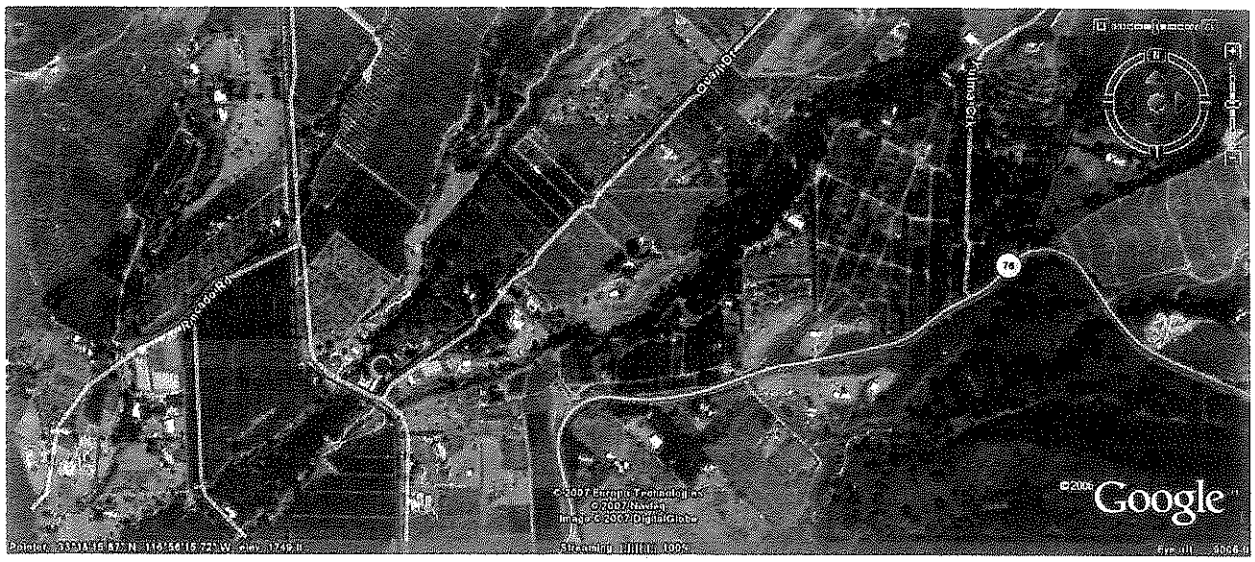
# JENKINS PROPERTY

# TENTATIVE PARCEL MAP 21023

## PRELIMINARY HYDROLOGY STUDY

**January 2007**




**Prepared For:**

**Jenkins Family Trust**
**5530 Brookmead Drive**
**Whittier, CA 90601**

**Prepared By:**

**R.E. Berg Engineering, Inc.**
**726 California Oaks Drive**
**Vista, CA 92081**

REGISTERED PROFESSIONAL ENGINEER
RICHARD E. BERG
No. 41,782
Exp. 3-31-08
CIVIL
STATE OF CALIFORNIA

**Richard E. Berg, P.E.**

# TABLE OF CONTENTS


**SECTION** **PAGE**

**1. INTRODUCTION** ..... **1**

1.1 PURPOSE OF STUDY ..... 1
1.2 SCOPE ..... 1

**2. DESCRIPTION OF WATERSHED** ..... **1**

2.1 AREA CHARACTERISTICS ..... 1
2.2 SOIL TYPE ..... 1
2.3 LAND USES ..... 2
2.4 TOPOGRAPHY ..... 2

**3. METHODOLOGY** ..... **2**

3.1 MODIFIED RATIONAL METHOD ..... 2

**4. RESULTS** ..... **4**

4.1 RATIONAL METHOD ..... 4
4.2 SWALE CALCULATIONS ..... 4

**5. CONCLUSION** ..... **4**

**6. REFERENCES** ..... **5**

# TABLE OF APPENDICES

**APPENDIX I SUPPORTING TABLES AND FIGURES**

Vicinity Map

Table 3-1 Runoff Coefficients for Urban Areas

Figure 3-1 Intensity-Duration Design Chart

Table 3-2 Maximum Overland Flow Length & Initial Time of Concentration

Figure 3-3 Rational Formula – Overland Time of Flow Nomograph

San Diego County Soils Interpretation Study – Boucher Hill

San Diego County Pala-Pauma Subregional Plan (Land Use Elements)

100-Year – 6-Hour Precipitation

100-Year – 24-Hour Precipitation

**APPENDIX II CALCULATIONS**

Rational Method Calculations

Existing Hydrology – 100-Year, West Sub-Basin

Existing Hydrology – 100-Year, East Sub-Basin

Proposed Hydrology – 100-Year, West Sub-Basin

Proposed Hydrology – 100-Year, East Sub-Basin

Ditch Calculations

**APPENDIX III MAPS**

Existing Conditions Drainage Map

Proposed Conditions Drainage Map

# 1. INTRODUCTION

## 1.1 Purpose of Study

This study provides hydrologic and hydraulic analyses in support of Tentative Parcel Map 21023 (APN # 132-220-18), which is located in Pauma, California in the County of San Diego. The proposed site development consists of two parcels on approximately 10.35 acres, construction of one single family residence pad; a driveway; private waterline and dry utilities; septic tanks and drain fields. This study evaluates onsite and offsite drainage patterns for both existing and proposed conditions.

Hydrologic and hydraulic calculations were performed using methodologies defined in the County of San Diego Hydrology Manual (June 2003). First, watershed boundaries, points of flow concentrations and land uses were established. This data was then entered into hydrologic modeling software and 100-year peak flows were calculated. Finally, hydrology exhibits were prepared to illustrate the model parameters and hydrologic characteristics of the existing and proposed conditions.

## 1.2 Scope

This study involves the hydrologic analysis of an approximately 29-acre watershed, which is divided into two major sub-basins (designated as west and east). The Jenkins Tentative Parcel Map encompasses 10.35 acres of which approximately 9 acres are included in this watershed. The remaining 1.35 acres of the Jenkins property discharges directly into a tributary of Yuima Creek. Existing and proposed development peak runoff values for the 100-year peak flows were determined for the project site using the Rational Method. The 100-year proposed condition flows will be used to size onsite drainage ditches and culverts. A site visit was performed to verify and document existing hydrologic characteristics and hydraulic structures.

# 2. DESCRIPTION OF WATERSHED

## 2.1 Area Characteristics

The project site is located on Quail Drive, in the unincorporated area of Pauma, off of State Route 76 and Rincon Rancho Road. The existing site is comprised of orange groves. The surrounding area is mainly agricultural fields and groves combined with low density residential. See Vicinity Map.

Surface runoff from the contributing watershed sheet flows southwesterly along two major sub-basins parallel to Quail Drive. The topography is similar to an alluvial fan and flows between Yuima Creek to the south and a tributary to Yuima Creek to the north. Once runoff reaches Yuima Creek, it is conveyed southwesterly where it eventually discharges into the San Luis Rey River, approximately 2.3 miles downstream.

## 2.2 Soil Type

The San Diego County Soils Interpretation Study Map for Boucher Hill was used to determine Hydrologic Soil Groups for the watershed. Soil groups A and B were used for all areas in this

study. Soil groups shown on the County Map were digitized and overlain onto the drainage boundaries.

### 2.3 Land Uses

The existing site is comprised of orange groves over two parcels. Parcel 2 also includes an existing trailer on a graded pad. The site and contributing watershed have a land use designation of Multiple Rural Use (1.0 DU/4, 8 & 20 acres) according to the County of San Diego Pala-Pauma Subregional Area Land Use Map.

The proposed improvements include: construction of one single family residence pad on Parcel 1; new driveway from Quail Drive to pad; private waterlines and dry utilities; septic tanks and septic drain fields for proposed home (Parcel 1) and existing trailer (Parcel 2).

The proposed project will not significantly alter the overall drainage patterns on the site. Runoff will continue to sheet flow southwesterly parallel to Quail Drive and eventually discharge into Yuima Creek.

The proposed project will construct one new residential lot. The runoff coefficient is 0.32 for the existing watershed based on the guidelines within the hydrology manual. These values represent low-density (1.0 du/ac or less) residential land uses. The proposed graded pad is 0.20 acres, therefore a runoff coefficient of 0.48 (medium-density residential, 7.3 du/acre or less) is appropriate. A runoff coefficient of 0.87 was used for the driveway with some adjacent landscaping.

### 2.4 Topography

We used one-foot contour mapping for the onsite portion of the project site. However, this topographic information does not extend far enough to the northeast to capture the entire watershed boundary limits. As such, we used the 1"=200' orthotopo mapping from the County of San Diego for areas outside the project limits.

## 3. METHODOLOGY

### 3.1 Modified Rational Method

Per the County of San Diego Hydrology Manual (dated June 2003) for watersheds less than one square mile with stream junctions, we used the modified rational formula, as excerpted below. Computer calculations were prepared using CIVILDESIGN Rational Method Hydrology Program. The calculations are included in Appendix II.

From the Hydrology Manual, this method is as follows:

Use the Rational Formula Q = CIA where:

Q is the peak rate of flow in cubic feet per second.

C is a runoff coefficient expressed as that percentage of rainfall that becomes surface runoff.

