Final Report

California Statewide Local Streets and Roads Needs Assessment

Nichols Consulting Engineers, Chtd.
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Executive Summary

California's local street and road system is reaching a point of crisis. City streets and county roads are where every trip begins and ends. Whether traveling by bike, bus, rail, truck or family automobile, Californians need the local system.

As the first comprehensive statewide study of California's local street and road system, this report provides critical analysis and information on the local transportation network's condition and funding needs.

The study's objective was to fully assess the condition of the local system and complete the overall transportation-funding picture for California's transportation network. We wanted answers to the following: What are the pavement conditions of local streets and roads? What will it cost to bring pavements to a Best Management Practices (BMP) or most cost-effective condition? How much will it cost to maintain them once we achieve the BMP or optimal pavement condition? What are the needs for the essential components to a functioning system? Is there a funding shortfall? If so, what is it? What are the solutions? This study collected existing road condition information to determine the future funding needs necessary to maintain the system in good condition.

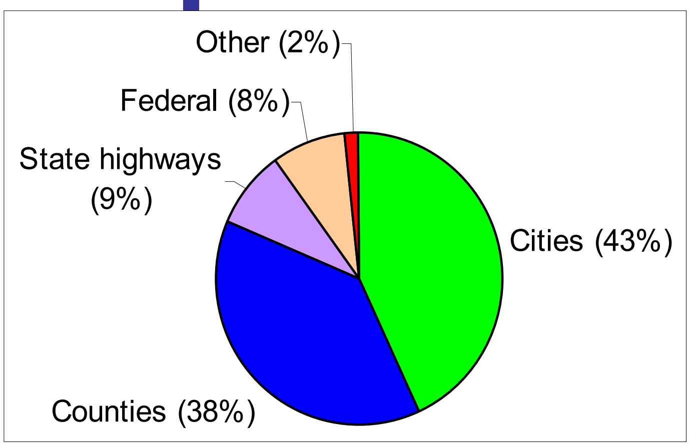


Figure 1. Breakdown of Maintained Centerline Miles

As owners and operators of 81 percent of the state's roads (Figure 1), cities and counties found that this study was of critical importance for several reasons. While federal and state governments' regularly assess their system needs, no such data existed for the local component of the state's transportation network. Historically, statewide transportation funding investment decisions have not been based on local pavement condition data, or adequate recognition for the local system. Further, recent actions to remove city and county discretion over federal and state funding have diminished resources available to the local system.

The goal is to use the findings of this study to educate policymakers at all levels of government about the infrastructure investments needed to provide California with a seamless transportation system. The findings of this study will provide credible and defensible analysis to support a dedicated, stable funding source for maintaining the local system at an optimum level. It will also provide for the most effective and efficient investment of public funds.

The study surveyed all of California's 58 counties and 478 cities in 2007-08. The response was outstanding. Information collected resulted in capturing data from more than 93% of the state's local streets and roads. Furthermore, since the majority of the data submitted came from recognized pavement management systems, the accuracy of the data is very high. Where no data existed, models were developed, tested, and used to estimate the pavement condition and funding needs.

The results show that California's local streets and roads are on the edge of a cliff. On a scale of zero (failed) to 100 (excellent), the statewide average pavement condition index (PCI) is 68 ("at risk category"). If current funding remains the same, the statewide condition is projected to deteriorate to a PCI of 58 in 10 years, and further to 48 ("poor" category) by 2033 (see Figure 2). Even more critical, the unfunded backlog will more than double from $37 billion to $79 billion by 2033.

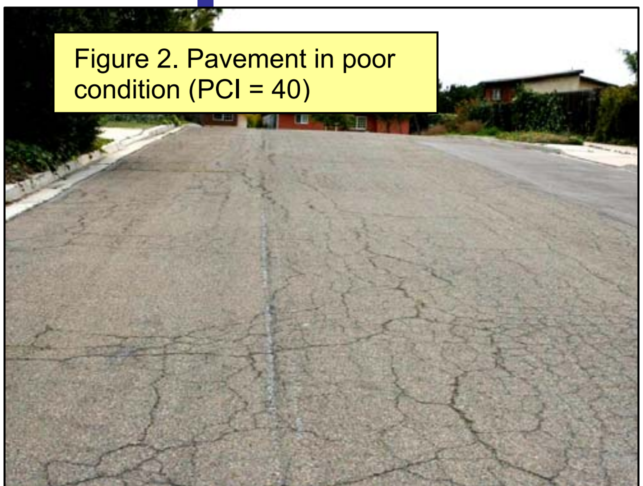


Figure 2. Pavement in poor condition (PCI = 40)

Based on the results of this study, approximately $51.7 billion of additional funding is needed to bring just the pavement condition of the state's local streets and roads to a level where the taxpayer's money can be spent cost-effectively.

To spend the taxpayer's money cost-effectively, it makes more sense to preserve and maintain our roads in good condition than to let them deteriorate, which will only make it more costly in the future. Consistent with that approach, the costs developed in this study are based on achieving a roadway pavement condition of what the industry calls Best Management Practices (BMPs). This condition represents improving the roadway condition to a level where roads need preventative maintenance treatments (i.e., slurry seals, chip seals, thin overlays). These treatments have the least impact on the public's mobility and commerce. Further, these treatment types are more environmentally friendly than the next level of construction that would be required (i.e. rehabilitation and reconstruction).

The importance of this approach is significant. As roadway pavement conditions deteriorate, the cost to repair them increases exponentially. For example, it costs twelve times less to maintain a BMP pavement compared to a pavement that is at the end of its service life. Even a modest resurfacing is four times costlier than a pavement in the BMP condition. With counties and cities on fixed budgets, employing maintenance practices consistent with BMP results in treating four to twelve times more road area. By bringing the roads to BMP conditions, cities and counties will be able to maintain streets and roads at the most cost-effective level. It is a goal that is not only optimal, but also necessary.

Although no similar statewide bridge needs assessment were available for inclusion in this study, a brief review indicates that approximately $2.6 billion of bridge projects have been identified and approved for funding. Of this, local agencies must provide 11.47% (approximately $300 million) as the local match.

This study helps answer the following key questions:

What are the pavement conditions of local streets and roads?

California's local streets and roads are on the edge. Currently at a PCI of 68, the pavement condition will decline to 48 (poor condition) by 2033 based on existing funding levels available to cities and counties.

What will it cost to bring pavements to a BMP or most cost-effective condition?

It will cost $67.6 billion to reach BMP in 10 years.

How much will it cost to maintain them once we achieve the BMP or optimal pavement condition?

Once the BMP condition is reached, it will cost approximately $1.8 billion a year to maintain them at that condition.

What are the needs for the essential components to a functioning system?

The transportation network includes essential safety and traffic components such as curb ramps, sidewalks, storm drains, streetlights and signals. These components require $32.1 billion over the next 10 years.

Is there a funding shortfall? If so, what is it?

Yes. The table below shows the pavement and essential component shortfall of $71.4 billion over the next 10 years.

Summary of 10 Year Needs and Shortfall (2008 $Billion)

Transportation Asset	Needs	Funding	Shortfall
Pavements	$ 67.6	$ 15.9	**$ 51.7**
Essential Components	$ 32.1	$ 12.4	**$ 19.7**
Totals	**$ 99.7**	**$ 28.3**	**$ 71.4**

What are the Solutions?

To bring the state's local street and road system to a best management practice level where the taxpayer's money can be spent cost effectively, we will need up to approximately $51.7 billion of additional funding for pavement alone and more than $71 billion, including the essential components, for a functioning system over the next 10 years. The sooner this is accomplished, the less funding will be required in the future.

The conclusions from this study are inescapable. Given existing funding levels available to cities and counties for maintaining the local system, California's local streets and roads will deteriorate rapidly within the next 25 years to a poor condition. Unless this condition is addressed, costs to maintain the local system will only continue to grow, while the quality of California's local transportation network deteriorates.

To bring the local system back into a cost-effective condition, thereby preserving the public's $271 billion pavement investment and stopping further costly deterioration, at least $7 billion annually in new money is needed to stop the further decline and deterioration of local streets and roads. This is equivalent to about a 38-cent gas tax increase. Or to put it another way, the average driver will pay an additional 50 cents a day for gas. It is imperative that cities and counties receive a stable and dedicated revenue stream for cost effective maintenance of the local system to avoid this crisis.

Chapter 1. Introduction

1.1 Background

California's 58 counties and 478[1] cities own and maintain 141,554[2] centerline-miles of local streets and roads. This is an impressive 81% of the state's total publicly maintained lane-miles (see Figure 1.1 below). Conservatively, this network is valued at $271 billion.

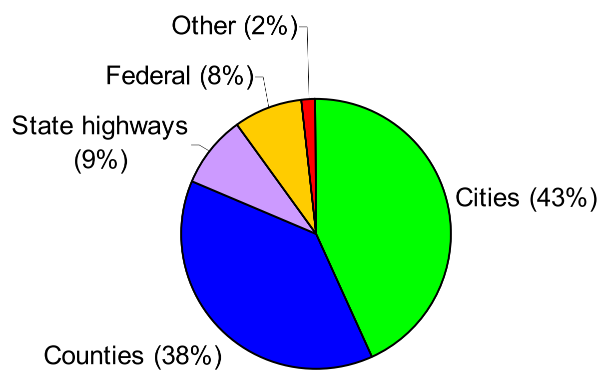


Figure 1.1 Breakdown of Maintained Road Centerline Miles by Agency[2]

Since lane-miles are more commonly used in pavement management analyses (the costs derived are based on areas, and lane-miles are a more accurate depiction of pavement areas) the table below shows the breakdown of lane-miles for local streets and roads by functional classification as well as for unpaved roads. Major streets or roads are those that are classified as arterials or collectors, and local streets or roads are those that are classified as residentials and alleys. Unpaved roads are defined as those that have either dirt or gravel surfaces.

Table1.1 Breakdown by Functional Classification & Unpaved Roads[2]

	Lane-miles			
	Major	Local	Unpaved	Total
Cities	76,629	100,912	887	178,428
Counties	51,821	72,652	14,563	139,036
Totals	**128,450**	**173,564**	**15,450**	**317,464**

Note: San Francisco is included as a city only.

[1] Two new cities, Wildomar and Menifee, were incorporated in 2008 and therefore not included in the original survey. However, their pavement network is included as part of the Riverside County's network.
[2] *2006 California Public Road Data – Statistical Information Derived from the Highway Performance Monitoring System*, State of California Department of Transportation, Division of Transportation System Information, July 2007.

There is no dispute that the transportation system has a significant role in the state's economy, as this road network is a critical contributor to maintaining California's status in the top 10 largest economies in the world[3]. The transportation system contributes to trade (import/exports), freight movement, retail, agriculture, tourism, mining, construction and manufacturing. In terms of jobs and trade, transportation and utilities comprise the largest sector in California in 2006 and second in terms of output[4].

Therefore, the maintenance of the transportation system should be a major concern for all Californian cities and counties.

In 1999, Senate Resolution 8[5] (Burton, 1999) requested the California Transportation Commission (CTC) to produce a "10 year needs assessment of the state's transportation system," that included the "unfunded rehabilitation and operations needs for state highways, local streets and roads, the state's intercity rail programs, and urban, commuter and regional transit systems, including ferry systems, over the next 10 years."

In the SR8 report, 57 counties and nearly 400 cities responded to a questionnaire regarding pavement rehabilitation. The estimated shortfall was an estimated $10.5 billion in unfunded needs, plus an annual shortfall of $400 million to keep up with annual maintenance and rehabilitation expenditures. This backlog, built up since the 1970s, represented nearly 8 years of rehabilitation needs. In addition, regional agencies also identified $13.1 billion in high priority local arterial expansion projects.

In the decade that has elapsed since then, the cost of rehabilitation has increased tremendously, but revenues have not kept up. Figure 1.2 illustrates the dramatic (more than ten-fold) increases in asphalt prices since 1997. Since the majority of local streets and roads are constructed of asphalt concrete (less than 0.5% are Portland cement concrete), this has a direct impact on the costs of maintenance and rehabilitation.

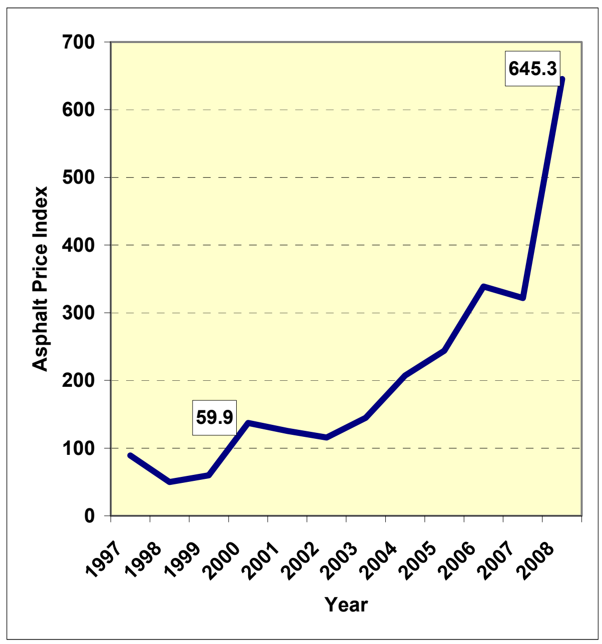


Figure 1.2 Caltrans Asphalt Price Index (1997 to 2008)[1]

However, increased material costs is not the only reason for increased maintenance costs. The cost of *deferring* maintenance is also a significant factor in higher maintenance costs. When agencies do not have sufficient funds to

[3] http://www.lao.ca.gov/2006/cal_facts/2006_calfacts_econ.htm

[4] http://www.census.gov/eos/www/naics/

[5] *Inventory of Ten-Year Funding Needs For California's Transportation Systems*, California Transportation Commission, May 5, 1999.

maintain their roads, maintenance efforts are delayed or postponed, which often results in a more expensive treatment later.

This study was commissioned to build upon, update the results of the previous study (SR8), and determine the funding needed to maintain the local streets and roads system for the next 10 years. However, state highways were not included as this was part of Caltrans State Highway Operation and Protection Plan (SHOPP).

1.2 Study Objectives

The objectives of this study may be summarized as a series of questions:

- What are the conditions of local streets and roads?
- What will it cost to bring them up to an acceptable condition?
- How much will it cost to ***maintain*** them in an acceptable condition for the next 10 years?
- Similarly, what are the needs for other essential components, such as safety, traffic and regulatory items?
- Is there a funding shortfall? If so, what is it?

Another objective was to develop a methodology that could be used for periodic updates by other agencies such as RTPAs or MPOs in the development of their Regional Transportation Plans.

A major goal of this study was to find the most cost-effective way of maintaining local streets and roads, and this is reflected in the methodology used (discussed in Chapter 3).

Finally, it was desirable to contact all 478 cities and 58 counties in California to get this information. Chapter 2 discusses in more detail the data collection efforts.

1.3 Study Assumptions

There were some important assumptions that were made during our analyses of the data received from cities and counties. These differ in several instances from those used in the SR8 report as well as Caltrans 2007 SHOPP[6]. Notably, they are:

1. The analysis period used in this study is 10 years, which is different from the SR8 report which only looked at a one-time backlog, but is consistent with SHOPP.

2. All numbers reported in this study are in constant 2008 dollars – this is consistent with both SHOPP and SR8.

3. The pavement condition goal was to reach a condition where best management practices (BMP) can occur. This translates to a PCI in the low 80's (on a scale of 0 to 100, where 0 is failed and 100 is excellent). SR8 defined the goal as reaching a statewide index of 70. Caltrans SHOPP defines performance goals quite differently, i.e. the goal is to reduce the percentage of distressed highways from 28% to 10%.

[6] *Ten Year State Highway Operation & Protection Plan (FY 2008/09 to 2017/18*), Caltrans.

4. Two scenarios are reported in this study for the pavement analysis:
   a. Impacts of existing budget
   b. Funds needed to reach goal within 10 years

   These scenarios were not analyzed in the SR8 report.

5. It is assumed that no new streets or roads are added within the analysis period. This is consistent with both the SHOPP and SR8 analyses.

6. Capital improvement projects are not included, e.g. realignments, widening, grade separations etc.

7. The inclusion of safety, traffic and regulatory components of the roadway system such as sidewalks, ADA ramps, storm drains etc were was not previously included in SR8, although they are included in Caltrans SHOPP.

8. A bridge needs assessment was not included in this study, although both the SHOPP and SR8 did. However, a brief summary of the bridge projects that have been identified and approved for funding is included in Chapter 5.

Table 1.2 below summarizes the assumptions used in this study as well as in SR8 and Caltrans SHOPP.

Table 1.2 Summary of Study Assumptions

Assumptions	This Study	SR 8 Report	Caltrans SHOPP
Analysis Period	10 years	One-time backlog	10 years
Cost Basis	2008 dollars	1999 dollars	2007 dollars
Goals	Best management practices (PCI* = low 80's)	PCI = 70 ("Good" condition)	% of distressed pavements < 10%
Total Scenarios Evaluated	2	1	1
Capital Improvement Projects	No	Yes	Only related to operational improvement
Essential Components**	Yes	No	Yes
Bridges	Partial	Yes	Yes

*PCI = pavement condition index (scale of 0 to 100, with 0 = failed and 100 = excellent).
** Includes safety, traffic and regulatory components

1.4 Report Structure

Chapter 2 of this report discusses the data collection efforts, including the survey methodology used.

Chapter 3 presents the pavement needs assessments.

Chapter 4 presents the needs assessment for safety, traffic and regulatory components.

Chapter 5 presents a short description of bridges and the local projects identified for funding.

Chapter 6 summarizes the findings.

The appendices contain detailed explanations and tables to support the discussions in the above chapters. Appendix F includes a discussion of the needs assessment approach for future updates.

1.5 Study Sponsors

This study was sponsored by the cities and counties of California, and managed by the County of Los Angeles, Department of Public Works. The Oversight Committee is composed of representatives from the following:

- League of California Cities (League)
- California State Association of Counties (CSAC)
- County Engineers Association of California (CEAC)
- County of Los Angeles Department of Public Works
- California Regional Transportation Planning Agencies (RTPA)
- California Rural Counties Task Force (RCTF)

Chapter 2. Data Collection

This chapter describes in detail the data collection efforts. The goal was to ensure participation by all 58 counties and 478[1] cities. SR 8 had set the bar high in 1999 by obtaining responses from 57 counties and nearly 400 cities, so this study could aim for no less.

2.1 Outreach Efforts

Tremendous efforts were made to reach all 536 agencies between April to August 2008. This included letters, emails, phone calls, and presentations at meetings and conferences by members of the Oversight Committee as well as by Nichols Consulting Engineers, Chtd. (NCE).

An initial database of over 900 contacts was compiled for all cities and counties. The data came from a variety of sources, i.e. the memberships of both CSAC and the League as well as NCE's contacts. Signup sheets from the Joint League Public Works Officers Institute/CEAC Spring conference in La Jolla (March 2008) were also included. The initial contacts focused on Public Works staff (Directors or engineers responsible for pavement/asset management) but later included City Managers, County Administrative Officers as well as RTPAs and MPOs (Metropolitan Planning Agencies).

Over 900 contact letters were mailed out the first week of April, 2008 (see Appendix A) with copies of the survey questionnaire and a fact sheet explaining the project. The letter was mailed out on Los Angeles County letterhead. Within 2 weeks, NCE made at least two follow-up phone calls to the recipients to ensure that they had received the letter and realized the importance of the study and survey. The original deadline for submittal of the survey questionnaire was April 30th, 2008.

However, by early May, it was clear from our follow up phone calls that most agencies needed more time to compile the information, particularly as the construction season commenced. Based on this input, the Oversight Committee decided to extend the deadline to August 31st, 2008 and assisted in making renewed efforts to get their members to respond.

In addition, presentations were made at a variety of meetings and conferences to "spread the word". This included the spring conference in La Jolla as well as chapter meetings of the American Public Works Association (APWA) and at RTPA meetings.

2.2 Project Website

A website was designed and developed for this study at www.SaveCaliforniaStreets.org (see Figure 2.1). The intent of this website was to act as both an information resource on this study as well as a repository of related reports that may be of interest to cities and counties. More importantly, it was a portal to the online survey that is described in Section 2.3.

Figure 2.1 Home Page of www.SaveCaliforniaStreets.org Website

The domain name was registered for five years (expires February 27, 2013) and can be used for future updates after this study is completed. The website currently contains the following information:

- Home page
- Project status
- Reports for downloading
- Related Links
- FAQ
- Contact Us
- Participate in study – includes link to www.surveygizmo.com, which contains the online questionnaire as well as the ability to upload reports and other files to our ftp site.

2.3 Survey Questionnaire

A survey questionnaire was prepared and finalized in early April 2008 (see Appendix A). Briefly, it included a request for the following information:

1. Contact name and information
2. Pavements
    a. Pavement management software used, if any
    b. Network inventory data
    c. Distress survey procedures

d. Pavement condition ratings and needs
3. Safety, Traffic and Regulatory Components
   a. Asset inventory
   b. Replacement costs
4. Funding sources and expenditures

The survey was also available online at www.surveygizmo.com so that agencies had the option to enter this information online. The advantage of this was that it automatically tracked the responses, and produced a database containing all the data.

Since the questionnaire was similar to others that had been sent out by the Metropolitan Transportation Commission in the San Francisco Bay Area and the Metropolitan Transportation Authority in Los Angeles County, agencies in these areas had the option of not filling out the questionnaire (in MTC's case), or only filling out portions (if you were in MTA's jurisdiction). Our analyses for these two regions depended to some extent on the data provided by MTC and MTA.

While the request for pavement information was relatively straightforward, there was more discussion on what elements of the safety, traffic and regulatory components should be collected. The original Request for Proposal identified the following elements to be of interest:

- **Storm drains**
- **Curb & gutters**
- **Sidewalks**
- **Traffic signals**
- **Street lights**
- Bicycle paths
- Bridges
- Corporate yards
- Curb medians
- Curb ramps
- Guardrails
- Heavy equipment
- Parking lots
- Pathways
- Public parks
- Sewer - pipelines
- Sound/retaining walls
- Speed bumps
- Storm damage costs
- Traffic circles
- Traffic signs
- Trees

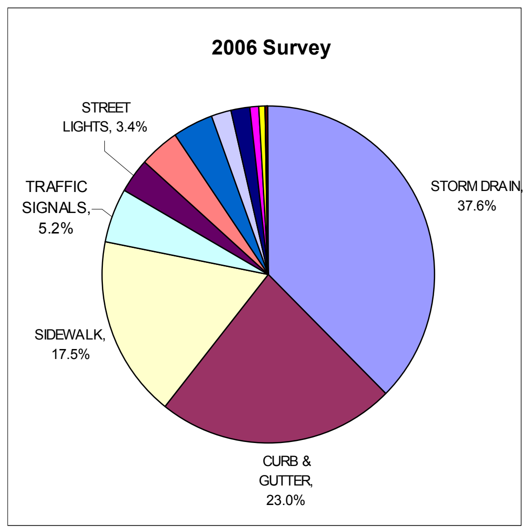


Figure 2.2 Replacement Costs of Safety, Traffic & Regulatory Components from MTC study[7]

However, a survey conducted by MTC in 2006[7] on over 100 agencies indicated that the top five categories (highlighted in bold/blue above) comprised almost 90% of the total value (see Figure 2.2). Therefore, it was agreed that the survey questionnaire would only include these five categories as well as the following six other categories:

- Curb ramps

[7] *Non-Pavement Needs Assessment*, Metropolitan Transportation Commission, Oakland, CA, October 2007.

- Sound/retaining walls
- Traffic signs
- NPDES (National Pollutant Discharge Elimination System) requirements
- Other ADA (American with Disabilities Act) compliance needs
- Other physical assets/expenditures that comprised >5% of total costs, e.g. heavy equipment, corporation yards, etc.

The intent of reducing the number of elements was to reduce the burden of data collection/reporting for the agencies by focusing only on those that represented the highest costs. However, the primary reason to include the costs of curb ramps, ADA and NPDES was to capture the impacts of the ever-changing regulatory climate.

2.4 Results of Data Collection

By September 2008, the data collection phase was essentially completed, although a late entry was received in early November. A total of 415 agencies responded to the survey – 56 counties and 359 cities. This represented more than 76% of the agencies surveyed, but more importantly, it represented more than 93% of the total centerline miles of local streets and roads in the state (see Figure 2.3). This was an incredible launch to this study; by comparison, many national surveys performed by the National Cooperative Highway Research Program (NCHRP) have survey responses of less than 30%.

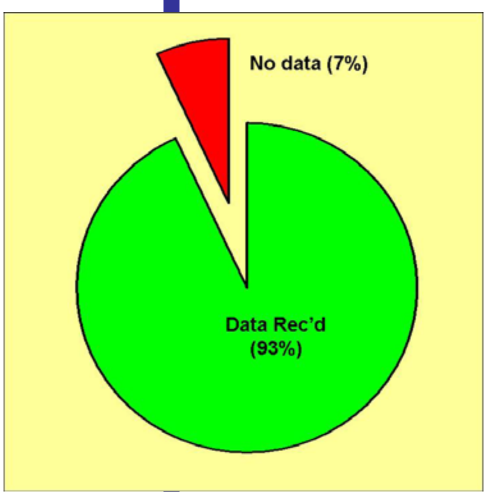


Figure 2.3 Responses to Survey (% centerline miles)

Both large and small (in terms of size of pavement network) agencies responded – the largest was the City of Los Angeles with over 6,500 miles, and the smallest was the City of Hidden Hills, with only 0.3 miles.

Many of the missing 130 agencies were contacted multiple times, either by NCE or by members of the Oversight Committee. In some instances, they reported no data available, or that they were currently performing an update of their system. More frequently, they reported a lack of resources to collect the information requested – this was particularly true of many of the smaller cities.

93% of the state's local streets and roads are included in this study.

Only two counties did not submit any data – San Benito County and Mono County. In the case of Mono County, NCE's archives contained a PMS database that was approximately five years old – this was used to project the current conditions. In the case of San Benito County, neighboring agencies were used to arrive at the current condition. This is further discussed in Chapters 3 and 4.

Of the data received, 97% of the responding agencies reported inventory data, and 93% reported information on their pavement needs. Encouragingly, 72% also reported some data on the safety, traffic and regulatory components – this was positive given that it was probably the first time a statewide survey had requested this information.

2.4.1 Are Data Representative?

Throughout the data collection phase, it was important to ensure that the data received were representative in nature. This was critical for the analyses – the criterion used was network size.

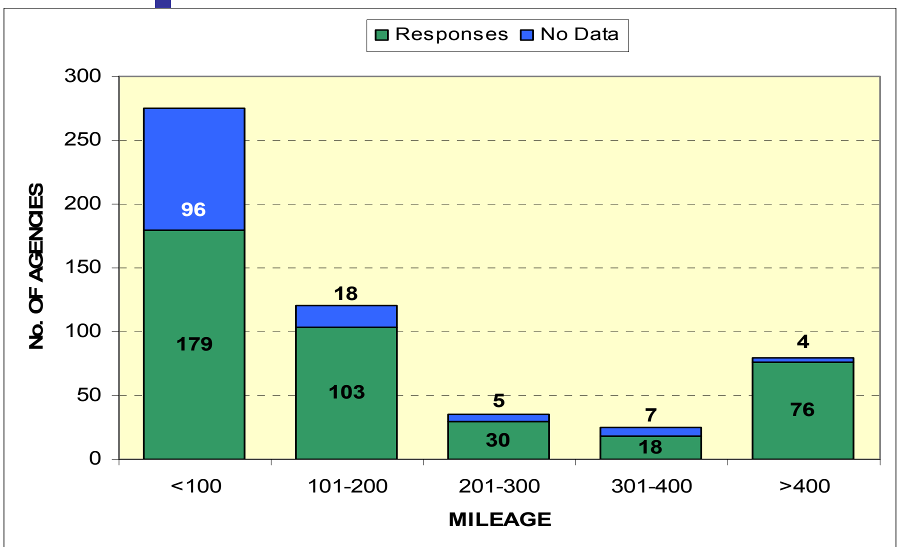


Figure 2.4 Distribution of Agency Responses by Network Size (Centerline miles)

The distribution of responses with respect to network size is shown in Figure 2.4. Small agencies are those that have less than 100 centerline miles; medium between 101 to 300 miles, and large agencies have more than 300 miles.

Figure 2.4 shows all the agencies who responded in green, and the ones who did not in blue. Clearly, the bulk of the agencies who did not respond had less than 100 miles of pavement network i.e. small cities, but we still had 179 responses (65%) in this size category, so our confidence in the responses were validated.

An important point to note is that small agencies account for a very small percentage of the state's pavement network. There are 275 Cities with less than 100 centerline miles of streets, and 167 Cities with less than 50 centerline miles of streets. However, they comprise only 8.7% and 3.2% of the total miles in the state, respectively. Their impact on the statewide needs is consequently minimal.

2.4.2 PMS Software

The survey responses showed that 85% of the responding agencies had some pavement management system (PMS) software in place (see Figure 2.5). The StreetSaver® (40%) and MicroPAVER (20%) software programs are the two main ones in the state, not surprising given their roots in the public domain and reasonable costs. StreetSaver® was developed and supported by the Metropolitan Transportation Commission (MTC) and MicroPAVER supported by the American Public Works Association (APWA).

The remaining agencies used a variety of PMS software, including:

- Cartegraph
- Stantec
- Infra Manager
- Windows PMS Pro
- Custom Excel/Access programs

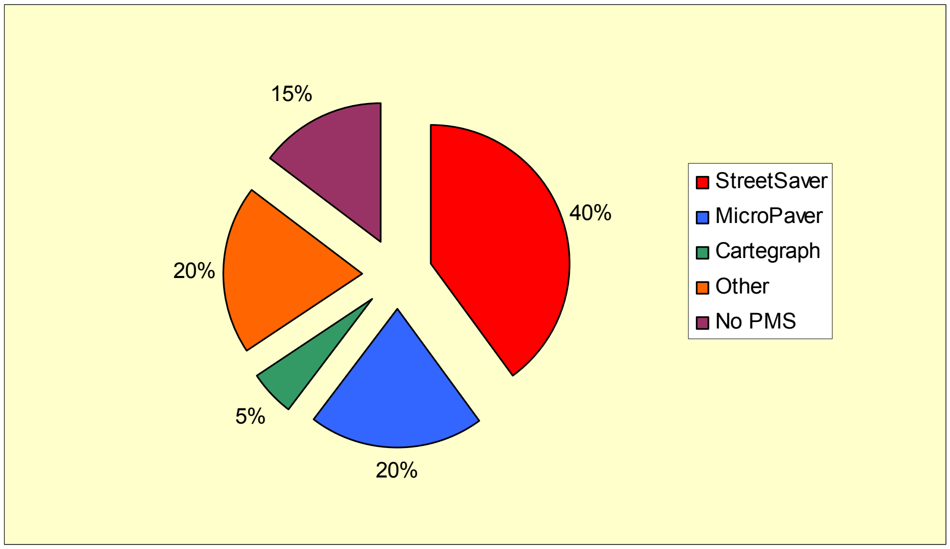


Figure 2.5 PMS Software Used from Survey Responses

2.4.3 Importance of PMS

It cannot be emphasized enough the importance of implementing and maintaining a pavement management system in an agency. Aside from the oft-mentioned benefits of one, it added tremendously to the quality of data received in this survey. The pavement distress survey procedures employed were probably the most important element. They were largely consistent and well-documented procedures (usually the StreetSaver® or MicroPAVER procedures) for collecting this information. Even those agencies which used other PMS software employed pavement distress survey procedures that were similar to those used by StreetSaver® or MicroPAVER.

