Searching the Optimal and Acceptable Urban Form for Regional Sustainable Planning

By

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Abstract

This paper asserts that the identification of the optimal and locally acceptable urban form would warrant the successful implementation of Sustainable Communities Strategy (SCS) in the Regional Transportation Plan, as required in the Senate Bill (SB) 375 of California. This paper shows how to search the optimal and locally acceptable urban form to achieve the regional greenhouse gas (GHG) emission (measured in vehicle miles of travel) reductions target by applying growth visioning strategies (e.g., transit oriented development and transportation efficient development) in the Southern California region. A number of urban forms might be found optimal as a result of iterative search and modeling process. The paper assesses the spatial distribution and local acceptability of optimal urban forms. The more acceptable urban form will be closer to the planned urban form based on the current planning framework. The paper also discusses issues and challenges in identifying the optimal and acceptable urban form. The incremental approach toward the more optimal urban form will warrant the success of implementing regional sustainable planning.

The views and opinions expressed in this paper are those of the authors and do not necessarily reflect those of the Southern California Association of Governments.

Introduction

There have been internationally organized scientific and cooperative efforts to address the global climate change since the late 1980s. In 1988, Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess the latest scientific, technical and socio-economic literature relevant to the understanding of human-induced climate change. The Kyoto Protocol (1992) is intended to alleviate greenhouse gas (GHG) concentrations in the atmosphere at a more acceptable level. According to the Kyoto Protocol, countries are mandated to reduce major GHGs. For example, the Kyoto Protocol suggests the United States to reduce 7% reductions of GHG emissions. The Clinton Administration of the United States once adopted the 1993 Climate Change Action Plan, which intended to bring GHG emissions to 1990 levels by the year 2000.

The State of California has made efforts to deal with the global climate change. California has introduced two major laws to reduce Greenhouse Gas (GHG) emissions. The first bill (AB32: Global Warming Solutions Act) is signed by Governor of California Arnold Schwarzenegger in 2006. AB32 is intended to reduce GHG emissions to 1990 levels by the year 2020. According to the recent PPIC survey for California residents (http://www.ppic.org/main/pressrelease.asp?p=965), majorities of California residents favor state policies to curb global warming. 66% of survey respondents support AB32.

California Air Resources Board (CARB) estimates that 2004 GHG emissions from automobiles and light trucks reached 135 million metric tons. Automobiles and light trucks account for almost 30 percent of the GHG emissions throughout California. Given the significant contribution of transportation sector in producing GHG emissions, SB 375 is passed by the State legislature and signed by Governor Schwarzenegger on September 2008 to provide a means for achieving AB 32 goals from cars and light trucks. This bill shows a significant effort of the State of California to implement the global warming goals of AB 32.

SB 375 requires Metropolitan Planning Organizations (MPOs) in California to develop a sustainable communities strategy (SCS) as a major element of the regional transportation plan (RTP) to reduce GHG emissions. SB375 acknowledges that the transportation sector contributes to the generation of GHG emissions, and it suggests that MPOs reduce the GHG emissions from cars and light trucks through the stronger coordination of land use and transportation. The MPOs have become important in the federally mandated regional planning process since the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991 and the Clean Air Act Amendments (CAAA) in 1990. They are now expected to play more important role in the state mandated regional planning process, as required in SB 375.

SCS includes general location of diverse land uses, residential densities and building intensities as a land use element in the RTP. SCS, however, is limited in its applicability, because planned land uses in local general plans don’t have to conform to SCS. The land

use plan element and its relevant strategies in the RTP would encourage smart growth and sustainable development such as transit oriented development; mixed use development, provision of housing opportunities near job centers, and job opportunities in housing-rich communities; focus of growth along transit corridors and nodes to utilize available capacity. As a result, transit use or walking becomes more popular, and the planned reductions of GHG emissions will be achieved by the target date. If SCS still can not meet the emission reduction targets, an alternative planning strategy (APS) should be prepared and would propose alternative development patterns, infrastructure, or additional transportation measures or policies to reduce the target emissions. The best case scenario is that the regional SCS might be properly aligned with the current local planning efforts to improve sustainability and livability through the local general plans. The smaller gap between SCS and local general plans would likely increase the local acceptability of the regional SCS.

This paper presents how to search the optimal and locally acceptable urban form to achieve the regional greenhouse gas (GHG) emission (measured in vehicle miles of travel) reductions target in the Southern California Region. First, the study discusses the current regional planning efforts in land use, housing, transportation, and environment. Second, the paper discusses the concept of both the optimal and the locally acceptable urban form to achieve the GHG emission targets as required in SB 375. Third, the paper assesses optimality, acceptability, and spatial distribution of urban forms (measured in residential and employment locations). The optimality of urban forms will be measured through the travel demand forecasting model and its resulting greenhouse emissions measure (e.g., vehicle miles traveled), while the acceptability of urban forms will be measured using the current local general plan. The Hoover concentration index will be used to assess the concentration of population and employment. Fourth, the paper discusses issues and challenges (e.g., setting the regional GHG emissions reduction targets) in identifying the optimal and acceptable urban form.

The Current Regional Planning Efforts: Land Use, Housing, Transportation, and Environment

The traditional regional planning efforts focus on improving the regional mobility and other related performance measures. The regional planning efforts evolved from the early 1960s: Federal-Aid Highway Act (1962) and Urban Mass Transportation Act (1964), and federal transportation funds were distributed with participation of cities or regions. The Federal-Aid Highway Act of 1962 required, as a condition attached to federal transportation financial assistance, that transportation projects in urbanized areas of 50,000 or more in population be based on a continuing, comprehensive, urban transportation planning process undertaken cooperatively by the states and local governments (U.S DOT, 1988). This law lays foundation for the 3C (continuing, comprehensive and cooperative) planning process.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) brought several innovative ideas into the regional planning practice to effectively deal with transportation planning and policy. This law was followed by the Transportation Equity Act for the 21st

Century (TEA-21) and most recently in 2005, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) have followed. The key elements of ISTEA are as follows: First, COGs or MPOs can have stronger roles and responsibilities than before. ISTEA requires strong working relationships between MPOs and other agencies. Second, long-range plans must evaluate a variety of scenarios. In this scenario building, public participation and their opinions are very important. ISTEA requires the long-range plan to define and evaluate several distinct alternatives in terms of broad costs and benefits and the ability to accomplish clearly stated area wide goals. Third, Regional Transportation Plan (RTP) and Regional Transportation Improvement Programs (RTIP) should be clearly related. And these two RTP and RTIP must be financially constrained. Fourth, ISTEA requires TIP to conform to air quality goals and places restrictions on the kind of programs they can fund if regions are in non-attainment of Clean Air Act standards. Fifth, as an important political and governing change, significant public participation is required. ISTEA requires a proactive public involvement process, including access to compete technical and policy information, timely notices, full access to key decisions, and support for early and continuing involvement in plan and TIP development.

