Hydrology Study

for

Tentative Tract No. 20022

SAN BERNARDINO COUNTY APN 0305-061-32 & 0305-061-33,
BEING A PORTION OF PARCEL 1, PM 7222, PMB 72/81-83,
TOGETHER WITH A PORTION OF E ½ SEC 28,T1N, R1W, SBM

Prepared for:

HIGHEST AND BEST USE, LLC
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San Francisco, CA 94103
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Prepared by:

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Civil Engineer

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NOT APPROVED

REVIEWED
By Osvaldo Roque at 8:04 am, Aug 23, 2019

Submittal Date: August 14, 2017

Revision Date:

Approval Date:

Table of Contents

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Discussion & Summary of Study:

Project Overview

The proposed project is located in the unincorporated community of Angelus Oaks, in the San Bernardino Mountains within San Bernardino County, on APN 0305-061-32 and 0305-061-33. It is further described as being a Portion of the East ½ Section 28, Township 1 North, Range 1 West, San Bernardino Meridian.

Tentative Tract 20022 includes 85.31 acres, of which, 6 lots totaling 15.15 acres will be subdivided for residential development. Of these 15 acres, only 2.75 acres total is proposed to be disturbed and developed for dwellings on 6 separate lots. These Lots are referenced as Lots 1 through 6, inclusive. A reduction of Tentative Tract 20022 is attached as Exhibit E.

Residential Lot size varies from 1.01 acres to 5.66 acres. Disturbed area within each lot to create lot pads, slopes, infiltration ponds and driveway access within each lot varies from 0.36 acres to 0.69 acres. The intent of this development is to create 6 single family dwellings, and to minimize the impact upon the existing land by minimizing the disturbance of the natural drainage pattern. Table 1 illustrates lot areas and disturbed areas.

Existing drainage swales will not be disturbed or intercepted within the tract land area. They are expected to function in their present location. It is the intent for development that occurs to intercept, route, and treat by infiltration, the runoff caused by development. For a design storm, the runoff in the post developed condition will be less than the pre-developed condition.

Table 1 : Lot Use / Developed Areas & Percent Disturbed

Lot No.	Lot Area (Acres)	Developed Drea (Acres)	Undisturbed Area (Acres)	% Disturbed of Lot Area	Description of Intended Lot Use
1	1.15	0.36	0.79	31	Residential
2	1.27	0.34	0.93	27	Residential
3	1.01	0.50	0.51	50	Residential
4	1.06	0.50	0.56	47	Residential
5	5.00	0.69	4.31	14	Residential
6	5.66	0.36	5.30	7	Residential
A	6.77	0.0	6.77	0	SBCFCD (Shadow Lake)
B	6.33	0.0	6.33	0	Glen Martin Mutual Water Co.
Remainder	57.06	0.0	57.06	0	Public Land - US Forest Service
Totals	85.31	2.75	82.56	3.2 Avg. % disturbed - entire tract	
6 Lots	15.15	2.75	12.40	18.2 Avg. % Disturbed - Lots 1-6	

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SBCFCD will not accept easement. The sump is categorized as a dam and falls under a separate regulatory jurisdiction.

Land Use of Proposed Lots

Existing land uses are graphically represented on Exhibit B. Land use includes National Forest land and single family residential use. The southern portion of the tract contain Lots A and B as described below:

Lot A includes Shadow Lake, a man-made flood control sump that collects tributary drainage for most of the tract property, the adjacent existing Tract No. 3130 (MB 39/6), existing Tract 4024 (MB 55/69-70), together with a portion of the North side of State Route 38. Arrangements for transfer of title for Lot A to the San Bernardino County Flood Control District (SBCFCD) will be made by the project sponsor at the appropriate time upon final approval of the project.

Lot B includes property that will be reserved for development, operation, and / or maintenance of a domestic water supply and use. Similarly, arrangements for transfer of title for Lot B to the Glen Martin Mutual Water Company will be made by the project sponsor at the appropriate time upon final approval of the project.

For tentative tract maps, the goal of the hydrology study is to provide flood protection through identification and protection of drainage courses. Provide drainage easements where drainage courses can affect existing and proposed facilities and cause drainage issues. SB County criteria calls for flow rate bulking of $1.5Q_{100}$ rounded up to the nearest 10' (typical).

Lots 1 through 6 are vacant woodland, ers upon adjacent single family lots, some o dwellings and mountain cabins. A paved alt dikes, Mountain Home Creek Road, run access to the tracts referenced above fr e east edge of the project.

The Remainder Parcel, 57.06 acres is, Bernardino National Forest, intended fo Service. Upon final project approval, arr nder Parcel will be made to the United States Government by the project sponsor. No development or disturbance on the Remainder Parcel is proposed by this project.

Hydrology Methodology

In this document, site hydrology, before and after development will be determined. The drainage subareas reviewed and noted hereafter are given in Exhibit A, following this Discussion portion of the study. Methods used to determine tributary site runoff were determined under the Rational Method as given in the County of San Bernardino Hydrology Manual (1986, as amended in 2010). Rainfall intensity for 10 year-one hour storms were determined, with runoff determined and scaled to specific drainage patterns by use of the sub-area's respective time of concentration. Flow volumes and velocities for open channels and pipes were determined by use of respective Manning equations and calculated by use of engineering hydrology methodology for hydraulic flow. These methods and equations are as given by the Handbook of Hydraulics, 6th Edition, as prepared by Brater and King (King's Handbook).

Hydrology calculations to determine the pre-developed volume of storm flows on the tributary drainage subareas that include the six developed lots were determined in

accordance with the County Hydrology Manual. Infiltration based upon USDA Natural Resource Conservation Service (NRCS) soil type. Hydrology calculations to determine the volume of storm flow on the developed pads tributary to each respective pond was also determined in accordance with the San Bernardino County Hydrology Manual.

Post development hydrology runoff volumes for the drainage subareas are computed as the difference between the pre-developed condition and the retained runoff for developed areas within their respective subareas. As we propose 100% treatment by infiltration, the net runoff volume after development is expected to be decreased, so offsite runoff control is not anticipated or expected.

Hydrology manual calls for 100 year return period flood protection.

Local Rainfall:

Local rainfall intensity was obtained from the National Oceanic and Atmospheric Administration's (2013) Precipitation Frequency Data Server Atlas 14. A point near the centroid of the drainage area was selected, and one-hour rainfall rates for return frequency for a storms ranging from 10 year for hydrology and 2 year for onsite storm water treatment were obtained. Rainfall intensities for site hydrology are derived from intensity duration graph from the County of San Bernardino Hydrology Manual (1986, 2010). The coefficient value of 0.7 is used for the slope of this graph for mountain areas. Flow volumes are calculated per the Hydrology Manual, as modified by land cover, infiltration rates and soil types as noted in this Manual.

Preliminary Water Quality Management Plan (WQMP) and Preliminary Grading Plan for Tentative Tract 20022

Reference is made to the Preliminary Water Quality Management Plan (WQMP) and the Preliminary Grading Plan for Tentative Tract 20022, both prepared by Louis Waldo Flores, P.E. Civil Engineer. The WQMP outlines the proposed onsite storm water treatment of the 2.75 acres of disturbed soil on the six residential lots known as Lots 1 through 6. A reduced copy of the preliminary grading plan map sheet is attached as Exhibit D. The preliminary grading plan graphically depicts the existing topography, the proposed residential pads, and proposed retention ponds.

Onsite storm water treatment of the graded lot pads will consist of retention ponds that are sized to collect and intended to infiltrate all tributary storm water from within the developed building pads and constructed slopes draining to each pad. Each lot will drain to its own pond. Pond size was initially determined based upon available topography and constructability within each lot, with attention paid to avoiding or minimizing the removal of existing trees.

