TECHNICAL EVALUATION OF THE GREENHOUSE GAS EMISSIONS REDUCTION QUANTIFICATION FOR THE SACRAMENTO AREA COUNCIL OF GOVERNMENTS' SB 375 SUSTAINABLE COMMUNITIES STRATEGY

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California Environmental Protection Agency
Air Resources Board

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I. EXECUTIVE SUMMARY

The Sustainable Communities and Climate Protection Act of 2008 (Senate Bill [SB] 375) is intended to support the State's broader climate goals by encouraging integrated regional transportation and land use planning that reduces greenhouse gas (GHG) emissions from passenger vehicle use. The metropolitan planning organizations (MPOs) of California develop regional Sustainable Communities Strategies (SCS) as part of the Regional Transportation Plan (RTP). These SCSs demonstrate whether the MPO can meet the per capita passenger vehicle-related GHG emissions targets (targets) for 2020 and 2035 set by the California Air Resources Board (ARB or Board).

The Sacramento Area Council of Governments (SACOG) is the transportation planning agency responsible for developing and implementing the long-range transportation plan, known as the Metropolitan Transportation Plan (MTP), for the six-county, 22-city Sacramento metropolitan region. SACOG does this by coordinating transportation planning and long-range land use planning efforts among the local jurisdictions, and by programming funding for transportation infrastructure in the region. SACOG's 2016 MTP covers the time period from 2016 through 2036.

For the SACOG region, the Board set targets of 7 percent per capita reduction in 2020 and 16 percent per capita reduction in 2035, from a base year of 2005. In April 2012, SACOG adopted its first MTP/SCS and the Board determined that the SCS, if implemented, would achieve the 2020 and 2035 GHG emission reduction targets. ARB's technical evaluation of SACOG's first SCS[1] was completed in May 2012, and contains detailed information about the methods SACOG used to quantify GHG emissions from its 2012 MTP/SCS. Much of that information is still relevant for this technical evaluation of SACOG's second SCS, and is referred to throughout this report.

Over the past four years, SACOG has begun implementing its 2012 SCS while simultaneously developing the second SCS. There are many elements of the first SCS, and preceding MTPs, that have been implemented including the completion of bike and

[1] http://www.arb.ca.gov/cc/sb375/sacog_scs_tech_eval0512.pdf

pedestrian projects, expansion of light rail service, and funding assistance for local sustainability planning efforts. On February 18, 2016, SACOG adopted its second SCS.

This 2016 MTP/SCS continues to emphasize the key strategies from the first SCS that reduce barriers to infill development, and increase density in targeted areas served by transit to make the transit system more viable and efficient. SACOG also took a "fix-it-first" approach when prioritizing roadway funding. Roadway maintenance and rehabilitation projects were prioritized over projects that would add new roadway capacity.

SACOG is also implementing its complete streets policy by configuring on-street bike lanes and including pedestrian safety improvements into scheduled roadway maintenance projects. Since there is limited funding available to complete all the desired transportation projects in the region, SACOG applied project phasing criteria regarding roadway utilization and peak period congestion to determine which transportation projects should be completed within the 20-year plan horizon, and which projects would have to wait.

The outcome of SACOG's growth strategy in the 2016 MTP/SCS is to accommodate a 36 percent population increase on less than 2 percent of the region's land area. To put that in context, the development footprint over the next 20 years would expand by approximately 7 percent to accommodate a 36 percent population increase.

In addition to its land use and transportation strategies, SACOG is supporting the State's initiatives to reduce GHG emissions from the vehicle fleet. The SACOG Board adopted a Plug-In Electric Vehicle (EV) and Infrastructure Readiness Plan in 2014. The EV Readiness Plan outlines the strategies related to planning, permitting, and installing electric vehicle charging stations in the Sacramento region.

The performance outcomes of SACOG's 2016 MTP/SCS, compared to today, will include an increase in the number of homes and jobs near transit, improved jobs/housing balance, over a doubling of bike lane miles, and expansion of transit services. SACOG's quantification of GHG emissions reductions from the 2016 SCS indicates that the plan would result in per capita emissions reductions of 8 percent by 2020 and 16 percent by 2035 from a base year of 2005.

SB 375 directs the Board to accept or reject the determination of each MPO that its SCS would, if implemented, achieve the region's GHG emissions reduction targets for 2020 and 2035. This report reflects ARB staff's technical evaluation of SACOG's 2016 MTP/SCS and describes the methods used to evaluate the MPO's GHG quantification. Based on all the evidence including model inputs, outputs, and assumptions, the SCS strategies, and the performance indicators, ARB staff concludes that SACOG's 2016 MTP/SCS would, if implemented, meet the targets of 7 and 16 percent.

II. IMPLEMENTATION OF SACOG'S FIRST SCS

The purpose of this report is to provide an overview and analysis of the SACOG's 2016 MTP/SCS, also known as *Building a Sustainable System*. SACOG's 2016 MTP/SCS is focused on overcoming the challenges to implementing the 2012 MTP/SCS, making progress on the policy commitments set forth in the 2012 plan, and maintaining the existing transportation system.

SACOG's previous SCS identified policies to further improve the performance of the regional transportation system in a manner that supports more sustainable urban development, air quality goals, and better quality-of-life outcomes. The foundation for the 2016 MTP/SCS is the 2004 SACOG Blueprint, a voluntary growth management strategy that the region's 28 local jurisdictions are encouraged to follow. Each subsequent MTP adopted after the SACOG Blueprint has invested a greater a share of transportation funding resources in alternative modes than in the previous MTP, and made stronger linkages between the projected land use pattern and transportation system.

SACOG's 2016 MTP/SCS is an update to the 2012 MTP/SCS, rather than an overhaul, intended to address the implementation challenges of the 2012 MTP. Specifically, five key implementation themes were central to the 2016 MTP update:

- Capturing transportation revenue from all available sources (local, state, and federal);
- Bringing the transportation system to a state-of-good-repair through rehabilitation and maintenance of existing facilities;
- Changing investment timing and project phasing within the planning period;
- Understanding the viability of the land use allocation between greenfield and infill development; and
- Measuring and tracking plan performance and effectiveness over time.

Development in the Sacramento region was hampered substantially by the recession, and is just beginning to return to pre-recession levels. Despite the lack of substantial observed land use changes over the last four years, SACOG has taken several steps that show the region's commitment to implementing its SCS.

The ability of the region to achieve the goals set forth in the MTP/SCS will depend on successful implementation by both SACOG and local governments, in collaboration with transit operators, Caltrans, developers, and a wide range of interest groups.

SACOG is completing transportation projects that relieve congestion and expand mobility options, securing and providing funds for local and regional planning and project development, and providing technical assistance to local governments to enhance their capacity to implement local sustainability projects.

A. Enhancing the Multi-Modal System

The SACOG region has delivered, or is nearing completion on, over $3 billion in projects implementing the 2012 MTP/SCS and supporting SACOG's Blueprint planning initiative. Projects include extensions to the transit system; road and bridge capital and rehabilitation projects; and bicycle, pedestrian, and streetscape improvements. Some projects that highlight implementation successes of the MTP/SCS include:

Bike and Pedestrian Bridge over Union Pacific Railroad
Photo source: SACOG

- More than $130 million in bicycle, and pedestrian improvements, including new bike lanes, sidewalks, and intersection improvements in several cities and counties;
- Bike and pedestrian connections over and under major physical barriers including Highway 50 at Watt Avenue, the American River at Hazel Avenue, Union Pacific Railroad at Sacramento City College, and over I-80 in the City of Sacramento;

Tower Bridge Gateway bicycle improvements
Photo source: SACOG

- The Northside School Class 1 Bike Path in El Dorado County;
- Extension of Sacramento Regional Transit Light Rail Blue Line to Cosumnes River College in South Sacramento.
- New carpool lanes on US Highway 50 and Interstate 80.
- Complete streets improvements on Auburn and Sunrise Boulevards, major arterial streets located in Citrus Heights; and Garden Highway in Yuba City;
- Tower Bridge Gateway and bicycle improvements to accommodate the planned Downtown Sacramento Riverfront Streetcar.

B. Encouraging Sustainable Land Use

SACOG's 2016 MTP/SCS continues the transit-supportive, infill-oriented land use planning approach set forth in the 2012 MTP/SCS, along with SACOG's Rural-Urban Connections Strategy (RUCS), first launched in 2008. The RUCS program is designed to help implement the Sacramento Region Blueprint by minimizing the amount of open land that will be needed to accommodate the region's growth, while also ensuring the economic vitality of the region's rural areas. Approximately 75 percent of the SACOG region's land area is agricultural, forest, or other open space. The RUCS program uses parcel-level mapping data to minimize impacts to important farmland, habitat, and other resources associated with urban expansion, and to minimize land use conflicts at the urban/rural interface. Rural lands are often converted to urban uses when the land owner cannot maintain a living on that land. Through several case studies, the RUCS program explores complementary policies that support the economic vitality of rural land uses, and SACOG integrates those applicable policies into the MTP/SCS.

C. Funding Assistance

SACOG receives federal, state, and local funding to support transportation investments, each with specific purposes and restrictions. SACOG estimates, on average, approximately $1.6 billion per year (in current year dollars) in revenues to implement the MTP.

1. State Funding Programs

SACOG anticipates that the State Cap and Trade programs will provide a combined $1.3 billion (year of expenditure) in funding through 2036.[2]

As of February 2016, SACOG has been awarded over $18.5 million in Greenhouse Gas Reduction Funds through three programs focused on transportation and sustainable communities:

[2] SACOG 2016a. Appendix B-1 Financial Plan. Attachment A.

- *Affordable Housing and Sustainable Communities:* $6.7 million awarded to the City of West Sacramento for the West Gateway Place Affordable Housing and Grand Gateway Transportation Infrastructure Project
- *Transit and Intercity Rail Capital Program:* $6.4 million awarded for refurbishment of light rail vehicles, and $4.6 million awarded to Amtrak Capitol Corridor Joint Powers Authority for service improvements connecting Sacramento to the Bay Area
- *Low Carbon Transit:* $760,000 awarded to various transit agencies for transit service improvements, expansions, and enhancements

In addition, SACOG has been awarded funding through the following state programs that will facilitate implementation of the SCS:

- PEV Infrastructure Implementation (California Energy Commission grant): This project will begin implementing the regional PEV infrastructure plan adopted by the SACOG Board in 2013.
- California Transportation Commission's Active Transportation Grant Program (CTC 2016): SACOG has been awarded approximately $32 million in the 2014 and 2015 grant cycles. Examples of projects that have been funded include numerous Safe Routes to Schools projects and bike and pedestrian gap closure projects throughout the region.
- California Strategic Growth Council (SGC): SACOG received a $900,000 grant from SGC in 2014 to implement the MTP/SCS by providing technical assistance to member jurisdictions. The grant's major activities include: removing barriers to revitalization and intensification, and advancing healthy communities through active design/transportation projects.

2. Local Funding Programs

Only a relatively small portion of SACOG's total transportation funding can be used for flexible purposes. For example, SACOG estimates that about $145 million was available for competitive award through SACOG's regional funding framework during 2015 (SACOG 2015).

SACOG allocates funding to projects based on available apportionments of regional Congestion Mitigation and Air Quality (CMAQ), Regional Surface Transportation Program (RSTP), State Transportation Improvement Program (STIP), and Active Transportation Program (ATP) funds. These funds are distributed through the following Programs.

- *Regional/Local Funding Program:* funds projects that will help implement the MTP/SCS by providing regional benefits to the transportation network.
- *Bicycle & Pedestrian Funding Program*: supports the efforts of local agencies to construct walking, bicycling, and transit infrastructure, and provide connections between communities.
- *Community Design Funding Program:* provides financial assistance to local government agencies that seek to implement physical development that is consistent with SACOG's Blueprint.

The following projects were awarded funding in the 2015 funding round approved by the SACOG Board:

- Upper Broadway Bicycle Lanes in Placerville connecting to the El Dorado Rail Trail;
- Del Rio Class I Trail in Sacramento connecting existing neighborhoods to regional parks, area schools, markets, and other activity centers;
- West Woodland Safe Routes to School Project to provide cross town connectivity and close gaps in the bicycle and sidewalk networks;
- Sycamore Park Bicycle and pedestrian overpass in West Sacramento;
- Dos Rios and Horn Road Light Rail Transit Stations;
- Extend bus/carpool lanes on the Capital City Freeway (SR51); and
- Road rehabilitation and complete streets projects in Elk Grove, Galt, Sacramento County, West Sacramento, Yolo County, and Yuba County.

D. Policy Guidance and Strategic Planning Documents

SACOG has prepared several regional policy documents that support implementation of the 2012 SCS. The following efforts were completed or have been on-going since May 2012.

- *Take Charge Sacramento*: In 2014, the SACOG Board adopted a plug-in EV readiness plan outlining strategies for planning, permitting, and installing EV charging infrastructure in the region.
- *Bicycle, Pedestrian, and Trails Master Plan Update*: Updated in 2015, the Master Plan provides a list of active transportation projects in the region with the goal of providing a connected, convenient, and safe system. The Master Plan will be used to assist with complete streets planning, prioritizing active transportation funding, and promoting multi-modal trips through transit connections.
- *Rural Urban Connections Strategy (RUCS)*: This long-standing, on-going SACOG project conducts studies and analysis to provide information to decision

makers as they balance competing pressures of urbanization and resource conservation. The RUCS supports rural and urban agricultural production, promotes greater access to local, healthy food in the region, and minimizes the MTP's impacts on farmland.

- *Transportation Demand Management (TDM) Strategic Plan*: SACOG's TDM program supports and promotes alternative, non-drive-alone transportation modes, including carpooling, vanpooling, public transit, bicycling, walking, and telecommuting. SACOG is currently updating its TDM Strategic Plan with the goal of better framing opportunities for the regional TDM program.

SACOG's actions over the past four years demonstrate the region's commitment to implementing the first SCS, and establish a foundation for continued implementation of the policies and programs that are reflected in both the 2012 and 2016 plans.

III. REGIONAL LAND USE AND TRANSPORTATION TRENDS

To develop the land use and transportation assumptions that are the basis for the MTP/SCS, SACOG revisits its population, employment, and housing growth projections every four years. The short-term growth forecast in the 2012 MTP slowed during the recession, which dampened the overall amount of growth expected by the end of the plan horizon. SACOG now projects the addition of approximately 811,000 people between the 2016 MTP's base year of 2012 and horizon year 2036, where the previous plan estimated 871,000 additional people between 2008 and 2035. Likewise, SACOG now projects 285,000 new homes for the region between 2012 and 2036, compared to 303,000 new homes by 2035 in the previous plan. Employment growth in the 2016 MTP appears higher than the previous MTP because SACOG's forecast now reflects both jobs recovered from the recession, and new jobs. Employment growth projections include 439,000 new employees from 2012 to 2036, compared to 361,000 new employees forecast in the prior plan from 2008 to 2035. SACOG's growth projections from the 2012 and 2016 MTPs are compared in Table 1 below.

Table 1: SACOG Growth Forecast Compared to Previous MTP/SCS

Year	Population		Housing Units		Employees	
	2012 MTP	2016 MTP	2012 MTP	2016 MTP	2012 MTP	2016 MTP
2008	2,215,044		884,725		966,316	
2012		2,268,138		903,451		887,965
2020	2,519,044	2,472,567	1,003,725	951,495	1,068,839	1,033,297
2035	3,086,213	3,040,591	1,187,744		1,327,424	
2036		3,078,772		1,188,347		1,327,323

Source: SACOG 2016a.

