

Development And Implementation Of Washington State's Pavement Management System

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| 16. Abstract <p>This report describes the pavement management system developed by WSDOT staff over a period of five years. Both project-level and network-level pavement management are represented within the four broad areas of data processing which combine to constitute the foundation of the system.</p> <p>The design of a pavement data file is laid out together with the process of assembling it. Also shown are the methods used to analyze and convert the file data from pavement condition ratings to pavement performance curves for each project. The performance curves are then used, together with appropriate cost data, to determine the most cost-effective type and time of fix. The network-level program then summarizes the needed work for each year of a rehabilitation program. Means are provided for adjusting the program to fit budget constraints or minimum acceptable levels of average pavement condition.</p> <p>It is concluded that the system, operating on biennial pavement condition ratings, provides a good solid framework for orderly analysis to estimate the economic benefits of the type, timing, and sequence of rehabilitation activities applied to a pavement.</p> | | | | | |
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WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY

DEVELOPMENT AND IMPLEMENTATION OF
WASHINGTON STATE'S
PAVEMENT MANAGEMENT SYSTEM

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SUMMARY

This report describes the pavement management system developed by WSDOT over a period of five years. It represents an organized approach to providing the Department's administration with the necessary information for more efficiently managing its investment in roadway pavements. Both project-level and network-level pavement management are represented within the four broad areas of data processing which combine to constitute the foundation of the system.

Functional Aspects

There are four basic components of this system:

1. Master File
2. Interpreting Program
3. Project-Level Optimizing Program
4. Network-Level Program

Master File

The foundation of this system is the Master File which combines information from five other existing data files:

1. Roadlife History (construction history)
2. Roadway Inventory (geometric data)
3. Annual Traffic File
4. Surface Friction File
5. Pavement Condition Rating File

The Master File is indexed according to milepost limits of the most recent paving contracts and is utilized in two ways:

1. To track the progression of distress over the service life of a pavement.
2. As input to the first of three computer programs in the system, the interpreting program.

Interpreting Program

The interpreting program translates the raw distress codes contained in the Master File into average ratings for each project. This is accomplished by applying weighting values to the extent and severity of each distress category. Regression analysis is then applied to the ratings to fit a performance curve which is used for predicting future pavement performance and the potential time of rehabilitation.

The output listing from the interpreting program consists of the following for each project:

1. A tabulated summary of the performance history.
2. A summary of traffic information for the project.
3. The constants for the performance equation with related statistical data.
4. A plot of average ratings with high and low ratings for each survey year shown and the performance curve fitted to the points.

The interpreting program also generates a new data processing file that contains all of the above-noted information on a project-by-project basis.

This file is used in two ways:

1. To study the correlation of other parameters such as design mixes, environmental effects, traffic characteristics, etc., with trends in pavement performance.
2. As input to the second major program in the system, the project-level optimizing program.

Project-Level Optimizing Program

This program utilizes the performance equations produced in the interpreting phase to establish the most probable period of rehabilitation for each project. After selecting a set of viable alternatives and developing their associated performance equations, the program generates all possible rehabilitation strategies which might be considered within a specified period. These strategies are defined as a combination of rehabilitation alternatives designated by type, sequence, and application time. Each strategy is evaluated on the basis of economics and the best are tabulated on an output listing for each project.

Categories of cost considered in the evaluation process are:

1. Construction cost of rehabilitation.
2. Annual cost of routine maintenance.
3. Cost incurred by the highway user due to pavement condition.
4. Cost of delay time incurred by the highway user due to traffic interruption during rehabilitation.
5. Salvage value of the pavement at the end of the consideration period.

This program also generates a new data processing file which is used as input to the next program in line, the Network-Level Program.

Network-Level Program

The function of this last program is to establish a network-level six-year rehabilitation program based on the optimum strategies as determined by project-level optimizing. Through a system of aggregating the recommended rehabilitation

alternatives and performance of all project segments on the network, a schedule of anticipated action, cost, and performance can be tabulated for a future number of years. By applying budget and condition-level constraints for each year, the network program will produce an entire balanced rehabilitation program. By varying the budget and condition-level constraints and tabulating the results in projected performance with proposed budgets, good comparisons are demonstrated for what can be obtained with different budget levels and most of the "what if" questions faced by administrators are answered.

The system is currently in operation within WSDOT. The performance curves produced by the interpreting phase are used to prioritize pavement sections for rehabilitation. The optimizing program and network-level program are both used by the districts to influence their decisions in preparing rehabilitation programs.

CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the system, operating on biennial pavement condition ratings, provides a good solid framework for orderly analysis to estimate the economic benefits of the type, timing, and sequence of rehabilitation activities applied to a pavement. As such, it is expected to be a great aid to WSDOT in providing the citizens of the state with the best pavements for their tax dollars.

During the course of development, the importance of maintaining pavement condition ratings in their raw coded form became very obvious. By doing this, weighting values can be recalibrated as each pavement survey is completed, greater insight to the interplay of pavement distress is acquired, and the expertise in performance analysis is improved.

In this system, "optimization" is applied at the project level. All work at the network level is related to gauging the effectiveness of different programs by applying constraints--either budget or pavement condition-level. It is concluded that network optimization would involve "trade-offs" between alternatives applied on all projects in order to make the greatest gains in long-term pavement condition for the dollars available. This process was not developed in the scope of this study, but represents an objective of further research and development.

Successful development and implementation of this pavement management system were accomplished with three basic considerations:

1. The production of a feasibility study by an outside consultant which determined adequate information and expertise were available within WSDOT to develop and implement a PMS.
2. The assignment of developing the system to the Materials Laboratory which has responsibility for pavement design approval, and pavement materials and construction specifications, as well as conducting the biennial pavement condition survey.
3. The formation of a steering committee consisting of top-level management personnel was considered essential for implementation.

The data base and interpreting system provide the necessary tools for further research. The possibility exists for correlating design parameters, materials and construction methods, and surfacing types and thicknesses to such factors as projected pavement life, area under the performance curve, degree of curvature, etc.

The performance model was developed with a strong consideration for simplicity and may not be accurate in the low ranges of pavement rating (severe distress). It is recommended that typical performance curve tails be developed for specific pavement types when they approximate this low range of rating.

The cost models relating user-incurred costs are weak and based on outdated information. It is recommended that better models be developed in the future if user costs are to be a consideration.

It should be noted that the framework of this system could be utilized by any agency that has the two basic constituents for the master file:

1. A construction history file with construction dates, types of surfacing, etc.
2. A pavement rating history file that relates to severity and extent of different distress types.

With this information available, it would be possible to calibrate distress weightings to relate to any combination of distress types and to represent the genesis of pavement deterioration in almost any geographical area. Once performance curves are developed, the mechanics of the rest of this system fall into line.

Chapter 1

HISTORY AND BACKGROUND

Purpose

This report presents a method for accomplishing one of the foremost goals in pavement management--that of maintaining the condition of the pavement for the least cost to all concerned. The phrase "pavement management" encompasses many disciplines of highway engineering. Haas and Hudson¹ define pavement management as "a comprehensive, coordinated set of activities associated with the planning, design, construction, maintenance, evaluation, and research of pavements". This report addresses the assessment of pavement performance, the selection of the most cost-effective rehabilitation alternative and its timing, and the development of a six-year rehabilitation program on a system basis.

The highway industry appears to be heading for a restrained effort of maintaining those facilities which already exist, or improving them as best they can with the limited amount of funding available. Little new construction will be accomplished in the future. The reasons for this are evident. Funding will be severely limited and there are other modes of transportation which must act in concert with the automobile. The price of oil is spiraling upward, strongly influencing national economy, and the effect of oil price increases on the highway industry is far more severe than other areas of the national economy. With inflation limiting the amount of construction possible and the gas-tax revenue decreasing from reduced sales, the funding picture for the highway industry does not look promising. The need for an efficient method of allocating highway funds is very obvious.

In the past, the Washington State Department of Transportation, WSDOT, has utilized a priority programming procedure for the selection of projects and the allocation of funds. It consisted of a complex procedure which prioritized by functional classification all anticipated projects in several construction categories. This procedure can respond to present needs, but there is no recognition of the long-term economic benefits or consequences associated with each action. To make and administer funding decisions for a budget as large as the WSDOT construction budget, the benefits and consequences of such decisions should be considered. The procedures presented in this report will accomplish that task.

Procedure

How can the basic needs for optimizing the results of expenditures and improving the management of pavement condition be realized? The answer to

this question is developed throughout the remainder of this report and is founded on relating operating and rehabilitation costs to pavement condition. As Marshall and LeClerc² pointed out in 1968, "It is an unfortunate fact that pavements wear out, and highway officials have been working for years to produce a method whereby the present serviceability of a pavement could be rated, levels of satisfactory service established, and predictions made as to the most economical time for any particular section of pavement to be reconditioned".

Figure 1 is a typical performance curve relating the pavement rating to the age of the pavement. As a pavement ages, its condition gradually deteriorates to the point where some type of rehabilitation is applied. This brings about an increased pavement rating and the beginning of a new cycle. Over the total life of a pavement, many applications of rehabilitation can be made and thus many cycles of resulting pavement performance are possible. These cycles are determined by the type, timing, and application sequence of rehabilitation alternatives (see Figure 2). By evaluating several different cycle combinations (rehabilitation strategies) over a set time span or consideration period, the least expensive combination (strategy) may be identified and compared to others on the basis of economy.

This approach precipitates two basic problems:

1. The performance of existing pavement as well as each successive rehabilitation alternative must be accurately predicted and forecast.
2. Accurate cost modeling must be accomplished in order to develop realistic costs.

The method demonstrated in the following pages provides a good, solid framework for systematic analysis--one which, because of the system and programming design, can be easily modified for use by other agencies or for updating functions and models. The system is designed to improve with time and the acquisition of new data.

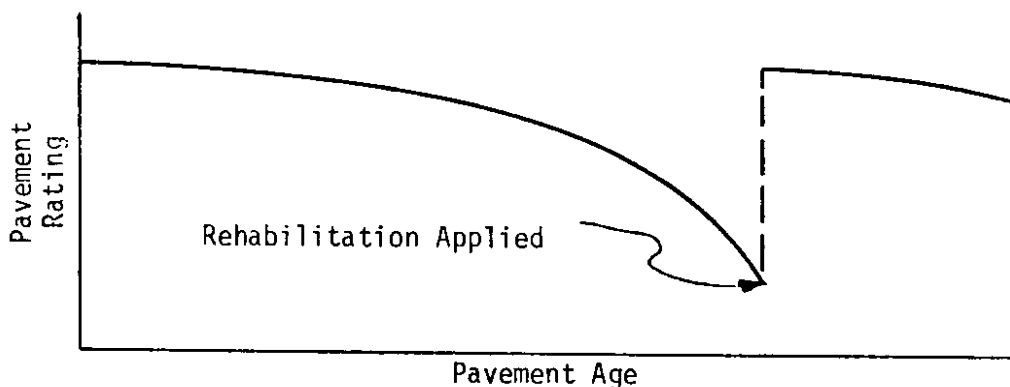


Figure 1. Typical Performance Curve

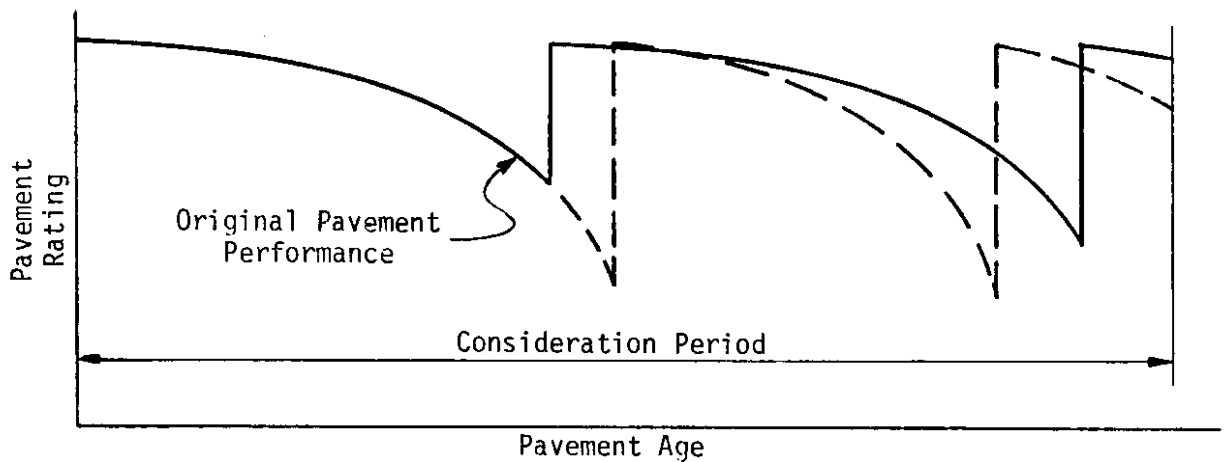


Figure 2. Application of Rehabilitation Alternatives

History of Development

The need for this approach to managing pavements was recognized very early by key administrators within WSDOT as evidenced by correspondence dating back into the 60's. Since the department has been rating pavements from about 1965, it was thought that these data could be used for developing performance curves. A consultant was hired in 1973 to study the proposal and determine the feasibility of initiating a pavement management system. A report³ was submitted by the consultant in August of 1974. The report indicated that most of the resources required for a pavement management system were present and that it was feasible to attempt pavement management on a trial basis. The feasibility study did much more than study feasibility, however. It provided a pavement performance model, documented cost functions for use in the economic evaluation, and provided computer programs which could be used for the analysis. As is often the case in feasibility studies, it also pointed out many needs. If a pavement management system were to be developed, the acquisition of new cost data and coordination of existing data-processing files would be required.

Based on the recommendations and findings in the feasibility study, the WSDOT administration authorized a research study for developing a pavement management system in May of 1975. However, because of personnel movement within the agency, the project only sputtered until April of 1977.

At that time, much work was dedicated to investigating the applicability of the consultant's model to its intended purpose of predicting performance. This model, the Markov chain model, was described in the consultant's study

and recommended because of its ease of handling probability and updating. Unfortunately, the Markov model did not predict pavement performance within an acceptable range for individual projects on our system. It appeared more applicable to system performance prediction, but with lower correlation factors.

Concurrently, there was difficulty in comparing pavement rating data from one generation to the next. As would be common, the department made improvements to the rating system over a period of time--expanding rating categories for some types of distress, dropping or adding some distress types, revising weighting values for distresses, changing ride meters, and revising the rating equation which combined ride data with distress data. To further complicate this situation, mileposting on many sections was revised between generations of rating data. This occurred whenever there were geometric realignments or system realignments. Because of this problem, mileposting on the entire state highway system had to be traced back to the first generation of data in order to establish the pertinent time of revision on each section.

In the beginning, computer programs were written to convert each generation of rating data to a common rating base. The mileposting problem was handled manually by hand-tabulating the rating for selected projects, generation by generation. Needless to say, this was a very time-consuming approach. A great amount of time was spent identifying project limits and tabulating pavement condition ratings to find projects with consistent performance. From a large number of surfacing projects, only a few could be shown to have deteriorating ratings related to time. One of these, a section of SR 395 north of Spokane, was used in the example for the paper⁴ presented at the Tumwater workshop. It was obvious, though, that there were significant problems with the ratings.

The WSDOT pavement rating is composed of a ride rating, determined objectively with a modified PCA ride meter, and a structural distress rating, determined subjectively by rating the extent and severity of several distress categories such as cracking, rutting, flushing, etc. Since any or all of the rating components were candidates for the cause of inconsistency, a strategy was outlined to identify that cause. A portion of Interstate 90 from near Ellensburg to the Idaho border was selected as a test section since it was predominantly asphalt concrete built on new alignment in the late 60's.

By tabulating the trend of each distress category for the history of each project in the test section, the consistent and inconsistent items were identified. Those most consistent were the distress categories of transverse cracking, longitudinal cracking, alligator cracking, and patching. Other distress categories

proved to be very inconsistent and were identified as being responsible for the random fluctuation in pavement ratings. The ride component was also found to have little correlation with time.

These findings supported our conclusion that the cause for overlaying a pavement is most often severe cracking and patching.

With the more consistent distress categories identified, a new rating equation was developed which incorporated only those categories of cracking and patching. This equation was applied to all projects in the test section and it was found that most then had consistent performance with time. A few projects still had poor time-related performance, but there were identifiable reasons for these.

A subjective evaluation obviously cannot be perfect and repeatable. A section of pavement is not always rated by the same crew year after year, and even when it is, the same crew may render a different evaluation the following year. Another problem which may have contributed to the inconsistent projects was that of data organization. Pavement rating is done by even mileposts, not by project limits. In order to associate ratings with a project, there will usually be some overlap involved at the beginning and end of each project. And if the project is relatively short, the ratings may not be associated with the project at all.

Much was learned by studying the I-90 projects: new rating equations were developed; a great amount of experience was gained in regression and correlation analysis; and it was realized that the consultant's program was no longer adequate for accomplishing the original objectives. Probably the most important benefit gained was some insight on the required constituents of a data file. A tremendous amount of time was spent retrieving and tabulating the input data required for the computer program. For pavement management to be efficient, a data file would have to be built and maintained for quick access. A complete data file is the foundation of any pavement management system.

It also became apparent that a step should be provided prior to optimizing the rehabilitation treatment for each project. In studying the I-90 projects, too much time was used in analyzing the yearly performance ratings and developing performance equations for each project. Although it was necessary to do this at the time to understand the processes involved, this analysis phase was considered best applied in a new computer program. By providing this step in the system, a great amount of flexibility was added. A data base could now be maintained, with all data stored in original format. By using

another input data set for interpreting parameters, the data file could be translated into project performance in an almost infinite number of ways. Some of the interpreting parameters included are weighting values for the extent and severity of each distress type, and different transformation constants for the regression analysis. By simply editing the interpreting parameters, it is possible to change the influence each distress type has on the resulting equation. It is also possible to look at the extent and severity of each distress type as it progresses through time. This aspect had been missing in maintaining only the numerical (weighted) ratings from year to year.

With the realization that the optimizing program developed by the consultant was no longer adequate, an entirely new "optimizing program" was written. The analysis path is similar, but is modularized for ease of updating and modifying, and was written to process output from the interpreting program. It is also composed in much the same way as the interpreting program in that it utilizes optimizing parameters. By doing this, constants for the cost models could be changed for different geographical areas, or the effective interest rate can be changed to provide a different outlook. Other items and controls are included in the parameters to consider different sets of rehabilitation alternatives.

Figure 3 is an example of the "system" as it was conceived in August of 1978. Three main phases were recognized: building a data file; interpreting the data; and optimizing each project based on total cost over an analysis period.

Writing the new optimizing program proved to be a much easier task than designing and building the data file. An initial version of the new program was completed in just over a month's time. Designing the data file was probably the single largest obstacle faced in developing a PMS; building the data file was an easy second. The winter of 1978-79 saw many milestones reached: the data file was designed and built for the statewide system; the interpreting program was written and used to improve the weighting values for the distress categories; and the optimizing program was modified a number of times as our expertise improved in that area.

By July of 1979 a substantially assembled and workable framework was at hand for accomplishing the original goal--to determine the least costly method of maintaining an acceptable level of pavement condition on any project. In addition, there was a better perspective of pavement management and a much clearer picture of what was needed. Pavement management data, to be most effective, must be made available to all areas of design, construction,

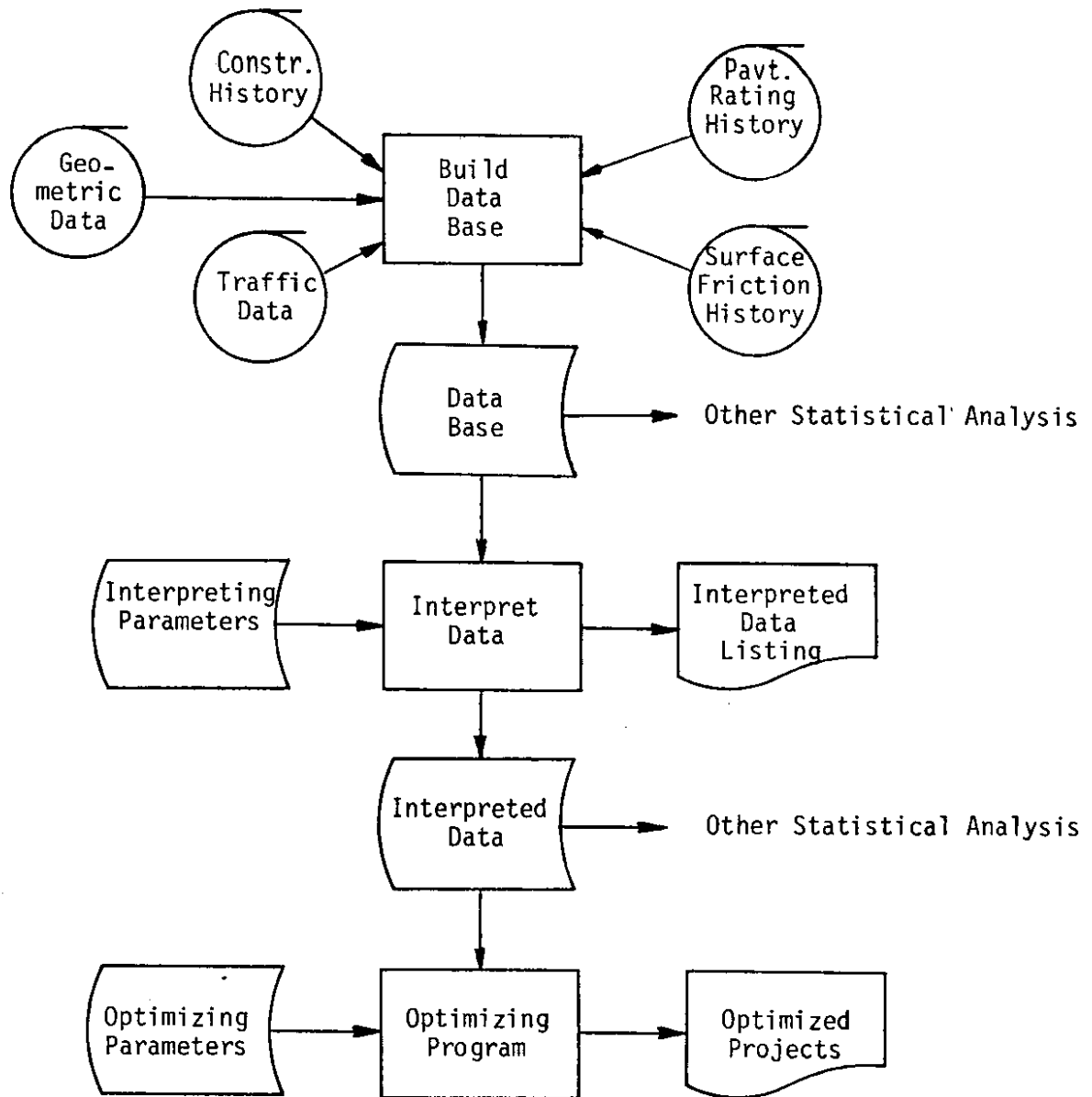


Figure 3. Conceptual Flow Chart of PMS at Early Stage

maintenance, and budgeting. To function properly, detailed information, results of several types of analysis, and feedback must all be utilized in those areas.

The framework being developed fulfilled most of these criteria, but fell short in others. All programs and files were run or accessed through batch processing, and it was necessary to make the data accessible so it could be used in the everyday functions of the department. It was realized that there were two levels of pavement management--project level and network level--and that all efforts had been directed toward the project level. Another problem surfaced in determining how this new system would be implemented in conjunction with the priority programming procedures already in use. A remaining concern was the accuracy of the cost models.

The fall of 1979 and winter of 1979-80 again saw some significant advances. All cost models were analyzed and polished in detail. Most of the project-level programs and data were installed as an interactive, on-line version for ease of access from any remote terminal. In this way all of the department's offices had access to and could make use of all available pavement-related information.

The biggest achievement of this period, however, was the development of network-level programming. Although there was an awareness of what was to be gained through this level of analysis, the method was not entirely clear until complete development of project-level optimizing had been attained. The completion of this level provided added insight.

Network-level programming is based on the optimum rehabilitation strategy as determined by project-level optimizing. Through a system of aggregating the recommended rehabilitation alternatives and performance of all project segments on the network, a schedule of anticipated action, cost, and performance can be tabulated for a future number of years. If adequate funding is available, no further information would be required--the anticipated rehabilitation program would be established. But this is not reality for most public agencies. Some further recourse is required when there is a limit on available funds. This action consists of: assigning a priority to each rehabilitation project for the first year; accumulating cost for each project in priority order until the budget limit is reached; delaying the residual projects to the following year and prioritizing the projects for that year; and repeating this process in an iterative manner until a rehabilitation program is established. The problem with this approach is the prioritizing formula. This formula must consist of the criteria deemed most desirable for the good of the system as a whole--not just the section with the lowest rating.

Budget constraints in terms of limited funding only present one side of the network problem. The other side is precipitated when funding is so limited that an acceptable level of pavement condition cannot be sustained. The approach to this problem is much the same as the first. When tailoring a program to fit available funding, the cost of each project is accumulated until the total dollars reach the funding limitation. A program constrained with limited funds will provide some specific level of average pavement condition. In the latter case, however, each project is gauged for its effect on the overall average pavement condition, with each raising the average to an increasingly higher level. Ultimately, of course, a specified level of "acceptable" average pavement condition is reached. A rehabilitation program compiled to provide a

minimum level of pavement condition will require a certain level of funding. So it is obvious there are two types of constraints involved at the network level:

1. Budget Constraint - A funding limitation which restricts the number of possible projects and provides a specific level of average pavement condition.
2. Condition-Level Constraint - A specified level of average pavement condition deemed to be a minimum which requires sufficient projects to be implemented and demands a certain level of funding.

By preparing several programs, each with a different level of constraint, graphs can be plotted to demonstrate the effects of limited funding or the demand on funding required to sustain minimum levels of pavement condition.

Network-level programming is that part of the system which informs upper level management of the potential impact to be derived from varying certain levels of budget constraint, from raising or lowering the minimum acceptable level of pavement condition, or from the effects of projected interest and inflation rates. With this part of the system in operation, the WSDOT has detailed information both at the project level and at the network level to aid and influence cost-effective decision-making for maintaining pavement condition.

Figure 4 represents a conceptual flow chart of the operations involved in the final system. These operations are separated into four basic phases:

1. Building the data file
2. Interpreting the data file (performance analysis)
3. Optimizing the proposed action on each project (economic analysis)
4. Preparing a network rehabilitation program

Chapters 2 through 5 describe in detail how and why each phase was designed. It is hoped these chapters will serve not only to describe what has been done in the WSDOT system, but also to aid other agencies in their PMS development.

In the spring of 1980, two meetings were held with district representatives to present the PMS. District reception was mixed. Some could see the PMS as a great help; others were skeptical about it working with old roadways; and still others reserved judgment until they could see examples of how it would function on certain roadways within their own districts. The PMS that had been developed was a fairly comprehensive system, and it was asking quite a bit for people unfamiliar with it to fully appreciate the benefits on the strength of a 1½-hour presentation and subsequent discussion. However, it was felt that examples of its use within each district would enable the district people to appreciate its potential.

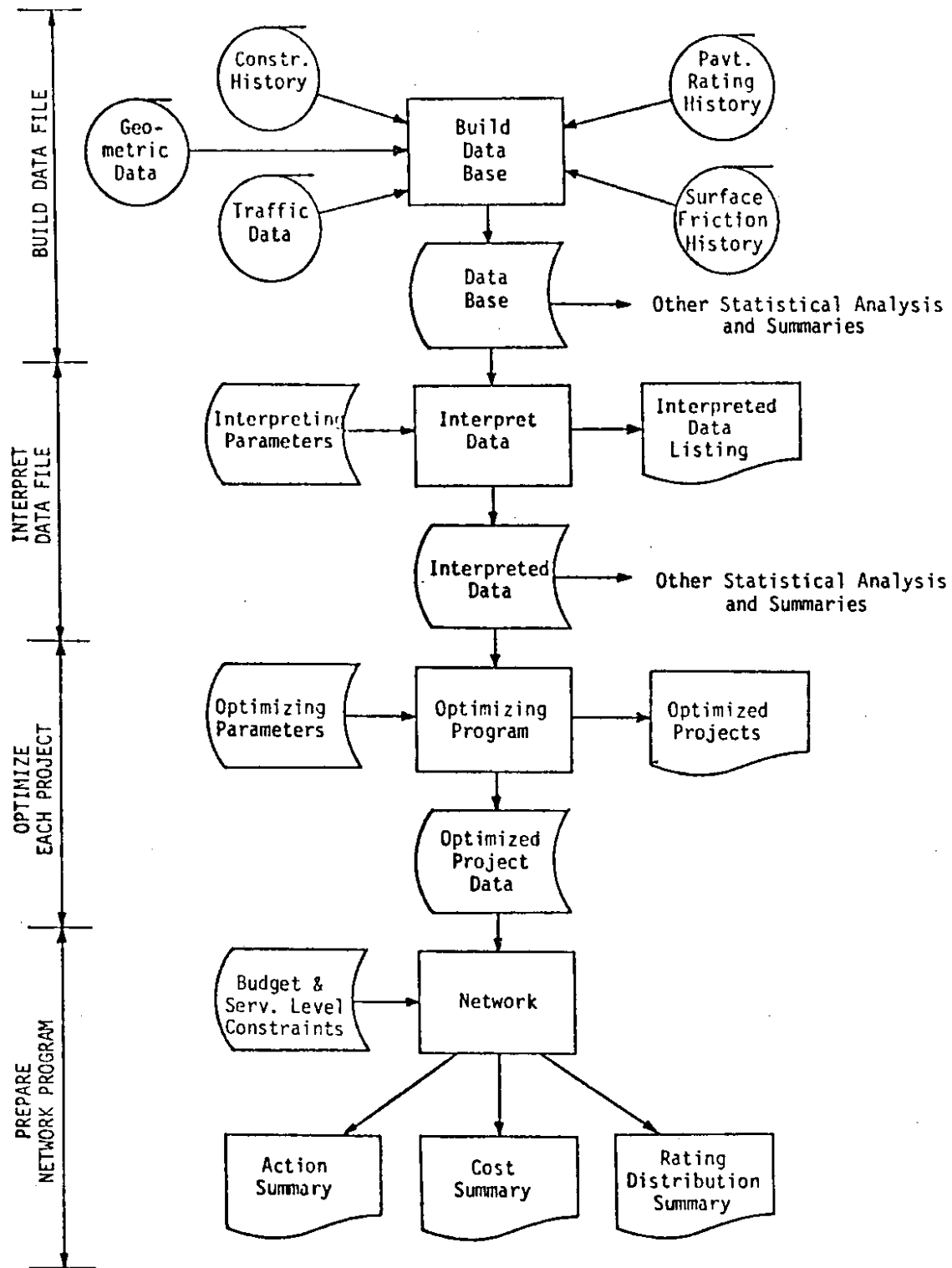


Figure 4. A Conceptual Flow Chart of PMS Operations

In order to ensure an adequate indoctrination and ultimate acceptance within the department, a PMS Steering Committee was formed in early June of 1980. This committee consisted of:

Construction Engineer (Chairman)
Maintenance and Operations Engineer
Roadway Development Engineer
Materials Engineer
District Administrator (D-3)
Program Development Engineer
Deputy Secretary of Transportation

Subsequent meetings with the Steering Committee generated many requests and further examination of the PMS influence on departmental operations. Of particular interest to the Committee were:

1. The difference between pavement ratings--old and new.
2. The difference between programs resulting from use of project limits vs. analysis units.
3. Implementing the PMS in conjunction with the existing Priority Array System.
4. A correlation of pictures to pavement ratings.

Approximately one year elapsed in this phase of the project--answering all the questions and assuring upper level management of satisfactory operation.

Finally in the fall of 1981, the WSDOT staff gave approval and direction to apply the PMS in establishing the pavement-related portions of the Priority Array for the 83-89 Legislative Program and the 83-85 Operating Program. The Pavement Management System is now an integrated part of WSDOT operations.

ASSEMBLING THE DATA FILE

Background

Designing and building the required data file was probably the greatest obstacle faced in developing this system. Selection of the specific data items and design of the record layout and file structure presented some very perplexing problems. This selection and design also had to recognize certain functional specifications, or how the file was to be used. Because the evolution of this system began with a cost-optimizing program, the items included in this file were originally selected as input data for that program. The record layout and file structure were then dictated by the type of data available and how it was to be used.

Many organizations involved in the development of a PMS have been bogged down in their attempts to assemble a data base. Their problems stem from attempting to include far too many items in order to ensure that data required in subsequent programs will be available when needed. By doing this, the problem becomes far more complex. More items imply greater coordination in file design and record structure, i.e., not all items can be associated in the same way. The amount of time dedicated to acquiring the information also amplifies this endeavor to an almost insurmountable task. By limiting the data file to little more than the essentials, the task at hand can be managed.

This method of assembling the data file did have its drawbacks, however. With the file containing only those items required as input to a specific program, subsequent modifications to the program often required expanding or even rebuilding the data file to include new data.

Available Data Files

After the essential elements were identified, current data processing files were studied to locate and retrieve the required data items. Fortunately, almost all items were available in department files. The only missing item was annual pavement maintenance cost associated with specific projects.

The files recognized as having desirable data items were:

1. Roadlife History
2. Roadway Inventory
3. Annual Traffic File
4. Surface Friction File
5. Pavement Condition Rating Files

Following is a brief description of each file:

Roadlife History

The Roadlife History is basically a milepost-by-milepost breakdown of the entire construction history of every mile of roadway on the state system. Record layout is such that each record represents a homogeneous roadway section. Every surfacing action from the data of original construction to the most recent rehabilitation is noted by type, depth, and date. Also recorded are contract numbers, functional classification, type of highway configuration, base material types and depths, and provisions for locating added lanes and old PCC pavements.

Roadway Inventory

The Roadway Inventory represents a collection of geometric, physical, and other descriptive features of the state highway system. Items included in the file are: state route milepost; equivalent control section milepost; description of the nearest physical landmark; lane widths; shoulder widths; median widths; type of terrain; junctions with other city, county, or state roads; federal aid classification; and others which describe characteristics of the highway system. This file is used in producing the State Route Log and in various needs studies.

Annual Traffic File

The Annual Traffic File is maintained by the Public Transportation and Planning Division and provides traffic volumes at all locations throughout the network. Items contained in this file include: average annual daily traffic, growth rate, single unit truck percentages, combination truck percentages, K factor for reducing AADT to a design hour volume, D factor for splitting the DHV into a directional volume, and three previous years' AADT. This file is the source of the Annual Traffic Report.

Surface Friction File

All past and present friction measurements are recorded for each state route milepost of the system. Items also recorded include: surface type, direction of test, test lane, test speed, and month and year of testing. Data from this file are used to identify hazardous locations and represent one source of input to the department's Priority Array relating to safety conditions.

Pavement Condition Rating Files

These files (one for each pavement condition survey) are a collection of the raw coded ratings for each of several surface distress categories, together with roughness data acquired with a modified PCA ride meter. Items coded in this file include ratings for: pavement rutting and wear, alligator cracking, ravelling or flushing, longitudinal cracking, transverse cracking, and patching--all associated with bituminous pavements; cracking, ravelling-disintegration-popouts-scaling, joint spalling, pumping and blowing, blowups, faulting-curling-warping-settlement, patching, and pavement rutting and wear--all associated with portland cement concrete pavements. This file has been the basis for establishing pavement rehabilitation priorities.

Data Problems

On inspection of these files, several problems became evident, two of which were of paramount concern: the problem of mileposting structure used to index records; and the problem of overlap relating project limits to rating sections or other required records. These problems represented significant obstacles to overcome in designing and building the data base.

Mileposting Problem

The WSDOT employs two uniquely different systems of mileposting. The first, state route mileposting, might be considered as conventional mileposting. Under this system, mileposts begin at the southernmost or westernmost terminus and increase in a northerly or easterly direction respectively. This system is perhaps the most common and the easiest to comprehend. The other type of mileposting utilized is a system of segregating the highway network into small sections called control sections. The purpose for doing this is to establish cost association with jurisdictions, legal entities, or specific boundaries such as city limits, county limits, urban areas, legislative districts, congressional districts, etc. Each of these sections has its own set of mileposting.

The problems arise when each division maintaining a file utilizes its own indexing system. Different methods include: beginning control section mileposts (BCSMP); ending control section mileposts (ECSMP); beginning state route mileposts (BSRMP); ending state route mileposts (ESRMP); or inclusive mileposts in either system. Features may be recorded consecutively through a control section on the left side and then repeated for the right side. Another method involved alternate records from left to right throughout the section.

To further complicate the problem, each time a highway is realigned for one reason or another, the mileposting is updated or an equation is inserted. Trackability of recorded information from one year to the next then becomes a formidable task.

Overlap Problem

The prime objective of the pavement management system is to track performance of pavements so a time to failure can be projected, and cost effectiveness of rehabilitation gauged. For the past 12 to 15 years, the State of Washington has been evaluating its entire network of pavements each two years. These ratings together with construction history constitute the major requirements for tracking performance relative to project limits. However, when the sections rated do not coincide with project limits, a major problem is sometimes encountered.

Pavement condition is evaluated on maximum one-mile intervals starting at the beginning of each control section. Should the rating team observe a significant change in the pavement condition before completing a one-mile section, they are instructed to begin a new section. In all cases, a break is noted at the even milepost: 1, 2, 3, 4, 5, etc., ± 0.1 mile. This is done to maintain continuity from one generation of ratings to the next. When several years have passed since construction or rehabilitation, the rating teams may no longer notice the distinct breaks in pavement condition. Project limits no longer stand out with a great degree of contrast between old and new. When this break in project limits is not picked up in the rating limits, a problem of overlap occurs. Figure 5 is an illustration of the overlap problem indicating three possible cases of overlap and the ideal situation where no overlap occurs (Case 4).

A recent modification of the rating forms will help eliminate this problem in time. By precoding rating limits to match rating limits from previous years and recent rehabilitation limits, the raters will be alerted to these breaks during the time of pavement condition survey.

Designing the Master File

The information previously described represents all data used to assemble the master file. The basis for coordinating these files was eventually determined to be the limits of the last paving contract applied. Since the ratings are primarily indicative of surface distress, all data are related to a surface age and other construction parameters such as type and thickness of surfacing.

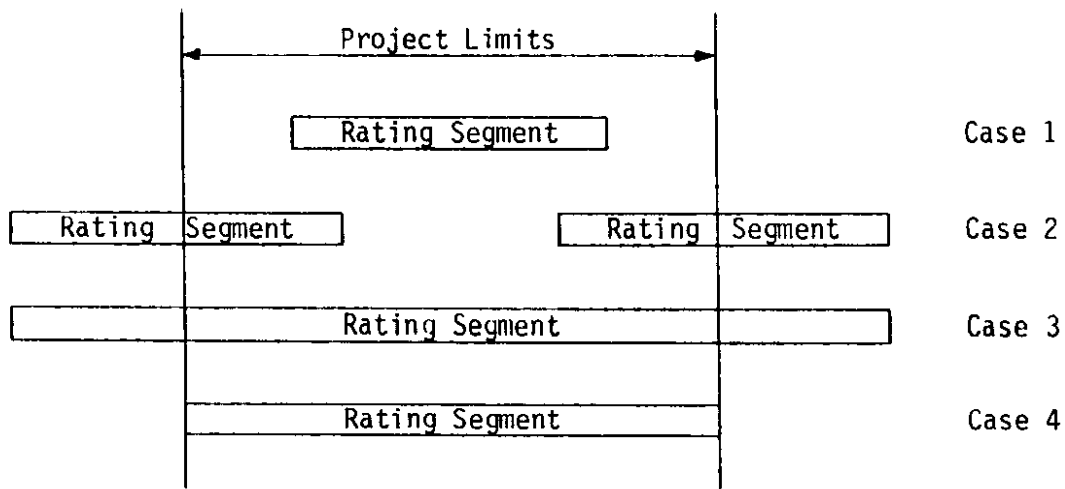


Figure 5. Overlap Problem

The first step in designing the file was the determination of broad fields for layout and organization. These fields represented general areas and were not refined to specific data items. Project identification and description represented the most obvious items since everything else is naturally related. Traffic data, friction data, and pavement condition data comprise the other broad fields. Construction history is included in the project description and identification. Figure 6 is an illustration of the general record structure for one record in the master file.

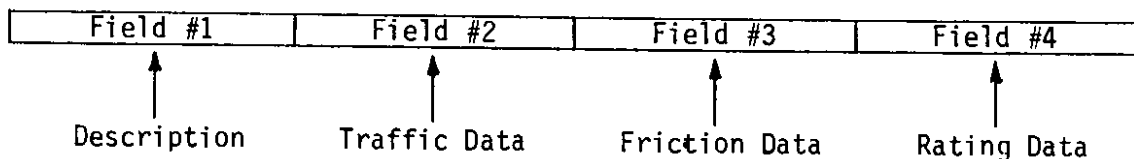


Figure 6. Typical Record - Broad Fields

This appears to be a rather simple record layout. However, because there are several generations of data to be related to each project, the file structure was not quite so easy to perceive. Each project differs in age and length. This tends to vary the amount of data to be related for each project. Several methods of combining records for assembling the master file were considered: assembling coordinated files; building records with variable record lengths; or stacking records in a hierarchical structure. In the interest of keeping the programming as simple as possible, the hierarchical structure was selected.

Figure 7 depicts the hierarchical structure developed. At the top are all data related to the project itself, regardless of year or specific location. This includes project description, identification, construction parameters, and traffic information. Since traffic is not available for previous years, it was decided to utilize the most recent traffic available. This prevents correlation with past performance, but with growth factors included, does allow future projection of traffic. The top of the hierarchy thus combined the first two broad fields into one, designated the master index field since everything is related to it.

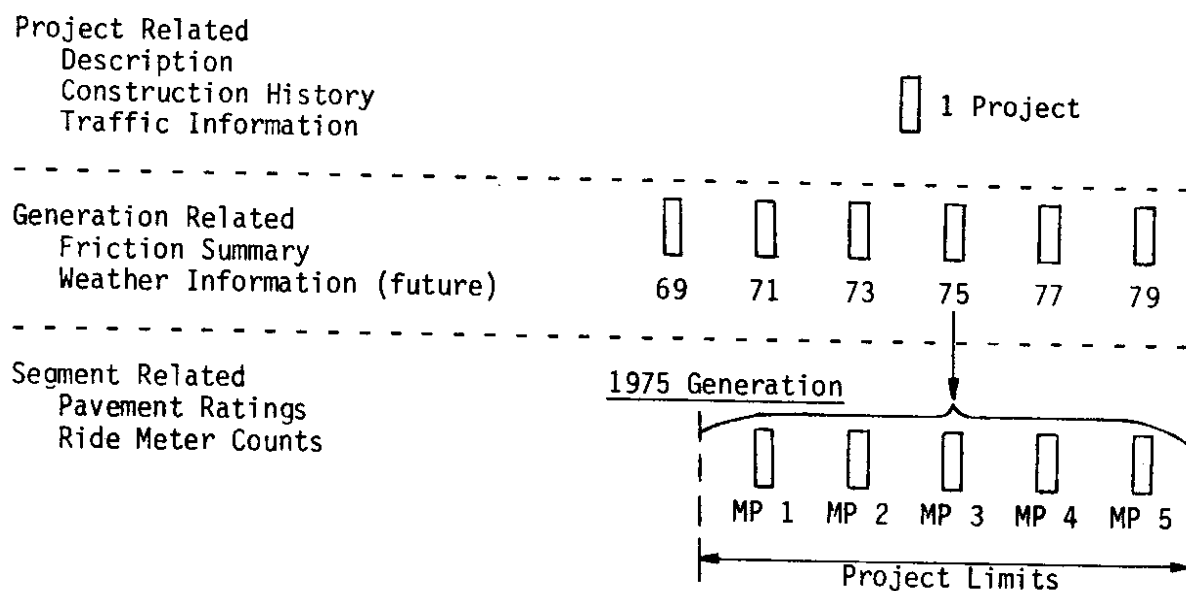


Figure 7. Hierarchical Record Structure

Next in order of the hierarchy are data associated with each generation involved. It is possible to relate much of the available project data to generations, or years. Data fitting into this category include friction summaries. Traffic information would also logically fit at this level if it were available. Future considerations include historic weather information.

At the lowest level of the hierarchy are all data that can be tied down to specific segments for each generation of a project. This includes pavement condition ratings and roughness measurements which are recorded by one-mile increments.

Assembling the Data File

The hierarchical structure is evident in Figure 8 which is an example of the master file layout. This system of stacking records presents a much simpler method of assembly than the other file structures considered. The file is built through a series of record-matching programs and available system utility programs. Figure 9 is a conceptual flow chart which portrays each step in this building process. The steps are simply named to relate the specific operations involved. Although the actual assembly is much more complex, involving many more steps, a conscious effort has been made to explain the purpose of each step and avoid some of the superfluous details.

| Record # | 1ST FIELD Master Index Portion | 2ND FIELD Generation Related | 3RD FIELD Segment Related |
|----------|-----------------------------------|---------------------------------|------------------------------|
| 1 | 1st Project Descr. & Traffic | 1st Gen. Summary | 1st Gen. 1st Mile |
| 2 | " " | " " | 2nd Mile |
| 3 | " " | " " | 3rd Mile |
| 4 | " " | " " | Nth Mile |
| 5 | " " | 2nd Gen. Summary | 2nd Gen. 1st Mile |
| 6 | " " | " " | 2nd Mile |
| 7 | " " | " " | 3rd Mile |
| 8 | " " | " " | Nth Mile |
| | " " | Xth Gen. Summary | Xth Gen. 1st Mile |
| | " " | " " | 2nd Mile |
| | " " | " " | 3rd Mile |
| | " " | " " | Nth Mile |
| | 2nd Project Descr. & Traffic | 1st Gen. Summary | 1st Gen. 1st Mile |
| | " " | | |
| | " " | | |
| | " " | | |
| | " " | | |
| | " " | Xth Gen. Summary | Xth Gen. Nth Mile |
| | | | |
| | Mth Project Descr. & Traffic | Xth Gen. Summary | Xth Gen. Nth Mile |

Figure 8. General Layout of Master File

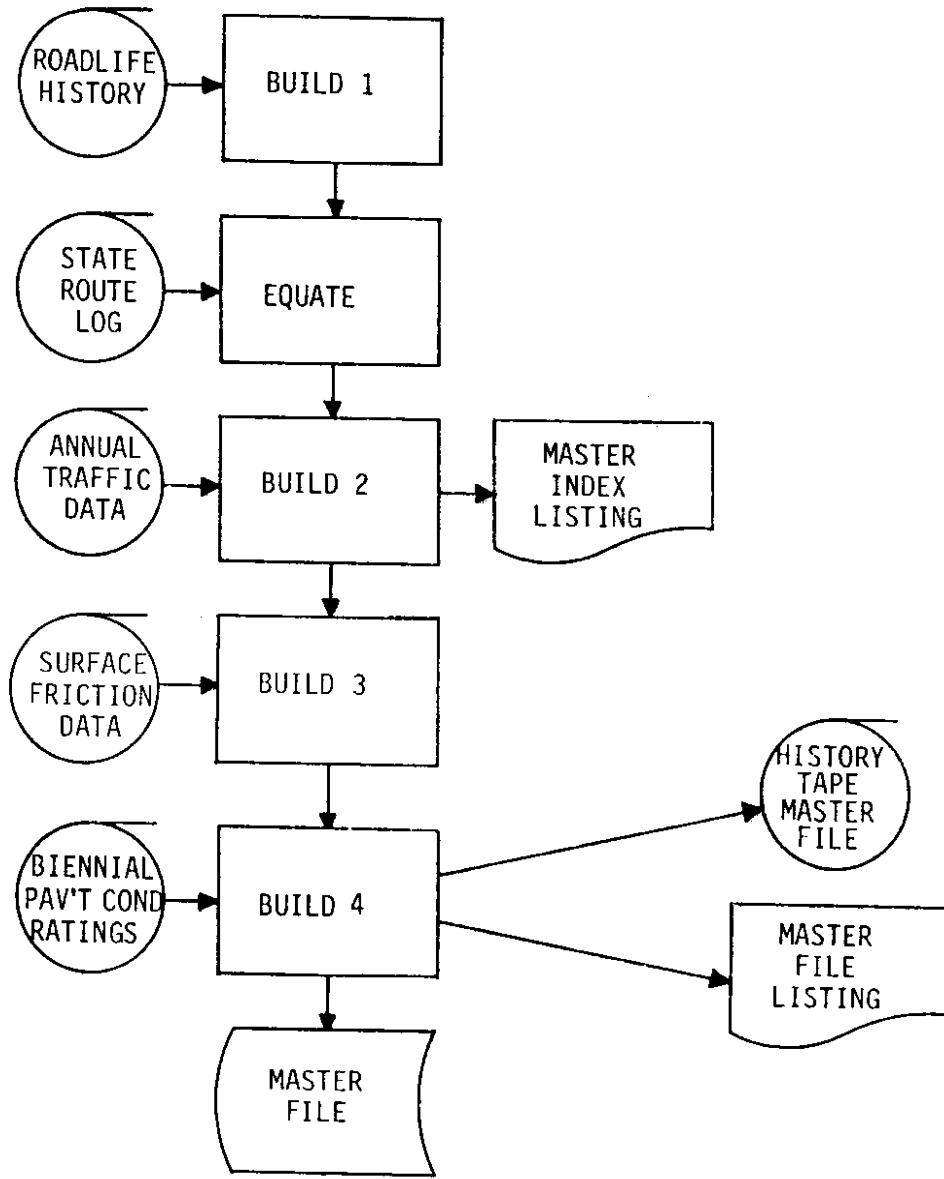


Figure 9. Conceptual Flow Chart of Building Process

Each of the steps indicated in the flow chart is briefly explained below:

Build 1

This step represents a program which uses the Road Life History File as input to produce a file containing the project limits for the most recent consecutive surfacing contracts throughout the entire state highway network. With the data in this file, the pavement surface age as well as the type and depth of material present can be determined for any location. The specific contract number is recorded together with a code representing the underlying

materials. In the case of rehabilitation applications, prior project limits will not match up, causing the new limits to represent a non-homogeneous section. For this reason, a two-digit code is recorded to indicate the predominant or most representative type of material under the surfacing.

Equate

This step utilizes the file produced with Build 1 and the Roadway Inventory File. Because WSDOT uses two different sets of mileposting, a necessary step in the process is identifying project limits with both sets of mileposting. Limits generated in Build 1 are beginning and ending control section mileposts. The Roadway Inventory File contains dual mileposting for all identifiable locations on the highway system, thus making it possible to equate project limits in terms of both mileposting systems. With project limits identified by both methods, it is then possible to relate all other files to each project segment.

Other data provided in this process are the roadway and shoulder widths, plus other geometric features. These are items needed for cost modeling in project-level optimizing.

Build 2

This program assigns relevant traffic data to the project limits developed. By using the Annual Traffic File as one source of input and the file produced by Equate as the other, traffic is matched to project limits. Realizing that traffic data is a point-associated quantity, a weighted average is applied to each project.

The output file produced with Build 2 is a file containing project limits, description and date of last surfacing contract, number of lanes, roadway and shoulder widths, base material type, and all required traffic information. This output file is known as the Master Index since it represents all data in the top of the hierarchical record structure. Figure 10 represents one page from a listing of the Master Index. Figure 11 is a decoding table for the Master Index.

Build 3

This step represents the first move down in the hierarchical structure. Build 3 is a program which associates yearly summaries of friction data with each project. A decision was made at this point to include only yearly summaries instead of mile-by-mile data because friction data is not included in the performance equation. Friction information recorded includes the high,

RA7710MT

| CS | REG | END | D | SR | REG | END | LENG | FC | L | HT | RUM | RSH | LSH | CONT# | TY | SF | TK | M | YR | BASE | RO | ADT | GRW | SU | CM |
|------|------|------|---|-----|-------|-------|------|----|---|----|-----|-----|-----|-------|----|----|----|---|----|------|-------|-----|-----|----|----|
| 2303 | 0 | 707 | 3 | 101 | 31023 | 32170 | 1146 | R1 | R | 02 | 22 | 2 | 2 | 02061 | 20 | 40 | 12 | 9 | 81 | 11 | 2800 | 49 | 5 | 5 | |
| 2303 | 707 | 1005 | 3 | 101 | 32170 | 32468 | 298 | P1 | R | 02 | 22 | 2 | 2 | 08493 | 20 | 40 | 4 | 0 | 68 | 11 | 2800 | 49 | 5 | 5 | |
| 2303 | 1005 | 1225 | 3 | 101 | 32468 | 32883 | 415 | R1 | R | 02 | 22 | 4 | 6 | 00555 | 20 | 40 | 6 | 4 | 77 | 11 | 5000 | 38 | 5 | 5 | |
| 2303 | 1225 | 1710 | 3 | 101 | 32883 | 33173 | 290 | R1 | R | 02 | 23 | 4 | 4 | 00555 | 20 | 40 | 12 | 4 | 77 | 11 | 5800 | 31 | 5 | 5 | |
| 2303 | 1710 | 2237 | 3 | 101 | 33173 | 33700 | 527 | R1 | R | 02 | 23 | 4 | 4 | 02018 | 20 | 40 | 8 | 7 | 81 | 11 | 5800 | 31 | 5 | 5 | |
| 2302 | 0 | 245 | 3 | 101 | 33700 | 33945 | 245 | P1 | R | 02 | 23 | 3 | 3 | 09022 | 20 | 40 | 15 | 8 | 71 | 11 | 4600 | 43 | 5 | 5 | |
| 2302 | 245 | 430 | 3 | 101 | 33945 | 34130 | 185 | R1 | R | 02 | 23 | 4 | 4 | 02018 | 20 | 40 | 8 | 7 | 81 | 10 | 5400 | 43 | 5 | 5 | |
| 2302 | 430 | 790 | 3 | 101 | 34130 | 34490 | 360 | R1 | R | 02 | 23 | 4 | 4 | 09022 | 20 | 40 | 15 | 8 | 71 | 10 | 5400 | 43 | 5 | 5 | |
| 2302 | 790 | 811 | 3 | 101 | 34490 | 35020 | 451 | U1 | R | 02 | 24 | 11 | 11 | 09361 | 0 | 40 | 50 | 1 | 75 | 10 | 4900 | 56 | 5 | 5 | |
| 2301 | 430 | 507 | 3 | 101 | 35020 | 35097 | 77 | P1 | L | 32 | 24 | 10 | 4 | 07573 | 0 | 40 | 25 | 9 | 65 | 10 | 12300 | 56 | 5 | 5 | |
| 2301 | 507 | 670 | 3 | 101 | 35097 | 35260 | 163 | R1 | L | 32 | 30 | 0 | 0 | 01289 | 20 | 40 | 6 | 0 | 78 | 11 | 12500 | 56 | 5 | 5 | |
| 2301 | 670 | 1009 | 3 | 101 | 35260 | 35599 | 339 | R1 | L | 32 | 24 | 10 | 4 | 01907 | 20 | 40 | 6 | 0 | 80 | 32 | 10800 | 56 | 5 | 5 | |
| 2301 | 1009 | 1104 | 3 | 101 | 35599 | 35694 | 95 | R1 | L | 32 | 24 | 10 | 4 | 01289 | 20 | 40 | 6 | 0 | 78 | 32 | 10800 | 56 | 5 | 5 | |
| 2301 | 0 | 430 | 3 | 101 | 34490 | 35020 | 451 | U1 | R | 02 | 24 | 10 | 4 | 09361 | 0 | 40 | 50 | 1 | 75 | 10 | 4900 | 56 | 5 | 5 | |
| 2301 | 430 | 507 | 3 | 101 | 35020 | 35097 | 77 | R1 | R | 32 | 24 | 10 | 4 | 07573 | 0 | 40 | 25 | 9 | 65 | 10 | 12300 | 56 | 5 | 5 | |
| 2301 | 507 | 670 | 3 | 101 | 35097 | 35260 | 163 | R1 | R | 32 | 30 | 0 | 0 | 01289 | 20 | 40 | 6 | 0 | 78 | 11 | 12500 | 56 | 5 | 5 | |
| 2301 | 670 | 1010 | 3 | 101 | 35260 | 35600 | 340 | R1 | R | 32 | 24 | 10 | 4 | 01907 | 20 | 40 | 6 | 0 | 78 | 11 | 12500 | 56 | 5 | 5 | |
| 2301 | 1010 | 1104 | 3 | 101 | 35600 | 35694 | 94 | P1 | R | 32 | 24 | 10 | 4 | 01289 | 20 | 40 | 6 | 0 | 78 | 32 | 10800 | 56 | 5 | 5 | |
| 3406 | 0 | 448 | 3 | 101 | 35692 | 36140 | 448 | P1 | L | 32 | 24 | 10 | 4 | 00150 | 20 | 40 | 6 | 7 | 76 | 32 | 9300 | 61 | 5 | 5 | |
| 3406 | 0 | 448 | 3 | 101 | 35692 | 36140 | 448 | R1 | R | 32 | 24 | 10 | 4 | 00150 | 20 | 40 | 6 | 7 | 76 | 32 | 9300 | 61 | 5 | 5 | |
| 3405 | 0 | 589 | 3 | 101 | 36152 | 36741 | 589 | R1 | L | 32 | 24 | 10 | 4 | 09509 | 20 | 40 | 6 | 8 | 73 | 32 | 22600 | 68 | 5 | 5 | |
| 3405 | 0 | 589 | 3 | 101 | 36152 | 36741 | 589 | U1 | P | 32 | 24 | 10 | 4 | 09509 | 20 | 40 | 6 | 8 | 73 | 32 | 22600 | 68 | 5 | 5 | |

Figure 10. Master Index Listing

Shown on the Master Index Listing from left to right are: CS = Control Section, Beginning CSMP, Ending CSMP, D = District, SR = Sign Route, Beginning SRMP, Ending SRMP, LENG = Length of Project, FC = Functional Classification (see below), L = Lane (Right or Left; for simple two-lane roads R is always shown), HT = Highway Type (1st character represents highway type [see below], 2nd character indicates the number of lanes), RDW = Roadway Width, RSH = Right Shoulder Width, LSH = Left Shoulder Width, CONT# = Most Recent Surfacing Contract Number, TY = Type of Construction (see below), SF = Type of Surfacing (see below), TK = Thickness of surfacing built on last contract, M = Month of year completed (see below), YR = Year completed, Base = Predominant type of surfacing below last contract (see below), the most recently available ADT, GRW = annual traffic growth rate (expressed as a percentage with one decimal point implied), SU = single unit truck percentage, and CM = combination truck percentage.

| <u>Functional Classes</u> | <u>Highway Type, HT</u> | <u>Months</u> |
|---------------------------|-------------------------|-------------------------|
| U = Urban | 0 = Simple Highway | 1-9 = January-September |
| R = Rural | 1 = Extra Lane | 0 = October |
| 1 = Principal Arterial | 2 = Undivided | - = November |
| 2 = Minor Arterial | 3 = Divided | + or & = December |
| 3 = Major Collector | 4 = One-Way City | |
| 4 = Unclassified | 5 = Independent Line | |
| 5 = Interstate | and Grade | |

| <u>Type of Construction, TY</u> | <u>Type of Surfacing, SF</u> |
|----------------------------------|----------------------------------|
| 00 = New Construction | 10 = CSTC |
| 10 = Reconstruction | 20 = BST |
| 20 = Resurfacing | 21 = Mixed Bituminous |
| 30 = Bridge | 22 = Penetration Macadam |
| 40 = City or County Road Project | 23 = SAM |
| 01 = First Stage Construction | 30 = PCC |
| 02 = Second Stage Construction | 40 = ACP |
| | 41 = w/SAM I |
| | 42 = w/Fabric |
| | 43 = Open-Graded Friction Course |
| | 44 = Open-Graded Emulsion ACP |
| | 45 = Slurry Seal |
| | 46 = Recycled |

Base Type

- 10 = Gravel and/or CSTC (original construction)
- 11 = Gravel and/or CSTC (overlaid old ACP)
- 12 = Gravel and/or CSTC (overlaid old PCC)
- 13 = Gravel and/or CSTC (overlaid old Bit.)
- 21 = Asphalt Treated Base (original construction)
- 22 = Asphalt Treated Base (overlaid old ACP)
- 23 = Asphalt Treated Base (overlaid old PCC)
- 31 = Cement Treated Base (original construction)
- 32 = Cement Treated Base (overlaid old ACP)
- 33 = Cement Treated Base (overlaid old PCC)
- 41 = Old PCC with Cushion Course of CSTC
- 42 = Old AC with Cushion Course of CSTC

Figure 11. Master Index Decoding Table

low, and average friction number of each year that surface friction was tested. It is worthy to note that for each year of friction data available for each project, a new record is created with an identical Master Index field. Until other yearly summary data are identified, Build 3 completes all processing necessary at the second level of the hierarchical structure.

Build 4

This is the final step in the file-building process and is applied at the lowest level of the hierarchical structure. In Build 4, the pavement condition ratings are matched to each year for each project. However, since pavement condition ratings are acquired by the mile, each rating creates a new record with the proper output record from Build 3 filling the Master Index field and generation field. With completion of Build 4 on each year's pavement condition ratings, the Master File is essentially built.

Master File

The ratings in the Master File are listed as raw data, not numerical score, for each distress category. The first digit indicates the column that was coded (extent, or percentage of area affected in most cases), and the second number is the digit that was coded on the recording sheet (severity in most cases). If there is no distress present for a specific distress type, an "N" is coded in the first column to indicate the raters considered that distress. This concept is depicted in Figure 12.

Figure 13 is an example of the Master File listing. The top line of data is representative of the Master Index field. Below that are all pavement condition ratings for each year and each mile in that particular project. To the right of the raw ratings are: the raw unadjusted roughness measurements; the speed at which the counts were acquired; an adjusted count for the speed, meter, and vehicle used; and a ride rating (scale 0.0 to 1.0) related to the adjusted bump count.

Figure 14 is an example of the coding form used for rating pavement condition. Note that by inspecting the trends in distress codings as shown on the Master File listing, the consistent and inconsistent categories can be quickly identified.

With the file, as it is now assembled, it is possible to distinguish the gradual deterioration of pavements in terms of order of occurrence and magnitude of distress types from year to year. Basically, this is all that is required to gauge the performance aspect in a pavement management system.

| PORTLAND CEMENT CONCRETE | | | | | | | | | | | | | | | | | | | |
|--|-----------------|---|--------------|--|---------------|--|-----------------|---------------------|-------------------|---|--------------------|---|-------------------|--------------------|--------------------|-------------------|--------------------|---------------------|-----|
| CRACKING Units Panel Length (1) 1 - 2 (2) 3 - 4 (3) 4 Plus | | RAVELING DISINTE- GRATION, POP OUT, SCALING (1) Slight (2) Moderate (3) Severe | | JOINT SPALLING Width (1) 0 - 1" (2) 1 - 3" (3) 3 Plus Inches | | PUMPING BLOWING % Panel Lgth (1) 0 - 9% (2) 10 - 50% (3) Over 50% | | BLOWUPS NO./MILE | | FAULTING, CURLING, WARPING, SETTLEMENT (1) 0-1/4" (2) 1/4"-1/2" (3) 1/2" Plus | | PATCHING % Panels (1) 1 - 5% (2) 6 - 20% (3) Over 20% | | PAVT. WEAR | | | | | |
| 1 - 25% PANELS | 26 - 50% PANELS | OVER 50% PANELS | 1 - 25% AREA | 26 - 75% AREA | OVER 75% AREA | 1 - 15% JOINTS | 16 - 50% JOINTS | OVER 50% JOINTS | 1 - 15% OF PANELS | 16 - 35% OF PANELS | OVER 35% OF PANELS | NO./MILE | 1 - 15% OF PANELS | 16 - 35% OF PANELS | OVER 35% OF PANELS | 1 - 5% AREA/PANEL | 6 - 25% AREA/PANEL | OVER 25% AREA/PANEL | ** |
| 3 | | | N | | | 2 | | | 2 | | | | 1 | | | N | | | 1 |
| (13) | | | (1N) | | | (12) | | | (32) | | | | (21) | | | (1N) | | | (1) |

Coding: (AB) A = Column Coded
B = Number Coded

Note: "N" indicates no distress present.

Figure 12. Representation of Pavement Rating Raw Coding

R67714MF 06/14/82

CS REG END D SR REG END *** 2331 343 591 3 3 72 320 248 FC UI R 02 23 3 01437 20 40 15 8 80 11 4400 53 5 2

| GEN | SIDE | ECSMP | WEAR | RUTT | WAVE | SAGS | CRG | ALG | FLU | HT | RDW | RSH | LSH | CONI# | TY | SE | IK | M | YR | BASE | 80 | ADT | GRW | SU | CM |
|-----|------|-------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-------|------|-----|------|------|------|------|------|------|------|------|------|
| *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** |
| 69 | B | 371 | N | N | 11 | 11 | IN | IN | 11 | 11 | 11 | IN | IN | IN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 69 | B | 471 | N | N | 11 | 11 | IN | IN | 11 | 11 | 11 | IN | IN | IN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 69 | B | 671 | N | N | 11 | 11 | IN | IN | 11 | 11 | 11 | IN | IN | IN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | B | 371 | I | I | 12 | 12 | IN | IN | 13 | 13 | 31 | 31 | 31 | 11 | 667 | 40 | 518 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 71 | B | 471 | I | I | 12 | 12 | IN | IN | 13 | 13 | 31 | 31 | 31 | 11 | 1435 | 50 | 2254 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | |
| 71 | B | 671 | I | I | 12 | 12 | IN | IN | 13 | 13 | 21 | 21 | 21 | 11 | 1184 | 50 | 1825 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | |
| 71 | B | 671 | I | I | 12 | 12 | IN | IN | 13 | 13 | 21 | 21 | 21 | 11 | 910 | 50 | 1356 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | |
| 73 | B | 371 | I | I | 12 | 12 | IN | IN | 31 | 31 | 33 | 31 | 31 | 21 | 665 | 30 | 153 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| 73 | B | 571 | I | I | 12 | 12 | IN | IN | 31 | 31 | 33 | 31 | 31 | 21 | 512 | 30 | 623 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| 73 | B | 671 | I | I | 12 | 12 | IN | IN | 31 | 31 | 33 | 31 | 31 | 21 | 763 | 50 | 589 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| 75 | B | 400 | R | R | 12 | 12 | IN | IN | 12 | 12 | 31 | 31 | 31 | IN | 979 | 30 | 1658 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | |
| 75 | B | 500 | R | R | 12 | 12 | IN | IN | 12 | 12 | 31 | 31 | 31 | IN | 1648 | 50 | 1648 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | |
| 75 | B | 600 | R | R | 12 | 12 | IN | IN | 12 | 12 | 31 | 31 | 31 | IN | 1680 | 50 | 1680 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | |
| 77 | B | 400 | N | N | 12 | 12 | IN | IN | 12 | 12 | 21 | 21 | 21 | 22 | 1540 | 40 | 1926 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | |
| 77 | B | 500 | N | N | 12 | 12 | IN | IN | 12 | 12 | 21 | 21 | 21 | 22 | 2118 | 50 | 2118 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | |
| 77 | B | 600 | N | N | 12 | 12 | IN | IN | 12 | 12 | 21 | 21 | 21 | 22 | 1233 | 40 | 1554 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | |
| 79 | B | 400 | N | N | 12 | 12 | IN | IN | 12 | 12 | 21 | 21 | 21 | 23 | 2102 | 50 | 2102 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | |
| 79 | B | 500 | N | N | 12 | 12 | IN | IN | 12 | 12 | 21 | 21 | 21 | 23 | 1747 | 50 | 1747 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | |
| 79 | B | 600 | N | N | 12 | 12 | IN | IN | 12 | 12 | 21 | 21 | 21 | 23 | 1358 | 50 | 1358 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | |
| 81 | B | 340 | N | N | 11 | 11 | IN | IN | 21 | 21 | IN | IN | IN | IN | 1854 | 50 | 1418 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | |
| 81 | B | 400 | N | N | 11 | 11 | IN | IN | 21 | 21 | IN | IN | IN | IN | 1731 | 50 | 1331 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | |
| 81 | B | 500 | N | N | 11 | 11 | IN | IN | 21 | 21 | IN | IN | IN | IN | 1619 | 50 | 1251 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | |
| 81 | B | 600 | N | N | 11 | 11 | IN | IN | 21 | 21 | IN | IN | IN | IN | 1101 | 50 | 876 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | |

Figure 13. Master File Listing

INTERPRETING THE DATA BASE

Background

Early in the development of this system, it became apparent that a step should be provided to analyze the performance of each project in the master file prior to any consideration of rehabilitation alternatives. Bartell and Kampe⁵, who were working on development of a PMS for the California DOT, were concerned about the usefulness of a combined rating that does not identify specific distress problems. Their reasoning was based on the importance of knowing what is specifically wrong with a pavement in order to provide the proper fix. A major objective in the development of this system, however, was to achieve a predictive capability--something that could only be accomplished with a combined rating. Without overlooking the importance of specific types of distress, some type of combined rating was necessary to rank projects and provide a pavement rating vs. age relationship so that time to failure might be predicted.

This dichotomy of opinion was recognized and the interpreting phase was developed to accommodate both approaches. With this method, raw coded data indicating severity and extent of each distress type are maintained in the master file. These data are then translated into a combined rating in the interpreting phase, giving this system flexibility and the utility of an analytical tool. By utilizing parameters that are not an integral part of the interpreting program, distress weightings can be altered or adjusted after inspection of an initial run. This is an asset in calibrating weighting values for the types of distress rated, or studying any combination of distress types since weighting values can be zeroed for no influence.

An additional aspect of the interpreting phase is the potential for statistical analysis of performance trends. Since the interpreting program generates a file of performance data related to project segments, the results can be analyzed with SPSS⁶ or BMD⁷ software packages. Topics of particular interest might include correlation of pavement performance to specific measures of construction quality, geographic location, pavement type, rehabilitation type, or even a specific version of construction specifications. Information gained from these studies could lead to improvement of the currently used design formulas for surfacing depths or rehabilitation methods.

Interpreting Program

The interpreting program performs five basic functions:

1. Converts raw distress codings into numerical ratings.
2. Computes biennial mean ratings for each project and indicates the high and low ratings for each period.
3. Produces a performance curve for each project.
4. Plots the past ratings together with the performance curve for each project.
5. Generates a file with all results stored for further analysis and use.

Input for this program comes from two sources:

1. The master file previously described.
2. A direct access data set that contains the distress weighting matrix and other interpreting parameters. (See Figure 25.)

Control of the interpreting program is administered by editing the parameters in the small direct access data set.

The first function of the program is to translate the raw coded distress data and bump count for each record into a combined numerical rating. These ratings are calculated with the following equation:

$$\text{Combined Pavement Rating} = (100 - \Sigma D) \cdot (1.0 - 0.3 \left(\frac{\text{CPM}}{5000} \right)^2)$$

$$\text{Combined Pavement Rating} = (\text{distress rating}) \cdot (\text{ride rating})$$

Explaining the evolution of this formula is most simply done by addressing the distress rating and ride rating separately before describing the relationship between them.

As stated earlier, pavement surface distress is rated by judging the severity and extent of several types of distress. Each of these distress ratings has an associated weighting value. Since a pavement in perfect condition (no signs of distress) has a rating of 100, the sum of weighting values, ΣD , is subtracted from 100 to establish the overall distress rating (see Figure 15). Since we are most concerned with rehabilitation related to distress, the distress rating is the major part of the formula.

The ride rating portion of the formula actually plays a minor role. The combination of the ride rating with the distress rating has long represented much concern to us. However, the department fully recognizes that while distress bears significance to the highway engineer, pavement roughness, or rideability, relates to the user.

Early in PMS development it was determined that there is little or no correlation between the progression of distress and the deterioration of ride

| <u>CPM</u> | <u>Ride Rating</u> | <u>CPM</u> | <u>Ride Rating</u> |
|------------|--------------------|--------------|--------------------|
| <500 | 1.00 | 6450 | .50 |
| 2000 | .95 | 7050 | .40 |
| 2900 | .90 | 7650 | .30 |
| 4100 | .80 | 8150 | .20 |
| 5000 | .70 | 8650 | .10 |
| 5750 | .60 | <u>≥9100</u> | 0 |

Figure 16. Ride Rating vs. Roughness (CPM)

WSDOT has been evaluating pavement roughness with ride meters since approximately 1970. Prior to, during, and after each survey the meter is run through a "standard" section to ensure its repeatability and calibration. There have been changes in meters and vehicles over this time. As each change occurred, much effort was dedicated to producing accurate equations for relating the old meter setup to the new. These equations are utilized in the interpreting program. All counts are related to one common count base for use in the rating formula.

