

SECTION 7.7

BUILDING CONSTRUCTION DUST

(Updated August 1997)

EMISSION INVENTORY SOURCE CATEGORY

Miscellaneous Processes / Construction and Demolition

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION

630-622-5400-0000 (47357) Building Construction Dust - Residential

630-624-5400-0000 (47365) Building Construction Dust - Commercial

630-626-5400-0000 (47373) Building Construction Dust - Industrial

630-628-5400-0000 (54551) Building Construction Dust - Institutional

630-630-5400-0000 (60400) Building Construction Dust - Governmental

METHODS AND SOURCES

The building construction dust source category provides estimates of the fugitive dust particulate matter caused by construction activities while building residential, commercial, industrial, or institutional, or governmental structures. The emissions result predominantly from site preparation work which may include scraping, grading, loading, digging, compacting, light-duty vehicle travel, and other operations. Particulate matter emissions estimates for construction activities are listed in Table 1.

OVERVIEW OF ESTIMATION METHODOLOGY

Dust emissions from construction operations are computed by using a PM₁₀ emission factor developed by Midwest Research Institute during 1996.¹ The emission factor is based on observations of construction operations in California and Las Vegas. Activity data for construction is expressed in terms of acre-months of construction. Acre-months are based on estimates of the acres disturbed for residential construction, and project valuation for other, non-residential, construction. The activity data used for the construction operations emissions is based on 1987 baseline activity estimates, grown to 1993 for this update.

EMISSIONS ESTIMATION METHODOLOGY

Emission Factor. The emission factor used for our estimates of geologic dust emissions from construction activities is based on work performed by Midwest Research Institute (MRI)¹ under contract to the PM₁₀ Best Available Control Measure working group. For most parts of the State, the emission factor used is 0.11 tons PM₁₀/acre-month of activity (or 0.17 tons TSP/acre-month). This emission factor is based on MRI's observation of the types, quantity, and duration of operations at eight construction sites (three in Las Vegas, and five in California). The bulk of the operations observed were site preparation related activities. The observed activity data were then combined with operation specific emission factors provided in U.S. EPA's AP-42 (5th Edition)² document to produce site emissions estimates. These site estimates were then combined to produce the overall average emission factor of 0.11. This emission factor is approximately 71% lower than the previous emission factor that was used from the 4th Edition of AP-42.

The construction emission factor is assumed to include the effects of typical control measures such as routine watering. A dust control effectiveness of 50% is assumed from these measures, which is based on the estimated control effectiveness of watering.³ Therefore, if this emission factor is used for construction activities where watering is not used, it should be doubled to more accurately reflect the actual emissions. The MRI document lists their average emission factor values as uncontrolled. However, our judgement is that the activities observed and the emission estimates do include the residual effects of controls. All of the test sites observed were actual operations that used watering controls as part of their standard industry practice in California and Las Vegas. So, even if in some cases watering was not performed during the actual site visits, the residual decreases in emissions from the watering controls and raising the soil moisture are thought to be included in the MRI estimates.

The MRI report also includes an emission factor for worst-case emissions of 0.42 tons PM₁₀/acre-month. This emission factor is appropriate for large scale construction operations which involve substantial earthmoving operations. The South Coast Air Quality Management District (SCAQMD) estimated that a percentage of their construction projects involve these types of operations, and applied the larger emission factor to the activities. For the remainder of the State, such detailed information is not readily available, so the average emission factor of 0.11 tons PM₁₀/acre-month was used.

This methodology directly computes PM₁₀ emissions. The TSP emissions are PM₁₀ x 1.56.⁴

Activity Data. For the purpose of estimating emissions, it is assumed that the fugitive dust emissions are related to the acreage affected by construction. Because region-wide estimates of the acreage under construction are not directly available, other construction activity data are used to derive acreage estimates. Activity data are estimated separately for residential construction, and the other types of construction (commercial, industrial, institutional, and governmental). The baseline activity data for construction are based on 1987 estimates, which are grown, using construction activity projections, to 1993 levels.