The SACOG region has already recouped most of the jobs lost during the recession. SACOG still expects long-term regional growth to outpace the State's rate of growth as a whole.

Major employment sectors in the region include government and construction, which were hit hard by the recession. Job growth is occurring in the professional and business services, educational and health services, life sciences, food/agriculture technologies, and clean energy technology sectors.

A. Land Use

The SACOG region consists of six counties: El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba Counties. SACOG's total population is approximately 2.4 million, which is about 6 percent of the State's total population. About 60 percent of SACOG's population lives in Sacramento County. The most populous city, Sacramento, is home to 485 thousand people, approximately 20 percent of the Region's population (US Census 2014).

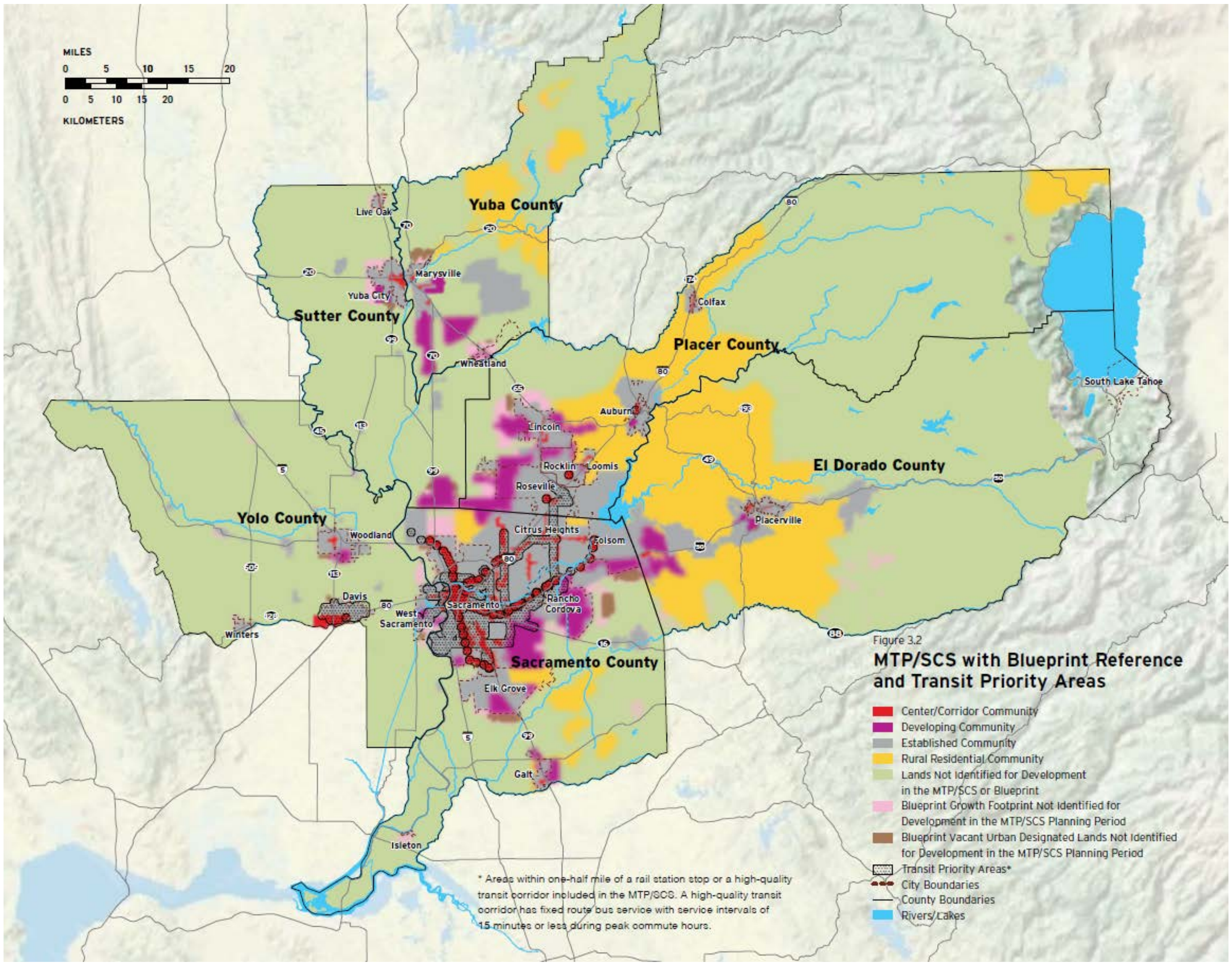
SACOG identified four community types to describe the areas where growth is expected during the MTP/SCS planning period. These four land use place types reflect generalized categories of land uses in local general plans, including:

- Center and Corridor Communities: higher density and mix of uses; historic downtowns, main streets, and central business districts.
- Established Communities: low to medium-density development adjacent to centers and corridor communities; "first-tier" or "inner-ring" suburbs.
- Developing Communities: typically characterized as vacant or "greenfield" land on the edge of contiguous urbanized areas and are slated for urban expansion.
- Rural Residential: characterized by very low density, and located outside urbanized area among small-scale or commercial farms.

Land use allocations in SACOG's growth forecast were weighted heavily toward building out fully entitled projects in Established Communities and construction of fully entitled projects in Developing Communities.

SACOG identified three Transit Priority Areas (TPAs) in the region, which are areas situated within one-half-mile of a major existing or planned high-quality transit stop or corridor. SACOG's TPAs are a geographic overlay to the community types described above, and illustrated in Figure 1 below. The three TPAs include the major transit corridors in Placer, Sacramento, and Yolo Counties.

Figure 1: MTP/SCS Community Types and Transit Priority Areas



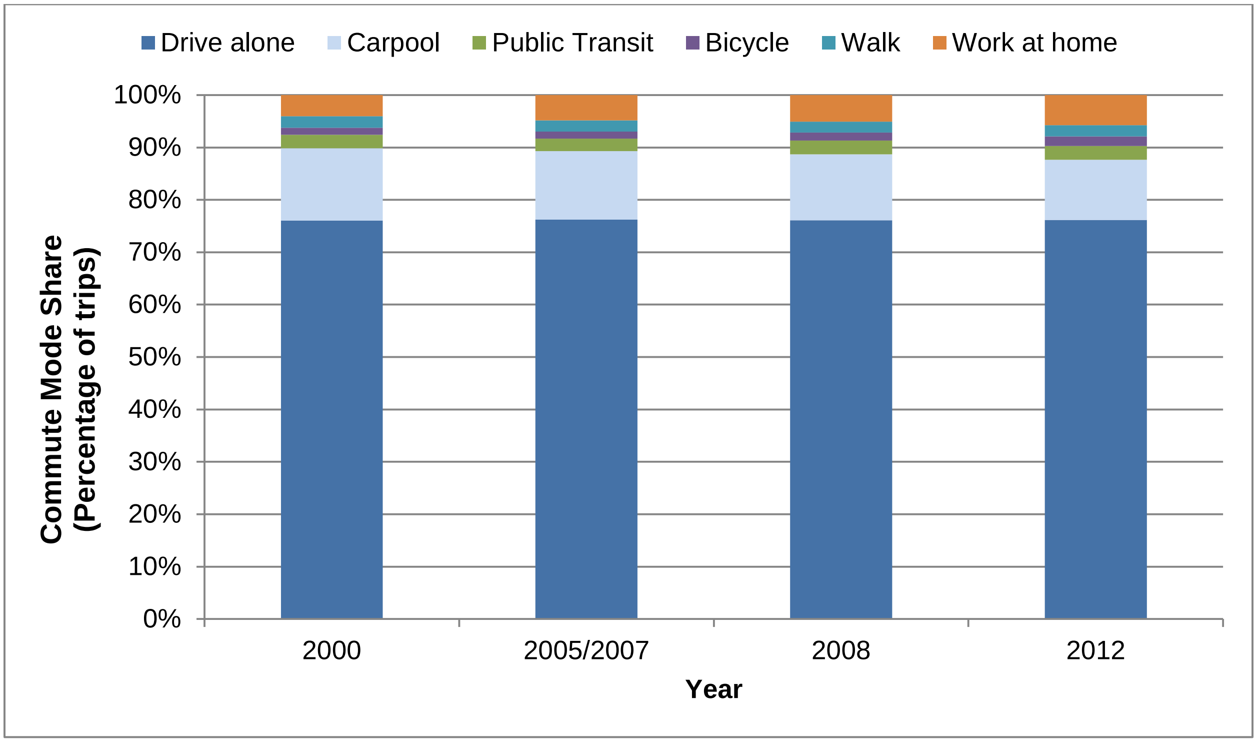
Source: SACOG 2016a.

B. Transportation

SACOG's transportation network includes roadway, light rail, bus, commuter rail, bicycle and pedestrian infrastructure. The majority of trips in the region are taken by automobile, either in single occupant vehicles (SOV) or as shared ride trips in high occupant vehicles (HOV).

Figure 2 illustrates the historical mode split of commute trips in the SACOG region during the period of 2000-2012.

Figure 2: SACOG Commute Mode Share 2000-2012



Source: U.S. Census Bureau, as cited in SACOG 2016a.

SACOG's steps to implement the first SCS provide opportunities to influence different mode choices in the future. SACOG has already begun making investments in active transportation infrastructure to reduce the reliance on SOV travel, and the 2016 MTP/SCS allocates greater funding to active transportation infrastructure than any previous MTP.

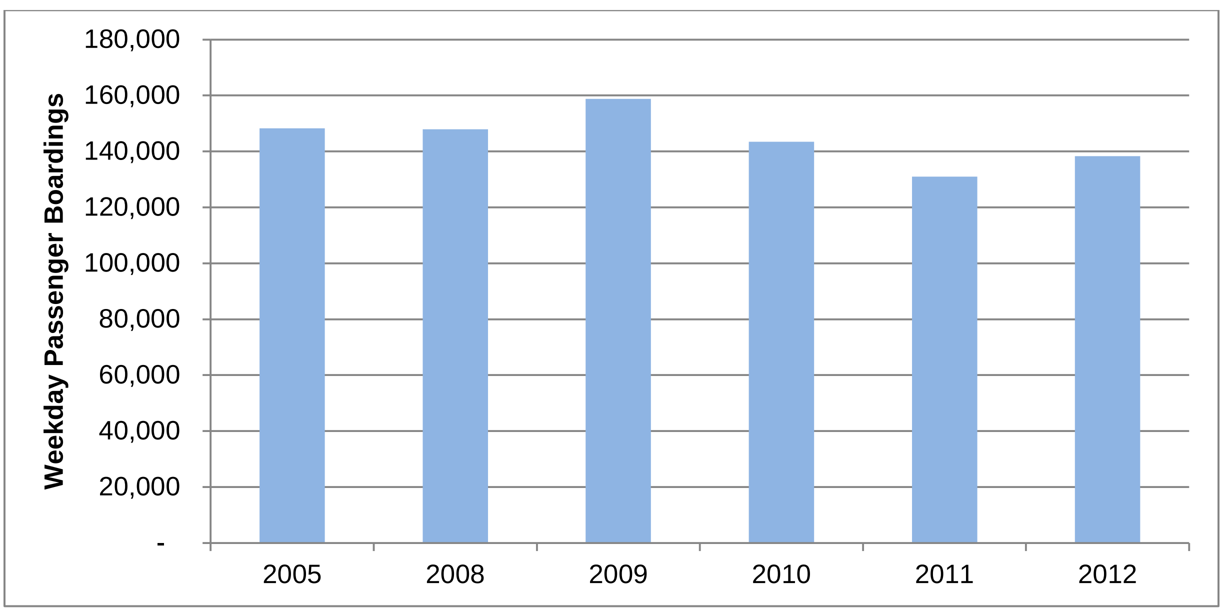
1. Roads

SACOG is shifting its investment priorities away from capacity-increasing roadway projects to roadway maintenance and rehabilitation. SACOG identified 80 new capacity projects identified in the 2012 MTP that were re-phased and deferred beyond the 2036 planning horizon of the 2016 MTP, for a net reduction of 185 lane miles. This re-phasing expands available funding to support road maintenance and rehabilitation and reduce congested vehicle miles traveled (VMT). SACOG's strategy also addresses capacity needs and congestion on commute corridors through freeway HOV and auxiliary lanes, interchange improvements, new river crossings, and some capacity expansion on major arterials. SACOG has completed 27 miles of new HOV lanes between 2005 and 2012.

2. Transit

There are currently 14 transit service providers in the SACOG region. Public transit boardings in the SACOG region declined slightly between 2008 and 2012 (Figure 3). This is due to a variety of compounding financial challenges and factors impacting transit providers in the SACOG region, specifically Sacramento Regional Transit. The recession, which reduced commute ridership and fare collection, resulted in reduced operating revenue, which triggered a 14 percent reduction in service hours and an increase in transit fares. Two local sales tax measures pending for Fall 2016 would help provide additional funding for transit, and SACOG's financial plan for the MTP assumes these new tax measures will be enacted. SACOG's land use strategy in the MTP/SCS also aims to increase density in transit priority areas, making transit service more viable, and improving the region's transit systems' revenue recovery rate in the long-term.

Figure 3: Transit Passenger Boardings in the SACOG Region



Source: SACOG 2016a, pg 106.

3. Active Transportation

SACOG's existing bike infrastructure network is estimated at over 1,500 miles of class I and class II bike lanes, or approximately 70 miles per 100,000 people. Total and per capita bike and walk trips are on the rise in the SACOG region. An observed 0.5 percent increase in non-motorized commute mode from 2000-2012 is modest, but notable, because this followed a 1 percent decline in non-motorized mode share between 1990 and 2000. Observed active commute travel statistics in the SACOG region are summarized in Table 2.

Table 2: Observed Active Commute Travel in the SACOG Region

Commute Mode	2000	2005/2007	2008	2012
Bike	1.3%	1.3%	1.5%	1.8%
Walk	2.2%	2.1%	2.1%	2.1%
Combined Bike and Walk	3.5%	3.4%	3.6%	3.9%
Source: U.S. Census Bureau, as cited in SACOG 2016a.				

4. Transportation Demand Management

Telecommuting is on the rise in the SACOG region, however, carpooling is on the decline. Carpool mode share declined by about 1.5 percent from 2005 to 2012, while the proportion of single occupant vehicle commuters was relatively unchanged. Some of the observed reduction in carpooling can likely be explained by jobs lost during the recession, while other former carpoolers switched to teleworking and/or active transportation modes.

5. Emerging Trends: Mobility

New mobility options have emerged in the SACOG region since the 2012 MTP/SCS, as described below. These new transportation alternatives are early in their deployment, but present opportunities for long-term GHG reductions, as described in Appendix A to this report.

Private Transportation Companies:
There is currently one market-based, private car-sharing business that offers short-term car rentals in the region. Since the 2012 SCS was adopted, on-demand ride-sourcing and transportation network companies, such as Uber and Lyft, began offering service in the SACOG region, providing another alternative to automobile ownership.

Electric Vehicles:
Electric vehicles have also been gaining popularity in the SACOG region. Fully electric vehicles, like the Nissan Leaf and Chevrolet Spark, rely completely on electric batteries.

Many of these models became available after 2010. Before SACOG's EV readiness plan was adopted in 2014, there were approximately 2,000 EVs on the road in the SACOG region. SACOG currently estimates there are 4,500 EVs on the road in the region.

Bike Share:

Bike share systems are emerging around the country to support active transportation modes. They offer convenient first-last mile connections to existing transit systems, and an alternative to bicycle ownership. SACOG is the project manager for a new regional bike-share project that is scheduled to become operational in 2017. The initial bike share system will serve the cities of Sacramento, West Sacramento, and Davis.