The second function of the program is to compute mean, high, and low ratings for each occasion the pavement is rated. To accomplish this, the program determines the length for each section rated based on the beginning and ending limits of the project, the ending milepost read on each record, and the ending milepost read on the preceding record. Each converted rating is then weighted by this length to compute the mean project rating for the year. As the averaging process is applied, the program compares each rating with previous ratings to determine the high and low for the year.

The third function of the program is to produce a performance curve which best represents the pavement's anticipated performance. This curve can be used to predict future performance for that section.

Figure 17 illustrates the general shape of a performance curve. From this illustration it is seen that a pavement deteriorates with age, the rate usually increasing each year, until it reaches a state of slower deterioration. This decelerated rate of deterioration can be attributed to application of temporary fixes to hold the pavement together until a major remedy can be applied. These temporary fixes tend to cause short duration, random fluctuations in the pavement rating--probably best represented by a curve which passes through the mean value in this phase. The performance model developed for use in the interpreting program presently ignores the maintenance or temporary fix influence because it

is assumed the Department will initiate action prior to reaching the lower portion of the curves. A contemplated improvement in the future is to enhance the performance model by incorporating better representation in the lower range.

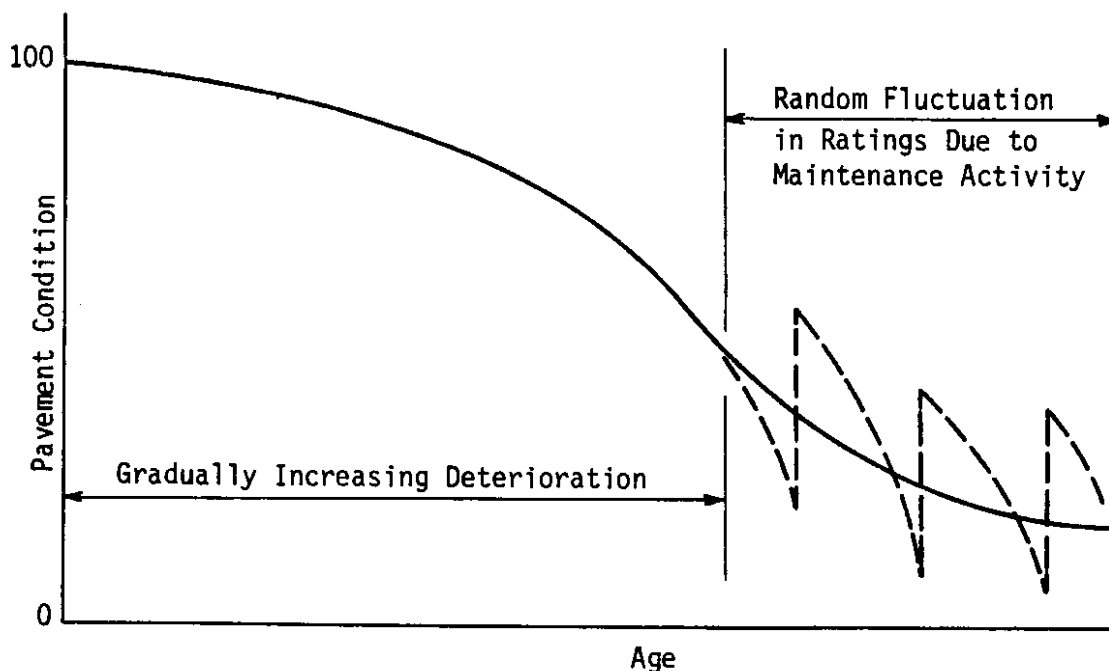


Figure 17. Typical Performance Curve

Figure 18 is an illustration of this model relating pavement rating to age. The general form of the performance equation adapted is:

$$R = C - mA^B$$

where R and A represent rating and age respectively, C is the model constant for maximum rating (~ 100), m is the slope coefficient, and B is a constant that controls the degree of curvature.

Figure 19 is an example of different shapes the curve might assume. Curves 1 and 2 are linear and demonstrate the influence of the slope, m. Curves 2, 3, and 4 demonstrate the control that B exerts on the degree of curvature. Note that exponents greater than 1 indicate convex curvature, while exponents less than 1 indicate concave curvature.

In fitting the best curve to the pavement ratings, the program substitutes a number of different exponents (B) to transform the independent variable, age. The best fit is determined by the highest R^2 value (coefficient of determination) using the sum of least squares method. Statistics associated with the curve equation are the R^2 value and the standard error of estimate.

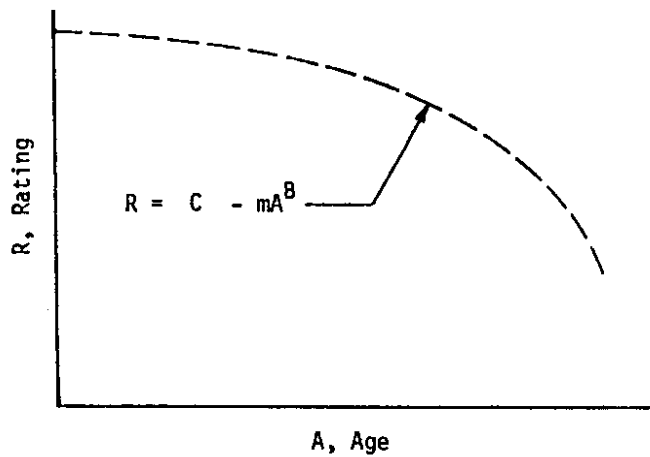


Figure 18. Performance Curve Model

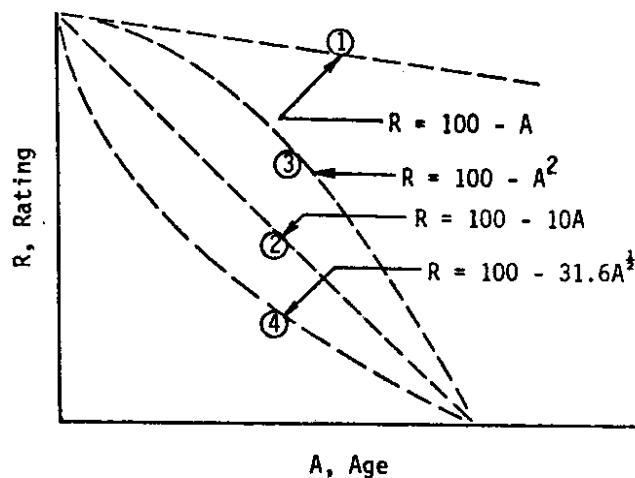


Figure 19. Example of Curve Model Shapes

Regression analysis is the initial approach employed in generating a performance equation. However, regression analysis may not always produce acceptable equations. The project being analyzed may have been in existence for only a few years--thus providing too few rating values for the application of regression analysis. Another problem encountered is the random fluctuation of ratings for some projects. Inconsistent ratings cause a bad fit (low R^2) when using regression analysis.

These problems are addressed in the interpreting program by utilizing three different methods of producing performance curves:

1. When the project being considered does not have at least three ratings, a typical equation for the specific pavement type, surfacing depth, and geographical area is assigned. This is justifiable because the pavement would be relatively new and should not need rehabilitation for some time. The equation generated is used primarily in network analysis. Should the project have only two ratings, with the second rating falling beyond that allowed for in the typical equation, the performance equation is modified so as to reflect that rating.
2. Regression analysis is applied to all projects that have at least three ratings. This is the primary method of developing performance equations.
3. When regression analysis does not produce a reasonably good fit, R^2 value less than minimum acceptable, a "typical" curve is fitted through the first and last values.

These three methods of developing performance equations are incorporated in the interpreting program as an algorithm for automation. They may not always produce acceptable equations. For this reason, all projects are reviewed and the resulting interpreted data file is edited to reflect engineering judgment.

The fourth function of the program is to tabulate and plot the annual mean, high, and low ratings with the mathematically fitted performance curve. Figures 20, 21, and 22 are examples of the listing produced. The top line on each describes the project with the same format as that used in the Master Index listing and the Master File listing. Below the description is a tabulation of performance and traffic data. The lower half of the listing is dedicated to the plot. By inspecting this plot, it is possible to see how well the curve fits the rating, how long the pavement might last until rehabilitation is required, and how much variation there is in the ratings by noting the high and low values for each year. Note that each of these three projects demonstrates different performance.

The last function of the program is directed at generating an output file that includes the results of all processing. This file is used for several purposes, the principal ones being:

1. Input to the optimizing program.
2. Correlation analysis with various factors such as pavement type, surfacing depth, geographical area, climate, etc.
3. Statistical analysis using SPSS⁶, BMD⁷, or other available statistical programs.

Figure 23 is an example of items included in this file with the general layout scheme. Figure 24 is an example of a summary listing generated from this file.

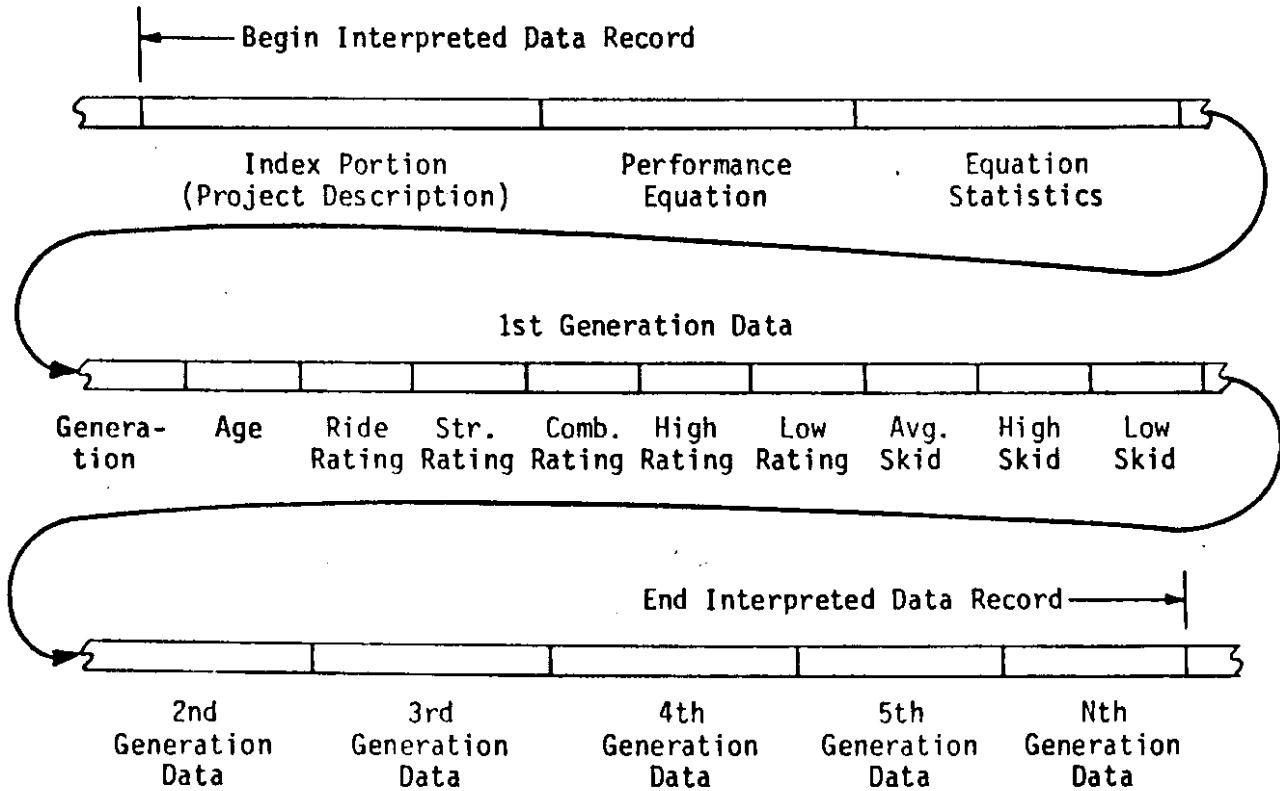


Figure 23. Interpreted Data File Layout

When analyzing specific items with the statistical software packages such as SPSS⁶ or BMD⁷, composition of a small FORTRAN program is necessary for reformatting the data into a file which conforms to their particular specifications.

With each distress category rated by severity and extent, it became obvious while writing the interpreting program that the corresponding weighting values could be stored in a two-dimensional array, or matrix. As each distress code is read, the two digits in each raw coding point to the address within the weighting matrix. This matrix contains the weighting value for the extent and severity of each specific distress type. Consider the category of longitudinal cracking which is rated with three levels of severity: cracks less than 1/4"; cracks greater than 1/4"; and spalled cracks. It is also rated with three areas of extent: 0-99 lineal feet per station; 100-199 lineal feet per station;

| 0 | SK | FSDMP | LENG | COMPT | TY | SE | IK | YR | RS | ADT | GRW | SU | CM | TI | ECONS | EVAP | EPOM | RSO | LF 60 | LF 40 | |
|---|-----|-------|------|-------|-----|-----|-----|-----|-----|-------|-----|-----|-----|-----|--------|----------|------|---------|-------|-------|-----|
| * | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** |
| 3 | 3 | 0 | 23 | 09361 | 0 | 40 | 70 | 74 | 10 | 9300 | 58 | 5 | 2 | 6.7 | 100.00 | -0.02808 | 3.00 | 0.0 | 11.25 | 12.88 | |
| 3 | 3 | 23 | 143 | 01507 | 20 | 40 | 8 | 80 | 11 | 10000 | 58 | 5 | 2 | 6.7 | 100.00 | -0.27777 | 3.00 | 0.0 | 5.24 | 6.00 | |
| 3 | 3 | 72 | 320 | 01437 | 20 | 40 | 15 | 80 | 11 | 4400 | 53 | 5 | 2 | 6.4 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | |
| 3 | 3 | 143 | 72 | 01907 | 20 | 40 | 12 | 80 | 11 | 9400 | 54 | 5 | 2 | 6.7 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | |
| 3 | 3 | 320 | 425 | 01437 | 0 | 40 | 35 | 80 | 10 | 4200 | 54 | 5 | 2 | 6.4 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | |
| 3 | 3 | 425 | 488 | 01437 | 20 | 40 | 15 | 80 | 11 | 4200 | 56 | 5 | 2 | 6.4 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | |
| 3 | 3 | 488 | 553 | 01800 | 0 | 40 | 35 | 80 | 10 | 4200 | 56 | 5 | 2 | 6.4 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | |
| 3 | 3 | 553 | 631 | 01800 | 20 | 40 | 15 | 80 | 11 | 4100 | 56 | 5 | 2 | 6.4 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | |
| 3 | 3 | 631 | 959 | 02010 | 20 | 40 | 8 | 80 | 11 | 3100 | 56 | 5 | 2 | 6.2 | 100.00 | -0.27777 | 3.00 | 0.0 | 5.24 | 6.00 | |
| 3 | 3 | 959 | 1717 | 03463 | 20 | 40 | 15 | 73 | 11 | 2500 | 56 | 5 | 2 | 6.1 | 99.26 | -0.00193 | 4.00 | 0.91097 | 11.94 | 13.23 | |
| 3 | 3 | 1717 | 2067 | 00366 | 20 | 40 | 15 | 76 | 11 | 3400 | 66 | 5 | 2 | 6.3 | 100.74 | -4.28382 | 1.00 | 0.94937 | 9.51 | 14.18 | |
| 3 | 3 | 2067 | 2228 | 09497 | 20 | 40 | 15 | 73 | 11 | 3800 | 68 | 5 | 2 | 6.3 | 100.11 | -1.13594 | 1.25 | 0.92594 | 17.31 | 23.93 | |
| 3 | 3 | 2228 | 2375 | 09022 | 20 | 40 | 10 | 71 | 11 | 6100 | 39 | 5 | 2 | 6.5 | 100.00 | -1.04630 | 1.75 | 0.0 | 8.02 | 10.11 | |
| 3 | 3 | 2375 | 2957 | 01540 | 20 | 40 | 12 | 80 | 11 | 7000 | 52 | 5 | 2 | 6.6 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | |
| 3 | 3 | 2957 | 3180 | 00135 | 20 | 40 | 15 | 76 | 11 | 8500 | 53 | 5 | 2 | 6.7 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | |
| 3 | 3 | 3180 | 3187 | 00665 | 20 | 40 | 10 | 77 | 11 | 8500 | 53 | 5 | 2 | 6.7 | 100.01 | -1.45205 | 1.50 | 0.99990 | 9.12 | 11.95 | |
| 3 | 3 | 3187 | 3223 | 00665 | 20 | 40 | 10 | 77 | 11 | 39000 | 54 | 5 | 2 | 7.3 | 100.13 | -0.15453 | 4.00 | 0.99996 | 4.01 | 4.44 | |
| 3 | 3 | 3223 | 3346 | 00572 | 20 | 40 | 8 | 77 | 11 | 39200 | 56 | 5 | 2 | 7.3 | 100.00 | -0.27777 | 3.00 | 0.0 | 5.24 | 6.00 | |
| 3 | 3 | 3346 | 3495 | 09203 | 0 | 40 | 60 | 73 | 10 | 14100 | 56 | 5 | 6 | 7.3 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | |
| 3 | 3 | 3495 | 3752 | 09476 | 0 | 40 | 60 | 75 | 10 | 14500 | 56 | 4 | 4 | 7.1 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | |
| 3 | 3 | 3752 | 3786 | 09476 | 20 | 40 | 15 | 75 | 11 | 22000 | 56 | 4 | 2 | 7.0 | 99.08 | -0.02649 | 4.00 | 0.99595 | 6.20 | 6.87 | |
| 3 | 3 | 3786 | 3774 | 09476 | 20 | 40 | 15 | 75 | 11 | 22000 | 56 | 4 | 2 | 7.0 | 100.00 | -0.02753 | 4.00 | 0.97896 | 6.17 | 6.63 | |
| 3 | 3 | 3774 | 4022 | 05328 | 0 | 40 | 58 | 68 | 10 | 21100 | 60 | 4 | 2 | 7.0 | 102.08 | -0.00131 | 4.00 | 0.82123 | 13.38 | 14.75 | |
| 3 | 3 | 4022 | 4022 | 05328 | 0 | 40 | 58 | 68 | 10 | 20600 | 60 | 4 | 2 | 7.0 | 100.88 | -0.00138 | 4.00 | 0.95707 | 13.12 | 14.50 | |
| 3 | 3 | 4022 | 4324 | 09269 | 0 | 40 | 35 | 74 | 10 | 16400 | 65 | 4 | 2 | 6.9 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | |
| 3 | 3 | 4324 | 4324 | 09269 | 0 | 40 | 35 | 74 | 10 | 14900 | 65 | 4 | 2 | 6.9 | 99.18 | -0.05541 | 3.00 | 0.94035 | 8.91 | 10.22 | |
| 3 | 3 | 4324 | 4475 | 00724 | 0 | 40 | 60 | 72 | 10 | 9300 | 69 | 4 | 2 | 6.6 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | |
| 3 | 3 | 4475 | 4475 | 00724 | 0 | 40 | 60 | 72 | 10 | 9300 | 69 | 4 | 2 | 6.6 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | |

Figure 24. Interpreted Data Listing

Figure 23 is an example of items included in this file with the general layout scheme. Figure 24 is an example of a summary listing generated from this file.

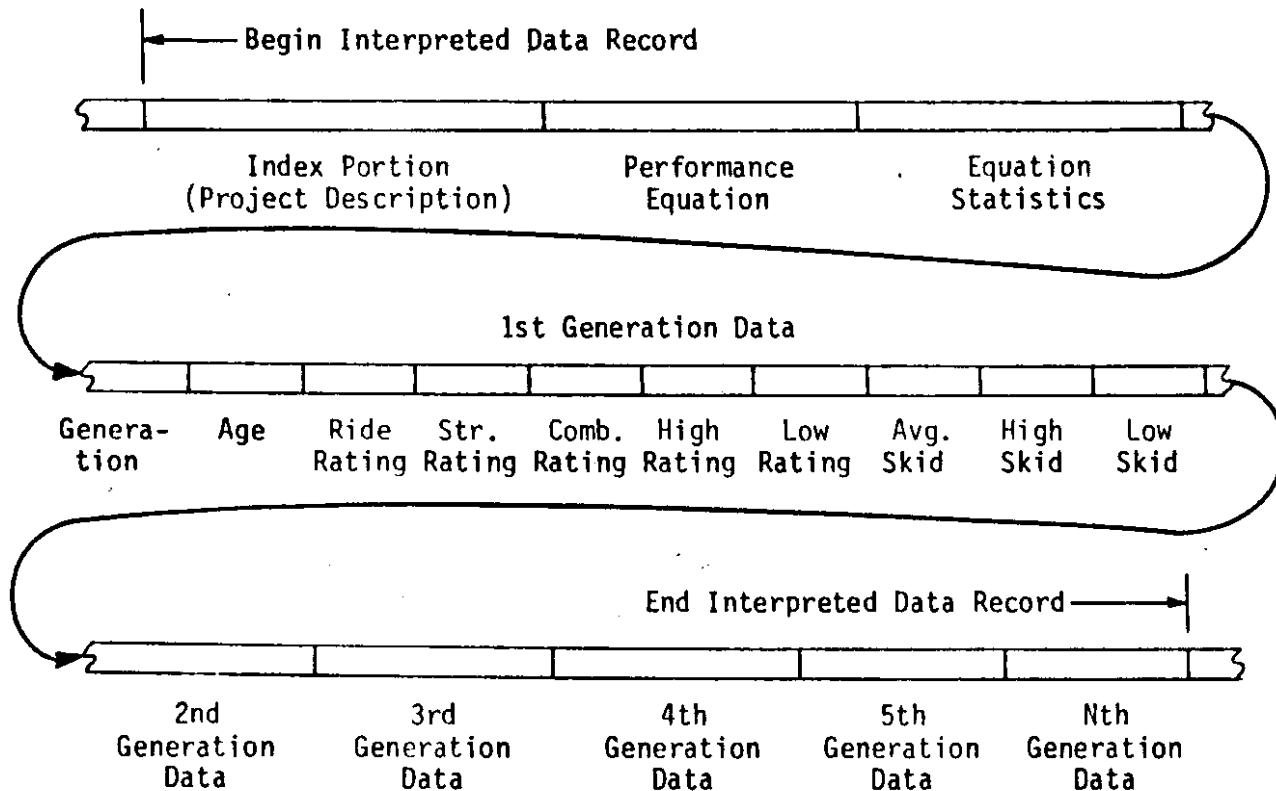


Figure 23. Interpreted Data File Layout

When analyzing specific items with the statistical software packages such as SPSS⁶ or BMD⁷, composition of a small FORTRAN program is necessary for reformatting the data into a file which conforms to their particular specifications.

With each distress category rated by severity and extent, it became obvious while writing the interpreting program that the corresponding weighting values could be stored in a two-dimensional array, or matrix. As each distress code is read, the two digits in each raw coding point to the address within the weighting matrix. This matrix contains the weighting value for the extent and severity of each specific distress type. Consider the category of longitudinal cracking which is rated with three levels of severity: cracks less than 1/4"; cracks greater than 1/4"; and spalled cracks. It is also rated with three areas of extent: 0-99 lineal feet per station; 100-199 lineal feet per station;

| 0 | SK | FSPMP | FSPMP | LENG | CONT | TY | SE | TK | YR | RS | ADT | GRW | SII | CM | TI | ECCNS | EVAP | EPOM | RSO | LF | 60 | LF | 40 |
|---|----|-------|-------|------|-------|----|----|----|----|----|-------|-----|-----|----|-----|--------|----------|------|---------|-------|-------|----|----|
| 3 | 3 | 23 | 0 | 23 | 09361 | 0 | 40 | 70 | 74 | 10 | 9300 | 58 | 5 | 2 | 6.7 | 100.00 | -0.02808 | 3.00 | 0.0 | 11.25 | 12.88 | | |
| 3 | 3 | 23 | 143 | 120 | 01507 | 20 | 40 | 8 | 80 | 11 | 10000 | 58 | 5 | 2 | 6.7 | 100.00 | -0.27777 | 3.00 | 0.0 | 5.24 | 6.00 | | |
| 3 | 3 | 72 | 320 | 248 | 01437 | 20 | 40 | 15 | 80 | 11 | 4400 | 53 | 5 | 2 | 6.4 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | | |
| 3 | 3 | 143 | 72 | 200 | 01907 | 20 | 40 | 12 | 80 | 11 | 9400 | 54 | 5 | 2 | 6.7 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | | |
| 3 | 3 | 320 | 425 | 105 | 01437 | 0 | 40 | 35 | 80 | 10 | 4200 | 54 | 5 | 2 | 6.4 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | | |
| 3 | 3 | 425 | 488 | 63 | 01437 | 20 | 40 | 15 | 80 | 11 | 4200 | 56 | 5 | 2 | 6.4 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | | |
| 3 | 3 | 488 | 553 | 54 | 01800 | 0 | 40 | 35 | 80 | 10 | 4200 | 56 | 5 | 2 | 6.4 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | | |
| 3 | 3 | 553 | 631 | 78 | 01800 | 20 | 40 | 15 | 80 | 11 | 4100 | 56 | 5 | 2 | 6.4 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | | |
| 3 | 3 | 631 | 959 | 326 | 02010 | 20 | 40 | 8 | 81 | 11 | 3100 | 56 | 5 | 2 | 6.2 | 100.00 | -0.27777 | 3.00 | 0.0 | 5.24 | 6.00 | | |
| 3 | 3 | 959 | 1737 | 778 | 03463 | 20 | 40 | 15 | 73 | 11 | 2500 | 56 | 5 | 2 | 6.1 | 99.26 | -0.00193 | 4.00 | 0.91097 | 11.94 | 13.23 | | |
| 3 | 3 | 1737 | 2067 | 330 | 00366 | 20 | 40 | 15 | 76 | 11 | 3400 | 66 | 5 | 2 | 6.3 | 100.74 | -4.28382 | 1.00 | 0.98937 | 9.51 | 14.18 | | |
| 3 | 3 | 2067 | 2228 | 141 | 09497 | 20 | 40 | 15 | 73 | 11 | 3800 | 68 | 5 | 2 | 6.3 | 100.11 | -1.13594 | 1.25 | 0.92594 | 17.31 | 23.93 | | |
| 3 | 3 | 2228 | 2375 | 147 | 09022 | 20 | 40 | 10 | 71 | 11 | 6100 | 39 | 5 | 2 | 6.5 | 100.00 | -1.04630 | 1.75 | 0.0 | 8.02 | 10.11 | | |
| 3 | 3 | 2375 | 2957 | 582 | 01540 | 20 | 40 | 12 | 80 | 11 | 7000 | 52 | 5 | 2 | 6.6 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | | |
| 3 | 3 | 2957 | 3160 | 223 | 00135 | 20 | 40 | 15 | 76 | 11 | 8500 | 53 | 5 | 2 | 6.7 | 100.00 | -0.02743 | 3.50 | 0.0 | 8.02 | 9.00 | | |
| 3 | 3 | 3160 | 3187 | 7 | 00665 | 20 | 40 | 10 | 77 | 11 | 8500 | 53 | 5 | 2 | 6.7 | 100.01 | -1.45205 | 1.50 | 0.99990 | 9.12 | 11.95 | | |
| 3 | 3 | 3187 | 3223 | 36 | 00665 | 20 | 40 | 10 | 77 | 11 | 39000 | 54 | 5 | 2 | 7.1 | 100.13 | -0.15453 | 4.00 | 0.99996 | 4.01 | 4.44 | | |
| 3 | 3 | 3223 | 3348 | 175 | 00572 | 20 | 40 | 8 | 77 | 11 | 39200 | 56 | 5 | 2 | 7.3 | 100.00 | -0.27777 | 3.00 | 0.0 | 5.24 | 6.00 | | |
| 3 | 3 | 3348 | 3495 | 77 | 04203 | 0 | 40 | 60 | 73 | 10 | 14100 | 56 | 5 | 6 | 7.3 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | | |
| 3 | 3 | 3495 | 3752 | 74 | 09476 | 0 | 40 | 60 | 75 | 10 | 14500 | 56 | 4 | 4 | 7.1 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | | |
| 3 | 3 | 3752 | 3786 | 34 | 09476 | 20 | 40 | 15 | 75 | 11 | 22000 | 56 | 4 | 2 | 7.0 | 99.08 | -0.02649 | 4.00 | 0.99595 | 6.20 | 6.87 | | |
| 3 | 3 | 3786 | 3774 | 22 | 09476 | 20 | 40 | 15 | 75 | 11 | 22000 | 56 | 4 | 2 | 7.0 | 100.00 | -0.02753 | 4.00 | 0.97896 | 6.17 | 6.83 | | |
| 3 | 3 | 3774 | 4022 | 242 | 05328 | 0 | 40 | 58 | 68 | 10 | 21100 | 60 | 4 | 2 | 7.0 | 102.06 | -0.00131 | 4.00 | 0.82123 | 13.38 | 14.75 | | |
| 3 | 3 | 4022 | 4022 | 256 | 05328 | 0 | 40 | 58 | 68 | 10 | 20600 | 60 | 4 | 2 | 7.0 | 100.88 | -0.00138 | 4.00 | 0.95707 | 13.12 | 14.50 | | |
| 3 | 3 | 4022 | 4324 | 301 | 09269 | 0 | 40 | 35 | 74 | 10 | 16400 | 65 | 4 | 2 | 6.9 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | | |
| 3 | 3 | 4324 | 4324 | 301 | 09269 | 0 | 40 | 35 | 74 | 10 | 16900 | 65 | 4 | 2 | 6.9 | 99.18 | -0.05541 | 3.00 | 0.94035 | 8.91 | 10.22 | | |
| 3 | 3 | 4324 | 4475 | 151 | 00724 | 0 | 40 | 80 | 78 | 10 | 9300 | 69 | 4 | 2 | 6.6 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | | |
| 3 | 3 | 4475 | 4475 | 151 | 00724 | 0 | 40 | 80 | 78 | 10 | 9300 | 69 | 4 | 2 | 6.6 | 100.00 | -0.00289 | 4.00 | 0.0 | 10.85 | 12.00 | | |

Figure 24. Interpreted Data Listing

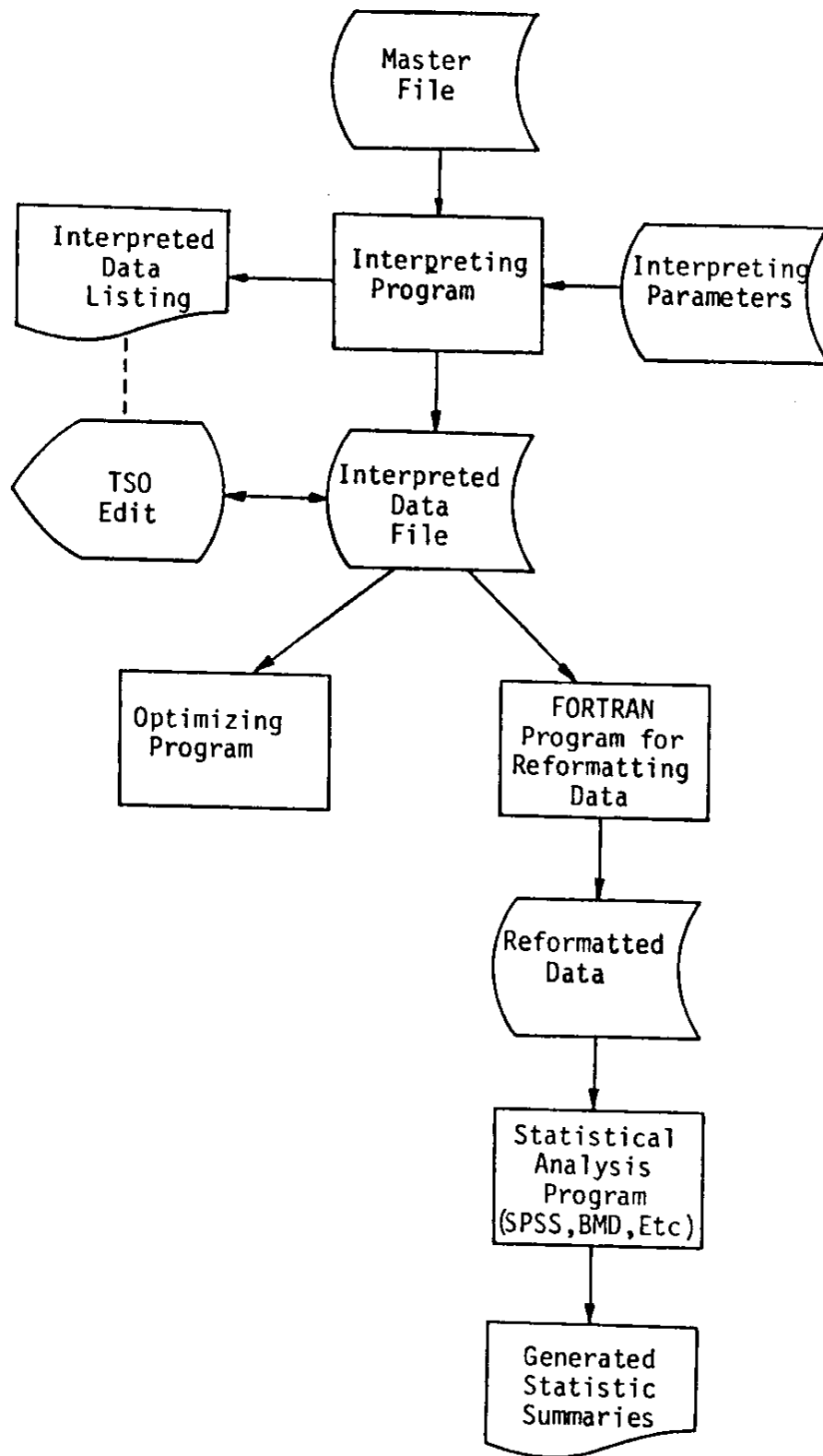


Figure 26. Conceptual Flow Chart of Interpreting Phase

A good example of cycling is shown in Figure 27. This occurs when there is undocumented maintenance or a rehabilitation project has been overlooked and subsequently was not coded.

When the performance of a specific portion of the section is substantially different from the rest, the project may be divided into two or more projects with new project limits.

As was mentioned in the chapter describing the data base, there is a problem with relating some pavement ratings to smaller projects because of overlap. The ratings indicated in the Master File may not be related to that section at all. To allow for this during performance analysis, sections which are extremely short are combined with adjacent sections demonstrating similar performance.

After the first review, the Master File is edited to reflect changes in mileposting for specific sections and then reanalyzed with the interpreting program. This process is reiterated until satisfaction is obtained that all performance sections and the curves representing them are as good as they can be. Some curves will obviously be synthetic since some of the pavements are structurally inadequate. Ultimately, performance curves for the entire state highway system are stored in the Interpreted Data File. It is important to note that although the Master File is originally based on past surfacing contract limits, these limits may eventually be adjusted to represent the best divisions of pavement performance. However, these changes represent a very small percentage of the system.

Determination of Distress Weightings

Many man-months were invested both in identifying the significant categories of distress and how each should be weighted. Two considerations were emphasized in identifying the significant categories of distress:

1. The consistency of ratings with time.
2. The relationship of each to rehabilitation criteria.

With the master file assembled to track raw coded ratings (purely extent and severity--no weighted or combined ratings), it was apparent after studying many sections which categories best fulfilled these considerations. These were transverse cracking, longitudinal cracking, alligator cracking, and patching. All other categories of distress are presently unweighted and employed as supplemental information only. They will, however, continue to be rated and may prove beneficial in correlation and multiple regression analysis at a later time.

D SR SRMP END SRMP CS SEQ CSMP BEG CSMP END CSMP PROJ FNC SIDE R 0 2 24 8 8 07593 0-64 20 20 4 42
 6 2 2281C 23016 2203 220 721 527 206 R-1 R 0 2 24 8 8 07593 0-64 20 20 4 42

| PERFORMANCE HISTORY | | APPROXIMATE TRAFFIC DATA | | PERFORMANCE EQUATION | | | |
|---------------------|------|--------------------------|------|----------------------|------|--------------|----------|
| YEAR | 69 | 71 | 73 | 75 | 77 | EQUA CNST = | 100.00 |
| AGE | 5 | 7 | 9 | 11 | 13 | EQUA COEFF = | -2.61966 |
| RIDE | 1.00 | 0.98 | 0.92 | 1.00 | 1.00 | EQUA PCMR = | 1.00 |
| STRUCR | 62.4 | 60.2 | 3.3 | 99.8 | 81.9 | R SQUARE = | 0.0 |
| COMBD | 62.4 | 51.7 | 3.3 | 99.3 | 81.7 | STD ERROR = | 0.0 |
| HIGH | 95.0 | 92.4 | 39.9 | 99.9 | 99.8 | TIME TO 60 = | 15.27 |
| LOW | 60.0 | 47.1 | -5.0 | 53.9 | 69.7 | TIME TO 50 = | 19.09 |
| F-HIGH | 0 | 0 | 0 | 0 | 0 | TIME TO 40 = | 22.90 |
| F-LOW | 0 | 0 | 0 | 0 | 0 | TIME TO 30 = | 26.72 |
| AVG | 0 | 0 | 0 | 0 | 0 | TIME TO 20 = | 30.54 |
| FRICITION | 0 | 0 | 0 | 0 | 0 | | |

79 ADT 2400
 GROWTH RATE 5.4%
 SINGLE UNITS 7.2%
 COMBINATIONS 4.4%
 TRAFFIC INDEX 6.4%
 K = 13% D = 58%
 2 AXLE TRUCKS = 4.7%
 3 AXLE TRUCKS = 3.1%
 4 AXLE TRUCKS = 0.5%
 5 AXLE TRUCKS = 2.7%

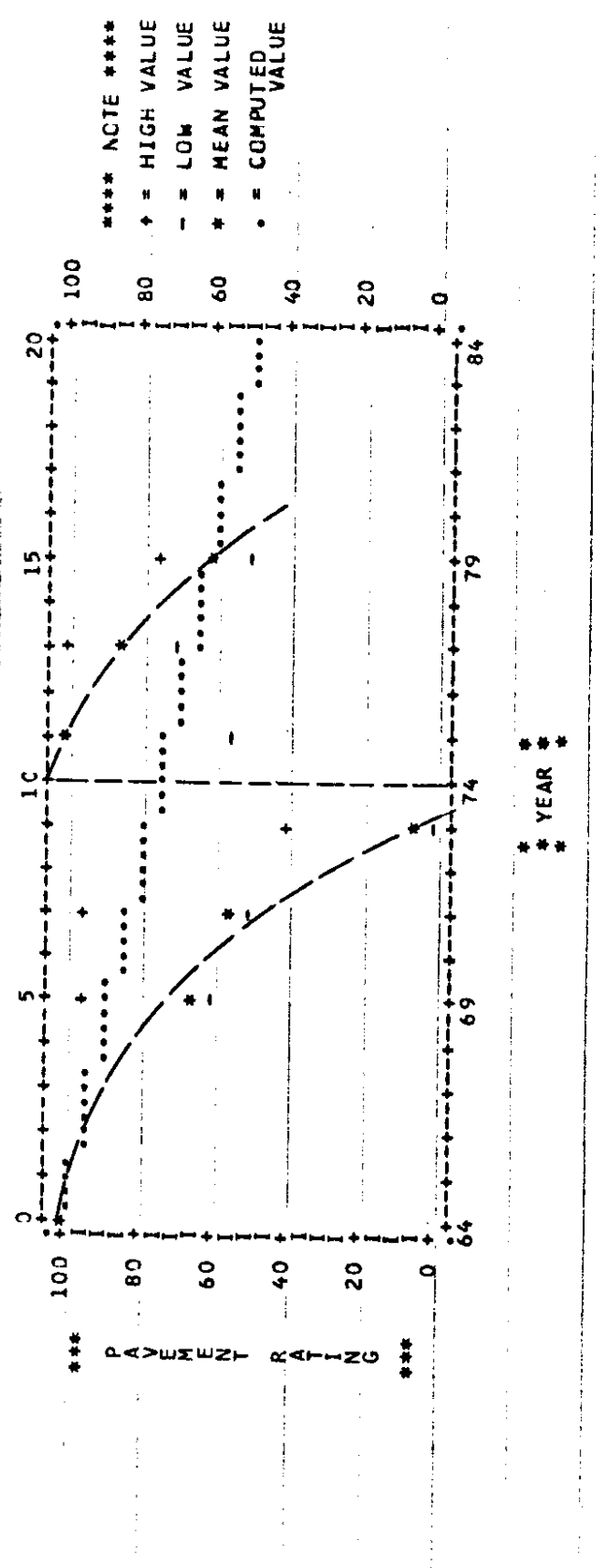


Figure 27. Example of Performance Cycling

Development of the proper weighting values was much more complicated, although simply described here. Essentially, expert personnel working in pavement design and rehabilitation provided initial weightings related to:

- the genesis of distress development
- maximum values required to trigger rehabilitation.

However, this only represented a starting point. A large number of pavement sections with consistent ratings (gradually deteriorating with time--no random fluctuations) and meeting several other criteria such as minimum length = 2 miles, minimum age = 8 years, etc., were selected to test the initial weighting values with the interpreting program. Several modifications were made on the original weighting values through successive program runs to obtain the highest R^2 (coefficient of determination) and lowest average standard error of estimate. In each iterative run of the program much consideration was given to the interplay of distress states. For instance, when a pavement section has been rated with the greatest extent and severity of longitudinal cracking with little or no alligator cracking one year, the following year the longitudinal cracking may have evolved into alligator cracking, and thus the longitudinal cracking actually is shown to decrease while alligator cracking increases. After many such evaluations, the present weighting values were selected.

Figures 28 and 30 represent the weightings used by WSDOT for many years in the operation of the Priority Programming System. Figures 29 and 31 represent the distress weightings presently being used. It is interesting to note that several categories were zeroed because of random ratings. It is felt that improvement can still be made in these weighting values. Rutting and pavement wear, for instance, were "eyeballed" prior to the 1975 survey. Since that time this rating has been physically measured with a straightedge and drop pin. Eventually, enough information will be acquired to associate weighting values commensurate with varying degrees of rutting and pavement wear.

A prime consideration in this system is to reevaluate the weighting values after each survey and, based on the entire rating history, to verify, improve, and fine tune the weighting values currently in use. This aspect is made possible by maintaining historical pavement ratings in their raw coding form in the master file and providing the weighting association later in the interpreting program.

**PAVEMENT CONDITION RATING
BITUMINOUS PAVEMENTS
DEFECT DEDUCTIONS**

Priority Programming

Negative Values are Assigned
to the Failures by Degree

| | | | | | | | |
|--|----------------------------------|---|------------------------------------|----------------|----------------|--------------------|--------------------|
| RUTTING PAVEMENT WEAR | Average Depth in Inches | (1) 1/4-1/2" (2) 1/2-3/4" (3) Over 3/4" | Throughout Rated Section | | | | Negative Values |
| | | | None | 1/4-1/2 | 1/2-3/4 | 3/4+ | |
| | | | 5 | 12 | 20 | | |
| CORRUGATIONS WAVES SAGS HUMPS | Percent of Roadway | (1) 1-25 (2) 26-75 (3) 76+ | Change Per 10 Feet in Inches | | | | Negative Values |
| | | | None | 1/4-2 | 2-4 | 4+ | |
| | | | 0 | 2 | 3 | | |
| | | | 0 | 3 | 4 | | |
| | | | 0 | 4 | 5 | | |
| ALLIGATOR CRACKING | | (1) Hairline (2) Spalling (3) Spalling & Pumping | Percent of Wheel Track Per Station | | | | Negative Values |
| | | | None | 1-24 | 25-49 | 50-74 | |
| | | | 2 | 5 | 10 | 15 | |
| | | | 5 | 10 | 15 | 20 | |
| | | | 10 | 15 | 20 | 25 | |
| RAVELING OR FLUSHING | | (1) Slight (2) Moderate (3) Severe | Local- ized | Wheel Paths | Entire Lane | Negative Values | |
| | | | | | | | |
| | | | 0 | 0 | 0 | | |
| | | | 5 | 10 | 15 | | |
| | | | 10 | 15 | 20 | | |
| LONGITUDINAL CRACKING | Lineal Feet Per Station | (1) 1-99 (2) 100-199 (3) 200+ | Average Width in Inches | | | | Negative Values |
| | | | None | 1/8-1/4 | 1/4+ | Spalled | |
| | | | 10 | 15 | 20 | | |
| | | | 15 | 20 | 25 | | |
| | | | 20 | 25 | 30 | | |
| TRANSVERSE CRACKING | Number Per Station | (1) 1-4 (2) 5-9 (3) 10+ | Average Width in Inches | | | | Negative Values |
| | | | None | 1/8-1/4 | 1/4+ | Spalled | |
| | | | 8 | 10 | 15 | | |
| | | | 9 | 12 | 17 | | |
| | | | 10 | 15 | 20 | | |
| PATCHING | Percent Area Per Station | (1) 1-5 (2) 6-25 (3) 26+ | Average Depth in Inches | | | | Negative Values |
| | | | None | 0-1/2 | 1/2-1 | 1+ | |
| | | | 2 | 5 | 7 | | |
| | | | 5 | 7 | 10 | | |
| | | | 7 | 10 | 15 | | |

Figure 28. Table of Weighting Values for
Bituminous Pavements Used
Prior to PMS Development

**PAVEMENT CONDITION RATING
BITUMINOUS PAVEMENTS
DEFECT DEDUCTIONS**

PMS

Negative Values are Assigned
to the Failures by Degree

| | | | | | | | |
|--|----------------------------------|---|------------------------------------|----------------|----------------|--------------------|--------------------|
| RUTTING PAVEMENT WEAR | Average Depth in Inches | (1) 1/4-1/2" (2) 1/2-3/4" (3) Over 3/4" | Throughout Rated Section | | | | Negative Values |
| | | | None | 1/4-1/2 | 1/2-3/4 | 3/4+ | |
| | | | 0 | 0 | 0 | | |
| CORRUGATIONS WAVES SAGS HUMPS | Percent of Roadway | (1) 1-25 (2) 26-75 (3) 76+ | Change Per 10 Feet in Inches | | | | Negative Values |
| | | | None | 1/4-2 | 2-4 | 4+ | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| ALLIGATOR CRACKING | | (1) Hairline (2) Spalling (3) Spalling & Pumping | Percent of Wheel Track Per Station | | | | Negative Values |
| | | | None | 1-24 | 25-49 | 50-74 | |
| | | | 20 | 25 | 30 | 35 | |
| | | | 35 | 40 | 45 | 50 | |
| | | | 50 | 55 | 60 | 65 | |
| RAVELING OR FLUSHING | | (1) Slight (2) Moderate (3) Severe | Local- ized | Wheel Paths | Entire Lane | Negative Values | |
| | | | | | | | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| LONGITUDINAL CRACKING | Lineal Feet Per Station | (1) 1-99 (2) 100-199 (3) 200+ | Average Width in Inches | | | | Negative Values |
| | | | None | 1/8-1/4 | 1/4+ | Spalled | |
| | | | 5 | 15 | 30 | | |
| | | | 15 | 30 | 45 | | |
| | | | 30 | 45 | 60 | | |
| TRANSVERSE CRACKING | Number Per Station | (1) 1-4 (2) 5-9 (3) 10+ | Average Width in Inches | | | | Negative Values |
| | | | None | 1/8-1/4 | 1/4+ | Spalled | |
| | | | 5 | 10 | 15 | | |
| | | | 10 | 15 | 20 | | |
| | | | 15 | 20 | 25 | | |
| PATCHING | Percent Area Per Station | (1) 1-5 (2) 6-25 (3) 26+ | Average Depth in Inches | | | | Negative Values |
| | | | None | 0-1/2 | 1/2-1 | 1+ | |
| | | | 10 | 15 | 20 | | |
| | | | 15 | 20 | 25 | | |
| | | | 20 | 25 | 30 | | |

Figure 29. Table of Weighting Values for
Bituminous Pavements Developed
for PMS

**PAVEMENT CONDITION RATING
CEMENT CONCRETE PAVEMENT
DEFECT DEDUCTIONS**

Priority Programming

Negative Values are Assigned
to the Failures by Degree

| | | | | | | | |
|--|---|---|---------------------------|---------|---------|------|--------------------|
| CRACKING AVERAGING 1/8+ | Units Per Panel Length | (1) 1-2 (2) 3-4 (3) 4+ | Percent of Panels | | | | Negative Values |
| | | | None | 1-25 | 26-50 | 51+ | |
| | | | 5 | 10 | 20 | | |
| | | | 10 | 20 | 35 | | |
| | | | 15 | 30 | 50 | | |
| RAVELING DISINTEGRATION POPOUTS SCALING | | (1) Slight (2) Moderate (3) Severe | Percent of Area | | | | Negative Values |
| | | | None | 1-25 | 26-75 | 76+ | |
| | | | 5 | 10 | 20 | | |
| | | | 10 | 20 | 35 | | |
| | | | 15 | 30 | 50 | | |
| SPALLING AT JOINTS AND CRACKS | Average Width in Inches | (1) 1/4-1 (2) 1-3 (3) 3+ | Percent of Joints | | | | Negative Values |
| | | | None | 1-15 | 16-50 | 51+ | |
| | | | 5 | 10 | 20 | | |
| | | | 10 | 20 | 35 | | |
| | | | 15 | 30 | 50 | | |
| PUMPING BLOWING | Percent of Panel Length | (1) 1-9 (2) 10-50 (3) 51+ | Percent of Panels | | | | Negative Values |
| | | | None | 1-15 | 16-35 | 36+ | |
| | | | 5 | 20 | 35 | | |
| | | | 10 | 25 | 40 | | |
| | | | 15 | 30 | 45 | | |
| BLOWUPS | Number Per Mile | (1) 1 (2) 2-3 (3) 4+ | Blowups Per Mile | | | | Negative Values |
| | | | None | 1 | 2-3 | 4+ | |
| | | | 5 | | | | |
| | | | | 10 | | | |
| | | | | | 15 | | |
| FAULTING CURLING WARPING SETTLEMENT | Average Displace- ment in Inches | (1) 1/8-1/4 (2) 1/4-1/2 (3) 1/2+ | Percent of Panels | | | | Negative Values |
| | | | None | 1-15 | 16-35 | 36+ | |
| | | | 0 | 10 | 20 | | |
| | | | 5 | 15 | 25 | | |
| | | | 10 | 20 | 30 | | |
| PATCHING | Percent of Panels | (1) 1-5 (2) 6-20 (3) 21+ | Percent of Area Per Panel | | | | Negative Values |
| | | | None | 1-5 | 6-25 | 26+ | |
| | | | 2 | 5 | 7 | | |
| | | | 5 | 7 | 10 | | |
| | | | 7 | 10 | 15 | | |
| RUTTING PAVEMENT WEAR | Average Depth in Inches | (1) 1/4-1/2" (2) 1/2-3/4" (3) Over 3/4" | Throughout Rated Section | | | | Negative Values |
| | | | None | 1/4-1/2 | 1/2-3/4 | 3/4+ | |
| | | | 5 | | | | |
| | | | | 12 | | | |
| | | | | | 20 | | |

Figure 30. Table of Weighting Values for Portland Cement Concrete Pavements Used Prior to PMS Development

**PAVEMENT CONDITION RATING
CEMENT CONCRETE PAVEMENT
DEFECT DEDUCTIONS**

PMS

Negative Values are Assigned
to the Failures by Degree

| | | | | | | | |
|--|---|---|---------------------------|---------|---------|------|--------------------|
| CRACKING AVERAGING 1/8+ | Units Per Panel Length | (1) 1-2 (2) 3-4 (3) 4+ | Percent of Panels | | | | Negative Values |
| | | | None | 1-25 | 26-50 | 51+ | |
| | | | 5 | 10 | 20 | | |
| | | | 10 | 20 | 35 | | |
| | | | 15 | 30 | 50 | | |
| RAVELING DISINTEGRATION POPOUTS SCALING | | (1) Slight (2) Moderate (3) Severe | Percent of Area | | | | Negative Values |
| | | | None | 1-25 | 26-75 | 76+ | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| SPALLING AT JOINTS AND CRACKS | Average Width in Inches | (1) 1/4-1 (2) 1-3 (3) 3+ | Percent of Joints | | | | Negative Values |
| | | | None | 1-15 | 16-50 | 51+ | |
| | | | 5 | 10 | 15 | | |
| | | | 10 | 20 | 30 | | |
| | | | 15 | 30 | 50 | | |
| PUMPING BLOWING | Percent of Panel Length | (1) 1-9 (2) 10-50 (3) 51+ | Percent of Panels | | | | Negative Values |
| | | | None | 1-15 | 16-35 | 36+ | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| BLOWUPS | Number Per Mile | (1) 1 (2) 2-3 (3) 4+ | Blowups Per Mile | | | | Negative Values |
| | | | None | 1 | 2-3 | 4+ | |
| | | | 0 | | | | |
| | | | | 0 | | | |
| | | | | | 0 | | |
| FAULTING CURLING WARPING SETTLEMENT | Average Displace- ment in Inches | (1) 1/8-1/4 (2) 1/4-1/2 (3) 1/2+ | Percent of Panels | | | | Negative Values |
| | | | None | 1-15 | 16-35 | 36+ | |
| | | | 5 | 10 | 20 | | |
| | | | 10 | 20 | 30 | | |
| | | | 15 | 30 | 40 | | |
| PATCHING | Percent of Panels | (1) 1-5 (2) 6-20 (3) 21+ | Percent of Area Per Panel | | | | Negative Values |
| | | | None | 1-5 | 6-25 | 26+ | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| | | | 0 | 0 | 0 | | |
| RUTTING PAVEMENT WEAR | Average Depth in Inches | (1) 1/4-1/2" (2) 1/2-3/4" (3) Over 3/4" | Throughout Rated Section | | | | Negative Values |
| | | | None | 1/4-1/2 | 1/2-3/4 | 3/4+ | |
| | | | 0 | | | | |
| | | | | 0 | | | |
| | | | | | 0 | | |

Figure 31. Table of Weighting Values for Portland
Cement Concrete Pavements Developed
for PMS

Other Programs in the Interpreting Phase

Although the reason for the interpreting phase evolved primarily to generate performance equations for projects, there are many other functions inherent to this level.

With the weighting values determined, another program called LISTMSTR (an acronym for List Master File) was developed to list the master file with the distress ratings and combined ratings for each mile listed. An example of this listing is shown in Figure 32.

In order to gauge the condition status of the system, it is important to be cognizant of the distribution picture of distress types and pavement ratings. There is a need to compare pavement status in different functional classifications, different districts, and from one year to the next. To do this, a program called RATGRP (an acronym for ratings by group) was developed. This program applies the distress weighting matrix to one generation of survey data and produces several distribution tables and summaries. The output data from this program can be divided into eight major sets of tables: seven sets of tables (one for each of six districts and one statewide) summarized by Functional Classification; one set of tables statewide summarized by district. Each set of tables consists of:

- Rating distribution summaries for
 - asphalt concrete pavement
 - bituminous pavement
 - portland cement concrete pavements
 - all pavements combined
- Distress summaries for
 - asphalt pavements
 - bituminous pavements
 - portland cement concrete pavements

Figures 33 through 38 are included to provide examples of the type of tables produced by RATGRP.

Figure 33 is a rating distribution table for the miles of asphalt pavement rated in District 1. This table is divided into three sections: distress rating (100 - Σ D); ride rating (bump count or surface roughness); and combined rating. Each table is summarized by Functional Classification vertically (see Figure 11 for explanation of FC codes) and by 10 even divisions of rating listed horizontally across the page. Each number in the table represents the miles of pavement rated in that category.

Figure 34 is a summary table for the miles of asphalt pavement rated within each distress range (extent and severity for District 1). This table

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| CS | REG | END | D | SR | REG | END | LENG | FC | L | HT | ROW | RSH | LSH | CONI | TY | SF | TK | M | YR | BASE | 80 | ADT | GRW | SU | CM |
|------|------|-------|------|------|------|-----|------|-----|------|------|-------|-------|------|-------|------|-------|------|--------|-------|--------|-------|--------|-------|-------|-----|
| *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** |
| 2331 | 343 | 591 | 3 | 3 | 72 | 320 | 248 | U1 | R | 02 | 23 | 3 | 3 | 01437 | 20 | 40 | 15 | 8 | 80 | 11 | 4400 | 53 | 5 | 2 | |
| GFN | SIDE | ECOMP | WEAR | RUTT | WAVE | ALG | FLV | CRK | LONG | IRNS | PITCH | BUMPS | BUMP | SPEED | ADJ | BUMPS | RIDE | RATING | STRUC | RATING | COMBD | RATING | STRUC | COMBD | |
| *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | |
| 69 | R | 371 | N | 11 | 11 | IN | 11 | IN | 11 | IN | IN | 0 | 0 | 0 | 0 | 0 | 1.00 | 1.00 | 95 | 95.0 | 95.0 | 95.0 | 95.0 | | |
| 69 | R | 471 | N | 11 | 11 | IN | 11 | IN | 11 | IN | IN | 0 | 0 | 0 | 0 | 0 | 1.00 | 1.00 | 95 | 95.0 | 95.0 | 95.0 | 95.0 | | |
| 69 | R | 571 | N | 11 | 11 | IN | 11 | IN | 11 | IN | IN | 0 | 0 | 0 | 0 | 0 | 1.00 | 1.00 | 85 | 85.0 | 85.0 | 85.0 | 85.0 | | |
| 71 | R | 371 | 1 | 12 | 12 | IN | 13 | 31 | 31 | 31 | 11 | 667 | 40 | 518 | 1.00 | 10 | 1.00 | 10 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | | |
| 71 | R | 471 | 1 | 12 | 12 | IN | 13 | 31 | 31 | 31 | IN | 1435 | 50 | 2254 | 0.94 | 10 | 0.94 | 20 | 19.4 | 19.4 | 19.4 | 19.4 | 19.4 | | |
| 71 | R | 571 | 1 | 12 | 12 | IN | 13 | 21 | 21 | IN | 11 | 910 | 50 | 1356 | 0.98 | 75 | 0.98 | 75 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | | |
| 73 | R | 371 | 1 | 12 | 22 | IN | 31 | 33 | 33 | 31 | 21 | 965 | 30 | 153 | 1.08 | -30 | 1.08 | -30 | -30.0 | -30.0 | -30.0 | -30.0 | -30.0 | | |
| 73 | R | 471 | 1 | 12 | 22 | IN | 31 | 33 | 33 | IN | 21 | 762 | 50 | 420 | 1.00 | 0 | 1.00 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 73 | R | 571 | 1 | 12 | 22 | IN | 31 | 33 | 33 | IN | 21 | 975 | 50 | 589 | 1.00 | 0 | 1.00 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 75 | R | 400 | R | 12 | 12 | IN | 12 | 31 | 31 | IN | IN | 979 | 30 | 1658 | 0.97 | 35 | 0.97 | 35 | 33.8 | 33.8 | 33.8 | 33.8 | 33.8 | | |
| 75 | R | 500 | R | 13 | 22 | IN | 32 | 31 | 31 | IN | IN | 1648 | 50 | 1648 | 0.97 | 25 | 0.97 | 25 | 24.2 | 24.2 | 24.2 | 24.2 | 24.2 | | |
| 75 | R | 600 | R | 13 | 22 | IN | 32 | 31 | 31 | IN | IN | 1680 | 50 | 1680 | 0.97 | 30 | 0.97 | 30 | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | | |
| 77 | R | 400 | N | 12 | 13 | IN | 21 | 21 | 21 | 21 | 23 | 1540 | 40 | 1926 | 0.96 | 0 | 0.96 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| 77 | R | 500 | N | 12 | 12 | IN | 11 | 21 | 21 | IN | 22 | 2118 | 50 | 2118 | 0.95 | 35 | 0.95 | 35 | 23.7 | 23.7 | 23.7 | 23.7 | 23.7 | | |
| 77 | R | 600 | N | 12 | 12 | IN | 11 | 21 | 21 | IN | 22 | 1233 | 40 | 1554 | 0.97 | 30 | 0.97 | 30 | 24.4 | 24.4 | 24.4 | 24.4 | 24.4 | | |
| 79 | R | 400 | N | 12 | 12 | IN | 12 | 21 | 21 | IN | 23 | 2102 | 50 | 2102 | 0.95 | 25 | 0.95 | 25 | 23.7 | 23.7 | 23.7 | 23.7 | 23.7 | | |
| 79 | R | 500 | N | 12 | 12 | IN | 12 | 21 | 21 | IN | 23 | 1747 | 50 | 1747 | 0.96 | 25 | 0.96 | 25 | 24.1 | 24.1 | 24.1 | 24.1 | 24.1 | | |
| 79 | R | 600 | N | 12 | 12 | IN | 12 | 21 | 21 | IN | 23 | 1358 | 50 | 1358 | 0.98 | 25 | 0.98 | 25 | 24.4 | 24.4 | 24.4 | 24.4 | 24.4 | | |
| 81 | R | 344 | N | 11 | 11 | IN | 21 | IN | IN | IN | IN | 1854 | 50 | 1418 | 0.98 | 100 | 0.98 | 100 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | | |
| 81 | R | 400 | N | 11 | 11 | IN | 21 | IN | IN | IN | IN | 1731 | 50 | 1371 | 0.98 | 100 | 0.98 | 100 | 98.1 | 98.1 | 98.1 | 98.1 | 98.1 | | |
| 81 | R | 500 | N | 11 | 11 | IN | 21 | IN | IN | IN | IN | 1618 | 50 | 1251 | 0.99 | 100 | 0.99 | 100 | 99.1 | 99.1 | 99.1 | 99.1 | 99.1 | | |
| 81 | R | 600 | N | 11 | 11 | IN | 21 | IN | IN | IN | IN | 1101 | 50 | 876 | 0.99 | 100 | 0.99 | 100 | 99.1 | 99.1 | 99.1 | 99.1 | 99.1 | | |

Figure 32. List Master File

DISTRICT 1 B1 DEFECT RATING SUMMARY FOR ASPHALT PAVTS

| FC | 100-91 | 90-81 | 80-71 | 71-60 | 60-51 | 50-41 | 40-31 | 30-21 | 20-11 | 10-0 | AVG |
|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| 1 | 204.0 | 54.1 | 44.9 | 40.7 | 20.7 | 26.5 | 17.3 | 6.7 | 14.0 | 23.3 | 76.6 |
| 2 | 210.0 | 32.9 | 34.6 | 40.7 | 26.3 | 30.6 | 18.6 | 19.6 | 13.4 | 34.3 | 72.0 |
| 3 | 48.4 | 16.6 | 21.9 | 12.8 | 10.0 | 5.5 | 5.2 | 3.4 | 1.1 | 5.0 | 76.4 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 127.5 | 16.0 | 5.1 | 13.2 | 3.5 | 4.9 | 0.8 | 1.9 | 3.7 | 0.0 | 90.6 |
| TOTAL | 589.9 | 119.7 | 106.5 | 107.5 | 60.4 | 67.5 | 41.8 | 31.6 | 32.3 | 62.6 | 76.9 |

BUMP COUNT SUMMARY FOR ASPHALT PAVTS

| FC | LT 500 | 5K-1K | 1K-1.5K | 1.5K-2K | 2K-3K | 3K-4K | 4K-5K | 5K-7.5K | 7.5-10K | GT 10K | AVG |
|-------|--------|-------|---------|---------|-------|-------|-------|---------|---------|--------|--------|
| 1 | 24.4 | 119.8 | 100.6 | 79.1 | 80.5 | 34.2 | 9.6 | 3.7 | 0.2 | 0.2 | 1643.7 |
| 2 | 41.9 | 130.1 | 127.0 | 68.3 | 55.2 | 17.8 | 9.7 | 6.9 | 0.5 | 0.0 | 1455.2 |
| 3 | 4.0 | 43.9 | 42.5 | 16.6 | 16.3 | 5.6 | 0.1 | 0.7 | 0.2 | 0.0 | 1382.9 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 85.0 | 69.2 | 11.0 | 4.9 | 4.9 | 1.4 | 0.1 | 0.1 | 0.0 | 0.0 | 661.3 |
| TOTAL | 155.4 | 363.0 | 281.2 | 168.9 | 156.9 | 59.0 | 19.5 | 11.4 | 0.9 | 0.2 | 1402.1 |

COMBINED RATING SUMMARY FOR ASPHALT PAVTS

| FC | 100-91 | 90-81 | 80-71 | 71-60 | 60-51 | 50-41 | 40-31 | 30-21 | 20-11 | 10-0 | AVG |
|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| 1 | 187.4 | 56.1 | 44.3 | 46.3 | 23.8 | 27.0 | 20.4 | 7.4 | 14.0 | 23.5 | 73.6 |
| 2 | 203.7 | 35.2 | 34.3 | 38.6 | 27.5 | 33.4 | 19.4 | 20.8 | 13.7 | 34.4 | 70.0 |
| 3 | 47.8 | 15.7 | 22.7 | 11.9 | 10.7 | 5.9 | 5.5 | 3.5 | 0.9 | 5.4 | 74.4 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 126.5 | 16.7 | 4.7 | 13.6 | 3.5 | 5.0 | 0.8 | 1.9 | 3.7 | 0.0 | 90.0 |
| TOTAL | 565.4 | 123.8 | 106.0 | 112.6 | 65.5 | 71.3 | 46.0 | 33.7 | 32.3 | 63.4 | 74.7 |

Figure 33. Rating Distributions - Districtwide by Functional Class

R67750

DISTRICT 1

04/21/82

81 PAVEMENT CONDITION DEFICIENCY SUMMARY

ASPHALT CONCRETE PAVEMENT

ALLIGATOR CRACKING

| FUNCTIONAL CLASS | NONE | 1-24 PERCENT | | 25-49 PERCENT | | 50-74 PERCENT | | 75-100 PERCENT | | TOTAL | |
|----------------------------|-------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|----------|-------|
| | | WHEEL TRACK/STA H-LINE SPAL PUMP | WHEEL TRACK/STA H-LINE SPAL PUMP | WHEEL TRACK/STA H-LINE SPAL PUMP | WHEEL TRACK/STA H-LINE SPAL PUMP | WHEEL TRACK/STA H-LINE SPAL PUMP | WHEEL TRACK/STA H-LINE SPAL PUMP | WHEEL TRACK/STA H-LINE SPAL PUMP | WHEEL TRACK/STA H-LINE SPAL PUMP | | |
| ¹ MILES PERCENT | 349: 77: | 77: 17: | 15: 3: | 0: 0: | 5: 1: | 4: 1: | 0: 0: | 0: 0: | 1: 0: | 0: 0: | 452. |
| ² MILES PERCENT | 296: 64: | 16: 16: | 23: 5: | 0: 0: | 16: 3: | 30: 7: | 0: 0: | 4: 1: | 13: 3: | 0: 0: | 461. |
| ³ MILES PERCENT | 86: 66: | 30: 23: | 10: 8: | 0: 0: | 2: 2: | 1: 1: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 130. |
| ⁴ MILES PERCENT | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | C. |
| ⁵ MILES PERCENT | 168: 95: | 6: 3: | 1: 1: | 0: 0: | 0: 0: | 1: 1: | 0: 0: | 0: 0: | 0: 0: | 0: 0: | 177. |
| TOTAL MILES PERCENT | 899: 74: | 188: 15: | 45: 4: | 0: 0: | 23: 2: | 37: 3: | 0: 0: | 5: 0: | 14: 1: | 0: 0: | 1220. |

Figure 34. Distress Type Distribution - Districtwide by Functional Class

is tabulated by Functional Classification vertically and distress range horizontally. Numbers listed in the table represent miles of pavement rated in each category (top number in each row) and the percentage of that FC (bottom number of each row).

Figures 35, 36, 37, and 38 are similar to the two figures just described. Figures 35 and 36 are identical, but represent the entire statewide system.

Figures 37 and 38 are tabulated by district instead of Functional Classification.

Figures 34, 36, and 38 illustrate only the distress type of alligator cracking. All distress categories are summarized the same way.

It is important to realize that all of these tables are produced each time a pavement condition survey has been completed. By comparing tables from one year to the next, many interesting plots and tables can be produced. Examples of these are shown in Figures 39, 40, and 41.

While RATGRP provides information on rating distributions, another program named RATGEN (an acronym for ratings by generation) provides a consecutive listing of raw ratings with their translated score. This listing provides basically the same type of distress information shown on the Master File listing but only represents one generation of survey data and is not related to performance sections.

Figure 42 is an example of the RATGEN listing. Note that different column headings appear across the top of the page than across the bottom. The top heading is related to asphalt or bituminous pavements, while the bottom heading is related to portland cement concrete pavement. This was done because different distress categories are rated for the different pavement types. The columns are staggered to easily and quickly differentiate between the ratings and to denote the separations of pavement types.

It is important to note that both of these programs, RATGRP and RATGEN, utilize the same interpreting parameters used in the main interpreting program, INTERP. This includes the weighting matrix. By editing the interpreting parameters, control over all three programs is exercised. This is illustrated in Figure 43.

Summary of the Interpreting Phase

The purpose of the interpreting phase is to maintain pavement rating data in its raw coded form and then translate it into a numerical rating through the application of a weighting matrix. This enables the engineer to inspect the present extent and severity of each distress category as well as track the

progression of distress over a period of time. The weighting matrix allows total flexibility in controlling the influence each type of distress exerts on the final rating.

The three computer programs involved at this level are:

1. INTERP - translates mile-by-mile raw distress ratings into yearly average ratings and uses these primarily in regression analysis to produce a performance curve.
2. RATGEN - translates mile-by-mile raw distress ratings into a mile-by-mile listing of the raw and weighted ratings for one survey year.
3. RATGRP - translates mile-by-mile raw distress ratings into distribution summaries of miles rated.

All three programs utilize the same weighting matrix, thus assuring consistency in relating all results.

The main interpreting program, INTERP, generates a file of all results including performance equations. This file is used as input to the subsequent optimizing and network programs as well as providing a data base for further statistical analysis. The data base may be edited after inspection of the generated performance curves, thus ensuring the most reasonable forecasting possible.

