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

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California Environmental Protection Agency

Air Resources Board

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Executive Summary

The Sustainable Communities and Climate Protection Act of 2008 (Senate Bill 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. Now in its sixth year of implementation, SB 375 has resulted in several regional Sustainable Communities Strategies (SCS) which are developed as part of the Regional Transportation Plan (RTP). These SCSs demonstrate whether, if implemented, the metropolitan planning organizations (MPOs) of California can meet the per capita passenger vehicle GHG emissions targets for 2020 and 2035 set by the California Air Resources Board (ARB or Board) in 2010.

For the Stanislaus Council of Governments (StanCOG), the MPO for the county of Stanislaus, the Board set passenger vehicle GHG emissions reduction targets of 5 percent per capita reduction in 2020 and 10 percent per capita reduction in 2035 from a base year of 2005. The StanCOG board of directors adopted its first SCS on June 18, 2014 and made a finding that, if implemented, the SCS would meet the GHG emissions reduction targets established by the Board. StanCOG submitted its adopted SCS and related GHG determination to ARB for review on April 10, 2015. The ARB staff evaluation presented in this report affirms that StanCOG's 2014 SCS would, if implemented, meet the Board-adopted per capita GHG emissions reduction targets.

Stanislaus County (county) is in the San Joaquin Valley (Valley), a significant agricultural region of the state with unique socioeconomic characteristics and environmental challenges. The county is home to over 520,000 people, roughly comparable to the population of the City of Fresno. It is the northern portion of the Valley sharing a boundary with Santa Clara and Alameda counties in the San Francisco Bay Area (Bay Area). Its proximity to large employment centers in the Bay Area and availability of relatively affordable housing make Stanislaus County attractive to residents who commute long distances to jobs outside the county.

Of the nine incorporated cities in the county, Modesto is the largest, with a population of just over 200,000. Turlock is the next largest city with a population of just under 70,000. Ceres, Riverbank, Oakdale and Patterson are the next largest cities, all with populations between 20,000 and 45,000. A little over 20 percent of the county's population lives in numerous unincorporated rural towns.

The urban development pattern in the county over the last thirty years has been characterized by low density housing and suburban style commercial development with dispersed job centers. This past pattern of sprawl development has contributed to conversion of important agricultural land and open space, as cities have grown outward from their centers in the relatively flat agricultural valley floor.

The recession of 2008 led to an historic number of homes in foreclosure, and economic recovery has been long and slow. Recognizing the need to minimize land consumption, preserve natural resources and increase travel choices, StanCOG adopted the *San Joaquin Valley Blueprint* (Blueprint) in 2010. The *Blueprint* established the policy foundation for subsequent development of the 2014 RTP/SCS with the identification of regional goals that included targeting growth in existing urban areas, promoting infill and redevelopment, providing a variety of housing choices, offering multi-modal transportation options, and sustaining agricultural lands. In 2013, Stanislaus County adopted the Regional Sustainability Toolbox which provides local planning tools to guide communities as they adopt general plans, zoning ordinances, non-motorized transportation policies, low impact development standards, urban forest plans, and climate action plans consistent with the *Blueprint* vision.

The transportation and land use policies identified in the RTP/SCS are intended to reduce the distance that residents will need to drive to their jobs and amenities. Calling for a greater proportion of multifamily housing, and more mixed-use and infill development, StanCOG's SCS would result in consumption of less farmland, higher residential densities, and more jobs and houses located near transit. The plan allocates more than twice as much funding for transit as compared to the previous RTP. Projects funded in the 2014 RTP/SCS are designed to increase transit service frequencies and provide better connections to transit services, including the extension of commuter rail service to Modesto and Turlock which would connect the region to the Bay Area. In addition, the region has allocated funds to begin planning a bus rapid transit service between the region's largest cities, Modesto and Ceres. The regional plan also allocates an increased amount of funding for active transportation projects compared to the previous RTP.

SB 375 directs the Board to accept or reject the determination of each MPO that its SCS would, if implemented, achieve the GHG emissions reduction targets for 2020 and 2035. This report represents ARB staff's technical analysis of StanCOG's SCS and GHG determination, and describes the methods used to evaluate the MPO's GHG quantification. StanCOG's SCS estimates that the region's per capita GHG emissions would decrease by 26 percent by 2020 and 22 percent by 2035. While staff's analysis acknowledges that the per capita reductions estimated by StanCOG are high compared to other MPOs, staff's analysis provides evidence to support a conclusion that reductions of 5 and 10 percent are achievable.

ARB staff's technical analysis was enhanced by being able to run StanCOG's travel model which was provided by the MPO. The travel demand model used by StanCOG was developed jointly by StanCOG, the San Joaquin Council of Governments, and the Merced County Association of Governments to forecast travel demand in these three counties. Also known as the Three-County Model, it is a conventional travel demand model similar in structure to other models used by MPOs in the Valley.

Staff reviewed the central components of StanCOG's quantification methodology and supporting analyses, and evaluated model sensitivity tests and performance indicators. The MPO's model is similar to that of other MPOs in the Valley. Model inputs and assumptions were also found to be comparable to those of other MPOs. In addition, the results of model sensitivity tests, the performance indicators, and the nature of the land use and transportation strategies in the SCS support staff's conclusion that the SCS, if implemented, would achieve the targets set by the Board.

The evaluation identified several areas in which the MPO could improve the quality of its data inputs and assumptions for improved forecasting of GHG emissions in future planning cycles. Throughout this report are several recommendations for modeling improvements that should be considered by StanCOG in its 2016 update of the Three-County Model. If implemented, these recommended improvements should enable the model to better capture the GHG benefits of the land use and transportation strategies in StanCOG's next SCS.

I. Stanislaus Council of Governments

The Stanislaus Council of Governments (StanCOG) is both the State-designated Regional Transportation Planning Agency (RTPA) and the federally designated Metropolitan Planning Organization (MPO) for Stanislaus County. Federal regulations designate MPOs as the responsible agencies to prepare Regional Transportation Plans (RTP), and California's Senate Bill 375, the Sustainable Communities and Climate Protection Act of 2008 (SB 375, Chapter 728, Statutes of 2008) designates MPOs as the responsible agencies to prepare Sustainable Communities Strategies (SCS).
SB 375 requires preparation of an SCS as part of the RTP to demonstrate a reduction in regional GHG emissions from automobiles and light trucks through policies that coordinate land use and transportation planning. The *2014 Regional Transportation Plan/Sustainable Communities Strategy for Stanislaus County* (2014 RTP/SCS) is StanCOG's response towards fulfillment of these federal and State requirements, laying out the region's policies, strategies, and financial plan to achieve the region's transportation and GHG emissions reduction goals.

The StanCOG Policy Board is composed of 17 members, including representatives from the region's nine incorporated cities (Modesto, Turlock, Ceres, Riverbank, Oakdale, Patterson, Newman, Waterford, and Hughson, in descending order of population), Stanislaus County, and one non-voting member representing Caltrans District 10. This Board worked with technical and policy advisory committees, members of the public, various stakeholder groups, and several governmental agencies to develop the 2014 RTP/SCS. The StanCOG Policy Board adopted the 2014 RTP/SCS on June 18, 2014, and submitted its GHG determination to ARB on April 10, 2015.

A. Planning Area

San Joaquin Valley Context

As shown in Figure 1, Stanislaus County (county) is in the northern portion of the San Joaquin Valley (Valley), which includes a total of eight counties (San Joaquin, Stanislaus, Merced, Madera, Fresno, Tulare, Kings, and Kern). Table 1 identifies the eight Valley counties and their major cities. The Valley is characterized by agricultural communities and small urban areas predominantly located near the State Route 99 (SR-99) corridor, which runs north-south through the center of this central California region. There is heavy truck travel on SR-99 and on the Interstate 5 (I-5) corridor, which runs along the western edge of the Valley and serves as the backbone for freight movement throughout the State.

Figure 1: Stanislaus County in California's Central Valley

Table 1: 2013 Populations of Valley Counties and Their Largest Cities

Valley County	County Population	Largest City	
		City	Population
Fresno	953,179	Fresno	508,994
Kern	861,164	Bakersfield	360,633
San Joaquin	701,745	Stockton	297,757
Stanislaus	523,038	Modesto	205,562
Tulare	456,037	Visalia	128,525
Merced	262,390	Merced	80,572
Madera	152,525	Madera	62,960
Kings	151,127	Hanford	55,122

Source: California Department of Finance's estimates for January 1, 2013 at http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php

Stanislaus County is the fourth most populous of the eight counties that comprise the Valley, which collectively account for about 11 percent of California's population. As the Valley continues to grow, it is expected to account for about 15 percent of California's population by 2050.

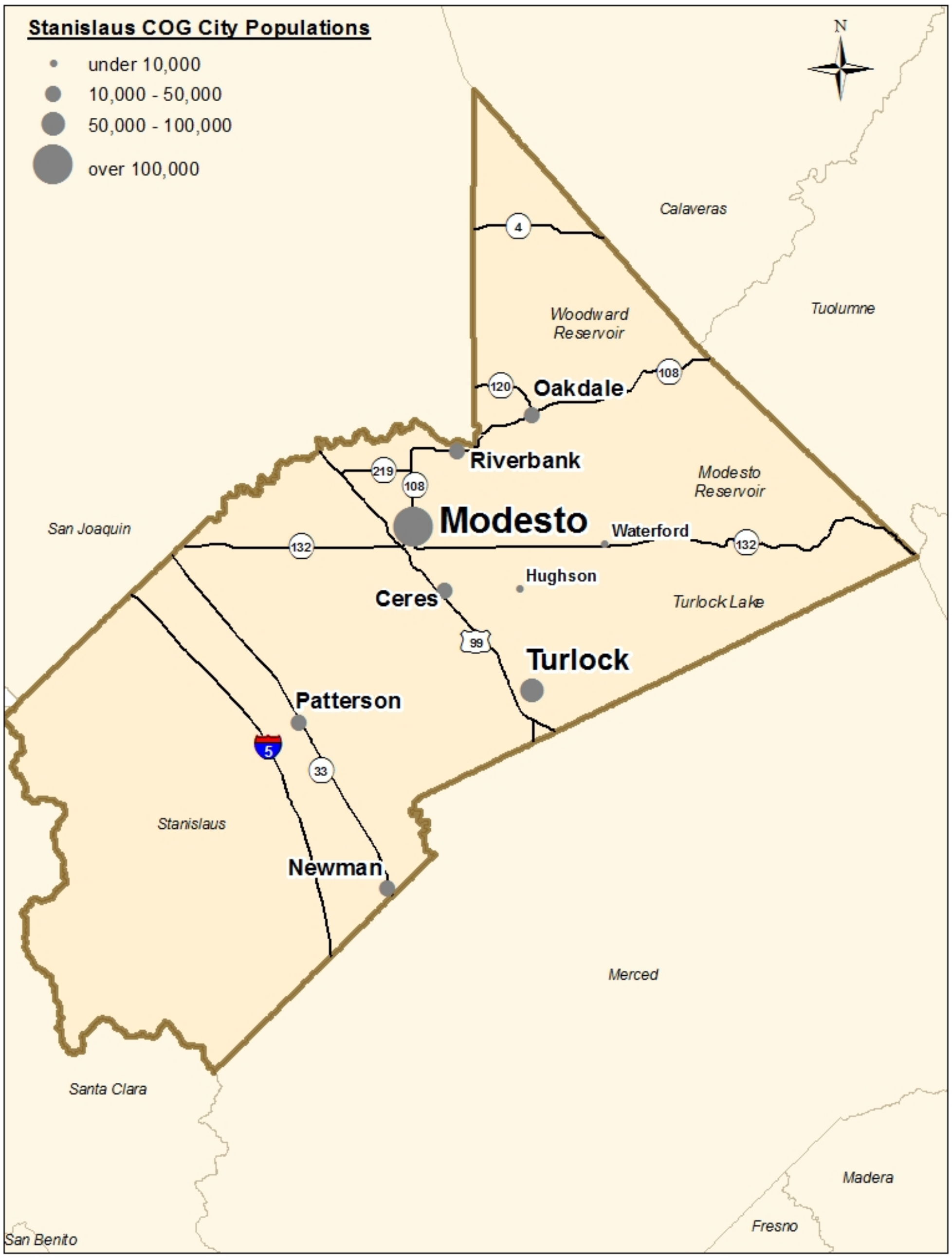
The residents of the Valley face challenges of poor air quality, high unemployment, and below average incomes. Most of the jobs across the Valley in 2012 were in education, health and social services (21.5 percent), agriculture (12 percent), retail trade (11.3 percent), and manufacturing (8.5 percent). The unemployment rate in 2012 averaged 15.3 percent which is higher than the 11.4 percent State average. Education levels for Valley residents lag behind the statewide average, with only 24 percent of people aged 25 years or older having a college degree, compared to 39 percent statewide. Related to these unemployment and educational factors, the Valley's 2012 median annual household income of $45,000 was only three-fourths of the State average of $58,000.

Stanislaus County

Stanislaus County (Figure 2) is largely flat, except in the western portion of the county, which is in the California Coast Range, and the far eastern portion where the Sierra Nevada foothills begin. The flat central portion of the county is predominantly agricultural and grazing land with scattered urban areas. The coastal mountain areas are largely uninhabited. The county is bounded by San Joaquin, Calaveras, Tuolumne, Mariposa, Merced, Santa Clara, and Alameda counties.

It is a rural county, with a population of about 520,000, comparable to the population of the City of Fresno in Fresno County. Stanislaus County's residents are largely concentrated in its nine incorporated cities. About 206,000 residents, or nearly 40 percent of the region's population, live in the largest city, Modesto. The majority of the cities in Stanislaus County have populations under 25,000. Just over 20 percent of the county's population resides in numerous unincorporated communities and towns which range in size from just over 100 to about 14,000 residents.

Figure 2: Stanislaus County



Although the Valley as a whole is known for its agricultural industry, the majority of Stanislaus County's jobs are in wholesale and retail trade, government, health and education, and manufacturing. The greatest proportion of the jobs in the region in 2012 were in wholesale and retail trade (16.9 percent), government (16.1 percent), health and education (15.3 percent), and manufacturing (13.2 percent), with farm employment representing only 8.5 percent of the region's employment. The median annual household income in Stanislaus County was $49,297 between 2009 and 2013, according to the U.S. Census Bureau. Stanislaus County's residents earn the second highest incomes in the Valley on average, second only to San Joaquin County, but still lower than the statewide average.

The numbers of employed residents of Stanislaus County who work in the county has decreased in the past decades as job opportunities in nearby regions have grown. As such, a substantial number of workers commute from Stanislaus County to neighboring regions with available employment, including San Joaquin County, the San Francisco Bay Area (Bay Area), and the Sacramento region.

The recession of 2007 – 2009 hit Stanislaus County especially hard. While unemployment in the Valley has typically been higher than that of the State and the nation, Stanislaus County's unemployment levels were especially high, rising above 18 percent during several months in 2010 and 2011. Nearly 9 percent of all houses and condominiums in the county were in foreclosure in 2007 and 2008.

B. Current Land Use

Stanislaus County's 956,026 acres are used for farmland, developed residential, industrial, and commercial land, roadways, parks and other open space lands, waterbodies and waterways, and mining areas. About 6 percent of the county is urbanized, while about 87 percent of the land is under agricultural use, with the balance comprised of roadways, water bodies, and various commercial and industrial uses.

While the farming sector represents less than 9 percent of the region's employment, it is an important sector in the region's economy, with over $3.66 billion in gross production value in 2013. Almonds, milk, walnuts, cattle and calves, and chickens yielded the largest production value for the county agriculture sector. In addition, farm related services such as processing, transporting, and marketing of agricultural products contributed to the regional economy. In 2010, 690,110 acres of land in Stanislaus County, over 70 percent of the region's total acreage, were protected under the "Williamson Act" ranking the county seventh highest in the state for total acreage preserved under this California Land Conservation Act. Landowners who participate in the Williamson Act receive property tax relief for a period of ten or twenty years, during which time the land must remain undeveloped.

C. Current Transportation System

With the majority of its population relying on passenger vehicles to transport them within Stanislaus County and to destinations outside the county, roadways continue to be important both for passenger vehicles as well as for freight movement. Nine different highways/freeways connect the region's cities and towns and provide access to other regions. The system of local streets, roads, arterials, and highways consists of 4,638 roadway lane miles.

Major thoroughfares include I-5 and SR-99, both of which run north-south connecting southern and northern California, and carry truck volumes greater than the statewide average. Both of these major highways are important freight movement routes in the state, and also carry passenger vehicles that begin and end their journeys outside of Stanislaus County. The main east-west route through the county is SR-132, which runs from the eastern end of the county, through Waterford and Modesto, and connects with I-5 and I-580 just outside of the county, carrying vehicles to the Bay Area, San Joaquin County, and northward. Other highways in the region include State Routes 4, 33, 108, 120, 165, and 219, which provide connections between unincorporated communities and the cities, and out to the surrounding counties.

In addition to highways, several arterial roadways form links between communities within the county, and to other counties. These arterials provide connections between the downtowns of the various communities, and connect to major activity centers throughout the county.

Transit

Stanislaus County has several forms of transit services available including intercity and interregional bus services, local buses within the individual cities, on-demand (dial-a-ride) bus services for rural areas, interregional passenger rail service, and other multi-modal services such as vanpools. Four local transit operators provide bus service in Stanislaus County, Greyhound provides interregional bus service with stops in Modesto and Turlock, and Amtrak provides interregional passenger rail service with stops in Modesto and Denair/Turlock, connecting Stanislaus County with the Bay Area, Sacramento, and other parts of the Valley.

Stanislaus County Regional Transit (StaRT) provides fixed route, intercity bus services for all of the cities and some unincorporated communities, as well as dial-a-ride services, some with fixed stops in addition to curb-to-curb services. Most of these services run Monday through Saturday, though some are unavailable on Saturdays. Two of the fixed routes extend service into Merced County. After the Riverbank-Oakdale Transit Authority (ROTA) ceased operation in late 2012, StaRT added a fixed route to provide bus service to these cities, and took over some of the dial-a-ride services that ROTA had previously provided.

Other bus transit service providers, Modesto Area Express (MAX), Ceres Area Transit (CAT), and Bus Line Service of Turlock (BLST) provide fixed route, intra-city services within those individual communities, and dial-a-ride services within those cities and their nearby unincorporated areas. In addition, MAX provides three morning and four afternoon trips connecting with the Altamont Corridor Express in Manteca/Lathrop, and two morning and afternoon weekday trips to the Bay Area Rapid Transit station in Dublin/Pleasanton. Bicycle racks are available on each bus system's buses.

Bicycles and Pedestrians

StanCOG's 2013 Non-motorized Transportation Master Plan contains a partial inventory of the region's Class I, II, and III bikeways and pedestrian network, indicating at least 125 miles of bikeways can be found in the cities and unincorporated areas of the county. As would be expected, the region's two largest cities, Modesto and Turlock, have the highest number of miles of bikeways. It is typical in the region for sidewalks to be fairly complete in newer residential areas, but there are significant gaps in the pedestrian network, especially in older residential neighborhoods and industrial areas; most rural roads are lacking sidewalks altogether.

Vanpooling

In Stanislaus County, almost 40 vanpools were registered in 2014 through the Commute Connection program which provides ride-matching services for carpools and vanpools, as described further in Section II.

II. Stanislaus COG's Sustainable Communities Strategy

StanCOG's 2014 RTP/SCS is a long-range plan for the period 2014 to 2040. Development of the plan began in 2011 with the development of a public participation plan. The following section describes the public input process that led to adoption of the final plan; the policy foundation for the SCS; the development of the SCS based on strategies, scenarios, and performance measures; and selection of the preferred scenario.

A. Public Outreach Process

In 2010, the eight counties in the Valley secured funding from the Strategic Growth Council to enhance the public outreach process and develop a Valleywide campaign branded "Valley Visions." This included online surveys, social media, YouTube videos, newspapers, and radio and television advertisements in an effort to reach as many community members and interested groups as possible during the RTP/SCS planning process. StanCOG leveraged this public outreach effort to create "Valley Vision Stanislaus" to assist with the SB 375 required outreach activities.

In November 2010, the Valley Vision Stanislaus Steering Committee was formed to help guide the public participation process and development of the RTP/SCS. The Steering Committee included 15 members with representatives for each local agency, the Local Agency Formation Commission (LAFCO), the StanCOG Policy Board, and representatives from each of StanCOG's standing committees. In addition, StanCOG provided Steering Committee materials to representatives of the Building Industry Association, Stanislaus County Farm Bureau, Stanislaus County Health Services Agency, and the Stanislaus County Agency on Aging to ensure these stakeholders had the opportunity to participate in the process.

StanCOG developed and implemented a Public Participation Plan (adopted in September 2011) that was designed to engage a broad range of stakeholders. For the 2014 RTP/SCS, StanCOG conducted three series of workshops and presentations to obtain public and stakeholder input. The first series was to inform the public and stakeholders about SB375 and the SCS. The second series was to establish a vision for the 2014 RTP/SCS as well as development of the 2014 RTP/SCS alternative planning scenarios. The third series was focused on selecting a preferred scenario that would be incorporated into the final plan. In total, StanCOG conducted over 40 public workshops, presentations, and informational talks throughout the region over a three-year period (2010-2013). The last two series attracted several hundred participants each. Furthermore, StanCOG gathered input from over 350 Modesto High School students in the scenario selection process and additionally collected over 600 mail/online completed surveys from the general public.

The public input process identified public health and safety, followed by economic and community vitality, as the top two goals for the 2014 RTP/SCS. In regards to the scenario development process, the public highlighted four preferences:

- more compact urban form
- preservation of agriculture land and natural resources
- maintain the region's small-town feel and rural atmosphere
- provision of more transportation choices.

In early 2013, StanCOG developed four alternative planning scenarios referred to as the Historical Trend, New Trend, Moderate Change, and More Change scenarios. During the scenario workshops and presentations, StanCOG had participants rank the four alternative scenarios based on several factors, such as preference for mobility, social equity, and economic and community vitality. The public repeatedly preferred Scenario 3 (Moderate Change) followed by Scenario 2 (New Trend). This input was used in the selection of the preferred scenario adopted by the StanCOG Board in 2013.

