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Improving the Traffic Census and Highway Performance Monitoring System (HPMS) Programs

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15. Supplementary Notes

The objective of this research study was to support the Traffic Census and Highway Performance Monitoring System (HPMS) Programs in identifying locations for motorized traffic data collection on public roads in California.

The study analyzed the traffic census count locations for each District to determine at which Census count locations the automated and continuously collected Caltrans Performance Measurement System (PeMS) data could be used in lieu of manual traffic counts.

Next, this research identified and evaluated count locations for motorized traffic data collection on non-State Highway System Routes to help meet Federal Highway Administration (FHWA) requirements for the Caltrans Highway Performance Monitoring System (HPMS) program.

Lastly, this research reviewed and summarized the emerging traffic data collection technologies and data sources appropriate for Caltrans HPMS and/or Census reporting purposes.

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UNIVERSITY OF CALIFORNIA, BERKELEY

Improving the Traffic Census and Highway Performance Monitoring System (HPMS) Programs

Final Report

June 30, 2020

Partners for Advanced Transportation Technology works with researchers, practitioners, and industry to implement transportation research and innovation, including products and services that improve the efficiency, safety, and security of the transportation system.

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1. INTRODUCTION

Traffic volume data is collected using automated and manual traffic and vehicle classification counters to conduct analyses and achieve the objectives of the FHWA Traffic Monitoring Program, Highway Performance Monitoring System (HPMS), Traffic Accident Surveillance and Analysis System (TASAS), Highway Safety Improvement Program (HSIP), Pavement Management System (PaveM) and other transportation information systems. Multiple Caltrans programs depend on current and reliable traffic data to conduct required accurate performance evaluations and provide meaningful recommendations. Collecting accurate traffic data enhances the Department's ability to conduct safety analysis, implement strategies to reduce injuries/fatalities, accurately measure and manage congestion and monitor the effects of transportation improvements.

In California, there are over 110,000 miles of roadways owned by 58 counties and 482 cities that are not on the Federal-aid system and are classified as local roads (Functional Classification 7). While meeting FHWA requirements, the process of collecting local traffic volumes currently does not follow a robust, systematic approach to monitor the traffic volumes on this portion of the highway system to produce estimates of vehicle-miles traveled (VMT). Also, Caltrans resources for the Traffic Census Program have decreased, while statewide VMT has significantly increased resulting in an increase in the number of count locations necessary to accurately estimate traffic volumes. As a result of inadequate resources, Caltrans District Traffic Census personnel must prioritize which counts can be completed within their given allocation.

The objective of this research study is to support the Traffic Census and Highway Performance Monitoring System (HPMS) Programs in identifying locations for motorized traffic data collection on public roads in California. The study analyzes the traffic census count locations for each District to determine at which Census count locations the automated and continuously collected Caltrans Performance Measurement System (PeMS) data can be used in lieu of manual traffic counts. At the same time, the Highway Performance Monitoring System (HPMS) needs research support to identify and evaluate count locations for motorized traffic data collection on non-State Highway System Routes as part of Federal Highway Administration (FHWA) requirements.

This research project was divided into six project work tasks:

- Task #1: Project Kick-Off Meeting
- Task #2: Project Management with Quarterly Progress Reports as Deliverables
- Task #3: Needs Assessment & Data Analysis with Technical Memorandum as Deliverable
- Task #4: Emerging Data Collection Technologies with Technical Memorandum as Deliverable
- Task #5: Draft Final Report
- Task #6: Final Report and Workshop

Tasks #1 and #2 were project management and/or served administrative purposes. Accordingly, these two tasks produced no research findings or results and they are not discussed further in this final report.

Task #3 provided research support to the Traffic Census and Highway Performance Monitoring System (HPMS) Programs. As such, the Task #3 research objective is presented as two independent objective statements – the first for the HPMS Program, followed by the problem statement for the Census Program. Likewise, the research methods and associated findings are presented in two separate sections of this report – Section 2 for HPMS Program and Section 3 for the Census Program.

Research Task #4 reviewed and summarized the emerging traffic data collection technologies and data sources appropriate for Caltrans HPMS and/or Census reporting purposes. The Task #4 findings are presented in Section 4 of this final report.

This draft final report is the deliverable for Task #5. It is a compilation of the Task #3 and Task #4 technical memorandums, which were reviewed and approved by Caltrans HQ, HPMS, and Census Departments.

Upon review and approval by Caltrans, this Task #5 deliverable will serve as the basis for the Task #6 final report.

The Task #2, Task #3 and Task #4 research objectives are discussed next.

1.1. HPMS PROGRAM – RESEARCH OBJECTIVE

The traffic count data for HPMS reporting of the State Highway System (SHS) or On-System roadways are provided by the Caltrans Traffic Census Branch. Traffic count data collection is performed according to a 3-year cycle for highways, and a 6-year cycle for freeway ramps.

The traffic count data for Off-System roads (i.e., those roadways which are not part of the SHS) are collected by commercial traffic data collection contractors via a competitive bid selection process. These contracts are administered and managed by the Caltrans HPMS Branch.

The traffic count data collection is conducted according to a 3-year cycle for Functional Class FC=2 through FC=6 [Urban] roadways, and on a 6-year cycle for FC=6 [Rural] and FC=7 roadways. The FC=6 [Rural] and FC=7 roadways are reported as summary, not on every segment of roadway. (Note to reader: The FHWA roadway Functional Classifications (FC) are listed in Table 2-4 on page 8 of this report.)

At the time of the discussions with the HPMS unit for this research effort, Caltrans HPMS program managers stated that only the FC=3 through FC=6 [Urban] Off-System roadways were being covered by vehicle count contracts with commercial count vendors. And at that time, Caltrans was preparing to update or issue new traffic count collection contracts (using a three-year contracting period) for approximately 30,000 count locations that cover the 41,356 miles of FC=2 through FC=6 [Urban] Off-System roadways. Normally each of these Caltrans contracts collect both vehicle volume-only and vehicle classification counts. It should be noted that there is just under one mile of FC=2 Off-System roadways in California (0.66 miles in Los Angeles County, 0.07 miles in Fresno County, 0.08 miles in Sacramento County, 0.05 miles in Solano County, and 0.12 miles in San Joaquin County).

Due to the very high number of count locations (and the 3-year and 6-year data collection cycles), the state has been divided into three contract zones. Caltrans has attempted to create zones so that the yearly workload in each zone is approximately the same. Every year the contract is assigned to a different zone; on a 3-year rotating cycle. This results in approximately 3,000 to 4,000 count locations per contract. Occasionally, due to unforeseen circumstances, contractors will overrun the allocated contractual time limit, and time extensions need to be applied.

In past contracts Caltrans did not collect data during the months of January, June, July, August, and December. In the new upcoming contracts, the contracted data collection will be performed throughout a calendar year, with no months excluded. Past Caltrans data collection practices excluded holiday months.

In more recent data collection efforts, this restriction has been relaxed to only exclude holiday "days" to provide more flexibility and available dates for commercial data collection vendors to fulfill their contractual obligations.

For past 10 years or so, Caltrans has not been collecting FC=7 data (by contracting) due to lack of resources. One of Caltrans main concerns regarding HPMS data collection and reporting is the lack of FC=7 traffic data on 119,142 miles of local roadways. However, Caltrans is still required to report the VMT for FC=7 to FHWA in a summary table format.

From email, phone and in-person discussions with Caltrans HQ and HPMS Program management, one of the main objectives of this research project was established – to provide a data collection implementation plan that contains data collection methods, data collection cycles, sampling site selection and estimated costs for FC=7 roadways in California. Additionally, Caltrans does not have any year-round count stations for the Off-System roadway sections (for developing seasonal correction factors).

1.2. CENSUS PROGRAM – RESEARCH OBJECTIVE

Each Caltrans District is responsible for meeting the requirements of the three-year traffic count cycle that includes continuous and quarterly (also known as control and/or trend counts), profile, ramp, truck, and intersection counts. For the years when a traffic count is not collected and recorded at a given location (e.g., for all non-count year locations), either the previous year's data is used and reported, or growth factors calculated using control station data are applied and an estimated volume is generated and reported. For more than a decade, resources devoted to the Traffic Census effort have declined in real and nominal values, with the result that Caltrans Districts routinely request more funding to perform their traffic volume counts than is available.

On a parallel tract, Caltrans Districts (and the Census Program) historically and currently only nominally leverage PeMS data for meeting their annual traffic count obligations, even though the Caltrans PeMS system archives traffic data from thousands of permanent vehicle detector stations in Districts 3, 4, 5, 6, 7, 8, 10, 11, and 12 (all but rural Districts 1, 2 and 9).

Quickly following this project's kick-off meeting a series of discussions and emails with Caltrans HQ and Census Program management and staff provided additional valuable information on Caltrans' practices, unmet needs and how this research project could provide the most real benefit to the Census Program with respect to meeting the annual count obligations. The outcome of these discussions resulted in one of the main objectives of this research project (in support of the Census Program), to explore the feasibility of more effectively utilizing PeMS data for fulfilling the annual Census count obligations.

1.3. EMERGING DATA COLLECTION TECHNOLOGIES – RESEARCH OBJECTIVE

For this Task, the research team identified potential technologies to use per count location type to maximize efficiency and improve safety. The UC Berkeley team performed a literature review of commercially available traffic volume estimates. The literature review included gathering information on AADT data costs and relevant results from all available data validation studies. The research team also gathered information (i.e., lessons learned) from other state DOTs that have used contractors to obtain AADT data for HPMS and other mandated traffic volume monitoring reporting purposes. Finally, the research team made recommendations

on how well suited the commercially-available AADT estimates are for Caltrans HPMS reporting purposes, as compared to the status quo methods of collecting AADTs for HPMS reporting.

The Task #3 research methodology and findings in support of the HPMS Program are discussed next (in Section 2); followed by a discussion of the research methodologies and findings for the Census Program (in Section 3). Section 4 describes the Task #4 Emerging Data Collection Technologies findings.

The recommendations for the Caltrans HPMS program are presented in Section 2 along with the HPMS Program's research methodologies and findings. Accordingly, the recommendations for the Caltrans Census Program are contained within Section 3, and the recommendations resulting from the Emerging Data Collection Technologies research effort are presented in Section 4. The report closes with a Concluding Comments discussion in Section 5.

2. HPMS PROGRAM – RESEARCH METHODOLOGY AND FINDINGS

All roads open to public travel are reported in HPMS regardless of ownership, including Federal, State, county, city, and privately-owned roads such as toll facilities.[1] There are over 175,000 total miles of public roadways in California. The public roadways can be categorized as "On-System" roadways or "Off-System" roadways. On-System roadways are owned and maintained by Caltrans. The Off-System roadways are owned and maintained by other government agencies or private authorities.

Table 2-1 lists California's public roadway mileage by the FHWA Functional Classification System.

Table 2-2 lists California's On-System roadway mileage by the FHWA Functional Classification System.

Table 2-3 lists California's Off-System roadway mileage by the FHWA Functional Classification System.

Table 2-1: Total Miles of Public Roadways in California (2018)

Area Type	Interstate FC = 1 (miles)	Principal Arterial (Freeway or Expressway) FC = 2 (miles)	Principal Arterial (Other) FC = 3 (miles)	Minor Arterial FC = 4 (miles)	Major Collector FC = 5 (miles)	Minor Collector FC = 6 (miles)	Local FC = 7 (miles)	2018 Total Distance (miles)
Rural	1,186	369	3,264	6,140	12,032	7,487	40,797	71,275
Urban	1,270	1,550	6,696	10,960	12,613	368	70,858	104,315
Total	2,456	1,919	9,960	17,100	24,645	7,854	111,655	175,589

Table 2-2: "On-System" Miles of Public Roadways in California (2018)

[1] Highway Performance Monitoring System Field Manual (Section1.2 Scope of the HPMS).
Federal Highway Administration (FHWA), Office of highway Policy Information. December 2016.
Website: https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual

Area Type	Interstate FC = 1 (miles)	Principal Arterial (Freeway or Expressway) FC = 2 (miles)	Principal Arterial (Other) FC = 3 (miles)	Minor Arterial FC = 4 (miles)	Major Collector FC = 5 (miles)	Minor Collector FC = 6 (miles)	Local FC = 7 (miles)	2018 Total Distance (miles)
Rural	1,186	369	3,070	4,891	743	-	-	10,259
Urban	1,270	1,549	1,382	563	69	-	-	4,833
Total	2,456	1,918	4,452	5,454	812	-	-	15,091

Table 2-3: "Off-System" Miles of Public Roadways in California (2018)

Area Type	Interstate FC = 1 (miles)	Principal Arterial (Freeway or Expressway) FC = 2 (miles)	Principal Arterial (Other) FC = 3 (miles)	Minor Arterial FC = 4 (miles)	Major Collector FC = 5 (miles)	Minor Collector FC = 6 (miles)	Local FC = 7 (miles)	2018 Total Distance (miles)
Rural	-	-	194	1,249	11,289	7,487	40,797	61,016
Urban	-	1	5,313	10,398	12,544	368	70,858	99,482
Total	-	1	5,508	11,646	23,833	7,854	111,655	160,498

Source: Caltrans, HQ Division of Research, Innovation & System Information (November 4, 2019 email)
Note: Red shaded cells (FC= 6 [Rural] and FC=7).

2.1. HPMS ROADWAY SECTIONS AND SAMPLES

For each route, the FHWA HPMS process segments public roadways by five distinguishing categories:

- AADT (volume group)
- Functional Classification System (Interstate: FC=1 … Local: FC=7)
- Through Lanes (number of traffic through lanes)
- Urban Code
- Facility Type

These distinguishing categories are described next as they pertain to California and this research effort.

Functional Classification System: All streets and highways are grouped into one of seven classes, depending on the character of the roadway and the degree of land access that they allow. The seven functional classes

are represented by a one-digit code and are used to represent a specific classification of road regardless of whether it is located in an urban or rural area.

Table 2-4 displays the Functional Roadway Classification System used by FHWA and all State DOTs for HPMS reporting.

Table 2-4: FHWA Functional Classification System

Functional Classification Code	Description
1	Interstate
2	Principal Arterial – Other Freeway and Expressway
3	Principal Arterial – Other
4	Minor Arterial
5	Major Collector
6	Minor Collector
7	Local

Source: HPMS Field Manual, page 5-1 (FHWA, December 2016)

Urban Code: The U.S. Census-based Urban Area (UA) Boundaries are an important part of the HPMS Functional Classification system. As such, the Functional Classification codes and Census-defined UA Boundary codes must be included in HPMS reporting for all Federal-aid roadways. California has 57 Urban Areas, along with the generic Small Urban (#99998) and Rural (#99999) urban categories.

Table 2-5 lists the US Census-defined Urban Area Boundary codes for California along with the 2018 population totals for the Census-defined Urban Areas.

Table 2-5: Urbanized Area Codes and 2018 Population Data

Urban Code	Caltrans District	Urban Area Name	Part	State Portion of Urban Population	Total UCAE Population
02683	4	Antioch, CA		277,634	277,634
03196	5	Arroyo Grande--Grover Beach, CA		52,000	52,000
04681	6	Bakersfield, CA		523,994	523,994
12754	7	Camarillo, CA		71,772	71,772
16318	2	Chico, CA		98,176	98,176
19504	4	Concord, CA		615,968	615,968
22420	3	Davis, CA		72,794	72,794
22987	6	Delano, CA		54,372	54,372
26416	11	El Centro--Calexico, CA		107,672	107,672

Urban Code	Caltrans District	Urban Area Name	Part	State Portion of Urban Population	Total UCAE Population
27261	5	El Paso de Robles (Paso Robles)--Atascadero, CA		65,088	65,088
28657	4	Fairfield, CA		133,683	133,683
31843	6	Fresno, CA		654,628	654,628
33328	4	Gilroy--Morgan Hill, CA		98,413	98,413
36703	6	Hanford, CA		87,941	87,941
38215	8	Hemet, CA		163,379	163,379
41347	8	Indio--Cathedral City, CA		345,580	345,580
47611	7	Lancaster--Palmdale, CA		341,219	341,219
50527	4	Livermore, CA		81,624	81,624
50851	10	Lodi, CA		68,738	68,738
51040	5	Lompoc, CA		51,509	51,509
51445	7	Los Angeles--Long Beach--Anaheim, CA		12,150,996	12,150,996
52984	6	Madera, CA		78,413	78,413
54145	10	Manteca, CA		83,578	83,578
56251	10	Merced, CA		136,969	136,969
57709	12	Mission Viejo--Lake Forest--San Clemente, CA		583,681	583,681
58006	10	Modesto, CA		358,172	358,172
60799	8	Murrieta--Temecula--Menifee, CA		441,546	441,546
61057	4	Napa, CA		83,913	83,913
66673	7	Oxnard, CA		367,260	367,260
68887	4	Petaluma, CA		64,078	64,078
71074	10	Porterville, CA		70,272	70,272
73774	2	Redding, CA		117,731	117,731
74179	3	Reno, NV--CA	P	9	392,141
75340	8	Riverside--San Bernardino, CA		1,932,666	1,932,666
77068	3	Sacramento, CA		1,723,634	1,723,634
78310	5	Salinas, CA		184,809	184,809
78661	11	San Diego, CA		2,956,746	2,956,746
78904	4	San Francisco--Oakland, CA		3,281,212	3,281,212
79039	4	San Jose, CA		1,664,496	1,664,496
79147	5	San Luis Obispo, CA		59,219	59,219
79282	5	Santa Barbara, CA		195,861	195,861
79309	7	Santa Clarita, CA		258,653	258,653
79336	5	Santa Cruz, CA		163,703	163,703
79417	5	Santa Maria, CA		130,447	130,447
79498	4	Santa Rosa, CA		308,231	308,231
80362	5	Seaside--Monterey, CA		114,237	114,237
82144	7	Simi Valley, CA		125,206	125,206

Urban Code	Caltrans District	Urban Area Name	Part	State Portion of Urban Population	Total UCAE Population
85087	10	Stockton, CA		370,583	370,583
87490	7	Thousand Oaks, CA		214,811	214,811
88273	10	Tracy, CA		87,569	87,569
89083	10	Turlock, CA		99,904	99,904
89866	4	Vacaville, CA		93,141	93,141
90028	4	Vallejo, CA		165,074	165,074
90541	8	Victorville--Hesperia, CA		328,454	328,454
90946	10	Visalia, CA		219,454	219,454
92890	5	Watsonville, CA		73,534	73,534
96994	3	Woodland, CA		55,513	55,513
97939	3	Yuba City, CA		116,719	116,719
98020	11	Yuma, AZ--CA	P	1,011	135,267
99999	n/a	Rural		n/a	n/a
99998	n/a	Small Urban		n/a	n/a

Source: Caltrans – Highway Performance Monitoring System (HPMS) Data
https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system

Facility Type: The HPMS Facility Type code categorize public roadways according to the operational characteristic of the roadway. Table 2-6 lists the HPMS Facility Type codes and their descriptions.

Table 2-6: Facility Type describes the operational characteristic of the roadway.

Facility Type	Description	
1	One=Way Roadway	Roadway that operates with traffic moving in a single direction during non-peak period hours.
2	Two-Way Roadway	Roadway that operates with traffic moving in both directions during non-peak period hours.
4	Ramp	Non-mainline junction or connector facility contained within a grade-separated interchange
5	Non Mainline	All non-mainline facilities excluding ramps.
6	Non Inventory Direction	Individual road/roads of a multi-road facility that is/are not used for determining the primary length for the facility.
7	Planned / Unbuilt	Planned roadway that has yet to be constructed.

Volume Group (AADT): HPMS uses 12 volume groups for stratification purposes.

Table 2-7 lists the (AADT) volume group ranges to be used for HPMS stratification purposes.

Table 2-7: Volume Group / AADT Ranges

Volume Group	AADT Ranges
1	Under 500
2	500 to 1,999
3	2,000 to 4,999
4	5,000 to 9,999
5	10,000 to 19,999
6	20,000 to 34,999
7	35,000 to 54,999
8	55,000 to 84,999
9	85,000 to 124,999
10	125,000 to 174,999
11	175,000 to 249,999
12	250,000 and more

Source: HPMS Field Manual, Table 6.1, page 6-3 (FHWA, December 2016)

2.2. HPMS SAMPLING PROCEDURES – SELECTING SAMPLE PANEL DATA LOCATIONS

For HPMS reporting and for sample selection, California's roadway system is represented by a set of roadway sections, called the Table of Potential Samples (TOPS).

Full Extent Data: Full Extent Data refers to a limited set of data items that are reported for an entire roadway system such as the National Highway System (NHS) or an entire functional system (e.g., Interstate roadways).

Sample Panel Data: Sample Panel Data consists of data items that are reported for select portions of a given roadway system. The sampled sections are a fixed sample panel of roadway sections that are monitored from year to year and, when expanded, represent the Full Extent of the systems that are sampled. The more detailed information collected for a Sample Panel section is used to represent similar conditions on the associated functional system after expansion.

Caltrans provided the U.C. Berkeley research team with the 2018 HPMS full extend database ("5 TOPS items.csv"), the HPMS Sample Panel database ("Samples TOPS.csv"), and the On-Road and Off-Road GIS shapefiles for this research effort. They served as the primary data sources to validate the HPMS sampling procedures, and to develop the sampling procedures and parameters for estimating the required sample sizes for the Minor Collector (FC=6) and Local (FC=7) roadway sections that are presented later in this report.

For the HPMS sample size estimation process, FHWA defines and specifies precision levels that are applied to each roadway Functional Classification. FHWA defines the term precision level as "the degree of accuracy resulting from the use of a statistical sample". For example, if a sample is designed at the 90-10 confidence

interval and precision rate, the resultant sample estimate will be within ±10 percent of the true value, 90 percent of the time.

Table 2-8 lists the required HPMS precision levels by Urban Code and roadway Functional Classification code.

Table 2-8: HPMS Sampling Precision Levels (for California)

HPMS Urban Group	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7
Rural	90-05	90-05	90-05	90-10	80-10	80-10	80-10
Small Urban	90-05	90-05	90-05	90-10	80-10	80-10	80-10
Urbanized <200,000 population	80-10	80-10	80-10	70-15	70-15	70-15	70-15
Urbanized ≥ 200,000 population	90-10	90-10	90-10	90-10	80-10	80-10	80-10

Source: HPMS Field Manual, Table 6.2, page 6-4 (FHWA, December 2016)
Note: Red shaded Precision Levels were assigned by UC Berkeley ITS/PATH based on values in adjacent cells.

Sample size requirements by functional system will vary from State to State and between urban areas, dependent on the total number of TOPS sections, the number of predetermined volume groups, that variation in the State's AADT data, and the desired precision level. The HPMS sample size requirements are more stringent for the freeways and principal arterial systems, where higher levels of precision are needed due to their national significance.

The size of the HPMS samples are based on three components:

1. the variability (i.e. coefficient of variance of AADT with a volume group
2. the functional system confidence interval and precision level
3. the number of TOPS sections in a volume group available for sampling

From the HPMS Field Manual (Section 6.4, Sample Size Estimation Procedures), the sample-size estimation formula is:

$$n = \frac{\left(\frac{Z^2 C^2}{d^2}\right)}{1 + \left(\frac{1}{N}\right)\left(\left(\frac{Z^2 C^2}{d^2}\right) - 1\right)}$$

Where:

n = Required sample size

Z = Value of the standard normal statistic for an alpha confidence level (two-sided):

Confidence Level	Value of Z
90 Percent	1.645
80 Percent	1.282
70 Percent	1.040

C = AADT coefficient of variation from State's AADT data

d = Desired precision rate (from HPMS Table 6.2)

N = TOPS or population stratum size (number TOPS sections available for sampling in a volume group)

Table 2-9 summarizes California's roadway mileage by California's Urban Areas and the HPMS Roadway Functional Classification system.

Table 2-10 shows the number of TOPS sections by California's Urban Areas and the HPMS Roadway Functional Classification system. These TOPS (roadway) sections are used to represent the California roadway system for HPMS reporting. In statistical terms, the set of TOPS roadway sections are the population, or the group of TOPS sections that the TOPS samples will be selected from.

Table 2-11 displays the resulting number of required TOPS samples by Urban Code and Functional Classification.

- 02683 – 97939 California's Urban Codes
- 99998 California "Small Urban" TOPS sections and samples
- 99999 California "Rural" TOPS sections and samples

Table 2-11 displays the resulting number of required "Urban" TOPS samples by Caltrans District.

Table 2-12 displays the resulting number of required "Small Urban" TOPS samples by Caltrans District.

Table 2-13 displays the resulting number of required "Rural" TOPS samples by Caltrans District.

Table 2-9: 2018 HPMS Mileage Summary by Urban Code and Roadway Functional Classification Types

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
2683	-	20	49	56	76	2	709	913
3196	-	14	10	38	49	2	154	267
4681	-	39	171	194	171	4	1,568	2,147
12754	-	8	16	36	26	-	166	251
16318	-	-	36	46	35	2	290	408

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
19504	43	21	131	181	210	9	1,496	2,091
22420	5	5	5	31	31	2	130	208
22987	-	8	-	33	28	-	120	189
26416	5	-	46	44	72	3	235	405
27261	-	20	14	68	67	2	301	472
28657	18	3	28	42	55	-	270	417
31843	-	54	122	298	227	8	1,849	2,558
33328	-	16	19	37	60	4	234	369
36703	-	14	15	53	59	-	300	441
38215	-		25	38	79	-	453	595
41347	27	7	80	139	201	3	784	1,240
47611	-	13	96	272	156	2	857	1,396
50527	8	-	19	37	47	4	237	353
50851	-	11	14	26	42	1	170	264
51040	-	-	20	13	33	-	119	185
51445	338	305	2,376	3,056	2,567	44	16,356	25,042
52984	-	7	5	55	40	2	225	334
54145	-	18	24	19	46	2	224	333
56251	-	14	37	81	84	1	381	598
57709	23	18	137	127	107	-	992	1,403
58006	-	17	80	100	216	7	875	1,295
60799	42	-	30	105	173	-	1,336	1,687
61057	-	10	20	20	47	-	209	306
66673	-	24	112	77	113	1	727	1,053
68887	-	8	8	16	40	1	165	239
71074	-	-	17	28	29	2	234	310
73774	23	22	11	105	83	-	442	685
75340	118	71	211	700	805	2	4,409	6,317
77068	64	77	389	402	667	45	4,336	5,982
78310	-	24	40	30	67	7	349	517
78661	163	124	308	764	984	13	5,302	7,658
78904	147	111	466	846	896	10	4,911	7,387
79039	42	80	318	371	391	6	2,707	3,915
79147	-	7	14	26	16	2	138	203
79282	-	42	55	68	132	-	365	662
79309	15	10	41	35	58	-	459	617
79336	-	21	20	74	122	1	358	597

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
79417	-	11	18	69	56	-	254	408
79498	-	37	33	117	157	1	744	1,091
80362	-	12	42	35	110	-	354	553
82144		9	10	50	24	-	273	365
85087	21	20	90	70	139	2	879	1,221
87490	-	28	53	88	70	-	498	736
88273	7	-	30	24	48	1	183	293
89083	-	16	15	24	112	5	246	417
89866	13		23	17	45	-	235	335
90028	19	6	54	57	58	2	341	536
90541	18	-	61	312	253	2	1,398	2,044
90946	-	31	56	122	110	8	752	1,079
92890	-	4	11	14	70	1	103	204
96994	8	4	12	22	31	3	129	211
97939	-	9	28	63	90	4	356	550
99998	103	100	527	1,087	1,832	140	8,171	11,959
99999	1,186	369	3,264	6,140	12,032	7,487	40,797	71,275
State Wide	**2,456**	**1,919**	**9,960**	**17,100**	**24,645**	**7,854**	**111,655**	**175,589**

Source: Caltrans – Highway Performance Monitoring System (HPMS) Data
https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system

Table 2-10: 2018 HPMS TOPS Sections by Urban Code and Roadway Functional Classification Type

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
2683	-	59	476	450	808	6	236	2,035
3196	-	35	101	329	545	3	51	1,064
4681	-	126	1,192	1,378	1,568	16	523	4,803
12754	-	16	90	235	201	-	55	597
16318	-	-	307	403	307	7	97	1,121
19504	163	116	1,221	1,797	2,326	126	499	6,248
22420	14	13	59	202	264	3	43	598
22987	-	12	4	224	207	-	40	487
26416	11	-	294	352	676	10	78	1,421
27261	-	37	87	502	517	7	100	1,250
28657	47	16	177	371	574	1	90	1,276
31843	-	233	950	2,425	1,912	22	616	6,158
33328	-	30	173	350	649	49	78	1,329
36703	-	24	149	375	577	1	100	1,226
38215	-	-	85	212	745	-	151	1,193
41347	38	9	465	879	1,475	12	261	3,139
47611	-	34	489	1,862	1,014	12	286	3,697
50527	16	-	118	296	532	1	79	1,042
50851	-	25	110	346	471	4	57	1,013
51040	-	-	81	201	235	-	40	557
51445	1,920	1,688	24,963	36,452	33,310	405	5,452	104,190
52984	-	15	54	373	325	5	75	847
54145	-	48	203	149	517	7	75	999
56251	-	39	258	657	625	3	127	1,709
57709	99	80	999	989	1,313	7	331	3,818
58006	-	41	551	894	2,127	19	292	3,924
60799	69		115	795	1,202	-	445	2,626
61057	-	33	191	247	471	-	70	1,012
66673	-	70	736	669	1,282	6	242	3,005
68887	-	22	83	138	401	2	55	701
71074	-	-	64	244	250	3	78	639
73774	57	103	112	882	731	-	147	2,032
75340	378	278	1,376	5,269	7,028	10	1,470	15,809
77068	223	253	3,544	3,186	6,177	196	1,445	15,024
78310	-	63	268	286	532	14	116	1,279
78661	804	587	2,380	6,932	10,937	47	1,767	23,454

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
78904	660	484	5,038	9,570	10,417	101	1,637	27,907
79039	209	369	3,054	4,562	4,717	27	902	13,840
79147	-	21	117	238	164	2	46	588
79282	-	121	400	564	1,368	3	122	2,578
79309	49	31	290	290	543	-	153	1,356
79336	-	56	311	1,066	1,412	10	119	2,974
79417	-	22	121	556	615	-	85	1,399
79498	-	140	293	1,150	1,343	12	248	3,186
80362	-	66	298	405	1,264	3	118	2,154
82144	-	35	57	470	278	1	91	932
85087	73	83	777	634	1,464	7	293	3,331
87490	-	88	389	643	645	2	166	1,933
88273	29	-	293	225	487	4	61	1,099
89083	-	40	112	182	1,044	17	82	1,477
89866	48	-	169	158	409	1	78	863
90028	76	39	441	590	742	9	114	2,011
90541	34	-	273	2,161	1,997	16	466	4,947
90946	-	87	379	1,088	1,007	24	251	2,836
92890	-	20	124	136	549	3	34	866
96994	22	10	75	215	335	5	43	705
97939	-	19	136	640	871	10	119	1,795
99998	249	193	3,323	8,599	16,821	782	2,724	32,691
99999	1,419	509	5,357	9,811	29,968	749	4,080	51,893
State Wide	**6,707**	**6,538**	**64,352**	**115,304**	**161,291**	**2,792**	**27,699**	**384,683**

Source (FC=1 through FC=6, except FC=6 [Rural]): Caltrans – Highway Performance Monitoring System (HPMS) Data
https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system

Source (FC=6 [Rural] and FC=7): UC Berkeley ITS/PATH using HPMS roadway miles and HPMS recommendations.

Table 2-11: 2018 HPMS Required Samples by Urban Code and Roadway Functional Classification Type

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
2683		15	28	55	39	6	1	144
3196		3	19	21	19	3		65
4681		26	65	89	62	10	2	254
12754		3	10	15	17			45
16318			23	19	23	7		72
19504	16	19	67	65	72	11	2	252
22420	6	6	12	13	18	3		58
22987		3	4	16	17			40
26416	5		30	21	35	9		100
27261		9	20	20	21	4		74
28657	9	4	15	23	19	1		71
31843		21	73	70	69	13	2	248
33328		9	22	21	27	13		92
36703		8	22	15	18	1		64
38215			19	21	18		1	59
41347	10	4	31	47	65	11	1	169
47611		9	73	150	83	12	1	328
50527	6		18	12	17	1		54
50851		5	14	11	16	3		49
51040			10	12	16			38
51445	27	39	113	124	82	51	21	457
52984		3	12	23	22	3		63
54145		6	19	14	17	3		59
56251		6	21	20	26	3	1	77
57709	10	16	34	68	71	7	1	207
58006		8	35	64	61	11	1	180
60799	10		30	79	87		2	208
61057		7	23	22	16			68
66673		14	47	62	56	6	1	186
68887		3	20	13	12	2		50
71074			10	28	20	3		61
73774	10	15	20	22	23		1	91
75340	18	23	72	113	87	10	6	329
77068	17	28	82	120	78	45	6	376
78310		9	16	13	15	9		62
78661	21	34	60	77	72	25	7	296

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
78904	24	24	86	93	78	27	6	338
79039	12	23	79	124	66	14	4	322
79147		6	13	23	18	2		62
79282		14	34	19	23	3		93
79309	17	9	25	42	43		1	137
79336		15	19	19	33	6		92
79417		7	17	19	23			66
79498		18	41	60	58	9	1	187
80362		12	48	29	39	3		131
82144		9	14	27	23	1		74
85087	9	9	29	69	74	7	1	198
87490		13	37	75	63	2	1	191
88273	3		15	20	24	4		66
89083		6	9	18	30	9		72
89866	12		16	18	15	1		62
90028	12	12	34	27	23	8		116
90541	9		23	203	103	10	2	350
90946		14	41	78	67	13	1	214
92890		6	11	14	27	3		61
96994	9	6	14	12	19	4		64
97939		8	19	25	29	4		85
99998	63	47	234	149	82	65	69	709
99999	106	86	290	160	102	77	84	905
State Wide	**441**	**699**	**2,337**	**2,901**	**2,478**	**558**	**227**	**9,642**

Source (FC=1 through FC=6, except FC=6 [Rural]): Caltrans – Highway Performance Monitoring System (HPMS) Data
https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system

Source (FC=6 [Rural] and FC=7): UC Berkeley ITS/PATH using HPMS roadway miles and HPMS sample procedures.

The resulting number of required samples for Minor Collector (FC=6) roadways in Rural areas and for Local (FC=7) roadway sections (as shown in Table 2-10) are a major finding of this research effort. It is recommended that Caltrans initiate efforts to collect additional traffic count data to meet these requirements.

To help design a count schedule, the HPMS traffic count locations were summed by Caltrans Districts. The resulting District summary tables are presented next.

Table 2-12 shows the number of required Urban roadway samples by Caltrans District and Functional Classification.

Table 2-13 shows the number of required Small Urban roadway samples by Caltrans District and Functional Classification.

Table 2-14 shows the number of required Rural roadway samples by Caltrans District and Functional Classification.

Note that the cells in Tables 2-12 through 2-14 with a burnt-red background shading represent the findings from this UC Berkeley research effort; whereas the cells with no shading represent a District summation from the 2018 FHWA HPMS evaluation process (i.e., from the 2018 HPMS "Samples TOPS.csv" database).

Table 2-12: Required Urban Samples by Caltrans District and Roadway Functional Classification Type

Caltrans District Number	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
1	-	-	-	-	-	-	-	-
2	10	15	43	41	46	7	1	163
3	32	48	127	170	144	56	6	583
4	91	134	449	533	442	93	14	1,756
5	-	81	207	189	234	33	-	744
6	-	61	176	213	188	27	4	669
7	44	96	319	495	367	72	25	1,418
8	47	27	175	463	360	31	12	1,115
9	-	-	-	-	-	-	-	-
10	12	54	193	322	335	56	4	976
11	26	34	90	98	107	34	7	396
12	10	16	34	68	71	7	1	207
State Wide	**272**	**566**	**1,813**	**2,592**	**2,294**	**416**	**74**	**8,027**

Source (FC=1 through FC=6, except FC=6 [Rural]): Caltrans – Highway Performance Monitoring System (HPMS) Data
https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system

Source (FC=6 [Rural] and FC=7): UC Berkeley ITS/PATH using HPMS roadway miles and HPMS sample procedures.

Table 2-13: Required Small Urban Samples by Caltrans District and Functional Classification Type

Caltrans District Number	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
1	-	-	44	16	11	2	7	80
2	22	1	7	5	4	2	2	43
3	22	8	49	25	17	14	14	149
4	2	1	13	7	4	3	3	33
5	-	13	8	13	6	4	4	48
6	2	23	40	46	17	11	21	160
7	-	1	5	2	2	-	1	11
8	15	-	36	20	11	2	10	94
9	-	-	6	1	2	4	1	14
10	-	-	17	11	6	19	5	58
11	-	-	9	3	2	4	1	19
12	-	-	-	-	-	-	-	-
State Wide	**63**	**47**	**234**	**149**	**82**	**65**	**69**	**709**

Source (FC=1 through FC=6, except FC=6 [Rural]): Caltrans – Highway Performance Monitoring System (HPMS) Data
https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system

Source (FC=6 [Rural] and FC=7): UC Berkeley ITS/PATH using HPMS roadway miles and HPMS sample procedures.

