STORMWATER MANAGEMENT PLAN

For the construction of an Education Center, Gymnasium, Ward Center and Columbarium in Spring Valley, California.

Prepared By:

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For:
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Spring Valley, California.

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1. DESCRIPTION OF PROPOSED PROJECT

1.1 Project Location

The project site is located at the west side of Kenwood Drive in the City of Spring Valley, in the County of San Diego. Figure 1-1 is the vicinity map showing the location of the property.

1.2 Project Description

1.2.1 Physical Features

The existing site consists of 5.71 acres of developed land. The site is located at the top of a hill, existing improvements are: Sanctuary, administration building, hall building, education building, coach classrooms, cell tower room and classrooms with associated driveway, parking lot and landscaping areas as shown on figure 1-2. Existing vegetation consists of grass, shrubs and trees. Exiting hydrologic soil type is 'C' as shown in appendix A ~~A-1 and A-2~~.

The project proposed to add approximately 5100 ft^3 of impervious area. The proposed project consists of an education center, gymnasium, columbarium and ward center. Portion of the existing parking area will be modified and the existing coach classroom (trailer) will be removed. Proposed site will maintain existing drainage patterns as shown on figure 1-3.

1.2.2 Land Use

Surrounding land use is medium density residential. Existing and propose land use is church and school which is compatible with residential use.

1.3 Watershed Contribution

This project is located in the Sweetwater Hydrologic Unit 909, Lower Sweetwater Hydrologic area(909.10) and La Nacion Hydrologic Sub area (909.12) defined in the California Regional Water Quality Control Board's Water Quality Control Plan for the San Diego Basin (9). The waterbody downstream of the project is the Sweetwater River. Sweetwater River is located approximately 4 miles downstream from our project. Sweetwater River discharges its water to the San Diego Bay which is listed on the 303(d) list as an impaired body by bacteria indicators caused by Urban Runoff, Storm Sewers, Marinas, boatyards, boat discharges and Vessel Wastes. San Diego Bay is located approximately 12 miles downstream from our project.

Sweetwater watershed has an area of about 230 square miles. The site consists of 5.71 acres of developed land, representing approximately 2.48% of the watershed.

Existing beneficial uses of inland surface waters for Spring Valley within the Sweetwater River basin are: Industrial Service Supply (IND), Non-contact Water Recreation (REC2), Warm Freshwater Habitat (WARM) and Wildlife Habitat (WILD). Potential beneficial use is Contact Water Recreation (REC1). Surface waters for Spring Valley are exempted from the municipal use designation (MUN).

Beneficial uses of groundwater within the La Nacion Hydrologic Sub area (909.12) are: Municipal and Domestic Supply (MUN), Agricultural Supply (AGR) and Industrial Service Supply (IND).

2. POTENTIAL EFFECTS TO THE WATER QUALITY ENVIRONMENT

2.1 Surface Waters

The following is a list of anticipated pollutants generated by the proposed project:

- Trash and Debris
- Oil and Grease
- Bacteria & Viruses
- Pesticides

Because landscaping exists on-site, potential pollutants are:

- Sediments
- Nutrients
- Oxygen Demanding Substances

Site BMP's have been chosen to mitigate for these particular pollutants. Refer to Section 4 for BMP descriptions.

2.2 Groundwater

As with most development projects, minor amounts of runoff may be infiltrated and enter the groundwater during sheet flow.

3. CHARACTERIZATION OF PROJECT RUNOFF

3.1 Storm Water Quality at Outfall

This project seeks to preserve the water quality of the existing downstream storm drain system through site design BMP's , sourse control BMP's and Treatment control BMP's.

3.2 Tributary Drainage Area to Outfall

Most of the site area drains into the Kenwood Drive, where runoff is concentrated in the existing grass-asphalt concrete pavement swale and then is channeled to an inlet by flowing along the existing curb. A concentrated flow is located west of the property and one more is located north of the property as shown on figure 1-3 and figure 1-4. Remain areas discharges into adjacent properties via sheet flows.

3.3 Site Hydrology

The Rational Method was used to compute the pre-developed and post-developed peak flows (Q_{100}). Tree systems has been analyzed, refer to appendix B for hydrologic calculations. Table 1-1 and Table 1-2 from appendix B shows a summary of pre-development and post-development runoff parameters respectively. The runoff produced from the proposed conditions is more than the existing site runoff; this is due to the increase of impervious area, as shown in Table 3-1. Because small increments are expected for the post-development condition it is for this reason that the new development is not anticipated to cause significant impacts downstream.

Table 3.1:

Node*	Q_{100} (cfs)		Net increment(+)	% Incremented(+)/
	Pre-Developed	Post-Developed	Net decrement (-)	Decremented (-)
2	12.15	11.90	-0.25	-2.1%
4	2.16	2.22	+0.06	+2.8%
6	1.30	1.14	-0.16	-14.0%

* Refer to Pre-Developed (figure 1-2) and Proposed Hydrology Map (figure 1-3)

Mitigation measures to minimize the possible erosion are further discussed in Section 4 of this report.

3.4 Water Quality Design Flow Based on Water Quality Design Storm

The rational method was used to compute the water quality design flow. Using a rainfall intensity of 0.2 inch of rainfall per hour. The water quality design flow was calculated as Q= 0.08 cfs, refer to appendix C for calculations.

3.5 Adjacent Land Use

Land use surrounding the project site consists of medium density residential.

3.6 Soil Characteristics

The soils on this site are sandy-loam with severe erodibility and moderate limitations for conversions from brush to grass. Hydrologic soil type is classified as 'C' as shown on appendix A-1 and A-2, taken from the soil survey of the San Diego Area, California, United States Department of Agriculture, soil conservation service, issued December 1973.

3.7 Conditions of Concern

Based on the soil characteristics and existing site grades, slope erosion has been identified as a Condition of Concern for this project. Because erosion of the downstream slopes is a concern, grass swale has been proposed to slow runoff velocities of post-developed flows. Post-development peak runoff flow rates and velocities from the project were analyses and were found that there is no significant increase in flow rates and velocities. Because no directly connected impervious areas are proposed and existing and proposed slopes are well vegetated, project site will not cause a significant increase in downstream erosion.

4. MITIGATION MEASURES TO PROTECT WATER QUALITY

4.1 Site Design and Source Control BMP'S

Site Design BMP's

Site design BMP's that have been incorporated in the project design are:

- Conserve existing trees and vegetation.
- Two-story buildings are proposed to minimize impervious footprint.
- Impervious areas are not directly connected to a storm drain system.
- Directly connected areas are not proposed

Source Control BMP's

Source control BMP's that have been incorporated into the project design are:

- Area disturbed by project development shall be landscaped with deep rooted, drought tolerant plant species for erosion control with efficient Irrigation System.

4.2 Structural Treatment BMP'S

The following post-construction treatment BMP is proposed for this project:

Bio filtration Swale:
The post-construction BMP proposed is a vegetative or Bio-filtration Swale. The design is shown in appendix C. Figure 1-5 is the Post-construction BMP Map that shows the location of the proposed BMPs.

Benefits:
-Easy to maintain
-Easy and Inexpensive to install
-Storm water pollution filtration and treatment
-Vegetation will blend into any landscaping

The swale vegetation type will be non-native grasses. The implementation of the above described post construction BMP shall serve to reduce, to the maximum extend practicable, the introduction of site generated pollutants into the storm water discharge from the subject property.

Level of Pollutant Effectiveness:

The following table shows the level of removal efficiency of the bio filtration swale, for the identified Pollutants of Concern (see Section 2):

Pollutants of Concern:	Bio filtration Swale:
Trash and Debris	Low
Oil and Grease	Low
Bacteria and Viruses	Unknown
Pesticides	Unknown
Sediment	Medium
Nutrients	Low
Oxygen Demanding Substances	Low

Ripraps

Ripraps are proposed as energy dissipaters at the outlet of concrete ditches. This is a lining of heavy rocks covering the vulnerable ground to protect the ground surface and slow the discharging velocity at the same time. These devices are considered as erosion prevention BMPs and do not contribute significantly on pollutants removal.

5. MAINTENANCE STORMWATER MANAGEMENT PROGRAM

5.1 Maintenance Responsibility

The property owner will be required to maintain the BMP described herein, in perpetuity, per the County Stormwater Standards Manual. The mechanism to ensure the long-term maintenance of these BMPs shall be in place prior to building occupancy.

The estimated cost for the structural BMP maintenance is:

- Bio filtration Swale: $400/year
- Riprap: $150/year

5.2 Maintenance Activities per BMP's

The following is a list of permanent site BMP's, which will require maintenance and the maintenance activities needed for each item:

Bio filtration Swale:					
Preventative Maintenance and Routine Inspection					
Routine Action	Maintenance Indicator	Field Measurement	Measurement Frequency	Maintenance Activity	Site-Specific Requirements
Mowing	grass too high	>6" grass height	2-3 weeks (summer) 1-2 mos. (winter)	Conventional lawn-mowing	N/A
Clearing Sediment Debris and Trash	Sediment Debris and Trash accumulation	visual	When needed	Clean up	N/A
Irrigating	Grass is brown.	visual	visual	Watering or irrigating	N/A

Riprap:

Maintenance and inspection.

- Inspect temporary measures prior to the rainy season, after rainfall events, and regularly (approximately once per week during rainy season.
- Inspect apron for displacement of the riprap and/or damage to the underlying fabric. Replace fabric and replace riprap which was washed away.
- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices shall be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

5.3 Mechanism to Assure Maintenance:

The proposed BMPs fit into the first category. The county should have minimal concern for ongoing maintenance. Property owners will maintain the BMPs as an incident of taking

The proposed mechanisms to assure maintenance are as follows:

1. The Stormwater Ordinance Requirement [section 67.819(a) & (b)]: The County of San Diego Watershed Protection, Stormwater Management, and Discharge Control Ordinance (S.O.) requires this ongoing maintenance. In the event that the mechanism below prove ineffective, or in addition to enforcing those mechanism, civil action, criminal action or administrative citation could also be pursued for violations of the ordinance.
2. Public Nuisance Abatement: Under the Stormwater Ordinance failure to maintain a BMP would constitute a public nuisance, which may be abated under the Uniform Public Nuisance Abatement Procedure. This provides an enforcement mechanism additional to the above, and would allow costs of maintenance to be billed to the owner, a lien placed on the property, and the tax collection process to be used.
3. Notice to Purchasers. Section 67.819(e) of the SO requires developers to provide clear written notification to persons acquiring land upon which a BMP is located, or others assuming a BMP maintenance obligation, of the maintenance duty.
4. Conditions in Ongoing Land Use Permits: For those applications (listed in SO Section 67.804) upon whose approval ongoing conditions may be imposed, a condition will be added which requires the owner of the land upon which the stormwater facility is located to maintain that facility in accordance with the requirements specified in the SMP. Failure to perform maintenance may then be addressed as a violation of the permit, under the ordinance governing that permit process.
5. Subdivision Public Report: Tentative Map and Tentative Parcel Map approvals will be conditioned to require that, prior to approval of a Final or Parcel Map, the subdivider shall provide evidence to the Director of Public Works, that the subdivider has requested the California Department of Real Estate to include in the public report to be issued for the sales of lots within the subdivision, a notification regarding the maintenance requirement. (The requirement for this condition would not be applicable to subdivisions which are exempt from regulation under the Subdivided Lands Act, or for which no public report will be issued.)