I is the average rainfall intensity in inches per hour for a storm duration equal to the time of concentration ($T_c$) of the contributing drainage area.

A is the drainage area in acres tributary to design point.

1) Runoff Coefficient, C

Table 3-1 lists the estimated coefficient for each type of land use. Multiply this coefficient by the percentage of the total area included in that class. The sum of the products for all land uses in San Diego County is the weighted runoff coefficient.

2) Rainfall Intensity, I

Intensity - duration - frequency curves applicable to all areas within San Diego County are given in Figure 3-1.

3) Time of Concentration, Tc

The time of concentration for initial areas was determined using the maximum overland flow length per Table 3-2 of the hydrology manual. The initial time of concentration was obtained using Figure 3-3. Where distances for initial areas were greater than those listed in Figure 3-3 the Kirpich formula was used to determine the time for the remaining distance and the time was added to the initial time of concentration. The time of concentration between nodes is calculated using Manning's equation for open channels.

# 4. RESULTS

## 4.1 Rational Method

The results of the existing and proposed condition analyses are summarized in Table 4.1.1 below. The West Sub-Basin represents the contributing drainage area that flows to the southwest corner of the study area. The East Sub-Basin represents the contributing drainage area that flows to the southeast corner of the watershed. The node numbers, watershed boundaries, and drainage systems discussed in this section are shown on the maps located in Appendix III.

**Table 4.1.1 – Rational Method Results**

| Location | Existing | | Proposed | |
|---|---|---|---|---|
| | Area (Acre) | 100-Yr Flow (cfs) | Area (Acre) | 100-Yr Flow (cfs) |
| West Sub-Basin | 21.94 | 34.7 | 21.94 | 34.7 |
| East Sub-Basin | 7.10 | 11.5 | 7.10 | 12.0 |
| **TOTAL** | **29.04** | **46.2** | **29.04** | **46.7** |

As shown in Table 4.1.1, there is less than a 5% increase of flow in the east sub-basin due to the proposed improvements. This increase can be attributed to the increase in impervious area from the graded pad and the proposed driveway. These improvements are consistent with the land use designation of 1 DU per 4 acres as shown on the County Land Use Map (Parcel 1 is 5.10 acres). This minor increase in storm runoff is insignificant when compared to the total contributing watershed to Yuima Creek.

## 4.2 Swale Calculations

The proposed onsite swale has adequate capacity to convey the proposed 100-year peak discharges (see Area 14 on Proposed Conditions Drainage Map). There is also a proposed vegetated swale that is designed to treat stormwater runoff from the proposed paved areas within the project boundaries. Swale design flow calculations are included in Appendix II.

# 5. CONCLUSION

There will be an approximately 5% increase in 100-year peak flows due to the proposed project. Underground detention is proposed for each lot to mitigate this increase. Based on our site visit and proposed mitigation, we do not anticipate any increased impact to downstream watershed conditions as a result of this project. The proposed project will not substantially alter the existing drainage pattern of the area or substantially increase the rate or amount of surface runoff in a manner that would cause either substantial erosion or substantial siltation on- or off-site.

# 6. REFERENCES

CivilCadd/CivilDesign Engineering Software, Rational Method Hydrology System Model, © 1989-2001, Version 6.4.

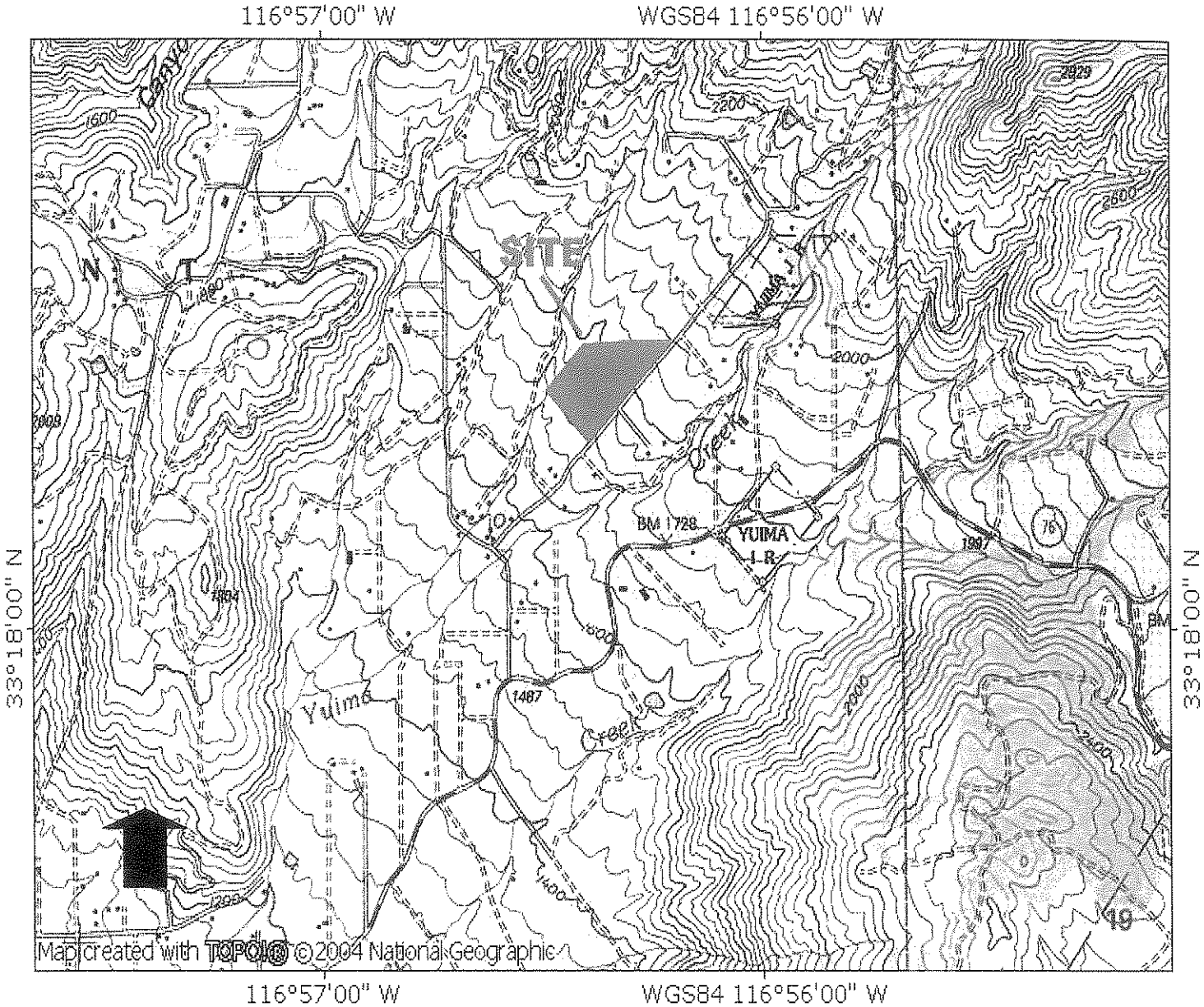
County of San Diego, Hydrology Manual, June 2003

Tory R. Walker Engineering (TRWE), "*Hydrologic Study Report for Single Lot Detention Basin Analysis*", August 18, 2006