Table 2-14: Required Rural Samples by Caltrans District and Roadway Functional Classification Type

Caltrans District Number	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
1	-	-	32	9	6	4	5	56
2	10	-	57	30	12	13	15	137
3	16	7	25	17	11	13	12	101
4	3	4	8	9	7	4	3	38
5	-	34	8	12	7	5	4	70
6	16	35	45	27	18	14	19	174
7	2	-	11	6	5	3	1	28

Caltrans District Number	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
8	36	1	14	18	11	2	7	89
9	-	-	25	10	6	2	3	46
10	10	4	48	11	13	10	10	106
11	13	1	17	11	6	7	5	60
12	-	-	-	-	-	-	-	-
State Wide	**106**	**86**	**290**	**160**	**102**	**77**	**84**	**905**

Source (FC=1 through FC=6, except FC=6 [Rural]): Caltrans – Highway Performance Monitoring System (HPMS) Data https://dot.ca.gov/programs/research-innovation-system-information/highway-performance-monitoring-system

Source (FC=6 [Rural] and FC=7): UC Berkeley ITS/PATH using HPMS roadway miles and HPMS sample procedures.

The HPMS software provides the randomly selected count locations for the Interstate (FC=1), Principal Arterial (FC=2 and FC=3), Minor Arterial (FC=4), Major Collector (FC=5) and Minor Collector (FC=6) roadway sections in Urban and Small Urban areas. Likewise, the HPMS software provides the randomly selected count locations for the Interstate (FC=1), Principal Arterial (FC=2 and FC=3), Minor Arterial (FC=4), and Major Collector (FC=5) roadway sections in Rural areas.

A set of randomly generated count locations were selected for the:

- 74 required locations on Local (FC=7) roadways in Urban areas,
- 69 required locations on Local (FC=7) roadways in Small Urban areas,
- 77 required locations on Minor Collector (FC=6) roadways in Rural areas.
- 84 required locations on Local (FC=7) roadways in Rural areas.

The random location selection process was performed using the Caltrans Linear Referencing System (LRS) shapefile for Off-System roadways. To create an unbiased selection process, the random location selection process was weighted by Caltrans LRS segment lengths (i.e., roadway section lengths) such that a roadway segment with length 2.0 miles was four times more likely to be selected as a roadway segment with a length of 0.5 miles.

- Appendix A: Table A-1 shows a representative set of random count locations for the Local (FC=7) roadways in Urban areas.
- Appendix A: Table A-2 shows a representative set of random count locations for the Local (FC=7) roadways in Small Urban areas.
- Appendix A: Table A-3 shows a representative set of random count locations for the Minor Collector (FC=6) roadways in Rural areas.
- Appendix A: Table A-4 shows a representative set of random count locations for the Local (FC=7) roadways in Rural areas.

2.3. HPMS COUNT SCHEDULE (FREQUENCY OF TRAFFIC COUNTS)

The Caltrans HPMS Branch currently has a suitable count schedule for all public roadways in California to meet HPMS requirements; that is, except for the Rural FC=6 (Minor Collector) roadways and FC=7 (Local) roadways in the State. In the previous section of this report, the number of recommended count locations was established to provide adequate sampling on these FC=6 and FC=7 roadways. This section describes the traffic count schedule that was developed for these 304 newly recommended FC=6 and FC=7 count locations:

- 74 Local (FC=7) roadways in Urban areas
- 69 Local (FC=7) roadways in Small Urban areas
- 77 Minor Collector (FC=6) roadways in Rural areas
- 84 Local (FC=7) roadways in Rural areas

Table 2-15 shows the number of needed new FC=6 and FC=7 count locations by District and Urbanized Area categories.

Table 2-15: Required Rural Samples by Caltrans District and Roadway Functional Classification Type

Caltrans District	Urbanized Area and Roadway Functional Classification Types				
	Urban	Small Urban	Rural	Rural	All Facility Types
	Local (FC=7)	Local (FC=7)	Minor Collector (FC=6)	Local (FC=7)	
1	-	7	4	5	16
2	1	2	13	15	31
3	6	14	13	12	45
4	14	3	4	3	24
5	-	4	5	4	13
6	4	21	14	19	58
7	25	1	3	1	30
8	12	10	2	7	31
9	0	1	2	3	6
10	4	5	10	10	29
11	7	1	7	5	20
12	1	-	-	-	1
CA-Statewide	**74**	**69**	**77**	**84**	**304**

Caltrans HPMS performs the traffic count data collection is on a on a 6-year cycle for FC=6 [Rural] and FC=7.

Table 2-16 display a plausible count schedule, with about 1/6 of the total counts counted in each of the six years in the count cycle, segregating the required counts by Caltrans District.

Table 2-16: Potential 6-Year Count Cycle for HPMS Minor Collector and Local Roadway Counts

Count Cycle (Year)	Caltrans Districts	Number of Counts
Year-1	1, 2	47
Year-2	3	45
Year-3	4, 5, 9	43
Year-4	8, 10	60
Year-5	7, 11, 12	51
Year-6	6	58
CA-Statewide	**Total**	**304**

For roadways that are not on the State Highway System (e.g., urban collectors and rural major collectors), the Caltrans Traffic Count Guidelines states "It is recommended that two-thirds of the HPMS counts be volume counts, and that one-third be classification counts."

Next, the annual costs for collecting the recommended traffic counts on the Local (FC=7) roadways and the Minor Collector (FC=6) roadways in Small Urban areas were estimated.

Table 2-17 displays the current per location bid rate for traffic volume data collection contracts.

Table 2-17: Budget Estimates for HPMS Recommended Counts

Number of Lanes	Class / Non-Class	Current Bid Rate
1 to 2	Class	$75.00
3 to 4	Class	$325.00
5 to 6	Class	$550.00
7 to 8	Class	$925.00
1 to 2	Non-Class	$55.00
3 to 4	Non-Class	$80.00
5 to 6	Non-Class	$105.00
7 to 8	Non-Class	$125.00

The annual costs would be in the range of $3,145 per year (17 x $75.00 + 34 x $55.00), with 304 total additional count stations, a 6-year count cycle, and 1/3 of the count stations collecting classification counts. For budgeting purposes, it was assumed that these local and minor collector streets are one lane in each direction.

2.4. SAMPLE ADEQUACY AND MAINTENANCE

The Caltrans roadway sections in the 2018 HPMS-TOPS database were evaluated using the HPMS Field Manual guidelines for sample adequacy and maintenance. The HPMS guidelines are outlined in this section of the report, followed by the findings, and any resulting recommendations.

The HPMS Field Manual (Section 6.5, Sample Adequacy and Maintenance) states that:

> Each HPMS section should be relatively homogeneous as to geometrics, traffic volume, cross-section, and condition, and should be long enough to constitute a logical section for National-level analysis purposes.
> In general:
> - The length for a rural section should range from 0.3 to 10.0 miles.
> - The length for a section that is an urban access-controlled facility typically should not exceed 5.0 miles.
> - The length for all other urban sections should range from 0.1 to 3.0 miles.

The lengths of the TOPS sections in the Caltrans 2018 TOPS samples dataset were evaluated and compared to the above HPMS recommendations.

Table 2-18 summarizes the results, showing that there are several TOPS samples that fall outside the HPMS recommended section-length ranges.

Additionally, the HPMS Field Manual (Section 6.5, Sample Adequacy and Maintenance) states that:

> Sample adequacy and maintenance is a process that should be integrated as part of the routine data management activities of the State throughout the year. Once the State has uploaded HPMS data, the HPMS software will produce the TOPS and this information will be available to the States (as discussed in Section 6.2). The States will need to then review their sample framework to determine the necessary adjustments and add new sample sections as needed, prior to the next HPMS submittal cycle. Some of the guidelines recommended by FHWA for the States to adhere to include the following:
> - Provide a 5-10 percent sample surplus per volume group, if possible.
> - Add/delete samples as needed using a random process.
> - Provide their sample deletion plan to FHWA for the review of any significant deletions.
> - Check for un-sampled, under-sampled, and over-sampled volume groups.
> - Ensure a minimum of 3 samples per volume group; sample all if there are < 3 samples in a volume group.
> - Maintain a maximum expansion factor of 100.000.

Table 2-19 shows the number (count) of 2018 TOPS samples with an expansion factor that is greater than 100. As can be seen, there are 507 roadway samples with expansion factors greater than 100 in the Caltrans TOPS sample dataset, the vast majority being FC=3, FC=4, or FC=5 (Principal Arterials, Minor Arterials or Major Collector roadways).

Table 2-18: Number of 2018 TOPS Samples Outside HPMS Recommended Section Length Ranges

HPMS Field Manual Recommended TOPS Section Quality Check	Number of Caltrans 2018 TOPS Samples Exceeding Threshold
Rural Sections (Urban Code=99999) with length < 0.3 miles	121 (16.3%)
Rural Sections (Urban Code=99999) with length > 10.0 miles	5 (0.7%)
Urban Access Controlled Facility Sections (FC=1 or FC=2) with length > 5.0 miles	3 (0.3%)
Other Urban Sections (FC=3 through FC=6) with length < 0.1 mile	3,356 (40.9%)
Other Urban Sections (FC=3 through FC=6) with length > 3.0 miles	67 (0.8%)

Table 2-19: Count of 2018 TOPS Samples with Expansion Factor > 100

Urban Code	Interstate FC = 1	Principal Arterial (Freeway or Expressway) FC = 2	Principal Arterial (Other) FC = 3	Minor Arterial FC = 4	Major Collector FC = 5	Minor Collector FC = 6	Local FC = 7	All Facility Types
4681	-	-	8	-	11	-	n/a	19
33328	-	-	3	-	-	-	n/a	3
50527	-	-	3	-	-	-	n/a	3
51445	3	-	24	48	50	-	n/a	125
66673	-	-	3	-	-	-	n/a	3
73774	-	-	-	3	7	-	n/a	10
75340	-	-	3	5	8	-	n/a	16
77068	-	-	17	-	-	-	n/a	17
78310	-	-	-	-	3	-	n/a	3
78661	3	-	-	5	28	-	n/a	36
78904	-	-	23	19	44	-	n/a	86
79039	-	-	18	19	7	-	n/a	44
79309	-	-	6	-	-	-	n/a	6
79417	-	-	-	-	3	-	n/a	3
99998	-	-	-	21	38	-	n/a	59
99999	-	-	-	21	53	n/a	n/a	74
State Wide	**6**	**0**	**108**	**141**	**252**	**0**	**n/a**	**507**

Many of the TOPS samples with an expansion factor > 100 are also shorter than the HPMS recommended section length. These TOPS samples with expansion factors greater than 100 should be reviewed by Caltrans HPMS engineers to determine if the section lengths can be increased or if (longer) adjacent sections could serve as HPMS TOPS samples in lieu of these short sample sections.

Additionally, it is recommended that Caltrans select a small subset of the off-system count locations in each District; and install year-round count stations at these locations. Currently Caltrans does not have any year-round count stations that could be used to develop seasonal correction factor for the off-system SHWY roadway sections.

3. CENSUS PROGRAM – RESEARCH METHODOLOGY AND FINDINGS

The federal government requires that states collect traffic census or traffic count data per Title 23 (Highways) of the United States Code of Federal Regulations (CFR). Subpart B (Traffic Monitoring Systems) sections 500.201 through sections 500.204 specify the purpose of the required traffic monitoring system (TMS), TMS definitions, TMS general requirements, and the TMS components for highway traffic data.[2]

The Caltrans Traffic Census Program serves as the Traffic Monitoring System for California, as required by Title 23, United States Code Sections 500.201-204 that sets forth requirements for development, establishment, implementation, and continued operation of a Traffic Monitoring System for highways.[3]

Additionally, traffic census counts are critical for roadway design, long-range planning, project prioritization, budget allocation, safety analysis, and other key activities that enable State DOTs to manage their transportation systems. Further, federal transportation re-authorization language (MAP-21) placed even greater reliance on the use of system performance measures.

Caltrans Traffic Counts are summarized annually into four categories:

1. Traffic Volumes: Annual Average Daily Traffic (AADT)
2. Truck Traffic: Annual Average Daily Truck Traffic
3. Ramp Volumes
4. Peak Hour Volume Data

The traffic count year is from October 1st through September 30th. Currently, very few locations in California are actually counted continuously (that are used for Census reporting). Traffic counting is generally performed using electronic counting instruments moved from one location to another throughout the State in a program of continuous traffic count sampling. The resulting counts are adjusted to an estimate of annual average daily traffic (AADT) by compensating for seasonal influence, weekly variation and other variables that may be present.

Annual ADT (AADT) is necessary for presenting a statewide picture of traffic flow, evaluating traffic trends, computing accident rates, planning and designing highways and other purposes. Further, the Census count staff provide on-system Census count data for Caltrans HPMS reporting.

Additionally, the Census count data serve as one of the key inputs used by Caltrans Traffic Accident Surveillance and Analysis System (TASAS) branch to estimate collision rates. The Traffic Census Program is tasked with collecting intersection data to support the Traffic Safety Program's development of TASAS Table C (Collision Concentration report) and Table B (Accident Rate report).

[2] Electronic Code of Federal Regulations (e-CFR). Website: ecfr.io/Title-23/pt23.1.500#se23.1.500_1204.

[3] Update of Guidelines and Operating Procedures for the Traffic Census Program, Cambridge Systematics, Inc. September 10, 2008.

Caltrans Districts (and the Census Program) historically and currently only nominally leverage PeMS data to meet their annual traffic count obligations even though the Caltrans PeMS system archives traffic data from thousands of vehicle detector stations in Districts 3, 4, 5, 6, 7, 8, 10, 11, and 12 (all but rural Districts 1,2, and 9).

The UC research team collected current (year 2020) Census traffic station data for Districts 3, 4, 5, 6, 7, 8, 10, 11, and 12 to identify suitable PeMS vehicle detector stations that could (potentially) serve to provide the traffic count data needed to meet Census reporting requirements.

Prior to using PeMS data for Census/HPMS reporting purposes, the Districts should check the data fidelity for each PeMS station identified as a potential HPMS/Census data collection site. In PeMS, the data fidelity has a maximum of 100% of observed traffic counts every 5 minutes per sensor per hour, as a measure of data quality. Currently, in the Caltrans "Procedures for Extracting PeMS data by location for TC.pdf", Caltrans uses 90% of observed traffic counts per sensor per hour for data quality. Likewise, Caltrans uses 90% Traffic Volume Accuracy and Accuracy Limits of Average Daily Traffic (ADT). For more information see Chapter 2 of the Caltrans Traffic Manual, Traffic Volumes System, Page 2-23, 8-1979.

3.1. IDENTIFYING SUITABLE PEMS STATIONS AT CENSUS COUNT LOCATIONS

For this effort, the current Census traffic station listing by District and route was provided by Caltrans Census Program personnel. These were provided in PDF format, one file for each District ("Current Dxx Traffic Station Listing by Route.PDF" where xx is the District number). The current Caltrans PeMS mainline vehicle detector station (VDS) location listing was downloaded from the Caltrans PeMS website.

For each Census count location, the closest freeway mainline (and HOV-lane station where applicable) PeMS station was identified using Route number and Post-Mile designations. Next, the number of traffic lanes in the Census database was compared to the number of traffic lanes at the closest identified PeMS station. The results of the Census-PeMS location matching efforts were tallied and tables were prepared showing the results.

Table 3-1 lists the resulting number of Census stations where the field "ROADLOC TYPE" is coded as "FWY", "EXP" or "CON" (Freeway, Express Way or Conventional Highway), along with the number of locations where there was a suitable Caltrans PeMS station.

Even though the resulting Census-to-PeMS tables are the main output or work product of this research subtask, they have been placed in the following appendices simply because these are large (11x17 page) multi-page tables, one table for each Caltrans District. The tables in Appendix B of this report list the Freeway, Expressway and Conventional Highway Census along with the closest available PeMS mainline vehicle detector station (VDS), given that there was at least one PeMS mainline VDS within 0.5 miles of the Census count location. There is one table for each Caltrans District in Appendix B, with the exception of District 1, 2 and 9 which do not have any mainline VDS locations reporting data to Caltrans PeMS.

Table 3-1: Number of 2019 Freeway Mainline Census Stations and Matching PeMS Stations

Caltrans District	Number of Mainline Census Stations (FWY, EXP or CON)	Number of Matching Mainline PeMS Stations			Number of Matching Mainline PeMS Stations with Matching Number of Lanes			Average Distance between Census & PeMS Stations (miles)	
		Primary Direction	Secondary Direction	Both Directions	Primary Direction	Secondary Direction	Both Directions	Primary Direction	Secondary Direction
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-
3	383	79	87	79	11	15	11	0.10	0.12
4	371	175	165	165	45	46	45	0.14	0.13
5	144	26	23	23	6	3	3	0.13	0.15
6	365	85	88	85	8	7	7	0.17	0.17
7	306	181	181	181	34	31	31	0.16	0.16
8	236	75	72	72	22	20	20	0.15	0.14
9	-	-	-	-	-	-	-	-	-
10	214	46	46	46	8	13	8	0.13	0.12
11	253	104	110	104	7	16	7	0.14	0.15
12	100	68	67	67	38	32	32	0.12	0.11
CA Statewide	**2,372**	**839**	**839**	**822**	**179**	**183**	**164**	**0.14**	**0.14**

Source: Census Count Locations: Caltrans – Traffic Census Program (Current DXX Traffic Station Listing by Route.pdf)
PeMS Mainline Station (VDS) Locations: Caltrans – PeMS
Census-To-PeMS Matching: U.C. Berkeley ITS/PATH calculation

3.2. FINDINGS AND RECOMMENDATIONS

Overall or statewide, there are an additional 822 Census stations with matching mainline freeway PeMS stations in close proximity to the Census station (in both the primary and secondary direction). Of these, 164 of the Census stations and matching PeMS stations list the same number of traffic lanes in both directions.

We recommend that the Census program managers look closely at these 164 locations to determine how well the Census reported AADTs match the PeMS estimated AADTs to identify if PeMS is a suitable data source for Caltrans Census needs. This simple straightforward evaluation and a simple change of data collection procedures that could result in significant annual data collection costs. Further, the AADTs at these locations could be updated and reported annually instead of once every three years, with intermittent AADT values (i.e., years) being interpolated.

We also recommend that the Census program management review the Census locations where either the primary direction or the secondary direction had matching number of Census and PeMS reported lanes (but not matching number of lanes in the other direction) to ascertain whether or not PeMS AADT estimates could be used even though not fully available in both directions.

Furthermore, the Census locations where the number of lanes reported by PeMS and Census do not match still might prove meaningful for developing seasonality trends (i.e., monthly count adjustment factors), day-of-week factors and time-of-day factors (i.e., K and/or D factors). Additional work or research would be necessary to determine the usefulness of the Census-PeMS locations with reported mismatching number of lanes.

Lastly, page #14 of the "***Integrated Traffic Data Collection and Management Plan for the Shasta County South Central Urban Region (SCUR), Final Report***" stated that there were "16 permanent stations for continuous counts, known as trend counts, that remotely collect and transmit data via dial-up or cellular modem and submitted to Caltrans Headquarters on a monthly basis". Similarly, the "***Caltrans District 1 Evaluation of StreetLight Data InSight Transportation Data Analytics Platform***" mentioned (on page 9 of 32) that "twenty-eight counters had data for the entire fiscal year (365 days)". We recommend that Caltrans determine if these 16 District 2 stations and these 28 District 1 stations can be cost effectively incorporated into Caltrans PeMS and proceed to do so if feasible. In addition, obviously, these continuous count stations should be used for Census and HPMS reporting if this is not already the case.

4. EMERGING DATA COLLECTION TECHNOLOGIES

A literature review was performed to gain insights into lessons learned and the state of the practice for HPMS traffic data collection procedures. The findings from this literature review are presented in Section 2.1.

Next, information was gathered (via a web search and phone discussions with data providers) on commercially provided "big-data" traffic data. Section 2.2 summarizes the findings on the commercial "big-data" traffic count/volume data providers.

4.1. LITERATURE REVIEW

The findings from the literature review of traffic count data technologies is presented next, with each relevant publication discussed in separate subsection.

Highway Performance Monitoring System Traffic Data for High Volume Routes: Best Practices and Guidelines (FHWA, Final Report, September 8, 2004)

The authors of the FHWA report stated that: Equipment problems are common to all states interviewed, regardless of the type of equipment. Non-intrusive equipment is increasingly being used or considered for data collection by several states. States need to develop specification and criteria to guide the selection and testing of such equipment.

The authors went on to say that: The potential for using ITS data for HPMS has been recognized by many states. Increasingly, states areturning to ITS-generated data for HPMS reporting. Several states like Florida, Ohio, Michigan, and Illinois have successfully used ITS data for HPMS reporting. Other states are experimenting with using ITS data sources for HPMS reporting.

Chapter 4 Traffic Data Collection Equipment for High-Volume Locations -- 4.3 Equipment Summary

While there have been rapid advances in vehicle detection technology, inductive loops and piezo electric sensors are considered by states as the most efficient way to collect traffic data. Improvements in loop installations and vehicle counters have greatly reduced the problems associated with inductive loops. Advanced vehicle counters with loop signatures-based detection and classifications promise to build upon the improvements. However, the use of loops continues to be cumbersome due to its inherent requirements such as pavement cutting, traffic control and lane closures, and maintenance problems. Pneumatic tubes are the preferred technology for short-term counts.

Non-intrusive detectors provide an alternative to minimize or eliminate some of the safety and maintenance issues with loops and tubes. These technologies include infrared-, acoustic-, microwave- and video-based sensors. Various tests have shown that these sensors currently meet requirements as far as volume monitoring is concerned but fall short on classification of vehicles.

Even though the 2004 FHWA report is a bit dated now, the general findings still hold. Many of the traffic count technologies that were popular 0-15 years back are still widely used. And, the finding that state DOTs

and MPOs are tending toward using ITS-generated data for HPMS traffic volume reporting is still a valid conclusion.

The complete text from Chapter 4 of the Traffic Data Collection Equipment for High-Volume Locations has been included in Appendix C of this report.

Integrated Traffic Data Collection and Management Plan for the Shasta County South Central Urban Region (SCUR) (Kimley-Horn, Final Report, October 3, 2013)

The authors conducted a technology evaluation of several transportation data collection technologies for Caltrans District 2. Of the data collection technologies evaluated, the overall feasibility for those technologies well suited for collecting traffic counts for HPMS purposes are listed in the following paragraphs.

Inductive Detector Loops – Inductive detector loops are the best and most conventional option to collect vehicle data. The technology is well-developed and has already been deployed throughout Shasta County and District 2. Existing non-permanent (i.e. counter is only on-site during data collection periods) stations already have in-pavement loops and could be upgraded to permanent stations (i.e. install cabinet and counter in order to collect data at all times) or Traffic Monitoring Stations (TMS). The use of detector loops can also be paired with statewide infrastructure since TMS stations with loops are most commonly used. Loop detectors are highly feasible to deploy.

Radar Detection – Radar detection is a feasible option for additional count stations in areas where data is desired and does not exist. They can be installed along I-5 at regular intervals and could transmit data to the TMC. This type of detector could also be used for on and off ramp volumes and replace the need to manually deploy tube counters to collect the data. Installation of this technology would not require any traffic-impacting construction as no roadway pavement work is needed. An upgrade to the District's central equipment and software would be necessary to deploy radar. The process of collecting the data and transferring it to PeMS would require a Front-End Protocol Translator (FEPT), which the District does not currently have.

Stand-alone radar stations with solar power and cellular communication are a great option for detection locations far away from existing power and communication infrastructure. The feasibility of this option, however, would depend on site conditions and whether or not cellular connection is available at a specific location.

Since radar detectors are generally weather resistant, inclement winter weather would not affect them. However, since I-5 is a major route for truck movement, high truck volumes could interfere with the accuracy of detectors due to occlusion. Installation of radar detectors on overhead structures could be considered to minimize occlusion. However, overhead installation and maintenance of radar detectors would require lane closures. District 2 has deployed microwave detectors at two test sites on I-5 that were installed in the center median area to mitigate occlusion impacts, but these are not currently in use nor integrated into the existing system.

Radar detection has limited capabilities to detect classification. Although it is able to detect vehicle length and type, which is a form of vehicle classification, it does not automatically detect number of axles and thus does not fit all census statistics requirements.

Video Image Detection – Video image detection is an option for filling in gaps where count stations are missing throughout the Shasta region. It is an effective non-intrusive technology that has the option to be a stand-alone system since it is capable of utilizing solar for power and cellular for communications (however, this option is dependent on good cellular service reception and direct sunlight). Construction of this type of detector would not typically require any lane closures.

For the Shasta region, video image detectors may lose reliability due to their susceptibility to weather related technical problems. Snow and rain during the winter months can hinder the quality and accuracy of the detectors. Also, though they can detect vehicle classification, they cannot automatically detect the type of classification counts that fit the criteria that census statistics require (i.e., number of axles).

Although this technology is as an option for traffic monitoring but might be better suited for signalized intersections (which was not an objective of the stakeholders) rather than arterial freeways such as I-5.

Magnetometers – Magnetometers are an option for the installation of new count stations at desirable locations within the County. This technology can replace non-permanent loop locations or any loops that are no longer functional. They are easy to install and require minimal lane closures and disruption of traffic.

Because magnetometers are currently used by other Caltrans districts, integration to Caltrans' current infrastructure may not be as intensive. This technology can be installed on mainlines as well as on and off ramps for volume monitoring. Furthermore, magnetometers can be paired with a system that communicates directly with the TMC and would require low communication bandwidth to transfer data.

Since magnetometers cannot detect stopped vehicles, they may have trouble detecting vehicle presence during inclement weather in winter months. Vehicles stopped along I-5 would not be captured by the magnetometers. Stopped vehicles on ramps may also not be detected; therefore, this technology may not be feasible for use with a ramp metering system. Magnetometers are also incapable of detecting any form of vehicle classification.

Overall, magnetometers are a good option for the District to consider. Moderately priced and easy to install, this technology is comparable to inductive detector loops and can have many applications for Shasta County.

Caltrans Traffic Census Program Improvement Study

(Preliminary Report, Value Management Strategies Inc. (VMS), August 2015)

A previous (2015) Caltrans Census program improvement study was performed as part of a Department-wide effort to improve efficiency and cost-effectiveness. The overall project's focus was to identify recommendations that would ensure the Traffic Census Program:

- Delivers timely data that meets minimum standards consistently across the state, for a realistic cost
- Is flexible enough to meet other data needs as they become known, with appropriate cost accounting
- Is accountable to management for meeting (or failing to meet) these goals

The VMS report from the **Caltrans Traffic Census Program Improvement Study** listed several recommendations. Of the recommendations, one is particularly relevant to this emerging data collection technologies evaluation – Recommendation 3.2 "*Evaluate District Census Locations and Develop Plans for Optimum Technology Usage*". Recommendation 3.2 from the VMS report is presented next.

Caltrans Traffic Census Program Improvement Study – Recommendation No. 3.2

Evaluate District Census Locations and Develop Plans for Optimum Technology Usage

Description of Baseline Process / Problem Statement: Each District currently has a three-year count cycle schedule that includes continuous and quarterly (also known as control and/or trend counts), profile, ramp, truck, and intersection counts. These schedules are based on a master count location listing developed in the 1970s. Historically, Districts have been tasked with identifying and capturing data for areas that have experienced a change in volume (increase or decrease) and adjusting count locations accordingly. However, many Districts have requested explicit requirements from HQ TC on which locations require counts; HQ TC in turn refers Districts to their three-year count cycle and guidelines documents. As it stands, the count cycles currently in use are the best representation available for the Federal requirements although it is unclear how many Districts are updating them.

An assessment of each District's location map is needed to ensure compliance with Federal requirements as well as ensuring other stakeholder needs (such as other Caltrans Divisions) are being met.

Furthermore, Tube Counters are used at approximately 75% of all locations statewide. With increasing traffic volumes on the highways, setting the tubes exposes staff to live traffic hazards, particularly on ramps which account for approximately 40% of the Tube Counter locations. Due in part to these hazards and to reported staffing shortfalls, only approximately 48% of ramps are being counted.

Description of Recommended Change / Solution:

- **Description of Recommendation:** This recommendation suggests conducting detailed analysis of each District's TC location map and three-year count schedule to determine the viability of each location and the best type of technology to use. This recommendation does not suggest the wholesale replacement of Tube Counters, as they offer significant benefits, such as low cost and location flexibility. However, census-specific inductive loops, piezos, and numerous non-intrusive devices such as Microwave-Radar Systems, Video Systems, Laser Systems and Radar Systems should be considered as well to optimize efficiency, streamline data collection at more locations, and reduce risk to field staff. In addition, the Traffic Census Improvement team is studying the viability of using Traffic Signal loops to collect census data. Preliminary research shows very strong indications that it is both feasible and economical.
- **Relevance for New CT Mission, Vision, and Goals:** The recommended changes directly support the Department's mission of providing a "safe, sustainable, integrated and efficient transportation system" by reducing the number of trips census staff need to take into the field while increasing data quantity and improving data quality.

Caltrans Traffic Census Program Improvement Study – Recommendation No. 3.2

Advantages:

- Optimizing census locations will ensure needed data is being collected in the most efficient way possible. For example, the devices can be remotely accessed from the District office, eliminating travelling to the sites and thus reducing travel time. This change should increase to total quantity of locations being counted.
- Communications costs for integrated Traffic Census and Traffic Signals equipment can be shared between both groups.
- Mio-Vision and Sierzega Radar Systems are portable and can be set up in a short time.

Disadvantages:

- Integrating TC with Traffic Signals will require programming a new "middleware" to pull data from each District's new TMSS server to either PeMS or a new District Census server.
- The non-invasive technologies have limitations and trade versatility for improved safety.

Discussion: The Traffic Census Improvement team suggests a multi-pronged solution. After reevaluating each District's census map and count cycle, existing permanent equipment in good condition should be identified to continue collecting needed data. The remaining locations would then be analyzed to determine the best of the following technological options.

- **Shared Loops for Traffic Signals and Traffic Census:** Currently, it is very common for permanent TC field assets to share the same cabinets as traffic signals, ramp meters, and TMS. It is also common for TC to have their own proprietary counter and redundant set of loops just in front of the traffic signal loops. The TC loops often do not terminate at the traffic signal cabinet and are left in a pull-box alongside the roadway without power. The new 2070 traffic signal controllers are network capable and can also be used as a traffic counter. Unfortunately, very few traffic controllers are currently on the network. Combining the efforts of traffic signals and census makes sense to minimize the number of elements required to complete both tasks. Additionally, there is a maintenance and construction benefit from having fewer TC-specific loops.

  The first step to develop a traffic signal as a traffic counter is to install communications to each traffic signal cabinet to allow TSMSS servers to communicate. It is anticipated that this work may already be planned by Traffic Signals, which would provide cost sharing potential to both groups. (Please refer to the next page for a breakdown of the financial implications.) Ongoing communications costs could also be shared and would vary depending on usage and frequency.

  The next step would be to have "middleware" developed (ideally by Transcore the TSMSS server company) that formats and outputs data for Traffic Census's use. This could be routed through PeMS or to a new separate District TC server. Verification and validation of the data shall be applied by each District prior to being sent to TSN. Training of all TC personnel would be offered to ensure correct usage of the new data process.

Caltrans Traffic Census Program Improvement Study – Recommendation No. 3.2

- **Non-Intrusive Technologies:** New non-intrusive technologies to replace Tube Counters and providing reliable counts should be considered. There are limitations to these systems but they can replace current Tube Counters in many locations. Both systems can be used at ramp locations and where special counts are requested. However, their data may be less reliable when used on larger roadways up to four lanes. For this reason, it is recommended that permanent inductive loops, or joined traffic signal / census loops, be used on larger roadways.

  Due to its limited battery capacity, the Sierzega Radar System cannot be deployed for long periods. Therefore, it is most suitable for ramp counts.

  The Mio Vision System is limited in that the cost of processing the video for a single count can be over $3,300. For multiple locations, the high costs of processing the video as well as video storage are some of the limiting factors. There will be additional batteries needed for a full 24 hours/7 days count as the regular unit will lasts 3 full days. Another complication for this technology is the viability of having data stored offsite by a vendor. This is currently under review by IT. If it is determined that data may not be stored in this manner, use of this technology would not be feasible.

- **New Inductive Loops:** Inductive loops with wireless communications remain one of the most efficient methods of collecting TC data in use today. Where other options are not viable, this remains a preferred solution. It is recommended that these locations be mapped to future capital projects whenever possible.

Implementation Considerations:

- **Financial Implications and Return on Investment:**
  - Estimated costs for collecting traffic census data from traffic signal loops:
    - Consultant fees for count cycle reevaluation, technology plan, etc. is estimated to be about $150,000 per District.
    - Initial investment of $1500 for wireless cellular modem for each traffic signal cabinet plus 4 hours of labor per site to set up communications where needed. D-3, a mid-sized District, has approximately 450 locations ($675,000 + 1800 labor hours or about 1 PY).
    - Reoccurring $5-$40/month per location for communications service based on data usage. This cost could be minimized by sharing with Traffic Signals.
  - Non-Invasive Technologies:
    - Depending on system selected, the costs vary from $3,000 to $5,000 per unit for Mio Vision and Radar systems. There are also data storage costs per location per year, making this option not feasible.
  - New Inductive Loops:

The current construction estimate for an inductive loop system is $10,000 to $15,000 for coverage of a two-lane section. These costs include installing the inductive loops, trenching, pull-boxes and cabinets to house the counters. Additional costs may include loops for additional lanes as well as lane closure costs during construction.

Caltrans Traffic Census Program Improvement Study – Recommendation No. 3.2

- **Organizational Impact:**
  - **Employee Impact:** This would depend on the technologies selected. There would be a need for staff augmentation as the new system is developed and deployed; there would be efficiencies over time as data is collected more efficiently.
  - **Stakeholder Impact:** The Department will be able to provide more traffic data to both internal and external stakeholders.
- **Policy Impact:** None anticipated.
- **Risks:**
  - **Risks of no action:** If no action is taken, Caltrans field workers will continued to be exposed to the traffic hazards they are currently facing. Due to safety concerns, the Department will be unable to collect traffic data at high risk roadways and resulting in less published data for use by other agencies.
  - **Risks of recommendation implementation:** None anticipated.
- **Performance Measurement:** The collection of data (quantity), data quality, and field worker safety records.
- **Implementation Authority:**
  - Headquarters Traffic Operations
  - District Traffic Operations DDD
- **Recommended Responsible / Involved Parties:**
  - Headquarters Traffic Operations – TMS Manager
  - District Traffic Operations Chief over signal integration
  - District Traffic Operations Chief over traffic census
- **Timeline:**
  - Six to 12 months for statewide count location and cycle analysis and findings. Using a consultant team for all Districts will ensure a uniform approach is taken statewide.
  - Six to 12 months for procurement of the non-intrusive systems after approval of funding.
  - Twelve months for integration with traffic signals.
  - The inductive loop systems will have an ongoing project development process as construction funding becomes available.

District 1 Evaluation of StreetLight Data InSight® Transportation Data Analytics Platform

(Caltrans, District 1 Traffic Operations, February 24, 2020)

Nine staff members from Caltrans District 1 Planning, Advance Planning, and Traffic Operations evaluated the StreetLight platform. In the Executive Summary the District 1 authors concluded that:

- StreetLight is designed and suitable for planning applications. StreetLight can help elucidate general traffic patterns for engineering studies, but the platform is insufficient for engineering applications that require precise volume estimates (e.g. signal warrant analyses). The accuracy of volume estimates is continually increasing as the amount of location-based data available for Big Data platforms is rapidly expanding. Additional gains in accuracy can be obtained by including more traffic census data from California in the calibration process, including District 1 which is not currently considered by StreetLight during calibration. Additional improvements to increase the utility of both the StreetLight platform and the Caltrans Census program were identified.

- Big Data technologies like StreetLight are powerful new analytical tools that provide significant transportation data and analytics at scale and at low cost. StreetLight provides many new capabilities that were previously unavailable e.g. origin-destination by mode, traveler demographics. StreetLight can replace several existing field survey types (e.g. free flow speed) with desktop exercises thereby improving safety by eliminating field exposure and reducing labor costs, fuel costs, vehicle miles traveled, and greenhouse gas emissions.

Cost estimates for STREETLIGHT traffic volumes were shown in Table 6 (page 25 / 32) of the "Caltrans District 1 Evaluation of StreetLight Data InSight® Transportation Data Analytics Platform" report (see Table 4-1).

