FRESNO COUNTY SB 743 IMPLEMENTATION TECHNICAL REPORT

LSA

March 2021

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Fresno Council of Governments

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CHAPTER 1: FRESNO COUNCIL OF GOVERNMENTS ACTIVITY-BASED MODEL BASE YEAR UPDATE (2014 TO 2019) METHODOLOGY

1.1 The 2014 Socioeconomic Dataset

The base land use and demographic data associated with the base 2014 Fresno Activity-Based Model (ABM) is a socioeconomic dataset that estimates residential and employment information at the parcel level. Residential data include built housing units by type, occupied housing units (households), household population, group quarters population, and school enrollment by age group.

1.2 Capturing Residential Growth from 2014–2019

A variety of datasets were analyzed to determine Micro Analysis Zone (MAZ)-level household growth.

1.2.1 Jurisdictional Population and Housing Estimates from the California Department of Finance

Jurisdictional targets for occupied and unoccupied housing units were attained for 2019 by referencing the California Department of Finance (DOF) Table E-5: "Population and Housing Estimates for Cities, Counties, and the State."[1] Relevant data points from this dataset include the following, by city and for the unincorporated area: household population; group quarters population; housing units by type; occupied housing units (households); vacancy rate; and average household size. Fresno Council of Governments (FresnoCOG) sought to match these estimates in its 2019 land-use data.

Group quarters population by MAZ were determined by scaling existing group quarters data from 2014 to match jurisdiction targets for 2019.

1.2.2 Residential Permits from Municipalities

Permit data were collected from each local jurisdiction, including all residential new construction and demolition permits from 2014 to 2019. These data were geocoded by assessor's parcel number and/or street address and incorporated into the base 2014 parcel fabric dataset to create an approximation of constructed housing units for 2019.

1.2.3 Aerial Photography

Where there were gaps between the updated residential unit data and the jurisdiction counts from the DOF, FresnoCOG staff referred to Bing aerial photography to validate and add omitted or incomplete information to the dataset.

Once the residential unit counts represented the estimates from the DOF, average vacancy rates by jurisdiction from Table E-5 were applied to the housing unit counts to generate occupied unit counts by MAZ. These data, in addition to other relevant information (such as residential unit types by

[1] https://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-5/

Traffic Analysis Zone [TAZ] and county household population) were used to generate the synthetic population in PopulationSim.

1.3 Capturing Employment Growth from 2014–2019

Employment growth from 2014–2019 was estimated based on permit data and adjusted to match 2019 regional industry labor statistics from the California Employment Development Department (EDD).

1.3.1 Commercial Permits from Municipalities

Along with residential permits (see above), commercial development permits were also collected from each local jurisdiction from 2014 to 2019. These data were geocoded by assessor's parcel number and/or street address to determine the locations of new businesses. Employment values and industry types for these businesses were estimated based on permit information and by referring to data from similar businesses in the region.

1.3.2 Business Employment Counts from Various Sources

New business employment counts were verified using a variety of sources, depending on business size and availability. Validation sources included business representatives, with data from manta.com, and/or other sources as available.

1.3.3 Regional Employment Values by Industry from the California Employment Development Department

Annualized 2019 employment by industry data were acquired from the EDD[2] and translated into Fresno ABM employment categories to create employment targets by type. Industry employment from existing businesses were adjusted regionally to match the reported totals from the EDD.

1.3.4 School Enrollment Data from the National Center for Education Statistics

Regional school enrollment targets for 2019 was taken from the National Center for Education Statistics (NCES).[3] Enrollment for new schools and educational centers was determined by contacting faculty and/or estimated based on average employment-to-enrollment ratios for similar facilities, depending on availability. Regional enrollment was then adjusted to match totals from the NCES.

Once these data were complete, they were aggregated by MAZ and incorporated into the 2019 Fresno ABM land use input dataset.

1.4 Model Network

Base year 2014 highway and transit network were edited to fit the 2019 scenario.

2 https://www.labormarketinfo.edd.ca.gov/data/employment-by-industry.html.
3 https://nces.ed.gov/ccd/elsi/tableGenerator.aspx (grade school); https://nces.ed.gov/ipeds/use-the-data (college).

1.4.1 Highway Network

The projects completed between 2014 and 2019 were coded in the master highway network. The coded projects include the capacity expansion and bike and pedestrian projects. The list of major capacity expansion projects completed in between 2014 and 2019 is included as Appendix A.

1.4.2 Transit Network

Bus Rapid Transit (BRT) service was launched by Fresno Area Express (FAX) on the Blackstone-Kings Canyon corridors in February 2018. The frequency of the BRT during the peak period is 10 minutes. After the introduction of BRT, existing FAX 30 service was discontinued. Also, 15-minute service started on FAX 9 (on Shaw Avenue) and FAX 38 (on Cedar Avenue) in January 2017. All these transit lines are defined as the high-quality transit corridors because of 15-minutes-or-less frequency. All these changes were incorporated into the existing 2014 transit network to create a 2019 transit network.

CHAPTER 2: ESTABLISH APPROPRIATE VMT METRICS

FresnoCOG with assistance from LSA has chosen to use California Office of Planning and Research (OPR) suggested efficiency metrics of Vehicle Miles Traveled (VMT) per capita and VMT per employee in the evaluation of land use projects. Both VMT per capita and VMT per employee metrics include two components of VMT: internal-internal (I-I) VMT and internal-external (I-X) or external-internal (X-I) VMT. FresnoCOG's ABM uses DaySim to simulate individual travel and estimation of VMT. However, DaySim estimates only the I-I portion of VMT. The I-X/X-I portion of the VMT is estimated using external trips in the model. The following sections describe, in detail, the development of VMT per capita and VMT per employee metrics using the ABM.

2.1 VMT per Capita

LSA used ABM's DaySim to estimate I-I VMT for the households. The DaySim simulates individual travel in the region and so it was possible to track and include all trip purposes of household individuals in the estimation of household VMT. The calculations are not constrained only to home-based trip purposes as in a trip-based model.

2.1.1 Development of I-I VMT

LSA used the 2019 land use data and 2019 roadway and transit networks to conduct the model run for use in the VMT threshold development. One of the outputs from the DaySim is a roster of all I-I trips that occur in the county. The trip roster includes details such as identity of the person making the trip, the corresponding household identification, trip purpose, origin TAZ, destination TAZ, trip duration, trip time, and the trip length of the trip. Trip file along with the DaySim household file is used to estimate VMT per capita for each TAZ. More details about the trip roster can be found in FresnoCOG's ABM documentation.

The following steps detail the development of the I-I portion of VMT per capita.