As part of the federal transportation funding requirements, the RTP should conform to the regional emission requirements. The Clean Air Act (CAA) was introduced along with ISTEA in 1990, and it intends to reduce smog and air pollution by establishing air quality standards and planning requirements for various air pollutants. The CAA requires federally supported highway and transit project activities to meet federal air quality requirements. Under the U.S. Department of Transportation (DOT) Metropolitan Planning Regulations and U.S. Environmental Protection Agency's (EPA) Transportation Conformity Rule requirements, the MPO's Regional Transportation Plan (RTP) needs to pass regional emission analysis test. The analysis should demonstrate a positive conformity finding.

In additional to the federal efforts to improve both the regional mobility and air quality associated with emission of light and medium vehicles, California has focused on two major regional planning efforts: the regional housing needs allocation and the regional blueprint. First, the regional housing needs allocation (RHNA) is intended to improve the affordability of residents through the RHNA process and the resulting local housing element update for several decades. The regional housing needs allocation RHNA process establishes minimum housing development capacity that cities and counties are to make available via their land use powers to accommodate growth within a short-term planning period. RHNA numbers are assigned by four income categories as guideposts for each community to develop a mix of housing types for all economic segments of the population. The process is also known as "fair share" planning. The RHNA results should be consistent with other goals of the State Law: increasing the housing supply and the mix of housing types, tenure, and affordability in an equitable manner; promoting infill development and socioeconomic equity; promoting an improved intraregional relationship between jobs and housing; and allocating a lower proportion of housing need to an income category when a jurisdiction already has a disproportionately high share compared to the countywide distribution (California Senate Bill No. 12 65584 (d)). Every

city and county in California must adopt a comprehensive "general plan" to govern its land use and planning decisions. All planning and development actions must be consistent with the general plan. The general plan housing element must be periodically updated using the latest RHNA allocation plan. A housing element must first include an assessment of the locality's existing and future housing needs. This assessment must include the community's "fair share" RHNA for all income groups (very low, low, moderate and above moderate) as determined by the regional Council of Governments (COG).

The regional blueprint planning program is introduced to help Metropolitan Planning Organizations (MPOs) to develop alternative growth scenarios. The program would be used to utilize previously unallocated federal funding, as well as improving the comprehensive level of transportation/land use planning. The Regional Blueprint Planning Program is a voluntary, discretionary grant program that provides seed funding to MPOs to conduct regional blueprint planning. The program contributes to the vision of improved quality of life within California by addressing future growth on a twenty-year horizon through the integration of transportation, housing, land use, environmental resources, other infrastructure, and services. The program requires enhanced public engagement and is currently underway in most urbanized areas of the state, including several rural counties (Joan Sollenberger & Lisa Klein, Regional Transportation Plan Guidelines Work Group Meeting, June 28, 2007). The regional blueprints are not required to be part of the RTP. How they affected transportation funding decisions has, thus far, been limited. However, their main purpose is to incentivize different local government planning and development approval decisions. They have also been made a factor in the decision-making of state agencies allocating Proposition 1B (California Transportation Commission) and Proposition 1C (HCD) discretionary funding awards of state bond funds.(CALCOG, Guide to Regional Planning as Revised by SB 375, January 2009)

In general, two major federal programs (RTP and conformity analysis), two state programs (RHNA and Blueprint), and local general plan have been loosely interlinked among them before SB 375 (see figure 1). The clear linkage is federally or state mandated for: 1) RHNA, local general plan (through the housing element update), and RTP, 2) RTP through conformity analysis. There has been an issue with different planning horizons of RHNA (8 years) and RTP (minimum 20 years). Since compass blueprint program was voluntary and educational in terms of its nature, it has a limited effect on both RTP and RHNA, while there was an enhanced effort to integrate the growth forecasts for both RHNA and RTP for the short term forecast period (e.g., RHNA planning horizon of 8 years).

With introduction of SB 375, the relationship among five programs and plan has strengthened (see figure 2). First, the development pattern in an SCS must comply with federal law, which requires that any pattern be based upon “current planning assumptions” that includes the information in local general plans and sphere of influence boundaries. The SCS will not directly affect local land use decisions. The SCS does not in any way supersede a local general plan, local specific plan, or local zoning. SB 375

does not require that a local general plan, local specific plan, or local zoning be consistent with the SCS. An SCS would be understood as a regional version of the land use element in the local general plan. SB 375 explicitly integrates three key planning elements: SCS, RTP, and RHNA to achieve the regional GHG emissions target. The long-term transportation plan (planning horizon of minimum 20 years) and the short term housing needs allocation plan (8 year planning horizon) are linked each other through SCS and prepared on the same planning cycle. The RHNA has an implication for the future affordable housing needs and additional housing supply for local jurisdictions, while the RTP is assumed to bring the additional financial resources to communities. Local jurisdictions tend to underestimates the affordable housing needs because of the social costs, while they tend to overestimate transportation needs due to financial packages. Once these two different perspectives can be discussed together on the same planning cycle, the growth issues might be better sorted out in more balanced way. Third, SB 375 provides financial and regulatory incentives for the effective implementation of land development through the SCS. The financial incentive is available through the consistency requirement of the financial element of the RTP (e.g., allocation of transportation funds) with the SCS, its land use plan, and transportation policies, targeting GHG emissions reductions. Since the land use plan (growth allocation) of the SCS must be based upon the most current planning assumptions, it is generally taken from local city and county general plans (CSAC Analysis, 2008?). If SCS can not achieve the GHG emission reductions target, Alternative Planning Strategy (APS) should be prepared. The financial incentives are also provided to cities and counties that have resource areas or farmland, for the purposes of, for example, transportation investments for the preservation and safety of the city street or county road system, farm to market, and interconnectivity transportation needs. An MPO or county transportation agency shall also consider financial assistance for counties to address countywide service responsibilities in counties that contribute towards the GHG emissions reductions targets by implementing policies for growth to occur within their cities. The regulatory incentives such as CEQA exemptions and streamlining are also available for the certain projects achieving the goals of reducing GHG emissions by their proximity to transit or by their consistency with the SCS. As cities and counties use the CEQA exemption/streamlining in SB 375, their assumptions of future growth and land use will tend to be more consistent with those in the SCS.

