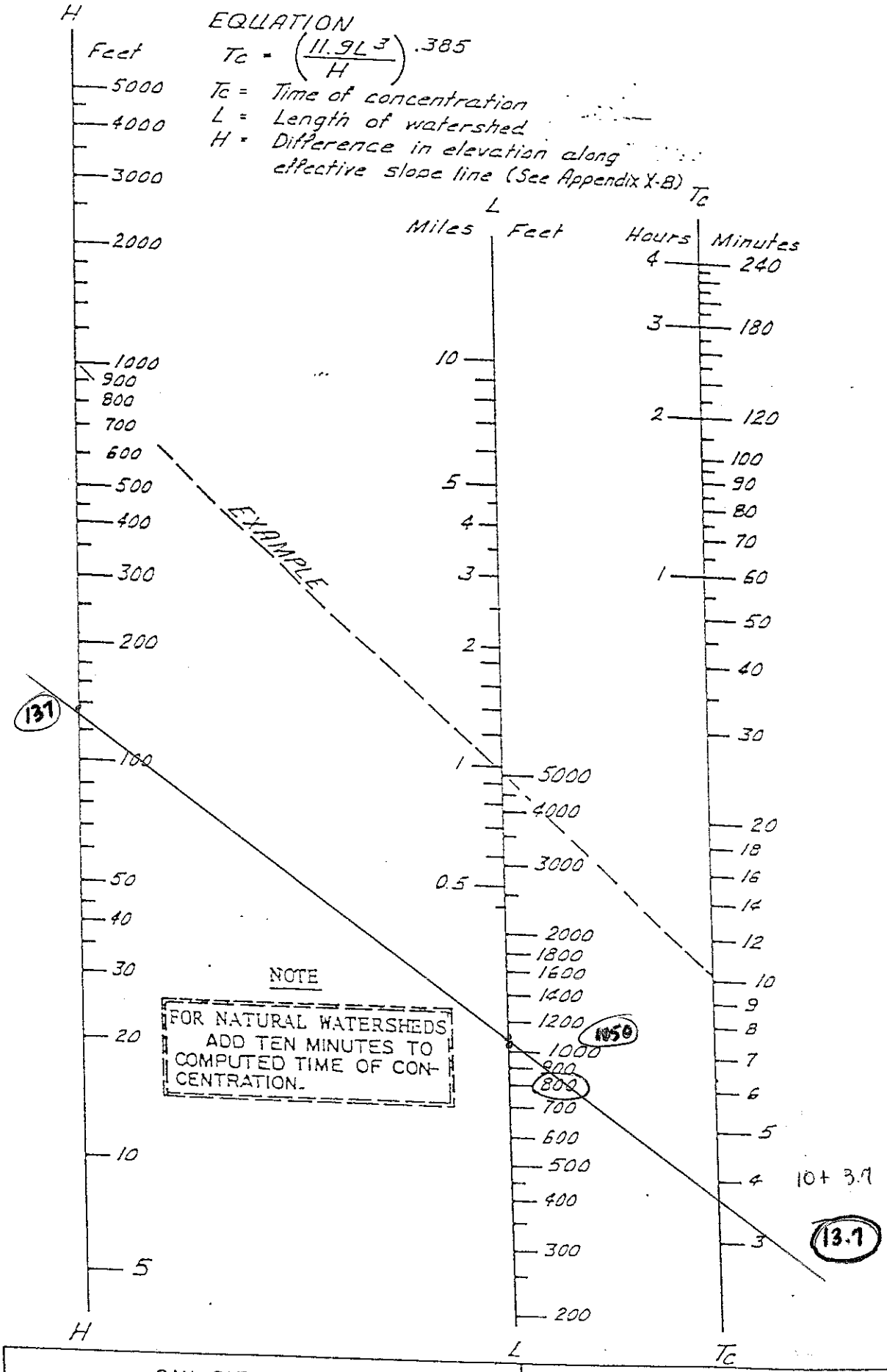
SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED [illegible]	URBAN AREAS OVERLAND TIME OF FLOW CURVES DATE 12/1/69 APPENDIX X-C

BASIN 6

EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-B)



H = 817 − 680

10 + 3.7

SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B. H. Hohmacher	NOMOGRAPH FOR DETERMINATION OF TIME OF CONCENTRATION (Tc) FOR NATURAL WATERSHEDS
	DATE 12/1/69 — APPENDIX X

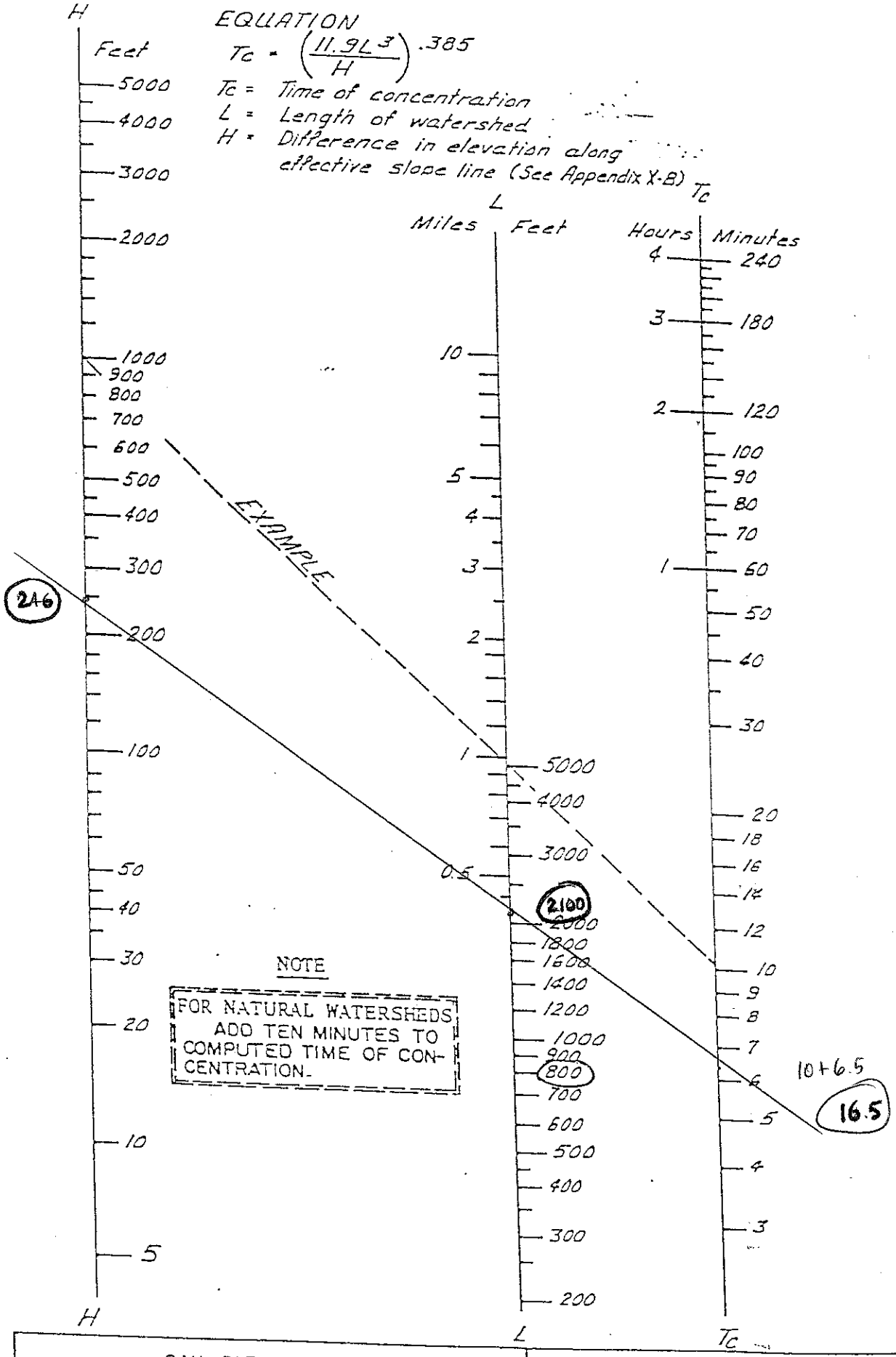
BASIN 7

EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-8)

H = 896 - 650



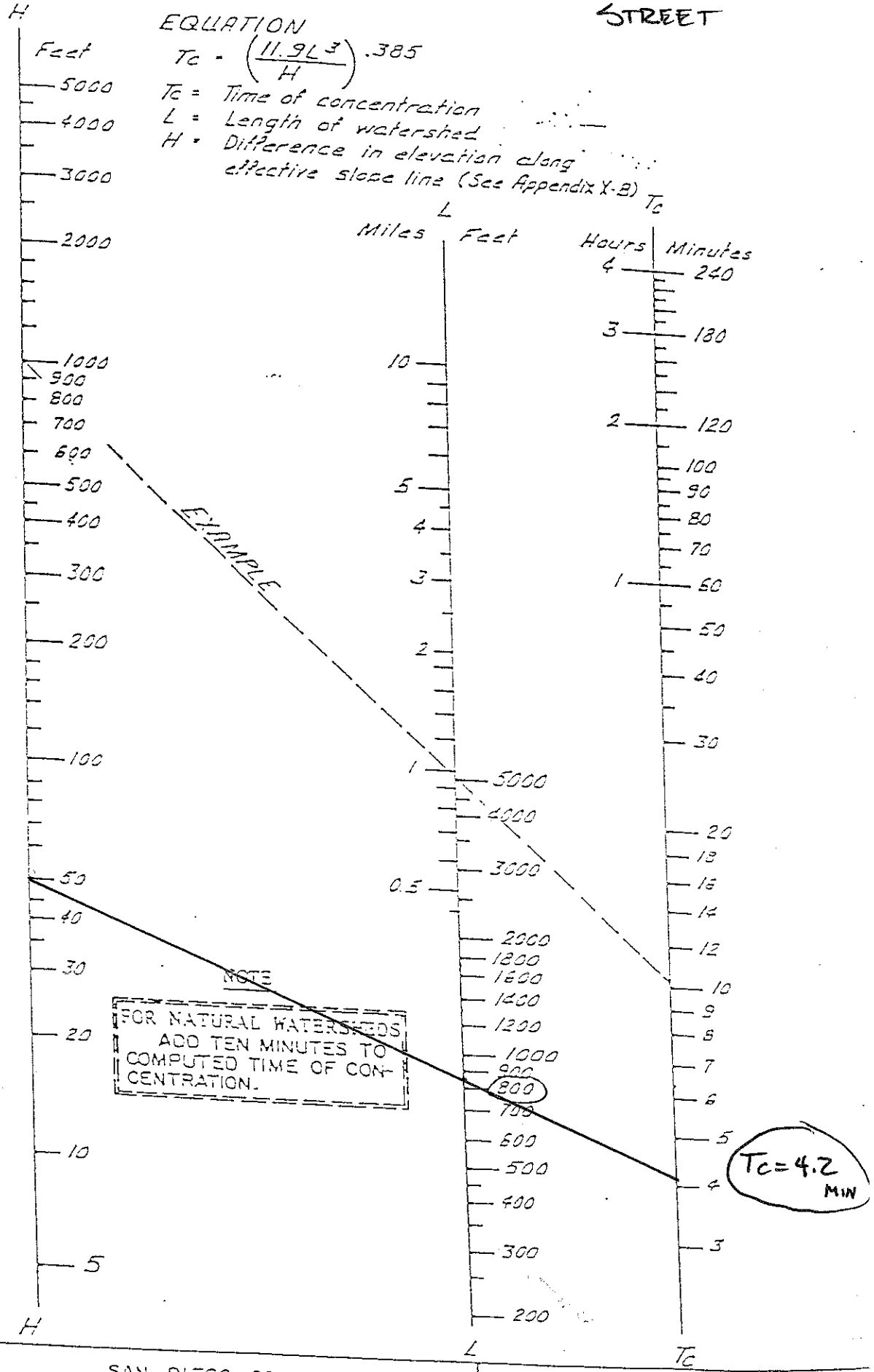
SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B.H. Kuhnacker	NOMOGRAPH FOR DETERMINATION OF TIME OF CONCENTRATION (Tc) FOR NATURAL WATERSHEDS DATE 12/1/69 APPENDIX

BASIN 7
STREET

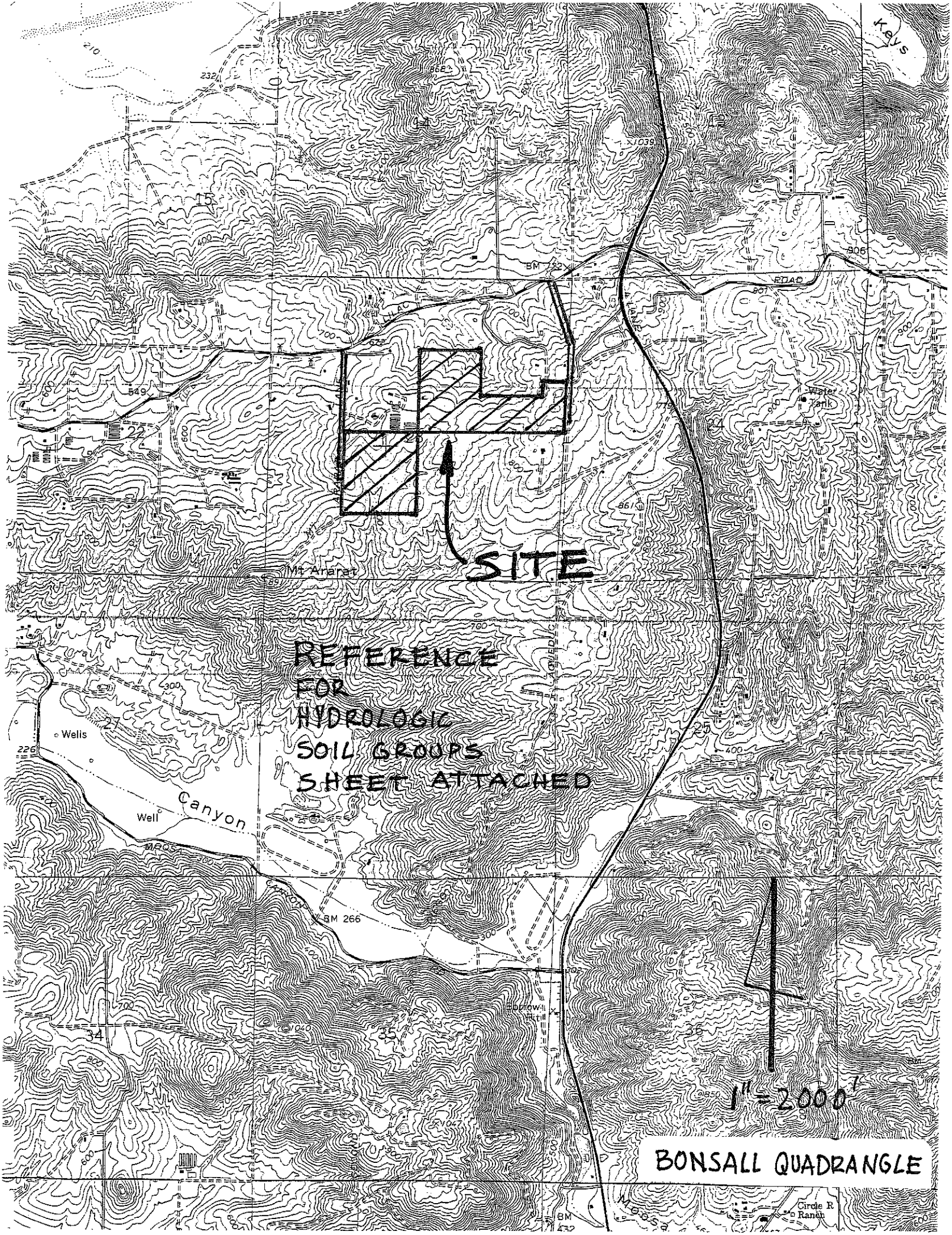
EQUATION

$$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$$

T_c = Time of concentration
L = Length of watershed
H = Difference in elevation along effective slope line (See Appendix X-B)



SAN DIEGO COUNTY DEPARTMENT OF SPECIAL DISTRICT SERVICES DESIGN MANUAL APPROVED B. H. Hahnenkamp	NOMOGRAPH FOR DETERMINATI OF TIME OF CONCENTRATION (FOR NATURAL WATERSHEDS
	DATE 12/1/69 — APPENDI


SITE
REFERENCE
FOR
HYDROLOGIC
SOIL GROUPS
SHEET ATTACHED
Mt Ararat
Wells
Well
Canyon
Water Tank
BM 266
Circle R Ranch
1" = 2000'
BONSALL QUADRANGLE

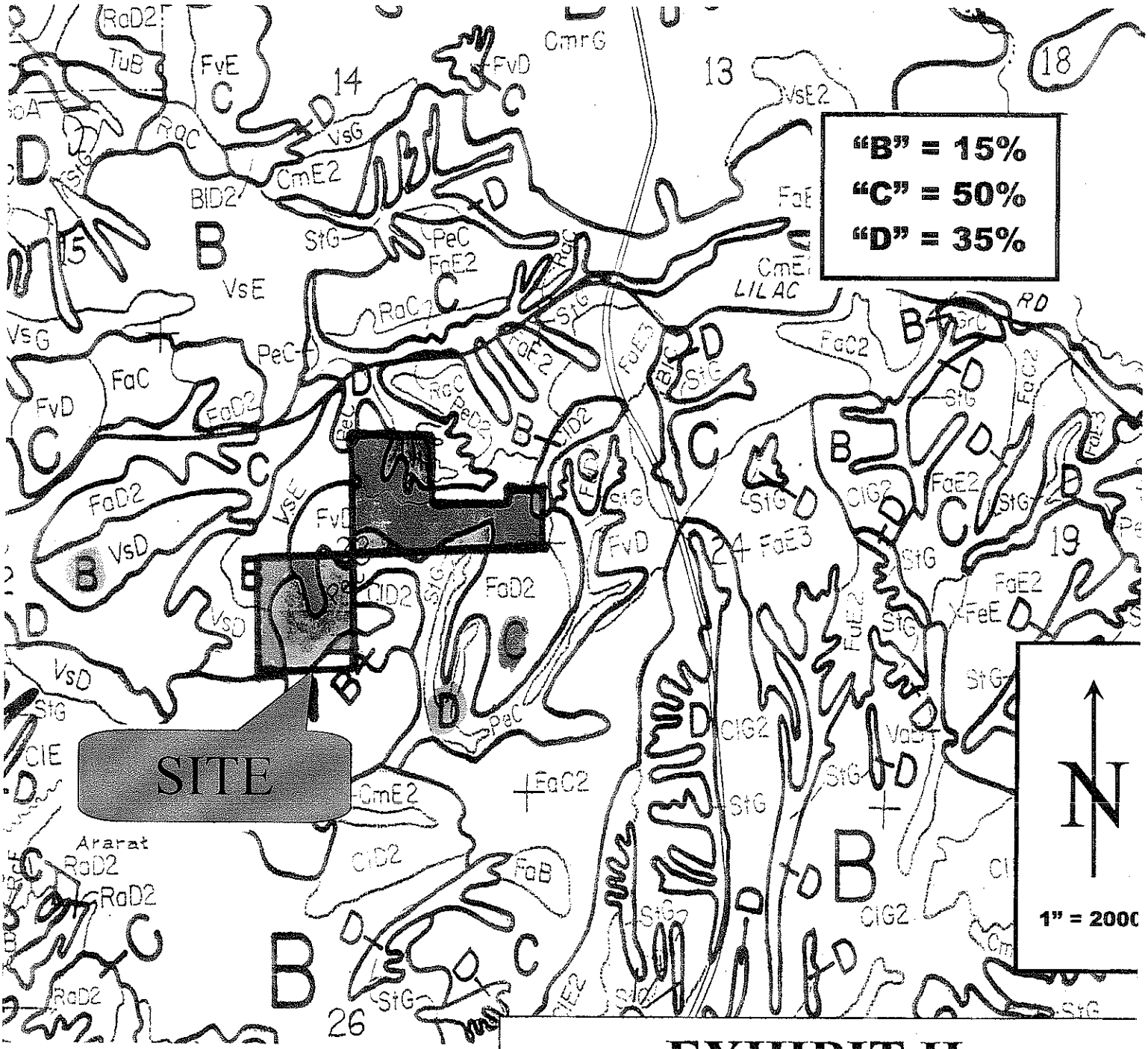


EXHIBIT H:

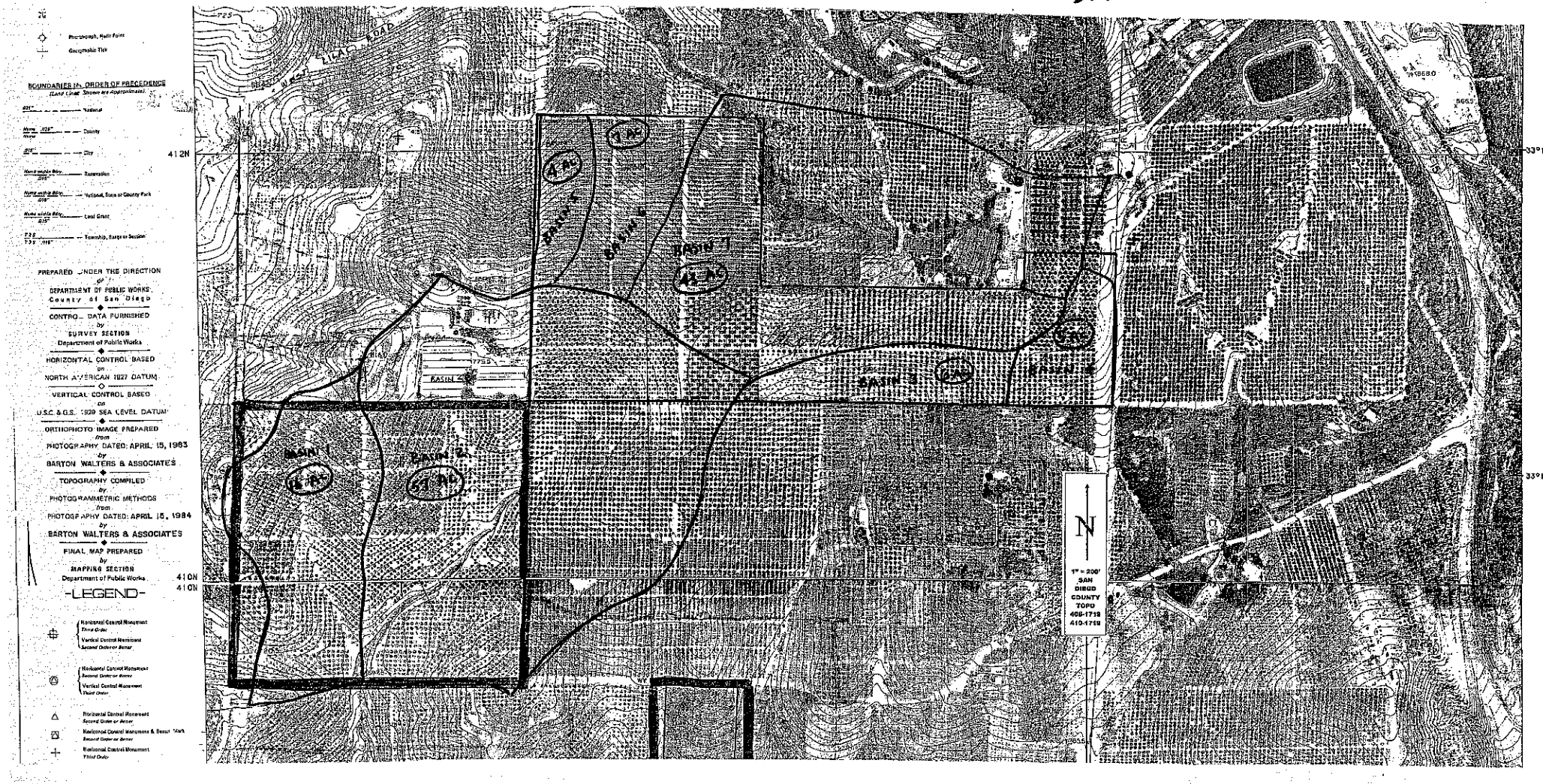
ON-SITE HYDROLOGIC SOIL GROUPS

Sheet No: 12

Sheet Name: Bonsall

WEST LILAC FARMS TM 5276

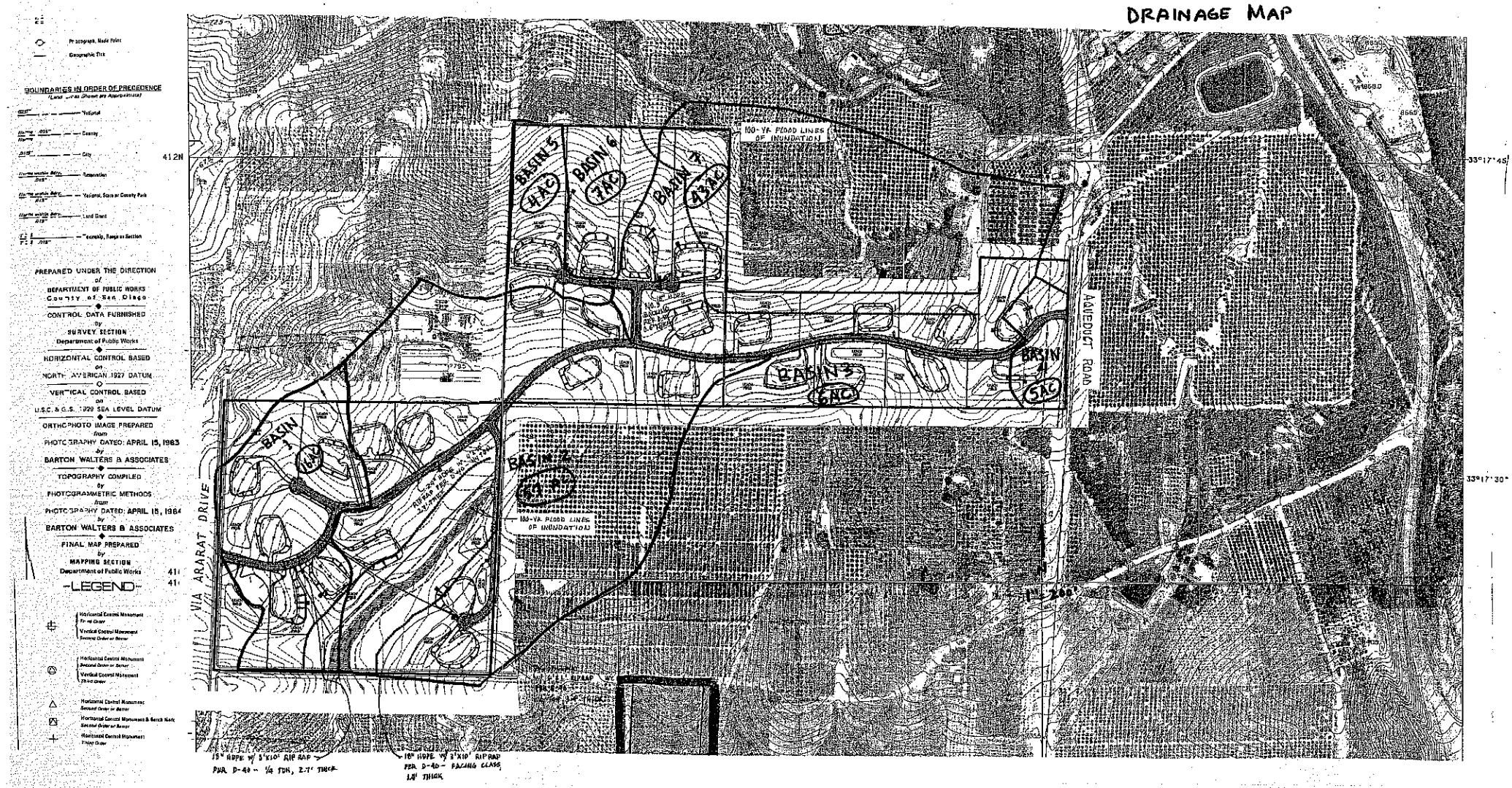
EXISTING CONDITION
DRAINAGE MAP

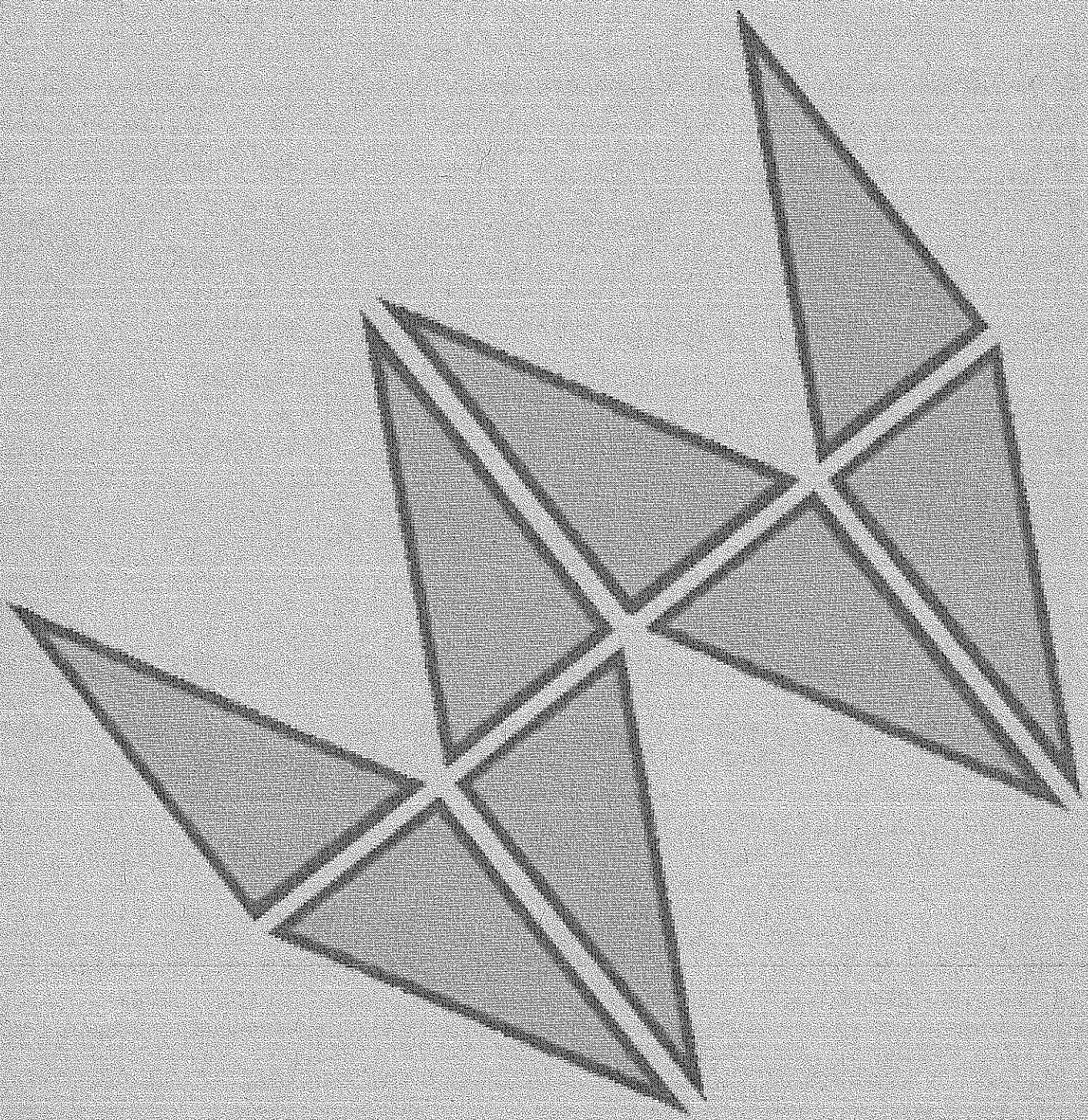


WEST LILAC FARMS TM 5276

PROPOSED CONDITION

DRAINAGE MAP





ONSITE

WALSH ENGINEERING
& SURVEYING, INC.

DRAINAGE STUDY
for
Aqueduct Road & Via Ararat Drive
in connection with
West Lilac Farms
Tentative Map 5276

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

Lawrence W. Walsh, RCE 46316 — 5/25/05 Date

Prepared for:
James D. Pardee, Jr.
267 Stonecreek Court
Westlake Village, CA 91361
(Walsh Engineering Job No 01246)

1870 Cordell Court, Suite 102 • El Cajon CA 92020 • Phone (619) 588-6747 • Fax (619) 448-7132
www.walsh-engineering.com

Table of contents

	Section
Introduction, Vicinity Map	A
Via Ararat Dive	B
Aqueduct Road	C
Appendix (Reference Tables, Plans and Maps)	D

Section A

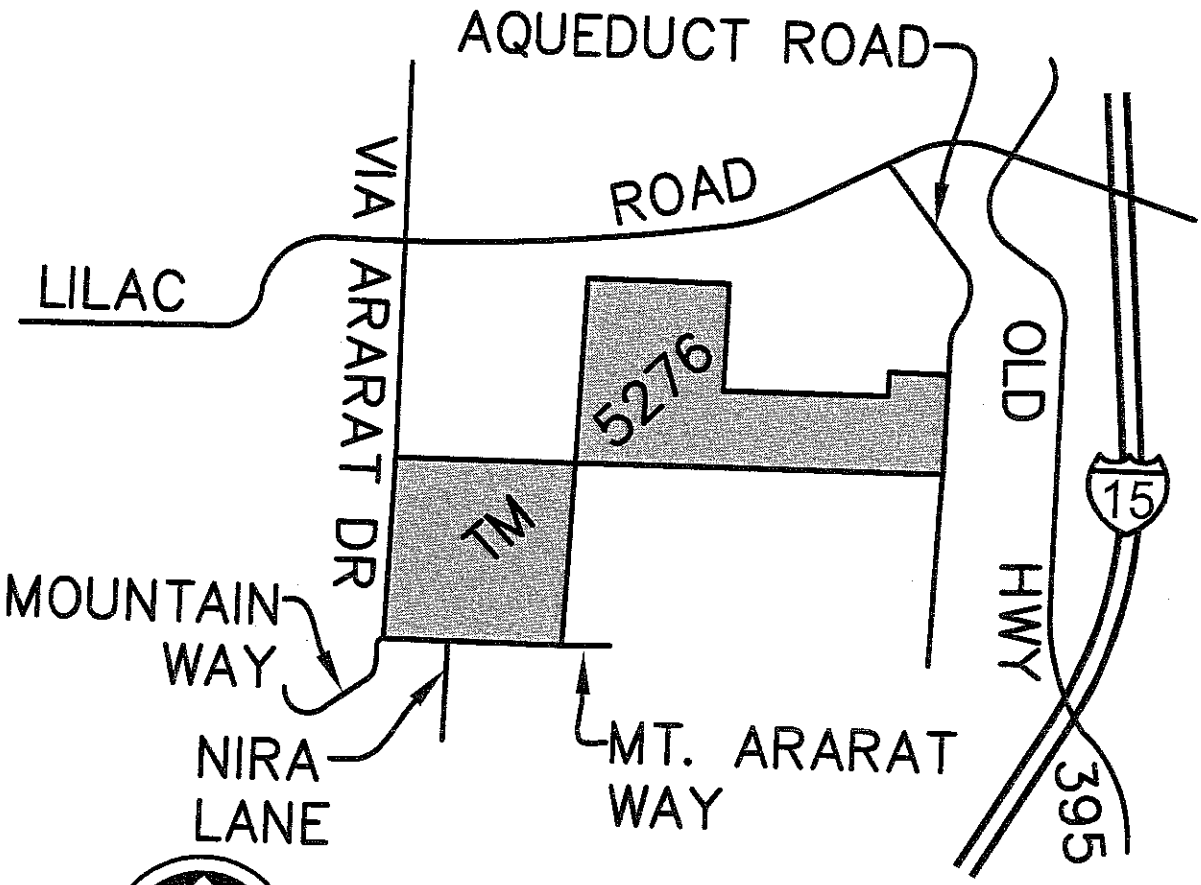
INTRODUCTION

This drainage study is for the offsite improvements of Tentative Map, TM 5276. This study focuses on the existing and proposed improvements of Aqueduct Road and Via Ararat Drive. For the onsite drainage study, please refer to the original "Drainage Study for West Lilac Farms, Tentative Map 5276 dated May 24, 2004".

In the existing condition, Aqueduct Road runs along the easterly side of TM 5276 northerly to West Lilac Road. The road is approximately 20 feet wide and is paved in the northerly section and DG in the southerly section. In the proposed condition the road will be widened to 24-foot paved with 2-foot DG shoulders along both sides of the road. The existing cross slopes of the road will be maintained.

In the existing condition, Via Ararat Drive is approximately 20 feet wide. The surface of the road is paved with AC and is located on the easterly side of a 40-foot private road easement. In the proposed condition the road will be widened to 24-foot paved with 2-foot DG shoulder along the westerly edge of the road. The existing cross slopes of the road will be maintained.

In conclusion, there will be a slight increase in flowrate due to the widening of the existing roads. Since the project is not proposing new roads, the existing drainage patterns of the area will not be altered. Therefore, the proposed widening of the roads will not cause erosion to the existing swales. Finally, since the existing drainage patterns will stay the same, there will be no people or structures in risk of loss, injury or death resulting from flooding.



VICINITY MAP

NO SCALE

THOMAS BRO MAP NO. 1048, G-7 & H-7
AND NO. 1068, G-1 & H-1

Section B

BASIN 1
VIA ARARAT DRIVE

VIA ARARAT DRIVE

Basin 1 Hydrology (Existing Condition)

$Q_{100} = CIA$

C-Value:

$C_{SOIL\ B} = 0.32$ (see Table 3-1, Appendix)

Intensity Calculations:

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

Where

$T_C = T_i + T_X$

And:

$T_i = 11.5$ minutes (see Table 3-2 on following pages).

$T_X = 2.0$ minutes (see Figure 3-4 on following pages).

Then:

$T_C = 11.5 + 2.0 = 13.5$ minutes

Also,

$P_6 = 3.5$ inches (see Rainfall Isopluvial, Appendix)

$I = 7.44\ (3.5)\ (13.5)^{-0.645}$ (also see Figure 3-1 on following pages)

Then

$I = 4.9$ in/hr

Area:

$A = 2.9$ acres (see Drainage Basin Maps, Appendix)

Flow Rate:

$Q_{100} = CIA$

$Q_{100} = 0.32\ (4.9)\ (2.9)$

Then

$Q_{100} = 4.5$ cfs

Basin 1 Hydrology (Proposed Condition)

The purpose for the calculations below is to account for the additional paving due to the widening of Via Ararat Drive.