Due to the widespread use of a PMS, the quality of the pavement data received contributed immensely to the validity of this study's results.

This resulted in a remarkable consistency in the pavement conditions reported, which in turn, allowed us to do an "apples and apples" comparison between agencies and reduced the complexity of this study. The quality of this information contributed immensely to the validity of the results of this study.

Equally important, almost all the medium and large agencies used a pavement management system, which lent more credibility to the results. Overall, 85% of the state's local pavement network was included in a PMS database.

2.4.4 Quality Assurance

The adage "garbage in, garbage out" applies to any data collection effort. Therefore, a quality assurance program was necessary to ensure that the data received was valid for our analyses. While it was not possible to check every single value supplied by the agencies in the surveys, several validation checks were made, particularly on those items that would have an impact on the analysis results. Examples are described below.

1. Inventory – an easy check was to validate the lengths (lane-miles, centerline miles) of the pavement network reported. This was compared with the lengths reported in the

HPMS (Highway Performance Monitoring System) data[2] and any significant differences (more than ±10%) were red-flagged and follow up phone calls made. Minor differences in these numbers were expected due to the many different ways that a pavement network can be sectionalized, e.g. bi-directional streets, double counting of intersections, inclusion or exclusion of unpaved roads, etc.

2. Lane-miles, areas and lane widths - Since we also asked for pavement areas, a quick check was to calculate the average lane-widths. Extreme values, such as widths more than 20 feet or less than 5 feet were flagged for follow up calls.

3. Math errors – surprisingly enough, there were multiple math errors, i.e. the individual components did not add up to the totals submitted.

4. Mismatching units – Particularly for the safety, traffic and regulatory components, the wrong units were used, e.g. feet instead of yards. Any extreme values identified became reasonable once the right units were applied.

5. Tests of reasonableness – in many cases, we had to use simple tests of reasonableness. For example, one medium sized city of 200 miles reported more than 1,300 traffic signals! Another small city with 33 miles reported future pavement expenditures of more than $500,000/mile, which is more than 20 times the state average. For the medium to large agencies, these results triggered a follow-up phone call to obtain explanations. In most instances, they were simple errors in data entry.

Our QA tests resulted in additional follow up calls to between 75 to 100 agencies. Again, we focused primarily on the medium to large agencies (i.e., more than 100 centerline miles) in this instance.

2.5 Summary

Overall, the number and quality of the survey responses received exceeded expectations and more than met the needs of this study. To obtain data on more than 93% of the state's local streets and roads network was a remarkable achievement. That 85% of the agencies that responded also had some pavement management system in place removed many obstacles in the technical analyses. In particular, the consistency in the pavement conditions reported contributed enormously to the validity of the study.

Finally, to obtain some data from 72% of the agencies on their safety, traffic and regulatory components was an encouraging first step.

Chapter 3. Pavement Needs Assessment

In this chapter, the methodology and assumptions used for the pavement needs assessment are discussed, and the results of our analyses presented.

3.1. Methodology

Since not all 536 cities and counties responded to survey, a methodology had to be developed to estimate the needs of the missing agencies. The following paragraphs describe in detail the methodology that was used in the study.

3.1.1. Filling In the Gaps

Inventory

Figure 3.1 on the next page outlines the first steps in “filling in the gaps”. Briefly, this process was to determine the total miles (both centerline and lane-miles) and pavement areas, as this would be crucial in estimating the pavement needs for an agency.

1. If no centerline miles are reported, then the centerline miles reported in the HPMS[2] report was used.

2. From the HPMS, the statewide centerline mile average indicated that 37% of the pavements were classified as major and 63% as local. These averages were also used to determine the functional class breakdown.

3. If no lane-miles were reported, then statewide averages from the HPMS report were used to arrive at this information.

    a. For counties, the statewide average was approximately 2.1 lane-miles per centerline mile for major roads, and 2 lane-miles per centerline mile for locals.

    b. For cities, the statewide average was approximately 3 lane-miles per centerline mile for major roads, and 1.9 lane-miles per centerline mile for locals.

4. If no pavement areas were reported, again, statewide averages from the HPMS report were used to determine this value. The average lane width was 15.9 feet per lane for major roads and 15 feet per lane for local roads.

Steps 1 through 3 were also part of validation checks discussed in Chapter 2. Table 3.1 summarizes the results for all the counties (cities included in counties) for both major and local streets and roads.

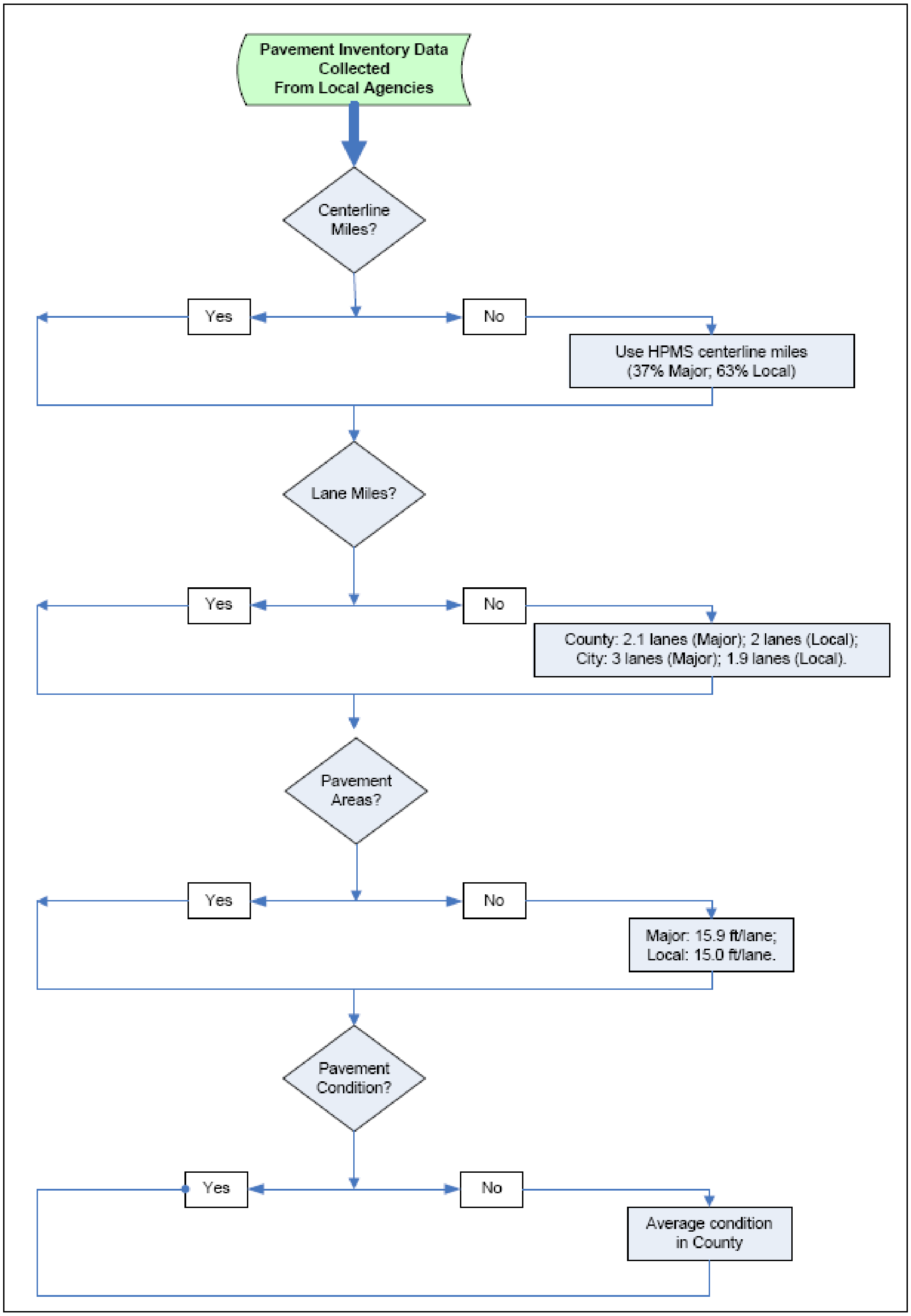


Figure 3.1 Flowchart to Estimate Pavement Inventory and Condition Data

Table 3.1 Summary of Inventory & Pavement Condition Data by County (Cities Incl.)

County*	Centerline Miles				Lane Miles				Current Average PCI**		
	All	Major	Local	Unpaved	All	Major	Local	Unpaved	All	Major	Local
Alameda County	3,473	1,279	2,194	0	7,933	3,716	4,217	0	66	66	66
Alpine County	135	38	15	82	270	75	30	164	40	40	40
Amador County	476	202	252	22	955	408	503	44	31	31	31
Butte County	1,783	522	986	274	3,684	1,195	1,943	545	70	72	68
Calaveras County	715	323	297	95	1,344	656	593	95	55	56	50
Colusa County	987	277	474	236	1,524	541	746	236	61	69	58
Contra Costa County	3,013	1,104	1,909	0	6,973	3,221	3,752	0	72	72	72
Del Norte County	334	79	146	109	675	178	290	207	70	70	70
El Dorado County	1,253	416	765	72	2,490	858	1,525	108	62	73	57
Fresno County	6,009	2,287	3,641	81	12,852	5,439	7,252	161	74	75	70
Glenn County	942	349	448	145	1,892	713	892	288	68	68	68
Humboldt County	1,477	526	225	725	2,972	1,153	441	1,377	61	55	73
Imperial County	2,994	1,244	1,743	6	6,088	2,610	3,468	11	74	74	74
Inyo County	1,684	208	353	1,124	2,933	435	363	2,136	75	75	74
Kern County	5,520	1,841	3,494	185	12,787	5,296	7,121	370	66	71	60
Kings County	1,328	425	833	70	2,796	962	1,694	140	63	70	59
Lake County	752	239	362	152	1,497	477	720	299	33	36	30
Lassen County	942	354	76	513	1,900	727	148	1,026	55	49	61
Los Angeles County	20,269	7,414	12,742	112	56,864	21,833	34,858	174	68	72	66
Madera County	1,827	567	1,195	66	3,652	1,185	2,354	113	48	58	43
Marin County	1,030	381	649	0	2,033	893	1,140	0	61	62	61
Mariposa County	560	207	353	0	1,142	435	706	0	53	53	53
Mendocino County	776	356	419	2	1,530	727	800	3	51	56	45
Merced County	2,229	822	1,244	163	4,710	1,828	2,556	326	57	64	54
Modoc County	1,515	394	631	490	3,041	800	1,260	980	42	52	32
Mono County	737	275	462	0	1,498	581	917	0	71	72	72
Monterey County	1,942	659	1,275	8	3,980	1,454	2,514	11	63	64	62
Napa County	739	273	466	0	1,500	635	865	0	53	53	53
Nevada County	771	285	338	148	1,564	595	673	296	72	70	74
Orange County	6,316	2,112	4,204	0	15,190	6,947	8,243	0	78	75	78
Placer County	1,989	559	1,370	60	4,099	1,262	2,717	120	79	79	79
Plumas County	700	233	259	208	1,407	474	516	416	71	71	71
Riverside County	7,114	2,555	4,243	316	15,583	6,638	8,321	624	71	71	72
Sacramento County	4,861	957	3,878	26	11,423	3,352	8,020	51	68	72	66
San Benito County	421	156	265	0	868	340	528	0	68	68	68
San Bernardino County	8,502	3,091	5,258	153	19,350	8,393	10,502	455	72	73	73
San Diego County	7,683	3,085	4,497	101	17,408	8,389	8,817	202	74	75	73
San Francisco County	855	316	539	0	2,044	983	1,061	0	62	62	62
San Joaquin County	3,318	1,204	2,095	19	7,040	2,899	4,102	39	70	69	69
San Luis Obispo Co	1,929	729	960	241	4,078	1,707	1,889	482	64	66	62
San Mateo County	1,826	676	1,151	0	3,889	1,806	2,082	0	69	69	69
Santa Barbara County	1,569	489	1,078	2	3,322	1,218	2,100	4	72	78	68
Santa Clara County	4,450	1,647	2,804	0	9,215	4,279	4,936	0	70	70	70
Santa Cruz County	883	400	483	0	1,837	884	953	0	52	56	48
Shasta County	1,694	1,109	354	231	3,501	2,361	702	438	64	62	74
Sierra County	499	182	106	211	1,001	368	211	423	73	73	73
Siskiyou County	1,516	557	463	497	3,066	1,154	919	993	57	61	51
Solano County	1,739	643	1,096	0	3,563	1,597	1,966	0	66	66	66

County*	Centerline Miles				Lane Miles				Current Average PCI**		
	All	Major	Local	Unpaved	All	Major	Local	Unpaved	All	Major	Local
Stanislaus County	2,820	963	1,815	42	5,974	2,295	3,596	83	60	61	64
Sutter County	1,196	281	752	163	2,439	627	1,486	326	73	65	71
Tehama County	1,197	328	595	274	2,401	658	1,194	549	69	69	64
Trinity County	919	283	410	226	1,837	565	819	452	52	57	48
Tulare County	3,988	1,363	2,514	110	8,209	3,025	4,964	220	66	72	67
Tuolumne County	532	211	284	37	1,228	511	643	74	62	62	62
Ventura County	2,410	856	1,549	4	5,333	2,405	2,919	9	64	66	61
Yolo County	1,352	439	791	122	2,709	1,026	1,507	175	69	72	67
Yuba County	724	282	340	102	1,504	592	709	204	74	74	74
Total or Average	141,554	49,916	83,613	8,025	317,465	128,451	173,564	15,450	68	70	67

* All cities within county are included.
** Average PCI is weighted by pavement area.

Current Pavement Condition

Table 3.1 above includes the current pavement condition index (PCI) for each county (including cities). Again, this is based on a scale of 0 (failed) to 100 (excellent). This is weighted by the pavement area, i.e. longer roads have more weight than short roads when calculating the average PCI.

For those agencies that did not report any current pavement condition, the average current pavement condition in that county/region was used. These were obtained from those agencies that utilized a PMS. Cities were determined separately from counties, i.e. a city's condition was based only on the average condition of cities within the county, but the county was based on surrounding like counties.

The only exception to this rule was for some cities in Los Angeles County; due to the large size of the county and differences in the rural and urban regions, an individual city's pavement condition came from the cities in the same geographic area, e.g. San Fernando Valley or the coast.

The average pavement condition index for streets and roads statewide is 68. This rating is considered to be in the "at risk" category.

From this table, we can see that the statewide weighted average PCI for all local streets and roads is 68, with major roads slightly better and local roads slightly worse. The PCI ranges from a high of 79 in Placer County to a low of 31 in Amador County. It should be emphasized that the PCI reported above is only the weighted average for each county and includes the cities within the county. This means that Amador County may well have pavement sections that have a PCI of 100, although the average is 31.

Another way of interpreting the PCI is to use condition categories to describe the PCI ranges. Figure 3.2 shows the most common thresholds – these were used in this study. The descriptions used for each category are typical of most agencies, although there are many variations on this theme. For example, it is not unusual for local streets to have slightly lower thresholds indicating that they are held to lower condition standards.

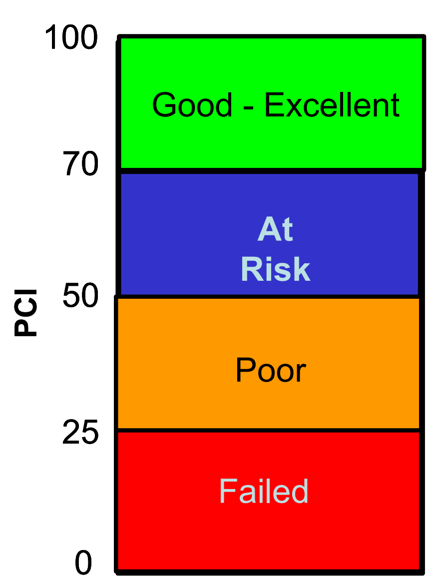


Figure 3.2 PCI Categories

The PCI can also be used as an indicator of the type of repair work that will be required. This is described in more detail in Section 3.1.3. To provide a sense of what the PCI values mean, Figures 3.3 to 3.7 are photographs of some pavements with different PCIs.

Figure 3.3 PCI = 98 (Excellent Condition)

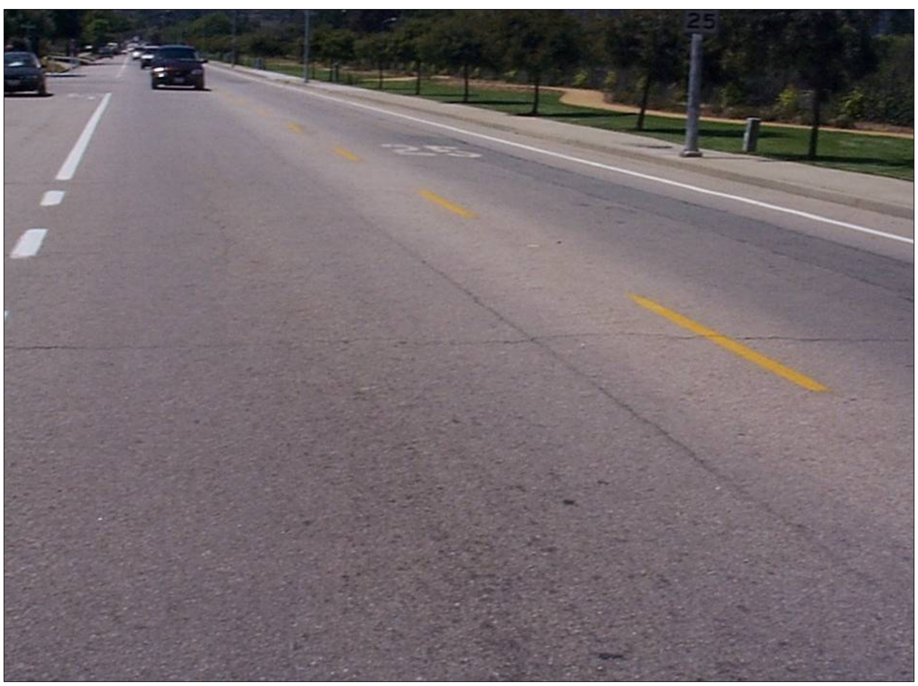


Figure 3.4 PCI = 82 (Good Condition)

Figure 3.5 PCI = 68 ("At Risk")

Figure 3.6 PCI = 40 (Poor Condition)

Figure 3.7 PCI <10 (Failed Condition)

3.1.2. What Does a PCI of 68 Mean?

An average pavement condition of 68 is not necessarily good news. While it seems just a couple of points shy of the "good/excellent" category, it has significant implications for the future. From the generalized pavement life cycle curve in Figure 3.8, a newly constructed pavement will have a PCI of 100. In the first five years of its life, there is a gradual and slow deterioration. As more time passes, this pavement deterioration begins to accelerate, until the steep part of the curve is reached at approximately 15 years (the exact timing will depend on the traffic volume, climate, pavement design, maintenance, etc).

From here, the pavement deterioration is very rapid – if repairs are delayed by just a few years, the costs of the proper treatment may increase significantly, as much as ten times. The financial advantages of maintaining pavements in good condition are many; they include saving the taxpayers' dollars, less disruption to the traveling public as well as more environmental benefits.

Therefore, a PCI of 68 should be viewed with caution – it indicates that our local streets and roads are, as it were, poised on the edge of a cliff.

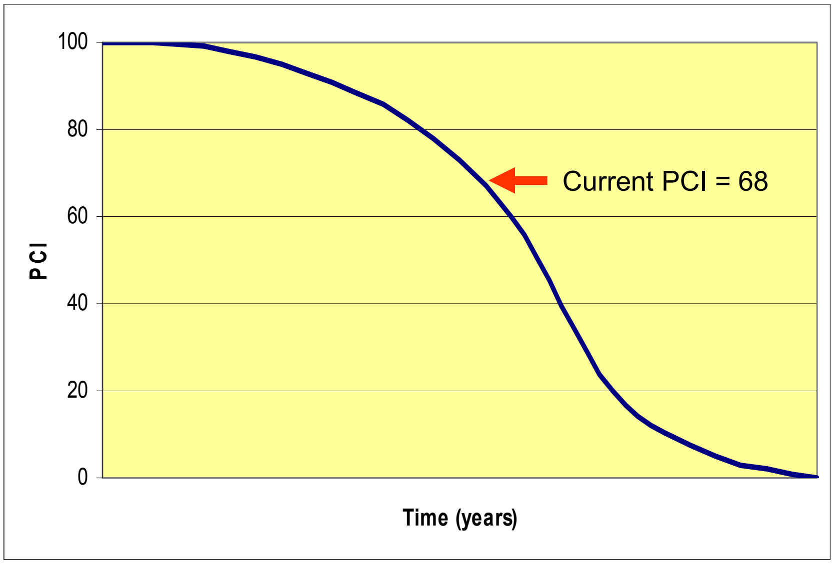


Figure 3.8 Generalized Pavement Life Cycle Curve

Figure 3.9 shows the distribution of pavement conditions by county. As can be seen, a majority of the counties in the state have pavement conditions that are either "At Risk" or in "Poor" condition. Some of the "green" counties are green due to recent population growth patterns. For example, San Bernardino County has experienced a significant increase in population growth that has resulted in an explosion of new subdivisions with new roads. Therefore, their pavement conditions are somewhat "skewed" due to the larger percentage of new roads with high PCIs. However, despite their color, none of the "green" counties have a PCI greater than 80; in fact, the majority are in the low 70's, indicating that they will turn "blue" in a few years.

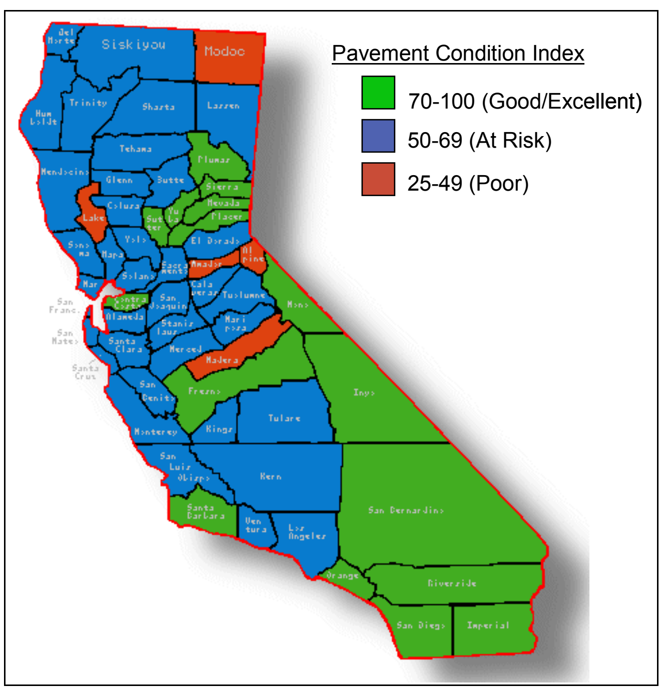


Figure 3.9 Average Pavement Condition by County

3.1.3. Needs Assessment Goal

To determine the pavement needs, we first need to define the goals that we would like to achieve. For instance, the funding required to achieve a PCI goal of 50 would be significantly less than that for say, a PCI of 75 since it would cost more to maintain pavements at a higher PCI. Of course, the tradeoff is that we end up with roads in "poor" condition that will cost more to improve and maintain in the long term.

Our goal is to bring streets and roads to a condition where best management practices (BMP) can occur.

In this study, the goal of the needs assessment is for all pavements to reach a condition where best management practices (BMP) can occur, i.e. where only the most cost-effective pavement preservation treatments are needed. Other benefits such as a reduced impact to the public in terms of delays and environment (dust, noise, energy usage) will also be realized.

In short, the BMP goal is to reach a PCI in the low 80s and the elimination of the backlog of work. The deferred maintenance or "backlog" is defined as work that is needed, but is not funded.

For this goal to be effective, it should also be attainable within a specific timeframe. Although four funding scenarios were included in our analysis, only two are included in this report for brevity:

1. Funding required to achieve BMP in 10 years
2. Impacts of existing funding on PCI and backlog

The second scenario was to determine the impacts of the existing funding with respect to the pavement condition as well as the deferred maintenance or backlog.

To perform these analyses, MTC's StreetSaver® pavement management system program was used. This program was selected because the analytical engine was able to perform the required analyses, and the default pavement performance curves were based on data from California cities and counties.

Once the current PCI and analysis goal were determined, two additional pieces of information were needed to perform the needs assessment:

1. The types of **maintenance and rehabilitation treatments** that are assigned to a pavement section during the analysis period. For example, if Main Street had a PCI of 45, then the required treatment may be an overlay at a cost of $26/square yard.

2. **Performance models** to predict the future PCI of the pavement sections with and without treatment.

Sections 3.1.4 and 3.1.5 describe both of these processes in more detail.

3.1.4 Maintenance and Rehabilitation Decision Tree

Assigning the appropriate maintenance and rehabilitation (M&R) treatment is a critical component of the needs assessment. It is important to know both the ***type*** of treatment as well as ***when*** to apply it. This is typically described as a decision tree.

Figure 3.10 summarizes the types of treatments and their costs in this study. Briefly, good to excellent pavements (PCI >70) are best suited for pavement preservation techniques, i.e. preventive maintenance treatments such as chip seals or slurry seals. These are usually applied at intervals of five to seven years depending on the traffic volumes.

As pavements deteriorate, treatments that address structural adequacy are required. Between a PCI of 25 to 69, asphalt concrete (AC) overlays are usually applied at varying thicknesses. Finally, when the pavement has failed (PCI<25), reconstruction is typically required. Note that if a pavement section has a PCI between 90 and 100, no treatment is applied.

The PCI thresholds shown in Figure 3.10 are generally accepted industry standards.

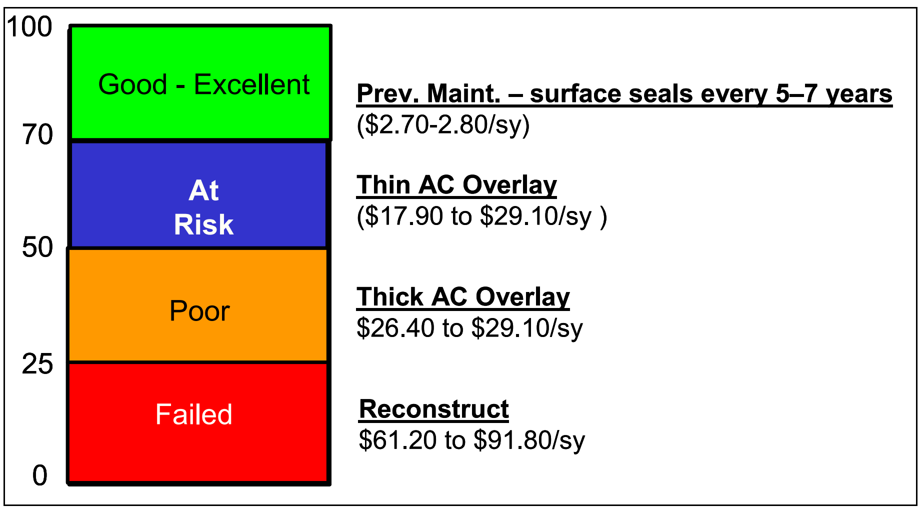


Figure 3.10 Final M&R Tree and Unit Costs

Multiple treatments may occur within the analysis period. For example, if Main Street were reconstructed in 2012, typical treatments over the analysis period may include a slurry seal every 5 years to preserve the pavement. Therefore, an accurate needs assessment must also include the cost of these seals in addition to the cost of reconstruction.

The unit costs shown in Figure 3.10 are statewide averages. The range in costs for each treatment is for the different functional classes of pavements, i.e. majors have a higher cost than locals.

Cost data from almost 50 agencies covering different climatic regions were examined. The intent was to determine if there was a regional difference in unit costs. From Figure 3.11, it can be seen that there were wide ranges in the costs for overlays and reconstruction, although there were no regional trends. The high end of an overlay could be as much as ten times more than the low end.

While it may make intuitive sense that unit costs should vary by geography or climate, the reality is that there are so many other factors that affect the cost, such as:

- Size of project
- Distance from hot mix plant/haul distances
- Asphalt prices
- Time of year

Even within the same county, there can be large variations in the unit cost for the same treatment. Only surface seals were fairly consistent in price. Therefore, we used the statewide averages for this study.

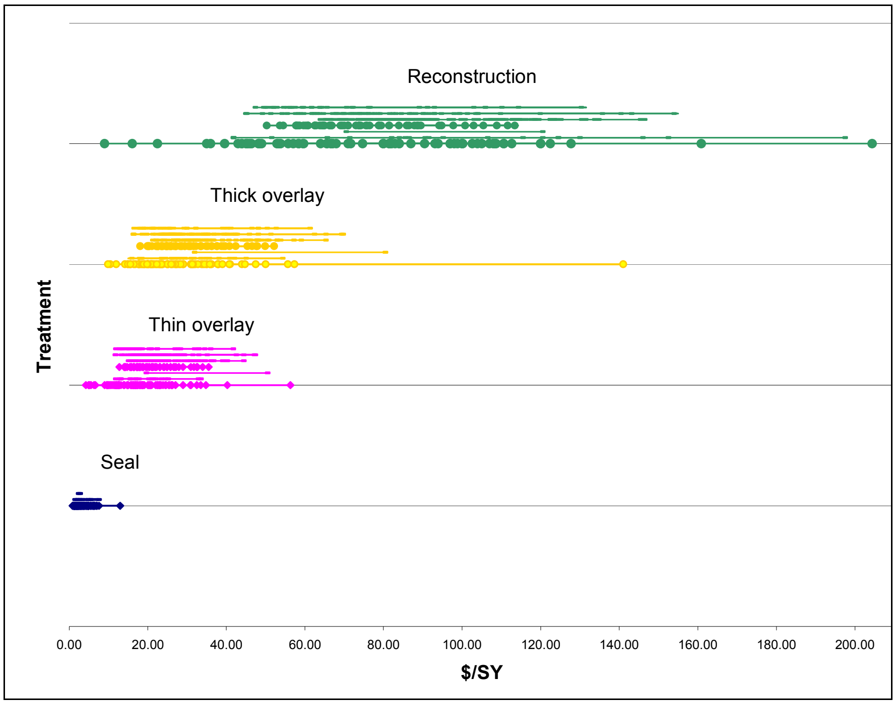


Figure 3.11 Range of Unit Costs for M&R Treatments

3.1.5 Pavement Performance (Prediction) Models

Since the analysis period is 10 years, the future condition of all the pavement sections have to be predicted or forecast. For example, if Main Street had a current PCI of 65 in 2008 and is to be overlaid in 2009, what will the PCI be in 2012? What if it was slurried in 2015?