Required pond sizes for 100% treatment were determined in accordance with methodology as specified in the Technical Guidance Document (TGD) for Water Quality Management Plans, under the authority of the County of San Bernardino Area-Wide Storm Water Program. In each case, the provided infiltration pond capacity far exceeds

the required treatment volumes for each lot. This will allow flexibility for increasing impermeable surface areas on each respective lot when individual dwellings are proposed and the Final Water Quality Management Plans are prepared at the discretion and schedule of each individual lot owner. In addition, this flexibility will allow other treatment strategies that may be employed to create a residence within the forest environment without limiting it to the impermeable surface coverage estimated for each lot used in creation of the Preliminary WQMP. Infiltration pond sizes provided and required are tabulated for comparison on Table 4.

Treatment of runoff in disturbed areas.

The disturbed areas will collect and route building pad storm water to a drain inlet. The drain inlet will convey this runoff by subsurface pipes to a graded infiltration pond. Treatment occurs by infiltration within these ponds within each respective lot. The ponds will be checked to retain the 2 year-24 hour storm volume as noted in the Technical Guidance Document (TGD) for Water Quality Management Plans (WQMP) of San Bernardino County. The ponds are sized to collect and retain much more runoff than needed for the design storm. Table 4 shows the comparison. The intent is for these infiltration ponds collect and detain the maximum credible design storm runoff, thus reducing the overall outflow for the developed 15.15 acres than would be for the pre-developed condition.

Swale flowlines adjacent to development will have an organic fiber mesh mat placed, together with rock check dams to minimize and collect runoff and sediment from adjacent graded slopes that do not drain to within the developed pad. Graded slopes are intended to be stabilized during construction by hydro-seeding with a native seed mix of grasses and wildflowers.

Storm water treatment will focus upon mitigating the runoff from the developed 2.75 Acre portion of the six residential lots. Offsite tributary flow is intended to continue undisturbed, as is the undisturbed portions of Lots 1 through 6. Runoff in the developed lots will be routed to infiltration ponds, including driveways, for four of the six developed lots. The remaining two lots have driveways that drain to Mountain Home Creek Road. The net effect of runoff is intended to be less than the undeveloped condition. See Table 2 for more information.

The remaining lots are not being developed by this project, are not affected by the developed portions of the project, and are not intended to mitigate any storm water. Subsequent improvement on these lots will have their discharges and storm water treatment met by the owner of each respective lot for subsequent development, if any.

This analysis will reveal the existing drainage pattern and determine the flow volumes that are anticipated through the portion of the project being developed. The flow volumes of the developed portion of the lots will also be determined. Storm water treatment is intended for only the disturbed areas that comprise the developed portions of the lots. The project must be graded in accordance with the proposed grading plan in

order for the existing drainages and flowlines within the project are expected to remain unimpeded. When graded per plan, the swales will function as if no development occurred. Storm flows have been determined to verify the flowlines through and adjacent to disturbed areas have the cross section available to convey the storm volumes without risking damage to adjacent developed features. No treatment is proposed for those drainage flowlines within undeveloped lot areas, upstream of developed portions of the lots. Drainage flowlines adjacent to developed portions of lots are intended to have erosion control mats placed in the drainage flowlines. Erosion control, soil stabilization and rip rap is intended to be placed at the toes of constructed slopes a s. This is intended to help protect the developed slopes t vere storm event.

Report is not exactly clear how these flow rates were determined.

Disturbed lot areas will have onsite lot retention of storm flows adjacent to the graded building pad. This will negate the need for other onsite treatment or offsite drainage improvements. No widening or street improvements are expected as nearby tract development does not have these improvements. The roadway is at its full developed width. Street edges are lined with Paved AC Dikes. The overall net decrease in post developed runoff is intended to negate the need for treatment of pass through storm flows.

Post development analysis only includes

Table 2 : Drainage Sub-Area Discharge Volumes – Pre and Post Construction

Drainage Sub Area	Pre-Dvpt Q (cfs)	Retained Q (cfs) Area	Post-Dvpt Q (cfs)	Description / Location of Sub Area
F	14.5	0.0	14.5	Offsite tributary above Lot 5, NE
G	18.5	0.0	18.5	Offsite tributary above Lot 5, N
C	52.2	3.3	48.9	Lots 5 & 6 retained within C
J	24.1	0.0	24.1	Offsite, out of tract, drains to street
H	20.1	0.0	20.1	Offsite, out of tract, drains to street
A	4.7	2.9	1.8	Lots 1, 2, & 3 retained within A
B	3.3	1.3	2.0	Lot 4 retained within B
D	14.9	0.0	14.9	Offsite drains thru Lot 6 & part of 5
E	16.4	0.0	16.4	Offsite drains thru Lot 6 to Tr 3130
Totals	168.7	7.5	161.2	

Soil Type and Classification within the project

Soil types are based upon information available from the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS). The NCRS is formerly known as the Soil Conservation Service. Infiltration rates for Hydrology prior to construction is based upon the County Hydrology Manual. Infiltration rates for the developed lots to compute the runoff and retention pond capacities required were obtained from NRCS data and referenced in Musgrave (1955). See Table C, following this section.

The NCRS describes soils in the United States are assigned to four basic Hydrologic Soil Groups (HSG), namely A, B, C, and D. These HSG groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that texture. These soils have a moderate

thoroughly wet. These movement of water or s have a slow rate of wat transmission.

Infiltration testing as described in Appendix D of WQMP TGD must be provided to determine design infiltration rates. A more typical approach is to show the attenuation of the flow rate through detention of the water quality volume. See section F of hydrology manual.

USDA Websoils survey identifies the project area to consist of group C and D soils. Revise calculations.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Soils on the site within the limits of this study are Group B or Group C soils.

Table 3: NRCS Soil Infiltration Rates (Asymptotic values)
Per Musgrave, (1955)

HSC Group	Maximum (In/Hr)	Range (In/Hr)	Average (In/Hr)	Infiltration Rate Used (In/Hr)*
B	0.30	0.15-0.30	0.23	**0.24**
C	0.15	0.05-0.15	0.10	**0.10**

* Values used in determining infiltration pond capacities used in WQMP.

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Table 4 : Infiltration Pond Data for Lots 1 through 6

Lot Number	WQMP Required Volume (cu ft)	WQMP Provided Volume (cu ft)	Pond Area (sq ft)	Pond Depth (ft)
1	230	900	450	2
2	358	2106	702	3
3	661	3888	1296	3
4	660	3882	1294	3
5	817	4005	1602	2.5
6	257	1008	504	2