Figure 1. Relationship of Major Plans and Programs: Before SB375

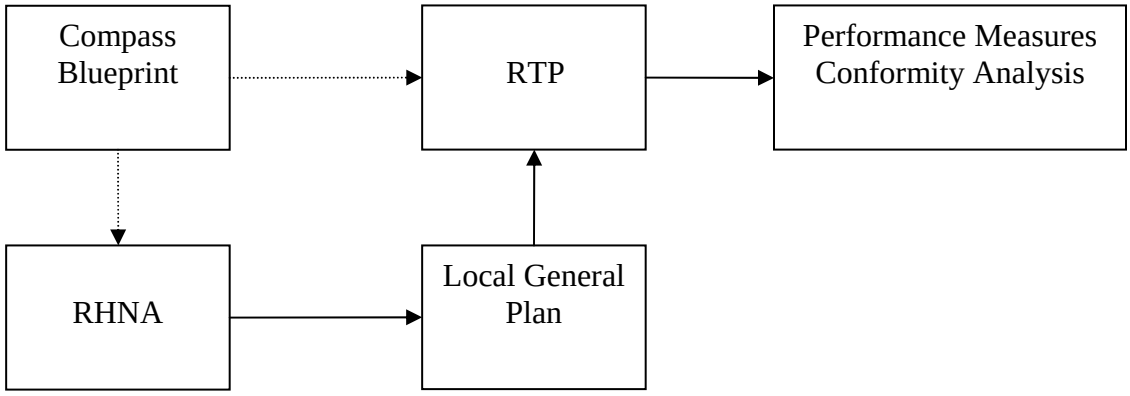
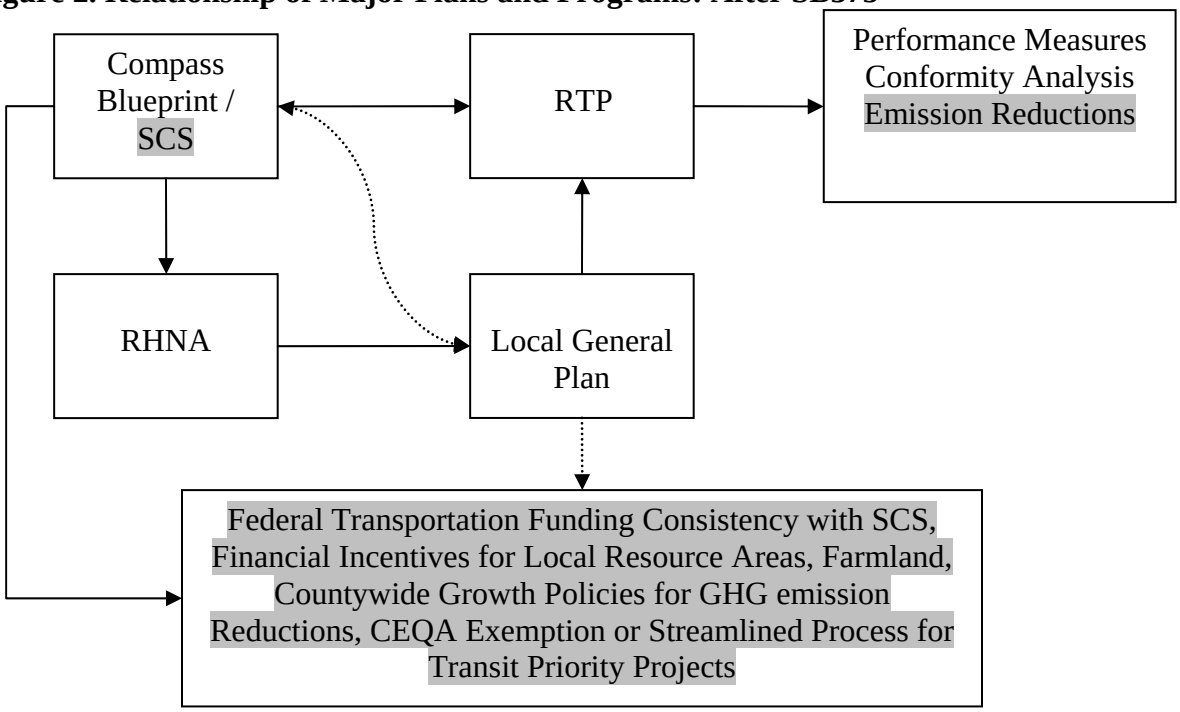


Figure 2. Relationship of Major Plans and Programs: After SB375



The Locally Acceptable and Optimal Urban Form for GHG Emission Reduction

Diverse urban forms result from the change of urban residential and employment activities and land use assumptions, and are assessed through the transportation demand modeling and conformity analysis. According to Federal law, regional transportation plans should estimate a likely or realistic development pattern for the region over the next 20 to 30 years, and MPOs should make a conformity finding that the RTP is consistent

with the requirements of the federal Clean Air Act. Some regions in California have already involved in a regional "blueprint" process to prepare the visionary and alternative land use/development pattern. As the region's urban form (e.g., distribution of population and employment) would influence the travel demand model results and their conformity implications, the necessary assumptions should meet the requirements of both currency and reasonableness, as specified in the Federal law. First, the Clean Air Act (Section 176(c)(1)(B)(iii)) specifies that the determination of conformity should be based on the latest planning assumptions derived from the most recent population, employment, travel, and congestion estimates. Second, land development and use scenarios must be consistent with the future transportation system for which emissions are being estimated, and the distribution of employment and residences for the transportation system must be reasonable. (US EPA & DOT, Guidance for the Use of Latest Planning Assumptions in Transportation Conformity Determinations, 12 2008).
http://www.epa.gov/otaq/stateresources/transconf/policy/420b08901.pdf

In order for the planning assumptions to be current and reasonable, MPOs make every effort to reflect the most recent information in a local general plan, local specific plan, or local zoning, in the future development pattern of the region. SCAG developed and updated assumptions: 1) reasonable and realistic; 2) based on the best and most up-to-date information; and 3) consistent with planned transportation infrastructure, in the recent 2008 RTP development process. All land use, population, households, employment, and network-based model assumptions were updated for 2008 RTP and documented in 2008 RTP: Integrated Growth Forecast and Regional Land Use Policies Report. Scenarios of land development and use are consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options is reasonable.