1. The trip roster file (model run folder\11_DaySim_trip.tsv) contains information about all I-I trips.
2. Each record in the trip roster has a sample weight (trexpfac) of 0.33 to account for model randomness. Each person is sampled 3 times in the DaySim to minimize the result variations, thus giving each person a weight of 0.33.
3. The average trip length for each trip (travdist) is also included in the trip file.
4. VMT of each trip is estimated by using trip distance and expansion weight (VMT = trexpfac × travdist). The expansion factor/weight is used to account for the sampling as described above.
5. Trip VMT is aggregated to household ID (hhno) to estimate the household VMT.
6. DaySim folder also includes a sample household file (model run folder\11_DaySim\ _household.tsv) that includes household ID (hhno) and the household characteristics such as household size, income, and workers.

7. Aggregated VMT at the household from the trips file are joined (join field – hhno) to the household file (_household.tsv) from above to arrive at household VMT and the corresponding TAZ.
8. The joined file from the above step is aggregated by the household TAZ (hhtaz) and household weight of 0.33 (hhexpfac) to estimate total VMT and household population for each TAZ.
9. Total VMT and household population (VMT/population) is used to estimate I-I VMT per capita for each TAZ.

2.1.2 Development of I-X VMT

The above-described methodology only accounts for trips that have both of the trip ends within the county, i.e., I-I trips only. However, the OPR Technical Advisory (TA) suggests not to truncate the trip lengths at the jurisdiction border and to account for the entire trip length even if the trip crosses the jurisdictional boundary. In order to account properly for the external trip lengths, LSA used California Statewide Transportation Demand Model (CSTDM). See Figures 2.1 and 2.2. CSTDM and Worker Fraction File were used to estimate I-X and X-I VMT and distribution of I-X/X-I VMT to residential and non-residential shares appropriately. The following steps describe the I-X/X-I VMT computation in detail.

1. Estimate adjustment for the FresnoCOG model's external centroid connector lengths is based on weighted average trip lengths from CSTDM. Trips that have only one trip end within Fresno County and the other trip end outside the county were used in this estimation process.
2. To avoid any unintended consequences to the ABM's calibration and validation, the following process was used to estimate modified (due to update of external centroid connectors) I-X/X-I VMT.
    A. Start a new model run and just run the "Input Processing" step of the model.
    B. Open the model network for the scenario (scenario folder\00_InputProcessing*.net).
    C. Adjust the length (DISTANCE) of the model's external centroid connectors based on adjustments from CSTDM (see Table 2.1).
    D. Run new skims with adjusted centroid connector lengths.
    E. Estimate updated external station VMT using Origin-Destination (OD) matrices (scenario folder\09_Assignment) from the original ABM run and updated skim matrices (scenario folder\01_Skims) with modified external station connectors.
3. Skim matrices are available for peak and off-peak periods whereas OD matrices are available for four time periods: AM, PM, Off-Peak (OP), and Nighttime (NT). OD matrices are aggregated to peak and off-peak periods. AM and PM OD matrices are combined into peak and OP. NT matrices are combined into off-peak.
4. Distance core (7DIST_ 1Veh) from the updated skim matrices along with aggregated (peak/off-peak) OD matrices were used to estimate I-X/X-I VMT for each model TAZ.