In addition to workshops and presentations, a Valley Vision Stanislaus website was created to keep interested parties informed of the process, promote outreach activities, and conduct online surveys. The website hosted an online workshop that attracted over 150 participants during the preferred scenario selection process. An email database with over 25,000 Stanislaus County residents was used to promote meetings, provide information, conduct topic-specific surveys, and encourage participation in the web-based activities. Additional outreach efforts included a quarterly e-newsletter called “On the Move” that was distributed to over 1,000 individuals including governmental agencies, non-governmental organizations, and individual members of the public.

B. SCS Foundational Policies

Many goals of the 2014 RTP/SCS are rooted in policies and programs established prior to 2014. Below is a description of some of the key policies that have influenced and set the direction for StanCOG’s 2014 RTP/SCS.

San Joaquin Valley Regional Blueprint

The San Joaquin Valley Blueprint (Blueprint) planning process is a Valley-wide program that began in 2006 to establish a long range, sustainable vision for the eight Valley counties. The final Blueprint, adopted in 2009 by the San Joaquin Valley Regional Policy Council, identified a growth scenario, a Valleywide target density of 6.8 units per acre (average) for new residential development to the year 2050, and 12 voluntary smart growth principles. The 12 principles are as follows:

- Create a range of housing opportunities and choices
- Create walkable neighborhoods
- Encourage community and stakeholder collaboration
- Foster distinctive, attractive communities with a strong sense of place
- Make development decisions predictable, fair, and cost-effective
- Mix land uses
- Reserve open space, farmland, natural beauty, and critical environmental areas
- Provide a variety of transportation choices
- Strengthen and direct development toward existing communities
- Take advantage of compact building design
- Enhance the economic vitality of the region
- Support actions that encourage environmental resource management

Many of the Blueprint’s goals are especially relevant to the development of StanCOG’s SCS, such as: providing support for sustainable planning and growth strategies which target growth in existing urban areas, with an emphasis on efficient design, land conservation, infill, and redevelopment; providing a variety of housing choices; providing multi-modal transportation and mobility options with intra- and inter-city/regional connections; and sustaining agricultural lands and supporting the preservation of natural resource and open space lands. The eight Valley counties have also developed an online educational guide and reference to help implement sustainable communities planning at the local level known as the Blueprint Planning Toolkit.

San Joaquin Valley Regional Greenprint

The Greenprint project serves as a resource to Valley planners, decision makers, resource managers and the general public by providing data, online mapping tools and analysis to protect and conserve natural resources. Fresno COG manages the Greenprint project on behalf of the Valley MPOs. Greenprint phase 1 was completed in 2014 and resulted in an inventory of parks, open space, critical habitat, floodplains, and groundwater recharge zones which were useful in developing StanCOG's 2014 RTP/SCS. With additional funding from the Strategic Growth Council, phase 2 will begin in 2015 and includes pilot projects that make use of the inventory, development of a guide on resource management strategies, and creation of an expert panel to discuss methods to address challenges in resource management.

Thirty-Year Land Use Restriction Initiative (Measure E)

Measure E was approved by Stanislaus County voters in 2008 to preserve agriculture land and promote more compact development throughout the region. Measure E added a policy to the Stanislaus County General Plan Land Use Element that requires a majority vote of county voters on any proposal to redesignate or rezone unincorporated land from agricultural or open space to a residential use. This applies to all designated agricultural or open space land on the county's General Plan Land Use Map. The measure also requires the county to streamline the permit process for infill sites in unincorporated communities with the intent to increase the supply of affordable housing. Measure E does not limit residential development by incorporated cities within existing or amended spheres of influence. The measure is effective for 30 years and will expire in 2038.

StanCOG Non-Motorized Transportation Master Plan

StanCOG's Non-Motorized Transportation Plan was approved in 2013. The plan guides efforts to improve bicycle and pedestrian infrastructure and safety and complies with the California Streets and Highways Code Section 891.2, which is necessary to secure state funding for implementation. The plan describes the condition of the existing bicycle and pedestrian infrastructure, and recommends improvements to the bicycle and pedestrian network for the unincorporated county areas and each of the nine cities. The plan contains an individual chapter for each city, which can be adopted at the local level. Overall goals include: improved access and safety, increased number of bicycle and pedestrian trips, and improved regional and local connections.

Local General Plans and Sustainability Plans

Several local jurisdictions are updating their General Plans[1] to be more aligned with the goals and policies of the 2014 RTP/SCS. Since the passage of SB 375, the cities of Oakdale, Patterson, Riverbank, Turlock, and Waterford have updated their General Plans, and the City of Modesto received grant funding for a General Plan amendment to update the land use and circulation elements. These cities have incorporated complete streets principles and sustainable community policies that align with the 2014 RTP/SCS. In addition, the Stanislaus County General Plan Housing Element was updated in 2012 to incorporate the latest available housing information and position the county for State funding programs related to affordable housing.

Several cities have also adopted Bicycle and Pedestrian Master Plans including Oakdale and Waterford, and a Non-Motorized Transportation Plan in the City of Newman. Complete Streets Master Plans and related policies have been adopted by the Cities of Hughson, Oakdale, and Turlock. Modesto's General Plan Amendment will also focus on policies that promote non-motorized transportation by encouraging more bicycle and pedestrian paths for a fully connected system. Additional plans include the City of Hughson's Climate Action Plan and the City of Waterford's Urban Forest Plan. These plans, policies, and programs provided a foundation to encourage more compact urban development supported by transportation options and improved connectivity.

Farmland Preservation Programs

In 2012, the Stanislaus Local Agency Formation Commission (LAFCO) adopted an Agricultural Preservation Policy that requires applicants for boundary changes to identify impacts to agricultural lands resulting from annexation or sphere of influence proposals, and to propose strategies to minimize those impacts. In addition, Stanislaus County developed a Farmland Mitigation Program included in Appendix B of the county's General Plan Agricultural Element. This program requires permanent protection of farmland based on a one-to-one ratio through agricultural conservation easements. In effect, any agricultural land converted to residential use in the unincorporated areas of the county must be replaced at a one-to-one ratio with agricultural land of equal quality. The City of Hughson's Farmland Preservation Program, established in 2013, builds upon the county's mitigation program and increases that ratio to two acres of farmland preserved for every one acre converted to residential uses. These efforts attempt to minimize the loss of agricultural lands to urbanization and preserve the economic foundation of the region.

Commute Connection

A transportation demand management program provided by San Joaquin, Stanislaus, and Merced counties, Commute Connection serves commuters and employers in the three-county region by providing a free ride-matching system for carpoolers and

[1] General Plans are comprehensive long-range plans, required for municipalities in California that establish the growth policy direction for the next 20 years.

vanpoolers, as well as promoting bicycling, walking, and public transit to reduce the number of single occupancy vehicles on the road. The Commute Connection program, working directly with employers and commuters, provides transit and tax credit information, commuter subsidies, and an emergency ride home program. This program has helped Stanislaus County to support 39 vanpools in the 2013-14 fiscal year, serving about 230 participants in Stanislaus County.

Regional Housing Needs Assessment

A regional housing needs assessment (RHNA) is, for Stanislaus County and other Valley MPOs, a county-level housing target set by the California Department of Housing and Community Development (HCD) to ensure that local governments adequately plan to meet current and future housing needs of the population in four family income categories. At the end of 2013, HCD determined StanCOG's overall RHNA allocation of 21,330 housing units for the 2014-2023 housing element cycle. SB 375 requires that the housing distribution to the local jurisdictions be consistent with the land use distribution in the RTP/SCS. However, the different projection period cycles of RHNA and the RTP/SCS (eight years and 26 years, respectively) prevent direct comparisons. The StanCOG Policy Board adopted the final Regional Housing Needs Allocation Methodology in December 2013 after the local jurisdictions had 74 days to review their housing unit allocations. In June 2014, the StanCOG Policy Board adopted the final 2014 – 2023 Regional Housing Needs Plan, accommodating the number of housing units required by HCD, and detailing the total number of housing units for which each city and the unincorporated county must plan. Local jurisdictions have 18 months from the June 2014 adoption date, to update their local housing elements showing that they meet the allocations.

C. 2014 RTP/SCS Development

1. Regional Growth Forecast

Forecasting how a region's population, housing, and employment are expected to change over time is at the foundation of RTP/SCS development. Knowing how many people will be in a region can help determine how many more houses need to be built, which influences where the focus on transit and/or roads needs to be. Knowing how many new jobs, and in what types of industries, might be expected, can help guide the location of the new housing units, and transit and roadway needs. These forecasts are fundamental to the development of transportation and land use scenarios.

The population of the region is forecast to grow from about 514,000 in 2010 to about 764,000 in 2040. The percentage change in population from 2010 to 2035 is approximately 40 percent for Stanislaus County, which is comparable to the Valley overall growth of 44 percent for the same time period.

2. Performance Indicators

StanCOG developed a set of 23 performance indicators under three broad categories (Table 2), which would be used to compare and evaluate the alternative SCS planning scenarios. The performance measures provide information on how well the transportation system is performing compared to historic trends. They also identify opportunities for system improvements and assess system-wide impacts of future improvements.

Table 2: StanCOG's 2014 RTP/SCS Performance Measures

Quality of Life
Jobs-housing balance
Affordability of new housing stock
Vehicle hours of congestion
Average bike or walk trip length
Percent of housing within one-half mile of parks and open space
Percent of housing within 500 feet of a major transportation corridor
Mobility and Accessibility
Percent of low-income and/or minority persons benefitting from roadway expenditures
Percent of housing within on-half mile of frequent transit service
Percent of low-income housing within on-half mile of frequent transit service
Peak period transit ridership
Percentage of congested lane miles
Congested lane miles on major goods movement corridors
Weekday vehicle miles of travel per capita
Injury or fatality rate per 100,000 vehicle miles traveled
Environment and Sustainability
Housing mix by housing type
Total bikeway improvement funding
Roadway maintenance
Greenhouse gas emissions per capita
Health-based criteria pollutant emissions
Overall residential density
Acres of land consumed per 1,000 new residents
Total acres of land consumed by new development
Total acres of Prime Farmland consumed by new development

Source: StanCOG 2014 RTP/SCS Table 1.2

3. Transportation Project Selection

Development of the 2014 RTP/SCS transportation project list began with the development of a revenue estimate for the 26-year life of the plan. StanCOG coordinated with local jurisdictions to project local, State, and federal revenue sources for transportation based on average growth and historical trends. These revenue forecasts through 2040 were essential to identify the projects that could reasonably be assumed to be funded (i.e., "revenue constrained project list"). StanCOG also coordinated with local jurisdictions to develop the project list and the land use scenarios, working closely with the local agencies, various community groups, and the public to encourage public participation and build consensus. Projects were selected based on their ability to contribute to an efficient transportation system that meets local development patterns. StanCOG conducted workshops throughout the RTP/SCS development process to prioritize projects and ensure that the project list reflected the needs of the jurisdictions, supported the land use pattern of SCS growth, and would meet the regional policy objectives of the SCS. Incorporating public input and reaching consensus on projects were part of the iterative process that led to the final RTP project list.

4. SCS Alternative Scenarios

StanCOG used a variety of tools and data inputs and assumptions to develop the four alternative land use scenarios presented for discussion at public workshops. The main components of each scenario were the development patterns, housing options, growth locations and intensities, and transportation investments that would shape the region's land use, housing, and transportation over the next 26 years. Key elements of each scenario are described below.

Scenario 1—Historical Trend
This scenario was referred to as StanCOG's "business-as-usual" (BAU) scenario, as it represents the allowable densities established by the local agencies in their General Plans, and contains transportation investments proportional to those in the previous RTP. The Historical Trend scenario assumes growth just outside of existing communities, with very little infill development, resulting in separation of services and employment areas from residential areas. Low density, large-lot, single-family homes are typical, with very limited multifamily housing available. Transportation investments largely focus on capacity expansion of roadways, with little funding dedicated to transit, bicycle, or pedestrian improvements.

Scenario 2—New Trend
The New Trend scenario was analyzed to show the results of following the adopted general plans of the local jurisdictions, with a slight increase in density of new development, and an increase in the amount of infill development, while still including lower density, large-lot, single-family housing, along with some single-family housing on smaller lots, and a limited amount of multifamily housing. Compared to Scenario 1, a smaller percentage of transportation investments in this scenario would be dedicated to roadways in general, and specifically to roadway capacity expansion, while a greater percentage of investments would be allocated to complete streets, transit, bicycle, and pedestrian improvements

Scenario 3—Moderate Change [the preferred scenario]
Future growth in this scenario emphasizes compact, mixed-use, and infill development, especially in downtown areas, and includes more multifamily and

attached single-family, small-lot housing and townhouses, while reducing the amount of large-lot, single-family development. Transportation funding in this scenario further reduces the emphasis on roadway projects compared to Scenarios 1 and 2, and increases the percentage of revenues allocated for transit, active transportation, complete streets, maintenance, rehabilitation, and operational improvements.

Scenario 4—More Change
In this scenario, future growth does not rely upon the local jurisdictions' existing general plans with respect to location of housing and housing types, but instead shifts new housing more towards the cities along SR-99, more in the incorporated areas, and less in the outlying cities than in Scenario 3. In addition, compared to Scenario 3, there is an even greater focus on mixed-use and infill development in downtown areas, more multifamily and attached single-family, small-lot housing and townhouses, and fewer large-lot, single-family housing units. Transportation investments for this scenario increase the focus on transit, bicycle, and pedestrian projects, and further reduce the focus on roadway projects.

5. Selection of the SCS Preferred Scenario

Using the performance indicators described above, Scenarios 2, 3, and 4 were compared to Scenario 1. Scenarios 2, 3, and 4 allocated more funding into transit and less funding for roadway infrastructure compared to Scenario 1. In addition, development would be progressively denser with more compact and mixed-use centers and infill development especially in downtown areas throughout the region. This would result in fewer acres of farmland consumed by new development, lower vehicle miles traveled (VMT) per capita and lower GHG emissions per capita compared to Scenario 1.

Taking into consideration the recommendations of the Steering Committee, local jurisdictions, stakeholders, and feedback from the public outreach efforts, in September 2013, the StanCOG Policy Board chose Scenario 3 – Moderate Change – as the preferred scenario. Scenario 3 proposes a greater mix of housing types than Scenarios 1 and 2 with 35 percent of new development as multifamily homes and 65 percent as single family homes. Roadway investments are shifted from new capacity-expanding projects to complete streets projects, maintenance, rehabilitation, and operational improvements. The preferred scenario moves the region away from BAU with respect to land use patterns and transportation investments.

D. 2014 RTP/SCS Land Use and Transportation Strategies

StanCOG's 2014 RTP/SCS forecasts reductions in GHG emissions based on its ability to reduce the number of miles that passenger vehicles are driven, which is influenced by the proximity of the region's housing to jobs, shopping areas, and other amenities, and the residential and employment densities of new growth.

1. Land Use Strategies

StanCOG worked with its local jurisdictions to incorporate into the 2014 RTP/SCS, such foundational policies and programs as those set in recent general plan updates, local climate or sustainability action plans, and others described earlier in this report. Compared to the BAU scenario, Modesto and Hughson would see more mixed use development under the 2014 RTP/SCS, and there would be less residential development on the outskirts of some urban areas, especially the northern end of Modesto.

StanCOG's 2014 RTP/SCS encourages local jurisdictions to support compact, mixed-use, infill and transit-oriented development, and to provide a range of housing choices. Programs that are already in place that address these goals include the Valley Blueprint and Greenprint efforts, the 2008 county-passed Measure E, LAFCO's Agricultural Preservation Policy, the County's Farmland Mitigation Program, and Hughson's Farmland Preservation Program. As a result, the 2014 RTP/SCS is expected to result in approximately 4,150 fewer acres of farmland consumed than under the BAU conditions.

The 2014 RTP/SCS also encourages new development in the existing urban centers which would help preserve agricultural lands and create a more compact urban form. The 2014 RTP/SCS encourages new development in infill sites, redevelopment areas, and available grayfield and brownfield sites. In addition, according to the county's General Plan Housing Element Update (2012), the unincorporated county areas would concentrate growth within four existing rural communities: Denair, Diablo Grande, Keyes and Salida. These communities are guided by community plans and served by special districts that provide sewer and water systems necessary to accommodate new development.

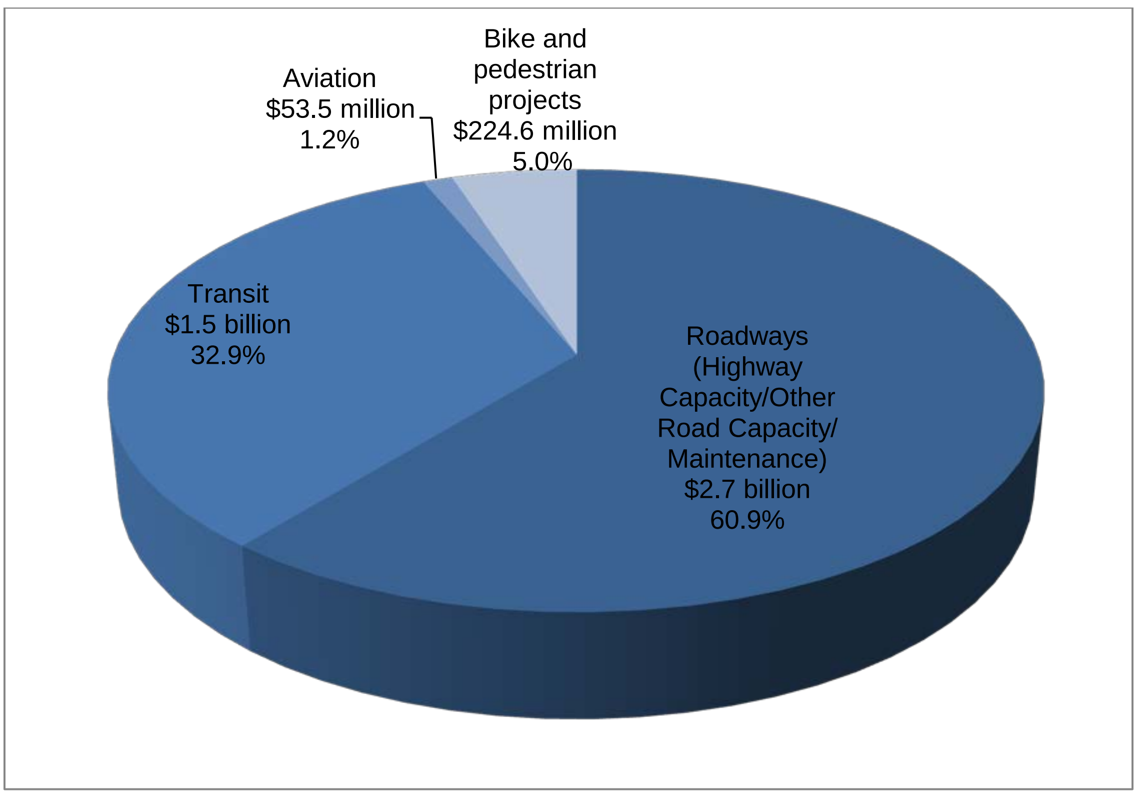
The 2014 RTP/SCS also envisions increasing residential density compared to BAU. This would be accomplished by reducing the number of large lot single family homes and increasing the number of small lot single family housing, multifamily housing, and townhomes for new development. The new development housing mix is expected to be approximately 86 percent multifamily homes and 13 percent single family homes. This would shift the overall housing mix to 33 percent multifamily and 67 percent single family by 2040, as compared to the mix of existing homes (in 2008) of about 76 percent single family and 24 percent multifamily. These strategies would also lead to an increase in the total number of households within walking distance of transit.

2. Transportation Strategies

StanCOG's 2014 RTP/SCS dedicates a substantial increase in funding for transit as well as some increase in bicycle and pedestrian infrastructure funding, while decreasing the funding for roadways, as compared to the 2011 RTP. Some of the key transportation strategies in this plan that support sustainability include the addition of complete streets, increasing transit frequencies, and adding new transit services such as bus rapid transit, express buses, and passenger rail.

With a total budget of nearly $4.46 billion, StanCOG's 2014 RTP/SCS lays out the region's priorities for operating, maintaining, and improving the region's transportation system through 2040. Most of this funding comes from State and federal sources, as Stanislaus County does not have a local tax measure for transportation funding, as do other Valley counties such as Fresno and San Joaquin. The 2014 RTP/SCS allocates about 60 percent of the total expenditures to roadways, including operations, maintenance, and capacity expansion projects; 33 percent to transit projects; and 5 percent to active transportation projects. Compared to the expenditures for the 2011 RTP, StanCOG's 2014 RTP/SCS allocates approximately 26 percent less for roadway projects, 216 percent more for transit, and 14 percent more for bicycle and pedestrian projects. Figure 3 illustrates the allocated amounts in these expenditure categories in the 2014 RTP/SCS.

Figure 3: 2014 RTP/SCS Expenditures by Project Category



Under federal requirements, an MPO's long-range plan must be a financially constrained plan, with projects and services not exceeding reasonably expected federal, State, and local funding sources. With development impact fees, gas tax subvention funds, general funds, local transportation funds, and transit fares dedicated to fund 2014 RTP/SCS projects, approximately 40 percent of the funding sources for this plan are expected to come from local sources. StanCOG anticipates about 33 percent of the funding to come from federal sources such as the Federal Transit Administration, and the Federal Highway Administration's Congestion Mitigation and Air Quality Program and Regional Surface Transportation Program. Twenty six percent of the plan's revenue sources are expected to be State-funded, from such programs as the State Transportation Improvement Program and the State Highway Operation and Protection Program.

Transit Improvements

Transit investments in the 2014 RTP/SCS would make improvements to existing services, increase transit frequencies, and add new services such as bus rapid transit (BRT), express services, and extending commuter rail into Stanislaus County. Helping to create a more balanced, multimodal plan to achieve the region's long-term transportation goals, projects dedicated to transit receive nearly a third of the 2014 RTP/SCS's investments. Stanislaus County's transit-dependent riders, and those who ride by choice, benefit from approximately $1.46 billion in transit investments. Bus transit projects include the addition of a new BRT route in and between Modesto and Ceres between 2020 and 2022; the purchase of new buses for all four of the region's transit providers (Modesto Area Express [MAX], Bus Line Service of Turlock [BLAST], Ceres Area Transit [CAT], and the countywide system, Stanislaus Regional Transit [StaRT]); the addition of express bus services through StaRT, and bus stop improvements. Passenger rail projects added to the 2014 RTP/SCS project list include construction of new passenger rail stations and rail line in Modesto and Turlock, in anticipation of extension of the Altamont Corridor Express and, eventually, high speed rail to Stanislaus County. In addition to the funds designated specifically for transit projects, many roadway projects in StanCOG's 2014 RTP/SCS also include "complete streets" improvements that incorporate better access for transit, such as bus pull-outs, along with bicycle and pedestrian access to transit. Funding for these complete streets projects is in addition to the funding dedicated solely to transit projects.

