Pavement Management System: Demonstration for Washington Counties

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16. Abstract

The pavement management system developed be the State of Washington was modified to meet the needs of the counties in the State of Washington within the constraints of available data and resources. The modified system, called the Washington County Pavement Management System (WCPMS), was tested for Thurston and Benton counties. Results of this testing show that; (1) The WCPMS can be operated using the existing data in the county road log in combination with collected pavement condition survey data; (2) computer resources are available to most counties to access the State computer to execute the various programs in the WCPMS; and (3) routine usage of the WCPMS for a network of 1000 miles will require a level of effort of about 150 person-days and a computer cost of $1,000.

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Final Report

Pavement Management System: Demonstration for Washington Counties

Prepared for

Thurston County, Washington

by

Ram B. Kulkarni and Fred N. Finn

January 1986

Woodward-Clyde Consultants
One Walnut Creek Center
100 Pringle Avenue
Walnut Creek, CA 94596

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1.0
EXECUTIVE SUMMARY

The pavement management system developed by the State of Washington was modified to meet the needs of the counties in the State of Washington within the constraints of available data and resources. The modified system, called the Washington County Pavement Management System (WCPMS), was tested for Thurston and Benton counties. Results of testing show that the WCPMS can be operated with the existing data in the county road log and additional data to be collected in pavement condition surveys and that computer resources are available to most counties to access the State computer system to execute the various programs in the WCPMS.

A routine usage of the WCPMS for a network of about 1000 miles will require a level of effort of about 150 person-days and a computer cost of $1000.

Significant benefits -- both monetary and non-monetary -- would be expected from the implementation and routine use of the system. The systematic use of the WCPMS should enable a county to maintain past pavement performance standards with a lower budget, or to improve the performance standards with the existing budget levels. Non-monetary benefits include: the availability of objective, reliable, and current data base of information; improved response to legislative or public requests regarding roadway improvement plans; and a common basis for evaluating pavement maintenance needs across different counties in the State of Washington.

2.0
POTENTIAL BENEFITS FROM USING THE PMS

As is noted in Section 3, a commitment of staff and computer resources must be made in order to use the Washington County Pavement Management System on a routine basis. To justify the commitment of these resources, specific benefits of using the system must be identified. It will be difficult to estimate monetary benefits before the system has been in use for several years. After the system has been used for several years to develop maintenance programs, a comparison can be made between the maintenance dollars spent to achieve certain performance standards prior to and after implementing the system. The experience of several agencies that have used the system over a period of three to five years has been that the system was responsible for producing significant cost savings. Such savings were reflected in one of two ways. Either the same performance standards were maintained with a lower budget, or better performance standards were maintained with the same budget.

In addition to the potential monetary benefits, several significant non-monetary benefits should accrue from the routine PMS usage. These include the following:

- An objective, reliable, and current data base of information is provided to support management decisions concerning pavement maintenance and rehabilitation.

- The most cost-effective treatment can be determined for each project based on the consideration of life cycle costs.

- The impact of alternative funding levels on the performance of the system can be demonstrated.

- A schedule for timely and economical pavement maintenance and rehabilitation is developed in an attempt to protect the substantial capital investment in the road network.

- Improved response to special legislative, political, or public requests regarding plans for the improvement of certain roads is possible.

If the WCPMS is used by most of the counties in the State of Washington to estimate budget requirements and to develop pavement rehabilitation programs, several additional benefits could accrue. These benefits include the following:

- Uniform procedures would be developed for all participating counties to evaluate and summarize pavement conditions.

- A common basis would be provided for evaluating pavement rehabilitation needs across different counties.

- An objective procedure would be developed to allocate maintenance funds among the various counties based on the evaluation of needs and life cycle costs.

- Common resources among the counties could be utilized more effectively. The activities which could be shared by all the counties include: a common training program for pavement condition survey personnel and the appointment of a state-wide county coordinator to assist all the counties in PMS implementation with the best utilization of the State's computer system.