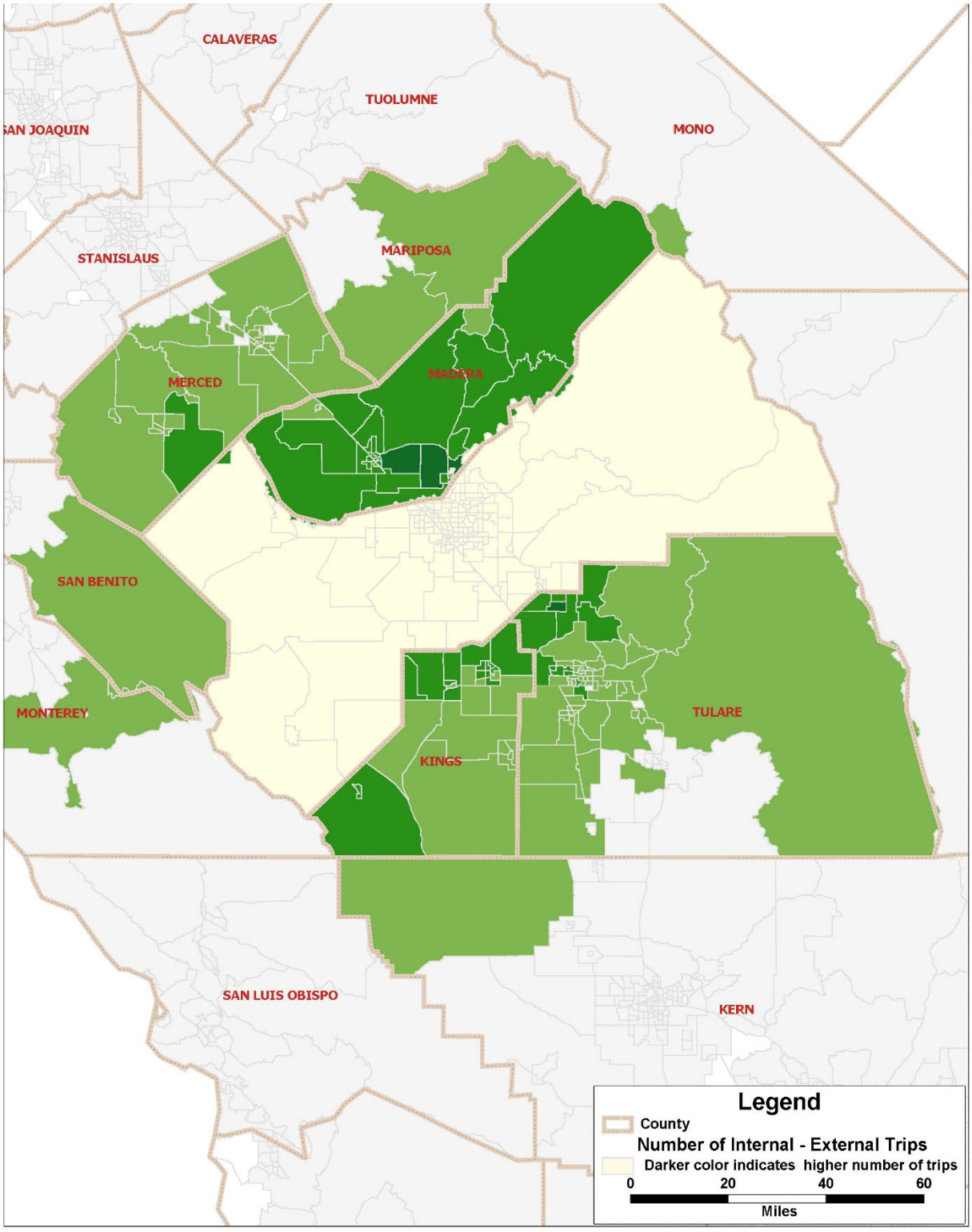

Figure 2.1: CSTDM Fresno County Internal-External Trip Distribution

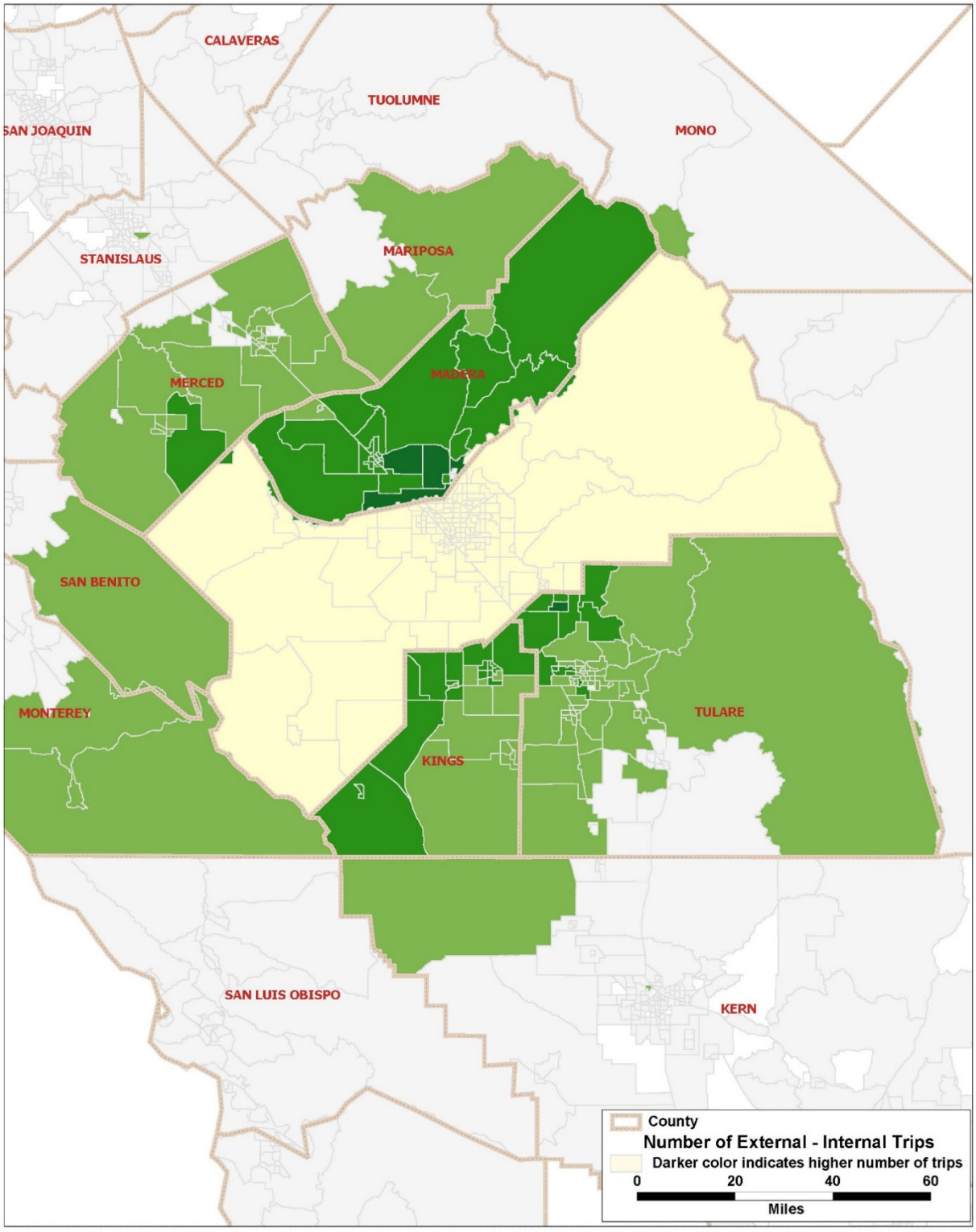

Figure 2.2: CSTDM Fresno County External-Internal Trip Distribution

Table 2.1: CSTDM Adjusted External Centroid Connector Distances

External Station ID	Description	Centroid Connector Length	Adjusted Centroid Connector Length
43	SR 198 W	104.0	98.6
44	Panoche	84.0	84.0
45	Ltl Panoch	84.0	84.0
61	Rt 99 N	68.0	23.7
62	Rt 41 N	39.0	18.1
63	Friant N	73.0	33.8
64	Powerhouse	33.0	15.3
65	SR 249/245	2.5	1.7
66	SR 63 S	44.0	29.9
67	Alta	21.0	14.3
68	Frankwood	26.0	12.3
69	Mtn View	23.0	10.9
70	SR 201 S	25.0	11.9
71	Rt 99 S	81.0	38.4
72	10th Ave	0.5	0.2
73	SR 43 S	51.0	27.2
74	Fowler	0.8	0.4
75	SR 41	63.0	33.6
76	Excelsior	49.0	26.1
77	Marks	25.0	13.3
78	Page/Elder	34.0	18.1
79	SR 198 E	40.0	21.3
80	I 5S	107.0	29.2
81	SR 269 S	74.0	20.2
82	SR 33 S	55.0	15.0
83	Jayne	54.0	14.8
84	I 5 N	143.0	24.8
85	SR 33	42.0	7.3
86	12th/13th	34.0	11.9
87	SR 145 N	61.0	21.3

The I-X/X-I VMT for each TAZ (matrix marginal) estimated from above steps is in OD format. Total I-X/X-I for each TAZ should be distributed between population and employment. FresnoCOG and LSA reviewed available sources such as CSTDM and the previous trip-based model to arrive at the distribution. However, given the differences in the model approaches, the employee fraction file

from the ABM was used for this purpose (model folder\1_Inputs\8_DaySim\05_ixxi\ Fresno_worker_ixxifractions.dat). The worker fraction file identifies, for each TAZ, the number of household workers going outside the county and also the number of jobs in that TAZ that are being filled by workers from outside the county. The following steps describe the distribution methodology.

1. Total I-X/X-I VMT for each TAZ is estimated from the above-detailed approach.
2. For each TAZ, estimate the number of household workers based on the household file (average household workers × number of households).
3. Use the worker fraction file to calculate the number of household workers that are commuting outside the county (worker I-X fraction × number of household workers in the TAZ).
4. Similarly use the worker fraction file and the TAZ employment to estimate the number of jobs in the TAZ being filled by workers from outside the county (worker X-I fraction × number of employees in the TAZ).
5. Distribute the total I-X/X-I VMT from step 1 according to the ratio of household workers (step 3) and employees (step 4) commuting to/from outside the county.

FresnoCOG and LSA understand that this approach is an approximation, but, given the available data, this approach was deemed appropriate. Also, on a typical weekday, there is a much higher probability of people crossing the county boundaries for work purposes; more than any other trip purpose and, therefore, the use of TAZ household workers and employment provides a good approximation in the distribution of total I-X/X-I VMT toward residential and non-residential metrics.

2.2 VMT per Employee

2.2.1 Development of I-I Trips/VMT

In order to account for VMT due to an employee, OPR suggests inclusion of all trips related to the employee. All trips related to primary work tour and their sub tours were used to estimate total II employee-related VMT. The employee-related VMT is assigned to the primary work location of the employee. The employee VMT aggregated to TAZ and total number of employees in the TAZ are used to estimate I-I VMT per employee.