The assumption update process begins with population and economic forecasts through SCAG's Integrated Growth Forecasting process, which laid the foundation for the land use assumptions that were then developed in collaboration with local governments. The Integrated Growth Forecast sets the optimal stage for a future regional growth scenario as it ties housing to transportation planning, considering both needs simultaneously in communities throughout the region. This approach ensures that the resulting assumptions are consistent with planned transportation infrastructure. Based on a combination of recent and past trends, reasonable key technical assumptions, and existing and new local or regional policy options, the Integrated Growth Forecast provides the basis for developing the land use assumptions at the regional and small area levels which build the Plan Alternative.

The following is a procedure that SCAG took to develop land use assumptions:
1. Analyze recent regional growth trends and the collection of significant local plan updates: A variety of large area estimates and projections are collected from the federal and state governments. The selected sources included information from the following agencies: U.S. Census Bureau, U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, U.S. Internal Revenue Service (IRS), U.S. Citizenship and Immigration

Services, California Department of Finance (DOF), California Employment Development Department
2. Review and update the 2004 RTP regional growth forecast methodology and key assumptions. The widely used methodology included the cohort-component and shift-share methods. The key technical assumptions included updates regarding the fertility rate, mortality rate, net immigration, domestic in-migration, domestic out-migration, labor force participation rates, double jobbing rates, unemployment rates, and headship rates.
3. Review and update existing regional growth policies and strategies was conducted, including Compass Blueprint strategies, economic growth initiatives, Goods Movement strategies, and others. Relevant analyses included general plan capacity analyses, demonstration projects, regional growth principles, polling and focus groups, and public workshops.
4. Develop and evaluate the draft regional Integrated Growth Forecast scenarios with small area distributions: Regional growth forecast scenarios were developed and allocated into the smaller geographic levels using public workshops. The small area distributions of the regional growth were evaluated using transportation and emission modeling results and environmental impact review.
5. Select and adopt a preferred regional growth forecast, followed by the development of a regional growth scenario with selected small area distributions using transportation and environmental performance measures.

An organized forecasting decision making process is required to develop a consensus regional growth forecast in an efficient, open, and fair way. A variety of groups or input involved in the forecasting process include panel of experts, subregional/local review, stakeholders/data users, public outreach, technical committee, policy committee, and the Regional Council.

Through the multi-year "assumption update" process, SCAG could identify the urban form (e.g., distribution of population and employment), which met the federal requirements of currency and reasonableness. SCAG went though the assumption update process through the bottom up process. The local jurisdictions provided SCAG with the most recent assumptions of population and employment reflecting the information in the local general plan, local specific plan, or local zoning. SCAG also used an integrated forecasting approach and consensus-built growth visioning process to develop alternative urban form, which shows the better transportation and air quality performance. The growth assumptions, vision and policies were all developed in coordination with technical analyses, local input, land use and growth experts, and on-the-ground "reality checks."

Widespread public participation was the cornerstone of the visioning process, with over 15,000 stakeholders taking part in dozens of workshops, focus groups and polls region-wide. Using the extensive input from these efforts, in conjunction with capacity, economic and redevelopment analyses, technical modeling analysis and expert peer review, SCAG established regional consensus toward the Compass Vision. Driven by four guiding principles of mobility, livability, prosperity and sustainability, the Growth

Vision provided a policy based growth alternative, encouraging future population and economic growth in strategic opportunity areas thought the region. Specifically, the plan called for mixed use and transit-oriented development, a range of housing and transportation options, jobs-housing balance and more walkable communities in existing and planned centers and along transportation corridors. Using these growth strategies, subsequent analyses found that anticipated growth could be accommodated through modest changes to just 2% of the region that adopt these policy alternatives.

This locally preferred land use and development scenario and other alternative land use and develop scenario are tested using transportation and air quality measures. Although LP scenario shows the lowest transportation performance of alternative scenarios, it was eventually adopted as the land use scenario as part of 2008 RTP. This regional policy decision is fully justified for the adopted urban form scenario's local acceptability. As the locally preferred urban form has been evolving due to the changing dynamics of economy, demographics, federal and state urban form policies, etc., the diverse elements of the evolving urban form are explicitly or implicitly imbedded in the recent local general plan or specific plan. A limited number of the local plans already reflect the changing social norms for accepting higher density standard, transit oriented development, mixed use development, transit corridor development. The local preferred land use scenario might not be aggressive in achieving the "maximum" transportation and air quality benefits to the society, but realistic and reasonable in achieving the "socially acceptable" transportation and air quality benefits to the society

Now the regional planners in California face one more requirement to assess the "social acceptance" of the locally preferred urban form. The locally preferred urban form, so-called sustainable communities strategy (SCS), should prove whether the regional greenhouse gas emission reductions assigned by California Air Resource Board (ARB) are made possible by 2020 or 2035. Although there have been a lot of efforts to deal with many challenges, in particular, establishing the regional GHG emission targets and modeling the performance measurement, SCAG makes an effort to develop applicable modeling tools for the better performance measurement. SCAG maintains and is in the process of developing tools appropriate for the measure of greenhouse gas emission reductions as called for in the statute. These include two currently operational tools: a transportation demand model and "4-D" analysis tool. Further, SCAG is developing and anticipates having available for use with the 2012 RTP/SCS, two additional tools: an activity based model, and an integrated land use model. SCAG will use available tools to measure the performance of regional and subregional SCSs. (Attachment Framework..)

The dilemma for regional planners is well described by Bill Fulton (CP & CR 009). "If a certain type of development pattern is unlikely to emerge from local decision-making," League of California Cities lobbyist Bill Higgins noted recently, "it will be difficult for the regional agency to say that it reflects current planning assumptions." As is typically the case in planning, the SCS can contain only "feasible" measures to reduce greenhouse gas emissions. If SCS can not achieve the regionally assigned emission targets, there is still an option of developing an Alternative Planning Strategy

(APS). The APS is technically separate from the RTP but nevertheless must contain alternative land use and transportation strategies.

From the visionary planning perspective, there might be alternative urban forms other than locally acceptable urban form possible to meet the transportation goals (e.g., mobility, accessibility, etc), pass the conformity test, and achieve the regionally assigned greenhouse gas emissions target. We might introduce and implement a wide range of optimal urban form strategies including jobs housing balance, transit oriented development, mixed use development, employment centers development, etc. to meet those requirements above. The socially optimal urban forms derived above might be too aggressive or unrealistic to achieve the projected land use and development pattern. These urban form assumptions might be in conflict with the federal requirements of realistic, current, reasonable, and feasible land use and development pattern. We probably might end up with the APS to be used for the RTP process.