County of San Diego, Pala-Pauma Subregional Area Land Use Map, July 2004

County of San Diego, Soils Interpretation Study, Boucher Hill, 1969

# APPENDIX I: SUPPORTING TABLES AND FIGURES




NATIONAL GEOGRAPHIC

0 .5 1 MILES

1000 0 1000 2000 3000 4000 5000 FEET

1 .5 0 KILOMETERS 1

1000 0 METERS 1000

TN MN 13°

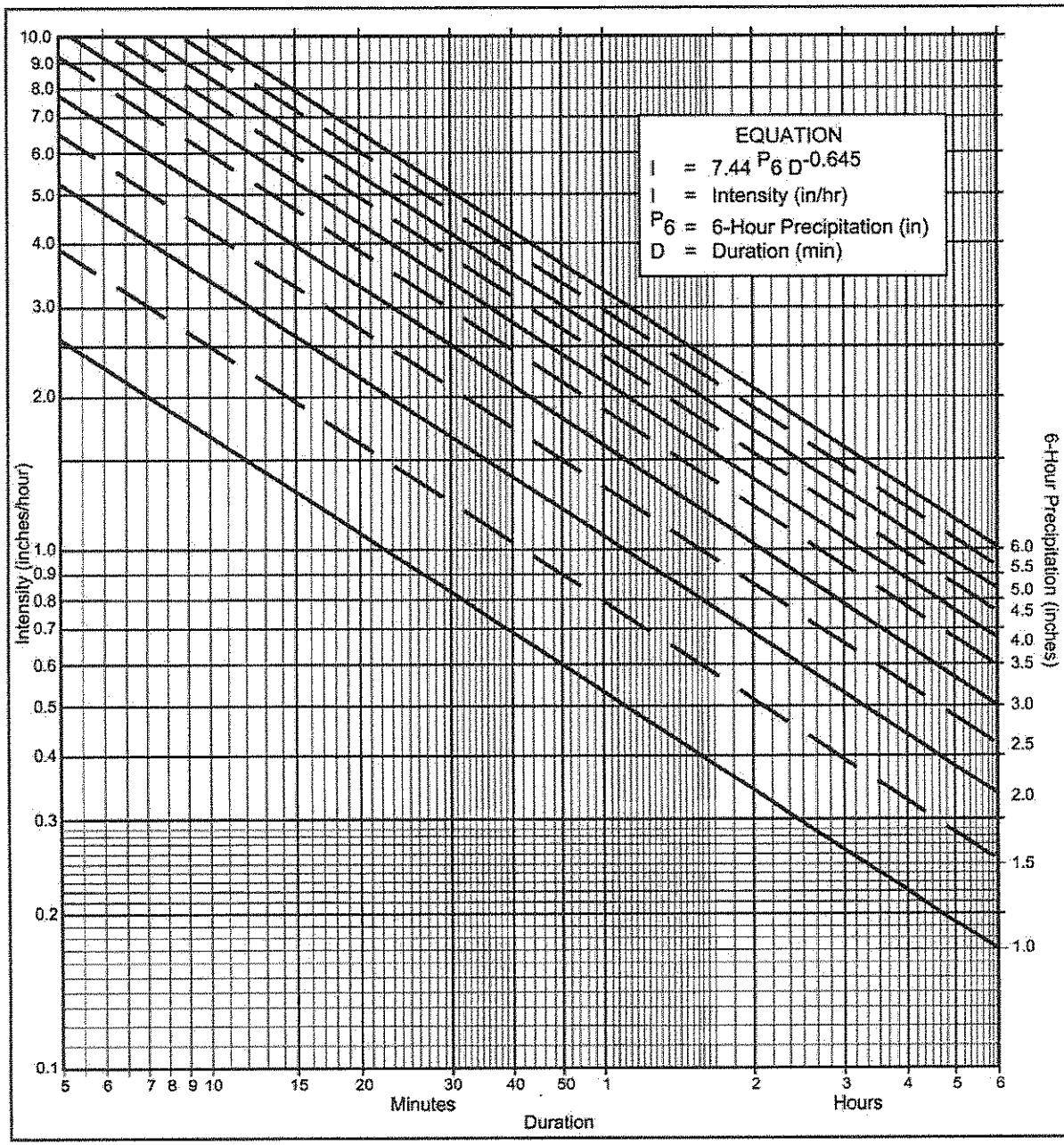
01/25/07

| | | |
|---|---|---|
| Date 01/29/2007<br>Path<br>DWG Name: VICINITY MAP<br>Plotting View NONE<br>Designer REB Proj Mgr | R.E. BERG ENGINEERING, INC.<br>726 CALIFORNIA OAKS DRIVE<br>VISTA, CA 92081<br>(760) 599-9031 (760) 599-9041 FAX | VICINITY MAP<br>JENKINS PROPERTY<br>TPM 21023 – PAUMA, CA<br>COUNTY OF SAN DIEGO<br>JOB NUMBER: 07-0001 1 OF 1 SHEETS |

## Table 3-1
## RUNOFF COEFFICIENTS FOR URBAN AREAS

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

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




**Directions for Application:**

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

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

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

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

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

**Application Form:**

(a) Selected frequency _____ year

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

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

(d) $t_x$ = _____ min.

(e) I = _____ in./hr.

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

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

**Intensity-Duration Design Chart - Template**

FIGURE

**3-1**

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

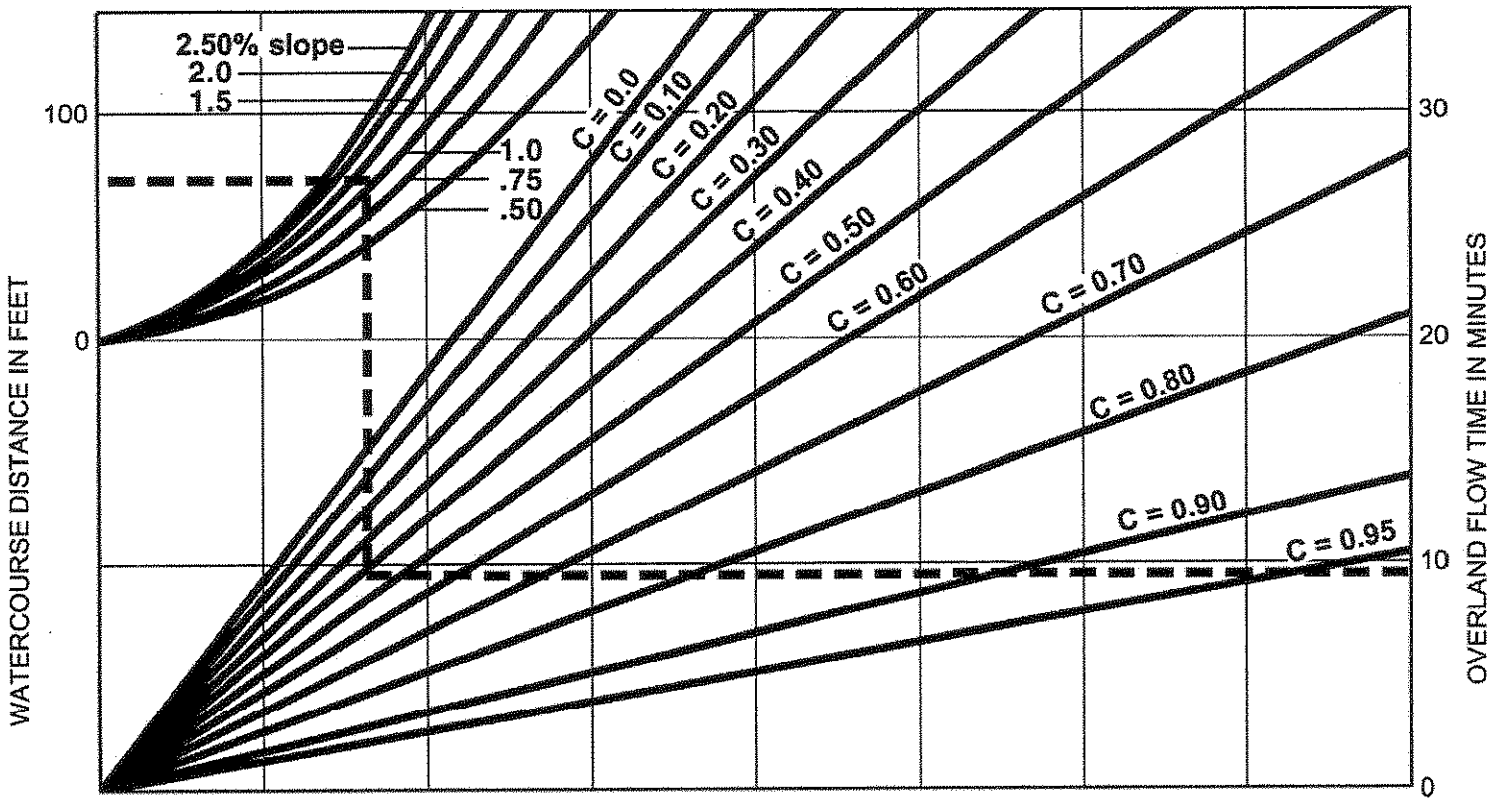
Table 3-2 provides limits of the length (Maximum Length ($L_M$)) of sheet flow to be used in hydrology studies. Initial $T_i$ values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be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

**Table 3-2**

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

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

*See Table 3-1 for more detailed description




EXAMPLE:

