

HYDROLOGY STUDY FOR

**Fletcher 15
705 & 715 Fletcher Ave, Orange, CA**

Prepared For:

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Revised September 2025**

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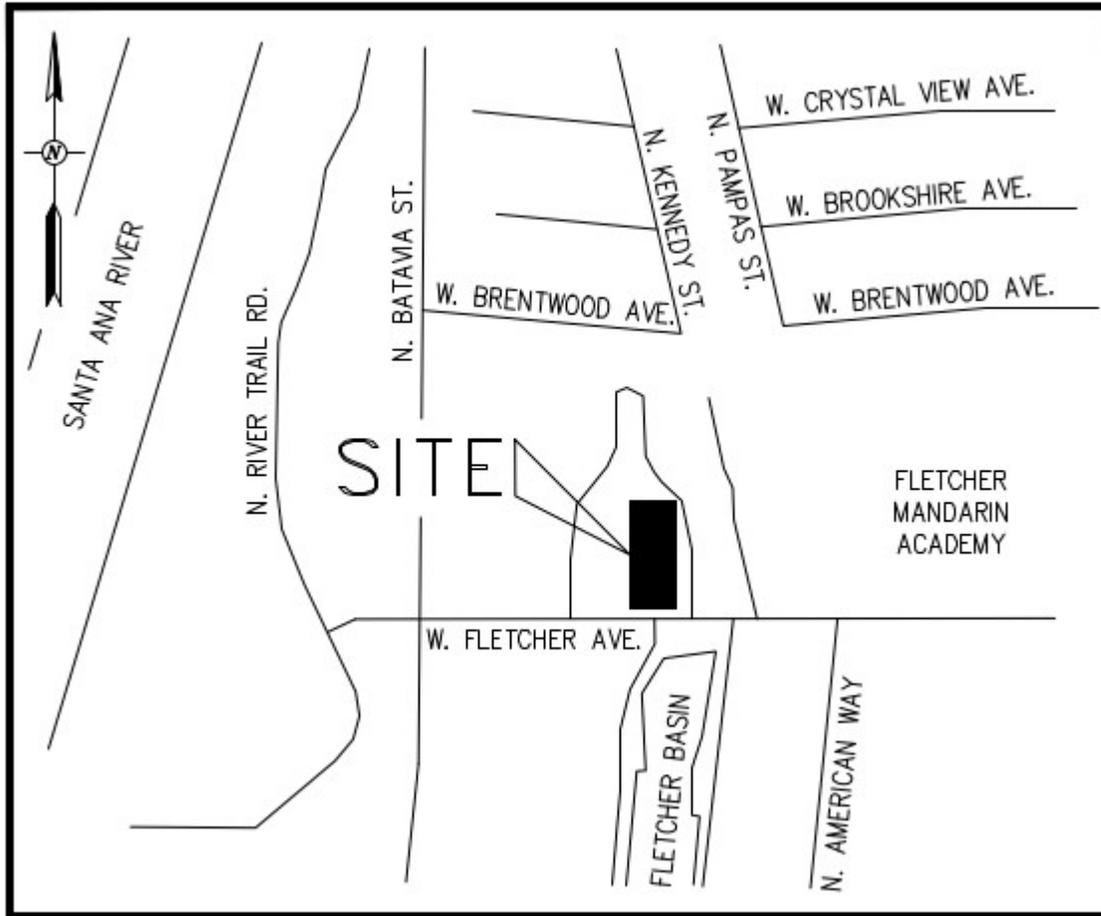
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I. VICINITY MAP



II. DISCUSSION

Introduction

This report presents a hydrology study for the proposed “Fletcher 15”, located at 705 & 715 Fletcher Ave, Orange, CA. The primary purpose of this study is to determine the existing and proposed stormwater discharge flow for the project, providing critical data for drainage design and stormwater management. This report is prepared for ADC Fletcher 15, LLC.

Existing Conditions

The project site, encompassing 0.72 acres, is currently vacant and was most recently utilized by a street sweeping business. Historically, the site has served various purposes, including orchards and residences. The topography of the site is relatively flat, with elevations ranging from 201.6 to 202.4 feet above mean sea level. The existing drainage pattern indicates a general flow towards Fletcher Avenue to the south. There are no sensitive environmental features (e.g., wetlands, critical habitats, protected species) identified on or near the site that require special consideration. The predominant soil type at the site is classified as Group B, and the current vegetation cover consists of bare soil with sparse grasses, typical of vacant lots in the area.

There are no direct offsite flows draining to the subject property, and the property does not drain to any adjacent private property.

Project Description

The proposed project involves the development of 15 small-lot, three-story single-family homes on a private drive. The development will also include common space, which features a small landscaped park and nine parking stalls. The proposed development will result in a significant alteration of the site's impervious areas. The impervious area will increase from an existing 60% to 76% in the developed condition. To facilitate proper grading for the proposed development, the site will be slightly raised. Despite this change in topography, the drainage patterns will continue to direct stormwater towards Fletcher Avenue, utilizing a system of street gutters, storm drain inlets, and pipes.

Hydrology and Calculation Methodology

The hydrologic analysis for this study utilized a custom Rational Method as prescribed by the Orange County Hydrology Manual. This customized approach differs from the standard Rational Method by incorporating a specific procedure for calculating the Maximum Effective Pervious Area Loss Rate (F_p) and Maximum Loss Rate (F_m).

The methodology involves the following steps:

1. Maximum Effective Pervious Area Loss Rate (F_p): This value is determined from Table C.2 in the Orange County Hydrology Manual and is based solely on the Soil Group (in this case, Soil Group B).
2. Maximum Loss Rate (F_m): Calculated using the formula: $F_m = A_p \cdot F_p$, where A_p represents the pervious area percentage.
3. Runoff Flow Rate (Q): The final runoff flow rate is calculated using the formula: $Q = 0.9 \cdot (I - F_m) \cdot A$, where I is the rainfall intensity (in/hr), and A is the total area of the site.

The rainfall intensity (I) is determined by the formula: $I(t) = a \cdot t^b$, where t is the time of concentration for the subarea, and the coefficients a and b are obtained from Figure B-3 of the Orange County Hydrology Manual, varying by the return period.

The analysis considered the following design storm events:

- 2-year storm
- 10-year storm
- 25-year storm
- 100-year storm

The Orange County Hydrology Manual served as the sole source for all hydrologic data used in this analysis, including rainfall intensity parameters and the specific custom Rational Method procedures.

Results

The hydrologic analysis determined the pre-development and post-development peak flow rates and runoff volumes for the specified design storm events. The results indicate an increase in both peak flow rates and runoff volumes post-development before considering stormwater quality measures. However, with the proposed capture and infiltration of 1,687 CF, the net post-development runoff volumes are reduced.

The quantitative results, including the differences between pre- and post-development values and the impact of infiltration, are presented in the table below:

Storm Event	2-YR	10-YR	25-YR	100-YR
Pre-Developed X1 Flow (cfs)	0.95	1.71	2.05	2.62
Post-Developed P1 Flow (cfs)	0.95	1.73	2.08	2.67

Difference	0.0	+0.02	+0.03	+0.05
Percent Change	0%	+1.2%	+1.4%	+1.8%
Pre-Developed X1 Volume (cf)	4,449	7,987	9,745	12,219
Post-Developed P1 Volume (cf)	3,842	6,896	8,414	10,550
Design Capture Volume (cf)	1,687	1,687	1,687	1,687
Difference	-2,295	-2,778	-3,018	-3,356
Percent Change	-52%	-35%	-31%	-28%

Conclusion

This hydrology study for “Fletcher 15” has assessed the existing and proposed stormwater discharge flows for the project site at 705 & 715 Fletcher Ave, Orange, CA. The analysis, conducted using the Orange County custom Rational Method, demonstrates that the proposed development will result in an increase in peak stormwater discharge flows across all analyzed storm events (2-year, 10-year, 25-year, and 100-year). This is primarily attributed to the decrease in the site's impervious area from 91% to 76%.

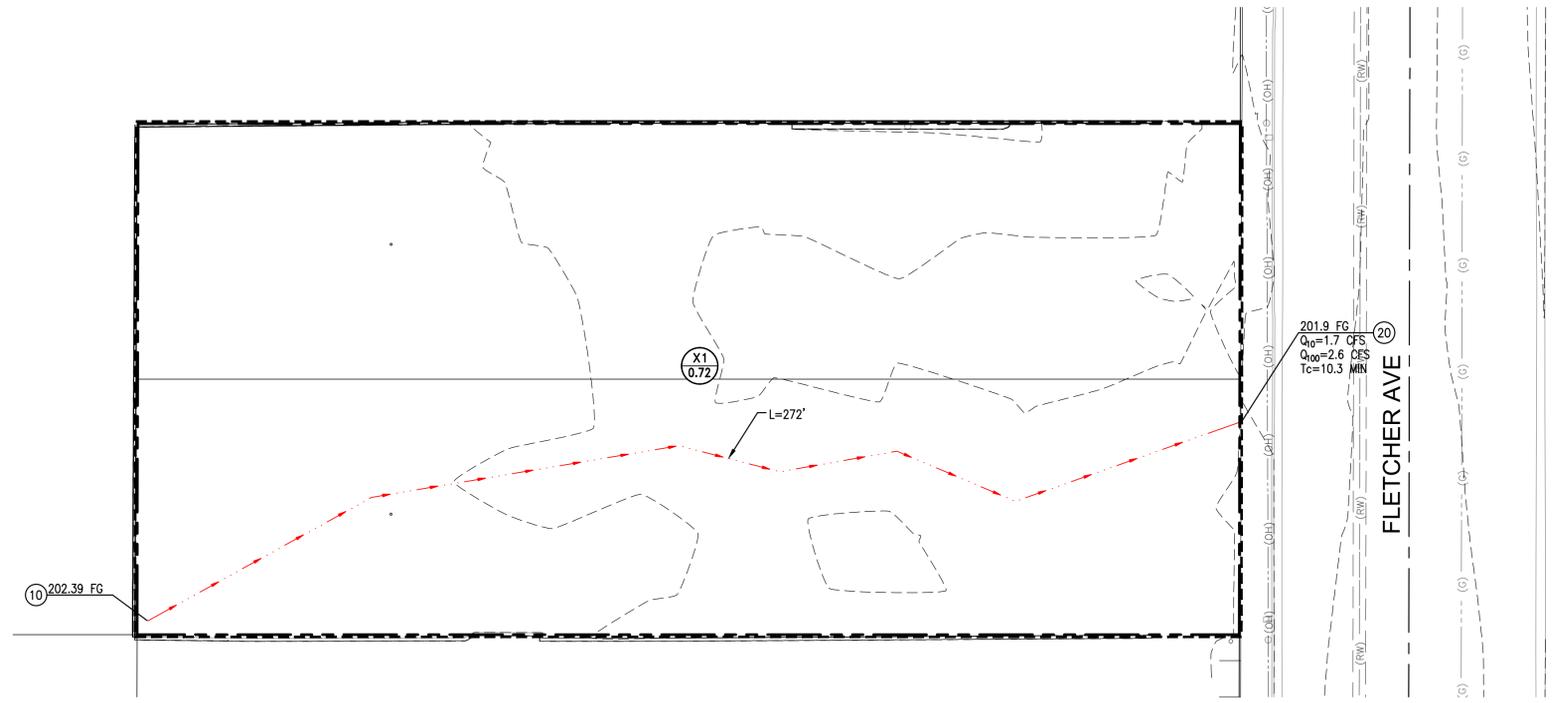
The post-development peak flows range from 0.95 cfs for a 2-year storm to 2.67 cfs for a 100-year storm, representing slight increases of 0.02 cfs and 0.05 cfs, respectively, compared to pre-development conditions.

However, as part of the stormwater quality requirements, a minimum of 1,687 cubic feet (CF) of storm runoff will be captured and infiltrated on-site. When accounting for this infiltration, the net post-development runoff volumes are significantly reduced for the smaller storm events. For the 2-year, 10-year, 25-year, and 100-year storm events, the post-development runoff volumes (after infiltration) are less than the pre-development volumes, indicating a beneficial impact on stormwater quantity for these common events.

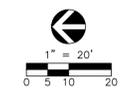
These findings highlight that while peak flows will increase slightly, the proposed stormwater quality measure of capturing and infiltrating runoff will effectively manage runoff volumes for typical storm events. Further detailed design of on-site drainage infrastructure, including street gutters, storm drain inlets, and pipes, will be required to effectively convey the remaining runoff to Fletcher Avenue and ensure compliance with local regulations for both stormwater quantity and quality.

APPENDIX A – HYDROLOGY MAPS

EXISTING HYDROLOGY MAP
 715 FLETCHER AVE
 ORANGE, CA



- LEGEND**
- PROPERTY LINE
 - [Pattern] LANDSCAPE AREAS
 - [Pattern] PCC HARDSCAPE
 - (X) DRAINAGE AREA
 - (XX) ACREAGE
 - (15) NODE REFERENCE
 - (C) SOILS GROUP AREA
 - DRAINAGE BOUNDARY



NOTE: EXISTING PERVIOUS AND IMPVIOUS AREAS BASED ON MOST RECENT LAND USE BUT IS NOT DEPICTED ABOVE.

REVISIONS			
NO.	DATE	DESCRIPTION	APPROVED

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PREPARED BY:
MFKessler
 Civil Engineering, Land Planning, Surveying

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 IRVINE, CA 92618
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 CONTACT: ALI MONSHIZADEH



CITY OF ORANGE
 OFFICE OF THE CITY ENGINEER

EXISTING
 HYDROLOGY MAP

SCALE: HORIZ.: SEE PLAN
 VERT.: SEE PLAN

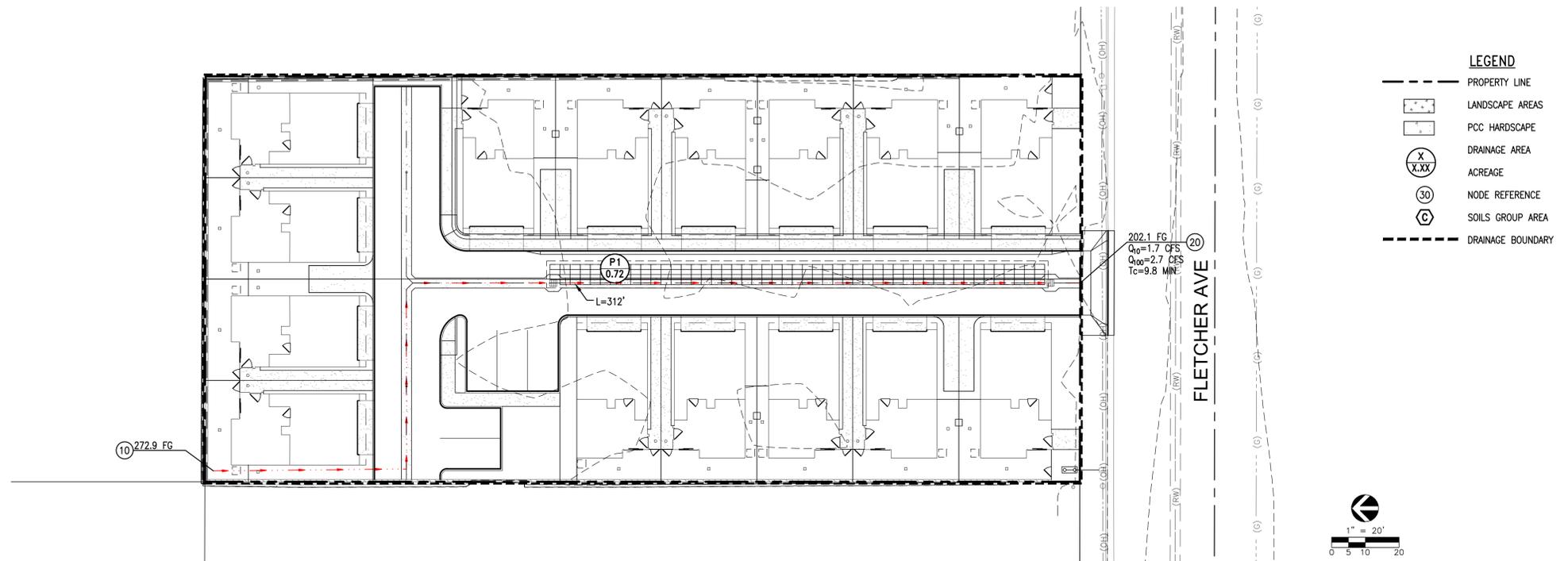
SHEET No. 1 OF 1

DRAWN BY: STAFF
 CHECKED BY: AM

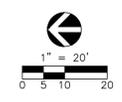
PROJECT NUMBER

ALI MONSHIZADEH, R.C.E. No. C67674 DATE

PROPOSED HYDROLOGY MAP
715 FLETCHER AVE
ORANGE, CA



- LEGEND**
- PROPERTY LINE
 - [Pattern] LANDSCAPE AREAS
 - [Pattern] PCC HARDSCAPE
 - (X/XX) DRAINAGE AREA
 - (XX) ACREAGE
 - (30) NODE REFERENCE
 - (C) SOILS GROUP AREA
 - DRAINAGE BOUNDARY