In summary, the locally acceptable and optimal urban form might have been developed to meet the federal and state requirements of the regional transportation plan. As the sustainable communities strategy is introduced into the existing regional transportation plan as part of the regional plan, development of the locally acceptable and optimal urban form might be a more challenging task than ever. The level of regional GHG emission target most likely would determine whether the MPOs develop SCSs or APSs because of the gap in the planning requirements between the Federal and State laws. If the regional GHG emission target is determined close and low enough to the locally preferred urban form, SCS will be a possible option as the locally acceptable and optimal urban form. If not, APS will be an option as the locally unacceptable and optimal urban form.

Data & Methods

Data

The study area covers the whole Southern California Association of Governments (SCAG) region, comprised of six counties: Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura (see map). The SCAG region encompasses 189 cities, 38,000 square miles, and nearly 19 million people. SCAG is the largest of approximately 700 councils of governments (COG) in the United States in terms of land area and population, functioning as the Metropolitan Planning Organization (MPO) for Southern California. SCAG is mandated by the federal and state governments to develop regional plans for transportation, growth management, housing development, air quality and other issues of regional significance.

The spatial unit of analysis in this study is primarily transportation analysis zone (TAZ), the current number of which is 4,109. The current TAZ is based on 2000 Census Tract, and is updated every ten years, whenever the new decennial census data are available. These TAZs are aggregated to 302 Community Statistical Areas (CSAs) and 55 Regional Statistical Areas (RSAs).

The study uses a draft regional baseline growth forecast for 2008 RTP as a regional control for urban form analysis. A draft regional baseline growth forecast was prepared for diverse policy analysis in the middle of year 2007. The draft regional baseline growth forecast is a future snapshot of the most likely population and employment distribution without regional policy input. It reflects historical trends, based on reasonable key technical assumptions and existing and newly approved local or regional projects. According to the draft regional baseline growth forecast, the region will add 6.4 million people to reach nearly 24 million people by 2035. Supporting this population in 2035 will be a total of 10.3 million jobs in 2035 with 2.7 million new jobs. This level of population and job growth is expected to yield 2.1 million additional households in the region at an average of three persons per household. It is clear that the substantial amount of projected growth will pose serious transportation and air quality challenges for the region.

Table 1. The Draft Regional Baseline Growth Forecasts, 2003-2035. Unit: Thousands

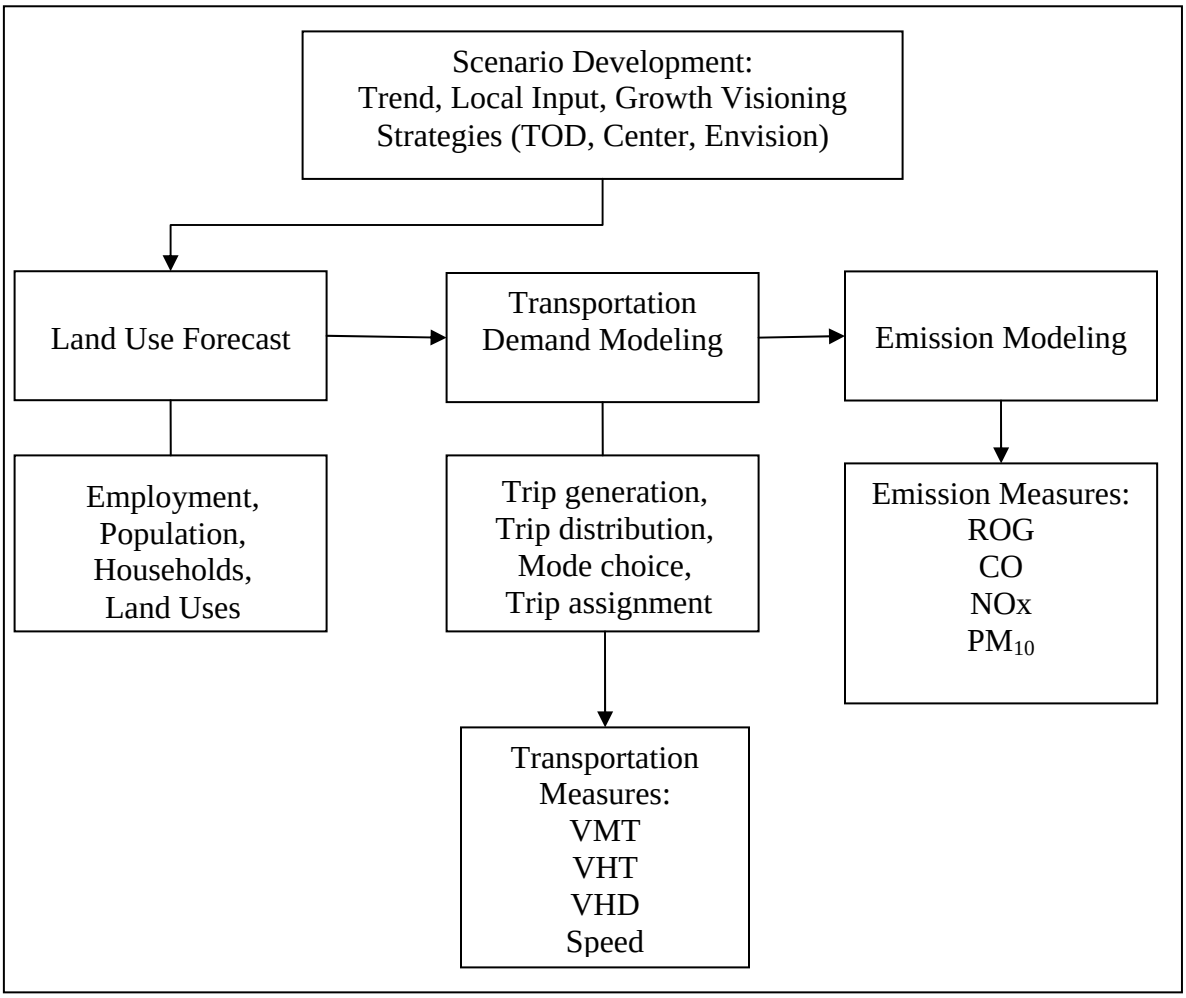
	2003	2035	Change	% Change, 2003-2035
Population	17,593	23,993	6,400	36%
Households	5,549	7,666	2,117	38%
Employment	7,540	10,277	2,737	36%

Source: SCAG, Draft 2008 RTP, July 2007.

