CHAPTER 5A

Land Use–Transportation Connection Trends and Performance

Introduction

Because the MTP/SCS is a long-range plan, the degree to which it enhances the performance of the region's transportation system and improves mobility and access for residents of the region over time are key measures of success. This is especially important to ensure more efficient vehicle and freight movement and improve mobility options for cost, health, environmental, or other reasons.

This chapter is divided into three sections to fully describe the performance of the transportation system planned for in this MTP/SCS: Chapter 5A provides an overview of the land use-transportation connection; Chapter 5B describes the performance of the roadways in terms of vehicle miles traveled and roadway congestion and delay; and Chapter 5C discusses transit and non-motorized travel (i.e., bicycling and walking).

Chapter 5A provides background for Chapters 5B and 5C and is divided into three sections. The first section describes the indicators critical to evaluating performance of the transportation system and how the MTP/SCS performs on them (Overview of Transportation Performance Indicators); the second section describes the analytical framework and modeling tools used to measure these indicators (Technical Analysis Framework and Tools); and the third section describes the primary relationships between land use and transportation that influence these indicators (Land Use-Transportation Connection).

Transportation plans often focus on improving mobility through investment in transportation infrastructure and services. Measures of mobility, such as the percent of travel using a particular travel mode or mode share, travel time, and travel delay provide valuable information about how well current and planned transportation systems function. Through the course of the entire MTP/SCS planning process and SACOG's ongoing Congestion Management Process (CMP), the performance focus has been on the following critical indicators:

- vehicle miles traveled (VMT) on the region's roadways;
- the level of congestion and delay for all modes, but especially roadway congestion;

- transit ridership and the share of trips made by transit modes; and
- travel by non-motorized travel modes (bike and walk) and the share of trips made by those modes.

A major part of the performance outcomes of this MTP/SCS relates to a heightened emphasis on maintenance of the transportation system. This emphasis resulted in a critical look at investments which expand the transportation system. To the extent that some system expansion investments can be delayed, greater investment can be made in maintenance of the system. From the perspective of plan performance, the challenge is to make this change in emphasis in investments without sacrificing the high performance achieved in prior plans.

The background for assessing performance of this MTP/SCS is somewhat different and more complicated than the 2012 MTP/SCS, as well, starting with the base year against which the forecast horizon years are evaluated. For this MTP/SCS, the base year is 2012, which is a recession year. For the last MTP/SCS, the base year was 2008, which was the last year before the recession took hold of the economy in this region. Because 2012 was a recession year, overall employment and household incomes were down, relative to 2008, and the amount of travel was also down. The horizon year forecasts prepared for this MTP/SCS assumed the region's economy returned to a more normal level of employment. So, a normal future year forecast is being compared to a recession base year. For all of the metrics used to evaluate this MTP/SCS, this factor is significant. In some cases, in addition to the 2012 base year, comparisons to the 2008 base year are also provided, to allow for a more consistent assessment of change over time.

Highlights of the performance of the MTP/SCS are:
- Decline in VMT per capita–Expected VMT from all sources in the region decline by 3.7 percent from 2012 levels. This sustains an achievement of the 2012 MTP/SCS.
- Decline in congested VMT per capita–The long range MTP/SCS is forecasted to result in a increase in the amount of congested vehicle travel per capita compared to 2012. This result is related to 2012 being a recession year, with unusually low congestion. Compared to 2008, this MTP/SCS delivers a

decline in congested VMT per capita by 3.9 percent, sustaining this achievement of the 2012 MTP/SCS.

- Increase in travel by transit, bicycle and walking–The MTP/SCS is forecasted to increase trips per capita by transit, bicycle or walk by 30.0 percent, also comparable to the increase in the 2012 MTP/SCS.
- Increase in Productivity of the Transportation System–The MTP/SCS roadway system will be more efficiently used, with the proportion of VMT in the optimal use range increasing. The MTP/SCS is also forecasted to more than double the productivity of the region's transit system, from about 33 boardings per service hour to 57, a 71 percent increase. This improvement in transit productivity will substantially increase the amount of service which can be funded through passenger fares.