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

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

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

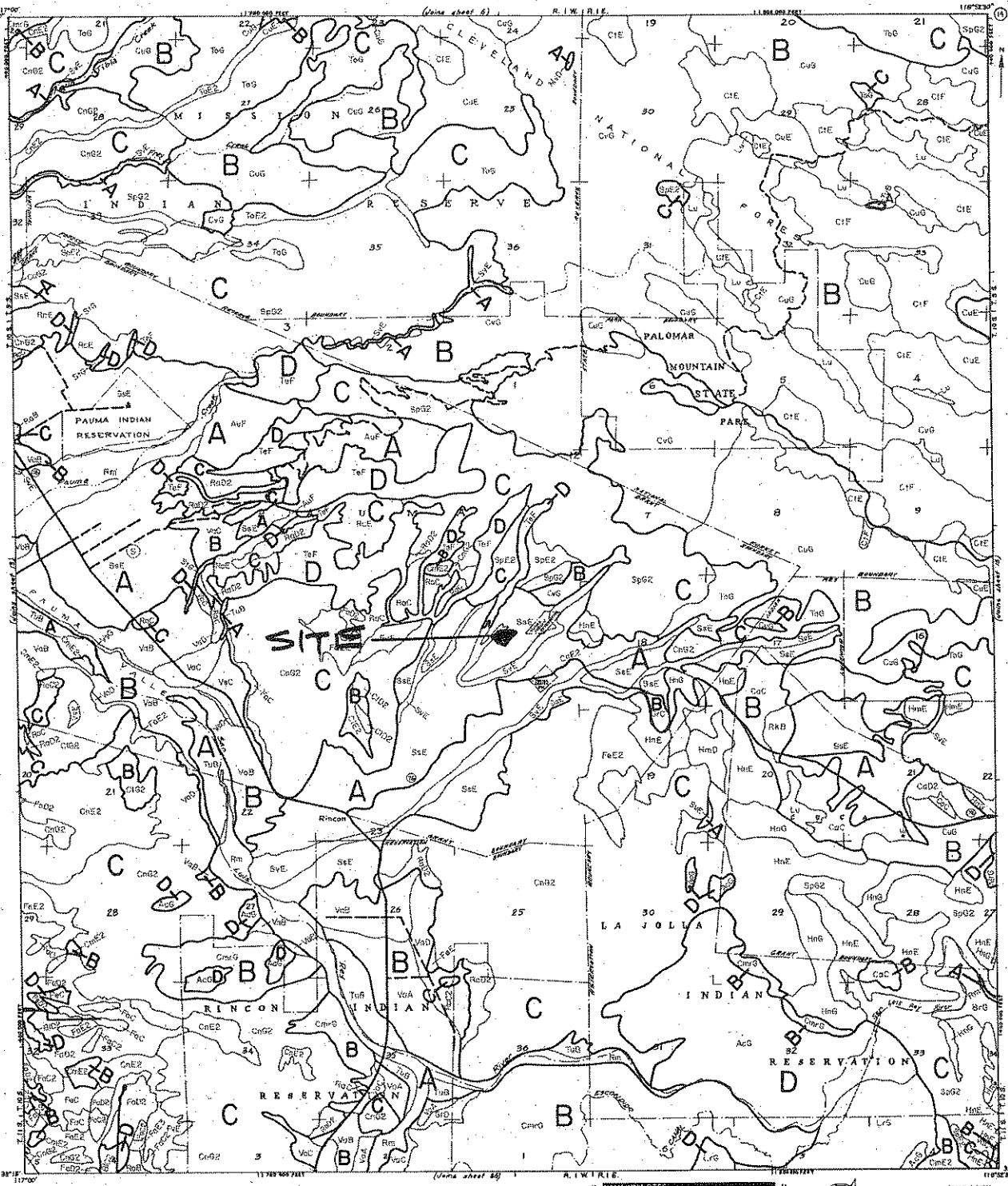
FIGURE

**Rational Formula - Overland Time of Flow Nomograph**

**3-3**

# Boucher Hill

San Diego County, California




San Diego County Soils Interpretation Study

**HYDROLOGIC SOIL GROUPS - Runoff Potential**

| Group A | Group B | Group C | Group D |
|---|---|---|---|
| A Low Runoff Potential | B Moderate Runoff Potential | C High Runoff Potential | D Very High Runoff Potential |

CAUTION NOTES

1. Use is urged to refer to corresponding SUPPLEMENTAL DATA SHEET for assumptions, criteria and sources, additional legend items, and necessary explanation of ratings shown on map.
2. This map does not alternate the need for detailed results investigation of the soil and site to determine nature and conditions prior to undertaking any construction, grading, planting, or other environmental activity.

Base Map Source: U. S. Geological Survey with California State Coordinate System, Zone 6 Indicated

Prepared by: U. S. Department of Agriculture, Soil Conservation Service

Published by: San Diego County Planning Department for the Comprehensive Planning Organization — 1968

North

SCALE 1:20000

0 2000 4000 8000 feet

0 ½ mile 1 mile

FEDERAL ASSISTANCE — The preparation of this map was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development.