Q_{100} = CIA

Updated Area:

$A_{total} = A_{Exist} + A_{Asph}$

Where:

Existing Area (A_{Exist})	=	2.9	acres	(see Drainage Basin Maps, Appendix)
New Pavement Area (A_{Asph})	=	0.05	acres	(see Preliminary Grading Plan, Appendix)

Then

$$\boxed{A_{total} = 2.9 + 0.05 = 2.95 \text{ acres}}$$

C-Value:

$$C_{weighted} = [(C_{SOIL\ B} * A_{Exist}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$$

Where:

New Pavement (C_{Asph})	=	0.95	(see Table II, Appendix)

Then:

$$C = [(0.32)(2.9) / 2.95] + [(0.95)(0.05) / 2.95]$$

$$\boxed{C = 0.33}$$

Flow Rate:

Q_{100} = CIA

Q_{100} = 0.33 (4.9) (2.95)

Then

$$\boxed{Q_{100} = 4.7 \text{ cfs}}$$

Basin 1 Comparison

Q_{100} Existing	=	4.5	cfs
Q_{100} Proposed	=	4.7	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	[illegible]	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
(VIA ARARAT)

EQUATION

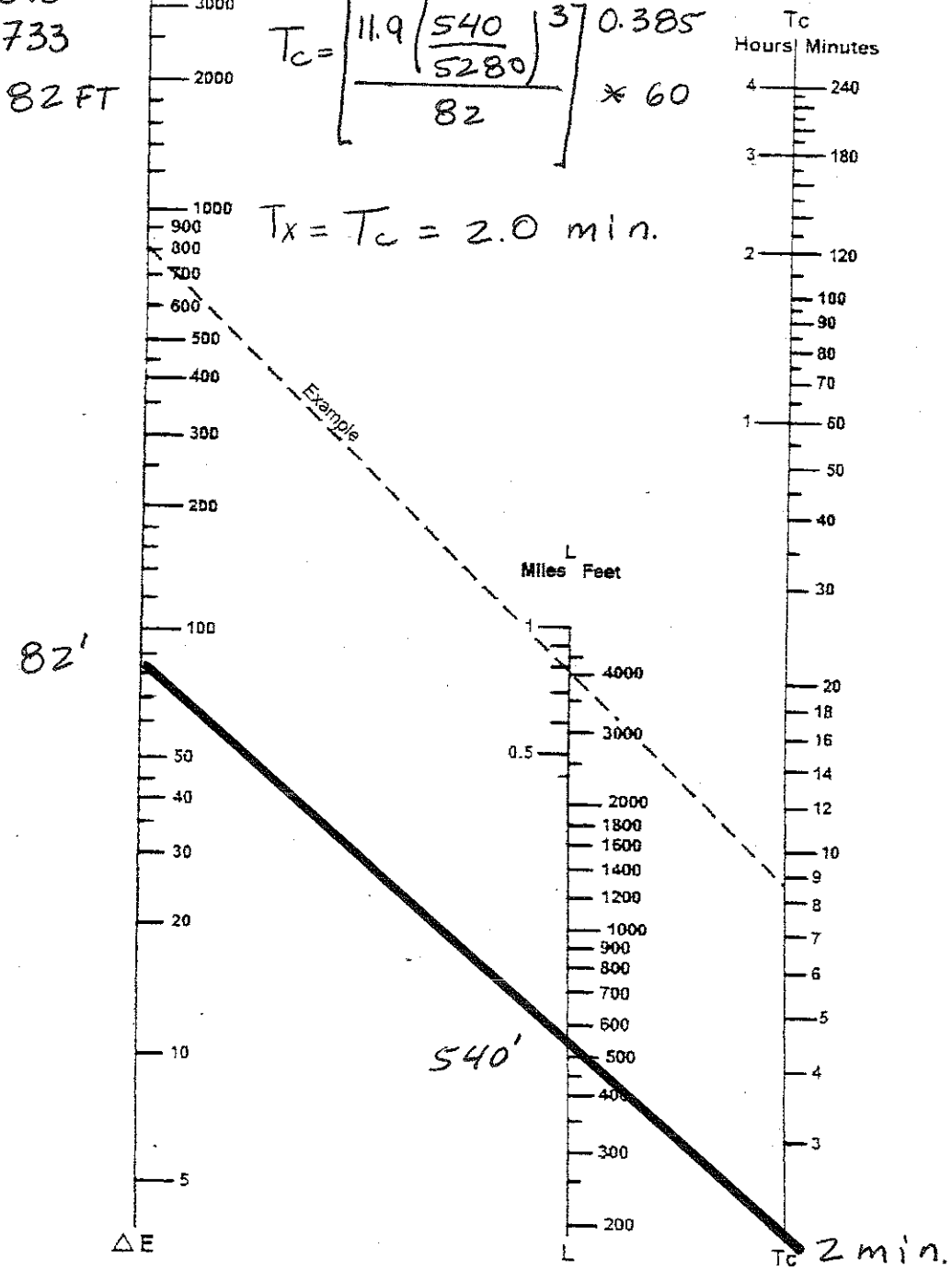
$$T_c = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

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

$\Delta E = 815 - 733 = 82$ FT

$$T_c = \left[\frac{11.9\left(\frac{540}{5280}\right)^3}{82}\right]^{0.385} * 60$$

$T_x = T_c = 2.0$ min.

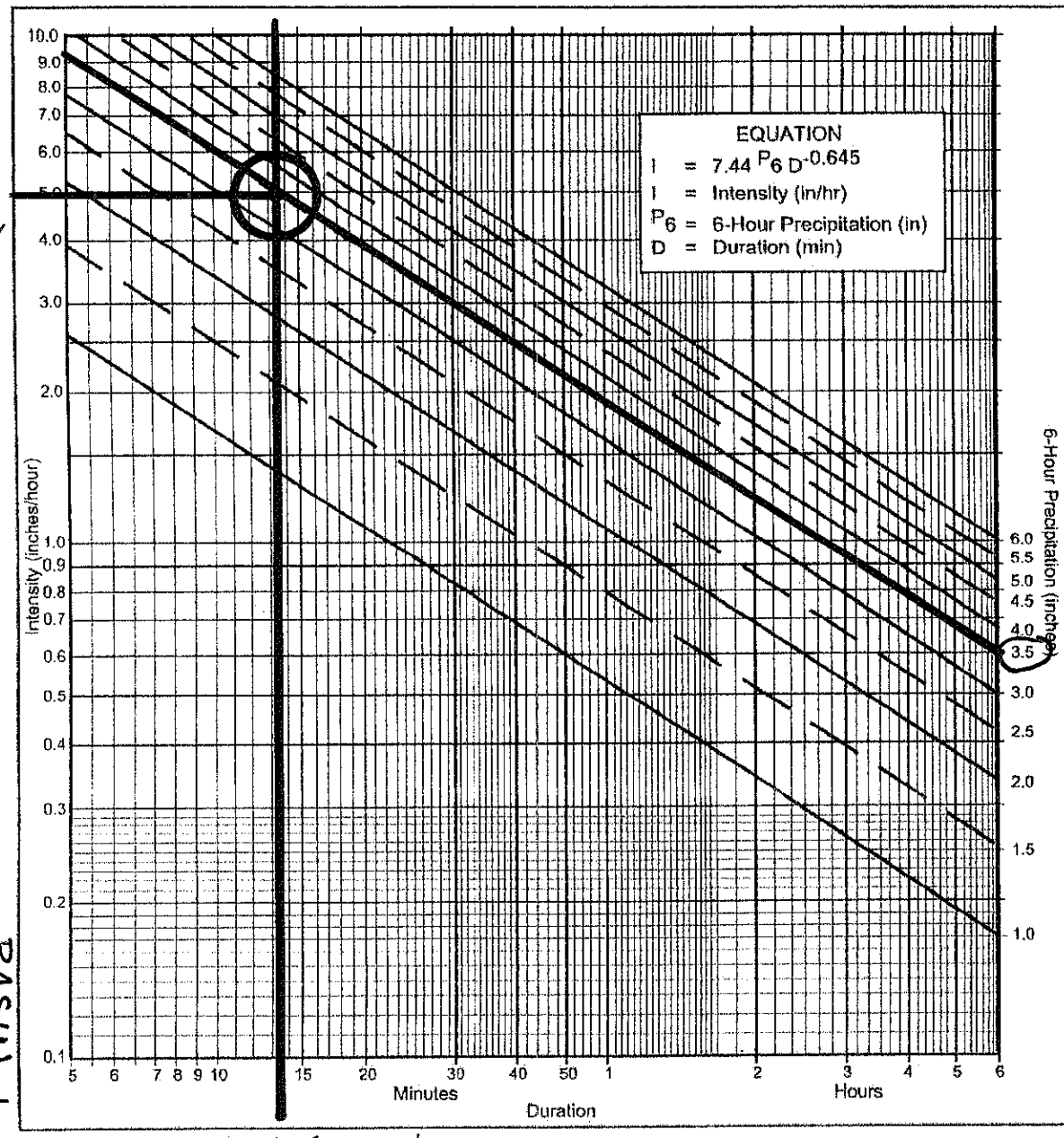


SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE 3-4

BASIN 1
(VIA ARARAT)



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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 13.5 min.

(e) I = 4.9 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 1 (VIA ARARAT DR.)

Intensity-Duration Design Chart - Template

FIGURE **3-1**

Basin 1 Hydraulics (Proposed Condition)

The flow from Basin 1 is directed towards an existing 12" RCP that crosses under Via Ararat Drive, see the picture below. The capacity of said pipe 12" RCP is 4.2 cfs per the following Inlet Control Chart. However, the peak discharge is 4.7 cfs. Therefore, 0.5 cfs will bypass the 12" RCP in the 100-year storm and flow into Basin 3.

The culvert has a flow velocity ($V = Q_{100} / A = 4.7$ cfs / 0.79 ft^2) of 5.9 ft/sec. Therefore, from Table 200-1.6.1(A) in the Appendix, the rock size for the outlet will be 1.5' thick Facing Class rip rap.

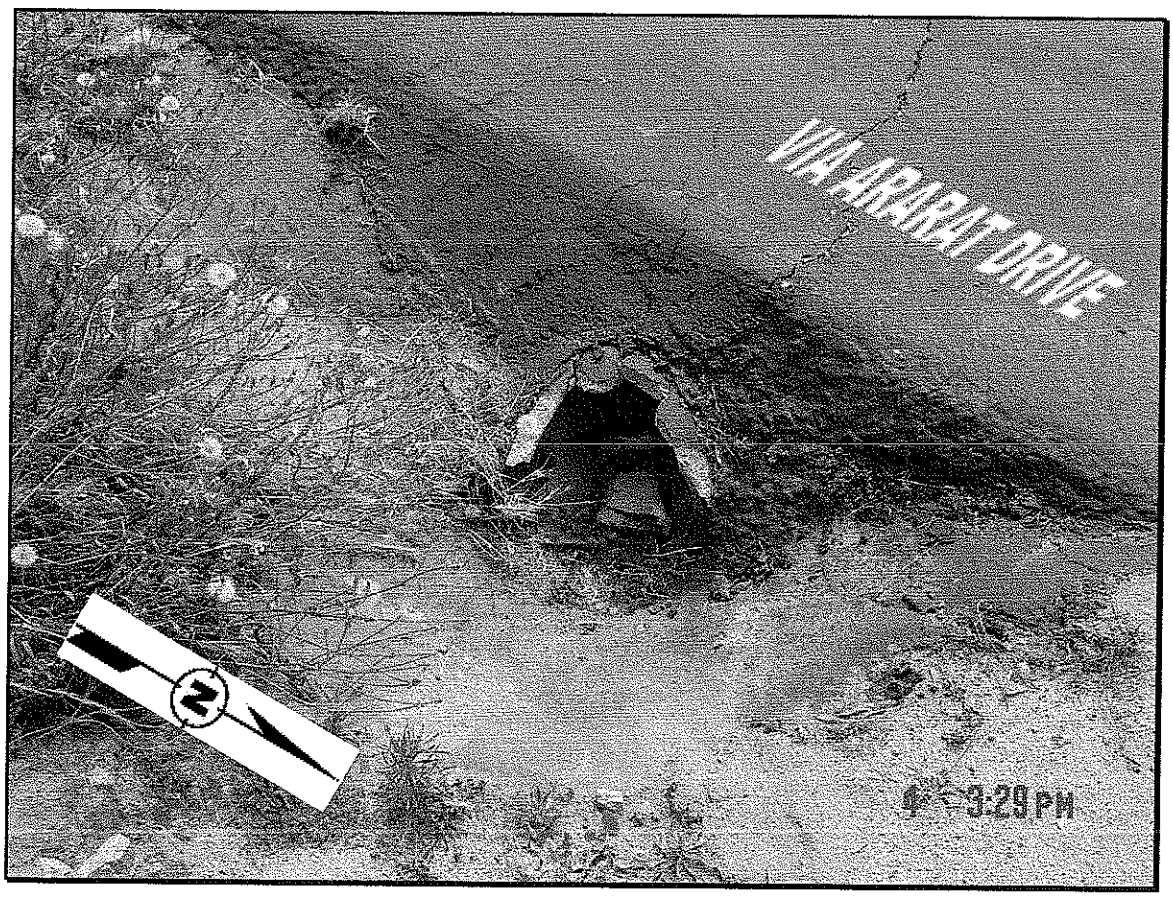
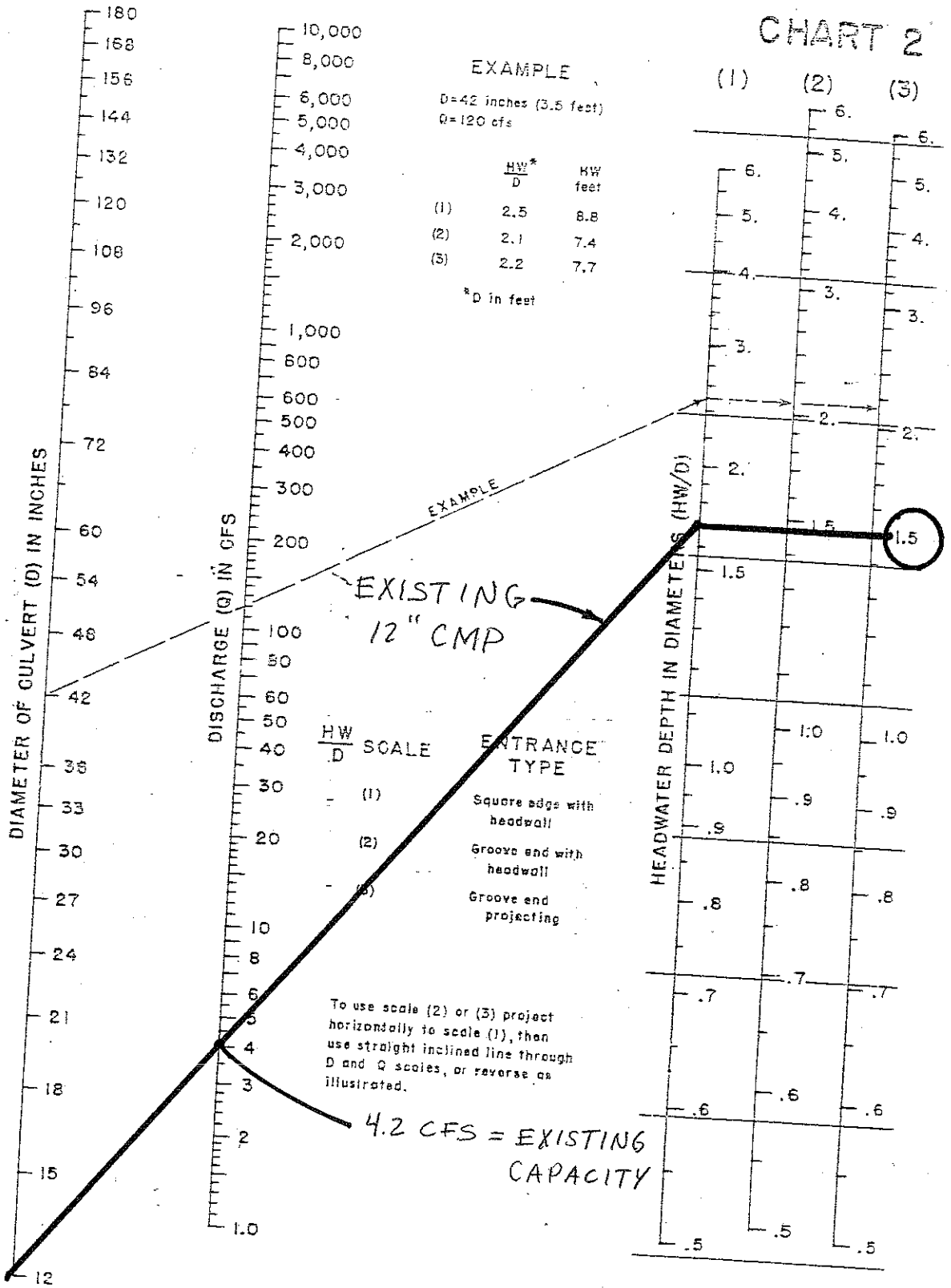


CHART 2



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

4.7 − 4.2 = 0.5 cfs that will bypass the pipe in a 100-yr storm

BASIN I
VIA ARARAT DR.

BASIN 2
VIA ARARAT DRIVE

Basin 2 Hydrology (Existing Condition)

$Q_{100} = CIA$

C-Value:

$C_{SOIL\ B} = 0.32$ (see Table 3-1, Appendix)

Intensity Calculations:

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

Where

$T_C = T_i + T_X$

And:

$T_i = 11.5$ minutes (see Table 3-2 on following pages).

$T_X = 1.9$ minutes (see Figure 3-4 on following pages).

Then:

$T_C = 11.5 + 2.1 = 13.4$ minutes

Also,

$P_6 = 3.5$ inches (see Rainfall Isopluvial, Appendix)

$I = 7.44\ (3.5)\ (13.4)^{-0.645}$ (also see Figure 3-1 on following pages)

Then

$I = 4.9$ in/hr

Area:

$A = 0.7$ acres (see Drainage Basin Maps, Appendix)

Flow Rate:

$Q_{100} = CIA$

$Q_{100} = 0.32\ (4.9)\ (0.7)$

Then

$Q_{100} = 1.1$ cfs

Basin 2 Hydrology (Proposed Condition)

The flow rate for Basin 2 does not change from the existing conditions since the Basin is not on Via Ararat Drive and therefore remains unchanged (see Drainage Map Attached, Appendix).

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.

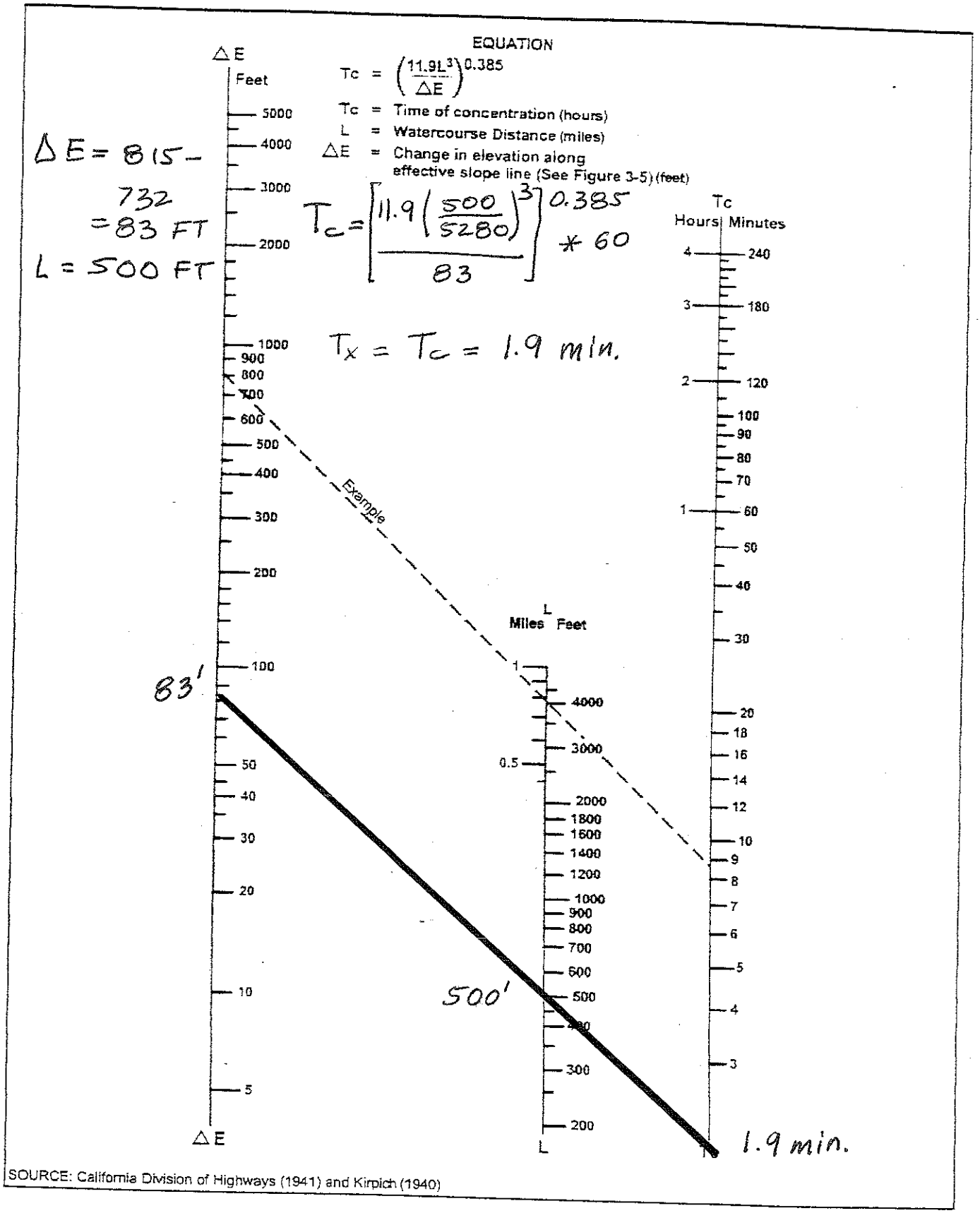
Table 3-2

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	[illegible]	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
(VIA ARARAT)

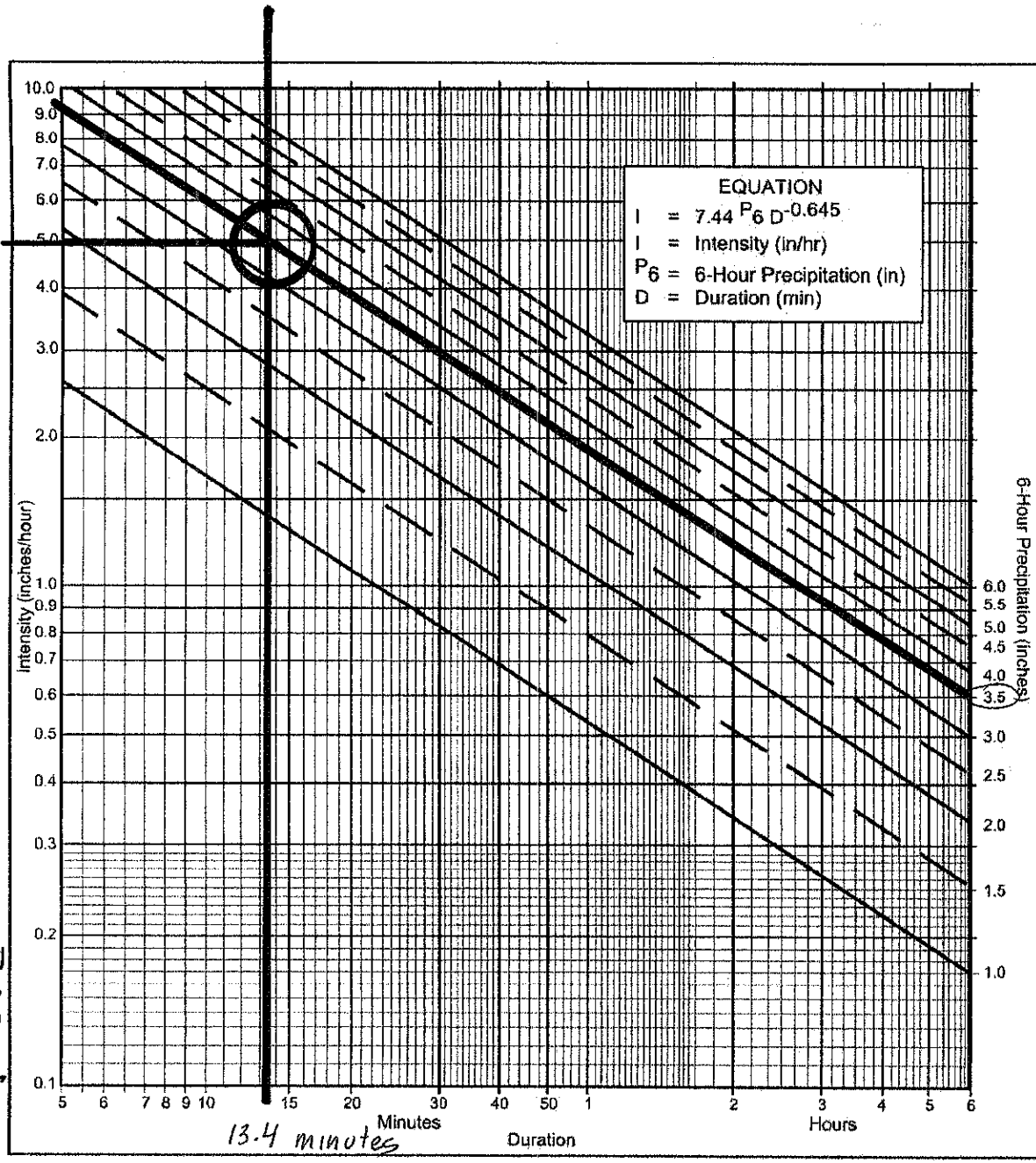


SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE 3-4

BASIN 2
(VIA ARARAT)



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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted $P_6^{(2)}$ = 3.5 in.

(d) t_x = 13.4 min.

(e) I = 4.9 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	0.66	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 2 (VIA ARARAT DR.)

Intensity-Duration Design Chart - Template

FIGURE 3-1

Basin 2 Hydraulics (Proposed Condition)

The flow from Basin 2 is directed towards an existing 12" RCP that crosses under Via Ararat Drive, see the picture below. The capacity of said pipe 12" RCP is 2.4 cfs per the following Inlet Control Chart. The peak discharge is 1.1 cfs. Therefore, the existing 12" RCP is adequate in the 100-year storm.

The culvert has a flow velocity ($V = Q_{100} / A = 1.1$ cfs / 0.79 ft^2) of 1.4 ft/s. Therefore, from Table 200-1.6.1(A) in the Appendix, the rock size for the outlet will be 1.5' thick Facing Class rip rap.

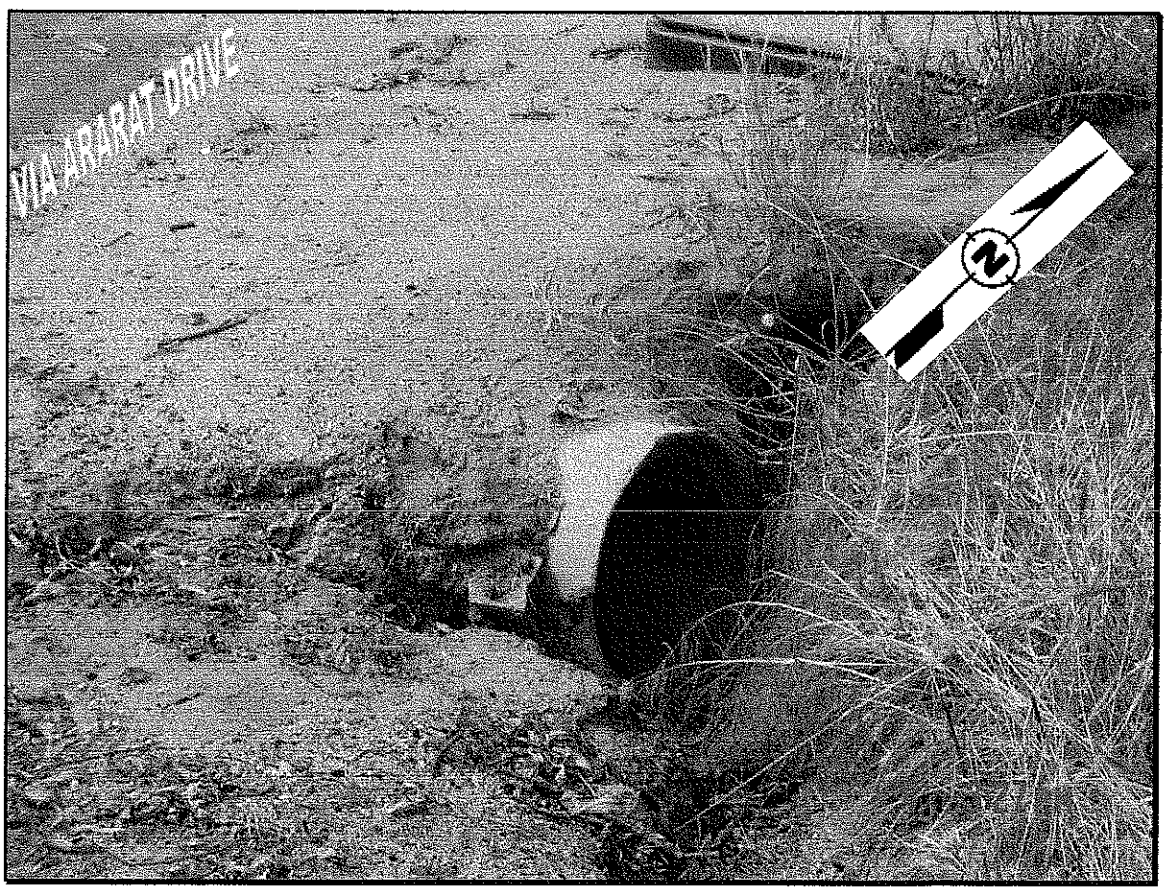
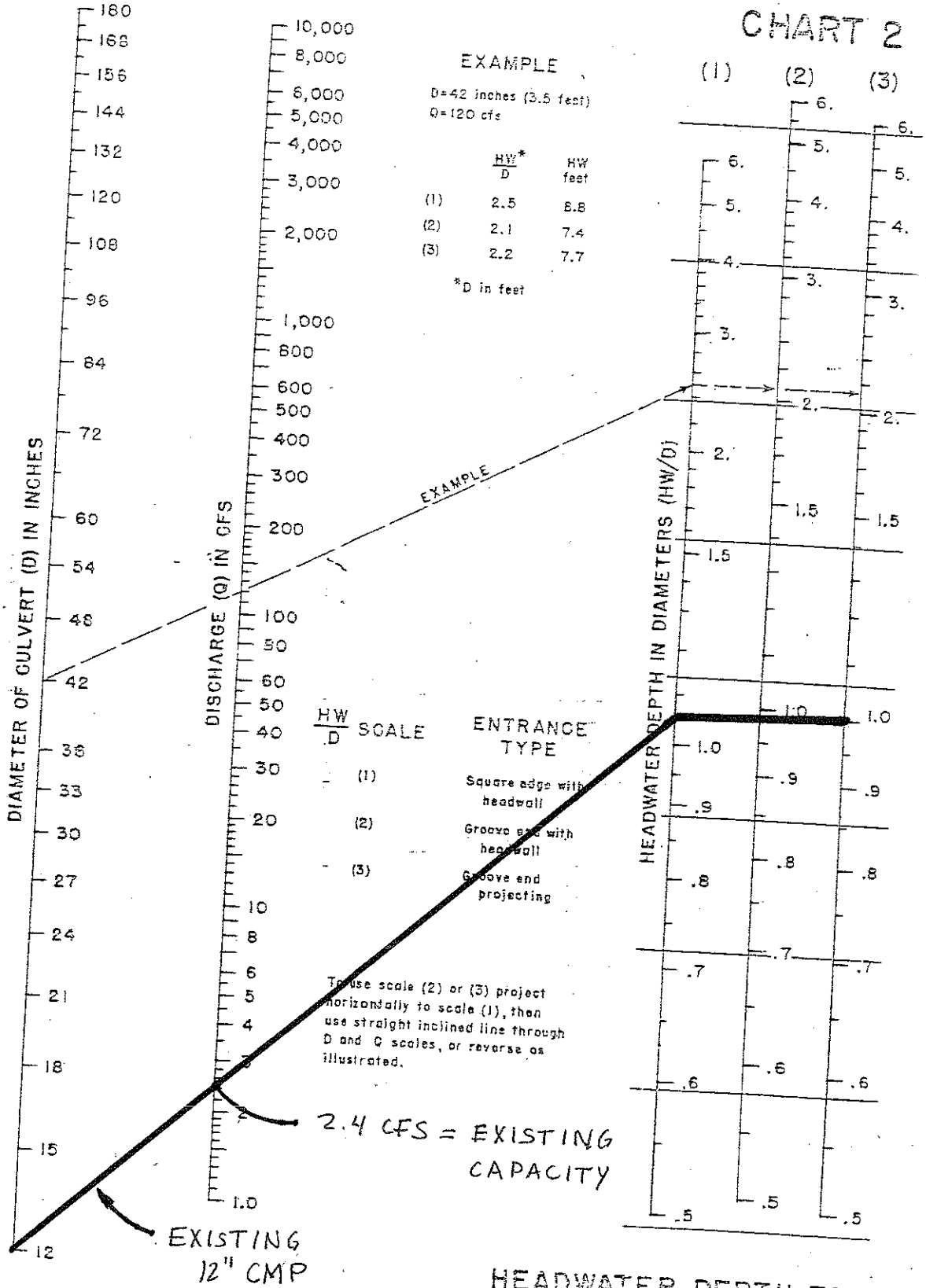


CHART 2



HEADWATER SCALES 2.83
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

5-22

EXISTING CAPACITY = 2.4 CFS

EXISTING Q_{PEAK} = 1.1 CFS

2.4 > 1.1 ∴ EXISTING PIPE IS ADEQUATE

BASIN 2
(VIA ARARAT DR.)

BASIN 3
VIA ARARAT DRIVE

Basin 3 Hydrology (Existing Condition)

$Q_{100} = CIA$

C-Value:

$C_{SOIL\ B} = 0.32$ (see Table 3-1, Appendix)

Intensity Calculations:

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

Where

$T_C = T_i + T_X$

And:

$T_i = 11.5$ minutes (see Table 3-2 on following pages).

$T_X = 2.1$ minutes (see Figure 3-4 on following pages).

Then:

$T_C = 11.5 + 2.1 = 13.6$ minutes

Also,

$P_6 = 3.5$ inches (see Rainfall Isopluvial, Appendix)

$I = 7.44\ (3.5)\ (13.6)^{-0.645}$ (also see Figure 3-1 on following pages)

Then

$I = 4.8$ in/hr

Area:

$A = 1.6$ acres (see Drainage Basin Maps, Appendix)

Flow Rate:

$Q_{100} = CIA$

$Q_{100} = 0.32\ (4.8)\ (1.6)$

Then

$Q_{100} = 2.5$ cfs

Basin 3 Hydrology (Proposed Condition):

The purpose for the calculations below is to account for the additional paving due to the widening of Via Ararat Drive.

Q_{100} = CIA

Updated Area:

$A_{total} = A_{Exist} + A_{Asph}$

Where:

New Pavement Area (A_{Asph}) = 0.02 acres (see Preliminary Grading Plan, Appendix)

Then

A_{total} = 1.6 + 0.02 = 1.62 acres

C-Value:

$C = [(C_{SOIL\ B} * A_{Exist}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$

Where:

New Pavement (C_{Asph}) = 0.95 (see Table II, Appendix)

$C = [(0.32)(1.6) / 1.62] + [(0.95)(0.02) / 1.62]$

Then

C = 0.33

Flow Rate:

Q_{100} = CIA

Q_{100} = 0.33 (4.8) (1.62)

Then

Q_{100} = 2.6 cfs

Basin 3 Comparison

Q_{100} Existing = 2.5 cfs

Q_{100} Proposed = 2.6 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	[illegible]	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	[illegible]	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 3
(VIA ARARAT)

EQUATION

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

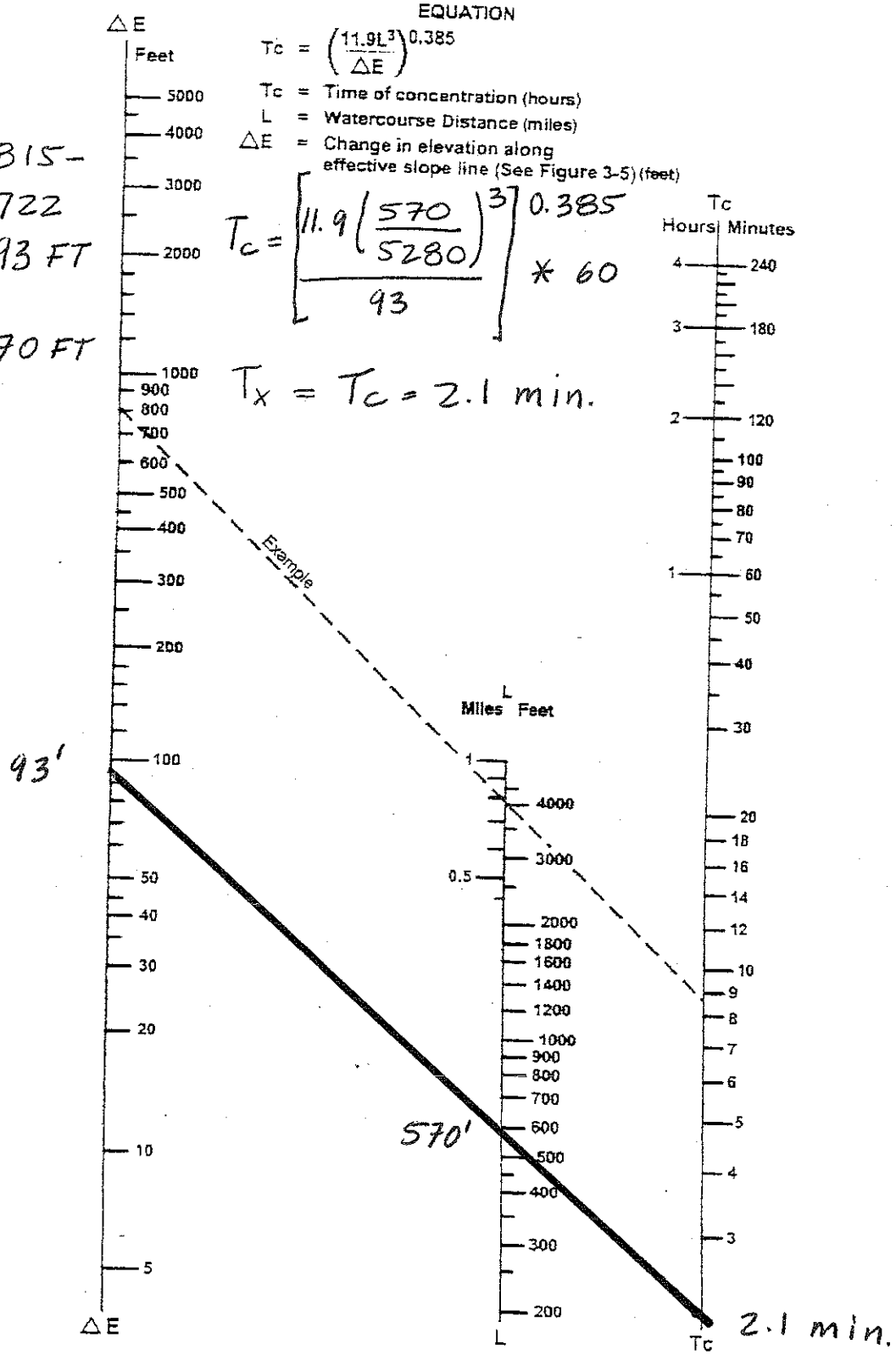
T_c = Time of concentration (hours)
L = Watercourse Distance (miles)
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 815 - 722 = 93$ FT

$L = 570$ FT

$$T_c = \left[\frac{11.9\left(\frac{570}{5280}\right)^3}{93}\right]^{0.385} * 60$$

$T_x = T_c = 2.1$ min.

