PERFORMANCE MEASURES

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS

2016 2040 RTPSCS

APPENDIX

ADOPTED | APRIL 2016

2016 2040 RTPSCS

APPENDIX

PLAN PERFORMANCE | PERFORMANCE MEASURES

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INTRODUCTION

The investments identified in the 2016 RTP/SCS are expected to result in significant benefits to our region, not only for mobility and accessibility but also in the areas of air quality, economic activity and job creation, sustainability, and environmental justice. The Plan, when fully implemented, is expected to achieve several performance outcomes that reflect these benefits. The outcomes and the performance measures that will be used to gauge our progress toward achieving each outcome are detailed in this Appendix. SCAG encourages, but does not require, agencies to be consistent with the Plan performance measures to the extent practical in their sub-regional and project-level planning studies.

SCAG has a history of using performance measurement in developing the RTP, beginning with the 1998 RTP. For the 2004 RTP, SCAG developed a set of measurable goals and outcomes that were based upon the principle of sustainability, which is not limited only to the environment and the transportation-land use connection, but also has important implications for how the region meets its critical system preservation needs. The 2016 RTP/SCS builds upon the sustainability goals established in previous RTP cycles, reflecting the ever-evolving needs and concerns of our region. The 2016 RTP/SCS goals are listed in **TABLE 1.**

TABLE 1 2016 RTP/SCS Goals

2016 RTP/SCS Goals
Align the plan investments and policies with improving regional economic development and competitiveness.
Maximize mobility and accessibility for all people and goods in the region.
Ensure travel safety and reliability for all people and goods in the region.
Preserve and ensure a sustainable regional transportation system.
Maximize the productivity of our transportation system.
Protect the environment and health of our residents by improving air quality and encouraging active transportation (non-motorized transportation, such as bicycling and walking).
Actively encourage and create incentives for energy efficiency, where possible.
Encourage land use and growth patterns that facilitate transit and non-motorized transportation.
Maximize the security of the regional transportation system through improved system monitoring, rapid recovery planning, and coordination with other security agencies.*

**SCAG does not yet have an agreed-upon security performance measure. Therefore, it is not included in the table.*

SCAG is committed to building on past successes by refining and enhancing performance measures to meet the region's priorities. In the spring of 2015, SCAG's three Policy Committees reviewed the updated draft proposed set of 2016 RTP/SCS performance measures in a joint meeting. With this input, SCAG developed revised performance goals, outcomes and supporting performance measures. The primary performance goals of the 2016 RTP/SCS are focused on outcomes that strengthen the land use-transportation connection and the physical health of our region's residents. In the fall of 2015, the goals and outcomes recommended by the Policy Committees for the 2016 RTP/SCS were presented to the Regional Council. The 2016 RTP/SCS incorporates these goals and outcomes. The set of performance measures to be used to evaluate the 2016 RTP/SCS is shown in **TABLE 2**.

SCAG's Policy Committees also reviewed the 2016 RTP/SCS guiding policies that help to focus future investments on the best-performing projects and strategies that seek to preserve, maintain, and optimize the performance of the existing system policies (see Chapter 4 of the 2016 RTP/SCS main document for a detailed discussion of these system policies). The first of those policies states that "transportation investments shall be based on SCAG's adopted Regional Performance Measures."

ENVIRONMENTAL JUSTICE

SCAG has also developed a separate set of performance measures to assess the progress of our regional Environmental Justice program. **TABLE 3** presents the environmental justice outcomes and performance measures to evaluate regional performance on matters of social equity and disproportionate impacts. The full results of the analysis conducted in support of the 2016 RTP/SCS Environmental Justice program are included in the Environmental Justice Appendix.

In support of the 2016 RTP/SCS, SCAG has developed a toolbox of potential mitigation measures to address impacts to environmental justice communities. The toolbox presents optional mitigation recommendations that may be effective in addressing project-specific environmental justice impacts after a comprehensive review of impacts and consultation with all stakeholders. The list of strategies included in the Environmental Justice Toolbox can be found in the Environmental Justice Appendix.

TABLE 2 2016 RTP/SCS Performance Measures

Outcome	Performance Measure	Definition	Outcome Required	Supports RTP Goals	Data Source(s)
LOCATION EFFICIENCY	Share of growth in High Quality Transit Areas (HQTAs)	Share of the region's household and employment growth occurring in HQTAs		Improvement (increase) over No Project Baseline	SCAG Integrated Growth Forecast
	Land consumption	Greenfield land consumed and refill land consumed		Improvement (decrease) over No Project Baseline	Scenario Planning Model
	Vehicle Miles Traveled (VMT) per capita*	Daily vehicle miles driven per person (automobiles and light trucks)		Improvement (decrease) over No Project Baseline	Travel Demand Model
	Transit mode share*	The share of total trips that use transit for work and non-work trips		Improvement (increase) over No Project Baseline	Travel Demand Model
	Average distance for work and non-work trips	The average distance traveled for work and non-work trips		Improvement (decrease) over No Project Baseline	Travel Demand Model
	Percent of trips less than 3 miles	The share of work and non-work trips which are less than 3 miles in length		Improvement (increase) over No Project Baseline	Travel Demand Model
	Work trip length distribution	The statistical distribution of work trip length in the region		Improvement (decrease in trip length) over No Project Baseline	Travel Demand Model
MOBILITY AND ACCESSIBILITY	Person delay per capita	Daily minutes of delay experienced per capita		Improvement (decrease) over No Project Baseline	Travel Demand Model
	Person hours of delay by facility type (mixed flow, HOV, arterials)	Excess travel time resulting from the difference between a reference speed and actual speed		Improvement (decrease) over No Project Baseline	Travel Demand Model
	Truck delay by facility type (highways, arterials)	Excess travel time for heavy duty trucks resulting from the difference between a reference speed and actual speed		Improvement (decrease) over No Project Baseline	Travel Demand Model
	Travel time distribution for transit, SOV, and HOV modes for work and non-work trips	Travel time distribution for transit, SOV, and HOV modes		Improvement (decrease in travel time) over No Project Baseline	Travel Demand Model

*New performance measure for the 2016 RTP/SCS

TABLE 2 2016 RTP/SCS Performance Measures Continued

Outcome	Performance Measure	Definition	Outcome Required	Supports RTP Goals	Data Source(s)
SAFETY AND HEALTH	Collision rates by severity and by mode	Collision rate involving fatalities and serious injuries per 100 million vehicle miles by mode; and number of fatalities and serious injuries by mode (all, bicycle/pedestrian)		Improvement (decrease) over No Project Baseline	Statewide Integrated Traffic Records System (SWITRS), Travel Demand Model Mode Split Outputs
	Criteria pollutants emissions	CO, NO_X, $PM_{2.5}$, PM_{10}, NO_2, and ROG	Meet Federal Transportation Conformity requirements	No change - requirements continue to be met	Travel Demand Model/ARB EMFAC Model
	Air pollution-related health measures*	Pollution-related respiratory disease incidence and cost		Improvement (decrease) over No Project Baseline	Scenario Planning Model
	Physical activity-related health measures*	Physical activity/weight related health issues and costs		Improvement over No Project Baseline	Scenario Planning Model
	Mode share of walking and biking*	Mode share of walking and biking for work and non-work trips		Improvement (increase) over No Project Baseline	Travel Demand Model
ENVIRONMENTAL QUALITY	Criteria pollutant and greenhouse gas emissions	CO, NO_X, $PM_{2.5}$, PM_{10}, NO_2, and ROG emissions; and per capita greenhouse gas emissions (CO_2)	Meet Federal Transportation Conformity requirements and State SB 375 per capita GHG reduction targets	No change - requirements continue to be met	Travel Demand Model/ ARB EMFAC Model
ECONOMIC OPPORTUNITY	Additional jobs supported by improving competitiveness	Number of jobs added to the economy as a result of improved transportation conditions which make the region more economically competitive		Improvement (increase) over No Project Baseline	Regional Economic Model (REMI)
	Additional jobs supported by transportation investment	Total number of jobs supported in the economy as a result of transportation expenditures.		Improvement (increase) over No Project Baseline	Regional Economic Model (REMI)
INVESTMENT EFFECTIVENESS	Benefit/Cost Ratio	Ratio of monetized user and societal benefits to transportation system investment costs		Greater than 1.0	California Benefit/Cost Model

*New performance measure for the 2016 RTP/SCS

TABLE 2 2016 RTP/SCS Performance Measures Continued

Outcome	Performance Measure	Definition	Outcome Required	Supports RTP Goals	Data Source(s)
TRANSPORTATION SYSTEM SUSTAINABILITY	Cost per capita to preserve regional multimodal transportation system to current state of good repair	Annual cost per capita required to preserve the regional multimodal transportation system to current conditions		Improvement (decrease) over Base Year	Estimated using SHOPP Plan and recent California Transportation Commission 10-Year Needs Assessment
	State Highway System pavement condition*	Share of distressed State Highway System lane miles		Improvement (decrease) over No Project Baseline	Pavement Management System (Caltrans)
	Local roads pavement condition*	Pavement Condition Index (PCI) rating for local roads		Improvement (increase) over No Project Baseline	Local Arterial Survey Database
ENVIRONMENTAL JUSTICE	See Table 3: Performance Measures: Environmental Justice		Meet Federal Environmental Justice requirements. No unaddressed disproportionately high and adverse effects for low income or minority communities		

*New performance measure for the 2016 RTP/SCS

Acronyms:
ARB: California Air Resources Board
EMFAC Emissions Factors model (ARB)
GHG: Greenhouse Gas Emissions
HOV: High-Occupancy Vehicle
SHOPP: State Highway Operation & Protection Program
SOV: Single-Occupancy Vehicle

TABLE 3 2016 RTP/SCS Performance Measures: Environmental Justice

Performance Measure	Definition	Performance Target	Data Source(s)
2016 RTP/SCS revenue sources in terms of tax burdens*	Proportion of RTP/SCS revenue sources (taxable sales, income, and gasoline taxes) for low income and minority populations	No unaddressed disproportionately high and adverse effects for low income or minority communities	U.S. Census, BLS Consumer Expenditure Survey, BOE Taxable Sales, SCAG Integrated Growth Forecast
Share of transportation system usage*	Comparison of transportation system usage by mode for low income and minority households in relation to each group's population share in the greater region	No unaddressed disproportionately high and adverse effects for low income or minority communities	NHTS, SCAG Integrated Growth Forecast
2016 RTP/SCS investments*	Allocation of RTP/SCS investments by mode (bus, HOV lanes, commuter/high speed rail, highways/arterials, and light/heavy rail transit)	No unaddressed disproportionately high and adverse effects for low income or minority communities	RTP/SCS Finance Strategy, Integrated Growth Forecast, Regional Travel Demand Model
Distribution of travel time savings and travel distance reductions*	Evaluate comparative benefits received as a result of the Plan by demographic group in terms of travel time and distance savings	No unaddressed disproportionately high and adverse effects for low income or minority communities	NHTS, SCAG Integrated Growth Forecast, Regional Travel Demand Model
Geographic distribution of transportation investments	Examination of the spatial distribution of transit, roadway, and active transportation infrastructure investments in various communities throughout the region	No unaddressed disproportionately high and adverse effects for low income or minority communities	2016 RTP/SCS, U.S. Census, SCAG Integrated Growth Forecast
Jobs-housing imbalance*	Comparison of median earnings for intra-county vs inter-county commuters for each county in the SCAG region; analysis of relative housing affordability and jobs throughout the region	Establish baseline conditions to evaluate future performance (not a performance measure for the Plan)	U.S. Census PUMS data
Accessibility to employment and services*	Percentage of employment and shopping destinations within a one and two mile travel buffer from each neighborhood; also share of employment and shopping destinations that can be reached within 30 minutes by auto or 45 minutes by bus or all transit modes during the evening peak period	No unaddressed disproportionately high and adverse effects for low income or minority communities	InfoUSA, Regional Travel Demand Model, U.S. Census, SCAG Integrated Growth Forecast, NHTS
Accessibility to parks and natual lands*	Share of population within a one and two mile travel buffer from a regional park; also, share of park acreage that can be reached within 30 minutes by auto or 45 minutes by bus or all transit modes during the evening peak period	No unaddressed disproportionately high and adverse effects for low income or minority communities	SCAG parcel level land use data, California Protected Areas Database (CPAD), Regional Travel Demand Model, Integrated Growth Forecast, NHTS
Gentrification and displacement*	Examination of historical and projected demographic and housing trends for areas surrounding rail transit stations	Establish baseline conditions to evaluate future performance (not a performance measure for the Plan)	High Quality Transit Areas (HQTA), U.S. Census, NHTS
Emissions impact analysis*	Comparison of Plan and Baseline scenarios; identification of areas that are lower performing as a result of the Plan, along with a breakdown of demographics for those areas	No unaddressed disproportionately high and adverse effects for low income or minority communities	ARB EMFAC Model
Air quality impacts along freeways and highly traveled corridors*	Comparison of Plan and Baseline scenarios and demographic analysis of communities in close proximity to freeways and highly traveled corridors	No unaddressed disproportionately high and adverse effects for low income or minority communities	ARB EMFAC Model, SCAG Integrated Growth Forecast

**Performance measures used in the Environmental Justice analysis for the 2012 RTP/SCS*

TABLE 3 2016 RTP/SCS Performance Measures: Environmental Justice Continued

Performance Measure	Definition	Performance Target	Data Source(s)
Aviation noise impacts*	Comparison of Plan and Baseline scenarios; breakdown of population by race and ethnicity for low performing airport noise impacted areas	No unaddressed disproportionately high and adverse effects for low income or minority communities	Projected noise impacts from aircraft operations for 2040 (PEIR), SCAG Integrated Growth Forecast
Roadway noise impacts*	Comparison of Plan and Baseline scenarios, identification of areas that are low performing as a result of the Plan; breakdown of population for these impacted areas by race/ethnicity and income	No unaddressed disproportionately high and adverse effects for low income or minority communities	Regional Travel Demand Model, SCAG Integrated Growth Forecast
Active transportation hazards	Breakdown of population by demographic group for areas that experience the highest rates of bicycle and pedestrian collisions	No unaddressed disproportionately high and adverse effects for low income or minority communities	SCAG Integrated Growth Forecast, Statewide Integrated Traffic Records System (SWITRS)
Rail-related impacts*	Breakdown of population by demographic group for areas in close proximity to rail corridors and planned grade separations	No unaddressed disproportionately high and adverse effects for low income or minority communities	Rail network geodata, rail traffic data, grade separation geodata, U.S. Census, SCAG Integrated Growth Forecast
Public health impacts	Historical emissions and health data summarized for areas that have high concentrations of minority and low income population	Establish baseline conditions to evaluate future performance (not a performance measure for the Plan)	ARB historical emissions data, CalEnviroScreen, SCAG Integrated Growth Forecast
Climate vulnerability	Breakdown of population by demographic group for areas potentially impacted by substandard housing, sea level rise, and wildfire risk	Establish baseline conditions to evaluate future performance (not a performance measure for the Plan)	SCAG Integrated Growth Forecast, CalFIRE, National Oceanic and Atmospheric Administration Coastal Services Center
Proposed Mileage-Based User Fee (MBUF) impacts*	Examination of potential impacts from implementation of a mileage-based user fee on low income households in the region	No unaddressed disproportionately high and adverse effects for low income or minority communities	U.S. Census, BLS Consumer Expenditure Survey, BOE Taxable Sales, SCAG Integrated Growth Forecast

**Performance measures used in the Environmental Justice analysis for the 2012 RTP/SCS*

Acronyms:
ARB: California Air Resources Board
BLS: Bureau of Labor Statistics
BOE: Board of Equalization
CalFIRE: California Department of Forestry and Fire Protection
HOV: High-Occupancy Vehicle
NHTS: National Household Travel Survey
PUMS: Public Use Microdata Sample
VMT: Vehicle Miles Traveled

The 2016 RTP/SCS recognizes that two general types of performance measures are appropriate for monitoring progress toward achieving our regional goals. One type of measure relies on readily available data that can be forecast into the future, and can therefore be used for evaluating 2016 RTP/SCS alternatives. A second type of measure is more valuable for on-going system monitoring. This type of measure typically cannot be readily forecast, but allows the region to monitor how well goals are being met over a period of time. Within this group are additional measures that will be evaluated for future integration into SCAG's performance monitoring efforts as reliable data becomes available. **TABLE 4** shows the performance measures that will be used for on-going monitoring of our regional transportation system. Each measure will be discussed, with results presented where data is available.