3.0
RESOURCE REQUIREMENTS

The Washington County Pavement Management System (WCPMS) is now ready for implementation and routine operation by any county in the State of Washington. To use the State's mainframe, an access code will have to be obtained from the Washington State Department of Transportation, State Aid Office. The activities necessary to fully utilize the WCPMS and the resource requirements in terms of personnel and computer costs are described in this section.

Table 1 lists the level of effort in person-days that would be required to complete each of the eight steps described in Section 5. Wherever appropriate, computer costs are also estimated based on the assumption that the Washington State Department of Transportation mainframe computer system will be used to execute all the computer programs in the WCPMS. At the present time, the computer programs are being converted to run on an IBM personal computer (PC). Once this effort is completed, a county will be able to install and execute the system on a PC such as IBM-XT.

The estimates of level of effort and computer costs in Table 1 are based on the experience of the Thurston County staff in operating the system. For purposes of this table, a county network of 1,000 miles is assumed. All of the routine operation activities are assumed to be carried out by county staff with the assistance of a County Coordinator in Olympia to coordinate computer operations on the State computer system. A unit cost of $250/person-day is assumed in converting person-days into labor costs. It should be noted that all the steps involved in the execution of the WCPMS will be completed once every two years. Thus, the estimated costs would be incurred on a biennial basis.

The key assumptions made in estimating the resource requirements for each step are described below.

1. Conduct a Pavement Condition Survey

A productivity of 25 miles/crew-day (with a crew of two persons) is assumed. This is a conservative estimate, and the actual productivity after some experience may be in the range of 40 to 50 miles/crew-day. The use of college students to conduct condition surveys has proved to be quite effective and economical. A comprehensive training program will be essential to achieve consistency and reliablity in the subjective pavement ratings. The cost of training is included in the cost of Step 1 shown in Table 1.

2. Create a Pavement Defects Data File

This step will involve keypunching the data recorded on pavement rating forms and then executing the program REFORM to create a reformatted data set. Alternatively, the user could directly produce the reformatted data set using a data base management software on a PC and then transfer the data set to the State's main frame computer. With either option, about 15 person-days of effort would be necessary. The computer cost shown in Table 1 is for the option of using the State computer. This cost would be eliminated if a local PC is used. Once the defects data set is created, it should be checked for any inaccuracies or inconsistencies. If any such problems are found, they should be corrected. To get RATGEN out at this step without going to the next step would involve minimal additional cost.

3. Create a Project Data File

This file is created by executing the program MASTINDX. After creating this file for the first time, it may require revisions if new road segments are added or an existing segment is divided into two separate projects because of different performance. The Master Index file generated from this step should be reviewed to make sure that the project data are correctly transferred.

4. Create Master File

This step is completed by first running the program BUILDGEN to combine the Master Index file and the Pavement Defects Data file for a given generation year and then running the program SORTGEN to combine files from all generation years. A listing of the Master File obtained from this step should be checked for any possible errors.

5. Execute Interpreting Program

To complete this step, a direct data file containing interpreting parameters is first created (or reviewed, if such a file already exists) and then the program INTERP is executed. As is discussed in Section 5, the performance curves produced in the INTERP output should be carefully reviewed to make sure that the projections of future performance are reasonable and meet prior expectations based on engineering judgments.

6. Obtain Various Outputs from Phase I Programs

The various outputs that could be obtained from Phase I are described in Section 5. The output reports will be generated by executing the necessary programs on the State's mainframe computer. These reports can then be transferred to the county's computer system (a PC, for example) and printed at the county office. Alternatively, hard copies of the reports can be generated on the State computer system and mailed to the county.

7. Execute Optimizing Program

To complete this step, a direct data file containing optimizing parameters is first created. If such a file already exists from a previous run, it should be reviewed to decide if any revisions would be necessary. The computer program OPTAL is then executed to determine the optimal maintenance strategy for each project.