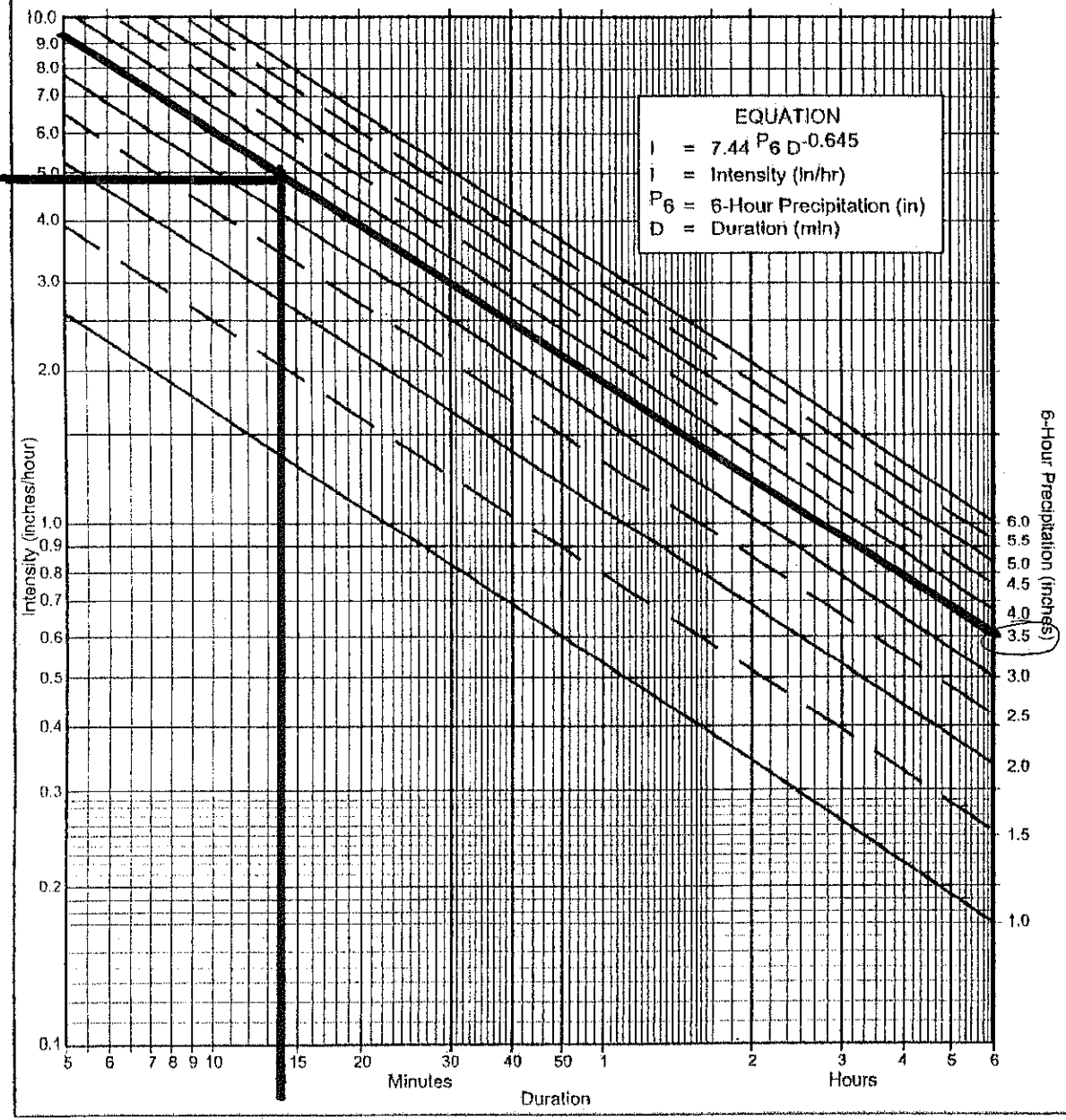


SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE 3-4

BASIN3
(VIA ARARAT)



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 = 3.5 in., P_{24} = 6.0 $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 13.6 min.

(e) I = 4.8 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

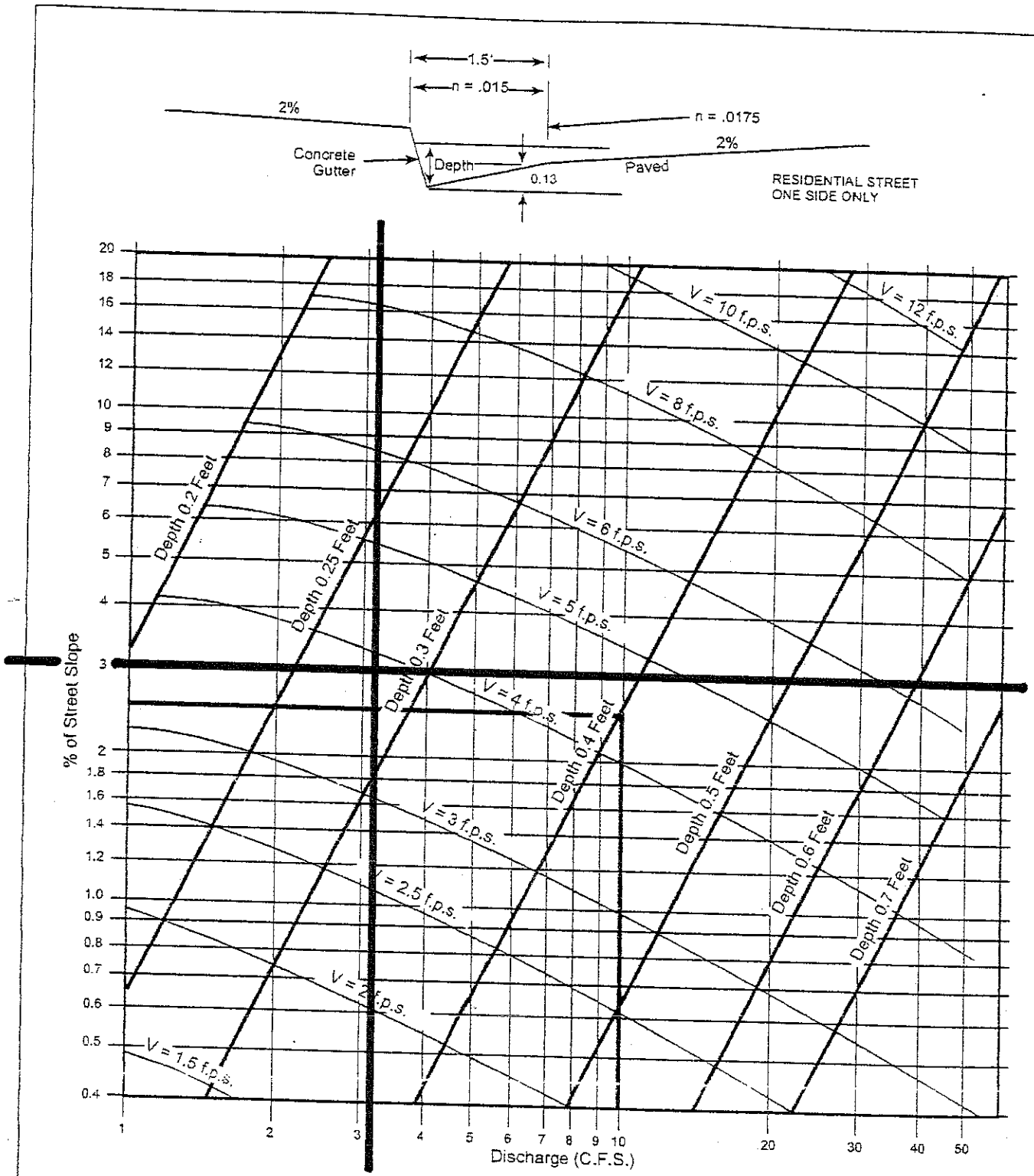
FIGURE

3-1

Basin 3 Hydraulics (Proposed Condition)

In the existing condition, the storm water from this basin sheet flows across Via Ararat Drive to the westerly side of the road. There is a 6-inch AC dike along the west side of the road that directs the runoff into a driveway (see the picture below) for property of APN 127-271-49. The runoff then sheet flows off the northerly edge of the driveway and continues in a northerly direction. See the contours on the 200-scale Drainage Map in the Appendix.

From Figure 3-6, located on the following page, a depth of 0.27 feet is obtained in the gutter. Therefore, a 6-inch dike "Type A" G-5 per RSDs is adequate to handle a 100-year storm.



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

2.6 + 0.5 = 3.1 CFS

OVERFLOW FROM BASIN 1

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

Gutter and Roadway Discharge - Velocity Chart

FIGURE

3-6

V = 3.8 f.p.s.

D = 0.27 ft

BASIN 3

VIA ARARAT DR.

BASIN 4
VIA ARARAT DRIVE

Basin 4 Hydrology (Existing Condition)

$Q_{100} = CIA$

C-Value:

$C_{Exist} = [(C_{SOIL\,B} * \%_{SOIL\,B}) / 100] + [(C_{SOIL\,C} * \%_{SOIL\,C}) / 100]$

Where:

$C_{SOIL\,B} = 0.32$ (see Table 3-1, Appendix)

$C_{SOIL\,C} = 0.36$ (see Table 3-1, Appendix)

Percentage of Soil Type "B" ($\%_{SOIL\,B}$) = 70 % of Basin Area (see Hydrologic Soil Groups, Appendix)

Percentage of Soil Type "C" ($\%_{SOIL\,C}$) = 30 % of Basin Area (see Hydrologic Soil Groups, Appendix)

Then

$C = [(0.32)(70) / 100] + [(0.36)(30) / 100]$

$\boxed{C = 0.33}$

Intensity Calculations:

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

Where

$T_C = T_i + T_X$

And:

$T_i = 6.4$ minutes (see Table 3-2 on following pages).

$T_X = 2.0$ minutes (see Figure 3-4 on following pages).

Then:

$T_C = 6.4 + 2.0 = 8.4$ minutes

Also,

$P_6 = 3.5$ inches (see Rainfall Isopluvial, Appendix)

Then

$I = 7.44\,(3.5)\,(8.4)^{-0.645}$ (also see Figure 3-1 on following pages)

Therefore:

$\boxed{I = 6.6 \text{ in/hr}}$

Area:

$\boxed{A = 1.0 \text{ acres}}$ (see Drainage Basin Maps, Appendix)

Flow Rate:

$Q_{100} = CIA$

$Q_{100} = 0.33\,(6.6)\,(1.0)$

Then

$\boxed{Q_{100} = 2.2 \text{ cfs}}$

Basin 4 Hydrology (Proposed Condition)

The flow rate for Basin 4 does not change from the existing conditions since the Basin is not on Via Ararat Drive and therefore remains unchanged (see Drainage Map Attached, Appendix).

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	[illegible]
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	[illegible]
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 4
(VIA ARARAT DR.)

EQUATION

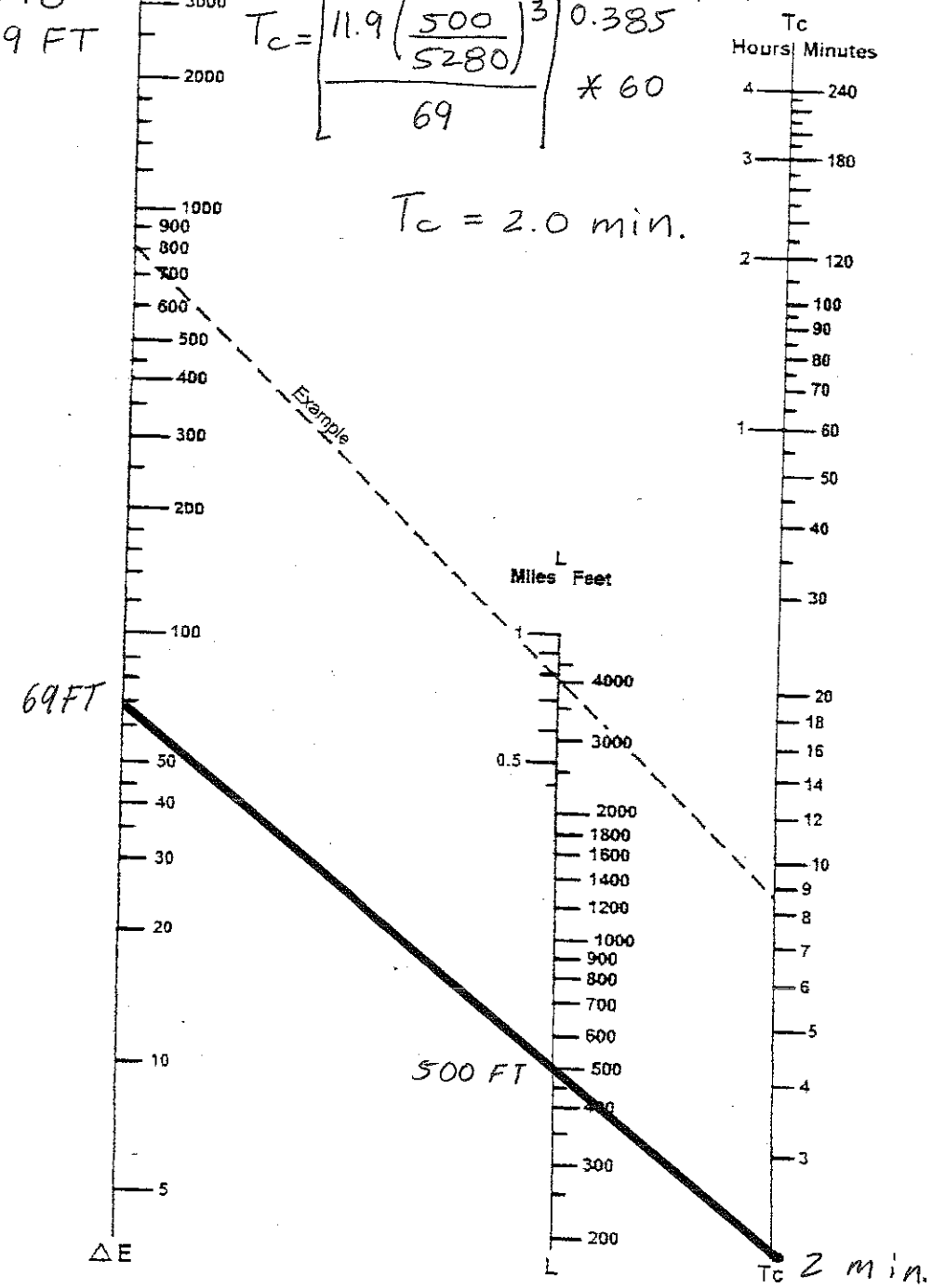
$$T_c = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

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

$\Delta E = 767 - 698 = 69$ FT

$$T_c = \left[\frac{11.9\left(\frac{500}{5280}\right)^3}{69}\right]^{0.385} * 60$$

$T_c = 2.0$ min.

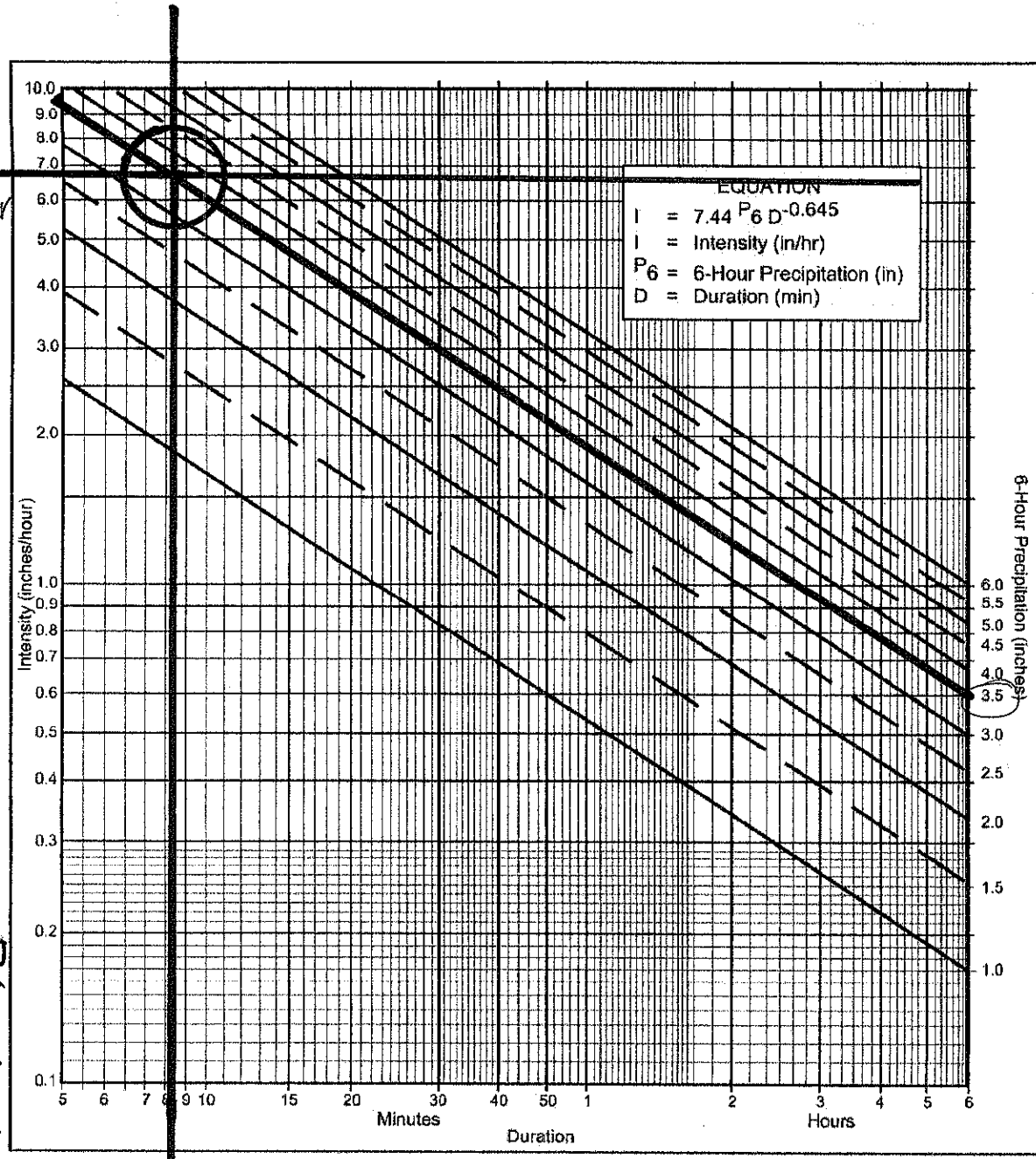


SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE 3-4

BASIN 4
(VIA ARARAT DR)



BASIN 4 (VIA ARARAT DR.)

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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 8.4 min.

(e) I = 6.6 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

FIGURE

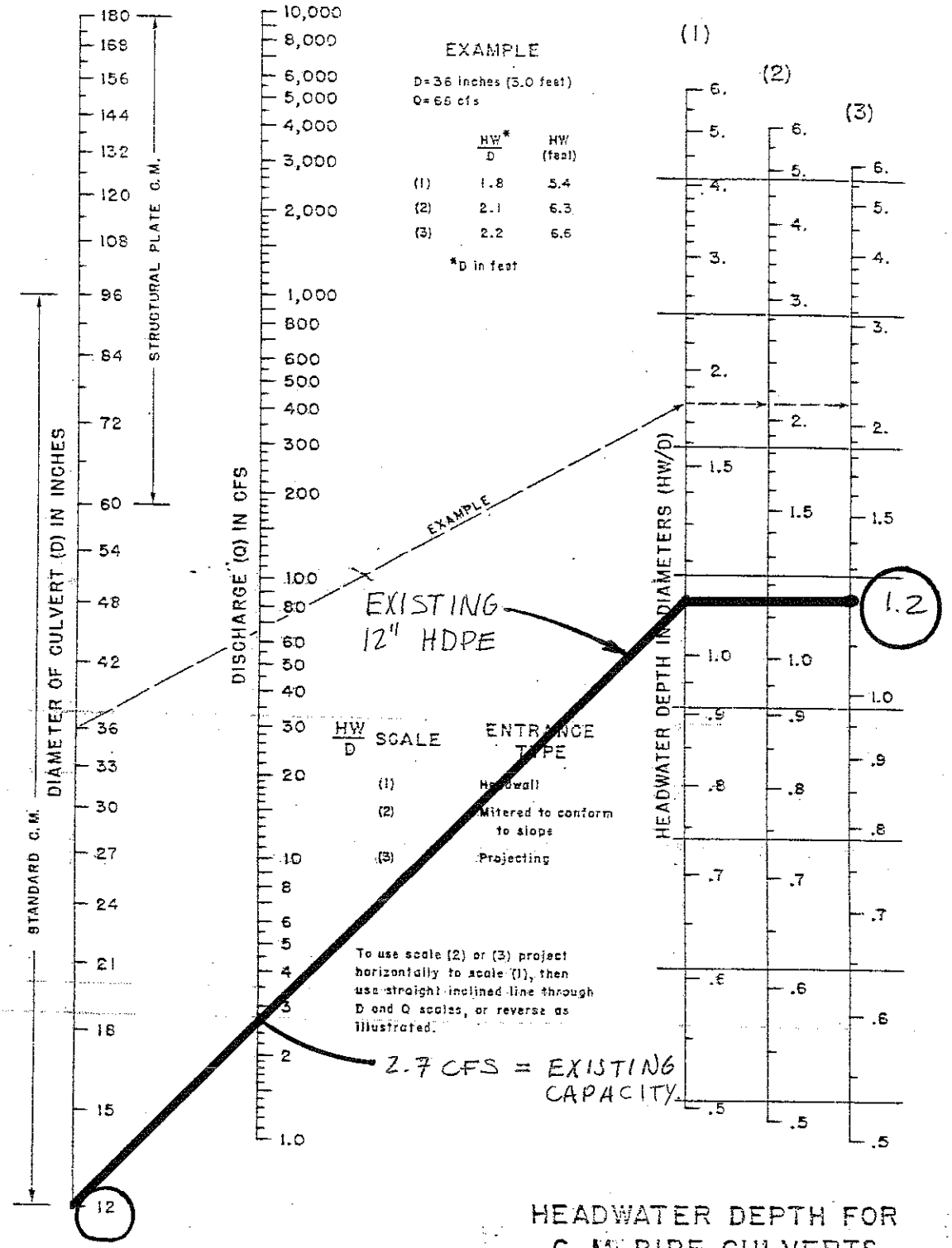
3-1

Basin 4 Hydraulics (Proposed Condition)

The flow from Basin 4 is directed towards an existing 12" HDPE that crosses under Via Ararat Drive, see the 40-scale Drainage Map in the Appendix. The capacity of said 12" HDPE is 2.7 cfs per the following Inlet Control Chart. The peak discharge is 2.2 cfs. Therefore, the existing 12" HDPE is adequate in the 100-year storm.

The culvert has a flow velocity ($V = Q_{100} / A = 2.2$ cfs / 0.79 ft^2) of 2.8 ft/s. Therefore, from Table 200-1.6.1(A) in the Appendix, the rock size for the outlet will be 1.5' thick Facing Class rip rap.

CHART 5



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

BUREAU OF PUBLIC ROADS JAN. 1963

EXISTING PEAK DISCHARGE = 2.2 CFS

2.7 > 2.2 ∴ PIPE IS ADEQUATE FOR A 100-YR STORM

BASIN 4
VIA ARARAT DR.

BASIN 5
VIA ARARAT DRIVE

Basin 5 Hydrology (Existing Condition)

$Q_{100} = CIA$

C-Value:

$C_{Exist} = [(C_{SOIL\,B} * \%_{SOIL\,B}) / 100] + [(C_{SOIL\,C} * \%_{SOIL\,C}) / 100]$

Where:

$C_{SOIL\,B}$	=	0.32	(see Table 3-1, Appendix)
$C_{SOIL\,C}$	=	0.36	(see Table 3-1, Appendix)
Percentage of Soil Type "B" ($\%_{SOIL\,B}$)	=	60 % of Basin Area	(see Hydrologic Soil Groups, Appendix)
Percentage of Soil Type "C" ($\%_{SOIL\,C}$)	=	40 % of Basin Area	(see Hydrologic Soil Groups, Appendix)

$C = [(0.32)(60) / 100] + [(0.36)(40) / 100]$

Then

$\boxed{C = 0.34}$

Intensity Calculations:

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

Where

$T_C = T_i + T_{X1} + T_{X2}$

And:

T_i	=	11.5	minutes	(see Table 3-2 on following pages).
T_{X1}	=	2.9	minutes	(see Figure 3-4 on following pages).

T_{X2} is the time it takes the runoff to travel along the gutter flow line. The time it takes the water to travel from the initial point of the gutter flow to the concentration point is calculated using the velocity and the distance traveled. The velocity is calculated using Figure 3-6 of the San Diego hydrology manual and the distance traveled is obtained from the Drainage Basin Map. The Q_{100} used for Figure 3-6 is assumed and then divided by two to average the amount of runoff in the gutter. This assumption is later checked for accuracy. See below for the calculation:

T_{X2} = Distance Traveled / Velocity

Where:

Velocity (V)	=	4.8	fps	(see Figure 3-6 on following pages)
Distance Traveled	=	520	feet	(see Drainage Basin Map, Appendix)

Then:

$T_{X2} = 520 / 4.8 = 108.3$ seconds $= 1.8$ minutes

Therefore:

$T_C = 11.5 + 2.9 + 1.8 = 16.2$ minutes

Also,

$P_6 = 3.5$ inches (see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\,(3.5)\,(16.2)^{-0.645}$ (also see Figure 3-1 on following pages)

Then:

$\boxed{I = 4.3 \text{ in/hr}}$

Area:

$\boxed{A = 14.4 \text{ acres}}$ (see Drainage Basin Maps, Appendix)

Basin 5 cont...

Flow Rate:

$$Q_{100} = CIA$$
$$Q_{100} = 0.34\ (4.3)\ (14.4)$$

Then

$$\boxed{Q_{100} = 20.9 \quad cfs}$$

* The assumption for the Q_{100} for the velocity calculation is found to be correct with accepatable tolerance.

Basin 5 Hydrology (Proposed Condition):

The purpose for the calculations below is to account for the additional paving due to the widening of Via Ararat Drive.

$$Q_{100} = CIA$$

Updated Area:

$$A_{total} = A_{Exist} + A_{Asph}$$

Where:

New Pavement Area (A_{Asph}) = 0.07 acres (see Preliminary Grading Plan, Appendix)

Then

$$\boxed{A_{total} = 14.4 + 0.07 = 14.47 \quad acres}$$

C-Value:

$$C = [(C_{Exist} * A_{Exist}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$$

Where:

New Pavement (C_{Asph}) = 0.95 (see Table II, Appendix)

Then:

$$C = [(0.34)\ (14.4) / 14.47] + [(0.95)\ (0.07) / 14.47]$$

$$\boxed{C = 0.345}$$

Flow Rate:

$$Q_{100} = CIA$$
$$Q_{100} = 0.345\ (4.3)\ (14.47)$$

Then

$$\boxed{Q_{100} = 21.5 \quad cfs}$$

<u>Basin 5 Comparison</u>

Q_{100} Existing = 20.9 cfs

Q_{100} Proposed = 21.5 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	[illegible]	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 5
(VIA ARARAT DR.)

EQUATION

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

T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

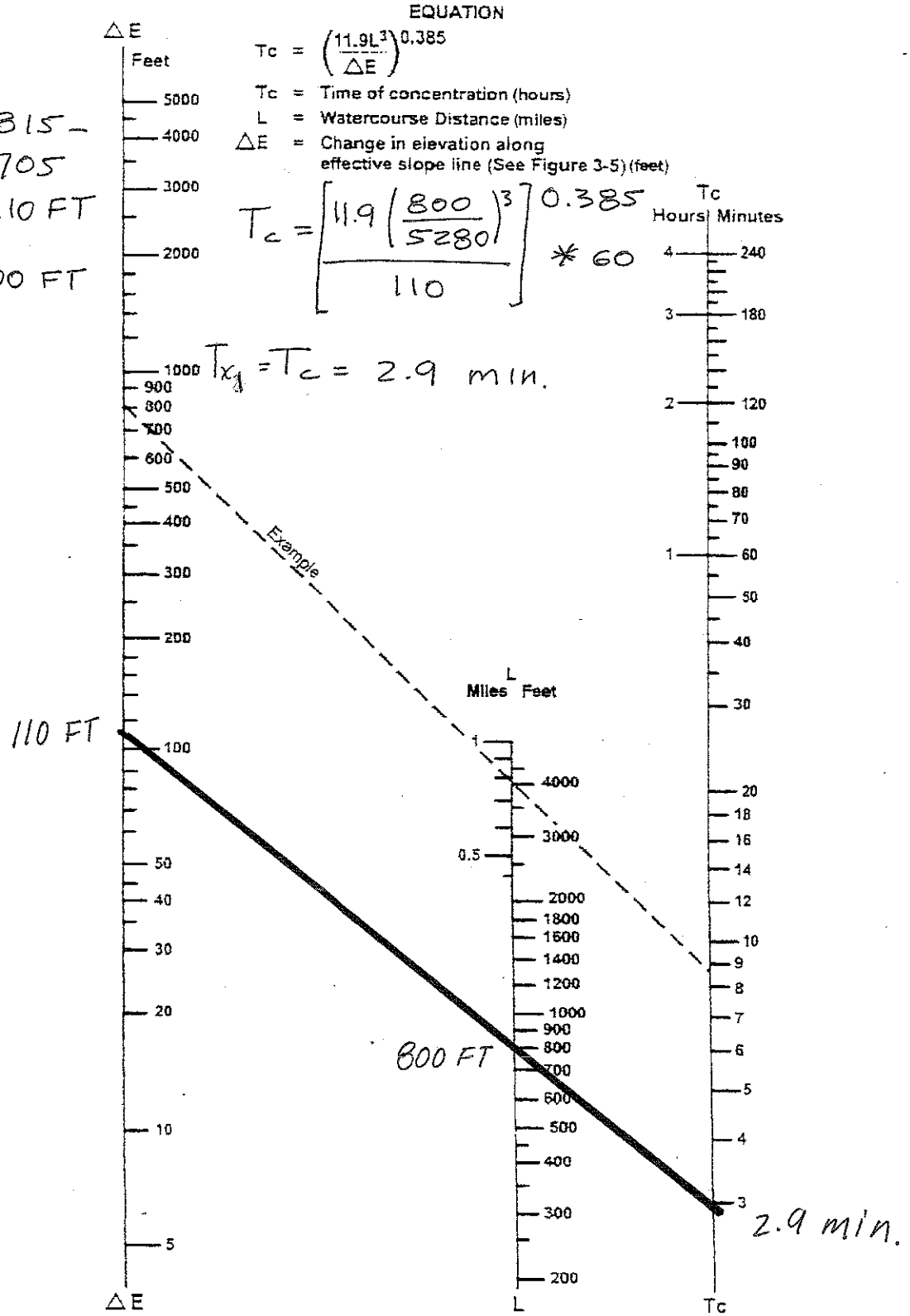
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 815 - 705 = 110$ FT

$L = 800$ FT

$$T_c = \left[\frac{11.9\left(\frac{800}{5280}\right)^3}{110}\right]^{0.385} * 60$$

$T_{x_1} = T_c = 2.9$ min.



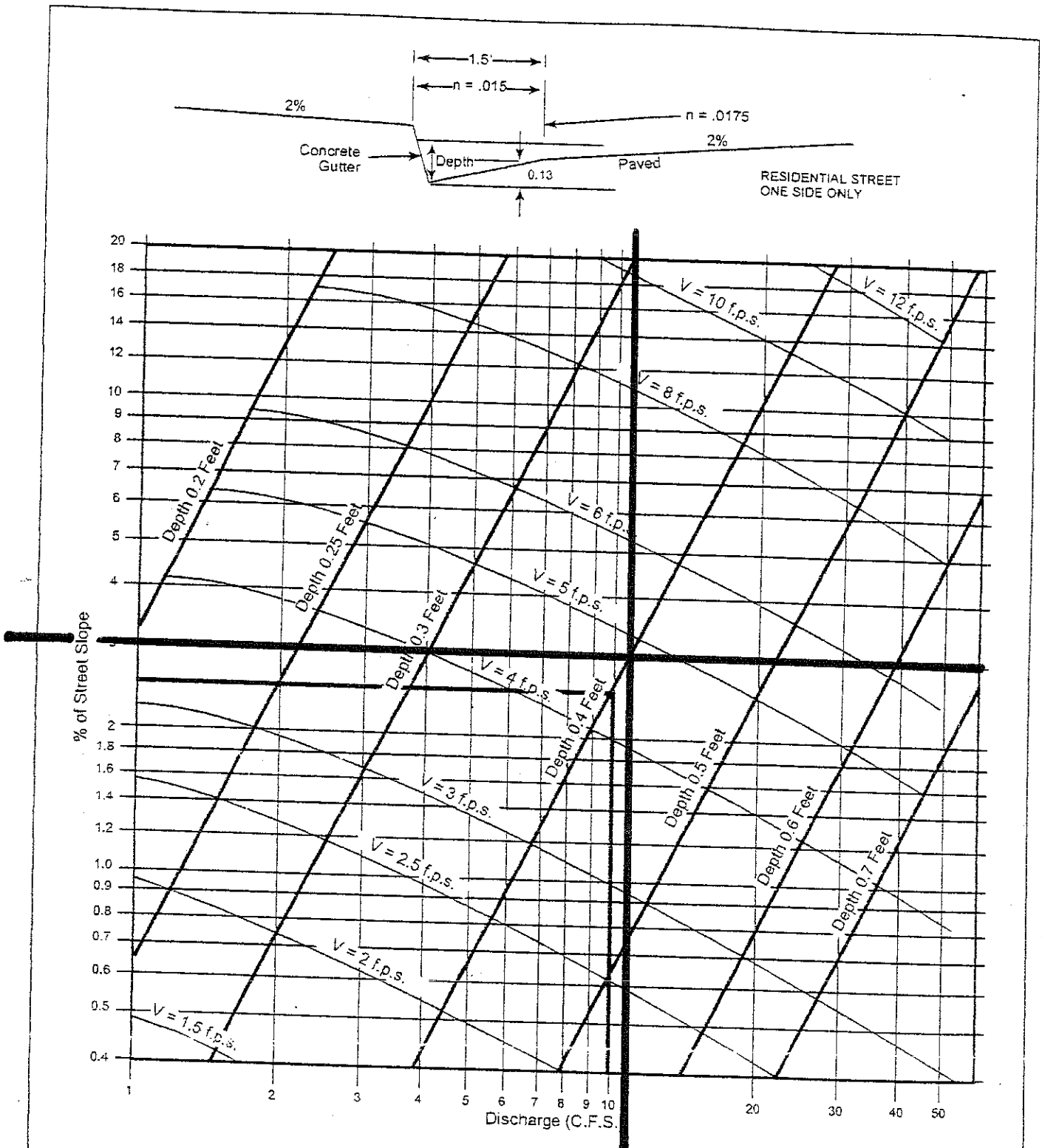
SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

3-4

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

BASIN 5
(VIA ARARAT DR.)



EXAMPLE:

Given: Q = 10 S = 2.5%

Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

$\frac{Q}{2} = 11$ CFS

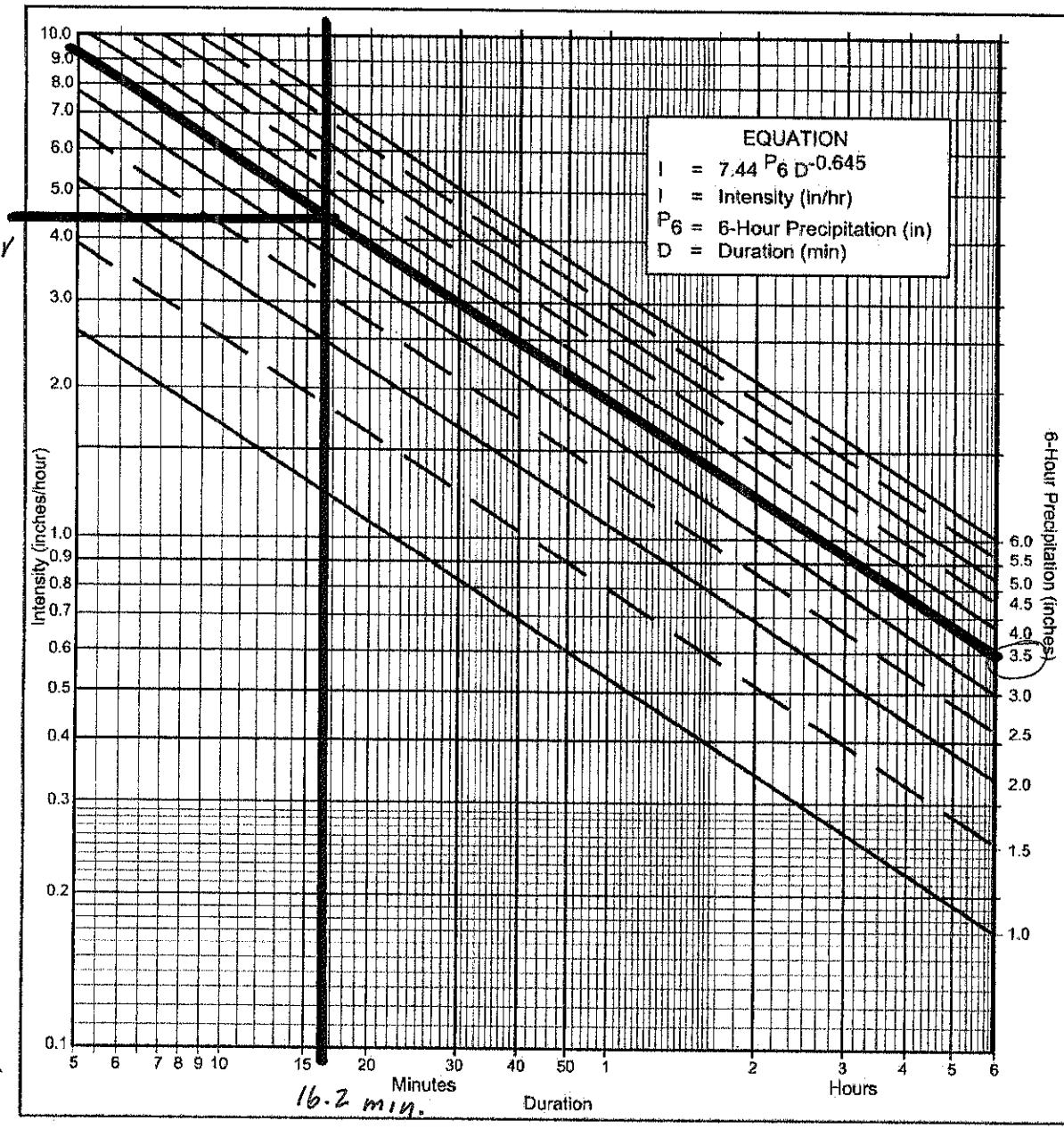
SOURCE: San Diego County Department of Special District Services Design Manual

FIGURE

3-6

Gutter and Roadway Discharge - Velocity Chart

V = 4.8 f.p.s



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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 16.2 min.