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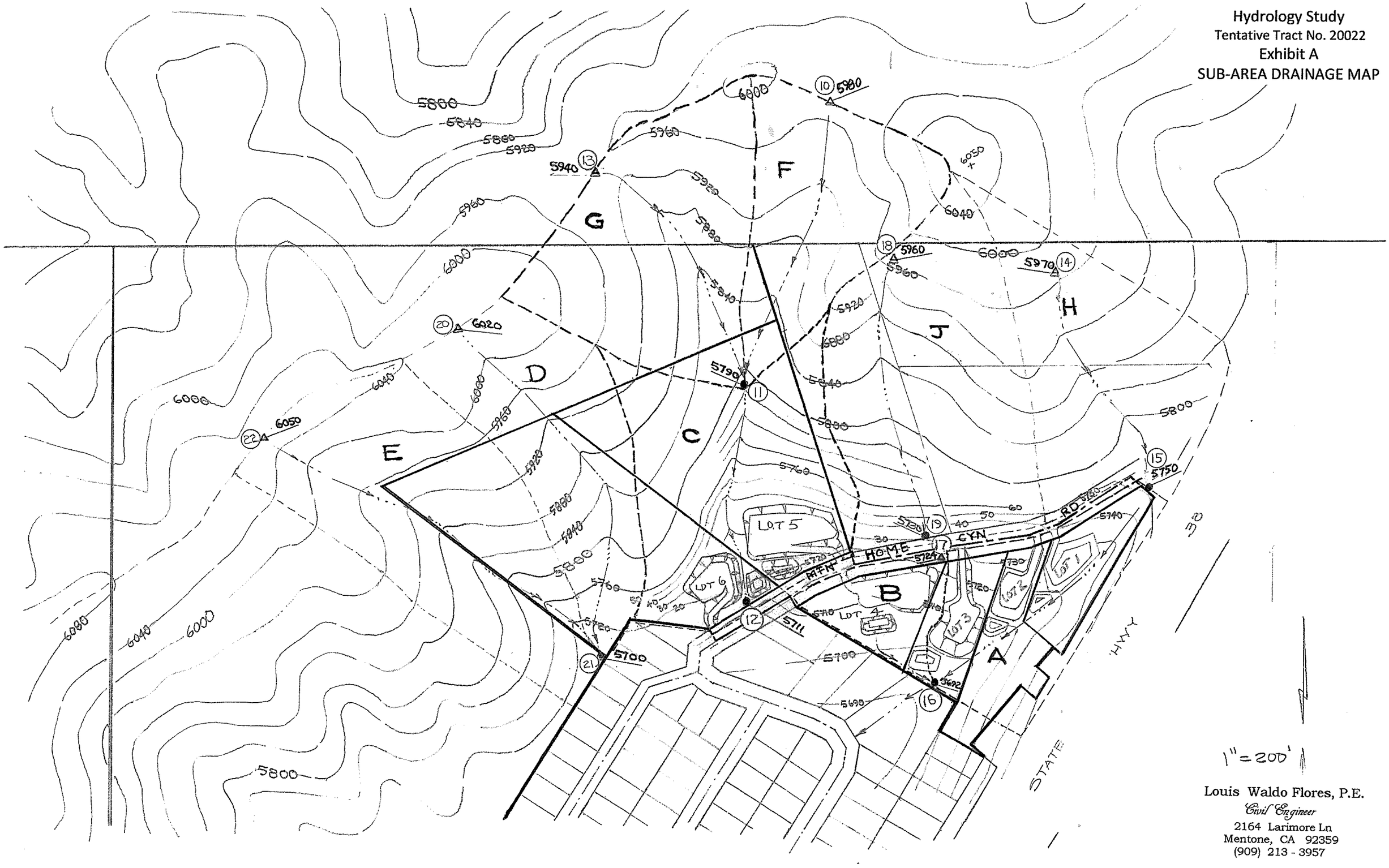
Hydrology Study
Tentative Tract No. 20022
Exhibit A
SUB-AREA DRAINAGE MAP



1" = 200'

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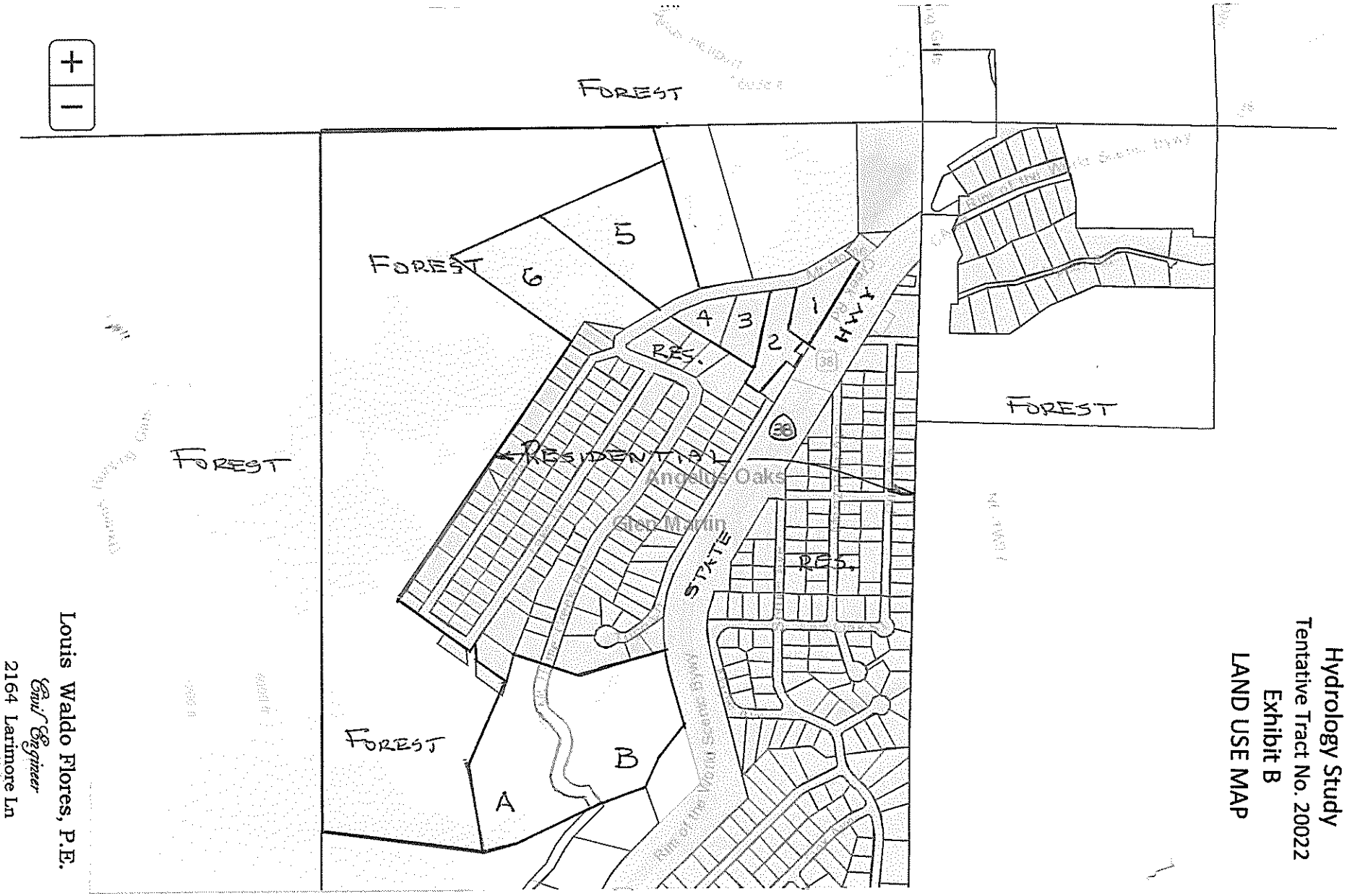
Land Use Services Zoning Look-up