Bicycle and Pedestrian Improvements

While active transportation modes of travel are somewhat challenging for many residents due to the existing dispersed land use pattern in many parts of the region, the weather and flat topography make bicycling and walking possible in many months of the year. StanCOG's 2014 RTP/SCS encourages more active transportation by adding bicycle and pedestrian infrastructure, and by calling for more compact urban development in some areas. With projects ranging from construction of new Class I bike paths, adding road striping and/or signage or widening roadway shoulders to create Class II and III bikeways, [2] to filling in the gaps in sidewalks in some communities, more than $224 million is to be directed towards bicycle, pedestrian, and Safe Routes to School projects, a 14 percent increase in spending over the 2011 RTP.

[2] Class I bikeways are known as bike paths, and provide completely separate rights-of-way for bicycles and pedestrians. Class II bikeways, or bike lanes, are designated for bicycle use with a striped lane on streets and highways. Class III bikeways are also known as bike routes, and use signs or pavement markings to indicate shared use for bicycles, pedestrian, and motor vehicles.

All nine cities have plans to improve their bicycle and/or pedestrian infrastructure, as does the county.

Roadways

Approximately $2.71 billion of the 2014 RTP/SCS's revenues are allocated for roadway rehabilitation, reconstruction, capacity expansion, and complete streets projects. Most of the cities in the region have complete streets projects included on the constrained budget list of projects. In addition to providing for road widenings, extensions, and new roadways, StanCOG's roadway funding includes transportation system management (TSM) projects to improve the efficiency of traffic flow, including such projects as improving the condition of roadway pavement, installing roundabouts, installing ramp metering systems, synchronizing traffic signals, and other Intelligent Transportation System (ITS) improvements. Other roadway projects include transportation demand management (TDM) projects that focus on changing travel behavior and choices such as encouraging ridesharing, carpooling and vanpooling.

E. Environmental Justice Analysis

StanCOG prepared an environmental justice (EJ) analysis of its RTP, per Presidential Executive Order 12898 on environmental justice. StanCOG's EJ analysis is intended to ensure that minority and low income communities are not disproportionately impacted by any adverse effects of the RTP/SCS, and that these communities have a reasonable share of the benefits of the RTP/SCS's investments.

StanCOG used the U.S. Census Bureau's definitions to identify minority and low income populations. Those who identify themselves as Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, some other race, multiple races, or Hispanic/Latino of any race are considered a member of a minority group. Countywide, 35 percent of the population was in the minority category according to the 2011 American Community Survey 5-Year Estimates. Low income populations are defined according to the U.S. Census Bureau's poverty threshold, and by the level of household income relative to other households in the region. According to the 2011 American Community Survey 5-Year Estimates, approximately 16 percent of the county's population lived in poverty.

StanCOG identifies EJ communities as any census tract containing a higher percentage of minority and/or low-income population than the countywide averages. StanCOG excluded Census tracks with population densities of less than one-thousand persons per square mile to prevent a rural area bias. These Census tracts were then mapped at the TAZ level and incorporated in the transportation model to analyze performance of the 2014 RTP/SCS. StanCOG developed six performance measures to analyze the social equity impacts within EJ communities compared to the countywide averages. The six performance measures and results are described in Table 3 below.

Table 3: Environmental Justice Performance Measures

Performance Measures	Result
Percent of low income housing/population within ½ mile of frequent transit	Approximately 40 percent of low-income households are within walking distance to frequent transit compared to the historical trend of 39 percent.
Percent of low income/minority population benefiting from roadway expenditures	EJ populations utilize new transportation projects slightly more (50.2 percent) than non-EJ populations (49.8 percent).
Percent of housing within 500 feet of a major transportation corridor	EJ households total 3.4 percent of the households within 500 feet of a major roadway, compared to 0.9 percent of the general population. The historical trend for *total* housing within 500 feet of a major transportation facility has declined from 3.3 percent to 3.1 percent.
Disparity in countywide housing-type stock	Approximately one-half of new housing would be multifamily and townhomes and an additional one-third would be small lot single family homes, resulting in almost 90 percent of new housing. This is an increase from the historical average of 70 percent.
Availability and variety of housing at all economic levels	Approximately 50 percent of all new housing would be available to households earning less than $75,000 per year, an increase from the historical trend of approximately 30 percent.
Financial Equity Analysis	On a per capita basis, the non-low-income population benefits more from roadway expenditures; however, low-income households benefit significantly more from transit and bicycle and pedestrian expenditures due to their higher use of transit, walking, and bicycling for commute purposes.

The low-income and minority populations perform better or proportionally to the non-EJ population in regards to high-frequency transit access, improved housing choices and affordability, and increased expenditures in transit and bicycle and pedestrian infrastructure. Roadway expenditures for new roadway projects benefited both populations equally. Although EJ communities are more likely to be in close proximity to a major transportation corridor, the overall number of households in proximity to major corridors has decreased compared to historical averages. StanCOG determined that the 2014 RTP/SCS does not have a disparate adverse impact on EJ communities.

F. Plan Implementation and Next Steps

Planning and development at the local level provides examples of how the regional strategy of more compact, infill development within existing urban areas is being implemented. Many of these examples can be seen in the city of Modesto, the region's largest city, where much of the region's new growth is expected to occur.

Modesto is in the process of amending its Zoning Code to a Form Based Code that will expand the Downtown Core Zone to accommodate additional and more intensified development. Modesto has also commissioned the Crows Landing Road Corridor Study that plans for a safe and efficient multi-model transportation facility that will serve the southern portion of Modesto, western extension of Ceres, and portions of unincorporated Stanislaus County. This plan may also serve as initial planning for the BRT between Modesto and Ceres. Modesto also plans to implement a “Road Diet Plan” that will reduce a four lane roadway to three lanes with new bicycle and pedestrian infrastructure. Construction has begun on “Tower Park,” an affordable housing and senior living development with an overall density of 67 units per acre in close proximity to transit services.

A three city partnership among Modesto, Riverbank, and Oakdale will identify urban design and streetscape concepts along with regulatory guidance and incentives that would encourage reinvestment along State Route 108 (SR-108), which is a major thoroughfare through these cities. The SR-108 Relinquishment and Reinvestment Plan is intended to promote mixed use development and place more housing in proximity to existing and future commercial uses and employment centers along 4.5 miles of SR-108 starting in downtown Modesto.

The City of Turlock is in the process of approving the Morgan Ranch Master Plan, a 1,000 unit residential project at much higher densities than currently seen in Turlock. It is consistent with the General Plan that promotes more compact development in order to preserve agricultural land and reduce air pollution. The Master Plan zoning will allow for double the typical density, up to 9 units per acre versus the 4.5 units per acre currently seen in the city. Turlock is also preparing an Active Transportation Plan to establish a planning strategy and identify funding sources for new bicycle and pedestrian infrastructure.

In 2013, Stanislaus County adopted the Regional Sustainability Toolbox which provides local planning tools to guide communities as they adopt general plans, zoning ordinances, non-motorized transportation policies, low impact development standards, urban forest plans, and climate action plans consistent with the *Blueprint* vision. The Toolbox has resulted in the development of model ordinances and plans that have been adopted by various local communities in the region, such as Modesto’s Form Based Code.

III. ARB Staff Technical Analysis

Senate Bill 375 calls for ARB's "acceptance or rejection of the MPO's determination that the SCS would, if implemented, achieve the GHG emission reduction targets" in 2020 and 2035. StanCOG'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. Those targets for StanCOG are 5 percent per capita reduction in 2020 and 10 percent per capita reduction in 2035. The remainder of this report describes the method ARB staff used to review StanCOG's determination that its SCS would meet its targets, and reports the results of staff's technical evaluation of StanCOG's quantification of passenger vehicle GHG emissions reductions.

Government Code section 65080(b)(2)(J)(i) requires the MPO to submit a description to ARB of the technical methodology it intends to use to estimate GHG emissions from its SCS. StanCOG's February 2014 technical methodology identifies its transportation modeling system, which includes the regional travel demand model, model inputs and assumptions, land use projections, growth forecast, performance indicators, and sensitivity analyses, as the technical foundation for its quantification.

StanCOG's analysis estimates that the SCS, if implemented, would achieve a 26 percent per capita reduction in GHG emissions from passenger vehicles by 2020, and a 22 percent per capita reduction by 2035. ARB staff's evaluation of StanCOG's SCS and its technical documentation indicates that while the MPO's estimates are high, the SCS, if implemented, would meet the targets of 5 and 10 percent.

A. Application of ARB Staff Review Methodology

ARB's review of StanCOG's quantification focused on the technical aspects of regional modeling that underlie the quantification of GHG emissions reductions. The review is structured to examine StanCOG's modeling tools, model inputs, application of the model, and modeling 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." To address the unique characteristics of each MPO region and modeling system, ARB's methodology is tailored for the evaluation of each MPO. StanCOG provided a copy of its Three-County travel demand model to ARB staff which enabled a first-hand assessment of the model's structure and performance.

ARB staff evaluated how StanCOG's model operates and performs when estimating travel demand, land use impacts, and future growth, and how well it is able to quantify GHG emissions reductions associated with the SCS. In evaluating whether or not StanCOG's model is reasonably sensitive for this purpose, ARB staff examined issues such as:

- How does the growth forecast reflect the recent economic recession?
- What is the basis for allocation of land use changes?

- How well does StanCOG's travel demand model replicate observed results?
- Are cost assumptions (fuel price and auto operating cost) used in the model reasonable?
- How sensitive is StanCOG's Three-County Model to changes in key land use and transportation variables as compared with the empirical literature?
- How well addressed is inter-regional travel in StanCOG's RTP/SCS?

To help answer these and other questions, ARB staff used publicly available information in StanCOG's RTP/SCS and accompanying documentation, including the RTP technical appendices and the model description and validation report. In addition, StanCOG provided clarifying information, sensitivity analyses, and a data table, as listed in Appendix A.

Four central components of StanCOG's GHG quantification methodology and supporting analyses were reviewed for technical soundness and general accuracy:

- Data Inputs and Assumptions for Modeling Tools
- Modeling Tools
- Model Sensitivity Analyses
- Performance Indicators

Data Inputs and Assumptions for Modeling Tools

StanCOG's key model inputs and assumptions were evaluated to assess whether they represent current and reliable data, and were appropriately used in their model. Specifically, a subset of the most relevant model inputs were reviewed, including: 1) regional socioeconomic characteristics, 2) the region's transportation network inputs and assumptions, and 3) cost assumptions. In evaluating these four input types, model inputs were compared with underlying data sources. The assumptions StanCOG used to forecast growth and VMT were also reviewed. 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.

Modeling Tools

ARB staff assessed how well the Three-County Model replicates observed results based on both the latest inputs (socioeconomic, land use, and travel data) and assumptions used to model the SCS. The documentation of StanCOG's application of the Envision Tomorrow™ land use scenario planning tool and results were reviewed to assess whether an appropriate methodology was used to quantify the expected reduction in GHG emissions from its SCS. StanCOG's modeling practices were also compared against California Transportation Commission (CTC) "2010 California Regional Transportation Plan Guidelines," the Federal Highway Administration's (FHWA) "Model Validation and Reasonableness Checking Manual," and other key modeling guidance and documents.

Model Sensitivity Analysis

Sensitivity testing is often used to assess whether a model is reasonably responsive to changes in key inputs, including changes to land use and transportation factors. These tests often involve systematically changing model input variables and measuring variations in output variables. They can also be performed by examining variations in independent and dependent variables across a dataset, and evaluating the correlations between the variables. StanCOG conducted sensitivity tests of the Three-County Model to support its GHG emissions quantification analyses. The results of StanCOG's sensitivity tests were compared to those found in the available empirical literature.[3] As part of the sensitivity analysis review, responsiveness of the Three-County Model to changes for the StanCOG region in the following input variables was examined:

- Auto operating costs
- Household income distribution
- Transit frequency
- Proximity to transit
- Residential density

Regional Performance Indicators

Performance indicators help to explain changes in VMT and related GHG emissions that are expected to occur, whether through changes in travel modes, vehicle trip distances, or through some other means. The performance indicators ARB analyzed include residential density, mix of housing types, jobs/housing balance, land consumption, passenger VMT, Bus rapid transit service coverage, and transportation investments. For each performance indicator, ARB staff performed a qualitative evaluation to determine if increases or decreases in a subset of these individual indicators are directionally consistent with StanCOG's modeled GHG emissions reductions.

B. Data Inputs and Assumptions for Modeling Tools

StanCOG's key model inputs and assumptions were evaluated to confirm that model inputs represent current and reliable data, and were used appropriately. Specifically, a subset of the most relevant model inputs were reviewed, including: 1) regional growth forecast, 2) the region's transportation network, and 3) cost assumptions. In evaluating these three input types, ARB staff reviewed the assumptions StanCOG used to forecast growth and VMT, and compared model inputs with underlying data sources. This involved using publicly available, authoritative sources of information, such as national

[3] Empirical literature elasticities were taken from a series of empirical literature reviews commissioned by ARB. These reviews can be accessed on ARB's website at: http://arb.ca.gov/cc/sb375/policies/policies.htm.

and statewide survey data on socioeconomic and travel factors, as well as region-specific forecasting documentation.

1. Demographics and the Regional Growth Forecast

For StanCOG, as for all of the Valley MPOs, demographic forecasts were prepared by The Planning Center, resulting in three primary forecasts for population, households, and housing units. The Planning Center's March 2012 report cites data sources including the California Department of Finance (DOF), U.S. Census Bureau, and the California Employment Development Department, and describes the application of the least-squares method to determine a line of best fit for the trend data for the primary forecasts. The forecast for an increase in households was used to derive the forecasted population, while the housing unit forecast was developed from DOF projections of total estimated housing units. The employment forecast used the California Employment Development Department at-place employment by sector. Several other projections, such as household income and average household size, were derived from the primary forecasts. StanCOG used the Planning Center forecast as the countywide control values and then disaggregated the information to the local level with input from local agencies. StanCOG's growth forecast is summarized in Table 4. The population of the StanCOG region is forecast to grow from about 514,000 in 2010 to about 764,000 in 2040.

Table 4: Stanislaus County Regional Growth Forecast

Year	Population	Housing Units	Employment
2005	503,191	160,808	172,800
2010	514,000	188,000	171,000
2020	594,000	194,000	184,000
2035	722,000	206,000	197,000
2040	764,000	257,000	236,000

Source: StanCOG Data Table (2005) and StanCOG 2014 RTP/SCS, pg. 51

Demographic data and forecasts describe a number of key characteristics used in travel demand models. The regional forecast forms the vision of how many people will live in the region, how many jobs the region will have, and the anticipated number of households. The population, household, and employment projections for Stanislaus County were conducted by The Planning Center in March 2012. StanCOG's 2020 population forecast differs from DOF's forecast by 3.5 percent, and in 2035 the difference is almost 6 percent. Forecasts were based on a least-squares linear curve. The main population, household, and housing unit forecasts used the projections of several trends including: household trend, total housing unit trend, housing construction trend, employment trend, cohort-component model, population trend, average household size trend, and household income trend. The employment forecast used the California Employment Development Department employment by sector data.

a) Population

The county is projected to grow at a rate of 1.3 percent annually between 2010 and 2040 which is lower than the annual growth rate of 3.3 percent experienced between 1970 and 1990, and slightly lower than the annual growth rate of 1.7 percent between 1990 and 2010.

b) Employment
The employment forecast considered the anticipated changes to employment sectors from recent employment figures. Employment in Stanislaus County is forecast to increase by about 66,000 jobs between 2008 and 2040, yielding an annual employment growth rate of about 1.0 percent.

c) Households
Household sizes are projected to increase slightly from 3.08 persons per household in 2008 to 3.14 persons per household in 2040. The forecast for average household size uses U.S. Census data from 1990, 2000, and 2010, adjusted with data on race and ethnicity from 2000 and 2010. The increase in household size has an impact on the total amount of housing units needed because some of the total growth in household population will be accommodated by existing units, and fewer new housing units would be needed because each household on average will contain more people. StanCOG's data on projected housing units between 2008 and 2040 indicates an annual growth rate of 1.0 percent. The forecast for housing units is based on estimates by DOF and projections based on the number of units constructed.

The number of households is projected to increase by almost 73,000 between 2008 and 2040, yielding an annual growth rate in households of about 1.2 percent. Given the increase in household size, the slightly smaller annual growth rate of households as compared to an annual growth rate in total population of 1.3 percent in the same time period seems reasonable.

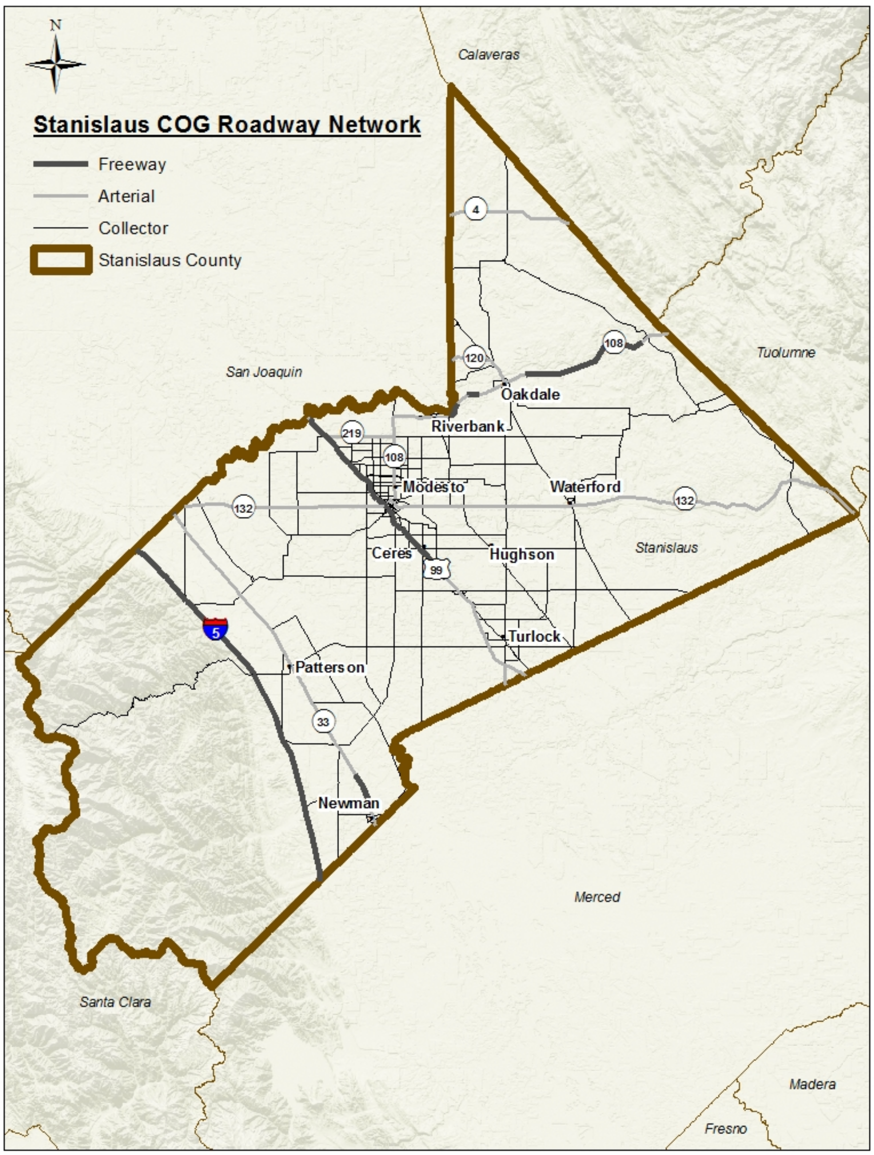
2. Transportation Network Inputs and Assumptions

The transportation network is a map-based representation of the transportation system serving the StanCOG region. One part of the transportation network is the roadway network, which consists of an inventory of the existing road system, and highway travel times and distances. The other part of the transportation network is the transit network, which contains data such as route name, stop locations, transit fares, headway, and type of transit service. The Three-County Model includes roadway and transit networks for both the model base year of 2008 and for future years (i.e. 2020, 2035). ARB staff reviewed the StanCOG regional roadway network, transit network, and network assumptions such as link capacity and free-flow speeds. The methodologies StanCOG used to develop the transportation network and model input assumptions is consistent with guidelines given in the National Cooperative Highway Research Program (NCHRP) Report 365.

Roadway Network

StanCOG's roadway network is a representation of the automobile roadway system (Figure 4), which includes freeway, highway, expressway, arterial, collector, local and freeway ramps in the region. Roadways in the Three-County Model were also grouped by adjacent development (i.e. central business district, fringe, urban, suburban, or rural) and terrain (i.e. flat, rolling, or mountains). The roadway network provides the basis of estimating zone-to-zone travel times and costs (in terms of travel distance and travel time) for the trip distribution and mode choice steps of the modeling process, and for trip routing in vehicle assignments.

Figure 4. Existing Roadways in StanCOG



The Three-County Model uses facility type classifications consistent with the Federal Function Highway Classification system. Table 5 summarizes the reported roadway lane miles in the StanCOG region in 2008 by facility type. In the roadway network, link attributes (e.g. route/street name, distance, capacity, speed) are coded for each roadway segment.

Table 5: Lane Miles in 2008 by Facility Type

Facility Type	Lane miles in 2008
Freeway	260
Arterial	3,397
Collector	967
Local	14
Total	**4,638**

Link Capacity

Link capacity is defined as the number of vehicles that can pass a point of roadway at free-flow speed in an hour. One important reason for using link capacity as an input to the Three-County Model is for congestion impact, which can be estimated as the additional vehicle-hours of delay traveling based on the 2000 Highway Capacity Manual (2000 HCM). Table 6 summarizes the reported link capacity assumptions used in the Three-County Model. The capacity of each road segment in the network is based on the terrain, facility type, and area type, and is determined using the methodology suggested in the 2000 HCM.