For residential construction, the number of new housing starts, estimated by the Department of Finance⁵ for 1987, was used to estimate acreage disturbed. Based on reference sources,^{6,7,8} it was estimated that single-family living units (houses) are built on 1/7 of an acre in heavily populated counties, and 1/5 of an acre in less populated counties. It was also estimated that multiple living units, such as apartments, occupy 1/20 of an acre per living unit. For all of these residential construction activities, a project duration of six months is assumed.⁶ Applying these factors to the reported number of new units in each county result in an estimate of acre-months of construction. This, combined with the construction emission factor is used to estimate residential construction particulate emissions.

For commercial, industrial, and institutional building construction, construction acreage is based on project valuations obtained from the Department of Finance.⁹ The valuations are 3.7, 4.0, and 4.4 acres per million dollars of valuation for the respective construction types listed.^{10,11} Valuations are corrected from 1977 to 1987 values using the U.S. Department of Commerce composite cost indices.¹¹ Each acre is assumed to be under construction for 11 months for each project type.⁶

The South Coast Air Quality Management District also computes construction activity emissions for governmental construction activities. The air district uses the same methods and assumptions used for the other non-residential construction. The SCAQMD governmental construction PM₁₀ emissions are included in the ARB's database, but are not included in the emissions summary in Table 1.

TEMPORAL ACTIVITY AND GROWTH

Temporal activity is assumed to occur five days a week between the hours of 8:00 a.m. and 4:00 p.m. The table below shows the percentage of construction activity that is estimated to occur during each month. The monthly activity increases during the spring and summer months as shown below. Some districts use a slightly different profile that has a larger peak during the summer months. Construction emissions for future years are based on construction activity projections.

CES	Hours	Days	Weeks
ALL	8	5	52

CES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALL	6.4	6.4	8.3	9.2	9.2	9.2	9.2	9.2	9.2	8.3	8.3	7.3

ASSUMPTIONS AND LIMITATIONS

1. The current methodology assumes that all construction operations in all parts of the state emit the same levels of PM_{10} on a per acre basis.
2. It is assumed that watering techniques are used statewide, reducing emissions by 50% and making it valid to apply the MRI emission factor without correction.
3. The methodology assumes that valuation is proportional to acreage disturbed, even for high-rise type building construction.
4. The methodology assumes that construction dust emissions are directly proportional to the number of acres disturbed during construction.
5. The estimates of acreage disturbed are limited in their accuracy. Housing starts and project valuations do not provide direct estimates of actual acreages disturbed by construction operations in each county.

CHANGES IN THE METHODOLOGY

The major change to the methodology is the incorporation of the MRI emission factor for construction, which reduces the PM_{10} emission estimates by over 70%.

COMMENTS AND RECOMMENDATIONS

To improve the construction dust estimates, both the emission factor and activity data require attention. Possible improvements to the methodology that could be made are: better estimates of the actual acreages disturbed by projects and the duration of the projects; gathering of more detailed site data to allow use of the more site-specific emission factors listed in the MRI document;¹ and, probably most needed, the update of activity levels to reflect conditions more recent than 1987 (even if the existing methodology is used). In most cases these activity data are difficult to derive on a statewide basis.

SAMPLE CALCULATIONS

The instructions and associated table below provide an example of estimating residential and commercial building construction dust emissions for Alameda county. This example is adapted from the previous methodology, dated March 1990.

Step 1: Construction Basis. Enter the units the estimates of construction activity are based on into Table A. For residential construction, the units are 'units built', for the other

construction, the units are 'construction valuation'.

Step 2: Construction Basis Value. Using Table 2 for residential construction, or Table 3 for non-residential construction, locate the appropriate values for each construction type. Enter the residential construction value. Prior to entering the non-residential construction value, it must first be scaled to reflect 1987 dollar valuations. This is required because the acres per dollar valuation values (i.e., 3.7, 4.0, or 4.4 acres per million) are based on 1977 valuations. Using the ratio of the 1977 to 1987 Department of Commerce composite indices,¹¹ the Table 3 valuations are scaled. The ratio of the 1977 to 1987 values is 63.5/114.3 which equals 0.556. So, multiplying the Table 3 valuations by 0.556 provides the correct value for entry into Step 2 of the emissions estimation table.

Step 3: Acres/Basis Unit. Enter the acres per construction units. For residential construction in Alameda county, this is 1/7 acres per home, and 1/20 acres per multi-unit dwelling (see Table 4 for the acreage assignments). For commercial construction, the acres/unit is 3.7 acres per million dollars of valuation.