Note that some regionally important measures are discussed in other areas of the 2016 RTP/SCS. For example, infrastructure investment measures, including the percentage of total funding to be invested in transit and active transportation, are addressed as part of the investment allocation descriptions in the Transportation Finance Appendix.

In the discussion of performance measures and outcomes, three scenarios are referenced: Base Year, Baseline, and Plan.

- **Base Year** represents existing conditions as of 2012–that is, our region as it was in 2012: our transportation system, land use patterns, and socio-economic characteristics (e.g. households and employment). The year 2012 was selected as the Base Year for this analysis because it is the year of the previous RTP/SCS.
- **Baseline** assumes a continuation of the development trends of recent decades, with local General Plans not reflecting the intensified growth distribution policies promoted in the Plan. This scenario represents a future in 2040 in which only the following have been implemented: projects currently under construction or undergoing right of way acquisition; those programs and projects programmed and committed to in the 2015 Federal Transportation Improvement Program (FTIP); and projects that have already received environmental clearance.
- **Plan** represents future conditions in 2040 in which investments and strategies detailed in the 2016 RTP/SCS are fully realized.

The specific projects associated with the 2016 RTP/SCS are identified in the Project List Appendix.

The following sections describe each of the performance outcomes in detail along with their associated performance measures. The first section discusses the performance outcomes and measures used to evaluate alternatives and to forecast the performance of the system as a result of implementing the 2016 RTP/SCS. The second section discusses the outcomes and measures to be used for on-going system monitoring.

2016 RTP/SCS OUTCOMES AND PERFORMANCE MEASURES

LOCATION EFFICIENCY

As an outcome for evaluating the 2016 RTP/SCS, Location Efficiency reflects the degree to which improved coordination of land use and transportation planning impacts the movement of people and goods in the SCAG region. This outcome has several associated performance measures that will be used for monitoring the degree to which the region is advancing toward our Location Efficiency goals:

- Share of Growth in High Quality Transit Areas (HQTAs)
- Land Consumption
- Vehicle Miles Traveled (VMT) Per Capita
- Transit Mode Share
- Average Distance for Work and Non-Work Trips
- Percent of Trips Less than Three Miles
- Work Trip Length Distribution

In addition to these seven metrics, measures of mobility and accessibilty also serve to further reinforce the importance of the Location Efficiency outcome. Measures supporting the Mobility and Accessibility outcome are described in the next section of this Appendix.

The following is a summary of the performance measures that support the Location Efficiency outcome.

SHARE OF GROWTH IN HIGH QUALITY TRANSIT AREAS (HQTAS)

Between 2012 and 2040, growth in both households and employment in the HQTAs is projected to increase from the Baseline scenario to the Plan scenario. Specifically, the share of growth in households in HQTAs increases from 36 percent under the Baseline to 46 percent under the Plan. During the same period, the share of regional employment growth in the HQTAs increases from 44 percent under the Baseline to 55 percent under the Plan. **EXHIBIT 1** shows Plan 2040 HQTA locations.

LAND CONSUMPTION

The land consumption metric quantifies the amount of agricultural land that has changed from rural to more intensive development patterns to accommodate new growth. Greenfield land consumption refers to development that occurs on land that has not previously been developed for, or otherwise impacted by, urbanized use, including agricultural land, forests,

TABLE 4 2016 RTP/SCS Performance Measures for On-Going Monitoring

Outcome	Performance Measure	Definition	Performance Target	Data Source(s)
LOCATION EFFICIENCY	Share of growth in High Quality Transit Areas (HQTA)	Share of the region's growth in households and employment in High Quality Transit Areas	Improvement (increase) over Base Year	American Community Survey, SCAG GIS database
	Land consumption	Number of square miles of agricultural or otherwise previously undeveloped land converted to more urban uses	Improvement (decrease) over Base Year	California Farmland Mapping and Monitoring Program
	Vehicle Miles Traveled (VMT) per capita	Average daily vehicle miles traveled per person (autos and light trucks)	Improvement (decrease) over Base Year	Highway Performance Monitoring System
	Transit mode share*	Share of transit for work and non-work trips	Improvement (increase) over Base Year	American Community Survey, California Household Travel Survey
	Transit trips per capita*	Average annual number of transit trips taken per person	Improvement (increase) over Base Year	National Transit Database
	Annual household transportation cost	Annual household spending on transportation including costs of vehicle ownership, operation and maintenance, and public transportation	Improvement (decrease) over Base Year	Center for Neighborhood Technology
	Percent of income spent on housing and transportation	The share of household income spent on both housing and transportation	Improvement (decrease) over Base Year	U.S. Bureau of Labor Statistics, American Community Survey
MOBILITY AND ACCESSIBILITY	Highway non-recurrent delay for mixed flow and HOV lanes	Delay caused by accidents, incidents, weather, planned lane closures, special events, or other atypical traffic patterns	Improvement (decrease) over Base Year	Caltrans Performance Measurement System (PeMS)
	Mode share for work trips*	Share of work trips using various travel modes	Improvement (decrease in Single Occupied Vehicle mode share) over Base Year	American Community Survey
	Travel time to work*	Average travel time to work	Improvement (decrease) over Base Year	American Community Survey

*New performance measure for on-going monitoring

TABLE 4 2016 RTP/SCS Performance Measures for On-Going Monitoring Continued

Outcome	Performance Measure	Definition	Performance Target	Data Source(s)
RELIABILITY	Variability of travel time for automobiles	Day-to-day change in travel times experienced by auto travelers	Improvement (decrease in variability) over Base Year	Caltrans Performance Measurement System (PeMS)
	Variability of travel time for trucks	Day-to-day change in travel times experienced by trucks	Improvement (decrease in variability) over Base Year	Caltrans Performance Measurement System (PeMS)
PRODUCTIVITY	Lost lane miles for highways and percent seat miles utilized for transit	Percent utilization of regional transportation system during peak demand conditions	Improvement (decrease in highway lost lane miles and increase in transit seat miles utilized) over Base Year	Caltrans Performance Measurement System (PeMS), National Transit Database
SAFETY AND HEALTH	Collision rates by severity and by mode	Collision rates involving fatalities and serious injuries per 100 million vehicle miles by mode; and number of fatalities and serious injuries by mode (all, bicycle/ pedestrian)	Improvement (decrease) over Base Year	Caltrans Performance Measurement System (PeMS), Traffic Accident Surveillance and Analysis System (TASAS)
	Mode share of walking and biking	Mode share of walking and biking for work and non-work trips	Improvement (increase) over Base Year	American Community Survey, California Household Travel Survey
	Daily amount of walking and biking related to work and non-work trips*	Percent of population who had walk or bike trips during the day; and average number of minutes of walking and biking for those who had walk or bike trips	Improvement (increase) over Base Year	California Household Travel Survey
	Asthma incidence	Share of population in the region who were ever diagnosed with asthma	Improvement (decrease) over Base Year	California Health Interview Survey
	Asthma exacerbation	Share of population in the region already diagnosed with asthma who had asthma-related emergency room visits in the last 12 months	Improvement (decrease) over Base Year	California Health Interview Survey
	Percent of households living <500 feet from high volume roadways	Share of total regional households that live within 500 feet of a high volume roadway, defined as having traffic volumes of over 100,000 vehicles per day in urban areas, and 50,000 vehicles per day in rural areas	Improvement (decrease) over Base Year	SCAG GIS database

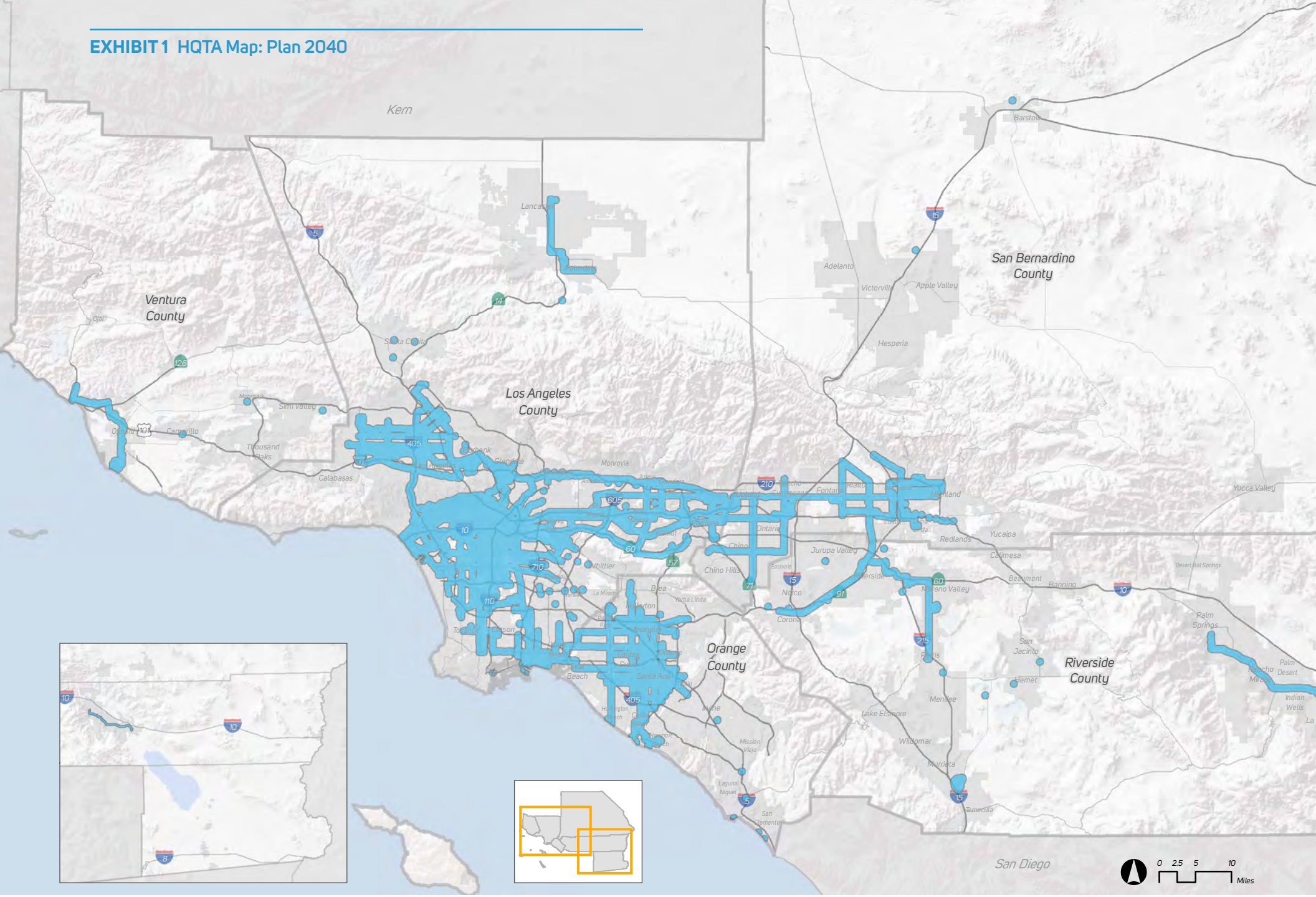
*New performance measure for on-going monitoring

TABLE 4 2016 RTP/SCS Performance Measures for On-Going Monitoring Continued

Outcome	Performance Measure	Definition	Performance Target	Data Source(s)
SAFETY AND HEALTH	Premature deaths due to $PM_{2.5}$	The number of premature deaths due to long-term exposure to particulate matter (estimated from monitored or modeled $PM_{2.5}$ concentrations)	Improvement (decrease) over Base Year	California Air Resources Board
	Percent of residents within 1/2 mile walk to parks and open space*	Share of regional population that lives within walkable distance to a park	Improvement (increase) over Base Year	SCAG GIS database
	Number of acres of parks per 1,000 residents*	Number of acres of parks for every 1,000 residents	Improvement (increase) over Base Year	SCAG GIS database
ENVIRONMENTAL QUALITY	Ambient air quality conditions	Existing condition of air quality in the various air basins	Improvement over Base Year	California Air Resources Board
TRANSPORTATION SYSTEM SUSTAINABILITY	State Highway System pavement condition*	Share of distressed lane miles of the State Highway System	Improvement (decrease) over Base Year	Pavement Management System (Caltrans)
	Local roads pavement condition*	Pavement Condition Index (PCI) rating for local roads	Improvement (increase) over Base Year	Local Arterial Survey Database
RESOURCE EFFICIENCY	Energy consumption*	Energy (electricity, natural gas) consumption per capita	Improvement (decrease) over Base Year	California Energy Commission, Caltrans
	Water consumption*	Urban water consumption per capita	Improvement (decrease) over Base Year	Metropolitan Water District

*New performance measure for on-going monitoring

EXHIBIT 1 HQTA Map: Plan 2040



High Quality Transit Areas (2040 Plan)

Note: High Quality Transit Areas refer to transportation corridors within ½ mile of a major transit route that feature peak commute period service frequencies of 15 minutes or less

(Source: SCAG)

deserts, and other undeveloped sites. As discussed above, the Plan directs more growth into the HQTAs than the Baseline. The vast majority of HQTAs are within existing urbanized areas. Accordingly, the Plan consumes 23 percent fewer square miles of greenfield land than the Baseline (118 square miles compared with 154 square miles).

VEHICLE MILES TRAVELED (VMT) PER CAPITA

Vehicle Miles Traveled (for automobiles and light trucks) per capita has become an increasingly significant metric since the passage of SB 375, which includes a requirement to achieve, if feasible, state-determined reduction targets for regional greenhouse gas emissions from automobiles and light trucks. Automobiles and light trucks are a major contributor to greenhouse gas emissions, producing more than 60 percent of transportation sector emissions.[1] Therefore, VMT reduction is a critical component in a comprehensive regional strategy for reducing greenhouse gas emissions. By monitoring progress in reducing per capita VMT through implementation of the various transportation investments and land use strategies outlined in this Plan, we will be better able to accurately gauge our momentum toward achieving our goals for reducing regional greenhouse gas emissions. Daily per capita VMT is projected to decrease in 2040 by 7.4 percent, from 22.1 miles under the Baseline, to 20.5 miles under the Plan. **FIGURE 1** shows weekday per capita VMT for each of the six counties in the SCAG region.

TRANSIT MODE SHARE

Transit mode share is another new metric for the 2016 RTP/SCS. It measures the share of transit trips made throughout the region for work and non-work purposes. This new measure will help us to identify how well the transit strategies and improvements proposed in the 2016 RTP/SCS are working toward providing better and more diverse commuting options for the traveling public. Ideally, with the provision of better transit service, more commuters will choose that option over driving alone in their automobiles, further reducing VMT and regional greenhouse gas emissions. The transit mode share for all trips is projected to increase in 2040 from 2.2 percent under the Baseline to 3.1 percent under the Plan. However, for work trips, the transit mode share is expected increase from 5.6 percent under the Baseline to 8.2 percent under the Plan. **TABLE 5** shows transit mode shares by county for both work trips and all trips as projected for 2040 under the Plan.

AVERAGE DISTANCE FOR WORK AND NON-WORK TRIPS

The average distance for work trips in 2040 is projected to increase slightly from 15.1 miles under the Baseline, to 15.5 miles under the Plan. The average distance traveled for non-work trips in 2040 is expected to remain relatively constant at about 7.8 miles under both the Baseline and the Plan.