IV. 2016 SCS DEVELOPMENT AND STRATEGIES

This section provides an overview of the alternative scenario development process and highlights the key land use and transportation strategies that are reflected in the adopted SCS. SACOG's 2016 MTP/SCS is an update to the 2012 MTP/SCS, rather than an overhaul, intended to address the implementation challenges of the 2012 MTP.

A. Alternative Land Use and Transportation Scenarios

SACOG evaluated three alternative land use and transportation scenarios for the 2016 MTP. The alternative scenarios were developed to illustrate trade-offs and effects of different development patterns and transportation investments compared to the 2012 MTP/SCS. Scenario 2 was most similar to continued implementation of the then-current (2012) MTP. Scenario 1 represented slightly lower development densities with higher auto-mode investment, and Scenario 3 was based on slightly higher density development with higher multi-modal investment, compared with Scenario 2. Scenarios 1 and 3 represented alternative bookends to facilitate discussion among stakeholders and the SACOG Board that assisted in making necessary refinements to Scenario 2. SACOG refreshed its revenue assumptions and imposed fiscal constraint and major market and policy/regulatory influences on all three scenarios. SACOG also conducted a transportation project phasing analysis to explore rescheduling of certain transportation projects within the Plan horizon.

B. Preferred Scenario

The Preferred Scenario that was ultimately selected and adopted is a blend of all three scenarios that best addresses the implementation commitments from the 2012 MTP/SCS, and achieves the region's air quality and GHG reduction goals. The key differences between the 2012 MTP/SCS and the preferred scenario for the 2016 plan are:

- As much or slightly more growth in infill areas and small-lot single-family and attached (multi-family) housing, and, correspondingly slightly less growth in greenfield areas;
- As much or slightly more improvement in sub-regional jobs-housing balance;
- A reduction in spending on system expansion in favor of increased funding for roadway maintenance and rehabilitation; and
- Strategic changes in project phasing to optimize system performance.

C. SCS Land Use Strategies

Between 2012 and 2036, the SACOG region is expected to grow by 36 percent, or by about 811,000 people. Over half (58 percent) of new housing growth in the SACOG region would occur in Center and Corridor and Established Community types. Approximately 40 percent of SACOG's new housing is forecast in Developing Communities, and 2 percent in Rural Residential areas. By 2036, SACOG forecasts that over 80 percent of the region's housing will be located within Center and Corridor and Established Communities.

> 86 percent of all jobs and 78 percent of housing will be within a half mile of a transit station or stop by 2036.

Likewise, SACOG expects that 37 percent of new housing units and 42 percent of new jobs will be located in TPAs[3] between 2012 and 2036. SACOG projects that the housing product mix within TPAs will be 76 percent attached units (densities of 8-50 dwelling units/acre) and 19 percent small-lot (8-25 dwelling units/acre) single-family units, with only 5 percent large-lot (1-8 dwelling units/acre) single-family units.

Land use decisions made at the local level influence development patterns and the GHG emissions from passenger vehicles. As discussed previously, SACOG's 2016 MTP/SCS must consider local adopted land use plans, which direct growth in existing urbanized areas and along key transportation corridors. The local plans in the SACOG region can accommodate a much greater quantity of growth than SACOG's demographic projections predict. SACOG staff worked with the local jurisdictions to conduct a theoretical supply analysis of the local plans to derive the most likely development pattern. The supply analysis takes into account practical considerations, such as infrastructure and resources constraints, market conditions, local approvals, and other factors and trends that influence the feasibility of development.

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[3] Transit Priority Areas are those areas of the region within one-half mile of a major transit stop (existing or planned light rail, street car, or train station) or high-quality transit corridor. A high-quality transit corridor is a corridor with fixed route bus service with service intervals no longer than 15 minutes during peak commute hours (Pub. Resources Code, § 21155).

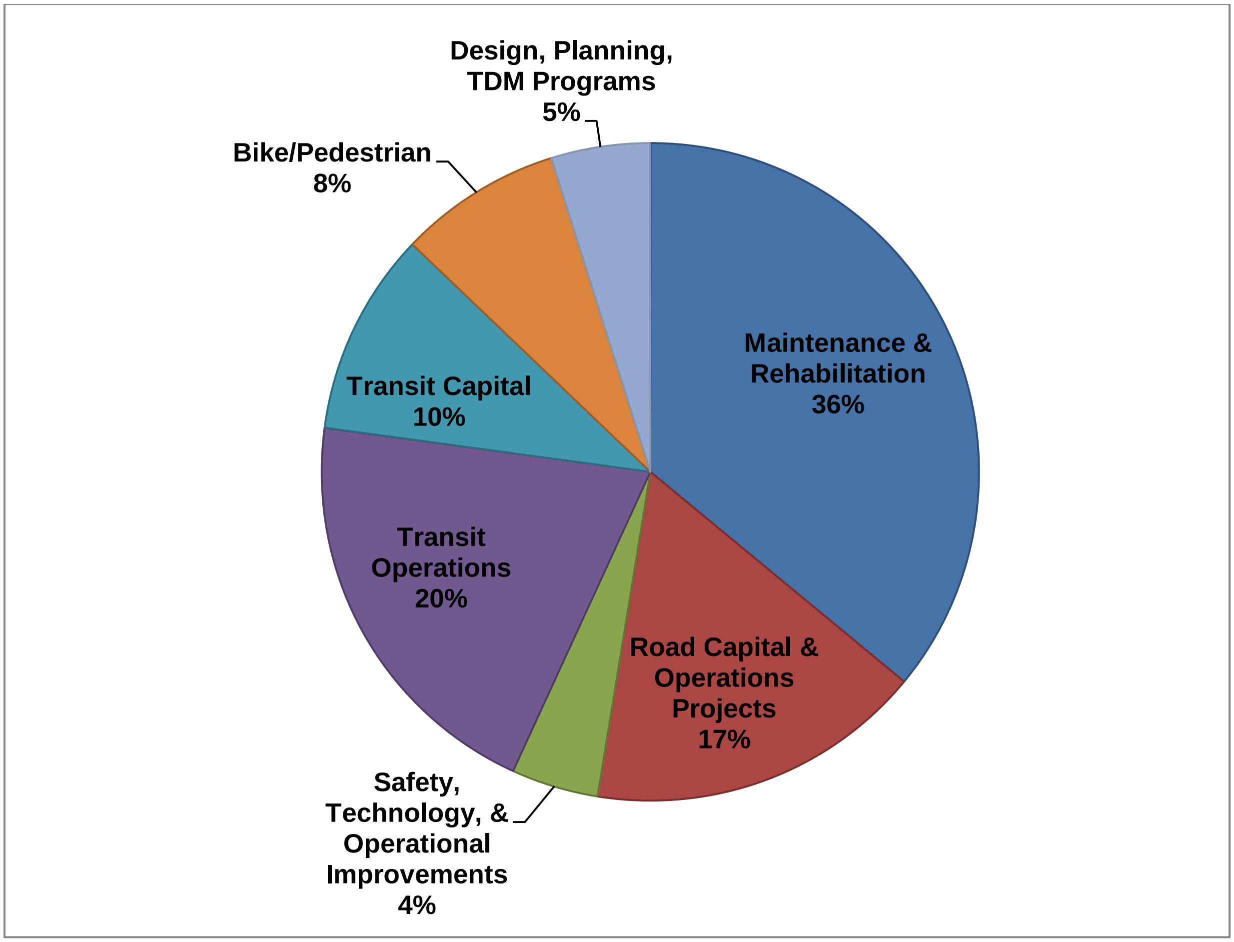
One example of a local land use decision that supports SCS implementation is the City of Sacramento's initiative to add 10,000 new housing units to the central City within 10 years that would be affordable to various income levels, including 1,500 units for re-housing homeless populations.

Overall, these strategies would result in closer proximity of homes and jobs to high frequency transit. In addition, multi-family (attached) housing would make up 45 percent of new housing units through 2036, and the total share of multi-family units would increase from 25 percent in 2012 to 30 percent in 2036 (SACOG 2016b: pg 12-32, 40).

D. SCS Transportation Strategies

The total proposed investments in the 2016 MTP/SCS is $35.2 billion (current year dollars) and $45.8 billion (year of expenditure) through 2036. Figure 4 illustrates how this money will be spent, with nearly a third of the budget dedicated to transit. The plan invests more in active transportation and in transportation system maintenance and rehabilitation than prior MTPs. Approximately 5 percent of the Roadway Maintenance and Rehabilitation budget (or about 2 percent of the total MTP budget) is for complete streets improvements.

Figure 4: SACOG 2016 MTP/SCS Budget 2016-2036



Source: SACOG 2016a, pg. 52

1. Transit

As mentioned previously, public transit boardings in the SACOG region declined slightly between 2008 and 2012. To improve transit ridership, the 2016 MTP/SCS plans for a targeted increase in density around transit stations and along routes to make the public transit system more productive, and thereby, more cost-effective. Improving the region's transit farebox recovery rate is expected to result in a positive feedback mechanism whereby transit operators recover more revenue, enabling them to improve service, which will, in turn, attract greater ridership.

The 2016 MTP assumes a 6 percent funding increase for transit capital projects, with $3.5[4] billion for new transit. The transit operating budget remains the same ($7.1 billion). SACOG continues to allocate 30 percent of the MTP's total budget to transit capital and operations. The 2016 MTP estimates a 122 percent increase in total daily transit vehicle service hours, and a doubling of transit routes that provide 15-minute or better headways by 2036.

2. Roads

SACOG is prioritizing roadway maintenance and preservation of the existing transportation system over projects that would add new capacity. The 2016 MTP increases the budget for maintenance and rehabilitation by 20 percent compared to the 2012 MTP. About two-thirds of the $12.6 billion maintenance and rehabilitation budget is related to city and county maintenance of local streets. SACOG assumes that, where appropriate, roadway maintenance projects will include improvements that enhance mobility and balance the needs of all potential users of a street. SACOG estimates that at least one-third of the roadway projects in the 2016 MTP/SCS include these "complete streets" elements, and account for about $600 million (5 percent) of the total roadway maintenance and rehabilitation budget.

The 2016 MTP reduced new roadway capacity investments by 9 percent and plans for fewer lane miles of new capacity compared with the 2012 MTP. Of the $5.8 billion of budgeted new capacity investment, two-thirds is for capacity expansion on existing facilities, including the region's worst traffic congestion bottlenecks. More than 90 percent of new lane mile capacity planned in the 2016 MTP is on surface streets which are also well-suited to complete streets improvements. Although the 2016 MTP allocates less funding for capacity expansion than the 2012 MTP, SACOG still expects the plan will reduce congested VMT per capita in 2036 compared to 2008 conditions, despite the addition of over 800 thousand people (almost a 40 percent increase in population) to the region's transportation network. This suggests that SACOG is

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[4] All monetary values are cited in current year dollars.

making strategic capacity investments that maximize the benefit on system performance.

3. Active Transportation

> SACOG proposes to more-than double the number of bike lane miles in the region.

The 2016 MTP/SCS puts greater emphasis on active transportation than previous plans. The 2016 MTP/SCS provides $2.8 billion for bicycle and pedestrian improvements, in addition to the $600 million estimated for complete streets projects under the roadway maintenance and rehabilitation budget. All told, SACOG allocated nearly 10 percent of the MTP's budget for about 4 percent of the region's current mode share. This shows SACOG's commitment to increasing non-motorized travel options in the region.

4. Design, Programs, and Transportation Demand Management

SACOG includes funding in the MTP budget to encourage smart-growth development that supports the SCS; funding for community enhancements such as traffic calming, streetscape improvements, and corridor or intersection safety improvements; and funding for planning, studies, and preliminary design work.

TDM programs encourage the use of alternative modes of transportation. Existing TDM programs include funding the region's Transportation Management Associations (TMAs), ride-matching services, and promotional campaigns including the very popular "May is Bike Month" campaign.

Transportation System Management (TSM) and intelligent transportation systems (ITS) investments focus on cost-effective system operational improvements, such as crosswalk signals with pedestrian countdown timers, real-time transit and traveler information, signal priority for buses, signal synchronization, and smart corridors. In the future, SACOG plans to develop a real-time, web-based trip planner.

SACOG's 2016 MTP supports $1.7 billion in funding for programs and planning efforts including community design, ITS, TDM, TSM, and education programs.

V. 2016 SCS PLAN PERFORMANCE

Implementation of the projects and strategies in the MTP/SCS is expected to lead to changes across the region, as evidenced by several indicators. ARB staff analyzed indicators related to land use and transportation to determine whether they provide supportive, qualitative evidence that the SCS could meet its GHG targets. Staff relied on the relationships expressed in the empirical literature between each metric and VMT and/or GHG emissions to understand whether the changes are consistent with the SCS's forecasted GHG emission reduction trends. Data for this analysis came from the SACOG Data Table (Appendix B).

A. Land Use Indicators

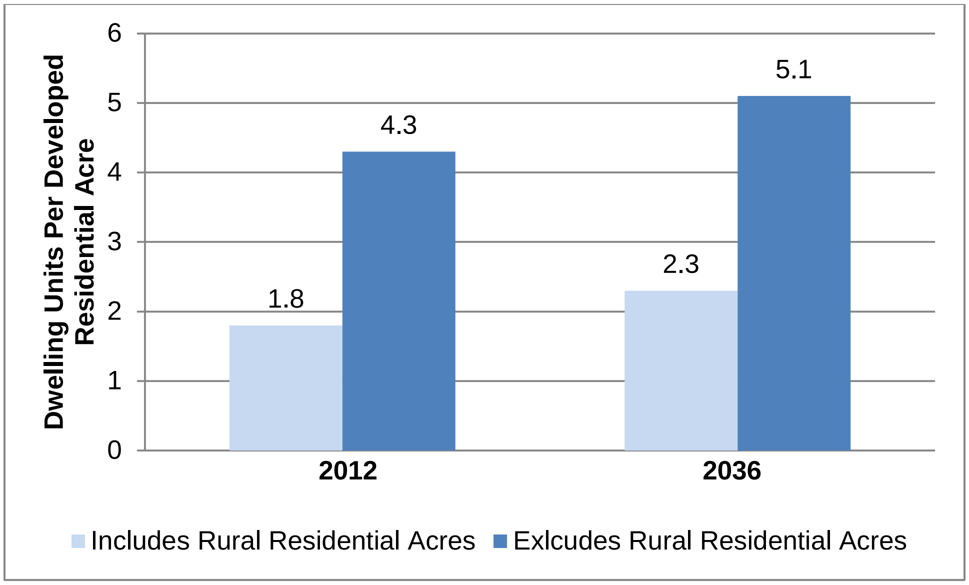
Land use influences the travel behavior of residents including both mode choice and trip length. In order to determine the benefits of the SCS development pattern on GHG emissions from passenger vehicles, the evaluation focused on the following land use-related performance indicators: residential density, housing type mix, the percentage of housing and employment near transit, and sub-regional jobs /housing balance.

1. Residential Density

Residential density is a measure of the average number of dwelling units per acre of developed land. A review of empirical literature reveals that increases in density can reduce VMT. Denser housing development significantly reduces annual vehicle mileage and fuel consumption (Brownstone and Golob 2009). A doubling of residential density can reduce VMT an average of five to 12 percent (Boarnet and Handy 2014) and a 1 percent increase in population density leads to a 0.2 to 1.45 percent decrease in the demand for car travel (Litman 2013).

As shown in Figure 5, SACOG projects that the regional residential density will increase by 28 percent between 2012 and 2036. The regional residential density will increase 19 percent when excluding rural residential developed acres.

