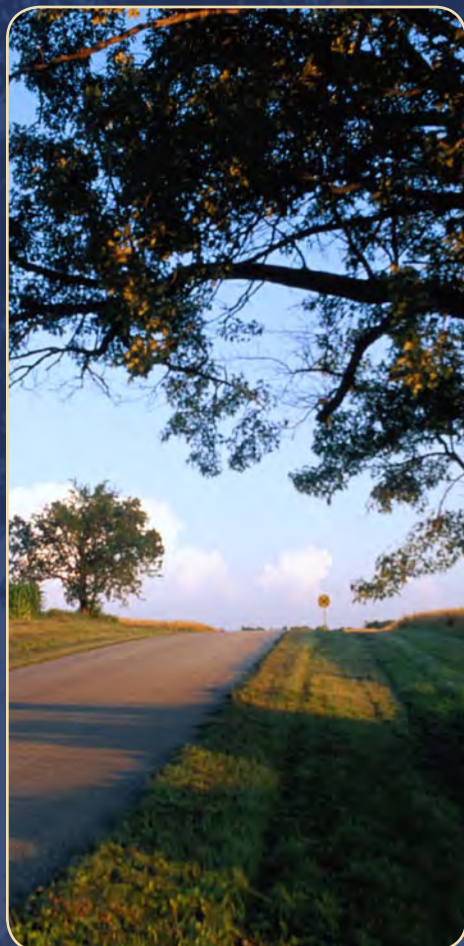

Performance Measures for Rural Transportation Systems

TECHNICAL SUPPLEMENT

Caltrans

JUNE 2006

Contents

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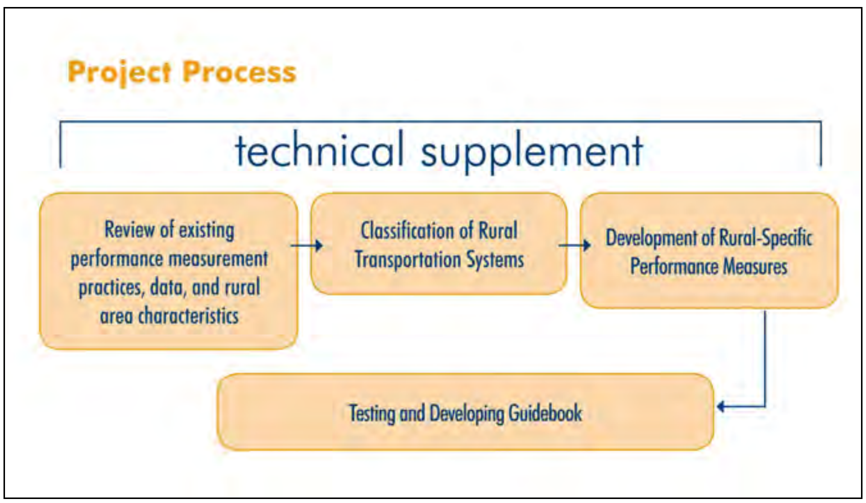
continued

Technical Supplement
Introduction

The purpose of the Performance Measures for Rural Transportation Systems Project is to provide guidance to rural areas regarding a standardized and supportable performance measurement process for transportation systems. This Technical Supplement is intended to accompany the main document entitled "Performance Measures for Rural Transportation Systems Guidebook" (referred to throughout this document as "Guidebook"). The Guidebook describes tested procedures for measuring, assessing, and improving performance of rural transportation systems.

Throughout the project process, the project team and stakeholders have recognized the need to optimize existing agency data and often limited resources. This Technical Supplement documents the project process, findings, and case studies which support the methodologies in the Guidebook. The overall project process is represented in the Figure below, where the Technical Supplement comprises the three stages of the project (review of existing practices, classification of rural transportation systems, and development of rural-specific performance measures) leading up to development of the final Guidebook:



Additionally the data in this document also provides an extensive one-stop reference regarding economic, geographic, and transportation characteristics of rural counties throughout California. This data was collected and interpreted with regular stakeholder direction and feedback, which formed the backbone of the project process. Other data sources included phone interviews with rural agencies and rural transportation organizations, recent Regional Transportation Plans (RTPs), and current research literature.

This research indicated areas of differing emphases among rural areas versus urban and suburban areas, further supporting the need for an approach to performance measurement which recognizes these issues. For example, the research showed that while issues such as system preservation, safety, and economic vitality are pertinent statewide, the emphasis on these issues, such as the relative problem of system preservation on rural roadways, distinguishes rural county issues from urban issues. A majority of rural counties also identified maintenance of existing roadways, public transit, non-motorized systems, and safety as key issues. Development of new roadways is another important issue for over 50 percent of the rural counties. The review found that traffic congestion and level of service, though key issues in urban areas, were only mentioned as issues by 35 percent of all rural counties. These findings demonstrate that although rural and non-rural areas share some common concerns, their priorities differ.

When studying and developing performance measurement, it is important to first understand the difference between the terms “performance outcome area” (or “performance category”, taken here to be synonymous), and “performance measure”. Throughout this project, an “outcome area” or “performance category” refers to the general benefit(s) or goal(s) the transportation system is trying to achieve. For example, the California Department of Transportation (Caltrans) has identified nine outcome areas as follows:

- Mobility/Reliability/Accessibility
- Productivity
- System Preservation
- Safety
- Environmental Quality
- Coordinated Transportation and Land Use
- Economic Development
- Return on Investment
- Equity

Other entities may suggest different outcome areas such as Customer Satisfaction. Thus, outcome areas are broad, high-level references to the overall impact or “outcome” of a transportation system.

At a more detailed level, a “performance measure” is a characterization of performance which is usually quantitative; for example, travel time (associated with the outcome area of mobility), accident rates (associated with the outcome area of safety), or passengers per vehicle revenue mile (associated with the outcome area of mobility). Over time, performance measures should indicate trends and achievements compared to goals.

Based on all of the background data on rural areas and additional investigation into the state of the practice in performance measurement, it was determined that rural areas can effectively apply performance measures and methodologies already in use elsewhere, while placing emphasis on issues of particular concern to rural areas (for example, system preservation). Given the resource constraints faced by rural areas, ways to utilize existing data and existing data collection programs for standardized performance measurement were investigated. Furthermore, it is recognized that rural areas will be at different stages in resource availability and expertise; thus, methodologies were developed to correspond to the following different levels as appropriate:

Basic No or little standardized performance measurement

Intermediate Somewhat standardized performance measurement, often using current tools and methods

Advanced Regular or frequent performance measurement using current tools and methods

Building on this background and the above definitions, the remainder of this Technical Supplement is organized as follows:

§ **Chapter 1: Definition of Rural**
Chapter 1 clarifies the definition of "rural", since different entities have different definitions. As defined in the Guidebook, according to the US Census, a rural area is defined to include all territory, population, and housing units that are located outside of an Urbanized Area (UA). The US Census further defines a rural territory as one that has a population density of less than 1,000 persons per square mile, considering any geographic entity, such as a census tract, county, or Metropolitan Statistical Area (MSA), to be "split" between both urban and rural depending on population density. Using this definition, low-density areas within MSAs are considered to be "rural". For purposes of this study, however, splitting counties into rural versus urban areas would significantly and inaccurately complicate the strategic application of performance measures that are frequently tied to programming decisions made at the Metropolitan Planning Organization (MPO, in urban areas) or Regional Transportation Planning Agency (RTPA, in rural areas) level. Performance measures, associated goals and objectives, planning functions, and programming documents considered for this report were all at the MPO or RTPA level and as all MPO and RTPA boundaries coincide with county boundaries, the delineation of rural versus urban is made at the county level. Although all performance measures and measurement techniques contained in the Guidebook were developed using the delineation of rural described above, all rural areas should benefit from the guidance contained within.

§ **Chapter 2: Existing Performance Measurement in California**
Chapter 2 provides a review of existing performance measures in statewide transportation systems in California, a comparison of performance measures used in rural areas and statewide, and a review of existing performance measures used in other western states and nationwide. Informative findings include the emphasis by rural counties on system preservation and safety, and general RTPA characteristics such as availability of staff as measured in Full Time Equivalent (FTE) employees. The data also highlighted that half of the RTPAs are independent agencies (with limited resources available for data updating and/or more frequent data collection and monitoring).

§ **Chapter 3: Classification of Rural Transportation Systems**
Chapter 3 investigates the classification of Rural Transportation Systems based on existing county characteristics that affect transportation system performance.

Economic, geographic, and transportation-related characteristics are investigated, including population, population density and trends, taxable sales, commercial and hospital facilities, roadway inventory and conditions, and public transit and aviation. The result is an informative categorization of rural counties which was used as a basis for Chapter 4, Chapter 5, and the Guidebook itself.

§ **Chapter 4: Rural-Specific Performance Measures**
Chapter 4 discusses rural-specific performance measures. Building upon the categorization developed in Chapter 3, it was determined that data collected by rural counties and performance measures used do not differ significantly based on the categorization. Other categorization alternatives were assessed and it was eventually determined that rural areas could approach performance measurement differently based on their current stage in performance measurement. Furthermore, although the statewide performance categories (which apply to urban and rural areas) were found to be applicable, the performance measurement practices in those categories were explored in detail and enhanced to meaningfully reflect rural area characteristics. For example, methodologies and tools which are not cost prohibitive are described, along with ways to build on existing data and practices. The practices are not intended to apply to every rural situation, but rather to present the "toolbox" which is eventually described in the Guidebook from which rural agencies can select those performance measures appropriate to their own resources, expertise, and policies.

Performance measures other than those described in the Guidebook may be used in addition to them if a rural area feels that different performance measures would be applicable to their area. However, those additional performance measures would need to be rigorous and supportable in order to be meaningful for decisionmaking, and that rural area would likely need to develop documentation showing the validity of the additional performance measures.

§ **Chapter 5: Case Studies**
The Rural Performance Measures Guidebook contains step-by-step guidance for data collection and determination of quantified performance measures. Chapter 5 of this Technical Supplement contains case studies which demonstrate the proof of concept for these rural-specific performance measures. Through stakeholder outreach and input, actual data used for the case studies was obtained from rural counties in California where available. The data sources are outlined in the table on the following page.

Performance Category	Data Used for Final Case Study (obtained from public channels where applicable)
Safety	§ AADT § Accident data § Population § Vehicle Registration From Modoc
System Preservation	§ Pavement Condition § Maintenance Information § Current PMS Status From § Plumas (Basic) § Mendocino (Intermediate) § Nevada (Advanced)
Mobility	§ Speeds and Travel Times from Route 1 project in Santa Cruz § Used Route 17 detector data in Santa Cruz available from PeMS to demonstrate Proof of Concept
Accessibility	§ Accessibility time difference between fastest route to State Highway System (SHS) and second fastest route to SHS § Used generic data from Trinity County and demonstrated Intermediate guidance using mapping software capabilities. Cost of mapping software was approximately $60.
Reliability	Used Route 17 detector data in Santa Cruz available from PeMS to demonstrate Proof of Concept
Productivity	
Return on Investment	No Case Study since no data available; instead, explanation of Cal-B/C model is offered as a starting point

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Chapter 1

Definition of Rural

Chapter 1
Definition of Rural

As a first step for the California Department of Transportation (Caltrans) Performance Measures for Rural Transportation Systems study, it is important to define the term "rural." This will effectively delineate the study area. Both Caltrans and the US Census have defined the term "rural" based on various factors, as discussed below.

According to the US Census, a rural area is defined to include all territory, population, and housing units that are located outside of an Urbanized Area (UA). The US Census further defines a rural territory as one that has a population density of less than 1,000 persons per square mile, considering any geographic entity, such as a census tract, county, or Metropolitan Statistical Area (MSA), to be "split" between both urban and rural depending on population density[1]. Using this definition, low-density areas within MSAs would be considered to be "rural."

For purposes of this study, however, splitting counties into rural versus urban areas would significantly complicate the application of performance measures. Performance measures, associated goals and objectives, planning functions, and programming documents, are all considered at the Metropolitan Planning Organization (MPO, in urban areas) or Regional Transportation Planning Agency (RTPA, in rural areas) level. All MPO and RTPA boundaries coincide with county boundaries. It is therefore recommended that the definition of rural versus urban be considered only at the county level.

It is next necessary to identify those California counties that are considered to be rural. Through the Rural Planning Assistance (RPA) program, Caltrans has defined "rural" areas as the 26 counties encompassed by the 26 RTPAs shown in Table 1 and Figure 1 and listed below:

- Alpine
- Amador
- Calaveras
- Colusa
- Del Norte
- El Dorado
- Glenn
- Humboldt
- Inyo
- Lake
- Lassen
- Mariposa
- Placer
- Mendocino
- Modoc
- Mono
- Monterey
- Nevada
- Plumas
- San Benito
- Santa Cruz
- Sierra
- Siskiyou
- Tehama
- Trinity
- Tuolumne

1 Census 2000

Figure 1: RTPA Counties

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Chapter 2

Existing Performance Measures

Chapter 2
Existing Performance Measures

Over the last decade, the use of Performance Measures (PMs) has become an increasingly important tool in California transportation issues, specifically for program and system performance evaluation, system planning, budget prioritization, and public accountability. The California Department of Transportation (Caltrans) has declared its commitment of customer focus in applying performance measures throughout the state, focusing on those performance outcomes appropriate for each region. Caltrans also supports the use of PMs for all transportation systems in the state, beyond those directly under Caltrans jurisdiction. Urban, rural, local, and regional needs will determine the choice of measures and which ones will be emphasized in each area.

Performance measures are used to assess the operations of multi-modal transportation systems. The measures help to identify transportation needs and aid in managing transportation fund allocation by establishing appropriate performance measures for every region. Caltrans has been striving to integrate the concepts of performance management in order to create a more accountable framework for decision making. This action addresses both the 1993 *California Transportation Plan* (CTP), which called for a systems-level approach for performance measurement, as well as California Senate Bill 45, which further directed Caltrans (in cooperation with others) to develop State Transportation Improvement Program (STIP) guidelines.

While the focus has always been statewide, the initial focus of PM efforts has been on the urban and suburban areas that have the greatest transportation demands in the state. This was partially due to the accessibility of data in these areas. Caltrans, the California Transportation Commission (CTC), and various statewide transportation stakeholders from both the private and the public sector identified nine performance outcome areas for use in measuring system performance statewide, as described in Table 1 below. Stakeholder representatives included staff from Caltrans, the CTC, Federal Highway Administration (FHWA), Regional Transportation Planning Agencies (RTPAs), Metropolitan Planning Organizations (MPOs), local transportation commissions, and the Rural Counties Task Force (RCTF).

As the statewide indicators are primarily applicable to urban/suburban transportation systems, to date there is no definitive outcomes set specifically developed for rural areas. Developing this PM strategy is the key purpose of this study. Interim study products will be provided in a series of “technical memoranda” to provide opportunities for input as the study progresses. This first technical memorandum provides a:

- Review of the existing standard PMs designated for California transportation systems statewide
- Comparison of existing PMs in rural areas and statewide.
- Review of the standard PMs used by other western states.

- Review of nationwide professional literature regarding PMs for rural transportation systems.

In order to develop PMs for rural areas, it is first necessary to identify those areas in California that are considered to be rural for purposes of this effort. One issue is the fact that both rural and urban clusters are scattered throughout the entire state, making it difficult to clearly delineate rural from urban. This is especially true for counties that are experiencing rapid growth. For this study, rural areas will be considered only on a county-wide basis. In order to connect plans and projects, a county-level approach is necessary. Counties, furthermore, develop Regional Transportation Plans (RTPs) that identify both project and program level goals. Through the Rural Planning Assistance (RPA) program, a portion of statewide funding is provided to rural counties.

It bears noting that, due to the geography of the state, none of these counties are in Southern California. Along with the urban counties, these 26 rural counties are expected to measure transportation system performance using the performance measures contained in the outcome areas described in Table 1. Specific system-level PMs may be more appropriate in urban areas making an across-the-board application of one set of PMs in both urban and rural areas very difficult.

TABLE 1: Statewide Performance Measures

Note: Nine Performance Measure Outcome Areas defined by Caltrans in bold

System Outcome Areas	General Definition	Key Indicators	Examples of Typical Data to Collect
Mobility/ Reliability/ Accessibility	Minimize time and cost and maximize choice and dependability. Reach desired destinations within reasonable time, cost, choice, dependability and ease.	Travel Time (Mobility)	• Travel time within key regional travel corridors
		Travel Delay (Mobility)	• Total persons (passenger) hours of delay
		Available Travel Choices (Accessibility)	• List modes available in key corridors and at key transportation centers. • Travel time to paces of work • Modal split (including ridership) • Percent of jobs located within a ¼ mile of a transit station or bus stop/corridor
		Percent On-Time Performance Travel (Reliability)	• On-time performance • Variability in travel time (state highways)
Productivity	Maximize throughput or efficiency (system wide).	Throughput (persons and vehicles)	• Percent utilization during peak period (highway) • Passengers per vehicle revenue mile (transit) • Passengers per vehicle revenue hour (transit) • Percent trucks
System Preservation	Preserve the publicly-owned transportation system at a specified state-of-repair or condition. Physical condition of the system.	Highways, Streets and Roads	• Pavement conditions – smooth versus distressed (highway) • Percent deficient bridges • Roadside conditions
		Transit and Passenger Rail	• Vehicle fleet age • Miles between service calls
		Aviation	• Number of airports • Departures and movements • Pavement condition
Safety	Reduce fatalities, injury, and property loss of system users and workers. Facilitate perception of personal safety.	Traveler Safety	• Accident rates
Environmental Quality	Maintain and enhance the quality of the natural and human environment.	Air Quality	• Days exceeding national/state standards
		Noise	• Number of residential units exposed to noise generated by transportation exceeding standards
		Energy Consumption	• Fossil fuel use ratio to passenger miles traveled
Coordinated Transportation and Land Use	Ensure transportation decisions promote and support job/housing proximity.	*See Accessibility Indicators*	
Economic Development	Contribute to California's economic growth.	Economic growth	• State / local growth • Business relocation (due to corridor efficiency
Equity	Ensure no person shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance. Ensure no disproportionate impact based on income and ethnic groups. Ensure equitable sharing of benefits. Ensure accessibility for people with disabilities.	Share of benefits	• User cost • Level of promotion, advertisement • Availability of transit service that is ADA accessible
Return on Investment	Benefit cost analysis or best return on investment (includes life□cycling costing).	Cost/Benefit	• Ratio of service cost to changes in traffic speed/flow/throughput • Total cost to agencies
Efficient Freight Travel	Key improvements to transportation systems that identifies long-term issues for freight and cargo industry. Identify efficiency in heavy vehicle traffic and incident response.	Goods Movement	• % of roadway system able to accommodate STAA vehicles • Road, air, and sea freight/cargo movement • Road, air, and sea freight/cargo movement
Customer Satisfaction	Ensures consistency between service and expectations.	Accessibility, System improvements	• Citizen feedback • Survey of ridership experience (accessibility / affordability)

Review of Existing Adopted Performance Measures for Rural Areas of California

Performance measures offer the opportunity for decision makers to measure existing systems by analyzing operational functions in detail. As previously shown in Table 1, the most optimal system outcome areas on which to focus attention for transportation systems in California was decided upon by the stakeholder team. The list includes the nine standard PMs as well as a few which have not been explicitly recommended by Caltrans and the stakeholder team. Also included in this table is a brief definition of each PM, key indicators, and the typical data collection effort necessary in order to quantify each outcome.

SYSTEM-LEVEL PERFORMANCE MEASURES

By State law, all portions of the state are represented by either a Metropolitan Planning Organization (MPO) or a Rural Transportation Planning Agency (RTPA). Each of the rural counties has an individual RTPA. Also by State law, each RTPA must adopt a Regional Transportation Plan (RTP) that identifies transportation issues on both a programmatic and project specific level, outlining current and future projects (10 and 20 year forecasts). Each RTP states the need to provide and maintain a transportation system that enhances safety, efficiently moves all people, goods, and services.

While the RTPAs recognize the state-wide performance measure objectives put forth by Caltrans, there are invariably issues that are exclusive to rural areas. Particular system level PMs, such as those relating to mobility and air quality, may not be appropriate indicators for rural areas. If the issues are not prominent, they become less of a priority. The focus and level of funding for multi-modal transportation systems, which includes the data collection effort necessary to measure performance, is a key differentiating factor between urban and rural areas.

Table 2 illustrates the existing PMs currently identified by the rural counties in a regional, systemwide context, based upon the RTP of each county. As also shown in Figure 2, the most adhered to performance outcome area category is mobility/reliability/accessibility, which is mentioned in 100 percent of the county's RTP documents. Productivity and environmental quality are also frequently mentioned, with 80 percent of counties identifying performance measures for these categories. Other PMs that are identified by a majority of rural counties fall within the safety and system preservation categories.

TRANSIT PERFORMANCE

Performance measures are more consistent with respect to transit because they are required to be under the requirements for funding programs provided through the California Transportation Development Act (TDA) and the Federal Transit Administration (FTA). In addition to the RTP documentation, Short Range Transit Plans (SRTPs) document performance measures for use by transit systems in California's rural counties, which include ADA and paratransit service. Presented in Table 3 is a summary of the transit performance measures identified in the SRTPs. As indicated, all or virtually all counties identified performance measures for ridership, costs, cost effectiveness (such as cost per passenger-trip), and service effectiveness (such as passenger-trips per mile of service). A majority also indicated performance measures for cost efficiency (such as cost per mile of service) and service quality. *Note*: In the case of Glenn and Mariposa Counties, there was no response with regards to this data after attempting to reach these counties on four separate occasions.

TABLE 2: Statewide Existing Performance Outcome Areas for Rural Areas

Note 1: Nine Outcome Areas defined by Caltrans in **bold**

Performance Outcome Areas	County: Alpine	Amador	Calaveras	Colusa	Del Norte	El Dorado	Glenn	Humboldt	Inyo	Lake	Lassen	Mariposa	Mendocino
Mobility/Reliability/Accessibility	x	x	x	x	x	x	x	x		x	x	x	x
Productivity	x	x			x	x	x			x	x		x
System Preservation		x		x	x	x	x	x		x	x	x	x
Safety	x	x	x	x	x	x	x	x				x	x
Environmental Quality	x	x	x	x	x	x		x	x			x	x
Coordinated Transportation and Land Use									x		x		
Economic Development	x	x	x	x	x		x	x	x			x	
Equity	x	x	x	x	x			x					
Return on Investment (Cost Effectiveness)	x	x	x	x	x		x						x
Customer Satisfaction		x						x					
Goods Movement		x							x				
Transit Cost Effectiveness			x	x	x								
Provide Alternative Modes of Transportation							x						
Community Awareness	x	x											
Funding		x				x	x					x	
Historic Preservation	x	x											
Transportation Systems Management (TSM)													

	County: Modoc	Mono	Monterey	Nevada	Placer	Plumas	San Benito	Santa Cruz	Sierra	Siskiyou	Tehama	Trinity	Tuolumne	Total: #	%
Mobility/Reliability/Accessibility	x	x	x	x	x	x	x	x	x	x	x	x	x	25	96%
Productivity	x	x	x	x	x		x	x		x	x			20	77%
System Preservation	x	x	x	x	x		x	x	x	x	x	x	x	24	92%
Safety	x	x			x	x	x		x			x	x	18	69%
Environmental Quality	x	x		x	x		x	x	x	x		x	x	20	77%
Coordinated Transportation and Land Use												x	x	3	12%
Economic Development		x				x				x			x	11	42%
Equity								x						8	31%
Return on Investment (Cost Effectiveness)			x	x		x			x					11	42%
Customer Satisfaction			x							x				4	15%
Goods Movement	x											x		5	19%
Transit Cost Effectiveness			x							x		x		7	27%
Provide Alternative Modes of Transportation	x		x		x		x					x		7	27%
Community Awareness	x				x				x				x	5	19%
Funding	x										x		x	7	27%
Historic Preservation/Tourism														1	4%
Transportation Systems Management (TSM)													x	1	4%

Note 2: Includes Roadways, Public Transit, Aviation, Bike/Ped, Parking, Public Facilities

Source: Regional Transportation Plan (RTP) documents, Regional Transportation Planning Agency (RTPA) and Local Transportation Commission (LTC) officials, county/municipal agency representatives

Figure 2

Rural Counties with Adopted Performance Outcome Areas

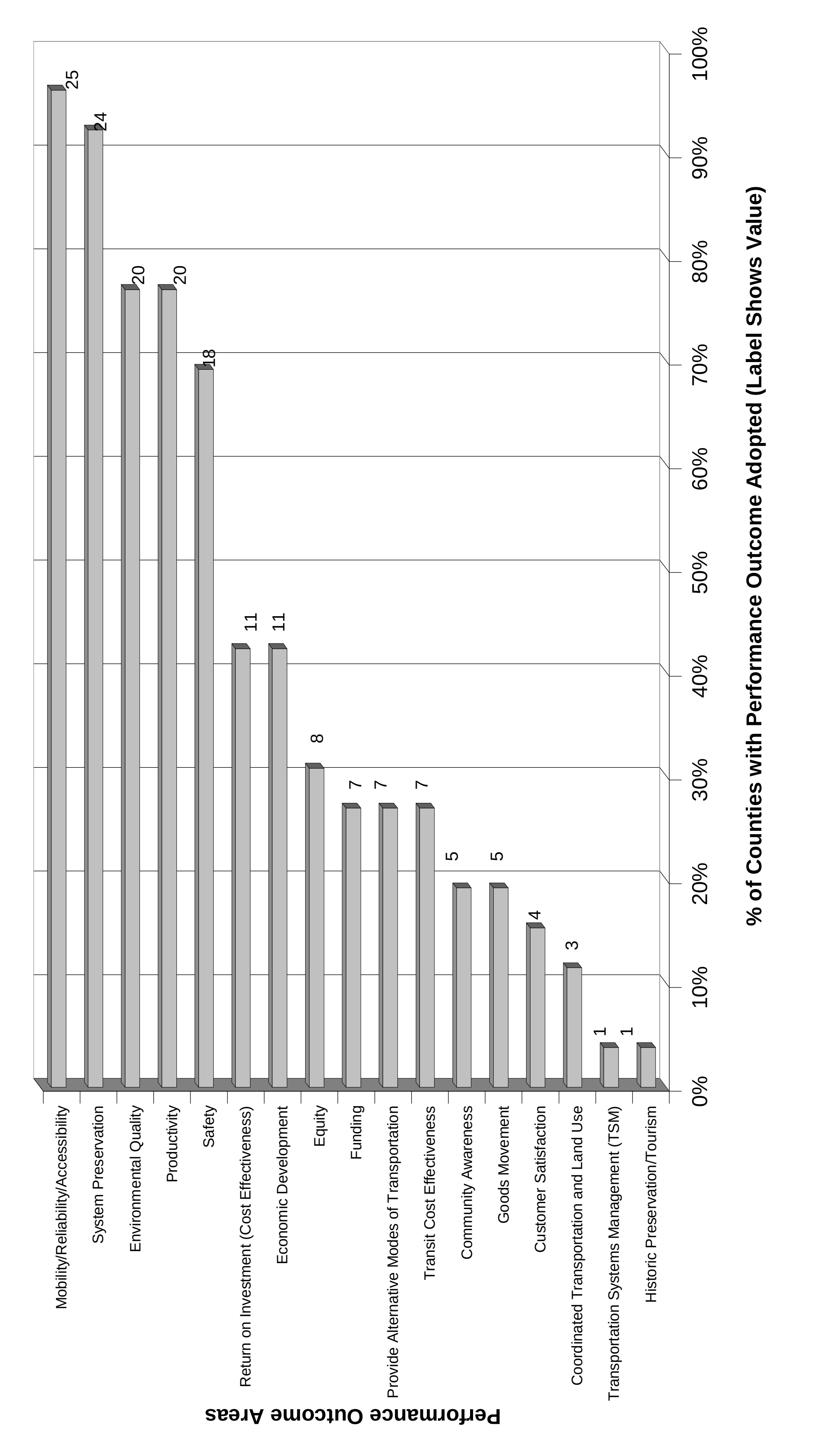


TABLE 3: Transit Performance Measures

County	Ridership	Total Operating Cost & Subsidy	Cost Effectiveness	Cost Efficiency	Service Effectiveness	Service Quality	Safety	Convenience	On-Time Performance
Alpine			x				x		
Amador	x	x	x	x	x	x	x	x	
Calaveras	x	x	x		x	x	x	x	
Colusa	x	x	x		x	x			
Del Norte	x	x	x	x	x	x	x		
El Dorado	x	x	x			x	x		
Humboldt	x	x	x	x	x		x		
Inyo	x	x	x	x	x	x			
Lake	x	x	x		x		x		
Lassen	x	x	x		x	x	x		
Mendocino	x	x	x	x	x	x	x		
Modoc	x	x	x	x	x	x	x		
Mono	x	x	x	x	x		x		
Monterey	x	x	x	x	x	x	x	x	
Nevada	x		x		x	x	x		
Placer			x		x	x	x		x
Plumas	x	x	x	x	x	x	x		
San Benito	x				x		x	x	
Santa Cruz	x	x		x			x	x	
Sierra	x	x	x	x	x	x	x		
Siskiyou	x	x	x	x	x				
Tehama			x	x			x		
Trinity		x		x	x	x	x		x
Tuolumne	x	x	x	x	x		x	x	x

Source: Short Range Transit Plans and RTPs.

Note: SRTPs not provided by Glenn or Mariposa County after three requests.

EXISTING KEY RURAL TRANSPORTATION ISSUES

As a basis for evaluating rural transportation performance measures, the Consultant Team conducted research into the key transportation-related issues facing RTPAs. In addition to the review of existing policy documents (as discussed previously), individual telephone interviews were held with representatives of approximately one half of the rural county agencies.

Table 4 and Figure 3 summarize the key programmatic issues identified by the rural counties. While these issues may appear to be applicable to both urban and suburban settings, the differences lie primarily in the availability of adequate funding. As indicated, all counties responding indicate that the provision of adequate funding is a key issue. In fact, all of the rural counties identified this as their number one issue. It is worth noting that although rural issues resemble urban and suburban issues, the magnitude of these issues varies. A common comment was that the transportation programs are limited by available funding, and are still "falling behind" on addressing system preservation issues. While issues such as funding, safety, and economic vitality are pertinent statewide, the emphasis on these issues, such as the relative problem of system preservation on rural roadways, distinguishes rural county issues from urban issues.

A large majority of counties also identified maintenance of existing roadways, public transit, non-motorized systems, and safety as key issues. Development of new roadways is also another important issue for over 50 percent of the rural counties. Other issues that are of concern for a majority of rural counties include environmental stability, community awareness, urban growth management, and Transportation Management Systems.

Another interesting finding of this review was the fact that traffic congestion and level of service, which are key issues in urban areas, were only mentioned as issues by 35 percent of all rural counties. This reflects one aspect of the differing issues – and differing need for performance measurement – between the urban and rural areas of the state.

EXISTING RURAL PERFORMANCE MEASUREMENT

Presented in Table 5 is a summary of existing RTPA characteristics, as well as their current performance measurement procedures. This table indicates the following:

- All of the RTPAs are single-purpose agencies (which tends to increase the administrative costs associated with transportation management).

- The majority of RTPAs are staffed by persons also employed by local governments (typically county public works departments). While this tends to reduce the administrative costs associated with transportation management (through sharing of staff and resources) it raised the potential for conflict of interest between the differing functions of the RTPA and the local jurisdictions.

- Performance measurement is typically tied to the RTP and SRTP update cycle. Excluding ongoing traffic counts and transit operations reports, few RTPAs conduct performance measurement on a more frequent basis than required by the four-year RTP cycle and the five-year SRTP cycle.

While the majority of RTPs describe the application of transportation performance measures at the programmatic level (in making funding decisions), in reality, the allocated funding is spent on a priority basis. Roadways in dire need of repair receive first priority despite the use of performance measures to indicate funding allocation on a programmatic level.

The characteristics presented in Table 5 highlight the point that half of the RTPAs are independent agencies, with limited resources available in order to update their data. Data is collected on an "as needed" basis for specific RTP or SRTP planning studies, and not on a more frequent basis (such as annually). In addition, Alpine, Mono, Modoc Plumas, Sierra, and Siskiyou Counties currently do not have a computerized traffic model. The summary further points out the fact that the agencies have little available funding for more frequent data collection and monitoring.

Availability of staff and funding for performance measurement is often an issue in rural counties where resources are focused primarily on monitoring existing service, such as monthly transit ridership. Table 6 and Figure 4 present a summary of the existing staffing levels, as measured in Full Time Equivalent (FTE) employees. The FTE numbers are relative to each county. Counties with 0 FTE have no available funding for either RTPA or county staff to monitor performance measures. *Note*: The study team attempted to contact each RTPA and county/municipal jurisdiction via telephone and email in order to identify the FTE. In a few cases, there was not a response after attempting to contact the agencies on four or five separate occasions. Table 6 summarizes the final results as of November, 2005.

TABLE 4: Existing Rural County Transportation Major Issues (Part 1 of 2)

County	Provision of Adequate Funding	Maintenance of Existing Roadways	Development of New Roadways	Expand/Maintain Public Transit	Expand/Maintain Non-motorized Systems	Safety	Goods Movement	Community Awareness	Environment Sustainability
Alpine	x	x		x		x			
Amador	x	x		x	x	x			
Calaveras	x	x				x	x		
Colusa	x	x	x	x	x	x	x		x
Del Norte	x	x	x	x	x		x		x
El Dorado	x	x	x	x	x		x		x
Glenn	x	x	x	x	x	x			
Humboldt	x	x		x	x		x		x
Inyo	x			x		x			
Lake	x	x	x	x	x				x
Lassen	x	x	x	x	x				
Mariposa	x	x	x	x	x				x
Mendocino	x	x	x	x	x		x		
Modoc	x	x		x		x	x	x	
Mono	x	x	x	x	x	x	x		x
Monterey	x					x	x	x	x
Nevada	x	x	x	x	x	x			x
Placer	x	x	x	x	x	x	x		
Plumas	x	x	x	x	x	x			x
San Benito	x	x	x	x	x	x	x		x
Santa Cruz	x	x		x	x	x		x	x
Sierra	x	x	x	x	x	x			
Siskiyou	x	x		x	x	x		x	
Tehama	x	x		x	x	x			
Trinity	x			x	x	x		x	x
Tuolumne	x	x	x			x		x	x
# of Counties	26	22	14	23	20	19	11	6	14
%	100%	85%	54%	88%	77%	73%	42%	23%	54%

Source: Regional Transportation Plan (RTP) documents, Regional Transportation Planning Agency (RTPA) and Local Transportation Commission (LTC) officials

TABLE 4: Existing Rural County Transportation Major Issues (Part 2 of 2)

County	Economic Vitality	Urban Growth Management	Increase Recreation/ Tourism Activity	Aviation - Maintenance & Operations)	TSM, ITS, New Technology	Land Use/ Trans-portation Integration	Affordability	Access	Traffic Congestion/ LOS
Alpine									x
Amador	x								
Calaveras									x
Colusa	x				x				
Del Norte	x		x	x	x				
El Dorado		x		x	x				x
Glenn		x							
Humboldt			x		x	x			
Inyo									
Lake		x				x		x	
Lassen				x					x
Mariposa				x					
Mendocino				x	x				
Modoc				x			x	x	
Mono		x		x	x	x		x	x
Monterey							x		x
Nevada						x	x		
Placer			x	x	x	x			
Plumas		x		x					
San Benito	x				x	x		x	
Santa Cruz		x				x			x
Sierra									
Siskiyou	x					x		x	x
Tehama									x
Trinity	x				x		x	x	
Tuolumne					x		x	x	
# of Counties	6	6	3	9	10	8	5	7	9
%	23%	23%	12%	35%	38%	31%	19%	27%	35%

Source: Regional Transportation Plan (RTP) documents, Regional Transportation Planning Agency (RTPA) and Local Transportation Commission (LTC) officials

Figure 3
Major Issues Examined by Rural Counties

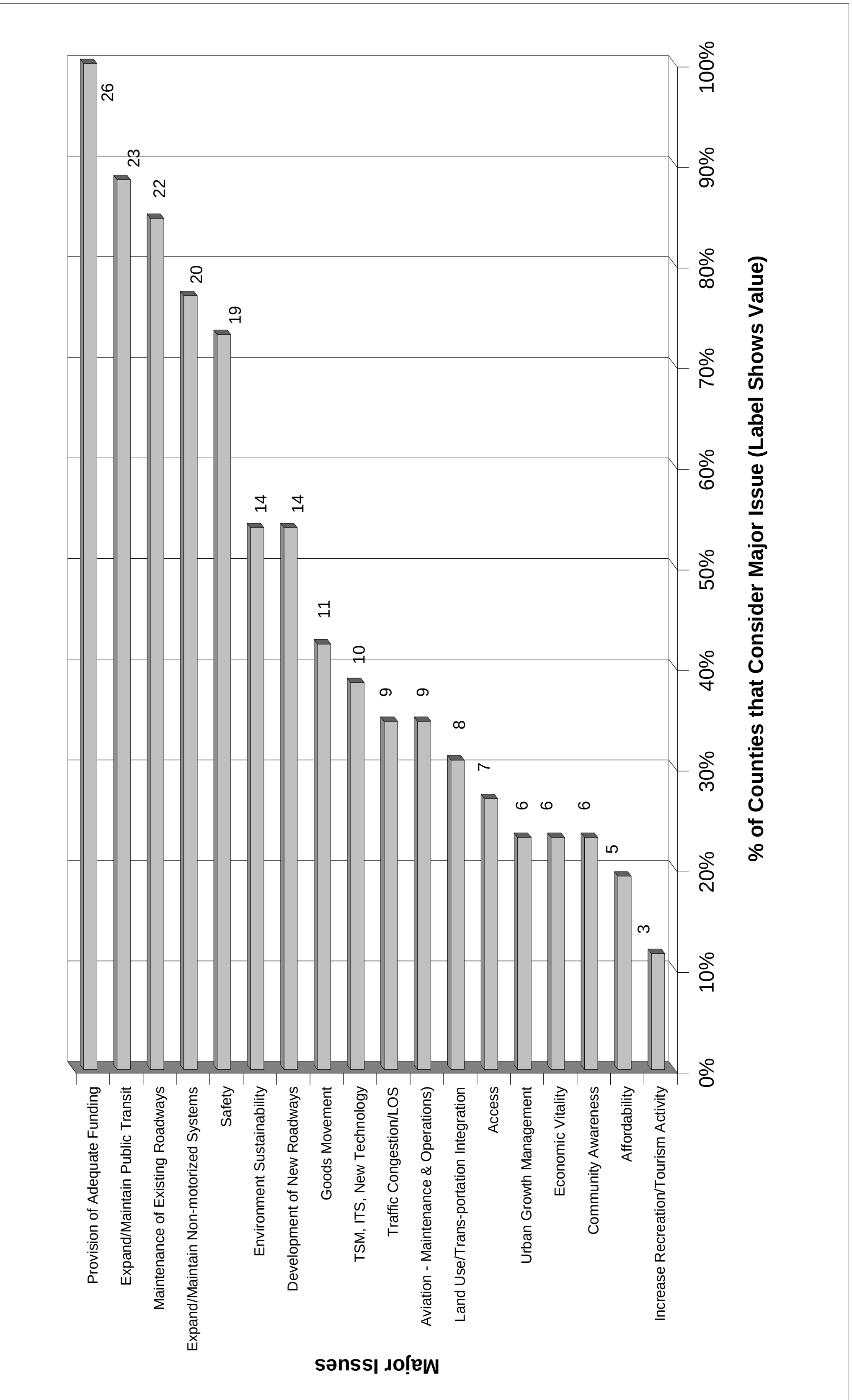


TABLE 5: Regional Transportation Planning Agency Characteristics

County	Single or Multipurpose Agency	Independent Agency	Traffic/Transit Data Updates	Updated Computerized Traffic Model
Alpine	Single	No	RTP 4 years, SRTP 5 years	No
Amador	Single	No	Transit - annual. Pavement conditions - biannually. Traffic counts - collected by request	Yes
Calaveras	Single	Yes	As needed	Yes
Colusa	Single	No	*Unavailable*	*Unavailable*
Del Norte	Single	Yes	N/A	Yes
El Dorado	Single	Yes	RTP 4 years, SRTP 5 years	Yes
Glenn	Single	No	*Unavailable*	*Unavailable*
Humboldt	Single	Yes	RTP 4 years, TDP 5 years	In Process
Inyo	Single	No	RTP 4 years	
Lake	Single	Yes	RTP 4 years	Yes
Lassen	Single	Yes	Every 3 to 4 years. Data collection put on hold for 2 years.	Yes
Mariposa	Single	No	Traffic modeling - every 2-3 years. Transit updated every 5 years	Yes
Mendocino	Single	Yes	RTP 4 years	
Modoc	Single	No	RTP 4 years, SRTP 5 years	No
Mono	Single	No	RTP 4 years, SRTP 5 years	No
Monterey	Single	Yes	RTP 4 years	Yes
Nevada	Single	Yes	RTP 4 years, SRTP 5 years	Yes
Placer	Single	Yes	As needed	Yes (1)
Plumas	Single	Yes	As needed. (Asset management database system-CarteGraph)	No
San Benito	Single	Yes	RTP 4 years, SRTP 5 years	Yes
Santa Cruz	Single	Yes	Every 2 to 10 years	Yes
Sierra	Single	No	RTP 4 years, SRTP, 5 years	No
Siskiyou	Single	No	RTP 4 years	No
Tehama	Single	No	RTP 4 years	Yes
Trinity	Single	No	RTP 4 years, SRTP 5 years	Yes
Tuolumne	Single	No	RTP 4 years	Yes