Table 6: Default Link Capacity

Facility Type	Terrain		
	Flat	Rolling	Mountain
Freeway	1,750 to 2,100	1,580 to 1,800	1,310 to 1,500
Highway	1,300 to 1,680	1,060 to 1,300	570 to 700
Expressway	800 to 1,155	650 to 1,300	350 to 700
Arterial	750 to 945	610 to 1,300	330 to 700
Collector	700 to 735	570 to 1,300	310 to 700
Local	600	550 to 1,000	330 to 600
Ramps	1,250 to 1,900	1,250 to 1,800	1,250 to 1,500

Free-Flow Speed

Free-flow speed is used to estimate the shortest travel time between origin and destination zone in the highway network. Factors such as prevailing traffic volume on the link, posted speed limits, adjacent land use activity, functional classification of the street, type of intersection control, and spacing of intersection controls can affect link speed. The Three-County Model estimated the free-flow speed of each link segment (Table 7) using the Bureau of Public Roads formulas suggested in the 2000 HCM.

Table 7: Free-Flow Speed Assumptions

Facility Type	Terrain		
	Flat	Rolling	Mountain
Freeway	55 to 70	65 to 70	65
Highway	40 to 45	40 to 45	40 to 45
Expressway	40 to 55	50 to 65	40 to 55
Arterial	25 to 45	30 to 45	30 to 45
Collector	35 to 50	50	25 to 40
Local	25 to 40	50	25 to 40
Ramps	45 to 50	45 to 50	35 to 50

ARB staff reviewed the methodology used in estimating highway free-flow speeds in the StanCOG region. The Three-County Model's estimation of free-flow speed, based on the posted speed, is consistent with the recommended practice indicated in the NCHRP Report 365.

Transit Network

Besides the roadway network, the transportation network of the Three-County Model also includes a transit network. The three counties built the transit network using the completed roadway network to which transit routes and stops information was added. The purposes of developing a transit network are: verification of access links and transfer points, performance of system level checks on frequency and proximity between home and transit station or stop, and relating transit speed to highway speeds.

Elements coded in the transit network include walk/bike access to transit, drive access to transit, park-and-ride lots, highway based (i.e. bus) and non-highway based (i.e. rail) transit in the study area. Some attributes coded in the transit network include transit fare, travel time, park-and-ride locations, and maximum distance for walk and ride to transit stops. StanCOG estimated transit bus travel times from the highway network, with a delay factor to account for stops and slow operating speeds. The Three-County Model assumes a walking speed of three miles per hour for walk access in estimating transit travel time. The three counties derived bus travel time from the roadway network including a delay factor to account for stops and slower operating speeds. The three counties also agreed to set the maximum wait time between buses at transfer location to be five minutes rather than one-half the headway.

The methodology StanCOG used in developing its transit network was reviewed and found consistent with the procedures discussed in the NCHRP Report 365 and USDOT-FHWA Manual. In future model updates, StanCOG should consider coding transit routes and stops on a GIS-based layer, and include bike and pedestrian facilities (e.g. bike paths, bike lanes) in the transit network to reflect walk- or bike-access to transit stations, which may increase the model's sensitivity to transit trips. Additionally, StanCOG should consider including more details of transit related attributes such as operational miles of local bus, transit fares assumptions, and bike and pedestrian lane miles in the model document.

3. Cost Inputs and Assumptions

Travel cost is one of the major factors determining the mode of transportation for any given trip. ARB staff reviewed basic travel cost components, such as auto operating cost and value of time, that were used as inputs in the Three-County Model. To examine the responsiveness of the Three-County Model to changes in the cost variable or other model inputs, model sensitivity tests performed by StanCOG, such as auto operating cost, and transit frequency were evaluated. The results of the sensitivity tests are presented in the model sensitivity analysis section of this report.

Auto Operating Cost

Auto operating cost is a key parameter used in the mode choice step of the Three-County Model. StanCOG staff defined auto operating costs solely from cost of fuel. Fuel cost is an important factor that influences per capita VMT. The price of fuel is the amount consumers pay at the pump for regular grade gasoline (in dollars/gallon). When gasoline prices go up, drivers are expected to decrease their frequency of driving, reduce their travel distance, increase their use of public transit, and/or switch to more fuel efficient cars. Lower gas prices would be expected to have the opposite effects on VMT.

StanCOG staff followed the procedures documented in the 2009 Regional Transportation Plan Analysis performed by the Metropolitan Transportation Commission (MTC) to forecast fuel price in the region. The fuel price in 2020 and 2035 was forecasted using the historical trend from 1998 to 2008 in the StanCOG region. The corresponding auto operating costs were then derived by dividing the fuel price of the year by the fuel efficiency assumptions. Table 8 summarizes the reported year 2008 and future years' auto operating cost in the StanCOG region.

Table 8: Auto Operating Cost in StanCOG (in 2009 Dollars)

	2008	2020	2035
Auto Operating Cost	0.19	0.22	0.24

Though fuel cost is the major component of travel cost of auto mode, other minor costs such as the cost of vehicle maintenance and tire replacement are considered in some California MPO regional travel demand models. ARB staff recommends StanCOG include these minor costs such as tire and maintenance cost in estimating auto operating cost in its future model update.

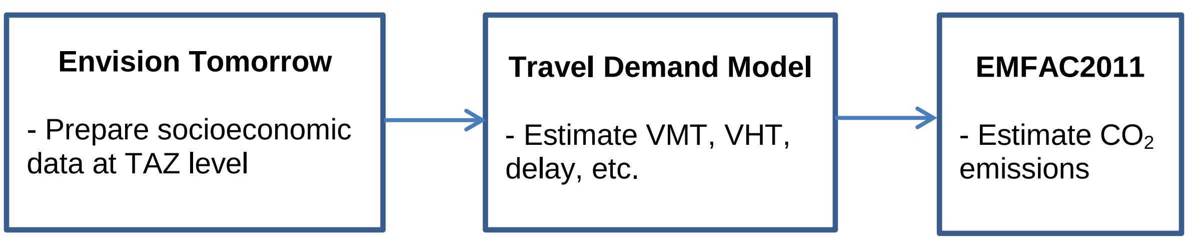
Cost of Time

A value of time assumption is used in the trip distribution step to estimate the travel cost of alternative routes. StanCOG staff converted travel cost to cost of time using a value of time. The average perceived value of time that StanCOG uses, similar to that used by other MPOs in the Valley, was six dollars per hour per person. The value of time was also further adjusted according to vehicle ownership status.

C. Modeling Tools

Similar to other MPOs in the Valley (e.g. Fresno Council of Governments, San Joaquin Council of Governments), StanCOG used a land use scenario planning tool (i.e. Envision Tomorrow™), a trip-based travel demand model, and the ARB vehicle emission model (i.e. EMFAC2011) to quantify the GHG emissions for its 2014 RTP/SCS. The analysis years for the GHG emissions were 2005, 2020, and 2035. Figure 5 shows the flow chart of the modeling process. The Envision Tomorrow™ land use tool takes demographic data (e.g. population, house units) and future socioeconomic changes as inputs, and then allocates growth in housing, employment, and population at the Transportation Analysis Zone (TAZ) level. The outputs of the land use tool were fed as inputs to the travel demand model to estimate the amount of travel in the StanCOG region. Results from the travel model, such as VMT by time of day, were input to EMFAC2011 to estimate GHG emissions associated with the 2014 RTP/SCS. StanCOG developed its current travel model as part of the San Joaquin Valley Model Improvement Program (MIP) which was completed in 2012. This is the first RTP to be developed using the new MIP model.

Figure 5: StanCOG's Modeling Tools



1. Land Use Tool

StanCOG used the Envision Tomorrow™ land use tool to develop and compare alternative land use scenarios for its 2014 RTP/SCS. For each planning scenario, StanCOG used Envision Tomorrow™ to allocate the projected number and types of housing and employment at the parcel-level within specific planning areas. Land use modeling results and calculation elements associated with a scenario are stored in look-up table and GIS-map based files. Different land use scenarios based on different policies were then developed for evaluation and comparison purposes. The spreadsheet formatted outputs associated with StanCOG's preferred scenario served as inputs to the travel demand model (i.e. the Three-County Model).

For validation purpose, StanCOG developed a base year land use database to provide inputs to the tool for the 2008 condition. The 2008 population and household inputs were initially developed based on 2000 U.S. Census information by census block. The increment between the 2000 Census and the 2008 model base year was based on building permits.

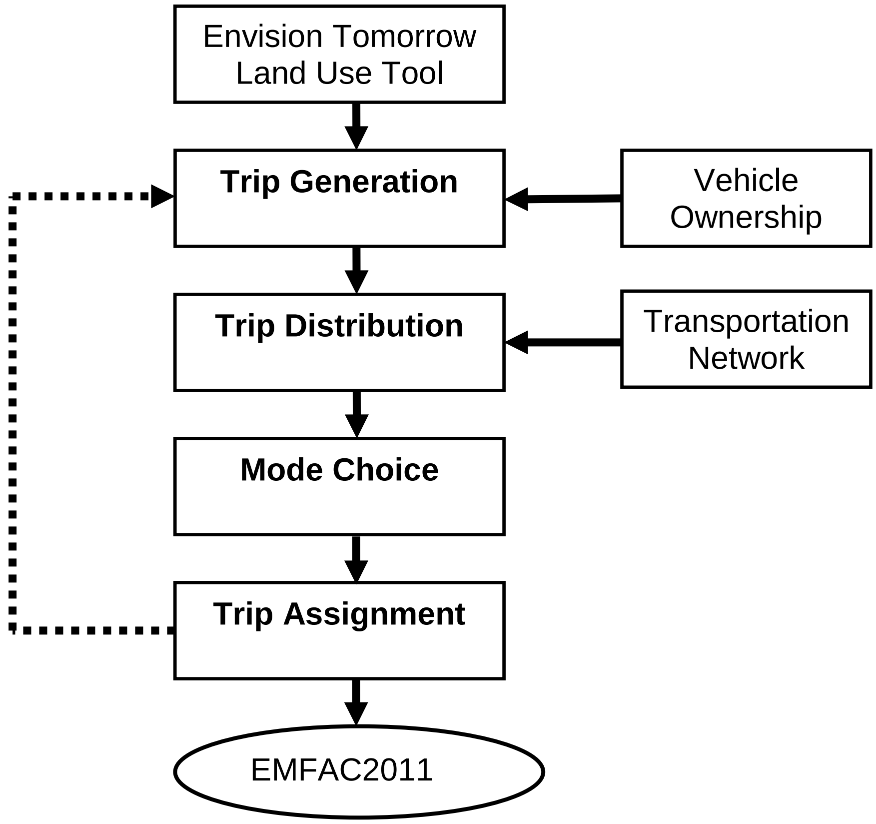
2. Travel Demand Model

In 2010, the eight MPOs in the Valley began a collaborative process to improve their travel demand modeling capabilities. This process, known as the San Joaquin Valley Model Improvement Plan (MIP) was funded by the Strategic Growth Council (SGC) and was completed in 2012. The MIP effort substantially upgraded and standardized travel demand models of the Valley MPOs and improved on their ability to evaluate land use and transportation strategies pertinent to meeting SB 375 requirements.

Additionally, in 2013, StanCOG together with the Merced County Association of Governments and San Joaquin Council of Governments further updated the MIP model to reflect model base year (2008) conditions of their regions. The resulting model, covering all three counties, is known as the Three-County Model. The 2014 RTP/SCS is StanCOG's first RTP to be developed using the Three-County Model. Similar to most regional travel demand models, the Three-County Model is a four-step model that includes trip generation, trip distribution, mode choice, and trip assignment (Figure 6). The model uses land use, socioeconomic, and roadway network data to estimate travel patterns, roadway traffic volumes and transit volumes. The model contains approximately 6,600 transportation analysis zones (TAZs) representing origins and destinations of travel in the model area. Travel to/from and through the model area is represented by 100 gateway zones at major road crossings of the county line for an interregional travel estimate.

Zonal level land use inputs from the Envision Tomorrow™ land use tool to the Three-County Model include population-related inputs such as total population and numbers of households by structure type, household income, age of population in households, and housing density- and employment-related inputs such as employee by detailed sector and employment density, and student enrollment.

Figure 6: Three-County Travel Demand Model



Vehicle Ownership

Modeling of vehicle ownership is a new component of the Three-County Model. Previously StanCOG used a fixed rate of vehicle ownership. The new model calculates the number of motor vehicles in the StanCOG region based on demographic characteristics, auto operating cost, and accessibility, which helps to capture the economic characteristics of each household. The output of this component is a critical input to the trip generation step, accounting for travelers' long term decisions for mode of transportation.

ARB staff evaluated the structure and variables used in the vehicle ownership model, as well as whether the model followed the state of the practice.[4] The model captures the relationship between household characteristics and vehicle ownership, and shows that the number of vehicles available per household increases as the average household income rises. This is consistent with the recommended practice in the Federal Highway Administration's "Model Validation and Reasonableness Checking Manual" (FHWA 2010). For future model improvements, StanCOG should consider including the sensitivity to land use and transit accessibility in modeling auto ownership, as well as

[4] The state of the practice indicates the methods used by most MPOs in developing their travel demand models.

validating the vehicle ownership model results against the Department of Motor Vehicles' (DMV) data.

Trip Generation

Trip generation, the first step of travel demand modeling, quantifies the amount of travel in terms of person-trips in a model area. StanCOG estimates person-trips by trip purpose using cross-classification, which is similar to a look-up table of residential data, employment information, and school enrollment based on the 2000/2001 California Household Travel Survey (CHTS) and is supplemented by information from previously developed models. There are 11 trip purposes contained in this step of the Three-County Model: home-based work (HBW), home-based shopping (HBShop), home-based K12 (HBK12), home-based college (HBCollege), home-based other (HBO), work-based other (WBO), other-based other (OBO), highway commercial, trucks-small, trucks-medium, and trucks-large.

Consistent with a conventional trip-based travel demand model, the Three-County Model has two trip ends, trip production[5] and trip attraction.[6] The trip production rates for HBW trips by housing type and by auto ownership, and for WBO by employment type were derived from survey results from the 2000/2001 CHTS. The Three-County Model also used survey results from all eight counties in the Valley to ensure larger sample sizes. HBW trip attraction rates were also derived from the 2000/2001 CHTS because the survey has records of surveyed households and their employment information. Table 9 summarizes the trip productions and attractions rates by trip purpose. The differences between estimated trip productions and attractions were within the 10 percent difference stated in the 2010 FHWA's Travel Model Validation and Reasonable Checking Manual, except for HBW trips, which were within 15 percent. StanCOG stated the reason for the difference in HBW trips is due to limited sample sizes for Valley counties from the 2000/2001 CHTS. ARB staff recommends StanCOG use the latest available household travel survey data for their next model update.

Table 9: Trip Productions and Attractions

Trip Purpose	Productions	Attractions	Percent Difference	FHWA Criterion
HBW	510,513	587,396	15%	±10%
HBSchool*	294,572	296,142	1%	±10%
HBO	1,135,038	1,173,813	3%	±10%
NHB	719,092	740,799	3%	±10%
Total	2,659,215	2,798,150	5%	±10%

Source: Fehr & Peers (2014). Three-County Model Description.
*HBSchool is an aggregation of HBK12 and HBCollege.

[5] Trip production is defined as the home end of any home-based trip, regardless of whether the trip is directed to or from home. If neither end of the trip is a home, it is defined as the origin end.
[6] Trip attraction is defined as the non-home end of a home-based trip. If neither end of the trip is a home, the trip attraction is defined as the destination end.

The OBO trip production and attraction rates for each employment type were estimated by comparing the trip generation derived from the 2000/2001 CHTS to standard vehicle trips in the Institute of Transportation Engineers (ITE) Trip Generation manual. The modeled person trip rates were then converted to vehicle trips using average auto occupancies for the three counties for each trip purpose (i.e. drive alone, shared ride 2, shared ride 3+).[7]

As part of the evaluation of the trip generation step, ARB staff reviewed the parameters used in the trip production and attraction models, their association to trip rates, and the responsiveness of trip rates to key parameters in the model. Analysis of the trip generation component of the Three-County Model indicates that trip rates tend to increase as household income and household size increases. Overall, the trip generation model followed the process for estimating trip generation outlined in NCHRP Report 365. As part of future model improvement, StanCOG should consider including some sensitivity to land-use mix, particularly in areas with high transit use to capture the transit-oriented development travel behavior. ARB staff recommends StanCOG use the latest available independent data sources such as the National Household Travel Survey (NHTS), Census Transportation Planning Package (CTPP), and the American Community Survey (ACS) to validate the travel model.

Trip Distribution

The trip distribution step is the second step of the Three-County Model, which utilizes a gravity model[8] to estimate how many trips travel from one zone to any other zone. The inputs to the gravity model include the person trip productions and attractions for each zone, zone-to-zone travel cost, and friction factors[9] that define the effect of travel time. The travel time (or skim) between a pair of zones is based on the shortest path connecting the two zones. The results of the zone-to-zone travel times serve as input to the trip distribution process. Intrazonal travel times were assumed to be 100 percent of the average travel time to the nearest adjacent urban TAZ and one-third the average travel time to the nearest adjacent rural TAZ.

Because time is an important factor in trip distribution, the Three-County Model added terminal times to reflect the average time to access one's vehicle at the each end of the trip. The model estimated terminal time by taking the difference between the model estimate of roadway network travel time and the reported travel times for trips in the three counties from the 2000/2001 CHTS. The three counties agreed to use a terminal time of one minute for all TAZs in the model area of the Three-County Model.

[7] Shared ride 3+ includes vehicles with 3 or more riders including driver in the vehicle, calculated as 3.5 persons per vehicle.
[8] A gravity model assumes that urban places will attract travel in direct proportion to their size in terms of population and employment, and in inverse proportion to travel distance.
[9] Friction factors represent the effect that travel time exerts on the propensity for making a trip to a given zone.

In evaluating the trip distribution step of the Three-County Model, the average travel time by trip purpose was reviewed. Table 10 shows the average travel time by trip purpose from the model. StanCOG explained that the differences between the modeled travel time and the observed travel time (CHTS) are due to the limited samples from the 2000/2001 CHTS for the three counties, the time gap between model base year (i.e. 2008) and survey year, and also due to the different survey information collection locations in California which could vary from the three counties' demographic make-up. In addition, ARB staff reviewed the interregional travel pattern in StanCOG. The details are discussed in the Interregional Travel section later in this report.

Table 10: Average Travel Time by Trip Purpose

Trip Purpose	Model	CHTS
HBW	14.9	21.5
HBO	23.8	15
NHB	15.1	14.4

To better estimate the GHG reductions associated with SCS strategies in the future, ARB staff recommends that StanCOG consider developing a destination choice model, which can improve the sensitivity of changes to land use and socioeconomic factors on trip distribution by better reflecting the attributes that influence a person's decision to travel. Also StanCOG should provide goodness-of-fit statistics in future model documentation and the frequency distribution of trip lengths along with coincidence ratios for different trip types to evaluate the travel model.

Mode Choice

The mode choice step of the Three-County Model uses demographics, travel cost and time from trip distribution outputs, and average ratios of persons to vehicle from travel surveys to assign person-trips by mode of transportation. The Three-County Model uses a multinomial logit model[10] to assign the person-trips to mode of drive-alone, shared ride 2 people, shared ride 3+ people, local bus, regional bus, BRT, or walk and bike. For the transit modes, the model further distinguishes between walk- and drive-access. The mode choice model estimates for the 2008 base year were calibrated using the 2000/2001 CHTS survey data. Table 11 shows the calibrated percent mode share in the model base year for the model area. Mode share estimates were compared against the observed data from CHTS. The differences between model estimates and observed data were expected due to the time gap between the model base year and the time of the survey. StanCOG staff mentioned there are significant commuter trips by carpool and vanpool in the region, especially for farmers, and residents who work outside the region, which supports the lower share of SOV and higher share of HOV compared to CHTS results.

[10] A multinomial logit model assigns the probability of using a particular mode based on an attractiveness measure or utility for an alternative mode in relation to the sum of the attractiveness measures for all modes.

Table 11: Person-trips by Mode in 2008

Mode	Model	CHTS
SOV	41.00%	52%
HOV	49.70%	44%
Transit	1.50%	1%
Bike and walk	7.80%	3%

The Three-County Model estimated transit ridership for each of the transit services for the 2008 base year. The model estimate for fixed-route bus ridership in 2008 is 35,033, while the observed ridership from survey data shows 21,908. The model estimate is about 37 percent higher than reported data from the San Joaquin Regional Transit District and Merced Country Transit in 2008. This difference falls outside the suggested evaluation criterion of 20 percent difference that the three counties chose. However, FHWA does not suggest a reasonable range for transit ridership validation. StanCOG attributed the difference between the observed ridership and the modeled ridership to the nature of transit in the rural areas of the region. For example, fixed-route bus transit stops in the rural areas are still far from some households, and service coverage is quite limited.

In evaluating the mode choice component of the Three-County Model, ARB staff reviewed the model structure, the input data, and data sources that the three counties used to develop and calibrate the model, model parameters, and auto-occupancy rates[11] by purpose. Estimated mode share by trip purpose was also compared against the observed data, including transit ridership.

The method the three counties used to develop their mode choice model is consistent with the approaches used nationwide as cited in NCHRP Report 365. However, the coefficients and constants used in the mode choice model are based on other regional models. In future model updates, the three counties should consider developing a nested logit based mode choice model since they have more than two mode choices. The mode choice model should consider including demographic and socioeconomic characteristics in allocating the trips between modes. Model documentation should consider including more details on the model estimation process, estimated parameters, and statistical significance of the estimates. The three counties should consider auto occupancy rates by trip purpose in the mode choice step, and use the latest household travel survey data.

Trip Assignment

In the trip assignment step, vehicle trips from one zone to another are assigned to specific travel routes between the zones in the transportation network. Congested travel information serves as feedback to the beginning of the process until convergence is

[11] Auto-occupancy indicates the number of people, including the driver, in a vehicle at a given time.

reached. This process utilizes a user equilibrium assignment concept to assign vehicles to roadways in the network. The iteration runs until no driver can shift to an alternative route with a faster travel time. The convergence criteria used in the Three-County Model is 0.001 relative gap,[12] or a maximum internal iteration of 20 iterations for peak and off-peak period traffic assignments and 50 iterations for peak hour traffic assignments. The Three-County Model used the Bureau of Public Roads (BRP) formula to estimate congested travel time, which is a common practice among transportation planning agencies.