To predict the future PCI, performance models were used. As was mentioned earlier, one of the reasons to use the StreetSaver® software was because the default performance models were developed using data from California cities and counties. Originally, it was the intent of this study to determine if regional prediction models could be developed, i.e. desert, mountains or coastal. However, raw performance data was not available so it was not possible to develop these curves. Therefore, the default StreetSaver® models were used.

The general form of the model is:

$$\mathbf{PCI = 100 - \rho / (\ln (\alpha/Age))^{(1/\beta)}}$$

Where:

PCI = pavement condition index
α, β, ρ = regression coefficients depending on the functional class (major or local) and surface type of pavement (asphalt concrete, Portland cement concrete or surface treated only)
Age = age of pavement, years

The development of these performance equations can be found in the Technical Appendices of the StreetSaver® manual[8]. They included the analyses of thousands of data points from multiple cities and counties.

3.1.6 Escalation Factors

In addition, the use of an appropriate escalation factor for use in the analysis was examined. Table 3.2 summarizes the asphalt price index as well as the price for asphalt concrete every year since 1998. The average annual increase over the ten-year period is 7.1%.

However, subsequent discussions with other agencies and the Oversight Committee modified our decision to use constant 2008 dollars in our analyses. Therefore, an escalation factor was not used. Note too that the SHOPP as well as some Regional Transportation Plans also report their needs assessments in constant dollars.

[8] *Technical Appendices Describing the Development and Operation of the Bay Area Pavement Management System*, by Roger E. Smith, Texas A&M University, 1987.

Table 3.2 Price Index and Asphalt Concrete Unit Cost from 1998 (*ref. Caltrans*)

Year	Price Index		Asphalt Concrete		Average % of Change per Year (from 1998 to this year)
	Value	% of Change per Year (from 1998 to this year)	$/Ton	% of Change per Year (from 1998 to this year)	
1998	128.6		$38.78		
1999	139.2	8.2%	$40.14	3.5%	5.9%
2000	146.2	6.6%	$45.12	7.9%	7.2%
2001	154.1	6.2%	$43.89	4.2%	5.2%
2002	142.2	2.5%	$49.00	6.0%	4.3%
2003	148.6	2.9%	$48.35	4.5%	3.7%
2004	216.2	9.0%	$53.55	5.5%	7.3%
2005	268.3	11.1%	$75.72	10.0%	10.6%
2006	280.6	10.2%	$86.04	10.5%	10.4%
2007	261.1	8.2%	$85.48	9.2%	8.7%
2008	240.3	6.5%	$85.02	8.2%	7.3%
				Average	**7.1%**

3.1.7 Distribution of Pavement Areas by Condition Category

As an additional note, the responses to our survey provided us with only the average PCI. This did not offer any information on the distribution of PCIs within that particular network or database. For example, if City X reported an average PCI of 75, there was no corresponding information on what % of streets were actually 90, or 55 or 32. An infinite number of combinations were possible to arrive at an average of 75. This distribution was required to perform the needs analysis.

Therefore, we examined the distribution of PCIs for 128 agencies and arrived at Table B.1 in Appendix B – this appendix also contains a more detailed discussion of the development of the PCI distributions.

3.1.8 Unpaved Roads

The needs assessment for unpaved roads is much simpler – 74 agencies reported data on their unpaved road network, including their needs. This resulted in an average cost of $9,800 per centerline mile per year. Since StreetSaver®, like all pavement management software only analyzes paved roads, the average cost for unpaved roads from the survey was used for those agencies which did not report any funding needs.

An example of this calculation is also included in Appendix B.

3.1.9 Needs Calculations

The determination of pavement needs and backlog is based on four primary factors:

- Existing condition, i.e. PCI
- Appropriate treatment(s) to be applied from decision tree and unit costs
- Performance models
- Funding available during analysis period

The calculation of the pavement needs is conceptually quite simple. Once the PCI of a pavement section is known, a treatment and unit cost from (Figure 3.10) is applied. This is performed for all sections within the 10-year analysis period. A section may receive multiple treatments within this time period, e.g. Walnut Avenue may be overlaid in Year 1, and then slurried in Year 5 and again in Year 10.

The next step is to determine **when** this treatment is applied. In the case of the 10-year scenario, ten years is needed to achieve the goal; therefore, the appropriate treatments must be applied between Years 1 to 10.

However, the optimal time is when to get the "biggest bang for the buck". Therefore, a cost-benefit analysis is performed to determine the biggest bang. From Figure 3.12, when an overlay is applied, the PCI will improve to 100, and a new performance curve is determined. The "benefit" is the area under the curve, also known as the "effectiveness area".

This is divided by the equivalent uniform annual cost of the treatment and a weighting factor based on traffic volumes is then applied. The Weighted Effectiveness Ratio (WER) is calculated as follows:

$$WER = \frac{(Effectiveness\ Area / Year)}{EUAC / SY} * WF$$

where:
WER = Weighted effectiveness ratio
Effectiveness area = area under PCI curve shown in Figure 3.12
Year = years affected
WF = weighting factor based on traffic volumes (1.0 for major streets, 0.55 for local streets)
EUAC = equivalent uniform annual cost of treatment
SY = area of pavement section in sq. yards

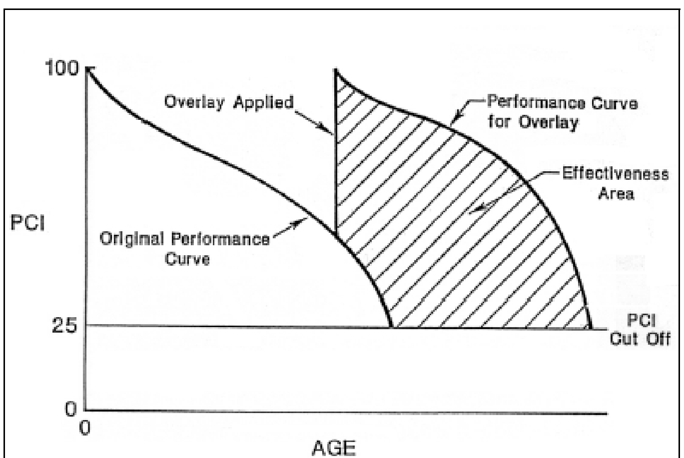


Figure 3.12 Calculation of Effectiveness Area[9]

The pavement sections are then prioritized by the WER, i.e. the sections with the highest WER will be selected for treatment first. This process is performed for all the sections in the database until the goals are achieved within the first ten years. The cost of all the treatments applied are then summed up annually.

The deferred maintenance or "backlog" is defined as work that is needed, but is not funded. It is possible to fully fund ALL the needs in the first year and thereby result in a backlog of zero. However, the funding constraint for the scenario is to achieve our BMP goal within 10 years. Assuming a constant annual funding level for each scenario, the backlog will gradually decrease to zero by the end of year 10.

Appendix B contains an example of the needs calculations.

3.1.10 Results

The results are summarized in Table 3.3 and indicate that $67.6 billion is required to achieve the BMP goals in 10 years. Again, this is in constant 2008 dollars. Detailed results by County for each scenario are included in Appendix C. The results for the cities and counties within MTC's jurisdiction (i.e. within Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano and Sonoma Counties) were provided by MTC.

Table 3.3 Cumulative Pavement Needs (2008 $)

Cumulative Needs (2008 dollars)		
Year No.	Year	Reach BMP Goal in 10 Years
1	2009	$ 6,763,602,217
2	2010	$13,527,204,434
3	2011	$20,290,806,651
4	2012	$27,054,408,868
5	2013	$33,818,011,085
6	2014	$40,581,613,302
7	2015	$47,345,215,519
8	2016	$54,108,817,736
9	2017	$60,872,419,953
10	2018	$67,636,022,170

3.1.11 Funding to Maintain Network at BMP

Additional analyses were performed to determine the funding required to *maintain* the pavement network after the BMP goal was reached in 10 years. An iterative process was used to calculate the funding level required to maintain the pavement condition at this level for an additional 15 years (i.e. a total analysis period of 25 years was used to determine this).

This was determined to be $1.8 billion annually, which is not too far from the existing funding level of $1.59 billion (see next section). This much smaller funding level is because only pavement preservation policies are required to maintain the pavement network once it has been improved. These policies cost significantly less, as was described in Section 3.1.4.

3.2 Existing Funding Sources

The survey also asked agencies to provide both their revenue sources as well as pavement expenditures for FY 2006/07, FY 2007/08 as well as estimating an annual average for future years. Local agencies identified a myriad of sources of funds for their pavement expenditures, broadly categorized into federal, state or local. They included the following examples (this is by no means an exhaustive list):

Federal

- Regional Surface Transportation Program (RSTP)
- Congestion Mitigation & Air Quality Improvement (CMAQ)
- Emergency Relief
- High Risk Rural Roads (HR3)
- Safe Routes to School (SRTS)
- Transportation Enhancement Activities (TE)
- Community Development Block Grants (CDBG)

State

- Gas taxes
- Proposition 1B
- Proposition 42/AB 2928
- State Transportation Improvement Program (STIP)
- AB 2766 (vehicle surcharge)
- Bicycle Transportation Account (BTA)
- Safe Routes to School (SR2S)
- Transportation Development Act (TDA)

Local

- General funds
- Local sales taxes
- Developers fees
- Various assessment districts – lighting
- Redevelopment
- Traffic impact fees
- Traffic safety/circulation fees
- Utilities
- Transportation mitigation fees
- Parking and various permit fees

Table 3.4 summarizes the percentage of funding sources from the different categories for FY 2006/07 to FY 2007/08 as well as the estimated sources for future years. Note that Prop. 1B funds were a significant percentage of the total (10%), equaling the federal category, but this is only a one-time funding source. Transportation funding from the American Recovery and Reinvestment Act (ARRA) was also included below. However, it was estimated that only 40% of the $1.6 billion (i.e. $640 million) would be spent on local streets and roads, and that this would be available only in FY 2008/09.

More than one-third of pavement funding comes from local sources.

The more important item to note is that local funding sources come from many sources, and include a range of original fees. Local funding sources form a significant percentage of the total funding, more than one-third.

Table 3.4 Sources of Funding Sources

Funding Sources	Annual Funding		
	FY 2006/07 & 07/08	Estimated for FY 08/09	Estimated for FY 09/10 onwards
State	41.0%	40.5%	52.9%
State – Prop 1B only	10.0%	0%	0%
Federal with ARRA*	10.8%	35.9%	10.4%
Local	38.1%	23.6%	36.8%

*ARRA for cities and counties is assumed to be 40% of $1.6 billion (FY 08/09)

The survey also asked for a breakdown of pavement expenditures into four categories:

- Preventive maintenance, such as slurry seals
- Rehabilitation and reconstruction, such as overlays
- Other pavement related activities e.g. curb and gutters
- Operations and maintenance

Table 3.5 shows the breakdown in pavement expenditures for cities, counties and cities/counties combined. These were consistent within 1-2% points for all the years reported.

Table 3.5 Percentage of Pavement Expenditures

	Percentage of Pavement Expenditures			
	Preventive Maintenance	Rehabilitation & Reconstruction	Other Pavement Related	Operations & Maintenance
Counties	13%	42%	8%	37%
Cities	14%	60%	9%	17%
Cities & Counties combined	14%	52%	9%	26%

Encouragingly, approximately 13-14% of pavement expenditures are for preventive maintenance, which indicates that many agencies are cognizant of the need to preserve pavements. The main difference between counties and cities is the percent allocated to operations and maintenance. This is expected, since county networks tend to have different characteristics from city streets, thereby incurring a higher percentage of operations and maintenance costs.

Cities and Counties are estimated to spend $1.59 billion annually on pavements.

On average, anticipated pavement expenditures for the next ten years are expected to be $7,426/centerline-mile for counties and $15,173/centerline-mile for cities (not including operations and maintenance). These values were used to estimate the expenditures for those agencies that did not report this information. The resulting total pavement expenditures for all 536 cities and counties were therefore estimated to be $1.59 billion annually. This value is used in the analysis discussed below.

To put this funding level in perspective, $1.59 billion/year is less than 0.06% of the total investment in the pavement network, which is estimated to be $271 billion.

3.2.1. Impacts of Existing Funding

The second scenario estimates what the impacts will be on the pavement condition and backlog if the existing funding ($1.59 billion/year) stays constant. The results are shown in Figure 3.13.

Under the existing funding scenario, the blue line shows that the PCI will gradually decrease to 58 by 2018; more troubling, the red bars show that backlog will increase from $37 billion to almost $58 billion in 10 years.

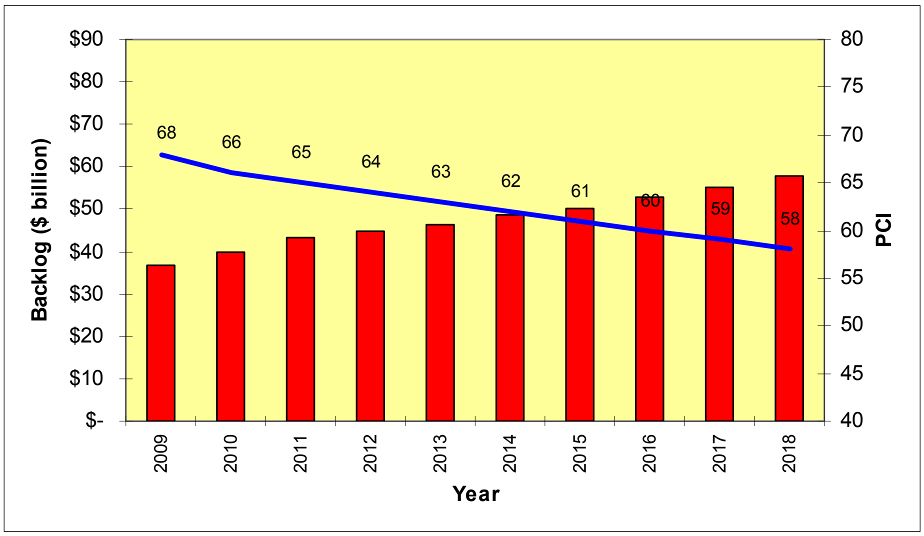


Figure 3.13 Impacts of Existing Funding on Pavement Condition and Backlog

3.3 Funding Shortfall

Given the needs results from Table 3.5 and the estimated available funding, it is a simple task to estimate the funding shortfall. Table 3.6 below shows this calculation – the shortfall is $51.7 billion. Clearly, the available funding is woefully inadequate in meeting BMP within the period analyzed.

Table 3.6 Shortfall Calculations (2008 dollars)

Scenario	10 Year Needs ($ billion)	Available Funding ($ billion)	Funding Shortfall ($ billion)
Achieve BMP Goal in 10 years	$ 67.6	$ 15.9	$ (51.7)

Chapter 4. Safety, Traffic & Regulatory Needs Assessment

The analyses for the safety, traffic and regulatory components are quite different from those for the pavement needs; regression techniques are employed instead.

A total of 246 survey responses were received, of which 188 were partial responses and 58 were complete responses. Agencies were asked to provide specific information on the inventory and replacement cost for their safety, traffic and regulatory components:

- Miles of pipelines for storm drains
- Other storm drain components (lump sum)
- Linear feet of curb and gutter
- Square feet of sidewalk
- Number of curb ramps
- Number of traffic signals
- Number of street lights
- Square feet of sound/retaining walls
- Traffic signs
- NPDES requirements (lump sum)
- ADA compliance needs (lump sum)
- Other (lump sum)

Additionally, mileage information (rural and urban centerline miles) was available from the Highway Performance Monitoring System (HMPS) and used in this analysis.

4.1 Data Quality Assurance

Before any analysis was performed, the survey responses were checked for errors and to make sure that all units were consistent. Unit costs were calculated based on the inventory and total cost data in order to compare the range of values. Where inconsistencies were found, the agencies were contacted and asked to clarify. Most agencies contacted responded either with corrections or further explanations that justified their responses. Examples of common errors were:

- Wrong units – response was in miles instead of linear feet.
- Typos – additional zeros
- Calculated units costs were too high or too low – most due to typos; some due to specific agency circumstances.

One issue of interest is the submission of partial responses. Most agencies left the answers of one or more of the twelve components blank. It could be assumed that these agencies are not responsible for such components; however, there is also the possibility that they do maintain those components but did not have accurate information to provide. To use the most accurate data, only complete responses were used in the analysis.

4.2 Regression Analysis

The costs of all 12 safety, traffic and regulatory components listed above were added to obtain the total replacement cost. This cost was used as the response variable. The objective of this analysis was to find a statistical model to predict the total replacement cost using either the mileage data from HPMS or the data from the survey responses as predictors. Numerous models were considered:

- Cost vs. Total Miles
- Cost vs. Urban Miles, Rural Miles
- Cost vs. Urban Miles
- Log Cost vs. Urban Miles
- $\sqrt{}$ Cost vs. Urban Miles
- Cost vs. Storm Drain, Curb & Gutter, Sidewalk, Curb Ramps, Traffic Signals, Street Lights, Sound/Retaining Walls, Traffic Signs
- Log Cost vs. Storm Drain, Curb & Gutter, Sidewalk, Curb Ramps, Traffic Signals, Street Lights, Sound/Retaining Walls, Traffic Signs
- Log Cost vs. Curb & Gutter, Street Lights, Sound/Retaining Walls
- Log Cost vs. Curb & Gutter, Street Lights

However, none of these models were adequate for various reasons. A more detailed discussion on the statistical analyses used is included in Appendix D.

4.2.1 Final Model

The final model considered total replacement cost as the response variable and total miles, agency type and climate type as predictors and was as follows:

log Cost = 17.9 + 0.00189 Total Miles – 2.09 Type_Rural + 0.682 Climate_Central

where:

Cost = total replacement cost, $
Total miles = total centerline-miles
Type_Rural = indicator variable and is equal to 1 if agency is rural, 0 otherwise
Climate_Central = indicator variable and is equal to 1 if agency is along the central coast, south coast or inland valley (see Figure D.1 in Appendix D).

It should be noted that:

- If the agency type is “Urban” or “Combined” or if the climatic region is other than “Central” the indicator variables will have a value of zero and the model will depend only on total miles.
- “log” refers to the natural logarithm

Conceptually, the model indicates that the replacement costs are decreased if an agency is considered rural (defined as an agency with less than 25% urban miles) and increased if it is within the central or south coast or inland valley regions. Intuitively, this makes sense, as rural agencies tend to have less safety, traffic and regulatory components. In addition, since the majority of the urban population resides in the central/south coast and inland valley, these agencies will have more safety, traffic and regulatory components and therefore, higher costs.

A more detailed discussion of the regression analysis is included in Appendix D.

As a check, the predicted or estimated replacement cost was compared with those provided by the survey respondents. Table 4.1 shows that the proposed equation provides a good estimate of the total replacement cost.

Table 4.1 Comparison of Reported and Calculated Costs

Total Replacement Cost ($ Million Reported)	Total Replacement Cost ($ Million Calculated)	Difference*
24,726	27,992	13%

*Comparison based on data from 58 complete responses.

4.3 Determination of Safety, Traffic and Regulatory Needs

The regression model obtained above estimates the total replacement cost for the safety, traffic and regulatory components. To estimate the needs, this cost needs to be converted to an annual amount based on the estimated service life of the different non-pavement assets.

Figure 4.1 shows the distribution of the replacement costs by asset. For agencies with no data, the total replacement cost will be calculated with the regression model and the replacement cost of each asset will be assigned using the percentages in Figure 4.1. For agencies that provided complete or partial data, the actual percentages will be used in the analysis.

Note that both ADA (0.4%) and NPDES (0.3%) categories are very small percentages of the total replacement cost. We believe that both of these are under-estimated because both costs are usually included in the pavement rehabilitation costs during a resurfacing or reconstruction contract, and few agencies actually extract this from the data that were provided.

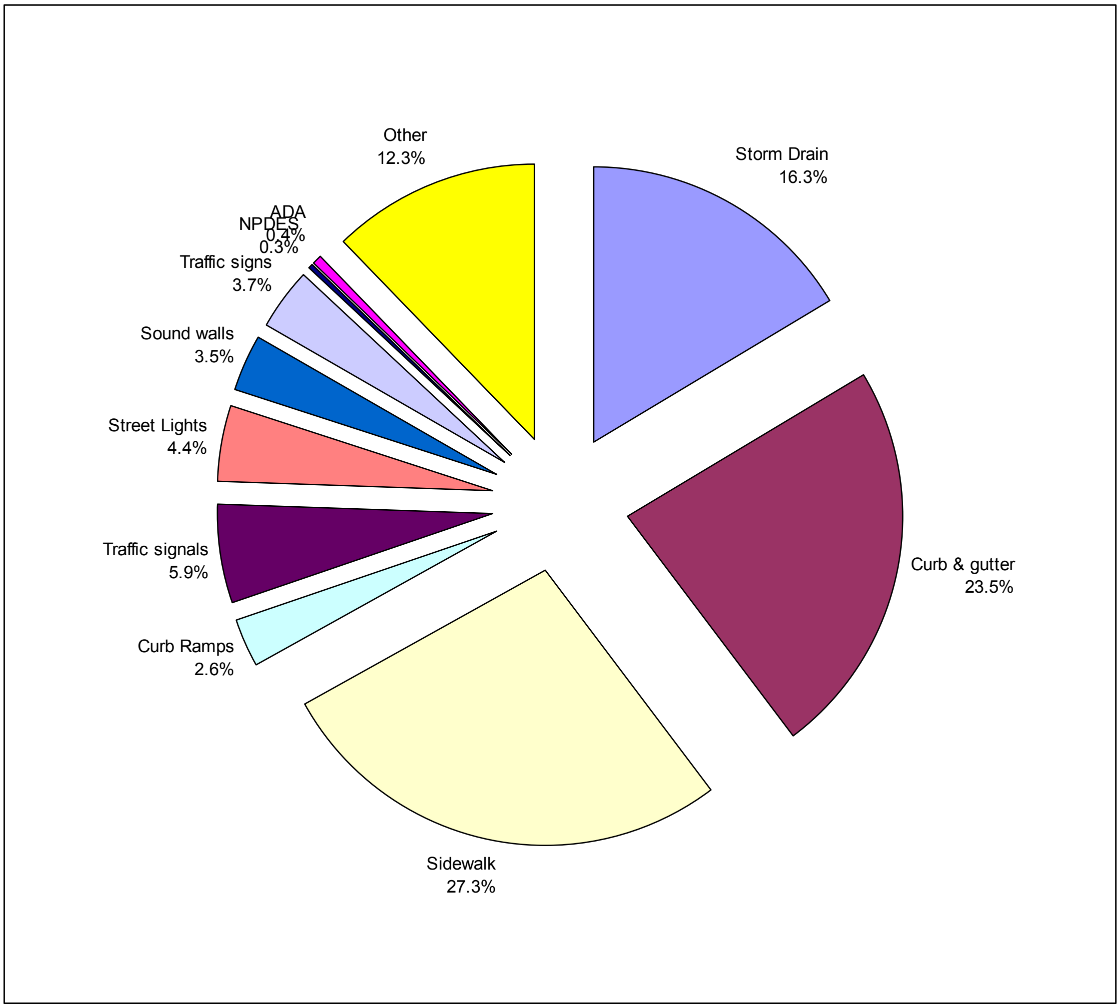


Figure 4.1 Distribution of Replacement Cost by Safety, Traffic and Regulatory Category

Table 4.2 shows the estimated service life of each asset based on industry standards[9]. The replacement costs of each asset will be divided by their respective service life to obtain the annual needs by asset category. The sum of all the needs will be the total annual needs. An example calculation is included in Appendix D.

Table 4.2 Service Lives of Safety, Traffic and Regulatory Components[9]

Asset	Service Life (Yrs)
Storm Drain	50
Curb & Gutter	35
Sidewalk	35
Curb Ramps	35
Traffic Signals	40
Street Lights	30
Sound/Retaining Walls	30
Traffic Signs	10

[9] Sources: Portland Transportation Assets Management, Handbook of Facility Assessment, Plastics Pipe Institute.

4.4 Results

The analysis to determine the available funding for safety, traffic and regulatory components is similar to that performed for the pavement analysis in Chapter 3. The average funding for cities was $21,712/centerline mile for cities and $1,402/centerline-mile for counties. The large difference between the two is expected, since it is the cities (mostly urban in nature) that have the most inventories in these categories.

However, there were a few agencies that reported revenues that were greater than their needs. In these cases, the shortfall was reported as zero (see Appendix E). Table 4.3 summarizes the results. Again, there is a significant shortfall of $19.7 billion. Appendix E contains the detailed results by county.

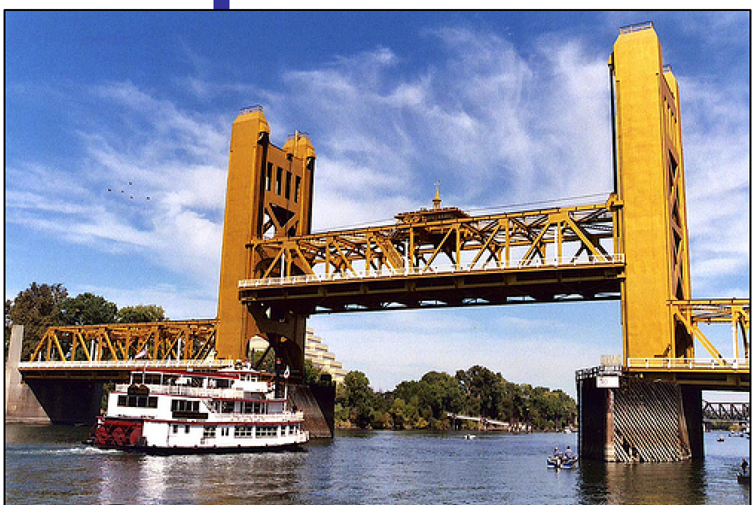
Table 4.3 Safety, Traffic and Regulatory Needs and Shortfall (2008 Dollars)

	10 year Needs ($ billion)	10 year Revenues ($ billion)	Shortfall ($ billion)
Safety, Regulatory & Operational Components	$ 32.1	$ 12.4	$ (19.7)

* Data from San Francisco Bay area provided by MTC.

Chapter 5. Bridges

Bridges are an integral part of the transportation system and therefore a study such as this one would be incomplete without a short discussion of their needs. Unfortunately, there has been no statewide local bridge needs assessment performed in California. Some MPOs such as MTC have performed bridge assessments[10] for their regions, but these are just pieces of the bigger picture.



Local bridges are defined as bridges that are owned by a county, city or town or by a local park. Transit or railroad bridges (e.g. bridges owned and maintained by BART – Bay Area Rapid Transit) are not included in this category. According to Caltrans, there are approximately 12,000 state bridges and 12,200 local bridges[11]. This does not include structures such as culverts that have a span of less than 20 feet.

Caltrans maintains a bridge management system (PONTIS) that contains inventory and condition data for all the bridges in the state, regardless of whether a city/county owns it. This condition data assists in determining what bridge repairs would be necessary (seismic retrofits, bridge replacements or maintenance).

However, there have been no comprehensive needs assessment performed with this data at the statewide level.

Bridge condition is typically characterized by a bridge health index or sufficiency rating, similar to the PCI used for pavements. The sufficiency rating ranges from zero (insufficient) to 100 and is based on four factors:

- Structural adequacy and safety
- Serviceability and functional obsolescence
- Essentiality for public use
- Special reductions i.e. detours, safety features

The sufficiency rating is used to determine eligibility for Federal Highway Bridge Program (HBP) funding. Structures are eligible for rehabilitation funding when the structure has a sufficiency rating ≤ 80, and replacement when the sufficiency rating is ≤ 50.

There are two primary sources of funding for local bridges – the Federal HBP and a local match. The local match is usually from local sales taxes, gas taxes or general funds. For those bridges in the mandatory seismic retrofit program, Proposition 1B (the Highway Safety, Traffic Reduction, Air Quality, and Port Security measure approved by the voters in November 2006) provides the funding for the local match. The HBP program provides approximately 88.53% of the total funding.

[10] *MTC Local Bridge Needs Update – Final Report*, Metropolitan Transportation Commission, April 2008.
[11] http://www.dot.ca.gov/hq/structur/strmaint/

The “needs” for bridges can be broadly categorized into preservation, rehabilitation, replacement and improvement needs. Improvement needs include safety, strengthening (including seismic strengthening), widening or raising a structure.

Solely based upon projects identified by local agencies and approved by Caltrans for future federal funding, the local streets and roads bridge needs total $2.6 billion. Of this amount, local agencies are required to finance 11.47 percent or approximately $300 million of which $133 million is to be financed from Proposition 1B and other approved State transportation funds.

Chapter 6. Summary

As outlined in Chapter 1, the study objectives were to determine the answers to a series of questions:

1. What are the conditions of local streets and roads?
2. What will it cost to bring them up to an acceptable condition?
3. How much will it cost to ***maintain*** them in an acceptable condition for the next 10 years?
4. Similarly, what are the needs for safety, regulatory and operational components?
5. Is there a funding shortfall? If so, what is it?

The results of this study are sobering. It is clear that California's local streets and roads are not just at risk; they are on the edge of a cliff with an average PCI of 68. With this pavement condition and the existing funding climate, there is a clear downward trend.

By 2018, with the current funding, the pavement condition index is expected to deteriorate to 58. Even more critically, the backlog will increase from $37 billion to $58 billion. This is assuming that construction costs do not outstrip the anticipated revenues. It also does not include any additional costs due to new roads/streets that will be added.

Table 6.1 summarizes the results from both Chapters 3 and 4 and the answers to Questions 2 to 5 above. The total funding needs over the next 10 years is $99.7 billion, and the resulting shortfall is $51.7 billion for pavements, and $19.7 billion for the safety, regulatory and operational components. The total shortfall is $71.4 billion.

Table 6.1 Summary of 10-Year Needs and Shortfall Calculations (2008 $ Billion)

Transportation Asset	Needs	Funding	Shortfall
Pavements	$ 67.6	$ 15.9	$ 51.7
Essential Components	$ 32.1	$ 12.4	$ 19.7
Totals	**$ 99.7**	**$ 28.3**	**$ 71.4**

The conclusions that can be drawn from this study are inescapable. Given existing funding levels, California's local streets and roads can be expected to deteriorate rapidly within the next 10 years. In addition, costs of any deferred maintenance will only continue to grow.

To bring the transportation network to an acceptable level will require more than double the existing level of funding, i.e. for pavements, it will require an increase of at least $51.7 billion and for safety, traffic and regulatory components, it will require $19.7 billion for a total of $71.4 billion.

However, once the BMP goal is reached, it will only require approximately $1.8 billion annually to maintain the pavement network at this level.

Finally, although a statewide bridge needs assessment was not included in this study, Caltrans has identified and approved $2.6 billion for bridge projects, of which approximately $300 million is the local match.

