The Evaluation of the Expert System for Pavement Evaluation and Rehabilitation (EXPEAR) in Washington State

WA-RD 169.1

Final Report
April 1989

Washington State Department of Transportation
Planning, Research and Public Transportation

in cooperation with the
United States Department of Transportation
Federal Highway Administration

Final Report

Research Project GC8286, Task 31
"EXPEAR" Evaluation

THE EVALUATION OF THE EXPERT SYSTEM FOR PAVEMENT EVALUATION AND REHABILITATION (EXPEAR) IN WASHINGTON STATE

by

Holly A. Simmons
Research Assistant
University of Washington

Joe P. Mahoney
Professor of Civil Engineering
University of Washington

Linda M. Pierce
Transportation Engineer 2
Materials Laboratory
Washington State Department
of Transportation

Newton C. Jackson
Pavement and Soils Engineer
Materials Laboratory
Washington State Department
of Transportation

Washington State Transportation Center (TRAC)
University of Washington
The Corbet Building, Suite 204
4507 University Way N.E.
Seattle, Washington 98105

Washington State Department of Transportation
Technical Monitor
Newton C. Jackson
WSDOT Pavement and Soils Engineer

Prepared for

Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

April 17, 1989

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. WA-RD 169.1	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE THE EVALUATION OF THE EXPERT SYSTEM FOR PAVEMENT EVALUATION AND REHABILITATION (EXPEAR) IN WASHINGTON STATE		5. REPORT DATE April 17, 1989 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Holly A. Simmons, Linda M. Pierce, Joe P. Mahoney, and Newton C. Jackson		8. PERFORMING ORGANIZATION REPORT NO. WA-RD 169.1
9. PERFORMING ORGANIZATION NAME AND ADDRESS Washington State Transportation Center (TRAC) University of Washington, JE-10 The Corbet Building, Suite 204; 4507 University Way N.E. Seattle, Washington 98105		10. WORK UNIT NO. 11. CONTRACT OR GRANT NO. GC8286, Task 31
12. SPONSORING AGENCY NAME AND ADDRESS Washington State Department of Transportation Transportation Building, KF-10 Olympia, Washington 98504		13. TYPE OF REPORT AND PERIOD COVERED Draft Technical Report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. The contract monitor for the FHWA was James Bednar of the Office of Implementation, Turner-Fairbank Research Center.

16. ABSTRACT

The EXpert system for Pavement Evaluation And Rehabilitation (EXPEAR) is an advisory system to assist the practicing engineer in evaluating a specific pavement section and selecting pavement rehabilitation alternatives. The objectives of this study were both to evaluate EXPEAR by using Washington state project data to determine the reasonableness of the program's output in comparison to WSDOT's current procedures, and to identify any existing program "bugs" and/or desirable program enhancements.

To evaluate EXPEAR program output, pavement design and condition data were entered from four test sections in Washington. After the pavement data were input, the EXPEAR output results were reviewed subjectively for reasonableness and compared to the state's current procedures for determining appropriate rehabilitation.

Although EXPEAR offers several positive attributes, this study found problems with its output. For example, the transverse cracking model predicted cracking that was more severe than WSDOT has observed. Often EXPEAR predicted distress trends that were not reasonable. Also, a test of the risk of the different rehabilitation options appeared to be missing from the program.

The researchers concluded that the high level of effort expended in creating EXPEAR is commendable and that a system of this type can be a useful tool not only for pavement design but also as a scoping and planning tool for pavement rehabilitation. However, WSDOT will probably not use EXPEAR in its present form because the performance predictions of both existing pavements and and rehabilitation strategies were generally inconsistent with what has been observed in Washington.

17. KEY WORDS expert system, pavement, rehabilitation, portland cement concrete		18. DISTRIBUTION STATEMENT No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616	
19. SECURITY CLASSIF. (of this report) None	20. SECURITY CLASSIF. (of this page) None	21. NO. OF PAGES 270	22. PRICE

DOT FORM 310-022 (11/86) -1216-

DISCLAIMER

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

INTRODUCTION

The Washington State Department of Transportation (WSDOT) alone is responsible for a highway system consisting of 7,057 centerline miles of pavement, approximately six percent of which are portland cement concrete (PCC) pavements. The majority of these pavements are quickly approaching or, in some cases, have exceeded their design life. Prolonging the lives of pavements through various rehabilitation techniques has become a major concern of not only the WSDOT but many other state highway agencies as well.

The selection of a feasible rehabilitation strategy that will not only remedy the existing distresses but possess the structural capacity and integrity to support future increased traffic volumes is a difficult and critical task that requires a thorough understanding of how pavements perform. While some aspects of rehabilitation design may be solved deterministically using mechanistic models and established principles and procedures, others must be solved heuristically, using subjective knowledge, opinions, beliefs, and judgment possessed by the individual engineer.

While deterministic knowledge is easily obtained and preserved in textbooks and other published literature, heuristic knowledge is not. Often, as in the case of pavement engineering, heuristic knowledge is possessed by a limited number of experienced engineering specialists who are found only in some state and federal agencies, private companies, and universities. Furthermore, since it is acquired by individual engineers through experience, it is not easily transferred, and as these engineers retire, it may be lost. These concerns spurred the development of "knowledge-based systems" and, more specifically, the subset of these systems called "expert systems." These computer programs attempt to capture the knowledge of experts and use it to solve difficult problems within a specifically defined subject range.

EXPEAR is such a system. It was developed to help knowledgeable pavement engineers solve the difficult problem of selecting an appropriate rehabilitation strategy for specific projects.

The objectives of this study were both to evaluate EXPEAR using Washington state project data to determine the reasonableness of the program's output in comparison to WSDOT's current procedures, and to identify any existing program "bugs" and/or desirable program enhancements.

EXPEAR

The EXpert system for Pavement Evaluation And Rehabilitation (EXPEAR) is an advisory system to assist the practicing engineer in evaluating a specific pavement section and selecting pavement rehabilitation alternatives. EXPEAR consists of three separate programs; they include Jointed Plain Concrete Pavements (JPCP), Continuously Reinforced Concrete Pavements (CRCP), and Jointed Reinforced Concrete Pavements (JRCP). The program was written with Borland International, Inc.'s Turbo-Pascal and is designed to operate on any IBM PC or compatible with a 256 Kilobyte memory.

The evaluation of a candidate rehabilitation project begins with the collection of some basic inventory and survey data. The inventory data include such things as the pavement cross-section, subgrade classification, joint spacing, lane widths, climate and traffic data. The survey data quantify the present pavement condition and are taken for a number of sample units within the project based on the pavement distress classification system found in NCHRP Report No. 277. The monitoring data also include the present serviceability rating (PSR) as determined by a team of two engineers who drive over the entire length of the project and rate the ride. This information is then input to EXPEAR, which extrapolates the conditions described in the sample units to cover the entire project length.

The program then evaluates the existing pavement condition in twelve specific areas of pavement performance including structural adequacy, roughness, drainage, joint deterioration, foundation movement, joint sealant condition, skid resistance, joint construction, concrete durability, load transfer, loss of support, and shoulders. The evaluation uses decision trees to compare the pavement's condition with predetermined critical distress levels for each of the 12 categories. At this point, EXPEAR also predicts future performance without rehabilitation, based on a number of models from the COncrete Pavement Evaluation System (COPES), as well as a few recommendations for further physical testing.

Finally, EXPEAR provides the major rehabilitation techniques that it considers to be feasible for the project. The principle techniques include reconstruction of both lanes, reconstruction of the outer lane with restoration of the inner lane, restoration of both lanes, asphalt concrete (AC) structural overlay, portland cement concrete (PCC) bonded overlay, or (PCC) unbonded overlay. The engineer may then select one or more of these strategies for evaluation and EXPEAR predicts its performance for the next 20 years, based on another group of predictive models that include those from the COPES as well as some from the Development of Illinois Pavement Feedback System, an ongoing study being conducted for the Illinois Department of Transportation.

METHODOLOGY

To evaluate the reasonableness of EXPEAR program output, pavement design and condition data were entered from four test sections within Washington state. The evaluation was limited to the EXPEAR JCP program, since there are few CRCP or JRCP pavements in Washington state. After pavement data were input, the EXPEAR output and results were then reviewed subjectively for reasonableness and compared to the findings of that study, as well as the state's current procedures for determining appropriate rehabilitation. The projects used for input included the PCC rehabilitation test sites on I-5 in Spokane, as well as two other sites worthy of investigation located on I-90 near Snoqualmie Pass (about 50 to 60 miles east of Seattle). The EXPEAR output was then compared with the pavement's present condition (1988). The analysis was limited on all test sites to the outside or truck lane, since in all case studies the pavement distresses were relatively insignificant in adjacent lanes.

FINDINGS

In general the transverse cracking model predicted cracking that was much more severe than WSDOT observed. The transverse cracking model was insensitive to existing cracks that would be expected to return in PCC bonded overlays. The EXPEAR models predicted premature failures for newly reconstructed pavements that the WSDOT has observed to perform very well for performance periods greater than 20 years. EXPEAR predicted the severity of reflection cracking to be greater in a pavement that had undergone cracking and seating before overlaying than in one that had not, even though it predicted more total reflection cracking in the latter pavement.

Often, EXPEAR predicted distress trends that were not reasonable, such as the improvement (self-healing effect) of the PSR over time. The reflection cracking model was not especially sensitive to AC overlay thicknesses. EXPEAR did not distinguish asphalt treated bases from other stabilized bases, such as cement or lime stabilized bases, which are known to perform differently. In addition, EXPEAR did not account for the unique material properties found in Washington, such as the strength and durability of asphalt concrete mixes used in overlays, or asphalt treated bases used beneath concrete pavements.

A test of the risk of rehabilitation options, as well as the human element, appeared to be missing from the program, which relied heavily on predictive models. Finally, EXPEAR did not address longitudinal cracking, which is a significant distress type in Washington, in its predictive models.

Despite its problems, the EXPEAR system did have several positive attributes, including the following.

- EXPEAR incorporates some of the information known about pavement rehabilitation options and assembles it in a useful manner.
- The estimates of future pavement performance could be useful in the scoping and planning stages of rehabilitation projects.
- EXPEAR provides an automated procedure for organizing survey inventory and monitoring data that did not previously exist.
- By allowing the user to manipulate and analyze a variety of rehabilitation options that are applicable to a particular project, different geographical locations are accommodated while the analysis of other options is encouraged.
- EXPEAR provides a standardized method of evaluating concrete pavements and classifying distresses (COPES).
- EXPEAR addresses the problem of documenting the heuristic knowledge possessed by pavement engineers that is necessary for successful rehabilitation design.
- In its current form, EXPEAR (version 1.1) is a relatively "bug-free" program that functions smoothly and quickly.

CONCLUSIONS AND RECOMMENDATIONS

The models primarily used in EXPEAR are from the COPES. Because of local conditions these models had little chance of producing reasonable predictions. However, because of various factors, the exact duplication of field observations and test results is impractical. While the first condition should be investigated by the developers of EXPEAR, the last reason suggests that both the developers and users of EXPEAR will have to develop a level of tolerable and acceptable differences if EXPEAR and systems like it are to become an integral part of pavement engineering.

The researchers concluded that the obvious high level of effort expended in creating EXPEAR is commendable. A system of this type can be a useful tool not only for pavement design but also as a scoping and planning tool for pavement rehabilitation. In addition, it provides an automated, practical means of recording pavement survey and monitoring data, which did not previously exist.

However, the Washington State DOT will probably not use EXPEAR in its present form. The performance predictions of both existing pavements and rehabilitation strategies are generally inconsistent with what has been observed in Washington state. For the near term, individual performance models that are found to be representative of Washington's conditions will be used where applicable (mostly for rehabilitation scoping or planning).

CHAPTER 1. INTRODUCTION AND RESEARCH APPROACH

Over the last few decades, many of the United States' high type pavements, including those that make up the vital Interstate System, have been exposed to volumes of heavy truck traffic far in excess of that for which they were designed. This combined with age (many of the Interstate pavements are 20 to 30 years old) is resulting in deteriorated pavement structures [1]. The Washington State Department of Transportation (WSDOT) alone is responsible for a highway system consisting of 7,057 centerline miles of pavement, approximately six percent of which are portland cement concrete (PCC) pavements mostly located in urban areas with high traffic volumes [2]. The majority of these pavements are quickly approaching or, in some cases, have exceeded their design life. Prolonging the lives of pavements through various rehabilitation techniques has become a major concern of not only the WSDOT but many other state highway agencies as well.

The selection of a feasible rehabilitation strategy that will not only remedy the existing distresses but possess the structural capacity and integrity to support future increased traffic volumes is a difficult and critical task that requires a thorough understanding of how pavements perform. In addition, the task is complicated by uncertainty about future traffic volumes, truck weights, and construction costs, as well as factors relating to construction, design, material properties, and the environment that affect pavements in ways which are not clearly defined. So while some aspects of rehabilitation design may be solved deterministically using mechanistic models and established principles and procedures, others must be solved heuristically, using subjective knowledge, opinions, beliefs, and judgment possessed by the individual engineer.

While deterministic knowledge is easily obtained and preserved in textbooks and other published literature, heuristic knowledge is not. Often, as in the case of pavement engineering, heuristic knowledge is possessed by a limited number of experienced engineering specialists who are found only in some state and federal agencies, private companies, and universities. Furthermore, since it is acquired by individual engineers through experience, it is not easily transferred, and as these engineers retire, it may be lost. These concerns spurred the development of "knowledge-based systems" and, more specifically, the subset of these systems called "expert systems." These computer programs attempt to capture the knowledge of experts and use it to solve difficult problems within a specifically defined subject range. EXPEAR is such a system, and was developed to help knowledgeable pavement engineers solve the difficult problem of selecting an appropriate rehabilitation strategy for specific projects [2].

OBJECTIVES

The objectives of this study are as follows:

1. to evaluate EXPEAR using Washington state project data to determine the reasonableness of the program's output in comparison to WSDOT's current procedures; and
2. to identify any existing program "bugs" and/or desirable program enhancements before its distribution.

REPORT OVERVIEW

This report consists of four additional chapters. Chapter 1 contains a general introduction to expert systems, an introduction to the EXPEAR system, and a review of the case studies used in the evaluation of the EXPEAR system, including the methodology used, site descriptions, and the data input to the system. Chapter 2 discusses the results of the EXPEAR analysis and compares EXPEAR output and WSDOT practices and procedures. Chapter 3 discusses the use of EXPEAR, including its user friendliness, the user's manual, bugs detected, and suggested enhancements. Finally, Chapter 4 contains the conclusions and recommendations of the study.

EXPERT SYSTEMS

With the rapid increase in capability and decrease in price of mini-and microcomputers, a great deal of interest in expert system technology has been generated in many industries. Recently, the Federal Highway Administration (FHWA) and others in the highway community have been considering the potential application for this technology in highway engineering.

History

Expert systems research, which is a branch of the field of artificial intelligence, began in the late 1950s as an attempt to automate the thought processes of scientists [3]. The early programs were run on mainframe computers and were usually written using LISP, which is the common language for artificial intelligence. Eventually a program called "MYCIN" was developed by Feigenbaum and Shortliffe through the Heuristic Programming Project at Stanford University [4]. This program was designed to help doctors diagnose bacteriological diseases. MYCIN is still in use today and became a landmark in expert system technology for two reasons. First, it was the first expert system that had the ability to explain why decisions were made. Secondly, it was the first system that was able to separate the decision making process from the rules and data [3].

As this and other expert systems evolved, it became increasingly apparent that the decision process contained in these programs was largely independent of the type of expert system, rules, and data. Researchers found that the logic could be applied to create other expert systems using different rules and data sets. As a result, "EMYCIN" was developed, which is basically the decision making process used in MYCIN stripped from the rules and data sets contained in that program. EMYCIN was termed a "shell" program, which could be used to develop other expert systems in different fields [3].

Although the development of shell programs greatly facilitated the development of expert systems in various applications, expert systems were still used almost exclusively in the university setting because they were run on mainframe computers [3]. Only after a great deal of research were shell programs made capable of operation on mini-and microcomputers, which is why members of the engineering community have only recently taken interest in the development of expert systems [5].

Structure

An expert system consists of three major components. These include the knowledge base, the inference engine, and the user interface [5]. The knowledge base consists of rules and facts that capture an expert's or group of experts' knowledge, opinions, beliefs, rules of thumb, intuition, and experience. The inference engine is the part of the program that combines rules and data to make decisions, assertions, hypotheses, and conclusions. It is through the inference engine that the reasoning strategy (or method of solutions) is controlled [4]. The part of the program extracted from MYCIN to create EMYCIN (the shell) is an inference engine, which combines information supplied by the user with information and facts contained in the knowledge base to advise the user on how to solve a specific problem or attain a goal [3]. The inference engine may also make decisions about what additional information may be needed or what conclusions may be drawn based on the information supplied. The user interface then translates the information contained in the knowledge base and processed by the inference engine to a form that is comprehendible and useful to the user [5]. This structure is illustrated in Figure 1.

General Applications

Expert systems may be applied in several different situations, but they are primarily applicable to situations that require special knowledge, experience, or judgment to diagnosis, analyze, and provide a feasible solution strategy [6]. The following have been offered as criteria for implementation of an expert system to any given situation:

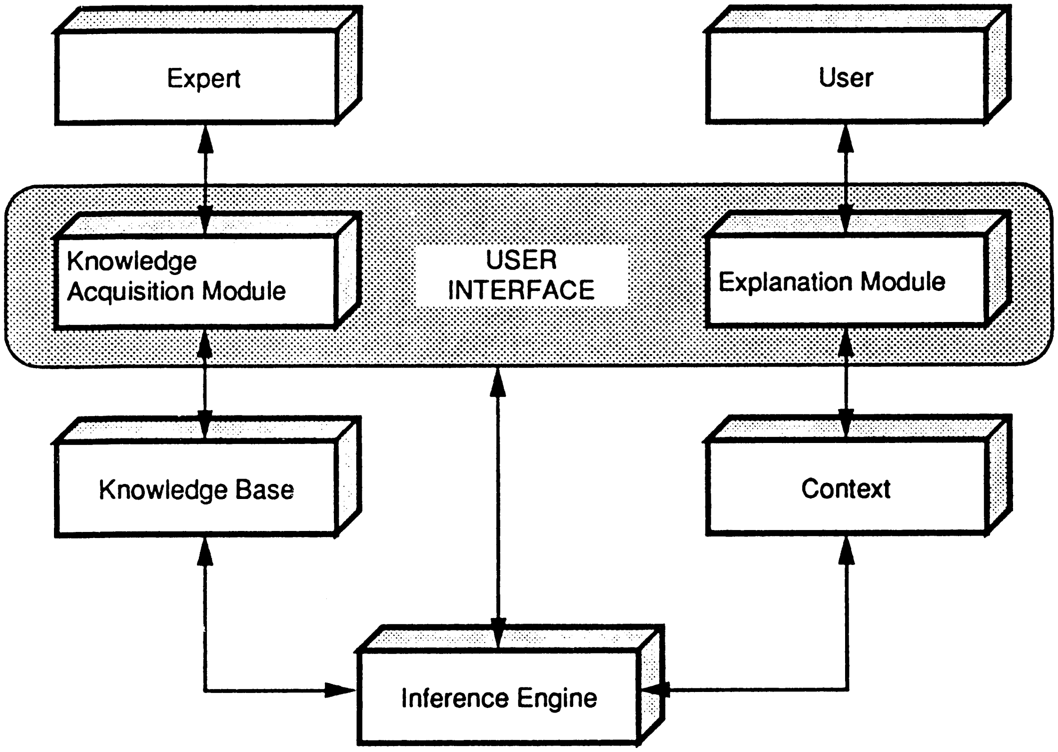


Figure 1. Basic Structure of an Expert System [after ref. 6]

Technical Considerations

- Both the problem to be addressed and the expected output from the advisory system can be clearly defined.
- There are recognized experts in the field, and there is general agreement among these experts on the knowledge required to solve the problem.
- Experts need private knowledge (experience, heuristics, etc.) in addition to technical tools (such as handbooks and computers) to identify the problem, make inferences about it, and analyze it.

Management and Human Requirements

- The end users must be identified and their needs and skills considered. The transfer to and application by the end users of the completed system must be major factors in the system planning and design.
- Someone in the organization must be an advocate of the advisory system. Ideally this includes both a developer and a user [5].

Some may argue that the conditions that exist in the design and analysis of pavement rehabilitation strategy meet most of the above criteria, and therefore it is a potential candidate for the implementation of an expert system. However, in the field of highway technology there have been a relatively small number of expert systems developed for pavement applications. The shortage of good, practical pavement Knowledge-Based Expert Systems (KBES) in this field is due not so much to the limitations of present KBES frameworks as to the difficulty of compiling, organizing, and formalizing the huge body of heuristic expertise that characterizes the profession [4]. However, a few useful pavement systems do exist.

Pavement Applications

SCEPTRE (A Surface Condition Expert System for Pavement Rehabilitation) is one such example. This prototype system for the rehabilitation of flexible pavements was developed cooperatively by the University of California (Irvine), the University of Washington, and the WSDOT under a partial grant by the National Science Foundation. The system is capable of deducing a set of feasible project rehabilitation strategies for subsequent detailed analysis and design based on a knowledge-base representing several human experts and user inputs. In addition, SCEPTRE can explain its line of reasoning and is easily modified, making it potentially valuable to a broad range of users. The program utilizes a shell program called "EXSYS," which is an expert system development package for IBM PC and compatible microcomputers [6].

Another pavement related expert system was developed as part of a joint investigation conducted by Purdue University in cooperation with the Indiana Department of Highways and the FHWA. The program is entitled "An Expert System to Estimate Highway Pavement Routine Maintenance Work Load." The program was written in LISP and may be used to estimate highway pavement routine maintenance needs at a subdistrict level. The system contains a knowledge-base that was prepared by from the experience and judgment of unit foremen and requires user input relating to the general features of the highway section and its existing distresses. The output gives specific recommendations as to the type and quantity of activities to be performed, as well as the expected costs for these activities [7].

"Pavement Expert" is an expert system that was developed in the United Kingdom to aid in the evaluation of concrete pavements. This system is intended to operate on a portable microcomputer mounted to a surveying car. It is designed to guide the user through the pavement evaluation process, to present information for error checking and to provide pertinent help at any time. The program builds a model representing the general condition of the road being evaluated as information is input during the survey. This model is then used to calculate the Structural Damage Index and the Pavement Condition Rating (PCR), which relate to the structural capacity and the general riding condition of the pavement, respectively. Pavement Expert is then able to present the pavement condition information graphically, as well as make some general conclusions. The knowledge-base contained in this system was extracted from the documents for the PCR, as well as some experts in this field. The knowledge-base is represented by a rule base expert system shell called "Savoir" and runs on any IBM or compatible microcomputer [8].

Pavement management may also be an excellent application for expert systems. Currently the data requirements are fairly well established, and in general there is agreement on how to quantify pavement serviceability and failure. However, many of the rules regarding breakpoints for pavement distress severities and extents need further definition and development [3].

In addition to those mentioned previously, several other pavement-related expert systems exist. Some of these systems will be presented and/or demonstrated at a Workshop on Expert Systems in Pavement Engineering to be held before the TRB Annual meeting in January of 1989. The workshop will focus on the development, operation, performance, and benefits of expert systems, as well as their limitations [9].

EXPEAR

The EXpert system for Pavement Evaluation And Rehabilitation (EXPEAR) was originally developed by Kathleen T. Hall and Michael I. Darter at the University of Illinois for the Federal Highway Administration [1]. Currently, the system is being further developed for the Illinois Department of Transportation (IDOT). According to the FHWA, "EXPEAR is an advisory system to assist the practicing engineer in evaluating a specific pavement section and selecting pavement rehabilitation alternatives" [9]. EXPEAR consists of three separate programs; they include Jointed Plain Concrete Pavements (JPCP), Continuously

Reinforced Concrete Pavements (CRCP), and Jointed Reinforced Concrete Pavements (JRCP). The program was written with Borland International, Inc.'s Turbo-Pascal and is designed to operate on any IBM PC or compatible with a 256 Kilobyte memory [1].

Operation Summary

The evaluation of a candidate rehabilitation project begins with the collection of some basic inventory and survey data. The inventory data include such things as the pavement cross-section, subgrade classification, joint spacing, lane widths, climate and traffic data. The survey data quantify the present pavement condition and are taken for a number of sample units within the project based on the pavement distress classification system found in NCHRP Report No. 277 [10]. The monitoring data also include the present serviceability rating (PSR) as determined by a team of two engineers who drive over the entire length of the project and rate the ride. This information is then input to EXPEAR, which extrapolates the conditions described in the sample units to cover the entire project length.

The program then evaluates the existing pavement condition in twelve specific areas of pavement performance including structural adequacy, roughness, drainage, joint deterioration, foundation movement, joint sealant condition, skid resistance, joint construction, concrete durability, load transfer, loss of support, and shoulders. The evaluation uses decision trees to compare the pavement's condition with predetermined critical distress levels for each of the 12 categories. At this point, EXPEAR also predicts future performance without rehabilitation, based on a number of models from the CОncrete Pavement Evaluation System (COPES) [11], as well as a few recommendations for further physical testing.

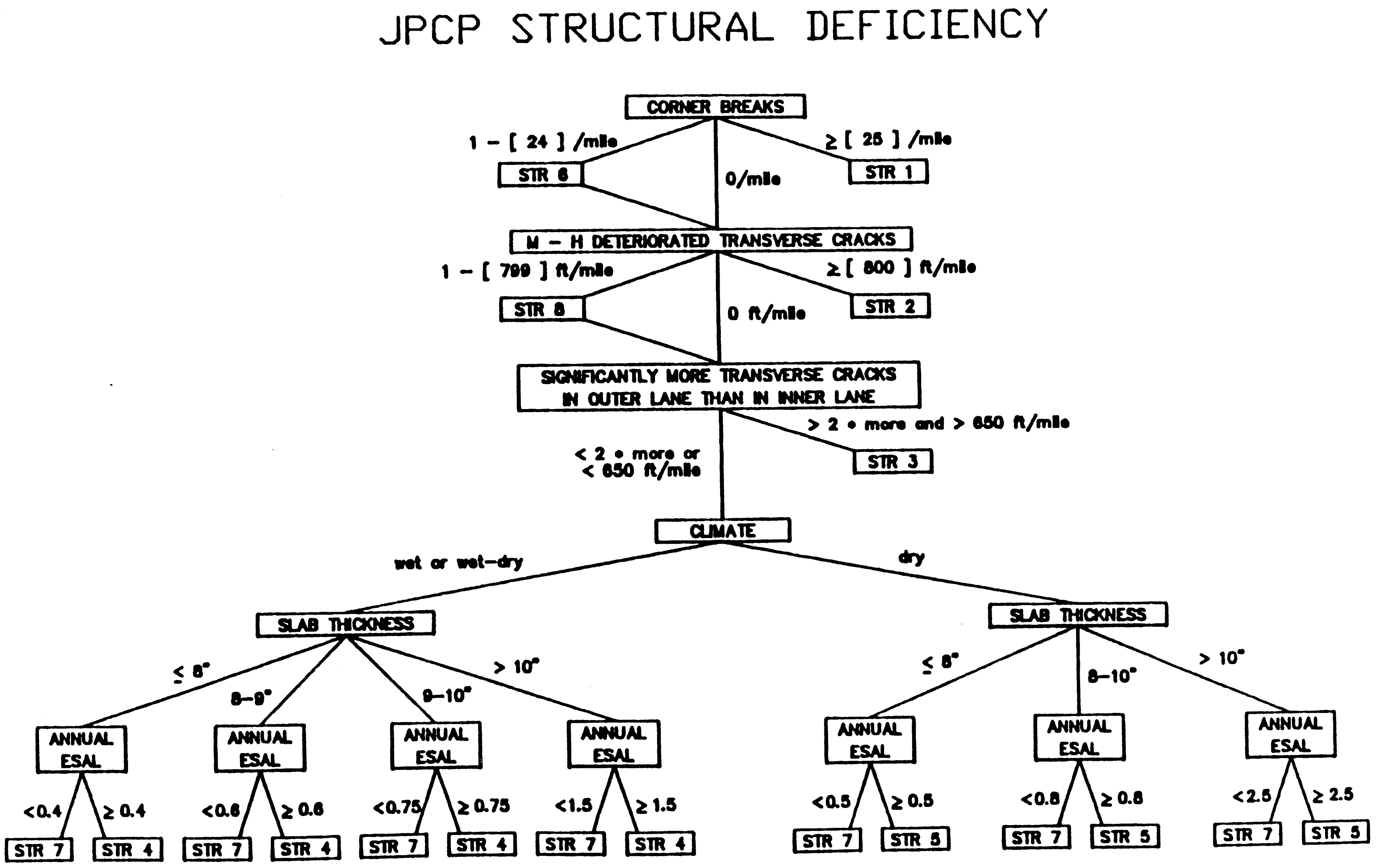
Finally, EXPEAR provides the major rehabilitation techniques that it considers to be feasible for the project. The principle techniques include reconstruction of both lanes, reconstruction of the outer lane with restoration of the inner lane, restoration of both lanes, asphalt concrete (AC) structural overlay, portland cement concrete (PCC) bonded overlay, or (PCC) unbonded overlay. The engineer may then select one or more of these strategies for evaluation and EXPEAR predicts its performance for the next 20 years, based on another group of predictive models that include those from the COPES as well as some from the Development of Illinois Pavement Feedback System, an ongoing study being conducted for the Illinois Department of Transportation [2].

Decision Trees

EXPEAR uses a decision tree format to perform the diagnostic activities of concrete pavement evaluation. A sample decision tree is shown in Figure 2. The decision trees consist of a configuration of nodes, branches, and conclusions. Nodes represent bits of information related to the pavement in question that are input to the system by the user. At each node, EXPEAR must decide which branch of the tree should be followed, according to the values for the choice shown for the branches. By proceeding down the branches of the tree, a conclusion is eventually reached that determines the presence or absence of specific deficiencies within one major problem area. Decision trees exist for each of the 12 pavement performance areas. Each of the evaluation conclusions is accompanied by one or more possible rehabilitation techniques that could be performed to correct the deficiency concluded to exist. Although these techniques are not used at this point to develop a rehabilitation strategy, they do give the engineer an idea of the types of repairs that may be appropriate for correcting any specific deficiency irrespective of other deficiencies that may exist [1].

Pavement Performance Predictions without Rehabilitation

The performance prediction models used to evaluate the pavement's future condition without rehabilitation were, as mentioned previously, developed under NCHRP Project 1-19 [10] with data from 418 pavement sections representing over 1,305 miles of mostly heavily trafficked interstate highways. The data represent



• Annual ESAL in millions

FIGURE 2. Sample Decision Tree--JPCP Structural Deficiency [from Ref. 2]

seven states, including Illinois, Georgia, Utah, Minnesota, Louisiana, and California, and to a lesser extent, Nebraska [10]. The performance of the pavement is predicted for key distress types, including faulting, cracking, joint deterioration, pumping, and for the PSR. The program uses the extrapolated input values of these distresses to calculate future distresses and displays one or more sentences describing the deficiencies predicted to occur and the years in which the critical values of these deficiencies are triggered. These critical values can be the system's default values or they can be values specified by the engineer.

Selection of Major Rehabilitation Approaches

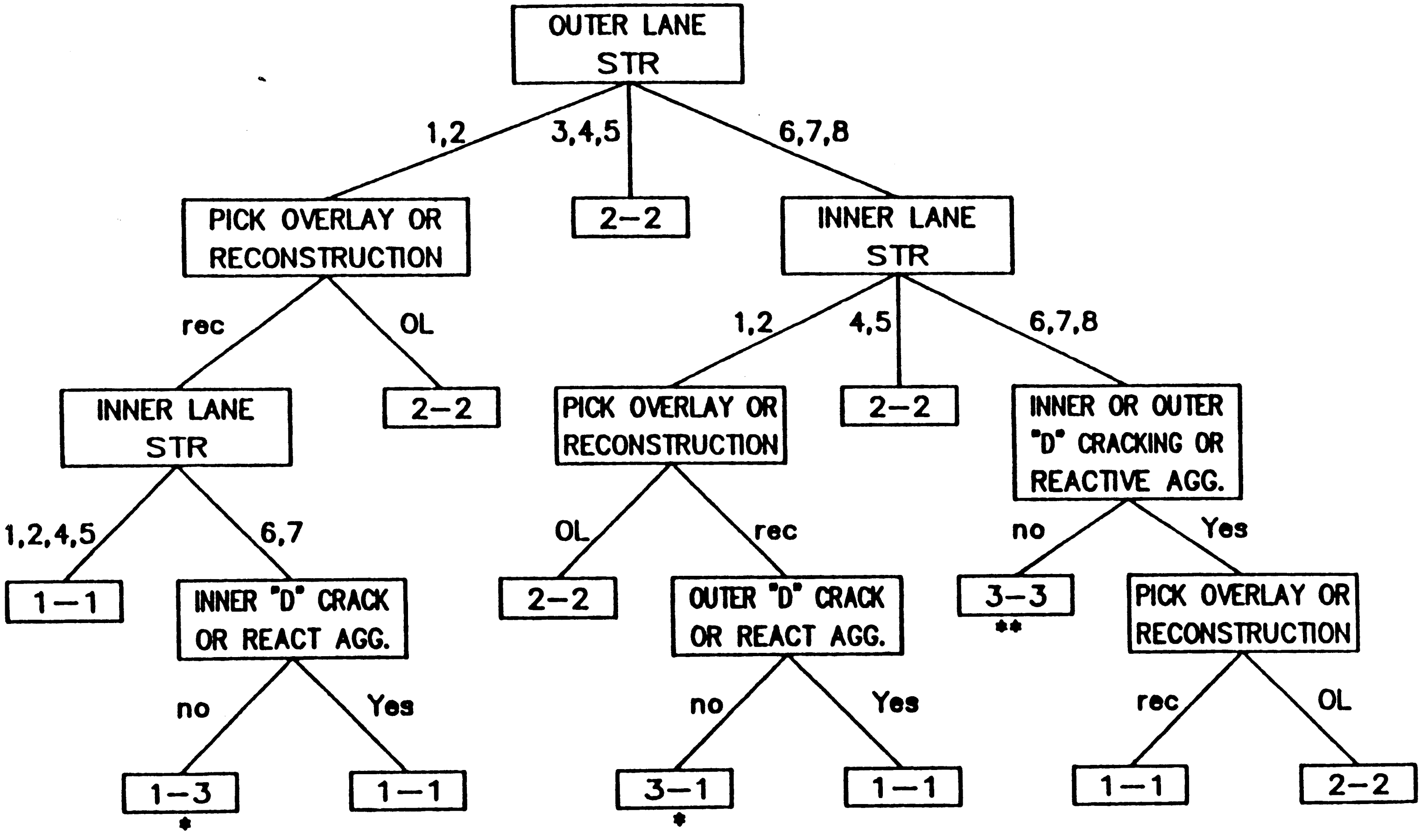
On the basis of user inputs and the evaluation results, the major rehabilitation approaches are selected using another decision tree, shown in Figure 3. This decision tree is based on the following guidelines:

- Substantial load-related distress indicates a structural deficiency and may be corrected by either a structural overlay or reconstruction.
- Structural overlays are used to correct structural deficiencies indicated by design and traffic factors.
- High-severity D-cracking or reactive aggregate distress indicates a durability deficiency and is correctable by either a structural overlay (unbonded PCC only) or reconstruction.
- All other pavement deficiencies are corrected by restoration techniques [1].

Development of a Rehabilitation Strategy

Once the major rehabilitation approaches have been established, the user interacts with the system to develop a rehabilitation strategy for the project. The strategy includes specific techniques to be performed on each lane and on each shoulder. EXPEAR uses a different decision tree for each of the main rehabilitation approaches to determine the specific deficiencies that must be corrected on each lane and shoulder.