(e) I = 4.3 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

FIGURE

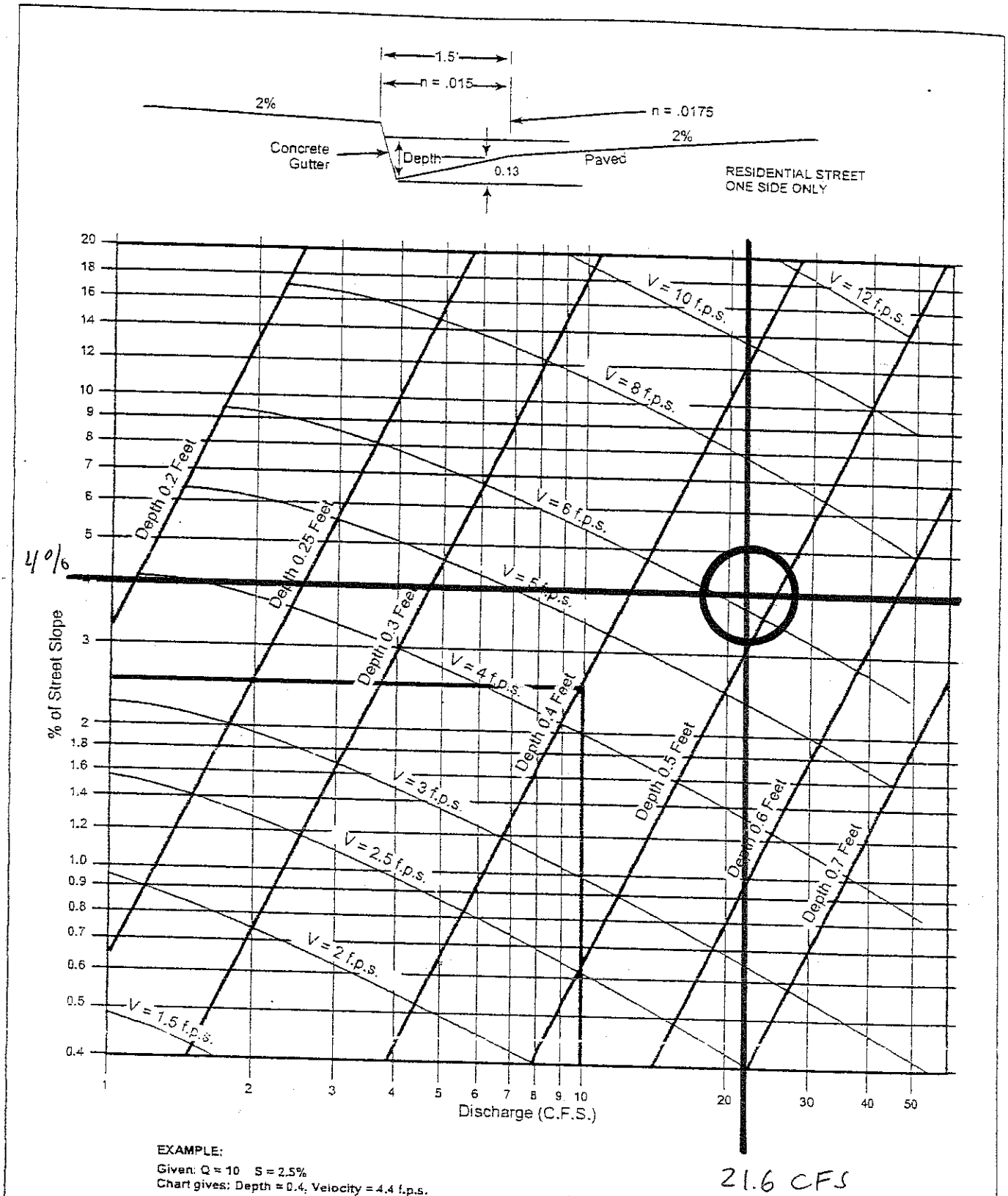
3-1

BASIN 5 (VIA ARARAT DR.)

Basin 5 Hydraulics (Proposed Condition)

In the existing condition, the storm water flows along the westerly side of Via Ararat Drive, see the picture below. There is a 6-inch AC dike along this side of the road that directs the runoff into a spillway located north of the driveway for the property of APN 127-271-44, see the 200-scale Drainage Map in the Appendix.

From Figure 3-6, located on the following page, a depth of 0.48 feet is obtained. Therefore, an 8-inch AC dike "Type B" G-5 per RSDs is proposed to handle a 100-year storm.



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

FIGURE 3-6

Gutter and Roadway Discharge - Velocity Chart

V = 6.2 fps
D = 0.48 ft

BASIN 5
(VIA ARARAT DR.)

BASIN 6
VIA ARARAT DRIVE

Basin 6 Hydrology (Existing Condition)

Q_{100} = CIA

C-Value:

$C_{SOIL\,C}$ = 0.36 (see Table 3-1, Appendix)

Intensity Calculations:

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

Where

$T_C = T_i + T_{X1} + T_{X2}$

And:

T_i = 6.4 minutes (see Table 3-2 on following pages).

T_{X1} = 0.3 minutes (see Figure 3-4 on following pages).

T_{X2} is the time it takes the runoff to travel along the gutter flow line. The time it takes the water to travel from the initial point of the gutter flow to the concentration point is calculated using the velocity and the distance traveled. The velocity is calculated using Figure 3-6 of the San Diego hydrology manual and the distance traveled is obtained from the Drainage Basin Map. The Q_{100} used for Figure 3-6 is assumed and then divided by two to average the amount of runoff in the gutter. This assumption is later checked for accuracy. See below for the calculation:

T_{X2} = Distance Traveled / Velocity

Where:

Velocity (V) = 3.5 fps (see Figure 3-6 on following pages)

Distance Traveled = 100 feet (see Drainage Basin Map, Appendix)

Then:

T_{X2} = 100 / 3 = 29 seconds = 0.5 minutes

Therefore:

T_C = 6.4 + 0.3 + 0.5 = 7.2 minutes

Also,

P_6 = 3.5 inches (see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\,(3.5)\,(7.2)^{-0.645}$ (also see Figure 3-1 on following pages)

Then

I = 7.3 in/hr

Area:

A = 0.2 acres (see Drainage Basin Maps, Appendix)

Flow Rate:

Q_{100} = CIA

Q_{100} = 0.36 (7.3) (0.2)

Then

Q_{100} = 0.5 cfs

* The assumption for the Q_{100} for the velocity calculation is found to be correct with accepatable tolerance.

Basin 6 Hydrology (Proposed Condition):

The purpose for the calculations below is to account for the additional paving due to the widening of Via Ararat Drive.

Q_{100} = CIA

Updated Area:

$A_{total} = A_{Exist} + A_{Asph}$

Where:

New Pavement Area (A_{Asph}) = 0.01 acres (see Preliminary Grading Plan, Appendix)

Then

A_{total} = 0.2 + 0.01 = 0.21 acres

C-Value:

$C = [(C_{Exist} * A_{Exist}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$

Where:

New Pavement (C_{Asph}) = 0.95 (see Table II, Appendix)

$C = [(0.36)(0.2) / 0.21] + [(0.95)(0.01) / 0.21]$

Then:

C = 0.39

Flow Rate:

Q_{100} = CIA

Q_{100} = 0.39 (7.3) (0.21)

Then

Q_{100} = 0.6 cfs

<u>Basin 6 Comparison</u>

Q_{100} Existing = 0.5 cfs

Q_{100} Proposed = 0.6 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	[illegible]
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 6
(VIA ARARAT DR)

EQUATION

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

T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

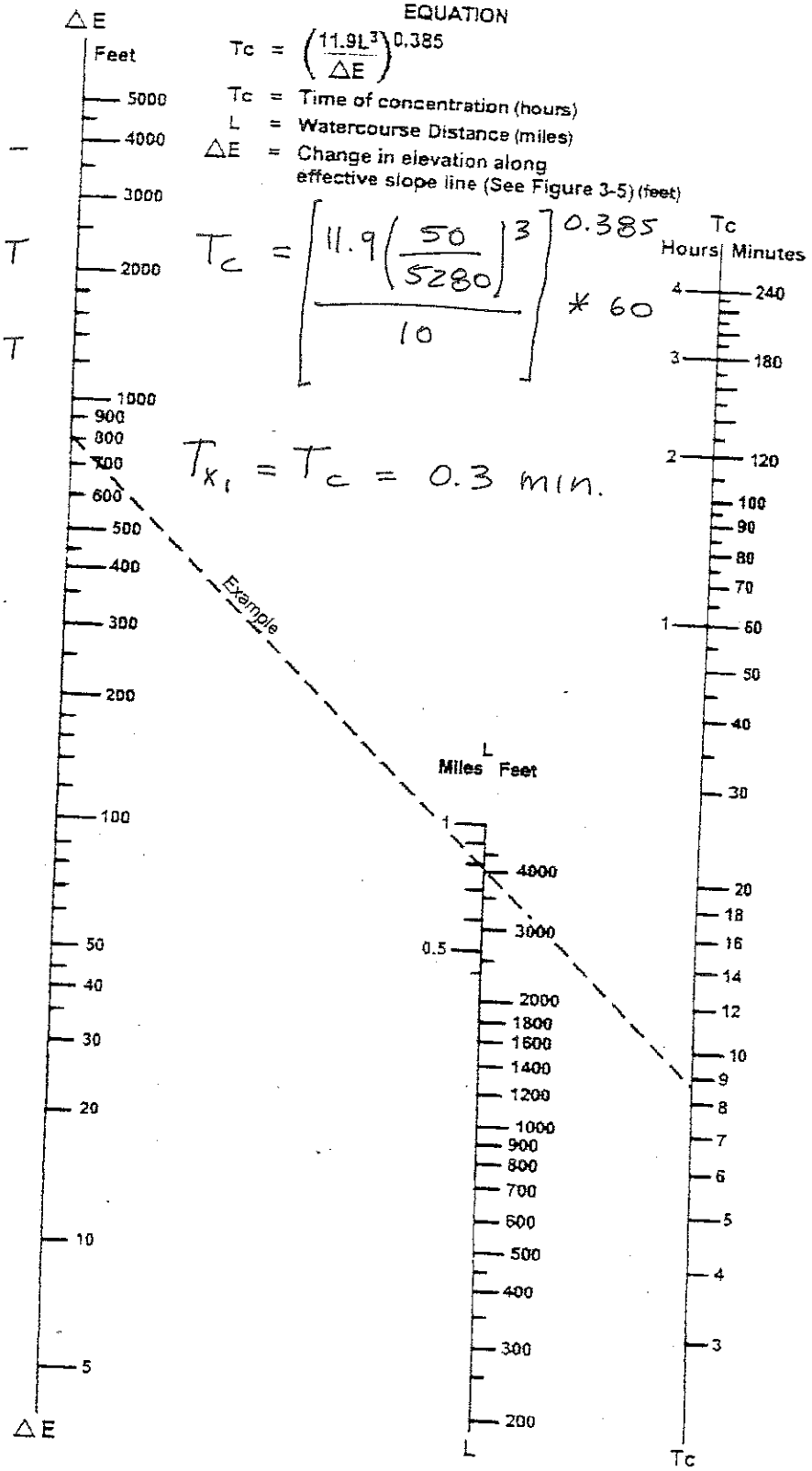
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 693 - 683 = 10$ FT

$L = 50$ FT

$$T_c = \left[\frac{11.9\left(\frac{50}{5280}\right)^3}{10}\right]^{0.385} * 60$$

$T_{x_1} = T_c = 0.3$ min.



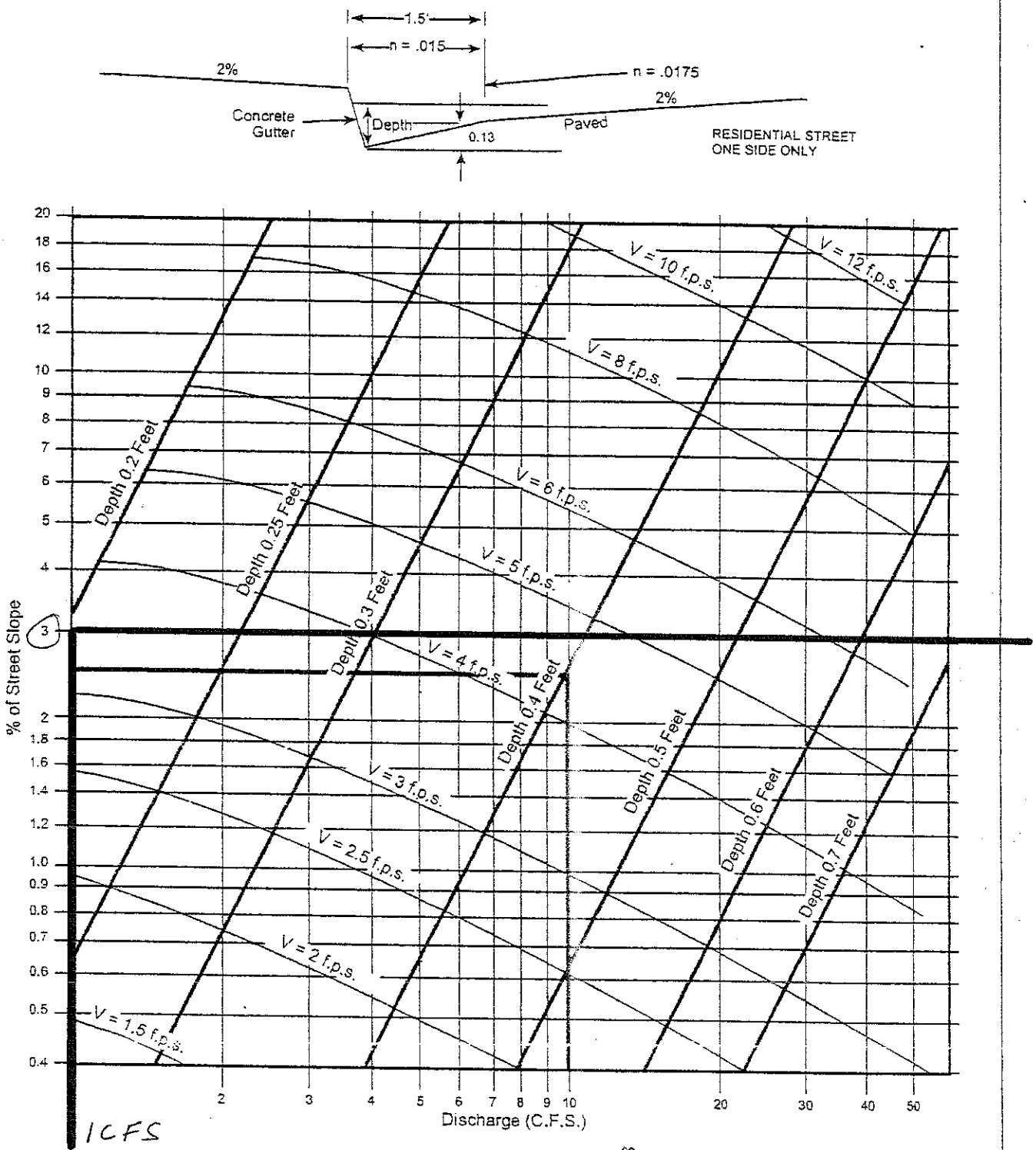
SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE

3-4

BASIN 6
(VIA ARARAT DR.)



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

$\frac{Q}{2} = 1$ CFS
(Q assumed = 2CFS)

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

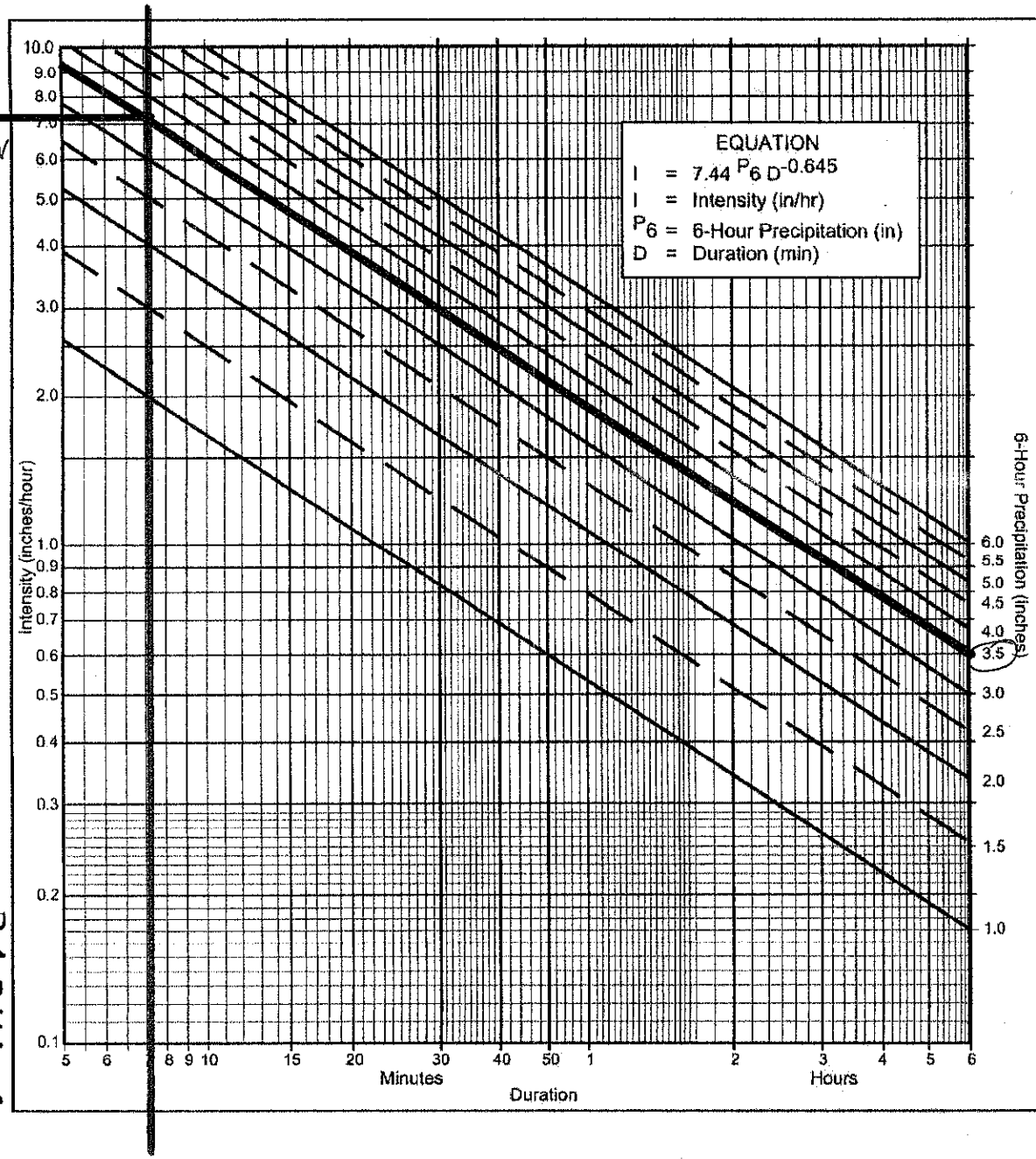
FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

V = 3.5 fps

BASIN 6
(VIA ARARAT DR.)



BASIN 6 (VIA ARARAT DR)

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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 7.2 min.

(e) I = 7.3 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

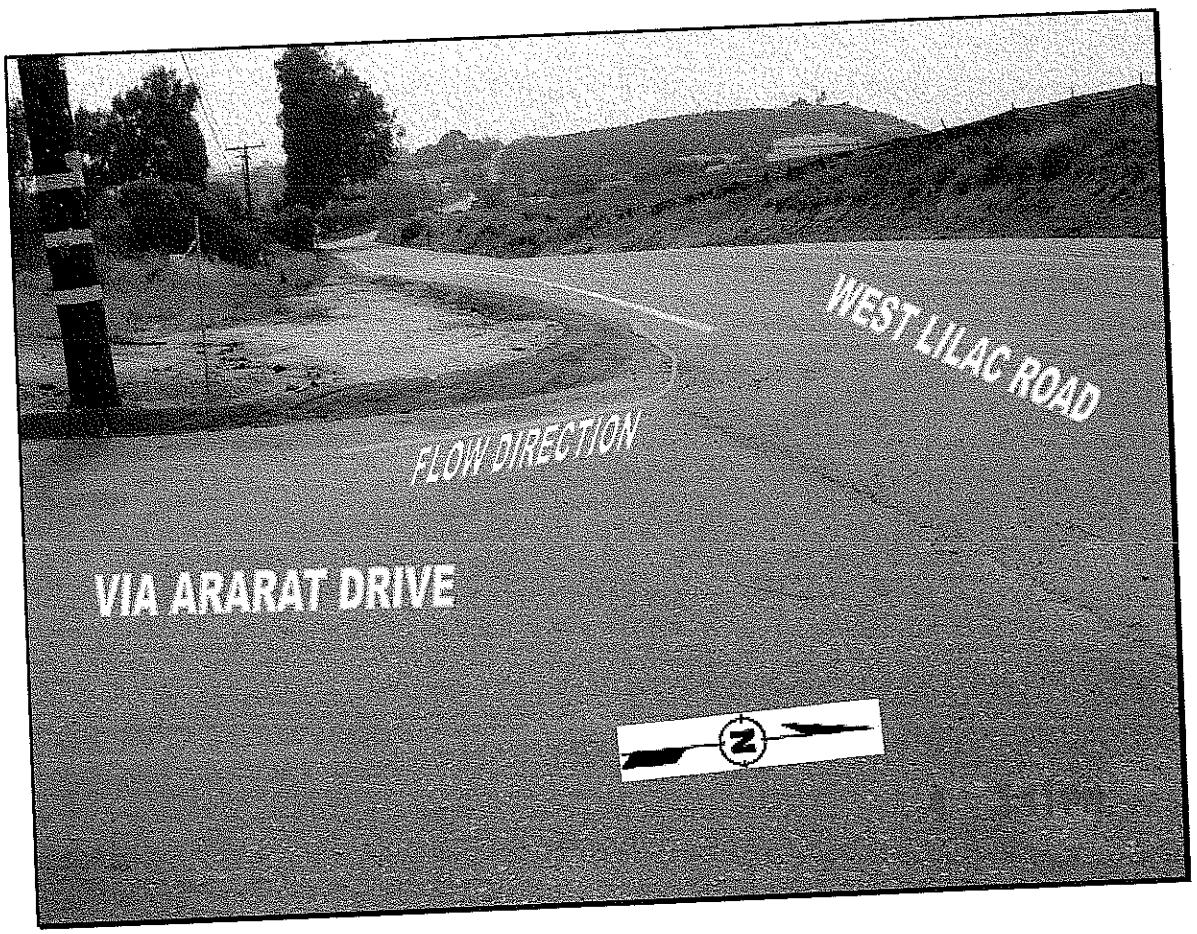
FIGURE

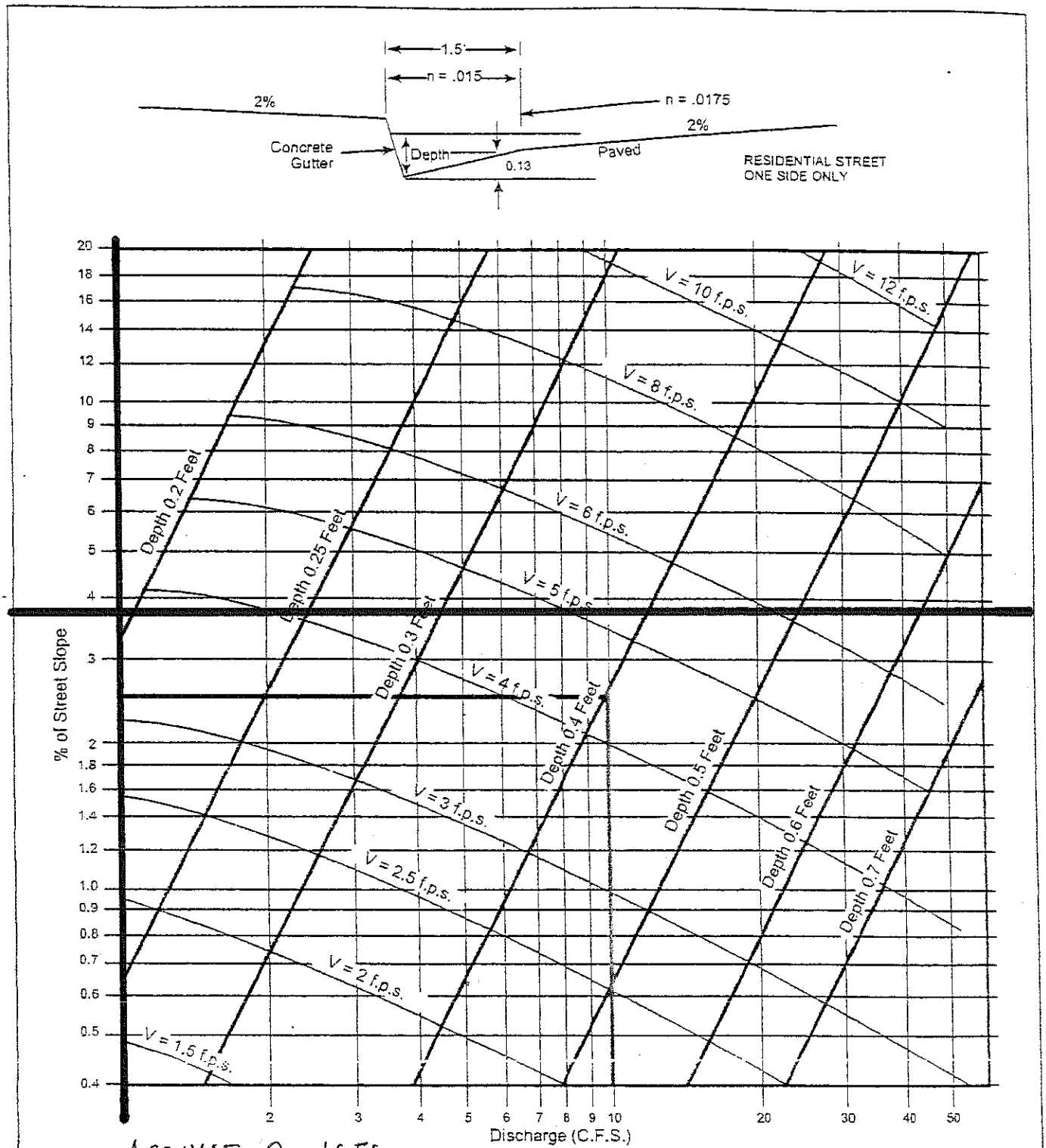
3-1

Basin 6 Hydraulics (Proposed Condition)

In the existing condition, the storm water from this basin sheet flows across Via Ararat Drive to the westerly side of the road. There is a 6-inch AC dike along this side of the road that directs the runoff to West Lilac Road, see the picture below.

From Figure 3-6, located on the following page, a depth of less than 0.2 feet is obtained in the gutter. Therefore, a 6-inch dike "Type A" G-5 per RSDs is adequate to handle a 100-year storm.





ASSUME Q = 1CFS → Q_{PEAK} = 0.6, 1 > 0.6

ASSUMPTION IS OK.

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

V = 3.8 f.p.s

D < 0.2 FT

BASIN 6
(VIA ARARAT DR)

BASIN 7
VIA ARARAT DRIVE

Basin 7 Hydrology (Existing Condition)

$Q_{100} = CIA$

C-Value:

$C_{SOIL\ C} = 0.36$ (see Table 3-1, Appendix)

Intensity Calculations:

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

Where

$T_C = T_i + T_X$

And:

$T_i = 9.5$ minutes (see Table 3-2 on following pages).

$T_X = 2.6$ minutes (see Figure 3-4 on following pages).

Then:

$T_C = 9.5 + 2.6 = 12.1$ minutes

Also,

$P_6 = 3.5$ inches (see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\ (3.5)\ (12.1)^{-0.645}$ (also see Figure 3-1 on following pages)

Then

$I = 5.2$ in/hr

Area:

$A = 0.8$ acres (see Drainage Basin Maps, Appendix)

Flow Rate:

$Q_{100} = CIA$

$Q_{100} = 0.36\ (5.2)\ (0.8)$

Then

$Q_{100} = 1.5$ cfs

Basin 7 Hydrology (Proposed Condition)

The flow rate for Basin 7 does not change from the existing conditions since the Basin is not on Via Ararat Drive and therefore remains unchanged (see Drainage Map Attached, Appendix).

EQUATION

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

T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

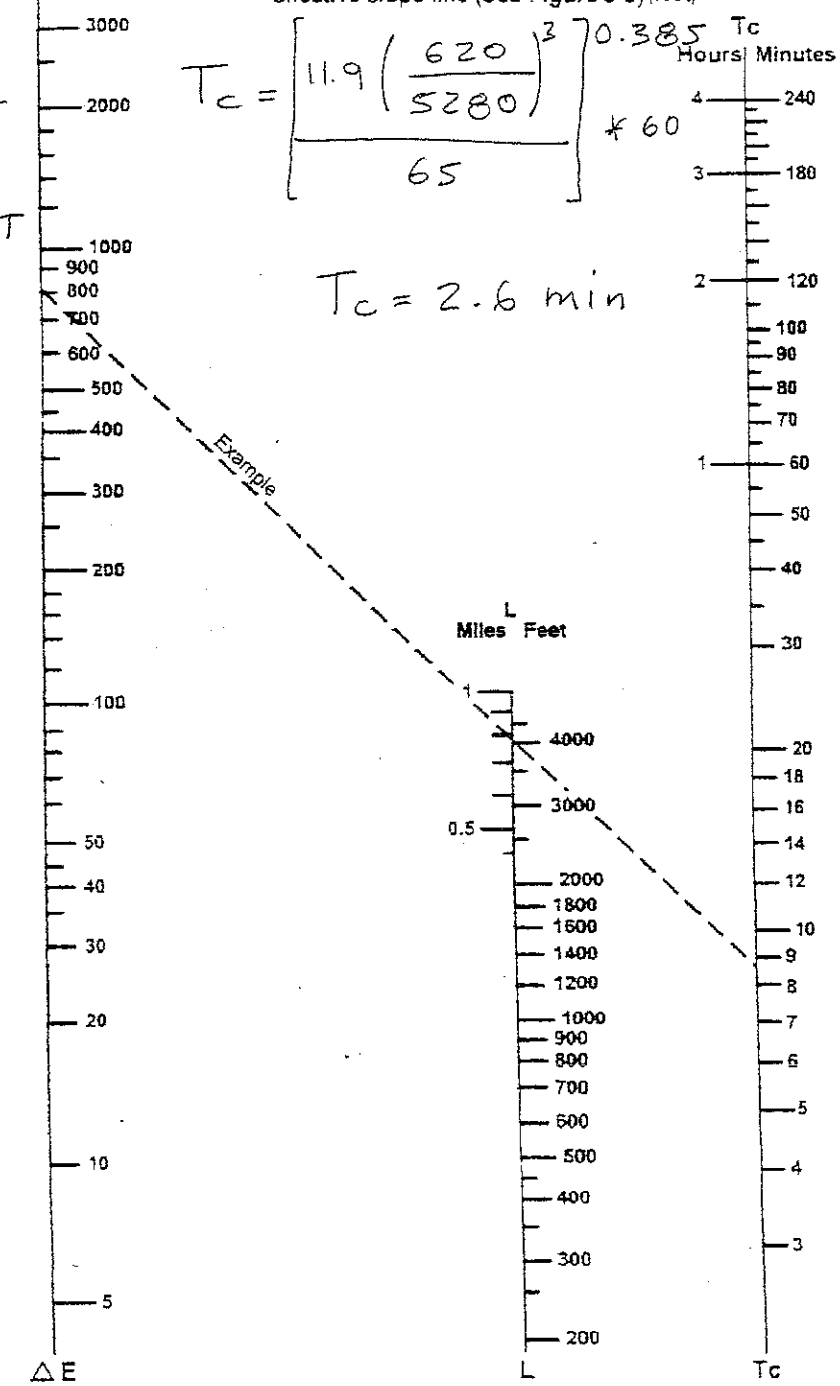
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 750 - 685 = 65$ FT

$L = 620$ FT

$$T_c = \left[\frac{11.9\left(\frac{620}{5280}\right)^3}{65}\right]^{0.385} * 60$$

$T_c = 2.6$ min



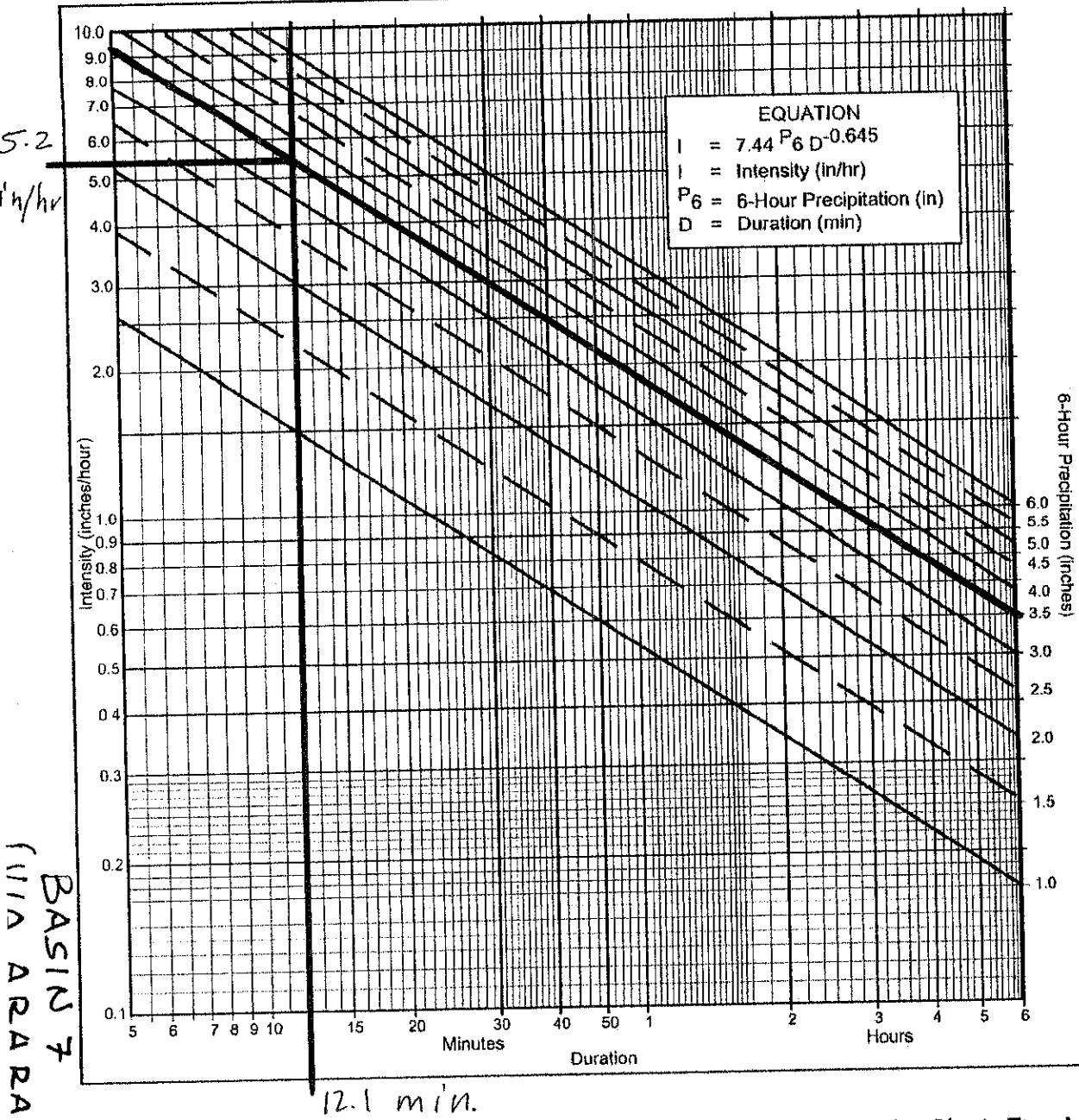
SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

3-4

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

BASIN 7
(VIA ARARAT DR



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 = 3.5 in., P_{24} = 6.0 , $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 12.1 min.

(e) I = 5.2 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 7 (U/A ARARAT DR.)

Intensity-Duration Design Chart - Template

FIGURE 3-1

Basin 7 Hydraulics (Proposed Condition)

The flow from Basin 7 is directed towards an existing 12" HDPE that crosses under Via Ararat Drive, see the picture below. The capacity of said 12" HDPE is 3.2 cfs per the following Inlet Control Chart. The peak discharge is 1.5 cfs. Therefore, the existing 12" HDPE is adequate in the 100-year storm.

The culvert has a flow velocity ($V = Q_{100} / A = 1.5$ cfs $/ 0.79$ ft^2) of 1.9 ft/s. Therefore, from Table 200-1.6.1(A) in the Appendix, the rock size for the outlet will be 1.5' thick Facing Class rip rap.

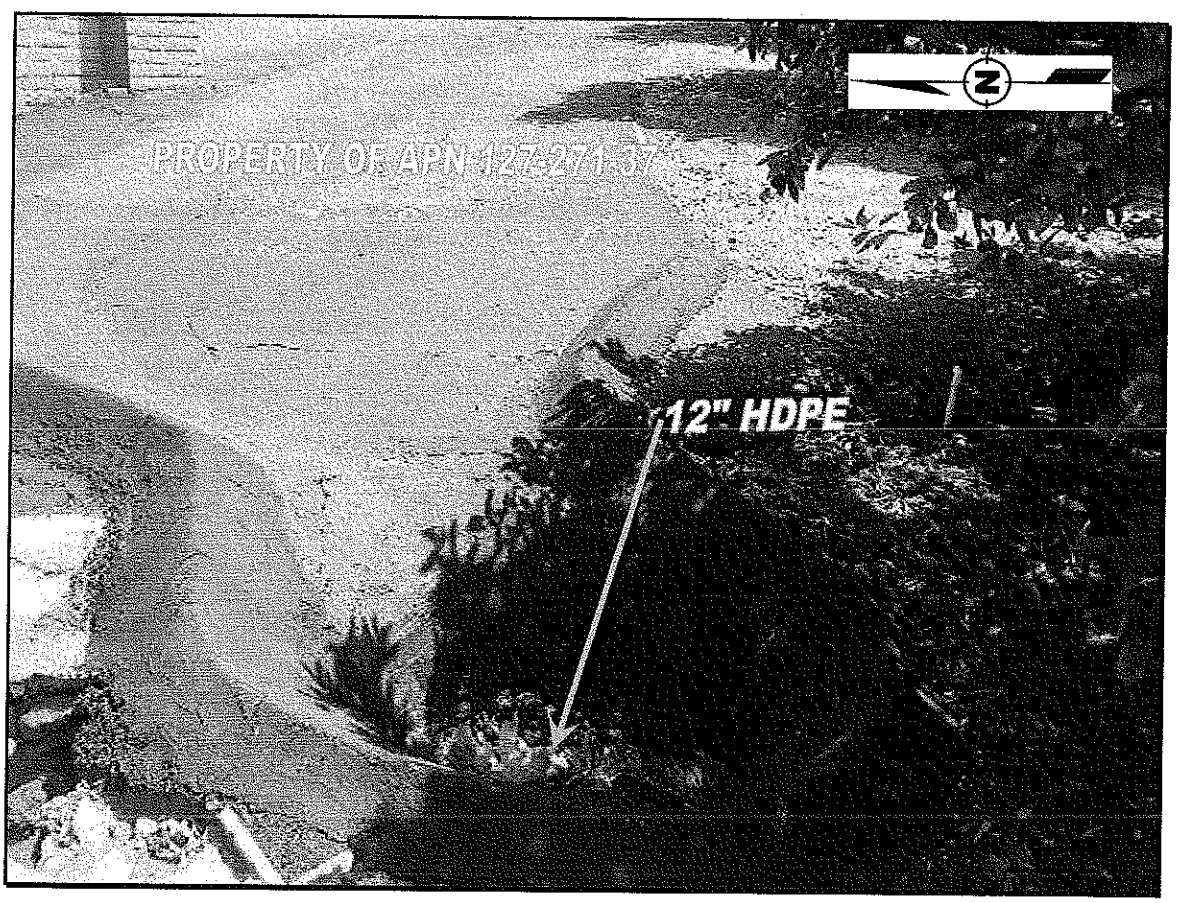
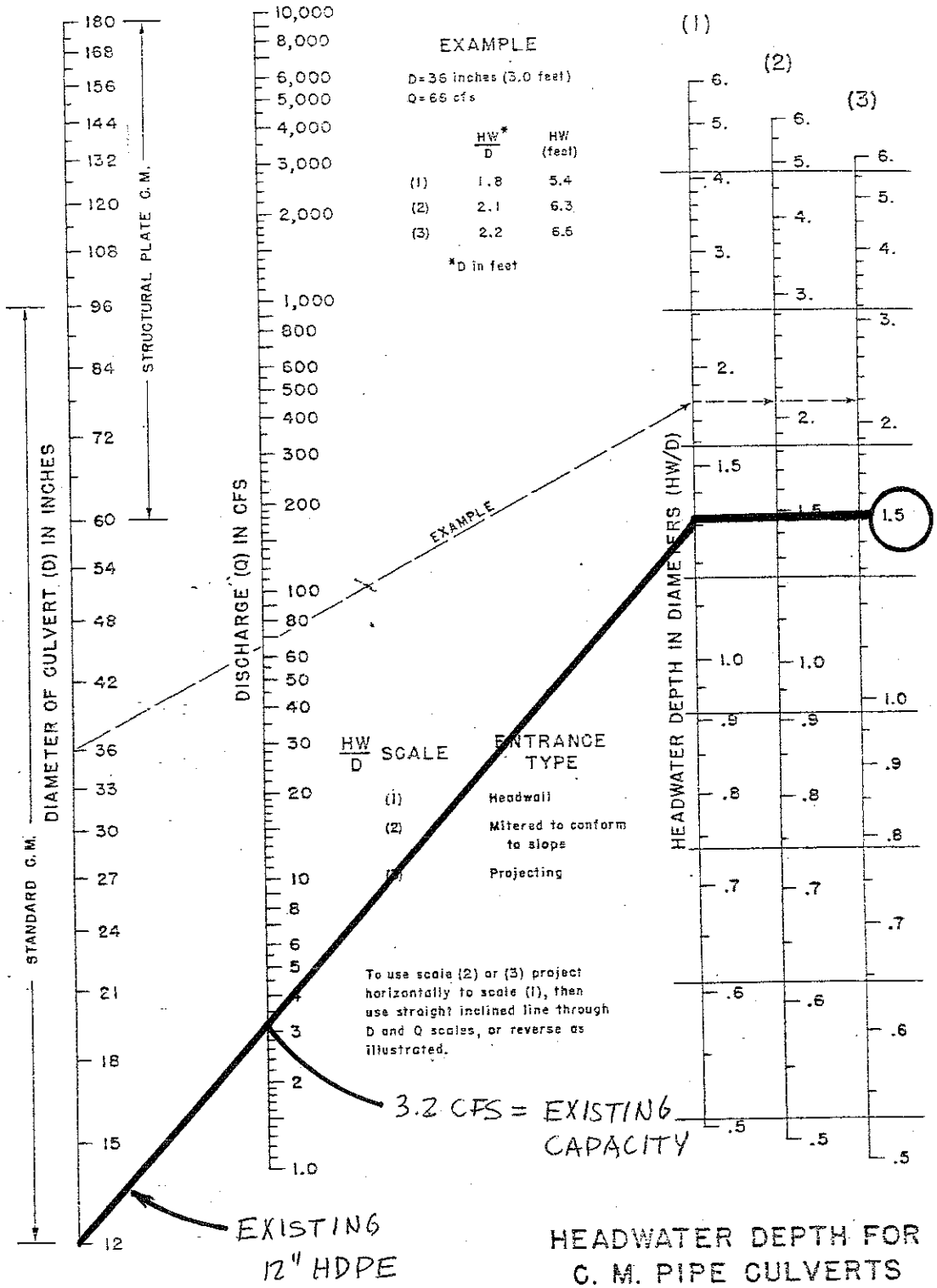


CHART 5



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

BUREAU OF PUBLIC ROADS JAN. 1963

EXISTING CAPACITY = 3.2 CFS

EXISTING Q_{PEAK} = 1.5 CFS

$\boxed{3.2 > 1.5}$ ∴ EXISTING PIPE IS ADEQUATE.

