CHAPTER 5B

Vehicle Miles Traveled and Roadway Congestion Trends and Performance

Vehicle Miles Traveled (VMT)

This section discusses why SACOG measures and monitors VMT, defines the various types of VMT that are modeled and analyzed for the MTP/SCS, reports observed trends in VMT in the region, reports the VMT performance of the MTP/SCS, and explains the VMT performance of the MTP/SCS.

Why We Measure VMT

A vehicle mile traveled, or VMT, is literally one vehicle traveling on a roadway for one mile. Regardless of how many people are traveling in the vehicle, each vehicle traveling on a roadway within the Sacramento region generates one VMT for each mile it travels. For this section and most of SACOG's technical analysis, VMT is estimated and projected for a typical weekday, as defined in Chapter 5A.

VMT is and has been a primary indicator of travel for policymakers and transportation professionals for decades. The prevalence of this measure is due to several factors:

First, it is relatively easy to measure by counting traffic on roadways at different locations. It is one of the few measures of transportation performance that has been consistently and comprehensively monitored and documented over time in the region.

Second, VMT bears a direct relationship to vehicle emissions, although the relationship is complex moving into the future. State[1] and federal[2] policies pertaining to vehicle efficiency and formulation of vehicle fuels suggest that on a per VMT basis, emissions for most pollutants will decline relative to today. However, even with these per VMT improvements due to fuel and vehicle technology changes, lower VMT will mean lower emissions. Looked at another way, lowering VMT is a way to expand the reductions expected from fuel and vehicle technology improvements.

Third, VMT can be influenced by policy in a number of different ways. By providing more attractive alternatives to driving alone, VMT can be reduced by shifting from vehicle to non-vehicle modes (i.e., from a car trip to a bike or walk trip), or from low occupancy to higher occupancy vehicles (i.e., from a single-occupant vehicle trip to a carpool or transit trip). VMT can be influenced by land use patterns as well. A better mix of residential, employment, education, and service uses in an area can allow people to accomplish their daily activities with less driving, and consequently, less VMT.

Fourth, VMT correlates with congestion. The more miles people are driving their vehicles, the more vehicles there are on the roadways at any given time. Higher numbers of vehicles eventually result in congestion.

Finally, VMT correlates with frequency of traffic accidents. Although vehicle design and safety features, roadway facility design and traveler behavior affect the frequency and severity of accidents, a major factor in determining the number of accidents that occur is the amount of travel. Safety analysts and researchers usually normalize the number of accidents with VMT in order to track and understand accident trends.

1 AB 1493 (Pavley rule) vehicle efficiency standards, and low-carbon-fuel standards (Executive Order S-01-07), implemented as part of California's Global Warming Solutions Act (AB 32)

2 National Highway Transportation Safety Administration Corporate Average Fuel Efficiency (CAFE) vehicle efficiency standards http://www.nhtsa.gov/cars/rules/cafe/overview.htm

Definitions of VMT Reported

Although the basic definition of VMT is one vehicle traveling on a roadway for one mile, VMT is reported here in two different ways: total VMT and VMT attributed to source: household-generated, commercial vehicle, or external.

Total VMT is all VMT for all types of vehicles totaled together. In this report, total VMT is reported by the geography in which it occurs, based on the locations of the roadways being analyzed. So, for example, total VMT reported for Sacramento County includes all VMT on roadways within Sacramento County, even though some VMT that occurs on Sacramento County roadways is generated by travelers residing outside Sacramento County, and vice versa.

VMT attributed to source splits VMT into one of three categories: household-generated, commercial vehicle, and external.

- Household-generated VMT includes VMT generated by residents of the region, for their travel within the region. Household-generated VMT includes vehicle travel for normal commuting, going to school, shopping, and personal business. Household-generated VMT usually includes about 80 percent of total VMT.
- Commercial vehicle VMT includes VMT generated by commercial vehicles moving goods or services within the region. Commercial vehicle VMT is usually about 15 percent of total VMT.
- External VMT includes VMT generated by passenger vehicles traveling through the region. Through-trips by commercial vehicles are tallied with commercial vehicle VMT described above. External VMT usually includes slightly less than 5 percent of total VMT.

Observed Data and Recent Trends in VMT

Observed VMT is collected by Caltrans as part of the Highway Performance Monitoring System (HPMS). HPMS data are based on a sampling approach, in which a sample of roadways of different types (e.g., freeway, rural highway, principal arterial) are counted, and statistically expanded to estimate total VMT in different areas within the state. Table 5B.1 provides a county-by-county tabulation of VMT within the region for 1996 through 2012.

- From 1996 to 2000, VMT growth (2.5 percent per year) outstripped population growth (2.0 percent per year), and VMT per capita increased (0.5 percent per year)
- Since about 2000, population growth, on average, has outstripped VMT growth, and VMT per capita has declined. From 2005 to 2008, total daily VMT actually stayed virtually constant, despite modest population growth (+1.2 percent per year), reflecting the slowing of the region's economy, increasing unemployment, higher fuel prices, and other factors. From 2008 to 2012, total VMT increased slightly (+0.3 percent per year), despite population growth at double that rate (+0.6 percent per year).
- The longer term historic growth rates, counting from 1996 to 2012, is 1.6 percent per year for population in the six-county region, and 1.3 percent per year in total VMT.

TABLE 5B.1

Vehicle Miles Traveled in the SACOG Region, 1996 to 2012

County	1996	2000	2005	2008	2012
Average Daily VMT on Roadways (in thousands)[1]					
El Dorado[2]	3,515	3,930	4,172	4,025	4,074
Placer[2]	6,144	7,361	8,581	8,502	8,605
Sacramento	26,122	29,244	32,145	32,530	32,937
Sutter	1,919	2,150	2,374	2,444	2,283
Yolo	4,584	5,132	5,683	5,489	5,785
Yuba	1,518	1,745	1,849	1,787	1,786
Region	44,875	49,562	54,804	54,777	55,470
Region Pop. (in thousands)[3]	1,751	1,896	2,140	2,215	2,268
VMT per Capita	25.6	26.1	25.6	24.7	24.5
	'96 to '00	**00 to '05**	**'05 to '08**	**'08 to '12**	**'96 to '12**
Average Annual Growth Rates					
VMT	+2.5%	+2.0%	-0.0%	+0.3%	+1.3%
Population	+2.0%	+2.5%	+1.2%	+0.6%	+1.6%
VMT per Capita	+0.5%	-0.4%	-1.2%	-0.2%	-0.3%

1 From "California Public Road Data" reports, compiled from Highway Performance Monitoring System data

2 Adjusted by SACOG to exclude Tahoe Basin

3 California Department of Finance, adjusted by SACOG to exclude Tahoe Basin

Vehicle Miles Traveled and the MTP/SCS

Table 5B.2 and Figure 5B.1 provide tabulations and illustrations of historic and projected VMT growth for MTP/SCS.

Weekday VMT in the region is projected to grow from 57.0 million in 2012 to about 63.2 million by 2020 (an 11 percent increase) and 74.5 million by 2035 (a 30 percent increase). Population over the same periods increases by 9 percent and 36 percent, respectively.

The VMT growth rate through 2035 is projected to decrease from the historic growth rate of +1.3 percent per year to +0.9 percent per year for the period from 2008 to 2036. Moreover, the VMT growth rate is projected to be lower than the population growth rate of +1.2 percent per year, and total VMT per capita is forecasted to decline at -0.3 percent per year.

