

**TECHNICAL EVALUATION OF THE  
GREENHOUSE GAS EMISSIONS REDUCTION QUANTIFICATION FOR THE  
TULARE COUNTY ASSOCIATION OF GOVERNMENTS'  
SB 375 SUSTAINABLE COMMUNITIES STRATEGY**

OCTOBER 2015



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# Table of Contents

I. EXECUTIVE SUMMARY.....	i
II. TULARE COUNTY ASSOCIATION OF GOVERNMENTS.....	1
A. Background.....	1
B. Transportation Planning in the Region .....	3
1. Transportation Systems .....	3
2. Transportation Funding.....	7
III. 2014 RTP/SCS DEVELOPMENT.....	9
A. SCS Foundational Policies.....	9
B. Development and Selection of the SCS Scenario .....	9
IV. ARB STAFF REVIEW .....	12
A. Data Inputs and Assumptions .....	12
1. Land Use Assumptions and Growth Forecast.....	13
2. Transportation Network Inputs and Assumptions.....	15
3. Cost Input and Assumptions .....	18
B. Modeling Tools.....	19
1. Land Use Allocation Tool .....	19
2. Travel Demand Model.....	20
3. Off-Model Adjustments .....	27
4. Planned Model Improvements .....	27
C. Model Sensitivity Analysis .....	28
1. Auto Operating Cost Sensitivity Test .....	29
2. Household Income Distribution .....	31
3. Transit Frequency .....	34
4. Residential Density .....	34
D. SCS Performance Indicators.....	36
1. Land Use Indicators .....	36
2. Transportation-related Indicators .....	40
V. CONCLUSION.....	42
VI. REFERENCES .....	43
APPENDIX A. TULARE COUNTY ASSOCIATION OF GOVERNMENTS' RTP/SCS DATA TABLE .....	47
APPENDIX B. 2010 CTC RTP GUIDELINES ADDRESSED IN TULARE COUNTY ASSOCIATION OF GOVERNMENTS' RTP/SCS .....	52

## LIST OF TABLES

Table 1: Tulare County Regional Blueprint Goals .....	9
Table 2: Regional Growth Forecast.....	13
Table 3: TCAG Highway Network Lane Miles by Facility Type (2010) .....	17
Table 4. TCAG Auto Ownership Model Calibration Results .....	21
Table 5: Trip Productions and Attractions .....	22
Table 6: Average Travel Time by Trip Purpose (Minutes) .....	23
Table 7: Person-trips by Mode in 2010.....	24
Table 8: Estimated and Observed Traffic Counts for TCAG Region .....	26
Table 9: Static Validation According to CTC’s 2010 RTP Guidelines .....	27
Table 10: Suggestions and Recommendations for Model Improvement .....	28
Table 11: Auto Operating Costs – Sensitivity Results .....	31
Table 12: Impact of Residential Density on VMT .....	35

## LIST OF FIGURES

Figure 1: TCAG Region.....	2
Figure 2: Distribution of RTP Expenditures by Project Category .....	7
Figure 3: TCAG Roadway Network .....	16
Figure 4: TCAG's Modeling Tools .....	19
Figure 5: The TCAG MIP Travel Demand Model .....	20
Figure 6: Mode Share Split and Auto Operating Cost .....	30
Figure 7: VMT Change and Auto Operating Cost.....	31
Figure 8: Household Vehicle Ownership Distribution .....	32
Figure 9: VMT Changes for Household Income Distribution Scenarios .....	33
Figure 10: Mode Share Response to Household Income Changes .....	33
Figure 11: Impact of Transit Frequency on Mode Share .....	34
Figure 12: Impact of Residential Density on Mode Share .....	36
Figure 13: Residential Density of New Development (2010 – 2035) .....	37
Figure 14: Shift towards Multi-Family Housing (2010-2035).....	38
Figure 15: Existing Farmland .....	39
Figure 16: Farmland Consumed by 2035.....	39
Figure 17: Jobs and Housing Near Transit in the TCAG Region (2010 – 2035).....	40
Figure 18: Average Auto Trip Length in TCAG Region .....	41
Figure 19: Per Capita Passenger VMT.....	42

## I. EXECUTIVE SUMMARY

The Sustainable Communities and Climate Protection Act of 2008 (SB 375) calls for the California Air Resources Board (ARB or Board) to accept or reject the determination of each metropolitan planning organization (MPO), that their Sustainable Communities Strategy (SCS) would, if implemented, achieve the passenger vehicle greenhouse gas (GHG) emission reduction targets (targets) for 2020 and 2035, set by the Board.

For the Tulare County Association of Governments (TCAG) region, the Board set targets at a five percent per capita decrease in 2020 and a 10 percent per capita decrease in 2035 from a base year of 2005. The TCAG Board adopted the final Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS), on June 30, 2014. TCAG's SCS projects that the region would achieve GHG emissions reductions beyond the established targets, reducing GHG emissions by 17.5 percent per capita in 2020 and 18.6 percent per capita in 2035. TCAG transmitted the adopted RTP/SCS and GHG quantification to ARB for review on September 10, 2015.

The TCAG region is located in the San Joaquin Valley (Valley) with a population of approximately 440,000 people concentrated in the eight incorporated cities of Dinuba, Exeter, Farmersville, Lindsay, Porterville, Tulare, Visalia, and Woodlake (Figure 1). The TCAG region is primarily rural with a large percentage of land dedicated to agricultural uses as well as State and federal lands. Tulare County is a top milk producer for the State of California, with a total gross value of over \$2.5 billion in milk production for 2014<sup>1</sup>. The transportation system is primarily auto-dependent, although public transit ridership has increased in the last five years from 2.6 million riders in 2010 to 3.3 million in 2015<sup>2</sup>. Urban development in the region has been mostly low density, with a predominance of single-family housing. The agricultural economy contributes to a reverse commute where many workers travel outside urban areas for employment.

TCAG's RTP/SCS builds upon the Tulare County Regional Blueprint (Blueprint), adopted in 2009, which encourages more compact growth. The RTP/SCS plans to increase the average density of new development by 25 percent. With SCS implementation, TCAG projects an increase in the share of multi-family housing region-wide as well as preservation of agricultural resources. It would improve the existing public transportation system by adding additional transit routes, clean fuel (natural gas) buses, and expanding night and weekend service. It increases the amount of investment in active transportation infrastructure such as new bicycle and pedestrian paths. The RTP/SCS also improves access to rural employment centers with plans to quadruple the number of vanpool riders in the region. It invests about \$5.2 billion for the

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<sup>1</sup> Tulare County Agricultural Commissioner/Sealer, *2014 Tulare County Annual Crop and Livestock Report*. <http://agcomm.co.tulare.ca.us/default/index.cfm/standards-and-quarantine/crop-reports1/crop-reports-2011-2020/2014-crop-report/>.

<sup>2</sup> Transit ridership numbers were provided by TCAG staff via email correspondence on August 21, 2015.

planning period of 2014-2040, allocated among transit, active transportation, and highway improvements. These strategies, together with transportation system management and trip reduction programs, are projected to reduce per capita passenger vehicle GHG emissions in the region.

This report represents ARB staff's technical analysis of TCAG's SCS and GHG determination, and describes methods used to evaluate the MPO's GHG quantification. ARB staff has concluded that the SCS, if implemented, would achieve the region's targets of five and 10 percent in 2020 and 2035, respectively. This conclusion is based on multiple factors, including the sensitivity of the MPO's travel model, the impact of assumptions used in the model, the types of projects and strategies in the SCS that support compact infill development, and qualitative evidence from SCS performance indicators that indicate the region's ability to reduce per capita emissions.

## **II. TULARE COUNTY ASSOCIATION OF GOVERNMENTS**

In California, MPOs are responsible for preparing and updating RTPs<sup>3</sup> that includes a SCS<sup>4</sup>, demonstrating a reduction in regional per capita GHG emissions from automobiles and light duty trucks to meet targets set by ARB. TCAG is the federally designated MPO for Tulare County (County).

The 16-member TCAG Board of Governors includes five members from the County Board of Supervisors, three members-at-large, and one representative from each of the eight incorporated cities in the region. The 2014 RTP/SCS represents the first SCS for the region, and was developed by TCAG through collaboration with member jurisdictions, technical advisory committees, community members, stakeholder groups and other government agencies. The RTP/SCS provides a set of policies, strategies, and investments to maintain and improve the transportation system to meet the needs of the region through 2040. The current RTP/SCS was adopted on June 30, 2014 and must be updated every four years.

### **A. Background**

The TCAG region encompasses approximately 4,838 square miles in central California. The region is primarily a rural agricultural county with 23 percent of the land area dedicated to farmland. A large percentage of the region is public land and there are few urbanized areas. Development is mostly low density, single-family residential, which constitutes approximately 80 percent of the existing housing supply. The largest city is the City of Visalia with almost 125,000<sup>5</sup> residents or about 30 percent of the region's total population. The remaining cities range in size from about 7,000 to 60,000 residents. The eight cities accommodate about 68 percent of the region's total population, with the remaining 32 percent residing in unincorporated communities.

Major urban development is concentrated in the western portion of the region along State Route 65 (SR 65) and State Route 99 (SR 99). The eastern half of the region is mostly composed of the Sierra Nevada Mountain Range and includes the Kings Canyon, Inyo, and Sequoia National Forests and the Sequoia National Park. The Tule River Indian Reservation and several designated wilderness areas are also located in the eastern portion of the region. The main transportation facilities include State Route 65, 99, 190, 198, as well as various county roads. The transportation corridors between

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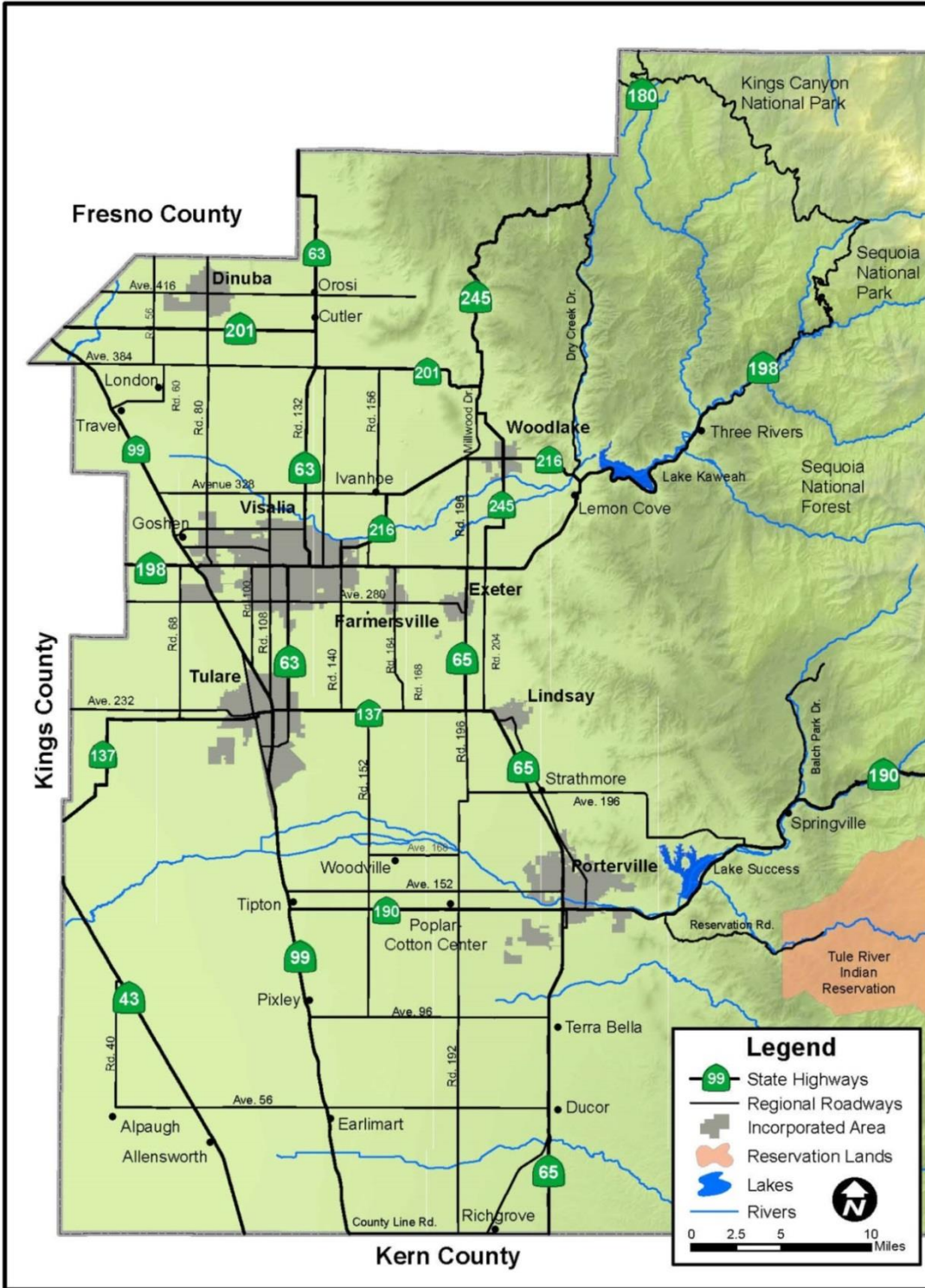
<sup>3</sup> An RTP is a federally required plan to finance and program regional transportation infrastructure projects, and associated operation and maintenance for the next 20 years.

<sup>4</sup> The SCS sets forth a forecasted development pattern for the region which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks. It shall include identification of the location of uses, residential densities and building densities, information regarding resource areas and farmland.

<sup>5</sup> 2010 U.S. Census

the Cities of Tulare and Visalia are some of the most impacted corridors in the TCAG region. Figure 1 shows the region's population centers and major roadway system.

**Figure 1: TCAG Region**



Source: RTP/SCS Figure 3-1, page 3-10



The top five industries by employment are: (1) educational services, health care, and social assistance; (2) agricultural, forestry, and mining; (3) retail trade; (4) manufacturing; and (5) arts, entertainment, recreation, accommodation and food services. Major employers include the Kaweah Delta Medical Center, College of the Sequoias, several packaging and food manufacturers (especially related to dairy such as Haagen-Dazs and Land O'Lakes), as well as governmental agencies. In the last few years, the TCAG region has experienced growth in the goods movement industry with additional distribution centers, including a new Wal-Mart Distribution Center in the City of Porterville and a Best Buy Distribution Center in the City of Dinuba. Wal-Mart stores and the Wal-Mart distribution center are also leading employers for the region.

Milk production is a leading commodity for the TCAG region, with a total gross value of over \$2.5 billion in 2014<sup>6</sup>. Tulare is the top milk producer for the State of California and a leader in the nation with almost 500,000 dairy cows<sup>7</sup>. In addition, 120 other agricultural commodities are produced in Tulare County including various nuts, citrus, fruit, and nursery products. The top three agricultural products, after milk products, are oranges, grapes, and cattle-calves. The agriculture industry is a major generator of truck traffic on State and local roads. The agricultural industry also contributes to a reverse commute with many commuters travelling outside population centers for employment destinations.

## **B. Transportation Planning in the Region**

The RTP is a long range plan that integrates local growth policies of local governments and the transportation system needed to support that growth. TCAG developed the RTP in close coordination with its member cities, the County, transit operators, Caltrans, the San Joaquin Valley Air Pollution Control District, and a wide array of community stakeholders.