STATEWIDE 81 DEFECT RATING SUMMARY FOR ASPHALT PAVTS

| FC | 100-91 | 90-81 | 80-71 | 71-60 | 60-51 | 50-41 | 40-31 | 30-21 | 20-11 | 10-0 | AVG |
|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 1 | 588.1 | 241.7 | 155.8 | 144.7 | 116.6 | 79.2 | 109.9 | 72.1 | 63.9 | 166.8 | 73.1 |
| 2 | 699.0 | 115.1 | 108.2 | 88.4 | 67.3 | 79.2 | 59.6 | 46.4 | 37.0 | 52.2 | 77.8 |
| 3 | 283.3 | 68.4 | 68.0 | 36.9 | 24.8 | 32.7 | 18.3 | 22.2 | 9.4 | 47.6 | 75.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 386.4 | 145.3 | 39.8 | 44.8 | 45.8 | 17.8 | 41.3 | 30.5 | 14.9 | 18.9 | 80.8 |
| TOTAL | 2356.7 | 570.5 | 415.8 | 314.8 | 254.4 | 254.7 | 229.1 | 171.2 | 125.2 | 285.6 | 75.8 |

BUMP COUNT SUMMARY FOR ASPHALT PAVTS

| FC | LT 50C | 5K-1K | 1K-1.5K | 1.5K-2K | 2K-3K | 3K-4K | 4K-5K | 5K-7.5K | 7.5-10K | GT 10K | AVG |
|-------|--------|--------|---------|---------|-------|-------|-------|---------|---------|--------|--------|
| 1 | 459.5 | 853.8 | 443.4 | 208.7 | 172.5 | 59.4 | 14.7 | 12.5 | 1.7 | 0.7 | 1105.3 |
| 2 | 242.4 | 428.5 | 315.0 | 166.8 | 119.9 | 40.3 | 18.2 | 11.9 | 0.5 | 0.0 | 1233.0 |
| 3 | 47.5 | 185.0 | 120.3 | 101.6 | 89.7 | 27.2 | 13.0 | 4.1 | 0.3 | 0.2 | 1457.5 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 527.6 | 205.8 | 25.4 | 9.1 | 11.0 | 2.2 | 0.1 | 0.3 | 0.0 | 0.0 | 505.1 |
| TOTAL | 1277.8 | 1673.0 | 904.1 | 486.2 | 393.0 | 129.1 | 46.0 | 28.8 | 2.5 | 0.9 | 1054.0 |

COMBINED RATING SUMMARY FOR ASPHALT PAVTS

| FC | 100-91 | 90-81 | 80-71 | 71-60 | 60-51 | 50-41 | 40-31 | 30-21 | 20-11 | 10-0 | AVG |
|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 1 | 962.0 | 248.3 | 197.6 | 152.2 | 121.6 | 124.8 | 113.7 | 76.2 | 63.4 | 168.8 | 71.6 |
| 2 | 688.4 | 116.7 | 108.3 | 85.4 | 65.2 | 82.9 | 60.8 | 50.0 | 38.2 | 52.5 | 76.1 |
| 3 | 278.5 | 56.6 | 74.1 | 42.6 | 26.8 | 33.0 | 19.1 | 22.9 | 9.6 | 48.4 | 72.8 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 383.7 | 147.2 | 35.9 | 45.3 | 45.7 | 18.0 | 41.3 | 30.5 | 14.9 | 18.9 | 80.4 |
| TOTAL | 2312.6 | 568.7 | 419.9 | 329.5 | 259.4 | 258.6 | 234.9 | 179.7 | 126.1 | 288.6 | 74.4 |

Figure 35. Rating Distributions - Statewide by Functional Class

81 PAVEMENT CONDITION DEFICIENCY SUMMARY
ASPHALT CONCRETE PAVEMENT

ALLIGATOR CRACKING

| FUNCTIONAL CLASS | NONE | 1-24 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMP | | | | 25-49 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMP | | | | 50-74 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMP | | | | 75-100 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMP | | | | TOTAL |
|------------------|------------|---|---------------|---------------|---------------|--|---------------|---------------|---------------|--|---------------|---------------|---------------|---|---------------|---------------|---------------|-------|
| | | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | |
| 1 | 1532 69 | 371 17 | 123 6 | 52 2 | 68 3 | 17 1 | 8 0 | 37 2 | 1 0 | 15 1 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 2225 | |
| 2 | 954 71 | 210 16 | 68 5 | 33 2 | 52 4 | 0 0 | 8 1 | 21 2 | 0 0 | 2 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 1352 | |
| 3 | 401 68 | 102 17 | 36 6 | 19 3 | 24 4 | 0 0 | 5 1 | 6 1 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 554 | |
| 4 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 | |
| 5 | 608 77 | 112 14 | 10 1 | 14 2 | 6 1 | 0 0 | 22 3 | 1 0 | 0 0 | 10 1 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 785 | |
| TOTAL | 3495 70 | 794 16 | 236 5 | 118 2 | 151 3 | 17 0 | 42 1 | 65 1 | 1 0 | 13 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 4954 | |

Figure 36. Distress Type Distribution - Statewide by Functional Class

STATEWIDE 81 DEFECT RATING SUMMARY FOR ASPHALT PAVTS

| DIST | 100-91 | 90-81 | 80-71 | 70-61 | 60-51 | 50-41 | 40-31 | 30-21 | 2C-11 | 10-0 | AVG |
|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 1 | 589.9 | 119.7 | 106.5 | 107.5 | 60.4 | 67.5 | 41.8 | 31.6 | 32.3 | 62.6 | 76.5 |
| 2 | 197.3 | 56.9 | 43.6 | 34.2 | 28.2 | 10.4 | 25.1 | 15.8 | 11.3 | 25.0 | 75.5 |
| 3 | 448.0 | 83.1 | 59.3 | 65.4 | 67.3 | 90.6 | 66.8 | 59.0 | 37.7 | 87.3 | 68.5 |
| 4 | 562.3 | 74.7 | 81.4 | 33.1 | 30.3 | 25.8 | 17.5 | 9.5 | 8.5 | 22.0 | 86.7 |
| 5 | 256.8 | 50.1 | 39.0 | 23.7 | 27.0 | 9.8 | 31.2 | 19.2 | 10.5 | 9.7 | 80.2 |
| 6 | 302.4 | 145.9 | 45.9 | 50.9 | 41.1 | 50.5 | 46.7 | 36.1 | 24.9 | 79.0 | 65.8 |
| TOTAL | 2356.7 | 570.5 | 415.8 | 314.8 | 254.4 | 254.7 | 229.1 | 171.2 | 125.2 | 285.6 | 75.8 |

BUMP COUNT SUMMARY FOR ASPHALT PAVTS

| DIST | LT 500 | 5K-1K | 1K-1.5K | 1.5K-2K | 2K-3K | 3K-4K | 4K-5K | 5K-7.5K | 7.5-10K | GT 10K | AVG |
|-------|--------|--------|---------|---------|-------|-------|-------|---------|---------|--------|--------|
| 1 | 155.4 | 363.0 | 281.2 | 168.9 | 156.5 | 55.0 | 19.5 | 11.4 | 0.9 | 0.2 | 1402.1 |
| 2 | 278.7 | 175.0 | 20.5 | 8.9 | 3.5 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 555.2 |
| 3 | 138.6 | 329.4 | 257.7 | 170.5 | 135.8 | 43.0 | 15.5 | 11.0 | 1.0 | 0.5 | 1384.8 |
| 4 | 124.1 | 320.3 | 211.6 | 106.9 | 65.4 | 17.3 | 4.0 | 3.6 | 0.1 | 0.0 | 1155.5 |
| 5 | 239.7 | 150.6 | 46.2 | 11.4 | 8.1 | 1.0 | 0.1 | 0.2 | 0.0 | 0.0 | 627.1 |
| 6 | 341.2 | 334.8 | 87.0 | 15.6 | 23.3 | 7.5 | 6.8 | 2.5 | 0.4 | 0.2 | 762.9 |
| TOTAL | 1277.8 | 1673.0 | 904.1 | 486.2 | 393.0 | 129.1 | 46.0 | 28.8 | 2.5 | 0.9 | 1054.0 |

COMBINED RATING SUMMARY FOR ASPHALT PAVTS

| DIST | 100-91 | 90-81 | 80-71 | 70-61 | 60-51 | 50-41 | 40-31 | 30-21 | 2C-11 | 10-0 | AVG |
|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 1 | 565.4 | 123.8 | 106.0 | 112.6 | 65.5 | 71.3 | 46.0 | 33.7 | 32.3 | 63.4 | 74.7 |
| 2 | 196.6 | 97.5 | 43.2 | 34.8 | 28.2 | 10.4 | 25.1 | 15.8 | 11.3 | 25.0 | 75.2 |
| 3 | 439.1 | 83.2 | 99.5 | 66.7 | 68.7 | 50.1 | 67.9 | 63.3 | 37.3 | 88.6 | 67.0 |
| 4 | 555.8 | 70.4 | 83.5 | 38.5 | 30.9 | 26.0 | 16.5 | 11.6 | 9.5 | 22.2 | 85.0 |
| 5 | 255.9 | 49.8 | 39.9 | 23.5 | 27.2 | 10.0 | 31.2 | 19.3 | 10.4 | 9.8 | 75.7 |
| 6 | 299.9 | 144.1 | 47.8 | 53.0 | 38.9 | 50.9 | 48.2 | 36.0 | 25.2 | 79.6 | 69.1 |
| TOTAL | 2312.6 | 568.7 | 419.5 | 329.5 | 259.4 | 258.6 | 234.9 | 179.7 | 126.1 | 288.6 | 74.4 |

Figure 37. Rating Distributions - Statewide by District

867750

STATEWIDE

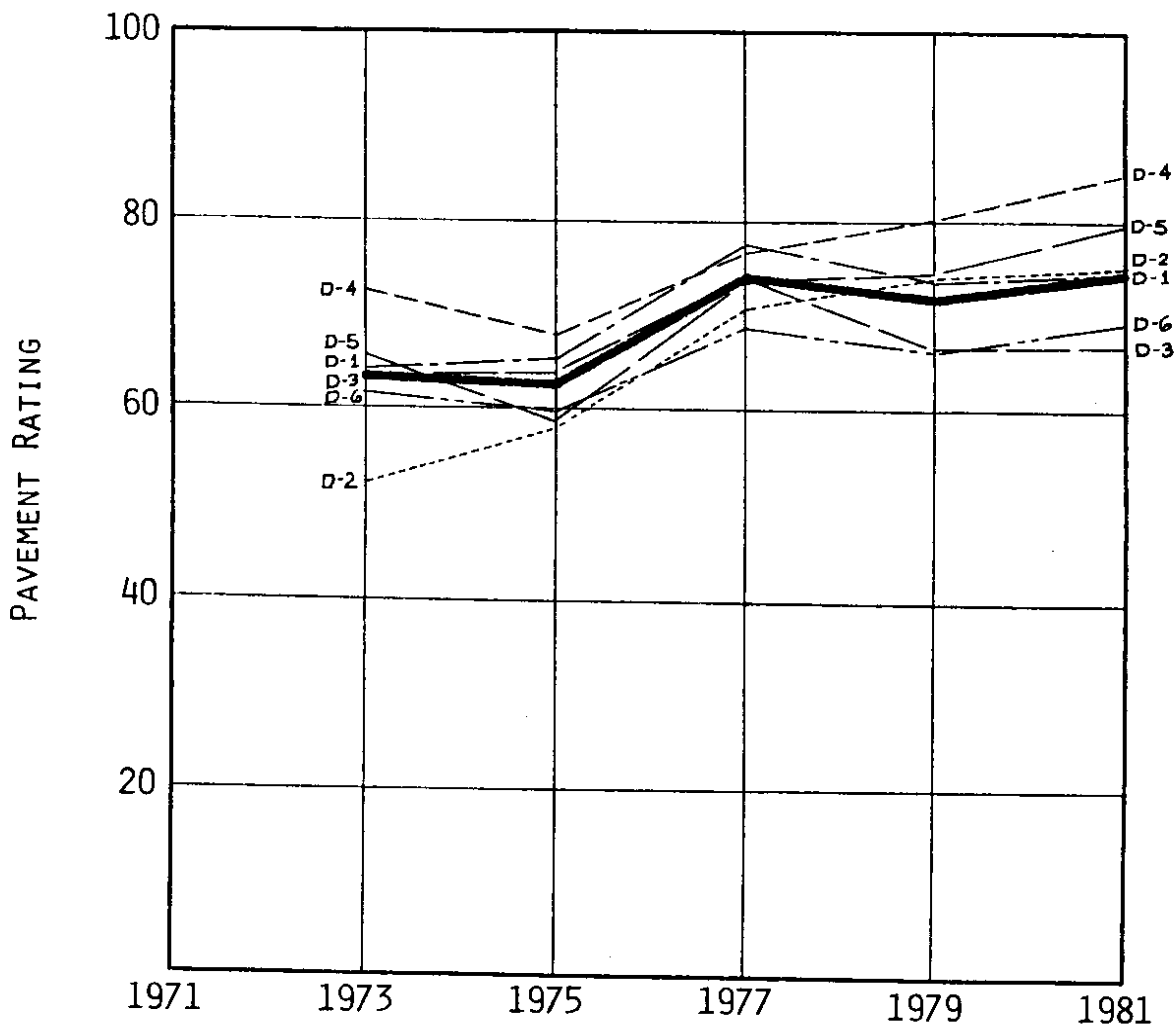
04/21/82

81 PAVEMENT CONDITION DEFICIENCY SUMMARY
ASPHALT CONCRETE PAVEMENT

ALLIGATOR CRACKING

| DISTRICT | ACME | 1-24 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMF | | | | 25-49 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMP | | | | 50-74 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMP | | | | 75-100 PERCENT WHEEL TRACK/STA H-LINE SPAL PUMP | | | | TOTAL |
|----------|--------------|---|---------------|---------------|---------------|--|---------------|---------------|---------------|--|---------------|---------------|---------------|---|---------------|---------------|---------------|-------|
| | | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | MILES PERCENT | |
| 1 | 899. 74. | 188. 15. | 49. 4. | 0. 0. | 23. 2. | 37. 3. | 0. 0. | 5. 0. | 14. 1. | 0. 0. | 4. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 122C. |
| 2 | 357. 73. | 83. 17. | 12. 2. | 0. 0. | 7. 2. | 16. 3. | 0. 0. | 2. 0. | 10. 2. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 48E. |
| 3 | 626. 57. | 235. 21. | 91. 8. | 2. 0. | 53. 5. | 55. 5. | 4. 0. | 11. 1. | 25. 2. | 1. 0. | 0. 0. | 1. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 11C4. |
| 4 | 719. 83. | 104. 12. | 19. 2. | 1. 0. | 12. 1. | 5. 1. | 0. 0. | 0. 0. | 1. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 865. |
| 5 | 340. 74. | 64. 14. | 24. 5. | 2. 0. | 8. 2. | 6. 1. | 1. 0. | 10. 2. | 0. 0. | 0. 0. | 0. 0. | 5. 1. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 455. |
| 6 | 555. 67. | 120. 15. | 41. 5. | 2. 0. | 14. 2. | 29. 3. | 13. 2. | 14. 2. | 15. 2. | 0. 0. | 7. 1. | 14. 2. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 823. |
| TOTAL | 3495. 70. | 794. 16. | 236. 5. | 7. 0. | 118. 2. | 151. 3. | 17. 0. | 42. 1. | 65. 1. | 1. 0. | 13. 0. | 21. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 0. 0. | 455E. |

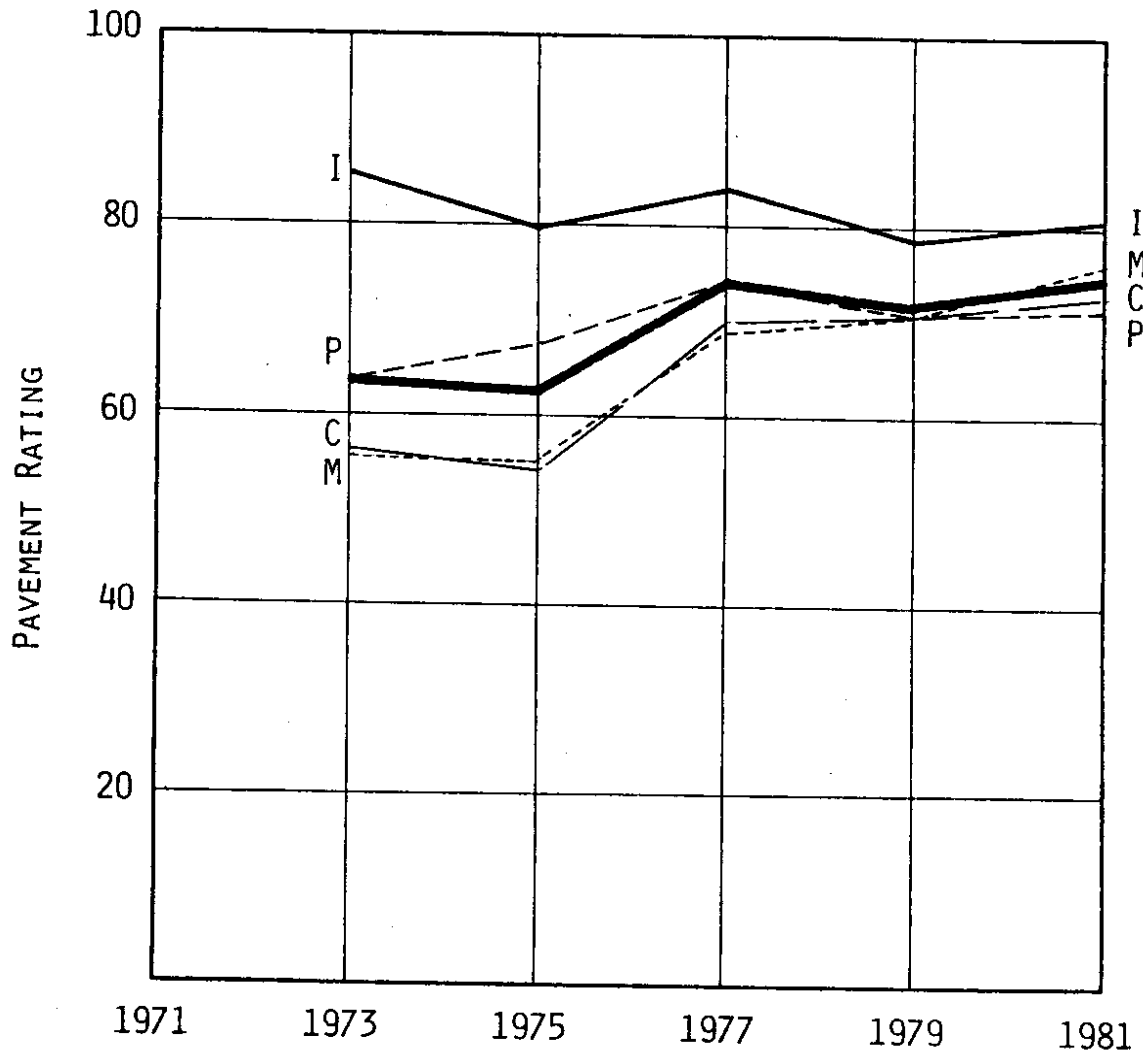
Figure 38. Distress Type Distribution - Statewide by District



AC PAVEMENTS

| DISTRICT | 1973 | 1975 | 1977 | 1979 | 1981 |
|----------|------|------|------|------|------|
| 1 | 63.8 | 65.3 | 77.5 | 73.4 | 74.7 |
| 2 | 52.2 | 58.1 | 70.4 | 73.7 | 75.2 |
| 3 | 63.5 | 63.4 | 74.2 | 66.5 | 67.0 |
| 4 | 72.4 | 67.9 | 76.4 | 80.1 | 85.0 |
| 5 | 65.4 | 58.8 | 73.6 | 74.3 | 79.7 |
| 6 | 61.8 | 59.8 | 68.7 | 66.4 | 69.1 |
| ALL | 63.5 | 62.8 | 74.2 | 71.9 | 74.4 |

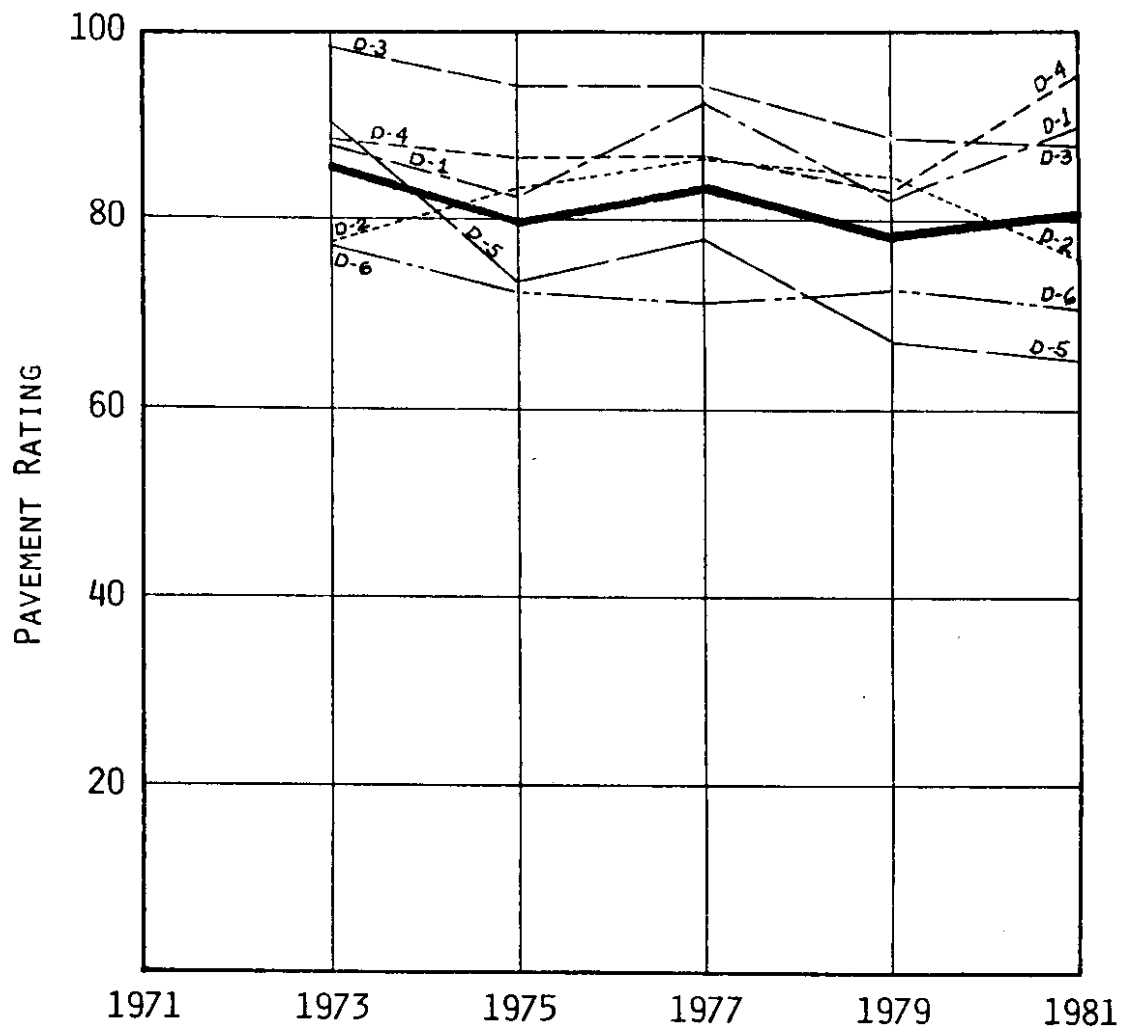
Figure 39. Table and Plot of AC Pavement Performance by District



AC PAVEMENTS

| FUNCTIONAL CLASS | 1973 | 1975 | 1977 | 1979 | 1981 |
|------------------|------|------|------|------|------|
| INTERSTATE | 85.3 | 79.9 | 83.6 | 78.4 | 80.4 |
| PRIN. ART. | 63.7 | 67.4 | 74.8 | 70.7 | 71.6 |
| MINOR ART. | 55.7 | 55.4 | 68.9 | 70.7 | 76.1 |
| COLLECTOR | 55.9 | 54.4 | 70.0 | 70.8 | 72.8 |
| ALL | 63.5 | 62.8 | 74.2 | 71.9 | 74.4 |

Figure 40. Table and Plot of AC Pavement Performance by Functional Class



ASPHALT - INTERSTATE

| DISTRICT | 1973 | 1975 | 1977 | 1979 | 1981 |
|----------|------|------|------|------|------|
| 1 | 87.5 | 82.3 | 92.8 | 82.0 | 89.8 |
| 2 | 77.5 | 83.2 | 86.5 | 84.5 | 76.0 |
| 3 | 98.7 | 94.6 | 94.6 | 88.4 | 88.0 |
| 4 | 88.4 | 86.4 | 86.8 | 82.7 | 95.3 |
| 5 | 90.4 | 73.5 | 77.9 | 67.3 | 65.3 |
| 6 | 77.0 | 72.5 | 71.1 | 72.9 | 70.6 |
| ALL | 85.3 | 79.9 | 83.6 | 78.4 | 80.4 |

Figure 41. Table and Plot of AC Pavement Performance on Interstate Routes by District

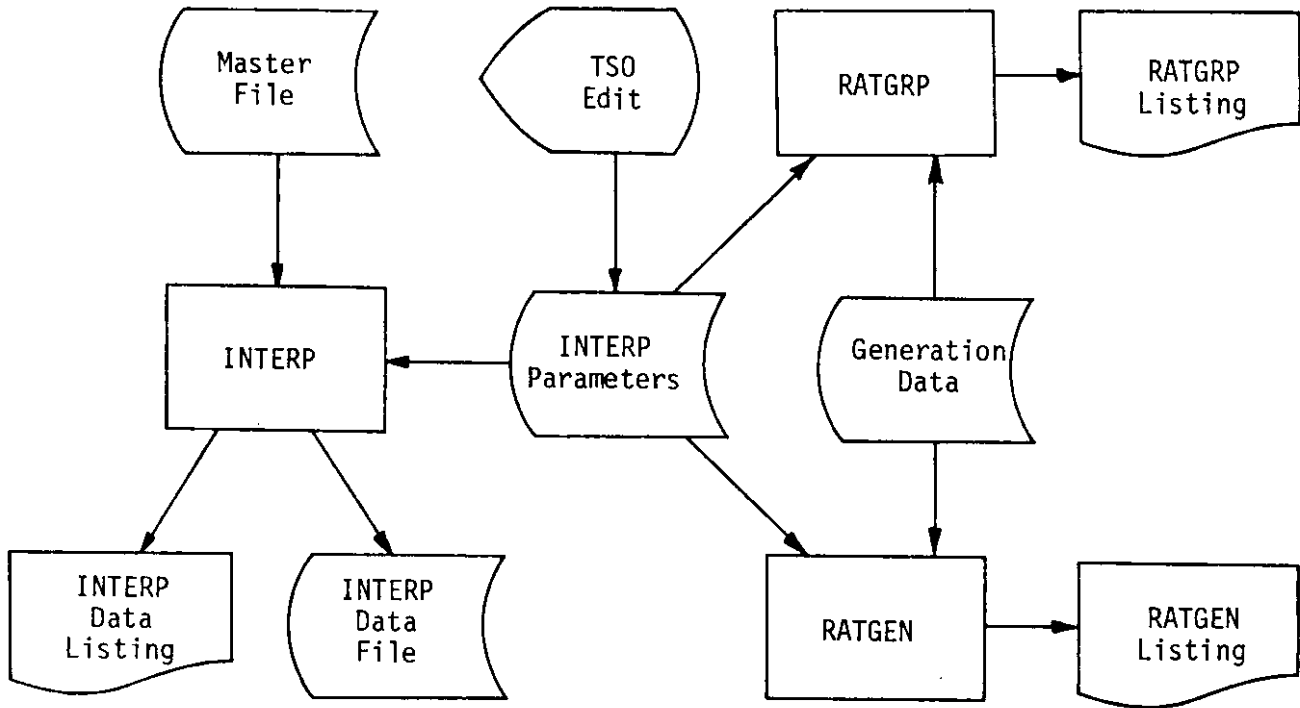


Figure 43. Coordinating Programs with Interpreting Parameters

OPTIMIZING AT THE PROJECT LEVEL

It should be noted that the cost-effective rehabilitation strategy identified with this optimizing procedure for each project is suitable for planning and budgeting purposes. However, further evaluation and engineering are required during the development of the actual construction project. This may lead to a rehabilitation strategy which is significantly different in scope than what was originally identified by the system.

There is a fear by many engineers and administrators that people responsible for project scheduling and budgeting will accept outputs from programs such as this as the final design. It is important to make it absolutely clear that this is not the intent and that in-depth analysis of each project will be required to assure that the work is both necessary and the design adequate.

This phase utilizes the performance equations produced by the interpreting program to establish the most cost-effective rehabilitation strategy for each project.

Figure 44 is a typical performance curve relating the pavement rating to the age of the pavement. As a pavement ages, its condition gradually deteriorates to a point where some type of rehabilitation should be applied. This is a state of deterioration at which distress is showing, but might not yet be severe enough to call for immediate remedial action. Unfortunately, this point is all too often passed and the pavement continues to deteriorate until something must be done to rehabilitate it. These two points on the performance curve, aptly named the "should" and "must" levels, define a probable rehabilitation period. In the event that the "must" level is surpassed without action, maintenance forces are then faced with applying temporary fixes until a major remedy can be applied. Temporary fixes tend to retard the rate of deterioration and flatten out the performance curves. However, the frequency of application and associated cost of a temporary fix are high compared to the benefit returned.

When rehabilitation treatment is eventually applied, the pavement rating increases abruptly, marking the beginning of a new cycle. Over the total existence of a pavement, many restorative actions like this occur, demonstrating a new performance cycle each time rehabilitation is applied. Obviously many different fixes are possible when the need for rehabilitation is faced, and each fix generates its own performance curve following application. Not only are many fixes possible, but a tremendous number of different combinations are possible when the timing, sequence, or type of action are changed over an extended period. In this report a rehabilitation strategy is defined as a

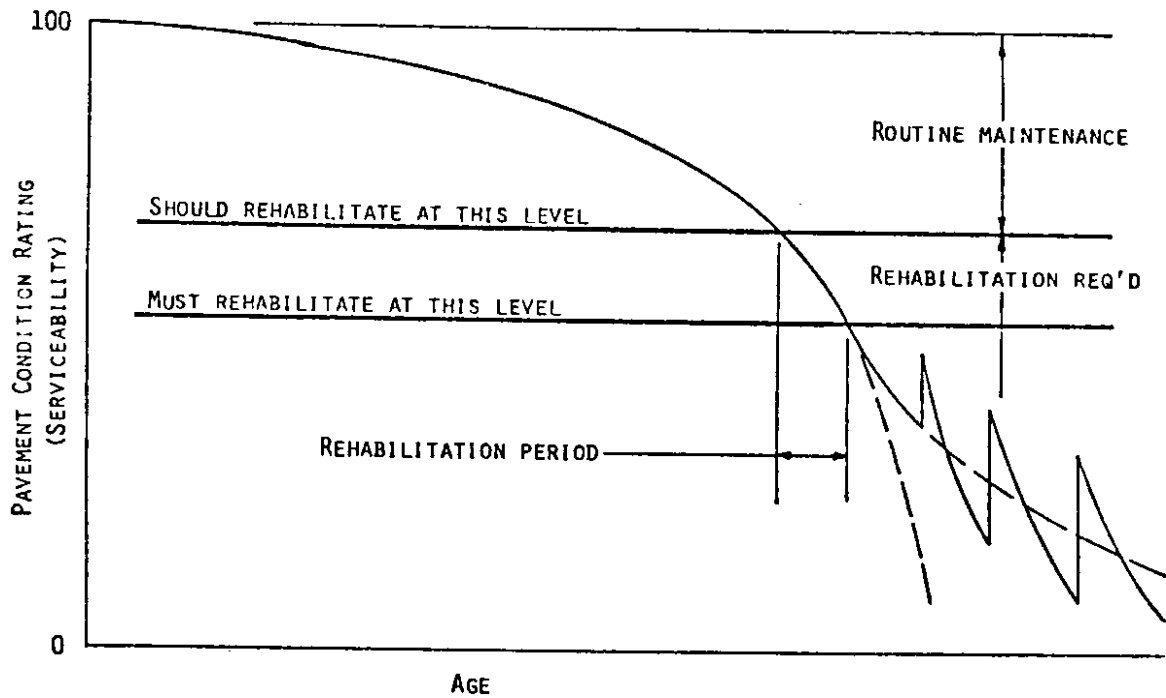


Figure 44. Typical Performance Curve

combination of rehabilitation alternatives designated by type, sequence, and application time. Figures 45a, b, c, and d illustrate this concept with a few examples of strategies.

One of the primary motives for improving our method of managing pavements is to be more cost-effective in providing satisfactory pavement condition. The methods presented here can achieve this by analyzing economically all strategies possible within a set time frame called a consideration period. Basic to the analysis is the stipulation of a minimum level of pavement condition ("must level") to be maintained throughout the consideration period. All costs associated with each strategy can then be totaled and brought back to present worth for comparison with other strategies--the desired strategy being the one with the least total cost. Costs considered in this analysis consist of:

1. Construction costs for each rehabilitation alternative applied.
2. Routine pavement-related maintenance costs (annual).
3. User-incurred costs related to the condition of the pavement.
4. User-incurred costs related to delay during rehabilitation.
5. Salvage value of the pavement at the end of the consideration period.

It is important to note that strategies can be selected on the basis of all these costs, or any combination of them, depending on management's preference.

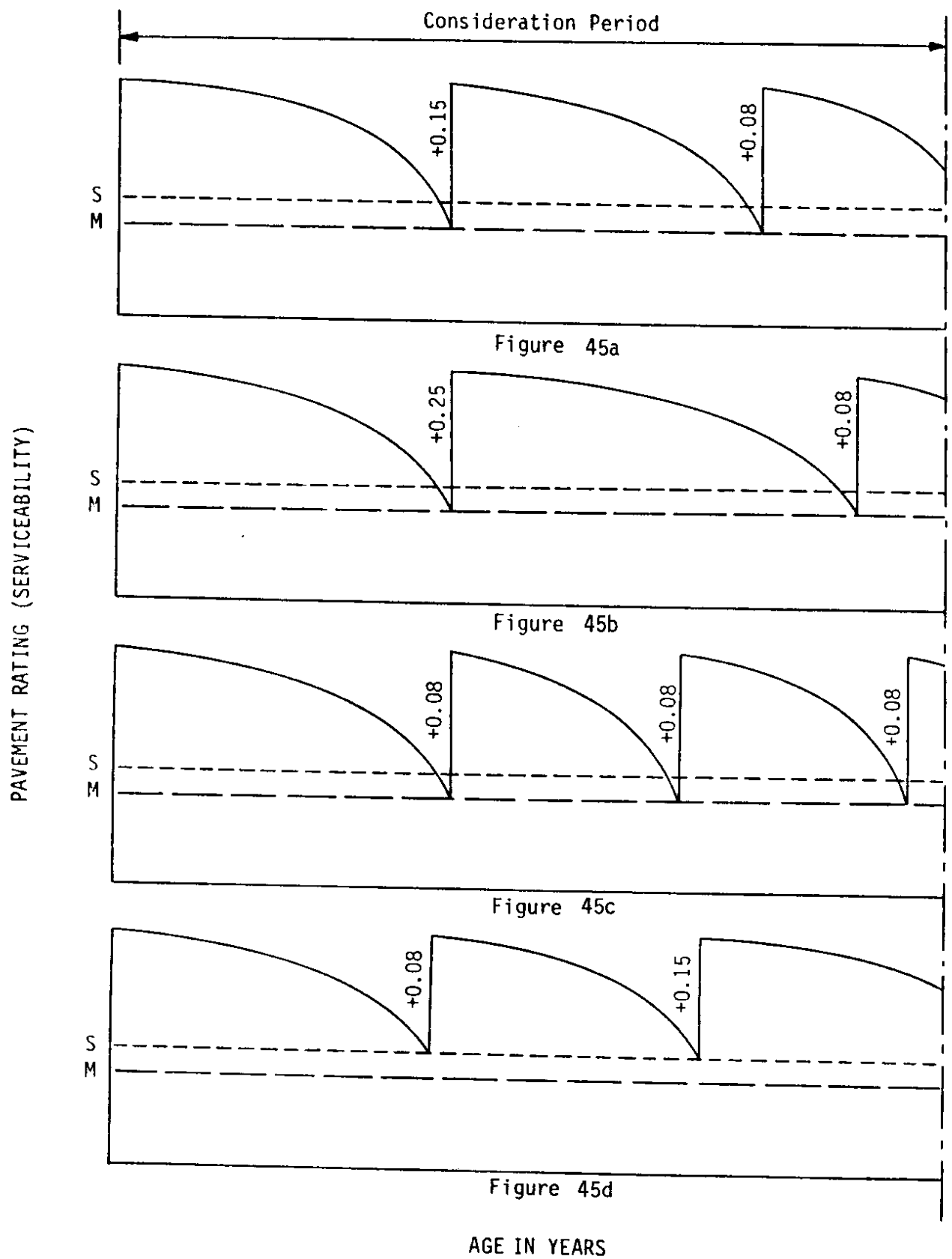


Figure 45. Examples of Rehabilitation Strategies
-71-

Figure 46 is a flow chart demonstrating the operations and work flow in the optimizing program. Each box on the flow chart represents a program module (subroutine) which can be easily replaced or modified as new data become available and operating procedures in each of these areas are improved.

Reading the Optimizing Parameters

The first phase of the program represents the means for inputting the parameters used in the optimizing process. In each run of the program, a small data set containing these parameters is read in apart from the project data. As can be seen from the flow chart, this input occurs only once in the process of one run.

In the data processing environment existent within WSDOT at the time this system was developed, CRT remote computer terminals were used for manually editing or inputting data. Because the optimizing parameters do not represent a very large set of data, it is a simple task to manually input this data in the required format. This data set is resident on a direct access system device (disk pack) on a semi-permanent basis. When a variation or change of parameters is desired, the data set is simply edited to reflect the change.

Following is a list of factors contained in the optimizing parameters. Although their uses may not be immediately obvious, they will become apparent in the explanation of other program phases.

Optimizing Parameters

- Present Year
- Year of Traffic Data
- Number of Periods in Consideration Span
- Number of Periods in Network Program Span
- Length of Periods
- Effective Interest Rate
- Listing Constant
- Should and Must Level Arrays by Functional Class
- Traffic Index Intervals for Strategy Array Selection
- Strategy Array Selection Matrix
- Alternative Array Matrix
- Rehabilitation Alternative Parameters
- Cost Model Delimiters

Reading Project Data

The second phase of the program is the beginning of a large iterative process and involves the inputting of all data needed to describe and analyze one project. These input records are the product of the interpreting program. A list of the data included on each of these records is as follows:

OPTIMIZED PROGRAM

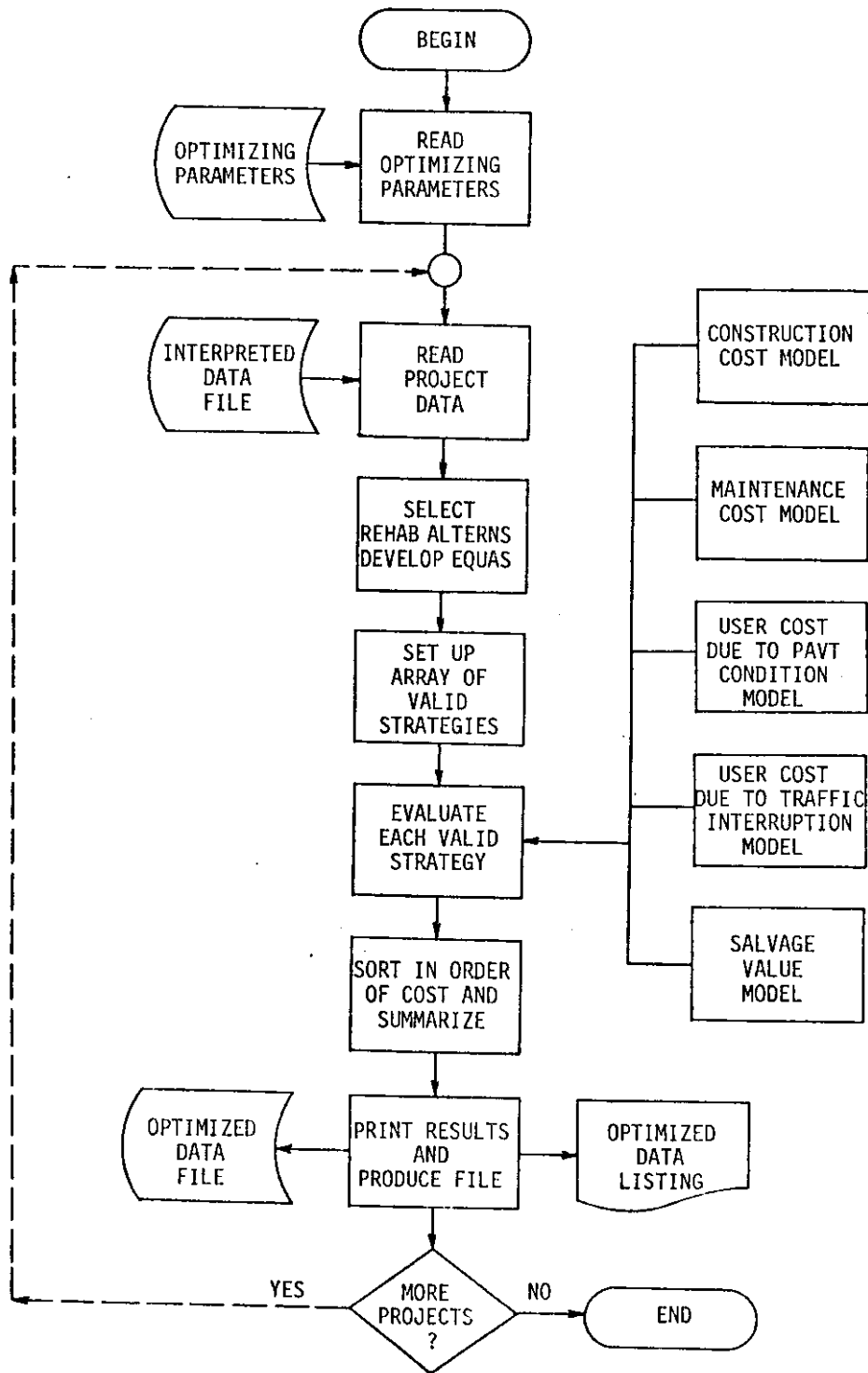


Figure 46. Conceptual Flow Chart of Optimizing Program

Project Input Data

Control Section
Beginning Control Section Milepost
Ending Control Section Milepost
District
State Route Number
Beginning State Route Milepost
Ending State Route Milepost
Length of Project
Urban or Rural
Functional Classification
If highway is divided, which side
Type of Facility
Number of Lanes
Roadway Width
Right Shoulder Width
Left Shoulder Width
Last Contract Number
Contract Type
Surfacing Layer Type
Surfacing Layer Thickness
Month and Year of Completion
Underlying Layers of Surfacing
Average Annual Daily Traffic
Yearly Traffic Growth Rate
Single Unit Truck Percentage
K Factor for Reducing ADT to Design Hour Volume
D Factor for Splitting DHV into Directional DHV
Traffic Index (logarithm of accumulated 5K wheel loads)
Performance Equation Constants
R Squared Value Associated with Performance Equation
Standard Error of Estimate
Projected Ages to Rating Levels of 60, 40, and 20
A Summary of Each Generation of Performance

Selecting Rehabilitation Alternatives and Developing Their Expected Performance Equations

This phase of the program has two purposes:

1. To select a reasonable set of rehabilitation alternatives for each individual project for later evaluation in the program.
2. To develop performance equations for the alternatives chosen so they can be evaluated.

The first task is handled by three basic components:

1. Selection Matrix
2. Array of alternative combinations
3. Array of rehabilitation alternatives

As can be seen in Figure 47, this process begins in the Selection Matrix. Based on the pavement type, functional classification, and traffic index, or

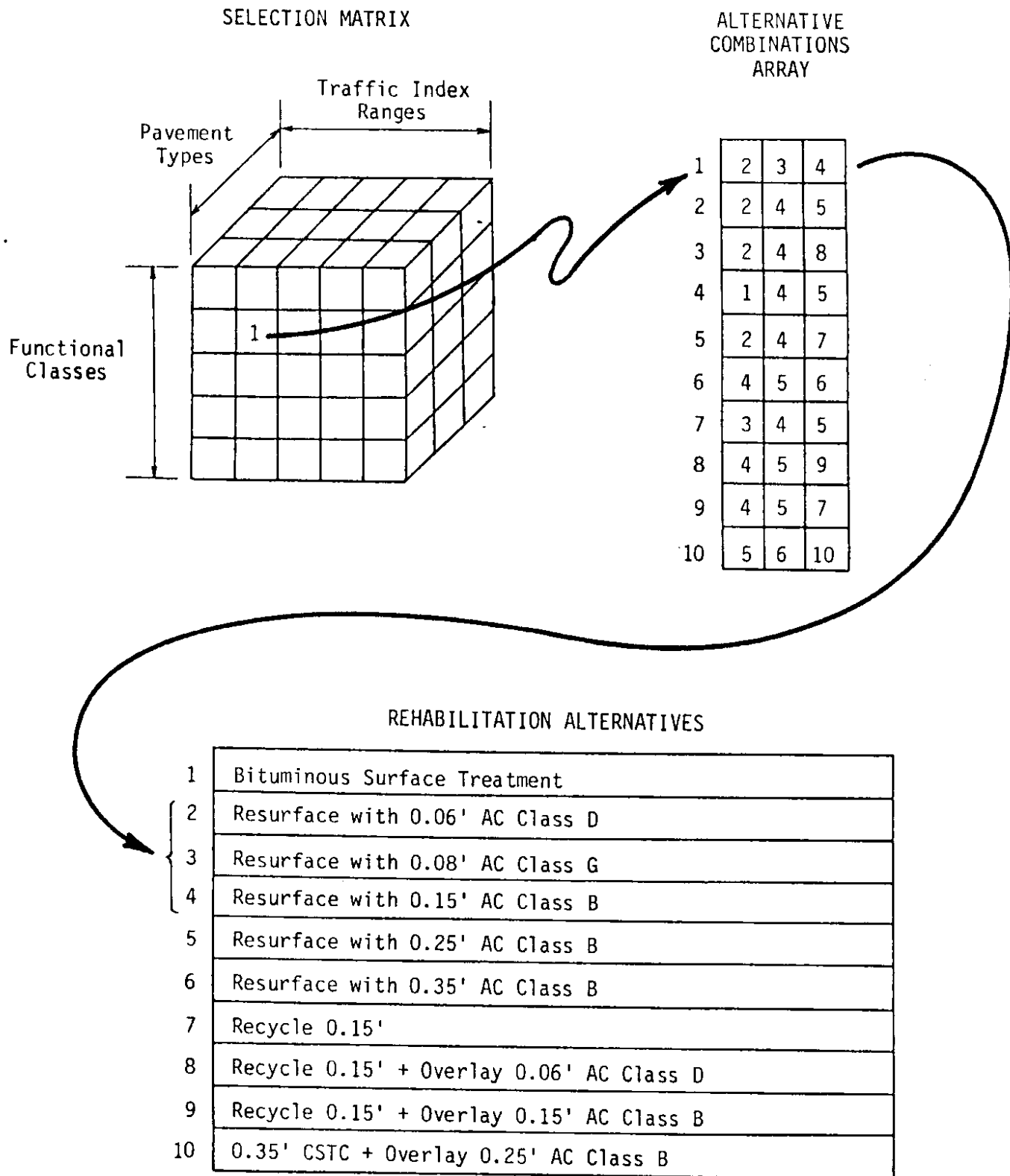


Figure 47. Process for Selecting Rehabilitation Alternatives

T.I. which is the logarithm of accumulated 5K wheel loads over a 10-year period, a particular cell in the matrix is addressed. This cell contains an index number that directs the program to one of many specific sets, or combinations, of rehabilitation alternatives contained in an array. Each set in this array contains three numbers which in turn identify the specific rehabilitation alternatives to be analyzed in the program. Each alternative carries with it certain parameters that will be used to:

- develop its performance equation
- determine its construction cost, and
- determine time of traffic delay during construction.

The use of this mechanism allows the program to initially consider an unlimited number of rehabilitation alternatives and reduces this number to three suitable alternatives for a particular project with certain attributes, namely; pavement type, functional classification, and traffic index.

These criteria were chosen for obvious reasons:

Pavement type - because different pavement types will inherently require different types of rehabilitation.

Functional class - because it is both a measure of the importance of the route (and possibly tolerance of lower level of service) and it is also a rough indicator of overall traffic volume, and

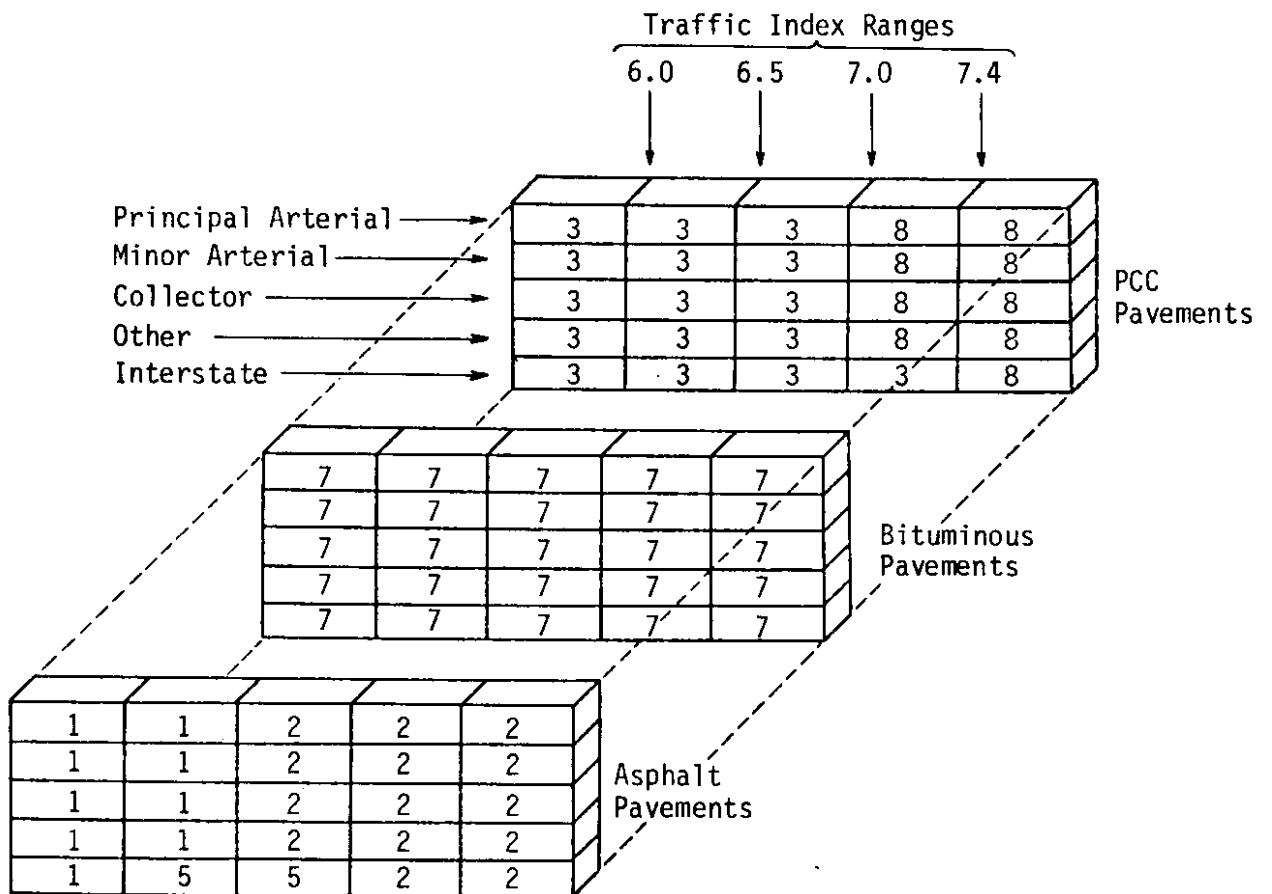
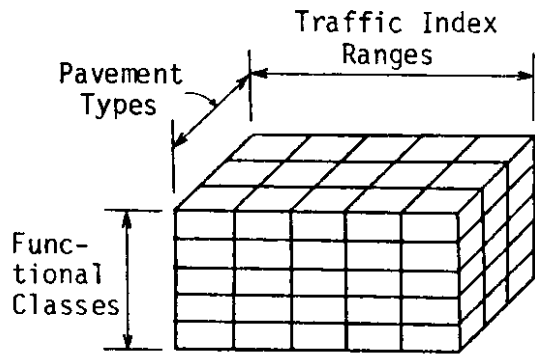
Traffic index - because this is a measure of the loading anticipated on the pavement--a major factor in pavement design.

Figure 48 is a more detailed illustration of the Selection Matrix.

The second task in this program is the development of performance equations for each of the alternatives selected. This process is based on relating the expected performance of the rehabilitation alternative to its average performance when placed on the type of pavement in place on the project, and tempered with how the pavement in place has performed. Because the existing pavement's performance is related to traffic loadings, environmental conditions such as weather and foundation support, and original construction quality, it is assumed the influencing factors for performance of the rehabilitated pavement will not change significantly and future performance will be related to the original pavement's performance.

The form of the equation generated in this phase is identical to that developed for the existing pavement in the Interpreting Program, i.e.,

$$R = C - mA^B$$



SELECTION MATRIX

Figure 48. Selection Matrix

In this equation, R and A represent the dependent and independent variables, rating and age respectively; C is the model constant for the maximum rating which approximates 100; and m and B are the slope coefficient and the degree of curvature exponent respectively which must be determined.

In order to determine the values for m and B in this equation, there are two main considerations:

1. Length of the curve (pavement age)
2. Degree of curvature, or shape of curve

It should be understood that these equations are used to: (1) determine the useful life of each specific rehabilitation alternative; and (2) to provide a datum, or reference line, that can be used for estimating certain categories of cost in economic analysis. Thus, length of curve and degree of curvature are the two basic considerations.

Length of Curve

The method for determining the length of curve for each alternative in this system is based on the age of pavement when its performance curve reaches the MUST level specified in the parameters. This is determined in the program by applying a factor to the projected life of the pavement in place, i.e.,

$$\begin{aligned} \text{Age of Alt. at Must} &= (\text{Age of Exist. Pavt. at Must}) \times (\text{Factor}) \quad \text{or} \\ \text{Life of Alternative} &= (\text{Projected Life of Pavt. in Place}) \times (\text{Factor}) \end{aligned}$$

These factors, arbitrarily called Equation Factors, are computed with the following formula:

$$\text{Equation Factor} = \frac{\text{Typical Life of Altern. Y Applied on Pavt. Type A}}{\text{Typical Life of Pavement Type A}}$$

As an example, consider that a full depth asphalt pavement in the State of Washington usually has a life expectancy of approximately 12 years. When overlaid with 0.15 ft of asphalt concrete, the pavement will, under normal conditions, last an additional 10 years. An equation factor for a 0.15-ft AC overlay on an existing full depth AC would then be:

$$\text{Equation Factor} = \frac{10 \text{ years (0.15-ft AC)}}{12 \text{ years (full depth AC)}} = 0.83$$

However, when estimating the life expectancy of a 0.15-ft AC on a specific project with full depth AC, it is noted that the existing pavement has a projected life of only 10 years. The program would then estimate that a 0.15-ft AC overlay would last only 8.3 years and not the average 10 years.

Degree of Curvature

The degree of curvature in the performance equation ($R = C - mA^B$) is controlled by the constant B . In studying a large number of performance curves produced by the interpreting program, it was noted that the degree of curvature is inversely proportional to the life of the pavement, i.e.,

$$B = \frac{K}{A}$$

where K is a constant representing the proportionality.

By studying the general form of the performance equation, it was quickly found that by solving the equation for B the same basic form was obtained.

$$B = \frac{\log \left(\frac{100-R}{m} \right)}{\log A} \quad \text{or} \quad B = \frac{\log K}{\log A}$$

$$\text{where: } K = \frac{100-R}{m}$$

Since R in the above equations is actually R_{must} , the MUST level of rating, and A is the age of pavement at the MUST level determined by the equation factor, then B is a function of the slope coefficient m , i.e.,

$$B = f(m) \text{ where } f(m) = \frac{\log \left(\frac{100-R_{\text{must}}}{m} \right)}{\log A_{\text{must}}}$$

Determining the coefficient constant, m , for the performance equation was the last item needed for developing performance equations for the rehabilitation alternatives. By selecting all performance equations with a coefficient of determination (R^2) equal to or greater than 0.85 for each type of rehabilitation, average values of m were developed for each. Figure 49 is a table of some typical rehabilitation alternatives with their respective equation factors and m values. Figure 50 is an example of a typical family of curves for one alternative type illustrating the relationship between age and degree of curvature as developed with this procedure.

Developing Equations for the Alternatives When the Existing Pavement has been Rehabilitated Previously

The procedure just described was developed for application on pavements that have not been rehabilitated since they were first built. Obviously, if an equation factor was applied to a rehabilitated pavement with a projected performance of very short duration, the expected life of alternatives estimated

TABLE OF TYPICAL REHABILITATION ALTERNATIVES

| Description of Alternates | Constr. Cost* | Equation Factors | | | "m" Value |
|----------------------------------|---------------|------------------|------|------|-----------|
| | | AC | Bit | PCC | |
| Bituminous Surface Treatment | 14,300 | 0.63 | 1.00 | -- | 8.27407 |
| Resurface with 0.06' AC Class D | 23,100 | 0.69 | -- | 0.30 | 0.66181 |
| Resurface with 0.08' AC Class G | 22,000 | 0.82 | -- | -- | 0.66181 |
| Resurface with 0.15' AC Class B | 35,800 | 0.96 | 1.51 | 0.42 | 0.22686 |
| Resurface with 0.25' AC Class B | 59,600 | 1.25 | 1.98 | 0.55 | 0.05231 |
| Resurface with 0.35' AC Class B | 68,500 | 1.79 | 2.82 | 0.79 | 0.13558 |
| Recycle 0.15' | 45,000 | 0.69 | -- | -- | 0.66181 |
| Recycle 0.15' + 0.06' AC Class D | 68,100 | 0.96 | -- | -- | 0.22686 |
| 0.35' CSTC + 0.25' AC Class B | 68,500 | -- | -- | 0.79 | 0.13558 |

*Construction Cost = Cost per 12' Lane-Mile

Figure 49. Table of Rehabilitation Alternatives

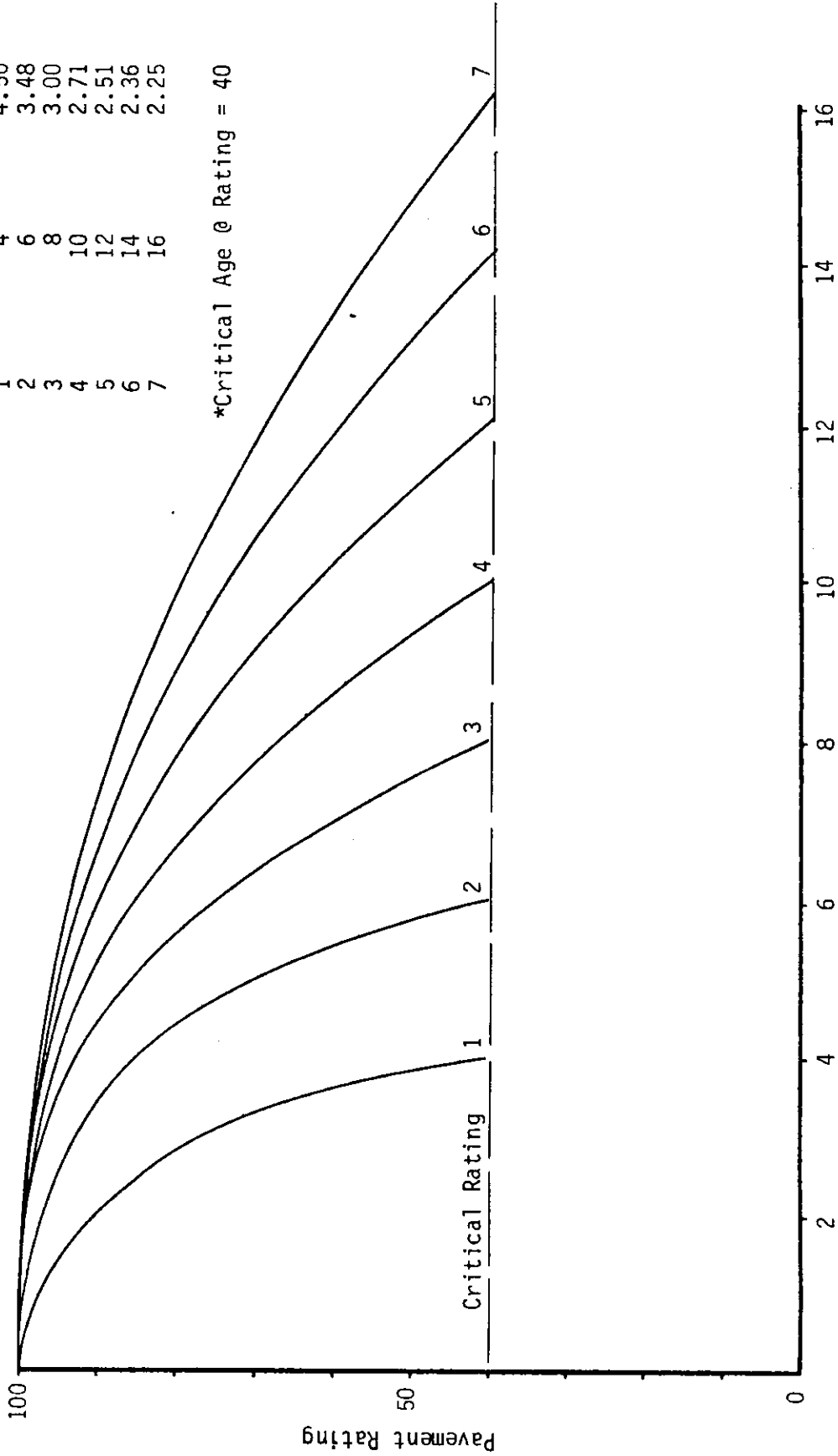
General Equation Form:

$$m = 0.1171875$$

$$\text{Pavement Rating} = 100 - m \text{ Age}^{\beta}$$

| Curve | Crit. Age* | Exp. β |
|-------|------------|--------------|
| 1 | 4 | 4.50 |
| 2 | 6 | 3.48 |
| 3 | 8 | 3.00 |
| 4 | 10 | 2.71 |
| 5 | 12 | 2.51 |
| 6 | 14 | 2.36 |
| 7 | 16 | 2.25 |

*Critical Age @ Rating = 40



Pavement Age, Years

Figure 50. Typical Family of Curves

in this way would not be reasonable. To allow for this, a somewhat inverted procedure is applied to a rehabilitated pavement prior to the above procedure.

Since equation factors relate performance of a rehabilitation type to the life of the original pavement, the type and thickness of rehabilitation presently existing are determined from the project description and used to identify the properly associated equation factor. The projected life of the pavement in place is then divided by this equation factor to estimate the life of original pavement to which the previously described procedure can be applied, i.e.,

$$\text{Estimated Life of Orig. Pavt.} = \frac{\text{Projected Life of Rehabilitated Pavt.}}{\text{Appropriate Equation Factor}}$$

$$\text{Life of Alternative} = (\text{Estimated Life of Orig. Pavt.}) \times (\text{Factor})$$

Comment on Method of Developing Equations for Alternatives

It should be noted that the procedures just described are very theoretical. However, this procedure does provide a reasonable means for comparing the predicted performance of rehabilitation alternatives. It is felt that over a period of time and with the acquisition of new data each time the pavements are rated, this process can be verified, or improved, through modification to produce more reasonable estimates. This procedure is simply that--an estimating procedure.

Setting Up the Array of Valid Strategies

This program phase is concerned with generating all strategies possible with the alternatives selected in the preceding phase. In this system, a rehabilitation strategy is defined as a combination of alternatives applied within a specified period (consideration period) identified by type, sequence, and specific application time.

In the preceding phase, three rehabilitation alternatives were selected for consideration on a specific project. In addition to these alternatives, the option of continuing "routine maintenance" is always considered. Each project, then, has four alternatives for analysis in generating and studying strategies for maintaining pavement condition:

- Alternative 1: Routine Maintenance - always considered
 - Alternative 2: Rehabilitation Option 1
 - Alternative 3: Rehabilitation Option 2
 - Alternative 4: Rehabilitation Option 3
- } — Selected in
Preceding Phase

Since the program considers four possible cycles of application in its analysis, there are 121 combinations of alternatives involving type and sequence as shown in Figure 51.

| No. | Alternatives | No. | Alternatives | No. | Alternatives |
|-----|--------------|-----|--------------|-----|--------------|
| 1 | 1 | 41 | 2-2-2-2 | 86 | 3-4-2-2 |
| 2 | 2 | 42 | 2-2-2-3 | 87 | 3-4-2-3 |
| 3 | 3 | 43 | 2-2-2-4 | 88 | 3-4-2-4 |
| 4 | 4 | 44 | 2-2-3-2 | 89 | 3-4-3-2 |
| 5 | 2-2 | 45 | 2-2-3-3 | 90 | 3-4-3-3 |
| 6 | 2-3 | 46 | 2-2-3-4 | 91 | 3-4-3-4 |
| 7 | 2-4 | 47 | 2-2-4-2 | 92 | 3-4-4-2 |
| 8 | 3-2 | 48 | 2-2-4-3 | 93 | 3-4-4-3 |
| 9 | 3-3 | 49 | 2-2-4-4 | 94 | 3-4-4-4 |
| 10 | 3-4 | 50 | 2-3-2-2 | 95 | 4-2-2-2 |
| 11 | 4-2 | 51 | 2-3-2-3 | 96 | 4-2-2-3 |
| 12 | 4-3 | 52 | 2-3-2-4 | 97 | 4-2-2-4 |
| 13 | 4-4 | 53 | 2-3-3-2 | 98 | 4-2-3-2 |
| 14 | 2-2-2 | 54 | 2-3-3-3 | 99 | 4-2-3-3 |
| 15 | 2-2-3 | 55 | 2-3-3-4 | 100 | 4-2-3-4 |
| 16 | 2-2-4 | 56 | 2-3-4-2 | 101 | 4-2-4-2 |
| 17 | 2-3-2 | 57 | 2-3-4-3 | 102 | 4-2-4-3 |
| 18 | 2-3-3 | 58 | 2-3-4-4 | 103 | 4-2-4-4 |
| 19 | 2-3-4 | 59 | 2-4-2-2 | 104 | 4-3-2-2 |
| 20 | 2-4-2 | 60 | 2-4-2-3 | 105 | 4-3-2-3 |
| 21 | 2-4-3 | 61 | 2-4-2-4 | 106 | 4-3-2-4 |
| 22 | 2-4-4 | 62 | 2-4-3-2 | 107 | 4-3-3-2 |
| 23 | 3-2-2 | 63 | 2-4-3-3 | 108 | 4-3-3-3 |
| 24 | 3-2-3 | 64 | 2-4-3-4 | 109 | 4-3-3-4 |
| 25 | 3-2-4 | 65 | 2-4-4-2 | 110 | 4-3-4-2 |
| 26 | 3-3-2 | 66 | 2-4-4-3 | 111 | 4-3-4-3 |
| 27 | 3-3-3 | 67 | 2-4-4-4 | 112 | 4-3-4-4 |
| 28 | 3-3-4 | 68 | 3-2-2-2 | 113 | 4-4-2-2 |
| 29 | 3-4-2 | 69 | 3-2-2-3 | 114 | 4-4-2-3 |
| 30 | 3-4-3 | 70 | 3-2-2-4 | 115 | 4-4-2-4 |
| 31 | 3-4-4 | 71 | 3-2-3-2 | 116 | 4-4-3-2 |
| 32 | 4-2-2 | 72 | 3-2-3-3 | 117 | 4-4-3-3 |
| 33 | 4-2-3 | 73 | 3-2-3-4 | 118 | 4-4-3-4 |
| 34 | 4-2-4 | 74 | 3-2-4-2 | 119 | 4-4-4-2 |
| 35 | 4-3-2 | 75 | 3-2-4-3 | 120 | 4-4-4-3 |
| 36 | 4-3-3 | 76 | 3-2-4-4 | 121 | 4-4-4-4 |
| 37 | 4-3-4 | 77 | 3-3-2-2 | | |
| 38 | 4-4-2 | 78 | 3-3-2-3 | | |
| 39 | 4-4-3 | 79 | 3-3-2-4 | | |
| 40 | 4-4-4 | 80 | 3-3-3-2 | | |
| | | 81 | 3-3-3-3 | | |
| | | 82 | 3-3-3-4 | | |
| | | 83 | 3-3-4-2 | | |
| | | 84 | 3-3-4-3 | | |
| | | 85 | 3-3-4-4 | | |

Figure 51. Combinations Possible with 3 Alternatives and 4 Application Cycles

In order to determine which strategies to evaluate, each of these combinations is assigned all possible times of application relative to the SHOULD and MUST levels prescribed in the optimizing parameters, and then tested for "validity" within the consideration period.

As an example, consider an analysis of the combination 2-4-3. The performance equation for the existing pavement is evaluated with the SHOULD and MUST rating levels to determine the available time periods for the first rehabilitation. The performance equations for each of the rehabilitation alternatives, 2, 3, and 4, are evaluated in the same way to determine the period of rehabilitation within their own life cycles. Graphically, the results of this preliminary evaluation would look like Figure 52.

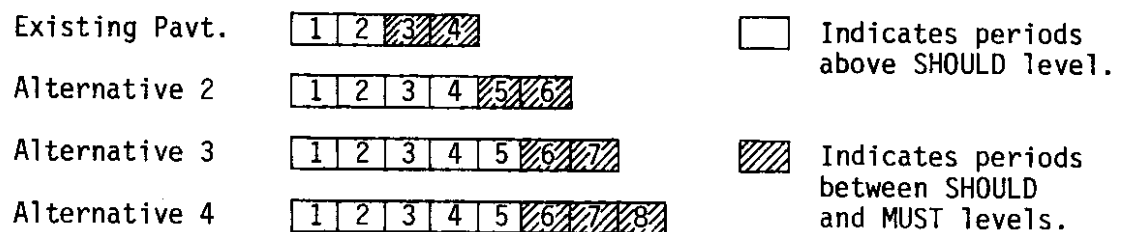


Figure 52. Determining Rehabilitation Timing

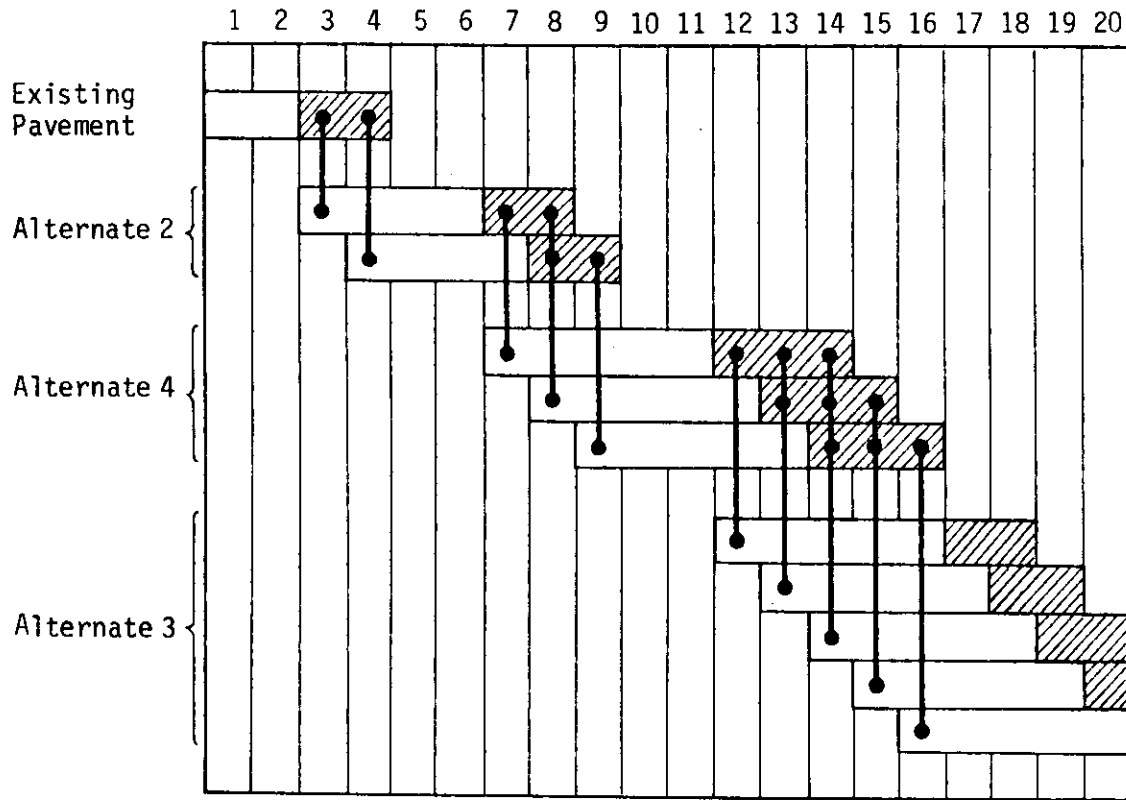
Given a specified period of time for evaluation in the economic analysis (consideration period), all possible "strategies" can then be determined. The program logic utilizes the rehabilitation timing determined for the existing pavement and each alternative in an iterative process to produce "valid" application timing. A "valid" selection of application timing is one which would allow rehabilitation to occur only when the pavement rating falls between the SHOULD and MUST level and which would not allow the pavement rating to fall below the MUST level at the end of the consideration period. A strategy would also be considered invalid if the last alternative in a combination is not needed, i.e., the preceding alternative did not fall below the MUST level before the end of the consideration period. Figure 53 is an illustrative example of the logic used to establish valid strategies and their respective timing.