Figure 5: Residential Density



Source: SACOG Data Table (Appendix B)

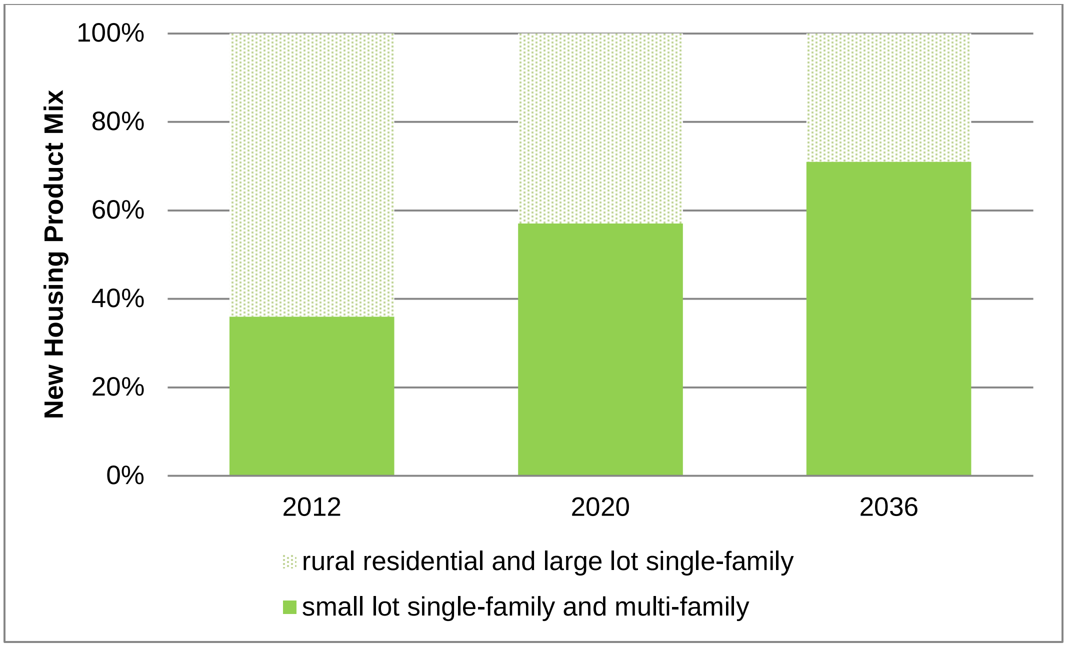
2. New Housing Product Mix

Travel characteristics in the region are expected to change as the housing market shifts from single family homes towards multi-family housing units. A greater proportion of multi-family and small-lot development allows for higher densities that support public transit systems and lower VMT, as discussed above.

Between 2012 and 2036, SACOG forecasts an increase in multi-family and small-lot single family households relative to the total number of households. Currently, attached and small-lot housing units make up 36 percent of SACOG's housing stock. By increasing the percentage of new multi-family and small-lot housing, this will shift to 44 percent by 2036.

Figure 6 shows the trend in new housing product mix over the plan horizon. This trend further supports the forecasted GHG emissions reductions.

Figure 6: Shift Towards More Multi-Family and Small-lot Single Family Housing



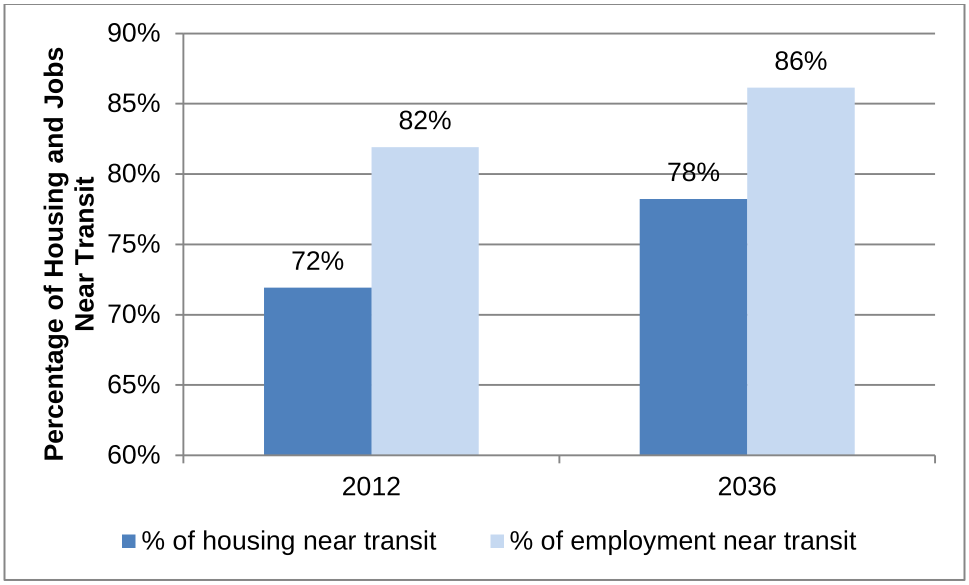
Source: SACOG Data Table (Appendix B), and SACOG 2016a, page 36.

3. Housing and Employment Near Transit

The SCS includes strategies to invest in transit near existing and future housing and employment locations, and increase density along transit routes. The empirical literature provides supporting evidence that concentrating housing and employment near transit stations can result in VMT and GHG emission reductions in the region. Boarnet, et al. (2013) suggests a 6 percent VMT decrease per mile closer to the rail station starting at 2.25 miles from the station, and a 2 percent VMT decrease per 0.25 mile closer to a bus stop starting at 0.75 miles from the stop.

Figure 7 shows that most of the region's housing and employment is already within a half-mile of a transit station or stop. The projected percentage of total housing and employment within a half-mile of transit stations is anticipated to increase further between 2012 and 2036.

Figure 7: Housing and Jobs within One-Half Mile of Transit



Source: SACOG Data Table (Appendix B)

4. Sub-Regional Jobs/Housing Balance

The 2016 MTP/SCS improves upon the sub-regional jobs/housing balance forecasted in the 2012 MTP/SCS. A jobs/housing ratio of 1.2 is considered balanced. SACOG analyzed the region's 15 largest sub-regional employment centers, based on the 2036 proposed growth allocations in the 2016 MTP/SCS. In a four-mile radius around 14 of these job-rich centers, SACOG forecasts an improvement in jobs/housing balance over the plan horizon (i.e., the jobs/housing ratio in each of those 14 areas, currently ranging from 3 to 16, would move closer to 1.2) (SACOG 2016a: 221-226). Average daily commute VMT per worker would decrease by about 15 percent, from 20.2 to 17.1 miles, around the major employment centers over the plan horizon (SACOG 2016a: 228).

B. Transportation-Related Indicators

ARB staff evaluated transportation-related performance indicators to determine whether the trends represented by the strategies in the SCS support GHG emission reductions.

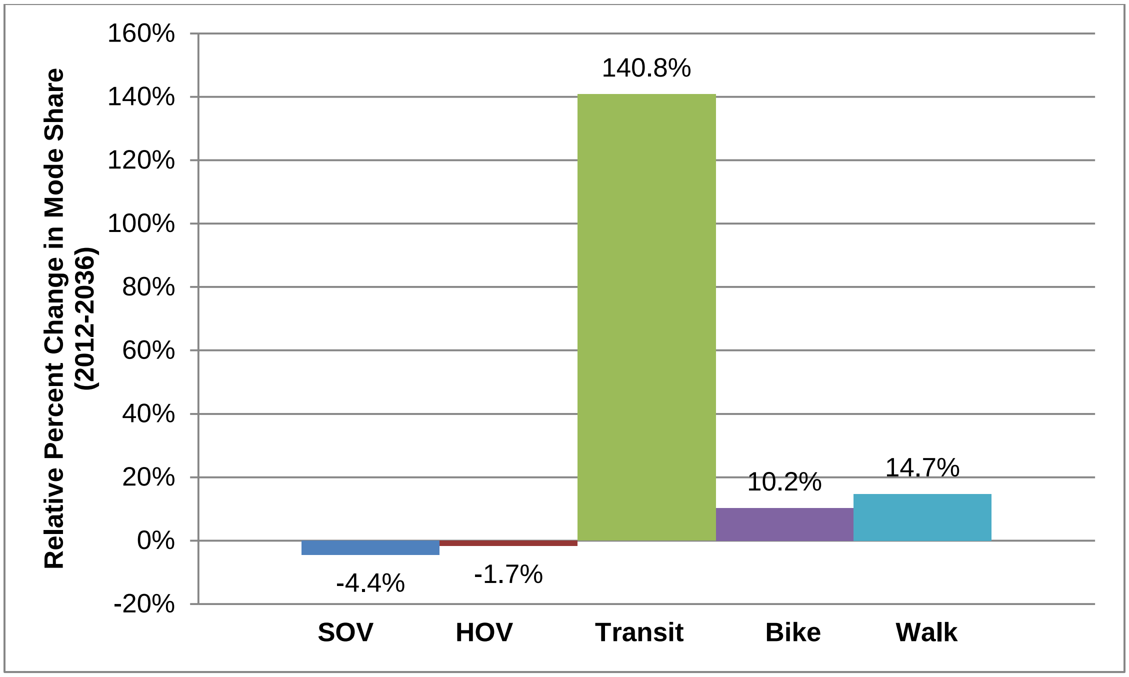
1. Mode Share

Shifting trips from auto to non-auto modes (e.g., bike, walk, transit working at home) can reduce vehicle GHG emissions in a region. While change in mode shares cannot generally be used to quantify a change in GHG emissions, the empirical literature indicate that GHG emissions per person are likely to decrease as SOV mode share decreases and transit, bike, and walk mode shares increase.

Mode share for all trips measures how people travel from home-to-work and back, as well as how they travel for school, shopping, and all other non-work trip purposes.

Figure 8 shows the expected mode share changes in 2036 as compared to the mode share in 2012. The automobile mode share is projected to decrease, and the transit, bike, and walk modes are projected to increase proportionally to the decrease in auto modes. These results are directionally consistent with and supportive of the reported GHG emission reduction trend over time.

Figure 8: Mode Share Changes

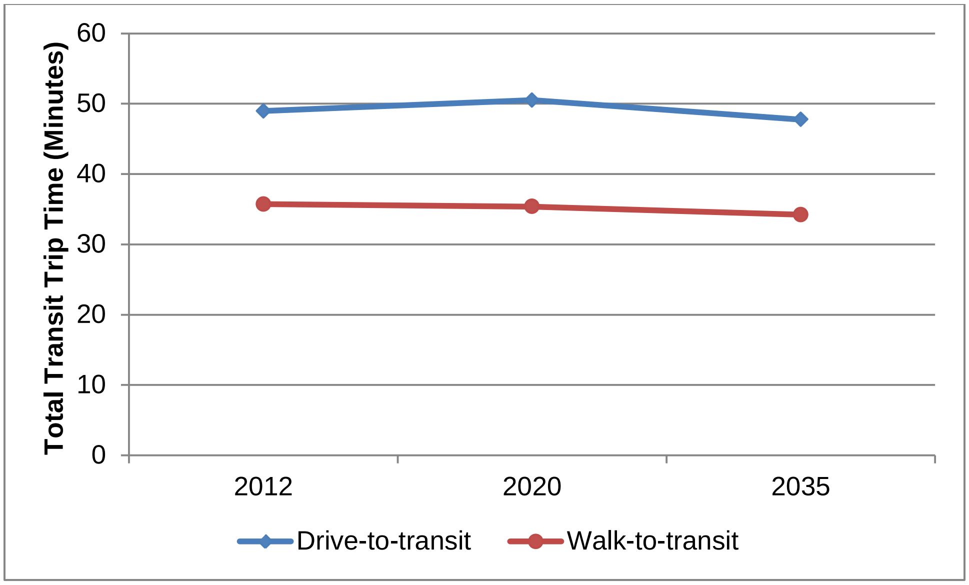


Source: SACOG data table (Appendix B)

2. Travel Time for Transit

One factor in determining whether a person decides to take a trip by car or transit is the duration of the trip. The average travel time for transit trips decreases for both riders that drive to start their trip (park-and-ride) and those who walk to transit. This trend is consistent with expectations to encourage transit ridership and mode choice decisions, which can potentially lead to GHG emission reductions. Figure 9 shows that the time it takes for walk-to-transit and drive-to-transit trips decreases an average of 3 percent by 2035.

Figure 9: Reduction in Transit Trip Times

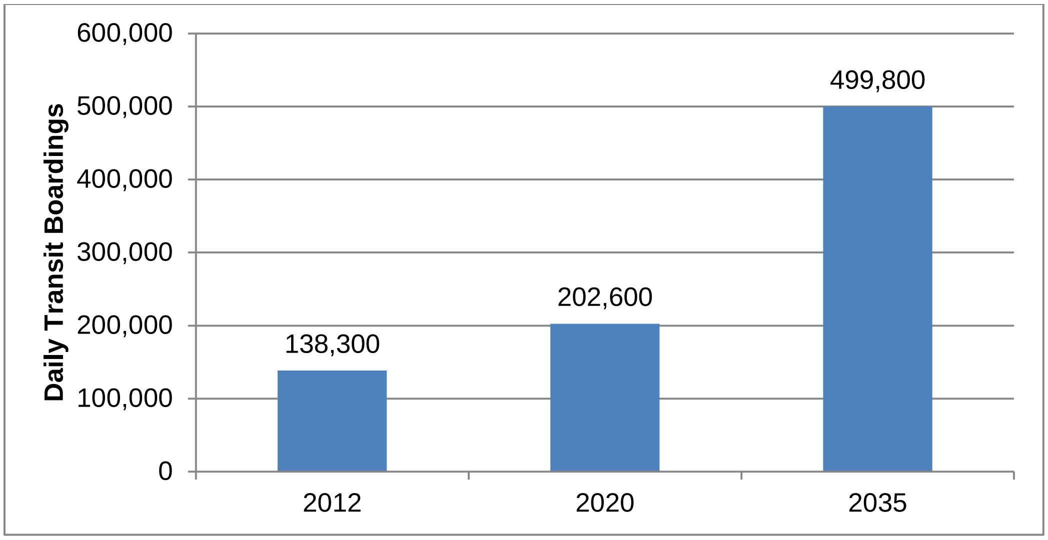


Source: SACOG Data Table (Appendix B)

3. Daily Transit Ridership

Changes in transit ridership indicate whether or not the SCS's transit investments will lead to increased transit system use. In general, transit service has a greater potential for reducing VMT if it attracts riders who would otherwise drive versus attracting riders who would otherwise walk, bike, or use some other type of transit for a particular trip. Figure 10 illustrates that the daily transit boardings are projected to increase 261 percent between 2012 and 2035.