PERCENT OF TRIPS LESS THAN THREE MILES

The vast majority of trips in Southern California today are made by people driving alone. As trip lengths become shorter, particularly to within a few miles, people are more likely to use transit, bike, walk, or choose other alternatives to driving alone. By 2040 the share of work trips less than three miles is projected to remain about the same, changing slightly from 20.4 percent under the Baseline to 20.3 percent under the Plan, while the share of non-work trips less than three miles is expected to remain constant with just under 42 percent of non-work

FIGURE 1 VMT Per Capita By County

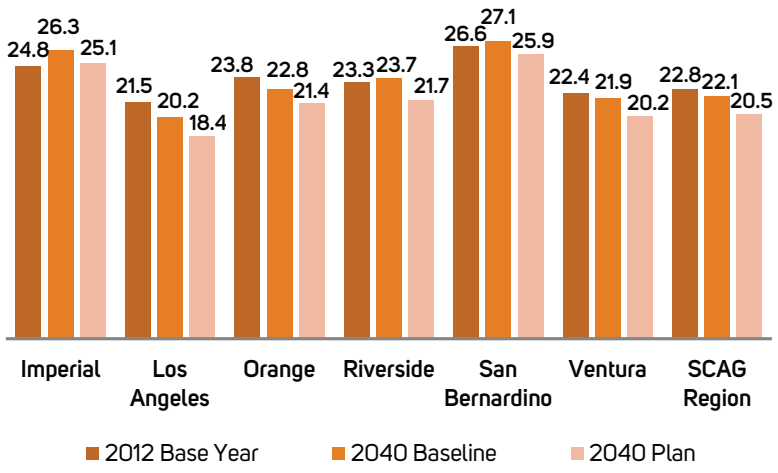


TABLE 5 Transit Mode Share by County (Plan 2040)

County	Work Trips	All Trips
Imperial	0.6%	0.3%
Los Angeles	12.0%	4.7%
Orange	3.8%	1.7%
Riverside	1.1%	0.5%
San Bernardino	2.1%	0.7%
Ventura	1.6%	0.7%
SCAG Region	8.2%	3.1%

trips under both the Baseline and the Plan to be within three miles as shown in **FIGURE 2**. The share of all trips less than three miles in length would increase slightly from 38 percent to about 39 percent. Changes in land use and investments in active transportation contribute toward achieving these results.

WORK TRIP LENGTH DISTRIBUTION

The share of trips less than ten miles remains about 48 percent in 2040 under both the Baseline and the Plan. Likewise, while the share of trips under 25 miles would be just over 80 percent for both the Baseline and the Plan. **TABLE 6** shows the distribution of work trip lengths in accordance with Plan 2040 projections.

MOBILITY AND ACCESSIBILITY

The Mobility and Accessibility outcome is defined as the ability to reach desired destinations with relative ease and within a reasonable time using reasonably available transportation options. In previous RTPs, mobility and accessibility were treated as separate outcomes. However, beginning with the 2012 RTP/SCS, they were combined into a single outcome with multiple performance measures. This section discusses the mobility and accessibility performance measures for the 2016 RTP/SCS, and provides results based on outputs from the SCAG Regional Travel Demand Model (RTDM).

FIGURE 2 Percentage of Trips Less than 3 Miles

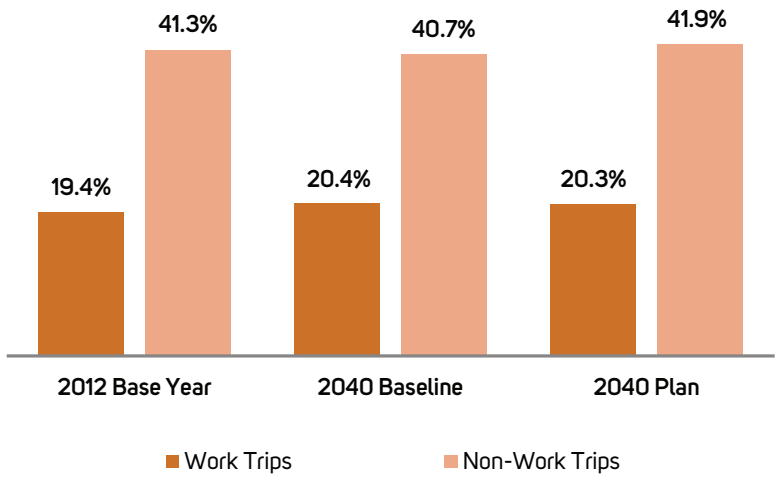


TABLE 6 Work Trip Length Distribution (Plan 2040)

Distance (miles)	Number of Trips	Share of Total
0 to <5	3,040,408	26.07%
5 to <10	2,527,411	21.67%
10 to <15	1,707,955	14.64%
15 to <20	1,194,262	10.24%
20 to <25	884,536	7.58%
25 to <30	594,768	5.10%
30 to <35	410,535	3.52%
35 to <40	299,059	2.56%
40 to <45	223,309	1.91%
45 to <50	176,629	1.51%
50 to <55	140,998	1.21%
55 to <60	107,635	0.92%
60 to <65	87,251	0.75%
65 to <70	66,575	0.57%
70 to <75	49,017	0.42%
75 to <80	37,931	0.33%
80 to <85	29,439	0.25%
85 to <90	22,641	0.19%
90 to <95	15,762	0.14%
95 to <100	10,548	0.09%
100+	36,079	0.31%
Total Trips	11,662,749	100.0%

MOBILITY

The mobility performance measure relies on the commonly used measure of delay. Delay is defined as the difference between actual travel time and the travel time at a pre-defined reference or optimal speed for each modal alternative. It is measured in vehicle-hours of delay (VHD), which can then be used to derive person-hours of delay. The mobility measures used to evaluate alternatives for this outcome include:

- Person Delay by Facility Type (Mixed Flow, High Occupancy Vehicle (HOV) Lanes, Arterials)
- Person Delay per Capita
- Truck Delay by Facility Type (Highway, Arterial)

One additional measure for delay that is available for on-going monitoring, but which cannot be readily forecast, is non-recurrent delay, which is the delay that is caused by accidents, weather, special events or other atypical incidents. Non-recurrent delay, and its impact on total congestion in the region, is discussed in greater detail in the Performance Measures for On-going Regional Monitoring section of this Appendix.

PERSON DELAY BY FACILITY TYPE (HIGHWAY/EXPRESSWAY, HOV, ARTERIAL)

Since the 2012 RTP/SCS, this measure has been expanded to differentiate between single-occupancy vehicle (SOV) and high-occupancy vehicle (HOV) delay. As shown in **FIGURE 3**, total person-hours of delay on our regional transportation system is expected to increase by more than 50 percent from the 2012 Base Year to the 2040 Baseline. However, under the Plan, delay on our highways would improve over Baseline conditions by more than 33 percent, while delay on HOV facilities would be reduced more dramatically, by 83 percent. Delay on our regional arterial roadways would also improve between the Baseline and the Plan by about 41 percent. Overall, person delay on our regional transportation system in 2040 under the Plan would represent an improvement over the Baseline by nearly 39 percent. In fact, conditions in 2040 under the Plan would represent an improvement over what was experienced in 2012 by 6 percent.

PERSON DELAY PER CAPITA

FIGURE 4 shows person delay per capita for each of the six counties in the region, and for the SCAG region as a whole. Normalizing delay by the number of people living in an area provides insight as to how well the region is mitigating traffic congestion in light of increasing population growth. Delay per capita is expected to grow considerably, particularly in the Inland Empire counties of Riverside and San Bernardino, under Baseline conditions. However, implementation of the Plan is projected to reduce regional per capita delay substantially, to below 2012 levels. Daily per capita delay in the region is expected to improve from 15 minutes under Baseline to just over 9 minutes under the Plan. Not only does this represent a 39 percent improvement over the Baseline, but also a 22 percent improvement over the 2012 Base Year.

FIGURE 3 Daily Person-Hours of Delay by Facility Type (in Thousands)

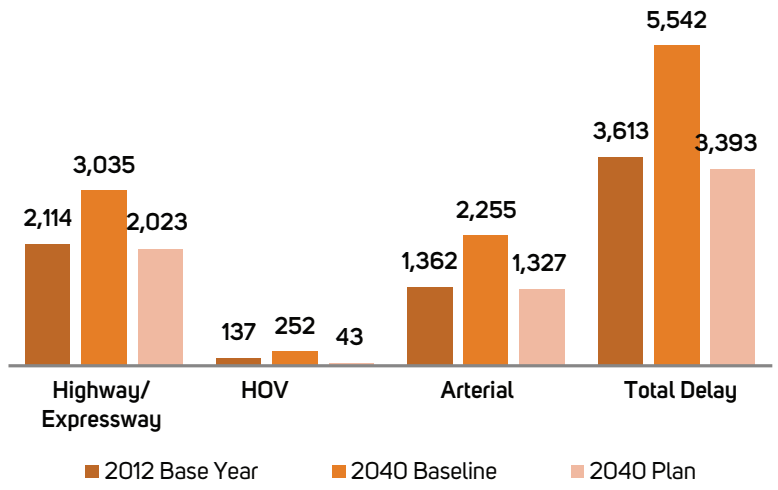
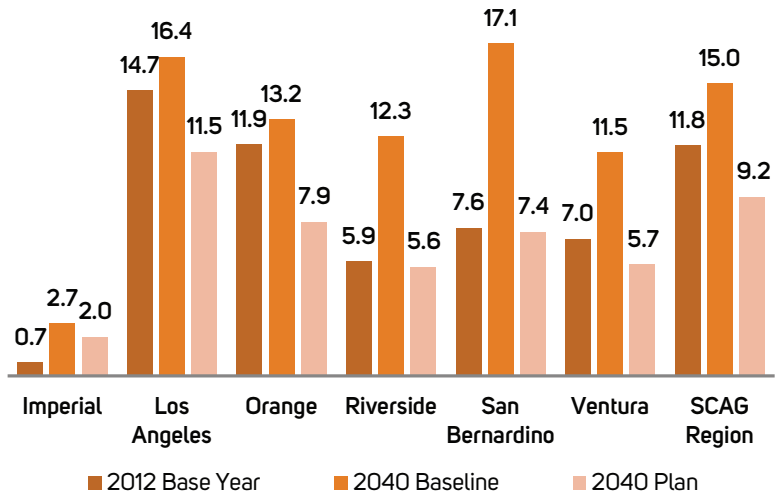


FIGURE 4 Daily Per Capita Person Delay By County (Minutes)



TRUCK DELAY BY FACILITY TYPE (HIGHWAY, ARTERIAL)

This measure estimates the average daily truck delay by facility type for highways and arterials **(FIGURE 5)**. The 2016 RTP/SCS includes significant investment in a regional freight corridor and other improvements to facilitate goods movement. The Plan is estimated to reduce heavy-duty truck delay by more than 37 percent over Baseline on the highway system, and by nearly 56 percent on the arterial system. However, truck delay under the Plan will still be above Base Year levels, due largely to the projected growth of trade and associated truck traffic.

HIGHWAY NON-RECURRENT DELAY

As indicated previously, this measure identifies the share of congestion that is considered to be atypical. Non-recurrent delay may be addressed by strategic operational investments such as traveler information systems, incident management strategies, and ramp metering. Regionally, about 48 percent of freeway congestion is estimated to be non-recurrent, but this estimate varies widely by county.

More suburban or rural areas with less overall congestion have a higher percentage of all congestion represented by non-recurring events. San Bernardino County, for example, was estimated to have the majority (78 percent) of its congestion caused by non-recurrent events in 2011 (the year of the most recent available data). In contrast, the more urbanized Los Angeles County had just over 44 percent of its total congestion represented by non-recurring incidents. Non-recurrent delay is a performance measure for our on-going regional monitoring program and is described in greater detail in the Performance Measures for On-going Regional Monitoring section of this Appendix.

HIGHWAY SPEED MAPS

EXHIBITS 2-4 (at end of this Appendix) depict the region's highway speed conditions during the afternoon peak period (3:00 PM to 7:00 PM) based upon the SCAG RTDM results for Base Year 2012, Baseline 2040, and Plan 2040. Additional speed maps are provided in the Highways and Arterials Appendix.

ACCESSIBILITY

The accessibility measure is used to evaluate how well the transportation system performs in providing people access to opportunities. Opportunities may include jobs, education, medical care, recreation, shopping, or any other activity that may help enhance a person's quality of life. For the 2016 RTP/SCS, accessibility is simply defined as the distribution of trips by mode by travel time.

As with the 2012 RTP/SCS, accessibility is measured by taking afternoon or PM peak period travel demand model results for the base and forecast years and identifying the percentage of commute or home-based work trips that are completed within 45 minutes. Peak periods are those times during the weekday when commuting travel on regional roadways reach their highest levels. Typically peak periods occur twice daily, first during the morning commute when people are traveling to their workplaces, and again in the late afternoon

FIGURE 5 Daily Heavy-Duty Truck Hours of Delay (in Thousands)

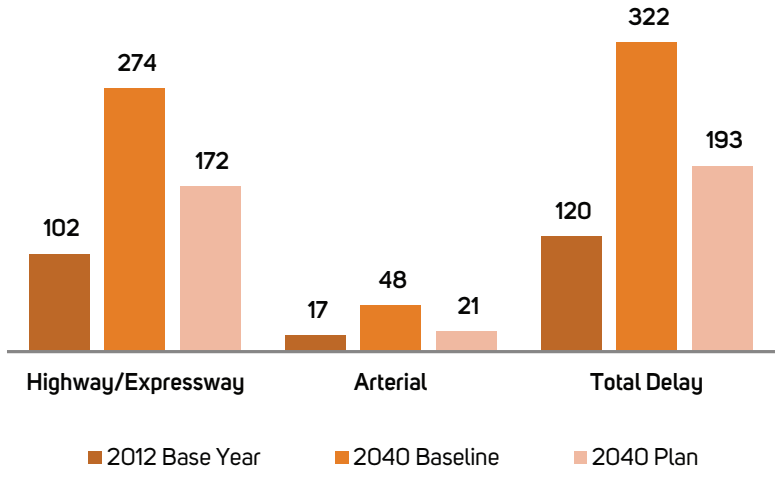
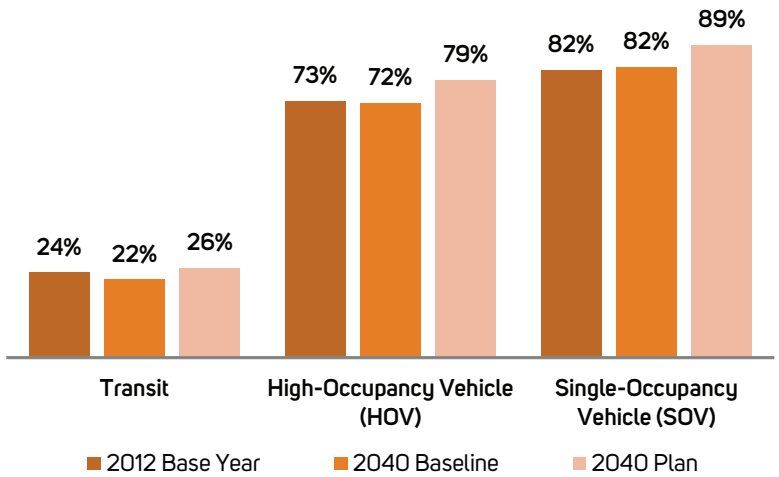


FIGURE 6 Percentage of PM Peak Period Home-Based Work Trips within 45 Minutes



when people are returning home from work. **FIGURE 6** shows these results. In all cases, the 2040 Plan improves accessibility for home-based work trips over the Baseline.

The 2016 RTP/SCS provides a comprehensive measure of accessibility, including the transit, HOV, and SOV modes, for both work and non-work trips. The results of these accessibility analyses are shown in **TABLE 7** (transit), **TABLE 8** (HOV), and **TABLE 9** (SOV).

SAFETY AND HEALTH

The Safety and Health performance outcome has been carried over from the 2012 RTP/SCS. The 2016 RTP/SCS includes new measures to evaluate the Health outcome. Safety addresses how well the transportation system performs in minimizing collisions and is measured in the number of collisions involving fatalities and serious injuries per million vehicle miles traveled by mode.

The safety and health impacts of regional transportation improvements cannot be easily forecast, but a reduction in total collisions can be shown in future years, particularly if people shift from transportation modes with higher collision risk to modes with lower collision risk. The total number of collisions is generally used as the performance measure for safety, and it can be partially projected by using mode and facility specific collision rates (highways, arterials, and transit). This approach is used for the 2016 RTP/SCS, but it is important to note that this methodology does not take into account safety improvements specific to each mode. It only reflects changes based on modal or facility shifts. For monitoring, this measure can be reported historically by time period (month) and by mode (including for active transportation).