Main Rehabilitation Approach for JPCP



* Option to go to 1−1 provided
** Option to go to 1−1, 1−3, or 2−2 provided

1−1 Reconstruct Both Lanes
1−3 Reconstruct Outer, Reconstruct Inner
3−1 Restore Outer, Reconstruct Inner
2−2 Overlay Both Lanes
3−3 Restore Both Lanes

FIGURE 3. Main Rehabilitation Approach Decision Tree for JPCP [from Ref. 2]

Rehabilitation Strategy Performance Predictions

As was done for the evaluation of the future performance of the pavement without rehabilitation, the future performance of the selected rehabilitation strategy is predicted in terms of levels of distress for key distress types. Future performance is calculated for a 20-year period and assumes rehabilitation occurs in the present year. The COPES models, along with models developed within the state of Illinois, are used to perform these calculations.

The key distress types predicted for AC overlays include rutting and reflective cracking, which is predicted in two ways: "total" feet of reflective cracking per mile as well as feet of "medium to high severity" reflective cracking. For both bonded and unbonded overlays the models predict faulting, transverse cracking, and joint deterioration. In the cases of reconstruction and restoration, the quantities of faulting, transverse cracking, joint deterioration and pumping are predicted. Full depth repair faulting is also included for the restoration case.

METHODOLOGY

To evaluate the reasonableness of EXPEAR program output, pavement design and condition data were entered from four test sections within Washington state. The evaluation was limited to the EXPEAR JPCP program, since there are few CRCP or JRCP pavements in Washington state. Two of the four test sections were also test sites in the PCC Rehabilitation Study (a WSDOT/FHWA HP&R research activity) [12]. After pavement data were input, the EXPEAR output and results were then reviewed subjectively for reasonableness and compared to the findings of that study, as well as the state's current procedures for determining appropriate rehabilitation. The projects used for input included the PCC Rehabilitation test sites on I-5 (MP 176, north) in Seattle and I-90 (MP 278, west) in Spokane, as well as two other sites worthy of investigation. These were located on I-90 near Snoqualmie Pass at MP 55 eastbound and MP 61 westbound. The I-90 (MP

55, east) Snoqualmie Pass project was somewhat unique because it was restored in 1986 and its condition prior to restoration was used as input to EXPEAR. The EXPEAR output was then compared with its present condition (1988). The analysis was limited on all test sites to the outside or truck lane ("lane one" as defined by EXPEAR), since in all case studies the pavement distresses were relatively insignificant in adjacent lanes. A summary of the pavement design and condition data is shown for each of these test sections in the following figures. (Figures 4 through 6 for I-5, MP 176, Figures 7 through 9 for I-90, MP 278, Figures 10 through 12 for I-90, MP 55, and Figures 13 through 15 for I-90, MP 61.)

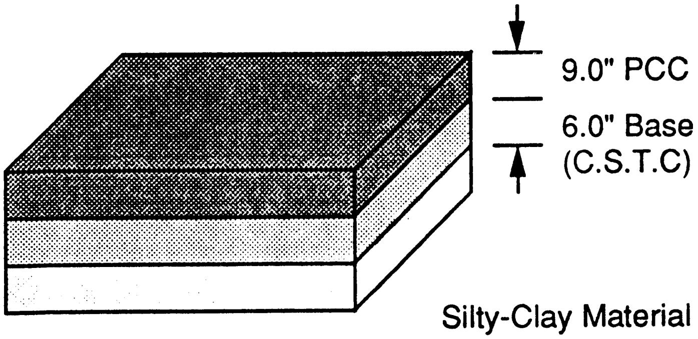
Site Descriptions

Much of the inventory data needed as input to the program were available for all four test sites from the Pavement Management System developed by the WSDOT, with the exception of the climate information, which was obtained from records of the Gale Research Company and the National Weather Bureau [13,14]. Existing pavement condition survey data were collected from several sources. For the Seattle and Spokane test sites, faulting surveys and distress mappings were obtained from the PCC Rehabilitation study. (Detailed survey information is contained in Appendix E). Faulting measurements, which are the only distress form on the I-90 west (MP 61) test site in Snoqualmie Pass, were taken specifically for this study. The data available for the I-90 east (MP 55) project were unique because the project was rehabilitated in 1986, but extensive distress mapping had been done before rehabilitation. This 1986 mapping, as well as faulting measurements, were available for input to this study. In addition, load transfer measurements, taken with a WSDOT Falling Weight Deflectometer (FWD), were available for all test sites.

Existing Forms of Distress

The primary forms of distress on I-5 through Seattle included longitudinal cracking and wheelpath wear. In addition, the joint sealant was in poor condition over most of the sample units surveyed. Faulting was not a major problem on this

Pavement Cross-Section



Silty-Clay Material
(AASHTO Classification = A-4
Average Subgrade Modulus = 22,400 psi

- 12 foot lane width
- 15 foot joint spacing
- No dowel bars

Climate

Climate Zone = Wet non-freeze
Average Annual Temperature = 53 °F
Average Annual Temperature Range = 39 °F
Mean Annual Precipitation = 39 inches
Corps of Engineers Mean Freezing Index = 25 °F-days

Traffic

Estimated two-way ADT = 145,900
% Trucks (single and combination units) = 4

Figure 4. Inventory Data, I-5 North (Milepost 176.35 -176.43)
Seattle, Washington

CURRENT FORMS OF DISTRESS

Distress Type	Lane 1 (Outer)	Lane 2 (Inner)
Longitudinal Cracking	2200 feet/mile	1467 feet/mile
Joint Faulting	0.10 in./mile	0 in/mile
Surface Polishing	yes	yes
Concrete Surface Wear (Rutting)	yes	yes

WSDOT PCR = 40
PSR (Lane 1) = 3.4
PSR (Lane 2) = 3.4

Figure 5. Condition Data, I-5 North (Milepost 176.35 -176.43)
Seattle, Washington

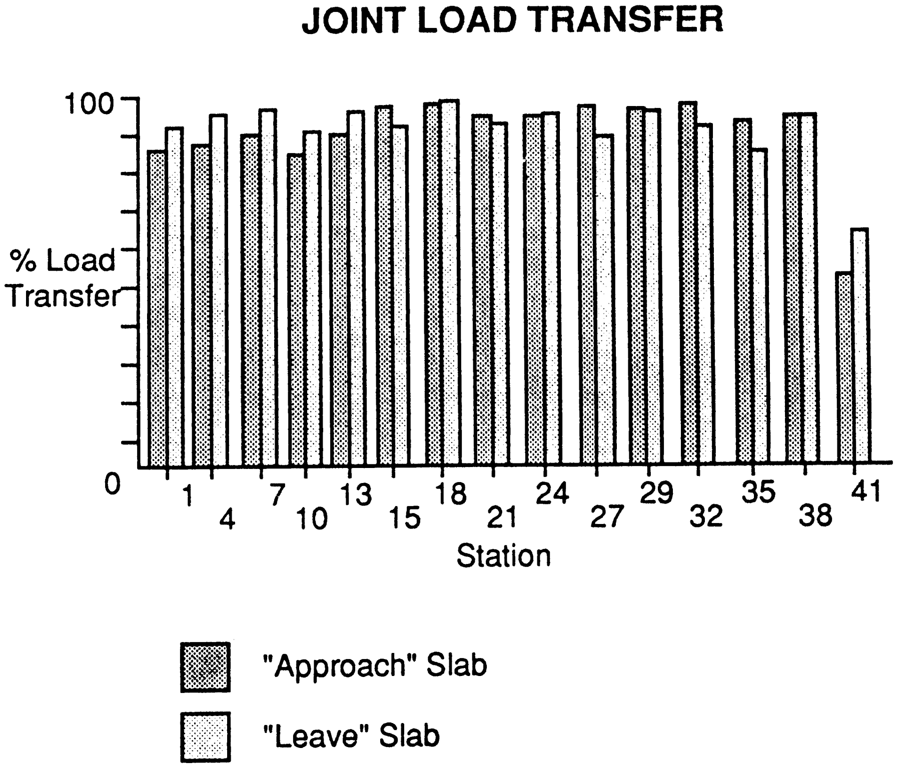
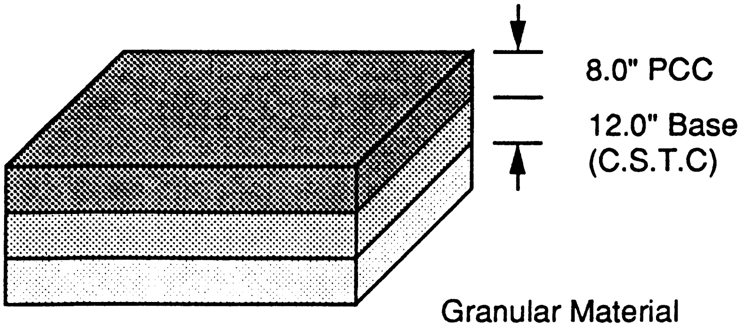


Figure 6. Inventory Data, I-5 North (Milepost 176.35 -176.43)
Seattle, Washington

Pavement Cross-Section



- 12 foot lane width
- 15 foot joint spacing
- No dowel bars

Climate

Climate Zone = Wet-dry freeze
Average Annual Temperature = 47 °F
Average Annual Temperature Range = 65 °F
Mean Annual Precipitation = 17 inches
Corps of Engineers Mean Freezing Index = 667 °F-days

Traffic

Estimated two-way ADT = 38,300
% Trucks (single and combination units) = 13

Figure 7. Inventory Data, I-90 West (Milepost 278.60 - 278.75)
Spokane, Washington

CURRENT FORMS OF DISTRESS

Distress Type	Lane 1 (Outer)	Lane 2 (Inner)
Joint Faulting	0.20 in./mile	0 in./mile
No. of Deter. Trans. Cracks	235/mile	0/mile
Longitudinal Cracking	440 ft/mile	0 ft/mile
Surface Polishing	yes	yes
Conc. Surface Wear (Rutting)	yes	yes

WSDOT PCR = 20
PSR (Lane 1) = 2.5
PSR (Lane 2) = 2.5

Figure 8. Condition Data, I-90 West (Milepost 278.60 - 278.75)
Spokane, Washington

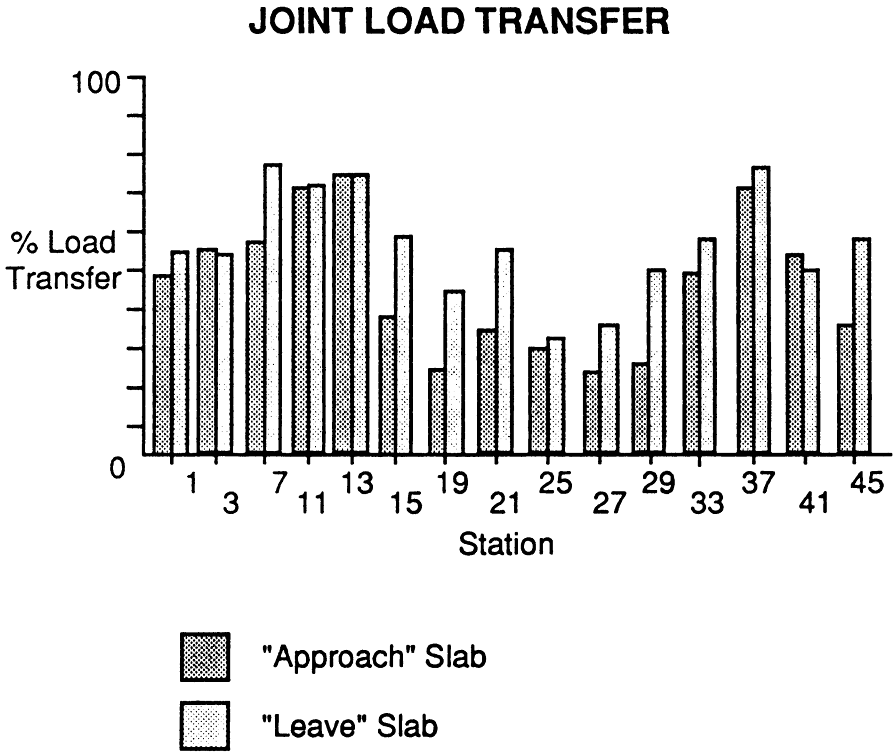
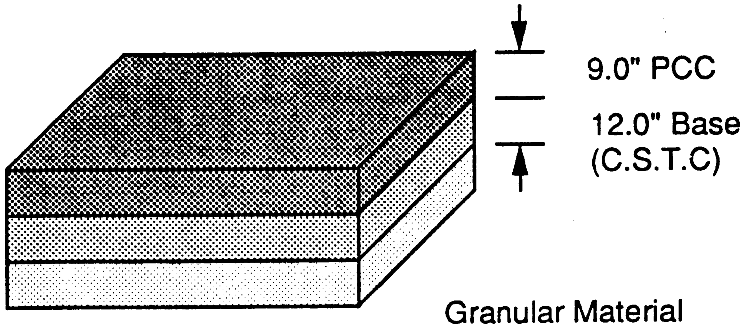


Figure 9. Inventory Data, I-90 West (Milepost 278.60 - 278.75)
Spokane, Washington

Pavement Cross-Section



Granular Material
AASHTO Classification = A-1
Average Subgrade Modulus = 15,800 psi

- 12 foot lane width
- 15 foot joint spacing
- No dowel bars

Climate

Climate Zone = Wet freeze-thaw
Average Annual Temperature = 42° F
Average Annual Temperature Range = 50° F
Mean Annual Precipitation = 108 inches
Corps of Engineers Mean Freezing Index = 937 °F-days

Traffic

Estimated two-way ADT = 17,300
% Trucks (single and combination units) = 19

Figure 10. Inventory Data, I-90 East (Milepost 55.50 - 63.99)
Snoqualmie Pass, Washington

1986 FORMS OF DISTRESS (Pre-CPR)

Distress Type	Lane 1 (Outer)	Lane 2 (Inner)
Joint Faulting	0.25 in./mi.	0 in./mile
No. of Deter. Trans. Cracks	17/mile	4/mile
Longitudinal Cracking	577 ft/mi.	95 ft/mile
Joints w/ Trans. Cracks w/in 2 ft.	1/mile	1/mile
Number of Corner Breaks	4/mile	1/mile
Surface Polishing	yes	yes

Estimated PSR (Lane 1) = 2.5
Estimated PSR (Lane 2) = 2.5

CURRENT 1988 FORMS OF DISTRESS
(Two years after CPR)

Distress Type	Lane 1 (Outer)	Lane 2 (Inner)
Joint Faulting	0.10 in./mi.	0 in./mile

WSDOT PCR = 63
PSR (Lane 1) = 2.5
PSR (Lane 2) = 2.5

Figure 11. Condition Data, I-90 East (Milepost 55.50 - 63.99)
Snoqualmie Pass, Washington

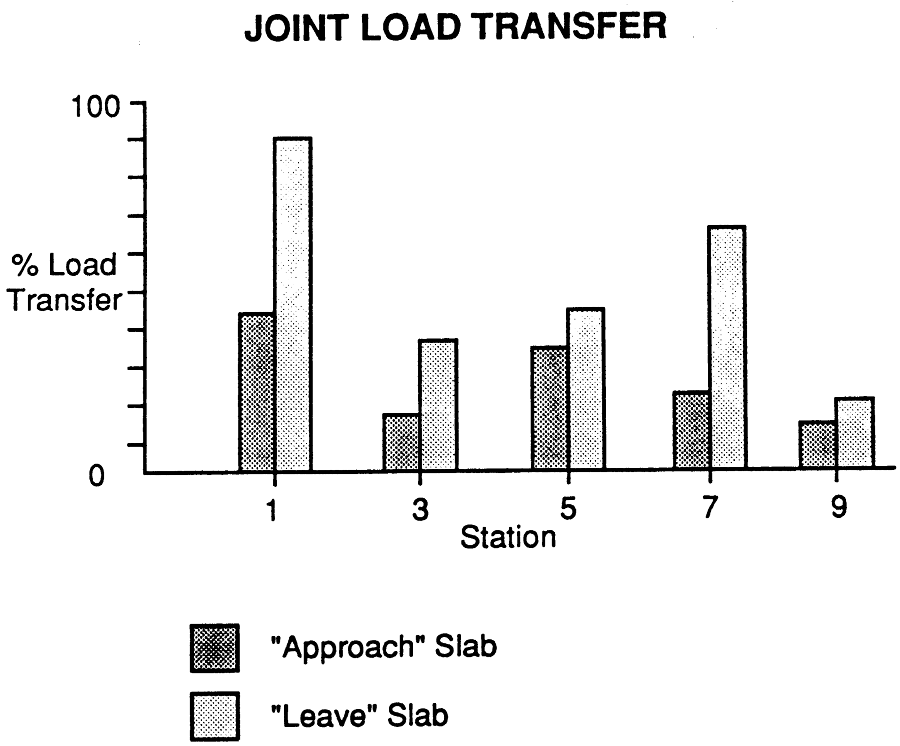
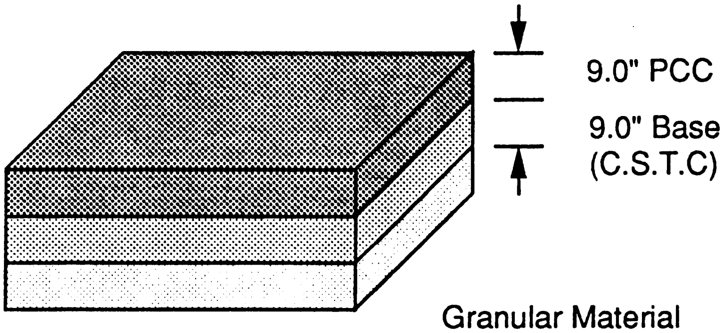


Figure 12. Inventory Data, I-90 East (Milepost 55.50 - 63.99)
Snoqualmie Pass, Washington

Pavement Cross-Section



Granular Material
AASHTO Classification = A-1
Average Subgrade Modulus = 15,800 psi

- 12 foot lane width
- 15 foot joint spacing
- No dowel bars

Climate

Climate Zone = Wet freeze-thaw
Average Annual Temperature = 42 °F
Average Annual Temperature Range = 50 °F
Mean Annual Precipitation = 108 inches
Corps of Engineers Mean Freezing Index = 937 °F-days

Traffic

Estimated two-way ADT = 17,300
% Trucks (single and combination units) = 19

Figure 13. Inventory Data, I-90 West (Milepost 61.00 – 61.01)
Snoqualmie Pass, Washington

CURRENT FORMS OF DISTRESS

Distress Type	Lane 1 (Outer)	Lane 2 (Inner)
Joint Faulting	0.13 in./mile	0 in./mile
Surface Polishing	yes	yes

WSDOT PCR = 50
PSR (Lane 1) = 2.5
PSR (Lane 2) = 2.5

Figure 14. Condition Data, I-90 West (Milepost 61.00 – 61.01)
Snoqualmie Pass, Washington

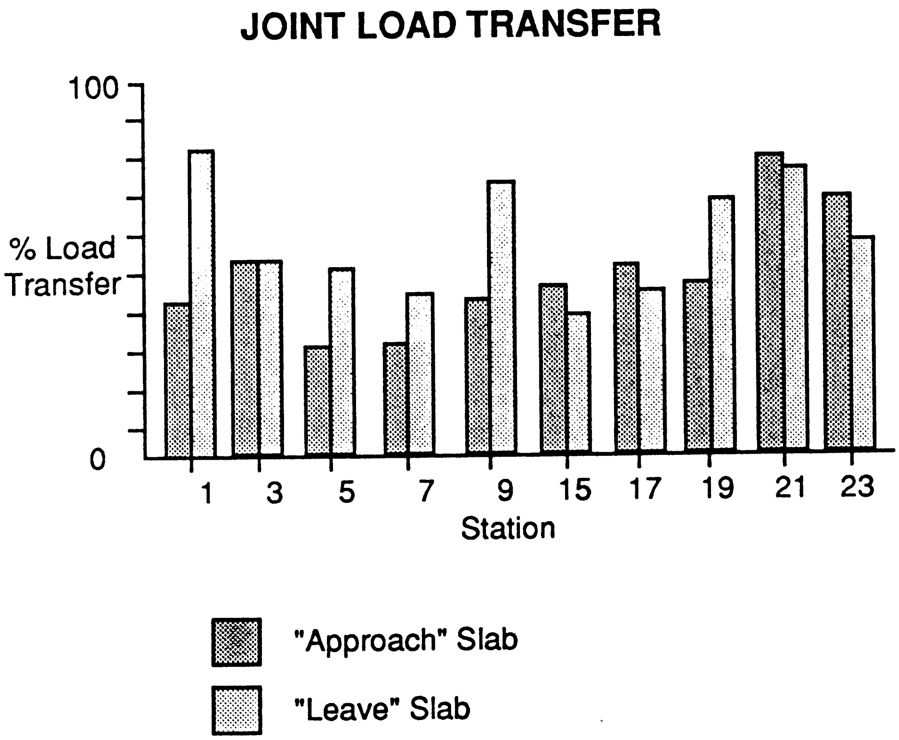


Figure 15. Inventory Data, I-90 West (Milepost 61.00 – 61.01)
Snoqualmie Pass, Washington

site; the average was about 0.10 inch, which is why the pavement still rode fairly well at a PSR of 3.4. (All PSR values were subjectively determined by two people who drove over the project site at the posted speed limit, as prescribed in the EXPEAR manual [11].) Faulting was a much more significant distress form on the I-90 Spokane project (MP 278), which also had a large number of deteriorated transverse cracks. The PSR for this pavement was only 2.5. This pavement is also worn in the wheelpaths (studded tire wear), and the joint sealant is in poor condition. Both the I-90 Spokane and I-5 Seattle pavements showed signs of fatigue and were expected to deteriorate over the coming years until rehabilitation could take place.

Before its restoration in 1986, the eastbound lanes of I-90 near Snoqualmie Pass (MP 55) had some transverse cracking, an average faulting at the joints of 0.25 inch, extensive full depth repairs, and a few corner breaks. The PSR was 2.5. The forms of pavement distress on the remaining I-90 westbound site (MP 61) included a modest amount of faulting (0.13 inch) and a number of deteriorated transverse joints.

CHAPTER 2. FINDINGS

COMPARISON OF EXPEAR RESULTS AND WSDOT PRACTICES

The above inventory and monitoring data were input using EXPEAR's full screen editor. These inputs, as well as the future performance predictions without rehabilitation, are shown in Appendices A, B, C, and D for the Seattle, Spokane, Snoqualmie westbound, and Snoqualmie eastbound test sites, respectively.

For the I-90 eastbound (MP 55) test section in Snoqualmie Pass, EXPEAR suggested four major rehabilitation options. These options included restoration of both lanes, overlaying both lanes, reconstruction of the outer lane with restoration of the inner lane, and reconstruction of both lanes. In 1986, the WSDOT essentially restored both lanes. This restoration included some full and partial slab replacements, subsealing of the slabs, resealing of the transverse joints, and diamond grinding of the pavement surface. EXPEAR recommended that restoration include resealing of the longitudinal centerline joint, full depth repair (FDR) of cracks and corner breaks, sealing of cracks, resealing of transverse joints, and grinding. The restoration performance predicted by EXPEAR was better in some respects than what was actually achieved. For example, EXPEAR predicted that the average faulting at the transverse joints would not be 0.10 inches until after ten years, when the actual faulting reached 0.10 inches only two years after restoration. (Compare Appendix C2.1 with Figure 11.) However, EXPEAR did predict that the PSR would be below the acceptable level of 3.0 in 1989, and since it actually was 2.5 in 1988, the estimate was reasonable. In addition, EXPEAR predicted that the pavement would have transverse cracking, pumping and faulting of the FDRs in the early 1990s. This may be true, but there is no evidence of these distresses as of November 1988.

EXPEAR suggested the same four rehabilitation techniques for both the I-90 westbound (MP 61) and the I-90 eastbound, (MP 55) Snoqualmie Pass test sections.

However, the WSDOT would probably rehabilitate the westbound site (MP 61) with a totally different technique. The probable rehabilitation would include removing the outer lane and replacing it with a full depth asphalt concrete pavement, approximately 10 inches thick, and restoring the inner lane. The reasoning behind this strategy is that while the outer lane could be replaced with PCC, the inner lane still has another ten years (estimated) of useful life. By replacing the outer lane with AC which will deteriorate within approximately the same amount of time, the reconstruction or overlaying of both lanes at the same time is facilitated. The WSDOT feels that this is the most cost-effective solution to remedy the current conditions at this site.

Replacement of the outer lane with a full depth AC concrete pavement is also a possible rehabilitation strategy for the Spokane test site; however, it is more likely that WSDOT policies will cause this section to be reconstructed with 12-inch PCC pavement over a 4-inch asphalt treated base (ATB) with new PCC tied shoulders (if funding allows). Reconstruction of both lanes was also an option considered in the PCC Rehabilitation study, although the full depth AC concrete option was not considered. Another possibility under the WSDOT's consideration is an AC overlay with cracking and seating. EXPEAR recommends two major rehabilitation strategies for this pavement. These include overlay and reconstruction.

EXPEAR's recommendation to overlay the I-5 Seattle (MP 176) agreed with one of the WSDOT's options to rehabilitate this section. The WSDOT AC overlay option is to overlay the existing concrete pavement with 4.2 inches of AC concrete. However, as on the Spokane project, it is viable for the WSDOT to remove and replace the existing pavement with 12 or more inches of concrete, if funding is available.

EXPEAR REHABILITATION RESULTS

After EXPEAR provided the major rehabilitation options, various runs of the program were conducted for each of these options. The tables on the following pages summarize these runs, giving the predicted performance of the major rehabilitation techniques prescribed by EXPEAR (Table 1 for I-90, MP 278, Table 2 for I-5, MP 176, Table 3 for I-90, MP 55, Table 4 for I-90, MP 61). The summary displays the techniques applied and the predicted performance within a 20-year period for that design. What is actually shown is the year in which a particular distress type reaches an unacceptable level, based on the following critical values:

Medium-high severity reflective cracking (M-H sev crks)---125 per mile
Total reflective cracking (ref crks)---250 per mile
Rutting (rutting)---0.5 inch
Joint faulting (faulting)---0.13 inch average per mile
Transverse cracking (trns crks)---800 feet per mile
PSR (PSR)---3.0
Joint deterioration (jt deter)---55 joints per mile
Pumping (pumping)---1.0 (low severity)
FDR faulting (FDR faulting)---0.13 inch

The actual EXPEAR output from each of these runs is contained in Appendices A, B, C, and D. (It should be noted that some of the input values contained in these appendices and in Tables 1-4, such as the 7/8" dowels and the 0.5" bonded overlays, were used only to "exercise" EXPEAR and thus may not be realistic.)

TABLE 1. EXPEAR REHABILITATION SUMMARY FOR I-90 WEST, MP 278

1. Location
I-90 Westbound, Spokane
Starting Milepost: 278.60
Ending Milepost: 278.75

2. Current (1988)Pavement Distress Types
Faulting, Transverse and Longitudinal Cracking, Surface Polishing, Surface Wear

3. WSDOT Rehabilitation Options
- Reconstruction
  - 12" PCC pavement
  - 4" Asphalt Treated Base
  - PCC tied shoulders
- Crack and Seat with AC Overlay

4. EXPEAR Major Rehabilitation Options:
- Overlay
- Reconstruction

5. EXPEAR Rehabilitation Performance Summary

(a)AC Structural Overlay	
4.2" AC	rutting--1998 ttl ref crks--2000 M-H sev ref crks--1989
(b)AC Overlay with Crack and Seat	
2.5'X 2.5' pieces, 15 ton roller	
0.5" AC	rutting--1998
1.0" AC	rutting--1998
3.0" AC	rutting--1998
4.2" AC	rutting--1998
(c)PCC Bonded Overlay	
2.0" PCC	jt deter--2005 trans crks--1996
3.0" PCC	jt deter--2005 trans crks--1996
6.0" PCC	jt deter--2005 trans crks--1996
(d)PCC Unbonded Overlay	
5.0" PCC	trans crks--1989
7.0" PCC	trans crks--1990
10.0" PCC	trans crks--2000
11.4" PCC	trans crks--2007
11.5" PCC	no failure--20 yrs
(e) Reconstruction	
Stabilized Base, 15' Joint Spacing	
12" PCC	faulting--2007
12.1" PCC	faulting--2007
12.2" PCC	no failure--20 yrs
Granular Base, 15' Joint Spacing	
12" PCC	faulting--1992

TABLE 2. EXPEAR REHABILITATION SUMMARY FOR I-5 NORTH, MP 176

1. Location
I-5 North, Seattle
Starting Milepost: 176.35
Ending Milepost: 176.43

2. Current (1988) Pavement Distress Types
Longitudinal Cracking, Faulting, Surface Polishing, Surface Wear

3. WSDOT Rehabilitation Options
- Overlay
  - 4.2" AC overlay
- Reconstruction
  - 12" PCC pavement
  - 4" Asphalt Treated Base
  - PCC tied shoulders

4. EXPEAR Major Rehabilitation Options
- Overlay

5. EXPEAR Rehabilitation Performance Summary

(a)<u>AC Structural Overlay</u>

1.0" AC	rutting--2006
4.2" AC	rutting--2006
10.0" AC	rutting--2005

(b)<u>AC Overlay with Crack and Seat</u>

2.5'X 2.5' pieces, 15 ton roller	
5.0" AC	rutting--2006
4.2" AC	rutting--2006
3.0" AC	rutting--2006
2'X 2' pieces, 15 ton roller	
5.0" AC	rutting--2006
4.2" AC	rutting--2006
6'X 5' pieces, 15 ton roller	
4.2" AC	rutting--2006
2'X 2' pieces, 20 ton roller	
5.0" AC	rutting--2006
6'X 5' pieces, 20 ton roller	
4.2" AC	rutting--2006

(c)<u>PCC Bonded Overlay</u>

0.5" PCC	no failure--20 yrs
1.0" PCC	no failure--20 yrs
2.0" PCC	no failure--20 yrs
3.0" PCC	no failure--20 yrs

(d)<u>PCC Unbonded Overlay</u>

2.0"PCC	trans crks--1989
7.0"PCC	trans crks--1994
8.5"PCC	trans crks--2007
8.6"PCC	no failure--20 yrs

TABLE 3. EXPEAR REHABILITATION SUMMARY FOR I-90 EAST, MP 55

1. Location
I-90 Eastbound, Snoqualmie Pass
Starting Milepost: 55.50
Ending Milepost: 63.99

2. Pavement Distress Types (prior to 1986)
Faulting, Longitudinal and Transverse Cracking, Corner Breaks, Surface Polishing

3. WSDOT Rehabilitation Options
- Concrete Pavement Restoration
  - Full and partial slab replacements, reseal transverse joints subsealing, grinding

4. EXPEAR Major Rehabilitation Options
- Restore both lanes
- Overlay both lanes
- Reconstruct outer lane, restore inner lane
- Reconstruct both lanes

5. EXPEAR Rehabilitation Performance Summary

(a) Restore Both Lanes
Reseal longitudinal CL joint, FDR cracks and corner breaks, seal cracks, reseal transverse joints, grinding

faulting at joints--2003
FDR faulting--1993
trans crks--1995
pumping--1990
PSR--1989

(b)AC Structural Overlay

1.4" AC	M-H sev crks--2007
1.5" AC	no failure--20 yrs
2.0" AC	no failure--20 yrs
4.2" AC	no failure--20 yrs

(c)AC Overlay with Crack and Seat
2.5'X 2.5' pieces, 15 ton roller

1.4" AC	rutting--2007
1.5" AC	no failure--20 yrs
4.2" AC	no failure--20 yrs

(d)PCC Bonded Overlay

12" PCC	trans crks--1994, jt deter--2005
18" PCC	trans crks--1994, jt deter--2005

TABLE 3. EXPEAR REHABILITATION SUMMARY FOR I-90 EAST, MP 55
(Continued)

(e)PCC Unbonded Overlay	
No Dowels	
8" PCC	trans crks--1995
10.5" PCC	trans crks--2007
10.6" PCC	no failure--20 yrs
* 7/8" Dowels	
10.5" PCC	trans crks--2007
10.6" PCC	no failure--20 yrs
(f)Reconstruct Both Lanes	
No Dowels, Stabilized Base	
12" PCC	faulting--2007,pump--1990, PSR--1993
18" PCC	pump--1991, PSR--1995
No Dowels, Granular Base	
12" PCC	faulting--1992, pump--1990, PSR--1993
18" PCC	faulting--1997, pump--1991, PSR--1995
* 7/8" Dowels, Stabilized Base	
12" PCC	pump--1990, PSR--1993
18" PCC	pump--1991, PSR--1995
* 7/8" Dowels, Granular Base	
12" PCC	faulting--2005, pump--1990, PSR--1993
18" PCC	pump--1991, PSR--1995

* Actually, larger diameter dowels would be specified by WSDOT, if used.

TABLE 4. EXPEAR REHABILITATION SUMMARY FOR I-90 WEST, MP 61

1. Location
I-90 Westbound, Snoqualmie Pass
Starting Milepost: 61.00
Ending Milepost: 61.01

2. Current (1988) Pavement Distress Types
Faulting, Surface Polishing

3. WSDOT Rehabilitation Options
Full Depth Asphalt Concrete Pavement Replacement of Truck Lane
4.2" overlay

4. EXPEAR Major Rehabilitation Options
Restore Both Lanes
Overlay Both Lanes
Reconstruct Outer, Restore Inner
(not shown since analysis is includes outer lane only)
Reconstruct Both Lanes

5. EXPEAR Rehabilitation Performance Summary
(a)<u>Restore Both Lanes</u>
reseal longitudinal CL joint, FDR cracks and corner breaks, seal cracks, reseal transverse joints, grinding
jt faulting--2003
FDR faulting--1993
trans crks--1995
jt deter--1989
pump--1990
PSR--1989

AC nonstructural overlay, reseal longitudinal CL joint, FDR joints reseal transverse joints

1" AC	ref crks--2000, rutting--2006 M-H sev ref crks--1989
2" AC	M-H sev ref crks--1990

(b)<u>AC Structural Overlay</u>

2" AC	M-H sev ref crks--1991
4.2" AC	M-H sev ref crks--1990
10" AC	M-H sev ref crks--1990

(c)<u>AC Overlay with Crack and Seat</u>
2.5'X 2.5' pieces, 15 ton roller

1.4" AC	rutting--2007
1.5" AC	no failure--20 yrs
4.2" AC	no failure--20 yrs

6'X 5' pieces, 15 ton roller

1.4" AC	rutting--2007
1.5" AC	no failure--20 yrs
4.2" AC	no failure--20 yrs

TABLE 4. EXPEAR REHABILITATION SUMMARY FOR I-90 WEST, MP 61
(Continued)

(d)<u>PCC Bonded Overlay</u>

3" PCC	trans crks--1994, jt deter--2005
5" PCC	trans crks--1994, jt deter--2005
7" PCC	trans crks--1994, jt deter--2005
12" PCC	trans crks--1994, jt deter--2005
24" PCC	trans crks--1994, jt deter--2005

(e)<u>PCC Unbonded Overlay</u>

No Dowels, 15' joint spacing

10.5" PCC	trans crks--2007
10.6" PCC	no failure--20 yrs

No Dowels, 13' joint spacing

10.5" PCC	trans crks--2007
10.6" PCC	no failure--20 yrs

No Dowels, 10' joint spacing

10.5" PCC	trans crks--2007
10.6" PCC	no failure--20 yrs

(f)<u>Reconstruction</u>

No Dowels, 15' joint spacing, stabilized base, 650 psi PCC modulus of rupture

12" PCC	faulting--2007, pump--1990, PSR--1993
18" PCC	pump--1991, PSR--1995

No Dowels, 15' joint spacing, stabilized base, 750 psi PCC modulus of rupture

12" PCC	faulting--2007, pump--1990, PSR--1993
18" PCC	pump--1991, PSR--1995

7/8" Dowels, 15' joint spacing, stabilized base, 650 psi PCC modulus of rupture

12" PCC	pump--1990, PSR--1993
18" PCC	pump--1991, PSR--1995

7/8" Dowels, 15' joint spacing, stabilized base, 750 psi PCC modulus of rupture

12" PCC	faulting--2007, pump--1990, PSR--1993
18" PCC	pump--1991, PSR--1995

No Dowels, 15' joint spacing, granular base, 750 psi PCC modulus of rupture

12" PCC	faulting--1992, pump--1990, PSR--1993
18" PCC	faulting--1997, pump--1991, PSR--1995

EXPEAR REHABILITATION OUTPUT SUMMARY

(The following is based mostly on trends observed in Washington State.)