Figure 10: Increase in Transit Riders



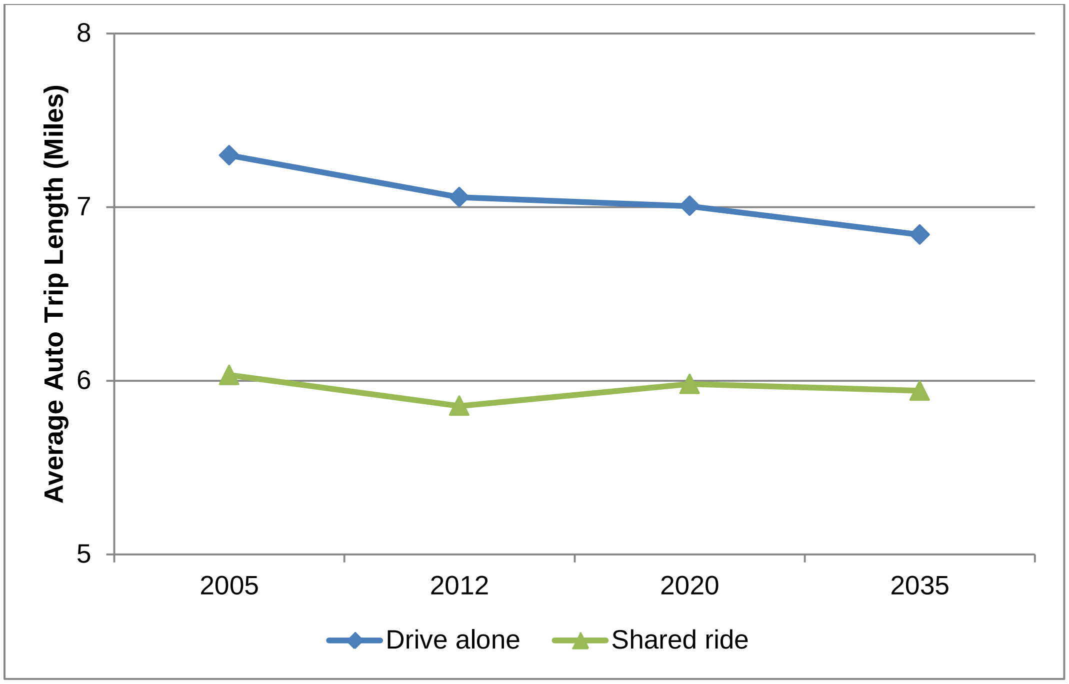
Source: SACOG Data Table (Appendix B)

4. Average Auto Trip Length and Passenger Vehicle Miles Traveled

A decline in VMT per capita can be the result of a reduced amount of vehicle trips, due to mode shifting, or of reduced trip distances due to a more compact urban form.

Decreases in average trip length for trips by auto can reduce a region's GHG emissions by decreasing overall miles traveled in a vehicle. Figure 11 illustrates the slight downward trend of both HOV and SOV trip lengths. Year 2005 is included to illustrate pre-recession average trip lengths. Year 2012 data reflects the lingering impact of the recession on the SACOG region, where fewer commuters were traveling to work. In addition, the average trip distance for transit riders who drive to a transit station is projected to decrease by 20 percent between 2012 and 2035.

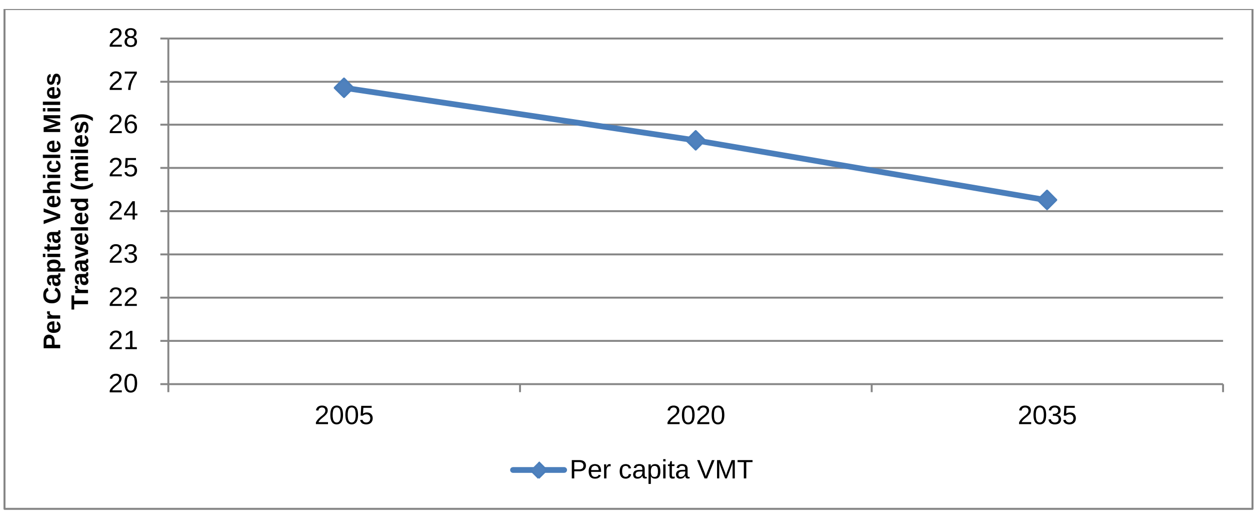
Figure 11: Declining Average Auto Trip Lengths



Source: SACOG Data Table (Appendix B)

SACOG's data projections show a decline in per capita passenger VMT over time. VMT per capita decreases 10 percent between 2005 and 2035 (from 26.85 weekday per capita VMT to 24.25), as shown in Figure 12.

Figure 12: Per Capita Passenger VMT Reductions



Source: SACOG Data Table (Appendix B)

The quantification of GHG emissions from passenger vehicles is a function of both VMT and vehicle speeds. These results are directionally consistent with, and supportive of, the reported GHG emission reduction trend over time.

VI. ARB STAFF REVIEW

SB 375 calls for ARB's "acceptance or rejection of the MPO's determination that the Sustainable Communities Strategy (SCS) would, if implemented, achieve the GHG emission reduction targets" in 2020 and 2035. SACOG's quantification of GHG emissions reductions in the SCS is central to its determination that the SCS would meet the targets established by ARB in September 2010. SACOG determined that the SCS would result in an 8 percent per capita reduction in GHG emissions from passenger vehicles by 2020, and a 16 percent per capita reduction by 2035.

See Appendix A for a detailed description of ARB staff's technical review of SACOG's methodology for estimating GHG emission reductions from the MTP/SCS.

VII. CONCLUSION

This report documents ARB staff's technical evaluation of SACOG's adopted 2016 MTP/SCS. SACOG used several models to quantify GHG emissions that would result from implementation of the 2016 MTP/SCS including the region's travel demand model (SACSIM), off-model quantification tools, and the ARB vehicle emissions model (EMFAC 2011). A description of ARB staff's technical review of SACOG's 2016 MTP/SCS is found in Appendix A of this report. ARB staff verified SACOG's carbon dioxide (CO_2) emissions calculations, and the collective results of SACOG's directly modeled CO_2 emissions reductions and calculated off-model adjustments would achieve per capita CO_2 emission reductions compared to 2005 levels of 8 percent in 2020 and 16 percent in 2035 when rounded to the nearest whole number.

This evaluation affirms that the SCS, if implemented, would meet the Board adopted per capita GHG emissions reduction targets of 7 percent reduction in 2020 and 16 percent reduction in 2035 from a base year of 2005.

VIII. REFERENCES

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APPENDIX A. ARB Technical Review

Technical review of SACOG's 2016 MTP/SCS focused on the aspects of regional modeling that underlie the quantification of GHG emission reductions. ARB staff examined SACOG's modeling inputs and assumptions, model responsiveness to variable changes, and model calibration and validation results. The general method of review is outlined in ARB's July 2011 document entitled "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies Pursuant to SB 375".[5] ARB's methodology is tailored to address each region's unique characteristics. ARB conducted a full evaluation of SACOG's travel demand model (Sacramento Activity Based Travel Simulation Model [SACSIM]) during staff's evaluation of SACOG's 2012 MTP/SCS. SACOG used the same model for the 2016 MTP/SCS, and the model's performance and sensitivity are unchanged. Please refer to ARB's Technical Evaluation for SACOG's 2012 MTP/SCS for the full evaluation of SACOG's travel demand modeling.

I. Data Inputs and Assumptions for Modeling Tools

SACOG's MTP/SCS is based upon a number of inputs and assumptions, which influence the modeled effectiveness of many of the strategies relevant to GHG emissions reductions. Inputs and assumptions fundamental to SACOG's travel demand model include land use, socioeconomic and transportation network characteristics, and travel costs. ARB staff evaluated the appropriateness of these assumptions. This involved using publicly available, well-documented sources of information, such as national and statewide survey data on socioeconomic and travel factors. ARB staff also evaluated documentation of regional forecasting processes and approaches.

[5] California Air Resources Board. 2011. Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375. http://www.arb.ca.gov/cc/sb375/scs_review_methodology.pdf

A. Demographics

SACOG's projections of total employment, population, and households are based on the 2012 MTP/SCS for the horizon year (2035). The cumulative growth in the SACOG region by the new horizon year 2036 is approximately the same as the previous MTP's forecast for year 2035. However, the rate of growth is slower in the early years of the plan due to the effects of the recession. The base year of the 2016 MTP is 2012 instead of 2008. Approximately the same total cumulative amount of growth originally forecast in the previous MTP over the period from 2008 through 2035 (27 years) is now projected to occur over the period 2012 through 2036 (24 years). SACOG's original regional growth projections are discussed in detail in the Technical Evaluation for SACOG's 2012 MTP/SCS.

The age distribution of the population in the SACOG region is projected to shift over the plan horizon. The percentage of population age 65+ years is projected to increase from about 12 percent in 2012 to 21 percent by 2036. This is the single largest demographic shift. SACOG's travel demand model assumes lower VMT rates for both all-purpose travel and commute travel for older and younger populations, which is consistent with household travel survey results. This demographic shift could have the effect of reducing VMT per capita in the SACOG region.

SACOG conducted a literature review on local and national housing market and demographic trends, as well as consulted with the development industry, in support of both the 2012 and 2016 MTP/SCSs. The main issues arising out of this research are housing affordability and changing preferences.

Many older adults in the SACOG region plan to downsize their home and seek more service-rich environments. Preference surveys indicate that two-thirds of older adults that plan to move want their next home to be a small-lot single-family home or an attached townhouse or condominium unit.[6]

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[6] SACOG. 2014. Trends in the Housing Market: Changing Demographics and Consumer Preferences. http://www.sacog.org/sites/main/files/file-attachments/6a-housing.pdf

Younger adults are delaying household formation and are waiting to rent or purchase homes. This is partly due to the recession, which disproportionately affected the millennial generation and their housing choices, especially in the SACOG region. Almost 20 percent of millennials in the SACOG region were unemployed in 2012, compared to the national rate of 14 percent. Other factors include rising college enrollment and debt, and declining marriage and birth rates. Young adults' housing preferences have shifted toward urban environments, with "walkability," proximity to amenities, and access to high-quality public transportation ranking as vital or important in deciding where to live.[6]

For the regions of the state covered by the four largest MPOs, including SACOG, this research suggests that new rental housing demand will represent about 75 percent of total new housing demand. Between 2010 and 2035, the demand for townhouse and small-lot homes will more than double, while demand for multi-family units will increase by as much as 50 percent in some areas.[6] This trend toward demand for more multi-family attached and small-lot single-family housing product mix is reflected in SACOG's 2012 and 2016 MTP/SCSs.

B. Income Distribution

Household income is used as a predictor of a household's decision to either drive or take transit. SACOG updated the household income distribution in this MTP due to three factors: a) the continuing effects of the recession, b) the importance that income plays in transportation decisions for many households, and c) the impact of employment sector growth rates within the regional economy. The change in income distribution compared to the previous MTP is summarized in Table 1 below.

Table 1: SACOG Comparison of Change in Household Income Distribution

Plan	Year	Percent of households within median income categories:				
		<$20K	$20K-$40K	$40K-$60K	$60K-$100K	$100K+
2012 MTP[1]	Base year	14%	19%	17%	25%	26%
	2020	14%	18%	17%	25%	26%
	2035	11%	15%	21%	23%	30%
2016 MTP[2]	Base year	17%	21%	16%	21%	24%
	2020	12%	17%	20%	17%	34%
	2036	12%	17%	20%	17%	34%

Notes:
[1] SACOG. 2011 (November). Appendix C-4, Travel Model Documentation to 2012 MTP/SCS, based on American Community Survey 2009 5-year Sample data. Household income in 2008 dollars.

[2] SACOG. 2015 (September). Appendix C-4, Travel Model Documentation to 2016 MTP/SCS, based on American Community Survey 2012 5-year Sample data. Household income in 2012 dollars.

The forecast median household income in the SACOG region ($54,100 in 2012 dollars) is lower compared with the previous MTP ($79,200 in 2009 dollars). When the average household income shifts downward, it is expected that households will have fewer available vehicles and similarly, produce fewer trips and less VMT. However, the percentage of households in the SACOG region that fall into the highest household income category is higher compared to the previous plan.

C. Auto Operating Cost

Auto operating cost is one of the major factors determining the mode of transportation for a trip. ARB staff reviewed the auto operating costs that were used as inputs in SACOG's travel demand model. SACOG came to agreement with the State's three other largest MPOs to use a consistent methodology to estimate auto operating cost[7]. The MPOs agreed to define auto operating cost as a combination of region-specific fuel

[7] Automobile Operating Cost for the Second Round of Sustainable Communities Strategies; MOU by MTC, SCAG, SACOG and SACOG. October, 2014.

price, non-fuel-related price, and effective passenger vehicle fuel efficiency. SACOG forecasted the fuel price based on the 2013 U.S. Department of Energy's annual forecast of motor vehicle gasoline prices and with historical information from 2005. In addition, SACOG added 32 cents to account for gasoline generally being more expensive in California than the rest of the nation. SACOG's auto operating cost assumptions for the 2016 MTP/SCS are summarized in Table 2 below.

Table 2: SACOG Region Auto Operating Costs (Prices in Year 2010 dollars)

Year	**Fuel price** (dollars per gallon)	**Non-fuel-related price** (dollars per mile)	**Effective passenger vehicle fuel efficiency*** (miles per gallon)	**Modeled automobile operating cost** (Cents per Mile)
2005	$2.74	$0.05	19.20	19.0
2020	$3.96	$0.07	24.92	23.0
2035	$4.70	$0.09	28.30	25.0

* EMFAC2011 Model
Source: Appendix A, and Automobile Operating Cost for the Second Round of Sustainable Communities Strategies, SACOG, October 2014.