BASIN 7
(VIA ARARAT DR.)

Section C

BASIN 1
AQUEDUCT ROAD

AQUEDUCT ROAD

Basin 1 Hydrology (Existing Condition)

Q_{100} = CIA

C-Value:

$C_{SOIL\ C}$ = 0.36 (see Table 3-1, Appendix)

Intensity Calculations:

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

Where:

$T_C = T_i + T_X$

And:

T_i = 11.5 minutes (see Table 3-2 on following pages).

T_X = 1.1 minutes (see Figure 3-4 on following pages).

Then:

T_C = 11.5 + 1.1 = 12.6 minutes

Also:

P_6 = 3.5 inches (see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\ (3.5)\ (12.6)^{-0.645}$ (also see Figure 3-1 on following pages)

Then:

I = 5.1 in/hr

Area:

A = 1.3 acres (see Drainage Basin Maps, Appendix)

Flow Rate:

Q_{100} = CIA

Q_{100} = 0.36 (5.1) (1.3)

Then

Q_{100} = 2.4 cfs

Basin 1 Hydrology (Proposed Condition)

The purpose for the calculations below is to account for the additional paving due to the widening of Aqueduct Road.

$$Q_{100} = CIA$$

Updated Area:

$$A_{total} = A_{Exist} + A_{Asph}$$

Where:

New Pavement Area (A_{Asph}) = 0.03 acres (see Preliminary Grading Plan, Appendix)

Then

$$\boxed{A_{total} = 1.3 + 0.03 = 1.33 \text{ acres}}$$

C-Value:

$$C = [(C_{Exist} * A_{Exist}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$$

Where:

New Pavement (C_{Asph}) = 0.95 (see Table II, Appendix)

Then:

$$C = [(0.36)(1.3) / 1.33] + [(0.95)(0.03) / 1.33]$$

$$\boxed{C = 0.37}$$

Flow Rate:

$$Q_{100} = CIA$$

$$Q_{100} = 0.37\ (5.1)\ (1.33)$$

Then

$$\boxed{Q_{100} = 2.5 \text{ cfs}}$$

Basin 1 Comparison

Q_{100} Existing = 2.4 cfs

Q_{100} Proposed = 2.5 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.

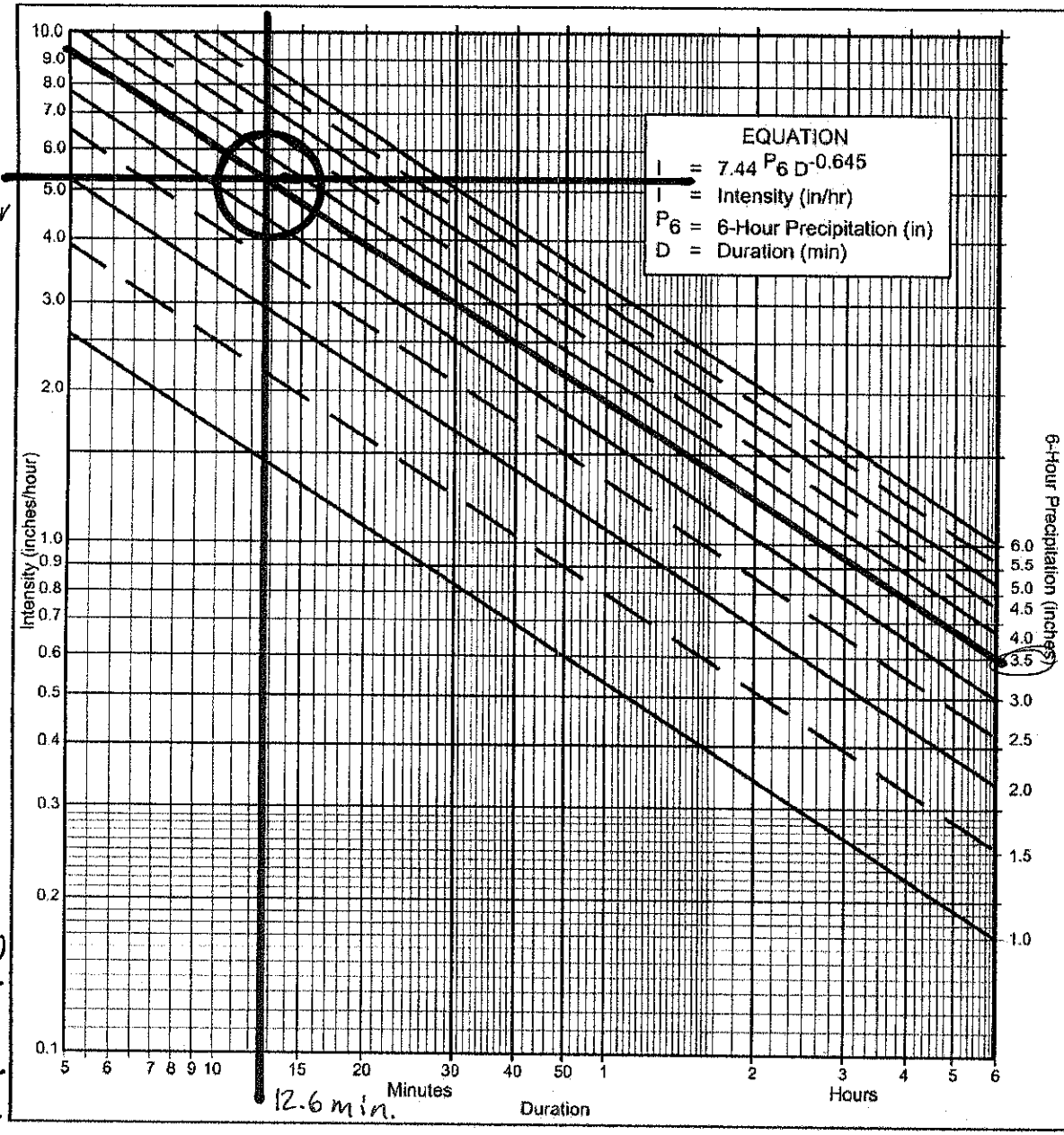
Table 3-2

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 1
(AQUEDUCT RD.)



BASIN 1 (ACCENCIST RD)

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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 12.6 min.

(e) I = 5.1 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

FIGURE

3-1

EQUATION

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

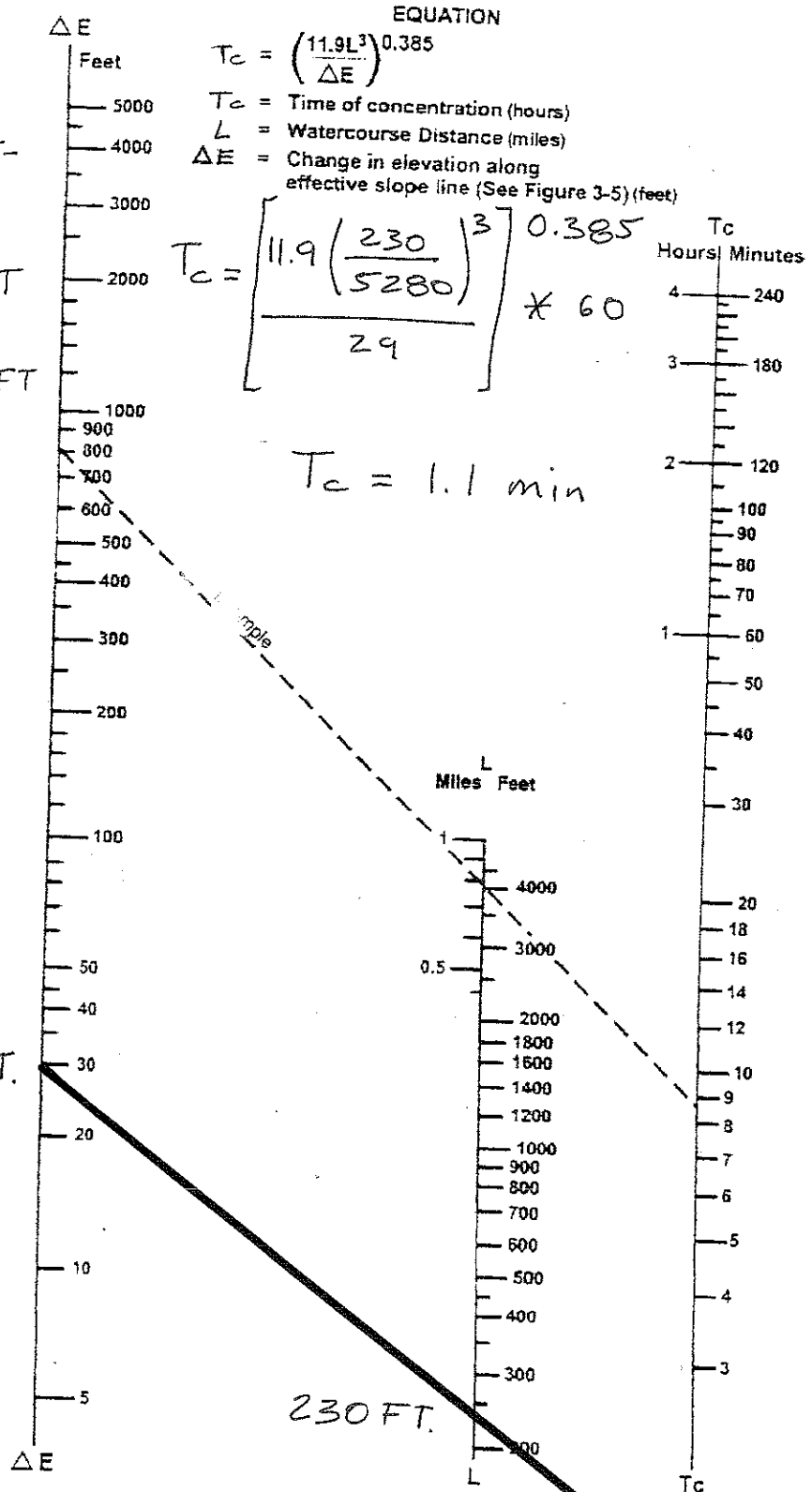
T_c = Time of concentration (hours)
L = Watercourse Distance (miles)
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 885 - 856 = 29$ FT

$L = 230$ FT

$$T_c = \left[\frac{11.9\left(\frac{230}{5280}\right)^3}{29}\right]^{0.385} * 60$$

$T_c = 1.1$ 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

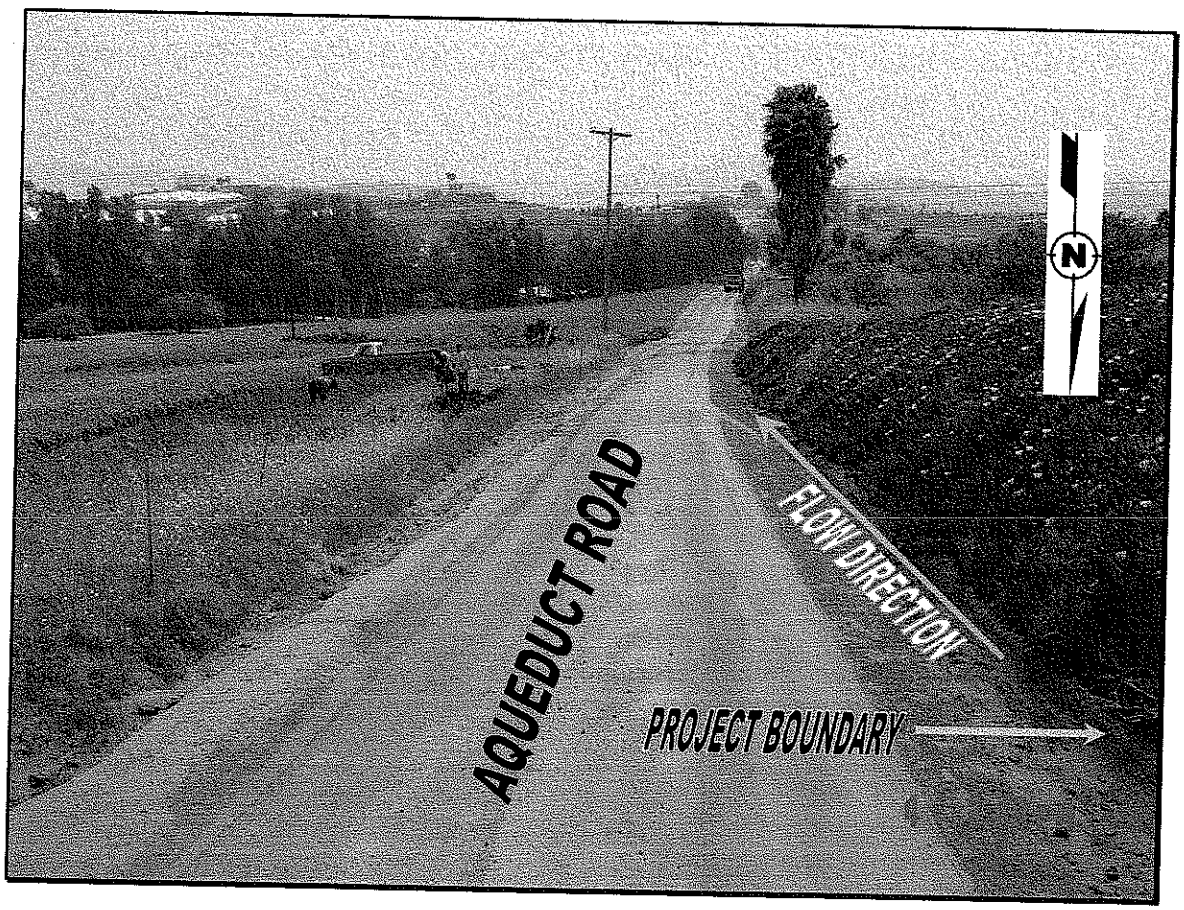
FIGURE 3-4

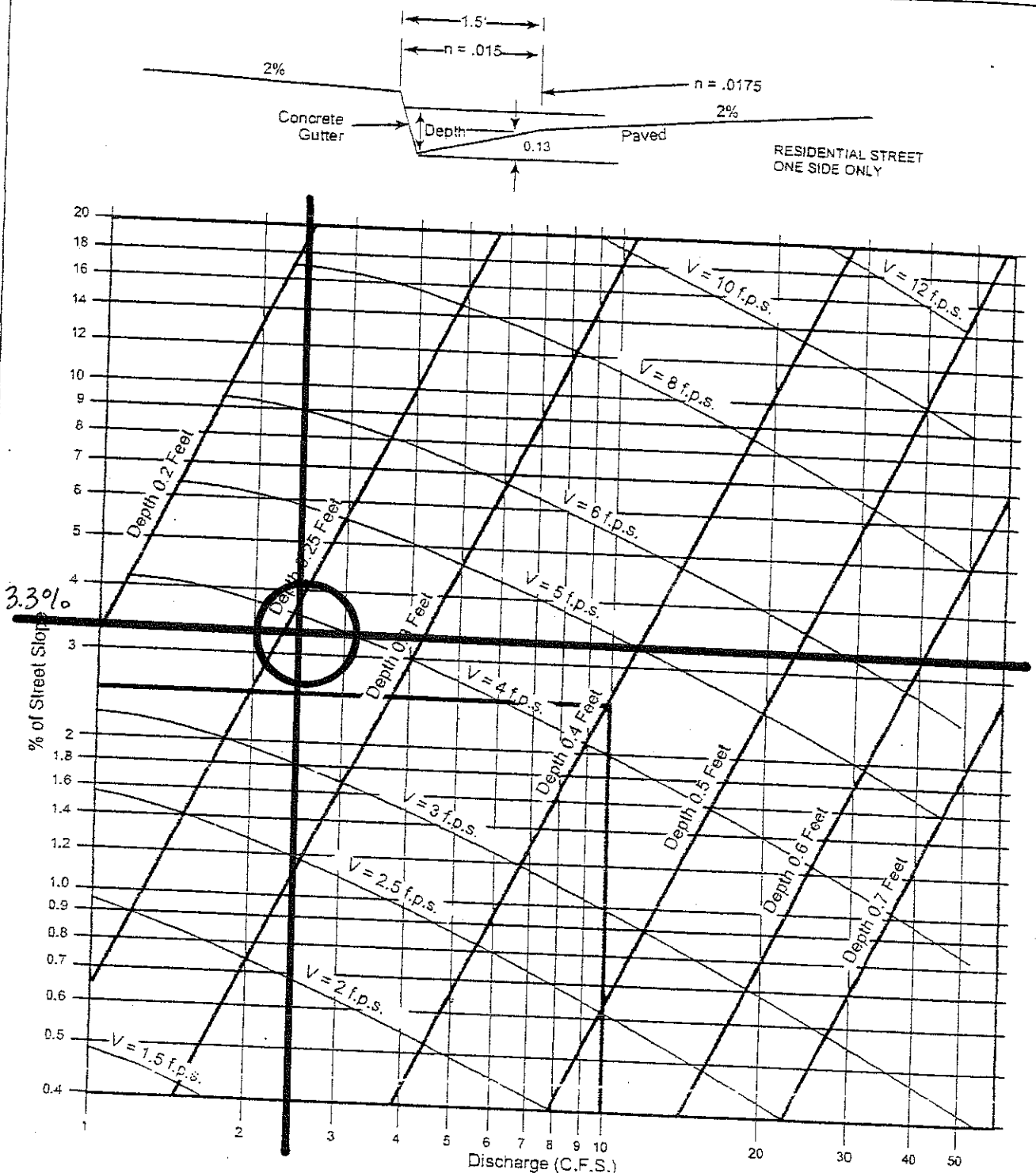
BASIN 1
(AQUEDUCT RD.)

Basin 1 Hydraulics (Proposed Condition)

In the existing condition, the storm water from this basin sheet flows southerly along the westerly edge of the dirt road (Aqueduct Road). See the picture below and the 40-scale Drainage Map in the Appendix

From Figure 3-6, located on the following page, a depth of 0.26 feet is obtained from the westerly edge of the road. Therefore, a 6-inch dike "Type A" G-5 per RSDs is adequate to handle a 100-year storm.





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

Gutter and Roadway Discharge - Velocity Chart

FIGURE 3-6

V = 3.9 fps
D = 0.26 ft

BASIN 1
(AQUEDUCT RD.)

BASIN 2
AQUEDUCT ROAD

Basin 2 Hydrology (Existing Condition)

$$Q_{100} = CIA$$

Area:

$$A_{total} = A_{Nat} + A_{Exist\ Asph}$$

Where:

Natural Area (A_{Nat})	=	0.76	acres	(see Drainage Map, Appendix)
Asphalt area ($A_{Exist\ Asph}$)	=	0.04	acres	(see Drainage Map, Appendix)

$$\boxed{A_{total} = 0.76 + 0.04 = 0.8 \text{ acres}}$$

C-Value:

$$C_{Exist} = [(C_{Nat} * A_{Nat} / A_{total}] + [(C_{Exist\ Asph} * A_{Exist\ Asph}) / A_{total}]$$

Where:

C_{Nat}	=	0.30	(see Table 3-1, Appendix)
$C_{Exist\ Asph}$	=	0.95	(see Table II, Appendix)

$$C_{Exist} = [(0.30)\ (0.76) / 0.8] + [(0.95)\ (0.04) / 0.8]$$

$$\boxed{C = 0.33}$$

Intensity Calculations:

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

Where

$$T_C = T_i + T_X$$

And:

T_i	=	8.0	minutes	(see Table 3-2 on following pages).
T_X	=	2.8	minutes	(see Figure 3-4 on following pages).

Then:

$$T_C = 8.0 + 2.8 = 10.8 \text{ minutes}$$

Also,

$$P_6 = 3.5 \text{ inches}$$ (see Rainfall Isopluvial, Appendix)

$$I = 7.44\ (3.5)\ (10.8)^{-0.645}$$ (also see Figure 3-1 on following pages)

Then

$$\boxed{I = 5.6 \text{ in/hr}}$$

Flow Rate:

$$Q_{100} = CIA$$

$$Q_{100} = 0.33\ (5.6)\ (0.8)$$

Then

$$\boxed{Q_{100} = 1.5 \text{ cfs}}$$

Basin 2 Hydrology (Proposed Condition)

The purpose for the calculations below is to account for the additional paving due to the widening of Aqueduct Road.

Q_{100} = CIA

Updated Area:

$A_{total} = A_{Nat} + A_{Asph}$

Where:

Natural Area (A_{Nat}) 0.64

Total Pavement Area (A_{Asph}) = 0.16 acres (see Preliminary Grading Plan, Appendix)

Then

A_{total} = 0.16 + 0.64 = 0.8 acres

C-Value:

$C = [(C_{Nat} * A_{Nat}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$

Then:

$C = [(0.30)(0.64)/0.8] + [(0.95)(0.16)/0.8]$

C = 0.43

Intensity Calculations:

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

Where

$T_C = T_i + T_{X1} + T_{X2}$

And:

T_i = 8.0 minutes (see Table 3-2 on following pages).

T_{X1} = 2.8 minutes (see Figure 3-4 on following pages).

T_{X2} is the time it takes the runoff to travel along the gutter flow line. The time it takes the water to travel from the initial point of the gutter flow to the concentration point is calculated using the velocity and the distance traveled. The velocity is calculated using Figure 3-6 of the San Diego hydrology manual and the distance traveled is obtained from the Drainage Basin Map. The Q_{100} used for Figure 3-6 is assumed and then divided by two to average the amount of runoff in the gutter. This assumption is later checked for accuracy. See below for the calculation:

T_{X2} = Distance Traveled / Velocity

Where:

Velocity (V) = 4.1 fps (see Figure 3-6 on following pages)

Distance Traveled = 430 feet (see Drainage Basin Map, Appendix)

Then:

T_{X2} = 430 / 4.1 = 105 seconds = 1.7 minutes

Therefore:

T_C = 8.0 + 2.8 + 1.7 = 12.5 minutes

Also,

P_6 = 3.5 inches (see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\,(3.5)\,(12.5)^{-0.645}$ (also see Figure 3-1 on following pages)

Then

I = 5.1 in/hr

Basin 2 cont...

Flow Rate:

$$Q_{100} = CIA$$

$$Q_{100} = 0.43\ (5.1)\ (0.8)$$

Then

$$\boxed{Q_{100} = 1.8 \quad \text{cfs}}$$

* The assumption for the Q_{100} for the velocity calculation is found to be correct with accepatable tolerance.

<u>Basin 2 Comparison</u>

Q_{100} Existing	=	1.5	cfs
Q_{100} Proposed	=	1.8	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 2
EXIST CONDITION
&
PROP. CONDITION

EQUATION

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

T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

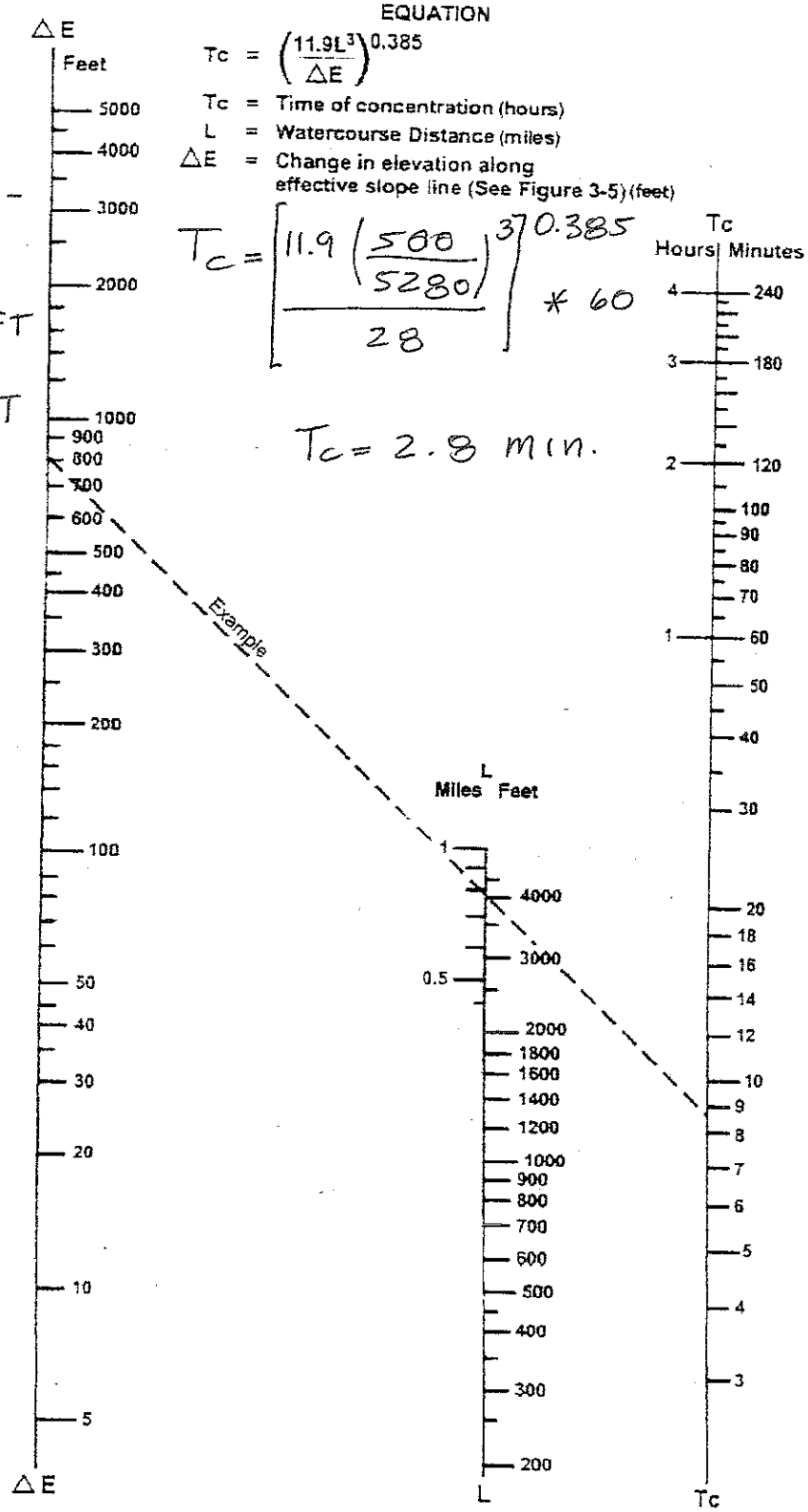
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 883 - 855 = 28$ FT

$L = 500$ FT

$$T_c = \left[\frac{11.9\left(\frac{500}{5280}\right)^3}{28}\right]^{0.385} * 60$$

$T_c = 2.8$ min.

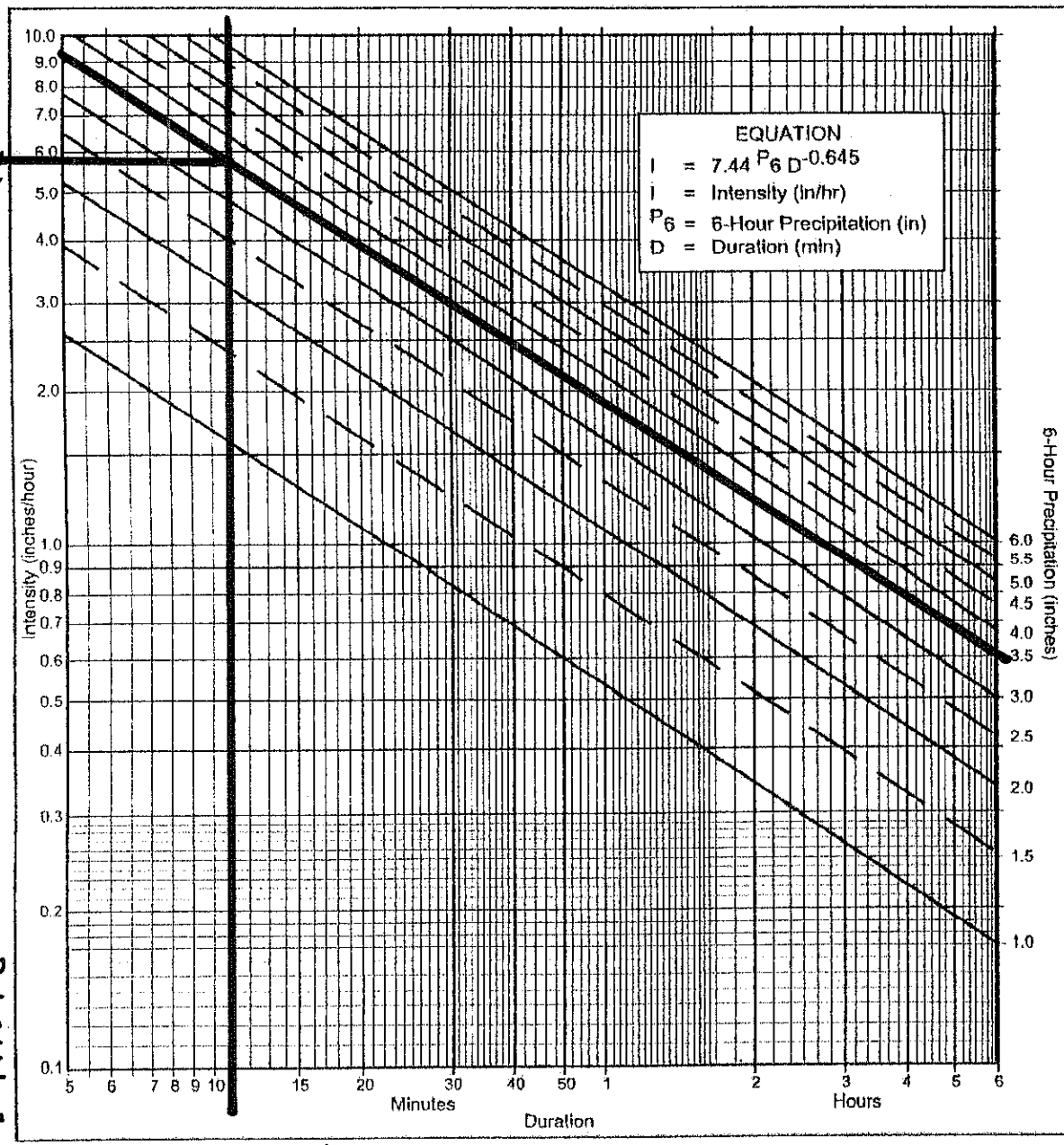


SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE 3-4

BASIN 2
EXIST CONDITION
(AQUEDUCT RD.)



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 = 3.5 in., P_{24} = 6.0 $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 10.8 min.

(e) I = 5.6 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 2
EXIST. COND.

Intensity-Duration Design Chart - Template

FIGURE
3-1

EQUATION

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

T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

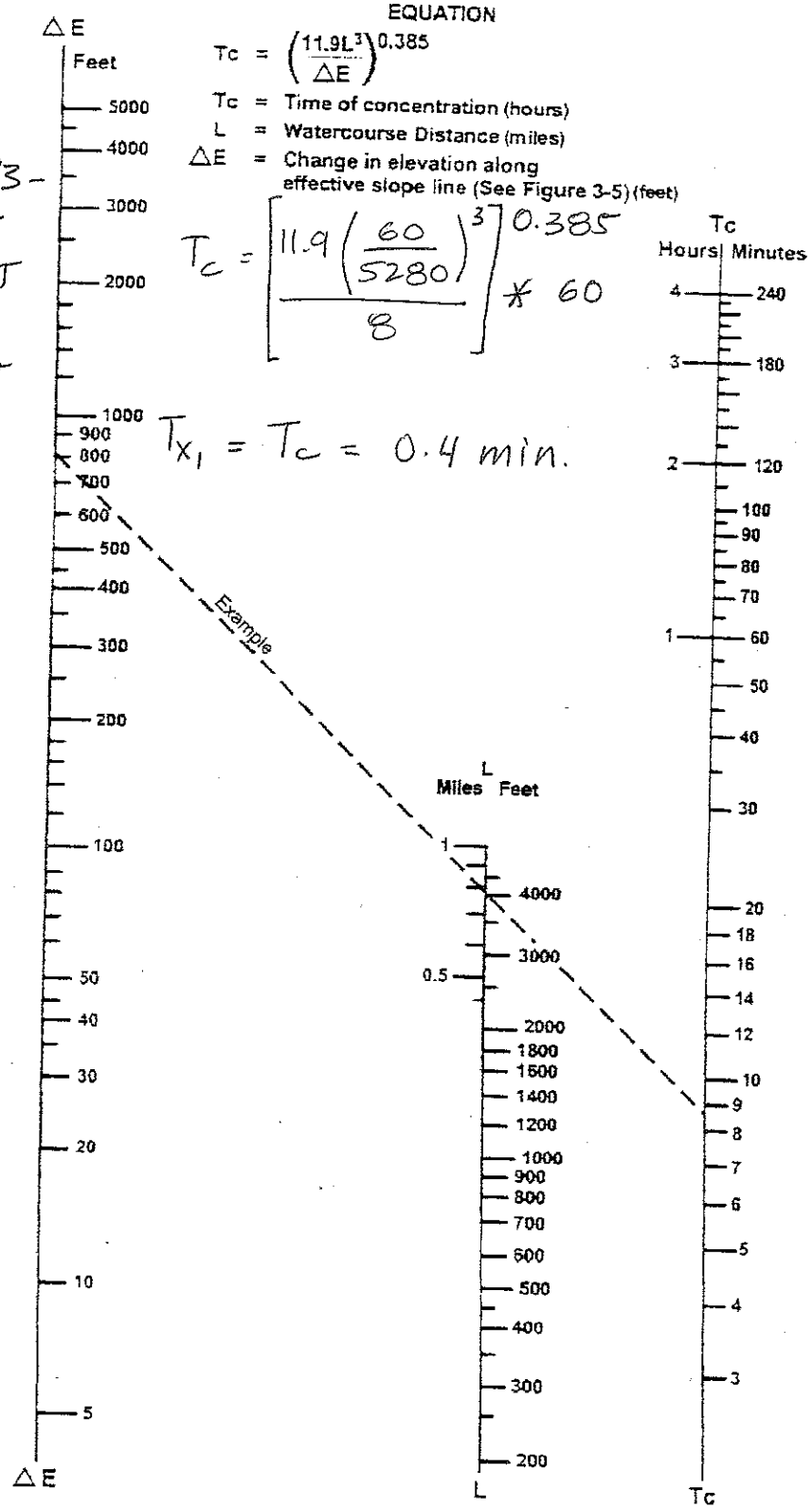
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 883 - 875 = 8$ FT

$L = 60$ FT

$$T_c = \left[\frac{11.9\left(\frac{60}{5280}\right)^3}{8}\right]^{0.385} * 60$$

$T_{x_1} = T_c = 0.4$ min.