The following steps describe the I-I VMT per employee methodology. The methodology estimates the primary work tour VMT and work sub tour VMT separately as shown below.

1. The trip file (model run folder\11_DaySim_trip.tsv), and tour file (model run folder\11_DaySim_tour.tsv) are used to estimate the employee-related VMT.
2. The tour file is used to select all tours where the primary tour purpose is work using the following conditions:
    - parent = 0 to indicate primary tour;
    - pdpurp = 1 for the work as the primary purpose; and
    - tdadtyp <>4 to identify the regular/primary work location.

3. The tours subset from the above step is joined (tour.id = trips.tour_id) with trip file (model run folder\11_DaySim_trip.tsv) to estimate primary work tour-related VMT using the expansion factors (trexpfac) and trip length (travdist). Each person is sampled three times in the DaySim to minimize the result variations, thus giving each person a weight of 0.33.
4. The VMT from the above step is aggregated to the primary work location TAZ (tdtaz) to estimate TAZ work-related VMT for the primary work tours.
5. The work sub tour estimation follows similar steps as the primary work tour VMT. However, the first step of work subtour selection uses different conditions as shown below:
    - parent >0 indicating the tour is a subtour; and
    - toadtyp =2 to select all trips that have an origin of work.
6. Once the work sub tours are selected, methodology similar to primary work tour VMT is used to estimate the work sub tour related VMT for each TAZ.
7. Primary work tour VMT and work sub tour VMT are aggregated by TAZ to compute total work related VMT. Total work related I-I VMT divided by total employment yields VMT per employee for each TAZ.

2.2.2 Development of X-I Trips/VMT

Section 2.1.2 describes in detail the estimation of I-X/X-I VMT and distribution of I-X/X-I VMT into I-X and X-I components.

Once the I-X component of external VMT is separated for residential inclusion, the X-I component of the VMT is added to the TAZ's nonresidential I-I VMT to estimate TAZ VMT per employee metric.

2.2.3 Limitations of Disaggregating VMT per Employee Based on Employment Type

Even though FresnoCOG's model is an ABM, the employment and work tours/trips are estimated at an MAZ level. The MAZs are similar to TAZs but much smaller in size. Each MAZ contains multiple employment types where work tours occur. The MAZ employment data were reviewed to isolate MAZs with unique employment categories. Given the limited number of unique employment MAZs and the number of assumptions needed to develop a regional VMT per employee metric by employment type, it was determined to include all employment categories in the VMT per employee metric. Also, it should be noted that, although OPR suggests office employment type, most employment categories except agriculture and retail in the model behave in similar fashion to the office category.

CHAPTER 3: VMT SCREENING MAPS DEVELOPMENT METHODOLOGY

3.1 VMT per Capita

As described in Chapter 2, VMT per capita was developed for each TAZ. Jurisdictional sphere of influence (SOI) boundaries were used to aggregate VMT and population totals by jurisdiction. VMT and population estimates (jurisdictional VMT/jurisdictional population) for the jurisdictions were used to estimate VMT per capita for each jurisdiction including unincorporated Fresno County and the County as a whole.

Two different thresholds were developed to assist the jurisdictions with their guidelines. The OPR TA has established a threshold of 15 percent below the existing VMT per capita for residential projects and VMT per employee for office projects. The California Air Resources Board (CARB) establishes greenhouse gas (GHG) emissions targets for each of the 18 Metropolitan Planning Organizations (MPOs) in the State, reviews the Sustainable Communities Strategies (SCSs) and makes a determination whether the SCSs would achieve GHG reduction targets if implemented. FresnoCOG's 2018 Regional Transportation Plan (RTP)/SCS demonstrated a GHG reduction of 10 percent by 2035 through the integrated land use, transportation initiatives, and capital project listing, which meets CARB targets. In the spring of 2018, CARB adopted new GHG targets for all the 18 MPOs in the State based on the 2017 Scoping Plan and other new data. CARB established a 13 percent GHG reduction target for 2035 for the Fresno region's third RTP/SCS. The State recognizes that Fresno County's contribution to the aggregate 15 percent statewide GHG emission reduction is 13 percent. Hence, for FresnoCOG VMT Analysis Guidelines, the option for a threshold of 13 percent has been determined for both residential and office projects in FresnoCOG member jurisdictions. The thresholds were used to identify and categorize the TAZs into a low, medium, or high VMT profiles. For example, the VMT profile classifications with 13 percent threshold have been determined as follows:

- LOW: TAZ VMT per capita is 13 percent or lower than the regional average.
- MEDIUM: TAZ VMT per capita is within ±13 percent of the regional average.
- HIGH: TAZ VMT per capita is 13 percent or more than the regional average.

Maps of VMT per capita illustrating the VMT profiles were created. These maps are intended to assist the land use projects, inform them of the existing VMT profile of project area, and possibly screen the land use projects in case they meet the criteria established in the FresnoCOG VMT Analysis Guide.

3.1.1 Definition of Region

The OPR allows the lead agency discretion to choose the definition of the region for threshold purposes. In case of VMT per capita, there is flexibility to choose the City/Jurisdiction or the entire county as the region; therefore, LSA developed VMT per capita thresholds for all 16 member jurisdictions including Fresno County as a whole. Individual jurisdictions have the liberty to choose the City/Jurisdiction as the region or the County as the region to establish as the threshold in evaluation of residential projects.

3.2 VMT per Employee

VMT for all employment-related trips was aggregated for the entire county, as described in chapter 2. Total employment, including all employment types, along with total employment-related VMT was used to estimate VMT per employee for the entire county.

Similar to VMT per capita, screening maps were created using two thresholds of 13 percent and 15 percent. For example, the VMT profile classifications with 13 percent threshold have been determined as follows:

- LOW: TAZ VMT per employees is 13 percent or lower than the County's average.
- MEDIUM: TAZ VMT per employee is within ±13 percent of the County average.
- HIGH: TAZ VMT per employee is 13 percent or more than the County average.

For office projects, consistent with the TA, FresnoCOG recommends using Fresno County as the region.

3.3 High Quality Transit

A high-quality transit area or transit corridor is a corridor with fixed route bus service/rail service with service intervals no longer than 15 minutes during peak commute hours. Fresno Area Express Route 1, Route 9, and Route 38 are identified using this criterion. Half-mile buffers were created around the route stops/stations to develop the definition of a high quality transit buffer in the region. Projects proposed in these areas may be presumed to have a less than significant transportation impact unless the project is inconsistent with the RTP/SCS, has a floor-area ratio (FAR) less than 0.75, provides an excessive amount of parking, or reduces the number of affordable residential units.