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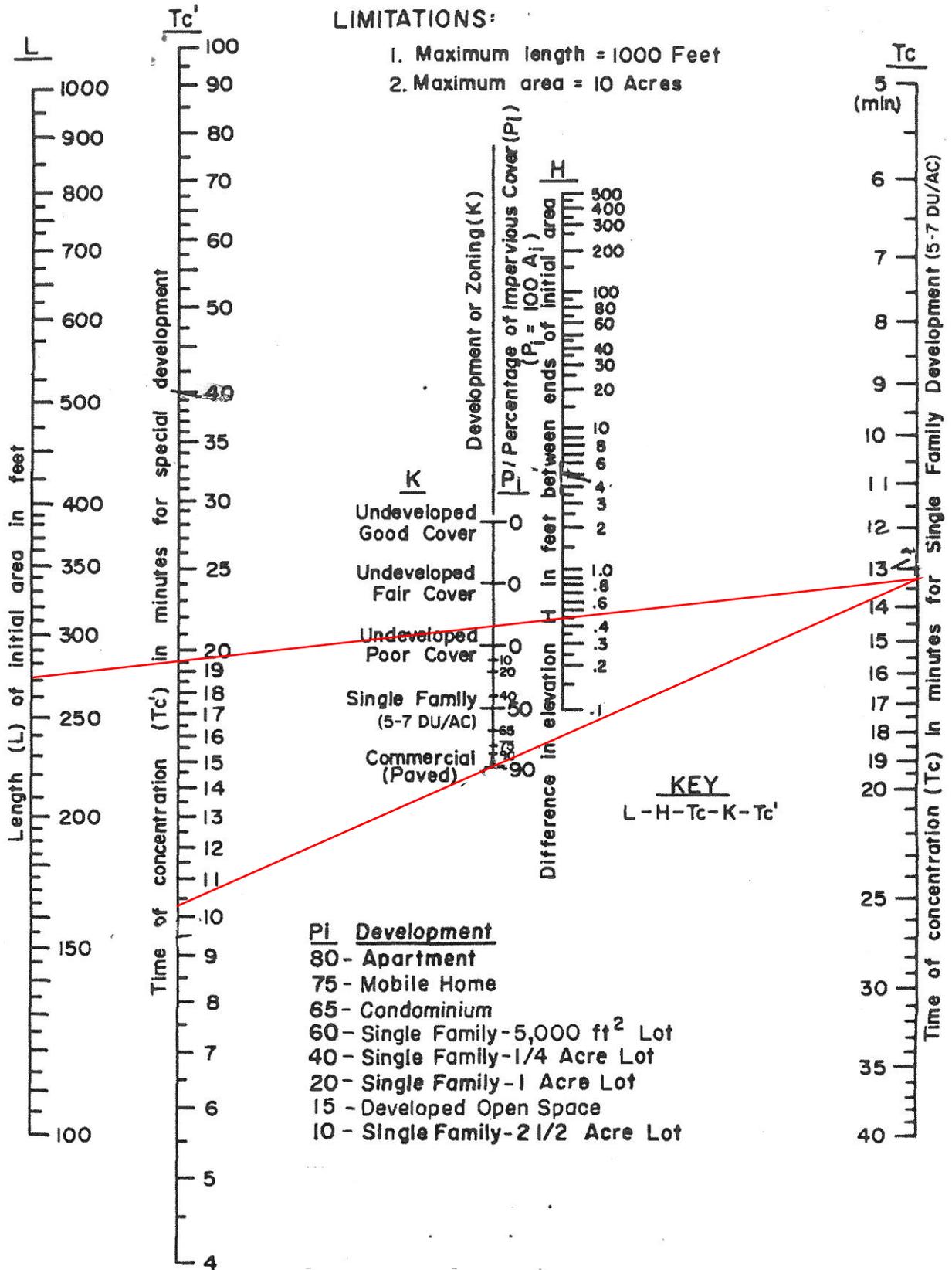
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 PROPOSED
 HYDROLOGY MAP
 SCALE: HORIZ.: SEE PLAN
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APPENDIX B – HYDROLOGY CALCULATIONS

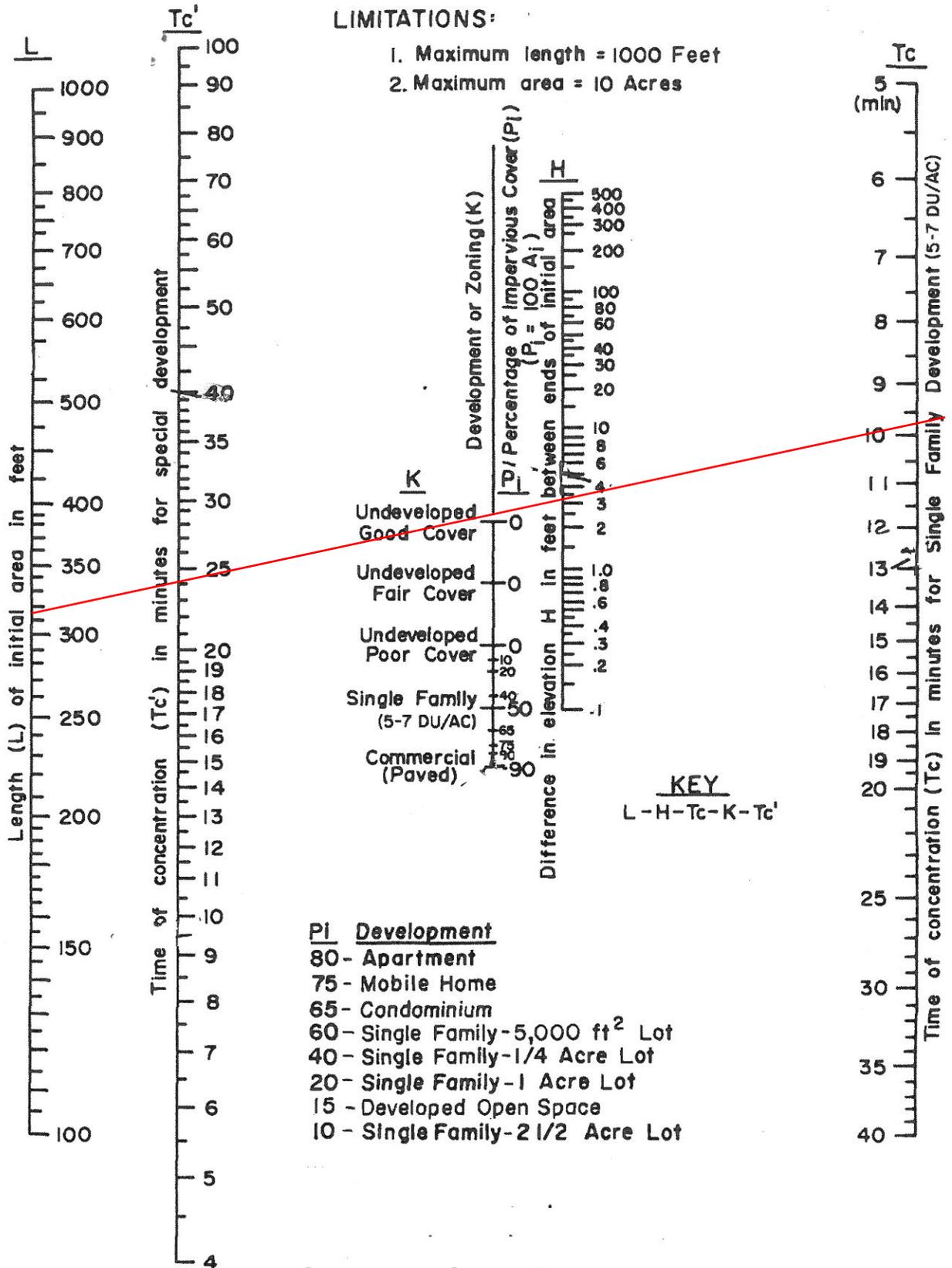
LIMITATIONS:

1. Maximum length = 1000 Feet
2. Maximum area = 10 Acres



LIMITATIONS:

1. Maximum length = 1000 Feet
2. Maximum area = 10 Acres



RATIONAL METHOD STUDY FORM

Orange County HYDROLOGY MANUAL			STUDY NAME: 715 Fletcher Ave, Orange CA							CALCULATED BY: TCA		DATE: 09/17/25		
			Existing & Proposed Stormwater Runoff Calculations							CHECKED BY: TCA		PAGE 1 OF 1		
Design Storm Freq.	AREA (ACRES)		SOIL	Ap	Fp	Fm	Tc	I	Q	d	Vol, cf	FLOW	ELEV	HYDRAULICS AND NOTES
	SUBAREA	PERVIOUS	TYPE	%PER	IN/HR	IN/HR	MIN	IN/HR	CFS	IN	EST.	PATH, FT	DIFF	
Existing X1														
2 year	0.72	0.06	B	9%	0.300	0.03	10.3	1.50	0.95	2.05	4449	272	0.49	Assumes most recent site utilization as a business
10 year	0.72	0.06	B	9%	0.300	0.03	10.3	2.68	1.71	3.68	7987			
25 year	0.72	0.06	B	9%	0.300	0.03	10.3	3.20	2.05	4.49	9745			
100 year	0.72	0.06	B	9%	0.300	0.03	10.3	4.09	2.62	5.63	12219			
Proposed A1														
2 year	0.72	0.17	B	24%	0.300	0.07	9.8	1.54	0.95	2.05	3842	313	3.33	
10 year	0.72	0.17	B	24%	0.300	0.07	9.8	2.76	1.73	3.68	6896			
25 year	0.72	0.17	B	24%	0.300	0.07	9.8	3.30	2.08	4.49	8414			
100 year	0.72	0.17	B	24%	0.300	0.07	9.8	4.21	2.67	5.63	10550			
NOTES: I(t) = at^b per (OC) Figure B-3 ; Q = 0.9*(I - Fm)*A per (OC) Equation D.4; Fp per (OC) Table C.2; d per (OC) Table B.1														

Estimated Peak Flow	2 year	10 year	25 year	100 year	Estimated 24-hr Volume	2 year	10 year	25 year	100 year
	Pre	0.95	1.71	2.05		2.62	Pre	4,449	7,987
Post	0.95	1.73	2.08	2.67	Post	3,842	6,896	8,414	10,550
Diff	0.00	0.02	0.03	0.05	DCV	1687	1687	1687	1687
Change	-0.2%	1.2%	1.4%	1.8%	Diff	-2295	-2778	-3018	-3356
					Change	-51.6%	-34.8%	-31.0%	-27.5%

Conclusion: While the Peak flow rate in the Post-development condition exceeds the Pre-development condition, the Rational Method calculation does not take into account the reduction of flow due to the capture and infiltration of the Stormwater Quality Design Capture Volume (DCV).