Step 4: Project Duration. Residential construction is estimated to take six months, commercial construction 11 months.

Step 5: Compute Acre-Months. Multiply the values from steps 2, 3, and 4 together to get acre-months. $Construction\ Basis\ Value \times Acres/Unit \times Months = Acre-Months$.

Step 6: Emission Factor. Input the emission factor. ARB's default factor is 0.11 tons PM_{10} /acre-month when watering practices are employed.

Step 7: Compute Emissions. Multiply the values from step 5 and step 6 to compute the annual PM_{10} emissions. $Acre-Months \times Emission\ Factor = Emissions$.

Use the steps above to compute the construction dust emissions for any of the other construction categories.

**Estimating PM₁₀ Construction Dust
In Alameda County**

		Construction Type		
		Residential Single Family	Residential Multiple Unit	Commercial
<i>Step 1</i>	Construction Basis	Units Built	Units Built	Valuation
<i>Step 2</i>	Construction Basis Value (<i>per year</i>)	4474 units	4900 units	\$124.86 million
<i>Step 3</i>	Acres/Basis	1/7 acres/unit	1/20 acres/unit	3.7 acres/million
<i>Step 4</i>	Project Duration	6 mos	6 mos	11 mos
<i>Step 5</i>	Acre-Months/year	3835	1470	5081.8
<i>Step 6</i>	Emission Factor (<i>tons PM₁₀/acre-month</i>)	0.11	0.11	0.11
<i>Step 7</i>	PM ₁₀ Emissions (<i>tons/year</i>)	421.8	161.7	559.0

ADDITIONAL CODES

SOURCE CATEGORY GROWTH AND CONTROL CODES

Various

SOURCE CATEGORY CODE POLLUTANT SPECIATION PROFILES

For All: PM = 391, VOC = not applicable

SOURCE CATEGORY CODE REACTIVITY FACTORS

Not Applicable

REFERENCES

1. Muleski, Greg. Improvement of Specific Emission Factors (BACM Project No. 1). Final Report. Midwest Research Institute, March 29, 1996.
2. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, AP-42, Section 13.2.3, Fifth Edition. January 1995.
3. PEDCo Environmental Specialists. Investigation of Fugitive Dust Sources - Emissions and Control. Prepared for the Environmental Protection Agency, OAQPS. Contract No. 68-02-0044. May 1973.
4. Taback, H.J., et al, Fine Particulate Emissions from Stationary and Miscellaneous Sources in the South Coast Air Basin, Report Number KVB 5806-783, KVB. February 1979.
5. California Department of Finance, 1988 California Statistical Abstract.
6. Midwest Research Institute, Inventory of Agricultural Tilling, Unpaved Roads and Airstrips and Construction Sites. For the U.S. Environmental Protection Agency, PB 238-919, Contract 68-02-1437. November 1974.
7. South Coast Air Quality Management District, Emissions from Construction/Demolition, Emission Programs Unit. December 1977.
8. Mark Anderson, California Building Industry Association, Sacramento, Telephone Conversation.
9. California Department of Finance, Financial and Economic Research Unit.
10. Taback, H.J., et al, Inventory of Emissions from Non-Automotive Vehicular Sources, Final Report, KVB. 1980.
11. Personal Communication with Viki Garrett, Construction Statistics division, Bureau of Census, (301) 763-5717. November 1988.

UPDATED BY

Patrick Gaffney
August 1997

Table 1. 1993 Building Construction Dust.