CHAPTER 4: LAND USE PROJECT SCREENING THRESHOLDS BASED ON DAILY TRIPS

4.1 GHG Emission to Daily Trips Correlation Modeling

In order to characterize the effect of changes in project-related average daily trips (ADT) to the resulting GHG emissions, the California Emissions Estimator Model (CalEEMod) was used. This model was selected because it is provided by CARB to be used statewide for developing project-level GHG emissions analyses. CalEEMod was used with the built-in default trip lengths and types to show the vehicular GHG emissions from incremental amounts of ADT. Table 4.1 shows the resulting annual VMT and GHG emissions from the incremental ADT.

Table 4.1: Representative VMT and GHG Emissions from CalEEMod

Average Daily Trips (ADT)	Annual Vehicle Miles Traveled (VMT)	GHG Emissions (Metric Tons CO_2e per year)
200	683,430	258
300	1,021,812	386
400	1,386,416	514
500	1,703,020	643
600	2,043,623	771

Source: CalEEMod version 2016.3.2. Example project used: 50 Single-Family Homes in Orange County.
CO_2e = carbon dioxide equivalent
GHG = Greenhouse Gas

A common GHG emissions threshold is 3,000 metric tons of carbon dioxide equivalent[4] per year (MT CO_2e/yr). The vehicle emissions are typically more than 50 percent of the total project GHG emissions. Thus, a project with 500 ADT would generally have total project emissions that would be less than 1,300 MT CO_2e/yr. As this level of GHG emissions would be less than 3,000 MT CO_2e/yr, the emissions of GHG from a project up to 500 ADT would typically be less than significant.

[4] Carbon dioxide equivalent (CO_2e) is a concept developed to provide one metric that includes the effects of numerous GHGs. The global warming potential (GWP) of each GHG characterizes the ability of each GHG to trap heat in the atmosphere relative to another GHG. The GWPs of all GHGs are combined to derive the CO_2e.

CHAPTER 5: DEVELOPMENT OF THE VMT CALCULATION TOOL

In addition to the development of Senate Bill (SB) 743 guidelines, this project also included development of a simple-to-use VMT calculator tool. The VMT calculator tool was developed to estimate VMT per capita or VMT per employee metrics for relatively small to medium-sized land use projects. The approach for the VMT calculator tool is based on the presumption that addition of relatively small to medium-sized land use projects (residential or nonresidential) in a region will not change the regional travel characteristics significantly.

The VMT tool uses the existing VMT metrics of the TAZ (VMT per capita or VMT per employee) as the primary/starting value. Based on the changes to the land densities, due to the addition of the project, the base VMT metric is adjusted using the elasticities estimated from numerous sensitivity test model runs conducted by FresnoCOG. In addition to the density elasticities, other adjustment factors, such as factors to account for existing mixture of single family and multifamily residential units in a TAZ, is also used in the VMT per capita calculation using the VMT calculator tool.

As stated before, the VMT calculator tool was developed based on the results from numerous ABM sensitivity model runs. FresnoCOG conducted multiple individual model runs for combination of each of the different variables: land use categories (single family, multifamily, and office employment), regional context (urban, suburban, and rural), and magnitude of development. VMT metrics (VMT per capita or VMT per employee) were estimated for each of the runs, which were compared with the existing base VMT metrics. The change in land use densities and change in VMT metrics were used in the development of elasticities. The elasticities were used in the development of the VMT calculator tool.

In addition to the development of elasticities, the sensitivity model runs were used to assist in the development of project size thresholds for the use of the VMT calculator tool in VMT analysis. The VMT calculator tool can be used only to evaluate single-family and multifamily for residential use and office employment for nonresidential use. Following are the project size limitations for VMT calculator use on both residential and nonresidential uses:

- Up to 500 dwelling units; and
- Up to 375 office employees.

5.1 Land Use Project Sensitivity Evaluation

5.1.1 Single-Family

FresnoCOG conducted multiple sensitivity runs to determine the impact of adding single-family residential development on the VMT per capita of a TAZ. FresnoCOG selected three TAZs in different area types to evaluate the changes. Research also indicates sensitivity of VMT to the densities; therefore, multiple magnitudes of the single-family development were tested. A total of 15 sensitivity runs were conducted for a combination of three area types (urban, suburban, and rural) and five densities (addition of 50, 250, 500, 750, and 1,000 households).

Given the travel model is an ABM, the single-family land use category was ensured by use of appropriate values for multiple household variables; household size, household income, auto ownership, etc. The model runs were used to develop elasticities for VMT per capita with respect to single-family development.

VMT metrics (VMT per capita or VMT per employee) include both components of I-I and I-X/X-I VMT. However, the sensitivity runs were used for comparative analysis and estimation of elasticities and so only I-I VMT estimates were used in the analysis. It is assumed that the external component of VMT per capita remains relatively constant.

5.1.2 Multifamily

Similar to single-family, FresnoCOG conducted model runs for multifamily residential units. The household variables, such as household size, household income, and auto ownership, were modified for reflect multifamily characteristics.

A total 15 model runs were conducted for multifamily to account for three area types (urban, suburban, and rural) and five densities (addition of 50, 250, 500, 750, and 1,000 households).

Multifamily households in general have a lower VMT profile than single-family households due to household income, size, auto ownership, household workers, etc. To account for this variation in the VMT calculator tool and as the starting project, VMT per capita is based on an existing model with an adjustment factor to account for the mixture of single-family and multifamily residential dwellings in the existing project. A TAZ was also developed using these sensitivity runs.

5.1.3 Office

FresnoCOG conducted nine model runs to evaluate the impact of employment densities on the VMT per employee metric. The sensitivity runs were conducted for both variables of three area types (urban, suburban, and rural), and three densities (addition of 125, 375, and 625 employees). Similar to residential uses, elasticities developed using these data were used in the VMT calculator tool.

The VMT calculator tool has been validated by estimating VMT metrics using both ABM runs and the VMT calculator tools. The validation indicated that the results from the VMT calculator tool are within 5 to 10 percent of the results from the ABM runs as shown in Table 5.1.

Table 5.1: Comparison of VMT Metrics–ABM and VMT Calculator Tool

Scenario	ABM		VMT Tool		Percent Difference	
	VMT per capita	VMT per employee	VMT per capita	VMT per employee	VMT per capita	VMT per employee
Single-Family (250 households)	16.6		16.4		-1.3%	
Multifamily (246 households)	14.5		15.1		4.2%	

Table 5.1: Comparison of VMT Metrics–ABM and VMT Calculator Tool

Scenario	ABM		VMT Tool		Percent Difference	
	VMT per capita	VMT per employee	VMT per capita	VMT per employee	VMT per capita	VMT per employee
Office (132 employees)		20.4		19.3		-5.2%

5.2 Quantification of Mitigation Measures

As part of the VMT calculator tool, some of the mitigation measures identified in the FresnoCOG SB 743 guidelines were also included. The mitigation measures in the VMT tool are limited to the measures where local data were available and quantification of those benefits due to those mitigation measures was possible. Available Transportation Demand Model (TDM) mitigation measures in the VMT calculator tool include:

- Carpool;
- Vanpool; and
- Affordable housing.