Note 1: Only portions of County in model area

Source: Regional Transportation Plan (RTP) documents, Regional Transportation Planning Agency (RTPA) and Local Transportation Commission (LTC) officials, county/municipal agency representatives

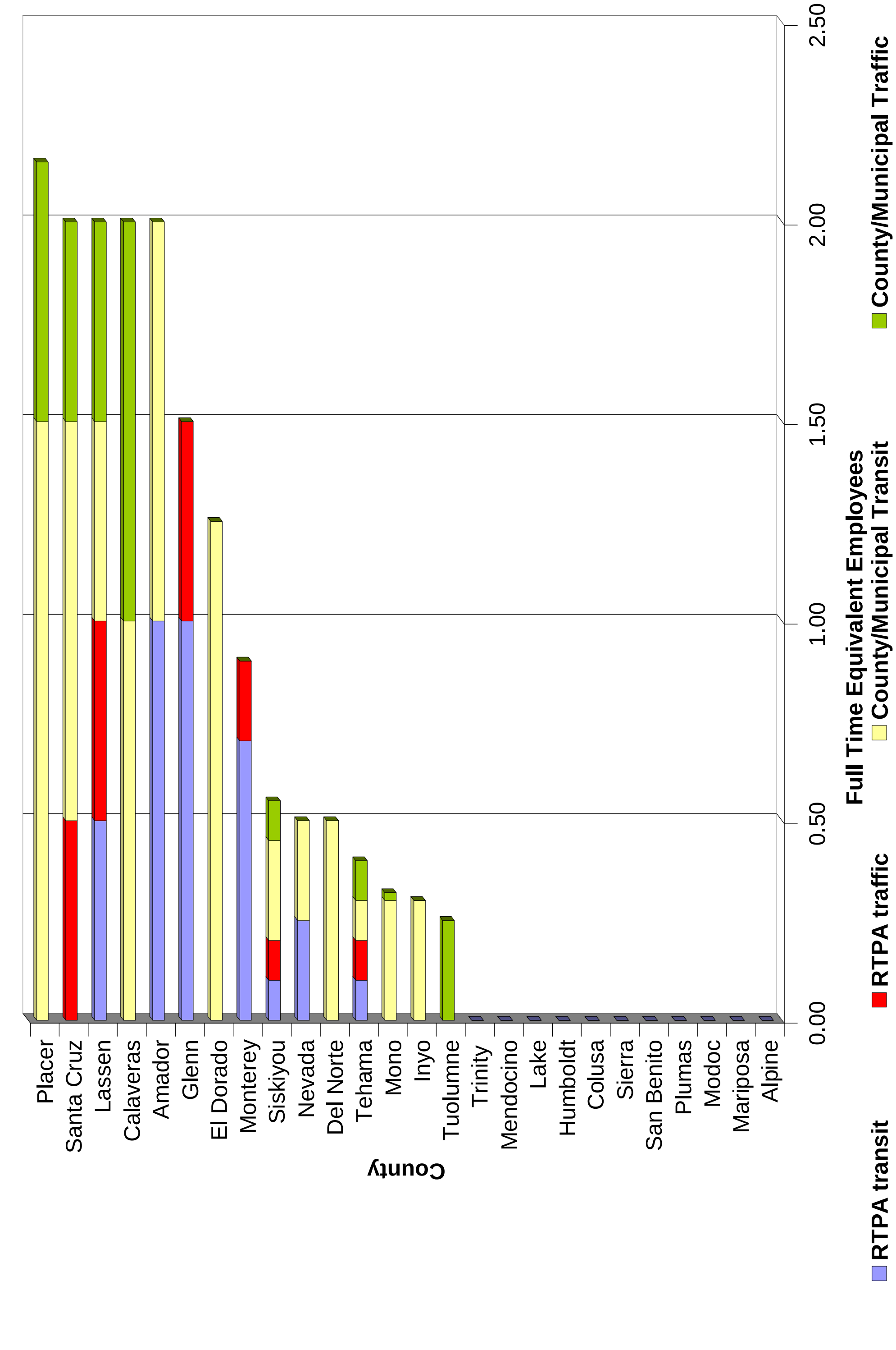
TABLE 6: Full Time Equivalent Employees Available for Existing and Additional Performance Measure Data Collection

	RTPA FTE Available for Data Collection		County/Municipal Jurisdiction FTE Available for Data Collection		
County	Transit	Traffic	Transit	Traffic	*Total FTE*
Alpine	Unavailable	Unavailable	Unavailable	Unavailable	-
Amador	1.00	0.00	1.00	0.00	2.00
Calaveras	0.00	0.00	1.00	1.00	2.00
Colusa	0.00	0.00	0.00	0.00	0.00
Del Norte	0.00	0.00	0.50	0.00	0.50
El Dorado	0.00	0.00	1.25	0.00	1.25
Glenn	1.00	0.50	0.00	0.00	1.50
Humboldt	0.00	0.00	0.00	0.00	0.00
Inyo	Unavailable	Unavailable	0.30	Unavailable	-
Lake	0.00	0.00	0.00	0.00	0.00
Lassen	0.50	0.50	0.50	0.50	2.00
Mariposa	Unavailable	Unavailable	Unavailable	Unavailable	-
Mendocino	0.00	0.00	0.00	0.00	0.00
Modoc	Unavailable	Unavailable	Unavailable	Unavailable	-
Mono	Unavailable	0.00	0.30	0.02	-
Monterey	0.70	0.20	Unavailable	Unavailable	-
Nevada	0.25	0.00	0.25	0.00	0.50
Placer	0.00	0.00	1.50	0.65	2.15
Plumas	0.00	0.02	0.16	0.02	0.20
San Benito	Unavailable	Unavailable	Unavailable	0.25	-
Santa Cruz	0.00	0.50	1.00	0.50	2.00
Sierra	Unavailable	Unavailable	Unavailable	Unavailable	-
Siskiyou	0.10	0.10	0.25	0.10	0.55
Tehama	0.10	0.10	0.10	0.10	0.40
Trinity	0.00	0.00	0.00	0.00	0.00
Tuolumne	0.00	0.00	0.00	0.25	0.25

Source: RTPA and County representatives

Figure 4

Full Time Equivalency (FTE) Available for Performance Measure Data Collection



EXISTING DATA SOURCES USED FOR RURAL PERFORMANCE MONITORING

The following data sources used in performance monitoring were identified by a majority of the counties in either the RTP or through conversations with employees from the county and/or RTPA. It is worth noting that these data sources do not apply across the board to all 26 rural counties, as data collection methods differ from county to county.

- *Traffic Data* – The primary source of traffic data for the majority of rural jurisdictions is the Caltrans annual traffic counts, which can be located at http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm . Directional roadway segment counts are provided for all state routes, Interstate routes, and US highways, including Annual Average Daily Traffic volumes, peak-month Average Daily Traffic volumes, and peak-hour volumes. Counts of truck traffic and interstate ramp volumes are also available through Caltrans. In some counties, Public Works employees also conduct traffic counts, largely on local roadways. A typical rural county maintains counts for roughly 40 to 80 locations. Intersection turning movement counts are typically only conducted as required for a specific project, or as needed for Regional Transportation Plan preparation.

- *Traffic Congestion/Delay Data* – California's rural jurisdictions typically do not collect data regarding traffic congestion or delay, such as travel time surveys. This data is only collected as needed for specific project-related traffic studies.

- *Public Transit Data* - Cities, counties, and transit districts which receive allocations from the Transportation Development Act are required to report transit characteristics to the California State Controller each year. Transit staff from Placer, Humboldt, and Inyo Counties were contacted to determine "the typical" data collection process. In general, ridership data is recorded by the driver using a manual counter as passengers board the bus or from a tally of dial-a-ride run sheets. Fixed route drivers typically record passenger boardings for a segment or route as a whole, rather than for each stop. Boarding and alighting surveys which record ridership data by stop are sometimes performed by outside consultants for SRTP or TDP updates. Each day the ridership data along with vehicle service miles and hours driven is passed along from the driver to transit agency staff that input these numbers into spreadsheets. Monthly and annual reports are compiled by the transit director. Fare revenue is counted on a daily basis by transit staff and data is input to the spreadsheets.

  As participation in the National Transit Database (NTD) program is only required for recipients of Federal Transit Administration Section 5307 funds, and these funds are only available for operators in urbanized areas, the large majority of transit operators in California's rural areas do not collect the extensive data required under this program. In 2003, only transit operators in Monterey, Santa Cruz, and Placer Counties participated in the NTD program among California's rural counties. However, the recent passage of SAFETEA-LU now requires NTD reporting for Section 5311 recipients (the key federal transit funding program for rural systems), which will expand NTD reporting requirements to the majority of rural California counties.

- *Aviation* – Counties receive operations (take-off/ landing) reports from both the commercial airline operators and fixed base operators (FBO's)   Private aircraft are required to pay landing and overnight fees through one of the FBO's. Smaller airports such as Alpine and Calaveras County do not keep track of aircraft movements. Often times noise monitors are installed at airport runways to track take offs and landings.

- *Traffic Safety* – The primary source of traffic safety data is the Statewide Integrated Traffic Records System (SWITRS) maintained by the California Highway Patrol. This database includes relatively detailed information on all reported fatal and injury collisions occurring on California's state highways and all other roadways (excluding private property), and is based on motor vehicle traffic collision reports received from local police and sheriff jurisdictions and from California Highway Patrol field offices. While data on Property Damage Only (PDO) collisions are also included, these are not exact statistics, as some local jurisdictions do not report data on all or some PDO accidents. Each year an Annual Report of Fatal and Injury Motor Vehicle Traffic Collisions is prepared from this database, providing summaries by jurisdiction, type of accident, contributing factors, and other characteristics. In addition, some (though not all) local rural jurisdictions individually track accidents, particularly fatal and injury accidents.

- *Pedestrian / Bicycle Travel* – Rural jurisdictions typically do not conduct counts of pedestrian or bicycle activity, except as needed for specific projects.

SUMMARY AND FINDINGS

Rural county representatives in California generally understand the need for performance measurement and standard statewide performance outcome categories. Though rural regions strive to measure system performance in accordance with statewide “standard” outcomes, they do not necessarily have the means or the resources to monitor system performance on a frequent or regular basis. In addition, the statewide “standard” performance measures are not applicable in all rural areas, which indicates that alternative rural performance measures are necessary. It is worth noting that an important goal of this study is to develop performance measures that are applicable in all rural areas, not only the 26 counties identified previously.

Typical rural transportation goals include the ability to make use of limited funding, to provide a safe transportation system, and to increase mobility and accessibility throughout the region using roadways as well as alternative modes of transportation. These goals do not necessarily correlate with the existing “standard” performance measures; however they can be measured using standard “rural” measures that will be defined in the latter portion of this study. It can be determined from the FTE data that there is very little funding/staff available for data collection. Through interviews with local and regional agency representatives along with the existing county documentation, it can be concluded that general funding and system preservation should be at the forefront of concern when determining standard measures for rural systems.

Subsequent portions of this study will discuss performance categories and measurements appropriate for rural transportation systems.

Existing Rural Performance Measures in Western States

California is not unique with respect to the issue of rural transportation performance measurement. Documents from several western states were surveyed to identify performance measures which may apply in California. The intent was to identify trends, focus areas, or frequently used measures in other similar states, which might then point to additional resources or “lessons learned” for those measures which may be useful for data collection and analysis in California.. Conversely, if there are particular performance measures currently (or planned to be) collected in California which are not common elsewhere, it may be informative for other states’ stakeholders to know as the rural performance measures are developed.

It is recognized that the California definition of “rural” follows county boundaries, and the performance measures documented above follow these boundaries. In other states, performance measures may be presented at a statewide and more general level (or may reflect those measures for which statewide consensus was achieved, though regional and local differences and needs were incorporated to a lesser extent) and thusly not all states were investigated to an analogous county level. Thus, the literature review for other states is not intended to provide direct county-level comparisons for performance measurement in differing areas, but again, to highlight general trends and frequently used measures or to highlight practices particular to California which are not currently implemented elsewhere in western states.

The review was limited to western states to provide a sample of states which might share similar needs and characteristics in their rural areas as California in its rural areas. The states included are:

- Arizona
- Idaho
- Montana
- Nevada
- Oregon
- Utah
- Washington
- Wyoming

Table 7 below summarizes the western state performance measures.

Nevada: Performance measures studied in Nevada are generally in line with those stressed by Caltrans. These include a concentration in environmental (specifically air) quality, pavement condition, traffic operations, vehicle miles of travel, and accidents. Specific performance measures to address these issues include miles of congested roadway, percentage of roadways operating at 80 percent or greater of specific capacity, fatal traffic crashes and fatalities, and comparisons to statewide standards for carbon monoxide levels.

One facet of the Nevada strategy is to implement a transportation plan to increase tourism and diversification by way of connecting urban areas to the key destinations within the state. These connections would be through rural areas; hence one associated performance measure for this initiative is tracking passenger enplanements from the four main airports in the state.

Arizona: Arizona statewide performance measures are very similar to the nine fundamental measures utilized by Caltrans, including mobility and accessibility, air and environmental quality, customer satisfaction, pavement condition, vehicle hours of delay, and accident data. Though the performance measures are for the state as a whole, the availability of efficient connections between cities and towns is highlighted, particularly those in the more rural regions of Arizona. This is measured by the passing ability on two-lane state highways, and the travel time of routes in high-priority corridors.

Arizona also invokes a performance measure studying the anticipated change in injuries and fatalities from accidents to assess safety. The measure analyzes the actual number of fatalities and injuries reduced, independent of the number of accidents reduced.

Oregon: Oregon Department of Transportation (ODOT) identifies a total of 22 key performance measures to analyze their state transportation systems, and reports these to the state Legislature as a required portion of the annual budget request. In order to accurately assess the multimodal transportation systems maintained by the state, the measures span bicycle and pedestrian needs, as well as rail, commercial, and non-commercial transportation. The performance measures are categorized by safety, efficient movement of people and goods, increasing livability and economic prosperity, and providing excellent customer service. ODOT focuses on three of the nine outcome areas identified by Caltrans, specifically looking at public safety and accident data, pavement condition (system preservation), and vehicle hours of travel and delay.

One performance measure unique to this state is the examination of construction job impact as a measure of providing a transportation system that supports livability and prosperity in the state, primarily in promoting rural jobs and net job growth. To quantify this, the number of jobs sustained as a direct result of annual construction project expenditures is tracked.

Wyoming: Wyoming focuses on assessing the performance of its' many transit agencies by providing a computerized method for agencies to complete monthly, quarterly, and annual reports. By doing such frequent measurements, both the transit agency as well as the State Transit Manager, to whom the information is presented monthly, have an accurate and timely view of how the states' transit agencies are performing. It additionally ensures uniformity in assessment as well as reporting. Performance measures studied for Wyoming transit, regardless of rural or urban usage, include vehicle service miles, passengers per vehicle-hour and vehicle-mile, cost per vehicle-hour and vehicle-mile, subsidy per passenger trip, and percent of population served.

Idaho: The Idaho Transportation Department (ITD) utilizes Targeted Performance Standards identified in their strategic plan to annually establish a current measure for each standard. These measures are determined by data collection and analysis to identify the time period over which each is assessed, and serve as an indicator of how well the department is accomplishing the Targeted Performance Standards.

Documents from Idaho emphasize complementary areas in terms of performance measures. The Strategic Plan focuses on facility improvement (referred to as system preservation in this report), and safety across all modes. It also highlights efficiency in the business practice sense: for example, efficiency in terms of funding, bidding, licensing, and coordinating projects. The three focus areas – system preservation, safety, and (business) efficiency – are complemented by those in Idaho's Transportation Vision which emphasizes mobility/reliability/accessibility (several related aspects such as accessibility, convenience, choices, flexibility, predictability, and connectivity), safety, and affordability (defined as equity of access for all income categories).

Idaho breaks out rural transportation system measures such as rural lane miles congested, further explaining that, "*Passing lane deficiencies are the primary cause of rural congestion. These deficiencies are determined by a roadway's traffic volume, percent of commercial vehicle traffic and terrain. Drivers who experience a lack of passing opportunity may be tempted to pass in dangerous locations. Therefore, all passing lane additions also improve highway safety*."[2] Further related to safety, in addition to accident rates, Idaho also measures fatality rates and seat belt usage rates.

Montana: Given that nearly three quarters of all Montana miles traveled are outside of urban areas, Montana focuses strongly on rural performance measures to assess state highway function. Montana distributes approximately 70 percent of its funding through the Performance Programming Process, "P3." The objectives, performance measures, and performance targets four key outcome areas – pavement, bridges, safety, and congestion – that form the foundation for ongoing performance measurement development. Each year the performance projections are updated.   An interesting performance measure for safety which differs from some other states is the "number of correctable crash sites funded for improvement." Additionally, Montana includes a calculation of the 20 year forecast for daily VMT as a measure of the adequacy of its' roadways performing to standards in the years to come, and as a measure of their current functions throughout the state.

Both TranPlan21 (Montana's long-range transportation policy plan) and the Strategic Business Plan emphasize the performance measures of mobility/reliability/accessibility, safety, and return on investment. System preservation is highly emphasized throughout TranPlan21.

Washington: In Washington, performance measures are assessed on a quarterly basis and presented to the Governor and the Washington State Transportation Commission. Within the report is information tracking performance and accountability measures throughout the state, as well as information on funding and current state projects. The performance measures quantified in this report are generally in line with those found in California and the other western states surveyed, with the exception of efficiency goals for both administration and transit costs. Washington also puts heavy emphasis on fatality data within their focus on safety. A final unique aspect of the benchmarks put forward by the state is a goal of non-auto commuting, which is broken out as a separate statewide goal.

Utah: Utah's performance measurement program studies the same basic measures as other states, including pavement and bridge conditions, pavement maintenance, reducing fatalities (both driver and pedestrian), and mobility. However, Utah does

[2] Idaho Department of Transportation 2006 Strategic Plan

introduce some interesting performance measures that could be of use in rural areas of California.

Utah focuses on snow and ice control with a goal of ensuring safety by removing snow and ice in a timely manner. This measure is quantified by a computerized maintenance system called MMQA+. The maintenance stations across the state compile data individually and enter it into the program, which then assigns a performance rating, similar to pavement condition software. This program is also utilized in the statewide measurement of signing and striping.

TABLE 7: *Existing Adopted Performance Outcomes in Other Western States*

	State							
Performance Measures (PMs)	Arizona	Idaho	Montana	Nevada	Oregon	Washington	Wyoming	Utah
Mobility/Reliability/Accessibility(1)	X	X	X		X	X	X	X
Productivity		X				X	X	
System Preservation	X	X	X	X	X			X
Safety	X	X	X	X	X	X		X
Environmental Quality	X	X		X		X		
Coordinated Transportation and Land Use		X				X		
Economic Development		X						
Equity		X				X		
Return on Investment (cost effectiveness)		X	X					
Customer Satisfaction	X							
Transit Cost Effectiveness						X	X	
Provide Alternative Modes of Transportation						X	X	

Note 1: Includes Roadways, Public Transit, Aviation, Bike/Ped, Parking, Public Facilities.

Source: Regional Transportation Plan (RTP) documents, Regional Transportation Planning Agency (RTPA) and Local Transportation Commission (LTC) officials, county/municipal agency representatives.

Literature Review

Other sources were consulted to determine the state of the practice for performance measurement in rural areas. Existing literature was not extensive in this regard.

A 2003 report by the United States Department of Transportation (USDOT) entitled "Performance Measures for Small Communities" acknowledges that most government funded research and writings have focused on larger MPOs and state DOTs. Seeing that these agencies are able to complete more labor intensive studies than smaller agencies, USDOT created a study focused on performance measures for smaller communities.

These areas were defined to be any that met one of two criteria, the first being an MPO with a population less than 300,000, and the second being a city or town with 50,000 or less people that operates apart from a regional program. The study centered around performance measures for roadway operations, namely "goal areas" of accessibility, mobility, operational efficiency, and quality of life.

Within each goal area, a number of different measures were identified. For example, within Accessibility, customer satisfaction and trip length were named as "measure subcategories", as were congestion, customer satisfaction, delay, density, LOS, and speed for mobility. For each measure, an appendix entry was made to detail the collection of such data. The information given addressed such issues as:

- Location of use (where the measure is applicable, being either at all levels, just at the national level, or only within an MPO)
- General data requirements
- Scale of application (level of analysis necessary, be it segment, corridor, or system level)
- Typical range of values

Following interviews of small community agencies, several observations were drawn regarding the roles of planning and traffic operations in these areas. One conclusion was that planning agencies are typically at the helm of performance measurement for systems operations, rather than engineering departments, in part due to TEA-21's influence in this area. It was also concluded that though many performance measures are available for smaller communities, very few are actually put into action to analyze performance. Additionally, the study found that evidence points to very few communities using travel time reliability measures, given the inherently vague definition of variability that is acceptable when using such measures. One final conclusion drawn shows that a majority of communities are interested in using measures understandable even by those not in the industry so that they can relate to the public more easily, and likely as well as to their elected officials.

Travel times collected by cars equipped with GPS were the basis for many of the suggested performance measures, including these studied by Lexington, Kentucky: travel rate index, average speed, and average delay per signalized intersection. This method of collection is useful for smaller agencies, and given that results can be used to determine a number of different performance measures for operations, it is worthy to keep in mind for rural California. Another data collection idea, this one utilized in Gainesville, Florida, involves partnering with other agencies for data collection sharing, which also helps to eliminate redundancy in collection.

A report published by the Transit Cooperative Research Program (TCRP) entitled "Users' Manual for Assessing Service-Delivery Systems for Rural Passenger Transportation" gives guidelines on planning and operating passenger transportation services in rural areas, including the restructuring and improvement of existing rural transportation. Public Transportation performance measures are discussed, and the delineation between rural and non-rural areas is made later in the report when actual data is provided and thresholds established for "good" performance using rural transportation systems as an example. However, when discussing the performance measures themselves, the report does not distinguish the measures themselves from those used in non-rural (urban) areas. The performance measures were categorized into four types:

§ Cost efficiency (resources expended per unit of public transportation service), for example, operating cost per vehicle service hour, and operating cost per vehicle service mile
§ Service effectiveness (amount of service consumed (or revenue received) at an established price relative to the service supply, for example, passengers per vehicle service hour and passengers per vehicle service mile
§ Cost effectiveness (resources expended per unit of consumption), for example, passenger revenue as a percent of total operating cost, passenger revenue as a percent of total operating cost, and total operating cost per passenger
§ Service quality (does service delivery meet or exceed customer expectations), for example, accessibility, availability, reliability, safety, and comfort.

The Western states, including California, examine many of the same outcome areas as California, including those relating to mobility, safety, system preservation, and environmental quality. However, the practices of other states provide some key performance measures that could be useful in California's rural areas to help agencies reach an accurate assessment of each outcome area, such as snow and ice removal in Utah, and focusing on the connections between urban and rural areas such as in Nevada. These outcome areas and performance measures are also echoed by national transportation agencies, and are in use throughout the United States. More research including the outcome of this project will inform performance measurement specifically in rural areas.

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Chapter 3

Classification of Rural Transportation Systems

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The purpose of classifying Rural Transportation Systems (RTS) is to differentiate expected performance in rural areas from those in both urban or suburban areas and from one another. RTS classification is dependent upon a collection of criteria that in one way or another effects performance. There is a potential range of "rural" classification based on existing county characteristics that will be discussed in this section of the report. The defining characteristics are appropriate indicators of widespread rural areas, rural areas in moderate transition, and rapidly growing rural areas. The classification issue is not readily apparent, however, due to the fact that many counties have urban and rural land use clusters. Demographic/geographic data and the availability of resources will be the criteria used to clarify this categorization. Population, population growth, and traffic volumes were specifically used to group rural counties by category.

Discussion of Rural Counties and Existing Transportation Systems

One goal of Caltrans is to create an efficient statewide system that relies on multi-modal transportation in order to safely move people and goods throughout the state. Both rural counties and urban areas in California report similar transportation system issues, such as road maintenance and safety. The difference lies in the relative importance of these issues in urban versus rural areas.

Rural areas (as defined in this study), include 8 percent of the population, yet make up fully 94 percent of California's land area. The challenge is to maintain roads and provide transit service to a small population over a large area. Tuolumne County, for instance, has 604 miles of road network to maintain.

While the existing state wide performance measures will assess a portion of rural system performance, more rural-specific measurements are needed in order to assist with adequate fund allocation for pavement conditions and safety. While these issues are similar statewide, the methods used to measure varying conditions in rural areas need to be focused on the resources available to quantify performance in the most efficient manner, therefore allowing the RTPAs to obtain relevant data. Rural-specific data collection methods will create a consistent application of laws and regulations, and ensure accountability in all areas of the state.

As mentioned, rural areas emphasize the preservation of county roads. Not only are rural transportation systems critical to residents and visitors, but the roadways must be reliable in order for the state to thrive economically. Maintaining interregional roadways for trucking access is also vital for California's economy. Agriculture produces approximately $25 billion of state revenue per year. In addition to the high revenue generated by the agriculture industry, tourism is growing substantially in rural counties. The maintenance of roadways is as essential for the hospitality/tourism industry as it is for the movement of agricultural goods. Harsh weather conditions generate deterioration on large road networks that must be maintained by a smaller population. The cost of snow removal and maintenance alone can consume an entire rural transportation budget.

In addition, rural counties face the challenge of measuring performance in various areas of concern that contribute to the economic health of both California and the nation, despite very limited financial resources. Rural counties are responsible for providing transit and paratransit services to people who rely on these services as their only means of transportation. Due to limited resources and demand, local transportation is often provided at very low frequencies on a limited route network. To address the realities of public transit services in rural areas while still meeting the very real needs of the residents, appropriate measures specifically developed for rural areas are necessary.

It is important to note that while the 26 counties defined by Caltrans as rural counties have been selected for this study, the applications and standards defined in the study are not limited to these counties. In other words, *any* rural area within an urbanized county or district should be able to apply the guidelines set forth in this study.

Rural County Characteristics

This section contains a description of key factors used to characterize the various California rural counties and their existing transportation systems.
Economic/geographic characteristics considered in this study consist of the following:

- Population
- Population density
- Population trends (both historic and forecast)
- Proportion of workers employed in the hospitality/tourism industry
- Annual total taxable sales
- Availability of hospitals and major retail facilities

Transportation characteristics consist of the following:

- Roadway inventory
- Roadway conditions
- Public transit
- Aviation
- Traffic volumes

The factors mentioned above were decided upon by the study team. They demonstrate the significance of a reliable transportation system to the residents in rural counties and provide insight into the current level of transportation data collected by each county.

POPULATION, POPULATION DENSITY AND POPULATION TRENDS

Population and population-related statistics such as population density and population trends (growth or decreases) directly affect the transportation system and its performance. These population statistics give indicators of the transportation system capacity needed by the area's residents, and businesses and services which those residents support. In rural areas, relatively low population densities spread out over large geographic areas generate increased auto travel and possibly longer travel times, and highlight the need for increased reliability in public transit services. Low population densities also call attention to the need for suitable accessibility for all residents to reach employment and commercial centers, and to access routes for regional and statewide travel. Population growth would foreshadow the need to improve system capacity in order to handle additional throughput of vehicles and goods accompanying the increased population. A summary of various population statistics is presented in Table 1. Demographic/ geographic characteristics such as population and employment data were obtained from the 2000 U.S. Census. While no demographic data collection effort can be fully error-free, the US Census is the single best and consistent source for basic demographic data.

As indicated in Table 1 and Figure 1, Monterey County had the largest population of 401,762 people in the year 2000. Other counties with relatively high populations are Santa Cruz, Placer, and El Dorado, all of which had a population of more than 150,000 persons in 2000. At the other extreme, Alpine County had a population of 1,208, while a total of eight counties (Alpine, Colusa, Inyo, Mariposa, Modoc, Mono, Sierra and Trinity) all had less than 20,000 people each.

Population density (persons per square mile) ranged from a high of 573 in Santa Cruz County down to 2 in Modoc and Alpine Counties, as shown in Figure 2. A total of nine counties had population densities below ten persons per square mile (Alpine, Inyo, Lassen, Modoc, Mono, Plumas, Sierra, Siskiyou, and Trinity).

Population change between 1990 and 2000 also show a dramatic range of values. As depicted in Figure 3, the highest growth rates occurred in San Benito (45 percent) and Placer (44 percent) Counties. At the other extreme, Trinity, Inyo, and Modoc Counties were all reported by the US Census to have lost population in the 1990's. The majority of counties (17 of the 26) had more moderate positive growth of 5 to 20 percent between 1990 and 2000.

TABLE 1: Rural County Population & Population Density

County	Total Population 1990	Total Population 2000	1990 - 2000 Change in Population #	1990 - 2000 Change in Population %	Size (sq. miles)	2000 Population density (persons / sq. mile)
Alpine	1,113	1,208	95	8.54%	734	2
Amador	30,039	35,100	5,061	16.85%	593	59
Calaveras	31,998	40,554	8,556	26.74%	1,020	40
Colusa	16,275	18,804	2,529	15.54%	1,151	16
Del Norte	23,460	27,507	4,047	17.25%	1,008	27
El Dorado	125,995	156,299	30,304	24.05%	1,712	91
Glenn	24,798	26,453	1,655	6.67%	1,315	20
Humboldt	119,118	126,518	7,400	6.21%	3,573	35
Inyo	18,281	17,945	-336	-1.84%	10,192	2
Lake	50,631	58,309	7,678	15.16%	1,259	46
Lassen	27,598	33,828	6,230	22.57%	4,558	7
Mariposa	14,302	17,130	2,828	19.77%	1,451	12
Mendocino	80,345	86,265	5,920	7.37%	3,509	25
Modoc	9,678	9,449	-229	-2.37%	3,944	2
Mono	9,956	12,853	2,897	29.10%	3,045	4
Monterey	355,660	401,762	46,102	12.96%	3,322	121
Nevada	78,510	92,033	13,523	17.22%	958	96
Placer	172,796	248,399	75,603	43.75%	1,404	177
Plumas	19,739	20,824	1,085	5.50%	2,554	8
San Benito	36,697	53,234	16,537	45.06%	1,389	38
Santa Cruz	229,734	255,602	25,868	11.26%	446	573
Sierra	3,318	3,555	237	7.14%	953	4
Siskiyou	43,531	44,301	770	1.77%	6,287	7
Tehama	49,625	56,039	6,414	12.92%	2,951	19
Trinity	13,063	13,022	-41	-0.31%	3,179	4
Tuolumne	48,456	54,501	6,045	12.48%	2,236	24
Total	1,634,716	1,911,494	276,778	16.93%	64,742	30

Source: US Census 2000, California, Summary File 1 (SF 1) and Summary File 3 (SF 3)

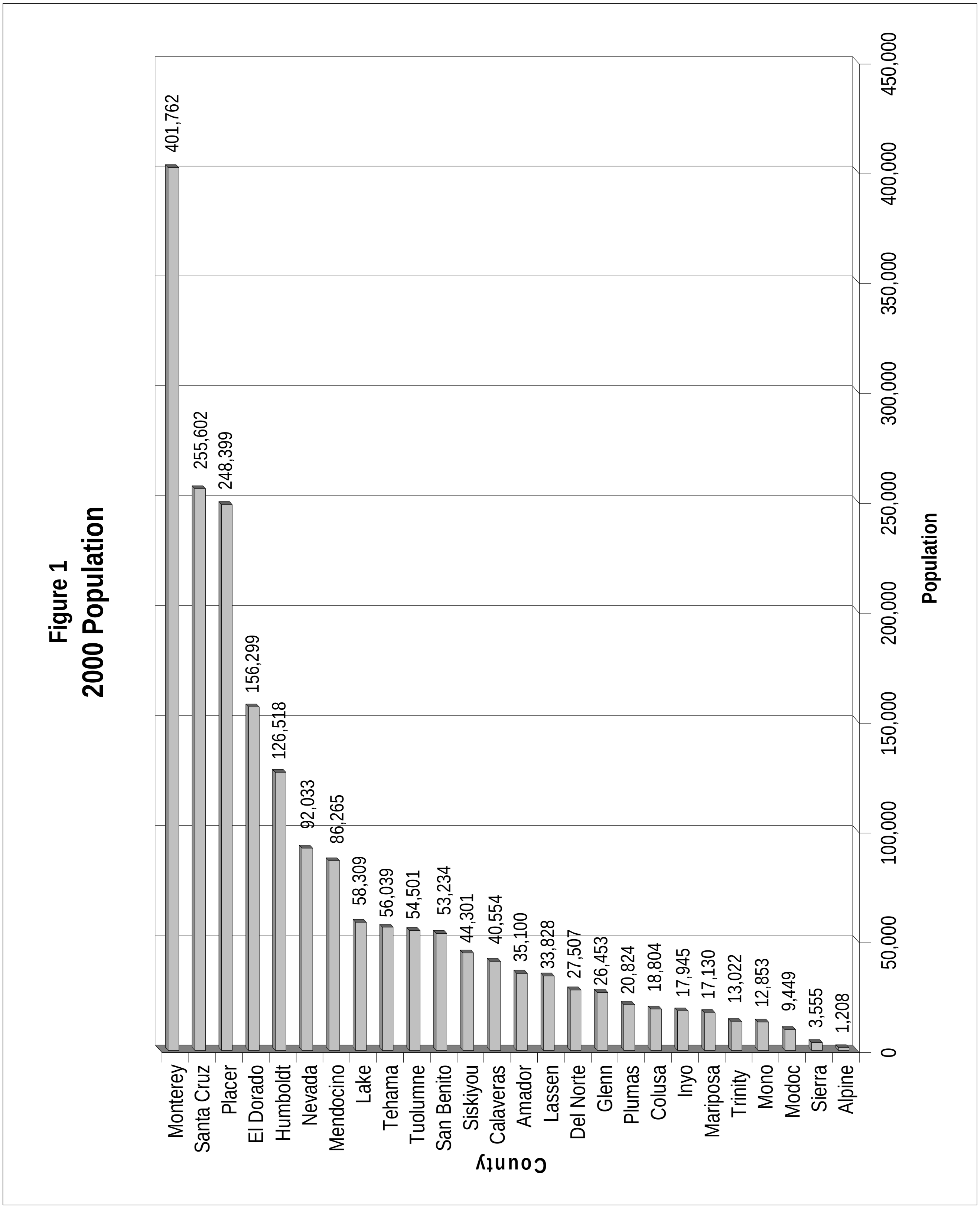
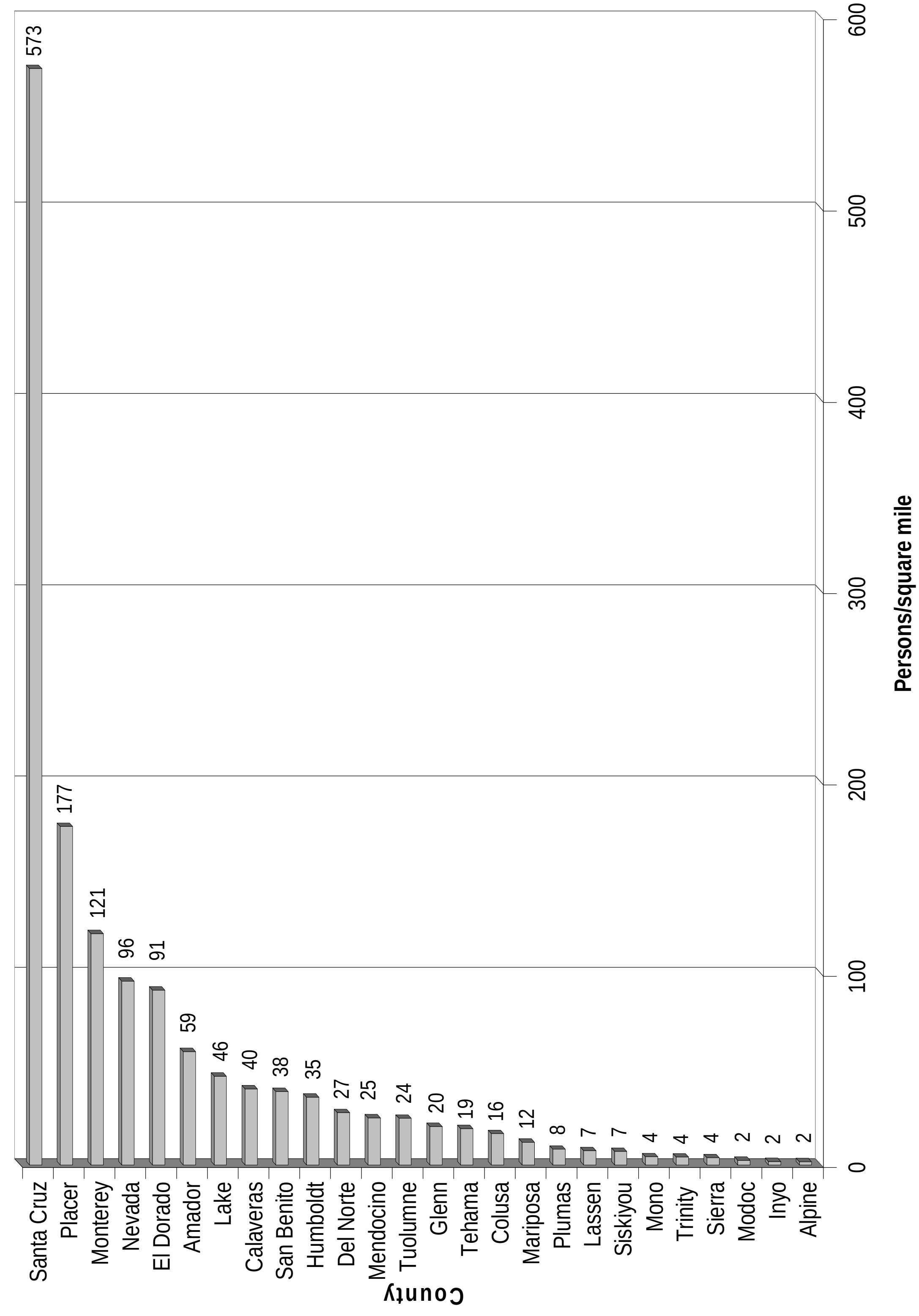


Figure 1
2000 Population

Figure 2
Population Density (persons/square mile)



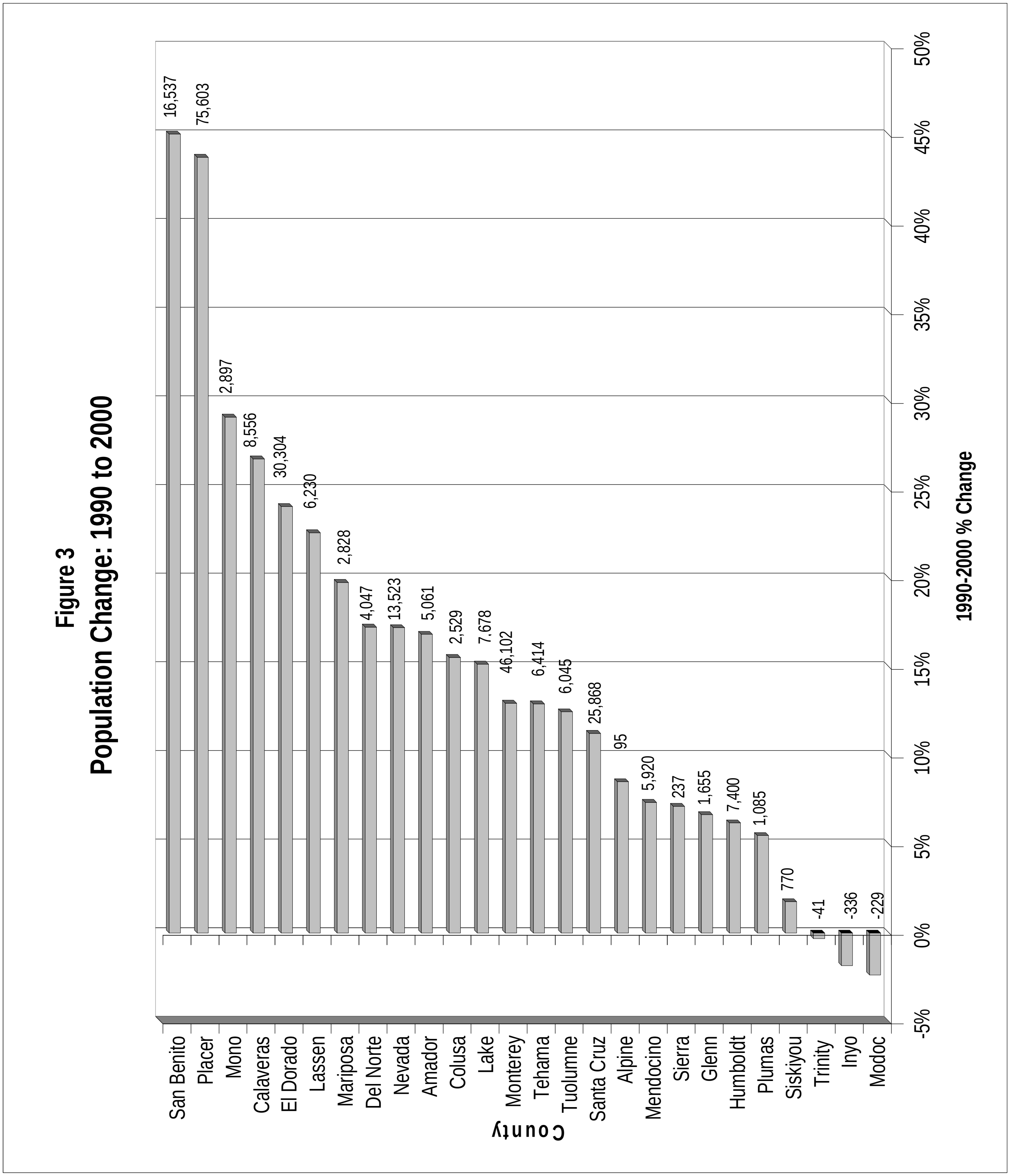


Figure 3

Population Change: 1990 to 2000

ROADWAY INVENTORY

Two important factors in rural county classification are mileage of maintained roadway and roadway elevation. The size of the roadway system (here measured in centerline-miles) indicates the capability of the transportation system to handle travel needs for the given population. A relatively small roadway system (measured in a low number of centerline-miles) implies that residents may have difficulty accessing different destinations, which ultimately affects productivity if more time is spent traveling. Also important are the portions of the roadway inventory under different jurisdictions (state or local), since the size of the system impacts the effectiveness of maintenance dollars allocated by those respective jurisdictions. A summary of state, county, and city road mileage data for each county is presented in Table 2 and illustrated Figure 4. Siskiyou and Humboldt Counties have the largest total road systems, with 3,426 and 2,455 miles of roadway, respectively. The largest local (city and county) roadway systems are in Monterey and Placer Counties, with 1,934 and 1,668 miles, respectively. The largest state highway network is in Inyo County (424 miles), while on the other extreme Alpine County has only 83 miles of state highway.