Hydrology Study
Tentative Tract No. 20022
Exhibit B
LAND USE MAP

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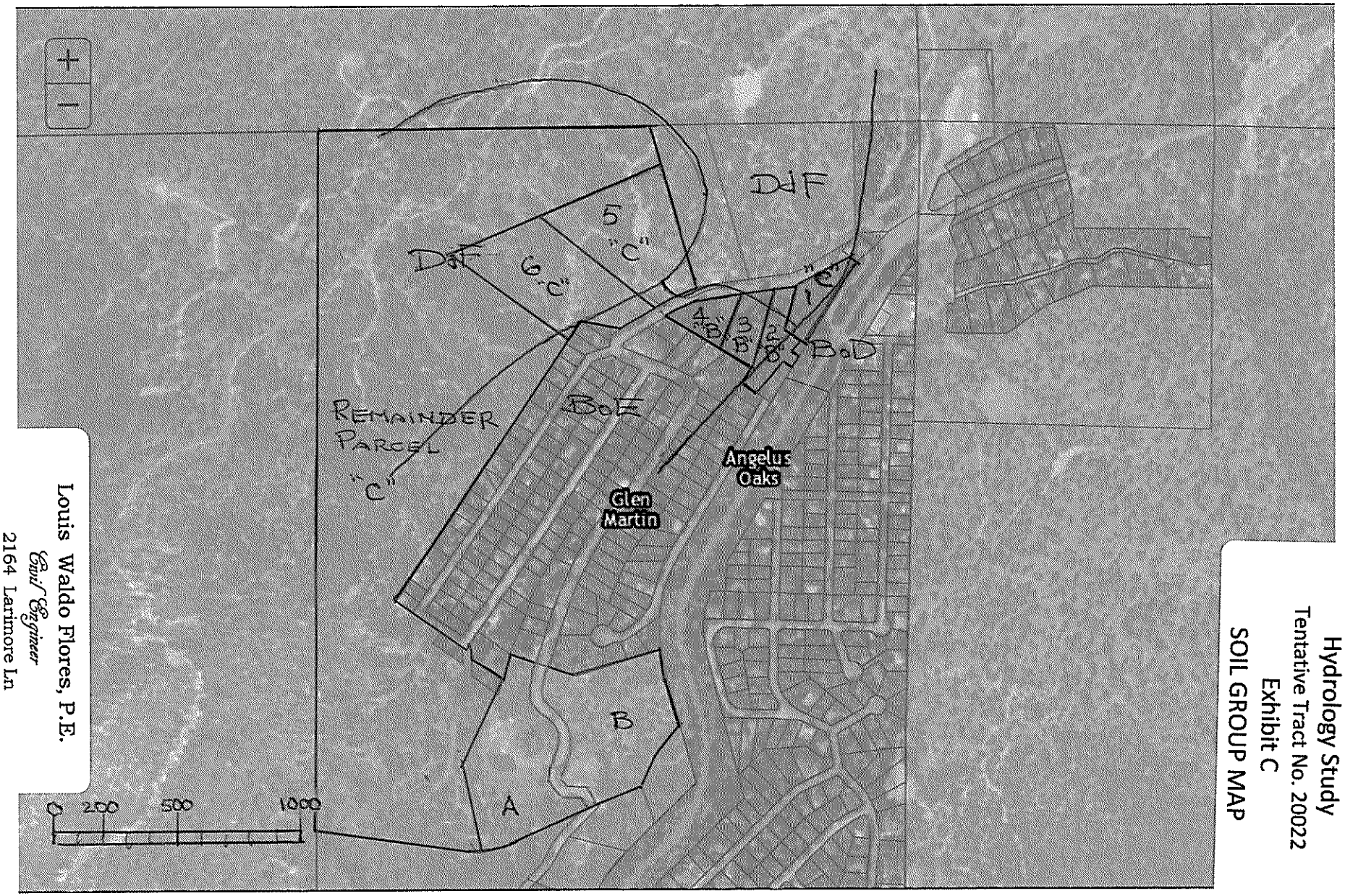
Land Use Services Zoning Look-up



Hydrology Study
Tentative Tract No. 20022
Exhibit C
SOIL GROUP MAP

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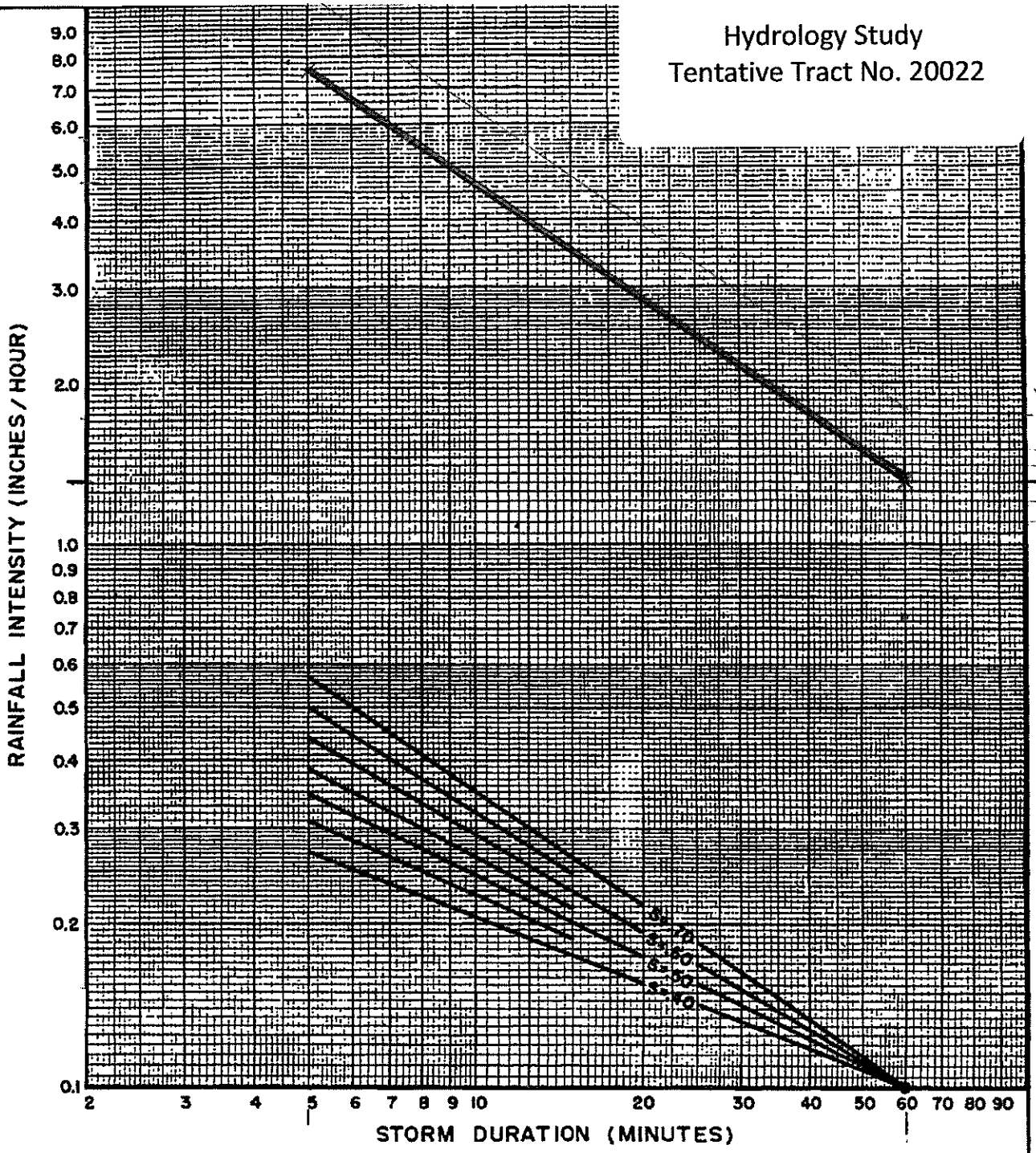

DESIGN STORM FREQUENCY = 10 YEARS
ONE HOUR POINT RAINFALL = 1.3 INCHES (SBd Co. Hydrology Manual, Fig. B-3) (1.73 / Y100, Fig B-4)
LOG-LOG SLOPE = 0.70
PROJECT LOCATION = ANGELUS OAKS - SBd MOUNTAINS

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

100yr-1hr storm analysis required for mitigation and easement sizing as described in hydrology manual.