### **1. Transportation Systems**

The transportation network consists of freeways, highways, local roadways, transit, and active transportation facilities. TCAG is also focused on enhancing the operational efficiency of its transportation network. The following section describes the existing and future transportation network as well as efficiency improvements in the TCAG region.

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<sup>6</sup> Tulare County Agricultural Commissioner/Sealer, *2014 Tulare County Annual Crop and Livestock Report*. <http://agcomm.co.tulare.ca.us/default/index.cfm/standards-and-quarantine/crop-reports1/crop-reports-2011-2020/2014-crop-report/>.

<sup>7</sup> California Department of Food and Agriculture, *2014 Dairy Statistics Annual* [http://www.cdffa.ca.gov/dairy/pdf/Annual/2014/2014\\_Statistics\\_Annual.pdf](http://www.cdffa.ca.gov/dairy/pdf/Annual/2014/2014_Statistics_Annual.pdf)

## **Roadways**

The TCAG region is heavily reliant on the roadway system for both residents and goods movement. The highway network includes nearly 4,000 lane miles of freeway, highways, expressway, arterials, collectors, and local streets, which is expected to increase to almost 4,500 lane miles by 2040. SR 99 is the major north-south connector that begins in Kern County at the City of Bakersfield, and travels north through Tulare County and on to Sacramento. Primary east-west traffic is served via State Routes 190 and 198. The roadway system is critical to TCAG's economic base providing transportation for the agricultural, industrial facilities, and distribution centers throughout the region. According to Caltrans traffic counts, truck traffic can account for almost a quarter of all vehicle trips on State highways through Tulare<sup>8</sup>.

Roadway projects listed in the RTP list of projects were evaluated using a cost/benefit analysis combined with a design standard/safety improvement score for project priority ranking. Over 75 percent of the roadway projects will be funded from Measure R, a local ½ cent sales tax passed in 2006, and the other 25 percent of the roadway projects will be funded from State, federal, or local sources. Projects at the regional level include improved freeway interchanges, additional lanes for congestion relief, safety improvements, and improvements to major commute corridors, especially those used for goods movement. Local projects include pothole repair, street repaving, bridge repair, traffic signals, sidewalks, additional local lanes, and traffic separation. Measure R funds are distributed to local jurisdictions based on a formula using population, maintained miles, and vehicle miles traveled.

## **Transportation System Management/Transportation Demand Management**

TCAG incorporated transportation system management (TSM) and transportation demand management (TDM) in the RTP/SCS to reduce the need for single-occupancy



vehicle travel and to help relieve congestion on the roadway system. TCAG has partnered with an adjacent MPO, FresnoCOG, on a carpool website ([www.valleyrides.com](http://www.valleyrides.com)), which allows Tulare County and Fresno County residents to find carpool partners with similar origins and destinations. TCAG will also continue to support the San Joaquin Valley Air Pollution Control District's Employer Based Trip Reduction Rule 9410 that requires employers of a certain size to encourage employees to reduce single-occupancy vehicle trips. TCAG encourages cities to

incorporate strategies such as traffic signal synchronization, adding bicycle facilities and bus pockets for better traffic flow. Several local TDM/TSM projects have been identified for Measure R funding.

Vanpooling is a viable transportation option for many residents in the TCAG region. In 2010, vanpool ridership was approximately 1,500 riders per weekday, and this is

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<sup>8</sup> TCAG 2014 RTP/SCS

anticipated to quadruple to almost 7,000 riders by 2040<sup>9</sup>. TCAG is also a member of the California Vanpool Authority (CalVans) which promotes vanpooling in the region. The City of Visalia recently approved an extensive CalVans marketing campaign and voucher program to encourage ridership and increase the number of vans.

### **Transit**

There are five public transit operators serving both incorporated and unincorporated areas in the TCAG region. This includes Tulare County Area Transit (TCat), Tulare Intermodal Express (TIME), Dinuba Area Regional Transit (DART), Visalia Transit, and Porterville Transit. The Tule River Indian Tribe provides transit for tribal residents and is assisted by the City of Porterville which offers a fixed transit route to/from the Tule River Indian Reservation. Visalia Transit also offers a trolley that serves the downtown business district. Transit service is offered to the State and national parks and neighboring Kings, Fresno, and Kern counties. All public transit agencies, as well as the cities of Exeter and Woodlake, offer dial-a-ride services and are equipped with natural gas vehicles. Private transit operators include Greyhound Bus, Amtrak Bus (connecting Visalia with the Amtrak Station in Kings County), and Orange Belt Stages, which offers coach bus service from Las Vegas to Hanford with stops in Porterville and Visalia.

Total transit ridership has increased almost 25 percent in the last five years, from 2.6 million riders in 2010 to 3.3 million in 2015<sup>10</sup>.

TCat experienced the largest increase in ridership – over 100 percent since 2010. The remaining four agencies had an increase in ridership between eight and 44 percent. Sales of the regional bus pass, known as the T-Pass, also doubled between 2010 and 2015, from 120,000 to over 240,000<sup>11</sup>. The T-Pass allows unlimited fixed route rides throughout the County for a monthly fee of \$50<sup>12</sup>. The College of

Sequoias Student Transit Pass offers students a semester-long transit pass as part of the student fees. Student ridership has also increased in the last several years.



To continue expansion and improvement for the transportation system, Measure R allocates funds for new transit routes, fleet improvements such as low emission buses, and expanding or adding night and weekend service. Although, bus rapid transit and light rail are not anticipated in the 2014 RTP/SCS, Measure R includes funds to preserve future right-of-way if further study indicates bus rapid transit is a viable option. In addition, the RTP/SCS includes the expansion of the Community College Transit Program that will provide discounted transit passes countywide for the student population.

<sup>9</sup> TCAG Data Table (Appendix A)

<sup>10</sup> Transit ridership numbers were provided by TCAG staff via email correspondence on August 21, 2015.

<sup>11</sup> Provided by TCAG staff via email correspondence on August 21, 2015.

<sup>12</sup> <http://www.tularecog.org/tpass/>

As a result of the RTP/SCS planning process, TCAG realized a need for a regional long range transit plan to better integrate the region's transit providers. Efforts to develop the Tulare County Long Range Transportation Plan, titled "*Destination 2040*" (<http://www.destination2040.com/>), began in May 2015 and will analyze existing transit service, travel patterns, and other data to identify potential improvements. It will look at improving connections within the TCAG region as well as service to Fresno and Kings County. The draft is expected to be released in fall of 2015.

California is expected to have the first high-speed rail system in the nation connecting San Diego to Sacramento totaling 800 miles with up to 24 stations. The project will be completed in two main phases: Phase 1 will connect San Francisco to Los Angeles by 2029 and Phase 2 will extend the system to Sacramento and San Diego. Construction of a Kings/Tulare station is expected in Phase 1 with a station located near the City of Hanford in Kings County (about a 30 minute drive from Visalia). TCAG is aware a future connection may be needed to connect Visalia to a potential high-speed rail station in Hanford. However, high-speed rail is not part of TCAG's 2014 RTP/SCS as the Hanford station planning and rail alignment have not been finalized.

### **Active Transportation**

All eight cities have adopted bicycle plans that are incorporated into TCAG's Regional Bicycle Plan, first prepared in 2000 and recently updated in 2014. The plan includes potential Class I, II, and III bikeway corridors to encourage bicycle commuting between cities and towns and encourages agencies and employers to provide facilities such as bicycle racks, lockers, and showers. To integrate transit and active transportation, most of the region's transit buses are equipped with bicycle racks.



Funding for active transportation projects is primarily through Measure R. The Measure R Expenditure Plan commits 16 specific bicycle or pedestrian projects, with additional funding for other local agency discretionary projects. One of the Measure R projects is a bicycle path that will connect the cities of Visalia and Tulare by using an abandoned Santa Fe railroad corridor. This Santa Fe Trail will be the first major cross-jurisdictional regional bicycle path in the region.

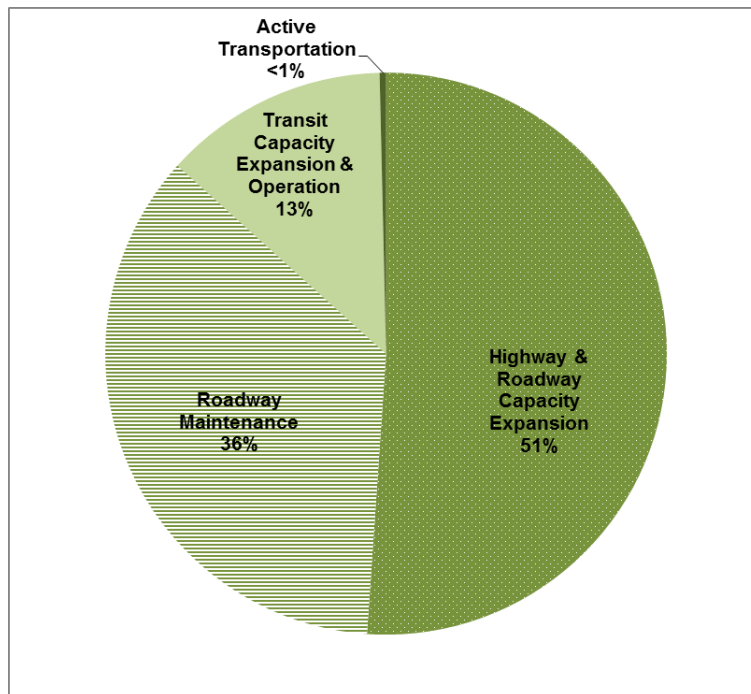
TCAG is currently developing the first Regional Active Transportation Plan for the county, called "Walk 'n Bike Tulare County". This plan will focus on making walking and biking safer and more convenient as well as identify the highest-priority pedestrian and bicycle improvements. It will be included in TCAG's 2018 RTP/SCS.

## 2. Transportation Funding

Funding for transportation projects comes from federal, State, and local sources, including federal transportation funding legislation, fuel taxes, license fees, and developer-paid impact fees. The region has implemented a self-help taxation measure, Measure R, to help raise additional transportation revenue. Measure R, passed in 2006, is a local ½ cent sales tax estimated to generate \$1.4 billion in funding over a 30-year period<sup>13</sup>. Projects to be funded in accordance with the Measure R expenditure plan (last amended in 2013) include State highway and regional roadway expansion projects, active transportation projects, transit expansion, and funding for environmental mitigation.

RTPs must be financially constrained, meaning that funding for planned transportation projects must be reasonably foreseeable. The RTP/SCS includes a constrained transportation list with total available funding of \$5.2 billion for the planning period 2014-2040. This plan allocates 14 percent of the total budget to transit and active transportation and 51 percent to highway projects. The remaining funds are for roadway maintenance. Figure 2 summarizes RTP expenditures by project type.

**Figure 2: Distribution of RTP Expenditures by Project Category**



Source: TCAG Data Table

Note: Percentages do not sum to 100 due to rounding

<sup>13</sup> TCAG 2104 RTP/SCS

### **Supplemental Funding**

In addition to federal, State, and local funding sources, TCAG has also received grant funding for projects related to mobility options and active transportation. Caltrans recently awarded a Transportation Planning Grant to the eight Valley MPOs and the University of California at Davis, Institute of Transportation Studies for a shared access pilot program to help address transit needs in rural areas<sup>14</sup>. This program will look at car, bike, and ridesharing options as well as other alternatives that may meet the transit needs of smaller communities in the Valley. Caltrans also awarded \$2 million in Active Transportation Program funds for eight bicycle and pedestrian projects including sidewalk improvements and the construction of new bike lanes and pedestrian corridors.

TCAG has been awarded \$3 million from the Strategic Growth Council's (SGC) Affordable Housing and Sustainable Communities Program for a vanpool expansion project<sup>15</sup>. The vanpool project will target farmworkers in rural areas of Tulare and several other counties.

Caltrans has also awarded funds for a Valley-wide goods movement planning effort that includes an Interstate 5 (I-5)/SR-99 Corridor Study and a Goods Movement Implementation Plan Update<sup>16</sup>. The Corridor Study will look at strategies to reduce truck emissions and the number of trucks on I-5/SR-99 and may also include a demonstration project for autonomous freight. The Implementation Plan Update will look at strategies to improve truck routing, parking needs, and other ways to reduce truck emissions Valley-wide.

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<sup>14</sup> <http://www.dot.ca.gov/hq/tpp/documents/AwardList.pdf>

<sup>15</sup> Strategic Growth Council June 30, 2015 Meeting Materials, Attachment A ([http://www.sgc.ca.gov/s\\_063015\\_meetingmaterials.php](http://www.sgc.ca.gov/s_063015_meetingmaterials.php))

<sup>16</sup> <http://sjvcogs.org/goods.html>

### III. 2014 RTP/SCS DEVELOPMENT

This section describes the planning context within which the RTP/SCS was developed and the process through which a final plan was formulated and adopted. TCAG began its public process in January 2013 by gathering public and stakeholder input on a vision for the future, and creating alternative growth scenarios to illustrate options for the future of the region through 2040.

#### A. SCS Foundational Policies

In 2009, TCAG adopted the long-range blueprint planning document, *Tulare County Regional Blueprint* (Blueprint), which was intended to set forth a more sustainable vision for the region. This Blueprint Growth Scenario was used as a starting point for the scenario development process in the RTP/SCS. Table 1 highlights the Blueprint Vision and Goals.

**Table 1: Tulare County Regional Blueprint Goals**

<b>Blueprint Vision</b>
Preservation of Agricultural and Environmentally Sensitive Lands
Focus Development in Urban Centers
Increase Mobility Options
<b>Blueprint Goals</b>
Increase county-wide development density by 25 percent
Achieve a region-wide average of five dwelling units per acre
Expand transit throughout the county
Maintain urban separators around cities
Direct growth into existing communities

Since 2009, three local jurisdictions have updated their general plans to incorporate sustainable development policies that better align with the Blueprint. This includes the City of Visalia, the City of Porterville and the County of Tulare. The Visalia General Plan Land Use Element was approved in 2014 and emphasizes infill and more compact development resulting in a smaller overall urban footprint. Visalia also developed an Infill Incentive Program<sup>17</sup> that encourages growth in existing urban areas by reducing development fees for projects located in a designated infill or downtown area.

#### B. Development and Selection of the SCS Scenario

TCAG began its RTP/SCS development process by updating its demographic and socioeconomic growth forecasts which are fundamental to an understanding of the needs of the people who will live, work, and travel in the region (see section IV.A.1 *Regional Growth Forecast* for more information on the regional growth forecast). TCAG created the RTP/SCS Roundtable, composed of 27 stakeholders appointed by the

<sup>17</sup> <http://www.visaliaedc.com/pdf/incentives2014.pdf>

TCAG Board to guide scenario selection and SCS development<sup>18</sup>. The Roundtable developed four land use scenarios that reflected different land use and transportation policies. Input to the scenario development involved extensive public outreach, including public workshops, presentations, surveys, email and online communications, and outreach at the Tulare County Fair. Of the four scenarios described below, the Blueprint Scenario was ultimately chosen as the preferred plan and adopted in the final RTP/SCS.

No Project Scenario – This scenario assumes that there is no RTP update and excludes all future transportation projects except those already programmed with a commitment of funds. This scenario would consume twice the amount of farmland acres compared to the Blueprint Scenario to accommodate growth by 2040.

