TECHNICAL EVALUATION OF THE GREENHOUSE GAS EMISSION REDUCTION QUANTIFICATION FOR BUTTE COUNTY ASSOCIATION OF GOVERNMENTS' SB 375 SUSTAINABLE COMMUNITIES STRATEGY

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California Environmental Protection Agency

Air Resources Board

Electronic copies of this document can be found on ARB's website at
http://www.arb.ca.gov/cc/sb375/sb375.htm.

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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 for 2020 and 2035, set by the Board in 2010.

The Butte County Association of Governments (BCAG) released the Public Review Draft of their Metropolitan Transportation Plan (MTP), on September 27, 2012. The MTP includes a chapter that serves as the region's SCS. It contains integrated land use and transportation strategies that will allow the Butte region to achieve targets for reducing greenhouse gas emissions by 2035. This region with approximately 220,000 people in the northern Sacramento Valley is largely agricultural with two established population centers and additional smaller jurisdictions.

For the Butte region, the Board set passenger vehicle greenhouse gas reduction targets at a one percent increase for 2020 and at one percent increase by 2035 based on the latest data available from BCAG at that time. The MTP/SCS adopted by the BCAG Board in December 2012 affirms that the region will achieve greenhouse gas reductions beyond the established targets by reducing greenhouse gas emissions by two percent in 2020 and two percent in 2035. On December 17, 2012, BCAG transmitted the adopted SCS to ARB for review.

Consistent with ARB's July 2011 technical methodology for SCS evaluation, ARB staff prepared this technical report to support the Board's action on BCAG's MTP/SCS. This report describes both the method ARB staff used to review BCAG's SCS greenhouse gas quantification and the results of ARB staff's technical evaluation. Specifically, staff reviewed how well the region's travel demand modeling and related analyses provide for the quantification of GHG emission reductions associated with the SCS. This included reviewing data inputs, planning assumptions on future year land use, housing, and transportation policies, and modeling results.

This review affirms that BCAG's adopted SCS demonstrates that, if implemented, the region will achieve a two percent per capita passenger vehicle greenhouse gas reduction in 2020, and a two percent reduction in 2035, exceeding the established targets.

I. BUTTE REGION

A. Background

Butte County encompasses approximately 1,665 square miles in northern central California. The western part of the county is located in the northern Sacramento Valley, while the eastern portion extends into the foothills of the Cascade and Sierra Nevada Mountain Ranges. The region's elevation ranges from 50 feet above sea level in the west to 7,000 feet above sea level near the county's northeastern border.

The Butte County Association of Governments is the federally designated Metropolitan Planning Organization (MPO) and the state designated Regional Transportation Planning Agency for Butte County. The BCAG Board of Directors includes each of the five Butte County Supervisors and one council person from each of the five incorporated cities/town: the cities of Biggs, Chico, Gridley, Oroville, and the Town of Paradise. The County is also home to four Native American Rancherias. These include Berry Creek Rancheria, Chico Rancheria, Enterprise Rancheria, and Mooretown Rancheria. Numerous unincorporated communities also dot the region. Development of the BCAG's 2012 Metropolitan Transportation Plan/Sustainable Communities Strategy was conducted through collaboration with member jurisdictions, the BCAG advisory committees, local Tribal Governments, interested State and federal agencies, and the public.

B. Blueprint Planning and MTP/SCS

Prior to 2008, when SB 375 introduced the requirement to develop a SCS, the Butte region had already begun efforts to integrate land use and transportation planning. Due to increasing growth pressures in the previous decade, BCAG initiated the Blueprint Planning Program in 2006 to establish a multi-faceted planning process that would help facilitate an informed land use and transportation decision-making process, and provide an improved environmental permitting process for future transportation and land use projects. One of the outcomes of the Blueprint Planning Program included the initiation of the Butte Regional Conservation Plan (BRCP). The BRCP is a joint Habitat Conservation Plan/Natural Communities Conservation Plan (HCP/NCCP) meant to bring stakeholders together to streamline development permitting and ensure habitat conservation for endangered and threatened species. The HCP/NCCP ties together federal and state conservation considerations into one planning process. Both the Blueprint Planning Program and the BRCP involved interested members of the public and local jurisdictions. These planning efforts helped to inform the land use and transportation options outlined in the BCAG Sustainable Community Strategy and led to the development of three scenarios from which BCAG crafted the region's preferred alternative.

C. BCAG Land Use Alternatives

One of the early steps BCAG took in developing their Sustainable Community Strategy was to design a number of land use and transportation alternatives. Once these alternatives were outlined, the MPO, in conjunction with its stakeholders, decided which of these alternatives best met its goals, including the regional passenger vehicle greenhouse gas reduction target of one percent increase in both 2020 and 2035.

BCAG developed three distinct land use alternatives for the purpose of illustrating the travel effects of different development patterns on the regional transportation system and the associated greenhouse gas emissions resulting from these patterns. Using the three scenarios, BCAG tested the performance of its regional travel demand model to ensure it adequately reflected modeled changes in land use. The land use scenarios were designed by first assembling a "balanced" scenario. BCAG prepared the "balanced" scenario, Scenario #1, based on land use information from recent general plan updates from its members, the latest information regarding planned development, assumptions regarding infill and redevelopment, regional growth forecasts, and a review of development attractions (i.e., motorized and non-motorized transportation networks, existing development, utility areas, etc.) and discouragements (i.e., resource areas and farmland, public lands, areas exceeding 25% slope, etc.). BCAG also prepared "dispersed" (Scenario #2) and "compact" (Scenario #3) scenarios. BCAG's description of all three scenarios is summarized in Table 1.

Table 1: BCAG Description of Land Use Alternatives

Scenario	Description
Balanced (1)	• Balanced share of new housing within the center, established and new growth areas • Contains reasonable levels of infill and redevelopment • Consistent with local land use plans and draft habitat conservation plan • Consistent with BCAG long-term regional growth forecasts by jurisdiction
Dispersed (2)	• Largest share of single-family housing with a greater amount of growth directed to the new, rural, and agricultural growth areas • Minimize the amount of infill and redevelopment • Exceeds the unincorporated areas local land use plans reasonable capacities for growth
Compact (3)	• Greatest share of infill and redevelopment within the established and center growth areas • Highest share of multi-family housing • Potential incompatibilities with existing infrastructure capacity • Exceeds the incorporated areas local land use plans reasonable capacities for growth • Inconsistent with known housing type demand

Source: BCAG 2012 MTP/SCS Land Use Scenario Analysis

Each of the scenarios was prepared using consistent regional employment, population and housing growth projections and the same regional transportation network. However, the following land use variables were adjusted to create the distinctive scenarios:

- The amount of development occurring within each of the five growth areas (i.e., urban center and corridor, established, new, rural, and agricultural).
- The levels of infill and redevelopment occurring within the urban center and corridor and established growth areas.
- The shares of single-family to multi-family development.
- The amount of growth being accommodated within each local jurisdiction.

These factors are consistent with guidance on developing SCS planning assumptions provided in the CTC's 2010 RTP Guidelines (see Appendix A for applicable guideline elements).

BCAG selected the balanced scenario as the basis upon which to achieve its 2020 and 2035 greenhouse gas reductions. To further describe the framework for the region in the MTP/SCS, BCAG developed a set of five growth area types, adapted from a framework crafted by the neighboring Sacramento Area Council of Governments (SACOG). Local land use plans including adopted and proposed general plans, specific plans, master plans, corridor plans, and others were divided into one of five growth area types based on the location of the plans (Table 2).

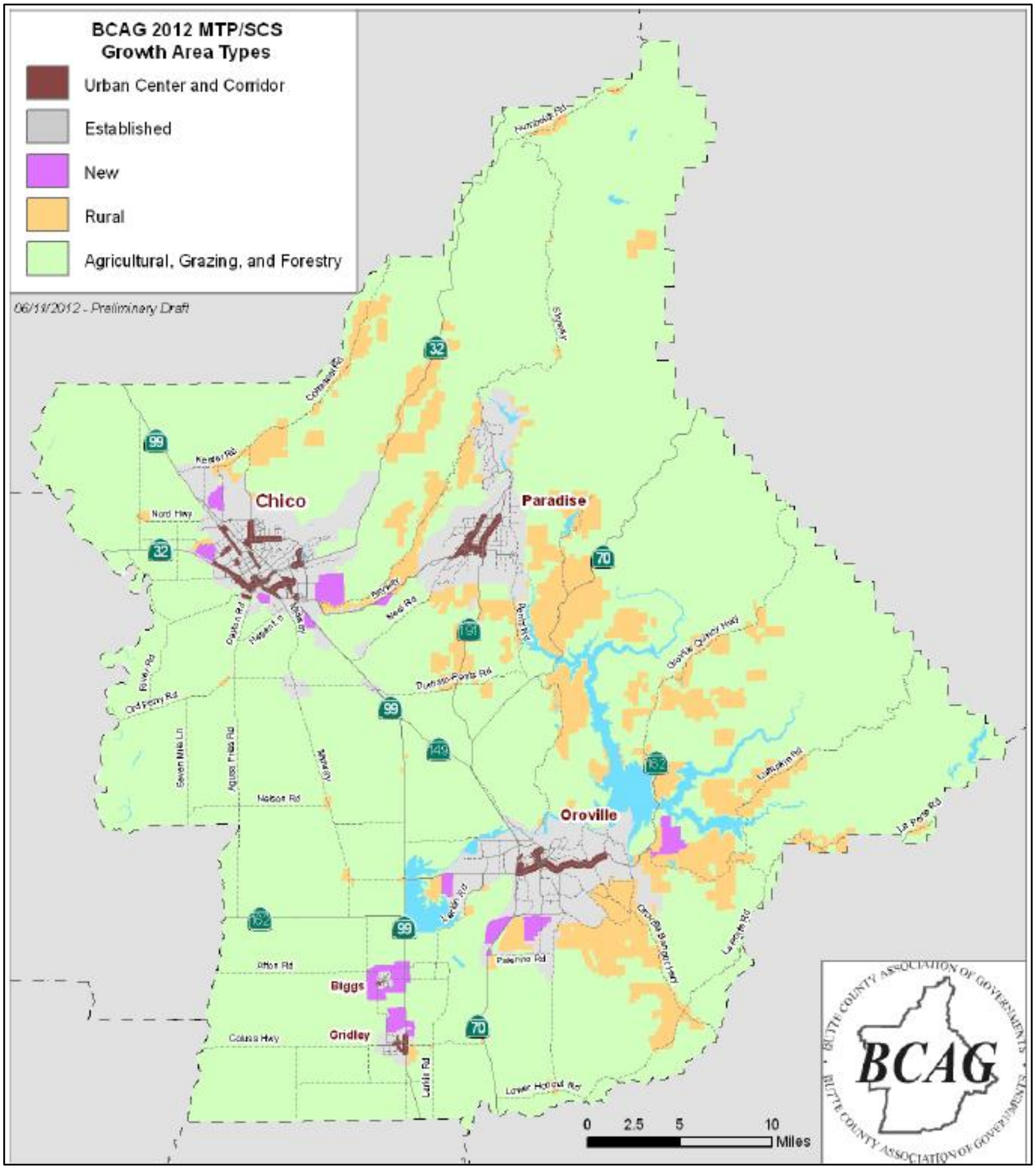
Table 2: BCAG Growth Area Type Description

Growth Area Type	Description
Urban Center and Corridor Areas	• Compact infill development, robust transit service, mixed land uses • Highest densities
Established Areas	• Existing urban development surrounding urban center and corridors. • Range of densities
New Areas	• Growth at the periphery of established areas. • May be residential, employment, or mixed uses at urban densities.
Rural Areas	• Limited transit, pedestrian, and bicycle infrastructure. Primarily residential. • Primarily residential area with low densities.
Agricultural, Grazing, & Forestry Areas	• Commercial and residential uses are secondary to agricultural, grazing, and forestry uses. • Lowest densities

Source: BCAG 2012 MTP/SCS Land Use Scenario Analysis

Figure 1 provides an illustration of the growth area types and the distribution of each growth type across the region.