APPENDIX C – HYDRAULIC CALCULATIONS

Manning's Equation Full Pipe Flow

n= 0.012

CFS	Diameter (inches)																		
	Slope	3	4	6	8	10	12	15	18	21	24	30	36	42	48	54	60	72	84
0.001	0.03	0.07	0.19	0.42	0.75	1.22	2.2	3.6	5.4	7.8	14.1	22.9	34.6	49.3	67.5	89.5	145.5	219.4	313.3
0.002	0.04	0.09	0.27	0.59	1.06	1.73	3.1	5.1	7.7	11.0	19.9	32.4	48.9	69.8	95.5	126.5	205.7	310.3	443.1
0.003	0.05	0.11	0.33	0.72	1.30	2.12	3.8	6.2	9.4	13.5	24.4	39.7	59.9	85.5	117.0	155.0	252.0	380.1	542.7
0.004	0.06	0.13	0.39	0.83	1.51	2.45	4.4	7.2	10.9	15.5	28.2	45.8	69.1	98.7	135.1	178.9	291.0	438.9	626.6
0.005	0.07	0.15	0.43	0.93	1.68	2.74	5.0	8.1	12.2	17.4	31.5	51.2	77.3	110.3	151.0	200.0	325.3	490.7	700.6
0.006	0.07	0.16	0.47	1.02	1.84	3.00	5.4	8.8	13.3	19.0	34.5	56.1	84.7	120.9	165.5	219.1	356.3	537.5	767.4
0.007	0.08	0.17	0.51	1.10	1.99	3.24	5.9	9.5	14.4	20.6	37.3	60.6	91.4	130.5	178.7	236.7	384.9	580.6	828.9
0.008	0.09	0.18	0.55	1.17	2.13	3.46	6.3	10.2	15.4	22.0	39.9	64.8	97.7	139.6	191.1	253.0	411.5	620.7	886.1
0.009	0.09	0.20	0.58	1.25	2.26	3.67	6.7	10.8	16.3	23.3	42.3	68.7	103.7	148.0	202.6	268.4	436.4	658.3	939.9
0.010	0.10	0.21	0.61	1.31	2.38	3.87	7.0	11.4	17.2	24.6	44.6	72.5	109.3	156.0	213.6	282.9	460.0	693.9	990.7
0.011	0.10	0.22	0.64	1.38	2.50	4.06	7.4	12.0	18.1	25.8	46.7	76.0	114.6	163.6	224.0	296.7	482.5	727.8	1039.1
0.012	0.11	0.23	0.67	1.44	2.61	4.24	7.7	12.5	18.9	26.9	48.8	79.4	119.7	170.9	234.0	309.9	503.9	760.2	1085.3
0.013	0.11	0.24	0.69	1.50	2.71	4.41	8.0	13.0	19.6	28.0	50.8	82.6	124.6	177.9	243.6	322.6	524.5	791.2	1129.6
0.014	0.11	0.24	0.72	1.55	2.82	4.58	8.3	13.5	20.4	29.1	52.7	85.7	129.3	184.6	252.7	334.7	544.3	821.1	1172.3
0.015	0.12	0.25	0.75	1.61	2.91	4.74	8.6	14.0	21.1	30.1	54.6	88.7	133.8	191.1	261.6	346.5	563.4	849.9	1213.4
0.016	0.12	0.26	0.77	1.66	3.01	4.90	8.9	14.4	21.8	31.1	56.4	91.6	138.2	197.4	270.2	357.9	581.9	877.8	1253.2
0.017	0.13	0.27	0.79	1.71	3.10	5.05	9.1	14.9	22.4	32.0	58.1	94.5	142.5	203.4	278.5	368.9	599.8	904.8	1291.8
0.018	0.13	0.28	0.82	1.76	3.19	5.19	9.4	15.3	23.1	33.0	59.8	97.2	146.6	209.3	286.6	379.6	617.2	931.0	1329.2
0.019	0.13	0.28	0.84	1.81	3.28	5.33	9.7	15.7	23.7	33.9	61.4	99.9	150.6	215.1	294.4	390.0	634.1	956.5	1365.6
0.020	0.14	0.29	0.86	1.86	3.37	5.47	9.9	16.1	24.3	34.8	63.0	102.5	154.6	220.7	302.1	400.1	650.6	981.4	1401.1
0.021	0.14	0.30	0.88	1.90	3.45	5.61	10.2	16.5	24.9	35.6	64.6	105.0	158.4	226.1	309.6	410.0	666.7	1005.6	1435.7
0.022	0.14	0.31	0.90	1.95	3.53	5.74	10.4	16.9	25.5	36.4	66.1	107.5	162.1	231.4	316.8	419.6	682.3	1029.3	1469.5
0.023	0.15	0.31	0.92	1.99	3.61	5.87	10.6	17.3	26.1	37.3	67.6	109.9	165.7	236.6	324.0	429.0	697.7	1052.4	1502.5
0.024	0.15	0.32	0.94	2.03	3.69	6.00	10.9	17.7	26.7	38.1	69.0	112.2	169.3	241.7	330.9	438.3	712.7	1075.0	1534.9
0.025	0.15	0.33	0.96	2.08	3.76	6.12	11.1	18.0	27.2	38.9	70.4	114.6	172.8	246.7	337.7	447.3	727.4	1097.2	1566.5
0.026	0.15	0.33	0.98	2.12	3.84	6.24	11.3	18.4	27.8	39.6	71.8	116.8	176.2	251.6	344.4	456.2	741.8	1118.9	1597.5
0.027	0.16	0.34	1.00	2.16	3.91	6.36	11.5	18.7	28.3	40.4	73.2	119.0	179.6	256.4	351.0	464.9	755.9	1140.2	1628.0
0.028	0.16	0.35	1.02	2.20	3.98	6.48	11.7	19.1	28.8	41.1	74.6	121.2	182.9	261.1	357.4	473.4	769.8	1161.2	1657.8
0.029	0.16	0.35	1.04	2.24	4.05	6.59	11.9	19.4	29.3	41.8	75.9	123.4	186.1	265.7	363.8	481.8	783.4	1181.7	1687.2
0.030	0.17	0.36	1.06	2.27	4.12	6.70	12.2	19.8	29.8	42.6	77.2	125.5	189.3	270.3	370.0	490.0	796.8	1201.9	1716.0
0.031	0.17	0.36	1.07	2.31	4.19	6.81	12.4	20.1	30.3	43.3	78.4	127.6	192.4	274.7	376.1	498.1	810.0	1221.8	1744.4
0.032	0.17	0.37	1.09	2.35	4.26	6.92	12.6	20.4	30.8	44.0	79.7	129.6	195.5	279.1	382.1	506.1	822.9	1241.3	1772.3
0.033	0.17	0.38	1.11	2.38	4.32	7.03	12.7	20.7	31.3	44.6	80.9	131.6	198.5	283.4	388.0	513.9	835.7	1260.6	1799.8
0.034	0.18	0.38	1.12	2.42	4.39	7.14	12.9	21.0	31.7	45.3	82.2	133.6	201.5	287.7	393.9	521.7	848.3	1279.5	1826.8
0.035	0.18	0.39	1.14	2.46	4.45	7.24	13.1	21.3	32.2	46.0	83.4	135.5	204.5	291.9	399.6	529.3	860.6	1298.2	1853.5
0.036	0.18	0.39	1.16	2.49	4.52	7.34	13.3	21.6	32.7	46.6	84.5	137.5	207.4	296.1	405.3	536.8	872.9	1316.6	1879.8
0.037	0.18	0.40	1.17	2.52	4.58	7.44	13.5	21.9	33.1	47.3	85.7	139.4	210.2	300.1	410.9	544.2	884.9	1334.8	1905.7
0.038	0.19	0.40	1.19	2.56	4.64	7.54	13.7	22.2	33.6	47.9	86.9	141.2	213.0	304.2	416.4	551.5	896.8	1352.7	1931.3
0.039	0.19	0.41	1.20	2.59	4.70	7.64	13.9	22.5	34.0	48.5	88.0	143.1	215.8	308.1	421.8	558.7	908.5	1370.4	1956.6
0.040	0.19	0.41	1.22	2.63	4.76	7.74	14.0	22.8	34.4	49.1	89.1	144.9	218.6	312.1	427.2	565.8	920.1	1387.9	1981.5
0.041	0.19	0.42	1.23	2.66	4.82	7.84	14.2	23.1	34.9	49.8	90.2	146.7	221.3	315.9	432.5	572.8	931.5	1405.1	2006.1
0.042	0.20	0.42	1.25	2.69	4.88	7.93	14.4	23.4	35.3	50.4	91.3	148.5	224.0	319.8	437.8	579.8	942.8	1422.1	2030.4
0.043	0.20	0.43	1.26	2.72	4.94	8.03	14.6	23.7	35.7	51.0	92.4	150.2	226.6	323.6	443.0	586.6	954.0	1439.0	2054.5
0.044	0.20	0.43	1.28	2.75	4.99	8.12	14.7	23.9	36.1	51.5	93.5	152.0	229.2	327.3	448.1	593.4	965.0	1455.6	2078.2
0.045	0.20	0.44	1.29	2.78	5.05	8.21	14.9	24.2	36.5	52.1	94.5	153.7	231.8	331.0	453.1	600.1	975.9	1472.1	2101.7
0.046	0.21	0.44	1.31	2.82	5.10	8.30	15.0	24.5	36.9	52.7	95.6	155.4	234.4	334.7	458.1	606.8	986.7	1488.3	2124.9
0.047	0.21	0.45	1.32	2.85	5.16	8.39	15.2	24.7	37.3	53.3	96.6	157.1	236.9	338.3	463.1	613.3	997.3	1504.4	2147.9
0.048	0.21	0.45	1.34	2.88	5.21	8.48	15.4	25.0	37.7	53.8	97.6	158.7	239.4	341.9	468.0	619.8	1007.9	1520.3	2170.6
0.049	0.21	0.46	1.35	2.91	5.27	8.57	15.5	25.3	38.1	54.4	98.6	160.4	241.9	345.4	472.8	626.2	1018.3	1536.1	2193.1
0.050	0.21	0.46	1.36	2.94	5.32	8.65	15.7	25.5	38.5	54.9	99.6	162.0	244.4	348.9	477.6	632.6	1028.7	1551.7	2215.4
0.051	0.22	0.47	1.38	2.96	5.37	8.74	15.8	25.8	38.9	55.5	100.6	163.6	246.8	352.4	482.4	638.9	1038.9	1567.1	2237.4
0.052	0.22	0.47	1.39	2.99	5.43	8.83	16.0	26.0	39.2	56.0	101.6	165.2	249.2	355.8	487.1	645.1	1049.0	1582.4	2259.2
0.053	0.22	0.48	1.40	3.02	5.48	8.91	16.2	26.3	39.6	56.6	102.6	166.8	251.6	359.2	491.8	651.3	1059.1	1597.6	2280.9
0.054	0.22	0.48	1.42	3.05	5.53	8.99	16.3	26.5	40.0	57.1	103.5	168.4	254.0	362.6	496.4	657.4	1069.0	1612.6	2302.3
0.055	0.23	0.48	1.43	3.08	5.58	9.08	16.5	26.8	40.4	57.6	104.5	169.9	256.3	365.9	501.0	663.5	1078.9	1627.4	2323.5
0.056	0.23	0.49	1.44	3.11	5.63	9.16	16.6	27.0	40.7	58.2	105.4	171.5	258.6	369.2	505.5	669.5	1088.6	1642.1	2344.5
0.057	0.23	0.49	1.46	3.13	5.68	9.24	16.8	27.2	41.1	58.7	106.4	173.0	260.9	372.5	510.0	675.4	1098.3	1656.7	2365.4
0.058	0.23	0.50	1.47	3.16	5.73	9.32	16.9	27.5	41.5	59.2	107.3	174.5	263.2	375.8	514.4	681.3	1107.9	1671.2	2386.0
0.059	0.23	0.50	1.48	3.19	5.78	9.40	17.0	27.7	41.8	59.7	108.2	176.0	265.5	379.0	518.9	687.2	1117.4	1685.6	2406.5
0.060	0.24	0.51	1.49	3.22	5.83	9.48	17.2	27.9	42.2	60.2	109.1	177.5	267.7	382.2	523.2	693.0	1126.9	1699.8	2426.8
0.061	0.24	0.51	1.51	3.24	5.88	9.56	17.3	28.2	42.5	60.7	110.0	178.9	269.9	385.4	527.6	698.7	1136.2	1713.9	2447.0
0.062	0.24	0.51	1.52	3.27	5.93	9.64	17.5	28.4	42.9	61.2	110.9	180.4	272.1	388.5	531.9	704.4	1145.5		

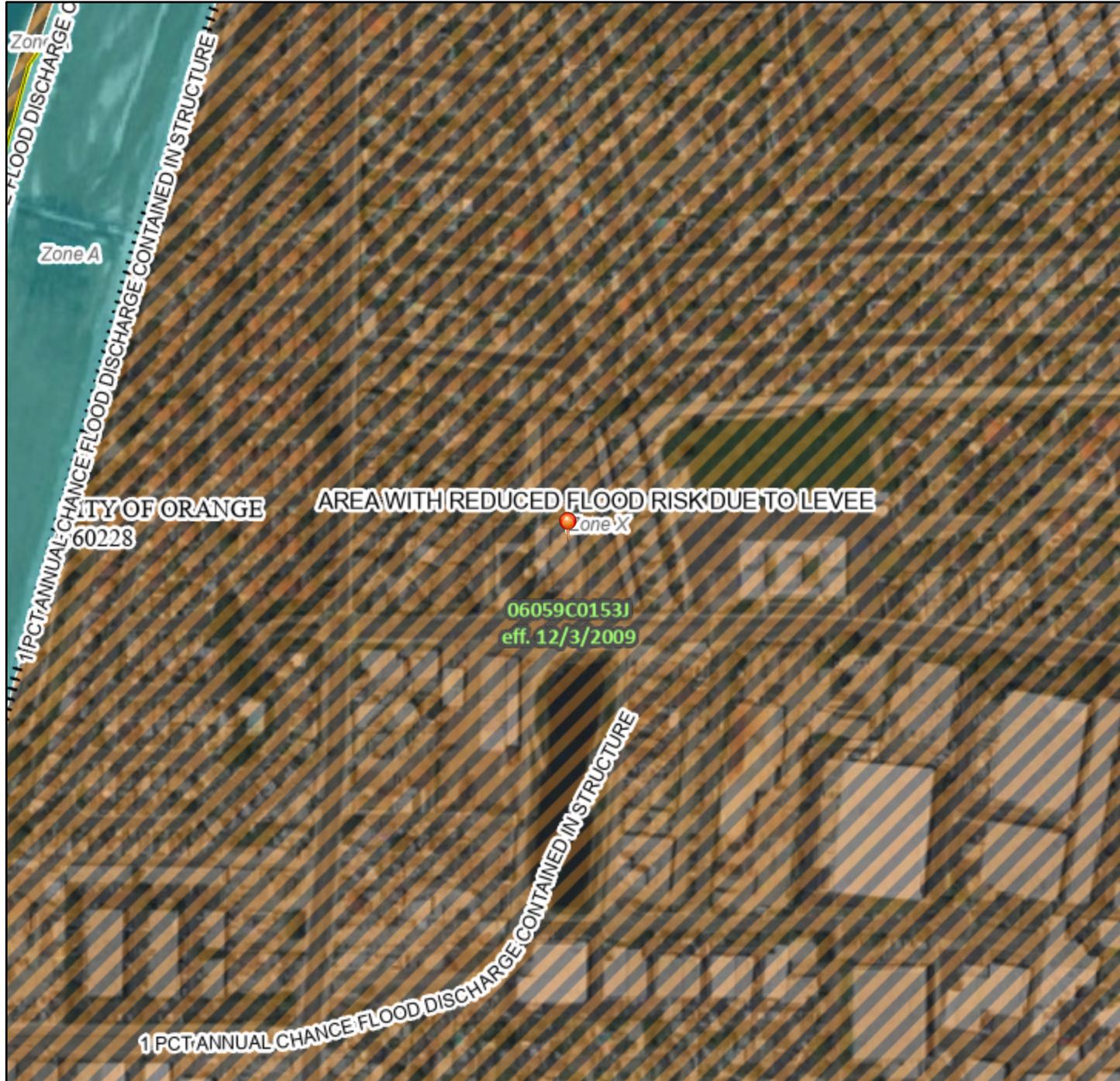
APPENDIX D – CURRENT PLANS

APPENDIX E – AS-BUILTS & REFERENCES

National Flood Hazard Layer FIRMette



117°51'54"W 33°50'4"N



1:6,000

117°51'16"W 33°49'34"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) <i>Zone A, V, A99</i>
		With BFE or Depth <i>Zone AE, AO, AH, VE, AR</i>
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile <i>Zone X</i>
		Future Conditions 1% Annual Chance Flood Hazard <i>Zone X</i>
		Area with Reduced Flood Risk due to Levee. See Notes. <i>Zone X</i>
		Area with Flood Risk due to Levee <i>Zone D</i>
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard <i>Zone X</i>
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard <i>Zone D</i>
		Channel, Culvert, or Storm Sewer
OTHER FEATURES		Levee, Dike, or Floodwall
		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
MAP PANELS		17.5 Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped
		The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.



This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

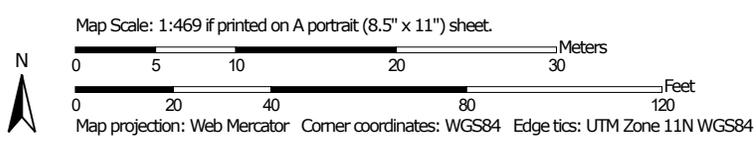
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **6/20/2025 at 10:09 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Hydrologic Soil Group—Orange County and Part of Riverside County, California
(705 west fletcher ave, orange california)



Soil Map may not be valid at this scale.



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Orange County and Part of Riverside County, California
 Survey Area Data: Version 18, Aug 30, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 14, 2022—Mar 17, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
163	Metz loamy sand	B	0.7	100.0%
Totals for Area of Interest			0.7	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The 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 have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

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.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Geotechnical Engineering Investigation
Proposed Residential Development
705 W. Fletcher Avenue
Orange, California

Keusder Homes, Inc.
3184 Airway Avenue, Suite B
Costa Mesa, CA 92626

Attn: Mr. Wes Keusder

Project Number 25305-25
May 29, 2025

NorCal Engineering

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NorCal Engineering
Soils and Geotechnical Consultants
10641 Humbolt Street Los Alamitos, CA 90720
(562) 799-9469

May 29, 2025

Project Number 25305-25

Keusder Homes, Inc.
3184 Airway Avenue, Suite B
Costa Mesa, California 92626

Attn.: Mr. Wes Keusder

RE: Geotechnical Engineering Investigation - Proposed Residential Development -
Located at 705 W. Fletcher Avenue, in the City of Orange, California

Dear Mr. Keusder:

Pursuant to your request, this firm has performed a Geotechnical Engineering Investigation for the above referenced project in accordance with your approval of our proposal dated February 11, 2025. The purpose of this investigation is to evaluate the geotechnical conditions of the subject site and to provide recommendations for the proposed residential development. The scope of work included the following: 1) site reconnaissance; 2) subsurface geotechnical exploration and sampling; 3) laboratory testing; 4) soil infiltration study; 5) engineering analysis of field and laboratory data; 5) preparation of a geotechnical engineering report.

1.0 Project Description

It is proposed to construct fifteen (15) detached single family residences as shown on the attached Site Plan. The proposed three-story residences will be supported by a conventional slab-on-grade foundation system with perimeter-spread footings and isolated interior footings. Other improvements will consist of a concrete/asphalt paved interior street, hardscape and landscaping. It is assumed that the proposed grading for the development will include cuts on the order of a few feet with minor fill procedures on to achieve finished grade elevations. Final building plans shall be reviewed by this firm prior to submittal for city approval to determine the need for any additional study and revised recommendations pertinent to the proposed development, if necessary.

2.0 Site Description

The 120' x 260' subject property is located within the west 700 block and north side of Fletcher Avenue, in the City of Orange. The generally rectangular-shaped parcel is elongated in a north to south direction with topography of the relatively level property descending slightly from back to front on the order of a few feet. The site is currently an undeveloped lot that is currently occupied by a few metal storage containers and parked motor home.

3.0 Site Exploration

The investigation consisted of the placement of nine (9) subsurface exploratory borings by a truck mounted hollow stem hand operated auger to depths ranging between 5 and 50 feet below current ground elevations. The explorations were visually classified and logged by a field engineer with locations of the subsurface explorations shown on the attached Site Plan. The field explorations revealed the existing earth materials to consist of fill and alluvium soil. Detailed descriptions of the subsurface conditions are listed on the boring logs in Appendix A. It should be noted that the transition from one soil type to another as shown on the boring logs is approximate and may in fact be a gradual transition. The soils encountered are described as follows:

Fill: A fill soil classifying as a brown, fine to medium grained, silty SAND with occasional gravel was encountered to depths ranging from 1 to 10 feet below ground surface. These soils were noted to be loose and dry to damp. Exploratory Boring B-8 appears to have been placed within a former underground tank excavation backfill area.