8. Execute the Network-Level Program

To complete this step, a direct data file containing network parameters is first created (or reviewed, if such a file already exists)

and the program NETWORK is then executed to develop a six-year maintenance program for the county-wide road network. The program NETWORK probably will be executed several times in order to evaluate the effect of different budget and condition constraints. Based on the analysis of the various output reports from the program NETWORK, a six-year maintenance program should be prepared that best meets the performance objectives of the county administrators within a realistic budgetary constraint.

Table 1. RESOURCE ESTIMATES FOR THE ROUTINE OPERATION OF THE WCPMS FOR A NETWORK OF 1,000 MILES

Step	Level of Effort (Person-Days)	Labor Cost $250 x Number of Person-Days ($)	Computer Cost ($)
1. Conduct a Pavement Condition Survey	80	20,000	--
2. Create a Pavement Defects Data file	15	3,750	200
3. Create a Project Data file	6	1,500	100
4. Create a Master File	3	750	200
5. Execute Interpreting Program (and manually edit output from the interpreting program)	12	3,000	200
6. Obtain various outputs from Phase I programs	2	500	100
7. Execute optimizing program	3	750	100
8. Execute the network-level program (and prepare six-year maintenance program)	22	5,500	200
TOTAL	143	$37,750	$1,100

4.0
BACKGROUND AND TECHNICAL APPROACH

4.1 BACKGROUND AND STUDY OBJECTIVES

A feasibility study conducted for Thurston County had concluded that it would be feasible and desirable to adopt and operate the Washington State Pavement Management System (WSPMS) for the needs of the counties in the State of Washington (1). The objectives of the study (described in this report) were to:

- Modify the computer programs in the WSPMS to fit the needs and available resources of the Washington counties.
- Demonstrate the operations of the modified pavement management system.
- Provide a step-by-step procedure for implementing the modified system by any county in the state of Washington.
- Identify resource requirements for system implementation and operation.

4.2 RESEARCH APPROACH

The feasibility study had identified the specific modifications that should be made to the WSPMS in order to make it suitable for a county road network. These modifications were made, and the modified system was tested with two counties -- Thurston and Benton. Only one year of

pavement condition survey data were available in these counties. In order to fully test the capabilities of the three major computer programs in the system (INTERP, OPT, and NETWORK), synthesized data were prepared for a selected number of projects (16 for Benton and 18 for Thurston). These data covered four to seven generations of pavement condition surveys. The input requirements and output description of each step in the execution of the county system were demonstrated to the personnel in the two counties. Using this experience, a stepwise procedure was developed for the implementation of the system by any county in the state of Washington. It was assumed that the computer programs for the county PMS would reside on the Washington State's mainframe computer and that a county would transfer the necessary data files to this computer and execute the various computer programs via a remote terminal or a personal computer (PC). At some future time, the various computer programs will be modified to fit on a PC. The counties then should be able to install the entire system on a PC available to them and would not need access to the State computer system.

5.0 USER MANUAL FOR THE IMPLEMENTATION OF THE WASHINGTON COUNTIES PAVEMENT MANAGEMENT SYSTEM

The Washington Counties Pavement Management System (WCPMS) can be implemented in three successive phases, with each phase providing output that can be used in its own right and can also serve as input to the next phase. A major advantage of a phased approach is that the user agency can begin to derive benefits from the system immediately and build on each of the completed phases to obtain more advanced capabilities. The three phases for the implementation of the WCPMS are:

Phase I - Obtain priority listing of all projects* in the network.

Phase II - Determine optimal rehabilitation strategy for each project.

Phase III - Develop network-level multi-year rehabilitation program.

Each phase will involve a series of distinct and well-defined steps which are described below. Instructions for completing each step are provided and the completion of each step is illustrated by an example drawn from the demonstration of the system for Thurston County.