AB	CO	NAME	Residential		Commercial		Industrial		Institutional		
			EIC: 630-622-5400-0000		630-624-5400-0000		630-626-5400-0000		630-628-5400-0000		
			PR (acre-mo/yr)	PM ₁₀ (tons/yr)	PR (acre-mo/yr)	PM ₁₀ (tons/yr)	PR (acre-mo/yr)	PM ₁₀ (tons/yr)	PR (acre-mo/yr)	PM ₁₀ (tons/yr)	
GBV	2	ALPINE	23.7	2.6	0.0	0.0	0.0	0.0	0.0	0.0	
	14	INYO	62.3	6.9	93.0	10.2	0.0	0.0	2.5	0.3	
	26	MONO	112.0	12.3	29.5	3.2	0.0	0.0	26.7	2.9	
LC	17	LAKE	493.5	54.3	116.3	12.8	44.0	4.8	709.2	78.0	
LT	9	EL DORADO	596.5	65.6	74.2	8.2	2.2	0.2	47.2	5.2	
	31	PLACER	194.3	21.4	46.7	5.1	6.7	0.7	30.5	3.4	
MC	3	AMADOR	474.3	52.2	60.7	6.7	11.2	1.2	28.7	3.2	
	5	CALAVERAS	858.7	94.5	58.8	6.5	1.3	0.1	102.0	11.2	
	9	EL DORADO	1885.7	207.4	235.3	25.9	6.7	0.7	149.2	16.4	
	22	MARIPOSA	189.0	20.8	7.3	0.8	0.0	0.0	21.8	2.4	
	29	NEVADA	1518.2	167.0	230.8	25.4	82.7	9.1	131.5	14.5	
	31	PLACER	661.5	72.8	159.2	17.5	23.3	2.6	104.0	11.4	
	32	PLUMAS	243.2	26.8	10.2	1.1	10.2	1.1	14.2	1.6	
	46	SIERRA	22.5	2.5	0.0	0.0	6.3	0.7	0.5	0.1	
	55	TUOLUMNE	688.5	75.7	64.8	7.1	10.7	1.2	46.7	5.1	
	NC	8	DEL NORTE	287.2	31.6	24.7	2.7	1.2	0.1	45.0	5.0
12		HUMBOLDT	568.0	62.5	441.7	48.6	23.3	2.6	75.0	8.3	
23		MENDOCINO	758.0	83.4	74.5	8.2	65.7	7.2	189.8	20.9	
49		SONOMA	593.2	65.3	274.8	30.2	31.5	3.5	104.0	11.4	
53		TRINITY	95.0	10.5	2.2	0.2	10.0	1.1	10.3	1.1	
NCC	27	MONTEREY	1663.0	182.9	704.0	77.4	223.5	24.6	311.0	34.2	
	35	SAN BENITO	434.5	47.8	70.5	7.8	52.2	5.7	7.2	0.8	
	44	SANTA CRUZ	1339.3	147.3	697.0	76.7	75.0	8.3	140.7	15.5	
NEP	18	LASSEN	205.3	22.6	11.2	1.2	7.8	0.9	18.0	2.0	
	25	MODOC	15.8	1.7	3.8	0.4	0.0	0.0	9.5	1.0	
	47	SISKIYOU	284.8	31.3	21.7	2.4	1.7	0.2	58.0	6.4	
SC	19	LOS ANGELES	3385	902.4	9495	2523.1	1120	297.6	2685	713.5	
	30	ORANGE	4434	1181.8	2649	703.8	407	108.1	523	139.1	
	33	RIVERSIDE	4811	1282.3	2286	607.4	233	61.9	292	77.5	
	36	SAN BERNARDINO	2937	782.9	1778	472.6	1181	313.7	250	66.5	
SCC	40	SAN LUIS OBISPO	2792.8	307.2	808.8	89.0	278.2	30.6	323.3	35.6	
	42	SANTA BARBARA	1449.2	159.4	883.0	97.1	423.0	46.5	339.5	37.3	
	56	VENTURA	3621.0	398.3	1028.3	113.1	611.3	67.2	920.7	101.3	