Total VMT per capita is forecasted to increase during the period from 2012 to 2020 (+0.2 percent per year—see Figure 5B.2 and Table 5B.2). This outcome is in part the result of unusually low VMT in 2012 due to the recession, and recovery of the economy in forecasted between 2012 and 2020, and a forecasted reduction of 8 percent in auto operating costs between 2012 and 2020. Compared to 2008 total VMT per capita, 2020 declines at 1.1 percent per year (see Table 5B.2)

TABLE 5B.2

Total Vehicle Miles Traveled in SACOG Region, 2012 and MTP/SCS

County	2008	2012	2020	2036
Total Weekday VMT on Roadways[1]				
El Dorado[2]	3,871	3,735	4,121	4,666
Placer[2]	9,790	9,894	11,360	13,762
Sacramento	34,666	33,760	37,092	43,669
Sutter	2,146	2,027	2,254	2,777
Yolo	5,807	5,862	6,442	7,431
Yuba	1,772	1,732	1,907	2,215
SACOG Region	58,051	57,010	63,176	74,520
Total VMT per Capita	26.2	25.1	25.6	24.2
Annual Average Growth Rates	**'08 to '20**	**'12 to '20**	**'20 to '36**	**'08 to '36**
VMT	-0.5%	+1.3%	+1.0%	+0.9%
Population	+0.6%	+1.1%	+1.4%	+1.2%
VMT Per Capita	-1.1%	+0.2%	-0.4%	-0.3%

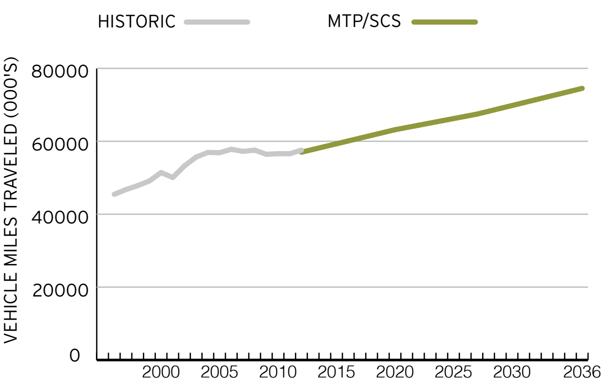
1 Roadway VMT is tallied based on the location of the roadway on which the VMT is forecasted to occur. It is comparable to the VMT reported in "California Public Road Data" reports; however, the CPRD reports average daily VMT, while this table reports typical weekday VMT. Typical weekday traffic is on average 5 percent higher than average daily traffic.

2 Tahoe Basin roadways are excluded from this tabulation

Although VMT increases in total through 2036 for the MTP/SCS, per capita VMT rates decline significantly over the same period. Total VMT per capita declines from 25.1 miles in 2012, to 24.2 by 2036, as shown in Table 5B.2 above and in Figure 5B.2. Although both total and per capita VMT increase from 2012 to 2020, this result is in part related to the relatively low VMT per capita in 2012. Compared to 2008 estimates, 2020 VMT per capita declines -0.2 percent per year.

FIGURE 5B.1

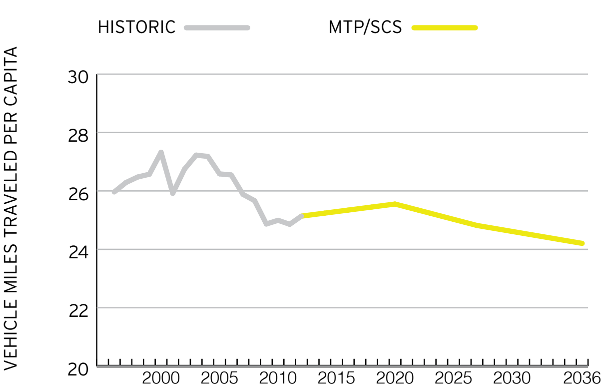
Total Vehicle Miles Traveled in the SACOG Region, Historic Trends and Projected MTP/SCS



Historic based on CPRD reports. MTP/SCS based on SACOG forecasts.

FIGURE 5B.2

Weekday Vehicle Miles Traveled per Capita in the SACOG Region, Historic Trends and Projected MTP/SCS



Historic based on CPRD reports. MTP/SCS based on SACOG forecasts.

VMT by Source

As mentioned above, three sources of VMT are considered: household-generated, commercial vehicle, and external. Household-generated—which includes all travel by residents of the region for work, school, shopping and other household purposes—accounts for almost three-quarters of all VMT in all scenarios. Table 5B.3 provides a tabulation of VMT by source in the region for 2012 and 2036. Household-generated VMT per capita is projected to decrease from 17.9 miles in 2012 to 17.0 miles by 2036, a decrease of 5.4 percent

Commute VMT as a share of total household-generated VMT decreases from 46 percent in 2012 to 45 percent for the MTP/SCS (Table 5B.3), largely due to higher transit, bike and walk mode shares and better jobs/housing balance within the region. Commute travel includes all travel by workers from home to work and back home, including any intermediate stops for other non-work activities (e.g., to drop off a child at school, to shop, or to attend to personal business).

Commercial vehicle travel includes vehicles of all types which are transporting services or goods on roadways within the SACOG region. This source of VMT is not just bigger, multi-axle trucks—it includes transportation of services (e.g. office equipment repair, plumbers, home delivery) which may use smaller vans or even passenger vehicles, as well as small-to-medium sized trucks. Like household-generated VMT, commercial or truck VMT is indirectly related to density—i.e. as density increases, commercial or truck VMT decreases. The MTP/SCS forecasts show a 6.4 percent decline in commercial/truck VMT per job between 2012 and 2036.

Combining all sources of VMT, including external and through travel VMT, forecasted VMT per capita declines from 25.1 miles to 24.2 miles from 2012 to 2036, a 3.7 percent change.

Figure 5B.3 provides an illustration of household-generated VMT per capita by the Community Type (defined fully in Chapter 3 — Land Use Forecast) of the household's place of residence. This measure rolls up all VMT generated by a household, regardless of where the VMT actually occurs, to the place of residence of the traveler(s) in that household.

- Residents of Center and Corridor Communities have the lowest per capita VMT for the MTP/SCS of all Community Types: 13.1 miles in 2012, decreasing to 11.9 miles by 2036. These rates are 27 to 30 percent lower than regional average. Centers and Corridors have the most compact land uses, which support walking and biking for shorter trips, and have the greatest access to transit, which provides alternatives to driving for longer trips.
- Residents of Established Communities have the next lowest per capita VMT: 17.3 miles in 2012, decreasing to 16.3 by 2036. Although Established Communities are neither as compact nor as well served by transit as Centers and Corridors, because of the proximity of Established Communities to existing developed areas, especially employment centers, there are more options for making shorter vehicle trips.
- Residents of Developing Communities have the next lowest per capita VMT: 21.4 miles in 2012, decreasing to 19.8 by 2036. These rates are 17 to 19 percent higher than regional average. Both of these levels are above the regional average (18.8 miles for 2012, and 17.0 for 2036). There are a number of factors related to these VMT rates. First, by 2036 the Developing Communities in the SCS are only partially built-out. Because these areas are in general at the edges of the urbanized area where factors like regional accessibility are

TABLE 5B.3

Vehicle Miles Traveled by Source in SACOG Region, 2012 and 2036

Variable	2012	2036
Weekday VMT by Source		
Household-Generated Commute VMT[1]	18,599,800	23,363,200
Household-Generated Other VMT[1]	22,109,800	28,895,700
Total Household-Gen. VMT[1]	40,709,600	52,258,900
Commute Share of HH-Gen VMT	46%	45%
External/Through VMT[2]	9,547,400	13,359,700
Through-Travel VMT[3]	6,752,900	8,901,100
Total VMT	**57,009,900**	**74,519,700**
Per Capita or Per Job Rates		
Population	2,268,100	3,078,800
Jobs	887,900	1,327,300
Household-Generated VMT per Capita	17.9	17.0
Commercial Vehicle VMT per Job	10.8	10.1
Total VMT per Capita	**25.1**	**24.2**
Percent Changes in VMT Per Capita or Per Job, compared to 2012		
HH-Generated VMT per Capita		-5.4%
Commercial Vehicle VMT per Job		-6.4%
Total VMT per Capita		**-3.7%**

1 Household-generated VMT is cumulative vehicle travel by residents of the region, for their travel within the region. Total household-generated VMT is split into commute (i.e., all VMT generated by workers going from home to work and back, with any stops along the way), and other (all non-commute).