The health outcome was first introduced for the 2012 RTP/SCS. Recognizing that the 2016 RTP/SCS integrates transportation and land use strategies and therefore generates impacts beyond those exclusively transportation-related, the 2016 RTP/SCS includes three new health-related measures: mode share for walking and biking; rates of physical activity and weight-related disease; and incidence of respiratory/pollution-related disease.

The health benefits of an active lifestyle have become increasingly apparent in recent years, and there is growing support for improving the walkability and bikability of the communities where we live and work. The linkage between obesity and disease has been well documented, and providing the appropriate community design and infrastructure to support a more active lifestyle may be an important first step toward promoting healthy communities.[2]

The walking and biking mode shares can be used to evaluate the 2016 RTP/SCS alternatives, while the disease-focused measures may also be useful for on-going monitoring. A health measure carried over from the 2012 RTP/SCS is tons of criteria air pollutants, which is highly correlated to public health concerns, such as asthma. The criteria pollutant measure supports both the Safety and Health outcome and the Environmental Quality outcome.

There are six common air pollutants that are monitored in accordance with federal air quality regulations.[3] These 'criteria' pollutants include particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NO_x), nitrogen dioxide (NO_2), and reactive organic gases (ROG). These pollutants require careful monitoring because of their known adverse effects on human health. While children, older citizens, and persons with existing respiratory illnesses are most vulnerable to the effects of air pollutants, the health effects of long term exposure are a concern for everyone in the region. Some of the major health concerns of exposure to high levels of air pollution include respiratory irritation, reduced lung capacity, chest pain, and aggravation of asthma and other respiratory illnesses.[4]

Airborne particulate matter comes in all sizes, however, particles smaller than ten micrometers in diameter (PM_{10}) are considered the most dangerous to human health because they are small enough to be absorbed into the lungs. The finer the particle size, the more dangerous they are. Particulate matter smaller than 2.5 micrometers is a particularly serious concern for people with existing heart or lung disease, as even short term exposure to high levels of $PM_{2.5}$ may aggravate symptoms. High levels of carbon monoxide is also considered a health hazard, especially for people with compromised respiratory or coronary function, as CO is known to reduce the flow of oxygen through the human body. Long term exposure to high levels of nitrogen dioxide, which is produced primarily through the burning of fossil fuels, may cause reduced lung function and narrowing of the bronchial airways, resulting in chronic bronchitis or aggravation of asthma symptoms.[5]

The 2016 RTP/SCS would improve physical activity outcomes through improved location efficiency, which increases the share of short trips, and through the provision of additional investments in active transportation networks including first/last mile improvements, Safe Routes to School projects, and regional bikeway infrastructure. It would also increase access to natural lands and parks which would further increase opportunities for physical activity. New for the 2016 RTP/SCS is an improvement of the Public Health module in the Scenario Planning Model which now allows us to measure the Plan's impact on physical activity. The updated module was evaluated by a statewide review panel consisting of representatives of state, regional, and local agencies. The Plan is expected to result in 4.3 additional minutes of physical activity per capita, which would improve health outcomes related to obesity by 2.7 percent and hypertension by 3.3 percent.

For a broader discussion of the Scenario Planning Model, please see the SCS Background Documentation Appendix. For more detailed information on the connection between physical activity and health outcomes, please see the Public Health Appendix.

TABLE 7 Transit Trips: Distribution by Trip Type & Model Run

Trip Type	Time Period	Model	<=5 min	<=10 min	<=15 min	<=30 min	<=45 min	<=60 min	<=90 min	>90 min
WORK	AM	2012 Base Year	0%	0%	1%	12%	29%	44%	70%	100%
		2040 Baseline	0%	0%	1%	11%	27%	42%	69%	100%
		2040 Plan	0%	0%	1%	13%	30%	47%	73%	100%
	Mid-Day	2012 Base Year	0%	0%	1%	11%	30%	46%	72%	100%
		2040 Baseline	0%	0%	1%	10%	28%	45%	72%	100%
		2040 Plan	0%	0%	1%	12%	31%	48%	73%	100%
	PM	2012 Base Year	0%	0%	1%	9%	24%	39%	64%	100%
		2040 Baseline	0%	0%	1%	8%	22%	36%	62%	100%
		2040 Plan	0%	0%	0%	9%	26%	41%	68%	100%
	Evening	2012 Base Year	0%	0%	1%	11%	30%	46%	72%	100%
		2040 Baseline	0%	0%	1%	10%	28%	45%	72%	100%
		2040 Plan	0%	0%	1%	12%	31%	48%	73%	100%
	Night	2012 Base Year	0%	0%	1%	11%	30%	46%	72%	100%
		2040 Baseline	0%	0%	1%	10%	28%	45%	72%	100%
		2040 Plan	0%	0%	1%	12%	31%	48%	73%	100%
OTHER	AM	2012 Base Year	0%	0%	1%	16%	38%	55%	79%	100%
		2040 Baseline	0%	0%	1%	15%	36%	54%	78%	100%
		2040 Plan	0%	0%	1%	16%	38%	56%	81%	100%
	Mid-Day	2012 Base Year	0%	0%	1%	15%	37%	57%	81%	100%
		2040 Baseline	0%	0%	1%	15%	36%	56%	80%	100%
		2040 Plan	0%	0%	1%	16%	39%	59%	84%	100%
	PM	2012 Base Year	0%	0%	0%	11%	28%	44%	70%	100%
		2040 Baseline	0%	0%	0%	10%	27%	43%	70%	100%
		2040 Plan	0%	0%	0%	11%	29%	47%	74%	100%
	Evening	2012 Base Year	0%	0%	1%	15%	35%	54%	80%	100%
		2040 Baseline	0%	0%	1%	15%	34%	53%	79%	100%
		2040 Plan	0%	0%	1%	16%	38%	58%	84%	100%
	Night	2012 Base Year	0%	0%	1%	16%	40%	60%	83%	100%
		2040 Baseline	0%	0%	1%	16%	38%	59%	82%	100%
		2040 Plan	0%	0%	1%	17%	41%	61%	85%	100%

TABLE 8 HOV Trips: Distribution by Trip Type & Model Run

Trip Type	Time Period	Model	<=5 min	<=10 min	<=15 min	<=30 min	<=45 min	<=60 min	<=90 min	>90 min
WORK	AM	2012 Base Year	12%	23%	33%	58%	74%	83%	93%	100%
		2040 Baseline	12%	22%	33%	58%	73%	82%	91%	100%
		2040 Plan	12%	24%	35%	61%	77%	86%	95%	100%
	Mid-Day	2012 Base Year	10%	21%	34%	66%	83%	91%	97%	100%
		2040 Baseline	10%	21%	33%	64%	82%	90%	96%	100%
		2040 Plan	10%	22%	35%	68%	84%	92%	98%	100%
	PM	2012 Base Year	12%	23%	34%	58%	73%	83%	94%	100%
		2040 Baseline	12%	23%	33%	57%	72%	82%	92%	100%
		2040 Plan	12%	24%	36%	63%	79%	88%	96%	100%
	Evening	2012 Base Year	17%	34%	51%	79%	90%	95%	99%	100%
		2040 Baseline	17%	34%	50%	79%	89%	94%	98%	100%
		2040 Plan	17%	35%	52%	80%	90%	95%	99%	100%
	Night	2012 Base Year	12%	27%	43%	76%	88%	94%	98%	100%
		2040 Baseline	12%	27%	43%	75%	87%	93%	98%	100%
		2040 Plan	13%	28%	44%	75%	88%	93%	98%	100%
OTHER	AM	2012 Base Year	33%	54%	67%	87%	95%	97%	99%	100%
		2040 Baseline	32%	53%	66%	87%	94%	97%	99%	100%
		2040 Plan	32%	54%	67%	89%	96%	98%	99%	100%
	Mid-Day	2012 Base Year	23%	41%	56%	85%	95%	97%	99%	100%
		2040 Baseline	23%	40%	56%	84%	94%	97%	99%	100%
		2040 Plan	23%	42%	58%	87%	95%	97%	99%	100%
	PM	2012 Base Year	24%	42%	55%	81%	92%	96%	99%	100%
		2040 Baseline	24%	41%	55%	80%	91%	96%	99%	100%
		2040 Plan	24%	43%	58%	85%	94%	97%	99%	100%
	Evening	2012 Base Year	20%	39%	55%	85%	94%	97%	99%	100%
		2040 Baseline	21%	39%	56%	86%	94%	97%	99%	100%
		2040 Plan	21%	40%	57%	87%	95%	97%	99%	100%
	Night	2012 Base Year	21%	41%	58%	87%	95%	97%	99%	100%
		2040 Baseline	22%	42%	59%	87%	95%	97%	99%	100%
		2040 Plan	22%	42%	60%	88%	95%	97%	99%	100%

TABLE 9 SOV Trips: Distribution by Trip Type & Model Run

Trip Type	Time Period	Model	<=5 min	<=10 min	<=15 min	<=30 min	<=45 min	<=60 min	<=90 min	>90 min
WORK	AM	2012 Base Year	14%	30%	43%	69%	83%	90%	97%	100%
		2040 Baseline	15%	31%	44%	70%	84%	91%	96%	100%
		2040 Plan	15%	32%	46%	75%	88%	94%	98%	100%
	Mid-Day	2012 Base Year	13%	30%	46%	77%	91%	96%	99%	100%
		2040 Baseline	13%	30%	46%	77%	90%	95%	99%	100%
		2040 Plan	13%	32%	49%	81%	93%	97%	100%	100%
	PM	2012 Base Year	14%	29%	42%	68%	82%	90%	97%	100%
		2040 Baseline	14%	30%	43%	69%	82%	90%	96%	100%
		2040 Plan	15%	31%	46%	76%	89%	95%	99%	100%
	Evening	2012 Base Year	18%	39%	57%	86%	95%	98%	100%	100%
		2040 Baseline	18%	40%	58%	86%	95%	98%	100%	100%
		2040 Plan	19%	41%	60%	88%	96%	98%	100%	100%
	Night	2012 Base Year	15%	36%	55%	87%	96%	98%	100%	100%
		2040 Baseline	16%	37%	57%	87%	96%	98%	100%	100%
		2040 Plan	16%	37%	57%	88%	96%	98%	100%	100%
OTHER	AM	2012 Base Year	36%	61%	76%	93%	98%	99%	100%	100%
		2040 Baseline	37%	62%	77%	94%	98%	99%	100%	100%
		2040 Plan	38%	65%	80%	96%	99%	100%	100%	100%
	Mid-Day	2012 Base Year	34%	59%	76%	96%	99%	100%	100%	100%
		2040 Baseline	35%	61%	77%	96%	99%	100%	100%	100%
		2040 Plan	37%	64%	80%	98%	100%	100%	100%	100%
	PM	2012 Base Year	33%	58%	73%	92%	97%	99%	100%	100%
		2040 Baseline	34%	59%	74%	93%	98%	99%	100%	100%
		2040 Plan	35%	62%	78%	96%	99%	100%	100%	100%
	Evening	2012 Base Year	33%	60%	78%	97%	99%	100%	100%	100%
		2040 Baseline	35%	62%	80%	97%	99%	100%	100%	100%
		2040 Plan	36%	64%	82%	98%	100%	100%	100%	100%
	Night	2012 Base Year	34%	62%	81%	97%	99%	100%	100%	100%
		2040 Baseline	35%	64%	82%	98%	99%	100%	100%	100%
		2040 Plan	36%	66%	83%	98%	100%	100%	100%	100%

ENVIRONMENTAL QUALITY

The Environmental Quality outcome is measured in terms of criteria pollutant and greenhouse gas emissions. Emissions are estimated using the SCAG RTDM results, which are input to the California Air Resources Board's (ARB) Emission Factors (EMFAC) model. Pollutant emissions are reported in detail in the Transportation Conformity Analysis Appendix.[6] The impact of air quality on public health is discussed in the Safety and Health outcome section of this Appendix.

Pursuant to SB 375, ARB set per capita greenhouse gas emissions reduction targets from passenger vehicles for each of the state's 18 Metropolitan Planning Organizations (MPOs). For the SCAG region, the targets set are 8 percent below 2005 per capita emissions levels by 2020 and 13 percent below 2005 per capita emissions levels by 2035. Although ARB has not adjusted SCAG's regional targets since the 2012 RTP/SCS, ARB is required to update regional emissions targets every eight years per state law, therefore SCAG anticipates the region's targets to change. Because the transportation sector is the largest contributor to California's greenhouse gas emissions (more than 36 percent), SCAG anticipates updated and more stringent regional greenhouse gas reduction targets may be forthcoming. In the meantime, the 2016 RTP/SCS achieves per capita greenhouse gas emissions reductions relative to 2005 of 8 percent in 2020, 18 percent in 2035, and 21 percent in 2040, exceeding the reduction targets the ARB currently requires **(TABLE 10)**.

MONITORING REGIONAL GREENHOUSE GAS EMISSIONS

Like all of California's MPOs, SCAG must prepare its Plan within the context of the requirements of SB 375. For the 2012 RTP/SCS, SCAG developed the Local Sustainability Planning Tool (LSPT) to analyze the performance of various land use and transportation strategies related to greenhouse gas emissions reduction and help local jurisdictions to assess impacts from different land use configurations and scenarios.[7] The LSPT is a GIS-based sketch planning tool that allows users to create land use scenarios and analyze their impacts. SCAG made the LSPT available to each of its member jurisdictions, trained hundreds of users, and worked one-on-one with planners to assist in their use of the tool. Provided with a variety of preliminary scenarios for their planning areas, local planners were able to create, modify, and compare a variety of future scenarios, and their subsequent impacts on vehicle ownership, vehicle miles traveled, mode choice, and greenhouse gas emissions.

TABLE 10 RTP/SCS Greenhouse Gas Reductions (Per Capita)

Year	% Reduction from 2005 Levels		
	ARB Target	2016 RTP/SCS	% Diff
2020	8%	8%	0%
2035	13%	18%	5%
2040	N/A*	21%	N/A

*ARB has set GHG emissions reduction targets for 2020 & 2035, but not for 2040

The California Transportation Commission (CTC) 2010 California Regional Transportation Plan Guidelines recommend that on-model or off-model calculations be formulated to produce realistic sensitivities to localized land use variations. For the 2016 RTP/SCS, our scenario modeling capabilities have been enhanced to provide added functionality in support of monitoring the impact of various land use options on regional greenhouse gas emissions. For development of the 2016 RTP/SCS, these enhanced modeling capabilities have been incorporated into the Scenario Planning Model (SPM), which was based on the LSPT. Using the SPM, SCAG is able to evaluate potential strategies, including land use changes and active transportation investments, for reducing regional VMT.

Investments in our regional active transportation network are critical components for achieving the sustainability and greenhouse gas reduction goals for the SCAG region. To better understand the co-benefits associated with investments in our regional active transportation network, an enhanced module was developed for the Scenario Planning Model as a supplement to SCAG's RTDM to measure the benefit of active transportation infrastructure through varying levels of investment. The enhanced module provides key input to the SCAG Scenario Planning Model for evaluating the impact of active transportation infrastructure investment in certain strategic areas. As indicated previously, the Scenario Plannng Model is now equipped with an improved Public Health module to measure some of the public health co-benefits of transportation investments and land use strategies. Providing more and better opportunities for physical activity is one of the goals for the 2016 RTP/SCS, and this enhanced modeling capability provides us a valuable tool for monitoring regional performance in regard to achieving that outcome.

ECONOMIC OPPORTUNITY

The Economic Opportunity outcome is measured in terms of additional jobs created through improved regional economic competitiveness as a result of the transportation investments provided through the 2016 RTP/SCS. An annual average of more than 188,000 new jobs will be generated by the construction and operations expenditures in the 2016 RTP/SCS, and an additional 351,000 annual jobs will be created in a broad cross-section of industries by the region's increased competitiveness and improved economic performance as a result of the improved transportation system.