Detailed description of the quantification of benefits due to these mitigation measures and their applicability methodology is presented in the following chapter.

CHAPTER 6: REGIONAL MITIGATION MEASURES CALCULATIONS

LSA, in coordination with FresnoCOG staff, reviewed currently available VMT mitigation measures from various sources such as the California Air Pollution Control Officers Association, OPR TA, and other jurisdictions. The mitigation measures that are applicable to the region were selected and documented as part of the SB 743 guidelines. The mitigation measures collected from different sources included a range of VMT reduction percentages associated with those measures. The range of VMT reductions is based on data from other regions or theoretical. However, for some of the applicable mitigation measures such as vanpool and carpool, observed data were available specific to the region. Observed data from FresnoCOG were used to measure the existing reduction in VMT due to vanpool and carpool use in the region.

6.1 Carpool

FresnoCOG does not administer the carpool program in the region; however, it does collect information about individual carpools in the region to provide carpool matching services. FresnoCOG also provides financial incentive to carpool participants. The provision of carpool matching and financial incentive encourages the participants to provide the carpool information, which is otherwise voluntary.

Carpool data from July 2019 to July 2020 were used to estimate the VMT reduction due to carpools. The data contained disaggregate trip information, which included the user email addresses, trip dates, OD addresses of the trips, number of miles of the trips, and the carpool network (employer name, e.g., CA Department of Corrections and Rehabilitation). The user email addresses are assumed to be unique, so the information was aggregated using the user email addresses. As indicated above, the trip information contained OD addresses; however, in order to apply the VMT reduction benefits depending on a project land use (residential versus non-residential), OD information was converted to home and work locations. The home and work locations were determined after the information was aggregated based on the user email addresses. For majority of the data, the carpool network (employer address) was used to identify the work location. In case the carpool network was unavailable, the addresses were looked up online to determine the location type (home/work).

The home and work addresses were geocoded to identify the carpool VMT reductions by jurisdiction. The raw carpool data contained approximately 59,000 records for the entire year. Once the data were aggregated and cleaned, the data had 303 total unique carpool users of which 156 users had residence in the county. Given the small sample size, it was determined to use area type/ typology definition (urban, suburban, and rural) of the residence locations to estimate the VMT reduction benefits, instead of the jurisdiction. Also, it was acknowledged that the average trip length of carpools vary more by the area type of the residence than the particular jurisdiction itself. Figure 6.1 identifies the home and work locations of the carpool users. Table 6.1 shows the average carpool trip lengths by area type/typology.

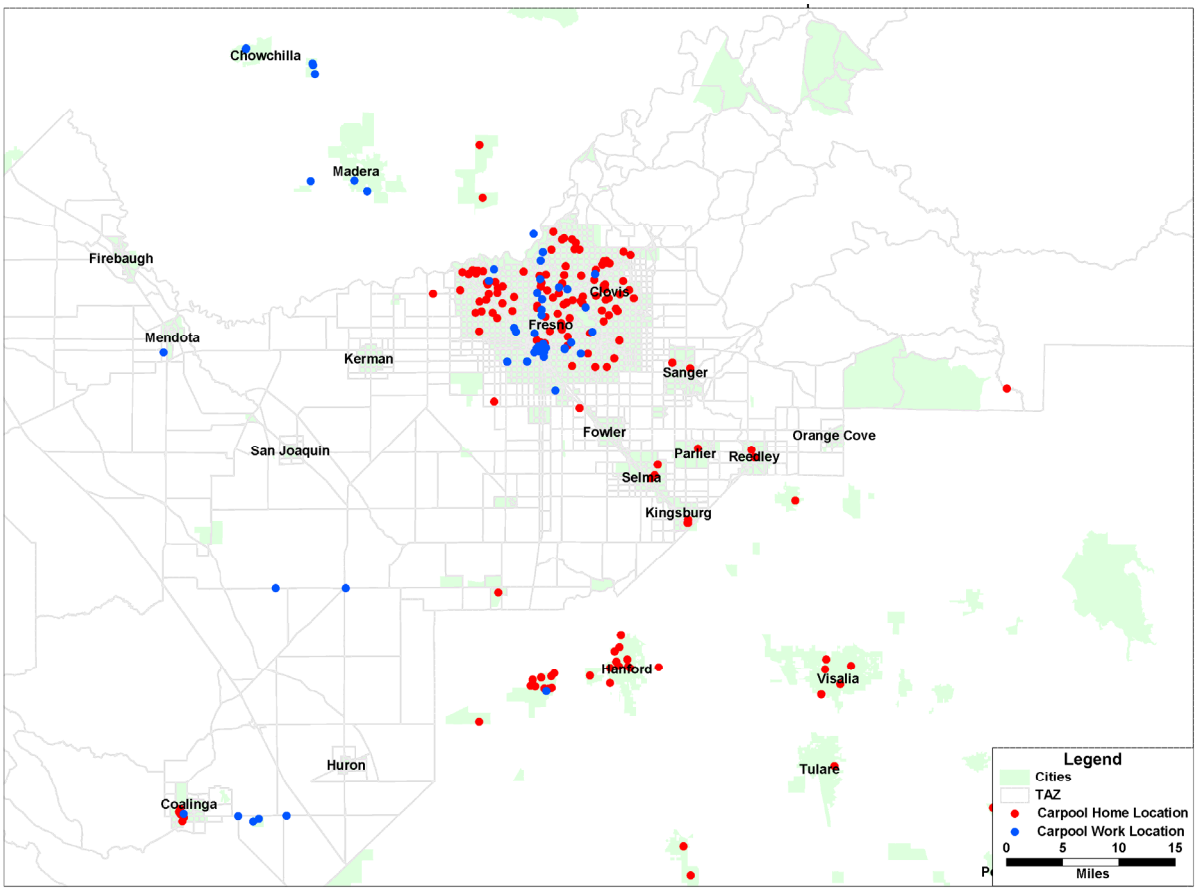

Figure 6.1: Home and Work Locations–Existing Carpool Participants

Table 6.1: Carpool Average Trip Length by Area Type/Typology

Home Location Typology	No of Carpools	Total Daily One-Way Miles (for all Carpools)	One-Way Miles per Carpool
Urban	120	2,603	21.7
Suburban	24	497	20.7
Rural	12	341	28.4
Total	156	3,440	22.1

The following steps identify the assumptions and methodology of VMT reduction calculations due to carpool for a residential project.

1. One carpool participant is assumed for each household participating in the carpool program.
2. Average trip length for the carpool was determined from Table 6.1 (based on the TAZ area type/ typology)
3. An average auto occupancy of 2 was assumed for carpool calculations to be conservative.

4. The total project residential VMT was estimated based on existing VMT per capita of the project TAZ:
    - Project VMT = no of households × TAZ average household size × TAZ VMT per capita.
5. For each carpool a total of 2 times the average trip length was reduced from the project VMT estimates, to account for round trip.
    - Project VMT with carpool reductions = Project VMT – 2 × Average Trip Length × (carpool participants – carpool participants ÷ 2).
6. It should be noted that the average trip length for carpool trips might be much longer than VMT per capita of the TAZ. VMT per capita includes all trip purposes whereas the carpool trips are mostly work-related. Typically, trips between home and work locations have the longest trip length compared to other trip purposes.