Although in general the transverse cracking model predicts cracking that is much more severe than WSDOT observed, the predicted distress trend for the I-90 (MP 278) Spokane project without rehabilitation was found to be reasonable. This could be because transverse cracking already exists on this site and the model is calibrated more appropriately than when no cracking is present. In addition, the amounts of transverse cracking predicted for unbonded overlays were both reasonable and sensitive to overlay thicknesses.

The transverse cracking model is insensitive to existing cracks that would be expected to return in PCC bonded overlays. For example, the 2-inch bonded overlay on the I-90 (MP 278) Spokane project is given too much integrity in regard to its ability to resist transverse cracking. Although EXPEAR assumes full depth repairs (FDR) of cracks before they are overlaid, the remaining life of the old pavement underneath the overlay is questionable and could reasonably be expected to crack.

The EXPEAR models predict premature failures for newly reconstructed pavements that the WSDOT has observed to perform very well for performance periods greater than 20 years. For example, consider the I-90 westbound (MP 61) Snoqualmie Pass project. Newly reconstructed pavements of both 12 and 18 inches with stabilized bases are predicted to have significant amounts of pumping and a PSR of 3.0 or less in the early 1990's--only a few years after reconstruction (Appendices D7.1-D7.8). The same is basically true for the reconstructed pavements proposed for the I-90 eastbound (MP 55) Snoqualmie Pass project (Appendices C7.1,C7.2,C7.5,C7.6). This is not representative of what has been observed in Washington state. Pavements only 8 or 9 inches thick with granular bases have been known to have a useful life of 30 years. A 12-inch thick pavement with an asphalt treated base would be expected to have a useful life of 35 to 40 years in Seattle, where the climate is a little milder but the traffic volume is much greater than that at Snoqualmie Pass. In addition, EXPEAR's predicted performance of these new pavements seems to be inconsistent with the AASHTO Design Guide [15].

EXPEAR predicts the severity of reflection cracking to be greater in a pavement that has undergone cracking and seating before overlaying than in one that has not, even though it predicts more total reflection cracking in the latter pavement. For example, consider the following 20-year quantities of reflection cracking predicted for these proposed I-5 northbound (MP 176) Seattle rehabilitation designs (Appendix A3.2 and A2.2):

	Cracking	
	M-H Severity	Total
4.2" AC overlay with cracking and seating	158	573
4.2" AC overlay (no cracking and seating)	0	1089

One would expect just the opposite to be true; that is, while there may be more reflective cracking in an overlay with cracking and seating (primarily because there are more cracks that can be reflected) the severity level of those cracks should be less than in the overlay without cracking and seating. Reducing the slab size reduces the relative vertical movement because of at least the following two reasons: First, if any voids exist beneath the pavement that may cause the uncracked panel to rock when it is loaded, the seating process will drive the smaller pieces into the base/subgrade, eliminating the potential for rocking. Secondly, the slab curling, which commonly occurs in slabs subject to varying temperatures, will be reduced in a shorter slab [16].

Often, EXPEAR predicts distress trends that are not reasonable, such as the improvement (self-healing effect) of the PSR over time. Specifically this occurred on the 12.2-inch newly reconstructed PCC pavement for the I-90 westbound (MP 278) Spokane project (Appendix B6.3). EXPEAR predicted the PSR to be 4.5 in the present year and by the year 2007, up to 4.6. It is not apparent why the PSR model calculated these predictions. Another example of an unreasonable prediction is the forecast that the depth of rutting will exceed the thickness of an AC overlay. This occurred on the 0.5 inch and 1.0 inch overlays with cracking and seating on the I-90, (MP 278) Spokane project (Appendices B3.1, B3.2). The predicted 20-year rutting depths were 1.34 inch and 0.5 inch for the 0.5 and 1.0 inch overlays, respectively.

Another concern is that the PSR is often predicted to reach a level of "0". One expects that few, if any, of the EXPEAR models were based on a PSR level of "0" (or approaching "0").

The reflection cracking model is not especially sensitive to AC overlay thicknesses. This was demonstrated in the predictions for the I-90 (MP 278) Spokane AC overlays with cracking and seating. Both the 4.2-inch and 0.5-inch overlays (also the 3-inch and 1-inch) were predicted to have exactly the same amount of reflection cracking over the 20-year period (Appendices B3.4, B3.1). This does not seem reasonable since, in general, thicker overlays provide better load transfer across the joints, reducing the amount of reflection cracking.

EXPEAR does not distinguish asphalt treated bases from other stabilized bases, such as cement or lime stabilized bases, which are known to perform differently. In addition, EXPEAR does not account for the unique material properties found in Washington, such as the strength and durability of asphalt concrete mixes used in overlays, or asphalt treated bases used beneath concrete pavements.

A test of the risk of rehabilitation options, as well as the human element, appears to be missing from the "expert" program, which relies heavily on predictive models. This is best shown by the example in which the user may input unreasonable overlay thicknesses for evaluation, such as the 0.5-inch PCC bonded overlay which was predicted to perform successfully for 20 years on the I-5 northbound (MP 176) Seattle project (Appendix A4.1). Not only would a bonded overlay be a poor rehabilitation strategy candidate for this project because it is not structurally sound, but it clearly would not perform as EXPEAR predicts. The same may be said for the 1.5-inch AC overlay with cracking and seating on the I-90 eastbound (MP 55) Snoqualmie Pass project (Appendix C4.2). This was predicted not to fail within 20 years as well, which is very unlikely. An expert system should have some minimum standards that prevent the input of unreasonable thicknesses.

Finally, EXPEAR does not address longitudinal cracking, which is a significant distress type in Washington state, in its predictive models.

CHAPTER 3. APPRAISAL AND APPLICATION

INTRODUCTION

Based on the research team's experience with the EXPEAR program, a number of observations regarding the user friendliness, the EXPEAR manual, program bugs, and opportunities for program enhancement were made. The following chapter summarizes these findings.

POSITIVE ATTRIBUTES OF EXPEAR

The following items were considered to be some of the positive attributes of the EXPEAR system:

- EXPEAR incorporates some of the information known about pavement rehabilitation options and assembles it in a useful manner.
- The estimates of future pavement performance could be useful in the scoping and planning stages of rehabilitation projects.
- EXPEAR provides an automated procedure for organizing survey inventory and monitoring data that did not previously exist.
- By allowing the user to manipulate and analyze a variety of rehabilitation options that are applicable to a particular project, different geographical locations are accommodated while the analysis of other options is encouraged.
- EXPEAR provides a standardized method of evaluating concrete pavements and classifying distresses (COPES).
- EXPEAR addresses the problem of documenting the heuristic knowledge possessed by pavement engineers that is necessary for successful rehabilitation design.
- In its current form, EXPEAR (version 1.1) is a relatively "bug-free" program, that functions smoothly and quickly.

EASE OF OPERATION AN USER FRIENDLINESS

The following items refer to items in the EXPEAR system which either hampered the ease of operation or detracted from the user friendliness of the program. Also noted are possible ways by which these problems could be addressed.

Ability of User to Specify Performance Period

Currently, concrete pavements are often designed for 30-year initial performance periods, but EXPEAR only uses a 20-year analysis period. The ability of the user to specify the performance period would accommodate the analysis of pavements that are known to last longer than 20 years.

Printing EXPEAR's Various Documents

In the program's present form, it is difficult to print the various output documentation EXPEAR generates. Print options are generally found only at the end of a program input session, making it impossible to retrieve old outputs without running through the input sequences again or exiting the program completely and printing from the disk operating system (DOS). A print menu that lists the various documents in the directory would be very helpful.

Ability to View Filenames of Existing Projects

When asked for a filename as input, the user should be able to view those that are available and not have to rely on memory or exit the program to view the DOS directory.

Requests for Irrelevant Data

When the toggle item "uniform joint spacing" is selected, the program should skip the question, "Transverse joint sequence, if random (feet):". Likewise, the request for "dowel bar diameter" should be skipped when "aggregate interlock" has been input as the load transfer mechanism. These types of requests for irrelevant data should be eliminated.

The ability to copy information that is likely to be identical for all sample units on a given project (drainage, loss of support, surface condition, joint sealant condition, concrete durability, previous repair) would be a time-saving enhancement. Likewise, the climate information that is requested by EXPEAR when it evaluates the performance of AC overlays should be retrieved from the initial project information file (including monthly temperature range).

Ability to Output Evaluations Directly to Printer

The user should be able to obtain a hard copy of the output without viewing it on the screen, which can be tedious and time-consuming.

Documentation of Rehabilitation Strategies Evaluated

Rehabilitation performance prediction output should be labeled with the material thicknesses, dowel bar diameters, joint spacings, material properties, project name, and other pertinent data.

Inputting the Number of Lanes on the Project

The toggle item should be for one or two lanes only, since the input of three or more lanes will result in an execution error.

EXPEAR MANUAL

Include Calibration Variables in PSR and Pumping Models

Pages 303 and 302 [2] should be corrected to show the calibration variables that the EXPEAR program uses to account for the present levels of distress.

Specify that "Joint Deterioration" Refers to Transverse Cracking

The manual, which refers to NCHRP 277 [11] for definitions of distress, should cite that a "deteriorated joint" refers to spalling of various severities (not faulting or joint sealant condition).

Specify that Cracking Model Refers to Transverse Cracking

Page 299 should cite that cracking refers to the total length of transverse cracking and does not include longitudinal cracking.

Cite that AVGMT is Equivalent to the Average Annual Temperature

In the PSR model, page 303, it should be pointed out that the average monthly temperature (AVGMT) is actually the same as the average annual temperature that EXPEAR requests as input.

Include "Tally Sheets" for the I10191 Sample Project

The inclusion of tally sheets for the sample project would be helpful in extending the procedures to other projects.

Include an Annual Precipitation Chart of Useful Scale

The annual precipitation chart included on page 260 should be blown up by sections to a legible scale.

PROGRAM BUGS

Only two "bugs" were found in EXPEAR. These are listed below.

An Execution Error Results if More than Two Lanes are Input for Analysis

This problem could be corrected if a toggle item that limited the number to one or two lanes only was used to input the value.

A Calculation Error Exists in the Restoration Future Distress Predictions Subroutine

When restoration has been selected as a rehabilitation technique, the program calculates the age of the pavement to be thousands of years older than it is (See Appendices D2.1,C2.1).

ENHANCEMENTS

In addition to the minor improvements to the program suggested above, several opportunities for significant enhancement exist. Some of these enhancements may have already been incorporated into new versions of EXPEAR that were not available for review, but they are mentioned here to underscore their importance.

Provide Cost Analysis for the Various Rehabilitation Strategies

Without a cost analysis, it is impossible to select the most appropriate and cost-effective rehabilitation strategy. A subroutine in the program to calculate construction and life cycle costs would facilitate this analysis, at least on a preliminary level. The program should allow the user to specify unit prices of construction and maintenance materials, as well as the analysis period.

Provide the Ability to Delay Rehabilitation for Analysis Purposes

Although EXPEAR addresses the condition of the pavement if no rehabilitation occurs by predicting the distresses for the next 20 years, it does not address the common situation in which rehabilitation cannot occur until some time later than the present year. The system would be more valuable if it could accept the distress values predicted at some specified point in time in the future and then use those values as input for the rehabilitation strategies.

Improve the Program's Capability to Explain its Line of Reasoning

One advantage of expert systems in general is their ability to explain the reasoning employed to reach conclusions. An inference engine should have the ability not only to use the rules and data in the knowledge-base to make conclusions, but also to retrace its path to explain which rules and data were critical to the conclusions. Although EXPEAR makes some references as to the critical values that caused it to select certain branches within decision trees, its overall transparency could be greatly improved. The benefits of explanation are threefold. First, erroneous, inconsistent or inappropriate rules are revealed. Secondly, the user has more confidence in the answers received from the system. Finally, the system could be used as a learning tool [3].

Include a Graphics Package

The capability of the system to plot distress trends for the purposes of comparing rehabilitation techniques, as well as to show the future conditions of a pavement without rehabilitation, would be a significant enhancement to the output obtained from EXPEAR.

CHAPTER 4. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The obvious high level of effort expended in creating EXPEAR, a unique system to aid in the design of pavement rehabilitation, is commendable. A system of this type can be a useful tool not only for pavement design but also as a scoping and planning tool for pavement rehabilitation. In addition, it provides an automated, practical means of recording pavement survey and monitoring data, which did not previously exist.

However, the Washington State DOT will probably not use EXPEAR in its present form. The performance predictions of both existing pavements and rehabilitation strategies are generally inconsistent with what has been observed in Washington state. For the near term, individual performance models that are found to be representative of Washington's conditions will be used where applicable (mostly for rehabilitation scoping or planning).

RECOMMENDATIONS

The models primarily used in EXPEAR are from the COPES. Because of local conditions (such as the independent variables being zero in multiplicative models, such as the joint deterioration model) these models had little chance of producing reasonable predictions. However, because of various factors, the exact duplication of field observations and test results is impractical. While the first condition should be investigated by the developers of EXPEAR, the last reason suggests that both the developers and users of EXPEAR will have to develop a level of tolerable and acceptable differences if EXPEAR and systems like it are to become an integral part of pavement engineering.

Perhaps the most beneficial aspect of an expert system is the separation of the inference engine and the knowledge base, since once the mechanics of the inference engine and the structure of rules has been established, the computer code should ideally never need to be rewritten whenever new rules or data are added. Once the program has been written, the programmer should be relieved of the burden of system maintenance. It should be placed in the hands of the experienced engineer, since the pavement engineer is most familiar with the data and is responsible for the answers produced by the system. Therefore this person should appropriately be entrusted with the structure of the system [3]. In addition, this would facilitate continual improvements and customization of the knowledge-base.

There are basically two ways to accommodate this, and really only one that may be appropriate. One option that should be avoided is to make the program source code available to all users. A completely "open" system presents several problems. First, an inexperienced programmer attempting to improve or correct the program, may aggravate existing errors with additional errors by not employing defensive programming techniques. The result of this action is that the program may produce results anywhere from slightly incorrect to absurd and could conceivably become unexecutable. Secondly, the EXPEAR developers could not provide support to programs that had been significantly modified.

However, another possibility is to create a system with completed shells so that rules may be introduced by the various users of EXPEAR. If the system could be created so that the user could introduce new rules for given computer runs, the system would not permanently incorporate the rules until they were authorized by an EXPEAR developer [17]. This could be a powerful tool in the hands of a competent pavement engineer, while it would also prevent possible damage to the system. In addition, if significant interest in improving the system existed among state highway agencies, an annual national workshop could be established at which proposals for enhancements, changes, and additions to the system could be made.

Since the program source code was not available for review in this study, it is not apparent that EXPEAR would lend itself to this kind of situation. However, it does not seem that it would be too difficult to make the coefficients of variables contained in various distress models modifiable to become more representative of local conditions.

In light of the above comments, this author recommends that further development of the inference engine and the definition of the rule structure be undertaken, for it is essential that the program be dynamic and have the capability to be customized to meet individual state requirements and conditions.

REFERENCES

1. "Key Facts: A Summary of Useful Transportation Data," Washington Department of Transportation, Olympia, Washington, September 1985.

2. "Development of an Expert System for Concrete Pavement Evaluation and Rehabilitation," Proceedings, Second North American Conference on Managing Pavements, 1987.

3. Flanagan, P.R. and Halbach, D.S., "Expert Systems as a Part of Pavement Management," Transportation Research Record 1123, January 1987.

4. Finn, G.A. and Reinschmidt, K.F., "Expert Systems in an Engineering-Construction Firm," Expert Systems in Civil Engineering, ASCE, 1986, pp. 40-54.

5. Wentworth, J.A., "Advisory (Expert) Systems--An Assessment of Opportunities in the Federal Highway Administration," Public Roads Vol. 51, No.2, September 1987, pp. 36-41.

6. Ritchie, S.G., Yeh, C-I, Mahoney, J.P., Jackson, N.C., "A Surface Condition Expert System For Pavement Rehabilitation," California University, Irvine Institute of Transportation Studies Irvine California 92717, August 1986.

7. Tandon, R.P. and Sinha, K.C., "An Expert System to Estimate Highway Pavement Routine Maintenance Work Load," National Research Council Transportation Research, Washington D.C., 1988.

8. Alshawi, M. and Cabrera, J.G., "An Expert System to Evaluate Concrete Pavements," Microcomputers in Civil Engineering, VOL 3, 1988, Elsevier Science Publishing Co., Inc., United Kingdom, pp. 191-197.

9. Transportation Research Board, Announcement of "Workshop on Expert Systems in Pavement Engineering," November, 1988.

10. Hall, K.T. and Darter, M.I., "User's Guide for EXPEAR, Expert System for Concrete Pavement Evaluation and Rehabilitation," University of Illinois at Urbana-Champaign, November 2, 1988.

11. Darter, M. I., Becker, J.M., Snyder, M.B., and Smith, R.E., "Concrete Pavement Evaluation System (COPES)," NCHRP Report No. 277, Transportation Research Board, 1984.

12. Pierce, L.M., "A Life-Cycle Cost Analysis for the Rehabilitation of Portland Cement Concrete Pavement in Washington State," (Thesis) University of Washington, 1988.

13. Climates of the States, Vol. 2, 3rd Edition, 1985, Gale Research Co., pp.1199, 1200.

14. U.S. Weather Bureau Climatological Summary, Washington State, 1964, p. R60-20.

15. American Association of State Highway and Transportation Officials, AASHTO Guide for Design of Pavement Structures, Washington, D.C., 1986, pp.II-37-II-49.

16. Federal Highway Administration, "Crack and Seat Performance," Review Report, Washington D.C. April 1987.

17. Kostem, C.N. (Fritz Engineering Laboratory) "Attributes and Characteristics of Expert Systems," Expert Systems in Civil Engineering, ASCE, 1986, pp. 30-39.

APPENDIX A

I-5 NORTH (MP 176) SEATTLE EXPEAR OUTPUT

APPENDIX A
I-5 NORTH (MP 176) SEATTLE
EXPEAR OUTPUT

EXPEAR 1.1

PROJECT EVALUATION AND REHABILITATION RECOMENDATIONS

FOR: **seattle**

1. Project Summary
2. Current Evaluation
3. Physical Testing Recommendations
4. Future Distress Predictions

Project Survey Summary For JRCP

Design engineer: Holly Simmons   Date of survey: 07/22/88

PROJECT IDENTIFICATION

Highway designation: I-90
State: washington
Direction of survey: North
Starting milepost: 176.35
Ending milepost: 176.43

Number of sample units: 3

CLIMATE

Climatic zone: wet nonfreeze
Estimated annual temperature range (F): 38.7
Mean annual precipitation (inches): 38.5
Corps of Engineers freezing index (Fahrenheit degree-days): 25.0
Average Annual Temperature (degrees Fahrenheit): 52.70

SLAB CONSTRUCTION

Year constructed: 1965
Slab thickness (inches): 9.0
width of traffic lanes (feet): 12.00
Concrete 28-day modulus of rupture (psi): 650.00

TRANSVERSE AND LONGITUDINAL JOINTS

Pattern of joint spacing: uniform
Transverse joint spacing if uniform (feet): 15.0
Transverse joint sequence if random (feet):
Type of sealant: liquid
Average transverse joint reservoir dimensions:
width (inches): 0.25
depth (inches): 1.50

Method used to form transverse joints: sawing
Transverse joint sawed depth (inches): 1.5

Type of load transfer system: aggregate interlock
Dowel bar diameter (inches): 0.00
Method used to form longitudinal joints between lanes: sawing
Longitudinal joint sawed or formed depth (inches): 2.3

BASE

Base type: dense-graded untreated aggregate
Modulus of subgrade reaction (psi/inch): 200.00

SUBGRADE

Predominant subgrade soil AASHTO classification: A4
Are swelling soils a problem in area: no
Were steps taken to prevent the swelling soils problem: n/a

SHOULDER

Type of shoulder: AC

Width of shoulders (feet): inner: 4.0 outer: 10.0

Inner lane slope direction: toward inner shoulder

TRAFFIC

Estimated current through two-way ADT: 145900

Percent commercial trucks: 4.0

Total number of lanes in direction of survey: 2

Future 18-kip ESAL growth rate (percent per year): 2.5

Truck traffic volume growth rate: approximately same as in past

	Lane two	Lane one
Total accumulated 18-kip ESAL (millions):	2.74	13.70
RIDE QUALITY		
PSR	3.5	3.4

```
SAMPLE UNIT IDENTIFICATION
   Sample unit number:  1/                   Starting milepost:  176.3
   Length of sample unit (feet): 60.0
                                                      Lane two         Lane one
   Number of deteriorated transverse cracks. L-M-H:    0                  0
   Mean faulting at transverse cracks (inches):       0.00               0.00
   Number of deteriorated transverse joints:           0                  0
   Mean faulting at transverse joints (inches):       0.00               0.07
   Number of transverse joints:                        4                  4
   Number of FDRS & slab replacements:                 0                  0
   Mean faulting at FDR & slab repl. jnts (inches):   0.00               0.00
   Number of FDR & slab replacement joints:            0                  0
   Number of corner breaks:                            0                  0
   Length of long. cracking, M-H only (feet):         0.0                30.0
   Length of scalling of longit. joint, M-H only:                        0.0

CRACKING AT TRANSVERSE JOINTS
   Total joints with trans. cracks within 2 feet:      0                  0

FOUNDATION MOVEMENT
   Number of settlements (M-H severity):               0                  0
   Number of heaves (M-H severity):                    0                  0

DRAINAGE
   Are longitudinal subdrains present and functional:  no
   What is the typical height of the pavement above the ditchline:  10.0
   Do ditches have standing water or cattails in them:  no

LOSS OF SUPPORT
   Extent of evidence of pumping or water bleeding:  none              none

SURFACE CONDITION
   Method used to texture the pavement at construction:  other
   Is the surface polished in the wheelpaths:        yes               yes
   Is significant tire rutting in the wheelpaths:    yes               yes

JOINT SEALANT CONDITION
   Condition of the transverse joint sealant:        high              high
   Condition of the longitudinal joint sealant:                        high
   Are substantial amnts of incompressibles in jnts: no                no

CONCRETE DURABILITY
   Extent of "D" cracking at joints or cracks:       none              none
   Extent of reactive aggregate distress:            none              none
   Extent of scaling:                                none              none

PREVIOUS REPAIR
   Are full-depth repairs placed with dowels:        yes               yes
   Are partial depth repairs present at most joints: no                no
   Has diamond grinding been done:                   no                no
   Has grooving been done:                           no                no
```

AC SHOULDERS	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/ravelling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	none
Blowholes at transverse joints:	none	some
Lane/Shoulder joint condition:	poor	poor

```
SAMPLE UNIT IDENTIFICATION
   Sample unit number:  07                      Starting milepost:  176.4
   Length of sample unit (feet): 60.0
                                                        Lane two          Lane one
   Number of deteriorated transverse cracks. L-M-H:       0                  0
   Mean faulting at transverse cracks (inches):         0.00               0.00
   Number of deteriorated transverse joints:              0                  0
   Mean faulting at transverse joints (inches):         0.00               0.11
   Number of transverse joints:                           4                  4
   Number of FDRS & slab replacements:                    0                  0
   Mean faulting at FDR & slab repl. jnts (inches):     0.00               0.00
   Number of FDR & slab replacement joints:               0                  0
   Number of corner breaks:                               0                  0
   Length of long. cracking, M-H only (feet):           0.0               30.0
   Length of spalling of longit. joint, M-H only:                          0.0

CRACKING AT TRANSVERSE JOINTS
   Total joints with trans. cracks within 2 feet:         0                  0

FOUNDATION MOVEMENT
   Number of settlements (M-H severity):                  0                  0
   Number of heaves (M-H severity):                       0                  0

DRAINAGE
   Are longitudinal subdrains present and functional:  no
   What is the typical height of the pavement above the ditchline:  10.0
   Do ditches have standing water or cattails in them:  no

LOSS OF SUPPORT
   Extent of evidence of pumping or water bleeding:    none               none

SURFACE CONDITION
   Method used to texture the pavement at construction:  other
   Is the surface polished in the wheelpaths:          yes                yes
   Is significant tire rutting in the wheelpaths:      yes                yes

JOINT SEALANT CONDITION
   Condition of the transverse joint sealant:          high               high
   Condition of the longitudinal joint sealant:                           high
   Are substantial amnts of incompressibles in jnts: no                   no

CONCRETE DURABILITY
   Extent of "D" cracking at joints or cracks:         none               none
   Extent of reactive aggregate distress:              none               none
   Extent of scaling:                                  none               none

PREVIOUS REPAIR
   Are full-depth repairs placed with dowels:          n/a                n/a
   Are partial depth repairs present at most joints: no                   no
   Has diamond grinding been done:                     no                 no
   Has grooving been done:                             no                 no
```

AC SHOULDERS	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/ravelling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	none
Blowholes at transverse joints:	none	none
Lane/Shoulder joint condition:	poor	poor

```
SAMPLE UNIT IDENTIFICATION
   Sample unit number:  37                    Starting milepost:  176.4
   Length of sample unit (feet): 60.0
                                                          Lane two        Lane one
   Number of deteriorated transverse cracks, L-M-H:         0               0
   Mean faulting at transverse cracks (inches):           0.02            0.00
   Number of deteriorated transverse joints:                0               0
   Mean faulting at transverse joints (inches):           0.00            0.13
   Number of transverse joints:                             4               4
   Number of FDRS & slab replacements:                      0               0
   Mean faulting at FDR & slab repl. jnts (inches):       0.00            0.00
   Number of FDR & slab replacement joints:                 0               0
   Number of corner breaks:                                 0               0
   Length of long. cracking, M-H only (feet):             50.0            45.0
   Length of spalling of longit. joint, M-H only:                         0.0

CRACKING AT TRANSVERSE JOINTS
   Total joints with trans. cracks within 2 feet:           0               0

FOUNDATION MOVEMENT
   Number of settlements (M-H severity):                    0               0
   Number of heaves (M-H severity):                         0               0

DRAINAGE
   Are longitudinal subdrains present and functional:  no
   What is the typical height of the pavement above the ditchline:  10.0
   Do ditches have standing water or cattails in them:  no

LOSS OF SUPPORT
   Extent of evidence of pumping or water bleeding:  none           none

SURFACE CONDITION
   Method used to texture the pavement at construction:  other
   Is the surface polished in the wheelpaths:         yes            yes
   Is significant tire rutting in the wheelpaths:     yes            yes

JOINT SEALANT CONDITION
   Condition of the transverse joint sealant:         high           high
   Condition of the longitudinal joint sealant:                      high
   Are substantial amnts of incompressibles in jnts: no             no

CONCRETE DURABILITY
   Extent of "D" cracking at joints or cracks:        none           none
   Extent of reactive aggregate distress:             none           none
   Extent of scaling:                                 none           none

PREVIOUS REPAIR
   Are full-depth repairs placed with dowels:         n/a            n/a
   Are partial depth repairs present at most joints: no             no
   Has diamond grinding been done:                    no             no
   Has grooving been done:                            no             no
```

AC SHOULDERS	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/ravelling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	none
Blowholes at transverse joints:	none	none
Lane/Shoulder joint condition:	poor	poor

```
           Extrapolated (Per Mile) Values For seattle

                                                     Lane two            Lane one
Number of deteriorated transverse cracks:                0                   0
Mean faulting at deter. trans. cracks (inches):       0.00                0.00
Number of deteriorated transverse joints:                0                   0
Mean faulting at transverse joints (inches):          0.00                0.10
Number of transverse joints:                           352                 352
Number of full-depth repairs:                            0                   0
Mean faulting at FDR joints (inches):                 0.00                0.00
Number of full-depth repair joints:                      0                   0
Number of corner breaks:                                 0                   0
Length of long. cracking, M-H only (feet):          1466.7                 3080.0
Length of spalling of longit. joint, M-H only:                            0.0

Total joints with trans. cracks within 2 feet:          0                   0

Number of settlements (M-H severity):                   0                   0
Number of heaves (M-H severity):                        0                   0
```

```
                     CURRENT PAVEMENT EVALUATION

***************************************************************************
LANE 1
***************************************************************************

----------------------------------------------------------------------
JOINT CONSTRUCTION DEFICIENCY:

A longitudinal joint construction deficiency in lane 1, likely due to
an inadequate depth of saw cut, is indicated by longitudinal cracking.

a. seal longitudinal cracks
b. stitch longitudinal cracks

The pavement in lane 1 shows no indications of a transverse joint
construction deficiency.

a. do nothing
----------------------------------------------------------------------
JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 1 by medium-
to high-severity joint sealant damage and an inadequate joint sealant
reservoir shape factor for the existing sealant type.

a. reseal transverse joints
----------------------------------------------------------------------
ROUGHNESS:

Rideability in lane 1 is acceptable.

a. do nothing
----------------------------------------------------------------------
DURABILITY DEFICIENCY:

The pavement in lane 1 shows no indications of significant surface or
concrete durability problems.

a. do nothing
----------------------------------------------------------------------
JOINT DETERIORATION:

Joint deterioration or other pavement deterioration in lane 1 may be
accelerated by water infiltration permitted by poor longitudinal
joint sealant condition.

a. reseal longitudinal centerline joint

No joint deterioration exists in lane 1.

a. do nothing
----------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

Structural deficiency of the pavement in lane 1 is indicated by a wet
```

or wet-dry climate, a slab thickness of 9.0 inches and 0.44 million annual 18-kip ESALs.

a. AC structural overlay
b. crack and seat and AC structural overlay
c. PCC bonded overlay
d. PCC unbonded overlay

SKID RESISTANCE DEFICIENCY:

Loss of skid resistance and potential for hydroplaning are indicated in lane 1 by polished wheel paths and studded tire rutting of 0.25 inches or more.

a. grinding
b. AC nonstructural overlay

LOAD TRANSFER DEFICIENCY:

No load transfer deficiency is indicated at transverse joints in lane 1.

a. do nothing

A potential load transfer deficiency exists at undowelled full-depth repairs in lane 1, but mean full-depth repair faulting is not significant.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

The pavement in the lane 1 shows no indications of loss of slab support.

a. do nothing

DRAINAGE DEFICIENCY:

The pavement in lane 1 shows no indications of a drainage deficiency.

a. do nothing

```
****************************************************************************
LANE 2
****************************************************************************

----------------------------------------------------------------------
JOINT CONSTRUCTION DEFICIENCY:

The pavement in lane 2 shows no indications of a transverse joint
construction deficiency.

a. do nothing
----------------------------------------------------------------------
JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 2 by medium-
to high-severity joint sealant damage and an inadequate joint sealant
reservoir shape factor for the existing sealant type.

a. reseal transverse joints
----------------------------------------------------------------------
ROUGHNESS:

Rideability in lane 2 is acceptable.

a. do nothing
----------------------------------------------------------------------
DURABILITY DEFICIENCY:

The pavement in lane 2 shows no indications of significant surface or
concrete durability problems.

a. do nothing
----------------------------------------------------------------------
JOINT DETERIORATION:

No joint deterioration exists in lane 2.

a. do nothing
----------------------------------------------------------------------
STRUCTURAL DEFICIENCY:
----------------------------------------------------------------------
SKID RESISTANCE DEFICIENCY:

Loss of skid resistance and potential for hydroplaning are indicated
in lane 2 by polished wheel paths and studded tire rutting
of 0.25 inches or more.

a. grinding
b. AC nonstructural overlay
----------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency is indicated at transverse joints in lane 2.

a. do nothing
```

A potential load transfer deficiency exists at undowelled full-depth repairs in lane 2, but mean full-depth repair faulting is not significant.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

The pavement in the lane 2 shows no indications of loss of slab support.

a. do nothing

DRAINAGE DEFICIENCY:

The pavement in lane 2 shows no indications of a drainage deficiency.

a. do nothing

****

INNER SHOULDER

****

Excessive infiltration of water beneath the pavement and inner AC shoulder is indicated by poor lane/shoulder joint sealant condition.

a. reseal lane/shoulder joint
b. do nothing

****

OUTER SHOULDER

****

Excessive infiltration of water beneath the pavement and **outer AC** shoulder is indicated by poor lane/shoulder joint **sealant condition.**

a. reseal lane/shoulder joint
b. do nothing

PHYSICAL TESTING RECOMMENDATIONS

NONDESTRUCTIVE DEFLECTION TESTING

Nondestructive deflection testing (NDT) of the pavement is recommended to further investigate deficiencies observed in the preliminary evaluation of the pavement. Use a Falling Weight Deflectometer or other NDT device capable of applying dynamic loads to the pavement over a range of load levels comparable to actual truck wheel loads (i.e., 9000 to 16000 pounds).

Nondestructive deflection testing should be conducted in a 0.1-mile section randomly selected within each mile of the project. Deflection testing should onl be conducted when the ambient temperature is between 50 and 80 degrees Fahrenhei to avoid joint and crack lock-up and excessive curling.

Testing should be performed at the following locations:

Center of the slab: Measure deflection basin in the center of the traffic lane in order to backcalculate elastic modulus of slab and effective k value be the slab. This information may be used in a structural analysis of the pavement in determining uniformity of support along the project (see NCHRP Report No. 281
Lane edge: Measure deflections at the outer edge of the traffic lane (next to the shoulder). If the pavement has a tied concrete shoulder, also measu deflections across lane/shoulder joint. This information may be used in a structural analysis of the pavement.

Corner of the slab: Measure deflections across transverse joints and cracks and compute their load transfer efficiencies. This information will be used in a structural analysis of the pavement.

DESTRUCTIVE DEFLECTION TESTING

Destructive testing (obtaining samples of material from the pavement structure) is recommended to further investigate deficiencies observed in the preliminary e material samples must be obtained by coring through the concrete surface and base with a core bit (6-inch diameter unless specified otherwise). Granular base bulk samples should be obtained. Stabilized base samples should be obtained from coring, if possible. Where undisturbed soil samples are require they should be obtained by sampling the soil beneath the pavement and base a thin-walled Shelby tube.

Each type of destructive testing required should be conducted on at least one and preferably three or more slabs in each 0.1-mile section randomly selecte within each mile of the project. For reasons of efficiency and safety, nondestru testing and destructive testing should be conducted concurrently.

The following types of destructive testing are recommended:

Obtain cores from the center of the traffic lane.

Obtain cores through selected transverse joints.

At locations along the longitudinal joint with significant spalling or nearby longitudinal cracks, core through the longitudinal joint (and adjacent cracks, if present). Examine the cores visually to determine whether the joint or one or more of the cracks is functioning as a joint.

Visual inspection and possibly laboratory testing of material samples obtained from destructive testing (coring) is recommended. The following types of information should be obtained from the material samples:

The strength of the cores obtained from the concrete slab should be determined by indirect tension testing in the laboratory. This information may be used in a structural analysis of the pavement. In the case of concrete deterioration due to poor durability (e.g., D cracking or reactive aggregate), the strength of the concrete is an indicator of the extent of the deterioration.

Examine the cores obtained from the center of the slab and through the transverse joints to determine the thickness and soundness of the concrete.

Determine the thickness of the base layer by examining the base material obtained from the coring operation.

SKID TESTING

No skid testing of the pavement is warranted because a structural deficiency exists and surface will likely be overlaid or reconstructed.

------------------------- ROUGHNESS TESTING --------------------------

Roughness testing is not warranted.