Figure 1: BCAG Growth Area Types



Source: 2012 BCAG MTP/SCS Land Use Allocation Model Technical Methdology

II. APPLICATION OF ARB STAFF REVIEW METHODOLOGY

The review of BCAG's SCS focuses on the technical aspects of regional modeling that underlie the quantification of GHG reductions. This review examines BCAG model inputs and assumptions, modeling tools, application of the model, and modeling results, following the general method described 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." ARB staff tailored the general methodology to be applicable for BCAG's SCS to address the unique characteristics of the Butte region and its transportation modeling approach. ARB staff evaluated how BCAG's models operate and perform in estimating travel demand, and how well they provide for quantification of GHG emissions reductions associated with the SCS. In evaluating whether BCAG's model is reasonably sensitive for these purposes, ARB staff examined how well BCAG's travel demand model replicated observed results.

To help answer these and other questions, ARB staff used publicly available information in BCAG's MTP/SCS, including MTP technical appendices, the MTP/SCS Draft Environment Impact Report, the First Administrative Draft of the Butte Regional Conservation Plan, and the model description and validation reports. In order to assess technical soundness and general accuracy of BCAG's GHG quantification, three central components of BCAG's GHG analyses were evaluated: data inputs and assumptions, modeling tools, and performance indicators. The evaluation of these three components is described below.

A. Data Inputs and Assumptions

ARB staff evaluated BCAG's key model inputs with underlying data sources and assumptions to confirm that they represent current and reliable data for use in their model. This involved using publicly available, authoritative sources of information, such as national and statewide survey data on socioeconomic and travel factors. Relevant model inputs for GHG quantification that staff reviewed included: 1) regional socio-economic characteristics, 2) the region's transportation network, and 3) travel inputs. Related documentation of region-specific forecasting processes and approaches were also evaluated, especially where applicable to the evaluation of the region's land use forecast.

B. Modeling Tools

BCAG's modeling documentation reports were reviewed to assess how well their travel demand model replicates observed results based on both the latest socioeconomic, and travel data inputs and assumptions used to model the SCS. ARB staff reviewed outputs from BCAG's run of ARB's Emissions Factors 2007 (EMFAC) model to assess reasonableness of the expected reduction in carbon dioxide emissions from BCAG's SCS. In addition, BCAG's modeling practices were reviewed for consistency with California Transportation Commission's (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 reference documents (see Appendix A for more detailed information).

C. Performance Indicator

Staff evaluations of SCSs use performance indicators to test the travel demand and land use allocation models for sensitivity to changes in vehicle miles traveled (VMT), whether through changes in travel modes, vehicle trip distances, or land use. For the Butte region, ARB staff selected residential density as the performance indicator to evaluate the passenger vehicle greenhouse gas reduction resulting from the implementation of the MTP/SCS. Residential density was selected as the performance indicator because the MTP/SCS suggests that changes in density will provide a substantial proportion of the greenhouse gas reductions. ARB staff performed a qualitative evaluation to determine if increases or decreases in this indicator were directionally consistent with BCAG's modeled greenhouse gas emissions reductions.

III. DATA INPUTS AND ASSUMPTIONS

BCAG's MTP/SCS modeling approach is based upon a number of inputs and assumptions, which influence the effectiveness of the GHG emission reduction strategies. Inputs and assumptions are fed into the model to characterize existing and future land use, socioeconomic and transportation network characteristics. ARB staff evaluated the appropriateness of the data that were used and the model's response to changes in these inputs and assumptions.

A. Demographics and the Regional Growth Forecast

Demographic data describe a number of key characteristics used in travel demand models. The MTP/SCS uses demographic data to describe where the Butte population lives, works, and travels during the planning period. Using demographic information and a set of assumptions, BCAG developed its 2010-2035 Regional Growth Forecast for three demographic inputs: population, employment and housing. Specifically, BCAG developed low, medium and high growth scenarios for the region's population, employment, and housing figures. BCAG regularly updates its Regional Growth Forecast and the agency plans to next update the Regional Growth Forecast in the 2014-2015 fiscal year. BCAG used its medium growth projections from the Regional Growth Forecast because that growth scenario was based on historic data and input from local planning staff, which BCAG staff found to result in the most realistic growth scenario. Table 3 reports BCAG's population, employment and housing figures for 2005 and 2010 and summarizes BCAG's medium growth forecasts for 2020 and 2035.

Table 3: BCAG Regional Growth Forecast

Year	Population	Employment	Housing Units
2005	214,582	73,400	91,666
2010	221,768	71,501	96,623
2020	257,266	87,214	111,813
2035	332,459	112,279	143,948

Source: 2010-2035 BCAG Regional Growth Forecast & BCAG Modeling Parameters

Butte's Regional Growth Forecast is based on data from the California Department of Finance and the California Employment Development Department.

Over the past several years, BCAG has coordinated a number of planning efforts through its Blueprint Planning Program that informed the Regional Growth Forecast. Established in 2006, BCAG initiated this multi-faceted planning process resulting in: 1) the 2008 Regional Growth Forecasts; 2) the establishment of Regional Guiding Principles, an Ecological Baseline Assessment Report, Landcover Mapping, Biological Constraints Analysis, and Butte County Meadowfoam Evaluation: 3) the initiation of the Butte Regional Conservation Plan; and 4) the integration of the region's local general plan updates, the Butte Regional Conservation Plan and Metropolitan Transportation Plan. As of 2012, four of the region's six local jurisdictions had completed general plan updates, and the remaining two jurisdictions had initiated an update process. The jurisdictions' new general plans provided the foundation for the region's SCS. While each city underwent its general plan update process, BCAG made available scientific information developed for the Butte Regional Conservation Plan in order to inform options that consider habitat conservation and as local jurisdictions decided on the size of their land use footprint.

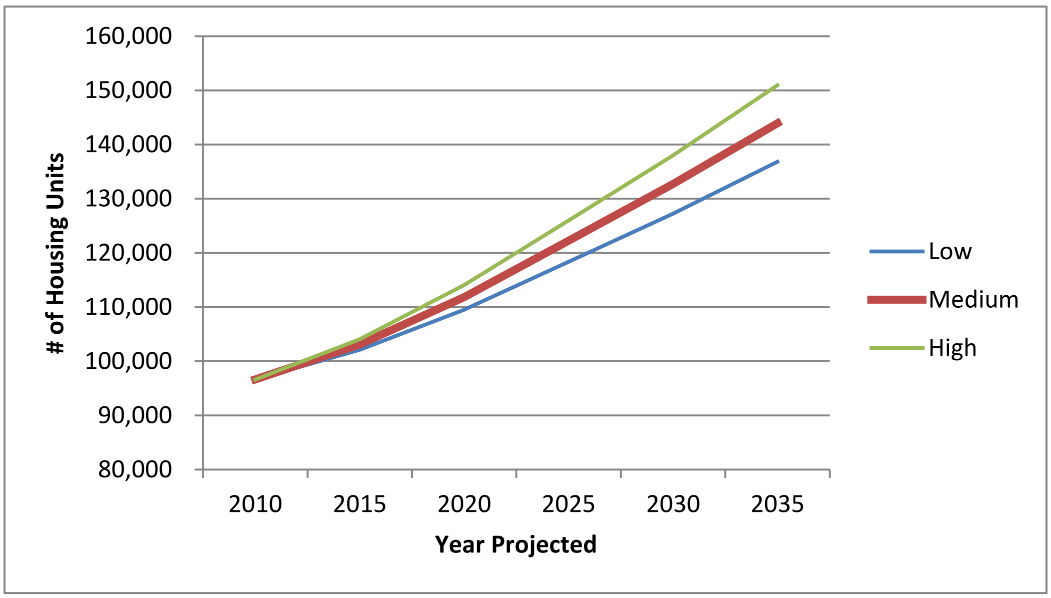
Housing

BCAG's Regional Growth Forecast developed three housing scenarios: low, medium, and high growth. BCAG elected to use the medium housing scenario in order to reflect the most probable scenario. To develop the forecasts, BCAG analyzed the December 2010 California Department of Finance (DOF) long range population and housing projections for the period between years 2010 and 2035. These projections suggest that the Butte County region will grow at a compound annual growth rate (CAGR) of 1.8%. This information was used to establish the control total for BCAG's high forecast scenario.

Next, BCAG gathered additional data and local input to develop a medium growth forecast scenario. BCAG compiled historic building permit data and revised its 2006 BCAG growth forecasts utilizing 2010 base line data from DOF for each jurisdiction in the region. After reviewing the information described above, planning staff from the local jurisdictions provided input on future housing development levels considering their most recent local land use plans and knowledge of current development activity. Based on the information gathered, BCAG developed an estimate of the production of new housing units occurring within each jurisdiction, for each five year increment out to the year 2035. That information resulted in a 1.6% regional CAGR for the middle growth forecast. BCAG applied that lower growth rate to the 2010 base year housing figure to represent the medium forecast scenario.

Based on the 0.2% compound annual growth rate difference between the high and medium scenarios, BCAG applied a CAGR of 1.4% to the baseline to develop the low growth scenario. Each jurisdiction's growth, represented in five year increments, was adjusted from the medium scenario to the high and low scenarios based on its share of growth. See Figure 2 for the low, medium, and high housing projections.