For transit trip assignment, the best path was chosen based on in-vehicle time plus weighted out-of-vehicle times. Transit trips were assigned in four groups: peak period, walk access; peak period, drive access; off-peak, walk access; and off-peak, drive access.

After the initial trip distribution and assignment using free-flow speed on the roadway network, the congested travel time from the most recent A.M. peak three-hour period is used as input to the HBW trip distribution, and the congested travel times from the most recent off-peak traffic assignment are used for the other trip purposes. However, the Three-County Model was not calibrated with a feedback mechanism for each step. ARB staff recommends the three counties include the feedback mechanism in the next model update.

In evaluating the trip assignment step, ARB staff reviewed the assignment function used in the model, and the estimated and observed volume counts by facility type (Table 12). ARB staff also compared these estimated volume counts by facility type with observed data in the region. The travel model uses an assignment function as required by CTC's "2010 California RTP Guidelines" to estimate the link volumes and speeds. The coefficients used in the assignment function were consistent with FHWA guidelines. Comparison of estimated and observed traffic counts at the screenline[13] locations by facility type in Table 12 shows that the differences did not fall within the recommended range of FHWA guidelines. StanCOG attributed this large difference to the lack of data points from certain facility types (e.g. freeway, collector). Between now and the next model update, StanCOG should consider gathering more recent traffic count data at different facility types and making sure there are large enough sample sizes.

[12] Relative gap measures the relative difference of traffic flow between current iteration and the previous iterations.
[13] The screenline is an imaginary line used to split the study area into different parts. Along these lines, traffic counts are collected to compare against the model estimates.

Table 12: Estimated and Observed Traffic Counts for StanCOG Region

Facility Type	Model Estimate	Traffic Count	Percent Difference	FHWA Guidelines
Freeway	1,324,728	963,793	37%	±7%
Expressway	108,223	129,055	-16%	±15%
Arterial	59,937	61,683	-3%	±15%
Collector	1,142	17,200	-93%	±25%

The estimated VMT from the Three-County Model for the StanCOG region and the observed data from the Caltrans Highway Performance Monitoring System (HPMS)[14] were compared at the county level (Table 13), and the difference was less than one percent.

Table 13: Model Validation - VMT for StanCOG Region

	Model	HPMS	Percent Difference
VMT	10,888,358	10,874,267	0.1%

Interregional Travel

Appropriately accounting for each type of interregional travel is important for GHG quantification. StanCOG used the same Three-County Model and a similar method as did in the San Joaquin Council of Governments (SJCOG) to quantify interregional travel. The following summarizes staff's assessment of the methodology that StanCOG used to estimate interregional travel and its influence on the region's GHG quantification.

Stanislaus County experiences a significant amount of interregional travel mainly due to the presence of major north-south transportation corridors such as Interstate 5 (I-5) and State Route 99 (SR-99) which carry significant amounts of traffic that pass through the Valley. The county also has a substantial amount of commute travel to neighboring counties, particularly to San Joaquin and Merced counties and the San Francisco Bay Area (Bay Area).

In 2010, 16,050 Stanislaus County residents commuted to and from the Bay Area based on an analysis conducted by the Business Forecasting Center in 2014. The majority of these commute trips were in single occupancy vehicles. The most common out-of-county commute for Stanislaus County residents is to Alameda and Santa Clara counties because of the proximity of those major job centers in the Bay Area and the relatively low cost and available supply of housing in Stanislaus County. Most of these travelers use I-580 and I-205 for their regular commute. While not as many residents of

[14] Highway Performance Monitoring System is a federally mandated program to collect roadway usage statistics for essentially all public roads in the US.

Stanislaus County commute to jobs in the Bay Area as do residents of San Joaquin County, this interregional travel still has a substantial impact on StanCOG's GHG quantification.

The method that StanCOG used to quantify interregional travel was similar to the method used by many MPOs, including the four largest MPOs in the state. The COG included 100 percent of VMT from internal (II) trips, 100 percent of VMT from interregional (IX and XI) trips, and excluded all of the VMT from through-trips (XX). However, for single-county MPOs, like StanCOG, the proportion of interregional trips to internal trips is greater than for multi-county regions. This affects both the total VMT and GHG per capita emissions calculation. Most SCS strategies in regional plans address internal travel, either by reducing the number of trips or shortening the length of these trips.

The high per capita GHG emissions reductions estimated in the StanCOG region are likely the result of several factors. Per capita VMT for in-county travel in Stanislaus County declines rapidly between 2005 and 2020, and we know this is related, in part, to the recession. After 2020, it continues to decline, but at a slower rate. On the other hand, per capita VMT for interregional travel is increasing over time. The Three-County Model forecasts that the amount of pass-through trips will double between 2005 and 2035.

The relatively large proportion of interregional travel compared to in-county travel poses a challenge to both the design of StanCOG's SCS and the quantification of GHG emissions reductions from the SCS. This is influenced by both the method used by StanCOG to estimate interregional travel, as well as the travel model's sensitivity to different assumptions regarding the distribution of interregional trips.

StanCOG used the Three-County Model, as did the SJCOG, to estimate both in-county travel (II) as well as interregional travel (XI, IX and XX). The major sources of data used to estimate interregional travel came from the Caltrans 2003 California Statewide Travel Demand Model (CSTDM) and the observed traffic counts on gateway roads/TAZs.[15] Given that the GHG quantification methodologies used by SJCOG and StanCOG were similar, including the use of the same travel model, data sources, and methodology for estimating interregional travel, StanCOG's modeling has yielded a magnitude of interregional VMT similar to that for SJCOG.

ARB staff included an analysis of the influence of interregional travel on GHG estimation for SJCOG in the May 2015 staff report on the evaluation of the SJCOG SCS. The analysis was enhanced by ARB staff's ability to run the Three-County Model used by SJCOG, StanCOG, and the Merced County Association of Governments, to assess the performance of the model to estimate interregional travel. The ARB staff report entitled "Technical Evaluation of the Greenhouse Gas Emissions Reduction Quantification for

[15] To capture the trips that enter or leave the model region, special TAZs are introduced at the boundaries of the model region. The Three-County Model has 47 gateway locations for monitoring traffic into, out of, and through the three-county region that includes Stanislaus County.

the San Joaquin Council of Governments' SB375 Sustainable Communities Strategy, May 2015" describes the complete interregional travel analysis. Based on this evaluation, staff found that the magnitude of the influence of interregional travel on StanCOG's VMT is similar to that for SJCOG, as discussed in the staff report referenced above.

As discussed in the May 2015 staff report on SJCOG's SCS, ARB staff found that using different assumptions about interregional travel based on the latest available data such as the American Community Survey (ACS) which reflects data from the period 2008-2012 and the 2010-2012 California Household Travel Survey (CHTS) resulted in lower VMT reductions for SJCOG. Using the same data set in the Three-County Model for StanCOG would yield similar VMT reductions. Given this impact of using more recent data, taken together with other factors such as the sensitivity of the model to SCS strategies, the types of land use strategies in the SCS, and supporting performance indicators, staff concludes that StanCOG's SCS would meet the targets.

To improve future interregional travel estimation, ARB staff recommends that StanCOG use the most current data available when updating its Three-County Model. In addition, ARB staff recommends that StanCOG work with neighboring MPOs to improve data quality for the gateway volumes by collecting additional cordon volumes along the Stanislaus County boundaries.

Model Validation

Model validation, usually the last step in the development of any regional travel demand model, reflects how well the model estimates match with observed data. The California Transportation Commission (CTC) Regional Transportation Guidelines suggests validation for a travel model should include both static and dynamic tests. The static validation tests compare the model's base year traffic volume estimates to traffic counts using the statistical measures and the threshold criteria. Testing the predictive capabilities of the model is called dynamic validation and it is tested by changing the input data for future year forecasts. During the model development process, the three counties performed five dynamic tests including adding lanes to a link in the network, adding/deleting a link, changing link speed, adding a toll fee, and reducing roadway capacity. In addition, StanCOG conducted model sensitivity tests as part of their model dynamic testing during ARB's evaluation process of StanCOG's 2014 RTP/SCS, which is summarized and discussed later in this report. StanCOG's model validation was based on a traffic count database, the Caltrans Performance Measurement System (PeMS), and HPMS. Based on the results presented in Table 14, the Three-County Model estimates for the StanCOG region has a correlation coefficient of 0.98 between the modeled and the observed volumes. However, the root mean square error (RMSE) for daily traffic assignment in the model is 78 percent, which is higher than the suggested criterion of 40 percent. Also, only 33 percent of the links with volume-to-count ratios from the Three-County Model for the StanCOG portion are within the Caltrans deviation allowance. The reason for the model estimates not meeting the criteria is probably due to aggregation of traffic count data from 2001 to 2012. In addition, the variation in methods used to collect data and the geographical locations of data collection may have contributed to this difference.

Table 14: Static Validation According to CTC's Guidelines

Validation Item	Criteria for Acceptance	Three-County Model for StanCOG
Correlation coefficient	at least 0.88	0.98
Percent RMSE	below 40%	78%
Percent of links with volume-to-count ratios within Caltrans deviation allowance	at least 75%	33%

Planned Model Improvements

For the next RTP update anticipated in 2018, StanCOG plans to continue to refine its travel demand model to better estimate trips and VMT in the region. The immediate and ongoing model improvement efforts include using the latest regional or local demographic data and using the 2010 Census, 2012 American Community Survey (ACS), and the 2012 CHTS travel data for model recalibration and revalidation. Immediate model improvements seek to increase model sensitivity to land use and transportation policies. These model improvements will increase the accuracy of estimates and forecasts of external trips, trip modes, and distribution for internal and inter-regional travels; and vehicle speeds (which is critical for air quality analysis).

The additional improvements to the Three-County Model will be built on the outcomes from the Valley-wide model improvements, known as the Valley Model Improvement Program 2 (VMIP2). For example, in VMIP2, the Valley MPOs planned to review and refine the model's TAZ structure based on the 2010 Census geography to update TAZ boundaries and the GIS layers.

In addition to the proposed enhancements to the Valley MPO models, ARB staff offers recommendations and suggestions for StanCOG to improve the Three-County's forecasting ability in this staff report's Sections III. B and C (Data Inputs and Assumptions, and Modeling Tools). These recommendations should be incorporated into the model improvement program that StanCOG is currently developing.

EMFAC Model

ARB's Emission Factor model (EMFAC2011) is a California-specific computer model which calculates weekday emissions of air pollutants from all on-road motor vehicles including passenger cars, trucks, and buses for calendar years 1990 to 2035. The model estimates exhaust and evaporative hydrocarbons, carbon monoxide, oxides of nitrogen, particulate matter, oxides of sulfur, methane, and CO_2 emissions. It uses vehicle activity provided by regional transportation planning agencies, and emission rates developed from testing of in-use vehicles. The model estimates emissions at the statewide, county, air district, and air basin levels. The EMFAC2011 modeling package contains three components: EMFAC2011-LDV for light-duty vehicles, EMFAC2011-HD for heavy-duty vehicles, and EMFAC2011-SG for future growth scenarios. EMFAC2011-SG uses the inventory from EMFAC2011-LDV and EMFAC2011-HD modules, and scales the emissions based on changes in total VMT, VMT distribution by vehicle class, and speed distribution. To estimate per capita CO_2 emissions, StanCOG estimated passenger vehicle VMT and speed profiles for the region using the travel demand model and off-model adjustment, and applied them to the EMFAC2011-SG model. StanCOG then divided the estimated CO_2 emissions for passenger vehicles by the year 2005, 2020, and 2035 residential populations to obtain CO_2 emissions per capita.

3. Off-Model Adjustments

StanCOG made off-model adjustments to estimate GHG emissions reductions from the future implementation of the San Joaquin Valley Air Pollution Control District's (SJVAPCD) e-TRIP Rule (also known as Rule 9410) in the region, to which the Three-County Model and land use tool are not sensitive. The SJVAPCD adopted Rule 9410: Employer Based Trip Reduction to require larger employers to establish an Employer Trip Reduction Implementation Plan (eTRIP) to encourage employees to reduce SOV trips. Rule 9410 applies to approximately 1,883 worksites including 500,000 commuting employees throughout the SJV. Rule 9410 distinguishes these worksites into two tiers: Tier One worksites are those with 100 to 249 eligible employees and Tier Two worksites are those with 250 or more eligible employees. StanCOG reported there are 170 Tier One worksites and 490 Tier Two worksites in the region.

To estimate the VMT reduction results from Rule 9410, StanCOG utilized the SJVAPCD Worksheet developed by Sierra Research. Input data of the Worksheet include an inventory of eligible employers[16] in the region from the Commute Connections data base, the Average Vehicle Ridership (AVR) estimated by SJVAPCD, average commute distance from the Three-County Model, and employment projection to 2040. Result of the analysis shows a VMT reduction of 151,740 and 158,452 from implementing Rule 9410 in the StanCOG region for year 2020 and 2035, respectively.

D. Model Sensitivity Analysis

Model sensitivity tests are used to study the responsiveness of the travel demand model to changes in selected input variables. The responsiveness, or sensitivity, of the model to changes in key inputs indicates whether the model can reasonably estimate the anticipated change in VMT and associated GHG emissions resulting from the policies in the SCS. A sensitivity test usually assumes one input variable change at a time and examines the range of output change. Sensitivity analyses are not intended to quantify model inputs or outputs or provide analyses of actual modeled data.

ARB requested that StanCOG conduct a series of sensitivity analyses for its model using the following variables:

[16] Two tiers of eligible employers: Tier I (more than 200 employees), and Tier II (more than 250 employees).

- Auto operating cost
- Household income distribution
- Transit frequency
- Residential density near transit
- Residential density

In addition, ARB staff assisted StanCOG in conducting the sensitivity tests by preparing input files for the income distribution test and providing general procedures on how to perform different test runs.

Following the methodology in ARB's "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375" (2011), ARB staff reviewed results from model sensitivity test runs on land use and transportation-related variables. Model sensitivity test results were compared to findings in the empirical literature as discussed in the ARB-funded policy briefs and corresponding technical background documents[17] in order to evaluate the model's ability, given the data inputs and assumptions, to produce reasonable estimates. In those cases where the findings were corroborated by the empirical literature, the findings were referred to as either sensitive directionally, meaning that the direction of change was consistent with findings in the empirical literature, or sensitive in magnitude, meaning that the amount of change predicted was consistent with the literature. In those cases where sensitivity analysis findings could not be specifically corroborated by the empirical literature, ARB staff indicated whether the model was sensitive directionally, meaning that changes in model inputs resulted in expected changes to model outputs.

1. Auto Operating Cost Sensitivity Test

StanCOG used four scenarios to examine the responsiveness of the model to changes in auto operating cost. Auto operating cost is an important factor influencing travelers' auto use. StanCOG's definition of auto operating cost for the region includes fuel price only. When the auto operating cost increases, travelers are expected to drive less. Conversely, when auto operating cost decreases, travelers are expected to drive more. In relation to mode share, it is expected that as auto operating cost increases, the number of drive-alone trips would shift to shared-ride-2 (SR2), shared-ride-3-plus (SR3+), transit, bicycling, and/or walking.

Figure 7 summarizes the change in mode share with a 50 percent decrease, 25 percent decrease, base case, 25 percent increase, and 50 percent increase from base case in auto operating cost. As expected, as auto operating cost increases, the percentage of drive alone trips decreases while percentages of other modes such as SR2, SR3+, and non-motorized trips increase, although the percentage increases in these modes are

[17] These policy briefs and technical background documents, which seek to identify the impacts of key transportation and land use policies on vehicle use and GHG emissions, based on the scientific literature, can be found at http://arb.ca.gov/cc/sb375/policies/policies.htm

small. StanCOG staff explained the subtle changes in mode share are due to the limitation of existing transit service within the region, and also due to commuting to work places outside the region. Even when auto operating cost increases or decreases, residents in the StanCOG region still rely on the auto mode to reach their destinations.

Figure 7: Mode Share Split and Auto Operating Cost

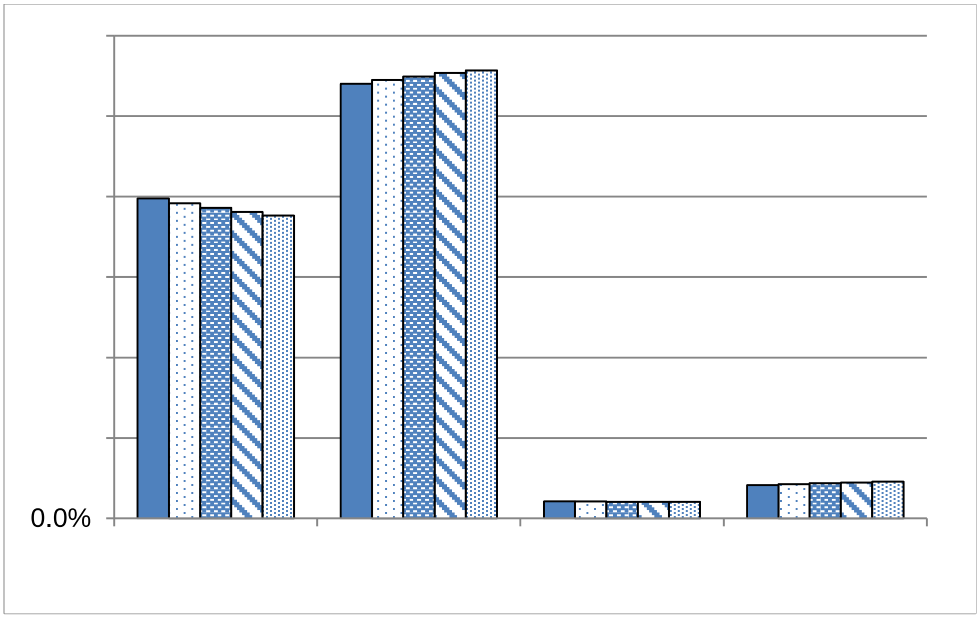


Figure 8 shows the VMT changes with respect to changes in auto operating cost. As auto operating cost increases, the model shows a decrease in VMT. The percentage of VMT change from the base case in each test scenario ranged from -7.2 percent to 8.5 percent.

Figure 8: VMT Change and Auto Operating Cost

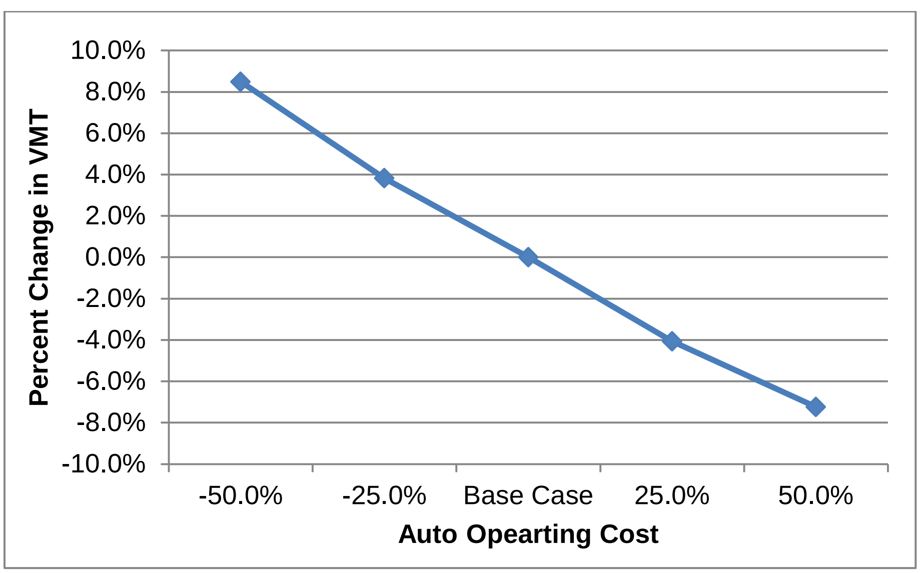


Table 15 summaries the VMT changes related to changes in auto operating cost. As auto operating cost increases, the model shows a decrease in VMT, which is expected. ARB staff compared these modeled VMTs to the expected range of VMT estimated based on elasticity[18] of VMT with respect to the change in auto operating cost from the empirical literature. Studies[19] showed that the short-run elasticities (less than five years) of VMT with respect to auto operating cost ranged from -0.026 (Small and Van Dender, 2010), -0.195 (Burt and Hoover, 2006), and -0.091 to -0.093 (Boilard, 2010). The long-run elasticities (greater than five years) ranged from -0.131 (Small and Van Dender, 2010), and -0.29 to -0.31 (Goodwin et al., 2004). The modeled VMT for each of the tests changed in the expected direction and fell within the expected range.

Table 15: Auto Operating Costs – Sensitivity Results

Test	Modeled VMT	Expected VMT (Short-Run)	Expected VMT (Long-Run)
50% Decrease from Base Case	11,812,348	11,029,907 - 11,949,973	11,601,545 - 12,576,053
25% Decrease from Base Case	11,303,938	10,959,132 - 11,419,165	11,244,952 - 11,732,206
Base Case (2008)	**10,888,358**	--	--
25% Increase from Base Case	10,445,931	10,357,551 - 10,817,584	10,044,510 - 10,531,764
50% Increase from Base Case	10,100,359	9,826,743 - 10,746,809	9,200,663 - 10,175,171
Source: -0.026 (Small and Van Dender, 2010) , -0.195 (Burt and Hoover, 2006), and -0.091 to -0.093 (Boilard, 2010) for short-run; -0.131 (Small and Van Dender, 2010), and -0.29 to -0.31 (Goodwin et al., 2004) for long-run.			