Table 4-1: StreetLight Pricing (Approximate) for an Unlimited Annual Multi-modal Tier License

Table 6: StreetLight Pricing (Approximate) for an Unlimited Annual Multi-modal Tier License

District	Individual District Licenses	Statewide License (all Districts and HQ)
1	$147,000	$5,682,514
2	$147,000	
3	$732,769	
4	$1,718,697	
5	$397,971	
6	$667,224	
7	$2,333,897	
8	$1,082,124	
9	$147,000	
10	$453,942	
11	$857,449	
12	$785,783	
Grand Total	**$9,470,856**	**$5,682,514**

Source: *Table 6, StreetLight Pricing (Approximate) for an Unlimited Annual Multi-modal Tier License*
"Caltrans District 1 Evaluation of StreetLight Data InSight® Transportation Data Analytics Platform"
Caltrans District 1 Traffic Operations, February 24, 2020

4.2. COMMERCIAL "BIG-DATA" SOURCES OF TRAFFIC DATA

In late 2019, UC Berkeley researchers reviewed commercial "Big-Data" sources of traffic data for another Caltrans research project. Many of the findings of that study are directly relevant here. The majority of the below listed findings are from the "Hybrid Data Project – Caltrans and Third-party Data Landscape, Technical Memo" (November 8, 2019) to Caltrans.

Basically, all of the commercial vendors of "big-data" roadway traffic utilization and performance data depend heavily on smartphone applications, in-vehicle OEM navigational devices, and data from fleet telematics and connected vehicles. To obtain these data, the vendors have business agreements with multiple cell phone manufacturers, carriers, and/or smartphone app providers. For example, INRIX has a free downloadable app aptly named "INRIX Traffic" which provides maps, navigational or route guidance information, and driver alerts. And, HERE Technologies is majority owned by a consortium of German automotive companies – as such, they have unique data sharing opportunities with these auto manufacturers.

For the commercially available "big-data" traffic datasets, aggregated traffic speed and travel time data were among the first of the roadway traffic data that became commercially available. The ability to provide trip origin-destination estimates came several years later. Providing traffic volume estimates is a relatively new feature for these "big-data" providers, only available within the last few years. As popularity of cell phones and vehicle route guidance apps grew, the amount of data available to these vendors increased, as did the reliability and accuracy of their traffic speed and travel time estimations improved (and the listing of products offered expanded). As technologies and the use of big-data in the transportation industries continue to evolve and advance, we should see costs continue to decline and the commercially available big-data continue to become even more reliable, robust, and comprehensive.

INRIX Volume Profiles [4] INRIX Volume Profiles provides average traffic counts for each day of the week at 15-minute granularity on over 2.6 million roadway miles in the USA. It is the most up-to-date, complete, and accurate source of such data that currently exists. The focus of this document is to describe at a high level how this ground-breaking product is generated, including data sources, methodology, and quality control.

INRIX creates their traffic volume datasets from mobile source GPS data – Volume profiles starts with GPS data from in-vehicle navigation, mobile applications, and SDKs. In addition to the high precision GPS data used in INRIX Traffic products, a broad spectrum of mobile application and SDK sources which may not fit the rigorous quality requirements of conventional traffic products are incorporated to maximize coverage and obviate the biases associated with any particular provider. The result is an agglomeration of data from the broadest possible collection of sources, but which requires a great deal of work to associated it with the road network and remove outlying, erroneous, and irrelevant GPS points.

[4] "INRIX Volume Profiles 2019 – Technical Information" INRIX (vp_white_paper.pdf).

At the time of the information gathering phase of this research task, no data validation studies were identified for INRIX traffic volume datasets.

CITILABS Streetlytics [5,6] The Streetlytics platform and available datasets provide detailed information about the movement of people and vehicles from place to place, and along streets and sidewalks. This information is calculated using robust analytical procedures applied to billions of points of anonymized location data, over 2 million traffic counts, current demographic data, and points of interest data.

Generally, Streetlytics provides three types of data:

- **Transportation Network Characteristics –** The transportation network characteristics dataset provides vehicular and pedestrian road volumes, vehicular occupancy, travel speed and characteristics of those travelers including their home locations. This information is provided on an all-street road network provided by HERE and includes several attributes which describe the road network such as street name, number of lanes and road type.
- **Travel Flows** – The travel flow dataset provides the number of vehicles moving from Census block group to Census block group.
- **Travel Routes** – Travel routes between each location and how travelers use each of the alternative routes is a third data set which is available on demand.

The Streetlytics volume, speed and traveler characteristics within the Transportation Network Characteristics dataset are provided by hour of the day and by type of day. Streetlytics data is available for four day-of-week categories:

- Weekday = Monday-Thursday (DT 1)
- Friday (DT 2)
- Saturday (DT 3)
- Sunday (DT 4)

The Streetlytics travel flow (i.e., traffic volume) data is provided by those same day types but segmented into five time of day periods:

- Early AM = midnight–6am (DP 1)
- Morning commute = 6am-10am (DP 2)
- Midday = 10am-3pm (DP 3)
- Evening commute = 3pm-7pm (DP 4)
- Evening = 7pm-midnight (DP 5)

Amid this research effort CITILABS was acquired by Bentley Systems Incorporated. At the time of the information gathering phase of this research task, no data validation studies were identified for CITILABS Streetlytics datasets.

[5] "Streetlytics Trial Dataset", CITILABS (Streetlytics-Understanding_Movement.pdf).

[6] "Understanding Movement Streetlytics Proprietary Optimization Process Assures Accurate Population Movement Analytics", CITITLABS (Streetlytics Trial Dataset.pdf).

STREETLIGHT InSights [7] StreetLight's AADT 2019 V2 metric is a relatively new product on the market, as an update to their previously released AADT metrics. Some highlights and improvements of the newly released 2019 metrics are:

- Training data was captured from 48 states across the U.S., an improvement from the 29 states used in the 2019 V1 model.
- Training data was increased to 10,785 permanent counter locations across the U.S., an improvement from 6,029 used in the 2019 V1 model.
- A "hybrid" model was implemented, combining a random forest model with two linear regression models at the high and low tails. This is meant to improve performance on low and high-volume roads, and better handle extremes.
- Selected features were adjusted across hybrid models to allow for improved performance.
- Overall estimation accuracy has significantly improved from prior versions, especially on lower-volume roads.

At the time of the data gathering efforts for this study, a few data validation studies published by STREETLIGHT were available. The most recent was "StreetLight AADT 2019 Methodology and Validation White Paper, United States (StreetLight Data, Version 1.0 – March 2020). Table 1c of the STREETLIGHT DATA published white paper listed Key results from StreetLight's 2019 national validation test – 90% confidence range. These are reproduced in Table 4-2.

Table 4-2: Key results from StreetLIght's 2019 national validation test – 90% confidence range (U.S.)

AADT Range	# of Segments	Mean Lower Boundary of 90% Confidence	Mean Upper Boundary of 90% Confidence	Actual AADT Within Confidence Range
50,000+	999	-19.63%	23.70%	85.09%
25,000 - 49,999	968	-19.73%	27.33%	87.09%
10,000 - 24,999	1500	-23.94%	33.81%	87.87%
5,000 - 9,999	955	-29.87%	45.02%	88.90%
2500 - 4,999	793	-34.74%	57.98%	88.90%
0 - 2,499	814	-41.64%	73.88%	88.94%

Source: Table 1c: Key results from StreetLIght's 2019 national validation test – 90% confidence range (U.S.)
"StreetLight AADT 2019 Methodology and Validation White Paper, United States"
StreetLight Data, Version 1.0 – March 2020.

[7] "StreetLight AADT 2019 Methodology and Validation White Paper (United States)", STREETLIGHT, "StreetLight 2019 V2 AADT Methodology and Validation White Paper.pdf"

Additionally, the STREETLIGHT volume estimation procedures (and the accuracy of the resulting traffic volumes) can be significantly improved if local count data (like Caltrans PeMS data, Census count data, or credible arterial roadway count data) are made available during the STREETLIGHT volume calibration and estimation process.

Currently, StreetLight Data is currently engaged with FHWA on a validation study for Big-Data as an alternate means for HPMS reporting. The project number and title are "***693JJ319C000015 for the Non-Traditional Methods to Obtain Annual Average Daily Traffic (AADT) Evaluation and Analysis***". The project's TAC members are state DOT representatives (see Table 4-3).

Table 4-3: TAC Members for the FHWA Project – Non-Traditional Methods to Obtain Annual Average Daily Traffic (AADT) Evaluation and Analysis

State	TAC Contact
Alaska	Scott Vockeroth
California	Afrid Sarker
Colorado	Steve Abeyta
Georgia	Eric Conklin
Idaho	John Phillips
Illinois	William (Bill) Morgan
Maryland	Lisa Shemer
Minnesota	Gene Hicks
Nebraska	David Schoenmaker
New Jersey	Chris Zajac
North Carolina	Kent Taylor
North Dakota	Terry Woehl
Oregon	Josh Roll
Ohio	Sandie Mapel
Pennsylvania	Greg Dunmire
South Carolina	Todd Anderson
Texas	Chris Didear
Virginia	Hamlin Williams

Furthermore, at least one state DOT (Minnesota) is using StreetLight Data under the alternate methods provision currently allowed by FHWA for reporting performance metrics

4.3. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations were based on the findings from the literature review and the other information gathered for this research project.

The uses of the datasets being compiled from the cell phone and in-vehicle GPS systems continue to grow over time. Meanwhile, the costs of these commercial datasets continue to drop. Furthermore, the reliability of the estimated traffic volumes, trip travel-times and other congestion metrics continue to improve as older vehicles in the vehicle fleet are replaced by new ones, and more travelers rely on cell phone apps for traveler information.

With this, commercial big-data has become a viable data source for HPMS/Census reporting purposes – and commercial big-data will become even more of a pragmatic (cost-efficient and appropriate) choice as the reliability and public acceptance continue to improve.

Use PeMS where possible – Use of PeMS data to fulfill HPMS/Census traffic volume requirements

Task 3 of this research effort identified several locations where Caltrans PeMS vehicle detector stations (VDS) closely match the location of Census count stations, and where the number of reported traffic lanes matched in the Census reports and PeMS. Caltrans should review the data quality at these locations and determine if PeMS volumes can be used for HPMS/Census needs.

Additionally, several other Caltrans PeMS VDS were identified with minor discrepancies in the number of lanes reported. These should also be reviewed to determine if lane-corrected (i.e., factored or adjusted) PeMS volumes are adequate for HPMS/Census reporting purposes.

Maintaining a system of automated traffic count stations is necessary to support traffic operations and traffic control systems, like on-ramp traffic metering systems, and signal control at roadway intersections. As such, these automated vehicle detection stations serve as a valuable source of traffic volume data for HPMS/Census reporting and should be fully leveraged.

Conduct a pilot study – using commercial big-data to fulfill HPMS/Census traffic volume requirements

A recently completed UC Berkeley ITS/PATH research project (Hybrid Data Project) conducted a review of the commercial "big-data" providers in the transportation industry that have the capability of providing traffic volume datasets.[8] Of the commercial vendors reviewed, about half had the capability of providing traffic volume data. Cost and ability to provide traffic volumes on a large scale (e.g., all state routes or all public roadways in a County, Caltrans District or Statewide) varied by vendor. At the time very few validation exercises had been conducted. Since then, Caltrans District 1 performed a traffic volume data validation for STREETLIGHT volume data. Building on the efforts of District 1, Caltrans should conduct a pilot study to

[8] **Caltrans and Third-party Data Landscape Technical Memo (Hybrid Data Project)**, A. Patire, M. Mauch, and A. Skabardonis, U.C. Berkeley ITS/PATH (November 2019)

determine if commercial big-data to can fulfill HPMS/Census traffic volume requirements (total traffic volumes only, not classification counts).

The goals of the pilot study would be to use the big-data traffic volumes for the current year Census and HPMS reporting, upon completing a validation effort of the big-data traffic volume dataset, by comparing the commercial big-data traffic volumes and volume factors with Caltrans published Census and HPMS traffic volumes and estimated factors, using the most current year's approved Caltrans HPMS and Census reports.

For the pilot study, Caltrans should select the most promising commercial big-data provider of AADT (traffic volumes) and pilot test region. The test region could be a Caltrans District or a set of two Caltrans Districts, one rural and one more urban.

The commercial big-data validation should include (at least) the following volume estimates and factors:

- AADTs (for locations with current year HPMS/Census count data)
- Seasonality or month-of-year factors,
- Day-of-week factors,
- K-factors (peak hour factors),
- D-factors (directionality factors),
- Estimated VMT by corridor and by roadway functional classification.

During the pilot study, Caltrans should collaborate with the selected commercial vendor and help the vendor gain familiarity with PeMS, such that the vendor is aware of the PeMS strengths, limitations, and known issues. This would enable the selected vendor to use these traffic counts during their volume estimation calibration/validation process. Thus, the vendor would be able to improve the accuracy of the resulting traffic volume estimates being provided to Caltrans for their HPMS/Census reporting.

Traditional vehicle classification counts will still be needed for HPMS/Census reporting, even if Caltrans elects to use commercial big-data to meet the HPMS/Census requirements for AADT and hourly volume profiles, seasonality factors and the like. Detailed classification count data are not currently available from commercial big-data vendors.

5. CONCLUDING COMMENTS

We commend Caltrans for continuing to seek out and investigate ways to control costs, improve their processes and programs. Initiatives like this one are instrumental in leveraging and better use their resources to meet their needs of safely and efficiently managing the State's transportation system.

Data collection cost savings and reduction in system redundancies can be obtained by integrating Caltrans PeMS traffic volume data into the Census and HPMS data collection and reporting procedures, as was noted and recommended in section 3 of this report. Additionally, there are continuous count stations in Districts 1 and 2 that are not connected into the Caltrans PeMS system. We recommend that Caltrans investigate the feasibility of adding these Districts and traffic count stations to the set of PeMS stations, along with any other continuous count stations monitored by the Districts.

Additionally, we recommend that Caltrans put careful thought into the decision process prior to expanding their physical infrastructure (i.e., in pavement loops or other local data collection technologies) if the primary need is to collect Census or HPMS total vehicle count data. Installing in-pavement loops and/or other permanent count stations are costly and should be considered a long-term investment. Specialty vehicle count data (like weigh-in-motion (WIM) data and vehicle classification count data) are a separate issue, as these are currently not available from any of the commercial vendors. We also recognize that local real-time traffic data are required for support of on-ramp metering and other operational traffic control systems, and these needs and cases lie outside of the just-stated recommendation.

The quality (i.e., accuracy) of the commercially available traffic volume data have improved significantly over the past few years and will continue to improve. Older vehicles in the vehicle fleet are replaced with new ones which are equipped with in-vehicle navigational support systems. This increases the proportion of the vehicle fleet that serve as probe vehicles for the commercial data providers, as does the increasing acceptance and usage of cell phone based navigational aid apps. At the same time, computer and software technologies continue to advance at an accelerated pace. The algorithms and artificial intelligence-based software platforms used for traffic volume estimation are continuously being improved upon.

Commercial traffic data vendors can potentially provide traffic volumes or AADTs on all Caltrans facilities (ramps and freeway-to-freeway connectors as well as mainline freeway and highway segments), not just a sampled subset of these. Currently, Caltrans and other state DOTs are conducting traffic counts on a 3-year or 6-year cycle whereby volumes are interpolated for intermediate years. With the current COVID-19 restrictions in place, the year 2020 traffic volumes and VMT estimates could be substantially biased if 3-year or 6-year interpolations are used. Commercial traffic data can be provided annually, thus eliminating the need for the volume interpolation between count years.

Given all these factors, we recommend that Caltrans seriously consider and investigate the feasibility of using third party or commercially available traffic data as an additional data source to help meet their Census and HPMS traffic count data needs.

6. APPENDIX A – RANDOMLY SELECTED HPMS COUNT LOCATIONS

Table A-1: Local (FC=7) Roadway Sample Locations in Urban Areas

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
2683	831084	Contra Costa County	Antioch City	CC_ANT_SHADDICK DR_P
4681	1214174	Kern County	COUNTY	KER_CO_BOUGHTON DR_P
4681	1928519	Kern County	COUNTY	KER_CO_S VINELAND RD_P
19504	2013792	Contra Costa County	San Ramon City	CC_SRMN_ENFIELD ST_P
19504	781145	Contra Costa County	Walnut Creek City	CC_WLC_HOMESTEAD AVE_P
31843	757292	Fresno County	Fresno City	FRE_FRE_E ROSEMONT LN_P
31843	814113	Fresno County	Fresno City	FRE_FRE_RIO LINDA DR_P
38215	1422573	Riverside County	Hemet City	RIV_HEM_RED OAK WAY_P
41347	1438848	Riverside County	Palm Springs City	RIV_PSP_SATURNINO RD_P
47611	1290990	Los Angeles County	COUNTY	LA_CO_E AVE S 6_P
51445	1541453	Orange County	Orange City	ORA_ORA_N RIDGECREST LN_P
51445	1604005	Los Angeles County	San Dimas City	LA_SDMS_N DARWOOD AVE_P
51445	1215541	Orange County	Fullerton City	ORA_FUL_HOLLYDALE DR_P
51445	1124711	Los Angeles County	Los Angeles City	LA_LA_CHARING CROSS RD_P
51445	1259666	Orange County	Buena Park City	ORA_BPK_DEL ROSA RD_P
51445	1270514	Los Angeles County	Los Angeles City	LA_LA_GLADE AVE_P
51445	1384644	Los Angeles County	Los Angeles City	LA_LA_KAILUA LN_P
51445	1443959	Los Angeles County	Los Angeles City	LA_LA_S FRESNO ST_P
51445	1103813	Los Angeles County	Artesia City	LA_ART_BELSHIRE AVE_P
51445	1243558	Los Angeles County	Redondo Beach City	LA_RDOB_HAVEMEYER LN_P
51445	1689722	Los Angeles County	Long Beach City	LA_LBCH_W COLUMBIA ST_P
51445	179538	Los Angeles County	Hermosa Beach City	LA_HMB_13TH ST_P
51445	1897375	Los Angeles County	Long Beach City	LA_LBCH_E 59TH ST_P
51445	1626981	Orange County	Santa Ana City	ORA_SA_W CENTRAL AVE_P
51445	1433716	Orange County	La Habra City	ORA_LHB_SIDON AVE_P
51445	1502789	Los Angeles County	Pomona City	LA_POM_SAN LUIS ST_P
51445	1224018	Los Angeles County	Los Angeles City	LA_LA_E 81ST ST_P
51445	1419129	Los Angeles County	Los Angeles City	LA_LA_S VERDUN AVE_P
51445	1946377	San Bernardino County	Chino City	SBD_CHN_OAKS AVE_P
51445	1463169	Los Angeles County	Los Angeles City	LA_LA_ROBINSON ST_P
51445	1451957	Los Angeles County	El Monte City	LA_EMTE_ROSEGLEN ST_P
56251	775349	Merced County	COUNTY	MER_CO_HATCH RD_P
57709	1350599	Orange County	Laguna Niguel City	ORA_LGNG_KINGS VW_P
58006	908437	Stanislaus County	Modesto City	STA_MOD_MUIR RD_P
60799	1664487	Riverside County	Murrieta City	RIV_MRTA_WESTERN JAY WAY_P
60799	1382859	Riverside County	Temecula City	RIV_TMCA_SPARKS CT_P
66673	1283912	Ventura County	Port Hueneme City	VEN_PHME_GLACIER AVE_P

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
73774	1885026	Shasta County	Redding City	SHA_RDG_WIMBLEDON DR_P
75340	1105684	Riverside County	Riverside City	RIV_RIV_AUTO DR_P
75340	1801356	Riverside County	Moreno Valley City	RIV_MORV_DOVER DR_P
75340	1877109	San Bernardino County	Yucaipa City	SBD_YCPA_CRAMER RD_P
75340	1713796	San Bernardino County	San Bernardino City	SBD_SBD_W IOLA PL_P
75340	1135183	San Bernardino County	San Bernardino City	SBD_SBD_BRADFORD AVE_P
75340	1269579	Riverside County	Beaumont City	RIV_BAU_ELIZABETH AVE_P
77068	808294	Sacramento County	Sacramento City	SAC_SAC_DYLAN AVE_P
77068	942764	Sacramento County	Folsom City	SAC_FOL_WIDGEON CT_P
77068	740331	Sacramento County	COUNTY	SAC_CO_BARNETT CIR_P
77068	974933	Placer County	Roseville City	PLA_RSV_CHENNAULT CT_P
77068	736229	Sacramento County	COUNTY	SAC_CO_ADELINA WAY_P
77068	936978	Sacramento County	COUNTY	SAC_CO_MILLRACE RD_P
78661	1392451	San Diego County	San Diego City	SD_SD_REDWOOD DR_P
78661	1634233	San Diego County	COUNTY	SD_CO_WREN BLUFF DR_P
78661	1549512	San Diego County	San Diego City	SD_SD_MARINE VIEW AVE_P
78661	1773769	San Diego County	San Diego City	SD_SD_AREY DR_P
78661	1765338	San Diego County	San Diego City	SD_SD_CABLE ST_P
78661	1251128	San Diego County	Carlsbad City	SD_CBD_HAVERHILL ST_P
78661	1545460	San Diego County	COUNTY	SD_CO_MILBURN AVE_P
78904	492736	Alameda County	Oakland City	ALA_OAK_ASHTON AVE_P
78904	91429	Marin County	Mill Valley City	MRN_MLV_ELM AVE_P
78904	662482	San Mateo County	San Bruno City	SM_SBR_OAK AVE_P
78904	585734	Marin County	Corte Madera Town	MRN_LKSP_INDUSTRIAL WAY_P
78904	580081	San Mateo County	Hillsborough Town	SM_HIL_KINGSWOOD DR_P
78904	794448	Contra Costa County	Richmond City	CC_RCH_5TH ST_P
79039	608846	Santa Clara County	San Jose City	SCL_SJS_SAN IGNACIO AVE_P
79039	610576	Santa Clara County	Campbell City	SCL_CMB_PAMLAR AVE_P
79039	670772	Santa Clara County	Mountain View City	SCL_MVW_TERRA BELLA AVE_P
79039	663486	Santa Clara County	San Jose City	SCL_SJS_NISICH DR_P
79309	1482265	Los Angeles County	Santa Clarita City	LA_SCTA_SIERRA ESTATES DR_P
79498	493858	Sonoma County	COUNTY	SON_CO_LAWNDALE RD_P
85087	776738	San Joaquin County	Stockton City	SJ_CO_ELMWOOD AVE_P
87490	1728030	Ventura County	Thousand Oaks City	VEN_THOK_TIMBERWOOD AVE_P
90541	1154478	San Bernardino County	Victorville City	SBD_VCTV_BLACK MOUNTAIN PL_P
90541	1522936	San Bernardino County	Apple Valley Town	SBD_APLV_PAUHASKA RD_P
90946	1314063	Tulare County	Visalia City	TUL_VIS_E VINE CT_P

Table A-2: Local (FC=7) Roadway Sample Locations in Small Urban Areas

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
99998	792272	Butte County	COUNTY	BUT_CO_GREENBRIER DR_P
99998	924586	Butte County	Paradise Town	BUT_PRDS_NUNNELEY RD_P
99998	801752	Butte County	Paradise Town	BUT_PRDS_GATE LN_P
99998	1032445	Calaveras County	COUNTY	CAL_CO_LAZER CT_P
99998	971564	Colusa County	Williams City	COL_WMS_WATERFOWL WAY_P
99998	113112	Del Norte County	COUNTY	DN_CO_ARNETT ST_P
99998	999596	El Dorado County	COUNTY	ED_CO_CHOCTAW ST_P
99998	998055	El Dorado County	South Lake Tahoe City	ED_SLTO_APRIL DR_P
99998	1042294	El Dorado County	South Lake Tahoe City	ED_SLTO_REGINA RD_P
99998	1863694	Fresno County	Sanger City	FRE_SGR_9TH ST_P
99998	837443	Fresno County	Selma City	FRE_SEL_PEACH ST_P
99998	1854992	Fresno County	Sanger City	FRE_SGR_OLIVE AVE_P
99998	1794270	Fresno County	Sanger City	ALY_813830_P
99998	52542	Fresno County	Fowler City	FRE_FOW_S 7TH ST_P
99998	1825771	Glenn County	Willows City	ALY_815756_P
99998	580625	Humboldt County	Arcata City	HUM_ARC_16TH ST_P
99998	1840047	Humboldt County	Eureka City	HUM_EUR_HIGHLAND AVE_P
99998	113004	Humboldt County	COUNTY	HUM_CO_HILLRAS WAY_P
99998	1350837	Imperial County	Brawley City	IMP_BRW_JONES ST_P
99998	1505676	Kern County	COUNTY	KER_CO_SCHOUT RD_P
99998	1526761	Kern County	COUNTY	KER_CO_STRADLEY AVE_P
99998	1798511	Kern County	Wasco City	ALY_813050_P
99998	1365784	Kern County	California City	KER_CALC_GANTT RD_P
99998	1817213	Kern County	COUNTY	KER_CO_GOLDEN HILLS BLVD_P
99998	1542494	Kern County	Ridgecrest City	KER_RGCR_S ALLEN ST_P
99998	303301	Kern County	COUNTY	KER_CO_TURN FOUR_P
99998	1314604	Kern County	Tehachapi City	KER_THPI_E D ST_P
99998	1784302	Kern County	Ridgecrest City	KER_RGCR_W BATAAN AVE_P
99998	1577874	Kern County	COUNTY	KER_CO_MATRA AVE_P
99998	268542	Kings County	COUNTY	KIN_CO_REEVES BLVD_P
99998	555062	Lake County	Clearlake City	LAK_CLLK_DAM RD EXD_P
99998	620375	Lake County	COUNTY	LAK_CO_SPRINGE ST_P
99998	733745	Madera County	COUNTY	MAD_CO_AVE 22 3/4_P
99998	682445	Mendocino County	COUNTY	MEN_CO_MADRONE PL_P
99998	534285	Mendocino County	Ukiah City	MEN_UKI_CARRIGAN LN_P
99998	1842877	Merced County	Los Banos City	MER_LBNS_PRAIRIE SPRINGS DR_P
99998	507585	Monterey County	Gonzales City	MON_GNZ_HEROLD PKWY_P

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
99998	1053890	Nevada County	Nevada City	NEV_NEVC_LOWER GRASS VALLEY RD_P
99998	1004653	Nevada County	Truckee Town	PLA_CO_DONNER PASS RD_P
99998	1013123	Nevada County	Grass Valley City	NEV_GVY_CHERRY LN_P
99998	997631	Placer County	Auburn City	PLA_AUB_BLUE WING PL_P
99998	1034927	Placer County	COUNTY	PLA_CO_OLD FORESTHILL RD_P
99998	1046747	Placer County	Auburn City	PLA_AUB_STADIUM WAY_P
99998	1537319	Riverside County	Desert Hot Springs City	RIV_CO_MAPLE RD_P
99998	1418884	Riverside County	COUNTY	RIV_CO_PICARD CT_P
99998	866382	Sacramento County	Galt City	SAC_GAL_RANCH RD_P
99998	613088	San Benito County	Hollister City	SBT_CO_MONTEREY ST_P
99998	1637751	San Bernardino County	Barstow City	SBD_BSW_LILLIAN DR_P
99998	1609233	San Bernardino County	Big Bear Lake City	SBD_BBL_OHIO LN_P
99998	1954122	San Bernardino County	COUNTY	SBD_CO_S DEPOT LOOP_P
99998	1242848	San Bernardino County	Yucca Valley Town	SBD_YUCV_DUMOSA AVE_P
99998	1696234	San Bernardino County	COUNTY	SBD_BBL_YOSEMITE DR_P
99998	1269586	San Bernardino County	COUNTY	SBD_CO_HOOK CREEK RD_P
99998	1162979	San Bernardino County	COUNTY	SBD_CO_ALPINE LN_P
99998	1595167	San Bernardino County	Twentynine Palms City	SBD_TNP_OLD DALE RD_P
99998	1357665	San Diego County	COUNTY	SD_CO_SCARBERY RD_P
99998	1518920	San Luis Obispo County	Morro Bay City	SLO_MOBY_PARK VIEW DR_P
99998	1663814	San Luis Obispo County	Morro Bay City	SLO_MOBY_MESA ST_P
99998	610296	San Mateo County	COUNTY	SM_CO_SANTIAGO AVE_P
99998	1331262	Santa Barbara County	Guadalupe City	SB_GDLP_HOLLY ST_P
99998	935752	Siskiyou County	COUNTY	SIS_CO_MADISON DR_P
99998	547049	Sonoma County	Sonoma City	SON_SON_FRYER CREEK DR_P
99998	1798770	Stanislaus County	Newman City	STA_CO_SHERMAN PKWY_P
99998	1858525	Tehama County	Red Bluff City	TEH_RBL_ORANGE ST_P
99998	1293972	Tulare County	Dinuba City	TUL_DBA_HOLDEN AVE_P
99998	1619718	Tulare County	COUNTY	TUL_CO_N LA PRIMAVERA AVE_P
99998	1025258	Tuolumne County	Sonora City	TUO_CO_SARATOGA RD_P
99998	1023115	Tuolumne County	COUNTY	TUO_CO_RAINIER CT_P
99998	1724667	Ventura County	Fillmore City	VEN_FIL_CLAY ST_P

Table A-3: Minor Collector (FC=6) Roadway Sample Locations in Rural Areas

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
99999	74264	Amador County	COUNTY	AMA_CO_STEINER RD_P
99999	808357	Butte County	COUNTY	BUT_CO_HAMILTON NORD CANA HWY_P
99999	103267	Calaveras County	COUNTY	CAL_CO_SUMMIT LEVEL RD_P
99999	913962	Colusa County	COUNTY	COL_CO_MYERS RD_P
99999	35559	El Dorado County	COUNTY	ED_CO_GRIZZLY FLAT RD_P
99999	1070414	El Dorado County	COUNTY	ED_CO_UNION RIDGE RD_P
99999	772792	Fresno County	COUNTY	FRE_CO_GEORGE SMITH RD_P
99999	755217	Fresno County	COUNTY	FRE_CO_E CENTRAL AVE_P
99999	833588	Fresno County	COUNTY	FRE_CO_S EL DORADO AVE_P
99999	876464	Fresno County	COUNTY	FRE_CO_N SAN DIEGO AVE_P
99999	755729	Fresno County	COUNTY	FRE_CO_DINKEY CREEK RD_P
99999	1893742	Fresno County	COUNTY	FRE_CO_TOLLHOUSE RD_P
99999	730087	Glenn County	COUNTY	GLE_CO_CO RD 28_P
99999	729091	Glenn County	COUNTY	GLE_CO_CO RD 305_P
99999	502976	Humboldt County	COUNTY	HUM_CO_COPENHAGEN RD_P
99999	1229754	Imperial County	COUNTY	IMP_CO_FIFIELD RD_P
99999	1063796	Imperial County	COUNTY	IMP_CO_ARNOLD RD_P
99999	1396266	Imperial County	COUNTY	IMP_CO_PULLIAM RD_P
99999	1638048	Imperial County	COUNTY	IMP_CO_WIEMAN RD_P
99999	1536262	Imperial County	COUNTY	IMP_CO_NOFFSINGER RD_P
99999	112376	Inyo County	COUNTY	INY_CO_INDIAN RANCH RD_P
99999	1184877	Kern County	COUNTY	KER_CO_CERRO NOROESTE RD_P
99999	1941929	Kern County	COUNTY	KER_CO_MOUNT PINOS RD_P
99999	1059953	Lassen County	COUNTY	LAS_CO_MAIL ROUTE RD_P
99999	1039363	Lassen County	COUNTY	LAS_CO_RICE CANYON RD_P
99999	32292	Los Angeles County	COUNTY	LA_CO_RIDGE ROUTE RD_P
99999	1577154	Los Angeles County	COUNTY	LA_CO_MULHOLLAND HWY_P
99999	208334	Los Angeles County	Malibu City	LA_MAL_ENCINAL CANYON RD_P
99999	782552	Madera County	COUNTY	MAD_CO_GRUB GULCH RD_P
99999	869660	Madera County	COUNTY	MAD_CO_RD 9_P
99999	65122	Marin County	COUNTY	MRN_CO_CHILENO VALLEY RD_P
99999	843691	Mariposa County	COUNTY	MER_CO_PRESTON RD_P
99999	1026084	Mariposa County	COUNTY	MPA_CO_INDIAN GULCH RD_P
99999	680345	Mendocino County	COUNTY	MEN_CO_LAYTONVILLE DOS RIOS RD_P
99999	654663	Mendocino County	COUNTY	MEN_CO_OLD STAGE RD_P
99999	902968	Merced County	COUNTY	MER_CO_MEADOW DR_P
99999	901783	Merced County	COUNTY	MER_CO_LE GRAND RD_P
99999	909629	Merced County	COUNTY	MER_CO_MCNAMARA RD_P

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
99999	751133	Modoc County	COUNTY	MOD_CO_CROWDER FLAT RD_P
99999	781658	Modoc County	COUNTY	MOD_CO_CROWDER FLAT RD_P
99999	1032791	Mono County	COUNTY	MNO_CO_OWENS GEORGE RD_P
99999	475925	Monterey County	COUNTY	MON_CO_ARROYO SECO RD_P
99999	444842	Monterey County	COUNTY	MON_CO_ARROYO SECO RD_P
99999	648862	Napa County	COUNTY	NAP_CO_LOWER CHILES VALLEY RD_P
99999	1023653	Nevada County	COUNTY	YUB_CO_PERIMETER RD_P
99999	1031081	Placer County	COUNTY	PLA_CO_IOWA HILL RD_P
99999	1040544	Plumas County	COUNTY	PLU_CO_ROUND VALLEY RD_P
99999	979533	Plumas County	COUNTY	PLU_CO_CARIBOU RD_P
99999	1322634	Riverside County	COUNTY	RIV_CO_22ND AVE_P
99999	855018	Sacramento County	COUNTY	SAC_CO_RILEY RD_P
99999	566537	San Benito County	COUNTY	SBT_HST_JOHN SMITH RD_P
99999	1988974	San Bernardino County	COUNTY	SBD_CO_DEEP CREEK RD_P
99999	1875936	San Diego County	COUNTY	SD_CO_COUSER CANYON RD_P
99999	1688263	San Diego County	COUNTY	SD_CO_TIERRA DEL SOL RD_P
99999	708929	San Joaquin County	COUNTY	SJ_CO_BACON ISLAND RD_P
99999	710985	San Joaquin County	COUNTY	SJ_CO_CLIFTON COURT RD_P
99999	1212560	San Luis Obispo County	COUNTY	SLO_CO_CHOLAME VALLEY RD_P
99999	1717570	San Luis Obispo County	COUNTY	SLO_CO_VAN DOLLEN RD_P
99999	1962462	Santa Barbara County	COUNTY	SB_CO_ROBLAR AVE_P
99999	677855	Santa Clara County	COUNTY	SCL_SJS_METCALF RD_P
99999	1005237	Sierra County	COUNTY	SIE_CO_HENNESS PASS RD_P
99999	936387	Siskiyou County	COUNTY	SIS_CO_LOWER LITTLE SHASTA RD_P
99999	752097	Siskiyou County	COUNTY	SIS_CO_COPCO RD_P
99999	752160	Siskiyou County	COUNTY	SIS_CO_AGER BESWICK RD_P
99999	553774	Sonoma County	COUNTY	SON_CO_FRANZ VALLEY RD_P
99999	781457	Stanislaus County	COUNTY	MER_CO_FAITH HOME RD_P
99999	907136	Sutter County	COUNTY	SUT_CO_SEYMOUR RD_P
99999	927926	Tehama County	COUNTY	TEH_CO_LOWERY RD_P
99999	653191	Trinity County	COUNTY	TRI_CO_LOWER SOUTH FORK RD_P
99999	687080	Trinity County	COUNTY	TRI_CO_WILD MAD RD_P
99999	1227475	Tulare County	COUNTY	TUL_CO_AVE 208_P
99999	1527297	Tulare County	COUNTY	TUL_CO_RD 140_P
99999	1915943	Tulare County	COUNTY	TUL_CO_ARMSTRONG AVE_P
99999	1767830	Tulare County	COUNTY	TUL_CO_RD 144_P
99999	980142	Tuolumne County	COUNTY	TUO_CO_ALGERINE RD_P
99999	735024	Yolo County	COUNTY	YOL_CO_CO RD 24_P
99999	1019741	Yuba County	COUNTY	YUB_CO_RICES CROSSING RD_P