Represents 30 acres

SHEET NAME: Boucher Hill

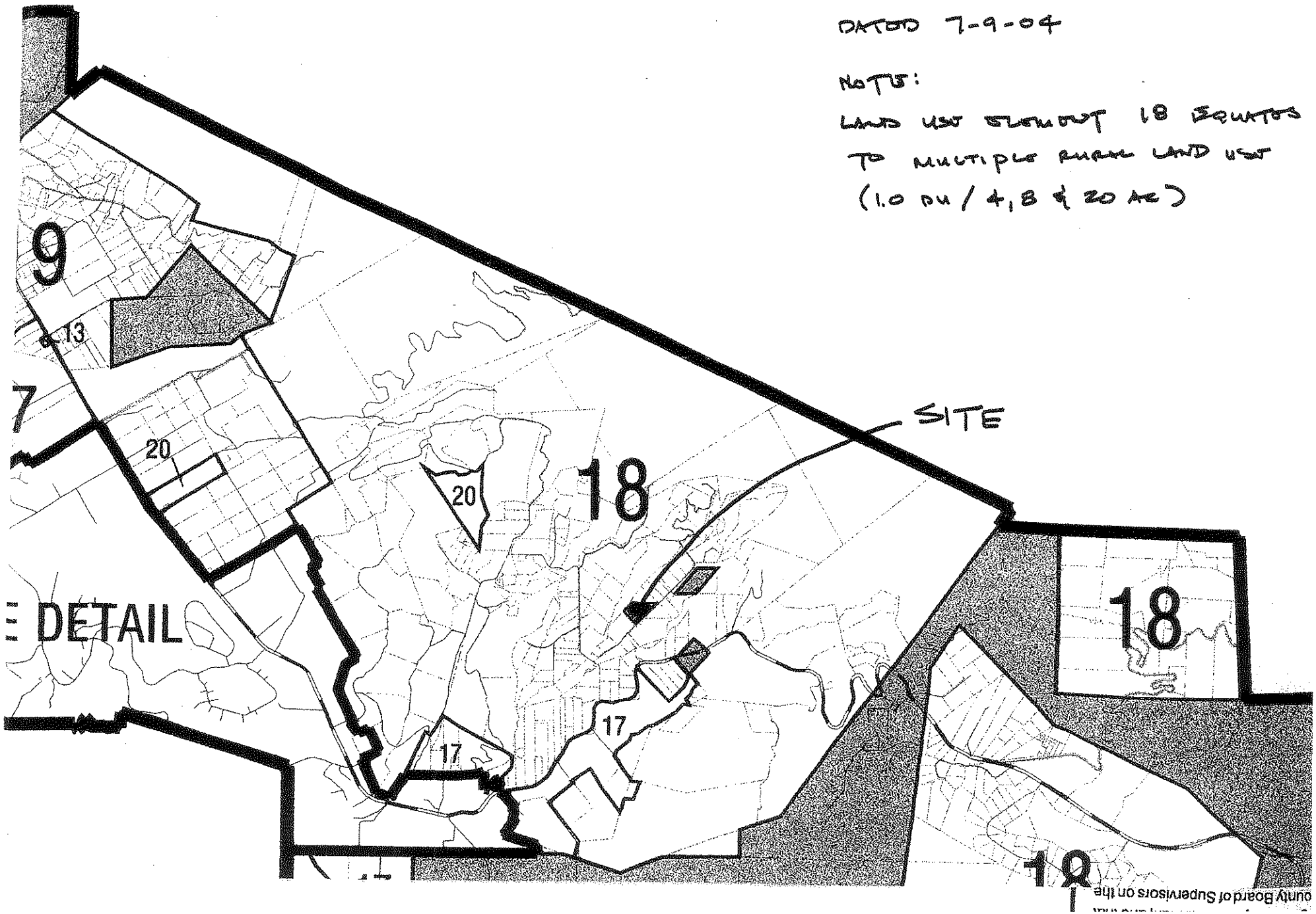
SHEET NUMBER: 14

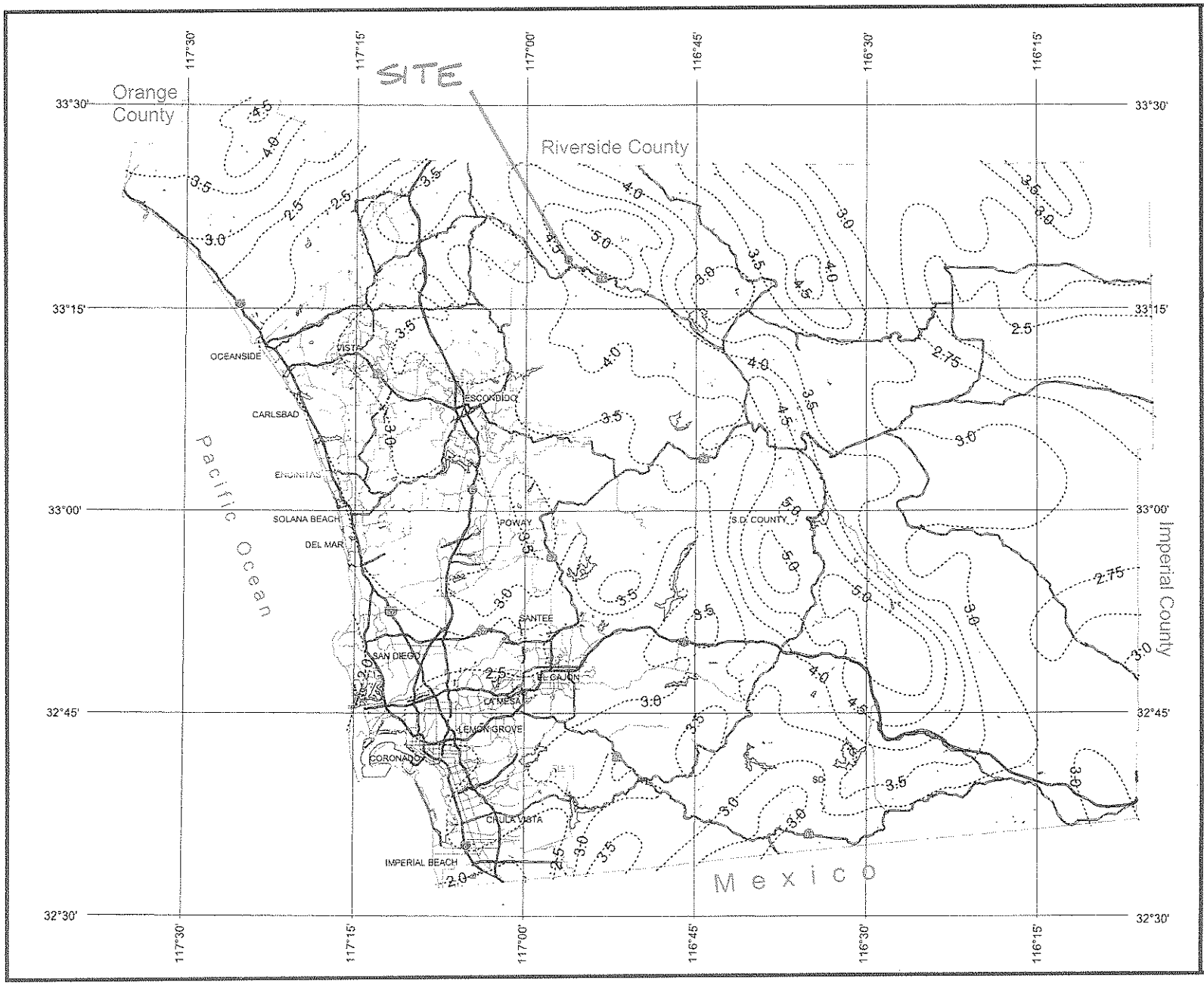
RUNOFF POTENTIAL

MAP NO. 14

REFERENCE:
COUNTY OF SAN DIEGO
PALA-PAUMA SUBREGIONAL PLAN
DATED 7-9-04

NOTE:
LAND USE ELEMENT 18 EQUATES
TO MULTIPLE RURAL LAND USE
(1.0 DU / 4, 8 & 20 AC)






# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 6 Hours**

Isopluvial (inches)

DPW GIS
Department of Public Works

SanGIS
We Have San Diego Covered!

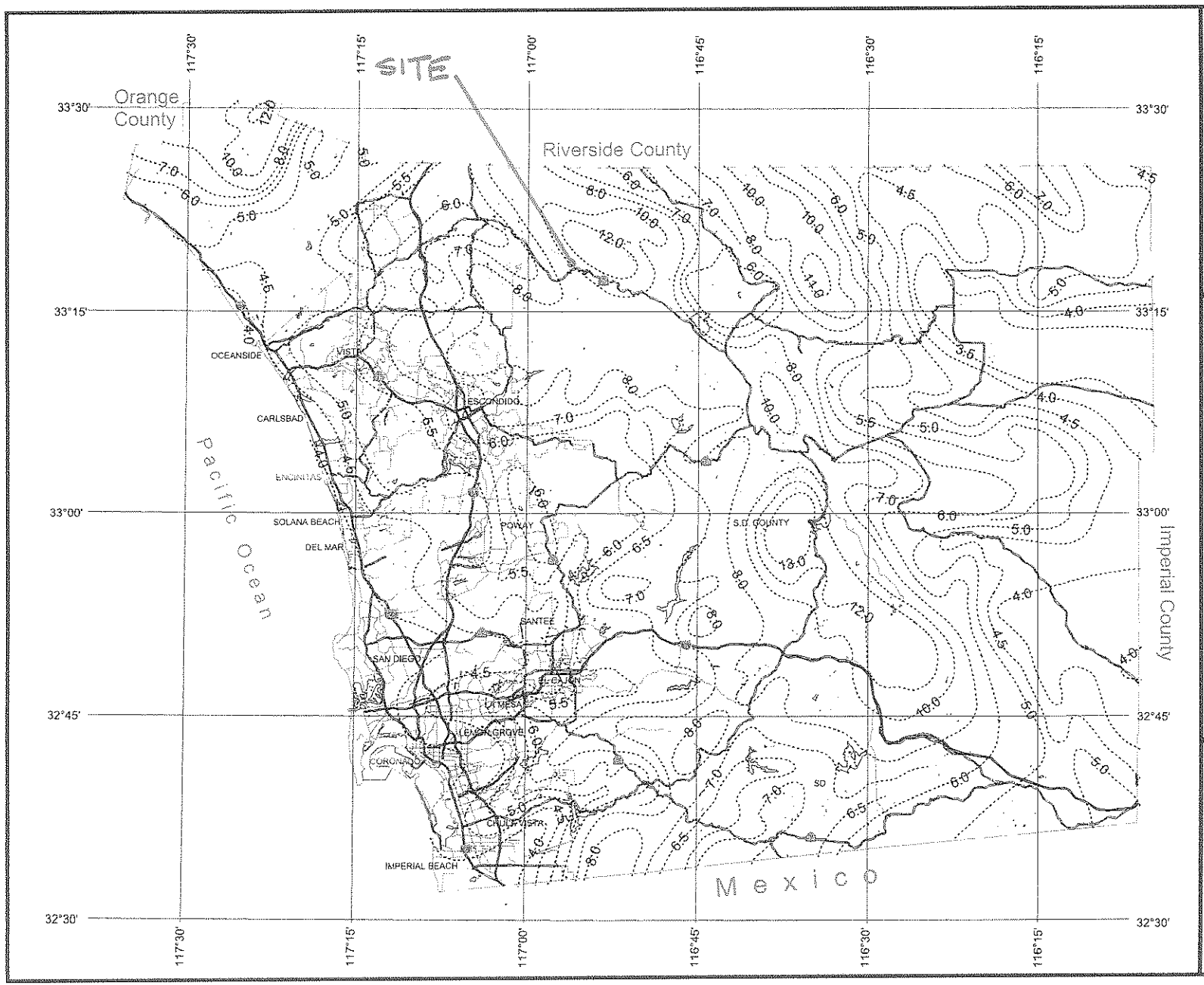
THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.
Copyright SanGIS. All Rights Reserved.

This product has certain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product has certain information which has been reproduced with permission granted by Thomas Brothers Maps.

N W E S

3 0 3 Miles




# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 24 Hours**

Isopluvial (inches)

DPW GIS

SanGIS
We Have San Diego Covered!