Note that in the example, combination 2-4-3 produces four valid strategies:

1. (2-3)(4-8)(3-15)
2. (2-4)(4-8)(3-15)
3. (2-4)(4-9)(3-15)
4. (2-4)(4-9)(3-16)

Thus, the strategies are defined by stipulating:

Consideration Time Span = 20 Years



Note: (A - P) A = Alternate
P = Period of Application

| | | | |
|-------|-------|--------|-----------|
| (2-3) | (4-7) | (3-12) | Not valid |
| (2-3) | (4-7) | (3-13) | Not valid |
| (2-3) | (4-7) | (3-14) | Not valid |
| (2-3) | (4-8) | (3-13) | Not valid |
| (2-3) | (4-8) | (3-14) | Not valid |
| (2-3) | (4-8) | (3-15) | Valid |
| (2-4) | (4-8) | (3-13) | Not valid |
| (2-4) | (4-8) | (3-14) | Not valid |
| (2-4) | (4-8) | (3-15) | Valid |
| (2-4) | (4-9) | (3-14) | Not valid |
| (2-4) | (4-9) | (3-15) | Valid |
| (2-4) | (4-9) | (3-16) | Valid |

Figure 53. Analysis of Valid Application Timing for Combination (2-4-3)

$$(A_1-P_1) (A_2-P_2) (A_i-P_i)$$

where: A is the alternative number

P is the period applied

i is the alternative application cycle (varies from 1 to 4)

and the strategies were developed from the combinations shown in Figure 51.

Discussion of Analysis Boundaries

It should be noted that this program considers 3 rehabilitation alternatives with 4 application cycles, and some discussion is merited on just how these numbers were selected. Much consideration, development, analysis of results, subsequent discussion, and redevelopment went into the determination of these analysis boundaries.

It should be obvious that with 121 combinations of sequence and alternatives available, and a number of different application time periods possible for each combination, there is a significantly large number of strategies that will have to be evaluated for each project. Certainly, no more than this would be reasonable, considering program efficiency and cost of operation.

Figure 54 is an example of the different total numbers of combinations possible when varying the number of rehabilitation alternatives and/or application cycles. These totals were computed using the following formula:

$$C = \sum_{i=0}^P A^i$$

where: C = Total number of combinations possible

P = Number of application cycles considered

A = Number of rehabilitation alternatives considered

| | | P - Number of Application Cycles | | | |
|----------------------------|---|----------------------------------|-----|-----|------|
| | | 2 | 3 | 4 | 5 |
| A - Number of Alternatives | 2 | 7 | 15 | 31 | 63 |
| | 3 | 13 | 40 | 121 | 364 |
| | 4 | 21 | 85 | 341 | 1365 |
| | 5 | 31 | 156 | 781 | 3906 |

Figure 54. Number of Possible Combinations

The program developed selects three different, but reasonable, alternatives from as large a list as may be desired. Based on experience, three were determined to be adequate. The parameters--Traffic Index, Functional Class, and Pavement Type--perform a function of selection which might be considered as a "narrowing down" process. Thus the program actually "considers" many more alternatives than those used in the final analysis.

The number of application cycles is related to the number of periods in the consideration period. Since the program was originally designed to accommodate up to 30 periods, it required at least four cycles to analyze alternatives with life expectancies of 7 or 8 years when the existing pavement is in immediate need of rehabilitation. Original versions of this program considered only two applications, and it was quickly found that this had shortcomings in comparing alternatives. Over a long consideration period, repetitive applications of a short-lived thin-lift alternative could not be compared to the application of a long-lived thick-lift alternative. Thus, four application cycles were eventually selected.

Evaluating the Valid Strategies

With three reasonable rehabilitation alternatives selected, performance equations developed for each, and all valid rehabilitation strategies identified, the next process in this program is the evaluation of each on the basis of overall total cost. This process involves several cost models, some of which are related to estimated pavement condition, and others that are related only to the chosen action.

There are seven basic cost factors involved in the evaluation of each valid strategy:

1. Construction cost of all rehabilitative action applied within the consideration period.
2. Cost of preparing the pavement immediately prior to each rehabilitation.
3. Salvage value of the pavement at the end of the consideration period.
4. Routine maintenance cost associated with the pavement throughout the consideration period.
5. User-incurred costs due to pavement condition.
6. User-incurred costs due to delay during rehabilitation.
7. Discounting of all estimates to present worth dollars for comparison.

Construction Cost of Each Rehabilitative Action

In order to estimate the construction cost for each rehabilitation alternative, average bid prices for contracts advertised in the preceding year are studied. These costs, which consider only typical projects, include some minor widening, drainage improvement, and normally associated other items such as striping. The total surface area of each project (length x average width) is used to reduce these costs to a cost per 12-ft lane-mile. With typical unit costs developed in this manner for each rehabilitation alternative, an inflation factor must be applied to each in order to estimate present-day costs. These unit costs are input to the program in conjunction with the optimizing parameters. As each alternative is then selected via the Selection Matrix, its unit cost is identified. When each project is read into the program, the physical description including roadway width, shoulder width, and number of lanes is also read. By applying the unit cost of each alternative to the computed surface area (12-ft lane-miles) of a specific project, reasonable and relative costs are generated.

Cost of Pavement Preparation

In rehabilitating different sections of pavement, it was noted that cost for the same treatment may vary widely from one project to another. This variation in cost can be due to contractors' competition, the availability of suitable materials, and differing contract requirements. It can also be attributed to the varying degrees of pavement deterioration which must be rehabilitated. Pavements in very poor condition will require much more preparation than those caught before they get too bad. This preparation cost can account for large differences in the total construction cost of the same alternative when applied to pavements with varying degrees of distress.

During the course of this study it was noted that there were generally three predominant types of preparation applied to asphalt pavement prior to an overlay:

1. Crack sealing
2. Preleveling
3. Pavement removal and replacement

In order to consider the cost of preparation in the economic analysis applied in this program, it was necessary to study the cost of these items as they related to the pavement rating of several recent rehabilitation projects.

The results of that study are shown in Figure 55 which demonstrates the cost of preparation as a function of the condition of the pavement. Also shown in this figure are the relative areas under the curve attributed to the three main components.

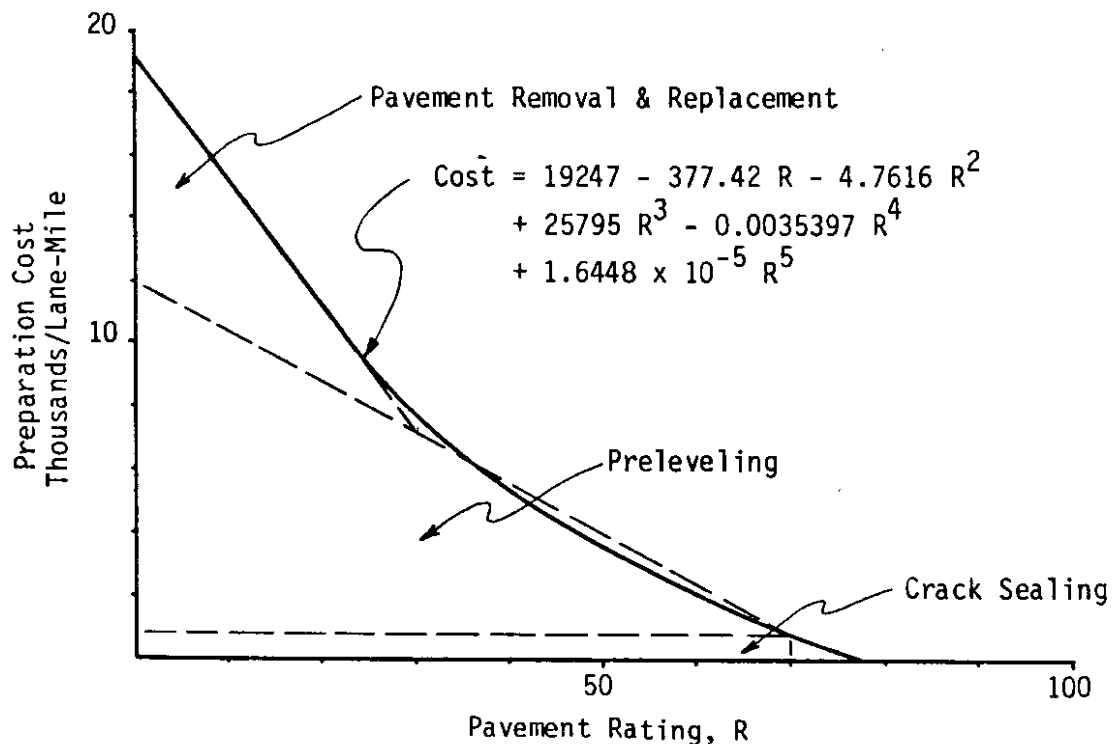


Figure 55. Preparation Cost Model

Salvage Value

In the economic analysis of each strategy, there must be a consideration for the value of the pavement at the end of the consideration period. The term "salvage value" normally conveys a meaning of "worth" at a time late in the useable life of a pavement. The application of salvage value in this analysis is a little different. In order to provide an equitable comparison of rehabilitation strategies, salvage value is used here to associate a dollar amount with the amount of pavement life remaining at the end of the consideration period. This is computed using the following formula:

$$\text{Salvage Value} = \frac{\text{Useable life left in pavement}}{\text{Total expected life of last action}} \times \text{Construction cost of last action}$$

The useable life left in the pavement is the time projected to again reach the MUST level after the end of the consideration period.

Routine Maintenance Cost

Routine maintenance costs have presented a problem to almost every agency attempting to develop a pavement management system. Because sufficient records have not been kept to relate man-hours, equipment-hours, and material costs for pavement maintenance to either specific projects or a defined level of pavement condition, the state of the art in maintenance cost models has not been greatly developed.

The maintenance cost model used in this program is based on a model originally developed in "Economic Analysis of Roadway Occupancy for Freeway Pavement Maintenance and Rehabilitation" by B. C. Buttler, Jr.⁸, which uses a logit function to relate maintenance costs to pavement age. The model illustrated in that report, however, related maintenance cost to pavement age instead of to pavement condition as was desired for this application.

Even though the logit function was used in Buttler's report to relate pavement maintenance cost to pavement age, it was decided that a sigmoidal curve represented the general relationship of pavement maintenance cost to pavement condition better than other known curve shapes. The general form of this equation is:

$$\text{Cost} = \frac{S}{1 + e^{-f(R)}}$$

where:

Cost = Maintenance Cost

S = Scale factor, or maximum cost level

R = Pavement condition rating

By obtaining typical maintenance costs on several control sections which represented pavements of approximately the same age, a sigmoidal function was calibrated to department costs, and to a typical performance curve relating ratings to age. This function is illustrated in Figure 56.

Note that this function demonstrates three basic phases of maintenance cost related to pavement condition:

1. No maintenance cost when pavement rating is high.
2. Variable maintenance cost in middle ranges of rating.
3. Maximum maintenance cost below a certain rating.

User-Incurred Costs Due to Pavement Condition

As was evident with routine maintenance costs, the topic of users' costs has also presented historic problems to those involved in PMS development. Because so little information in this area was available at the time of development, it was decided to assume a relationship between PSI and the newly developed pavement condition ratings as follows:

| <u>PSI</u> | <u>PMS Rating</u> |
|------------|-------------------|
| 5 | 100 |
| 4 | 80 |
| 3 | 60 |
| 2 | 40 |
| 1 | 20 |

With this assumption, relevant cost information developed by Robley Winfrey⁹ was updated to present values and a cost model then assembled for relating user cost, due to pavement condition, to pavement rating. Because user costs differ greatly between passenger vehicles and commercial trucks, vehicle counts for each are projected for each year in the consideration period. As can be seen in Figure 57, the model relates cost per vehicle-mile for each type to pavement condition.

With the length of project, the counts for autos and trucks, and the projected pavement rating for each year, an estimate of user cost can be generated.

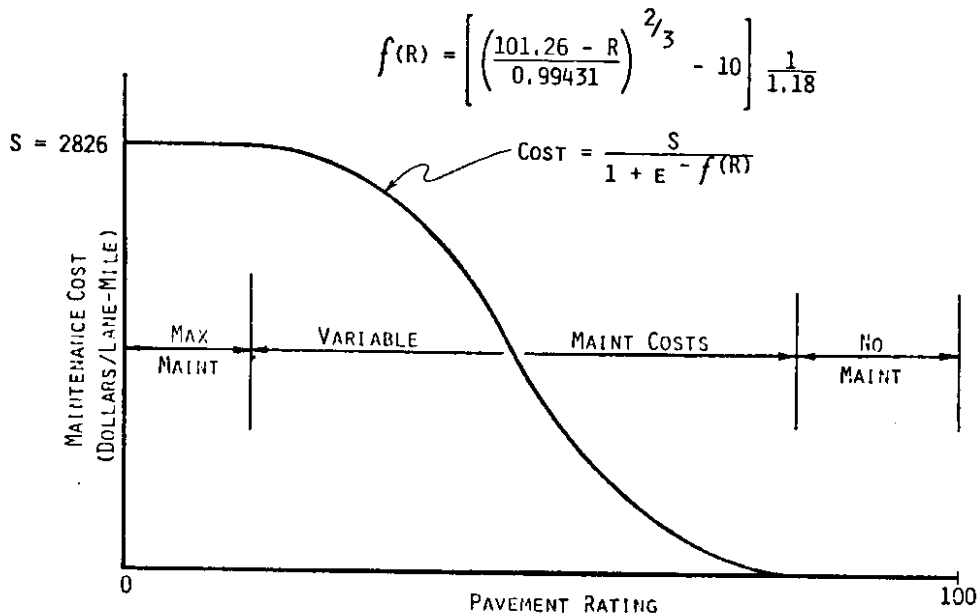


Figure 56. Maintenance Cost Model

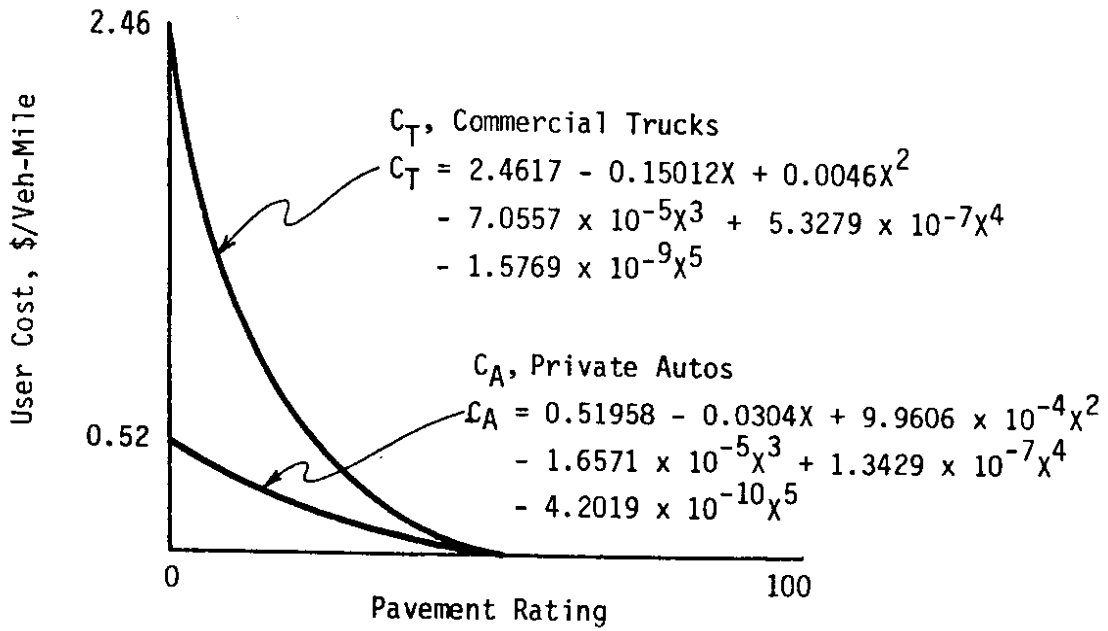


Figure 57. User Cost Function

User-Incurred Cost Due to Traffic Interruption During Construction of Each Alternative

User costs associated with delaying traffic during construction are dependent on the method of handling traffic, the number of lanes, and the volume of traffic. Figures 58 and 59 indicate the possible methods of handling traffic as developed by W. F. McFarland¹⁰. Methods II and III are the only ones considered in the program because they represent the most common approaches to handling traffic as used by WSDOT.

The general equation for developing these costs is:

$$UC = (MT)(P)(ADT)[(TP)K_1 + (1-TP)K_2]$$

where: UC = User Costs due to traffic interruption

MT = Time required to apply overlay

P = Average portion of ADT passing through project

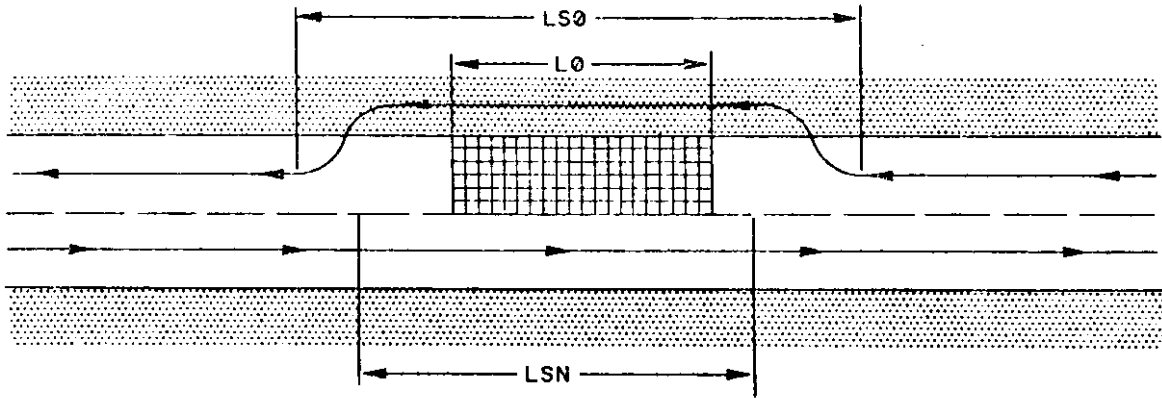
ADT = Average Daily Traffic (one direction only)

TP = Percentage of trucks in ADT

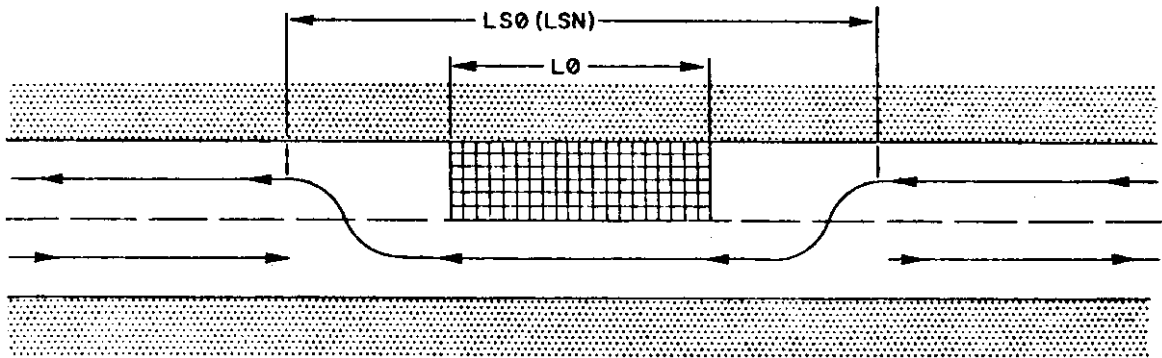
K_1 = User Costs per truck-mile

K_2 = User Costs per vehicle-mile

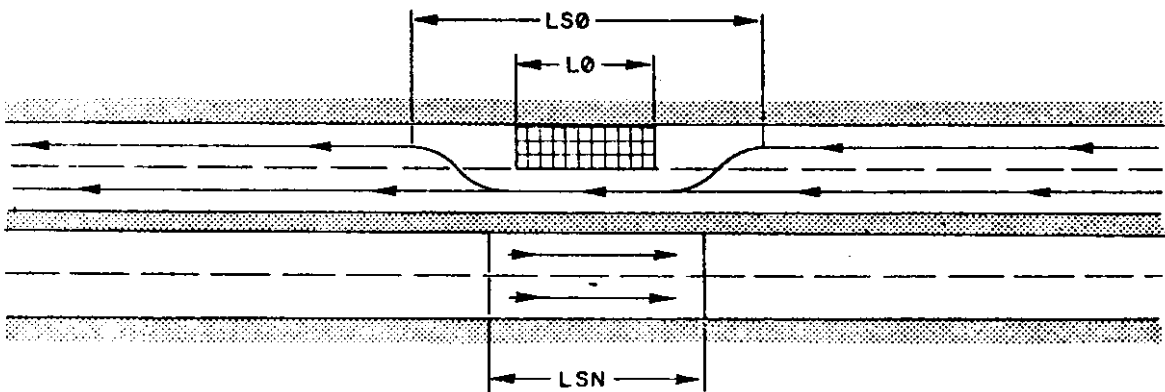
MT is computed based on the depth of overlay at an average rate of 100 tons/hr.



Method I: traffic routed to shoulder.

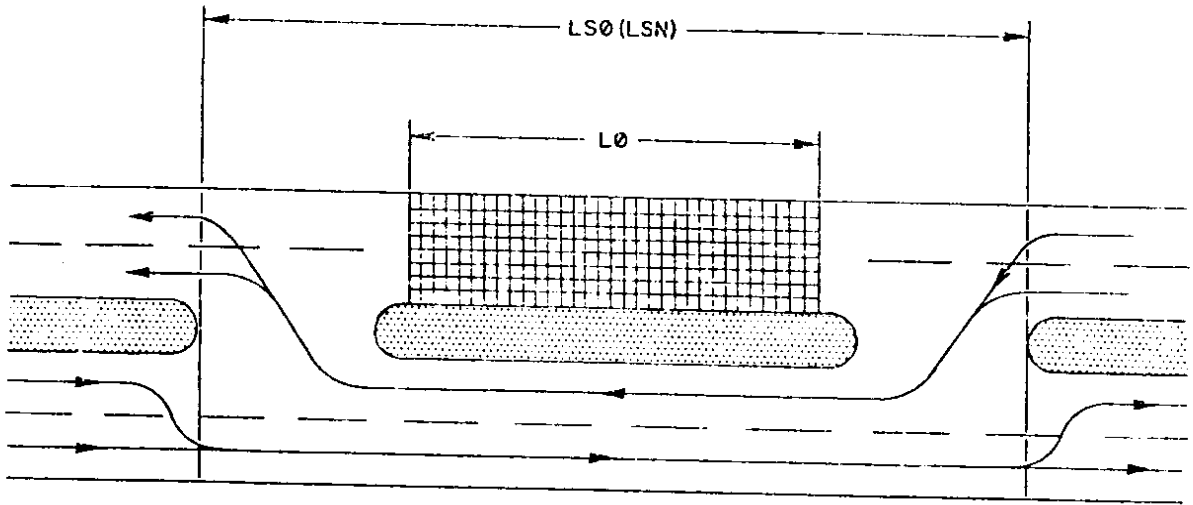


Method II: alternating traffic in one lane.

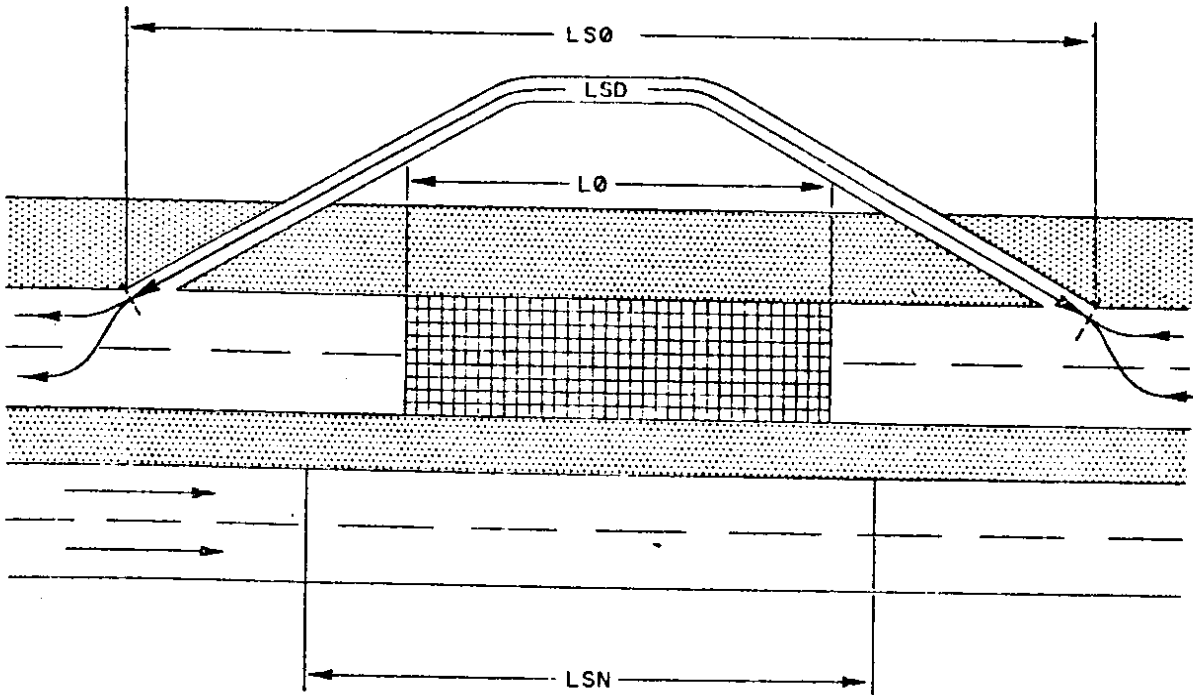


Method III: two lanes merge, nonoverlay direction not affected.

Figure 58. Traffic Interruption Methods



Method IV: overlay direction traffic routed to nonoverlay lanes.



Method V: overlay direction traffic routed to frontage road or other parallel route.

Figure 59. Traffic Interruption Methods

P is 0.06 for rural areas and 0.055 for urban areas as stated in HRB (1972) "Pavement Rehabilitation--Materials and Techniques," NCHRP Synthesis of Highway Practice 9, 41 p.¹¹.

ADT is projected to the specific year of construction for each alternative using the growth factors. TP is input with the project description data along with the base year ADT.

K₁ and K₂ are both related to the length of the construction area and the volume of traffic which must be handled. Assuming an affected length of 1.5 miles, and after updating truck and auto data, functions were developed to determine K₁ and K₂ for Method II from the total vehicle miles involved. These functions are illustrated in Figure 60.

K₁ and K₂ were determined to be 0.9435 and 0.1237, respectively, for Method III.

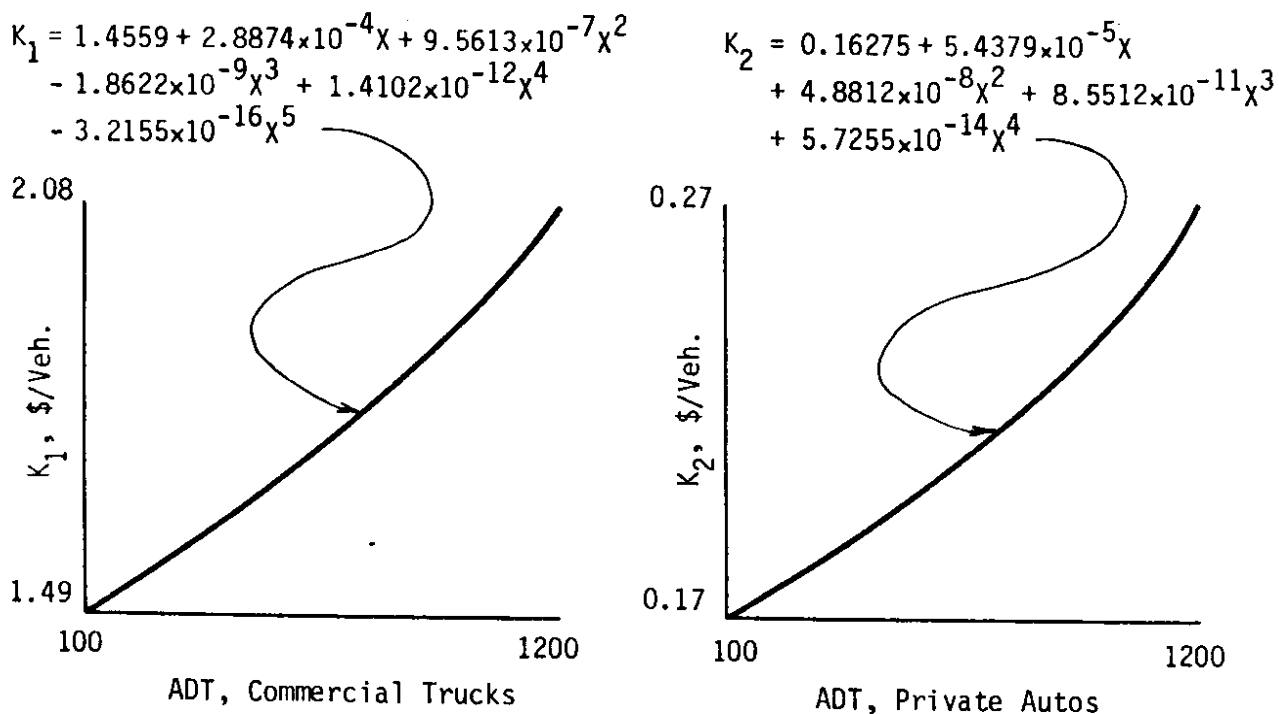


Figure 60. Vehicle Cost Functions for Traffic Interruption

Discounting Costs to Present Worth

Total project costs for each year in the consideration period are estimated according to the models just described. In order to economically gauge the timing, and more specifically the effect of interest rates and inflation on the timing of expenditures, all costs are discounted to present worth prior

to summation. This is accomplished by calculating a discount factor for each year according to the formula:

$$DF = \frac{1}{(1 + EI)^N}$$

where: DF = Discount Factor

EI = Effective Interest (interest rate - inflation rate)

N = Number of each consecutive year in the consideration period

These factors are then applied to the total costs estimated for each year.

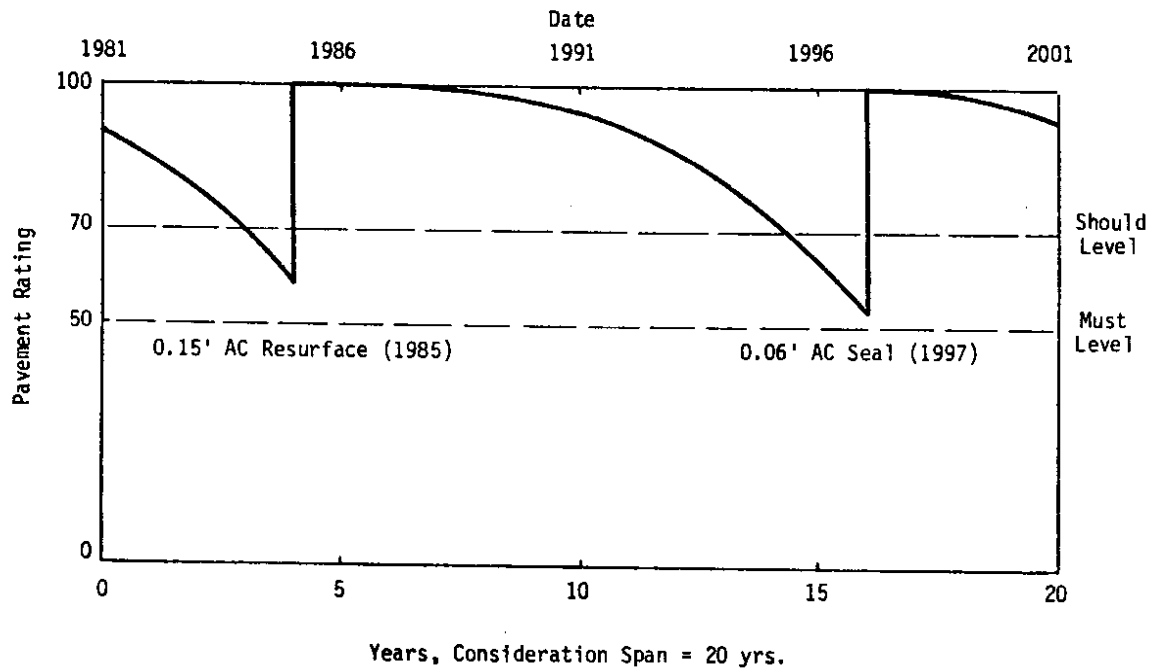
Program Output

Figure 61 is an example of the economic evaluation of one strategy with the tabulation of all costs involved for each year of the consideration span. The top portion of this figure illustrates graphically what type of performance can be expected by resurfacing in 1985 with 0.15-ft AC and again in 1997 with 0.06-ft AC seal. The tabulation in the lower portion lists not only the cost each year per category, but also projected pavement ratings, auto volumes, truck volumes, and the discount factors used to calculate these costs. The information shown at the bottom represents the initial data used to generate the traffic volumes and discount figures.

Figure 62 is an example of the output listing generated by the optimizing program for one project and represents the result of a long evolution of different output formats. To explain this listing, it has been segmented into five blocks of data as shown in Figure 63.

The top portion of this listing, as shown in Figure 64, labeled "Project Description and Performance," is identical to the upper half of the output listing generated by the interpreting program. This was explained in detail in Chapter 3.

The next block of data labeled "Optimizing Parameters" and shown in Figure 65 lists the parameters used in the analysis. The top two statements list the should and must levels and identify the specific year when these rating levels will be attained on the existing pavement. The next statement defines the consideration span in terms of period and explains the length of each period. The provision of changing the length of periods allows for considering two-year periods, or bienniums, for budgeting purposes, or possibly five-year periods when analyzing rigid pavements. The last line of information in this block indicates the effective interest applied in discounting and the equation factors used to develop the performance equations for the alternatives.



| | Predicted | | | Constr Cost | Prep Cost | Traffic Interr. Cost | Maint Cost | User Cost | Total Annual Cost | * Discount Factor |
|----|-------------|-------------|--------------|-------------|-----------|----------------------|------------|-----------|-------------------|-------------------|
| | Pavt Rating | Auto Volume | Truck Volume | | | | | | | |
| 1 | 84.94 | 26,683 | 6,259 | | | | | | | |
| 2 | 78.48 | 28,563 | 6,700 | | | | 1,128 | 13,971 | 15,099 | 0.9615 |
| 3 | 70.19 | 30,443 | 7,141 | | | | 3,723 | 14,561 | 18,284 | 0.9246 |
| 4 | 59.74 | 32,323 | 7,582 | 387,218 | 15,974 | 26,239 | 10,639 | 15,469 | 26,108 | 0.8890 |
| 5 | 99.97 | 34,203 | 8,023 | | | | 0 | 16,917 | 446,348 | 0.8548 |
| 6 | 99.78 | 36,083 | 8,464 | | | | 12 | 14,903 | 14,915 | 0.8219 |
| 7 | 99.27 | 37,963 | 8,905 | | | | 12 | 15,196 | 15,208 | 0.7903 |
| 8 | 98.26 | 39,843 | 9,346 | | | | 15 | 15,497 | 15,512 | 0.7599 |
| 9 | 96.61 | 41,723 | 9,787 | | | | 22 | 15,816 | 15,838 | 0.7307 |
| 10 | 94.14 | 43,603 | 10,228 | | | | 39 | 16,135 | 16,174 | 0.7026 |
| 11 | 90.69 | 45,483 | 10,669 | | | | 81 | 16,405 | 16,486 | 0.6756 |
| 12 | 86.11 | 47,363 | 11,110 | | | | 199 | 16,571 | 16,770 | 0.6496 |
| 13 | 80.22 | 49,243 | 11,551 | | | | 569 | 16,638 | 17,207 | 0.6246 |
| 14 | 72.87 | 51,123 | 11,992 | | | | 1,786 | 16,732 | 18,518 | 0.6006 |
| 15 | 63.89 | 53,003 | 12,433 | | | | 5,207 | 17,100 | 22,307 | 0.5775 |
| 16 | 53.11 | 54,883 | 12,874 | 156,057 | 14,970 | 21,399 | 10,143 | 17,953 | 28,096 | 0.5553 |
| 17 | 99.71 | 56,763 | 13,315 | | | | 0 | 19,226 | 211,652 | 0.5339 |
| 18 | 98.63 | 58,643 | 13,756 | | | | 8 | 15,851 | 15,859 | 0.5134 |
| 19 | 96.59 | 60,523 | 14,197 | | | | 12 | 15,927 | 15,939 | 0.4936 |
| 20 | 93.49 | 62,403 | 14,638 | | | | 26 | 16,045 | 16,071 | 0.4746 |
| | | | | | | | 66 | 16,101 | 16,167 | 0.4564 |

1980 ADT = 28,300

Trucks = 19%

Growth Rate = 8.2%

Effective Interest = 4%

Subtotal \$978,558

Salvage Value -81,219

TOTAL STRATEGY COST = \$897,339

*Note: All costs in table have been discounted with listed discount factors.

Figure 61. Tabulation of Cost Evaluation

01/18/82

P677300PT

REG SR SRMP END CS REG FND PROJ FNC SIDE HWY NUM RDW-RSH-LSH LAST COMPLY CNT SURFACE BASE
 0 5 2638 2930 801 560 852 292 R-5 L 3 2 36 10 6 08759 9-71 0 40 70 21

 M-YR TYP-TPK TYPE

| PERFORMANCE HISTORY | | APPROXIMATE TRAFFIC DATA | | PERFORMANCE EQUATION | |
|---------------------|-------|--------------------------|------|----------------------|------------|
| YEAR | 73 | 77 | 79 | EQUA CONST | = 100.46 |
| AGE | 2 | 6 | 8 | EQUA COEFF | = -0.00106 |
| RIDE | 1.00 | 1.00 | 1.00 | EQUA POWER | = 4.00 |
| STUPCR | 100.0 | 100.0 | 97.4 | R SQUARE | = 0.97184 |
| CONCR | 100.0 | 99.9 | 97.2 | STD ERROR | = 0.78 |
| HIGH | 100.0 | 99.9 | 99.9 | TIME TO 60 | = 13.98 |
| LOW | 199.8 | 99.6 | 94.8 | TIME TO 40 | = 15.45 |
| HIGH FRICTION | 40 | 48 | 48 | TIME TO 20 | = 16.60 |
| AVG FRICTION | 40 | 48 | 48 | | |

SHOULD REHABILITATE AT 70.0 WHICH WILL OCCUR IN 1984
 MUST REHABILITATE AT 50.0 WHICH WILL OCCUR IN 1986
 CONSIDERATION SPAN = 20 PERIODS, FACTOR = 1.0 YEARS
 EFFECTIVE INTEREST RATE = 4.0% FACTORS : 67.0% 83.0% 100.0%

| DESCRIPTION OF THE ALTERNATIVES | | PERFORMANCE EQUATIONS | | CONSTRUCT COST | | MIN LIFE | | MAX LIFE | |
|---------------------------------|------------------------|-----------------------|---------------------|----------------|-------|----------|-------|----------|-------|
| ALTERNATE 1 | ROUTINE MAINTENANCE | P = 100.46 | = 0.00106 P ** 4.00 | 0 | 0 | 13.02 | 13.02 | 14.77 | 14.77 |
| ALTERNATE 2 | OVERLAY 0.06 CLASS D | R = 100.00 | = 0.28783 P ** 2.25 | 23100 | 23100 | 7.89 | 7.89 | 9.90 | 9.90 |
| ALTERNATE 3 | OVERLAY 0.15 CLASS R | R = 100.00 | = 0.02713 P ** 3.00 | 35800 | 35800 | 10.34 | 10.34 | 12.26 | 12.26 |
| ALTERNATE 4 | PFCYCLE + 0.06 CLASS D | R = 100.00 | = 0.01551 P ** 3.00 | 68100 | 68100 | 12.46 | 12.46 | 14.77 | 14.77 |

| ROUT MAINT COST | | COST OF TRAFFIC INTERPT | | USERP COST | | SALVAGE VALUE | | EXPECTED TOTAL COST | | NUMR POSS | | STRATEGY DESCRIPTION | | | |
|-----------------|--------|-------------------------|-------|------------|--------|---------------|----|---------------------|----|-----------|------|---|--|--|--|
| 31930 | 452691 | 411K9 | 406K5 | 322760 | 31555 | 817015 | 26 | 817015 | 26 | 2-94 | 2-94 | (ALTERNATIVE - PRD APPLIED) | | | |
| 27689 | 458887 | 47638 | 47069 | 323015 | 16777 | 833653 | 18 | 833653 | 18 | 2-93 | 2-93 | 1ST REHAB 2ND REHAB 3RD REHAB 4TH REHAB | | | |
| 23876 | 574218 | 47069 | 47069 | 321377 | 61219 | 897339 | 9 | 912723 | 9 | 2-97 | 2-97 | | | | |
| 31143 | 585276 | 703K6 | 69312 | 321932 | 67975 | 922723 | 9 | 1220317 | 9 | 2-96 | 2-96 | | | | |
| 21925 | 932025 | | | 320058 | 111519 | 1247736 | 9 | 1247736 | 9 | 4-85 | 4-85 | | | | |

Figure 62. Optimizing Program Listing

Optimizing Parameters

Project Description and Performance

| D | SP | REG | END | HEG | END | PROJ | FNC | Hwy | NUM | ROW | RSH | LSM | LAST | COMPLT | CNT | SURFACE | BASE | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|---------|-------|----|----|----|
| | | | | | | | | | | | | | | | | | | | | |
| 3 | 5 | 13554 | 13950 | 2719 | 0 | 396 | 396 | U-5 | P | 3 | 4 | 48 | 10 | 10 | 08603 | 5-70 | 20 | 40 | 33 | 11 |

| PERFORMANCE HISTORY | | | | | APPROXIMATE TRAFFIC DATA | | | | | PERFORMANCE EQUATION | | | | | | | | | | | | | | | | | | | | |
|---------------------|-----|------|--------|-------|--------------------------|-----|------|-----|-----|----------------------|-------------|--------------|--------------|---------------|---------|---------------|---------------|---------------|---------------|--------------------|-----------------------|-------------------|--------------------|------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--|
| YEAR | AGE | RIDE | STRUCR | COMHD | HIGH | LOW | HIGH | LOW | AVG | 79 ADT | GROWTH RATE | SINGLE UNITS | COMBINATIONS | TRAFFIC INDEX | K = 11% | 2 AXLE TRUCKS | 3 AXLE TRUCKS | 4 AXLE TRUCKS | 5 AXLE TRUCKS | EQUA CONST = 98.78 | EQUA COEFF = -0.01384 | EQUA POWER = 3.25 | R SQUARE = 0.93744 | STD ERROR = 1.99 | TIME TO 60 = 11.50 | TIME TO 50 = 12.34 | TIME TO 40 = 13.07 | TIME TO 30 = 13.72 | TIME TO 20 = 14.30 | |
| 71 | 3 | 98.1 | 100.0 | 99.3 | 99.9 | 45 | 43 | 44 | 44 | 78300 | 5.6% | 4% | 6% | 7.9 | 0 = 59% | 2.7% | 2.5% | 0.3% | 4.0% | | | | | | | | | | | |

SHOULD REHABILITATE AT 70.0 WHICH WILL OCCUR IN 1990
 MUST REHABILITATE AT 50.0 WHICH WILL OCCUR IN 1982
 CONSIDERATION SPAN = 20 PERIODS, EACH PERIOD = 1.0 YEARS
 EFFECTIVE INTEREST RATE = 0.0% FACTORS : 67.0% 83.0% 100.0%

| DESCRIPTION OF THE ALTERNATIVES | | PERFORMANCE EQUATIONS | CONSTRUCT COST | MIN LIFE | MAX LIFE |
|---------------------------------|----------------------|--------------------------|----------------|----------|----------|
| | | | 12' LANE MILE | AT SHUD | AT MUST |
| ALTERNATE 1 | ROUTINE MAINTENANCE | $R = 98.78 - 0.01384 P$ | 0 | 10.49 | 12.34 |
| ALTERNATE 2 | OVERLAY 0.05 CLASS D | $R = 100.00 - 0.30752 P$ | 23100 | 7.66 | 9.61 |
| ALTERNATE 3 | OVERLAY 0.15 CLASS B | $R = 100.00 - 0.10225 P$ | 35800 | 9.70 | 11.90 |
| ALTERNATE 4 | RECYCLE 0.06 CLASS D | $R = 100.00 - 0.01635 P$ | 68100 | 12.10 | 14.30 |

| ITEMIZED COSTS | | | | | | STRATEGY DESCRIPTION | | | | |
|-----------------|-------------------------|-------------------------|-----------|---------------|---------------------|----------------------|-----------------------------|-----------|-----------|-----------|
| ROUT MAINT COST | COST OF CONSTRA INCL PR | COST OF TRAFFIC INTERPT | USER COST | SALVAGE VALUE | EXPECTED TOTAL COST | NUMB POSS | (ALTERNATIVE - PRO APPLIED) | | | |
| | | | | | | | 1ST REHAB | 2ND REHAB | 3RD REHAB | 4TH REHAB |
| 160135 | 1633477 | 0 | 1321989 | 435044 | 2680537 | 155 | | | | |
| 201742 | 1468535 | 0 | 132744 | 497216 | 2697827 | 40 | 2-81 | 2-89 | | |
| 173062 | 1405090 | 0 | 1324666 | 123127 | 2779651 | 50 | 2-85 | 2-90 | | 2-99 |
| 158419 | 1378032 | 0 | 1322639 | 61563 | 2798527 | 20 | 3-81 | 2-93 | | |
| 164796 | 2093525 | 0 | 1307378 | 181594 | 3324132 | 18 | 3-81 | 2-92 | | |
| 143095 | 2120610 | 0 | 1314792 | 242125 | 3335372 | 9 | 4-81 | 2-94 | | |
| | | | | | | 9 | 4-82 | 2-95 | | |

Cost Summary

Summary of Strategies

Rehabilitation Alternatives

Figure 63. Division of Optimizing Program Listing

| 0 | SP | REG | END | REG | END | PROJ | FNC | Hwy | NUM | RDW | BSH | LSH | LAST | COMPLT | CNT | SURFACE | BASE | | | | |
|---------------------|----------|-------|-------|-------|-------|-------|-------|-------|-------|--------------------------|-------|--------|--------|--------|----------------------|----------|-------|----|-------|----|--|
| | | | | | | | | | | | | | | | | | | | | | |
| 3 | 5 | 13554 | 13950 | 2719 | 0 | 396 | 396 | U-5 | P | 3 | 4 | 48 | 10 | 10 | 08603 | 5-70 | 20 | 40 | 33 | 11 | |
| PERFORMANCE HISTORY | | | | | | | | | | APPROXIMATE TRAFFIC DATA | | | | | PERFORMANCE EQUATION | | | | | | |
| YEAR | | 71 | 73 | 75 | 77 | 79 | | | | 79 | ADT | 78300 | EQUA | CONST | = | 98.78 | | | | | |
| AGE | | 1 | 3 | 5 | 7 | 9 | | | | GROWTH | RATE | 5.6% | EQUA | COEFF | = | -0.01384 | | | | | |
| RIDE | RATING | 8.99 | 1.00 | 1.00 | 1.00 | 0.99 | | | | SINGLE | UNITS | 4% | EQUA | POWER | = | 3.25 | | | | | |
| STRUCR | RATING | 100.0 | 97.8 | 93.8 | 93.8 | 81.2 | | | | COMBINATIONS | 6% | R | SQUARE | = | 0.93746 | | | | | | |
| COMRD | RATING | 99.3 | 97.5 | 93.5 | 93.5 | 80.7 | | | | TRAFFIC | INDEX | 7.9 | STD | ERROR | = | 1.99 | | | | | |
| HIGH | RATING | 99.9 | 100.0 | 99.9 | 99.7 | 84.9 | | | | K | = | 11% | D | = | 59% | | | | | | |
| LOW | RATING | 97.9 | 89.7 | 89.2 | 84.2 | 69.8 | | | | 2 | AXLE | TRUCKS | = | 2.7% | TIME | TO | 60 | = | 11.50 | | |
| HIGH | FRICTION | 45 | 45 | 50 | 50 | 52 | | | | 3 | AXLE | TRUCKS | = | 2.5% | TIME | TO | 50 | = | 12.34 | | |
| LOW | FRICTION | 43 | 43 | 48 | 44 | 49 | | | | 4 | AXLE | TRUCKS | = | 2.5% | TIME | TO | 40 | = | 13.07 | | |
| AVG | FRICTION | 44 | 44 | 49 | 48 | 50 | | | | 5 | AXLE | TRUCKS | = | 4.0% | TIME | TO | 30 | = | 13.72 | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Figure 64. Project Description and Performance

SHOULD REHABILITATE AT 70.0 WHICH WILL OCCUR IN 1980
MUST REHABILITATE AT 50.0 WHICH WILL OCCUR IN 1982
CONSIDERATION SPAN = 20 PERIODS, EACH PERIOD = 1.0 YEARS
EFFECTIVE INTEREST RATE = 0.0% FACTORS : 67.0% 83.0% 100.0%

Figure 65. Parameters Used in Analysis

The third block of data, as shown in Figure 66, describes each of the rehabilitation alternatives and provides a performance equation for each respectively. As was mentioned earlier, the first alternative is always to continue routine maintenance. The performance equation opposite this alternative represents the existing pavement. To the right of the performance equations are the unit construction costs related to each of the alternatives. Note that a zero is shown for the first alternative since no actual construction is performed. The cost for routine maintenance varied with the condition of the pavement and is computed from model as described earlier. The final columns of data in this block are labeled "Minimum life at should" and "Maximum life at must". These figures indicate the number of years expected to elapse to reach the should or the must levels from time of construction. The numbers relating to should and must levels for the routine maintenance alternative indicate the elapsed time from day of construction of the pavement in place to reach the should and must levels.

| DESCRIPTION OF THE ALTERNATIVES | PERFORMANCE EQUATIONS | CONSTRUCT COST 12' LANE MILE | MIN LIFE AT SHUD | MAX LIFE AT MUST |
|----------------------------------|--------------------------------|---------------------------------|---------------------|---------------------|
| ALTERNATE 1 ROUTINE MAINTENANCE | P = 98.78 - 0.01384 P ** 3.25 | 0 | 10.49 | 12.34 |
| ALTERNATE 2 OVERLAY 0.06 CLASS D | P = 100.00 - 0.30752 P ** 2.55 | 23100 | 7.56 | 9.61 |
| ALTERNATE 3 OVERLAY 0.15 CLASS B | P = 100.00 - 0.10225 P ** 2.50 | 35800 | 9.70 | 11.90 |
| ALTERNATE 4 RECYCLE 0.06 CLASS 0 | P = 100.00 - 0.01645 P ** 3.00 | 69100 | 12.10 | 14.34 |

Figure 66. Description of Rehabilitation Alternatives

The block of information shown in Figure 67 is a summary of costs accumulated in the consideration span for each category of cost for each of the strategies shown.

| ITEMIZED COSTS | | | | | | |
|-----------------------|------------------------------|-------------------------------|--------------|------------------|---------------------------|--|
| ROUT MAINT COST | COST OF CONSTR INCL PR | COST OF TRAFFIC INTERPT | USER COST | SALVAGE VALUE | EXPECTED TOTAL COST | |
| 160135 | 1633477 | 0 | 1321989 | 435064 | 2680537 | |
| 201764 | 1460535 | 0 | 132744 | 497216 | 2697827 | |
| 173062 | 1405090 | 0 | 1324666 | 123127 | 2779691 | |
| 159419 | 1378032 | 0 | 1322639 | 61563 | 2798527 | |
| 104796 | 2093552 | 0 | 130737A | 181594 | 3324132 | |
| 143095 | 2120610 | 0 | 1314792 | 242125 | 3336372 | |

Figure 67. Summary of Itemized Costs

The final block of information shown in Figure 68 is the summary of strategies. In the early stages of development, the listing generated by the optimizing program showed the top 30 strategies determined by least total cost. A second output format listed all strategies--but this required several pages. The latest form of output "summarizes" the strategies based on the time and type of first rehabilitation action, i.e., several different strategies may all begin with the same alternative in the same time period but differ in types and timing of following actions. Of prime interest to the decision-maker, however, is the first action. For this reason, the strategies were divided into groups based on the time and type of first action. The least expensive strategy in each of these groups is listed in this summary. The column of numbers on the left side of this block indicates the total number of strategies analyzed (possible) and how many strategies were included in each group.

| NUMB POSS | STRATEGY DESCRIPTION | | | |
|--------------|-----------------------------|--------------|--------------|--------------|
| | (ALTERNATIVE - PRD APPLIED) | | | |
| | 1ST REHAB | 2ND REHAB | 3RD REHAB | 4TH REHAB |
| 155 | | | | |
| 40 | 2-81 | 2-89 | 2-98 | |
| 50 | 2-82 | 2-90 | 2-99 | |
| 29 | 3-82 | 2-93 | | |
| 18 | 3-81 | 2-92 | | |
| 9 | 4-81 | 2-94 | | |
| 9 | 4-82 | 2-95 | | |

Figure 68. Summary of Strategies

An example of how this block of information would be read is as follows:

- There were 155 rehabilitation strategies analyzed for this specific project.
- Forty of these strategies began with an alternative 2 (0.06-ft AC overlay) applied in 1981.
- The most cost-effective strategy in the first group was followed by an alternative 2 in 1989 and again in 1998.

Each successive line is read in the same manner. Note that the least costly strategy is at the top and that costs increase going from top to bottom.

Other Considerations

The optimizing program was developed as an analytical tool. By varying certain parameters, this program can be used to analyze the effects of interest, inflation, user impact, overall timing, etc. The framework of this program considers many different categories of cost. Of these, the routine maintenance cost model, the users' cost model relating to pavement condition, and the users' cost model relating to traffic interruption can all be zeroed for no influence. By zeroing the two user cost models, only those costs related to a highway agency's operating budget would be considered. Many variations in cost modeling can be applied with this program to analyze the economics of rehabilitation alternatives.

It is also important to note that this program has been assembled in a modular fashion. As newer information becomes available, the existing models can be updated or replaced very easily without the necessity of complicated editing in a large computer program.

NETWORK-LEVEL PROGRAMMING

The last phase in this pavement management system is network-level programming which is based on the optimum rehabilitation strategy, or alternatively one of the others. By aggregating the recommended rehabilitation actions in each year and tracking the performance and cost of all project segments on the network, a schedule of anticipated action, cost, and performance can be tabulated for a future number of years.

The function of network-level programming is to provide the best information possible to decision-makers for:

- Assembling rehabilitation programs
- Establishing effective funding levels, and
- Identifying the time and extent of future needs.

In order to accomplish this, the predicted performance for all segments of highway pavement in the network must be known as well as the most cost-effective or recommended fix, predicted performance of the fix, and estimate of cost for the fix for each of the sections requiring rehabilitation. With these items estimated, system performance levels can be tracked for each year of a rehabilitation program and levels of funding can be satisfactorily estimated.

In this system, network-level programming begins with the combined results of the interpreting phase and the optimizing phase. The interpreting program provides the performance equations needed to forecast pavement performance for all projects--those which require resurfacing as well as those that do not. The optimizing program provides a recommended fix for each project in need of rehabilitation together with estimated construction cost and a performance equation related to how the fix is expected to perform.

The network-level program generates three summaries for each year of a proposed program:

- Action Summary
- Cost Summary
- Rating Distribution Summary

Figure 69 is an example of the Action Summary generated. Since different "should" and "must" levels can be applied for different functional classes of highways, the particular levels used to develop the schedule of action are indicated at the top of the listing. Below that is a summary of all projects programmed for each year specified by route number and inclusive milepost limits, with a description of the action required and the associated cost--both in

present dollars and dollars inflated to the respective year. Also shown are the functional classification, length of project, and projected rating at time of intended action.

Figure 70 is an example of the Cost Summary. This summarizes by functional classification the gain in average pavement rating on the system anticipated as a result of funding and constructing all projects itemized on the Action Summary, and indicates the total demand on budget dollars for that year. Three types of dollars are shown on the Cost Summary: present dollars, inflated dollars, and discounted dollars. Inflated dollars indicate the estimated cost at time of construction. Present dollars represent a direct comparison to current-day funding levels, and the discounted dollars are shown to gauge the effect of interest and inflation on the particular time of expenditure.

All costs shown on both the Action Summary and the Cost Summary relate only to construction and preparation costs, since the other costs generated in the optimizing program are not considered in the budget analysis.

The last listing produced in the network program on a yearly basis is the Rating Distribution Summary shown in Figure 71. This listing indicates the number of rating-miles present in pavement condition rating groups before and after completion of all proposed action for each year.

The network-level program is thus a summarizing program which takes into account the performance of existing projects and the recommended time of rehabilitation with a performance equation commensurate to the type of fix for each project requiring rehabilitation.

The flow of network analysis utilizes these three listings for a set number of consecutive years (say six years) to compare different programs. By tabulating directly, without any constraint, the summaries for six years (Figure 72), it is realized that there is an enormous volume of need for rehabilitation within the first few years. This need places a corresponding demand on funding which is neither available nor necessarily desirable. Simply, it may not be possible to fund a program like this, nor would it be good management. A tremendous fluctuation in workload from one year to the next is not desirable from a management standpoint because a fairly consistent work force must be maintained. A shift in timing for some of the projects is required to dampen this fluctuation. The specific projects to be delayed are selected by placing them in a priority order based on their effect on system performance.

The assembling of a balanced rehabilitation program by shifting project timing then becomes constrained by what we are trying to accomplish. There are basically two objectives in building a rehabilitation program:

DISTRICT 3
1981 ACTION SUMMARY

| FC | SR | REG SRMP | END SRMP | LENG | CS | REF PTNG | PROPOSED | ACTION | DES | PRESENT COST | INFLATED COST |
|----|----|-------------|-------------|------|------|-------------|------------|---------------|-----|-----------------|------------------|
| U | 3 | 0 | 6 | 363 | 2331 | 18.6 | RITUMINOUS | SURF CLASS | 3 | 4492 | 4941 |
| U | 3 | 224 | 388 | 147 | 2331 | 23.8 | OVERLAY | 0.08 CLASS | 3 | 286483 | 315131 |
| U | 3 | 167 | 167 | 80 | 2331 | 4.7 | OVERLAY | 0.15 CLASS | 3 | 1157785 | 1270563 |
| U | 3 | 240 | 240 | 24 | 2331 | 1.0 | OVERLAY | 0.08 CLASS | 3 | 1359661 | 1395557 |
| P | 3 | 384 | 964 | 574 | 2331 | 20.0 | RITUMINOUS | SURF CL TREAT | 3 | 4131835 | 4555218 |
| P | 3 | 480 | 480 | 4 | 1805 | 1.0 | OVERLAY | 0.08 CLASS | 1 | 70004 | 7704 |
| P | 3 | 516 | 480 | 7 | 1805 | 1.0 | RITUMINOUS | SURF CL TREAT | 1 | 49055 | 53960 |
| P | 3 | 212 | 522 | 6 | 1805 | 1.0 | OVERLAY | 0.08 CLASS | 1 | 4437 | 53220 |
| P | 3 | 213 | 533 | 118 | 1805 | 4.0 | RITUMINOUS | SURF TREAT | 1 | 99887 | 109887 |
| P | 3 | 587 | 587 | 118 | 1805 | 4.0 | OVERLAY | 0.08 CLASS | 1 | 203123 | 2233438 |
| P | 3 | 269 | 587 | 26 | 1805 | 1.0 | OVERLAY | 0.08 CLASS | 1 | 30723 | 33661 |
| U | 5 | 267 | 1024 | 28 | 3401 | 49.3 | RITUMINOUS | 0.25 AC | 2 | 20900 | 266583 |
| U | 5 | 405 | 1040 | 1476 | 3401 | 53.1 | CSTC | 0.25 AC | 2 | 622344 | 665231 |
| U | 5 | 909 | 1090 | 50 | 3407 | 46.8 | CSTC | 0.25 AC | 2 | 10620589 | 1182333 |
| U | 5 | 919 | 1091 | 10 | 3407 | 55.2 | CSTC | 0.25 AC | 2 | 16207589 | 1782333 |
| P | 5 | 24 | 1070 | 161 | 2701 | 58.2 | OVERLAY | 0.08 CLASS | 3 | 159144 | 175060 |
| P | 5 | 170 | 1190 | 161 | 2701 | 58.2 | OVERLAY | 0.08 CLASS | 3 | 169144 | 181060 |
| P | 5 | 190 | 1190 | 240 | 2702 | 38.2 | OVERLAY | 0.08 CLASS | 3 | 12670523 | 1393757 |
| U | 5 | 144 | 1214 | 16 | 2702 | 55.5 | CSTC | 0.25 AC | 2 | 154771 | 160442 |
| U | 5 | 440 | 1244 | 179 | 2718 | 41.4 | CSTC | 0.25 AC | 2 | 56402 | 62042 |
| U | 5 | 59 | 1244 | 479 | 2718 | 41.4 | CSTC | 0.25 AC | 2 | 16547216 | 1820176 |
| U | 5 | 59 | 1295 | 479 | 2719 | 44.5 | CSTC | 0.25 AC | 2 | 16907327 | 1859804 |
| U | 5 | 158 | 1315 | 113 | 2799 | 43.8 | CSTC | 0.25 AC | 2 | 7503251 | 825559 |
| U | 5 | 173 | 1317 | 113 | 2799 | 43.7 | CSTC | 0.25 AC | 2 | 340019 | 387915 |
| U | 5 | 288 | 1328 | 113 | 2799 | 45.9 | CSTC | 0.25 AC | 2 | 3425280 | 377627 |
| U | 5 | 10 | 1341 | 112 | 2799 | 41.9 | CSTC | 0.25 AC | 2 | 619529 | 681547 |
| U | 5 | 43 | 1324 | 112 | 2799 | 40.8 | OVERLAY | 0.08 CLASS | 3 | 105727 | 116293 |
| U | 5 | 43 | 1355 | 112 | 2711 | 33.4 | OVERLAY | 0.08 CLASS | 3 | 334531 | 373368 |
| P | 7 | 364 | 395 | 157 | 2711 | 30.1 | RITUMINOUS | SURF TREAT | 3 | 39411 | 410352 |
| P | 7 | 473 | 473 | 145 | 2711 | 30.1 | RITUMINOUS | SURF TREAT | 3 | 39411 | 410352 |

Figure 69. Network Action Summary

'67XXX

1981 DISTRICT SUMMARY

04/09/80

| FC | RTNG AVG REF ACTN | RTNG AVG AFT ACTN | NUMR PROJ | MILFS ACTED ON | TOTAL MILES | % ACTED ON | PRESENT COST | INFLATED COST | DISCOUNTED COST |
|-----|----------------------|----------------------|--------------|-------------------|----------------|---------------|-----------------|------------------|--------------------|
| 1 | 53 | 90 | 157 | 312 | 644 | 48 % | 30632400 | 33695545 | 29454227 |
| 2 | 54 | 83 | 104 | 115 | 278 | 41 % | 8557393 | 9413074 | 8228260 |
| 3 | 36 | 87 | 30 | 82 | 144 | 57 % | 6888495 | 7577323 | 6623550 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 % | 0 | 0 | 0 |
| 5 | 71 | 90 | 21 | 39 | 107 | 36 % | 10969766 | 12066726 | 10547846 |
| ALL | 52 | 87 | 312 | 550 | 1174 | 46 % | 57048054 | 62752668 | 54853883 |

Figure 70. Network Cost Summary

1981 RATING DISTRIBUTION SUMMARY

04/09/80

SHUP MUST FC 1 FC 2 FC 3 FC 4 FC 5
 *** 60 60 *** 50 50 *** 70 50
 *** 40 40 *** 30 30 ***

| FC | LANE MILES IN RATING GROUP BEFORE ACTION | | | | | | | | | | AVG RTNG | TOTAL MILES |
|-----|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|----------|-------------|
| | 100-91 | 90-81 | 80-71 | 70-61 | 60-51 | 50-41 | 40-31 | 30-21 | 20-11 | 10-0 | | |
| 1 | 131.4 | 82.7 | 43.0 | 70.9 | 41.9 | 21.9 | 53.3 | 47.7 | 22.3 | 129.2 | 53.3 | 644.5 |
| 2 | 27.7 | 13.7 | 34.1 | 45.9 | 34.1 | 33.0 | 45.2 | 12.7 | 9.0 | 17.8 | 54.2 | 278.3 |
| 3 | 28.4 | 1.8 | 4.3 | 0.8 | 3.4 | 18.8 | 11.7 | 6.9 | 25.1 | 43.0 | 36.2 | 144.2 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 27.1 | 19.5 | 14.1 | 7.2 | 16.6 | 19.3 | 3.6 | 0.0 | 0.0 | 0.0 | 71.1 | 107.4 |
| ALL | 214.7 | 117.7 | 100.5 | 124.8 | 96.0 | 92.9 | 113.8 | 67.4 | 56.5 | 190.0 | 53.1 | 1174.4 |

| FC | LANE MILES IN RATING GROUP AFTER ACTION | | | | | | | | | | AVG RTNG | TOTAL MILES |
|-----|---|-------|-------|-------|-------|-------|-------|-------|-------|------|----------|-------------|
| | 100-91 | 90-81 | 80-71 | 70-61 | 60-51 | 50-41 | 40-31 | 30-21 | 20-11 | 10-0 | | |
| 1 | 444.3 | 82.7 | 43.0 | 41.4 | 32.6 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 90.8 | 644.5 |
| 2 | 143.1 | 13.7 | 39.1 | 44.5 | 34.1 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 83.1 | 278.3 |
| 3 | 110.7 | 1.8 | 4.3 | 0.8 | 3.4 | 18.8 | 4.5 | 0.0 | 0.0 | 0.0 | 87.7 | 144.2 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 66.7 | 19.5 | 14.1 | 7.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 90.1 | 107.4 |
| ALL | 764.9 | 117.7 | 100.5 | 93.9 | 70.1 | 22.8 | 4.5 | 0.0 | 0.0 | 0.0 | 69.6 | 1174.4 |

Figure 71. Network Rating Distribution Summary

1. To identify those projects that can be constructed with available funding--the budget constraint.
2. To identify those projects that must be constructed to attain some minimum acceptable level of pavement condition--the condition-level constraint.

| <u>Year</u> | <u>Before</u> | <u>After</u> | <u>Mileage % Aff.</u> | <u>Cost*</u> |
|-------------------------------|---------------|--------------|---------------------------|---------------|
| 1981 | 53.1 | 88.6 | 46 | \$62,752,668 |
| 1982 | 83.6 | 87.6 | 8 | 11,758,111 |
| 1983 | 83.3 | 86.4 | 5 | 6,624,903 |
| 1984 | 81.4 | 83.4 | 4 | 5,661,168 |
| 1985 | 77.2 | 81.9 | 8 | 14,155,899 |
| 1986 | 75.4 | 83.1 | 15 | 33,893,546 |
| | | | | \$134,846,295 |
| 6-Yr Avg Rating = 80.4 | | | | |
| *All costs are inflated costs | | | | |

Figure 72. Six-Year Summary of Cost

Budget Constraint

In order to understand how a budget constraint is applied, consider Figure 73. The optimizing program identifies a number of projects scheduled for rehabilitation in each year of the next several years. The projects for the first year are arranged in some priority order. Total estimated cost for the year is accumulated in that order, one project at a time, until the constrained limit for that year is reached. The residual projects are delayed to the following year, and a second iteration of this same process is applied. This process is repeated for the specified number of years in the program and summarized with the network program.

Results of this process are shown in Figures 74 and 75. These summaries were generated by applying budget constraints to the same network and set of projects that were summarized in Figure 72 without constraints. Plotting the average rating for each year provides a graphic representation of the gains and losses expected from implementing each program (Figure 76).

| <u>Year</u> | <u>Before</u> | <u>After</u> | <u>Mileage % Aff.</u> | <u>Cost</u> |
|------------------------|---------------|--------------|---------------------------|------------------|
| 1981 | 53.1 | 59.3 | 7 | \$9,050,095 |
| 1982 | 52.3 | 57.4 | 7 | 9,048,675 |
| 1983 | 51.2 | 57.5 | 7 | 10,299,085 |
| 1984 | 51.7 | 56.1 | 6 | 10,300,148 |
| 1985 | 50.5 | 52.8 | 3 | 9,449,439 |
| 1986 | 47.4 | 49.7 | 4 | <u>9,449,286</u> |
| | | | | \$57,596,728 |
| 6-Yr Avg Rating = 53.2 | | | | |

Figure 74. Six-Year Summary of Cost with Budget 1

| <u>Year</u> | <u>Before</u> | <u>After</u> | <u>Mileage % Aff.</u> | <u>Cost</u> |
|------------------------|---------------|--------------|---------------------------|-------------------|
| 1981 | 53.1 | 62.0 | 11 | \$12,349,188 |
| 1982 | 55.4 | 61.9 | 8 | 12,349,691 |
| 1983 | 55.9 | 63.3 | 9 | 14,949,463 |
| 1984 | 57.6 | 63.4 | 7 | 14,949,477 |
| 1985 | 58.0 | 65.0 | 9 | 17,954,686 |
| 1986 | 59.7 | 64.6 | 8 | <u>17,952,927</u> |
| | | | | \$90,050,432 |
| 6-Yr Avg Rating = 60.0 | | | | |

Figure 75. Six-Year Summary of Cost with Budget 2

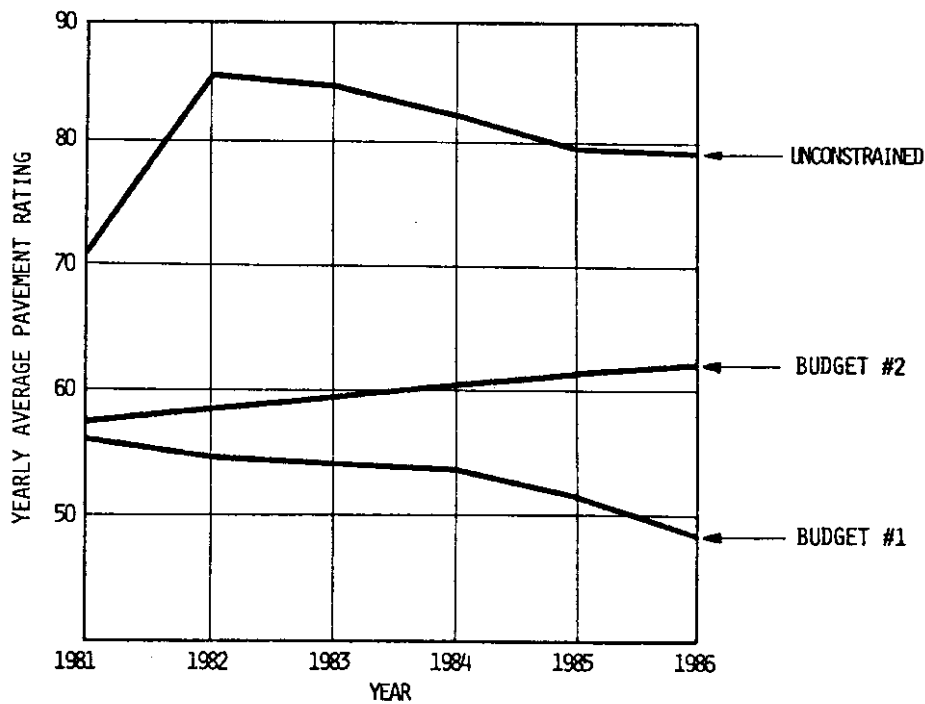


Figure 76. Plot of Six-Year Cost Summaries

Condition-Level Constraint

The approach for applying the condition-level constraint is very similar to the budget constraint. As can be seen in Figure 77, the item accumulated and compared is net gain in average rating. Because the average pavement condition is weighted by miles, the constraint and accumulation figures are both expressed as a product of miles and average rating.

Figure 78 is an illustration that demonstrates how the condition-level constraint was utilized to summarize three future bienniums. The bottom line on the graph indicates a program which maintains the network in its present state. The corresponding bottom line of figures indicates the funding required in each biennium to keep the system where it is. The percentages below the dollar figures indicate how much of the system must be rehabilitated in each biennium to maintain it at its present level. The middle line in the plot represents a modest upgrade in the system over three bienniums, while the top line indicates the unconstrained program. Corresponding dollar amounts and system percentages are shown at the bottom.