Alluvium: An undisturbed Young Alluvium soil deposit classifying as a light brown fine to coarse grained, slightly silty SAND with occasional gravel and cobble was encountered beneath the fill soils. These soils were observed to be medium dense to dense and damp. Deeper soils consisted of a fine to coarse grained, gravelly SAND do sandy to clayey SILT which were noted to be dense to medium stiff and damp to moist.

The overall engineering characteristics of the earth material were relatively uniform with each excavation. Groundwater was not encountered to the depths of our borings and some caving occurred in the deeper cohesionless soils.

4.0 **Laboratory Tests**

Relatively undisturbed samples of the subsurface soils were obtained to perform laboratory testing and analysis for direct shear, consolidation tests, and to determine in-place moisture/densities. These relatively undisturbed ring samples were obtained by driving a thin-walled steel sampler lined with one-inch long brass rings with an inside diameter of 2.42 inches into the undisturbed soils. Bulk bag samples were obtained in the upper soils for expansion index tests and maximum density tests.

Standard penetration tests were obtained by driving a steel sampler unlined with an inside diameter of 1.5 inches into the soils. This standard penetrometer sampler was driven a total of eighteen inches with blow counts tallied every six inches. Blow count data is given on the Boring Logs in Appendix A. All test results are included in Appendix B, unless otherwise noted.

- 4.1 **Field Moisture Content** (ASTM: D 2216) and the dry density of the ring samples were determined in the laboratory. This data is listed on the logs of explorations.
- 4.2 **Sieve analyses** (ASTM: D 422-63) and the percent by weight of soil finer than the No. 200 sieve (ASTM: 1140) were performed on selected soil samples. These results are shown later within the body of this report.
- 4.3 **Maximum Density tests** (ASTM: D 1557) were performed on typical samples of the upper soils. Results of these tests are shown on Table I.
- 4.4 **Expansion Index tests** (ASTM: D 4829) were performed on remolded samples of the upper soils to determine expansive characteristics. Results of these tests are provided on Table II.
- 4.5 **Atterberg Limits** (ASTM: D 4318) consisting of liquid limit, plastic limit and plasticity index were performed on representative soil samples. Results are shown on Table III.
- 4.6 **Corrosion tests** consisting of sulfate, pH, resistivity and chloride analysis to determine potential corrosive effects of soils on concrete and underground utilities. Test results are provided on Table IV.

- 4.7 **Direct Shear tests** (ASTM: D 3080) were performed on undisturbed and/or remolded samples of the subsurface soils. The test is performed under saturated conditions at loads of 1,000 lbs./sq.ft., 2,000 lbs./sq.ft., and 3,000 lbs./sq.ft. with results shown on Plate A.
- 4.8 **Consolidation tests** (ASTM: D 2435) were performed on undisturbed samples to determine the differential and total settlement which may be anticipated based upon the proposed loads. Water was added to the samples at a surcharge of one KSF and the settlement curves are plotted on Plates B and C.

5.0 Seismicity Evaluation

The proposed development lies outside of any Alquist Priolo Special Studies Zone and the potential for damage due to direct fault rupture is considered unlikely. The nearest fault is located about 10 kilometers from the site and is capable of producing a Magnitude 6.8 earthquake. Ground shaking originating from earthquakes along other active faults in the region is expected to induce lower horizontal accelerations due to smaller anticipated earthquakes and/or greater distances to other faults.

The following seismic design acceleration parameters for the project site are provided below based on the ASCE/SEI 7-16 American Society of Civil Engineers (ASCE) website, <https://asce7hazardtool.online/> and is attached in Appendix C.

Seismic Design Acceleration Parameters

Latitude	33.830
Longitude	-117.860
Site Class	D
Risk Category	II
Mapped Spectral Response Acceleration	$S_S = 1.501$ $S_1 = 0.531$
Adjusted Maximum Acceleration	$S_{MS} = 1.501$
Design Spectral Response Acceleration Parameters	$S_{DS} = 1.001$
Peak Ground Acceleration	$PGA_M = 0.698$

Use of these values is dependent on requirements of Section 11-4.8, ASCE 7 exception 2 that requires the value of the seismic response coefficient C_s be determined by Equation 12.8.2 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either 12.8-3 for $T_L \geq T \geq 1.5T_s$ or Equation 12.8-4 for $T > T_L$. Computations and verification of these conditions is referred to the structural engineer.

6.0 Liquefaction Evaluation

The site is expected to experience ground shaking and earthquake activity that is typical of Southern California area. It is during severe ground shaking that loose, granular soils below the groundwater table can liquefy. A review of the exploratory boring log and the laboratory test results on selected soil samples obtained indicate the following soil classifications, field blowcounts and amounts of fines passing through the No. 200 sieve.

Field Blowcount and Gradation Data

Boring No.	Classification	Blowcounts (blows/ft)	Relative Density	% Passing No. 200 Sieve
B-3 @ 5'	SW	7	Medium Dense	5
B-3 @ 10'	SW	10	Dense	9
B-3 @ 15'	SW	17	Dense	5
B-3 @ 20'	SW	20	Dense	2
B-3 @ 25'	ML	10	Medium Stiff	61
B-3 @ 30'	SW	69	Very Dense	16
B-3 @ 35'	SW	58	Very Dense	9
B-3 @ 40'	ML	18	Medium Stiff	63
B-3 @ 45'	SW	85	Very Dense	5
B-3 @ 50'	SW	67	Very Dense	7

Based upon information in the California Division of Mines and Geology "Seismic Hazard Zone Map – Orange Quadrangle" (1997), the subject site is situated in an area of historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions to indicate a potential for permanent ground displacement.

Our liquefaction evaluation utilized the nearest mode of predominate Magnitude 6.8 Mw earthquake. Review of the *California Department of Conservation – Division of Mines and Geology Open File Report 97-03, Plate 1.2*, indicates a historic high groundwater level greater than 25 feet below ground surface.

The results of our analysis indicates the liquefaction potential at this site to be low based upon the historic groundwater depth and a Peak Ground Acceleration (PGA_M) of 0.698g. The associated seismic-induced settlements would be less than one inch and would occur rather uniformly across the site. Differential settlements would be on the order of 1/2 inch over a 50-foot (horizontal) distance. Our seismic settlement calculations are included in Appendix C.

7.0 Infiltration Characteristics

Infiltration tests were performed in accordance with the Orange County Technical Guidance Document (OCTGD) Appendix VII – Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations with field infiltration rates calculated using the Porchet Method (aka Inverse Borehole Method).

A truck mounted Simco 2800 Drill Rig equipped with a hollow stem auger was used to excavate the exploratory borings (B-1 and B-2) to depths of 5 and 10 feet below existing ground surface. The infiltration test borings consisted of six-inch diameter test holes. A three-inch diameter perforated PVC casing with solid end cap was installed in each boring and then surrounded with gravel materials to prevent caving. The infiltration holes were carefully filled with clean water and refilled after two initial readings.

Based upon the initial rates of infiltration at each location, test measurements were measured at selected maximum intervals thereafter. Measurements were obtained by using an electronic tape measure with 1/16-inch divisions and timed with a stopwatch. The field data sheets are provided in Appendix D.

The drainage disposal system shall utilize design infiltration rates based on the safety factor required by the county standard. A total reduction factor of 3.0 should be used to calculate the design infiltration rates, as listed below.

$RF_t = 1.0$ for small diameter borings

$RF_v = 1.0$ for site variability

$RF_s = 1.0$ for long-term siltation plugging and maintenance. The subsurface soils are likely to have some plugging and regular maintenance of storm water discharge devices is required.

Boring/Test No.	Depth	Soil Classification	Field Infiltration Rate	Design Rate
B-1/TH-1	5'	SAND	75 in/hr	25 in/hr
B-2/TH-2	10'	SAND	150 in/hr	50 in/hr

All systems must meet the latest city and/or county specifications and the California Regional Water Quality Control Board (CRWQCB) requirements. It is recommended that foundations shall be setback a minimum distance of 10 feet from the drainage disposal system and the bottom of footing shall be a minimum of 10 feet from the expected zone of saturation. The boundary of the zone of saturation may be assumed to project downward from the top of the permeable portion of the disposal system at an inclination of 1 to 1 or flatter, as determined by the geotechnical engineer.

8.0 **Conclusions and Recommendations**

Based upon our evaluations, the proposed development is acceptable from a geotechnical engineering standpoint. By following the recommendations and guidelines set forth in our report, the structures will be safe from excessive settlements under the anticipated design loadings and conditions. The proposed development shall meet all requirements of the City Building Ordinance and will not impose any adverse effect on existing adjacent structures.

The following recommendations are based upon soil conditions encountered in our field investigation; these near-surface soil conditions could vary across the site. Variations in the soil conditions may not become evident until the commencement of grading operations for the proposed development and revised recommendations from the geotechnical engineer may be necessary based upon the conditions encountered.

It is recommended that site inspections be performed by a representative of this firm during all grading and construction of the development to verify the findings and recommendations documented in this report. Any unusual conditions which may be encountered in the course of the project development may require the need for additional study and revised recommendations.

8.1 **Site Grading Recommendations**

Any vegetation and/or demolition debris shall be removed and hauled from proposed grading areas prior to the start of grading operations. Existing vegetation shall not be mixed or disced into the soils. Any removed soils may be reutilized as compacted fill once any deleterious material or oversized materials (in excess of eight inches) is removed. Grading operations shall be performed in accordance with the attached *Specifications for Placement of Compacted Fill*.

All disturbed soils and/or fill (about 1 to 10 feet below ground surface) shall be removed to competent alluvium material, the exposed surface scarified to a depth of 12 inches, brought to within 2% of optimum moisture content and compacted to a minimum of 90% of the laboratory standard (ASTM: D 1557) prior to placement of any additional compacted fill soils, foundations, slabs-on-grade and pavement. Grading shall extend a minimum of five horizontal feet outside the edges of foundations or equidistant to the depth of fill placed, whichever is greater.

Due to the potential for differential settlement of foundations placed on compacted fill and alluvium, it is recommended that building foundations including floor slab areas be underlain by a uniform compacted fill blanket at least two feet in thickness. This fill blanket shall extend a minimum of five horizontal feet outside the edges of foundations or equidistant to the depth of fill placed, whichever is greater.

It is possible that isolated areas of undiscovered fill not described in this report are present on site; if found, these areas should be treated as discussed earlier. A diligent search shall also be conducted during grading operations in an effort to uncover any underground structures, irrigation or utility lines. If encountered, these structures and lines shall be either removed or properly abandoned prior to the proposed construction.

Any imported fill material should be preferably soil similar to the upper soils encountered at the subject site. All soils shall be approved by this firm prior to importing at the site and will be subjected to additional laboratory testing to assure concurrence with the recommendations stated in this report.

Care should be taken to provide or maintain adequate lateral support for all adjacent improvements and structures at all times during the grading operations and construction phase. Adequate drainage away from the structures, pavement and slopes should be provided at all times.

8.2 **Temporary Excavations**

Temporary unshored excavations in the existing site materials may be made at vertical inclinations up to 4 feet in height unless cohesionless soils are encountered. In areas where soils with little or no binder are encountered, where adverse geological conditions are exposed, or where excavations are adjacent to existing structures, shoring or flatter excavations may be required. Additional recommendations regarding specific excavations may be provided once typical detail sections are made available.

The temporary cut slope gradients given above do not preclude local raveling and sloughing. All excavations shall be made in accordance with the requirements of the soils engineer, CAL-OSHA and other public agencies having jurisdiction. Care should be taken to provide or maintain adequate lateral support for all adjacent improvements and structures at all times during the grading operations and construction phase.

8.3 **Foundation Design**

All foundations for the proposed residences may be designed utilizing an allowable bearing capacity of 2,000 psf for an embedded depth of 24 inches into approved engineered fill. A one-third increase may be used when considering short-term loading and seismic forces. Any foundations for smaller structures (site walls, etc.) located along property line may utilize an allowable bearing capacity of 2,000 psf and embedded a minimum depth of 18 inches and into competent native soils. A representative of this firm shall inspect all foundation excavations prior to pouring concrete.

8.4 Settlement Analysis

Resultant pressure curves for the consolidation tests are shown on Plates B and C. Computations utilizing these curves and the recommended allowable soil bearing capacities reveal that the foundations will experience settlements on the order of ¾ inch and differential settlements of less than ¼ inch.

8.5 Lateral Resistance

The following values may be utilized in resisting lateral loads imposed on the structure. Requirements of the California Building Code should be adhered to when the coefficient of friction and passive pressures are combined.

Coefficient of Friction - 0.40

Equivalent Passive Fluid Pressure = 250 lbs./cu.ft.

Maximum Passive Pressure = 2,500 lbs./cu.ft.

The passive pressure recommendations are valid only for approved compacted fill soils or competent native materials.

8.6 Retaining Wall Design Parameters

Active earth pressures against retaining walls will be equal to the pressures developed by the following fluid densities. These values are for **approved granular backfill material** placed behind the walls at various ground slopes above the walls.

Surface Slope of Retained Materials (Horizontal to Vertical)	Equivalent Fluid Density (lb./cu.ft.)
Level	30
5 to 1	35
4 to 1	38
3 to 1	40
2 to 1	45

Any applicable short-term construction surcharges and seismic forces should be added to the above lateral pressure values. An equivalent fluid pressure of 45 pcf may be utilized for the restrained wall condition with a level grade behind the wall.

The seismic-induced lateral soil pressure for walls greater than 6 feet may be computed using a triangular pressure distribution with the maximum value at the top of the wall. The maximum lateral pressure of $(20 \text{ pcf}) H$ where H is the height of the retained soils above the wall footing should be used in final design of retaining walls. Sliding resistance values and passive fluid pressure values may be increased by $1/3$ during short-term wind and seismic loading conditions.

All walls shall be waterproofed as needed and protected from hydrostatic pressure by a reliable permanent subdrain system. The granular backfill to be utilized immediately adjacent to retaining walls shall consist of an approved select granular soil with a sand equivalency greater than 30. This backfill zone of free draining material shall consist of a wedge beginning a minimum of one horizontal foot from the base of the wall extending upward at an inclination of no less than $3/4$ to 1 (horizontal to vertical).

8.7 **Slab Design**

All concrete slabs shall be a minimum of four inches in thickness and placed on approved subgrade soils. Any concrete slab-on-grade in pavement areas shall be a minimum of five inches in thickness reinforced and placed on approved subgrade soils. A vapor retarder (10-mil minimum thickness) should be utilized in areas which would be sensitive to the infiltration of moisture. This retarder shall meet requirements of ASTM E 96, *Water Vapor Transmission of Materials* and ASTM E 1745, *Standard Specification for Water Vapor Retarders used in Contact with Soil or Granular Fill Under Concrete Slabs*. The vapor retarder shall be installed in accordance with procedures stated in ASTM E 1643, *Standard practice for Installation of Water Vapor Retarders used in Contact with Earth or Granular Fill Under Concrete Slabs*.

The moisture retarder may be placed directly upon compacted subgrade soils conditioned to near optimum moisture levels, although one to two inches of sand beneath the membrane is desirable. The subgrade upon which the retarder is placed shall be smooth and free of rocks, gravel or other protrusions which may damage the retarder. Use of sand above the retarder is under the purview of the structural engineer; if sand is used over the retarder, it should be placed in a dry condition.

8.8 **Utility Trench and Excavation Backfill**

Trenches from installation of utility lines and other excavations may be backfilled with on-site soils or approved imported soils compacted to a minimum of 90% relative compaction. All utility lines shall be properly bedded with clean sand having a sand equivalency rating of 30 or more. This bedding material shall be thoroughly water jetted around the pipe structure prior to placement of compacted backfill soils.

8.9 **Corrosion Design Criteria**

Representative samples of the surficial soils, typical of the subgrade soils expected to be encountered within foundation excavations and underground utilities were tested for corrosion potential. The minimum resistivity value obtained for the samples tested is representative of an environment that may be severely corrosive to metals. The soil pH value was considered mildly acidic and may not have a significant effect on soil corrosivity. Consideration should be given to corrosion protection systems for buried metal such as protective coatings, wrappings or the use of PVC where permitted by local building codes.