SD	37	SAN DIEGO	18905.7	2079.6	14536.3	1599.0	3236.8	356.0	3030.3	333.3	
SED	13	IMPERIAL	458.5	50.4	172.0	18.9	2128.8	234.2	2118.8	233.1	
	15	KERN	1065.8	117.2	409.2	45.0	100.8	11.1	478.0	52.6	
	19	LOS ANGELES	1230	327.8	484	128.5	59	15.6	54	14.4	
	33	RIVERSIDE	1219	324.9	460	122.3	40	10.7	79	21.1	
	36	SAN BERNARDINO	2767.7	304.4	1904.3	209.5	779.8	85.8	222.0	24.4	
SF	1	ALAMEDA	3164.5	348.1	3950.0	434.5	3040.9	334.5	861.8	94.8	
	7	CONTRA COSTA	3342.7	367.7	3021.8	332.4	1111.8	122.3	659.1	72.5	
	21	MARIN	668.2	73.5	350.0	38.5	19.1	2.1	76.4	8.4	
	28	NAPA	376.4	41.4	240.9	26.5	494.5	54.4	52.7	5.8	
	38	SAN FRANCISCO	471.8	51.9	1586.4	174.5	28.2	3.1	346.4	38.1	
	41	SAN MATEO	959.1	105.5	2410.0	265.1	1160.9	127.7	525.5	57.8	
	43	SANTA CLARA	2982.7	328.1	4938.2	543.2	3612.7	397.4	1077.3	118.5	
	48	SOLANO	1460	160.6	424.5	46.7	144.5	15.9	92.7	10.2	
	49	SONOMA	1826.4	200.9	1357.3	149.3	169.1	18.6	296.4	32.6	
	SV	10	FRESNO	4898.3	538.8	1460	160.6	510.0	56.1	1007.8	110.9
15		KERN	4262.5	468.9	1636.7	180.0	403.5	44.4	1911.5	210.3	
16		KINGS	500.5	55.1	88.2	9.7	43.5	4.8	112.3	12.4	
20		MADERA	1058.2	116.4	110.3	12.1	68.3	7.5	638.8	70.3	
24		MERCED	1235.7	135.9	245.5	27.0	47.7	5.2	690.5	76.0	
39		SAN JOAQUIN	3090.7	340.0	849.8	93.5	854.3	94.0	636.8	70.0	
50		STANISLAUS	4385.8	482.4	1289.8	141.9	1592.7	175.2	543.5	59.8	
54		TULARE	2227.2	245.0	262.0	28.8	1096.3	120.6	328.5	36.1	
SV		4	BUTTE	1656.2	182.2	580.5	63.9	19.8	2.2	485.8	53.4
		6	COLUSA	89.2	9.8	5.5	0.6	0.0	0.0	62.7	6.9
	11	GLENN	113.2	12.5	24.2	2.7	3.2	0.4	25.3	2.8	
	31	PLACER	3032.0	333.5	728.2	80.1	106.3	11.7	475.8	52.3	
	34	SACRAMENTO	9579.5	1053.7	5126.5	563.9	768.7	84.6	1942.8	213.7	
	45	SHASTA	1498.2	164.8	316.8	34.8	87.0	9.6	161.0	17.7	
	48	SOLANO	1011.3	111.2	218.5	24.0	55.8	6.1	34.5	3.8	
	51	SUTTER	526.0	57.9	106.2	11.7	6.3	0.7	112.0	12.3	
	52	TEHAMA	323.5	35.6	46.7	5.1	61.5	6.8	102.5	11.3	
	57	YOLO	1282.3	141.1	778.3	85.6	190.8	21.0	70.0	7.7	
58	YUBA	207.0	22.8	36.7	4.0	0.0	0.0	76.5	8.4		
			Residential		Commercial		Industrial		Institutional		
Statewide Total*			119574	15974	72596	10656	26993	3442	27106	3587	

