Proposed Matrix for the Use of AASHTO T283 (June 23, 2002)

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Caltrans/Industry Moisture Sensitivity Sub-Committee No. 1

1. Identification of Climate Regions and Environmental Risk Levels

High amount of rainfall, multiple freeze-thaw cycles and extended high temperature periods are three main environmental factors thought to contribute to moisture damage in asphalt concrete pavements[1]. The state of California was divided into four regions according to different combinations of levels of the above three factors, as shown in Table 1. An Environmental Risk Level for moisture damage was assigned for each region in Table 1, either Low Risk, Moderate Risk or High Risk. The corresponding draft map is shown in Figure 1. The western states have been included in the map to provide reference for the application of the T283 test method across states such as Nevada and Oregon.

Table 1 Environmental Risk Levels for Four Climate Regions

	PRECIP < 650 mm*	**PRECIP > 650 mm***
FTC < 50	Low	Moderate
FTC > 50	High	High

*about 26 inches
Note: FTC – Annual freeze-thaw cycles;
PRECIP – Annual rainfall (mm).

The factor of high temperature was not included in Table 1, after discussion by Sub-Committee 1, because it was found that there were not many regions in the state with Precipitation > 650 mm and Degree Days above 30 C of more than 450 C-days. Initially, this factor was also included (see appendix), which resulted in a total number of eight regions. The environmental risks, however, differed with those in Table 1 only in one

region (FTC > 50, DD > 450 C·days, PRECIP < 650 mm). Being simpler and more conservative, the four-region classification was recommended.

The transition values for the three factors were determined with engineering judgement and the program *Climate Database for Pavements* being developed for Caltrans by Pavement Systems LLC and the UC Pavement Research Center. GIS based maps were created from output from this program using the Arcview software.

2. Consideration of 1999 Criteria and Traffic Variables

One of the main differences between this approach to climate region classification and the approach used in the matrix proposed in 1999 (Table 2) is that the temperature data from weather stations were used directly in this approach rather than using elevation as a surrogate. The precipitation (>20 in. [500 mm]) and elevation (>2,500 ft) based map corresponding to the 1999 matrix (Table 2) is shown in Figure 2 for comparison. Also shown, in Figure 3, is another criterion discussed by Caltrans and Industry (precipitation > 26 in. [650 mm], elevation > 3,500 ft). As can be seen, the high environmental risk region in Figure 1 differs with that in Figure 2 or 3 only in District 2.

Table 2. Matrix proposed in 1999

Classification & Treatment Options	**Climate Condition & TSR Results**			
	Wet / Freeze	*Wet / No Freeze*	*Dry/ Freeze*	*Dry/No Freeze*
Good (No Treatment)	>74	>69	>69	>69
Marginal (Lime-Marination) (Lime-No Marination) (Liquid Anti-Strip	65-74	60-69	60-69	60-69
Poor (Lime-Marination)	<65	<60	<60	<60

[1]Little, D. and J. Epps. 2001. The Benefits of Hydrated Lime in Hot Mix Asphalt, Prepared for the

Truck traffic is another important factor affecting moisture sensitivity of asphalt pavements, so traffic risk might also be included in the matrix, as a function of traffic volume or axle load repetitions. A criterion of 10-year Traffic Index of 9 or greater was discussed, based on some understanding of Nevada DOT practice for high and low volume roads (low volume in Nevada being much lower than for any roads in California). The Caltrans Weigh-In-Motion database was used to calculate 10 year Traffic Indexes for all 98 Caltrans WIM stations. The results showed that the 10-year Traffic Indexes are all equal to or greater than 9 (see appendix), so truck traffic was excluded from the definition of regions without further traffic information.

3. Proposed Matrix for the Use of AASHTO T283

An adverse environment, truck traffic and a potentially risky mix (here defined by AASHTO T283) are thought to be the three prerequisites for moisture damage in asphalt pavements. Truck traffic was considered to be high enough for most California routes to be risky across the state. The assumption made is that in a region with a low environmental risk level, moisture damage will probably not occur even if the asphalt mixture has low or moderate moisture sensitivity, so treatment with lime or other anti-stripping agents becomes unnecessary. High risk mixes were assumed to need some type of treatment as a safe guard even where the environmental risk is low. On the other hand, in a region with a high environmental risk, the decision of whether using treatment or not will be similar to the matrix proposed in 1999 (Table 2). Based on these considerations, the following matrix, shown in Table 3, is proposed for use with AASHTO T283.

National Lime Association.