5.4 Funding:

Funding is not necessary for BMPs that fit the first category.

6. REFERENCES

A. County Ordinance No. 9424 (N.S.) AN ORDINANCE AMENDING THE COUNTY CODE OF REGULATORY ORDINANCES RELATING TO STORMWATER REGULATION

B. County of San Diego STORMWATER STANDARDS MANUAL

C. Los Angeles County STANDARD URBAN STORMWATER MITIGATION PLAN MANUAL

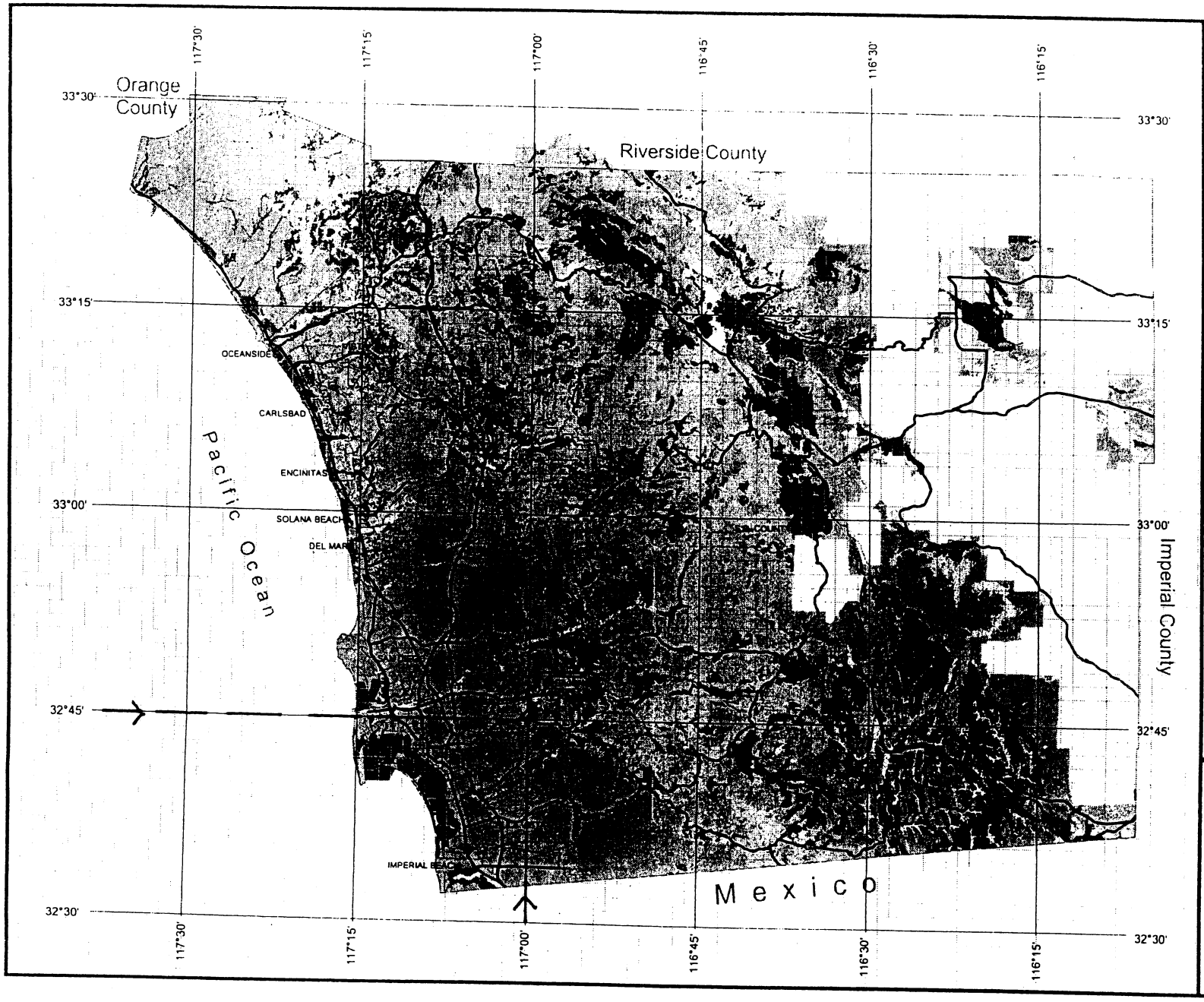
D. California Stormwater Quality Association CALIFORNIA STORMWATER BMP HANDBOOK

E. King County, Washington SURFACE WATER DESIGN MANUAL

F. U.S Environmental Protection Agency website

APPENDIX A

HYDROLOGY MAPS



County of San Diego Hydrology Manual

Soil Hydrologic Groups

Legend

Soil Groups

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

32° 45' 1.39"
117° 00' 22.56"
SOIL GROUP 'C'

DPW GIS

SanGIS

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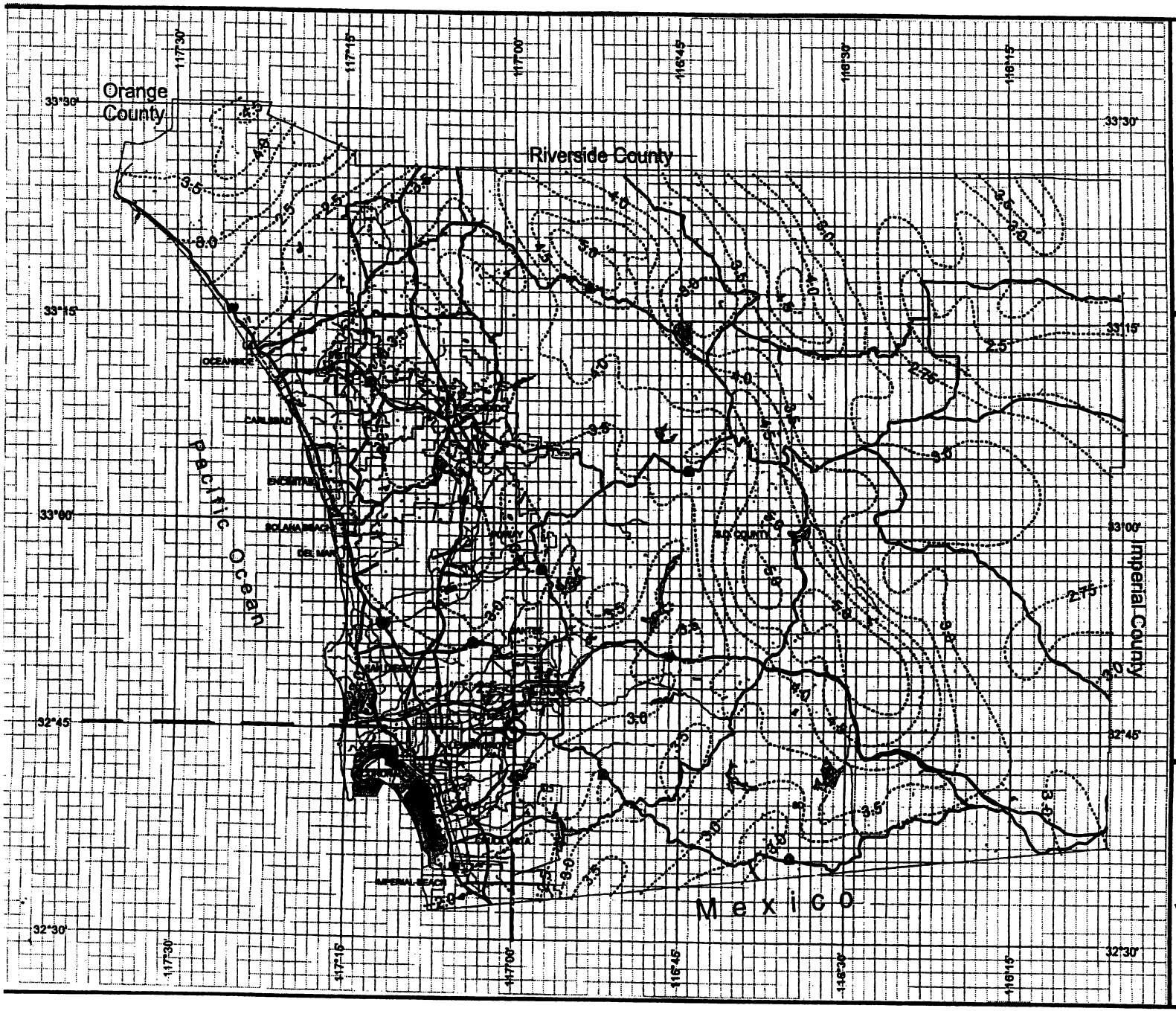
N W E S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

32° 45' 1.39"
117° 00' 22.56"
P_6 = 2.75 inches

DPW GIS
Department of Public Works Geographic Information Services

SanGIS
We Have San Diego Covered!

N
W E
S

3 0 3 Miles

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APPENDIX B

HYDROLOGY CALCULATIONS

PRE-DEVELOPMENT CONDITIONS.

Figure 1-2 shows the pre-development hydrology map for this site.