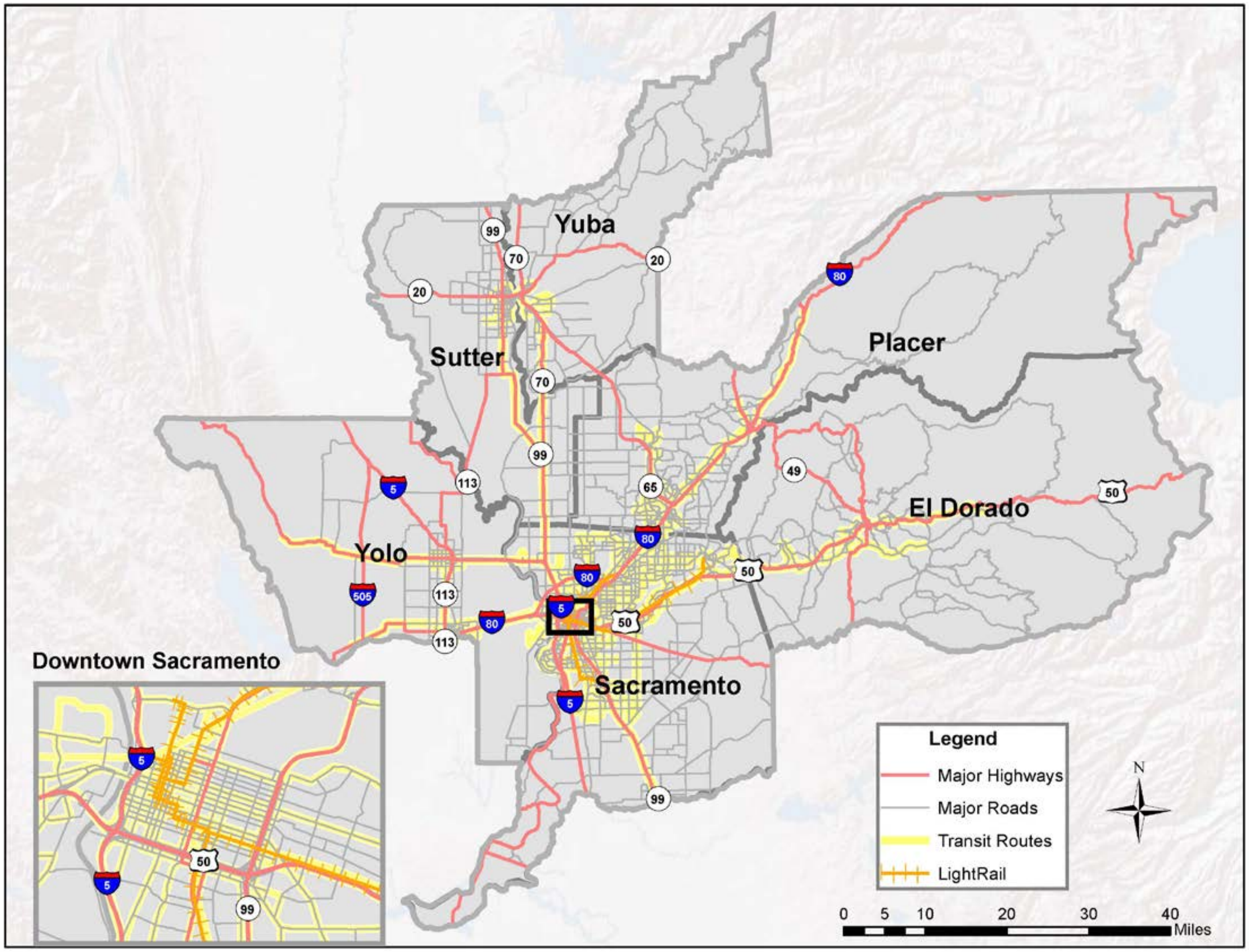
ARB staff observed that the auto operating cost estimated by SACOG has decreased compared to the previous plan. Although auto operating cost still increases over time, the relative cost of driving in the SACOG region is less than projected in the 2012 MTP/SCS due to a lower forecast price of fuel. When auto operating cost goes down, drivers are expected to increase their frequency of driving, increase their travel distance, decrease their use of public transit, and/or own less fuel-efficient cars. Higher auto operating cost would be expected to have the opposite effects on VMT. Auto operating cost in years 2020 and 2035 decreased by 16 and 12 percent, respectively, compared to the previous plan, which increases the per capita VMT and GHG emissions in those years compared to what was projected in the 2012 MTP.

D. Network Inputs

The methodologies SACOG used to develop the transportation network and travel demand model input assumptions are the same as were conducted in 2012, and are consistent with guidelines in the National Cooperative Highway Research Program (NCHRP) Report 716.[8] The NCHRP Report 716 reflects current travel characteristics, and provides guidance on travel demand forecasting procedures and their applications for solving common transportation problems. The SACOG transportation network is depicted in Figure 1 below.

[8] Transportation Research Board. 2012. Travel Estimation Techniques for Urban Planning. National Cooperative Highway Research Program (NCHRP) Report 716. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_716.pdf

Figure 1: SACOG Base Year Transportation Network



Source: SACOG. 2016. http://www.sacog.org/post/transportation.

II. Overview of Modeling Tools

SACOG used traditional geographic information systems (GIS) to manually allocate land uses, an activity-based travel demand model (SACSIM), an off-model post-processing tool, and the ARB vehicle emissions model (EMFAC 2011) to quantify the GHG emissions for its 2016 MTP/SCS. SACOG employs off-model post-processing tools to account for additional VMT and GHG emissions reductions related to land use and transportation strategies to which the travel demand model is not responsive. SACOG converted VMT outputs to GHG emissions by running ARB's vehicle emissions model, EMFAC 2011.

A. Land Use Allocation

SACOG used standard GIS and database tools to manually develop the land use scenario inputs into the travel demand model. The preferred land use scenario was developed between SACOG staff and member agency staff, and is closely related to the preferred land use scenario from the 2012 MTP/SCS. Because the 2016 MTP/SCS's emphasis is on implementing the 2012 MTP/SCS rather than generating new land use scenarios, this meant that much of data could be transferred rather than created.

B. Travel Demand Model

SACOG used its SACSIM activity-based travel demand model to forecast VMT, which is the same model used to develop SACOG's 2012 MTP/SCS. SACSIM has been improved through updating of the basic software modules used to run the model, improved transit network representation, improvements to the process of spatially distributing demographic and population data, and improvements to the treatment of bicycle lane coding and skimming. Collectively, these enhancements have been rolled into SACSIM15, which is the model version used for the 2016 MTP/SCS.

Although the basic structure of the model remained similar between the 2012 and 2016 MTP, these model changes introduce differences between the VMT (and associated GHG emissions) generated using SACSIM15 when compared to the prior version of the travel demand model that was used to forecast VMT for the 2012 MTP/SCS.

SACOG chose to recalculate 2005 VMT (and associated per capita GHG emissions) using SACSIM 2015, along with the region's most recent population estimate for 2005, to make the model outputs for years 2005, 2020, and 2035 more directly comparable. This model output was used for purposes of evaluating the 2016 MTP/SCS for consistency with SACOG's SB 375 GHG emission reduction targets.

In addition, SACOG performed multiple sensitivity tests on land use variables, fuel prices, auto operating costs, added highway capacity, and transit fares for the 2012 MTP/SCS. Because SACSIM15 uses the same basic activity-based travel demand simulation sub-model that was used in SACSIM11 (DAYSIM11), the previous model sensitivity tests are still valid. For a detailed evaluation of SACOG's travel demand model, please refer to the Technical Evaluation for SACOG's 2012 MTP/SCS.

Model Sensitivity Analysis: Transit Frequency

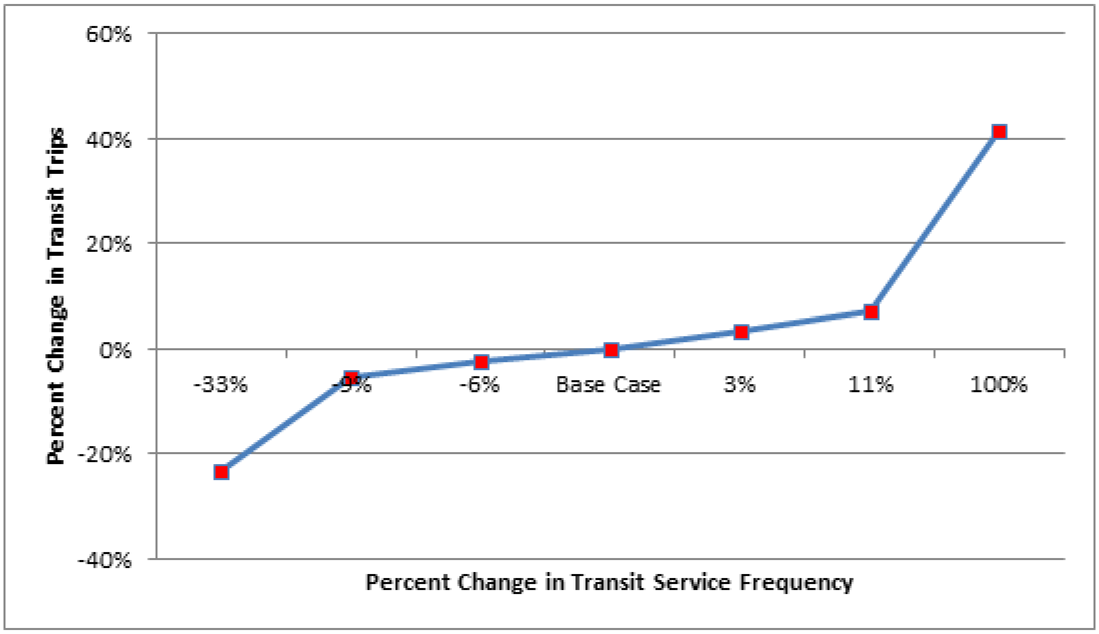
Because SACOG used the same travel demand model that was used to develop SACOG's 2012 MTP/SCS, ARB did not require SACOG to repeat sensitivity tests that were conducted in 2012 because the results would be the same. ARB's prior assessment of SACSIM model sensitivity still applies. Refer to the Technical Evaluation for SACOG's 2012 MTP/SCS for sensitivity test results related to auto operating cost, transit fare, household income, roadway capacity, regional accessibility, mix of land use, proximity to transit, street pattern and urban design, and residential density.

SACOG conducted one additional sensitivity test related to transit frequency to support ARB staff's evaluation of the 2016 MTP/SCS.

Transit frequency is an indicator of the supply side of transit. When the transit frequency increases, the transit headways decrease and service improves. When transit frequency decreases, transit boardings will decrease since less transit supply is offered and travelers will choose other modes of transportation.

SACOG designed six scenarios to test the model's responsiveness to transit frequency changes relative to the base case: 33 percent decrease, 9 percent decrease, 6 percent decrease, 3 percent increase, 11 percent increase, and 100 percent increase. As expected, the model shows an increase in transit trips when transit frequency increases (Figure 2). The change in percentage of transit trips from the base case in each scenario ranged from -23 percent to 42 percent. SACOG's travel demand model can capture changes in the number of transit trips when transit service frequency changes.

Figure 2. Transit Frequency - Sensitivity Results



C. EMFAC Model

ARB's Emission Factor model (EMFAC) is a California-specific computer model that calculates weekday emissions of air pollutants from all on-road motor vehicles including passenger cars, trucks, and buses. EMFAC is used to support ARB's regulatory and air quality planning efforts and to meet the Federal Highway Administration's transportation planning requirements. SACOG used EMFAC 2011, which was the approved version of EMFAC available at the time the Draft MTP/SCS was released. SACOG converted the estimated passenger vehicle VMT and speed profiles into EMFAC 2011 inputs. SACOG then calculated per capita CO_2 emissions by using residential populations and estimated CO_2 emissions for passenger vehicles in 2020 and 2035.

ARB staff developed a *Methodology to Calculate CO_2 Adjustment to EMFAC Output for SB 375 Target Demonstrations* to allow MPOs to adjust the calculation of percent reduction in per capita CO_2 emissions used to meet the established targets when using a different version of EMFAC for the second MTP/SCS. This adjustment factor neutralizes the changes in fleet average emission rates between the version of EMFAC used for the 2012 MTP/SCS (in SACOG's case, EMFAC 2007) and the version used for the 2016 MTP/SCS (EMFAC 2011). The goal of the methodology is to hold each MPO to the same level of stringency in achieving their targets, regardless of the version of EMFAC used for its second SCS. SACOG followed the methodology and their CO_2 per capita reductions results were adjusted accordingly.

III. Summary of Modeling Results

SACOG's travel demand model was used to estimate regional passenger VMT. SACOG converted VMT to CO_2 emissions using ARB's EMFAC model, and then divided the total CO_2 emissions by the human population during the respective analysis years to obtain CO_2 emissions per capita. SACOG's CO_2 emissions calculations were verified by ARB staff, and are summarized in Table 3. Per capita CO_2 emissions decline over 14 percent by 2035. Off-model adjustments were used to account for additional reductions, as described in the following section.

Table 3: SB 375 Modeled GHG Emissions Reductions

	2005	2020	2035
Population	2,139,955	2,472,567	3,040,591
Passenger VMT per weekday (000s)[1]	49,993	54,070	62,816
CO_2 emissions (tons per day)	24,279	25,460	29,577
CO_2 per capita (tons per day)	22.69	20.59	19.45
Modeled % CO_2 per capita reduction from 2005		-9.2%	-14.3%

Source: Appendix B.

Notes:
[1] Passenger vehicle classes include light-duty autos, light-duty trucks, and medium-duty trucks. Excludes trips that originate and terminate outside the SACOG region ("X-X", or "pass-through" trips), and excludes VMT from interregional trips ("I-X", "X-I" trips) that occur outside the SACOG region.

A. Off-Model Adjustments

SACOG made off-model adjustments to estimate GHG emissions reductions from some strategies that the travel demand model cannot fully capture. Further, other off-model strategies include locally-initiated programs to facilitate deployment of EV-supportive infrastructure (e.g., charging stations), and to accelerate and increase market penetration of EVs in the region. These off-model adjustments are based on local knowledge and empirical data, which demonstrate the potential for GHG emissions reductions from several SCS strategies, including transportation demand management (TDM) (including carpool and vanpool), car sharing, transportation system management/intelligent transportation systems (TSM/ITS), work-at-home workers, and EV charging infrastructure.

1. Transportation Demand Management

There are currently 13 transportation management associations (TMAs) in the SACOG region. The 2016 MTP/SCS provides funding for expansion of investment in management and efficiency programs like TDM. An update of the TDM Strategic Plan for the region is underway. SACOG assumed that TDM services would expand significantly to include direct incentive programs at worksites employing up to 80 percent of the region's workers. Direct incentives could include: partial or full subsidies transit passes, cash incentives for biking or walking, and partial or full subsidies for vanpool participants.

2. Car sharing

Car sharing is a short-term vehicle use program in which participants rent cars for short periods of time, often by the hour. Car sharing provides a flexible transportation alternative to vehicle ownership for people that use a vehicle only occasionally. There is currently one short-term car rental operator serving four communities in the SACOG region, and SACOG assumes that car sharing will expand to serve two additional communities or job centers by 2035.

3. Transportation Systems Management/Intelligent Transportation Systems

SACOG's current TSM/ITS strategies deployed in the region include: ramp metering, variable message signs, active traffic management, transportation management centers, incident detection and management, arterial corridor management, and traveler information.

SACOG plans to deploy integrated corridor management for the US 50 freeway corridor, and this project is in the development stage. In addition, the MTP/SCS includes future deployment of vehicle-to-infrastructure systems, in which vehicles communicate with roadside infrastructure (e.g., traffic signals) to improve traffic flow.

These programs improve system operations by smoothing traffic flow and reducing vehicle hours of travel. Off-model adjustments can be used to capture the GHG reducing effects of these programs.

4. Increased Work-at-Home Workers

Between 2000 and 2010, the change in the percentage of workers reporting working at home increased more than any other "mode" of commute: from four percent in 2000, to 5.2 percent in 2010. SACOG expects this trend to continue into the future, based on changes in the workforce, changes in preferences by employers, and improvements to telecommunications and computing, which make home workplaces more viable. This adjustment does not count flexible or compressed work schedules, which are part of the TDM adjustments, but rather includes home-based businesses, contract workers working from home offices, and other more permanent work arrangements. The SACSIM model showed that workers working at home traveled 5.9 miles less per day than other workers, on average. The off-model adjustment was used to calculate the GHG reduction benefits of the long-term trend of more home-based working arrangements.

5. Electric Vehicles

SACOG's TakeCharge EV Readiness program is intended to extend, expand, and leverage existing EV purchase and infrastructure programs. SACOG worked with the UC Davis Institute of Transportation Studies Plug-in Hybrid EV and Hybrid Research Center to evaluate the likely impact of TakeCharge incentives and programs coordinated with other local programs by the local utilities (i.e., Sacramento Metropolitan Utilities District [SMUD] and Pacific Gas and Electric [PG&E]), and SACOG member agencies, on EV market penetration in the Sacramento region.