Table 3. Proposed Matrix for the Use of AASHTO T283

TSR	Mix Risk Level	Environmental Risk Level		
		Low	**Moderate**	**High**
> *y**	Low	NT	NT	NT
x - *y**	Moderate	NT	AS, LNM, LM**	AS, LNM, LM**
< *x**	High	AS, LNM, LM**	LM	LM

* *x* and *y* are transition TSR values to be determined.
** Select one treatment.
Note: TSR – retained tensile strength per AASHTO T 283
NT – No Treatment;
AS – Liquid Anti-strip;
LNM – Lime-No Marination;
LM – Lime-Marination;

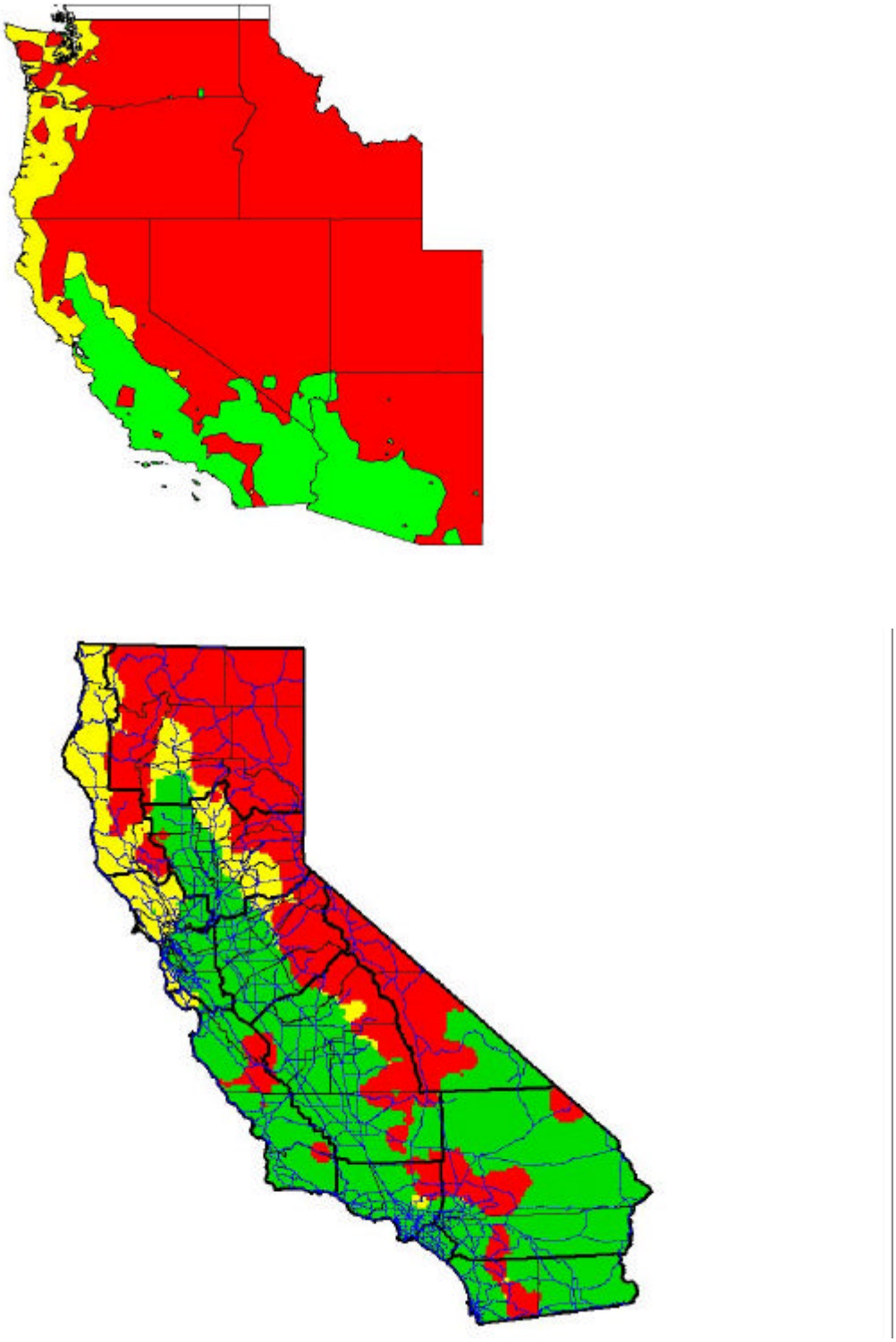


Figure 1. Environmental risks for the four regions defined in Table 1 (Green is low environmental risk, yellow is moderate environmental risk, red is high environmental risk).