Since the WCPMS computer programs will reside on the State's main-frame computer at the present time, it will be necessary for a county that plans to use the WCPMS to access the State computer via a remote terminal or a personal computer (PC). The State computer will

*See Step 4 (page 5-4) for the definition of a project.

have to be accessed for: (a) transferring data files from the county PC to the State computer, (b) transmitting instructions to execute the necessary computer programs, and (c) retrieving data files including program output on the county PC. Table 2 summarizes the instructions to access the State's main-frame computer from the county's terminal to accomplish these three functions.

5.1 PHASE I - OBTAIN PRIORITY LISTING OF ALL PROJECTS IN THE NETWORK

The primary objective of this phase is to prioritize all projects in the county-wide network based on pavement defect ratings sorted by functional class. The major steps involved in this phase are described below.

Step 1: Conduct a Pavement Condition Survey

It will be necessary to conduct a pavement condition survey of the entire network at least once every two years. The surveys should be scheduled for the same time of year and should be completed in no more than three months. The preferred time to do the survey would be in early spring before heavy maintenance programs are initiated.

In order to assure uniformity in the condition data from year to year or between agencies, a condition survey manual will be required. The manual prepared for Thurston County (Trowbridge, 1983) can be used for this purpose. This manual describes the procedures to be used by field personnel in identifying and recording observed conditions of the pavement. Figures 1 and 2 show the forms that should be used for recording surface defects for bituminous and Portland cement concrete pavements, respectively.

It is recommended that two-person teams be used for the condition surveys. A range of choices are available in selecting personnel for pavement condition surveys. Experience indicates that some maintenance

people do well as surveyors since they are usually familiar with the road network and also with distinguishing characteristics of various types of distress. Part-time employees (e.g., college students) have also been used for condition surveys. In either case, a thorough training program is essential in preparing personnel for a condition survey. A centralized training program for all county surveyors should be considered to reduce costs per county and promote uniformity of procedures.

Figure 3 shows an example of a completed Pavement Condition Rating form for Thurston County (note the use of road name).

Step 2: Create a Pavement Defects Data File

In this step, the data recorded on the Pavement Condition Rating forms are transferred to the computer to create a Pavement Defects Data File. This can be done in one of two ways:

(i) The data on the Pavement Condition Rating forms can be keypunched and, using an IBM utility program on the State computer, read to create the required data file, or

(ii) Using a PC available to the county, the county personnel could directly create the Pavement Defects Data File in the format shown in Figure 4-a and then transfer this data file to the State's main-frame computer either via telephone lines or by sending a tape to a coordinator who would put the tape on the State system.

Thurston County has developed a program utilizing KeepIT Software for uploading and downloading rating data to and from the State's mainframe. For those jurisdictions with KeepIT software, this program is available from Thurston County. Once the Pavement Defects Data file has been transmitted to the State's mainframe, the file structure is rearranged in the format shown in Figures 4-b and 4-c.

Step 3: Obtain Reports from RATGEN

The program RATGEN can be used at this stage to obtain a consecutive listing of raw condition ratings with their translated scores for all rated segments within a project. This will provide an early output from the WCPMS without having to go to any of the subsequent steps. The RATGEN report can be downloaded to a PC for data manipulation. Figure 5 shows the file format for RATGEN output as it is downloaded to a PC.

Step 4: Create a Project Data File

The Project Data File contains the project limits (beginning and ending mileposts) for the most recent consecutive surfacing contracts throughout the entire county road network. Each project is selected so as to represent a homogeneous roadway section. The information to be recorded for each project is shown in Figure 6.

All the data items in Figure 6, with the exception of "year of last construction", "last construction thickness",* and "traffic index", are contained in the County Road Log. The three data items that are not in the County Road Log will either have to be estimated or based on other records. For traffic index, the following values were suggested in the feasibility study report:

Principal arterial: 7.0 and above

Minor arterial: 6.5

Major collector: 6.0

Minor collector: 5.0

Local access: 4.0 or less.