According to Table 4.3.1 of ACI 318 Building Code and Commentary, these contents revealed negligible sulfate concentrations. Therefore, a Type II cement according to latest CBC specifications may be utilized for building foundations at this time. It is recommended that additional sulfate tests be performed at the completion of site grading to assure that the as graded conditions are consistent with the recommendations stated in this design. Corrosion test results may be found on the attached Table IV.

8.10 **Expansive Soil**

If expansive soils are encountered, special attention should be given to the project design and maintenance. The attached *Expansive Soil Guidelines* should be reviewed by the engineers, architects, owner, maintenance personnel and other interested parties and considered during the design of the project and future property maintenance.

9.0 Closure

The recommendations and conclusions contained in this report are based upon the soil conditions uncovered in our test excavations. No warranty of the soil condition between our excavations is implied. NorCal Engineering should be notified for possible further recommendations if unexpected to unfavorable conditions are encountered during construction phase. It is the responsibility of the owner to ensure that all information within this report is submitted to the Architect and appropriate Engineers for the project.

A preconstruction conference should be held between the general contractor, grading contractor, city inspector, architect, and geotechnical engineer to clarify any questions relating to the grading operations and subsequent construction. Our representative should be present during the grading operations and construction phase to certify that such recommendations are complied within the field.

This geotechnical investigation has been conducted in a manner consistent with the level of care and skill exercised by members of our profession currently practicing under similar conditions in the Southern California area. No other warranty, expressed or implied is made.

We appreciate this opportunity to be of service to you. If you have any further questions, please do not hesitate to contact the undersigned.

Respectfully submitted,
NORCAL ENGINEERING



Keith D. Tucker
Project Engineer
R.G.E. 841



Scott D. Spensiero
Project Manager

NorCal Engineering

References

1. American Society of Civil Engineers (ASCE) website, <https://asce7hazardtool.online/>
2. California Building Code, 2022.
3. California Department of Conservation, California Geological Survey, 2007, Fault-Rupture Hazard Zones in California; Special Publication 42.
4. California Department of Water Resources, Internet Website, <http://www.water.ca.gov/waterdatalibrary/index.cfm>.
5. California Division of Mines and Geology, 1998, Seismic Hazard Zone for Orange 7.5-Minute Quadrangle, Orange County, California
6. California Division of Mines and Geology, 2008, Guidelines for Evaluating and Mitigating Seismic Hazards in California: Special Publication 117A.
7. Earthquake Zones of Required Investigation, Seismic Hazard Zones, Orange Quadrangle (1997) published by the California Geological Survey.
8. Orange County Technical Guidance Document (OCTGD) Appendix VII – Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations dated December 20, 2013.

SPECIFICATIONS FOR PLACEMENT OF COMPACTED FILL

Excavation

Any existing low-density soils and/or saturated soils shall be removed to competent natural soil under the inspection of the Geotechnical Engineering Firm. After the exposed surface has been cleansed of debris and/or vegetation, it shall be scarified until it is uniform in consistency, brought to the proper moisture content and compacted to a minimum of 90% relative compaction (in accordance with ASTM: D 1557).

In any area where a transition between fill and native soil or between bedrock and soil are encountered, additional excavation beneath foundations and slabs will be necessary in order to provide uniform support and avoid differential settlement of the structure.

Material for Fill

The on-site soils or approved import soils may be utilized for the compacted fill provided they are free of any deleterious materials and shall not contain any rocks, brick, asphaltic concrete, concrete or other hard materials greater than eight inches in maximum dimensions. Any import soil must be approved by the Geotechnical Engineering firm a minimum of 72 hours prior to importation of site.

Placement of Compacted Fill Soils

The approved fill soils shall be placed in layers not excess of six inches in thickness. Each lift shall be uniform in thickness and thoroughly blended. The fill soils shall be brought to within 2% of the optimum moisture content, unless otherwise specified by the Soils Engineering firm. Each lift shall be compacted to a minimum of 90% relative compaction (in accordance with ASTM: D 1557) and approved prior to the placement of the next layer of soil. Compaction tests shall be obtained at the discretion of the Geotechnical Engineering firm but to a minimum of one test for every 500 cubic yards placed and/or for every 2 feet of compacted fill placed.

The minimum relative compaction shall be obtained in accordance with accepted methods in the construction industry. The final grade of the structural areas shall be in a dense and smooth condition prior to placement of slabs-on-grade or pavement areas. No fill soils shall be placed, spread or compacted during unfavorable weather conditions. When the grading is interrupted by heavy rains, compaction operations shall not be resumed until approved by the Geotechnical Engineering firm.

Grading Observations

The controlling governmental agencies should be notified prior to commencement of any grading operations. This firm recommends that the grading operations be conducted under the observation of a Soils Engineering firm as deemed necessary. A 24-hour notice must be provided to this firm prior to the time of our initial inspection.

Observation shall include the clearing and grubbing operations to assure that all unsuitable materials have been properly removed; approve the exposed subgrade in areas to receive fill and in areas where excavation has resulted in the desired finished grade and designate areas of overexcavation; and perform field compaction tests to determine relative compaction achieved during fill placement. In addition, all foundation excavations shall be observed by the Geotechnical Engineering firm to confirm that appropriate bearing materials are present at the design grades and recommend any modifications to construct footings.

EXPANSIVE SOIL GUIDELINES

The following expansive soil guidelines are provided for your project. The intent of these guidelines is to inform you, the client, of the importance of proper design and maintenance of projects supported on expansive soils. ***You, as the owner or other interested party, should be warned that you have a duty to provide the information contained in the soil report including these guidelines to your design engineers, architects, landscapers and other design parties in order to enable them to provide a design that takes into consideration expansive soils.***

In addition, you should provide the soil report with these guidelines to any property manager, lessee, property purchaser or other interested party that will have or assume the responsibility of maintaining the development in the future.

Expansive soils are fine-grained silts and clays which are subject to swelling and contracting. The amount of this swelling and contracting is subject to the amount of fine-grained clay materials present in the soils and the amount of moisture either introduced or extracted from the soils. Expansive soils are divided into five categories ranging from “very low” to “very high”. Expansion indices are assigned to each classification and are included in the laboratory testing section of this report. *If the expansion index of the soils on your site, as stated in this report, is 21 or higher, you have expansive soils.* The classifications of expansive soils are as follows:

Classification of Expansive Soil*

Expansion Index	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
Above 130	Very High

*From Table 18A-I-B of California Building Code (1988)

When expansive soils are compacted during site grading operations, care is taken to place the materials at or slightly above optimum moisture levels and perform proper compaction operations. Any subsequent excessive wetting and/or drying of expansive soils will cause the soil materials to expand and/or contract. These actions are likely to cause distress of foundations, structures, slabs-on-grade, sidewalks and pavement over the life of the structure. ***It is therefore imperative that even after construction of improvements, the moisture contents are maintained at relatively constant levels, allowing neither excessive wetting or drying of soils.***

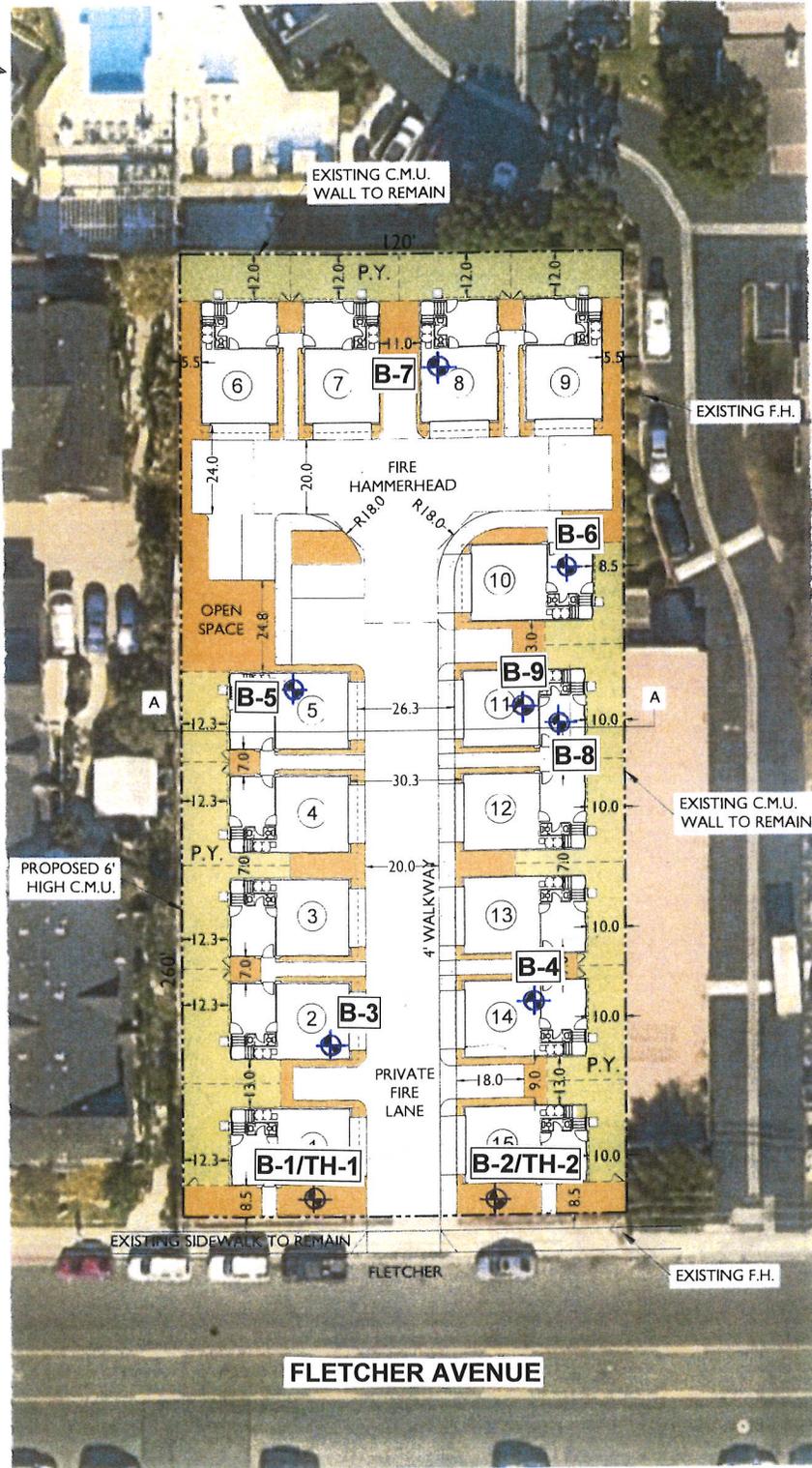
Evidence of excessive wetting of expansive soils may be seen in concrete slabs, both interior and exterior. Slabs may lift at construction joints producing a trip hazard or may crack from the pressure of soil expansion. Wet clays in foundation areas may result in lifting of the structure causing difficulty in the opening and closing of doors and windows, as well as cracking in exterior and interior wall surfaces. In extreme wetting of soils to depth, settlement of the structure may eventually result. Excessive wetting of soils in landscape areas adjacent to concrete or asphaltic pavement areas may also result in expansion of soils beneath pavement and resultant distress to the pavement surface.

Excessive drying of expansive soils is initially evidenced by cracking in the surface of the soils due to contraction. Settlement of structures and on-grade slabs may also eventually result along with problems in the operation of doors and windows.

Projects located in areas of expansive clay soils will be subject to more movement and "hairline" cracking of walls and slabs than similar projects situated on non-expansive sandy soils. There are, however, measures that developers and property owners may take to reduce the amount of movement over the life the development. The following guidelines are provided to assist you in both design and maintenance of projects on expansive soils:

- Drainage away from structures and pavement is essential to prevent excessive wetting of expansive soils. Grades should be designed to the latest building code and maintained to allow flow of irrigation and rain water to approved drainage devices or to the street. Any “ponding” of water adjacent to buildings, slabs and pavement after rains is evidence of poor drainage; the installation of drainage devices or regrading of the area may be required to assure proper drainage. Installation of rain gutters is also recommended to control the introduction of moisture next to buildings. Gutters should discharge into a drainage device or onto pavement which drains to roadways.
- Irrigation should be strictly controlled around building foundations, slabs and pavement and may need to be adjusted depending upon season. This control is essential to maintain a relatively uniform moisture content in the expansive soils and to prevent swelling and contracting. Over-watering adjacent to improvements may result in damage to those improvements. NorCal Engineering makes no specific recommendations regarding landscape irrigation schedules.
- Planting schemes for landscaping around structures and pavement should be analyzed carefully. Plants (including sod) requiring high amounts of water may result in excessive wetting of soils. Trees and large shrubs may actually extract moisture from the expansive soils, thus causing contraction of the fine-grained soils.
- Thickened edges on exterior slabs will assist in keeping excessive moisture from entering directly beneath the concrete. A six-inch thick or greater deepened edge on slabs may be considered. Underlying interior and exterior slabs with 6 to 12 inches or more of non-expansive soils and providing presaturation of the underlying clayey soils as recommended in the soil report will improve the overall performance of on-grade slabs.

- Increase the amount of steel reinforcing in concrete slabs, foundations and other structures to resist the forces of expansive soils. The precise amount of reinforcing should be determined by the appropriate design engineers and/or architects.
- Recommendations of the soil report should always be followed in the development of the project. Any recommendations regarding presaturation of the upper subgrade soils in slab areas should be performed in the field and verified by the Soil Engineer.



NORTH

 1 INCH = 50 FEET

NorCal Engineering

SOILS AND GEOTECHNICAL CONSULTANTS

SITE PLAN

PROJECT	25305-25	DATE	MAY 2025
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List of Appendices **(in order of appearance)**

Appendix A – Log of Excavations

Log of Borings B-1 to B-9

Appendix B – Laboratory Tests

Table I – Maximum Dry Density

Table II – Expansion

Table III – Atterberg Limits

Table IV – Corrosion

Plate A – Direct Shear

Plates B and C - Consolidation

Appendix C – Liquefaction Analysis

Liquefaction Calculations

Seismic Design Report

Seismic Hazard Zones Map

Geologic Map

Appendix D – Soil Infiltration Data

Field Data Sheets and Calculations

Appendix A

Log of Excavations

MAJOR DIVISION			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS			
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL, SAND MIXTURES, LITTLE OR NO FINES			
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES			
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES			
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES			
	MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		
					SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		
		MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	SANDS WITH FINE (APPRECIABLE AMOUNT OF FINES)			SM	SILTY SANDS, SAND-SILT MIXTURES	
						SC	CLAYEY SANDS, SAND-CLAY MIXTURES	
			FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
							CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY						
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS		
					CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
					OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS		
					PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS		
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS			

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

KEY:

- Indicates 2.5-inch Inside Diameter. Ring Sample.
- ⊗ Indicates 2-inch OD Split Spoon Sample (SPT).
- Indicates Shelby Tube Sample.
- Indicates No Recovery.
- Indicates SPT with 140# Hammer 30 in. Drop.
- ⊗ Indicates Bulk Sample.
- ▣ Indicates Small Bag Sample.
- Indicates Non-Standard
- ⊗ Indicates Core Run.

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5mm) to No. 200 (0.074mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074 mm)

COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Trace	1 - 5%
Few	5 - 10%
Little	10 - 20%
Some	20 - 35%
And	35 - 50%

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
DAMP	Some perceptible moisture; below optimum
MOIST	No visible water; near optimum moisture content
WET	Visible free water, usually soil is below water table.