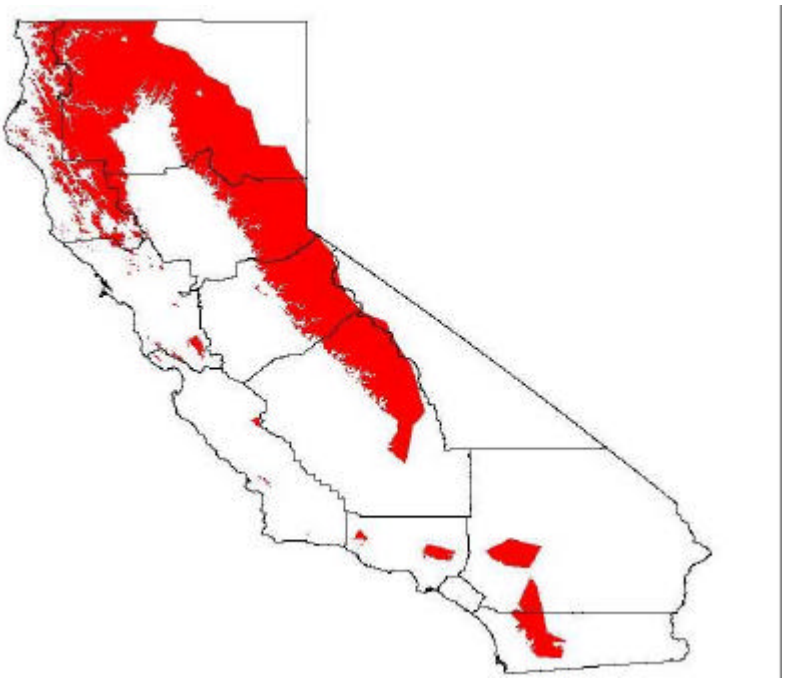


Figure 2. Climate region with high environmental risk (Elevation > 2500 feet, Annual Precipitation > 20 inches [500 mm]) per 1999 matrix.

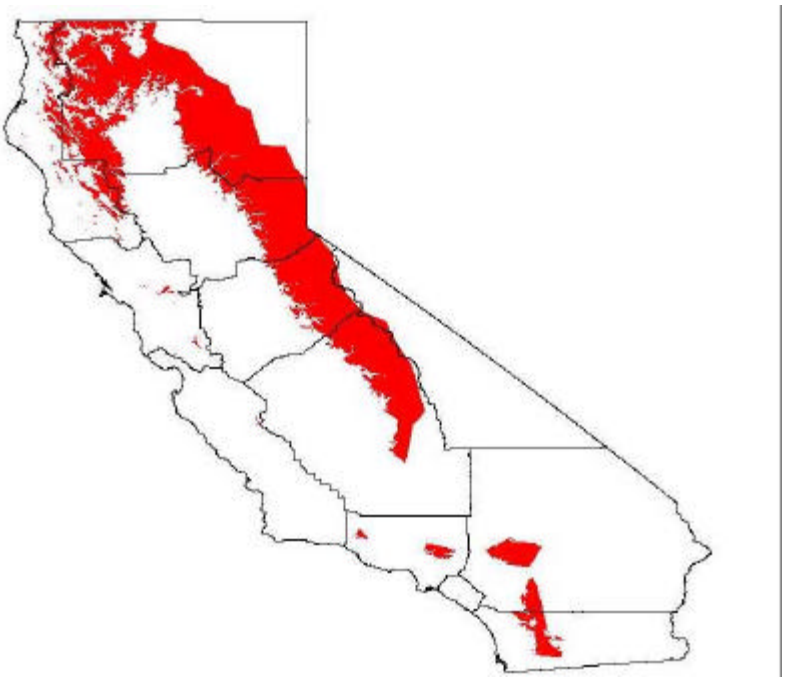


Figure 3. Climate region with high environmental risk (Elevation > 3500 feet, Annual Precipitation > 26 inches [650 mm]) per criteria previously discussed by Caltrans and Industry.