N
W E
S

3 0 3 Miles

# APPENDIX II: CALCULATIONS

# ***Rational Method Calculations***

```
            San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
      Rational Hydrology Study        Date: 01/27/07
------------------------------------------------------------------------
JENKINS PROPERTY TPM
100-YEAR STORM, EXISTING CONDITIONS
WEST SUB-BASIN
JENKINSW100EX
------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 4071

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

Map data precipitation entered:
6 hour,  precipitation(inches) =  4.500
24 hour precipitation(inches) = 10.000
P6/P24 =    45.0%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       1.000 to Point/Station       2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation = 2215.000(Ft.)
Lowest elevation = 2198.000(Ft.)
Elevation difference =   17.000(Ft.) Slope = 17.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  17.00 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.46 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3200)*( 100.000^.5)/(  17.000^(1/3)]=   5.46
Rainfall intensity (I) =     11.202(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.320
Subarea runoff =      0.215(CFS)
Total initial stream area =        0.060(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       2.000 to Point/Station       3.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  2198.000(Ft.)
Downstream point elevation =  2098.000(Ft.)
```

```
Channel length thru subarea  =   500.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      2.963(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.963(CFS)
Depth of flow =   0.263(Ft.), Average velocity =   4.282(Ft/s)
Channel flow top width =    5.260(Ft.)
Flow Velocity =    4.28(Ft/s)
Travel time  =    1.95 min.
Time of concentration =    7.41 min.
Critical depth =      0.352(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Rainfall intensity =      9.202(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.320  CA =      0.611
Subarea runoff =      5.409(CFS) for      1.850(Ac.)
Total runoff =      5.624(CFS)      Total area =       1.910(Ac.)
Depth of flow =   0.335(Ft.), Average velocity =   5.027(Ft/s)
Critical depth =      0.457(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  2098.000(Ft.)
Downstream point elevation =  1860.000(Ft.)
Channel length thru subarea  =  1788.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     16.836(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     16.836(CFS)
Depth of flow =   0.545(Ft.), Average velocity =   5.676(Ft/s)
Channel flow top width =   10.893(Ft.)
Flow Velocity =    5.68(Ft/s)
Travel time  =    5.25 min.
Time of concentration =   12.66 min.
Critical depth =      0.707(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      6.513(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.276  CA =      4.291
Subarea runoff =     22.325(CFS) for     13.630(Ac.)
Total runoff =     27.950(CFS)      Total area =      15.540(Ac.)
Depth of flow =   0.659(Ft.), Average velocity =   6.442(Ft/s)
Critical depth =      0.867(Ft.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        5.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1860.000(Ft.)
Downstream point elevation =  1779.000(Ft.)
Channel length thru subarea  =   661.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     30.504(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     30.504(CFS)
Depth of flow =   0.691(Ft.), Average velocity =   6.384(Ft/s)
Channel flow top width =   13.825(Ft.)
Flow Velocity =    6.38(Ft/s)
Travel time  =    1.73 min.
Time of concentration =   14.38 min.
Critical depth =      0.898(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      5.998(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.275  CA =      5.496
Subarea runoff =      5.010(CFS) for      4.460(Ac.)
Total runoff =     32.960(CFS)      Total area =      20.000(Ac.)
Depth of flow =   0.712(Ft.), Average velocity =   6.508(Ft/s)
Critical depth =      0.922(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        5.000 to Point/Station        6.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1779.000(Ft.)
Downstream point elevation =  1738.000(Ft.)
Channel length thru subarea  =   350.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     33.880(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     33.880(CFS)
Depth of flow =   0.725(Ft.), Average velocity =   6.444(Ft/s)
Channel flow top width =   14.502(Ft.)
Flow Velocity =    6.44(Ft/s)
Travel time  =    0.91 min.
Time of concentration =   15.29 min.
Critical depth =      0.938(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
```

```
Sub-Area C Value = 0.270
Rainfall intensity =      5.766(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.274  CA =      6.019
Subarea runoff =      1.748(CFS) for      1.940(Ac.)
Total runoff =     34.708(CFS)      Total area =      21.940(Ac.)
Depth of flow =   0.732(Ft.), Average velocity =   6.483(Ft/s)
Critical depth =      0.945(Ft.)
End of computations, total study area =          21.940 (Ac.)
```

```
            San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
      Rational Hydrology Study        Date: 01/27/07
------------------------------------------------------------------------
JENKINS PROPERTY TPM
100-YEAR STORM, EXISTING CONDITIONS
EAST SUB-BASIN
JENKINSE100EX
------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 4071

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

Map data precipitation entered:
6 hour,  precipitation(inches) =  4.500
24 hour precipitation(inches) = 10.000
P6/P24 =    45.0%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       10.000 to Point/Station       11.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                      ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation = 2000.000(Ft.)
Lowest elevation = 1985.000(Ft.)
Elevation difference =   15.000(Ft.) Slope = 15.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  15.00 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.06 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.2700)*( 100.000^.5)/(  15.000^(1/3)]=   6.06
Rainfall intensity (I) =     10.476(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.270
Subarea runoff =      0.141(CFS)
Total initial stream area =        0.050(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       12.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1985.000(Ft.)
Downstream point elevation =  1860.000(Ft.)
```

```
Channel length thru subarea  =   915.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      2.072(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.072(CFS)
Depth of flow =   0.247(Ft.), Average velocity =   3.394(Ft/s)
Channel flow top width =    4.941(Ft.)
Flow Velocity =    3.39(Ft/s)
Travel time  =   4.49 min.
Time of concentration =   10.55 min.
Critical depth =      0.305(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                      ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      7.324(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.270  CA =      0.537
Subarea runoff =      3.794(CFS) for      1.940(Ac.)
Total runoff =      3.935(CFS)      Total area =       1.990(Ac.)
Depth of flow =   0.314(Ft.), Average velocity =   3.985(Ft/s)
Critical depth =      0.395(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       12.000 to Point/Station       13.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1860.000(Ft.)
Downstream point elevation =  1775.000(Ft.)
Channel length thru subarea  =   674.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      6.171(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      6.171(CFS)
Depth of flow =   0.378(Ft.), Average velocity =   4.328(Ft/s)
Channel flow top width =    7.553(Ft.)
Flow Velocity =    4.33(Ft/s)
Travel time  =    2.60 min.
Time of concentration =   13.15 min.
Critical depth =      0.473(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                      ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      6.356(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.270  CA =      1.309
Subarea runoff =      4.387(CFS) for      2.860(Ac.)
Total runoff =      8.323(CFS)      Total area =       4.850(Ac.)
Depth of flow =   0.422(Ft.), Average velocity =   4.664(Ft/s)
Critical depth =      0.531(Ft.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       13.000 to Point/Station       14.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1775.000(Ft.)
Downstream point elevation =  1730.000(Ft.)
Channel length thru subarea  =   360.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      9.954(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      9.954(CFS)
Depth of flow =   0.453(Ft.), Average velocity =   4.861(Ft/s)
Channel flow top width =    9.051(Ft.)
Flow Velocity =    4.86(Ft/s)
Travel time  =    1.23 min.
Time of concentration =   14.38 min.
Critical depth =      0.570(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      5.998(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.270  CA =      1.917
Subarea runoff =      3.176(CFS) for      2.250(Ac.)
Total runoff =     11.498(CFS)      Total area =       7.100(Ac.)
Depth of flow =   0.478(Ft.), Average velocity =   5.039(Ft/s)
Critical depth =      0.605(Ft.)
End of computations, total study area =           7.100 (Ac.)
```

```
            San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
      Rational Hydrology Study        Date: 01/28/07
------------------------------------------------------------------------
JENKINS PROPERTY TPM
100-YEAR STORM, PROPOSED CONDITIONS
WEST SUB-BASIN
JENKINSW100PR
------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 4071

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

Map data precipitation entered:
6 hour,  precipitation(inches) =  4.500
24 hour precipitation(inches) = 10.000
P6/P24 =    45.0%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        2.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation = 2215.000(Ft.)
Lowest elevation = 2198.000(Ft.)
Elevation difference =   17.000(Ft.) Slope = 17.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  17.00 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.46 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3200)*( 100.000^.5)/(  17.000^(1/3)]=   5.46
Rainfall intensity (I) =     11.202(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.320
Subarea runoff =      0.215(CFS)
Total initial stream area =        0.060(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        2.000 to Point/Station        3.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  2198.000(Ft.)
Downstream point elevation =  2098.000(Ft.)
```

```
Channel length thru subarea  =   500.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      2.963(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.963(CFS)
Depth of flow =   0.263(Ft.), Average velocity =   4.282(Ft/s)
Channel flow top width =    5.260(Ft.)
Flow Velocity =    4.28(Ft/s)
Travel time  =    1.95 min.
Time of concentration =    7.41 min.
Critical depth =      0.352(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Rainfall intensity =      9.202(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.320  CA =      0.611
Subarea runoff =      5.409(CFS) for      1.850(Ac.)
Total runoff =      5.624(CFS)      Total area =       1.910(Ac.)
Depth of flow =   0.335(Ft.), Average velocity =   5.027(Ft/s)
Critical depth =      0.457(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  2098.000(Ft.)
Downstream point elevation =  1860.000(Ft.)
Channel length thru subarea  =  1788.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     16.836(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     16.836(CFS)
Depth of flow =   0.545(Ft.), Average velocity =   5.676(Ft/s)
Channel flow top width =   10.893(Ft.)
Flow Velocity =    5.68(Ft/s)
Travel time  =    5.25 min.
Time of concentration =   12.66 min.
Critical depth =      0.707(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      6.513(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.276  CA =      4.291
Subarea runoff =     22.325(CFS) for     13.630(Ac.)
Total runoff =     27.950(CFS)      Total area =      15.540(Ac.)
Depth of flow =   0.659(Ft.), Average velocity =   6.442(Ft/s)
Critical depth =      0.867(Ft.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        5.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1860.000(Ft.)
Downstream point elevation =  1779.000(Ft.)
Channel length thru subarea  =   661.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     30.504(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     30.504(CFS)
Depth of flow =   0.691(Ft.), Average velocity =   6.384(Ft/s)
Channel flow top width =   13.825(Ft.)
Flow Velocity =    6.38(Ft/s)
Travel time  =    1.73 min.
Time of concentration =   14.38 min.
Critical depth =      0.898(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      5.998(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.275  CA =      5.496
Subarea runoff =      5.010(CFS) for      4.460(Ac.)
Total runoff =     32.960(CFS)      Total area =      20.000(Ac.)
Depth of flow =   0.712(Ft.), Average velocity =   6.508(Ft/s)
Critical depth =      0.922(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        5.000 to Point/Station        6.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1779.000(Ft.)
Downstream point elevation =  1738.000(Ft.)
Channel length thru subarea  =   350.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     33.880(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     33.880(CFS)
Depth of flow =   0.725(Ft.), Average velocity =   6.444(Ft/s)
Channel flow top width =   14.502(Ft.)
Flow Velocity =    6.44(Ft/s)
Travel time  =    0.91 min.
Time of concentration =   15.29 min.
Critical depth =      0.938(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
```

```
Sub-Area C Value = 0.270
Rainfall intensity =      5.766(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.274  CA =      6.019
Subarea runoff =      1.748(CFS) for      1.940(Ac.)
Total runoff =     34.708(CFS)      Total area =      21.940(Ac.)
Depth of flow =   0.732(Ft.), Average velocity =   6.483(Ft/s)
Critical depth =      0.945(Ft.)
End of computations, total study area =          21.940 (Ac.)
```

```
            San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
     Rational Hydrology Study        Date: 01/28/07
------------------------------------------------------------------------
JENKINS PROPERTY TPM
100-YEAR STORM, PROPOSED CONDITIONS
EAST SUB-BASIN
JENKINSE100PR
------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 4071

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

Map data precipitation entered:
6 hour,  precipitation(inches) =  4.500
24 hour precipitation(inches) = 10.000
P6/P24 =    45.0%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       10.000 to Point/Station       11.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation = 2000.000(Ft.)
Lowest elevation = 1985.000(Ft.)
Elevation difference =   15.000(Ft.) Slope = 15.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  15.00 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.06 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.2700)*( 100.000^.5)/(  15.000^(1/3)]=   6.06
Rainfall intensity (I) =     10.476(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.270
Subarea runoff =      0.141(CFS)
Total initial stream area =        0.050(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       12.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1985.000(Ft.)
Downstream point elevation =  1860.000(Ft.)
```

```
Channel length thru subarea  =   915.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      2.072(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.072(CFS)
Depth of flow =   0.247(Ft.), Average velocity =   3.394(Ft/s)
Channel flow top width =    4.941(Ft.)
Flow Velocity =    3.39(Ft/s)
Travel time  =    4.49 min.
Time of concentration =   10.55 min.
Critical depth =      0.305(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      7.324(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.270  CA =      0.537
Subarea runoff =      3.794(CFS) for      1.940(Ac.)
Total runoff =      3.935(CFS)      Total area =      1.990(Ac.)
Depth of flow =   0.314(Ft.), Average velocity =   3.985(Ft/s)
Critical depth =      0.395(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       12.000 to Point/Station       13.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1860.000(Ft.)
Downstream point elevation =  1771.000(Ft.)
Channel length thru subarea  =   693.000(Ft.)
Channel base width       =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      6.125(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      6.125(CFS)
Depth of flow =   0.375(Ft.), Average velocity =   4.349(Ft/s)
Channel flow top width =    7.506(Ft.)
Flow Velocity =    4.35(Ft/s)
Travel time  =    2.66 min.
Time of concentration =   13.21 min.
Critical depth =      0.473(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      6.337(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.270  CA =      1.299
Subarea runoff =      4.294(CFS) for      2.820(Ac.)
Total runoff =      8.230(CFS)      Total area =      4.810(Ac.)
Depth of flow =   0.419(Ft.), Average velocity =   4.682(Ft/s)
Critical depth =      0.531(Ft.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       13.000 to Point/Station       16.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1771.000(Ft.)
Downstream point/station elevation =  1768.000(Ft.)
Pipe length  =    18.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     8.230(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     8.230(CFS)
Normal flow depth in pipe =    6.46(In.)
Flow top width inside pipe =   11.96(In.)
Critical depth could not be calculated.
Pipe flow velocity =     19.09(Ft/s)
Travel time through pipe =    0.02 min.
Time of concentration (TC) =    13.22 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       14.000 to Point/Station       16.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Time of concentration =    13.22 min.
Rainfall intensity =      6.332(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.270  CA =      1.380
Subarea runoff =      0.507(CFS) for      0.300(Ac.)
Total runoff =      8.736(CFS)      Total area =       5.110(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       15.000 to Point/Station       16.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                     ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    13.22 min.
Rainfall intensity =      6.332(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.278  CA =      1.476
Subarea runoff =      0.608(CFS) for      0.200(Ac.)
Total runoff =      9.344(CFS)      Total area =       5.310(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       16.000 to Point/Station       16.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
```

```
[INDUSTRIAL area type                          ]
(General Industrial        )
Impervious value, Ai = 0.950
Sub-Area C Value = 0.870
Time of concentration =    13.22 min.
Rainfall intensity =      6.332(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.283  CA =      1.519
Subarea runoff =      0.275(CFS) for      0.050(Ac.)
Total runoff =      9.620(CFS)      Total area =       5.360(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       16.000 to Point/Station       17.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =  1768.000(Ft.)
Downstream point elevation =  1730.000(Ft.)
Channel length thru subarea  =   318.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     10.844(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     10.844(CFS)
Depth of flow =   0.471(Ft.), Average velocity =   4.883(Ft/s)
Channel flow top width =    9.425(Ft.)
Flow Velocity =    4.88(Ft/s)
Travel time  =    1.09 min.
Time of concentration =   14.31 min.
Critical depth =      0.594(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                       ]
(1.0 DU/A or Less        )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Rainfall intensity =      6.018(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.280  CA =      1.989
Subarea runoff =      2.350(CFS) for      1.740(Ac.)
Total runoff =     11.970(CFS)      Total area =       7.100(Ac.)
Depth of flow =   0.489(Ft.), Average velocity =   5.005(Ft/s)
Critical depth =      0.617(Ft.)
End of computations, total study area =           7.100 (Ac.)
```