Trend Scenario – This scenario assumes a land use forecast based on existing general plans and growth projections consistent with the existing development pattern. This includes the two updated general plans for the City of Porterville (2008) and Tulare County (2012), which deviate slightly from previous growth and development trends. Average density for new development is four dwelling units per acre in 2035. This is also considered the “business-as-usual” scenario and would have similar impacts on farmland as the No Project Scenario.

Blueprint Scenario – This scenario is based on the 2009 Tulare County Regional Blueprint and assumes a 25 percent higher overall density for new development compared to the Trend Scenario. This results in an average density of five dwelling units per acre in 2035. This scenario would consume significantly less farmland than the No Project and Trend Scenarios. The public favored the Trend and Blueprint Scenarios almost equally.

Blueprint Plus Scenario – The scenario is the most aggressive scenario of the four and assumes a 30 percent increase in density for new development compared to the Trend Scenario. This scenario places priority on active transportation and transit projects over congestion relief projects and assumes the maximum amount discretionary funding. This scenario consumes the least amount of farmland of all four scenarios.

TCAG’s modeling results show that all four scenarios achieved the SB375 regional greenhouse gas emissions targets and conformity requirements under the Clean Air Act. The RTP/SCS Roundtable voted on each scenario after receiving input from the public outreach process. It was determined that the No Project and Trend Scenarios were not aggressive enough to meet the overall RTP/SCS goals. Although the Blueprint Plus Scenario achieved the greatest reductions in greenhouse gas emissions, it would require local governments to make significant land use policy changes and was therefore not considered feasible.

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<sup>18</sup> TCAG 2014 RTP/SCS



The Blueprint Scenario was selected as the preferred scenario for the RTP/SCS. It was supported by the public, as it continued the vision and policies of the Blueprint which had been publicly vetted and adopted in 2009. This scenario would consume significantly less farmland than the Trend Scenario and improves the regional-jobs housing balance. It would also result in an increase in the total regional share of multi-family housing to 30 percent by 2040.

## **IV. ARB STAFF REVIEW**

TCAG's quantification of GHG emissions reductions in the SCS is central to its determination that the SCS would meet the targets established by ARB. This section describes the method ARB staff used to review TCAG's determination that its SCS would meet its targets, and reports the results of staff's technical evaluation of TCAG's quantification of passenger vehicle GHG emissions reductions.

TCAG's analysis estimates that the SCS, if implemented, would achieve a 17.5 percent per capita reduction in GHG emissions from passenger vehicles by 2020, and an 18.6 percent per capita reduction by 2035. Based on ARB staff's evaluation of TCAG's SCS and technical documentation, the SCS, if implemented, would meet the targets set by the Board.

### ***Methodology***

ARB's review of TCAG's quantification focused on the technical aspects of regional modeling that underlie the quantification of GHG emissions reductions. To assess the technical soundness and general acceptability of the TCAG GHG quantification, four central components were evaluated: 1) data inputs and assumptions, 2) modeling tools, 3) model sensitivity, and 4) performance indicators. 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<sup>19</sup>." To address the unique characteristics of each MPO region and modeling system, ARB's methodology is tailored for the evaluation of each MPO.

ARB staff evaluated how TCAG'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 the TCAG's models are reasonably sensitive for these purposes, ARB staff examined how well TCAG's travel demand model (TDM) responded to specific changes in input values, as well as how accurately it replicated observed results.

ARB staff used publicly available information in TCAG's RTP/SCS and accompanying documentation, including the RTP technical appendices, model documentation and validation reports, and data table (see Appendix A).

### **A. Data Inputs and Assumptions**

TCAG'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 socioeconomic characteristics and growth assumptions, 2) the region's transportation network inputs and assumptions, and 3) cost assumptions. In evaluating these three input types, ARB

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<sup>19</sup> [http://www.arb.ca.gov/cc/sb375/scs\\_review\\_methodology.pdf](http://www.arb.ca.gov/cc/sb375/scs_review_methodology.pdf)

staff reviewed the assumptions TCAG used to forecast growth and vehicle miles traveled (VMT), and compared model inputs with underlying data sources. This involved using publicly available, authoritative sources of information, such as national and statewide survey data on socioeconomic and travel factors, as well as region-specific forecasting documentation.

## 1. Land Use Assumptions and Growth Forecast

Demographic data describe a number of key characteristics used in travel demand models. The travel demand model uses demographic data to describe where the region's population lives, works, and travels during the planning period.

The 2040 regional growth forecast for the RTP/SCS planning process is based on two primary sources: the California Department of Finance (DOF) state-wide population forecast by county<sup>20</sup> and the Planning Center/DC&E (Planning Center) 2012 county-level forecast<sup>21</sup>. The growth forecast for this RTP/SCS is the first to incorporate information from the 2010 census and projections that reflect the recent economic recession. The RTP/SCS growth forecast is more conservative than the previous 2010 RTP growth forecast.

TCAG used the DOF population forecast as the base forecast and the Planning Center forecast as the primary county-level reference. The DOF forecast is based on detailed projections of birth, death, and migration rates through the year 2060 for each county in the State of California. The Planning Center's forecast is based on historical data from the California Department of Finance, the United States Census Bureau, and the California Employment Development Department. This forecast includes population, households, and housing units through the year 2050 for each Valley county. Table 2 shows the adopted TCAG regional growth forecast for the years 2010 to 2040. Overall, population and housing units are expected to grow about 50 percent, while employment is expected to more than double between 2010 and 2035.

**Table 2: Regional Growth Forecast**

Year	Population	Housing Units	Employment
<b>2010</b>	442,127	141,696	113,210
<b>2020</b>	520,542	164,553	194,173
<b>2035</b>	664,878	206,287	243,419
<b>2040</b>	721,391	222,535	262,591

Source: TCAG Data Table (Appendix A)

<sup>20</sup> State of California, Department of Finance, Report P-1 (County): State and County Total Population Projections, 2010-2060. Sacramento, California, January 2013

<sup>21</sup> The eight San Joaquin Valley COG's commissioned the Planning Center/DC&E to prepare *The San Joaquin Valley Demographic Forecasts 2010 to 2050* (March 27, 2012).

After the Planning Center published its San Joaquin Valley Demographic Forecasts, it was discovered that the projections for Tulare County were substantially lower (nine percent) than the most recent Department of Finance projections. The Planning Center met with DOF to review the underlying model assumptions and found an anomaly in the fertility rate used by DOF. This skewed DOF's population projection to overestimate the population growth rate. Both agencies revised their growth forecasting models to correct the underlying assumptions. The Planning Center submitted a memorandum, dated June 19, 2012, to TCAG with a revised regional demographic forecast.

The regional growth forecast is closely related to the Regional Housing Needs Assessment (RHNA), which uses the growth projections as a basis for distributing the housing units and jobs in the RHNA allocation. The California Department of Housing and Community Development (HCD) provided the TCAG region a final RHNA determination of need for 26,910 housing units for an eight-year projection period. TCAG adopted the 2014 Regional Growth Forecast, the final RHNA Determination, and the RTP/SCS on June 30, 2014. HCD approved the RHNA Plan on July 15, 2014.

### ***Population***

TCAG selected a linear growth rate which fit the DOF forecast within three percent through the RTP planning horizon of 2040. Growth rates for each city were adjusted relative to the county-wide rate based on available DOF and Census historical data. The TCAG region has only one city with a population over 100,000 residents, the City of Visalia. This is a major population and employment center and is expected to have almost 30 percent of the growth for the region. The county-wide average annual population growth rate is 1.23 percent between 2010 and 2040, less than the overall average annual growth rate of 1.41 percent for the eight Valley counties. The region's population is expected to grow by over 220,000 (or 50 percent) by 2035.

### ***Households***

To calculate the number of households, TCAG used a linear growth rate that was determined by adjusting to a reasonable housing vacancy rate based on the Planning Center projections. Household size is projected to increase slightly from 3.34 persons per household in 2010 to 3.43 persons per household in 2040. The number of housing units is projected to increase by almost 65,000 (or 46 percent) by 2035.

### ***Employment***

Employment growth was based on the housing unit to jobs ratio projection in the Planning Center model and California Employment Development Department Labor Market Information. TCAG also used information provided by Woods & Poole Economics<sup>22</sup>, a consulting firm that develops proprietary county level-forecasts based on national databases. Employment in the TCAG region is forecast to increase by about 130,000 jobs (or 115 percent) between 2010 and 2035.

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<sup>22</sup> <https://www.woodsandpoole.com/>

### **Land Use Assumptions**

There are nine local jurisdictions in the TCAG region (eight cities and Tulare County) that adopt unique comprehensive land use plans commonly known as general plans. The land uses identified in these general plans are categorized in a variety of ways by the jurisdictions. Land use information had to be standardized for use in the regional land use allocation tools and the travel demand model. The eight counties in the San Joaquin Valley, with the help of a consulting firm, developed a uniform land use classification system for use in the regional land use model. TCAG jurisdictions reviewed the land use designations to ensure accuracy before input into the land use tool, UPlan<sup>23</sup>, which is described below under Modeling Tools.

## **2. Transportation Network Inputs and Assumptions**

The transportation network is a map-based representation of the transportation system serving the TCAG region. One part of TCAG's transportation network is the roadway network, which consists of an inventory of the existing road system, and highway travel times and distances. Another part of the transportation network is the synthetic transit network, which is a simplified representation of the transit lines in the region. The model includes roadway network and transit network for the model base year of 2010 and for future years (i.e. 2020, 2035). ARB staff reviewed the regional roadway network and network assumptions such as link capacity and free-flow speeds. The methodologies TCAG used to develop the transportation network and model input assumptions is consistent with guidelines provided in the National Cooperative Highway Research Program (NCHRP) Report 365.

### **Roadway Network**

TCAG's roadway network (Figure 3) is a representation of the automobile roadway system, which includes freeways<sup>24</sup>, highways<sup>25</sup>, expressways<sup>26</sup>, arterials<sup>27</sup>, collectors<sup>28</sup>, local roads<sup>29</sup>, and freeway ramps<sup>30</sup> in the region. The roadway network provides the basis for estimating zone-to-zone travel times and costs (in terms of travel distance and

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<sup>23</sup> Fehr & Peers. 2013. Technical Summary for the Tulare County Association of Governments Traffic Model to Meet the Requirements of SB375. April 2013. <http://www.tularecog.org/wp-content/uploads/2015/06/Appendix-E-Technical-Summary-for-TCAG-Traffic-Model-to-meet-Requirements-of-SB375.pdf>

<sup>24</sup> The 2012 California MUTCD defines freeway as a divided highway with full control of access.

<sup>25</sup> The 2012 California MUTCD defines highway as a general term for denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

<sup>26</sup> The 2012 California MUTCD defines expressway as a divided highway with partial control of access.

<sup>27</sup> The 2012 California MUTCD defines arterial as a general term denoting a highway primarily used by through traffic, usually on a continuous route or a highway designated as part of an arterial system.

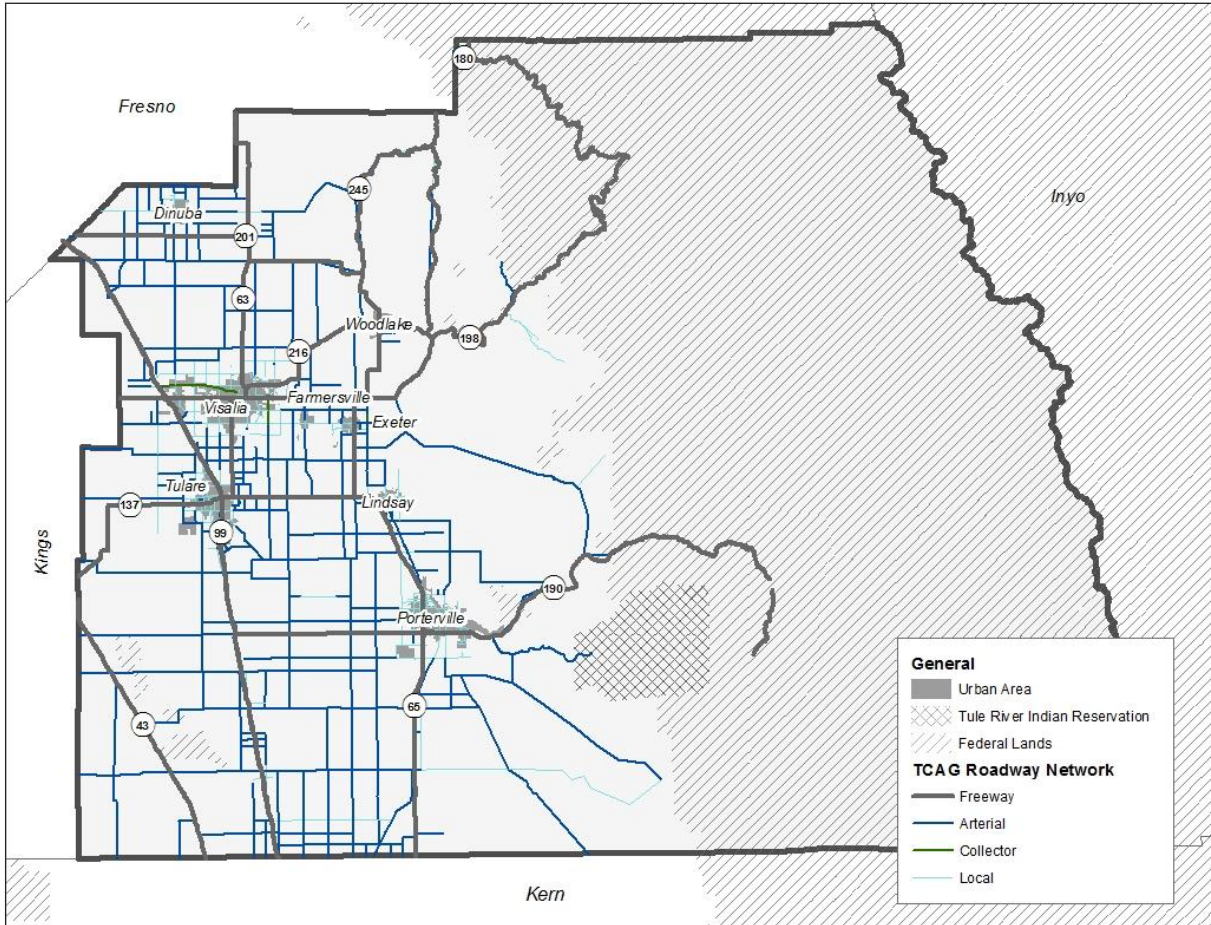
<sup>28</sup> The 2012 California MUTCD defines collector as a term denoting a highway that in rural areas connects small towns and local highways to arterial highways, and in urban areas provides land access and traffic circulation within residential, commercial, and business areas and connects local highways to the arterial highways.

<sup>29</sup> FHWA defines local roads as all roads not defined as arterials or collectors; primarily provides access to land with little or no through movement.

<sup>30</sup> FHWA defines freeway ramps as access or egress points of freeway.

travel time) for the trip distribution and mode choice steps of the modeling process, and for trip routing in vehicle assignments.

**Figure 3: TCAG Roadway Network**



The TCAG model uses facility type classifications consistent with the Federal Highway Administration (FHWA) approved functional system. Table 3 summarizes the reported roadway lane miles in the TCAG region in 2010 by facility type. In the roadway network, link attributes (e.g. route/street name, distance, capacity, speed) are coded for each roadway segment.