Overall, California's rural counties are served by 38,423 centerline-miles of public roadways. Of this total, 61 percent are local roadways, 13 percent are state (including US) highways, and the remaining 26 percent are largely Forest Service and Bureau of Land Management roadways. Considered another way, there are more than four times as many local roadway miles in California's rural counties as there are state and US highway miles.

Roads above the "snow line" (generally around 3,000 feet) require higher levels of maintenance in terms of snow removal and road disintegration. Counties with roads above 3000 feet, therefore, are likely to spend more money on weather-related maintenance. Table 2 and Figure 5 present the state highway centerline mileage for roadways over 3,000 feet in elevation. Roadway elevations were estimated using GIS data from ESRI which can be found at http://arcdata.esri.com/data/tiger2000/tiger_statelayer.cfm?sfips=06 . Figure 6 illustrates the complete network of roadways in rural counties above 3,000 feet. As shown, the greatest amount of high-elevation mileage is in Inyo County, with 354 miles, while several counties are wholly below the snow line. All of the state highways in Alpine, Modoc, Mono and Lassen Counties are in snow country.

TABLE 2: Mileage of Maintained Public Roads by Jurisdiction

County	Total Centerline Mileage						State Hwy Mileage
	City Roads	County Roads	Subtotal: Local Roads	State Highway	Other	Total	Over 3,000 Feet Elevation
Alpine	0	133	133	83	70	286	83
Amador	69	412	481	127	62	670	50
Calaveras	29	689	718	149	184	1052	35
Colusa	43	717	759	115	58	932	0
Del Norte	22	304	325	92	415	833	0
El Dorado	170	1064	1234	182	741	2157	96
Glenn	69	861	930	110	79	1120	29
Humboldt	276	1205	1481	337	637	2455	0
Inyo	15	1133	1148	424	508	2081	354
Lake	182	613	795	136	140	1071	1
Lassen	47	905	952	303	390	1646	303
Mariposa	0	560	560	117	199	876	112
Mendocino	104	1019	1123	381	356	1860	0
Modoc	36	987	1023	178	497	1698	178
Mono	44	685	729	315	380	1424	315
Monterey	692	1242	1934	289	172	2395	0
Nevada	208	565	772	131	219	1123	78
Placer	625	1043	1668	156	325	2150	74
Plumas	22	674	696	182	956	1835	154
San Benito	77	385	462	90	314	866	0
Santa Cruz	284	599	884	124	124	1132	0
Sierra	7	390	397	98	299	794	84
Siskiyou	162	1362	1524	349	1553	3426	160
Tehama	99	1091	1190	206	288	1685	73
Trinity	0	700	700	201	826	1726	46
Tuolumne	30	604	634	152	347	1133	104
Total	3313	19943	23256	5027	10140	38423	2327

Source: Caltrans Highway Performance Monitoring System (HPMS), 2003 California Public Road Data, United State Geological Survey (USGS)

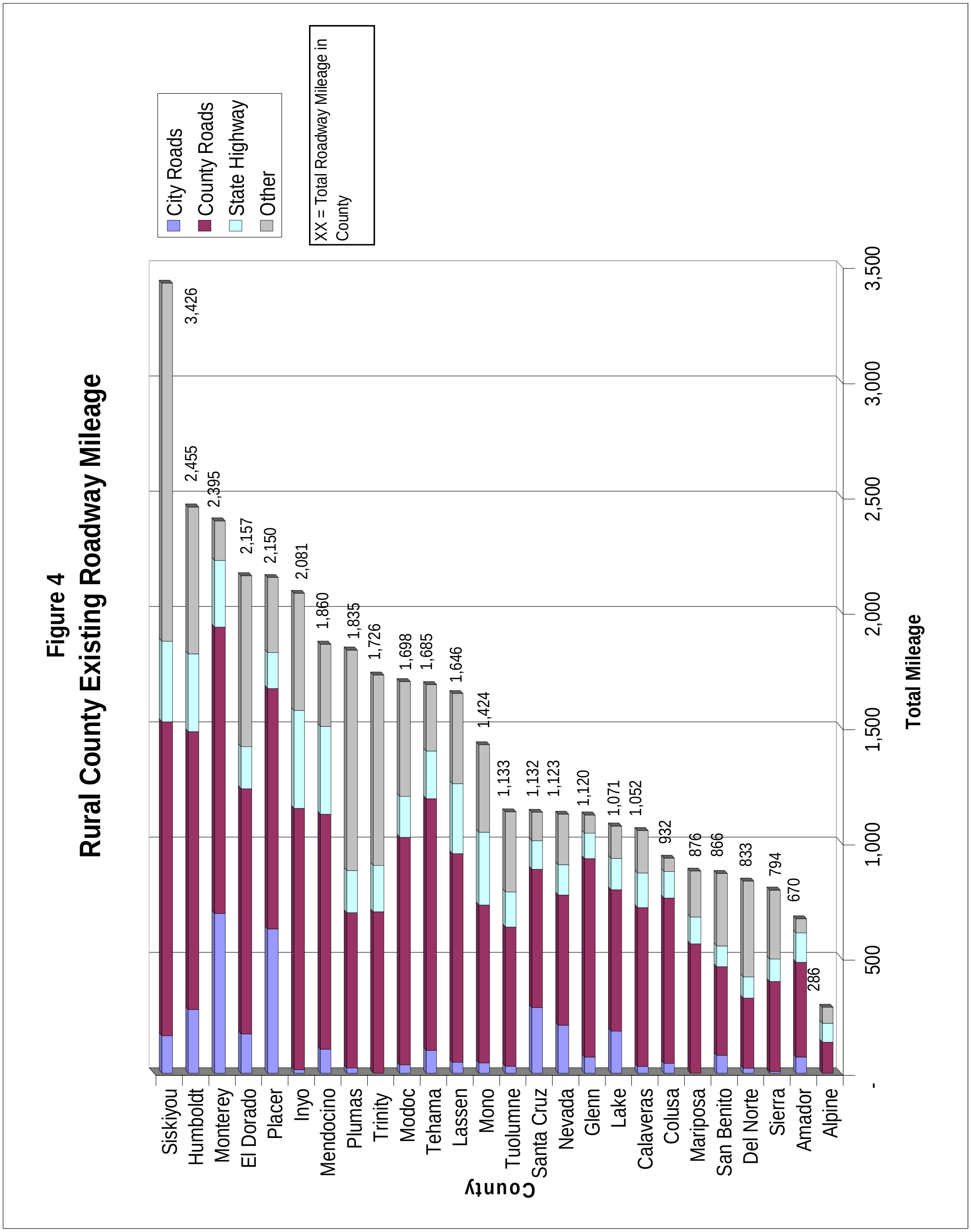


Figure 4
Rural County Existing Roadway Mileage

Figure 5
Total State Hwy Mileage Over 3,000 Feet Elevation

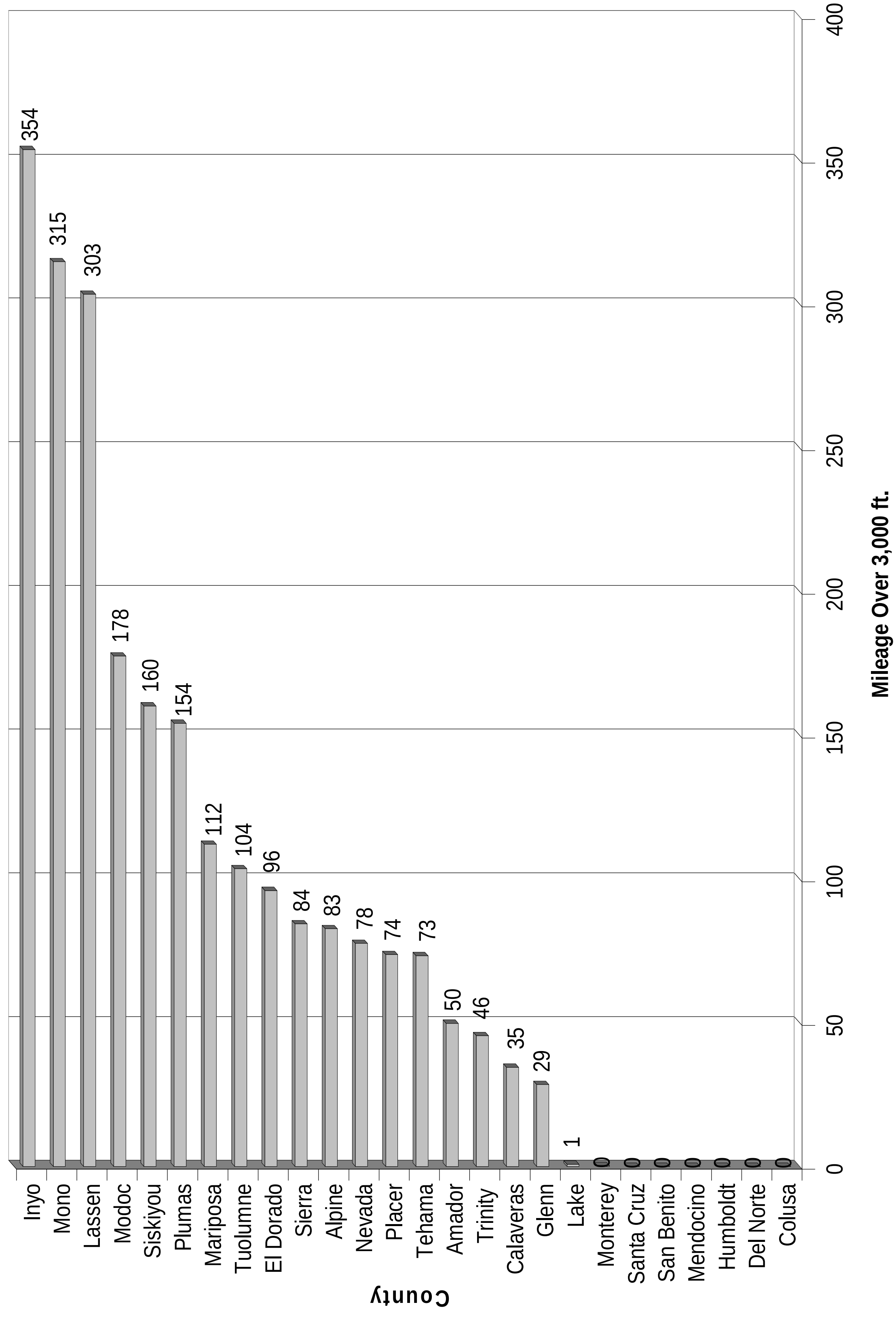
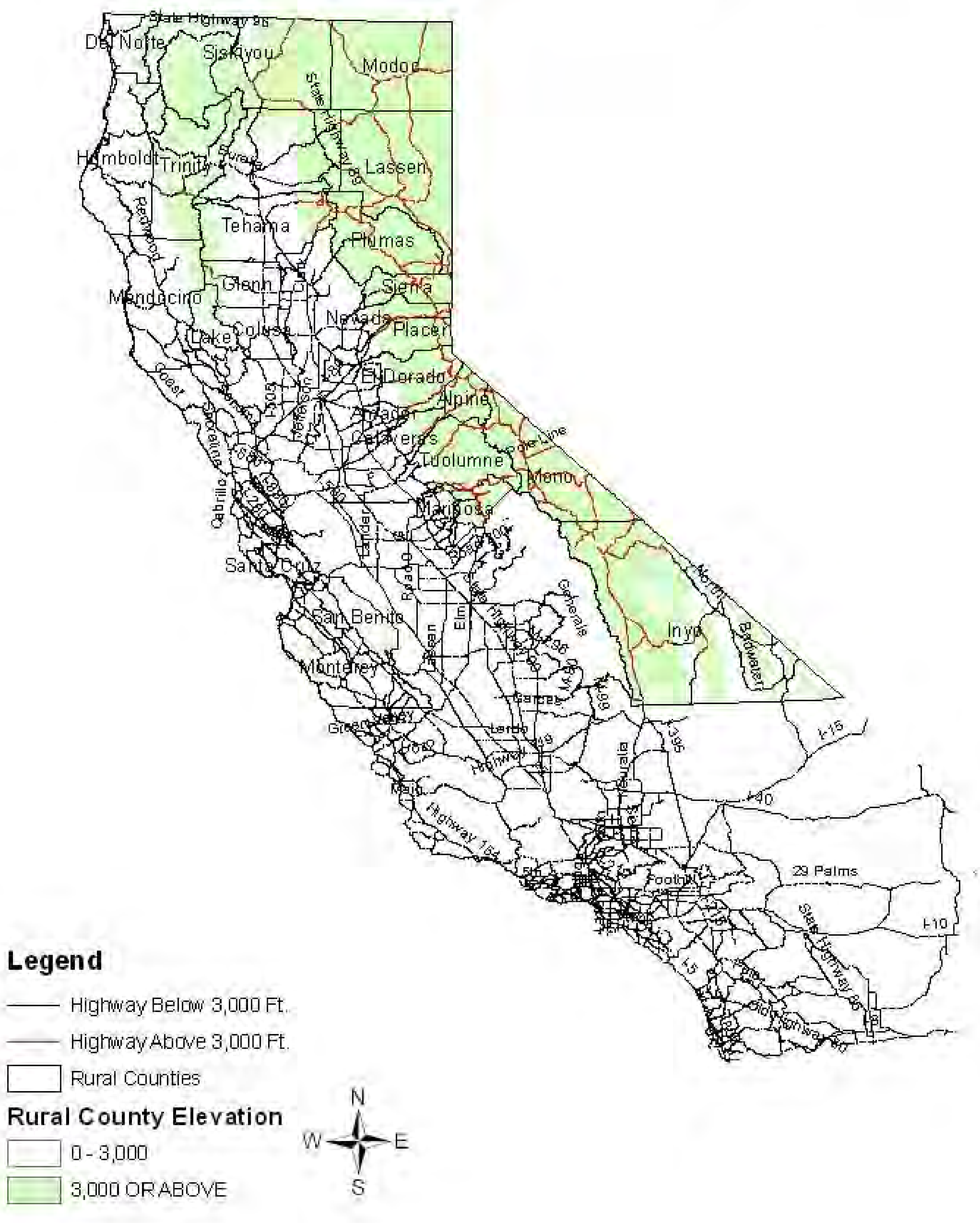


Figure 6
U.S. and State Highways
Located Above 3,000 Ft .Elevation in Rural Counties



PUBLIC TRANSIT CHARACTERISTICS

Rural areas are challenged with providing transit service across long distances with relatively low population. Table 3 summarizes the characteristics of the existing local public transit services. This data was drawn from the California Department of Finance's Annual State Controllers Report, as well as the individual Short Range Transit Plans for each county. As shown, the scope of the transit programs ranges dramatically, from a two-vehicle program in Tehama and Sierra counties up to 238 vehicles in Santa Cruz County.

Table 4 describes general transit service availability. As shown, all rural counties have some level of general public transit service. Many of the less populated counties do not have separate elderly/disabled transit services, but rather operate forms of public transit (such as route deviation) that accommodate elderly and disabled passengers along with the general public. Service frequencies range from every five minutes all the way to one or two runs per week.

Table 4 also summarizes the availability of intercity rail or bus service. As shown, seven counties (Alpine, Colusa, Lassen, Plumas, Modoc, Sierra and Trinity) have no intercity transit service available within the county, requiring residents to travel outside of the county to access the country's intercity ground transportation network. It should be noted that several of these counties have initiated local transit service to provide at least a minimum level of connections to intercity services for residents.

AVIATION

The existence of rural airports allows aviation to contribute to the local economies of rural areas and small urban communities. Use of aviation for movement of people and goods both allows higher throughput while alleviating possible stresses on portions of the existing surface transportation system. Furthermore, the presence of airports may contribute to ease of seasonal travel, facilitating temporary increases in population (and thus in transportation needs) during certain times of the year. The size of the airport may also determine the extent of economic impact on a community. Larger airports may adversely impact the surrounding surface transportation system as passengers and goods access the airport. Table 5 illustrates various statistics relating to aviation service in rural areas:

- Each county has at least one public airstrip, with the largest number (nine) in Humboldt County.

- Out of twenty-six rural counties, only three public airports in rural counties provide scheduled passenger air service, in Del Norte, Humboldt, and Monterey.

- The reported average daily number of airplane operations (total take-offs and landings by airport) ranges from a low of 2 in Alpine County to a high of 607 in Monterey County.

This data is provided by the Federal Aviation Administration (FAA) in the Airport Data (5010) Report, which can be located at http://www.faa.gov/arp/safety/5010/index.cfm?nav=safedat . Figure 7 illustrates the total number of airplane operations per day at public airports in each county.

TABLE 3: Common Rural Public Transit System Data

County	Annual Fare Revenue	Annual Operating Costs	Total Number of Transit Vehicles	Annual Vehicle-Hours of Service	Annual Vehicle-Miles of Service	Annual Ridership (1-way passenger-trips)
Alpine	$1,500	$34,000	6	1,150	32,000	1,428
Amador	$178,753	$796,093	12	13,948	316,737	99,619
Calaveras	$33,022	$324,650	11	8,857	289,307	32,144
Colusa	$71,682	$578,374	10	12,215	230,190	53,263
Del Norte	$59,988	$566,679	16	21,434	207,584	37,319
El Dorado	$1,060,607	$4,079,831	51	74,227	1,729,043	948,269
Glenn	$44,222	$351,021	4	7,663	168,291	38,473
Humboldt	$676,568	$3,369,047	4	10,437	137,300	190,845
Inyo	$133,328	$985,725	27	29,464	516,224	89,548
Lake	$253,322	$1,168,429	17	28,222	529,477	181,594
Lassen	$100,224	$542,123	14	8,986	150,322	61,060
Mariposa	$566,154	$2,792,765	6	11,650	180,417	8,939
Mendocino	$566,154	$2,792,765	35	63,066	927,382	473,871
Modoc	$23,061	$145,979	4	3,630	108,378	7,627
Mono	$36,308	$587,937	Note 1	8,723	135,915	27,334
Monterey	$4,617,081	$15,891,646	117	254,052	3,920,407	4,830,693
Nevada	$402,155	$2,349,124	49	74,127	1,145,513	476,878
Placer	$1,052,267	$7,651,381	101	169,651	2,295,933	1,151,204
Plumas	$78,008	$422,112	5	9,658	204,624	30,532
San Benito	$154,588	$1,487,758	20	32,075	478,726	168,003
Santa Cruz	$5,688,024	$26,184,182	238	463,209	5,605,072	6,482,856
Sierra	$6,842	$66,947	2	Unavailable	27,956	2,695
Siskiyou	$129,738	$722,976	11	14,307	394,826	74,810
Tehama	$54,532	$813,073	2	15,079	73,536	45,032
Trinity	$15,544	$147,638	4	2,718	72,899	10,706
Tuolumne	$86,838	$547,774	4	17,641	317,064	53,088

Note 1: Included with Inyo County

Source: California State Controller Transit and Non-Transit Claimants Annual Report, FY 2002/03, Alpine County Countywide Transit Needs Assessment, 2001

TABLE 4: Public Transit Service Availability

County	Presence of local general public transit service	Presence of separate local elderly/disabled transit service	Typical weekday span of service (start time, end time)	Days per week of service	Typical service frequency	Availability of intercity bus or rail service (1)
Alpine	X	X	7:00 a.m. - 5:30 p.m.	M-F	Fixed intervals, vary	No
Amador	X		5:40 a.m. - 7:15 p.m.	M-F	2-6 runs a day for 7 deviated fixed routes	No
Calaveras	X		6:00 a.m. - 8:00 p.m.	M-F	Deviated fixed-routes every hour during peak	No
Colusa	X		7:30 a.m. - 5:00 p.m.	M-F	Variable	No
Del Norte	X	X	6:30 a.m. - 7:20 p.m.	M-Sa	Variable	Yes
El Dorado	X	X	6:15 a.m. - 6:30 p.m.	M-Su	Peak, 10-20 minute intervals	Yes
Glenn	X		7:30 a.m. - 6:00 p.m.	M-Sa	7 round trips/day	No
Humboldt	X	X	6:00 a.m. - 10:30 p.m.	M-F	35 trips per day	Yes
Inyo	X	X	8:00 a.m. - 5:00 p.m.	M-Sa	Variable	No
Lake	X	X	8:00 a.m. - 7:30 p.m.	M-F	1 - 2 hour loops	No
Lassen	X	X	5:00 a.m. - 7:00 p.m.	M-F	Every hour	No
Mariposa	X		Variable	M-F	Variable	No
Mendocino	X	X	7:00 a.m. - 5:00 p.m.	M-F	Frequent peak trips	Yes
Modoc	X	X	7:30 a.m. - 4:40 p.m.	M-Su	Variable	No
Mono	X	X	7:00 a.m. - 7:00 p.m.	M-Sa	Peak 1/2 hour interval	No
Monterey	X	X	6:00 a.m. - 7:00 p.m., limited evening service M-Sa	M-Su	Peak 15 minute intervals	Yes
Nevada	X	X	7:00 a.m.- 8:00 p.m.	M-F	Variable	No
Placer	X		5:00 a.m. - 9:00 p.m.	M-Sa	15 minutes peak	Yes
Plumas	X	X	7:00 a.m. - 6:00 p.m.	M-F	Variable	No
San Benito	X	X	6:20 a.m. - 5:45 p.m.	M-F	30 - 45 minutes intervals	Yes
Santa Cruz	X	X	6:00 a.m. - 6:00 p.m.	M-Su	Peak 5 minute intervals	Yes
Sierra	X		Variable	M-F	10-12 major stops daily	No
Siskiyou	X		7:00 a.m. - 5:00 p.m.	M-F	Variable	Yes
Tehama	X	X	6:30 a.m. - 6:30 p.m.	M-F	Fixed intervals, vary	Yes
Trinity	X		6:45 a.m. to 5:00 p.m.	M-F	Typically every hour	No
Tuolumne	X	X	6:00 a.m. - 7:00 p.m.	M-F	Variable	No

Source: County Short-Range Transit Plans; County Transit Development Plans

Note 1: Considers only intercity private services only, excluding local public connecting services.

TABLE 5: Existing Aviation Data

County	Number of Public Airports	Availability of Scheduled Air Passenger Service	Daily Operations (Take-offs and Landings)	Percent Commercial Aircraft Movements
Alpine	1	NO	2	n/a
Amador	1	NO	68	n/a
Calaveras	1	NO	68	n/a
Colusa	1	NO	77	n/a
Del Norte	3	YES	37	21%
El Dorado	4	NO	409	n/a
Glenn	2	NO	147	n/a
Humboldt	9	YES	501	28%
Inyo	7	NO	155	n/a
Lake	2	NO	212	n/a
Lassen	5	NO	44	n/a
Mariposa	1	NO	88	n/a
Mendocino	6	NO	184	n/a
Modoc	6	NO	137	n/a
Mono	3	NO	53	n/a
Monterey	4	YES	607	n/a
Nevada	2	NO	177	n/a
Placer	4	NO	385	n/a
Plumas	3	NO	123	n/a
San Benito	2	NO	159	n/a
Santa Cruz	1	NO	260	n/a
Sierra	1	NO	3	n/a
Siskiyou	7	NO	145	n/a
Tehama	2	NO	96	n/a
Trinity	5	NO	156	n/a
Tuolumne	2	NO	216	n/a

Source: Federal Aviation Administration (FAA), Airport Data (5010) Reports, http://www.faa.gov/arp/safety/5010/index.cfm?nav=safedata

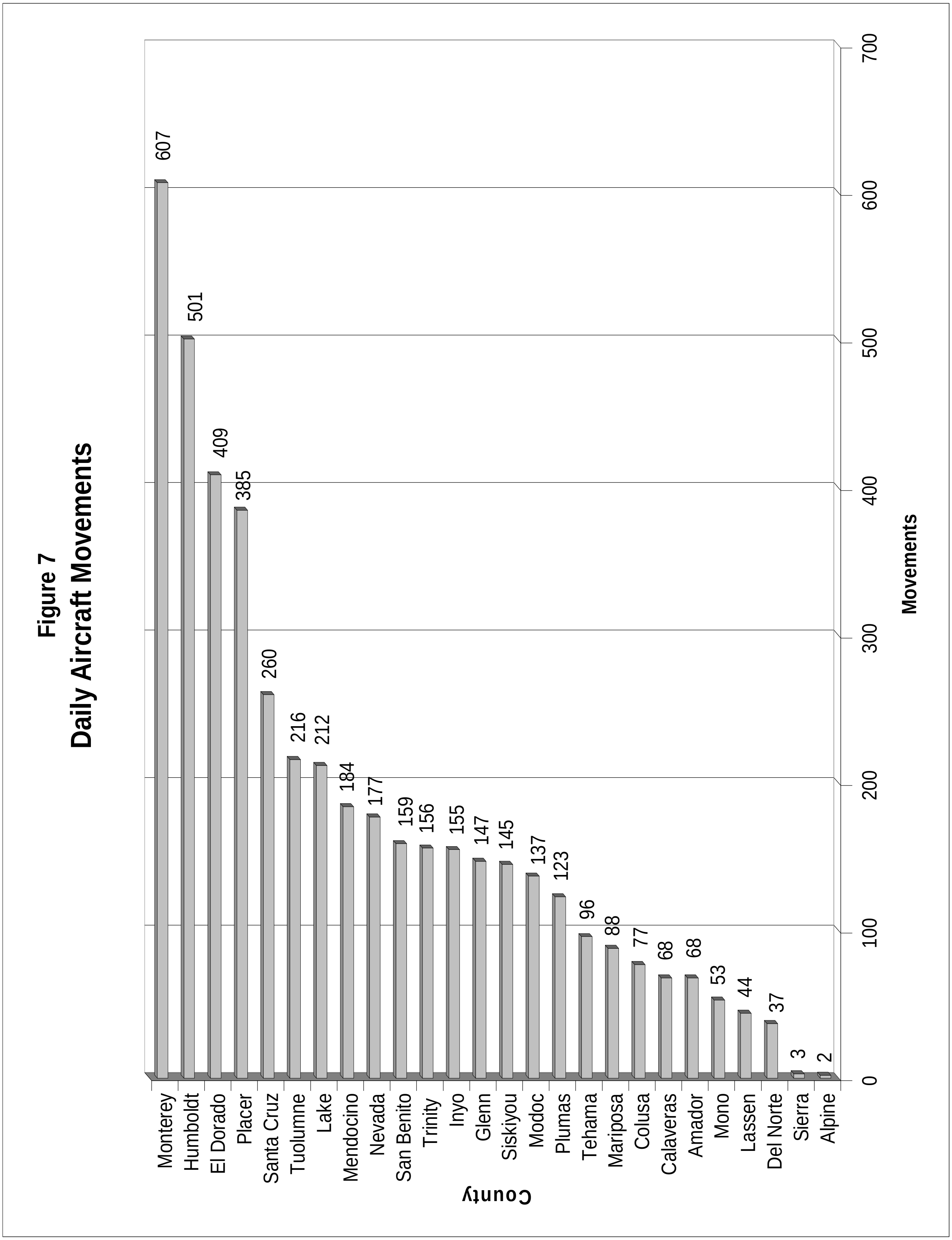


Figure 7
Daily Aircraft Movements

PEAK MONTH AVERAGE DAILY TRAFFIC / AVERAGE ANNUAL DAILY TRAFFIC

As a measure of total traffic levels in each of the rural counties, data was collected for the Peak Month Average Daily Traffic (ADT) and Average Annual Daily Traffic (AADT) volumes at all state highway locations crossing rural county boundaries. Total traffic levels are important because they signify the size of the transportation system required by a geographical area, and because they are a way of standardizing measurements between areas. This data is drawn from the Caltrans traffic count website (http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm). Counts are conducted for all state highways (including Interstate and US designated highways) for segments generally several miles in length (in rural areas. Directional counts on the majority of segments are conducted for a several day period once every three years (and then factored to estimate annual, peak-month and peak-month volumes). In addition, permanent count stations are also maintained (generally at several locations along each state route in each county). These counts are summarized in Table 6 and illustrated in Figure 8. As shown, the county with the greatest traffic volumes at the county boundaries is Placer County, with a peak month ADT of 349,800 and AADT of 308,900. At the other extreme, Modoc County traffic volumes are only 6,840 peak month ADT and 5,430 AADT.

It is also informative to consider the ratio of peak month ADT to AADT, as an appropriate measure of the seasonal variation in traffic activity (largely a result of tourist traffic). As also shown in Table 6, the highest seasonal variation occurs in Alpine County, where peak month volumes are 43 percent greater than average annual volumes. Other counties with relatively high seasonal factors are Inyo, Plumas, Siskiyou and Trinity. At the other extreme, volumes vary by only 9 percent in Amador County, and 10 percent in Calaveras County.

TABLE 6: Traffic Volume and Vehicle-Miles of Travel Data

County	State Highway Traffic Volumes at County Boundary		Peak Month ADT / AADT Ratio	Countywide Annual Vehicle-Miles of Travel (in Millions)			2001 Estimated Annual VMT per Capita	Percent of Countywide VMT by Road System	
	Total Peak Month ADT	Total AADT		On State Highways	On Other Roads	Total		On State Highways	On Other Roads
Alpine	11,130	7,800	1.43	45	12	57	46,586	78%	22%
Amador	37,800	34,800	1.09	260	107	367	10,271	71%	29%
Calaveras	33,900	30,800	1.10	244	141	385	9,238	63%	37%
Colusa	77,280	66,850	1.16	408	115	523	27,405	78%	22%
Del Norte	20,750	14,900	1.39	152	86	239	8,527	64%	36%
El Dorado	161,550	136,850	1.18	840	772	1,612	10,069	52%	48%
Glenn	78,800	68,450	1.15	308	130	438	16,441	70%	30%
Humboldt	26,630	20,640	1.29	702	506	1,208	9,487	58%	42%
Inyo	22,330	16,800	1.33	407	111	518	28,896	79%	21%
Lake	19,650	16,100	1.22	295	183	478	8,076	62%	38%
Lassen	33,440	26,750	1.25	293	284	577	16,668	51%	49%
Mariposa	19,110	14,760	1.29	122	138	260	14,910	47%	53%
Mendocino	45,000	38,200	1.18	698	446	1,145	13,171	61%	39%
Modoc	6,840	5,430	1.26	80	108	188	19,899	43%	57%
Mono	22,670	16,840	1.35	240	56	296	22,373	81%	19%
Monterey	174,600	149,440	1.17	2,024	1,585	3,609	8,867	56%	44%
Nevada	172,950	140,850	1.23	745	383	1,127	12,042	66%	34%
Placer	349,800	308,900	1.13	1,702	1,180	2,881	11,113	59%	41%
Plumas	20,550	15,090	1.36	175	174	349	16,670	50%	50%
San Benito	174,050	153,680	1.13	348	178	526	9,454	66%	34%
Santa Cruz	161,850	140,600	1.15	1,014	1,024	2,038	7,886	50%	50%
Sierra	56,800	45,160	1.26	68	44	112	31,316	61%	39%
Siskiyou	55,950	43,070	1.30	582	300	882	19,885	66%	34%
Tehama	98,680	82,680	1.19	557	274	830	14,631	67%	33%
Trinity	11,675	8,665	1.35	113	71	185	14,195	61%	39%
Tuolumne	42,360	34,840	1.22	300	263	563	10,199	53%	47%

Source: 2004 Traffic Volumes on California State Highways (Caltrans),

California Department of Transportation, Division of Transportation System Information, Office of Travel Forecasting & Analysis, Statewide Travel & Analysis Branch. "California Motor Vehicle Stock, Travel and Fuel Forecast - 2001", Appendix B, http/www.dot.ca.gov/hq/tsip

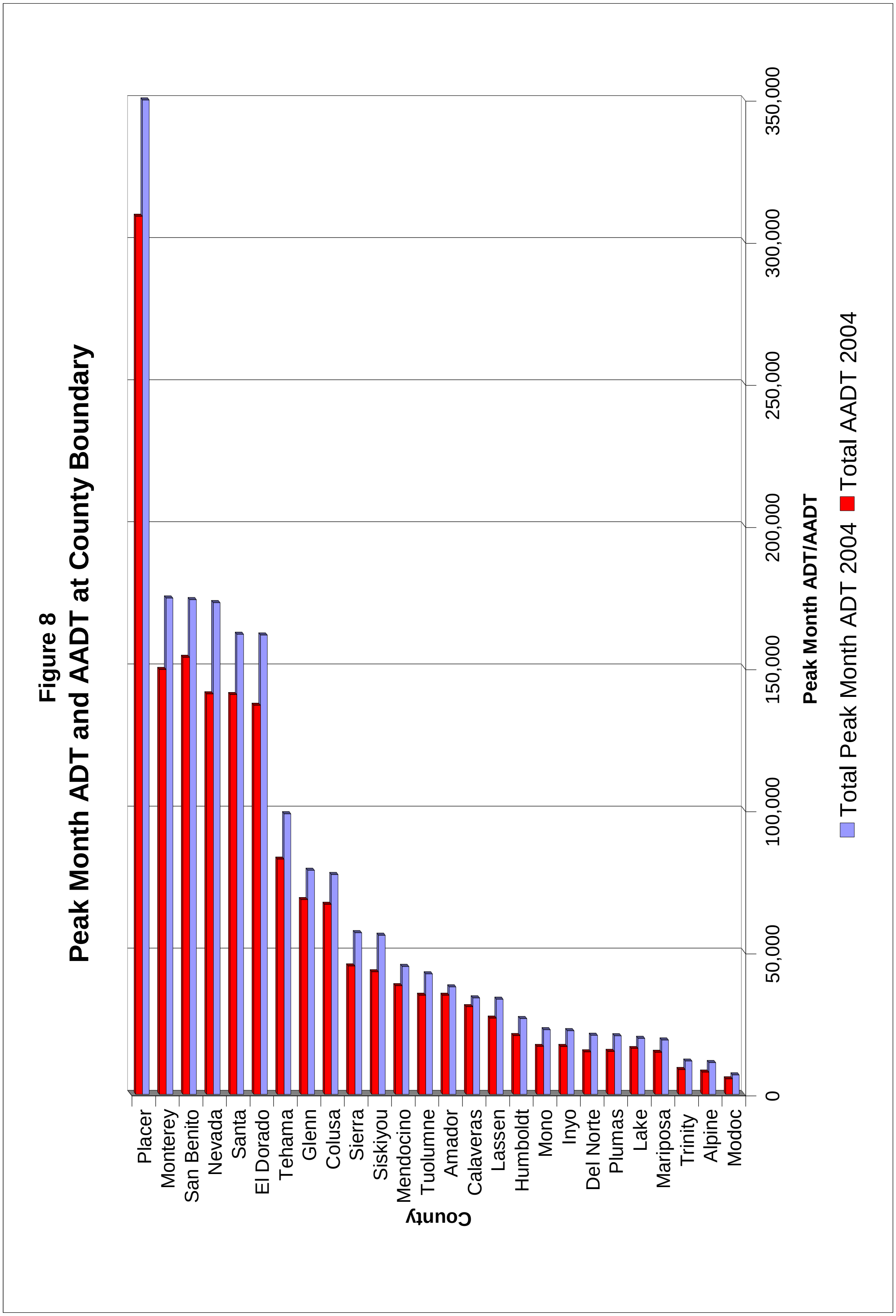


Figure 8
Peak Month ADT and AADT at County Boundary
County
Placer
Monterey
San Benito
Nevada
Santa
El Dorado
Tehama
Glenn
Colusa
Sierra
Siskiyou
Mendocino
Tuolumne
Amador
Calaveras
Lassen
Humboldt
Mono
Inyo
Del Norte
Plumas
Lake
Mariposa
Trinity
Alpine
Modoc
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
Peak Month ADT/AADT
Total Peak Month ADT 2004
Total AADT 2004

Vehicle-Miles of Travel per Capita

An additional informative measure is the Vehicle-Miles of Travel (VMT) per capita. VMT per capita is important because it shows impact on the condition of the transportation system: the more miles are traversed on a given system, the more wear-and-tear experienced by the transportation facilities and the more maintenance and repair are required. VMT per capita also indicates characteristics of the transportation system and different modes; for example, a low VMT per capita may indicate low automobile ownership or high reliance on transit. The Statewide Travel & Analysis Branch of Caltrans' Division of Transportation System Information's Office of Travel Forecasting & Analysis prepares an annual report ("California Motor Vehicle Stock, Travel, and Fuel Forecast – 2000," Appendix B, which can be found at http://www.dot.ca.gov/hq/tsip provides estimates of VMT on both the state highway system as well as on other roadways. Table 6 and Figure 9 present the estimated countywide 2001 per capita. As indicated, Alpine County had the highest VMT in the year 2001 at 46,586. Other counties with relatively high VMT per capita were Sierra (31,316), Inyo (28,896), and Colusa (27,405). Santa Cruz, Lake, and Del Norte Counties had the lowest VMT per capita at 7,886, 8,076, and 8,527 respectively.