Figure 2: Housing Projections (2010-2035)



Source: 2010-2035 BCAG Regional Growth Forecast

The housing projection in the SCS must link to the Regional Housing Needs Assessment (RHNA). California jurisdictions must adopt housing element updates that demonstrate accommodation of an eight-year projection of housing need outlined through a region's RHNA allocation. The methodology takes each jurisdiction's percentage share of growth forecasted in the Butte County Long-Term Regional Growth Forecasts 2010-2035 for the period from 2015 to 2025, and multiplies that percentage by the overall RHNA allocation mandated by Housing and Community Development. The resulting number is the total unit allocation for each jurisdiction. In Butte's case that allocation amounts to 10,320 housing units. The Butte Regional Housing Needs Plan (RHNP) figures, as well as the proposed SCS housing allocations, are shown in Table 4. Consistent with SB 375 requirements, BCAG's SCS provides sufficient housing to meet the total housing allocation.

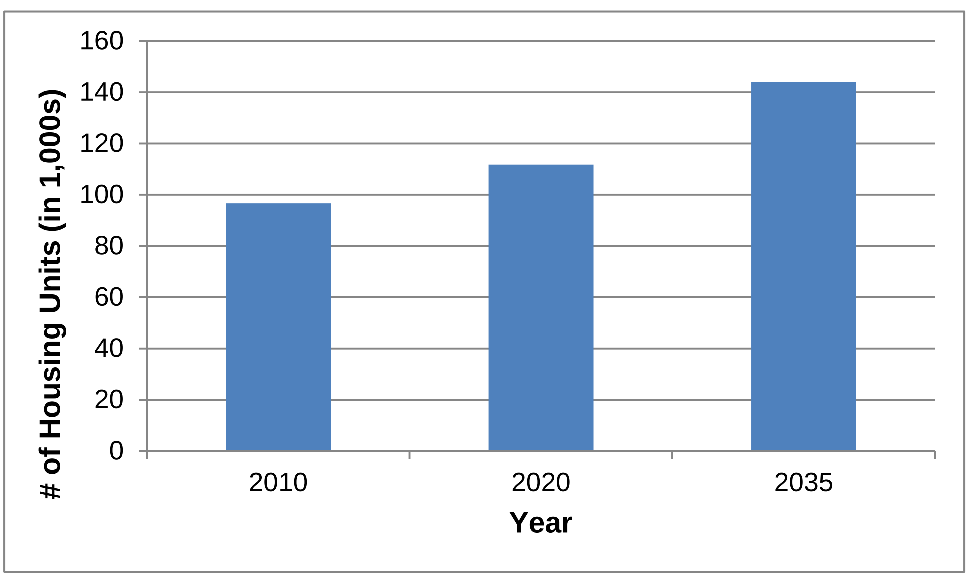
Table 4: Housing Allocation by Jurisdiction

Jurisdiction	Total Housing Unit Medium Growth Forecast (2010 – 2035)	RHNP Growth Allocation (2014-2022)
Biggs	950	184
Chico	19,255	3,963
Gridley	3,405	769
Oroville	6,565	1,793
Paradise	2,975	637
Butte County Unincorporated	14,175	2,974
Total Region Growth	47,325	10,320

Source: BCAG 2012 MTP/SCS

In 2010, the Butte region had approximately 96,600 housing units. At that time, the largest number of housing units existed in the Established Area growth type. The MTP/SCS shows the majority of planned housing growth occurring in the Established Area, minimizing development on currently undeveloped, agriculturally significant, and/or environmentally sensitive areas. There will still be growth in the New Area growth type, specifically 32% of the region's new housing by 2035. Despite the economic down turn, BCAG expects that the housing supply will increase by over 47,000 units from the 2010 to 2035 (Figure 3). Most of that growth occurs after 2020, reflecting BCAG's assumption that historic growth rates will return after the year 2020.

Figure 3: Housing Growth Forecast



Source: 2010-2035 BCAG Regional Growth Forecast

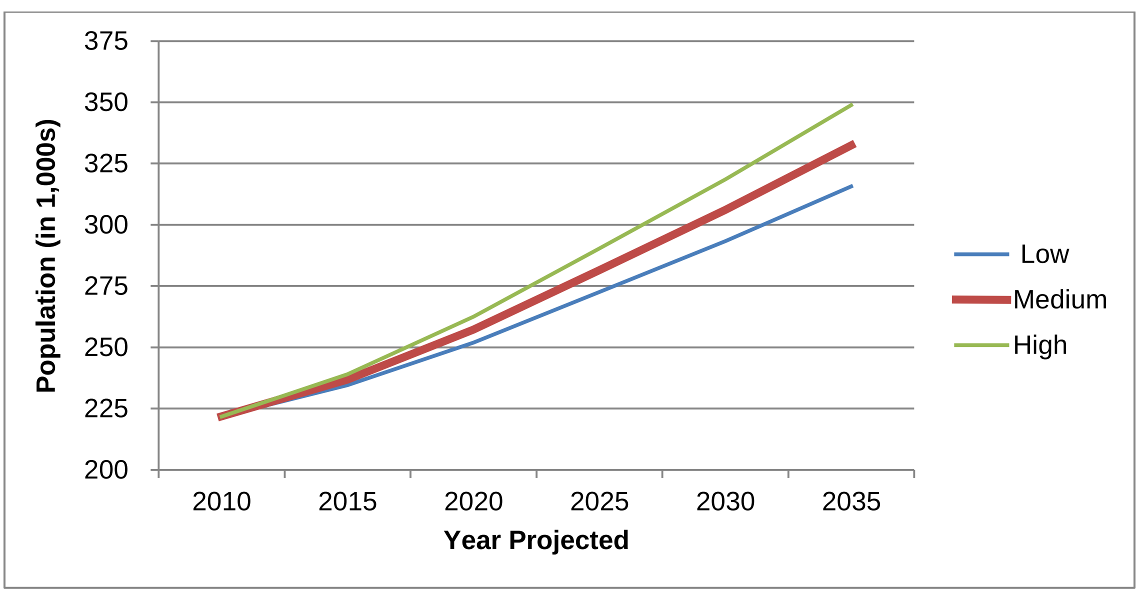
Assuming that the housing growth occurs evenly throughout the planning cycle, the Butte region would need to add nearly 1,900 housing units per year between 2010 and 2035, for a total of approximately 47,000 units to meet the projections outlined in the MTP/SCS. Between 2010 and 2020, BCAG projects the region will add approximately 15,190 housing units and in the following fifteen years increase the stock by about 32,135 units.

Population

As was done for the housing projection, BCAG established a low, medium and high population growth forecast. For the purposes of the SCS, BCAG chose the medium growth population forecast (Figure 4). The forecast indicates that the Butte region population is expected to grow by approximately 36,000 people between 2010 and 2020, and by about 111,000 people between 2010 and 2035. That growth between 2010 and 2035 amounts to about a thirty-five percent increase, even after including the effects of the recent economic slowdown, most evident in the near term of 2010 to 2020 (Table 5). In total, BCAG projected its population to reach about 332,000 by 2035.

In May 2012, the DOF released a population projection for years 2015 to 2050 in five year increments by county, which reflect the impacts of the recession and the 2010 U.S. Census data. For Butte County, the DOF forecasted 244,417 people in 2020 and 290,186 for 2035. In contrast, the BCAG population forecast was developed prior to both the 2012 DOF release and the 2010 U.S. Census release. As a result, the BCAG projection is higher by 12,849 people in 2020 and by 42,273 people in 2035. In other words, the Butte's forecast is about five percent higher than the most recent DOF forecast in 2020 and about thirteen percent higher in 2035. This difference is explained in that Butte's forecast was built from 2010 DOF data that may not have fully captured the effects of the recession as well as the most recent 2012 data.

Figure 4: Population Growth Forecast



Source: 2010-2035 BCAG Regional Growth Forecast

Table 5: Population Growth Forecast

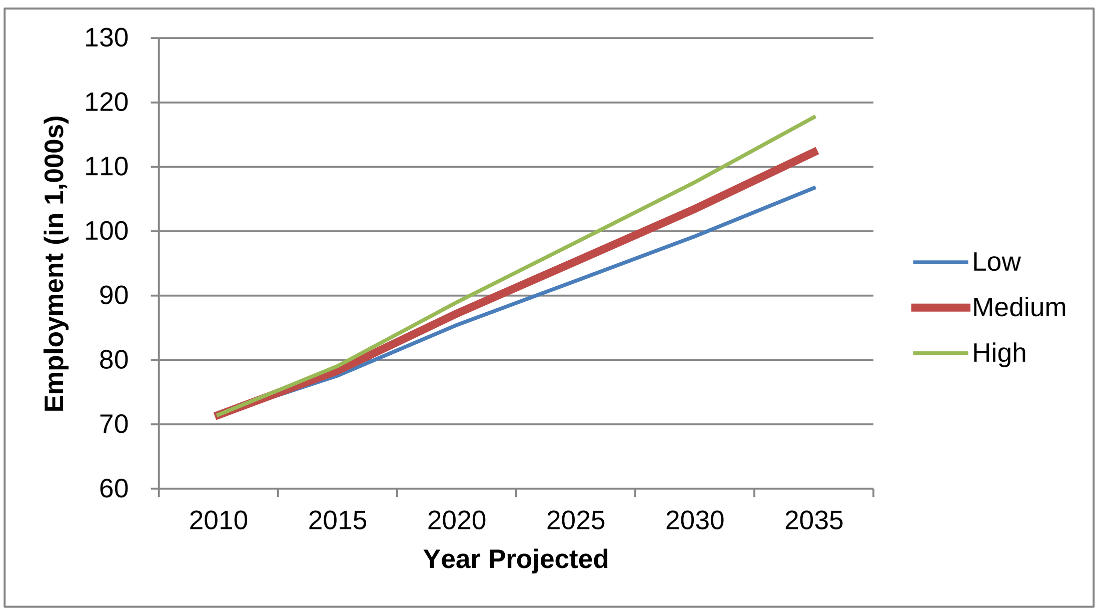
Year	Population Growth Forecast	Population Growth Between Planning Years
2010	221,768	--
2020	257,266	35,498
2035	332,459	75,193

Source: 2010-2035 BCAG Regional Growth Forecast

Employment

BCAG in its regional growth forecast prepared employment figures for low, medium and high growth scenarios, and elected to use the medium growth forecast as the basis for its MTP/SCS (Figure 5). BCAG prepared its employment forecast for the region as a whole. The employment forecasts are based on a ratio of jobs per housing unit. BCAG reported that employment should rebound from its current estimate of 0.74 jobs per housing unit in 2010 to moderate historic levels by the year 2020 and then maintain a 0.78 ratio into the horizon year of 2035.