Table A-4: Local (FC=7) Roadway Sample Locations in Rural Areas

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
99999	993443	Amador County	Amador City	AMA_CO_FLEEHART ST_P
99999	792166	Butte County	COUNTY	BUT_CO_DOE MILL RD_P
99999	982416	Calaveras County	COUNTY	CAL_CO_CHUCKWAGON DR_P
99999	986130	Colusa County	COUNTY	COL_CO_TWO MILE RD_P
99999	618068	Del Norte County	COUNTY	DN_CO_ROCK RD_P
99999	1021130	El Dorado County	COUNTY	ED_CO_SWEETWATER DR_P
99999	897399	Fresno County	COUNTY	FRE_CO_N ROLINDA AVE_P
99999	871963	Fresno County	COUNTY	FRE_CO_N MONROE AVE_P
99999	899061	Fresno County	COUNTY	MER_CO_MINT RD_P
99999	871945	Fresno County	COUNTY	FRE_CO_N MACDONOUGH AVE_P
99999	939929	Fresno County	COUNTY	FRE_CO_W JENSEN AVE_P
99999	802750	Glenn County	COUNTY	GLE_CO_FOREST RTE 24N02_P
99999	1848492	Humboldt County	COUNTY	HUM_CO_BEAR CREEK RD_P
99999	537199	Humboldt County	COUNTY	HUM_CO_BAUDER LN_P
99999	1079669	Imperial County	COUNTY	IMP_CO_COACHELLA CANAL RD_P
99999	1080443	Imperial County	COUNTY	IMP_CO_COOPER RD_P
99999	1062134	Imperial County	COUNTY	IMP_CO_ARCTIC AVE_P
99999	1260033	Imperial County	COUNTY	IMP_CO_HILO AVE_P
99999	1015746	Inyo County	COUNTY	INY_CO_FOOTHILL RD_P
99999	1011347	Inyo County	COUNTY	INY_CO_FURNACE CREEK RD_P
99999	1908179	Kern County	COUNTY	KER_DLN_CECIL AVE_P
99999	1719084	Kern County	COUNTY	KER_CO_W TULARE AVE_P
99999	1911459	Kern County	COUNTY	KER_SHF_BEECH AVE_P
99999	1978092	Kern County	COUNTY	KER_CO_MOCAL RD_P
99999	1996438	Kings County	COUNTY	KIN_CO_ELDER AVE_P
99999	1322510	Kings County	COUNTY	KIN_CO_DEVILS DEN RD_P
99999	508973	Lake County	COUNTY	LAK_CO_BARTLETT SPRINGS RD_P
99999	1057876	Lassen County	COUNTY	LAS_CO_MAHOGANY WAY_P
99999	1004967	Lassen County	COUNTY	LAS_CO_FOREST RTE 32N09_P
99999	1295348	Los Angeles County	COUNTY	VEN_CO_HUNGRY VALLEY RD_P
99999	831468	Madera County	COUNTY	MAD_CO_RD 800_P
99999	918099	Madera County	COUNTY	MAD_CO_WINDING WAY_P
99999	822109	Madera County	COUNTY	MAD_CO_JENNIFER CT_P
99999	1010934	Mariposa County	COUNTY	MPA_CO_JONES ST_P
99999	683789	Mendocino County	COUNTY	MEN_CO_TOCK LN_P
99999	692303	Mendocino County	COUNTY	MEN_CO_NAVARRO RIDGE RD_P
99999	835823	Merced County	COUNTY	MER_CO_S BAXTER RD_P

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
99999	764634	Merced County	COUNTY	MER_CO_HILLDALE AVE_P
99999	751427	Modoc County	COUNTY	MOD_CO_CO RD 187C_P
99999	848354	Modoc County	COUNTY	MOD_CO_46N10 RD_P
99999	992600	Mono County	COUNTY	MNO_CO_AURORA CANYON RD_P
99999	444301	Monterey County	COUNTY	MON_CO_BIG SANDY RD_P
99999	1052939	Nevada County	COUNTY	NEV_CO_OLD RENO RD_P
99999	1004694	Placer County	COUNTY	PLA_CO_GARDEN BAR RD_P
99999	1021343	Placer County	COUNTY	PLA_CO_POWER LINE RD_P
99999	1046403	Plumas County	COUNTY	PLU_CO_SCHOOL ST_P
99999	1371031	Riverside County	COUNTY	RIV_CO_IDA AVE_P
99999	1812935	Riverside County	COUNTY	RIV_CO_PAINTED CANYON RD_P
99999	808297	Sacramento County	Sacramento City	SAC_CO_HEDGE AVE_P
99999	1815577	San Bernardino County	COUNTY	SBD_CO_IVANPAH CIMA RD_P
99999	1817694	San Bernardino County	COUNTY	SBD_CO_MANIX RD_P
99999	1526841	San Bernardino County	COUNTY	SBD_CO_SILVER LAKE RD_P
99999	1147621	San Bernardino County	COUNTY	SBD_CO_COXEY RD_P
99999	1251084	San Diego County	COUNTY	SD_CO_FARMER RD_P
99999	799908	San Joaquin County	COUNTY	SJ_CO_GRACE ST_P
99999	764484	San Joaquin County	COUNTY	SJ_CO_ACAMPO RD_P
99999	1333087	San Luis Obispo County	COUNTY	SLO_CO_HUASNA TOWNSITE RD_P
99999	1915365	Santa Barbara County	COUNTY	SB_CO_CEBADA CANYON RD_P
99999	822589	Shasta County	COUNTY	SHA_CO_FOREST RTE 32N12_P
99999	953292	Shasta County	COUNTY	SHA_CO_OAK KNOLL DR_P
99999	1010387	Sierra County	COUNTY	SIE_CO_FOREST RTE 93_P
99999	941226	Siskiyou County	COUNTY	SIS_CO_LADD RD_P
99999	823782	Siskiyou County	COUNTY	SIS_CO_GANGER RD_P
99999	946927	Siskiyou County	COUNTY	SIS_CO_MEISS LAKE RD_P
99999	837653	Solano County	COUNTY	SOL_CO_ROBINSON RD_P
99999	131478	Sonoma County	COUNTY	SON_CO_GOLD RIDGE RD_P
99999	755168	Stanislaus County	COUNTY	STA_CO_GRIMES AVE_P
99999	913239	Stanislaus County	COUNTY	STA_CO_ORCHARD RD_P
99999	971077	Sutter County	COUNTY	SUT_CO_WALTZ RD_P
99999	824971	Tehama County	COUNTY	TEH_CO_HAILLE RD_P
99999	900452	Tehama County	COUNTY	TEH_CO_MUD FLAT RD_P
99999	563362	Trinity County	COUNTY	TRI_CO_FOREST RTE 16_P
99999	686268	Trinity County	COUNTY	TRI_CO_USFS RD 34N05_P
99999	654192	Trinity County	COUNTY	TRI_CO_MANN RD_P
99999	1206929	Tulare County	COUNTY	TUL_CO_AVE 340_P

Urban Code	Caltrans LRS Record ID	County	City	Caltrans LRS Key Code
99999	1719464	Tulare County	COUNTY	TUL_CO_AVE 104_P
99999	1958380	Tulare County	COUNTY	TUL_CO_RD 248_P
99999	1494087	Tulare County	COUNTY	TUL_CO_RD 118_P
99999	1744532	Tulare County	COUNTY	TUL_CO_RD 250_P
99999	1500085	Tulare County	COUNTY	TUL_CO_RD 60_P
99999	984586	Tuolumne County	COUNTY	MPA_CO_TIOGA RD_P
99999	250863	Ventura County	COUNTY	VEN_CO_BUCK CREEK RD_P
99999	738628	Yolo County	COUNTY	YOL_CO_CO RD 18A_P
99999	1055091	Yuba County	COUNTY	YUB_CO_PENDOLA RD_P

7. APPENDIX B – CENSUS STATIONS WITH MATCHING PEMS LOCATIONS

Table B-1: Table Field Names and Descriptions

Field Name	Description
TRAFFICST CHP ID	CHP - Traffic Stop ID Number
CNTY	County
RTE	State Route Number
POSTMILE	Caltrans Route Post Mile (miles)
ROADLOC TYPE	"FWY" = Freeway; "CON" = Conventional Highway
LOCATION DESCRIPTION	Name of nearest cross street, or freeway interchange
PRIM DIR	Primary direction of Travel: (North, South, East, West)
NO LNS	Number of traffic lanes in primary direction
SEC DIR	Secondary direction of Travel: (North, South, East, West)
NO LNS	Number of traffic lanes in secondary direction
PeMS ML VDS Prim Dir	Closest PeMS mainline VDS in primary direction of travel
PeMS HV VDS Prim Dir	Closest PeMS HOV-lane VDS in primary direction of travel
PeMS-ML VDS Sec Dir	Closest PeMS mainline VDS in secondary direction of travel
PeMS HV VDS Sec Dir	Closest PeMS HOV-lane VDS in secondary direction of travel
PeMS-ML Lanes Prim Dir	PeMS - Number of mainline traffic lanes in primary direction
PeMS-HV Lanes Prim Dir	PeMS - Number of HOV-lane traffic lanes in primary direction
PeMS-ML Lanes Sec Dir	PeMS - Number of mainline traffic lanes in secondary direction
PeMS-HV Lanes Sec Dir	PeMS - Number of HOV-lane traffic lanes in secondary direction
PeMS ML Dist. Error Prim Dir	Distance error term: distance between Census station location and closest PEMS mainline VDS location – primary direction
PeMS ML Dist. Error Sec Dir	Distance error term: distance between Census station location and closest PEMS mainline VDS location – secondary direction

Table Headings

Grey shaded headings: Caltrans Census Count data/information.

Green shaded headings: UC Berkeley calculated from Census & PeMS data/information.

Table Cells/Values

Green shaded cells (in table): Census and PeMS number of lanes are consistent.

Orange shaded cells (in table): Census and PeMS number of lanes not consistent.

Table B-2: District 3 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
9	SAC	005	012.037	FWY	LAGUNA BOULEVARD	North	2	South	3	312133	-	315060	-	3	-	3	-	0.15	0.16
10	SAC	005	012.037	FWY	LAGUNA BOULEVARD	North	3	South	3	312133	-	315060	-	3	-	3	-	0.15	0.16
12	SAC	005	017.185	FWY	SACRAMENTO, FLORIN ROAD	North	3	South	3	314899	-	318599	-	3	-	4	-	0.08	0.22
15	SAC	005	017.185	FWY	SACRAMENTO, FLORIN ROAD	North	4	South	4	314899	-	318599	-	3	-	4	-	0.08	0.22
19	SAC	005	020.534	FWY	SACRAMENTO, SUTTERVILLE ROAD INTERCHANGE	North	6	South	5	314968	-	318680	-	4	-	4	-	0.05	0.05
20	SAC	005	022.565	FWY	SACRAMENTO, JCT. RTE. 50	North	6	South	5	314808	-	314814	-	3	-	3	-	0.07	0.07
25	SAC	005	023.177	FWY	SACRAMENTO, P/Q STREETS	North	6	South	5	314955	-	318484	-	4	-	3	-	0.01	0.07
30	SAC	005	023.799	FWY	SACRAMENTO, I STREET	North	5	South	6	315017	-	318674	-	4	-	5	-	0.03	0.27
40	SAC	005	026.722	FWY	SACRAMENTO, JCT. RTE. 80	North	5	South	6	-	-	318249	-	-	-	4	-	-	0.23
39	SAC	005	026.722	FWY	SACRAMENTO, JCT. RTE. 80	North	6	South	6	-	-	318249	-	-	-	4	-	-	0.23
44	SAC	005	029.022	FWY	SACRAMENTO, DEL PASO ROAD	North	5	South	5	-	-	318721	-	-	-	4	-	-	0.05
45	SAC	005	029.022	FWY	SACRAMENTO, DEL PASO ROAD	North	5	South	5	-	-	318721	-	-	-	4	-	-	0.05
50	SAC	005	029.907	FWY	SACRAMENTO, JCT. RTE. 99 NORTH	North	2	South	2	317843	-	317842	-	3	-	2	-	0.25	0.25
65	YOL	005	005.530	FWY	COUNTY ROAD 102	North	3	South	3	-	-	318698	-	-	-	2	-	-	0.10

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
409	YOL	050	000.350	FWY	WEST SACRAMENTO JCT. RTE. 80	East	4	West	4	313824	-	313822	-	4	-	4	-	0.23	0.23
410	YOL	050	002.477	FWY	WEST SACRAMENTO, JCT RTE 84	East	5	West	5	313840	-	313835	-	3	-	3	-	0.09	0.09
422	SAC	050	002.430	FWY	SACRAMENTO, JCT RTES 99 AND 51	East	7	West	7	312098	-	312188	-	4	-	4	-	0.09	0.10
225	SAC	050	002.131	FWY	SACRAMENTO, 59TH STREET	East	5	West	5	318282	-	312236	-	4	-	4	-	0.00	0.07
228	SAC	050	003.674	FWY	JCT. RTE. 16	East	4	West	5	314371	-	312205	-	4	-	4	-	0.06	0.25
230	SAC	050	005.336	FWY	SACRAMENTO, WATT AVENUE	East	5	West	5	319631	319630	313874	-	4	1	4	-	0.09	0.01
232	SAC	050	007.746	FWY	BRADSHAW ROAD	East	5	West	6	314668	318900	313003	318744	4	1	4	1	0.05	0.01
234	SAC	050	010.919	FWY	ZINFANDEL DRIVE	East	4	West	4	318993	318985	313037	319193	4	1	4	1	0.07	0.08
313	SAC	050	017.008	FWY	FOLSOM BOULEVARD/NATOMA	East	4	West	4	318551	318550	313339	315913	2	1	2	1	0.08	0.14
315	ED	050	031.299	FWY	SLY PARK ROAD	East	2	West	2	308511	-	308512	-	2	-	2	-	0.33	0.33
382	ED	050	070.621	CON	JCT. RTE. 89 SOUTH	East	2	West	1	3054051	-	3054053	-	1	-	3	-	0.03	0.03
383	ED	050	070.621	CON	JCT. RTE. 89 SOUTH	East	1	West	2	3054051	-	3054053	-	1	-	3	-	0.03	0.03
316	ED	050	072.710	CON	SAWMILL ROAD	East	1	West	1	317711	-	317710	-	1	-	1	-	0.01	0.01
388	ED	050	080.140	CON	SOUTH LAKE TAHOE, PARK AVENUE	East	2	West	2	317736	-	317735	-	2	-	2	-	0.34	0.34
386	ED	050	080.140	CON	SOUTH LAKE TAHOE, PARK AVENUE	East	2	West	2	317736	-	317735	-	2	-	2	-	0.34	0.34
427	SAC	051	001.204	FWY	SACRAMENTO, H STREET	North	6	South	6	312694	-	312854	315860	4	-	3	1	0.12	0.11

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
426	SAC	051	001.204	FWY	SACRAMENTO, H STREET	North	6	South	6	312694	-	312854	315860	4	-	3	1	0.12	0.11
430	SAC	051	003.357	FWY	SACRAMENTO, EXPOSITION BOULEVARD	North	3	South	3	314147	-	312757	-	2	-	5	-	0.05	0.03
432	SAC	051	004.061	FWY	SACRAMENTO, ARDEN WAY	North	5	South	4	312782	-	318540	-	4	-	4	-	0.21	0.21
433	SAC	051	007.969	FWY	SACRAMENTO, WATT AVENUE	North	4	South	4	316114	-	312946	-	4	-	3	-	0.00	0.00
288	PLA	065	005.926	FWY	ROSEVILLE, HARDING BOULEVARD	North	3	South	4	3075061	-	3075081	-	3	-	3	-	0.14	0.19
292	PLA	065	009.569	FWY	PLACER/SUNSET BOULEVARDS	North	2	South	2	318401	-	318412	-	2	-	2	-	0.04	0.07
291	PLA	065	009.569	FWY	PLACER/SUNSET BOULEVARDS	North	2	South	3	318401	-	318412	-	2	-	2	-	0.04	0.07
278	PLA	065	010.579	FWY	WHITNEY RANCH	North	4	South	3	316617	-	320036	-	2	-	2	-	0.08	0.05
277	PLA	065	011.921	FWY	TWELVE BRIDGES OVERCROSSING	North	5	South	4	317081	-	317088	-	2	-	2	-	0.08	0.06
279	PLA	065	012.412	FWY	INDUSTRIAL AVENUE	North	4	South	4	3048041	-	3048042	-	2	-	2	-	0.24	0.26
280	PLA	065	013.359	FWY	FERRARI RANCH RD	North	6	South	0	319252	-	319239	-	2	-	2	-	0.12	0.08
282	PLA	065	015.568	EXP	NELSON RD NB 65	North	2	South	2	319032	-	319036	-	2	-	2	-	0.11	0.11
283	PLA	065	015.568	EXP	NELSON RD NB 65	North	2	South	2	319032	-	319036	-	2	-	2	-	0.11	0.11
612	YUB	070	003.382	EXP	PLUMAS LAKE RD EB 70	East	4	West	0	317916	-	317924	-	2	-	2	-	0.04	0.11
346	YOL	080	000.000	FWY	SOLANO/YOLO COUNTY LINE	East	4	West	4	318113	-	318102	-	3	-	3	-	0.32	0.32
405	YOL	080	007.090	FWY	YOLO CAUSEWAY	East	4	West	4	316803	-	316808	-	3	-	3	-	0.15	0.15

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
406	YOL	080	009.861	FWY	WEST SACRAMENTO, JCT RTE 50	East	6	West	5	318135	-	318142	-	4	-	4	-	0.34	0.34
970	YOL	080	009.905	FWY	WEST SACRAMENTO, JCT. RTE. 50	East	4	West	4	316817	-	316822	-	3	-	3	-	0.36	0.35
972	SAC	080	000.000	FWY	YOLO/SACRAMENTO COUNTY LINE	East	4	West	4	314509	-	319142	-	2	-	3	-	0.16	0.37
982	SAC	080	006.116	FWY	SACRAMENTO, NORWOOD AVENUE	East	3	West	3	313132	320656	316174	320513	3	1	3	1	0.17	0.08
990	SAC	080	007.634	FWY	SACRAMENTO, RALEY BOULEVARD	East	4	West	4	315993	320658	316001	320662	3	1	3	1	0.05	0.04
995	SAC	080	009.401	FWY	SACRAMENTO, LONGVIEW DRIVE	East	5	West	7	316063	316064	313487	317064	4	1	3	1	0.13	0.05
444	SAC	080	012.476	FWY	MADISON AVENUE	East	7	West	6	316328	317168	314485	315883	5	1	4	1	0.04	0.04
302	SAC	080	014.454	FWY	GREENBACK LANE	East	6	West	6	314460	315866	314419	315887	4	1	4	1	0.04	0.04
299	SAC	080	016.685	FWY	ANTELOPE ROAD	East	5	West	0	313456	315876	313450	315892	5	1	4	1	0.01	0.03
300	SAC	080	016.685	FWY	ANTELOPE ROAD	East	0	West	5	313456	315876	313450	315892	5	1	4	1	0.01	0.03
450	PLA	080	000.268	FWY	ROSEVILLE, RIVERSIDE DRIVE	East	5	West	4	319351	319350	313493	319339	4	1	4	1	0.02	0.02
452	PLA	080	003.661	FWY	ROSEVILLE, TAYLOR ROAD	East	6	West	6	318764	318775	318788	318787	5	1	4	1	0.27	0.02
451	PLA	080	007.421	FWY	ROCKLIN, SIERRA COLLEGE BOULEVARD	East	3	West	3	317752	-	317157	-	3	-	3	-	0.14	0.05
456	PLA	080	018.943	FWY	EB OFF TO LINCOLN WAY	East	4	West	4	-	-	316222	-	-	-	3	-	-	0.37
458	PLA	080	023.429	FWY	CLIPPER GAP	East	3	West	3	317619	-	317624	-	3	-	3	-	0.28	0.26
325	PLA	080	026.209	FWY	APPLEGATE ROAD	East	3	West	2	316249	-	316252	-	3	-	2	-	0.02	0.02

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
751	PLA	080	063.517	FWY	CISCO GROVE	East	3	West	3	319427	-	319430	-	2	-	2	-	0.01	0.01
750	PLA	080	063.517	FWY	CISCO GROVE	East	3	West	3	319427	-	319430	-	2	-	2	-	0.01	0.01
348	PLA	080	063.517	FWY	CISCO GROVE	East		West		319427	-	319430	-	2	-	2	-	0.01	0.01
757	NEV	080	002.476	FWY	SODA SPRINGS	East	3	West	3	317797	-	317798	-	3	-	2	-	0.03	0.03
756	NEV	080	002.476	FWY	SODA SPRINGS	East	3	West	3	317797	-	317798	-	3	-	2	-	0.03	0.03
755	NEV	080	005.066	FWY	CASTLE PEAK	East	4	West	3	317791	-	317789	-	3	-	3	-	0.02	0.02
754	NEV	080	005.066	FWY	CASTLE PEAK	East	4	West	3	317791	-	317789	-	3	-	3	-	0.02	0.02
759	NEV	080	009.007	FWY	DONNER LAKE	East	3	West	4	319415	-	318688	-	2	-	3	-	0.02	0.18
758	NEV	080	009.007	FWY	DONNER LAKE	East	3	West	4	319415	-	318688	-	2	-	3	-	0.02	0.18
760	NEV	080	013.210	FWY	TRUCKEE, DONNER PARK	East	3	West	4	319673	-	319674	-	2	-	2	-	0.00	0.00
761	NEV	080	013.210	FWY	TRUCKEE, DONNER PARK	East	3	West	3	319673	-	319674	-	2	-	2	-	0.00	0.00
495	NEV	080	029.489	FWY	FARAD	East	2	West	2	314277	-	317147	-	2	-	2	-	0.02	0.02
655	ED	089	008.550	CON	JCT. RTE. 50	North	1	South	1	3054056	-	3054057	-	6	-	7	-	0.03	0.02
656	ED	089	008.560	CON	JCT. RTE. 50	North	3	South	4	3054056	-	3054057	-	6	-	7	-	0.04	0.03
308	SAC	099	010.070	FWY	GRANT LINE ROAD	North	2	South	3	317146	-	317139	-	2	-	2	-	0.08	0.06
521	SAC	099	017.242	FWY	SACRAMENTO, STOCKTON BOULEVARD	North	3	South	3	312233	315836	314617	315837	3	1	3	1	0.08	0.19

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
520	SAC	099	017.242	FWY	SACRAMENTO, STOCKTON BOULEVARD	North	4	South	4	312233	315836	314617	315837	3	1	3	1	0.08	0.19
349	SAC	099	019.612	FWY	FLORIN ROAD	North	4	South	4	312422	315849	3046032	3046031	3	1	3	1	0.11	0.04
512	SAC	099	023.128	FWY	SACRAMENTO, 12TH AVENUE	North	4	South	4	312562	315825	318859	318858	4	1	4	1	0.07	0.07
545	SAC	099	033.364	FWY	ELKHORN BOULEVARD	North	2	South	2	316827	-	317045	-	2	-	2	-	0.02	0.02
544	SAC	099	035.370	EXP	ELVERTA ROAD	North	2	South	2	-	-	320552	-	-	-	2	-	-	0.06
585	BUT	099	030.603	FWY	CHICO, SKYWAY OVERCROSSING	North	2	South	2	318509	-	318510	-	2	-	2	-	0.14	0.14
717	YOL	113	010.218	FWY	WOODLAND, MAIN STREET	North	4	South	4	316482	-	316485	-	2	-	2	-	0.17	0.17
719	YOL	113	010.218	FWY	WOODLAND, MAIN STREET	North	3	South	3	316482	-	316485	-	2	-	2	-	0.17	0.17
830	SAC	160	046.581	FWY	SACRAMENTO, JCT. RTE. 51	North	2	South	2	-	-	314159	-	-	-	2	-	-	0.10

Table B-3: District 4 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
541	CC	004	005.168	FWY	MC EWEN ROAD	East	2	West	2	402518	-	402517	-	2	-	2	-	0.07	0.07
523	CC	004	008.549	FWY	MARTINEZ, ALHAMBRA BOULEVARD	East	2	West	3	402835	-	402834	-	2	-	3	-	0.05	0.05
120	CC	004	009.185	FWY	MARTINEZ, PINE STREET	East	2	West	2	402513	-	414306	-	3	-	3	-	0.06	0.13
912	CC	004	011.400	FWY	PACHECO BLVD	East	3	West	3	401952	-	402208	-	2	-	2	-	0.28	0.18
23	CC	004	012.667	FWY	JCT. RTE. 680	East	2	West	2	406623	-	401756	-	2	-	2	-	0.09	0.08
24	CC	004	012.667	FWY	JCT. RTE. 680	East	2	West	2	406623	-	401756	-	2	-	2	-	0.09	0.08
121	CC	004	016.834	FWY	WILLOW PASS ROAD (WEST)	East	3	West	3	401568	-	401476	-	4	-	4	-	0.06	0.06
416	CC	004	020.102	FWY	BAILEY ROAD	East	2	West	2	400324	-	404360	-	4	-	5	-	0.04	0.04
122	CC	004	027.790	FWY	ANTIOCH, A STREET/LONETREE	East	2	West	2	402491	-	402490	-	2	-	2	-	0.05	0.11
542	CC	004	028.940	FWY	ANTIOCH, HILLCREST AVENUE	East	2	West	2	402489	-	402488	-	2	-	2	-	0.06	0.06
484	CC	004	031.368	FWY	LAUREL ROAD	East	2	West	2	402088	-	402089	-	3	-	2	-	0.17	0.04
6	NAP	012	000.000	CON	JCT. RTE. 29, NAPA, SOUTH	East	2	West	1	406788	-	406793	-	2	-	2	-	0.40	0.40
74	NAP	012	000.240	CON	KELLY ROAD	East	2	West	1	406788	-	406793	-	2	-	2	-	0.16	0.16
906	NAP	012	002.300	CON	.2-MI N/O NAPA/SOLANO COUNTY LINE	East	2	West	2	406791	-	406796	-	2	-	2	-	0.06	0.06
312	SOL	012	002.794	CON	JCT. RTE. 80	East	1	West	1	420469	-	409486	-	1	-	2	-	0.38	0.38

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
313	SOL	012	001.801	CON	JCT. RTE. 80	East	3	West	2	409481	-	409485	-	2	-	2	-	0.14	0.14
432	SCL	017	007.073	FWY	LOS GATOS, JCT. RTE. 9 WEST	North	2	South	2	400154	-	400416	-	2	-	2	-	0.02	0.09
130	ALA	024	001.848	FWY	OAKLAND, JCT RTE 580	East	4	West	4	403280	-	401390	-	3	-	3	-	0.25	0.21
418	ALA	024	005.887	FWY	OAKLAND, CALDECOTT TUNNEL	East	4	West	4	407992	-	408000	-	4	-	4	-	0.26	0.31
521	CC	024	002.313	FWY	ORINDA, CAMINO PABLO	East	4	West	5	400438	-	400617	-	4	-	4	-	0.06	0.03
417	CC	024	004.397	FWY	LAFAYETTE, ACALANES ROAD	East	5	West	5	400171	-	400800	-	4	-	5	-	0.13	0.04
543	CC	024	006.257	FWY	LAFAYETTE, OAK HILL ROAD	East	4	West	4	400251	-	400550	-	4	-	4	-	0.14	0.19
63	SCL	025	002.528	CON	GILROY, JCT RTE 101	North	1	South	1	401680	-	401685	-	1	-	1	-	0.43	0.43
79	NAP	029	013.058	EXP	JCT. TRANCAS/REDWOOD ROADS	North	2	South	2	401796	-	401797	-	2	-	2	-	0.04	0.04
409	MRN	037	011.961	EXP	NOVATO, NOVATO CREEK BRIDGE	East	2	West	2	422007	-	422009	-	2	-	2	-	0.29	0.27
324	SOL	037	007.213	FWY	WALNUT AVENUE	East	2	West	2	402047	-	402046	-	2	-	2	-	0.03	0.03
309	SOL	037	009.665	FWY	JCT. RTE. 29	East	3	West	3	401694	-	401700	-	3	-	2	-	0.13	0.13
392	SOL	037	009.665	FWY	JCT. RTE. 29	East	3	West	3	401694	-	401700	-	3	-	2	-	0.13	0.13
326	SOL	037	011.728	FWY	VALLEJO, JCT. RTE. 80	East	3	West	3	402051	-	402050	-	4	-	3	-	0.11	0.11
500	ALA	080	001.989	FWY	SAN FRANCISCO-OAKLAND BAY BRIDGE TOLL PLAZA	East	6	West	22	401892	-	401503	-	6	-	7	-	0.33	0.42
133	ALA	080	003.786	FWY	EMERYVILLE, POWELL STREET	East	6	West	5	401513	-	401698	-	6	-	5	-	0.10	0.11

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
549	ALA	080	003.786	FWY	EMERYVILLE, POWELL STREET	East	6	West	5	401513	-	401698	-	6	-	5	-	0.10	0.11
247	ALA	080	005.823	FWY	BERKELEY, UNIVERSITY AVENUE INTERCHANGE	East	5	West	5	400728	-	400176	-	5	-	5	-	0.00	0.07
546	CC	080	000.216	FWY	RICHMOND, CENTRAL AVENUE	East	3	West	3	402062	-	409584	-	4	-	4	-	0.16	0.01
547	CC	080	004.341	FWY	SAN PABLO, SAN PABLO DAM ROAD	East	3	West	3	400770	-	406660	-	4	-	4	-	0.04	0.14
134	CC	080	005.983	FWY	RICHMOND, HILLTOP DRIVE	East	3	West	3	401209	-	411149	-	4	-	4	-	0.05	0.07
902	CC	080	007.615	FWY	PINOLE, APPIAN WAY	East	4	West	4	400865	-	400313	-	4	-	4	-	0.00	0.00
548	CC	080	010.017	FWY	HERCULES, JCT RTE 4	East	3	West	3	401090	-	401226	-	5	-	4	-	0.11	0.05
503	SOL	080	000.000	FWY	CARQUINEZ BRIDGE	East	9	West	3	423339	-	401636	-	4	-	4	-	0.42	0.23
489	SOL	080	001.144	FWY	VALLEJO, JCT. RTE. 29 NORTHWEST	East	3	West	3	400829	-	400337	-	3	-	3	-	0.05	0.05
308	SOL	080	001.144	FWY	VALLEJO, JCT. RTE. 29 NORTHWEST	East	3	West	3	400829	-	400337	-	3	-	3	-	0.05	0.05
328	SOL	080	002.881	FWY	VALLEJO, GEORGIA STREET	East	3	West	3	404388	-	404408	-	3	-	3	-	0.07	0.07
329	SOL	080	003.494	FWY	VALLEJO, TENNESSEE STREET	East	3	West	3	423336	-	400074	-	3	-	3	-	0.09	0.06
330	SOL	080	005.634	FWY	VALLEJO, JCT. RTE. 37 WEST	East	4	West	4	407866	-	402077	-	5	-	4	-	0.10	0.11
333	SOL	080	008.103	FWY	AMERICAN CANYON ROAD	East	3	West	3	410778	-	410820	-	4	-	4	-	0.06	0.05
360	SOL	080	012.839	FWY	JCT. RTE. 680 SOUTH	East	4	West	0	401781	-	401782	-	5	-	5	-	0.14	0.35
334	SOL	080	015.815	FWY	FAIRFIELD, EAST JCT. RTE. 12	East	4	West	4	410745	-	410782	-	5	-	5	-	0.45	0.24

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
331	SOL	080	020.925	FWY	FAIRFIELD, NORTH TEXAS STREET	East	4	West	4	403455	-	410803	-	4	-	4	-	0.09	0.13
335	SOL	080	023.958	FWY	PLEASANT VALLEY	East	4	West	4	401878	-	401877	-	4	-	4	-	0.00	0.00
359	SOL	080	027.172	FWY	ALLISON DR/MONTE VISTA	East	4	West	4	410752	-	410788	-	4	-	4	-	0.15	0.16
332	SOL	080	027.238	FWY	VACAVILLE, MONTE VISTA/ALISON DR	East	5	West	4	410752	-	410788	-	4	-	4	-	0.08	0.09
901	SOL	080	029.859	FWY	VACAVILLE, LEISURE TOWN	East	4	West	4	-	-	411140	-	-	-	4	-	-	0.36
340	SOL	080	035.547	FWY	DIXON/GRANT ROAD	East	3	West	3	402251	-	402252	-	3	-	3	-	0.15	0.02
342	SOL	080	038.210	FWY	JCT. RTE. 113 SOUTH	East	3	West	3	402261	-	402260	-	3	-	3	-	0.01	0.03
449	SCL	085	003.930	FWY	SAN JOSE, BLOSSOM HILL ROAD	North	3	South	3	400444	-	400754	-	3	-	3	-	0.09	0.11
469	SCL	085	010.997	FWY	LOS GATOS, WINCHESTER BLVD.	North	2	South	2	400464	-	400907	-	3	-	3	-	0.12	0.12
448	SCL	085	010.997	FWY	LOS GATOS, WINCHESTER BLVD.	North	3	South	3	400464	-	400907	-	3	-	3	-	0.12	0.12
447	SCL	085	017.699	FWY	CUPERTINO, STEVENS CREEK BOULEVARD	North	3	South	3	400677	-	400209	-	4	-	4	-	0.21	0.21
193	SCL	085	018.861	FWY	CUPERTINO, HOMESTEAD ROAD	North	3	South	3	407331	-	407373	-	4	-	3	-	0.16	0.01
446	SCL	085	022.163	FWY	JCT. RTE. 237	North	3	South	3	407325	-	407348	-	3	-	3	-	0.03	0.01
194	SCL	085	023.829	FWY	JCT RTE 101; MOFFETT BOULEVARD	North	2	South	2	400174	407332	400869	407359	3	1	3	1	0.35	0.35
450	SCL	087	000.000	EXP	SAN JOSE, JCT. RTE 85	North	2	South	2	400280	-	400842	-	2	-	2	-	0.45	0.45
241	SCL	087	005.156	FWY	SAN JOSE, JCT. RTE. 280	North	2	South	3	400563	-	400236	-	3	-	3	-	0.10	0.10

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
451	SCL	087	005.156	FWY	SAN JOSE, JCT. RTE. 280	North	2	South	2	400563	-	400236	-	3	-	3	-	0.10	0.10
197	SM	092	007.303	FWY	JCT. RTE. 280	East	3	West	3	401547	-	401223	-	2	-	2	-	0.04	0.04
198	SM	092	011.208	FWY	JCT. RTE. 82	East	3	West	3	421771	-	400905	-	2	-	2	-	0.05	0.05
199	SM	092	012.143	FWY	SAN MATEO, JCT. RTE. 101	East	3	West	4	401053	-	401065	-	2	-	3	-	0.23	0.16
910	SM	092	013.831	FWY	FOSTER CITY BOULEVARD	East	3	West	3	400683	-	400071	-	3	-	3	-	0.10	0.10
505	ALA	092	005.594	FWY	SAN MATEO-HAYWARD BRIDGE TOLL PLAZA	East	2	West	7	406695	-	406719	-	2	-	4	-	0.25	0.06
443	ALA	092	004.477	FWY	HAYWARD, CLAWITER ROAD	East	2	West	3	406688	-	406713	-	3	-	4	-	0.06	0.06
58	SCL	101	003.197	EXP	JCT. RTE. 25 EAST	North	2	South	2	409893	-	409933	-	2	-	2	-	0.00	0.00
230	SCL	101	006.080	FWY	GILROY, JCT. RTE. 152 EAST	North	3	South	3	409884	-	401691	-	4	-	3	-	0.05	0.04
911	SCL	101	010.270	FWY	MASTEN AVENUE	North	3	South	3	410106	-	410563	-	3	-	3	-	0.10	0.11
425	SCL	101	012.460	FWY	SAN MARTIN	North	3	South	3	409859	-	409929	-	3	-	3	-	0.08	0.10
229	SCL	101	016.006	FWY	EAST DUNNE AVENUE	North	3	South	3	401581	-	409942	-	3	-	3	-	0.08	0.10
200	SCL	101	028.609	FWY	SAN JOSE, JCT. RTE. 82 NORTH	North	4	South	4	400474	-	400742	-	4	-	4	-	0.11	0.17
453	SCL	101	036.144	FWY	SAN JOSE, MC KEE ROAD	North	5	South	5	400668	-	400440	-	4	-	4	-	0.08	0.03
424	SCL	101	037.726	FWY	SAN JOSE, OAKLAND ROAD	North	5	South	5	400965	-	400109	-	4	-	4	-	0.11	0.12
426	SCL	101	038.300	FWY	SAN JOSE, JCT. RTE. 880	North	5	South	5	400001	-	400394	-	5	-	5	-	0.04	0.05