The economic benefits of the 2016 RTP/SCS are discussed in greater detail in Chapter 7 of the 2016 RTP/SCS (A Plan that Creates Economic Opportunity).

INVESTMENT EFFECTIVENESS

The Investment Effectiveness outcome is measured in terms of the degree to which the Plan's expenditures generate benefits that transportation users can experience directly. This outcome is important because it describes how the Plan's transportation investments make productive use of increasingly scarce funds. The benefit/cost ratio is the measure used to evaluate the cost-effectiveness outcome, as it compares the incremental benefits with the incremental costs of multimodal transportation investments. The benefits are divided into several categories, including:

- Savings resulting from reduced travel delay
- Air quality improvements
- Safety improvements
- Reductions in vehicle operating costs

For these categories, travel demand and air quality models are used to estimate the benefits of the Plan compared with the Baseline. Most of these benefits are a function of changes in Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT). Not all impacts are linear, so reductions in congestion can increase or decrease vehicle operating costs and emissions. Delay savings are reflected directly in the VHT statistics.

To estimate the benefit/cost ratio, the benefits in each category are converted into dollars and added together. These are divided by the total incremental costs of the Plan's transportation improvements to produce a ratio.

The investments in the 2016 RTP/SCS would provide a return of $2.00 for every dollar invested, providing a benefit/cost ratio of 2.0 and a 100 percent return on our investment. For this analysis, all benefits and costs are expressed in 2012 dollars. Benefits are estimated over the RTP/SCS planning period through 2040. The user benefits are estimated using California's Cal-B/C framework and incorporate SCAG's RTDM outputs. The costs include the incremental public expenditures over the entire 2016 RTP/SCS planning period.[8]

TRANSPORTATION SYSTEM SUSTAINABILITY

A transportation system is sustainable if it maintains its overall performance over time in an equitable manner with minimum damage to the environment and, at the same time, does not compromise the ability of future generations to address their transportation needs. Sustainability, therefore, pertains to how our decisions today impact future generations. One of the measures used to evaluate transportation system sustainability is the total inflation-adjusted cost per capita to maintain our overall multimodal transportation system performance at current conditions. The 2016 RTP/SCS includes two additional new measures to support this outcome: state highway system pavement condition and local roads pavement condition. These additional performance measures will strengthen the Transportation System Sustainability outcome and further support implementation of the current federal transportation authorization program which requires a performance-based approach for evaluating transportation system investment priorities.

The performance measures presented in this Appendix serve to demonstrate that the planned transportation system in 2040 will perform better and more efficiently compared with today. The 2016 RTP/SCS is committed to maintaining a sustainable regional transportation system by allocating $275.5 billion toward maintaining and operating the system in a state of good repair over the period of the Plan. This is an average annual per capita investment of about $368 (in 2015 dollars) for each year of the Plan period (roughly one dollar per person per day).

Another measure used in the 2016 RTP/SCS to evaluate performance under the Transportation System Sustainability outcome is pavement condition. With diminishing resources available to finance new roadways or major roadway rehabilitation projects, the condition of our pavement has deteriorated over the years and it has become increasingly important to maintain the transportation infrastructure we already have. By monitoring the condition of our regional roadways and highways, we are better able to allocate our resources to facilities that are most in need. Pavement condition is monitored for both the state highway system and for our locally maintained arterial roadways. The condition of our regional roadways impacts transportation safety for all modes. Smooth road conditions allow for better vehicle and bicycle control and reduced hazards. Currently, about 16 percent of the state highway system in the SCAG region is considered distressed, meaning it will require some level of maintenance or rehabilitation to improve conditions.

FIGURE 7 shows the share of distressed lane miles on our state highway system by county. There are three categories used by Caltrans to describe distressed pavement conditions: 'Major,' 'Minor', and 'Poor Ride Quality'. As suggested by its name, 'Major' distress is the most costly to correct. Los Angeles and San Bernardino counties each have more than 200 'Major' distressed lane miles on the state highway system.[9]

The measure used by most local agencies to evaluate pavement condition on our local roadways is the Pavement Condition Index (PCI). PCI evaluates pavement condition on a scale of 0 to 100, with 100 being the best possible score, and 0 being the worst. Local arterials in the SCAG region have an average PCI rating of 69 out of 100, where scores lower than 70 typically translate to conditions that are inadequate, and ratings below 50 indicating pavement conditions that will require major rehabilitation. This suggests that a substantial proportion of our local roadways are in need of pavement improvements to enhance multimodal safety and improve the longevity of our existing transportation infrastructure. It

FIGURE 7 Pavement Condition: State Highway System (2013)

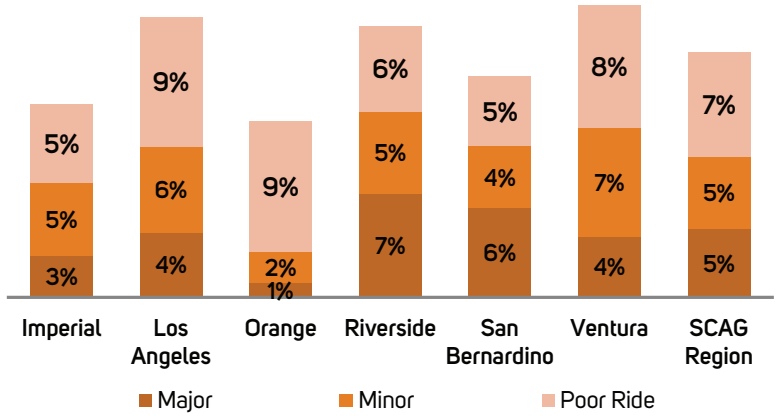
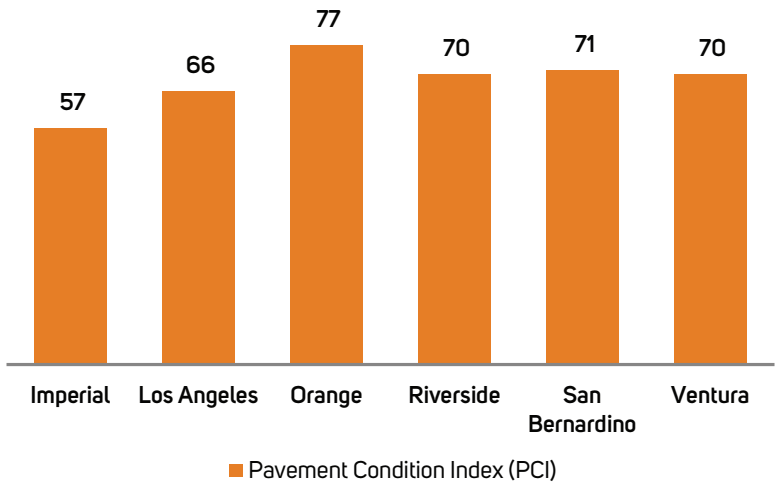


FIGURE 8 Pavement Condition: Local Roadways (2013)



is important to note that without the funding provided in the 2016 RTP/SCS for pavement preservation, local roadways would deteriorate significantly across the region to an average PCI rating below 50. However, with the preservation investments provided in the Plan, the regional PCI score is projected to increase to 83.

FIGURE 8 shows the current pavement condition summary for local roadways in the SCAG region by county. In 2013, average county-wide PCI ratings in the SCAG region ranged from a low of 57 in Imperial County to a high of 77 in Orange County.

PERFORMANCE MEASURES FOR ON-GOING REGIONAL MONITORING

This section discusses those measures not directly or only partially used for evaluating the performance of the 2016 RTP/SCS Plan. These measures will be used for on-going monitoring of the Plan until the next RTP/SCS update occurs. The measures used for on-going monitoring are presented at the beginning of this Appendix in **TABLE 4**. These on-going monitoring measures are not typically forecast, but they allow us to monitor how well our regional goals are being met. This group of outcomes include additional measures that will be investigated for future integration into SCAG's performance monitoring efforts as reliable data becomes available.

LOCATION EFFICIENCY

This outcome, first introduced in the 2012 RTP/SCS, is used both to evaluate performance of the 2016 RTP/SCS and for on-going regional monitoring. Location Efficiency includes several associated performance measures that reflect the impact of improved land use and transportation coordination in support of the SCS, as required by SB 375. The Location Efficiency outcome describes how well regional coordination of transportation and land use planning affects the efficient movement of people and goods. The performance measures to be used to support this outcome for on-going regional monitoring are described in this section.

SHARE OF GROWTH IN HIGH QUALITY TRANSIT AREAS (HQTA)

As an on-going performance monitoring metric, this variable will focus on regional HQTA growth trends as compared to the 2012 Base Year. In 2012, 30 percent of the households and 38 percent of the employment in the region were located within the HQTAs. A map showing Plan 2040 HQTA locations is presented in **EXHIBIT 1** of this Appendix.

LAND CONSUMPTION

Included as a key measure for evaluating performance of 2016 RTP/SCS alternatives, this measure will also be used in an on-going regional monitoring capacity, focusing on the identification of regional trends in the conversion of agricultural land to urban uses occurring since the 2012 Base Year.

VEHICLE MILES TRAVELED (VMT) PER CAPITA

As an on-going monitoring metric, VMT per capita will evaluate regional trends in personal travel mileage (for automobiles and light trucks) in comparison to the 2012 Base Year. In 2012, daily VMT per capita for the region was 22.8 miles. In 2040, per capita VMT is projected to decrease to 22.1 miles under the Baseline, and to 20.5 miles under the Plan. Results for this indicator as a performance measure for the 2016 RTP/SCS are discussed in more detail in the RTP/SCS Outcomes and Performance Measures section of this Appendix.

TRANSIT MODE SHARE

The transit mode share for work and non-work trips will also be monitored on an on-going basis to identify regional trends evolving since 2012. In 2012, the transit mode share in the SCAG region for all trips was 2.2 percent. Transit mode share is projected to increase for all trips in 2040 from 2.2 percent under the Baseline to 3.1 percent under the Plan. For work trips, the share of transit use is higher, accounting for a 4.8 percent mode share in the 2012 Base Year, 5.6 percent under the 2040 Baseline, and 8.2 percent under the 2040 Plan.

TRANSIT TRIPS PER CAPITA

To be used exclusively as an on-going performance measure, transit trips per capita will monitor the average annual number of transit trips taken by people as a means of evaluating regional transit system improvements over time. Transit trips per capita in the SCAG region was 39 in 2012, but is projected to increase in 2040 from 48 trips under the Baseline to 63 trips under the Plan.

ANNUAL HOUSEHOLD TRANSPORTATION COST

The average annual household transportation expense for the SCAG region in 2012 was $12,079. These expenses included both fuel costs and motor vehicle ownership and maintenance costs. Annual transportation costs in the region are projected to increase by 5.7 percent to $12,766 under the Baseline, however under the Plan, these expenses would decrease by more than 13 percent from the Baseline to $11,068. This projected reduction in household transportation costs under the Plan would also represent an 8 percent decrease from the 2012 Base Year. Since both the Baseline and Plan scenarios use the same assumptions regarding future fuel costs and vehicle fuel efficiency, much of the decline in transportation expense may be attributed to the multimodal investments and location efficient land use strategies promoted in the 2016 RTP/SCS.

PERCENT OF INCOME SPENT ON HOUSING AND TRANSPORTATION

Households in the SCAG region are estimated to spend an average of 59 percent of their incomes on the combination of housing and transportation expenses, including over 37 percent for housing and about 22 percent for transportation. While 2040 projections are not currently available for this variable, it is anticipated that with the decrease in transportation costs projected under the Plan for 2040, the average percentage of household income spent in the SCAG region for housing and transportation will also decline.[10]

LOCATION EFFICIENCY MEASURES REQUIRING FURTHER RESEARCH

There are several additional measures that have been suggested by stakeholders for on-going monitoring of the Location Efficiency outcome. However, these measures require further research to determine their potential use for monitoring. They will be included in future RTP/SCS updates if additional research warrants their inclusion.

The following measures require further research to determine their potential suitability for on-going monitoring:

- Percent of households with walk access to neighborhood services
- Percent of existing and new below-market rental housing units in transit-oriented development (TOD) areas

MOBILITY AND ACCESSIBILITY

This section discusses the mobility and accessibility performance measures that will be used for on-going monitoring of the regional transportation network.

As discussed earlier in this Appendix, the primary measure for monitoring the mobility outcome in the 2016 RTP/SCS is delay due to recurring congestion. Another mobility measure that will be used for on-going regional monitoring is non-recurrent delay. As previously mentioned, recurrent delay is the day-to-day delay that occurs because too many vehicles are on the road at the same time. Non-recurrent delay is the delay that is caused by accidents, weather, special events, or other atypical incidents. Non-recurrent delay can be mitigated or reduced by improving incident management strategies. Other uses of intelligent transportation technologies, such as traffic signal coordination and the provision of real-time information about unexpected delays, allow travelers to make better informed decisions regarding the availability of transportation alternatives, including transit.

Data from the Caltrans Performance Measurement System (PeMS) is used to assess the level of non-recurrent delay on regional freeways using the 'congestion pie' feature of PeMS. This module breaks down congestion into recurrent and non-recurrent congestion, with

recurrent congestion being that day-to-day delay that occurs when there are simply too many vehicles on the road at the same time.[11]

PeMS evaluates non-recurring congestion by categorizing the data into two major components: 'Accidents' and 'Miscellaneous'. Accident-related congestion is estimated by comparing incident location data provided through the Caltrans Traffic Accident Surveillance and Analysis System (TASAS) to congestion levels reported by roadway sensors. If excess congestion beyond what is considered normal is reported at a location where TASAS reports that an accident occurred, that surplus congestion is classified as accident-related congestion. If congestion being reported by a sensor is above normal and there was no accident report, then that congestion is classified in the miscellaneous category.

The most recent available PeMS congestion classification data is for the fourth quarter of 2011. **FIGURE 9** shows the percentage of freeway congestion during a typical day (5:00 AM through 8:00 PM) classified as either recurrent or non-recurrent. The data is reported for each county and for the region as a whole. Please note that congestion data was not available for Imperial County. In 2011, the estimated regional average percentage of congestion that was due to accidents or other incidents was around 48 percent. While San Bernardino County has less congestion overall, the county is more susceptible to congestion caused by incidents, with PeMS data indicating that up to 78 percent of all congestion in the county being non-recurrent. In the more urbanized Los Angeles County, the data reported that 44 percent of countywide congestion was non-recurrent, with the remaining 56 percent being of the recurrent variety.

Other mobility and accessibility measures to be used for on-going system monitoring include mode share for work trips and average travel time to work. In 2012, nearly 77 percent of commuters traveled to work alone in a single occupant vehicle, while approximately 14 percent carpooled, about 5 percent used transit, and just over 4 percent used active transportation (bicycling/walking). Under the Plan, the share of commuters traveling to work by single occupant vehicle would decline to about 72 percent, with nearly 16 percent carpooling, more than 8 percent using transit, and about 5 percent traveling to work using active transportation modes.

In 2012, the average travel time to work in the SCAG region was 27.3 minutes. In 2040, travel time is projected to increase by 4 percent to 28.4 minutes under the Baseline scenario. However, average travel time to work will decrease by 9 percent from the Baseline to 25.9 minutes under the Plan, which also represents a decrease of more than 5 percent from the 2012 Base Year.