APPENDIX A

Contact Letter, Survey Questionnaire & Fact Sheet

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

"To Enrich Lives Through Effective and Caring Service"

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (626) 458-5100
http://dpw.lacounty.gov

DEAN D. EFSTATHIOU, Acting Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

April 4, 2008

Subject: California Statewide Local Streets and Roads Needs Assessment

To Whom It May Concern:

WE NEED YOUR HELP!

As you may be aware, cities and counties received only 10% of the recent $20 billion transportation bond measure (Prop. 1B) despite the fact that the local streets and roads comprise 83% of the State's publicly maintained miles. This is partly because it has been difficult to document what the statewide local needs are for our transportation infrastructure.

To assist cities and counties in communicating their local streets and roads pavement and non-pavement needs to policy makers and to secure sufficient funding to adequately maintain them, we have selected Nichols Consulting Engineers, Chtd. (NCE) to undertake a comprehensive statewide needs assessment. For the first time, a systematic analysis of the streets and roads infrastructure needs for all local agencies in California is being performed. A fact sheet is included with this letter to provide you with an overview of the project.

We need your immediate assistance on the following three items:

1. **Provide NCE with your agency's contact information if you are not the appropriate contact. This person(s) should be able to provide all the information requested in Items #2 and #3.**
2. **Provide NCE with a copy of any recent studies that your agency has completed for your local streets and roads pavement and non-pavement assets. Examples include your pavement management and GASB 34 reports.**
3. **Fill out the attached questionnaire and mail it to the address on the next page or fill out the questionnaire online at www.savecaliforniastreets.org.**

Nichols Consulting Engineers, Chtd.
Attn: Margot Yapp, P.E.
501 Canal Blvd., Suite I
Pt. Richmond, CA 94804
(510) 215-3620

It is essential that we have this data no later than April 30th, 2008. A NCE engineer will be in touch with you within 2 weeks to answer any questions you may have. Should you have any questions, please do not hesitate to contact Margot Yapp at (510) 215-3620 or at myapp@nce.reno.nv.us.

We appreciate your help in providing this information.

Sincerely,

Patrick V. DeChellis
Deputy Director/Project Manager
County of Los Angeles

Margot Yapp, P.E.
Vice President/Project Manager
Nichols Consulting Engineers, Chtd.

Enclosures: Fact Sheet
Survey Questionnaire

California Statewide Needs Assessment
Survey Questionnaire

Your Contact Information

Agency: ____________________

County: ____________________

Contact Name(s): ____________________

Title: ____________________

Department/Division: ____________________

Address Line 1: ____________________

Address Line 2: ____________________

City: ____________________

Zip code: ____________________

Phone Number: ____________________

Email: ____________________

Are you in MTC's jurisdiction?

If your agency is within the Metropolitan Transportation Commission's (MTC) jurisdiction, you do not need to fill out this questionnaire. We will be contacting MTC directly for the regional needs.

Are you in Los Angeles or Orange County?

If your agency is within Los Angeles or Orange Counties, you will only need to fill out the non-pavement and funding sources & expenditures portions of this questionnaire.

Do you have reports that contain the information requested in this questionnaire?

If your reports contain the information requested, just send us the reports and databases. See instructions below for uploading your files.

If your reports do not contain this information, or you don't have a report, or you're not sure, please fill out the questionnaire.

To submit your survey questionnaire

You can submit your completed questionnaire in one of 2 ways:

1. Login to www.SaveCaliforniaStreets.org and fill out the questionnaire online. Instructions are on the website.

2. Or fill out and send this hard copy to:
Nichols Consulting Engineers, Chtd.
Attention: Margot Yapp
501 Canal Blvd, Suite I
Pt. Richmond, CA 94804
Phone: (510) 215.3620

To upload reports & databases

Go to www.SaveCaliforniaStreets.org and click on the "Participate in Study" button. Instructions are on the website.

PART I: PAVEMENTS

A. Pavement Management System (PMS) Software

Question	Example Response	Your Response
1. Does your agency use Pavement Management System (PMS) software? (Y/N)	Yes	
2. If you answered "Yes" to the above question, indicate the PMS software name (MicroPaver, StreetSaver, Cartegraph, etc.)	MicroPaver	

If your reports contain the information requested, just send us the reports and databases e.g. Microsoft Access, SQL or Oracle database files.

B. Inventory Data

Include both paved and unpaved network. Do not include roads/streets maintained by other agencies e.g. Caltrans or private. If your database does not contain ALL the streets/roads, please indicate.

3. Centerline Miles, Lane Miles and Pavement Areas

Major Streets e.g. principal arterials, collectors	Centerline miles	42	
	Lane-miles*	168	
	Area (sq yards)**	1,182,720	
	% PCC (by area)	3.00%	
Residentials/Locals (include alleys etc)	Centerline miles	90	
	Lane-miles*	225	
	Area (sq yards)**	1,584,000	
	% PCC (by area)	1.00%	
Unpaved e.g. dirt, gravel	Centerline miles	12	
	Lane-miles*	24	
	Area (sq yards)**	168,960	

*Lanes are defined as travel lanes only.
** Areas should include parking lanes, cul-de-sacs, turn pockets etc.

4. If your database does not contain all the streets/roads, explain:
Example Response: Database only contains principal arterials and collectors.

C. Pavement Distress Survey Procedures

If you use MicroPAVER or StreetSaver, you can skip this section.

Question	Example Response	Your Response
5. How is pavement condition rating calculated?	Developed in-house	
6. What pavement distresses do you collect for AC (Asphalt Concrete)?	alligator cracking, block cracking, patching, rutting	
7. What pavement distresses do you collect for PCC (Portland Cement Concrete)?	corner break, divided slab, faulting, spalling	
8. What other condition data e.g. ride quality or deflection data do you collect? Describe how this is used in analyses.	Deflection data only used at project level to determine overlay thickness.	

<table>
<tr><th colspan="4"><u>D. Pavement Condition Ratings and Needs</u></th></tr>
<tr><th colspan="2">Question</th><th>Example Response</th><th>Your Response</th></tr>
<tr><td colspan="2">9. When was the pavement condition data last updated?</td><td>2007 (arterials only)
2005 (collectors and residentials)</td><td></td></tr>
<tr><td colspan="2">10. What is the pavement condition index/rating used (e.g. 0 -100, A - F)? Indicate worst to best.</td><td>0 - 100
0=failed, 100=excellent</td><td></td></tr>
<tr><td rowspan="5">11. What is the average weighted pavement condition rating?</td><td>Overall Network</td><td>75</td><td></td></tr>
<tr><td>- Major Streets</td><td>79</td><td></td></tr>
<tr><td>- Residential/Locals</td><td>69</td><td></td></tr>
<tr><td>- Unpaved</td><td>6</td><td></td></tr>
<tr><td>Explain here if unpaved roads use a different rating scale</td><td>0 to 10 scale</td><td></td></tr>
<tr><th colspan="4">12. Define Condition Categories and corresponding pavement rating ranges.</th></tr>
<tr><td colspan="2">Excellent</td><td>85 - 100</td><td></td></tr>
<tr><td colspan="2">Good</td><td>70 - 85</td><td></td></tr>
<tr><td colspan="2">Fair</td><td>50 - 70</td><td></td></tr>
<tr><td colspan="2">Poor</td><td>25 - 50</td><td></td></tr>
<tr><td colspan="2">Very Poor</td><td>0 - 25</td><td></td></tr>
</table>

13. What are your pavement needs?

Pavement Needs	5-Year Needs ($)	25-Year Needs ($)
Overall Network		
Major Streets		
Residentials/Locals		
Unpaved		

PART II: NON-PAVEMENT ASSETS

14. Please identify your non-pavement assets.

Non-Pavement Category*	Inventory (quantity)	Unit	Total Replacement Cost ($)	How accurate is this information? (Accurate, Informed Estimate or Guess)
Storm Drains - pipelines		mi		
Other elements e.g. manholes, inlets, culverts, pump stations etc		ea		
Curb and gutter		ft		
Sidewalk (public)		ft^2		
Curb ramps		ea		
Traffic signals		ea		
Street Lights		ea		
Sounds Walls/Retaining walls		ft^2		
Traffic signs		ea		
NPDES (National Pollutant Discharge Elimination System) requirements		Lump Sum		
Other ADA compliance needs (not included in above)		Lump Sum		
Other physical assets or expenditures that constitute >5% of total non-pavement asset costs e.g. heavy equipment, corporation yards etc		ea		

* Use GASB34 reports if available. If information is not available or not applicable, indicate with "N/A".

PART III. FUNDING SOURCES & EXPENDITURES

A. Actual/Estimated Revenues for All Transportation Activities

Please identify the total amount of recurring revenue received for transportation needs. This table should include all available revenue sources that are used for all types of transportation projects within your jurisdiction, not just pavement improvements. Examples of funds include: General Funds, Gas Tax, STP, Proposition 42, Prop. 1B, sales taxes, Assessment District, TEA, CMAQ, AHRP, SRTS, etc.

(Add more rows if needed).

Funding Source	Type of Funding (Local, State or Federal)	FY 2006/2007	FY 2007/2008	Annual Average FY 2008/2009 to 2012/2013
15. Pavement related				
Ex - Measure A sale tax	Local	$425,000	$450,000	$520,000
16. Non-Pavement Assets				
Ex. Assessment District Sidewalks	Local	$155,000	$155,000	$155,000

B. Actual Expenditures

Please report actual expenditures incurred in your jurisdiction.

Treatment Type	FY 2006/2007	FY 2007/2008	Annual Average FY 2008/2009 to 2012/2013
17. Pavement related			
Preventive Maintenance e.g. crack seals, slurry seals etc			
Rehabilitation & reconstruction e.g. overlays			
Other (pavement related)			
Other Operations & Maintenance e.g. vegetation, cleaning ditches, sweeping etc			
18. Non-Pavement Assets*			
Storm Drains			
Sidewalk, Curb and gutter, ramps			
Traffic signals			
Street Lights			
Sounds Walls/Retaining walls			
Traffic signs			
NPDES (National Pollutant Discharge Elimination System) requirements			
Other ADA compliance needs (not included in above)			
Other physical assets or expenditures that constitute >5% of total non-pavement asset costs e.g. heavy equipment, corporation yards etc			

* Use GASB34 reports if available. If information is not available or not applicable, indicate with "N/A"

California Statewide Needs Assessment Project

www.SaveCaliforniaStreets.org

FACT SHEET

What is this study about?

This is a statewide study that will help us answer the following questions:

- What are the conditions of local streets and roads and non-pavement assets?
- What will it cost to bring them up to good condition?
- How much will it cost to ***maintain*** them in good condition for the next 25 years?
- Is there a funding shortfall? If so, what is it?

Our goal is to contact all 536 cities and counties in California to get this information.

Why is this study needed?

There is no comprehensive and systematic statewide approach to quantify local streets and roads needs statewide. Only 10% of the recent $20 billion transportation bond measure (Prop. 1B) went to cities and counties, despite the fact that local streets and roads comprise 83% of the State's publicly maintained miles.

Who is sponsoring this project?

Many cities and counties contributed funding to this study, including the County of Los Angeles. The agencies listed below have accepted the leadership responsibility of completing this study on behalf of the cities and counties in California.

- California State Association of Counties (CSAC)
- League of California Cities (LOCC)
- County Engineers Association of California (CEAC)
- County of Los Angeles
- California Regional Transportation Planning Agencies (RTPA)
- California Rural Counties Task Force (RCTF)

The Oversight Committee is composed of representatives from each organization, with the County of Los Angeles, Department of Public Works acting as the Project Manager.

How is this information going to be used?

The results will be used to assist local and regional agencies in securing funding for their streets and roads infrastructure needs. It will also provide, for the first time, an analysis of the streets and roads infrastructure needs for all local agencies in California. Also, the standard needs assessment approach developed from this study will enable quicker and more efficient reporting of statewide needs in the future.

The results will be presented to the Governor and State Legislature as part of a plan to secure additional infrastructure funding for Cities and Counties.

FACT SHEET

What will the website contain?

The website (www.saveCaliforniastreets.org) will contain information on the study and provide progress reports. We will also provide your agency with log-in information so you can upload information on your pavement and non-pavement assets for inclusion in this study.

How can Cities and Counties help?

We need information from your agency! Do you have a current needs assessment report that includes the following:

- Number of road and street lane miles maintained
- Pavement condition ratings/scores/indices
- Pavement maintenance treatments used by your agency and the corresponding trigger levels for each treatment
- Type of pavement management system used for analysis and prioritization
- Data on non-pavement assets (e.g. sidewalks, street lights, signals etc)
- Available revenues to maintain both pavements and non-pavement assets
- Funding shortfalls

Please provide us with the contact person who is responsible for both pavement and non-pavement assets in your agency. We will be in touch with them soon to obtain this information.

Who will perform this study?

Nichols Consulting Engineers, Chtd. has been selected to perform this study. The Project Manager is Ms. Margot Yapp.

When will this project be completed?

April 2009.

Who should I contact for more information?

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APPENDIX B

Pavement Needs Calculations

This appendix contains an example of the pavement needs calculation. County X was selected, as it was a large county with both rural and urban elements. The following information was provided in the survey.

Pavement Area (sq. yd.):	24 million (major) & 13.4 million (local)
Unpaved Roads:	100 centerline miles
Average PCI:	78 (major), 73 (local)
Scenario:	Reach Best Management Practice (BMP) condition in 10 years

The following steps describe the systematic process used to estimate the pavement needs for this scenario.

Step 1: Determine the distribution of pavement area percentages in each of the four condition categories using Table B.1.

Again, recall that the survey questionnaire only asked agencies to provide their average PCI; however, they did not include the distribution of pavements in different conditions. As was explained in Chapter 3, this did not offer any information on the distribution of PCIs within that particular network or database. For example, if City X reported an average PCI of 75, there was no corresponding information on what percentage of streets were actually 90, or 55 or 32. An infinite number of combinations were possible to arrive at an average of 75. This distribution was required to perform the needs analysis.

Therefore, we examined the distribution of PCIs for 128 agencies and arrived at Table B.1. Most of the 128 agencies came from agencies came from the San Francisco Bay area, since MTC was able to provide this detailed breakdown readily. However, we also included data from rural agencies to ensure that we had a representative sample.

The condition categories are defined as:

- Category I (PCI from 70 to 100)
- Category II (PCI from 50 to 69)
- Category III (PCI from 25 to 49)
- Category IV (PCI from 0 to 24)

These categories were based on widely accepted industry standards as well as from the survey responses (see Figure B.1).

For each condition category, a best-fit curve was developed to calculate the pavement area percentages. Figures B.2 to B.5 present the graphs showing the best-fit curves and the actual data points from the 128 agencies. These curves were used to develop the pavement percentages in Table B.1 (PCI Distribution Table).

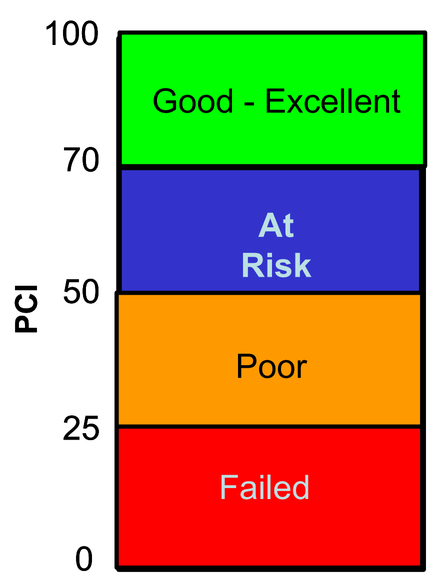


Figure B.1 PCI Categories

Since the average PCIs for most of the jurisdictions in California fall between 50 to 85, this portion of the table was used most frequently. Figure B.6 shows that the middle two quartiles of the PCIs from the surveys falls between 60 and 75.

In this step, we used the PCI distribution table (Table B.1) to look up the distribution of pavement areas in the four condition categories.

- The average PCI for County X's major roads is 78. From Table B.1, for a PCI of 78, the pavement areas in Condition Category I, II, III and IV are 79.0%, 15.10%, 4.9% and 1.0% of the total area of the major roads, respectively. This row is highlighted in yellow.

- The average PCI of County X's local roads is 73. From Table B.1, for a PCI of 73, the pavement areas in Condition Category I, II, III and IV are 69.2%, 18.6%, 9.7% and 2.5%, respectively. This row is highlighted in yellow.

Table B.1 PCI Distribution Table

PCI	Pavement Area (%)				
	Condition Category I (PCI: 70 to 100)	Condition Category II (PCI: 50 to 69)	Condition Category III (PCI: 25 to 49)	Condition Category IV (PCI: 0 to 24)	Total
0	0.0	0.0	0.0	100.0	100.0
1	0.4	0.0	1.1	98.5	100.0
2	0.7	0.0	2.3	97.0	100.0
3	1.1	0.0	3.4	95.5	100.0
4	1.5	0.0	4.5	94.0	100.0
5	1.9	0.0	5.6	92.5	100.0
6	2.2	0.0	6.8	91.0	100.0
7	2.6	0.0	7.9	89.5	100.0
8	3.0	0.0	9.0	88.0	100.0
9	3.4	0.0	10.1	86.5	100.0
10	3.7	0.0	11.3	85.0	100.0
11	4.1	0.0	12.4	83.5	100.0
12	4.5	0.0	13.5	82.0	100.0
13	4.9	0.0	14.6	80.5	100.0
14	5.3	0.0	15.8	78.9	100.0
15	5.7	0.0	16.9	77.4	100.0
16	6.1	0.0	18.0	75.9	100.0
17	6.4	0.1	19.1	74.4	100.0
18	6.7	0.1	20.3	72.9	100.0
19	7.0	0.2	21.4	71.4	100.0
20	7.4	0.2	22.5	69.9	100.0
21	7.7	0.3	23.6	68.4	100.0
22	8.0	0.3	24.8	66.9	100.0
23	8.3	0.4	25.9	65.4	100.0
24	8.7	0.4	27.0	63.9	100.0
25	9.1	0.4	28.1	62.4	100.0
26	9.3	0.5	29.3	60.9	100.0
27	9.7	0.5	30.4	59.4	100.0

Table B.1 PCI Distribution Table (cont'd)

PCI	Pavement Area (%)				
	Condition Category I (PCI: 70 to 100)	Condition Category II (PCI: 50 to 69)	Condition Category III (PCI: 25 to 49)	Condition Category IV (PCI: 0 to 24)	Total
28	10.0	0.6	31.5	57.9	100.0
29	10.4	0.6	32.6	56.4	100.0
30	10.6	0.7	33.8	54.9	100.0
31	11.5	2.1	33.5	52.9	100.0
32	12.4	3.4	33.3	50.9	100.0
33	13.3	4.7	33.0	49.0	100.0
34	14.1	6.0	32.8	47.1	100.0
35	15.1	7.2	32.5	45.2	100.0
36	16.0	8.4	32.2	43.4	100.0
37	17.1	9.5	31.8	41.6	100.0
38	18.1	10.6	31.5	39.8	100.0
39	19.1	11.6	31.2	38.1	100.0
40	20.2	12.6	30.8	36.4	100.0
41	21.2	13.6	30.4	34.8	100.0
42	22.3	14.5	30.0	33.2	100.0
43	23.5	15.3	29.6	31.6	100.0
44	24.6	16.1	29.2	30.1	100.0
45	25.9	16.8	28.7	28.6	100.0
46	27.1	17.5	28.2	27.2	100.0
47	28.2	18.2	27.8	25.8	100.0
48	29.5	18.8	27.3	24.4	100.0
49	30.7	19.4	26.8	23.1	100.0
50	32.1	19.9	26.2	21.8	100.0
51	33.5	20.3	25.7	20.5	100.0
52	34.8	20.8	25.1	19.3	100.0
53	36.3	21.1	24.5	18.1	100.0
54	37.5	21.5	24.0	17.0	100.0
55	39.1	21.7	23.3	15.9	100.0
56	40.5	22.0	22.7	14.8	100.0
57	42.0	22.1	22.1	13.8	100.0
58	43.5	22.3	21.4	12.8	100.0
59	45.0	22.4	20.8	11.8	100.0
60	46.6	22.4	20.1	10.9	100.0
61	48.1	22.4	19.4	10.1	100.0
62	49.9	22.3	18.6	9.2	100.0
63	51.5	22.2	17.9	8.4	100.0
64	53.0	22.1	17.2	7.7	100.0
65	54.8	21.9	16.4	6.9	100.0
66	56.5	21.7	15.6	6.2	100.0
67	58.2	21.4	14.8	5.6	100.0
68	60.0	21.0	14.0	5.0	100.0

Table B.1 PCI Distribution Table (cont'd)

PCI	Pavement Area (%)				
	Condition Category I (PCI: 70 to 100)	Condition Category II (PCI: 50 to 69)	Condition Category III (PCI: 25 to 49)	Condition Category IV (PCI: 0 to 24)	Total
69	61.8	20.6	13.2	4.4	100.0
70	63.6	20.2	12.3	3.9	100.0
71	65.5	19.7	11.4	3.4	100.0
72	67.3	19.2	10.6	2.9	100.0
73	69.2	18.6	9.7	2.5	100.0
74	71.1	18.0	8.8	2.1	100.0
75	73.1	17.3	7.8	1.8	100.0
76	75.0	16.6	6.9	1.5	100.0
77	77.0	15.9	5.9	1.2	100.0
78	79.0	15.1	4.9	1.0	100.0
79	81.0	14.2	4.0	0.8	100.0
80	83.2	13.3	2.9	0.6	100.0
81	85.3	12.3	1.9	0.5	100.0
82	87.4	11.3	0.9	0.4	100.0
83	89.3	10.3	0.0	0.4	100.0
84	90.4	9.2	0.0	0.4	100.0
85	91.9	8.1	0.0	0.0	100.0
86	92.5	7.5	0.0	0.0	100.0
87	93.0	7.0	0.0	0.0	100.0
88	93.5	6.5	0.0	0.0	100.0
89	94.1	5.9	0.0	0.0	100.0
90	94.6	5.4	0.0	0.0	100.0
91	95.2	4.8	0.0	0.0	100.0
92	95.7	4.3	0.0	0.0	100.0
93	96.2	3.8	0.0	0.0	100.0
94	96.8	3.2	0.0	0.0	100.0
95	97.3	2.7	0.0	0.0	100.0
96	97.8	2.2	0.0	0.0	100.0
97	98.4	1.6	0.0	0.0	100.0
98	98.9	1.1	0.0	0.0	100.0
99	99.5	0.5	0.0	0.0	100.0
100	100.0	0.0	0.0	0.0	100.0

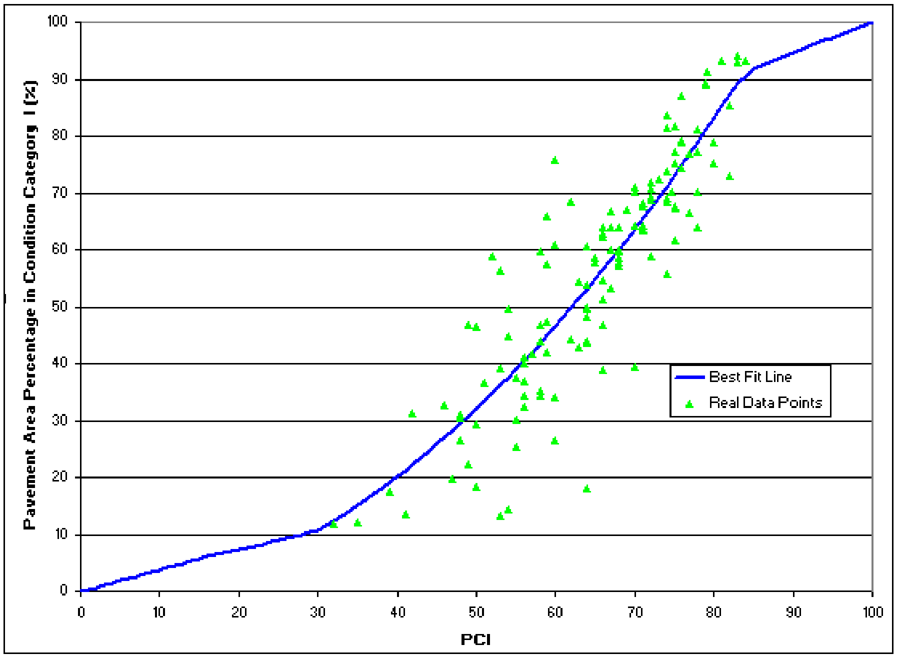


Figure B.2 Pavement Area Distribution in Condition Category I

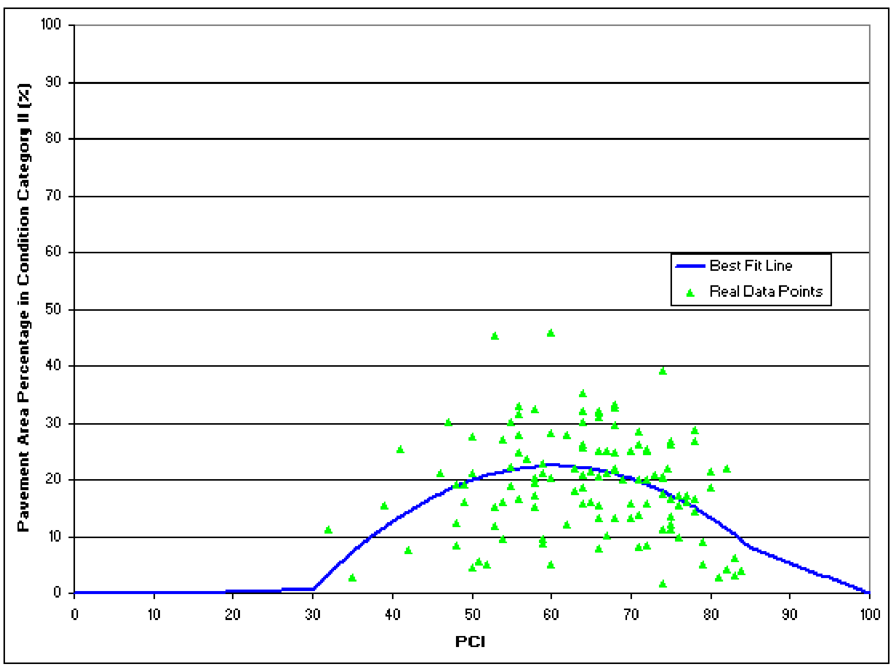


Figure B.3 Pavement Area Distribution in Condition Category II

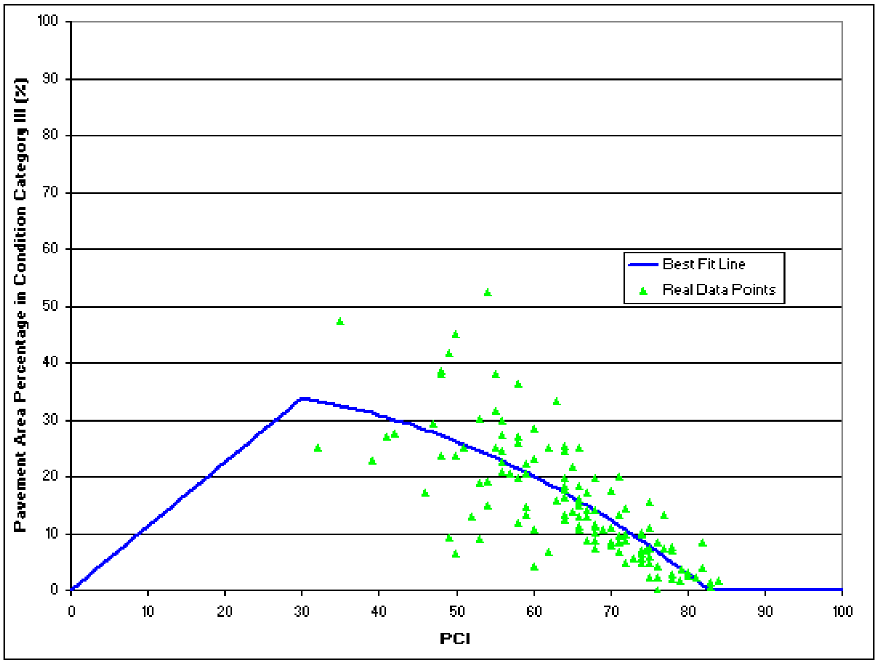


Figure B.4 Pavement Area Distribution in Condition Category III

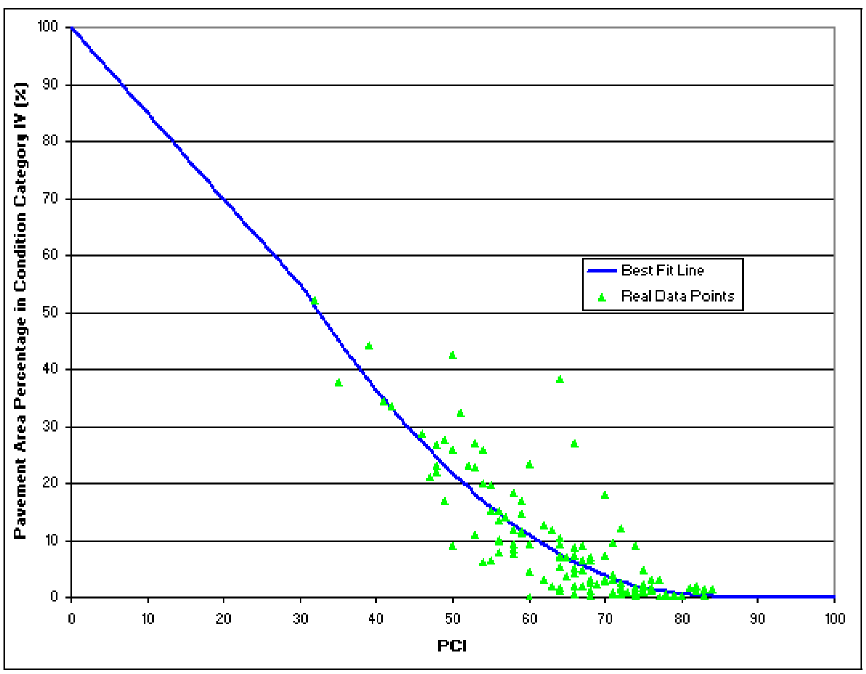


Figure B.5 Pavement Area Distribution in Condition Category IV

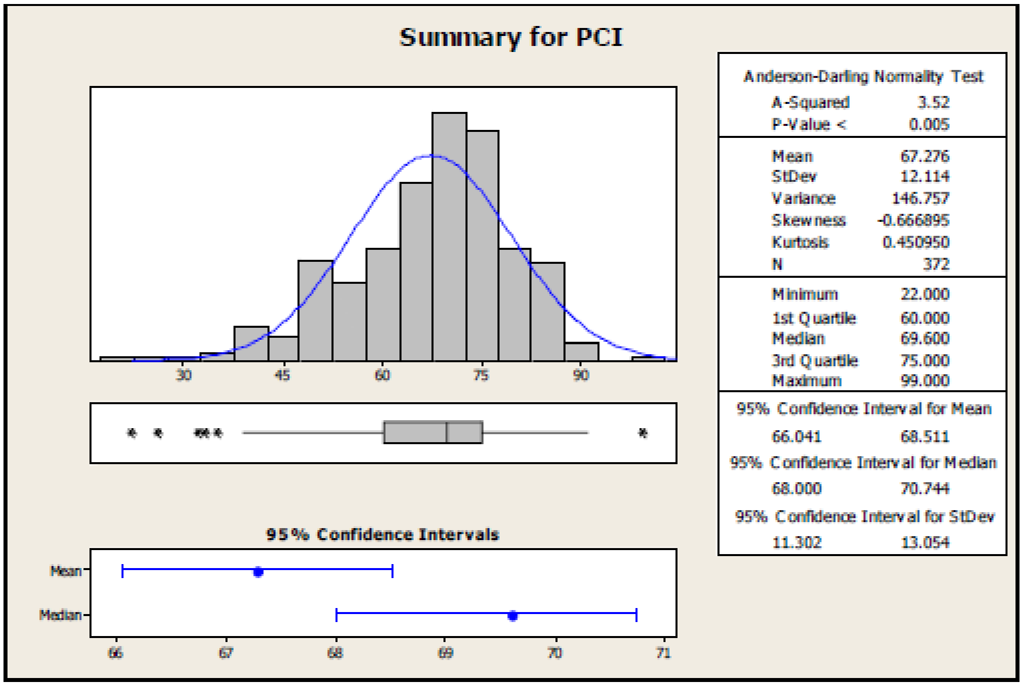


Figure B.6 PCI Distribution for California Cities & Counties

Step 2: Calculate pavement areas and pavement area factors in each of the four condition categories for majors and locals.