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
413	SCL	101	039.925	FWY	JCT. RTE. 87, GUADALUPE PARKWAY	North	5	South	5	400760	-	-	-	4	-	-	-	0.18	-
242	SCL	101	046.134	FWY	SUNNYVALE, JCT. RTE. 237	North	4	South	4	404522	-	400545	-	4	-	4	-	0.06	0.11
452	SCL	101	048.103	FWY	MOUNTAIN VIEW, JCT. RTE. 85 SOUTH	North	4	South	4	401948	-	401936	-	5	-	4	-	0.11	0.28
226	SM	101	000.890	FWY	EAST PALO ALTO, UNIVERSITY AVENUE	North	4	South	4	400859	-	400425	-	4	-	4	-	0.29	0.11
227	SM	101	006.623	FWY	REDWOOD CITY, WHIPPLE AVENUE	North	4	South	4	401833	-	401861	-	5	-	4	-	0.03	0.05
445	SM	101	013.461	FWY	SAN MATEO, THIRD AVENUE	North	4	South	4	403261	-	405877	-	4	-	4	-	0.08	0.07
201	SM	101	013.461	FWY	SAN MATEO, THIRD AVENUE	North	4	South	4	403261	-	405877	-	4	-	4	-	0.08	0.07
436	SM	101	016.575	FWY	BURLINGAME, BROADWAY	North	4	South	4	400797	-	400098	-	4	-	4	-	0.07	0.07
905	SM	101	017.950	FWY	MILLBRAE AVENUE	North	4	South	4	401336	-	401631	-	5	-	4	-	0.20	0.04
228	SM	101	019.801	FWY	JCT RTE 380; SAN BRUNO AVENUE	North	4	South	4	400331	-	400977	-	5	-	4	-	0.17	0.17
225	SM	101	022.713	FWY	SOUTH SAN FRANCISCO, OYSTER POINT BOULEVARD	North	4	South	4	402390	-	408101	-	4	-	4	-	0.01	0.13
108	SF	101	000.774	FWY	SAN FRANCISCO, THIRD STREET	North	4	South	4	401795	-	401454	-	5	-	4	-	0.12	0.12
109	SF	101	002.920	FWY	SAN FRANCISCO, ARMY STREET	North	4	South	4	400868	-	401285	-	4	-	5	-	0.38	0.31
110	SF	101	005.322	CON	SAN FRANCISCO, TURK STREET	North	3	South	3	401819	-	401820	-	3	-	2	-	0.14	0.14
438	MRN	101	000.318	FWY	SAUSALITO ROAD	North	4	South	4	402553	-	402554	-	4	-	4	-	0.07	0.08
524	MRN	101	005.694	FWY	JCT. RTE. 131 EAST	North	4	South	4	402573	-	402574	-	4	-	4	-	0.01	0.04

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
82	MRN	101	013.713	FWY	MANUEL FREITAS PARKWAY	North	5	South	4	402591	-	402592	-	4	-	4	-	0.01	0.11
442	MRN	101	019.085	FWY	NOVATO, JCT. RTE. 37 EAST	North	5	South	5	400390	-	400000	-	4	-	4	-	0.15	0.15
83	MRN	101	019.085	FWY	NOVATO, JCT. RTE. 37 EAST	North	3	South	3	400390	-	400000	-	4	-	4	-	0.15	0.15
11	SON	101	003.664	FWY	PETALUMA, SOUTH JCT. RTE. 116 EAST	North	2	South	2	415649	-	402005	-	2	-	2	-	0.16	0.15
84	SON	101	012.682	FWY	COTATI, NORTH JCT. RTE. 116	North	2	South	2	402665	-	402666	-	2	-	2	-	0.12	0.12
404	SON	101	019.646	FWY	SANTA ROSA, JCT. RTE. 12	North	2	South	2	402125	-	402124	-	3	-	4	-	0.06	0.03
85	SON	101	027.618	FWY	SHILOH ROAD	North	2	South	2	409681	-	409728	-	3	-	3	-	0.04	0.03
403	SON	101	038.558	FWY	LYTTON SPRINGS ROAD	North	2	South	2	402727	-	402728	-	2	-	2	-	0.44	0.44
525	SON	101	043.373	FWY	JCT. RTE. 128 EAST	North	2	South	2	402742	-	402743	-	2	-	2	-	0.10	0.10
86	SON	101	051.617	FWY	CITRUS FAIR DRIVE	North	2	South	2	402767	-	402768	-	2	-	2	-	0.01	0.01
13	SON	101	053.400	FWY	JCT RTE 128 WEST	North	2	South	2	406742	-	406760	-	2	-	2	-	0.07	0.07
12	SON	101	053.545	FWY	JCT. RTE. 128 WEST	North	2	South	2	406742	-	406760	-	2	-	2	-	0.08	0.08
12	SON	101	054.201	FWY	JCT. RTE. 128 WEST	North	2	South	2	402773	-	402774	-	2	-	2	-	0.20	0.20
61	SCL	152	021.977	EXP	JCT. RTE. 156 SOUTH	East	1	West	1	406888	-	406890	-	1	-	1	-	0.17	0.17
427	SCL	152	021.977	EXP	JCT. RTE. 156 SOUTH	East	2	West	3	406888	-	406890	-	1	-	1	-	0.17	0.17
501	CC	160	001.327	CON	CONTRA COSTA/SACRAMENTO COUNTY LINE	North	3	South	2	402071	-	402070	-	3	-	3	-	0.47	0.47

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490	SCL	237	004.599	FWY	SUNNYVALE, LAWRENCE EXPRESSWAY INTERCHANGE	East	4	West	4	400970	-	400274	-	3	-	3	-	0.13	0.08
491	SCL	237	004.599	FWY	SUNNYVALE, LAWRENCE EXPRESSWAY INTERCHANGE	East	4	West	4	400970	-	400274	-	3	-	3	-	0.13	0.08
495	SCL	237	006.866	EXP	SAN JOSE, NORTH FIRST/ TAYLOR STREETS	East	4	West	4	400567	-	400201	-	4	-	3	-	0.17	0.17
482	SCL	237	008.020	FWY	SAN JOSE, ZANKER ROAD INTERCHANGE	East	4	West	4	400296	-	401014	-	3	-	3	-	0.01	0.01
480	SCL	237	008.020	FWY	SAN JOSE, ZANKER ROAD INTERCHANGE	East	4	West	4	400296	-	401014	-	3	-	3	-	0.01	0.01
148	ALA	238	016.279	FWY	SAN LEANDRO, HESPERIAN BOULEVARD	North	2	South	2	401392	-	401385	-	2	-	4	-	0.04	0.04
149	CC	242	000.000	FWY	CONCORD, JCT. RTE. 680	North	2	South	2	414247	-	414250	-	3	-	3	-	0.33	0.33
36	CC	242	003.398	FWY	CONCORD, JCT. RTE. 4	North	3	South	2	-	-	414253	-	-	-	3	-	-	0.21
231	SCL	280	000.355	FWY	SAN JOSE, AVENUE MCLAUGHLIN	North	5	South	6	401655	-	401391	-	5	-	2	-	0.13	0.18
237	SCL	280	002.522	FWY	SAN JOSE, JCT. RTE. 87	North	5	South	4	413878	-	403409	-	4	-	5	-	0.20	0.08
527	SCL	280	003.993	FWY	SAN JOSE, MERIDIAN ROAD	North	4	South	4	414694	-	401327	-	4	-	4	-	0.08	0.02
217	SCL	280	005.408	FWY	SAN JOSE, 17/880 JCT. RTES.	North	4	South	4	407710	-	407711	-	3	-	4	-	0.08	0.07
236	SCL	280	005.408	FWY	SAN JOSE, 17/880 JCT. RTES.	North	4	South	4	407710	-	407711	-	3	-	4	-	0.08	0.07
528	SCL	280	007.388	FWY	STEVENS CREEK BOULEVARD	North	5	South	5	400560	-	400429	-	4	-	4	-	0.24	0.41
219	SCL	280	010.741	FWY	SUNNYVALE, JCT. RTE. 85	North	4	South	4	401845	-	401846	-	4	-	4	-	0.27	0.27
218	SCL	280	010.741	FWY	SUNNYVALE, JCT. RTE. 85	North	5	South	5	401845	-	401846	-	4	-	4	-	0.27	0.27

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904	SM	280	005.600	FWY	1-MI. S/O CANADA ROAD	North	4	South	4	403318	-	403319	-	4	-	4	-	0.43	0.43
221	SM	280	010.833	FWY	JCT RTE 92	North	4	South	4	400319	-	400350	-	4	-	4	-	0.11	0.05
531	SM	280	024.197	FWY	DALY CITY, HICKEY BOULEVARD	North	4	South	4	400703	-	403908	-	4	-	4	-	0.07	0.09
106	SF	280	003.279	FWY	SAN FRANCISCO, ALEMANY BOULEVARD INTERCHANGE	North	4	South	4	400575	-	400552	-	4	-	4	-	0.16	0.16
105	SF	280	004.341	FWY	SAN FRANCISCO, JCT. RTE. 101	North	5	South	5	400322	-	401018	-	4	-	4	-	0.47	0.47
113	SF	280	006.603	FWY	SAN FRANCISCO, MARIPOSA STREET	North	4	South	4	400573	-	400231	-	3	-	3	-	0.08	0.08
152	ALA	580	008.265	FWY	LIVERMORE, GREENVILLE ROAD	East	5	East	5	402410	-	-	-	5	-	-	-	0.20	-
532	ALA	580	010.689	FWY	FIRST STREET	East	4	East	4	402030	-	-	-	6	-	-	-	0.11	-
533	ALA	580	013.219	FWY	LIVERMORE, PORTOLA AVENUE	East	4	East	4	402434	-	-	-	4	-	-	-	0.12	-
420	ALA	580	020.726	FWY	PLEASANTON, JCT. RTE. 680	East	5	East	5	401695	-	-	-	4	-	-	-	0.09	-
534	ALA	580	028.413	FWY	CROW CANYON ROAD	East	4	East	4	406604	-	-	-	4	-	-	-	0.45	-
238	ALA	580	028.413	FWY	CROW CANYON ROAD	East	4	East	4	406604	-	-	-	4	-	-	-	0.45	-
535	ALA	580	030.354	FWY	STROBRIDGE AVENUE	East	5	East	5	402537	-	-	-	3	-	-	-	0.17	-
38	ALA	580	030.589	FWY	JCT RTE 238	East	4	East	6	402537	-	-	-	3	-	-	-	0.07	-
153	ALA	580	039.240	FWY	OAKLAND, JCT. RTE. 13 NORTH	East	4	East	4	400492	-	-	-	4	-	-	-	0.35	-
243	ALA	580	040.647	FWY	OAKLAND, 35TH AVENUE	East	4	East	4	402105	-	-	-	4	-	-	-	0.15	-

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154	ALA	580	045.151	FWY	OAKLAND, JCT. RTES. 24/980	East	6	East	6	401899	-	-	-	3	-	-	-	0.15	-
28	ALA	580	047.350	FWY	ALBANY, NORTH JCT. RTE. 80	East	2	East	2	401218	-	-	-	2	-	-	-	0.14	-
504	CC	580	006.130	FWY	RICHMOND-SAN RAFAEL BRIDGE	East	2	East	7	424055	-	-	-	3	-	-	-	0.08	-
224	SCL	680	000.385	FWY	SAN JOSE, KING ROAD	North	6	South	6	407165	-	407194	-	6	-	6	-	0.10	0.10
544	SCL	680	001.410	FWY	SAN JOSE, CAPITOL EXPRESSWAY	North		South		407170	-	407197	-	4	-	4	-	0.01	0.01
233	SCL	680	002.376	FWY	SAN JOSE, MC KEE ROAD	North	4	South	4	407179	-	407204	-	4	-	4	-	0.06	0.15
545	SCL	680	005.068	FWY	SAN JOSE, CAPITOL AVENUE	North	4	South	4	407153	-	407200	-	4	-	4	-	0.05	0.05
423	SCL	680	009.935	FWY	SANTA CLARA/ALAMEDA COUNTY LINE	North	4	South	4	400870	-	400791	-	3	-	5	-	0.33	0.33
39	ALA	680	001.961	FWY	EAST WARREN AVE, SCOTT CREEK	North	3	South	3	403250	-	403251	-	3	-	5	-	0.03	0.03
40	ALA	680	002.382	FWY	FREMONT, JCT. RTE. 262 WEST	North	3	South	3	400376	-	400566	-	4	-	4	-	0.10	0.10
155	ALA	680	006.396	FWY	FREMONT, JCT. RTE. 238 NORTH	North	3	South	3	402799	-	402798	-	3	-	4	-	0.03	0.03
156	ALA	680	006.396	FWY	FREMONT, JCT. RTE. 238 NORTH	North	4	South	3	402799	-	402798	-	3	-	4	-	0.03	0.03
914	ALA	680	008.312	FWY	SHERIDAN ROAD INTERCHANGE	North	4	South	0	-	-	403334	-	-	-	5	-	-	0.01
41	ALA	680	011.042	FWY	JCT. RTE. 84 WEST	North	3	South	3	-	-	403340	-	-	-	4	-	-	0.15
42	ALA	680	011.845	FWY	JCT. RTE. 84 EAST	North	3	South	3	-	-	403343	-	-	-	3	-	-	0.19
157	ALA	680	020.057	FWY	PLEASANTON, JCT. RTE. 580	North	3	South	3	401697	-	401705	-	5	-	3	-	0.08	0.23

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557	CC	680	000.010	FWY	SAN RAMON, ALCOSTA BOULEVARD	North	3	South	3	401434	-	402103	-	4	-	4	-	0.12	0.10
900	CC	680	000.020	FWY	ALAMEDA/CONTRA COSTA COUNTY LINE	North	4	South	4	401434	-	402103	-	4	-	4	-	0.11	0.09
419	CC	680	006.764	FWY	DANVILLE, SYCAMORE VALLEY ROAD	North	3	South	3	400972	-	400437	-	4	-	4	-	0.11	0.11
158	CC	680	008.751	FWY	DANVILLE, EL PINTADO ROAD	North	3	South	3	400712	-	400852	-	4	-	4	-	0.06	0.06
302	CC	680	012.613	FWY	WALNUT CREEK, RUDGEAR ROAD INTERCHANGE	North	3	South	3	401566	-	401519	-	4	-	5	-	0.18	0.18
159	CC	680	013.082	FWY	WALNUT CREEK, SOUTH MAIN STREET	North	4	South	5	400774	-	401840	-	5	-	5	-	0.04	0.05
301	CC	680	018.707	FWY	CONCORD, JCT. RTE. 242 NORTH	North	4	South	5	420613	-	420643	-	3	-	4	-	0.03	0.05
43	CC	680	021.191	FWY	JCT. RTE. 4	North	3	South	3	401718	-	405930	-	5	-	5	-	0.08	0.09
161	CC	680	022.429	FWY	MARTINEZ, PACHECO BOULEVARD	North	3	South	3	404687	-	404728	-	4	-	4	-	0.20	0.00
511	CC	680	024.560	FWY	BENICIA MARTINEZ BRIDGE	North	12	South	4	402411	-	402412	-	4	-	4	-	0.33	0.08
554	SOL	680	000.627	FWY	JCT. RTE. 780	North	3	South	3	402157	-	407477	-	5	-	2	-	0.03	0.20
336	SOL	680	001.463	FWY	SB OFF TO INDUSTRIAL WAY	North	2	South	2	400295	-	400265	-	2	-	2	-	0.00	0.00
355	SOL	680	007.324	FWY	MARSHOVIEW ROAD	North	2	South	2	401424	-	401421	-	2	-	2	-	0.25	0.25
362	SOL	780	001.221	FWY	BEGIN ROUTE 780	East	3	East	2	402464	-	-	-	3	-	-	-	0.06	-
304	SCL	880	001.250	FWY	BASCOM AVENUE	North	3	South	3	400057	-	400723	-	3	-	4	-	0.08	0.00
300	SCL	880	001.250	FWY	BASCOM AVENUE	North	3	South	3	400057	-	400723	-	3	-	4	-	0.08	0.00

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127	ALA	880	002.283	FWY	FREMONT, JCT. RTE. 262 EAST	North	3	South	3	408755	-	408757	-	4	-	4	-	0.02	0.04
239	ALA	880	013.051	FWY	UNION CITY, ALVARADO/NILES ROAD	North	3	South	3	400536	-	400853	-	5	-	4	-	0.09	0.05
909	ALA	880	014.537	FWY	HAYWARD, INDUSTRIAL PARKWAY	North	5	South	5	400611	-	401450	-	4	-	4	-	0.15	0.00
126	ALA	880	015.645	FWY	HAYWARD, TENNYSON ROAD	North	5	South	5	400284	-	400681	-	4	-	4	-	0.11	0.15
128	ALA	880	018.353	FWY	HAYWARD, A STREET	North	5	South	5	400275	-	400670	-	5	-	5	-	0.13	0.10
129	ALA	880	026.607	FWY	OAKLAND, 66TH AVENUE	North	5	South	5	400949	-	400956	-	4	-	4	-	0.23	0.28
520	ALA	980	002.036	FWY	OAKLAND, JCT. RTE. 580	East	5	West	5	400642	-	401911	-	3	-	3	-	0.21	0.42

Table B-4: District 5 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
532	MON	001	075.135	FWY	JCT. RTE. 68, CARMEL-PACIFIC GROVE	North	2	South	2	500010051	-	500010052	-	2	-	2	-	0.17	0.17
259	MON	001	075.135	FWY	JCT. RTE. 68, CARMEL-PACIFIC GROVE	North	2	South	2	500010051	-	500010052	-	2	-	2	-	0.17	0.17
261	MON	001	079.357	FWY	SEASIDE, JCT. RTE. 218	North	2	South	2	500010142	-	500010143	-	2	-	2	-	0.18	0.18
44	SCR	001	000.716	FWY	JCT. RTE. 129	North	2	South	2	500013012	-	500013013	-	2	-	2	-	0.16	0.16
414	SCR	001	002.683	FWY	JCT. RTE. 152	North	2	South	3	500013031	-	500013032	-	2	-	2	-	0.26	0.26
428	SCR	001	009.153	FWY	RIO DEL MAR N/O FREEDOM BOULEVARD	North	2	South	2	500013122	-	500013123	-	2	-	2	-	0.14	0.14
701	SCR	001	012.088	FWY	CAPITOLA, PARK AVENUE	North	2	South	2	500014021	-	500014022	-	2	-	2	-	0.21	0.21
721	SCR	001	013.620	FWY	CAPITOLA, 41ST AVENUE	North	2	South	2	500014063	-	500014062	-	2	-	2	-	0.00	0.01
45	SCR	001	017.560	CON	JCT. RTE. 9 NORTH, RIVER STREET	North	2	South	2	-	-	500014142	-	-	-	1	-	-	0.43
172	SCR	017	000.000	FWY	SANTA CRUZ, JCT. RTE. 1	North	2	South	3	500017011	-	500017012	-	2	-	2	-	0.07	0.07
263	MON	068	004.264	CON	JCT. RTE. 1, CARMEL-PACIFIC GROVE	East	1	West	1	506800011	-	-	-	2	-	-	-	0.15	-
524	MON	068	003.948	CON	JCT. RTE. 1, CARMEL-PACIFIC GROVE	East	1	West	1	506800012	-	-	-	2	-	-	-	0.15	-
537	MON	068	017.190	FWY	RESERVATION ROAD	East	2	West	2	506800131	-	-	-	2	-	-	-	0.07	-
501	SB	101	000.634	FWY	JCT. RTE. 150 EAST	North	2	South	2	501010012	-	501010013	-	3	-	3	-	0.32	0.32
117	SB	101	009.003	FWY	MONTECITO, SHEFFIELD DRIVE	North	2	South	2	501010122	-	501010124	-	2	-	2	-	0.14	0.14

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
549	SB	101	016.552	FWY	SANTA BARBARA, JCT. RTE. 225 SOUTHEAST	North	3	South	3	501012022	-	501012021	-	3	-	3	-	0.30	0.30
502	SB	101	018.364	FWY	JCT. RTE. 154	North	3	South	3	501012051	-	501012052	-	3	-	3	-	0.11	0.11
120	SB	101	024.762	FWY	STORKE ROAD	North	2	South	2	501012152	-	501012151	-	2	-	2	-	0.35	0.35
431	SB	101	087.603	FWY	EAST STOWELL ROAD	North	2	South	2	501014062	-	501014061	-	3	-	3	-	0.04	0.04
441	SLO	101	017.756	FWY	PISMO BEACH, JCT. RTE. 1 SOUTH	North	2	South	2	501016052	-	501016053	-	2	-	2	-	0.16	0.16
534	SLO	101	025.911	FWY	SAN LUIS OBISPO, LOS OSOS ROAD	North	2	South	2	501016123	-	501016122	-	2	-	2	-	0.06	0.06
540	SLO	101	027.501	FWY	SAN LUIS OBISPO, MADONNA ROAD	North	2	South	2	501016153	-	501016152	-	2	-	2	-	0.02	0.02
238	SLO	101	029.985	FWY	SAN LUIS OBISPO, BUENA VISTA INTERCHANGE	North	0	South	2	501017051	-	501017052	-	2	-	2	-	0.04	0.04
507	SLO	101	037.863	FWY	JCT. RTE. 58 EAST, SANTA MARGARITA	North	2	South	2	501017133	-	501017132	-	2	-	2	-	0.10	0.10
267	MON	101	085.624	FWY	SALINAS, AIRPORT BOULEVARD	North	2	South	2	501019011	-	-	-	2	-	-	-	0.02	-
253	MON	101	091.900	EXP	SALINAS, ESPINOSA/RUSSELL ROADS	North	2	South	2	501019092	-	501019091	-	3	-	3	-	0.01	0.01
249	SBT	156	000.000	CON	NORTH JCT. RTE. 101, SAN JUAN BAUTISTA	East	1	West	1	501560012	-	501560013	-	1	-	1	-	0.06	0.06

Table B-5: District 6 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
500	KER	005	010.153	FWY	GRAPEVINE INTERCHANGE	North	4	South	0	601510	-	602510	-	4	-	4	-	0.02	0.02
501	KER	005	010.158	FWY	GRAPEVINE UC, LEFT	North	0	South	4	601510	-	602510	-	4	-	4	-	0.02	0.02
631	KER	005	013.523	FWY	WHEELER RIDGE ROAD	North	4	South	4	601339	-	602339	-	4	-	4	-	0.47	0.47
158	KER	005	033.489	FWY	JCT. RTE. 223	North	2	South	2	601309	-	602309	-	2	-	2	-	0.03	0.03
681	KER	005	038.793	FWY	JCT. RTE. 119	North	2	South	2	601310	-	602310	-	2	-	2	-	0.38	0.36
682	KER	005	056.642	FWY	7TH STANDARD ROAD	North	2	South	2	601315	-	602315	-	2	-	2	-	0.02	0.05
571	KIN	005	012.362	FWY	UTICA AVENUE INTERCHANGE	North	2	South	2	601505	-	602505	-	2	-	2	-	0.00	0.00
598	FRE	005	014.873	FWY	JCT. RTE. 198	North	2	South	2	601592	-	602592	-	2	-	2	-	0.12	0.12
851	FRE	005	048.990	FWY	PANOCHE ROAD	North	2	South	2	601340	-	602340	-	2	-	2	-	0.37	0.37
675	FRE	005	065.782	FWY	NEES AVENUE INTERCHANGE	North	2	South	2	601338	-	602338	-	2	-	2	-	0.26	0.27
659	FRE	041	008.107	CON	CONEJO AVENUE	North	2	South	2	601515	-	602515	-	2	-	2	-	0.49	0.49
641	FRE	041	020.084	FWY	NORTH AVENUE	North	2	South	2	601222	-	602517	-	2	-	2	-	0.20	0.48
642	FRE	041	021.859	FWY	JCT RTE 99	North	3	South	3	601522	-	602522	-	3	-	3	-	0.09	0.09
240	FRE	041	023.498	FWY	FRESNO, HUNTINGTON BOULEVARD	North	4	South	4	601526	-	602526	-	4	-	4	-	0.06	0.05
656	FRE	041	024.210	FWY	FRESNO, JCT RTE 180 (O STREET)	North		South		601528	-	602529	-	5	-	3	-	0.01	0.01

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
243	FRE	041	026.461	FWY	FRESNO, SHIELDS AVENUE	North	3	South	3	601214	-	601412	-	3	-	3	-	0.06	0.07
247	FRE	041	028.751	FWY	ON BLACKSTONE, N OF SHAW AVE	North		South		601415	-	602538	-	3	-	3	-	0.17	0.23
250	FRE	041	030.447	FWY	FRESNO, HERNDON AVENUE	North	4	South	3	601542	-	601218	-	4	-	3	-	0.45	0.16
252	FRE	041	031.350	FWY	FRIANT RD	North	0	South	0	614163	-	624163	-	4	-	2	-	0.04	0.04
917	FRE	041	031.683	FWY	FRESNO, FRIANT ROAD	North	2	South	2	614163	-	601219	-	4	-	2	-	0.29	0.13
814	KER	058	053.387	FWY	H STREET	East	1	West	1	-	-	601582	-	-	-	3	-	-	0.08
585	KER	058	055.404	FWY	COTTONWOOD ROAD	East	3	West	3	601588	-	601587	-	3	-	3	-	0.09	0.08
332	KER	058	057.412	FWY	OSWELL STREET	East	3	West	3	625851	-	615851	-	3	-	3	-	0.06	0.06
202	KER	099	020.200	FWY	BAKERSFIELD, PACHECO ROAD	North	4	South	4	619978	-	629976	-	3	-	3	-	0.19	0.15
601	KER	099	021.082	FWY	BAKERSFIELD,WHITE LANE	North	4	South	4	619979	-	629979	-	3	-	3	-	0.21	0.21
425	KER	099	023.514	FWY	JCT. RTE. 58 EAST	North	4	South	4	-	-	619982	-	-	-	4	-	-	0.31
426	KER	099	023.514	FWY	JCT. RTE. 58 EAST	North	4	South	4	-	-	619982	-	-	-	4	-	-	0.31
603	KER	099	024.599	FWY	BAKERSFIELD, CALIFORNIA AVENUE	North	4	South	4	629992	-	602358	-	4	-	4	-	0.01	0.49
170	KER	099	027.046	FWY	JCT RTE 204/AIRPORT DRIVE	North	5	South	5	629995	-	619985	-	4	-	4	-	0.02	0.02
904	KER	099	027.866	FWY	OLIVE DRIVE INTERCHANGE	North	4	South	4	601934	-	601260	-	3	-	4	-	0.33	0.07
664	KER	099	029.878	FWY	JCT. RTE. 65	North	3	South	3	601369	-	602369	-	3	-	3	-	0.01	0.01

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
90	KER	099	029.878	FWY	JCT. RTE. 65	North	3	South	3	601369	-	602369	-	3	-	3	-	0.01	0.01
663	KER	099	044.307	FWY	JCT. RTE. 46	North	3	South	3	601374	-	602374	-	3	-	3	-	0.01	0.00
602	KER	099	044.307	FWY	JCT. RTE. 46	North	3	South	3	601374	-	602374	-	3	-	3	-	0.01	0.00
690	KER	099	050.410	FWY	MC FARLAND, ELMO HIGHWAY INTERCHANGE	North	3	South	3	601106	-	602106	-	4	-	3	-	0.01	0.01
91	KER	099	052.450	FWY	POND ROAD	North	2	South	2	601379	-	602379	-	3	-	3	-	0.02	0.02
905	KER	099	055.521	FWY	DELANO, JCT. RTE. 155	North	3	South	3	601947	-	602947	-	3	-	3	-	0.20	0.20
906	TUL	099	000.000	FWY	KERN/TULARE COUNTY LINE (DELANO, NORTH CITY LIMITS)	North	2	South	2	601904	-	602904	-	2	-	2	-	0.36	0.36
428	TUL	099	003.055	FWY	RADNOR, AVENUE 24 INTERCHANGE	North	2	South	2	601381	-	602381	-	2	-	2	-	0.15	0.14
691	TUL	099	012.297	FWY	AVENUE 96/PARK DRIVE	North	2	South	2	601916	-	602916	-	2	-	2	-	0.19	0.19
429	TUL	099	013.330	FWY	AVENUE 104	North	2	South	2	601917	-	602917	-	2	-	2	-	0.26	0.26
632	TUL	099	023.489	FWY	AVENUE 184	North	2	South	2	601926	-	602926	-	2	-	2	-	0.09	0.09
670	TUL	099	025.433	FWY	AVENUE 200	North	2	South	2	601942	-	602942	-	2	-	2	-	0.40	0.40
684	TUL	099	025.433	FWY	AVENUE 200	North	2	South	2	601942	-	602942	-	2	-	2	-	0.40	0.40
672	TUL	099	027.600	FWY	PAIGE ROAD INTERCHANGE (AVENUE 216)	North	2	South	2	601927	-	602927	-	2	-	2	-	0.18	0.18
669	TUL	099	051.806	FWY	DODGE AVENUE	North	3	South	3	601367	-	602367	-	3	-	3	-	0.03	0.04
605	FRE	099	011.098	FWY	FOWLER, MERCED STREET	North	3	South	3	601901	-	602901	-	3	-	3	-	0.09	0.11

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
855	FRE	099	017.255	FWY	FRESNO, NORTH AVENUE	North	3	South	3	629952	-	619951	-	3	-	3	-	0.27	0.25
854	FRE	099	018.544	FWY	FRESNO, JENSEN AVENUE	North	4	South	5	619953	-	629953	-	3	-	3	-	0.24	0.24
982	FRE	099	021.857	FWY	JCT. RTE. 180	North	3	South	4	601432	-	602432	-	3	-	3	-	0.05	0.05
981	FRE	099	021.857	FWY	JCT. RTE. 180	North	3	South	3	601432	-	602432	-	3	-	3	-	0.05	0.05
638	FRE	099	026.554	FWY	ASHLAN AVENUE INTERCHANGE	North	3	South	3	601436	-	601268	-	3	-	3	-	0.41	0.09
636	FRE	099	028.102	FWY	SHAW AVENUE	North	3	South	3	601314	-	602314	-	3	-	3	-	0.10	0.10
633	FRE	099	030.988	FWY	HERNDON AVENUE	North	3	South	3	601313	-	602313	-	3	-	3	-	0.08	0.08
679	MAD	099	000.989	FWY	AVENUE 7 INTERCHANGE (RIPPERDAN AVENUE)	North	2	South	2	601311	-	602311	-	2	-	3	-	0.04	0.04
423	MAD	099	007.463	FWY	AVENUE 12 INTERCHANGE	North	2	South	2	601320	-	602320	-	2	-	2	-	0.11	0.11
618	MAD	099	010.268	FWY	MADERA, JCT. RTE. 145	North	2	South	2	601302	-	602302	-	2	-	2	-	0.04	0.04
614	MAD	099	010.268	FWY	MADERA, JCT. RTE. 145	North	2	South	2	601302	-	602302	-	2	-	2	-	0.04	0.04
607	MAD	099	012.752	FWY	MADERA, AVENUE 16	North	2	South	2	601306	-	602306	-	2	-	2	-	0.09	0.09
952	MAD	099	023.770	FWY	AVENUE 24 INTERCHANGE	North	2	South	2	601322	-	602322	-	2	-	2	-	0.22	0.20
92	MAD	099	026.576	FWY	JCT. RTE. 233 WEST	North	2	South	2	601323	-	602323	-	2	-	2	-	0.33	0.30
955	MAD	099	026.576	FWY	JCT. RTE. 233 WEST	North	2	South	2	601323	-	602323	-	2	-	2	-	0.33	0.30
152	MAD	152	001.070	EXP	COUNTY ROAD 4/LINCOLN ROAD	East	2	West	2	601325	-	602325	-	2	-	2	-	0.10	0.10

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
502	MAD	152	001.070	EXP	COUNTY ROAD 4/LINCOLN ROAD	East	2	West	2	601325	-	602325	-	2	-	2	-	0.10	0.10
693	FRE	168	000.993	FWY	MCKINLEY AVENUE	East	4	West	4	601229	-	601228	-	3	-	3	-	0.01	0.08
567	FRE	168	002.017	FWY	SHIELDS AVENUE	East	3	West	3	601226	-	601227	-	3	-	3	-	0.18	0.24
568	FRE	168	003.035	FWY	ASHLAN AVENUE	East	3	West	3	601223	-	603223	-	3	-	3	-	0.22	0.22
697	FRE	168	004.258	FWY	SHAW AVENUE	East	3	West	3	601231	-	601236	-	3	-	3	-	0.01	0.32
696	FRE	168	004.258	FWY	SHAW AVENUE	East	4	West	3	601231	-	601236	-	3	-	3	-	0.01	0.32
569	FRE	168	006.866	FWY	HERNDON AVENUE	East	4	West	3	601722	-	602722	-	2	-	2	-	0.06	0.06
699	FRE	168	008.042	FWY	FOWLER AVENUE	East	3	West	2	601258	-	601257	-	2	-	2	-	0.16	0.18
570	FRE	168	009.150	FWY	TEMPERANCE AVENUE	East	2	West	2	603243	-	601243	-	2	-	2	-	0.05	0.05
178	KER	178	007.687	EXP	MORNING DRIVE	East	2	West	2	601174	-	601173	-	2	-	2	-	0.20	0.11
309	KER	178	007.687	EXP	MORNING DRIVE	East	3	West	3	601174	-	601173	-	2	-	2	-	0.20	0.11
678	FRE	180	056.520	FWY	JCT RTE 99	East	3	West	3	601703	-	602703	-	2	-	3	-	0.04	0.04
704	FRE	180	057.069	FWY	BROADWAY STREET	East	4	West	4	601343	-	602343	-	4	-	4	-	0.02	0.04
705	FRE	180	057.843	FWY	FRESNO STREET	East	4	West	4	601204	-	601203	-	3	-	3	-	0.16	0.08
841	FRE	180	058.664	FWY	JCT. RTE. 41	East	2	West	3	601346	-	602346	-	3	-	3	-	0.32	0.32
706	FRE	180	062.893	FWY	CLOVIS AVENUE	East	3	West	4	603248	-	601249	-	3	-	3	-	0.14	0.04

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
707	FRE	180	066.023	FWY	TEMPERANCE AVE	East	2	West	2	601495	-	602495	-	2	-	2	-	0.11	0.06
36	KIN	198	008.897	FWY	JCT. RTE. 41	East	2	West	2	601501	-	602501	-	2	-	2	-	0.32	0.32
441	KIN	198	008.897	FWY	JCT. RTE. 41	East	4	West	3	601501	-	602501	-	2	-	2	-	0.32	0.32
198	KIN	198	016.910	EXP	12TH AVENUE INTERCHANGE	East	2	West	2	601504	-	602504	-	2	-	2	-	0.33	0.33
199	TUL	198	003.711	FWY	JCT. RTE. 99	East	3	West	3	601493	-	602493	-	2	-	2	-	0.40	0.40
29	TUL	198	003.711	FWY	JCT. RTE. 99	East	2	West	2	601493	-	602493	-	2	-	2	-	0.40	0.40
610	TUL	198	004.796	FWY	ALTA AVENUE; COUNTY ROAD 80	East	2	West	2	601564	-	602564	-	2	-	2	-	0.44	0.44
668	TUL	198	007.760	FWY	DEMAREE ROAD	East	3	West	3	601500	-	602500	-	3	-	3	-	0.50	0.50
133	TUL	198	008.753	FWY	VISALIA, JCT. RTE. 63 SOUTH	East	3	West	3	601521	-	602521	-	3	-	3	-	0.48	0.48

Table B-6: District 7 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
749	LA	2	017.778	FWY	AT ROUND TOP ROAD; WEST OF JCT. RTE. 134, VENTURA FREEWAY	East	5	West	5	767620	-	767621	-	4	-	4	-	0.22	0.22
243	LA	2	020.574	FWY	AT SHERER LANE; WEST OF JCT. RTE. 210, FOOTHILL FREEWAY	East	5	West	4	767597	-	767598	-	5	-	4	-	0.23	0.23
903	LA	2	021.900	FWY	WEST OF JCT. RTE. 210, FOOTHILL FREEWAY	East	5	West	4	767609	-	767610	-	5	-	4	-	0.40	0.40
475	LA	5	00.700	FWY	N/O ORANGE COUNTY LINE	North	4	South	3	716896	-	715898	-	4	-	3	-	0.01	0.01
52	LA	5	003.971	FWY	SILVER BOW POC; S/O NORWALK BL	North	3	South	3	718081	-	716908	-	3	-	3	-	0.25	0.31
722	LA	5	007.834	FWY	N/O JCT RTE 605; LEMORAN AVE	North	4	South	4	763985	-	763990	-	4	-	4	-	0.03	0.03
453	LA	5	012.00	FWY	NORTH OF WASHINGTON BOULEVARD	North	4	South	4	715938	-	718364	-	4	-	4	-	0.18	0.18
454	LA	5	013.880	FWY	NORTH OF JCT RTE 710	North	5	South	5	718086	-	715947	-	4	-	3	-	0.21	0.21
27	LA	5	015.329	FWY	ESPERANZA STREET	North	5	South	5	759576	-	759700	-	5	-	5	-	0.19	0.19
28	LA	5	017.800	FWY	FIRST STREET	North	6	South	6	-	-	716940	-	-	-	5	-	-	0.13
29	LA	5	019.200	FWY	N/O JCT RTE 10, @ NORTH MAIN ST	North	5	South	4	716942	-	716944	-	5	-	4	-	0.49	0.25
30	LA	5	021.300	FWY	NORTH OF JCT RTE 110	North	5	South	5	718371	-	718370	-	5	-	5	-	0.17	0.17