Table 6 also presents the proportion of total countywide VMT that is carried by the state (and US) highway system versus the proportion carried on other roadways (local, Forest Service, BIA, etcetera). As shown, the highest proportion of total VMT on the state highway system is estimated to occur in Inyo, Alpine, and Calaveras Counties, with 79 percent, 78 percent, and 78 percent of total travel, respectively. At the other extreme, 57 percent of travel in Modoc County occurs on non-state routes, followed by 53 percent in Mariposa County.

Hospitality/Tourism Industry

Another potential measure of tourism activity in each county is the proportion of workers employed in the hospitality/tourism industry. The amount of workers employed in this industry provides an indication of the level of tourism in each county, which in turn can reflect the need for transportation system improvements in order to support the traffic generated by tourism. Table 7 and Figure 10 present this information, as drawn from Summary File 4 (SF 4) of the 2000 US Census.

As shown, this percentage ranges from a low of 5.5 percent in Modoc County to a high of 28.5 percent in Alpine County. As measured by the number of hospitality/tourism employees, Monterey has the largest amount of employees in the tourism industry with 16,965. Other counties with relatively high numbers of these employees are Santa Cruz County (11,095) and El Dorado County (10,371). At the other extreme, Sierra County has only 147 employees in the tourism industry.

Recreational traffic is also a function of second home ownership. Table 8 and Figure 11 present the number and proportion of dwelling units in each county that are second homes, based on 2000 US Census data Summary File 4 (SF 4). As shown, the counties with the greatest absolute number of second homes are El Dorado and Placer, with roughly 10,100 second homes in each. Other rural counties with relatively high numbers of second homes (between 5,000 and 10,000) are Calaveras, Lake, Mono, Nevada, Santa Cruz, and Tuolumne. On a proportional basis, the counties with the highest percentage of all housing stock used as second or seasonal homes are Alpine (62 percent), Mono (50 percent), Plumas (27 percent), Sierra (24 percent) and Calaveras (24 percent).

ANNUAL SALES

Total taxable sales are an accurate measure of the economy in each county. The state of the economy both impacts and is impacted by transportation system performance, since effective transportation facilities increase residents' access to jobs, housing, businesses and recreation, which in turn increases productivity. The state of the economy also impacts where businesses and retail establishments locate, which in turn affects the transportation system due to higher traffic levels sometimes generated to access those establishments. This data is based on information available through the University of California's "Counting California" website, http://countingcalifornia.cdlib.org/title/castat03.html . Table 9 and Figure 12 present annual taxable sales by county. As indicated, Placer County generated the highest revenue in taxable sales in 2002, at approximately $4.2 billion. Other counties that had high revenue in taxable sales in 2002 are Monterey ($3.5 billion) and Santa Cruz ($2.1 billion). At the opposite extreme, taxable sales in Alpine County were $4,067,000 (or only 0.1 percent of Placer Countys').

Figure 9
2001 Countywide VMT per Capita

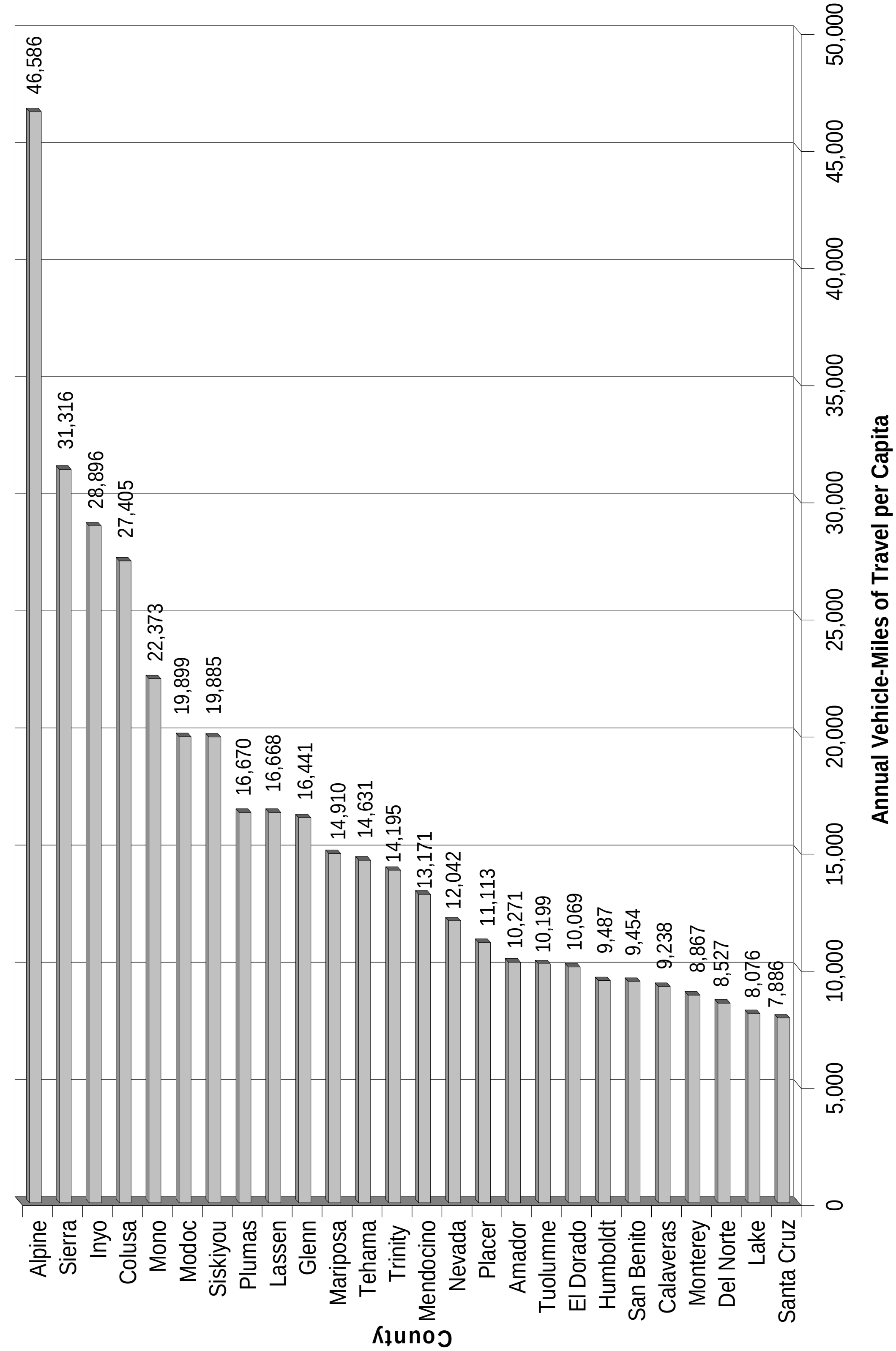


TABLE 7: Employees in the Hospitality/Tourism Industry, Age 16 Years and Over

County	Total Employed Civilian Population 16 Years and Over	Employed Civilian Population 16 Years and Over: Hospitality/Tourism Industry (1)	Percentage Employees: Hospitality/Tourism
Alpine	628	179	28.5%
Amador	13,610	1,720	12.6%
Calaveras	16,202	1,548	9.6%
Colusa	7,237	614	8.5%
Del Norte	8,959	1,163	13.0%
El Dorado	73,821	10,371	14.0%
Glenn	10,527	685	6.5%
Humboldt	55,426	5,408	9.8%
Inyo	8,007	1,432	17.9%
Lake	20,503	2,064	10.1%
Lassen	10,161	700	6.9%
Mariposa	6,833	1,571	23.0%
Mendocino	38,575	4,635	12.0%
Modoc	3,635	200	5.5%
Mono	7,153	2,147	30.0%
Monterey	163,987	16,965	10.3%
Nevada	41,553	4,133	9.9%
Placer	118,647	9,652	8.1%
Plumas	8,520	936	11.0%
San Benito	23,663	1,478	6.2%
Santa Cruz	129,380	11,093	8.6%
Sierra	1,515	147	9.7%
Siskiyou	17,269	1,767	10.2%
Tehama	21,018	1,647	7.8%
Trinity	4,529	391	8.6%
Tuolumne	20,419	2,450	12.0%

Source: US Census 2000 Summary File 4 (SF 4)

Note 1: Employed civilian population 16 years and over in arts, entertainment, recreation, accommodation, and food services

Figure 10
Total Employees in the Hospitality/Tourism Industry, Age 16 Years and Over

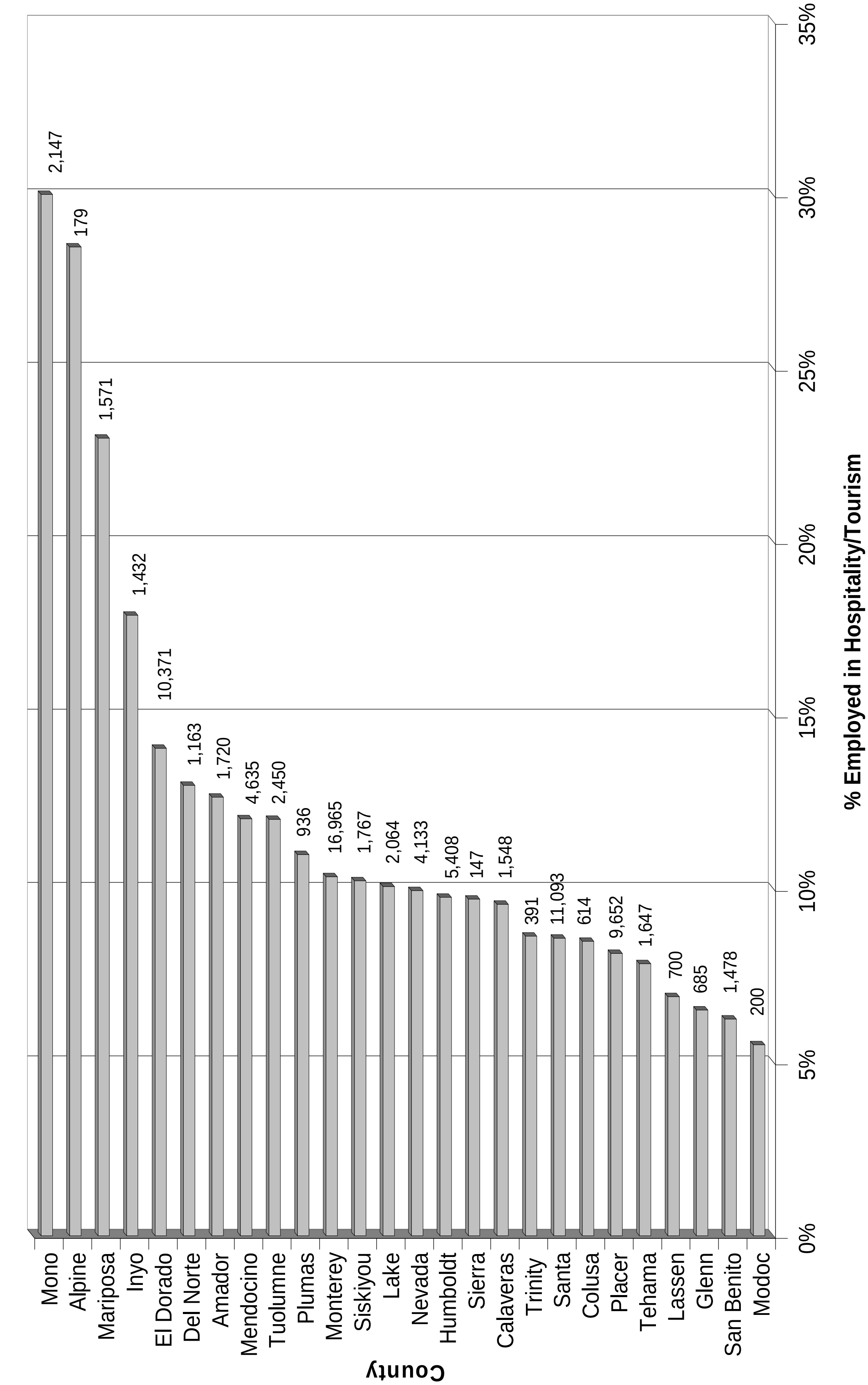


TABLE 8: Rural County Second Homes			
	Housing Units		Percentage of Total Units: Seasonal, Recreational, or Occasional Use
County	Total	Seasonal, Recreational, or Occasional Use	
Alpine	1,514	935	62%
Amador	15,035	1,712	11%
Calaveras	22,946	5,564	24%
Colusa	6,774	322	5%
Del Norte	10,434	565	5%
El Dorado	71,278	10,101	14%
Glenn	9,982	172	2%
Humboldt	55,912	1,950	3%
Inyo	9,042	614	7%
Lake	32,528	6,050	19%
Lassen	12,000	1,147	10%
Mariposa	8,826	1,659	19%
Mendocino	36,937	2,151	6%
Modoc	4,807	368	8%
Mono	11,757	5,856	50%
Monterey	131,708	4,180	3%
Nevada	44,282	6,094	14%
Placer	107,302	10,111	9%
Plumas	13,386	3,578	27%
San Benito	16,499	160	1%
Santa Cruz	98,873	5,167	5%
Sierra	2,202	526	24%
Siskiyou	21,947	1,592	7%
Tehama	23,547	931	4%
Trinity	7,980	1,697	21%
Tuolumne	28,336	6,035	21%

Source: US Census 2000

AVAILABILITY OF HOSPITALS AND MAJOR RETAIL

A final indicator of the need for transportation in a rural county is the availability of major commercial and medical facilities within the county. While all rural counties generate some out-of-county travel for these purposes, the absence of these trip attractors increases the need for county residents to travel outside the county, thereby generating both increased auto travel as well as an increased need for public transit services.

A clear-cut indicator of the availability of major medical services within the county is the presence (and size) of a hospital. The statewide inventory of hospital facilities maintained by the California Health and Human Service Agency, which can be found at http://www.ruralhealth.oshpd.state.ca.us/reports_resources.htm , was reviewed for the presence of a “General Acute Care” facility (excluding psychiatric, long-term care, and chemical dependency hospitals), and the number of licensed medical/surgery beds. As shown in Table 10, Humboldt, Monterey, and Plumas Counties each have four hospitals that fit the above criteria, while Alpine, Amador, Del Norte, and San Benito Counties have no major hospital facilities within the county.

The presence of major retail stores within each county was identified through a review of the websites of the major national “big box” stores, such as Target, Wal-Mart, and K-Mart. As also shown in Table 10, 9 of the 26 rural counties (or roughly one-third) do not have a major retail store within their borders. In order for residents in counties such as Alpine or Sierra to travel to a major retail center, they are required to leave the county, generating more automobile traffic.

Figure 11

Percentage of Total Dwelling Units: Seasonal, Recreational, or Occasional Use (not vacant)

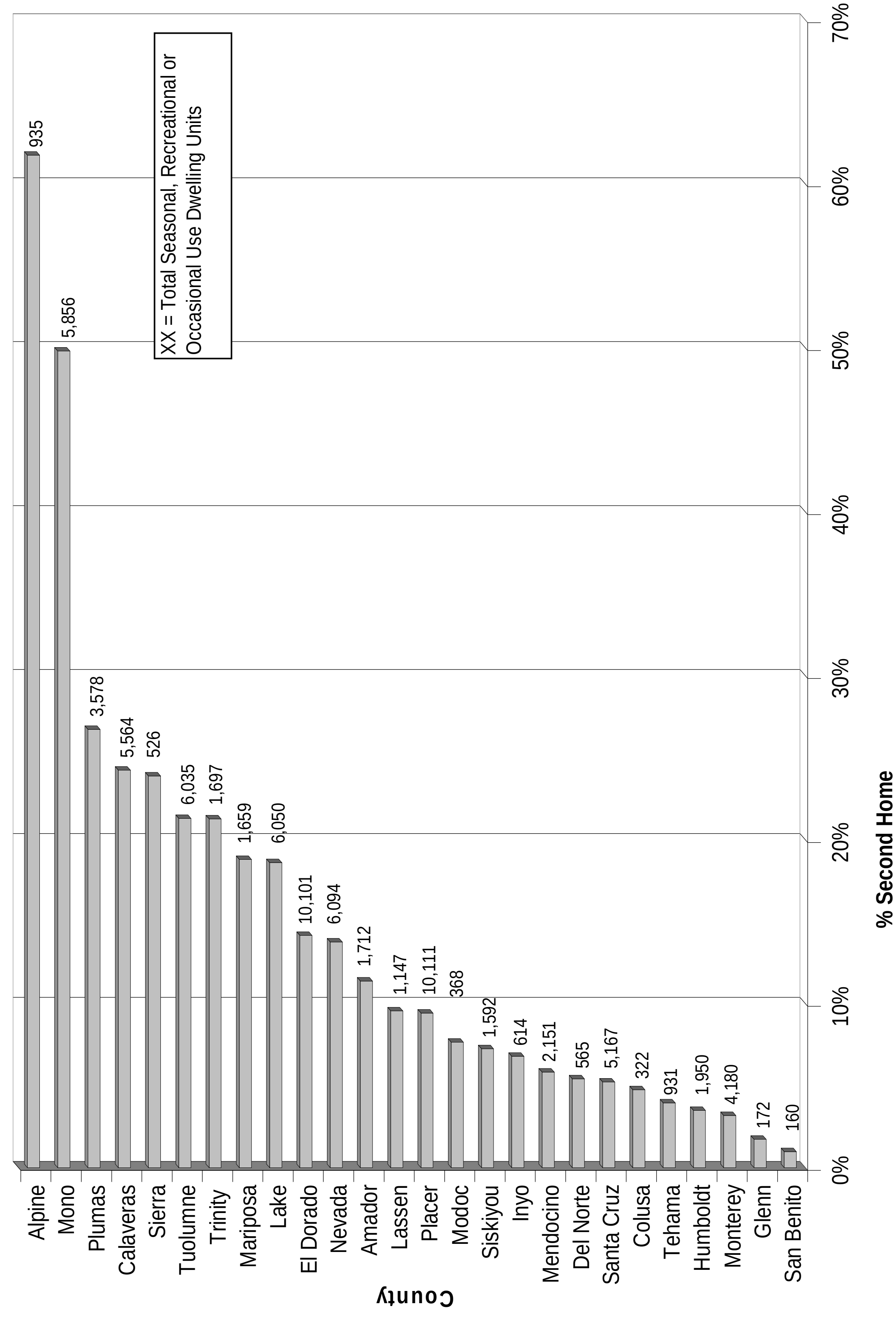


TABLE 9: Taxable Sales by County, 2002

County	Annual Taxable Sales (in thousands)
Alpine	$4,067
Amador	$291,185
Calaveras	$169,834
Colusa	$129,435
Del Norte	$122,978
El Dorado	$994,293
Glenn	$145,220
Humboldt	$989,252
Inyo	$172,805
Lake	$327,824
Lassen	$146,864
Mariposa	$44,199
Mendocino	$758,790
Modoc	$44,934
Mono	$133,743
Monterey	$3,457,449
Nevada	$701,019
Placer	$4,161,204
Plumas	$115,474
San Benito	$302,374
Santa Cruz	$2,106,775
Sierra	$9,777
Siskiyou	$260,430
Tehama	$378,356
Trinity	$39,201
Tuolumne	$410,747

Source: Counting California, Taxable Sales by County, 2002 - State of California, Table K07, http://countingcalifornia.cdlib.org/title/castat03.html

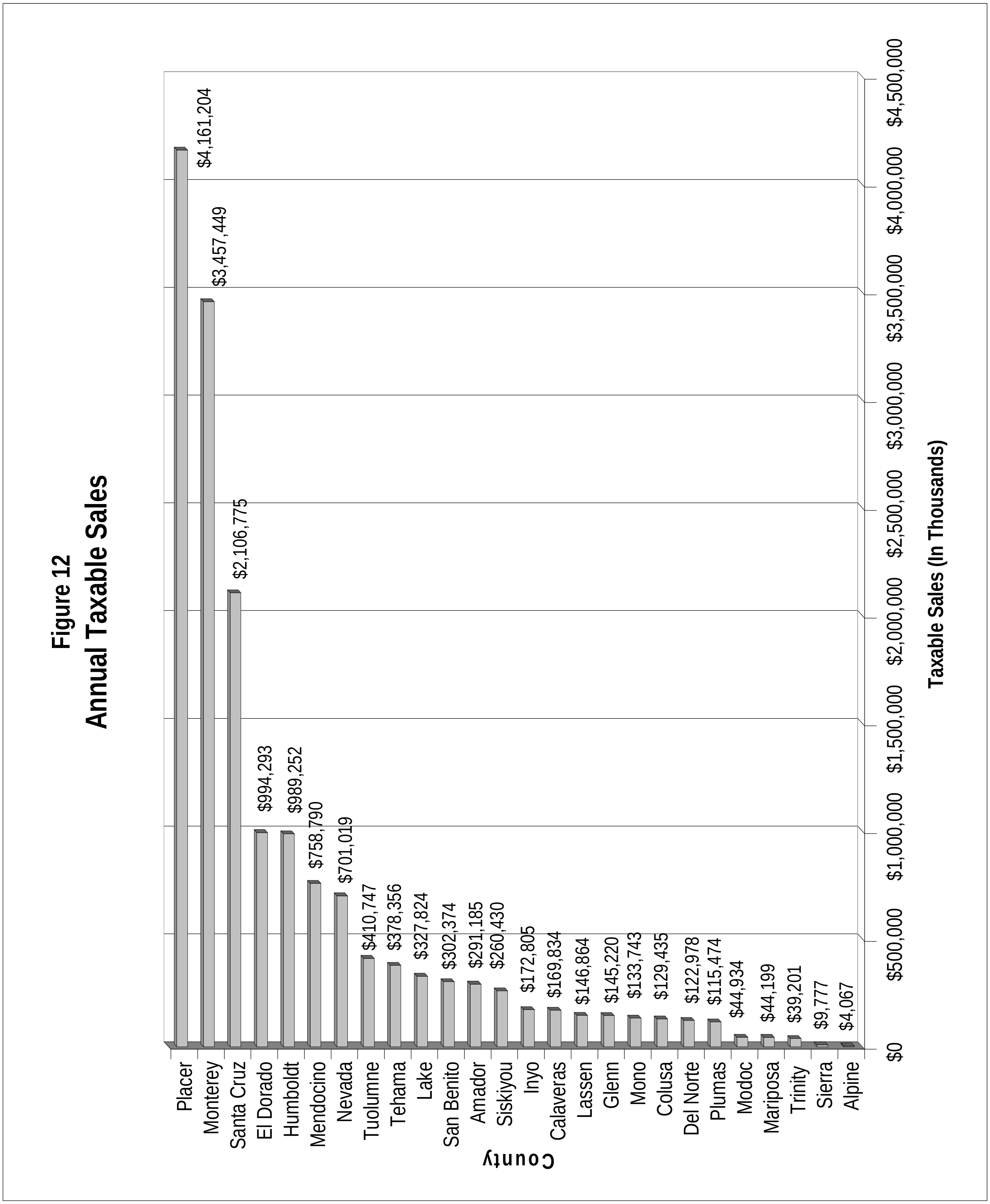


Figure 12
Annual Taxable Sales

TABLE 10: Availability of Hospital Facilities and Major Retail Stores

County	General Acute Care Hospitals: # Hospitals	# Hospital Beds	Availability of Major Discount Retail Store
Alpine	0	0	No
Amador	1	66	Yes
Calaveras	1	48	No
Colusa	1	48	No
Del Norte	1	59	Yes
El Dorado	3	241	Yes
Glenn	1	49	Yes
Humboldt	5	361	Yes
Inyo	2	69	Yes
Lake	2	101	Yes
Lassen	1	38	Yes
Mariposa	1	34	No
Mendocino	3	165	Yes
Modoc	2	113	No
Mono	1	15	No
Monterey	4	679	Yes
Nevada	2	193	Yes
Placer	10	2,204	Yes
Plumas	4	114	No
San Benito	2	246	Yes
Santa Cruz	4	515	Yes
Sierra	1	40	No
Siskiyou	2	108	Yes
Tehama	1	76	Yes
Trinity	1	51	No
Tuolumne	4	263	Yes

Source: State of California, http://www.oshpd.ca.gov/HQAD/Hospital/hosplist.htm

Note: Hospitals represent general acute care (GAC) facilities only

Classification of Rural Counties

For any performance measurement system to be valid, it needs to be based upon standards appropriate for each independent jurisdiction. A key element, therefore, is to classify the various California rural counties into appropriate categories for performance evaluation. This is particularly important in light of the great variation in the characteristics of the rural counties, as discussed in the previous section. For instance, the performance categories and measures appropriate for Modoc County are likely not those appropriate for Monterey County, due to the differences in demographics, geography, and transportation concerns. Performance measures will be developed in accordance with county characteristics such as population, growth, and industry. At that point, the requirements for a Rural Transportation System appropriate for each county can be assessed.

No two counties, of course, are exactly alike (particularly in California). Any classification system therefore requires some amount of simplification in order to generate useful categories. At the same time, those comparing counties within a category should be aware that not all of the differences between counties are reflected in the factors used in their classification, and that some variation in performance indicator values is thus to be expected.

Summary of County Classification

In developing a classification system, the following guidelines were followed:

- A classification system should result in categories with more than a single county (and preferably three or four) in each, in order to evaluate counties with similar characteristics.

- Given the first point and the limited (26) number of rural counties, no more than two or three factors can be used in the classification system.

- The data used for the classification system must be both reasonably accurate and readily available.

- Factors should reflect those characteristics that most directly “drive” the need for transportation services in each county. These factors, moreover, should be applied in an order that best reflects standard classifications of transportation system performance.

Using these guidelines, the rural counties were classified as follows as shown in Figure 8 above.

1. **Population** was applied as the first factor, as this is a key determinant in overall demand for travel. Using the data presented in Table 1 and Figure 1, the rural counties were grouped into three categories: high population over 150,000

population (El Dorado, Monterey, Placer, and Santa Cruz), moderate population between 50,000 and 150,000 population (Humboldt, Lake, Mendocino, Nevada, San Benito, Tehama, and Tuolumne), and low population below 50,000 (the remainder). The 150,000 value used to define the high versus moderate groups results in El Dorado County just attaining the high population group, which is appropriate given the rapidly urbanizing nature of much of this county and also avoids a category of a single county at the next level of categorization.

2. **Population Growth Rate** was next applied. This is a key transportation factor, as it both indicates the level of need for new facilities as well as impacts that rapid growth can have on transportation system that may be outdated. It is worth noting that not all of the rural systems are outdated, but a high population growth rate increases the focus that is needed on ensuring that these systems can provide the necessary capacity. The criteria used for classification of this factor depended on the population level:

   - For high population counties, ten-year growth rates of 20 percent or higher were considered high population growth rate counties (Placer and El Dorado), while those with lower rates (less than 20 percent) were considered low population growth rate counties (Monterey and Santa Cruz).

   - For moderate population counties, a value of 15 percent growth over ten years was used to differentiate high population growth rate counties (Lake, Nevada, and San Benito) which were greater than or equal to15 percent from low population growth rate counties (Humboldt, Mendocino, Tehama, and Tuolumne), which were less than 15 percent.

   - For low population counties, three growth rate categories were identified: high population growth rate counties with ten-year growth over 20 percent (Mono, Calaveras, and Lassen), moderate population growth rate counties, with growth rates between 10 and 20 percent (Amador, Colusa, Del Norte, and Mariposa), and low population growth rate counties (Alpine, Glenn, Inyo, Modoc, Sierra, Siskiyou, and Trinity), which had rates which were less than 10 percent.

   Historic (1990 to 2000) growth was used rather than forecast growth, as the level of accuracy of census counts exceeds that of even the best projections. For the most part, current transportation needs reflect past growth and the inability to fully accommodate this growth.

3. For the Low Population/Low Growth Rate counties (and only for these counties), a third factor was also applied, in order to differentiate those counties most heavily impacted by tourist traffic. The ratio of peak month to average annual daily traffic was applied, as the best indicator of the impacts of tourist traffic on local transportation systems. (Demographic factors, such as the proportion of employees in the tourism industry or the proportion of second homes, do not reflect tourist traffic that may pass through a rural county en route to another area). A ratio of 1.3 (i.e., peak month ADT that is 30 percent or more above annual average ADT) was

applied to identify the high tourism counties (Alpine, Inyo, Plumas, Siskiyou, and Trinity) from the low tourism counties (Glenn, Modoc, and Sierra). This third factor was not applied to other categories both to avoid single-member categories and as seasonal swings in traffic are as not as important factor in overall transportation issues in high growth or high population areas as they are in the smallest low-growth counties.

In summary, the following factors were used:

Population (US Census)
High population >150,000 people
Moderate population = 50,000 – 150,000 people
Low population <50,000 people

1990-2000 Population Growth Rate (US Census)
High population growth ≥ 20%
Moderate population growth = 10%-20%
Low population growth <10%

Ratio of Peak Month ADT to Average ADT (Caltrans)
High rate of tourism ≥ 1.3
Low rate of tourism < 1.3

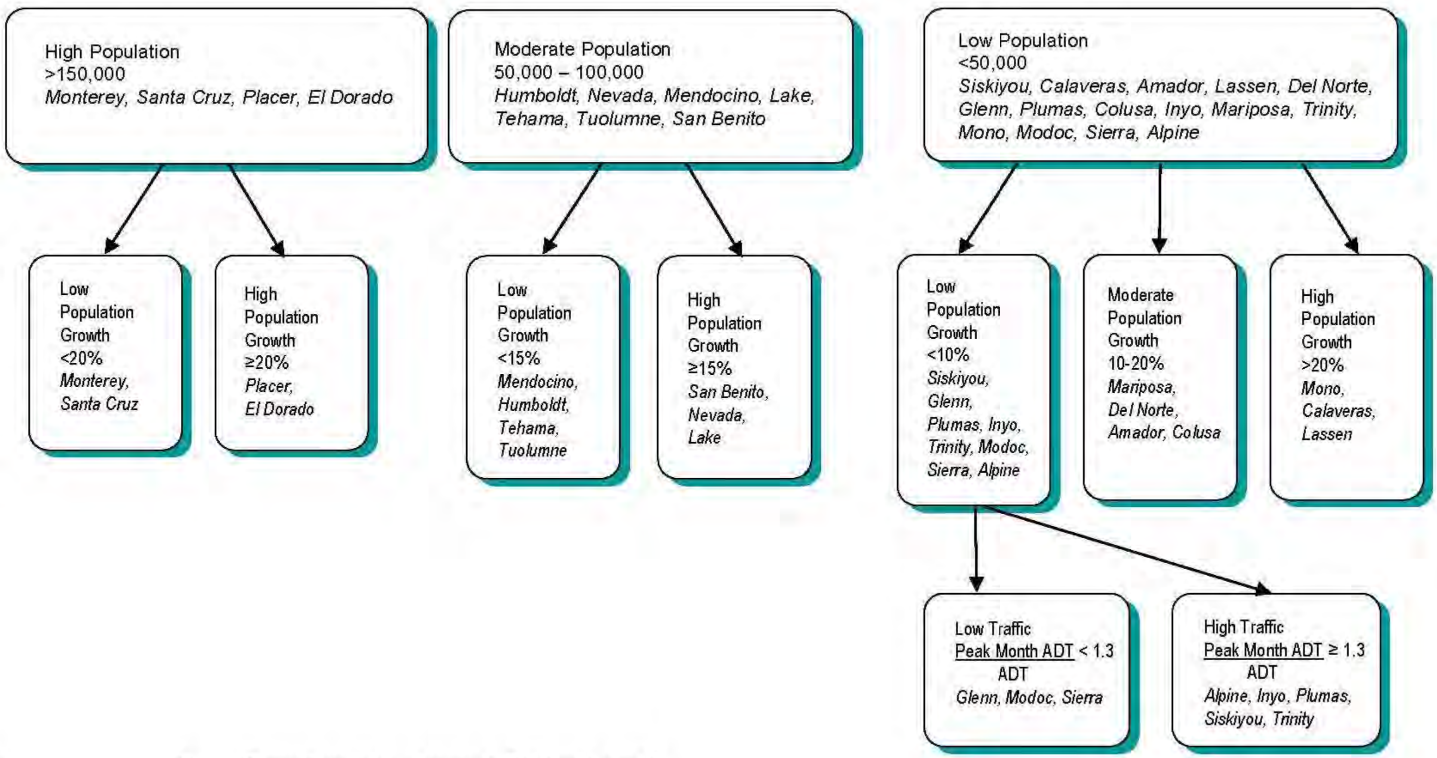
Applied to the 26 rural California counties, these factors and criteria yield a total of eight categories, each of which contain two to five counties, as shown in Figure 13 and Table 11.

Findings

The list above illustrates the potential categorization of the 26 rural counties. The eight categories listed above will provide Caltrans and stakeholders an understanding of the similar and dissimilar factors relevant within each group when deciding on Performance Measure policies for RTS. For instance, counties with a high population and high growth of rate can be considered within one category. In this case, Placer and El Dorado Counties have the highest population as well as the highest rate of growth. These two counties can be considered with the same goals in mind.

It should also be noted that classification of counties with regards to specific travel modes may differ from those presented above. For instance, a classification of county roadway systems for analysis of maintenance costs would probably include a factor for elevation to reflect the impacts of snow on maintenance costs.

Figure 13
Categorization of Counties by Population and Tourism Characteristics



Note: Based on data shown in Tables 1 and 6.

TABLE 11: Rural California County Classification

High Population / High Growth

Placer, El Dorado

High Population / Low Growth

Monterey, Santa Cruz

Moderate Population / High Growth

Lake, San Benito, Nevada

Moderate Population / Low Growth

Humboldt, Tehama, Mendocino, Tuolumne

Low Population / High Growth

Calaveras, Mono, Lassen

Low Population / Moderate Growth

Amador, Del Norte, Colusa, Mariposa

Low Population / Low Growth / Low Seasonal Traffic

Glenn, Sierra, Modoc

Low Population / Low Growth / High Seasonal Traffic

Alpine, Plumas, Trinity, Inyo, Siskiyou

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Chapter 4

Rural-Specific Performance Measures

Chapter 4

Rural-Specific Performance Measures

Note that many of the examples shown in Section 7 in this Chapter of the report are from urban counties. They are used to demonstrate concepts and approaches suggested for consideration to rural counties. In subsequent tasks of this project, the suggestions in this document will be "tested" using rural county data only. Such testing will be critical to ensure that the methodologies described and the examples provided can indeed be developed with rural county data. At the end of this study, a guidebook will be developed that includes the specific rural examples developed.

The remainder of this part of the document is organized as follows:

- Section 2: Performance Measurement Categories (Outcomes) - identifies the statewide performance measure categories and briefly discusses how they relate to RTS
- Section 3: Summary of Suggestions - identifies which categories and related suggestions different rural counties should consider and provides a high level estimate of the associated costs
- Section 4: Managerial and Operating Practices - discusses some of the major transportation-related differences between rural and urban counties in terms of priorities and how this document may add value despite these differences
- Section 5: County Organization - presents the Task 2 proposed organization for rural counties for reference purposes
- Section 6: Performance Data and Measures - summarizes findings from the review of rural county RTPs and SRTPs
- Section 7: Performance Measures for RTS - presents suggestions for enhancing current practices by performance category.

2 Performance measurement categories (Outcomes)

As will be evident in the remainder of the document, by and large, RTS can and should be evaluated using the same over-arching performance measure categories (or outcomes) used in urban and sub-urban areas as developed by Caltrans in coordination with metropolitan planning organizations (MPOs) and county transportation commissions (CTCs). That is one critical conclusion of the effort to date. That does not mean that the priorities for rural counties do not differ significantly from the priorities in urban counties. Rather, it means that the statewide measures are comprehensive enough that they allow for assessing all kinds of transportation systems, including RTS. The statewide measure categories were therefore used to assess currently used performance data and propose specific measures for use in rural counties. The list of performance categories used includes:

- Safety
- Mobility
- Accessibility
- Reliability
- Productivity
- System Preservation
- Return on Investment/Life Cycle Costs
- Environmental Quality
- Economic Development

Note that other categories mentioned in some of the rural county RTPs are not included, primarily because they were not mentioned within the context of the RTS. Rather, they reflected county priorities related to project selection and community values. Examples of such categories include: community acceptance, cultural resource preservation, and equity. Although these examples are important to many of the rural (and some urban) counties, our experience suggests that they are difficult to relate in terms of a specific performance measure.

3 Summary Of Suggestions

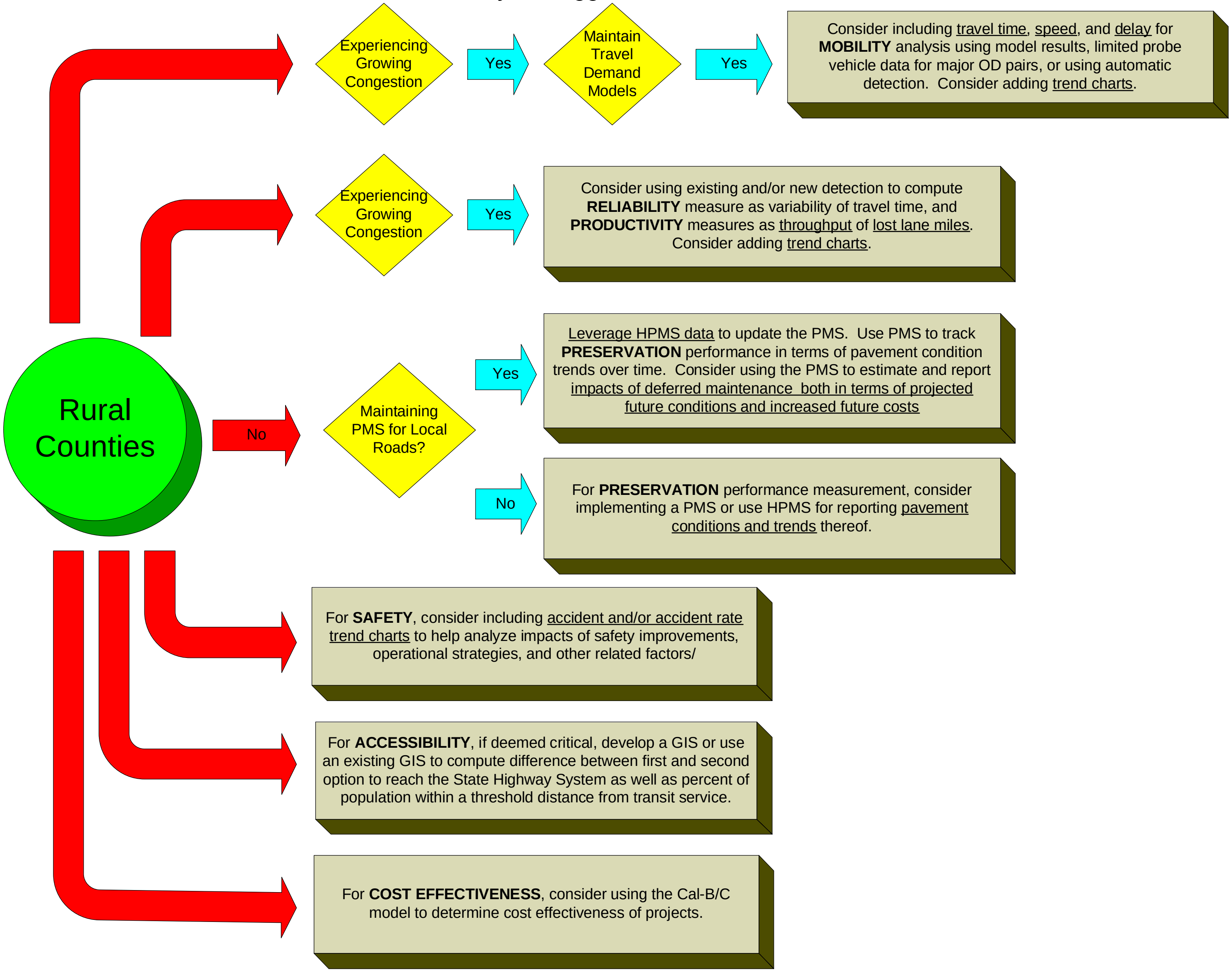
As mentioned before, the suggestions detailed in this document (in Section 6) are not appropriate for every rural county. Therefore, this section provides direction as to which county should consider the different suggestions. Exhibit 1 depicts the factors that help guide rural counties in identifying the appropriate suggestions that may apply to them and further discussed below. Note that for the purposes of cost estimation we present the cost of suggestions as low, medium, and high. Low costs refer to actions that do not require specific expenditures. They do however require additional time resources from staff. Medium costs refer to the need for specific expenditures that are below $100,000. We recognize that for some rural counties, these costs are still considered high, but we use the term "medium" for comparison purposes. The high costs refer to expenditures above $100,000 and they usually relate to installation of detection equipment to collect continuous data. Within this context, the following summarizes our suggestions:

- All counties should consider suggestions related to the safety, accessibility, and cost effectiveness performance categories. These suggestions relate to reporting trends, free existing tools, or implementing low-cost approaches. None of these suggestions are cost prohibitive.
- All counties should consider suggestions related to leveraging existing data (i.e., HPMS) and report on pavement condition trends as part of the preservation performance category. Again, the associated costs are low and require obtaining data from Caltrans and/or FHWA and then reporting the trend of pavement conditions in the county. For counties that maintain a pavement management system (PMS) with predictive capabilities, the additional data can only improve the results of these models. Furthermore, these counties can leverage their PMS predictive capabilities to report on unmet needs and trends thereof.
- Some counties may want to consider implementing a PMS to evaluate future conditions under different scenarios and identify the optimal use of limited funding for preservation. These models can be expensive, but some regions have managed to share existing software at no additional costs. This suggestion requires an investment in time, data entry, and possibly software and we would consider these costs to be medium.
- Counties that do not face growing congestion and therefore do not face a congestion problem should probably disregard suggestions related to the mobility, productivity, and reliability performance categories. These suggestions are very data intensive and are therefore expensive to implement.
- Counties that do face growing congestion that maintain a travel demand model should consider including delay and speed as part of the mobility performance category. The cost of this action is low.
- The same counties should consider collecting travel time data between major origin destination pairs. The cost of this action is also low.
- The same counties may want to consider installing automatic detection on their major congested roads which would enable them to report on the mobility,

productivity, and reliability performance measures. The costs of these actions are high.