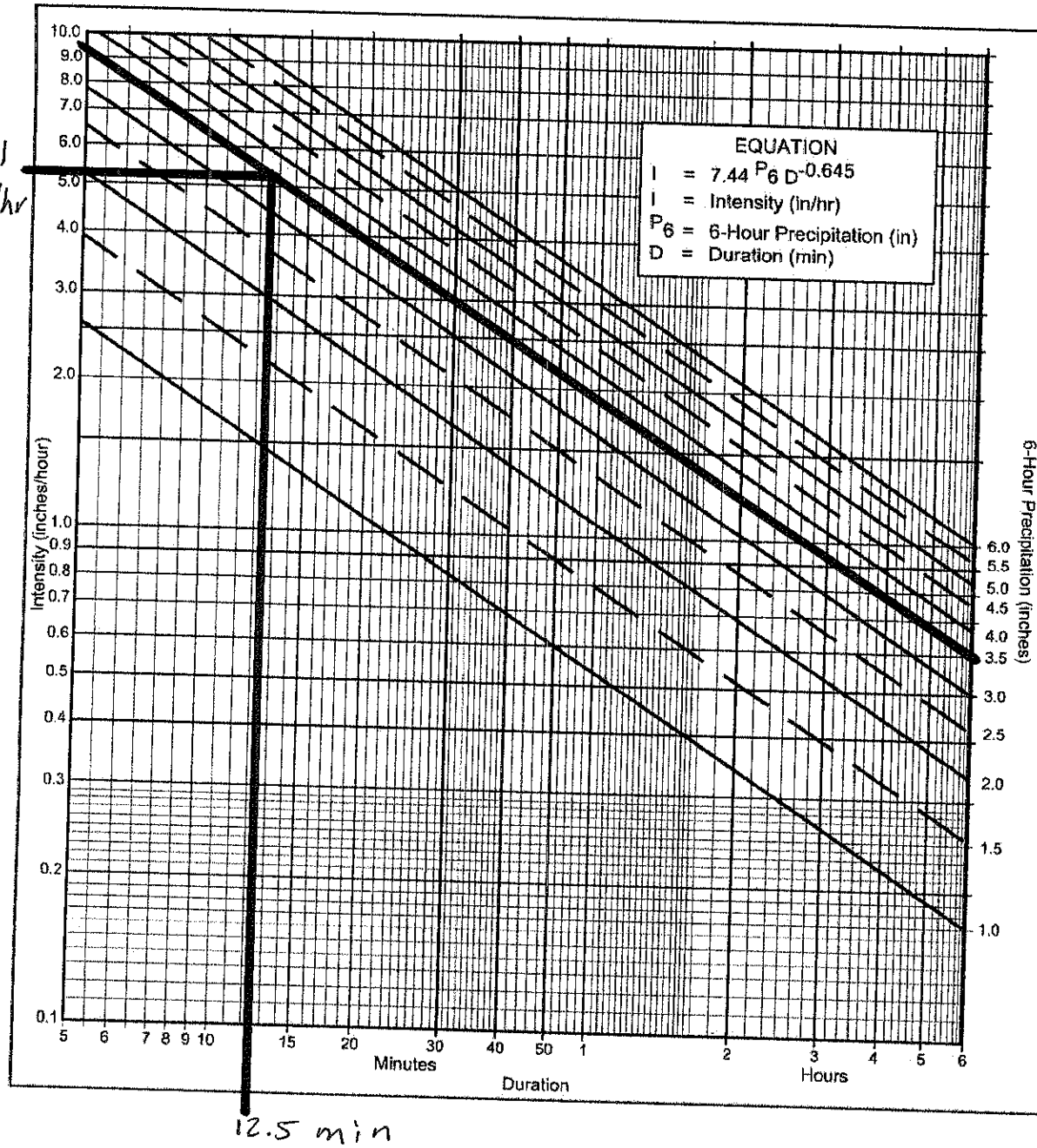


SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE 3-4

PROPOSED COND BASIN 2 (AQUEDUCT RD.)



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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 12.5 min.

(e) I = 5.1 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

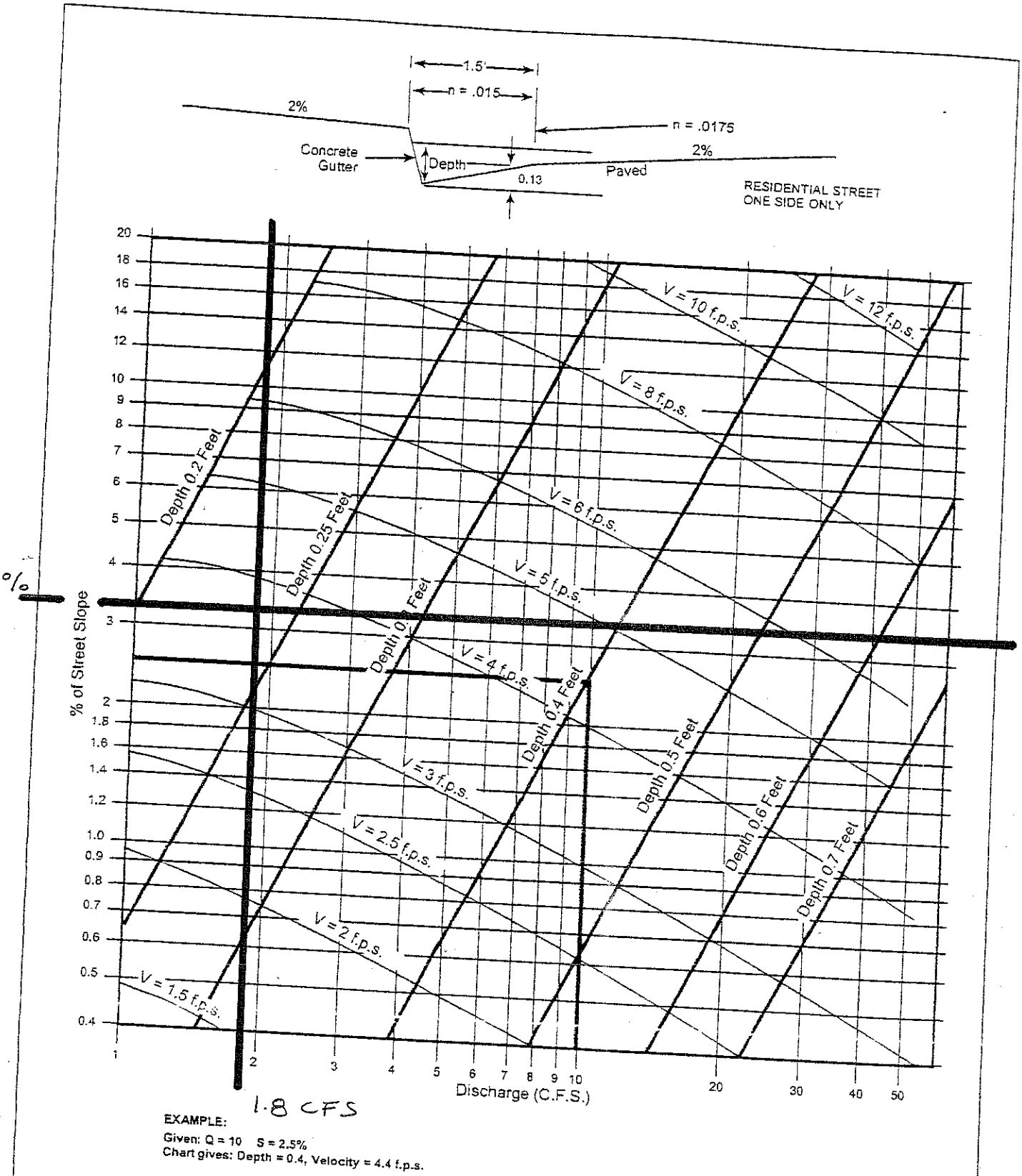
FIGURE **3-1**

BASIN 2 (PROP COND)

Basin 2 Hydraulics (Proposed Condition)

In the existing condition, the storm water from this basin sheet flows southerly in the easterly edge of the dirt road (Aqueduct Road), see the picture below and the 40-scale Drainage Map in the Appendix.

From Figure 3-6, located on the following page, a depth of 0.24 feet is obtained from the easterly edge of the road. Therefore, a 6-inch dike "Type A" G-5 per RSDs is adequate to handle a 100-year storm.



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

Gutter and Roadway Discharge - Velocity Chart

FIGURE 3-6

V = 3.7 fps
D = 0.24 ft

BASIN 2
(AQUEDUCT ROAD

BASIN 3
AQUEDUCT ROAD

Basin 3 Hydrology (Existing Condition)

Q_{100} = CIA

Area:

$A_{total} = A_{Nat} + A_{Exist\ Asph}$

Where:

Natural Area (A_{Nat})	=	0.25	acres	(see Drainage Map, Appendix)
Asphalt and Roof area ($A_{Exist\ Asph}$)		0.55	acres	(see Drainage Map, Appendix)

A_{total} = 0.25 + 0.55 = 0.8 acres

C-Value:

$C_{Exist} = [(C_{Nat} * A_{Nat} / A_{total}] + [(C_{Exist\ Asph} * A_{Exist\ Asph}) / A_{total}]$

Where:

C_{Nat}	=	0.25	(see Table 3-1, Appendix)
$C_{Exist\ Asph}$	=	0.95	(see Table II, Appendix)

$C_{Exist} = [(0.25)\ (0.25) / 0.8] + [(0.95)\ (0.55) / (0.8)]$

C_{Exist} = 0.73

Intensity Calculations:

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

Where

$T_C = T_i + T_{X1} + T_{X2}$

And:

T_i	=	11.5	minutes	(see Table 3-2 on following pages).
T_{X1}	=	0.5	minutes	(see Figure 3-4 on following pages).

T_{X2} is the time it takes the runoff to travel along the gutter flow line. The time it takes the water to travel from the initial point of the gutter flow to the concentration point is calculated using the velocity and the distance traveled. The velocity is calculated using Figure 3-6 of the San Diego hydrology manual and the distance traveled is obtained from the Drainage Basin Map. The Q_{100} used for Figure 3-6 is assumed and then divided by two to average the amount of runoff in the gutter. This assumption is later checked for accuracy. See below for the calculation:

T_{X2} = Distance Traveled / Velocity

Where:

Velocity (V)	=	5.4	fps	(see Figure 3-6-1 on following pages)
Distance Traveled	=	140	feet	(see Drainage Basin Map, Appendix)

Then:

T_{X2} = 140 / 5.4 = 26 seconds = 0.4 minutes

Therefore:

T_C = 11.5 + 0.5 + 0.4 = 12.4 minutes

Also,

P_6 = 3.5 inches (see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\ (3.5)\ (12.4)^{-0.645}$ (also see Figure 3-1 on following pages)

Then:

I = 5.1 in/hr

Flow Rate:

$$Q_{100} = CIA$$
$$Q_{100} = 0.73\ (5.1)\ (0.8)$$

Then

$$\boxed{Q_{100} = 3.0 \quad \text{cfs}}$$

* The assumption for the Q_{100} for the velocity calculation is found to be correct with accepatable tolerance.

Basin 3 Hydrology (Proposed Condition)

The purpose for the calculations below is to account for the additional paving due to the widening of Aqueduct Road.

$$Q_{100} = CIA$$

Updated Area:

$$A_{total} = A_{Exist} + A_{Asph}$$

Where:

New Pavement Area (A_{Asph}) = 0.03 acres (see Preliminary Grading Plan, Appendix)

Then

$$\boxed{A_{total} = 0.8 + 0.03 = 0.83 \quad \text{acres}}$$

C-Value:

$$C = [(C_{Exist} * A_{Exist}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$$

Where:

New Pavement (C_{Asph}) = 0.95 (see Table II, Appendix)

Then:

$$C = [(0.73)\ (0.8)/0.83] + [(0.95)\ (0.03)\ /\ 0.83]$$

$$\boxed{C = 0.74}$$

Flow Rate:

$$Q_{100} = CIA$$
$$Q_{100} = 0.74\ (5.1)\ (0.83)$$

Then

$$\boxed{Q_{100} = 3.1 \quad \text{cfs}}$$

Basin 3 Comparison

Q_{100} Existing = 3.0 cfs

Q_{100} Proposed = 3.1 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 3
(AQUEDUCT RD.)

$\Delta E = 896 - 887 - = 9$ FT

$L = 80$ FT.

EQUATION

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

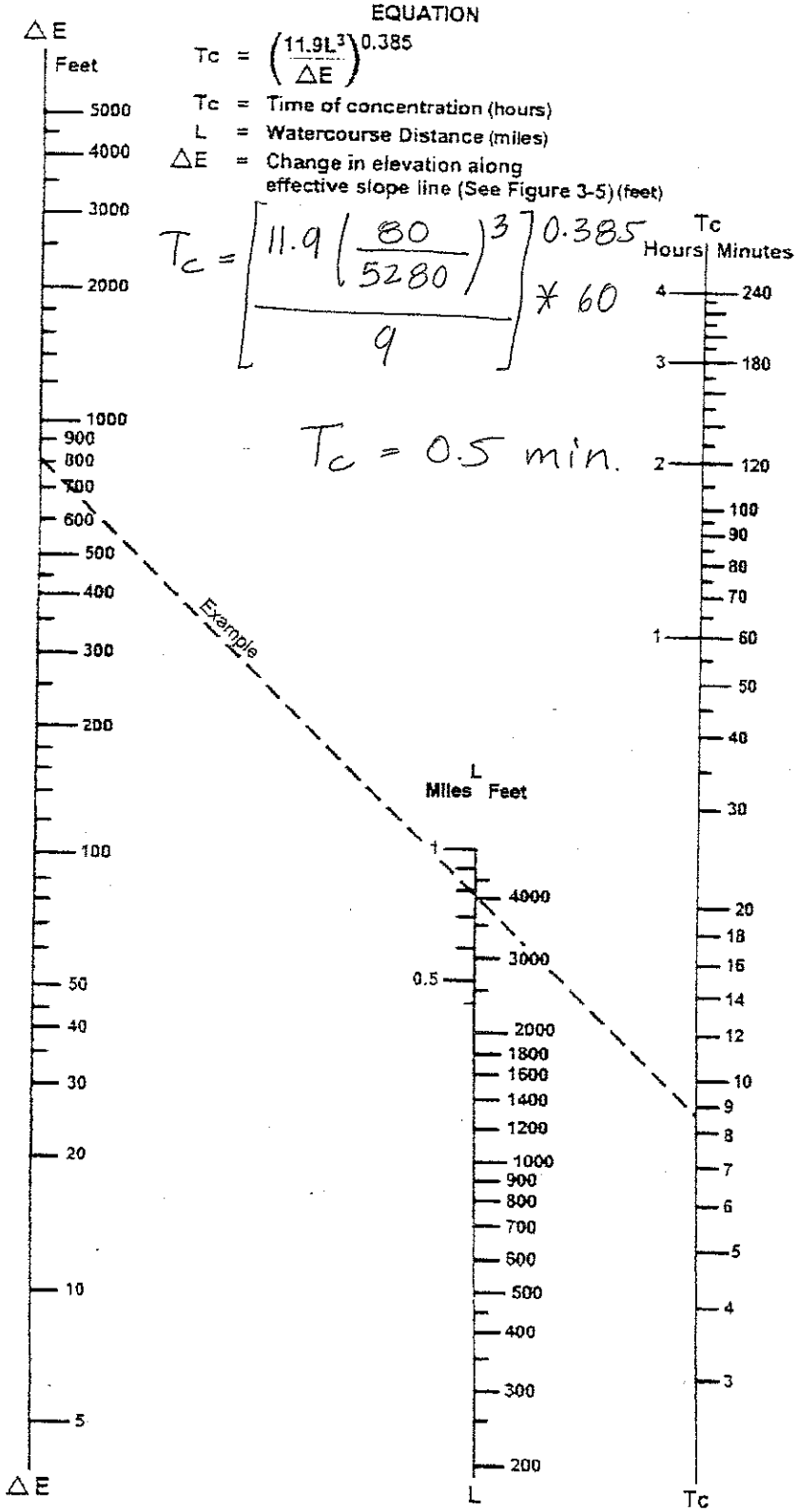
T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

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

$$T_c = \left[\frac{11.9\left(\frac{80}{5280}\right)^3}{9}\right]^{0.385} * 60$$

$T_c = 0.5$ min.

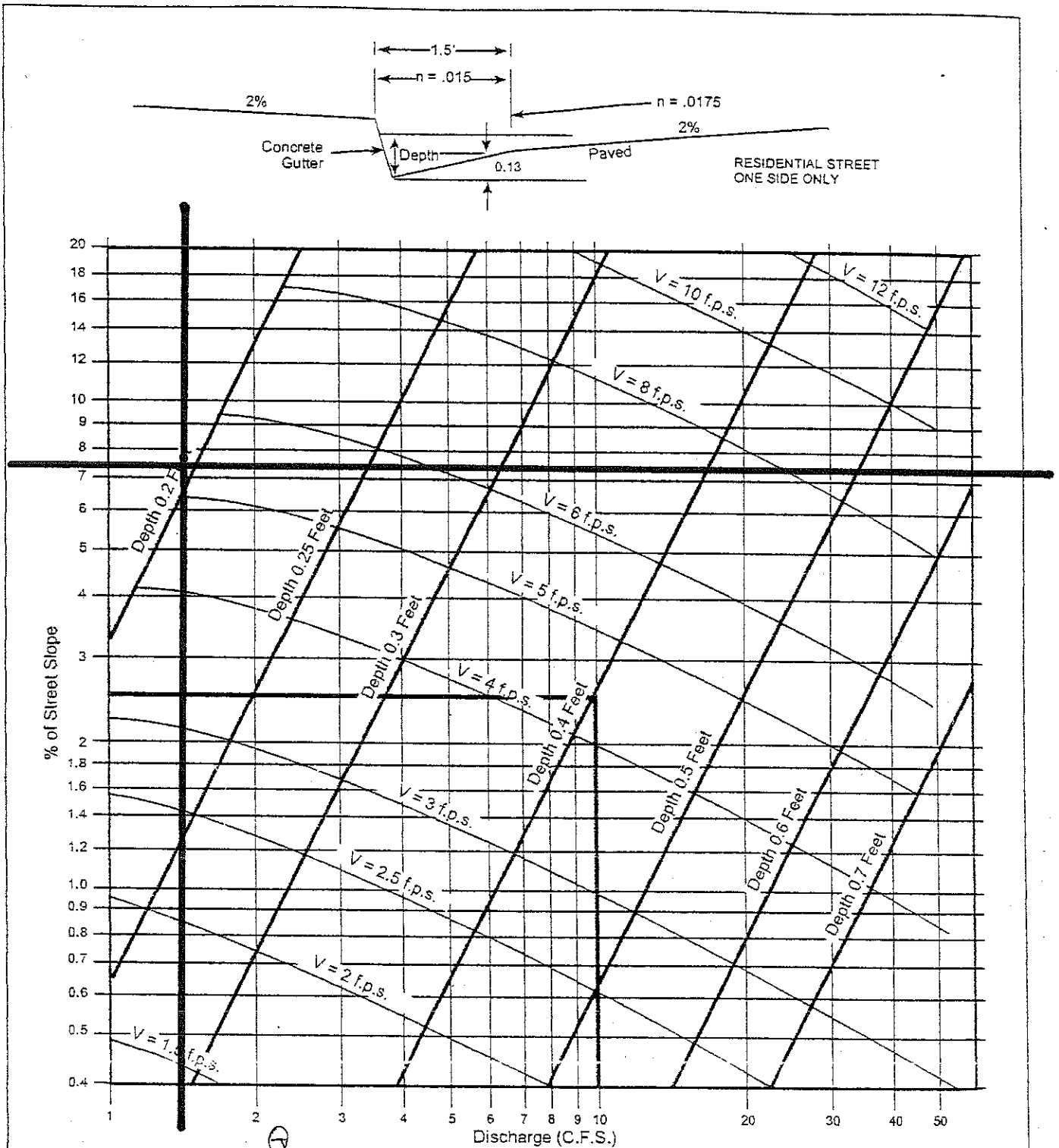


SOURCE: California Division of Highways (1941) and Kirpich (1940)

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

FIGURE 3-4

BASIN 3
(AQUEDUCT RD.)



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

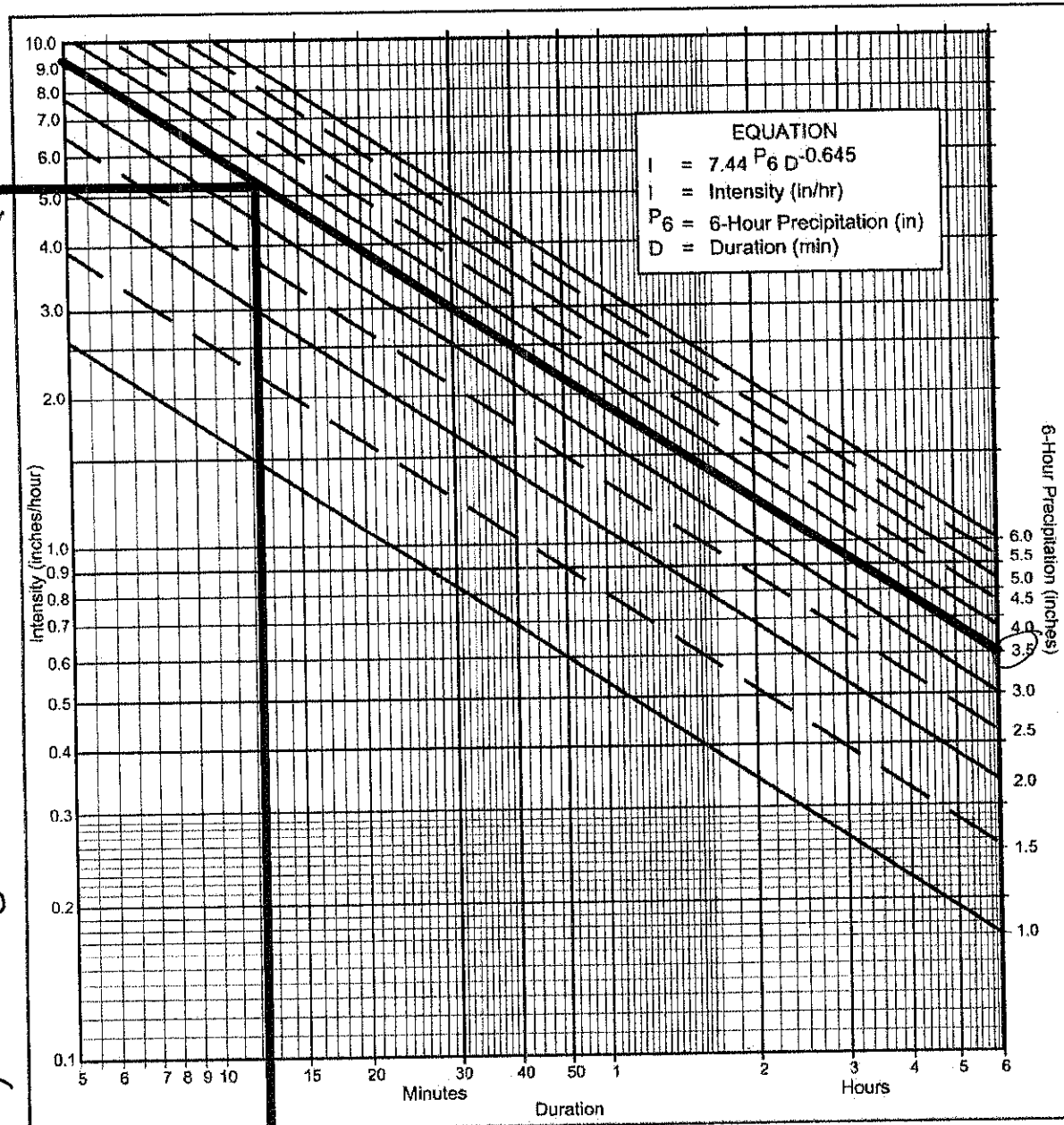
FIGURE

3-6-1

Gutter and Roadway Discharge - Velocity Chart

V = 5.4 ft/s

BASIN 3
(AQUEDUCT RD.)



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 = 3.5 in., P_{24} = 6.0 $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted $P_6^{(2)}$ = 3.5 in.

(d) t_x = 12.4 min.

(e) I = 5.1 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

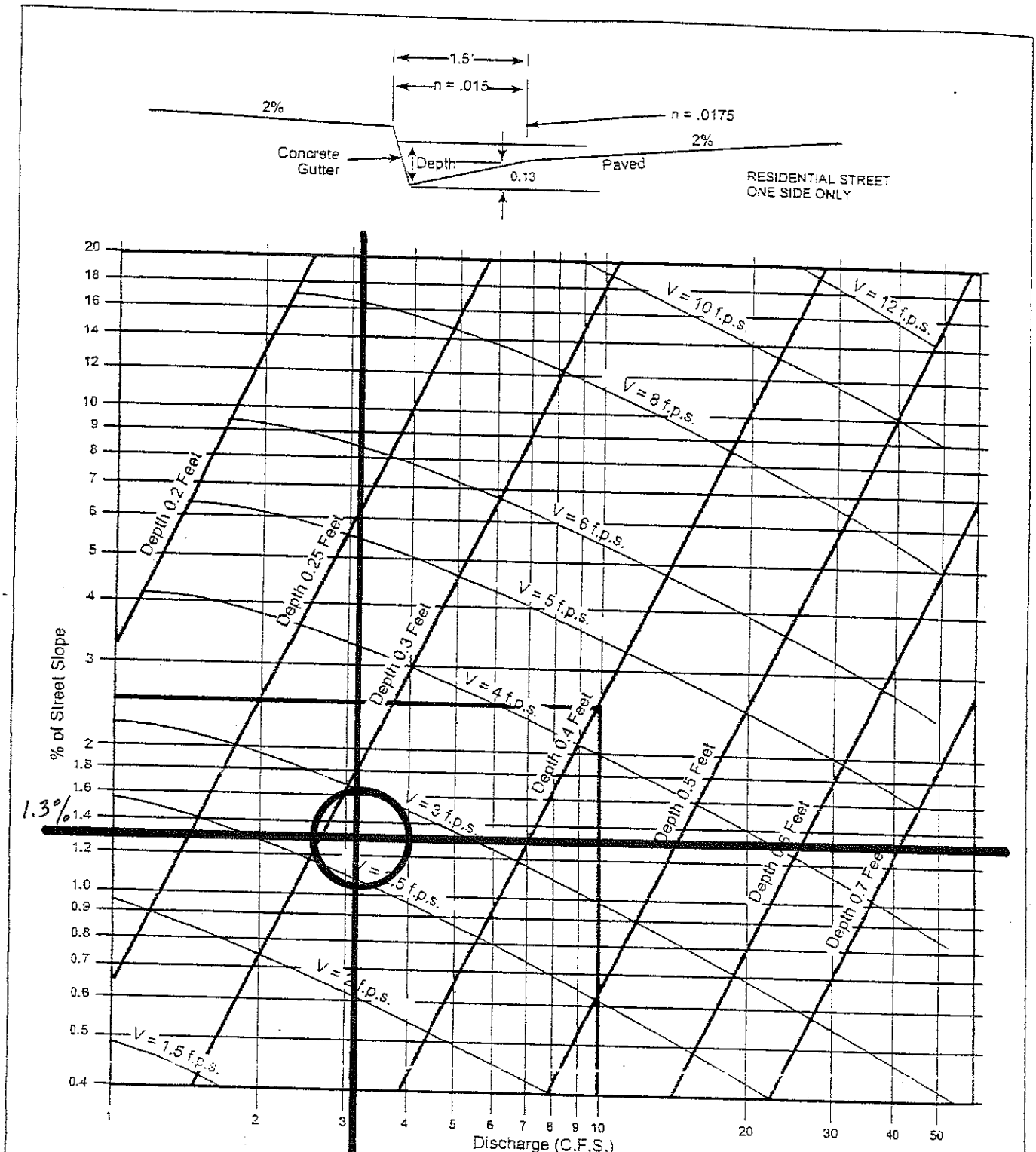
FIGURE 3-1

BASIN 3 (AQUEDUCT RD.

Basin 3 Hydraulics (Proposed Condition)

In the existing condition, the storm water from this basin sheet flows southerly on the westerly edge of Aqueduct Road, see the picture below. The runoff then sheet flows across to the easterly edge of the road and continues in an easterly direction. See the 40-scale Drainage Map in the Appendix.

From Figure 3-6-2, located on the following page, a depth of 0.32 feet is obtained in the westerly edge of the road. Therefore, a 6-inch dike "Type A" G-5 per RSDs is adequate to handle a 100-year storm.



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

Gutter and Roadway Discharge - Velocity Chart

FIGURE 3-6-2

V = 2.7 f.p.s.
D = 0.32 ft

BASIN 3
(AQUEDUCT RD.)

BASIN 4
AQUEDUCT ROAD

Basin 4 Hydrology (Existing Condition)

Q_{100} = CIA

Area:

$A_{total} = A_{Nat} + A_{Exist\ Asph}$

Where:

Natural Area (A_{Nat})	=	1.7	acres	(see Drainage Map, Appendix)
Asphalt and Roof area ($A_{Exist\ Asph}$)		2.0	acres	(see Drainage Map, Appendix)

A_{total} = 1.7 + 2.0 = 3.7 acres

C-Value:

$C_{Exist} = [(C_{Nat} * A_{Nat} / A_{total}] + [(C_{Exist\ Asph} * A_{Exist\ Asph}) / A_{total}]$

Where:

C_{Nat}	=	0.30	(see Table 3-1, Appendix)
$C_{Exist\ Asph}$	=	0.95	(see Table II, Appendix)

$C_{Exist} = [(0.30)\ (1.7) / 3.7] + [(0.95)\ (2.0) / 3.7]$

C_{Exist} = 0.65

Intensity Calculations:

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

Where

$T_C = T_i + T_{X1} + T_{X2}$

And:

T_i	=	6.4	minutes	(see Table 3-2 on following pages).
T_{X1}	=	0.7	minutes	(see Figure 3-4 on following pages).

T_{X2} is the time it takes the runoff to travel along the gutter flow line. The time it takes the water to travel from the initial point of the gutter flow to the concentration point is calculated using the velocity and the distance traveled. The velocity is calculated using Figure 3-6 of the San Diego hydrology manual and the distance traveled is obtained from the Drainage Basin Map. The Q_{100} used for Figure 3-6 is assumed and then divided by two to average the amount of runoff in the gutter. This assumption is later checked for accuracy. See below for the calculation:

T_{X2} = Distance Traveled / Velocity

Where:

Velocity (V)	=	6.8	fps	(see Figure 3-6-1 on following pages)
Distance Traveled	=	1080	feet	(see Drainage Basin Map, Appendix)

Then:

T_{X2} = 1080 / 6.8 = 159 seconds = 2.6 minutes

Therefore:

T_C = 6.4 + 0.7 + 2.6 = 9.7 minutes

Also,

P_6	=	3.5	inches	(see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\ (3.5)\ (9.7)^{-0.645}$ (also see Figure 3-1 on following pages)

Then:

I = 6.0 in/hr

Basin 4 cont...

Flow Rate:

$$Q_{100} = CIA$$
$$Q_{100} = 0.65\ (6.0)\ (3.7)$$

Then

$$\boxed{Q_{100} = 14.4 \quad cfs}$$

* The assumption for the Q_{100} for the velocity calculation is found to be correct with accepatable tolerance.

Basin 4 Hydrology (Proposed Condition)

The purpose for the calculations below is to account for the additional paving due to the widening of Aqueduct Road.

$$Q_{100} = CIA$$

Updated Area:

$$A_{total} = A_{Exist} + A_{Asph}$$

Where:

New Pavement Area (A_{Asph}) = 0.12 acres (see Preliminary Grading Plan, Appendix)

Then

$$\boxed{A_{total} = 3.7 + 0.12 = 3.82 \quad acres}$$

C-Value:

$$C = [(C_{Exist} * A_{Exist}) / A_{total}] + [(C_{Asph} * A_{Asph}) / A_{total}]$$

Where:

New Pavement (C_{Asph}) = 0.95 (see Table II, Appendix)

Then:

$$C = [(0.65)\ (3.7) / 3.82] + [(0.95)\ (0.12) / 3.82]$$

$$\boxed{C = 0.66}$$

Flow Rate:

$$Q_{100} = CIA$$
$$Q_{100} = 0.66\ (6.0)\ (3.82)$$

Then

$$\boxed{Q_{100} = 15.1 \quad cfs}$$

Basin 4 Comparison

Q_{100} Existing = 14.4 cfs

Q_{100} Proposed = 15.1 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	[illegible]
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 4
(AQUEDUCT RD.)

EQUATION

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

T_c = Time of concentration (hours)

L = Watercourse Distance (miles)

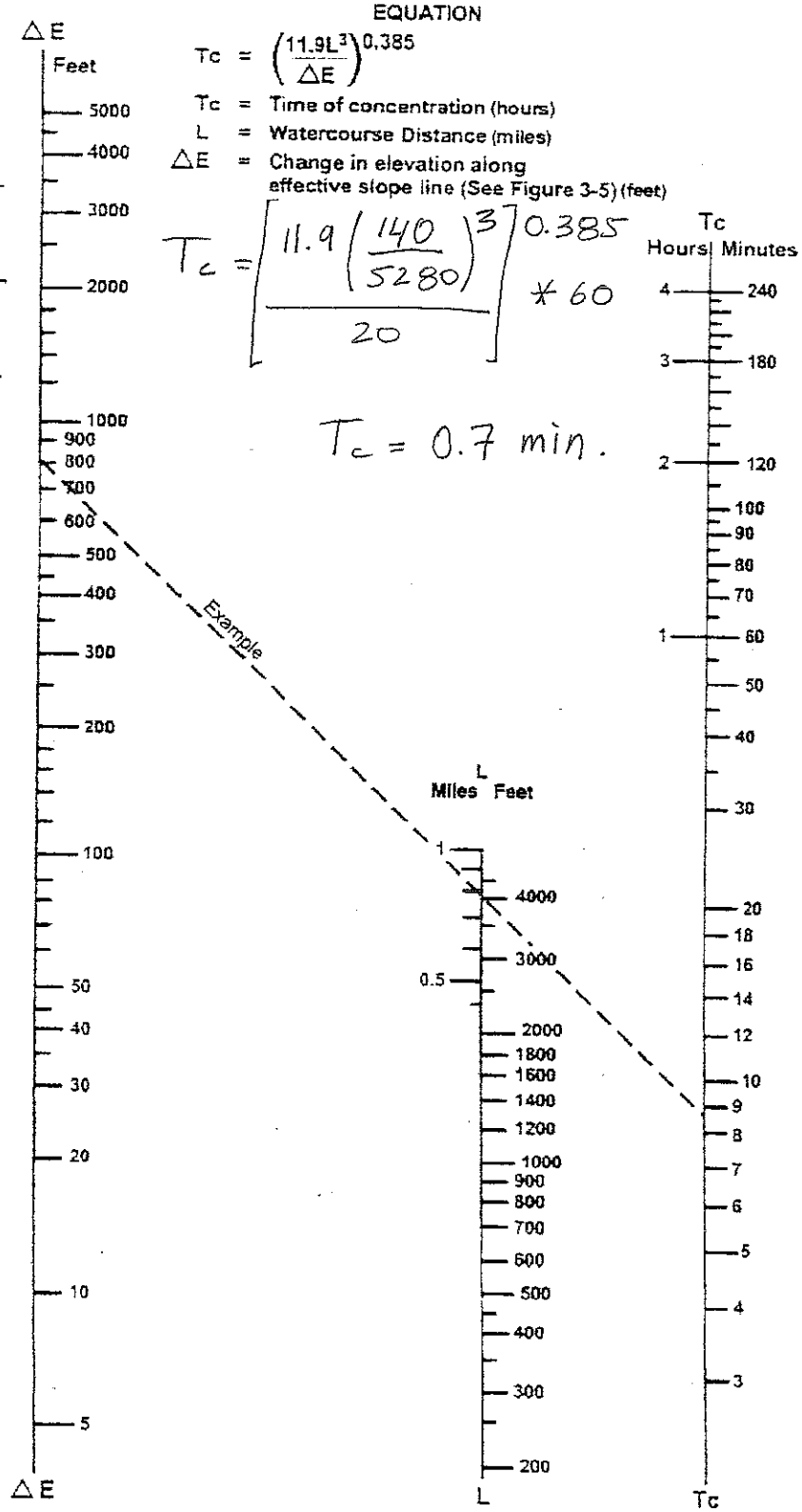
ΔE = Change in elevation along effective slope line (See Figure 3-5) (feet)

$\Delta E = 860 - 840 = 20\,FT$

$L = 140\,FT$

$$T_c = \left[\frac{11.9\left(\frac{140}{5280}\right)^3}{20}\right]^{0.385} * 60$$

$T_c = 0.7$ min.



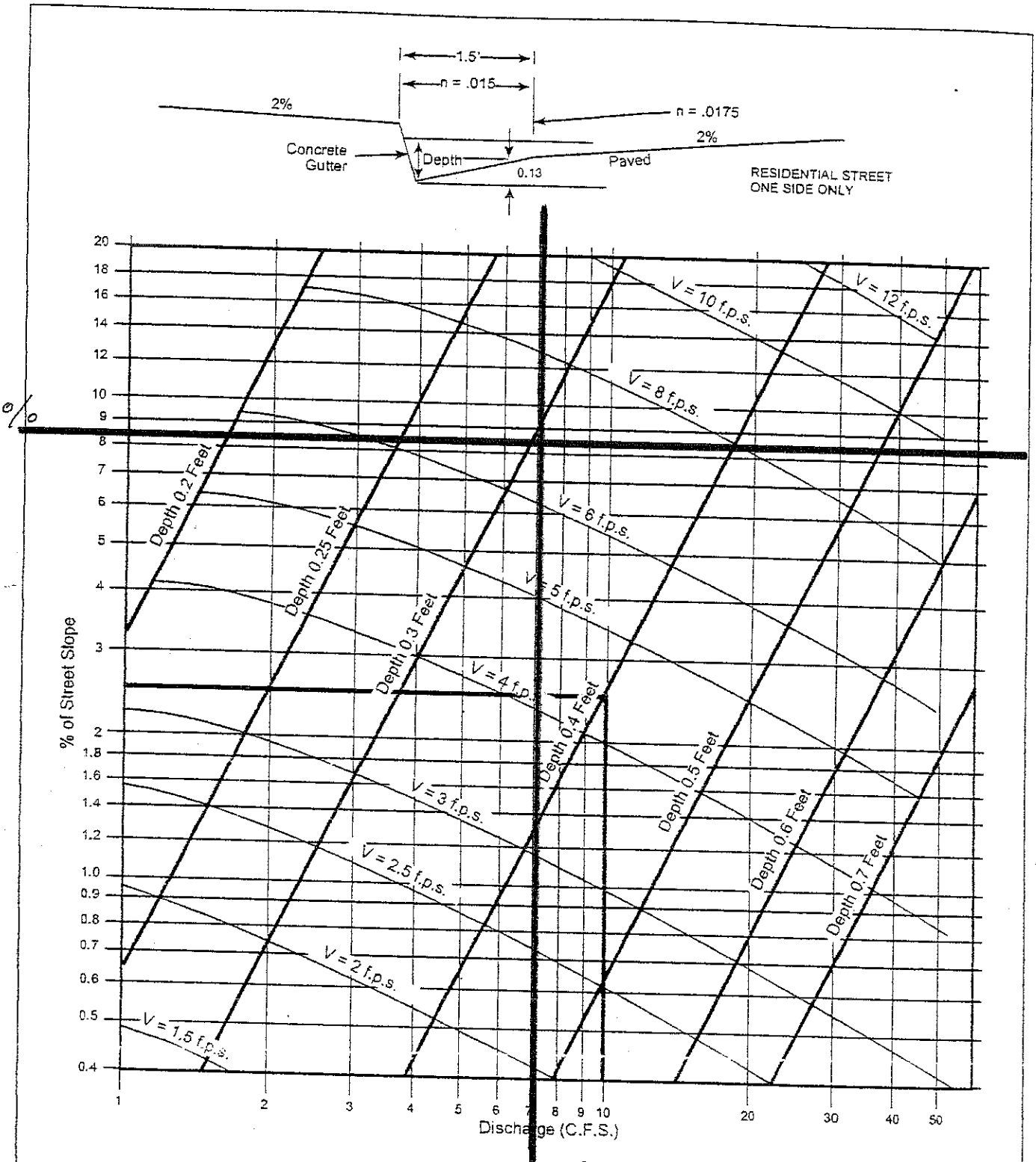
SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

3-4

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

BASIN 4
(AQUEDUCT RD.)