**Table 3: TCAG Highway Network Lane Miles by Facility Type (2010)**

<b>Facility Type</b>	<b>Lane Miles</b>
Freeway	339
Highway	2,199
Expressway	64
Arterial	918
Collector/Local	468

*Source: TCAG Data Table, 2015*

***Link Capacity and Free Flow Speed***

Link capacity is defined as the number of vehicles that can pass a point on a roadway at free-flow speed in an hour. One important reason for using link capacity as a model input is for congestion impact; which can be estimated as the additional vehicle-hours of delay based on the 2000 Highway Capacity Manual (2000 HCM). The capacity assumption used in the TCAG model of each road segment in the network is based on the terrain, facility type, and area type, which is consistent with the methodology suggested in the 2000 HCM.

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. TCAG estimated the free-flow speed of each link segment using the Bureau of Public Roads formulas suggested in the 2000 HCM.

The methodology used in estimating highway free-flow speeds in the TCAG region was reviewed. TCAG’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 TCAG model also includes a synthetic transit network, which contains peak and off-peak headway information to represent the average wait time for transit at transportation analysis zone (TAZ) level. 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. The methodology TCAG used in developing its transit network was reviewed and found consistent with the procedures discussed in the NCHRP Report 365 and FHWA Model Validation and Reasonableness Checking Manual. For future model improvement, TCAG can consider developing a GIS-based transit network that includes geocoded transit lines, stops, headway, and fare information to better estimate transit travel time.

### 3. Cost Input 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 TCAG's model. To examine the responsiveness of the model to changes in the cost variable or other model inputs, model sensitivity tests performed by TCAG, such as auto operating cost and household income distribution were evaluated. The results of the sensitivity tests are presented in the model sensitivity analysis section of this report on page 28.

#### ***Auto Operating Cost***

Auto operating cost, an important factor influencing per capita VMT, is a key parameter used in the mode choice step of the TCAG model. TCAG defined auto operating costs as the cost of fuel alone. 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 effect on VMT.

TCAG followed a similar method as other Valley MPOs to estimate auto operating cost as 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 in 2035 was forecasted using the historical trend from 1998 to 2008 in the TCAG region. The corresponding auto operating costs were then derived by dividing the fuel price of the year by the fuel efficiency assumptions. Auto operating cost in 2005 was estimated at 11 cents per gallon, and was projected to increase to 18 cents per gallon in 2020 and 19 cents per gallon in 2035.

Although fuel cost is the major component of travel cost for 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 TCAG include these minor costs such as tire and maintenance costs 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. TCAG staff converted travel cost to cost-of-time using a value of time. The average perceived value of time that TCAG used, similar to that used by other MPOs in the Valley, was six dollars<sup>31</sup> per hour per person.

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<sup>31</sup> Fehr & Peers. 2012. Documentation for the Eight San Joaquin Valley MPO Traffic Models to Meet the Requirements of SB375. Accessed in March 2015 from [http://www.kerncog.org/images/docs/transmodel/MIP\\_Documentation\\_20120830.pdf](http://www.kerncog.org/images/docs/transmodel/MIP_Documentation_20120830.pdf).

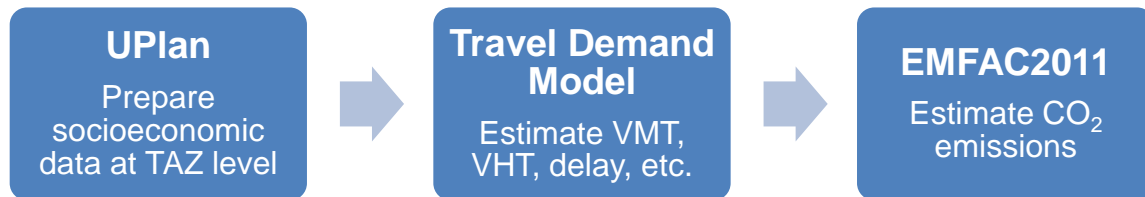


## B. Modeling Tools

ARB staff assessed how well the travel 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 TCAG's application of the UPlan 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. TCAG'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.

Similar to other MPOs in the Valley (e.g. Fresno Council of Governments and Kern Council of Governments), TCAG used a land use scenario planning tool, a trip-based travel demand model, and the ARB vehicle emission model (EMFAC2011) to quantify the GHG emissions for its 2014 RTP/SCS. The analysis years for the GHG emissions were 2005, 2020, and 2035. Figure 4 illustrates the modeling process and the following section provides a detailed description of each component.

**Figure 4: TCAG's Modeling Tools**



### 1. Land Use Allocation Tool

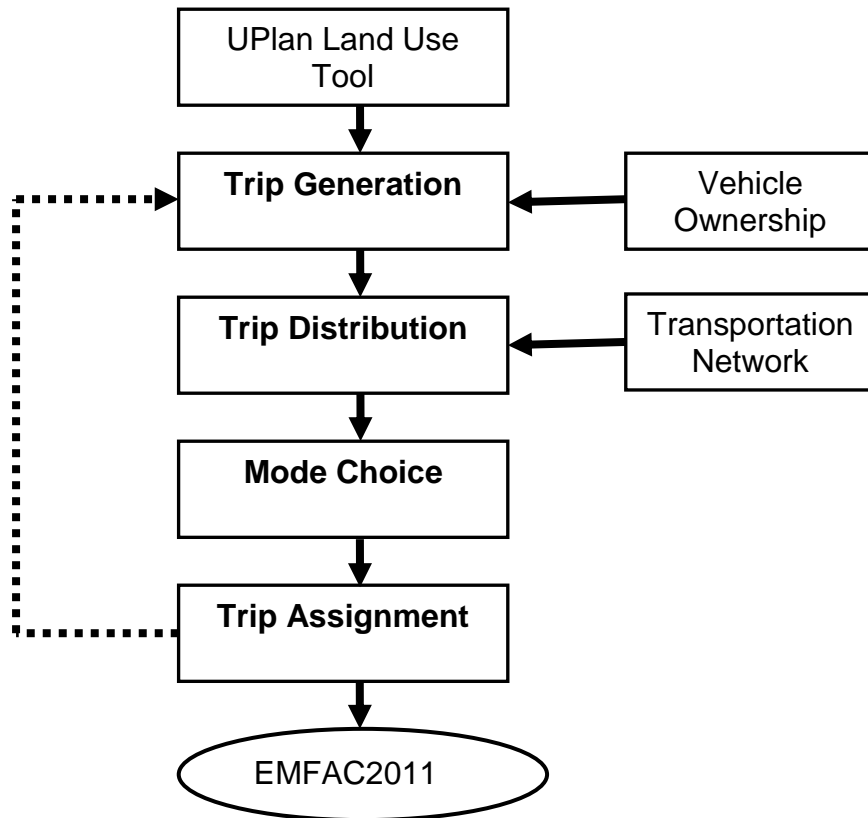
TCAG used UPlan, a land use allocation tool to prepare population, household, employment, and land use datasets to run the travel model for its preferred scenario for 2020 and 2035. The UPlan land use tool takes demographic data and future socioeconomic changes as inputs, and then allocates growth in housing, employment, and population at the TAZ level. Inputs for the UPlan tool include total population, number of households by structure type, household income, age of population in households, and housing density. It also includes employment related inputs such as employees by detailed sector, employment density, and student enrollment. UPlan designates areas for future development and excludes the areas that are not suitable for development, e.g., waterways, State and federal land. The outputs of the land use tool are then used as inputs to the travel demand model to estimate the amount of travel in the TCAG region.

## 2. Travel Demand Model

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 their ability to evaluate land use and transportation strategies central to meeting SB 375 requirements.

Additionally, in 2013, TCAG's consultant, Fehr & Peers, completed the validation for various components of the MIP model for Tulare County. The resulting model is known as the TCAG travel demand model (or TCAG model). The 2014 RTP/SCS is the first RTP to be developed by TCAG using the new model. The TCAG model is a four-step model that includes trip generation, trip distribution, mode choice, and trip assignment (Figure 5). The model uses land use, socioeconomic, and roadway network data to estimate travel patterns, roadway traffic volumes and transit volumes. The model contains approximately 1,300 TAZs representing origins and destinations of travel in the model area. Travel to/from and through the model area is represented by 45 gateway zones at major road crossings of the county line in order to estimate interregional travel.

**Figure 5: The TCAG MIP Travel Demand Model**



### ***Vehicle Ownership***

Modeling of vehicle ownership is a new component of the TCAG model. Previously TCAG used a fixed rate of vehicle ownership. The new model estimates the number of

motor vehicles in the TCAG region based on variables (e.g. household size, number of adults in household, housing type) from the 2009 National Household Travel Survey (2009 NHTS). The vehicle ownership model was then calibrated to the 2006-2010 American Community Survey (ACS) data for Tulare County. The modeled auto ownership is summarized in Table 4. The differences between modeled and observed auto ownership range from 3 to 7 percent, which is reasonable given the limited sample size availability for calibration for TCAG region. The output of this component is a critical input to the trip generation step, accounting for travelers' long term decisions for mode of transportation.

**Table 4. TCAG Auto Ownership Model Calibration Results**

Household Size	Model Output						Observed Data from ACS (2006-2010)					
	Total (%)	0 Veh (%)	1 Veh (%)	2 Vehs (%)	3 Vehs (%)	4+ Vehs (%)	Total (%)	0 Veh (%)	1 Veh (%)	2 Vehs (%)	3 Vehs (%)	4+ Vehs (%)
One person	18.5	3.2	13.1	1.9	0.3	0.0	17.3	2.9	11.3	2.4	0.6	0.1
Two people	25.8	1.4	5.9	14.1	2.6	1.8	26.9	1.3	6.5	14.2	3.8	1.1
Three people	17.3	0.9	3.7	7.6	3.6	1.5	16.4	1.0	4.2	6.6	3.6	1.0
Four+ people	38.4	1.1	6.8	16.8	9.5	4.2	39.4	2.0	8.8	16.3	7.4	4.9
<b>Total</b>	<b>100.0</b>	<b>6.6</b>	<b>29.5</b>	<b>40.4</b>	<b>16.0</b>	<b>7.5</b>	<b>100.0</b>	<b>7.2</b>	<b>30.8</b>	<b>39.5</b>	<b>15.4</b>	<b>7.1</b>

ARB staff evaluated the structure and variables used in the vehicle ownership model, and compared it to the approach commonly used by other MPOs. 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, TCAG should consider including the sensitivity to land use and transit accessibility in modeling auto ownership, as well as 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. TCAG 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). The trip generation step contain trip purposes, such as home-based work (HBW), home-based shopping (HBSshop), home-based K12 (HBK12), home-based college (HBCollege), home-based other (HBO), work-based other (WBO), and other-based other (OBO).

Consistent with a conventional trip-based travel demand model, the TCAG model has two trip ends, trip production<sup>32</sup> and trip attraction.<sup>33</sup> 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 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 5 summarizes the trip production and attraction rates by trip purpose. The differences between estimated trip productions and attractions were within 10 percent, consistent with the guidance in the 2010 FHWA’s Travel Model Validation and Reasonable Checking Manual. The modeled person trip rates were then converted to vehicle trips using average auto occupancies for the County for each trip purpose (i.e. drive alone, shared ride two, shared ride three plus)<sup>34</sup>.

**Table 5: Trip Productions and Attractions**

Trip Purpose	Productions	Attractions	Percent Difference	FHWA Criterion
HBW	198,467	196,658	-1%	±10%
HBSchool*	112,624	108,306	-4%	±10%
HBO**	422,326	426,300	1%	±10%
NHB***	389,510	379,002	-3%	±10%
Total	1,122,927	1,110,266	-1%	±10%

\*HBSchool is an aggregation of HBK12 and HBCollege.

\*\*HBO is an aggregation of HBO and HBShop

\*\*\*NHB is an aggregation of WBO and OBO.

Source: Fehr and Peer (2013). Technical Summary for TCAG Traffic Mode.

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 TCAG model indicates that trip rates tend to increase as household income and household size increases, similar to other Valley MPOs’ models. Overall, the trip generation model followed the process for estimating trip generation outlined in NCHRP Report 365.

As part of future model improvement, TCAG 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 TCAG use the latest available independent data sources such as the National Household Travel Survey (NHTS),

<sup>32</sup> 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.

<sup>33</sup> 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.

<sup>34</sup> Shared ride 3+ includes vehicles with 3 or more riders including driver in the vehicle, calculated as 3.5 persons per vehicle.

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 TCAG model, which utilizes a gravity model<sup>35</sup> 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<sup>36</sup> that define the effect of travel time. The travel time 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.

Because time is an important factor in trip distribution, the 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 Tulare County from the 2000/2001 CHTS. The TCAG model assumed a terminal time of one minute for all TAZs in the model area, which is similar to some other MPOs in the Valley.

In evaluating the trip distribution step of the TCAG model, the average travel time by trip purpose was reviewed. Table 6 shows the average travel time by trip purpose from the model. Similar to other Valley MPOs, 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 region, the time gap between model base year (i.e., 2008) and survey year, and also the survey data collected from other locations in California which could vary from the region's demographic make-up.

**Table 6: Average Travel Time by Trip Purpose (Minutes)**

<b>Trip Purpose</b>	<b>Model</b>	<b>CHTS</b>
HBW	19.5	19.5
HBO	17.9	19.5
<i>NHB</i>	16.4	13.7

*Source: Fehr & Peers (2013). Technical Summary for the Tulare County Association of Governments Traffic Model to Meet the Requirements of SB375.*

To better estimate the GHG reductions associated with SCS strategies in the future, ARB staff recommends that TCAG consider developing a destination choice model or other method, 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. TCAG should also provide goodness-of-fit statistics, the

<sup>35</sup> 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.

<sup>36</sup> Friction factors represent the effect that travel time exerts on the propensity for making a trip to a given zone.

frequency distribution of trip lengths, and coincident ratios for different trip types in future model documentation.

**Mode Choice**

The mode choice step of the TCAG model uses demographics and the comparison of distance, time, cost, and access between modes to estimate the proportions of the total person trips using drive-alone, shared-ride two people, shared ride three or more people, transit, walk or bike modes for travel between origin zone and destination zone. The mode choice model estimates for the 2010 base year were calibrated using the 2000/2001 CHTS survey data. Table 7 shows the calibrated percent mode share in the model base year for the TCAG region. Mode share estimates were compared against the observed data from CHTS. The modeled mode share results are similar to the observed data. The small 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.

**Table 7: Person-trips by Mode in 2010**

Mode	Model	CHTS
Drive alone	22.7%	26.1%
Shared ride 2	27.0%	26.0%
Shared ride 3+	46.5%	43.3%
Transit	0.5%	0.7%
Walk	0.8%	3.2%
Bike	2.4%	0.6%
<b>Total</b>	<b>100%</b>	<b>100%</b>

Source: Fehr & Peers (2013). *Technical Summary for the Tulare County Association of Governments Traffic Model to Meet the Requirements of SB375.*

In evaluating the mode choice component of the TCAG model, ARB staff reviewed the model structure, the input data, and data sources that TCAG used to develop and calibrate the model, model parameters, and auto-occupancy rates<sup>37</sup> by purpose. Estimated mode share by trip purpose was also compared against the observed data, including transit ridership. The method TCAG used to develop their mode choice model is consistent with the approaches used nationwide as cited in NCHRP Report 365. In future model updates, TCAG should considering continuing improving the mode choice tool with updated household travel data and transit ridership data to better capture how the residents and commuter travel to different activities in the region.