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
31	LA	5	023.965	FWY	LOS ANGELES, GRIFFITH PK POC	North		South		759591	-	716960	-	4	-	4	-	0.11	0.20
414	LA	5	025.500	FWY	S OF COLORADO BLVD EXTENSION	North	5	South	5	761599	-	718379	-	5	-	5	-	0.40	0.35
443	LA	5	027.00	FWY	N/O JCT RTE 134	North	5	South	5	761604	-	759747	-	4	-	5	-	0.12	0.20
32	LA	5	29.389	FWY	MAGNOLIA AVE OC (BURBANK)	North	5	South	5	716974	-	716977	-	4	-	4	-	0.12	0.29
754	LA	5	33.981	FWY	N/O SUNLAND BLVD; OLINDA ST	North	5	South	5	716994	-	716993	-	4	-	4	-	0.26	0.26
33	LA	5	036.900	FWY	N OF JCT RTE 170; BRANFORD ST	North	6	South	6	764156	775442	764151	775443	4	2	4	2	0.02	0.02
455	LA	5	043.00	FWY	S/O JCT RTE 210; N/O ROXFORD ST	North	7	South	7	759636	771155	-	-	5	1	-	-	0.25	-
751	LA	5	044.500	FWY	SOUTH OF JCT RTE 14	North	7	South	7	718404	771157	774344	774345	4	1	4	1	0.18	0.30
706	LA	5	046.550	FWY	N/O JCT RTE 14; WELDON CANYON	North	5	South	5	716007	-	759172	-	5	-	5	-	0.22	0.02
76	LA	5	052.00	FWY	NORTH OF MC BEAN PARKWAY	North	4	South	4	759654	-	772055	-	4	-	4	-	0.46	0.40
707	LA	5	055.480	FWY	SANTA CLARITA, NORTH JCT. RTE. 126, HENRY MAYO DRIVE INTERCHANGE	North	4	South	4	769054	-	769055	-	4	-	4	-	0.18	0.18
906	LA	5	056.602	FWY	HASLEY CANYON ROAD INTERCHANGE	North	5	South	4	759672	-	773630	-	4	-	4	-	0.16	0.10
442	LA	10	017.00	CON	E/O ALAMEDA ST; BEGIN BUSWAY	East	2	West	2	763458	-	-	-	5	-	-	-	0.16	-
456	LA	10	018.410	FWY	LOS ANGELES, JCT. RTE. 5, GOLDEN STATE FREEWAY INTERCHANGE	East	1	West	1	776906	762408	717049	762472	1	1	3	1	0.09	0.12

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
783	LA	10	019.714	FWY	BUSWAY; EAST LA CITY LIMITS	East	1	West	1	716075	762422	716076	762423	6	1	6	1	0.05	0.05
785	LA	10	024.309	FWY	BUSWAY; EAST OF GARFIELD AVE	East	2	West	2	717084	762492	716101	762491	4	2	4	2	0.01	0.00
43	LA	10	002.155	FWY	SANTA MONICA, JCT. RTE. 1, LINCOLN BOULEVARD INTERCHANGE	East		West		759257	-	759259	-	3	-	3	-	0.18	0.18
402	LA	10	003.890	FWY	W/O CNTINELA AV; DORCHESTER PUC	East	4	West	4	737257	-	737258	-	4	-	4	-	0.04	0.04
44	LA	10	005.454	FWY	LOS ANGELES, JCT. RTE. 405, SAN DIEGO FREEWAY INTERCHANGE	East		West		718410	-	718411	-	3	-	3	-	0.16	0.17
525	LA	10	006.745	FWY	E/O OVERLAND AVE; MOTOR AVENUE	East	5	West	4	717008	-	716032	-	5	-	4	-	0.01	0.01
215	LA	10	010.430	FWY	LOS ANGELES, LA BREA AVENUE INTERCHANGE	East		West		717028	-	773647	-	4	-	4	-	0.10	0.03
46	LA	10	010.710	FWY	EAST OF LA BREA AVENUE	East	5	West	5	716047	-	717029	-	4	-	4	-	0.01	0.01
460	LA	10	013.540	FWY	E/O NORMANDIE AVE; BUDLONG AVE	East	7	West	7	717042	-	716063	-	4	-	4	-	0.01	0.01
461	LA	10	015.800	FWY	LOS ANGELES, LOS ANGELES STREET INTERCHANGE	East	5	West	5	763453	-	769097	-	4	-	4	-	0.02	0.02
463	LA	10	017.350	FWY	LOS ANGELES, ALAMEDA STREET INTERCHANGE	East	5	West	5	737158	-	769118	-	5	-	5	-	0.05	0.22
752	LA	10	019.668	FWY	EAST LOS ANGELES CITY LIMITS	East	6	West	6	716075	762422	716076	762423	6	1	6	1	0.01	0.01
721	LA	10	024.315	FWY	EAST OF GARFIELD AVENUE	East	4	West	4	717084	762492	716101	762491	4	2	4	2	0.00	0.01
801	LA	10	027.500	FWY	E/O ROSEMEAD BLVD (RTE 164)	East	4	West	4	717136	768426	717135	762504	5	1	4	2	0.33	0.13

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
429	LA	10	030.300	FWY	EAST OF PECK ROAD	East	5	West	5	717155	768751	767329	768752	4	1	4	1	0.32	0.32
50	LA	10	031.540	FWY	BALDWIN PARK, BESS AVENUE/ FRAZIER STREET INTERCHANGE	East		West		768173	775553	717160	-	4	1	4	-	0.24	0.18
48	LA	10	034.282	FWY	E/O PUENTE AVE; CAMERON AVENUE	East	5	West	5	717179	-	717176	-	4	-	4	-	0.16	0.08
748	LA	10	037.720	FWY	EAST OF CITRUS STREET	East	5	West	5	717205	-	717207	-	4	-	4	-	0.13	0.20
173	LA	10	040.840	FWY	E/O VIA VERDE DR; W/O KELLOGG	East	5	West	4	763479	-	717226	-	5	-	4	-	0.25	0.49
705	LA	10	043.120	FWY	E OF JCT RTES 57/71	East	5	West	5	716181	768369	717238	768370	5	1	4	1	0.36	0.36
54	LA	10	047.110	FWY	WEST OF INDIAN HILL BOULEVARD	East	5	West	5	774729	774731	774728	774730	4	1	4	1	0.09	0.09
73	VEN	23	004.320	FWY	N OF JCT RTE 101; PAIGE LANE	North	5	South	3	771578	-	771577	-	4	-	4	-	0.10	0.10
51	VEN	23	010.780	FWY	TEMPORARY END MOORPARK FREEWAY	North	3	South	3	771431	-	771432	-	3	-	3	-	0.02	0.02
447	LA	47	002.100	CON	VINCENT THOMAS BR TOLL PLAZA	North	2	South	2	772421	-	772420	-	2	-	2	-	0.35	0.35
77	LA	57	003.167	FWY	DIAMOND BAR, PATHFINDER ROAD INTERCHANGE	North	5	South	5	769068	769069	763590	763588	4	1	4	1	0.12	0.17
97	LA	57	006.850	FWY	S OF JCT RTES 10 AND 71	North	5	South	5	774841	-	774842	-	5	-	5	-	0.05	0.05
763	LA	57	007.720	FWY	JCT RTES 10 & 71	North		South		774902	-	774901	-	3	-	3	-	0.20	0.20
416	LA	57	009.816	FWY	SAN DIMAS AVENUE	North	4	South	4	718356	-	763649	-	4	-	4	-	0.10	0.10

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
464	LA	60	00.281	FWY	BOYLE AVENUE OC	East	5	West	5	717262	-	764418	-	3	-	4	-	0.24	0.17
98	LA	60	002.220	FWY	EAST OF INDIANA ST; ROWAN AVE	East	6	West	6	717265	-	717266	-	5	-	5	-	0.17	0.17
99	LA	60	003.876	FWY	BELVEDERE PARK PEDESTRIAN OVERCROSSING	East	6	West	6	773274	-	773273	-	6	-	6	-	0.08	0.08
499	LA	60	007.774	FWY	MONTEBELLO, PARAMOUNT BOULEVARD INTERCHANGE	East	5	West	5	717285	-	717288	-	4	-	5	-	0.03	0.04
100	LA	60	010.600	FWY	WEST OF PECK ROAD	East	5	West	5	773330	-	773329	-	5	-	5	-	0.00	0.00
101	LA	60	012.200	FWY	E/O JCT RTE 605; W/O CROSSROADS PKY	East	7	West	5	716237	-	716238	-	6	-	5	-	0.10	0.10
112	LA	60	016.547	FWY	E/O HACIENDA BLVD; BARFORD POC	East	5	West	5	718123	774623	718124	774624	4	1	4	1	0.01	0.01
102	LA	60	020.920	FWY	E/O NOGALES ST; W/O FAIRWAY DR	East	5	West	5	773535	773536	773537	773538	4	1	4	1	0.08	0.08
657	LA	60	023.560	FWY	DIAMOND BAR, JCT. RTE. 57 SOUTH, ORANGE FREEWAY INTERCHANGE	East	7	West	7	774180	774182	774181	774183	4	1	4	1	0.14	0.14
607	LA	60	025.464	FWY	DIAMOND BAR, JCT. RTE. 57 NORTH, ORANGE FREEWAY INTERCHANGE	East	7	West	7	766661	766660	766788	766789	4	1	4	1	0.24	0.25
671	LA	60	029.392	FWY	POMONA, JCT. RTE. 71, CHINO VALLEY FREEWAY INTERCHANGE	East	7	West	7	766620	766619	766622	766621	4	1	4	1	0.12	0.12
105	LA	71	00.900	FWY	S OF JCT RTES 10/57	South	3	North	3	716271	-	767166	-	1	-	2	-	0.06	0.06
106	LA	71	001.622	EXP	POMONA, MISSION BOULEVARD	South	2	North	2	775100	-	775101	-	2	-	2	-	0.08	0.08
803	LA	71	004.310	FWY	POMONA, JCT. RTE. 60, POMONA FREEWAY INTERCHANGE	South	6	North	5	766685	-	-	-	2	-	-	-	0.42	-

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198	LA	90	002.080	FWY	WEST OF JCT. RTE. 405, INGLEWOOD BLVD.	East	4	West	4	774279	-	774278	-	3	-	3	-	0.34	0.34
125	LA	91	006.344	EXP	LOS ANGELES, JCT. RTE. 110, HARBOR FREEWAY INTERCHANGE	East		West		716273	-	764425	-	3	-	3	-	0.22	0.22
904	LA	91	007.426	FWY	CARSON, AVALON BOULEVARD INTERCHANGE	East	5	West	5	717369	-	717368	765594	4	-	4	1	0.12	0.12
537	LA	91	009.162	FWY	COMPTON, WILMINGTON AVENUE INTERCHANGE	East	5	West	5	717379	759996	717378	759981	4	1	4	1	0.05	0.06
103	LA	91	010.620	FWY	E/O ALAMEDA ST; SANTA FE AVE	East	7	West	7	717387	763602	717388	-	4	1	4	-	0.14	0.14
126	LA	91	013.348	FWY	E/O CHERRY; N LONG BEACH OH	East	6	West	6	717402	759967	717404	759984	4	1	5	1	0.09	0.16
127	LA	91	016.300	FWY	WEST OF JCT RTE 605	East	7	West	6	716312	768914	716311	767313	6	1	5	1	0.08	0.08
407	LA	91	017.570	FWY	E/O JCT RTE 605; GRIDLEY RD	East	6	West	6	766209	766210	766211	766212	5	1	3	1	0.20	0.20
431	LA	101	00.00	FWY	LOS ANGELES, JCT. RTE. 5, SANTA ANA FREEWAY, EAST LOS ANGELES INTERCHANGE	North	2	South	2	776425	-	773062	-	4	-	4	-	0.19	0.45
131	LA	101	00.907	FWY	LOS ANGELES, FIRST STREET INTERCHANGE	North	3	South	4	776752	-	776751	-	3	-	4	-	0.09	0.09
441	LA	101	00.460	FWY	NORTH OF VIGNES STREET	North	6	South	4	776480	-	773062	-	5	-	4	-	0.06	0.01
702	LA	101	002.068	FWY	LOS ANGELES, EDGEWARE ROAD	North	4	South	4	776136	-	716328	-	5	-	4	-	0.27	0.01
446	LA	101	005.200	FWY	S/O SANTA MONICA BLVD (RTE 2)	North	5	South	5	717460	-	717461	-	4	-	4	-	0.11	0.11
302	LA	101	010.800	FWY	SOUTH OF VINELAND AVENUE	North	5	South	4	716359	-	717489	-	5	-	5	-	0.27	0.27

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
135	LA	101	012.352	FWY	S/O LAUREL CYN BL; COLFAX AVE	North	5	South	5	717492	-	768477	-	5	-	3	-	0.37	0.37
335	LA	101	016.500	FWY	N/O VAN NUYS BL; S/O SEPULVEDA	North	5	South	5	769431	-	769430	-	6	-	6	-	0.10	0.10
136	LA	101	019.994	FWY	LOS ANGELES, ENCINO AVENUE PED OC	North	5	South	5	772596	-	717508	-	5	-	5	-	0.19	0.16
448	LA	101	024.500	FWY	N/O DE SOTO AVE; S/O CANOGA AVE	North	6	South	6	717519	-	717520	-	5	-	5	-	0.05	0.26
703	LA	101	027.600	FWY	SOUTH OF PARKWAY CALABASAS	North	4	South	4	772354	-	772355	-	4	-	4	-	0.00	0.00
203	LA	101	036.180	FWY	AGOURA HILLS, REYES ADOBE ROAD INTERCHANGE	North	5	South	5	759271	-	718150	-	4	-	4	-	0.10	0.11
901	LA	101	037.540	FWY	N/O LINDERO CANYON ROAD	North	5	South	5	765101	-	764622	-	4	-	4	-	0.06	0.04
119	VEN	101	003.107	FWY	THOUSAND OAKS, JCT. RTE. 23 NORTH, MOORPARK FREEWAY INTERCHANGE	North	4	South	5	764829	-	764824	-	4	-	4	-	0.06	0.05
457	VEN	101	007.500	FWY	N/O BORCHARD RD; S/O WENDY DR	North	4	South	4	764900	-	764905	-	3	-	3	-	0.27	0.20
909	VEN	101	007.885	FWY	THOUSAND OAKS, WENDY DRIVE INTERCHANGE	North	3	South	0	764910	-	764905	-	3	-	3	-	0.02	0.19
908	VEN	101	012.298	FWY	CAMARILLO, PLEASANT VALLEY ROAD INTERCHANGE	North	0	South	3	764932	-	764937	-	3	-	3	-	0.03	0.02
147	VEN	101	020.200	FWY	NORTH OF SANTA CLARA AVENUE	North	3	South	3	775365	-	775314	-	4	-	3	-	0.05	0.17
758	VEN	101	040.030	FWY	NORTH OF SEACLIFF DRIVE	North	3	South	3	-	776631	776628	776630	-	1	2	1	-	0.36
500	LA	105	00.500	FWY	LOS ANGELES, JCT. RTE. 1, SEPULVEDA BOULEVARD INTERCHANGE	East	4	West	5	760046	-	716402	-	3	-	3	-	0.40	0.10

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502	LA	105	002.600	FWY	E/O JCT RTE 405	East	6	West	5	767838	767839	716409	763710	3	1	3	1	0.10	0.00
504	LA	105	004.750	FWY	E/O CRENSHAW BLVD	East	5	West	5	760101	760100	760452	760454	3	1	3	1	0.15	0.05
506	LA	105	007.200	FWY	W/O JCT RTE 110; E/O VERMONT	East	5	West	5	774614	774615	716426	760490	3	1	4	1	0.00	0.10
508	LA	105	008.450	FWY	E/O JCT RTE 110; W/O STANFORD	East	5	West	5	716433	760178	716434	760505	4	1	4	1	0.05	0.05
510	LA	105	011.00	FWY	E/O WILMINGTON BL; W/O STATE ST	East	4	West	4	716442	760213	716443	763716	3	1	3	1	0.10	0.10
512	LA	105	012.600	FWY	W/O JCT RTE 710; E/O HARRIS AVE	East	5	West	5	716449	760242	716450	760550	4	1	4	1	0.00	0.00
514	LA	105	014.370	FWY	E/O JCT RTE 710; FACADE AVENUE	East	5	West	5	716456	760279	716457	760580	5	1	5	1	0.03	0.03
516	LA	105	015.600	FWY	W/O LAKEWOOD BLVD	East	5	West	5	760301	760303	760398	760395	3	1	3	1	0.00	0.00
518	LA	105	017.00	FWY	E/O BELLFLOWER BL; W/O RTE 605	East	5	West	6	760330	760329	760369	760333	3	1	4	1	0.20	0.20
246	LA	105	017.823	FWY	NORWALK, JCT. RTE. 605, SAN GABRIEL RIVER FREEWAY INTERCHANGE	East	2	West	2	760349	-	760358	-	2	-	2	-	0.31	0.08
520	LA	105	018.100	EXP	W/O STUDEBAKER RD; END FREEWAY	East	3	West	3	760349	-	760361	-	2	-	2	-	0.03	0.03
715	LA	110	002.771	FWY	LOS ANGELES, C STREET INTERCHANGE	North	4	South	4	763502	-	775774	-	4	-	4	-	0.07	0.12
57	LA	110	004.630	FWY	N OF PACIFIC COAST HIGHWAY	North	4	South	4	763512	-	-	-	4	-	-	-	0.46	-
809	LA	110	012.898	FWY	LOS ANGELES, EL SEGUNDO BOULEVARD INTERCHANGE	North	6	South	6	763367	-	763309	-	4	-	4	-	0.04	0.14

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
487	LA	110	016.500	FWY	N/O MANCHESTER; S/O FLORENCE	North	7	South	7	763400	763280	763275	763272	4	2	4	2	0.48	0.08
708	LA	110	020.720	FWY	S OF JCT RTE 10; ADAMS BLVD	North	5	South	5	764032	-	764037	-	5	-	5	-	0.12	0.12
479	LA	110	021.444	FWY	LOS ANGELES, JCT. RTE. 10, SANTA MONICA FREEWAY INTERCHANGE	North	5	South	5	718165	-	718166	-	3	-	3	-	0.08	0.08
450	LA	110	023.500	FWY	SOUTH OF JCT RTE 101	North	7	South	7	772501	-	775610	-	5	-	3	-	0.30	0.30
59	LA	110	023.964	FWY	ALPINE STREET; N/O JCT. RTE. 101	North	3	South	3	718046	-	775610	-	3	-	3	-	0.50	0.16
60	LA	110	026.500	FWY	PASADENA AVENUE; N/O JCT RTE 5	North	3	South	3	773013	-	773012	-	3	-	3	-	0.50	0.50
360	LA	110	029.500	FWY	LOS ANGELES, YORK BOULEVARD INTERCHANGE	North	3	South	3	767760	-	767759	-	3	-	3	-	0.00	0.00
458	VEN	118	018.500	FWY	W/O PRINCETON AVE/LA AVE	East	2	West	2	-	-	717554	-	-	-	2	-	-	0.50
303	VEN	118	021.863	FWY	WEST OF LOS ALAMOS CANYON RD	East	2	West	2	772125	-	772126	-	2	-	2	-	0.36	0.36
459	VEN	118	023.600	FWY	E/O MADERA RD; W/O FIRST	East	3	West	3	760801	-	760971	-	3	-	3	-	0.18	0.02
782	VEN	118	027.811	FWY	TAPO STREET	East	4	West	4	764185	-	764189	-	4	-	4	-	0.00	0.00
444	LA	118	001.190	FWY	LOS ANGELES/VENTURA COUNTY LINE	East	5	West	5	765920	765921	765922	765923	4	1	4	1	0.09	0.09
152	LA	118	001.799	FWY	LOS ANGELES, JCT. RTE. 27, TOPANGA CANYON BOULEVARD INTERCHANGE	East		West		717525	717526	760828	760827	4	1	4	1	0.15	0.09
480	LA	118	005.195	FWY	E/O TAMPA AVE; WILBUR AVE POC	East	5	West	5	765958	765959	765960	765961	4	1	5	1	0.00	0.00

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767	LA	118	009.100	FWY	EAST OF WOODLEY AVENUE	East	6	West	6	717547	716541	717546	760677	5	1	5	1	0.17	0.17
422	LA	118	010.800	FWY	EAST OF JCT RTE 405; FOX ST	East	7	West	7	771690	771692	771691	771693	6	1	6	1	0.00	0.00
167	LA	134	001.359	FWY	FORMAN AVENUE	East	5	West	5	717570	760975	717571	-	4	1	4	-	0.41	0.41
168	LA	134	005.667	FWY	LOS ANGELES, JCT. RTE. 5, GOLDEN STATE FREEWAY INTERCHANGE	East	5	West	5	773927	761005	774067	-	4	1	3	-	0.03	0.28
731	LA	134	007.127	FWY	GLENDALE, BRAND BOULEVARD INTERCHANGE	East	5	West	5	717583	761014	717582	761041	4	1	4	1	0.28	0.42
756	LA	134	010.300	FWY	EAGLE ROCK; EAST OF JCT RTE 2	East	5	West	5	774011	774013	774012	774014	4	1	4	1	0.36	0.36
540	LA	134	012.090	FWY	W/O SAN RAFAEL AV; E/O FIGUEROA	East	5	West	5	717601	763608	717599	763610	4	1	4	1	0.36	0.18
182	LA	170	015.700	FWY	N OF MAGNOLIA BL; CHANDLER OH	North		South		764106	765608	717608	717609	4	1	4	1	0.26	0.26
541	LA	170	017.620	FWY	S/O SHERMAN WAY; VAN OWEN ST	North	5	South	5	764115	765612	761070	761076	4	1	4	1	0.46	0.32
183	LA	170	019.721	FWY	LOS ANGELES, ROSCOE BOULEVARD INTERCHANGE	North		South		763995	765616	716573	761085	3	1	3	1	0.10	0.08
641	LA	170	020.400	FWY	SOUTH OF JCT RTE 5	North	3	South	3	764430	765618	717614	-	2	1	3	-	0.13	0.13
527	LA	210	003.570	FWY	E/O POLK ST; ASTORIA ST PED OC	East	3	West	3	770012	-	770229	-	3	-	3	-	0.17	0.07
199	LA	210	004.936	FWY	LOS ANGELES, MACLAY STREET INTERCHANGE	East		West		770036	-	770243	-	3	-	3	-	0.16	0.24
781	LA	210	007.194	FWY	TERRA BELLA STREET	East	4	West	4	770544	-	770545	-	4	-	4	-	0.00	0.00

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544	LA	210	017.700	FWY	E/O LA CRESCENTA; ROSEMONT AVE	East	5	West	6	769866	-	769926	-	4	-	6	-	0.30	0.20
252	LA	210	018.872	FWY	LA CANADA-FLINTRIDGE, WEST JCT. RTE. 2, GLENDALE FREEWAY INTERCHANGE	East	5	West	5	770385	-	770386	-	4	-	4	-	0.23	0.23
759	LA	210	023.547	FWY	W/O JR 134/170; WASHINGTON BL	East	5	West	5	717620	-	770568	-	4	-	4	-	0.39	0.26
445	LA	210	026.500	FWY	EAST OF LAKE AVENUE	East	7	West	7	717635	761098	717637	761322	5	1	5	1	0.01	0.32
156	LA	210	027.409	FWY	PASADENA, ALLEN AVENUE INTERCHANGE	East		West		717640	761105	-	-	5	1	-	-	0.24	-
760	LA	210	030.450	FWY	E/O ROSEMEAD BLVD (RTE 164)	East	6	West	6	773154	773155	717663	761329	5	1	4	1	0.05	0.04
810	LA	210	031.460	FWY	SANTA ANITA AVE UC (ARCADIA)	East		West		-	-	717669	717670	-	-	4	1	-	0.27
529	LA	210	032.420	FWY	E/O SANTA ANITA AVENUE UC	East		West		773193	773195	773194	773196	4	1	5	1	0.08	0.08
194	LA	210	035.244	FWY	DUARTE, BUENA VISTA STREET INTERCHANGE	East	6	West	6	761177	761174	761374	761371	5	1	4	1	0.12	0.12
204	LA	210	037.00	FWY	EAST OF JCT. RTE. 605	East	6	West	6	772857	772859	772858	772860	5	1	5	1	0.10	0.10
905	LA	210	041.594	FWY	GLENDORA, GRAND AVENUE INTERCHANGE	East	5	West	5	717692	761242	717688	717689	4	1	4	1	0.10	0.09
761	LA	210	042.661	FWY	BONNIE COVE AVENUE	East	5	West	5	772953	772955	772954	772956	4	1	4	1	0.06	0.06
128	LA	210	046.207	FWY	SAN DIMAS CANYON ROAD	East	3	West	4	-	-	769136	769137	-	-	3	1	-	0.25

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495	LA	210	051.849	FWY	CLAREMONT, BASELINE ROAD INTERCHANGE	East	5	West	4	768041	768040	768055	768054	4	1	3	1	0.00	0.09
895	LA	210	052.148	FWY	BASELINE ROAD	East	5	West	4	768041	768040	768055	768054	4	1	3	1	0.30	0.21
210	LA	405	00.400	FWY	NORTH OF STUDEBAKER ROAD	North	5	South	6	717696	762517	717697	762518	4	1	4	1	0.20	0.20
465	LA	405	003.820	FWY	N/O LAKEWOOD BL; REDONDO AVE	North	6	South	6	716632	764661	717710	764663	5	1	5	1	0.00	0.00
211	LA	405	006.810	FWY	S/O JCT RTE 710; N/O PACIFIC AV	North	7	South	6	771863	771865	771864	771866	6	1	5	1	0.03	0.03
600	LA	405	008.200	FWY	N/O JCT. RTE. 710	North	6	South	6	717727	762538	718247	762594	4	1	4	1	0.18	0.15
212	LA	405	011.900	FWY	S/O JCT RTE 110; CARSON SCALES	North	6	South	6	716659	764659	766493	766494	5	1	5	1	0.08	0.08
910	LA	405	012.00	FWY	MAINLINE WIM @ CARSON SCALES	North	6	South	6	766505	766506	716660	764657	5	1	5	1	0.05	0.05
213	LA	405	014.920	FWY	N/O WESTERN AVE; VAN NESS AVE	North	5	South	5	716670	761439	717746	761440	4	1	4	1	0.04	0.04
228	LA	405	017.589	FWY	LAWNDALE, HAWTHORNE BOULEVARD INTERCHANGE	North		South		717755	717756	718275	718276	4	1	4	1	0.07	0.05
551	LA	405	018.629	FWY	N/O INGLEWOOD AVE; MARINE AVE	North	5	South	5	717760	717761	718277	718278	4	1	4	1	0.28	0.33
739	LA	405	024.273	FWY	LOS ANGELES, LA TIJERA BOULEVARD/HOWARD HUGHES PARKWAY INTERCHANGE	North	4	South	5	717779	769265	718287	769238	4	1	4	1	0.02	0.02
490	LA	405	025.274	FWY	S/O JCT RTE 90; @ CENTINELA AVE	North	7	South	6	718291	769242	718290	769241	5	1	5	1	0.14	0.14
545	LA	405	028.300	FWY	NORTH OF VENICE BOULEVARD	North	7	South	7	772437	772439	772438	772440	6	1	6	1	0.20	0.20

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216	LA	405	030.500	FWY	N/O OLYMPIC BL; S/O JCT RTE 2	North	6	South	5	716720	775170	716719	775169	6	1	5	1	0.03	0.03
410	LA	405	035.810	FWY	S/O MULLHOLLAND; BEL AIR CREST	North	5	South	5	716733	775193	718314	766954	5	1	4	1	0.01	0.01
412	LA	405	037.026	FWY	LOS ANGELES, MULHOLLAND DRIVE INTERCHANGE	North	5	South	5	717806	775205	718315	766952	5	1	4	1	0.10	0.48
730	LA	405	040.600	FWY	LOS ANGELES, BURBANK BOULEVARD	North	5	South	5	717818	762565	767350	767352	4	1	4	1	0.27	0.30
902	LA	405	042.900	FWY	N/O SHERMAN WAY; SATICOY ST	North	5	South	5	767367	767369	767366	767368	4	1	4	1	0.30	0.30
217	LA	405	044.270	FWY	N/O ROSCOE BLVD; PARTHENIA ST	North	6	South	5	717825	762571	717826	762604	4	1	4	1	0.40	0.39
218	LA	405	047.600	FWY	N/O JCT RTE 118;S/O RINALDI ST	North	4	South	4	772011	772012	771997	771998	3	1	4	1	0.34	0.01
220	LA	605	002.310	FWY	N/O CARSON ST; CENTRALIA RD	North	5	South	5	716760	766512	717842	766530	4	1	4	1	0.03	0.03
221	LA	605	005.580	FWY	N/O JCT RTE 91; S/O ALONDRA BL	North	6	South	6	717857	762653	716778	762652	6	1	6	1	0.15	0.15
485	LA	605	008.900	FWY	SOUTH OF JCT RTE 5	North	6	South	5	717875	717876	717877	762667	5	1	4	1	0.40	0.26
222	LA	605	011.00	FWY	N/O TELEGRAPH RD; S/O SLAUSON	North	5	South	5	716800	762619	717885	762620	4	1	4	1	0.09	0.09
660	LA	605	016.100	FWY	S/O PECK RD; N/O ROSE HILLS RD	North	5	South	5	717929	762634	717930	763475	4	1	4	1	0.44	0.44
240	LA	605	021.620	FWY	NORTH OF RAMONA BOULEVARD	North		South		773774	-	773773	-	4	-	4	-	0.02	0.02
547	LA	605	022.920	FWY	SAN GABRIEL RIVER BRIDGE	North	4	South	4	773785	-	773784	-	4	-	4	-	0.22	0.22

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37	LA	710	007.600	FWY	N OF JCT. RTE. 1; PAC COAST HWY	North	3	South	3	774411	-	774389	-	3	-	3	-	0.41	0.41
421	LA	710	011.500	FWY	NORTH OF DEL AMO BOULEVARD	North	5	South	4	717962	-	717963	-	4	-	4	-	0.50	0.39
39	LA	710	014.400	FWY	NORTH OF ALONDRA BL; COMPTON BL	North	6	South	6	718488	-	761851	-	6	-	6	-	0.02	0.02
40	LA	710	019.100	FWY	N/O FIRESTONE BOULEVARD	North	4	South	4	776266	-	776295	-	4	-	4	-	0.40	0.40
41	LA	710	023.280	FWY	SOUTH OF JCT. RTE. 5	North	5	South	5	763468	-	716891	-	3	-	3	-	0.12	0.12
435	LA	710	023.750	FWY	SOUTH OF JCT RTE 60	North	5	South	5	768978	-	716875	-	5	-	4	-	0.04	0.04
42	LA	710	025.212	FWY	N/O FLORAL DRIVE	North	4	South	3	776242	-	718018	-	4	-	3	-	0.09	0.32

Table B-7: District 8 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
842	SBD	010	003.468	FWY	UPLAND, JCT. RTE. 83	East	4	West	4	801250	806579	801247	806581	1	1	4	1	0.13	0.14
102	SBD	010	009.176	FWY	ONTARIO, MILLIKEN AVENUE	East	5	West	5	817213	-	817198	-	5	-	5	-	0.05	0.19
707	SBD	010	009.936	FWY	ONTARIO, JCT. RTE. 15	East	4	West	4	818158	-	818157	-	4	-	4	-	0.26	0.26
824	SBD	010	013.169	FWY	FONTANA, CHERRY AVENUE	East	5	West	4	825534	-	825549	-	4	-	4	-	0.13	0.06
858	SBD	010	024.240	FWY	COLTON, JCT. RTE. 215	East	5	West	5	816966	-	816967	-	4	-	4	-	0.01	0.01
705	SBD	010	024.240	FWY	COLTON, JCT. RTE. 215	East	4	West	4	816966	-	816967	-	4	-	4	-	0.01	0.01
843	SBD	010	029.313	FWY	ALABAMA STREET OC	East	5	West	5	822504	-	816364	-	4	-	4	-	0.15	0.15
150	SBD	010	031.405	FWY	CHURCH STREET	East	3	West	3	820849	-	818199	-	3	-	3	-	0.29	0.29
862	RIV	010	003.048	FWY	CHERRY VALLEY BOULEVARD	East	3	West	3	819059	-	819058	-	3	-	3	-	0.01	0.01
103	RIV	010	011.962	FWY	22ND STREET	East	4	West	4	822607	-	822608	-	4	-	4	-	0.04	0.04
808	RIV	010	019.400	FWY	MAIN STREET	East	4	West	4	821344	-	821345	-	4	-	4	-	0.00	0.00
871	RIV	010	052.342	FWY	JEFFERSON STREE/INDIO BOULEVARD	East	3	West	3	827560	-	827600	-	3	-	3	-	0.13	0.01
873	RIV	010	058.916	FWY	COACHELLA, DILLON ROAD	East	2	West	2	821461	-	826277	-	2	-	2	-	0.02	0.02
908	RIV	010	149.150	FWY	JCT. RTE. 78 SOUTH	East	2	West	2	822877	-	822878	-	2	-	2	-	0.35	0.35

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720	RIV	015	004.980	FWY	RANCHO CALIFORNIA ROAD INTERCHANGE	North	4	South	4	817039	-	817040	-	4	-	4	-	0.12	0.12
901	RIV	015	008.737	FWY	JCT. RTE. 215 NORTH	North	5	South	5	817087	-	817081	-	4	-	4	-	0.34	0.34
807	RIV	015	008.737	FWY	JCT. RTE. 215 NORTH	North	3	South	3	817087	-	817081	-	4	-	4	-	0.34	0.34
622	RIV	015	020.962	FWY	NORTH OF MAIN STREET	North	4	South	4	817386	-	817387	-	3	-	3	-	0.14	0.14
849	RIV	015	038.693	FWY	CORONA, ONTARIO AVENUE	North	4	South	4	827299	-	827296	-	4	-	4	-	0.13	0.13
155	RIV	015	041.501	FWY	JCT. RTE. 91	North	4	South	4	806224	-	826074	-	3	-	5	-	0.04	0.04
156	RIV	015	044.662	FWY	NORCO, 4TH STREET	North	3	South	3	801335	-	826055	-	3	-	3	-	0.03	0.03
711	RIV	015	047.140	FWY	SOUTH OF LIMONITE AVENUE	North	3	South	3	807804	-	826139	-	3	-	3	-	0.29	0.29
161	RIV	015	050.130	FWY	CANTU-JALLEANO RANCH OC	North	3	South	4	815347	-	815332	-	3	-	3	-	0.02	0.03
708	SBD	015	001.015	FWY	ONTARIO, JURUPA AVENUE	North	5	South	4	805628	-	805627	-	4	-	4	-	0.05	0.05
605	SBD	015	005.973	FWY	RANCHO CUCAMONGA, MILLER AVENUE	North	4	South	4	808292	-	808293	-	4	-	4	-	0.03	0.03
709	SBD	015	006.783	FWY	RANCHO CUCAMONGA, BASE LINE AVENUE	North	4	South	4	827241	-	826496	-	4	-	4	-	0.28	0.00
625	SBD	015	011.033	FWY	DUNCAN CANYON ROAD	North	4	South	4	826013	-	826010	-	4	-	4	-	0.11	0.11
627	SBD	015	015.650	FWY	GLEN HELEN PARKWAY	North	6	South	5	827211	-	827210	-	7	-	6	-	0.10	0.10
630	SBD	015	021.373	FWY	JCT. RTE. 138	North	4	South	4	821735	-	821736	-	5	-	4	-	0.13	0.13
900	SBD	015	032.323	FWY	JOSHUA STREET/PALM AVENUE	North	3	South	3	821780	-	821781	-	3	-	3	-	0.28	0.28