Section 7 in this Chapter details all these suggestions in more detail.

Exhibit 1 - Summary of Suggested Actions for Rural Counties



4 Managerial and operating practices

Rural and urban counties by and large face different problems. With the exception of a few rural counties (e.g., Santa Cruz, Monterey), congestion and its ramifications (especially air pollution and air quality attainment requirements) are not major challenges. So whereas urban counties with growing congestion have spent more than a decade developing a variety of tools and models to help them evaluate methods to mitigate congestion, most rural counties did not.

Another major difference between the two groups is the availability of funding for planning related activities. Many rural counties have limited resources to be able to collect data, conduct detailed analyses or develop planning tools. So while these counties still develop RTPs and SRTPs, they tend to rely on less complex tools, fewer data, and engineering judgment as appropriate.

In general, these counties know their main problems, namely road conditions and unmet preservation needs. Funding levels simply have not kept up with roadway rehabilitation and maintenance needs. As a result, some counties had to abandon roadways in order to focus their existing funding on the rest of the network. Management at these counties works diligently to find ways to secure additional funding. In fact, many RTPs, in one form or another, state that securing "funding" or "resources" is a critical policy or objective. Of course, this document and this study will not increase transportation funding to rural counties.

So how do these challenges and limitations relate to performance measurement in general, and how do this document and overall study add value to these rural counties?

§ First, transportation system performance measurement is now more than ever a means by which to maximize the returns on investments, regardless of how small or large the investment may be. In fact, it could be argued that the more limited the resources are, the more critical performance measurement becomes.

§ Secondly, performance measurement allows its practitioners to present their findings to stakeholders and decision makers in a compelling manner. If one competes for funding, one must present its needs in the most compelling way possible. Performance measurement helps do just that.

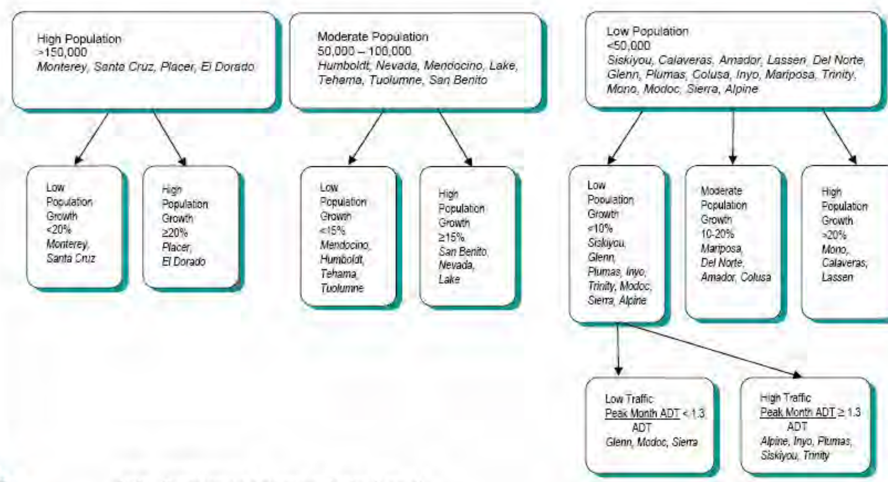
§ Finally, performance measurement facilitates "learning from experience" and promotes "accountability". Institutions evolve over time with management and staff changes. Few organizations, urban or rural, truly evaluate the effectiveness of previous investments and compare it to expected impacts. As a result, some may be destined to repeat previous mistakes or not fully leverage previous successes.

5 County Organization

For reference purposes, Exhibit 2 below is a copy from the Task 2 final report developed by the consulting team. This report uses these categories to the extent possible. However, as will be evident, data collected by rural counties and performance measures used do not differ significantly based on the county categorization presented.

Exhibit 2 – Copy of the County Categorization Presented in Task 2

Figure 13
Categorization of Counties by Population and Tourism Characteristics



Note: Based on data shown in Tables 1 and 8.

6 Performance Data and Measures

The findings are broken down by performance category and include summary statistics and discussion for each. A distinction is made between "monitored" and "forecast" data for performance measure. This distinction is important since most investment decisions are made for the future and hence benefit from a forecasting capability. Monitoring is generally used to assess whether the forecasted performance has been attained and to calibrate transportation models.

SAFETY

- Monitoring Data - The data for roadway accidents are consistent across counties. All counties, to some degree or another, have access to the Statewide Integrated Traffic Records System (SWITRS) and the Traffic Accident Surveillance and Analysis System (TASAS). These systems include all CHP (and sometimes other reported collisions). No specific transit safety measures were identified in the county SRTPs, although we suspect that the data exists to some extent with the transit providers.
- Forecasting Data – None of the counties, nor Caltrans, forecast accidents. This is consistent with national practices.

- Performance Measure – The measures for roadway accidents is collisions (by severity) per million vehicle miles traveled. It is suggested to report collision rates and fatality rates (which is a subset of collision rates). Only a few counties actually report the specific rates in their RTPs, sometimes comparing its facility rates to statewide averages. None of the counties reported trends in accident rates on roadways.
- Remarks – Rural counties generally define safety as a major, if not the major priority in their RTPs. It may be useful for counties to specifically report on accident rates on roadways and include a trend analysis so that decision makers can evaluate the effectiveness of safety related investments (e.g., SHOPP safety projects). It would also be useful for rural counties to track road closures due to weather conditions. This issue was brought up by several stakeholders during discussions, but has generally not been addressed directly in the RTPs.

MOBILITY

- Monitoring and Forecasting Data – sources are shown Exhibit 3 below. Note that the size of the county does not necessarily determine whether or not traffic models are maintained and used. Also note that Caltrans counts are used by every county. For transit, no specific mobility data is used, although all counties report ridership and may report ridership trends.

Exhibit 3 – Mobility Data Source by County

County	Population ((H/M/L)	Population Growth (H/L)	Peak ADT/ADT (L,H,NA)	Monitoring Source	Forecasting Source	Metric
Alpine	L	L	H	Caltrans traffic counts	no specifics	LOS
Amador	L	M	NA	count data, Caltrans data	no specifics	LOS
Calaveras	L	H	NA	count data, Caltrans data	County travel demand model	LOS
Colusa	L	M	NA	count data, Caltrans data	no specifics	LOS
Del Norte	L	M	NA	Caltrans traffic counts	no specifics	LOS
El Dorado	H	H	NA	TDM model and counts	TDM model	LOS
Glenn	L	L	L	count data, Caltrans data	traffic forecasting worksheets	LOS
Humboldt	M	L	NA	Highway Log and some counts from Department of Public Works	Assumes 1.5% increase per year	LOS
Inyo	L	L	H	count data	Not clear, some discussion on projections	LOS
Lake	M	H	NA	TDM model and counts	QRS II model	LOS
Lassen	L	H	NA	no specifics (assessment study under way)	no specifics (assessment study under way)	LOS
Mariposa	L	M	NA	count data, Caltrans data	TDM Model	LOS
Mendocino	M	L	NA	Simple Travel Demand model and counts	QRS II model	LOS
Modoc	L	L	L	electronic counters (State Highways only)	Traffic analysis	LOS
Mono	L	H	NA	count data, Caltrans data	no specifics	LOS
Monterey	H	L	NA	TDM model and some counts	TDM Model	LOS
Nevada	M	H	NA	model and some counts	model	LOS
Placer	H	H	NA	SACMET model	SACMET model	LOS
Plumas	L	L	H	QRS II model and needs study	QRS II model	
San Benito	M	H	NA	no specifics, mentions LOS once	no specifics	LOS
Santa Cruz	H	L	NA	AMBAG model and counts	AMBAG model	LOS
Sierra	L	L	L	Caltrans counts, estimates on local roadways	Transportation Concept Reports Fact Sheets	LOS
Siskiyou	L	L	H	no specifics	no specifics	no specifics
Tehama	M	L	NA	Caltrans D2 - no more specifics	Caltrans D2 - no more specifics	LOS
Trinity	L	L	H	some traffic counts	Traffic analysis	LOS
Tuolumne	M	L	NA	no specifics	no specifics	specifics

- Performance Measure – All counties use Level of Service (LOS) as shown in the same table. Travel time, speeds, and delays were not reported by any county, even those counties with relatively high congestion.
- Remarks – Travel time and speeds could be added to LOS in many counties by using vehicles equipped with speed measuring instrumentation and/or GPS. Count data could be automated at key locations using electronic counting technology that is becoming more affordable. Dependence on LOS is understandable, but does not always allow for trend analysis and for evaluating the effectiveness of smaller congestion relief investments that may ease congestion without changing the LOS.

ACCESSIBILITY

- Monitoring Data – Accessibility is rarely used by any of the rural counties. A couple of counties reported using a GIS system to determine accessibility.
- Forecasting Data – Accessibility is not forecasted.
- Performance Measure – Percent of population within a certain distance to transit was used once relying on GIS.
- Remarks – It is unclear how critical accessibility is to rural counties. GIS is a tool that can help estimate access to transit stations, and even access to essential services such as hospitals.

RELIABILITY

- Monitoring and Forecasting Data – None of the counties mentioned reliability of travel time as a critical need.
- Performance Measure – Not applicable
- Remarks – Some of the counties with relatively high congestion could compute reliability with automatic detection equipment, especially on State Highways and critical local roads and streets.

PRODUCTIVITY

- Monitoring Data – None of the rural counties track roadway productivity (e.g., throughput during peak demand conditions), even those with relatively high congestion levels. Transit productivity data is based on surveys by counties/transit operators.
- Forecasting Data – None of the rural counties forecast roadway or transit productivity
- Performance Measure – For transit, some report transit productivity in terms of passengers (or passenger miles) per vehicle hour. Others just report ridership.
- Remarks – As Caltrans starts reporting productivity on the State Highway System, counties can leverage this data, and possibly augmenting it by applying the same concepts to major arterials.

SYSTEM PRESERVATION

- Monitoring Data – Sources are shown Exhibit 4 below. Note that the use of pavement management systems for roadway preservation is not necessarily dependent on the size of the county in terms of population. Transit vehicle conditions are not usually reported, which is understandable given the generally accepted replacement cycles.

Exhibit 4 – System Preservation Data Sources by County

County	Population ((H/M/L)	Population Growth (H/L)	Peak ADT/ADT (L,H,NA)	Monitoring Source	Forecasting Source
Alpine	L	L	H	no specifics	no specifics
Amador	L	M	NA	Mentions 1999 PMS Study and local pavement management systems	no specifics
Calaveras	L	H	NA	survey	no specifics
Colusa	L	M	NA	no specifics	no specifics
Del Norte	L	M	NA	no specifics	no specifics
El Dorado	H	H	NA	Use a lump sum for rehab in Placerville and El Dorado County, not clear how they prioritize. They do mention which rehab were completed recently and the next target for rehab	no forecast in RTP
Glenn	L	L	L	pavement management system	no forecast in RTP
Humboldt	M	L	NA	Mentions County and City Pavement Management Systems. However, no detail provided regarding current overall pavement rehabilitation needs	no forecast in RTP
Inyo	L	L	H	Not clear, but deficiencies identified by roadway	no forecast in RTP, but rehab strategy identified
Lake	M	H	NA	Pavement management system, study	no specifics
Lassen	L	H	NA	no specifics (assessment study under way)	no specifics (assessment study under way)
Mariposa	L	M	NA	Pavement management system	no specifics
Mendocino	M	L	NA	Mentions PMS Report and updates thereto (used the MTC software)	no forecast in RTP
Modoc	L	L	L	no specifics, mentions the need for more funding	no forecast in RTP, mentions the increased cost over time
Mono	L	H	NA	Mentions county and local pavement management systems	no specifics
Monterey	H	L	NA	Has specific rehab projects but no discussion regarding overall quality. Mentions that some of the pavement are in need to repair.	no forecast in RTP
Nevada	M	H	NA	Identifies some rehab projects, but no specifics on overall needs or costs	no specifics
Placer	H	H	NA	has specific rehab projects by road/location	no forecast in RTP
Plumas	L	L	H	pavement management system, surveys	no forecast in RTP
San Benito	M	H	NA	no specifics	no specifics
Santa Cruz	H	L	NA	Has deferred maintenance estimate	no forecast in RTP
Sierra	L	L	L	no specifics, mentions the need for more funding	no specifics
Siskiyou	L	L	H	no specifics	no specifics
Tehama	M	L	NA	Identifies investment needed to address distressed pavement. Mentions the use of a pavement management system.	no forecast in RTP
Trinity	L	L	H	no specifics, mentions the need for a pavement management system	no forecast in RTP, but rehab strategy identified
Tuolumne	M	L	NA	no specifics	no specifics

- Forecasting Data – The data sources are shown on the aforementioned exhibit. Rural counties, even the ones with pavement management systems, do not forecast the expected conditions. Several counties reported the amount of deferred maintenance.

- Performance Measure – The specific measures were not generally reported. A few counties that did report a measure used a pavement condition index (PCI) or average pavement condition rating (APCR).
- Remarks – By far, preservation is the most critical issue for most rural counties. Some of the higher populated counties are the exception. Overall, there seems to be more emphasis on the use of pavement management systems. The cost associated with collecting pavement condition data may be mitigated by using a random sample as an indicator for the county. Although not precise, it can then be used in conjunction with pavement management software to demonstrate the incremental cost of deferring maintenance and rehabilitation investments. Cooperative agreements among neighboring counties may also offer some economies of scale for data collection.

RETURN ON INVESTMENT / LIFE CYCLE COSTS

- Monitoring Data – None of the rural counties (or urban counties that we know of) routinely monitor to compare how the return on investment or life cycle costs of projects compare to the estimates before project completion.
- Forecasting Data – Many rural counties forecasted different data to reflect cost effectiveness. However, none specifically projected ROI or life cycle costs for projects or for the RTP as a whole.
- Performance Measure – For transit, subsidy per passenger was reported as a measure of cost effectiveness and goals were set to maintain acceptable levels for the measure. For roadways, a few reported an interesting measure: construction cost per new trip.
- Remarks – Cost effectiveness will become increasingly important to decision makers. Rural counties that have travel demand models could estimate the total ROI on their RTIP projects by computing total travel time with and without the RTIP investments and then relying on a tool such as the Caltrans Benefit Cost model to derive the ROI. It is understandable for counties that do not have a travel demand model the computations would be more difficult. For pavement rehabilitation investments, pavement management systems can derive the incremental costs of deferring maintenance, which can then be used as a proxy for cost effectiveness.

ENVIRONMENTAL QUALITY

- Monitoring and Forecasting Data – Counties in non attainment areas must comply with federal and state regulations and generally use travel demand models for their EIR process.
- Performance Measure – Counties in non attainment areas must show compliance with federal and state regulations by certain dates. So they have to demonstrate such attainment goals using the outputs of their travel demand models.

- Remarks – Beyond non-attainment issues, rural counties are probably better positioned to decide on which measures are important to their region and how to track these measures. It is probably beyond the scope of this project to identify every environmental quality factor or data source.

ECONOMIC DEVELOPMENT

- Monitoring Data – Most rural counties report on population, employment, and other economic activities and measures.
- Forecasting Data – Some counties identify specific projects slated to help economic development in the region or locality.
- Performance Measure – Employment and sometimes revenues are used.
- Remarks – Economic development is a local concern and can be measured and reported in different manners. Some economic input output models exist (e.g., Regional Economic Modeling Inc. or REMI) that could be used to estimate the economic impacts of different investments.

7 Performance Measures for RTS

In developing suggested performance measures for RTS, several conclusions from the performance data analysis were taken into account. These conclusions are summarized below:

- The categorization criteria (i.e., population and population growth) may not be appropriate for developing the final guidance related to RTS performance measurement. One alternative may "be where the county is at" in terms of performance measurement, associated data collection, and the use of tools. For instance, counties that are maintaining travel demand models may be best served by providing guidance on how to use these models to compute different performance measures (e.g., travel time, delay, and benefit-cost ratios). Others that do not maintain such models may best benefit from approaches to collecting sample data and estimating future conditions using other tools.
- The two most important areas related to RTS are preservation and existing/emerging congestion. Many rural counties collect data related to these categories of performance. However, even the ones with the most data do not report trends of their performance. For instance, not one rural county presented trends of congestion or trends in pavement quality over time. This may be one area this study can address. Monitoring trends not only provides a reference point (i.e., how are we doing today compared to before), but it allows decision makers at all levels to assess the effectiveness of past decisions and take this information into consideration when making decisions for the future. Note that this is a remark that is also applicable in many ways to Caltrans and urban regions as well.
- Pavement management systems are used by several counties to assess the maintenance needs of their roads (and sometimes bridges). It is unclear how sophisticated some of these systems are. However, there are many such systems that not only summarize today's conditions, but can help prioritize investments and project future conditions. These types of capabilities are important, since the highest priority may not always be the worst pavement.

Rather, it may be the investment that will save the county the most in the long run. It may be possible for rural counties to combine their resources to acquire PMS software with such capabilities at relatively low costs. Of course, these systems are only as good as the data in them. For pavement condition data, it may be useful for rural counties to plan an update cycle of four years since that is the period now required for their RTP updates. For rural counties that simply do not have the resources to complete such an update every four years, a sample of critical county and local roads should be considered as a proxy.

- The use of LOS for mobility is not conducive for trend analysis. Unless there is significant congestion, LOS can be augmented with travel time and speeds using relatively simple Highway Capacity Model approaches. For areas with significant congestion, the use of roving cars and/or electronic detection may be less expensive than currently perceived.
- Productivity is a relatively new performance category and the rural counties with relatively high congestion should consider monitoring it so that they can assess the effectiveness of operational strategies (e.g., ITS, ramp metering, and auxiliary lanes).
- Transit performance data and measures are comprehensive, partly due to reporting requirements. Note that the new federal transportation re-authorization bill requires smaller operators to report on their performance, which will make their data more comprehensive and accessible.
- Accessibility, if deemed important by certain rural counties, can be computed fairly easily using GIS.
- Safety statistics and especially safety trends are not generally reported by rural counties even though reasonably good data exist. This may be due to liability concerns. However, for safety project effectiveness monitoring, the before and after project completion would be useful.

As a result, the suggested performance measure by category should be evaluated by each rural county in terms of usefulness and linkage to county priorities. If mobility is not an issue for a given county, then the mobility related performance measures will not be needed. The following represents the suggested performance measures and uses of these measures by category. Where appropriate, examples are provided to help understand the suggestion and illustrate its use.

<u>Also note that several of the suggestions are resource intensive and complex. They are meant to demonstrate the current state-of-the-art in performance measurement in California. However, if resources are unavailable, or the given performance category is not critical to a rural county, the suggestions would obviously not apply. Examples of such suggestions include measures for the productivity and reliability categories discussed below. These two would only be relevant to a few counties and only if resources are available to implement them.</u>

Safety Performance Measures

Safety performance measures include total number of accidents by category (e.g., fatal, injury) and accidents per million vehicle miles traveled. Regardless of which measures the rural counties prefer, they should consider tracking the safety trends over time. This allows for annual comparisons and evaluating the effectiveness of safety specific investments (e.g., the safety program within SHOPP).

Using the same data sources as currently used by the rural counties (e.g., TASAS), a trend chart can be easily developed as shown in Exhibit 5, which shows average daily accidents by month for portions of the 880 corridor in the Bay Area. Note that the downward trend since early 2002 which was caused in part as a result of implementing ramp metering and improving incident management practices.

It would also be useful for rural counties that experience many road closures due to weather to track the percent of time that critical roads are closed.

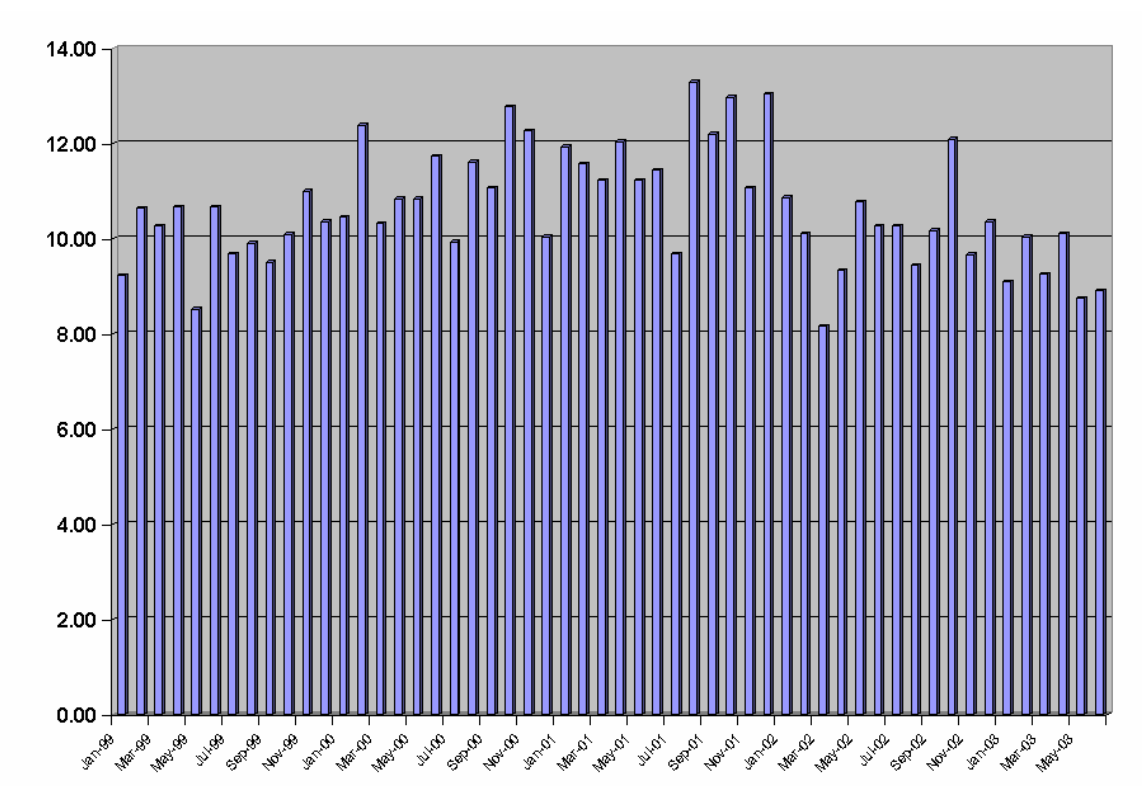


Exhibit 5 – Average Daily Accidents by Month for the Alameda 880 Corridor

In summary, the rural counties are familiar with safety data sources and use them frequently. They should consider augmenting their analysis to include longer term trends to assess the effectiveness of implemented safety projects or operations practices.

Mobility Performance Measures

It is suggested for counties with congestion problems/issues to use more than LOS as a performance measure. Although LOS is used extensively by many rural counties, it does not lend itself to trend analysis over time. Three measures are suggested for consideration:

- Travel time between major origin destination (OD) pairs – From a monitoring perspective, this measure requires the use of probe vehicles to record time and speeds or use automatic detection equipment. If detection equipment is used, then travel times must be computed as follows by dividing the distance between the origin and destination by the average speeds

  Travel Time (in hours) = Distance (in miles) /Speed (in miles per hour)

  As conditions change over time, the trend of travel times can illustrate the improvement or worsening of conditions. For counties that use travel demand models, travel times can be estimated for forecasting purposes. Note that aggregating travel times for multiple corridors or for an entire county is not recommended. In our experience, it is best used for individual OD pairs.
- Speed – Average speeds on congested corridors or segments within corridors can also be monitored using probe vehicles and forecasted with travel demand models. Similar to travel time, it is not recommended to aggregate speeds across time periods, corridors, or for an entire county.
- Delay – Delay is a measure that subtracts travel time under ideal conditions (e.g., posted speeds) from the actual travel times experienced. Again, travel times can be monitored using probe vehicles or detection equipment. In addition, delay can be easily forecast with travel demand models. Delay computations are shown below:

Actual Travel Time (in hours) = Distance (in miles) /Actual Speed (in miles per hour)

Optimal Travel Time (in hours) = Distance (in miles)/Posted Speed (in miles per hour)

Delay = Actual Travel Time – Optimal Travel Time

Several examples are shown for illustration purposes. Exhibit 6 shows a trend analysis of delay by Caltrans district from the 2001 Highway Congestion Monitoring Program (HICOMP) report. These results were developed using the combination of probe vehicles and automatic detection.

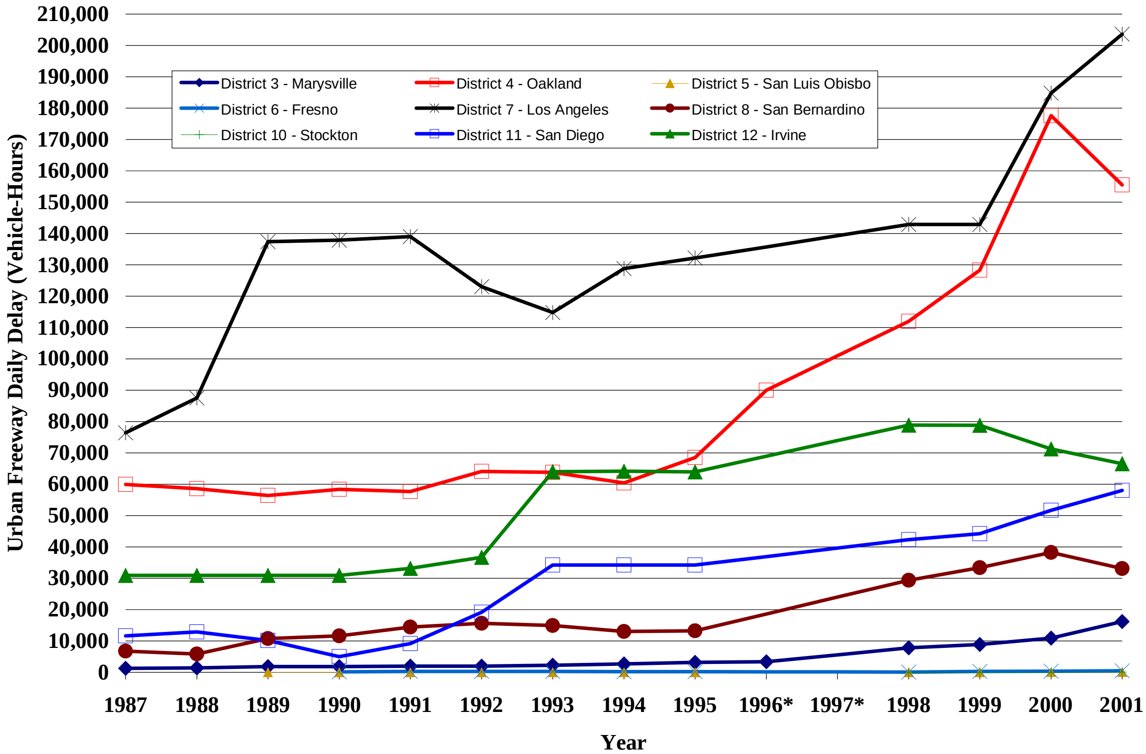


Exhibit 6 – Daily Vehicle Hours of Delay by Caltrans District

Note that if counties can install automatic detection equipment on their roads, they can transmit the data to the Performance Measurement System (PeMS) that will in turn provide most of the mobility statistics discussed in this section. The system can be accessed at: http://pems.eecs.berkeley.edu/.

The next example illustrates the use of travel times between major origin-destination pairs. Exhibit 7 is from the Metropolitan Transportation Commission's (MTC) annual State of the System Report. Note that MTC ranks the commutes and compares ranking over a four year period. The report is accessible at: http://www.mtc.ca.gov/library/state_of_the_system/

Bay Area Freeway Locations With Most Delay During Commute Hours, 2004

2004 Rank	Location	2004 Daily (Weekday) Vehicle Hours of Delay	2003 Rank	2002 Rank	2001 Rank	2000 Rank
1	**Interstate 80, westbound, a.m.** — Alameda/Contra Costa County *State Route 4 to Bay Bridge metering lights*	10,080	1	1	1	1
2	**Interstate 580, westbound, a.m.** — Alameda County *North Flynn Road to Airway Boulevard*	5,120	3	5	12	14
3	**Interstate 580, eastbound, p.m.** — Alameda County *Hopyard Road to west of El Charro Road*	4,320	3	3	5	13
4	**U.S. 101, northbound and Interstate 80, eastbound, p.m.** — San Francisco *Cesar Chavez Street to west end of Bay Bridge*	3,840	2	4	4	5
5	**Route 92, eastbound, p.m.** — Alameda County *Clawiter Road to I-880 interchange*	3,760	15	35	11	8
6	**Route 4, westbound, a.m.** — Contra Costa County *Lone Tree Way to west of Loveridge Road*	3,600	5	7	15	32
7	**U.S. 101, southbound, a.m.** — Marin County *North of Route 37 to Interstate 580*	3,110	6	9	8	6
8	**U.S. 101, northbound, p.m.** — Marin County *Route 1 to north of Interstate 580*	2,680	20	16	22	22
9	**U.S. 101, northbound, a.m..** — Santa Clara County *Interstate 280 to north of Trimble Road*	2,560	14	14	42	19
10	**Interstate 80, eastbound, p.m.** — San Francisco and Alameda counties *West of Treasure Island to east of Powell Street*	2,430	18	38	34	41

Sources: Metropolitan Transportation Commission, Caltrans District 4

Rankings are for routes in which continuous stop-and-go conditions occur with few, if any, breaks in the queue. Thus, corridors that have equally severe delays, but where congestion is broken into several segments, may rank lower in this type of congestion listing.

Exhibit 7 – Travel Time by Major OD in the Bay Area

The final example illustrates the use of travel demand models to project future speeds and delay. Exhibit 8 is from a report generated by the Southern California Association of Governments (SCAG) during the development of the region's 2004 RTP. Rural counties do not necessarily need to develop projections, but if they maintain travel demand models, they can summarize their performance projections in a similar manner.

```
 Total Modeling Area (Daily)
   Avg Mix-Flow Speed                        38.7867
   Avg HOV Speed                             40.6253
   Avg Arterial Speed                        25.7269
   Avg Speed (All Facilities)                29.6171

 Total Modeling Area (3hr AM Peak)
  Avg Mix Flow Speed                         31.2880
  Avg Hov      Speed                         34.0414
  Avg Arterial speed                         22.9157
  Avg Speed (All Facilities)                 25.5689

-Vehicle Miles Traveled (VMT)
  Light and Medium Duty Vehicle            489132087
  Heavy Duty Truck                          34786677
  All Vehicles and trucks                  523918764

-Vehicle Hours Traveled (VHT)
  Light and Medium Duty Vehicle             16515183
  Heavy Duty Truck                            916927
  All Vehicles and trucks                   17432110

-Vehicle Hours Delayed
  Light and Medium Duty Vehicle              4709741
  Heavy Duty Truck                            232720
  All Vehicles and trucks                    4942461
```

Exhibit 8 – Travel Demand Speed and Delay Results from SCAG

The results from the SCAG model are automatically generated for year 2030. For speed, it averages out speeds across each link of the network modeled weighted by the vehicle miles traveled. Delay is calculated as previously defined for each link and then added up for the entire network.

Of course, the examples provided are from major urban counties and districts. They do illustrate how the measures can be monitored and projected for the future. Rural counties that experience significant congestion should consider the following:

- If they do have a travel demand model they use for RTP development purposes, they generally calibrate these models with selected field measurements. They can then report on current delay, speeds, and travel times using their base year model and project the future performance measures using the forecast year model runs.
- If they do not have travel demand models, they should consider collecting sample data for major corridors and/or major OD pairs. The use of probe vehicles is generally less expensive for one-time measurements. However, implementing automatic detection technology on sample corridors would provide continuous performance data and may be less expensive over time. Note that technology is evolving quickly and new detection technologies are emerging that are a fraction of the cost of older technologies.

ACCESSIBILITY PERFORMANCE MEASURES

As mentioned in the previous section, accessibility is rarely used by rural counties. When used, it generally focuses on transit and the measure used is percent of population within a certain distance from a bus stop.

One Steering Committee member voiced interest in an additional measure for "redundancy" to reflect how many rural county residents have only one way to access the State Highway System. If for some reason that access is removed, these residents would obviously be isolated. Presumably by identifying such cases, a rural county would work with Caltrans to potentially add a new access approach linking the local roadway system to the SHS.

Research on this specific category did not yield any results. However, if a rural county has a full GIS system with the primary local roads and the State Highway System (SHS), it would be possible to estimate the first and second fastest ways to access the SHS. The difference between these two can then be used to reflect whether "redundancy" is a problem or not.

For instance if a given community can access the SHS at a given location in 5 minutes, but would require 40 minutes to access a different location, then 35 minutes would be the difference. Obviously, if there are communities that do not have any secondary SHS access, then redundancy for that community would be need and an issue.

Of course, this measure would need to be tested before it can be recommended to the rural counties. It would at a minimum require:

- A full GIS for the county with critical local roads and the SHS
- Population layers, which are available at Caltrans (e.g., by zip code)
- Analytic capability for shortest path algorithm (available with some GIS software)

Travel demand models can also be used for this analysis, but would require manually removing links from the system and then re-running the model, which would be very cumbersome and resource intensive.

While GIS roadway and demographic data layers are readily available at low cost, GIS software and technical expertise may not be readily available for some rural RTPAs. A low-cost option could be to use one of the commercially available street mapping software programs. One example is the DeLORME Street Atlas USA program.

These programs (which generally cost less than $100) typically include an extensive network of state, local, and Forest Service roadways, and allow the non-technical user to enter in a trip origin (such as a community) and destination (such as an external point to the county highway network). The program then calculates the travel time and distance. Individual links then can eliminated from the routable network to identify the impact that loss of a key roadway link would have on travel time/distance.

One note of caution is that these programs typically assume an average travel speed for various classifications of roadway types. Optimally, the analyst would review these default speeds and, as necessary, specify speeds that are appropriate for locally-observed conditions.

RELIABILITY PERFORMANCE MEASURES

Reliability is a category that may be of interest to rural counties facing increasing congestion. However, it requires detailed data for a large sample of days. This means that it is not cost efficient to rely on probe vehicles to collect such data. Automatic detection is required.

Once automatic detection is available, hourly or peak period travel time data for major OD pairs is compiled and a measure for reliability can be computed. The method used by Caltrans is to divide the standard deviation of travel time by the average travel time. The result can then be displayed as a percentage. A high percentage would reflect high variability in travel time. This may be due to accidents, re-occurring special events, or other factors that cause travel time to vary.

An illustrative example is shown on Exhibit 9. It shows reliability for 20 OD pairs in District 7 in Los Angeles, 10 during the AM peak period, and 10 during the PM peak period. The X-axis shows designated the OD pair (e.g., AM02 is the second OD pair for the AM peak period) as defined by the SCAG model as major.

The Y-axis shows the variability of travel time. Looking at PM04 for example (pointed to by the arrow), one can see that travel time varies the most during the second hour of the PM peak period (between 4 and 5 pm). If a traveler wants to minimize the chances of encountering unexpected delays, he/she would be better served leaving earlier or later.

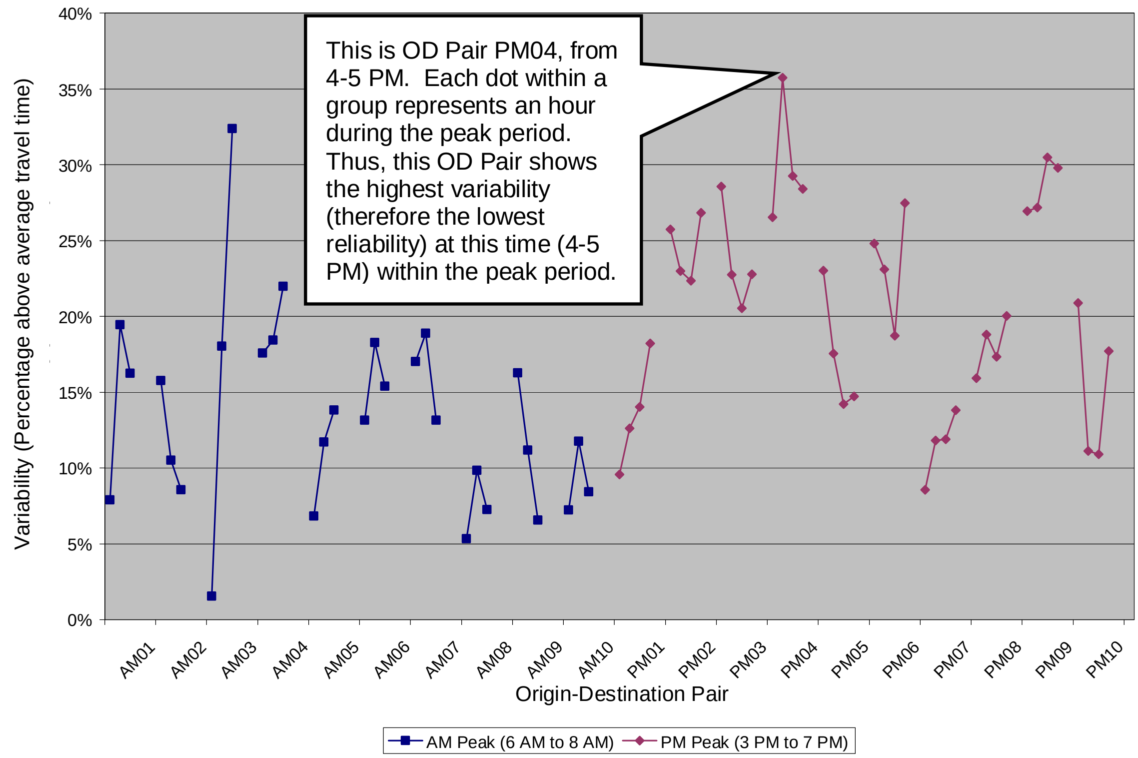


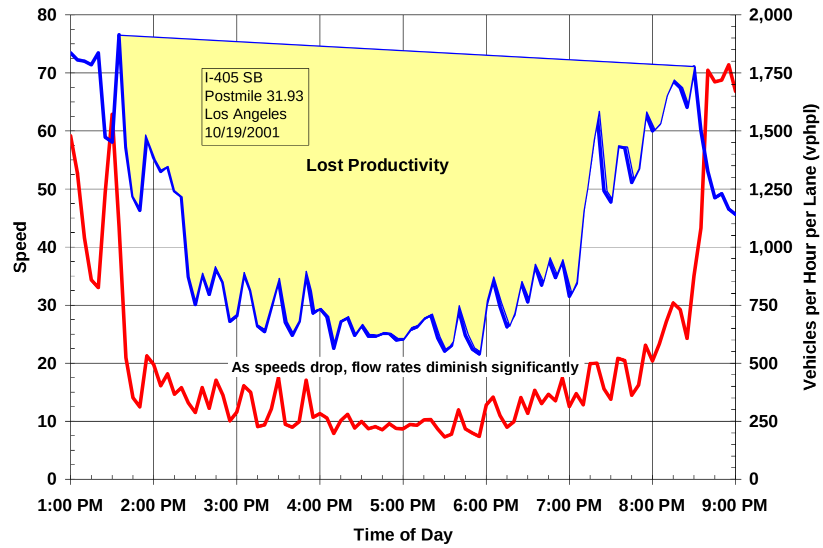
Exhibit 9 – Example Reliability Results in District 7, Los Angeles

This measure is used by several agencies besides Caltrans and helps evaluate the effectiveness of incident management and special event management strategies.