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 1

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	**Deter. Joints**	Transverse Cracking	PSR
13.7	0.79	1988	0.0	0.10	0	0	3.4
14.5	0.81	1989	0.0	0.10	0	20	3.3
15.3	0.83	1990	0.1	0.10	0	41	3.2
16.2	0.85	1991	0.1	0.11	0	63	3.2
17.0	0.87	1992	0.2	0.11	0	88	3.1
17.9	0.89	1993	0.2	0.11	0	114	3.0
18.8	0.91	1994	0.3	0.11	0	142	2.9
19.8	0.93	1995	0.3	0.11	0	173	2.8
20.7	0.96	1996	0.3	0.11	0	207	2.7
21.7	0.98	1997	0.4	0.11	0	243	2.6
22.7	1.01	1998	0.4	0.11	0	282	2.5
23.8	1.03	1999	0.5	0.11	0	325	2.4
24.8	1.06	2000	0.5	0.11	0	372	2.3
25.9	1.08	2001	0.5	0.11	0	422	2.2
27.0	1.11	2002	0.6	0.11	0	477	2.1
28.2	1.14	2003	0.6	0.12	0	537	2.0
29.3	1.17	2004	0.7	0.12	0	602	1.9
30.5	1.20	2005	0.7	0.12	0	672	1.8
31.7	1.23	2006	0.7	0.12	0	749	1.6
33.0	1.26	2007	0.8	0.12	0	833	1.5
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 2

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	**Deter. Joints**	Transverse Cracking	PSR
2.7	0.44	1988	0.0	0.00	0	0	3.5
3.2	0.45	1989	0.1	0.00	0	10	3.4
3.6	0.46	1990	0.1	0.00	0	20	3.4
4.1	0.47	1991	0.2	0.01	0	30	3.3
4.6	0.48	1992	0.2	0.01	0	40	3.3
5.1	0.50	1993	0.3	0.01	0	50	3.2
5.6	0.51	1994	0.3	0.01	0	59	3.1
6.1	0.52	1995	0.3	0.01	0	69	3.1
6.7	0.53	1996	0.4	0.01	0	79	3.0
7.2	0.55	1997	0.4	0.01	0	89	2.9
7.8	0.56	1998	0.5	0.02	0	100	2.9
8.3	0.58	1999	0.5	0.02	0	111	2.8
8.9	0.59	2000	0.6	0.02	0	122	2.7
9.5	0.60	2001	0.6	0.02	0	133	2.7
10.2	0.62	2002	0.6	0.02	0	146	2.6
10.8	0.63	2003	0.7	0.02	0	159	2.5
11.4	0.65	2004	0.7	0.02	0	172	2.4
12.1	0.67	2005	0.8	0.02	0	186	2.4
12.8	0.68	2006	0.8	0.02	0	201	2.3
13.5	0.70	2007	0.8	0.03	0	218	2.2
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

```
                         FUTURE PAVEMENT EVALUATION

***************************************************************************
LANE 1
***************************************************************************

---------------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 1 occurs in 1993 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
---------------------------------------------------------------------------
JOINT DETERIORATION:

No significant joint deterioration in lane 1 occurs over the next 20 years.
---------------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

Structural deficiency of the pavement in lane 1 occurs in 2007 as
indicated by  800 feet or more of deteriorated transverse cracks per mile.

a. full-depth repair of cracks, AC structural overlay
b. full-depth repair of cracks. crack and seat and AC structural overlay
c. full-depth repair of cracks, PCC bonded overlay
d. full-depth repair of cracks. PCC unbonded overlay
e. reconstruct
---------------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency at transverse joints in lane 1 occurs based
on predicted joint faulting over the next 20 years.
---------------------------------------------------------------------------
LOSS OF SUPPORT:

No loss of slab support in lane 1 occurs based on predicted joint
faulting over the next 20 years.
---------------------------------------------------------------------------
DRAINAGE DEFICIENCY:

No drainage deficiency in lane 1 occurs over the next 20 years, based on
the predicted level of pumping.
```

```
*******************************************************************************
LANE 2
*******************************************************************************

----------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 2 occurs in 1996 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
----------------------------------------------------------------------
JOINT DETERIORATION:

No significant joint deterioration in lane 2 occurs over the next 20 years.
----------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

No structural deficiency in lane 2 occurs based on predicted transverse
cracking over the next 20 years.
----------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency at transverse joints in lane 2 occurs based
on predicted joint faulting over the next 20 years.
----------------------------------------------------------------------
LOSS OF SUPPORT:

No loss of slab support in lane 2 occurs based on predicted joint
faulting over the next 20 years.
----------------------------------------------------------------------
DRAINAGE DEFICIENCY:

No drainage deficiency in lane 2 occurs over the next 20 years, based on
the predicted level of pumping.
```

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	1025	0	0.00
1990	2	1.63	1064	0	0.00
1991	3	2.48	1087	0	0.02
1992	4	3.35	1104	0	0.05
1993	5	4.24	1118	0	0.08
1994	6	5.15	1129	0	0.11
1995	7	6.08	1139	0	0.14
1996	8	7.04	1147	0	0.17
1997	9	8.02	1155	0	0.21
1998	10	9.03	1161	0	0.24
1999	11	10.06	1168	0	0.27
2000	12	11.12	1173	0	0.30
2001	13	12.20	1179	0	0.34
2002	14	13.32	1183	0	0.37
2003	15	14.46	1188	0	0.40
2004	16	15.62	1193	0	0.44
2005	17	16.82	1197	0	0.47
2006	18	18.05	1201	0	0.51
2007	19	19.30	1204	0	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	925	0	0.00
1990	2	1.63	961	0	0.00
1991	3	2.48	983	0	0.03
1992	4	3.35	998	0	0.06
1993	5	4.24	1010	0	0.09
1994	6	5.15	1021	0	0.12
1995	7	6.09	1029	0	0.15
1996	8	7.04	1037	0	0.18
1997	9	8.02	1044	0	0.21
1998	10	9.03	1050	0	0.24
1999	11	10.06	1056	0	0.27
2000	12	11.12	1061	0	0.31
2001	13	12.20	1066	0	0.34
2002	14	13.32	1070	0	0.37
2003	15	14.46	1075	0	0.41
2004	16	15.62	1079	0	0.44
2005	17	16.82	1082	0	0.48
2006	18	18.05	1086	0	0.52
2007	19	19.30	1089	0	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

✓Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	870	0	0.00
1990	2	1.63	903	0	0.02
1991	3	2.48	924	0	0.05
1992	4	3.35	939	0	0.08
1993	5	4.24	950	0	0.11
1994	6	5.15	960	0	0.14
1995	7	6.08	968	0	0.17
1996	8	7.04	975	0	0.20
1997	9	8.02	982	0	0.23
1998	10	9.03	988	0	0.26
1999	11	10.06	993	0	0.29
2000	12	11.12	998	0	0.33
2001	13	12.20	1003	0	0.36
2002	14	13.32	1007	0	0.39
2003	15	14.46	1011	0	0.43
2004	16	15.62	1015	0	0.46
2005	17	16.82	1018	0	0.50
2006	18	18.05	1022	0	0.53
2007	19	19.30	1025	0	0.57
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2005.

Page

A3. AC Overlay with Crack and Seat

2.5'X 2.5' pieces, 15 ton roller

2'X 2' pieces, 15 ton roller

6'X 5' pieces, 15 ton roller

2'X 2' piece, 20 ton roller

6'X 5' pieces, 20 ton roller

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	38	0	0.00
1990	2	1.63	43	0	0.00
1991	3	2.48	49	0	0.03
1992	4	3.35	55	0	0.06
1993	5	4.24	61	0	0.09
1994	6	5.15	67	0	0.12
1995	7	6.08	74	0	0.15
1996	8	7.04	80	0	0.18
1997	9	8.02	87	0	0.21
1998	10	9.03	94	0	0.24
1999	11	10.06	101	0	0.28
2000	12	11.12	108	0	0.31
2001	13	12.20	115	0	0.34
2002	14	13.32	137	14	0.38
2003	15	14.46	160	29	0.41
2004	16	15.62	183	44	0.45
2005	17	16.82	206	59	0.48
2006	18	18.05	230	74	0.52
2007	19	19.30	253	89	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	38	0	0.00
1990	2	1.63	43	0	0.00
1991	3	2.48	49	0	0.03
1992	4	3.35	55	0	0.06
1993	5	4.24	61	0	0.09
1994	6	5.15	67	0	0.12
1995	7	6.08	74	0	0.15
1996	8	7.04	80	0	0.18
1997	9	8.02	87	0	0.21
1998	10	9.03	94	0	0.24
1999	11	10.06	101	0	0.27
2000	12	11.12	108	0	0.31
2001	13	12.20	115	0	0.34
2002	14	13.32	137	14	0.37
2003	15	14.46	160	29	0.41
2004	16	15.62	183	44	0.44
2005	17	16.82	206	59	0.48
2006	18	18.05	230	74	0.52
2007	19	19.30	253	89	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	38	0	0.00
1990	2	1.63	43	0	0.00
1991	3	2.48	49	0	0.03
1992	4	3.35	55	0	0.06
1993	5	4.24	61	0	0.08
1994	6	5.15	67	0	0.11
1995	7	6.08	74	0	0.15
1996	8	7.04	80	0	0.18
1997	9	8.02	87	0	0.21
1998	10	9.03	94	0	0.24
1999	11	10.06	101	0	0.27
2000	12	11.12	108	0	0.30
2001	13	12.20	115	0	0.34
2002	14	13.32	137	14	0.37
2003	15	14.46	160	29	0.41
2004	16	15.62	183	44	0.44
2005	17	16.82	206	59	0.48
2006	18	18.05	230	74	0.51
2007	19	19.30	253	89	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	0	0	0.00
1990	2	1.63	0	0	0.02
1991	3	2.48	0	0	0.03
1992	4	3.35	0	0	0.06
1993	5	4.24	0	0	0.09
1994	6	5.15	0	0	0.12
1995	7	6.08	3	0	0.15
1996	8	7.04	10	0	0.18
1997	9	8.02	16	0	0.21
1998	10	9.03	23	0	0.24
1999	11	10.06	30	0	0.28
2000	12	11.12	38	0	0.31
2001	13	12.20	58	13	0.34
2002	14	13.32	81	28	0.38
2003	15	14.46	104	44	0.41
2004	16	15.62	127	59	0.45
2005	17	16.82	150	74	0.48
2006	18	18.05	174	89	0.52
2007	19	19.30	198	104	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.52 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	0	0	0.00
1990	2	1.63	0	0	0.00
1991	3	2.48	0	0	0.03
1992	4	3.35	0	0	0.06
1993	5	4.24	0	0	0.09
1994	6	5.15	0	0	0.12
1995	7	6.08	3	0	0.15
1996	8	7.04	10	0	0.18
1997	9	8.02	16	0	0.21
1998	10	9.03	23	0	0.24
1999	11	10.06	30	0	0.27
2000	12	11.12	38	0	0.31
2001	13	12.20	58	13	0.34
2002	14	13.32	81	28	0.37
2003	15	14.46	104	44	0.41
2004	16	15.62	127	59	0.44
2005	17	16.82	150	74	0.48
2006	18	18.05	174	89	0.52
2007	19	19.30	198	104	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	289	0	0.00
1990	2	1.63	295	0	0.00
1991	3	2.48	301	0	0.03
1992	4	3.35	307	0	0.06
1993	5	4.24	313	0	0.09
1994	6	5.15	319	0	0.12
1995	7	6.08	325	0	0.15
1996	8	7.04	332	0	0.18
1997	9	8.02	345	6	0.21
1998	10	9.03	367	21	0.24
1999	11	10.06	389	36	0.27
2000	12	11.12	411	52	0.31
2001	13	12.20	434	67	0.34
2002	14	13.32	457	82	0.37
2003	15	14.46	480	97	0.41
2004	16	15.62	503	112	0.44
2005	17	16.82	526	127	0.48
2006	18	18.05	550	143	0.52
2007	19	19.30	573	158	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	55	0	0.00
1990	2	1.63	60	0	0.00
1991	3	2.48	66	0	0.03
1992	4	3.35	72	0	0.06
1993	5	4.24	78	0	0.09
1994	6	5.15	84	0	0.12
1995	7	6.08	91	0	0.15
1996	8	7.04	97	0	0.18
1997	9	8.02	104	0	0.21
1998	10	9.03	111	0	0.24
1999	11	10.06	118	0	0.28
2000	12	11.12	125	0	0.31
2001	13	12.20	133	0	0.34
2002	14	13.32	153	13	0.38
2003	15	14.46	176	28	0.41
2004	16	15.62	199	43	0.45
2005	17	16.82	223	58	0.48
2006	18	18.05	246	74	0.52
2007	19	19.30	270	89	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.81	377	0	0.00
1990	2	1.63	363	0	0.00
1991	3	2.46	388	0	0.03
1992	4	3.35	394	0	0.06
1993	5	4.24	400	0	0.09
1994	6	5.15	407	0	0.12
1995	7	6.08	413	0	0.15
1996	8	7.04	420	0	0.18
1997	9	8.02	426	0	0.21
1998	10	9.03	439	6	0.24
1999	11	10.06	461	21	0.27
2000	12	11.12	484	36	0.31
2001	13	12.20	506	51	0.34
2002	14	13.32	529	67	0.37
2003	15	14.46	552	82	0.41
2004	16	15.62	575	97	0.44
2005	17	16.82	598	112	0.48
2006	18	18.05	622	127	0.52
2007	19	19.30	646	142	0.55
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.00	0.1	21
1990	2	1.63	0.00	0.3	35
1991	3	2.48	0.00	0.8	47
1992	4	3.35	0.00	1.5	59
1993	5	4.24	0.00	2.5	69
1994	6	5.15	0.00	3.8	79
1995	7	6.08	0.00	5.4	89
1996	8	7.04	0.00	7.4	98
1997	9	8.02	0.00	9.7	108
1998	10	9.03	0.00	12.4	116
1999	11	10.06	0.00	15.4	125
2000	12	11.12	0.00	18.9	134
2001	13	12.20	0.00	22.7	142
2002	14	13.32	0.00	27.0	150
2003	15	14.46	0.00	31.6	158
2004	16	15.62	0.00	36.7	166
2005	17	16.82	0.00	42.3	174
2006	18	18.05	0.00	48.3	182
2007	19	19.30	0.00	54.8	189
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.00	0.1	21
1990	2	1.63	0.00	0.3	35
1991	3	2.48	0.00	0.8	47
1992	4	3.35	0.00	1.5	59
1993	5	4.24	0.00	2.5	69
1994	6	5.15	0.00	3.8	79
1995	7	6.08	0.00	5.4	89
1996	8	7.04	0.00	7.4	98
1997	9	8.02	0.00	9.7	108
1998	10	9.03	0.00	12.4	116
1999	11	10.06	0.00	15.4	125
2000	12	11.12	0.00	18.9	134
2001	13	12.20	0.00	22.7	142
2002	14	13.32	0.00	27.0	150
2003	15	14.46	0.00	31.6	158
2004	16	15.62	0.00	36.7	166
2005	17	16.82	0.00	42.3	174
2006	18	18.05	0.00	48.3	182
2007	19	19.30	0.00	54.8	189
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.00	0.1	21
1990	2	1.63	0.00	0.3	35
1991	3	2.48	0.00	0.8	47
1992	4	3.35	0.00	1.5	59
1993	5	4.24	0.00	2.5	69
1994	6	5.15	0.00	3.8	79
1995	7	6.06	0.00	5.4	89
1996	8	7.04	0.00	7.4	98
1997	9	8.02	0.00	9.7	108
1998	10	9.03	0.00	12.4	116
1999	11	10.06	0.00	15.4	125
2000	12	11.12	0.00	18.9	134
2001	13	12.20	0.00	22.7	142
2002	14	13.32	0.00	27.0	150
2003	15	14.46	0.00	31.6	158
2004	16	15.62	0.00	36.7	166
2005	17	16.82	0.00	42.3	174
2006	18	18.05	0.00	48.3	182
2007	19	19.30	0.00	54.8	189
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.00	0.1	21
1990	2	1.63	0.00	0.3	35
1991	3	2.48	0.00	0.8	47
1992	4	3.35	0.00	1.5	59
1993	5	4.24	0.00	2.5	69
1994	6	5.15	0.00	3.8	79
1995	7	6.08	0.00	5.4	89
1996	8	7.04	0.00	7.4	98
1997	9	8.02	0.00	9.7	108
1998	10	9.03	0.00	12.4	116
1999	11	10.06	0.00	15.4	125
2000	12	11.12	0.00	18.9	134
2001	13	12.20	0.00	22.7	142
2002	14	13.32	0.00	27.0	150
2003	15	14.46	0.00	31.6	158
2004	16	15.62	0.00	36.7	166
2005	17	16.82	0.00	42.3	174
2006	18	18.05	0.00	48.3	182
2007	19	19.32	0.00	54.6	189
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.03	0.0	6210359
1990	2	1.63	0.03	0.0	43274927
1991	3	2.48	0.04	0.0	136799822
1992	4	3.35	0.05	0.0	312747757
1993	5	4.24	0.05	0.0	598661994
1994	6	5.15	0.05	0.0	1024242840
1995	7	6.08	0.06	0.0	1621762199
1996	8	7.04	0.06	0.0	2426422211
1997	9	8.02	0.06	0.0	3476696524
1998	10	9.03	0.07	0.0	4814672066
1999	11	10.06	0.07	0.0	6486401193
2000	12	11.12	0.07	0.0	8542270519
2001	13	12.20	0.08	0.0	11037390988
2002	14	13.32	0.08	0.0	14032012908
2003	15	14.46	0.08	0.0	17591969193
2004	16	15.62	0.08	0.0	21789149877
2005	17	16.82	0.09	0.0	26702010905
2006	18	18.05	0.09	0.0	32416120242
2007	19	19.30	0.09	0.0	39024744426
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1989.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.03	0.0	220
1990	2	1.63	0.03	0.0	322
1991	3	2.48	0.04	0.0	417
1992	4	3.35	0.05	0.0	522
1993	5	4.24	0.05	0.0	648
1994	6	5.15	0.05	0.0	803
1995	7	6.08	0.06	0.0	996
1996	8	7.04	0.06	0.0	1238
1997	9	8.02	0.06	0.0	1536
1998	10	9.03	0.07	0.0	1902
1999	11	10.06	0.07	0.0	2348
2000	12	11.12	0.07	0.0	2885
2001	13	12.20	0.08	0.0	3526
2002	14	13.32	0.08	0.0	4288
2003	15	14.46	0.08	0.0	5184
2004	16	15.62	0.08	0.0	6233
2005	17	16.82	0.09	0.0	7454
2006	18	18.05	0.09	0.0	8866
2007	19	19.30	0.09	0.0	10493
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	**TRANSVERSE CRACKING**
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.03	0.0	90
1990	2	1.63	0.03	0.0	128
1991	3	2.48	0.04	0.0	159
1992	4	3.35	0.05	0.0	186
1993	5	4.24	0.05	0.0	212
1994	6	5.15	0.05	0.0	238
1995	7	6.08	0.06	0.0	265
1996	8	7.04	0.06	0.0	293
1997	9	8.02	0.06	0.0	322
1998	10	9.03	0.07	0.0	355
1999	11	10.06	0.07	0.0	390
2000	12	11.12	0.07	0.0	429
2001	13	12.20	0.08	0.0	473
2002	14	13.32	0.08	0.0	522
2003	15	14.46	0.08	0.0	577
2004	16	15.62	0.08	0.0	639
2005	17	16.82	0.09	0.0	708
2006	18	18.05	0.09	0.0	786
2007	19	19.30	0.09	0.0	874
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.81	0.03	0.0	85
1990	2	1.63	0.03	0.0	121
1991	3	2.48	0.04	0.0	150
1992	4	3.35	0.05	0.0	176
1993	5	4.24	0.05	0.0	200
1994	6	5.15	0.05	0.0	224
1995	7	6.08	0.06	0.0	248
1996	8	7.04	0.06	0.0	274
1997	9	8.02	0.06	0.0	300
1998	10	9.03	0.07	0.0	329
1999	11	10.06	0.07	0.0	360
2000	12	11.12	0.07	0.0	395
2001	13	12.20	0.08	0.0	433
2002	14	13.32	0.08	0.0	475
2003	15	14.46	0.08	0.0	523
2004	16	15.62	0.08	0.0	575
2005	17	16.82	0.09	0.0	635
2006	18	18.05	0.09	0.0	701
2007	19	19.30	0.09	0.0	775
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

APPENDIX B

I-90 WEST (MP 278) SPOKANE EXPEAR OUTPUT

APPENDIX B
I-90 WEST (MP 278) SPOKANE
EXPEAR OUTPUT

EXPEAR 1.1

PROJECT EVALUATION AND REHABILITATION RECOMENDATIONS

FOR: spokane

1. Project Summary
2. Current Evaluation
3. Physical Testing Recommendations
4. Future Distress Predictions

Project Survey Summary For JRCP

Design engineer: HOLLY SIMMONS   Date of survey: 07/07/88

PROJECT IDENTIFICATION
Highway designation: I-90
State: WASHINGTON
Direction of survey: West
Starting milepost: 278.60
Ending milepost: 278.75

Number of sample units: 3

CLIMATE
Climatic zone: wet-dry freeze
Estimated annual temperature range (F): 64.0
Mean annual precipitation (inches): 16.7
Corps of Engineers freezing index (Fahrenheit degree-days): 667.0
Average Annual Temperature (degrees Fahrenheit): 47.20

SLAB CONSTRUCTION
Year constructed: 1965
Slab thickness (inches): 8.0
Width of traffic lanes (feet): 12.00
Concrete 28-day modulus of rupture (psi): 650.00

TRANSVERSE AND LONGITUDINAL JOINTS
Pattern of joint spacing: uniform
Transverse joint spacing if uniform (feet): 15.0
Transverse joint sequence if random (feet):
Type of sealant: liquid
Average transverse joint reservoir dimensions:
width (inches): 0.25
depth (inches): 1.50

Method used to form transverse joints: sawing
Transverse joint sawed depth (inches): 1.5

Type of load transfer system: aggregate interlock
Dowel bar diameter (inches): 0.00
Method used to form longitudinal joints between lanes: sawing
Longitudinal joint sawed or formed depth (inches): 2.3

BASE
Base type: dense-graded untreated aggregate
Modulus of subgrade reaction (psi/inch): 200.00

SUBGRADE
Predominant subgrade soil AASHTO classification: A2
Are swelling soils a problem in area: no
Were steps taken to prevent the swelling soils problem: n/a

SHOULDER

Type of shoulder: AC

Width of shoulders (feet): inner: 2.0 outer: 10.0

Inner lane slope direction: toward inner shoulder

TRAFFIC

Estimated current through two-way ADT: 38300

Percent commercial trucks: 13.0

Total number of lanes in direction of survey: 2

Future 18-kip ESAL growth rate (percent per year): 8.2

Truck traffic volume growth rate: approximately same as in past

	Lane two	Lane one
Total accumulated 18-kip ESAL (millions):	1.26	6.30
RIDE QUALITY		
PSR	2.5	2.5

SAMPLE UNIT IDENTIFICATION

Sample unit number: 1/ Starting milepost: 278.6

Length of sample unit (feet): 60.0

	Lane two	Lane one
Number of deteriorated transverse cracks, L-M-H:	0	2
Mean faulting at transverse cracks (inches):	0.00	0.10
Number of deteriorated transverse joints:	0	0
Mean faulting at transverse joints (incnes):	0.00	0.19
Number of transverse joints:	4	4
Number of FDRS & slab replacements:	0	0
Mean faulting at FDR & slab repl. jnts (inches):	0.00	0.00
Number of FDR & slab replacement joints:	0	0
Number of corner breaks:	0	0
Length of long. cracking, M-H only (feet):	0.0	0.0
Length of spalling of longit. joint, M-H only:		0.0

CRACKING AT TRANSVERSE JOINTS

Total joints with trans. cracks within 2 feet:	0	0

FOUNDATION MOVEMENT

Number of settlements (M-H severity):	0	0
Number of heaves (M-H severity):	0	0

DRAINAGE

Are longitudinal subdrains present and functional: no

What is the typical height of the pavement above the ditchline: 0.5

Do ditches have standing water or cattails in them: no

LOSS OF SUPPORT

Extent of evidence of pumping or water bleeding:	none	none

SURFACE CONDITION

Method used to texture the pavement at construction: other

Is the surface polished in the wheelpaths:	yes	yes
Is significant tire rutting in the wheelpaths:	yes	yes

JOINT SEALANT CONDITION

Condition of the transverse joint sealant:	high	high
Condition of the longitudinal joint sealant:		high
Are substantial amnts of incompressibles in jnts:	yes	yes

CONCRETE DURABILITY

Extent of "D" cracking at joints or cracks:	none	none
Extent of reactive aggregate distress:	none	none
Extent of scaling:	none	none

PREVIOUS REPAIR

Are full-depth repairs placed with dowels:	n/a	n/a
Are partial depth repairs present at most joints:	no	no
Has diamond grinding been done:	no	no
Has grooving been done:	no	no

AC SHOULDERS	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/ravelling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	none
Blowholes at transverse joints:	none	none
Lane/Shoulder joint condition:	poor	poor

SAMPLE UNIT IDENTIFICATION

Sample unit number: 2/ Starting milepost: 278.1
Length of sample unit (feet): 60.0

	Lane two	Lane one
Number of deteriorated transverse cracks, L-M-H:	0	2
Mean faulting at transverse cracks (inches):	0.00	0.09
Number of deteriorated transverse joints:	0	0
Mean faulting at transverse joints (inches):	0.00	0.24
Number of transverse joints:	4	4
Number of FDRS & slab replacements:	0	0
Mean faulting at FDR & slab repl. jnts (inches):	0.00	0.00
Number of FDR & slab replacement joints:	0	0
Number of corner breaks:	0	0
Length of long. cracking, M-H only (feet):	0.0	0.0
Length of spalling of longit. joint, M-H only:		0.0

CRACKING AT TRANSVERSE JOINTS

Total joints with trans. cracks within 2 feet:	0	0

FOUNDATION MOVEMENT

Number of settlements (M-H severity):	0	0
Number of heaves (M-H severity):	0	0

DRAINAGE

Are longitudinal subdrains present and functional: no
What is the typical height of the pavement above the ditchline: 0.5
Do ditches have standing water or cattails in them: no

LOSS OF SUPPORT

Extent of evidence of pumping or water bleeding:	none	none

SURFACE CONDITION

Method used to texture the pavement at construction: other

Is the surface polished in the wheelpaths:	yes	yes
Is significant tire rutting in the wheelpaths:	yes	yes

JOINT SEALANT CONDITION

Condition of the transverse joint sealant:	high	high
Condition of the longitudinal joint sealant:		high
Are substantial amnts of incompressibles in jnts:	no	no

CONCRETE DURABILITY

Extent of "D" cracking at joints or cracks:	none	none
Extent of reactive aggregate distress:	none	none
Extent of scaling:	none	none

PREVIOUS REPAIR

Are full-depth repairs placed with dowels:	n/a	n/a
Are partial depth repairs present at most joints:	no	no
Has diamond grinding been done:	no	no
Has grooving been done:	no	no

AC SHOULDERS	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/ravelling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	none
Blowholes at transverse joints:	none	none
Lane/Shoulder joint condition:	poor	poor

```
SAMPLE UNIT IDENTIFICATION
   Sample unit number:  3/                    Starting milepost:  278.1
   Length of sample unit (feet): 60.0
                                                          Lane two        Lane one
   Number of deteriorated transverse cracks, L-M-H:         0               4
   Mean faulting at transverse cracks (inches):           0.00            0.08
   Number of deteriorated transverse joints:                0               0
   Mean faulting at transverse joints (inches):           0.00            0.19
   Number of transverse joints:                             4               4
   Number of FDRS & slab replacements:                      0               0
   Mean faulting at FDR & slab repl. jnts (inches):       0.00            0.00
   Number of FDR & slab replacement joints:                 0               0
   Number of corner breaks:                                 0               0
   Length of long. cracking, M-H only (feet):             0.0             15.0
   Length of spalling of longit. joint, M-H only:                         0.0

CRACKING AT TRANSVERSE JOINTS
   Total joints with trans. cracks within 2 feet:           0               0

FOUNDATION MOVEMENT
   Number of settlements (M-H severity):                    0               0
   Number of heaves (M-H severity):                         0               0

DRAINAGE
   Are longitudinal subdrains present and functional:  no
   What is the typical height of the pavement above the ditchline:  0.5
   Do ditches have standing water or cattails in them:  no

LOSS OF SUPPORT
   Extent of evidence of pumping or water bleeding:  none           none

SURFACE CONDITION
   Method used to texture the pavement at construction:  other
   Is the surface polished in the wheelpaths:          yes             yes
   Is significant tire rutting in the wheelpaths:      yes             yes

JOINT SEALANT CONDITION
   Condition of the transverse joint sealant:          high            high
   Condition of the longitudinal joint sealant:                        high
   Are substantial amnts of incompressibles in jnts: no                no

CONCRETE DURABILITY
   Extent of "D" cracking at joints or cracks:         none            none
   Extent of reactive aggregate distress:              none            none
   Extent of scaling:                                  none            none

PREVIOUS REPAIR
   Are full-depth repairs placed with dowels:          n/a             n/a
   Are partial depth repairs present at most joints: no                no
   Has diamond grinding been done:                     no              no
   Has grooving been done:                             no              no
```

AC SHOULDERS

	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/ravelling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	none
Blowholes at transverse joints:	none	none
Lane/Shoulder joint condition:	poor	poor

Extrapolated (Per Mile) Values For spokane

	Lane two	Lane one
Number of deteriorated transverse cracks:	0	235
Mean faulting at deter. trans. cracks (inches):	0.00	0.09
Number of deteriorated transverse joints:	0	0
Mean faulting at transverse joints (inches):	0.00	0.21
Number of transverse joints:	352	352
Number of full-depth repairs:	0	0
Mean faulting at FDR joints (inches):	0.00	0.00
Number of full-depth repair joints:	0	0
Number of corner breaks:	0	0
Length of long. cracking, M-H only (feet):	0.0	440.0
Length of spalling of longit. joint, M-H only:		0.0
Total joints with trans. cracks within 2 feet:	0	0
Number of settlements (M-H severity):	0	0
Number of heaves (M-H severity):	0	0

CURRENT PAVEMENT EVALUATION

LANE 1

JOINT CONSTRUCTION DEFICIENCY:

A longitudinal joint construction deficiency in lane 1, likely due to an inadequate depth of saw cut, is indicated by longitudinal cracking.

a. seal longitudinal cracks
b. stitch longitudinal cracks

The pavement in lane 1 shows no indications of a transverse joint construction deficiency.

a. do nothing

JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 1 by medium- to high-severity joint sealant damage and an inadequate joint sealant reservoir shape factor for the existing sealant type.

a. reseal transverse joints

ROUGHNESS:

Poor rideability in lane 1 is indicated by total faulting of more than 46 inches per mile at joints, cracks, and full-depth repairs (if present), and an unacceptably low PSR (3.0) for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay

DURABILITY DEFICIENCY:

The pavement in lane 1 shows no indications of significant surface or concrete durability problems.

a. do nothing

JOINT DETERIORATION:

Joint deterioration or other pavement deterioration in lane 1 may be accelerated by water infiltration permitted by poor longitudinal joint sealant condition.

a. reseal longitudinal centerline joint

No joint deterioration exists in lane 1.

a. do nothing

STRUCTURAL DEFICIENCY:

Structural deficiency of the pavement in lane 1 is indicated by 800 or more feet of deteriorated transverse cracks per mile.

a. full-depth repair of cracks, AC structural overlay
b. full-depth repair of cracks, crack and seat and AC structural overlay
c. full-depth repair of cracks, PCC bonded overlay
d. full-depth repair of cracks, PCC unbonded overlay
e. reconstruct

SKID RESISTANCE DEFICIENCY:

Loss of skid resistance and potential for hydroplaning are indicated in lane 1 by polished wheel paths and studded tire rutting of 0.25 inches or more.

a. grinding
b. AC nonstructural overlay

LOAD TRANSFER DEFICIENCY:

Aggregate interlock is providing inadequate load transfer in lane 1 at the transverse joints, as indicated by mean transverse joint faulting of more than 0.13 inches.

a. load transfer restoration at joints

No load transfer deficiency is indicated at deteriorated transverse cracks in lane 1.

a. do nothing

No undowelled full-depth repairs are present in lane 1.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

Loss of slab support in the lane 1 is indicated by faulting greater than 0.13 inches at joints and cracks.

a. subseal at joints and cracks

DRAINAGE DEFICIENCY:

A drainage deficiency is indicated in lane 1 by faulting greater than 0.13 inches occurring in a wet or wet-dry climate.

a. install or repair longitudinal subdrains
b. install or repair longitudinal subdrains, seal all joints and cracks

```
***********************************************************************
LANE 2
***********************************************************************

----------------------------------------------------------------------
JOINT CONSTRUCTION DEFICIENCY:

The pavement in lane 2 shows no indications of a transverse joint
construction deficiency.

a. do nothing
----------------------------------------------------------------------
JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 2 by medium-
to high-severity joint sealant damage and an inadequate joint sealant
reservoir shape factor for the existing sealant type.

a. reseal transverse joints
----------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 2 is indicated by an unacceptably low PSR for
the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
----------------------------------------------------------------------
DURABILITY DEFICIENCY:

The pavement in lane 2 shows no indications of significant surface or
concrete durability problems.

a. do nothing
----------------------------------------------------------------------
JOINT DETERIORATION:

No joint deterioration exists in lane 2.

a. do nothing
----------------------------------------------------------------------
STRUCTURAL DEFICIENCY:
----------------------------------------------------------------------
SKID RESISTANCE DEFICIENCY:

Loss of skid resistance and potential for hydroplaning are indicated
in lane 2 by polished wheel paths and studded tire rutting
of 0.25 inches or more.

a. grinding
b. AC nonstructural overlay
----------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency is indicated at transverse joints in lane 2.
```

a. do nothing

No undowelled full-depth repairs are present in lane 2.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

The pavement in the lane 2 shows no indications of loss of slab support.

a. do nothing

DRAINAGE DEFICIENCY:

The pavement in lane 2 shows no indications of a drainage deficiency.

a. do nothing

****

INNER SHOULDER

****

Excessive infiltration of water beneath the pavement and inner AC shoulder is indicated by poor lane/shoulder joint sealant condition.

a. reseal lane/shoulder joint
b. do nothing

****
OUTER SHOULDER
****

Excessive infiltration of water beneath the pavement and outer AC shoulder is indicated by poor lane/shoulder joint sealant condition.

a. reseal lane/shoulder joint
b. do nothing

PHYSICAL TESTING RECOMMENDATIONS

-------------------- NONDESTRUCTIVE DEFLECTION TESTING -------------------

Nondestructive deflection testing (NDT) of the pavement is recommended to further investigate deficiencies observed in the preliminary evaluation of the pavement. Use a Falling Weight Deflectometer or other NDT device capable of applying dynamic loads to the pavement over a range of load levels comparable to actual truck wheel loads (i.e., 9000 to 16000 pounds).

Nondestructive deflection testing should be conducted in a 0.1-mile section randomly selected within each mile of the project. Deflection testing should onl be conducted when the ambient temperature is between 50 and 80 degrees Fahrenhei to avoid joint and crack lock-up and excessive curling.

Testing should be performed at the following locations:

Center of the slab: Measure deflection basin in the center of the traffic lane in order to backcalculate elastic modulus of slab and effective k value be the slab. This information may be used in a structural analysis of the pavement in determining uniformity of support along the project (see NCHRP Report No. 281

Lane edge: Measure deflections at the outer edge of the traffic lane (next to the shoulder). If the pavement has a tied concrete shoulder, also measu deflections across lane/shoulder joint. This information may be used in a structural analysis of the pavement.

Corner of the slab: Measure deflections across transverse joints and cracks and compute their load transfer efficiencies. This information will be used in a structural analysis of the pavement.

Corner of the slab over a range of load levels: Measure deflections at the corne the slab using a range of load levels between 9000 and 16000 pounds. When the me deflections are plotted on a load versus deflection graph and straight lines are through points, the lines which do not intersect the deflection axis within 0.00 of the origin will indicate corners with loss of support beneath the slab (see NCHRP Report No. 281).