2. Household Income Distribution

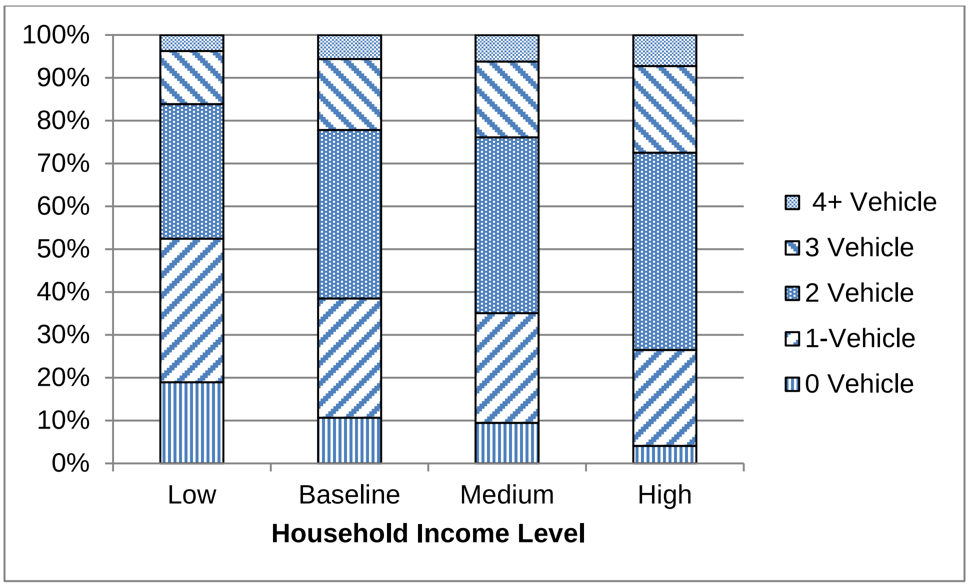
Household income distribution plays an important role in the trip generation step of the travel demand model. Household income is linked to the available number of vehicles which then impacts the total number of trips. The expectation of the income distribution sensitivity testing is that as household income increases, so will the proportion of households with a greater number of vehicles. Given the predetermined trip generation rates in the model, if a household has more vehicles, it generates more trips and more VMT. If the income distribution shifts downward, it is expected that the vehicle

[18] Elasticity is defined as the percent change in one variable divided by the percent change in another variable.
[19] The studies cited this section regarding elasticity of VMT with respect to the change in auto operating cost are mentioned in the ARB-funded policy brief, “Impacts of Gas Price on Passenger Vehicle Use and Greenhouse Gas Emissions” regarding the case studies mentioned in this section, which can be found at http://www.arb.ca.gov/cc/sb375/policies/gasprice/gasprice_brief.pdf

ownership model will predict more households with fewer available vehicles and similarly, fewer trips and less VMT.

To test the responsiveness of the Three-County Model to changes in household income distribution, three testing scenarios were designed and tested using the average household income as an indicator, while controlling the total number of households at approximately the same as in the base case. The 2008 average household income of $54,862 from the Three-County Model for the StanCOG region was used as the base case. ARB staff designed three testing scenarios with average household incomes of Low ($37,471), Medium ($59,913) and High ($70,529). Figure 9 summarizes the auto ownership changes under the different household income scenarios. As expected, households shift towards having more vehicles available as household income increases, and vice versa.

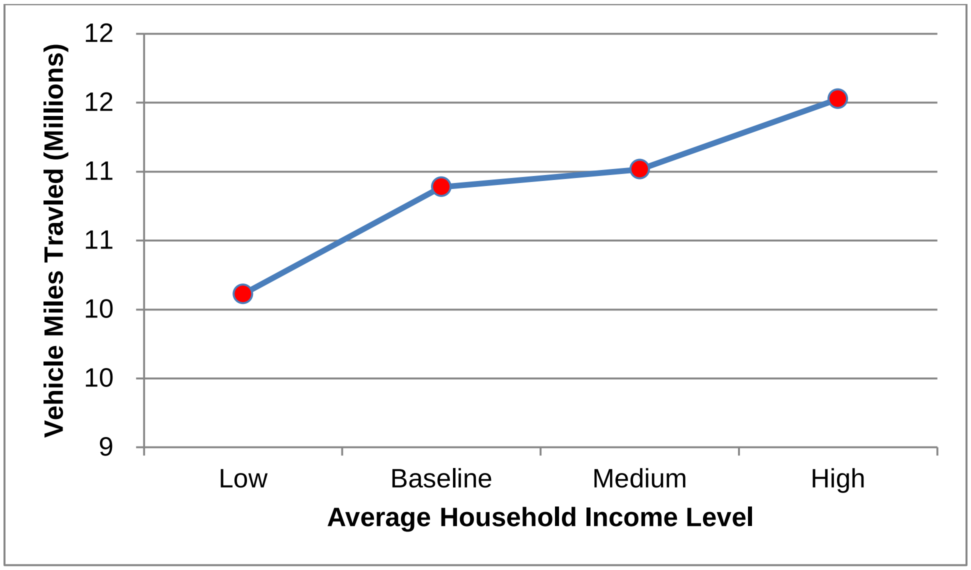
Figure 9: Household Vehicle Ownership Type Distribution



There is relatively little in the empirical literature that cites the direct effect of household income on household VMT. Murakami and Young (1997) report that low income households make 20 percent fewer trips than other households. Since this number counts all trips (including walking and transit), the effect on VMT is even more significant: VMT per household in low income households is about half of that in other households.

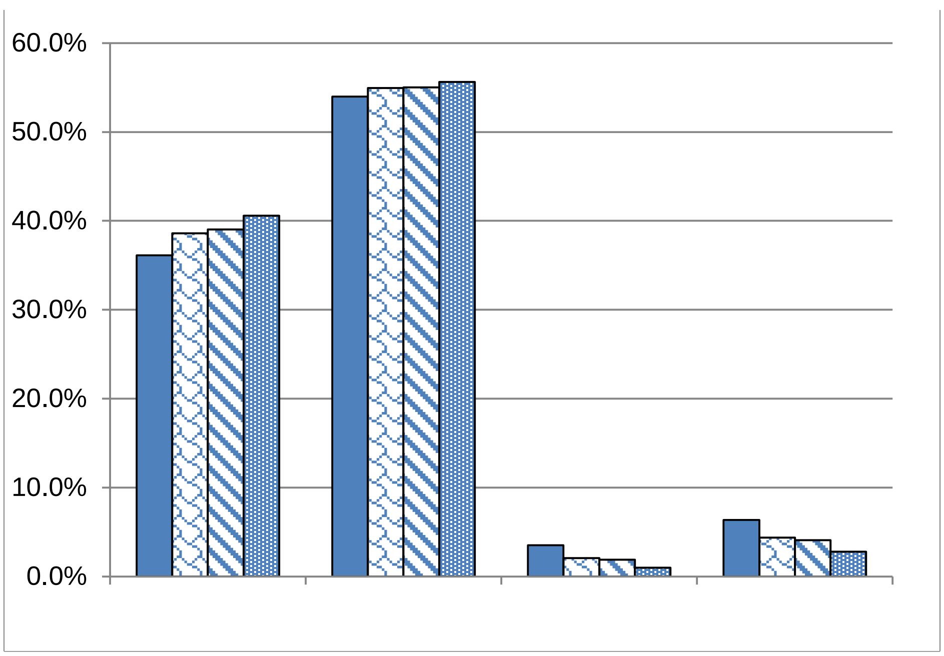
Figure 10 lists the modeled VMT for each test scenario of household income distribution. The test results showed the Three-County Model responds to changes in household income distribution in the right direction (i.e. more income correlates with more VMT), but the degree of change cannot be evaluated since no elasticities specific to income were identified in the empirical literature. However, the responsiveness of the Three-County Model to the change in average household income is similar to that of other MPO models in California.

Figure 10: VMT Changes for Household Income Distribution Scenarios



The impact of household income on daily mode share was also examined. It is expected that as household income increases, travelers will be more likely to drive autos or use the auto mode in general. As shown in Figure 11 the mode share responded to household income distribution changes as expected. The drive alone share increased when household income increased while transit and non-motorized trips decreased.

Figure 11: Mode Share Response to Household Income Changes



3. Transit Frequency

Transit service frequency is a key to the effectiveness of regional transit service. To determine the responsiveness of the Three-County Model to transit frequency, four alternative frequencies were tested: 1) 50 percent increase; 2) 50 percent decrease; 3) 75 percent decrease; and 4) 100 percent decrease from the base case. As transit service becomes more frequent, transit ridership is expected to increase, and conversely, transit ridership is expected to decline with decreasing frequency. Table 16 summarizes the response of ridership to the change in transit frequency. The test results were compared to expected values based on the empirical literature[20] which suggests that a 1 percent increase in frequency results in a 0.5 percent increase in ridership. As expected, the modeled transit ridership decreases as transit frequency declines compared to base case, and vice versa. The change in magnitude is not as great as the nationwide average, probably due to less public transit service coverage and transit users in the StanCOG region relative to urban transit centers that were studied in the national surveys. StanCOG staff also mentioned some residents in the region, especially for low income in the rural area, have to rely on transit service to get to work or other activities regardless how frequent the bus transit runs in the area.

Table 16: Transit Frequency Impact on Ridership

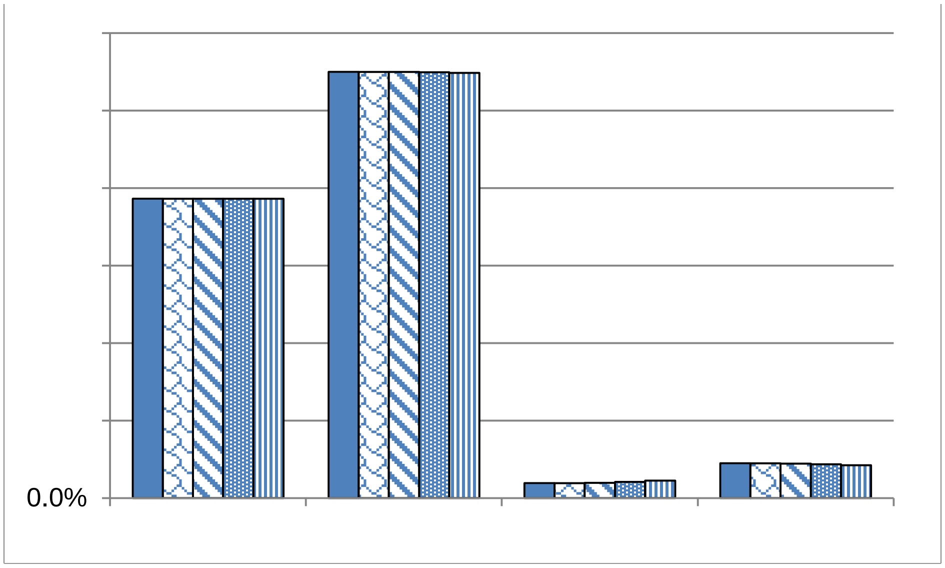
Test	Modeled Transit Ridership	Expected Transit Ridership
100% Decrease from Base Case	42,305	25,501
75% Decrease from Base Case	43,722	31,876
50% Decrease from Base Case	45,716	38,252
Base Case (2008)	**51,002**	**--**
50% Increase from Base Case	59,349	63,753
Source: Evans (2004), bus ridership increases by 0.5% for each 1% increase in service frequency. Taylor et al. (2009), total ridership increases by 0.5% for each 1% increase in service frequency.		

Figure 12 shows the change in mode share as transit frequency changes. When transit frequency increases, it is expected that transit mode share will increase as travelers are more attracted to use public transit when waiting time is shortened. The test results do not show a significant difference from one test scenario to another. StanCOG explained this was due to the overall very low transit mode share in StanCOG and limited transit coverage in the model base year (2008). Although the magnitude of change in mode share is subtle, the model is sensitive to change in transit frequency directionality. For example, with a 50 percent increase in transit frequency, the transit mode share peaks

[20] The empirical literature cited in this section regarding elasticity of VMT with respect to the change in transit frequency are mentioned in the ARB-funded policy brief, “Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions” regarding the case studies mentioned in this section, which can be found at http://www.arb.ca.gov/cc/sb375/policies/transitservice/transit_brief.pdf

with 2.3 percent of the total trips, whereas the 100 percent decrease in transit frequency results in a transit mode share of 1.9 percent of total trips.

Figure 12: Impact of Transit Frequency on Mode Share



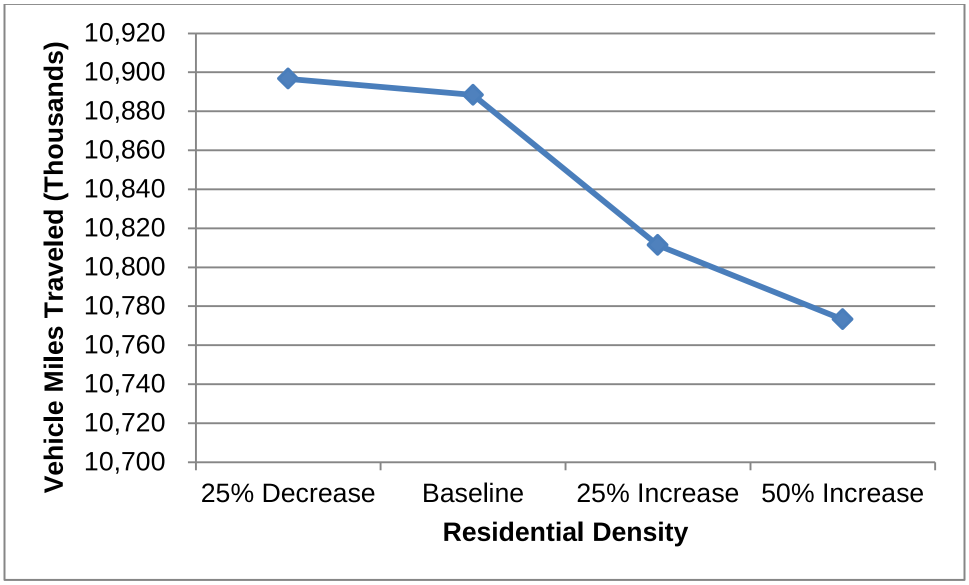
4. Proximity to Transit

The responsiveness of the Three-County Model to residential proximity to transit was tested by reallocating households to be along existing transit corridors (i.e. in transit-oriented development areas). It is expected that households relocated to transit corridors would be more likely to use transit which would, in turn, increase transit ridership and decrease household travel cost.

StanCOG tested the responsiveness of the Three-County Model to proximity to transit by placing more or less housing units in TAZs within a half-mile of transit stops or stations. Using the 2008 totals for each housing type as a base case, TAZs within a half-mile of a transit line either lost or gained units to represent decreases and increases in density, respectively. The total household counts for each TAZ were adjusted proportionally to maintain their respective countywide totals. The aggregated household total for TAZs near transit was compared against the base household count to calculate the countywide residential housing unit redistribution. When more households are located near transit, more households would be expected to use transit instead of auto, which leads to a decrease in VMT, and vice versa.

Figure 13 shows the VMT response to changes in proximity to transit. As expected, regional VMT decreases when the number of residential units near transit increases, and vice versa.

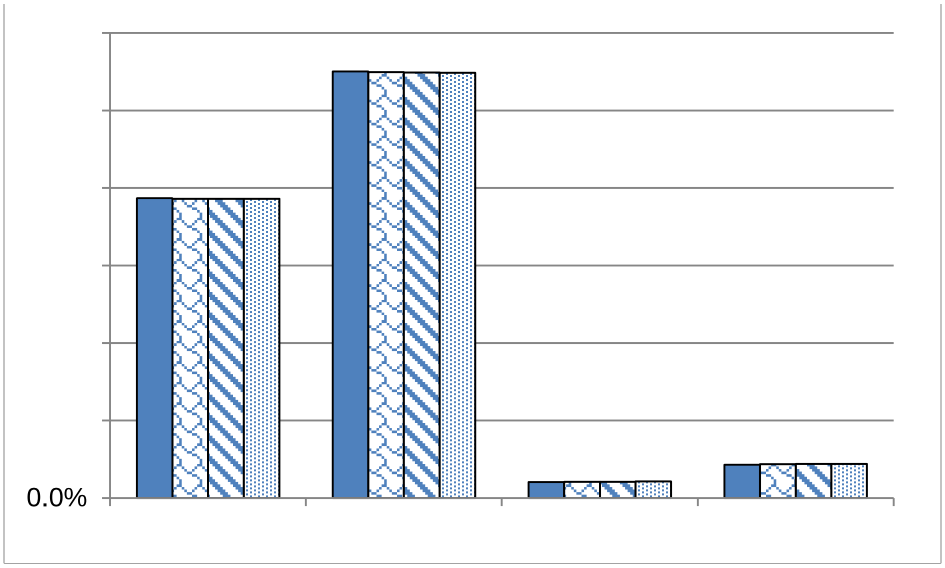
Figure 13: Impact of Residential Density near Transit on VMT



The model's change is sensitive directionally to the change in residential density near transit. StanCOG explained the low magnitude change from scenario to scenario is probably due to the limited transit options in the region.

Figure 14 summarizes the change in mode share as residential density near transit changes. Though not large in magnitude, transit mode share increases slightly, while overall auto mode share stays unchanged, as residential density increases near transit stops or stations. Overall the model's change is sensitive directionally to the change in residential density near transit based on the change in VMT. StanCOG explained the low magnitude change from scenario to scenario is probably due to the limited transit options in the region.

Figure 14: Mode Share Changes in Response to Change in Residential Density Near Transit



5. Residential Density

Residential density is usually defined as the number of housing units per acre. Increasing residential density has been considered an effective land use strategy to reduce VMT in a region because denser residential developments tend to be associated with fewer trips and less VMT.

StanCOG, with assistance from ARB staff, developed a methodology to examine the sensitivity of the Three-County Model to changes in residential density. The three sensitivity tests involved a 25 percent decrease, 25 percent increase, and 50 percent increase in average residential density. Changes to residential density focused on the urban areas of the StanCOG region to match the urban area focus of the empirical literature. For each test, StanCOG kept the totals for each housing type the same as the 2008 base case. For the density-increasing scenarios, StanCOG assumed that TAZs that currently have higher than average residential density would be more likely to gain more housing units than those with a lower than average residential density. StanCOG incorporated a residential index system to indicate which TAZs have higher and which TAZs have lower than average residential density as compared to the regional average.

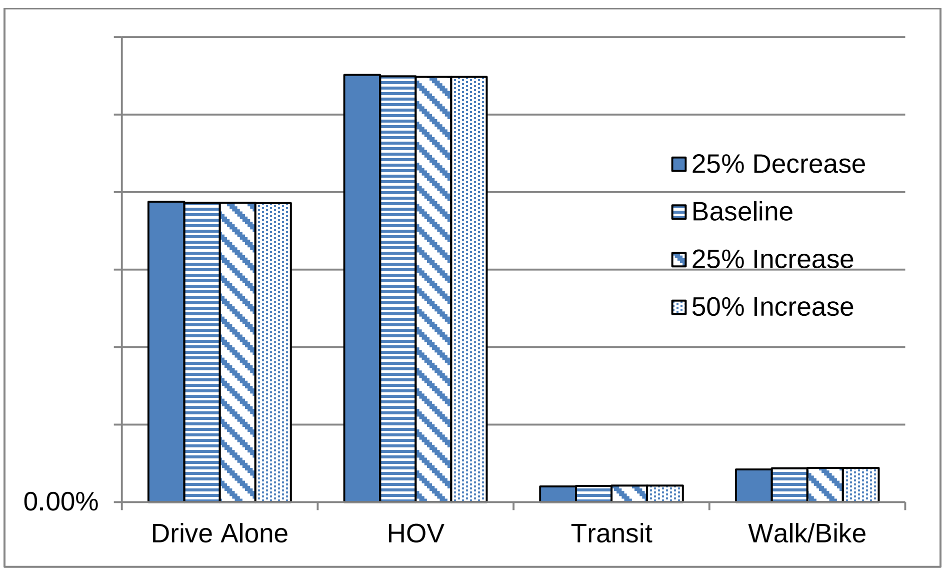
Most of the studies cited in the empirical literature that relate to residential density focus on overall population density, which is probably the best proxy for residential density. The elasticities for the impacts of population density on VMT cited in the studies range from -0.05 to -0.12 (Boarnet and Handy, 2014). As expected, when residential density increases, VMT decreases, and vice versa (Table 17). StanCOG's sensitivity analysis indicates that the Three-County Model is directionally sensitive to changes in residential density. The change in magnitude is smaller than observations from the case studies in large urban areas. This is probably due to that fact that the StanCOG region is less populated, and transportation connectivity in the region is not as developed as regions cited in the empirical literature.

Table 17: Impact of Residential Density on VMT

Test	Modeled VMT	Expected VMT
25% Decrease from Base Case	10,977,833	11,024,462 - 11,215,009
Base Case (2008)	**10,888,358**	--
25% Increase from Base Case	10,758,958	10,561,707 - 10,752,254
50% Increase from Base Case	10,722,632	10,235,057 - 10,616,149
Source: Boarnet and Handy (2013) the impacts of population density on VMT range from -0.05 to -0.12.		

As residential density in the region increases (Figure 15), mode shares for auto decrease slightly due to some travelers switching to using transit and non-motorized mode. The Three-County Model is sensitive directionally but not in magnitude to changes in residential density due to limited existing transit options and walk/bike facilities in the region.

Figure 15: Impact of Residential Density on Mode Share



E. SCS Performance Indicators

ARB staff evaluated changes in important non-GHG indicators that describe SCS performance. These indicators are examined to determine if they can provide qualitative evidence that the SCS, if implemented, could meet its GHG targets. The evaluation looked at directional consistency of the indicators with StanCOG's modeled GHG emissions reductions, as well as the general relationships between those indicators and GHG emissions reductions based on the empirical literature as discussed in the ARB-funded policy briefs and corresponding technical background documents.[21] The SCS performance indicators evaluated include residential density, mix of housing types, jobs and housing near transit, farmland preservation, per capita passenger VMT, Bus rapid transit service coverage, and transportation investment. The staff assessment relies on key empirical studies for each indicator that illustrate qualitatively how changes in these indicators can increase or decrease VMT and/or GHG emissions.

1. Land Use Indicators

To determine the benefits of the development pattern in the SCS on GHG emissions from passenger vehicles, the evaluation focused on four performance indicators related to land use: changes in residential density, mix of housing types, jobs and housing near transit, and farmland preservation.

Residential Density

Residential density is a measure of the average number of dwelling units per acre of developed land. When residential density increases, it is expected to change travel behavior including reductions in average trip length, and eventually a decrease in regional VMT, which is supported by relevant empirical literature. Brownstone and Golob (2009) analyzed National Household Travel Survey (NHTS) data and observed that denser housing development significantly reduces annual VMT and fuel consumption, which directly results in the reduction in GHG emissions. They also reported that households in areas with 1,000 or more units per square mile drive 1,171 fewer miles and consume 64.7 fewer gallons of fuel than households in less dense areas. Boarnet and Handy (2014) reported that doubling residential density reduces VMT on an average of 5 to 12 percent.