PRODUCTIVITY PERFORMANCE MEASURES

Productivity for roadways is another category only of interest to rural counties experiencing growing congestion. It reflects how well the system is operating under high demand conditions. Like reliability, it cannot be measured without automatic detection.

Throughput is used by Caltrans and “equivalent lost lane miles” is another one worth noting. Throughput is computed by dividing actual volumes going through a point of the roadway by the design capacity of the roadway. For instance, freeways are designed to carry up to 2,000 vehicles per lane per mile. As Exhibit 10 shows, when congestion occurs, this throughput can decline dramatically, most often because of merges and weaving. In the example below, throughput declines to below 50 percent of the design capacity at the bottleneck. This means that the section of the freeway acts as a “smaller” facility due to excessive merging and weaving. This can happen at an interchange with heavy traffic flowing onto the freeway from an on-ramp or another freeway, when an accident occurs that closes one or more lanes forcing significant merge activity, or even when a lane is dropped (e.g., when it goes from 5 to 4 lanes).



Source: Performance Measurement System (PeMS) – October 2001
Vphpl: volume per lane per hour

Exhibit 10 – Lost Productivity Example Using Automatic Detection

Using throughput is a useful way to analyze corridors and bottlenecks. It does pose challenges when one attempts to aggregate it across corridors. One way to address these challenges is to compute the lost capacity for each segment in terms of lane miles. SCAG does this type of aggregation for their entire freeway segment and reports on region-wide effective lost lane miles as shown in Exhibit 10 for District 7 in Los Angeles. This measure reflects the aggregation of all shaded areas similar to the area in Exhibit 9.

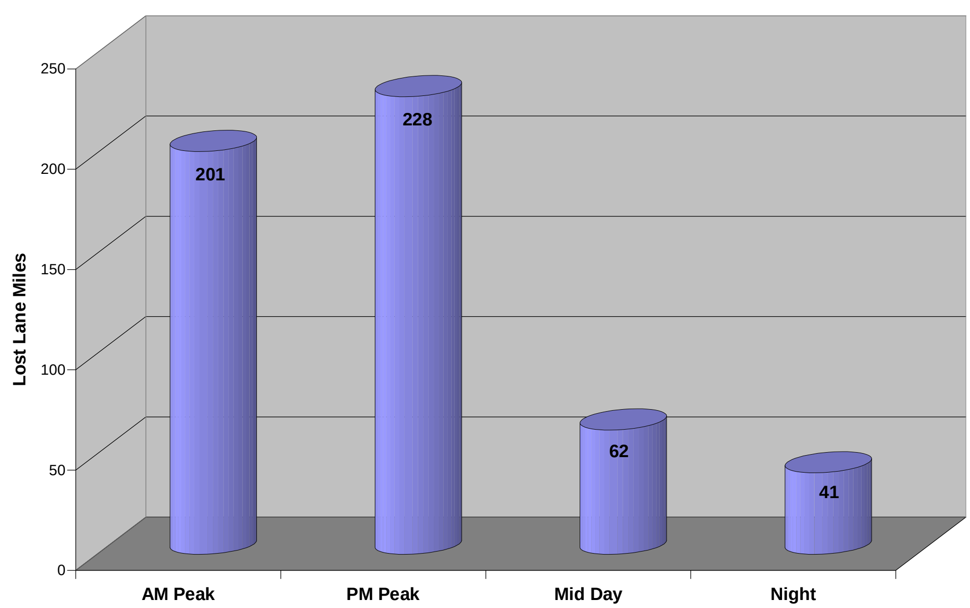


Exhibit 11 – Lost Lane Miles by Time Period for District 7 in Los Angeles

The lost lane miles can also be used to communicate the equivalent cost of lost productivity to decision makers by multiplying the results by the cost per lane mile for freeway construction of a given region.

Preservation Performance Measures

As mentioned before, preservation is generally the most critical priority for most of California's rural counties. Pavement management systems are the primary tools for measuring the conditions of the SHS or local roads. Rural counties rely on Caltrans for the SHS portion of their RTS. For local roads, rural counties have used an assortment of pavement management systems (PMS).

A true PMS must have several components: an inventory of current conditions, algorithms that estimate pavement decay over time, costs for different pavement improvement projects, and an optimization capability to identify the most cost effective projects under different investment scenarios.

Such a system helps decision makers allocate their resources as optimally as possible. Note that some counties may have systems that only provide partial PMS capabilities (e.g., summarizing current conditions) without the predictive capabilities. Others may be storing their condition data in spreadsheets only.

It is suggested for all counties to try and use true PMS if the can afford to. These systems not only allow users to summarize current conditions and deficiencies, they generally project future conditions under different funding scenarios. Although such projections would by no means guarantee increased funding in the future, they serve to let decision makers and the public at large understand the current and future fiscal challenges that their RTS faces.

Caltrans has helped collect pavement condition data in rural counties for federal HPMS reporting purposes for some time. It is unclear whether these counties are fully leveraging the data collected by Caltrans. It is therefore suggested for counties to work closely with Caltrans to obtain the data and leverage it to the extent possible. Moreover, rural counties that do not have a pavement management system may consider relying on the HPMS, which does allow for pavement condition reporting. Consistent with other performance categories, it is also suggested to include a trend analysis of pavement conditions over time.

Exhibit 12 (from a Caltrans SHOPP report) shows how the cost of pavement maintenance can vary drastically when organizations defer maintenance. This type of exhibit can normally be generated by true pavement management systems. Note how the costs can more than quadruple as conditions deteriorate.

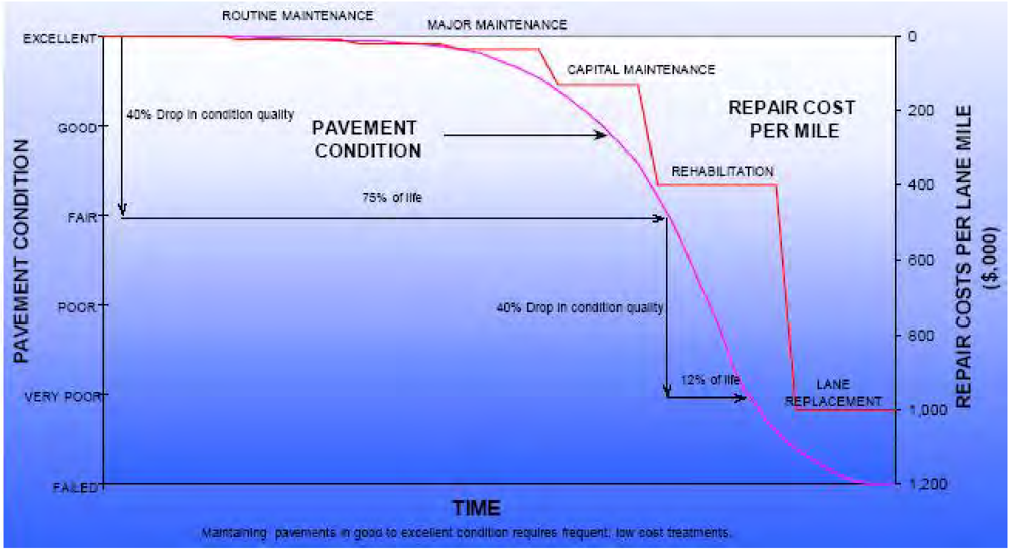


Exhibit 12 – Pavement Condition versus Cost of Repair

To summarize, rural counties that currently have true pavement management systems should investigate whether they are leveraging the pavement condition data collected by Caltrans and obtain the data to update their systems as appropriate.
Rural counties that do not have pavement management systems or have only partial PMS capabilities should consider obtaining the software from other agencies and leveraging the Caltrans data. Alternatively, they may consider using the HPMS system directly to report on pavement conditions. For more information on HPMS, counties can access the Caltrans web information at http://www.dot.ca.gov/hq/tsip/hpms/index.html . They can also access additional federal web information at http://www.fhwa.dot.gov/policy/ohpi/hpms/ . Finally, all counties should consider including trend analysis for their pavement conditions to alert of impending challenges or report on progress achieved.

RETURN ON INVESTMENT / LIFE CYCLE COSTS

Return on investment communicates to decision makers what the value the public can expect compared to the investments planned and programmed. Rural counties do not use this measure, but are encouraged to consider it. One way to approach this is to use the Cal-B/C model developed by Caltrans. It allows for project evaluation and in fact gets used for most STIP projects submitted. The model can be directly downloaded and the associated user documentation is accessible via the web at: http://www.dot.ca.gov/hq/tpp/offices/ote/benefit_cost.htm .

This model can be useful to rural counties that do not maintain travel demand models since it has Highway Capacity Manual (HCM) computation capabilities that estimate project benefits. Note that it has analytic capabilities for project types that may be of interest to some rural counties such as truck climbing lanes and passing lanes. It also provides for the ability to estimate user benefits from pavement projects. For counties with increasing congestion, the model translates other measures such as delay and accidents into economic value in dollars and divides these monetized benefits by the costs of the projects.

Chapter 5

Case Studies

Chapter 5

Case Studies

This report carries out the guidance based on Chapter 4 of this report and described in the Guidebook, using actual data and input from selected rural counties. This chapter demonstrates step-by-step application of the methodologies and attempts to address any difficulties encountered so that future use of the methodologies will be straightforward.

Through stakeholder outreach and input, actual data for the case studies was obtained from rural counties in California where available for each of the seven main performance categories, as summarized in the table below.

Performance Category	Data Used for Final Case Study (obtained from public channels where applicable)
Safety	§ AADT § Accident data § Population § Vehicle Registration From Modoc
System Preservation	§ Pavement Condition § Maintenance Information § Current PMS Status From § Plumas (Basic) § Mendocino (Intermediate) § Nevada (Advanced)
Mobility	§ Speeds and Travel Times from Route 1 project in Santa Cruz § Used Route 17 detector data in Santa Cruz available from PeMS to demonstrate Proof of Concept
Accessibility	§ Accessibility time difference between fastest route to State Highway System (SHS) and second fastest route to SHS § Used generic data from Trinity County and demonstrated Intermediate guidance using mapping software capabilities. Cost of mapping software was approximately $60.
Reliability Productivity	Used Route 17 detector data in Santa Cruz available from PeMS to demonstrate Proof of Concept
Return on Investment	No Case Study since no data available; instead, explanation of Cal-B/C model is offered as a starting point

As in the Guidebook, case studies in this chapter are presented at different levels based on the following degree of performance measurement maturity:

Basic No or little standardized performance measurement

Intermediate Somewhat standardized performance measurement, often using current tools and methods

Advanced Regular or frequent performance measurement using current tools and methods

Please consult the Guidebook for the full step-by-step methodologies.

If a rural area:	Safety measurement capabilities could be considered:	Safety would be measured using:
§ Needs to analyze safety at various specific locations	Basic	§ Accident data and traffic volumes (AADT) as shown

The accident rate was calculated using the following equation:

$$AR = \frac{A \times 1{,}000{,}000}{L \times Y \times AADT \times 365}$$

Where:

AR = Accident rate per million vehicle miles traveled

A = Number of accidents

L = Length of the segment in miles

Y = Number of years

AADT = Average annual daily traffic along the corridor

365 = Number of days in a year

Œ **Compile Accident Data.** This data was received from the local agency. For this Case Study, Route 1 was investigated in the year 2005. From accident data, this roadway had a total of 6 accidents.

- **Determine Roadway Length.** A computer street atlas program was used to measure the length of the roadways within the county in miles.

Ž **Calculate Average Annual Daily Traffic (AADT).** Data from the local agency was obtained.

	A	B	C	E	G	H	I	J	K	L	M
6	Road	Mile									
7	Station	Post	Location	Class					Year and Count		
8	1-1N	33.541	South of 49 Lane	Major	8/5/1977	5/20/1985	**8/1/2005**				
9	1-1N				263	365	**588**				
10	1-2N	71.000	Bridge - Ore. St. Line	Major	4/24/1992	7/31/1995					
11	1-2N				15.28	18.1					
12	1-3N	69.195	Cowhead Pit Road	Major	4/24/1992	7/12/1993	7/31/1995	10/9/1996			
13	1-3N				19.7	49	34	55			
14	1-4N	**56.335****	North of Ft. Bidwell	Major	7/31/1995	**7/12/02****					
15	1-4N	55.710			160.1	**167****					
16	1-5N		100 yd. West of CR 6	Major	5/20/1985	7/17/1989					
17	1-5N				98	132					
18	1-6N	53.551	South of Ft. Bidwell	Major	8/11/1977	5/20/1985	7/17/1989	7/31/1995	**8/1/2005**		
19	1-6N				232	211	230	344.3	**274**		
20	1-7N	**39.714****	North of Lake City	Major	7/21/1995	**7/12/02****					
21	1-7N	39.488			310	**291****					
22	1-8N	29.663	North of Cedarville	Major	8/5/1977	9/14/1979	5/20/1985	7/17/1989	7/21/1995	**7/2/2002**	**8/1/2005**
23	1-8N				845	593	655	822	844	**836**	**805**
24	1-9S	27.454	South of Cedarville	Major	9/8/1977	9/14/1979	5/13/1985	9/28/1988	7/21/1995	**7/2/2002**	
25	1-9S				630	548	478	652	724.9	**586**	
26	1-10S	15.200	North of CR 35	Major	**9/14/2001**						
27	1-10S				**372**						
28	1-11S	14.547	North of Eagleville P.O.	Major	9/8/1977	5/13/1985	9/28/1988	7/21/1995			
29	1-11S				338	248	317	470.1			
30	1-12S	13.072	South of Eagleville	Major	5/13/1985	9/28/1988	**6/21/2002**				
31	1-12S				168	251	**281**				
32	1-13S	3.513	Lassen County Line	Major	5/13/1985	7/12/1993	7/21/1995	**10/6/1995**			
33	1-13S				105	218	218	**254**			
34	1-14S	3.000	South County Line	Major	**9/14/2001**						
35	1-14S				**186**						
36	1-15S	0.000	Nevada State Line	Major	9/8/1977	5/13/1985					
37	1-15S				108	72					
38	2-1		East of SR 395	Rural	8/27/1977	10/9/1985	8/7/1989				
39	2-1				66	185	67.8				

ADT

AADT data from Local Agency

There were three counts taken in 2005, so these values will be averaged for an AADT of 556.

- **Perform calculation above.** A spreadsheet was created to compile the necessary data as shown below. The blue cells represent where data was entered according to the information gathered, and the equations were calculated in the 'Accident Rate' row to show the resulting rates for each year for the specific roadways.

County Road 1

Accidents	6
Length	67
# Years	1
ADT	556

Year 2005

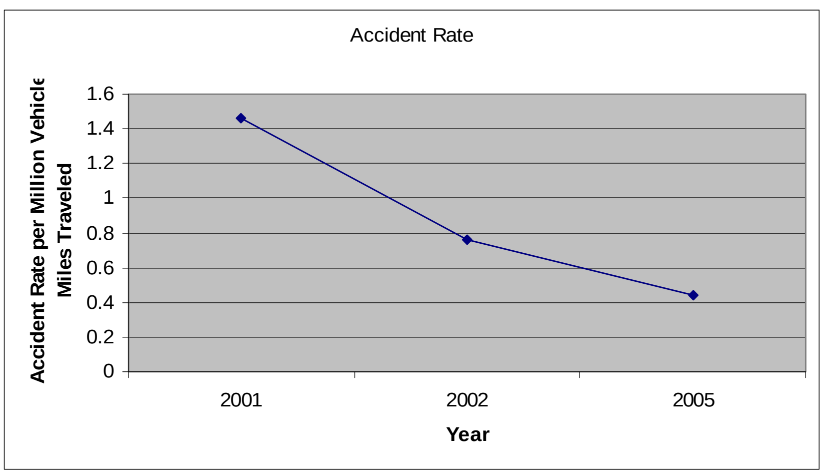
Accident Rate 0.441274

- **Analyze trends over time.** To trend over time, repeat steps Œ through • for the years that will be trended.

Accidents	10	8	6
Length	67	67	67
# Years	1	1	1
ADT	279	432	556
Year	2001	2002	2005
Accident Rate	1.465643	0.757249	0.441274

Then, create a line graph to show the year versus accident rate to trend over a span of years as seen below.

County Road 1



Note: Data was not available for 2003 & 2004; downward trend between 2002 and 2005 therefore should be interpreted with caution.

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System Preservation

If your rural area:	You could be considered:	Your possible goals could include:
§ Has no pavement monitoring § Manages pavement database in Excel or other spreadsheet program § Performs reactive maintenance based on citizen requests	Basic	§ Formal pavement inspections § Spreadsheet-based pavement inventory § Record of current and future maintenance needs
§ Maintains a formal PMS § Generates PCI reports § Records maintenance information § No forecasting	Intermediate	§ A fully updated PMS § A PMS to generate reports to assess pavement condition and allocate resources § Maintenance records in PMS for use with funding scenarios to plan for future needs
§ Has the characteristics of Intermediate programs § Forecasts future deterioration, maintenance § Utilizes funding forecasts to allocate resources	Advanced	§ A fully updated PMS and a GIS linking it with PMS information

Case Study Basic

The case study county selected to represent a Basic pavement management system currently maintains an Excel database containing the length (in miles) of roadway for each street, miles paved and unpaved, ADT, and functional classification. Data is forecast based on previous maintenance and basic field visualization, maintenance needs from 1-15 years in the future, as seen below.

Functional Classifications:
FED-Aid 7 Major Rural Collector
8 Minor Rural Collector
9 Local Road

ADT = Average Daily Traffic where available.
Estimates for Existing ADT based on land use and Trip Generation Manual.
Future Estimates based on existing studies and annual growth rate.

	Maint. Dist.	ROAD #	NAME	LENGTH (MILES)	PAVED	UNPAVED	Functional Classification	2005 ADT	Date of ADT or Estimated	2010 ADT	2015 ADT	Needs: 1-5 Yrs (Miles) Reconstruction	Needs: 1-5 Yrs (Miles) Overlay	Needs: 1-5 Yrs (Miles) Chip Seal	Needs: 6-10 Yrs (Miles) Reconstruction	Needs: 6-10 Yrs (Miles) Overlay	Needs: 6-10 Yrs (Miles) Chip Seal	Needs: 11-15 Yrs (Miles) Reconstruction	Needs: 11-15 Yrs (Miles) Overlay	Needs: 11-15 Yrs (Miles) Chip Seal	COMMENTS
10	1	102		0.218	0.218		9						0.100	0.100						0.218	Railroad Xing Project delayed, difficult to plow sno
11	1	102A		0.526	0.526		9							0.526						0.526	
12	1	102B		0.072	0.072		9							0.072						0.072	
13	1	103		3.910	0.200	3.710	9					0.500								0.200	Grind, recompact and pave
14	1	104		0.310	0.310		9										0.310				
15	1	105		1.790		1.790	9														
16	1	106		2.820	1.520	1.300	9	100								1.300				2.820	Grindings placed on unpaved portion in 2005
17	1	107		3.260	0.260	3.000	9										0.260				Known as Marble Hot Springs Road on West End, I
18	1	107		6.930	6.930		8	180					1.000	1.000						6.930	
19	1	108		4.320	4.320		8	390												4.320	
20	1	108A		0.460	0.050	0.410	9										0.050				
21	1	109		8.630	8.630		7	750					4.800							8.630	3.8 mi. Chip Sealed in 2002, 4.8 mi. on STIP Pendin
22	1	109B		0.190		0.190	9														
23	1	110		0.006	0.006		9										0.006				
24	1,2	111		25.178	5.500	19.678	9	120												2.000	CFLHD Proposes project through Mapes Canyon
25	1,2	112		18.000	5.000	13.000	9	610					2.000							5.000	
26	1	112		6.360	6.360		7	960												4.000	Depends on the extent of the developer's work
27	1,5	114		1.849	1.849		8	1650									1.849				
28	1	117		3.750	3.750		8	400						3.750						3.750	1.1 Miles Overlaid in 1999
29	1	117A		3.230		3.230	9														
30	1	118		3.000	3.000		9													3.000	
31	1	119		0.038	0.038		9													0.038	
32	1	120		0.040	0.040		9													0.040	
33	1	121		1.250		1.250	9														
34	1	122		1.051	1.051		9						1.051							1.051	
35	1	123		0.140	0.140		9							0.140						0.140	
36	1	124		2.273	2.273		9	300					2.273							2.273	Severe pavement distress needs immediate overla
37	1	124A		0.161	0.161		9						0.161							0.161	End of Rocky Point Rd. @ church, Proposed City c
38	1	124B		0.239	0.239		9							0.239						0.239	
39	1	125		0.966	0.966		9						0.966							0.966	Old highway alignment east of Rest Area.
40	1	125A		0.114	0.114		9						0.114							0.114	East terminus of old hwy alignment.
41	1	126		7.195	7.195		7	510					4.200	2.500						7.195	4.2 miles Overlay on STIP Pending List
42	1	127		0.265	0.265		9										0.265				
43	1	128	OLD GRIZZLY ROAD	0.668		0.668	9														Old road alignment. Very little use.

dist1 dist2 dist3 dist4 dist5 TotalMileage

Ready NUM

Excel Maintenance Database from Basic Case Study

This information is compiled for each district in the county, and summed up in a 'State of the Pavement' spreadsheet that applies dollar amounts to the maintenance required based on previous costs. These values are summed up for 1-5 years, 5-10 years, and 10-15 years in the future, including a goal for the current maintenance season and the STIP funds available during the current funding cycle.

	A	B	C	D	E	F	G	H	I	J	K
1	**2006 STATE OF THE PAVEMENT**			678.963	in 2005						
2							**As of Sept. 2005**				
3		1999	**2005**			**2005-2009**	**Remaining Needs that are not funded by other sources**				
4		Maintained	**TOTAL**	**PAVED**	**UNPAVED**	**1-5 YEAR NEEDS**			**% of Pavement**		
5	**Supervisorial**	Mileage	**MILEAGE**	**MILEAGE**	**MILEAGE**	**Reconst.**	**Overlay**	**Chip Seal**	**Treatment Needed**		
6	District 1	115.247	117.198	68.972	48.226	0.500	17.485	11.354	42.54%		
7	District 2	176.489	175.813	98.830	76.983	0.900	2.350	36.390	40.11%		
8	District 3	133.861	138.994	94.894	44.100	0.000	12.065	35.021	49.62%		
9	District 4	91.646	91.934	82.557	9.377	0.950	4.155	8.324	16.27%		
10	District 5	156.681	154.992	128.959	26.033	1.980	7.500	11.766	16.48%		
11	**TOTAL**	**673.924**	**678.931**	**474.212**	**204.719**	**4.330**	**43.555**	**102.855**	**31.79%**		
12		**Check Sum:**	**-0.032**		**2006 Avg. Cost/mile:**	**$ 750,000**	**$ 200,000**	**$ 30,000**	**Total**		
13					**Total:**	**$ 3,247,500**	**$ 8,711,000**	**$ 3,085,650**	**$ 15,044,150**		
14									**$ 99,801.98**	**per mile**	
15					**Annual Miles to treat:**	**1.083**	**10.889**	**25.714**	**$ 3,761,038**	**06-09 ANNUAL EXPENDITURE PROJECTION**	
16					**Annual Cost:**	**$ 811,875**	**$ 2,177,750**	**$ 771,413**	**$ 2,989,625**	**Max. Target for STIP**	
17					**Summer 2006 Goal:**		**2.00**	**27.00**		**Available in 2006 STIP:**	**$ -**
18											
19		1999	**2005**			**2010-2014**					
20		Maintained	**TOTAL**	**PAVED**	**UNPAVED**	**6-10 YEAR NEEDS**			**% of Pavement**		
21	**Supervisorial**	Mileage	**MILEAGE**	**MILEAGE**	**MILEAGE**	**Reconst.**	**Overlay**	**Chip Seal**	**Treatment Needed**		
22	District 1	115.247	117.198	68.972	48.226	0.000	1.641	3.479	7.42%		
23	District 2	176.489	175.813	98.830	76.983	0.839	0.000	24.724	25.87%		
24	District 3	133.861	138.994	94.894	44.100	0.000	0.000	23.104	24.35%		
25	District 4	91.646	91.934	82.557	9.377	1.150	2.150	25.145	34.45%		
26	District 5	156.681	154.992	128.959	26.033	0.000	0.510	61.506	48.09%		
27	**TOTAL**	**673.924**	**678.931**	**474.212**	**204.719**	**1.989**	**4.301**	**137.958**	**30.42%**		
28		**Check Sum:**	**-0.032**		**Avg. Cost/mile:**	**$ 869,475**	**$ 231,860**	**$ 34,779**	**Total**		
29	5 YEARS OF 3% ANNUAL APPRECIATION				**Total:**	**$ 1,729,386**	**$ 997,230**	**$ 4,798,041**	**$ 7,524,657**		
30									**$ 52,164.72**	**per mile**	
31					**Annual Miles to treat:**	**0.398**	**0.860**	**27.592**	**$ 1,504,931**	**10-14 ANNUAL EXPENDITURE PROJECTION**	
32					**Annual Cost:**	**$ 345,877**	**$ 199,446**	**$ 959,608**			
33											
34		1999	**2005**			**2015-2019**					
35		Maintained	**TOTAL**	**PAVED**	**UNPAVED**	**11-15 YEAR NEEDS**			**% of Pavement**		
36	**Supervisorial**	Mileage	**MILEAGE**	**MILEAGE**	**MILEAGE**	**Reconst.**	**Overlay**	**Chip Seal**	**Treatment Needed**		
37	District 1	115.247	117.198	68.972	48.226	0.000	0.000	60.592	87.85%		

dist1 / dist2 / dist3 / dist4 / dist5 / TotalMileage

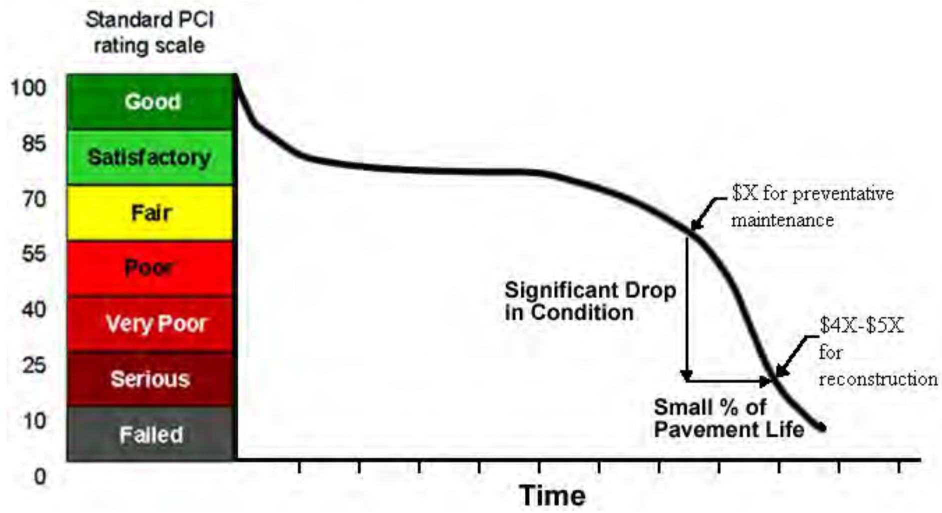
Ready NUM

Budgetary Forecasts

For an Excel database, this is quite an advanced collection of data, and is a solid start for beginning a formal pavement inspection cycle. The maintenance needs calculated are in depth and fairly precise, and would make a good case for funding applications. However, while it does calculate maintenance needs and funding projections, the current overall condition of the pavement inventory is largely unknown, and is likely measured on a subjective basis that is difficult to replicate.

To build on existing procedures such as these, a rural area in the Basic category might consider incorporating the follow methodologies in order to move towards a standardized method for quantifying pavement condition.

Pavement condition is measured by the Pavement Condition Index, or PCI. This is a scale ranging from 0-100 that is based on a standard methodology of inspection. A newly paved roadway has a PCI of 100. Pavement condition generally deteriorates following a rough curve over time as shown below. This deterioration begins slowly, then increases more rapidly. It is far more costly to repair and/or replace pavement later in its' lifespan than it is to do preventative maintenance early on. Keeping track of pavement condition allows for tracking this deterioration, allocating funds, and maintaining the overall PCI at a certain level.



Source: MicroPAVER

Œ **Become Familiar with Pavement Distress Types**

Learn to discern between the different types of distresses and the causes of each. Create additional columns in the Excel spreadsheet for each distress and severity level, or create a new similar spreadsheet specifically for tracking field data.

PCI is based on a survey of the seven different distress types. Distress surveys aim to answer three questions: what is wrong (type), how bad is it (severity), and how much distress is present (density). The seven distress types are as follows:

Distress Types

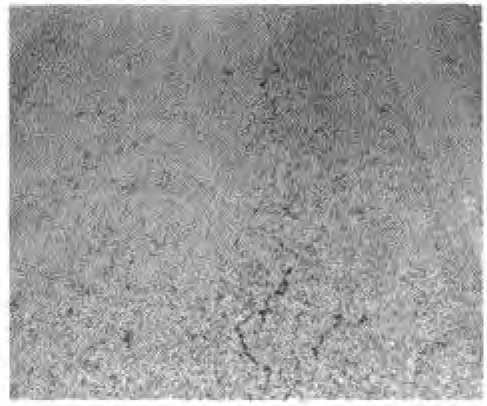
1. Alligator Cracking
2. Block Cracking
3. Distortions
4. Longitudinal and Transverse (LT) Cracking
5. Patching and Utility Cut Patching
6. Rutting and Depressions
7. Weathering and Raveling

These distress types, characteristics, and measurement techniques are summarized below:

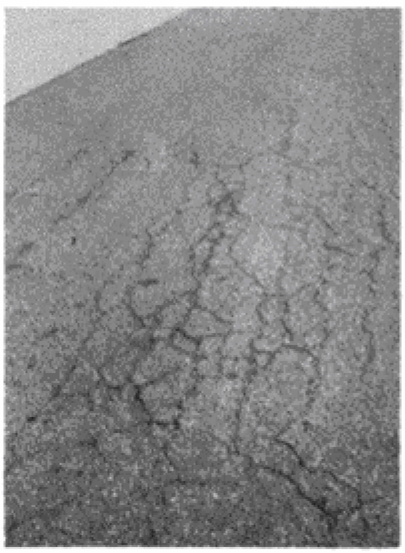
1. **Alligator cracking**: Also known as fatigue cracking, alligator cracking is caused by repeated traffic loading. It is a series of interconnecting cracks in the wheel path that develop a pattern resembling that of alligator skin. Alligator cracking is considered a major structural distress. Potholes are an example of severe alligator cracking. Low severity alligator cracking are fine, longitudinal hairline cracks running parallel to each other with only a few interconnecting cracks. Medium severity would be slightly more developed with a pattern or network of cracks that may contain light spalling. High severity alligator cracking has highly defined pieces due to large cracks. Alligator cracking is measured in square footage. If the different levels of severity in a sample

cannot be distinguished, the entire area should be measured and rated as the highest severity level present.

Low Severity

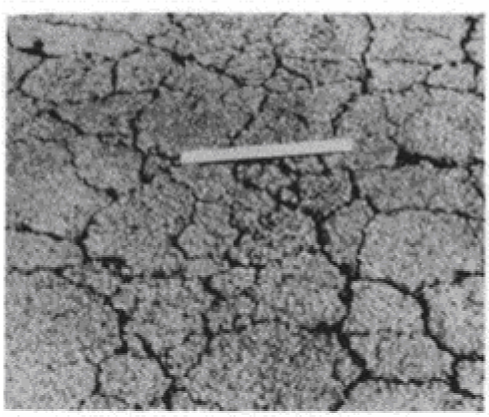


Low Severity

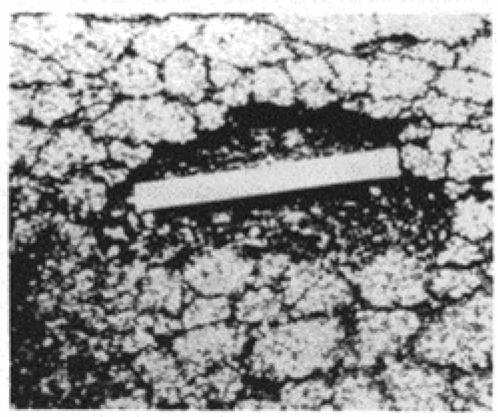


Medium Severity

Medium Severity



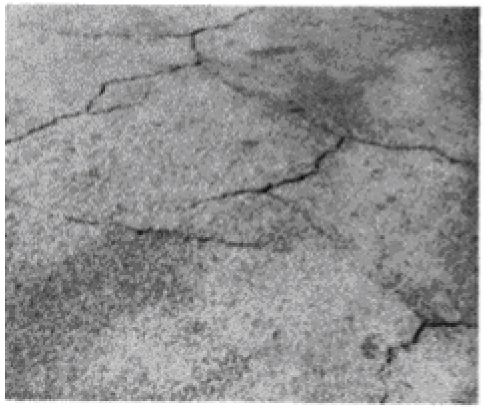
High Severity



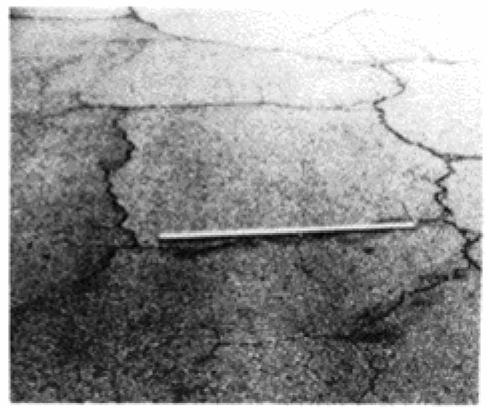
High Severity

Source: Metropolitan Transportation Commission (MTC)

2. **Block Cracking**: Block cracking is defined by interconnected cracks that separate the pavement into rectangular, or block, shapes. This type of distress typically occurs over a large area of the pavement surface, not only in traffic areas. The severity levels for this type of cracking are defined by the severity of the cracks that form the blocks (i.e. low severity cracks would indicate low severity block cracking, etc). This is measured as a square footage.



Low Severity

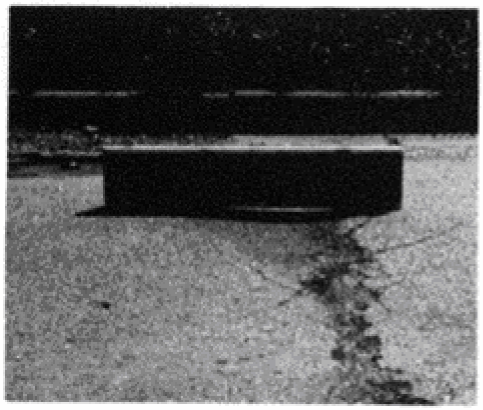


Medium Severity

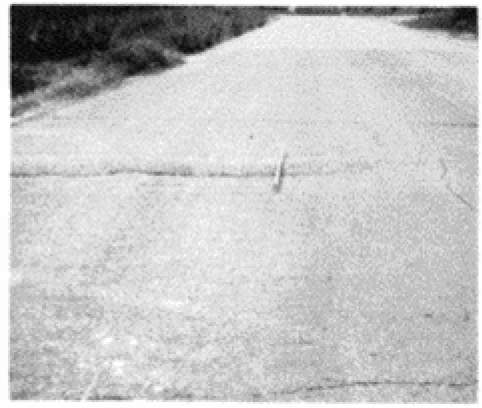
High Severity

Source: MTC

3. **Distortions**: Distortions are localized distresses that are upward or downward displacements in the pavement surface and affect overall ride quality. Distortions are otherwise called sags, bumps, shoving, or corrugation. A low severity distortion would cause noticeable vehicle jarring, but no reduction in speed is necessary. Medium severity distortions cause significant vehicle vibrations, and require some reduction in speed for comfort. A high severity distortion induces such extreme vibrations that a considerable reduction in speed is necessary both for comfort and safety. Distortions are measured in square footage, and severity is found by driving a vehicle over the surface at the posted speed limit.



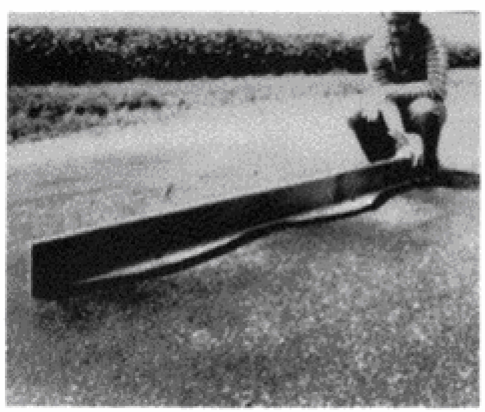
Medium Severity Sag



Medium Severity Bump

Medium Severity Shoving

High Severity Shoving

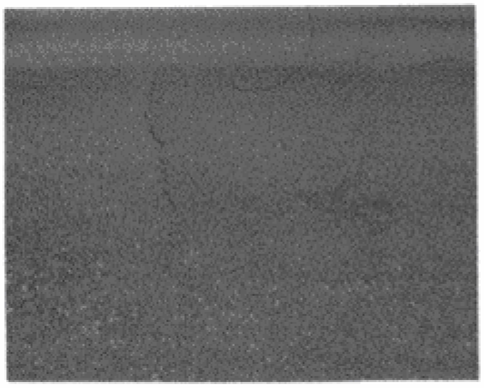


High Severity Corrugation

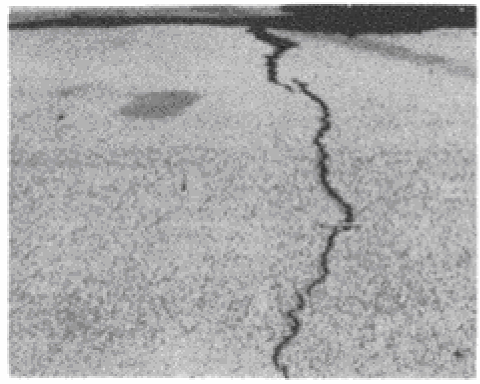
Source: MTC

4. **Longitudinal and Transverse (LT) Cracking**: LT cracking is characterized by cracks that are parallel to the centerline or laydown direction. These are caused by numerous things, among which are an ill-constructed paving lane joint, shrinking of the pavement surface, or a reflective crack caused by cracks or joints underneath the asphalt. Unlike alligator cracks, longitudinal and transverse cracking is not load-related and as such can occur anywhere on the street surface. Low severity cracking would be a non-filled crack with a width less than 3/8" or a filled crack of any width. Medium severity is characterized by a non-filled crack 3/8 to 3 inches, or a non-filled crack or filled crack

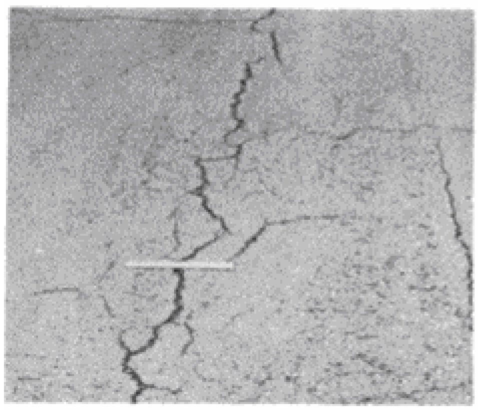
surrounded by adjacent light cracking. High severity LT cracking is any filled or non-filled crack surrounded by medium or high severity random cracking or a non-filled crack with a width of over 3 inches. Longitudinal and transverse cracks are measured by severity level in linear feet.