System 1:

Runoff coefficient is calculated using the following formula:

$$C = 0.90 \times (\%\ \text{Impervious}) + C_p \times (1 - \%\ \text{Impervious})$$

$C_p = 0.30$ from table 3-1 (Soil type "C")

$$\%\ \text{Impervious} = \frac{\text{Imp. Area}}{\text{Tot. Area}} \times 100\% = \frac{2.423}{3.38} \times 100\% = 7.$$

$$C = (0.90 \times 0.7169) + (0.30\ (1 - .7169))$$

$$C = 0.73$$

Area, $A_{1-2} = 3.38$ acres

$$CA = (0.73)(3.38)$$

$$CA = 2.47$$

$L = 855'$ (use 100' max. length for neighborhood Comerci per table 3-2 of the Hydrology Manual)

$\Delta E = 589.7 - 538.25 = 51.45$ feet

$S = \Delta E / L = 6\%$

From Figure 3-3 of the Hydrology Manual, $T_i = 5.5$ minutes for the initial 100' travel length.

Because the area is a neighborhood commercial in wich impervious areas are not directly connected to a storm drain system, we are using the Kirpich formula (Figure 3-4 of the Hydrology Manual) to determine the travel time T_t across the

remaining 755' of length in the area

From Figure 3-4 of the Hydrology Manual, $T_t = 3.6$ minut

Total time of concentration = 5.5 + 3.6

$T_{c_{1-2}} = 9.1$ minutes

Using figure 3-1 of the Hydrology Manual to determine "I".

$I_{1-2} = 4.92$ in/hr

Peak Discharge flow rate for the area is computed using the rational formula, for the 100-year frequency storm:

$$Q = (CA)I$$
$$Q = (2.47)(4.92)$$
$$Q = 12.15 \text{ cfs}$$

SYSTEM 2:

Runoff coefficient is calculated using the following formula:

$$C = 0.90 \times (\% \text{ Impervious}) + C_p \times (1 - \% \text{ Impervious})$$

$C_p = 0.30$ from table 3-1 (Soil type C)

$$\% \text{ Impervious} = \frac{\text{Imp. Area}}{\text{Tot. Area}} \times 100\% = \frac{0.36 \text{ ac}}{0.58 \text{ ac}} \times 100\% = 62\%$$

$$C = (0.90 \times 0.62) + 0.30 \times (1 - 0.62)$$

$$C = 0.67$$

Area, $A_{3-4} = 0.58$ acres

$CA = 0.67 \times 0.58$

$CA = 0.39$

$L = 326'$ (use 100' max. length for neighborhood commercial per Table 3-2)

$\Delta E = 590 - 559 = 31$ feet

$S = \Delta E / L = 9.5\%$

From figure 3-3 of the Hydrology Manual, $T_i = 6.4$ for the initial 100' travel length.

Because the area is neighborhood commercial in wich impervious areas are not directly connected to a storm drain system, we are using the Kirpich formula (figure 3-4 of the Hydrology Manual) to determine the travel time T_t across the remain 226' of length in the area.

From figure 3-4, $T_t = \left(\frac{11.9\ L^3}{\Delta E}\right)^{0.385}$

$L = 226' = 0.0428$ miles
$\Delta E = 30.3'$ } $T_t = 0.01833$ hours $= 1.10$ minu

Then $T_c = T_i + T_t = 6.45 + 1.10$

$T_{c_{3-4}} = 7.55$ minutes

Using figure 3-1 of the Hydrology Manual to determine "I".

$I_{3-4} = 5.55$ in/hr

Peak Discharge flow rate for the area is computed using the rational formula, for the 100-year frequency storm:

$$Q = (CA)\,I$$
$$Q = (0.39)\,(5.55)$$
$$\underline{Q = 2.16 \text{ cfs}}$$

SYSTEM 3.

Runoff coefficient is calculated using the following formula:

$$C = 0.90 \times (\%\ \text{Impervious}) + C_p \times (1 - \%\ \text{Impervi}$$

$C_p = 0.30$ from Table 3-1 (Soil Typ

$$\%\ \text{Imperv.} = \frac{\text{Impr. Area}}{\text{Tot. Area}} \times 100\% = \frac{0.19}{0.46} = 0.41$$

$$C = (0.90 \times 0.41) + 0.30 \times (1 - 0.41)$$
$$\underline{C = 0.55}$$

Area, $\underline{A_{5-6} = 0.46 \text{ acres}}$

$$CA = 0.55 \times 0.46$$
$$CA = 0.25$$

$L = 210'$ (use 100' max. lenght for neighborhoo commertial per table 3-2)

$$AE = 579 - 565.3 = 13.70 \text{ feet}$$

$$s = \frac{AE}{L} = 6.5\%$$

From figure 3-3 of the Hydrology Manual, $T_i = 7.45$ for the initial 100' travel length

Because the area is neighborhood commertial in wich impervious areas are not directly connected to a storm drain system, we are using the Kirpich formula (figure 3-4 of the Hydrology Manu to determine the travel time Tt across the remaining 110' of length in the area.

From figure 3-4, $T_t = \left(\frac{11.9\ L^3}{\Delta E}\right)^{0.385}$

$L = 110' = 0.02$

$\Delta E = 5.45'$

$T_t = 0.93$ minutes

Then $T_c = T_i + T_t = 7.45 + 0.93$

$T_c = 8.38$

Using figure 3-1 of the Hydrology Manual to determine "I".

$I_{5-6} = 5.19$ in/hr

Peak Discharge flow rate is computed using the rational formula, for the 100yea frequency storm:

$Q = (CA)I$

$Q = (0.25)(5.19)$

$Q = 1.30$ cfs

POST- DEVELOPMENT CONDITIONS

Figure 1-3 shows the post-development hydrology map for this site.

SYSTEM 1.

Runoff coefficient is calculated using the following formula:

$$C = 0.90 \times (\%\ Imperv.) + C_p \times (1 - \%\ Imperv.)$$

$C_p = 0.30$ from table 3-1 (Soil type C)

$$\%\ Impervious = \frac{Imprv.\ Area}{Tot.\ Area} \times 100 = \frac{\cancel{2.46}\ 2.48}{\cancel{3.38}\ 3.42} \times 100 = \cancel{72.78}\ 72.5\%$$

$$C = 0.90 \times (\cancel{0.7278}\ 0.725) + 0.30 \times (1 - 0.71)$$

$$C = 0.65 + 0.082$$

$$C = \cancel{0.74}\ 0.73$$

Area $A_{1-2} = \cancel{3.38}\ 3.42$ acres

$$CA = \cancel{0.74}\ 0.73 \times \cancel{3.38}\ 3.42$$

$$CA = 2.50$$

$L = \cancel{855'}\ 938'$ ~~(using 100' max. length per Table 3-2)~~

$$\Delta E = \cancel{589.7}\ 591.45 - 538.25 = \cancel{51.45}\ 53.20 \text{ feet.}$$

$$S = \Delta E / L = \cancel{6\%}\ 5.67\%$$

From figure 3-3 of the Hydrology Manual, $T_i = 5.5$ minutes for the initial 100' travel length.

Because impervious areas are not directly connected to a storm drain system, we will use the Kirpich formula to determine the travel time T_t across the remaining ~~755'~~ 838' of length in the area.

From figure 3-4 of the Hydrology Manual, $T_t = \cancel{3.6}\ 4.1$ minu

$T_c = T_i + T_t = 5.5 + 4.1$

$T_{c_{1-2}} = \cancel{9.1}\ 9.6$ minutes

Using figure 3-1 of the Hydrology Manual to determine "I".

$I_{1-2} = \cancel{4.92}\ 4.76$ in/hr

Peak Discharge flow rate is computed using the rational formula, for the 100-year frequency storm:

$Q = (CA)I$

$Q = (2.5)(\cancel{4.92}\ 4.76)$

$Q = \cancel{12.30}$ cfs

11.90 cfs

SYSTEM 2:

Runoff coefficient is calculated using the following fomula:

$C = 0.90 \times (\%\ \text{Impervi.}) + C_p \times (1 - \%\ \text{Impervi.})$

$C_p = 0.30$ from Table 3-1 (Soil type C

$\%\ \text{Impervious} = \frac{\text{Imprv. Area}}{\text{Tot. Area}} \times 100 = \frac{\cancel{0.41}\ 0.30\text{ac}}{0.58\text{ac}} \times 100 = \cancel{70.}\ 0.$

$C = (0.90 \times \cancel{0.7069}\ 0.65) + 0.30(1 - \cancel{0.7069}\ 0.65)$

$\cancel{.587}$ $+ 0.105$

$C = \cancel{0.72}\ 0.69$

Area, $A_{3-4} = 0.58$ ac. ✓

$CA = \cancel{0.72}\ 0.69 \times 0.58$

$CA = \cancel{0.42}\ 0.40$

$L = 326'$ (using 100' max. length per Table 3-2)

$\Delta E = 51.45'$

$S = 6\%$

From figure 3-3 of the Hydrology Manual, $T_i = 6.4$ minutes for the initial 100' travel length.

Because impervious areas are not directly connected to a storm drain system, we will use the Kirpich formula to determine the travel time T_t across the remaining 226' of length in the area.

From figure 3-4, $T_t = \left(\frac{11.9\ L^3}{\Delta E}\right)^{0.385}$

$T_t = 1.10$ minutes.

Then $T_c = T_i + T_t = 6.45 + 1.10$

$T_{c_{3-4}} = 7.55$ minutes

Using figure 3-1 of the Hydrology Manual to determine I:

$I_{3-4} = 5.55$ in/hr

Peak Discharge flow rate for the 100-year frequency storm is;

$Q = (C\ A)\ I$

$Q = \cancel{(0.42)}\ 0.40\ (5.55)$

$Q = \cancel{2.33}$ cfs

2.22

SYSTEM 3.