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

$\frac{Q}{2} = 7$ CFS

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

FIGURE

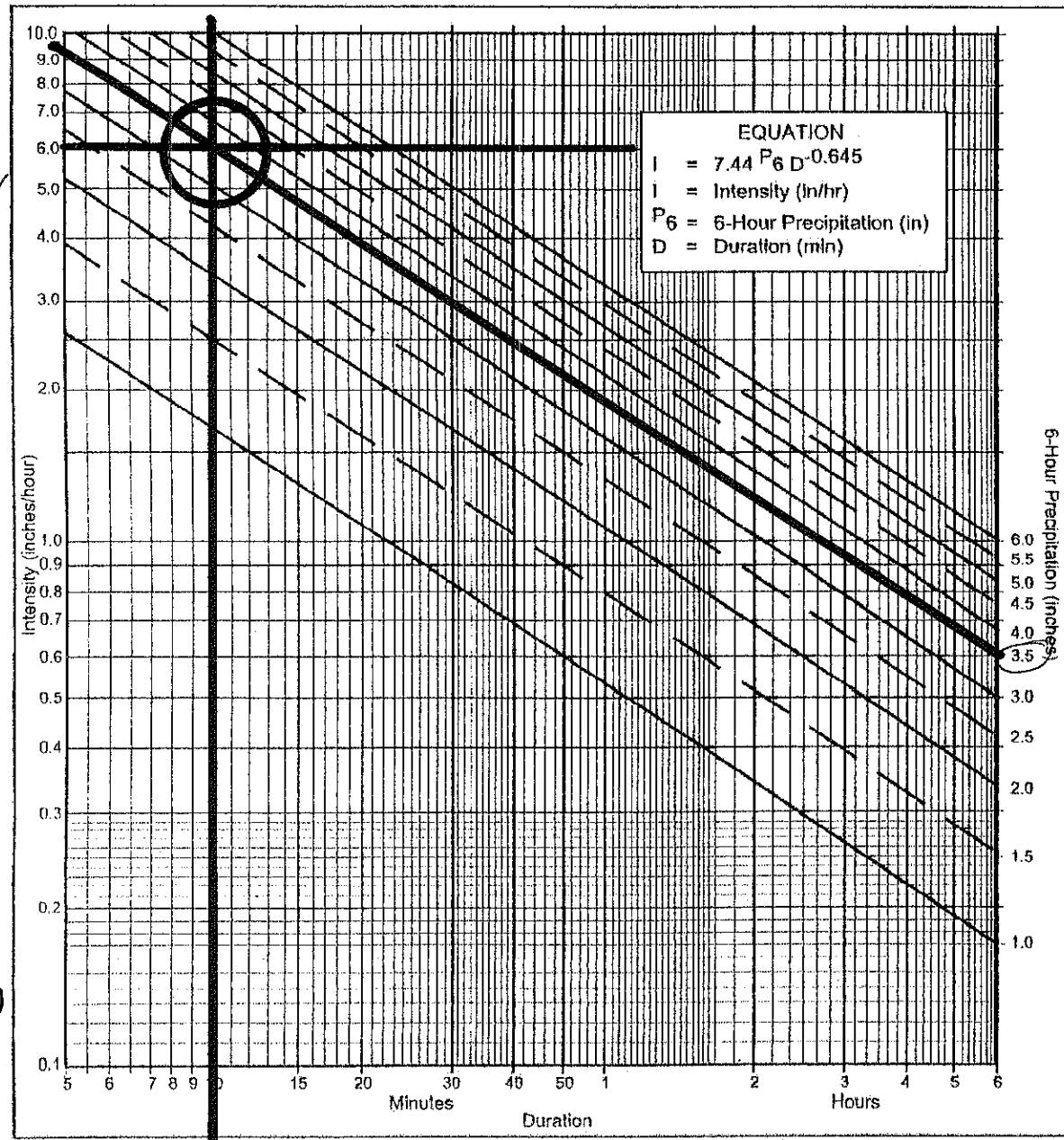
Gutter and Roadway Discharge - Velocity Chart

3-6-1

V = 6.8 ft/s

BASIN 4
(AQUEDUCT RD.)

6.0 in/hr



9.7 min.

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 = 3.5 in., P_{24} = 6.0 $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 9.7 min.

(e) I = 6.0 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 4 (AQUEDUCT RD.)

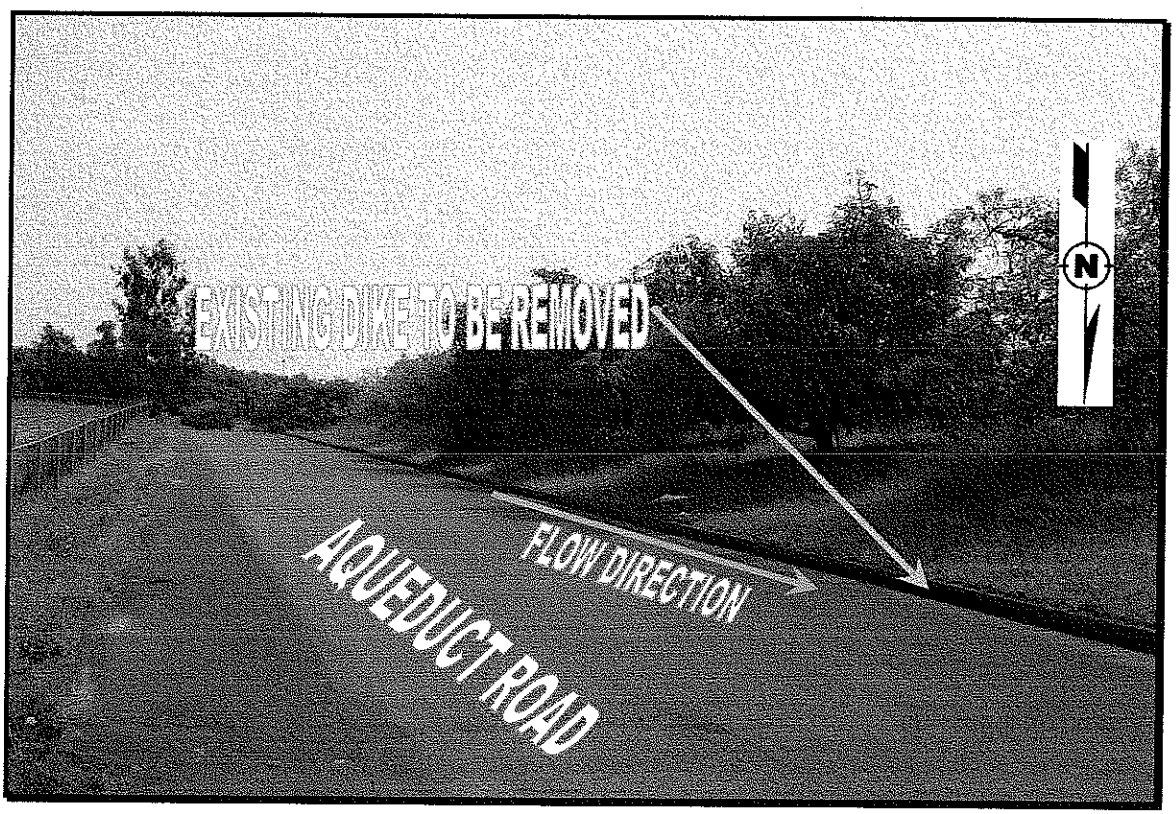
Intensity-Duration Design Chart - Template

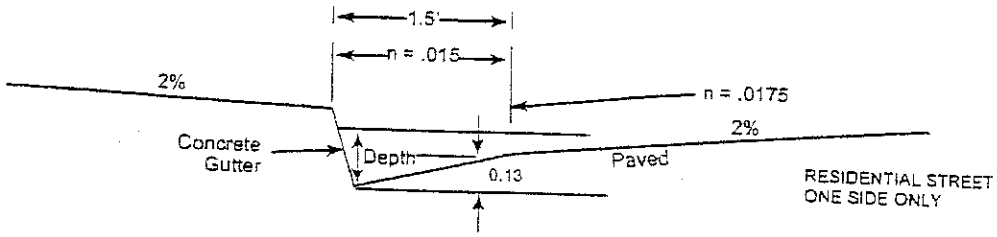
FIGURE **3-1**

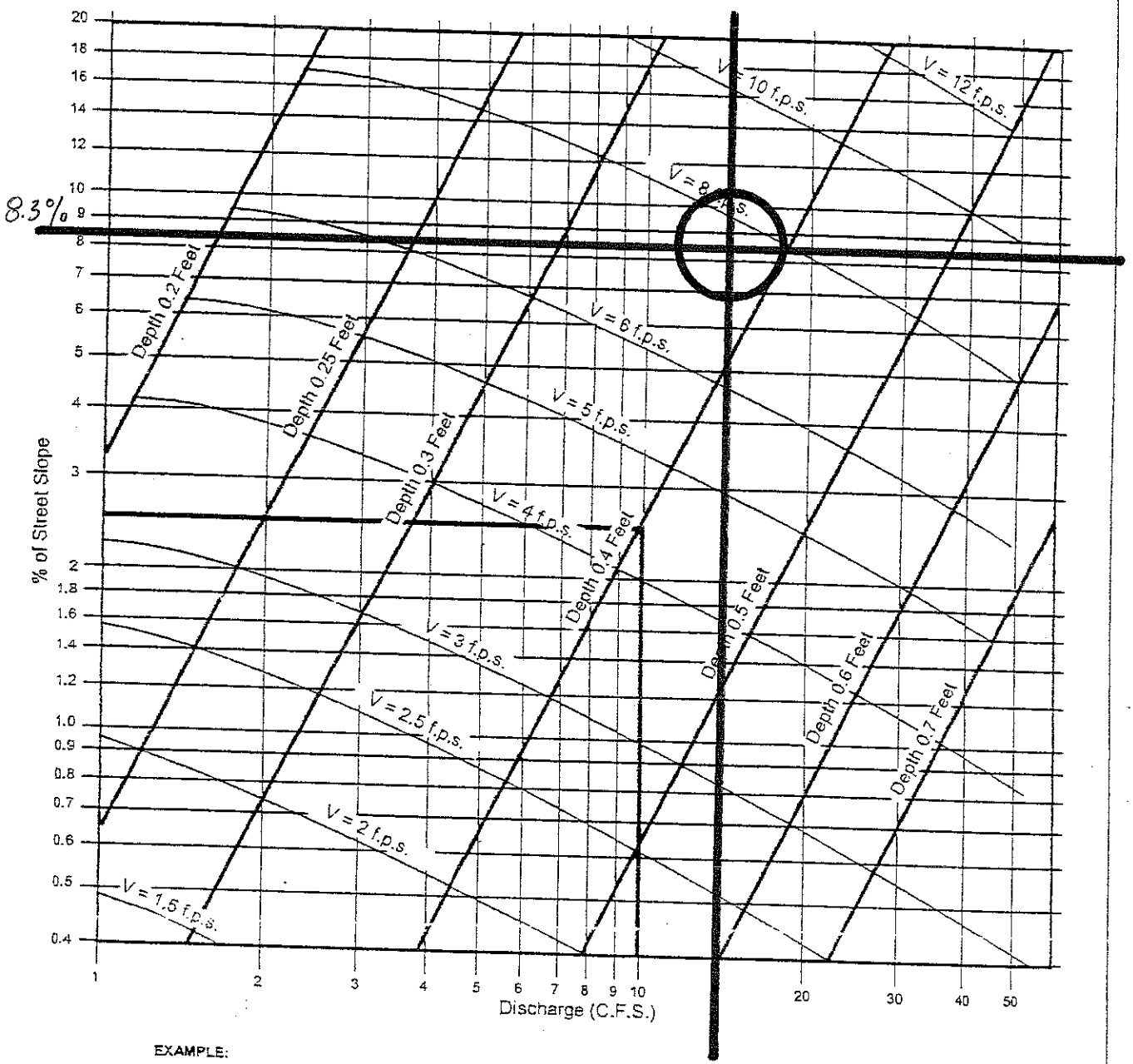
Basin 4 Hydraulics (Proposed Condition)

In the existing condition, the storm water from this basin sheet flows across Aqueduct Road to the westerly side of the road. There is a 6-inch AC dike along this side of the road that directs the runoff to West Lilac Road. See the picture below and the 40-scale Drainage Map in the Appendix.

From Figure 3-6-2, located on the following page, a depth of 0.38 feet is obtained. Therefore, a 6-inch AC dike "Type A" G-5 per RSDs is proposed to handle a 100-year storm.







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

FIGURE

3-6-2

Gutter and Roadway Discharge - Velocity Chart

V = 7.6 f.p.s

D = 0.38 ft.

BASIN 4
(AQUEDUCT RD.)

BASIN 5
AQUEDUCT ROAD

Basin 5 Hydrology (Existing Condition)

Q_{100} = CIA

C-Value:

C_{Asph} = 0.95 (see Table II, Appendix)

Area:

A = 0.1 acres (see Drainage Basin Map, Appendix)

Intensity Calculations:

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

Where

$T_C = T_i + T_X$

And:

T_i = 6.4 minutes (see Table 3-2 on following pages).

T_X is the time it takes the runoff to travel along the gutter flow line. The time it takes the water to travel from the initial point of the gutter flow to the concentration point is calculated using the velocity and the distance traveled. The velocity is calculated using Figure 3-6 of the San Diego hydrology manual and the distance traveled is obtained from the Drainage Basin Map. The Q_{100} used for Figure 3-6 is assumed and then divided by two to average the amount of runoff in the gutter. This assumption is later checked for accuracy. See below for the calculation:

T_X = Distance Traveled / Velocity

Where:

Velocity (V) = 5.6 fps (see Figure 3-6-1 on following pages)

Distance Traveled = 540 feet (see Drainage Basin Map, Appendix)

Then:

T_{X2} = 540 / 5.6 = 96 seconds = 1.6 minutes

Therefore:

T_C = 6.4 + 1.6 = 8.0 minutes

Also,

P_6 = 3.5 inches (see Rainfall Isopluvial, Appendix)

Now:

$I = 7.44\ (3.5)\ (8.0)^{-0.645}$ (also see Figure 3-1 on following pages)

Then:

I = 6.8 in/hr

Flow Rate:

Q_{100} = CIA

Q_{100} = .95 (6.8) (0.1)

Then

Q_{100} = 0.6 cfs

* The assumption for the Q_{100} for the velocity calculation is found to be correct with accepatable tolerance.

Basin 5 Hydrology (Proposed Condition):

The purpose for the calculations below is to account for the additional paving due to the widening of Aqueduct Road.

Updated Area:

$Q_{100} = CIA$

Where:

$A_{total} = A_{Exist} + A_{Asph}$

New Pavement Area (A_{Asph}) = 0.03 acres (see Preliminary Grading Plan, Appendix)

Then

A_{total} = 0.1 +0.03 = 0.13 acres

C-Value:

C_{Asph} = 0.95 (see Table II, Appendix)

Flow Rate:

$Q_{100} = CIA$

$Q_{100} = 0.95\ (6.8)\ (0.13)$

Then

Q_{100} = 0.8 cfs

Basin 5 Comparison

Q_{100} Existing = 0.6 cfs

Q_{100} Proposed = 0.8 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.

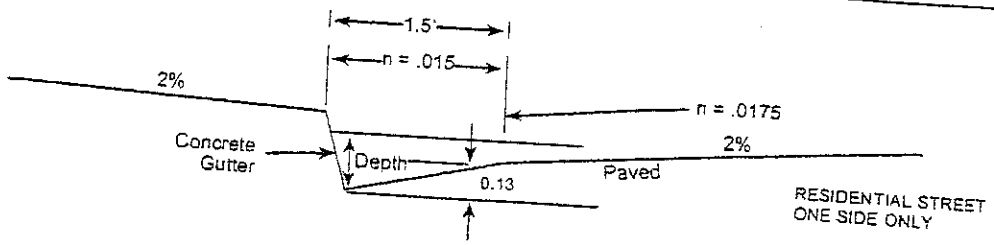
Table 3-2

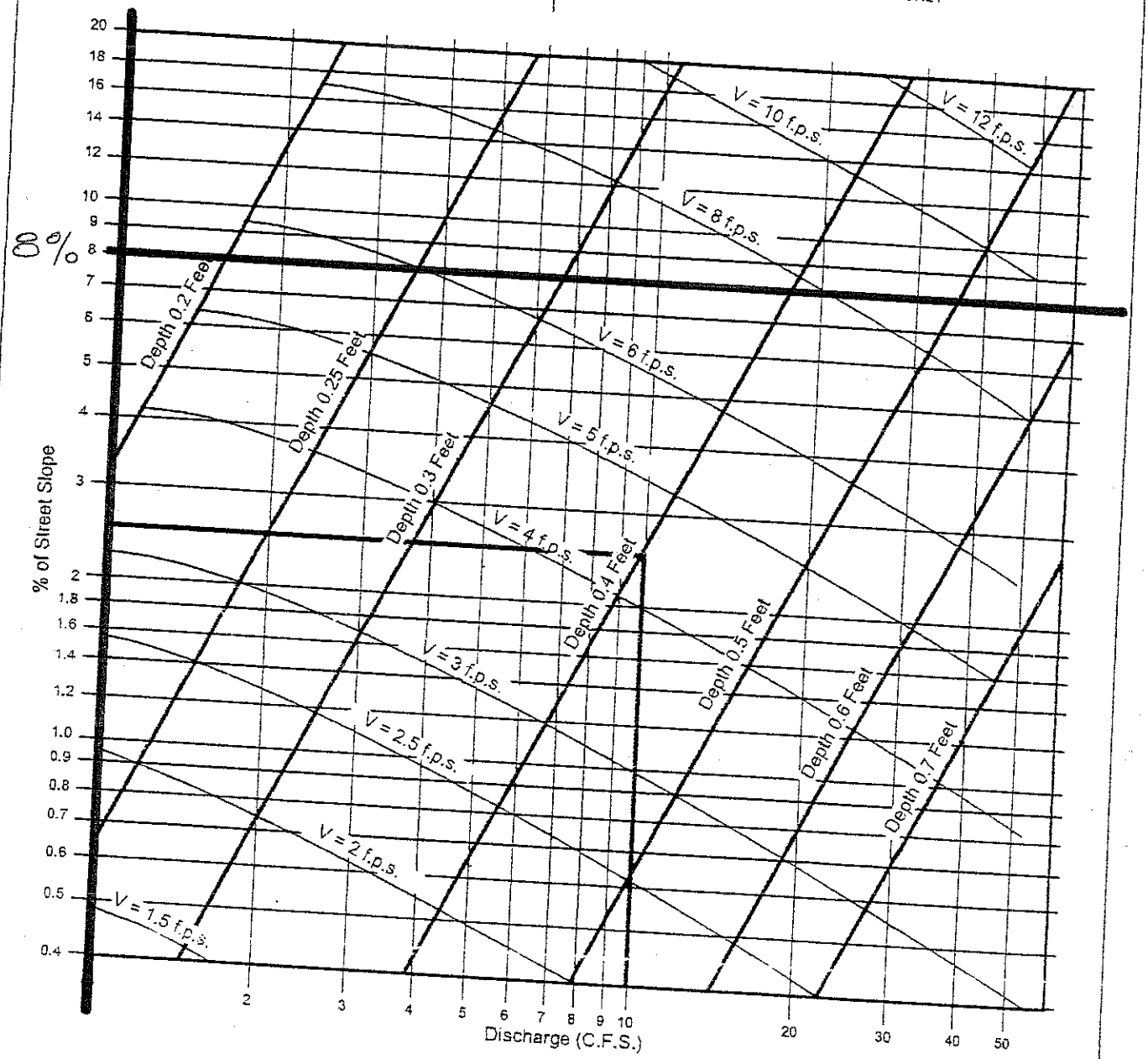
MAXIMUM OVERLAND FLOW LENGTH (L_M)
& INITIAL TIME OF CONCENTRATION (T_i)

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 5
(AQUEDUCT RD.)





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

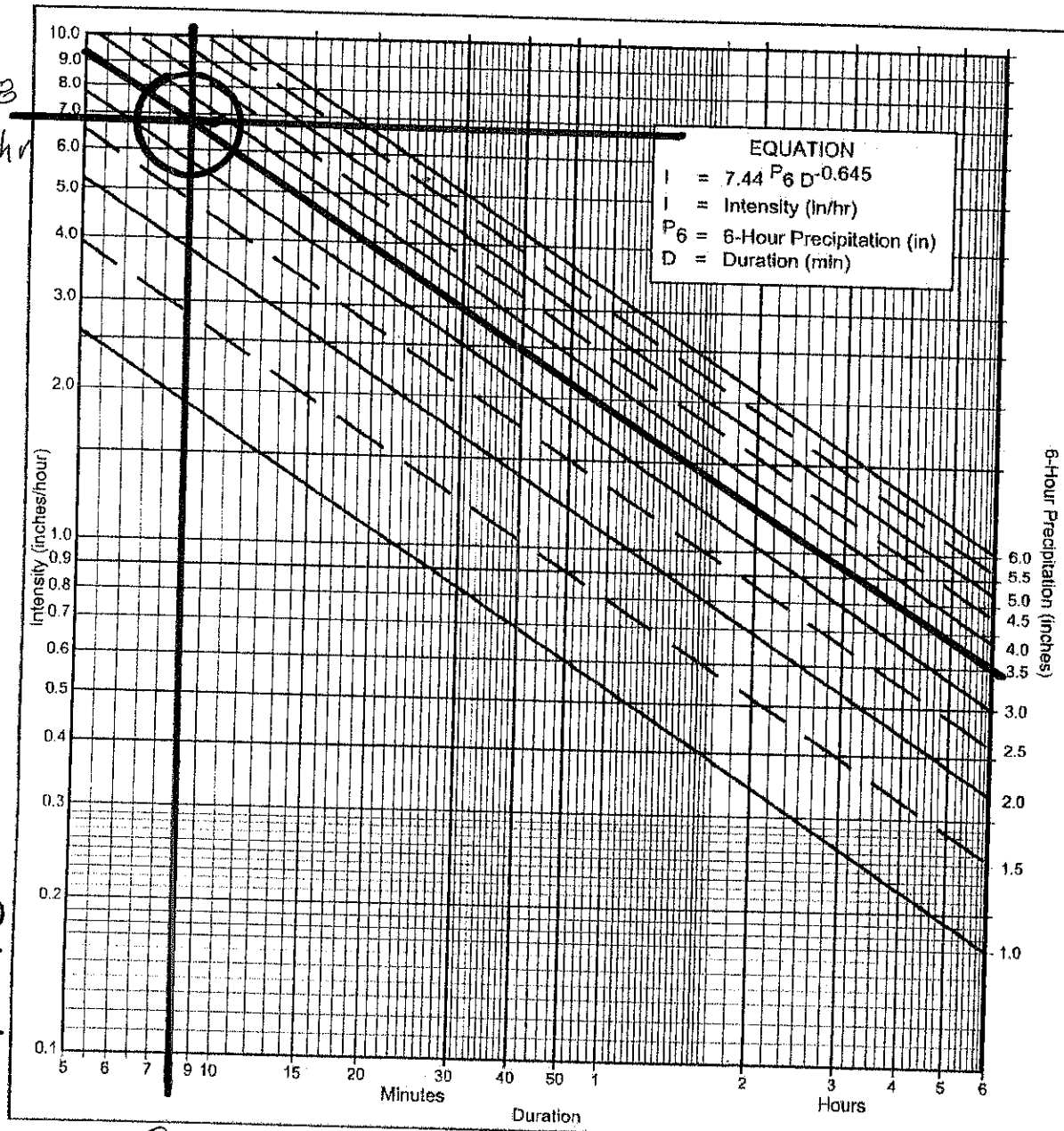
Gutter and Roadway Discharge - Velocity Chart

FIGURE

3-6-1

V = 5.6 ft/s

BASIN 5
(AQUEDUCT RD.)



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 = 3.5 in., P_{24} = 6.0 , $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted P_6(2) = 3.5 in.

(d) t_x = 8.0 min.

(e) I = 6.8 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

BASINS (AQUEDUCT RD.)

Intensity-Duration Design Chart - Template

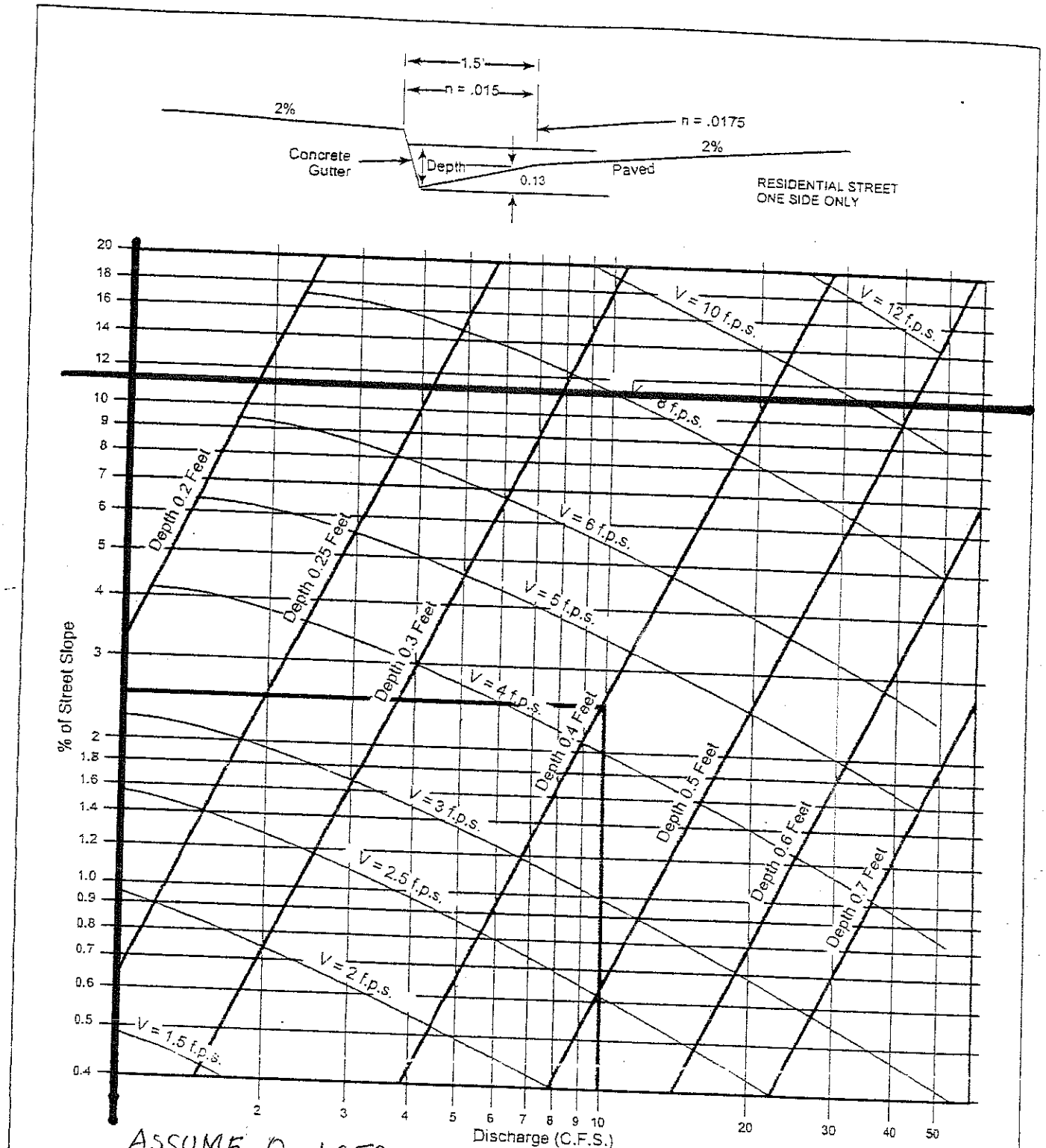
FIGURE

3-1

Basin 5 Hydraulics (Proposed Condition)

In the existing condition, the storm water from this basin sheet flows down the easterly side of the road towards West Lilac road. See the picture below and the 40-scale Drainage Map in the Appendix.

From Figure 3-6-2, located on the following page, a depth of less than 0.2 feet is obtained. Therefore, a 6-inch AC dike "Type A" G-5 per RSDs is proposed to handle a 100-year storm.



ASSUME Q = 1 CFS → Q_{PEAK} = 0.8, 1.0 > 0.8

ASSUMPTION IS OK

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

Gutter and Roadway Discharge - Velocity Chart

FIGURE

3-6-2

V ≅ 6.2 f.p.s

D < 0.2 ft

BASIN 5
(AQUEDUCT RD.)

Section D

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

ALL BASINS (EXIST & PROP.)

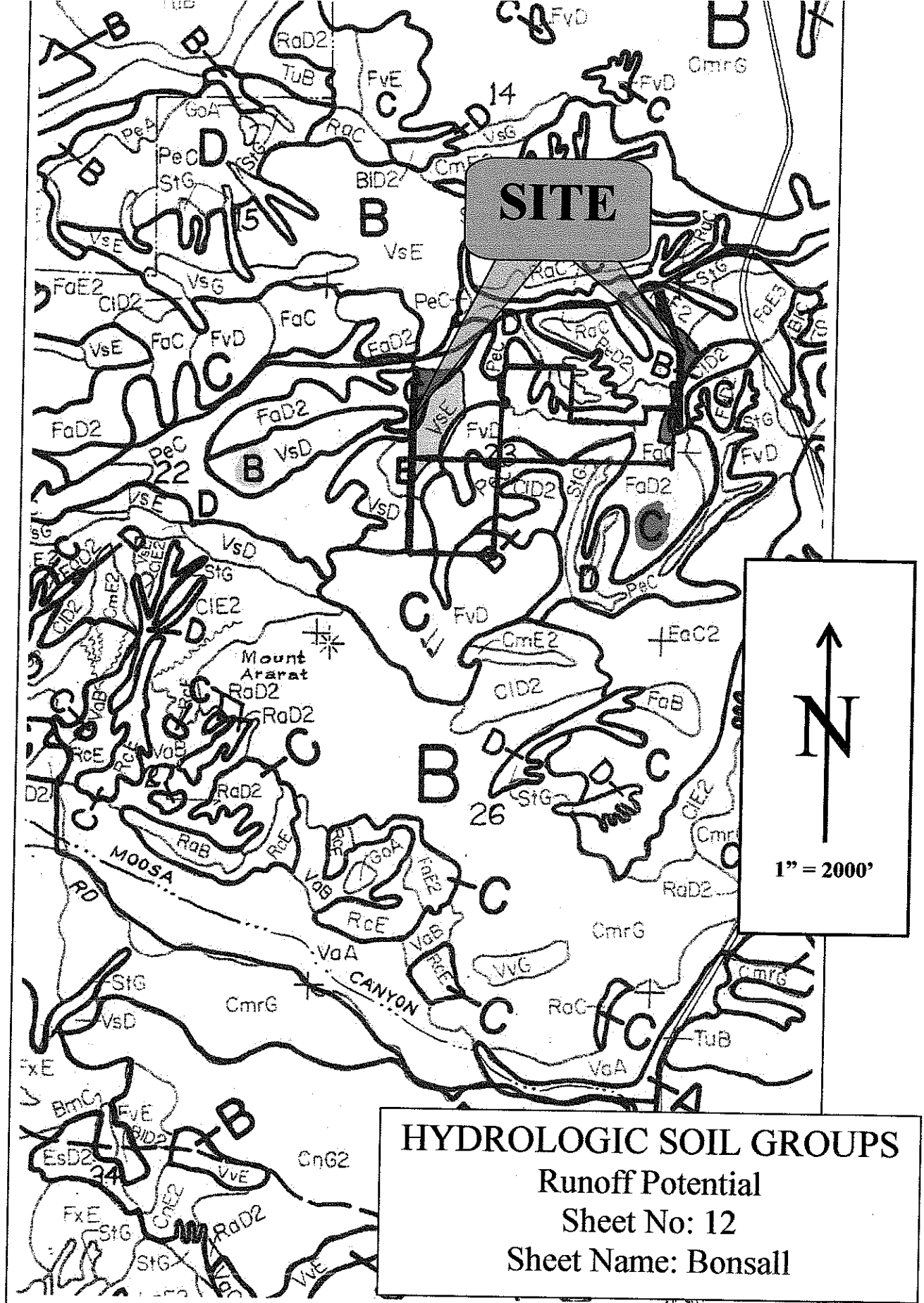
Table II

Land Use/Type of Surface	Range of "C" Values
Business downtown	0.70 to 0.95
Business in neighborhoods	0.50 to 0.70
Single family	0.30 to 0.50
Multi-units, detached	0.40 to 0.60
Multi-units, attached	0.60 to 0.75
Suburban Residential	0.25 to 0.40
Apartment	0.50 to 0.70
Light Industrial	0.50 to 0.80
Heavy Industrial	0.60 to 0.90
Parks and Cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yard	0.20 to 0.35
Unimproved land	0.10 to 0.30
Asphalt and Concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.75 to 0.95
Sandy soil lawn, 2 percent slope	0.05 to 0.10
Sandy soil lawn, 2 to 7 percent slope	0.10 to 0.15
Sandy soil lawn, >7 percent slope	0.15 to 0.20
Heavy soil lawn, 2 percent slope	0.13 to 0.17
Heavy soil lawn, 2 to 7 percent slope	0.18 to 0.22
Heavy soil lawn, >7 percent slope	0.25 to 0.35

III. SAN DIEGO COUNTY LAND USE ELEMENTS

There are 28 different types Land Use Elements within the County of San Diego General Plan. Of the 28 Land Uses, 15 have densities of one or more dwelling units per acre and are listed in Table III with respect to their Land Use Element Number. The effective percent impervious is based on discussions with the Planning Department, evaluation of typical land use patterns, amount of roofs, driveways, parking surfaces, etc. that are direct/indirect connection to the storm system and the Soil Conservation Service (SCS) criteria in the County Hydrology Manual.

ALL BASINS (EXIST & PROP)

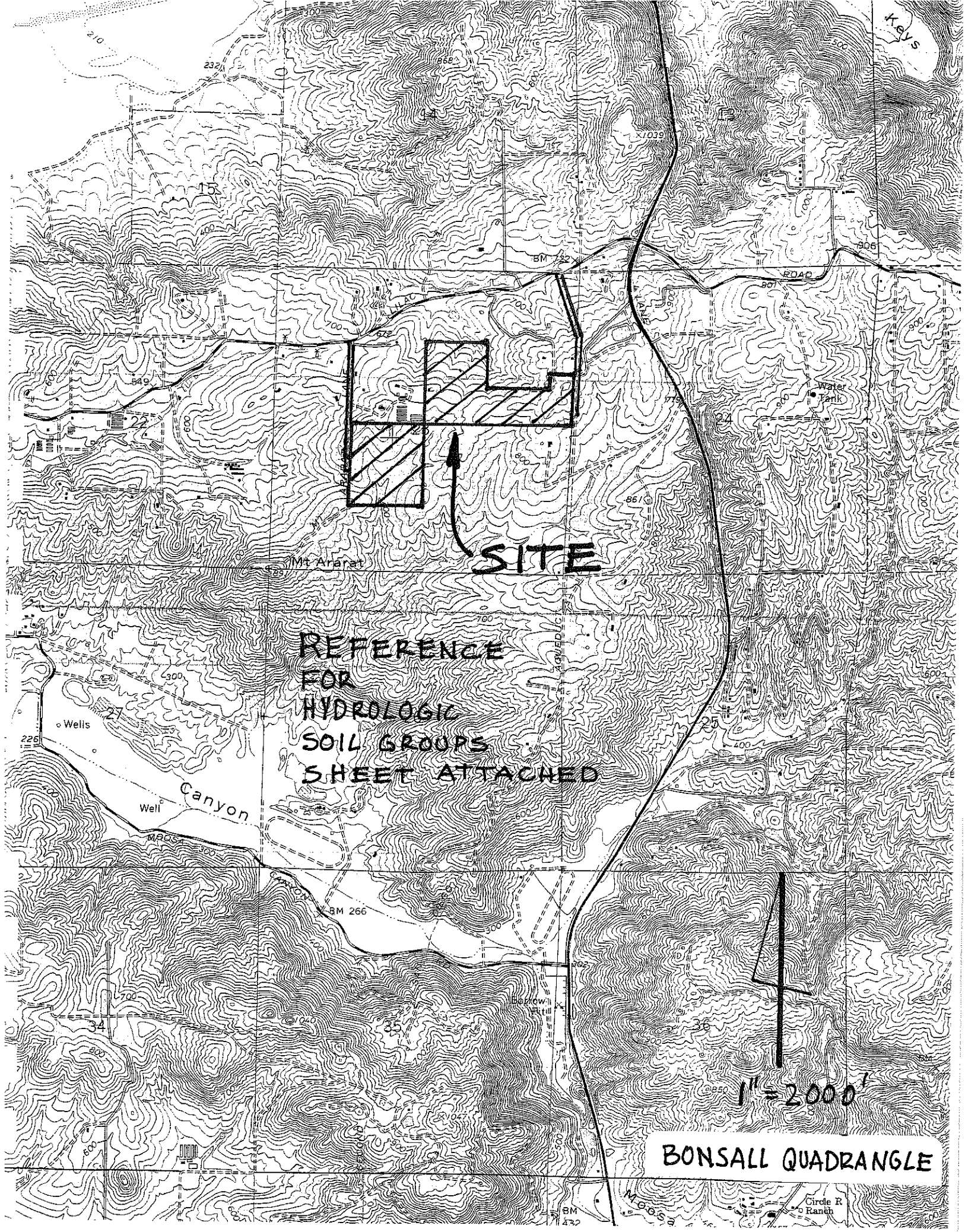


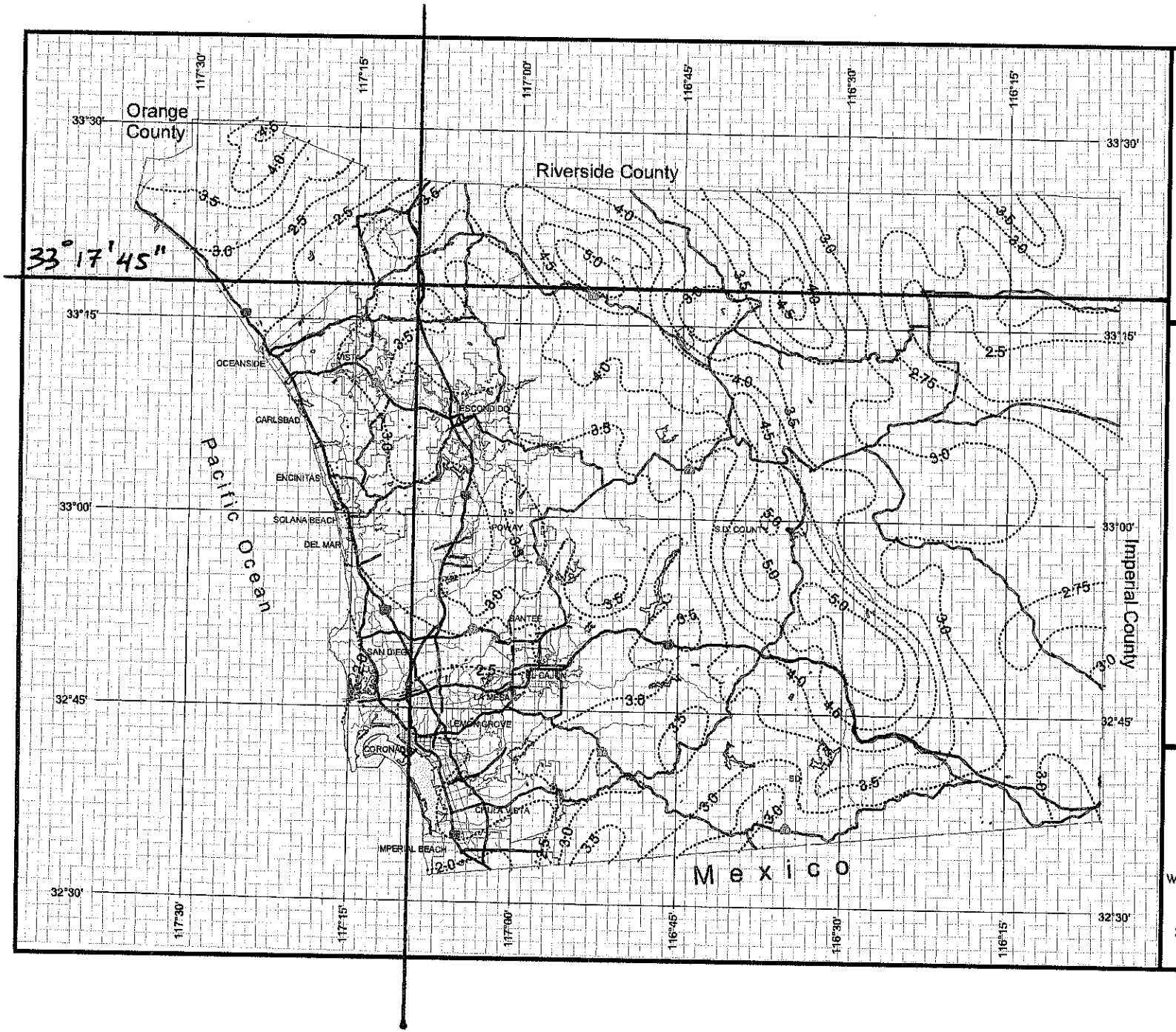
HYDROLOGIC SOIL GROUPS

Runoff Potential

Sheet No: 12

Sheet Name: Bonsall


SITE
REFERENCE
FOR
HYDROLOGIC
SOIL GROUPS
SHEET ATTACHED
Mt Ararat
Wells
Well
Canyon
Mesa
BM 266
Borrow Pit
Water Tank
Circle R Ranch
1" = 2000'
BONSALL QUADRANGLE