Technical Analysis Framework and Tools

In evaluating the performance of the MTP/SCS and the ongoing CMP efforts, the major points of reference for each key indicator is:

- What have the historic trends been for each indicator?
- How do the projections for the MTP/SCS affect the historic trends moving forward to the forecast horizon years?

Forecasting and Analysis Tools

The main tools used for the transportation analysis of the MTP/SCS are SACOG's land use scenario software and databases, and regional travel demand model. SACOG has been at the forefront of development and application of travel demand modeling tools, and throughout the Blueprint project SACOG undertook research and analysis activities to evaluate and improve the ability to capture land use-transportation interrelationships using computer models.

SACOG utilized its regional travel demand model to compare the MTP/SCS 2036 conditions to the existing conditions for the 2012 base year. SACOG's primary model is the Sacramento Regional Activity-Based Simulation Model (SACSIM). SACOG periodically updates and improves SACSIM, and releases versions of the model and data for use by member agencies when the MTP/SCS is adopted, with versions numbered according to the year the version was finalized. SACSIM11 was used for the 2012 MTP/SCS. SACSIM15 was used for the analysis of this MTP/SCS.

SACSIM includes four sub-models for predicting travel demand. The major sub-model is DAYSIM, which is an activity-based tour sub-model for predicting household-generated travel. DAYSIM is an advanced practice[1] demand micro-simulation, which represents

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1   Advanced practice travel demand modeling is defined in TRB Special Report 288, "Metropolitan Travel Forecasting: Current Practice and Future Direction".

travel activities as tours, or series of trips, connecting the activities a person engages in during the course of a normal day. DAYSIM allows for much more detailed representation of key factors influencing household-generated travel, such as detailed characteristics of land use in the region, age of residents, household income, cost of fuel, and other factors.

SACSIM also includes a more conventional, state-of-practice[2] sub-model for predicting commercial vehicle travel. Two classes of commercial vehicles are modeled: two-axle commercial vehicles, and three-plus-axle commercial vehicles. Two-axle commercial vehicles include a wide range of vehicles, from a passenger vehicle which might be used to transport a computer repair person and their tools and equipment to an office to perform a repair, to a relatively small truck delivering produce to a restaurant or store. Three-plus-axle commercial vehicles also include a wide array of vehicles, from medium-sized delivery trucks to large, 5-axle tractor-trailer combinations. The common element tying these vehicles together is that they are used to transport goods and services and are not used for personal (household-generated) travel.

SACSIM also includes sub-models for predicting air passenger ground access to the Sacramento International Airport, and for predicting external travel, including travel by residents of the region to locations outside the region, residents outside the region traveling to locations within the region, and travel which goes through the region, but does not stop within the region.

Travel demand for vehicle or passenger trips estimated using SACSIM are combined for assignment to detailed computer representations of the region's highway and transit networks using software and programs. The resulting assignments are used for evaluation of VMT on roadways, congested travel on roadways, and travel on the region's transit system.

The analysis period of SACSIM is a typical weekday. A typical weekday is intended to represent weekday conditions during a non-summer month (i.e., a time period when most workers are at work, rather than on vacation, and when schools are normally in session). Where annual or other time periods are required, typical weekday estimates of travel are scaled up to represent those time periods. Within the typical weekday are four demand periods: A.M. peak period (7:00–10:00 a.m.); midday period (10:00 a.m.–3:00 p.m.); P.M. peak period (3:00–6:00 p.m.); and the late evening/overnight period (6:00 p.m.–7:00 a.m.).