Based on the reported 2014 RTP/SCS land use data, residential density of new development from 2008 to 2035 in the StanCOG region would increase to approximately 5.8[22] dwelling units per acre. The residential density associated with new growth increased more than 50 percent in the 2014 RTP/SCS compared to its BAU scenario, which represents the allowable densities established by the local agencies in their General Plans, and contains transportation investments proportional to those in the previous RTP (Figure 16). This increase in residential density is consistent with the empirical literature, which indicates the likelihood of reductions in household VMT and auto trip length, shifts in travel mode away from single occupant vehicles, and resulting reductions in GHG emissions.

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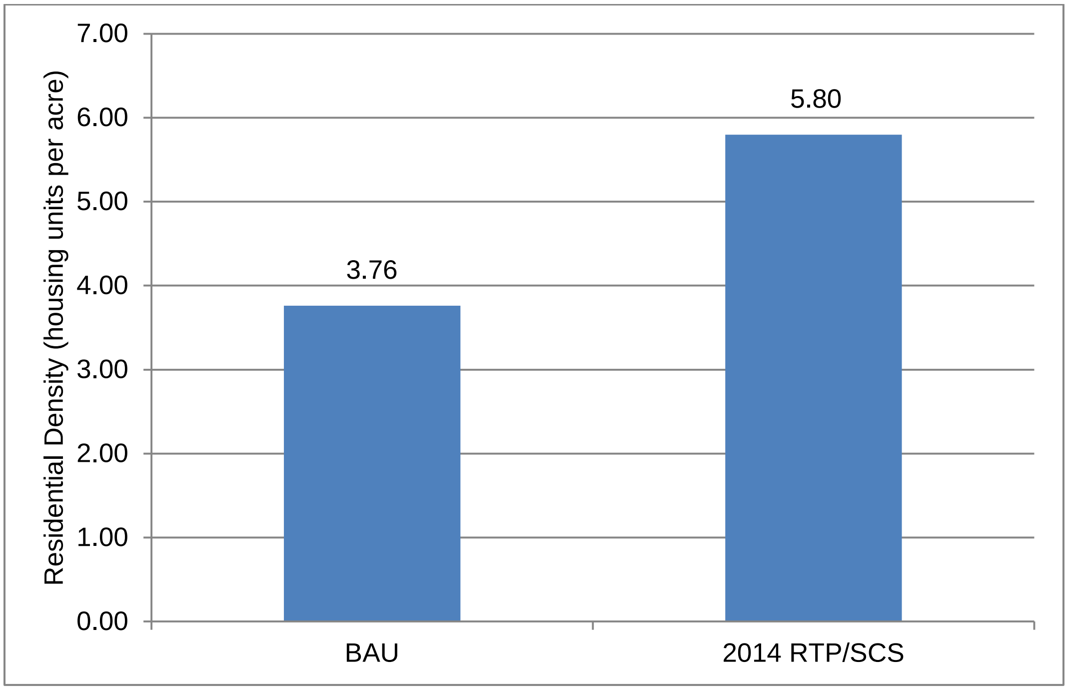
[21] These policy briefs and technical background documents, which seek to identify the impacts of key transportation and land use policies on vehicle use and GHG emissions, based on the scientific literature, can be found at http://arb.ca.gov/cc/sb375/policies/policies.htm

[22] ARB staff estimated the residential density of new development from 2008 to 2035 based on the reported 2008 base year and 2010 to 2035 net growth land use information provided by SJCOG staff.

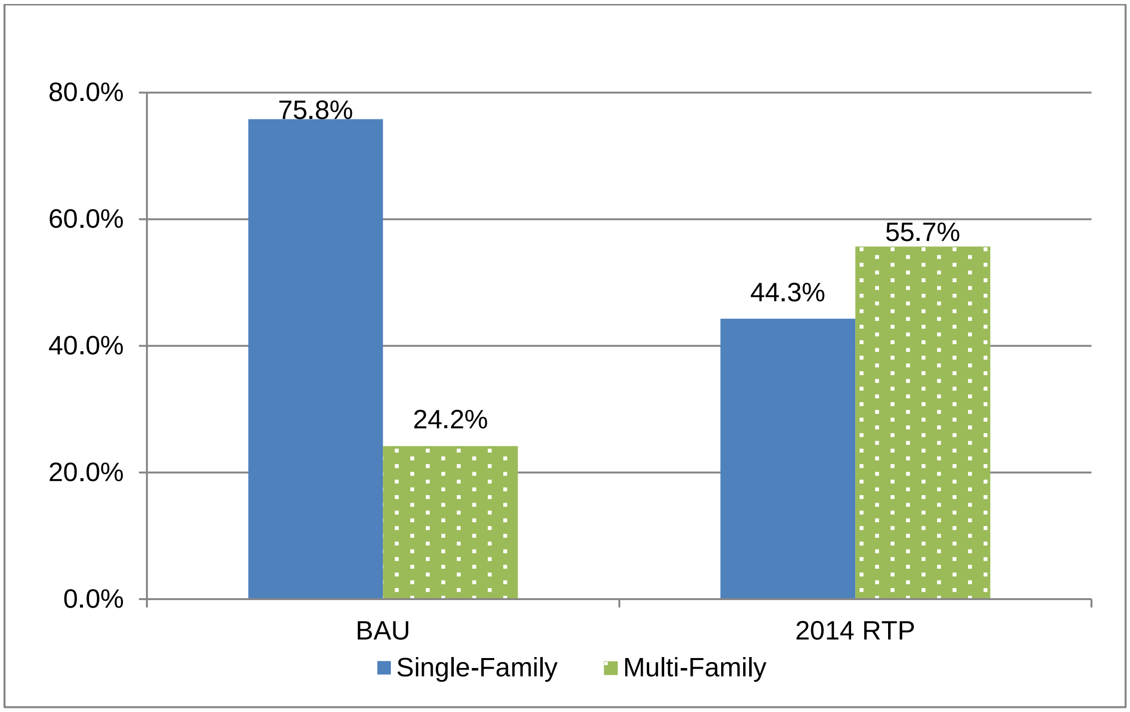
Figure 16: Residential Density of New Development (2008 – 2035)



Mix of Housing Types

Housing type mix influences the land use patterns that can be achieved in a region. StanCOG's 2014 RTP/SCS also indicates a shift towards a greater percentage of new multifamily housing units. Figure 17 shows the percentage of new housing types anticipated by the BAU scenario and the 2014 RTP/SCS. By 2035, the share of new multifamily housing units is forecasted to increase from 24.2 percent of the total new housing units (BAU) to 55.7 percent (2014 RTP/SCS). The share of single-family units decreases from 75.8 percent of new units to 44.3 percent of new units by 2035.

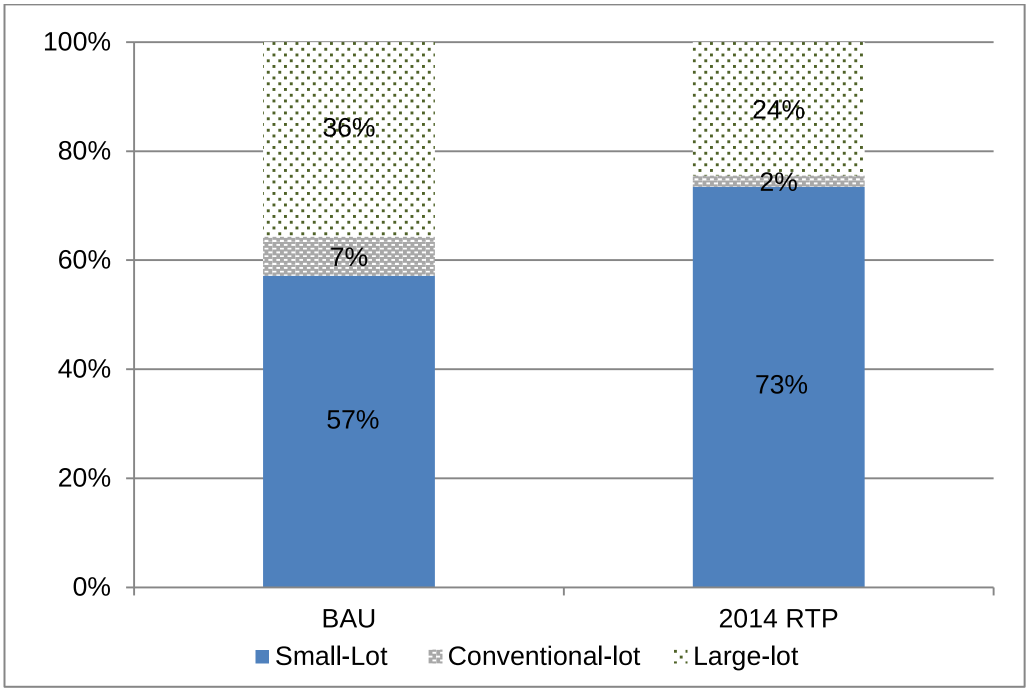
Figure 17: Shift towards Multifamily Housing (2008-2035)



In addition, of the new housing units from 2008 to 2035, the composition of single-family housing shifts towards building on small-lot size. Figure 18 shows that, of the total new single-family housing units in the region, the share of single-family on small-lot[23] housing is estimated to increase from 57 percent in 2008 to 73 percent by 2035. The greater the proportion of housing growth that is small-lot and attached housing types, the more opportunity a region has to accommodate future growth through a more compact land use pattern. As the housing market shifts from single unit homes on large lots to single unit homes on smaller lots and multifamily housing, the travel characteristics in the StanCOG region are expected to change.

[23] Small-lot size equals to or less than 5,000 square feet; conventional-lot size equals to or less than 5,000 square feet; and large lot size is larger than 7,001 square feet.

Figure 18: Shift towards Smaller Lot Size for Single-Family Housing Units (2008 – 2035)



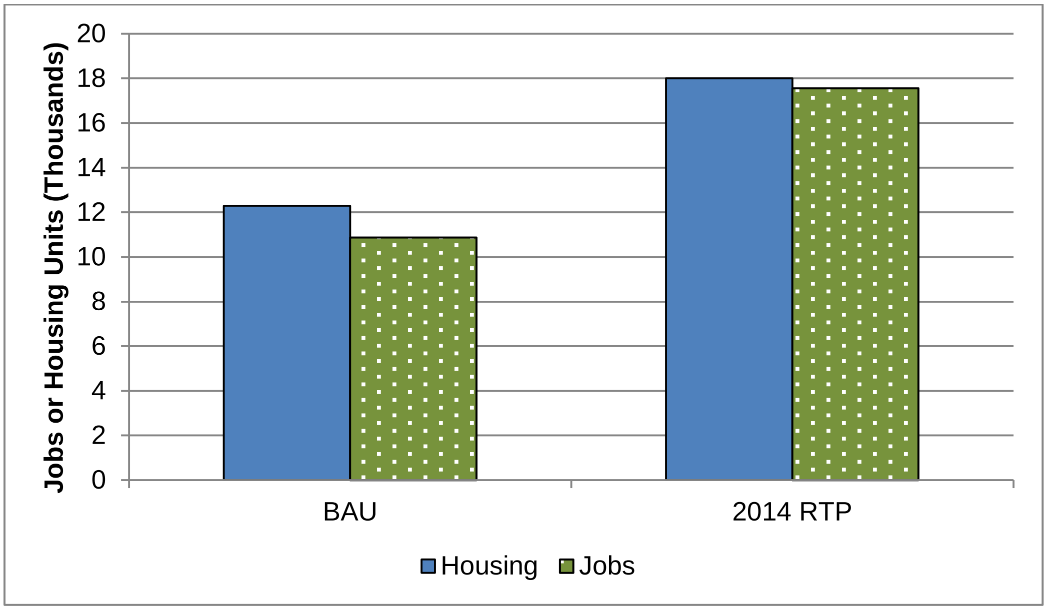
Jobs and Housing near Transit

Proximity of housing and employment to transit is a commonly used performance indicator for evaluating the effectiveness of transit-oriented development (TOD). The empirical literature indicates that focusing growth in areas with access to transit will encourage the use of transit, reducing vehicle trips, and subsequently reducing passenger vehicle-related GHG emissions.

Studies show that proximity of housing and employment to transit stations or stops is highly correlated with increased transit ridership as housing and employment increases within a one mile radius of transit stations (Kolko 2011). Other studies also illustrate significant VMT reductions through placement of housing and employment closer to rail stations and bus stops (Tal, et.al 2013).

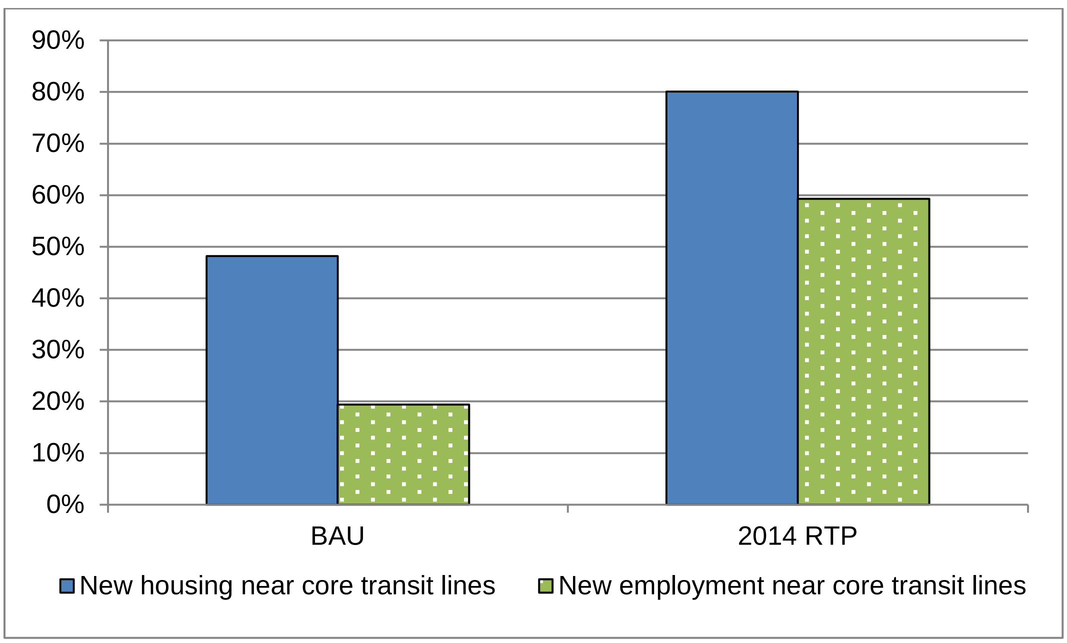
Figure 19 summarizes the forecasted number of jobs and housing units within one-half-mile of transit stations or stops based on StanCOG's BAU scenario and the 2014 RTP/SCS. Compared to StanCOG's BAU scenario, its 2014 RTP/SCS shows an increase in the numbers of jobs and housing units near transit, between 2008 and 2035.

Figure 19: Jobs and Housing near High Quality Transit Areas (2008 – 2035)



In addition, compared to BAU, the 2014 RTP/SCS places 80 percent of the new housing and 59 percent of the new employment that are within the proximity to transit along the core transit lines[24] (Figure 20).

Figure 20: Percent New Jobs and Housings Near Core Transit Lines by 2035

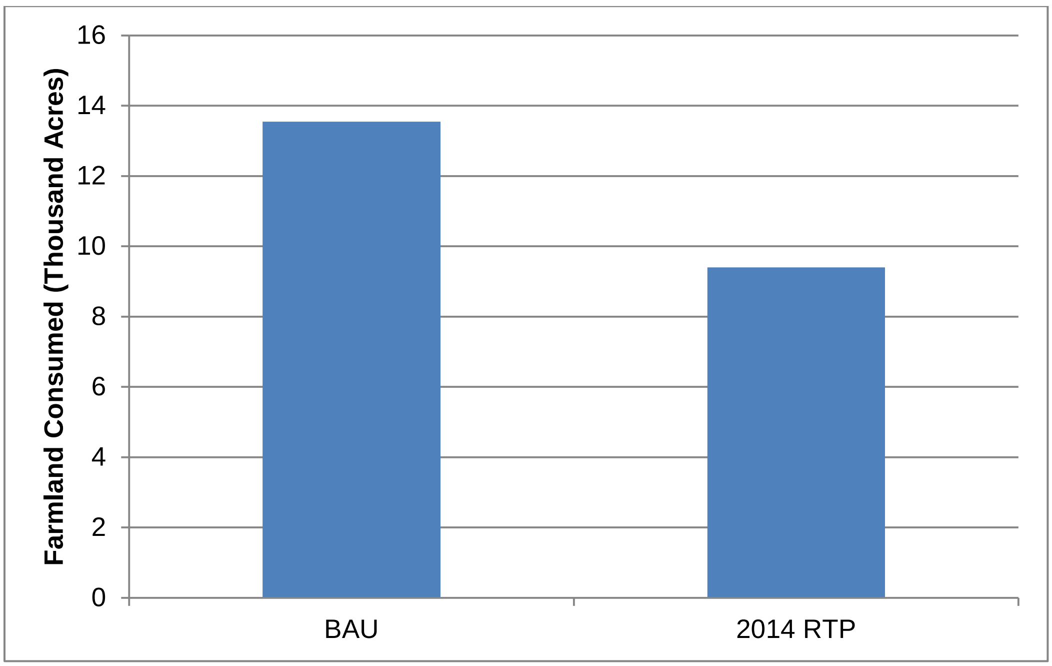


[24] StanCOG refers to core transit lines as transit service in the region's three largest cities, Modesto, Turlock, and Ceres. See Appendix A for more details.

Farmland Preservation

The Valley is known as a major agriculture production area in the U.S. StanCOG's 2014 RTP/SCS encourages development within existing communities to preserve farmland in the region. Figure 21 compares the forecasted consumption of farmland as defined in SB 375[25] and indicated in the BAU scenario, with the 2014 RTP/SCS. Between 2008 and 2035, the 2014 RTP/SCS consumes 30 percent fewer acres of farmland by 2035 as compared to the BAU scenario.

Figure 21: Farmland Consumed (2008 - 2035)



2. Transportation-related Indicators

Besides the land use-related performance indicators, ARB staff also evaluated three transportation-related performance indicators along with supporting data inputs, assumptions, and sensitivity analyses. These indicators are passenger VMT, bus rapid transit service coverage, and transportation investments.

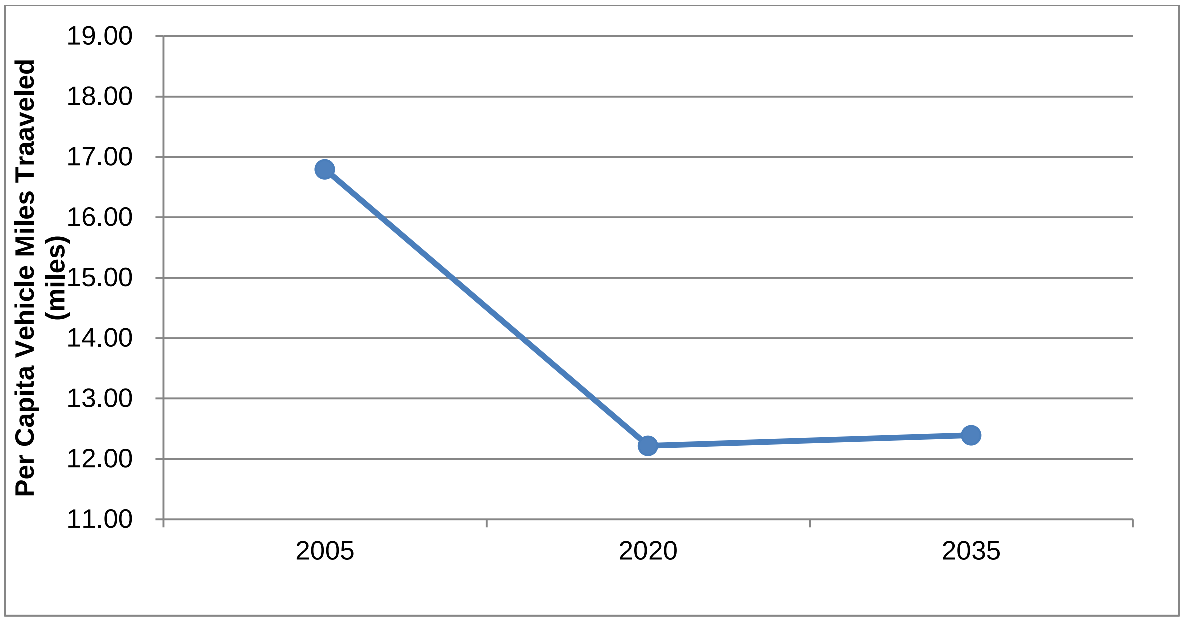
Vehicle Miles Traveled (Per capita VMT)

The StanCOG 2014 RTP/SCS shows a decline in per capita passenger vehicle VMT between 2005 and 2035, as shown in Figure 22. Per capita VMT decreases by 26.6 percent between 2005 and 2020, and by 22.9 percent between 2005 and 2035. The reported statistics show that the average number of vehicle trips per person per

[25] Important farmland outside of existing spheres of influence.

weekday for all trip purposes in the StanCOG region would be reduced from 2005 to 2035 consistently. Moreover, the quantification of GHG emissions from passenger vehicles is a function of VMT and vehicle speeds. StanCOG explained the higher reduction in per capita VMT and CO_2 was due to the economic recovery. By 2020, StanCOG expects the number of jobs will match with the level before the recession. The strategies and policy of the 2014 RTP/SCS continue to have an effect on per capita CO_2 at a consistent level, but overall the reduction by 2035 is lower than the 2020 level due to new jobs and the associated VMT of commute trips.