**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

<sup>37</sup> 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 criterion used in the TCAG model is a 0.001 relative gap,<sup>38</sup> 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 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 model chooses the best path 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 and the off-peak traffic assignment are inputted back to the trip generation step to re-run the process until congested travel times between consecutive runs converge.

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 8). 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<sup>39</sup> locations by facility type in Table 8 shows that the differences for some facility types were outside the recommended range of FHWA guidelines due to the lack of data points from certain facility types for Tulare County. Although the modeled traffic volume for expressway is 52 percent higher than observed data, traffic volume of expressway only represents about three percent of the traffic counts in the region. Between now and the next model update, TCAG should continue to gather the most recent traffic count data at different facility types to ensure there are sufficient sample sizes.

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<sup>38</sup> Relative gap measures the relative difference of traffic flow between current iteration and the previous iterations.

<sup>39</sup> 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 8: Estimated and Observed Traffic Counts for TCAG Region**

Facility Type	Model Estimate	Traffic Count	Percent Difference	FHWA Guidelines
Freeway	509,549	452,850	13%	±7%
Expressway	35,160	23,091	52%	±15%
Arterial	197,957	234,877	-16%	±15%
Collector	32,095	26,095	23%	±25%

The estimated total VMT for the region from the TCAG model and the observed data from the Caltrans Highway Performance Monitoring System (HPMS)<sup>40</sup> were 9,828,330 and 9,603,600, respectively. The difference was 2.3 percent, which is within the three percent evaluation criterion used by TCAG.

### ***Model Validation***

Model validation, usually the last step in the development of any regional travel demand model, reflects how well the model matches observed data. The CTC's 2010 California RTP 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, TCAG performed dynamic tests to study the responsiveness of the model to changes in land use, traffic assignment, travel cost, induced demand, and auto ownership. In addition, TCAG conducted model sensitivity tests as part of their model dynamic testing during ARB's evaluation process of the 2014 RTP/SCS, which is summarized and discussed later in this report.

TCAG'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 9, the TCAG model estimate for the region has a correlation coefficient of 0.80 between the modeled and the observed volumes. The root mean square error (RMSE) for daily traffic assignment in the model is 68 percent, which is outside the suggested criterion of 40 percent. Additionally, only 63 percent of the links with volume-to-count ratios from the model for the TCAG region 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 where data were collected may have contributed to this difference.

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<sup>40</sup> Highway Performance Monitoring System is a federally mandated program to collect roadway usage statistics for essentially all public roads in the US.



**Table 9: Static Validation According to CTC’s 2010 RTP Guidelines**

<b>Validation Item</b>	<b>Criteria for Acceptance</b>	<b>TCAG Model</b>
Correlation coefficient	at least 0.88	0.80
Percent RMSE	below 40%	68%
Percent of links with volume-to-count ratios within Caltrans deviation allowance	at least 75%	63%

***EMFAC Model***

ARB’s Emission Factor model (EMFAC2011) is a California-specific 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. TCAG used EMFAC 2011, which was the latest approved version of the model at the time the RTP/SCS was being developed, to quantify GHG emissions following instructions provided by ARB staff.

**3. Off-Model Adjustments**

In 2012, TCAG’s consultant, Fehr & Peers, developed the smart growth post-processor (TxD) for its 2014 RTP/SCS. The TxD was funded by the California Department of Transportation (Caltrans) to evaluate and adjust travel model sensitivity based on empirical research. The TxD factor was applied to adjust VMT associated with HBW and HBO trip purposes. Based on the result of the off-model analysis, TCAG claims an overall reduction of per capita VMT from all trip purposes of 2.16 percent and 1.56 percent in 2020 and 2035, respectively.

**4. Planned Model Improvements**

For the next RTP update anticipated in 2018, TCAG 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 ACS, and the 2012 CHTS travel data for model recalibration and revalidation. These model improvements will increase the accuracy of estimates and forecasts of external trips, trip modes, distribution for internal and interregional travel, and vehicle speeds (which is critical for air quality analysis).

TCAG is currently developing a mode choice tool, which will help to analyze the regional transportation system impacts of transportation and transit projects and policies (e.g. high-occupancy vehicle (HOV) lanes, toll facilities, high-occupancy toll (HOT) lanes, park-and-ride facilities, bus rapid transit) for the next RTP update.

In this staff report, throughout the above sections on data inputs and assumptions and modeling tools, ARB staff offers recommendations and suggestions for TCAG to improve the model’s forecasting ability. These recommendations, summarized in the

following table, should be considered during TCAG’s currently ongoing model improvement program.

**Table 10: Suggestions and Recommendations for Model Improvement**

<b>ARB Staff Suggestions for TCAG Model Improvements</b>
Consider developing a GIS-based transit network that includes geocoded transit lines, stops, headway, and fare information to better estimate transit travel time
Include costs such as tire and maintenance costs in estimating auto operating cost
Include sensitivity to land use and transit accessibility in modeling auto ownership
Validate the vehicle ownership model results against the Department of Motor Vehicles’ (DMV) data
Include some sensitivity to land-use mix, particularly in areas with high transit use to capture the transit-oriented development travel behavior
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
Develop a destination choice model or other method, 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
Provide goodness-of-fit statistics, the frequency distribution of trip lengths, and coincident ratios for different trip types in future model documentation
Continue improving the mode choice tool with updated household travel data and transit ridership data to better capture how the residents and commuter travel to different activities in the region
Continue to gather the most recent traffic count data at different facility types to ensure there are sufficient sample size
Improve its representation of residential density in their model so that the model is more sensitive

### **C. 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 a change in one input variable 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 TCAG conduct a series of sensitivity analyses for its model using the following variables:

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

ARB staff prepared input files for the income distribution test and provided general procedures for running several other tests.

Model sensitivity test results were compared to findings in the empirical literature as discussed in ARB policy briefs and corresponding technical background documents<sup>41</sup> 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 or sensitive in magnitude. If the modeled direction of change was consistent with findings in the empirical literature, the model was considered directionally sensitive. If the amount of change predicted by the model was consistent with the literature, the model was considered sensitive in magnitude. In those cases where sensitivity test results could not be specifically corroborated by the empirical literature, ARB staff has indicated whether the model was at least sensitive directionally, meaning that changes in model inputs resulted in expected changes to model outputs.

### **1. Auto Operating Cost Sensitivity Test**

Auto operating cost is an important factor influencing travelers' auto use. TCAG used four scenarios to examine the responsiveness of the model to changes in auto operating cost. These four scenarios included a 25 percent decrease, 50 percent decrease, 25 percent increase, and 50 percent increase from the base case. TCAG's definition of auto operating cost for the region includes fuel price only, similar to other Valley MPOs. When auto operating cost increases, the number of drive-alone trips is expected to shift to shared ride two (SR2), shared ride three plus (SR3+), transit, bicycling, and/or walking. With respect to VMT, it is expected that as auto operating cost increases, travelers are expected to drive less. Conversely, when auto operating cost decreases, travelers are expected to drive more.

Figure 6 summarizes the change in mode share for the four modeled scenarios. As expected, as auto operating cost increases, the percentage of drive alone trips decreases while the percentages of other modes such as HOV and non-motorized increase, although the percentage increases in these modes are small. TCAG staff explained the subtle changes in mode share are due to the limited transit service coverage within the region and also due to commuting outside population centers, to job centers in rural areas. Even when auto operating cost increases or decreases, residents in the TCAG region must still rely on the auto mode to reach their destinations. In addition, the current model utilized a synthetic transit network and the lack of transit data made it difficult to capture transit mode share change.

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<sup>41</sup> These policy briefs and technical background documents, which seek to identify the impacts of key transportation and land use policies on vehicle use and greenhouse gas emissions, based on the scientific literature, can be found at <http://arb.ca.gov/cc/sb375/policies/policies.htm>

**Figure 6: Mode Share Split and Auto Operating Cost**

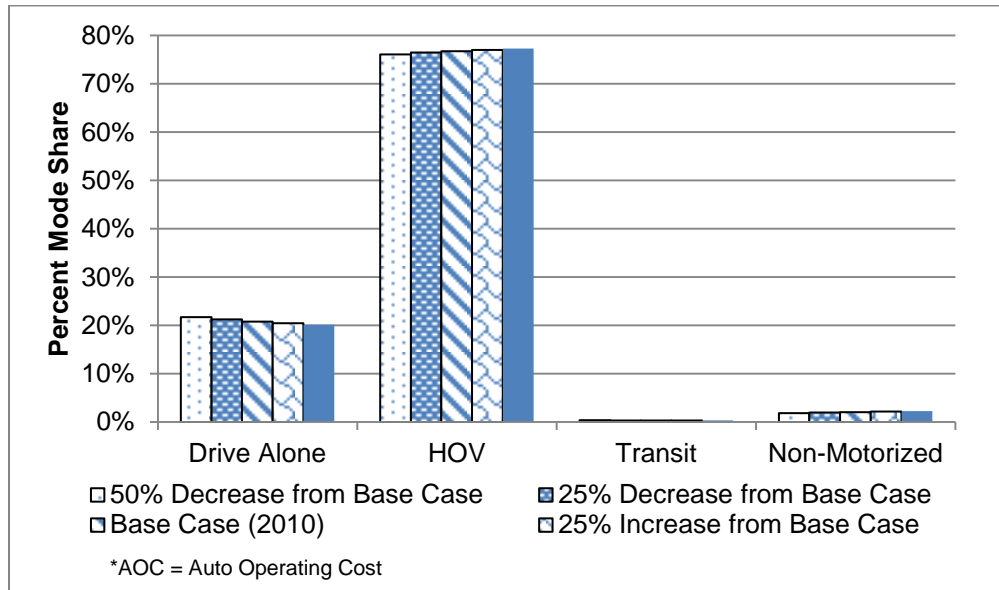


Table 11 summarizes the VMT changes related to changes in auto operating cost. As auto operating cost increases, the model shows a decrease in VMT, which is expected. ARB staff compared these modeled VMTs to what would be expected based on the elasticity<sup>42</sup> of VMT with respect to the change in auto operating cost from the empirical literature. The modeled VMT from each of TCAG's sensitivity tests changed in the expected direction and fell within the expected range.

<sup>42</sup> Elasticity is defined as the percent change in one variable divided by the percent change in another variable.

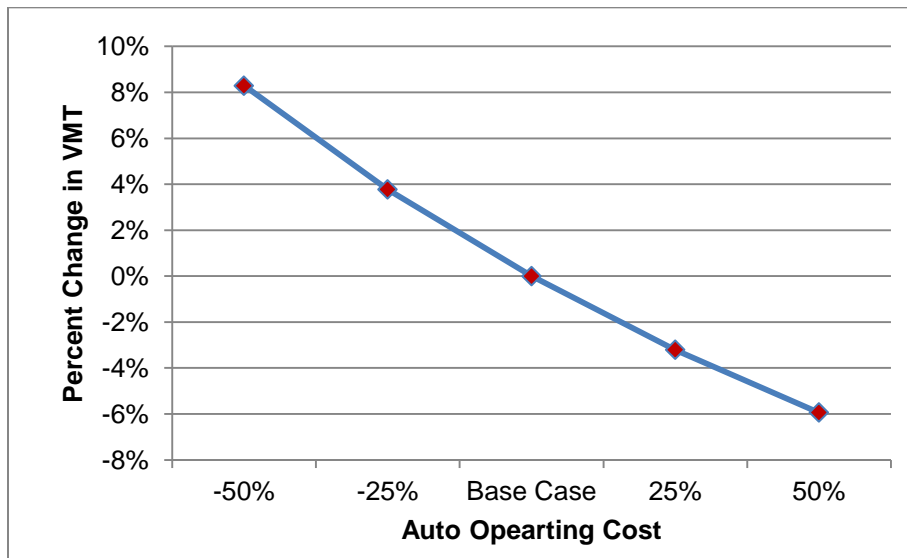
**Table 11: Auto Operating Costs – Sensitivity Results**

Test	Modeled VMT	Expected VMT (Short-Run)	Expected VMT (Long-Run)
50% Decrease from Base Case	10,989,379	10,249,817 - 11,315,392	10,706,492 - 11,873,551
25% Decrease from Base Case	10,530,818	10,199,076 - 10,731,863	10,427,413 - 11,010,942
<b>Base Case (2010)</b>	<b>10,148,334</b>	--	--
25% Increase from Base Case	9,822,302	9,564,805 - 10,097,592	9,285,726 - 9,869,255
50% Increase from Base Case	9,545,322	8,981,276 - 10,046,851	8,423,117 - 9,590,176

Source: -0.026 (Small and Van Dender, 2010) , -0.195 (Burt and Hoover, 2006), and -0.091 to -0.093 (Boillard, 2010) for short-run; -0.131 (Small and Van Dender, 2010), and -0.29 to -0.31 (Goodwin et al., 2004) for long-run.

Figure 7 shows the VMT changes with respect to changes in auto operating cost under the four scenarios as compared to the base case. As auto operating cost increases, the model shows a decrease in VMT.