Appendix

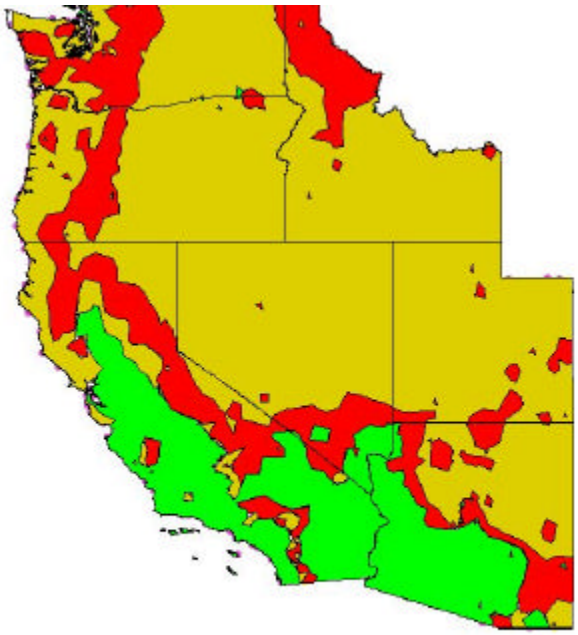
1. Initial Definitions of Climate Regions When High Temperature Considered

Table A1 Initial Definitions of Climate Regions

		PRECIP < 650 mm*	**PRECIP > 650 mm***
FTC < 50	**DD < 450 degree · days**	Low	Moderate
	DD > 450 degree · days	Low	Moderate
FTC > 50	**DD < 450 degree · days**	Moderate	High
	DD > 450 degree · days	High	High

*about 26 inches

Note: FTC – Annual freeze-thaw cycles;
DD – Degree days above 30 C (C degree · day);
PRECIP – Annual rainfall (mm).



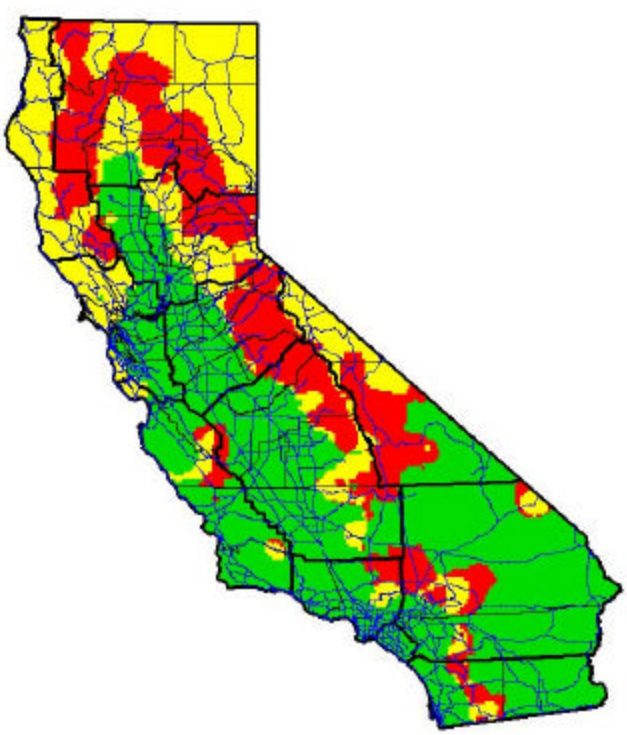


Figure A1 Initial climate regions when high temperature considered (Green is low environmental risk, yellow is moderate environmental risk, red is high environmental risk) per matrix of climate region definitions of Table A1.