Figure 22: Per Capita Passenger VMT

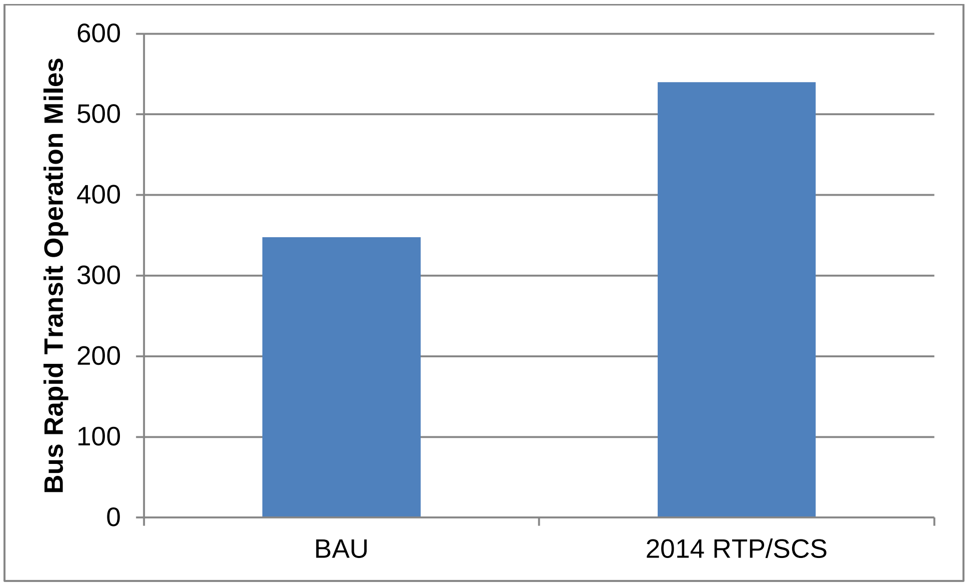


Bus Rapid Transit Service Coverage

The bus rapid transit (BRT) system for standard passenger buses in StanCOG is similar in function and service to a light rail train. The purpose of having BRT is to increase speed and reduce travel time for bus service. The empirical literature states that BRT may have more potential than regular bus transit service to attract riders from cars, but this also depends on the specific context. Diaz and Hinebaugh (2009) found that the estimate of new BRT ridership drawn from private vehicles for one line in Boston was 2 percent of riders, while for another line in Boston, it was 50 percent of riders. Thole et. al (2009) also studied a BRT line in Eugene, OR, and found that 16 percent of new BRT riders were drawn from the auto mode.

In the 2014 RTP/SCS, StanCOG will expand its BRT system to 540 operation miles in the region by 2035, which is more than 50 percent increase compared to the BAU scenario (Figure 23).

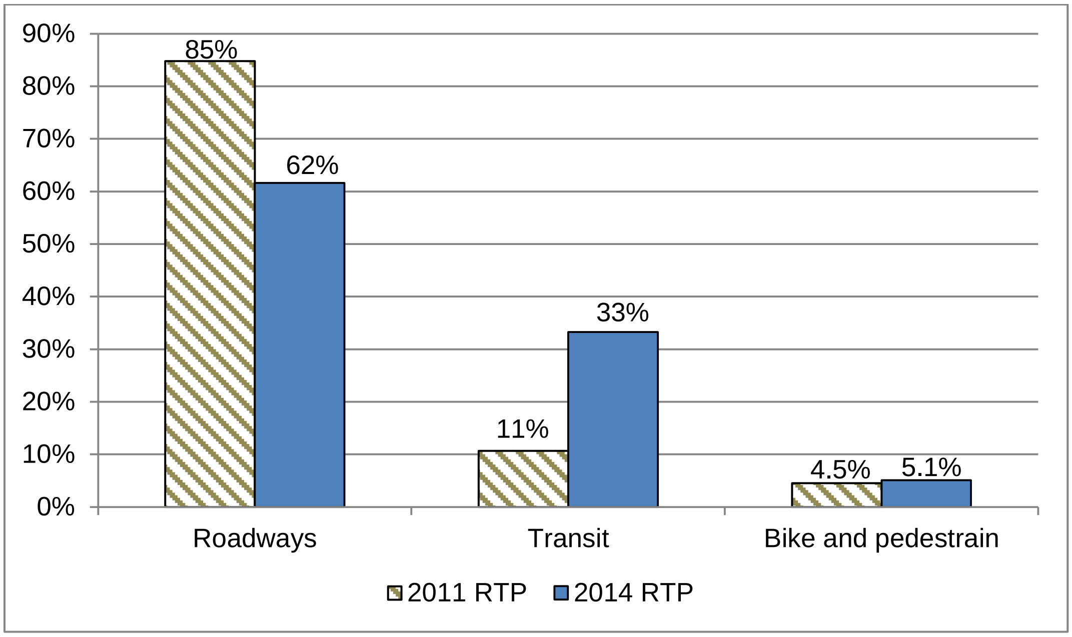
Figure 23: Increase in Bus Rapid Transit Operation Miles



Transportation Investment

The 2014 RTP/SCS increases investment in bike and walk facilities and public transit as compared to the 2011 RTP (Figure 24). Investment in transit significantly increases from 11 percent to 33 percent of the total budget, or $1.5 billion. The increase in investments in public transit is expected to provide greater opportunities for travelers to take advantage of these non-automobile modes of travel, thereby encouraging a shift away from vehicle use and with it, a reduction in GHG emissions.

Figure 24: Increased Investment in Transit and Bike/Walk Facilities



IV. Conclusion

This report documents ARB staff's technical evaluation of StanCOG's adopted 2014 RTP/SCS, and affirms that, if implemented, StanCOG's adopted 2014 SCS would meet the per capita GHG emissions reduction targets of 5 percent reduction in 2020 and 10 percent reduction in 2035, adopted by the Air Resources Board.

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APPENDIX A. StanCOG's Modeling Parameters for SCS Evaluation (Data Table)

This appendix contains StanCOG's responses to data requests, received on May 5, 2015, to supplement ARB staff's evaluation of StanCOG's quantification of GHG emissions. ARB requested this data in accordance with the general approach described in ARB's July 2011 evaluation methodology document.

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
DEMOGRAPHICS									
Total population	503191	507450	594000	594000	722000	722000	764000	764000	San Joaquin Valley Demographic Forecasts
Group quarters population	NOT AVAILABLE	6210	7488	7488	9325	9325	9775	9775	Caltrans Economic Forecast
Total employment (employees)	172800	170000	184250	184250	222874	222874	235749	235749	San Joaquin Valley Demographic Forecasts
Average unemployment rate (%)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	
Total number of households	160808	170038	188467	188467	223541	223541	235233	235233	San Joaquin Valley Demographic Forecasts
Persons per household	3.08	3.08	3.1	3.1	3.12	3.12	3.14	3.14	San Joaquin Valley Demographic Forecasts
Auto ownership per household	1.956	1.956	1.956	1.961	1.963	1.982	1.964	NOT AVAILABLE	
Median household income	NOT AVAILABLE	48100	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	San Joaquin Valley Demographic Forecasts
LAND USE [4]									

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total acres within MPO	956026	956026	956026	956026	956026	956026	956026	956026	US Geological Survey
Total resource area acres (CA GC Section 65080.01)	NOT AVAILABLE	446702	446702	446702	446702	446702	446702	446702	US Geological Survey
Total prime farmland acres (CA GC Section 65080.01)	NOT AVAILABLE	253433	250413	249083	244033	239883	NOT AVAILABLE	NOT AVAILABLE	CA Department of Conservation and 2014 RTP/SCS
Total developed acres					11522 (Net new 2010-2035)				
Total commercial developed acres	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	2762 (Net new 2010-2035)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	
Total residential developed acres	NOT AVAILABLE	75,713	NOT AVAILABLE	NOT AVAILABLE	83,300	85,976	NOT AVAILABLE	NOT AVAILABLE	2008 value from 3-County Model
Total housing units	167050	176624	194388	194388	237185	237185	256535	256535	SJV Demographic Forecasts, 2040 values based on 2040 BAU Scenario Work
Housing vacancy rate (Percentage)	3.74%	3.73%	3.05%	3.05%	5.75%	5.75%	9.40%	8.30%	SJV Demographic Forecasts
Total single-family detached housing units	131254	134234	143116	146669	164515	176627	174189	190172	Department of Finance, SJV Demographic Forecasts, 2040 values based on 2040 BAU Scenario Work

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total small-lot single family detached housing units (x,xxx sq. ft. lots and smaller)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	
Total conventional-lot single family detached units (between x,xxx and x,xxx sq. ft. lots)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	
Total large-lot single family detached units (x,xxx sq. ft. lots and larger)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	
Total single-family attached housing units	NOT AVAILABLE	6782	8114	7635	11324	9689	12775	10618	Department of Finance, SJV Demographic Forecasts, 2040 values based on 2040 BAU Scenario Work
Total multi-family housing units	26696	26706	33368	30223	49416	38697	56673	42528	Department of Finance, SJV Demographic Forecasts 2040 values based on 2040 BAU Scenario Work

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total mobile home units & other	9100	8902	9790	9861	11930	12172	12898	13217	Department of Finance, SJV Demographic Forecasts, 2040 values based on 2040 BAU Scenario Work
Total infill housing units	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	
Total mixed use buildings	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	
Total households within 1/4 mile of transit stations and stops	NOT AVAILABLE	15662.5	17648.75	16136	20164.5	18733.5	21535	19689	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total households within 1/2 mile of transit stations and stops	NOT AVAILABLE	62650	70595	64544	80658	74934	86140	78756	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total employment within 1/4 mile of transit stations and stops	NOT AVAILABLE	15112.5	16122	14740	19501.5	17829.75	20628.25	18859.75	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total employment within 1/2 mile of transit stations and stops	NOT AVAILABLE	60450	64488	58960	78006	71319	82513	75439	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total households and Employment Within Walking Distance of Premium Transit Service (Higher Frequency Service Along Established Core Transit Lines in Modesto, Turlock and Ceres)[7]									

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total households within 1/2 mile of premium transit stations and stops (2 Buses per Hour)	NOT AVAILABLE	64053	NOT AVAILABLE	NOT AVAILABLE	78472	69976	NOT AVAILABLE	NOT AVAILABLE	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total households within 1/2 mile of premium transit stations and stops (4 Buses per Hour)	NOT AVAILABLE	22784	NOT AVAILABLE	NOT AVAILABLE	31599	29164	NOT AVAILABLE	NOT AVAILABLE	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total households within 1/2 mile of transit stations and stops (6 Buses per Hour)	NOT AVAILABLE	4537	NOT AVAILABLE	NOT AVAILABLE	9299	8957	NOT AVAILABLE	NOT AVAILABLE	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total employment within 1/2 mile of transit stations and stops (2 Buses per Hour)	NOT AVAILABLE	75626	NOT AVAILABLE	NOT AVAILABLE	86035	77737	NOT AVAILABLE	NOT AVAILABLE	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total employment within 1/2 mile of transit stations and stops (4 Buses per Hour)	NOT AVAILABLE	34228	NOT AVAILABLE	NOT AVAILABLE	36599	32324	NOT AVAILABLE	NOT AVAILABLE	2014 RTP, 2040 values based on 2040 BAU Scenario Work
Total employment within 1/2 mile of transit stations and stops (6 Buses per Hour)	NOT AVAILABLE	15337	NOT AVAILABLE	NOT AVAILABLE	17346	14108	NOT AVAILABLE	NOT AVAILABLE	2014 RTP, 2040 values based on 2040 BAU Scenario Work

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
TRANSPORTATION SYSTEM									
Freeway general purpose lanes – mixed flow lane miles									
Freeway	260	260	263	271	276	301	276	Not Available	
Arterial (lane miles)	3,397	3,397	3,523	3,547	3,737	3,641	3,737	Not Available	
Collector (lane miles)	967	967	982	978	990	979	990	Not Available	
Local (lane miles)	14	14	14	14	14	14	14	Not Available	
Local, express bus, and neighborhood shuttle operation miles	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Bus rapid transit bus operation miles	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Passenger rail operation miles	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Transit total daily vehicle service hours	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Bicycle and pedestrian trail/lane miles	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Vanpool (total riders per weekday)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
TRIP DATA [5]									

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Number of trips by trip purpose									
Home-Work	317,402	321,872	345,308	348,067	406,337	415,288	431,145	Not Available	
Home-Shop	199,779	207,579	231,988	232,788	272,523	277,972	286,774	Not Available	
Home-Other	766,496	790,568	878,842	883,429	1,028,179	1,041,391	1,084,933	Not Available	
Work-Other	64,835	65,459	68,726	68,389	83,411	82,111	88,302	Not Available	
Other-Other	482,999	489,399	518,105	515,595	623,681	616,898	658,801	Not Available	
MODE SHARE									
Vehicle Mode Share (Whole Day)									
SOV (% of trips)	39.14%	38.61%	37.65%	38.28%	37.86%	38.15%	37.79%	Not Available	
SharedRide 2(% Trips)	20.52%	20.28%	20.43%	20.23%	20.17%	20.06%	20.19%	Not Available	
SharedRide 3+ (% Trips)	34.33%	34.66%	35.48%	35.14%	35.76%	35.83%	35.84%	Not Available	
Transit (% of trips)	0.08%	2.09%	2.08%	2.05%	2.01%	1.92%	1.98%	Not Available	
Walk (% Trips)	1.25%	1.07%	1.12%	1.10%	1.08%	1.05%	1.08%	Not Available	
Bike (% Trips)	4.68%	3.29%	3.24%	3.19%	3.12%	2.99%	3.12%	Not Available	
Average weekday trip length (miles)									
SOV	13.36	13.95	13.71	13.87	14.36	15.15	14.14	Not Available	
SharedRide 2	16.83	17.3	16.68	16.82	17.06	18.62	16.99	Not Available	
SharedRide 3+	15.09	15.56	14.96	15.12	15.43	17.03	15.38	Not Available	
Transit	6.54	10.56	10.44	10.64	10.84	10.82	10.55	Not Available	
Walk/Bike	2.65	3.05	3.12	3.12	3.17	3.18	3.18	Not Available	

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Average weekday travel time (minutes)									
SOV	19.14	19.74	19.75	19.9	20.44	20.2	20.2	Not Available	
SharedRide 2	22.87	23.36	22.92	23.04	23.28	23.08	23.24	Not Available	
SharedRide 3+	21.05	21.55	21.13	21.28	21.58	21.75	21.56	Not Available	
Transit	11.26	15.64	15.73	15.84	16.04	15.68	15.78	Not Available	
Walk/Bike	6.6	7.15	7.3	7.29	7.36	7.35	7.38	Not Available	
Vehicle Trips by Trip Purpose									
Home-Work	285,948	289,974	311,089	313,574	366,069	374,133.00	388,419	Not Available	
Home-Shop	146,897	152,631	170,579	171,168	200,385	204,391.00	210,863	Not Available	
Home-Other	497,725	513,356	570,676	573,655	667,649	676,228.00	704,502	Not Available	
Work-Other	55,893	56,430	59,247	58,956	71,906	70,785.00	76,123	Not Available	
Other-Other	333,103	337,517	357,314	355,583	430,125	425,447.00	454,346	Not Available	
TRAVEL MEASURES									
Total VMT per weekday for passenger vehicles (ARB vehicle classes of LDA, LDT1, LDT2 and MDV) (miles)	8,450,503	Not Available	7,257,227	7,537,090	8,946,507	9,317,726	9,543,961	Not Available	Per Day
Total II (Internal) VMT per weekday for passenger vehicles (miles)	7,834,636	Not Available	6,377,948	6,636,580	7,687,510	8,006,490	8,200,887	Not Available	Per Day

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total IX/XI VMT per weekday for passenger vehicles (miles)	615,867	Not Available	879,279	900,510	1,258,997	1,311,237	1,343,074	Not Available	Per Day
Total XX VMT per weekday for passenger vehicles (miles)	1,954,272	Not Available	2,608,301	2,509,330	3,280,289	3,160,184	3,426,104	Not Available	Per Day
Congested Peak Hour VMT on freeways (Lane Miles, V/C ratios >0.75)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Congested Peak VMT on all other roadways (Lane Miles, V/C ratios >0.75)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
CO2 EMISSIONS[6]									
Total CO2 emissions per weekday for passenger vehicles (ARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons)	4004	Not Available	3470	3589	4429	4577	4716	Not Available	Per Day
Total II (Internal) CO2 emissions per weekday for passenger vehicles (tons)	3712	Not Available	3050	3160	3806	3942	4071	Not Available	Per Day

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total IX / XI trip CO2 emissions per weekday for passenger vehicles (tons)	292	Not Available	420	429	623	635	645	Not Available	Per Day
Total XX trip CO2 emissions per weekday for passenger vehicles (tons)	1005	Not Available	1331	1366	1684	1646	1734	Not Available	Per Day
Local, express bus, and neighborhood shuttle operation miles	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Bus rapid transit bus operation miles			347.52	347.52	540	347.52	540	347.52	
Passenger rail operation miles	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Transit total daily vehicle service hours	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Bicycle and pedestrian trail/lane miles	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Vanpool (total riders per weekday)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
INVESTMENT									

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total RTP Expenditure (Year XXXX $)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	4,456,466,519	4,384,516,800	2014 Plan with project, 2011 Plan without project
Roadways ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	2,713,501,300	3,683,937,100	2014 Plan with project, 2011 Plan without project
Highway capacity expansion (S)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	**	**	2014 Plan with project, 2011 Plan without project
Other road capacity expansion ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	**	**	2014 Plan with project, 2011 Plan without project
Roadway maintenance ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	**	**	2014 Plan with project, 2011 Plan without project
Transit ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	1,464,834,119	464,187,400	2014 Plan with project, 2011 Plan without project
BRT projects ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	***	***	2014 Plan with project, 2011 Plan without project
Transit capacity expansion ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	***	***	2014 Plan with project, 2011 Plan without project
Transit operations($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	***	***	2014 Plan with project, 2011 Plan without project
Aviation ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	53,512,800	39,398,600	2014 Plan with project, 2011 Plan without project

Modeling Parameters[1]	2005	2008	2020		2035		2040		Data Source(s)
	(if available)	(base year)	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Bike and pedestrian projects ($)	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	224,618,300	196,993,700	2014 Plan with project, 2011 Plan without project
TRANSPORTATION USER COSTS									
Vehicle operating costs (Year 2000 $ per mile)	0.113	0.153	0.178	0.178	0.189	0.189	0.192	0.192	
Gasoline price (Year 2000 $ per gallon)	$2.24	$3.65	$4.46	$4.46	$6.06	$6.06	$6.17	6.17	
Average transit fare (Year XXXX $)									
Parking cost (Year XXXX $)	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	

[1] When reporting $ units, indicate whether they are current dollars, YOE (year of exchange), or other.
[2] This scenario includes modeling of all planned and programmed projects in RTP/SCS for respective calendar year.
[3] This scenario should reflect the MPO's Business as Usual scenario, which for most is what would happen under the MPO's previously adopted RTP for the respective calendar year.
[4] In cases where "TOTAL" land use data is reflective of "GROWTH ONLY", please indicate those instances within the table.
[5] Please include any other trip type that may be applicable to your region.
[6] Please provide ARB staff with the EMFAC Input and Output files associated with these outputs.
"[7] While the StanCOG region does not have High Quality Transit Service as defined by SB 375, it does offer what it calls ""premium"" transit. Premium transit is defined in the data table as a route or stop with a minimum of two buses per hour regardless of route. Note, StanCOG has developed individual numbers for 2, 4, and 6 buses per hour, per stop to provide the benefits of increased transit frequency at varying levels. Due to the rural nature of Stanislaus County and the absence of SB 375 High quality transit areas, StanCOG developed this metric as part of RTP/SCS development to articulate improvements to transit accessibility. As more people move toward these key stops, transit accessibility increases."
*Reflects Off-Model Adjustments resulting from the enhanced Implementation of the SJVUAPCD Rule 9410 through the Commute Connection program. No adjustments were made to year 2005 and 2008 values as Rule 9410 was not adopted by the Air District Board until December 2009.
**Included in the Roadways total, above.
***Included in the Transit total, above.

APPENDIX B. 2010 CTC RTP Guidelines Addressed in StanCOG's RTP

This appendix lists the requirements in the California Transportation Commission's (CTC) Regional Transportation Planning (RTP) Guidelines that are applicable to the Three-County travel demand model, and which StanCOG followed. In addition, listed below are the recommended practices from the CTC RTP Guidelines that StanCOG 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. (Title 23 CFR Part 450.322(a))
- 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. (Title 40 CFR Part 93.111(a))
- Each MPO shall quantify the reduction in greenhouse gas emissions projected to be achieved by the SCS. (California Government Code Section 65080(b)(2)(G))
- 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. (Title 23 CFR Part 450.322(e))
- The metropolitan transportation plan shall include the projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan. (Title 23 CFR Part 450.322(f)(1))
- The region 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. (Title 40 CFR Part 93.122 (b)(1)(i))
- Land use, population, employment, and other network-based travel model assumptions shall be documented and based on the best available information. (Title 40 CFR Part 93.122 (b)(1)(ii))
- 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. (Title 40 CFR Part 93.122(b)(1)(iii))
- A capacity-sensitivity assignment methodology shall be used, and emissions estimates shall be based on methodology which differentiates between peak- and off-peak link volumes and speeds and uses speeds based on final assigned volumes. (Title 40 CFR Part 93.122 (b)(1)(iv))
- Zone-to-zone travel impedance 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. (Title 40 CFR Part 93.122(b)(1)(v))

- Network-based travel models shall be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices. (Title 40 CFR Part 93.122 (b)(1)(vi))
- 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. (Title 40 CFR Part 93.122(b)(2))
- Highway Performance Monitoring System (HPMS) estimates of vehicle miles travel (VMT) shall be considered the primary measure of VMT within the portion of the nonattainment or maintenance area and for the functional classes of 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 Section 93.105(c)(1)(i). (Title 40 CFR Part 93.122(b)(3))

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 models 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 models should address changes in regional demographic patterns.
- Geographic Information System (GIS) capabilities should be developed in these counties, leading to simple land use models in a few years.
- All natural resources 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 (as described in Categories B through E), 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.

- 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. This venue provides an excellent opportunity to share ideas and help to ensure agencies are informed of current modeling trends and requirements.
- 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. Additional research and development is required to bring these new modeling approaches into mainstream modeling practice.
- These regions should develop 4-step travel models as soon as is possible. In the near-term, post-processing should be used.
- The travel model set should be run to a reasonable convergence towards equilibrium across all model steps.
- Simple land use models should be used, such as GIS rule-based ones, in the short term.
- 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.
- A simple freight model should be developed and used.
- 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, at a minimum, have four-step models with full feedback across travel model steps and some sort of land use modeling.
- 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.
- Feedback loops should be used and take into account the effects of corridor capacity, congestion and bottlenecks on mode choice, induced demand, induced growth, travel speed and emissions.
- Freight models should be implemented in the short term and commodity flows models within a few years.
- 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.