Using the pavement area percentages determined in Step 1, Tables B.2 (major roads) and B.3 (local roads) illustrate the pavement area factor calculations used in this example.

Table B.2 Pavement Area Factors(Major Roads)

(1)	(2)	(3)	(4)
Condition Category	Pavement Area %	Pavement Area (sq. yd.) [24,000,000 x Column (2)/100]	Pavement Area Factor [Column (3)/10,000]
I	79.0	18,960,000	1896.00
II	15.1	3,624,000	362.40
III	4.9	1,176,000	117.60
IV	1.0	240,000	24.00
Total	100	24,000,000	2,400.00

Table B.3 Pavement Area Factors (Local Roads)

(1)	(2)	(3)	(4)
Condition Category	Pavement Area %	Pavement Area (sq. yd.) [13,400,000 x Column (2)/100]	Pavement Area Factor [Column (3)/10,000]
I	69.2	9,272,800	927.28
II	18.6	2,492,400	249.24
III	9.7	1,299,800	129.98
IV	2.5	335,000	33.50
Total	100	13,400,000	1,340.00

Step 3: Look up benchmark results to determine pavement needs.

In order to determine the pavement needs for all the scenarios, benchmark databases were created to determine the needs for a standard 10,000 sq. yds. of pavements. Table B.4 summarizes the eight (8) benchmark databases that were created.

Table B.4 Benchmark Databases

Database No.	Functional Class	Condition Category	PCI Range
1	Major	I	70 – 100
2	Major	II	50 – 69
3	Major	III	25 – 49
4	Major	IV	0 – 24
5	Local	I	70 – 100
6	Local	II	50 – 69
7	Local	III	25 – 49
8	Local	IV	0 – 24

MTC's StreetSaver® program was used to determine the cost to reach the (BMP) goal in 10 years.

Each benchmark databases included the maintenance and rehabilitation (M&R) decision tree and costs discussed in Chapter 3. Assigning the appropriate maintenance and rehabilitation (M&R) treatment is a critical component of the needs assessment. It is important to know both the ***type*** of treatment as well as ***when*** to apply that treatment. This is typically described as a decision tree.

Figure B.7 summarizes the types of treatments and their costs in this study. Briefly, good to excellent pavements (PCI >70) are best suited for pavement preservation techniques i.e. preventive maintenance treatments such as chip seals or slurry seals. These are usually applied at intervals of five to seven years depending on the traffic volumes.

As pavements deteriorate, treatments that address structural adequacy are required. Between a PCI of 25 to 69, asphalt concrete (AC) overlays are usually applied at varying thicknesses. Finally, when the pavement has failed (PCI<25), reconstruction is typically required. Note that if a pavement section has a PCI between 90 and 100, no treatment is applied.

The PCI thresholds shown in Figure B.7 are generally accepted industry standards.

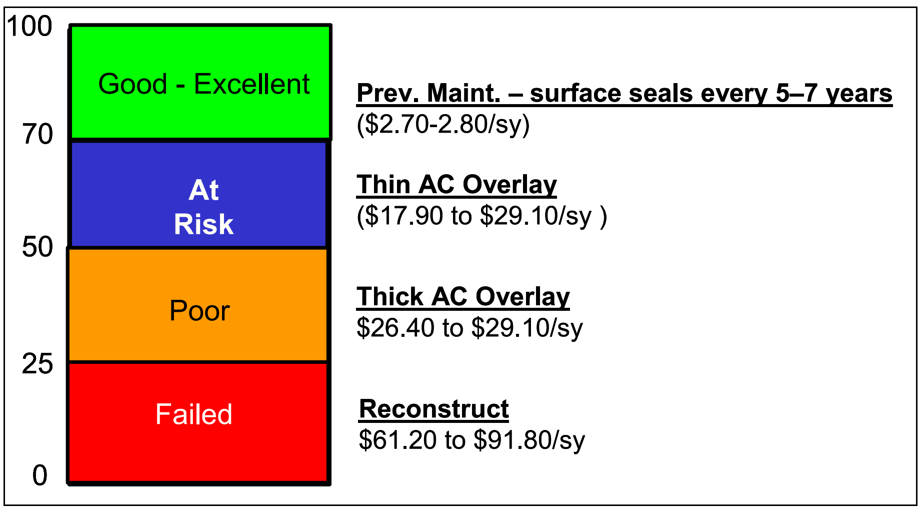


Figure B.7 Final M&R Tree and Unit Costs

Multiple treatments may occur within the analysis period. For example, if Main Street were reconstructed in 2012, typical treatments over the 10-year analysis period may include a slurry seal every 7 years in order to preserve the pavement. Therefore, an accurate needs assessment must also include the cost of these seals in addition to the cost of reconstruction.

The unit costs shown in Figure B.7 are statewide averages. The range in costs for each treatment is for the different functional classes of pavements i.e. majors have a higher cost than locals.

In the development of the statewide needs estimate, benchmark templates were developed for the analysis that were used for the needs calculations for each agency. By utilizing the pavement area factors for each agency and the benchmark templates, their needs are determined. The calculations assume that the BMP goal is reached and the backlog eliminated within the analysis period i.e. 10 years.

Table B.5 contains the pavement needs and backlog results. Each column is further described below:

- Year: 1 to 10. The analysis period is 10 years.

- Major Roads/Local Roads: The analysis was separate for major roads and local roads and so are the results;
- Condition Category I/II/III/IV: The results are further presented under each of the four Condition Categories.
- Needs: Each year's pavement needs or required budget to meet the goal.
- Backlog: Each year's unmet pavement maintenance and rehabilitation.
- Total: The needs are summed for the 10 years.

The calculations are detailed in Tables B.6 (major roads) and B.7 (local roads). For each condition category:

From Table B.6, the total pavement needs of County X's major roads are:

$156,078,720 + $145,866,000 + $89,286,624 + $22,354,560 = $413,585,904

From Table B.7, the total pavement needs of County X's local roads are:

$58,251,730 + $68,017,596 + $66,617,350 + $20,755,260 = $213,641,936

Step 4: Calculate needs of unpaved roads

It is estimated that unpaved road needs is $9,800 per centerline mile per year. This is the average unpaved road needs from the statewide online survey. Since there are 100 centerline miles of unpaved roads in County X:

Unpaved road needs = $9,800/yr/mile x 10 years x 100 miles = $9,800,000

Step 5: Sum up paved and unpaved needs

Paved needs for major roads:	$413,585,904
Paved needs for local roads:	$213,641,936
Unpaved road needs:	$ 9,800,000
TOTAL	**$637,027,840**

Figure B.8 below presents cumulative needs by year. It shows that in order to reach the BMP goal in ten years, approximately $64 million is needed per year for the next ten years.

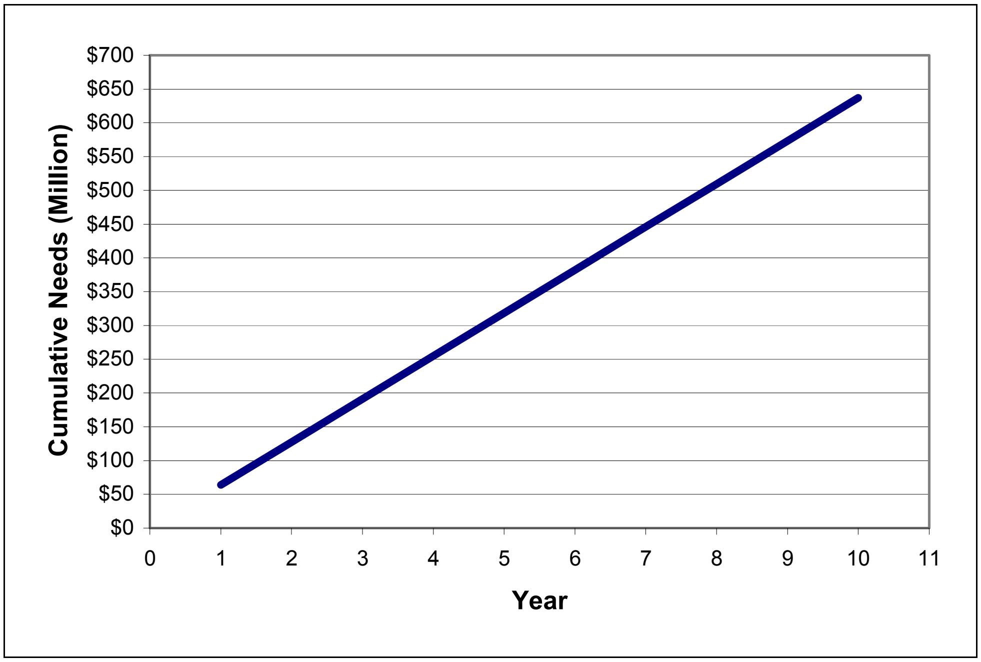


Figure B.8 Cumulative Needs by Year

Table B.5 Benchmark Analysis Results: Reach the Best Management Practice (BMP) goal in 10 years

Year	Major Roads								Local Roads							
	Condition Category I		Condition Category II		Condition Category III		Condition Category IV		Condition Category I		Condition Category II		Condition Category III		Condition Category IV	
	Needs	Backlog	Needs	Backlog	Needs	Backlog	Needs	Backlog	Needs	Backlog	Needs	Backlog	Needs	Backlog	Needs	Backlog
1	$8,232	$0	$40,250	$167,050	$75,924	$290,316	$93,144	$824,856	$6,282	$0	$27,290	$160,210	$51,252	$240,588	$61,956	$550,044
2	$8,232	$0	$40,250	$140,750	$75,924	$314,712	$93,144	$731,712	$6,282	$0	$27,290	$141,420	$51,252	$231,096	$61,956	$488,088
3	$8,232	$0	$40,250	$114,450	$75,924	$339,108	$93,144	$638,568	$6,282	$0	$27,290	$122,630	$51,252	$221,604	$61,956	$426,132
4	$8,232	$0	$40,250	$88,150	$75,924	$338,424	$93,144	$545,424	$6,282	$0	$27,290	$103,840	$51,252	$212,112	$61,956	$364,176
5	$8,232	$0	$40,250	$52,550	$75,924	$362,820	$93,144	$452,280	$6,282	$0	$27,290	$85,050	$51,252	$188,700	$61,956	$302,220
6	$8,232	$0	$40,250	$19,750	$75,924	$293,616	$93,144	$361,376	$6,282	$0	$27,290	$66,260	$51,252	$179,208	$61,956	$240,264
7	$8,232	$0	$40,250	$0	$75,924	$221,052	$93,144	$271,592	$6,282	$0	$27,290	$38,970	$51,252	$141,876	$61,956	$178,308
8	$8,232	$0	$40,250	$12,200	$75,924	$147,368	$93,144	$180,688	$6,282	$0	$27,290	$14,380	$51,252	$96,024	$61,956	$118,512
9	$8,232	$0	$40,250	$6,100	$75,924	$73,684	$93,144	$90,904	$6,282	$0	$27,290	$0	$51,252	$49,092	$61,956	$59,796
10	$8,232	$0	$40,250	$0	$75,924	$0	$93,144	$0	$6,282	$0	$27,290	$0	$51,252	$0	$61,956	$0
Total	$82,320		$402,500		$759,240		$931,440		$62,820		$272,900		$512,520		$619,560	

Table B.6 - Needs Calculation for County X (Major Roads)

Year	Condition Category I					Condition Category II				
	from Benchmark Results		Area Factor	Actual (benchmark results x area factor)		from Benchmark Results		Area Factor	Actual (benchmark results x area factor)	
	Needs	Backlog		Needs	Backlog	Needs	Backlog		Needs	Backlog
1	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$167,050	362.40	$14,586,600	$60,538,920
2	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$140,750	362.40	$14,586,600	$51,007,800
3	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$114,450	362.40	$14,586,600	$41,476,680
4	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$88,150	362.40	$14,586,600	$31,945,560
5	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$52,550	362.40	$14,586,600	$19,044,120
6	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$19,750	362.40	$14,586,600	$7,157,400
7	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$0	362.40	$14,586,600	$0
8	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$12,200	362.40	$14,586,600	$4,421,280
9	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$6,100	362.40	$14,586,600	$2,210,640
10	$8,232	$0	1896.00	$15,607,872	$0	$40,250	$0	362.40	$14,586,600	$0
Total				**$156,078,720**					**$145,866,000**	

Table B.6 - Needs Calculation for County X (Major Roads) (Continued)

Year	Condition Category III					Condition Category IV				
	from Benchmark Results		Area Factor	Actual (benchmark results x area factor)		from Benchmark Results		Area Factor	Actual (benchmark results x area factor)	
	Needs	Backlog		Needs	Backlog	Needs	Backlog		Needs	Backlog
1	$75,924	$290,316	117.60	$8,928,662	$34,141,162	$93,144	$824,856	24.00	$2,235,456	$19,796,544
2	$75,924	$314,712	117.60	$8,928,662	$37,010,131	$93,144	$731,712	24.00	$2,235,456	$17,561,088
3	$75,924	$339,108	117.60	$8,928,662	$39,879,101	$93,144	$638,568	24.00	$2,235,456	$15,325,632
4	$75,924	$338,424	117.60	$8,928,662	$39,798,662	$93,144	$545,424	24.00	$2,235,456	$13,090,176
5	$75,924	$362,820	117.60	$8,928,662	$42,667,632	$93,144	$452,280	24.00	$2,235,456	$10,854,720
6	$75,924	$293,616	117.60	$8,928,662	$34,529,242	$93,144	$361,376	24.00	$2,235,456	$8,673,024
7	$75,924	$221,052	117.60	$8,928,662	$25,995,715	$93,144	$271,592	24.00	$2,235,456	$6,518,208
8	$75,924	$147,368	117.60	$8,928,662	$17,330,477	$93,144	$180,688	24.00	$2,235,456	$4,336,512
9	$75,924	$73,684	117.60	$8,928,662	$8,665,238	$93,144	$90,904	24.00	$2,235,456	$2,181,696
10	$75,924	$0	117.60	$8,928,662	$0	$93,144	$0	24.00	$2,235,456	$0
Total				**$89,286,624**					**$22,354,560**	

Table B.7 - Needs Calculation for County X (Local Roads)

Year	Condition Category I					Condition Category II				
	from Benchmark Results		Area Factor	Actual (benchmark results x area factor)		from Benchmark Results		Area Factor	Actual (benchmark results x area factor)	
	Needs	Backlog		Needs	Backlog	Needs	Backlog		Needs	Backlog
1	$6,282	$0	927.28	$5,825,173	$0	$27,290	$160,210	249.24	$6,801,760	$39,930,740
2	$6,282	$0	927.28	$5,825,173	$0	$27,290	$141,420	249.24	$6,801,760	$35,247,521
3	$6,282	$0	927.28	$5,825,173	$0	$27,290	$122,630	249.24	$6,801,760	$30,564,301
4	$6,282	$0	927.28	$5,825,173	$0	$27,290	$103,840	249.24	$6,801,760	$25,881,082
5	$6,282	$0	927.28	$5,825,173	$0	$27,290	$85,050	249.24	$6,801,760	$21,197,862
6	$6,282	$0	927.28	$5,825,173	$0	$27,290	$66,260	249.24	$6,801,760	$16,514,642
7	$6,282	$0	927.28	$5,825,173	$0	$27,290	$38,970	249.24	$6,801,760	$9,712,883
8	$6,282	$0	927.28	$5,825,173	$0	$27,290	$14,380	249.24	$6,801,760	$3,584,071
9	$6,282	$0	927.28	$5,825,173	$0	$27,290	$0	249.24	$6,801,760	$0
10	$6,282	$0	927.28	$5,825,173	$0	$27,290	$0	249.24	$6,801,760	$0
Total				**$58,251,730**					**$68,017,596**	

Table B.7 - Needs Calculation for County X (Local Roads) (Continued)

Year	Condition Category III					Condition Category IV				
	from Benchmark Results		Area Factor	Actual (benchmark results x area factor)		from Benchmark Results		Area Factor	Actual (benchmark results x area factor)	
	Needs	Backlog		Needs	Backlog	Needs	Backlog		Needs	Backlog
1	$51,252	$240,588	129.98	$6,661,735	$31,271,628	$61,956	$550,044	33.50	$2,075,526	$18,426,474
2	$51,252	$231,096	129.98	$6,661,735	$30,037,858	$61,956	$488,088	33.50	$2,075,526	$16,350,948
3	$51,252	$221,604	129.98	$6,661,735	$28,804,088	$61,956	$426,132	33.50	$2,075,526	$14,275,422
4	$51,252	$212,112	129.98	$6,661,735	$27,570,318	$61,956	$364,176	33.50	$2,075,526	$12,199,896
5	$51,252	$188,700	129.98	$6,661,735	$24,527,226	$61,956	$302,220	33.50	$2,075,526	$10,124,370
6	$51,252	$179,208	129.98	$6,661,735	$23,293,456	$61,956	$240,264	33.50	$2,075,526	$8,048,844
7	$51,252	$141,876	129.98	$6,661,735	$18,441,042	$61,956	$178,308	33.50	$2,075,526	$5,973,318
8	$51,252	$96,024	129.98	$6,661,735	$12,481,200	$61,956	$118,512	33.50	$2,075,526	$3,970,152
9	$51,252	$49,092	129.98	$6,661,735	$6,380,978	$61,956	$59,796	33.50	$2,075,526	$2,003,166
10	$51,252	$0	129.98	$6,661,735	$0	$61,956	$0	33.50	$2,075,526	$0
Total				**$66,617,350**					**$20,755,260**	

APPENDIX C

Pavement Needs for Each Scenario by County

Table C.1 Funding Needs by County (2008 $M Dollars)

County (Cities included)	10-year Pavement Needs (2008 Dollars)
Alpine County	$64,507,790
Amador County	$384,841,340
Butte County	$638,443,620
Calaveras County	$339,949,100
Colusa County	$293,047,560
Del Norte County	$101,404,580
El Dorado County	$466,857,690
Fresno County	$2,276,919,660
Glenn County	$292,386,410
Humboldt County	$522,863,760
Imperial County	$1,447,999,060
Inyo County	$230,598,210
Kern County	$2,942,884,540
Kings County	$537,151,860
Lake County	$500,704,900
Lassen County	$354,811,210
Los Angeles County	$11,726,818,890
Madera County	$932,883,690
Mariposa County	$388,324,300
Mendocino County	$571,617,490
Merced County	$1,061,774,130
Modoc County	$683,398,110
Mono County	$270,705,610
Monterey County	$1,022,501,370
Nevada County	$203,631,590
Orange County	$2,314,243,310
Placer County	$441,760,640
Plumas County	$289,664,180
Riverside County	$3,003,214,150
Sacramento County	$2,349,651,780
San Benito County	$181,808,470
San Bernardino County	$3,455,878,560
San Diego County	$2,853,789,270
San Joaquin County	$1,348,749,750
San Luis Obispo County	$1,767,891,330
Santa Barbara County	$576,112,990
Santa Cruz County	$580,349,190
Shasta County	$903,872,780
Sierra County	$129,575,000
Siskiyou County	$592,904,530
Stanislaus County	$1,319,426,760
Sutter County	$362,416,700
Tehama County	$365,605,940
County	**10-year Pavement**

(Cities included)	Needs (2008 Dollars)
Trinity County	$362,744,110
Tulare County	$1,303,997,720
Tuolumne County	$470,299,090
Ventura County	$1,354,816,520
Yolo County	$496,612,150
Yuba County	$220,446,390
San Francisco Bay Area Counties*	$12,333,164,390
Total	**$67,636,022,170**

* These values were provided by MTC for Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano and Sonoma Counties.

APPENDIX D

Regression Analysis for Safety, Traffic & Regulatory Components

Regression analysis was used to develop a model to estimate the safety, traffic and regulatory needs. As discussed in Chapter 4, multiple models were examined before the final model was selected.

The final model considered total replacement cost as the response variable and total miles, agency type and climate type as predictors. The variables agency type and climatic region are indicator variables and do not have a natural scale or measurement. They were used to group the data and account for variations not explained with quantitative variables.

The indicator variables used in this model are described below.

Agency Type:

- Urban: Urban miles ≥ 75% of total miles
- Rural: Urban miles ≤ 25% of total miles
- Combined: Urban miles between 26% and 74% of total miles

Climatic Region:

- Central: Central Coast, South Coast, Inland Valley
- Coast: North Coast, Low Mountain, South Mountain
- Mountain: High Mountain, High Desert
- Desert: Desert
- Mixed: Any combination of regions

The climatic regions were based on Caltrans specifications for PG binder grade selection and are shown in Figure D.1.

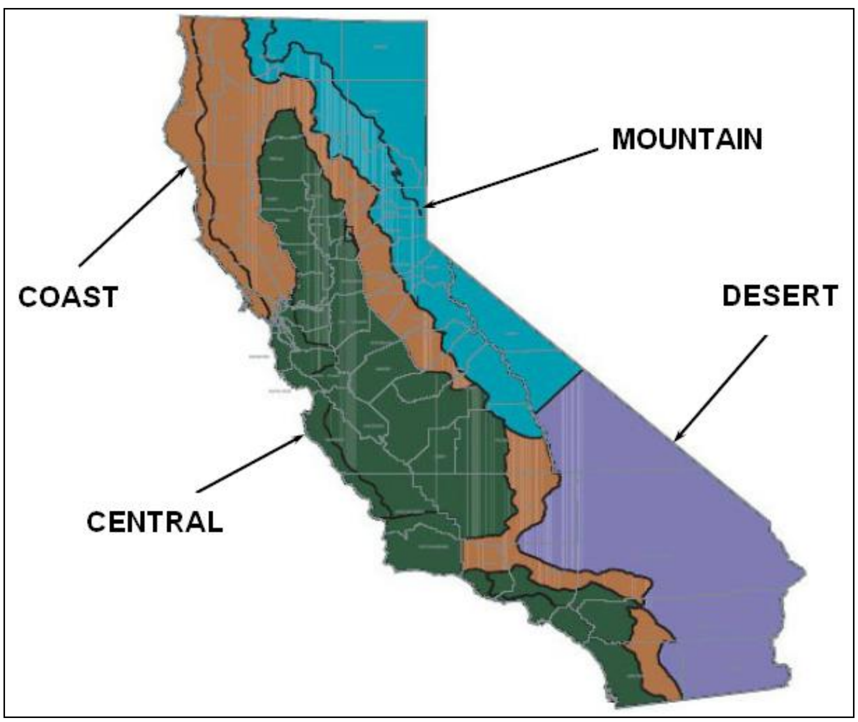


Figure D.1. Caltrans Performance Grade Binder Map

Indicator variables have values of 0 and 1 to identify the different types described above. For example, in the regression the variable agency type was defined as follows:

Type_Urban	=	1 if the agency is urban 0 otherwise
Type_Rural	=	1 if the agency is rural 0 otherwise
Type_Combined	=	1 if the agency is combined 0 otherwise

Once the variables were defined, the next step was to perform a multiple regression between the response and all the possible predictors. The output of the regression provides several parameters that were used to evaluate the model:

- **Analysis of Variance:** This approach was used to test the significance of the regression. If the p-value from the analysis of variance is < 0.05, it indicated that there was a linear relationship between the response and at least one of the predictors (at a 95% confidence level).

- **p-values for individual coefficients:** these values indicated the significance of each predictor within the model. p-values < 0.05 indicate that the predictor was highly significant at 95% confidence level.

- **Variance Inflation Factors (VIF):** These values were used to identify multicollinearity (strong correlation among the predictors), which can dramatically impact the ability to estimate regression coefficients. VIFs larger than 10 imply serious problems with multicollinearity.

- **R^2 and adjusted R^2:** R^2 indicates the proportion of variation explained by the predictors. Values of R^2 close to 1 imply that most of the variability in the response was explained by the regression model. The adjusted R^2 penalizes the addition of variables that were not significant to the model and was useful in evaluating and comparing candidate regression models.

In addition, the adequacy of the model was checked to ensure that the following assumptions were met:

- The relationship between the response and the predictors was linear.
- The error term had constant variance (was homogeneous)
- The errors were normally distributed.

Figure D.2 is the output from the initial regression. The p-value from the analysis of variance was < 0.05, which indicated that there was a relationship between at least one of the predictors and the total cost. VIFs < 10 indicate that there were no multicollinearity problems. R^2 = 52.3% indicate that there was about 48% of the variability not explained by the model.

```
The regression equation is
TOTAL COST = - 2.45E+09 + 2205308 TOTAL MILES - 8.67E+08 TYPE_RURAL
             + 1.21E+09 TYPE_URBAN + 1.33E+09 CLIMATE_CENTRAL
             + 1.23E+09 CLIMATE_COAST


Predictor               Coef    SE Coef      T      P    VIF
Constant         -2447667582  787650028  -3.11  0.003
TOTAL MILES          2205308     315946   6.98  0.000  2.385
TYPE_RURAL        -867135945  641001247  -1.35  0.182  1.494
TYPE_URBAN        1209008158  468666129   2.58  0.013  2.545
CLIMATE_CENTRAL   1331953147  659775232   2.02  0.049  7.799
CLIMATE_COAST     1233703077  704556212   1.75  0.086  7.734


S = 728821732   R-Sq = 52.3%   R-Sq(adj) = 47.7%


Analysis of Variance

Source          DF           SS           MS      F      P
Regression       5  3.03235E+19  6.06470E+18  11.42  0.000
Residual Error  52  2.76214E+19  5.31181E+17
Total           57  5.79449E+19
```

Figure D.2 Initial Regression Output

Model Adequacy Checking

Several basic assumptions were made when building the initial model:

- The relationship between the response and the predictors was linear.
- The error term was homogeneous (constant variance).
- The errors were normally distributed.

It was necessary to examine the adequacy of the proposed model because any violations of the assumptions above may yield an unstable model. The residual analysis method was used in this study. Residuals are a measure of the variability in the observations not explained by the regression model and can identify departures from the model assumptions. Studentized residuals are adjusted residuals with constant variance that provide a better scale. The following are graphical methods used to check the model assumptions:

- **Linearity:** Plot residuals versus fitted values. If a curve band or a non-linear pattern showed up, then either polynomial terms or a transformation should be considered (Figure D.3).

- **Constant Variance:** Plot studentized residuals versus fitted values. If scatter increased with fitted values, the errors have non-constant variance (Figure D.4).

- **Normality:** Create a normal probability plot by plotting the ordered studentized residuals versus the expected order statistics from a standard normal distribution. If the resulting plot produces points close to a straight line then the data are consistent with that from a normal distribution (Figure D.5).

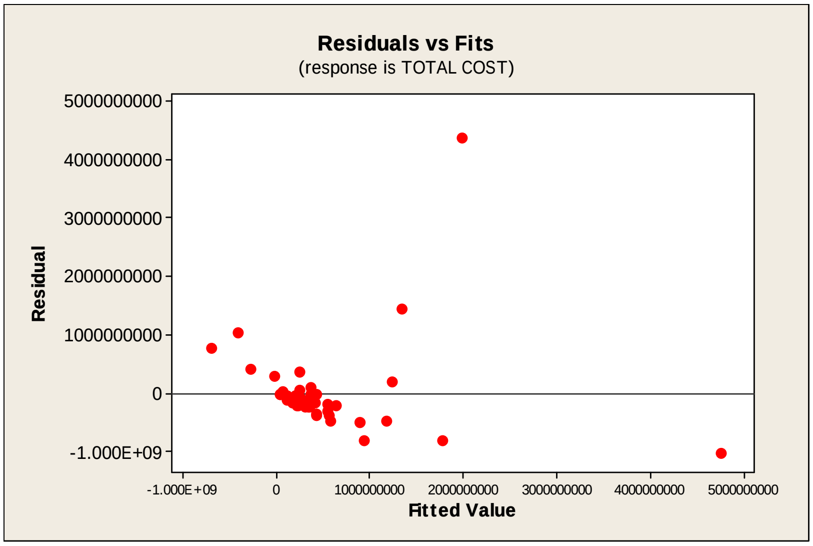


Figure D.3. Residual Plot

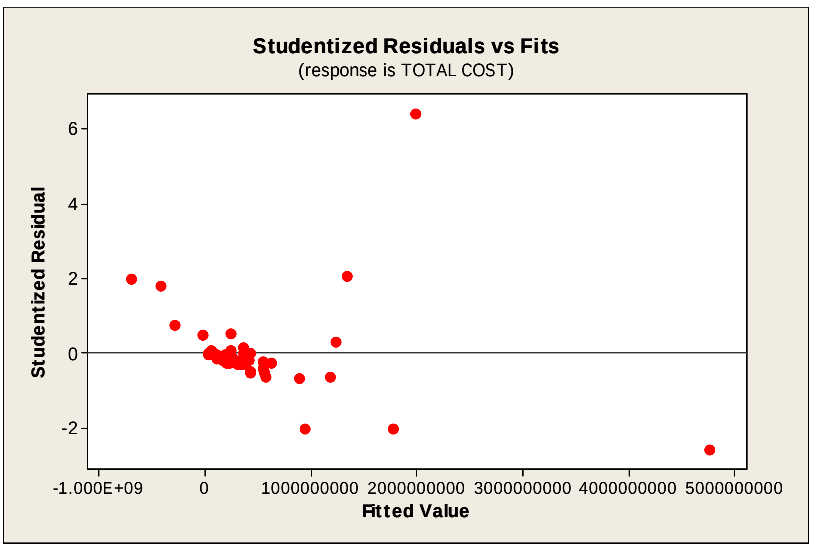


Figure D.4 Studentized Residual Plot

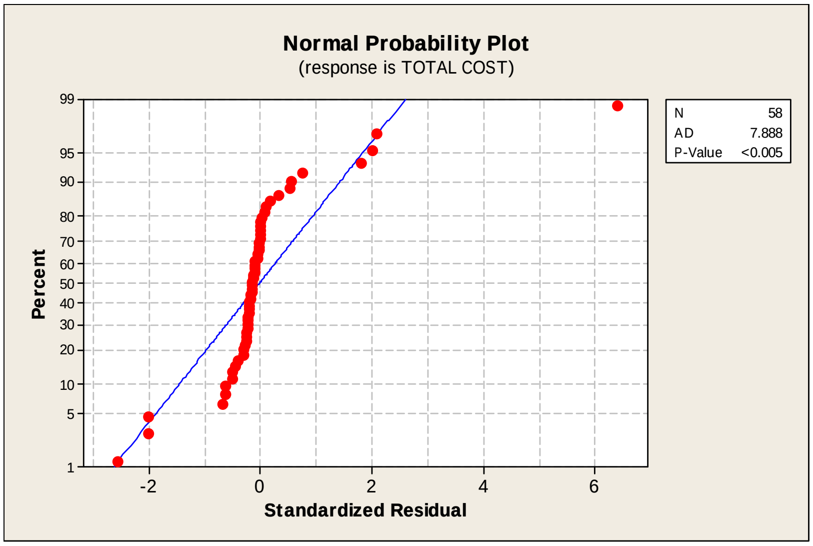


Figure D.5 Normal Probability Plot

From Figures D.4 through D.5, it can be observed that the model assumptions of constant variance and normality were violated.