Method

The study assesses the effects of land use forecast scenarios on the urban form (e.g., the spatial distribution of population and employment) and GHG emissions (e.g., VMT) through the existing SCAG's regional transportation modeling process (see figure 3). The baseline transportation network is assumed unchanged to measure the net effects of the land use forecast scenarios on urban form and GHG emissions.

Figure 3. Modeling Process



1. Scenario Development

The study is mostly based on existing land use forecast scenarios used for the large-scale land use and transportation plan development process during 2007. Only the trend scenario is separately developed to understand the potential difference with other land use forecast scenarios. The following is a list of five growth scenarios and provides a brief description of how they were developed:

1. Trend Scenario: The Trend Scenario is a technical projection that provides a best estimate of future growth based on past trends. The 2035 trend projection at the small area level is developed using the historical trends (2000-2005) and the extrapolation methods. The share of growth methods are applied to population and household projections, while the constant share method is applied to employment projections.
2. Locally Preferred Scenario: The Locally Preferred Scenario represents the most likely growth and growth distribution of the region in the absence of the explicit regional policies. The local input by county reflecting the current general plan as a desired future

of the communities forms the foundation of the Locally Preferred Scenario. Local Input is collected from counties, subregions, and local jurisdictions. Local input becomes the locally preferred scenario, once it meets the evaluation criteria (e.g., an unemployment rate of 5%-7% at the regional level) at the regional level.
3. TOD Scenario: The Visioning Scenarios (TOD, Center, Envision) were based on the Compass Blueprint Principles, which promote the region's mobility and access, livability, and prosperity. TOD is focused on improving the mobility for all residents. The TOD scenario resulted from assigning greater housing and employment capacity to areas around transit stations (e.g., Bus Rapid Transit (BRT), Metro Rail (Light Rail), MetroLink (Commuter Rail)). Mathematical redistributions were made to move housing from areas with long commutes to the new found capacity of the TOD areas.
4. Center Scenario: As one of the Visioning Scenarios, the Center Scenario is intended to focuse development in urban centers and existing cities. The Center scenario resulted from assigning greater housing and employment capacity to areas in and around significant employment centers.
5.Envision Scenario: The Envision Scenario reflects an aggressive application of the Compass visioning principles. It tends to focus growth toward Centers, Transit areas and the more utilization of mixed-use development. This scenario increases housing and employment capacity of selected TOD areas and Centers.

2. Spatial Concentration of Population and Employment: Hoover Concentration Index

The Hoover concentration index has been widely used to measure the spatial concentration (Hoover, 1941; Duncan, Cuzzort, and Duncan, 1961, Vining and Strauss, 1977; Lichter, 1985; Plane and Rogerson, 1994; Iceland and Daniel H. Weinberg with Erika Steinmetz, 2002). The current study uses the Hoover index to examine the trends of population and employment concentration and dispersion at different levels of geography. The Hoover concentration index can be calculated in the following way (Plane and Rogerson, 1994):

$$H = 50\sum_{i=1}^{r}\left|p_i - a_i\right|$$

where p_i is percentage of an area's population (or employment) in area i at time t, a_i represents the percentage of the area's land area covered by area i and r is the number of areas. If p_i is equal to a_i for all areas, then population or employment is distributed at equal density across all the areas in proportion to land area and H is equal to 0. This indicates a perfectly dispersed pattern of population or employment distribution. The distribution of population or employment across areas becomes increasingly concentrated as H approaches 100.

3 Travel Modeling & Mobility Measures

The study uses the SCAG's Regional Travel Demand Model to measure the transportation performance (e.g., VMT, VHT, VHD, Speed, etc). In particular, the VMT will be sued for measuring GHG emission as a proxy measure. The SCAG's Regional

Travel Demand Model follows a standard four step modeling approach: trip generation, trip distribution, mode choice, network assignment. The Model was calibrated and validated for the Year 2003. which is the base year for the 2008 RTP. The SCAG's Regional Transportation Modeling area covers the entire SCAG region, and the modeling area is divided into 4109 Transportation Analysis Zones (TAZs).

Results & Discussion

The first analysis focused on population and employment distribution at the County level. According to table 2 and 3, there is a continuous decentralization in population and employment growth from Los Angeles County to Riverside and San Bernardino Counties between 2003 and 2035. Both population and employment growth is moving toward the Inland Empire, while the decentralization of employment is a little faster than that of population during the same period. The spatial distribution of population and employment of five growth scenarios did not show much difference. Even the Envision Scenario does not show little difference in the spatial distribution of population and employment from the Trend Scenario. When seeing the spatial distribution of population and employment from the County level, the significant difference between growth scenarios is not found, while those scenarios show much different spatial distribution than that of the base year.

Table 2. County Share of Regional Population Forecasts

	2003	2035					Difference in (2003-2035Trend)	Range of 2035 County Share
		Trend	LP	TOD	Center	Envision		
Imperial	1%	1%	1%	2%	2%	2%	0%	1%-2%
Los Angeles	57%	51%	51%	53%	52%	51%	-6%	51%-53%
Orange	17%	15%	16%	15%	15%	14%	-2%	14%-16%
Riverside	10%	15%	15%	14%	14%	16%	5%	14%-16%
San Bernardino	11%	13%	13%	13%	13%	13%	2%	13%-13%
Ventura	5%	4%	4%	5%	5%	4%	-1%	4%-5%
Region	100%	100%	100%	100%	100%	100%	0%	

Table 3. County Share of Regional Employment Forecasts

	2003	2035					Difference in (2003-2035Trend)	Range of 2035 County Share
		Trend	LP	TOD	Center	Envision		
Imperial	1%	1%	1%	1%	1%	1%	0%	1%-1%
Los Angeles	58%	49%	49%	50%	51%	50%	-9%	49%-51%
Orange	21%	19%	20%	19%	19%	18%	-2%	18%-20%
Riverside	8%	14%	13%	13%	13%	14%	6%	13%-14%
San Bernardino	8%	12%	12%	12%	12%	12%	4%	12%-12%
Ventura	4%	5%	4%	4%	4%	4%	1%	4%-5%
Region	100%	100%	100%	100%	100%	100%	0%	