Runoff coefficient is calculated using the following formula:

$$C = 0.90 \times (\%\,\text{Impervious}) + C_p \times (1 - \%\,\text{Impervious})$$

$C_p = 0.30$ from Table 3-1 (soil Type C)

$$\%\,\text{Imperv.} = \frac{\text{Imprv. Area}}{\text{Tot. Area}} \times 100 = \frac{\cancel{0.22}\ 0.16}{\cancel{0.48}\ 0.44} = \cancel{0.46}\ 0.3$$

$$C = (0.90 \times \cancel{0.46}\ 0.36) + 0.30 \times (1 - \cancel{0.46}\ 0.36)$$

$$\underline{C = \cancel{0.58}\ 0.51}$$

$0.32 + 0.19$

Area, $\underline{A_{S-6} = \cancel{0.48}\ 0.44 \text{ acres}}$

$$CA = \cancel{0.58} \times \cancel{0.48}$$

$$CA = \cancel{0.28}\ 0.22$$

0.51×0.44

$L = 210'$ (using 100' max. lenght per table 3-2)

$\Delta E = 13.70$ feet

$$s = \frac{\Delta E}{L} = 6.5\%$$

From figure 3-3 of the Hydrology Manual $T_i = 7.45$ minutes for the initial 100' travel length

Because impervious areas are not directly connected to a storm drain system, we will use the Kirpich formula to determine the travel time (T_t) acros the remaining 110' of length in the area.

From figure 3-4, $T_t = \left(\frac{11.9\ L^3}{\Delta E}\right)^{0.385}$

$\underline{T_t = 0.93 \text{ minutes}}$

Then $T_c = T_i + T_t$

$T_c = 8.38$ minutes. ✓

Using figure 3-1 to determine "I":

$I_{5\text{-}6} = 5.19$ in/hr

Peak Discharge flow rate for the 100-year frequency storm is;

$$Q = (CA)\,I$$

$$Q = (\cancel{0.28}\ 0.22)(\cancel{5.19})$$

$$Q = \cancel{1.45}\ \text{cfs}$$

$$1.14\ \text{cfs.}$$

Table 1-1
Summary of runoff parameters computed for the *pre-developed* conditions.

node	A (acres)	C	A*C	Tc (min)	i (in/h)	Q (cfs)
Sytem 1						
1-2	3.38	0.73	2.47	9.10	4.92	12.15
Sytem 2						
3-4	0.58	0.67	0.39	7.55	5.55	2.16
Sytem 3						
5-6	0.46	0.55	0.25	8.38	5.19	1.30

Table 1-2
Summary of runoff parameters computed for the *post-developed* conditions.

node	A (acres)	C	A*C	Tc (min)	i (in/h)	Q (cfs)
Sytem 1						
1-2	3.42	0.73	2.50	9.60	4.76	11.90
Sytem 2						
3-4	0.58	0.69	0.40	7.55	5.55	2.22
Sytem 3						
5-6	0.44	0.51	0.22	8.38	5.19	1.14

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

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

All Channels Report

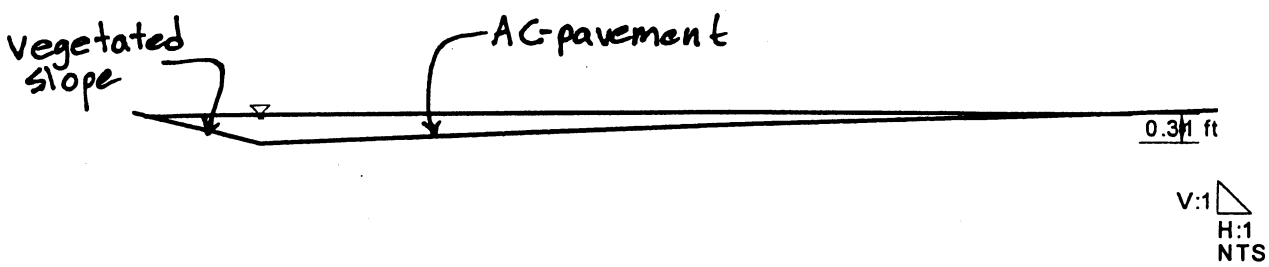
Label	Worksheet Type	Mannings Coefficient	Slope (ft/ft)	Depth (ft)	Left Side Slope (H : V)	Right Side Slope (H : V)	Bottom Width (ft)	Discharge (cfs)	Flow Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	. (ft)	Critical Depth (ft)	Critical Slope (ft/ft)	Velocity (ft/s)	Velocity Head (ft)	Specific Energy (ft)	Froude Number	Flow Type
Node-2 Post- Dev	Triangular	0.015	.070000	0.31	4.00	30.00		11.90	1.6	10.45	10.40		0.50	).005242	7.48	0.87	1.17	3.37	Supercritic:
Node-2 Pre-Dev	Triangular	0.015	.070000	0.31	4.00	30.00		12.15	1.6	10.53	10.48		0.50	).005228	7.52	0.88	1.19	3.37	Supercritic:
Node-4-Post Dev	Trapezoida	0.035	.200000	0.09	2.00	2.00	6.00	2.22	0.6	6.42	6.38		0.16	).033989	3.82	0.23	0.32	2.23	Supercritic:
Node-4 Pre-Dev	Triangular	0.030	.200000	0.39	2.00	2.00		2.16	0.3	1.76	1.58		0.59	).022839	6.96	0.75	1.15	2.77	Supercritic:
Node-6 Post-Dev	Triangular	0.035	.010000	0.44	4.00	4.00		1.14	0.8	3.59	3.48		0.35	).033317	1.51	0.04	0.47	0.57	Subcritical
Node-6 Pre-Dev	Triangular	0.035	.010000	0.46	4.00	4.00		1.30	0.8	3.77	3.66		0.37	).032739	1.56	0.04	0.49	0.57	Subcritical
Typical BMP-100yr	Trapezoida	0.035	.025000	0.32	2.00	2.00	2.00	2.22	0.8	3.43	3.28		0.30	).030201	2.63	0.11	0.43	0.92	Subcritical
Typical BMP-WQ	Trapezoida	0.035	.025000	0.05	2.00	2.00	2.00	0.08	0.1	2.21	2.18		0.04	).055105	0.83	0.01	0.06	0.70	Subcritical

Cross Section
Cross Section for Triangular Channel

Project Description	
Worksheet	Node-2 Pre-Development
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.015	
Slope	070000	ft/ft
Depth	0.31	ft
Left Side Slope	4.00	H : V
Right Side Slope	30.00	H : V
Discharge	12.15	cfs (100yr-storm)

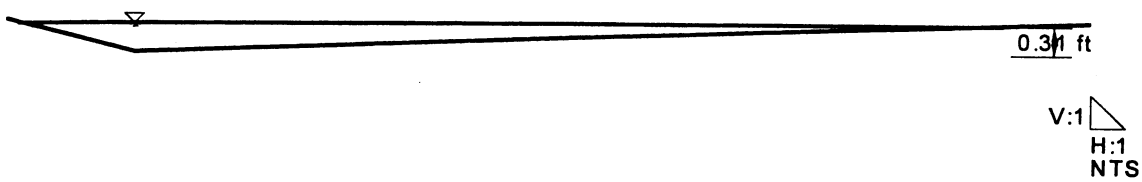
V = 7.52 Fps



Cross Section
Cross Section for Triangular Channel

Project Description	
Worksheet	Node-2 Post- Development
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.015	
Slope	070000	ft/ft
Depth	0.31	ft
Left Side Slope	4.00	H : V
Right Side Slope	30.00	H : V
Discharge	11.90	cfs

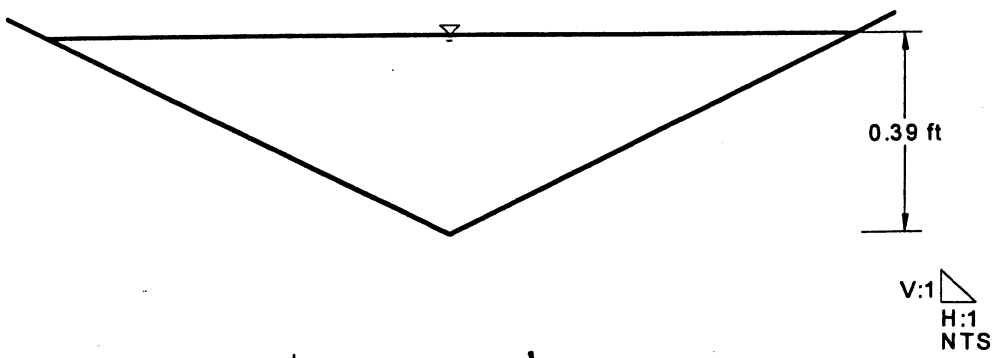


Cross Section
Cross Section for Triangular Channel

Project Description	
Worksheet	Node-4 Pre-Dev
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.030	
Slope	0.200000	ft/ft
Depth	0.39	ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Discharge	2.16	cfs

V = 6.96 fps

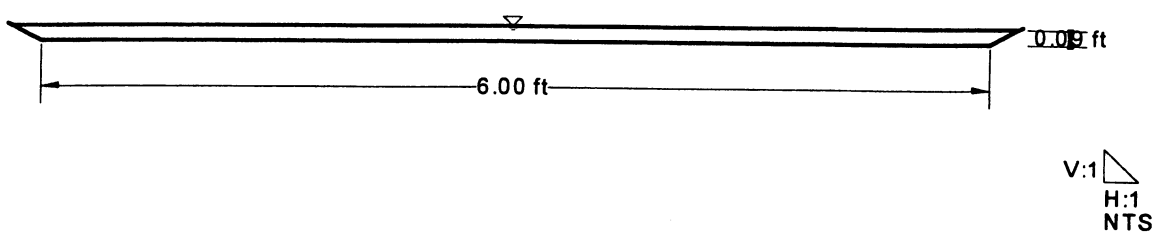


Dirt swale

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Node-4-Post Development
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.035	
Slope	200000	ft/ft
Depth	0.09	ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	6.00	ft
Discharge	2.22	cfs

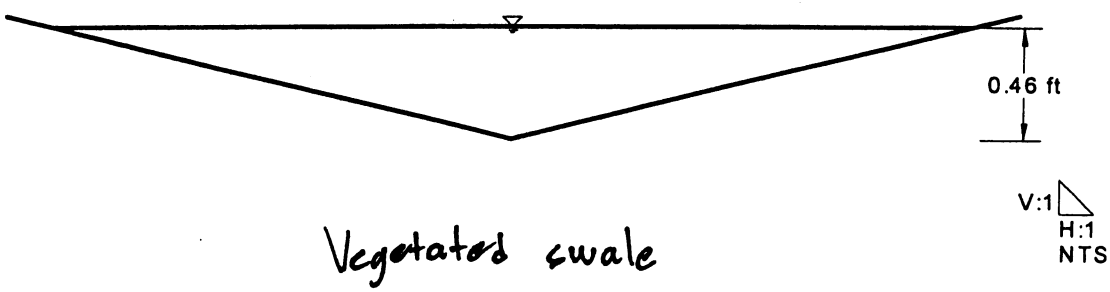


Cross Section
Cross Section for Triangular Channel

Project Description	
Worksheet	Node-6 Pre-Development
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.035	
Slope	0.010000	ft/ft
Depth	0.46	ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Discharge	1.30	cfs