Demographics

Demographics are a key factor influencing travel behavior. As mentioned above, SACSIM relies on a more detailed representative population file for its micro-simulation of travel demand. The representative population files are prepared using open source Pop-Gen software, developed by Arizona State University. The 2008-2012, five-year sample American Community Survey (ACS) data were used to establish controls at tract level and for the 2012 base year representative population file. Control variables at tract level included: number of persons per household; number of workers per household; household income; age of householder; and age of person within household. Because 2012 was a recession year, some of the 2012 tract-level control variables based on the five-year sample data were adjusted to reflect conditions in 2012 based on single-year ACS data at regional level. For 2036 demographics, the 2012 demographic controls were adjusted to reflect changes to population, household size, age of householder, and household income, which were forecasted by the Center for Continuing Study of the California Economy (CCSCE), and approved for use in the development of this plan by the SACOG Board in December 2013. Forecasts projected:

- Household population in the SACOG region increasing by 205,000 from 2012 to 2020, and 811,000 to 2036; and
- The percentage of persons 65-year-and-older increasing from 12.5 percent in 2012 to 16.7 percent by 2020, and 20.9 percent by 2036; and
- Total employment, after dropping 9 percent between 2008 and 2012, increasing 16 percent by 2020 and 50 percent by 2036.

2   Ibid.

Costs of Travel

Another key factor influencing travel behavior is the relative cost of different forms of travel. The time period from about 2005 to the present has seen unprecedented volatility in fuel prices. Year 2008 (the base year for the 2012 MTP/SCS) was the most volatile year on record, with gasoline price-per-gallon reaching a historic high of $4.55 in June, then plummeting to a five-year low of $1.88 by December. Since 2008, price volatility has not been as high, but average prices statewide have in general increased, with 2012 being the highest average fuel price in California ($3.81 in 2010 dollars).

As part of its work to implement technical aspects of SB 375, SACOG worked with other state MPOs to develop consistent consensus future projections of fuel prices for use in each respective region's implementation of SB 375 greenhouse gas reduction targets. SACOG used this consensus future projection in the preparation of the MTP/SCS: By 2020, fuel prices were assumed to increase to marginally from an average per-gallon price of $3.81 in 2012 to $3.94, and $4.68 by 2035 (all stated in 2010 dollars).[3]

Part of the same MPO technical coordination effort resulted in a consensus for projecting the most likely passenger vehicle fleet fuel efficiency to use for SB 375 implementation, based in part on changes to vehicles required by California's Pavley rule, authorized by AB 1493 in 2002. For SACOG, 2020 passenger vehicle fleet efficiency was assumed to be 24.9 miles per gallon (mpg), increasing to 28.2 mpg by 2036 (compared to 20.0 mpg in 2012). The combination of the fuel prices and fleet fuel efficiency, along with estimates of the costs of maintenance and other operating costs (but not insurance or depreciation), resulted in projected auto operating costs which remain essentially unchanged from the 2012 average cost of $0.25: $0.23 per mile by 2020 (a decrease of almost 8 percent) and $0.25 by 2036 (no change from 2012).[4]

Land Use-Transportation Connection

The Sacramento region's Blueprint, completed in 2004, relied on a growing body of research on the land use/transportation connection. The Blueprint relied on the latest research at that time to forecast the effects on travel outcomes (i.e., VMT, transit mode share, congestion, and non-motorized mode share) based on changes to future land use patterns. Since that time, the body of research and knowledge on the land use-transportation connection has expanded and matured. The latest research results were published in a 2010 meta-analysis (i.e., a rigorous review and compilation of studies) by Robert Cervero and Reid Ewing in the *Journal of the American Planning Association*.[5] The meta-analysis examined the following land use/transportation factors:

- *Regional Accessibility* is a way of quantifying how connected a given area is to the existing development, and is usually stated as the number of jobs within an average auto commute time. It is a measure of how many activities are within a reasonable drive time from a place of residence. In areas within the existing urbanized area, regional accessibility is usually higher, and in outlying areas or areas on the urban edge, it tends to be lower. This factor has the strongest potential effect on VMT—a 10 percent increase would result in a 2 percent decline in VMT for residents of an area.

- Street Pattern/Urban Design refers to how walkable a given area is, based on characteristics of the street pattern in that area. It is usually measured as the density of intersections in a given area. The greater the number of intersections, the smaller the blocks and the more potential walking connections there are in that area. Although other factors affect walkability and walk mode share, (e.g., presence/absence of sidewalks, pedestrian amenities on the street, traffic volumes on streets, presence/absence of crosswalks, treatment of pedestrians at signalized intersections.) street pattern has been used in research as a proxy for

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3   These price forecasts, though higher than 2012, are much smaller increases than those used for the 2012 MTP/SCS. The comparable per-gallon gasoline price forecasts used for the 2012 MTP/SCS were $4.79 by 2020 (21 percent higher than used for this MTP/SCS) and $5.30 by 2035 (13 percent higher than used for this MTP/SCS).