2 Commercial vehicle VMT is cumulative vehicle travel for moving goods, services and freight within the region. It includes commercial travel in passenger vehicles, light trucks, and vans as well as in larger trucks.

3 Externally-generated VMT is cumulative vehicle travel from residents outside the region, but who travel to destinations within the region, or travel through the region.

below average (see Table 5A-2), partial build-out limits the potential for land use and transportation factors to reduce VMT. Also, transit service in these areas, while present in the SCS, is limited. As Developing Communities develop more fully, and the full value of planned land uses in these areas emerge, the VMT rates for residents should drop significantly.

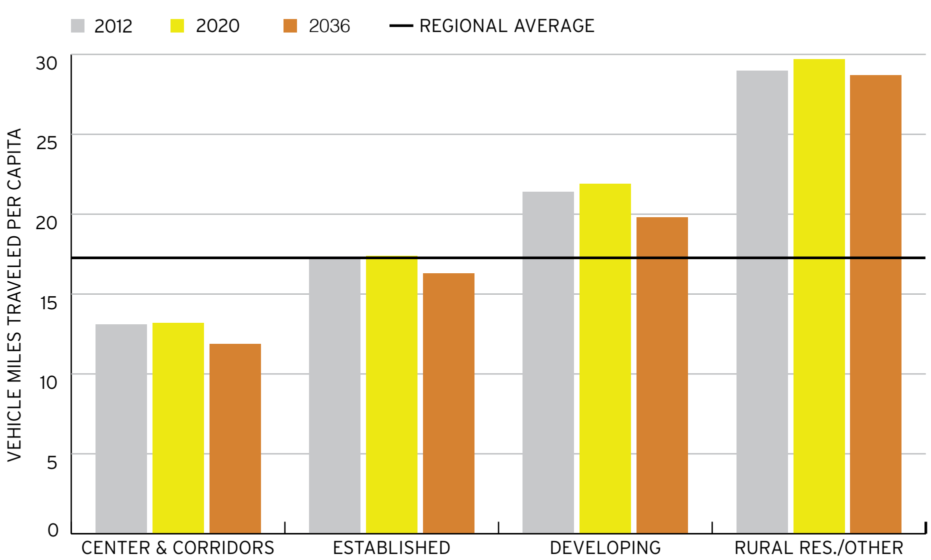
- Residents of Rural Residential Communities and Lands not Identified for Development in the MTP/SCS are similar in VMT per capita: about 29.0 miles in 2012, declining slightly to about 28.7 miles in 2036. These rates are 62 to 69 percent higher than regional average. Because of the locations of these Community Types, options for shortening vehicle trips are few, and most of the areas have limited, if any, transit service.

Figure 5B.4 provides an illustration of household-generated VMT per capita rates for residents of Transit Priority Areas (TPAs), compared to residents outside the TPAs in Placer, Sacramento and Yolo counties.

- For all TPA areas, residents' VMT per capita rates are below the averages for residents of the counties they are in 2036. Residents of TPAs in Placer County are 29 percent below the county average in 2036. Residents of Sacramento and Yolo County TPAs are 23 and 20 percent below the county averages. The variation across counties relates in part to the extent of the TPAs in each county: the Placer County TPA is expected to include about 39,900 people by 2036 (about 11 percent of the county population), while the Sacramento and Yolo County TPAs include 850,000 and 154,000 people, respectively (45 and 56 percent of the county populations, respectively).

FIGURE 5B.3

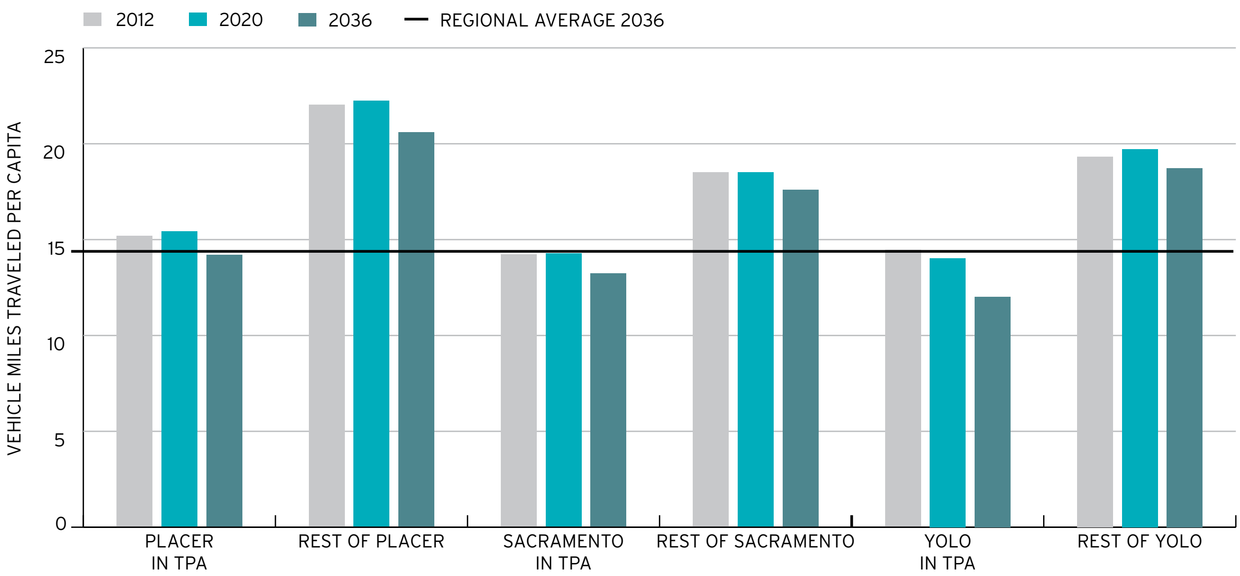
Weekday Household Vehicle Miles Traveled per Capita by Community Type in the SACOG Region[1]



1 Household-generated VMT as defined in this report is rolled up to place of residence, and then totaled to the Community Type of the place of residence.

FIGURE 5B.4

Weekday Household Vehicle Miles Traveled per Capita by Transit Priority Area in the SACOG Region[1]



1 Household-generated VMT as defined in this report is rolled up to place of residence, and then totaled to the TPA areas of the place of residence within counties.

VMT and Commute Travel

Commute travel accounts for 45 percent of all household-generated travel in 2036 (see Table 5B.3). Table 5B.4 provides a tally of commute VMT by Community Type, normalized by the number of workers in those areas.

- Commute VMT per worker declines 11.5 percent, from 20.8 miles per worker in 2012 to 18.4 miles by 2036.
- Workers residing in Center and Corridor Communities have the lowest commute VMT per worker—about 33 percent below the regional average for the 2036 horizon year. Workers residing in Developing Communities have commute VMT per worker 16 percent above regional average; workers residing in Rural Residential and lands not identified for development in the MTP/SCS have commute VMT per worker nearly 71 percent above the regional average.
- All Community Types show declines in commute VMT per worker from 2012 to 2036, ranging from 6 to 16 percent compared to 2012 levels.