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N -VALUE

COHESIONLESS SOILS		COHESIVE SOILS		
Density	N (blows/ft)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	Very Soft	0 to 2	< 250
Loose	4 to 10	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	Very Stiff	15 to 30	2000 - 4000
		Hard	over 30	> 4000

Keusder Homes, Inc.
25305-25

Log of Boring B-1

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

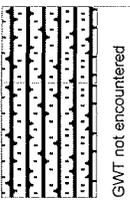
Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, loose, dry; with occasional gravel Alluvium					
5		Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble Boring completed at depth of 5'					
10							
15							
20							
25							
30							
35							

NorCal Engineering

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, loose, dry; with occasional gravel Alluvium					
5		Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble					
10		Boring completed at depth of 10'					
15							
20							
25							
30							
35							

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog425305-25.log Date: 5/27/2025

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory	
			Type	Blow Counts	Moisture	Dry Density
0		FILL Silty (fine to medium grained) SAND Brown, loose, dry; with occasional gravel Alluvium Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble		3/3/4 4/5/5 5/7/10 4/8/12 4/5/5 20/32/37	2.0 4.8 4.1 3.4 19.9 6.3	5 9 5 2 61 16
5		Sandy SILT Light grey brown, medium stiff, moist				
10						
15						
20						
25		Gravelly (fine to coarse grained) SAND Brown, dense to very dense, slightly moist to damp; slightly silty with cobbles				
30						
35						

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog\25305-25.log Date: 5/29/2025

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory	
			Type	Blow Counts	Moisture	Dry Density
35		Gravelly (fine to coarse grained) SAND Brown, dense to very dense, damp; slightly silty with cobbles		19/27/31	5.3	9
40		Clayey SILT Dark brown, medium stiff, moist		8/9/9	17.0	63
45		Gravelly (fine to coarse grained) SAND Brown, very dense, damp; slightly silty with cobbles		30/35/50	3.7	5
50		Boring completed at depth of 51.5'		30/32/35	4.2	7
55						
60						
65						
70						

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\25305-25.log Date: 5/27/2025

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

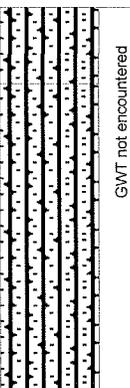
Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory	
			Type	Blow Counts	Moisture	Dry Density
0		FILL Silty (fine to medium grained) SAND Brown, loose, dry; with occasional gravel Alluvium				
5		Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble	█	7/7	2.8	98.2
10		Boring completed at depth of 10	█	7/10	2.0	98.0
15						
20						
25						
30						
35						

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

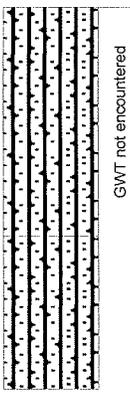
Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory	
			Type	Blow Counts	Moisture	Dry Density
0	 <p>GWT not encountered</p>	FILL Silty (fine to medium grained) SAND Brown, loose, dry to moist; with occasional gravel and cobbles	█	3/3	5.9	93.3
5		Alluvium Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble	█	2/5	4.7	95.1
10		Boring completed at depth of 10'	█	8/8	2.6	102.8
15						
20						
25						
30						
35						

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0		FILL	█	5/8	1.5	101.8	
		Silty (fine to medium grained) SAND Brown, loose, dry; with occasional gravel					
		Alluvium					
5		Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble					
10			█	5/6	4.2	97.0	
15			█	8/9	3.7	102.2	
Boring completed at depth of 15'							

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\25305-25.log Date: 5/27/2025

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

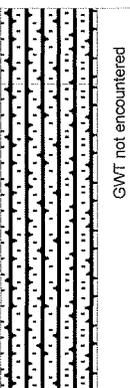
Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory	
			Type	Blow Counts	Moisture	Dry Density
0		FILL Silty (fine to medium grained) SAND Brown, loose, dry; with occasional gravel Alluvium				
5		Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble	█	5/5	1.7	96.3
10			█	5/9	2.8	103.3
10		Boring completed at depth of 10'				
15						
20						
25						
30						
35						

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

Groundwater Depth: None Encountered

Drilling Method: Hand Auger

Hammer Weight:

Drop:

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	 GWT not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, dry to damp; with occasional gravel	■		6.4	93.3	
5				■		5.8	94.9
10		Alluvium Silty (fine to coarse grained) SAND Light brown, medium dense, moist; slightly silty with occasional gravel Boring completed at depth of 11'					
15							
20							
25							
30							
35							

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\25305-25.log Date: 5/27/2025

Boring Location: 705 W. Fletcher Avenue, Orange

Date of Drilling: 5/16/2025

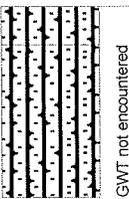
Groundwater Depth: None Encountered

Drilling Method: Hand Auger

Hammer Weight:

Drop:

Surface Elevation:

Depth (feet)	Lithology	Material Description	Samples		Laboratory	
			Type	Blow Counts	Moisture	Dry Density
0		FILL Silty (fine to medium grained) SAND Brown, loose, dry; with occasional gravel Alluvium				
5		Silty (fine to coarse grained) SAND Light brown, medium dense to dense, damp; slightly silty with occasional gravel and cobble Boring completed at depth of 5'				
10						
15						
20						
25						
30						
35						

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog\425305-25.log Date: 5/27/2025

Appendix B

Laboratory Tests

TABLE I
MAXIMUM DENSITY TESTS

Sample	Classification	Optimum Moisture (%)	Maximum Dry Density (lbs/cu.ft)
B-4 @ 2'	Silty SAND	9.0	112.0

TABLE II
EXPANSION TESTS

Sample	Classification	Expansion Index
B-4 @ 2'	Silty SAND	0

TABLE III
ATTERBERG LIMITS

Sample	Liquid Limit	Plastic Limit	Plasticity Index
B-3 @ 25'	26	21	5
B-3 @ 40'	30	22	8

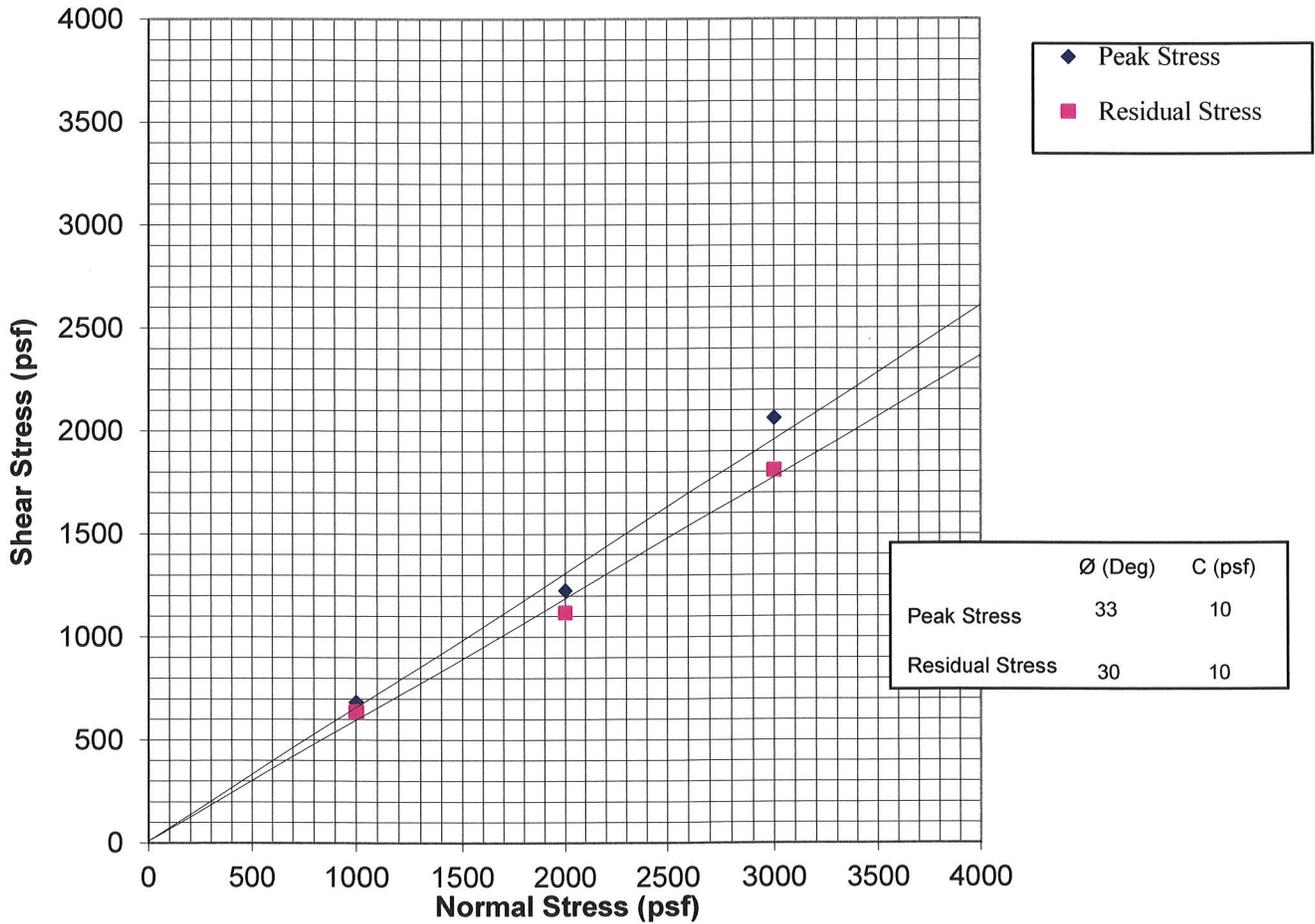
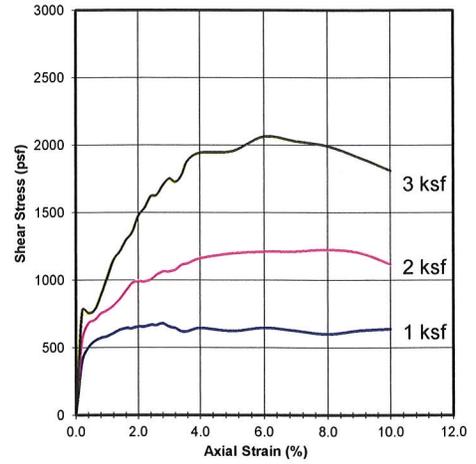
TABLE IV
CORROSION TESTS

Sample	pH	Electrical Resistivity	Sulfate (%)	Chloride (ppm)
B-4 @ 2'	6.8	7,920	0.003	210

% by weight
ppm – mg/kg

Sample No. B6@2'
 Sample Type: Undisturbed-Saturated
 Soil Description: F-M Grained Sand w/ Some Silt

		1	2	3
Normal Stress	(psf)	1000	2000	3000
Peak Stress	(psf)	684	1224	2064
Displacement	(in.)	0.070	0.200	0.150
Residual Stress	(psf)	636	1116	1812
Displacement	(in.)	0.250	0.250	0.250
Initial Dry Density	(pcf)	101.8	101.8	101.8
Initial Water Content	(%)	1.5	1.5	1.5
Strain Rate	(in./min.)	0.020	0.020	0.020



NorCal Engineering
 SOILS AND GEOTECHNICAL CONSULTANTS

Keusder Homes Inc.

PROJECT NUMBER: 25305-25

DATE: 5/29/2025

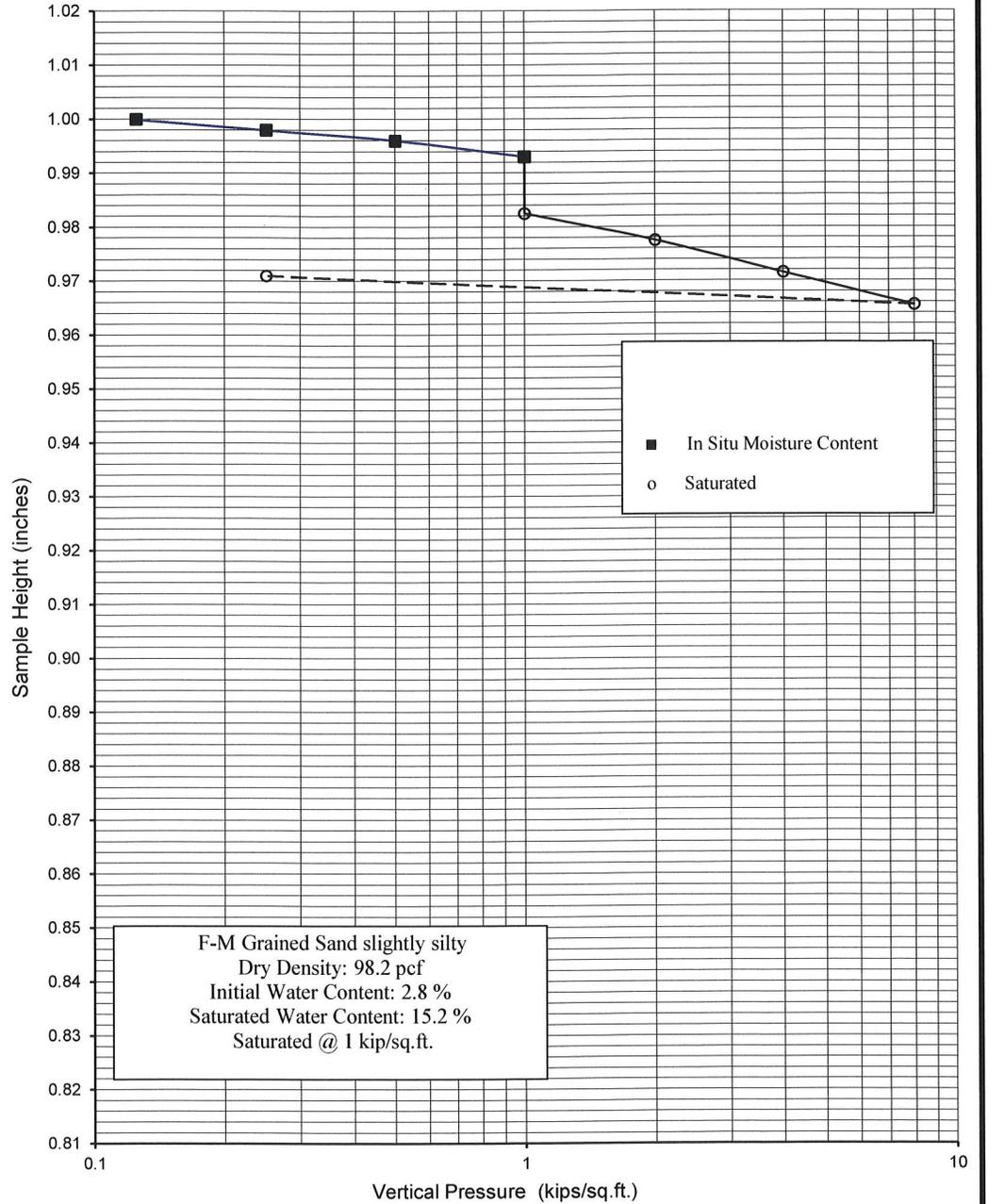
DIRECT SHEAR TEST
ASTM D3080

Plate A

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	Saturated	Sample No.	B4	Depth	5'	Date	5/29/2025
------------------------------------	---------------------------	----------------------------	-----------	------------	----	-------	----	------	-----------

0.125	1.0000	0.0
0.25	0.9980	0.2
0.5	0.9960	0.4
1	0.9930	0.7
1	0.9825	1.8
2	0.9775	2.3
4	0.9715	2.9
8	0.9655	3.5
0.25	0.9710	2.9

Date Tested: 5/27/2025
Sample: B4
Depth: 5'