FIGURE D-3

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Existing - Pre Development

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL

STUDY NAME: 10 -YEAR STORM 1-HOUR RAINFALL (INCH)= 1.33 ; SLOPE = 0.7

Calculated by L.W. Flores Date 6-6-17
Checked by _____ Date _____
Page _____ of _____

Concentration Point	Area (Acres) Subarea	Area (Acres) Total	Soil Type	Dev. Type	T_t min.	T_c min.	I in/hr	Fm in/hr	Fm avg.	Q Total	Flow Path Length ft.	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
10 → 11	4.5	4.5	C	UNDEV. WOODS GRASS		12.5	4.0	0.43	0.43	14.5	710	0.268	8.2	"F" INITIAL SUBAREA
											655	0.229	8.4	"G" INITIAL SUBAREA
13 → 11	6.0	6.0	C	UNDEV. WOODS GRASS		13.0	3.85	0.43	0.43	18.5				
Confluence at node 11										33.7	515	0.153	9.3	"C" EXITS TO STREET
11 → 12	6.2	16.7	C	UNDEV. WOODS GRASS	1.1	~~13~~ 14.1	~~3.85~~ 2.4	~~0.43~~ 0.93	~~0.43~~ 0.43	~~19.1~~ 18.5				
12									USE	52.2				
14 → 15	5.5		C	UNDEV. WOODS GRASS		10.6	4.5	0.43	0.43	20.1	585	0.376	9.9	OFFSITE TO LOT 1 "H"
16	3.7	9.2	B		2.0	12.6	2.0	0.72	0.58	4.7 20.1	705	0.082	5.8	"A"
										24.8				
17 → 16	1.5		B	UNDEV. WOODS GRASS		16.5	3.15	0.72	0.72	3.3	370	0.087	3.9	"B"
16		10.7							B 16	28.1				LOTS 1-4 EXIT FLOW TO PM 11207
Pm (1) Confluence:														
$Q_{11(1)}$ = 32.4	= 18.5	+ 14.5	3.85 / 4.0	0.43 / 0.43										
$Q_{11(2)}$ = 33.7	= 18.5	+ 14.5	3.85 / 4.0	0.43 / 0.43	13.0 / 12.5									
Q_{11} = 33.7														

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RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL

STUDY NAME: 10-YEAR STORM 1-HOUR RAINFALL (INCH)= 1.33 ; SLOPE = 0.7

Calculated by LWF/DRES Date 6-4-17
Checked by _____ Date _____
Page _____ of _____

Concentration Point	Area (Acres) Subarea	Area (Acres) Total	Soil Type	Dev. Type	T_t min.	T_c min.	I in/hr	Fm in/hr	Fm avg.	Q Total	Flow Path Length ft.	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
18 → 19	7.3	7.3	C	UNDEV. WOODS/GRASS		12.0	4.1	0.43	0.43	24.1	680	0.338	10.0	
														SHEET FLOW TO STREET "J"
19		7.3												
											905	0.354	9.2	"D"
20 → 21	4.9	4.9	C	UNDEV. WOODS/GRASS		13.3	3.8	0.43	0.43	14.9				
											965	0.363	9.6	"E"
22 → 21	7.1	7.1	C	UNDEV. WOODS/GRASS		13.5	3.8	0.43	0.43	16.4				D & E EXITS TO TR 3130
21		12.0								27.8				

J
D
E

D-16

Figure D-6

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RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL

STUDY NAME: Post Development?

10 -YEAR STORM 1-HOUR RAINFALL (INCH)= 1.33 ; SLOPE = 0.7

Calculated by _____ Date _____

Checked by _____ Date _____

Page _____ of _____

Concentration Point	Area (Acres) Subarea	Area (Acres) Total	Soil Type	Dev. Type	T_t min.	T_c min.	I in/hr	Fm in/hr	Fm avg.	Q Total
To PAD from D/W Lot 1	0.04		C	R-1		5.0	7.6	0.28	—	0.26
D1 Lot 1	0.12	0.16	C	"	0.12	7.5	5.8	0.75	0.63	0.74 0.37 cfs
Lot 1 Pond 1 outlet	—	0.16	C	"		7.62	5.7	0.75	0.63	0.73 0.59
										Lot 1
D/W to PAD Lot 2 DW	0.04		B	R-1		4.0	8.8	0.28	—	0.31
PAD to DI Lot 2	0.11	0.15	B	"	0.22	7.4	5.7	0.75	0.62	0.48
Lot 2 Pond 2 outlet	—	0.15	B	"		7.62	5.7	0.75	0.62	0.24 cfs 0.79
										Lot 2
Lot 3 D/W	0.04		B	R-1		4.3	8.4	0.28	—	0.29
PAD to DI Lot 3	0.18	0.22	B	"	2.35	7.0	6.0	0.75		0.85 0.93 cfs
Lot 3 Pond 3 D of lot 3	—	0.22	B	"		9.35		0.75		1.14
										Lot 3
To PAD Lot 4 from D/W	0.02		B	R-1		4.2	8.4	0.28	—	0.16
To D-I from PAD	0.26	0.28	B	"	0.17	8.2	5.2	0.75		1.04 0.52 cfs
PAD to Pond Inlet Lot 4		0.28	B	"		8.37	5.3	0.75		1.15
										1.31

Flow Path Length ft.	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
120	0.12	2.7	D/W n=0.015
2 @ 150' ea	0.01	0.4	2 Swales each is 150' Long
38	0.171	5.1	6"ϕ PVC n=0.012 $V=\frac{0.59}{n} d^{2/3} S^{1/2}$
			2.5 cfs flowing 6" ϕ @ 0.171 slope
115	0.135	2.9	$Q=\frac{0.463}{n} d^{8/3} S^{1/2}$ D/W n=0.015
100' & 120'	0.01	0.3	2 Swales on PAD
44	0.245	1.9	6"ϕ PVC n=0.012
130	0.12	2.8	D/W n=0.015
120' 135'	0.01	0.9	(2) Swales
56	0.30	13.0	6"ϕ PVC d=0.33 $V=\frac{0.59}{0.013}(0.335)^{2/3}(0.3)^{1/2}$
62	0.10	1.04	D/W n=0.015
190' 205'	0.01	1.01	2 Swales on PAD
		4.76	6" ϕ PVC

Please provide clear text and explain methodology in report. These calculations appear to show the runoff calculations for the post-development condition, but the results are not used to support the report findings.

Figure D-1

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL

STUDY NAME:

10 -YEAR STORM 1-HOUR RAINFALL (INCH)= 1.33 ; SLOPE = 0.7

Calculated by LW FLORES Date 6-21-17

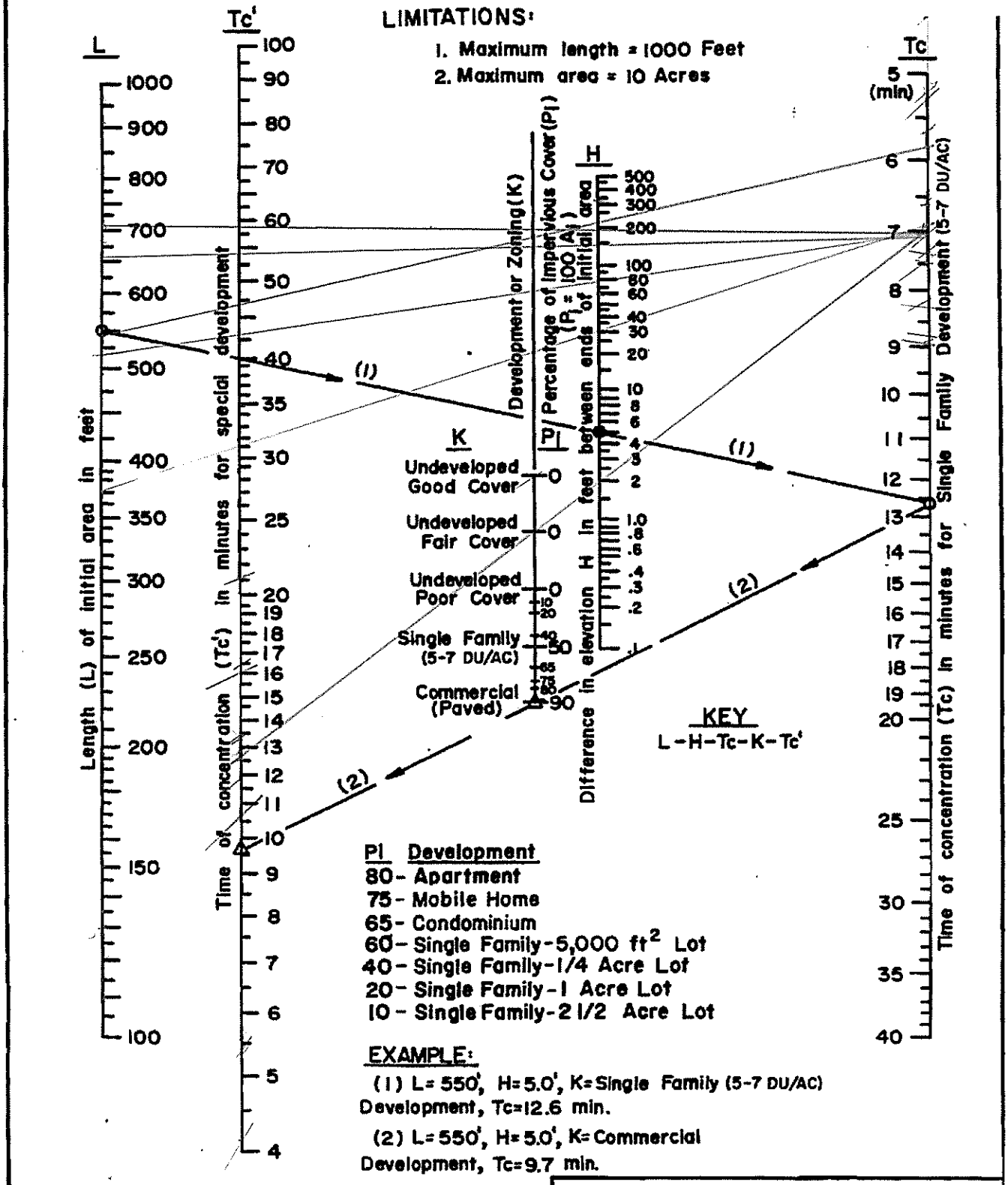
Checked by _____ Date 6-21-17

Page ____ of ____

Concentration Point	Area (Acres) Subarea	Area (Acres) Total	Soil Type	Dev. Type	T_t min.	T_c min.	I in/hr	Fm in/hr	Fm avg.	Q Total	Flow Path Length ft.	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
PAD To DI Lot 5	0.56	0.56	C	R1-5		9.1	5.0	0.75		2.14 1.07/AC	252	0.01	1.10	2.5
											248	0.01		2 Swales
DI to Lot 5 Inlet		0.56	C	"	0.03	9.13	5.0	0.75		2.14	30	0.27	18.6	8Y=8 d=0.83'
											145	0.01	1.03	1.4
											126	0.01		1 Swale
PAD TO DI Lot 6	0.26	0.26	C	R1-5		7.3	5.8	0.75		1.18 0.59/AC				
DI to PAD Lot 6		0.26	C	"	2.19	9.49	4.8	0.75		2.95 1.18	44	0.15	10.2	d=0.39 8Y=6.7
														$V=\frac{0.59}{0.012}(0.39)^{2/3}(0.15)^{1/2}$

For post development analysis, AMC III should be used for soil loss rates.

Figure D-4



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

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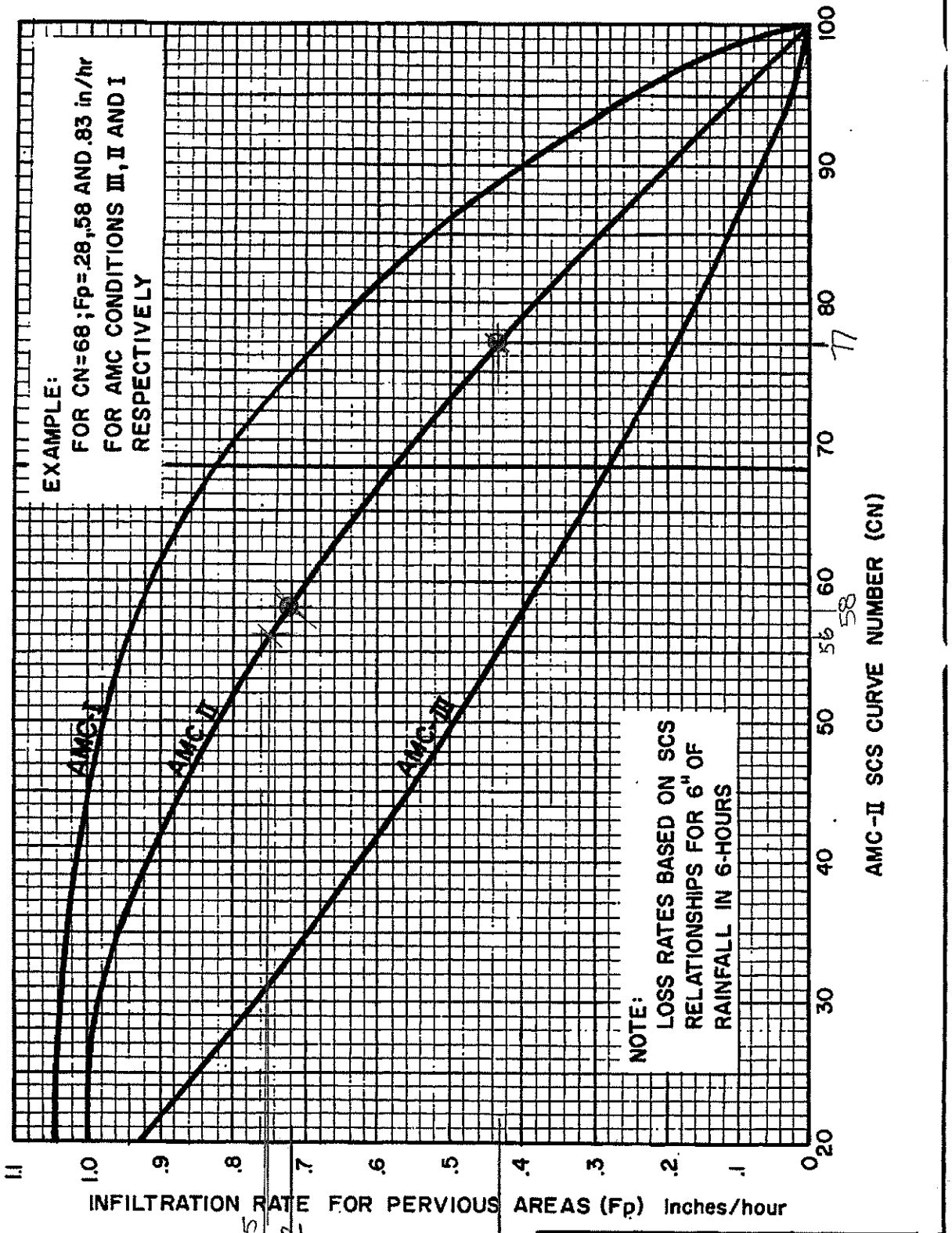

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

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Curve (I) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
* Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent) SUBAREA "C-J" A & B	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.) DEVELOPED LOT PADS	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

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Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (Continued)					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

Notes:

1. All curve numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:

   Poor-Heavily grazed, regularly burned areas, or areas of high burn potential. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.

   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Figure C-2 for definition of cover types.

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (2 of 2)

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JOB TT 20022 - Hydrology 22
SHEET NO. 22 OF
CALCULATED BY LWF DATE 6-6-17
CHECKED BY DATE 6-8-17
SCALE

HYDROLOGY ANALYSIS - RATIONAL METHOD - OPEN CHANNEL

VOLUME - AREA - VELOCITY FOR OPEN STREAM FLOW LINE

FLOWLINE BOTTOM - APPROXIMATES A PARABOLIC SECTION
PER KING'S HANDBOOK, 6TH EDITION, p. 7-19

$$\text{VOLUME} = Q = \frac{K' T^{8/3} S^{1/2}}{n}$$

Q = Flow (cfs)
K' = Dimensionless
T = Top Width Wetted Area (ft)
S = slope (ft/ft, a decimal)
n = Manning Friction coefficient for Natural Stream Channel
Rough w/ growth & Stones
n ⟹ Use $n = 0.040$; (King's, p. 7-22)

Concentration Point 11 is noted as (11)
For (11) at "F"

$Q = 14.5$ cfs, $S = 0.268$

$$Q = 53.5 = \frac{(0.00891)(0.268^{1/2})(10)^{8/3}}{(0.040)}$$

Solving for T (w/ $K' = 0.00891$)
and $Q = 14.5$ cfs:

$$\frac{(Q)(n)}{(K')(S^{1/2})} = T^{8/3}$$

$$T_{11} = \left[\frac{Q\,n}{K'\,S^{1/2}}\right]^{3/8}$$

$$T_{11} = 6.12' = \left[\frac{(14.5)(0.040)}{(0.00891)(0.268)^{1/2}}\right]^{3/8} = [125.74]^{3/8}$$

$\Rightarrow D = 0.43$ ft $\cong 5.2''$

K' values obtained in Table 7-16, p. 7-65, Kings HB Ed.