-------------------- DESTRUCTIVE DEFLECTION TESTING --------------------

estructive testing (obtaining samples of material from the pavement structure)
s recommended to further investigate deficiencies observed in the preliminary e
aterial samples must be obtained by coring through the concrete surface
nd base with a core bit (6-inch diameter unless specified otherwise).
ranular base bulk samples should be obtained. Stabilized base samples should
e obtained from coring, if possible. Where undisturbed soil samples are require
hey should be obtained by sampling the soil beneath the pavement
nd base a thin-walled Shelby tube.

ach type of destructive testing required should be conducted on at least
ne and preferably three or more slabs in each 0.1-mile section randomly selecte
ithin each mile of the project. For reasons of efficiency and safety, nondestru
esting and destructive testing should be conducted concurrently.

he following types of destructive testing are recommended:

btain cores from the center of the traffic lane.

btain cores through selected transverse joints.

t locations along the longitudinal joint with significant spalling or
earby longitudinal cracks, core through the longitudinal joint (and
djacent cracks, if present). Examine the cores visually to determine
hether the joint or one or more of the cracks is functioning
s a joint.

MATERIALS EVALUATION

Visual inspection and possibly laboratory testing of material samples obtained from destructive testing (coring) is recommended. The following types of information should be obtained from the material samples:

The strength of the cores obtained from the concrete slab should be determined by indirect tension testing in the laboratory. This information may be used in a structural analysis of the pavement. In the case of concrete deterioration due to poor durability (e.g., D cracking or reactive aggregate), the strength of the concrete is an indicator of the extent of the deterioration.

Examine the cores obtained from the center of the slab and through the transverse joints to determine the thickness and soundness of the concrete.

Determine the thickness of the base layer by examining the base material obtained from the coring operation.

Determine the permeability of the granular base. This information may be used to verify the pavement subdrainage capability and the need for a drainage improv

Determine the Atterberg limits (liquid limit, plastic limit, and plasticity index) of the subgrade soil in the laboratory. This information is needed to determine the permeability of the subgrade soil, and the susceptibility of the soil to foundation movement (swelling, frost heave, and localized consolidation.)

Determine the classification of the subgrade soil (proportions of gravel, sand, silt and clay) in the laboratory using either the AASHTO or Unified soil classification systems. This information is needed to estimate the permeability of the subgrade soil, and the susceptibility of the soil to foundation movement (swelling, frost heave, and localized consolidation).

------------------------------ SKID TESTING ------------------------------

No skid testing of the pavement is warranted because a structural deficiency exists and surface will likely be overlaid or reconstructed.

------------------------- ROUGHNESS TESTING -------------------------

Roughness testing is recommended in each traffic lane to verify that the pavement is excessively rough and to determine the cause of the roughness. Roughness testing should be performed over the entire length of the pavement and the roughness measured at each 0.1 mile segment.

Test the pavement with roughness equipment capable of producing either a response-type measurement of the pavement's roughness (e.g., Mays Meter) or a profile measurement device. Compare the measured roughness to your agency's standard for an acceptable level of roughness. Prepare a profile of the roughness index along the project for each traffic lane to identify points of significant roughness that need special attention.

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 1

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	Deter. Joints	Transverse Cracking	PSR
6.3	0.79	1988	0.0	0.21	0	2816	2.5
7.2	0.85	1989	0.1	0.21	0	3054	2.4
8.1	0.92	1990	0.2	0.21	0	3344	2.4
9.1	1.00	1991	0.3	0.21	0	3700	2.3
10.1	1.08	1992	0.5	0.22	0	4137	2.3
11.3	1.17	1993	0.6	0.22	0	4675	2.2
12.6	1.26	1994	0.7	0.22	0	5337	2.1
13.9	1.37	1995	0.8	0.23	0	6152	2.0
15.4	1.48	1996	1.0	0.23	0	7156	2.0
17.0	1.60	1997	1.1	0.23	0	8392	1.9
18.7	1.73	1998	1.2	0.23	0	9912	1.8
20.6	1.87	1999	1.4	0.24	0	11781	1.7
22.6	2.02	2000	1.5	0.24	0	14077	1.6
24.8	2.19	2001	1.7	0.24	0	16895	1.5
27.2	2.37	2002	1.8	0.24	0	20350	1.3
29.8	2.56	2003	2.0	0.25	0	24584	1.2
32.5	2.78	2004	2.1	0.25	0	29768	1.1
35.5	3.00	2005	2.3	0.25	0	36111	0.9
38.8	3.25	2006	2.5	0.25	0	43864	0.8
42.3	3.52	2007	2.6	0.26	0	53337	0.6
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 2

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	Deter. Joints	Transverse Cracking	PSR
1.3	0.26	1988	0.0	0.00	0	0	2.5
1.5	0.28	1989	0.1	0.00	0	49	2.5
1.8	0.30	1990	0.2	0.01	0	100	2.4
2.2	0.33	1991	0.3	0.01	0	155	2.4
2.5	0.35	1992	0.4	0.01	0	213	2.4
2.9	0.38	1993	0.4	0.02	0	278	2.3
3.3	0.41	1994	0.5	0.02	0	350	2.3
3.8	0.45	1995	0.6	0.02	0	431	2.2
4.3	0.49	1996	0.7	0.02	0	524	2.2
4.8	0.53	1997	0.8	0.03	0	631	2.2
5.4	0.57	1998	0.9	0.03	0	757	2.1
6.0	0.62	1999	1.0	0.03	0	905	2.1
6.6	0.67	2000	1.1	0.03	0	1080	2.0
7.4	0.72	2001	1.2	0.04	0	1289	2.0
8.1	0.78	2002	1.3	0.04	0	1539	1.9
9.0	0.84	2003	1.4	0.04	0	1839	1.8
9.9	0.91	2004	1.5	0.04	0	2202	1.8
10.9	0.99	2005	1.6	0.05	0	2640	1.7
11.9	1.07	2006	1.7	0.05	0	3170	1.6
13.1	1.16	2007	1.8	0.05	0	3813	1.5
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

```
                    FUTURE PAVEMENT EVALUATION

************************************************************************************
LANE 1
************************************************************************************

------------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 1 occurs in 1988 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
------------------------------------------------------------------------
JOINT DETERIORATION:

No significant joint deterioration in lane 1 occurs over the next 20 years.
------------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

Structural deficiency of the pavement in lane 1 occurs in 1988 as
indicated by  800 feet or more of deteriorated transverse cracks per mile.

a. full-depth repair of cracks, AC structural overlay
b. full-depth repair of cracks, crack and seat and AC structural overlay
c. full-depth repair of cracks, PCC bonded overlay
d. full-depth repair of cracks, PCC unbonded overlay
e. reconstruct
------------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

Inadequate load transfer at transverse joints in lane 1 occurs in 1988 as
indicated by predicted faulting of 0.13 inches or more.

a. load transfer restoration at joints
b. do nothing
------------------------------------------------------------------------
LOSS OF SUPPORT:

Loss of slab support in lane 1 occurs in 1988 as indicated by predicted
faulting greater than 0.13 inches at transverse joints.

a. subseal at joints and cracks
```

```
*********************************************************************************
LANE 2
*********************************************************************************

------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 2 occurs in 1988 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
------------------------------------------------------------------
JOINT DETERIORATION:

No significant joint deterioration in lane 2 occurs over the next 20 years.
------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

Structural deficiency of the pavement in lane 2 occurs in 1999 as
indicated by  800 feet or more of deteriorated transverse cracks per mile.

a. full-depth repair of cracks, AC structural overlay
b. full-depth repair of cracks, crack and seat and AC structural overlay
c. full-depth repair of cracks, PCC bonded overlay
d. full-depth repair of cracks, PCC unbonded overlay
e. reconstruct
------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency at transverse joints in lane 2 occurs based
on predicted joint faulting over the next 20 years.
------------------------------------------------------------------
LOSS OF SUPPORT:

No loss of slab support in lane 2 occurs based on predicted joint
faulting over the next 20 years.
------------------------------------------------------------------
DRAINAGE DEFICIENCY:

A drainage deficiency in lane 2 occurs in 1999 as indicated by predicted
pumping reaching the low severity level.

a. install or repair longitudinal subdrains
b. install or repair longitudinal subdrains, seal all joints and cracks
```

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.85	2624	1610	0.18
1990	2	1.77	2720	2119	0.21
1991	3	2.77	2779	2496	0.24
1992	4	3.85	2822	2811	0.27
1993	5	5.01	2856	2856	0.31
1994	6	6.27	2885	2885	0.34
1995	7	7.64	2910	2910	0.38
1996	8	9.12	2932	2932	0.42
1997	9	10.71	2952	2952	0.46
1998	10	12.44	2970	2970	0.51
1999	11	14.32	2987	2987	0.56
2000	12	16.34	3003	3003	0.61
2001	13	18.53	3018	3018	0.67
2002	14	20.90	3032	3032	0.72
2003	15	23.47	3045	3045	0.78
2004	16	26.24	3058	3058	0.85
2005	17	29.24	3070	3070	0.92
2006	18	32.49	3082	3082	1.00
2007	19	36.01	3093	3093	1.08
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total relfective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 3000 feet per mile in 2000.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 1500 feet per mile in 1989.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 1998.

Page

B3. AC Overlay with Crack and Seat

2.5'X 2.5' pieces, 15 ton roller

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.83	350	0	0.44
1990	2	1.77	384	0	0.47
1991	3	2.77	420	0	0.50
1992	4	3.85	459	0	0.54
1993	5	5.01	501	0	0.57
1994	6	6.27	546	0	0.61
1995	7	7.64	596	0	0.65
1996	8	9.12	649	0	0.69
1997	9	10.71	707	0	0.73
1998	10	12.44	769	0	0.78
1999	11	14.32	837	0	0.83
2000	12	16.34	910	0	0.88
2001	13	18.53	989	0	0.93
2002	14	20.90	1075	0	0.99
2003	15	23.47	1167	0	1.05
2004	16	26.24	1268	0	1.12
2005	17	29.24	1376	0	1.19
2006	18	32.49	1493	0	1.26
2007	19	36.01	1620	0	1.34
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 1991.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.02	0	0	0.02
1989	1	0.85	350	0	0.26
1990	2	1.77	384	0	0.29
1991	3	2.77	420	0	0.32
1992	4	3.85	459	0	0.36
1993	5	5.01	501	0	0.39
1994	6	6.27	546	0	0.43
1995	7	7.64	596	0	0.47
1996	8	9.12	649	0	0.51
1997	9	10.71	707	0	0.55
1998	10	12.44	769	0	0.60
1999	11	14.32	837	0	0.65
2000	12	16.34	910	0	0.70
2001	13	18.53	989	0	0.75
2002	14	20.90	1075	0	0.81
2003	15	23.47	1167	0	0.87
2004	16	26.24	1268	0	0.94
2005	17	29.24	1376	0	1.01
2006	18	32.49	1493	0	1.08
2007	19	36.01	1620	0	1.16
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 1996.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.85	350	0	0.17
1990	2	1.77	384	0	0.20
1991	3	2.77	420	0	0.23
1992	4	3.85	459	0	0.27
1993	5	5.01	501	0	0.30
1994	6	6.27	546	0	0.34
1995	7	7.64	596	0	0.38
1996	8	9.12	649	0	0.42
1997	9	10.71	707	0	0.46
1998	10	12.44	769	0	0.51
1999	11	14.32	837	0	0.56
2000	12	16.34	910	0	0.61
2001	13	18.53	989	0	0.66
2002	14	20.90	1075	0	0.72
2003	15	23.47	1167	0	0.78
2004	16	26.24	1268	0	0.85
2005	17	29.24	1376	0	0.92
2006	18	32.49	1493	0	0.99
2007	19	36.01	1620	0	1.07
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 1998.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.02
1989	1	0.85	350	0	0.18
1990	2	1.77	384	0	0.21
1991	3	2.77	420	0	0.24
1992	4	3.85	459	0	0.27
1993	5	5.01	501	0	0.31
1994	6	6.27	546	0	0.34
1995	7	7.64	596	0	0.38
1996	8	9.12	649	0	0.42
1997	9	10.71	707	0	0.46
1998	10	12.44	769	0	0.51
1999	11	14.32	837	0	0.56
2000	12	16.34	910	0	0.61
2001	13	18.53	989	0	0.67
2002	14	20.90	1075	0	0.72
2003	15	23.47	1167	0	0.78
2004	16	26.24	1268	0	0.85
2005	17	29.24	1376	0	0.92
2006	18	32.49	1493	0	1.00
2007	19	36.01	1620	0	1.08
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 1998.

Page

B4. PCC Bonded Overlay

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.85	0.03	0.1	183
1990	2.	1.77	0.03	0.4	308
1991	3	2.77	0.04	1.0	417
1992	4	3.85	0.04	1.9	518
1993	5	5.01	0.04	3.2	614
1994	6	6.27	0.04	4.9	705
1995	7	7.64	0.05	7.0	794
1996	8	9.12	0.05	9.6	880
1997	9	10.71	0.05	12.7	963
1998	10	12.44	0.05	16.2	1045
1999	11	14.32	0.05	20.3	1126
2000	12	16.34	0.05	25.0	1206
2001	13	18.53	0.06	30.2	1284
2002	14	20.90	0.06	36.1	1361
2003	15	23.47	0.06	42.6	1438
2004	16	26.24	0.06	49.7	1514
2005	17	29.24	0.06	57.5	1590
2006	18	32.49	0.06	66.0	1665
2007	19	36.01	0.07	75.2	1740
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1996.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.85	0.03	0.1	183
1990	2	1.77	0.03	0.4	308
1991	3	2.77	0.04	1.0	417
1992	4	3.85	0.04	1.9	518
1993	5	5.01	0.04	3.2	614
1994	6	6.27	0.04	4.9	705
1995	7	7.64	0.05	7.0	794
1996	8	9.12	0.05	9.6	880
1997	9	10.71	0.05	12.7	963
1998	10	12.44	0.05	16.2	1045
1999	11	14.32	0.05	20.3	1126
2000	12	16.34	0.05	25.0	1206
2001	13	18.53	0.06	30.2	1284
2002	14	20.90	0.06	36.1	1361
2003	15	23.47	0.06	42.6	1438
2004	16	26.24	0.06	49.7	1514
2005	17	29.24	0.06	57.5	1590
2006	18	32.49	0.06	66.0	1665
2007	19	36.01	0.07	75.2	1740
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1996.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.85	0.03	0.1	183
1990	2	1.77	0.03	0.4	308
1991	3	2.77	0.04	1.0	417
1992	4	3.85	0.04	1.9	518
1993	5	5.01	0.04	3.2	614
1994	6	6.27	0.04	4.9	705
1995	7	7.64	0.05	7.0	794
1996	8	9.12	0.05	9.6	880
1997	9	10.71	0.05	12.7	963
1998	10	12.44	0.05	16.2	1045
1999	11	14.32	0.05	20.3	1126
2000	12	16.34	0.05	25.0	1206
2001	13	18.53	0.06	30.2	1284
2002	14	20.90	0.06	36.1	1361
2003	15	23.47	0.06	42.6	1438
2004	16	26.24	0.06	49.7	1514
2005	17	29.24	0.06	57.5	1590
2006	18	32.49	0.06	66.0	1665
2007	19	36.01	0.07	75.2	1740
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1996.

Page

B5. PCC Unbonded Overlay

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.02	0.0	0
1989	1	0.85	0.03	0.0	3290
1990	2	1.77	0.04	0.0	7929
1991	3	2.77	0.04	0.0	17030
1992	4	3.85	0.05	0.0	32894
1993	5	5.01	0.05	0.0	58250
1994	6	6.27	0.06	0.0	96456
1995	7	7.64	0.06	0.0	151682
1996	8	9.12	0.07	0.0	229112
1997	9	10.71	0.07	0.0	335189
1998	10	12.44	0.08	0.0	477902
1999	11	14.32	0.08	0.0	667141
2000	12	16.34	0.09	0.0	915128
2001	13	18.53	0.09	0.0	1236936
2002	14	20.90	0.09	0.0	1651123
2003	15	23.47	0.10	0.0	2180509
2004	16	26.24	0.10	0.0	2853108
2005	17	29.24	0.11	0.0	3703271
2006	18	32.49	0.11	0.0	4773072
2007	19	36.01	0.12	0.0	6113986
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1989.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.85	0.03	0.0	633
1990	2	1.77	0.04	0.0	995
1991	3	2.77	0.04	0.0	1429
1992	4	3.85	0.05	0.0	2016
1993	5	5.01	0.05	0.0	2839
1994	6	6.27	0.06	0.0	3987
1995	7	7.64	0.06	0.0	5573
1996	8	9.12	0.07	0.0	7732
1997	9	10.71	0.07	0.0	10633
1998	10	12.44	0.08	0.0	14484
1999	11	14.32	0.08	0.0	19543
2000	12	16.34	0.09	0.0	26127
2001	13	18.53	0.09	0.0	34626
2002	14	20.90	0.09	0.0	45524
2003	15	23.47	0.10	0.0	59412
2004	16	26.24	0.10	0.0	77017
2005	17	29.24	0.11	0.0	99230
2006	18	32.49	0.11	0.0	127143
2007	19	36.01	0.12	0.0	162090
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1990.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.85	0.03	0.0	116
1990	2	1.77	0.04	0.0	168
1991	3	2.77	0.04	0.0	213
1992	4	3.85	0.05	0.0	255
1993	5	5.01	0.05	0.0	299
1994	6	6.27	0.06	0.0	346
1995	7	7.64	0.06	0.0	398
1996	8	9.12	0.07	0.0	458
1997	9	10.71	0.07	0.0	529
1998	10	12.44	0.08	0.0	612
1999	11	14.32	0.08	0.0	713
2000	12	16.34	0.09	0.0	836
2001	13	18.53	0.09	0.0	987
2002	14	20.90	0.09	0.0	1171
2003	15	23.47	0.10	0.0	1399
2004	16	26.24	0.10	0.0	1679
2005	17	29.24	0.11	0.0	2026
2006	18	32.49	0.11	0.0	2453
2007	19	36.01	0.12	0.0	2981
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2000.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.85	0.03	0.0	60
1990	2	1.77	0.04	0.0	87
1991	3	2.77	0.04	0.0	109
1992	4	3.85	0.05	0.0	130
1993	5	5.01	0.05	0.0	150
1994	6	6.27	0.06	0.0	169
1995	7	7.64	0.06	0.0	190
1996	8	9.12	0.07	0.0	212
1997	9	10.71	0.07	0.0	236
1998	10	12.44	0.08	0.0	262
1999	11	14.32	0.08	0.0	292
2000	12	16.34	0.09	0.0	326
2001	13	18.53	0.09	0.0	366
2002	14	20.90	0.09	0.0	412
2003	15	23.47	0.10	0.0	466
2004	16	26.24	0.10	0.0	531
2005	17	29.24	0.11	0.0	609
2006	18	32.49	0.11	0.0	702
2007	19	36.01	0.12	0.0	814
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.85	0.03	0.0	58
1990	2	1.77	0.04	0.0	83
1991	3	2.77	0.04	0.0	105
1992	4	3.85	0.05	0.0	124
1993	5	5.01	0.05	0.0	143
1994	6	6.27	0.06	0.0	162
1995	7	7.64	0.06	0.0	181
1996	8	9.12	0.07	0.0	202
1997	9	10.71	0.07	0.0	224
1998	10	12.44	0.08	0.0	249
1999	11	14.32	0.08	0.0	277
2000	12	16.34	0.09	0.0	308
2001	13	18.53	0.09	0.0	344
2002	14	20.90	0.09	0.0	387
2003	15	23.47	0.10	0.0	437
2004	16	26.24	0.10	0.0	496
2005	17	29.24	0.11	0.0	566
2006	18	32.49	0.11	0.0	651
2007	19	36.01	0.12	0.0	753
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

Page

B6. Reconstruction

Stabilized Base, 15' Joint Spacing

Granular Base, 15' Joint Spacing

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.85	0.07	46	0.0	0.2	4.1
1990	2	1.77	0.08	67	0.0	0.2	4.1
1991	3	2.77	0.09	84	0.0	0.3	4.1
1992	4	3.85	0.09	99	0.0	0.3	4.1
1993	5	5.01	0.09	114	0.0	0.4	4.1
1994	6	6.27	0.10	129	0.0	0.4	4.1
1995	7	7.64	0.10	144	0.0	0.4	4.1
1996	8	9.12	0.10	160	0.0	0.5	4.0
1997	9	10.71	0.11	176	0.0	0.5	4.0
1998	10	12.44	0.11	194	0.0	0.5	3.9
1999	11	14.32	0.11	214	0.0	0.6	3.9
2000	12	16.34	0.11	235	0.0	0.6	3.8
2001	13	18.53	0.11	260	0.0	0.6	3.8
2002	14	20.90	0.12	288	0.0	0.7	3.7
2003	15	23.47	0.12	321	0.0	0.7	3.6
2004	16	26.24	0.12	359	0.0	0.7	3.6
2005	17	29.24	0.12	403	0.0	0.8	3.5
2006	18	32.49	0.12	456	0.0	0.8	3.4
2007	19	36.01	0.13	519	0.0	0.9	3.3
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 2007.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PSR on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.85	0.07	44	0.0	0.2	4.1
1990	2	1.77	0.08	64	0.0	0.2	4.1
1991	3	2.77	0.09	80	0.0	0.3	4.1
1992	4	3.85	0.09	95	0.0	0.3	4.1
1993	5	5.01	0.09	109	0.0	0.3	4.1
1994	6	6.27	0.10	123	0.0	0.4	4.1
1995	7	7.64	0.10	138	0.0	0.4	4.1
1996	8	9.12	0.10	152	0.0	0.4	4.0
1997	9	10.71	0.11	168	0.0	0.5	4.0
1998	10	12.44	0.11	185	0.0	0.5	4.0
1999	11	14.32	0.11	203	0.0	0.5	3.9
2000	12	16.34	0.11	224	0.0	0.6	3.9
2001	13	18.53	0.11	247	0.0	0.6	3.8
2002	14	20.90	0.12	273	0.0	0.6	3.7
2003	15	23.47	0.12	303	0.0	0.7	3.7
2004	16	26.24	0.12	338	0.0	0.7	3.6
2005	17	29.24	0.12	379	0.0	0.7	3.5
2006	18	32.49	0.12	427	0.0	0.8	3.4
2007	19	36.01	0.13	485	0.0	0.8	3.3
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0--5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 2007.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane **1 is not** predicted to reach an unacceptable level within the next **twenty** years.

Pumping on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PSR of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.85	0.05	5	0.0	-0.2	4.6
1990	2	1.77	0.07	8	0.0	-0.2	4.7
1991	3	2.77	0.07	10	0.0	-0.3	4.8
1992	4	3.85	0.07	11	0.0	-0.3	4.8
1993	5	5.01	0.08	13	0.0	-0.4	4.9
1994	6	6.27	0.08	15	0.0	-0.4	4.9
1995	7	7.64	0.08	16	0.0	-0.4	4.9
1996	8	9.12	0.08	18	0.0	-0.5	4.9
1997	9	10.71	0.09	19	0.0	-0.5	4.9
1998	10	12.44	0.09	21	0.0	-0.5	4.9
1999	11	14.32	0.09	22	0.0	-0.6	4.9
2000	12	16.34	0.09	24	0.0	-0.6	4.9
2001	13	18.53	0.09	25	0.0	-0.6	4.9
2002	14	20.90	0.09	27	0.0	-0.7	4.8
2003	15	23.47	0.10	29	0.0	-0.7	4.8
2004	16	26.24	0.10	30	0.0	-0.7	4.8
2005	17	29.24	0.10	32	0.0	-0.8	4.7
2006	18	32.49	0.10	34	0.0	-0.8	4.6
2007	19	36.01	0.10	36	0.0	-0.8	4.5
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PSR of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.85	0.10	46	0.0	0.2	4.1
1990	2	1.77	0.11	67	0.0	0.2	4.1
1991	3	2.77	0.12	84	0.0	0.3	4.1
1992	4	3.85	0.13	99	0.0	0.3	4.1
1993	5	5.01	0.13	114	0.0	0.4	4.1
1994	6	6.27	0.14	129	0.0	0.4	4.1
1995	7	7.64	0.14	144	0.0	0.4	4.1
1996	8	9.12	0.14	160	0.0	0.5	4.0
1997	9	10.71	0.15	176	0.0	0.5	4.0
1998	10	12.44	0.15	194	0.0	0.5	3.9
1999	11	14.32	0.15	214	0.0	0.6	3.9
2000	12	16.34	0.15	235	0.0	0.6	3.8
2001	13	18.53	0.16	260	0.0	0.6	3.8
2002	14	20.90	0.16	288	0.0	0.7	3.7
2003	15	23.47	0.16	321	0.0	0.7	3.6
2004	16	26.24	0.17	359	0.0	0.7	3.6
2005	17	29.24	0.17	403	0.0	0.8	3.5
2006	18	32.49	0.17	456	0.0	0.8	3.4
2007	19	36.01	0.17	519	0.0	0.9	3.3
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 1992.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PSR on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

APPENDIX C

I-90 EAST (MP 55) SNOQUALMIE PASS
EXPEAR OUTPUT

APPENDIX C
I-90 EAST SNOQUALAMIE PASS
EXPEAR OUTPUT

APPENDIX C
I-90 EAST SNOQUALAMIE PASS
EXPEAR OUTPUT (continued)

7/8" Dowels, Stabilized Base

7/8" Dowels, Granular Base

EXPEAR 1.1

PROJECT EVALUATION AND REHABILITATION RECOMENDATIONS

FOR: presno

1. Project Summary
2. Current Evaluation
3. Physical Testing Recommendations
4. Future Distress Predictions

Project Survey Summary For JRCP

Date of survey: 08/26/88

Design engineer: Holly Simmons

PROJECT IDENTIFICATION
Highway designation: I-90
State: Washington
Direction of survey: East
Starting milepost: 55.50
Ending milepost: 63.99

Number of sample units: 1

CLIMATE
Climatic zone: wet freeze-thaw
Estimated annual temperature range (F): 49.5
Mean annual precipitation (inches): 107.6
Corps of Engineers freezing index (Fahrenheit degree-days): 937.0
Average Annual Temperature (degrees Fahrenheit): 41.80

SLAB CONSTRUCTION
Year constructed: 1959
Slab thickness (inches): 9.0
Width of traffic lanes (feet): 12.00
Concrete 28-day modulus of rupture (psi): 650.00

TRANSVERSE AND LONGITUDINAL JOINTS
Pattern of joint spacing: uniform
Transverse joint spacing if uniform (feet): 15.0
Transverse joint sequence if random (feet):
Type of sealant: liquid
Average transverse joint reservoir dimensions:
width (inches): 0.25
depth (inches): 1.50

Method used to form transverse joints: sawing
Transverse joint sawed depth (inches): 1.5

Type of load transfer system: aggregate interlock
Dowel bar diameter (inches): 0.00
Method used to form longitudinal joints between lanes: sawing
Longitudinal joint sawed or formed depth (inches): 2.3

BASE
Base type: open-graded drainage layer
Modulus of subgrade reaction (psi/inch): 200.00

SUBGRADE
Predominant subgrade soil AASHTO classification: A1
Are swelling soils a problem in area: no
Were steps taken to prevent the swelling soils problem: n/a

SHOULDER

Type of shoulder: AC

Width of shoulders (feet): inner: 4.0 outer: 10.0

Inner lane slope direction: toward inner shoulder

TRAFFIC

Estimated current through two-way ADT: 17300

Percent commercial trucks: 19.0

Total number of lanes in direction of survey: 2

Future 18-kip ESAL growth rate (percent per year): 6.6

Truck traffic volume growth rate: approximately same as in past

	Lane two	Lane one
Total accumulated 18-kip ESAL (millions):	0.82	8.19
RIDE QUALITY		
PSR	2.5	2.5

SAMPLE UNIT IDENTIFICATION

Sample unit number: 1/

Starting milepost: 55.5

Length of sample unit (feet): 44827.2

	Lane two	Lane one
Number of deteriorated transverse cracks, L-M-H:	33	144
Mean faulting at transverse cracks (inches):	0.00	0.00
Number of deteriorated transverse joints:	0	0
Mean faulting at transverse joints (inches):	0.00	0.25
Number of transverse joints:	2988	2988
Number of FDRS & slab replacements:	0	0
Mean faulting at FDR & slab repl. jnts (inches):	0.00	0.00
Number of FDR & slab replacement joints:	0	0
Number of corner breaks:	10	33
Length of long. cracking, M-H only (feet):	810.0	4900.0
Length of spalling of longit. joint, M-H only:		0.0

CRACKING AT TRANSVERSE JOINTS

Total joints with trans. cracks within 2 feet:	11	6

FOUNDATION MOVEMENT

Number of settlements (M-H severity):	0	0
Number of heaves (M-H severity):	0	0

DRAINAGE

Are longitudinal subdrains present and functional: no

What is the typical height of the pavement above the ditchline: 5.0

Do ditches have standing water or cattails in them: no

LOSS OF SUPPORT

Extent of evidence of pumping or water bleeding:	none	none

SURFACE CONDITION

Method used to texture the pavement at construction: other

Is the surface polished in the wheelpaths:	yes	yes
Is significant tire rutting in the wheelpaths:	no	no

JOINT SEALANT CONDITION

Condition of the transverse joint sealant:	high	high
Condition of the longitudinal joint sealant:		high
Are substantial amnts of incompressibles in jnts:	yes	yes

CONCRETE DURABILITY

Extent of "D" cracking at joints or cracks:	none	none
Extent of reactive aggregate distress:	none	none
Extent of scaling:	none	none

PREVIOUS REPAIR

Are full-depth repairs placed with dowels:	no	no
Are partial depth repairs present at most joints:	no	no
Has diamond grinding been done:	yes	yes
Has grooving been done:	no	no

AC SHOULDERS	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/raveiling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	some
Blowholes at transverse joints:	none	none
Lane/Shoulder joint condition:	good	good

Extrapolated (Per Mile) Values For Fresno

	Lane two	Lane one
Number of deteriorated transverse cracks:	4	17
Mean faulting at deter. trans. cracks (inches):	0.00	0.00
Number of deteriorated transverse joints:	0	0
Mean faulting at transverse joints (inches):	0.00	0.25
Number of transverse joints:	352	352
Number of full-depth repairs:	0	0
Mean faulting at FDR joints (inches):	0.00	0.00
Number of full-depth repair joints:	0	0
Number of corner breaks:	1	4
Length of long. cracking, M-H only (feet):	95.4	577.1
Length of spalling of longit. joint, M-H only:		0.0
Total joints with trans. cracks within 2 feet:	1	1
Number of settlements (M-H severity):	0	0
Number of heaves (M-H severity):	0	0

CURRENT PAVEMENT EVALUATION

****
LANE 1
****

JOINT CONSTRUCTION DEFICIENCY:

A longitudinal joint construction deficiency in lane 1, likely due to an inadequate depth of saw cut, is indicated by longitudinal cracking.

a. seal longitudinal cracks
b. stitch longitudinal cracks

A transverse joint construction deficiency in lane 1, likely due to an inadequate depth of saw cut, is indicated by transverse cracking within 2 feet of transverse joints.

a. seal cracks near transverse joints
b. load transfer restoration at cracks near transverse joints, seal cracks near transverse joints

---

JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 1 by medium- to high-severity joint sealant damage and an inadequate joint sealant reservoir shape factor for the existing sealant type.

a. reseal transverse joints

ROUGHNESS:

Poor rideability in lane 1 is indicated by total faulting of more than 46 inches per mile at joints, cracks, and full-depth repairs (if present), and an unacceptably low PSR (3.0) for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay

DURABILITY DEFICIENCY:

The pavement in lane 1 shows no indications of significant surface or concrete durability problems.

a. do nothing

JOINT DETERIORATION:

Joint deterioration or other pavement deterioration in lane 1 may be accelerated by water infiltration permitted by poor longitudinal joint sealant condition.

a. reseal longitudinal centerline joint

No joint deterioration exists in lane 1.

a. do nothing

STRUCTURAL DEFICIENCY:

The pavement in lane 1 exhibits some load-associated distress (between 1 and 24 corner breaks per mile) which requires repair but does not indicate a structural deficiency.

a. full-depth repair of corner breaks

The pavement in lane 1 exhibits some load-associated distress (between 1 and 799 feet of deteriorated transverse cracks per mile) which requires repair but does not indicate a structural deficiency.

a. full-depth repair of cracks

SKID RESISTANCE DEFICIENCY:

Loss of skid resistance in lane 1 is indicated by polished wheel paths.

a. grinding
b. grooving
c. AC nonstructural overlay

LOAD TRANSFER DEFICIENCY:

Aggregate interlock is providing inadequate load transfer in lane 1 at the transverse joints, as indicated by mean transverse joint faulting of more than 0.13 inches.

a. load transfer restoration at joints

No load transfer deficiency is indicated at deteriorated transverse cracks in lane 1.

a. do nothing

A potential load transfer deficiency exists at undowelled full-depth repairs in lane 1, but mean full-depth repair faulting is not significant.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

The pavement in the lane 1 shows no indications of loss of slab support.