Low Severity



Medium Severity



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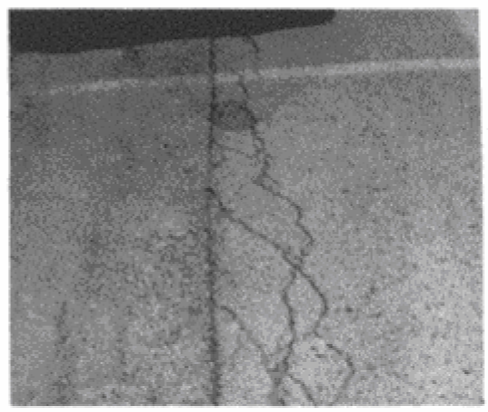
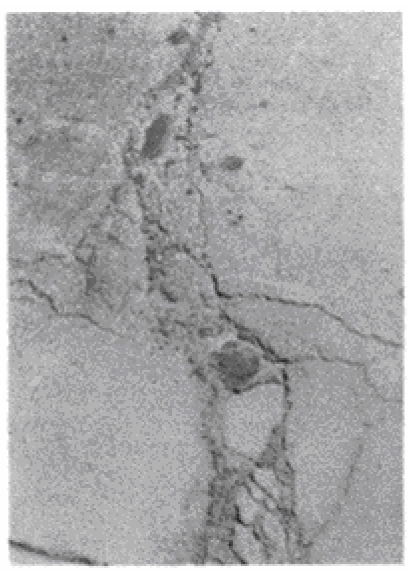


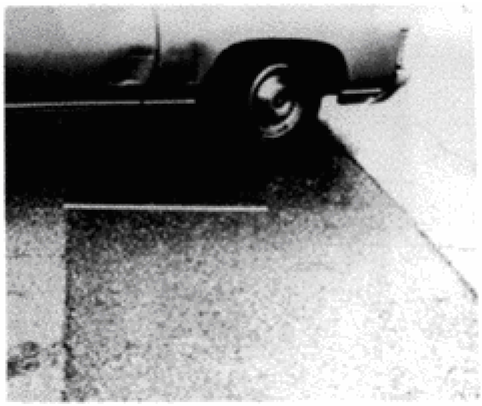
Medium Severity



High Severity

Source: MTC

5. **Patching and Utility Cut Patching**: A patch is an area of the street surface that has been replaced with new material in areas where the existing pavement was in need of repair or had utility work done. Regardless of condition, patches are considered defects in that they typically do not perform as well as an original section of pavement. A low severity patch is one in good condition, with good ride quality. A medium severity patch causes slightly reduced ride quality and may be slightly deteriorated. High severity patches require a reduction of speed, or are highly deteriorated and require replacement. Patches are measured in square feet.



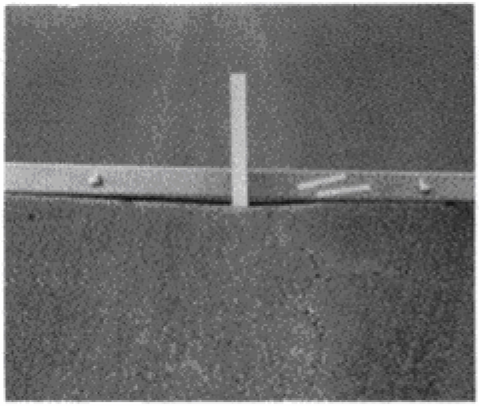
Low Severity

Medium Severity

High Severity

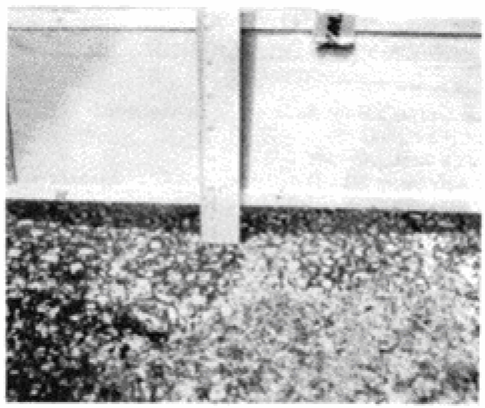
Source: MTC

6. **Rutting and Depressions**: The characteristic of rutting is a depression in the wheel path, and is a signal of permanent deformation in the pavement layers. Rutting is due to traffic loads. Depressions, also called ‘bird baths’ occur in localized areas where the surface is lower than in surrounding areas. A low severity depression would have a depth of ½” to less than 1”, medium would be 1” to less than 2”, and a high severity depression would be 2” or greater depth. Rutting and depressions are measured in square feet.



Low Severity

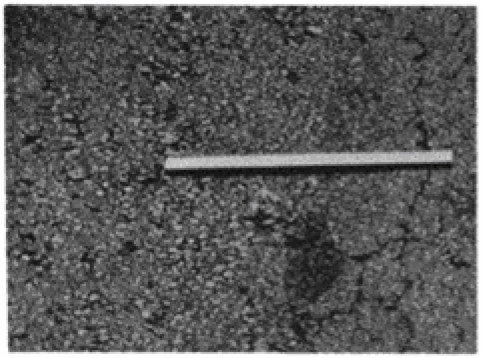
Medium Severity



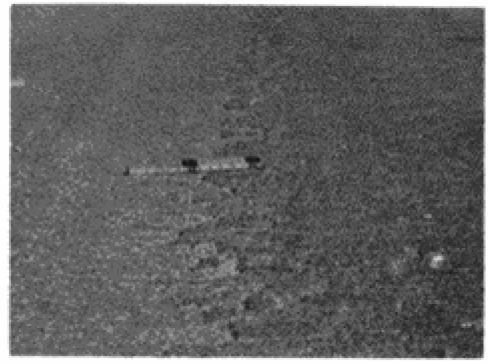
High Severity

Source: MTC

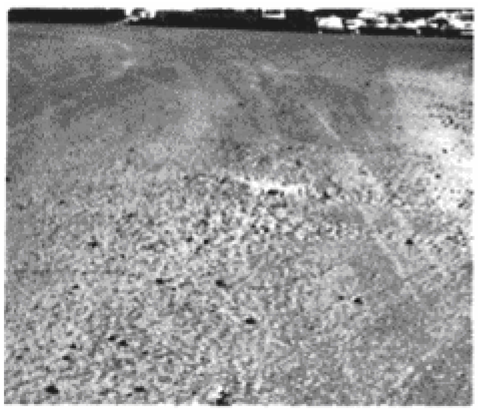
7. **Weathering and Raveling**: These distresses are characterized by the wearing away of the pavement material due to the loss of asphalt and dislodged particles. This is caused by a poor quality mix, traffic usage, or hardening of the asphalt binder. In other cases, softening of the roadway surface due to oil or fuel may cause raveling as well. Low severity weathering is indicated when some of the surface seal or pavement has begun to wear away. If an oil spill, the surface would still be hard, though an oil stain is noticeable. Medium severity weathering and raveling is characterized by the aggregate and/or binder wearing away, or original surface would be showing through surface seals. The texture would be mildly pitted and rough. In the case of an oil spill, the surface would be soft and penetrable by a coin. High severity weathering shows a large amount of surface seal being lost and/or the aggregate is excessively worn away. This distress is measured in square feet.



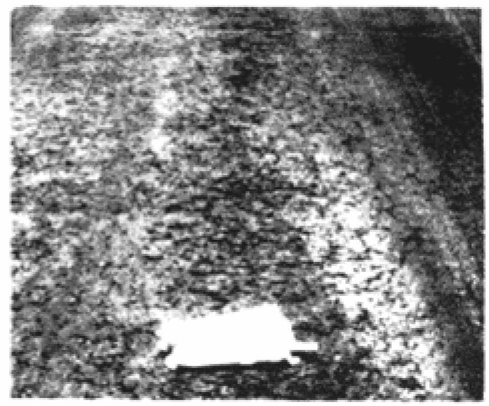
Low Severity



Low Severity



Medium Severity



Medium Severity

Source: MTC

- **Pavement Inspections**

These methods for the physical inspection of the roadway can be utilized for a formal PMS program, or for a less advanced spreadsheet-based system.

Inspections are typically performed for about 10% of a roadway, or 100 feet for every 1000 feet of road surface. These inspections are done on ‘representative samples’ of a road, which is to say that the segments inspected should encompass the overall condition of the roadway, and represent neither the best nor the worst conditions of the road as a whole. The inspections should be done for every roadway in a jurisdiction, be it by city or by county. This could be done all in the same year, or on a rotating basis, meaning that a portion of a jurisdiction would be surveyed each year, and thusly the total mileage would be surveyed every X number of years as determined by those in charge. It is conceivable that a lack of funding or availability will render a jurisdiction unable to perform this process fully. In that case, it is encouraged that at least the major, most heavily traveled (traffic volume and/or heavy vehicle volume) local roads be surveyed, or that a lesser percentage of each roadway be inspected. Additionally, counties are encouraged to take advantage of Caltrans’ HPMS resource, which has the road conditions of the State Highway System (SHS) for each county.

If using a PMS, individual reports for each street segment can be generated and printed out for the field inventories. These paper forms are then filled out in the field and the data is entered into the computer at a later time. Another method that some PMS programs may support is a database stored in a handheld PDA that allows field inspection data to be input into the PDA then uploaded at the end of the day to an office PC and main database. If using a spreadsheet program like Excel, a table can be made for each street segment showing the seven distresses and severity levels to be completed in the field.

In the field, verify street width. Then, using a measuring wheel and pavement spray paint, mark off a 100 ft. length of roadway. However, if the width is greater than 40 feet, only a 50 foot section should be surveyed for every 1000 feet of roadway. The width of the roadway will help ascertain the square footage of the section: if the street is 26 feet wide, the segment will be 2600 sq. feet (26 x 100 = 2600). This information is then extrapolated over the 1000 foot street length, which is why selection of a 'representative sample' is key.

Next is the measurement of each distress type. Several different levels of severity may exist within the same area, so carefully separate them to accurately measure and record the information. These measurements are most easily made with a measuring wheel.

Ž Data Entry

If using a pavement management system, simply transfer the data from the field inspection forms into the computer database.

If just beginning, use a spreadsheet to track densities of the distresses over time as an introduction to the usage of pavement management software. This information will then be easy to enter into a PMS when the county acquires it. For an Excel database, create a spreadsheet showing the street segment name, limits, width, length of segment (typically 100 ft.), the seven major distresses, and the three severity levels for each. Then enter the field data under the appropriate columns.

Create a new column that calculates the square footage of the segment (width x length). Then, create a column that will sum up the total measurements done in the field (all distresses and all severity levels). Though some distresses are in linear feet, we will assume that they have a width of 1 foot for this calculation. Next, create a column that divides the sum of distresses by the total square footage of the segment. Format that column so it is a percentage. This will be the percentage of the segment that is distressed in some manner. Though crude and not a weighted sum, this will give a general idea of the condition of the pavement. Use the following rating scale to define overall condition level:

0-30%	Good
31-60%	Fair
61-100%	Poor

This scale would mean that if the roadway surface is 0-30% distressed, it is in 'Good' condition, and does not immediately require maintenance. A roadway with 31-60% of the surface distressed would be in 'Fair' condition, and would require attention. A rating of 'Poor', or 61-100% distressed, would be in need of further inspection and/or maintenance as soon as the budget allows.

Manual calculations of PCI are possible, but very time consuming due to the necessity to look up information for each distress by severity level to determine 'deduct values'. When the need for PCI calculations and information arises, the county should consider investing in a PMS program.

- **Maintenance Data**

On a separate Excel tab, a maintenance log file should be created to keep track of the maintenance work done and/or scheduled on the street segments. This information can be used to predict future maintenance needs. For example, if the date of a road rehabilitation is entered, a reasonable estimation can be made as to when chip seals, slurry seals, etc. will be required based on historical data available. This can also be used for a preliminary start to a PCI database given that pavement that is new has a PCI of 100, and deteriorates along a known curve.

- **Pavement Management Programs**

After beginning to build a pavement condition database, the county should consider making the investment in a PMS. These programs are a preferred method to maintaining a database of pavement conditions and maintenance/rehabilitation (M&R) information. They are also utilized as tools to predict M&R needs many years into the future based on different funding situations.

The two main pavement management systems utilized in California are StreetSaver and MicroPAVER. StreetSaver was developed by the Bay Area Metropolitan Transportation Commission (MTC) as a three part solution to the issue of local jurisdictions not performing enough pavement maintenance and upkeep. The program aimed to provide a pavement condition index (PCI), maintenance treatments for the Bay Area, and a network level assignment procedure. Two versions of StreetSaver are available for use: a web-based interface and a desktop program. Both are available to users outside of the Bay Area for a slightly higher cost. The online version has a yearly subscription fee, while the desktop version has a flat fee. Training and tutorials are available through MTC. StreetSaver allows for field collection via printed paper forms or handheld PDAs. Analysis available through StreetSaver includes budget needs for maintenance, impacts of various funding situations, event-based calculation, and project selection. Reports that can be generated include 30 standard reports and graphs, customized reports, depreciation method, GIS linkage, and reports fitting the requirements of GASB 34.

MicroPAVER was first developed by the Army Corps of Engineers to help manage maintenance and rehabilitation of Department of Defense's pavement inventory. It uses the PCI index to describe the current pavement condition and to predict M&R needs for the future, as well as analysis of where to allocate funding for maintenance. MicroPAVER utilizes either paper forms or handheld devices to enter field data. The reports section of MicroPAVER offers numerous options to provide basic pavement information: summary charts, standard reports (branch listing, work history, etc.), re-inspection reports, user-defined reports (ability to create custom reports), and GIS reports (preset views that show information in a graphical display; available when a map has been linked to the database). Forecasting abilities of MicroPAVER include prediction modeling and work planning (including budget consequences, elimination of M&R backlog calculations, steps toward reaching preferred PCI, etc.). MicroPAVER training is available through the University of Illinois, Urbana-Champaign.

Case Study Intermediate

The case study selected to represent an intermediate system preservation system currently uses the desktop version of StreetSaver v.7.5. This version is no longer supported by MTC, so it is first recommended that an upgrade to Version 8 be made.

The database is fully populated with field inspections from 2004. From this, a full PCI report was generated showing street name and identification, inspection date, PCI number, the high and low values if more than one inspection unit was used, and the percentage of distresses due to load, environmental distress, or distortions, as well as square footage of the segment.

To build on this information, the following procedures are suggested to gain more use of all of the functionalities of the PMS.

Œ **Conduct Field Inspections**

The data in the program is from the 2004 pavement inspection cycle. A new cycle of inspections should be done in the next year to establish a pattern of updates every third year as is recommended by MTC.

• **Compile Reports**

The current usage of the report generation is a good start to exploring the options available through these programs. To further break down the data to begin seeing trends in the PCIs, it may be useful to develop some of the graphs shown in the Step by Step instructions for Intermediate areas, including the Weighted Average PCI and PCI by Functional Class. This will allow the jurisdiction to view the overall PCI for all roadways surveyed and begin to assess if there are specific trends to the PCI values based on roadway classification. The Road Condition graph generation will demonstrate the percentage distribution of the PCI values.

Ž **Funding Scenarios**

Further usage of the software capabilities is to begin testing various funding scenarios for future maintenance. This will use the data in the inspection fields to forecast future M&R needs, and budget according to various funding options that may be available. It will also show the deterioration of the PCI if no work is done, or if no preventative maintenance budget is established.

• **Log Maintenance Data**

Incorporating maintenance data into the program will help make budgeting, forecasting, and apportioning funding more accurate based on the historical data of pavement life and treatment costs for the particular rural area. It will also aid in planning out M&R needs for the future, which can be combined with Step Ž to determine funding and budgeting.

Case Study **Advanced**

The county selected as an Advanced case study utilizes the online version of StreetSaver v. 8.0. This county has fully complete inspection data, and utilizes the program to create reports of overall PCI, as well as more tailored reports based on specific criteria. It also makes use of the funding scenarios and forecasting available to predict pavement needs 5 years in the future.

These activities all create a full view of the current pavement condition and performance, as well as future performance and maintenance needs. Further usage of the PMS functionalities at this point in the process will only help to give more information on the performance of certain areas, as well as to identify more trends in pavement performance and needs.

Œ **Populate Database**

The data from this county is complete as of 2005. It is unknown when the next scheduled database update is, but will likely be in the next two years if the MTC preferred three-year update cycle is followed.

- **Consider GIS Linkage**

The usage of the GIS Linkage tool is based on if the area also has a map to link to the data. However, inclusion of this service will create a dynamic mapping tool that will show the roadway condition based on geographical area. This is often useful for government presentations, and to identify if certain regions contribute lower PCI values based on different usage patterns, weather, etc.

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If your rural area:	You could be considered:	And measure Mobility using:
§ Has not measured Mobility § Uses probe vehicles	Basic	§ Travel Times
§ Has automated detection § Uses a Travel Demand Model (TDM)	Intermediate	TDM output § Travel Times § Speeds § Delays OR If TDM is unavailable, can transmit the data to PeMS
§ Has extensive automated detection § Uses a TDM § Transmits data to PeMS	Advanced	TDM output § Travel Times § Speeds § Delays OR If TDM is unavailable, can transmit the data to PeMS

Case Study Basic

This case study demonstrates the mobility calculation using data from probe vehicles for Santa Cruz County along Route 1.

Œ **Choose coverage and time**
The available data covers Route 1. Actual speed data is available from Spring 2001, Summer 2001, and Fall 2003 for each of the AM, Midday, and PM peaks in both directions.

• **Identify endpoints** of the major corridors, or congested segments within corridors, selected within the rural area in Step Œ. The available data covers Route 1 from Branciforte Drive to State Park Drive (a total distance of 6.2 miles).

Ž **Actual speeds were collected during the studies**.

• **Probe vehicle runs had already been performed to obtain the data.**

• **Data is for this one corridor only.** Within this corridor, however, several different OD pairs may be analyzed (ie. data is available for several segments within the entire corridor so one section may be of more interest than the entire corridor).

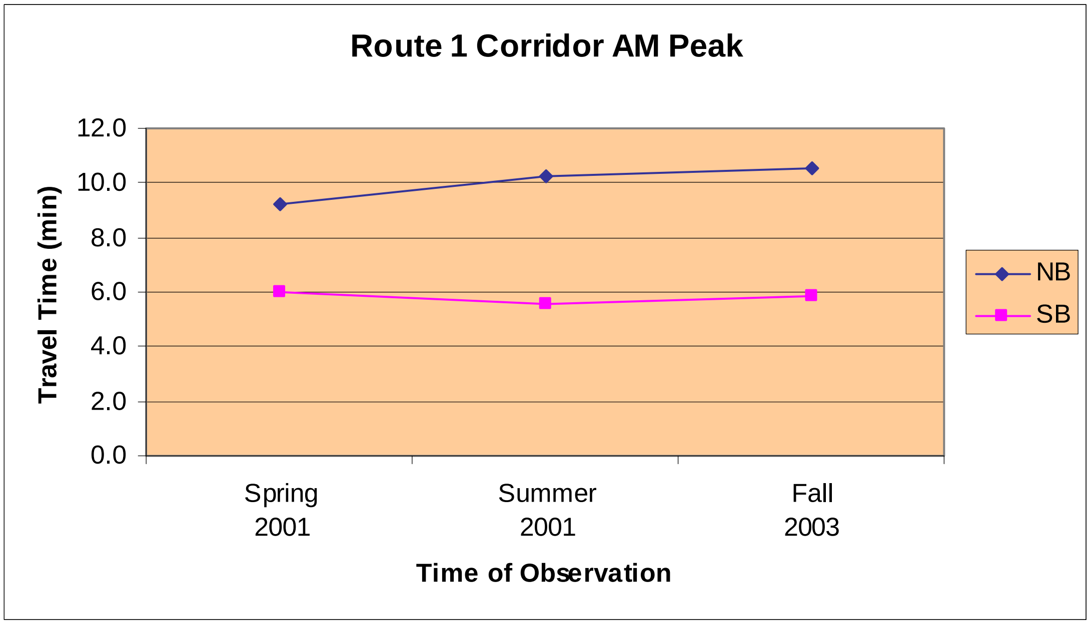
Milepost	Landmark	AM NB			AM SB			Midday NB			Midday SB			PM NB			PM SB		
		Spring 2001	Summer 2001	Fall 2003	Spring 2001	Summer 2001	Fall 2003	Spring 2001	Summer 2001	Fall 2003	Spring 2001	Summer 2001	Fall 2003	Spring 2001	Summer 2001	Fall 2003	Spring 2001	Summer 2001	Fall 2003
0.0	Branciforte Drive	42	36	48	65	60	65	60	60	60	51	60	55	55	65	65	55	45	22
0.2		48	40	45	60	60	72	65	65	65	60	55	60	60	65	45	60	19	26
0.4		65	40	33	60	72	65	65	60	72	55	72	65	60	65	48	60	28	29
0.6	Morissey Boulevard	48	45	33	55	65	65	65	55	72	65	60	65	51	60	60	51	31	20
0.8		42	55	33	55	65	72	65	65	65	55	65	65	55	72	60	55	23	42
1.0		48	34	36	60	72	72	65	65	55	60	65	65	51	65	55	51	28	31
1.2		42	38	23	60	65	72	65	65	72	65	65	65	45	72	51	45	25	24
1.4	Soquel Avenue	51	31	55	55	65	72	65	60	65	60	65	65	45	72	48	45	21	24
1.6		40	30	55	65	65	72	60	65	72	72	65	65	34	65	51	34	18	27
1.8		42	42	36	60	65	72	60	65	65	60	65	55	38	72	55	38	20	27
2.0		42	22	30	65	65	72	72	60	65	65	60	65	45	60	45	45	16	21
2.2		31	30	23	65	60	72	60	65	65	65	65	55	38	72	55	38	18	18
2.4		38	18	17	60	60	60	65	55	60	60	65	60	45	60	51	45	23	23
2.6		51	23	33	65	65	48	65	45	60	65	60	65	38	60	48	38	24	27
2.8	41st Avenue	45	26	36	60	65	72	65	55	65	65	60	60	48	65	45	48	22	30
3.0		36	34	42	60	72	48	65	72	60	72	65	55	51	60	42	51	18	26
3.2		34	48	51	65	65	60	65	55	65	65	65	72	55	60	48	55	16	36
3.4	Bay/Porter Road	33	40	25	65	72	51	65	55	55	60	60	55	60	65	60	60	18	45
3.6		31	45	36	65	65	65	60	55	72	65	65	72	60	60	55	60	21	55
3.8		31	36	33	72	60	60	55	60	65	72	65	60	55	60	55	55	30	55
4.0		51	36	36	60	72	60	60	51	72	65	55	72	60	60	60	60	38	55
4.2		45	45	34	60	65	72	65	55	72	60	51	65	72	60	45	72	55	60
4.4	Park Avenue	28	45	34	60	65	72	60	55	65	72	60	60	65	60	55	65	51	72
4.6		40	45	36	65	72	60	65	60	60	65	65	60	65	60	55	65	65	60
4.8		36	51	40	65	72	60	65	55	60	60	65	72	65	55	55	65	55	48
5.0		51	48	51	72	65	65	72	51	65	72	65	65	72	55	55	72	65	55
5.2		25	48	34	65	72	65	65	55	55	72	65	65	65	51	55	65	65	48
5.4		51	55	40	72	72	51	72	60	72	72	65	60	65	65	65	65	65	72
5.6		51	55	55	65	72	65	72	60	60	65	60	65	65	60	55	65	65	60
5.8		45	45	55	55	72	65	72	55	65	60	65	65	65	60	60	65	60	51
6.0		42	30	45	65	72	60	65	48	65	65	65	65	60	48	55	60	60	65
6.2	State Park Drive	42	NA	48	72	72	65	66	29	65	72	72	65	60	36	60	60	60	65

Raw Speed Data obtained along Route 1

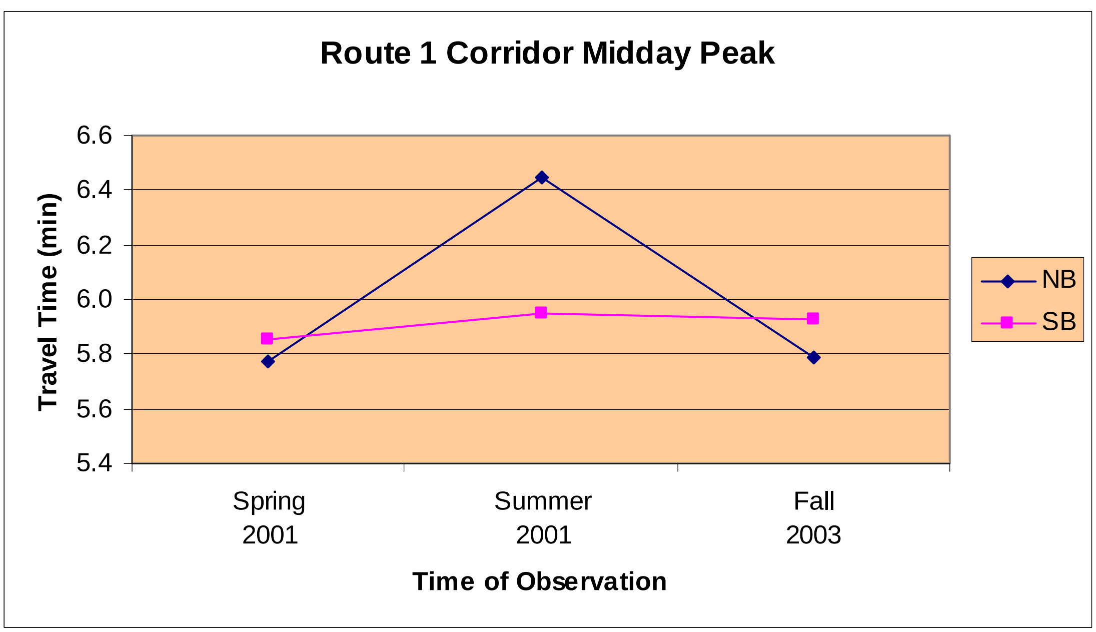
Calculate performance measures

The graphs on the following pages show the results of the calculations shown in the guidance for each of the peak time periods. **Travel times** over the corridor were computed by dividing the distance between the origin and destination by the average speeds.

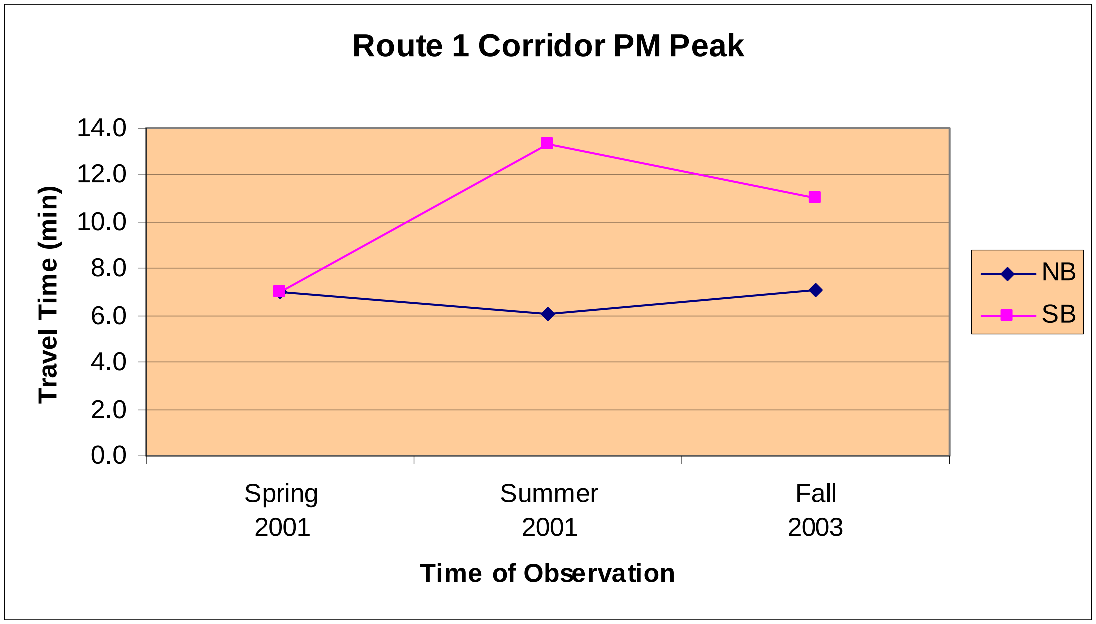
Travel Time *(in hours) = Distance (in miles) /Speed (in miles per hour)*



Mobility Trend (AM Peak, 2001-2003)



Mobility Trend (Midday Peak, 2001-2003)



Mobility Trend (PM Peak, 2001-2003)

Case Study Advanced

A case study below considers an example of obtaining mobility performance measures for a segment of SR-17 in Santa Cruz, California. The segment from Glenwood Drive to Ocean Street in the southbound direction (length: 5.8 miles) and Route 1 to Granite Creek Road in the northbound direction (length 5.3 miles) will be considered.

Œ **Contact PeMS Staff Regarding Connection of Rural Detectors to PeMS, Electronically Transmit Rural Area Detector Data to PeMS, and Apply for a Free PeMS Account**
Go to the PeMS website at http://pems.eecs.berkeley.edu/Public/ . With the username provided to you by PeMS, log into the website to access the local freeway data available in your area.

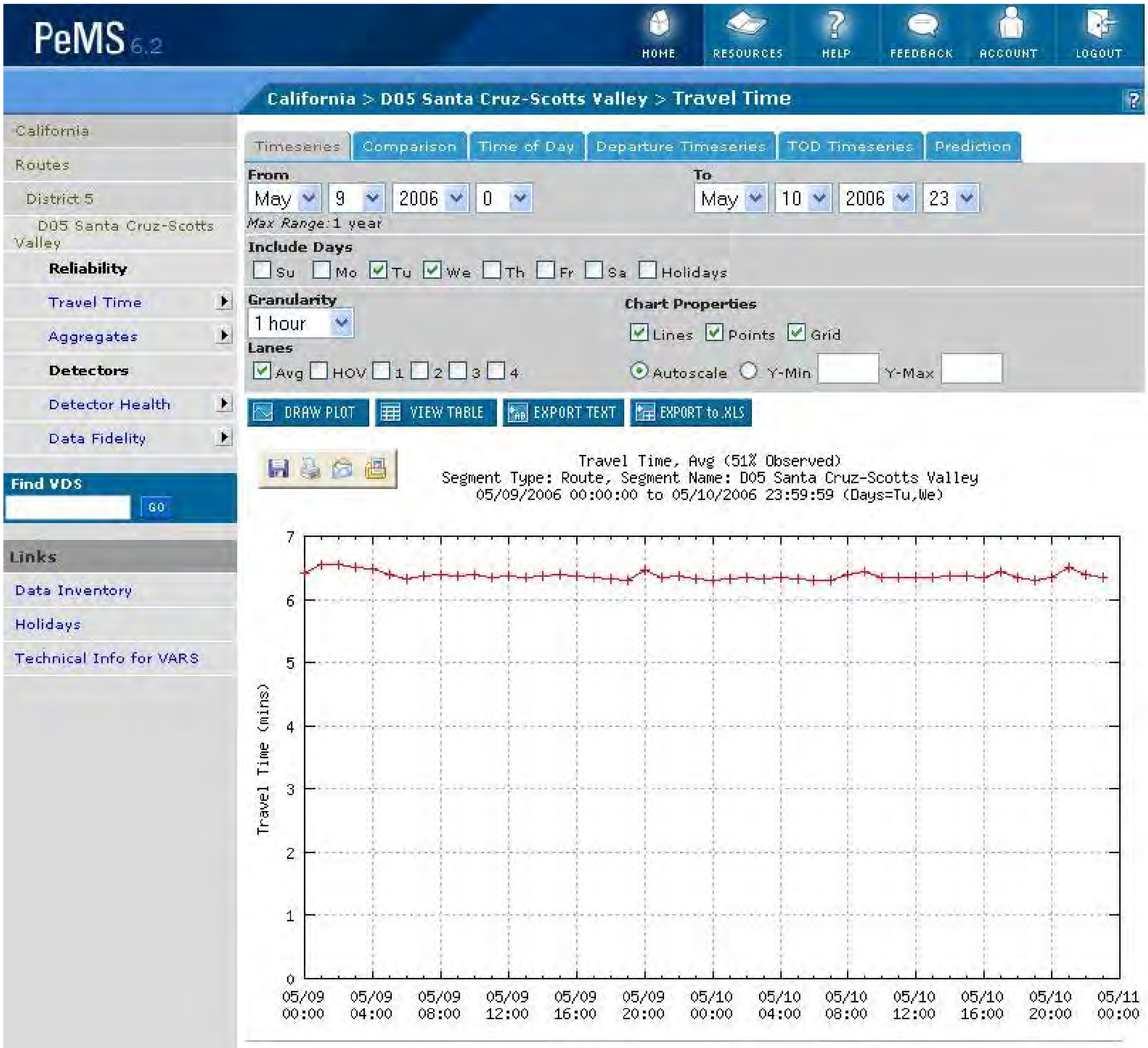
- **Select Study Parameters**
To obtain the information required to calculate mobility of the roadway segment under study, identify the Caltrans district where your county is located. In this case study, the rural highway is SR-17 in Santa Cruz, which is located in Caltrans District 5 was analyzed. On the toolbar located on the left-hand side of the PeMS website, click ‘Routes’. A list of detector station locations will be displayed. Select the segment in District 5 that represents the northbound direction (D05 Santa Cruz – Scotts Valley, see screenshot in Figure on following page). All the information that is available pertaining to this freeway will be displayed on the left side toolbar. In this case, the available information is travel time. The travel time information for this segment of the freeway can be accessed by clicking the ‘Travel Time’ link.

Starting District ▲	Route Name	From	To	Total Miles	# ML	# HV	# VDS/Mile
3	D03 50E Sacramento-Folsom	50-E/State...	50-E/Folso...	17.5	28	0	1.60
3	D03 Davis-Sacramento	80-E/Richa...	50-E/5th/X...	12.4	7	0	0.56
3	D03 Elk Grove-Sacramento	99-N/Elk G...	51-N/N/30t...	11.3	22	0	1.96
3	D03 Sacramento-Elk Grove	51-S/N/29t...	99-S/Elk G...	11.3	14	0	1.24
3	D03 Folsom-Sacramento	50-W/Folso...	50-W/State...	17.5	36	0	2.06
3	D03 51N	P St ON	Rte 244 OF...	7.7	13	0	1.69
3	D03 51S	51-S/Aubur...	51-S/29th/...	7.8	14	0	1.79
3	D03 Sacramento-Davis	50-W/5th S...	80-W/Richa...	12.4	5	0	0.40
4	D04 San Jose-San Francisco	101-N/Brok...	280-N/6th/...	42.7	58	0	1.36
4	D04 Livermore-Walnut Creek	580-W/Vasc...	680-N/Olym...	25.5	42	0	1.65
4	D04 Walnut Creek-Livermore	680-S/Olym...	580-E/Vasc...	24.7	39	0	1.58
4	D04 Oakland-Fremont	880-S/Emba...	880-S/Thor...	21.0	50	0	2.38
4	D04 Livermore-San Jose	580-W/Spri...	680-S/Mont...	31.9	9	0	0.28
4	D04 San Francisco-San Ramon	80-E/5th/B...	680-S/Boll...	30.1	48	0	1.59
4	D04 San Ramon-San Francisco	680-N/Boll...	80-W/5th/H...	29.9	57	0	1.91
4	D04 San Jose-Livermore	680-N/Mont...	580-E/Vasc...	32.7	14	0	0.43
4	D04 Fremont-Oakland	880-N/Thor...	880-N/Broa...	22.0	48	0	2.18
4	D04 Vallejo-Oakland	80-W/Solan...	580-E/Nort...	22.8	56	0	2.46
4	D04 Walnut Creek-San Jose	680-S/Hill...	280-N/Sant...	48.2	47	0	0.98
4	D04 Oakland-Vallejo	580-W/Nort...	80-E/Linco...	22.8	50	0	2.19
4	D04 San Jose-Walnut Creek	280-S/Stat...	680-N/Ygna...	47.7	50	0	1.05
4	D04 San Francisco-San Jose	280-S/5th/...	101-S/Brok...	42.9	67	0	1.56
5	D05 Santa Cruz-Scotts Valley	1-N/Morris...	17-N/Grani...	6.0	1	0	0.17
5	D05 Scotts Valley-Santa Cruz	17-S/Glenw...	1-N/Ocean ...	5.8	1	0	0.17
6	D06 41N	41-N/Centr...	41-N/Child...	15.0	7	0	0.47
6	D06 41S	41-S/Child...	41-S/Centr...	15.0	7	0	0.47
7	D07 Los Angeles-Simi Valley	101-N/Los ...	118-W/Tapo...	36.5	52	16	1.87
7	D07 Los Angeles-Santa Clarita	101-N/Los ...	5-N/Valenc...	32.7	44	0	1.35
7	D07 Los Angeles-Thousand Oaks	101-N/Los ...	101-N/Moor...	41.0	51	0	1.24
7	D07 Los Angeles-Santa Monica	10-W/Maple...	10-W/4th S...	13.5	35	0	2.59
7	D07 Los Angeles-Long Beach	101-S/Los ...	710-S/Will...	19.0	22	0	1.16
7	D07 Los Angeles-West Covina	101-S/Los ...	10-E/Vince...	13.8	30	17	3.42

Obtaining Required Data from PeMS Website

Ž **Login and Obtain Outputs from PeMS**

On the 'Travel Time' information page, a wide-range of dates, granularity levels, and a specific lane (or set of lanes) can be chosen for travel time. A given weekday can also be excluded (such as a weekend day), if necessary. There are also different sets of tabs available for travel time such as 'Timeseries', 'Comparison', etc. In this case study, only the Tuesday and Wednesday during the week of May 8, 2006 on the 'Timeseries' tab were analyzed with a '1-hour' granularity and 'average' travel time for all the lanes that have data available. The default options for 'Chart Properties' were chosen (see screenshot in Figure on following page).



District 5 SR-17 Travel Time Plot

- **Analyze Trends**
  Once all the parameters are chosen click the 'Draw Plot' button to display the plot that shows the travel time for each hour of the day. This data can be exported and saved as either a text file (txt) or a Microsoft Excel file (xls). The excel spreadsheet will contain the following information:
  1. Hour of day and date
  2. Average observed travel time for that segment

  For this case study, the travel time in minutes will be displayed for each hour from 00:00 on May 9, 2006 to 23:59 on May 10, 2006 and the data is exported and saved as an excel file 'SR-17 NB May 8 - May 12 2006.xls'.

  Open the excel file and add two more columns to the table indicating the length and the posted speed limit of the roadway segment. The posted speed limit data is required to calculate the delay (in minutes or seconds) experienced on the roadway segment. In this case study, the length of the segment is 5.3 miles and the posted speed limit on the northbound segment of SR-17 is 55 mph. At this point, we have the required data to calculate mobility of the roadway segment. A snap shot of the excel spreadsheet is illustrated in the Figure below.