The carpool reduction in VMT is included in the VMT calculator tool. However, a separate spreadsheet tool was also developed to estimate the VMT reductions due to carpools in case the ABM was used for project's VMT evaluation.

6.2 Vanpool

Similar to carpool, local vanpool data were available from FresnoCOG. The vanpool program in the region is administered by third-party operators; however, FresnoCOG had access to the vanpool data as a funding partner. The vanpool data were available for Fiscal Year 2019–2020 and contained information about van coordinator, van ID, number of people in the van, total number of miles traveled during the month, and OD addresses. Even though the data were for the year, the data only contained average monthly miles traveled information and disaggregate information was not available. OD information from the vanpool data was geocoded so that the data could be aggregated to the work location area type/typology for average trip length analysis.

The methodology to estimate the VMT benefits due to vanpool was borrowed from "San Diego Association of Government's (SANDAG) *Mobility Management VMT Reduction Calculator Tool.*" The formula below estimates the percentage VMT reduction due to vanpool.

$$\% \text{ Change in VMT} = (M_A \times L_A + M_V \times L_V \div O_V) \div (M_A \times L_A + M_V \times L_V) - 1$$

M_A = auto (non-vanpool) mode share
M_v = vanpool mode share
L_A = length of average auto commute trip
L_V = length of average vanpool /long commute trip
O_V = Average vanpool occupancy

The vanpool mode share is estimated based on the user input for the project. The auto mode share is estimated using existing employment, project employment, and project vanpool percentage. A weighted auto mode share is calculated using these three variables. Average trip length for auto commute trips is obtained from the model data aggregated to the three regional typologies. Average trip length for the vanpool was obtained from observed and geocoded vanpool data. Average vanpool occupancy was left at its default of 6.25, from the SANDAG tool. Auto trips and

VMT from the existing travel model along with the vanpool data were aggregated to the three typologies (urban, suburban, and rural) for use in the analysis. Since vanpool programs are mostly work-related, the vanpool VMT reductions are applicable to non-residential land uses only. Figure 6.2 identifies home and work locations of the vanpool participants in the region. Table 6.2 shows the average vanpool trip lengths by area type/typology.

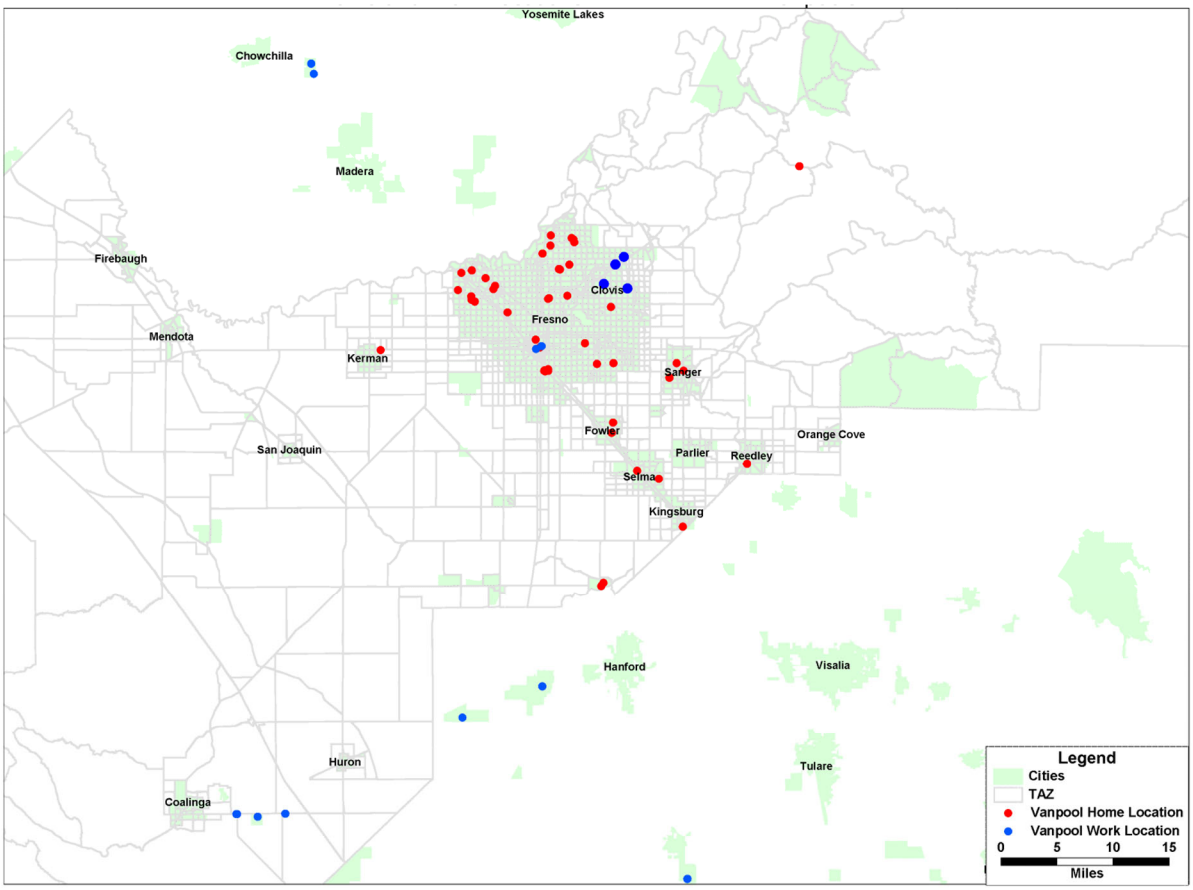

Figure 6.2: Home and Work Locations–Existing Vanpool Participants

Table 6.2: Vanpool Average Trip Length by Area Type/Typology

Work Location Typology	No of Vanpools	Total Daily One-Way Miles (for all Vanpools)	One Way Miles per Van
Urban	2	48	24.0
Suburban*	0	—	74.7
Rural	21	1,568	74.7
Total	23	1,616	70.3

* *No data points were available. Used Rural trip length for Suburban*

The VMT reduction due to vanpool is included in the VMT calculator tool. Additionally, the spreadsheet tool cited above for carpool also includes vanpool VMT reduction calculations, in case the ABM is used for the project VMT evaluation.

6.3 Affordable Housing

Research indicates that number of trips and VMT can be correlated to household income in addition to other household variables. Low-income households have a lower VMT compared to higher-income households. Inclusion of affordable housing can be considered as a mitigation measure or project feature in case of land use projects. LSA reviewed available research to quantify the VMT reduction due to affordable housing and used "Income, Location Efficiency, and VMT: Affordable Housing as a Climate Strategy" by Gregory L. Newman and Peter M. Haas as the source. The research was conducted using California Household Travel Surveys to include data for the entire State. The purchasing power in different parts of California vary significantly and so the household incomes were normalized for use in the research.