# ***Swale Calculations***

# JENKINS TENTATIVE PARCEL MAP
# GRASSED SWALE CALCULATIONS

| LOCATION | AREA (acres) | C | I (in/hr) | $Q_{BMP}$ (cfs) | $V_{BMP}$ (fps) | DESIGN LENGTH (ft) |
|---|---|---|---|---|---|---|
| **HOUSE PAD** | 0.2 | 0.48 | 0.2 | 0.019 | 0.14 | |
| **DRIVEWAY** | 0.05 | 0.87 | 0.2 | 0.009 | 0.11 | |
| **TOTAL** | | | | 0.028 | 0.14 | **58.8** |

**NOTES:**

1. SWALE GEOMETRY:
   - BOTTOM WIDTH = 2 FT
   - SIDE SLOPE = 3:1
   - FLOW DIRECTION SLOPE = 1.0%
2. DESIGN FLOW VELOCITY BASED ON N=0.20
3. DESIGN LENGTH = (7 MIN) X (FLOW VELOCITY) X 60

CIVILCADD/CIVILDESIGN Engineering Software, (c) 2004 Version 7.0

---

JENKINS PROPERTY TPM
GRASSED SWALE CALCULATION
JENKINSVEGSWALE

---

Program License Serial Number 4071

---

*** Improved Channel Analysis ***

Upstream (headworks) Elevation = 1769.000(Ft.)
Downstream (outlet) Elevation = 1768.000(Ft.)
Runoff/Flow Distance = 100.000(Ft.)
Maximum flow rate in channel(s) = 0.028(CFS)

---

---

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

*** CALCULATED DEPTH DATA AT FLOW = 0.03(CFS) ***
Channel base width = 2.000(Ft.)
Slope or 'Z' of left channel bank = 3.000
Slope or 'Z' of right channel bank = 3.000
Manning's 'N' = 0.200
Maximum depth of channel = 0.500(Ft.)
Flow(q) thru channel = 0.028(CFS)
Depth of flow = 0.090(Ft.)
Average velocity = 0.137(Ft/s)
Total flow rate in 1/2 street = 0.028(CFS)
Channel flow top width = 2.539(Ft.)
Depth of flow in channel = 0.09(Ft.)

Total number of channels (same dimensions) = 1
Flow Velocity = 0.14(Ft/s)
Individual channel flow = 0.028(CFS)
Total capacity of channel(s) = 0.028(CFS)

Sub-Channel No. 1 Critical depth = 0.018(Ft.)
' ' ' Critical flow top width = 2.108(Ft.)
' ' ' Critical flow velocity= 0.754(Ft/s)
' ' ' Critical flow area = 0.037(Sq.Ft)

---

## Grassed Swales

### General

A Grass swale is a wide, shallow densely vegetated channel that treats stormwater runoff as it is slowly conveyed into a downstream system. These swales have very shallow slopes in order to allow maximum contact time with the vegetation. The depth of water of the design flow should be less than the height of the vegetation. Contact with vegetation improves water quality by plant uptake of pollutants, removal of sediment, and an increase in infiltration. Overall the effectiveness of a grass swale is limited and it is recommended that they are used in combination with other BMPs.

This BMP is not appropriate for industrial sites or locations where spills occur. Important factors to consider when using this BMP include: natural channelization should be avoided to maintain this BMP's effectiveness, large areas must be divided and treated with multiple swales, thick cover is required to function properly, impractical for steep topography, and not effective with high flow velocities.

Grass Swale Design Criteria:

| Design Parameter | Unit | Design Criteria |
|---|---|---|
| Design Flow | cfs | $Q_{BMP}$ |
| Minimum bottom width | ft | 2 ft [2] |
| Maximum channel side slope | H:V | 3:1 [2] |
| Minimum slope in flow direction | % | 0.2 (provide underdrains for slopes < 0.5) [1] |
| Maximum slope in flow direction | % | 2.0 (provide grade-control checks for slopes >2.0) [1] |
| Maximum flow velocity | ft/sec | 1.0 (based on Manning n = 0.20) [1] |
| Maximum depth of flow | inches | 3 to 5 (1 inch below top of grass) [1] |
| Minimum contact time | minutes | 7 [1] |
| Minimum length | ft | Sufficient length to provide minimum contact time [1] |
| Vegetation | - | Turf grass or approved equal [1] |
| Grass height | inches | 4 to 6 (mow to maintain height) [1] |

1 Ventura County's Technical Guidance Manual for Stormwater Quality Control Measures
2 City of Modesto's Guidance Manual for New Development Stormwater Quality Control Measures
3 CA Stormwater BMP Handbook for New Development and Significant Redevelopment
4 Riverside County DAMP Supplement A Attachment

CIVILCADD/CIVILDESIGN Engineering Software, (c) 2004 Version 7.0

---

JENKINS PROPERTY TPM
ONSITE EARTHEN SWALE
JENKINSSWALE

---

Program License Serial Number 4071

---

*** Improved Channel Analysis ***

Upstream (headworks) Elevation = 1770.000(Ft.)
Downstream (outlet) Elevation = 1769.000(Ft.)
Runoff/Flow Distance = 100.000(Ft.)
Maximum flow rate in channel(s) = 0.510(CFS)