Figure 5: Regional Employment Growth Forecast



Source: 2010-2035 BCAG Regional Growth Forecast

Baseline 2010 employment data was obtained from the California Employment Development Department (EDD) for the year 2009 – an annual average for 2010 was not available at the time the BCAG regional forecasts were prepared. The 2009 EDD data provide a total of all non-farm jobs for the region. This information was then used in conjunction with 2009 DOF preliminary housing unit estimates to calculate a ratio of 0.74 jobs per housing unit.

Historic employment information was also obtained from the EDD for the period between 1990 and 2009 and averaged to calculate a long range jobs to housing unit ratio of 0.78. This ratio was applied to the years 2020-2035 and based on the assumption that historic rates of employment will return by the year 2020. Anticipating a recovery from the existing lows of the economy, an average of the 2010 ratio and long-term ratios were prepared for the year 2015, resulting in a ratio of 0.76 jobs per housing unit. Lastly, the jobs to housing unit ratio developed for each 5 year period was applied to all scenarios. The long-term forecasts estimate that the region will return to historic levels of 0.78 jobs per housing unit by the year 2020, suggesting an improved jobs-housing balance for the region.

Butte's growth forecast indicates a need to accommodate approximately 15,700 new employees between 2010 and 2020, and approximately 25,065 new employees between 2020 and 2035 (Table 6). That would result in a regional increase of new employees between 2010 and 2035 to 41,000 employees. Most of the new employees would be in Established Areas and the second most growth would occur in Urban Center and Corridor Areas.

Table 6: Employment Growth Forecast by Growth Type

Growth Area Type	2010 Existing Employees	2010 - 2020 New Employees	2010 - 2035 New Employees	Total 2035 Forecasted Employees
Urban Center and Corridor Areas	30,471	3,063	9,804	40,275
Established Areas	37,535	11,137	23,573	61,108
New Areas	1,277	893	6,229	7,506
Rural Areas	950	429	902	1,852
Agricultural, Grazing, and Forestry Areas	1,268	192	271	1,539
Region Total	71,501	15,713	40,778	112,279

Source: BCAG 2012 MTP/SCS

The growth forecasts used in the SCS modeling analysis for housing, population, and employment used reasonable methodologies for MPO forecasting. BCAG relied on appropriate federal and state sources, such as the U.S. Census (2000 and 2010) and the California Department of Finance, and also convened a panel of local planning staff as part of its growth forecast process. Butte's forecasting methods are consistent with those used by the U.S. Census Bureau and the California Department of Finance (DOF). Since the completion of BCAG's Regional Growth Forecast in early 2011, the Department of Finance has revised its population and housing projections, thus the BCAG Regional Growth Forecast slightly overestimates population, housing and employment figures when compared to the data available in 2012.

B. Current and Future Land Use Development Patterns

As part of the MTP/SCS development process, BCAG created the region's first land use allocation model for the purpose of assisting in preparing the forecasted development pattern for the MTP/SCS. The model was used to develop three distinct land use allocation scenarios for analysis in the MTP/SCS. One of these land use scenarios was selected as the basis from which BCAG will plan to address transportation infrastructure needs. Forecasting of future development patterns is an important step to developing an accurate picture of future travel demand in the region.

All three scenarios were prepared using the same regional employment, population and housing growth projections and regional transportation network. However, the following land use variables were adjusted to create the distinct scenarios:

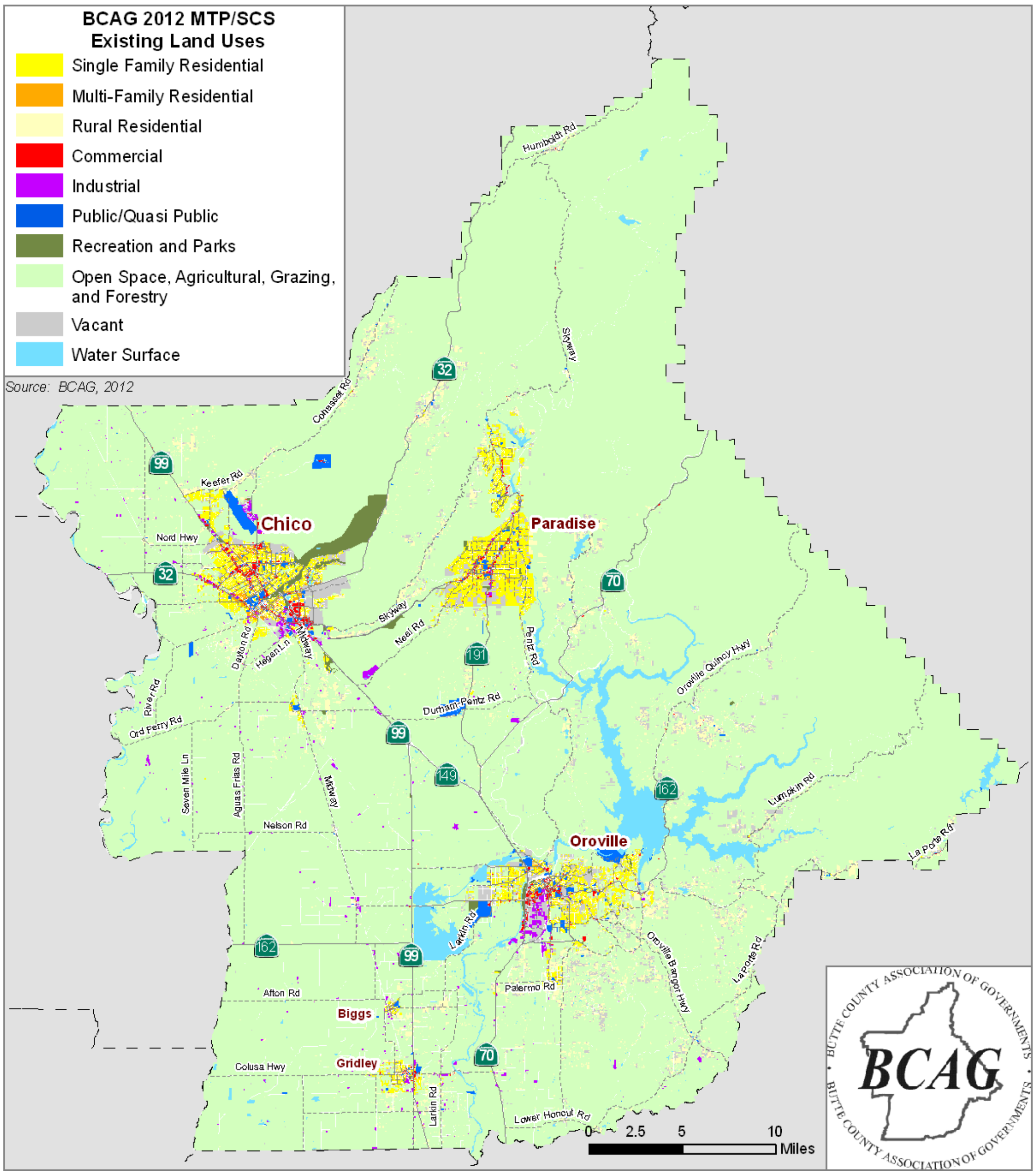
- The amount of development occurring within each of the five Growth Areas (i.e., Urban Center and Corridor, Established, New, Rural, and Agricultural).
- The levels of infill and redevelopment occurring within the Urban Center and Corridor and Established Growth Areas.
- The shares of single-family to multi-family development.
- The amount of growth accommodated within each local jurisdiction.

The land use scenarios were designed by first assembling the "balanced" scenario. The "balanced" scenario (scenario #1) was prepared based on land use information from the recent general plan updates, the latest information regarding planned development, reasonable assumptions regarding infill and redevelopment, regional growth forecasts, and a review of development attractions (i.e., motorized and non-motorized transportation networks, existing development, utility areas, etc.) and discouragements (i.e., resource areas and farmland, public lands, areas exceeding 25% slope, etc.). Secondly, the "dispersed" (scenario #2) and "compact" (scenario #3) scenarios were prepared to represent development occurring at opposing ends of the spectrum from scenario #1.

Current Land Use

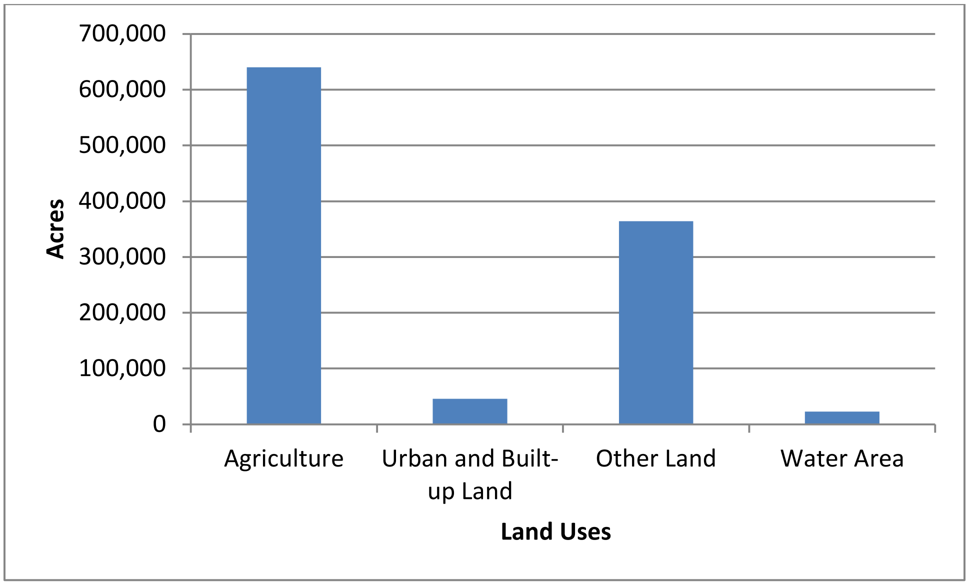
Land use patterns in the county are primarily determined by geographic conditions and political jurisdiction. In Butte County, most of the land is purposed as agricultural (Figure 6). Only about 45,000 acres are classified as urban and built-up land, while about 650,000 acres are categorized as agricultural land and 356,000 are classified as "other" lands under the California Department of Conservation Farmland Mapping and Monitoring program (Figure 7). The Department of Conservation defines other lands as land not included in any other mapping category. Common examples include low density rural developments, brush, timber, wetland, and riparian areas not suitable for livestock grazing, confined livestock facilities, strip mines, and water bodies smaller than forty acres.