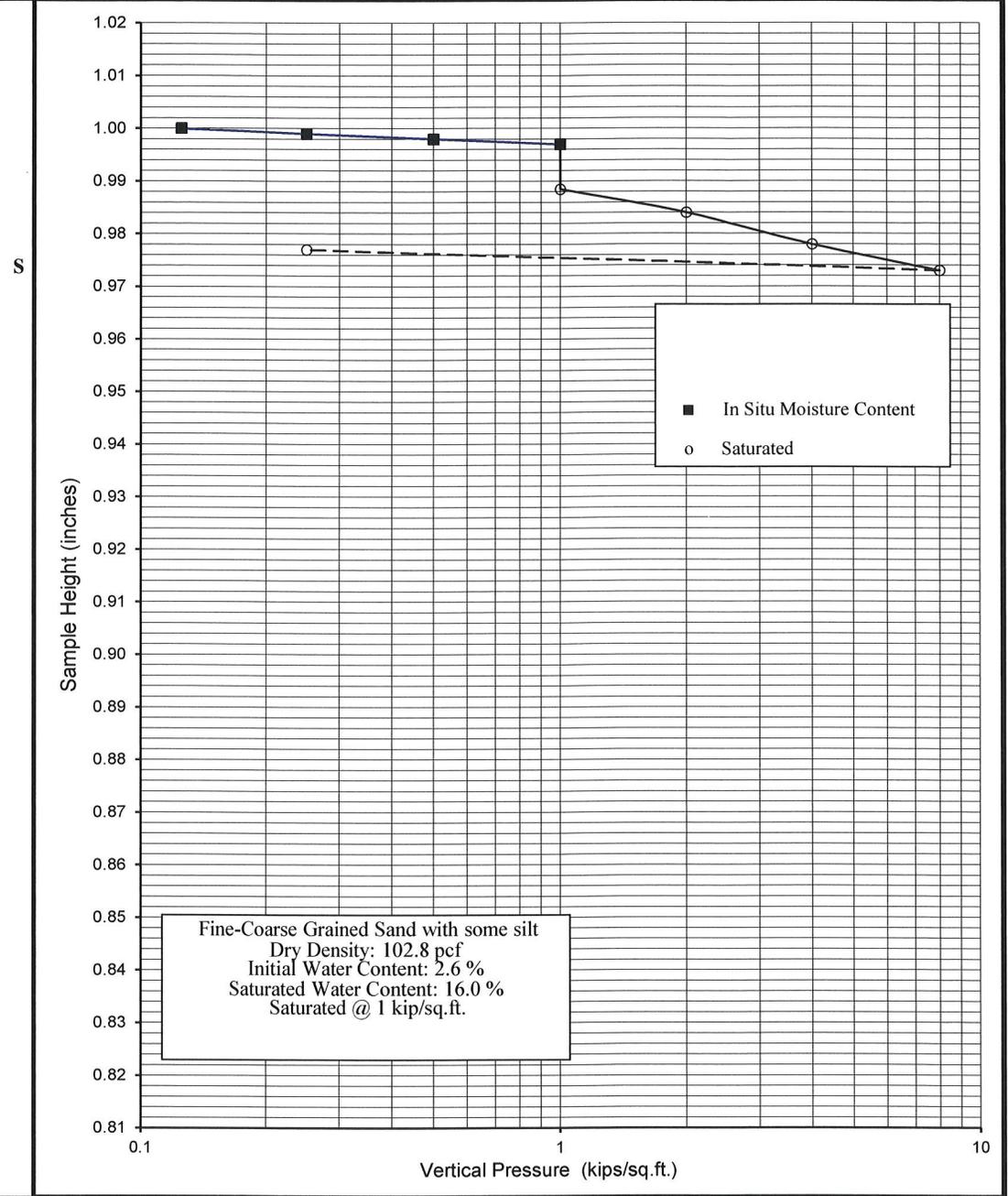


NorCal Engineering SOILS AND GEOTECHNICAL CONSULTANTS Keusder Homes, Inc.		CONSOLIDATION TEST ASTM D2435 Plate B
PROJECT NUMBER:	25305-25	DATE: 5/29/2025

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	Saturated	Sample No. B5	Depth 10'	Date 5/29/2025
------------------------------------	---------------------------	----------------------------	-----------	---------------	-----------	----------------

0.125	1.0000	0.0
0.25	0.9990	0.1
0.5	0.9980	0.2
1	0.9970	0.3
1	0.9885	1.2
2	0.9840	1.6
4	0.9780	2.2
8	0.9730	2.7
0.25	0.9770	2.3

Date Tested: 5/27/2025
Sample: B5
Depth: 10'



NorCal Engineering SOILS AND GEOTECHNICAL CONSULTANTS		CONSOLIDATION TEST ASTM D2435 Plate C	
Keusder Homes Inc.			
PROJECT NUMBER: 25305-25	DATE: 5/29/2025		

Appendix C

Liquefaction Analysis

SITE LOCATION: _____

GEOTECHNICAL REPORT: _____

GEOLOGY REPORT: _____

DEPTH TO WATER TABLE = 25

EARTHQUAKE MAGNITUDE = 6.8

PEAK GROUND ACCELERATION = 0.70g

DEPTH BELOW FINAL GRADE (FEET)	MOIST DENSITY (PCF)	σ_0 TOTAL STRESS (PSF)	σ_0 EFFECTIVE STRESS (PSF)	σ_v/σ_0 (-)	r_d (-)	T_{h1}/σ_0 (-)	N VALUE (BLOWS/FT)	RELATIVE DENSITY (%)	C_u (-)	C_E (-)	C_B (-)	C_R (-)	C_S (-)	(N ₁) ₆₀ (BLOWS/FT)	FINES (%)	CRR M=7.5 (-)	MSF (-)	CRR M=6.8 (-)	LQR. F.S.
5	100	500	Same	1.00	0.99	0.46	7	60	>1.6	1.00	1.05	0.70	1.20	>10	5	>0.11	1.4	>0.15	>0.3
10	↓	1000	↓	↓	0.96	0.44	10	65	1.4	↓	↓	↓	↓	13	9	0.17	↓	0.24	0.5
15	105	1525	↓	↓	0.92	0.42	17	75	1.15	↓	↓	↓	↓	21	5	0.23	↓	0.32	0.8
20	↓	2050	↓	↓	0.87	0.40	20	75	1.0	↓	↓	↓	↓	23	2	0.25	↓	0.35	0.9
25	↓	2575	↓	↓	0.80	0.36	10	55	0.9	↓	↓	↓	↓	11	91	>0.20	↓	>0.28	>0.8
30	↓	3100	2788	1.11	0.74	0.38	69	>90	0.83	↓	↓	↓	↓	72	16	>0.50	↓	>0.70	>1.8
35	↓	3625	3001	1.21	0.68	0.38	58	>90	0.78	↓	↓	↓	↓	57	9	>0.50	↓	>0.70	>1.8
40	↓	4150	3214	1.29	0.64	0.38	18	60	0.74	↓	↓	↓	↓	17	63	>0.30	↓	>0.42	>1.1
45	↓	4675	3427	1.36	0.61	0.38	85	>90	0.70	↓	↓	↓	↓	75	5	>0.50	↓	>0.70	>1.8
50	↓	5200	3640	1.43	0.58	0.38	67	>90	0.66	↓	↓	↓	↓	56	7	>0.50	↓	>0.70	>1.8

① INDUCED CYCLIC STRESS RATIO = $T_{ave}/\sigma_0 = 0.65 \cdot \frac{\sigma_{max}}{g} \cdot \frac{\sigma_0}{\sigma_0} \cdot r_d$

• C_E = Corr. - Energy Ratio = Energy Ratio / 60%

• C_B = Corr. - Borehole Dia. = 1.15 for 8" dia. borehole

• C_R = Corr. - Rod Length

• C_S = Corr. - Sampling Method

Actual Energy Ratio = 0.67-1.17 (Safety Hammer)

= 0.50-1.00 (Dowt Hammer)

Sampling Method = 1.0 Standard sampler

= 1.2 Sampler w/o liners

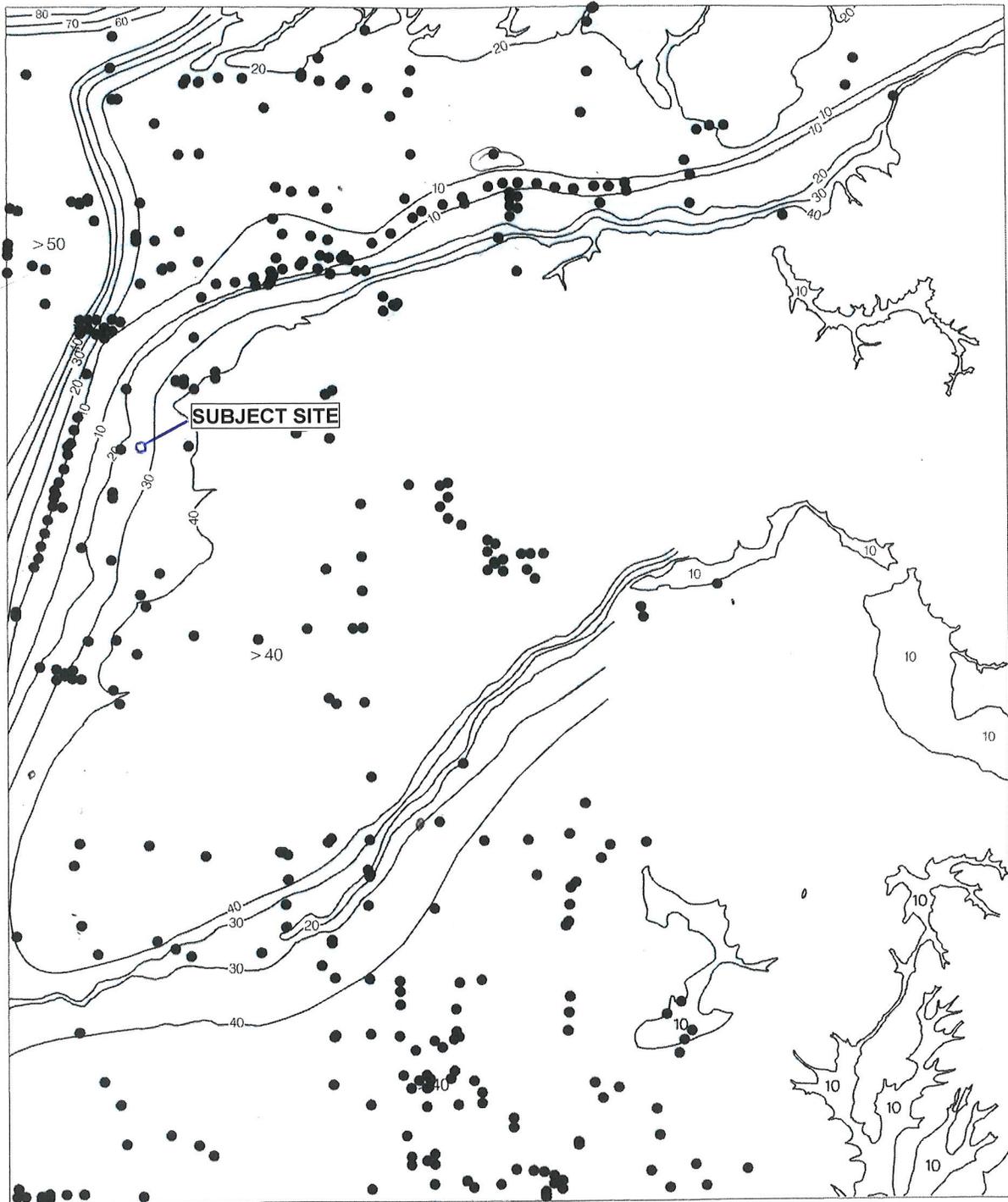
NorCal Engineering
SOILS AND GEOTECHNICAL CONSULTANTS

EVALUATION OF LIQUEFACTION POTENTIAL

PROJECT _____

DATE _____

117° 52' 30"
33° 52' 30"



Base map enlarged from U.S.G.S. 30 x 60-minute series

117° 45'
33° 45'

Plate 1.2 Historically Highest Ground Water Contours and Borehole Log Data Locations, Orange 7.5-minute Quadrangle, California.

● Borehole Site

— 30 — Depth to ground water in feet

ONE MILE
SCALE

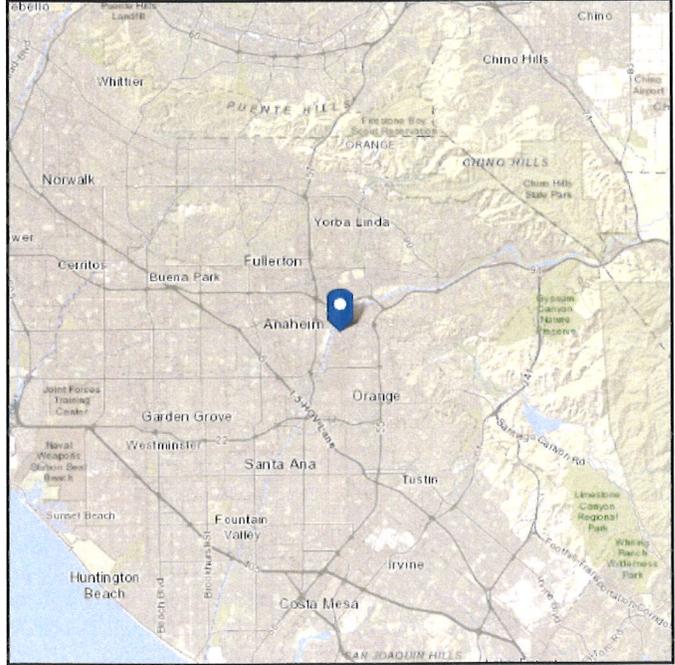
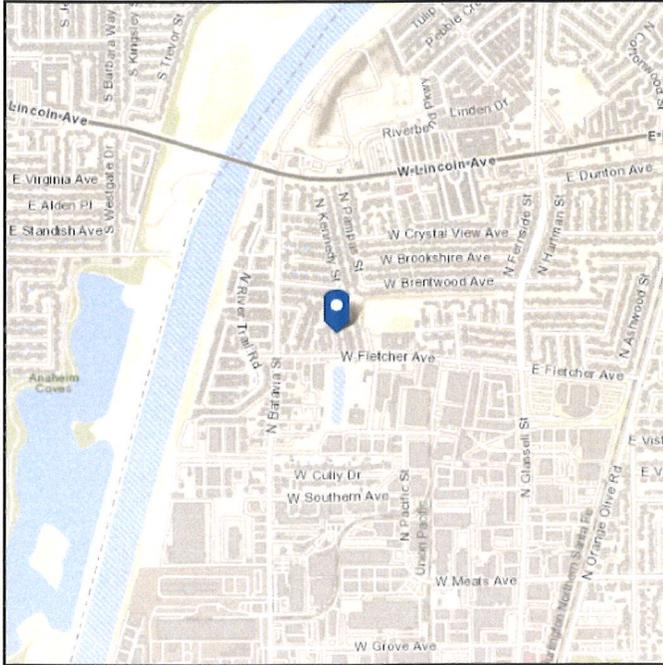


ASCE Hazards Report

Address:
705 W Fletcher Ave
Orange, California
92865

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Stiff Soil

Latitude: 33.83029
Longitude: -117.859731
Elevation: 202.4649512131302 ft
(NAVD 88)



Seismic

Site Soil Class: D - Stiff Soil

Results:

S_s :	1.501	S_{D1} :	N/A
S_1 :	0.531	T_L :	8
F_a :	1	PGA :	0.634
F_v :	N/A	PGA _M :	0.698
S_{MS} :	1.501	F_{PGA} :	1.1
S_{M1} :	N/A	I_e :	1
S_{DS} :	1.001	C_v :	1.4

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Data Accessed: Tue May 13 2025