Based on the research, the reduction in VMT for low-income housing has been stratified into multiple categories based on income and regional context. The low-income households were disaggregated into low, very low, and extremely low income households. In the regional context, the VMT reductions are disaggregated by rural areas, small cities, and metro regions. Extremely low income households in metro regions had the lowest VMT compared to all other categories of low incomes and regional contexts. Based on the discussions with FresonCOG, given the local context, and to be conservative, low income category in rural and small cities was deemed applicable categories for Fresno County. Table 6.3 shows the categories and their corresponding percent reductions in VMT.

Table 6.3: VMT Reductions for Affordable Housing

Income Category	Regional Context	Percent reduction in VMT
Low Income	Rural Areas	7.9%
	Small Cities	9.8%
	Metro Regions	10.2%
Very Low Income	Rural Areas	19.5%
	Small Cities	24.2%
	Metro Regions	25.2%
Extremely Low Income	Rural Areas	25.3%
	Small Cities	31.3%
	Metro Regions	32.5%

Percent reduction in VMT per capita due to affordable housing is also included in both the VMT calculator tool and the spreadsheet tool along with carpool and vanpool mitigation measures.

APPENDIX A

MAJOR CAPACITY EXPANSION PROJECTS COMPLETED IN BETWEEN 2014 AND 2019

PROJECT ID	PROJECT TITLE	PROJECT DESCRIPTION	LEAD AGENCY	STREET NAME	PROJECT LIMITS	OPEN TO TRAFFIC
FRE090602	Temperance Ave, N and S of Sierra Travel Lane Improvements 1 to 2 lanes	Center and outside travel lane improvements on Temperance Avenue north and south of Sierra Avenue. Widen to two lanes of travel in each direction.	Clovis, City of	Temperance	From:N/O Sierra To:S/O Sierra Dist:0.5	2015
FRE092509	Temperance Ave-From Enterprise Canal to Shepherd	Temperance Ave: From Enterprise Canal to Shepherd; Widen from 3 LD to 4 Lane Divided Expressway/Arterial & Install Traffic Signal at Nees and paving, curb & gutter, sidewalk, irrigation, street lights, and landscaping.(Measure C Project E1 in the Urban Regional Program)	Clovis, City of	Temperance	From:Enterprise Canal To:Shepherd Dist:.5	2015
FRE110604	Alluvial Avenue-Fowler to McKelvy: Install Center Travel Lane	Alluvial Avenue, between Fowler and McKelvy Avenues; Install 12' Center Travel Lane	Clovis, City of	Alluvial	From:Fowler Avenue To:Mckelvy Avenue Dist:.75	2016
FRE111303	Willow-1/8 Mile North of Alluvial to Alluvial	Construct curb, gutter, AC pavement and pedestrian sidewalk improvements, including ADA compliant curb returns, striping, and the relocation of utilities. Construct outside travel Lane on East side; street lights, median curb, landscaping and bike lane. Measure C Project D3 in the Urban Regional Program.	Clovis, City of	Willow	From:Alluvial To:1/8 mile North of Alluvial Dist:.08	2017
FRE111325	Shaw-Locan to Maine: 2 LU to 6 LD	Widen from 2 LU to 6 LD; curb & gutter; street lights; sidewalk; traffic signal(Measure C Project L1 in the Urban Regional Program)	Clovis, City of	Shaw	From:Locan To:Maine Dist:0.25	2015

PROJECT ID	PROJECT TITLE	PROJECT DESCRIPTION	LEAD AGENCY	STREET NAME	PROJECT LIMITS	OPEN TO TRAFFIC
FRE111332	Willow Widening-Shepherd to Perrin	Construct 2nd & 3rd NB Lanes; curb & gutter, concrete median, landscaping & irrigation; Signal @ Perrin (part of Measure C Project D1 in the Urban Regional Program-split between FRE's 111332, 111340, 111341, 111342)	Clovis, City of	Willow	From:Shepherd Ave To:Perrin Ave Dist:N/A	2018
FRE111336	Alluvial Avenue-Fowler to Sunnyside: Construct Outside Travel Lane	Alluvial Avenue, between Fowler and Sunnyside Avenues; Construct 12' EB Outside Travel Lane; street lights	Clovis, City of	Alluvial	From:Fowler To:Sunnyside Dist:0.5	2016
FRE111339	Shaw-DeWolf to Highland: 2 LU to 6 LD	6 LN Divided expressway; travel lane; curb & gutter; street lights; median; landscaping; under crossing (part of Measure C L2 in the Urban Regional Program-split between FRE's 111326 and 111339)	Clovis, City of	Shaw	From:DeWolf To:Highland Dist:N/A	2018
FRE111340	Willow Widening-Perrin to Behymer	Construct 2nd & 3rd NB Lanes; curb & gutter, concrete median, landscaping & irrigation; Signal @ Perrin (part of Measure C Project D1 in the Urban Regional Program-split between FRE's 111332, 111340, 111341, 111342)	Clovis, City of	Willow	From:Perrin To:Behymer Dist:.50	2018
FRE092517	Mountain View Ave, Bethel to East of Smith-Widen from 2 LU to 4 LD	Mountain View Ave.: From Bethel to e/o Smith (Tulare County Line); widen from 2 LU to 4 LD.(Measure C Project I in the Rural Regional Program)	Fresno County	Mountain View	From:Bethel To:Tulare County Line Dist:N/A	2017
FRE070609	Willow-0.25 miles South of Nees to Shepherd	Operational improvements to relieve congestion and reduce delay on Willow Ave. This project will add 2 additional southbound lanes within the project limits.(Measure C Project D5A in the Urban Regional Program)	Fresno, City of	Willow	From:0.25 miles South of Nees To:Shepherd Dist:N/A	2015

PROJECT ID	PROJECT TITLE	PROJECT DESCRIPTION	LEAD AGENCY	STREET NAME	PROJECT LIMITS	OPEN TO TRAFFIC
FRE110619	Herndon Westbound Auxiliary Lane-Fresno St to SR 41	Herndon Westbound Auxiliary Lane-Fresno St to SR 41	Fresno, City of	Herndon	From:Fresno St To:SR 41 Dist:N/A	2018
FRE110620	Herndon Avenue-Brawley to Valentine:Widen to 6 Lanes	Herndon Avenue Widening from Brawley to Valentine Ave 4 to 6 lanes (Measure C Project K5a)	Fresno, City of	Herndon	From:Brawley AveTo:Valentine Ave Dist:0.5	2015
FRE130010	Herndon Avenue Widening from Brawley to Blythe	Herndon Avenue from Brawley to Blythe; Road Rehabilitation and Widening from 4 to 6 Lanes. INCLUDED FOR INFORMATIONAL PURPOSES ONLY(Measure C Project K5B and K5C in the Urban Regional Program)	Fresno, City of	Herndon	From:Brawley To:Blythe Dist:.5	2019