**Figure 7: VMT Change and Auto Operating Cost**



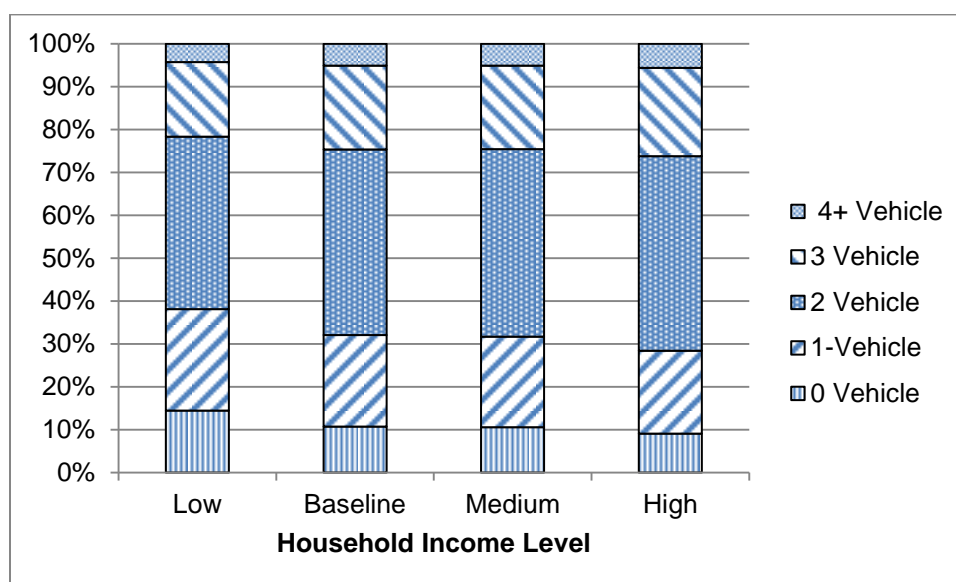
## 2. Household Income Distribution

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

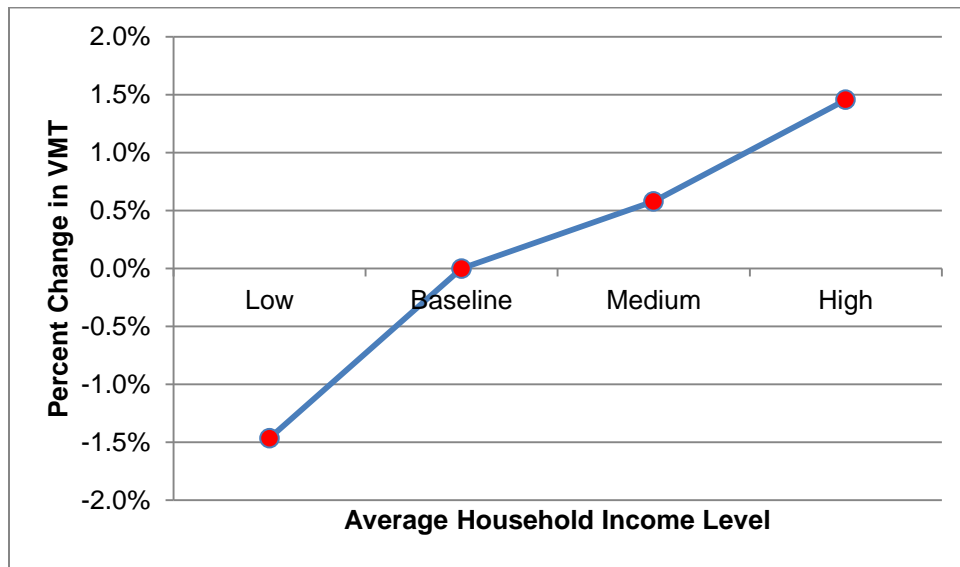
To test the responsiveness of the TCAG model to changes in household income distribution, three scenarios were designed and tested using the average household income as an indicator, while controlling the total number of households at approximately the same as in the base case. The 2010 average household income of \$50,193 from the TCAG model was used as the base case. ARB staff designed three scenarios with average household incomes of Low (\$42,101), Medium (\$51,295) and High (\$66,117). Figure 8 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 8: Household Vehicle Ownership Distribution**



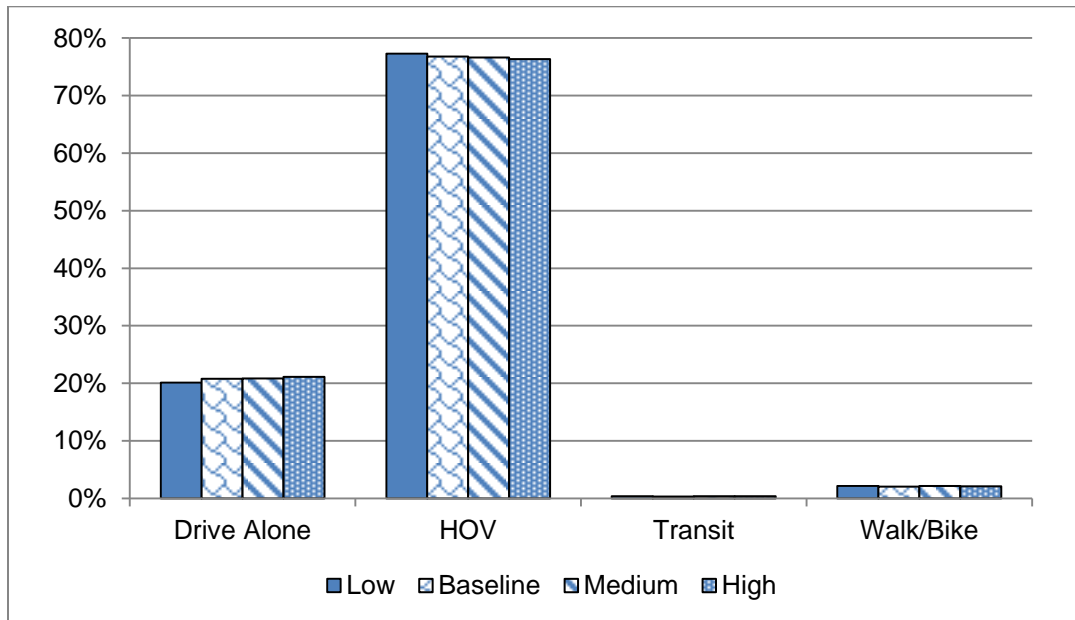
There is relatively little in the empirical literature that cites the direct effect of household income on household VMT. Murakami and Young (1997) report that low income households make 20 percent fewer trips than other households. Since this number counts all trips (including walking and transit), the effect on VMT is even more significant: VMT per household in low income households is about half of that in other households. Figure 9 shows the change in VMT for each household income scenario. The test results showed the TCAG 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 TCAG model to the change in average household income is similar to that of other MPO models in California.

**Figure 9: 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 10 the mode share responded to changes in household income distribution as expected. Though the change is subtle, the drive alone share increased with increasing household income while transit and non-motorized trips decreased.

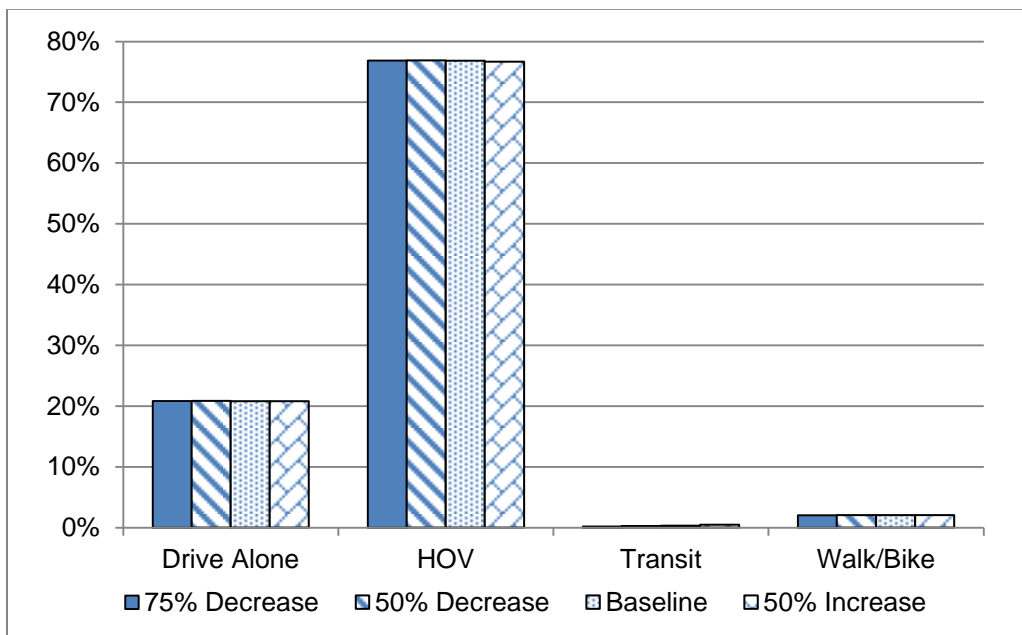
**Figure 10: Mode Share Response to Household Income Changes**



### 3. Transit Frequency

Transit service frequency is known to influence transit ridership. To determine the responsiveness of the TCAG model to transit frequency, four alternative frequencies were tested in addition to the base case: 1) 50 percent increase; 2) 50 percent decrease; 3) 75 percent decrease; and 4) 100 percent decrease. When transit frequency increases, it is expected that transit mode share will increase. Figure 11 shows the change in mode share as transit frequency changes. The test results do not show a significant difference from one test scenario to another. The overall transit mode share in TCAG is very low (0.33% in 2010 base case) and transit coverage in the base year is limited, so it is not surprising that there is almost no change. The change in transit mode share with respect to the change in transit frequency also was not in the expected direction. TCAG staff explained that this may be due to limitations of their current mode choice estimation of the model, which will be improved with the use of a mode choice tool that is currently under development (see discussion of Model Improvements).

**Figure 11: Impact of Transit Frequency on Mode Share**



### 4. 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.

TCAG, with assistance from ARB staff, developed a methodology to examine the sensitivity of the 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 compared to the base case. The tests focused on the urban areas of the TCAG region to match the urban area focus of the empirical literature. For each test, TCAG kept the totals for each housing type the same as the 2010 base case. For the density-increasing scenarios, TCAG 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. TCAG 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 tests showed that when residential density increased, VMT decreased, and vice versa (Table 12). TCAG’s sensitivity analysis indicates that the model is not directionally sensitive to changes in residential density. The change of VMT in magnitude is outside the expected range. TCAG explained that Tulare County has mostly rural areas and very limited urban area, the residential density at TAZ level stayed almost unchanged from one test scenario to another.

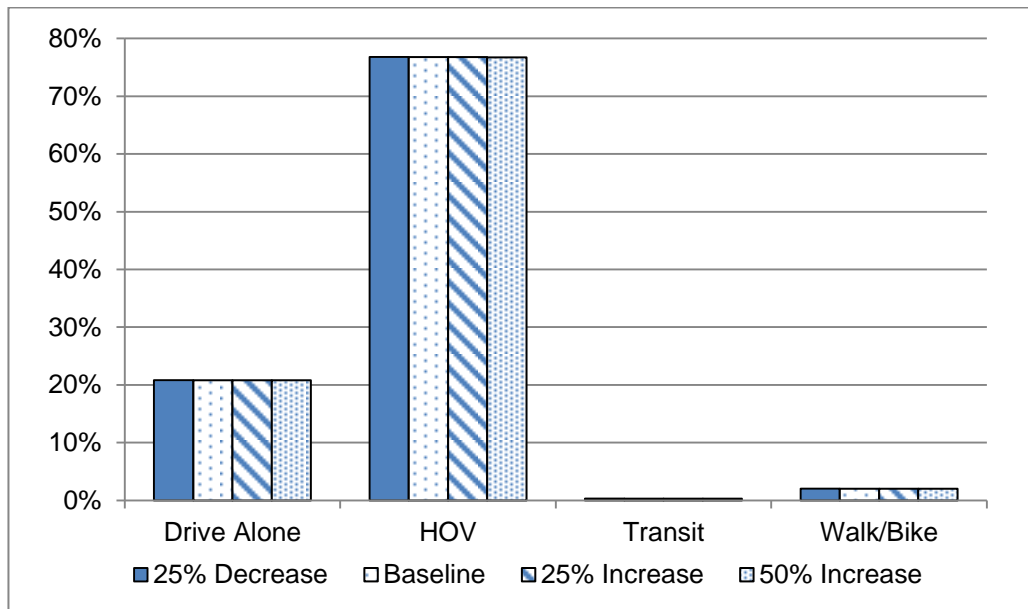
**Table 12: Impact of Residential Density on VMT**

Test	Modeled VMT	Expected VMT
<b>25% Decrease from Base Case</b>	10,149,765	10,275,188 - 10,452,784
<b>Base Case (2010)</b>	10,148,334	--
<b>25% Increase from Base Case</b>	10,163,493	9,843,884 - 10,021,480
<b>50% Increase from Base Case</b>	10,148,637	9,539,434 - 9,894,626

*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, test results also showed that mode shares for auto stayed almost unchanged across scenarios (Figure 12). For future residential density sensitivity testing, ARB will continue to work with TCAG to explore a more suitable test method for rural counties. In addition, TCAG could improve its representation of residential density in their model so that the model is more sensitive.

**Figure 12: Impact of Residential Density on Mode Share**



## D. SCS Performance Indicators

ARB staff examined changes in non-GHG indicators that describe SCS performance to look for qualitative evidence that the SCS could meet the region’s targets. The evaluation looked at directional consistency of the indicators with TCAG’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-published policy briefs and corresponding technical background documents<sup>43</sup>. The SCS performance indicators evaluated include residential density, mix of housing types, farmland preservation, jobs and housing near transit, average auto trip length, and per capita passenger VMT.

### 1. Land Use Indicators

The evaluation focused on three performance indicators related to land use: changes in residential density, mix of housing types, and farmland preservation. These three indicators are focused on new development only between the plan’s base year (2010) and 2035.

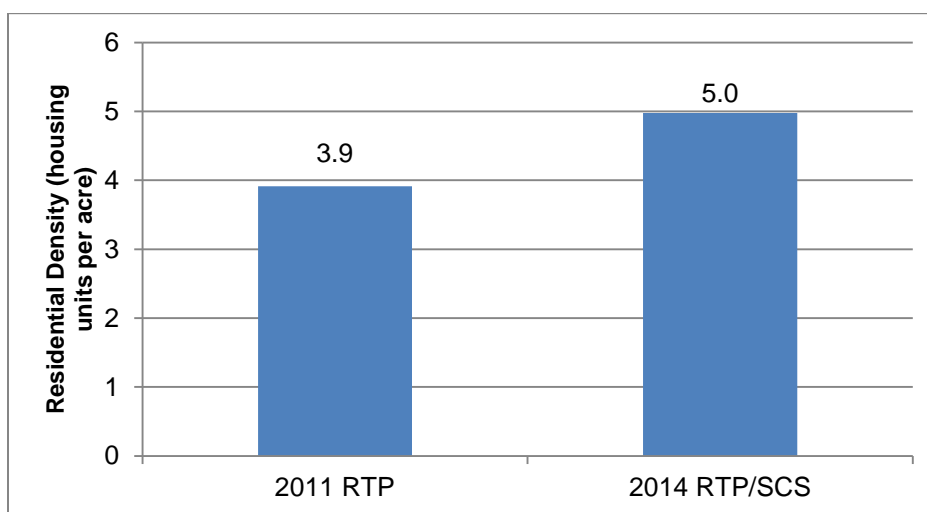
<sup>43</sup> These policy briefs and technical background documents, which seek to identify the impacts of key transportation and land use policies on vehicle use and greenhouse gas emissions, based on the scientific literature, can be found at <http://arb.ca.gov/cc/sb375/policies/policies.htm>

### ***Residential Density***

Residential density is a measure of the average number of dwelling units per acre of developed residential land. When residential density increases, it is expected to change travel behavior including a reduction in average trip length, and a related 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 per year per household and consume 64.7 fewer gallons of fuel per year per household than households in less dense areas. Boarnet and Handy (2014) reported that doubling residential density reduces VMT an average of five to 12 percent.

Based on the land use data provided by TCAG, residential density of new development will increase from 3.9 to 5.0 dwelling units per residential acre between 2010 and 2035 (Figure 13). The residential density associated with new growth increased by 27 percent in the 2014 RTP/SCS compared to the 2011 RTP. Based on findings from existing literature, this increase in residential density will reduce household VMT, and the resulting reduction in CO<sub>2</sub> emissions. The reduction in VMT can be attributed to shorter auto trips and, shifts in travel mode away from single occupant vehicles.