TABLE 5B.4

Commute Vehicle Miles Traveled by Community Type in SACOG Region

Geography	2012	2020	2036
Center/Corridor Communities			
Household-Generated Commute VMT[1]	1,331,100	1,480,300	2,052,200
Resident Workers	90,600	105,900	167,400
Commute VMT per Worker	14.7	14.0	12.3
% Change from 2008 Per Worker Rate	n/a	-4.8%	-16.3%
Established Communities			
Household-Generated Commute VMT[1]	14,026,000	14,961,600	15,105,900
Resident Workers	699,600	778,400	850,500
Commute VMT per Worker	20.0	19.2	17.8
% Change from 2008 Per Worker Rate	n/a	-4.0%	-11.0%
Developing Communities			
Household-Generated Commute VMT[1]	901,800	1,482,600	3,594,200
Resident Workers	36,300	61,200	168,200
Commute VMT per Worker	24.8	24.2	21.4
% Change from 2008 Per Worker Rate	n/a	-2.4%	-13.7%
Rural Residential Communities			
Household-Generated Commute VMT[1]	2,340,900	2,579,400	2,610,900
Resident Workers	69,800	77,900	83,200
Commute VMT per Worker	33.5	33.1	31.4
% Change from 2008 Per Worker Rate	n/a	-1.2%	-6.3%
Region Total			
Household-Generated Commute VMT[1]	18,599,800	20,503,900	23,363,200
Resident Workers	896,300	1,023,400	1,269,300
Commute VMT per Worker	20.8	20.0	18.4
% Change from 2008 Per Worker Rate	n/a	-3.8%	-11.5%

Source: SACOG, July 2015.

1 Commute tours combine all trips from home to work and back to home into one unit. Tours are roughly equivalent to commute round trips.

Key Factors Related To Declining VMT per Capita

It is impossible to attribute the full decline in VMT per capita (5.6 percent in household-generated VMT, and 3.7 percent in total VMT) to specific policies or factors. However, the list of factors that will contribute to the reduction includes:

- Improvements in Accessibility (i.e., the number of activities which can be reached within a given travel time)—In Chapter 5A, Table 5A.3 illustrates how this factor changes by 2036 for the MTP/SCS. Because the growth that occurs between 2012 and 2036 is more compact, the number of activities within a reasonable travel time increases by 37 percent. This change means that most residents will be able to find jobs, schools, shopping, and other activities closer to their place of residence, and their vehicle trips will be shorter.
- Improvements in Mix of Land Uses—Table 5A.3 also shows that most areas within the region improve to some degree in the balance of complementary land uses. This allows for a higher share of wants and needs to be met closer to a place of residence, which in turn allows for shortening of vehicle trips and creates more opportunities for non-motorized travel.
- Improvements in Jobs/Housing Balance—Table 9.7 provides tallies of overall improvement in jobs/housing balance for the MTP/SCS. Improving jobs/housing balance facilitates shorter commutes for most workers, and allows for transit, biking and walking to compete with auto modes.
- Improvements in Transit Service and Walkability—Shifts in mode of travel from private vehicle (e.g., driving alone and carpooling) to non-auto modes (i.e., transit, bicycling and walking) are another key factor, which will be discussed in greater detail in Chapter 5C.

In addition to these land use/transportation factors, demographic factors influence the decline in VMT per capita to some degree: for example, aging of the population, which is likely to result in less out-of-home activities, and in turn, less travel for a significant percentage of the population.

Roadway Congestion and Delay

This section: defines roadway congestion and discusses why SACOG measures it; reports observed trends in roadway congestion in the region; reports the roadway congestion performance of the MTP/SCS; explains the roadway congestion performance of the MTP/SCS; and then discusses the relationship between congestion and roadway efficiency.

What is Roadway Congestion and Why Do We Measure it

Roadway congestion is an indicator with a much less specific and determined definition than VMT. In general, congestion occurs on roadways when the number of drivers who wish to use a particular route exceeds the capacity of that route. The typical signs of congestion are stop-and-go driving conditions on freeways, lines of drivers and vehicles waiting to get through a traffic light or from a ramp onto or off a freeway, and the accompanying frustration experienced by those drivers and passengers.

Delay, in general, refers to time wasted traveling on congested facilities. However, to quantify that delay requires some presumption of what time it should take to travel on a particular route, or a standard travel time which drivers and passengers should expect. Setting a standard by which delay can be quantified is a subjective exercise. For example, some might define a standard travel time as free-flow or totally uncongested conditions. The standard for freeways by this definition might be 60 MPH, and the standard travel time would be one minute for a one-mile stretch of freeway. If the actual travel speed, with congestion, was 40 MPH, the travel time would be 1.5 minutes, and the delay for each driver and passenger in that condition would be 30 seconds. Others may define the standard as a modest or tolerable level of congestion. For the same one-mile stretch of freeway, someone might define 35 MPH as the standard for measurement of delay—this is approximately the speed of travel for optimal throughput on a freeway lane. With the same actual travel speed of 40 MPH, no delay would be experienced, because the actual speed is higher than the standard.

SACOG has always focused more on the presence of congestion on roadways rather than an amount of delay. Specifically, SACOG estimates and tracks how much of the total VMT occurs on roadways that are at or above their reasonable capacities. SACOG defines a congested VMT (CVMT) as a VMT that occurs on roadways with volume-to-capacity ratios of greater than 1.0. An example of CVMT is a vehicle and its driver and passenger(s) going westbound on I-80 during the busy morning commute period between Madison Avenue and the I-80/Capital City Freeway split.

Observed Data and Historic Trends in Roadway Congestion

While VMT has been consistently and comprehensively monitored in the region since the mid-1990s, monitoring of congestion and delay inform CMP activities. Two sources are presented here.

Delay data have been collected by Caltrans, primarily on freeway facilities, since 1998. Caltrans defines 35 MPH as a travel speed standard for freeways, with delay calculated as the difference between actual travel time and travel time at 35 MPH for the vehicles on the roadway segment in question. Caltrans collects field data for this measure annually, but has transitioned from one data collection/processing approach (known as HICOMP program) from 1998 to 2009, to the Mobility Performance Reports (MPR) starting in 2009, but with a back-cast to 2005. Freeway delay by this measure is presented in Table 5B.5.

Delay estimates have been made for the Sacramento urbanized area (as well as most other urbanized areas in the U.S.) by the Texas Transportation Institute (TTI) annually since 1990 (see Table 5B.5). The standard for delay in the TTI reports is free-flow conditions, compared to 35 MPH for the Caltrans measure. TTI considers arterial and surface street conditions as well as freeways. Finally, TTI attempts to account for vehicle occupancy, and estimate passenger delay, rather than vehicle delay. For all of these reasons, the TTI measure is a much bigger number in scale than the Caltrans measure. Despite these differences, these two sources show similar trend lines in delay:

- Very high increases in delay during years 2000 to 2005 (+9 percent per year in the TTI data—no data available for 2000 from the MPR reports).
- Significant decreases during the years 2005 to 2008 (-14 percent per year in HICOMP/MPR, -10 percent per year in TTI). Although the factors which influence the amount of delay experienced by travelers is complicated, an over-arching factor affecting this extraordinary increase and then decrease in delay is the level of economic activity in the region. Since delay is strongly influenced by travel conditions during peak periods, the amount of work travel affects the amount of delay, all else being equal. Regional unemployment rate in 2000 was about 6 percent, and in 2005, it dropped below 5 percent; by the end of 2008, it was nearly 12 percent.
- The MPR and TTI data show differing results for the 2008 to 2011 period: MPR shows -5 percent per year change for delay on the state highway system; TTI shows a modest +2 percent per year change in for all roadways.
- For the entire period between 2005 to 2011, both measures show delay decreasing significantly (MPR shows -9 percent per year change and TTI shows -5 percent per year change).

Chapter 9 — Economic Vitality, discusses the TTI calculation of the total cost of congestion, estimated at $834 million in the region in 2012.