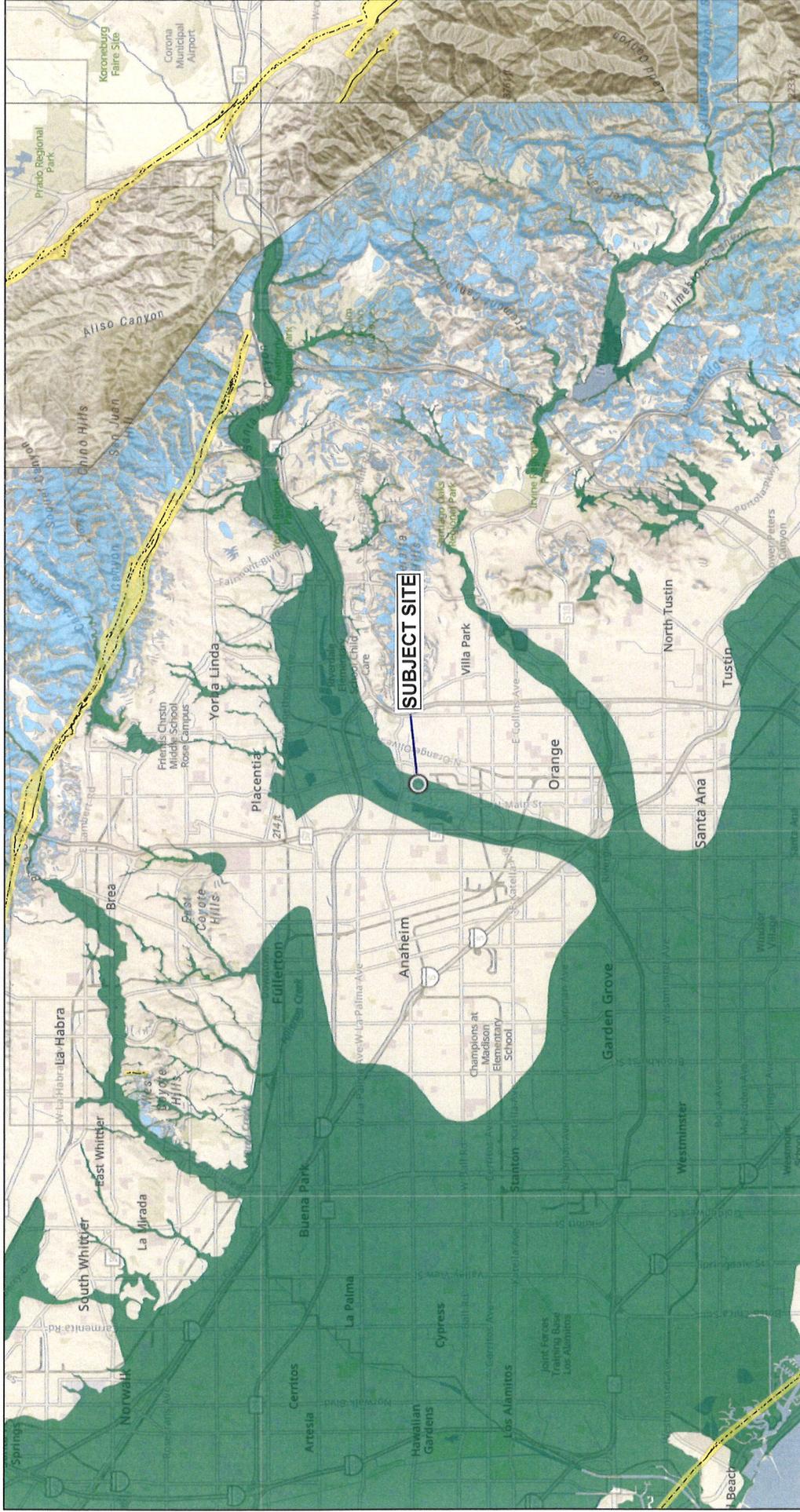
Date Source: [USGS Seismic Design Maps](#)

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ArcGIS Web Map



5/13/2025, 1:37:40 PM

CGS Alquist Priolo Fault Traces

----- Concealed

----- Concealed, Queried

CGS Liquefaction Zones

CGS Landslide Zones

CGS SHZ Unevaluated Areas

CGS Alquist-Priolo Fault Zones

1:144,352

0 1.5 3 4.5 6 mi

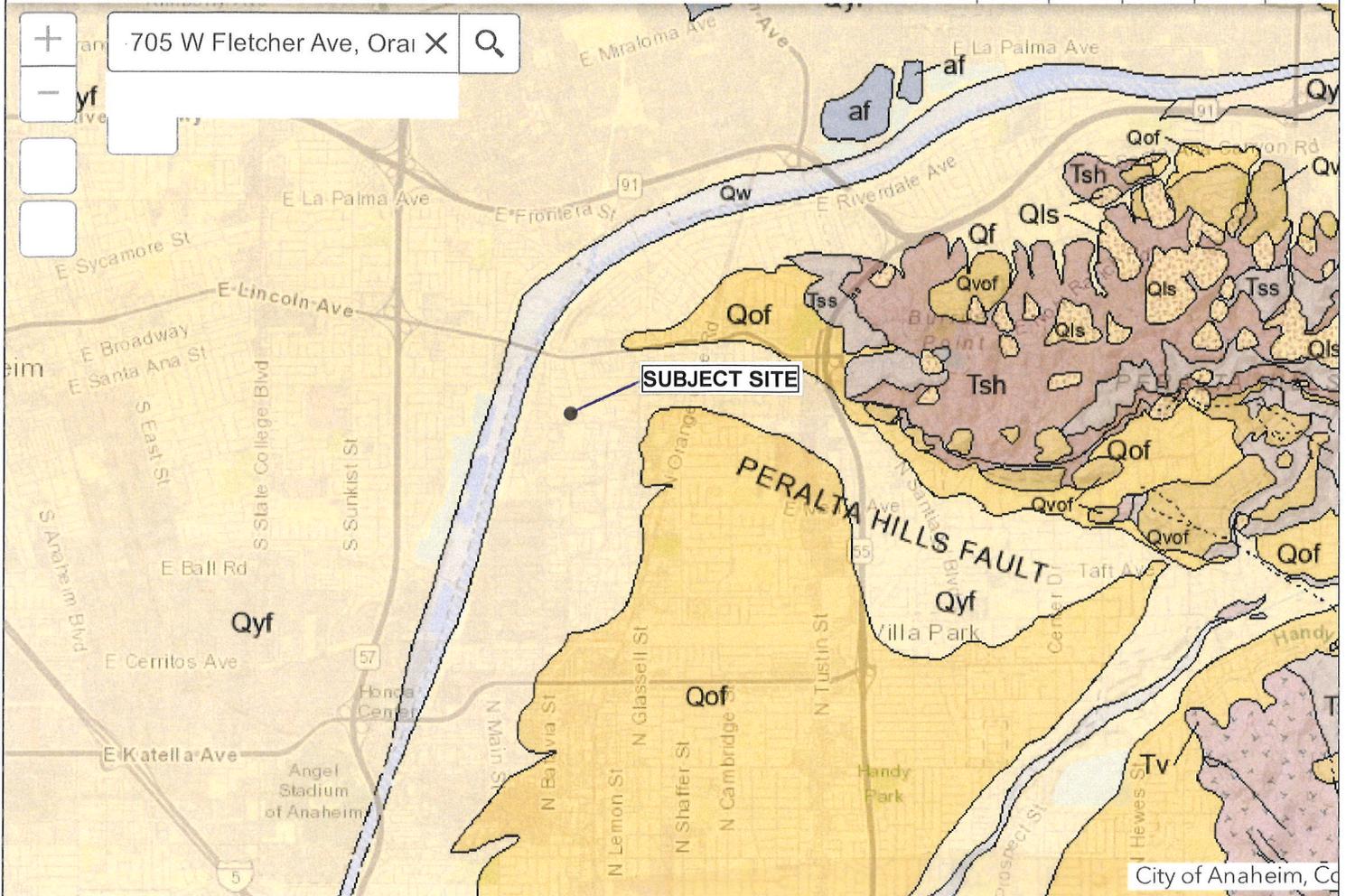
0 2.25 4.5 9 km



Esri, NASA, NGA, USGS, Earthstar, Geographics, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



Compilation of Quaternary Surficial Deposits



PType	Qyf
Name	Young Alluvial Fan Deposits
Source Quadrangle	Santa Ana 30' x 60'
Source	USGS
Reference Document	santa_ana_30x60_reference.pdf



1mi

-117.805 33.827 Degrees

Appendix D

Soil Infiltration Data



SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

Client: Keusder Homes, Inc.	Date: 5/16/2025
Project No.: 25305-25	Tested By: J.S.
Test Hole: 1	USCS Soil Classification:
Depth of Test Hole: 5' (60")	Sides (if rectangular):
Diameter of Test Hole: 6"	Length:
Sandy Soil Criteria Test*:	Width:

TRIAL NO.	START TIME	STOP TIME	TIME INTERVAL (MIN)	INITIAL DEPTH TO WATER (IN)	FINAL DEPTH TO WATER (IN)	CHANGE IN WATER LEVEL (IN)	GREATER THAN OR EQUAL TO 6"
1	7:22	7:23	1	45.0	60.0	15.0	
2	7:23	7:24	1	45.0	60.0	15.0	

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight. Obtain at least twelve measurements per hole over at least six hours (approximately 30-minute intervals) with a precision of at least 0.25".

TRIAL NO	START TIME	STOP TIME	ΔT TIME INTERVAL (MIN)	Do INITIAL DEPTH TO WATER (IN)	Df FINAL DEPTH TO WATER (IN)	ΔD CHANGE IN WATER LEVEL (IN)	PERCOLATION RATE (MIN/IN)
1	7:24	7:25	1	45.0	60.0	15.0	
2	7:25	7:26	1	45.0	60.0	15.0	
3	7:26	7:27	1	45.0	60.0	15.0	
4	7:27	7:28	1	45.0	60.0	15.0	
5	7:28	7:29	1	45.0	60.0	15.0	
6	7:29	7:30	1	45.0	60.0	15.0	
7	7:30	7:31	1	45.0	60.0	15.0	
8	7:31	7:32	1	45.0	60.0	15.0	
9	7:32	7:33	1	45.0	60.0	15.0	
10	7:33	7:34	1	45.0	60.0	15.0	
11	7:34	7:35	1	45.0	60.0	15.0	
12	7:35	7:36	1	45.0	60.0	15.0	
13	7:36	7:37	1	45.0	60.0	15.0	
14	7:37	7:38	1	45.0	60.0	15.0	
15	7:38	7:39	1	45.0	60.0	15.0	

COMMENTS:



SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

TRIAL NO	START TIME	STOP TIME	ΔT TIME INTERVAL (MIN)	Do INITIAL DEPTH TO WATER (IN)	Df FINAL DEPTH TO WATER (IN)	ΔD CHANGE IN WATER LEVEL (IN)	PERCOLATION RATE (MIN/IN)
16	7:39	7:40	1	45.0	60.0	15.0	
17	7:40	7:41	1	45.0	60.0	15.0	
18	7:41	7:42	1	45.0	60.0	15.0	
19	7:42	7:43	1	45.0	60.0	15.0	
20	7:43	7:44	1	45.0	60.0	15.0	
21	7:44	7:45	1	45.0	60.0	15.0	
22	7:45	7:46	1	45.0	60.0	15.0	
23	7:46	7:47	1	45.0	60.0	15.0	
24	7:47	7:48	1	45.0	60.0	15.0	
25	7:48	7:49	1	45.0	60.0	15.0	
26	7:49	7:50	1	45.0	60.0	15.0	
27	7:50	7:51	1	45.0	60.0	15.0	
28	7:51	7:52	1	45.0	60.0	15.0	
29	7:52	7:53	1	45.0	60.0	15.0	
30	7:53	7:54	1	45.0	60.0	15.0	
31	7:54	7:55	1	45.0	60.0	15.0	
32	7:55	7:56	1	45.0	60.0	15.0	
33	7:56	7:57	1	45.0	60.0	15.0	
34	7:57	7:58	1	45.0	60.0	15.0	
35	7:58	7:59	1	45.0	60.0	15.0	
36	7:59	8:00	1	45.0	60.0	15.0	
37	8:00	8:01	1	45.0	60.0	15.0	
38	8:01	8:02	1	45.0	60.0	15.0	
39	8:02	8:03	1	45.0	60.0	15.0	
40	8:03	8:04	1	45.0	60.0	15.0	
41	8:04	8:05	1	45.0	60.0	15.0	
42	8:05	8:06	1	45.0	60.0	15.0	
43	8:06	8:07	1	45.0	60.0	15.0	
44	8:07	8:08	1	45.0	60.0	15.0	
45	8:08	8:09	1	45.0	60.0	15.0	
46	8:09	8:11	2	45.0	60.0	15.0	
47	8:11	8:13	2	45.0	60.0	15.0	

COMMENTS:



SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

Client: Keusder Homes, Inc.	Date: 5/16/2025
Project No.: 25305-25	Tested By: J.S.
Test Hole: 2	USCS Soil Classification:
Depth of Test Hole: 10' (120")	Sides (if rectangular):
Diameter of Test Hole: 10"	Length:
Sandy Soil Criteria Test*:	Width:

TRIAL NO.	START TIME	STOP TIME	TIME INTERVAL (MIN)	INITIAL DEPTH TO WATER (IN)	FINAL DEPTH TO WATER (IN)	CHANGE IN WATER LEVEL (IN)	GREATER THAN OR EQUAL TO 6"
1	7:35	7:36	1	105.0	120.0	15.0	
2	7:36	7:37	1	105.0	120.0	15.0	

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight. Obtain at least twelve measurements per hole over at least six hours (approximately 30-minute intervals) with a precision of at least 0.25".

TRIAL NO	START TIME	STOP TIME	ΔT TIME INTERVAL (MIN)	Do INITIAL DEPTH TO WATER (IN)	Df FINAL DEPTH TO WATER (IN)	ΔD CHANGE IN WATER LEVEL (IN)	PERCOLATION RATE (MIN/IN)
1	7:37	7:38	1	105.0	120.0	15.0	
2	7:38	7:39	1	105.0	120.0	15.0	
3	7:39	7:40	1	105.0	120.0	15.0	
4	7:40	7:41	1	105.0	120.0	15.0	
5	7:41	7:42	1	105.0	120.0	15.0	
6	7:42	7:43	1	105.0	120.0	15.0	
7	7:43	7:44	1	105.0	120.0	15.0	
8	7:44	7:45	1	105.0	120.0	15.0	
9	7:45	7:46	1	105.0	120.0	15.0	
10	7:46	7:47	1	105.0	120.0	15.0	
11	7:47	7:48	1	105.0	120.0	15.0	
12	7:48	7:49	1	105.0	120.0	15.0	
13	7:49	7:50	1	105.0	120.0	15.0	
14	7:50	7:51	1	105.0	120.0	15.0	
15	7:51	7:52	1	105.0	120.0	15.0	

COMMENTS:



SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

TRIAL NO	START TIME	STOP TIME	ΔT TIME INTERVAL (MIN)	Do INITIAL DEPTH TO WATER (IN)	Df FINAL DEPTH TO WATER (IN)	ΔD CHANGE IN WATER LEVEL (IN)	PERCOLATION RATE (MIN/IN)
16	7:52	7:53	1	105.0	120.0	15.0	
17	7:53	7:54	1	105.0	120.0	15.0	
18	7:54	7:55	1	105.0	120.0	15.0	
19	7:55	7:56	1	105.0	120.0	15.0	
20	7:56	7:57	1	105.0	120.0	15.0	
21	7:57	7:58	1	105.0	120.0	15.0	
22	7:58	7:59	1	105.0	120.0	15.0	
23	7:59	8:00	1	105.0	120.0	15.0	
24	8:00	8:01	1	105.0	120.0	15.0	
25	8:01	8:02	1	105.0	120.0	15.0	
26	8:02	8:03	1	105.0	120.0	15.0	
27	8:03	8:04	1	105.0	120.0	15.0	
28	8:04	8:05	1	105.0	120.0	15.0	
29	8:05	8:06	1	105.0	120.0	15.0	
30	8:06	8:07	1	105.0	120.0	15.0	
31	8:07	8:08	1	105.0	120.0	15.0	
32	8:08	8:09	1	105.0	120.0	15.0	
33	8:09	8:10	1	105.0	120.0	15.0	
34	8:10	8:11	1	105.0	120.0	15.0	
35	8:11	8:12	1	105.0	120.0	15.0	
36	8:12	8:13	1	105.0	120.0	15.0	
37	8:13	8:14	1	105.0	120.0	15.0	
38	8:14	8:15	1	105.0	120.0	15.0	
39	8:15	8:16	1	105.0	120.0	15.0	
40	8:16	8:17	1	105.0	120.0	15.0	
41	8:17	8:18	1	105.0	120.0	15.0	
42	8:18	8:19	1	105.0	120.0	15.0	
43	8:19	8:20	1	105.0	120.0	15.0	
44	8:20	8:21	1	105.0	120.0	15.0	
45	8:21	8:22	1	105.0	120.0	15.0	
46	8:22	8:23	1	105.0	120.0	15.0	
47	8:23	8:24	1	105.0	120.0	15.0	

COMMENTS:

SOIL INFILTRATION RATE CALCS ⇒ PORCHET METHOD

Location:	TH-1	TH-2
• Depth of Hole =	5.0'	10.0'
• Hole Radius =	3"	3"
• Drop = Δh	15"	15"
• Time = Δt Interval	2 min	1 min
• Initial Water Depth = H_0	15"	15"
• Final Water Depth = H_t	ϕ	ϕ
• Average Water Head = H_{avg}	7.5"	7.5"
• INFILTRATION RATE	75 in/hr	150 in/hr

$$\text{Infiltration Rate} = \frac{\Delta h (60)(r)}{\Delta t (r + z + H_{avg})}$$

$$\text{Average Water Head} = \frac{1}{2} (H_t - H_0)$$