Figure 6: Current Land Uses



Source: BCAG 2012 MTP/SCS Public Workshop Presentation

Figure 7: Current Land Use by Category (2010)



Source: California Department of Conservation, Farmland Mapping And Monitoring Program, 2012

Forecast Process

The primary resource in preparing the MTP/SCS land use forecast was the latest local general plans which were developed in coordination with BCAG as part of the Blueprint Planning Program. As the estimated land use forecast was developed, BCAG consulted with local governments and stakeholders as it considered a number of factors throughout the process. The BCAG Planning Directors Group was the principal means for ongoing coordination between local planning staff and BCAG. The process BCAG used to develop its assumptions about future land use patterns and the influence from associated transportation strategies were included in the evaluation. During the land use forecast process in the Regional Plan, BCAG considered the integrated local general plan updates and regional conservation plans to define zoning, management strategies, and allowable land uses. In addition, the balanced scenario proposes a land use mix that responds to the public and enhances sustainability, while supporting the SCS targets. These factors are consistent with guidance on developing SCS planning assumptions provided in the CTC's 2010 RTP Guidelines.

To further describe the land use framework for the region in the MTP/SCS, BCAG developed a set of Growth Area Types. Local land use plans, such as general plans, specific plans, master plans, and corridor plans, were divided into one of the five Growth Area Types. The following contains a description of each Growth Area Type and a summary of land uses allocated within each, based on the preferred "balanced" land use scenario.

- **Urban Center and Corridor Areas:** This Growth Area type represents land uses most associated with urban areas. This area features higher densities, mixed land uses, robust transit service and planned or existing non-motorized transportation infrastructure. These areas typically have existing or planned infrastructure for non-motorized transportation modes which are more supportive of walking and bicycling. Growth in this area would include compact infill developments on underutilized lands, or redevelopment of existing developed lands. Local plans often label these areas as downtowns, central business districts, or mixed use corridors.

- **Established Areas:** This category generally includes existing urban developments surrounding the Urban Center and Corridor Areas. Locations disconnected from Urban and Corridor Centers may be residential-only, employment-only, or a mix of uses with urban densities. These areas consist of a range of urban development densities with most locations having access to transit through the urban fixed route system or commuter service. Future growth within these areas typically utilizes locations of currently planned developments or vacant infill parcels. Local plans generally seek to maintain the existing character of these areas.

- **New Areas:** The New Areas are typically connected to the outer edge of an Established Area. These areas currently consist of vacant land adjacent to existing development and represent areas of future urban expansion. Future growth within these areas will most often consist of urban densities of residential and employment uses with a few select areas being residential only. Local plans identify these areas as special planning or specific plan areas, master plans, and planned development or planned growth areas. Currently, fixed route transit does service such areas. However, fixed route transit service would likely be provided to areas which are directly adjacent to current urban routing as part of build-out. Planning requirements by local jurisdictions would generally call for the construction of quality pedestrian and bicycle infrastructure to accompany New Area developments.

- **Rural Areas:** This Growth Area type is made up of areas outside existing and planned urban areas with development at low residential densities. These areas are predominantly residential and may contain a small commercial component. The densities at which these areas are developed do not reasonably allow for pedestrian or bicycle infrastructure and transit service is limited or nonexistent. Automobile travel is typically the transportation option.

- **Agricultural, Grazing, and Forestry Areas:** This area represents the remaining areas of the region not being planned for development at urban densities. These areas support agricultural, grazing, forestry, mining, recreational, and resource conservation type uses. Locations within these areas may be protected from future urban development under federal, state, and local plans or programs such as the Chico area “greenline”, Williamson Act contracts, or conservation easements. Employment and residential uses are typically allowed within portions of this area but are most often secondary to agricultural, forestry, or other rural uses.

The MTP/SCS estimates that there will be an increased demand for multi-family housing. BCAG defines multi-family housing as attached dwelling units with densities of 13 to 50 units per acre, while single-family housing is defined as detached residential dwellings ranging from 13 units per acre to 1 unit per 160 acres. Regionally, 28% of the new housing in the forecasted development pattern is multi-family and 72% is single family. This demonstrates a moderate shift in the housing mix from the estimated existing mix of 25% multi-family and 75% single family (see Table 7).

Table 7: Percent of Housing Units by Growth Type

Growth Area Type	2010 Existing Housing Units		2010-2020 New Housing Units		2020-2035 New Housing Units	
	Single Family	Multi-Family	Single Family	Multi-Family	Single Family	Multi-Family
Urban Center and Corridor Areas	42%	58%	44%	56%	26%	74%
Established Areas	74%	26%	72%	28%	74%	26%
New Areas	99%	1%	74%	26%	68%	32%
Rural Areas	100%	0%	100%	0%	100%	0%
Agricultural, Grazing, and Forestry Areas	97%	3%	100%	0%	100%	0%
Region Total	75%	25%	74%	26%	72%	28%

Source: BCAG 2012 MTP/SCS

The greatest shift in housing mix is within the Urban Center and Corridor Growth Areas and the New Growth Areas. The share of multi-family housing in the Urban Center and Corridor Areas grows 16% from 58% in 2010 to 74% in 2035. A similar trend appears in the New Area Growth type where it is estimated that 32% of the new housing in the New Growth Areas will be multi-family housing by 2035. The distributions for all growth areas are summarized in Table 7. Although this table suggests that there are significant shifts in residential land use and housing types, the share of multi-family and single-family residences remains fairly similar between the base year and 2035. Because of the broad range of density used to define single family and multi-family as previously described, there could be shifts in land use that would support lower vehicle miles traveled, for example, if more single family units were developed on smaller lot sizes.

C. Transportation Network Inputs and Assumptions

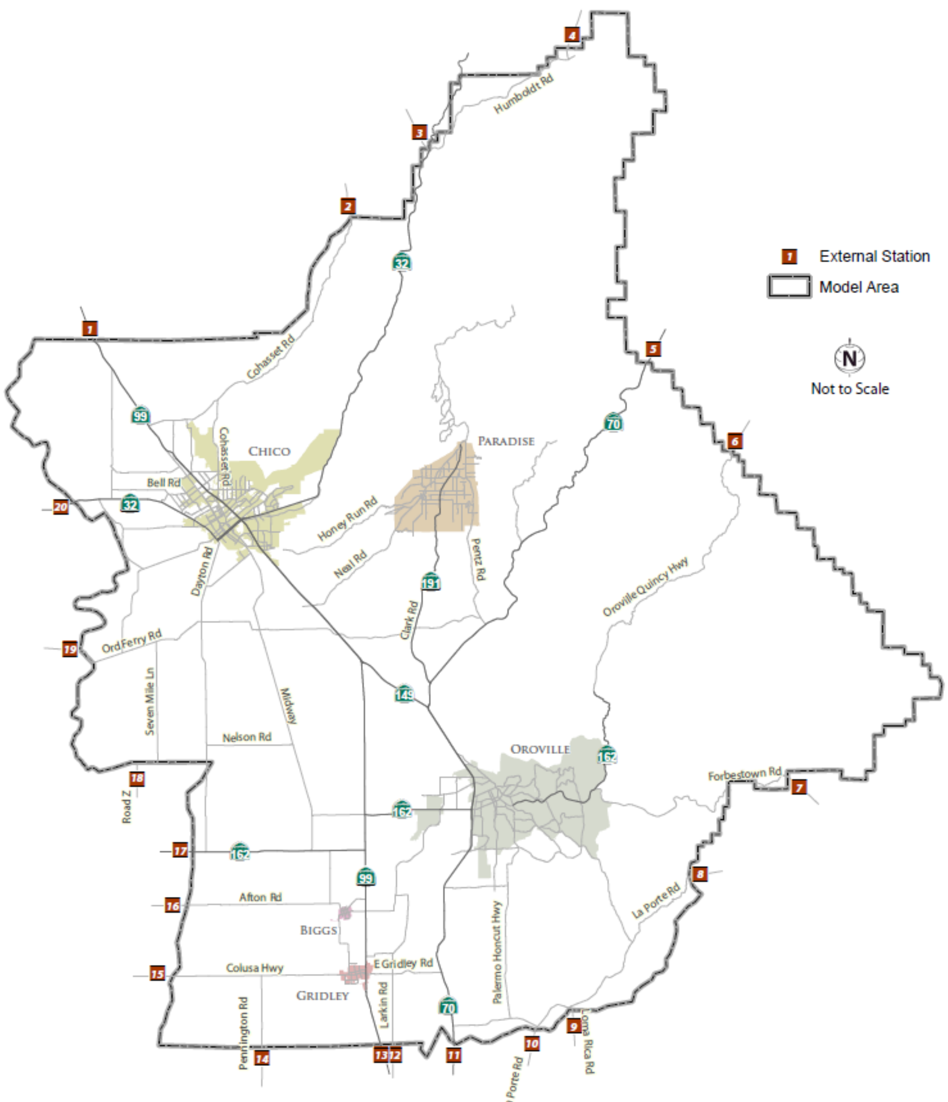
Inputs and assumptions associated with the BCAG trip-based travel demand model, such as street network, link capacity, free-flow speed, were reviewed per standard evaluation procedure. BCAG states that the sources of model inputs include Caltrans traffic data, Department of Finance housing estimates, Employment Development Department employment estimates, California Statewide Household Travel Survey

(2001), U.S. Census (2000), Butte Regional Transit ridership data, BCAG parcel and footprint land use data, and the 2010 Info USA employment data.

Street Network

The BCAG street network is a representation of the automobile roadway system, which includes freeways, state highways, arterials, collectors, and local roads within the model area (Figure 8). The street network database includes attributes such as street name, distance, functional class, speed, link capacity, and number of lanes. BCAG's consultant verified these attributes using maps, aerial photographs, and data provided by BCAG staff. Figure 8 summarizes BCAG's 2010 roadway inventory in lane miles by functional class.

Figure 8: Street Network of BCAG



Source: BCAG (2011) Draft: Model Development Report

Table 8: BCAG Base Year Network Lane Miles by Functional Class

Functional Class	Lane Miles (2010)
Freeway	189
Arterials/Expressway	731
Collector and Local Street	6,276

ARB staff compared the methodology BCAG used in the street network development with suggestions from the National Cooperative Highway Research Program (NCHRP) Report 365. BCAG followed acceptable practice, and their methodology is consistent with the NCHRP 365 report[1]. In addition, the functional classification definitions used in the street network are consistent with FHWA's Federal Functional Highway Classification system.

Street Capacity

Street capacity is defined as the number of vehicles that can pass a certain point of the roadway at free-flow speed in an hour. BCAG's travel demand model uses street capacity as an input for estimating congestion. BCAG categorizes street capacities by functional class, which are expressed as hourly capacity in terms of vehicles-per-lane-per-hour (vplph), as summarized in Table 9.