Table 4 shows the Hoover Concentration Index of 2003 and five growth scenarios at different level of geography (RSA, CSA, TAZ). The more number of observations tends to be the high the Hoover Concentration Index. The distribution of population and employment at three different level of geography (RSA, CSA, TAZ) confirms that the Trend Scenario or the Locally Preferred Scenario shows the most deconcentrated growth distribution pattern over 2003, while the Growth Vision Scenarios (TOD, Center, Envision) relatively shows the concentrated growth distribution pattern over the Trend Scenario or the Locally Preferred Scenario. For example, the Hoover concentration Index of 2003 population at TAZ level is 87.5, and becomes 86.1 (Trend Scenario) and 84.8 (Locally Preferred Scenario). Locally Preferred Scenario shows the most deconcentrated population distribution. The Hoover Concentration Index becomes 86.9 (TOD Scenario), 86.9 (Center Scenario), and 87.2 (Envision Scenario). The Hoover Concentration Index of the Envision Scenario is very close to that of 2003. Employment distribution is not much different from population distribution, except the Trend Scenario is more deconcentrated than Locally Preferred Scenario. The Hoover concentration Index of 2003 employment at TAZ level is 88.7, and becomes 85.5 (Trend Scenario) and 86.1 (Locally Preferred Scenario). Locally Preferred Scenario shows the most deconcentrated population distribution. The Hoover Concentration Index becomes 87.3 (TOD Scenario), 87.5 (Center Scenario), and 88.1 (Envision Scenario). The Hoover Concentration Index of the Envision Scenario is very close to that of 2003. The county level population and employment distribution confirms the consistent deconcentrated pattern of the five growth scenarios over 2003, while analysis of other smaller geographical level's population and employment distribution indicates a notable difference among five growth scenarios relative to 2003. We might say that the macro geographical scale population and employment generally become more deconcentrated (probably sprawl), but the smaller geographical scale population and employment distribution pattern is more diverse depending on growth scenarios. In particular, the Envision Scenario tends to influence the spatially deconcetrated distribution of population and employment observed in the Trend Scenario or the Locally Preferred Scenario.

Table 4. 2003 Land Use vs. 2035 Alternative Land Use Scenarios: Hoover Concentration Index of Population and Employment Using Three Different Levels of Geography in the Southern California Region

	Population			Employment		
	RSA	CSA	TAZ	RSA	CSA	TAZ
2003	77.9	83.1	87.5	81.2	85.1	88.7
Trend	75.4	81.4	86.1	76.8	81.0	85.5
LP	74.0	79.7	84.8	77.2	82.1	86.1
TOD	77.7	82.5	86.9	77.9	82.5	87.3
Center	77.6	82.4	86.9	78.4	82.8	87.5
Envision	76.2	82.4	87.2	78.5	83.2	88.1
Number of Observations	56	302	4,191	56	302	4,191

Note: RSA, CSA, TAZ

Four major transportation performance measures (VMT, VHT, Delay, and Speed) were derived through tThe SCAG's transportation model (see table 5). All of four transportation measures of the Trend Scenario are worse than those of 2003. The locally preferred scenario and three visioning scenarios (TOD, Center, Envision) show a better performance in VMT, VHT, Delay, and Speed than that of the Trend Scenario, and met the conformity requirements. The Envision Scenario performs the best in transportation measures among five growth scenarios. As observed in tables 5 and 6, the relatively concentrated urban form imbedded with several policy tools (e.g., Transit Oriented Development, Center Development, Mixed Use Development, Job-Housing Balance Strategy, etc) Center might contribute to better transportation performance and more GHG emission (e.g., VMT) reductions.

Table 5. 2003 Land Use vs. 2035 Alternative Land Use Scenarios: VMT and Other Mobility Measures

	VMT*	VHT*	Delay*	Speed**
2003	23.3	0.76	0.23	30.52
Trend	23.8	0.89	0.35	26.76
LP	23.0	0.83	0.31	27.57
TOD	22.2	0.80	0.29	27.74
Center	22.0	0.79	0.29	27.85
Envision	21.7	0.77	0.28	28.03

Note: * Per Capita ** Average Miles Per Hour

An optimal urban form can be operationally defined as the regional distribution of residential and employment activities showing the good transportation performance, while meeting the conformity requirements and achieving the targeted GHG emission (per capita VMT) reductions. The Envision Scenario might represent the globally optimal urban form among five land use forecast scenarios, achieving the best transportation performance and the highest GHG emission reductions. Although the Envision Scenario can be proposed as an ideal urban form in the future, the scenario is unrealistic because of its aggressive allocation of population and employment into the areas of 2% from the

local planning perspective based on the general plan land use. What would be a reasonable urban form scenario to achieve the planning goals (e.g., achieve transportation goals, meet the conformity requirements, reduce the targeted GHG emissions)? It would be somewhere between the locally preferred scenario (moderate urban form change) and the Envision Scenario (aggressive urban form change), and it would be determined depending on how high the regional GHG emission targets would be. After a lengthy discussion at the Regional Targets Advisory Committee (RTAC) meetings, RTAC makes a recommendation of how to set the emission targets (e.g., reductions in total or per capita GHG emissions), and what year's data (base year or future year) to use against the GHG emissions of the proposed land use forecast distribution. First, RTAC recommends the emission targets expressed in terms of a percent reduction in per capita GHG emissions. This metric approach is preferred because it simple and easy to understand. This approach can also address the projected growth rate differences between MPO regions, which will affect the magnitude of change. Second, RTAC recommends a current base year of 2005 to use against the per capita GHG emissions of the proposed land use forecast distribution. A current base year is preferred over a future base Year (e.g. business as usual scenario) since it relies on recent, existing information and is less sensitive to varying assumptions.

Table 6 shows the relative impacts of 2035 Land Use Scenarios on Per Capita VMTs relative to the current base year (2003) and the future base year (business as usual). According to table 7, the per capita VMT ranged from 23.3 of the current base year for 2003 to 21.7 of the Envision Scenario for 2035. Following the RTAC recommended base year approach, the Trend Scenario increased the per capita VMT by 2.1% over the current base year, while the Locally Preferred Scenario reduced the per capita VMT by 1.3% over the current base year, and other Visioning Scenarios reduced by 5%-7% over the current base year. The business as usual approach using the Trend Scenario as a reference data shows a consistent VMT reduction pattern of the alternative scenarios over the Trend Scenario.