2. Traffic Indices Calculated from Caltrans Weigh-In-Motion Database

Site_No	Name	District	County	Route	AADTT	Growth Rate	ESAL/1000Trucks	**10-year TI**
001	Lodi	10	San Joanquin	5	5200	4%	1338.36	13.5
002	Redding	2	Shasta	5	3117	4%	1222.59	12.5
003004	Antelope	3	Sacramento	80	3344	5%	787.41	12
005	Indio	8	Riverside	10	3950	5%	1148.13	13
006	Newhall	7	Los Angeles	5	4047	5%	1006.78	12.5
007	Santa Nella	10	Merced	5	3954	5%	1313.46	13
008009	Conejo	7	Ventura	101	2516	3%	553.55	11
010	Fresno	6	Fresno	99	5038	3%	1338.18	13.5
011	Sonoma	4	Sonoma	37	1198	4%	1200.29	11
012013	Van Nuys	7	Los Angeles	405	2779	2%	930.12	12
014	San Marcos	11	San Diego	78	1606	6%	757.59	11
015016	Irvine	12	Orange	5	5070	3%	787.54	12.5
017018	Hayward	4	Alameda	880	4639	3%	653.84	12
020	Loleta	1	Humboldt	101	723	0%	1094.46	10
021	Mojave	6	Kern	58	2722	4%	1069.44	12
022	Jeffrey	11	Imperial	8	833	6%	861.45	10.5
023	El Centro	11	Imperial	8	1609	9%	929.9	11.5
024	Napa	4	Napa	12	1122	8%	749.65	11
025	Newberry	8	San Bernardino	40	2912	3%	1216.17	12.5
026	Cameron	11	San Diego	8	906	8%	760.95	10.5
027	Tracy	10	San Joanquin	5	2880	7%	948.34	12.5
028	Macdoel	2	Siskiyou	97	541	0%	1083.42	10
029	Arco	3	Sacramento	5	2022	3%	1311.21	12
030	Mt Shasta	2	Siskiyou	5	2845	2%	1068.77	12
031032	Woodside	4	San Mateo	280	889	9%	616.98	10.5
033034	Burlingame	4	San Mateo	101	4278	6%	740.36	12.5
035	Pacheco	4	Santa Clara	152	2005	1%	998.13	11.5
036	Los Banos	10	Merced	152	1291	1%	830.11	10.5
037038	Elsinore	8	Riverside	15	3110	8%	750.19	12
039	Redlands	8	San Bernardino	30	1191	7%	1339.52	11.5
040	Coachella	8	Riverside	86	1081	3%	1001.06	11
041042	Vacaville	4	Solanno	80	3102	3%	762.24	12
043	Cholame	5	San Luis Obispo	46	891	3%	952.71	10.5
044	Banta	10	San Joanquin	205	1970	3%	714.63	11
045	Carbona	10	San Joanquin	580	2859	7%	950.72	12.5
046	Galt	3	Sacramento	99	3359	4%	911.27	12.5
047048	Castaic	7	Los Angeles	5	6379	2%	917.51	13
049	Auburn	3	Placer	49	469	3%	498.2	9
050	Elmira	4	Solanno	505	1167	1%	1381.25	11
051052	West Sac	3	Yolo	50	2173	3%	842.93	11.5
055056	Dublin	4	Contra Costa	680	2773	1%	861.84	11.5
057058	Pinole	4	Contra Costa	80	3450	5%	766.32	12
059060	LA - 710	7	Los Angeles	710	10250	1%	975.12	14
061062	Peralta	12	Orange	91	4139	3%	765.34	12
063	Murrieta	8	Riverside	215	1606	7%	769.55	11
064	Foster City	4	San Mateo	92	2244	6%	720.43	11.5
065	Piru	7	Ventura	126	1251	5%	850.33	11
066	Calico	8	San Bernardino	15	3292	2%	1042.66	12.5
067	Devore	8	San Bernardino	215	1893	2%	957.3	11.5
068	Gilroy	4	Santa Clara	101	2598	3%	769.76	11.5
069070	Fontana	8	San Bernardino	15	5254	5%	1072.07	13
071	Hinkley	8	San Bernardino	58	1892	2%	967.1	11.5
072	Bowman	3	Placer	80	2123	2%	1090.06	11.5

(Continued)

Site_No	Name	District	County	Route	AADTT	Growth Rate	ESAL/1000Trucks	**10-year TI**
073	Stockdale	6	Kern	5	3802	3%	965.54	12.5
074	Bakersfield	6	Kern	99	3412	3%	837.28	12
075	Keyes	10	Stanislaus	99	4839	3%	1020.01	13
076	Templeton	5	San Luis Obispo	101	1808	6%	842.48	11.5
077078	Colton	8	San Bernardino	10	7283	5%	760.15	13
079080	Artesia	7	Los Angeles	91	4687	2%	741.39	12.5
081	Positas	5	San Benito	101	1950	3%	749.68	11
082083	Glendora	7	Los Angeles	210	4677	3%	764.34	12.5
084085	Leucadia	11	San Diego	5	3704	3%	596.98	11.5
086	Ukiah	1	Mendocino	101	1029	3%	2408.54	12
087088	Balboa	11	San Diego	15	2721	3%	910.44	12
089090	Dekema	11	San Diego	805	3739	3%	1034.52	12.5
091092	Poggi	11	San Diego	805	2797	3%	807.1	12
093	Lakeport	1	Lake	29	281	3%	714.9	9
094	Greenfield	5	Monterey	101	1562	3%	860.66	11
095096	Ontario	8	San Bernardino	60	10912	3%	777.09	14
097	Chino	8	San Bernardino	83	1248	3%	837.69	10.5
098	Prado	8	San Bernardino	71	1389	3%	759.97	10.5
099	Tulloch	10	Toulumne	120	540	3%	896.31	10
100101	Miramar	11	San Diego	163	1461	3%	590.62	10.5