Table 9: Reported BCAG Street Capacity

Functional Class	Street Capacity (vplph)	FHWA's Estimate on Maximum Street Capacity (vplph)
Freeway	1,800	2,350
Expressway	1,500	2,100
Arterial	800	1,408
Collector	700	1,408
Local Street	600	1,408

BCAG's street capacity assumptions are reasonable. The reported capacity values are less than the maximum allowable street capacities suggested by FHWA.

Free-Flow Speed

Travel demand models use free-flow speed to estimate the shortest travel time between the origin and the destination of a trip that is assigned to the street network. Factors such as the prevailing traffic volume on a link, posted speed limits, adjacent land use

[1] The NCHRP Report 365 describes travel demand modeling theory and techniques, and their common applications by transportation planning agencies, and observed data for key modeling parameters at the national level.

activity, functional classification of a street, type of intersection control, and spacing of intersection controls can affect the actual travel speed. BCAG uses posted speed limits as free-flow speeds in travel demand modeling development. The reported speed limits in BCAG are listed by functional class in Table 10.

Table 10: BCAG Free-Flow Speed by Functional Class

Functional Class	Range of Speed (mph)
Freeways	55 to 65
Expressways	55 to 65
Arterials	30 to 40
Collectors	25 to 35
Local Streets	20 to 25

The methodology BCAG used in the estimation of free-flow speed based on the posted speed limits is consistent with the recommended practice indicated in the NCHRP Report 365.

Transit and Non-Motorized Transportation Facility

Table 11 summarizes the 2010 existing transit and non-motorized transportation facilities within BCAG. The region's transit needs are served by Butte Regional Transit, which operates "B-Line" fixed route bus service throughout the region. The definitions of bike path and bike lane used in the non-motorized facility are consistent with those given in the Caltrans Highway Design Manual.

Table 11: BCAG Transit and Non-Motorized Facility Lane Miles

Transportation Facility	Lane Miles (2010)
Fixed Route Transit Operation	333
Bike Lane (Class I[2] & II[3])	78

D. Travel Demand Inputs and Assumptions

Assumptions related to the number of vehicle trips and trip lengths influence a travel demand model's estimation and forecast on the amount of travel occurring in a region. ARB staff reviewed the key inputs and assumptions associated with the BCAG trip-

[2] Class I bicycle facilities are bike paths that provide a completely separated right of way for the exclusive use of bicycles and pedestrians, with cross-flow by motorists minimized.
[3] Class II bicycle facilities are bike lanes for one-way bike travel on a street or highway, which is demarcated with road striping.

based travel demand model. Upon availability and application of findings from empirical literature, trip data reported by BCAG are compared to independent sources.

Trip Generation Rates

Vehicle trip generation rates are used in a travel demand model to gauge what influences the amount of travel in a region and how the travel is generated. These factors usually include automobile ownership, household income, household size, types of land use, levels of employment, availability of public transportation, and quality of the transportation system. Trip generation inputs to the travel demand model are used to reflect the average weekday vehicle trips per household for each trip purpose in the BCAG region.

BCAG's consultant estimated trip generation rates for single- and multi-family homes based on data from the 2000 US Census. The selected variables for the trip generation step of the BCAG travel demand model are household size, number of workers, and household income. Trips are classified into one of five trip purposes: home-based work (HBW), home-based other (HBO), home-based casino (HB-Casino), home-based school (HB-School), or non-home-based (NHB). The reported base year vehicle trip rates per household are summarized in Table 12. The NCHRP Report 365 presents trip rate estimates associated with an urbanized area with a population of 200,000 to 499,999, which embraces the population size of a region similar to BCAG. Compared to the national average vehicle trips per household presented in the NCHRP Report 365, the trip rates of BCAG are reasonable.

Table 12: Average Vehicle Trip Rates per Household by Trip Purpose

Trip Purpose	BCAG (2010)	NCHRP Report 365 (1998)
HBW	1.67	1.64
HBO[4]	4.69	4.37
NHB	1.84	1.79

Trip Length Distribution

In the traffic assignment step of the travel demand model, trip lengths are estimated using the street network and used to calculate interzonal travel impedances. Table 13 summarizes the average reported auto trip length for all trip purposes of BCAG region.

[4] Home-based other (HBO) trips here include the original HBO, home-based casino, and home-based school trips reported by BCAG.

Table 13: Average Auto Trip Length

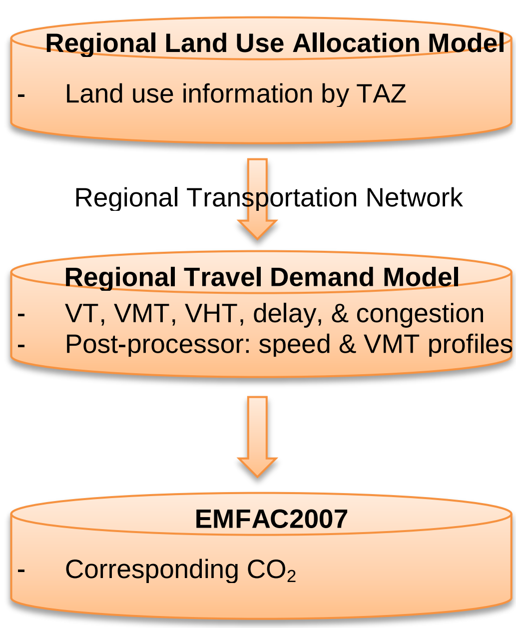
Mode	Average Trip Length (miles)	
	BCAG (2010)	NHTS (2009)
Auto	6.58	9.72

Compared to the average vehicle trip length indicated in the National Household Travel Survey (2009), the BCAG average trip is lower. This may be due to the physical size of the County. BCAG's consultant explains that in modeling interregional trips (i.e. IX/XI trips), the model trip lengths are measured up to the Butte County boundary because this approach is sufficient for air pollution analysis purpose within BCAG region. As a result, the model trip lengths of interregional trips do not reflect the entire length of the trips. Similar modeling approaches for interregional trips are used by some other California MPOs.

IV.MODELING TOOLS

BCAG utilizes three modeling tools to quantify GHG emissions that would result from the implementation of its 2012 MTP/SCS (Figure 9). The three modeling tools are the BCAG Regional Land Use Allocation Model, the BCAG Regional Travel Demand Model, and the Air Resources Board 2007 Emission Factor (EMFAC2007) model. BCAG uses the land use allocation model to develop land use scenarios for years 2020 and 2035.

Figure 9: Flowchart of BCAG's Modeling Process



BCAG then uses the land use allocation model outputs by traffic analysis zone (TAZ) and the regional transportation network as inputs to the travel demand model to forecast travel activity. The outputs of the travel demand model are vehicle trip, vehicle miles traveled (VMT), vehicle hours of travel (VHT), delay, and congestion. A post-processor is then used to divide the VMT outputs into 13 separate speed bins set at five mile per hour intervals as a preparation process for running EMFAC2007. Lastly, BCAG estimates base and forecasted years' CO_2 emissions using EMFAC2007. The inputs and assumptions used in the modeling process of the land use allocation model and travel demand model were reviewed following the ARB evaluation methodology.

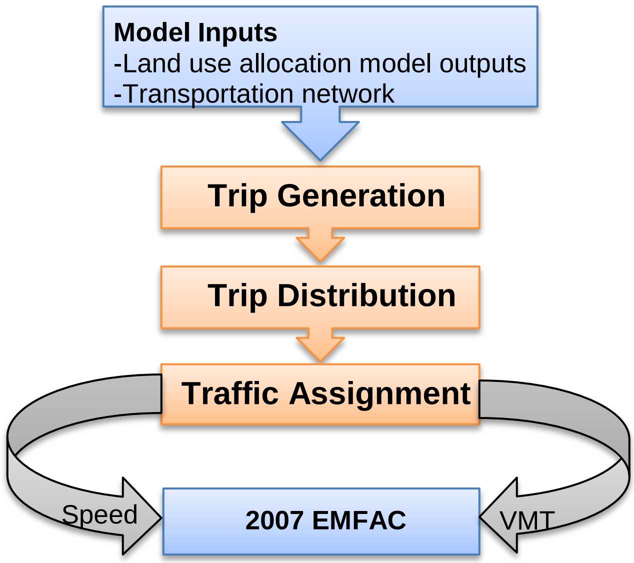
A. Land Use Allocation Model

The BCAG land use allocation model allocates future residential and employment growth while considering the region's existing land use plans, growth forecasts, and development attractions and discouragements. The land use allocation model was updated with land use data for year 2010, and was used to develop land use scenarios for the forecasted years. For each land use scenario, growth was modeled separately for the BCAG member jurisdictions: Chico, Paradise, Oroville, Gridley, Biggs, and the remaining unincorporated area of Butte County. Each jurisdiction was split into the five previously described Growth Area Types: center, established, new, rural, and agricultural growth areas. Land use assumptions, such as dwelling units per acre, average square footage per employee, floor area ratio, mixed use ratio, were developed for where new growth would be assigned. The land use allocation forecast was based on the considerations of regional guiding principles and growth forecasts, current and proposed land use plans, modeled attractions and discouragements, and input from local jurisdiction planners, and public outreach. The forecasted residential and employment results for base and forecasted years by TAZ then served as inputs to the travel demand model.

B. Travel Demand Model

The BCAG Travel Demand Forecasting (TDF) model is a three-step model consisting of trip generation, trip distribution, and trip assignment (Figure 10).

Figure 10: Flowchart of the Trip-Based Travel Demand Model



Trip Generation

The trip generation step consists of the residential trip generation and non-residential trip generation. The residential trip generation estimates trip rates associated with single family and multi-family by household size, number of workers, and household income. These household characteristics were obtained from the 2000 US Census database.

Household vehicle trips were grouped by trip purpose: home-based work (HBW), home-based other (HBO), non-home-based (NHB), home-base school (HB-School), and home-based casino (HB-Casino). BCAG staff utilized statistics from the California Household Travel Survey (2001) to split trips by purpose. BCAG vehicle trip rates are based on person-trip rates from the Sacramento Area Council of Governments' SACMET travel demand forecast model.

The estimated vehicle trips were then divided by the number of occupied residential units to obtain vehicle trip rate at an aggregate level. For the non-residential trip generation sub-model, BCAG started with the national averages of vehicle trip generation rates for a variety of land uses in suburban locations, such as serving retail, industrial, office, hospital, hotels, school, and park. These trip rates were then calibrated for major non-residential land uses within Butte County.

The Federal Highway Administration's Transportation Model Improvement Program (TMIP) and National Highway Cooperative Research Program guidelines suggest that, prior to balancing, the number of productions and attractions should match to within plus or minus 10%. Based on the results presented in Table 14, BCAG's model results meet the guidelines for HBW, HBO, and NHB trips.