Included in Table 5B.5 are estimates of congested VMT. Compared to the delay estimates, the changes in congested VMT are somewhat muted. For example, congested VMT was estimated to +5 percent per year increases from 2000 and 2005, compared to +9 percent per year from the TTI data. Similarly, the 2005 to 2008 declines in delay were much greater than the estimated decline in congested VMT (-1 percent per year for the congested VMT measure, compared to -10 percent per year for TTI and -14 percent per year for MPR. The comparison flips, though, when looking at the 2008 to 2012 time period: the congested VMT measure shows -12 percent per year change, compared to -5 percent per year for MPR, and +2 percent per year for TTI. For the common period between all three measures, 2005 to 2012, they are fairly consistent: -5 percent per year for the congested VMT measure, compared to -4 percent per year for TTI and -9 percent per year for MPR. The major inconsistency between the measures is the timing of changes in congestion between 2008 and 2012—both TTI and MPR show significant decrease in congestion between 2005 and 2008, and modest change from 2008 to 2012. The congested VMT measure shows modest change between 2005 and 2008, and greater change between 2008 and 2012.

There are several factors which may explain this. First, the delay estimates take account of the severity of congestion, while congested VMT takes account of the presence of congestion. For example, a roadway segment which may be 20 percent over normal capacity may have more severe delay due to vehicles moving slowly through interchanges or on/off ramps and other detailed operational factors.

TABLE 5B.5

Historic Travel Delay in the SACOG Region

Congestion/Delay Measure	2000	2005	2008	2011/12
Freeway Vehicle Hours of Delay (daily) [1]	n/a	5,399	3,448	2,989
All Road Traveler Hours (yearly, in thousands) [2]	32,076	49,837	36,362	39,138
Congested Vehicle Miles Traveled (weekday, in thousands) [3]	2,541	3,314	3,264	2,250
Annual Average Growth Rates	**'00 to '05**	**'05 to '08**	**'08 to '12**	**'05 to '11/12**
Freeway Vehicle Hours of Delay [1]	n/a	-14%	-5%	-9%
All Road Traveler Hours of Delay [2]	+9%	-10%	+2%	-4%
Congested Vehicle Miles Traveled [3]	+5%	-1%	-12%	-5%

1 Caltrans District 3 "Highway Congestion Monitoring Program Reports." Caltrans defines delay as the difference between travel time at 35 MPH and actual travel time for state highways. All segments included in the monitoring reports for the SACOG region are freeways.

2 Texas Transportation Institute "Urban Mobility Report" for Sacramento urbanized area. TTI estimates delay as the difference between free flow travel time and actual travel time, including both surface streets and freeways.

3 SACOG estimates, made using SACSIM regional travel demand model. Congested VMT are VMT occurring on roadways at or near generalized hourly capacity.

Roadway Congestion and the MTP/SCS

Several principles guided the development of the roadway network for the three scenarios discussed at the MTP workshops held in October 2010 (and described in more detail in Chapter 2—The Planning Process). Based on the results of those public workshops and direction from the SACOG Board for development of the MTP/SCS, the following principles guided development of the MTP/SCS roadway system.

For freeways, emphasizes new investments at major current bottleneck locations and congestion points. Examples of these investments are:

- providing alternative modes of travel, which reduces demand in bottleneck locations and provides travel options for commuters and other travelers to avoid the worst congestion (e.g., dedicated transit lanes on the Watt/U.S. 50 interchange and express bus services along new high-occupancy vehicle (HOV) lanes in congested areas);
- constructing the Green Line light rail extension in the I-5/Natomas corridor;
- increasing frequency of commuter and express bus lines from Yolo, Yuba, Sutter, Placer and El Dorado counties into downtown Sacramento; and
- providing new Class 1 bicycle paths (see section on non-motorized travel improvements in Chapter 5C for more detail).

In some locations, adds auxiliary lanes and/or makes operational improvements to freeways to reduce delays and improve efficiency of the roadway system. Examples:

- new auxiliary lanes on the Capital City Freeway-American River Bridge, (the worst single freeway bottleneck in the region);
- new auxiliary lanes and other capacity improvements on SR-65 in Placer County;
- operational improvements to U.S. 50 through Rancho Cordova and Folsom;
- improvements to the I-5/SR-113 interchange in Woodland; and
- spot improvements in other locations.

Adds freeway HOV lanes to provide carpooling options to avoid the worst peak period congestion, including:

- I-80 HOV lanes between I-5 and Watt in Sacramento County;
- Capital City Freeway HOV lanes, from "J" Street to Arden Way;
- U.S. 50 in El Dorado County and in Sacramento County from Watt Avenue to SR-99; and
- I-5 into downtown Sacramento from the north and south.

Provides new or expanded local street connections across rivers to serve shorter trips in congested corridors, such as:

- new crossings of the Sacramento and American rivers into downtown Sacramento and
- widening crossings of the Feather River between Yuba City and Marysville.

Provides modest new and expanded surface streets serving longer trips in areas where freeways and other restricted access facilities have not been developed, including:

- improvements and widening to the highest priority segments of the Southeast Capital Connector corridor;
- construction of the initial phases of the Placer Parkway in Placer County; and
- completion of widenings and improvements on SR-70 in Yuba County and SR-99 in Sutter County.

Estimates of congested VMT in the future were made using SACOG's travel demand models, and are shown in Table 5B.6 and Figures 5B.5 and Figure 5B.6.

Congested VMT are estimated to increase from 2.3 million daily miles in 2012 to 4.4 million miles in 2036. This is a total increase of 94 percent from 2012, and an average annual increase of 2.8 percent per year over the same time period. Although historically, congestion grew at 5 percent or more per year during the period between 2000 and 2005, this forecasted growth in congestion is significant. However, it should be kept in mind that 2012 was a relatively low year in terms of congestion, due to the effects of the recession on travel in general, and work-related, peak-period travel especially. So, the high growth in congestion from 2012 to 2036 is a result of 2012 being so low, than it is from 2036 being so high.

Another point of reference in looking at changes in congestion is 2008. Compared to 2008, total congested VMT increases by 34 percent, or about one percent per year. On a per capita basis, 2036 congested VMT declines from 2008, from about 1.47 miles to 1.42 mile (-4 percent).

TABLE 5B.6

Congested Travel in the SACOG Region, 2008, 2012 and 2036

Variable	2008	2012	2020	2036
Total Congested VMT [1]	3,264,000	2,251,500	3,262,400	4,359,100
Population	2,215,000	2,268,100	2,472,600	3,078,800
Cong. VMT per Capita	1.47	0.99	1.32	1.42
% Change from 2008	n/a	-33%	-10%	-4%
% Change from 2012	n/a	n/a	+33%	+43%

1 SACOG estimates made using SACSIM regional travel demand model. Congested VMT are VMT occurring on roadways at or near generalized hourly capacity.

FIGURE 5B.5

Total Congested Travel in the SACOG Region, Historic Trends and Projected MTP/SCS[1]

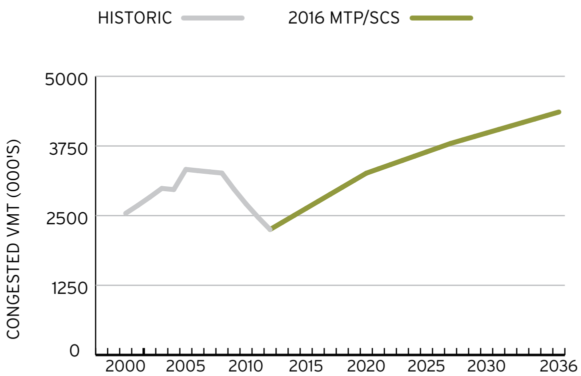
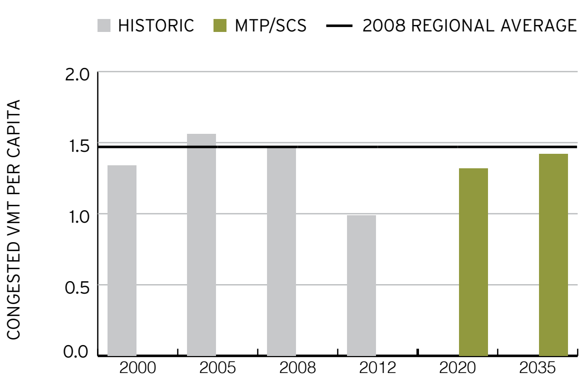


FIGURE 5B.6

Congested Vehicle Miles Traveled per Capita in the SACOG Region, Historic Trends and MTP/SCS



Congested VMT by Source and Community Type

Table 5B.7 provides a tabulation of household-generated, commercial vehicle, and external congested VMT in the SACOG region. Compared to 2012, total congested VMT increases to 3.3 million miles (+45 percent) by 2020, and 4.4 million miles (+94 percent) by 2036. Congested VMT generated by households increases the least, from 1.8 million in 2012 to 3.1 million by 2036 for the MTP/SCS, an increase of 72 percent. Commercial vehicle and externally generated congested VMT increases more over the MTP/SCS planning period: commercial vehicle congested VMT increases by 117 percent, and externally generated travel by 313 percent, from 2012. One reason for this apparent disparity is that more of the land use and transportation elements of the MTP/SCS are targeted at travel by residents of the region, which allow those residents to avoid the most congested routes. For example, the new Green Line light rail extension into Natomas allows residents of that corridor to avoid congestion on I-5; that option is not available to commercial vehicles and most residents of areas outside the region.