Applications of Network Analysis

It should be clearly understood that through multiple applications of constraints and subsequent summarizing with the network level program, many different informative graphs can be generated.

Figure 79 illustrates the resulting average pavement condition on the network that could be expected as a function of available funding in the first year of a program. It was generated by applying various budget constraints. Note that a "no action" program would leave the network average very close to 60, while an unlimited budget would raise the system average to just under 90. Note also that the present network average is indicated together with the level of funding that would be required to maintain it at this level.

Figure 80 is supplemental to Figure 79. In order to gauge the long-term effects of different first-year budgets, a constant budget of \$10 million was applied as a constraint to the five remaining years of each program. This was considered to be the best method for comparing the long-term effects of the first-year programs, since the amount of work in any year is affected by the work accomplished in preceding years.

Figure 81 is an example of multiple applications of the condition-level constraint. This figure illustrates the levels of funding required to sustain the various levels of average pavement condition over a six-year period.

- K = DESIRED LEVEL OF AVERAGE PAVEMENT CONDITION
- T = TOTAL SYSTEM MILEAGE
- B = SYSTEM AVERAGE PAVEMENT CONDITION BEFORE PROGRAM ACTION
- A = SYSTEM AVERAGE PAVEMENT CONDITION AFTER PROGRAM ACTION
- M_N = MILEAGE OF INDIVIDUAL PROJECT
- R_N = PRESENT RATING OF INDIVIDUAL PROJECT

NET GAIN IN AVG. = $M_N (100 - R_N)$

$AT = BT + \sum [M_N (100 - R_N)]$

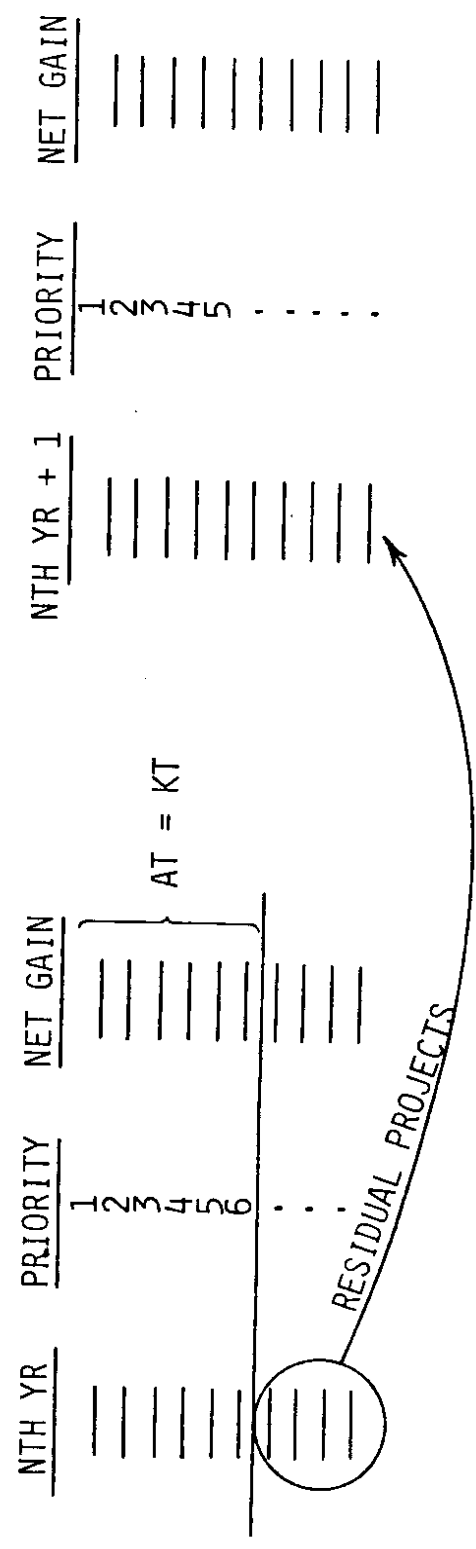
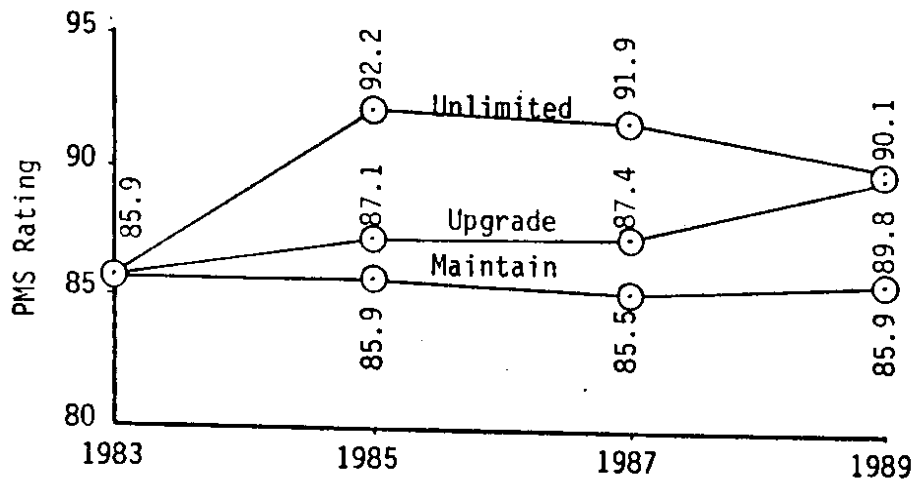


Figure 77. Process of Applying Condition-Level Constraints



| | | | | |
|----------------------|---------------------|---------------------|---------------------|---|
| Unlimited Budget | 36,114,882 (20%) | 25,286,924 (13%) | 28,367,426 (15%) | ← \$ in program ← % of system acted on |
| Upgrade Cond. Level | 19,226,745 (10%) | 24,439,130 (13%) | 42,077,816 (22%) | |
| Maintain Cond. Level | 16,572,007 (8%) | 21,205,024 (11%) | 32,500,680 (16%) | |

Figure 78. Example of Application of Condition-Level Constraint

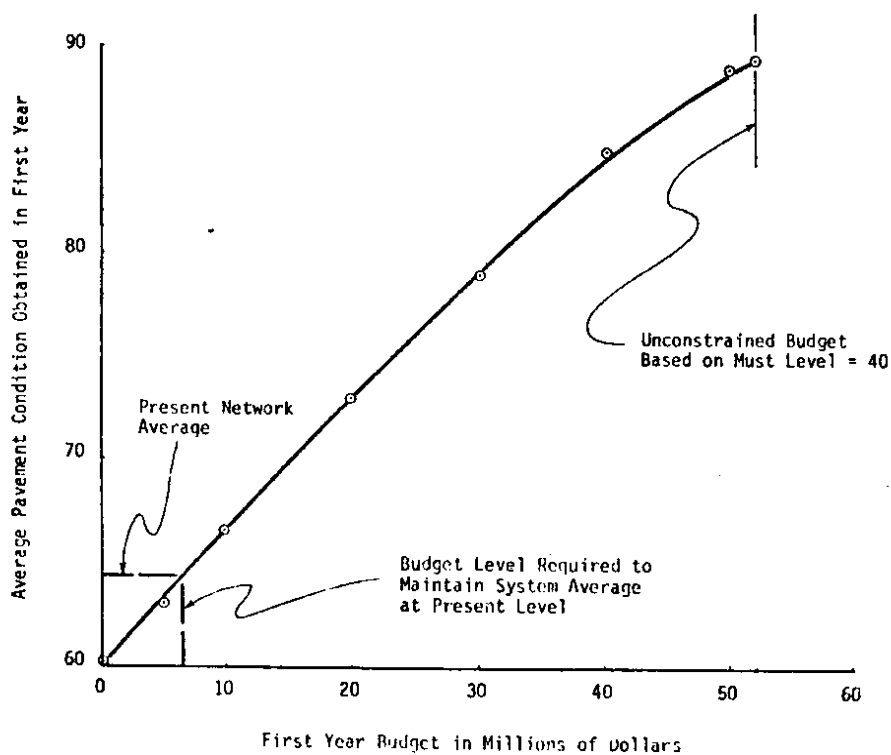


Figure 79. Average Pavement Condition vs. First Year Budget Constraint

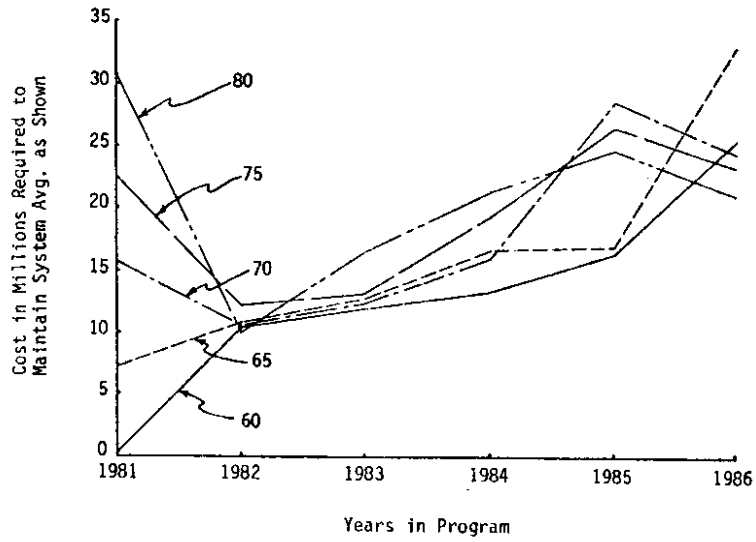


Figure 80. Six-Year Summary of Costs Required to Maintain Minimum Levels of Average Pavement Condition

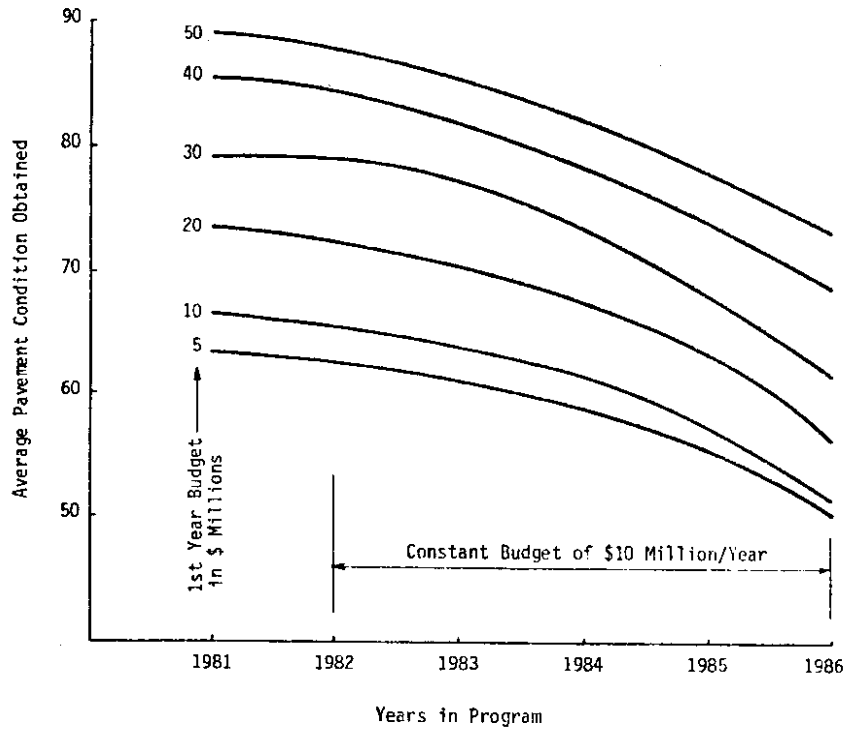


Figure 81. Average Pavement Condition Obtained After First Year Program

Figures 79, 80, and 81 represent examples of network program analysis that are possible through multiple applications of constraints. Another feature of network-level programming lies in the influence of the results from the optimizing program upon which the network analysis is based. Since the "should" and "must" levels applied will have significant bearing on the number of projects needed in each year, the complexion of a rehabilitation program can be altered by changing these parameters.

Figure 82 represents an application of varying the "should" and "must" levels. As would be expected, on an unconstrained program there is a large difference in the average level of pavement condition obtained for the first year which results from varying the "should" and "must" levels. Figure 83 is directly related and indicates the levels of funding required in an unconstrained program resulting from varying the "should" and "must" levels.

It is interesting to note that a different mix of projects is identified by varying the "should" and "must" levels. To summarize the effects on the mix of projects, histograms of mileage were prepared indicating the status of the system prior to any action, and then indicating what portion of each group was acted on by varying the trigger levels.

Figures 84, 85, and 86 represent these different project mixes. In all cases, 100 percent of the mileage below the "must" level is acted on. The difference occurs above the "must" level.

Figure 87 indicates the effects on average pavement condition over a six-year period with unconstrained programs resulting from varying the trigger levels.

Prioritizing Function

It is important to realize that the shift of project timing applied using either constraint requires a prioritizing function. It was stated earlier that projects are prioritized based on their effect on system performance. This can be referred to as the "effect of delay," or how much the delay of a project will affect pavement condition in the following year.

Consider Figure 88. This figure shows the performance curves for two different existing pavement projects. As can be seen, projects 1 and 2 deteriorate at very different rates. The effect of delaying project 1 would have far greater consequences than delaying project 2. By prioritizing projects based on their predicted ratings one year later and applying either constraint, better gains in average pavement condition are achieved.

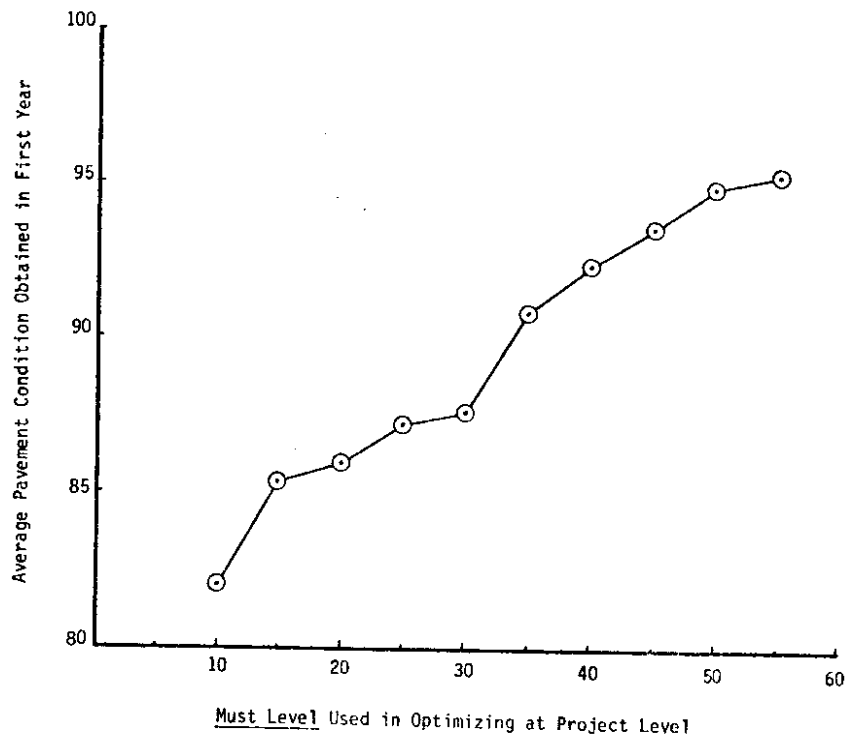


Figure 82. Average Pavement Condition Obtained by Varying the Must Level

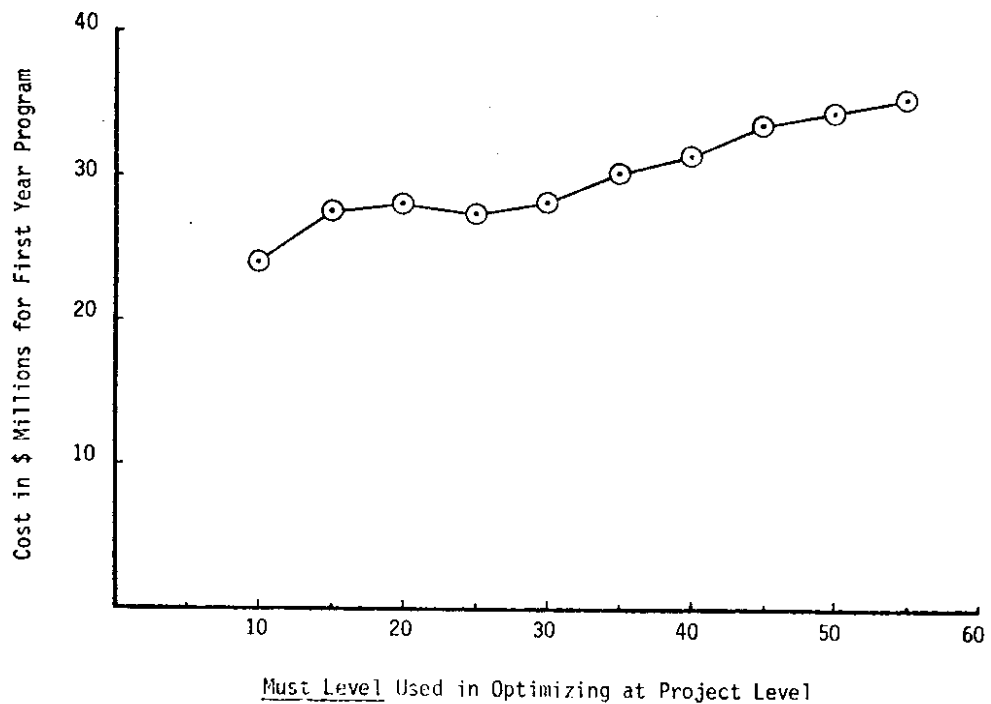


Figure 83. Annual Program Cost Incurred by Varying the Must Level

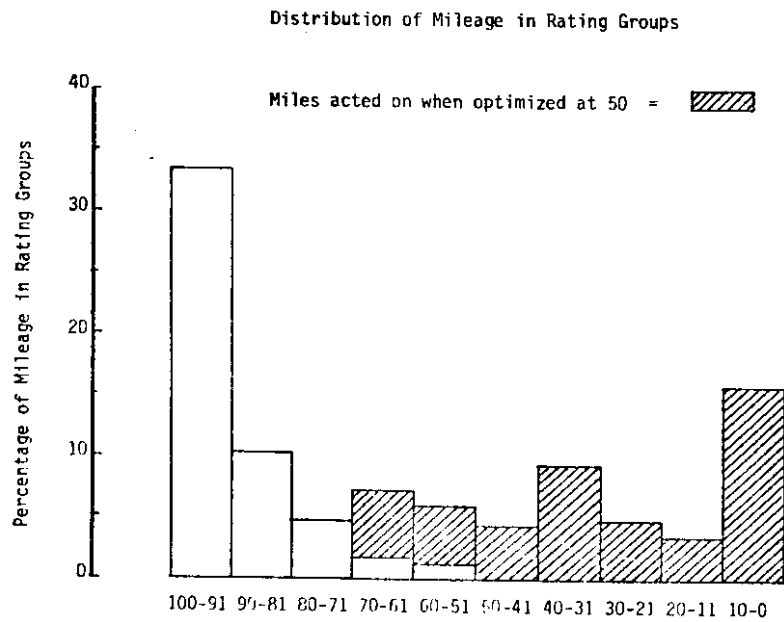


Figure 84. Distribution of Mileage Acted on with Must Level at 50

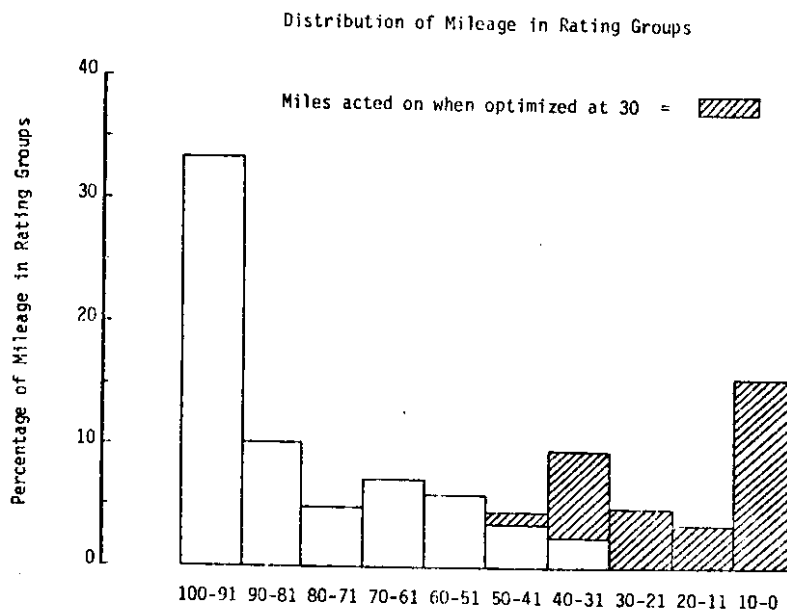


Figure 85. Distribution of Mileage Acted on with Must Level at 30

Distribution of Mileage in Rating Groups

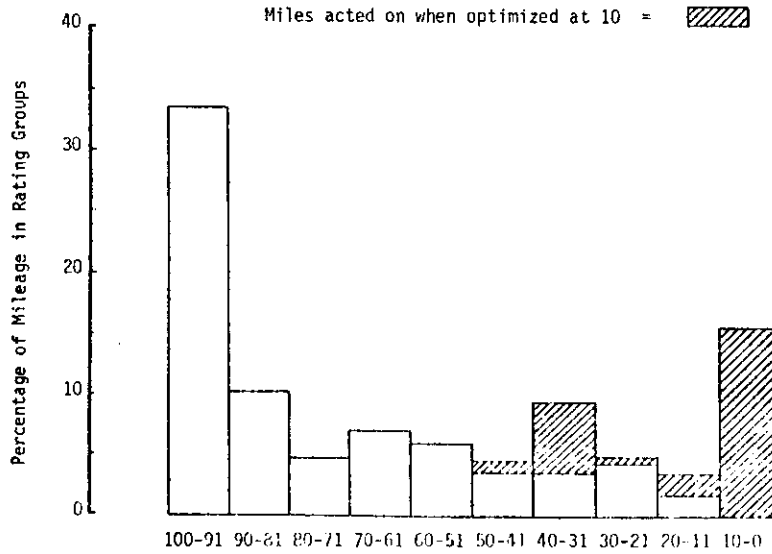


Figure 86. Distribution of Mileage Acted on with Must Level at 10

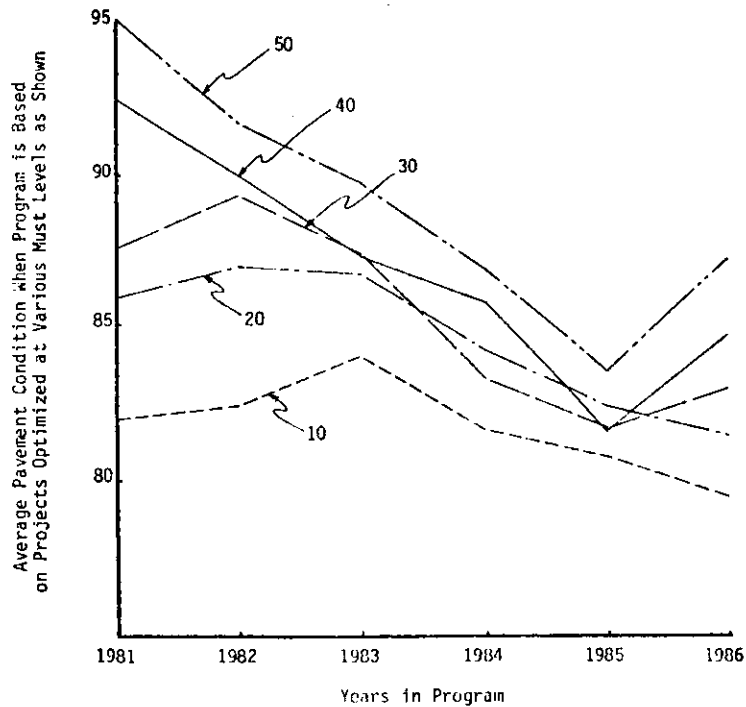


Figure 87. Effects on Average Pavement Condition with Unconstrained Programs Generated at Various Must Levels

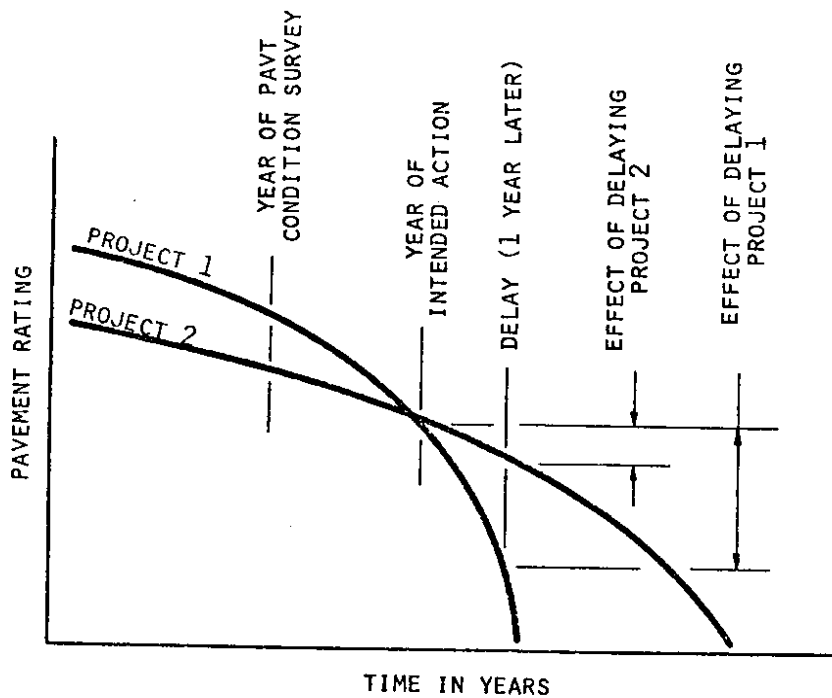


Figure 88. Comparison of Two Different Performance Curves - The Effect of Delay

It should be understood that the "effect of delay" is a useful rule to apply to extract the greatest gains in pavement condition from a rehabilitation program. This approach may not always be the most practical, however. Often the pavements that are in the worst condition are found in the lower classified portion of the system. Highway agencies that prioritize entirely on present pavement condition are often faced with pavements that are not quite bad enough to get into the rehabilitation program, yet they carry a much greater portion of the traffic load than other pavements scheduled for resurfacing. When delayed for a year, these projects will represent a greater impact on serving the public.

There are certainly many factors that could be considered in the prioritizing formula. Among them are:

- Effect of delaying a project on system average
- Average Daily Traffic, a functional need
- Demand on the maintenance budget
- Coordinating with the urgency to rectify other deficiencies such as volume/capacity problems, safety problems, geometric deficiencies
- Administrative priority--a commitment to the public to rectify a problem.

All of these factors should have influence on the priority of placing projects in a program, and they all play a part in the decision process today. By formulating a utility function with these factors weighted to represent management policy, the scope of analyzing the effects of policy is greatly enhanced. However, with a utility function which includes all of these factors, prioritizing might not generate the greatest gains in average pavement condition when applying constraints.

Other Considerations

Because the network program is based on the projects identified by the optimizing program, a new parameter was added to the operation of that program. By defining the length of the network program to be analyzed, all projects that require rehabilitation outside the scope of the network analysis are not optimized (six years was used in all examples). A simple test is applied as the first step in that program to determine whether or not the project will require rehabilitation within the network programming period. The application of this parameter significantly reduces the volume of projects to be analyzed.

Summary of Network Program Analysis

The purpose of this phase is to provide the best information possible to decision-makers for:

- Assembling rehabilitation programs
- Establishing effective funding levels, and
- Identifying the time and extent of future needs.

This is accomplished by aggregating the recommended rehabilitation actions in each year and tracking the performance and cost of all project segments on the network. The network program produces a summary of anticipated action, cost, and performance for each year considered.

The network program can be constrained in two ways:

1. Budget Constraint which limits the amount of work that can be accomplished.
2. Condition-Level Constraint which requires that a minimum level of pavement condition must be obtained with a rehabilitation program.

Application of both constraints requires a prioritizing function. In order to gain optimum results in terms of pavement condition, the rate of deterioration should be used to establish priority.

By plotting the results of the program in terms of funding or average pavement condition for several years, different programs can be compared.

By applying a utility function, which weights other factors of management policy to the prioritizing formula, effects on each program can be gauged.

By varying the "should" and "must" trigger levels in the optimizing program, different projects are identified and a whole new picture can be inspected.

All of these methods constitute what can be accomplished in network program analysis with this pavement management system. With this information available, top-level management will have the factual data they have always desired to identify the benefits and consequences of the alternatives they must face.

APPLICATION OF THE PMS IN WSDOT

The preceding chapters describing WSDOT's pavement management system may lead to the belief that the computer programs and data files constitute the system, and all one has to do is push a button to generate a rehabilitation program. This definitely is not the case. The computer programs, data files, and information generated only serve to enhance our long-established pavement management practices. The purpose of this chapter is to explain how WSDOT's current pavement management operations will be improved with this system.

The most obvious area of application lies in budgeting and programming rehabilitation projects. In order to understand this application, a knowledge of the current method of identifying and programming projects is required.

Programming and Budget Cycle

The current programming cycle requires a two-year effort and begins in early spring of the odd-numbered calendar years (i.e., every other year). At this time every mile of pavement under state jurisdiction is evaluated with a pavement condition survey. Results of this survey are used in two ways:

1. To report the biennial pavement condition which informs district personnel where the pavement problems are.
2. To establish the pavement condition groups within the Priority Array.

The biennial pavement condition report is published and sent to the districts during the month of August. This report provides mile-by-mile pavement ratings so that bad sections of pavement can be identified and rehabilitation projects can be defined to address them. From this time until the complete construction program is approved, each district utilizes the pavement condition report to help prepare a document called a Project Prospectus for each candidate project. These documents are the building blocks of the construction program and define the project limits, scope of work, and estimate of cost for each project. They also represent an agreement between the district and headquarters as to the definition of a project. Because each project in the ultimate construction program must fulfill the requirements of the Priority Array--i.e., that all projects in a lower group must be addressed before considering projects in a higher group--the Project Prospectus serves as the document that ensures this action is the proper action.

While the pavement condition report identifies bad pavement sections and the Project Prospectus defines the project, the Priority Array effects the order of construction related to first, second, or third biennium.

The Priority Array is developed on a biennial basis in accordance with Washington State law, which requires that consideration be given to the highway's structural condition, capacity and congestion, alignment and geometrics, and accident experience. The Priority Array is based on an engineering analysis of existing conditions at the same point in time and reflects several categories of roadway deficiency--not just pavement condition. Categories of deficiency are arranged in 15 groups as shown below. As can be seen, pavement condition is addressed in groups 2, 6, 12, and 15. Traditionally these groups have been related to the first, second, and third bienniums, and beyond three bienniums respectively.

The separation between groups 2, 6, 12, and 15 is based on an accumulated distribution of mileage related to pavement condition. Traditionally, group 2 has been related to the worst 16 percent of the system in terms of pavement condition, group 6 to the next 16 percent of the system, group 12 to the following 16 percent, and group 15 to the remainder.

Priority Array Groups

1. Bridge Condition
- *2. Pavement Condition
3. Hazardous Accident
4. Volume/Capacity
5. Horizontal Curvature
- *6. Pavement Condition
7. Bridge Roadway Width
8. Bridges Posted
9. Pavement Width
10. Bridge Clearance
11. Volume/Capacity
- *12. Pavement Condition
13. Stopping Sight Distance
14. Roadway Width
- *15. Pavement Condition

The Priority Array is transmitted to each district about mid-November. From this point until about mid-April, the districts decide how each identified problem area will be addressed, submit a Project Prospectus for each project to headquarters, and schedule the timing for each phase of the project. Major phases include preliminary engineering, acquisition of right of way, and construction. Depending on the size and complexity of the project, all phases of work may be completed within one biennium or they may extend through as many as three bienniums. Scheduling of each project and phase of work at this stage is also influenced by the availability of funding and manpower. There are basically three categories of funding:

Category A - resurfacing, roadway reconstruction, bridge replacement, safety improvements, etc.

Category B - interstate system improvements financed at the 90/10 matching rate.

Category C - construction on new alignment, or improvements which significantly increase capacity.

Finally, in about mid-April of even-numbered years, all districts must submit their six-year construction programs to headquarters. All district programs are combined into one published document which must be approved at various levels. The Secretary of Transportation approves the program in mid-July; the Transportation Commission approves it in mid-September. Finally, the Legislature meets in January through mid-April and appropriates funding for the first two years of the six-year construction program.

The next step in this process reverts to the districts. After appropriation of funds by the Legislature, each district must review the current status of work in progress, funding carryover from the present biennium, potential overruns, and cash flow. Based on these factors, the district may elect to modify the timing of some projects. Essentially, there are no additions or deletions to the program--only minor adjustments in timing for some projects. From this point on, the program is known as the operating program.

The operating program receives its final approval from the Transportation Commission in mid-September of odd-numbered years. This biennial cycle begins in early spring of the odd-numbered years and culminates 2½ years later in the fall of odd-numbered years.

Application of PMS to Programming and Budget Cycle

One of the biggest problems with the current cycle of programming is the lag time between the pavement condition survey and final approval of the operating program. Approximately 2½ years elapse during which time the condition of pavements can change drastically. It was very obvious from studying the performance curves that every project deteriorates at a different rate. For this reason it is essential that rehabilitation projects are programmed based on their projected ratings instead of ratings at one point in time. In other words, it makes more sense to evaluate the need for rehabilitation on the basis of rating and construction history instead of just one pavement survey.

Another problem with the current methods of programming is the determination of sections that are compared and reported in both the biennial pavement condition report and the Priority Array. These sections, presently known as analysis

units, are established to make comparisons on the basis of several categories of deficiency--not just pavements. They are not related to prior contract limits, pavement type, or separating good sections of pavements from poor ones. In order to better distinguish sections of pavement for analysis purposes, prior contract limits as well as current and historical performance should be considered.

Implementation of the pavement management system will address both of these problem areas. Determination of the pavement performance sections will result from a thorough analysis of present and past performance as well as the construction history involved. Once these sections have been established, a performance curve for each will be generated with the interpreting program. These areas will then be reviewed and edited until satisfaction has been obtained for each section. The prioritization of each section will ultimately depend on the rate of deterioration as depicted by these performance curves. Thus, application of the pavement management system will rectify the deficient aspects of WSDOT's current programming scheme.

Although program development will essentially remain the same, implementation of the PMS will provide additional benefits. As the districts assemble their construction programs, each phase of the PMS will be applied to improve the process. The master file listing will help define more precisely the construction limits and demonstrate the nature of distress to be rehabilitated. The performance curves in conjunction with the project optimizing information will be used to help determine the type of fix and construction timing. The network program will be used to fit a program to the funding needs.

There are three primary areas of application for the pavement management system:

1. Provide pavement analysis results to program development section for their use in establishing the Priority Array.
2. Provide pavement performance curves, project optimizing data, and network analysis data to each district for their use in assembling the six-year Legislative Program and two-year Operating Program.
3. Provide detailed information to the District Materials Engineers for their use in designing the most effective rehabilitation alternative for each project.

While these applications represent the primary operations, there are several others:

Provide long-range network analysis data for use in the 12-year
Transportation Plan

Each two years the department assembles a long-range (12-year) plan which describes goals, objectives, problems, funding, etc., as a reference document. This is to be used by the Legislature, the Transportation Commission, and department administrators as a basis for decisions and guidance in the long-term planning of the department. One component of this report is an estimate of 2-, 6-, and 12-year pavement rehabilitation needs. Application of the PMS to this task is particularly well-suited. Computer programs and models have been developed not only to project needs, but to match funding levels with specific levels of pavement condition.

Provide PMS data to the Maintenance and Operations Division for their
use in the Maintenance Management System

The PMS identifies all sections of pavement on the system needing rehabilitation. Those sections identified but not included in the program because of budget constraints will have to be addressed by the Maintenance Division. With the PMS, a reasonable estimate of maintenance needs and obligations as well as good logistics can be generated.

Monitor system performance

Development of the PMS has provided a means for analyzing the historical pavement rating files. With the PMS, the status of the system can be gauged from many perspectives. Listings can be generated by district, functional class, pavement type, distress category, etc., to indicate miles and percentages in each. The department has a need to be cognizant of trends in pavement performance and distress character from year to year. Information produced by the PMS will be used in many critical areas, particularly pavement design and budgeting. In order to maintain confidence in our decisions, this information must be the best possible. This can only be accomplished through constant improvement and monitoring.

Provide pavement performance data and/or economics data to other
department offices on request

Because the PMS is the focal point for deriving most pavement-related information, other department offices will obtain this from the pavement management section in the Materials Laboratory. Offices such as the Public Affairs Office, and those in Planning, Maintenance, and Design require

detailed and consistent information relating to our pavements. The PMS will provide accurate and consistent information.

Perform research on pavement performance trends and correlation analysis for improving design formulas and materials specifications

With the performance curves generated in the interpreting phase, it is possible to apply correlation analysis to items such as axle and wheel loads, climate, design formulas, materials specifications, different construction methods, etc. This correlation will be applied to such performance factors as elapsed time to reach a level of rating, degree of curvature of the performance curve, area under the performance curve, etc. Each time the Master File is updated, there are approximately 3000 to 4000 segments of pavement identified, each of which has its own performance curve based primarily on a simple regression fit. This represents an ample data base for analysis purposes. The objective of such analyses is to improve our in-house design formulas, and materials and construction specifications so that our pavements are more cost-effective.

As can be seen from Figure 89, the PMS is central to all other pavement functions. Design, construction, and maintenance need the PMS to improve cost effectiveness. Programming and budgeting need the PMS to establish programs better tailored to the funding available. Planning needs the pavement performance projections from PMS for the 12-year Transportation Plan. And finally, the pavement research area needs the PMS because of its inherent data base and programming facilities. The pavement management system acts as a focal point to all of these activities.

Interactive Version

Because WSDOT has been committed to automated data processing for many years, the department possesses a very complete computer system with remote terminals in each district and virtually every project engineer office. In addition, there are presently 89 remote terminals distributed throughout WSDOT headquarters. With this network of computer terminals, access to PMS files can be accomplished very easily.

During development of this system, an interactive version including some of the basic PMS programs was written to make access to this data faster and easier. Information made available consists of the Master Index, Master File, Interpreted Data, and Optimized Data. Examples of the interactive version are shown in Figures 90, 91, and 92.

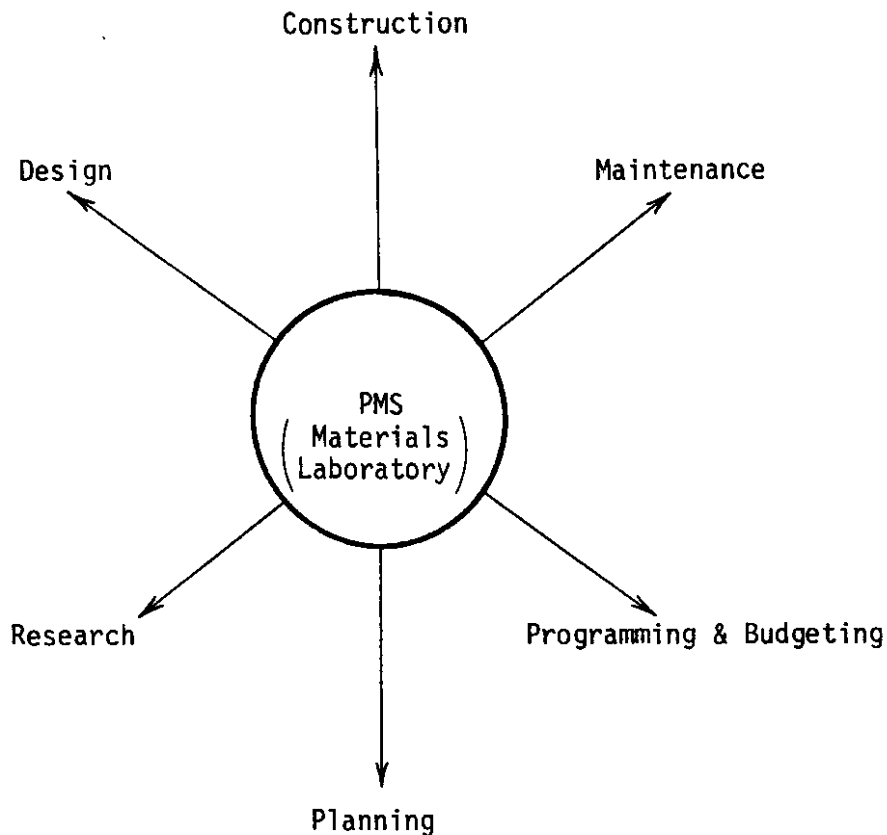


Figure 89. Relationship of PMS to All Pavement Activities

Figure 90 demonstrates how one would identify prior surfacing limits, and then with a subsequent demand obtain a performance summary for one of the identified segments. The top portion is generated with the command LPROJ which is an acronym for list projects. The syntax for the command is:

```
LPROJ SR(XXX) BEG(XXXXX) END(XXXXX)
```

This is explained as "List all surfacing project limits on SR XXX between milepost XXXXX and milepost XXXXX". The information listed is a portion of the Master Index between the respective milepost limits.

The lower half of this figure illustrates the retrieval of a performance summary for one of the projects within the aforementioned milepost limits. The command associated syntax is:

```
PROJ DSN1(XXXXX) SR(XXX) BEG(XXX) END(XXX) SIDE(X)
```

This is read as "List the project from the specific district output (District 3 is indicated in the example) for the specific project limits and on the specific side". The indication for side is required because project limits and pavement ratings are acquired on both sides for multilane sections and divided highways.

LPROJ SR(5) BEG(8500) END(11000)
R67

03/06/80

| CS | BEG | END | D | SR | BEG | END | LENG | FC | L | HT | RDW | RSH | LSH | CONT# | TY | S | THK | M | YR | BASE | 78 | ADT | GRW | SU | CM |
|------|------|------|---|-----|-------|-------|------|----|---|----|-----|-----|-----|-------|----|---|-----|---|----|------|-------|-----|-----|----|----|
| **** | **** | **** | * | *** | ***** | ***** | **** | ** | * | ** | *** | *** | *** | ***** | ** | * | ** | * | ** | **** | ***** | *** | ** | ** | ** |
| 2104 | 58 | 274 | 4 | 5 | 8335 | 8551 | 216 | U5 | L | 32 | 24 | 10 | 4 | 09638 | 3 | 6 | 35 | 5 | 75 | 12 | 27700 | 56 | 6 | 16 | |
| 2104 | 58 | 274 | 4 | 5 | 8335 | 8551 | 216 | U5 | R | 32 | 24 | 10 | 4 | 00003 | 3 | 6 | 35 | 7 | 76 | 12 | 27700 | 56 | 6 | 16 | |
| 3401 | 0 | 312 | 3 | 5 | 8551 | 8863 | 312 | R5 | L | 32 | 24 | 10 | 4 | 00003 | 3 | 6 | 35 | 7 | 76 | 12 | 29400 | 48 | 6 | 16 | |
| 3401 | 0 | 322 | 3 | 5 | 8551 | 8873 | 322 | R5 | R | 32 | 24 | 10 | 3 | 00003 | 3 | 6 | 35 | 7 | 76 | 12 | 29400 | 48 | 6 | 16 | |
| 3401 | 312 | 1718 | 3 | 5 | 8863 | 10269 | 1406 | R5 | L | 32 | 24 | 10 | 3 | 07540 | 3 | 6 | 25 | 4 | 65 | 32 | 32800 | 54 | 6 | 16 | |
| 3401 | 322 | 1718 | 3 | 5 | 8873 | 10269 | 1396 | R5 | L | 32 | 24 | 10 | 4 | 07540 | 3 | 6 | 25 | 4 | 65 | 32 | 32800 | 54 | 6 | 16 | |
| 3401 | 1718 | 1746 | 3 | 5 | 10269 | 10297 | 28 | U5 | L | 32 | 24 | 10 | 4 | 05075 | 0 | 7 | 75 | 9 | 56 | 10 | 37700 | 74 | 6 | 16 | |
| 3401 | 1746 | 1854 | 3 | 5 | 10297 | 10405 | 108 | U5 | L | 32 | 24 | 10 | 4 | 05733 | 0 | 7 | 75 | 7 | 59 | 10 | 37700 | 74 | 6 | 16 | |
| 3401 | 1718 | 1854 | 3 | 5 | 10269 | 10405 | 136 | U5 | R | 32 | 24 | 10 | 4 | 05733 | 0 | 7 | 75 | 7 | 59 | 10 | 37200 | 74 | 6 | 16 | |
| 3407 | 0 | 476 | 3 | 5 | 10405 | 10881 | 476 | U5 | R | 32 | 24 | 10 | 4 | 05733 | 0 | 7 | 75 | 7 | 59 | 10 | 51500 | 66 | 4 | 9 | |
| 3407 | 0 | 504 | 3 | 5 | 10405 | 10909 | 504 | U5 | L | 33 | 36 | 10 | 8 | 05733 | 0 | 7 | 75 | 7 | 59 | 10 | 51500 | 66 | 4 | 9 | |
| 3407 | 504 | 514 | 3 | 5 | 10909 | 10919 | 10 | U5 | L | 32 | 33 | 10 | 4 | 08360 | 0 | 7 | 67 | 8 | 68 | 21 | 44500 | 66 | 4 | 9 | |
| 3407 | 476 | 514 | 3 | 5 | 10881 | 10919 | 38 | U5 | R | 33 | 48 | 10 | 6 | 08360 | 0 | 7 | 67 | 8 | 68 | 21 | 44500 | 66 | 4 | 9 | |
| 3402 | 0 | 582 | 3 | 5 | 10919 | 11501 | 582 | U5 | L | 33 | 36 | 10 | 6 | 08360 | 0 | 7 | 67 | 8 | 68 | 21 | 48800 | 68 | 4 | 9 | |
| 3402 | 0 | 605 | 3 | 5 | 10919 | 11524 | 605 | U5 | R | 33 | 44 | 10 | 6 | 08360 | 0 | 7 | 67 | 8 | 68 | 21 | 48800 | 68 | 4 | 9 | |

NUMBER OF PROJECTS WITHIN MILEPOSTS LIMITS = 15

END CLIST

READY

PROJ DSNI(030UT) SR(5) BEG(8863) END(10269) SIDE(L)

1 R67

03/06/80

BEG END SRMP CSMP CSMP CSMP PROJ FNC HUY NUM ROW-RSH-LSH LAST COMPT CNT SURFACE BASE
D SR SRMP SRMP CS CSMP CSMP LENG CLS SIDE TYP LNS WIDTHS CONTR M-YR TYP-THK TYPE
* *** *****

3 5 8863 10269 3401 312 1718 1406 R-5 L 3 2 24 10 3 07540 4-65 3 6 25 32

PERFORMANCE HISTORY

| YEAR | 69 | 71 | 73 | 75 | 77 | 79 | 78 | ADT | 32800 | EQUA | CONST | = | 98.97 | | | | |
|--------|-----------|------|------|------|------|------|--------------|-------|-------|--------|-------|---------|----------|----|----|---|-------|
| AGE | 4 | 6 | 8 | 10 | 12 | 14 | GROWTH | RATE | 5.4% | EQUA | COEFF | = | -0.00029 | | | | |
| RIDE | RATING | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | SINGLE | UNITS | 6% | EQUA | POWER | = | 4.00 | | | | |
| STRUCK | RATING | 96.3 | 98.7 | 99.7 | 94.7 | 96.2 | COMBINATIONS | 16% | R | SQUARE | = | 0.80543 | | | | | |
| COMBD | RATING | 96.3 | 98.2 | 99.7 | 94.6 | 96.0 | TRAFFIC | INDEX | 8.0 | STD | ERROR | = | 2.19 | | | | |
| HIGH | FRICITION | 57 | 54 | 0 | 52 | 59 | K | = | 11% | D | = | 60% | TIME | TO | 60 | = | 19.23 |
| LOW | FRICITION | 51 | 46 | 0 | 46 | 47 | 2AX | = | 4.0% | 3AX | = | 5.2% | TIME | TO | 40 | = | 21.33 |
| AVG | FRICITION | 53 | 50 | 0 | 49 | 52 | 4AX | = | 2.1% | 5AX | = | 10.7% | TIME | TO | 20 | = | 22.94 |

Figure 90. Interactive PMS Listing Showing Master Index and Performance Summary

DO YOU WANT LISTING OF OPTIMUM REHABILITATION STRATEGIES ? (YES OR NO)

YES

SHOULD REHABILITATE AT 60.0 WHICH WILL OCCUR IN 1984
 MUST REHABILITATE AT 40.0 WHICH WILL OCCUR IN 1986
 CONSIDERATION SPAN = 20 PERIODS, EACH PERIOD = 1.0 YEARS
 EFFECTIVE INTEREST RATE = 4.0% FACTORS : 40.0% 70.0% 95.0%

| DESCRIPTION OF THE ALTERNATIVES | PERFORMANCE EQUATIONS | CONSTRUCT COST 12' LANE MILE | MIN LIFE AT SHUD | MAX LIFE AT MUST |
|----------------------------------|--------------------------------|---------------------------------|---------------------|---------------------|
| ALTERNATE 1 ROUTINE MAINTENANCE | R = 98.97 - 0.00029 P ** 4.00 | 0 | 19.15 | 21.24 |
| ALTERNATE 2 OVERLAY 0.08 CLASS G | R = 100.00 - 0.39782 P ** 2.25 | 19100 | 7.76 | 9.29 |
| ALTERNATE 3 OVERLAY 0.15 CLASS B | R = 100.00 - 0.01394 P ** 3.00 | 35800 | 14.21 | 16.26 |
| ALTERNATE 4 OVERLAY 0.25 CLASS B | R = 100.00 - 0.00558 P ** 3.00 | 59600 | 19.28 | 22.07 |

| ITEMIZED COSTS | | STRATEGY DESCRIPTION | | | |
|-----------------------|--------------------------------|---------------------------------|----------------|--------------------|-----------------------------|
| ***** | | ***** | | | |
| ROUT MAINT COST | + COST OF CONSTR INCL PR | + COST OF TRAFFIC INTERPT | + USER COST | - SALVAGE VALUE | = EXPECTED TOTAL COST |
| 278631 | 1288912 | 104571 | 1650741 | 145141 | 3177714 |
| 249457 | 1299717 | 104492 | 1637780 | 93819 | 3197627 |
| 274220 | 1246904 | 205757 | 1647272 | 136817 | 3237336 |
| 226848 | 1319783 | 104240 | 1636458 | 45801 | 3241528 |
| 323826 | 1238130 | 204935 | 1666384 | 182422 | 3250853 |
| 263189 | 1280900 | 205504 | 1652276 | 146515 | 3255354 |
| 246252 | 2072972 | 196072 | 1639490 | 705485 | 3449301 |
| 188523 | 2115139 | 195924 | 1619501 | 651435 | 3467652 |
| 132921 | 2167822 | 195450 | 1606461 | 601857 | 3500797 |

NUMB
POSS

39 (ALTERNATIVE - PRD APPLIED)

1ST 2ND 3RD 4TH
REHAB REHAB REHAB REHAB

3-86
3-85
2-85 2-93
3-84
2-86 2-94
2-84 2-93
4-85
4-84

END CLIST
READY

Figure 92. Interactive PMS Listing Showing Cost Analysis

Figure 91 is an example of the option which follows when a project performance summary is requested. By responding "yes" to the question, "Do you want itemized defect listing?" a master file listing is generated. A "no" will skip this output and precipitate the next question as shown in Figure 92. "Do you want a listing of optimum rehabilitation strategies?" With a response of "yes" by the operator, the results of the economic analysis are provided.

This interactive program was developed specifically for individual offices located anywhere in WSDOT to generate PMS data on sections of interest with the quickest response possible.

Future Research

There are many problems to be solved in the area of pavement management. The pavement management system described in this report may not be a "perfect" system; however, it does provide a data base of pavement information to expand on and the necessary tools to help analyze it. Some of the intended areas of research have already been mentioned:

Correlation analysis of performance with:

- geographic areas
- axle loads
- pavement types
- materials and construction specifications
- deflection or pavement strength

Distress trend analysis - a study of the historical progression or regression of specific distress categories.

Other areas of future research may include improvement of each category of cost modeling considered in the project optimizing program, and development of methods to "optimize" at the network level.

One topic of future research and development will be an improvement on the performance curve model. The present equation, $R = C - mA^B$, is reasonably accurate in the upper rating levels, but not in the lower ranges of rating where the curve is almost vertical. For the modeling that is related to the curve in the optimizing program, this is acceptable since the MUST level is always applied at a higher level than the vertical portion. However, for prioritizing projects based on the rate of deterioration, or for the rating distributions calculated in the network programs, a more accurate representation of performance in the lower ranges is necessary. The solution presently contemplated to cure this problem is to develop typical curve "tails" for different categories of pavement types. This concept is illustrated in Figure 93. By

studying the performance of pavements only in the low ranges of rating, one or possibly many tails may emerge.

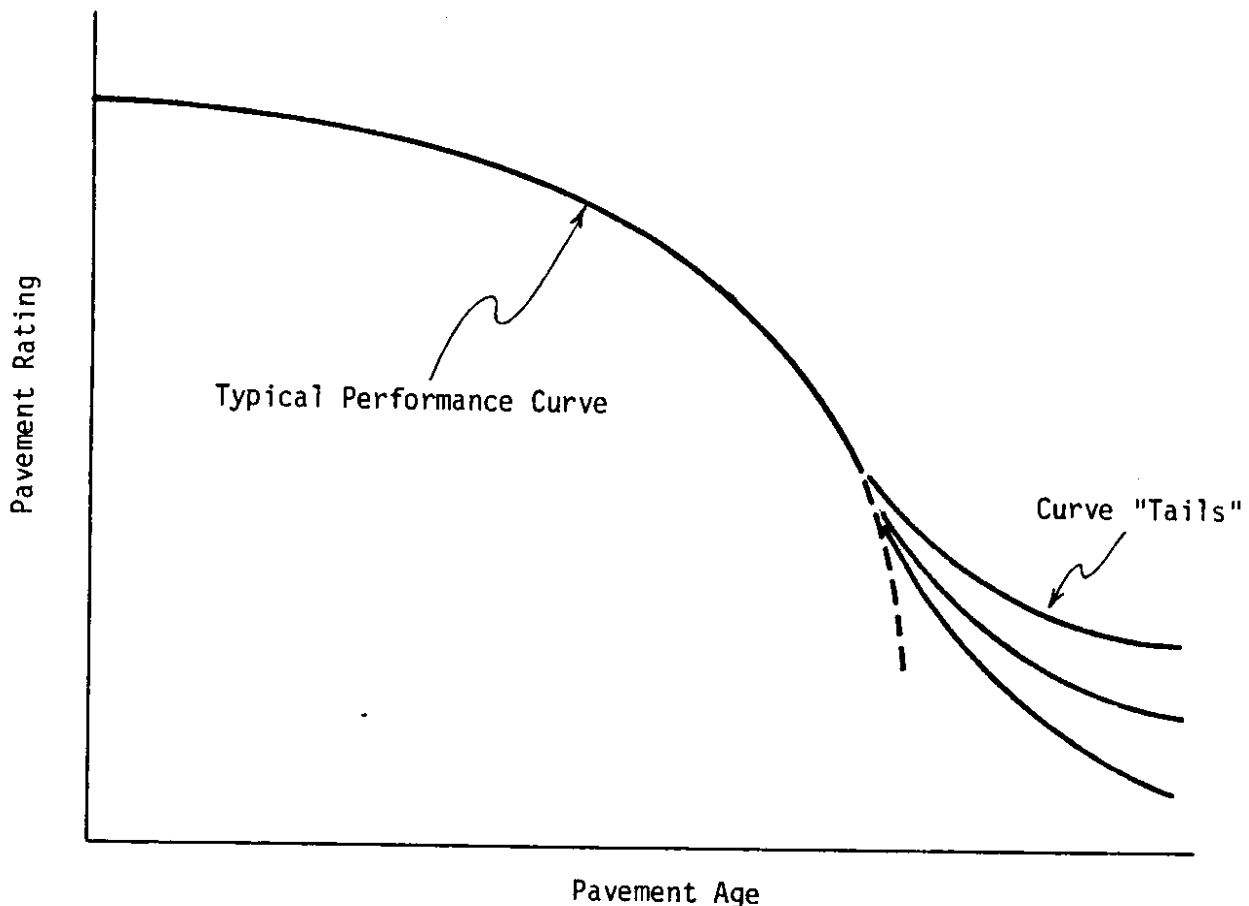


Figure 93. Typical Performance Curve with Curve Tails

Adaptability of the System

It should be noted that the framework of this system could be utilized by any agency that has the two basic constituents for the master file:

1. A construction history file with construction dates, types of surfacing, etc.
2. A pavement rating history file that relates to severity and extent of different distress types.

With this information available, it would be possible to calibrate distress weightings to relate to any combination of distress types and to represent the genesis of pavement deterioration in almost any geographical area. Once performance curves are developed, the mechanics of the rest of this system fall into line.

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APPENDICES

- A. Interpreting Source Program
- B. Optimizing Source Program
- C. Network Source Program
- D. Job Control Language and Program Modules
for Applying Constraints
- E. RATGRP Source Program.

APPENDIX A

INTERPRETING SOURCE PROGRAM

00000100
 00000200
 00000300
 00000400
 00000500
 00000600
 00000700
 00000800
 00000900
 00001000
 00001100
 00001200
 00001300
 00001400
 00001500
 00001600
 00001700
 00001800
 00001900
 00002000
 00002100
 00002200
 00002300
 00002400
 00002500
 00002600
 00002700
 00002800
 00002900
 00003000
 00003100
 00003200
 00003300
 00003400
 00003500
 00003600
 00003700
 00003800
 00003900
 00004000
 00004100
 00004200
 00004300
 00004400

PROGRAM INTERP
 THIS PROGRAM TRANSLATES THE RAW DISTRESS CODES CONTAINED IN THE
 MASTER FILE INTO AVERAGE RATINGS FOR EACH PROJECT. THIS IS
 ACCOMPLISHED BY APPLYING WEIGHTING VALUES TO THE EXTENT AND
 SEVERITY OF EACH DISTRESS CATEGORY. REGRESSION ANALYSIS IS
 THEN APPLIED TO THE RATINGS TO FIT A PERFORMANCE CURVE.

IMPLICIT INTEGER (A-Z)

COMMON /COMRAT/
 1 AMTRX,
 2 D1,
 3 D48,
 D7A,
 CMTRX,
 D3A,
 D5B,
 D8A,
 PTYP,
 D3B,
 D6A,
 D8B,
 STRUCR,
 D4A,
 D6B.

COMMON /COMREG/
 1 RMEAN,
 2 NEXP,
 RATHI,
 RGEN,
 EXP,
 RATLO,
 ECONS,
 JK,
 EVAR,
 LZR,
 EPOW,
 SE,
 R2,

REAL
 1 RAT(50),
 2 ECONS,
 3 LIFE60,
 4 RDR(50),
 5 MSTR(10),
 6 AX3,
 7 RATHI(50),
 8 RATLO(10),
 9 DAGE,
 EPN(4,3,4),
 ACUM,
 EVAR,
 LIFE40,
 MRDR(10),
 RMSTR(10),
 AX4,
 RATHI(50),
 RATLO(10),
 DAGE,
 EPN(4,3,4),
 MEAN(10),
 EXP(20),
 LIFE20,
 RMRDR(10),
 AX5,
 LORAT(10),
 RATHI(10),
 EC(3,4),
 RMEAN(10),
 EPOW,
 RF,
 SGR(50),
 RGRW,
 MINR2,
 HIRAT(50),
 LIFE50,
 EV(3,4),
 R2,
 TI,
 ARDR,
 ASTR,
 AX2,
 LTI,

REAL*8
 DATE

DIMENSION
 1 GEN(10),
 2 RGEN(10),
 3 RAGE(10),
 RHISK(10),
 AMTRX(3,21),
 FIMTRX(5,5),
 HISK(10),
 RLOSK(10),
 BMTRX(3,21),
 STMTRX(10,3),
 LOSK(10),
 RAVSK(10),
 CMTRX(3,21),
 TIR(4),
 AVSK(10).

CCCCCCCCCCCC C
 CC
 CC
 C C

```

CCCC
CCC
CC
CCCC
      DEFINE B.L.R AS DATA
      DATA B,L,R/H,L,L,R/
      CALL GETDAT( DATE )
      READ INTERPRETING PARAMETERS
      DO 3 I = 1,3
      READ (4,401) (AMTRX(I,J),J=1,21)
      FORMAT (21I2)
      CONTINUE
      DO 4 I = 1,3
      READ (4,401) (BMTRX(I,J),J=1,21)
      CONTINUE
      DO 5 I = 1,3
      READ (4,401) (CMTRX(I,J),J=1,21)
      CONTINUE
      DO 6 I = 1,3
      READ (4,402) NEXP,NOW,TRAFYR,MINR2,WATE
      FORMAT (3I2,F3.2,I3)
      READ (4,403) (EXP(J),J=1,20)
      FORMAT (20F4.2)
      DO 7 I = 1,3
      READ (4,404) (EC(I,J),J=1,4)
      FORMAT (4(F5.1,5X))
      DO 8 I = 1,4
      READ (4,405) (EV(I,J),J=1,4)
      FORMAT (4(F8.5,2X))
      DO 9 I = 1,4
      READ (4,406) (EP(I,J),J=1,4)
      FORMAT (1X,4(F4.2,6X))
      CONTINUE
      DO 10 I = 1,4
      DO 11 J = 1,3
      READ (4,407) (EPN(I,J,K),K=1,4)
      FORMAT (4(F4.2,2X))
      CONTINUE
      CONTINUE
      INITIALIZE COUNTERS
CCCC

```

```

00004500
00004600
00004700
00004800
00004900
00005000
00005100
00005200
00005300
00005400
00005500
00005600
00005700
00005800
00005900
00006000
00006100
00006200
00006300
00006400
00006500
00006600
00006700
00006800
00006900
00007000
00007100
00007200
00007300
00007400
00007500
00007600
00007700
00007800
00007900
00008000
00008100
00008200
00008300
00008400
00008500
00008600
00008700
00008800

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```

RCNT=0
FIRST=0
LLEMP=0
LREMP=0
TI=0
JJ=0
CC HEGIN PEADING PROJECT DATA
100 PEAD (5.501.END=998)
1  CSI,
2  SRI,
3  FCI,
4  RSI,
5  SURFI,
6  ADTI,
7  KDI,
8  SPED,
9  D3A,
A  D5B,
B  D8A,
CROSS
C 501 FORMAT (3I4,A3,A1,A3,2I5,I4,A1,I1,A1,2I1,3A2,A1,A4,3I2,A1,2I2,
1  I6,I3,4I2,F3,I1,I2,I4,A1,I2,I5,3A1,6(I1,A1),3I2,I1)
C
C FIRST = FIRST + 1
IF (FIRST .EQ. 1) GO TO 30
IF (GENI .NE. LGEN) GO TO 20
IF (ESMPI .NE. LESMP .OR. LANEI .NE. LLANE) GO TO 20
CC 30 CALL ARAT
CC
CC ADJUST COUNT
CC CALL RIDADJ(GENI,SPED,COUNT,PTYP,ACOUNT)
CC COMPUTE HIDE FACTOR
CC PF = 1.0 - (0.3 * (FLOAT(ACOUNT)/ 5000) ** 2)
IF (RF .LT. 0.01) PF = 0.01
CC COMPUTE LENGTH FOR THIS DEFECT RECORD
00008900
00009000
00009100
00009200
00009300
00009400
00009500
00009600
00009700
00009800
00009900
00010000
00010100
00010200
00010300
00010400
00010500
00010600
00010700
00010800
00010900
00011000
00011100
00011200
00011300
00011400
00011500
00011600
00011700
00011800
00011900
00012000
00012100
00012200
00012300
00012400
00012500
00012600
00012700
00012800
00012900
00013000
00013100
00013200
DI,
URI,
RWI,
CTYPI,
BASEI,
KI,
SIDE,
D2,
D5A,
D7B,
AVSKI,
SEGI,
LENGI,
NLI,
SNUMI,
YRI,
COMBI,
EMP,
D1,
D4B,
D7A,
LOSKI,
ECMPI,
ESMPI,
HTI,
SPI,
MNTHI,
SUI,
GENI,
PTYP,
D4A,
D6B,
HISKI,
HCMPI,
HSMPI,
LANEI,
LSI,
LTKI,
GRWI,
TI,
COUNT,
D3B,
D6A,
D8R,

```



```

00013300
00013400
00013500
00013600
00013700
00013800
00013900
00014000
00014100
00014200
00014300
00014400
00014500
00014600
00014700
00014800
00014900
00015000
00015100
00015200
00015300
00015400
00015500
00015600
00015700
00015800
00015900
00016000
00016100
00016200
00016300
00016400
00016500
00016600
00016700
00016800
00016900
00017000
00017100
00017200
00017300
00017400
00017500
00017600

```

```

C
IF (SIDE .EQ. L .AND. LLEMP .GT. 0) GO TO 31
IF (SIDE .EQ. R .AND. LREMP .GT. 0) GO TO 33
RLENG = EMP - BCMPI
GO TO 35
31 IF (CROSS .GT. 0) GO TO 32
IF (LENG = EMP - LLEMP)
IF (EMP .GE. ECMPI) RLENG = ECMPI - LLEMP
GO TO 35
32 IF (CROSS .EQ. 1) RLENG = EMP - LLEMP
IF (CROSS .EQ. 2) RLENG = EMP
IF (CROSS .EQ. 3) RLENG = ECMPI - LLEMP
IF (CROSS .EQ. 4) RLENG = ECMPI
GO TO 35
33 IF (CROSS .GT. 0) GO TO 34
RLENG = EMP - LREMP
IF (EMP .GE. ECMPI) RLENG = ECMPI - LREMP
GO TO 35
34 IF (CROSS .EQ. 1) RLENG = EMP - LREMP
IF (CROSS .EQ. 2) RLENG = EMP
IF (CROSS .EQ. 3) RLENG = ECMPI - LREMP
IF (CROSS .EQ. 4) RLENG = ECMPI
IF (RLENG = CLLENG + RLENG)
35
MODIFY DISTRESS RATING WITH RIDE FACTOR & RATING LENGTH
II = II + 1
RATN(II) = STRUCR * RF * RLENG
RDR(II) = RF * RLENG
STR(II) = STRUCR * 1.0 * RLENG
CHANGE ALL ID VARIABLES FROM VARIABLES-IN TO LAST-VARIABLES
FOR COMPARISON PURPOSES IN TRIGGERING MEAN COMPUTATIONS,
REGRESSION ANALYSIS AND USING PROPER ID IN OUTPUT
LCS = CSI
LRCMP = RCMPI
LECMP = ECMPI
LSEQ = SEQI
LD = DI
LRSMP = SPI
LRSMP = HSMPI

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```

00017700
00017800
00017900
00018000
00018100
00018200
00018300
00018400
00018500
00018600
00018700
00018800
00018900
00019000
00019100
00019200
00019300
00019400
00019500
00019600
00019700
00019800
00019900
00020000
00020100
00020200
00020300
00020400
00020500
00020600
00020700
00020800
00020900
00021000
00021100
00021200
00021300
00021400
00021500
00021600
00021700
00021800
00021900
00022000

```

```

LFSMP = ESMP I
LLENG = LENG I
LFC = FCI I
LHHT = HT I
LNLANE = NLANE I
LRW = RWI I
LRS = RSI I
LSSP = SPI I
LSNUM = SNUM I
LCTYP = CTYP I
LSURF = SURF I
LTHK = THK I
LMNTH = MNTH I
LYRASE = YRASE I
LGEN = GENI I
LADT = ADT I
LGRW = GRW I
LSU = SU I
LCOMPR = COMBI I
LKO = KI I
LTI = TI I

```

```

C
IF (HISKI .EQ. 0 .AND. GENI .EQ. LGEN) GO TO 36
LHISK = HISKI
IF (LOSKI .EQ. 0 .AND. GENI .EQ. LGEN) GO TO 37
LLOSK = LOSKI
IF (LAVSKI .EQ. 0 .AND. GENI .EQ. LGEN) GO TO 38
LAVSK = AVSKI
C
IF (SIDE .EQ. R .OR. SIDE .EQ. B) LREMP = EMP
IF (SIDE .EQ. L .OR. SIDE .EQ. B) LLEMP = EMP
IF (SIDE .EQ. H) LLEMP = LANEI
GO TO 100
C
C COMPUTE MEAN RATING VALUE FOR EACH GENERATION
C
998 LAST = 1
20 ACUM = 0
APDR = 0

```

```

C
  ASTR=0
  JJ = JJ + 1
  DO 21 N = 1, I
    ACUM = ACUM + RAT(N)
    ARDR = ARDR + RDR(N)
    ASTR = ASTR + STR(N)
    IF (N.EQ.1) LORAT(JJ) = RATIN(N)
    IF (RATIN(N) .LT. LORAT(JJ)) LORAT(JJ) = RATIN(N)
    IF (N.EQ.1) HIRAT(JJ) = RATIN(N)
    IF (RATIN(N) .GT. HIRAT(JJ)) HIRAT(JJ) = RATIN(N)
  21 CONTINUE
C
  MEAN(JJ) = ACUM/CLENG
  MRDR(JJ) = ARDR/CLENG
  MSTR(JJ) = ASTR/CLENG
  GEN(JJ) = LGEN
  HISK(JJ) = LHISK
  LOSK(JJ) = LLOSK
  AVSK(JJ) = LAVSK
  CLENG = 0
  LREMP = 0
  LI = 0
  IF (RSMPI .NE. LRSMP .OR. ESMP1 .NE. LESMP ) GO TO 10
  IF (LAST.EQ.1) GO TO 10
  IF (LLANE .NE. LANFI) GO TO 10
  GO TO 30
C
  SELECT MEAN RATINGS ATTRIBUTED TO MOST RECENT CONTRACT AND
  PERFORM REGRESSION ANALYSIS
C
  10 AGE= NOW - LYR
  JK = 0
C
  DO 11 I = 1, JJ
    IF (GEN(I) .GE. LYR) GO TO 12
    GO TO 11
  11 JK = JK + 1
  12 RMEAN(JK) = MEAN(I)
  RMRDR(JK) = MRDR(I)
  RMSTR(JK) = MSTR(I)
  RGEN(JK) = GEN(I)
  RPAGE(JK) = GEN(I) - LYR

```

```

00022100
00022200
00022300
00022400
00022500
00022600
00022700
00022800
00022900
00023000
00023100
00023200
00023300
00023400
00023500
00023600
00023700
00023800
00023900
00024000
00024100
00024200
00024300
00024400
00024500
00024600
00024700
00024800
00024900
00025000
00025100
00025200
00025300
00025400
00025500
00025600
00025700
00025800
00025900
00026000
00026100
00026200
00026300
00026400

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000266500
 000266600
 000266700
 000266800
 000266900
 000267000
 000267100
 000267200
 000267300
 000267400
 000267500
 000267600
 000267700
 000267800
 000267900
 000268000
 000268100
 000268200
 000268300
 000268400
 000268500
 000268600
 000268700
 000268800
 000268900
 000269000
 000269100
 000269200
 000269300
 000269400
 000269500
 000269600
 000269700
 000269800
 000269900
 000270000
 000270100
 000270200
 000270300
 000270400
 000270500
 000270600
 000270700
 000270800
 000270900
 000271000

```

RHISK(JK) = HISK(I)
RLOSK(JK) = LOSK(I)
RAVSK(JK) = AVSK(I)
RATHI(JK) = HIRAT(I)
RATLC(JK) = LORAT(I)
IF (RGEN(JK) .GT. LYR) GO TO 11
RMEAN(JK) = 100.0
RMSTR(JK) = 100.0
RATHI(JK) = 100.0
RATLC(JK) = 100.0
CONTINUE
  
```

11

```

C IF (LYR .LE. NOW) GO TO 15
  JK = 1
  RGEN(JK) = LYR
  RAGE(JK) = 0
  RMEAN(JK) = 100.0
  RMSTR(JK) = 100.0
  RATHI(JK) = 100.0
  RATLC(JK) = 100.0
  RHISK(JK) = LHISK
  RLOSK(JK) = LLOSK
  RAVSK(JK) = LAVSK
  
```

C

15 JJ = 0

C
 C
 C
 C