Table 14: Production to Attraction Ratio by Trip Purpose

Trip Purpose	Production to Attraction Ratio	Acceptable Range
Home-based work	0.98	0.90 to 1.10
Home-based other	0.99	
Non-home-based	1	

Trip Distribution

The second stage of the BCAG travel demand model is the trip distribution sub-model, which determines the specific destination of each of the vehicle trips that are estimated by the trip generation sub-model. The four types of trips in this sub-model are intra-zonal trips (I-I), internal-external trips (I-X), external-internal trips (X-I), and external-external trips (X-X). The trip distribution sub-model utilizes a gravity model[5] equation to estimate an accessibility index for each zone based on the number of attractions in each zone and a friction factor. Friction factors are travel time factors, which are used in calculating the relative attractiveness of each destination zone and the number of potential origins and destinations in each TAZ. BCAG uses the friction factors suggested in National Cooperative Highway Research Program Report 365.

Traffic Assignment

The trip assignment step assigns the route that each vehicle trip takes from the origin to destination. The traffic assignment sub-model is designed to be sensitive to the effects of congestion; and selects the shortest travel time for each vehicle trip. This sub-model incorporates an iterative, capacity-restrained assignment, and volume adjustment for results to approach equilibrium. Four time periods are used in traffic assignment: AM peak period (6:00 am to 9:00am), mid-day period (9:00 am to 4:00 pm), PM peak period (4:00 pm to 7:00 pm) and off-peak period (7:00 pm to 6:00 am).

Model Validation and Model Improvement

Model validation examines how well the outputs of a travel demand model match with observed travel data in the base year. During the model validation process, BCAG calibrated the travel demand model inputs to match observed travel data. The 2010 California Transportation Commission's Regional Transportation Plan guidelines recommend both static[6] and dynamic[7] model validation to be performed for a region the size of the Butte County (see Appendix A for more details). The results of the daily model's static validation test are summarized in Table 15. The daily model outputs are within the acceptable range suggested by the CTC's RTP guidelines.

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[5] 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.

[6] Static validation tests compare the model's prediction of traffic volumes against existing traffic counts.

[7] Dynamic validation tests evaluate the model's response to changes in land use and transportation system assumptions.

Table 15: Base Year Static Model Validation Results of the Daily Model

Validation Item	BCAG's Model Result	CTC's RTP Guideline Criteria for Acceptance
Percent of Links within Allowable Deviation	81%	≥75%
Correlation Coefficient	0.93	≥0.88
Percent Root Mean Squared Error (% RMSE)	31%	≤40%

Note: The deviation is the difference between the model volume and the actual count divided by the actual count. It is an indication of the correlation between the actual traffic counts and the estimated traffic volumes from the model. RMSE is the square root of the model volume minus the actual count squared divided by the number of the counts.

In addition to the static validation suggestions given in the CTC guidelines, BCAG checked the model-wide volume-to-count ratio against a designed maximum threshold of no more than ten percent deviation; the result, -5%, is within BCAG's designed range.

For dynamic validation, BCAG changed variables associated with land use or the transportation network to examine whether its model could produce reasonable VMT figures. In general, the dynamic validation outputs show consistent directional changes as expected. For example, when roadway capacity increases or decreases, the corresponding VMT goes up or down, respectively.

Compared to the previous version of the travel demand model, BCAG's new travel demand forecast now captures residential and non-residential vacancy rates and is more sensitive to the cost of travel, smart growth development, and changes to the transit system. Under the 2010 CTC travel model grouping guidelines, BCAG is classified as Group B region, which allows for the use of a three-step model. Overall, this travel demand model is consistent with the requirements in the 2010 CTC Regional Transportation Guidelines.

C. EMFAC Model

ARB's Emission Factor model (EMFAC2007) is a California-specific computer model which calculates weekday emissions of air pollutants from all on-road motor vehicles including passenger cars, trucks, and buses for calendar years 1965 to 2040. The model estimates exhaust and evaporative hydrocarbons, carbon monoxide, nitrogen oxides, particulate matter, oxides of sulfur, lead, methane, and CO_2 emissions. It uses vehicle activity provided by regional transportation planning agencies, and emission rates developed from testing of in-use vehicles. The model estimates emissions at the statewide, county, air district, and air basin levels. Types of emission processes included in EMFAC 2007 are running exhaust, idle exhaust, starting exhaust, diurnal, resting loss, hot soak, running losses, tire wear, and brake wear. To estimate per capita

CO_2 emissions, BCAG estimated total VMT and speed profiles for the region using its travel demand model, and then applied them to the EMFAC2007 model. EMFAC2007 calculated the emissions based on total VMT, VMT distribution by vehicle class, and speed distribution. The estimated total weekday CO_2 emissions for year 2005, 2010, 2020, and 2035 were converted to obtain per capita CO_2 emissions.

V. LAND USE PERFORMANCE INDICATOR

ARB staff evaluated residential density as a qualitative performance indicator of whether the SCS could meet its GHG targets if implemented. The evaluation uses empirical studies on residential density that illustrate qualitatively how changes in residential density can increase or decrease VMT and/or GHG emissions. ARB staff's review focuses on changes in passenger vehicle GHG emissions reductions from development patterns assumed in the balanced land use scenario.

Residential density is a measure of the average number of dwelling units per acre of developed land. BCAG's SCS anticipates a change in travel characteristics in the region as the housing market shifts from single unit homes on larger lots, to single unit homes on smaller lots, townhomes, and multi-family housing. These changes in travel behavior include reductions in average trip length and decreased regional VMT. The Butte region currently has about 96,623 dwelling units. Roughly 75% are single-family homes with densities ranging anywhere from thirteen units per acre in the urban areas to one unit per 160 acres in timber and agricultural areas. The other 25% are multi-family dwelling units, built at densities ranging from 13 to 50 units per acre.

The Butte SCS reports an average residential density of 1.59 housing units per acre in 2010. By 2020, that figure increases to 1.62 units per acre and increases again in 2035 to 1.7 units per acre. This represents an increase of 0.11 housing units per acre between 2010 and 2035. During the same period, the Butte SCS also reports a regional per capita VMT decrease of 0.03%.

A review of relevant empirical literature reveals supports this observation. Brownstone and Golob analyzed National Household Travel Survey (NHTS) data and observed that denser housing development significantly reduces annual vehicle mileage and fuel consumption, which directly results in the reduction in GHG emissions. They also reported that households in areas with 1,000 or more units per square mile drive 1,171 fewer miles and consume 64.7 fewer gallons of fuel than households in less dense areas. Boarnet and Handy (2010) reported that doubling residential density reduces VMT an average of 5 to 12 percent. Manville and Shoup (2005) reported that a 1% population density increase is associated with a 0.58% reduction in VMT in a survey of twenty urbanized areas. As Boarnet and Handy (2010) report, due to the urban focus in the literature, it is important to note that there is little evidence that explores in any specificity on the way that residential density interacts with VMT in rural areas.

While the levels of increased residential density in Butte are relatively low, they are directionally consistent with what the literature would indicate as resulting in reduced vehicle miles traveled and thus greenhouse gas emissions. These increases in density are consistent with the empirical literature indicating likely reductions in VMT and auto trip length, shifts in travel mode away from single occupant vehicles, and reductions in GHG emissions.

VI. CONCLUSION

This report documents ARB staff's technical review of the draft plan together with its subsequent review of the adopted MTP/SCS. This review affirms that BCAG's adopted SCS demonstrates that, if implemented, the region will achieve a 2 percent passenger vehicle greenhouse gas per capita reduction in 2020, and a 2 percent reduction in 2035. These reductions meet the targets established for BCAG of 1 percent and 1 percent GHG per capita increase from 2005 for the years 2020 and 2035, respectively.

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Appendix A: 2010 CTC RTP Guidelines Addressed in BCAG's MTP

This Appendix describes the requirements in the CTC Guidelines that are applicable to the BCAG regional travel demand model, as well as the recommendations that BCAG incorporated into the model.

Requirements	1. 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. 2. MPO models shall be capable of estimating future transportation demand at least 20 years into the future. (Title 23 CFR Part 450.322(a)) 3. For federal conformity purposes, each MPO shall model criteria pollutants from on-road vehicles as applicable. Emission projections shall be performed using modeling software approved by the EPA. (Title 40 CFR Part 93.111(a)) 4. Each MPO shall quantify the reduction in greenhouse gas emissions projected to be achieved by the SCS. (California Government Code Section 65080(b)(2)(G)) 5. The MPO, the state(s), and the public transportation operator(s) shall validate data utilized in preparing other existing modal plans for providing input to the regional transportation plan. In updating the RTP, the MPO shall base the update on the latest available estimates and assumptions for population, land use, travel, employment, congestion, and economic activity. The MPO shall approve RTP contents and supporting analyses produced by a transportation plan update. (Title 23 CFR Part 450.322(e)) 6. The metropolitan transportation plan shall include the projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan. (Title 23 CFR Part 450.322(f)(1))
Recommendations	1. The use of three-step models can continue for the next few years. The models should be run to a reasonable convergence towards equilibrium. 2. 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. 3. During the development period of more sophisticated/detailed models, there may be a need to augment current models with other methods to achieve reasonable levels of sensitivity. Post-processing should be applied to adjust model outputs where the models lack capability, or are insensitive to a particular policy or factor. The most commonly referred to post-processor is a "D's" post-processor, but post-processors could be developed for other non-D factors and policies, too. 4. The models should address changes in regional demographic patterns. 5. Geographic Information System (GIS) capabilities should be developed in these counties, leading to simple land use models in

	a few years. 6. All natural resources data should be entered into the GIS. 7. Parcel data should be developed within a few years and an existing land use data layer created. 8. For the current RTP cycle (post last adoption), MPOs should use their current travel demand model for federal conformity purposes, and a suite of analytical tools, including but not limited to, travel demand models (as described in Categories B through E), small area modeling tools, and other generally accepted analytical methods for determining the emissions, VMT, and other performance factor impacts of sustainable communities strategies being considered pursuant to SB 375. 9. 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. 10. 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. 11. 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. 12. 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. 13. When the transit mode is modeled, speed and frequency, days, and hours of operation of service should be included as model inputs. 14. When the transit mode is modeled, the entire transit network within the region should be represented. 15. Agencies are encouraged to participate in the California Inter-Agency Modeling Forum. This venue provides an excellent opportunity to share ideas and help to ensure agencies are informed of current modeling trends and requirements. 16. MPOs should work closely with state and federal agencies to secure additional funds to research and implement the new land use and activity-based modeling methodologies. Additional research and development is required to bring these new modeling approaches into mainstream modeling practice.

Appendix B: Modeling Parameters for SCS Evaluation (Data Table)

This appendix contains BCAG's responses to data requests, received on December 12, 2012, to supplement ARB staff's evaluation of BCAG's quantification of GHG emissions. ARB requested this data in accordance with the general approach described in ARB's July 2011 evaluation methodology document (or the modified evaluation methodology document).