Table 5B.7 also provides congested VMT per capita for household-generated travel, and per jobs for commercial vehicle. Household-generated congested VMT per capita declines from 0.78 VMT per person in 2012 to 0.99 by 2036, an increase of 27 percent. Congested VMT experienced by commercial vehicles, normalized by the number of jobs in the region, increases from 0.38 VMT per job in 2012 to 0.55 in 2036, an increase of 45 percent. However, this increase is largely due to the unusually low level of congestion in 2012, during the recession and when unemployment was very high. Compared to 2008, as shown in Figure 5B.6, per capita congested VMT in 2020 and 2036 is significantly lower, preserving the improvement in this metric over time achieved in the 2012 MTP/SCS.

TABLE 5B.7

Congested Vehicle Miles Traveled by Source in the SACOG Region, 2008, 2012 and 2036

Travel Source	2008	2012	2020	2036
Region Total				
Household-Generated Commute CVMT[1]	1,640,100	1,071,200	1,580,400	1,773,400
Household-Generated Other CVMT[1]	967,800	704,800	955,100	1,280,800
Household-Generated CVMT[1]	**2,607,900**	**1,776,000**	**2,535,500**	**3,054,200**
Commute Share of Household-Generated CVMT	**63%**	**60%**	**62%**	**58%**
Commercial Vehicle CVMT[2]	472,900	336,000	496,800	728,900
Externally Generated CVMT[3]	183,200	139,600	230,100	576,100
Total CVMT	**3,264,000**	**2,251,600**	**3,262,400**	**4,359,200**
Per Capita Rates				
Population	2,215,044	2,268,138	2,472,567	3,078,772
Jobs	969,838	887,920	1,033,250	1,327,278
Household-Generated CVMT per Capita	1.18	0.78	1.03	0.99
Commercial Vehicle CVMT per Job	0.49	0.38	0.48	0.55
Total CVMT per Capita	**1.47**	**0.99**	**1.32**	**1.42**
Percent Changes in Congested VMT Per Capita or Per Job, compared to 2012				
Household-Generated CVMT per Capita		n/a	+31.0%	+26.7%
Commercial Vehicle CVMT per Job		n/a	+27.1%	+45.1%
Total CVMT per Capita		**n/a**	**+32.9%**	**+42.6%**
Percent Changes in Congested VMT Per Capita or Per Job, compared to 2008				
Household-Generated CVMT per Capita		n/a	-12.9%	-15.7%
Commercial Vehicle CVMT per Job		n/a	-1.4%	+12.6%
Total CVMT per Capita		**n/a**	**-10.5%**	**-3.9%**

1 Household-generated CVMT is cumulative vehicle travel by residents of the region on roadways which are at-or-above capacity, for their travel within the region. Household-generated CVMT is split into commute and other shares.

2 Commercial vehicle VMT is cumulative vehicle travel for moving goods, services and freight within the region. It includes commercial travel in passenger vehicles, light trucks, and vans as well as in larger trucks.

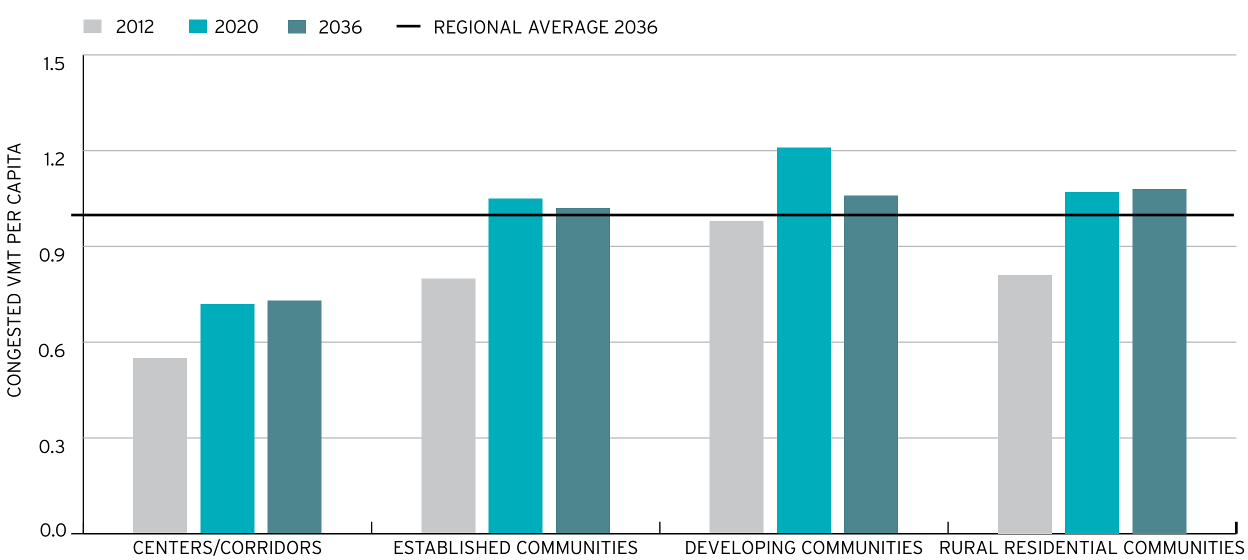
3 Externally generated VMT is cumulative vehicle travel from residents outside the region, but who travel to destinations within the region, or travel through the region.

Figure 5B.7 provides an illustration of congested VMT per capita for household-generated travel only, tallied back to the Community Type of the residence of the travelers. The amount of congested VMT which residents of the different Community Types would experience varies widely.

- For residents of Center and Corridor Communities, the average amount of congested travel a resident would experience increases very slightly, from 0.55 miles per capita in 2012 to 0.73 miles in 2036. Although increasing, the 2036 congested VMT per capita for Center and Corridor Community residents is still nearly 30 percent below the 2035 regional average. In part, this is due to much lower commute VMT per capita (see Table 5B.4), and in part due to the availability of transit options during peak periods, when congestion is worst.
- For residents of Established Communities, the average amount of congested travel is, not surprisingly, near the average. About two-thirds of all residents of the region by 2035 would reside in Established Communities, so their travel strongly affects the regional average. Relative to 2012, per capita congested VMT increases by 28 percent over the MTP/SCS planning period; relative to 2008, it decreases by about 15 percent.
- Residents of Developing Communities would experience congested travel about 7 percent higher than the regional average of 0.99 miles per weekday. The increase in congested travel for residents of these communities is due to several factors. First, as mentioned above, these communities are expected to be partially, not fully, developed. Because of the location of these communities closer to the edges of the urbanized area, and further from job centers, commutes for workers residing in these areas will tend to be longer than for workers in other communities (see Table 5B.7), which also exposes these workers to more congestion.
- Residents of Rural Residential Communities would experience congested travel at 9 percent higher than regional average.