4   Comparable 2008, 2020, and 2035 auto operating costs used for

the 2012 MTP/SCS area $0.22, $0.27, and $0.29 per mile.

5   Ewing, R. and Cervero, R., "Travel and the Built Environment: A Meta-Analysis", Journal of the American Planning Association, Vol. 76, No. 3, Summer 2010.

walkability, in part because it is relatively easy to assemble data. In terms of VMT reduction, street pattern is the second strongest factor.

- Mix of Use refers to the inclusion in an area of a range of complementary land uses, which allows for more activities (i.e., working, shopping, school) to be contained within that area. Good land use mix allows for reductions in VMT through shortening of vehicle trips or shifting to other non-vehicle modes of travel such as walking. The most common measures of mix of use combine the relative proportions of residential, overall jobs, retail and other residential-supporting land uses into an entropy formula, which translates the balance of land use mix into a 0 to 100 scale.

- Proximity to Transit refers to the distance from a residence to the nearest transit station or stop, with VMT declining, and both walking and transit use increasing, as distance to the nearest transit gets shorter.

- Residential Density refers to the number of persons or dwellings clustered into a given area. Conceptually, density is quite easy to understand—the number of persons or housing units located in a given area. However, because there are different definitions of area (e.g., net acreage, gross acreage, total area) the effects of density are often over- or under-stated. The Ewing and Cervero meta-analysis controlled for differences in definition of density across the studies they reviewed.

Table 5A.1 provides a summary of the results of the Ewing/Cervero meta-analysis of land use/transportation factors and travel outcomes. The table provides the elasticity of the travel outcomes for each land use/transportation factor, which is the percentage change in the outcome for each one percent increase in the factor. So, an elasticity of -0.2 means a change of -0.2 percent in the outcome, for a one percent increase in the factor.

Not shown on Table 5A.1, but documented in two of research studies, is an indirect relationship between commercial vehicle VMT and land use density.[6, 7] Both studies showed a significant, but not totally consistent, reduction in commercial vehicle VMT per capita in metropolitan areas with higher land use densities, or with higher percentages of population residing in urbanized areas.

Additionally, at least one research study has identified a significant relationship between commute VMT and access to jobs in metropolitan areas . The research focused on the number of jobs within a 4-mile radius of place of residence, which is technically an accessibility measure. However, in jobs-poor locations (i.e. where jobs/housing balance is poor), access to jobs is very poor, too, so for the purposes of the research, access to jobs was treated as a jobs/housing balance variable. The study found significantly lower commutes where jobs/housing balance was better. This basic research finding is corroborated by ACS data in the Sacramento region, where the longest commutes are made by residents of counties with the poorest jobs/housing balance (see Table 5A-2).

6   Michael Burt and Greg Hoover (2006), Build It and Will They Drive? Modelling Light-Duty Vehicle Travel Demand, Conference Board of Canada (www.conferenceboard.ca); available at http://sso.conferenceboard.ca/e-Library/LayoutAbstract.asp?DID=1847.

7   M. S. Bronzini (2008), Relationships Between Land Use and Freight and Commercial Truck Traffic in Metropolitan Areas, for the Committee on the Relationships Among Development Patterns, Vehicle Miles Traveled, and Energy Consumption; for Special Report 298, Driving And The Built Environment: The Effects Of Compact Development On Motorized Travel, Energy Use, And CO2 Emissions, Transportation Research Board (www.trb.org); at http://onlinepubs.trb.org/Onlinepubs/sr/sr298.pdf.