Detection of Outliers

Outliers are data points which are not typical of the rest of the data. If the studentized residual fell outside the interval -2 to 2, the point was considered an outlier. If outliers were detected, they were thoroughly investigated before any actions were taken. The following outliers were detected:

Table D.1. Outliers Detected

County	Agency	Studentized Residual
Orange	Huntington Beach	2.07
San Diego	San Diego	-2.57
San Diego	San Diego County	-2.01
San Francisco	San Francisco	6.40
San Luis Obispo	San Luis Obispo County	-2.01
Shasta	Shasta County	2.01

No action was taken because these data points correspond to large agencies that should be considered in the analysis.

Leverage and Influence Points

Leverage and influence points have considerable influence on the fitted model. A leverage point is a point whose x-value is distant from the other x-values. It does not affect the estimate of the regression coefficients but will have a significant impact on the model summary statistics such as R^2. Influence points have both x and y-values that are distant from the other data points and have noticeable impact on the model coefficients.

The following unusual observations were identified:

Table D.2 Leverage and Influence Points

County	Agency	Leverage Point	Influence Point
Marin	Marin County	X	
San Diego	San Diego	X	X
San Diego	San Diego County	X	X
San Luis Obispo	San Luis Obispo County	X	
San Francisco	San Francisco		X
San Luis Obispo	San Luis Obispo County		X
San Mateo	San Mateo County	X	
Shasta	Shasta County	X	X

Once again, no action was taken because there is no reason to doubt the validity of the data.

Correction of Model Inadequacies

Model inadequacies can sometimes be corrected through data transformation. A log transformation was applied to the response in order to stabilize the variance and normalize the distribution of the errors. The output and residual analysis from the transformed model are shown in Figures D.6 through D.9.

```
The regression equation is
LOG COST = 17.0 + 0.00216 TOTAL MILES - 1.74 TYPE_RURAL + 0.442 TYPE_URBAN
           + 1.11 CLIMATE_CENTRAL + 0.541 CLIMATE_COAST


Predictor              Coef    SE Coef      T      P    VIF
Constant             16.980      1.053  16.13  0.000
TOTAL MILES       0.0021573  0.0004223   5.11  0.000  2.385
TYPE_RURAL          -1.7438     0.8567  -2.04  0.047  1.494
TYPE_URBAN           0.4422     0.6264   0.71  0.483  2.545
CLIMATE_CENTRAL      1.1131     0.8818   1.26  0.212  7.799
CLIMATE_COAST        0.5415     0.9416   0.58  0.568  7.734


S = 0.974061   R-Sq = 46.0%   R-Sq(adj) = 40.9%


Analysis of Variance

Source          DF       SS      MS     F      P
Regression       5  42.0968  8.4194  8.87  0.000
Residual Error  52  49.3373  0.9488
Total           57  91.4342
```

Figure D.6 Transformed Regression Output

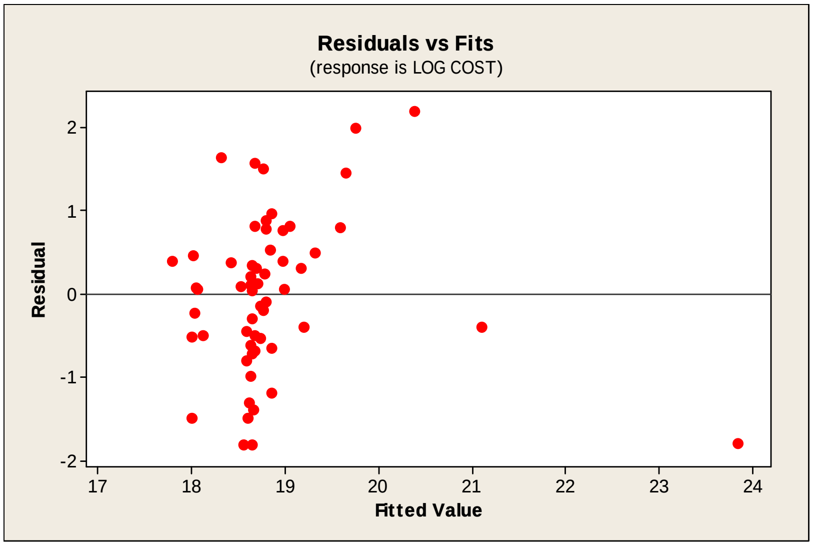


Figure D.7 Residual Plot

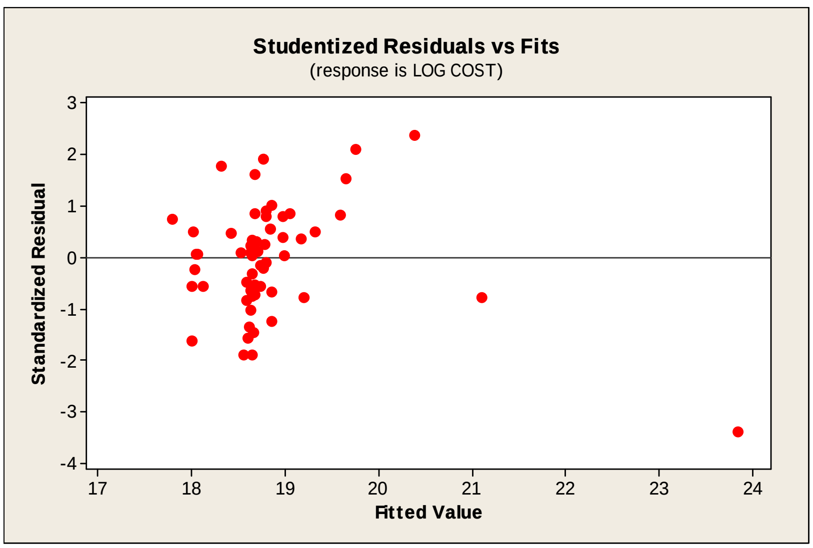


Figure D.8 Studentized Residual Plot

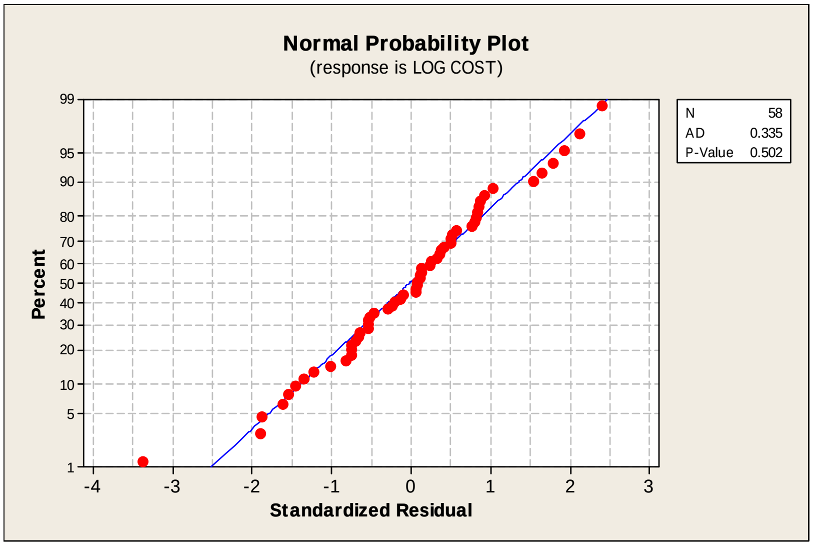


Figure D.9 Normal Probability Plot

The residual plots show that the model inadequacies have been corrected with the transformation.

Variable Selection

Variable selection is a technique used to ensure that all the predictors in the model are significant. Using stepwise regression methods, it was determined that only the following predictors contribute to the model:

- Total Miles
- Type_Rural
- Climate_Central

Figure D.10 shows the output of the reduced model.

```
The regression equation is
LOG COST = 17.9 + 0.00189 TOTAL MILES - 2.09 TYPE_RURAL + 0.682
CLIMATE_CENTRAL


Predictor              Coef    SE Coef      T      P    VIF
Constant            17.8872     0.2948  60.67  0.000
TOTAL MILES       0.0018856  0.0002957   6.38  0.000  1.194
TYPE_RURAL          -2.0947     0.7616  -2.75  0.008  1.206
CLIMATE_CENTRAL      0.6818     0.3158   2.16  0.035  1.021

S = 0.963894   R-Sq = 45.1%   R-Sq(adj) = 42.1%

Analysis of Variance

Source          DF      SS      MS      F      P
Regression       3  41.263  13.754  14.80  0.000
Residual Error  54  50.171   0.929
Total           57  91.434
```

Figure D.10 Reduced Regression Output

Final Model

The final model that met all these requirements was as follows:

log Cost = 17.9 + 0.00189 Total Miles – 2.09 Type_Rural + 0.682 Climate_Central

It should be noted that:

- If the agency type was “Urban” or “Combined” or if the climatic region is other than “Central” the indicator variables will have a value of zero and the model will depend only on total centerline miles.
- “log” refers to the natural logarithm

Table D.3 below is an ***example*** of the estimation of the safety, traffic and regulatory needs for an analysis period of 25 years and a total replacement cost of $1.0 billion.

Table D.3 Example of 25 Year Safety, Traffic & Regulatory Needs Calculations

Asset	% of Total Repl. Cost (1)	Replacement Cost (2)	Service Life (3)	Annual Needs (4)	25 Yr Needs (5)
Storm Drain	27.0	269,594,241	50	5,391,885	5,391,885
Curb & Gutter	26.1	260,972,222	35	7,456,349	7,456,349
Sidewalk	28.5	284,676,623	35	8,133,618	8,133,618
Curb Ramps	2.75	27,506,916	35	785,912	785,912
Traffic Signals	7.09	70,926,984	40	1,773,175	1,773,175
Street Lights	4.15	41,486,571	30	1,382,886	1,382,886
Sound/Retaining Walls	3.38	33,768,503	30	1,125,617	1,125,617
Traffic Signs	1.11	11,067,939	10	1,106,794	1,106,794
Total	**100**	**1,000,000,000**	**--**	**27,156,235**	**678,905,868**

Column (2) = $1.0 billion x Column (1)
Column (4) = Column (2) / Column (3)
Column (5) = Column (4) x 25 years

APPENDIX E

Safety, Traffic and Regulatory Component Needs by County

Table E.1 Summary of Safety, Traffic & Regulatory Needs and Shortfall by County

COUNTY	10 YR NEEDS	10 YR REVENUE	SHORTFALL
ALAMEDA*	$ 1,289,224,081	$ 344,564,888	$ 944,659,193
ALPINE	$ 2,623,953	$ 1,892,139	$ 731,813
AMADOR	$ 5,299,302	$ 4,192,173	$ 1,107,129
BUTTE	$ 81,152,673	$ 57,895,550	$ 23,257,123
CALAVERAS	$ 18,876,851	$ 11,817,401	$ 7,059,450
COLUSA	$ 23,925,276	$ 17,568,510	$ 6,356,766
CONTRA COSTA*	$ 857,363,781	$ 345,716,797	$ 511,646,984
DEL NORTE	$ 21,185,817	$ 10,828,757	$ 10,357,060
EL DORADO	$ 100,694,107	$ 45,743,273	$ 54,950,835
FRESNO	$ 410,435,164	$ 176,734,395	$ 233,700,769
GLENN	$ 56,283,352	$ 19,456,075	$ 36,827,277
HUMBOLDT	$ 78,565,522	$ 54,199,275	$ 24,366,248
IMPERIAL	$ 111,100,671	$ 79,882,646	$ 31,218,024
INYO	$ 12,385,638	$ 9,838,909	$ 2,546,729
KERN	$ 1,614,594,694	$ 216,992,318	$ 1,397,602,377
KINGS	$ 150,637,749	$ 48,239,336	$ 102,398,413
LAKE	$ 27,577,345	$ 27,577,345	
LASSEN	$ 21,017,426	$ 14,081,611	$ 6,935,814
LOS ANGELES	$ 5,544,596,561	$ 2,826,303,406	$ 2,718,293,155
MADERA	$ 98,364,754	$ 73,347,852	$ 25,016,902
MARIN*	$ 218,528,973	$ 67,327,196	$ 151,201,778
MARIPOSA	$ 4,763,357	$ 4,763,357	
MENDOCINO	$ 62,601,434	$ 34,094,769	$ 28,506,665
MERCED	$ 160,202,949	$ 54,682,327	$ 105,520,623
MODOC	$ 3,547,746	$ 3,547,746	
MONO	$ 9,606,315	$ 9,606,315	
MONTEREY	$ 502,057,061	$ 80,428,538	$ 421,628,522
NAPA*	$ 151,740,858	$ 80,740,474	$ 71,000,385
NEVADA	$ 62,814,003	$ 40,721,958	$ 22,092,046
ORANGE	$ 2,628,990,947	$ 923,361,511	$ 1,705,629,436
PLACER	$ 333,506,426	$ 67,456,898	$ 266,049,528
PLUMAS	$ 9,674,979	$ 9,674,979	
RIVERSIDE	$ 1,004,467,373	$ 665,566,325	$ 338,901,048
SACRAMENTO	$ 2,536,612,764	$ 523,871,897	$ 2,012,740,866
SAN BENITO	$ 46,827,441	$ 13,563,917	$ 33,263,524
SAN BERNARDINO	$ 4,299,360,537	$ 747,379,658	$ 3,551,980,879
SAN DIEGO	$ 2,460,240,585	$ 1,025,519,657	$ 1,434,720,929
SAN FRANCISCO*	$ 717,112,030	$ 497,831,215	$ 219,280,816
SAN JOAQUIN	$ 378,527,591	$ 232,718,749	$ 145,808,842
SAN LUIS OBISPO	$ 254,953,762	$ 107,364,409	$ 147,589,353
SAN MATEO*	$ 672,204,919	$ 195,875,118	$ 476,329,801
SANTA BARBARA	$ 382,475,492	$ 125,878,619	$ 256,596,873
SANTA CLARA*	$ 1,602,353,226	$ 1,090,702,620	$ 511,650,607
SANTA CRUZ	$ 173,539,563	$ 99,341,454	$ 74,198,108
SHASTA	$ 150,056,204	$ 58,668,463	$ 91,387,740

COUNTY	10 YR NEEDS	10 YR REVENUE	SHORTFALL
SIERRA	$ 6,308,545	$ 4,535,336	$ 1,773,209
SISKIYOU	$ 23,981,600	$ 19,822,034	$ 4,159,566
SOLANO*	$ 433,233,563	$ 91,885,283	$ 341,348,280
SONOMA*	$ 467,705,087	$ 181,693,692	$ 286,011,395
STANISLAUS	$ 609,674,596	$ 285,883,510	$ 323,791,086
SUTTER	$ 115,563,429	$ 51,390,507	$ 64,172,922
TEHAMA	$ 26,375,450	$ 21,754,571	$ 4,620,879
TRINITY	$ 8,088,354	$ 1,600,000	$ 6,488,354
TULARE	$ 341,285,839	$ 177,870,729	$ 163,415,109
TUOLUMNE	$ 80,748,325	$ 14,501,193	$ 66,247,132
VENTURA	$ 433,455,505	$ 320,039,495	$ 113,416,010
YOLO	$ 180,351,575	$ 86,805,426	$ 93,546,149
YUBA	$ 32,493,245	$ 2,749,080	$ 29,744,165
TOTAL	**$32,111,936,364**	**$ 12,408,091,679**	**$ 19,703,844,685**

* Data from San Francisco Bay area provided by MTC.

APPENDIX F

Development of a Standard Needs Assessment Approach

> ***"All long-term plans are about change. There can be disagreement about precisely which changes the future will bring, or how fast they will occur, or what can and should be done about them — but no one doubts that conditions 25 or 30 years hence will be different than they are today. Change is a certainty, and to plan means to reckon with change."*** [12]

The quote above is from a draft of the current Regional Transportation Plan undertaken by the Metropolitan Transportation Commission (MTC), and it rings true for planning studies such as this one. Engineering and planning studies of this nature, where a "snapshot" of existing conditions is taken and the results used for policy decisions such as funding, are applicable only for a short duration. The key is to continue to maintain and update the results of these studies as things change i.e. as the state continues to grow in both population and the resulting transportation infrastructure. Typical examples include Regional Transportation Plans (RTP) and the Caltrans SHOPP, which are updated biennially.

Ten years elapsed between SR 8 and this study – and it was the consensus of the Oversight Committee that this lapse led to a loss of momentum in the on-going need for funding to maintain local streets and roads. During this time, the cost of pavement construction materials increased dramatically, the pavement network and traffic volumes continued to grow, and new regulatory requirements materialized but the funding levels were not commensurate with these changes. As a result, pavement maintenance levels began to fall behind.

With the completion of this study comes the opportunity to develop a framework that will institutionalize the effort required to maintain and update this study periodically and to incorporate any future changes. This will ensure that any momentum generated by this study is not lost. In essence, this study is really just the first step in a process to continually update the status and needs of the local streets and roads infrastructure.

Therefore, one of the key tasks of this study was to establish a consistent method to update and determine the needs on a cyclical basis.

> ***The overall goal would be to have an institutional framework available that would generate the analyses required to update the study every two or more years, as required. Ideally, this approach would require all Cities and Counties to provide their infrastructure information in a format to an umbrella entity that would then be able to aggregate the data and perform the analyses in an efficient manner.***

To arrive at this overall vision requires that we address some key questions and issues as discussed in the following pages.

1. How can we assure data consistency and quality in future updates?

The most challenging aspect of any study such as this is the aggregation of data from 536 sources (at least 538 in future updates since two new Cities were incorporated in late 2008).

[12] *Transportation 2035: Change in Motion – Transportation 2035 Plan for the San Francisco Bay Area*, Draft, December 2008.

Several technical issues relating to the data collection process and data quality are discussed below.

a. Pavement Management Systems (PMS)

It is difficult, if not impossible, to perform any accurate and rational needs assessment without the use of a pavement management system. A PMS sets up a formal process where pavement data are collected in a systematic and consistent manner, analyzed so that budgeting and planning decisions can be made in the most cost-effective manner. In particular, PMS assist in assessing the long-term ramifications of different budgeting levels as well as the identification of funding needs to reach pavement goals set by cities and counties.

Therefore, one of the first things we did in the survey was to identify who used a pavement management system (PMS). An excellent sign was that at least two-thirds of the agencies in California (66%) use a PMS (see Figure F-1) and 11% indicated that they did not have a PMS. Almost a quarter (23%) did not respond to the survey, so we have no information on whether they have a PMS or not.

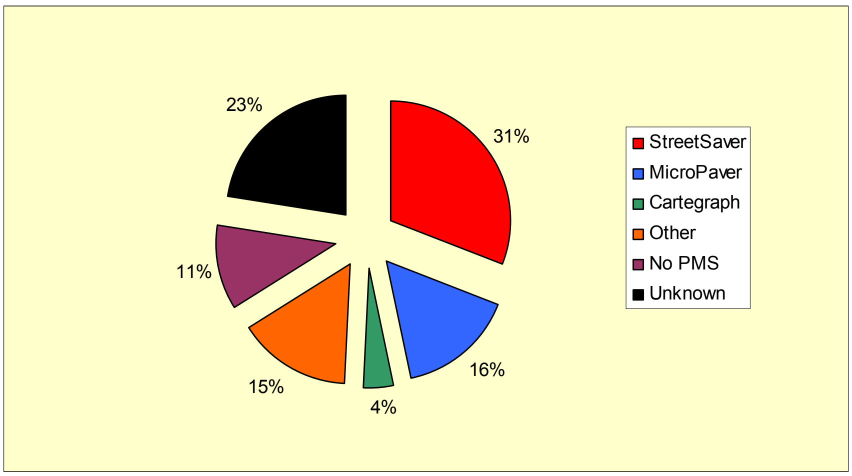


Figure F-1. Types of PMS Software Used by Agency

In terms of centerline miles, the numbers are even more encouraging. We can see from Figure F-2 that 86% of the states local street and road network is included in a PMS.

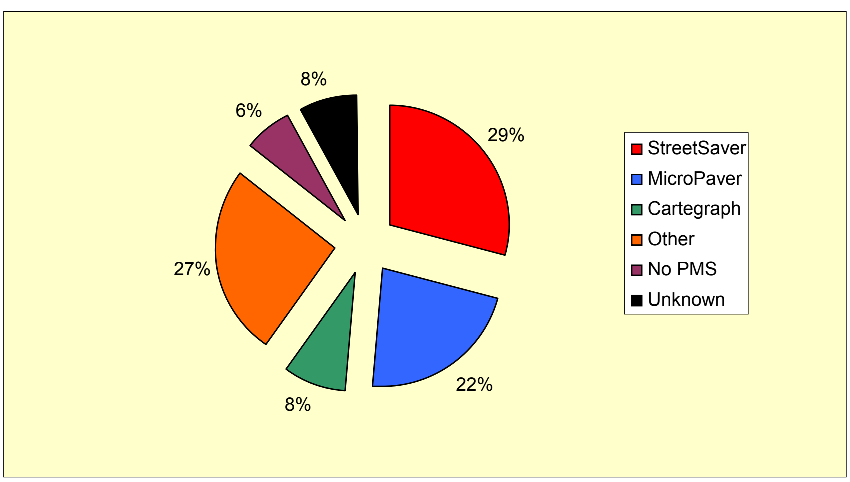


Figure F-2. Types of PMS Software Used by Centerline Miles

This had a huge implication for this study. First, the fact that 86% of the pavement network was included in a pavement management system (PMS) was extremely encouraging. **As was noted in Chapter 2, the presence of a PMS greatly added to the data quality and the validity of the results from this study.**

Both Figures F-1 and F-2 indicate that the three most common PMS software used are StreetSaver, MicroPAVER and Cartegraph. The first two are public domain software, developed by public agencies (MTC and the Corps of Engineers, respectively). The latter is a proprietary system.

Briefly, all three programs have the following common elements that are found in a PMS i.e.

- An inventory of all pavements, with basic information such as street or road name, limits, lengths, widths, areas, functional classifications, surface type and age
- Pavement condition data i.e. pavement distresses collected and condition index (0-100 scale)
- The use of deduct values in calculating a pavement condition index
- Maintenance treatments and unit costs

The key differences lie in the use of performance prediction models (family curves, straight-line or custom models) and how they prioritize which streets to fix first given limited funding (ranking based on condition index, cost-benefit analysis, priority matrix). These range from relatively simple ranking methods to more complex multi-year prioritization algorithms. Attachment F-1 is an excerpt from the FHWA's "Pavement Management Catalog" where each of these three PMS programs are described in more detail.

In the development of the statewide needs estimate, we utilized the pavement condition index from each of the PMS and the StreetSaver program to perform the statewide analyses. This program was selected for several reasons:

- By using the common elements of the software and standardizing the approach for determining the pavement needs, it greatly improved the accuracy of the needs assessment.
- The default prediction models are based on California cities and counties. The other two programs default to a straight-line or require significant data to create custom curves.
- The prioritization algorithms are based on an approach that is analogous to a cost-benefit analysis. The principles of pavement preservation are key to this approach.
- The ability to use different treatments as well as different unit costs for different classes of pavements i.e. arterials vs. local streets.
- The ability to program multiple treatments within an analysis period. This was particularly important since the study looked at both 10 and 25-year horizons, and a series of treatments are typically programmed for a pavement section within that analysis period.

A small percentage of the state reported **not** having a PMS. This is despite Section 2108.1 of the Streets and Highways Code, which requires all Cities and Counties receiving state funding to implement a PMS.

Section 2108.1 of the Streets and Highway Codes states*:*

> *By July 1, 1990, the City, County, State Cooperation Committee in the department shall develop and adopt a pavement management program to be utilized on local streets or highways that receive funding under the state transportation improvement program. The pavement management program shall be transmitted to every County or City for possible adoption or incorporation into an existing pavement management program. The City, County, State Cooperation Committee shall solicit recommendations from transportation planning agencies and any other entity the committee deems appropriate.*

While it would be desirable to ensure that all Cities and Counties have a PMS in place for future updates, many small agencies, due to limited resources, do not have one. To put their impact in perspective, there are 275 Cities with less than 100 centerline miles of streets, and 167 Cities with less than 50 centerline miles of streets. However, they comprise only 8.7% and 3.2% of the total miles in the state, respectively. Their impact on the statewide needs is consequently minimal.

Therefore, any benefit derived from obtaining data from small agencies would be offset by the considerable cost and effort required to implement and maintain a PMS. One recommendation would be for a larger neighboring agency to assist them in their efforts. For example, Mendocino County is responsible for Point Arena's 3.8 miles of pavements. Humboldt County is in the process of including tribal roads within their PMS database, since many reservations and Rancherias have less than 10 miles of roads. For future updates, we recommend that the efforts be focused on larger agencies with no PMS i.e. more than 100 centerline miles of roads.

Although we recommend that the focus for future updates should be on agencies with no PMS and with more than 100 miles, nonetheless, an effort should be made to encourage all local agencies to implement and use a PMS. Not only will this greatly ease future updates, it will allow for better and a more efficient use of public funds in road maintenance and pavement preservation. One way would be for entities such as the League of California Cities or the California State Association of Counties (CSAC) to endorse or encourage the use of a pavement management system. For example, one reason why the MicroPAVER PMS is so widespread in the United States is that the American Public Works Association (APWA) has formally endorsed its use to member agencies. Both the League and CSAC are the closest to a statewide entity; both hold annual conferences and both have both technical and policy committees where transportation is a key issue.

Another effective means to encourage the use of a PMS is a grant program. The Metropolitan Transportation Commission (MTC) has used a portion of STP funding to assist their jurisdictions (smaller ones have received a higher priority in the past) in implementing or updating their PMS since 1999. The PTAP (Pavement management Technical Assistance Program) grant program is relatively small; it averages around $1 million a year spread out over 100 agencies. Grant amounts range from $7,500 to $40,000 per agency, depending on size. The goal is to allow all agencies to receive a grant at least once every 2 or 3 years. In addition to the grant, MTC selects a list of qualified consultants and assigns them to agencies; they also administer the grant and contracts with the assigned consultant. Therefore, agencies do not have the contract administration responsibilities that can be onerous with the receipt of federal funds. This is particularly helpful for those smaller jurisdictions. The results of the PTAP program are impressive; all agencies are actively using a PMS today.

Further, to encourage agencies to implement and maintain a PMS, we recommend that any future funding sources be linked with compliance with Section 2108.1. The enforcement or monitoring would be left to the administrative entity described in a later section. The Orange County Transportation Authority (OCTA), similarly to MTC, has required the use of PMS to be eligible for Measure M funds (1/2 cent sales tax). A recent survey (June 2009) by NCE showed that all but one agency has a PMS.

b. Distress Survey Protocols

Of the 415 agencies who responded, 60% employed the distress survey protocols established by either the U.S. Army Corps of Engineers (MicroPAVER) or the Metropolitan Transportation Commission (MTC StreetSaver). Both methods of surveying pavement distresses are well-documented, similar, and share common deduct curves. Both result in a Pavement Condition Index (PCI) that are, largely, the same. The PCI uses a 0-100 rating scale.

The Cartegraph program has two distress survey protocols as defaults; one is the MicroPAVER protocol, the other is the SHRP (Strategic Highway Research Program) protocol which is used mostly by state highway agencies. Most local agencies will use the MicroPAVER protocols. This ensures a high comfort level in the quality of the data collected, since 65% of the responding agencies use similar distress survey procedures.

The most common distress types collected for asphalt pavements are fatigue (alligator) cracking, block cracking, longitudinal and transverse cracking, rutting, patching, shoving/distortions, weathering and raveling. For Portland cement concrete pavements, they are corner breaks, divided/shattered slabs, faulting, linear cracking, scaling/map cracking/crazing and spalling.

The remaining 20% collected the same kind of pavement distresses that are found in either MicroPAVER or StreetSaver, but may have different protocols for collection and calculating the condition ratings. Of the differences found, most were related to collecting additional types of data, primarily deflection and ride quality. However, not all the information collected was used in the calculation of the condition rating or index (see Table F-1).

Table F-1. Summary of Additional Distress Data Collected and Usage

	Deflection	Ride Quality	Friction	Drainage	Structure/Core	Citizen Complaints	Pavement Age
Number of Agencies	38	37	4	6	12	1	3
How is Data Used?							
Project level (design)	27	4	1	1	6	0	0
Condition Rating	11	31	3	4	6	1	3
Inventory only	0	2	0	1	0	0	0

In terms of using a rating scale, 90% of the agencies reported using a 0-100 scale.

One of the original concerns at the outset of this study was that there would be so many variations in survey procedures that comparing apples and apples would be extraordinarily difficult. However, given that almost 65% of the respondents use MicroPAVER or StreetSaver protocols, this ensured that the comparisons made were largely valid.

While it is desirable to have all agencies use the same distress survey protocols to arrive at a common condition rating scale, it is difficult to impose this requirement on all agencies. Many agencies, particularly the larger ones, have invested significant funds in customizing or integrating their distress protocols and rating systems with other programs, and adopting a new rating scale may result in wholesale abandonment of many years of historical data.

However, the industry trend is leaning towards adoption of a 0-100 scale, with similar distress types and deduct values found in either the MicroPAVER or StreetSaver programs. For example, there is an on-going study in Orange County to adopt one standard methodology for distress surveys. The enforcement of this requirement is linked to a “stick” i.e. Measure M funds as previously mentioned. We believe that time and local/regional efforts will gradually result in a more or less consistent rating system statewide.

The method of collecting data was not explicitly requested in the survey but does have an impact on the data reported. There are three primary types of data collection, and each has its own advantages and disadvantages:

Windshield surveys - These are performed with two-person crews in a vehicle traveling at low speeds (under 15 mph). The major advantage is that 100% of the roadway is surveyed, and it can be accomplished very quickly, safely and inexpensively. However, the disadvantage is that the data collected tends to be of variable quality. In particular, low-severity distresses are typically not visible from a moving vehicle. This results in a higher than expected condition rating of the streets, and consequently, a lower estimate of the backlog and pavement needs.