DRAINAGE DEFICIENCY:

The pavement in lane 1 shows no indications of a drainage **deficiency**.

a. do nothing

```
**********************************************************************
LANE 2
**********************************************************************
-----------------------------------------------------------------
JOINT CONSTRUCTION DEFICIENCY:

A transverse joint construction deficiency in lane 2, likely due to
an inadequate depth of saw cut, is indicated by transverse cracking
within 2 feet of transverse joints.

a. seal cracks near transverse joints
b. load transfer restoration at cracks near transverse joints, seal cracks
   near transverse joints
-----------------------------------------------------------------
JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 2 by medium-
to high-severity joint sealant damage and an inadequate joint sealant
reservoir shape factor for the existing sealant type.

a. reseal transverse joints
-----------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 2 is indicated by an unacceptably low PSR for
the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
-----------------------------------------------------------------
DURABILITY DEFICIENCY:

The pavement in lane 2 shows no indications of significant surface or
concrete durability problems.

a. do nothing
-----------------------------------------------------------------
JOINT DETERIORATION:

No joint deterioration exists in lane 2.

a. do nothing
-----------------------------------------------------------------
STRUCTURAL DEFICIENCY:

The pavement in lane 2 exhibits some load-associated distress (between
1 and  24 corner breaks per mile) which requires repair but does not
indicate a structural deficiency.

a. full-depth repair of corner breaks

The pavement in lane 2 exhibits some load-associated distress (between
1 and  799 feet of deteriorated transverse cracks per mile) which requires
repair but does not indicate a structural deficiency.
```

a. full-depth repair of cracks

SKID RESISTANCE DEFICIENCY:

Loss of skid resistance in lane 2 is indicated by polished wheel paths.

a. grinding
b. grooving
c. AC nonstructural overlay

LOAD TRANSFER DEFICIENCY:

No load transfer deficiency is indicated at transverse joints in lane 2.

a. do nothing

A potential load transfer deficiency exists at undowelled full-depth repairs in lane 2, but mean full-depth repair faulting is not significant.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

The pavement in the lane 2 shows no indications of loss of slab support.

a. do nothing

DRAINAGE DEFICIENCY:

The pavement in lane 2 shows no indications of a drainage deficiency.

a. do nothing

****

OUTER SHOULDER

****

The outer AC shoulder shows no indications of significant deterioration.

a. do nothing

****
INNER SHOULDER
****

The inner AC shoulder shows no indications of significant **deterioration.**

a. do nothing

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 1

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	Deter. Joints	Transverse Cracking	PS
8.2	0.56	1988	0.0	0.25	0	204	2.
8.8	0.60	1989	1.0	0.25	4	288	0.
9.4	0.64	1990	1.1	0.25	8	386	0.
10.1	0.68	1991	1.2	0.26	13	499	0.
10.8	0.73	1992	1.4	0.26	18	630	0.
11.6	0.78	1993	1.5	0.26	23	783	0.
12.5	0.83	1994	1.6	0.26	29	960	0.
13.3	0.88	1995	1.8	0.26	35	1165	0.
14.3	0.94	1996	1.9	0.26	41	1405	0.
15.3	1.00	1997	2.1	0.27	47	1683	0.
16.3	1.07	1998	2.2	0.27	54	2008	0.
17.5	1.14	1999	2.4	0.27	62	2386	0.
18.7	1.22	2000	2.6	0.27	70	2827	0.
20.0	1.30	2001	2.7	0.27	78	3342	0.
21.4	1.38	2002	2.9	0.27	86	3943	0.
22.9	1.47	2003	3.0	0.28	95	4644	0.
24.4	1.57	2004	3.0	0.28	104	5462	0.
26.1	1.67	2005	3.0	0.28	114	6417	0.
27.9	1.78	2006	3.0	0.28	124	7533	0.
29.8	1.90	2007	3.0	0.28	135	8836	0.
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 2

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	Deter. Joints	Transverse Cracking	PSR
0.8	0.13	1988	0.0	0.00	0	47	2.5
1.0	0.13	1989	0.1	0.00	4	56	2.3
1.1	0.14	1990	0.2	0.01	8	66	2.1
1.2	0.15	1991	0.3	0.01	13	76	1.9
1.4	0.16	1992	0.4	0.01	18	86	1.7
1.6	0.17	1993	0.5	0.01	23	96	1.5
1.8	0.18	1994	0.6	0.01	29	107	1.3
2.0	0.20	1995	0.7	0.02	35	119	1.1
2.2	0.21	1996	0.8	0.02	41	132	0.8
2.4	0.22	1997	0.8	0.02	47	145	0.6
2.6	0.24	1998	0.9	0.02	54	159	0.3
2.9	0.25	1999	1.0	0.02	62	175	0.0
3.2	0.27	2000	1.1	0.03	70	192	0.0
3.4	0.29	2001	1.2	0.03	78	211	0.0
3.8	0.31	2002	1.3	0.03	86	232	0.0
4.1	0.33	2003	1.4	0.03	95	255	0.0
4.4	0.35	2004	1.5	0.03	104	281	0.0
4.8	0.37	2005	1.7	0.03	114	311	0.0
5.2	0.40	2006	1.8	0.04	124	344	0.0
5.6	0.42	2007	1.9	0.04	135	382	0.0
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

```
                    FUTURE PAVEMENT EVALUATION

********************************************************************************
LANE 1
********************************************************************************

-----------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 1 occurs in 1988 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
-----------------------------------------------------------------------
JOINT DETERIORATION:

Significant joint deterioration in lane 1 occurs in 1999 as indicated by
 55 or more deteriorated joints per mile.

a. full-depth repair at joints
-----------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

Structural deficiency of the pavement in lane 1 occurs in 1994 as
indicated by  800 feet or more of deteriorated transverse cracks per mile.

a. full-depth repair of cracks, AC structural overlay
b. full-depth repair of cracks, crack and seat and AC structural overlay
c. full-depth repair of cracks, PCC bonded overlay
d. full-depth repair of cracks, PCC unbonded overlay
e. reconstruct
-----------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

Inadequate load transfer at transverse joints in lane 1 occurs in 1988 as
indicated by predicted faulting of 0.13 inches or more.

a. load transfer restoration at joints
b. do nothing
-----------------------------------------------------------------------
LOSS OF SUPPORT:

Loss of slab support in lane 1 occurs in 1988 as indicated by predicted
faulting greater than 0.13 inches at transverse joints.

a. subseal at joints and cracks
-----------------------------------------------------------------------
DRAINAGE DEFICIENCY:

A drainage deficiency in lane 1 occurs in 1989 as indicated by predicted
pumping reaching the low severity level.

a. install or repair longitudinal subdrains
b. install or repair longitudinal subdrains, seal all joints and cracks
```

```
*****************************************************************************
LANE 2
*****************************************************************************

---------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 2 occurs in 1988 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
---------------------------------------------------------------------
JOINT DETERIORATION:

Significant joint deterioration in lane 2 occurs in 1999 as indicated by
 55 or more deteriorated joints per mile.

a. full-depth repair at joints
---------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

No structural deficiency in lane 2 occurs based on predicted transverse
cracking over the next 20 years.
---------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency at transverse joints in lane 2 occurs based
on predicted joint faulting over the next 20 years.
---------------------------------------------------------------------
LOSS OF SUPPORT:

No loss of slab support in lane 2 occurs based on predicted joint
faulting over the next 20 years.
---------------------------------------------------------------------
DRAINAGE DEFICIENCY:

A drainage deficiency in lane 2 occurs in 1999 as indicated by predicted
pumping reaching the low severity level.

a. install or repair longitudinal subdrains
b. install or repair longitudinal subdrains, seal all joints and cracks
```

PHYSICAL TESTING RECOMMENDATIONS

--------------------- NONDESTRUCTIVE DEFLECTION TESTING ------------------

Nondestructive deflection testing (NDT) of the pavement is recommended to further investigate deficiencies observed in the preliminary evaluation of the pavement. Use a Falling Weight Deflectometer or other NDT device capable of applying dynamic loads to the pavement over a range of load levels comparable to actual truck wheel loads (i.e., 9000 to 16000 pounds).

Nondestructive deflection testing should be conducted in a 0.1-mile section randomly selected within each mile of the project. Deflection testing should on be conducted when the ambient temperature is between 50 and 80 degrees Fahrenhe to avoid joint and crack lock-up and excessive curling.

Testing should be performed at the following locations:

Center of the slab: Measure deflection basin in the center of the traffic lane in order to backcalculate elastic modulus of slab and effective k value b the slab. This information may be used in a structural analysis of the pavemen in determining uniformity of support along the project (see NCHRP Report No. 28 Lane edge: Measure deflections at the outer edge of the traffic lane (next to the shoulder). If the pavement has a tied concrete shoulder, also meas deflections across lane/shoulder joint. This information may be used in a structural analysis of the pavement.

Corner of the slab: Measure deflections across transverse joints and cracks and compute their load transfer efficiencies. This information will be used in a structural analysis of the pavement.

---------------------- DESTRUCTIVE DEFLECTION TESTING ---------------------

Destructive testing (obtaining samples of material from the pavement structure) is recommended to further investigate deficiencies observed in the preliminary Material samples must be obtained by coring through the concrete surface and base with a core bit (6-inch diameter unless specified otherwise). Granular base bulk samples should be obtained. Stabilized base samples should be obtained from coring, if possible. Where undisturbed soil samples are requir they should be obtained by sampling the soil beneath the pavement and base a thin-walled Shelby tube.

Each type of destructive testing required should be conducted on at least one and preferably three or more slabs in each 0.1-mile section randomly select within each mile of the project. For reasons of efficiency and safety, nondestr testing and destructive testing should be conducted concurrently.

The following types of destructive testing are recommended:

Obtain cores from the center of the traffic lane.

Obtain cores through selected transverse joints.

At locations along the longitudinal joint with significant spalling or nearby longitudinal cracks, core through the longitudinal joint (and adjacent cracks, if present). Examine the cores visually to determine whether the joint or one or more of the cracks is functioning as a joint.

MATERIALS EVALUATION

Visual inspection and possibly laboratory testing of material samples obtained from destructive testing (coring) is recommended. The following types of information should be obtained from the material samples:

The strength of the cores obtained from the concrete slab should be determined by indirect tension testing in the laboratory. This information may be used in a structural analysis of the pavement. In the case of concrete deterioration due to poor durability (e.g., D cracking or reactive aggregate), the strength of the concrete is an indicator of the extent of the deterioration.

Examine the cores obtained from the center of the slab and through the transverse joints to determine the thickness and soundness of the concrete.

Determine the thickness of the base layer by examining the base material obtained from the coring operation.

SKID TESTING

Physical testing is recommended to further investigate and quantify the causes of poor skid resistance observed in the preliminary evaluation. The following types of testing are recommended:

Measure the skid resistance of the pavement with either a ribbed tire (ASTM E 501) or a bald tire (ASTM E 524) mounted on a locked-wheel skid trailer. Testing with both types of tires is preferred in order to obtain good estimates of both the macrotexture and microtexture of the pavement surface. If only one type of tire can be used, the bald tire is recommended. Measure skid resistance with the skid trailer over a section of pavement at least 1500 feet long (approximately 0.3 mile) within each mile of the project to obtain an estimate of the overall skid resistance of the pavement surface.

ROUGHNESS TESTING

Roughness testing is recommended in each traffic lane to verify that the pavement is excessively rough and to determine the cause of the roughness. Roughness testing should be performed over the entire length of the pavement and the roughness measured at each 0.1 mile segment.

Test the pavement with roughness equipment capable of producing either a response-type measurement of the pavement's roughness (e.g., Mays Meter) or a profile measurement device. Compare the measured roughness to your agency's standard for an acceptable level of roughness. Prepare a profile of the roughness index along the project for each traffic lane to identify points of significant roughness that need special attention.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RESTORATION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	FDR FAULTING	TRANSVERSE CRACKING	JOINT DETERIOR.	PUMPING	PSR
1988	2937	8.19	0.00	0.00	0	0.0	0.0	4.5
1989	2938	8.79	0.03	0.06	85	352.0	0.9	2.4
1990	2939	9.43	0.04	0.08	182	352.0	1.4	2.3
1991	2940	10.12	0.05	0.10	296	352.0	1.9	2.2
1992	2941	10.85	0.06	0.11	427	352.0	2.4	2.1
1993	2942	11.62	0.06	0.13	579	352.0	2.8	2.1
1994	2943	12.45	0.07	0.15	756	352.0	3.0	2.0
1995	2944	13.33	0.08	0.16	962	352.0	3.0	1.9
1996	2945	14.28	0.08	0.18	1201	352.0	3.0	1.9
1997	2946	15.28	0.09	0.20	1480	352.0	3.0	1.8
1998	2947	16.35	0.10	0.22	1804	352.0	3.0	1.7
1999	2948	17.49	0.10	0.23	2183	352.0	3.0	1.6
2000	2949	18.70	0.11	0.25	2624	352.0	3.0	1.5
2001	2950	20.00	0.11	0.27	3139	352.0	3.0	1.4
2002	2951	21.38	0.12	0.29	3739	352.0	3.0	1.3
2003	2952	22.85	0.13	0.31	4440	352.0	3.0	1.1
2004	2953	24.42	0.13	0.33	5259	352.0	3.0	1.0
2005	2954	26.09	0.14	0.36	6214	352.0	3.0	0.8
2006	2955	27.88	0.14	0.38	7330	352.0	3.0	0.6
2007	2956	29.78	0.15	0.40	8632	352.0	3.0	0.4
		18-kip millions	Inches	Inches	Feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches in 2003.

Full-depth repair faulting on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches in 1993.

Cracking on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1995.

Joint deterioration on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 55 joints per mile in 1989.

Pumping on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the restored pavement in lane 1 is predicted to equal or fall below an unacceptable level of 3.0 in 1989.

Page

C3. Structural Overlay

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	1465	432	0.00
1990	2	1.24	1519	568	0.00
1991	3	1.93	1553	668	0.00
1992	4	2.66	1577	751	0.00
1993	5	3.43	1597	824	0.00
1994	6	4.26	1613	890	0.01
1995	7	5.14	1627	950	0.04
1996	8	6.09	1640	1007	0.07
1997	9	7.09	1651	1061	0.10
1998	10	8.16	1661	1112	0.13
1999	11	9.30	1670	1162	0.17
2000	12	10.51	1679	1210	0.20
2001	13	11.81	1687	1256	0.24
2002	14	13.19	1695	1302	0.28
2003	15	14.66	1702	1347	0.32
2004	16	16.23	1709	1390	0.36
2005	17	17.90	1716	1434	0.41
2006	18	19.69	1722	1476	0.45
2007	19	21.59	1728	1518	0.50
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 1500 feet per mile in 2007.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	1458	426	0.00
1990	2	1.24	1512	560	0.00
1991	3	1.93	1546	658	0.00
1992	4	2.66	1570	740	0.00
1993	5	3.43	1589	812	0.00
1994	6	4.26	1606	877	0.00
1995	7	5.14	1620	937	0.02
1996	8	6.09	1632	993	0.05
1997	9	7.09	1643	1046	0.09
1998	10	8.16	1653	1096	0.12
1999	11	9.30	1663	1145	0.15
2000	12	10.51	1671	1192	0.19
2001	13	11.81	1679	1238	0.23
2002	14	13.19	1687	1283	0.27
2003	15	14.66	1694	1327	0.31
2004	16	16.23	1701	1370	0.35
2005	17	17.90	1708	1413	0.39
2006	18	19.69	1714	1455	0.44
2007	19	21.59	1720	1496	0.49
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	1429	401	0.00
1990	2	1.24	1483	527	0.00
1991	3	1.93	1515	620	0.00
1992	4	2.66	1539	697	0.00
1993	5	3.43	1558	764	0.00
1994	6	4.26	1574	825	0.00
1995	7	5.14	1588	881	0.00
1996	8	6.09	1600	934	0.01
1997	9	7.09	1611	984	0.04
1998	10	8.16	1621	1032	0.08
1999	11	9.30	1630	1077	0.11
2000	12	10.51	1639	1122	0.15
2001	13	11.81	1647	1165	0.18
2002	14	13.19	1654	1207	0.22
2003	15	14.66	1661	1249	0.26
2004	16	16.23	1668	1289	0.31
2005	17	17.90	1675	1329	0.35
2006	18	19.69	1681	1369	0.40
2007	19	21.59	1687	1408	0.45
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	1358	343	0.00
1990	2	1.24	1409	450	0.00
1991	3	1.93	1442	530	0.00
1992	4	2.66	1463	595	0.00
1993	5	3.43	1481	653	0.00
1994	6	4.26	1496	705	0.00
1995	7	5.14	1509	753	0.00
1996	8	6.09	1521	798	0.00
1997	9	7.09	1532	841	0.00
1998	10	8.16	1541	882	0.02
1999	11	9.30	1550	921	0.05
2000	12	10.51	1558	959	0.09
2001	13	11.81	1566	996	0.12
2002	14	13.19	1573	1032	0.16
2003	15	14.66	1580	1067	0.20
2004	16	16.23	1586	1102	0.25
2005	17	17.90	1592	1136	0.29
2006	18	19.69	1598	1170	0.34
2007	19	21.59	1604	1203	0.39
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	789	789	0.00
1990	2	1.24	799	799	0.00
1991	3	1.93	807	807	0.00
1992	4	2.66	816	816	0.00
1993	5	3.43	824	824	0.00
1994	6	4.26	831	831	0.01
1995	7	5.14	838	838	0.04
1996	8	6.09	844	844	0.07
1997	9	7.09	850	850	0.10
1998	10	8.16	855	855	0.13
1999	11	9.30	859	859	0.17
2000	12	10.51	863	863	0.20
2001	13	11.81	866	866	0.24
2002	14	13.19	868	868	0.28
2003	15	14.66	869	869	0.32
2004	16	16.23	869	869	0.36
2005	17	17.90	869	869	0.41
2006	18	19.69	867	867	0.45
2007	19	21.59	864	864	0.50
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	789	789	0.00
1990	2	1.24	799	799	0.00
1991	3	1.93	807	807	0.00
1992	4	2.66	816	816	0.00
1993	5	3.43	824	824	0.00
1994	6	4.26	831	831	0.00
1995	7	5.14	838	838	0.02
1996	8	6.09	844	844	0.05
1997	9	7.09	850	850	0.09
1998	10	8.16	855	855	0.12
1999	11	9.30	859	859	0.15
2000	12	10.51	863	863	0.19
2001	13	11.81	866	866	0.23
2002	14	13.19	868	868	0.27
2003	15	14.66	869	869	0.31
2004	16	16.23	869	869	0.35
2005	17	17.90	869	869	0.39
2006	18	19.69	867	867	0.44
2007	19	21.59	864	864	0.49
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	789	789	0.00
1990	2	1.24	799	799	0.00
1991	3	1.93	807	807	0.00
1992	4	2.66	816	816	0.00
1993	5	3.43	824	824	0.00
1994	6	4.26	831	831	0.00
1995	7	5.14	838	838	0.00
1996	8	6.09	844	844	0.00
1997	9	7.09	850	850	0.00
1998	10	8.16	855	855	0.02
1999	11	9.30	859	859	0.05
2000	12	10.51	863	863	0.09
2001	13	11.81	866	866	0.12
2002	14	13.19	868	868	0.16
2003	15	14.66	869	869	0.20
2004	16	16.23	869	869	0.25
2005	17	17.90	869	869	0.29
2006	18	19.69	867	867	0.34
2007	19	21.59	864	864	0.39
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Page

C5. PCC Bonded Overlay

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.05	0.1	224
1990	2	1.24	0.06	0.4	376
1991	3	1.93	0.07	1.0	509
1992	4	2.66	0.08	2.0	633
1993	5	3.43	0.08	3.3	749
1994	6	4.26	0.09	5.0	860
1995	7	5.14	0.09	7.2	967
1996	8	6.09	0.09	9.9	1071
1997	9	7.09	0.10	13.0	1172
1998	10	8.16	0.10	16.6	1271
1999	11	9.30	0.10	20.8	1368
2000	12	10.51	0.11	25.5	1463
2001	13	11.81	0.11	30.8	1557
2002	14	13.19	0.11	36.7	1650
2003	15	14.66	0.12	43.2	1742
2004	16	16.23	0.12	50.4	1833
2005	17	17.90	0.12	58.2	1923
2006	18	19.69	0.12	66.7	2012
2007	19	21.59	0.13	75.9	2101
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.05	0.1	224
1990	2	1.24	0.06	0.4	376
1991	3	1.93	0.07	1.0	509
1992	4	2.66	0.08	2.0	633
1993	5	3.43	0.08	3.3	749
1994	6	4.26	0.09	5.0	860
1995	7	5.14	0.09	7.2	967
1996	8	6.09	0.09	9.9	1071
1997	9	7.09	0.10	13.0	1172
1998	10	8.16	0.10	16.6	1271
1999	11	9.30	0.10	20.8	1368
2000	12	10.51	0.11	25.5	1463
2001	13	11.81	0.11	30.8	1557
2002	14	13.19	0.11	36.7	1650
2003	15	14.66	0.12	43.2	1742
2004	16	16.23	0.12	50.4	1833
2005	17	17.90	0.12	58.2	1923
2006	18	19.69	0.12	66.7	2012
2007	19	21.59	0.13	75.9	2101
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

Page

C6. PCC Unbonded Overlay

No Dowels

7/8" Dowels

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.02	0.0	171
1990	2	1.24	0.03	0.0	258
1991	3	1.93	0.04	0.0	349
1992	4	2.66	0.04	0.1	457
1993	5	3.43	0.05	0.2	595
1994	6	4.26	0.05	0.3	773
1995	7	5.14	0.05	0.5	1005
1996	8	6.09	0.06	0.7	1305
1997	9	7.09	0.06	1.1	1690
1998	10	8.16	0.06	1.5	2182
1999	11	9.30	0.07	2.0	2805
2000	12	10.51	0.07	2.6	3588
2001	13	11.81	0.08	3.3	4565
2002	14	13.19	0.08	4.1	5778
2003	15	14.66	0.08	5.0	7275
2004	16	16.23	0.09	6.1	9113
2005	17	17.90	0.09	7.4	11360
2006	18	19.69	0.09	8.8	14097
2007	19	21.59	0.10	10.3	17419
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.02	0.0	46
1990	2	1.24	0.03	0.0	66
1991	3	1.93	0.04	0.0	83
1992	4	2.66	0.04	0.1	100
1993	5	3.43	0.05	0.2	116
1994	6	4.26	0.05	0.3	133
1995	7	5.14	0.05	0.5	152
1996	8	6.09	0.06	0.7	173
1997	9	7.09	0.06	1.1	197
1998	10	8.16	0.06	1.5	224
1999	11	9.30	0.07	2.0	257
2000	12	10.51	0.07	2.6	295
2001	13	11.81	0.08	3.3	340
2002	14	13.19	0.08	4.1	393
2003	15	14.66	0.08	5.0	457
2004	16	16.23	0.09	6.1	534
2005	17	17.90	0.09	7.4	625
2006	18	19.69	0.09	8.8	734
2007	19	21.59	0.10	10.3	864
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.02	0.0	44
1990	2	1.24	0.03	0.0	63
1991	3	1.93	0.04	0.0	79
1992	4	2.66	0.04	0.1	95
1993	5	3.43	0.05	0.2	110
1994	6	4.26	0.05	0.3	126
1995	7	5.14	0.05	0.5	144
1996	8	6.09	0.06	0.7	163
1997	9	7.09	0.06	1.1	185
1998	10	8.16	0.06	1.5	210
1999	11	9.30	0.07	2.0	240
2000	12	10.51	0.07	2.6	274
2001	13	11.81	0.08	3.3	315
2002	14	13.19	0.08	4.1	363
2003	15	14.66	0.08	5.0	421
2004	16	16.23	0.09	6.1	489
2005	17	17.90	0.09	7.4	571
2006	18	19.69	0.09	8.8	668
2007	19	21.59	0.10	10.3	785
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.02	0.0	46
1990	2	1.24	0.02	0.0	66
1991	3	1.93	0.03	0.0	83
1992	4	2.66	0.03	0.1	100
1993	5	3.43	0.03	0.2	116
1994	6	4.26	0.04	0.3	133
1995	7	5.14	0.04	0.5	152
1996	8	6.09	0.04	0.7	173
1997	9	7.09	0.04	1.1	197
1998	10	8.16	0.05	1.5	224
1999	11	9.30	0.05	2.0	257
2000	12	10.51	0.05	2.6	295
2001	13	11.81	0.05	3.3	340
2002	14	13.19	0.06	4.1	393
2003	15	14.66	0.06	5.0	457
2004	16	16.23	0.06	6.1	534
2005	17	17.90	0.06	7.4	625
2006	18	19.69	0.07	8.8	734
2007	19	21.59	0.07	10.3	864
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.02	0.0	44
1990	2	1.24	0.02	0.0	63
1991	3	1.93	0.03	0.0	79
1992	4	2.66	0.03	0.1	95
1993	5	3.43	0.03	0.2	110
1994	6	4.26	0.04	0.3	126
1995	7	5.14	0.04	0.5	144
1996	8	6.09	0.04	0.7	163
1997	9	7.09	0.04	1.1	185
1998	10	8.16	0.05	1.5	210
1999	11	9.30	0.05	2.0	240
2000	12	10.51	0.05	2.6	274
2001	13	11.81	0.05	3.3	315
2002	14	13.19	0.06	4.1	363
2003	15	14.66	0.06	5.0	421
2004	16	16.23	0.06	6.1	489
2005	17	17.90	0.06	7.4	571
2006	18	19.69	0.07	8.8	668
2007	19	21.59	0.07	10.3	785
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

Page

C7. Reconstruct Both Lanes

No Dowels, Stabilized Base

No Dowels, Granular Base

7/8" Dowels, Stabilized Base

7/8" Dowels, Granular Base

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.07	23	0.0	0.9	3.9
1990	2	1.24	0.08	34	0.0	1.2	3.7
1991	3	1.93	0.09	42	0.0	1.4	3.4
1992	4	2.66	0.09	50	0.1	1.7	3.1
1993	5	3.43	0.10	57	0.2	1.9	2.8
1994	6	4.26	0.10	64	0.3	2.0	2.4
1995	7	5.14	0.10	71	0.5	2.2	2.0
1996	8	6.09	0.10	79	0.7	2.4	1.6
1997	9	7.09	0.11	87	1.1	2.6	1.1
1998	10	8.16	0.11	96	1.5	2.7	0.6
1999	11	9.30	0.11	106	2.0	2.9	0.1
2000	12	10.51	0.11	116	2.6	3.0	-0.4
2001	13	11.81	0.12	128	3.3	3.0	-1.0
2002	14	13.19	0.12	142	4.1	3.0	-1.6
2003	15	14.66	0.12	157	5.0	3.0	-2.2
2004	16	16.23	0.12	175	6.1	3.0	-2.9
2005	17	17.90	0.12	195	7.4	3.0	-3.6
2006	18	19.69	0.12	219	8.8	3.0	-4.4
2007	19	21.59	0.13	246	10.3	3.0	-5.2
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 2007.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.06	3	0.0	0.6	4.3
1990	2	1.24	0.07	4	0.0	0.8	4.2
1991	3	1.93	0.07	5	0.0	1.0	4.0
1992	4	2.66	0.08	6	0.1	1.1	3.7
1993	5	3.43	0.08	6	0.2	1.2	3.5
1994	6	4.26	0.08	7	0.3	1.4	3.1
1995	7	5.14	0.08	8	0.5	1.5	2.8
1996	8	6.09	0.09	9	0.7	1.6	2.4
1997	9	7.09	0.09	9	1.1	1.7	2.0
1998	10	8.16	0.09	10	1.5	1.8	1.5
1999	11	9.30	0.09	11	2.0	1.9	1.0
2000	12	10.51	0.09	11	2.6	2.1	0.5
2001	13	11.81	0.09	12	3.3	2.2	-0.0
2002	14	13.19	0.10	13	4.1	2.3	-0.6
2003	15	14.66	0.10	14	5.0	2.4	-1.2
2004	16	16.23	0.10	14	6.1	2.5	-1.9
2005	17	17.90	0.10	15	7.4	2.6	-2.6
2006	18	19.69	0.10	16	8.8	2.7	-3.3
2007	19	21.59	0.10	17	10.3	2.8	-4.1
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.10	23	0.0	0.9	3.9
1990	2	1.24	0.11	34	0.0	1.2	3.7
1991	3	1.93	0.12	42	0.0	1.4	3.4
1992	4	2.66	0.13	50	0.1	1.7	3.1
1993	5	3.43	0.13	57	0.2	1.9	2.8
1994	6	4.26	0.13	64	0.3	2.0	2.4
1995	7	5.14	0.14	71	0.5	2.2	2.0
1996	8	6.09	0.14	79	0.7	2.4	1.6
1997	9	7.09	0.14	87	1.1	2.6	1.1
1998	10	8.16	0.15	96	1.5	2.7	0.6
1999	11	9.30	0.15	106	2.0	2.9	0.1
2000	12	10.51	0.15	116	2.6	3.0	-0.4
2001	13	11.81	0.16	128	3.3	3.0	-1.0
2002	14	13.19	0.16	142	4.1	3.0	-1.6
2003	15	14.66	0.16	157	5.0	3.0	-2.2
2004	16	16.23	0.16	175	6.1	3.0	-2.9
2005	17	17.90	0.17	195	7.4	3.0	-3.6
2006	18	19.69	0.17	219	8.8	3.0	-4.4
2007	19	21.59	0.17	246	10.3	3.0	-5.2
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 1992.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.09	3	0.0	0.6	4.3
1990	2	1.24	0.10	4	0.0	0.8	4.2
1991	3	1.93	0.10	5	0.0	1.0	4.0
1992	4	2.66	0.11	6	0.1	1.1	3.7
1993	5	3.43	0.11	6	0.2	1.2	3.5
1994	6	4.26	0.12	7	0.3	1.4	3.1
1995	7	5.14	0.12	8	0.5	1.5	2.8
1996	8	6.09	0.12	9	0.7	1.6	2.4
1997	9	7.09	0.13	9	1.1	1.7	2.0
1998	10	8.16	0.13	10	1.5	1.8	1.5
1999	11	9.30	0.13	11	2.0	1.9	1.0
2000	12	10.51	0.13	11	2.6	2.1	0.5
2001	13	11.81	0.13	12	3.3	2.2	-0.0
2002	14	13.19	0.14	13	4.1	2.3	-0.6
2003	15	14.66	0.14	14	5.0	2.4	-1.2
2004	16	16.23	0.14	14	6.1	2.5	-1.9
2005	17	17.90	0.14	15	7.4	2.6	-2.6
2006	18	19.69	0.15	16	8.8	2.7	-3.3
2007	19	21.59	0.15	17	10.3	2.8	-4.1
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 1997.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.05	23	0.0	0.9	3.9
1990	2	1.24	0.06	34	0.0	1.2	3.7
1991	3	1.93	0.06	42	0.0	1.4	3.4
1992	4	2.66	0.06	50	0.1	1.7	3.1
1993	5	3.43	0.07	57	0.2	1.9	2.8
1994	6	4.26	0.07	64	0.3	2.0	2.4
1995	7	5.14	0.07	71	0.5	2.2	2.0
1996	8	6.09	0.07	79	0.7	2.4	1.6
1997	9	7.09	0.07	87	1.1	2.6	1.1
1998	10	8.16	0.07	96	1.5	2.7	0.6
1999	11	9.30	0.08	106	2.0	2.9	0.1
2000	12	10.51	0.08	116	2.6	3.0	-0.4
2001	13	11.81	0.08	128	3.3	3.0	-1.0
2002	14	13.19	0.08	142	4.1	3.0	-1.6
2003	15	14.66	0.08	157	5.0	3.0	-2.2
2004	16	16.23	0.08	175	6.1	3.0	-2.9
2005	17	17.90	0.08	195	7.4	3.0	-3.6
2006	18	19.69	0.08	219	8.8	3.0	-4.4
2007	19	21.59	0.09	246	10.3	3.0	-5.2
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.04	3	0.0	0.6	4.3
1990	2	1.24	0.04	4	0.0	0.8	4.2
1991	3	1.93	0.04	5	0.0	1.0	4.0
1992	4	2.66	0.05	6	0.1	1.1	3.7
1993	5	3.43	0.05	6	0.2	1.2	3.5
1994	6	4.26	0.05	7	0.3	1.4	3.1
1995	7	5.14	0.05	8	0.5	1.5	2.8
1996	8	6.09	0.05	9	0.7	1.6	2.4
1997	9	7.09	0.05	9	1.1	1.7	2.0
1998	10	8.16	0.05	10	1.5	1.8	1.5
1999	11	9.30	0.06	11	2.0	1.9	1.0
2000	12	10.51	0.06	11	2.6	2.1	0.5
2001	13	11.81	0.06	12	3.3	2.2	-0.0
2002	14	13.19	0.06	13	4.1	2.3	-0.6
2003	15	14.66	0.06	14	5.0	2.4	-1.2
2004	16	16.23	0.06	14	6.1	2.5	-1.9
2005	17	17.90	0.06	15	7.4	2.6	-2.6
2006	18	19.69	0.06	16	8.8	2.7	-3.3
2007	19	21.59	0.06	17	10.3	2.8	-4.1
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.08	23	0.0	0.9	3.9
1990	2	1.24	0.09	34	0.0	1.2	3.7
1991	3	1.93	0.09	42	0.0	1.4	3.4
1992	4	2.66	0.10	50	0.1	1.7	3.1
1993	5	3.43	0.10	57	0.2	1.9	2.8
1994	6	4.26	0.10	64	0.3	2.0	2.4
1995	7	5.14	0.11	71	0.5	2.2	2.0
1996	8	6.09	0.11	79	0.7	2.4	1.6
1997	9	7.09	0.11	87	1.1	2.6	1.1
1998	10	8.16	0.11	96	1.5	2.7	0.6
1999	11	9.30	0.11	106	2.0	2.9	0.1
2000	12	10.51	0.12	116	2.6	3.0	-0.4
2001	13	11.81	0.12	128	3.3	3.0	-1.0
2002	14	13.19	0.12	142	4.1	3.0	-1.6
2003	15	14.66	0.12	157	5.0	3.0	-2.2
2004	16	16.23	0.12	175	6.1	3.0	-2.9
2005	17	17.90	0.13	195	7.4	3.0	-3.6
2006	18	19.69	0.13	219	8.8	3.0	-4.4
2007	19	21.59	0.13	246	10.3	3.0	-5.2
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 2005.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.06	3	0.0	0.6	4.3
1990	2	1.24	0.07	4	0.0	0.8	4.2
1991	3	1.93	0.08	5	0.0	1.0	4.0
1992	4	2.66	0.08	6	0.1	1.1	3.7
1993	5	3.43	0.08	6	0.2	1.2	3.5
1994	6	4.26	0.08	7	0.3	1.4	3.1
1995	7	5.14	0.09	8	0.5	1.5	2.8
1996	8	6.09	0.09	9	0.7	1.6	2.4
1997	9	7.09	0.09	9	1.1	1.7	2.0
1998	10	8.16	0.09	10	1.5	1.8	1.5
1999	11	9.30	0.09	11	2.0	1.9	1.0
2000	12	10.51	0.10	11	2.6	2.1	0.5
2001	13	11.81	0.10	12	3.3	2.2	-0.0
2002	14	13.19	0.10	13	4.1	2.3	-0.6
2003	15	14.66	0.10	14	5.0	2.4	-1.2
2004	16	16.23	0.10	14	6.1	2.5	-1.9
2005	17	17.90	0.10	15	7.4	2.6	-2.6
2006	18	19.69	0.11	16	8.8	2.7	-3.3
2007	19	21.59	0.11	17	10.3	2.8	-4.1
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

APPENDIX D

I-90 WEST (MP 61) SNOQUALMIE PASS EXPEAR OUTPUT

APPENDIX D
I-90 WEST (MP 61) SNOQUALAMIE PASS
EXPEAR OUTPUT

APPENDIX D
I-90 WEST (MP 61) SNOQUALAMIE PASS
EXPEAR OUTPUT (continued)

EXPEAR 1.1

PROJECT EVALUATION AND REHABILITATION RECOMENDATIONS

FOR: snosub

1. Project Summary
2. Current Evaluation
3. Physical Testing Recommendations
4. Future Distress Predictions

Project Survey Summary For JRCP

Design engineer: Holly Simmons Date of survey: 08/26/88

PROJECT IDENTIFICATION
Highway designation: I-90
State: Washington
Direction of survey: West
Starting milepost: 61.00
Ending milepost: 61.01

Number of sample units: 1

CLIMATE
Climatic zone: wet freeze-thaw
Estimated annual temperature range (F): 49.5
Mean annual precipitation (inches): 107.6
Corps of Engineers freezing index (Fahrenheit degree-days): 937.0
Average Annual Temperature (degrees Fahrenheit): 41.80

SLAB CONSTRUCTION
Year constructed: 1959
Slab thickness (inches): 9.0
Width of traffic lanes (feet): 12.00
Concrete 28-day modulus of rupture (psi): 650.00

TRANSVERSE AND LONGITUDINAL JOINTS
Pattern of joint spacing: uniform
Transverse joint spacing if uniform (feet): 15.0
Transverse joint sequence if random (feet):
Type of sealant: liquid
Average transverse joint reservoir dimensions:
width (inches): 0.19
depth (inches): 1.50

Method used to form transverse joints: sawing
Transverse joint sawed depth (inches): 1.5

Type of load transfer system: aggregate interlock
Dowel bar diameter (inches): 0.00
Method used to form longitudinal joints between lanes: sawing
Longitudinal joint sawed or formed depth (inches): 2.3

BASE
Base type: open-graded drainage layer
Modulus of subgrade reaction (psi/inch): 200.00

SUBGRADE
Predominant subgrade soil AASHTO classification: A1
Are swelling soils a problem in area: no
Were steps taken to prevent the swelling soils problem: n/a

SHOULDER

Type of shoulder: AC

Width of shoulders (feet): inner: 4.0 outer: 10.0

Inner lane slope direction: toward inner shoulder

TRAFFIC

Estimated current through two-way ADT: 17300

Percent commercial trucks: 19.0

Total number of lanes in direction of survey: 2

Future 18-kip ESAL growth rate (percent per year): 6.6

Truck traffic volume growth rate: approximately same as in past

	Lane two	Lane one
Total accumulated 18-kip ESAL (millions):	0.82	8.19

RIDE QUALITY

PSR	2.5	2.5

SAMPLE UNIT IDENTIFICATION
Sample unit number: 1/ Starting milepost: 61.0
Length of sample unit (feet): 60.0

	Lane two	Lane one
Number of deteriorated transverse cracks, L-M-H:	0	0
Mean faulting at transverse cracks (inches):	0.00	0.00
Number of deteriorated transverse joints:	0	2
Mean faulting at transverse joints (inches):	0.00	0.13
Number of transverse joints:	4	4
Number of FDRS & slab replacements:	0	0
Mean faulting at FDR & slab repl. jnts (inches):	0.00	0.00
Number of FDR & slab replacement joints:	0	0
Number of corner breaks:	0	0
Length of long. cracking, M-H only (feet):	0.0	0.0
Length of spalling of longit. joint, M-H only:		0.0