V= 1.56 fps



Vegetated swale

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	Node-6 Post-Development.
Flow Element	Triangular Char
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.035	
Slope	010000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Discharge	1.14	cfs

Results		
Depth	0.44	ft
Flow Area	0.8	ft²
Wetted Perim	3.59	ft
Top Width	3.48	ft
Critical Depth	0.35	ft
Critical Slope	0.033317	ft/ft
Velocity	1.51	ft/s
Velocity Head	0.04	ft
Specific Energ	0.47	ft
Froude Numb	0.57	
Flow Type	Subcritical	

APPENDIX C

WATER QUALITY CALCULATIONS

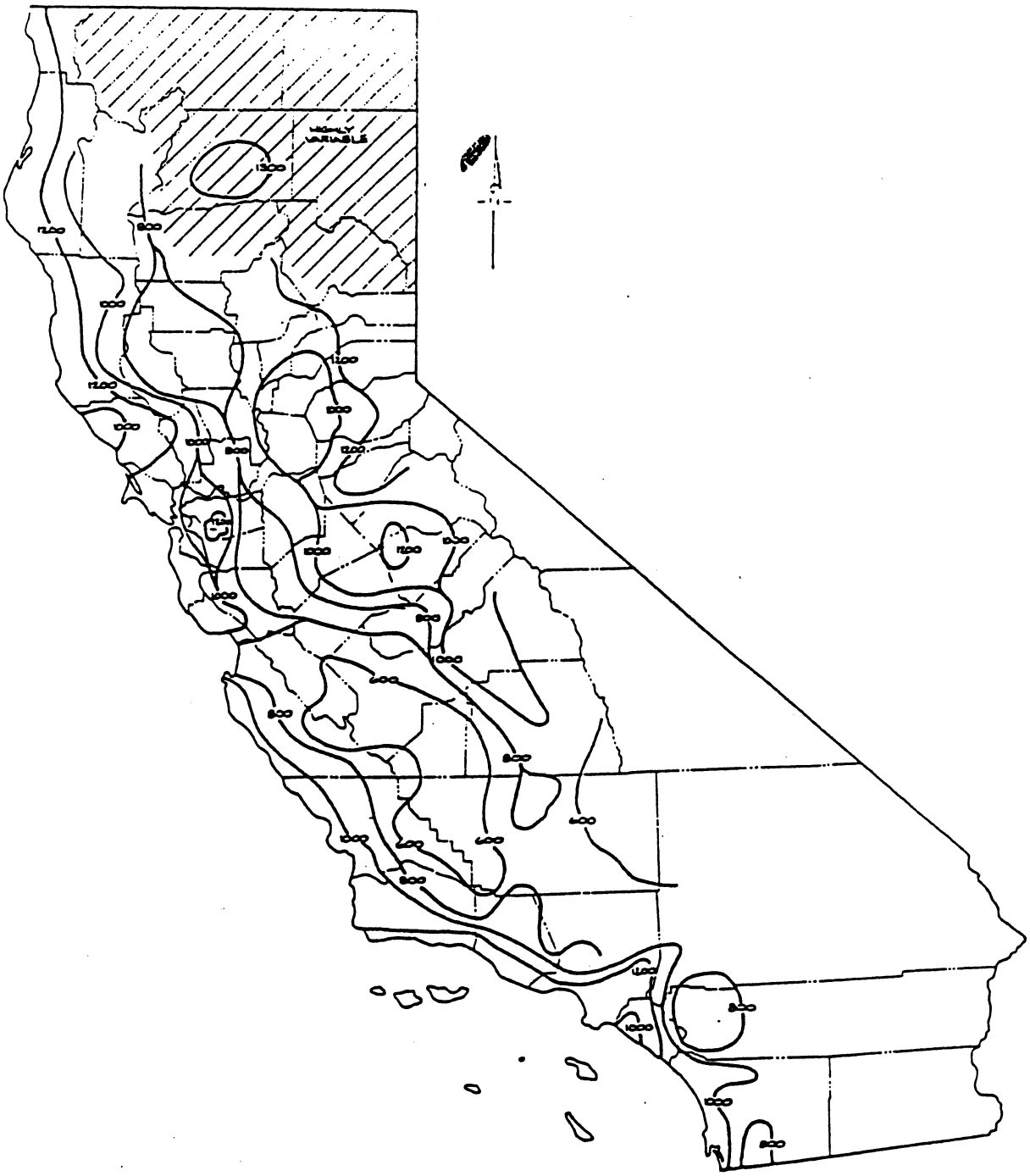


FIGURE 4A. SIZING GUIDELINE FOR BIOFILTERS (SQ. FT./IMPERVIOUS ACRE)

TC4

DATE _____ SHEET _____

ENGR _____ JOB NO _____

PROJECT

burkett & wong
structural & civil engineers

WATER QUALITY DESIGN FLOW
GRASS SWALE (BMP: Biofilter)
(TYPICAL SECTION)

The surface area is defined by Figure 4A, from the California Storm Water Best Management Practice Handbooks.

$$\left(900 \frac{sf}{\text{Imp. Acre}}\right)\left(\cancel{0.05}\ 0.02 \text{ acres of new impervious}\right) = 45\ sf$$

(More than 45 sf are proposed per drainage area).

The minimum width is determined by Manning's Equation.

$n = 0.035$

$s = \cancel{0.01}\ 0.025$

Flow Base Water Q. → $Q_{BMP} = (0.2)CA$

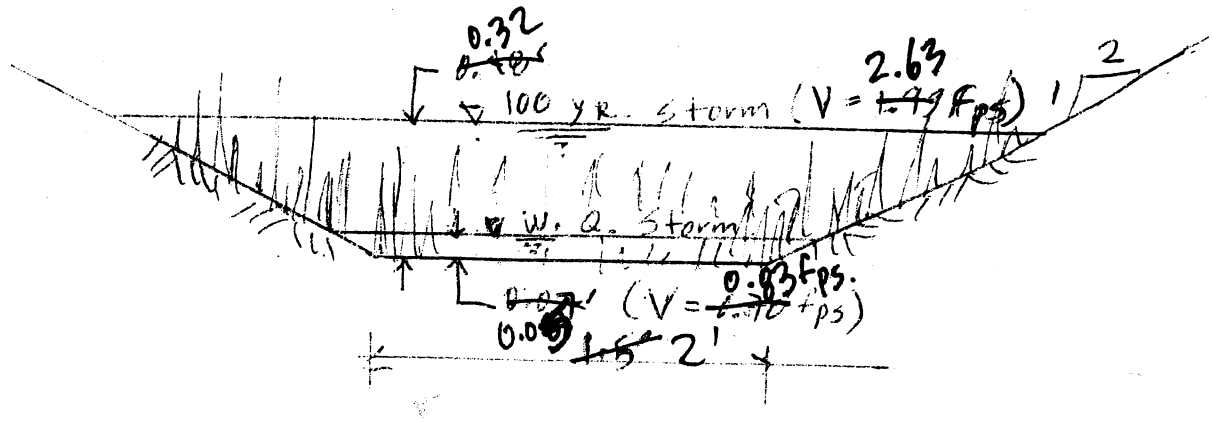
$Q_{BMP} = (0.2)(\cancel{0.74}\ 0.69)(0.58)$

$Q_{BMP} = \cancel{0.086}\ 0.08$ cfs.

$Q_{100} = \cancel{2.33}\ 2.22$ cfs.

Considering a 4" height grass depth of water must be below grass. **at the design treatment rate.**

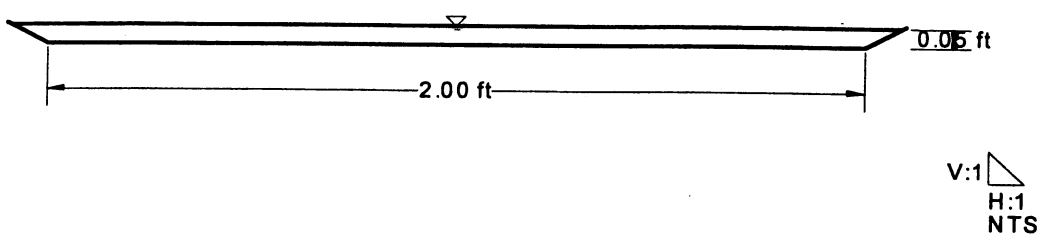
Solving Manning's Equation with Haestad Methods software see attached worksheets **on appx.**



Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Typical BMP-WQ
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

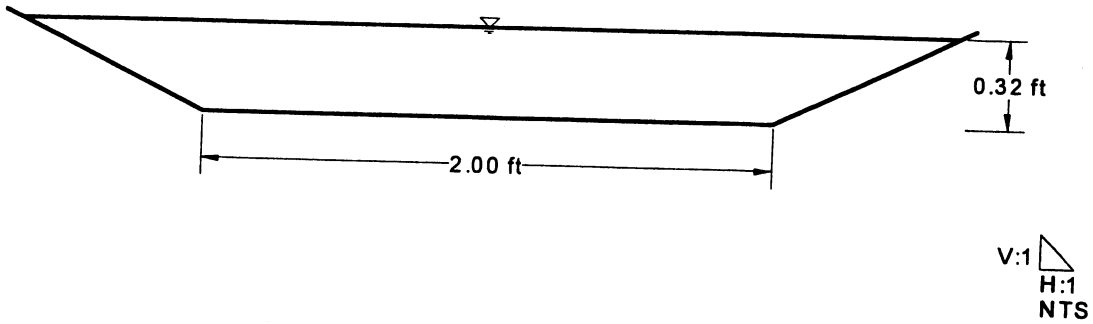
Section Data		
Mannings Coeffic	0.035	
Slope	025000	ft/ft
Depth	0.05	ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	0.08	cfs



Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Worksheet	Typical BMP-100 yr
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.035	
Slope	025000	ft/ft
Depth	0.32	ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	2.00	ft
Discharge	2.22	cfs