Walking Surveys - These are performed with a one-person crew where distresses are collected for a representative portion of the pavement. For high volume streets like expressways or major arterials, two-person crews may be needed for safety. The major advantage of this survey method is that it is highly accurate, since cracks and all other pavement distresses are measured and recorded. However, walking surveys are more labor-intensive and are thus more expensive than windshield surveys.

Automated surveys – These are typically performed with a customized vehicle that is equipped with a video or digital camera and/or laser bars. The major advantage is that they are equipped to perform surveys very quickly and safely. However, post-processing time can offset cost-savings in the field, and the quality of the data can be variable depending on light conditions (e.g. tree-lined streets with contrasts in light and dark) because shadows can mask some distresses. Typically, only the outer travel lanes are surveyed, and for most residential streets, only one lane is surveyed.

The MicroPAVER, StreetSaver and SHRP protocols call for walking surveys; however, it is our experience that all of the above types of surveys (or combinations) have been used for these three programs. While the method of data collection affects the condition index, for a statewide study, the impacts are probably not significant.

A standardized list of distresses to be collected and included in a rating scale (0 to 100) is recommended to facilitate future updates. The distresses should include, as a minimum:

Asphalt Concrete	Portland cement concrete
Fatigue/alligator cracking	Corner breaks
Block cracking	Divided (shattered) slab
Distortions/swell	Faulting
Longitudinal and transverse cracking	Longitudinal, transverse and diagonal cracking
Patching and utility cuts	Patching and utility cuts
Rutting and depressions	Scaling/map cracking/crazing
Weathering and raveling	Spalling

The three most common PMS software described previously i.e. MicroPAVER, StreetSaver and Cartegraph all include these distresses as a minimum.

c. Data Collection

Since this was the most time intensive and consequently, the most expensive, portion of the study, we spent considerable efforts at rethinking this process and looking for ways to get more data in as efficient a manner as possible. We also looked at ways to improve data quality. If a similar collection effort is performed for the next update, the following observations and suggestions are included to assist future efforts.

Online Questionnaire/Survey – This still remains a very comprehensive method of collecting and storing data in a reasonably cost effective manner. An online survey website service was originally selected due to time constraints – we had to get started on the data collection very quickly, which meant that a readily available commercial service was utilized rather designing a database from scratch.

However, the limitations of the survey website we used (i.e. www.surveygizmo.com) was quickly reached. As we discovered, most online survey websites were not intended for the detailed qualitative and quantitative analysis such as that required for this study. These online surveys work well when responses are in yes/no or multiple choice formats, which facilitates the quantitative analyses. However, since the responses we received were more open format, i.e. where explanations or text descriptions were common, it limited our use of the analytical tools available.

Another problem was the inability to apply restrictions to any fields, so any data could be entered without the ability to perform automatic validation checks e.g. lane widths that were 24 feet wide, or users entering “3 million” instead of “3,000,000” or the wrong units applied (feet instead of yards). While these may seem minor problems, in reality, it was easily a 150 to 200 hour effort to filter out what was reasonable or unreasonable when faced with almost 40,000 individual data fields that had to be analyzed. Even though we were able to automate a large percentage of the data validation checks, in many cases, we still had to contact the agency which submitted the data in an effort to ensure that there were no errors.

In some cases, we needed to clarify or provide more instructions on how to fill out the survey. This has to be balanced with keeping the survey short so as to retain the attention span of the user. Other changes recommended include using radio buttons to minimize the amount of text entered, allowing users to print results so they can check/preview their responses before submitting, ask for more details on unit costs etc. All these changes are minor in nature, but addressing them will result in a more efficient and higher quality data set in the future.

Therefore, if a survey is used for future data collection, we recommend modifications to the online survey based on the lessons we learnt, and more importantly, we recommend developing a custom database with MS Access (or similar) that may then be linked to the current www.SaveCaliforniaStreets.org website. This will facilitate future data collection efforts and minimize the time required to check and validate the responses received.

Attachment F-2 contains a list of the data recommended for future updates. This is a simplified list and focuses the data collection effort at the pavement condition index as the key input. The data needed for the other elements (safety, traffic, regulatory and funding) are largely unchanged.

Filling in the Gaps – There were 121 agencies who did not respond at all to the survey; of the remaining agencies, a significant percentage had data gaps, especially for the safety, traffic and regulatory components. For many, the main reason cited was a lack of resources, particularly in those small (less than 100 centerline miles) Cities.

In the case of pavement condition, averages from surrounding agencies were used to fill in the gaps. However, a more accurate process may be to provide these Cities with information on their neighbors and let them make the assessment as to what best matches their agency. The online survey would need to be populated with this information. We feel that this would provide a "quick and easy" method for those agencies with limited resources to provide us with the required data.

d. Pavement Condition Thresholds

Most of the responses used thresholds for treating their pavements that were similar to the example provided in the survey (see Table F-2). However, it was not always possible to determine if they did, in fact, trigger similar treatments. For example, an agency may have programmed reconstruction in the "poor" category, and another may have programmed an overlay. This results in inconsistent standards, and may not be consistent with pavement preservation principles.

Table F-2. Example of Thresholds Used in Survey

Condition Description	Agency's Condition Rating Ranges
Excellent	85-100
Good	70-85
Fair	50-70
Poor	25-50
Very Poor	0-25

To help remove this inconsistency, we recommend that Table F-2 be modified to reflect the thresholds that trigger maintenance activities instead (see Table F-3), as this would more explicitly link condition to maintenance in the agency. We suspect that this would also engender more thought (and thereby more accuracy) when filling out the survey. In addition, if other factors are used to make these decisions, such as ride or deflection data, this would be more likely to draw out that information.

Future surveys should also look at the differences between an urban street and a rural road. Treatment decisions are likely to be different, and the thresholds that trigger that treatment.

For the needs assessment, the thresholds used should be consistent with pavement preservation principles i.e. ensuring that good roads are maintained and preserved. This was also indicated in the original RFP.

Table F-3. Example of Thresholds for Future Surveys

Maintenance Activity	Condition Thresholds	
	Urban	Rural
Do Nothing	86-100	75-100
Preventive Maintenance	70-85	60-75
Surface seal e.g. slurry, cape	70-85	60-75
Thin AC overlay	50-70	40-60
Thick AC overlay	25-50	0-40
Reconstruction	0-25	Never

e. Maintenance Costs

Since maintenance costs play such a critical role in determining the pavement needs, it is important that accurate costs be obtained. In this study, we used a statewide average based on 50 agencies to determine appropriate unit costs. However, this data was not part of the questionnaire.

For future updates, we would recommend that the survey be expanded to include gathering this information. Appropriate instructions are also needed to ensure that agencies provide the same kind of information. For example, some agencies provided us contract costs only, others included design and inspection, and still others included materials costs but no labor when the work was done in-house.

To our knowledge, only one region (MTC) requires their member jurisdictions to supply their unit cost data with the same set of assumptions. This is performed through a biennial survey, and costs are then averaged by County. All regional needs assessments are then performed at the County level and aggregated regionally.

In the study, a consistent set of assumptions was used. Future surveys should also tease out in more detail the differences between rural and urban roads and streets. Anecdotal evidence suggests that the costs for an overlay on a rural road would be less than that for an urban street, but we did not have sufficient information from the surveys in this study to arrive at this conclusion, so a statewide average was used.

For future updates, standard unit costs should be used statewide. These unit costs should reflect the full cost of construction, and include design and engineering costs, construction inspection and testing, contract administrations as well as ancillary elements required by law e.g. upgrading curb ramps as per the American Disabilities Act (ADA).

f. Pavement Performance (Prediction) Models

For any needs assessment, prediction models are required to determine future conditions and hence, future needs. In this study, we used default prediction models developed by MTC – these were based on data from Cities and Counties in the San Francisco bay area. These models are usually known as "family" curves i.e. each curve represents a "family" such as asphalt concrete (AC) arterials. Family curves are available for all combinations of functional classifications (arterial, collector and residential/local) and surface types (AC, AC over AC, Portland cement concrete (PCC), AC over PCC and surface treated).

While these curves were more than adequate for this study, questions may arise about the different climatic regions, and therefore, different pavement performances e.g. alpine environment vs. the desert. While it is desirable to develop unique prediction models (the RFP specifically also addressed this issue of regional curves), which will lead to greater accuracy in our needs assessment, a note of caution is needed. The effort required to develop these models will be significant, and very few agencies have the data or resources to develop unique models. This level of effort is usually only undertaken at the state Department of Transportation level, or for very large Cities/Counties. In California, not even Caltrans has yet developed different prediction models based on climate or facility for their PMS.

Therefore, if funding is a constraint, we do not recommend developing unique models. However, as more information is obtained in future updates, this option should be reviewed and adopted if necessary. It is also important that the entity responsible for future updates have the ability and technical expertise to perform these analyses and develop new models if required.

g. Pavement Needs Calculations

We are confident that the methodology that was developed for this study will be appropriate for future updates, and do not have any modifications to recommend. This is described in detail in the appendices of the final report, but briefly, the procedure is as follows. Eight benchmark databases were created to perform the needs assessment (two functional classes, major and local pavements, and four condition categories, PCI from 0-25, 26-50, 51-70, 71-100). Each database contains sections that have a range of distresses and PCIs and include maintenance and rehabilitation decision trees that have appropriate treatments and costs. The needs and scenarios analyses were performed for each section over the analysis period. The resulting PCI and backlog were also determined for every year.

Once an agency reports their pavement condition rating for both their major and local roads, the appropriate database is used to determine their needs. These databases are provided as part of the Final Report.

h. PMS Software

For software companies to include the aforementioned capabilities in their software is a policy issue. Ultimately, the profit motive drives the private-sector vendors. Therefore, if an agency were to specify the above items in its Request for Proposals (RFPs), most vendors would undoubtedly adapt. The question is – who will pay the cost of modifying the software to meet the above noted requirements? We would expect that there will be resistance from local agencies if they have to bear additional software costs, particularly if they have already invested significant resources elsewhere.

However, there are various approaches that may be considered, some of which are briefly discussed below.

- Let the market rule – The local agency can specify the requirements, and the vendor who wishes to be successful in winning the work will respond/comply. This is somewhat similar to the policies adopted by the California Air Resources Board and the auto industry: To continue to serve the very profitable California market, automobile manufacturers will eventually adapt. However, agencies will still have to be persuaded that their current software needs modification.

- Create incentives (carrots) for agencies to comply – MTC, for instance, subsidizes the software cost so that all local agencies can afford to implement or maintain at a minimal cost to them. OCTA has also made available funds to assist agencies in transitions costs.
- Create disincentives (the stick) – OCTA, for example, requires all agencies to have a PMS. Also, OCTA imposes certain requirements, e.g., consistent distress types, before the agency is eligible for Measure M funds. MTC requires the agency to be certified before it is eligible for federal funds. Both approaches have been successful.
- Fund the cost of software modifications to the two primary PMS programs i.e. MicroPAVER and StreetSaver so that agencies do not have to bear the costs. This would allow compliance with any future updates to be relatively painless.
- Combinations of all the above.

As a minimum, the software should have distresses collected using either the MicroPAVER or StreetSaver protocols. Since this is the baseline for future needs assessment, this should be the standard.

i. Safety, Traffic and Regulatory Components

The main challenge we encountered in this area was that not many agencies were able to provide the data requested. This is partly because many agencies do not maintain good inventories, electronic or otherwise, and partly due to lack of staff time to gather this information. However, it is a huge component of the needs assessment for the state's infrastructure (an estimated 32% of the total needs), and therefore cannot be ignored.

We recommend that future surveys continue to ask for this information as we believe that the data quality will continue to improve over time, and that the regression equations be modified as necessary to accommodate any changes in the data. However, in order to facilitate this process, we recommend that future surveys be more streamlined and include more instructions on what data to include. Again, it is important that the entity responsible for future updates have the ability and technical expertise to perform these analyses and develop new models if required.

In the case of NPDES and ADA requirements, it was clear that agencies are, largely not tracking these costs separately. Therefore, to be able to quantify these costs, we recommend a case study approach. A range of agencies (large, medium and small) should be selected and interviewed to examine their costs in complying with both NPDES permits and ADA requirements.

j. Funding & Expenditures

As was expected, the data received on funding and expenditures was mixed. In some cases, expenditures exceeded the available funds. This could be due to the lack of understanding of the funding process by the person filling out the survey (in some cases, we had engineering technicians filling out the surveys). Therefore, for this study, expenditure data were used to indicate the funding available.

We recommend that additional guidance or examples be provided to assist future updates. The survey will need to emphasize the importance of accurate data, and the implication if it is not. One possibility is to address this portion of the survey to the finance division for their feedback.

2. How can we best collect the data at regular intervals?

The time required to gather data was about 5-6 months, with data trickling in as late as three months after our deadlines had elapsed. The high percentage of responses received were a result of a huge effort by CSAC, the League and member groups represented in the Oversight Committee. Literally thousands of letters and emails were sent out to City Mangers and County Administrative Officers all the way down to the Public Works Departments and the engineers or planners responsible for the data requested.

This level of effort is expensive and time consuming. And yet, there is no current requirement for agencies to provide this information outside of their goodwill. There needs to be some incentive or disincentives where Cities and Counties are required to provide this information.

Currently, there are only two RTPAs in California that have a formal process in place to collect this information biennially. **OCTA** in Orange County employs a “stick” approach; it requires that all its member jurisdictions update their arterial and major collectors every 2 years in order to be eligible for Measure M (local sales tax) funds. A report indicating that this update has been performed is submitted biennially. Further, projects that are submitted for competitive funding must have information on the pavement condition. The pavement condition index reported meets guidelines established by OCTA in the late 1990s.

In the San Francisco Bay area, **MTC** has a similar requirement. The “stick” ties eligibility for federal funds with compliance to maintaining a PMS. Agencies are required to update the condition ratings for arterials and collectors every two years, and residential streets every five years. MTC’s website also lists their expiration of individual agency certifications, so that all are aware of when they need to perform their updates.

However, a “carrot” approach is also included – as preciously mentioned, approximately $1 million a year is available to assist Cities and Counties with updating their condition ratings through a competitive grant process. This is to assist primarily small agencies who do not have the staff or financial resources to update their pavement networks. In the 10 years that this grant program has been in place, the agencies who actively use and maintain a PMS went from approximately 35-40% to 100%.

Finally, MTC publishes the pavement conditions of all the agencies annually – this is often picked up by the local media and becomes front page news of local papers. It can generate a lot of local interest from elected officials, and has contributed to institutionalizing the concept of pavement conditions and maintaining pavements in both the public and elected officials’ mindsets.

Other regions (Mendocino, El Dorado, Butte, Lake etc) have a more ad hoc approach – typically, they assist their member agencies in implementing or updating their PMS by obtaining the funding and then administering the project Countywide. This may occur once, or at irregular intervals. There is no formal process to require agencies to submit data on a consistent and regular basis, nor are they required to do so.

In future updates, there are two categories of agencies that need to be addressed:

- Agencies with data need to be encouraged to submit it.
- Agencies without data need to be encouraged to collect and submit it. If financial or staff resources are an issue, then a grant program will assist them.

Funding is the most compelling reason for compliance - if an agency sees their eligibility for funding tied to maintaining their PMS and submitting this information, they will usually find the resources to do so. The caveat is that the requirements for this funding cannot be too onerous e.g. many small Cities forego federal funds because of the lack of staffing to comply with the regulatory requirements.

Therefore, it is recommended that any future funding sources generated as a result of this study be tied to some requirement to maintain a PMS, and to submit this data to an entity on a regular basis. The pavement data should be from a pavement management system.

3. Who will do the work? What umbrella entity is needed, and what is the institutional framework in which they will function? What mechanisms or policies are needed to be in place in order for this entity to function and perform the analyses?

As this study wraps up, one of the most difficult challenges facing the Oversight Committee is "***Who will perform the updates in the future?***" This study has resulted in valuable information to assist Cities and Counties in developing policies regarding future sources of funding. But as was pointed out earlier, consistent updates are needed to accommodate changes in the future, and also to maintain the momentum in the on-going discussion on transportation funding. This study is only the first step in a continual process to update and maintain the discussion on the funding needs for the local streets and roads infrastructure.

Getting the study off the ground required significant effort from member Cities and Counties, as well as funding. The County of Los Angeles stepped forward and volunteered to both provide a significant portion of the funding, as well as the project management in order to get this project started.

For future updates to be successful and to be institutionalized, much as RTPs and the SHOPP are, an entity has to be identified that will include this effort as part of their responsibilities. Unfortunately, there is no one umbrella organization that represents all the Cities and Counties. The state highway system has one agency, Caltrans, that is responsible for maintenance, but the state's local streets and roads network have (now) 538 Cities and Counties, with 538 different governing Councils/Boards and departments of transportation or public works overseeing the maintenance.

In our evaluation of what is needed in order to develop the institutional framework for future updates, we focused on several key criteria for a responsible entity which are discussed below.

a. Statewide Perspective & Credibility

Since this is a statewide study, the entity must have a statewide perspective, and not get bogged down with their local or regional needs. The strategy that makes most sense from a statewide perspective may not necessarily be advantageous at the local or regional level. An impartial and wider viewpoint is absolutely essential.

Related to this is the entity's standing statewide. It must have the credibility to have its results accepted by the Legislature, the California Transportation Commission and Caltrans.

Although CSAC, CEAC and the League are well known in Sacramento, the agency that undertakes the technical study must be able to complement their efforts.

b. Technical Skills

Generally, the staff required to perform this study will require formal training in civil engineering, asset or pavement management systems, statistics, operation research techniques, databases and good analytical and communication skills. Since pavement engineering and technology is a specialized field, very few civil engineering programs include courses in this area. Most of the experienced staff we have encountered have usually developed their expertise or experience in pavements from on-the-job training or more formal educational workshops.

This combination of technical skills is usually found only in state highway agencies or other large agencies, whether local or regional. The technical skills are essential to understanding and performing the analyses required.

c. Pavement Management Software Expertise

Although knowledge of pavement management software is part of the technical skills required, it is important enough to warrant additional discussion. The analyses used in this study require an in-depth knowledge of issues such as prediction models, decision trees and prioritization or optimization techniques. The analytical routines are heavily dependent on computers, databases and PMS software. It is therefore incumbent that the entity performing the update have the specialized knowledge to be able to understand the software and algorithms used, and perhaps more importantly, to understand the limitations of the PMS software or methodology.

A plus would be an entity with the capability to undertake software development. Future updates may require, say, new prediction models, or different pavement distresses, so the ability to accommodate this in the PMS software would be extremely helpful. Few agencies will have in-house software programmers on staff, so the ability to contract this service out will be needed.

An implicit assumption is that there needs to be a fundamental understanding of pavement engineering and design principles e.g. what a slurry seal is and what the appropriate applications are, and when it may be more appropriate for an overlay.

d. Familiarity With User Community

Since the user community is comprised of Cities and Counties, it is important that the entity be familiar with the organizational structure and constraints on local agencies, particularly the staff and financial limitations. Well established lines of communication with Cities and Counties are essential, as data collection is a critical component of this type of study.

Given that small agencies (i.e. less than 100 centerline miles) comprise 51% of the Cities and Counties in California, a special sensitivity to their constraints is needed. Many of these agencies have only one full time Director of Public Works and a part time engineer on staff to take care of the entire City's infrastructure needs. Demanding data that is outside of their capabilities to provide would be counterproductive.

e. Advisory Group/Stakeholders

An advisory group is required to provide strategic guidance and technical advice. Most, if not all, RTPAs or MPOs will have a Technical Advisory Committee (TAC) that can function as the advisory group. In the case of MTC, they have a Local Streets and Roads Working Group (LSRWG) that meets monthly to discuss regional needs and have a similar function. Alternatively, it is common to set up a Technical Steering Committee that meets only to discuss a specific study or project.

The responsibility of the advisory group should include:

- Ensuring that the overall goals are met and that they are consistent with the overall program
- Setting priorities
- Developing communication strategies to maximize awareness of the study, to facilitate data collection and to disseminate the results
- Monitoring progress on study

The members should include representatives from both the Cities and Counties' departments of public works or equivalent, as well as from the RTPAs. All regions of the state should be represented i.e. north, south, rural, urban, cities, counties etc. The Oversight Committee should be represented in this group as well.

f. Contractual Framework

The entity may need to enter into a Memorandum of Understanding (MOU) with CSAC, CEAC and/or the League. This will be a joint responsibility for all agencies.

Further, should specialized skills be needed e.g. software development or media strategies, a contract and procurement process is required to obtain these skills. This includes developing a competitive process such as a Request for Proposals (RFP) for selecting a consultant or vendor.

g. Stable Funding Source

A stable source of funding will be required to perform future updates. Currently, funding for this study came from contributions from member Cities and Counties. However, future updates will require a more stable source of funding. Current regional efforts at similar studies come from a variety of sources – some are funded by federal funds (STP), some are local. Many are handicapped by the lack of a funding source for what is, essentially, a planning study.

h. Experience

Finally, a logical question to ask is who or what organization has performed similar studies. Regional agencies, such as the Regional Transportation Planning Agencies (RTPA) or Metropolitan Planning Organizations (MPOs) are the only candidates since they encompass multiple Cities and Counties. Examples of these agencies include:

- Mendocino County Council of Governments (MCOG) was the lead agency to implement and update a pavement management system for the Cities and County.

There results were aggregated for the RTP and information used to generate support for a local sales tax measure in the mid 2000s.

- Lake County/City Area Planning Council (LC/APC) was the lead agency to implement and update a pavement management system for the Cities and County, similar to that for MCOG.

- Stanislaus County Council of Governments (StanCOG) undertook a similar study for all the Cities and the County in Stanislaus County as far back as 2001. However, sales tax measures were not successful.

- Orange County Transportation Authority (OCTA) has required that all Cities and the County use a pavement management system in order to be eligible for Measure M funds (a local sales tax measure). In 2005-06, the results were aggregated in a study similar to this one to assist in determining if Measure M should be renewed.

- Metropolitan Transportation Authority (MTA) performed a condition and needs assessment study for all Cities and the County in Los Angeles in 2005.

- Metropolitan Transportation Commission (MTC) in the San Francisco Bay area has performed these regional needs assessment for its Cities and Counties since the 1990s. It is also the only agency that has included the safety, traffic and regulatory components in their needs assessment.

- The County of Los Angeles, while not a regional agency, is currently the Project Manager for this study in consultation with the Oversight Committee.

Of the examples above, almost all are regional agencies – all but MTC have contracted with consultants to assist in performing the studies. This is because most do not have engineers with the technical background on staff to perform the work.

Summary and Recommendations

The use of a PMS in 86% of the state's local streets and roads network greatly added to the data quality in this study. Even more importantly, we discovered that there was a lot of consistency in distress surveys and condition ratings overall. Therefore, our recommendations include:

1. To comply with Section 2108.1, an overall goal should be to have all agencies implement and maintain a PMS with the following minimum requirements:
    - Pavement distresses to be collected for asphalt pavements should include fatigue (alligator) cracking, block cracking, longitudinal and transverse cracking, rutting, patching, shoving/distortions, weathering and raveling. For Portland cement concrete pavements, this should include corner breaks, divided/shattered slabs, faulting, linear cracking, scaling/map cracking/crazing and spalling.
    - Deduct values used should be the same as those used in StreetSaver or MicroPAVER.
    - A condition rating scale from 0-100 should be used.
    - The ability to program maintenance treatments based on pavement condition thresholds or triggers, including pavement preservation treatments should be included.
    - The ability to include user modified unit costs for maintenance treatments.
    - The ability to modify or incorporate new or regional prediction models in the

future should be included.

Currently, both the MicroPAVER and StreetSaver programs have the ability to perform the requirements above. The primary distinction between these two programs is the ability to perform multi-year prioritization based on a cost-benefit analysis approach. This is a key requirement for long-term needs assessment as multiple treatments need to be considered within the analysis period.

2. Although the overall goal is to have all agencies implement and maintain a PMS, the initial focus (on implementing a PMS and collecting data) should be on agencies with more than 100 centerline miles.

3. To encourage the implementation and use of a PMS, we recommend :

    a. Future funding requirements to be tied to the use of a PMS
    b. Funding assistance provided at the regional level to encourage the implementation and continual update of a PMS
    c. Using the "bully" pulpit of the League and CSAC to promulgate the benefits of a PMS

4. Use the StreetSaver software and methodology developed in this study to calculate future needs assessments.

We have also identified various technical issues that need to be addressed in future updates. They include:

5. If an online survey is to be used for future updates, then the following modifications should be made:
    a. Develop a custom database for the online survey instead of using a commercial survey.
    b. Populate future surveys with known information to facilitate the data collection process.
    c. Include maintenance thresholds.
    d. Distinguish between urban and rural streets/roads.
    e. Include maintenance costs.

6. Continue to collect safety, traffic and regulatory data.

7. Adopt a case study approach for NPDES and ADA categories.

8. Include finance departments/divisions in data collection.

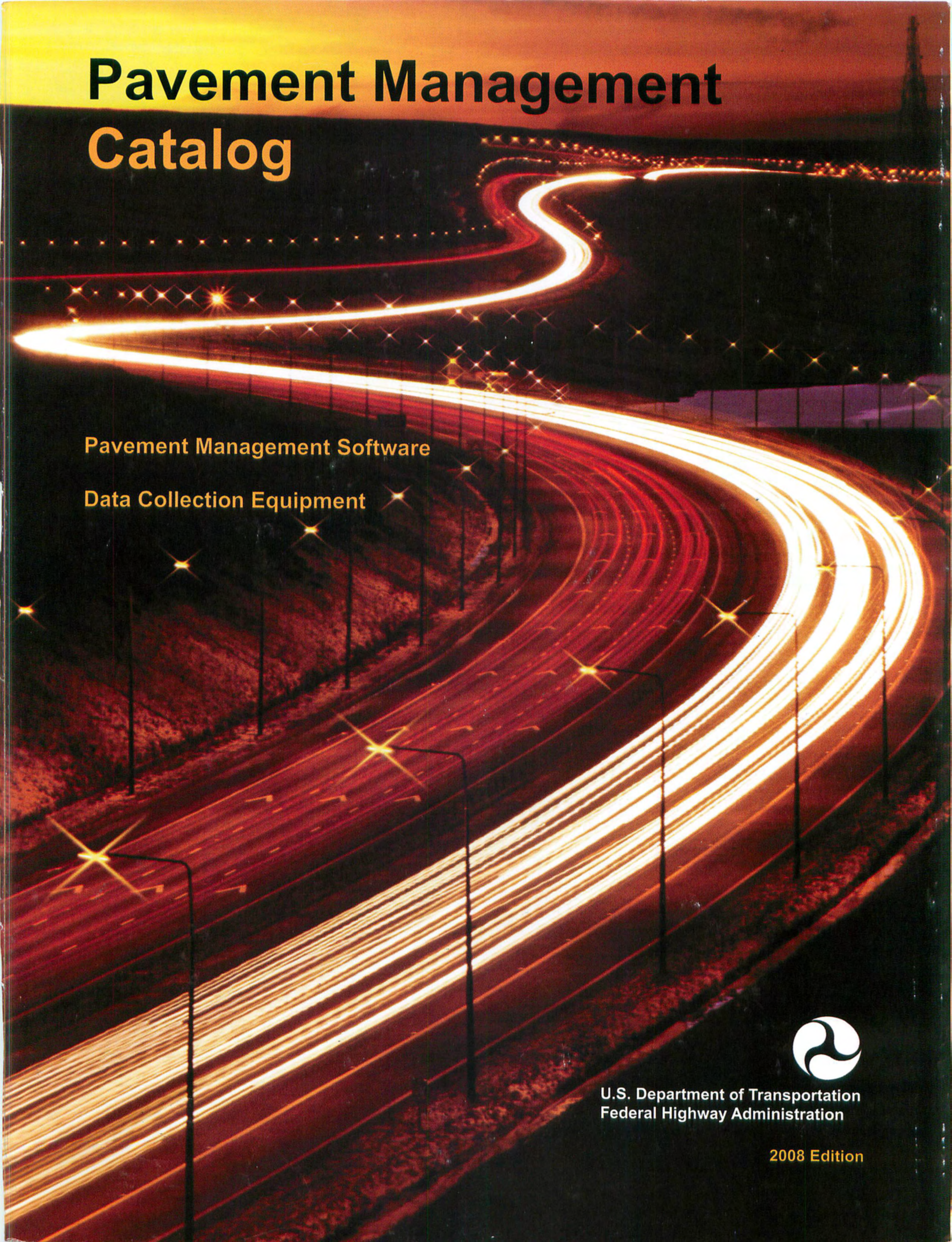
We also identified several key criteria that are needed in establishing the institutional framework for future updates. This is a key policy decision, and our objective was to ensure that the entity responsible must posses:

- Statewide perspective & credibility
- Technical skills
- Pavement management software expertise
- Familiarity with user community
- Advisory group/stakeholders
- Contractual framework
- Stable funding source for future updates
- Experience

Attachment F-1

Excerpt from "Pavement Management Catalog" Published by the FHWA, 2008 Edition

Pavement Management Catalog



Pavement Management Software

Data Collection Equipment

U.S. Department of Transportation
Federal Highway Administration

2008 Edition

Pavement Management Catalog

Pavement
Management Software

Data
Collection Equipment

U.S. Department of Transportation
Federal Highway Administration

2008 EDITION

Technical Report Documentation

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9. Performing Organization Name and Address Soil and Materials Engineers, Inc. 43980 Plymouth Oaks Blvd. Plymouth, MI 48170		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFH61-04-D-00010
12. Sponsoring Agency Name and Address Federal Highway Administration Office of Asset Management 1200 New Jersey Avenue S.E. Washington, DC 20590		13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

Mr. Thomas Van of the Federal Highway Administration served as the program manager for this project. Mr. Mark Swanlund of the Federal Highway Administration served as Contracting Officers Technical Representative.

16. Abstract

This document is a new edition of the Pavement Management Catalog that was last published in 2002, and contains a pavement management software catalog and a data collection equipment catalog.

The pavement management software catalog provides information about twelve software developed by private companies and four software developed by public agencies. Each software was evaluated based on a pre-determined list of criteria.

The data collection equipment catalog presents information about various equipment that collect pavement data to support pavement management systems. Details about ground penetrating radar equipment, falling weight and rolling wheel deflectometers, road profilers, skid testers, and multifunction data collection systems that are equipped with a variety of systems to collect various data (e.g., photographs of the pavement surface to evaluate pavement distress, a profiling system to evaluate pavement roughness, a rut depth measuring system, etc.) are presented together with information about manufacturers of such equipment.

This catalog is intended as a sourcebook of information to assist officials in selecting systems to meet the needs of their communities.