T TYP. WIDTH = 10 ft
D TYP. DEPTH = 0.7 ft (8½")
$X = D/T = 0.07$ ⟹ $K' = 0.00891$

For Natural Eroded Stream bottom, the Ratios of D & T are taken as similar for various flow Q's

T & X vary, but ratios are similar.

$$A = \frac{(2)(0.43)^2}{(3)(0.07)} = 1.76 \text{ ft}^2 \quad \text{per Eq. 7-13, p. 7-19 Kings} \Rightarrow A = \frac{2D^2}{3X}$$

$$A = \frac{2D^2}{3X}$$

$$V_{11} = \frac{Q}{A} = \frac{14.5}{1.76} = 8.23 \text{ fps} \quad (11) \text{ at "F"}$$

V_{11F} USE 8.2 fps

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JOB JT 20072 - HYDROLOGY
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SCALE

STREAM VELOCITIES, Cont.

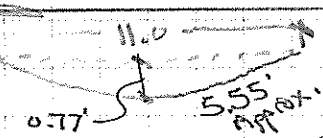
T_{11G} at "G": $Q = 18.5$ cfs; $S = 0.229$

$$T_{11G} = 6.91' = \left[\frac{(18.5)(0.040)}{(0.00891)(0.229)^{1/2}}\right]^{3/8} \Rightarrow D_{11F} = 0.48' = (0.07)(6.91') = 5.8''$$

$$A = 2.19\ ft^2 = \frac{(2)(0.48)^2}{(3)(0.07)} \Rightarrow V_{11G} = 8.43\ ft/s = \frac{18.5\ cfs}{2.19\ ft^2}$$

$V_{11G} \cong 8.4$ ft/s

T_{12C} (Sub Area "C") $Q = 52.2$ cfs; $S = 0.153$



$$T_{12C} = 11.0 = \left[\frac{(52.2)(0.040)}{(0.00891)(0.153)^{1/2}}\right]^{3/8} \Rightarrow D_{12C} = 0.77' = (0.07)(11.0)^{\frac{2}{3}} = 9.3''$$

$$A = 5.64\ ft^2 = \frac{(2)(0.77)^2}{(3)(0.07)} \Rightarrow V_{12C} = 9.26 \cong \frac{52.2\ cfs}{5.64\ ft^2}$$ CHECKS OK

AT NODE 12 $T_T = 1.06\ min = \frac{515\ (ft)}{8.1\ ft/s\ (60\ s/min)}$

$T_C = 14.1 = 1.1 + 13$

$V_{12C} = 9.3$ fps $\Rightarrow L = 515'$

$V = \left(\frac{1.486}{0.040}\right)(0.51)^{2/3}(0.153)^{1/2} = 9.27$ VELOCITY CHECK USING MANNING EQ. 7.35a Kings, P. 7-14

T_{15H} (Sub Area "H") $Q = 20.1$ cfs; $S = 0.376$

$$T_{15H} = 6.5' = \left[\frac{(20.1)(0.040)}{(0.00891)(0.376)^{1/2}}\right]^{3/8} \Rightarrow D_{15H} = 0.46' = (0.07)(6.5) = 5.5''$$

$$A = 2.02\ ft^2 = \frac{(2)(0.46)^2}{(3)(0.07)} \Rightarrow V_{15H} = 9.9\ ft/s = \frac{20.1\ cfs}{2.02\ ft^2}$$

T_{16A} (Sub Area "A") $Q = 20.1$ cfs; $S = 0.082$ $D_{16A} = 0.61 = (0.07)(8.65) = 7.3''$

$$T_{16A} = 8.65\ ft = \left[\frac{(20.1)(0.040)}{(0.00891)(0.082)^{1/2}}\right]^{3/8} \Rightarrow$$

$$A = 3.49\ ft^2 = \frac{(2)(0.61)^2}{(3)(0.07)} \Rightarrow V_{16A} = 5.75\ ft/s = \frac{20.1\ cfs}{3.49\ ft^2}$$

$T_T = 2.0\ m = \frac{705\ ft}{(5.8)\ ft/s\ (60\ s/m)}$

$T_C = 12.6 = 10.6 + 2.0$

$V_{16A} = 5.8$ ft/s

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STREAM VELOCITIES, CONT

T_{16-B} @ SUBAREA "B" $Q = 3.3$ cfs ; $S = 0.087$

$$T_{16-B} = 4.3 \text{ ft} = \left[\frac{(3.3)(0.040)}{(0.00891)(0.087)^{1/2}}\right]^{3/8} \Rightarrow D_{16-B} = 0.30 \text{ ft} = (0.07)(4.3') = 3.6 \text{ in}$$

$$A = 0.86 \text{ ft}^2 = \frac{(2)(0.30)^2}{(3)(0.07)} \Rightarrow V_{16-B} = 3.85 \text{ ft/s} = \frac{3.3 \text{ cfs}}{0.86 \text{ ft}^2}$$

$V_{16-B} = 3.9$ ft/s

T_{19-J}, SUBAREA "J" $Q = 24.1$ cfs ; $S = 0.338$

$$T_{19-J} = 7.1 \text{ ft} = \left[\frac{(24.1)(0.040)}{(0.00891)(0.338)^{1/2}}\right]^{3/8} \Rightarrow D_{19-J} = 0.50 \text{ ft} = (0.07)(7.1) = 6.0 \text{ in}$$

$$A = 2.38 \text{ ft} = \frac{(2)(0.50)^2}{(3)(0.07)} \Rightarrow V_{19-J} = 10.0 \text{ ft/s} = \frac{24.1 \text{ cfs}}{2.4 \text{ ft}^2}$$

T_{21-D} SUBAREA "D" $Q = 14.9$ cfs ; $S = 0.354$

$$T_{21-D} = 5.88 \text{ ft} = \left[\frac{(14.9)(0.040)}{(0.00891)(0.354)^{1/2}}\right]^{3/8} \Rightarrow D_{21-D} = 0.41 \text{ ft} = (0.07)(5.88) = 4.9 \text{ in}$$

$$A = 1.61 \text{ ft} = \frac{(2)(0.41)^2}{(3)(0.07)} \Rightarrow V_{21-D} = 9.2 \text{ ft/s} = \frac{14.9 \text{ cfs}}{1.61 \text{ ft}^2}$$

T_{21-E}; SUBAREA "E" $Q = 16.4$ cfs ; $S = 0.363$

$$T_{21-E} = 6.06 \text{ ft} = \left[\frac{(16.4)(0.040)}{(0.00891)(0.363)^{1/2}}\right]^{3/8} \Rightarrow D_{21-E} = 0.42 \text{ ft} = (0.07)(6.06) = 5.1 \text{ in}$$