```

TEST SECTIONS FOR AGE
IF TOO YOUNG: ASSIGN SYNTHETIC EQUATIONS
  
```

```

IF (JK .GE. 3 .AND. RMEAN(JK) .LE. 95.0) GO TO 300
IF (LSURF .GE. 20 .AND. LSURF .LT. 30) S = 1
IF (LSURF .GE. 40) S = 2
IF (LSURF .EQ. 30) S = 3
T = 1
IF (LCTYP .NE. 20) GO TO 210
T = 2
IF (LTHK .GE. 10 .AND. LTHK .LT. 20) T = 3
IF (LTHK .GE. 20) T = 4
ECONS = EC(S,T)
EVAR = EV(S,T)
FPOW = EP(S,T)
R2 = 0
SE = 0
  
```

210

```

00030900
00031000
00031100
00031200
00031300
00031400
00031500
00031600
00031700
00031800
00031900
00032000
00032100
00032200
00032300
00032400
00032500
00032600
00032700
00032800
00032900
00033000
00033100
00033200
00033300
00033400
00033500
00033600
00033700
00033800
00033900
00034000
00034100
00034200
00034300
00034400
00034500
00034600
00034700
00034800
00034900
00035000
00035100
00035200

```

```

C      GOOD = 1
C      GO TO 400
C      CALL THE REGRESSION SUBROUTINE
C      CALL REGR
C      GOOD = 2
C      300
C      TEST THE RESULTS OF THE REGRESSION ANALYSIS FOR POSSIBLE
C      SYNTHESIZING OF EQUATIONS
C      IF (R2 .GE. MINR2) GO TO 400
C      ECONS = 100.0
C      PR2 = 0
C      SE = 0
C      IF (LSURF .GE. 20 .AND. LSURF .LT. 30) SS = 1
C      IF (SSURF .GE. 40 .AND. LCTYP .LT. 20) SS = 2
C      IF (LSURF .EQ. 30) SS = 3
C      IF (LCTYP .GE. 20 .AND. LCTYP .LT. 30) SS = 4
C      IF (LTHK .LT. 10) TT = 1
C      IF (LTHK .GE. 10 .AND. LTHK .LT. 20) TT = 2
C      IF (LTHK .GE. 20) TT = 3
C      IF (AGE .LT. 8) AA = 1
C      IF (AGE .GE. 8 .AND. AGE .LT. 12) AA = 2
C      IF (AGE .GE. 12 .AND. AGE .LT. 19) AA = 3
C      IF (AGE .GE. 19) AA = 4
C      EPW = EPW(SS,TT,AA)
C      EVAR = (RMEAN(JK) - 100.0)/(AGE ** EPW)
C      GOOD = 3
C      COMPUTE THE LIF AT RATINGS OF 20, 30, 40, 50, AND 60
C      400
C      IF (EVAR .GE. -.00000) EVAR = -.00001
C      LIFE40 = ((ECONS - 60.0)/(-1.0 * EVAR)) ** (1.0/EPW)
C      IF (LIFE40 .GT. 99) LIFE40 = 99.99
C      LIFE50 = ((ECONS - 50.0)/(-1.0 * EVAR)) ** (1.0/EPW)
C      IF (LIFE50 .GT. 99) LIFE50 = 99.99
C      LIFE40 = ((ECONS - 40.0)/(-1.0 * EVAR)) ** (1.0/EPW)
C      IF (LIFE40 .GT. 99) LIFE40 = 99.99

```



```

6 F9.5/,,RIDE RATING = ,1(F5.2/,,T63,,SINGLE UNITS,,5X,I2. 00044100
7 ,,,T88,,EQUA POWER = ,1(F5.2/,,STRUCR RATING,,1(F5.1,2X), 00044200
RT63,,COMBINATIONS,,5X,I2,,T88,,R SQUARE = ,F8.5/,,COMBD 00044300
9 RATING,,1(F5.1,2X),T63,,TRAFFIC INDEX,,4X,F3.1,T88,,STD FRPDR = 00044400
A ,,,HIGH RATING,,1(F5.2/,,LOW RATING,,1(F5.1, 00044500
H ,,,T88,,TIME TO 60 = ,F4.1,,T88,,TIME TO 50 = ,F5.2/,, 00044600
C2X),T62,,2 AXLE TRUCKS = ,F4.1,,T88,,TRUCKS = ,F4.1,,T88, 00044700
D,,HIGH FRICTION,,4X,I(12,5X),T62,,3 AXLF TRUCKS = ,F4.1,,T88, 00044800
E,TIME TO 40 = ,F5.2/,,LOW FRICTION,,4X,I(12,5X),T62,,4 AXLE 00044900
F,TRUCKS = ,F4.1,,T88,,TIME TO 30 = ,F5.2/,,AVG FRICTION,, 00045000
G.4X,I(12,5X),T62,,5 AXLE TRUCKS = ,F4.1,,T88,,CURVE 00045100
H IX,I/,,108(,,))
C
GO TO 65
C
C
60 WRITE (6.605) (RGEN(K),K=1,6), LADT, ECONS,
1 (WAGE(K),K=1,6), LEVAP,
2 (RMSTR(K),K=1,6), LLSU,
3 (RMEAN(K),K=1,6), LCOMB,
4 (RATHI(K),K=1,6), LTI,
5 (RATLO(K),K=1,6), LK,
6 (RPHISK(K),K=1,6), AX2, LIFE50,
7 (RLOSK(K),K=1,6), AX3, LIFE40,
8 (PAVSK(K),K=1,6), AX4, LIFE30,
9 (PAVSK(K),K=1,6), AX5, GOOD
C
605 FORMAT (,T18,,PERFORMANCE HISTORY,,T61,,APPROXIMATE TRAFFIC DAT
1A,,T89,,PERFORMANCE EQUATION,,)
2
3-----/,,YEAR,,13X,
4 6(I2,5X),T63,I2,,ADT,,8X,I6,T88,,EQUA CONST = ,F6.2/,,AGE, 00047100
5 14X,6(I2,5X),T63,,GROWTH RATE,,4X,F4.1,,T88,,EQUA COEFF = , 00047200
6 F9.5/,,RIDE RATING,,6(F5.2,2X),T63,,SINGLE UNITS,,5X,I2. 00047300
7 ,,,T88,,EQUA POWER = ,F5.2/,,STRUCR RATING,,6(F5.1,2X), 00047400
RT63,,COMBINATIONS,,5X,I2,,T88,,R SQUARE = ,F8.5/,,COMBD 00047500
9 RATING,,6(F5.1,2X),T63,,TRAFFIC INDEX,,4X,F3.1,T88,,STD ERROR = 00047600
A ,,,HIGH RATING,,1(F5.2/,,LOW RATING,,1(F5.1, 00047700
R ,,,T88,,TIME TO 60 = ,F4.1,,T88,,TIME TO 50 = ,F5.2/,, 00047800
C2X),T62,,2 AXLE TRUCKS = ,F4.1,,T88,,TRUCKS = ,F4.1,,T88, 00047900
D,,HIGH FRICTION,,4X,6(I2,5X),T62,,3 AXLE TRUCKS = ,F4.1,,T88, 00048000
E,TIME TO 40 = ,F5.2/,,LOW FRICTION,,4X,6(I2,5X),T62,,4 AXLE 00048100
F,TRUCKS = ,F4.1,,T88,,TIME TO 30 = ,F5.2/,,AVG FRICTION,, 00048200
G.4X,6(I2,5X),T62,,5 AXLE TRUCKS = ,F4.1,,T88,,CURVE 00048300
H IX,I/,,108(,,))

```



```

C H 1X,11//',10R('**'))
C GO TO 65
C
61 WRITE (6,606) (RGEN(K),K=1,5), (LADT, ECONS,
1 (RAGE(K),K=1,5), (RGRW, TRAFYR,
2 (RMRDR(K),K=1,5), (LEVAR, EPON,
3 (RMSTR(K),K=1,5), (LSU, RGRW,
4 (RMEAN(K),K=1,5), (LCCOMB,
5 (RATHI(K),K=1,5), (LTI,
6 (RATLO(K),K=1,5), (LX2, LIFE50,
7 (RHISK(K),K=1,5), (AX3, LIFE40,
8 (RLOSK(K),K=1,5), (AX4, LIFE30,
9 (RAVSK(K),K=1,5), (AX5, GOOD)
C
606 FORMAT ('',T18,'PERFORMANCE HISTORY',T61,'APPROXIMATE TRAFFIC DAT
1A',T9,'PERFORMANCE EQUATION',/
2
3
4
5
6
7
8
9
A
B
C
D
E
F
G
H
1X,11//',10R('**'))
GO TO 65
C
C
62 WRITE (6,607) (RGEN(K),K=1,4), (LADT, ECONS,
1 (RAGE(K),K=1,4), (RGRW, TRAFYR,
2 (RMRDR(K),K=1,4), (LEVAR, EPON,
3 (RMSTR(K),K=1,4), (LSU, RGRW,
4 (RMEAN(K),K=1,4), (LCCOMB,
5 (RATHI(K),K=1,4), (LTI,
6 (RATLO(K),K=1,4), (LX2, LIFE50,
7 (RHISK(K),K=1,4), (AX3, LIFE40,
8 (RLOSK(K),K=1,4), (AX4, LIFE30,
9 (RAVSK(K),K=1,4), (AX5, GOOD)
C
C

```

```

6 (RATLO(K),K=1,4) . AX2 . LIFE50,
7 (RHISK(K),K=1,4) . AX3 . LIFE40,
8 (RLOSK(K),K=1,4) . AX4 . LIFE30,
9 (RAVSK(K),K=1,4) . AX5 . GOOD
00529000
00053000
00053100
00053200
00053300
00053400
00053500
00053600
00053700
00053800
00053900
00054000
00054100
00054200
00054300
00054400
00054500
00054600
00054700
00054800
00054900
00055000
00055100
00055200
00055300
00055400
00055500
00055600
00055700
00055800
00055900
00056000
00056100
00056200
00056300
00056400
00056500
00056600
00056700
00056800
00056900
00057000
00057100
00057200

```

C 607 FORMAT (I,I,I18,PERFORMANCE HISTORY,T61,APPROXIMATE TRAFFIC DAT
1A,T89,PERFORMANCE EQUATION,/,
2-----
3 /, , , YEAR, 13X,
4 4(I2,5X),T63,I2, , ADT, 8X,T88, EQUA CONST = ,F6,2/, , , AGE,
5 14X,4(I2,5X),T63, ,GROWTH RATE,4X,F4,1, , ,T88, EQUA COEFF = ,
6 F9,5/, , , RIDE RATING ,4(F5,2,2X),T63, ,SINGLE UNITS,5X,I2, ,
7 , ,T88, EQUA POWER = ,F5,2/, , , STRUCR RATING ,4(F5,1,2X), ,
8 RT63, ,COMBINATIONS,5X,I2, , ,T88, ,R SQUARE ,4X,F3,1, ,T88, ,STD ERROR =
9 RATING ,4(F5,1,2X),T63, ,TRAFFIC INDEX,4X,F3,1, ,T88, ,CORBD =
A , ,F5,2/, , , HIGH RATING ,4(F5,1,2X),T63, ,K = ,I2, , ,6X, ,D =
B , ,I2, , ,T88, ,TIME TO 60 = ,F4,1, , , LOW RATING ,4(F5,1, ,
C2X),T62, ,2 AXLE TRUCKS = ,F4,1, , ,T88, ,TIME TO 50 = ,F5,2/, , ,
D , ,HIGH FRICTION,4X,4(I2,5X),T62, ,3 AXLE TRUCKS = ,F4,1, , ,T88, ,
E,TIME TO 40 = ,F5,2/, , , LOW FRICTION,4X,4(I2,5X),T62, ,4 AXLE
FTRUCKS = ,F4,1, , ,T88, ,TIME TO 30 = ,F5,2/, , , AVG FRICTION,00054900
G,4X,4(I2,5X),T62, ,5 AXLE TRUCKS = ,F4,1, , ,T88, ,CURVE
H 1X,I1/, , ,10R(, , ,))

C GO TO 65

C

C 63 WRITE (6,608) (RGFN(K),K=1,3), ECONS,
1 LADT,
2 (RAGE(K),K=1,3), LEVAR,
3 (RMRDR(K),K=1,3), EPOM,
4 (RMSTR(K),K=1,3), R2,
5 (RMEAN(K),K=1,3), SE,
6 (RATHI(K),K=1,3), LK,
7 (RATLO(K),K=1,3), LKDE,50,
8 (RHISK(K),K=1,3), AX2, LIFE60,
9 (RLOSK(K),K=1,3), AX3, LIFE50,
0 (RAVSK(K),K=1,3), AX4, LIFE40,
1 AX5, AX5, GOOD

C 608 FORMAT (I,I,I18,PERFORMANCE HISTORY,T61,APPROXIMATE TRAFFIC DAT
1A,T89,PERFORMANCE EQUATION,/,
2-----
3 /, , , YEAR, 13X,
4 3(I2,5X),T63,I2, , ADT, 8X,I6,T88, EQUA CONST = ,F6,2/, , , AGE,
5 14X,3(I2,5X),T63, ,GROWTH RATE,4X,F4,1, , ,T88, EQUA COEFF = ,

```

6 F9.5/,,RIDE,RATING,,3(F5.2,2X),T63,SINGLE,UNITS,,5X,I2, 00057300
7 ,,,EQUA,POWER,,F5.2/,,STRUCR,RATING,,3(F5.1,2X), 00057400
8 ,,,COMBINATIONS,,5X,I2,,T88,,R,SQUARE,,F8.5/,,COMB 00057500
9 RATING,,3(F5.1,2X),T63,TRAFFIC,INDEX,,4X,F3.1,T88,,STD,ERROR 00057600
A ,,,HIGH,RATING,,3(F5.1,2X),T63,,K,,12,,%,6X,D 00057700
B ,,,TIME,TO,60,,F5.2/,,LOW,RATING,,3(F5.1, 00057800
C2X),T62,,T88,,TIME,TO,50,,F5.2/,,%,T88, 00057900
D ,,,HIGH,TRUCKS,,F4.1,,%,T88,TRUCKS,,F4.1,,%,T88, 00058000
E ,,,FRIC,TRUCKS,,4X,3(I2,5X),T62,,TRUCKS,,F4.1,,%,T88, 00058100
F ,,,TIME,TO,40,,F5.2/,,LOW,FRIC,TRUCKS,,4X,3(I2,5X),T62,,AXLE 00058200
G ,,,FRIC,TRUCKS,,F4.1,,%,T88,FRIC,TRUCKS,,4X,3(I2,5X),T62,,AVG 00058300
H 1X,I1/,,108(,*)) 00058400
C 00058500
C 00058600
C 00058700
C 00058800
C 00058900
C 00059000
C 00059100
C 00059200
C 00059300
C 00059400
C 00059500
C 00059600
C 00059700
C 00059800
C 00059900
C 00060000
1A ,,,PERFORMANCE,HISTORY,,T61,,APPROXIMATE,TRAFFIC,DAT 00060100
2 ,,,PERFORMANCE,EQUATION,,/,, 00060200
3 -----/,,YEAR,,13X, 00060300
4 2(I2,5X),T63,I2,,ADT,,8X,I6,T88,,EQUA,CONST,,F6.2/,,AGE,, 00060400
5 14X,2(I2,5X),T63,,GROWTH,RATE,,4X,F4.1,,%,T88,,EQUA,COEFF,,F6.2/,,AGE,, 00060500
6 F9.5/,,RIDE,RATING,,3(F5.2,2X),T63,SINGLE,UNITS,,5X,I2, 00060600
7 ,,,COMBINATIONS,,5X,I2,,T88,,R,SQUARE,,F8.5/,,COMB 00060700
8 T63,TRAFFIC,INDEX,,4X,F3.1,T88,,STD,ERROR 00060800
9 RATING,,2(F5.1,2X),T63,,K,,12,,%,6X,D 00060900
A ,,,TIME,TO,60,,F5.2/,,LOW,RATING,,3(F5.1, 00061000
C2X),T62,,T88,,TIME,TO,50,,F5.2/,,%,T88, 00061100
D ,,,HIGH,TRUCKS,,F4.1,,%,T88,TRUCKS,,F4.1,,%,T88, 00061200
E ,,,FRIC,TRUCKS,,4X,2(I2,5X),T62,,TRUCKS,,F4.1,,%,T88, 00061300
F ,,,TIME,TO,40,,F5.2/,,LOW,FRIC,TRUCKS,,4X,2(I2,5X),T62,,AXLE 00061400
G ,,,FRIC,TRUCKS,,F4.1,,%,T88,FRIC,TRUCKS,,4X,2(I2,5X),T62,,AVG 00061500
H 1X,I1/,,108(,*)) 00061600
C 00061700
C 00061800
C 00061900
C 00062000
C 00062100
C 00062200
C 00062300
C 00062400
C 00062500
C 00062600
C 00062700
C 00062800
C 00062900
C 00063000
C 00063100
C 00063200
C 00063300
C 00063400
C 00063500
C 00063600
C 00063700
C 00063800
C 00063900
C 00064000
C 00064100
C 00064200
C 00064300
C 00064400
C 00064500
C 00064600
C 00064700
C 00064800
C 00064900
C 00065000
C 00065100
C 00065200
C 00065300
C 00065400
C 00065500
C 00065600
C 00065700
C 00065800
C 00065900
C 00066000
C 00066100
C 00066200
C 00066300
C 00066400
C 00066500
C 00066600
C 00066700
C 00066800
C 00066900
C 00067000
C 00067100
C 00067200
C 00067300
C 00067400
C 00067500
C 00067600
C 00067700
C 00067800
C 00067900
C 00068000
C 00068100
C 00068200
C 00068300
C 00068400
C 00068500
C 00068600
C 00068700
C 00068800
C 00068900
C 00069000
C 00069100
C 00069200
C 00069300
C 00069400
C 00069500
C 00069600
C 00069700
C 00069800
C 00069900
C 00070000

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```

C      H IX,II/' ',108('**'))
C
C      65 CALL RPLOTT
C
C      375 FCONS = 0
C          FVAR = 0
C          EPOW = 0
C          SE = 0
C          R2 = 0
C          JK = 0
C
C          IF (LAST.EQ. 1) GO TO 999
C          GO TO 30
C
C      999 END FILE 9
C          STOP
C          END
C
C      SUBROUTINE ARAT
C
C      THIS SUBROUTINE USES ALL DEFECT DATA AND MATRICES AMTRX, BMTRX,
C      AND CMTRX, FOR ASPHALT PAVEMENTS, BITUMINOUS PAVEMENTS, AND
C      PCC PAVEMENTS RESPECTIVELY FOR COMPUTING THE STRUCTURAL
C      RATINGS.
C
C      IMPLICIT INTEGER (A-Z)
C      COMMON /COMRAT/ AMTRX,
C      1      D2,
C      2      D3A,
C      3      D4B,
C          D4A,
C          D5A,
C          D5B,
C          D6A,
C          D6B,
C          D7A,
C          D7B,
C          D7C,
C          D7N,
C          D7R,
C          D7S,
C          D7T,
C          D7U,
C          D7V,
C          D7W,
C          D7X,
C          D7Y,
C          D7Z,
C          COL(8), AMTRX(3,21), BMTRX(3,21), CMTRX(3,21)
C
C      DEF (1) = D1
C      DEF (2) = D2
C      DEF (3) = D3B
C      DEF (4) = D4B
C      DEF (5) = D5B
C      DEF (6) = D6B
C      DEF (7) = D7B

```

```

00061700
00061800
00061900
00062000
00062100
00062200
00062300
00062400
00062500
00062600
00062700
00062800
00062900
00063000
00063100
00063200
00063300
00063400
00063500
00063600
00063700
00063800
00063900
00064000
00064100
00064200
00064300
00064400
00064500
00064600
00064700
00064800
00064900
00065000
00065100
00065200
00065300
00065400
00065500
00065600
00065700
00065800
00065900
00066000

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DEF (A) = D8A
DO 10 I = 1,R
IF ( DEF (I) .EQ. N .OR. DEF (I) .EQ. R) DEF (I) = 0
IF ( DEF (I) .EQ. 0) GO TO 10
DEF (I) = BCORNV (DEF (I),I)
10 CONTINUE
IF (DEF (2) .LT. 0 .OR. DEF (2) .GT. 3) DEF (2) = 0
COL (1) = 1
COL (2) = 2
COL (3) = D3A + 2
COL (4) = D4A + 5
COL (5) = D5A + 9
COL (6) = D6A + 12
COL (7) = D7A + 15
COL (8) = D8A + 18
SCORE = 0
DO 20 M = 1,8
IF (DEF (M) .EQ. 0) GO TO 20
J = COL (M)
IF (PTYP .EQ. A) SCORE = SCORE + AMTRX (I,J)
IF (PTYP .EQ. R) SCORE = SCORE + BMTRX (I,J)
IF (PTYP .EQ. C) SCORE = SCORE + CMTRX (I,J)
20 CONTINUE
STRUCR = 100 - SCORE
RETURN
END

SUBROUTINE RIDADJ (GEN,SPEED,COUNT,PTYPE,ACOUNT)

THIS SUBROUTINE ADJUSTS THE RIDE COUNT TO A COMMON BASE
DEPENDING THE GENERATION OF SURVEY, THE VEHICLE USED,
AND THE PARTICULAR RIDE METER UTILIZED.

IMPLICIT INTEGER (A-7)

REAL CPM, LCPM50

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00066100
00066200
00066300
00066400
00066500
00066600
00066700
00066800
00066900
00067000
00067100
00067200
00067300
00067400
00067500
00067600
00067700
00067800
00067900
00068000
00068100
00068200
00068300
00068400
00068500
00068600
00068700
00068800
00068900
00069000
00069100
00069200
00069300
00069400
00069500
00069600
00069700
00069800
00069900
00070000
00070100
00070200
00070300
00070400

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CCC CCCCCC CC CC

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00070500
00070600
00070700
00070800
00070900
00071000
00071100
00071200
00071300
00071400
00071500
00071600
00071700
00071800
00071900
00072000
00072100
00072200
00072300
00072400
00072500
00072600
00072700
00072800
00072900
00073000
00073100
00073200
00073300
00073400
00073500
00073600
00073700
00073800
00073900
00074000
00074100
00074200
00074300
00074400
00074500
00074600
00074700
00074800

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```

C      DATA A,B,C/'A','R','C'/
C
C      IF (COUNT.EQ.0) GO TO 100
C      IF (GEN.EQ.69) GO TO 100
C      IF (GEN.EQ.71) GO TO 10
C      IF (GEN.GE.75.AND.GEN.LE.79) GO TO 50
C      IF (GEN.GE.81) GO TO 40
C
C      CPM = (0.4668 * COUNT) + 6.1004
C      GO TO 20
C
C      10 CPM = COUNT * 1.0
C      20 IF (SPEED.EQ.0) GO TO 30
C      IF (SPEED.EQ.50) GO TO 30
C      IF (SPEED.EQ.40.AND.(PTYPE.EQ.A.OR.PTYPE.EQ.B))
C          1 LCPM50 = (1.1924 * ALOG10(CPM)) - 0.7448
C      1 IF (SPEED.EQ.30.AND.(PTYPE.EQ.A.OR.PTYPE.EQ.B))
C          1 LCPM50 = (1.1569 * ALOG10(CPM)) - 0.5786
C      1 IF (SPEED.NE.150.AND.PTYPE.EQ.C)
C          1 LCPM50 = (1.2202 * ALOG10(CPM)) - 0.9093
C      CPM = 10 ** LCPM50
C      ACCOUNT = IFIX((CPM/0.585) - 198.8)
C      RETURN
C
C      40 CPM = COUNT * 1.0
C      LCPM50 = 1.36641 * (CPM ** .92294)
C      RETURN
C
C      50 IF (SPEED.EQ.50.OR.SPEED.EQ.0) GO TO 100
C      IF (SPEED.EQ.45) CPM = (1.09 * COUNT) + 28
C      IF (SPEED.EQ.40) CPM = (1.21 * COUNT) + 63
C      IF (SPEED.EQ.35) CPM = (1.37 * COUNT) + 119
C      IF (SPEED.EQ.30) CPM = (1.53 * COUNT) + 161
C      IF (SPEED.EQ.25) CPM = (1.78 * COUNT) + 180
C      ACCOUNT = IFIX(CPM)
C
C      100 ACCOUNT = COUNT

```

```

RETURN
END

SUBROUTINE PEGR
THIS SUBROUTINE PERFORMS LINEAR REGRESSION ANALYSIS USING YEARS
AS THE INDEPENDENT VARIABLE AND MEAN RATINGS FOR EACH YEAR AS
THE DEPENDENT VARIABLE. SEVERAL TYPICAL TRANSFORMATIONS ARE
APPLIED TO THE INDEPENDENT VARIABLE AND THE BEST FIT EQUATION
IS SELECTED BY THE HIGHEST R SQ. VALUE. THIS SUBROUTINE ALSO
COMPUTES THE STANDARD ERROR OF ESTIMATE FOR THE BEST FIT EQUA.

IMPLICIT INTEGER (A-7)
COMMON /COMREG/ RMEAN, RGEN, ECONS, EVAR, EPOW, R2,
NEXP, EXP, RATLO, JK, LVR, SE,
REAL ECONS, MEANX, MEANY, R2, MYSY, EXP(20), RSQ,
MEANX, MEANY, MEANY, SX2, MXSX, A, MXSX, SE,
RMEAN(10), SY2, B, X(11), Y(11), SUMX,
SUMY, RGEN(10), SUMX2, SUMY2

1 DIMENSION RGEN(10)
2
3
4
IF (RGEN(1) .EQ. LVR) GO TO 10
NUM = JK + 1
FX(1) = 0.0
Y(1) = 100.0
DO 15 I = 2, NUM
K = I - 1
FX(I) = (RGEN(K) - LVR) * 1.0
Y(I) = RMEAN(K)
15 CONTINUE
GO TO 20
DO 20 I = 1, NUM
FX(I) = (RGEN(I) - LVR) * 1.0
Y(I) = RMEAN(I)
20 CONTINUE
IF (NUM .EQ. 2) GO TO 30
PASS = 0
R2 = 0.0
DO 30 J = 1, NEXP

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00074900
00075000
00075100
00075200
00075300
00075400
00075500
00075600
00075700
00075800
00075900
00076000
00076100
00076200
00076300
00076400
00076500
00076600
00076700
00076800
00076900
00077000
00077100
00077200
00077300
00077400
00077500
00077600
00077700
00077800
00077900
00078000
00078100
00078200
00078300
00078400
00078500
00078600
00078700
00078800
00078900
00079000
00079100
00079200

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CC C C C C C C C C

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C

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00079300
00079400
00079500
00079600
00079700
00079800
00079900
00080000
00080100
00080200
00080300
00080400
00080500
00080600
00080700
00080800
00080900
00081000
00081100
00081200
00081300
00081400
00081500
00081600
00081700
00081800
00081900
00082000
00082100
00082200
00082300
00082400
00082500
00082600
00082700
00082800
00082900
00083000
00083100
00083200
00083300
00083400
00083500
00083600

```

```

SUMX = 0.0
SUMY = 0.0
SUMX2 = 0.0
SUMY2 = 0.0
DO 22 I = 1, NUM
  X(I) = EXP(I) ** EXP(J)
  SUMX = SUMX + X(I)
  SUMY = SUMY + Y(I)
  SUMXY = SUMXY + (X(I) ** 2) * Y(I)
  SUMX2 = SUMX2 + (X(I) ** 2)
  SUMY2 = SUMY2 + (Y(I) ** 2)
22 CONTINUE
MEANX = SUMX / NUM
MEANY = SUMY / NUM
MMSX = MEANX * SUMY
MMSY = MEANY * SUMX
MSXY = SUMXY - MMSX
MSX2 = SUMX2 - MMSX
MSY2 = SUMY2 - MMSY
R = (MSXY / MSX2) ** .5
A = MEANY - (R * MEANX)
RSQ = SQRT ((SY2 - (B * SXY)) / (NUM - 2))
IF (RSQ .GE. 0.5) GO TO 25
GO TO 30
25 PASS = PASS + 1
IF (PASS .GT. 1) GO TO 26
R2 = RSQ
ECONS = A
EPOW = EXP(J)
SEE = SEE
IF (RSQ .LE. R2) GO TO 30
R2CONS = A
EPOW = EXP(J)
SEE = SEE
30 CONTINUE
IF (R2 .GT. 0) GO TO 40
ECONS = 0

```



```

00083700
00083800
00083900
00084000
00084100
00084200
00084300
00084400
00084500
00084600
00084700
00084800
00084900
00085000
00085100
00085200
00085300
00085400
00085500
00085600
00085700
00085800
00085900
00086000
00086100
00086200
00086300
00086400
00086500
00086600
00086700
00086800
00086900
00087000
00087100
00087200
00087300
00087400
00087500
00087600
00087700
00087800
00087900
00088000

EVAR = 0
EPOW = 0
SE = 0
40 RETURN
END

SURROUTINE RPLOTT

THIS SUBROUTINE PLOTS A PROJECT SEGMENTS MEAN RATINGS WITH
RESPECT TO AGE AND PROVIDES THE MATHEMATICALLY FIT CURVE
THE HIGH AND LOW RATINGS FOR EACH AVAILABLE YEAR ARE ALSO
PLOTTED

IMPLICIT INTEGER (A-Z)

COMMON /COMREG/ RMEAN, RGEN, ECONS, EVAR, EPOW, R2,
1 NEXT, EXP, JK, LYM, SE,
2 RATHI, RATLO

REAL RMEAN(10), ECONS, EVAR, EPOW, R2, EXP(20), RVAL
SE, RATHI(10), RATLO(10), AGE(21)

DIMENSION RGEN(10), PLOT(21,92), AGE(21)

DATA PLOT/
1'E',N',T',1,17*,R',A',T',I',N',G',P',A',V',E',M',
2*1,43*,1,20*,0,3*,0,3*,0,3*,6,3*,2*,1,17*,
3*2,4*,0,3*,0,3*,0,3*,0,3*,4,3*,
4*2,1*,0,3*,0,3*,0,3*,0,3*,0,3*,
5*1,2,81*,1,3*,I,3*,I,3*,I,3*,I,3*,I,
6*2,1*,1,3*,I,3*,I,3*,I,3*,I,3*,I,
7*0,3*,1,3*,I,3*,I,3*,I,3*,I,3*,I,
8*0,3*,0,3*,0,3*,0,3*,0,3*,0,3*,
9*0,3*,0,3*,0,3*,0,3*,0,3*,0,3*,
A*0,3*,0,3*,0,3*,0,3*,0,3*,0,3*,
H*O,3*,0,3*,0,3*,0,3*,0,3*,0,3*,
C*O,3*,0,3*,0,3*,0,3*,0,3*,0,3*,
N*O,3*,0,3*,0,3*,0,3*,0,3*,0,3*,
P*1,2*,U,1,4*,V,1,4*,V,1,4*,V,1,4*,V,
D*1,2*,U,1,4*,V,1,4*,V,1,4*,V,
E*1,2*,U,1,4*,V,1,4*,V,1,4*,V,1,4*,V

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```

      COL = (RGEN(I) - YR) * 3 + 11
      PLOT(ROW1,COL) = PLUS
      PLOT(ROW2,COL) = MINUS
      PLOT(ROW3,COL) = AST
20  CONTINUE
      PYR5 = YR + 5
      PYR10 = PYR + 10
      PYR15 = PYR + 15
      PYR20 = PYR + 20
      AGE = AGE(I)
      AG5 = AG + 5
      AG10 = AG + 10
      AG15 = AG + 15
      AG20 = AG + 20
      IF (PYR.GT. 99) PYR = PYR - 100
      IF (PYR5.GT. 99) PYR5 = PYR5 - 100
      IF (PYR10.GT. 99) PYR10 = PYR10 - 100
      IF (PYR15.GT. 99) PYR15 = PYR15 - 100
      IF (PYR20.GT. 99) PYR20 = PYR20 - 100
      WRITE (6,601)
601  FORMAT ('//',T53,'**5X**//',T53,'** AGE **//',T53,'**',5X,
1
201  WRITE (6,602) AG, AG5, AG10, AG15, AG20
602  FORMAT ('//',T25,'5(I2.13X)')
603  FORMAT ('//',T25,'+',T20('---+'),',',)
C
      DO 100 I = 1,21
      WRITE (6,604) (PLOT(I,J),J=1,92)
604  FORMAT ('//',T16,'92A1)
100  CONTINUE
C
      WRITE (6,603)
      WRITE (6,602) PYR, PYR5, PYR10, PYR15, PYR20
      WRITE (6,605)
605  FORMAT ('//',T52,'**6X,**//',T52,'** YEAR **//',T52,
1
      RETURN
      END
C
C
C

```

```

00096900
00097000
00097100
00097200
00097300
00097400
00097500
00097600
00097700
00097800
00097900
00098000
00098100
00098200
00098300
00098400
00098500
00098600
00098700
00098800
00098900
00099000
00099100
00099200
00099300
00099400

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```

FUNCTION DETRMN(VAL)
INTEGER ROW, VAL
IF (VAL .GE. 96) .GT. 91) .ROW = 1
IF (VAL .LT. 91) .AND. VAL .GE. 86) .ROW = 2
IF (VAL .LT. 86) .AND. VAL .GE. 81) .ROW = 3
IF (VAL .LT. 81) .AND. VAL .GE. 76) .ROW = 4
IF (VAL .LT. 76) .AND. VAL .GE. 71) .ROW = 5
IF (VAL .LT. 71) .AND. VAL .GE. 66) .ROW = 6
IF (VAL .LT. 66) .AND. VAL .GE. 61) .ROW = 7
IF (VAL .LT. 61) .AND. VAL .GE. 56) .ROW = 8
IF (VAL .LT. 56) .AND. VAL .GE. 51) .ROW = 9
IF (VAL .LT. 51) .AND. VAL .GE. 46) .ROW = 10
IF (VAL .LT. 46) .AND. VAL .GE. 41) .ROW = 11
IF (VAL .LT. 41) .AND. VAL .GE. 36) .ROW = 12
IF (VAL .LT. 36) .AND. VAL .GE. 31) .ROW = 13
IF (VAL .LT. 31) .AND. VAL .GE. 26) .ROW = 14
IF (VAL .LT. 26) .AND. VAL .GE. 21) .ROW = 15
IF (VAL .LT. 21) .AND. VAL .GE. 16) .ROW = 16
IF (VAL .LT. 16) .AND. VAL .GE. 11) .ROW = 17
IF (VAL .LT. 11) .AND. VAL .GE. 6) .ROW = 18
IF (VAL .LT. 6) .AND. VAL .GE. 1) .ROW = 19
IF (VAL .LT. 1) .AND. VAL .GE. 0) .ROW = 20
DETRMN = ROW
RETURN
END

```


INTERPRETING PARAMETERS

DATA SET

APPENDIX B

OPTIMIZING SOURCE PROGRAM


```

CCCCCCCCCCCCCCCC
OPTIMIZING PROGRAM (OPTAL)
00000100
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00000300
00000400
00000500
00000600
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00001100
00001200
00001300
00001400
00001500
00001600
00001700
00001800
00001900
00002000
00002100
00002200
00002300
00002400
00002500
00002600
00002700
00002800
00002900
00003000
00003100
00003200
00003300
00003400
00003500
00003600
00003700
00003800
00003900
00004000
00004100
00004200
00004300
00004400

THIS IS THE MAIN PROGRAM FOR OPTIMIZING FROM IINPUT.DATA
IT UTILIZES SUBROUTINES: OPTAL, EVAL, SORT, WROUT1

IT ALSO UTILIZES HCT.OPT.LIB.DATA(PARMOPT) AS INPUT TO ROPTM

IMPLICIT INTEGER (A-Z)

SETUP COMMON AREAS BETWEEN MAIN-WROUT1, MAIN-RATES, MAIN-EVAL
AND MAIN-ROPTM

COMMON /DESCRP/
1 CS,MP,
2 BSRMP,
3 SNUM,
4 BASE,
5 GEN(9),
6 AVGSK(9),
7 STRUCR(9),
8 RATHI(9),
9 RATLO(9),
10 BCSMP,
11 ESRMP,
12 CTYP,
13 R2,
14 GAGE(9),
15 LIFE60,
16 RATING(9),
17 LIFE40,
18 GOOD,
19 SEQ,
20 LANE,
21 SURF,
22 SE,
23 RATE(9),
24 HISK(9),
25 LIFE20,
26 KADT,
27 DIST,
28 SP,
29 THK,
30 TI,
31 SR,
32 MNTH,
33 NPRJ,
34 LOSK(9),
35 RIDER(9),
36 DADT,
37 SR,

COMMON /MANVAL/
1 LENG,
2 LSH,
3 REHAB(3),
4 EPOW,
5 HWYT,
6 ADT,
7 FC,
8 UR,
9 NLANS,
10 GRW,
11 YR,
12 RDW,
13 SU,
14 ECONS,
15 RSH,
16 COMB,
17 EVAR,

COMMON /RPMRAT/
1 NPRDS,
2 EFFINT,
3 CONSTC(10),
4 TFACT(3),
5 MS(10),
6 FTMTRX(5,5,3),
7 LPRDS,
8 SHOULD(5),
9 EQUAF(10),
10 EXFACT(4),
11 AEG(10),
12 RMATRX(10,3),
13 YEAR,
14 MUSTA(5),
15 MAXRAT(10),
16 TIR(4),
17 BEG(10),
18 RMATRX(10,3),
19 TRAFYR,
20 DES(10,6),
21 BETA(30),
22 OTHK(10),
23 CFG(10),
24 NETPRD

```



```

1  LSH, ADT, GRW, SU, COMB,
2  REHAB(3), FC, YR, ECONS, EVAR,
3  EPOW,
COMMON /RPMRAT/
1  NPRDS, LPRDS, YEAR, TRAFYR,
2  EFFINT, SHOULD(5), MUSTA(5), DES(10,6),
3  CONSTC(10), EQUAF(10), MAXRAT(10), BETA(30),
4  TFACT(3), EXFACT(4), TIR(4), OTHK(10),
5  MS(10), AEO(10), BEQ(10), CEG(10),
FTMATRIX(5,5,3), RMATRIX(10,3), NETPRD
COMMON /NOCOST/ NOTCOS, NOMC, NOPC, NOUC
REAL
1  TI, GRW, STRUCR, RATING, LIFE60, LIFE40, LIFE20,
2  RIDER, RETHI, RATHI, EFFINT, SHOULD, MUSTA,
3  OTHK, TIR, AEO, TFACT, EXFACT, MS,
4  MAXRAT, R2, SE, EVAR, EPOW, EQUAF,
ECONS
READ PRESENT YEAR, TRAFFIC YEAR, NUMBER OF PERIODS BEING
CONSIDERED, LENGTH OF PERIODS, EFFECTIVE INTEREST, AND CONSTANT
IF LISTING THE OPTIMIZING PARAMETERS IS NOT DESIRED.
401 READ (4,401) YEAR,TRAFYR,NPRDS,NETPRD,LPRDS,EFFINT,NOPR
FORMAT (4I2,F4.2,F4.2,I1)
READ THICKNESS FACTORS FOR DETERMINING EQUATIONS FOR ALTS
404 READ (4,404) (IFACT(I), I = 1,3)
FORMAT (3(4X,F3.2))
READ EQUATION FACTORS FOR DETERMINING EQUATIONS FOR ALTS
WHEN THE ORIGINAL PAVEMENT HAS BEEN OVERLAYED BEFORE
405 READ (4,405) (EXFACT(I), I = 1,4)
FORMAT (4(F4.2,3X))

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00013300
00013400
00013500
00013600
00013700
00013800
00013900
00014000
00014100
00014200
00014300
00014400
00014500
00014600
00014700
00014800
00014900
00015000
00015100
00015200
00015300
00015400
00015500
00015600
00015700
00015800
00015900
00016000
00016100
00016200
00016300
00016400
00016500
00016600
00016700
00016800
00016900
00017000
00017100
00017200
00017300
00017400
00017500
00017600

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CCCCC
      READ SHOULD AND MUST LEVELS TO BE USED FOR EACH FUNC CLASS
      READ (4,402) (SHOULD(K),K=1,5)
      READ (4,402) (MUSTA(K),K=1,5)
      FORMAT (5F2.0)
      402
CCCCC
      READ TI SEGMENT BREAKS
      READ (4,409) (TIR(I),I=1,4)
      FORMAT (4F3.1)
      409
CCCCC
      READ FTMTRX WHICH IS FUNCTIONAL CLASS BY TI BY SURFACE TYPE
      DO 40 K = 1,3
      DO 30 I = 1,5
      READ (4,407) (FTMTRX(I,J,K),J=1,5)
      FORMAT (5I1)
      30 CONTINUE
      40 CONTINUE
      407
CCCCC
      READ RMATRIX WHICH ARE REHABILITATION ALTERNATIVES TO BE SELECTED
      DO 50 I = 1,9
      READ (4,408) (RMATRIX(I,J),J=1,3)
      FORMAT (3I1)
      50 CONTINUE
      408
CCCCCCCCCCCC
      READ REHABILITATION ALTERNATIVE CARDS
      EACH CARD CONTAINS:
      THE DESCRIPTION OF THE ALTERNATIVE
      CONSTRUCTION COST PER 12 FT LANE MILE
      TRAFFIC INTERRUPTION COST FACTORS
      EQUATION FACTOR FOR ALTERNATIVE
      CONSTANT SLOPE FACTOR
      50
00017700
00017800
00017900
00018000
00018100
00018200
00018300
00018400
00018500
00018600
00018700
00018800
00018900
00019000
00019100
00019200
00019300
00019400
00019500
00019600
00019700
00019800
00019900
00020000
00020100
00020200
00020300
00020400
00020500
00020600
00020700
00020800
00020900
00021000
00021100
00021200
00021300
00021400
00021500
00021600
00021700
00021800
00021900
00022000

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CC      DO 10 I=1,10
        READ (4,403) (DES(I,J),J=1,6), CONSID(I), OTHK(I), MS(I)
        1  AEG(I), BEQ(I), CEG(I), MAXPRAT(I),
        403  FORMAT (6A4,18,F3.2,3F4.2,F6.2,F7.5)
        10  CONTINUE
CC
CC      READ (4,406) NOTCOS,NOMC,NOPC,NOUC
        406  FORMAT (4I2)
CCCCC  SETUP BETA FACTORS FOR CONSIDERATION PERIOD
CC
CC      DO 20 I=1,NPRDS
        BETA(I) = 1.0 / ((1.0 + EFFINT) ** (I * LPRDS))
        20  CONTINUE
CC
CC      RETURN
        END
CC
CC      SUBROUTINE RATES
CCCCCCC THIS SUBROUTINE SETS UP THE EQUATIONS FOR THE ALTERNATIVES
        AND THEN SETS UP THE ARRAY OF RATINGS FOR EACH PERIOD IN
        EACH ALTERNATIVE INCLUDING THE ORIGINAL PAVEMENT
CC
CC      IMPLICIT INTEGER (A-Z)
        COMMON /MANVAL/ LENG, HWYT, ADT, FC, UR
        1  LSH, REHAB(3), EPOM, NLANES, GRW, YR, RDW, SU, ECONS, RSH, COMB,
        2  EVAR,
        3
CC

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00022100
00022200
00022300
00022400
00022500
00022600
00022700
00022800
00022900
00023000
00023100
00023200
00023300
00023400
00023500
00023600
00023700
00023800
00023900
00024000
00024100
00024200
00024300
00024400
00024500
00024600
00024700
00024800
00024900
00025000
00025100
00025200
00025300
00025400
00025500
00025600
00025700
00025800
00025900
00026000
00026100
00026200
00026300
00026400

```

```

C          COMMON /RPMRAT/
1          NPRDS,          LPRDS,          YEAR,          TRAFYR,
2          EFFINT,        SHOULD(5),      MUSTA(5),      DES(10,6),
3          CONSTC(10),   EQUAF(10),      MAXRAT(10),   BETA(30),
4          TFACT(3),     EXFACT(4),   TIR(4),      OTHK(10),
5          MS(10),       AEG(10),   BEQ(10),      CEQ(10),
          FTMTRX(5,5,3),  RMATRX(10,3), NETPRD
          00026500
          00026600
          00026700
          00026800
          00026900
          00027000
          00027100
          00027200
          00027300
          00027400
          00027500
          00027600
          00027700
          00027800
          00027900
          00028000
          00028100
          00028200
          00028300
          00028400
          00028500
          00028600
          00028700
          00028800
          00028900
          00029000
          00029100
          00029200
          00029300
          00029400
          00029500
          00029600
          00029700
          00029800
          00029900
          00030000
          00030100
          00030200
          00030300
          00030400
          00030500
          00030600
          00030700
          00030800

C          COMMON /RATOUT/
1          MR(4),        RC(4),          RP(4),          MINL(4),
2          SHUD,        MUST,          CRAGE(4),      MAXL(4),
          SHUDP(4),    MUSTP(4),    RATE(4,30),   BSLIFE
          00028000
          00028100
          00028200
          00028300
          00028400
          00028500
          00028600
          00028700
          00028800
          00028900
          00029000
          00029100
          00029200
          00029300
          00029400
          00029500
          00029600
          00029700
          00029800
          00029900
          00030000
          00030100
          00030200
          00030300
          00030400
          00030500
          00030600
          00030700
          00030800

C          COMMON /DESCRP/
1          CS,          BCSMP,        ECSP,          DIST,          SR,
2          BSRMP,       ESRMP,        LANE,         SP,            MNT,
3          SNUM,        CTYP,         SURF,         THK,          NPRJ,
4          BASE,        R2,          SE,          RATING(9),   HISK(9),
5          AVGSK(9),    GAGE(9),     LIFE60,      LIFE40,       LOSK(9),
6          STRUCR(9),   RATHI(9),   RATLO(9),    GOOD,         RIDER(9),
7          RATHI(9),   RATLO(9),   SEQ,         KADT,         DADT,
          00028000
          00028100
          00028200
          00028300
          00028400
          00028500
          00028600
          00028700
          00028800
          00028900
          00029000
          00029100
          00029200
          00029300
          00029400
          00029500
          00029600
          00029700
          00029800
          00029900
          00030000
          00030100
          00030200
          00030300
          00030400
          00030500
          00030600
          00030700
          00030800

C          REAL          GRW,          SHOULD,      ECONS,        EPOW,          PRDS,
1          MR,          RATE,        MUSTA,        MAXRAT,       BETA,
2          LIFE40,      RATHI,      LIFE20,      MINL,         MUST,
3          RATLO,      MSL,        RATLO,      RIDER,        RATING,
4          MSL,        MSL,        RATLO,      THIK,        CRTIME,
5          MSL,        MSL,        RATLO,      THIK,        EXFACT,
6          MSL,        MSL,        RATLO,      THIK,        EXFACT,
          00028000
          00028100
          00028200
          00028300
          00028400
          00028500
          00028600
          00028700
          00028800
          00028900
          00029000
          00029100
          00029200
          00029300
          00029400
          00029500
          00029600
          00029700
          00029800
          00029900
          00030000
          00030100
          00030200
          00030300
          00030400
          00030500
          00030600
          00030700
          00030800

C          SET UP EQUATIONS FOR ALTERNATIVES TO BE CONSIDERED BY EVALUATING
C          EQUATION FOR EXISTING PAVEMENT WITH INPUT CRITICAL LEVEL. OF THE
C          THE LIFE OF EACH ALTERNATIVE IS THEN A RATIO OF THE LIFE OF THE
C          EXISTING PAVEMENT.
          00028000
          00028100
          00028200
          00028300
          00028400
          00028500
          00028600
          00028700
          00028800
          00028900
          00029000
          00029100
          00029200
          00029300
          00029400
          00029500
          00029600
          00029700
          00029800
          00029900
          00030000
          00030100
          00030200
          00030300
          00030400
          00030500
          00030600
          00030700
          00030800

C          MR(1) = ECONS
C          RC(1) = EVAR * (-1.0)
C          RP(1) = EPOW
C          K = FC
          00028000
          00028100
          00028200
          00028300
          00028400
          00028500
          00028600
          00028700
          00028800
          00028900
          00029000
          00029100
          00029200
          00029300
          00029400
          00029500
          00029600
          00029700
          00029800
          00029900
          00030000
          00030100
          00030200
          00030300
          00030400
          00030500
          00030600
          00030700
          00030800

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```

SHUD = SHOULD(K)
MUST = MUSTA(K)
CRAGE(1) = ((MR(1) - MUST)/RC(1)) * (1/RP(1))
NETTIM = ((YEAR + NETPRD) - YR) * 1.0
IF (CRAGE(1) .GE. NETTIM) NPRDS = NETPRD
IF (CRAGE(1) .GE. NETTIM) GO TO 200
CRTIME = ((YEAR + NPRDS) - YR) * 1.0
IF (CRAGE(1) .GE. CRTIME) GO TO 200
IF (CRAGE(1) .GT. 40.0) CRAGE(1) = 40.0
IF (CRAGE(1) .LT. 4) CRAGE(1) = 4
BSLIFE = CRAGE(1)
C
IF (CTYP.GE.20.AND.CTYP.LT.30.AND.SURF.GE.40) GO TO 100
GO TO 105
C
100 THK = THK * .01
IF (THK .LE. TFACT(1)) Z = 1
IF (THK .GT. TFACT(1)) .AND. THK .LE. TFACT(2)) Z = 2
IF (THK .GT. TFACT(2)) .AND. THK .LE. TFACT(3)) Z = 3
IF (THK .GT. TFACT(3)) Z = 4
BSLIFE = BSLIFE / EXFACT(Z)
C
105 DO 110 I = 1,3
M = REHAB(I)
FACTOR = EQUAF(M)
MSL = MS(M)
N = I + 1
CRAGE(N) = BSLIFE * FACTOR
RP(N) = (ALOG10((100 - MUST) / MSL)) / ALOG10(CRAGE(N))
IF (RP(N) .LT. 0.50) RP(N) = 0.50
IF (RP(N) .GT. 4.00) RP(N) = 4.00
MR(N) = MAXRAT(M)
RC(N) = MSL
110 CONTINUE
C
CCCC
120 AGE = YEAR - YR
DO 70 I=1,4
KSHUD = 0
KMUST = 0
DO 80 K = 1,NPRDS

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000030900
000031000
000031100
000031200
000031300
000031400
000031500
000031600
000031700
000031800
000031900
000032000
000032100
000032200
000032300
000032400
000032500
000032600
000032700
000032800
000032900
000033000
000033100
000033200
000033300
000033400
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000033900
000034000
000034100
000034200
000034300
000034400
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000034900
000035000
000035100
000035200

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00035300
00035400
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00035900
00036000
00036100
00036200
00036300
00036400
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00037200
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00037400
00037500
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00037700
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00039000
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00039300
00039400
00039500
00039600

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IF (I .EQ. 1) GO TO 20
GO TO 30
RATE(I,K) = MR(I) - RC(I) * ((K+AGE)**RP(I))
IF (RATE(I,K) .LT. 0) RATE(I,K)=0.0
GO TO 40
RATE(I,K) = MR(I) - RC(I) * (K**RP(I))
IF (RATE(I,K) .LT. 0) RATE(I,K)=0.0
GO TO 50
IF (KSHUD .EQ. 1) GO TO 50
IF (KSHUD .EQ. 1) .LT. SHUD) KSHUD=1
IF (KSHUD .EQ. 1) SHUDP(I) = K-1
IF (SHUDP(I) .EQ. 0) SHUDP(I)=1
IF (KMUST .EQ. 1) GO TO 80
IF (RATE(I,K) .LT. MUST) KMUST=1
IF (KMUST .EQ. 1) MUSTP(I) = K-1
IF (MUSTP(I) .EQ. 0) MUSTP(I)=1
IF (K .EQ. NPRDS .AND. KSHUD .EQ. 0) SHUDP(I) = NPRDS
IF (K .EQ. NPRDS .AND. KMUST .EQ. 0) MUSTP(I) = NPRDS
80 CONTINUE
70 CONTINUE

CCCCC
CALCULATE THE MINIMUM LIFE EXPECTANCY AND MAXIMUM LIFE
EXPECTANCY FOR THE EXISTING PAVEMENT AND EACH OF THE REHAB
ALTERNATIVES, BASED ON THE SHOULD AD MUST LEVELS
DO 95 I = 1,4
MINL(I) = ((MR(I) - SHUD) / RC(I)) ** (1 / RP(I))
MAXL(I) = ((MR(I) - MUST) / RC(I)) ** (1 / RP(I))
IF (MINL(I) .GT. 99.0) MINL(I) = 99.0
IF (MAXL(I) .GT. 99.0) MAXL(I) = 99.0
95 CONTINUE
CC
RETURN
AGE = YEAR - YR
RSLIFE = CRAGE(I)
SHUDP(I) = 30
MUSTP(I) = 30
MINL(I) = ((MR(I) - SHUD) / RC(I)) ** (1/RP(I))
MAXL(I) = ((MR(I) - MUST) / RC(I)) ** (1/RP(I))
IF (MINL(I) .GT. 99.0) MINL(I) = 99.0
IF (MAXL(I) .GT. 99.0) MAXL(I) = 99.0
DO 210 I = 1,30
RATE(I,I) = MP(I) - RC(I) * ((I + AGE) ** RP(I))

```

CCCCC

CC

```

210 CONTINUE
DO 220 I = 2,4
MR(I) = MR(1)
RC(I) = RC(1)
RP(I) = RP(1)
MINL(I) = MINL(1)
MAXL(I) = MAXL(1)
CRAGE(I) = CRAGE(1)
SHUDP(I) = SHUDP(1)
MUSTP(I) = MUSTP(1)
DO 230 J = 1,30
RATE(I,J) = RATE(1,J)
220 CONTINUE
RETURN
END

SUBROUTINE VALSTR

THIS SUBROUTINE SELECTS ALL VALID STRATEGIES BASED ON SHOULD
AND MUST PERIODS COMPUTED FOR THE EXISTING PAVEMENT AND EACH
REHABILITATION ALTERNATIVE.

IMPLICIT INTEGER (A-Z)

COMMON /STROPT/ PRD1(2000), PRD2(2000), PRD3(2000), PRD4(2000),
ALT1(2000), ALT2(2000), ALT3(2000), ALT4(2000)

COMMON /RPMRAT/ NPRDS, LPRDS, SHOULD(5), YEAR, TRAFYR,
EFFINT, SHOUAF(10), EQUAF(10), MUSTA(5), DES(10,6),
TFAC(3), EXFACT(4), TIR(4), MAXRAT(10), BETA(30),
MS(10), AEO(10), REQ(10), OTHK(10),
FTMTRX(5,5,3), RMATRIX(10,3), CEO(10), NETPRD

1
2
3
4
5

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```

CCC CCCCCCCCCC CC CCCC

```

```

0000      COMMON /RATOUT/ MR(4), RC(4), PP(4), MINL(4),
0000      SHUD, MUST, CRAGE(4), MAXL(4),
0000      SHUDP(4), MUSTP(4), RATE(4,30), BSLIFE
0000      COMMON /STROUT/ ST
0000      REAL SHUD, MUST, LPRDS, SHOULD, MUSTA,
0000      EQUAF, MAXRAT, BETA, MR, RC,
0000      RP, CRAGE, RATE, TFAC, EXFACT, MS
0000      DO 10 K=1,2000
0000      ALI1(K) = 0
0000      ALI2(K) = 0
0000      ALI3(K) = 0
0000      ALI4(K) = 0
0000      PRD1(K) = 0
0000      PRD2(K) = 0
0000      PRD3(K) = 0
0000      PRD4(K) = 0
0000      10 CONTINUE
0000      SELECT ALL VALID STRATEGIES
0000      SELECT ALL POSSIBLE 2 COMBINATION STRATEGIES
0000      ST = 0
0000      N1=SHUDP(1)
0000      N2=MUSTP(1)
0000      TOPRC=MUSTP(1)
0000      IF (TOPRD.GE. NPPDS) GO TO 20
0000      GO TO 21
0000      20 ST = 1

```

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00044100
00044200
00044300
00044400
00044500
00044600
00044700
00044800
00044900
00045000
00045100
00045200
00045300
00045400
00045500
00045600
00045700
00045800
00045900
00046000
00046100
00046200
00046300
00046400
00046500
00046600
00046700
00046800
00046900
00047000
00047100
00047200
00047300
00047400
00047500
00047600
00047700
00047800
00047900
00048000
00048100
00048200
00048300
00048400

```

```

21 ALT1(ST)=1
GO TO 50
DO 22 I1=2,4
IF (MUSTP(I1)+MUSTP(I1).GE.NPRDS) GO TO 23
23 GO TO 24 K=N1,N2
DO 24 K=N1,N2
IF (K+MUSTP(I1).LT.NPRDS) GO TO 24
ST=ST+1
ALT1(ST)=I1
PRD1(ST)=K
24 CONTINUE
22 CONTINUE
DO 25 I2=2,4
DO 26 J2=2,4
IF (MUSTP(I1)+MUSTP(I2)+MUSTP(J2).GE.NPRDS) GO TO 27
27 GO TO 26 K=N1,N2
DO 28 K=N1,N2
IF (K+MUSTP(I2)+MUSTP(J2).LT.NPRDS) GO TO 28
N3=SHUDP(I2)
N4=MUSTP(I2)
DO 29 L=N3,N4
IF (K+L+MUSTP(J2).LT.NPRDS) GO TO 29
IF (K+L+GE.NPRDS) GO TO 29
ST=ST+1
ALT1(ST)=I2
ALT2(ST)=J2
PRD1(ST)=K
PRD2(ST)=K+L
25 CONTINUE
28 CONTINUE
26 CONTINUE
29 CONTINUE
CC SELECT ALL POSSIBLE 3 COMBINATION STRATEGIES
CC
DO 30 I3=2,4
DO 31 J3=2,4
DO 32 K3=2,4
IF (MUSTP(I1)+MUSTP(I3)+MUSTP(J3)+MUSTP(K3).GE.NPRDS) GO TO 33
33 GO TO 32 K=N1,N2
DO 34 K=N1,N2
IF (K+MUSTP(I3)+MUSTP(J3)+MUSTP(K3).LT.NPRDS) GO TO 34
N5=SHUDP(I3)
N6=MUSTP(I3)

```

```

00048500
00048600
00048700
00048800
00048900
00049000
00049100
00049200
00049300
00049400
00049500
00049600
00049700
00049800
00049900
00050000
00050100
00050200
00050300
00050400
00050500
00050600
00050700
00050800
00050900
00051000
00051100
00051200
00051300
00051400
00051500
00051600
00051700
00051800
00051900
00052000
00052100
00052200
00052300
00052400
00052500
00052600
00052700
00052800

```

```

DO 35 L=N5,N6
IF (K+L+MUSTP(J3)+MUSTP(K3).LT.NPRDS) GO TO 35
N7=SHUDP(J3)
N8=MUSTP(J3)
DO 36 M=N7,N8
IF (K+L+M+MUSTP(K3).LT.NPRDS) GO TO 36
IF (K+L+M.GE.NPRDS) GO TO 36
ST = ST + I
ALT1(ST)=I3
ALT2(ST)=J3
ALT3(ST)=K3
PRD1(ST)=K
PRD2(ST)=K+L
PRD3(ST)=K+L+M
CONTINUE
36 CONTINUE
35 CONTINUE
34 CONTINUE
33 CONTINUE
32 CONTINUE
31 CONTINUE
30 CONTINUE
SELECT ALL POSSIBLE 4 COMBINATION STRATEGIES
DO 37 I4=2,4
DO 38 J4=2,4
DO 39 K4=2,4
DO 40 L4=2,4
IF (MUSTP(I4)+MUSTP(J4)+MUSTP(K4)+MUSTP(L4).GE.NPRDS)
1 GO TO 41
GO TO 40
41 DO 42 K=N1,N2
IF (K+MUSTP(I4)+MUSTP(J4)+MUSTP(K4)+MUSTP(L4).LT.NPRDS) GO TO 42
N9=SHUDP(I4)
N10=MUSTP(I4)
DO 43 L=N9,N10
IF (K+L+MUSTP(J4)+MUSTP(K4)+MUSTP(L4).LT.NPRDS) GO TO 43
N11=SHUDP(J4)
N12=MUSTP(J4)
DO 44 M=N11,N12
IF (K+L+M+MUSTP(K4)+MUSTP(L4).LT.NPRDS) GO TO 44
N13=SHUDP(K4)
N14=MUSTP(K4)
DO 45 N=N13,N14
IF (K+L+M+N+MUSTP(L4).LT.NPRDS) GO TO 45

```

```

00052900
00053000
00053100
00053200
00053300
00053400
00053500
00053600
00053700
00053800
00053900
00054000
00054100
00054200
00054300
00054400
00054500
00054600
00054700
00054800
00054900
00055000
00055100
00055200
00055300
00055400
00055500
00055600
00055700
00055800
00055900
00056000
00056100
00056200
00056300
00056400
00056500
00056600
00056700
00056800
00056900
00057000
00057100
00057200

```

CC


```

C          COMMON /OPTOIT/  A1(40),  A2(40),  A3(40),  A4(40),
1          P1(40),  P2(40),  P3(40),  P4(40),
2          MCOST(40), CCOST(40), TICOST(40), UCOST(40),
3          SALV(40), TOTAL(40), TST(40), DIFST
00061700
00061800
00061900
00062000
00062100
00062200
00062300
00062400
00062500
00062600
00062700
00062800
00062900
00063000
00063100
00063200
00063300
00063400
00063500
00063600
00063700
00063800
00063900
00064000
00064100
00064200
00064300
00064400
00064500
00064600
00064700
00064800
00064900
00065000
00065100
00065200
00065300
00065400
00065500
00065600
00065700
00065800
00065900
00066000

          COMMON /STROPT/  PRD1(2000), PRD2(2000), PRD3(2000), PRD4(2000),
1          ALT1(2000), ALT2(2000), ALT3(2000), ALT4(2000)
00061700
00061800
00061900
00062000
00062100
00062200
00062300
00062400
00062500
00062600
00062700
00062800
00062900
00063000
00063100
00063200
00063300
00063400
00063500
00063600
00063700
00063800
00063900
00064000
00064100
00064200
00064300
00064400
00064500
00064600
00064700
00064800
00064900
00065000
00065100
00065200
00065300
00065400
00065500
00065600
00065700
00065800
00065900
00066000

          COMMON /STROUT/  ST
00061700
00061800
00061900
00062000
00062100
00062200
00062300
00062400
00062500
00062600
00062700
00062800
00062900
00063000
00063100
00063200
00063300
00063400
00063500
00063600
00063700
00063800
00063900
00064000
00064100
00064200
00064300
00064400
00064500
00064600
00064700
00064800
00064900
00065000
00065100
00065200
00065300
00065400
00065500
00065600
00065700
00065800
00065900
00066000

EVALUATE ALL STRATEGIES
DO 30 L=1,40
TST(L)=0
A1(L)=0
A2(L)=0
A3(L)=0
A4(L)=0
P1(L)=0
P2(L)=0
P3(L)=0
P4(L)=0
CONTINUE
I=0
DIFST=0
IF (ST.EQ.1) GO TO 50
DO 10 K=1,ST
MU1=PRD1(K)
MU2=PRD2(K)
MU3=PRD3(K)
MU4=PRD4(K)
NU1=ALT1(K)
NU2=ALT2(K)
NU3=ALT3(K)
NU4=ALT4(K)
30

```


00066100
 00066200
 00066300
 00066400
 00066500
 00066600
 00066700
 00066800
 00066900
 00067000
 00067100
 00067200
 00067300
 00067400
 00067500
 00067600
 00067700
 00067800
 00067900
 00068000
 00068100
 00068200
 00068300
 00068400
 00068500
 00068600
 00068700
 00068800
 00068900
 00069000
 00069100
 00069200
 00069300
 00069400
 00069500
 00069600
 00069700
 00069800
 00069900
 00070000
 00070100
 00070200
 00070300
 00070400

```

C C
C C
C C
CALL EVAL
11 IF (K .GT. 1) GO TO 12
I = I + 1
MCOST(I)=MC
CCOST(I)=CCOS
TICOST(I)=TCOS
UCOST(I)=UC
SALV(I)=SAL
TOTAL(I)=TOT
A1(I)=MU1
A2(I)=MU2
A3(I)=MU3
A4(I)=MU4
P1(I)=MU1
P2(I)=MU2
P3(I)=MU3
P4(I)=MU4
TST(I)=TST(I) + 1
GO TO 10
12 DO 20 J=1,I
IF (MU1 .EQ. A1(J) .AND. MU1 .EQ. P1(J)) GO TO 13
20 CONTINUE
13 IF (TOT .LT. TOTAL(J)) GO TO 14
GO TO 10
14 MCOST(J)=MC
CCOST(J)=CCOS
TICOST(J)=TCOS
UCOST(J)=UC
SALV(J)=SAL
TOTAL(J)=TOT
A1(J)=MU1
A2(J)=MU2
A3(J)=MU3
A4(J)=MU4
P1(J)=MU1
P2(J)=MU2
P3(J)=MU3
P4(J)=MU4

```



```

00079300
00079400
00079500
00079600
00079700
00079800
00079900
00080000
00080100
00080200
00080300
00080400
00080500
00080600
00080700
00080800
00080900
00081000
00081100
00081200
00081300
00081400
00081500
00081600
00081700
00081800
00081900
00082000
00082100
00082200
00082300
00082400
00082500
00082600
00082700
00082800
00082900
00083000
00083100
00083200
00083300
00083400
00083500
00083600

```

```

OTHK(10),
CEO(10),
NETPRD

```

```

TFACT(3), FXFACT(4), TIR(4),
MS(10), AEQ(10), REQ(10),
FTMTRX(5,5,3), RMATRX(10,3),

```

```

COMMON /STROUT/ ST

```

```

COMMON /NOCOST/ NOTCOS, NOMC, NOPC, NOUC

```

```

REAL RTNG(30), RATE,
1 MCOF, MEXP,
2 CC2, CC3, OTHK,
3 TIC3, TIC4, TIC1,
4 MTRC, TK2, TK3,
5 TK1, EPOW,
6 EVAR, EQUAF,
7 SHUD, MUST,
8 AGE4, AGE5,
9 RPS, RP6,
A MCOST, UCOST,
B TFACT, EXFACT,
C
D
MC,
BETA,
CC4,
VMI,
TCOS,
TEXP,
TK3,
LPRDS,
SAL,
CRAGE,
RPI,
LENGTH,
TICOST,
MS
MSURF,
CC(4),
MPPR,
TIC1,
UC,
MVEH,
TK4,
EFFINT,
MR,
AGE1,
RP2,
PADT,
MINL,
MCOF,
SURF,
PCOF,
TIC2,
TRKP,
VCOF,
GRW,
SHOULD,
RC,
AGE2,
RP3,
DEPTH,
MAXL,
MAXM,
CCI,
PEXP,
UCOS,
VEXP,
ECONS,
MUSTA,
RP,
AGE3,
RP4,
PCOST,
MCST,

```

```

USING THE ALTERNATIVE AND PERIOD NUMBERS THAT CONSTITUTE EACH
STRATEGY. ESTABLISH THE ARRAY OF RATINGS FOR THE STRATEGY.