As of 2016, the SACOG region has more than 4,500 plug-in EVs and more than 100 public charging stations. SACOG assumes future deployment of over 120 public charging stations by 2020, and over 200 by 2035. SACOG also projects 56,000 residential and 3,000 workplace charging stations in the region by 2035. The EMFAC model assumes a base level of EV market penetration based on existing fleet rules and regulations, such as ARB's Advanced Clean Cars program. SACOG estimated that local efforts would expand the fleet and the range of EVs traveling in the region, which would replace VMT from gasoline-fueled vehicles with zero-emission VMT.

B. Overall Off-Model Reduction

For its 2016 MTP/SCS, SACOG looked at both a "low" and a "high" level of deployment for the combined implementation of TDM, car sharing, TSM/ITS, work-at-home workers, and increased EV market penetration. The assumptions associated with these strategies were based on case studies and observed data collected from existing programs. In 2020, the effect ranges from 1.14 to 2.07 percent GHG reductions. In 2035, the range of reductions increases to 1.87 to 4.50 percent (Table 4). SACOG took the mid-point of these off-model reductions and is claiming a mid-range reduction of 1.62 percent for 2020, and a mid-range reduction of 3.17 percent for 2035.

Table 4: Off-Model GHG Reductions

Off-Model Strategy	Estimated GHG Reduction	
	2020	2035
TDM, Car sharing	0.90%-1.41%	1.44%-2.60%
ITS/TSM	0.07%-0.24%	0.09%-0.62%
Increased Work-at-Home	0.04%-0.17%	0.13%-0.39%
EV Local Programs	0.13%-0.25%	0.20%-0.90%
Combined Off-Model Adjustments	**1.14%-2.07%**	**1.87%-4.50%**
Source: SACOG 2016c.		

C. Combined Modeled and Off-Model Results

The collective results of SACOG's directly modeled CO_2 emissions reductions and calculated off-model adjustments are summarized in Table 5. SACOG estimates, and ARB staff confirms, that the 2016 MTP/SCS, if implemented, would achieve per capita CO_2 emission reductions compared to 2005 levels of 8 percent in 2020 and 16 percent in 2035 when rounded to the nearest whole number.

Table 5: SB 375 Target Achievement

Summary of GHG Emissions Reductions	**2020**	**2035**
Modeled % CO_2 per capita reduction from 2005	-9.2%	-14.3%
Off-Model Adjustments	-1.6%	-3.2%
EMFAC Adjustment Factor[1]	+3.2%	+1.9%
Combined % CO_2 per capita reduction from 2005	-7.6%	-15.6%
SACOG Region SB 375 Targets	-7%	-16%

Source: SACOG 2016c and Appendix B.

Notes:
[1] SACOG's 2005 CO_2 emissions were estimated using ARB's EMFAC 2007 model, which was the approved version of EMFAC at the time SACOG prepared its 2012 MTP/SCS. SACOG used the more recent EMFAC 2011 version to estimate CO_2 emissions from the 2016 MTP/SCS. ARB staff provided a methodology to the MPOs to neutralize the impact of switching to a newer version of the EMFAC model than was used in their first SCS. This EMFAC adjustment factor is calculated specifically for the SACOG region, and neutralizes any benefit or detriment associated with switching between versions of ARB's EMFAC model.

ARB staff acknowledges that there is an inherent amount of imprecision in modeling, and SACOG used conservative assumptions when estimating off-model adjustments. SACOG forecasts that the 2016 MTP/SCS will maintain similar levels of GHG emissions reductions as the first SCS, despite a decrease in future year auto-operating cost compared to the first SCS, which has the effect of increasing VMT and GHG. SACOG was able to overcome this effect by implementing additional strategies not evaluated in the 2012 SCS, such as EV charging infrastructure.

D. Planned Model Improvements

MPOs continually improve their models. SACOG has planned and allocated funding for a variety of model improvement projects. SACOG is currently working on model upgrades to its DAYSIM software using a "Modeling Incentives" grant from the Strategic Growth Council. This work will be complete by 2017, and the improvements will be available for use in the next MTP/SCS update, due in 2020. SACOG also plans to incorporate new California Household Travel Survey data that is expected to be available by the time of the next MTP.

As part of its Travel Model Improvement Program, SACOG has also completed or partially completed model improvements to better reflect pricing/tolling, transit enhancement, population datafile improvements, and model backcasting.

SACOG has initiated, or plans to initiate, improvements for short trip distance estimation, the vehicle ownership submodel, the commercial vehicle/freight submodel, scenario analysis/risk assessment capabilities, pedestrian environment/street pattern enhancement, the parking access submodel, and add a dynamic traffic assignment function. The dynamic traffic assignment improvement is expected to enhance SACOG's capability to evaluate various road-pricing strategies, including: high-occupancy toll lanes, congestion pricing, VMT fees, and transit fares.

ARB staff recommends that SACOG consider fully integrating the land use and travel demand models to predict economic activity associated with land use as a result of changes in transportation investments and policies. Integrating the land use model within SACSIM will enable SACOG better evaluate the effects of transportation and land use policy changes through interactions between variables and improve the representation of long-term choices such as residential and employment locations.

APPENDIX B. SACOG's Modeling Data Table

Modeling Parameters (1)	2005	2012	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
	(if available)	(base year)	With Project (2)			
DEMOGRAPHICS						
Total population	2,139,955	2,268,138	2,472,567	3,040,591	3,078,772	MTP/SCS Chapter 3, Table 3.1
Dormed University Students	5,711	7,231	8,309	11,374	11,658	Group quarters population not modeled for travel.
Total employment	1,000,887	887,965	1,033,297	1,310,668	1,327,323	MTP/SCS Chapter 3, Table 3.1
Total number of households	785,750	847,553	917,387	1,125,842	1,140,202	MTP/SCS Chapter 9, Table 9.5 for 2036 households.
Persons per household	2.72	2.68	2.70	2.70	2.70	Calculated for ARB based on reported MTP/SCS data
Auto ownership per household	1.853	1.756	1.791	1.755	1.754	Calculated for ARB based on reported MTP/SCS data
Median Household income (Base year 2012 $)	$65,900	$54,100	$54,100	$54,100	$54,100	MTP/SCS demographic data tabulated for ARB information.
LAND USE						

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			
Total resource area acres (CA GC Section 65080.01)	n/a	2,850,4531 945,4262	n/a	n/a	2,821,0423 932,4383	1EIR Table 6.1 Page 6-4 and 6-5, Wildland Cover, Source: Yuba-Sutter Regional Conservation Plan, 2015; County of Sacramento, et al., 2015; Placer County Conservation Plan, 2015; Yolo County HCP/NCCP, 2015; USFS, 2014; USACE and SACOG, 2011; Mayer and Laudenslayer, 1988. 2EIR Table 6.2 Page 6-16, Agricultural Land Cover, Source: Yuba-Sutter Regional Conservation Plan, 2015; County of Sacramento, et al., 2015; Placer County Conservation Plan, 2015; Yolo County HCP/NCCP, 2015; USFS, 2014; USACE and SACOG, 2011; Mayer and Laudenslayer, 1988. 3EIR Table 6.6 Page 6-40, Potential Impacts to Habitat Areas (see sources above).
Total farmland acres (CA GC Section 65080.01)	n/a	1,869,871	n/a	n/a	1,832,656	MTP/SCS Table 7.1 Page 144, Page 145; California Department of Conservation, FMMP, 2012
Total developed acres	n/a	718,356	n/a	n/a	765,919	EIR Table 12.2, Page 12-4; EIR Table 12.8, Page 12-30; Source: SACOG, June 2015
Total retail, office, and commercial developed acres	n/a	26,331	n/a	n/a	33,265	"
Total residential developed acres	n/a	592,794	n/a	n/a	629,055	"
Total mixed use (vertical) acres	n/a	539	n/a	n/a	1,258	"

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			
Total housing units	827,100	903,452	949,928	n/a	1,188,349	MTP/SCS Chapter 3, Table 3.1
Housing vacancy rate (%)	5.0%	7.0%	4.5%	n/a	5.0%	Presentation to SACOG Board, February 2015, Item #15-2-6A
Rural Residential	n/a	73,731	74,368	n/a	78,455	EIR Table 12.10 Page 12-32; SACOG, MTP/SCS Land Use Forecast, June 2015 (2020 is estimate from MTP/SCS Land Use Forecast data)
Large Lot Detached Units	n/a	503,518	523,418	n/a	582,101	"
Small lot detached	n/a	101,173	111,164	n/a	173,809	"
Attached	n/a	225,030	240,978	n/a	353,984	"
Average residential density - housing units per developed residential acre	n/a	1.8a / 4.3b	n/a	n/a	2.3a / 5.1b	a-Includes rural residential units and acres; b-excludes rural residential. Source: a--MTP/SCS Chapter 5a, Table 5a.1; b--MTP/SCS land use data tabulated for ARB information.
Total housing units within 1/4 mile of transit stations and stops	n/a	481,226	549,643	664,333	681,702	MTP/SCS land use and transportation network data tabulated at ARB request.
Total housing units within 1/2 mile of transit stations and stops	n/a	649,847	733,761	902,792	929,738	MTP/SCS land use and transportation network data tabulated at ARB request.
Total employment within 1/4 mile of transit stations and stops	n/a	596,320	753,859	930,239	939,803	MTP/SCS land use and transportation network data tabulated at ARB request.
Total employment within 1/2 mile of transit stations and stops	n/a	727,466	895,168	1,130,495	1,143,466	MTP/SCS land use and transportation network data tabulated at ARB request.
TRANSPORTATION SYSTEM						

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020 With Project (2)	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
Total lane miles	26,504	27,788	29,479	33,873	34,432	Years 2012 and 2036 from MTP/SCS DEIR, Table 16.1. Years 2005, 2020 and 2035 tabulated from MTP/SCS transportation network data at ARB request.
General Purpose Freeway (lane miles)	1,505	1,526	1,547	1,570	1,593	Years 2012 and 2036 from MTP/SCS DEIR, Table 16.1. Years 2020 and 2035 tabulated from MTP/SCS transportation network data at ARB request. Combines general purpose and auxiliary lanes.
Freeway Auxiliary Lanes	197	202	218	251	261	
Highway / Expressway Major Surface Streets (lane miles)	4,254	4,520	4,798	5,337	5,635	Years 2012 and 2036 from MTP/SCS DEIR, Table 16.1. Years 2020 and 2035 tabulated from MTP/SCS transportation network data at ARB request.
HOV (lane miles)	69	96	120	159	185	Years 2012 and 2036 from MTP/SCS DEIR, Table 16.1. Years 2020 and 2035 tabulated from MTP/SCS transportation network data at ARB request.
HOT or Toll (lane miles)	n/a	n/a	n/a	n/a	n/a	
Collector and Local (lane miles)	20,479	21,444	22,796	26,556	26,758	Years 2012 and 2036 from MTP/SCS DEIR, Table 16.1. Years 2020 and 2035 tabulated from MTP/SCS transportation network data at ARB request.
Regular transit bus vehicle service miles	n/a	48,600	56,200	97,800	97,800	MTP/SCS transportation network data tabulated at ARB request.

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			
Bus rapid transit bus vehicle service miles	n/a	0	1,000	12,800	12,800	MTP/SCS transportation network data tabulated at ARB request.
Commuter/Light Rail vehicle service miles	n/a	5,500	6,800	10,800	10,800	MTP/SCS transportation network data tabulated at ARB request.
Transit total daily vehicle seat miles	n/a	2,796,000	3,293,000	5,804,000	5,804,000	MTP/SCS transportation network data tabulated at ARB request.
Daily transit boardings	n/a	138,300	202,600	499,800	511,200	MTP/SCS Table 5C.9
Bicycle and pedestrian trail/lane miles						
Class I	n/a	478	n/a	1,032	1,032	MTP/SCS Table 5C.4
Class II	n/a	1,095	n/a	2,476	2,476	MTP/SCS Table 5C.4
Vanpool (total riders per weekday)	n/a	10,000	n/a	19,500	20,000	Not modeled. Estimates based on ACS for 2012, and off-model projections for 2020 and 2035.
TOUR & TRIP DATA						
Number of Tours (by tour purpose)						
Work	766,833	713,031	808,806	994,742	1,005,882	MTP/SCS travel model outputs tabulated at ARB request.
School	543,137	538,414	547,141	655,733	663,876	
Escort	292,850	320,733	326,129	406,806	412,028	
Personal Business	616,843	661,201	735,161	921,247	931,566	
Shopping	685,447	691,030	765,807	959,005	971,294	
Meal	88,156	94,928	109,538	137,680	139,160	
Social/Recreation	380,548	399,541	445,271	556,337	563,750	
Number of trips (by trip purpose) per day						

Modeling Parameters (1)	2005	2012	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
	(if available)	(base year)	With Project (2)			
Work	2,008,857	1,859,805	2,110,984	2,607,180	2,634,736	MTP/SCS travel model outputs tabulated at ARB request.
School	1,308,814	1,289,077	1,310,988	1,572,339	1,591,279	
Escort	657,632	721,819	733,054	912,942	923,933	
Personal Business	1,560,529	1,690,968	1,875,304	2,352,132	2,379,212	
Shopping	1,831,131	1,877,161	2,076,336	2,596,851	2,630,706	
Meal	199,609	216,266	248,553	312,479	316,058	
Social/Recreation	893,747	943,622	1,050,854	1,313,509	1,331,922	
Average trip distance (miles) by mode						
Drive alone	7.30	7.06	7.01	6.84	6.85	MTP/SCS travel model outputs tabulated at ARB request.
Shared ride (2 persons)	6.19	5.93	5.99	5.93	5.96	
Shared ride (3+ persons)	6.03	5.86	5.98	5.94	5.95	
School bus	5.36	5.20	5.35	5.34	5.31	
Drive-to-transit	6.33	6.07	7.17	7.42	7.29	
Walk-to-transit	4.30	4.34	4.62	5.13	5.12	
Bicycle	2.17	1.99	2.01	2.02	2.03	
Walk	0.84	0.85	0.85	0.86	0.86	
All modes	6.16	5.89	5.88	5.64	5.65	
Average trip distance (miles) by trip purpose						
Average work trip length	9.75	9.92	9.60	8.98	8.99	MTP/SCS travel model outputs tabulated at ARB request.
Average school trip length	4.47	4.06	4.13	4.01	4.03	

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			
Average escort trip length	4.07	3.81	3.82	3.72	3.73	
Average personal business trip length	5.70	5.43	5.42	5.29	5.30	
Average shopping trip length	4.61	4.37	4.34	4.21	4.23	
Average meal trip length	5.21	5.01	4.97	4.86	4.88	
Average social/recreation trip length	6.26	6.03	6.06	5.94	5.95	
Average trip duration (minutes) by mode						
Drive alone	13.78	12.99	13.09	12.84	12.85	MTP/SCS travel model outputs tabulated at ARB request.
Shared ride (2 persons)	11.39	10.88	11.10	11.08	11.11	
Shared ride (3+ persons)	11.14	10.76	11.12	11.14	11.15	
School bus	32.13	31.21	32.14	32.05	31.86	
Drive-to-transit	50.84	48.97	50.51	47.75	47.97	
Walk-to-transit	36.55	35.72	35.39	34.21	34.17	
Bicycle	12.99	11.95	12.09	12.14	12.17	
Walk	16.79	17.08	17.14	17.28	17.23	
All modes	13.51	12.93	13.20	13.38	13.39	
Average trip duration (minutes) by trip purpose						
work trip duration	19.16	18.80	19.04	19.20	19.20	MTP/SCS travel model outputs tabulated at ARB request.
school trip duration	15.86	15.13	15.73	16.08	16.11	
escort trip duration	8.58	8.34	8.45	8.55	8.55	