*Emissions/Process Rate = Emission Factor of 0.11 because SCAQMD uses slightly different emission factor.

PM Fraction: PM₁₀ = TSP x 0.64 (TSP Emissions = PM₁₀/0.64)

Table 2
Number and Valuation of New Housing Units Authorized
By Building Permits, California, 1987

County	Units			Valuation (in thousands)			
	Single	Multiple	Total	Single	Multiple	Additions	Total
TOTAL	133,289	115,406	248,695	\$13,487,123	\$5,695,428	\$2,085,114	\$21,267,666
ALAMEDA	4474	4900	9374	518711	240866	112670	872248
ALPINE	17	0	17	1523	0	0	1523
AMADOR	323	87	410	26303	3156	2428	31888
BUTTE	1053	595	1648	83500	25030	9562	118093
CALAVERAS	626	36	662	62145	2220	4009	68375
COLUSA	68	4	72	3655	201	1361	5219
CONTRA COSTA	5481	2950	8431	491836	119270	59640	670746
DEL NORTE	130	324	454	9940	14345	928	25214
EL DORADO	1684	300	1984	170041	12050	12024	194117
FRESNO	3072	2050	5122	208058	53276	17469	278804
GLENN	78	12	90	3666	264	881	4812
HUMBOLDT	388	138	526	24483	4600	6718	35801
IMPERIAL	318	108	426	19903	3119	4034	27057
INYO	47	0	47	4946	0	735	5682
KERN	3539	1426	4965	235360	44583	16024	295967
KINGS	336	130	466	26311	4402	3327	34041
LAKE	323	127	450	29599	4713	4513	38826
LASSEN	147	46	193	8304	1439	1133	10877
LOS ANGELES	16412	37766	54178	1961689	2138685	706361	4806736
MADERA	714	55	769	38379	1150	3168	42697
MARIN	815	469	1284	100040	32746	37283	170070
MARIPOSA	132	22	154	8894	395	801	10091
MENDOCINO	518	101	619	42636	3875	6656	53168
MERCED	812	244	1056	62523	9443	5294	77262
MODOC	12	0	12	651	0	464	1116
MONO	60	45	105	6102	1605	651	8359
MONTEREY	1114	608	1722	113523	29176	27765	170465
NAPA	518	9	527	59843	299	15019	75163
NEVADA	1019	172	1191	97449	7281	7936	112667
ORANGE	9323	15336	24659	1057372	703946	153340	1914660
PLACER	2463	629	3092	236631	23268	10850	270751
PLUMAS	179	0	179	13791	0	173	13964
RIVERSIDE	13733	3829	17562	1315016	169999	48165	1533181
SACRAMENTO	6167	4024	10191	601768	162105	54755	818629
SAN BENITO	318	12	330	28956	538	1149	30644
SAN BERNARDINO	14792	6837	21629	1205995	292136	87429	1585561
SAN DIEGO	15403	15113	30516	1913783	736527	128817	2779127
SAN FRANCISCO	155	2287	2442	27825	204464	111917	344207
SAN JOAQUIN	2031	948	2979	178463	39063	17711	235237
SAN LUIS OBISPO	1855	481	2336	179065	24080	13069	216215
SAN MATEO	1303	1708	3011	193096	89645	98989	381732
SANTA BARBARA	1234	701	1935	160571	34900	31043	226515
SANTA CLARA	3071	4431	7502	402215	202122	116880	721219
SANTA CRUZ	823	465	1288	98738	34797	21296	154831
SHASTA	1002	307	1309	68160	9770	4939	82870
SIERRA	18	0	18	1917	0	375	2293
SISKIYOU	216	2	218	15022	79	2696	17798
SOLANO	2780	429	3209	268751	17170	15022	300945
SONOMA	2700	1202	3902	239137	40217	22179	301533
STANISLAUS	2894	1044	3938	204132	32672	9104	245909
SUTTER	368	139	507	35051	4915	2964	42931
TEHAMA	209	136	345	17261	4963	2665	24870
TRINITY	70	0	70	2958	0	649	3602
TULARE	1370	678	2048	92667	18493	12861	124021
TUOLUMNE	465	110	575	22107	3469	1977	27554
VENTURA	3290	924	4214	421996	56909	38225	517121
YOLO	687	783	1470	52986	26212	5508	84701
YUBA	140	127	267	11651	4753	1488	17891

Note: Detail may not add to total because of rounding
Source: U.S. Department of Commerce, Bureau of the Census

Department of Finance
Financial and Economic Research Unit
(916) 322-2263

Table 3
Non-Residential Valuation -- County Summary
Valuation in Thousands of Dollars
(January-December, 1987)