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

3.5 inches

DPW GIS
Department of Public Works
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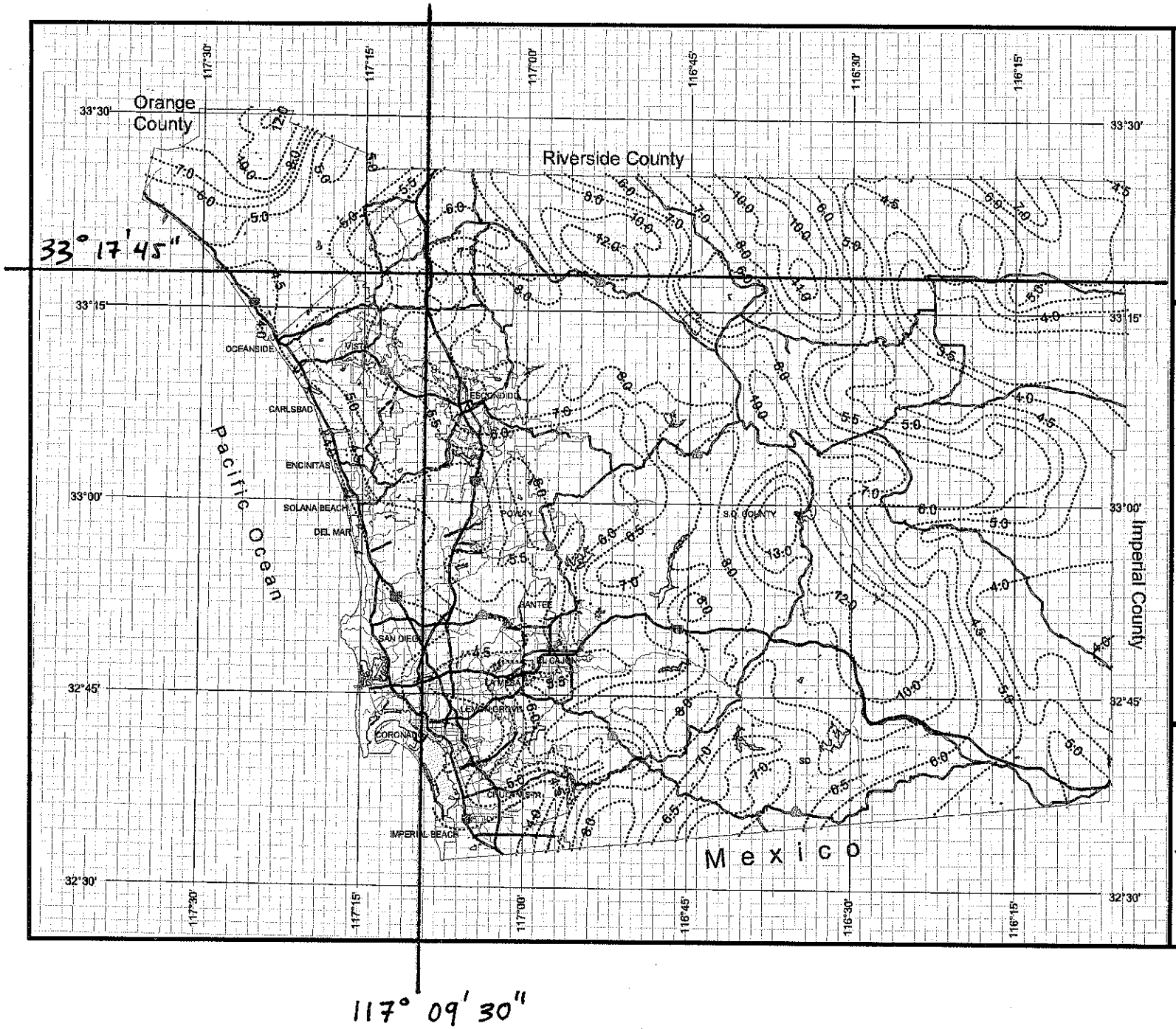
N W E S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

6.0 inches

DPW GIS
Department of Public Works
Geographic Information Services

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N W E S

3 0 3 Miles

Values of n to Be Used with the Manning Equation

Surface	Best	Good	Fair	Bad
Uncoated cast-iron pipe	0.012	0.013	0.014	0.015
Coated cast-iron pipe	0.011	0.012*	0.013*	
Commercial wrought-iron pipe, black	0.012	0.013	0.014	0.015
Commercial wrought-iron pipe, galvanized	0.013	0.014	0.015	0.017
Smooth brass and glass pipe	0.009	0.010	0.011	0.013
Smooth lockbar and welded "OD" pipe	0.010	0.011*	0.013*	
Riveted and spiral steel pipe	0.013	0.015*	0.017*	
Vitrified sewer pipe	0.010 0.011	0.013*	0.015	0.017
Common clay drainage tile	0.011	0.012*	0.014*	0.017
Glazed brickwork	0.011	0.012	0.013*	0.015
Brick in cement mortar; brick sewers	0.012	0.013	0.015*	0.017
Neat cement surfaces	0.010	0.011	0.012	0.013
Cement mortar surfaces	0.011	0.012	0.013*	0.015
Concrete pipe	0.012	0.013	0.015*	0.016
Wood stave pipe	0.010	0.011	0.012	0.013
Plank Flumes:				
Planed	0.010	0.012*	0.013	0.014
Unplaned	0.011	0.013*	0.014	0.015
With battens	0.012	0.015*	0.016	
Concrete-lined channels	0.012	0.014*	0.016*	0.018
Cement-rubble surface	0.017	0.020	0.025	0.030
Dry-rubble surface	0.025	0.030	0.033	0.035
Dressed-ashlar surface	0.013	0.014	0.015	0.017
Semicircular metal flumes, smooth	0.011	0.012	0.013	0.015
Semicircular metal flumes, corrugated	0.0225	0.025	0.0275	0.030
Canals and Ditches:				
Earth, straight and uniform	0.017	0.020	0.0225*	0.025
Rock cuts, smooth and uniform	0.025	0.030	0.033*	0.035
Rock cuts, jagged and irregular	0.035	0.040	0.045	
Winding sluggish canals	0.0225	0.025*	0.0275	0.030
Dredged earth channels	0.025	0.0275*	0.030	0.033
Canals with rough stony beds, weeds on earth banks	0.025	0.030	0.035*	0.040
Earth bottom, rubble sides	0.028	0.030*	0.033*	0.035
Natural Stream Channels:				
(1) Clean, straight bank, full stage, no rifts or deep pools	0.025	0.0275	0.030	0.033
(2) Same as (1), but some weeds and stones	0.030	0.033	0.035*	0.040
(3) Winding, some pools and shoals, clean	0.033	0.035	0.040	0.045
(4) Same as (3), lower stages, more ineffective slope and sections	0.040	0.045	0.050	0.055
(5) Same as (3), some weeds and stones	0.035	0.040	0.045	0.050
(6) Same as (4), stony sections	0.045	0.050	0.055	0.060
(7) Sluggish river reaches, rather weedy or with very deep pools	0.050	0.060	0.070	0.080
(8) Very weedy reaches	0.075	0.100	0.125	0.150

* Values commonly used in designing.

Table 7-14. Values of K' for Circular Channels in the Formula[1]

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

D = depth of water d = diameter of channel

$\frac{D}{d}$	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0		.00007	.00031	.00074	.00138	.00222	.00328	.00455	.00604	.00775
.1	.00967	.0118	.0142	.0167	.0195	.0225	.0257	.0291	.0327	.0366
.2	.0406	.0448	.0492	.0537	.0585	.0634	.0686	.0738	.0793	.0849
.3	.0907	.0966	.1027	.1089	.1153	.1218	.1284	.1352	.1420	.1490
.4	.1561	.1633	.1705	.1779	.1854	.1929	.2005	.2082	.2160	.2238
.5	.232	.239	.247	.255	.263	.271	.279	.287	.295	.303
.6	.311	.319	.327	.335	.343	.350	.358	.366	.373	.380
.7	.388	.395	.402	.409	.416	.422	.429	.435	.441	.447
.8	.453	.458	.463	.468	.473	.477	.481	.485	.488	.491
.9	.494	.496	.497	.498	.498	.498	.496	.494	.489	.483
1.0	.463									

Table 7-4. For Determining the Area of the Cross Section of a Circular Conduit Flowing Part Full

Let $\frac{\text{depth of water}}{\text{diameter of channel}} = \frac{D}{d}$ and C_a = the tabulated value. Then $a = C_a d^2$.

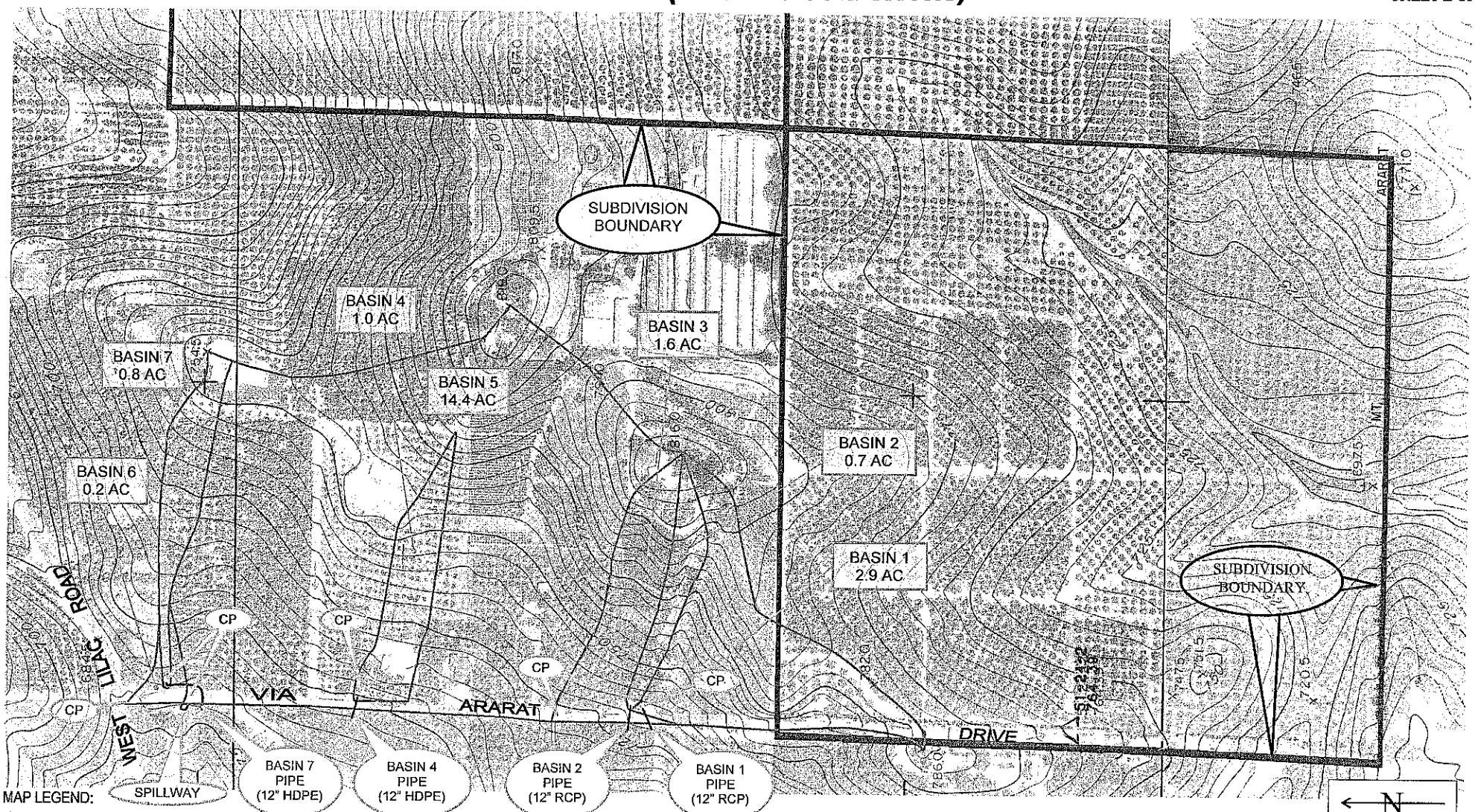
$\frac{D}{d}$	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.0000	.0013	.0037	.0069	.0105	.0147	.0192	.0242	.0294	.0350
.1	.0409	.0470	.0534	.0600	.0668	.0739	.0811	.0885	.0961	.1039
.2	.1118	.1199	.1281	.1365	.1449	.1535	.1623	.1711	.1800	.1890
.3	.1982	.2074	.2167	.2260	.2353	.2450	.2546	.2642	.2739	.2836
.4	.2934	.3032	.3130	.3229	.3328	.3428	.3527	.3627	.3727	.3827
.5	.393	.403	.413	.423	.433	.443	.453	.462	.472	.482
.6	.492	.502	.512	.521	.531	.540	.550	.559	.569	.578
.7	.587	.596	.605	.614	.623	.632	.640	.649	.657	.666
.8	.674	.681	.689	.697	.704	.712	.719	.725	.732	.738
.9	.745	.750	.756	.761	.766	.771	.775	.779	.782	.784

200-1.6.1 Selection of Riprap and Filter Blanket Material

Table 200-1.6.1(A)

Vel. Ft/Sec (1)	Rock Class (2)	Riprap Thickness "T"	Filter Blanket (3) Upper Layer(s)			
			Cpt.1 Sec. 200 (4)	Cpt.2 Sec.40 0 (4)	Cpt.3 (5)	Lower Layer (6)
6-7	No. 3 Backing	.6	3/16"	C1	D.G.	—
7-8	No. 2 Backing	1.0	1/4"	B3	D.G.	—
8-9.5	Facing	1.4	3/8"	—	D.G.	—
9.5-11	Light	2.0	1/2"	—	3/4" 1-1/2" P.B.	—
11/13	1/4 TON	2.7	3/4"	—	3/4" 1-1/2" P.B.	SAND
13-15	1/2 TON	3.4	1"	—	3/4" 1-1/2" P.B.	SAND
15-17	1 TON	4.3	1-1/2"	—	TYPE B	SAND
17-20	2 TON	5.4	2"	—	TYPE B	SAND

DRAINAGE MAP FOR VIA ARARAT DRIVE
(EXISTING CONDITIONS)



MAP LEGEND:

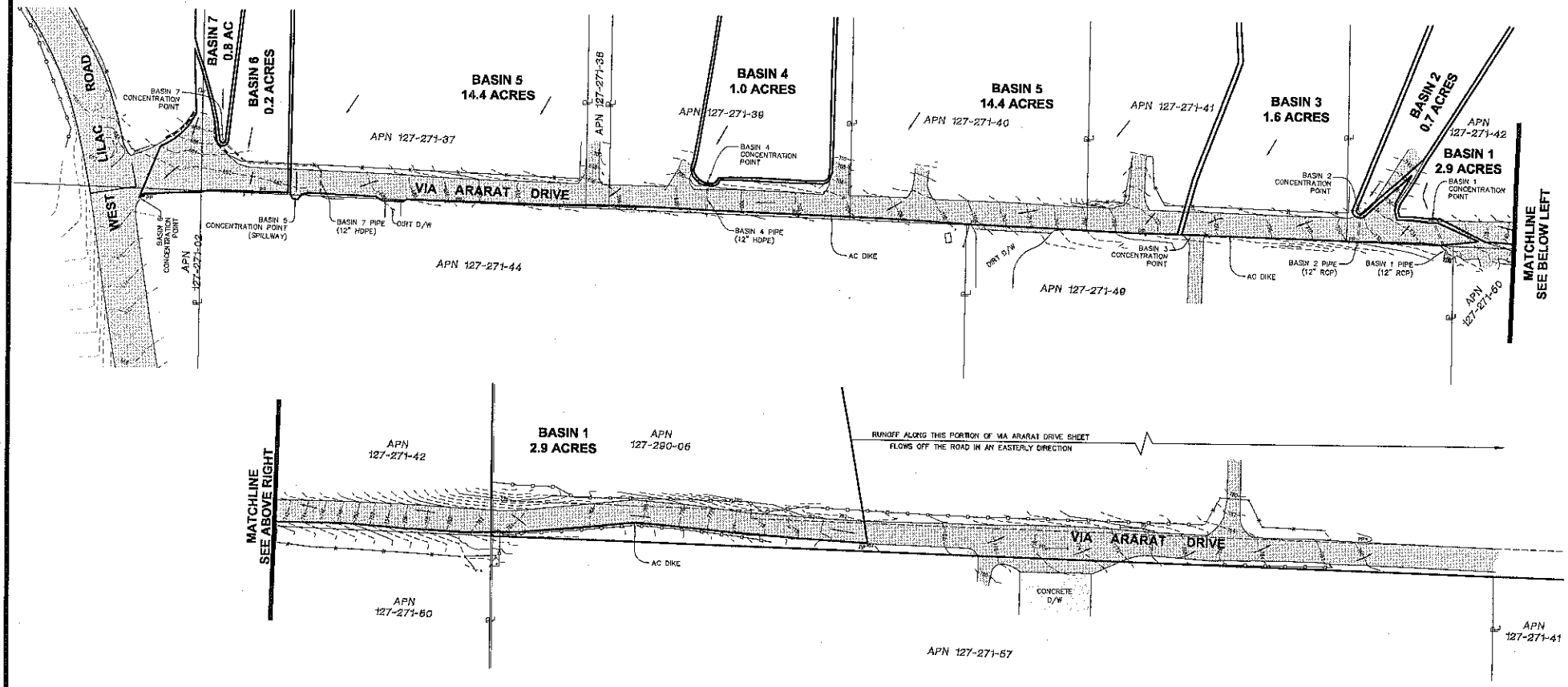
CONCENTRATION POINT CP

BASIN BOUNDARIES —

FLOW DIRECTION →

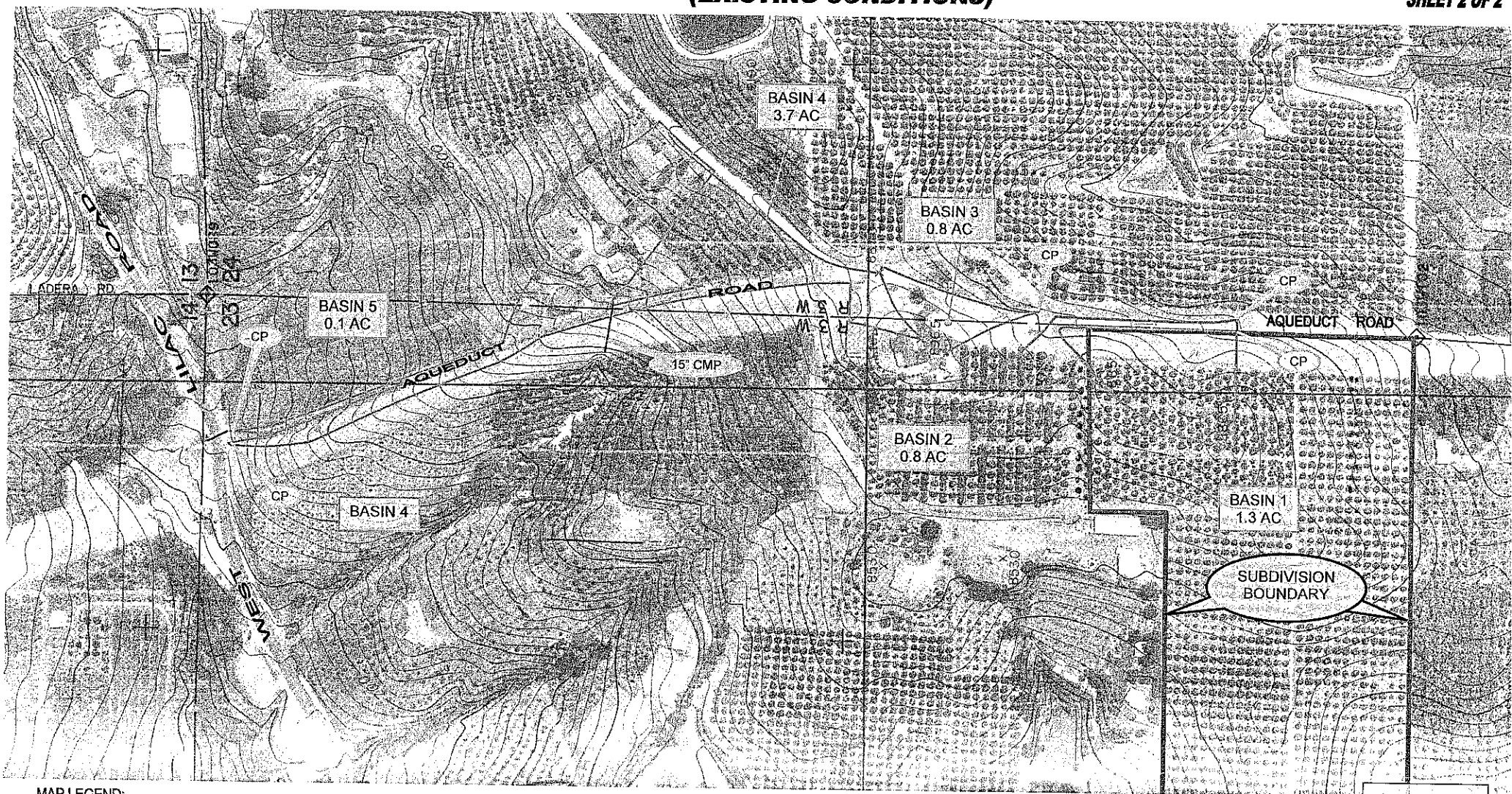
NOTE: SEE SHEET 1 OF 2 FOR A 40-SCALE DRAINAGE MAP

DRAINAGE MAP FOR VIA ARARAT DRIVE
(EXISTING CONDITIONS)



NOTE:
SEE SHEET 2 OF 2 FOR A 200-SCALE DRAINAGE MAP.

DRAINAGE MAP FOR AQUEDUCT ROAD
(EXISTING CONDITIONS)



MAP LEGEND:

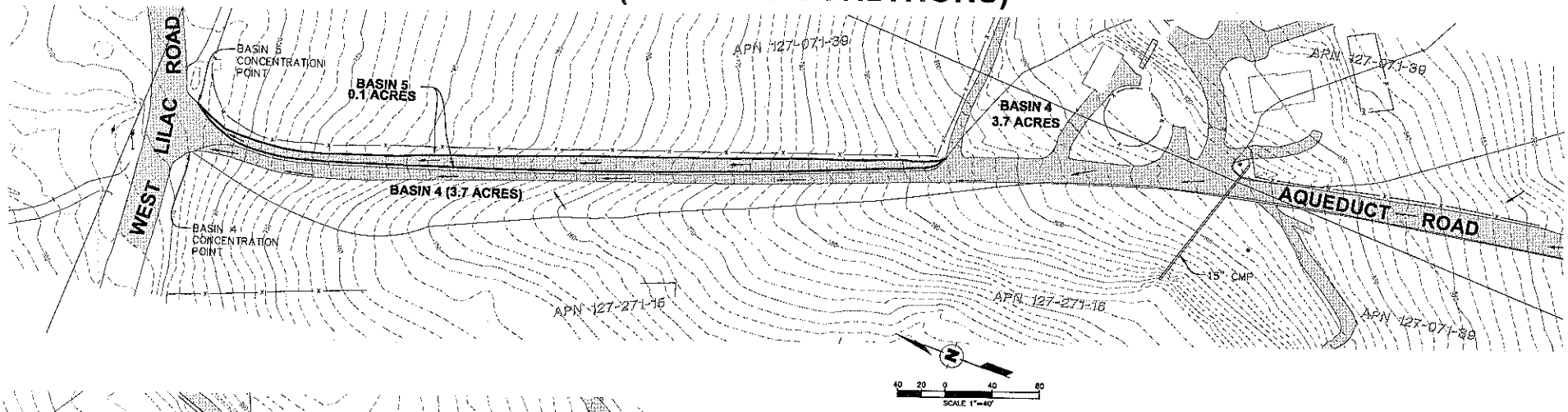
CONCENTRATION POINT CP

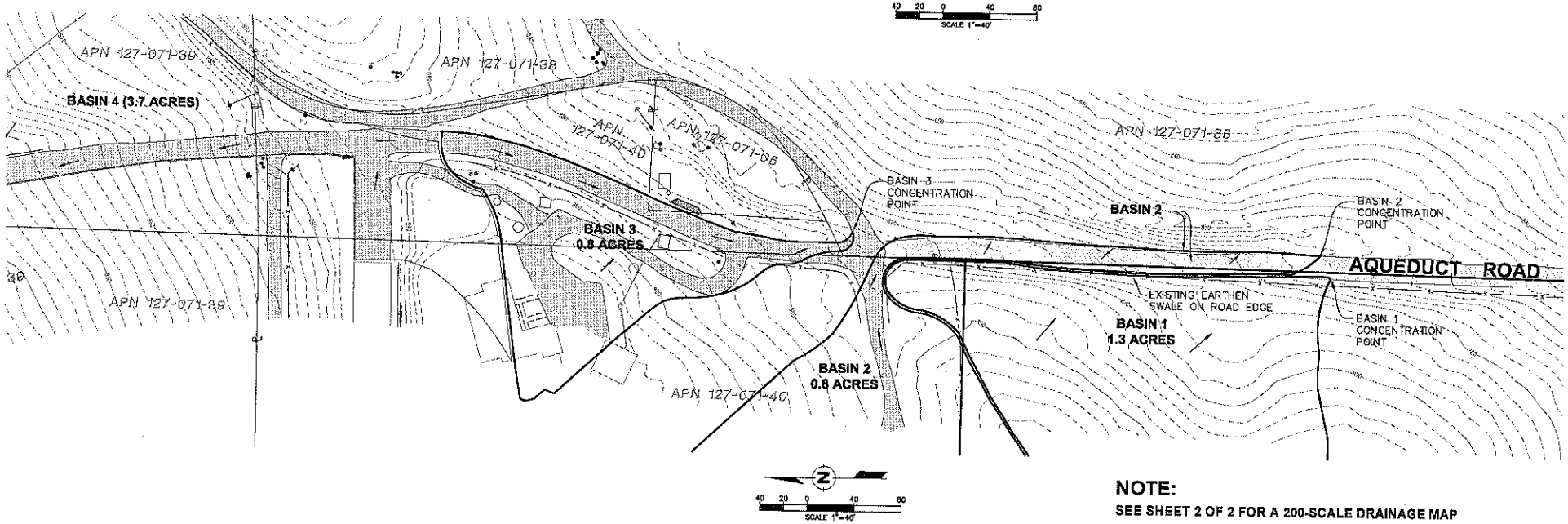
BASIN BOUNDARIES —

FLOW DIRECTION →

NOTE: SEE SHEET 1 OF 2 FOR A 40-SCALE DRAINAGE MAP

DRAINAGE MAP FOR AQUEDUCT ROAD
(EXISTING CONDITIONS)



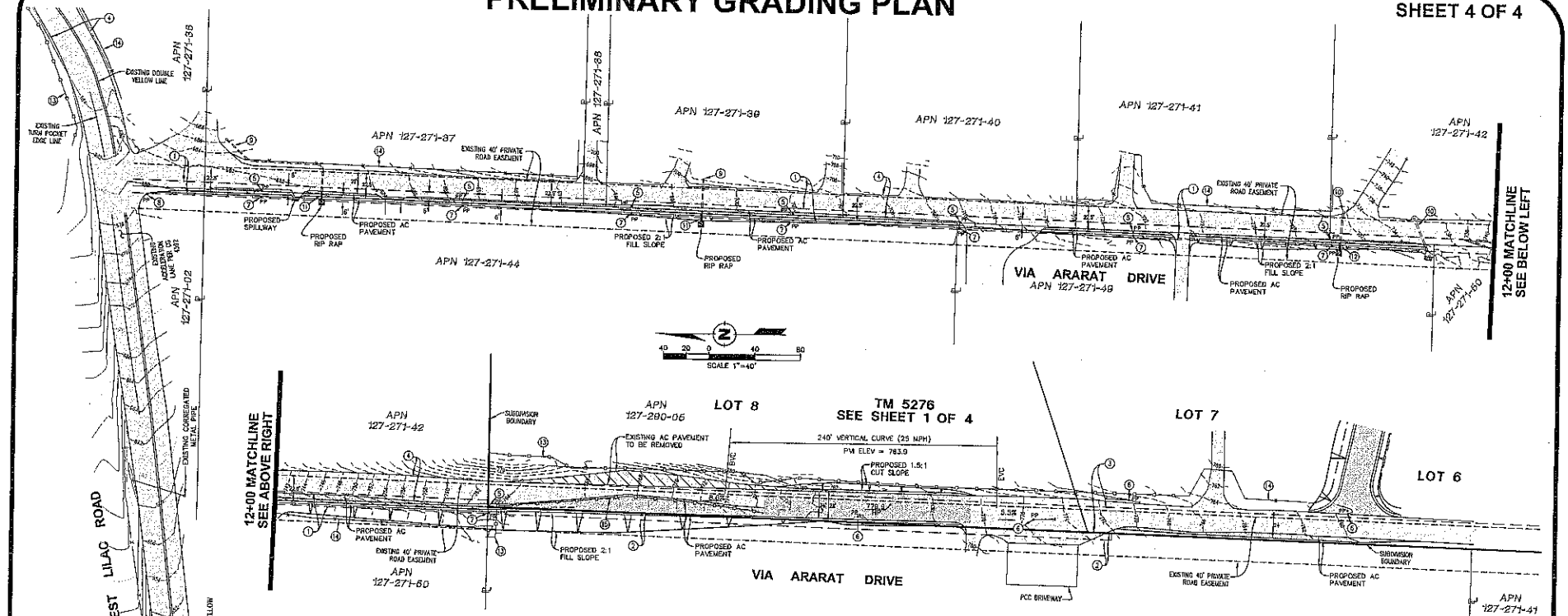


NOTE:

SEE SHEET 2 OF 2 FOR A 200-SCALE DRAINAGE MAP

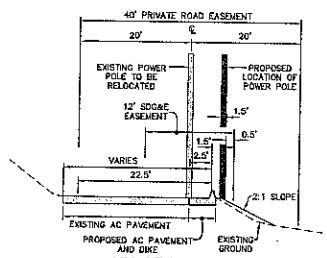
PRELIMINARY GRADING PLAN

SHEET 4 OF 4



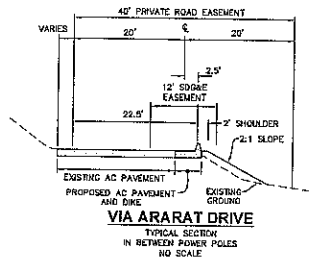
LEGEND:

1. EXISTING 12' SDG&E EASEMENT
2. EXISTING 6' SDG&E EASEMENT
3. EXISTING 23' SDG&E EASEMENT
4. EXISTING AC PAVEMENT
5. EXISTING POWER POLE TO BE RELOCATED
6. EXISTING POWER POLE TO BE REMOVED AND UTILITY LINES TO BE UNDERGROUNDED
7. PROPOSED LOCATION OF POWER POLE
8. EXISTING POWER POLE TO REMAIN
9. EXISTING 12" HDPE TO REMAIN
10. EXISTING 12" RCP TO REMAIN
11. PROPOSED 8"-12" HDPE AT 1% MIN.
12. PROPOSED 8"-12" RCP AT 1% MIN.
13. EXISTING WOOD FENCE TO REMAIN
14. EXISTING CHAINLINK FENCE TO REMAIN
15. EXISTING WOOD FENCE TO BE RELOCATED TO NEW EDGE OF PAVEMENT



VIA ARARAT DRIVE

TYPICAL SECTION
AT THE EIGHT OFFSITE POWER POLE LOCATIONS
NO SCALE



VIA ARARAT DRIVE

TYPICAL SECTION
IN BETWEEN POWER POLES
NO SCALE

NOTE:
THE EXISTING CROSS SLOPE VARIES BETWEEN A NORMAL CROWN AND A CONTINUOUS SLOPE TO ONE SIDE OR THE OTHER ALONG THE ENTIRE LENGTH OF THE ROAD. IN ORDER NOT TO DIVERT DRAINAGE, THE EXISTING CROSS SLOPE WILL BE MAINTAINED IN AREAS WHERE WIDENING IS PROPOSED.

OWNER/SUBDIVIDER:
JAMES D. PARDEE, JR.
WEST LILAC FARMS II, LLC
267 STONEBREEK COURT
WESTLAKE VILLAGE, CA 91361
1-805-373-5555

REGISTERED PROFESSIONAL ENGINEER LAWRENCE W. WALSH 46318 EXP. 12-31-06 CIVIL STATE OF CALIFORNIA

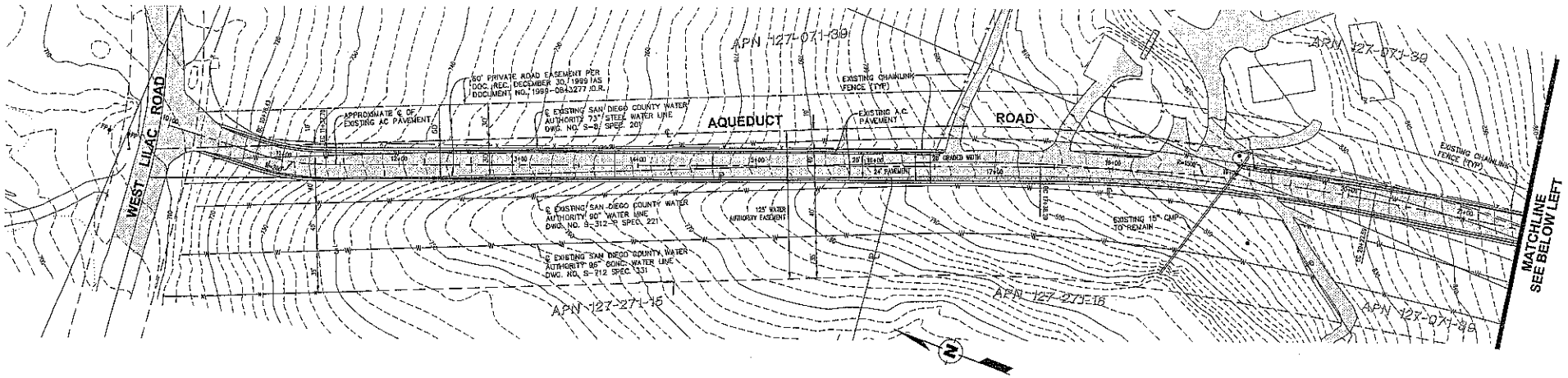
PREPARED BY:

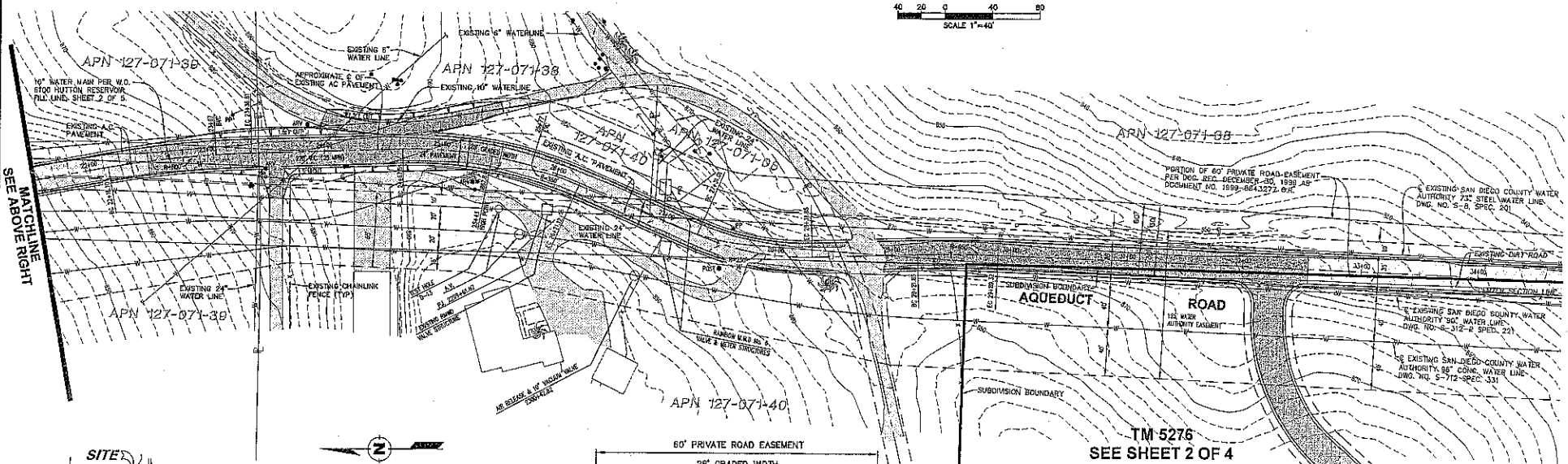
Lawrence W. Walsh 3/2/06
LAWRENCE W. WALSH RCE 46318 DATE

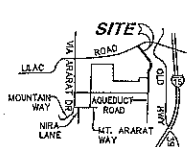
Walsh Engineering & Surveying, Inc.
1870 Cordell Court, Suite 102, El Cajon, CA 92020
(619) 588-8767 (619) 448-7132 Fax

L:\Projects\2004\Lilac Ridge\Lilac Ridge PGP.dwg 03/01/2006 7:16:14 PM PST

PRELIMINARY GRADING PLAN

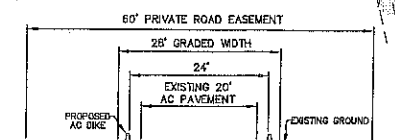






VICINITY MAP
NO SCALE
THOMAS BRO MAP NO. 1048, G-7 & H-7 AND NO. 1068, G-1 & H-1

NOTE:
THE EXISTING CROSS SLOPE VARIES BETWEEN A NORMAL CROWN AND A CONTINUOUS SLOPE TO ONE SIDE OR THE OTHER ALONG THE ENTIRE LENGTH OF THE ROAD. IN ORDER NOT TO DIVERT DRAINAGE, THE EXISTING CROSS SLOPE WILL BE MAINTAINED IN AREAS WHERE WIDENING IS PROPOSED.



AQUADUCT ROAD
TYPICAL SECTION
NO SCALE

SAN DIEGO COUNTY WATER AUTHORITY
REVIEWED BY:

WILLIAM J. ROSE — DATE
DIRECTOR OF RIGHT OF WAY
VALID FOR 18 MONTHS FROM THIS DATE OF APPROVAL
RIGHT OF WAY FILE No.: ROW2005-249

NOTE: "NOT APPROVED FOR CONSTRUCTION"

REGISTERED PROFESSIONAL ENGINEER — LAWRENCE W. WALSH — 46316 — EXP. 12-31-06 — CIVIL — STATE OF CALIFORNIA

PREPARED BY:

LAWRENCE W. WALSH — RCE 46316 — DATE

Walsh Engineering & Surveying, Inc.
1870 Cordell Court, Suite 102, El Cajon, CA 92020
(619) 588-6747 (619) 448-7132 Fax

L:\PROJECTS\61247\ENGINEERING\WATER BLOCKS\61248-UP.dwg 10/17/2005 11:16:34 AM PST