```

```

PD=0
IF (MU1.EQ.1) GO TO 20
DO 10 I=1,MU1
PD=PD+1
RTNG(PD)=RATE(1,I)
CONTINUE
10 IF (MU2.EQ.0) GO TO 22
GAP=MU2-MU1
DO 11 I=1,GAP

```

```

CCCC
CCC
CCC

```

```

CCCC
CC

```

```

11 PD=PD+1
   RTNG(PD)=RATE (NU1,I)
   CONTINUE
   IF (MU3 .EQ. 0) GO TO 24
   GAP=MU3-MU2
   DO 12 I=1,GAP
   PD=PD+1
   RTNG(PD)=RATE (NU2,I)
12 CONTINUE
   IF (MU4 .EQ. 0) GO TO 26
   GAP=MU4-MU3
   DO 13 I=1,GAP
   PD=PD+1
   RTNG(PD)=RATE (NU3,I)
13 CONTINUE
   GAP=NPRDS-MU4
   DO 14 I=1,GAP
   PD=PD+1
   RTNG(PD)=RATE (NU4,I)
14 CONTINUE
   GO TO 30
20 DO 21 I=1,NPRDS
   RTNG(PD)=RATE (1,I)
21 CONTINUE
   GO TO 30
22 GAP=NPRDS-MU1
   DO 23 I=1,GAP
   PD=PD+1
   RTNG(PD)=RATE (NU1,I)
23 CONTINUE
   GO TO 30
24 GAP=NPRDS-MU2
   DO 25 I=1,GAP
   PD=PD+1
   RTNG(PD)=RATE (NU2,I)
25 CONTINUE
   GO TO 30
26 GAP=NPRDS-MU3
   DO 27 I=1,GAP
   PD=PD+1
   RTNG(PD)=RATE (NU3,I)
27 CONTINUE

```

C

```

00083700
00083800
00083900
00084000
00084100
00084200
00084300
00084400
00084500
00084600
00084700
00084800
00084900
00085000
00085100
00085200
00085300
00085400
00085500
00085600
00085700
00085800
00085900
00086000
00086100
00086200
00086300
00086400
00086500
00086600
00086700
00086800
00086900
00087000
00087100
00087200
00087300
00087400
00087500
00087600
00087700
00087800
00087900
00088000

```



```

LENGTH = LENG * .01
WIDTH = RDW + RSH + LSH
IF (NU1 .EQ. 1) GO TO 38
PADI = ADT * (1.0 + (GRW * MU1 * .01))
DEPTH = OTHK(NU1)
TIC1 = BETA(MU1) * TICOST(PADI,TRKP,LENGTH,WIDTH,
DEPTH,NLANES,HWYT,UR)
1 IF (MU2 .EQ. 0) GO TO 39
PADI = ADT * (1.0 + (GRW * MU2 * .01))
DEPTH = OTHK(NU2)
TIC2 = BETA(MU2) * TICOST(PADI,TRKP,LENGTH,WIDTH,
DEPTH,NLANES,HWYT,UR)
1 IF (MU3 .EQ. 0) GO TO 40
PADI = ADT * (1.0 + (GRW * MU3 * .01))
DEPTH = OTHK(NU3)
TIC3 = BETA(MU3) * TICOST(PADI,TRKP,LENGTH,WIDTH,
DEPTH,NLANES,HWYT,UR)
1 IF (MU4 .EQ. 0) GO TO 41
PADI = ADT * (1.0 + (GRW * MU4 * .01))
DEPTH = OTHK(NU4)
TIC4 = BETA(MU4) * TICOST(PADI,TRKP,LENGTH,WIDTH,
DEPTH,NLANES,HWYT,UR)
1 TCOS=TIC1+TIC2+TIC3+TIC4
GO TO 42
38 TCOS=0
GO TO 42
39 TCOS=TIC1
GO TO 42
40 TCOS=TIC1+TIC2
GO TO 42
41 TCOS=TIC1+TIC2+TIC3
42 CONTINUE
C
C COMPUTE THE USER COSTS ASSOCIATED WITH EACH STRATEGY
UC=0
VMI=(ADT * LENG) * .01
DO 43 I=1,NPRDS
UCOS = (UCOST(RING(I),TRKP,VMI)) * BETA(I) * (1.0+(GRW* I * .01))
UC=UC+UCOS
43 CONTINUE
C
C COMPUTE THE SALVAGE VALUE AT THE END OF THE CONSIDERATION PERIOD
C
C

```

```

00092500
00092600
00092700
00092800
00092900
00093000
00093100
00093200
00093300
00093400
00093500
00093600
00093700
00093800
00093900
00094000
00094100
00094200
00094300
00094400
00094500
00094600
00094700
00094800
00094900
00095000
00095100
00095200
00095300
00095400
00095500
00095600
00095700
00095800
00095900
00096000
00096100
00096200
00096300
00096400
00096500
00096600
00096700
00096800

```

```

00096900
00097000
00097100
00097200
00097300
00097400
00097500
00097600
00097700
00097800
00097900
00098000
00098100
00098200
00098300
00098400
00098500
00098600
00098700
00098800
00098900
00099000
00099100
00099200
00099300
00099400
00099500
00099600
00099700
00099800
00099900
00100000
00100100
00100200
00100300
00100400
00100500
00100600
00100700
00100800
00100900
00101000
00101100
00101200

```

```

IF (MU4 .GT. 0) GO TO 44
GO TO 45
44 TK1=FLOAT(MUSTP(NU4)-(NPRDS-MU4))/FLOAT(MUSTP(NU4))
SAL=(CC4*TK1)*BETA(NPRDS-MU4)
GO TO 51
45 IF (MU3 .GT. 0) GO TO 46
GO TO 47
46 TK2=FLOAT(MUSTP(NU3)-(NPRDS-MU3))/FLOAT(MUSTP(NU3))
SAL=(CC3*TK2)*BETA(NPRDS-MU3)
GO TO 51
47 IF (MU2 .GT. 0) GO TO 48
GO TO 49
48 TK3=FLOAT(MUSTP(NU2)-(NPRDS-MU2))/FLOAT(MUSTP(NU2))
SAL=(CC2*TK3)*BETA(NPRDS-MU2)
GO TO 51
49 IF (NU1 .GT. 1) GO TO 50
SAL=0
GO TO 51
50 TK4=FLOAT(MUSTP(NU1)-(NPRDS-MU1))/FLOAT(MUSTP(NU1))
SAL=(CC1*TK4)*BETA(NPRDS-MU1)
51 MCI = IFIX(MC)
CCOSI = IFIX(CCOS)
TCOSI = IFIX(TCOS)
UCI = IFIX(UC)
SALI = IFIX(SAL)
IF (NOTCOS .EQ. 1) TCOSI=0
IF (NOMC .EQ. 1) MCI=0
IF (NOUC .EQ. 1) UCI=0
TOT = MCI + CCOSI + TCOSI + UCI + SALI
RETURN
END

```

REAL FUNCTION MCOST(X)

THIS FUNCTION COMPUTES THE MAINTENANCE COST PER
LANE MILE AS RELATED TO THE CONDITION OF THE
PAVEMENT

REAL MCOST

CCC CCCCCCCC C


```

C      REAL K1, K2
C
C      K1 = 2.4617 - (0.15012 * RTNG) + (0.0046009 * (RTNG**2))
1      - (7.0557E-5 * (RTNG**3)) + (5.3279E-7 * (RTNG**4))
2      - (1.5769E-9 * (RTNG**5))
C
C      K2 = 0.51958 - (0.030408 * RTNG) + (9.9606E-4 * (RTNG**2))
1      - (1.6571E-5 * (RTNG**3)) + (1.3429E-7 * (RTNG**4))
2      - (4.2019E-10 * (RTNG**5))
C
C      UCOST = VMI * ((TRKP * K1) + ((1 - TRKP) * K2))
C
C      RETURN
C      END
C
C      REAL FUNCTION TICOST(ADT,TRKP,LENGTH,WIDTH,
1      DEPTH,NLANES,HWYT,UR)
C
C      THIS FUNCTION COMPUTES THE TRAFFIC INTERRUPTION COSTS
C      INCURRED BY THE USER DURING THE APPLICATION OF A
C      REHABILITATION OVERLAY. IT USES THE FOLLOWING
C      EQUATION TO COMPUTE TI-COST.
C
C      COST = MT * P * ADT * ((TRKP * K1) + ((1 - TRKP) * K2))
C
C      WHERE: MT = TIME REQUIRED TO APPLY OVERLAY IN HRS / L-MILE
C              P = PERCENTAGE OF VEH PASSING THROUGH PROJECT
C              ADT = AVERAGE DAILY TRAFFIC
C              TRKP = PERCENTAGE OF TRUCKS
C
C      MAINTENANCE TIME, MT, IS COMPUTED FROM THE FOLLOWING
C      EQUATION:
C
C      MT = 4.01 * LANE-WIDTH(FT) * LENGTH(MI) * DEPTH(FT)
C
C      P = 0.06 IF RURAL, 0.055 IF URBAN

```

```

00105700
00105800
00105900
00106000
00106100
00106200
00106300
00106400
00106500
00106600
00106700
00106800
00106900
00107000
00107100
00107200
00107300
00107400
00107500
00107600
00107700
00107800
00107900
00108000
00108100
00108200
00108300
00108400
00108500
00108600
00108700
00108800
00108900
00109000
00109100
00109200
00109300
00109400
00109500
00109600
00109700
00109800
00109900
00110000

```

```

C C REAL MT, K, K1, K2, LENGTH
C C INTEGER HWYT, UR, WIDTH
C C DATA U,R/'U','R'/
C C TICOST = 0.0
C C MT = 4.01 * LENGTH * WIDTH * DEPTH
C C P = 0.060
C C IF (UR .EQ. U) P = 0.055
C C RADT = ADT * 1.0
C C IF (HWYT .EQ. 0 .OR. HWYT .EQ. 2) RADT = ADT * 0.5
C C IF (HWYT .EQ. 0 .AND. NLANES .EQ. 2) GO TO 20
C C IF (NLANES .GT. 2) GO TO 10
C C K1 = 0.9435
C C K2 = 0.1237
C C GO TO 30
C C E=2.718281828
C C IF (HWYT .EQ. 0 .AND. RADT .GT. 10000.0) RADT = 10000.0
C C K=RADT*.003
C C P01=0.5*(1-(E**(-K)))**2)
C C T1=1+(E**K)-K-1
C C T2=(E**K)-K-1
C C R1=(E**K)-1
C C D01=(T1*T2)/(2*RADT*R1*P01)
C C IF (D01 .GT. 0.25) D01=0.25
C C C02=D01*14.04
C C K1=2*((P01*(0.98334+C02))+((1-P01)*0.73104))
C C C02=D01*2.88
C C K2=2*((P01*(0.1097+C02))+((1-P01)*0.082))
C C TICOST = MT * P * RADT * ((TRKP * K1) + ((1 - TRKP) * K2))
C C 10 RETURN
C C END
C C

```

```

00110100
00110200
00110300
00110400
00110500
00110600
00110700
00110800
00110900
00111000
00111100
00111200
00111300
00111400
00111500
00111600
00111700
00111800
00111900
00112000
00112100
00112200
00112300
00112400
00112500
00112600
00112700
00112800
00112900
00113000
00113100
00113200
00113300
00113400
00113500
00113600
00113700
00113800
00113900
00114000
00114100
00114200
00114300
00114400

```

```

SUBROUTINE SORT
CCCCCCCC
THIS SUBROUTINE SORTS ALL STRATEGIES IN ORDER OF INCREASING
TOTAL COST WITH ONLY THE TOP STRATEGY FOR EACH DIFFERENT APPL
CCCCCCCC
IMPLICIT INTEGER (A-Z)
COMMON /OPTOUT/  A1(40),  A2(40),  A3(40),  A4(40),
                 P1(40),  P2(40),  P3(40),  P4(40),
                 MCOST(40), CCOST(40), TICOST(40), UCOST(40),
                 SALV(40), TOTAL(40), TST(40), DIFST
CC
COMMON /STROUT/ ST
CC
30
OL = DIFST - 1
DO 10 I=1,OL
JJ=DIFST-I
DO 20 KK=1, JJ
IF (TOTAL(KK).GT.TOTAL(KK+1)) GO TO 30
GO TO 20
M1=A1(KK+1)
M2=A2(KK+1)
M3=A3(KK+1)
M4=A4(KK+1)
M5=P1(KK+1)
M6=P2(KK+1)
M7=P3(KK+1)
M8=P4(KK+1)
Z1=MCOST(KK+1)
Z2=CCOST(KK+1)
Z3=TICOST(KK+1)
Z4=UCOST(KK+1)
Z5=SALV(KK+1)
Z6=TOTAL(KK+1)
A1(KK+1)=A1(KK)

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0011203100
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A2(KK+1)=A2(KK)
A3(KK+1)=A3(KK)
A4(KK+1)=A4(KK)
P1(KK+1)=P1(KK)
P2(KK+1)=P2(KK)
P3(KK+1)=P3(KK)
P4(KK+1)=P4(KK)
MCOST(KK+1)=MCOST(KK)
CCOST(KK+1)=CCOST(KK)
TICOST(KK+1)=TICOST(KK)
UCOST(KK+1)=UCOST(KK)
SALV(KK+1)=SALV(KK)
TOTAL(KK+1)=TOTAL(KK)
A1(KK)=M1
A2(KK)=M2
A3(KK)=M3
A4(KK)=M4
P1(KK)=M5
P2(KK)=M6
P3(KK)=M7
P4(KK)=M8
MCOST(KK)=Z1
CCOST(KK)=Z2
TICOST(KK)=Z3
UCOST(KK)=Z4
SALV(KK)=Z5
TOTAL(KK)=Z6
20 CONTINUE
10 RETURN
END

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SUBROUTINE WROUT1

THIS SUBROUTINE WRITES THE OUTPUT FOR THE OPTIMIZING PROGRAM ON SMALL (11") PAPER

IMPLICIT INTEGER (A-7)

COMMON /OPTOUT/ A1(40), A2(40), A3(40), A4(40),

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|------|---|------------|------------|-------------|------------|-----------|
| 0000 | 1 | P1(40), | P2(40), | P3(40), | P4(40), | 001233300 |
| | 2 | MCOST(40), | CCOST(40), | TICOST(40), | UCOST(40), | 001233400 |
| | 3 | SALV(40), | TOTAL(40), | TST(40), | DIFST | 001233500 |
| | | | | | | 001233600 |
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LIFE40 = ((ECONS - 40.0)/(-1.0 * EVAR)) ** (1.0/EPOW)
IF (LIFE40 .GT. 99) LIFE40 = 99.99
LIFE30 = ((ECONS - 30.0)/(-1.0 * EVAR)) ** (1.0/EPOW)
IF (LIFE30 .GT. 99) LIFE30 = 99.99
LIFE20 = ((ECONS - 20.0)/(-1.0 * EVAR)) ** (1.0/EPOW)
IF (LIFE20 .GT. 99) LIFE20 = 99.99
IF (GEN(7) .GT. 0) GO TO 59
IF (GEN(6) .GT. 0) GO TO 60
IF (GEN(5) .GT. 0) GO TO 61
IF (GEN(4) .GT. 0) GO TO 62
IF (GEN(3) .GT. 0) GO TO 63
IF (GEN(2) .GT. 0) GO TO 64
WRITE (6,604)
GEN(1), TRAFYR, ADT, ECONS,
GAGE(1), GRW, EVAR,
RIDER(1), SU, EPOW,
STRUCR(1), COMB, R2,
RATHI(1), TI, SE,
RATLO(1), KADT, DADI,50,
HISK(1), AX2, LIFE40,
LOGSK(1), AX3, LIFE30,
AVGSK(1), AX4, LIFE20,
T18,PERFORMANCE HISTORY,T61,APPROXIMATE TRAFFIC DAT
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7 8 9 EQUA POWER = ,F5.2/ , , STRUCR RATING , ,6(F5.1,2X), 00140900
8 T63, COMBINATIONS, 5X, I2, ,%, T88, ,R SQUARE = ,F8.5/ , , COMB 001411000
9 RATING , ,6(F5.1,2X), T63, ,TRAFFIC INDEX, F3, 1, T88, ,STD ERROR = 001411000
A , ,F5.2/ , , HIGH RATING , ,6(F5.1,2X), T63, ,K = ,I2, ,%, ,6X, ,D = 001411200
R , ,I2, ,%, T88, ,TIME TO 60 = ,F5.2/ , , LOW RATING , ,6(F5.1, 001411300
C2X), T62, ,2 AXLE TRUCKS = ,F4.1, ,%, T88, ,TIME TO 50 = ,F5.2/ , , 001411400
D, HIGH FRICTION, 4X, 6(I2, 5X), T62, ,3 AXLE TRUCKS = ,F4.1, ,%, T88, 001411500
E, TIME TO 40 = ,F5.2/ , , LOW FRICTION, 4X, 6(I2, 5X), T62, ,4 AXLE 001411600
F TRUCKS = ,F4.1, ,%, T88, ,TIME TO 30 = ,F5.2/ , , AVG FRICTION, 001411700
G, 4X, 6(I2, 5X), T62, ,5 AXLE TRUCKS = ,F4.1, ,%, T88, ,TIME TO 20 = 001411800
H F5.2/ , ,108( ,* ,* )) 001411900
JK = 6
GO TO 65
61 WRITE (6,606) (GEN(K),K=1,5), TRAFYR, ADT, ECONS,
GRW, TRAFYR,
SU, GRW,
COMB, SU,
TI, COMB,
KADT, TI,
AX2, KADT,
AX3, AX2,
AX4, AX3,
AX5, AX4,
(AVGSK(K),K=1,5), AX5, ,APPROXIMATE TRAFFIC DAT
(AVGSK(K),K=1,5), AX5,
1A, T89, PERFORMANCE EQUATION, / ,
1 2 3 4 5 6 7 8 9
-----
5(I2,5X),T63,I2, ,ADT, ,8X,I6,T88, ,EQUA CONST = ,F6.2/ , , YEAR, ,13X, 001433000
14X,5(I2,5X),T63, ,GROWTH RATE, 4X, F4, 1, ,%, T88, ,EQUA COEFF = , 001433500
F9.5/ , , RIDE RATING , ,5(F5.2,2X), T63, ,SINGLE UNITS, 5X, I2, 001437000
7 8 9 EQUA POWER = ,F5.2/ , , STRUCR RATING , ,5(F5.1,2X), 001439000
8 T63, COMBINATIONS, 5X, I2, ,%, T88, ,R SQUARE = ,F8.5/ , , COMB 001440000
A , ,F5.2/ , , HIGH RATING , ,6(F5.1,2X), T63, ,K = ,I2, ,%, ,6X, ,D = 001441000
R , ,I2, ,%, T88, ,TIME TO 60 = ,F5.2/ , , LOW RATING , ,6(F5.1, 001442000
C2X), T62, ,2 AXLE TRUCKS = ,F4.1, ,%, T88, ,TIME TO 50 = ,F5.2/ , , 001443000
D, HIGH FRICTION, 4X, 5(I2, 5X), T62, ,3 AXLE TRUCKS = ,F4.1, ,%, T88, 001444000
E, TIME TO 40 = ,F5.2/ , , LOW FRICTION, 4X, 5(I2, 5X), T62, ,4 AXLE 001445000
F TRUCKS = ,F4.1, ,%, T88, ,TIME TO 30 = ,F5.2/ , , AVG FRICTION, 001446000
G, 4X, 5(I2, 5X), T62, ,5 AXLE TRUCKS = ,F4.1, ,%, T88, ,TIME TO 20 = , 001447000
H F5.2/ , ,108( ,* ,* )) 001448000
JK = 5
GO TO 65
62 WRITE (6,607) (GEN(K),K=1,4), TRAFYR, ADT, ECONS,

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1  (GAGE(K),K=1,4),
2  (RIDER(K),K=1,4),
3  (STRUCR(K),K=1,4),
4  (RATING(K),K=1,4),
5  (RATHI(K),K=1,4),
6  (RATLO(K),K=1,4),
7  (HISK(K),K=1,4),
8  (LOGSK(K),K=1,4),
9  (AVGSK(K),K=1,4),
607  (T18,PERFORMANCE HISTORY),T61,APPROXIMATE TRAFFIC DAT
1A,TR9,PERFORMANCE EQUATION,/,
2-----
3  ADT,8X,I6,T88,EQUA CONST = ,F6,2/,YEAR,13X,
4 4(I2,5X),T63,I2,ADT,8X,I6,T88,EQUA CONST = ,F6,2/,AGE,
5 14X,4(I2,5X),T63,GROWTH RATE,4X,F4,1,%,T88,EQUA COEFF = ,
6 F9,5/,RIDE RATING,4(F5,2,2X),T63,SINGLE UNITS,5X,I2,
7 ,%,T88,EQUA POWER = ,F5,2/,STRUCR RATING,4(F5,1,2X),
8 T63,COMBINATIONS,5X,I2,%,T88,R SQUARE = ,F8,5/,COMBD =
9 RATING,4(F5,1,2X),TRAFFIC INDEX,4(F5,1,2X),T63,K = ,I2,%,STD ERROR =
A ,F5,2/,HIGH RATING,4(F5,2/,LOW RATING,4(F5,1,
B ,I2,%,T88,TIME TO 60 = ,F4,1,%,T88,TRUCKS = ,F5,2/,
C 2X),T62,I2,AXLE TRUCKS = ,F4,1,%,T88,AXLE TRUCKS = ,F5,2/,
D,HIGH FRICTION,4X,4(I2,5X),T62,I3,AXLE TRUCKS = ,F4,1,%,T88,
E,TIME TO 40 = ,F5,2/,LOW FRICTION,4X,4(I2,5X),T62,I4,AXLE
F TRUCKS = ,F4,1,%,T88,TIME TO 30 = ,F5,2/,AVG FRICTION,
G,4X,4(I2,5X),T62,I5,AXLE TRUCKS = ,F4,1,%,T88,TIME TO 20 = ,
H F5,2/,108(*))
JK = 4
GO TO 65
63 WRITE (6,608)
1  (GEN(K),K=1,3),
2  (GAGE(K),K=1,3),
3  (RIDER(K),K=1,3),
4  (STRUCR(K),K=1,3),
5  (RATHI(K),K=1,3),
6  (RATLO(K),K=1,3),
7  (HISK(K),K=1,3),
8  (LOGSK(K),K=1,3),
9  (AVGSK(K),K=1,3),
608  (T18,PERFORMANCE HISTORY),T61,APPROXIMATE TRAFFIC DAT
1A,TR9,PERFORMANCE EQUATION,/,
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3  ADT,8X,I6,T88,EQUA CONST = ,F6,2/,YEAR,13X,
4 3(I2,5X),T63,I2,ADT,8X,I6,T88,EQUA CONST = ,F6,2/,AGE,

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14X.3(I2,5X).T63.'GROWTH RATE'.4X.F4.1.'%.T88.'EQUA COEFF = 1.
5 F9.5/.'RIDE RATING'.3(F5.2).2X).T63.'SINGLE UNITS'.5X.I2.
6 F9.'T88.'EQUA POWER'.5X.I2.'%.T88.'STRUCR RATING'.3(F5.1.2X).
8T63.'COMBINATIONS'.5X.I2.'%.T88.'R SQUARE'.5X.I2.'%.COMBD
9 RATING'.3(F5.1.2X).T63.'TRAFFIC INDEX'.4X.F3.1.T88.'STD ERROR
A .I2.'%.T88.'HIGH TIME TO 60 = .F5.2/.'%.T88.'RATING'.3(F5.1.
H .I2.'%.T88.'HIGH TRUCKS = .F4.1.'%.T88.'TIME TO 50 = .F5.2/.'%.T88.
C2X).T62.'2 AXLE TRUCKS = .F4.1.'%.T88.'TRUCKS = .F4.1.'%.T88.
D.'HIGH FRICTION'.4X.3(I2.5X).T62.'3 AXLE TRUCKS = .F4.1.'%.T88.
E.'TIME TO 40 = .F4.1.'%.T88.'LOW FRICTION'.4X.3(I2.5X).T62.'4 AXLE
FTRUCKS = .F4.1.'%.T88.'TIME TO 30 = .F5.2/.'%.T88.'AVG FRICTION'.
G.4X.3(I2.5X).T62.'5 AXLE TRUCKS = .F4.1.'%.T88.'TIME TO 20 =
H.F5.2/.'%.T88.'MINL(1) = LIFE60
JK = 3
GO TO 65
64 WRITE (6,609)
1 (GEN(K),K=1,2),
2 (GAGE(K),K=1,2),
3 (RIDER(K),K=1,2),
4 (STRUCR(K),K=1,2),
5 (RATING(K),K=1,2),
6 (RATIO(K),K=1,2),
7 (RATLO(K),K=1,2),
8 (HISK(K),K=1,2),
9 (LOGSK(K),K=1,2),
609 FORMAT ('.T18.'PERFORMANCE HISTORY'.T61.'APPROXIMATE TRAFFIC DAT
1A.'PERFORMANCE EQUATION'/)
2
3
4 (I2,5X).T63.I2.'ADT'.8X.I6.T88.'EQUA CONST = .F6.2/.'%.YEAR'.13X.
5 14X.2(I2.5X).T63.'GROWTH RATE'.4X.F4.1.'%.T88.'EQUA COEFF = 1.
6 F9.5/.'RIDE RATING'.3(F5.2).2X).T63.'SINGLE UNITS'.5X.I2.
7 F9.'T88.'EQUA POWER'.5X.I2.'%.T88.'STRUCR RATING'.3(F5.1.2X).
8T63.'COMBINATIONS'.5X.I2.'%.T88.'R SQUARE'.5X.I2.'%.COMBD
9 RATING'.2(F5.1.2X).T63.'TRAFFIC INDEX'.4X.F3.1.T88.'STD ERROR
A .I2.'%.T88.'HIGH TIME TO 60 = .F5.2/.'%.T88.'RATING'.3(F5.1.
H .I2.'%.T88.'HIGH TRUCKS = .F4.1.'%.T88.'TIME TO 50 = .F5.2/.'%.T88.
C2X).T62.'2 AXLE TRUCKS = .F4.1.'%.T88.'TRUCKS = .F4.1.'%.T88.
D.'HIGH FRICTION'.4X.2(I2.5X).T62.'3 AXLE TRUCKS = .F4.1.'%.T88.
E.'TIME TO 40 = .F4.1.'%.T88.'LOW FRICTION'.4X.2(I2.5X).T62.'4 AXLE
FTRUCKS = .F4.1.'%.T88.'TIME TO 30 = .F5.2/.'%.T88.'AVG FRICTION'.
G.4X.2(I2.5X).T62.'5 AXLE TRUCKS = .F4.1.'%.T88.'TIME TO 20 =
H.F5.2/.'%.T88.'MINL(1) = LIFE60
65 IF (GOOD.EQ.0) MINL(1) = LIFE60

```



```

IX,P ** ,F4.2,5X,I8,X,F5.2,6X,F5.2)
10 CONTINUE
15 WRITE (6,614) ST
614 FORMAT (//, ,T75,NUMB,/, ,T29,ITEMIZED COSTS',T75,POSS',7X,
1 STRATEGY DESCRIPTION,/, ,T75,ITEMIZED COSTS',T75,POSS',7X,
2 *****//, ,RCUT + COST OF + USER ***** SALVA00159100
3 *****//, ,RCUT + COST OF + USER ***** SALVA00159100
4 GE = EXPECTED + COST (ALTERNATIVE - PRD APPLIED) / , , MA00159200
5 INT CONST TRAFFIC COST VALUE
6 , , COST 4TH,/, , INCL PR REHAB INTERPT',T63,'COST',T84,'1ST
7 , , 3RD I=1,DIFST , ,T83,'REHAB REHAB REHAB REHAB,/,
P1(I) = P1(I) + YEAR P1(I) = P1(I) - 100
IF (A2(I) .GE. 100) GO TO 49
P2(I) = P2(I) + YEAR P2(I) = P2(I) - 100
IF (A3(I) .GE. 100) GO TO 49
P3(I) = P3(I) + YEAR P3(I) = P3(I) - 100
IF (A4(I) .GE. 100) GO TO 49
P4(I) = P4(I) + YEAR P4(I) = P4(I) - 100
IF (A2(I) .GE. 100) P4(I) = P4(I) - 100
IF (A3(I) .EQ. 0 .AND. A4(I) .EQ. 0) GO TO 51
IF (A4(I) .EQ. 0) GO TO 53
49 IF (A4(I) .EQ. 0) GO TO 52
WRITE 4 COMBINATION STRATEGIES
WRITE (6,615) MCOST(I),CCOST(I),TICOST(I),UCOST(I),SALV(I),
TOTAL(I),TST(I),A1(I),P1(I),A2(I),P2(I),A3(I),P3(I),
A4(I),P4(I)
615 FORMAT( , ,1X,5(I7,5X),I8,4X,I4,5X,4(I1, ,-',I2,3X)
GO TO 50
WRITE 1 COMBINATION STRATEGIES
51 WRITE (6,616) MCOST(I),CCOST(I),TICOST(I),UCOST(I),SALV(I),
TOTAL(I),TST(I),A1(I),P1(I),
616 FORMAT( , ,1X,5(I7,5X),I8,4X,I4,5X,I1, ,-',I2)
GO TO 50
WRITE 2 COMBINATION STRATEGIES

```

```

00158500
00158600
00158700
00158800
00158900
00159000
00159100
00159200
00159300
00159400
00159500
00159600
00159700
00159800
00159900
00160000
00160100
00160200
00160300
00160400
00160500
00160600
00160700
00160800
00160900
00161000
00161100
00161200
00161300
00161400
00161500
00161600
00161700
00161800
00161900
00162000
00162100
00162200
00162300
00162400
00162500
00162600
00162700
00162800

```

```

52 WRITE (6,617) MCOST(I),CCOST(I),TICOST(I),UCOST(I),SALV(I),
1 TOTAL(I),TST(I),A1(I),P1(I),A2(I),P2(I)
617 FORMAT(' ',1X,5(I7,5X),I8,4X,I4,5X,2(I1,'-',I2,3X))
GO TO 50
C
C WRITE 3 COMBINATION STRATEGIES
C
53 WRITE (6,618) MCOST(I),CCOST(I),TICOST(I),UCOST(I),SALV(I),P3(I)
1 TOTAL(I),TST(I),A1(I),P1(I),A2(I),P2(I),A3(I),P3(I)
618 FORMAT(' ',1X,5(I7,5X),I8,4X,I4,5X,3(I1,'-',I2,3X))
50 CONTINUE
C
DO 71 M = 1,3
I = REHAB(M)
DESC(M,1) = DES(I,1)
DESC(M,2) = DES(I,2)
DESC(M,3) = DES(I,3)
DESC(M,4) = DES(I,4)
DESC(M,5) = DES(I,5)
DESC(M,6) = DES(I,6)
71 CONTINUE
C
WRITE (9,901)
1
2
3
4
5
6
7
8
9
GOOD, CS, ESRMP, LANE, LSH, THK, RC(I), K=1,3),
BSRMP, ESRMP, HWYT, SP, MNT, RP(I), I=1,4),
LANE, HWYT, SP, MNT, RP(I), I=1,4),
LSH, THK, RC(I), K=1,3),
DESC(M,1), DESC(M,2), DESC(M,3),
DESC(M,4), DESC(M,5), DESC(M,6), K=1,3),
A1(I), P1(I), A2(I), P2(I), A3(I),
P3(I), A4(I),
SEG, LENG, NLANES, SNUM, YR,
UR, RDWP, CTYP, (CONSTC(REHAB(K))),
DIST, SR, FC, RSH, SURF,
901 FORMAT (I1,I4,A3,A1,A3,2I5,I4,A1,I1,A1,2I1,3I2,A1,A4,3I2,A1,
12,4(F6.2,F9.5,F4.2),3I6,3(6A4),4(I1,I2),I1X)
C
998 RETURN
END

```

```

00162900
00163000
00163100
00163200
00163300
00163400
00163500
00163600
00163700
00163800
00163900
00164000
00164100
00164200
00164300
00164400
00164500
00164600
00164700
00164800
00164900
00165000
00165100
00165200
00165300
00165400
00165500
00165600
00165700
00165800
00165900
00166000
00166100
00166200
00166300
00166400
00166500
00166600

```

OPTIMIZING PARAMETERS

DATA SET

82802012 1000.041
 .08 .15 0.96 .25 1.25
 0.63 0.82
 5050404060
 4040303050
 6.06 57.07.4
 777777
 777777
 777777
 999993
 444444
 444444
 444444
 444444
 888886
 888886
 888886
 666666
 2345
 248
 147
 247
 345
 457

BITUMINOUS SURF TREATMNT
 OVERLAY 0.06 CLASS D
 OVERLAY 0.08 CLASS G
 OVERLAY 0.15 CLASS B
 OVERLAY 0.25 CLASS B
 OVERLAY 0.35 CLASS B
 RECYCLE 0.15
 RECYCLE + 0.06 CLASS D
 0.35 CSTC + 0.25 AC
 ROUTINE MAINTENANCE
 2 2 2 2

00000100
 00000200
 00000300
 00000400
 00000500
 00000600
 00000700
 00000800
 00000900
 00001000
 00001100
 00001200
 00001300
 00001400
 00001500
 00001600
 00001700
 00001800
 00001900
 00002000
 00002100
 00002200
 00002300
 00002400
 00002500
 00002600
 00002700
 00002800
 00002900
 00003000
 00003100
 00003200
 00003300
 00003400
 00003500
 00003600
 00003700
 00003800
 00003900
 00004000
 00004100

APPENDIX C

NETWORK SOURCE PROGRAM

00004500
 00004600
 00004700
 00004800
 00004900
 00005000
 00005100
 00005200
 00005300
 00005400
 00005500
 00005600
 00005700
 00005800
 00005900
 00006000
 00006100
 00006200
 00006300
 00006400
 00006500
 00006600
 00006700
 00006800
 00006900
 00007000
 00007100
 00007200
 00007300
 00007400
 00007500
 00007600
 00007700
 00007800
 00007900
 00008000
 00008100
 00008200
 00008300
 00008400
 00008500
 00008600
 00008700
 00008800

```

CALL GETDAT( DATE )
OPEN DATA SETS IN PROPER SEQUENCE FOR YEARLY ACTIVITY SUMMARIES
DO 5 DIST = 1,6
DO 6 YR = 1,6
UNIT = (DIST * 10) + YR
YEP = YEAR + YR
WRITE (UNIT,602) DIST, DATE, YER, (MUST(I),I=1,5), (I47,I4,
1 FORMAT (/, ,R67XXX, T52, DISTRICT, ,I1, T102, A8/, ,I47, I4,
1 T52, ACTION SUMMARY, //, , T43, FC 1, FC 2, FC 4,
2 T71, FC 5, //, , T43, 5(, , T36, SHUD, 4X, 5(I2,5X) /, ,
3 T36, MUST, 4X, 5(I2,5X) /
6 CONTINUE
5 CONTINUE
READ PROJECT RECORDS
100 HEAD (5,501,END=999)
1 SEQ, ESRMP,
2 BSRMP, LANE,
3 FC, RSH,
4 RDW, RCTYP,
5 CONTH, CYEAR,
6 MNTN, EQPOW(I), I=1,4),
7 (DESCR(1,I), I=1,6),
8 (DESCR(2,I), I=1,6),
9 (DESCR(3,I), I=1,6),
A ALT(I), AYEAR(I), I=1,4)
B
501 FORMAT (I1,I4,A3,I1,I3,2I5,I4,A1,I1,A1,2I1,3I2,A1,A4,I2,I2,I2,
A1,I2,4(F6.2,F9.5,F4.2),3I6,3(6A4),4(I1,I2))
ACCUMULATE IN BASIC ARRAYS WITH PROCESSING FOR EACH PROJECT
CONYR = CYEAR + 1900
APPYR = CONYR
LENGR = LENG * .01

```

```

00008900
00009000
00009100
00009200
00009300
00009400
00009500
00009600
00009700
00009800
00009900
00010000
00010100
00010200
00010300
00010400
00010500
00010600
00010700
00010800
00010900
00011000
00011100
00011200
00011300
00011400
00011500
00011600
00011700
00011800
00011900
00012000
00012100
00012200
00012300
00012400
00012500
00012600
00012700
00012800
00012900
00013000
00013100
00013200

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EQ1 = EQCONS(I)
EQ2 = EQVAP(I)
EQ3 = EQPOW(I)
DO 10 YR = 1,6
  AGE = (YEAR + YR) - CONYR
  IF (APPYR .NE. CONYR) AGE = (YEAR + YR) - APPYR
  RATEP = FQ1 - (EQ2 * (AGE ** EQ3))
  RATEW = RATEB
  IF (RATEB .LE. -99.9) RATEB = -99.9
  IF (RATEB .GT. 100.0) RATEB = 100.0
  IF (RATEW .LE. 0.0) RATEW = 0.01
  RATEA = RATEB
  GP = 1
  DO 20 J = 1,10
    IF (RATEW .LE. (110.0 - (J * 10.0))) .AND.
       (RATEW .GT. (100.0 - (J * 10.0))) GR = J
  20 CONTINUE
  RDB(YR,DIST,FC,GR) = RDB(YR,DIST,FC,GR) + LENGR
  RDR(YR,DIST,FC,12) = RDB(YR,DIST,FC,12) + LENGR
  RTXLNG = RATEB * LENGR
  SUMPLR(YR,DIST,FC) = SUMPLR(YR,DIST,FC) + RTXLNG
  IF (RDR(YR,DIST,FC,12) .EQ. 0.0) GO TO 21
  RDB(YR,DIST,FC,11) = SUMPLR(YR,DIST,FC) / RDB(YR,DIST,FC,12)
  21 L = 0
  7 = (YEAR + YR) - 1900
  DO 25 J=1,4
  IF (Z.EQ. AYEAR(J)) L = J
  25 CONTINUE
  IF (L .EQ. 0) GO TO 30
  K = ALT(L)
  EQ1 = EQCONS(K)
  EQ2 = EQVAP(K)
  EQ3 = EQPOW(K)
  APPYR = AYEAR(L) + 1900
  RATEA = 100.0
  CSUM(YR,DIST,FC,3) = CSUM(YR,DIST,FC,3) + 1
  CSUM(YR,DIST,FC,4) = CSUM(YR,DIST,FC,4) + LENG
  PREP = PCOST(RATEP)
  CCOST = FLOAT(ALTGST(K-1))
  SURF = LENGR * (FLOAT(RDW + RSH + LSH) / 12)
  MSURF = LENGR * (FLOAT(RDW) / 12)
  KOST3 = ((SURF * CCOST) + (MSURF * PREP)) * (1.0 + ENGCST)

```

C

```

COST = FIX(KOST3) + INFL) ** YR
KOST2 = COST * (1.0 + INFL) ** YR
KOST3 = FIX(KOST2)
KOST4 = KOST3 * (1.0 / ((1.0 + EI) ** YR))
FICOST = FIX(KOST4)
CSUM(YR,DIST,FC,7) = CSUM(YR,DIST,FC,7) + COST
CSUM(YR,DIST,FC,8) = CSUM(YR,DIST,FC,8) + ICOST
CSUM(YR,DIST,FC,9) = CSUM(YR,DIST,FC,9) + EICOST
IF (K.EQ.2) M = 1
IF (K.EQ.3) M = 2
IF (K.EQ.4) M = 3
DO 24 I = 1,6
DESCR(I) = DESCR(M,I)
24 CONTINUE
YEAR = YEAR + YR
UNIT = (DIST * 10) + YR
IF (LINES(UNIT) .EQ. 0) GO TO 26
GO TO 27
26 WRITE (UNIT,615)
615 FORMAT (I,/,T17,BEG,T25,END,T54,REF,T91,PRESENT,T101,INFL
1ATED,/,T5,FC SR SRMP LENG CS SIDE,
2T54,RTNG PROPOSED ACTION COST,/,
3,T4,/,
4T62,/,)
LINES(UNIT) = LINES(UNIT) + 13
27 IF (LINES(UNIT) .GT. 50) GO TO 28
GO TO 29
28 WRITE (UNIT,616)
616 FORMAT (I,/,T17,BEG,T25,END,T54,REF,T91,PRESENT,T101,INFL
1ATED,/,T5,FC SR SRMP LENG CS SIDE,
2T54,RTNG PROPOSED ACTION COST,/,
3,T4,/,
4T62,/,)
LINES(UNIT) = 4
29 WRITE (UNIT,601) UR, FC, SR, BSRMP, ESRMP, LENG, CS, LANE, RATEW,
(DES(I),I=1,6), COST, ICOST
601 FORMAT (I,/,2X,A1,2X,I1,3X,I3,2(3X,I5),2(3X,I4),5X,A1,4X,F4.1,
4X,6A4,4X,2(I8,3X))
30 CONTINUE
RTXLNG = RATEA * LENGR
SUMPLA(YR,DIST,FC) = SUMRLA(YR,DIST,FC) + RTXLNG

```

C
C

```

CSUM(YR,DIST,FC,1) = IF IX(RDB(YR,DIST,FC,11))
IF (PDB(YR,DIST,FC,12) .EQ. 0.0) GO TO 22
CSUM(YR,DIST,FC,2) = IFIX(SUMRLA(YR,DIST,FC) / RDB(YR,DIST,FC,12))
CSUM(YR,DIST,FC,5) = CSUM(YR,DIST,FC,5) + LENG
IF (CSUM(YR,DIST,FC,5) .EQ. 0) GO TO 31
TOP = FLOAT(CSUM(YR,DIST,FC,4))
SUM1 = (TOP / CSUM(YR,DIST,FC,5)) * 100.0
CSUM(YR,DIST,FC,6) = IFIX(SUM1)

GR = 1
IF (RATEA .LE. 0.0) GR = 10
IF 40 J=1,10
IF (RATEA .LE. (110.0 - (J * 10.0))) .AND.
1 RATEA .GT. (100.0 - (J * 10.0))) GR = J
40 CONTINUE
RDA(YR,DIST,FC,GR) = RDA(YR,DIST,FC,GR) + LENG
RDA(YR,DIST,FC,12) = RDA(YR,DIST,FC,12) + LENG
IF (PDA(YR,DIST,FC,12) .EQ. 0.0) GO TO 10
RDA(YR,DIST,FC,11) = SUMRLA(YR,DIST,FC) / RDA(YR,DIST,FC,12)
CONTINUE
GO TO 100

CCCCC
BUILD TOTALS FOR DISTRICT SUMMARIES
999 CONTINUE
DO 110 YR = 1,6
DO 120 DIST = 1,6
SUMRBL = 0
SUMRL = 0
DO 130 FC = 1,5
CSUM(YR,DIST,FC,3) = CSUM(YR,DIST,FC,3) + CSUM(YR,DIST,FC,3)
CSUM(YR,DIST,FC,4) = CSUM(YR,DIST,FC,4) + CSUM(YR,DIST,FC,4)
CSUM(YR,DIST,FC,5) = CSUM(YR,DIST,FC,5) + CSUM(YR,DIST,FC,5)
CSUM(YR,DIST,FC,7) = CSUM(YR,DIST,FC,7) + CSUM(YR,DIST,FC,7)
CSUM(YR,DIST,FC,8) = CSUM(YR,DIST,FC,8) + CSUM(YR,DIST,FC,8)
CSUM(YR,DIST,FC,9) = CSUM(YR,DIST,FC,9) + CSUM(YR,DIST,FC,9)
SUMRBL = SUMRBL + (CSUM(YR,DIST,FC,1) * 1.0)
SUMRL = SUMRBL * 1.0
CONTINUE
IF (CSUM(YR,DIST,FC,5) .EQ. 0) GO TO 131
DO 107 FC = 1,6
CSUM(YR,DIST,FC,4) = IFIX(CSUM(YR,DIST,FC,4) * .01)

```

```

00017700
00017800
00017900
00018000
00018100
00018200
00018300
00018400
00018500
00018600
00018700
00018800
00018900
00019000
00019100
00019200
00019300
00019400
00019500
00019600
00019700
00019800
00019900
00020000
00020100
00020200
00020300
00020400
00020500
00020600
00020700
00020800
00020900
00021000
00021100
00021200
00021300
00021400
00021500
00021600
00021700
00021800
00021900
00022000

```



```

107 CSUM(YR,DIST,FC,5) = IFIX(CSUM(YR,DIST,FC,5) * .01)
CONTINUE
TOP = FLOAT(CSUM(YR,DIST,6,4))
SUM1 = (TOP / CSUM(YR,DIST,6,5)) * 100.0
131 CSUM(YR,DIST,6,6) = IFIX(SUM1)
SUMRBL = 0
SUMRAL = 0
DO 140 FC = 1,5
DO 150 N = 1,10
RDR(YR,DIST,6,N) = RDB(YR,DIST,6,N) + RDA(YR,DIST,FC,N)
RDA(YR,DIST,6,N) = RDA(YR,DIST,6,N) + RDA(YR,DIST,FC,N)
150 CONTINUE
SUMRBL = SUMRBL + RDR(YR,DIST,FC,11) * RDR(YR,DIST,FC,12)
SUMRAL = SUMRAL + RDA(YR,DIST,FC,11) * RDA(YR,DIST,FC,12)
RDR(YR,DIST,6,12) = RDR(YR,DIST,6,12) + RDB(YR,DIST,FC,12)
RDA(YR,DIST,6,12) = RDA(YR,DIST,6,12) + RDA(YR,DIST,FC,12)
140 CONTINUE
IF (RDR(YR,DIST,6,12) .EQ. 0.0) GO TO 120
RDR(YR,DIST,6,11) = SUMRBL / RDB(YR,DIST,6,12)
RDA(YR,DIST,6,11) = SUMRAL / RDB(YR,DIST,6,12)
120 CSUM(YR,DIST,6,1) = IFIX(RDB(YR,DIST,6,11))
CSUM(YR,DIST,6,2) = IFIX(RDA(YR,DIST,6,11))
CONTINUE
110 CONTINUE

WRITE DISTRICT COST SUMMARIES

DO 300 YR = 1,6
DO 310 YR = 1,6
UNIT = (DIST * 10) + YR
YEAR = YEAR + YR
WRITE (UNIT, //, R67XXX', T52, 'DISTRICT', I=1,5), (MUST(I), I=1,5)
604 FCPMAT (UNIT, //, R67XXX', T52, 'DISTRICT', I=1,5), (MUST(I), I=1,5)
1T53, 'COST SUMMARY', //, T43, 'FC 1', FC 2, 'FC 3', FC 4, 'FC 5',
2, T43.5('***', 3X), T36, 'SHUD', 4X, 5(I2,5X) /, T36, 'MUST',
34X, 5(I2,5X) / //)
WRITE (UNIT, 605)
605 FCPMAT (UNIT, T11, 'RTNG AVG', RTNG AVG, 'NUMB', T42, 'MILES',
1T53, 'TOTAL BEF ACTN', T66, 'PRESENT PROJ', 'INFLATED', 'DISCOUNTED', /, /,
2T5, 'FC', 'AFT ACTN', 'COST', T190, 'COST', T103, 'COST', /, /, T14, 'MILES',
3T62, 'ACTED ON', T77, 'COST', T190, 'COST', T103, 'COST', /, /, T14, 'MILES',
4T11, 'ACTED ON', T77, 'COST', T190, 'COST', T103, 'COST', /, /, T14, 'MILES',

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```

000221100
000222100
0002222300
0002222400
0002222500
0002222600
0002222700
0002222800
0002222900
0002223000
0002223100
0002223200
0002223300
0002223400
0002223500
0002223600
0002223700
0002223800
0002223900
0002224000
0002224100
0002224200
0002224300
0002224400
0002224500
0002224600
0002224700
0002224800
0002224900
0002225000
0002225100
0002225200
0002225300
0002225400
0002225500
0002225600
0002225700
0002225800
0002225900
0002226000
0002226100
0002226200
0002226300
0002226400

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5T74,-----
DO 320 FC = 1.5
WRITE (UNIT,606) FC, (CSUM(YR,DIST,FC,J),J = 1,9)
606 FORMAT (,T6,I1,T14,I2,T25,I2,T33,I4,T42,I4,T53,I4,T63,I3,
1IX,I4,T74,I10,3X,I10,3X,I10/)
320 CONTINUE
607 WRITE (UNIT,607) (CSUM(YR,DIST,6,J),J = 1,9)
607 FORMAT (,T4,-----)
1T51,-----
2T100,-----
3T53,I4,T63,I3,I4,T74,I10,3X,I10,3X,I10)
WRITE RATING DISTRIBUTION SUMMARIES FOR DISTRICTS
WRITE (UNIT,608) DIST,DATE,YER,(SHUD(I),I=1,5),(MUST(I),I=1,5)
608 FORMAT (,R67XX',T52,DISTRICT',I1,T102,A8',I,T41,I4,
1T46,RATING DISTRIBUTION SUMMARY',I,T43,FC 1,FC 2,FC 3,
2T64,FC 4,T43,5(,****,3X)/,T36,SHUD,4X,
35(I2,5X)/,T36,MUST,4X,5(I2,5X)///)
WRITE (UNIT,609)
609 FORMAT (,T36,LANE MILES IN RATING GROUP BEFORE ACTION',,
1T63,****,T89,AVG
WRITE (UNIT,610)
610 FORMAT (,T9,FC,T16,100-91 90-81 80-71 70-61 60-51,
1T52,50-41 40-31 30-21 20-11 10-0 RTNG MILES',,
2T8,-----,2X,9(,-----,2X),2X,-----)
DO 330 FC = 1.5
WRITE (UNIT,611) FC, (RDB(YR,DIST,FC,J),J=1,12)
611 FORMAT (,T10,I1,T16,10(F6.1,1X),2X,F5.1,4X,F6.1/)
330 CONTINUE
612 WRITE (UNIT,612)
612 FORMAT (,T8,-----,2X,9(,-----,2X),2X,-----,
1T97,-----)
613 WRITE (UNIT,613) (RDB(YR,DIST,6,J),J=1,12)
613 FORMAT (,T9,ALL,4X,10(F6.1,1X),2X,F5.1,4X,F6.1)///)
614 WRITE (UNIT,614)
614 FORMAT (,T36,LANE MILES IN RATING GROUP AFTER ACTION',,
1T63,****,T89,AVG
WRITE (UNIT,610)
DO 340 FC = 1.5
WRITE (UNIT,611) FC, (RDA(YR,DIST,FC,J),J=1,12)
340 CONTINUE

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WRITE (UNIT,612)
WRITE (UNIT,613) (RDA(YR,DIST,6,J),J=1,12)
CONTINUE
UNIT = (DIST # 10) + 7
WRITE (UNIT,617) DIST, DATE
FORMAT (11, //, R67XXX, T52, DISTRICT, I1, T102, AB/, T40, RATING, T55,
1 T42, RATING AND COST YEARLY SUMMARY, //, T40, BEFORE, T55,
2 RATING, T70, MILEAGE, //, T25, YEAR, T40, BEFORE, T55,
3 AFTER, T71, % AFF, T87, COST, //, T25, T40, T87, T55,
4 T55, T70, T87, T55)
SUMRBL = 0
SUMRBL = 0
DO 350 YR = 1,6
YER = YEAR + YR
CSUM(7,DIST,6,8) = CSUM(7,DIST,6,8) + CSUM(YR,DIST,6,8)
SUMRBL = SUMRBL + RDB(YR,DIST,6,11) * RDA(YR,DIST,6,12)
SUMRBL = SUMRBL + RDA(YR,DIST,6,11) * RDA(YR,DIST,6,12)
RDA(7,DIST,6,12) = RRDB(7,DIST,6,12) + RDA(YR,DIST,6,12)
RDA(7,DIST,6,12) = RDA(7,DIST,6,11) + RDA(YR,DIST,6,11)
WRITE (UNIT,618) YER, RDB(YR,DIST,6,11), RDA(YR,DIST,6,11),
1 CSUM(YR,DIST,6,6), CSUM(YR,DIST,6,8)
FORMAT (//, T25, I4, T41, F5.1, T56, F5.1, T73, I2, T83, S, I10)
CONTINUE
IF (RDB(7,DIST,6,12) .EQ. 0.0) GO TO 300
RDA(7,DIST,6,11) = SUMRBL / RDB(7,DIST,6,12)
RDA(7,DIST,6,11) = SUMRBL / RDA(7,DIST,6,12)
DRAT = (RDB(7,DIST,6,11) + RDA(7,DIST,6,11)) / 2.0
WRITE (UNIT,619) CSUM(7,DIST,6,8), DRAT
FORMAT (//, T84, T83, T83, T25, T6-YR AVG RA
1 TING
CONTINUE
WRITE STATEWIDE SUMMARIES
IF (STAT .EQ. 1) GO TO 1000
BUILD TOTALS FOR STATEWIDE SUMMARIES
DO 710 YR = 1,6
DO 720 FC = 1,6

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SUMRBL = 0
DO 730 DIST = 1,6
  CSUM(YR,7,FC,3) = CSUM(YR,7,FC,3) + CSUM(YR,DIST,FC,3)
  CSUM(YR,7,FC,4) = CSUM(YR,7,FC,4) + CSUM(YR,DIST,FC,4)
  CSUM(YR,7,FC,5) = CSUM(YR,7,FC,5) + CSUM(YR,DIST,FC,5)
  CSUM(YR,7,FC,7) = CSUM(YR,7,FC,7) + CSUM(YR,DIST,FC,7)
  CSUM(YR,7,FC,8) = CSUM(YR,7,FC,8) + CSUM(YR,DIST,FC,8)
  CSUM(YR,7,FC,9) = CSUM(YR,7,FC,9) + CSUM(YR,DIST,FC,9)
  SUMRBL = SUMRBL + (CSUM(YR,DIST,FC,1) * CSUM(YR,DIST,FC,5) * 1.0)
  SUMRBL = SUMRBL + (CSUM(YR,DIST,FC,2) * CSUM(YR,DIST,FC,5) * 1.0)
CONTINUE
730 IF (CSUM(YR,7,FC,5) .EQ. 0) GO TO 731
TOP = FLOAT(CSUM(YR,7,FC,4))
SUM1 = (TOP / CSUM(YR,7,FC,5)) * 100.0
CSUM(YR,7,FC,6) = IFIX(SUM1)
SUMRBL = 0
731 SUMRBL = 0
DO 740 DIST = 1,6
DO 750 N = 1,10
  RDB(YR,7,FC,N) = RDB(YR,7,FC,N) + RDB(YR,DIST,FC,N)
  RDA(YR,7,FC,N) = RDA(YR,7,FC,N) + RDA(YR,DIST,FC,N)
CONTINUE
750 SUMRBL = SUMRBL + RDB(YR,DIST,FC,11) * RDB(YR,DIST,FC,12)
  RDB(YR,7,FC,12) = RDB(YR,7,FC,12) + RDB(YR,DIST,FC,12)
  RDA(YR,7,FC,12) = RDA(YR,7,FC,12) + RDA(YR,DIST,FC,12)
CONTINUE
740 IF (RDB(YR,7,FC,12) .EQ. 0.0) GO TO 720
  RDB(YR,7,FC,11) = SUMRBL / RDB(YR,7,FC,12)
  RDA(YR,7,FC,11) = SUMRBL / RDB(YR,7,FC,12)
  CSUM(YR,7,FC,1) = IFIX(RDB(YR,7,FC,11))
  CSUM(YR,7,FC,2) = IFIX(RDA(YR,7,FC,11))
CONTINUE
720 CONTINUE
710 CONTINUE

WRITE STATEWIDE COST SUMMARIES

DO 800 YR = 1,6
UNIT = (7 * 10) + YR
YR = YEAR + YR
WRITE (UNIT,620) DATE,YER,(SHUD(I),I=1,5), (MUST(I),I=1,5)

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00035300
00035400
00035500
00035600
00035700
00035800
00035900
00036000
00036100
00036200
00036300
00036400
00036500
00036600
00036700
00036800
00036900
00037000
00037100
00037200
00037300
00037400
00037500
00037600
00037700
00037800
00037900
00038000
00038100
00038200
00038300
00038400
00038500
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00038700
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00038900
00039000
00039100
00039200
00039300
00039400
00039500
00039600

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620 FORMAT ('1',//, R67XX',T52,'STATEWIDE',T102,A8',T48,I4,
1T53,'COST SUMMARY',//,T43,'BY FUNCTIONAL CLASSIFICATION',//,FC 5,
2T43,'FC 1',FC 2,FC 3,FC 4,FC 5,
3T43,'SHUD',4X,5(I2,5X)/,T36,'MUST',
44X,5(I2,5X)/)
WRITE (UNIT,605)
DO R20 FC = 1,5
WRITE (UNIT,606) FC, (CSUM(YR,7,FC,J),J = 1,9)
CONTINUE
WRITE (UNIT,607) (CSUM(YR,7,6,J),J = 1,9)

      WRITE RATING DISTRIBUTION SUMMARIES FOR STATEWIDE

621 WRITE (UNIT,621) DATE,YER,(SHUD(I),I=1,5),(MUST(I),I=1,5)
FORMAT ('1',//,R67XX',T52,'STATEWIDE',T102,A8',T41,I4,
1T46,'RATING DISTRIBUTION SUMMARY',//,T43,'BY FUNCTIONAL CLASSIFICATION',//,FC 5,
2T43,'FC 1',FC 2,FC 3,FC 4,FC 5,
3T64,'FC 4',FC 5,//,T43,5('***',3X)/,T36,'SHUD',4X,
45(I2,5X)/,T36,'MUST',4X,5(I2,5X)/)
WRITE (UNIT,609)
DO R30 FC = 1,5
WRITE (UNIT,610) FC, (RDR(YR,7,FC,J),J=1,12)
CONTINUE
WRITE (UNIT,611) FC, (RDA(YR,7,FC,J),J=1,12)
CONTINUE
WRITE (UNIT,612) FC, (RDR(YR,7,6,J),J=1,12)
WRITE (UNIT,613)
WRITE (UNIT,614)
DO R40 FC = 1,5
WRITE (UNIT,611) FC, (RDA(YR,7,FC,J),J=1,12)
CONTINUE
WRITE (UNIT,612)
WRITE (UNIT,613)
WRITE (UNIT,622)
FORMAT ('1',//,R67XX',T52,'STATEWIDE',T102,A8',T48,I4,
1T53,'COST SUMMARY',//,T51,'BY DISTRICT',//,FC 2,FC 3,FC 4,FC 5,
2T43,'FC 1',FC 2,FC 3,FC 4,FC 5,
3T43,'SHUD',4X,5(I2,5X)/,T36,'MUST',
44X,5(I2,5X)/)
WRITE (UNIT,623)
FORMAT ('1',//,T11,'RING AVG',RING AVG,NUMB,T42,'MILES',
1T53,'TOTAL',T66,'%',T76,'PRESENT',INFLATED,DISCOUNTED',//,

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214 DIST REF ACTN AFT ACTN PROJ ACTED ON MILES
3162 ACTED ON T77 COST T90 COST T103 COST / T4
4111 -----
5174 -----
DO R50 DIST = 1.6
WRITE (UNIT,606) DIST, (CSUM(YR,DIST,6,J),J = 1,9)
CONTINUE
WRITE (UNIT,607) (CSUM(YR,7,6,J),J = 1,9)
WRITE (UNIT,624) DATE,YER,(SHUD(I),I=1,5),(MUST(I),I=1,5)
624 FORMAT ('1',B67XXX,T52,STATEWIDE,T102,A8/,T41,I4,
1T46,RATING DISTRIBUTION SUMMARY/,T51,RY DISTRICT//',,
2T43,FC 1 FC 2
3T64,FC 4 FC 5/,T43,5('***',3X)/,T36,SHUD,4X,
45(I2.5X)/,T36,MUST,4X,5(I2.5X)//)
WRITE (UNIT,609)
WRITE (UNIT,625)
625 FORMAT ('1',T8,DIST,T16,100-91 90-81 80-71 70-61 60-51,
1T52,50-41 40-31 30-21 20-11 10 -0 RTNG MILES/,
2T8,-----,2X,9(-----,2X),2X,-----)
DO R60 DIST = 1.6
WRITE (UNIT,611) DIST, (RDB(YR,DIST,6,J),J=1,12)
CONTINUE
WRITE (UNIT,612)
WRITE (UNIT,626) (RDB(YR,7,6,J),J=1,12)
626 FORMAT ('1',T9,ALL,4X,I0(F6.1,1X),2X,F5.1,4X,F6.1//)
WRITE (UNIT,614)
WRITE (UNIT,625)
DO R70 DIST = 1.6
WRITE (UNIT,611) DIST, (RDA(YR,DIST,6,J),J=1,12)
CONTINUE
WRITE (UNIT,612)
WRITE (UNIT,626) (RDA(YR,7,6,J),J=1,12)
800 CONTINUE
UNIT = UNIT + 1
WRITE (UNIT,627) DATE
627 FORMAT ('1',//,R67XX,T52,STATEWIDE,T102,A8/,
1T42,RATING AND COST YEARLY SUMMARY//,T40,RATING,T55,
2,RATING,T70,MILEAGE//,T25,YEAR,T40,BEFORE,T55,
3,AFTER,T71,X AFF.,T87,COST//,T25,-----,T40,-----,
4 T55,-----,T70,-----,T87,-----)
SUMRBL = 0
SUMRAL = 0
DO R80 YR = 1,6
YER = YEAR + YR

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00044100
00044200
00044300
00044400
00044500
00044600
00044700
00044800
00044900
00045000
00045100
00045200
00045300
00045400
00045500
00045600
00045700
00045800
00045900
00046000
00046100
00046200
00046300
00046400
00046500
00046600
00046700
00046800
00046900
00047000
00047100
00047200
00047300
00047400
00047500
00047600
00047700
00047800
00047900
00048000
00048100
00048200
00048300
00048400

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CSUM(7,7,6,8) = CSUM(7,7,6,8) + CSUM(YR,7,6,8)
SUMRBL = SUMRBL + RDB(YR,7,6,11) * RDB(YR,7,6,12)
SUMRAL = SUMRAL + RDA(YR,7,6,11) * RDA(YR,7,6,12)
RDB(7,7,6,12) = RDB(7,7,6,12) + RDB(YR,7,6,12)
RDA(7,7,6,12) = RDA(7,7,6,12) + RDA(YR,7,6,12)
WRITE (UNIT,618)
      CSUM(YR,7,6,6), CSUM(YR,7,6,8)
1 CONTINUE
880 IF (RDE(7,7,6,12) .EQ. 0.0) GO TO 1000
      RDB(7,7,6,11) = SUMRBL / RDB(7,7,6,12)
      RDA(7,7,6,11) = SUMRAL / RDA(7,7,6,12)
      DRAT = (RDB(7,7,6,11) + RDA(7,7,6,11)) / 2.0
      WRITE (UNIT,619)
1000 CONTINUE
      STOP
      END
00048500
00048600
00048700
00048800
00048900
00049000
00049100
00049200
00049300
00049400
00049500
00049600
00049700
00049800
00049900
00050000

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APPENDIX D

JOB CONTROL LANGUAGE AND PROGRAM MODULES FOR APPLYING CONSTRAINTS


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// *THIS JOB CONTROL LANGUAGE IS SET UP TO RUN THE 'PMS' NETWORK
// *PROGRAM AND BUDGET CONSTRAINT PROGRAMS IN SEQUENCE. PASSING
// *ALONG ANY PROJCTS NOT ACTED ON IN THE SCHEDULED YEAR TO THE
// *FOLLOWING YEAR, REPRIORITIZING AND REBUDGETING THROUGHOUT THE
// *BUDGET PERIOD. --- RY DENNIS CRIMMINS FEB 1980
// *STEP1 EXEC PGM=BUDG1
// *STEP1H DD DSN=HCT.LOAD.LIB,DISP=SHR
// *FT05F001 DD DSN=MATLS.PERM.C346610.D10PT6,DISP=SHR
//          DD DSN=MATLS.PERM.C346610.D20PT6,DISP=SHR
//          DD DSN=MATLS.PERM.C346610.D30PT6,DISP=SHR
//          DD DSN=MATLS.PERM.C346610.D40PT6,DISP=SHR
//          DD DSN=MATLS.PERM.C346610.D50PT6,DISP=SHR
//          DD DSN=MATLS.PERM.C346610.D60PT6,DISP=SHR
//          DD SYSOUT=A
// *FT06F001 DD DSN=&&TEMP1A,DISP=(,PASS),UNIT=WORK,
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LRECL=240,BLKSIZE=6000)
//          DD DSN=&&TEMP1B,DISP=(,PASS),UNIT=WORK,
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LRECL=240,HLKSIZE=6000)
//          DD DSN=&&TEMP1C,DISP=(,PASS),UNIT=WORK,
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LPECL=240,RLKSIZE=6000)
//          DD DSN=&&TEMP1D,DISP=(,PASS),UNIT=WORK,
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LRECL=240,RLKSIZE=6000)
//          DD DSN=&&TEMP1E,DISP=(,PASS),UNIT=WORK,
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LPECL=240,RLKSIZE=6000)
//          DD DSN=&&TEMP1F,DISP=(,PASS),UNIT=WORK,
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LRECL=240,HLKSIZE=6000)
//          DD DSN=&&TEMP1G,DISP=(,PASS),UNIT=WORK,
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LRECL=240,HLKSIZE=6000)
//          DD *
// *STEP2 EXEC PGM=IEPRC000,REGION=76K
// *SYSOUT=A
// *SORTIN DD DSN=*STEP1.FT11F001,DISP=(OLD,DELETE),UNIT=WORK
// *SORTOUT DD DSN=&&TEMP2A,UNIT=WORK,DISP=(,PASS),
//          SPACE=(TRK,(5,5),RLSE),
//          DCB=(RECFM=FR,LRECL=240,HLKSIZE=6000)
//          DD *
00000100
00000200
00000300
00000400
00000500
00000600
00000700
00000800
00000900
00001000
00001100
00001200
00001300
00001400
00001500
00001600
00001700
00001800
00001900
00002000
00002100
00002200
00002300
00002400
00002500
00002600
00002700
00002800
00002900
00003000
00003100
00003200
00003300
00003400
00003500
00003600
00003700
00003800
00003900
00004000
00004100
00004200
00004300
00004400

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//SORTWK01 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK02 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK03 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SYSIN DD *
SORT FIELDS=(230,8,RI,A)
/*
//STEP3 EXEC PGM=RUDG2
//STEPLIB DD DSN=HCT,LOAD,LIB,DISP=SHR
//FT05F001 DD DSN=*,STEP2.SORTOUT,UNIT=WORK,DISP=(OLD,DELETE)
//FT06F001 DD SYSOUT=A
//FT08F001 DD DSN=88TEMP3A,UNIT=WORK,DISP=(,PASS),
SPACE=(TRK,(5,5),RLSE),
DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT09F001 DD DSN=88TEMP3A,UNIT=WORK,DISP=(,PASS),
SPACE=(TRK,(5,5),RLSE),
DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT04F001 DD *
81 80 0.13 0.17
0012600000
/*
//STEP4 EXEC PGM=IERRC00,REGION=76K
//SYSOUT DD SYSOUT=A
//SORTIN DD DSN=*,STEP3.FT09F001,DISP=(OLD,DELETE),UNIT=WORK
//SORTOUT DD DSN=88TEMP4,UNIT=WORK,DISP=(,PASS),
SPACE=(TRK,(5,5),RLSE),
DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//SORTWK01 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK02 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK03 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SYSIN DD *
SORT FIELDS=(230,8,RI,A)
/*
//STEP5 EXEC PGM=RUDG2
//STEPLIB DD DSN=HCT,LOAD,LIB,DISP=SHR
//FT05F001 DD DSN=*,STEP4.SORTOUT,UNIT=WORK,DISP=(OLD,DELETE)
//FT06F001 DD SYSOUT=A
//FT08F001 DD DSN=88TEMP5A,UNIT=WORK,DISP=(,PASS),
SPACE=(TRK,(5,5),RLSE),
DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT09F001 DD DSN=88TEMP5A,UNIT=WORK,DISP=(,PASS),
SPACE=(TRK,(5,5),RLSE),
DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT04F001 DD *

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```

00004500
00004600
00004700
00004800
00004900
00005000
00005100
00005200
00005300
00005400
00005500
00005600
00005700
00005800
00005900
00006000
00006100
00006200
00006300
00006400
00006500
00006600
00006700
00006800
00006900
00007000
00007100
00007200
00007300
00007400
00007500
00007600
00007700
00007800
00007900
00008000
00008100
00008200
00008300
00008400
00008500
00008600
00008700
00008800

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82 80 0.13 0.17
0012600000
/* STEP6 PGM=IERRC000,REGION=76K
//SYSOUT=A
//SORTIN DD DSN=*.STEP5,FT09F001,DISP=(OLD,DELETE),UNIT=WORK
//SORTOUT DD DSN=*.STEP1,FT13F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=&&TEMP6,UNIT=WORK,DISP=(,PASS),
// SPACE=(TRK,(5,5),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//SORTWK01 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK02 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK03 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SYSIN DD
// SORT FIELDS=(230,8,RI,A)
/* STEP7 EXEC PGM=BUDG2
//STEPLIB DD DSN=HCT.LOAD.LIR,DISP=SHR
//FT05F001 DD DSN=*.STEP6,SORTOUT,UNIT=WORK,DISP=(OLD,DELETE)
//FT06F001 DD SYSOUT=A
//FT08F001 DD DSN=&&TEMP7A,UNIT=WORK,DISP=(,PASS),
// SPACE=(TRK,(5,5),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT09F001 DD DSN=&&TEMP7B,UNIT=WORK,DISP=(,PASS),
// SPACE=(TRK,(5,5),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT04F001 DD *
83 80 0.13 0.17
0020085000
/* STEP8 PGM=IERRC000,REGION=76K
//SYSOUT=A
//SORTIN DD DSN=*.STEP7,FT09F001,DISP=(OLD,DELETE),UNIT=WORK
//SORTOUT DD DSN=&&TEMP8A,UNIT=WORK,DISP=(,PASS),
// SPACE=(TRK,(5,5),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//SORTWK01 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK02 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK03 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SYSIN DD
// SORT FIELDS=(230,8,BI,A)
/* STEP9 EXEC PGM=RUDG2

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```

00008900
00009000
00009100
00009200
00009300
00009400
00009500
00009600
00009700
00009800
00009900
00010000
00010100
00010200
00010300
00010400
00010500
00010600
00010700
00010800
00010900
00011000
00011100
00011200
00011300
00011400
00011500
00011600
00011700
00011800
00011900
00012000
00012100
00012200
00012300
00012400
00012500
00012600
00012700
00012800
00012900
00013000
00013100
00013200

```



```

//SORTOUT DD DSN=AA&&TEMP12,UNIT=WORK,DISP=(,PASS),
// SPACE=(TRK,(5,5),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//SORTWK01 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK02 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK03 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SYSIN DD *
// SORT FIELDS=(230,8,BI,A)
/*
//STEP13 EXEC PGM=BUDG2
//STEPLIB DD DSN=HCT.LOAD.LIB,DISP=SHR
//FT05F001 DD DSN=*,STEP12.SORTOUT,UNIT=WORK,DISP=(OLD,DELETE)
//FT06F001 DD SYSOUT=A
//FT08F001 DD DSN=AA&&TEMP13A,UNIT=WORK,DISP=(,PASS),
// SPACE=(TRK,(5,5),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT09F001 DD DSN=AA&&TEMP13B,UNIT=WORK,DISP=(,PASS),
// SPACE=(TRK,(5,5),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//FT04F001 DD *
// 86 80 0.13 0.17
// 0020115000
//STEP14
//SYSOUT=A
//SORTIN DD DSN=IFERRC00,REGION=76K
// DD DSN=*,STEP1.FT10F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=*,STEP3.FT08F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=*,STEP5.FT08F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=*,STEP7.FT08F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=*,STEP9.FT08F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=*,STEP11.FT08F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=*,STEP13.FT08F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=*,STEP13.FT09F001,DISP=(OLD,DELETE),UNIT=WORK
// DD DSN=MATLS.NETRI,VERSI,UNIT=SYSUDA,DISP=(,CATLG),
// SPACE=(TRK,(30,30),RLSE),
// DCB=(RECFM=FB,LRECL=240,BLKSIZE=6000)
//SORTWK01 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK02 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SORTWK03 DD UNIT=WORK,SPACE=(TRK,(100,10))
//SYSIN DD *
// SORT FIELDS=(219,2,RI,A,230,8,BI,A,10,3,BI,A,13,5,BI,A)
/*
//STEP15 EXEC PGM=NETWORK
//STEPLIB DD DSN=HCT.LOAD.LIB,DISP=SHR

```

```

00017700
00017800
00017900
00018000
00018100
00018200
00018300
00018400
00018500
00018600
00018700
00018800
00018900
00019000
00019100
00019200
00019300
00019400
00019500
00019600
00019700
00019800
00019900
00020000
00020100
00020200
00020300
00020400
00020500
00020600
00020700
00020800
00020900
00021000
00021100
00021200
00021300
00021400
00021500
00021600
00021700
00021800
00021900
00022000

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000222100
000222200
000222300
000222400
000222500
000222600
000222700
000222800
000222900
000223000
000223100
000223200
000223300
000223400
000223500
000223600
000223700
000223800
000223900
000224000
000224100
000224200
000224300
000224400
000224500
000224600
000224700
000224800
000224900
000225000
000225100
000225200
000225300
000225400
000225500
000225600
000225700
000225800
000225900
000226000
000226100
000226200
000226300
000226400

//FT05F001 DD CSN=MAILS.NET&1.VERS1•DISP=SHR
//FT06F001 DD SYSOUT=A
//FT04F001 DD *
1980 0.13 0 0.04 0.17
50 40 30 40 40 60
40 30 30 30 30 50

RASE BUDGET FOR 1982-87 PROGRAM

/*
//FT11F001 DD SYSOUT=A,DCB=RECFM=UA
//FT12F001 DD SYSOUT=A,DCB=RECFM=UA
//FT13F001 DD SYSOUT=A,DCB=RECFM=UA
//FT14F001 DD SYSOUT=A,DCB=RECFM=UA
//FT15F001 DD SYSOUT=A,DCB=RECFM=UA
//FT16F001 DD SYSOUT=A,DCB=RECFM=UA
//FT17F001 DD SYSOUT=A,DCB=RECFM=UA
//FT21F001 DD SYSOUT=A,DCB=RECFM=UA
//FT22F001 DD SYSOUT=A,DCB=RECFM=UA
//FT23F001 DD SYSOUT=A,DCB=RECFM=UA
//FT24F001 DD SYSOUT=A,DCB=RECFM=UA
//FT25F001 DD SYSOUT=A,DCB=RECFM=UA
//FT26F001 DD SYSOUT=A,DCB=RECFM=UA
//FT27F001 DD SYSOUT=A,DCB=RECFM=UA
//FT31F001 DD SYSOUT=A,DCB=RECFM=UA
//FT32F001 DD SYSOUT=A,DCB=RECFM=UA
//FT33F001 DD SYSOUT=A,DCB=RECFM=UA
//FT34F001 DD SYSOUT=A,DCB=RECFM=UA
//FT35F001 DD SYSOUT=A,DCB=RECFM=UA
//FT36F001 DD SYSOUT=A,DCB=RECFM=UA
//FT37F001 DD SYSOUT=A,DCB=RECFM=UA
//FT41F001 DD SYSOUT=A,DCB=RECFM=UA
//FT42F001 DD SYSOUT=A,DCB=RECFM=UA
//FT43F001 DD SYSOUT=A,DCB=RECFM=UA
//FT44F001 DD SYSOUT=A,DCB=RECFM=UA
//FT45F001 DD SYSOUT=A,DCB=RECFM=UA
//FT46F001 DD SYSOUT=A,DCB=RECFM=UA
//FT47F001 DD SYSOUT=A,DCB=RECFM=UA
//FT51F001 DD SYSOUT=A,DCB=RECFM=UA
//FT52F001 DD SYSOUT=A,DCB=RECFM=UA
//FT53F001 DD SYSOUT=A,DCB=RECFM=UA
//FT54F001 DD SYSOUT=A,DCB=RECFM=UA
//FT55F001 DD SYSOUT=A,DCB=RECFM=UA
//FT56F001 DD SYSOUT=A,DCB=RECFM=UA
//FT57F001 DD SYSOUT=A,DCB=RECFM=UA
//FT61F001 DD SYSOUT=A,DCB=RECFM=UA

SOURCE PROGRAM FOR BUDG 1


```

C          WRITE (UNIT,502)      (ALPHA(J),J=1,6),LENG,R,FC,(ALPHA(J),J=7,12),
1          YR,(ECONS(J), FVAR(J), EXP(J),J=1,4),(ALPHA(J),J=13,35),
2          (ALT(J),APPYR(J),J=1,4), PJ
C 502 FORMAT (5A4, A2, I4, A1, I1, 5A4, A1, I2, 4(F6.2, F9.5, F4.2),
C          22A4,A2,4(I1,I2), F8.1, 3X)
C          GO TO 100
C 999 CONTINUE
C          GO 200 I = 10,16
C          END FILE I
C          200 CONTINUE
C          STOP
C          END
00004500
00004600
00004700
00004800
00004900
00005000
00005100
00005200
00005300
00005400
00005500
00005600
00005700
00005800
00005900
00006000

```

SOURCE PROGRAM FOR BUDG 2


```

00004500
00004600
00004700
00004800
00004900
00005000
00005100
00005200
00005300
00005400
00005500
00005600
00005700
00005800
00005900
00006000
00006100
00006200
00006300
00006400
00006500
00006600
00006700
00006800
00006900
00007000
00007100
00007200
00007300
00007400
00007500
00007600
00007700
00007800
00007900
00008000
00008100
00008200
00008300
00008400
00008500
00008600
00008700
00008800