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
801	SBD	015	040.509	FWY	JCT. RTE. 18 SOUTH	North	3	South	3	821196	-	821197	-	3	-	3	-	0.41	0.41
315	SBD	015	040.509	FWY	JCT. RTE. 18 SOUTH	North	3	South	3	821196	-	821197	-	3	-	3	-	0.41	0.41
366	SBD	015	042.025	FWY	VICTORVILLE, MOJAVE DRIVE INTERCHANGE	North	3	South	4	821207	-	821208	-	4	-	4	-	0.42	0.42
907	SBD	015	138.456	FWY	EAST BAKER	North	3	South	2	822088	-	822089	-	2	-	3	-	0.16	0.16
981	SBD	060	00.00	FWY	LOS ANGELES/SAN BERNARDINO COUNTY LINE	East	4	West	4	809912	809925	825668	825667	4	1	4	1	0.38	0.38
956	SBD	060	004.130	FWY	JCT RTE 83	East		West		809968	809969	826166	826165	4	1	4	1	0.14	0.14
877	SBD	060	007.873	FWY	ARCHIBALD AVENUE INTERCHANGE	East	5	West	5	801374	820110	801373	820097	4	1	4	1	0.14	0.14
600	SBD	060	008.906	FWY	HAVEN AVENUE	East	5	West	5	820001	820000	801383	806370	4	1	4	1	0.11	0.14
602	RIV	060	00.491	FWY	JCT. RTE. 15	East	3	West	3	801390	806388	801391	820105	4	1	4	1	0.23	0.23
760	RIV	060	005.575	FWY	PYRITE STREET INTERCHANGE	East	5	West	5	821547	823448	821546	823447	4	1	4	1	0.08	0.08
895	RIV	060	011.732	FWY	RIVERSIDE, MAIN STREET INTERCHANGE	East		West		817553	821111	820851	820850	3	1	3	1	0.08	0.13
859	RIV	060	012.064	FWY	RIVERSIDE, JCT. RTES. 215/91	East	2	West	2	817553	821111	820851	820850	3	1	3	1	0.25	0.46
804	RIV	060	012.212	FWY	EAST JCT. RTE. 215	East	2	West	2	817553	821111	-	-	3	1	-	-	0.40	-
710	RIV	060	021.370	FWY	THEODORE STREET	East	2	West	2	820712	-	820713	-	2	-	2	-	0.03	0.03
892	SBD	071	00.00	FWY	LOS ANGELES/SAN BERNARDINO COUNTY LINE	South	6	North	5	812586	817586	-	-	4	1	-	-	0.38	-
933	SBD	071	004.886	FWY	SOQUEL CANYON	South	3	North	3	812788	812789	812800	812801	3	1	3	1	0.00	0.01

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
881	SBD	071	006.520	FWY	PINE AVE OC	South	3	North	3	825109	825108	812821	812822	2	1	2	1	0.17	0.17
931	SBD	071	007.983	FWY	JCT. RTE. 83 NORTH	South	3	North	3	812690	814860	812704	812705	2	1	2	1	0.03	0.04
938	SBD	071	007.983	FWY	JCT. RTE. 83 NORTH	South	4	North	2	812690	814860	812704	812705	2	1	2	1	0.03	0.04
800	RIV	091	006.360	FWY	CORONA, MAIN STREET	East	5	West	5	820549	826680	820559	826679	6	2	4	2	0.09	0.10
793	RIV	091	009.180	FWY	MC KINLEY STREET	East	5	West	5	806674	806676	801490	801491	4	1	3	1	0.03	0.09
812	RIV	091	011.991	FWY	RIVERSIDE, LA SIERRA AVENUE	East	4	West	4	820356	820355	801505	807270	3	1	3	1	0.06	0.11
791	RIV	091	017.426	FWY	MARY STREET	East	4	West	4	801541	807365	801543	826362	3	1	3	1	0.15	0.30
200	SBD	210	00.00	FWY	LOS ANGELES/SAN BERNARDINO COUNTY LINE	East	5	West	4	809294	809293	826061	826060	3	1	3	1	0.10	0.10
201	SBD	210	001.497	FWY	MOUNTAIN AVENUE	East	5	West	4	819613	819614	809322	809320	5	1	3	1	0.10	0.10
202	SBD	210	011.498	FWY	JCT RTE 15	East	5	West	4	825929	825953	810266	825952	3	1	4	1	0.20	0.20
204	SBD	210	011.498	FWY	JCT RTE 15	East	5	West	5	825929	825953	810266	825952	3	1	4	1	0.20	0.20
304	SBD	210	017.437	FWY	AYALA DRIVE	East	4	West	4	819142	819141	814027	814028	3	1	3	1	0.19	0.19
306	SBD	210	023.136	FWY	WB OFF TO H ST	East	3	West	3	819685	-	813995	-	4	-	3	-	0.42	0.14
210	SBD	210	023.588	FWY	ARROWHEAD OVERCROSSING	East	4	West	4	819685	-	819684	-	4	-	4	-	0.03	0.03
706	SBD	210	025.718	FWY	DEL ROSA AVENUE	East	2	West	2	821645	-	821646	-	3	-	3	-	0.02	0.02
211	SBD	210	026.729	FWY	HIGHLAND AVENUE	East	3	West	3	821652	-	821653	-	2	-	2	-	0.23	0.23

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
757	SBD	210	031.700	FWY	E/O SANTA ANA RIVER BRIDGE	East	2	West	2	819716	-	819717	-	2	-	2	-	0.30	0.30
902	RIV	215	009.507	FWY	MURRIETA HOT SPRINGS ROAD	North	2	South	2	822400	-	822391	-	3	-	2	-	0.09	0.00
827	RIV	215	026.308	FWY	PERRIS, NORTH JCT. RTE. 74	North	2	South	2	826465	-	826464	-	3	-	3	-	0.18	0.18
214	RIV	215	030.933	FWY	RAMONA EXPRESSWAY	North	2	South	2	818602	-	818601	-	3	-	3	-	0.13	0.13
215	RIV	215	035.760	FWY	CACTUS AVENUE	North	2	South	2	819081	-	-	-	3	-	-	-	0.14	-
701	RIV	215	038.339	FWY	JCT. RTE. 60 EAST	North	4	South	4	818224	816134	818225	819956	3	1	3	1	0.06	0.06
803	RIV	215	038.339	FWY	JCT. RTE. 60 EAST	North	3	South	3	818224	816134	818225	819956	3	1	3	1	0.06	0.06
230	RIV	215	042.163	FWY	RIVERSIDE, 3RD/ BLAINE STREETS INTERCHANGE	North	6	South	7	801589	816004	816009	816010	4	1	4	1	0.08	0.02
232	RIV	215	043.900	FWY	RIVERSIDE, COLUMBIA AVENUE INTERCHANGE	North	5	South	5	801595	825715	825749	825748	3	1	3	1	0.07	0.05
839	SBD	215	008.083	FWY	SAN BERNARDINO, BASELINE STREET	North	3	South	3	824306	824305	824303	824302	5	1	4	1	0.11	0.11
905	SBD	215	011.634	FWY	UNIVERSITY PARKWAY	North	2	South	2	818610	-	818611	-	2	-	2	-	0.17	0.17
606	SBD	215	014.104	FWY	SAN BERNARDINO, JCT RTE 206	North	2	South	2	818614	-	818615	-	2	-	2	-	0.10	0.10
822	SBD	215	017.323	FWY	DEVORE ROAD	North	2	South	2	827133	-	827131	-	4	-	3	-	0.19	0.19

Table B-8: District 10 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
45	TUO	049	016.480	CON	SONORA, EAST JCT. RTE. 108	North	2	South	2	10126110	-	10126010	-	2	-	1	-	0.19	0.19
17	TUO	049	016.480	CON	SONORA, EAST JCT. RTE. 108	North	2	South	2	10126110	-	10126010	-	2	-	1	-	0.19	0.19
337	AMA	088	038.170	CON	FIDDLETOWN, SILVER LAKE ROAD (SHAKE RIDGE RD)	East	2	West	1	10119310	-	10119410	-	2	-	1	-	0.01	0.01
148	ALP	088	019.223	EXP	WOODFORDS, EAST JCT. RTE. 89	East	2	West	1	10129810	-	10129910	-	1	-	1	-	0.01	0.01
77	ALP	088	019.223	EXP	WOODFORDS, EAST JCT. RTE. 89	East	2	West	1	10129810	-	10129910	-	1	-	1	-	0.01	0.01
20	MER	099	012.690	FWY	GERARD AVENUE	North	2	South	2	1016810	-	1016910	-	3	-	3	-	0.21	0.21
263	MER	099	015.799	FWY	MERCED, JCT. RTE. 140 WEST; JCT. RTE. 59 NORTH	North	2	South	2	1035510	-	1038210	-	2	-	2	-	0.24	0.13
49	MER	099	032.310	FWY	HIGHLINE CANAL	North	2	South	2	1036910	-	1039610	-	2	-	2	-	0.01	0.07
320	MER	099	034.429	FWY	SHANKS ROAD	North	3	South	2	1037210	-	1040010	-	2	-	2	-	0.20	0.26
318	STA	099	001.626	FWY	JCT. RTE. 165 SOUTH, LANDER AVENUE	North		South		10134110	-	10134410	-	3	-	3	-	0.07	0.12
57	STA	099	007.811	FWY	KEYES ROAD	North	3	South	3	10136210	-	10136410	-	3	-	3	-	0.24	0.24
349	STA	099	008.693	FWY	FAITH HOME ROAD (KEYES WIM)	North	3	South	3	1011410	-	1011210	-	3	-	3	-	0.10	0.00
309	STA	099	013.263	FWY	MODESTO, HATCH ROAD/9TH STREET	North	3	South	4	1047710	-	1047810	-	3	-	3	-	0.32	0.32
222	STA	099	016.121	FWY	MODESTO, JCT. RTE. 132	North	3	South	3	10139710	-	10139510	-	3	-	3	-	0.05	0.05

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
5	SJ	099	002.374	FWY	JACKTONE ROAD	North	3	South	3	1060210	-	1076610	-	3	-	3	-	0.13	0.02
4	SJ	099	002.374	FWY	JACKTONE ROAD	North	3	South	3	1060210	-	1076610	-	3	-	3	-	0.13	0.02
81	SJ	099	004.893	FWY	AUSTIN ROAD	North	3	South	3	1060510	-	1031010	-	3	-	3	-	0.08	0.15
6	SJ	099	006.654	FWY	MANTECA, NORTH JCT. RTE. 120	North	2	South	2	1097510	-	1097710	-	3	-	3	-	0.10	0.10
19	SJ	099	012.526	FWY	LITTLE JOHN CREEK	North	3	South	3	1099110	-	1099010	-	3	-	3	-	0.09	0.09
95	SJ	099	018.683	FWY	JCT. RTE. 4 WEST	North	3	South	3	10129410	-	10129510	-	3	-	3	-	0.02	0.02
96	SJ	099	018.683	FWY	JCT. RTE. 4 WEST	North	3	South	3	10129410	-	10129510	-	3	-	3	-	0.02	0.02
282	SJ	099	019.290	FWY	JCT. RTE. 26 EAST	North	2	South	2	10107010	-	10114810	-	3	-	3	-	0.11	0.07
115	SJ	099	021.674	FWY	WILSON WAY	North	3	South	3	1018410	-	1019310	-	3	-	3	-	0.06	0.06
265	SJ	099	022.922	FWY	HAMMER LANE	North	3	South	3	1018910	-	10111510	10130210	3	-	3	1	0.08	0.08
18	SJ	099	029.499	FWY	LODI, JCT. RTE. 12 WEST	North	3	South	2	1071410	-	1006510	-	2	-	2	-	0.19	0.40
209	SJ	099	031.578	FWY	LODI, TURNER ROAD	North	2	South	3	1068610	-	1067610	-	2	-	2	-	0.29	0.03
266	AMA	104	002.407	EXP	MICHIGAN BAR ROAD	East	1	West	1	1055210	-	1055110	-	1	-	1	-	0.01	0.01
267	AMA	104	002.407	EXP	MICHIGAN BAR ROAD	East	1	West	1	1055210	-	1055110	-	1	-	1	-	0.01	0.01
166	TUO	108	000.000	EXP	SONORA, JCT. RTE. 49	East	2	West		10125810	-	10125910	-	1	-	1	-	0.00	0.00
273	TUO	108	000.490	CON	SONORA, STEWART STREET	East	1	West		10127610	-	10127710	-	2	-	1	-	0.24	0.24

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
294	TUO	108	004.498	CON	PEACEFUL OAK RD	East	1	West		1081610	-	1081710	-	1	-	1	-	0.19	0.19
120	SJ	120	000.493	FWY	MOSSDALE, JCT. RTE. 5	East	2	West	2	1048710	-	1003310	-	2	-	2	-	0.00	0.00
211	AMA	124	000.000	CON	JCT. RTE. 88, IONE SOUTH	East	1	West	1	1054810	-	1054710	-	1	-	2	-	0.22	0.22
128	AMA	124	010.335	EXP	WAITES STATION, JCT. RTE. 16	East	1	West	1	10130510	-	10130610	-	2	-	2	-	0.01	0.01
201	SJ	132	000.000	FWY	JCT. RTE. 580	East	2	West	2	1093710	-	1094010	-	2	-	2	-	0.34	0.35
14	SJ	132	006.060	CON	JCT. RTE. 33	East	1	West	2	1091210	-	1091010	-	1	-	1	-	0.03	0.14
44	MER	152	013.244	EXP	WEST JCT RTE 33	East	2	West	2	1009010	-	1009110	-	2	-	2	-	0.11	0.11
348	MER	152	013.848	EXP	JCT. RTE. 5	East	2	West	2	1009010	-	1009110	-	2	-	2	-	0.50	0.50
190	MER	152	040.949	EXP	MERCED/MADERA COUNTY LINE	East	2	West	2	1040410	-	1040710	-	2	-	2	-	0.27	0.13
323	MER	165	026.872	CON	JCT. RTE. 140	North	1	South	1	10124610	-	10124710	-	1	-	1	-	0.01	0.01
67	MER	165	026.872	CON	JCT. RTE. 140	North	1	South	1	10124610	-	10124710	-	1	-	1	-	0.01	0.01
8	SJ	205	001.000	FWY	TRACY, MOUNTAIN HOUSE PARKWAY	East	3	West	3	1014510	-	1013510	-	3	-	3	-	0.24	0.18
64	SJ	205	002.381	FWY	HANSEN ROAD	East	2	West	2	1025110	-	10122610	-	4	-	4	-	0.41	0.41
334	SJ	205	002.850	FWY	TRACY, 11TH STREET	East	3	West	3	10122410	-	10122210	-	3	-	3	-	0.02	0.02
121	SJ	205	008.127	FWY	TRACY, MAC ARTHUR DRIVE	East	3	West	3	1025710	-	1027110	-	3	-	3	-	0.07	0.07
290	STA	219	000.116	CON	JCT. RTE. 99	East	1	West	1	10109410	-	10109510	-	3	-	4	-	0.05	0.05

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
179	STA	219	004.858	CON	JCT. RTE. 108 EAST	East	1	West	1	-	-	10102810	-	-	-	2	-	-	0.34
335	SJ	580	000.000	FWY	JCT. RTE. 5	East	2	East	2	1091510	-	-	-	2	-	-	-	0.26	-

Table B-9: District 11 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
501	SD	005	000.878	FWY	SOUTH JCT. RTE. 805	North	4	South	6	1118333	-	1118326	-	4	-	4	-	0.36	0.35
900	SD	005	001.198	FWY	VIA SAN YSIDRO INTERCHANGE	North		South		1118333	-	1118326	-	4	-	4	-	0.04	0.03
901	SD	005	004.632	FWY	JCT. RTE. 75 WEST	North	5	South	5	1118379	-	-	-	4	-	-	-	0.04	-
902	SD	005	008.562	FWY	E STREET	North	5	South	5	1118450	-	-	-	5	-	-	-	0.05	-
952	SD	005	011.129	FWY	8TH STREET	North	5	South	5	1118479	-	1118472	-	4	-	4	-	0.15	0.15
903	SD	005	012.647	FWY	JCT. RTE. 15 NORTH	North	5	South	5	1114211	-	1126864	-	4	-	4	-	0.20	0.20
956	SD	005	014.740	FWY	J STREET	North	5	South	5	1117782	-	1117774	-	5	-	5	-	0.22	0.22
977	SD	005	015.010	FWY	JCT RTE 94	North		South		1117809	-	1117789	-	4	-	4	-	0.33	0.04
896	SD	005	017.530	FWY	PACIFIC HIGHWAY VIADUCT	North	4	South	4	1118078	-	1117724	-	4	-	4	-	0.11	0.15
801	SD	005	022.262	FWY	CLAIREMONT DRIVE	North	4	South	4	1108547	-	1108711	-	4	-	5	-	0.06	0.18
802	SD	005	025.947	FWY	JCT. RTE. 52 EAST	North	5	South	5	1122594	-	1108667	-	4	-	5	-	0.02	0.10
502	SD	005	030.682	FWY	SAN DIEGO, NORTH JCT. RTE. 805	North	8	South	8	1123078	-	-	-	4	-	-	-	0.04	-
803	SD	005	030.682	FWY	SAN DIEGO, NORTH JCT. RTE. 805	North	4	South	4	1123078	-	-	-	4	-	-	-	0.04	-
898	SD	005	036.266	FWY	VIA DE LA VALLE	North	6	South	6	1108509	1122734	1108468	1120314	4	1	4	1	0.03	0.01
978	SD	005	041.509	FWY	ENCINITAS BOULEVARD	North	4	South	4	1122512	-	1108479	-	4	-	4	-	0.01	0.02

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
661	SD	005	042.712	FWY	LEUCADIA BOULEVARD	North	4	South	4	1108651	-	1108723	-	4	-	4	-	0.03	0.02
904	SD	005	049.278	FWY	TAMARACK AVENUE	North	5	South	5	1119934	-	1108560	-	4	-	4	-	0.25	0.03
905	SD	005	051.201	FWY	JCT. RTE. 78 EAST	North	6	South	5	1115289	-	1108461	-	6	-	4	-	0.23	0.23
907	SD	005	052.834	FWY	BROOKS ST OC	North	4	South	4	1115304	-	1108459	-	4	-	4	-	0.43	0.43
906	SD	005	053.932	FWY	JCT. RTE. 76	North	5	South	6	1115314	-	-	-	4	-	-	-	0.13	-
954	SD	005	054.390	FWY	HARBOR DRIVE/VANDERGRIFT	North	4	South	4	1115323	-	1122257	-	4	-	4	-	0.05	0.04
951	SD	008	001.213	FWY	MIDWAY DRIVE	East	3	West	2	1108728	-	1115555	-	2	-	5	-	0.00	0.28
958	SD	008	001.213	FWY	MIDWAY DRIVE	East	4	West	4	1108728	-	1115555	-	2	-	5	-	0.00	0.28
859	SD	008	000.023	FWY	JCT RTE 5/MORENA BOULEVARD	East	5	West	5	1113486	-	1116574	-	3	-	2	-	0.24	0.25
804	SD	008	000.946	FWY	HOTEL CIRCLE/TAYLOR STREET	East	4	West	5	1115413	-	1115517	-	5	-	5	-	0.02	0.03
953	SD	008	005.638	FWY	JCT. RTE. 15	East	6	West	6	1115450	-	1115584	-	4	-	4	-	0.16	0.17
808	SD	008	008.336	FWY	COLLEGE AVENUE	East	7	West	6	-	-	1118760	-	-	-	5	-	-	0.41
807	SD	008	008.336	FWY	COLLEGE AVENUE	East	7	West	6	-	-	1118760	-	-	-	5	-	-	0.41
805	SD	008	010.967	FWY	SPRING STREET	East	5	West	5	1108360	-	1108343	-	4	-	4	-	0.15	0.00
810	SD	008	011.764	FWY	JACKSON DRIVE	East	5	West	6	1127026	-	1118767	-	5	-	4	-	0.04	0.04
834	SD	008	012.649	FWY	SEVERIN DRIVE	East	6	West	6	1111535	-	1108347	-	4	-	4	-	0.30	0.24

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
806	SD	008	014.594	FWY	WEST MAIN STREET	East	4	West	4	1111531	-	1108353	-	4	-	4	-	0.07	0.07
824	SD	008	018.727	FWY	GREENFIELD DRIVE	East	3	West	2	1115477	-	1108389	-	2	-	2	-	0.32	0.12
888	SD	008	020.041	FWY	LOS COCHES UC	East	3	West	5	1111575	-	1108419	-	2	-	2	-	0.11	0.12
140	SD	011	000.745	FWY	SANYO AVE	East	2	West	2	-	-	1126505	-	-	-	2	-	-	0.11
141	SD	011	000.745	FWY	SANYO AVE	East	2	West	2	-	-	1126505	-	-	-	2	-	-	0.11
909	SD	015	000.405	FWY	MAIN STREET UC	North	4	South	5	1119689	-	1119683	-	4	-	2	-	0.18	0.18
836	SD	015	002.226	FWY	JCT. RTE. 94	North	5	South	4	1122942	-	1117920	-	3	-	2	-	0.00	0.12
910	SD	015	003.367	FWY	JCT. RTE. 805	North	5	South	5	1123165	-	1118900	-	3	-	3	-	0.09	0.09
813	SD	015	006.132	FWY	JCT. RTE. 8	North	8	South	6	1118941	-	1121074	-	4	-	4	-	0.00	0.03
911	SD	015	006.132	FWY	JCT. RTE. 8	North	6	South	6	1118941	-	1121074	-	4	-	4	-	0.00	0.03
682	SD	015	009.995	FWY	CLAIREMONT MESA BOULEVARD INTERCHANGE	North	4	South	4	1108534	-	1108521	-	4	-	4	-	0.03	0.04
912	SD	015	012.124	FWY	JCT. RTE. 163	North	7	South	9	1120611	-	1115811	1125276	8	-	8	3	0.05	0.34
999	SD	015	015.000	FWY	CARROLL CANYON ROAD	North	7	South	7	1108439	1115829	1108148	1125318	6	2	6	2	0.01	0.12
913	SD	015	015.924	FWY	MIRA MESA BOULEVARD INTERCHANGE	North	6	South	6	1108415	-	1108491	-	5	-	5	-	0.02	0.04
980	SD	015	020.574	FWY	CARMEL MOUNTAIN ROAD	North	6	South	5	1108590	1122962	1108427	1122967	5	2	5	2	0.01	0.04
934	SD	015	026.026	FWY	POMERADO ROAD	North	7	South	6	1108562	1121161	1108541	1121158	5	2	5	2	0.03	0.19

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
935	SD	015	026.026	FWY	POMERADO ROAD	North	7	South	7	1108562	1121161	1108541	1121158	5	2	5	2	0.03	0.19
914	SD	015	028.765	FWY	CITRACADO PARKWAY	North	7	South	6	1108769	1125486	1108516	1122116	5	2	4	2	0.06	0.14
918	SD	015	030.627	FWY	INTERCHANGE VALLEY PARKWAY	North	8	South	6	1108773	1125324	1108556	1125321	6	2	5	2	0.09	0.08
657	SD	015	031.517	FWY	JCT. RTE. 78	North	4	South	4	1119736	-	1125265	-	4	-	4	-	0.12	0.12
915	SD	015	031.517	FWY	JCT. RTE. 78	North	4	South	4	1119736	-	1125265	-	4	-	4	-	0.12	0.12
916	SD	015	036.636	FWY	DEER SPRINGS ROAD	North	5	South	5	1119780	-	-	-	4	-	-	-	0.34	-
720	SD	052	000.324	CON	JCT. RTE. 5	East	3	West	5	1126257	-	1114162	-	3	-	3	-	0.02	0.02
703	SD	052	003.761	FWY	JCT. RTE. 805	East	3	West	3	-	-	1121771	-	-	-	2	-	-	0.21
727	SD	052	008.713	CON	SANTO ROAD	East	5	West	5	1122789	-	1122781	-	3	-	3	-	0.25	0.23
728	SD	052	008.713	CON	SANTO ROAD	East	4	West	3	1122789	-	1122781	-	3	-	3	-	0.25	0.23
729	SD	052	013.273	FWY	MAST BOULEVARD	East	4	West	4	1111526	-	1111527	-	2	-	2	-	0.13	0.13
730	SD	052	013.273	FWY	MAST BOULEVARD	East	3	West	3	1111526	-	1111527	-	2	-	2	-	0.13	0.13
732	SD	052	014.962	FWY	JCT RTE 125	East	4	West	4	-	-	1125383	-	-	-	2	-	-	0.21
816	SD	054	004.207	FWY	WOODMAN STREET	East	4	West	4	1108731	-	1108735	-	3	-	3	-	0.08	0.17
815	SD	054	004.207	FWY	WOODMAN STREET	East	4	West	5	1108731	-	1108735	-	3	-	3	-	0.08	0.17
743	SD	054	004.994	FWY	BRIARWOOD ROAD	East	5	West	5	1108733	-	1108737	-	3	-	3	-	0.08	0.23

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
751	SD	056	000.309	FWY	EL CAMINO RL	East	5	West	4	1125689	-	-	-	3	-	-	-	0.11	-
752	SD	056	000.820	FWY	CARMEL CREEK RD	East	5	West	3	1108739	-	1108743	-	3	-	2	-	0.15	0.06
750	SD	056	003.103	FWY	CARMEL VALLEY RD	East	4	West	4	1113740	-	1125631	-	2	-	2	-	0.09	0.09
755	SD	056	003.103	FWY	CARMEL VALLEY RD	East	5	West	5	1113740	-	1125631	-	2	-	2	-	0.09	0.09
757	SD	056	007.562	FWY	BLACK MOUNTAIN RD	East	7	West	5	1125201	-	1125575	-	3	-	2	-	0.11	0.40
758	SD	056	008.540	FWY	RANCHO PENASQUITOS BLVD	East	3	West	3	1125527	-	1125531	-	2	-	2	-	0.29	0.26
759	SD	056	008.540	FWY	RANCHO PENASQUITOS BLVD	East	3	West	6	1125527	-	1125531	-	2	-	2	-	0.29	0.26
735	SD	067	001.951	FWY	NB 67/WB 52 CONN	North	4	South	4	1126476	-	1126462	-	2	-	2	-	0.33	0.33
736	SD	067	002.149	FWY	EB 52/NB 67 CONN	North	3	South	4	1126470	-	1126455	-	2	-	2	-	0.18	0.18
830	SD	076	017.303	EXP	JCT. RTE. 15	East	2	West	1	-	-	1127045	-	-	-	4	-	-	0.12
101	SD	076	017.303	EXP	JCT. RTE. 15	East	1	West	1	-	-	1127045	-	-	-	4	-	-	0.12
200	SD	078	000.024	EXP	JCT. RTE. 5	East	4	West	4	1112989	-	1112996	-	4	-	4	-	0.39	0.39
983	SD	078	001.498	FWY	OCEANSIDE, EL CAMINO REAL	East	5	West	4	1108639	-	1108621	-	3	-	3	-	0.10	0.11
984	SD	078	001.498	FWY	OCEANSIDE, EL CAMINO REAL	East	5	West	5	1108639	-	1108621	-	3	-	3	-	0.10	0.11
971	SD	078	004.384	FWY	VISTA, EMERALD DRIVE	East	4	West	4	1108328	-	1115897	-	3	-	6	-	0.09	0.09
985	SD	078	010.606	FWY	SAN MARCOS,RANCHO SANTA FE	East	5	West	4	1108549	-	1108631	-	3	-	3	-	0.07	0.17

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
986	SD	078	010.606	FWY	SAN MARCOS,RANCHO SANTA FE	East	4	West	5	1108549	-	1108631	-	3	-	3	-	0.07	0.17
677	SD	078	010.606	FWY	SAN MARCOS,RANCHO SANTA FE	East	3	West	3	1108549	-	1108631	-	3	-	3	-	0.07	0.17
987	SD	078	015.486	FWY	NORDAHL ROAD	East	5	West	5	1108706	-	1108704	-	3	-	3	-	0.11	0.12
835	SD	078	017.268	FWY	ESCONDIDO, CENTRE CITY PARKWAY	East	0	West	5	-	-	1108708	-	-	-	3	-	-	0.02
877	SD	078	017.680	CON	ESCONDIDO, BROADWAY/LINCOLN PARKWAY	East	2	West	3	-	-	1108708	-	-	-	3	-	-	0.40
936	SD	094	001.416	FWY	BEGIN RTE AT JCT RTE and EB 5 ON FRM "G" ST / 17TH	East	6	West	5	1108380	-	1118989	-	4	-	3	-	0.46	0.16
974	SD	094	002.214	FWY	28TH STREET	East	4	West	4	1108378	-	1108285	-	4	-	4	-	0.03	0.02
989	SD	094	005.789	FWY	56TH STREET/ KELTON ROAD	East	5	West	5	1108505	-	1108304	-	5	-	4	-	0.01	0.18
990	SD	094	008.983	FWY	LEMON GROVE AVENUE	East	5	West	5	1108501	-	1108317	-	4	-	4	-	0.03	0.11
992	SD	094	010.461	FWY	JCT. RTE. 125	East	5	West	5	-	-	1120121	-	-	-	3	-	-	0.20
746	SD	125	009.898	FWY	JAMACHA BOULEVARD/PARADISE VALLEY ROAD	North	5	South	5	1112964	-	1114006	-	3	-	3	-	0.09	0.23
991	SD	125	012.967	FWY	EAST JCT. RTE. 94	North	3	South	3	-	-	1113267	-	-	-	3	-	-	0.05
745	SD	125	018.422	FWY	FLETCHER PRKY/AMAYA	North	3	South	3	1111555	-	1111554	-	3	-	3	-	0.14	0.02
749	SD	125	022.172	FWY	JCT. RTE. 52, SANTEE	North	5	South	5	1113327	-	1113335	-	3	-	3	-	0.28	0.21
748	SD	125	022.301	FWY	MISSION GORGE ROAD	North	3	South	3	1113327	-	1113335	-	3	-	3	-	0.41	0.34
933	SD	163	002.490	FWY	ROBINSON AVENUE	North	2	South	2	1113279	-	1111539	-	2	-	2	-	0.00	0.00

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
957	SD	163	004.371	FWY	FRIARS ROAD	North	4	South	4	1114450	-	1111510	-	7	-	4	-	0.26	0.09
920	SD	163	008.010	FWY	SAN DIEGO, BALBOA AVENUE	North	4	South	4	1108564	-	1108484	-	4	-	4	-	0.00	0.04
685	SD	163	010.837	FWY	SAN DIEGO, KEARNEY VILLA ROAD INTERCHANGE	North	4	South	5	1108570	-	1108721	-	4	-	5	-	0.03	0.09
921	SD	163	011.662	FWY	JCT. RTE. 15	North	5	South	5	-	-	1111525	1126561	-	-	4	2	-	0.46
922	SD	805	000.647	FWY	SAN YSIDRO BLVD	North	5	South	4	1119797	-	1119790	-	4	-	4	-	0.13	0.13
681	SD	805	001.805	FWY	SAN DIEGO, JCT. RTE. 905	North	6	South	7	1118677	-	1118670	-	4	-	4	-	0.31	0.31
684	SD	805	005.542	FWY	NAPLE STREET UNDERCROSSING	North	5	South	5	1122693	-	1126790	1126792	4	-	4	1	0.20	0.20
923	SD	805	006.059	FWY	TELEGRAPH CANYON ROAD	North	5	South	6	-	1125505	1120291	1125978	-	1	4	1	-	0.15
944	SD	805	008.854	FWY	JCT. RTE. 54, SWEETWATER ROAD	North	8	South	7	1125958	1125960	1126006	1125962	4	1	4	1	0.39	0.13
924	SD	805	008.854	FWY	JCT. RTE. 54, SWEETWATER ROAD	North	6	South	6	1125958	1125960	1126006	1125962	4	1	4	1	0.39	0.13
925	SD	805	011.096	FWY	SAN DIEGO, 47TH STREET	North	7	South	7	1125925	1125931	1117979	1125932	4	1	4	1	0.01	0.01
926	SD	805	013.507	FWY	SAN DIEGO, JCT. RTE. 94	North	6	South	5	1108441	-	1111545	1125916	4	-	4	1	0.30	0.30
966	SD	805	014.461	FWY	JCT RTE 15	North	5	South	5	1119383	-	1118894	-	5	-	5	-	0.10	0.11
927	SD	805	016.431	FWY	EL CAJON BOULEVARD	North	5	South	6	1108403	-	1111542	-	4	-	5	-	0.07	0.07
928	SD	805	017.645	FWY	JCT. RTE. 8	North	6	South	6	1118924	-	1121288	-	4	-	4	-	0.28	0.28
929	SD	805	023.651	FWY	JCT. RTE. 52	North	5	South	5	1126184	1126596	1126191	1126627	4	1	5	1	0.00	0.00

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
683	SD	805	024.440	FWY	GOVERNOR DRIVE INTERCHANGE	North	5	South	5	1108580	1126303	1108410	1126301	4	1	4	1	0.09	0.01
930	SD	805	028.502	FWY	JCT. RTE. 5	North	4	South	4	1123084	1126589	-	-	2	1	-	-	0.04	-
947	SD	805	028.874	FWY	END OF ROUTE, END RIGHT LANES AT RTE 5	North	5	South	4	1123084	1126589	-	-	2	1	-	-	0.33	-
942	SD	905	005.164	FWY	JCT. RTE. 805	East	5	West	5	1125836	-	1126526	-	2	-	2	-	0.28	0.28
128	SD	905	009.778	FWY	LA MEDIA ROAD	East	4	West	3	1122380	-	1122394	-	3	-	3	-	0.06	0.03
127	SD	905	011.366	FWY	SIEMPRE VIVA RD O.C.	East	5	West	6	1123265	-	1122412	-	3	-	3	-	0.49	0.03
126	SD	905	011.366	FWY	SIEMPRE VIVA RD O.C.	East	6	West	6	1123265	-	1122412	-	3	-	3	-	0.49	0.03
689	SD	905	011.736	FWY	MEXICAN BORDER POE-TRUCK ENTRANCE	East	0	West	2	-	-	1122412	-	-	-	3	-	-	0.40

Table B-10: District 12 Census Locations (with Matching PeMS VDS Locations)

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
401	ORA	005	000.483	FWY	CONCORDIA SCHOOL ROAD PED OC	North	5	South	5	1204198	-	1204193	-	4	-	4	-	0.17	0.16
901	ORA	005	004.995	FWY	VAQUERO AVENUE	North	4	South	4	1221232	1221197	1221233	1221198	4	1	4	1	0.30	0.30
902	ORA	005	017.472	FWY	ALICIA PARKWAY	North	5	South	5	1204571	1210089	1204577	1211183	5	1	4	1	0.04	0.02
903	ORA	005	021.304	FWY	JCT. RTE. 405, SANTA ANA FREEWAY	North	6	South	6	1204703	1211856	1211853	1211854	3	1	3	1	0.05	0.05
900	ORA	005	024.999	FWY	N/O JEFFERY ROAD/YALE AVENUE	North	6	South	6	1204924	1204922	1204904	1204902	5	1	5	1	0.08	0.16
905	ORA	005	030.263	FWY	TUSTIN, JCT. RTE. 55, COSTA MESA FREEWAY	North	5	South	5	1205165	1208989	1205166	1208993	5	1	4	1	0.06	0.06
904	ORA	005	030.263	FWY	TUSTIN, JCT. RTE. 55, COSTA MESA FREEWAY	North	5	South	5	1205165	1208989	1205166	1208993	5	1	4	1	0.06	0.06
906	ORA	005	033.088	FWY	SANTA ANA, MAIN STREET	North	5	South	5	1205290	1209951	1205276	1209950	5	1	5	1	0.11	0.09
907	ORA	005	043.430	FWY	JCT. RTE. 39; BEACH BOULEVARD	North		South	3	1205636	1216409	1205632	1216408	5	1	5	1	0.15	0.13
908	ORA	005	043.430	FWY	JCT. RTE. 39; BEACH BOULEVARD	North	3	South		1205636	1216409	1205632	1216408	5	1	5	1	0.15	0.13
420	ORA	022	001.800	FWY	EAST OF VALLEY VIEW STREET	East	3	West	4	1202595	1214857	1202599	1214870	3	1	4	1	0.05	0.05
70	ORA	022	002.653	FWY	WESTMINSTER, KNOTT AVENUE/GOLDEN WEST STREET INTERCHANGE	East	0	West	0	1215092	1215090	1215091	1215089	3	1	3	1	0.06	0.06
71	ORA	022	007.310	FWY	W OF HARBOR BLVD; NEW HOPE ST	East	3	West	4	1215252	1215251	1215250	1215249	4	1	4	1	0.01	0.01
197	ORA	022	008.822	FWY	GARDEN GROVE, GARDEN GROVE BOULEVARD INTERCHANGE	East	0	West	0	1202844	1214771	1202840	1214770	4	1	4	1	0.14	0.14