Microsoft Excel - SR-17 NB May 9 - May 10 2006.xls

	A	B	C	D	E	F	G	H
1	1 hour	Avg	# Lane Points	% Observed	Segment Length	Posted Speed	Travel time	Delay (seconds)
2	5/9/2006 0:00	6.411111	36	66.66666667	5.3	55	5.78	37.8
3	5/9/2006 1:00	6.55	36	66.66666667	5.3	55	5.78	46.1
4	5/9/2006 2:00	6.554167	36	66.66666667	5.3	55	5.78	46.3
5	5/9/2006 3:00	6.5125	36	66.66666667	5.3	55	5.78	43.8
6	5/9/2006 4:00	6.486111	36	66.66666667	5.3	55	5.78	42.3
7	5/9/2006 5:00	6.386111	36	66.66666667	5.3	55	5.78	36.3
8	5/9/2006 6:00	6.3375	36	66.66666667	5.3	55	5.78	33.3
9	5/9/2006 7:00	6.369444	36	55.55555556	5.3	55	5.78	35.3
10	5/9/2006 8:00	6.384722	36	66.66666667	5.3	55	5.78	36.2
11	5/9/2006 9:00	6.381944	36	66.66666667	5.3	55	5.78	36.0
12	5/9/2006 10:00	6.384722	36	66.66666667	5.3	55	5.78	36.2
13	5/9/2006 11:00	6.35	36	66.66666667	5.3	55	5.78	34.1
14	5/9/2006 12:00	6.366667	36	66.66666667	5.3	55	5.78	35.1
15	5/9/2006 13:00	6.352778	36	66.66666667	5.3	55	5.78	34.3
16	5/9/2006 14:00	6.380556	36	66.66666667	5.3	55	5.78	35.9
17	5/9/2006 15:00	6.391667	36	66.66666667	5.3	55	5.78	36.6
18	5/9/2006 16:00	6.365278	36	66.66666667	5.3	55	5.78	35.0
19	5/9/2006 17:00	6.35	36	66.66666667	5.3	55	5.78	34.1
20	5/9/2006 18:00	6.333333	36	66.66666667	5.3	55	5.78	33.1
21	5/9/2006 19:00	6.306944	36	66.66666667	5.3	55	5.78	31.5
22	5/9/2006 20:00	6.455556	36	61.11111111	5.3	55	5.78	40.4
23	5/9/2006 21:00	6.344444	36	5.555555556	5.3	55	5.78	33.8

Excel Spreadsheet Output from PeMS (Analyzing roadway segment in Santa Cruz)

In the excel spreadsheet, the actual travel time can be calculated using the segment length and posted speed limit information. The difference between the average observed travel time and the actual travel time gives the delay experienced on the segment. Delay can be expressed in seconds, minutes, or hours depending on its magnitude. In the context of this case study, delay is expressed in seconds. For example, the delay experienced at 7:00 AM on 5/9/2006 is 35 seconds.

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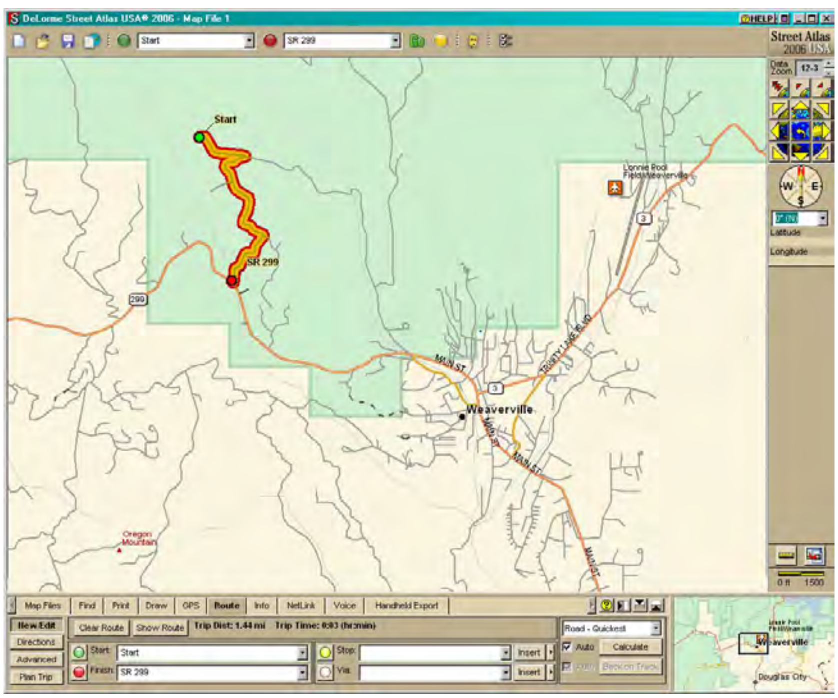
If your rural area:	You could be considered:	And measure Accessibility using:
§ Is using hard copy maps § Only wishes to calculate accessibility for selected points of interest or selected roadways of interest	Basic	§ Manual calculations
§ Has commercial mapping software § Wishes to refine measurements with population data § Wishes to calculate accessibility for several points of interest or critical roadways	Intermediate	§ More complex manual calculations
§ Has GIS software and expertise, with roadway and population layers § Wishes to calculate accessibility for many points of interest and possibly the entire rural area	Advanced	§ Automated GIS output (with minimal manual calculations, if necessary)

Case Study Intermediate

This example from Trinity County is run below using DeLorme Street Atlas USA software. This software, which at the time of this writing costs approximately $60, has various features such as a "Route Avoid" feature, and shortest path calculation features.

- **Choose points or roadways of interest as the beginning points (origins)**

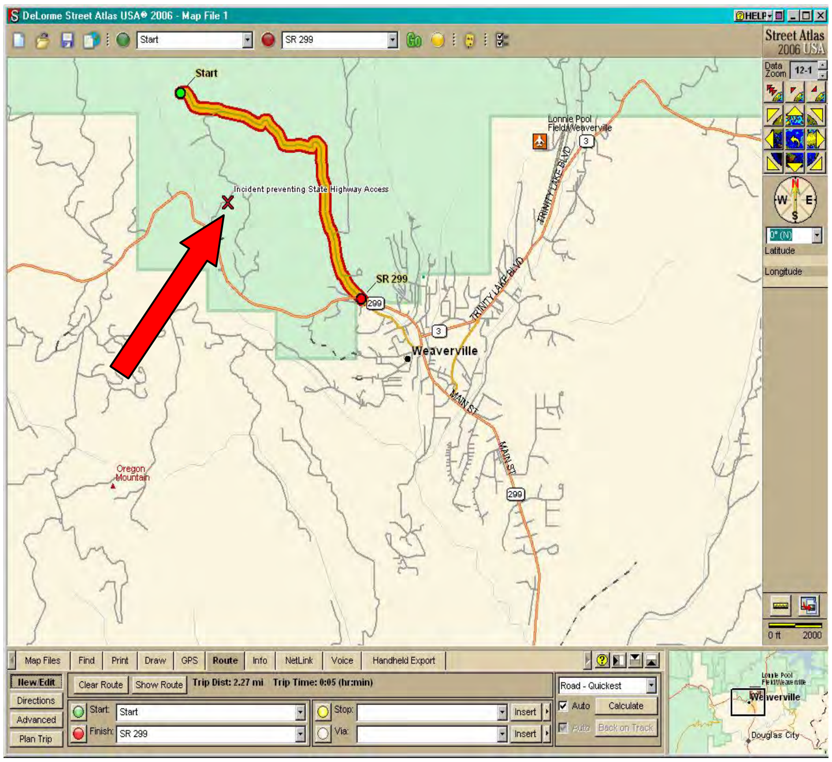
- **For each of those points of interest, create the fastest route from the point of interest to the State Highway System**
  - Mapping software packages typically allow one to type in addresses or intersections, OR to simply point-and-click to establish the beginning and end points of the route. Here, a beginning point was selected as shown in the Figure below.
  - In the mapping software, there is an option allowing for "route preferences", including roadway speed. Posted speed of 35 mph was entered for the selected route.
  - Once the route is created, one can usually select the "quickest path" option, and the screen should display the expected travel time along that route, along with the distance.



Fastest Route using Mapping Software

Ž **For each of those points of interest, measure the SECOND fastest distance to the State Highway System**

Repeat the above procedure to obtain travel times. This software has a “Route Avoid” feature which, when placed on the first route drawn, will automatically show the second fastest route. An example is shown in the screen shot below, where a fictitious incident (indicated with the red arrow) can be placed on the original path, and the software will show the second fastest route and calculate the new travel time.



Second-Fastest Route using ROUTE AVOID feature in Mapping Software

• **For each point of interest selected, calculate the Accessibility** by subtracting the results from Step • from the results from Step Ž for each route (so, the result will be separate Accessibility measures calculated for each point of interest). For example, for the points selected above:

Fastest time to State Highway: 3 min
Using automatic “Route Avoid” feature, Second-Fastest time to State Highway: 5 min

Accessibility Difference: 2 min

Other examples are shown in the table below.

Address	Shortest Distance to SHS		2nd Shortest Distance to SHS		Difference
	Distance [mi]	Time [min]	Distance	Time [min]	
200 Mad River Rd., Mad River, CA	12.8	22	32.94	56	34
Deadwood road, Lewiston, CA	10.2	22	10.96	25	3
100 Trinity Dam Blvd, Lewiston, CA	2.2	4	5.57	11	7

Calculation of Accessibility Difference for points of interest

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If your rural area:	You could be considered:	And measure Reliability using:
§ Has automated detection § Only needs to compute reliability for a limited date range or very few locations	Intermediate	§ Speeds (to estimate travel times) § manual processing needed § Note: the process for connecting to PeMS is straightforward and may be of benefit for future calculations
§ Has automated detection § Needs to compute this measure over a large date range, and/or for multiple corridors or areas § Can feed data to PeMS AND/OR § Uses a TDM	Advanced	§ PeMS output (gives variability for given date range and time range from specified detector(s)) followed by minimal manual processing if necessary OR § TDM Travel Times output followed by minimal manual processing if necessary

Case Study Advanced

A case study below considers an example of obtaining reliability performance measures for a segment of SR-17 in Santa Cruz, California. We will consider the segment from Glenwood Drive to Ocean Street in the southbound direction (length: 5.8 miles) and Route 1 to Granite Creek Road in the northbound direction (length 5.3 miles).

Œ **Contact PeMS Staff Regarding Connection of Rural Detectors to PeMS, Electronically Transmit Rural Area Detector Data to PeMS, and Apply for a Free PeMS Account**
Go to the PeMS website at http://pems.eecs.berkeley.edu/Public/ . With the username provided to you by PeMS, log into the website to access the local freeway data available in your area.

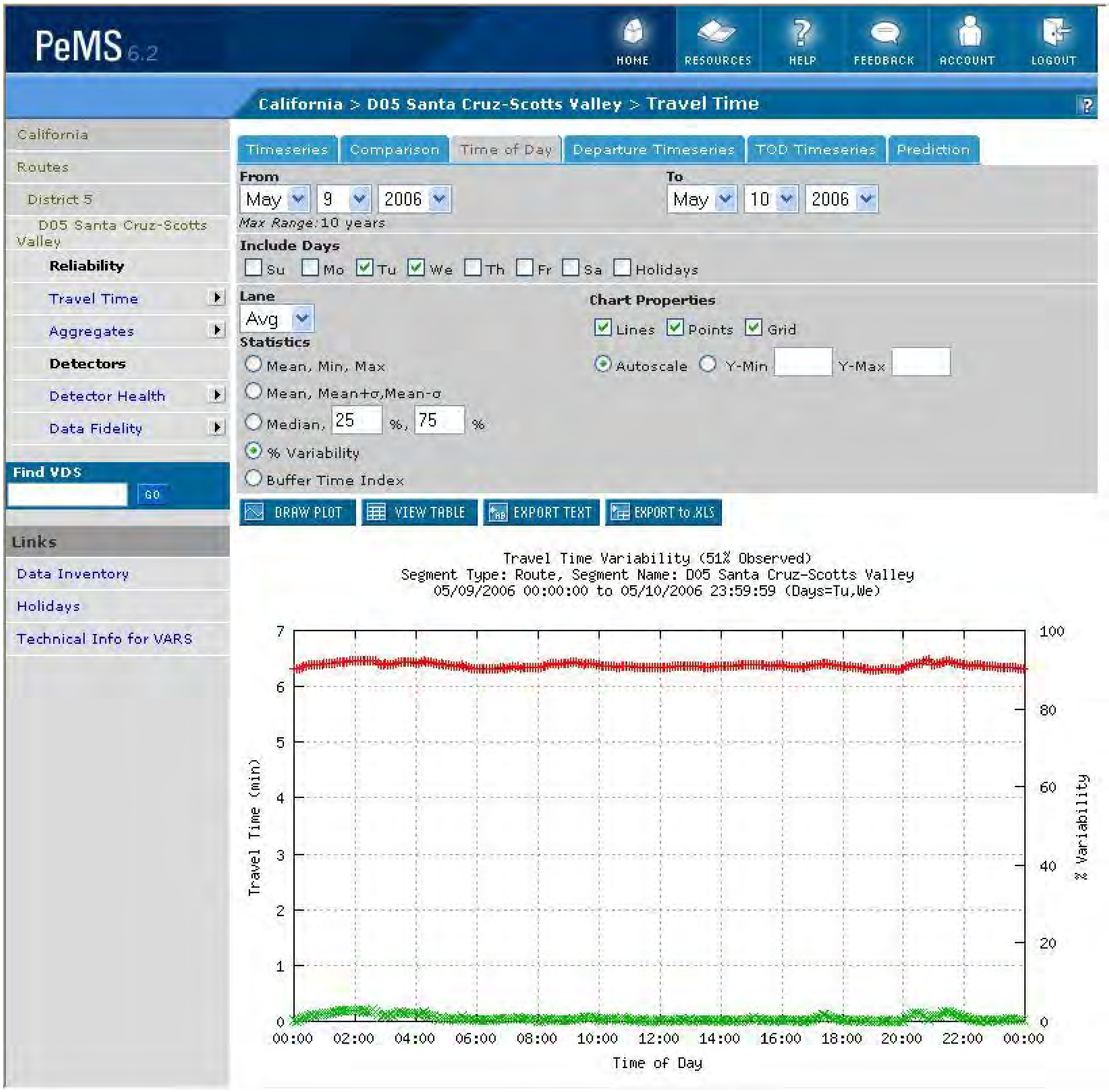
• **Select Study Parameters**
To obtain the information required to calculate reliability of the roadway segment under study, identify the Caltrans district where your county is located. In this case study, the rural highway SR-17 in Santa Cruz, which is located in Caltrans District 5 was analyzed. On the toolbar located on the left-hand side of the PeMS website, click 'Routes'. A list of detector station locations will be displayed. Select the segment in District 5 that represents the northbound direction (D05 Santa Cruz – Scotts Valley, see screenshot in Figure on following page). All the information that is available pertaining to this freeway will be displayed on the left side toolbar. In this case, the available information is travel time. The travel time information for this segment of the freeway can be accessed by clicking the 'Travel Time' link.

Starting District ▲	Route Name	From	To	Total Miles	# ML	# HV	# VDS/Mile
3	D03 50E Sacramento-Folsom	50-E/State...	50-E/Folso...	17.5	28	0	1.60
3	D03 Davis-Sacramento	80-E/Richa...	50-E/5th/X...	12.4	7	0	0.56
3	D03 Elk Grove-Sacramento	99-N/Elk G...	51-N/N/30t...	11.3	22	0	1.96
3	D03 Sacramento-Elk Grove	51-S/N/29t...	99-S/Elk G...	11.3	14	0	1.24
3	D03 Folsom-Sacramento	50-W/Folso...	50-W/State...	17.5	36	0	2.06
3	D03 51N	P St ON	Rte 244 OF...	7.7	13	0	1.69
3	D03 51S	51-S/Aubur...	51-S/29th/...	7.8	14	0	1.79
3	D03 Sacramento-Davis	50-W/5th S...	80-W/Richa...	12.4	5	0	0.40
4	D04 San Jose-San Francisco	101-N/Brok...	280-N/6th/...	42.7	58	0	1.36
4	D04 Livermore-Walnut Creek	580-W/Vasc...	680-N/Olym...	25.5	42	0	1.65
4	D04 Walnut Creek-Livermore	680-S/Olym...	580-E/Vasc...	24.7	39	0	1.58
4	D04 Oakland-Fremont	880-S/Emba...	880-S/Thor...	21.0	50	0	2.38
4	D04 Livermore-San Jose	580-W/Spri...	680-S/Mont...	31.9	9	0	0.28
4	D04 San Francisco-San Ramon	80-E/5th/B...	680-S/Boll...	30.1	48	0	1.59
4	D04 San Ramon-San Francisco	680-N/Boll...	80-W/5th/H...	29.9	57	0	1.91
4	D04 San Jose-Livermore	680-N/Mont...	580-E/Vasc...	32.7	14	0	0.43
4	D04 Fremont-Oakland	880-N/Thor...	880-N/Broa...	22.0	48	0	2.18
4	D04 Vallejo-Oakland	80-W/Solan...	580-E/Nort...	22.8	56	0	2.46
4	D04 Walnut Creek-San Jose	680-S/Hill...	280-N/Sant...	48.2	47	0	0.98
4	D04 Oakland-Vallejo	580-W/Nort...	80-E/Linco...	22.8	50	0	2.19
4	D04 San Jose-Walnut Creek	280-S/Stat...	680-N/Ygna...	47.7	50	0	1.05
4	D04 San Francisco-San Jose	280-S/5th/...	101-S/Brok...	42.9	67	0	1.56
5	D05 Santa Cruz-Scotts Valley	1-N/Morris...	17-N/Grani...	6.0	1	0	0.17
5	D05 Scotts Valley-Santa Cruz	17-S/Glenw...	1-N/Ocean ...	5.8	1	0	0.17
6	D06 41N	41-N/Centr...	41-N/Child...	15.0	7	0	0.47
6	D06 41S	41-S/Child...	41-S/Centr...	15.0	7	0	0.47
7	D07 Los Angeles-Simi Valley	101-N/Los ...	118-W/Tapo...	36.5	52	16	1.87
7	D07 Los Angeles-Santa Clarita	101-N/Los ...	5-N/Valenc...	32.7	44	0	1.35
7	D07 Los Angeles-Thousand Oaks	101-N/Los ...	101-N/Moor...	41.0	51	0	1.24
7	D07 Los Angeles-Santa Monica	10-W/Maple...	10-W/4th S...	13.5	35	0	2.59
7	D07 Los Angeles-Long Beach	101-S/Los ...	710-S/Will...	19.0	22	0	1.16
7	D07 Los Angeles-West Covina	101-S/Los ...	10-E/Vince...	13.8	30	17	3.42

Obtaining Required Data from PeMS Website

Ž **Analyze Variability**

On the 'Travel Time' information page, a wide-range of dates, granularity levels, and a specific lane (or set of lanes) can be chosen for travel time. A given weekday can also be excluded (such as a weekend day), if necessary. There are also different sets of tabs available for travel time such as 'Timeseries', 'Comparison', etc. In this case study, only Tuesday and Wednesday during the week of May 8, 2006 on the 'Time of Day' tab were analyzed with an 'average' travel time for all the lanes that have data available. Data is reported for each 5-minute interval by default. '% Variability' will be the measure of reliability for the case study example and is defined as the percentage difference between travel times between or among different days of the week at the same times of day. For example, the difference between the travel time at 16:00 hrs on a Tuesday and a Wednesday is the variability in travel time. The higher the variability, the lower will be the reliability of travel time information. The default options for 'Chart Properties' were chosen (see screenshot in Figure on following page).



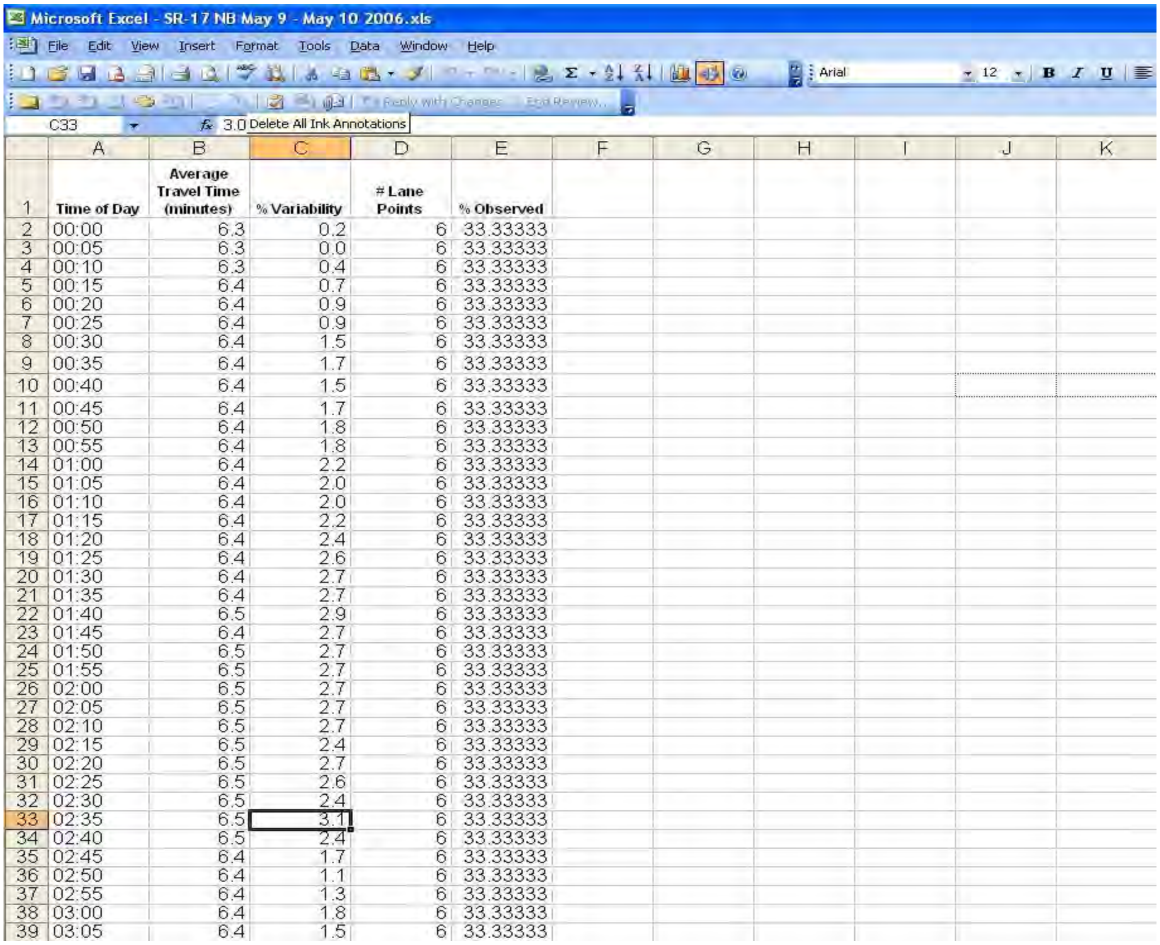
District 5 SR-17 Travel Time Variability Plot

Once all the parameters are chosen click the 'Draw Plot' button to display the plot that shows the travel time for each hour of the day on the left y-axis and % variability on the right y-axis. This data can be exported and saved as either a text file (txt) or a Microsoft Excel file (xls). As mentioned earlier, data is reported for each 5-minute interval by default. The excel spreadsheet will contain the following information:

1. Time of day
2. Average observed travel time for that segment (in this case study, the average between the observed travel time on Tuesday and Wednesday is reported).
3. '% Variability'

For this case study, the average travel time in minutes and % variability will be displayed for each 5-minute interval from 00:00 hrs to 23:59 hrs and the data is exported and saved as an excel file 'SR-17 NB May 9 - May 10 2006.xls'.

The percentage variability is a measure of reliability. In Figure 5 above, the highest variability occurs at approximately 02:35 AM with 3.1% variability; thus, people traveling along this corridor at that time experienced the highest unexpected delay. A snap shot of the excel spreadsheet with the highest variability of 3.1% is illustrated in the Figure below.



	Time of Day	Average Travel Time (minutes)	% Variability	# Lane Points	% Observed
2	00:00	6.3	0.2	6	33.33333
3	00:05	6.3	0.0	6	33.33333
4	00:10	6.3	0.4	6	33.33333
5	00:15	6.4	0.7	6	33.33333
6	00:20	6.4	0.9	6	33.33333
7	00:25	6.4	0.9	6	33.33333
8	00:30	6.4	1.5	6	33.33333
9	00:35	6.4	1.7	6	33.33333
10	00:40	6.4	1.5	6	33.33333
11	00:45	6.4	1.7	6	33.33333
12	00:50	6.4	1.8	6	33.33333
13	00:55	6.4	1.8	6	33.33333
14	01:00	6.4	2.2	6	33.33333
15	01:05	6.4	2.0	6	33.33333
16	01:10	6.4	2.0	6	33.33333
17	01:15	6.4	2.2	6	33.33333
18	01:20	6.4	2.4	6	33.33333
19	01:25	6.4	2.6	6	33.33333
20	01:30	6.4	2.7	6	33.33333
21	01:35	6.4	2.7	6	33.33333
22	01:40	6.5	2.9	6	33.33333
23	01:45	6.4	2.7	6	33.33333
24	01:50	6.5	2.7	6	33.33333
25	01:55	6.5	2.7	6	33.33333
26	02:00	6.5	2.7	6	33.33333
27	02:05	6.5	2.7	6	33.33333
28	02:10	6.5	2.7	6	33.33333
29	02:15	6.5	2.4	6	33.33333
30	02:20	6.5	2.7	6	33.33333
31	02:25	6.5	2.6	6	33.33333
32	02:30	6.5	2.4	6	33.33333
33	02:35	6.5	3.1	6	33.33333
34	02:40	6.5	2.4	6	33.33333
35	02:45	6.4	1.7	6	33.33333
36	02:50	6.4	1.1	6	33.33333
37	02:55	6.4	1.3	6	33.33333
38	03:00	6.4	1.8	6	33.33333
39	03:05	6.4	1.5	6	33.33333

Excel Spreadsheet Output from PeMS (Analyzing roadway segment in Santa Cruz)

Repeat steps above to obtain reliability for SR-17 the southbound direction.

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If a rural area:	Productivity measurement capabilities could be considered:	Productivity would be measured using:
§ Has automated detection § Needs to compute this measure over a large date range, and/or for multiple corridors or areas § Can feed data to PeMS AND/OR § Uses a Travel Demand Model	Advanced	§ PeMS output (gives variability for given date range and time range from specified detector(s)) followed by minimal manual processing if necessary OR § TDM Travel Times output followed by minimal manual processing if necessary

CASE STUDY Productivity

Œ A case study below considers an example of obtaining productivity performance measures for a segment of SR-17 in Santa Cruz, California. Consider the segment from Scott Valley, Mt Hermon Road to Scott Valley, Granite Creek Road (length: 2.01 miles). In general, there are three lanes in each direction on this segment of SR-17.

- The required data (traffic volume for a peak hour) was obtained from the Caltrans website at http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm. Peak hour ADT volume (for both directions) at north of Mt Hermon Road for the year 2004 was extracted from Caltrans website for the purpose of this exercise which is 5700 vehicles per hour. It is assumed in this exercise that this roadway segment is operating under congested conditions during peak hour periods.

Ž With a given capacity of 1667 vehicles per hour per lane, the capacity of the roadway segment under study is obtained as follows:

Total Capacity *C* = 1667 X total number of lanes
= 1667 X 6
= 10,002 vehicles per hour

Lane miles at capacity = Segment length X total number of lanes
= 2.01 X 6
= 12.06 lane-mi

- Lost lane miles (a measure of lost productivity) can now be calculated using the following equation and with all the available information described above:

Lost lane mi = lane miles at capacity - (flow rate / capacity) [vphpl] X lanes X length of segment [mi]
= 12.06 lane-mi - (5700/10,002) X 6 lanes X 2.01 mi
= 12.06 lane-mi – 6.87 lane-mi
= 5.19 lost lane-mi

- This calculation can be performed over several different years to see the trend over time.

Return on Investment

Among the rural areas reviewed, there were none which already analyzed Return on Investment (ROI) using a standardized measurement; thus, this methodology would be considered the basic level.

If a rural area:	Return on Investment measurement capabilities could be considered:	Return on Investment would be measured using:
§ Currently does not determine ROI using Travel Demand Models or other methods	Basic	§ The Cal-B/C Model or a similar method

CASE STUDY Return on Investment

Although many rural counties convey cost-effectiveness of projects using forecasted data, they currently do not actively use the specific performance measures related to Return on Investment, which include:

§ Life-cycle costs [dollars]
§ Life-cycle benefits [dollars]
§ Net present value [dollars]
§ Benefit/cost ratio [benefits divided by costs]
§ Rate of return on investment [percent return per year]
§ Project payback period [years]
§ Calculated benefits [dollars]
    o Travel time savings
    o Vehicle operating cost savings
    o Accident cost savings
    o Emission cost savings

free resource

These performance measures are directly output from the California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C). Cal-B/C is a spreadsheet-based tool developed by Caltrans for preparing analyses of both highway and transit projects. Users input data defining the type, scope, and cost of projects. The model then calculates the performance measures listed above. Cal-B/C is used for most STIP projects submitted. The model can be directly downloaded and the associated user documentation is accessible via the web at:

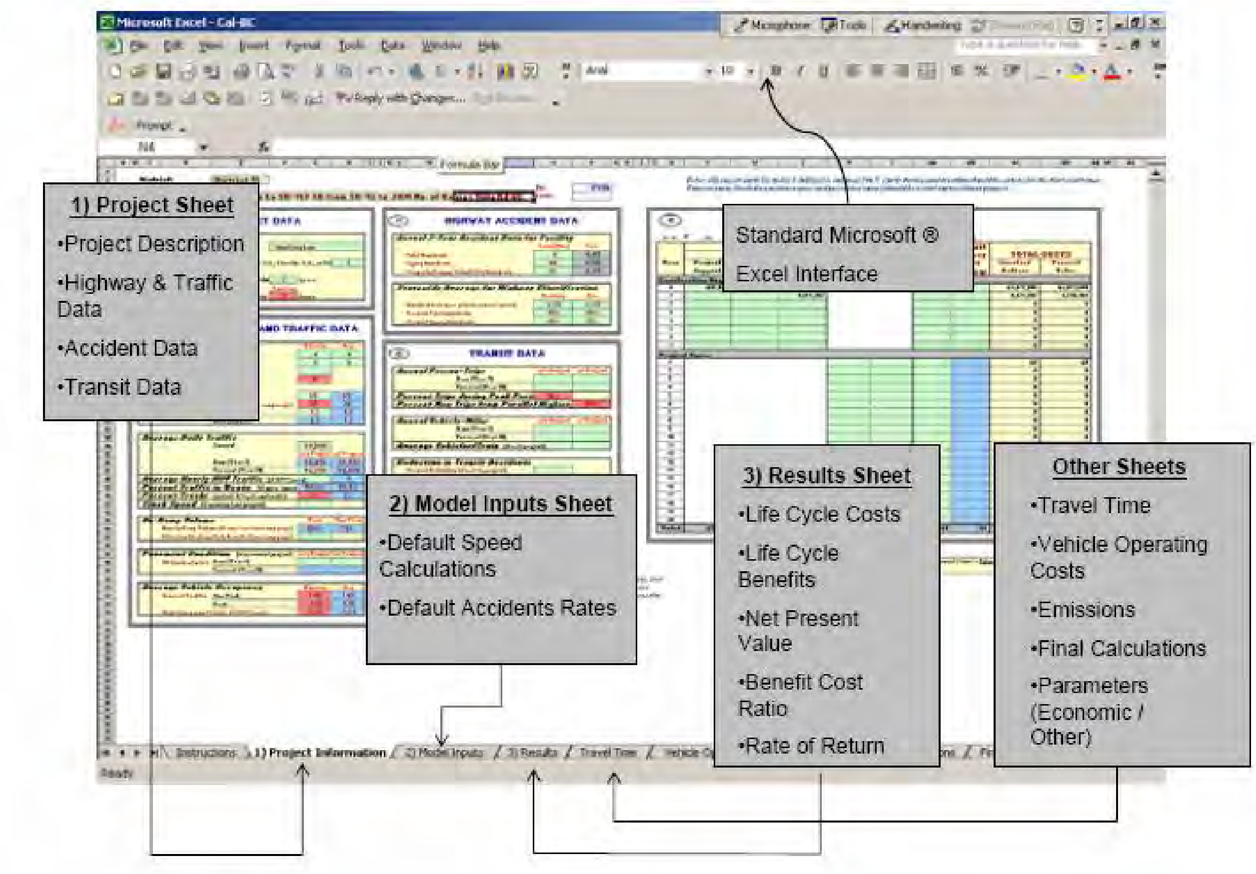
http://www.dot.ca.gov/hq/tpp/offices/ote/benefit_cost.htm

Step-By-Step Guidance **Basic**

As the Cal-B/C model is a readily available and free tool which already incorporates necessary calculations and economic assumptions, it is described here as being straightforward enough to be the first step for standardized ROI measurement for a rural area. Comprehensive and easy-to-follow documentation is available with the model.

Œ **Download Cal-B/C and User Documentation**
The Cal-B/C and all user documentation can be downloaded from the web at http://www.dot.ca.gov/hq/tpp/offices/ote/benefit_cost.htm. Instructions are also included with the spreadsheet model itself.

• **Input values in the green cells**
These values are further explained in the instructions (first tab of the spreadsheet). The model is illustrated in the Figure below.



Cal-B/C Graphical User Interface
(Source: Cal-B/C v3.2 User's Guide)

Ž **View and Modify Parameters**

Parameters may be viewed and modified by the user in the Parameters tab. Step-by-step calculations can be viewed for travel times, vehicle operating costs, accident costs, emissions, and net present value in the appropriate tabs. Outputs are provided automatically by the model and are summarized in the **Results** tab illustrated on the following page.

District: HQ

PROJECT: Hypothetical Project

EA:

PPNO:

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$0.0
Life-Cycle Benefits (mil. $)	$0.0
Net Present Value (mil. $)	$0.0
Benefit / Cost Ratio:	#DIV/0!
Rate of Return on Investment:	#NUM!
Payback Period:	21 years

ITEMIZED BENEFITS (mil. $	1st Year	20 Years
Travel Time Savings	$0.0	$0.0
Veh. Op. Cost Savings	$0.0	$0.0
Accident Reductions	$0.0	$0.0
Emission Reductions	$0.0	$0.0
TOTAL BENEFITS	$0.0	$0.0

Should results include:

1) Induced Travel? (y/n)	Y Default = Y
2) Vehicle Emissions? (y/n)	N Default = N

Cal-B/C "Results" Tab

(Source: Cal-B/C v3.2 User's Guide)

Summary

Through the overall project process and from ongoing feedback and direction from the Rural Performance Measures Project Steering Commitee, it was shown that:

§ Although rural and urban areas share some common transportation concerns, their priorities differ. Through interviews with local and regional agency representatives along with the existing county documentation, it was concluded that system preservation and safety are high priorities.

§ Rural areas can effectively apply performance measures and methodologies already in use elsewhere, while placing emphasis on these issues of particular concern to rural areas (for example, system preservation).

§ Though rural regions strive to measure system performance in accordance with statewide "standard" outcomes, they do not necessarily have the means or the resources to monitor system performance on a frequent or regular basis. It can be determined from the full time employee (FTE) data that there is very little funding or staff available for data collection.

Performance measurement methodology was developed (or existing methodologies were enhanced) that is applicable to rural areas. These measures fall under the performance categories of Safety, System Preservation, Mobility, Accessibility, Reliability, Productivity, and Return on Investment. High-level costs for these methodologies were determined within a framework of low (not requiring specific expenditures), medium (requiring specific expenditures below $100,000) and high (expenditures above $100,000, usually relating to installation of detection equipment to collect continuous data). It is recognized that for some rural counties, costs of $100,000 are still considered high and not medium, but we use the term "medium" for comparison purposes. Possible suggestions include:

§ LOW cost: All counties should consider suggestions related to the safety, accessibility, and cost effectiveness performance categories. These suggestions relate to reporting trends, free existing tools, or implementing low-cost approaches. None of these suggestions are cost prohibitive.

§ LOW cost: All counties should consider suggestions related to leveraging existing data such as HPMS and report on pavement condition trends as part of the preservation performance category. Again, the associated costs are low and require obtaining data from Caltrans and/or FHWA and then reporting the trend of pavement conditions in the county. For counties that maintain a pavement management system (PMS) with predictive capabilities, the additional data can only improve the results of these models. Furthermore, these counties can leverage their PMS predictive capabilities to report on unmet needs and trends thereof.

§ MEDIUM cost: Some counties may want to consider implementing a PMS to evaluate future conditions under different scenarios and identify the optimal use of limited funding for preservation. These models can be expensive, but some regions have managed to share existing software at no additional costs. This suggestion requires an investment in time, data entry, and possibly software.

- § Counties that do not face growing congestion and therefore do not face congestion problems can simply skip the sections related to the mobility, productivity, and reliability performance categories. These suggestions are very data intensive and are therefore expensive to implement.
- § LOW cost: Counties that do face growing congestion that maintain a travel demand model should consider including delay and speed as part of the mobility performance category. The cost of this action is low. The same counties should consider collecting travel time data between major origin destination pairs. The cost of this action is also low.
- § HIGH cost: The same counties (facing growing congestion) may want to consider installing automatic detection on their major congested roads which would enable them to report on the mobility, productivity, and reliability performance measures. The costs of these actions are high.

The case studies in Chapter 5 demonstrate a "proof of concept" describing actual application of the methodologies selected and developed for rural transportation system performance measurement, from data collection to calculations and analysis.

Resources

2003 California Public Road Data, State of California, August 2004
Alpine County Regional Transportation Plan, 2001
Alpine County Countywide Transit Needs Assessment, 2001
Amador County Transit Development Plan
Bureaus of Labor Statistics
Calaveras County Regional Transportation Plan, 2001
Caltrans, Transportation System Performance Measures State-of-the-System Prototype Report, January 2005
Del Norte County Regional Transportation Plan, 2002
El Dorado County Regional Transportation Plan, 2025
Glenn County Regional Transportation Plan, 2005
Humboldt County Regional Transportation Plan, 2004
Idaho Department of Transportation 2004 Highway Report
Idaho Department of Transportation 2005 STIP
Idaho Department of Transportation 2006 Strategic Plan
Idaho Department of Transportation 2034 Vision
Inyo County Regional Transportation Plan, 1994
Inyo County Short Range Transit Development Plan, 1997
Lake County Regional Transportation Plan, 2005
Lassen County Regional Transportation Plan Update, 1999
Mariposa County Regional Transportation Plan, 2001
Mendocino Regional Transportation Plan, 2005
Modoc County Transit Development Plan,
Mono County Short Range Transit Plan
Mono County Regional Transportation Plan, 1999
Montana Department of Transportation Performance Programming Process, 2000
Montana Department of Transportation Strategic Business Plan, 2004
Montana Department of Transportation TranPlan21 – Roadway System Performance Policy Paper, 2002 Update
Monterey County Regional Transportation Plan, 2005
MoveAZ Long Range Transportation Plan
Nevada Statewide Long Range Multimodal Transportation Plan (NevPlan)
Oregon Department of Transportation Annual Performance Progress Report
Placer County Draft Regional Transportation Plan, 2027
Plumas County Regional Transportation Plan
Rural County Task Force
Rural Performance Measures Project Steering Committee
San Benito County Regional Transportation Plan
Sierra County Regional Transportation Plan, 2001
Sierra County Short Range Transit Plan, 2003
Siskiyou County Regional Transportation Plan, 1996
TCRP: *A Guidebook for Developing a Transit Performance-Measurement System*
TCRP: *Users' Manual for Assessing Service-Delivery Systems for Rural Passenger Transportation*
Tehema County Draft Regional Transportation Plan Update, 2005
Trinity County Regional Transportation Plan, 1996
Trinity County Transportation Development Plan
Tuolumne County Regional Transportation Plan, 1996
US Census, 2000
US DOT, Summary of Roundtable on System Performance Measurement in Statewide and Metropolitan Transportation Planning, Washington, D.C., October 7-9, 2003
US DOT, Performance Measures for Small Communities-Final Report, May 2003
Utah Department of Transportation Performance Measures
Western Nevada County Transit Development Plan
Wyoming DOT: Final Report, Transit Performance Measures