TABLE 5A.1
Land Use/Transportation Factors and Travel Outcomes

Land Use /Transportation Factor	Travel Outcome		
	VMT	Walk	Transit
Elasticity (Change in Travel, with respect to 1% increase in Factor)[1]			
Regional Accessibility	-0.20	+0.15	n/a
Street Pattern/Urban Design	-0.12	+0.39	+0.23
Mix of Use	-0.09	+0.15	+0.12
Proximity to Transit	-0.05	+0.15	+0.29
Residential Density	-0.04	+0.07	+0.07
Change in Travel Outcome, with 10% Increase in Factor			
Regional Accessibility	-2.0%	+1.5%	n/a
Street Pattern/Urban Design	-1.2%	+3.9%	+2.3%
Mix of Use	-0.9%	+1.5%	+1.2%
Proximity to Transit	-0.5%	+1.5%	+2.9%
Density	-0.4%	+0.7%	+0.7%

1   Ewing, R. and Cervero, R., "Travel and the Built Environment: A Meta-Analysis," Journal of the American Planning Association, Vol. 76, No. 3, Summer 2010.

TABLE 5A.2
Workers/Jobs Balance and Commute Time

Land Use /Transportation Factor	2000	2007	2011	'00 to '07	'07 to '11
Workers per Job					
El Dorado	1.81	1.61	1.67	-10.9%	+3.9%
Placer	1.16	1.18	1.24	+1.3%	+5.4%
Sacramento	1.04	1.03	1.07	-1.1%	+4.1%
Sutter	1.39	1.28	1.30	-7.5%	+1.1%
Yolo	0.89	0.89	0.90	-0.0%	+0.9%
Yuba	1.25	1.40	1.52	+12.0%	+8.0%
Total	1.09	1.08	1.12	-1.1%	+3.9%
Commute Time (in minutes)				Rank on W/J	Rank on CT
El Dorado	29.7	29.1	29.0	6	6
Placer	27.0	26.7	27.2	3	4
Sacramento	25.4	25.6	25.6	2	2
Sutter	25.4	26.9	27.8	4	3
Yolo	21.2	21.0	22.2	1	1
Yuba	26.2	28.4	29.9	5	5

Although it is tempting to assume that the relationships shown in Table 5A.1 are discrete dials that can be adjusted to achieve pre-defined results, there are many factors that confound attempts to isolate individual effects. Self-selection bias is a major confounding factor, which is poorly accounted for in most of the research. Self-selection bias refers to the fact that personal preference affects where someone chooses to live and the travel choices they make. Individuals who like walking may gravitate to walkable environments in their place of residence or place of work, and some of the land use-transportation relationships which are shown in research based on travel surveys may simply be measuring these preferences. Replicating in new areas the high walk share observed in existing well-mixed, walkable neighborhoods may not be possible, simply because the existing areas may have attracted a unique population of individuals who prefer walking.

Further, interactions among the land use-transportation factors themselves are very difficult to control, and many factors are highly correlated. For example, many areas with good street patterns (i.e., higher intersection densities) are also more dense, simply because block and lot sizes are smaller. Research has also recognized that the combined effects of many factors is not always equal to adding up the individual effects of each factor—there may be ceilings on some of the combined results. On the other side, some of the combined effects may be greater than the sum of the individual effects. For example, evidence from transit-oriented developments suggests that the combined effects of density, proximity to transit, and street pattern around rail stations with frequent service may far exceed the reductions in VMT and increases in walking and transit travel suggested by Table 5A.1. Although some factors are known to have greater potential influence (e.g., regional accessibility on VMT), making significant changes to those factors may actually be difficult.

Land Use-Transportation in the MTP/SCS

Table 5A.3 provides a summary of key land use-transportation factors in the region, comparing the 2036 changes from the MTP/SCS to 2012. The factors are tabulated by Community Type (see Chapter 3 for a more detailed description of the Community Types).

- Regional accessibility increases by 37 percent overall, with all Community Types increasing by 29 percent or more, relative to 2012. Center and Corridor Communities have the highest level of regional accessibility in both 2012 and 2036 in the MTP/SCS—in both years, accessibility to jobs is nearly 50 percent higher for residents of these areas, compared to the regional average. Accessibility to jobs declines for the remaining area types, with residents of Rural Residential and Lands Not Identified for Development in the MTP/SCS having the lowest accessibility in both 2012 and 2036 at 60 percent or more below regional averages. This reflects the fact that Center and Corridor Communities are centrally located in the region, and in general are surrounded by urban development. Developing, Rural Residential, and Lands Not Identified for Development in the MTP/SCS are located on the urban edge, or completely outside the urbanized area. Developing Communities, to the extent they are at the edge of the urbanized area, have access to jobs on only one side. These locational factors drive down regional accessibility, and, by extension, drive up VMT generation.