**Figure 13: Residential Density of New Development (2010 – 2035)**

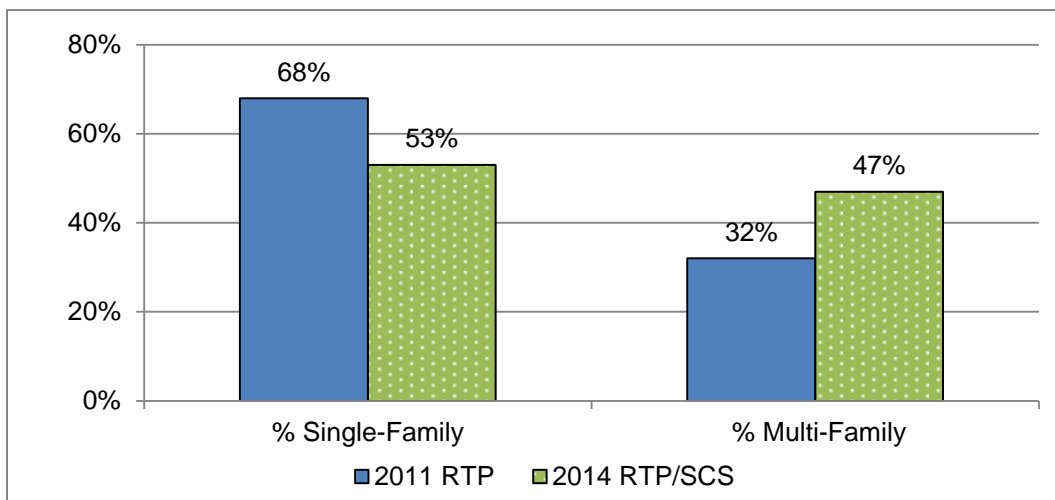


### ***Mix of Housing Types***

The mix of single-family and multi-family housing influences the land use patterns in a region. The greater the proportion of housing growth that is multi-family, 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 an emphasis on single unit homes on large lots to single unit homes on smaller lots and multi-family housing, the travel characteristics in the TCAG region are expected to change.

TCAG’s 2014 RTP/SCS indicates such a shift towards a greater percentage of new multi-family housing units. Figure 14 shows the percentage of new housing types anticipated by the 2014 RTP/SCS as compared to the prior plan. By 2035, the share of new multi-family housing units is forecasted to increase from 32 percent of the total new housing units (2011 RTP) to 47 percent (2014 RTP/SCS). The share of single-family units decreases from 68 percent of new units to 53 percent of new units by 2035.

**Figure 14: Shift towards Multi-Family Housing (2010-2035)**



***Farmland Preservation***

The San Joaquin Valley is known as a major agriculture production area in the United States. The RTP/SCS encourages development within existing communities to preserve farmland in the region (Figure 15). Figure 16 compares the forecasted consumption of farmland as defined in SB 375<sup>44</sup> between the 2011 RTP and the 2014 RTP/SCS. The 2014 RTP/SCS consumes fewer acres of farmland by 2035 as compared to the 2011 RTP.

<sup>44</sup> Important farmland outside of existing spheres of influence, including prime and unique farmland and farmland of statewide importance.

Figure 15: Existing Farmland

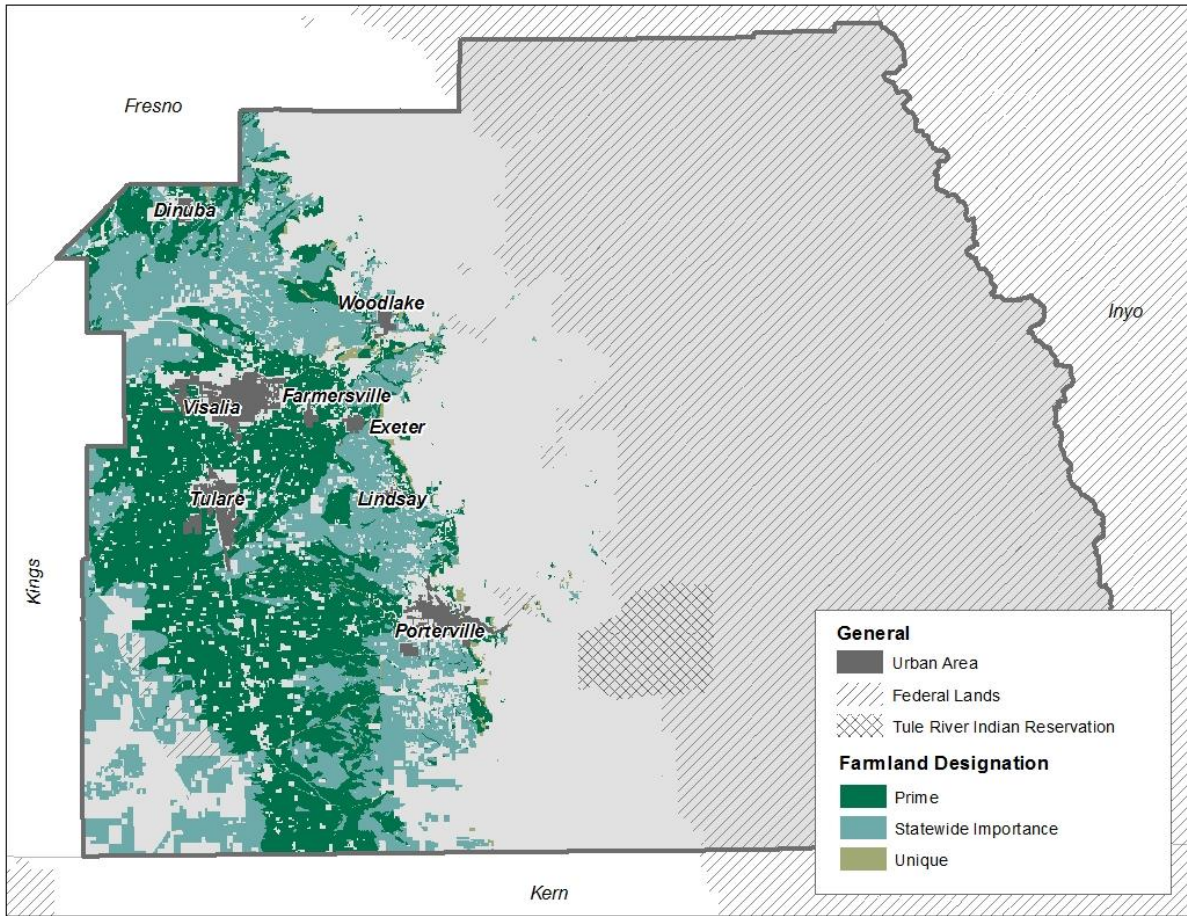
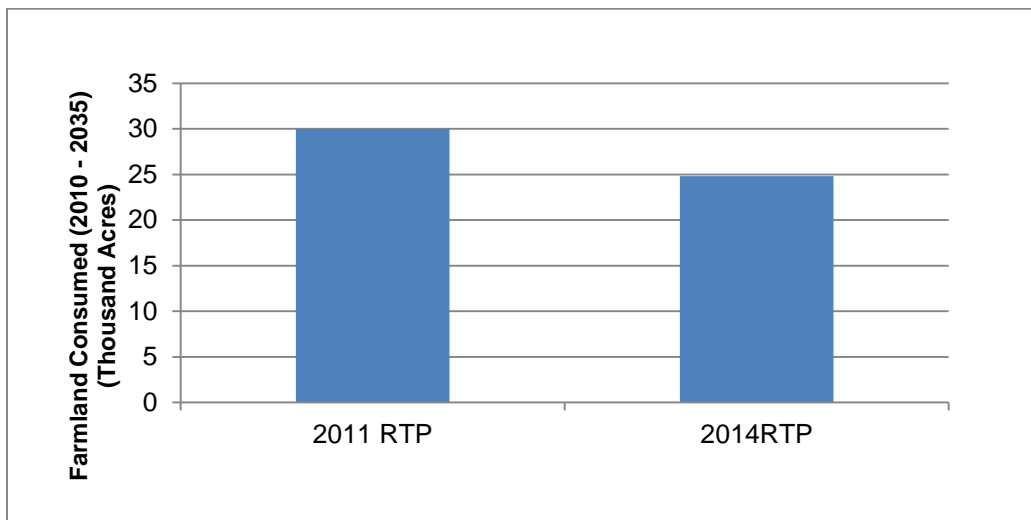


Figure 16: Farmland Consumed by 2035



## 2. Transportation-related Indicators

ARB staff evaluated three transportation-related performance indicators: the number of jobs and housing near transit, average auto trip length, and passenger VMT.

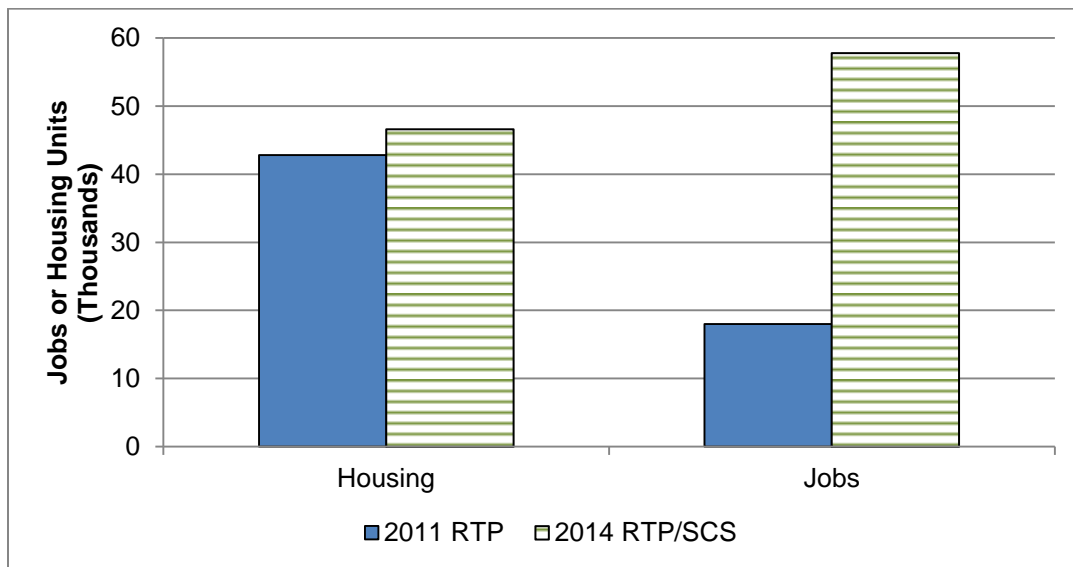
### ***Jobs and Housing Near Transit***

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, reduce vehicle trips, and subsequently reduce passenger vehicle-related GHG emissions.

One study shows 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). Another study also illustrates significant VMT reductions through placement of housing and employment closer to rail stations and bus stops (Tal, et.al 2013).

Figure 17 summarizes the forecasted number of jobs and housing units within one-half mile of transit stations or stops based on TCAG's 2014 RTP/SCS. Compared to the prior plan, the 2014 RTP/SCS shows an increase in the numbers of jobs and housing units near transit, between 2010 and 2035.

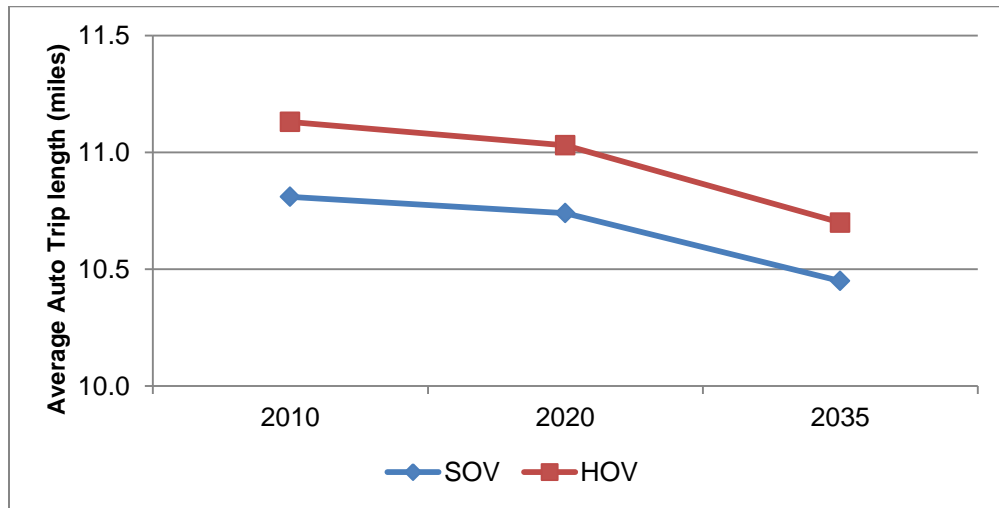
**Figure 17: Jobs and Housing Near Transit in the TCAG Region (2010 – 2035)**



### ***Average Auto Trip Length***

Figure 18 shows the change in average auto trip length by mode for all trip purposes in the TCAG region. The data show that the average auto trip length for SOV mode decreases by three percent between 2010 and 2035, while during the same time period, HOV trip length decreases by four percent. These trends support the GHG emissions reductions estimated for the TCAG region.

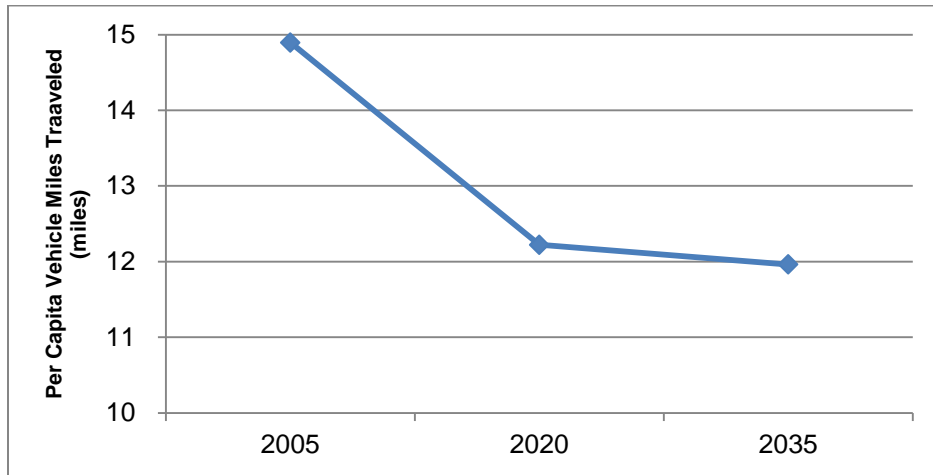
**Figure 18: Average Auto Trip Length in TCAG Region**



***Per Capita VMT***

The TCAG 2014 RTP/SCS shows a decline in per capita passenger vehicle VMT between 2005 and 2035, as shown in Figure 19. Per capita VMT decreases by 18 percent between 2005 and 2020, and by 20 percent between 2005 and 2035. Supporting statistics provided by TCAG show that average weekday trip length for all auto trips (including single-occupancy vehicle trips and high-occupancy vehicle trips for all trip purposes) will be reduced from 2010 to 2035 consistently. Reduction in per capita VMT indicates reduction in per capita GHG emissions because the quantification of GHG emissions from passenger vehicles is a function of VMT and vehicle speeds. These results are directionally consistent and support TCAG’s reported per capita GHG emissions reduction trend over time.