Table 6. Relative Impacts of 2035 Land Use Scenarios on Per Capita VMT: SCAG Region

		Business As Usual Approach		Base Year Approach	
	VMT*	Difference from Trend	% Difference from Trend	Difference from 2003	% Difference from 2003
2003	23.3				
Trend	23.8			0.5	2.1%
LP	23.0	-0.8	-3.4%	-0.3	-1.3%
TOD	22.2	-1.7	-6.7%	-1.1	-4.7%
Center	22.0	-1.8	-7.6%	-1.3	-5.6%
Envision	21.7	-2.1	-8.8%	-1.6	-6.9%

Note: * Per Capita

The current study's percentage change in VMT can be assessed for its reasonableness by comparing with the recent study (Rodier, 2008). Rodier reviewed the international modeling literature on land use, transit, and auto pricing policies to show a range of VKT

and GHG reductions for 10-, 20-, 30-, and 40-years time horizons. She showed a summary of 19 different land use scenarios and the related percentage change in VKT for the four time horizons. For example, the percentage change in VKT for 30 years ranges from -5.9% to -0.1% for a 68% range of study scenario results, and from -7.5% to 0.1% for a 95% range of study scenario results. The median percentage change in VKT is found to be -1.4%. The current study shows a wide range of percentage change in VMT associated with different land use scenarios. The Envision Scenario with a very aggressive and comprehensive land use scenario shows the most percentage reduction (6.9%) relative to the base year, while the Locally Preferred Scenario with a local general plan land use scenario shows the least percentage reduction (1.3%) relative to the base year. The Trend Scenario did not show the percentage reduction in VMT, but increased the percentage (2.1%) in VMT.

The GHG emission targets might be set at any level between the Locally Preferred Scenario and the Envision Scenario. Although Locally Preferred Scenario reduces the moderate per capita VMTs relative to 2003, it is generally based on the exiting local general plan land use, reflects the most current planning assumptions as required by the federal law, and is fully supported by local jurisdictions. The Envision Scenario reduces the most per capita VMTs relative to the base year (2003), might be unrealistic for its ambitious urban land use assumptions. The dilemma is found in the recent RTAC report (August 2009). According to the Report, there is general support for a method of target setting that supports actions well beyond the status quo, while some members emphasized the importance of achievability of the targets.

The moderate emission targets could be met through the sustainable communities strategy rather than alternative planning strategies. There might be only a need of an incremental effort of local jurisdictions to incorporate the selected number of diverse VMT sensitive land use policies (e.g., development density, land use mix, urban design/pedestrian environment, destination accessibility, jobs-housing fit, etc) into the existing general plan land use policy. This would warrant the early success of implementing SB 375. The high emission targets could be met through the alternative planning strategies rather than sustainable communities strategy. There might be a need of an extensive effort of local jurisdictions to incorporate the wide range of diverse VMT sensitive land use policies (e.g., development density, land use mix, urban design/pedestrian environment, destination accessibility, jobs-housing fit, etc) into the existing general plan land use policy. This would not warrant the early success of implementing SB 375, but requires long term public education and outreach effort. The SCAG's current Compass Blueprint program could be extended to enhance the awareness of alternative growth strategies by: 1) refining the regional vision, and identify additional strategies, policies and implementation tools to realize the Plan Alternative; 2) providing leadership and partnerships to local governments seeking to implement local planning policies and programs that are consistent with the Compass Blueprint growth scenario; 3) providing technical assistance and planning services to local and subregional leaders and agencies involved in land use decision-making to implement local planning policies and programs that are consistent with the Compass Blueprint growth scenario; 4) continuing outreach and education program that emphasizes partnerships and regional leadership,

through a shared understanding of the benefits and implications of Compass Blueprint, and reinforces mutual interests among Southern Californians (SCAG, 2009).

Conclusions

The study assesses the effects of land use forecast scenarios on the urban form (e.g., the spatial distribution of population and employment) and GHG emissions (e.g., VMT) through the existing SCAG's regional transportation modeling process. The macro geographical scale population and employment generally become more deconcentrated (probably sprawl), but the smaller geographical scale population and employment distribution pattern is more diverse depending on growth scenarios. In particular, the Envision Scenario tends to influence the spatially deconcentrated distribution of population and employment observed in the Trend Scenario or the Locally Preferred Scenario.

The Envision Scenario performs the best in transportation measures among five growth scenarios. The relatively concentrated urban form imbedded with several policy tools (e.g., Transit Oriented Development, Center Development, Mixed Use Development, Job-Housing Balance Strategy, etc) Center might contribute to better transportation performance and more GHG emission (e.g., VMT) reductions. The Envision Scenario might represent the globally optimal urban form among five land use forecast scenarios, achieving the best transportation performance and the highest GHG emission reductions. Although the Envision Scenario can be proposed as an ideal urban form in the future, the scenario is unrealistic because of its aggressive allocation of population and employment into the areas of 2% from the local planning perspective based on the general plan land use. What would be a reasonable urban form scenario to achieve the planning goals (e.g., achieve transportation goals, meet the conformity requirements, reduce the targeted GHG emissions)? It would be somewhere between the locally preferred scenario (moderate urban form change) and the Envision Scenario (aggressive urban form change), and it would be determined depending on how high the regional GHG emission targets would be.

The current study shows a wide range of percentage change in VMT associated with different land use scenarios. The Envision Scenario with a very aggressive and comprehensive land use scenario shows the most percentage reduction (6.9%) relative to the base year, while the Locally Preferred Scenario with a local general plan land use scenario shows the least percentage reduction (1.3%) relative to the base year. The Trend Scenario did not show the percentage reduction in VMT, but increased the percentage (2.1%) in VMT.

The GHG emission targets might be set at any level between the Locally Preferred Scenario and the Envision Scenario. Although Locally Preferred Scenario reduces the moderate per capita VMTs relative to 2003, it is generally based on the exiting local general plan land use, reflects the most current planning assumptions as required by the federal law, and is fully supported by local jurisdictions. The Envision Scenario reduces the most per capita VMTs relative to the base year (2003), might be unrealistic for its

ambitious urban land use assumptions. The moderate emission targets could be met through the sustainable communities strategy rather than alternative planning strategies. There might be a need of an incremental effort of local jurisdictions to incorporate the selected number of diverse VMT sensitive land use policies (e.g., development density, land use mix, urban design/pedestrian environment, destination accessibility, jobs-housing fit, etc) into the existing general plan land use policy. The incremental approach toward the more optimal urban form will warrant the success of implementing regional sustainable planning.

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