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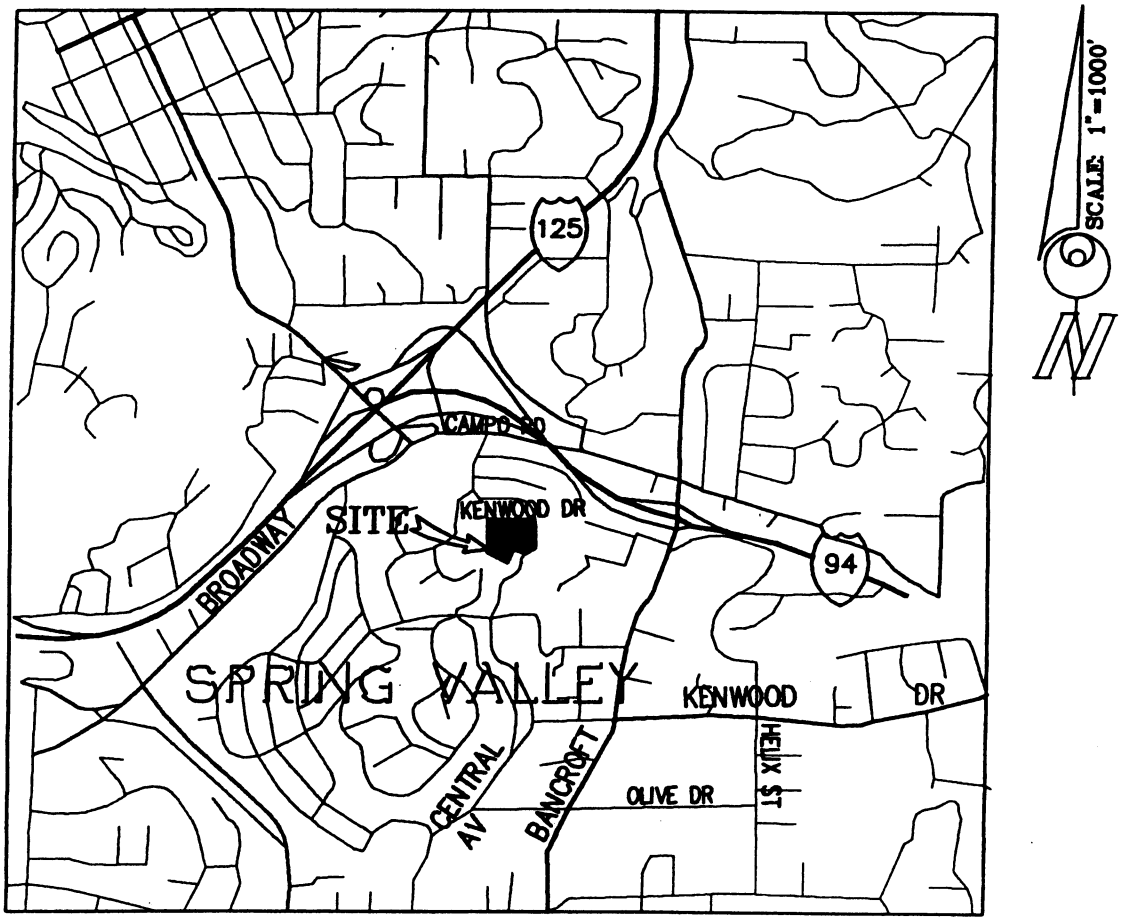
Burkett & Wong Engineers
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666
Project Engineer: Cesar Jimemez



VICINITY MAP

NOT TO SCALE

burkett & wong
engineers & surveyors
3434 fourth ave. san diego ca.
92103-5704 * (619) 299-5550

FIGURE 1-1

TRINITY PRESBYTARIAN CHURCH
VICINITY PLAN

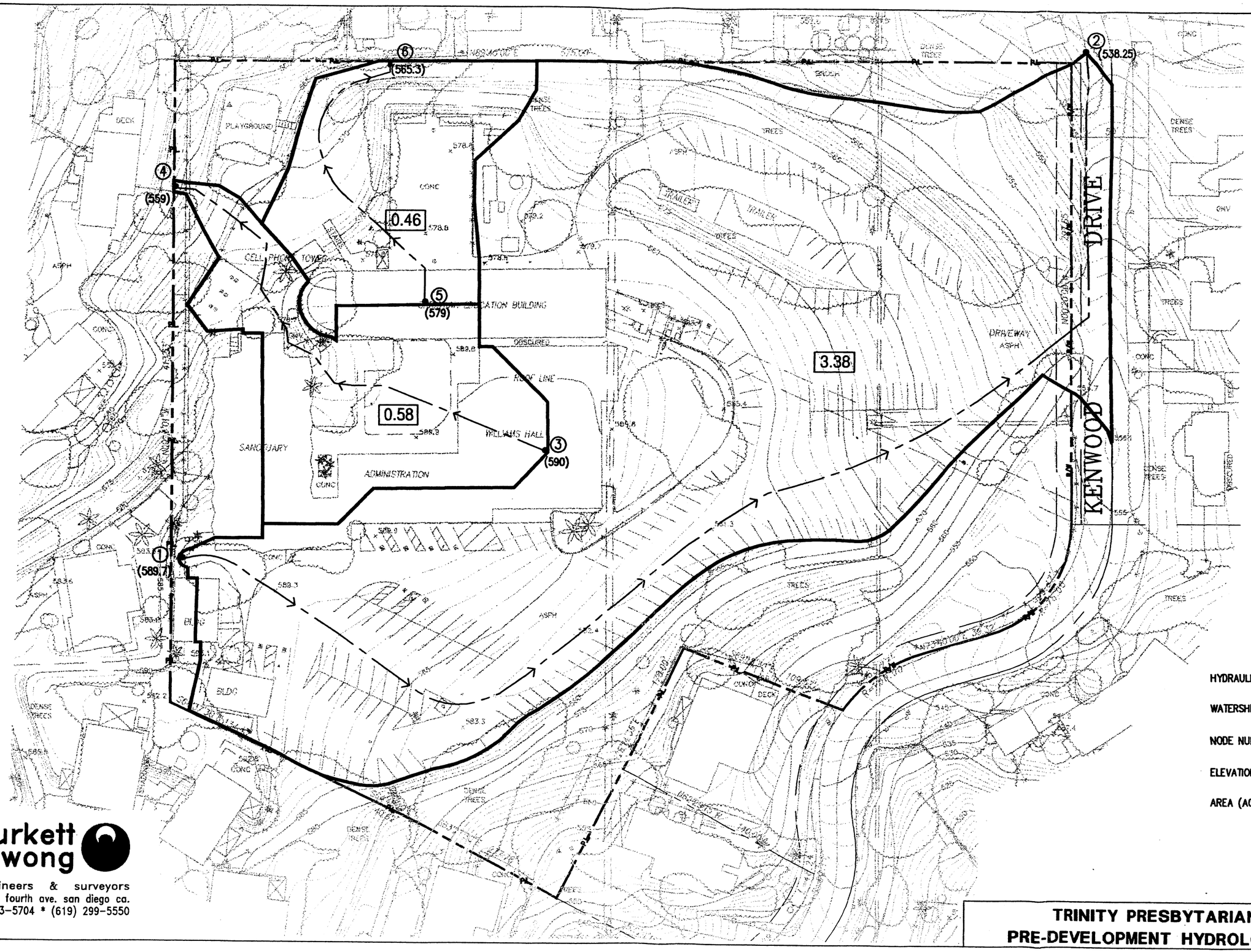


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FIGURE 1-2

TRINITY PRESBYTARIAN CHURCH
PRE-DEVELOPMENT HYDROLOGY PLAN

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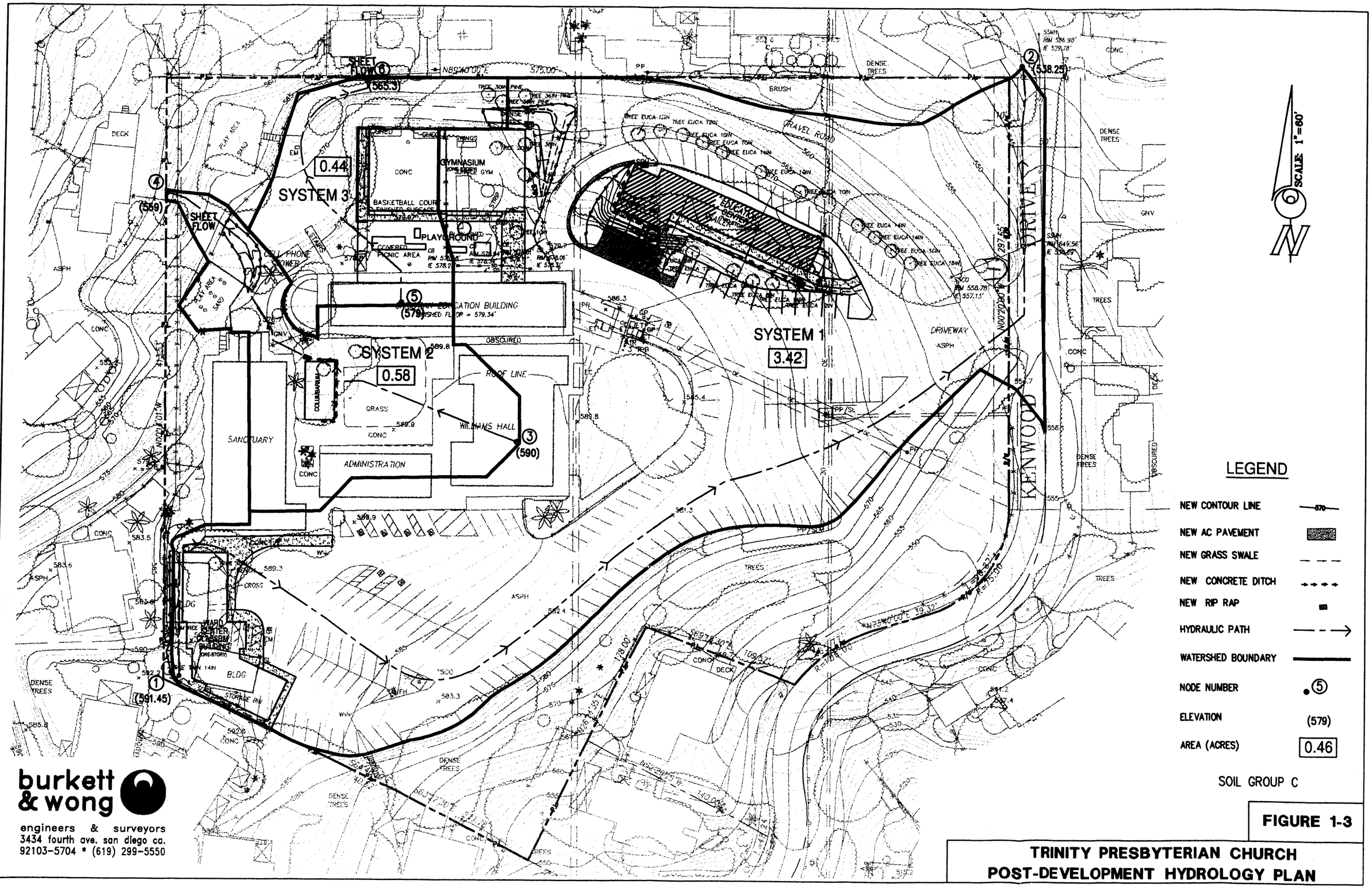