PRODUCTIVITY AND RELIABILITY

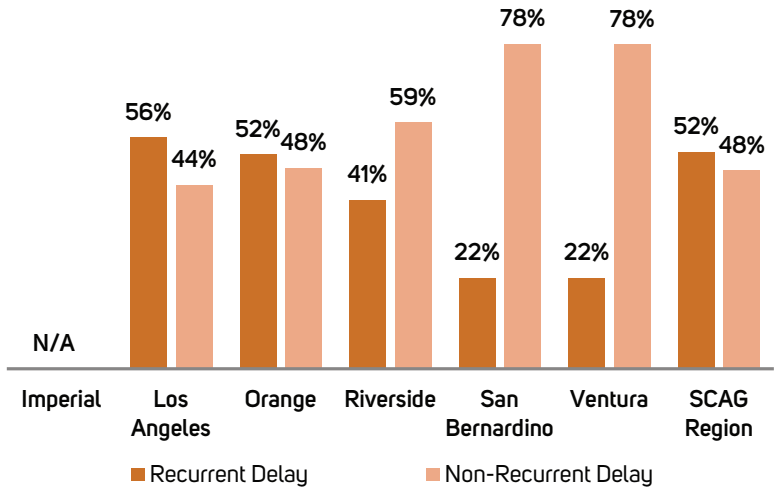
As with the non-recurrent congestion measure, the productivity and reliability outcomes cannot be readily forecast and are therefore not used for alternatives analysis in the 2016 RTP/SCS. They do, however, provide some guidance on how much benefit can be obtained by regional investments in operational improvements. Productivity and reliability are critical indicators since they reflect improvements in efficiency and non-recurrent congestion, respectively. SCAG plans to monitor progress achieved in improving productivity and reliability on a regular basis moving forward. As with the non-recurrent congestion analysis, the productivity and reliability estimates presented here are based on data from PeMS.

PRODUCTIVITY

The productivity outcome reflects the degree to which the transportation system performs during peak demand conditions and is therefore considered a system efficiency measure. The productivity measure is defined as the percentage of system utilization during peak demand conditions.

For highways, productivity is particularly important because when we need capacity the most, we often get the lowest level of production from our transportation system. On some

FIGURE 9 Recurrent vs. Non-Recurrent Congestion (2011)



corridors throughput can decline as much as 50 percent during peak periods, and most congested urban corridors typically lose 25 percent of their capacity during rush hour. This loss of productivity is illustrated in **FIGURE 10**, which provides an example of how vehicle throughput declines, and system productivity is lost, during peak commute periods, especially when average speeds drop below 35 miles per hour.

FIGURE 11 summarizes current estimates for productivity losses on the region's freeway system that occur during the morning and afternoon peak travel periods and the expected improvements due to Plan investments. Maximizing the system's productivity is a critical goal of this RTP/SCS, and the overall system management approach aims to recapture lost productivity. The total investment of over $9.2 billion to implement advanced operational strategies on our freeways and arterials is projected to recapture 20 percent of the lost productivity. These projections are based on recent studies indicating that investments in ramp metering, arterial signal coordination, traveler information systems, advanced incident management strategies, and integrated corridor management initiatives can achieve substantial improvements in system productivity.

The Plan improves the productivity of the regional transportation system by committing to investments in highway operations as discussed in the main RTP/SCS document. Transit productivity will also improve through increased ridership, which maximizes the number of seats occupied during peak demand conditions. **FIGURE 12** shows the percent of transit passenger miles traveled compared to the total number of seat miles provided. Overall, the trends in transit productivity have been positive, reflecting increased ridership on the various transit systems in our region.

A common industry standard for measuring transit productivity is number of passengers per service hour or mile. The decline in productivity shown for some counties in **FIGURE 12** is most likely a product of the increase in service hours over the last 20 years. As service has increased, it is no longer being used as intensely as it was in the early 1990s. Of course, there are valid policy reasons for having fewer passengers per hour or mile. For example, an agency could extend transit service later into the evening, seeking to provide later return trip options for travelers, or to provide mobility for service sector workers who often work late into the evening. Similarly, an agency might determine that the load factors on its runs are too high and choose to provide extra service so that travelers would have more comfortable, less crowded rides.

FIGURE 10 Illustrative Highway Productivity Losses

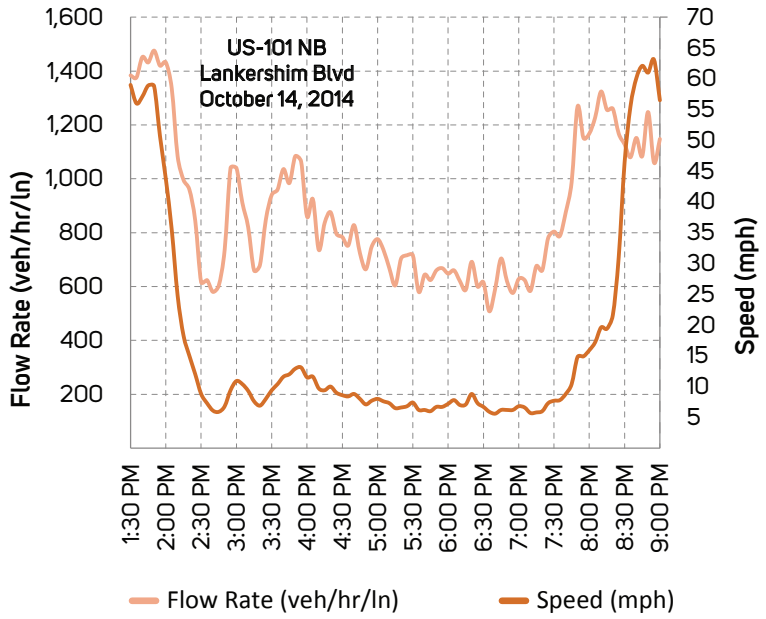
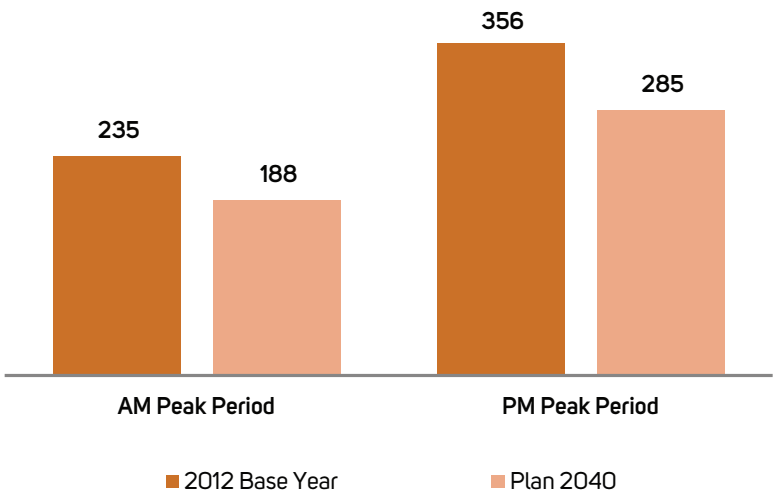


FIGURE 11 Highway System Productivity (Lost Lane-Miles)



RELIABILITY

Reliability measures the relative predictability of travel time for commuters. Unlike mobility, which measures how fast the transportation system is able to move people and goods, and accessibility, which addresses how much time people must spend traveling in total, reliability focuses on the degree to which mobility and accessibility vary for travelers from day to day. This variability is illustrated in **FIGURE 13**. Highway 'A' and Highway 'B' both have the same average travel time, meaning that they experience the same level of mobility. However, when each day's travel time is taken into account, it is apparent that Highway 'A' has less travel time variability than Highway 'B', and is therefore the more reliable alternative.

Reliability measures reflect the impacts of accidents, incidents, weather, and special events on reaching destinations in a predictable manner. There are currently no established methods to forecast reliability because regional travel demand models are not yet capable of evaluating variations in travel times, but can only estimate average travel times and delays (however, there is currently extensive research being conducted worldwide on reliability forecasting).

One way to measure reliability is to calculate the planning time that a person would need to allow to ensure an on time arrival, and a common measure for evaluating planning time is the 95th percentile travel time. The 95th percentile travel time represents the time that would be required to ensure reaching a destination on time 95 percent of the time. Severe events, such as collisions, could occasionally cause longer travel times, but the 95th percentile represents a balance between days with such extreme events and more typical travel days. The additional travel time needed (the difference between the planning time and the average travel time) is known as the 'buffer time' and the percentage of additional buffer time is referred to as the 'Buffer Index'.[12]

TABLE 11 illustrates the concept of reliability using data from PeMS for a person traveling northbound on US-101 from Soto Street in downtown Los Angeles to Laurel Canyon Boulevard in Studio City and leaving at three different times of the day in 2012. A traveler entering US-101 during rush hour at 5:00 PM would typically equire about 29 minutes to reach Laurel Canyon Boulevard. However, to ensure reaching their destination on time at least 95 percent of travel days, that person would need to allow for an additional 13 minutes (or 44 percent more time). Transportation System Management (TSM) investments that reduce incident response and clearance times, provide better traveler information during non-recurrent events, or provide other system management improvements, can reduce the buffer time needed to ensure an on-time arrival.

SAFETY AND HEALTH

For on-going monitoring purposes, the Safety performance measure can be reported historically by time period (month) and by mode (including for active transportation).

FIGURE 12 Ratio of Transit Passenger Miles/Seat Miles

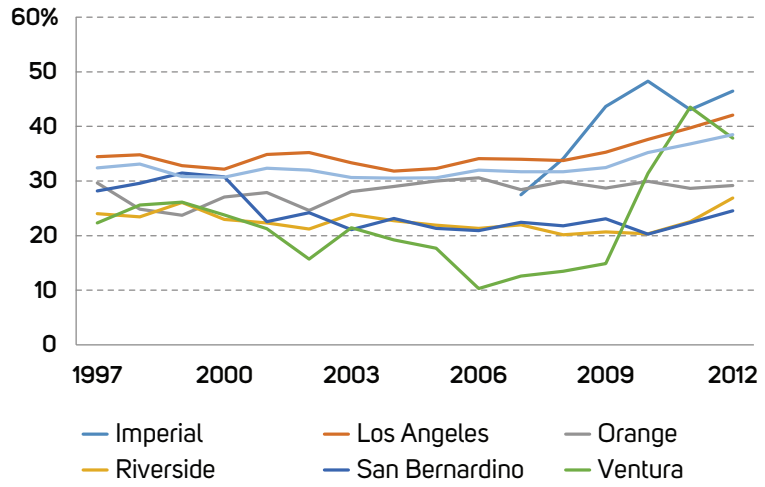
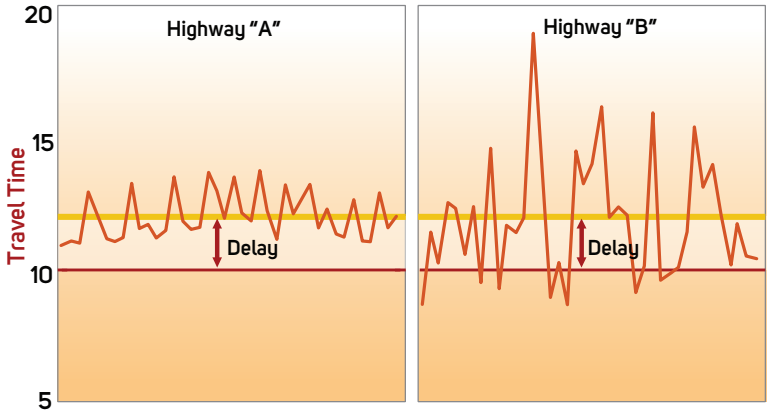


FIGURE 13 Difference between Reliability & Mobility



Same Mobility (same travel time and delay), but Highway "A" is much more reliable

TABLE 11 Example of Reliability on a Freeway Corridor*

Departure Time	Average Travel Time (minutes)	Planning Time (95th Percentile) (minutes)	Buffer Time (minutes)	Buffer Index (%)
8:00 AM	16	20	4	28%
Noon	15	18	3	17%
5:00 PM	29	42	13	44%

US-101 N/B from Soto Street in downtown Los Angeles to Laurel Canyon Blvd in Studio City

FIGURE 14 shows the rate for collisions that have resulted in serious injuries and fatalities per million vehicle miles traveled on regional roadways between 2002 and 2012. In 2012, the most recent date for which complete data is available, more than 1,300 people were killed and nearly 7,000 severely injured on roadways in the SCAG region. This translates to a regional fatality rate of 0.83 per 100 million VMT, which is lower than the statewide fatality rate of 0.91 per 100 million VMT, and significantly lower than the national rate of 1.09. The corresponding rate for collisions involving serious injuries was 4.29 in 2012. However, implementation of the 2016 RTP/SCS would reduce the rate of collisions involving fatalities in 2040 to 0.31 per 100 million VMT, while decreasing the rate of injury collisions to 1.60.

FIGURE 15 shows collision rates causing injuries and fatalities involving bicyclists and pedestrians per one thousand population for counties in the SCAG region for the years 2004 through 2012. While the overall trend for all types of collisions involving fatalities or serious injuries has been generally sloping downward, it must be noted that roadway safety in our region remains a serious concern. Over the last ten years, a total of 1,294 bicyclists have been killed and 8,421 severely injured in roadway collisions. During this same time period, 6,775 pedestrians were killed and 17,504 were severely injured.

The health measure was first introduced as a performance outcome in the 2012 RTP/SCS. For on-going monitoring purposes, this measure is reflected in terms of the health effects of pollutant emissions, noise, and access to parks and open space. This outcome also includes measures for use of bicycling and walking modes for work and non-work trips.

ASTHMA INCIDENCE AND EXACERBATION

Based on the 2014 California Health Interview Survey, 14.6 percent of the State's population has been diagnosed with asthma at some time during their lives. Among those who have ever been diagnosed with asthma, over two-thirds (68.2 percent) have experienced symptoms in the past 12 months, and 8.8 percent have visited an emergency

FIGURE 14 Total Injury & Fatality Rates per 100 Million Vehicle Miles: 2002-2012

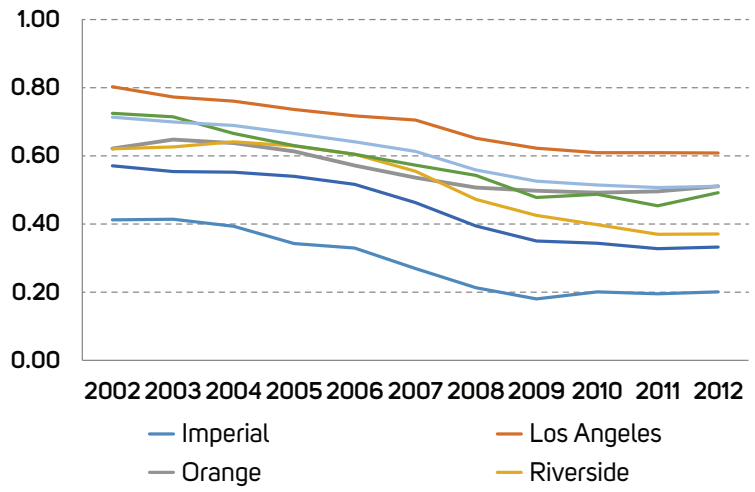
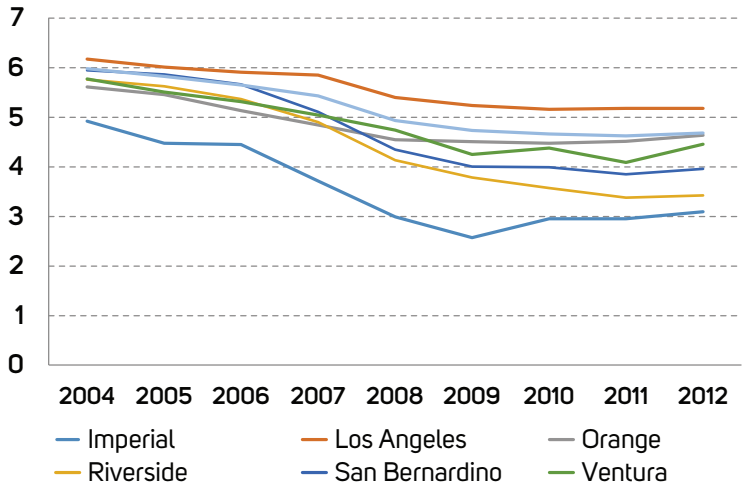


FIGURE 15 Bicycle & Pedestrian Injury & Fatality Rates per 1,000 Population: 2004-2012



room or urgent care facility. Thirty-five percent are currently taking daily medication to control asthma symptoms.[13]

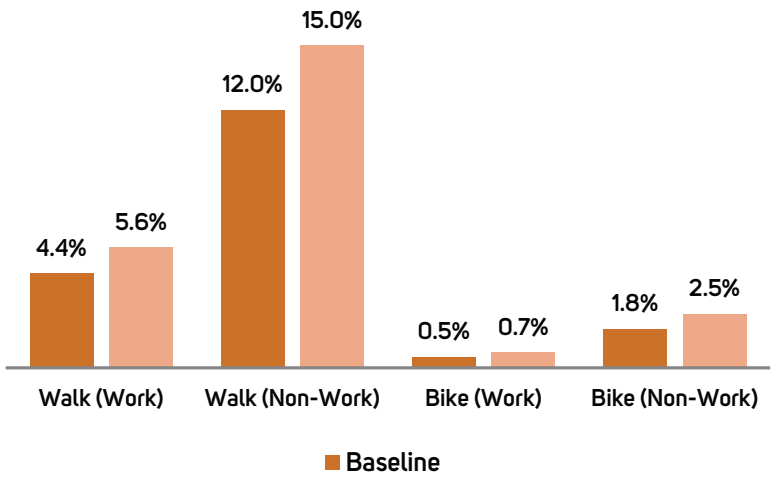
PERCENT OF HOUSEHOLDS LIVING LESS THAN 500 FEET FROM HIGH VOLUME ROADWAYS

High volume roads are defined as those with traffic volumes of more than 100,000 vehicles per day in urban areas and 50,000 vehicles per day in rural areas. Generally, diesel particulate concentrations and the associated cancer risk drop off with distance from the pollution source, such as high-volume roadways. Specifically, based on studies conducted by the California Air Resources Board (ARB), air pollution levels can be significantly higher within 500 feet of high volume roads and then diminish rapidly.[14] In 2012, there were a total of about 248,000 households in the SCAG region located within 500 feet of high-volume roadways. These represented 4.2 percent of total households in the region. In 2040, under the Baseline, about 4.1 percent of regional households will be located within the 500 foot zone, while this share would increase slightly to 4.2 percent under the Plan.