---

---

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

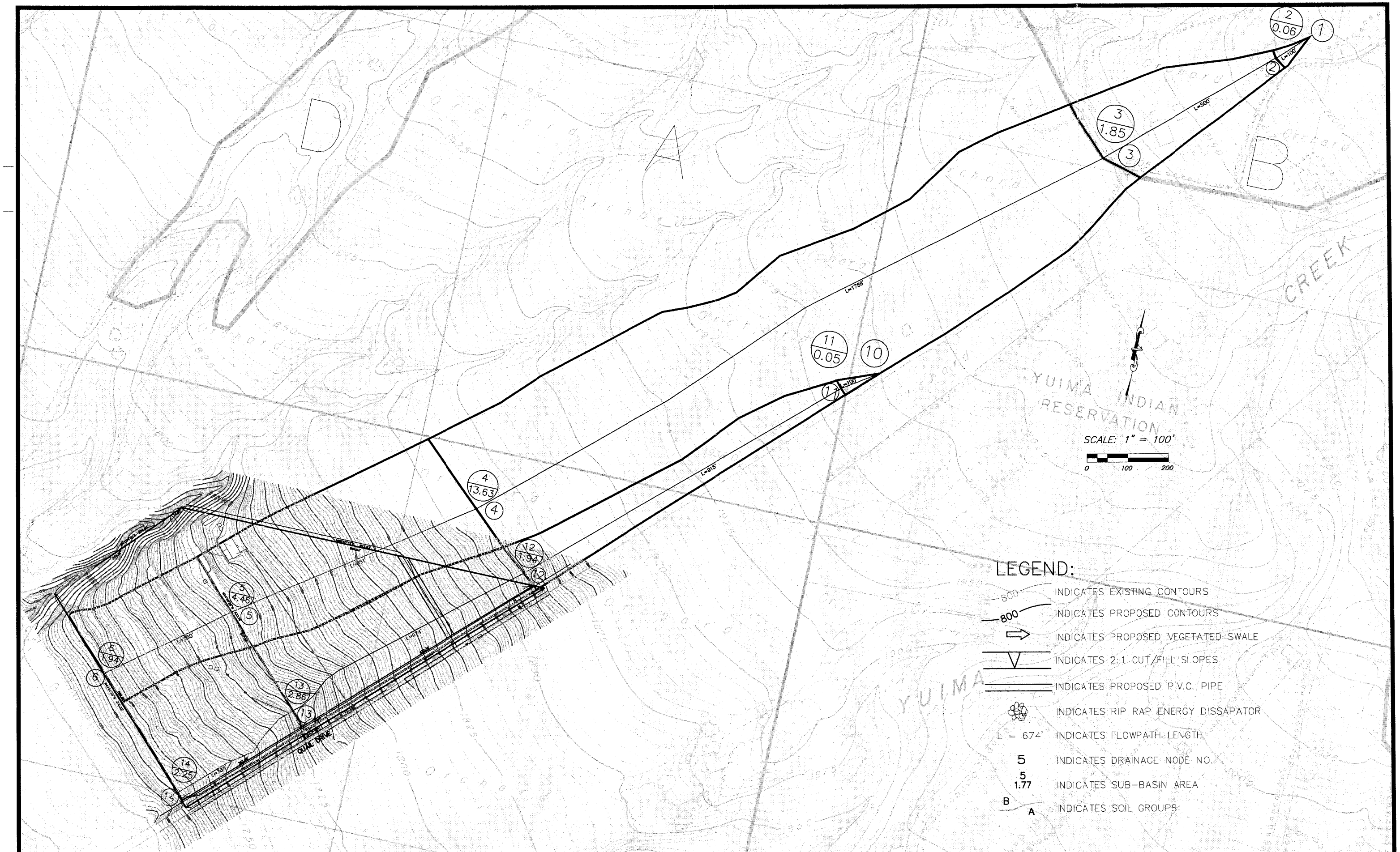
*** CALCULATED DEPTH DATA AT FLOW = 0.51(CFS) ***
Channel base width = 2.000(Ft.)
Slope or 'Z' of left channel bank = 3.000
Slope or 'Z' of right channel bank = 3.000
Manning's 'N' = 0.030
Maximum depth of channel = 1.000(Ft.)
Flow(q) thru channel = 0.510(CFS)
Depth of flow = 0.160(Ft.)
Average velocity = 1.283(Ft/s)
Total flow rate in 1/2 street = 0.510(CFS)
Channel flow top width = 2.961(Ft.)
Depth of flow in channel = 0.16(Ft.)

Total number of channels (same dimensions) = 1
Flow Velocity = 1.28(Ft/s)
Individual channel flow = 0.510(CFS)
Total capacity of channel(s) = 0.510(CFS)

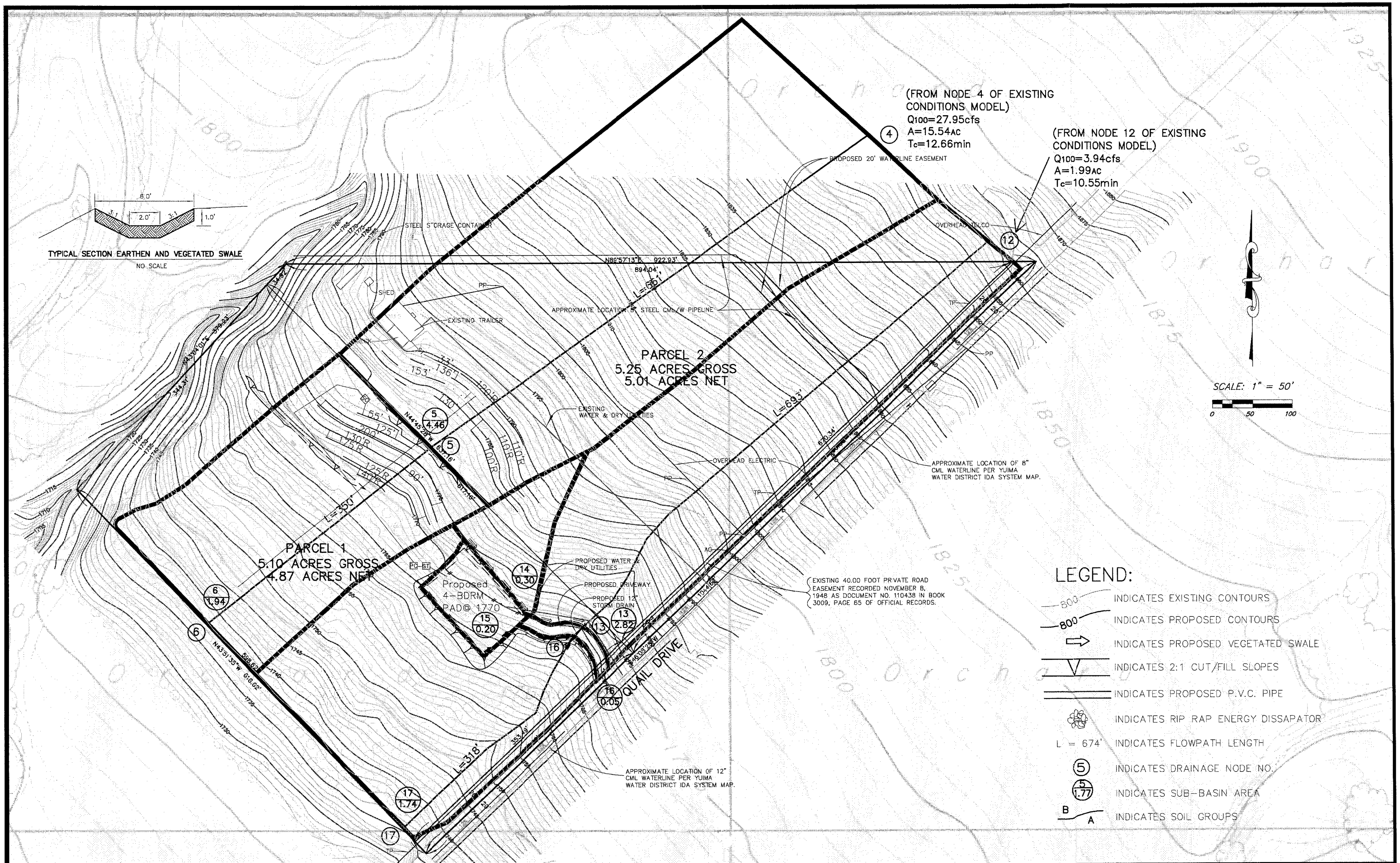
Sub-Channel No. 1 Critical depth = 0.119(Ft.)
' ' ' Critical flow top width = 2.715(Ft.)
' ' ' Critical flow velocity= 1.816(Ft/s)
' ' ' Critical flow area = 0.281(Sq.Ft)

---

# APPENDIX III: MAPS




| LYLE ENGINEERING, INC. | JENKINS PROPERTY TPM | EXISTING CONDITIONS DRAINAGE MAP | Job # 07-06 | 01/26/2007 |
|---|---|---|---|---|




| LYLE ENGINEERING, INC. | JENKINS PROPERTY TPM | PROPOSED CONDITIONS DRAINAGE MAP | Job # 07-06 | 01/26/2007 |
|---|---|---|---|---|