17. Key Words		18. Distribution Statement	
Pavements, Pavement Management Systems, Pavement Management, Pavement Management Software, Pavement Data Collection, Ground Penetrating Radar, Road Profiler, Falling Weight Deflectometer, Skid Testing		No restrictions.	
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 179	22. Price

ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
AALRS	Agile Assets Linear Referencing System
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ADA	Automated Distress Analyzer
ADT	Average Daily Traffic
ARAN	Automated Road Analyzer
ASCII	American Standard Code for Information Interchange
ASTM	American Society for Testing and Materials
CBR	California Bearing Ratio
CMS	CitiTech Management Software
CSV	Comma Separated Value
DAPS	Deflection Analysis of Pavement Structure
DHDV	Digital Highway Data Vehicle
DMI	Distance Measuring Instrument
DOT	Department of Transportation
ESAL	Equivalent Single Axle Load
ERI	Engineering & Research International, Inc.
FHWA	Federal Highway Administration
FWD	Falling Weight Deflectometer
GIS	Geographic Information System
GPMS	Geographic Pavement Management System
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GSSI	Geophysical Survey Systems Incorporated
HWD	Heavy Weight Deflectometer
ICON	Infrastructure Consultant
IMS	International Roughness Index
IRIS	Integrated Radar Inspection System
LTAP	Local Technical Assistance Program
LTPP	Long Term Pavement Performance
LVDT	Linear Variable Differential Transformer
MDB	Microsoft Database
MHIS	Multimedia-Based Highway Information System
MPD	Mean Profile Depth
M&R	Maintenance and Rehabilitation
MUC	Maintenance Urgency Categories
MTC	Metropolitan Transportation Commission
PCC	Portland Cement Concrete

PCA	Pavement Composition Analysis
PCI	Pavement Condition Index
PCR	Pavement Condition Rating
PDDX	Pavement Deflection Data Exchange
PDI	Pavement Distress Index
PERS	Performance and Economic Rating System
PI	Profile Index
PM	Preventive Maintenance
PMS	Pavement Management System
POS LV	Position and Orientation System for Land Vehicles
PQI	Pavement Quality Index
RN	Ride Number
ROW	Right-Of-Way
RSL	Remaining Service Life
RWD	Rolling Wheel Deflectometer
SDI	Surface Distress Index
SN	Structural Number
SQL	Structured Query Language
TAMS	Transportation Asset Management System
TIGER	Topologically Integrated Geographic Encoding and Referencing System
USACE	U.S. Army Corps of Engineers
XML	Extensible Markup Language

PAVEMENT MANAGEMENT SOFTWARE CATALOG

OVERVIEW OF PAVEMENT MANAGEMENT SOFTWARE

A pavement management system (PMS) provides the engineer with the tools necessary to perform cost-effective management of a roadway network. A PMS can be used to store a variety of information related to pavement segments. This information can include inventory data, construction and maintenance data, and condition data such as distress data, pavement roughness, and skid resistance. A PMS can be used for a variety of applications such as [1]:

- Obtain an overview of the current condition of the pavement network.
- Predict future conditions of the pavement network.
- Identify candidate projects for maintenance and rehabilitation.
- Develop a prioritized list of candidate sections for rehabilitation.
- Generate budget requirements for planning purposes.
- Analyze "what-if" policy questions for various budget scenarios.
- Forecast future conditions based on various funding levels.
- Retrieve data of pavement segments for informational purposes.

Many pavement management software have the ability to store the severity and quantity of various distresses present on the pavement. These distress data can then be used to compute an index that represents the condition of the pavement. The Pavement Condition Index (PCI) procedure developed by the Construction Engineering Research Laboratory of the U.S. Army Corps of Engineers is widely used to assess the condition of a pavement surface. This procedure is described in ASTM Standard D 6433.[2] In this procedure, the quantity and severity of various distresses on the roadway are recorded by performing a field survey. The ASTM standard presents guidelines for determining the severity level of a distress and how to measure the quantity of each distress. The data recorded in the field are then used to computes the PCI for the pavement. The PCI ranges from 0 to 100, with 100 being a pavement with no distress and 0 being a pavement in a failed condition.

FORMAT FOR PRESENTING THE RESULTS OF THE EVALUATION

Information about sixteen pavement management software is presented in this catalog. In order to develop the catalog, pavement management software providers were identified from the 2002 pavement management catalog, internet searches, and the authors' knowledge of software vendors. Twenty-one private companies and four agencies were identified as providers of pavement management software. These companies/agencies were contacted and requested to provide a copy of their software for evaluation. If a company/agency indicated they had difficulties in sending a copy of the software for evaluation, they were requested to fill out a questionnaire about their software. A total of eleven companies and four agencies indicated they wanted to be included in the catalog. One company (Stantec) provided information about two of their software. All of the participants except two provided a copy of their software for evaluation; the companies that did not provide software for evaluation (Agile Assets and Stantec) filled out a questionnaire.

Each pavement management software was evaluated according to the criteria presented later in this section. The results of the evaluation are presented separately for each software. The software has been divided into two categories, private company software and public agency software. Under each category, the software programs are listed in the alphabetical order of the company or agency name.

When presenting the results of the evaluations, the following information is presented for each software on the first page: name of the software, company (or agency) name, address, phone number, website, contact name, the e-mail of the contact, an overview of the software, and three users of the software. The next pages contain the results of the evaluation based on the following criteria: Inventory and Historical Information, Pavement Condition Data, Storing and Managing Data, Identifying Sections Needing Repair, Cost/Prioritization, Impact Analysis and What-if Budget Scenarios, Unpaved Roads, and Training/Support. The following format is used to present the results of the evaluation.

Overview of the Software

A brief summary of the capabilities of the software is presented.

A remark is made to indicate if the software is a stand-alone program or if it is a part of an asset management program. If other modules can be incorporated with the pavement management module, a brief description of those modules is presented.

A remark is made to indicate if the software can handle data in metric units.

A brief description of the Geographic Information System (GIS) capabilities of the software is presented.

A statement is made regarding the availability of a user manual and help functions in the software.

The version of the software that was evaluated is indicated.

User Contacts

Name, agency, address, and phone number of three users of the software that were provided by the vendor is presented in this section.

Inventory and Historical Information

This section indicates if the software can store the following information.

Item	Description
Length/Width/Area	Length, width, and area of the pavement section.
Surface Type	Surface type of the road (e.g., asphalt concrete, portland cement concrete, surface treatment).
Functional Class	Functional class of the road.
Number of Lanes	Number of lanes in the road.
Current ADT	Current average daily traffic (ADT) of the road.
Construction History	Date and type of construction (e.g., original construction, reconstruction, overlay).
Maintenance History	Date and type of maintenance (e.g., chip seal, microsurfacing, patching, crack sealing, joint sealing).
Historical Costs	Historical construction/maintenance cost for each section.
Layer Types and Thickness	Layer types and thickness of the pavement.
Programmed Work	Future plans for maintenance or rehabilitation.
Traffic History	Historical traffic information.
Projected Traffic.	Future traffic of the section either inputted by the user or predicted by the program based on current traffic and a traffic growth factor.
Images	Photographs of the section.

A "Yes" answer for any of the parameters indicated in the table above means there is a specific field in the software for that parameter. Some software programs have "User-Defined Fields" where a user can define an item to be stored. In such software, if a field is not available to store a parameter shown in the table above, the user may be able to use a "User-Defined Field" to store that item. The section "Additional Information" indicates if the software has "User-Defined Fields."

Pavement Condition Data

This section indicates if the software is capable of storing the following items, and if these items are used in analysis.

Item	Description
AC Distresses*	Can distresses in asphalt concrete (AC) surfaced pavements be stored?
PCC Distresses*.	Can distresses in portland cement concrete (PCC) surfaced pavements be stored?
Condition Index**	Is an index for pavement condition computed from distress data?
User-defined Index**	Can a user define a pavement condition index to be computed from the recorded distresses (e.g., select specific distresses to be included in the index, change deduct values)?
Subjective Rating**	Can a subjective rating for the pavement condition be recorded?
Roughness**	Can the roughness of the pavement section be recorded?
Skid Resistance**	Can the skid resistance of the pavement section be recorded?
FWD Data/Structural Capacity**	Can Falling Weight Deflectometer (FWD) data or structural capacity of the pavement section be recorded? The comment field indicates the type of information recorded.

* A "Y" under "Used in Analysis" indicates a condition index computed using the distresses is used in analysis.
** A "Y" under "Used in Analysis" indicates this value is used in analysis.

Note: In the evaluations, "Y" indicates Yes and "N" indicates No, and "N/A" indicates Not Applicable. A "Yes" answer for Subjective Rating, Roughness, Skid Resistance, and FWD Data/Structural Capacity is shown only if there is a specified field in the software for the parameter. Some software programs have "User-Defined Fields" where a user can define an item to be stored. If the software does not have a field to store the previously described parameters, the user may be able to use a "User-Defined Field" to store that item. The section "Additional Information" indicates if the software has "User-Defined Fields."

Managing Data

This section indicates if the software has the following features.

Item	Description
Password Protection	Can the software have password protection so only authorized personnel can enter or update information?
Importing Data	Can data obtained by data collection equipment (e.g., distress data collection vehicles, hand held devices) be imported?
Inventory Reports	Can inventory reports be generated?
Condition Summary	Can summary reports indicating pavement condition be generated?
Distress Reports	Can reports that indicate the type, severity, and quantity of distress present on the pavement be generated?
Future Conditions	Can future pavement conditions be predicted for each section?
Prediction Modeling	Can the existing pavement condition data be used to develop models to predict future pavement conditions for user-defined pavement groups?

Identifying Sections Needing Repair and Specifying Treatment

This section indicates if the software has the following features.

Item	Description
Sections Needing M&R	Can a list of sections needing Maintenance/Rehabilitation (M&R) be generated?
Trigger Parameters: Single Multiple	 Can a single trigger parameter be used to identify sections for M&R (e.g., pavement condition only), and if so which trigger parameter is used? Can multiple trigger parameters be used to identify sections for M&R (e.g., pavement condition and functional class), if so what are the parameters?
Recommend Treatment	Does the software recommend a treatment type (e.g., chip seal, slurry seal, overlay) for pavement sections?
Treatment Type: Interval Distress	 Is preventive maintenance treatment based on years between treatments? Is treatment type based on type/quantity of distress?
Maintenance/Rehab Policy	Can a user assign a maintenance/rehabilitation policy based on pavement condition?

Cost/Prioritization

This section indicates if the software has the following features.

Item	Description
Budget Reports	Can budget reports for maintenance/rehabilitation be generated?
Cost Per Year	Can the total cost per year for M&R be obtained?
Prioritized Candidate Sections	Does the software give a list of prioritized candidate sections for rehabilitation/maintenance?
Multi-Year Prioritization	Can a multi-year prioritization list of candidate sections for rehabilitation/maintenance be developed?
Prioritization – Pavement Condition	Can a prioritization list based on pavement condition be generated?
Prioritization – First Cost	Can a prioritization list based on cost of repair be generated?
Prioritization – Distress	Can a prioritization list based on user-defined (or in-built) distress type and quantity be generated?
Prioritization – Functional Class	Can the functional class be used as a parameter for prioritization?
Prioritization – Composite Criterion	Can prioritization be based on a composite criterion (e.g., pavement condition and functional class)?
Prioritization – Life Cycle Cost	Can the program use life cycle cost for prioritization?
Force Repair to a Specific Year	Can the user force a section to be repaired in a specific year?

Note: A "Yes" answer is indicated for the questions dealing with prioritization only if the software is able to do that function internally. In many software, the output can be exported to an Excel file, and then manipulated, to suit a user's prioritization criterion. A "No" answer is indicated if the prioritization is not done internally by the software.

Impact Analysis and What-if Budget Scenarios

This section indicates if the software has the following features.

Item	Description
Overall Condition.	Can the impact of budget level on overall condition be computed?
Condition by Category	Can the impact of budget levels on condition by category be shown (e.g., show percent of pavement area in excellent, good, fair, and failed condition)?
Backlog of Needs	Can the impact of budget level on backlog of needs be shown?
Remaining Life	Can the impact of budget level on remaining life of the pavements be shown?
Projected Condition w/wo Repair	Can the projected condition with and without repair be shown?

Unpaved Roads

This section indicates the ability of the software to handle the items indicated in the following table for unpaved roads.

Item	Description
Condition	Can distress be recorded, or a subjective rating given for the pavement condition?
Prediction	Can future pavement conditions be predicted?
Repair Cost	Can repair costs be computed?

Additional Information

Additional information about the software that was not covered previously is listed in this section. A comment is made regarding the availability of user-defined fields in the software.

Training and Support

This section indicates the type of training and support provided by the vendor.

Item	Description
Training Classes	Are there regularly scheduled training classes?
Support	What type of customer support does the vendor provide?

Note: In the evaluations, "Y" indicates Yes and "N" indicates No.

StreetSaver™Metropolitan Transportation Commission (MTC)
101 Eighth St, Oakland, CA 94607
Phone: (510) 817-5700
www.mtcpms.org
Contact Person: Sui Tan
Contact e-mail: stan@mtc.ca.gov

OVERVIEW OF THE SOFTWARE

StreetSaver™, with more than 350 users nationwide, is designed specifically to help local cities and counties better allocate resources, predict the future condition of their pavements at different levels of funding, and demonstrate the impacts of under funded road programs. StreetSaver™ is developed with pavement preservation principles. Cities and counties can plan and manage road improvement projects, document budget needs and shortfalls, and use the collected data to build support for additional transportation funding. Streetsaver™ utilizes seven distress types for AC and surface treated pavements as well as PCC pavements. A distress identification manual published by the MTC is available. Streetsaver™ can be utilized to generate GASB 34 reports for road assets utilizing the depreciation method. The event-based calculation method allows users to view the impact of different events, such as maintenance and rehabilitation treatments, on a road segment.

The program is a stand-alone pavement management program.

The software can handle data in U.S. customary or metric units.

Various consulting firms familiar with Streetsaver™ currently provide GIS/PMS related linkage products.

A user manual is provided. A help menu is available in the software.

Version 8 of the program was evaluated.

USER CONTACTS

Joel Condor Marion County PWD 5155 Silverton Rd NE Salem, OR 97305 Phone: (503) 373-4334	Vijay Sinha City of Stockton PWD 1465 South Lincoln St Stockton, CA 95206 Phone: (209) 937-7004	Tawfic Halaby City of Oakland PWD 250 Frank Ogawa Plaza, Suite 4314 Oakland, CA 94612 Phone: (510) 238-2293

INVENTORY AND HISTORICAL INFORMATION

Item	Store?	Comment
Length/Width/Area	Y	
Surface Type	Y	
Functional Class.	Y	
Number of Lanes	Y	
Current ADT	Y	
Construction History	Y	
Maintenance History	Y	
Historical Costs..	Y	
Layer Types and Thickness	N	
Programmed Work	Y	Plan M&R work up to 30 years.
Traffic History	Y	Traffic Index and ADT can be recorded.
Projected Traffic	N	
Images	Y	MPEG files can also be attached.

PAVEMENT CONDITION DATA

Item	Store?	Used in Analysis?	Comment
AC Distresses	Y	Y	7 distress types for AC as well as PCC. Severity and extent of distress in sample units recorded.
PCC Distresses	Y	Y	
Condition Index	Y	Y	Modified PCI (Corps of Engineers).
User-defined Index	N	N/A	
Subjective Rating	N	N/A	Can be added as user-defined fields.
Roughness	N	N/A	
Skid Resistance	N	N/A	
FWD Data/Structural Capacity	N	N/A	

MANAGING DATA

Item	Y/N?	Comment
Password Protection	Y	Allows multiple users with different securities.
Importing Data	Y	
Inventory Reports	Y	Standard and customized reports
Condition Summary	Y	
Distress Reports .	Y	
Future Conditions	Y	Default family curves are provided. Curves can be adjusted by observed conditions in the field.
Prediction Modeling	Y	

IDENTIFYING SECTIONS NEEDING REPAIR AND SPECIFYING TREATMENT

Item	Y/N?	Comment
Sections Needing M & R	Y	
Trigger Parameters:		PCI and condition category, surface type, functional class.
Single	Y	
Multiple	Y	
Recommend Treatment	Y	
Treatment Type:		
Interval	Y	
Distress	N	
Maintenance/Rehab Policy	Y	Based on user-defined PCI ranges.

COST/PRIORITIZATION

Item	Y/N?	Comment
Budget Reports	Y	Various standard and customized reports.
Cost Per Year	Y	
Prioritized Candidate Sections	Y	A portion of budget can be earmarked for Preventive maintenance (PM) and those funds used to select PM projects.
Multi-Year Prioritization	Y	Up to 30 years.
Prioritization – Pavement Condition	N	
Prioritization – First Cost	N	
Prioritization – Distress	N	
Prioritization – Functional Class.	N	
Prioritization – Composite Criterion	Y	First cost, pavement conditions, cost-effectiveness.
Prioritization – Life Cycle Cost	Y	
Force Repair to a Specific Year	Y	Also can delay section(s) for treatment.

IMPACT ANALYSIS AND WHAT-IF BUDGET SCENARIOS

Item	Y/N?	Comment
Overall Condition	Y	
Condition by Category	Y	
Backlog of Needs	Y	
Remaining Life	Y	
Projected Condition w/wo Repair	Y	

UNPAVED ROADS

Item	Y/N?	Comment
Condition	N	
Prediction	N	
Repair Cost	N	

ADDITIONAL INFORMATION

Five user-defined fields are available. Funding source and shoulder width for a section can be stored. Supplemental information about a section can be attached in the following file formats: PDF, Rich Text, Word, Excel, etc. Reports and results of analysis can be exported to various formats (e.g., Excel, PDF, text). The software has capabilities to generate a variety of graphs.

TRAINING AND SUPPORT

Item	Y/N?	Comment
Training Classes.	Y	Training classes 3 times a year during user meetings. Technology transfer seminars, and various workshops on specific features associated with Streetsaver™ such as distress identification, budget analysis, report generation, etc.
Support	Y	Phone support and virtual on-site support.

Micro PAVER

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Phone: (970) 377-9474
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Distribution: American Public Works Association
2345 Grand Blvd, Suite 500, Kansas City, MO 64108
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OVERVIEW OF THE SOFTWARE

The Micro PAVER Pavement Maintenance Management System was developed by the Construction Engineering Research Laboratory of the U.S. Army Corps of Engineers. It is distributed to non-Department of Defense users by the University of Illinois Technical Assistance Center and the American Public Works Association.

Micro PAVER uses distress data to compute the pavement condition index (PCI) that ranges from zero (failed) to 100 (excellent). Micro PAVER provides pavement management capabilities to: (1) develop and organize the pavement inventory, (2) assess the current condition of pavements; (3) develop models to predict future conditions, (4) report on past and future pavement performance, and (5) develop scenarios for M&R based on budget or condition requirements. The distress data and PCI values are used for predicting the M&R needs of a pavement network for future years.

Micro PAVER is a stand-alone pavement management program.

The software can handle data in U.S. customary or metric units.

GIS capabilities are integrated into the software. The GIS assignment tool links the Paver data for individual segments to GIS data. Once links are established, GIS Selector can be used to select sections from maps. The GIS feature can be used to point and click on a roadway segment and obtain information about that section. Information such as the latest PCI value and impact of various budget scenarios can be viewed on maps using GIS Reports feature.

A user manual is available. The user can open the manual through the help feature in the software as a PDF document. Version 5.3 of the software was evaluated.

USER CONTACTS

Justin Rabidoux City of Burlington 32 Kilburn St Burlington, VT 05402 Phone: (802) 863-9094	Greg Belancio Washoe County P.O. Box 11130 Reno, NV 89520 Phone: (702) 328-2052	Starr Kohn Soil and Materials Engineers 43980 Plymouth Oaks Blvd Plymouth, MI 48170 Phone: (734) 454-9900

INVENTORY AND HISTORICAL INFORMATION

Item	Store?	Comment
Length/Width/Area	Y	
Surface Type	Y	
Functional Class.	Y	
Number of Lanes	Y	
Current ADT	Y	ESALs can also be stored.
Construction History	Y	
Maintenance History	Y	
Historical Costs..	Y	
Layer Types and Thickness	Y	
Programmed Work	Y	
Traffic History	Y	
Projected Traffic	Y	
Images	Y	

PAVEMENT CONDITION DATA

Item	Store?	Used in Analysis?	Comment
AC Distresses	Y	Y	19 distresses are available for AC and PCC roads. Severity and quantity of distress can be recorded.
PCC Distresses	Y	Y	
Condition Index	Y	Y	PCI computed from distress data.
User-defined Index	Y	Y	User can define an index using distresses.
Subjective Rating	N	N	Can be added as a user-defined condition type.
Roughness	Y	N	
Skid Resistance	N	N	Can be added as a user-defined condition type.
FWD Data/Structural Capacity	Y	N	FWD deflection values and load transfer values for PCC pavements can be stored.

MANAGING DATA

Item	Y/N?	Comment
Password Protection	Y	
Importing Data	Y	The data must be in a specified format. A hand-held data collector can be used to record data and these data can be uploaded to the database.
Inventory Reports	Y	Standard reports can be generated. User-defined reports can be created.
Condition Summary	Y	
Distress Reports.	Y	
Future Conditions	Y	
Prediction Modeling	Y	

IDENTIFYING SECTIONS NEEDING REPAIR AND SPECIFYING TREATMENT

Item	Y/N?	Comment
Sections Needing M & R	Y	
Trigger Parameters:		
Single	Y	
Multiple	Y	
Recommend Treatment	Y	
Treatment Type:		
Interval	Y	
Distress	Y	
Maintenance/Rehab Policy	Y	

COST/PRIORITIZATION

Item	Y/N?	Comment
Budget Reports	Y	
Cost Per Year	Y	
Prioritized Candidate Sections	Y	
Multi-Year Prioritization	Y	
Prioritization – Pavement Condition	Y	Sections above a critical PCI that have load-related distress are given highest priority.
Prioritization – First Cost	N	
Prioritization – Distress	Y	
Prioritization – Functional Class.	Y	
Prioritization – Composite Criterion	Y	
Prioritization – Life Cycle Cost	N	
Force Repair to a Specific Year	N	

IMPACT ANALYSIS AND WHAT-IF BUDGET SCENARIOS

Item	Y/N?	Comment
Overall Condition	Y	
Condition by Category	Y	
Backlog of Needs	Y	
Remaining Life	N	
Projected Condition w/wo Repair	Y	

UNPAVED ROADS

Item	Y/N?	Comment
Condition	Y	Seven distress types recorded by severity and quantity
Prediction	Y	
Repair Cost	Y	

ADDITIONAL INFORMATION

User-defined fields can be added. A user-defined condition type can be added to rate any item (e.g., condition of shoulder, curb and gutter), and a numerical value can be entered to rate that item. There is a field to add comments for each section. The created reports can be exported into Excel. Graphs showing various inventory information and pavement conditions as well as results for various budget scenarios can be generated. Other items that can be stored are: shoulder type, street type, grade, and results of any types of tests performed on a pavement layer (e.g., surface, base) or subgrade.

TRAINING AND SUPPORT

Item	Y/N?	Comment
Training Classes.	Y	Offered through the University of Illinois at Urbana-Champaign Technical Assistance Center.
Support	Y	American Public Works Association offers a four-part web-based training course. Phone and e-mail support is available.

CartêGraph PAVEMENTview/PAVEMENTview Plus

CartêGraph Systems, Inc.
3600 Digital Dr, Dubuque, IA 52003
Phone: (800) 688-2656
www.cartegraph.com
Contact Person: Keri Samson
Contact e-mail: kerisamson@cartegraph.com

OVERVIEW OF THE SOFTWARE

PAVEMENT*view* is the basic pavement management module that helps maintain a pavement segment inventory that includes inspection and maintenance information. PAVEMENT*view* Plus is an optional module that works with the basic PAVEMENT*view* module to create budget scenarios, develop maintenance priorities on road segments, and create maintenance suggestions. For paved roads all distresses included in the Long Term Pavement Performance (LTPP) manual are provided, while for unpaved roads they are based on the U.S. Army Corps of Engineers procedures. Most of the fields and features in the software can be customized to suit a user's needs. Using the Report Builder feature of the software, user-defined indices can be created by building formulae from numeric data and the results can be printed as a report.

PAVEMENT*view* is a stand-alone program that is a part of the CartêGraph software suite. Other modules that aid in managing assets such as bridges, signs, utilities, signal lights, etc. are also available. A module for work management activities such as managing the vehicle fleet, keeping track of complaints, managing maintenance activities of infrastructure assets is also available.

The software can handle data either in U.S. customary units or metric units.

CartêGraph offers different levels of GIS integration depending on the user's needs. The CartêGraph MAPdirector can be used as a mapping tool or as an interface with ArcView or ArcGIS to view pavement segments, their condition, and the impact of budgets on the condition.

A user manual is provided. Help is available from the software's built-in help features and the website.

Version 7.0e of the software was evaluated.

USER CONTACTS

Available on request from Cartegraph.

INVENTORY AND HISTORICAL INFORMATION

Item	Store?	Comment
Length/Width/Area	Y	GPS information, roadway geometric information (e.g., grade, shoulder type, width, etc.) can be stored.
Surface Type	Y	
Functional Class.	Y	
Number of Lanes	Y	
Current ADT	Y	ESALs can be estimated from axle load spectra data.
Construction History	Y	Many other details such as reason for activity, work order number, agency involved, etc. can be stored.
Maintenance History	Y	
Historical Costs..	Y	
Layer Types and Thickness	Y	
Programmed Work	Y	
Traffic History	Y	
Projected Traffic	Y	Can be projected for a user-defined set of sections.
Images	Y	

PAVEMENT CONDITION DATA

Item	Store?	Used in Analysis?	Comment
AC Distresses	Y	Y	All distress types in the LTPP Distress Manual are available. User can customize them. Distress severity and quantity are stored.
PCC Distresses	Y	Y	
Condition Index	Y	Y	PCI is computed.
User-defined Index	Y	Y	Distresses to be included in computing PCI as well as deduct values can be customized. An overall condition index that is defined by the user is calculated using PCI, ride, friction, etc.
Subjective Rating	Y	Y	
Roughness	Y	Y	
Skid Resistance	Y	Y	
FWD Data/Structural Capacity	Y	N	Field for entering strength of layer (e.g. modulus or SN).

MANAGING DATA

Item	Y/N?	Comment
Password Protection	Y	
Importing Data	Y	The user can customize the file format needed for import.
Inventory Reports	Y	Reports can be customized.
Condition Summary	Y	
Distress Reports .	Y	
Future Conditions	Y	
Prediction Modeling	Y	A family of pavements for prediction can be defined by the user.

IDENTIFYING SECTIONS NEEDING REPAIR AND SPECIFYING TREATMENT

Item	Y/N?	Comment
Sections Needing M & R	Y	
Trigger Parameters: Single Multiple	 Y Y	An user-defined decision matrix can be created to include one or many factors.
Recommend Treatment	Y	All maintenance or rehabilitation decisions can be customized. The user can setup M&R protocol to disallow specific activities if a related type of activity has already been recommended.
Treatment Type: Interval Distress	 Y Y	
Maintenance/Rehab Policy	Y	

COST/PRIORITIZATION

Item	Y/N?	Comment
Budget Reports	Y	GASB 34 compatible financial summaries can be generated.
Cost Per Year	Y	
Prioritized Candidate Sections	Y	Priority method can be customized to include one or many of these factors and other factors such as speed limit, usage of the road, etc.
Multi-Year Prioritization	Y	
Prioritization – Pavement Condition	Y	
Prioritization – First Cost	Y	
Prioritization – Distress	Y	
Prioritization – Functional Class.	Y	
Prioritization – Composite Criterion	Y	
Prioritization – Life Cycle Cost	Y	
Force Repair to a Specific Year	Y	

IMPACT ANALYSIS AND WHAT-IF BUDGETING SCENARIOS

Item	Y/N?	Comment
Overall Condition	Y	Can also be viewed on a map.
Condition by Category	Y	
Backlog of Needs	Y	
Remaining Life	Y	
Projected Condition w/wo Repair	Y	Many user-defined scenarios can be tested.

UNPAVED ROADS

Item	Y/N?	Comment
Condition	Y	Uses U.S. Army Corps of Engineers rating methods by default.
Prediction	Y	
Repair Cost	Y	

ADDITIONAL INFORMATION

Many fields are available to input a variety of data such as: speed limit, right-of-way width, presence of sidewalks and bike paths, jurisdiction, service level, detour length, detour route, median type, median width, storm drain information, etc. Any kind of associated file (e.g., .doc, .jpeg, .txt) can be attached with a segment. Any type of information can be typed in the Notes section. The user has the ability to define their own distresses, and also customize the distress list. Many customization features are available in the software, which gives the user an opportunity to customize the software to suit their needs.

TRAINING AND SUPPORT

Item	Y/N?	Comment
Training Classes.	Y	
Support	Y	Toll-free customer support phone number.

Attachment F-2

Minimum Data Collection Requirements for Future Updates

Minimum Data Collection Requirements for Future Updates

1. **Contact Information**
   a. Agency and County
   b. Name, title, address, phone number and email address

2. **Pavement Data**
   a. Type of PMS software used
   b. Roadway system, separated into:
      i. Urban vs. rural
      ii. Major streets, residentials/locals and unpaved
      iii. Data should be reported by centerline miles, lane-miles, area
      iv. AC vs. PCC
      v. Comments
   c. Distress Surveys
      i. Description of rating procedure i.e. MicroPAVER, StreetSaver etc
      ii. Types of AC and PCC distresses collected
      iii. Other pavement data e.g. deflection, ride etc – how are these data used?
      iv. How is data collected? Walking surveys? Windshield? Automated?
   d. Pavement Condition Ratings
      i. What type of pavement rating scale is used? Describe.
      ii. What is agency's weighted (by area) average condition rating on a 0-100 scale? Report for major vs. residential/local roads
   e. Maintenance and rehabilitation thresholds (see example below)
   f. Typical unit costs for treatments applied

Maintenance Activity	Condition Thresholds	
	Urban	Rural
Do Nothing	86-100	75-100
Preventive Maintenance	70-85	60-75
Surface seal e.g. slurry, cape	70-85	60-75
Thin AC overlay	50-70	40-60
Thick AC overlay	25-50	0-40
Reconstruction	0-25	Never

3. **Safety, traffic and regulatory components**
   a. Categories to include (each category should include inventory, replacement cost and data source)
      i. storm drains
      ii. curb and gutters
      iii. sidewalks
      iv. ADA requirements and curb ramps
      v. traffic signals
      vi. street lights
      vii. Other
      viii. Source of data

4. **Past and Future Expenditures**
   a. Include previous 2 fiscal years for baseline comparison
   b. Estimated annual expenditures for next five fiscal years for each category below
      i. Pavements
         1. Preventive maintenance
         2. Rehabilitation and reconstruction
         3. Other pavement related costs
         4. Operations and maintenance
      ii. Safety, traffic and regulatory components
         1. storm drains
         2. curb and gutters
         3. sidewalks
         4. ADA requirements and curb ramps
         5. traffic signals
         6. street lights
         7. Others

For more information:

Federal Highway Administration
Office of Asset Management
1200 New Jersey Avenue S.E.
Washington, DC 20590

Tel: 202-366-1341
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www.fhwa.dot.gov/infrastructure/asstmgmt

Notice:

FHWA-HIF-08-007