	Commercial	Industrial	Other Nonresidential	Nonresidential Add. & Alt.	Total Nonresidential	Total Valuation
ALAMEDA	224742	115190	23200	181293	544427	1416676
ALPINE	0	0	0	0	0	1523
AMADOR	2340	403	931	199	3875	35763
BUTTE	22340	708	15721	5648	44418	162512
CALAVERAS	2304	52	3364	908	6629	75004
COLUSA	221	0	2162	344	2728	7947
CONTRA COSTA	147741	42631	37339	74761	302474	973221
DEL NORTE	959	49	1475	215	2699	27913
EL DORADO	11641	306	6213	3299	21460	215577
FRESNO	56667	18308	32884	20840	128700	407504
GLENN	917	112	805	746	2581	7393
HUMBOLDT	17417	852	2489	4500	25260	61061
IMPERIAL	6863	78577	71095	2204	158740	185797
INYO	3723	0	78	700	4501	10184
KERN	79313	18087	77899	28499	203800	499768
KINGS	3437	1568	3682	3274	11963	46005
LAKE	4439	1555	22732	3913	32640	71467
LASSEN	459	295	619	532	1907	12784
LOS ANGELES	1814253	418854	401231	1229169	3863508	8670245
MADERA	4021	2304	19587	556	26470	69168
MARIN	18468	646	3420	24662	47197	217268
MARIPOSA	285	0	708	619	1613	11704
MENDOCINO	2825	2307	6068	3674	14877	68046
MERCED	9197	1650	21758	6067	38674	115936
MODOC	147	0	313	361	822	1938
MONO	993	0	755	825	2573	10933
MONTEREY	28413	8338	10557	30861	78172	248637
NAPA	7925	18921	6205	14690	47742	122906
NEVADA	8556	2832	4103	1602	17095	129762
ORANGE	754493	157730	70825	354826	1337875	3252536
PLACER	33379	4511	18335	8144	64370	335121
PLUMAS	394	362	458	46	1261	15226
RIVERSIDE	275801	77840	79339	61142	494123	2027304
SACRAMENTO	203565	28230	64875	120702	417373	1236002
SAN BENITO	2761	1897	238	1265	6163	36807
SAN BERNARDINO	332972	246357	37964	89921	707216	2292778
SAN DIEGO	602644	124128	105646	293105	1125524	3904652
SAN FRANCISCO	89931	1292	12764	252520	356507	700714
SAN JOAQUIN	33071	30755	20832	27679	112339	347576
SAN LUIS OBISPO	30336	9650	10199	12339	62526	278742
SAN MATEO	142850	44547	11469	112911	311779	693511
SANTA BARBARA	34135	15130	11040	35937	96244	322759
SANTA CLARA	252452	136329	53675	316977	759434	1480652
SANTA CRUZ	25928	2582	4406	20378	53296	208128
SHASTA	12102	3072	5172	2024	22371	105242
SIERRA	0	250	21	194	466	2760
SISKIYOU	869	67	1962	838	3738	21536
SOLANO	33052	7815	4376	8661	53904	354849
SONOMA	73736	7790	23469	51374	156371	457904
STANISLAUS	49208	56196	17437	20613	143455	389364
SUTTER	4311	229	3826	2897	11264	54196
TEHAMA	1862	2271	3439	1128	8701	33591
TRINITY	82	357	335	175	951	4559
TULARE	9597	37171	10129	12260	69158	193182
TUOLUMNE	2456	374	1492	215	4538	32092
VENTURA	53032	29157	39925	67002	189117	706248
YOLO	28412	6448	2155	8794	45811	130518
YUBA	1616	0	2828	1656	6101	23994
TOTAL	5565653	1767082	1396024	3530684	12259521	33527185

Table 4
Estimated Acres Disturbed for Single Living Unit Construction
in California, 1987

1. Alameda	1/7	30. Orange	1/7
2. Alpine	1/5	31. Placer	1/5
3. Amador	1/5	32. Plumas	1/5
4. Butte	1/5	33. Riverside	1/7
5. Calaveras	1/5	34. Sacramento	1/5
6. Colusa	1/5	35. San Benito	1/5
7. Contra Costa	1/7	36. San Bernardino	1/7
8. Del Norte	1/5	37. San Diego	1/7
9. El Dorado	1/5	38. San Francisco	1/7
10. Fresno	1/5	39. San Joaquin	1/5
11. Glenn	1/5	40. San Luis Obispo	1/5
12. Humboldt	1/5	41. San Mateo	1/7
13. Imperial	1/5	42. Santa Barbara	1/7
14. Inyo	1/5	43. Santa Clara	1/7
15. Kern	1/5	44. Santa Cruz	1/5
16. Kings	1/5	45. Shasta	1/5
17. Lake	1/5	46. Sierra	1/5
18. Lassen	1/5	47. Siskiyou	1/5
19. Los Angeles	1/7	48. Solano	1/5
20. Madera	1/5	49. Sonoma	1/5
21. Marin	1/7	50. Stanislaus	1/5
22. Mariposa	1/5	51. Sutter	1/5
23. Mendocino	1/5	52. Tehama	1/5
24. Merced	1/5	53. Trinity	1/5
25. Modoc	1/5	54. Tulare	1/5
26. Mono	1/5	55. Tuolumne	1/5
27. Monterey	1/5	56. Ventura	1/7
28. Napa	1/5	57. Yolo	1/5
29. Nevada	1/5	58. Yuba	1/5