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FIGURE 1-3

TRINITY PRESBYTERIAN CHURCH
POST-DEVELOPMENT HYDROLOGY PLAN

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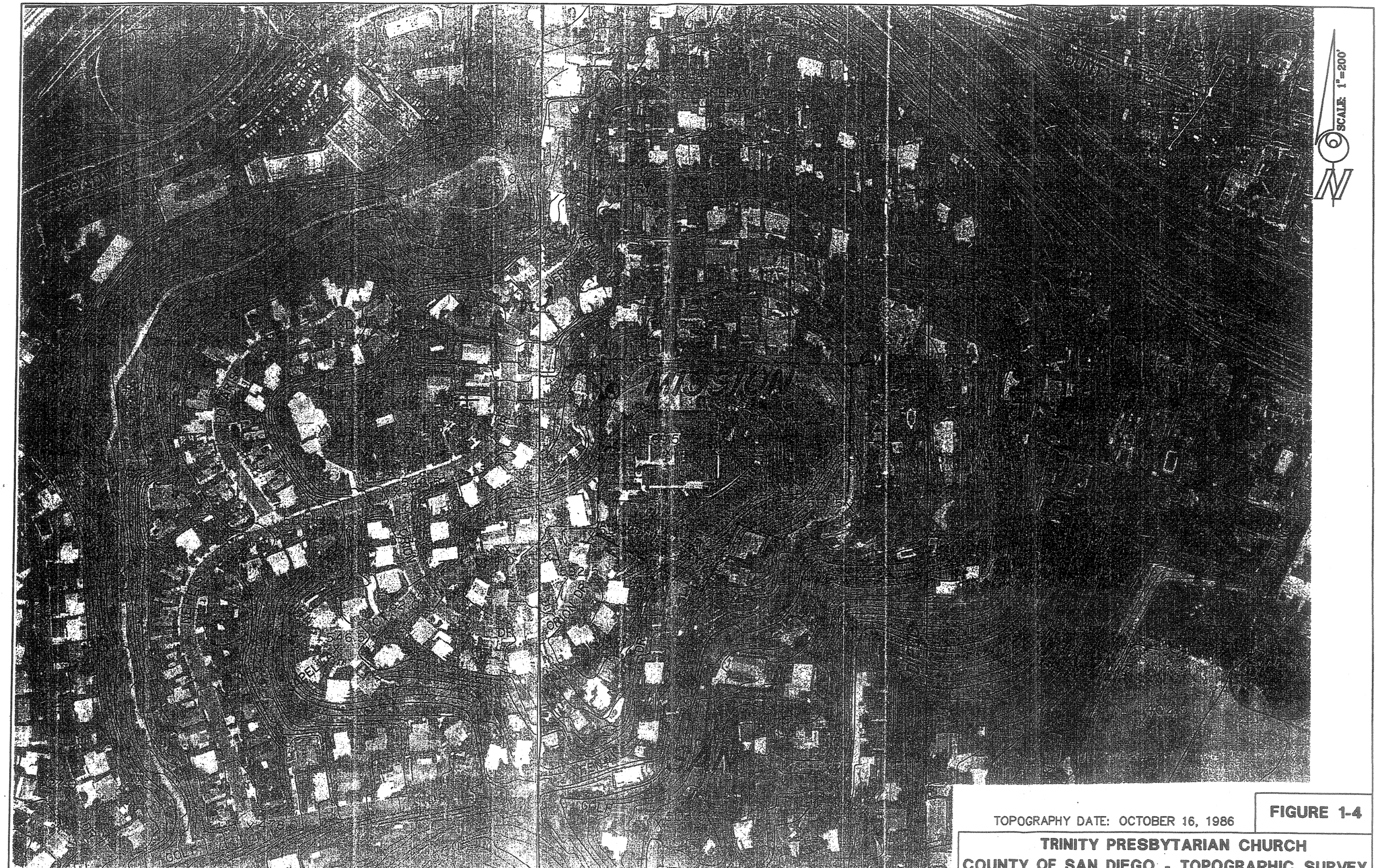
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N
MISSION
OAKVIEW DR
546.5
525
525
525