CRACKING AT TRANSVERSE JOINTS

Total joints with trans. cracks within 2 feet:	0	0

FOUNDATION MOVEMENT

Number of settlements (M-H severity):	0	0
Number of heaves (M-H severity):	0	0

DRAINAGE
Are longitudinal subdrains present and functional: no
What is the typical height of the pavement above the ditchline: 5.0
Do ditches have standing water or cattails in them: no

LOSS OF SUPPORT

Extent of evidence of pumping or water bleeding:	none	none

SURFACE CONDITION
Method used to texture the pavement at construction: other

Is the surface polished in the wheelpaths:	yes	yes
Is significant tire rutting in the wheelpaths:	no	no

JOINT SEALANT CONDITION

Condition of the transverse joint sealant:	high	high
Condition of the longitudinal joint sealant:		high
Are substantial amnts of incompressibles in jnts:	yes	yes

CONCRETE DURABILITY

Extent of "D" cracking at joints or cracks:	none	none
Extent of reactive aggregate distress:	none	none
Extent of scaling:	none	none

PREVIOUS REPAIR

Are full-depth repairs placed with dowels:	no	no
Are partial depth repairs present at most joints:	no	no
Has diamond grinding been done:	yes	yes
Has grooving been done:	no	no

AC SHOULDERS	Inner	Outer
Alligator cracking:	none	none
Linear Cracking:	none	none
Weathering/ravelling:	none	none
Lane/shoulder joint dropoff:	none	none
Settlements or heaves along outer edge:	none	some
Blowholes at transverse joints:	none	none
Lane/Shoulder joint condition:	good	good

```
          Extrapolated (Per Mile) Values For snosub

                                                Lane two        Lane one
Number of deteriorated transverse cracks:          0               0
Mean faulting at deter. trans. cracks (inches):  0.00            0.00
Number of deteriorated transverse joints:          0              176
Mean faulting at transverse joints (inches):     0.00            0.13
Number of transverse joints:                      352             352
Number of full-depth repairs:                      0               0
Mean faulting at FDR joints (inches):            0.00            0.00
Number of full-depth repair joints:                0               0
Number of corner breaks:                           0               0
Length of long. cracking, M-H only (feet):       0.0             0.0
Length of spalling of longit. joint, M-H only:                   0.0

Total joints with trans. cracks within 2 feet:     0               0

Number of settlements (M-H severity):              0               0
Number of heaves (M-H severity):                   0               0
```

```
                         CURRENT PAVEMENT EVALUATION

**************************************************************************
LANE 1
**************************************************************************

--------------------------------------------------------------------
JOINT CONSTRUCTION DEFICIENCY:

The pavement in lane 1 shows no indications of a longitudinal joint
construction deficiency.

a. do nothing

The pavement in lane 1 shows no indications of a transverse joint
construction deficiency.

a. do nothing
--------------------------------------------------------------------
JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 1 by medium-
to high-severity joint sealant damage and an inadequate joint sealant
reservoir shape factor for the existing sealant type.

a. reseal transverse joints
--------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 1 is indicated by  55 or more deteriorated joints
per mile and an unacceptably low PSR for the pavement's ADT level.

a. full-depth repair of joints
--------------------------------------------------------------------
DURABILITY DEFICIENCY:

The pavement in lane 1 shows no indications of significant surface or
concrete durability problems.

a. do nothing
--------------------------------------------------------------------
JOINT DETERIORATION:

Joint deterioration or other pavement deterioration in lane 1 may be
accelerated by water infiltration permitted by poor longitudinal
joint sealant condition.

a. reseal longitudinal centerline joint

Extensive joint deterioration exists ( 55 joints per mile) in lane 1,
likely due poor joint sealant condition permitting infiltration of water
and incompressibles.

a. full-depth repair of joints, reseal transverse joints
--------------------------------------------------------------------
STRUCTURAL DEFICIENCY:
```

SKID RESISTANCE DEFICIENCY:

Loss of skid resistance in lane 1 is indicated by polished wheel paths.

a. grinding
b. grooving
c. AC nonstructural overlay

LOAD TRANSFER DEFICIENCY:

No load transfer deficiency is indicated at transverse joints in lane 1.

a. do nothing

A potential load transfer deficiency exists at undowelled full-depth repairs in lane 1, but mean full-depth repair faulting is not significant.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

The pavement in the lane 1 shows no indications of loss of slab support.

a. do nothing

DRAINAGE DEFICIENCY:

The pavement in lane 1 shows no indications of a drainage deficiency.

a. do nothing

```
*************************************************************************
LANE 2
*************************************************************************

--------------------------------------------------------------------
JOINT CONSTRUCTION DEFICIENCY:

The pavement in lane 2 shows no indications of a transverse joint
construction deficiency.

a. do nothing
--------------------------------------------------------------------
JOINT SEALANT DEFICIENCY:

A transverse joint sealant deficiency is indicated in lane 2 by medium-
to high-severity joint sealant damage and an inadequate joint sealant
reservoir shape factor for the existing sealant type.

a. reseal transverse joints
--------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 2 is indicated by an unacceptably low PSR for
the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
--------------------------------------------------------------------
DURABILITY DEFICIENCY:

The pavement in lane 2 shows no indications of significant surface or
concrete durability problems.

a. do nothing
--------------------------------------------------------------------
JOINT DETERIORATION:

No joint deterioration exists in lane 2.

a. do nothing
--------------------------------------------------------------------
STRUCTURAL DEFICIENCY:
--------------------------------------------------------------------
SKID RESISTANCE DEFICIENCY:

Loss of skid resistance in lane 2 is indicated by polished wheel
paths.

a. grinding
b. grooving
c. AC nonstructural overlay
--------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency is indicated at transverse joints in lane 2.
```

a. do nothing

A potential load transfer deficiency exists at undowelled full-depth repairs in lane 2, but mean full-depth repair faulting is not significant.

a. do nothing

FOUNDATION MOVEMENT:

A potential for frost heave is indicated by a mean Freezing Index greater than 0.

a. do nothing

LOSS OF SUPPORT:

The pavement in the lane 2 shows no indications of loss of slab support.

a. do nothing

DRAINAGE DEFICIENCY:

The pavement in lane 2 shows no indications of a drainage deficiency.

a. do nothing

****
INNER SHOULDER
****

The inner AC shoulder shows no indications of significant deterioration.

a. do nothing

****
OUTER SHOULDER
****

The outer AC shoulder shows no indications of significant deterioration.

a. do nothing

PHYSICAL TESTING RECOMMENDATIONS

-------------------- NONDESTRUCTIVE DEFLECTION TESTING --------------------

The pavement does not have any deficiencies warranting nondestructive deflection testing.

---------------------- DESTRUCTIVE DEFLECTION TESTING --------------------

---------------------------- MATERIALS EVALUATION ----------------------------

No laboratory testing or other inspection of material samples is warranted.

SKID TESTING

Physical testing is recommended to further investigate and quantify the causes of poor skid resistance observed in the preliminary evaluation. The following types of testing are recommended:

Measure the skid resistance of the pavement with either a ribbed tire (ASTM E 501) or a bald tire (ASTM E 524) mounted on a locked-wheel skid trailer. Testing with both types of tires is preferred in order to obtain good estimates of both the macrotexture and microtexture of the pavement surface. If only one type of tire can be used, the bald tire is recommended. Measure skid resistance with the skid trailer over a section of pavement at least 1500 feet long (approximately 0.3 mile) within each mile of the project to obtain an estimate of the overall skid resistance of the pavement surface.

------------------------ ROUGHNESS TESTING --------------------------

Roughness testing is recommended in each traffic lane to verify that the pavement is excessively rough and to determine the cause of the roughness. Roughness testing should be performed over the entire length of the pavement and the roughness measured at each 0.1 mile segment.

Test the pavement with roughness equipment capable of producing either a response-type measurement of the pavement's roughness (e.g., Mays Meter) or a profile measurement device. Compare the measured roughness to your agency's standard for an acceptable level of roughness. Prepare a profile of the roughness index along the project for each traffic lane to identify points of significant roughness that need special attention.

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 1

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	Deter. Joints	Transverse Cracking	PSR
8.2	0.56	1988	0.0	0.13	176	0	2.5
8.8	0.60	1989	1.0	0.13	180	85	0.0
9.4	0.64	1990	1.1	0.13	184	182	0.0
10.1	0.68	1991	1.2	0.13	189	296	0.0
10.8	0.73	1992	1.4	0.13	194	427	0.0
11.6	0.78	1993	1.5	0.14	199	579	0.0
12.5	0.83	1994	1.6	0.14	205	756	0.0
13.3	0.88	1995	1.8	0.14	211	962	0.0
14.3	0.94	1996	1.9	0.14	217	1201	0.0
15.3	1.00	1997	2.1	0.14	223	1480	0.0
16.3	1.07	1998	2.2	0.15	230	1804	0.0
17.5	1.14	1999	2.4	0.15	238	2183	0.0
18.7	1.22	2000	2.6	0.15	246	2624	0.0
20.0	1.30	2001	2.7	0.15	254	3139	0.0
21.4	1.38	2002	2.9	0.15	262	3739	0.0
22.9	1.47	2003	3.0	0.15	271	4440	0.0
24.4	1.57	2004	3.0	0.16	280	5259	0.0
26.1	1.67	2005	3.0	0.16	290	6214	0.0
27.9	1.78	2006	3.0	0.16	300	7330	0.0
29.8	1.90	2007	3.0	0.16	311	8632	0.0
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

FUTURE DISTRESS PREDICTIONS

DISTRESS AND PSR PROJECTIONS FOR LANE 2

Cumulative ESAL	Annual ESAL	Year	Pumping	Faulting	Deter. Joints	Transverse Cracking	PS
0.8	0.13	1988	0.0	0.00	0	0	2.
1.0	0.13	1989	0.1	0.00	4	9	2.
1.1	0.14	1990	0.2	0.01	8	19	2.
1.2	0.15	1991	0.3	0.01	13	29	1.
1.4	0.16	1992	0.4	0.01	18	39	1.
1.6	0.17	1993	0.5	0.01	23	50	1.
1.8	0.18	1994	0.6	0.01	29	61	1.
2.0	0.20	1995	0.7	0.02	35	72	1.
2.2	0.21	1996	0.8	0.02	41	85	0.
2.4	0.22	1997	0.8	0.02	47	98	0.
2.6	0.24	1998	0.9	0.02	54	113	0.
2.9	0.25	1999	1.0	0.02	62	128	0.
3.2	0.27	2000	1.1	0.03	70	145	0.
3.4	0.29	2001	1.2	0.03	78	164	0.
3.8	0.31	2002	1.3	0.03	86	185	0.
4.1	0.33	2003	1.4	0.03	95	209	0.
4.4	0.35	2004	1.5	0.03	104	235	0.
4.8	0.37	2005	1.7	0.03	114	264	0.
5.2	0.40	2006	1.8	0.04	124	298	0.
5.6	0.42	2007	1.9	0.04	135	335	0.
18-kip millions	18-kip millions		0 = none 1 = low 2 = medium 3 = high	Inches	Joints per mile	Feet per mile	0-

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

```
                         FUTURE PAVEMENT EVALUATION

********************************************************************************
LANE 1
********************************************************************************

----------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 1 occurs in 1988 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
----------------------------------------------------------------------
JOINT DETERIORATION:

Significant joint deterioration in lane 1 occurs in 1988 as indicated by
 55 or more deteriorated joints per mile.

a. full-depth repair at joints
----------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

Structural deficiency of the pavement in lane 1 occurs in 1995 as
indicated by  800 feet or more of deteriorated transverse cracks per mile.

a.  full-depth repair of cracks, AC structural overlay
b.  full-depth repair of cracks, crack and seat and AC structural overlay
c.  full-depth repair of cracks, PCC bonded overlay
d.  full-depth repair of cracks, PCC unbonded overlay
e.  reconstruct
----------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

Inadequate load transfer at transverse joints in lane 1 occurs in 1988 as
indicated by predicted faulting of 0.13 inches or more.

a. load transfer restoration at joints
b. do nothing
----------------------------------------------------------------------
LOSS OF SUPPORT:

Loss of slab support in lane 1 occurs in 1988 as indicated by predicted
faulting greater than 0.13 inches at transverse joints.

a. subseal at joints and cracks
----------------------------------------------------------------------
DRAINAGE DEFICIENCY:

A drainage deficiency in lane 1 occurs in 1989 as indicated by predicted
pumping reaching the low severity level.

a. install or repair longitudinal subdrains
b. install or repair longitudinal subdrains, seal all joints and cracks
```

```
*****************************************************************************
LANE 2
*****************************************************************************

----------------------------------------------------------------------
ROUGHNESS:

Poor rideability in lane 2 occurs in 1988 as indicated by an unacceptably
low predicted PSR for the pavement's ADT level.

a. grinding
b. AC nonstructural overlay
----------------------------------------------------------------------
JOINT DETERIORATION:

Significant joint deterioration in lane 2 occurs in 1999 as indicated by
 55 or more deteriorated joints per mile.

a. full-depth repair at joints
----------------------------------------------------------------------
STRUCTURAL DEFICIENCY:

No structural deficiency in lane 2 occurs based on predicted transverse
cracking over the next 20 years.
----------------------------------------------------------------------
LOAD TRANSFER DEFICIENCY:

No load transfer deficiency at transverse joints in lane 2 occurs based
on predicted joint faulting over the next 20 years.
----------------------------------------------------------------------
LOSS OF SUPPORT:

No loss of slab support in lane 2 occurs based on predicted joint
faulting over the next 20 years.
----------------------------------------------------------------------
DRAINAGE DEFICIENCY:

A drainage deficiency in lane 2 occurs in 1999 as indicated by predicted
pumping reaching the low severity level.

a. install or repair longitudinal subdrains
b. install or repair longitudinal subdrains, seal all joints and cracks
```

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RESTORATION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	FDR FAULTING	TRANSVERSE CRACKING	JOINT DETERIOR.	PUMPING	PSR
1988	2595	8.19	0.00	0.00	0	0.0	0.0	4.5
1989	2596	8.79	0.03	0.06	85	352.0	0.9	2.3
1990	2597	9.43	0.04	0.08	182	352.0	1.4	2.2
1991	2598	10.12	0.05	0.10	296	352.0	1.9	2.1
1992	2599	10.85	0.06	0.11	427	352.0	2.4	2.0
1993	2600	11.62	0.06	0.13	579	352.0	2.8	1.9
1994	2601	12.45	0.07	0.15	756	352.0	3.0	1.8
1995	2602	13.33	0.08	0.16	962	352.0	3.0	1.7
1996	2603	14.28	0.08	0.18	1201	352.0	3.0	1.6
1997	2604	15.28	0.09	0.20	1480	352.0	3.0	1.5
1998	2605	16.35	0.10	0.22	1804	352.0	3.0	1.4
1999	2606	17.49	0.10	0.23	2183	352.0	3.0	1.3
2000	2607	18.70	0.11	0.25	2624	352.0	3.0	1.1
2001	2608	20.00	0.11	0.27	3139	352.0	3.0	1.0
2002	2609	21.38	0.12	0.29	3739	352.0	3.0	0.8
2003	2610	22.85	0.13	0.31	4440	352.0	3.0	0.7
2004	2611	24.42	0.13	0.33	5259	352.0	3.0	0.5
2005	2612	26.09	0.14	0.36	6214	352.0	3.0	0.3
2006	2613	27.88	0.14	0.38	7330	352.0	3.0	0.0
2007	2614	29.78	0.15	0.40	8632	352.0	3.0	0.0
		18-kip millions	Inches	Inches	Feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches in 2003.

Full-depth repair faulting on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches in 1993.

Cracking on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1995.

Joint deterioration on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 55 joints per mile in 1989.

Pumping on the restored pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the restored pavement in lane 1 is predicted to equal or fall below an unacceptable level of 3.0 in 1989.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC NONSTRUCTURAL OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	2637	1711	0.00
1990	2	1.24	2733	2249	0.00
1991	3	1.93	2791	2645	0.02
1992	4	2.66	2834	2834	0.02
1993	5	3.43	2868	2868	0.05
1994	6	4.26	2896	2896	0.08
1995	7	5.14	2921	2921	0.11
1996	8	6.09	2943	2943	0.14
1997	9	7.09	2962	2962	0.17
1998	10	8.16	2980	2980	0.20
1999	11	9.30	2996	2996	0.24
2000	12	10.51	3012	3012	0.27
2001	13	11.81	3026	3026	0.31
2002	14	13.19	3039	3039	0.35
2003	15	14.66	3052	3052	0.39
2004	16	16.23	3064	3064	0.43
2005	17	17.90	3076	3076	0.48
2006	18	19.69	3087	3087	0.53
2007	19	21.59	3098	3098	0.58
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total relfective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 3000 feet per mile in 2000.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 1500 feet per mile in 1989.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2006.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC NONSTRUCTURAL OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	2518	1478	0.00
1990	2	1.24	2610	1942	0.00
1991	3	1.93	2666	2285	0.00
1992	4	2.66	2706	2569	0.00
1993	5	3.43	2739	2739	0.00
1994	6	4.26	2766	2766	0.00
1995	7	5.14	2790	2790	0.00
1996	8	6.09	2810	2810	0.01
1997	9	7.09	2829	2829	0.04
1998	10	8.16	2846	2846	0.08
1999	11	9.30	2862	2862	0.11
2000	12	10.51	2876	2876	0.15
2001	13	11.81	2890	2890	0.18
2002	14	13.19	2903	2903	0.22
2003	15	14.66	2915	2915	0.26
2004	16	16.23	2927	2927	0.31
2005	17	17.90	2938	2938	0.35
2006	18	19.69	2948	2948	0.40
2007	19	21.59	2959	2959	0.45
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 1500 feet per mile in 1990.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Page

D3. AC Structural Overlay

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	2518	1478	0.00
1990	2	1.24	2610	1942	0.00
1991	3	1.93	2666	2285	0.00
1992	4	2.66	2706	2569	0.00
1993	5	3.43	2739	2739	0.00
1994	6	4.26	2766	2766	0.00
1995	7	5.14	2790	2790	0.00
1996	8	6.09	2810	2810	0.01
1997	9	7.09	2829	2829	0.04
1998	10	8.16	2846	2846	0.08
1999	11	9.30	2862	2862	0.11
2000	12	10.51	2876	2876	0.15
2001	13	11.81	2890	2890	0.18
2002	14	13.19	2903	2903	0.22
2003	15	14.66	2915	2915	0.26
2004	16	16.23	2927	2927	0.31
2005	17	17.90	2938	2938	0.35
2006	18	19.69	2948	2948	0.40
2007	19	21.59	2959	2959	0.45
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 1500 feet per mile in 1990.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	2396	1263	0.00
1990	2	1.24	2484	1660	0.00
1991	3	1.93	2537	1953	0.00
1992	4	2.66	2576	2195	0.00
1993	5	3.43	2607	2408	0.00
1994	6	4.26	2633	2600	0.00
1995	7	5.14	2655	2655	0.00
1996	8	6.09	2675	2675	0.00
1997	9	7.09	2693	2693	0.00
1998	10	8.16	2709	2709	0.02
1999	11	9.30	2724	2724	0.05
2000	12	10.51	2738	2738	0.09
2001	13	11.81	2751	2751	0.12
2002	14	13.19	2763	2763	0.16
2003	15	14.66	2775	2775	0.20
2004	16	16.23	2786	2786	0.25
2005	17	17.90	2797	2797	0.29
2006	18	19.69	2807	2807	0.34
2007	19	21.59	2817	2817	0.39
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 1500 feet per mile in 1990.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING AC OVERLAY

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	2261	1051	0.00
1990	2	1.24	2344	1381	0.00
1991	3	1.93	2394	1625	0.00
1992	4	2.66	2431	1827	0.00
1993	5	3.43	2460	2004	0.00
1994	6	4.26	2485	2164	0.00
1995	7	5.14	2506	2311	0.00
1996	8	6.09	2525	2450	0.00
1997	9	7.09	2542	2542	0.00
1998	10	8.16	2557	2557	0.00
1999	11	9.30	2571	2571	0.03
2000	12	10.51	2584	2584	0.07
2001	13	11.81	2597	2597	0.11
2002	14	13.19	2608	2608	0.15
2003	15	14.66	2619	2619	0.19
2004	16	16.23	2630	2630	0.23
2005	17	17.90	2640	2640	0.27
2006	18	19.69	2650	2650	0.32
2007	19	21.59	2659	2659	0.37
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 1500 feet per mile in 1991.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Page

D4. AC Overlay with Crack and Seat

2.5'X 2.5' pieces, 15 ton roller

6'X 5' pieces, 15 ton roller

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	789	789	0.00
1990	2	1.24	799	799	0.00
1991	3	1.93	807	807	0.00
1992	4	2.66	816	816	0.00
1993	5	3.43	824	824	0.00
1994	6	4.26	831	831	0.01
1995	7	5.14	838	838	0.04
1996	8	6.09	844	844	0.07
1997	9	7.09	850	850	0.10
1998	10	8.16	855	855	0.13
1999	11	9.30	859	859	0.17
2000	12	10.51	863	863	0.20
2001	13	11.81	866	866	0.24
2002	14	13.19	868	868	0.28
2003	15	14.66	869	869	0.32
2004	16	16.23	869	869	0.36
2005	17	17.90	869	869	0.41
2006	18	19.69	867	867	0.45
2007	19	21.59	864	864	0.50
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	789	789	0.00
1990	2	1.24	799	799	0.00
1991	3	1.93	807	807	0.00
1992	4	2.66	816	816	0.00
1993	5	3.43	824	824	0.00
1994	6	4.26	831	831	0.00
1995	7	5.14	838	838	0.02
1996	8	6.09	844	844	0.05
1997	9	7.09	850	850	0.09
1998	10	8.16	855	855	0.12
1999	11	9.30	859	859	0.15
2000	12	10.51	863	863	0.19
2001	13	11.81	866	866	0.23
2002	14	13.19	868	868	0.27
2003	15	14.66	869	869	0.31
2004	16	16.23	869	869	0.35
2005	17	17.90	869	869	0.39
2006	18	19.69	867	867	0.44
2007	19	21.59	864	864	0.49
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	789	789	0.00
1990	2	1.24	799	799	0.00
1991	3	1.93	807	807	0.00
1992	4	2.66	816	816	0.00
1993	5	3.43	824	824	0.00
1994	6	4.26	831	831	0.00
1995	7	5.14	838	838	0.00
1996	8	6.09	844	844	0.00
1997	9	7.09	850	850	0.00
1998	10	8.16	855	855	0.02
1999	11	9.30	859	859	0.05
2000	12	10.51	863	863	0.09
2001	13	11.81	866	866	0.12
2002	14	13.19	868	868	0.16
2003	15	14.66	869	869	0.20
2004	16	16.23	869	869	0.25
2005	17	17.90	869	869	0.29
2006	18	19.69	867	867	0.34
2007	19	21.59	864	864	0.39
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	858	858	0.00
1990	2	1.24	867	867	0.00
1991	3	1.93	876	876	0.00
1992	4	2.66	884	884	0.00
1993	5	3.43	892	892	0.00
1994	6	4.26	899	899	0.01
1995	7	5.14	906	906	0.04
1996	8	6.09	913	913	0.07
1997	9	7.09	918	918	0.10
1998	10	8.16	923	923	0.13
1999	11	9.30	928	928	0.17
2000	12	10.51	931	931	0.20
2001	13	11.81	934	934	0.24
2002	14	13.19	936	936	0.28
2003	15	14.66	937	937	0.32
2004	16	16.23	938	938	0.36
2005	17	17.90	937	937	0.41
2006	18	19.69	935	935	0.45
2007	19	21.59	932	932	0.50
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 0.50 inches in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	858	858	0.00
1990	2	1.24	867	867	0.00
1991	3	1.93	876	876	0.00
1992	4	2.66	884	884	0.00
1993	5	3.43	892	892	0.00
1994	6	4.26	899	899	0.00
1995	7	5.14	906	906	0.02
1996	8	6.09	913	913	0.05
1997	9	7.09	918	918	0.09
1998	10	8.16	923	923	0.12
1999	11	9.30	928	928	0.15
2000	12	10.51	931	931	0.19
2001	13	11.81	934	934	0.23
2002	14	13.19	936	936	0.27
2003	15	14.66	937	937	0.31
2004	16	16.23	938	938	0.35
2005	17	17.90	937	937	0.39
2006	18	19.69	935	935	0.44
2007	19	21.59	932	932	0.49
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING CRACK & SEAT

YEAR	AGE	CUM ESALs	TOTAL REFLECTIVE CRACKING	MEDIUM-HIGH REFLECTIVE CRACKING	RUTTING
1988	0	0.00	0	0	0.00
1989	1	0.60	858	858	0.00
1990	2	1.24	867	867	0.00
1991	3	1.93	876	876	0.00
1992	4	2.66	884	884	0.00
1993	5	3.43	892	892	0.00
1994	6	4.26	899	899	0.00
1995	7	5.14	906	906	0.00
1996	8	6.09	913	913	0.00
1997	9	7.09	918	918	0.00
1998	10	8.16	923	923	0.02
1999	11	9.30	928	928	0.05
2000	12	10.51	931	931	0.09
2001	13	11.81	934	934	0.12
2002	14	13.19	936	936	0.16
2003	15	14.66	937	937	0.20
2004	16	16.23	938	938	0.25
2005	17	17.90	937	937	0.29
2006	18	19.69	935	935	0.34
2007	19	21.59	932	932	0.39
		18-kip millions	Feet per mile	Feet per mile	Inches

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

Summary:

Total reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Medium- to high-severity reflective cracking of the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Rutting on the AC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.05	0.1	224
1990	2	1.24	0.06	0.4	376
1991	3	1.93	0.07	1.0	509
1992	4	2.66	0.08	2.0	633
1993	5	3.43	0.08	3.3	749
1994	6	4.26	0.09	5.0	860
1995	7	5.14	0.09	7.2	967
1996	8	6.09	0.09	9.9	1071
1997	9	7.09	0.10	13.0	1172
1998	10	8.16	0.10	16.6	1271
1999	11	9.30	0.10	20.8	1368
2000	12	10.51	0.11	25.5	1463
2001	13	11.81	0.11	30.8	1557
2002	14	13.19	0.11	36.7	1650
2003	15	14.66	0.12	43.2	1742
2004	16	16.23	0.12	50.4	1833
2005	17	17.90	0.12	58.2	1923
2006	18	19.69	0.12	66.7	2012
2007	19	21.59	0.13	75.9	2101
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.05	0.1	224
1990	2	1.24	0.06	0.4	376
1991	3	1.93	0.07	1.0	509
1992	4	2.66	0.08	2.0	633
1993	5	3.43	0.08	3.3	749
1994	6	4.26	0.09	5.0	860
1995	7	5.14	0.09	7.2	967
1996	8	6.09	0.09	9.9	1071
1997	9	7.09	0.10	13.0	1172
1998	10	8.16	0.10	16.6	1271
1999	11	9.30	0.10	20.8	1368
2000	12	10.51	0.11	25.5	1463
2001	13	11.81	0.11	30.8	1557
2002	14	13.19	0.11	36.7	1650
2003	15	14.66	0.12	43.2	1742
2004	16	16.23	0.12	50.4	1833
2005	17	17.90	0.12	58.2	1923
2006	18	19.69	0.12	66.7	2012
2007	19	21.59	0.13	75.9	2101
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.05	0.1	224
1990	2	1.24	0.06	0.4	376
1991	3	1.93	0.07	1.0	509
1992	4	2.66	0.08	2.0	633
1993	5	3.43	0.08	3.3	749
1994	6	4.26	0.09	5.0	860
1995	7	5.14	0.09	7.2	967
1996	8	6.09	0.09	9.9	1071
1997	9	7.09	0.10	13.0	1172
1998	10	8.16	0.10	16.6	1271
1999	11	9.30	0.10	20.8	1368
2000	12	10.51	0.11	25.5	1463
2001	13	11.81	0.11	30.8	1557
2002	14	13.19	0.11	36.7	1650
2003	15	14.66	0.12	43.2	1742
2004	16	16.23	0.12	50.4	1833
2005	17	17.90	0.12	58.2	1923
2006	18	19.69	0.12	66.7	2012
2007	19	21.59	0.13	75.9	2101
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.05	0.1	224
1990	2	1.24	0.06	0.4	376
1991	3	1.93	0.07	1.0	509
1992	4	2.66	0.08	2.0	633
1993	5	3.43	0.08	3.3	749
1994	6	4.26	0.09	5.0	860
1995	7	5.14	0.09	7.2	967
1996	8	6.09	0.09	9.9	1071
1997	9	7.09	0.10	13.0	1172
1998	10	8.16	0.10	16.6	1271
1999	11	9.30	0.10	20.8	1368
2000	12	10.51	0.11	25.5	1463
2001	13	11.81	0.11	30.8	1557
2002	14	13.19	0.11	36.7	1650
2003	15	14.66	0.12	43.2	1742
2004	16	16.23	0.12	50.4	1833
2005	17	17.90	0.12	58.2	1923
2006	18	19.69	0.12	66.7	2012
2007	19	21.59	0.13	75.9	2101
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING BONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.05	0.1	224
1990	2	1.24	0.06	0.4	376
1991	3	1.93	0.07	1.0	509
1992	4	2.66	0.08	2.0	633
1993	5	3.43	0.08	3.3	749
1994	6	4.26	0.09	5.0	860
1995	7	5.14	0.09	7.2	967
1996	8	6.09	0.09	9.9	1071
1997	9	7.09	0.10	13.0	1172
1998	10	8.16	0.10	16.6	1271
1999	11	9.30	0.10	20.8	1368
2000	12	10.51	0.11	25.5	1463
2001	13	11.81	0.11	30.8	1557
2002	14	13.19	0.11	36.7	1650
2003	15	14.66	0.12	43.2	1742
2004	16	16.23	0.12	50.4	1833
2005	17	17.90	0.12	58.2	1923
2006	18	19.69	0.12	66.7	2012
2007	19	21.59	0.13	75.9	2101
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is predicted to equal or exceed an unacceptable level of 55.00 joints per mile in 2005.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 1994.

Page

D6. PCC Unbonded Overlay

No Dowels, 15' joint spacing

No Dowels, 13' joint spacing

No Dowels, 10' joint spacing

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.02	0.0	46
1990	2	1.24	0.03	0.0	66
1991	3	1.93	0.04	0.0	83
1992	4	2.66	0.04	0.1	102
1993	5	3.43	0.05	0.2	116
1994	6	4.26	0.05	0.3	133
1995	7	5.14	0.05	0.5	152
1996	8	6.09	0.06	0.7	173
1997	9	7.09	0.06	1.1	197
1998	10	8.16	0.06	1.5	224
1999	11	9.30	0.07	2.0	257
2000	12	10.51	0.07	2.6	295
2001	13	11.81	0.08	3.3	340
2002	14	13.19	0.08	4.1	393
2003	15	14.66	0.08	5.0	457
2004	16	16.23	0.09	6.1	534
2005	17	17.90	0.09	7.4	625
2006	18	19.69	0.09	8.8	734
2007	19	21.59	0.10	10.3	864
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.62	0.02	0.0	44
1990	2	1.24	0.03	0.0	63
1991	3	1.93	0.04	0.0	79
1992	4	2.66	0.04	0.1	95
1993	5	3.43	0.05	0.2	110
1994	6	4.26	0.05	0.3	126
1995	7	5.14	0.05	0.5	144
1996	8	6.09	0.06	0.7	163
1997	9	7.09	0.06	1.1	185
1998	10	8.16	0.06	1.5	210
1999	11	9.30	0.07	2.0	240
2000	12	10.51	0.07	2.6	274
2001	13	11.81	0.08	3.3	315
2002	14	13.19	0.08	4.1	363
2003	15	14.66	0.08	5.0	421
2004	16	16.23	0.09	6.1	489
2005	17	17.90	0.09	7.4	571
2006	18	19.69	0.09	8.8	668
2007	19	21.59	0.10	10.3	785
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.02	0.0	0
1989	1	0.60	0.02	0.0	46
1990	2	1.24	0.03	0.0	66
1991	3	1.93	0.04	0.0	83
1992	4	2.66	0.04	0.1	100
1993	5	3.43	0.05	0.2	116
1994	6	4.26	0.05	0.3	133
1995	7	5.14	0.05	0.5	152
1996	8	6.09	0.06	0.7	173
1997	9	7.09	0.06	1.1	197
1998	10	8.16	0.06	1.5	224
1999	11	9.30	0.07	2.0	257
2000	12	10.51	0.07	2.6	295
2001	13	11.81	0.08	3.3	340
2002	14	13.19	0.08	4.1	393
2003	15	14.66	0.08	5.0	457
2004	16	16.23	0.09	6.1	534
2005	17	17.90	0.09	7.4	625
2006	18	19.69	0.09	8.8	734
2007	19	21.59	0.10	10.3	864
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESAL_s	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.60	0.02	0.0	44
1990	2	1.24	0.03	0.0	63
1991	3	1.93	0.04	0.0	79
1992	4	2.66	0.04	0.1	95
1993	5	3.43	0.05	0.2	110
1994	6	4.26	0.05	0.3	126
1995	7	5.14	0.05	0.5	144
1996	8	6.09	0.06	0.7	163
1997	9	7.09	0.06	1.1	185
1998	10	8.16	0.06	1.5	210
1999	11	9.30	0.07	2.0	240
2000	12	10.51	0.07	2.6	274
2001	13	11.81	0.08	3.3	315
2002	14	13.19	0.08	4.1	363
2003	15	14.66	0.08	5.0	421
2004	16	16.23	0.09	6.1	489
2005	17	17.90	0.09	7.4	571
2006	18	19.69	0.09	8.8	668
2007	19	21.59	0.10	10.3	785
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALS	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.00	0.00	0.0	0
1989	1	0.62	0.02	0.0	46
1990	2	1.24	0.03	0.0	66
1991	3	1.93	0.04	0.0	83
1992	4	2.65	0.04	0.1	102
1993	5	3.43	0.05	0.2	116
1994	6	4.26	0.05	0.3	133
1995	7	5.14	0.05	0.5	152
1996	8	6.09	0.06	0.7	173
1997	9	7.09	0.06	1.1	197
1998	10	8.16	0.06	1.5	224
1999	11	9.30	0.07	2.0	257
2000	12	10.51	0.07	2.6	295
2001	13	11.81	0.08	3.3	340
2002	14	13.19	0.08	4.1	393
2003	15	14.66	0.08	5.0	457
2004	16	16.23	0.09	6.1	534
2005	17	17.90	0.09	7.4	625
2006	18	19.69	0.09	8.8	734
2007	19	21.59	0.10	10.3	864
		18-KIP millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is predicted to equal or exceed an unacceptable level of 800 feet per mile in 2007.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING UNBONDED PCC OVERLAY

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	JOINT DETERIORATION	TRANSVERSE CRACKING
1988	0	0.02	0.00	0.0	0
1989	1	0.60	0.02	0.0	44
1990	2	1.24	0.03	0.0	63
1991	3	1.93	0.04	0.0	79
1992	4	2.66	0.04	0.1	95
1993	5	3.43	0.05	0.2	110
1994	6	4.26	0.05	0.3	126
1995	7	5.14	0.05	0.5	144
1996	8	6.09	0.06	0.7	163
1997	9	7.09	0.06	1.1	185
1998	10	8.16	0.06	1.5	210
1999	11	9.30	0.07	2.0	240
2000	12	10.51	0.07	2.6	274
2001	13	11.81	0.08	3.3	315
2002	14	13.19	0.08	4.1	363
2003	15	14.66	0.08	5.0	421
2004	16	16.23	0.09	6.1	489
2005	17	17.90	0.09	7.4	571
2006	18	19.69	0.09	8.8	668
2007	19	21.59	0.10	10.3	785
		18-kip millions	Inches	Joints per mile	Feet per mile

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the PCC overlay in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the PCC overlay is not predicted to reach an unacceptable level within the next twenty years.