Modeling Parameters	2005	2010 (base year)	2020 (With Project)	2020 (Without Project)	2035 (With Project)	2035 (Without Project)	Data Source(s)
DEMOGRAPHIC							
Total population[i]	214,582	221,768	257,266	---	332,459	---	BCAG Regional Growth Forecasts, State of California, and 2012 MTP/SCS - Chapter 6
Group quarters	---	---	---	---	---	---	
Total number of households[i]	85,478	90,405	108,095	---	139,686	---	
Persons per household	2.44	2.38	2.38	---	2.38	---	
Auto ownership per household	---	---	---	---	---	---	
Total number of jobs (Non-Farm)[ii]	73,400	71,501	87,214	---	112,279	---	
Average unemployment rate (%)	---	---	---	---	---	---	
Average household income ($)	---	---	---	---	---	---	
LAND USE							
Total housing/dwelling units[i]	91,666	96,623	111,813	---	143,948	---	Same as above
Total acreage developed	---	60,655	69,078	---	84,703	---	BCAG Regional Land Use Allocation Model and Geographic Information System (GIS)
Total acreage in region	1,172,912						
Total acreage available for new development	---	---	---	---	---	---	
Percent housing within 1/4 mile of transit stations/stops	---	---	---	---	---	---	
Percent housing within 1/2 mile of existing transit route	---	75%	74%	---	69%	---	
Percent employment within 1/4 mile of transit stations/stops	---	---	---	---	---	---	
Percent employees within 1/2 mile of transit stations/stops	---	87%	85%	---	83%	---	
Multi-family housing units	---	25%	25%	---	26%	---	
Single family housing units	---	75%	75%	---	74%	---	
Total Housing Units by Growth Area							BCAG Regional Land Use Allocation Model, GIS, and 2012 MTP/SCS - Chapter 6
Urban Center and Corridor	---	8,375	9,212	---	11,135	---	
Established	---	73,639	84,599	---	100,131	---	
New	---	440	2,264	---	14,299	---	
Rural	---	7,829	8,784	---	10,753	---	
Agricultural, Grazing, and Forestry	---	6,340	6,953	---	7,629	---	

Modeling Parameters	2005	2010 (base year)	2020 (With Project)	2020 (Without Project)	2035 (With Project)	2035 (Without Project)	Data Source(s)
Total Employees by Growth Area	---	---	---	---	---	---	BCAG Regional Land Use Allocation Model, GIS, and 2012 MTP/SCS - Chapter 6
Urban Center and Corridor	---	30,471	33,534	---	40,275	---	
Established	---	37,535	48,672	---	61,108	---	
New	---	1,277	2,170	---	7,506	---	
Rural	---	950	1,379	---	1,852	---	
Agricultural, Grazing, and Forestry	---	1,268	1,460	---	1,539	---	
Acreage of land zoned (used and available) for mixed use	---	---	---	---	---	---	---
Average residential density – (housing units/total acreage developed)	---	1.59	1.62	---	1.70	---	BCAG Regional GIS
TRANSPORTATION SYSTEM							
Freeway general purpose lanes –- mixed flow, auxiliary, etc. (lane miles)	---	189	194	---	196	---	BCAG Regional GIS
Freeway managed lanes--HOV, HOT, Tolled, etc. (lane miles)	---	---	---	---	---	---	
Arterial / Expressway (lane miles)	---	731	773	---	810	---	
Collector and Local (lane miles)	---	6,276	6,277	---	6,276	---	
Regular transit bus operation Miles [iii]	---	333	333	---	333	---	
Bus rapid transit bus operation miles	---	---	---	---	---	---	
Express bus operation miles	---	---	---	---	---	---	
Transit rail operation miles	---	---	---	---	---	---	
Bike lane (class I & II) miles[iv]	---	78	88	---	88	---	
Miles of sidewalk	---	---	---	---	---	---	

Modeling Parameters	2005	2010 (base year)	2020 (With Project)	2020 (Without Project)	2035 (With Project)	2035 (Without Project)	Data Source(s)
TRIP DATA							
Number of Vehicle trips by trip purpose							BCAG Regional Travel Demand Model
- Home-based work	146,044	150,801	174,453	---	222,507	---	
- Home-based school	58,547	60,576	69,914	---	89,628	---	
- Home-based college	---	---	---	---	---	---	
- Home-based shopping	---	---	---	---	---	---	
- Home-based recreational	---	---	---	---	---	---	
- Home-based casino	7,866	7,866	9,613	---	12,586	---	BCAG Regional Travel Demand Model
- Home-based others	344,670	355,381	411,342	---	508,654	---	
- Non home-based	167,826	166,026	192,578	---	235,737	---	
By trip purpose							
Average auto trip length (miles)	6.56	6.58	6.72	---	6.88	---	BCAG Regional Travel Demand Model
Average walk trip length (miles)	---	---	---	---	---	---	
Average bike trip length (miles)	---	---	---	---	---	---	
Average transit trip length (miles)	---	---	---	---	---	---	
Average auto travel time (minutes)	10.45	10.47	10.68	---	10.77	---	
Average walk travel time (minutes)	---	---	---	---	---	---	
Average bike travel time (minutes)	---	---	---	---	---	---	
Average transit travel time (minutes)	---	---	---	---	---	---	

Modeling Parameters	2005	2010 (base year)	2020 (With Project)	2020 (Without Project)	2035 (With Project)	2035 (Without Project)	Data Source(s)
PERCENT PASSENGER TRAVEL MODE SHARE (whole day)							
Auto	---	92.75%	91.41%	---	91.38%	---	BCAG Regional Travel Demand Model
All Other (transit & non-motorized)	---	7.25%	8.59%	---	8.62%	---	
SOV	---	---	---	---	---	---	
HOV	---	---	---	---	---	---	
HOT	---	---	---	---	---	---	
Public transit (Regular Bus)	---	---	---	---	---	---	
Public transit (Express Bus)	---	---	---	---	---	---	
Public transit (BRT)	---	---	---	---	---	---	
Public transit (Rail)	---	---	---	---	---	---	
Non-Motorized: Bike	---	---	---	---	---	---	
Non-Motorized: Walk	---	---	---	---	---	---	
PERCENT PASSENGER TRAVEL MODE SHARE (peak period)							
SOV	---	---	---	---	---	---	---
HOV	---	---	---	---	---	---	---
HOT	---	---	---	---	---	---	---
Public transit (Regular Bus)	---	---	---	---	---	---	---
Public transit (Express Bus)	---	---	---	---	---	---	---
Public transit (BRT)	---	---	---	---	---	---	---
Public transit (Rail)	---	---	---	---	---	---	---
Non-Motorized: Bike	---	---	---	---	---	---	---
Non-Motorized: Walk	---	---	---	---	---	---	---

Modeling Parameters	2005	2010 (base year)	2020		2035		Data Source(s)
			(With Project)	(Without Project)	(With Project)	(Without Project)	
VEHICLE MILES TRAVELED							
Total VMT per weekday for passenger vehicles (ARB vehicle classes of LDA, LDT1, LDT2 and MDV) (miles)	3,797,148	3,861,151	4,587,012	---	5,998,796	---	BCAG Regional Travel Demand Model and EMFAC 2007
Total II VMT per weekday for passenger vehicles (miles)	2,568,643	2,637,476	3,162,690	---	4,367,722	---	
Total IX/XI VMT per weekday for passenger vehicles (miles)[v]	1,099,357	1,095,524	1,234,310	---	1,313,278	---	
Total XX VMT per weekday for passenger vehicles (miles)	129,148	128,151	190,012	---	317,796	---	
CONGESTED TRAVEL MEASURES							
Congested weekday VMT on freeways (V/C ratios >1.0)	0	0	0	---	0	---	BCAG Regional Travel Demand Model
Congested weekday VMT on all other roadways (V/C ratios >1.0)	15,032	31,850	99,036	---	333,551	---	
CO2 EMISSIONS[vi]							
Total CO2 emissions per weekday for passenger vehicles (ARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons)	1,832	1,862	2,170	---	2,840	---	BCAG Regional Travel Demand Model and EMFAC 2007
Total II + IX / XI trip CO2 emissions per weekday for passenger vehicles (tons)	1,770	1,800	2,080	---	2,690	---	
Total XX trip CO2 emissions per weekday for passenger vehicles (tons)	62	62	90	---	150	---	

Modeling Parameters	2005	2010 (base year)	2020 (With Project)	2020 (Without Project)	2035 (With Project)	2035 (Without Project)	Data Source(s)
INVESTMENT (thousands in 2012$)							
Total Investment ($)	---	---	498,002	---	998,129	---	2012 MTP/SCS - Financial Element (Chapter 13)
Highway capacity expansion ($)	---	---	35,694	---	122,776	---	
Other road capacity expansion ($)	---	---	0	---	0	---	
Road and Highway maintenance and operations ($)	---	---	287,339	---	546,606	---	2012 MTP/SCS - Financial Element (Chapter 13)
Transit capital ($)	---	---	31,290	---	51,582	---	
Transit operations ($)	---	---	64,147	---	163,930	---	
Rail projects ($)	---	---	550	---	1,406	---	
Bike and pedestrian projects ($)	---	---	12,421	---	26,597	---	
Aviation projects ($)	---	---	59,017	---	67,282	---	
Planning projects ($)	---	---	7,545	---	17,949	---	
Other ($)	---	---	---	---	---	---	---
TRANSPORTATION USER COSTS AND PRICING							
Vehicle operating costs ($ per mile)	---	---	---	---	---	---	---
Gasoline price ($ per gallon)	---	---	---	---	---	---	---
Parking price ($ per day)	---	---	---	---	---	---	---
Toll price ($)	---	---	---	---	---	---	---
Congestion price ($ per mile)	---	---	---	---	---	---	---

[i] 2005 and 2010 data sources: State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark. Sacramento, California, May 2010.

[ii] 2005 and 2010 data sources: State of California, Employment Development Department, Butte County Industry Employment & Labor Force, March 2009 Benchmark. Sacramento, California, June 18, 2010.

iii Transit miles are a measure of service coverage, not service intensity. Reported figures represent the combined mileage of routes, not including frequency. The 2012 MTP/SCS does not include forecasted transit routing.

iv 2012 MTP/SCS does not forecast bicycle facility improvements beyond the 2013 FTIP horizon year of 2015/16.

v IX-XI VMT and CO2 were "split" at MPO boundary, per agreement with SACOG.

vi CO2 emissions were prepared in EMFAC 2007 for the II + IX/XI row only. Total and XX rows are estimated based on the ratio of VMT to CO2 for each analysis year.