FIGURE 5B.7

Congested Vehicle Miles Traveled by Community Type in SACOG Region[1]



1 Household-generated congested VMT as defined in this report is rolled up to place of residence, and then totaled to the Community Type of the place of residence.

Congested VMT and Commute Travel

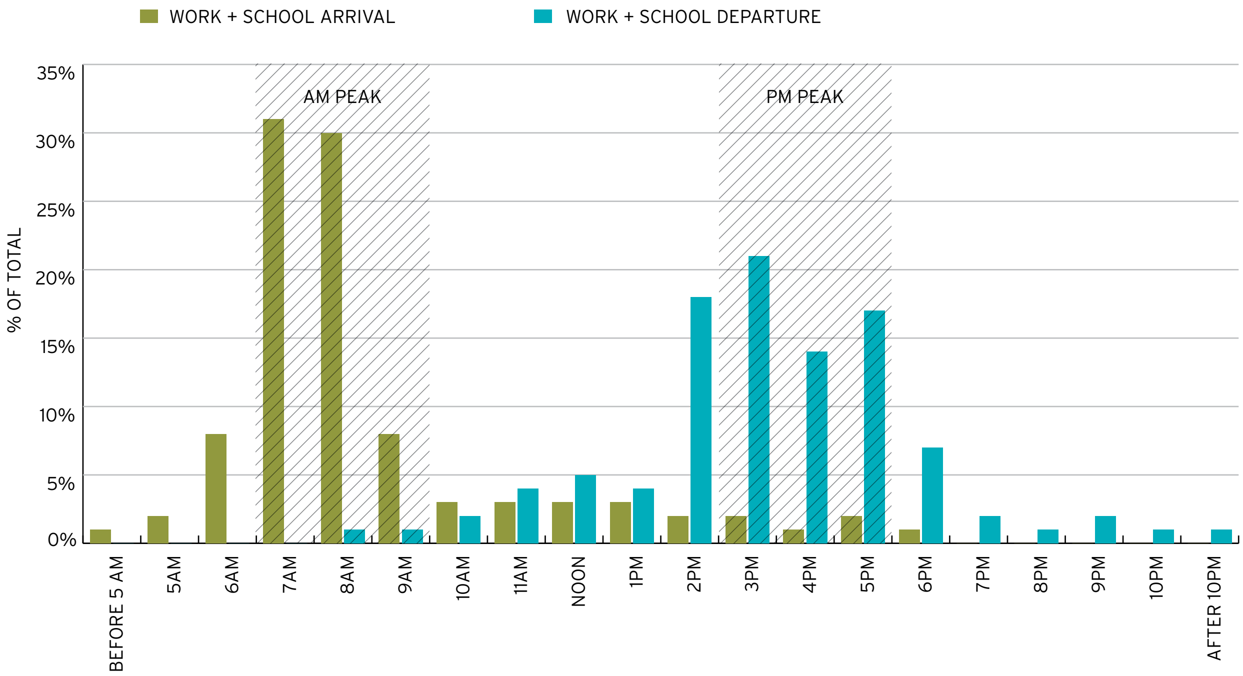
Commuting and congestion go together, for some obvious and less-obvious reasons. The most obvious reason is that the majority of commute travel occurs during peak periods, when travel demands frequently exceed available capacity, resulting in congestion. Peak periods are defined by when commute travel occurs. For example, in the SACOG region, during the period between 7:00 and 10:00 a.m., approximately 70 percent of all workers and students arrive at their workplace or school (see Figure 5B.8), with 30 percent arriving during a one-hour period. Conversely, for all other non-work travel (e.g., shopping, personal business), only about 17 percent of all arrivals at the activity location occur during the same three-hour period, with 8 percent occurring during the highest hour. The daily pattern of activities for work and school is bi-modal—that is, it has two extreme peaks, one in the morning and one in the afternoon. The daily pattern for all other activities is much flatter and more distributed over the entire day.

Commuters and students often have very little discretion over when they travel—their times of travel are dictated by their work or school hours. Although the amount of flexibility workers have on when to arrive at work may vary by employer, workers have far less freedom to choose when to travel than a non-working adult making a choice about when to go shopping. This difference makes commuters more willing to endure worse congestion than other travelers would—they endure it because they have little choice.

This relationship between commute travel and congestion is in evidence in the statistics presented earlier in Table 5B.7). Although commute travel accounts for only 45 percent of household-generated VMT, it accounts for about 60 percent of congested VMT.

FIGURE 5B.8

Peaks in Time of Travel for Work, School, and Other Trips



Based on 2000 Household Travel Survey.

Key Factors Influencing Reduction in Congested Travel in the MTP/SCS

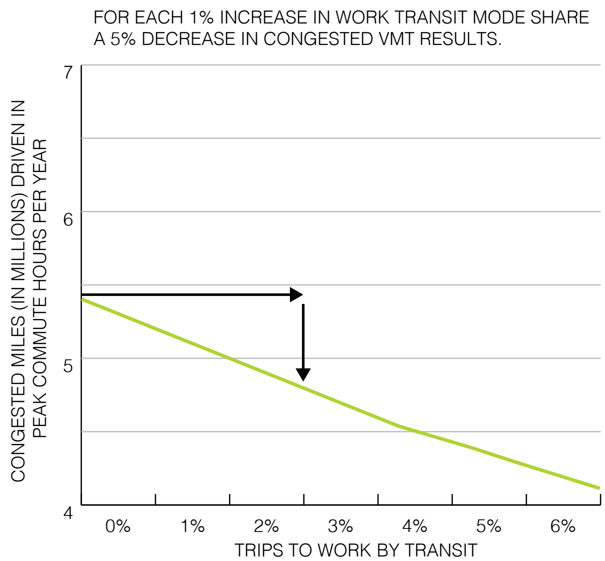
The reduction in congested travel is driven by two basic factors in the MTP/SCS:

- Roadway capacity investments include a significant number of projects that resolve or improve major existing bottlenecks, including several new projects for bottleneck locations not addressed in prior plans.
- On several major congested travel corridors, new transit options are provided in the MTP/SCS. Overall transit mode share increases, and commute transit share increases dramatically—the MTP/SCS forecasts show transit mode share increasing by 5 percentage points, from about 2.5 percent in 2012 to nearly 7 percent in 2036 (see Chapter 5C where this issue is discussed in greater detail). There is a strong relationship between the work travel mode share, and the level of congested VMT experienced during the peak period, illustrated in Figure 5B.9. For each incremental percentage point in work travel transit share, congested VMT decreases by 5 percent.[3]

3 Based on modeling by SACOG staff. Note that an increment in work transit mode share from, e.g., 3 percent to 4 percent, which is a one percent share increment, represents a 33 percent increase in the number of actual transit trips.

FIGURE 5B.9

Transit Mode Sh are and Congested Travel in the SACOG Region



Roadway Utilization and Efficiency

Increasing the productivity of the region's existing transportation infrastructure through more optimal use of the region's roadway system is an important goal for the MTP/SCS. The concept of optimal levels of use of roadways is a new one in transportation planning. Historically, the quality of service has been measured on a simple A-through-F scale, with the implication that level of service A is always better than level of service B, level of service B is better than C and so on. Optimal use takes a slightly different perspective, based not solely on the level of service to individual travelers in motorized vehicles only (which is the focus of level of service measurement), but on some level of system efficiency and on balance of benefit across travel modes.[4]

4 Milam, Ron, "Transportation Impact Analysis Gets A Failing Grade When It Comes to Climate Change and Smart Growth", published at the California Office of Planning and Research Level of Service Forum website, October 2008, http://opr.ca.gov/sch/pdfs/Ron_Milam_Fehr_and_Peers.pdf

The concept of optimal use applied to roadways starts with a few basic assumptions. First, travel demand is always subject to peaks and valleys, when demand is higher or lower than average. Second, achieving better levels of service during peak demand periods requires progressively greater infrastructure investments, and those investments may only really be used for one or two hours during the day—the rest of the time, those investments essentially sit idle. Finally, optimal use also recognizes that in addition to the infrastructure costs of providing higher levels of service during peak demand periods, those investments impose other costs, too, such as the costs associated with building wider roads, increased physical distances between uses, and making travel by transit, bicycle and walking more costly.