Page

D7. Reconstruction

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.07	23	0.0	0.9	3.9
1990	2	1.24	0.08	34	0.0	1.2	3.7
1991	3	1.93	0.09	42	0.0	1.4	3.4
1992	4	2.66	0.09	50	0.1	1.7	3.1
1993	5	3.43	0.10	57	0.2	1.9	2.8
1994	6	4.26	0.10	64	0.3	2.0	2.4
1995	7	5.14	0.10	71	0.5	2.2	2.0
1996	8	6.09	0.10	79	0.7	2.4	1.6
1997	9	7.09	0.11	87	1.1	2.6	1.1
1998	10	8.16	0.11	96	1.5	2.7	0.6
1999	11	9.30	0.11	106	2.0	2.9	0.1
2000	12	10.51	0.11	116	2.6	3.0	-0.4
2001	13	11.81	0.12	128	3.3	3.0	-1.0
2002	14	13.19	0.12	142	4.1	3.0	-1.6
2003	15	14.66	0.12	157	5.0	3.0	-2.2
2004	16	16.23	0.12	175	6.1	3.0	-2.9
2005	17	17.90	0.12	195	7.4	3.0	-3.6
2006	18	19.69	0.12	219	8.8	3.0	-4.4
2007	19	21.59	0.13	246	10.3	3.0	-5.2
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 2007.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.06	3	0.0	0.6	4.3
1990	2	1.24	0.07	4	0.0	0.8	4.2
1991	3	1.93	0.07	5	0.0	1.0	4.0
1992	4	2.66	0.08	6	0.1	1.1	3.7
1993	5	3.43	0.08	6	0.2	1.2	3.5
1994	6	4.26	0.08	7	0.3	1.4	3.1
1995	7	5.14	0.08	8	0.5	1.5	2.8
1996	8	6.09	0.09	9	0.7	1.6	2.4
1997	9	7.09	0.09	9	1.1	1.7	2.0
1998	10	8.16	0.09	10	1.5	1.8	1.5
1999	11	9.30	0.09	11	2.0	1.9	1.0
2000	12	10.51	0.09	11	2.6	2.1	0.5
2001	13	11.81	0.09	12	3.3	2.2	-0.0
2002	14	13.19	0.10	13	4.1	2.3	-0.6
2003	15	14.66	0.10	14	5.0	2.4	-1.2
2004	16	16.23	0.10	14	6.1	2.5	-1.9
2005	17	17.90	0.10	15	7.4	2.6	-2.6
2006	18	19.69	0.10	16	8.8	2.7	-3.3
2007	19	21.59	0.10	17	10.3	2.8	-4.1
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.07	15	0.0	0.9	4.0
1990	2	1.24	0.08	22	0.0	1.2	3.7
1991	3	1.93	0.09	28	0.0	1.4	3.5
1992	4	2.66	0.09	33	0.1	1.7	3.2
1993	5	3.43	0.10	37	0.2	1.9	2.9
1994	6	4.26	0.10	42	0.3	2.0	2.5
1995	7	5.14	0.10	46	0.5	2.2	2.1
1996	8	6.09	0.10	51	0.7	2.4	1.7
1997	9	7.09	0.11	56	1.1	2.6	1.3
1998	10	8.16	0.11	60	1.5	2.7	0.8
1999	11	9.30	0.11	66	2.0	2.9	0.3
2000	12	10.51	0.11	71	2.6	3.0	-0.3
2001	13	11.81	0.12	77	3.3	3.0	-0.8
2002	14	13.19	0.12	84	4.1	3.0	-1.4
2003	15	14.66	0.12	91	5.0	3.0	-2.1
2004	16	16.23	0.12	99	6.1	3.0	-2.8
2005	17	17.90	0.12	108	7.4	3.0	-3.5
2006	18	19.69	0.12	118	8.8	3.0	-4.2
2007	19	21.59	0.13	130	10.3	3.0	-5.0
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 2007.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.06	2	0.0	0.6	4.4
1990	2	1.24	0.07	3	0.0	0.8	4.3
1991	3	1.93	0.07	3	0.0	1.0	4.1
1992	4	2.66	0.08	4	0.1	1.1	3.9
1993	5	3.43	0.08	4	0.2	1.2	3.6
1994	6	4.26	0.08	5	0.3	1.4	3.3
1995	7	5.14	0.08	5	0.5	1.5	3.0
1996	8	6.09	0.09	6	0.7	1.6	2.6
1997	9	7.09	0.09	6	1.1	1.7	2.2
1998	10	8.16	0.09	7	1.5	1.8	1.7
1999	11	9.30	0.09	7	2.0	1.9	1.3
2000	12	10.51	0.09	8	2.6	2.1	0.8
2001	13	11.81	0.09	8	3.3	2.2	0.2
2002	14	13.19	0.10	8	4.1	2.3	-0.4
2003	15	14.66	0.10	9	5.0	2.4	-1.0
2004	16	16.23	0.10	9	6.1	2.5	-1.6
2005	17	17.90	0.10	10	7.4	2.6	-2.3
2006	18	19.69	0.10	10	8.8	2.7	-3.0
2007	19	21.59	0.10	11	10.3	2.8	-3.8
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.05	23	0.0	0.9	3.9
1990	2	1.24	0.06	34	0.0	1.2	3.7
1991	3	1.93	0.06	42	0.0	1.4	3.4
1992	4	2.66	0.06	50	0.1	1.7	3.1
1993	5	3.43	0.07	57	0.2	1.9	2.8
1994	6	4.26	0.07	64	0.3	2.0	2.4
1995	7	5.14	0.07	71	0.5	2.2	2.0
1996	8	6.09	0.07	79	0.7	2.4	1.6
1997	9	7.09	0.07	87	1.1	2.6	1.1
1998	10	8.16	0.07	96	1.5	2.7	0.6
1999	11	9.30	0.08	106	2.0	2.9	0.1
2000	12	10.51	0.08	116	2.6	3.0	-0.4
2001	13	11.81	0.08	128	3.3	3.0	-1.0
2002	14	13.19	0.08	142	4.1	3.0	-1.6
2003	15	14.66	0.08	157	5.0	3.0	-2.2
2004	16	16.23	0.08	175	6.1	3.0	-2.9
2005	17	17.90	0.08	195	7.4	3.0	-3.6
2006	18	19.69	0.08	219	8.8	3.0	-4.4
2007	19	21.59	0.09	246	10.3	3.0	-5.2
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR of the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.62	0.04	3	0.0	0.6	4.3
1990	2	1.24	0.04	4	0.0	0.8	4.2
1991	3	1.93	0.04	5	0.0	1.0	4.0
1992	4	2.66	0.05	6	0.1	1.1	3.7
1993	5	3.43	0.05	6	0.2	1.2	3.5
1994	6	4.26	0.05	7	0.3	1.4	3.1
1995	7	5.14	0.05	8	0.5	1.5	2.8
1996	8	6.09	0.05	9	0.7	1.6	2.4
1997	9	7.09	0.05	9	1.1	1.7	2.0
1998	10	8.16	0.05	10	1.5	1.8	1.5
1999	11	9.30	0.06	11	2.0	1.9	1.0
2000	12	10.51	0.06	11	2.6	2.1	0.5
2001	13	11.81	0.06	12	3.3	2.2	-0.0
2002	14	13.19	0.06	13	4.1	2.3	-0.6
2003	15	14.66	0.06	14	5.0	2.4	-1.2
2004	16	16.23	0.06	14	6.1	2.5	-1.9
2005	17	17.90	0.06	15	7.4	2.6	-2.6
2006	18	19.65	0.06	16	8.8	2.7	-3.3
2007	19	21.59	0.06	17	10.3	2.8	-4.1
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.02	0.00	0	0.0	0.0	4.5
1989	1	0.62	0.05	15	0.0	0.9	4.0
1990	2	1.24	0.06	22	0.0	1.2	3.7
1991	3	1.93	0.06	28	0.0	1.4	3.5
1992	4	2.66	0.06	33	0.1	1.7	3.2
1993	5	3.43	0.07	37	0.2	1.9	2.9
1994	6	4.26	0.07	42	0.3	2.0	2.5
1995	7	5.14	0.07	46	0.5	2.2	2.1
1996	8	6.09	0.07	51	0.7	2.4	1.7
1997	9	7.09	0.07	56	1.1	2.6	1.3
1998	10	8.16	0.07	60	1.5	2.7	0.8
1999	11	9.30	0.08	66	2.0	2.9	0.3
2000	12	10.51	0.08	71	2.6	3.0	-0.3
2001	13	11.81	0.08	77	3.3	3.0	-0.8
2002	14	13.19	0.08	84	4.1	3.0	-1.4
2003	15	14.66	0.08	91	5.0	3.0	-2.1
2004	16	16.23	0.08	99	6.1	3.0	-2.8
2005	17	17.90	0.08	108	7.4	3.0	-3.5
2006	18	19.69	0.08	118	8.8	3.0	-4.2
2007	19	21.59	0.09	130	10.3	3.0	-5.0
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.62	0.04	2	0.0	0.6	4.4
1990	2	1.24	0.04	3	0.0	0.8	4.3
1991	3	1.93	0.04	3	0.0	1.0	4.1
1992	4	2.66	0.05	4	0.1	1.1	3.9
1993	5	3.43	0.05	4	0.2	1.2	3.6
1994	6	4.26	0.05	5	0.3	1.4	3.3
1995	7	5.14	0.05	5	0.5	1.5	3.0
1996	8	6.09	0.05	6	0.7	1.6	2.6
1997	9	7.09	0.05	6	1.1	1.7	2.2
1998	10	8.16	0.05	7	1.5	1.8	1.7
1999	11	9.30	0.06	7	2.0	1.9	1.3
2000	12	10.51	0.06	8	2.6	2.1	0.8
2001	13	11.81	0.06	8	3.3	2.2	0.2
2002	14	13.19	0.06	8	4.1	2.3	-0.4
2003	15	14.66	0.06	9	5.0	2.4	-1.0
2004	16	16.23	0.06	9	6.1	2.5	-1.6
2005	17	17.90	0.06	10	7.4	2.6	-2.3
2006	18	19.69	0.06	10	8.8	2.7	-3.0
2007	19	21.59	0.06	11	10.3	2.8	-3.8
		18-kip millions	inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.62	0.10	15	0.0	0.9	4.2
1990	2	1.24	0.11	22	0.0	1.2	3.7
1991	3	1.93	0.12	28	0.0	1.4	3.5
1992	4	2.66	0.13	33	0.1	1.7	3.2
1993	5	3.43	0.13	37	0.2	1.9	2.9
1994	6	4.26	0.13	42	0.3	2.0	2.5
1995	7	5.14	0.14	46	0.5	2.2	2.1
1996	8	6.09	0.14	51	0.7	2.4	1.7
1997	9	7.09	0.14	56	1.1	2.6	1.3
1998	10	8.16	0.15	60	1.5	2.7	0.8
1999	11	9.30	0.15	66	2.0	2.9	0.3
2000	12	10.51	0.15	71	2.6	3.0	-0.3
2001	13	11.81	0.16	77	3.3	3.0	-0.8
2002	14	13.19	0.16	84	4.1	3.0	-1.4
2003	15	14.66	0.16	91	5.0	3.0	-2.1
2004	16	16.23	0.16	99	6.1	3.0	-2.8
2005	17	17.90	0.17	108	7.4	3.0	-3.5
2006	18	19.69	0.17	118	8.8	3.0	-4.2
2007	19	21.59	0.17	130	10.3	3.0	-5.0
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 1992.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1990.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1993.

PREDICTED PERFORMANCE FOR LANE 1 FOLLOWING RECONSTRUCTION

YEAR	AGE	CUMULATIVE ESALs	JOINT FAULTING	TRANSVERSE CRACKING	JOINT DETERIORATION	PUMPING	PSR
1988	0	0.00	0.00	0	0.0	0.0	4.5
1989	1	0.60	0.09	2	0.0	0.6	4.4
1990	2	1.24	0.10	3	0.0	0.8	4.3
1991	3	1.93	0.10	3	0.0	1.0	4.1
1992	4	2.66	0.11	4	0.1	1.1	3.9
1993	5	3.43	0.11	4	0.2	1.2	3.6
1994	6	4.26	0.12	5	0.3	1.4	3.3
1995	7	5.14	0.12	5	0.5	1.5	3.0
1996	8	6.09	0.12	6	0.7	1.6	2.6
1997	9	7.09	0.13	6	1.1	1.7	2.2
1998	10	8.16	0.13	7	1.5	1.8	1.7
1999	11	9.30	0.13	7	2.0	1.9	1.3
2000	12	10.51	0.13	8	2.6	2.1	0.8
2001	13	11.81	0.13	8	3.3	2.2	0.2
2002	14	13.19	0.14	8	4.1	2.3	-0.4
2003	15	14.66	0.14	9	5.0	2.4	-1.0
2004	16	16.23	0.14	9	6.1	2.5	-1.6
2005	17	17.90	0.14	10	7.4	2.6	-2.3
2006	18	19.69	0.15	10	8.8	2.7	-3.0
2007	19	21.59	0.15	11	10.3	2.8	-3.8
		18-kip millions	Inches	feet per mile	Joints per mile	0 = none 1 = low 2 = medium 3 = high	0-5

NOTE: These projections are estimates of expected performance based on predictive models. They should not be taken as exact values, but instead as relative indicators of performance.

SUMMARY:

Joint faulting on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 0.13 inches per mile in 1997.

Transverse cracking of the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

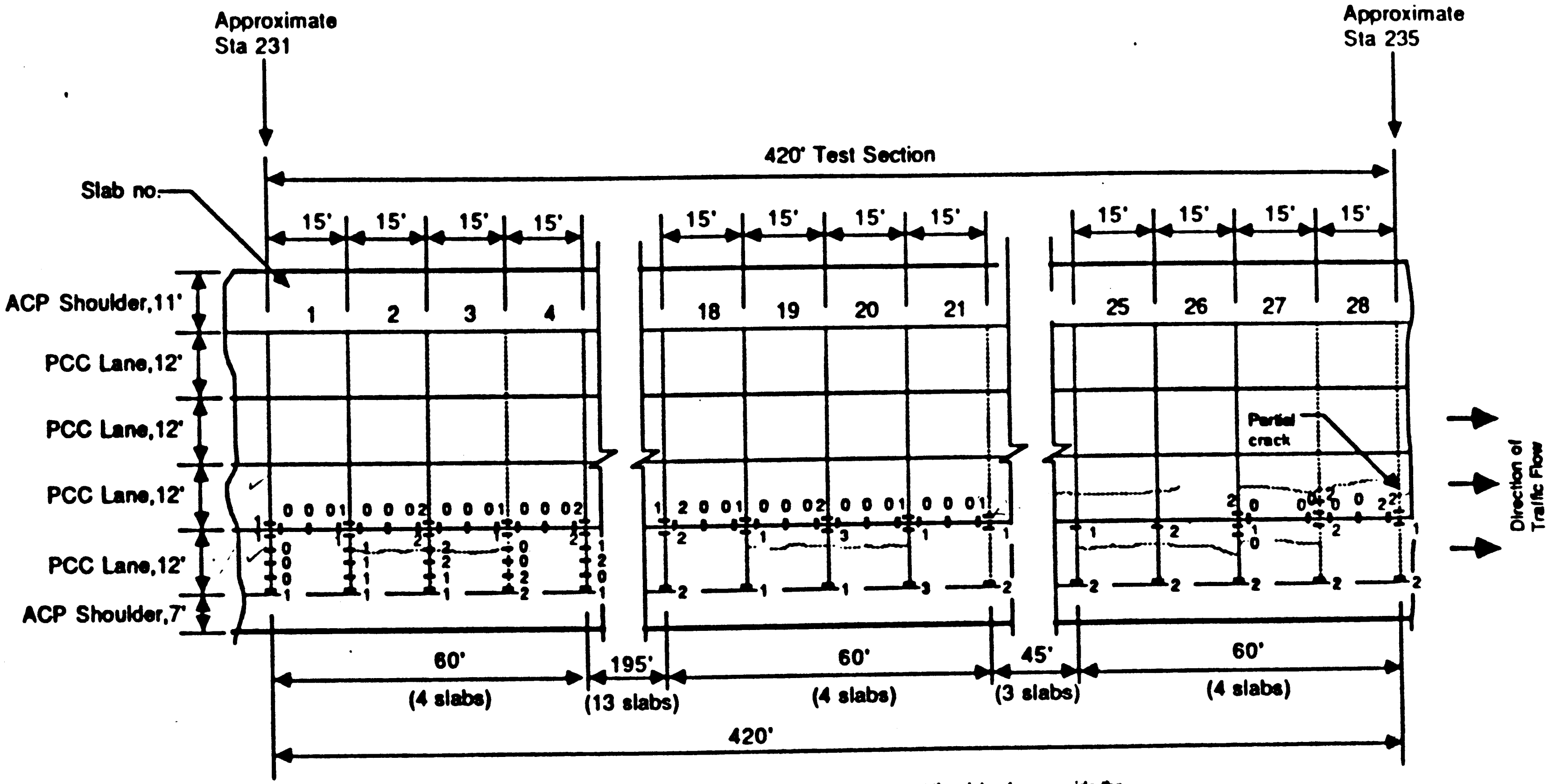
Joint deterioration on the reconstructed pavement in lane 1 is not predicted to reach an unacceptable level within the next twenty years.

Pumping on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 1.0 in 1991.

PSR on the reconstructed pavement in lane 1 is predicted to equal or exceed an unacceptable level of 3.00 in 1995.

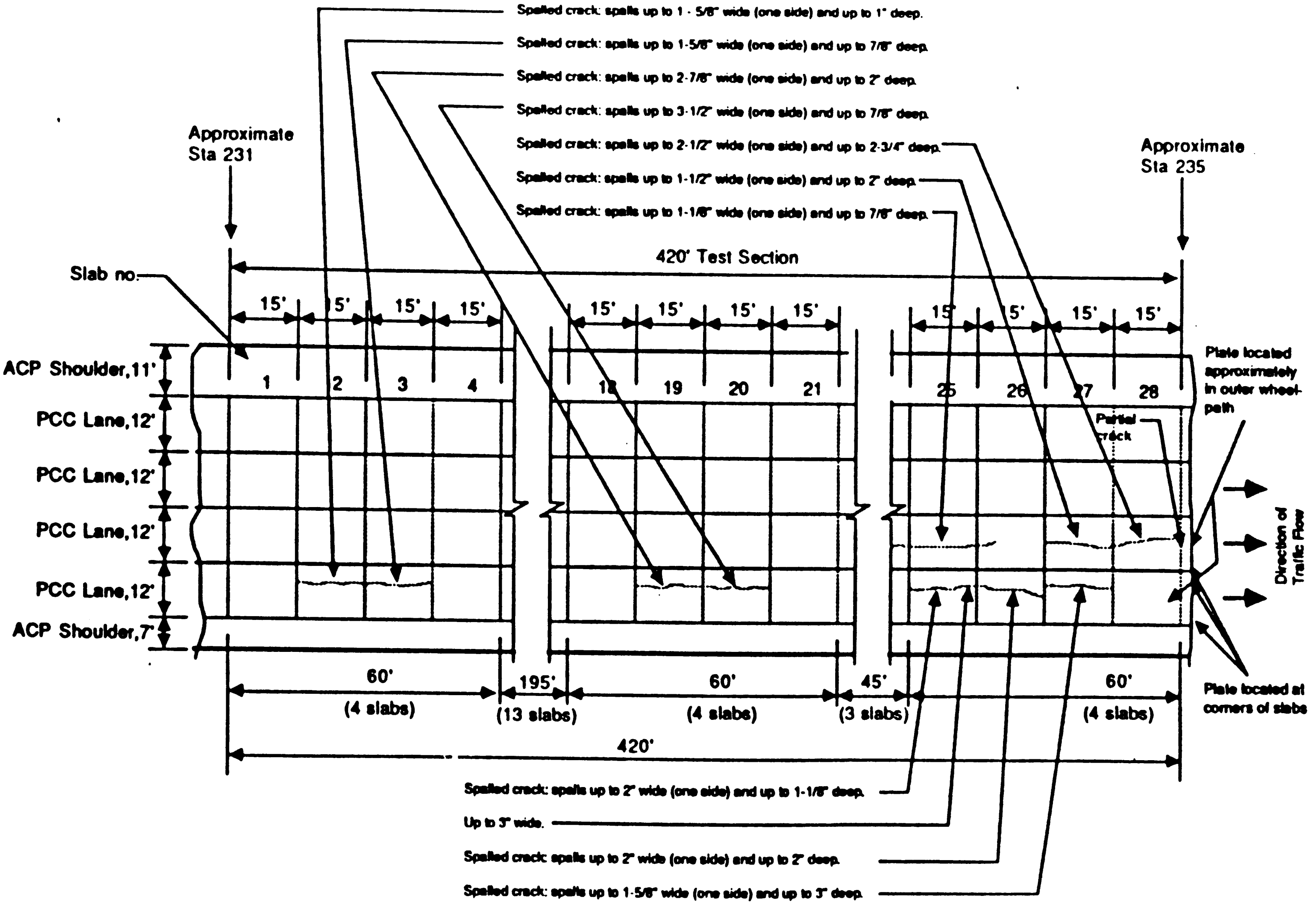
APPENDIX E

SURVEY DATA

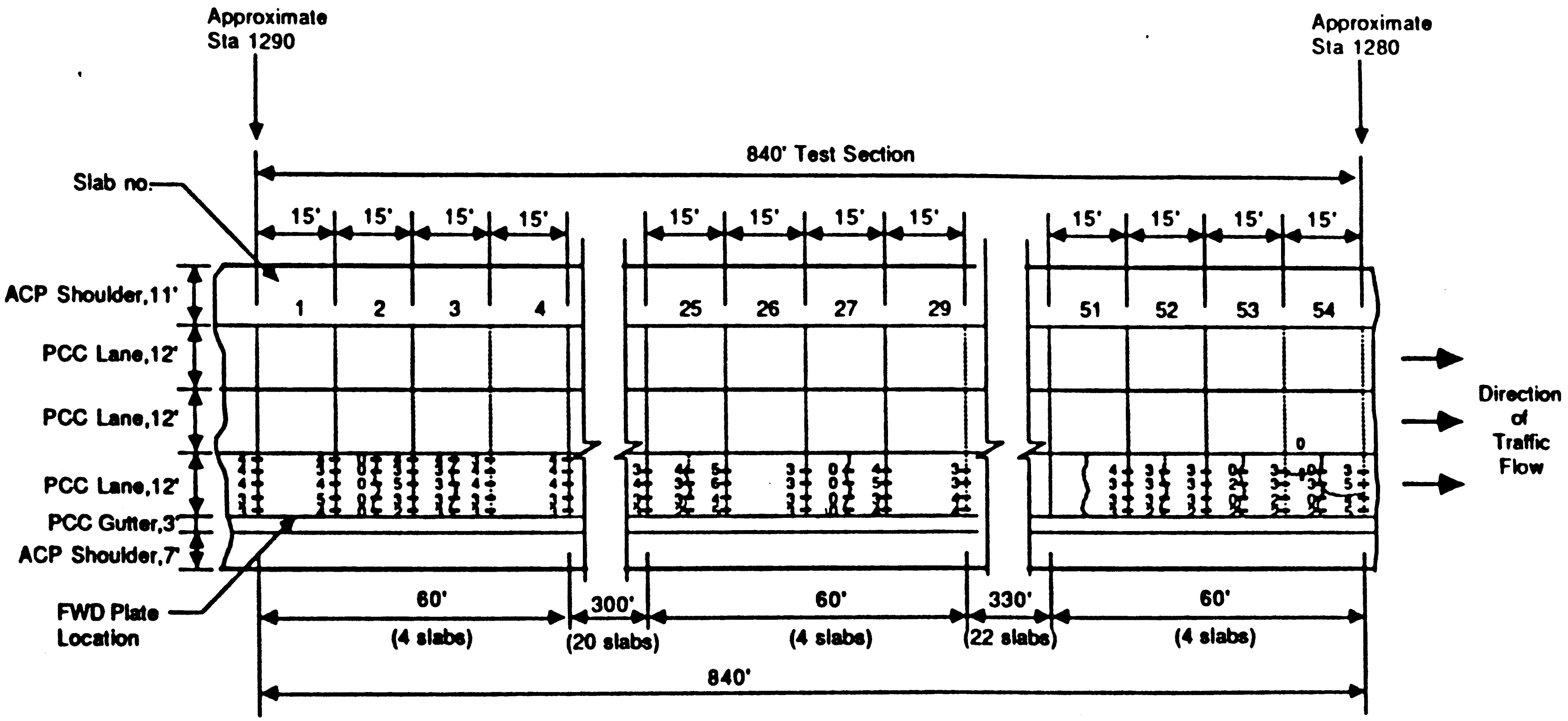


Note: Faulting survey conducted 9/3/86 and 9/4/86. Measurements at the slab edges provide the best estimate of true faulting since the wheelpaths have experienced significant wear. Measurements as shown in 1/16's of an inch.

E1--Faulting Survey I-5 North (MP 176) Seattle [from Ref. 12]

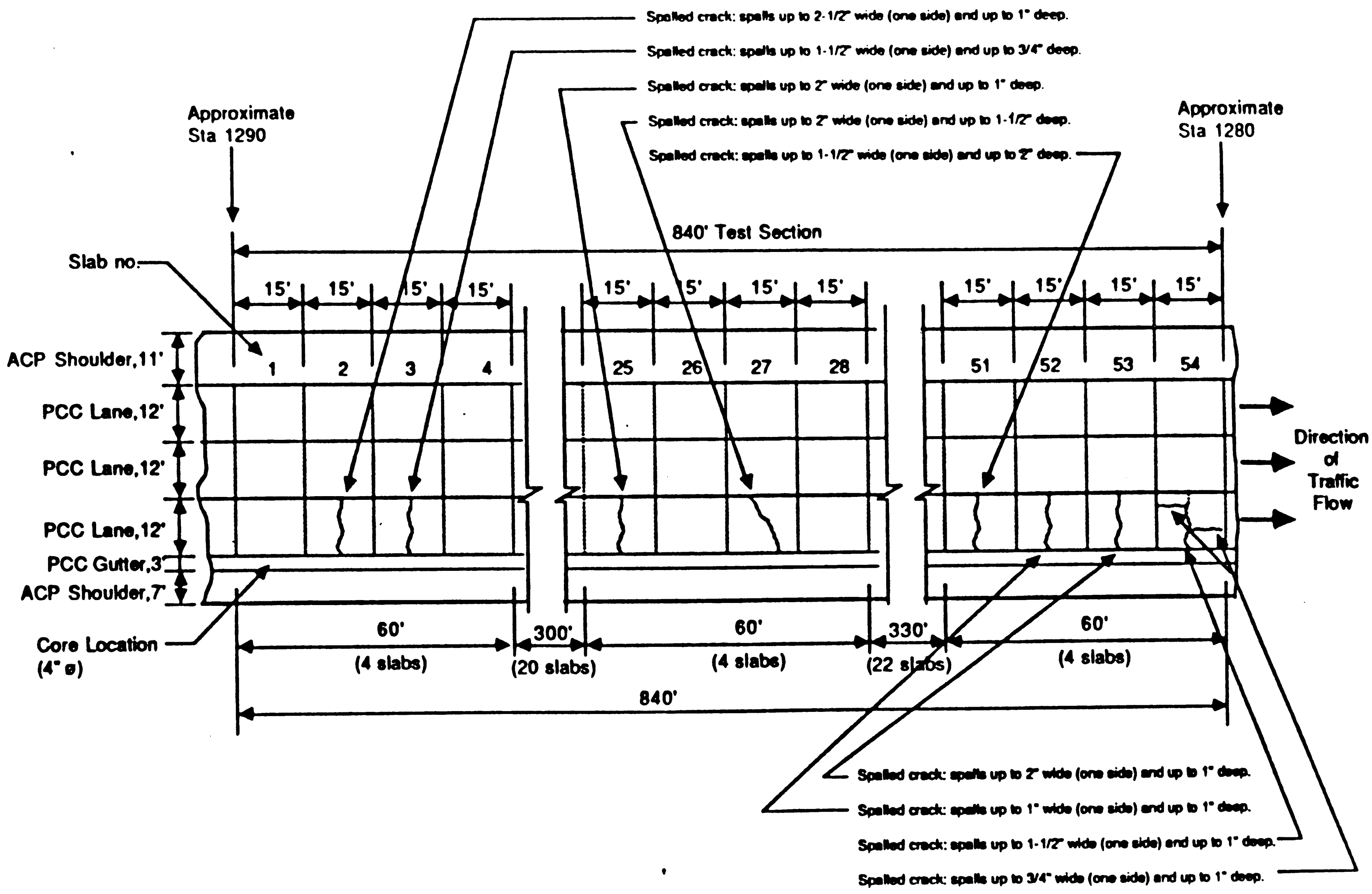


E2--Crack Survey I-5 North (MP 176) Seattle [from Ref. 12]



Note: Faulting measurements were taken near the slab edges, both wheel paths and the center of the slab at contraction joints and cracks in the direction of traffic flow. Measurements in 1/16's of an inch.

E3--Faulting Survey I-90 West (MP 278) Spokane [from Ref. 12]



E4--Crack Survey I-90 West (MP 278) Spokane [from Ref. 12]

APPENDIX F

TRAFFIC DATA

Equivalent Axle Load Estimate
I-5, NE 175th (MP 176.35)

		Percent Trucks						
YEAR	ADT (two way)	Single Units	Comb. Trucks	Daily Single Units	E.F.	Daily Comb. Trucks	E.F.	ESAL's per yr.
1965	52,000	3	2	780	0.13	520	0.91	209,824
1966	57,700	3	2	866	0.17	577	0.91	245,144
1967	59,400	3	2	891	0.17	594	0.91	252,367
1968	66,600	3	2	999	0.17	666	0.91	282,957
1969	72,100	3	2	1,082	0.17	721	0.84	288,166
1970	71,400	3	2	1,071	0.17	714	0.84	285,368
1971	68,700	2	3	687	0.17	1,031	0.84	358,580
1972	76,400	2	3	764	0.18	1,146	0.88	418,011
1973	76,900	2	3	769	0.18	1,154	0.88	420,747
1974	72,200	2	3	722	0.20	1,083	0.90	408,208
1975	78,000	2	3	780	0.20	1,170	0.90	441,000
1976	81,000	2	3	810	0.23	1,215	1.02	520,492
1977	85,900	2	3	859	0.23	1,289	1.02	551,978
1978	90,500	2	3	905	0.13	1,358	1.04	557,589
1979	101,800	2	3	1,018	0.23	1,527	1.16	730,692
1980	129,200	2	3	1,292	0.24	1,938	1.11	894,351
1981	133,100	2	3	1,331	0.24	1,997	1.11	923,291
1982	135,800	2	3	1,358	0.24	2,037	1.11	942,021
1983	113,200	2	3	1,132	0.24	1,698	0.99	713,355
1984	142,800	2	3	1,428	0.24	2,142	0.99	899,886
1985	147,000	2	3	1,470	0.24	2,205	0.99	926,354
1986	137,500	2	3	1,375	0.24	2,063	0.99	866,487
1987	144,400	2	3	1,444	0.24	2,166	0.99	909,969
1988	145,900	2	2	1,459	0.24	1,459	0.99	655,551
						TOTAL ESAL'S =		13,702,388

F1--Traffic Data, I-5 (MP 176) Seattle

Equivalent Axle Load Estimate
I-90, (MP ~~279.26~~)
278.60

		Percent Trucks						
YEAR	ADT (two way)	Single Units	Comb. Trucks	Daily Single Units	E.F.	Daily Comb. Trucks	E.F.	ESAL's per yr.
1965	11,200	2	7	112	0.13	392	0.91	135,415
1966	16,500	2	7	165	0.17	578	0.91	201,844
1967	17,800	2	7	178	0.17	623	0.91	217,747
1968	18,300	2	5	183	0.17	458	0.91	163,147
1969	19,400	2	5	194	0.17	485	0.84	160,739
1970	23,000	2	5	230	0.17	575	0.84	190,567
1971	24,300	4	4	486	0.17	486	0.84	179,164
1972	26,000	4	4	520	0.18	520	0.88	201,188
1973	28,200	4	4	564	0.18	564	0.88	218,212
1974	29,600	4	4	592	0.20	592	0.90	237,688
1975	28,600	4	4	572	0.20	572	0.90	229,658
1976	30,600	4	4	612	0.23	612	1.02	279,002
1977	32,200	4	4	644	0.23	644	1.02	293,590
1978	35,700	4	4	714	0.13	714	1.04	304,132
1979	36,000	3	3	540	0.23	540	1.16	273,772
1980	34,500	3	3	518	0.24	518	1.11	253,676
1981	35,300	3	3	530	0.24	530	1.11	260,331
1982	33,900	3	3	509	0.24	509	1.11	250,007
1983	34,000	4	4	680	0.24	680	0.99	305,534
1984	34,000	4	4	680	0.24	680	0.99	305,534
1985	34,000	4	4	680	0.24	680	0.99	305,534
1986	38,300	4	4	766	0.24	766	0.99	344,175
1987	33,300	4	4	666	0.24	666	0.99	299,244
1988	38,300	4	9	766	0.24	1,724	0.99	690,517
						TOTAL ESAL'S =		6,300,416

F2--Traffic Data, I-90 (MP 278) Spokane

Equivalent Axle Load Estimate
I-90, Snoqualmie Pass (MP 61.35)

YEAR	ADT (two way)	Percent Trucks Single Units	Comb. Trucks	Daily Single Units	E.F.	Daily Comb. Trucks	E.F.	ESAL's per yr.
1960	5,300	8	5	212	0.06	133	0.62	4,333
1961	6,000	8	5	240	0.28	150	0.88	24,703
1962	6,800	8	5	272	0.28	170	0.88	27,997
1963	6,600	8	5	264	0.28	165	0.88	64,754
1964	6,600	8	5	264	0.28	165	0.93	80,220
1965	7,700	5	9	193	0.13	347	0.91	121,006
1966	8,400	5	9	210	0.17	378	0.91	134,996
1967	8,700	5	9	218	0.17	392	0.91	143,390
1968	9,200	5	9	230	0.17	414	0.91	151,630
1969	10,000	4	7	200	0.17	350	0.84	119,720
1970	11,700	4	7	234	0.17	410	0.84	140,072
1971	13,200	4	7	264	0.17	462	0.84	158,030
+1972	13,100	4	17	262	0.18	1,114	0.88	374,248
+1973	13,100	4	17	262	0.18	1,114	0.88	374,248
1974	13,100	4	17	262	0.20	1,114	0.90	384,289
1975	13,400	4	17	268	0.20	1,139	0.90	393,090
1976	14,800	4	17	296	0.23	1,258	1.02	494,148
1977	15,300	4	17	306	0.23	1,301	1.02	510,842
1978	16,300	4	17	326	0.13	1,386	1.04	541,821
1979	15,100	4	17	302	0.23	1,284	1.16	566,885
1980	13,380	3	5	201	0.24	335	1.11	152,445
1981	14,098	3	5	211	0.24	352	1.11	160,934
1982	14,970	3	5	225	0.24	374	1.11	170,888
+1983	17,000	5	13	425	0.24	1,105	0.99	436,925
+1984	17,000	5	13	425	0.24	1,105	0.99	436,925
+1985	17,000	5	13	425	0.24	1,105	0.99	436,925
1986	19,500	4	15	390	0.24	1,463	0.99	563,172
+1987	18,000	4	15	360	0.24	1,350	0.99	519,851
1988	17,300	4	15	346	0.24	1,298	0.99	499,635
						TOTAL ESAL'S =		8,188,124

+ Estimate (missing data)

1965 - 1968 MP 61.53 used
1968 - 1979 MP 62.71 used
1979 - 1983 MP 35.30 used
1983 - 1986 MP 63.17 used

F3--Traffic Data, I-90 (MP 61) Snoqualmie Pass