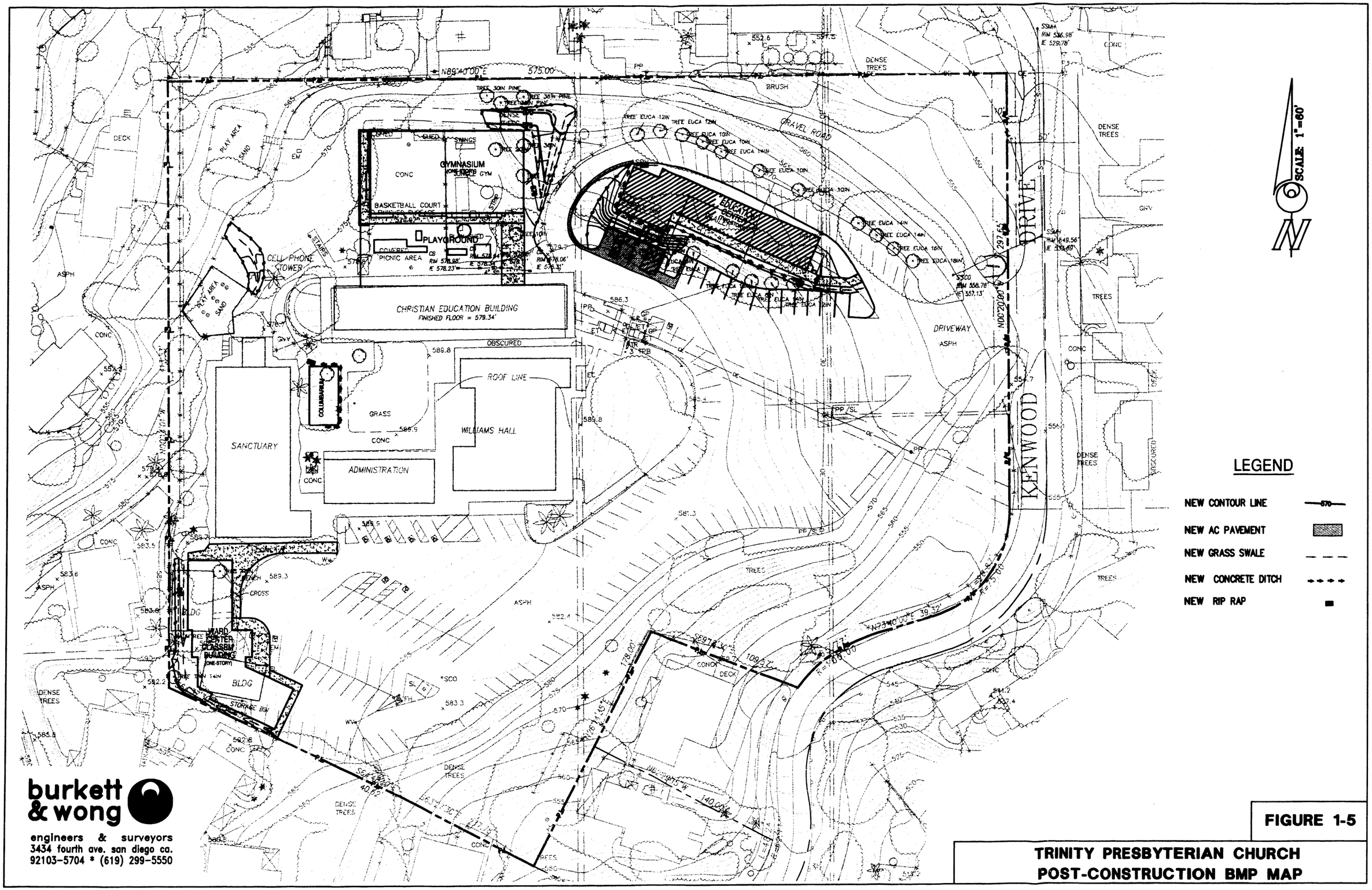

FIGURE 1-5

TRINITY PRESBYTERIAN CHURCH
POST-CONSTRUCTION BMP MAP

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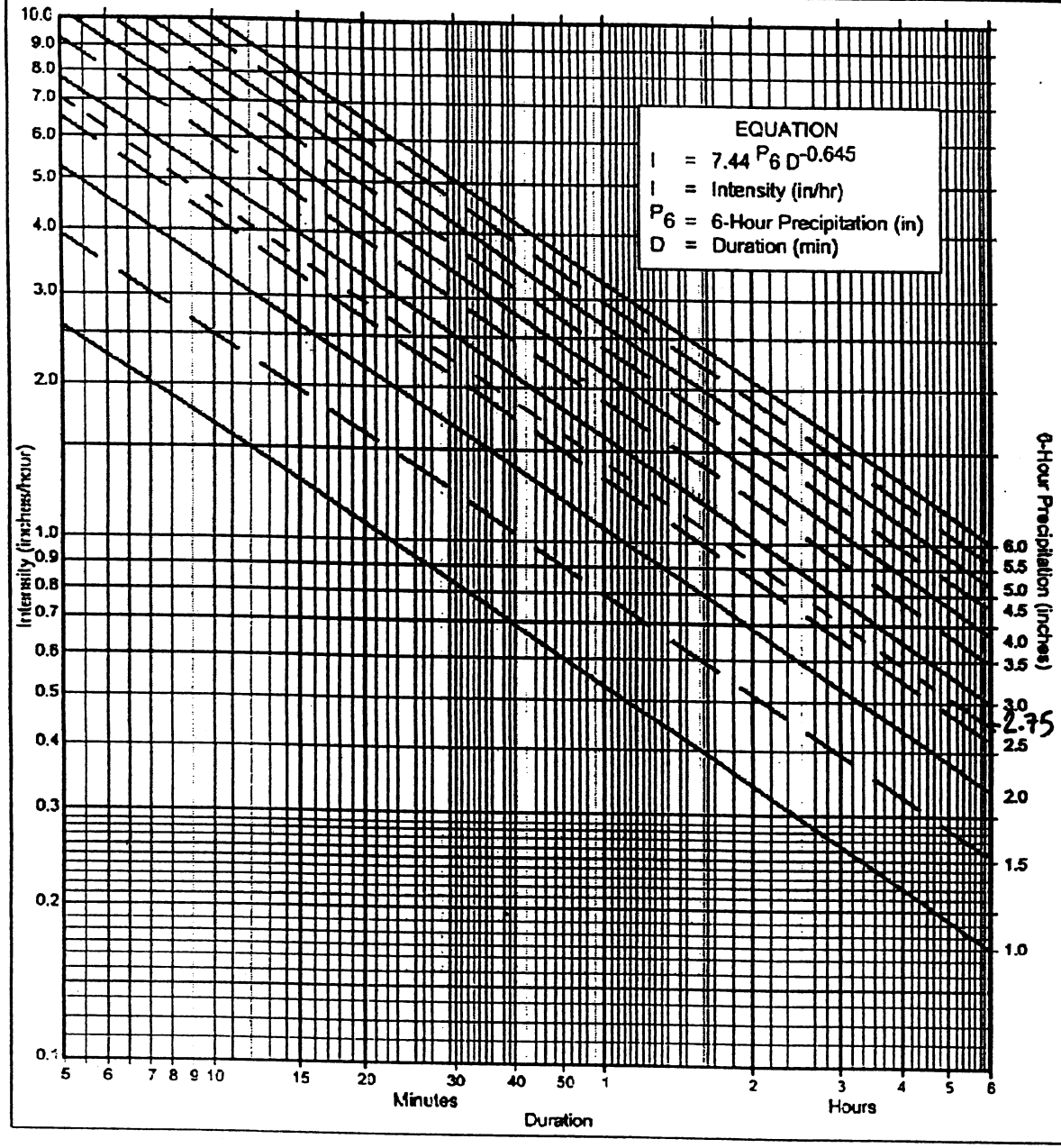


Directions for Application:

(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 = 2.75 in., P_{24} = 6 $\frac{P_6}{P_{24}}$ = 45.8 %(2)

(c) Adjusted P_6(2) = 2.75 in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

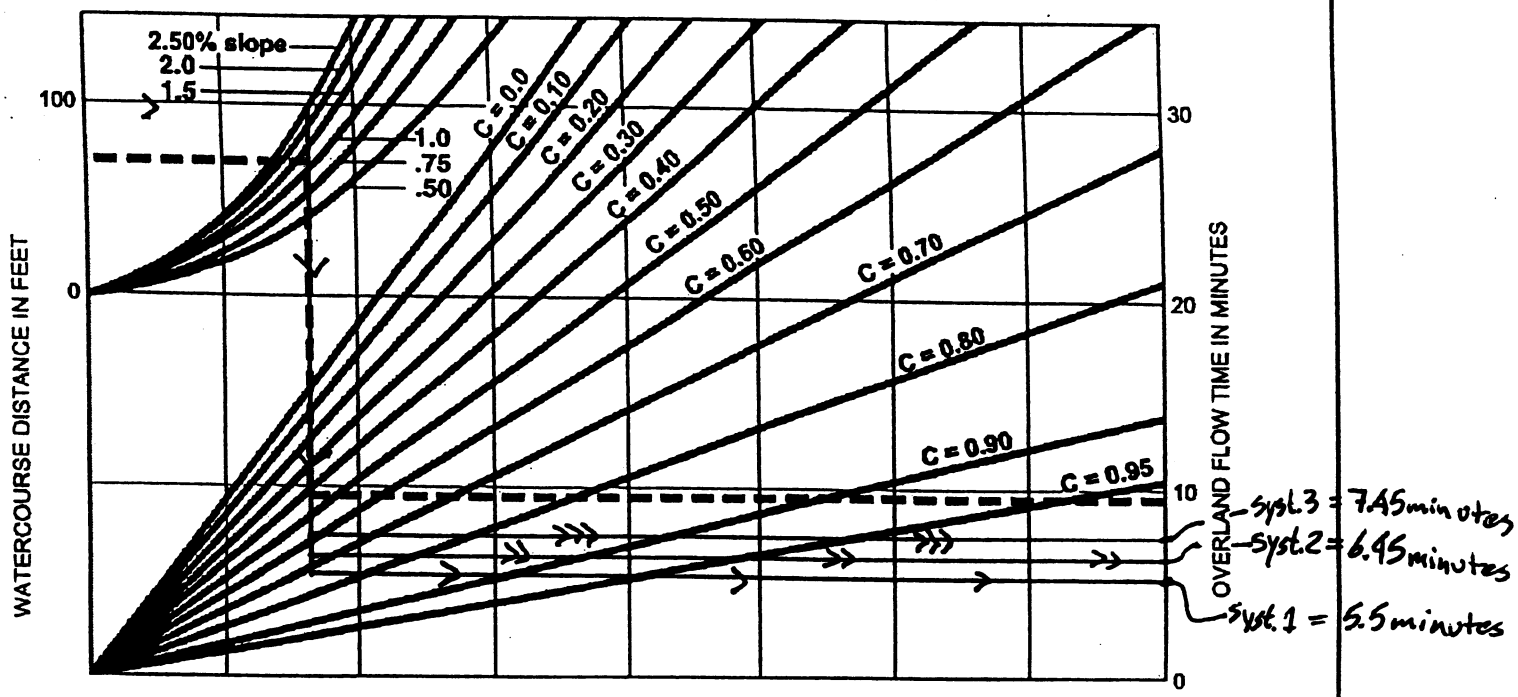
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

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



EXAMPLE:

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

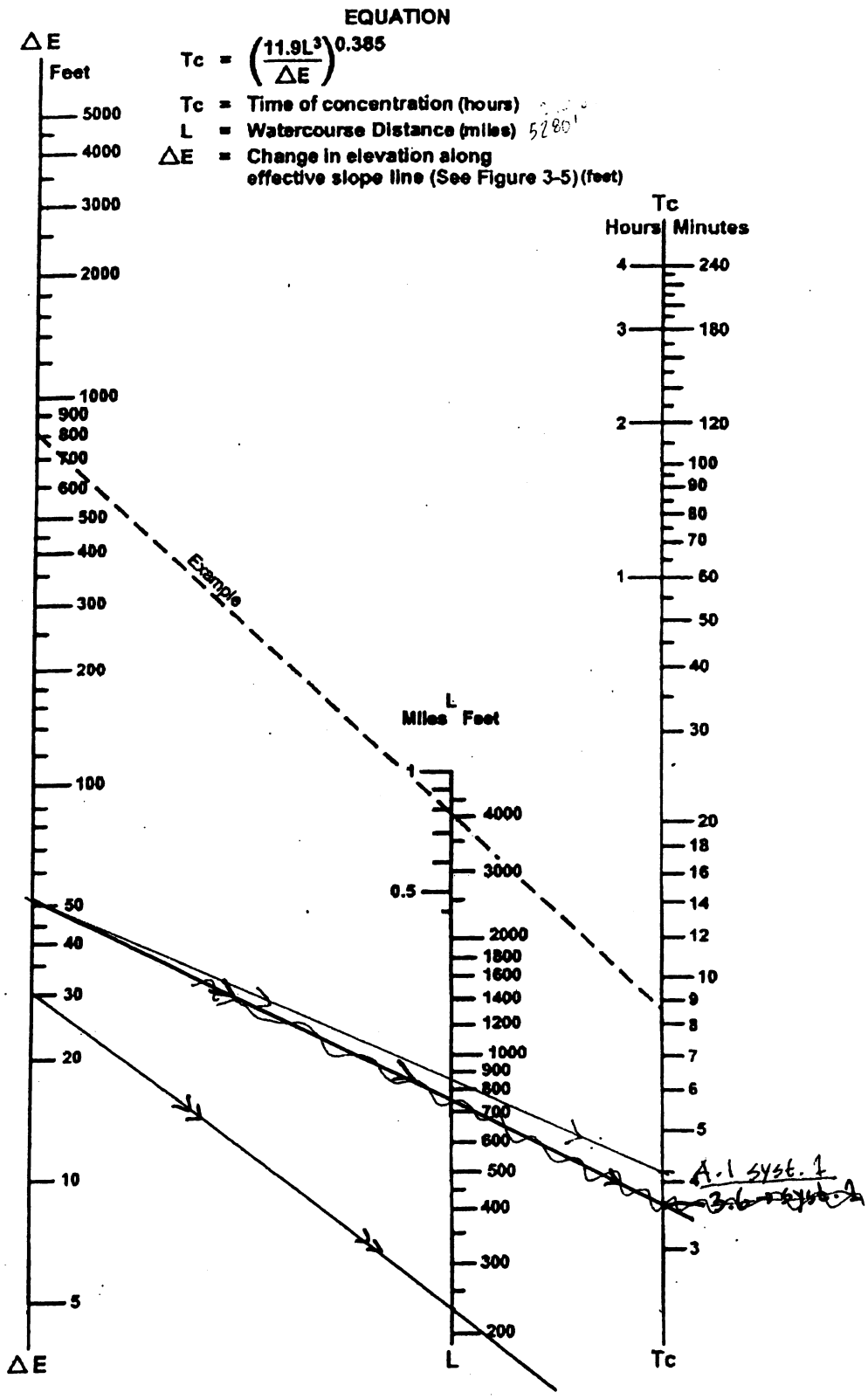
$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE

Rational Formula - Overland Time of Flow Nomograph

3-3



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