**Figure 19: Per Capita Passenger VMT**



## **V. CONCLUSION**

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



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## APPENDIX A. TULARE COUNTY ASSOCIATION OF GOVERNMENTS' RTP/SCS DATA TABLE

Modeling Parameters	2005 (if available)	2010 (base year)	2020 With Project	2020 Without Project	2035 With Project	2035 Without Project	2040 With Project	2040 Without Project	Data Sources
<b>DEMOGRAPHICS</b>									
Total population	404,148	442,179	5,726	520,542	664,878	664,878	721,391	721,391	DOF, TCAG Demographic Forecast
Group quarters population	5,490	4,772	194,174	5,726	7,314	7,314	7,935	7,935	DOF, TCAG Demographic Forecast
Total employment (employees)	166,300	113,210	N/A	194,174	243,420	243,420	262,591	262,591	CA EDD, Labor Market Info; TCAG Demographic Forecast
Average unemployment rate (%)	9.4%	17.2%	152,128	--	--	--	--	--	CA EDD, Labor Market Info
Total number of households	118,226	130,352	3.37	152,128	191,799	191,799	207,201	207,201	DOF, TCAG Demographic Forecast
Persons per household	3.37	3.34	1.87	3.37	3.41	3.41	3.43	3.43	DOF, TCAG Demographic Forecast
Auto ownership per household	1.77	--	45,417	1.87	1.86	1.86	1.86	1.86	CTPP/ACS, TCAG Demographic Forecast
Median household income	45,415 (2006, ACS)	43,397	45,417	45,417	48,446	48,446	49,456	49,456	Planning Center SJV Forecast, 2012
<b>LAND USE</b>									
Total acres within MPO	3,098,258	3,098,258	2,997,959	3,098,258	3,098,258	3,098,258	3,098,258	3,098,258	Tulare County GIS
Total resource area acres (CA GC Section 65080.01)	--	3,004,679	703,174 (2,081)	2,996,453	2,987,878	2,984,113	2,984,518	2,980,000	Greenprint/UC Davis, TCAG
Total farmland acres (saved by project) (CA GC Section 65080.01)	724,138	N/A	100,299	701,093	699,327 (5,203)	694,124	698,045 (6,244)	691,801	Greenprint/UC Davis, TCAG
Total developed acres	N/A	93,579	23,988	101,805	110,380	114,145	113,740	118,258	TCAG RTP/SCS Scenario Planning
Total commercial developed acres	N/A	22,459	76,311	24,087	26,282	26,529	27,047	27,343	TCAG RTP/SCS Scenario Planning
Total residential developed acres	N/A	71,120	164,553	77,718	84,098	87,616	86,694	90,915	TCAG RTP/SCS Scenario Planning
Total housing units	128,388	141,696	7.55%	164,553	206,287	206,287	222,535	222,535	DOF, TCAG Demographic Forecast
Housing vacancy rate	7.93%	8.01%	122,063	7.55%	7.02%	7.02%	6.89%	6.89%	DOF, TCAG Demographic Forecast
Total single-family detached housing units	100,356	110,752	N/A	126,573	144,978	154,642	154,953	165,319	DOF, TCAG Demographic Forecast

Total small-lot single family detached housing units (6,000 sq. ft. lots and smaller)	--	9,511	--	--	18,754	20,689	--	--	Estimated from TCAG Scenario Planning
Total conventional-lot single family detached units (between 6,001 and 21,780 sq. ft. lots)	--	81,556	--	--	98,842	112,937	--	--	Estimated from TCAG Scenario Planning
Total large-lot single family detached units (21,781 sq ft. lots and larger)	--	19,657	--	--	27,355	20,989	--	--	Estimated from TCAG Scenario Planning
Total single-family attached housing units	--	Included in small lot SF	42,490	--	Included in small lot SF	Included in small lot SF	--	--	Estimated from TCAG Scenario Planning
Total multi-family housing units	28,032	30,944	N/A	37,980	61,309	51,645	67,582	57,216	DOF, TCAG Demographic Forecast
Total mobile home units & other	(10,347 included in multi-family)	--	--	--	--	--	--	--	DOF, TCAG Demographic Forecast
Total infill housing units	--	--	--	--	--	--	--	--	N/A
Total mixed use buildings	--	--	--	--	--	--	--	--	N/A
Total housing units within 1/4 mile of transit stations and stops	--	48,414	--	--	69,497	59,940	--	--	TCAG Model
Total housing units within 1/2 mile of transit stations and stops	--	95,773	--	--	142,362	138,547	--	--	TCAG Model
Total employment within 1/4 mile of transit stations and stops	--	70,301	--	--	97,408	75,151	--	--	TCAG Model
Total employment within 1/2 mile of transit stations and stops	--	93,760	--	--	151,525	111,781	--	--	TCAG Model
<b>TRANSPORTATION SYSTEM</b>									
Freeway general purpose lanes – mixed flow lane miles	334.95	334.95	2,184.43	365.14	384.93	384.93	401.49	401.49	TCAG Model
Highway (lane miles)	2,199.08	2,199.08	101.03	2,184.43	2,114.59	2,114.59	2,117.18	2,117.18	TCAG Model
Expressway (lane miles)	63.97	63.97		101.03	241.60	241.60	241.60	241.60	TCAG Model
HOV (lane miles)			999.41						TCAG Model
Arterial (lane miles)	918.26	918.01	502.44	999.41	1,134.74	1,134.74	1,141.85	1,141.85	TCAG Model
Collector (lane miles)	461.75	465.06	3.08	502.44	545.01	545.01	545.01	545.01	TCAG Model
Local (lane miles)	3.01	3.01	5.25	3.08	3.08	3.08	3.08	3.08	TCAG Model
Freeway-Freeway (lane miles)	3.69	3.69	N/A	5.25	7.13	7.13	7.13	7.13	TCAG Model
Local, express bus, and neighborhood shuttle operation miles	--	--	--	--	--	--	--	--	(Average Daily) TCAG FY 2010-12 Triennial Perf. Audit

Bus rapid transit bus operation miles	--	--	--	--	--	--	--	--	N/A
Passenger rail operation miles	--	--	--	--	--	--	--	--	N/A
Transit total daily vehicle service hours	--	674	--	--	--	--	--	--	TCAG PY 2010-12 Triennial Perf. Audit
Bicycle and pedestrian trail/lane miles	--	--	3,348	--	--	--	--	--	
Vanpool (total riders per weekday)	633	1,538	3,348	3,348	6,062	6,062	6,967	6,967	Est. from CalVans 2014 data & 2002-2014 growth rate
<b>TRIP DATA</b>									
Number of trips by trip purpose	--	--	347,117	--	--	--	--	--	
Home-based work	288,974	296,493	787,923	342,090	427,869	423,898	459,823	455,736	TCAG Model
Home-based other	656,598	678,912	84,619	780,188	977,791	972,689	1,053,089	1,047,581	TCAG Model
Non-home-based work	73,682	75,392	519,703	92,246	105,464	114,967	113,560	123,907	TCAG Model
Non-home-based other	455,304	431,991	519,703	532,183	650,616	666,517	701,736	718,875	TCAG Model
<b>MODE SHARE</b>									
Vehicle Mode Share (Peak Period)	--	--	20.97	--	--	--	--	--	
SOV (% of trips)	21.65	20.93	77.29	20.92	20.84	20.74	20.77	20.64	TCAG Model
HOV (% of trips)	76.73	77.16	0.25	77.26	77.29	77.56	77.31	77.49	TCAG Model
Transit (% of trips)	0.26	0.27	1.49	0.34	0.23	0.23	0.26	0.23	TCAG Model
Non-motorized (% of trips)	1.36	1.65		1.58	1.64	1.47	1.65	1.64	TCAG Model
Vehicle Mode Share (Whole Day)	--	--	20.88	--	--	--	--	--	
SOV (% of trips)	21.56	20.83	76.95	20.82	20.74	20.65	20.67	20.54	TCAG Model
HOV (% of trips)	76.41	76.79	0.31	76.91	76.93	77.23	76.94	77.12	TCAG Model
Transit (% of trips)	0.32	0.33	1.87	0.28	0.28	0.28	0.33	0.28	TCAG Model
Non-motorized (% of trips)	1.71	2.06	--	1.98	2.04	1.83	2.06	2.06	TCAG Model
Average weekday trip length (miles)	--	--	10.74	--	--	--	--	--	
SOV	12.27	10.81	11.03	10.78	10.45	10.50	10.36	10.40	
HOV	12.40	11.13	7.16	11.03	10.70	10.70	10.59	10.58	TCAG Model (Average of SR2 & SR3+)
Transit	8.45	6.69	5.64	7.70	7.03	7.07	7.43	6.98	
Walk	5.61	5.28	--	5.59	5.53	5.52	5.56	5.50	TCAG Model (Average of Bike & Walk)
Bike	--	--	--	--	--	--	--	--	
Average weekday travel time (minutes)	--	--	16.51	--	--	--	--	--	
SOV	18.14	16.76	16.78	16.67	16.17	16.34	16.12	16.26	
HOV	18.23	17.04	12.46	16.88	16.40	16.51	16.32	16.41	TCAG Model (Average of SR2 & SR3+)

Transit	13.86	11.84	10.53	13.19	12.20	12.21	12.87	12.10	
Walk	10.43	10.11	--	10.53	10.44	16.43	10.45	10.42	TCAG Model (Average of Bike & Walk)
Bike	--	--	--	--	--	--	--	--	
<b>TRAVEL MEASURES</b>									
Total VMT per weekday for passenger vehicles (ARB vehicle classes of LDA, LDT1, LDT2 and MDV) (miles)	7,267,000	--	5,229,417	7,933,000	9,479,000	9,762,000	10,094,000	10,416,000	TCAG Travel Model & EMFAC 2011
Total II (Internal) VMT per weekday for passenger vehicles (miles)	4,927,411	--	1,133,323	5,441,161	6,660,076	6,934,750	7,173,627	7,474,419	TCAG Travel Model & EMFAC 2011
Total IX/XI VMT per weekday for passenger vehicles (miles)	1,092,825	--	1,340,260	1,120,274	1,292,923	1,273,850	1,340,857	1,327,450	TCAG Travel Model & EMFAC 2011
Total XX VMT per weekday for passenger vehicles (miles)	1,246,764	--	283,444	1,371,564	1,526,000	1,553,400	1,579,517	1,614,132	TCAG Travel Model & EMFAC 2011
Congested Peak Hour VMT on freeways (Lane Miles, V/C ratios >0.75)	313,949	--	316,877	279,421	313,092	309,343	319,446	314,847	TCAG Travel Model & EMFAC 2011
Congested Peak VMT on all other roadways (Lane Miles, V/C ratios >0.75)	12,900	--	316,877	314,439	341,115	345,462	368,560	358,252	TCAG Travel Model & EMFAC 2011
<b>CO2 EMISSIONS</b>									
Total CO2 emissions per weekday for passenger vehicles (ARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons)	3,440	--	2,488	3,776	4,548	4,687	4,850	5,006	TCAG Travel Model & EMFAC 2011
Total II (Internal) CO2 emissions per weekday for passenger vehicles (tons)	2,333	--	539	2,590	3,195	3,330	3,447	3,592	TCAG Travel Model & EMFAC 2011
Total IX / XI trip CO2 emissions per weekday for passenger vehicles (tons)	517	--	638	533	620	612	644	638	TCAG Travel Model & EMFAC 2011
Total XX trip CO2 emissions per weekday for passenger vehicles (tons)	590	--	638	653	732	746	759	776	TCAG Travel Model & EMFAC 2011
<b>INVESTMENT (Billions)</b>									
Total RTP Expenditure (YOE \$)	--	--	0.439	1.178	4.208	3.830	5.183	4.713	2011, 2014 RTP, both calculated 2014 forward
Highway capacity expansion (YOE \$)	--	--	0.206	0.490	1.478	1.632	1.824	2.012	2011, 2014 RTP, both calculated 2014 forward
Other road capacity expansion (YOE \$)	--	--	0.470	0.194	0.672	0.589	0.828	0.721	2011, 2014 RTP, both calculated 2014 forward



Roadway maintenance (YOE \$)	--	--	--	0.339	1.499	1.104	1.842	1.359	2011, 2014 RTP, both calculated 2014 forward
BRT projects (2006 \$)	--	--	0.166	--	--	--	--	--	BRT/Light Rail Feasibility Study in 2006
Transit capacity expansion + operation (YOE \$)	--	--	--	0.151	0.544	0.492	0.670	0.605	2011, 2014 RTP, both calculated 2014 forward
Transit operations (YOE \$) (combined w/cap. exp.)	--	--	0.005	--	--	--	--	--	N/A
Bike and pedestrian projects (2006 \$)	--	--	0.005	0.004	0.015	0.013	0.019	0.016	2011, 2014 RTP, both calculated 2014 forward
<b>TRANSPORTATION USER COSTS</b>									
Vehicle operating costs (Year 2000 ¢ per mile)	11.34	--	4.46	17.78	18.85	18.85	19.2	19.2	TCAG Model
Gasoline price (Year 2000 \$ per gallon)	2.24	--		4.46	6.06	6.06	6.85	6.85	TCAG Model
Average transit fare (Year XXXX \$)	--	0.81	--	--	--	--	--	--	N/A
Parking cost (Year XXXX \$)	--	--	--	--	--	--	--	--	N/A
	--	--	--	--	--	--	--	--	--

## **APPENDIX B. 2010 CTC RTP GUIDELINES ADDRESSED IN TULARE COUNTY ASSOCIATION OF GOVERNMENTS' RTP/SCS**

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

### **Requirements**

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

### **Recommendations**

- The use of three-step models can continue for the next few years. The models should be run to a reasonable convergence towards equilibrium.
- The models should account for the effects of land use characteristics on travel, either by incorporating effects into the model process or by post-processing.
- During the development period of more sophisticated/detailed models, there may be a need to augment current models with other methods to achieve reasonable levels of sensitivity. Post-processing should be applied to adjust model outputs where the model lack capability, or are insensitive to a particular policy or factor. The most commonly referred to post-processor is a "D's" post-processor, but post-processors could be developed for other non-D factors and policies, too.
- The model should address changes in regional demographic patterns.
- Geographic Information Systems (GIS) capabilities should be developed in these counties, leading to simple land use models in a few years.
- All natural sources data should be entered into the GIS.

- Parcel data should be developed within a few years and an existing land use data layer created.
- For the current RTP cycle (post last adoption), MPOs should use their current travel demand model for federal conformity purposes, and a suite of analytical tools, including but not limited to, travel demand models, small area modeling tools, and other generally accepted analytical methods for determining the emissions, VMT, and other performance factor impacts of sustainable communities strategies being considered pursuant to SB 375.
- Measures of means of travel should include percentage share of all trips (work and non-work) made by all single occupant vehicle, multiple occupant vehicle, or carpool, transit, walking, and bicycling.
- To the extent practical, travel demand models should be calibrated using the most recent observed data including household travel diaries, traffic counts, gas receipts, Highway Performance Monitoring System (HPMS), transit surveys, and passenger counts.
- It is recommended that transportation agencies have an on-going model improvement program to focus on increasing model accuracy and policy sensitivity. This includes on-going data development and acquisition programs to support model calibration and validation activities.
- For models with a mode choice step, if the travel demand model is unable to forecast bicycle and pedestrian trips, another means should be used to estimate those trips.
- When the transit mode is modeled, the entire transit network within the region should be represented.
- Agencies are encouraged to participate in the California Inter-Agency Modeling Forum.
- MPOs should work closely with state and federal agencies to secure additional funds to research and implement the new land use and activity-based modeling methodologies.
- These regions should develop 4-step travel models as soon as is possible.
- 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 investigate their model's volume-delay function and ensure that speeds outputted from the model are reasonable. Road capacities and speeds should be validated with surveys. The urban development footprint in GIS should be used to calculate environmental impacts on terrestrial and aquatic

ecosystems and/or inform the land use model of areas to be avoided in order to help locate alternative development.