For the development of this MTP/SCS, the concept of optimal use was implemented through a screening process, which focused on three questions:

1. Is the roadway congested during peak demand periods, either in the base year (2012) or the planning horizon year?
2. Is the increase in capacity on the roadway greater than the projected increase in travel on the roadway?
3. Is the roadway significantly under-utilized during peak periods?

If the answer to any these screening questions was "no", the project was flagged for potential re-phasing to a later date within the MTP/SCS planning period, including re-phasing to after 2036. This screening process, in combination with an overall policy emphasis on increasing expenditures on maintenance and state-of-good-repair, resulted in 170 lane miles of new or expanded major roadways being removed or delayed until after the planning horizon, compared to the 2012 MTP/SCS.

In order to evaluate the utilization level of roadways for the MTP/SCS an operational definition was developed based on the methods of evaluating roadway demand and supply in SACOG's SACSIM regional travel demand model. For roadway investments, overall efficiency is measured as the percent of total travel which occurs at optimal levels of use. Optimal use presumes that because of peaks and valleys in demand, and because of the extremely high cost of providing sufficient roadway infrastructure to provide a high level of service during peak demand times, some level of congestion is expected and, in a way, desired, at peak times. If free flow conditions prevail during peak demand times, this is an indication that roadways were over designed, and a high percentage of roadway capacity is un-utilized during non-peak periods. So, the key to defining optimal use is to define optimal utilization levels around moderate or tolerable levels of congestion.

The definition is based on roadway segment volume-to-capacity (V/C) ratios. In concept, segment V/C ratios are similar to intersection V/C ratios which are commonly reported as part of traffic impact studies. For computational efficiency, segment, rather than intersection, V/C ratios are used for regional travel demand models. Segment capacities are set to represent the number of vehicles which can pass through a segment based on normal operating conditions. Freeways, for example, are set at 2,000 vehicles per lane per hour. For surface streets, segment capacities depend heavily on intersection operations, and actual segment capacities can vary widely based on different ways of handling intersection operations (e.g., signalization, presence/absence of turning lanes). A working definition of optimal use needs to take account of some of these characteristics of segment capacities by different functional classes of roadways.

The following V/C ratio ranges were defined as optimal for this analysis:

- For general purpose freeways, V/C ratios between 0.90 and 1.05 (i.e., from 5 percent below to 5 percent above the normal capacity) were defined as optimal. Below the lower threshold, freeways may be considered to be over-capacity; above the upper threshold, congestion is likely to become unmanageable.
- For HOV lanes, it is presumed that a travel time advantage is desired compared to adjacent general purpose freeway lanes, so the optimal utilization level was set at 0.50 to 0.85. At these levels, near free flow speeds would be maintained in the HOV lanes.
- For arterial and expressway roadways, where actual capacities may vary due to intersection operations, a wider range of optimal utilization was specified than for freeways: 0.85 to 1.1.

- Local and collector streets are the streets with the most varied use patterns. For example, local streets are those onto which the majority of houses front, and these streets are not expected to be operating at capacity at any time of the day. In fact the streets may be used for everything from setting out a garbage or recycling container to playing catch with a child. For this reason, the optimal use level was set at a maximum V/C ratio of 0.85, or 85 percent of normal capacity.

For this analysis, only peak period (i.e. the combined AM three-hour and the PM three-hour periods) VMT and utilization levels were included.

Compared to 2012, the MTP/SCS is projected to:

- Increase the percentage of VMT which occurs at optimal utilization level from 28.5 percent to 32.0 percent in 2036 (see Table 5B.8).
- A decrease in the percentage of VMT which occurs at under utilized levels, from 65.8 percent, to 60.3 percent by 2036.
- Increase the percentage of VMT which occurs at over-utilized levels, from 5.7 percent to 7.6 percent. This change is in part due to the lower levels of roadway use and congestion in 2012 overall.

Compared to 2008, the MTP/SCS is projected to modestly improve roadway utilization in all categories:

- Increase optimally-utilized levels from 30.5 percent to 32.0 percent;
- Decrease under-utilized levels from 61.5 percent to 60.3 percent; and
- Decrease in over-utilized levels from 8.0 percent to 7.6 percent.

TABLE 5B.8

Roadway Utilization in the SACOG Region, 2008, 2012 and 2036

	Utilization Level [1,2]			
Roadway Type / Year	**Under-Utilized**	**Optimally-Utilized**	**Over-Utilized**	**Total**
2008 Peak Period VMT by Road Class (in thousands)				
General Purpose Freeways	6,547	2,136	791	9,474
HOV Lanes/Auxiliary Lanes	201	206	86	493
Freeway Ramps	393	48	29	470
Arterials/Expressways	5,641	1,988	531	8,160
Collectors/Local Streets	1,740	2,834	457	5,030
Total	14,522	7,212	1,894	23,627
2008 Share of VMT:	61.5%	30.5%	8.0%	100.0%
2012 Peak Period VMT by Road Class (in thousands)				
General Purpose Freeways	6,923	1,902	552	9,377
HOV Lanes/Auxiliary Lanes	276	265	51	591
Freeway Ramps	384	54	23	461
Arterials/Expressways	5,938	1,636	345	7,919
Collectors/Local Streets	1,713	2,729	351	4,794
Total	15,234	6,586	1,322	23,142
2012 Share of VMT:	65.8%	28.5%	5.7%	100.0%
2036 MTP/SCS Peak Period VMT by Road Class (in thousands)				
General Purpose Freeways	6,821	3,186	885	10,892
HOV Lanes	449	848	179	1,476
Auxiliary Lanes/Ramps	443	63	44	550
Arterials/Expressways	8,028	2,716	797	11,541
Collectors/Local Streets	2,318	2,774	379	5,472
Total	18,059	9,587	2,284	29,931
2036 MTP/SCS Share of VMT :	60.3%	32.0%	7.6%	100.0%

Source: SACOG, July 2015.

1 V/C ratio ranges are based on segment (not intersection) calculations.

2 Under-Utilized: <0.95 for GP Freeway; <0.50 for HOV and Aux/Ramp; <0.85 for Arterial/Expressway; no minimum for Collectors/Local Streets.

Over-Utilized: >1.05 for GP Freeway; >0.85 for HOV and Aux/Ramp; >1.15 for Arterial/Expressway; >0.75 for Collectors/Local Streets.

Key Factors in Increasing VMT in the Optimal Use Range

Discussed above in the sections on VMT and Roadway Congestion are several of the key factors that will lead to better utilization of the region's roadways:

- Targeted investments in projects which ameliorate some of the worst bottlenecks on the region's freeways and major roadways—Reducing the level of congestion at major existing bottleneck locations through targeted auxiliary lanes and operational improvements moves some of those bottlenecks from severe to manageable levels of congestion.
- Right-sizing roadway widening projects—Mentioned above are many locations where roadway widening projects in the MTP/SCS were down-sized from the projects in the 2008 MTP. The reduced-scale projects were often reconfigured as complete streets projects with multi-modal focus. Through the diligent efforts of local agencies in general plan circulation element updates, many of these downsized roadway projects result in more optimal use of roadways than the larger capacity projects they replaced.
- Roadways tied to growth—By tying the construction of new roadway facilities to the land use development and growth assumed in the MTP/SCS, new roadway facilities are better utilized in the MTP/SCS.

Chapter 10 — Financial Stewardship provides additional discussion of strategies in the MTP/SCS that increase efficient and productive use of the region's transportation infrastructure.