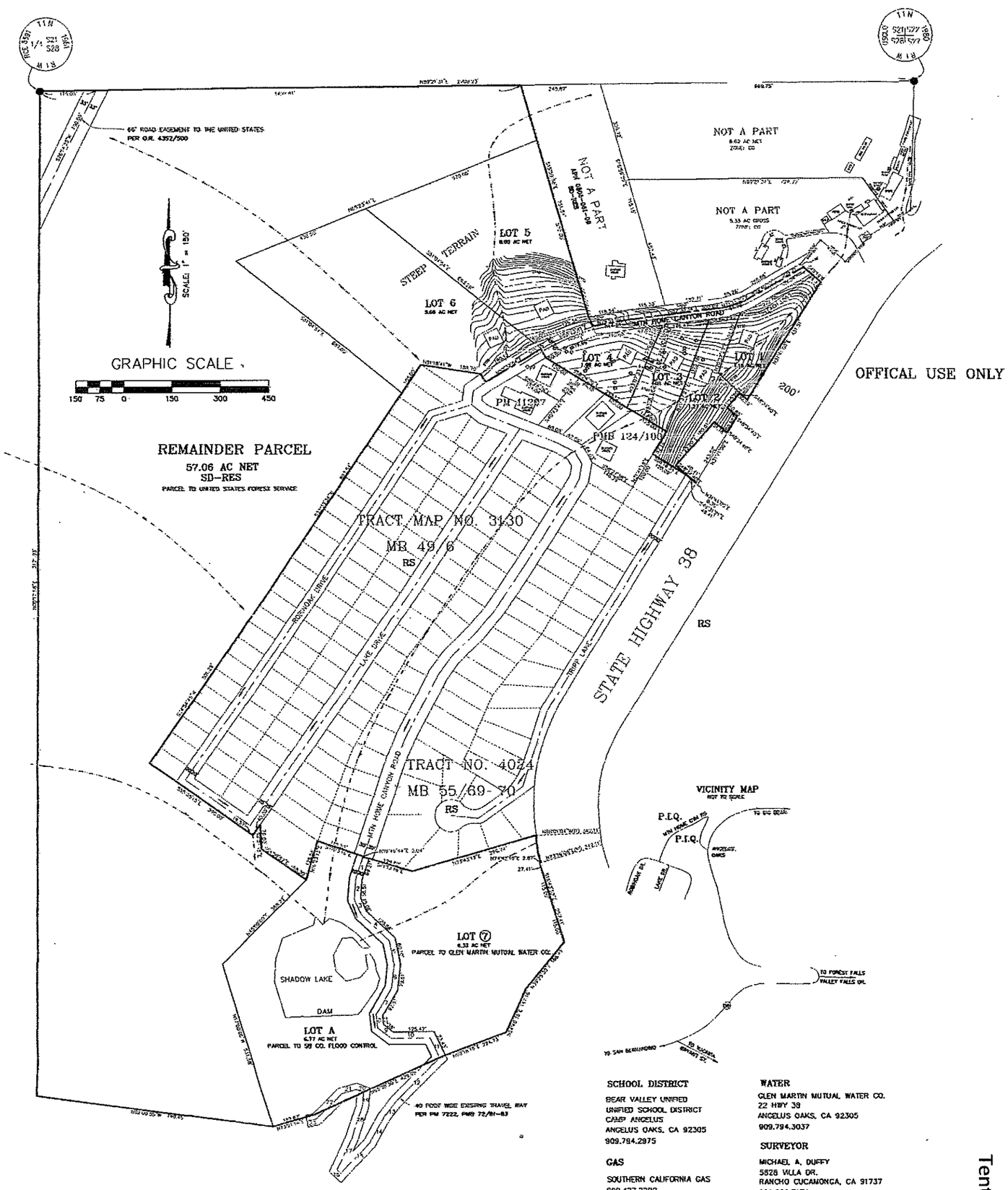
$$A = 1.72 \text{ ft} = \frac{(2)(0.42)^2}{(3)(0.07)} \Rightarrow V_{21-E} = 9.6 \text{ ft/s} = \frac{16.4 \text{ cfs}}{1.72 \text{ ft}^2}$$

IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA

TENTATIVE TRACT MAP NO. 20022

OF A PORTION OF PARCEL 1, PARCEL MAP NO. 7222 RECORDED IN PARCEL MAP BOOK 72, PAGES 81–83 AND A PORTION OF THE EAST HALF OF SECTION 28, T1N, R1W SBM

MICHAEL A. DUFFY, P.L.S. 5113 JANUARY 2017



NOTES

1. ALL DEDICATED ROADS AND TRAVEL WAYS SHOWN HEREON ARE PAVED.
2. BASIS OF BEARINGS IS THE NORTH LINE OF SECTION 28, T1N, R1W PER PM 7222 BEING N89°21'31"E.
3. DIRECTION OF DRAINAGE SHOWN BY ARROWS ON STREETS AND CANYONS.
4. PROJECT IS DESIGNED FOR LOT SALES, SINGLE FAMILY RESIDENCE.
5. LOT 7 IS NOT FOR SALE BUT WILL BE EXCHANGED WITH GLEN MARTIN MUTUAL WATER CO.
6. REMAINDER PARCEL IS NOT FOR SALE AND DESIGNATED FOR LAND EXCHANGE WITH U.S. FORESTRY.
7. LOT 'A' IS NOT FOR SALE AND DESIGNATED FOR DEDICATION TO SAN BERNARDINO CO. FLOOD CONTROL DIST.
8. ○ INDICATES MAJOR TREE LOCATION (24" TO 60" DIAMETER) OF CEDAR, FIR AND PINES.
9. CONTOURS ARE TWO FOOT INTERVALS
10. FRONT SETBACKS EQUAL 15 FEET, SIDE SETBACKS EQUAL 10 FEET
11. LOT DENSITY: 1 ACRE LOTS OR GREATER IN RS ZONE, 3 ACRE LOTS OR GREATER IN SD-RES ZONE

CENTERLINE DATA – EXISTING TRAVEL WAY

1.	N16°40'44"E	71.01'	13.	N30°09'09"E	58.15'
2.	N54°41'16"E	64.03'	14.	N28°26'42"E	97.01'
3.	N23°56'26"W	54.13'	15.	N43°34'15"E	129.59'
4.	N45°21'21"W	112.60'	16.	N47°52'55"W	15.75'
5.	N11°49'50"W	73.91'	17.	N24°56'00"E	132.04'
6.	N05°24'57"E	72.19'	18.	N17°33'44"E	103.00'
7.	N30°33'08"E	83.44'	19.	N09°51'25"E	45.68'
8.	N07°01'09"W	41.75'	20.	N58°07'47"W	23.85'
9.	N31°13'34"W	33.34'	21.	N14°34'05"E	47.01'
10.	N03°05'13"E	119.62'	22.	N44°40'43"E	112.25'
11.	N74°29'13"W	10.10'	23.	N77°12'45"E	29.75'
12.	N44°55'51"E	192.84'			

SCHOOL DISTRICT
BEAR VALLEY UNIFIED SCHOOL DISTRICT
CAMP ANGELUS
ANGELUS OAKS, CA 92305
909.794.2975

GAS
SOUTHERN CALIFORNIA GAS
800.427.2200

ELECTRIC
SOUTHERN CALIFORNIA EDISON
2244 WALNUT GROVE AVE.
ROSEMEAD, CA 91770

TELEPHONE
VERIZON
800.483.5000

CABLE
ADELPHIA CABLE
760.365.3378

ZONING
SD-RES: LOTS 5,6,7,A
RS: LOTS 1,2,3,4

WATER
GLEN MARTIN MUTUAL WATER CO.
22 HWY 38
ANGELUS OAKS, CA 92305
909.794.3037

SURVEYOR
MICHAEL A. DUFFY
5828 VILLA DR.
RANCHO CUCAMONGA, CA 91737
909.989.7174

LEGAL OWNERS
HIGHEST & BEST USE, LLC
123 10TH STREET
SAN FRANCISCO, CA 94103
858.315.7420

APPLICANT
HIGHEST & BEST USE, LLC
123 10TH STREET
SAN FRANCISCO, CA 94103
858.315.7420

SEWER
SEPTIC

7 LOTS
APN 0305-061-32,33
85.17 ACRES

MICHAEL A. DUFFY P.L.S. 5113

DATE

MICHAEL A. DUFFY P.L.S. 5113 EXPIRES 6/30/17 PROFESSIONAL LAND SURVEYOR STATE OF CALIFORNIA

Hydrology Study
Tentative Tract No. 20022
Exhibit D
Tentative Tract Map

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