IF (AK .EQ. 0) GO TO 299
AGE = AYEAP - YR
IF (APPLIC .GT. 1) AGE = AYEAP - APPYR(APPLIC - 1)
RTNG = CONST - (COEF * AGE ** EX)
IF (RTNG .LT. 0.0) RTNG = 0.0
SURF = (LENGTH * .01) * (FLOAT(RDW + RSH + LSH) / 12)
MSURF = (LENGTH * .01) * (FLOAT(RDW) / 12)
K = ALTNT - 1
PREP = PCOST(RTNG)
INFL = (1.0 + EI) ** (AYFAP - NOW)
COST = ((ACOST(K) * SURF) + (MSURF * PREP)) * INFL * (1.0 + ENGCST)
TOTAL = TOTAL + COST
IF (TOTAL .GT. RUDGET) GO TO 900
AGAIN = 0
MAPPL = APPLIC + 1
IF (MAPPL .EQ. 5) GO TO 30
NEXT = AYEAP + 1
FINAL = NOW + 6
IF (NEXT .EQ. FINAL) GO TO 35
DO 30 J = NEXT, FINAL
GO TO 36
J = NEXT
35 J = NEXT
36 IF (APPYR(MAPPL) .EQ. J) AGAIN = 1
30 CONTINUE
IF (AGAIN .EQ. 1) GO TO 800
WRITE (5,501)
1 (ALPHA(J), J=1,6), LENGTH, DUMY1, DUMY2, RDW,
2 RSH, LSH, (ALPHA(J), J=7,9), YR,
3 (CONST(I), COEFF(I), EXP(I), I=1,4),
4 (ACOST(J), J=1,3), (ALPHA(J), J=10,27),
  (ALT(J), APPYR(J), J=1,4), PI
CC
CC
CC
CC
CC
CC
CC
CC
CC

```


SOURCE PROGRAM FOR BUDG A


```

TOTMI = TOTMI + LENGTH
TOTPT = TOTPT + (LENGTH * RTNG)
K = 0
DO 10 I = 1,4
IF (AYR .NE. APPYR(I)) GO TO 10
K = I
10 CONTINUE
IF (K .GT. 0) GO TO 30
WRITE (8,502)
1 (ALPHA(J),J=1,6), LENGTH, DUMY1, DUMY2, RDW,
2 PSH, LSH, (ALPHA(J),J=7,9), YR,
3 (CONS(I), COEFF(I), EXP(I),I=1,4),
4 (ACOST(J),J=1,3), (ALPHA(J),J=10,27),
  (ALT(J), APPYR(J),J=1,4), PI
C 502 FORMAT(SA4, A2, I4, A4, A1, 3I2, 3A4, I2, 4(F6.2, F9.5,
  F4.2), 3I6, 18A4, 4(I1,12), F8.0)
C
C
C GO TO 100
30 KJ = 1
IF (K .GT. 1) KJ = ALT(K - 1)
AGE = AYR - YR
IF (K .GT. 1) AGE = AYR - APPYR(K - 1)
RTNG = CONS(KJ) * (COEFF(KJ) * (AGE + 1) ** EXP(KJ))
IF (RTNG .LT. -99.9) RTNG = -99.9
PI = RTNG + 100.0
WRITE (9,503)
1 (ALPHA(J),J=1,6), LENGTH, DUMY1, DUMY2, RDW,
2 PSH, LSH, (ALPHA(J),J=7,9), YR,
3 (CONS(I), COEFF(I), EXP(I),I=1,4),
4 (ACOST(J),J=1,3), (ALPHA(J),J=10,27),
  (ALT(J), APPYR(J),J=1,4), PI
C
C GO TO 100
C
C 995 WRITE (10,503) TOTMI, TOTPT
503 FORMAT (I8,F12.1)
END FILE 8
END FILE 9
END FILE 10
STOP

```

```

00004500
00004600
00004700
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00004900
00005000
00005100
00005200
00005300
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00005500
00005600
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00005800
00005900
00006000
00006100
00006200
00006300
00006400
00006500
00006600
00006700
00006800
00006900
00007000
00007100
00007200
00007300
00007400
00007500
00007600
00007700
00007800
00007900
00008000
00008100
00008200
00008300
00008400
00008500
00008600
00008700
00008800

```

END

00008900

SOURCE PROGRAM FOR BUDG B


```

COFF = COEFF(ALTINT)
FX = FXP(ALTINT)
GO TO 910
C
C
900 AYEAR = AYEAR + 1
    AGE = AYFAP - YR
    IF (APPLIC .GT. 1) AGE = AYEAR - APPYR(APPLIC - 1)
    IF (APPLIC .EQ. 4) GO TO 910
    DO 40 I = APPLIC,4
    IF (ALT(I) .EQ. 0) GO TO 40
    APPYR(I) = APPYR(I) + 1
    IF (APPYR(I) .GE. 100) APPYR(I) = APPYR(I) - 100
    CONTINUE
40 PTNG = CONST - (COEF * (AGE + 1) ** EX)
910 IF (RTNG .LT. -99.9) RTNG = -99.9
    IF (RTNG .GT. 100.0) PTNG = 100.0
    PI = RTNG + 100.0
C
C
998 WRITE (9.501)
    1 (ALPHA(J), J=1,6), LENGTH, DUMY1, DUMY2, RDW,
    2 RSH, LSH, (ALPHA(J), J=7,9), YR,
    3 (CONST(I), COEFF(I), EXP(I), I=1,4),
    4 (ACOST(J), J=1,3), (ALPHA(J), J=10,27),
    (ALT(J), APPYR(J), J=1,4), PI
C
C
GO TO 100
C
C
999 CONTINUE
END FILE 9
STOP
END
00008900
00009000
00009100
00009200
00009300
00009400
00009500
00009600
00009700
00009800
00009900
00010000
00010100
00010200
00010300
00010400
00010500
00010600
00010700
00010800
00010900
00011000
00011100
00011200
00011300
00011400
00011500
00011600
00011700
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00011900
00012000
00012100
00012200

```

APPENDIX E

SOURCE PROGRAM FOR RATGRP


```

CC      PROGRAM RATGRP      BY DMC 7-81
CC      THIS PROGRAM PRODUCES DISTRIBUTIONS OF MILEAGES BY DISTRICT
CC      AND STATEWIDE OF STRUCTURAL RATINGS AND BUMPCOUNTS FOR EVALUATION
CC      IN THE PAVEMENT MANAGEMENT SYSTEM.
CC      IMPLICIT INTEGER (A-7)
CC
CC      COMMON /COMRAT/ AMTRX, RMTRX, CMTRX, PTYPE, STRUCR,
1          D1, D2, D3A, D3B, D4A,
2          D4B, D5A, D5B, D6A, D6B,
3          D7A, D7B, D8A, D8B
CC
CC      REAL R2, EXP(20), LENG, COMBR,
1          AMILES(7,6,10), BCNTMI(7,6,10), ACNTMI(7,6,10),
2          BCNTMI(7,6,10), ACCUM(7,6), BCCUM(7,6,10),
3          ACCUM(7,6), BCLCUM(7,6), CCLCUM(7,6),
4          DBCAVG(7,6), DCCAVG(7,6), DBCNTC(7,6),
5          DALCUM(7,6), DACNTC(7,6), DCLCUM(7,6),
6          DRCMIL(7,6), DBLCUM(7,6), DCCMIL(7,6),
7          DCCAVG(7,6), DLCCUM(7,6), DCTAV(7,6),
8          DAAVG(7,6), DRAGV(7,6), DCNTC(7,6),
9          DBCTAV(7,6), DCCTAV(7,6), RF,
A          CCUM(7,6), DCUM(7,6), COMBM(7,6,10),
B          CNTMI(7,6,10), MDB(7,6,3,8,14),
C          PERC(7,6,3,8,13)
CC
CC      REAL*8 GETDAT, DATE
CC
CC      DIMENSION AMTRX(3,21), BMTRX(3,21), CMTRX(3,21),
1          DEF(8), DEFA(8), DEFB(8)
CC
CC      READ INTERPRETING PARAMETERS
CC
CC      READ (4,402) GENER
402  FORMAT (I2)
CC      CO 3 I = 1,3
CC      READ (4,401) (AMTRX(I,J),J=1,21)
401  FORMAT (2I12)

```

```

3 CONTINUE
DO 4 I = 1,3
  READ (4,401) (BMTRX(I,J),J=1,21)
4 CONTINUE
DO 5 I = 1,3
  READ (4,401) (CMTRX(I,J),J=1,21)
5 CONTINUE

C
C CALL THE SUBROUTINE THAT LISTS THE INTERPRETING PARAMETERS
C
C CALL LPARM
C
C CALL GETDAT(DATE)
C
C INITIALIZE
DATA A,B,C,L,R,N,F,'A','B','C','L','R','N','F',/
DATA AMILES,RMILES,CMILES/1260*0.0/
DATA DA AVG,DB AVG,DC AVG/126*0.0/
DATA DACUM,DB CUM,DC CUM/126*0.0/
DATA DALCUM,DR L CUM,DC L CUM/126*0.0/
DATA LCS,LRMP,LLMP,LRMP/4*0/
DATA ACNTMI,BCNTMI,CCNTMI,DACTAV,DBCTAV,DCCTAV/1386*0.0/
DATA DACNTC,DRCNTC,DCCNTC,DACMIL,DBCMIL,DCCMIL/252*0.0/
DATA ACCOMBM,BCOMBM,CCOMBM/1260*0.0/
DATA ACCUM,RCUM,CCUM,ACLCUM,BCLCUM,CCLCUM/252*0.0/
DATA DACAVG,DRCAVG,DCCA VG/126*0.0/
DATA COMP,MILES,CNTMI,CLCUM,CCUM,DCUM/1386*0.0/
DATA DLCUM,DCNTC,DCMIL,DCOAVG,DAVG,DCCTAV/252*0.0/
DATA MDH/14112*0.0,PERC/13104*0.0/

C
C READ EACH PAVEMENT RATING CARD ONE AT A TIME
C
100 READ (5,501,END=999) DIST,SR,FC,CS,CSMP,PTYPE,SIDE,D1,D2,D3A,D38,
1
501 FORMAT (2X,I1,3X,I3,I1,2I4,3X,2A1,6X,2A1,6(I1,A1),I2,I5)
IF (DIST.EQ.7) DIST = 1

C
C COMPUTE THE RATING SEGMENT LENGTH
C
IF (CS.EQ.LCS) GO TO 10
LRMP = 0
LLMP = 0

```

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00004500
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00004800
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00005000
00005100
00005200
00005300
00005400
00005500
00005600
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00005800
00005900
00006000
00006100
00006200
00006300
00006400
00006500
00006600
00006700
00006800
00006900
00007000
00007100
00007200
00007300
00007400
00007500
00007600
00007700
00007800
00007900
00008000
00008100
00008200
00008300
00008400
00008500
00008600
00008700
00008800

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```

10 LCS = CS
   IF (SIDE .EQ. L .OR. SIDE .EQ. B) GO TO 20
   LENG = FLOAT(CSMP - LRMP) * 0.01
   LRMP = CSMP
   GO TO 35
20 IF (SIDE .EQ. B) GO TO 30
   LENG = FLOAT(CSMP - LLMP) * 0.01
   LLMP = CSMP
   GO TO 35
30 LBMP = LRMP
   IF (LLMP .GT. LRMP) LBMP = LLMP
   LENG = FLOAT(CSMP - LBMP) * 0.01
   LBMP = CSMP
   LLMP = CSMP
   CALL THE SUBROUTINE THAT COMPUTES THE STRUCTURAL RATING
35 CALL ARAT
   CALL RIDADJ(GENER,SP,BUMP,PTYPE,COUNT)
   RF = 1.0 - (0.3 * (FLOAT(COUNT)/5000)) ** 2
   COMPR = STRUCR * RF
DEFA(1) = 0
DEFA(2) = 0
DEFA(3) = D3A
DEFA(4) = D4A
DEFA(5) = D5A
DEFA(6) = D6A
DEFA(7) = D7A
DEFA(8) = D8A
DEFB(1) = D1
DEFB(2) = D2
DEFB(3) = D3H
DEFB(4) = D4B
DEFB(5) = D5B
DEFB(6) = D6B
DEFB(7) = D7B
DEFB(8) = D8B
DC 200 I = 1.8
IF (DEFB(I) .EQ. N .OR. DEFR(I) .EQ. F .OR. DEFB(I) .EQ. R) DEFB(I) = 0
IF (DEFB(I) .EQ. 0) GO TO 200
00089000
00009000
00009100
00009200
00009300
00009400
00009500
00009600
00009700
00009800
00009900
00010000
00010100
00010200
00010300
00010400
00010500
00010600
00010700
00010800
00010900
00011000
00011100
00011200
00011300
00011400
00011500
00011600
00011700
00011800
00011900
00012000
00012100
00012200
00012300
00012400
00012500
00012600
00012700
00012800
00012900
00013000
00013100
00013200

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00013300
00013400
00013500
00013600
00013700
00013800
00013900
00014000
00014100
00014200
00014300
00014400
00014500
00014600
00014700
00014800
00014900
00015000
00015100
00015200
00015300
00015400
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00015600
00015700
00015800
00015900
00016000
00016100
00016200
00016300
00016400
00016500
00016600
00016700
00016800
00016900
00017000
00017100
00017200
00017300
00017400
00017500
00017600

200 DEFN(I) = HCDHNV(DEFN(I),1)
CONTINUE
DO 210 I = 1,4
IF (DEFA(I) .LE. 1) DEF(I) = DEFB(I) + 1
IF (DEFA(I) .EQ. 2) DEF(I) = DEFB(I) + 4
IF (DEFA(I) .EQ. 3) DEF(I) = DEFB(I) + 7
IF (DEFA(I) .EQ. 4) DEF(I) = DEFB(I) + 10
210 CONTINUE
IF (PTYPE .EQ. A) PAVE = 1
IF (PTYPE .EQ. B) PAVE = 2
IF (PTYPE .EQ. C) PAVE = 3
DO 220 CAT = 1,8
GR = DEF(CAT)
MDR(DIST,FC,PAVE,CAT,GR) = MDR(DIST,FC,PAVE,CAT,GR) + LENG
MDR(DIST,FC,PAVE,CAT,14) = MDR(DIST,FC,PAVE,CAT,14) + LENG
MDR(DIST,6,PAVE,CAT,GR) = MDR(DIST,6,PAVE,CAT,GR) + LENG
MDR(DIST,6,PAVE,CAT,14) = MDR(DIST,6,PAVE,CAT,14) + LENG
MDR(7,FC,PAVE,CAT,GR) = MDR(7,FC,PAVE,CAT,GR) + LENG
MDR(7,FC,PAVE,CAT,14) = MDR(7,FC,PAVE,CAT,14) + LENG
MDR(7,6,PAVE,CAT,GR) = MDR(7,6,PAVE,CAT,GR) + LENG
MDR(7,6,PAVE,CAT,14) = MDR(7,6,PAVE,CAT,14) + LENG
220 CONTINUE
CC
CC
CC
BRANCH FOR SEGREGATING THE PAVEMENT TYPES
IF (PTYPE .EQ. C) GO TO 80
IF (PTYPE .EQ. B) GO TO 40
CC
CC
ASSIGN MILEAGE TO STRUCTURAL RATING GROUPS FOR ASPHALT PAVTS
IF (STRUCR .LE. 100 .AND. STRUCR .GT. 90) GROUP = 1
IF (STRUCR .LE. 90 .AND. STRUCR .GT. 80) GROUP = 2
IF (STRUCR .LE. 80 .AND. STRUCR .GT. 70) GROUP = 3
IF (STRUCR .LE. 70 .AND. STRUCR .GT. 60) GROUP = 4
IF (STRUCR .LE. 60 .AND. STRUCR .GT. 50) GROUP = 5
IF (STRUCR .LE. 50 .AND. STRUCR .GT. 40) GROUP = 6
IF (STRUCR .LE. 40 .AND. STRUCR .GT. 30) GROUP = 7
IF (STRUCR .LE. 30 .AND. STRUCR .GT. 20) GROUP = 8
IF (STRUCR .LE. 20 .AND. STRUCR .GT. 10) GROUP = 9
IF (STRUCR .LE. 10) GROUP = 10
CC
CC
CC
SETUP ACCUMULATIONS TO BE USED FOR COMPUTING AVERAGES AFTER
ALL PAVEMENT RATING CARDS HAVE BEEN READ

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00017700
00017800
00017900
00018000
00018100
00018200
00018300
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00018600
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00020400
00020500
00020600
00020700
00020800
00020900
00021000
00021100
00021200
00021300
00021400
00021500
00021600
00021700
00021800
00021900
00022000

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AMILES(DIST,6,FC,GROUP) = AMILES(DIST,6,FC,GROUP) + LENG
AMILES(DIST,6,FC,GROUP) = AMILES(DIST,6,FC,GROUP) + LENG
AMILES(7,FC,GROUP) = AMILES(7,FC,GROUP) + LENG
AMILES(7,FC,GROUP) = AMILES(7,FC,GROUP) + LENG
DACUM(DIST,FC) = DACUM(DIST,FC) + (STRUCR * LENG)
DACUM(DIST,FC) = DACUM(DIST,6) + (STRUCR * LENG)
DACUM(7,6) = DACUM(7,6) + (STRUCR * LENG)
DACUM(7,FC) = DACUM(7,FC) + (STRUCR * LENG)
DALCUM(DIST,6) = DALCUM(DIST,6) + LENG
DALCUM(7,FC) = DALCUM(7,FC) + LENG
IF (COMBR .LE. 100.0 .AND. COMBR .GT. 90.0) GROUP = 1
IF (COMBR .LE. 90.0 .AND. COMBR .GT. 80.0) GROUP = 2
IF (COMBR .LE. 80.0 .AND. COMBR .GT. 70.0) GROUP = 3
IF (COMBR .LE. 70.0 .AND. COMBR .GT. 60.0) GROUP = 4
IF (COMBR .LE. 60.0 .AND. COMBR .GT. 50.0) GROUP = 5
IF (COMBR .LE. 50.0 .AND. COMBR .GT. 40.0) GROUP = 6
IF (COMBR .LE. 40.0 .AND. COMBR .GT. 30.0) GROUP = 7
IF (COMBR .LE. 30.0 .AND. COMBR .GT. 20.0) GROUP = 8
IF (COMBR .LE. 20.0 .AND. COMBR .GT. 10.0) GROUP = 9
IF (COMBR .LE. 10.0) GROUP = 10

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SETUP ACCUMULATIONS TO BE USED FOR COMPUTING AVERAGES AFTER
ALL PAVEMENT RATING CARDS HAVE BEEN READ

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ACOMBM(DIST,FC,GROUP) = ACOMBM(DIST,FC,GROUP) + LENG
ACOMBM(7,6,FC,GROUP) = ACOMBM(7,6,FC,GROUP) + LENG
ACOMBM(7,FC,GROUP) = ACOMBM(7,FC,GROUP) + LENG
ACCOM(DIST,FC) = ACCUM(DIST,FC) + (COMBR * LENG)
ACCOM(DIST,6) = ACCUM(DIST,6) + (COMBR * LENG)
ACCOM(7,6) = ACCUM(7,6) + (COMBR * LENG)
ACCOM(7,FC) = ACCUM(7,FC) + (COMBR * LENG)
IF (PUMP .EQ. 0) GO TO 100

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ASSIGN MILEAGE TO CPM GROUPS FOR ASPHALT PAVTS

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IF (COUNT .GE. 10000 ) GROUP = 10

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00026500
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00026700
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00026900
00027000
00027100
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00029500
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00029700
00029800
00029900
00030000
00030100
00030200
00030300
00030400
00030500
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00030800

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SETUP ACCUMULATIONS TO BE USED FOR COMPUTING AVERAGES AFTER
ALL PAVEMENT RATING CARDS HAVE BEEN READ

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RMILES(DIST,FC,GROUP) = BMILES(DIST,FC,GROUP) * LENG
RMILES(DIST,6,GROUP) = BMILES(DIST,6,GROUP) * LENG
RMILES(7,FC,GROUP) = RMILES(7,6,GROUP) * LENG
RMILES(7,FC,FC,GROUP) = RMILES(7,FC,FC,GROUP) * LENG
DBCUM(DIST,FC) = DBCUM(DIST,FC) + (STRUCR * LENG)
DBCUM(DIST,6) = DBCUM(DIST,6) + (STRUCR * LENG)
DBCUM(7,FC) = DBCUM(7,FC) + (STRUCR * LENG)
DBCUM(7,6) = DBCUM(7,6) + (STRUCR * LENG)
DBCUM(7,FC) = DBCUM(7,FC) + (STRUCR * LENG)
DBCUM(7,6) = DBCUM(7,6) + (STRUCR * LENG)
IF (COMBR .LE. 100.0 .AND. COMBR .GT. 90.0) GROUP = 1
IF (COMBR .LE. 90.0 .AND. COMBR .GT. 80.0) GROUP = 2
IF (COMBR .LE. 80.0 .AND. COMBR .GT. 70.0) GROUP = 3
IF (COMBR .LE. 70.0 .AND. COMBR .GT. 60.0) GROUP = 4
IF (COMBR .LE. 60.0 .AND. COMBR .GT. 50.0) GROUP = 5
IF (COMBR .LE. 50.0 .AND. COMBR .GT. 40.0) GROUP = 6
IF (COMBR .LE. 40.0 .AND. COMBR .GT. 30.0) GROUP = 7
IF (COMBR .LE. 30.0 .AND. COMBR .GT. 20.0) GROUP = 8
IF (COMBR .LE. 20.0 .AND. COMBR .GT. 10.0) GROUP = 9
IF (COMBR .LE. 10.0) GROUP = 10

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SETUP ACCUMULATIONS TO BE USED FOR COMPUTING AVERAGES AFTER
ALL PAVEMENT RATING CARDS HAVE BEEN READ

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RCOMBM(DIST,FC,GROUP) = BCOMBM(DIST,FC,GROUP) * LENG
RCOMBM(DIST,6,GROUP) = BCOMBM(DIST,6,GROUP) * LENG
RCOMRM(7,FC,GROUP) = BCOMRM(7,FC,GROUP) * LENG
RCUM(DIST,FC) = BCCUM(DIST,FC) + (COMBR * LENG)
RCLCUM(DIST,FC) = RCLCUM(DIST,FC) + (COMBR * LENG)
RCCUM(DIST,6) = RCCUM(DIST,6) + (COMBR * LENG)
RCCUM(7,FC) = RCCUM(7,FC) + (COMBR * LENG)
RCLCUM(7,FC) = RCLCUM(7,FC) + (COMBR * LENG)
RCLCUM(7,6) = RCLCUM(7,6) + (COMBR * LENG)
RCLCUM(7,FC) = RCLCUM(7,FC) + (COMBR * LENG)
IF (RUMP .EQ. 0) GO TO 100

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00035300
 00035400
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 00035700
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 00036400
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 00037100
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 00038500
 00038600
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 00038900
 00039000
 00039100
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 00039300
 00039400
 00039500
 00039600

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IF (STRUCR .LE. 20 .AND. STRUCR .GT. 10) GROUP = 9
IF (STRUCR .LE. 10) GROUP = 10

  SETUP ACCUMLATIONS TO BE USED FOR COMPUTING AVERGES AFTER
  ALL PAVEMENT RATING CARDS HAVE BEEN READ

  CMILES(DIST,FC,GROUP) = CMILES(DIST,FC,GROUP) + LENG
  CMILES(DIST,6,GROUP) = CMILES(DIST,6,GROUP) + LENG
  CMILES(7,6,GROUP) = CMILES(7,6,GROUP) + LENG
  CMILES(7,FC,GROUP) = CMILES(7,FC,GROUP) + LENG
  DCCUM(DIST,FC) = DCCUM(DIST,FC) + (STRUCR * LENG)
  DCLCUM(DIST,FC) = DCLCUM(DIST,FC) + LENG
  DCCUM(DIST,6) = DCCUM(DIST,6) + (STRUCR * LENG)
  DCLCUM(DIST,6) = DCLCUM(DIST,6) + LENG
  DCLCUM(7,FC) = DCLCUM(7,FC) + LENG
  DCLCUM(7,6) = DCLCUM(7,6) + LENG
  DCLCUM(7,FC) = DCLCUM(7,FC) + LENG
  IF (COMBR .LE. 100.0 .AND. COMBR .GT. 90.0) GROUP = 1
  IF (COMBR .LE. 80.0 .AND. COMBR .GT. 80.0) GROUP = 2
  IF (COMBR .LE. 70.0 .AND. COMBR .GT. 70.0) GROUP = 3
  IF (COMBR .LE. 60.0 .AND. COMBR .GT. 60.0) GROUP = 4
  IF (COMBR .LE. 50.0 .AND. COMBR .GT. 50.0) GROUP = 5
  IF (COMBR .LE. 40.0 .AND. COMBR .GT. 40.0) GROUP = 6
  IF (COMBR .LE. 30.0 .AND. COMBR .GT. 30.0) GROUP = 7
  IF (COMBR .LE. 20.0 .AND. COMBR .GT. 20.0) GROUP = 8
  IF (COMBR .LE. 10.0 .AND. COMBR .GT. 10.0) GROUP = 9

  SETUP ACCUMLATIONS TO BE USED FOR COMPUTING AVERGES AFTER
  ALL PAVEMENT RATING CARDS HAVE BEEN READ

  CCOMRM(DIST,FC,GROUP) = CCOMRM(DIST,FC,GROUP) + LENG
  CCOMRM(DIST,6,GROUP) = CCOMRM(DIST,6,GROUP) + LENG
  CCOMRM(7,6,GROUP) = CCOMRM(7,6,GROUP) + LENG
  CCOMRM(7,FC,GROUP) = CCOMRM(7,FC,GROUP) + LENG
  CCLCUM(DIST,FC) = CCLCUM(DIST,FC) + (COMBR * LENG)
  CCLCUM(DIST,FC) = CCLCUM(DIST,FC) + LENG
  CCLCUM(DIST,6) = CCLCUM(DIST,6) + (COMBR * LENG)
  CCLCUM(DIST,6) = CCLCUM(DIST,6) + LENG
  CCLCUM(7,FC) = CCLCUM(7,FC) + (COMBR * LENG)
  CCLCUM(7,FC) = CCLCUM(7,FC) + LENG
  CCLCUM(7,6) = CCLCUM(7,6) + (COMBR * LENG)
  CCLCUM(7,6) = CCLCUM(7,6) + LENG
  CCLCUM(7,FC) = CCLCUM(7,FC) + LENG
  CCLCUM(7,FC) = CCLCUM(7,FC) + LENG
  
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46 DCCAVG(I,J) = CCCUM(I,J) / CCLCUM(I,J)
IF (DALCUM(I,J) .EQ. 0 .OR. DACUM(I,J) .EQ. 0) GO TO 47
47 DAAVG(I,J) = DACUM(I,J) / DALCUM(I,J)
IF (DBLCUM(I,J) .EQ. 0 .OR. DBCUM(I,J) .EQ. 0) GO TO 48
48 DRAVG(I,J) = DBCUM(I,J) / DBLCUM(I,J)
IF (DCLCUM(I,J) .EQ. 0 .OR. DCCUM(I,J) .EQ. 0) GO TO 49
49 DCAVG(I,J) = DCCUM(I,J) / DCLCUM(I,J)
IF (DACMIL(I,J) .EQ. 0 .OR. DACNTC(I,J) .EQ. 0) GO TO 50
50 DACTAV(I,J) = DACNTC(I,J) / DACMIL(I,J)
IF (DBCML(I,J) .EQ. 0 .OR. DBCNTC(I,J) .EQ. 0) GO TO 51
51 DBCTAV(I,J) = DBCNTC(I,J) / DBCML(I,J)
IF (DCCMIL(I,J) .EQ. 0 .OR. DCCNTC(I,J) .EQ. 0) GO TO 60
60 DCCTAV(I,J) = DCCNTC(I,J) / DCCMIL(I,J)
CONTINUE
61 CONTINUE
DO 74 I = 1,7
DO 73 J = 1,6
DO 70 K = 1,10
COMBM(I,J,K) = ACOMBM(I,J,K) + BCOMBM(I,J,K) + CCOMBM(I,J,K)
MILES(I,J,K) = AMILES(I,J,K) + BMILES(I,J,K) + CMILES(I,J,K)
CNTMI(I,J,K) = ACNTMI(I,J,K) + BCNTMI(I,J,K) + CCNTMI(I,J,K)
CONTINUE
70 CLCUM(I,J) = ALCUM(I,J) + BLCUM(I,J) + CLCUM(I,J)
CCUM(I,J) = ACCUM(I,J) + BCCUM(I,J) + CCCUM(I,J)
DCUM(I,J) = DACUM(I,J) + DBCUM(I,J) + DCCUM(I,J)
DLCUM(I,J) = DALCUM(I,J) + DBLCUM(I,J) + DLLCUM(I,J)
DCNTC(I,J) = DACNTC(I,J) + DBCNTC(I,J) + DCCNTC(I,J)
DCMIL(I,J) = DACMIL(I,J) + DBCMIL(I,J) + DCCMIL(I,J)
IF (CLCUM(I,J) .EQ. 0 .OR. CCUM(I,J) .EQ. 0) GO TO 71
DCAVG(I,J) = CCUM(I,J) / CLCUM(I,J)
IF (DLCUM(I,J) .EQ. 0 .OR. DLCCUM(I,J) .EQ. 0) GO TO 72
71 DAVG(I,J) = DCUM(I,J) / DLCUM(I,J)
IF (DCNTC(I,J) .EQ. 0 .OR. DCMIL(I,J) .EQ. 0) GO TO 73
72 DCTAV(I,J) = DCMIL(I,J) / DCNTC(I,J)
73 CONTINUE
74 CONTINUE

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WRITE SUMMARIES OF DISTRIBUTIONS FOR ASPHALT PAVEMENTS

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DO 230 DIST = 1,7
DO 240 PAVE = 1,3
DO 250 CAT = 1,8
DO 260 FC = 1,6
TOP = MDB(DIST,FC,PAVE,CAT,14)

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00044200
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00044500
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00046400
00046500
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00046700
00046800
00046900
00047000
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00047500
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00047700
00047800
00047900
00048000
00048100
00048200
00048300
00048400

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612 WRITE (UNIT,612) (ACNTMI(DIST,2,J),J=1,10),DACTAV(DIST,2)
FORMAT (//,3X,2) ,2X,10(F7.1,2X),1X,F6.1/)
613 WRITE (UNIT,613) (ACNTMI(DIST,3,J),J=1,10),DACTAV(DIST,3)
FORMAT (//,3X,3) ,2X,10(F7.1,2X),1X,F6.1/)
614 WRITE (UNIT,614) (ACNTMI(DIST,4,J),J=1,10),DACTAV(DIST,4)
FORMAT (//,3X,4) ,2X,10(F7.1,2X),1X,F6.1/)
615 WRITE (UNIT,615) (ACNTMI(DIST,5,J),J=1,10),DACTAV(DIST,5)
FORMAT (//,3X,5) ,2X,10(F7.1,2X),1X,F6.1/)
616 WRITE (UNIT,616) (ACNTMI(DIST,6,J),J=1,10),DACTAV(DIST,6)
FORMAT (//,1X,TOTAL,2X,10(F7.1,2X),1X,F6.1/)
617 FORMAT (//,34X,'COMBINED RATING SUMMARY FOR ASPHALT PAVTS')
WRITE (UNIT,602) (ACOMBM(DIST,1,J),J=1,10),DACAVG(DIST,1)
WRITE (UNIT,603) (ACOMBM(DIST,2,J),J=1,10),DACAVG(DIST,2)
WRITE (UNIT,604) (ACOMBM(DIST,3,J),J=1,10),DACAVG(DIST,3)
WRITE (UNIT,605) (ACOMBM(DIST,4,J),J=1,10),DACAVG(DIST,4)
WRITE (UNIT,606) (ACOMBM(DIST,5,J),J=1,10),DACAVG(DIST,5)
WRITE (UNIT,607) (ACOMBM(DIST,6,J),J=1,10),DACAVG(DIST,6)
WRITE (UNIT,608)

WRITE SUMMARIES OF DISTRIBUTIONS FOR BITUMINOUS PAVEMENTS
IF (DIST.EQ.7) GO TO 152
WRITE (UNIT,618) DIST,GENER
FORMAT (//,25X,DISTRICT,11,3X,12,1X,'DEFECT RATING SUMMARY
FOR BITUMINOUS PAVTS')
GO TO 153
WRITE (UNIT,591) GENER
FORMAT (//,1,25X,'STATEWIDE',4X,12,1X,'DEFECT RATING SUMMARY FOR
BITUMINOUS PAVTS')
WRITE (UNIT,602) (BMILES(DIST,1,J),J=1,10),DBAVG(DIST,1)
WRITE (UNIT,603) (BMILES(DIST,2,J),J=1,10),DBAVG(DIST,2)
WRITE (UNIT,604) (BMILES(DIST,3,J),J=1,10),DBAVG(DIST,3)
WRITE (UNIT,605) (BMILES(DIST,4,J),J=1,10),DBAVG(DIST,4)
WRITE (UNIT,606) (BMILES(DIST,5,J),J=1,10),DBAVG(DIST,5)
WRITE (UNIT,607) (BMILES(DIST,6,J),J=1,10),DBAVG(DIST,6)
WRITE (UNIT,619)
FORMAT (//,35X,'BUMP COUNT SUMMARY FOR BITUMINOUS PAVTS')
WRITE (UNIT,610) (BCNTMI(DIST,1,J),J=1,10),DBCTAV(DIST,1)
WRITE (UNIT,611) (BCNTMI(DIST,2,J),J=1,10),DBCTAV(DIST,2)
WRITE (UNIT,612) (BCNTMI(DIST,3,J),J=1,10),DBCTAV(DIST,3)
WRITE (UNIT,613) (BCNTMI(DIST,4,J),J=1,10),DBCTAV(DIST,4)
WRITE (UNIT,614)

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WRITE (UNIT,615) (BCNTMI(DIST,5,J),J=1,10),DBCIAV(DIST,5) 00057300
WRITE (UNIT,616) (BCNTMI(DIST,6,J),J=1,10),DBCIAV(DIST,6) 00057400
WRITE (UNIT,620) 00057500
620 FORMAT (//,1,33x,'COMBINED RATING SUMMARY FOR BITUMINOUS PAVTS*') 00057600
WRITE (UNIT,602) (BCOMBM(DIST,1,J),J=1,10),DBC AVG(DIST,1) 00057700
WRITE (UNIT,603) (BCOMBM(DIST,2,J),J=1,10),DBC AVG(DIST,2) 00057800
WRITE (UNIT,604) (BCOMBM(DIST,3,J),J=1,10),DBC AVG(DIST,3) 00057900
WRITE (UNIT,605) (BCOMBM(DIST,4,J),J=1,10),DBC AVG(DIST,4) 00058000
WRITE (UNIT,606) (BCOMBM(DIST,5,J),J=1,10),DBC AVG(DIST,5) 00058100
WRITE (UNIT,607) (BCOMBM(DIST,6,J),J=1,10),DBC AVG(DIST,6) 00058200
WRITE (UNIT,608) 00058300
00058400
00058500
00058600
00058700
00058800
00058900
00059000
00059100
00059200
00059300
00059400
00059500
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00059900
00060000
00060100
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00060900
00061000
00061100
00061200
00061300
00061400
00061500
00061600
WRITE SUMMARIES OF DISTRIBUTIONS FOR PCC PAVEMENTS
IF (DIST, EQ, 7) GO TO 154
WRITE (UNIT,621) DIST, GENER
621 FORMAT (//,1,29x,'DISTRICT ',I1,3X,I2,' DEFECT RATING SUMMARY F 00059000
GO TO 155
154 WRITE (UNIT,592) GENER
592 FORMAT (//,1,29x,'STATEWIDE',4X,I2,I1X,'DEFECT RATING SUMMARY F 00059400
155 WRITE (UNIT,602) (CMILES(DIST,1,J),J=1,10),DCAVG(DIST,1) 00059500
WRITE (UNIT,603) (CMILES(DIST,2,J),J=1,10),DCAVG(DIST,2) 00059600
WRITE (UNIT,604) (CMILES(DIST,3,J),J=1,10),DCAVG(DIST,3) 00059700
WRITE (UNIT,605) (CMILES(DIST,4,J),J=1,10),DCAVG(DIST,4) 00059800
WRITE (UNIT,606) (CMILES(DIST,5,J),J=1,10),DCAVG(DIST,5) 00059900
WRITE (UNIT,607) (CMILES(DIST,6,J),J=1,10),DCAVG(DIST,6) 00060000
WRITE (UNIT,622) 00060100
622 FORMAT (//,1,39x,'BUMP COUNT SUMMARY FOR PCC PAVTS*') 00060200
WRITE (UNIT,610) (CCNTMI(DIST,1,J),J=1,10),DCCTAV(DIST,1) 00060300
WRITE (UNIT,611) (CCNTMI(DIST,2,J),J=1,10),DCCTAV(DIST,2) 00060400
WRITE (UNIT,612) (CCNTMI(DIST,3,J),J=1,10),DCCTAV(DIST,3) 00060500
WRITE (UNIT,613) (CCNTMI(DIST,4,J),J=1,10),DCCTAV(DIST,4) 00060600
WRITE (UNIT,614) (CCNTMI(DIST,5,J),J=1,10),DCCTAV(DIST,5) 00060700
WRITE (UNIT,615) (CCNTMI(DIST,6,J),J=1,10),DCCTAV(DIST,6) 00060800
WRITE (UNIT,616) 00060900
WRITE (UNIT,623) 00061000
623 FORMAT (//,1,36x,'COMBINED RATING SUMMARY FOR PCC PAVTS*') 00061100
WRITE (UNIT,602) (CCOMBM(DIST,1,J),J=1,10),DCCAVG(DIST,1) 00061200
WRITE (UNIT,603) (CCOMBM(DIST,2,J),J=1,10),DCCAVG(DIST,2) 00061300
WRITE (UNIT,604) (CCOMBM(DIST,3,J),J=1,10),DCCAVG(DIST,3) 00061400
WRITE (UNIT,605) 00061500
00061600

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WRITE (UNIT,606) (CCOMB(DIST,4,J),J=1,10),DCCAVG(DIST,4)
WRITE (UNIT,607) (CCOMB(DIST,5,J),J=1,10),DCCAVG(DIST,5)
WRITE (UNIT,608) (CCOMB(DIST,6,J),J=1,10),DCCAVG(DIST,6)

WRITE SUMMARIES OF DISTRIBUTIONS FOR PCC PAVEMENTS

IF (DIST, EQ, 7) GO TO 156
WRITE (UNIT,624) DIST, GENER
FORMAT (1,/,/,29X, 'DISTRICT ',11,3X,12, ' DEFECT RATING SUMMARY F
157 FOR ALL PAVTS')
GO TO 157
156 WRITE (UNIT,593) GENER
FORMAT (1,/,/,29X, 'STATEWIDE',4X,12,1X, 'DEFECT RATING SUMMARY F
157 FOR ALL PAVTS')
WRITE (UNIT,602) (MILES(DIST,1,J),J=1,10),DAVG(DIST,1)
WRITE (UNIT,603) (MILES(DIST,2,J),J=1,10),DAVG(DIST,2)
WRITE (UNIT,604) (MILES(DIST,3,J),J=1,10),DAVG(DIST,3)
WRITE (UNIT,605) (MILES(DIST,4,J),J=1,10),DAVG(DIST,4)
WRITE (UNIT,606) (MILES(DIST,5,J),J=1,10),DAVG(DIST,5)
WRITE (UNIT,607) (MILES(DIST,6,J),J=1,10),DAVG(DIST,6)
WRITE (UNIT,608) (MILES(DIST,6,J),J=1,10),DAVG(DIST,6)
FORMAT (/,/,/,39X, 'RUMP COUNT SUMMARY FOR ALL PAVTS')
WRITE (UNIT,610) (CNTMI(DIST,1,J),J=1,10),DCTAV(DIST,1)
WRITE (UNIT,611) (CNTMI(DIST,2,J),J=1,10),DCTAV(DIST,2)
WRITE (UNIT,612) (CNTMI(DIST,3,J),J=1,10),DCTAV(DIST,3)
WRITE (UNIT,613) (CNTMI(DIST,4,J),J=1,10),DCTAV(DIST,4)
WRITE (UNIT,614) (CNTMI(DIST,5,J),J=1,10),DCTAV(DIST,5)
WRITE (UNIT,615) (CNTMI(DIST,6,J),J=1,10),DCTAV(DIST,6)
WRITE (UNIT,616) (CNTMI(DIST,6,J),J=1,10),DCTAV(DIST,6)
FORMAT (/,/,/,36X, 'COMBINED RATING SUMMARY FOR ALL PAVTS')
WRITE (UNIT,602) (COMB(DIST,1,J),J=1,10),DCCAVG(DIST,1)
WRITE (UNIT,603) (COMB(DIST,2,J),J=1,10),DCCAVG(DIST,2)
WRITE (UNIT,604) (COMB(DIST,3,J),J=1,10),DCCAVG(DIST,3)
WRITE (UNIT,605) (COMB(DIST,4,J),J=1,10),DCCAVG(DIST,4)
WRITE (UNIT,606) (COMB(DIST,5,J),J=1,10),DCCAVG(DIST,5)
WRITE (UNIT,607) (COMB(DIST,6,J),J=1,10),DCCAVG(DIST,6)
WRITE (UNIT,608) (COMB(DIST,6,J),J=1,10),DCCAVG(DIST,6)

DO 290 PAVE = 1,3
DO 300 CAT = 1,8
IF (PAVE, EQ, 3) GO TO 350

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1      T80,F6.0,T100,F6.0/, , , PERCENT,T17,F4.0,T34,F4.0,
2      T59,F4.0,T82,F4.0//)
      GO TO 300
331 WRITE (UNIT,635)
635 FORMAT ('0',T41,CORRUGATIONS, WAVES, SAGS, HUMPS,/, '0',
, FUNCTIONAL NONE, T25, 1/8-2 IN CHANGE/10FT, 5X,
, 2-4 IN CHANGE/10FT OVER 4 IN CHANGE/10FT, T101,
, TOTAL,/, , , CLASS, T25,3('1-25 26-75 OVER 75',4X)//)
      DO 332 FC = 1,5
      WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
1      MDB(DIST,FC,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
636 FORMAT ('0',5X,T17, , , MILES, T16,F5.0,3(4X,F5.0,2X,F5.0,
, F5.0),T100,F6.0/, , , PERCENT,T17,F4.0,3(5X,F4.0,
, F4.0,4X,F4.0)//)
332 CONTINUE
      WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1      MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
637 FOPMAT ('0', , , TOTAL,/, , , MILES, T16,F5.0,3(4X,F5.0,
, F5.0),T100,F6.0/, , , PERCENT,T17,F4.0,3(5X,F4.0,
, F4.0,4X,F4.0)//)
      GO TO 300
333 WRITE (UNIT,638)
638 FORMAT ('0',T48,ALLIGATOR CRACKING,/, '0', , FUNCTIONAL NONE,
, T27, 1-24 PERCENT 25-49 PERCENT 50-74 PERCENT ,
, 6X, 75-100 PERCENT, T103, TOTAL,/, , , CLASS, T26,
, 4(WHEEL TRACK/STA,4X)/, , T25,4('H-LINE SPAL PUMP',2X)//)
      DO 334 FC = 1,5
      WRITE (UNIT,639) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,13),
1      MDB(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,13)
639 FORMAT ('0',5X,T17, , , PERCENT,T16,F5.0,T25,4(3(F5.0,1X),
, T102,F6.0/, , , PERCENT,T17,F4.0,T26,4(3(F4.0,2X),1X)//)
334 CONTINUE
      WRITE (UNIT,640) (MDB(DIST,6,PAVE,CAT,J),J=1,14),
1      (PERC(DIST,6,PAVE,CAT,J),J=1,13),
640 FORMAT ('0', , , TOTAL,/, , , MILES, T16,F5.0,T25,4(3(F5.0,1X),
, 1X),T102,F6.0/, , , PERCENT,T17,F4.0,T26,4(3(F4.0,2X),1X))
      GO TO 300
335 WRITE (UNIT,641)
641 FORMAT ('0',T47,RAVELING AND FLUSHING,/, '0',
, FUNCTIONAL NONE, T30, LOCALIZED, T53,
, WHEEL PATHS, T77, ENTIRE LANE, T101,
, TOTAL,/, , , CLASS, T25,3('SLIGHT MODER. SEVERE',4X)//)
      DO 336 FC = 1,5
      WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),

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00070500
00070600
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00072800
00072900
00073000
00073100
00073200
00073300
00073400
00073500
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00073800
00073900
00074000
00074100
00074200
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00074600
00074700
00074800

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1 MDB(DIST,FC,PAVE,CAT,14). (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
336 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
GO TO 300
337 WRITE (UNIT,642)
642 FORMAT (0,T46, LONGITUDINAL CRACKING',0',
, FUNCTIONAL NONE',T26, LESS THAN 1/4 INCH',T52,
, OVER 1/4 INCH',T78, SPALLED',T101,
, TOTAL',, CLASS',T27,3(LINEAL FT/STATION',7X)'/, ,
, T25,3(1-99 100-199 200+,4X)'/)
DO 338 FC = 1,5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
1 MDB(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
338 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
GO TO 300
339 WRITE (UNIT,643)
643 FORMAT (0,T47, TRANSVERSE CRACKING',0',
, FUNCTIONAL NONE',T29,3(NO./STATION',13X),T101,
, TOTAL',, CLASS',T25,3(1-4 5-9 10+,5X)'/)
DO 340 FC = 1,5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
1 MDB(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
340 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
GO TO 300
341 WRITE (UNIT,644)
644 FORMAT (0,T52, PATCHING',0',
, FUNCTIONAL NONE',T26, 0.10-0.50 IN THICK',5X,
, 0.50 - 1.0 IN THICK OVER 1.0 IN THICK',T101,
, TOTAL',, CLASS',T27,3(PCT AREA/STATION',8X)'/, ,
, T25,3(1-5 6-25 OVER25+,4X)'/)
DO 342 FC = 1,5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
1 MDB(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
342 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
GO TO 300
350 IF (DIST.EQ. 7) GO TO 345
WRITE (UNIT,645) DIST, DATE, GENER

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00074900
00075000
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00075300
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00076200
00076300
00076400
00076500
00076600
00076700
00076800
00076900
00077000
00077100
00077200
00077300
00077400
00077500
00077600
00077700
00077800
00077900
00078000
00078100
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00078300
00078400
00078500
00078600
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00078900
00079000
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00079200

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355 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 GO TO 300 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
356 WRITE (UNIT,649)
649 FORMAT ('0',T34,'RAVELLING, DISINTEGRATION, POP OUT, SCALING','0',
1 'FUNCTIONAL NONE',T28,'1 - 25 PERCENT',T51,
2 '75 PERCENT',T75,'OVER 75 PERCENT',T101,
3 'TOTAL',/,,' CLASS',T25,'3('SLIGHT MODER. SEVERE',4X)//)
DO 357 FC = 1,5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
1 MDR(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
357 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 GO TO 300 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
358 WRITE (UNIT,650)
650 FORMAT ('0',T50,'JOINT SPALLING','0',
1 'FUNCTIONAL NONE',T28,'1 - 15 PERCENT',T51,
2 '50 PERCENT',T75,'OVER 50 PERCENT',T101,
3 'TOTAL',/,,' CLASS',T27,'3('WIDTH IN INCHES',9X)/, ' ',
4 T25,'3('1/4-1 I-3 PLUS',4X)//)
DO 359 FC = 1,5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
1 MDR(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
359 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 GO TO 300 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
360 WRITE (UNIT,651)
651 FORMAT ('0',T49,'PUMPING, BLOWING','0',
1 'FUNCTIONAL NONE',T28,'10 - 15 PERCENT',T51,
2 '35 PERCENT',T75,'OVER 35 PERCENT',T101,
3 'TOTAL',/,,' CLASS',T27,'3('PCT PANEL LENGTH',8X)/, ' ',
4 T25,'3('1 - 9 10-50 OVER50',4X)//)
DO 361 FC = 1,5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
1 MDR(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
361 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 GO TO 300 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
362 WRITE (UNIT,652)
652 FORMAT ('0',T37,'FAULTING, CURLING, WARPING, SETTLEMENT','0',

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00083700
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00086300
00086400
00086500
00086600
00086700
00086800
00086900
00087000
00087100
00087200
00087300
00087400
00087500
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00087700
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1  , FUNCTIONAL NONE,,T28,,11 - 15 PERCENT,,T51,
2  ,16 - 35 PERCENT,,T75,,OVER 75 PERCENT,,T101,,TOTAL,/, , ,
3  , CLASS,,T32,3(.INCHES,,18X)/, , ,T25,
4  ,3(.1/8-1/4 1/4-1/2 1/2,,.3X)//)
DO 363 FC = 1.5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
363 CONTINUE
WRITE (MDB(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
1 GO TO 300
364 WRITE (UNIT,653)
653 FORMAT (,0,,T52,,PATCHING,/,0,, , FUNCTIONAL NONE,,T28,
1 ,1 - 5 PERCENT,,T52,,6 - 25 PERCENT,,T75,,OVER 25 PERCENT,,
2 ,T101,,TOTAL,/, , , CLASS,,T28,3(.PCT AREA/PANEL,,10X)/, , ;
3 ,T25,3(.1-5 6-20 OVER20,,.4X)//)
DO 365 FC = 1.5
WRITE (UNIT,636) FC, (MDB(DIST,FC,PAVE,CAT,J),J=1,10),
365 CONTINUE
WRITE (MDB(DIST,FC,PAVE,CAT,14), (PERC(DIST,FC,PAVE,CAT,J),J=1,10)
1 CONTINUE
WRITE (UNIT,637) (MDB(DIST,6,PAVE,CAT,J),J=1,10),
300 CONTINUE
290 CONTINUE
280 CONTINUE
WRITE (UNIT,690) GENER
690 FORMAT (,1,,26X,,STATEWIDE,,.4X,I2,,IX,,DEFECT RATING SUMMARY FOR AS
1PHALT PAVTS, )
WRITE (UNIT,702)
702 FORMAT (/, , ,2X,,DIST 100-91 20-11 10-0 80-71 70-61 60
1-51 **** ***** ***** ***** ***** *****
2, **** ***** ***** ***** ***** ***** *****
3 ***** ***** ***** ***** *****
WRITE (UNIT,603) (AMILES(1,6,J),J=1,10),DAAVG(1,6)
WRITE (UNIT,604) (AMILES(2,6,J),J=1,10),DAAVG(2,6)
WRITE (UNIT,605) (AMILES(3,6,J),J=1,10),DAAVG(3,6)
WRITE (UNIT,606) (AMILES(4,6,J),J=1,10),DAAVG(4,6)
WRITE (UNIT,607) (AMILES(5,6,J),J=1,10),DAAVG(5,6)
WRITE (UNIT,707) (AMILES(6,6,J),J=1,10),DAAVG(6,6)
707 FORMAT (, ,.3X,, 6 ,.2X,10(F7.1,2X),1X,F5.1/)

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WRITE (UNIT,608) (AMILES(7,6,J),J=1,10).DAAVG(7,6)
WRITE (UNIT,709)
FORMAT (/,'',37X,'BUMP COUNT SUMMARY FOR ASPHALT PAVTS*')
WRITE (UNIT,710)
710 FORMAT (/,'',2X,'DIST LT 500 5K-1K 1K-1.5K 1.5K-2K 2K-3K
3K-4K 4K-5K 5K-7.5K 7.5-10K GT 10K AVG',/,',.2X,')
1 * *****
2 * *****
3 * *****
WRITE (UNIT,611) (ACNTMI(1,6,J),J=1,10).DACTAV(1,6)
WRITE (UNIT,612) (ACNTMI(2,6,J),J=1,10).DACTAV(2,6)
WRITE (UNIT,613) (ACNTMI(3,6,J),J=1,10).DACTAV(3,6)
WRITE (UNIT,614) (ACNTMI(4,6,J),J=1,10).DACTAV(4,6)
WRITE (UNIT,615) (ACNTMI(5,6,J),J=1,10).DACTAV(5,6)
WRITE (UNIT,715) (ACNTMI(6,6,J),J=1,10).DACTAV(6,6)
715 FORMAT (/,'',3X,' 6',.2X,10(F7.1,2X),1X,F6.1/)
WRITE (UNIT,616) (ACNTMI(7,6,J),J=1,10).DACTAV(7,6)
717 FORMAT (/,'',34X,'COMBINED RATING SUMMARY FOR ASPHALT PAVTS*')
WRITE (UNIT,702) (ACOMBM(1,6,J),J=1,10).DACAVG(1,6)
WRITE (UNIT,603) (ACOMBM(2,6,J),J=1,10).DACAVG(2,6)
WRITE (UNIT,604) (ACOMBM(3,6,J),J=1,10).DACAVG(3,6)
WRITE (UNIT,605) (ACOMBM(4,6,J),J=1,10).DACAVG(4,6)
WRITE (UNIT,606) (ACOMBM(5,6,J),J=1,10).DACAVG(5,6)
WRITE (UNIT,607) (ACOMBM(6,6,J),J=1,10).DACAVG(6,6)
WRITE (UNIT,707) (ACOMBM(7,6,J),J=1,10).DACAVG(7,6)
WRITE (UNIT,608)
WRITE SUMMARIES OF DISTRIBUTIONS FOR BITUMINOUS PAVEMENTS
WRITE (UNIT,691) GENER
FORMAT (/,'',25X,'STATEWIDE',4X,I2,1X,'DEFECT RATING SUMMARY FOR BITUMINOUS PAVTS*')
WRITE (UNIT,702) (RMILES(1,6,J),J=1,10).DBAVG(1,6)
WRITE (UNIT,603) (RMILES(2,6,J),J=1,10).DBAVG(2,6)
WRITE (UNIT,604) (RMILES(3,6,J),J=1,10).DBAVG(3,6)
WRITE (UNIT,605) (RMILES(4,6,J),J=1,10).DBAVG(4,6)
WRITE (UNIT,606) (RMILES(5,6,J),J=1,10).DBAVG(5,6)
WRITE (UNIT,607) (RMILES(6,6,J),J=1,10).DBAVG(6,6)
WRITE (UNIT,608) (RMILES(7,6,J),J=1,10).DBAVG(7,6)
719 FORMAT (/,'',35X,'BUMP COUNT SUMMARY FOR BITUMINOUS PAVTS*')
WRITE (UNIT,710) (RCNTMI(1,6,J),J=1,10).DBCTAV(1,6)
WRITE (UNIT,611)

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WRITE (UNIT,612) (RCNTMI(2,6,J),J=1,10),DBCTAV(2,6)
WRITE (UNIT,613) (RCNTMI(3,6,J),J=1,10),DBCTAV(3,6)
WRITE (UNIT,614) (RCNTMI(4,6,J),J=1,10),DBCTAV(4,6)
WRITE (UNIT,615) (RCNTMI(5,6,J),J=1,10),DBCTAV(5,6)
WRITE (UNIT,616) (RCNTMI(6,6,J),J=1,10),DBCTAV(6,6)
WRITE (UNIT,720) (RCNTMI(7,6,J),J=1,10),DBCTAV(7,6)
FORMAT (/,'33X','COMBINED RATING SUMMARY FOR BITUMINOUS PAVTS')
WRITE (UNIT,702) (RCOMBM(1,6,J),J=1,10),DBC AVG(1,6)
WRITE (UNIT,603) (RCOMBM(2,6,J),J=1,10),DBC AVG(2,6)
WRITE (UNIT,604) (RCOMBM(3,6,J),J=1,10),DBC AVG(3,6)
WRITE (UNIT,605) (RCOMBM(4,6,J),J=1,10),DBC AVG(4,6)
WRITE (UNIT,606) (RCOMBM(5,6,J),J=1,10),DBC AVG(5,6)
WRITE (UNIT,707) (RCOMBM(6,6,J),J=1,10),DBC AVG(6,6)
WRITE (UNIT,608) (RCOMBM(7,6,J),J=1,10),DBC AVG(7,6)
WRITE SUMMARIES OF DISTRIBUTIONS FOR PCC PAVEMENTS
WRITE (UNIT,692) GENER
FORMAT (/,'29X','STATEWIDE',4X,I2,1X,'DEFECT RATING SUMMARY FOR PCC PAVTS')
WRITE (UNIT,702) (CMILES(1,6,J),J=1,10),DCAVG(1,6)
WRITE (UNIT,603) (CMILES(2,6,J),J=1,10),DCAVG(2,6)
WRITE (UNIT,604) (CMILES(3,6,J),J=1,10),DCAVG(3,6)
WRITE (UNIT,605) (CMILES(4,6,J),J=1,10),DCAVG(4,6)
WRITE (UNIT,606) (CMILES(5,6,J),J=1,10),DCAVG(5,6)
WRITE (UNIT,707) (CMILES(6,6,J),J=1,10),DCAVG(6,6)
WRITE (UNIT,608) (CMILES(7,6,J),J=1,10),DCAVG(7,6)
FORMAT (/,'39X','BUMP COUNT SUMMARY FOR PCC PAVTS')
WRITE (UNIT,710) (CCNTMI(1,6,J),J=1,10),DCCTAV(1,6)
WRITE (UNIT,611) (CCNTMI(2,6,J),J=1,10),DCCTAV(2,6)
WRITE (UNIT,612) (CCNTMI(3,6,J),J=1,10),DCCTAV(3,6)
WRITE (UNIT,613) (CCNTMI(4,6,J),J=1,10),DCCTAV(4,6)
WRITE (UNIT,614) (CCNTMI(5,6,J),J=1,10),DCCTAV(5,6)
WRITE (UNIT,715) (CCNTMI(6,6,J),J=1,10),DCCTAV(6,6)
WRITE (UNIT,616) (CCNTMI(7,6,J),J=1,10),DCCTAV(7,6)
FORMAT (/,'36X','COMBINED RATING SUMMARY FOR PCC PAVTS')
WRITE (UNIT,702) (CCOMBM(1,6,J),J=1,10),DCCAVG(1,6)
WRITE (UNIT,603) (CCOMBM(2,6,J),J=1,10),DCCAVG(2,6)
WRITE (UNIT,604) (CCOMBM(3,6,J),J=1,10),DCCAVG(3,6)
WRITE (UNIT,605) (CCOMBM(4,6,J),J=1,10),DCCAVG(4,6)
WRITE (UNIT,606) (CCOMBM(5,6,J),J=1,10),DCCAVG(5,6)
WRITE (UNIT,607) (CCOMBM(6,6,J),J=1,10),DCCAVG(6,6)
WRITE (UNIT,608) (CCOMBM(7,6,J),J=1,10),DCCAVG(7,6)

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WRITE (UNIT,604) (CCOMBM(2,6,J),J=1,10),DCCAVG(2,6)
WRITE (UNIT,605) (CCOMBM(3,6,J),J=1,10),DCCAVG(3,6)
WRITE (UNIT,606) (CCOMBM(4,6,J),J=1,10),DCCAVG(4,6)
WRITE (UNIT,607) (CCOMBM(5,6,J),J=1,10),DCCAVG(5,6)
WRITE (UNIT,608) (CCOMBM(6,6,J),J=1,10),DCCAVG(6,6)
WRITE (UNIT,608) (CCOMBM(7,6,J),J=1,10),DCCAVG(7,6)
C
C
WRITE SUMMARIES OF DISTRIBUTIONS FOR PCC PAVEMENTS
WRITE (UNIT,693) GENER
693 FORMAT (/,29X,'STATEWIDE',4X,I2,1X,'DEFECT RATING SUMMARY FOR
4P ALL PAVTS')
WRITE (UNIT,702) (MILES(1,6,J),J=1,10),DAVG(1,6)
WRITE (UNIT,603) (MILES(2,6,J),J=1,10),DAVG(2,6)
WRITE (UNIT,604) (MILES(3,6,J),J=1,10),DAVG(3,6)
WRITE (UNIT,605) (MILES(4,6,J),J=1,10),DAVG(4,6)
WRITE (UNIT,606) (MILES(5,6,J),J=1,10),DAVG(5,6)
WRITE (UNIT,607) (MILES(6,6,J),J=1,10),DAVG(6,6)
WRITE (UNIT,608) (MILES(7,6,J),J=1,10),DAVG(7,6)
725 FORMAT (/,39X,'BUMP COUNT SUMMARY FOR ALL PAVTS')
WRITE (UNIT,710) (CNTMI(1,6,J),J=1,10),DCTAV(1,6)
WRITE (UNIT,611) (CNTMI(2,6,J),J=1,10),DCTAV(2,6)
WRITE (UNIT,612) (CNTMI(3,6,J),J=1,10),DCTAV(3,6)
WRITE (UNIT,613) (CNTMI(4,6,J),J=1,10),DCTAV(4,6)
WRITE (UNIT,614) (CNTMI(5,6,J),J=1,10),DCTAV(5,6)
WRITE (UNIT,615) (CNTMI(6,5,J),J=1,10),DCTAV(6,6)
WRITE (UNIT,616) (CNTMI(7,6,J),J=1,10),DCTAV(7,6)
726 FORMAT (/,36X,'COMBINED RATING SUMMARY FOR ALL PAVTS')
WRITE (UNIT,702) (COMBM(1,6,J),J=1,10),DCOAVG(1,6)
WRITE (UNIT,603) (COMBM(2,6,J),J=1,10),DCOAVG(2,6)
WRITE (UNIT,604) (COMBM(3,6,J),J=1,10),DCOAVG(3,6)
WRITE (UNIT,605) (COMBM(4,6,J),J=1,10),DCOAVG(4,6)
WRITE (UNIT,606) (COMBM(5,6,J),J=1,10),DCOAVG(5,6)
WRITE (UNIT,607) (MILES(6,6,J),J=1,10),DCOAVG(6,6)
WRITE (UNIT,608) (COMBM(7,6,J),J=1,10),DCOAVG(7,6)
C
C
DO 390 PAVE = 1,3
DO 400 CAT = 1,8
00101300
00101400
00101500
00101600
00101700
00101800
00101900
00102000
00102100
00102200
00102300
00102400
00102500
00102600
00102700
00102800
00102900
00103000
00103100
00103200
00103300
00103400
00103500
00103600
00103700
00103800
00103900
00104000
00104100
00104200
00104300
00104400
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00104600
00104700
00104800
00104900
00105000
00105100
00105200
00105300
00105400
00105500
00105600

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IF (PAVE .EQ. 3) GO TO 450
IF (CAT .EQ. 2) GO TO 400
IF (PAVE .EQ. 2) GO TO 410
WRITE (UNIT,629) DATE, GENER
GO TO 420
WRITE (UNIT,631) DATE, GENER
410 IF (CAT .EQ. 8) GO TO 441
IF (CAT .EQ. 7) GO TO 439
IF (CAT .EQ. 6) GO TO 437
IF (CAT .EQ. 5) GO TO 435
IF (CAT .EQ. 4) GO TO 433
IF (CAT .EQ. 3) GO TO 431
WRITE (UNIT,732)
732 FORMAT ('0',T44,'RUTTING AND PAVEMENT WEAR',/,'0',
1 , ,T28,'1/4 - 1/2 INCH',T52,
2 , ,T76,'OVER 3/4 INCH',T101,
3 , ,T26.3('THROUGHOUT SECTION',6X)//)
DO 430 DIST = 1,6
WRITE (UNIT,633) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,4)
430 CONTINUE
WRITE (UNIT,634) (MDB(7,6,PAVE,CAT,J),J=1,4)
1 GO TO 400
WRITE (UNIT,735)
735 FORMAT ('0',T41,'CORRUGATIONS, WAVES, SAGS, HUMPS',/,'0',
1 , ,T25,'1/8-2 IN CHANGE/10FT',5X,
2 , ,T24,'OVER 4 IN CHANGE/10FT',T101,
3 , ,T25.3('1-25 26-75 OVER 75',4X)//)
DO 432 DIST = 1,6
WRITE (UNIT,636) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 (MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
432 CONTINUE
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 (MDB(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
GO TO 400
WRITE (UNIT,738)
738 FORMAT ('0',T48,'ALLIGATOR CRACKING',/,'0', DISTRICT NONE,
1 , ,T24,'PERCENT 25-49 PERCENT 50-74 PERCENT',
2 , ,T75-100,'PERCENT',T103,'TOTAL',/,' ,T26,
3 , ,T4,'WHEEL TRACK/STA',4X)/ ,T25.4('H-LINE SPAL PUMP',2X)//)
DO 434 DIST = 1,6
WRITE (UNIT,639) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,13),
1 (MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,13)

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434 CONTINUE
   1 WRITE (UNIT,640) (MDB(7.6,PAVE,CAT,J),J=1,14),
     (PERC(7.6,PAVE,CAT,J),J=1,13)
   2 GO TO 400
435 WRITE (UNIT,741)
741 FORMAT ('0',T47,'RAVELING AND FLUSHING','0',
, DISTRICT NONE,T30,'LOCALIZED',T53,
, WHEEL PATHS,T77,'ENTIRE LANE',T101,
, TOTAL,'',T25,3('SLIGHT MODER. SEVERE',4X)//)
   3 DO 436 DIST = 1.6
   1 WRITE (UNIT,636) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,10),
     MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
436 CONTINUE
   1 WRITE (UNIT,637) (MDB(7.6,PAVE,CAT,J),J=1,10),
     MDB(7.6,PAVE,CAT,14), (PERC(7.6,PAVE,CAT,J),J=1,10)
   2 GO TO 400
437 WRITE (UNIT,742)
742 FORMAT ('0',T46,'LONGITUDINAL CRACKING','0',
, DISTRICT NONE,T26,'LESS THAN 1/4 INCH',T52,
, OVER 1/4 INCH,T78,'SPALLED',T101,
, TOTAL,'',T27,3('LINEAL FT/STATION',7X)//,
, T25,3('1-99',100-199,200+.4X)//)
   3 DO 438 DIST = 1.6
   1 WRITE (UNIT,636) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,10),
     MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
438 CONTINUE
   1 WRITE (UNIT,637) (MDB(7.6,PAVE,CAT,J),J=1,10),
     MDB(7.6,PAVE,CAT,14), (PERC(7.6,PAVE,CAT,J),J=1,10)
   2 GO TO 400
439 WRITE (UNIT,743)
743 FORMAT ('0',T47,'TRANSVERSE CRACKING','0',
, DISTRICT NONE,T29,3('NO./STATION',13X),T101,
, TOTAL,'',T25,3('1-4',5-9,10+.5X)//)
   3 DO 440 DIST = 1.6
   1 WRITE (UNIT,636) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,10),
     MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
440 CONTINUE
   1 WRITE (UNIT,637) (MDB(7.6,PAVE,CAT,J),J=1,10),
     MDB(7.6,PAVE,CAT,14), (PERC(7.6,PAVE,CAT,J),J=1,10)
   2 GO TO 400
441 WRITE (UNIT,744)
744 FORMAT ('0',T52,'PATCHING','0',
, DISTRICT NONE,T26,'0.10-0.50 IN THICK',5X,
, T25,3('0.50 - 1.0 IN THICK
, '0.10-0.50 IN THICK',T101,
, 'OVER 1.0 IN THICK',T101,

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00110100
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3      'TOTAL',/,T27,3('PCT AREA/STATION',8X)/, ' ,
4      T25,3(1-5,6-25,OVER25,.4X)//)
DO 442 DIST = 1,6
WRITE (UNIT,636) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,10),
442 1 CONTINUE
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 WRITE MDB(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
GO TO 400
450 WRITE (UNIT,646) DATE, GENER
IF (CAT .EQ. 8) GO TO 464
IF (CAT .EQ. 7) GO TO 462
IF (CAT .EQ. 6) GO TO 460
IF (CAT .EQ. 5) GO TO 458
IF (CAT .EQ. 4) GO TO 456
IF (CAT .EQ. 3) GO TO 454
IF (CAT .EQ. 2) GO TO 452
WRITE (UNIT,632)
DO 451 DIST = 1,6
WRITE (UNIT,633) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,4),
451 CONTINUE
WRITE MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,4)
1 GO TO 400
452 WRITE (UNIT,634) (MDB(7,6,PAVE,CAT,J),J=1,4),
747 1 CONTINUE
WRITE (UNIT,747)
2 1-3 PER MILE ,T101, 'BLOWUPS',/,'0',
3 2-3 PER MILE ,T175, 'OVER 3 PER MILE',T101,
'TOTAL',//)
DO 453 DIST = 1,6
WRITE (UNIT,633) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,4),
453 CONTINUE
WRITE (UNIT,634) (MDB(7,6,PAVE,CAT,J),J=1,4),
1 GO TO 400
454 WRITE (UNIT,748)
748 1 CONTINUE
WRITE (UNIT,748)
2 1-3 PER MILE ,T101, 'CRACKING',/,'0',
3 2-3 PER MILE ,T175, 'OVER 3 PER MILE',T101,
4 2-3 PER MILE ,T175, 'OVER 3 PER MILE',T101,
'TOTAL',//)
DO 455 DIST = 1,6

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WRITE (UNIT,636) DIST, (MDR(DIST,6,PAVE,CAT,J),J=1,10),
1 CONTINUE
455 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 MDR(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
GO TO 400
456 WRITE (UNIT,749)
749 FORMAT ('0',I34,'RAVELING, DISINTEGRATION, POP OUT, SCALING','0',
1 '26 - 75 PERCENT, NONE, T28, I - 25 PERCENT, T51,
2 'TOTAL', 'T75, OVER 75 PERCENT, T101,
3 'T25, 3(SLIGHT MODER. SEVERE, 4X)')
DO 457 DIST = 1,6
WRITE (UNIT,636) DIST, (MDR(DIST,6,PAVE,CAT,J),J=1,10),
1 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
457 CONTINUE
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 MDR(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
GO TO 400
458 WRITE (UNIT,750)
750 FORMAT ('0',I50,'JOINT SPALLING','0',
1 '16 - 50 PERCENT, NONE, T28, I - 15 PERCENT, T51,
2 'TOTAL', 'T75, OVER 50 PERCENT, T101,
3 'T25, 3(WIDTH IN INCHES, 9X)')
4 DO 459 DIST = 1,6
WRITE (UNIT,636) DIST, (MDR(DIST,6,PAVE,CAT,J),J=1,10),
1 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
459 CONTINUE
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 MDR(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
GO TO 400
460 WRITE (UNIT,751)
751 FORMAT ('0',I49,'PUMPING, BLOWING','0',
1 '16 - 35 PERCENT, NONE, T28, I - 15 PERCENT, T51,
2 'TOTAL', 'T75, OVER 35 PERCENT, T101,
3 'T25, 3(PCT PANEL LENGTH, 8X)')
4 DO 461 DIST = 1,6
WRITE (UNIT,636) DIST, (MDR(DIST,6,PAVE,CAT,J),J=1,10),
1 MDR(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
461 CONTINUE
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 MDR(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
GO TO 400

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00122300
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00122500
00122600
00122700
00122800
00122900
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00123200

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462 WRITE (UNIT,752)
752 FORMAT ('0',I37,'FAULTING, CURLING, WARPING, SETTLEMENT','0',
1 'DISTRICT NONE',T28,'1 - 15 PERCENT',T51,
2 '16 - 35 PERCENT',T75,'OVER 75 PERCENT',T101,'TOTAL',' ',
3 'T32.3(INCHES',I8X) // ',T25,
4 '3(1/8-1/4 1/4-1/2 1/2+',3X) //)
DO 463 DIST = 1,6
WRITE (UNIT,636) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
463 CONTINUE
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 MDB(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
GO TO 400
464 WRITE (UNIT,753)
753 FORMAT ('0',I52,'PATCHING','0', 'DISTRICT NONE',T28,
1 '1 - 5 PERCENT',T52,'6 - 25 PERCENT',T75,'OVER 25 PERCENT',
2 'T101,'TOTAL',T128,3('PCT AREA/PANEL',I0X) // ',
3 'T25,3(1-5 6-20 OVER20,.4X) //)
DO 465 DIST = 1,6
WRITE (UNIT,636) DIST, (MDB(DIST,6,PAVE,CAT,J),J=1,10),
1 MDB(DIST,6,PAVE,CAT,14), (PERC(DIST,6,PAVE,CAT,J),J=1,10)
465 CONTINUE
WRITE (UNIT,637) (MDB(7,6,PAVE,CAT,J),J=1,10),
1 MDB(7,6,PAVE,CAT,14), (PERC(7,6,PAVE,CAT,J),J=1,10)
400 CONTINUE
390 CONTINUE
STOP
END
001233300
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