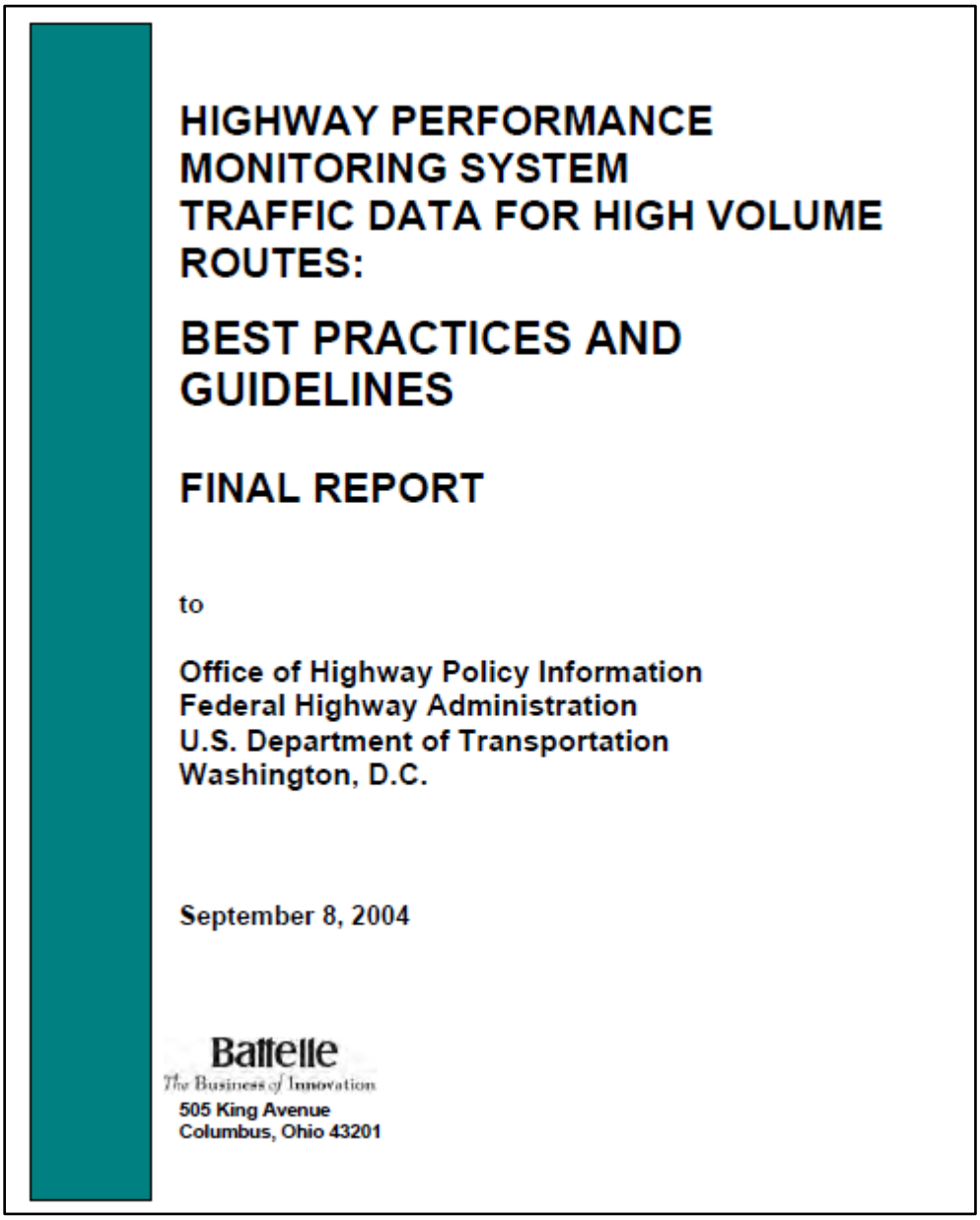
TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
72	ORA	022	012.360	FWY	W OF TUSTIN AVE; CAMBRIDGE ST	East	3	West	3	1214881	-	1214882	1215212	5	-	4	1	0.11	0.11
909	ORA	055	002.772	FWY	COSTA MESA, VICTORIA/22ND STREETS	North	4	South	4	1203021	-	1203016	-	4	-	3	-	0.00	0.00
910	ORA	055	003.776	FWY	FAIR DRIVE	North	4	South	4	1203057	-	1203050	-	4	-	4	-	0.19	0.19
190	ORA	055	007.500	FWY	SOUTH OF DYER ROAD; NORTH OF MCARTHUR BLVD.	North	5	South	5	1203172	1203146	1218332	1203159	4	1	4	1	0.35	0.12
911	ORA	055	008.503	FWY	WARNER AVENUE	North	5	South	5	1214253	1214255	1214215	1214254	4	1	5	1	0.10	0.10
803	ORA	055	010.450	FWY	TUSTIN, JCT. RTE. 5, SANTA ANA FREEWAY	North	0	South	0	1209873	1209874	1203266	1203264	3	1	4	1	0.05	0.05
205	ORA	055	012.290	FWY	S/O JCT RTE 22; SANTA CLARA AVE	North	4	South	4	1215811	1215810	1215809	1215808	5	1	5	1	0.01	0.01
94	ORA	055	014.370	FWY	NORTH OF CHAPMAN AVENUE; SOUTH OF KATELLA AVENUE	North	4	South	4	1212842	1212841	1212840	1212839	5	1	5	1	0.03	0.03
926	ORA	057	010.830	FWY	ORANGE, JCT. RTES. 5 AND 22, SANTA ANA/GARDEN GROVE FREEWAYS	North	4	South	4	1211907	1201989	1211954	1201991	5	1	2	1	0.27	0.03
766	ORA	057	011.240	FWY	ORANGE, CHAPMAN AVENUE	North	0	South	0	1202011	1211939	1201998	1211908	5	1	4	1	0.02	0.16
406	ORA	057	012.960	FWY	DOUGLASS OVERHEAD; N/O KATELLA	North	5	South	5	1213741	1213743	1213742	1202130	5	1	4	1	0.06	0.06
912	ORA	057	014.421	FWY	SOUTH STREET	North	5	South	5	1213122	1213120	1213121	1213119	5	1	5	1	0.02	0.02
927	ORA	057	015.600	FWY	ANAHEIM, JCT. RTE. 91, RIVERSIDE FREEWAY	North	4	South	4	1213672	1213709	1213673	1213710	3	1	4	1	0.10	0.10
95	ORA	057	016.770	FWY	N/O ORANGETHORPE; CROWTHER ST	North	5	South	5	1219462	1219466	1219461	1219464	6	1	4	1	0.23	0.23
196	ORA	057	020.380	FWY	N OF JCT RTE 90; BIRCH STREET	North	7	South	5	1202436	1202434	1202451	1202449	6	1	4	1	0.33	0.32
658	ORA	057	020.884	FWY	BREA, LAMBERT ROAD INTERCHANGE	North	5	South	5	1202464	1209031	1202451	1202449	4	1	4	1	0.28	0.18

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
916	ORA	073	011.760	EXP	GREENFIELD DR	North	3	South	3	1208886	-	1208809	-	3	-	3	-	0.12	0.12
918	ORA	073	026.581	FWY	COSTA MESA, JCT RTE 55	North	2	South	2	1212479	-	1212480	-	3	-	3	-	0.12	0.12
115	ORA	074	008.130	CON	TROUGH CREEK BRIDGE	East	1	West	1	1220664	-	1220665	-	1	-	1	-	0.10	0.10
226	ORA	091	001.317	FWY	HOLDER ST PED OC; W/O KNOTT AV	East	5	West	5	1213891	1213889	1213892	1213890	4	1	4	1	0.00	0.00
723	ORA	091	003.020	FWY	E/O BEACH BLVD; W/O JCT RTE 5	East	5	West	5	1214063	1214065	1214062	1214064	5	1	5	1	0.02	0.02
742	ORA	091	002.000	FWY	W/O EUCLID AVE; E/O BROOKHURST	East	3	West	4	1203561	1212124	1203549	1211922	4	1	4	1	0.01	0.01
129	ORA	091	005.530	FWY	EAST OF STATE COLLEGE BLVD	East	4	West	4	1213986	1213984	1213985	1213983	5	1	4	1	0.03	0.03
412	ORA	091	006.800	FWY	E/O JCT RTE 57; W/O KRAEMER	East	4	West	5	1203866	1213903	1203871	1213904	4	1	5	1	0.02	0.38
913	ORA	091	010.091	FWY	LAKEVIEW AVENUE	East	6	West	6	1203984	1219068	1203998	-	6	2	5	-	0.01	0.05
808	ORA	091	012.080	FWY	E/O IMPERIAL HIGHWAY; RTE 90	East	7	West	7	1208121	1208133	1208134	1208135	5	2	5	2	0.10	0.10
928	ORA	091	015.925	FWY	JCT RTE 241	East	3	West	3	1208199	1208212	1208208	1208214	4	2	4	2	0.13	0.13
914	ORA	091	017.973	FWY	COAL CANYON ROAD LEFT	East	5	West	5	1213680	1213691	1213686	1213690	5	3	4	2	0.03	0.03
166	ORA	133	009.130	FWY	S/O JCT RTE 5; N/O JCT RTE 405	North	2	South	3	1201076	-	1201054	-	3	-	3	-	0.03	0.13
920	ORA	133	010.206	FWY	S5/N133 CONN BR	North	3	South	3	1211760	-	1211761	-	2	-	3	-	0.16	0.16
942	ORA	133	013.644	FWY	JCT RTE 241	North	2	South	2	1211653	-	1211654	-	3	-	2	-	0.22	0.22
133	ORA	142	001.768	CON	CARBON CANYON ROAD EAST OF VALENCIA AVENUE	East	0	West	0	1220561	-	1221248	-	2	-	2	-	0.34	0.01

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
439	ORA	142	001.800	CON	CARBON CANYON RD; E/O VALENCIA	East	1	West	1	1220561	-	1221248	-	2	-	2	-	0.31	0.04
304	ORA	142	002.340	CON	CARBON CANYON; EAST OF ROSE DR	East		West		1220561	-	1220562	-	2	-	2	-	0.23	0.23
132	ORA	142	004.270	CON	OLINDA CREEK	East		West		1220593	-	1220594	-	1	-	1	-	0.07	0.07
440	ORA	142	006.350	CON	ORANGE/SAN BERNARDINO COUNTY LINE	East	1	West	1	1220613	-	-	-	1	-	-	-	0.35	-
921	ORA	241	020.077	FWY	LOS ALISOS BOULEVARD LP	North	3	South	2	1209606	-	1209594	-	3	-	2	-	0.05	0.32
922	ORA	241	027.378	FWY	JCT RTE 133 LP	North	4	South	4	1211296	-	1211298	-	2	-	2	-	0.05	0.05
924	ORA	241	032.541	FWY	CHAPMAN-SANTIAGO RD UC LP	North	3	South	3	1211560	-	1211562	-	2	-	2	-	0.17	0.17
923	ORA	241	032.541	FWY	CHAPMAN-SANTIAGO RD UC LP	North	3	South	3	1211560	-	1211562	-	2	-	2	-	0.17	0.17
938	ORA	261	000.000	FWY	IRVINE, WALNUT AVENUE LP	North	3	South	2	1212281	-	1212282	-	3	-	2	-	0.04	0.04
925	ORA	261	002.848	FWY	PORTOLA PARKWAY OC LP	North	3	South	3	1212362	-	1212359	-	3	-	2	-	0.14	0.14
409	ORA	405	000.230	FWY	IRVINE, JCT. RTE. 5 LP	North	4	South	4	1211066	1211067	1201118	1211065	3	1	5	1	0.37	0.37
939	ORA	405	000.949	FWY	IRVINE CENTER DRIVE LP	North	5	South	5	1201100	1208954	1201112	1201110	5	1	4	1	0.02	0.01
743	ORA	405	004.750	FWY	N/O JEFFREY RD; S/O CULVER DR LP	North	5	South	5	1201222	1201229	1201217	1201227	4	1	4	1	0.26	0.26
671 671	ORA	405	005.618	FWY	IRVINE, CULVER DRIVE LP	North	6	South	6	1201254	1201259	1201270	1201268	4	1	5	1	0.07	0.07
915	ORA	405	006.178	FWY	HARVARD AVENUE	North	5	South	5	1201298	1201304	1201292	1201290	5	1	6	1	0.03	0.03
919	ORA	405	008.740	FWY	COSTA MESA, JCT. RTE. 55, COSTA MESA FREEWAY	North	5	South	5	1214212	1214260	1221737	1221738	4	1	4	1	0.04	0.06

TRAFFICST CHP ID	CNTY	RTE	POSTMILE	ROADLOC TYPE	LOCATION DESCRIPTION	PRIM DIR	NO LNS	SEC DIR	NO LNS	PeMS ML VDS Prim Dir	PeMS HV VDS Prim Dir	PeMS-ML VDS Sec Dir	PeMS HV VDS Sec Dir	PeMS-ML Lanes Prim Dir	PeMS-HV Lanes Prim Dir	PeMS-ML Lanes Sec Dir	PeMS-HV Lanes Sec Dir	PeMS ML Dist. Error Prim Dir	PeMS ML Dist. Error Sec Dir
207	ORA	405	009.887	FWY	N/O BRISTOL STREET/BEAR STREET	North	6	South	6	1214080	1214082	1221869	1221870	5	1	5	1	0.01	0.00
208	ORA	405	015.900	FWY	S/O JCT RTE 39; NEWLAND ST	North	5	South	5	1221508	1221684	1221489	1221677	4	1	5	1	0.12	0.18
659	ORA	405	019.156	FWY	WESTMINSTER, WESTMINSTER AVENUE INTERCHANGE	North	5	South	5	1201899	1201897	1201883	1201881	4	1	4	1	0.08	0.11
209	ORA	405	020.110	FWY	S/O VALLEY VIEW STREET	North	5	South	5	1221346	1221347	1221337	1221339	4	1	4	1	0.23	0.23
434	ORA	405	021.200	FWY	NORTH OF JCT RTE 22 EAST	North	7	South	7	1221367	1221370	1221356	1221359	6	2	7	2	0.16	0.17
219	ORA	605	001.100	FWY	N/O JR 22/405; S/O KATELLA	North	5	South	5	1219551	1219564	1219560	1219563	5	1	5	1	0.00	0.00

8. APPENDIX C – CHAPTER 4, TRAFFIC DATA COLLECTION EQUIPMENT FOR HIGH-VOLUME LOCATIONS



HIGHWAY PERFORMANCE MONITORING SYSTEM
TRAFFIC DATA FOR HIGH VOLUME ROUTES:

BEST PRACTICES AND GUIDELINES

FINAL REPORT

to

Office of Highway Policy Information
Federal Highway Administration
U.S. Department of Transportation
Washington, D.C.

September 8, 2004

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The Business of Innovation
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HIGHWAY PERFORMANCE MONITORING SYSTEM
TRAFFIC DATA FOR HIGH VOLUME ROUTES:
BEST PRACTICES AND GUIDELINES

FINAL REPORT

Chapter 4.0
Traffic Data Collection Equipment for High-Volume Locations

The purpose of this chapter is to further describe intrusive and non-intrusive data collection equipment used by state DOTs. The discussion identifies the limitations, advantages, and evaluation results of the various data collection equipment. The descriptions are intended to provide a basic guide to technology selection.

Equipment used to count traffic volumes and classify vehicles is very similar. In many cases, the only differences are the layout of the sensors on the roadway and user-selectable inputs in the data collection electronics unit. The following sections identify intrusive and non-intrusive detection technologies that agencies typically use to count and classify vehicles. For HPMS purposes, there must be not only a count of total vehicles but a classification of vehicles according to the prescribed classification scheme. Perhaps the most common scenario for states is to maintain continuous count stations that provide year-round counts from automated systems and apply factors from short-term classification counts to estimate the number of vehicles by type.

4.1 Intrusive Data Collection Equipment

Agencies typically use portable traffic volume counters for short-term data collection where a single-axle sensor will suffice. These devices can count all traffic on a roadway or an individual lane, depending on how the installer configures the sensors. The road component may consist of pneumatic tubes or other types of sensors (i.e., piezoelectric film or cable, tape switches, inductive loops, and magnetometers).

For the most part, vehicle classification systems currently fit the “intrusive” category, and they can be either permanent or portable. They typically utilize inductive loops, piezoelectric sensors, or a combination of the two sensor types (AASHTO, 1992). In any case, a minimum of two sensors sends detections to a data collection and storage unit at the roadside. Most classifier systems generate their most accurate data by using a combination of both piezoelectric (or other axle sensor) and inductive loop detectors. This means either two piezoelectric sensors and one inductive loop (preferred) or two inductive loops and one piezoelectric sensor. The standard FHWA classification scheme (Scheme F) measures axle spacing, which requires an axle sensor, with inductive loops providing vehicle presence. Automatic vehicle classification (AVC) sites

store vehicle classification information for specific lanes (e.g., Long Term Pavement Performance [LTPP] sites) or for each lane of an entire roadway.

All states interviewed rely on a combination of intrusive permanent counting equipment (primarily loops plus piezoelectric sensors) and pneumatic road tubes for short-term counts. The primary method for short-term data collection is road tubes and inductive loops for permanent counts. All the states interviewed have similar issues with using road tubes on high-volume locations, including safety of data collection crew, securing road tubes, and classification errors.

The following are the common problems identified by the states for traffic data collection on high-volume routes:

- Safety concerns with installing traffic collection equipment
- Sensor problems due to rutting and pavement deterioration
- Equipment failures (e.g., piezos and loops)
- Damage to or loss of road tubes (e.g., tubes getting shredded, not staying on the ground,
- damaged by street cleaning operations, lost due to vandalism)
- Communication problems with the traffic counters, including failures, cross-talk,
- chattering among loops
- Congested stop-and-go traffic adds to the difficulty of collecting accurate vehicle
- classification data. Also, misclassification due to congested traffic in axle-counting
- programs
- Construction, while offering an opportunity to install new counters, can cause severe
- disruptions along the corridor in the count program, especially due to route diversions
- resulting in atypical data at some sites.

4.1.1 Pneumatic Tubes

Pneumatic tubes are hollow rubber tubes stretched across the portion of the roadway for collecting vehicle count and/or speed data. One end of the tube connects to a traffic counter/ classifier with the other end plugged to prevent air leakage as a vehicle crosses the tube. As a vehicle passes over the tube, its tires compress the tube, actuating an air pressure transducer on the classifier. This means that pneumatic tubes operate in pulse mode only.

Although there are several problems associated with them, these tubes are the most common device used by states for short-term counts. Tubes are relatively inexpensive, and installation is quick and easy. These tubes, typically 0.5 inch in diameter, are relatively accurate for light traffic flows, but they damage easily. The safety of traffic personnel installing road-tubes in high-volume roads is also a concern.

4.1.2 Inductive Loop Detectors

The inductive loop consists of one or more turns of insulated loop wire installed in a shallow slot that is sawed in the pavement, a lead-in cable, and a detector electronic unit. Electrical induction consists of a detector unit that passes a current through the stranded loop wire, thereby creating an electromagnetic field around the wire. Moving a conductive metal object, such as a vehicle, through this field disturbs the electromagnetic field, producing a change in energy level. As the

vehicle enters the electromagnetic field of the loop, it causes a decrease in the inductance of the loop and an increase in the oscillation frequency. The inductive loop detector, which was introduced in the 1960s, continues today as the most commonly used form of detector, even though its weaknesses are widely recognized.

Proper installation of the loop in the road surface is important to ensure the reliability of the system. Some pavement surfaces, such as bridge decks, preclude the saw cutting necessary to install permanent inductive loop detectors. A primary disadvantage of inductive loop detectors is the expense of relocating or repairing loops after installation. This procedure requires extensive traffic control and results in congestion and motorist delay (Tyburski, 1989). Detector "crosstalk" and increased pavement stress are two additional disadvantages of inductive loop detector systems. There are also several adverse conditions that affect the operation of inductive loops, including high voltage power lines under the pavement, a pavement subsurface with a high iron content, and unstable pavement conditions. Underground wires, conduit, and pull boxes are susceptible to being damaged by utility work. Modern detection electronics can overcome the first two conditions, but changing or unstable pavement conditions result in increased inductive loop maintenance costs (TTI, 1992). One advantage of inductive loop systems over some of the non-intrusive alternatives is their ability to maintain accuracy in all weather and lighting conditions (ITE, 1991).

Opinions differ on the reliability of inductive loop systems. Some agencies believe that inductive loop technology is the best available, while others have experienced high failure rates (TTI, 1992). Studies on inductive loops revealed that several installation processes needed revision to improve the inductive loop detectors' reliability. Improper saw-cutting techniques, loop-wire splicing, and inadequate loop-sealant bonding resulted in loop wire breakage (Labell and May, 1990).

Given the widespread use of inductive loops throughout the United States, it is logical to fully utilize their capabilities and even to further enhance these capabilities. Inductive loops detect "presence" of vehicles. In its typical use, the inductive loop is basically an on-off device, or a contact closure, indicating that a vehicle is either present or not. In conjunction with its companion electronics, a single loop can provide vehicle counts and occupancies, whereas dual loops (often referred to as "traps") can provide speeds and vehicle classification (by length). However, other useful information is available from inductive loops by adding the appropriate hardware and software. These new concepts need to be considered because they add a new dimension to a state or local agency's capabilities in traffic monitoring.

4.1.3 Vehicle Classifiers – General

The previous two sub-sections discussed traffic-detection equipment. Another component of traffic detection relates to the classifiers used to translate axle-presence detection to vehicle volumes and classes. There are many different classifiers in the market today that use the spacing between axle hits to determine classification based on previously determined class tables.

The Georgia Tech Research Institute and Georgia DOT performed a series of field tests on several vehicle classification devices that are currently used in order to determine accuracy and adequacy of the equipment. The field test location was on IH-20 in the metropolitan Atlanta area, and the test included two 48-hour tests for detailed vehicle-by-vehicle analysis and one seven-day test for longer term accuracy statistics (Harvey and Champion, 1996).

Published results were in a format that provided anonymity to participating companies and to specific equipment to avoid the appearance of competitiveness (Harvey and Champion, 1996). Documentation of results compared actual vehicle classification to system classification and the overall classification accuracy. The analysis of results found that the most common classification errors involved the differentiation of class 2 (Passenger Cars) and class 3 (Other Two-Axle, Four-Tire, Single Unit Vehicles) vehicles by test equipment. The results also found that the most accurately classified vehicles were large trucks, which comprise classes 8 through 12. The test team also found that there is a strong correlation between the accuracy of a classifier and the reliability of the axle sensor used to collect the data, and that axle-sensor error accounts for a large number of the overall classification errors. The increased accuracy regarding trucks is attributed to the distinct separation in the number and spacing of truck axles (Harvey and Champion, 1996).

Virginia DOT uses the following equipment and strategies:

- Continuous count locations use the Peek ADR 3000+ equipment with advanced piezo
- and loop boards. They also have advanced loop logic capabilities when used with the
- loop-piezo-loop sensor configuration.
- Coverage counts are collected with road-tubes using the ADR 1000+ in addition to
- tailgating logic algorithms. Classification tables are thoroughly reviewed and tested
- periodically.
- Each lane is counted separately in all cases. Road-tube arrays are independent of other
- lanes at the more challenging locations and shared arrays are used at low volume-low
- congestion traffic areas such as rural.
- Virginia uses two-man crews for high-volume areas.

4.1.4 Magnetometers

A magnetometer typically consists of an intrusive sensor about the size and shape of a small can, a lead-in cable, and an amplifier. The cylinder portion of the magnetometer contains sensor coils that operate similarly to inductive loops. These coils are installed in a small circular hole in the center of each lane and communicate with the roadside by wires or radio link. Magnetometers function by detecting increased density of vertical flux lines of the earth's magnetic field caused by the passage of a mass of ferrous metals, such as a motorized vehicle. They operate in either presence or pulse modes and are embedded in the pavement. Magnetometers require less cutting of the pavement than inductive loop sensors, are easier to install, and can be installed underneath bridge decks without damage to the deck. The disadvantages of magnetometers are similar to those of inductive loop detector systems, in that they sometimes double count trucks and are less likely to detect motorcycles due to the vehicle's small detection zone (Labell and May, 1990).

Illinois DOT has had great success in using Numetric Hi-Star sensors. These sensors use Vehicle Magnetic Imaging (VMI) technology and are capable of the volume, speed, and length classification of vehicles plus road surface temperature, wet/dry surface condition, and roadway occupancy. IDOT finds these sensors easy to install and found them to be excellent for traffic volume data for highways carrying less than 75,000 AADT. While high-volume routes exist in Illinois (especially in the Chicago area), IDOT does not use these sensors in such locations but gets the data from the Chicago Area Transportation Study (CATS). This equipment also performs well for length based classification which Illinois is a big proponent of.

4.1.5 Non-Invasive Microloop

The 3M system consisted of three components: Canoga Model 702 Non-Invasive microloop probes, Canoga C800 series vehicle detectors, and 3M ITS Link Suite application software. The microloop probes can monitor traffic from a three-inch non-metallic conduit 18 to 36 inches below the road surface or from underneath a bridge structure. Installers must use a magnetometer underneath bridges to determine proper placement of the probes; otherwise, optimum performance requires trial-and-error. Probes installed in a "lead" and "lag" configuration under pavements or bridges can monitor speeds by creating speed traps in each lane. One of the requirements of this system is that the probes remain relatively vertical, so keeping the horizontal bores straight is critical. Probes placed in a non-vertical orientation can lead to speed errors. MnDOT tests under pavement indicated excellent volume and speed results. The absolute percent volume difference between sensor and baseline was under 2.5 percent, which is within the accuracy capability of the baseline loop system. For speeds, the test system generated 24-hour test data with absolute percent difference of average speed between baseline and test system from 1.4 to 4.8 percent for all three lanes (Minnesota DOT, 2002).

At a relatively low-to-moderate volume site in College Station, Texas, TTI found that, for a six-day count period, 3M microloops were almost always within 5 percent of baseline counts. In the right lane, all except two 15-minute intervals out of the 330 total intervals were within 5 percent of baseline counts. The remaining two were within 10 percent of baseline counts. Therefore, microloop counts were within 5 percent of baseline counts 99.4 percent of the time in the right lane (dual probes). In the left lane (single probes), 94.5 percent of the 15-minute intervals were within 5 percent, 4.5 percent were between 5 and 10 percent, and 1.0 percent were more than 10 percent from the baseline (Middleton and Parker, 2000).

NYSDOT tested 3M Microloops for bridge deck applications. NYSDOT also tested SAS-1 Acoustic sensors due to their advantages of low-power requirements and low cost. The main advantage stated by New York is the safety of traffic personnel.

4.2 Non-Intrusive Data Collection Equipment

A number of non-intrusive technologies also can be used for counting traffic volumes and for classifying vehicles. The use of non-intrusive data collection equipment for traffic data collection has been investigated by various states. While some of the states are experimenting and testing some types of non-intrusive equipment, other states are now beginning to review that option. This category of vehicle detectors includes active and passive infrared sensing systems, passive acoustic detectors, ultrasonic detectors, microwave and radar detection systems,

automatic vehicle identification systems, and video detection systems. Some of the potential advantages of non-intrusive devices include ease of repair and ability to do so off the roadway. Several potential disadvantages were identified, including:

- Set-up can be difficult
- Classification problems, undercounting and length-based instead of axle-based
- calculations
- Occlusion problems
- Difficult to use as a volume or classification station over a long period of time.

Illinois DOT is a strong proponent of length-based classification and has worked with FHWA to report length-based classification for HPMS. The use of length-based classifications encourages the use of non-intrusive detectors. Often the inability of such devices to classify vehicles into 13 vehicle categories is mentioned as a major impediment to their increased use.
The following paragraphs describe each of these systems and discuss advantages and disadvantages of system equipment.

4.2.1 Active Infrared Detection Systems

Active infrared sensors operate by focusing a narrow beam of energy and either measuring the reflected energy or measuring the direct energy disruption by an infrared-sensitive cell. In the first case, one device both sends and receives energy, and interprets the reflected pattern. In the second, energy disruption represents vehicle presence so that detections occur when vehicles pass through the beam and interrupt the signal. The infrared beam can be transmitted from overhead or from one side of the road to the other. Infrared systems can provide information on vehicle height, width, and length, in addition to simple passage of vehicles.

Preliminary testing of active infrared detectors by public agencies indicates very promising results for monitoring vehicle speeds and classifications. TTI tested the *Autosense II* by Schwartz Electro-Optics (SEO) and found it to operate during day/night transitions and other lighting conditions without significant problems. However, its cost of $10,000 per lane may be a deterrent to its use. A second disadvantage of this sensor as compared to most other nonintrusive sensors is the requirement to be placed directly over each lane. This requires lane closure to install and remove the sensor element. Advantages include its ease of setup and generation of data protocols for interpreting its output. Also, it was more accurate in its classification accuracy (based on vehicle dimensions) than another non-intrusive sensors tested (Middleton et al. 1997). Based on information from others, weather conditions that appear to be problematic for this device are heavy fog, heavy dust, and heavy rain. England uses infrared detectors extensively for both pedestrian crosswalks and signal control. The San Francisco-Oakland Bay Bridge uses infrared detection systems to detect presence of vehicles across all five lanes of the upper deck of the bridge (ITE, 1991).

In contrast to the *SEO ASII*, which monitors and measures vehicle dimensions, the *Autosense IIA* counts axles. Installation of the *IIA* is above and to the side of each lane being monitored so that its field of scan includes a side view of the vehicle and its axles. Early testing by the vendor in November 1998 and during the first quarter of 1999 indicates axle-counting accuracy of 95 percent. The manufacturer anticipates further refinement of system algorithms based on “real

world" data and improvement of classification accuracy to the design goal of 99.5 percent. The design used by SEO for this detector allows its firmware to execute the axle-counting algorithm without a dedicated computer to perform post-processing. Vehicle classification and axle count are reported within 25 milliseconds of vehicle passage. The release date for the *Autosense IIA* to be available to the general public was scheduled for April 1999. The *Autosense IIA* is the only non-intrusive detector identified by the authors that can classify according to the standard FHWA classification scheme using number of axles and axle spacings.

4.2.2 Microwave Sensors

As noted earlier, ODOT uses EIS RTMS units in five locations to collect traffic volume data. ODOT also owns four Off Road Axle Detection Sensors (ORADS) developed and constructed as part of a research project. In addition, ODOT provided funding for an Ohio University research project on Improved Work Zone Design Guidelines. As part of this study, they will be purchasing 16 mobile trailer units equipped with non-intrusive sensors. ODOT will receive these units once the study is complete. ODOT also has tested video (Autoscope) and acoustic. ODOT feels that the main disadvantages are no classification information and difficult set-up.

Virginia DOT is actively researching several non-intrusive technology devices. To date, only the RTMS sidefire radar has been approved for use. It can be used as a portable detector and has the required accuracy needed. Virginia DOT has reviewed other non-intrusive products, but none has met their current needs. For example,

- Laser-detector technology may have an inherent limitation with respect to roadway crown at some locations.
- Due to occlusion (vehicles being missed due to being in the shadow of a larger vehicle), current technology limitations may not provide the needed performance at the more difficult congested traffic locations.
- Acoustic sensors require a higher setup requirement and do not meet the portable requirements of the current portable system. However, VDOT's ITS groups are working on establishing permanent count sites with acoustic sensors and the intention is to share these data.

Caltrans tested RTMS extensively but did not obtain favorable results, including long set-up times and occlusion problems. However, Caltrans recognizes that these technologies have improved since and has developed guidelines/requirements for non-intrusive detectors. The draft guidelines are intended to help California personnel make educated estimates of whether microwave sensors can fulfill their requirements. The document contains checklists of requirements that must be met, test results of various microwave models, technology descriptions, and installation overviews.

VDOT uses a portable customized side fire RTMS device for high-volume freeway. The device needs some training to set up and calibrate but works well for volume counts. TTI tested the accuracy of RTMS at a site on the I-35 in Texas. This site does have stop-and-go traffic sometimes during the peak periods so it provides a good test for non-intrusive sensors. It was noted that the RTMS has to be located a minimum of about 18-ft from the nearest traffic lane to be effective. Detectors located less than 6-ft from the nearest lane did not yield reasonable

results for that lane. The results indicate that, RTMS accuracy ranges 0 to 5 percent and that occlusion reduces accuracy (both counts and speeds). Also, slow speeds compromise RTMS accuracy. With regards to setup time, it was observed that it takes about an hour per lane even with trained personnel.

4.2.3 Passive Acoustic Detection Systems

The SmarTek SAS-1 is a passive acoustic detector that monitors vehicular noise (primarily tire noise) as vehicles pass the detection area. The detector can monitor as many as five lanes and the SAS-1 must be oriented in a sidefire position. Precise alignment is not critical because the sensor can cover a wide area. Heights recommended by the vendor range from 25 feet to 40 feet, and the recommended offset range is 10 feet to 20 feet. Higher mounting positions can reduce the effects of occlusion in multiple lane applications.

TTI research found that the SAS-1 predominantly undercounted in both peak and off-peak conditions. The SAS-1 speed estimates were within 5 to 10 mph of baseline during some peak periods but as much as 20 to 25 mph different in others. Free-flow speed estimates were usually within 5 mph of baseline speeds (Middleton and Parker, 2002). TTI has not tested the accuracy of the SAS-1 vehicle classification algorithm.

The Traffic Monitoring Unit of the New York State Department of Transportation has successfully developed a permanent acoustic traffic monitoring site. This type of site was developed in-house by NYSDOT personnel to support non-intrusive sensor technology with applications in data collection and ITS activities. The conceptual priority for use of this type of site was installation on facilities where the cost of in-pavement sensors was not justified due to roadway and traffic conditions that greatly limited sensor service life. Use of this type of site greatly reduces data collection costs, but still meets the needs of the Department. Each site consists of a Smartek SAS-1 acoustic sensor mounted on an existing light pole or sign structure at a height of 30 to 40 feet, structure dependant. A small cabinet mounted at the base houses Smartek electronic and communication interfaces as well as power management electronics. The platform is supported by a 12 volt electrical system with one 50 watt Kyocera solar module charging two 75 Ah deep-cycle batteries to supply power. A Trafinfo.com Trafmate digital pager is used to download archived data via telemetry.

In addition to using the acoustic sensors as permanent stations, NYSDOT also has four mobile platforms equipped with the sensor for portable counts including coverage counts, special counts and some ITS design applications. Four Mobile Traffic Monitoring Platforms have been built to date. Each is used to collect volume data on high-speed, high-volume multi-lane facilities where safety concerns or equipment limitations prevent use of typical collection methods. Each platform supports a Smartek SAS-1 acoustic sensor extended on a 35-foot telescoping mast. The platform weighs approximately 1000 pounds, is easily transportable, and can be erected outside the traveled way and operational in approximately 30 minutes.

The cost of each platform fully outfitted with solar power, deep-cycle batteries, a telescoping 35-foot mast, acoustic sensor, and supporting electronics is approximately $7,000. A somewhat

similar commercial version of the platform is available for approximately $28,000. However, that setup uses a different type of sensor with a high power consumption rate. It requires generator-supplied power and has no communications capability. The in-house research, development, and construction of this project represent an initial cost savings to NYSDOT of approximately $21,000 for each platform. The anticipated life span of the clean, maintenance free, solar cell-charged deep-cycle batteries is five years with no additional fuel costs. The batteries are recycled at the end of their useful life. The average cost of construction of one three-to-six-lane count site with loop sensors that is typically used for only a few weeks during the life span of the loops is approximately $30,000. Each count taken utilizing the platform at each location will save the Department $30,000 each time. Assuming two trailers will be used to take a minimum of ten scheduled counts each year on facilities with three or more lanes, the benefit cost ratio for such a device was estimated to be 21:4.

4.2.4 Video Image Detection Systems

A video image detection (VID) system consists of one or more cameras providing a clear view of the area, a microprocessor-based system to process the video image, and a module to interpret the processed images. Advanced VID systems can collect, analyze, and record traditional traffic data; detect and verify incidents; classify vehicles by length; and monitor intersections. The ability of VID systems to classify vehicles is generally limited to daylight hours unless street lighting is bright enough for the VID's daytime algorithm. Their nighttime detection algorithms depend on detection of headlights, and the systems cannot distinguish between the various headlights of individual vehicle classes. It should also be noted that video systems on the market today provide only three to five vehicle length classifications. Therefore, these systems cannot be used to classify by axles as required by the FHWA classification scheme unless approved by FHWA. The most recent Texas Transportation Institute (TTI) tests indicate some very promising features of one VID system, the Autoscope Solo Pro, but its classification accuracy was not included in the tests.

4.3 Equipment Summary

While there have been rapid advances in vehicle detection technology, inductive loops and piezo electric sensors are considered by states as the most efficient way to collect traffic data. Improvements in loop installations and vehicle counters have greatly reduced the problems associated with inductive loops. Advanced vehicle counters with loop signatures-based detection and classifications promise to build upon the improvements. However, the use of loops continues to be cumbersome due to its inherent requirements such as pavement cutting, traffic control and lane closures, and maintenance problems. Pneumatic tubes are the preferred technology for short-term counts.

Non-intrusive detectors provide an alternative to minimize or eliminate some of the safety and maintenance issues with loops and tubes. These technologies include infrared-, acoustic-, microwave-, and video-based sensors. Various tests have shown that these sensors currently meet requirements as far as volume monitoring is concerned but fall short on classification of vehicles.