- Street pattern follows a similar pattern as regional accessibility, with Center and Corridor Communities being the highest in both 2012 and 2036 in the MTP/SCS. Center and Corridor Communities are more likely to be in older developed areas of the region, with smaller-block, grid-patterned street networks. These older street patterns are, all other things being equal, considered to be more walkable than more curvilinear, cul-de-sac dominated street patterns in more recently developed areas.

- Mix of use is highest in Center and Corridor and Established Communities, largely because these areas are located near jobs and commercial centers. In 2012, Developing, Rural Residential, and Lands Not Identified for Development in the MTP/

SCS were very low in measured mix of land use, with all below 14 of 100 on the SACOG mix index . In general, measured land use mix is low in these areas, because they are predominantly residential, with very little commercial, school or other supportive non-residential uses within one-half mile of places of residence. The biggest change in mix of use between 2012 and 2036 in the MTP/SCS occurs in Developing Communities—this change is reflective of a significant amount of growth and consideration of land use mix in the planning for these areas.

- Proximity to transit, as expected, is greatest in Center and Corridor Communities, with distance to the nearest transit station or stop averaging less than one-quarter mile in 2012, and declining to about one-eighth mile by 2036 based on the MTP/SCS. Overall proximity to transit also improves, declining from 0.72 miles in 2012 to 0.55 miles by 2036.

- Residential density increases overall by 27 percent, but the changes are focused on two Community Types: Center and Corridor Communities, which increase from about 10 dwellings per residential acre to about 15 units; and Developing Communities, which increase from 1.3 dwellings per acre to about 4.5 units. The other Community Types changed by less than ten percent.

- Jobs/Housing Balance improves in major jobs centers, and areas surrounding those centers. Chapter 9 and Table 9.7 provide more detail on this metric and forecasted changes over time, but overall jobs/housing balance improves by about 4 percent, through a combination of development of housing in-and-around jobs-rich centers, and development of jobs in housing-rich centers.

TABLE 5A.3
Land Use/Transportation Factors by Community Type

Land Use /Transportation Factor[1]	Community Type				
	Centers / Corridors	Established	Developing	Rural Residential	Region
2012					
Regional Accessibility [2]	503,022	360,974	231,666	108,181	351,079
Street Pattern/Urban Design [3]	114	88	70	17	85
Mix of Use [4]	37	34	16	10	32
Distance to Transit [5]	0.15	0.41	1.03	2.98	0.61
Residential Density [6]	10.5	4.1	2.0	0.3	1.8
2036					
Regional Accessibility [2]	703,961	496,573	342,029	152,655	482,644
Street Pattern/Urban Design [3]	134	99	67	18	95
Mix of Use [4]	36	34	28	10	32
Distance to Transit [5]	0.12	0.36	0.65	3.03	0.54
Residential Density [6]	14.6	4.4	4.8	0.3	2.3
Change from 2012					
Regional Accessibility [2]	40%	38%	48%	41%	37%
Street Pattern/Urban Design [3]	18%	13%	-4%	6%	12%
Mix of Use [4]	-3%	0%	75%	0%	0%
Distance to Transit [5]	-20%	-12%	-37%	2%	-11%
Residential Density [6]	38%	6%	141%	5%	24%

1   All numbers are population-weighted averages for residences in each community type.

2   Total jobs within 30-minute drive from place of residence.

3   Intersection density, stated as intersections per square mile, within 1/2-mile of place of residence.

4   SACOG mix of use index, 0 to 100 scale with 0 = homogenous, 100 = perfect mix of use.

5   Shown as average distance from place of residence to nearest transit station or stop, in miles.

6   Dwelling units per net residential acre, within 1/2-mile of place of residence.