PREMATURE DEATHS DUE TO PM2.5

The U.S. Environmental Protection Agency estimates the number of annual $PM_{2.5}$ related premature deaths in California was 9,200 in 2009.[14] The $PM_{2.5}$ related mortality estimates primarily reflect cardiopulmonary and ischemic heart disease causes, which are the pathologies most closely associated with $PM_{2.5}$ exposure, and are also the most frequent causes of mortality in the U.S. Because of high $PM_{2.5}$ concentrations and a large population (over 16 million), most of the estimated premature deaths (4,900) occur in the South Coast Air Basin in the SCAG region, which includes the non-desert areas of Los Angeles, Riverside, and San Bernardino counties, plus the entirety of Orange County. The South Coast Air Basin includes nearly 87 percent of the population of the SCAG region.

FIGURE 16 Mode Share of Walking & Biking



BICYCLE AND PEDESTRIAN MODE SHARE

Supportive of the public health goals of the 2016 RTP/SCS, this measure will allow SCAG to monitor the relative share of regional travel that is conducted using active transportation modes. It is anticipated that through strategic investments in active transportation infrastructure, safety, and supportive land use changes, an increasing share of commuters in the region will opt for more healthful, sustainable transportation options for getting to their destinations. Bicycle mode share for work trips in the SCAG region is projected to increase from 0.5 percent in 2040 under the Baseline to 0.7 percent under the Plan, while the pedestrian share of work trips is expected to increase from 4.4 percent under the Baseline, to 5.6 percent under the Plan.

All of these measures represent improvements over the 2012 Base Year, when 0.4 percent of work trips were made by bicycle, and 4.2 percent by walking. The share for active transportation modes is generally higher for non-work trips, with a 1.8 percent bicycle mode share under the Baseline, and 2.5 percent under the Plan. The non-work pedestrian mode share is 12.0 percent under the Baseline, and 15.0 percent under the Plan **(FIGURE 16)**. In combination, active transportation modes would account for 15.7 percent of all trips under the Plan, in comparison to 12.3 percent under the Baseline.

DAILY AMOUNT OF WALKING AND BIKING

This new measure to be used for on-going regional monitoring, also supportive of the public health goal of the 2016 RTP/SCS, will assess the share of our population who include walking or biking trips during their day. This measure will also monitor the total number of minutes of walking and biking for those who used active transportation modes during their daily travels. The average adult in the SCAG region would walk for a total of 12.1 minutes each day in 2040 under the Baseline, while under the Plan, the amount of per capita daily walking increases by nearly one-third, to 16.0 minutes. The average amount of time an adult in the region spends riding a bicycle each day in 2040 under the Baseline would be 1.6 minutes, while under the Plan this value increases to 2.0 minutes, an increase of more than 25 percent.

PERCENT OF RESIDENTS WITHIN ½ MILE OF PARKS AND NATURAL LANDS

Another new metric for our on-going regional monitoring program, this measure will evaluate the proximity of people to neighborhood parks and natural lands. If there are recreational spaces available near enough for people to walk to from their homes, it is more likely they

will get more physical exercise and thereby improve their health and overall quality of life. It is estimated that over half (51.7 percent) of the population in the SCAG region lived within ½ mile of a local park in 2012.

NUMBER OF ACRES OF PARKS FOR EVERY 1,000 RESIDENTS

Similar to the proximity to park and natural lands metric described above, this measure, also new to SCAG's regional on-going monitoring program, will evaluate the availability of local park space to maximize opportunities for residents to engage in physical exercise near their homes. Easy accessibility to local parks offers residents the opportunity to obtain the benefits of physical exercise, including improved health and a better overall quality of life. The amount of local park land available for every 1,000 residents in the SCAG region in 2012 was estimated to be 3.3 acres.

ENVIRONMENTAL QUALITY

This outcome is measured in terms of ambient air quality. Ambient air quality monitoring is performed by the local air districts and the California Air Resources Board. The following are links to those agencies' websites.

- **California Air Resources Board:** www.arb.ca.gov
- **South Coast Air Quality Management District:** www.aqmd.gov
- **Antelope Valley Air Quality Management District:** www.avaqmd.ca.gov
- **Imperial County Air Pollution Control District:** www.co.imperial.ca.us/AirPollution
- **Mojave Desert Air Quality Management District:** www.mdaqmd.ca.gov
- **Ventura County Air Pollution Control District:** www.vcapcd.org

TRANSPORTATION SYSTEM SUSTAINABILITY

This outcome, like its counterpart in the set of performance measures being used to evaluate the 2016 RTP/SCS, seeks to monitor the overall performance of our regional multimodal transportation system over time. For purposes of on-going regional monitoring, this outcome will be evaluated in terms of how well our existing transportation system is being maintained. The two performance measures used to support this outcome include the share of distressed lanes miles on our state highway system, and the pavement condition of our local arterial roadways.

SHARE OF DISTRESSED LANE MILES ON STATE HIGHWAY SYSTEM

Using data provided by Caltrans, this measure will allow SCAG to monitor the general condition of our state highway system. Caltrans' Pavement Management System reports distressed pavement condition using three categories: 'Poor Ride' indicates low pavement quality that only affects the comfort level of the ride, with no apparent underlying weakness of the structural integrity of the facility. 'Minor' distress refers to a roadway structure that requires capital investment in preventative maintenance. 'Major' distress refers to a roadway facility that requires major rehabilitation to ensure its continued viability and operational safety.

According to the most recent data from the Pavement Management System (2013), about seven percent of state highway system lane miles in the SCAG region were classified as distressed in the 'Poor Ride' category, five percent were categorized in the 'Minor' distressed category, and another five percent were categorized as 'Major' distressed. In total, approximately 16 percent of state highway system lane miles in the SCAG region had pavement conditions that were classified as distressed.

PAVEMENT CONDITION ON LOCAL ROADWAYS

As an on-going performance metric, this measure will allow SCAG to monitor pavement condition on our locally maintained arterial roadways. As discussed previously in this Appendix, local pavement condition is most frequently evaluated using the Pavement Condition Index (PCI) which rates pavement condition on a scale of 0 to 100, with 100 being the best possible score, and 0 being the worst. According to the most recent data collected by SCAG from our local jurisdictions (2013), the average PCI rating for local roads in our region range from a low of 57 in Imperial County, to a high of 77 in Orange County. These conditions may be considered average to below average. But without the incremental investments for preservation as provided in the Plan, pavement conditions would significantly deteriorate by 2040 to an average PCI rating of below 50, which would require substantial expenditures for widespread major roadway rehabilitation and reconstruction projects. However, with the infrastructure preservation investments included in the Plan, roadways in the SCAG region are projected to achieve an average PCI score of 83 by 2040.

RESOURCE EFFICIENCY

Resource Efficiency is another new outcome for our on-going regional monitoring program that will serve to support our regional sustainability goals. The results provided by this outcome will provide a better understanding of how well the SCAG region is performing in the conservation of our energy and water resources over time. With growing concern over climate change and on-going statewide drought conditions, this outcome will help monitor our region's ability to adapt to these climatic challenges.

ENERGY CONSUMPTION

Energy consumption is an important performance measure for on-going monitoring in the SCAG region because of its impact on greenhouse gas emissions and our regional sustainability goals. With the passage of SB 375, reduction of greenhouse gas emissions has become a focal point in the development of community sustainability strategies among state, regional, and local agencies throughout the State of California. This measure will monitor energy consumption (electricity, natural gas, vehicle fuel) in the SCAG region. The careful monitoring of this metric over time will help us to distinguish which strategies have proven to be the most beneficial toward achievement of our regional sustainability goals.

The cumulative annual energy consumption for buildings in the SCAG region in 2040 under the Plan is projected to be 748 trillion British Thermal Units (BTU) less than what would be consumed under the Baseline, representing a 4 percent decrease in cumulative energy usage.

WATER CONSUMPTION

Similar to the energy consumption performance measure described above, the water consumption variable will also assist in helping to evaluate which of our sustainability strategies have been most effective toward achieving our regional goals. This measure will monitor water consumption in the urban areas of the SCAG region. With the continuing conditions of severe drought affecting our entire state, paired with escalating concern regarding the regional impacts of climate change, it is imperative that we develop effective strategies for reducing water consumption in our region.

Cumulative annual water consumption for buildings in the SCAG region in 2040 is projected to total nearly 134 million acre feet under the Baseline, however, under the Plan, water consumption drops to 133.2 million acre feet, representing a 0.6 percent decrease.

CONCLUSION

As demonstrated throughout this Appendix, the performance of the 2016 RTP/SCS yields beneficial results for our region in a wide variety of measurable categories, all of which contribute meaningfully toward achieving our regional goals of sustainability, transportation equity, improved public health and safety, and enhancement of our overall quality of life in Southern California. **TABLE 12** provides an overview of some of the key regional co-benefits that would be generated through implementation of the Plan. As indicated in the table, the transportation system investments and land use strategies outlined in the Plan produce very clear and positive results in terms of making progress toward achieving our regional sustainability and livability goals.

TABLE 13 provides a summary of the results of the 2016 RTP/SCS performance measures. Once again, progress is demonstrated through implementation of the Plan for nearly every outcome. An important function for developing these performance measures is to monitor how well our region responds over time to the transportation improvements and strategies promoted through the Plan. Our objective through the monitoring of these performance measures will be to identify areas where we are experiencing success toward achieving our regional goals and those areas where additional efforts or new strategies may be needed.

TABLE 12 Key Benefits of the Plan

Benefit Categories	Baseline	RTP/SCS	Savings	% Savings
Local Infrastructure and Services Costs: Capital and Operations and Maintenance Costs to Support New Growth: 2012-2040[1]	$40.7 billion	$37.3 billion	$3.4 billion	8.4%
Household Costs: Transportation and Home Energy/Water Use, All Households, Annual: 2040	$16,000	$14,000	$2,000	12.3%
Land Consumption: New (greenfield) land consumed to accommodate new growth: 2012-2040	154 sq miles	118 sq miles	36 sq miles	23.4%
Building Energy Use: Residential and Commercial Buildings, Cumulative: 2012-2040 (measured in British Thermal Units (BTUs))	20,311 trillion	19,563 trillion	748 trillion	3.7%
Building Energy Costs: Residential and Commercial Buildings, Cumulative: 2012-2040	$762 billion	$735 billion	$27 billion	3.5%
Building Water Use: Residential and Commercial Buildings, Cumulative: 2012-2040 (measured in Acre Feet (AF))	134 million	133.2 million	0.8 million	0.6%
Building Water Costs: Residential and Commercial Buildings, Cumulative: 2012-2040	$186 billion	$185 billion	$1 billion	0.5%
Household Driving: Annual Passenger Vehicle Miles Traveled: 2040	177.7 billion	150 billion	27.7 billion	15.6%

Source: SCAG Scenario Planning Model
Note: [1] Operations and maintenance costs referenced here include costs beyond those for transportation (e.g. sewer and water operations and maintenance costs).

TABLE 13 2016 RTP/SCS Performance Measures Results

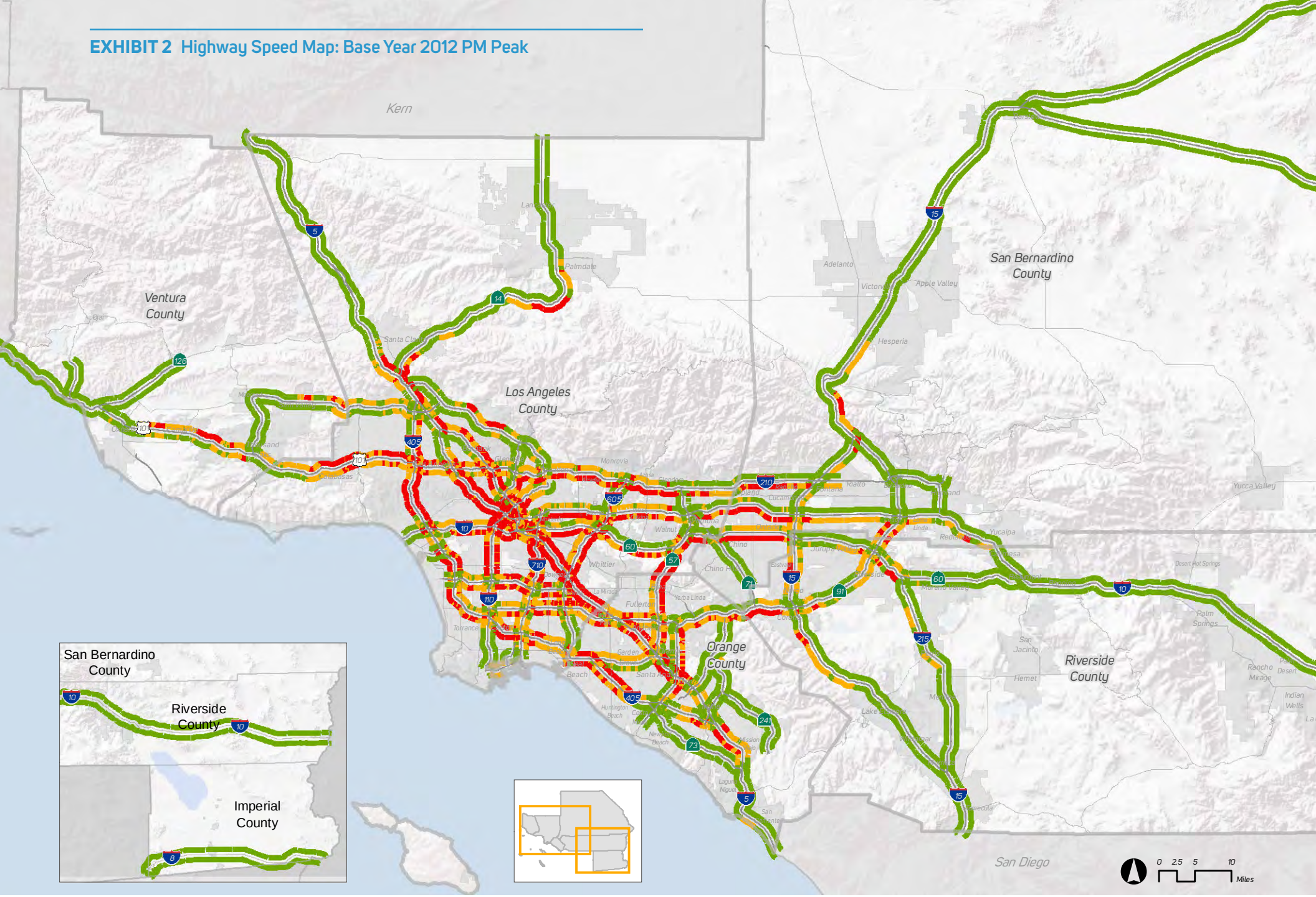
Outcome	Performance Measure	Category	2040 Baseline Result	2040 Plan Result	Trend
LOCATION EFFICIENCY	Share of growth in High Quality Transit Areas (HQTAs)	Percent of households in HQTA's	36%	46%	11.0%
		Percent of jobs in HQTA's	44%	55%	12.0%
	Land consumption	Greenfield land consumed	154 sq miles	118 sq miles	-23.4%
	Vehicle Miles Traveled (VMT) per capita	Automobiles and light-duty trucks	22.1 miles	20.5 miles	-7.4%
	Transit mode share	All Trips	2.2%	3.1%	0.9%
		Work Trips	5.6%	8.2%	2.6%
	Average distance traveled by trip type	Work Trips	15.1 miles	15.5 miles	2.5%
		Non-Work Trips	7.8 miles	7.9 miles	0.5%
	Percent of trips less than 3 miles	Work Trips	20.4%	20.3%	-0.1%
		Non-Work Trips	41.7%	41.9%	0.2%
	Work trip length distribution	Trip Length: 10 miles or Less	51.6%	50.9%	-0.7%
		Trip Length: 25 miles or Less	81.8%	81.0%	-0.8%
MOBILITY AND ACCESSIBILITY	Person delay per capita	Automobiles and light-duty trucks	15.0 mins	9.2 mins	-38.8%
	Person delay by facility type	Highway/Expressway	3,035,105 hrs	2,023,417 hrs	-33.3%
		HOV	251,547 hrs	42,590 hrs	-83.1%
		Arterial	2,254,896 hrs	1,327,235 hrs	-41.1%
	Truck delay by facility type	Highway	274,456 hrs	171,828 hrs	-37.4%
		Arterial	47,561 hrs	20,998 hrs	-55.9%
	Travel time distribution for transit, SOV, and HOV modes for work and non-work trips	% of PM peak transit trips <45 minutes	22.2%	25.6%	3.4%
		% of PM peak HOV trips <45 minutes	72.3%	78.8%	6.5%
		% of PM peak SOV trips <45 minutes	82.5%	88.7%	6.2%
SAFETY AND HEALTH	Collision rates by severity by mode (per 100 million vehicle miles)	Serious injuries	N/A	1.60	N/A
		Fatalities	N/A	0.31	N/A
	Criteria pollutants emissions (tons per day)	Reactive organic gases (ROG)	49.1 tons	45.0 tons	-8.4%
		Carbon monoxide (CO)	338.6 tons	307.7 tons	-9.1%
		Oxides of nitrogen (NO_x)	96.4 tons	88.2 tons	-8.5%
		Particulate matter (PM_{10})	32.6 tons	30.8 tons	-5.5%
		Particulate matter ($PM_{2.5}$)	13.3 tons	12.6 tons	-5.3%
		Nitrogen dioxide (NO_2)	94.6 tons	86.8 tons	-8.2%
	Air pollution-related health measures	Pollution-related health incidences (annual)	270,328	234,363	-13.3%
		Pollution-related health costs (annual)	$4.48 billion	$3.88 billion	-13.4%