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			
personal business trip duration	11.58	11.36	11.57	11.84	11.86	
shopping trip duration	9.80	9.42	9.49	9.64	9.67	
meal trip duration	10.96	10.61	10.75	11.05	11.07	
Social/Recreation trip duration	12.51	12.20	12.44	12.66	12.66	
MODE SHARE						
Vehicle Mode Share (Peak Period, AM or PM)						
Drive alone (% of trips)	45.2%	42.8%	43.3%	41.3%	41.2%	MTP/SCS travel model outputs tabulated at ARB request.
Shared ride (2 persons) (% of trips)	23.5%	24.6%	24.3%	24.0%	23.9%	
Shared ride (3+ persons) (% trips)	17.5%	18.0%	17.6%	17.5%	17.6%	
School Bus (% trips)	2.9%	3.0%	2.7%	2.6%	2.6%	
Drive-to-transit (% trips)	0.2%	0.2%	0.2%	0.3%	0.3%	
Walk-to-transit (% of trips)	1.2%	1.3%	1.7%	3.1%	3.1%	
Bike (% of trips)	2.0%	2.4%	2.4%	2.5%	2.5%	
Walk (% of trips)	7.5%	7.8%	7.7%	8.7%	8.7%	
Vehicle Mode Share (Whole Day)						
Drive alone (% of trips)	45.9%	43.5%	43.7%	41.6%	41.6%	MTP/SCS travel model outputs tabulated at ARB request.
Shared ride (2 persons) (% of trips)	25.3%	26.4%	26.1%	25.8%	25.8%	
Shared ride (3+ persons) (% trips)	17.4%	18.0%	17.7%	17.7%	17.7%	

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			
School Bus (% trips)	1.8%	1.8%	1.6%	1.6%	1.6%	
Drive-to-transit (% trips)	0.2%	0.1%	0.2%	0.3%	0.3%	
Walk-to-transit (% of trips)	0.9%	1.1%	1.5%	2.6%	2.6%	
Bike (% of trips)	1.6%	1.9%	2.0%	2.1%	2.1%	
Walk (% of trips)	7.0%	7.2%	7.2%	8.2%	8.2%	
TRAVEL MEASURES						
Vehicle Miles Traveled (typical weekday, all vehicles, all miles--in 000's)	57,311	57,010	63,176	73,471	74,520	Years 2012 and 2036 from MTP/SCS, Table 5B.3. Years 2005, 2020 and 2035 tabulated from MTP/SCS transportation network data at ARB request.
Total SB-375 VMT per weekday for passenger vehicles (ARB vehicle classes of LDA, LDT1, LDT2 and MDV) (miles--in 000's)	51,065	n/a	55,456	64,427	65,160	Tabulated from EMFAC11 output files at ARB request.
Total II (Internal) + SACOG share of IX/XI VMT per weekday for ARB vehicle classes (miles)	49,993	n/a	54,070	62,816	63,531	Tabulated from EMFAC11 output files at ARB request.
Total XX VMT per weekday for ARB vehicle classes (miles)	1,072	n/a	1,386	1,611	1,629	Tabulated from EMFAC11 output files at ARB request.
Congested Peak Hour VMT on freeways (Lane Miles, V/C ratios >1.0--in 000's)	1,450	935	1,572	2,896	2,352	Years 2012, 2020 and 2036 from MTP/SCS Table 5B.6, split to freeway vs all other roadways at ARB request. Years 2005 and 2035 tabulated from MTP/SCS travel demand model networks at ARB request.

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020 With Project (2)	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
Congested Peak Hour VMT on all other Roadways (Lane Miles, V/C ratios >1.0--in 000's)	1,879	1,316	1,690	1,921	2,007	Years 2012, 2020 and 2036 from MTP/SCS Table 5B.6, split to freeway vs all other roadways at ARB request. Years 2005 and 2035 tabulated from MTP/SCS travel demand model networks at ARB request.
CO2 EMISSIONS						
Total CO2 emissions per weekday for all vehicle classes all miles (tons)	32,650	n/a	35,041	41,315	41,792	Tabulated from EMFAC11 output files at ARB request.
Total CO2 emissions per weekday for passenger vehicles (SB 375 VMT) - not including off-model adjustments (for ARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons)	24,800	n/a	26,113	30,335	30,697	Tabulated from EMFAC11 output files at ARB request.
Total II (Internal) + SACOG share of IX/XI VMT per weekday for ARB vehicle classes (tons)	24,279	n/a	25,460	29,577	29,930	Tabulated from EMFAC11 output files at ARB request.
Total XX trip CO2 emissions per weekday for ARB vehicle classes (tons)	521	n/a	653	758	767	Tabulated from EMFAC11 output files at ARB request.
EMFAC Adjustment Factor (+ or - %)	n/a	n/a	+3.22%	+1.90%	+1.90%	Per ARB methodology for adjustment.
INVESTMENT (Billions)						
Total MTP Expenditure ($YOE)	n/a	n/a	$9.50	n/a	$45.80	2036 from Table 4.2 in MTP/SCS, 2020 tallied from Project List (Appendix A)
Road and Highway Capacity ($YOE)	n/a	n/a	$0.89	n/a	$7.70	2036 from Table 4.2 in MTP/SCS, 2020 tallied from Project List

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			
						(Appendix A)
Roadway maintenance ($YOE)	n/a	n/a	$4.40	n/a	$16.30	2036 from Table 4.2 in MTP/SCS, 2020 estimated using lump sums in Project List (Appendix A)
Transit capacity expansion ($YOE)	n/a	n/a	$0.49	n/a	$4.70	2036 from Table 4.2 in MTP/SCS, 2020 tallied from Project List (Appendix A)
Transit operations ($YOE)	n/a	n/a	$1.50	n/a	$9.10	2036 from Table 4.2 in MTP/SCS, 2020 tallied from budget forecast.
Bike and pedestrian projects ($YOE)	n/a	n/a	$1.00	n/a	$3.60	2036 from Table 4.2 in MTP/SCS, 2020 estimated using lump sums in Project List (Appendix A)
Other System Management, Operations, Programs, Planning, & Enhancements ($YOE)	n/a	n/a	$1.20	n/a	$4.40	2036 from Table 4.2 in MTP/SCS, 2020 estimated using lump sums in Project List (Appendix A)
TRANSPORTATION USER COSTS (1)						
Vehicle operating costs (2010$ per mile)	$0.19	$0.25	$0.23	$0.25	$0.250	Per 4 MPO method.
Gasoline price (current year $ per gallon)	$2.72	$3.81	$3.94	$4.68	n/a	Per 4 MPO method.
Average transit fare ($)	$1.12	$1.27	$1.27	$1.27	$1.27	Based on MTP/SCS travel model fares, weighted by boardings.
Parking cost (% increase from base year)	n/a	-8%	46%	102%	102%	Based on MTP/SCS travel model parking costs. 2012 based on Collier's parking cost reports + spot surveys.

NOTES:
(1) When reporting $ units, indicate whether they are current dollars (provide year), YOE (year of expenditure), or other
(2) This scenario includes modeling of all planned and programmed projects in the MTP/SCS for respective calendar year

Modeling Parameters (1)	2005 (if available)	2012 (base year)	2020	2035	2036	MTP/SCS Chapter-Page(s) or Data Source(s)
			With Project (2)			

**Tour/Trip Purpose definitions:
Work (full time or part time)
School (k12, college, university, or other education)
Personal Business (e.g. medical appointments)
Shopping
Meal (i.e. having a meal outside of the home)
Social/Recreation (e.g. going to gym, visiting a friend or family member
Escort (i.e. accompanying another person to an activity they are engaging in (carpooling), e.g. a parent driving a child to school or sports team event)

APPENDIX C. 2010 CTC RTP Guidelines Addressed in SACOG's MTP/SCS

This appendix lists the requirements in the California Transportation Commission's (CTC) Regional Transportation Planning (RTP) Guidelines[9] that are applicable to the SACOG regional travel demand model, and which SACOG followed. In addition, listed below are the recommended practices from the CTC RTP Guidelines that SACOG incorporated into its modeling system.

Requirements

- Each MPO shall model a range of alternative scenarios in the RTP Environmental Impact Report based on the policy goals of the MPO and input from the public.
- MPO models shall be capable of estimating future transportation demand at least 20 years into the future.
- For federal conformity purposes, each MPO shall model criteria pollutants from on-road vehicles as applicable. Emission projections shall be performed using modeling software approved by the EPA.
- Each MPO shall quantify the reduction in greenhouse gas emissions projected to be achieved by the SCS.
- The MPO, the state(s), and the public transportation operator(s) shall validate data utilized in preparing other existing modal plans for providing input to the regional transportation plan. In updating the RTP, the MPO shall base the update on the latest available estimates and assumptions for population, land use, travel, employment, congestion, and economic activity. The MPO shall approve RTP contents and supporting analyses produced by a transportation plan update.
- The metropolitan transportation plan shall include the projected transportation demand of persons and goods in the metropolitan planning are over the period of the transportation plan.

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[9] California Transportation Commission. 2010. Regional Transportation Plan Guidelines. http://www.catc.ca.gov/programs/rtp/2010_RTP_Guidelines.pdf

- These regions shall achieve the requirements of the Transportation Conformity Regulations of Title 40 CFR Part 93.
- Network-based travel models shall be validated against observed counts (peak and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination. Model forecasts shall be analyzed for reasonableness and compared to historical trends and other factors, and the results shall be documented.
- Land use, population, employment, and other network-based travel model assumptions shall be documented and based on the best available information.
- Scenarios of land development and use shall be consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options shall be reasonable.
- A capacity-sensitive assignment methodology shall be used, and emissions estimates shall be based on a methodology which differentiates between peak- and off-peak link volumes and speeds and uses speeds based on final assigned volumes.
- Zone-to-zone travel impedances used to distribute trips between origin and destination pairs shall be in reasonable agreement with the travel times that are estimated from final assigned traffic volumes.
- Network-based travel models shall be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices.
- Reasonable methods in accordance with good practice shall be used to estimate traffic speeds and delays in a manner that is sensitive to the estimated volume of travel on each roadway segment represented in the network-based travel model.
- Highway Performance Monitoring System (HPMS) estimates of vehicle miles traveled (VMT) shall be considered the primary measure of VMT within the portion of the nonattainment or maintenance area and for the functional classes of roadways included in HPMS, for urban areas which are sampled on a separate urban area basis. For areas with network-based travel models, a factor (or factors) may be developed to reconcile and calibrate the network-based travel model estimates of VMT in the base year of its validation to the HPMS estimates for the same period. These factors may then be applied to model estimates of future VMT. In this factoring process, consideration will be given to differences between HPMS and network-based travel models, such as differences in the facility coverage of the HPMS and the modeled network description. Locally developed count-based programs and other departures from these procedures are permitted subject to the interagency consultation procedures of §93.105(c)(1)(i).

Recommendations

- The models should account for the effects of land use characteristics on travel, either by incorporating effects into the model process or by post-processing.
- During the development period of more sophisticated/detailed models, there may be a need to augment current models with other methods to achieve reasonable levels of sensitivity. Post-processing should be applied to adjust model outputs where the model lack capability, or are insensitive to a particular policy or factor. The most commonly referred to post-processor is a “D’s” post-processor, but post-processors could be developed for other non-D factors and policies, too.
- The model should address changes in regional demographic patterns.
- Geographic Information Systems (GIS) capabilities should be developed in these counties, leading to simple land use models in a few years.
- All natural sources data should be entered into the GIS.
- Parcel data should be developed within a few years and an existing land use data layer created.
- For the current RTP cycle (post last adoption), MPOs should use their current travel demand model for federal conformity purposes, and a suite of analytical tools, including but not limited to, travel demand models, small area modeling tools, and other generally accepted analytical methods for determining the emissions, VMT, and other performance factor impacts of sustainable communities strategies being considered pursuant to SB 375.
- Measures of means of travel should include percentage share of all trips (work and non-work) made by all single occupant vehicle, multiple occupant vehicle, or carpool, transit, walking, and bicycling.
- To the extent practical, travel demand models should be calibrated using the most recent observed data including household travel diaries, traffic counts, gas receipts, Highway Performance Monitoring System (HPMS), transit surveys, and passenger counts.
- It is recommended that transportation agencies have an on-going model improvement program to focus on increasing model accuracy and policy sensitivity. This includes on-going data development and acquisition programs to support model calibration and validation activities.
- For models with a mode choice step, if the travel demand model is unable to forecast bicycle and pedestrian trips, another means should be used to estimate those trips.
- When the transit mode is modeled, speed and frequency, days, and hours of operation of service should be included as model inputs.

- When the transit mode is modeled, the entire transit network within the region should be represented.
- Agencies are encouraged to participate in the California Inter-Agency Modeling Forum.
- MPOs should work closely with state and federal agencies to secure additional funds to research and implement the new land use and activity-based modeling methodologies.
- The travel model set should be run to a reasonable convergence towards equilibrium across all model steps.
- Parcel data and an existing urban layer should be developed as soon as is possible.
- A digital general plan layer should be developed in the short-term.
- Several employment types should be used, along with several trip purposes.
- The models should have sufficient temporal resolution to adequately model peak and off-peak periods.
- Agencies should investigate their model's volume-delay function and ensure that speeds outputted from the model are reasonable. Road capacities and speeds should be validated with surveys.
- Agencies should, at a minimum, have four-step models with full feedback across travel model steps and some sort of land use modeling.
- If not already developed and validated for use for the current RTP cycle, MPOs are encouraged to transition to activity-based travel demand models for the following RTP cycle.
- In addition to the conformity requirements, these regions should also add an auto ownership step and make this step and the mode choice equations for transit, walking and bicycling and the trip generation step sensitive to land use variables and transit accessibility.
- Walk and bike modes should be explicitly represented.
- The carpool mode should be included, along with access-to-transit sub modes.
- Simple Environmental Justice analyses should be done using travel costs or mode choice log sums, as in Group *C.* Examples of such analyses include the effects of transportation and development scenarios on low-income or transit-dependent households, the combined housing/transportation cost burden on these households, and the jobs/housing fit.
- The next household travel survey should include activities and tours.
- Where use of transit currently is anticipated to be a significant factor in satisfying transportation demand, the travel times that are estimated from final assigned traffic volumes times should also be used for modeling mode splits.

- Travel demand processes should incorporate freight movement. Information from the statewide freight model, when available, local trip-based truck demand models, or more advanced commodity flows models could be used.
- MPOs should also build formal microeconomic land use models, as soon as is practical, so that they can be used to analyze and evaluate the effects of growth scenarios on economic welfare (utility), including land prices, home affordability, jobs-housing fit, the combined housing-transportation cost burden, and economic development (wages, jobs, exports). The land use and activity-based models should be integrated into a single modeling system – integrated land use/transportation model. This modeling approach allows planners to study the interactions between land use and the transportation system. ("Jobs-housing fit" is the extent to which the rents and mortgages in the community are affordable to the people who currently work there or will fill anticipated jobs.)
- Travel demand processes should incorporate freight movement. Information from the statewide freight model, when available, local trip-based truck demand models, or more advanced commodity flows models could be used.
- Commercial movements with truck and van tours should be accommodated in a commodity flow model.
- Freight data collection programs should be emphasized with coordination with statewide efforts.
- Household travel surveys should be activity-based and include a tour table. GPS sampling is encouraged or extra emphasis should be placed on accurate geocoding of households, workplace locations, and stops. Regions should take care in the design and data collection procedures of the survey to ensure survey results are appropriate to the type of model being utilized. Coordination with Caltrans' travel survey efforts is encouraged.
- Stated preference surveys of households and firms should be performed, as necessary, for use in location choice models.
- Microsimulation of households and firms should be investigated and developed, if feasible.