TABLE 13 2016 RTP/SCS Performance Measures Results Continued

Outcome	Performance Measure	Category	2040 Baseline Result	2040 Plan Result	Trend
SAFETY AND HEALTH	Physical activity-related health measures	Daily per capita walking	12.1 mins	16.0 mins	32.2%
		Daily per capita biking	1.6 mins	2.0 mins	25.9%
		Daily per capita driving	64.8 mins	61.9 mins	-4.5%
		Obese population (%)*	26.3%	25.6%	-2.7%
		High blood pressure (%)*	21.5%	20.8%	-3.3%
		Heart disease (%)*	4.4%	4.2%	-4.5%
		Diabetes Type 2 (%)*	6.1%	6.0%	-1.6%
	Mode share of walking and bicycling by trip type	Walk share (Work)	4.4%	5.6%	1.2%
		Bike share (Work)	0.5%	0.7%	0.2%
		Walk share (Non-Work)	12.0%	15.0%	3.0%
		Bike share (Non-Work)	1.8%	2.5%	0.7%
		Walk share (All Trips)	10.7%	13.5%	2.8%
		Bike share (All Trips)	1.6%	2.2%	0.6%
ENVIRONMENTAL QUALITY	Greenhouse gas emissions	Reduction in per capita GHG emissions from 2005 levels	N/A	8% in 2020 18% in 2035 21% in 2040	N/A
ECONOMIC OPPORTUNITY	Additional jobs supported by improving competitiveness	Annual number of new jobs generated	N/A	351,000+	N/A
	Additional jobs supported by RTP/SCS transportation investments	Annual number of new jobs generated	N/A	188,000+	N/A
INVESTMENT EFFECTIVENESS	Benefit/Cost Ratio	Benefit ratio received per $1 investment	N/A	2.0	N/A
TRANSPORTATION SYSTEM SUSTAINABILITY	Cost to preserve multimodal system to current and state of good repair	Annual per capita cost	N/A	$368	N/A
	State Highway System Pavement Condition	Share of distressed lane miles	Please refer to Figures 7 and 8 in this Appendix for 2013 pavement condition results		
	Local Roadways Pavement Condition	Pavement Condition Index (PCI) rating			

*Results are only for areas experiencing land use and population changes (not the entire SCAG region)

EXHIBIT 2 Highway Speed Map: Base Year 2012 PM Peak

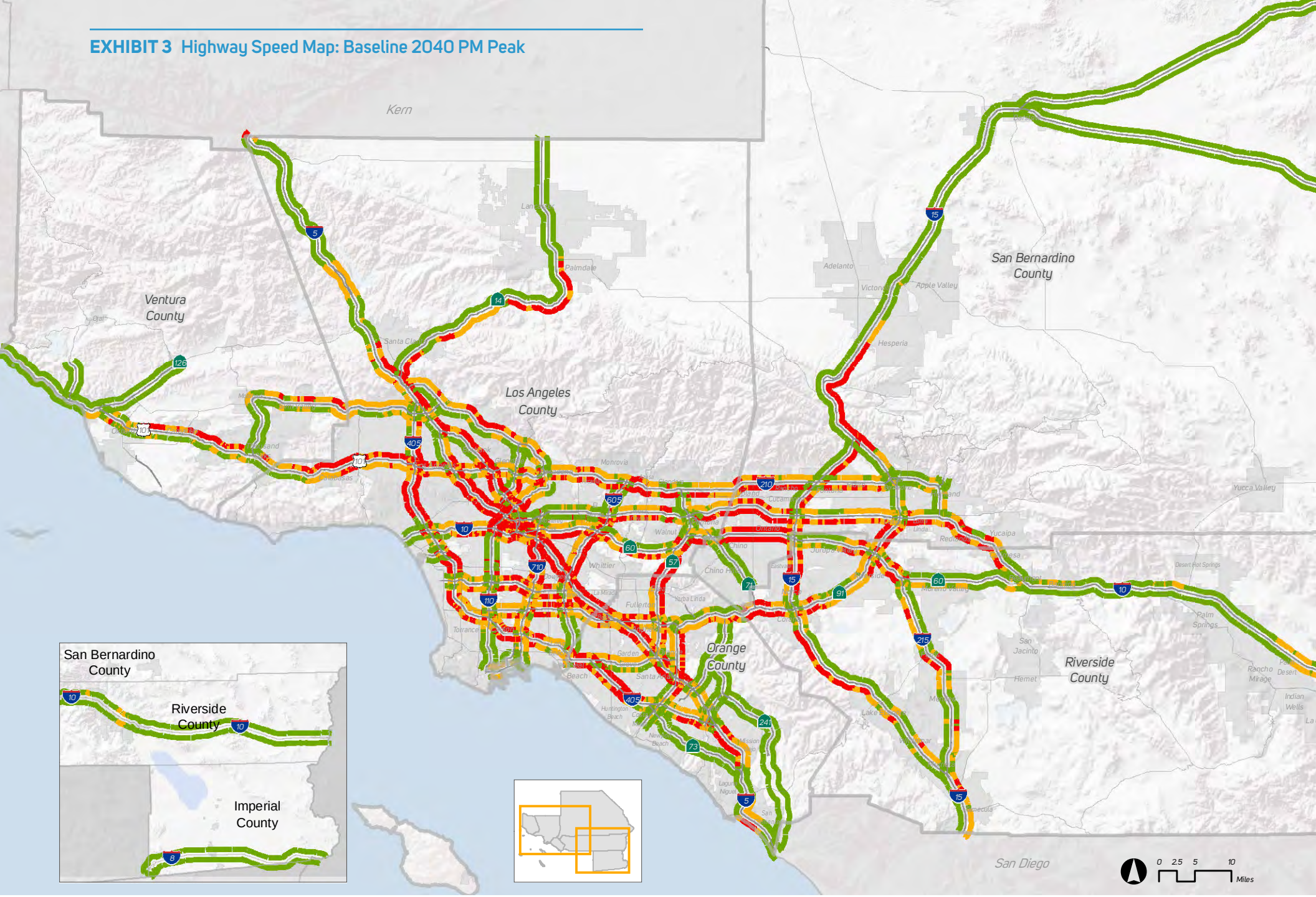


Speed in Miles per Hour

Less than 35 *36 to 50* *Greater than 50*

(Source: SCAG)

EXHIBIT 3 Highway Speed Map: Baseline 2040 PM Peak

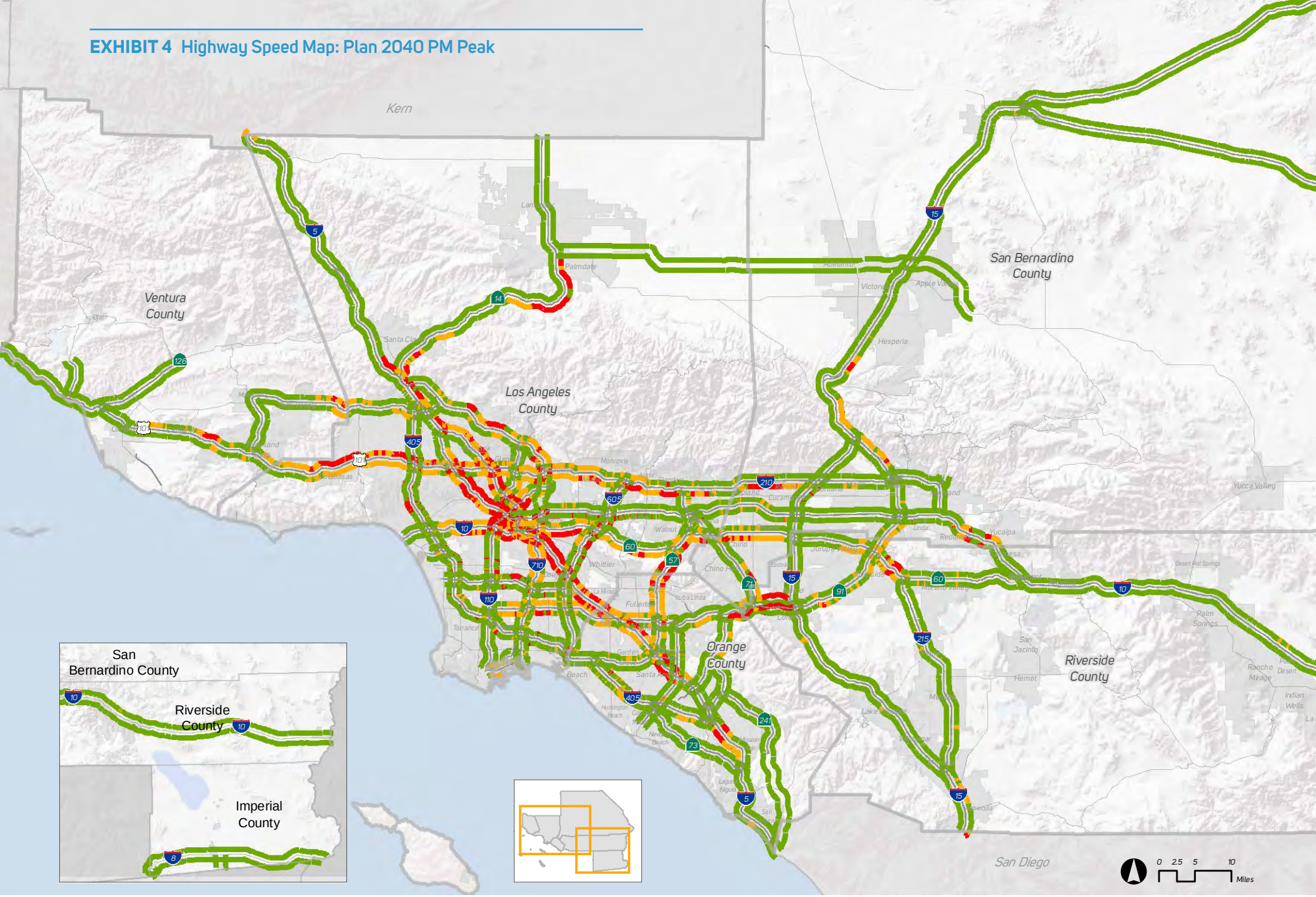


Speed in Miles Per Hour

Less than 35 *36 to 50* *Greater than 50*

(Source: SCAG)

EXHIBIT 4 Highway Speed Map: Plan 2040 PM Peak



Speed in Miles Per Hour

Less than 35 *36 to 50* *Greater than 50*

(Source: SCAG)

NOTES

1 U.S. Environmental Protection Agency, U.S. Transportation Sector Greenhouse Gas Emissions: 1990-2013.

2 Centers for Disease Control and Prevention, from http://www.cdc.gov/diabetes/data/. Last accessed August 5, 2015; and Centers for Disease Control and Prevention. Prevalence of Overweight, Obesity, and Extreme Obesity Among Adults: United States, Trends 1960–1962 through 2007–2008. June 2010.

3 For more information on Federal air quality standards, see U.S. Environmental Protection Agency, National Ambient Air Quality Standards (NAAQS): http://www3.epa.gov/ttn/naaqs/criteria.html

4 For more information on the health impacts of criteria air pollutants, see U.S. Environmental Protection Agency, Six Common Air Pollutants: http://www3.epa.gov/airquality/urbanair/

5 For more information on the health impacts of particulate matter, see U.S. Environmental Protection Agency, Particle Matter (PM) Health, Last Accessed October 7, 2015: http://www3.epa.gov/pm/health.html

6 For more information on Federal transportation conformity requirements, see U.S. Environmental Protection Agency, Transportation Conformity General Information: http://www3.epa.gov/otaq/stateresources/transconf/generalinfo.htm

7 California Air Resources Board, Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology, August 31, 2010: http://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf

8 California Department of Transportation, California Life-Cycle Benefit/Cost Analysis Model User's Guide, February 2009: http://www.dot.ca.gov/hq/tpp/offices/eab/benefit_files/CalBC_User_Guide_v8.pdf

9 Caltrans, 2013 State of the Pavement Report; http://www.dot.ca.gov/hq/maint/Pavement/Pavement_Program/PDF/2013_SOP_FINAL-Dec_2013-1-24-13.pdf

10 Center for Neighborhood Technology: http://www.cnt.org/

11 Caltrans, Performance Measurement System (PeMS): http://pems.dot.ca.gov/

12 For technical information regarding the Buffer Index, see Federal Highway Administration, Office of Operations: http://www.ops.fhwa.dot.gov/congestion_report_04/appendix_C.htm

13 UCLA Center for Health Policy Research, California Health Interview Survey: http://healthpolicy.ucla.edu/chis/Pages/default.aspx

14 California Air Resources Board, Air Quality and Land Use Handbook: A Community Health Perspective, April, 2005: http://www.arb.ca.gov/ch/handbook.pdf

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APPENDIX

PLAN PERFORMANCE | PERFORMANCE MEASURES

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