A computer program has been written to create the Project Data file from the County Road Log. The data file is created by selecting all

*Thickness of the last major maintenance activity (e.g., 2" overlay)

paved roads within a given county's jurisdiction. The required data for each road segment are copied to a new data set. For the three data items that are currently not in the County Road Log (namely, year of last construction, last construction thickness, and traffic index), the Road Log file has been adapted to store these data items in the following unused fields:

Unused Field	Data Item Stored For WCPMS
Pavement Rating	Year of Last Construction
Median Width Field	Last Construction Thickness
Equivalent Accidents Per Mile	Traffic Index

The following steps should be followed to create the Project Data File for a given county after accessing the WSDOT computer system:

(i) Type "EX 'HWY.MVS.CLSTLIB(CLSTLAPS)'", and hit the "ENTER" key.

(ii) Type "Y" to continue, "N" to abort.

(iii) Type "Y" to run overnight, "N" to run at daytime rates.

(iv) Enter the two-digit county number.

(v) Type in account number and hit the "ENTER" key.

(vi) Type "Y" to complete submittal, "N" to break off.

(vii) JOB # and JOBNAME will appear on the screen.

(viii) Output will be placed in computer bin.

The resulting data file will be named "UID.PMSXX.DATA" where "UID" is the Logon User Identification used when logged on the WSDOT mainframe

computer and "XX" is the two-digit number of the county selected. The county may edit the file, if necessary, before transmitting it to the State's main-frame computer.

Figure 7 shows an example of the Project Data File created for Thurston County. This listing is referred to as the Master Index Listing.

Step 5: Create Master File.

The Master File contains the Project Data File and the Pavement Defects Data File. For each project, the data from the Project Data File are first printed on one line. This is followed by pavement defects data for each of the rating segments within the project limits by the generation year of a pavement condition survey (see Figure 12).

Two options are available to a county to create the Master File:

(i) Execute the computer program BUILDGEN on the State's main-frame computer. This program will need the Pavement Defects Data File and the Project Data File. These two files will be merged by the program to produce the Master File. A listing of this file can then be obtained. Note that the program BUILDGEN should be run for each generation year of a Pavement Condition Survey.

(ii) Using a data base management software available on the PC, the county personnel can directly merge the Pavement Defects Data File and the Project Data File to create the Master File. The format for this file should be as shown in Figure 8. Note that all of the fields in Figure 8 starting from Column 75 should be repeated for each generation year of a pavement condition survey. The Master File can then be transmitted to the State's main-frame.

A listing of the Master File is best obtained after the next step and is described in Step 7.

Step 6: Execute Interpreting Program

The interpreting program, INTERP, 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 next rehabilitation.

Two data files are required to run INTERP: Master File and Interpreting Parameters. The Master File will have been created in Step 5. The data file containing interpreting parameters should be created directly by the user agency on the PC and transferred to the State's main-frame computer. Included in these parameters are the weighting values assigned to different severity and extent levels of each distress category in each pavement type, the present year, the number of exponents to be used in applying transformations to the independent variable in regression analysis, the minimum R^2 (square of the correlation coefficient) acceptable, an identification number to be used when making several runs on the same data (each with different weighting values), an array of exponents to be used for the transformation, and arrays of default performance equation parameters. A data file with the required interpreting parameters has been created for Thurston County and is shown in Figure 9. It is recommended that, at least initially, the same file be used by all counties in the State of Washington. As each county gains some experience with the WCPMS operation, the weighting values shown in Figure 9 could be modified if necessary. Note that the present year included in Figure 9 should be changed to correspond to the year at which the program is being executed. The field containing the present year is highlighted in Figure 9.

The execution of the program INTERP will produce a printout containing plots of performance curves. An example of this printout for one project is shown in Figure 10. The top line of the printout describes the project with the same format as that used in the Master

File listing. Below the description is a tabulation of performance history and details of the performance equation that is fitted to the data points. Note that the tabulation contains the average rating for the project as well as high and low ratings for the segments in the project. The form of the equation is

$$R = C - m\,A^{B}$$

where R is the pavement rating at age A; C is the model constant (called EQUA CONST in the printout) for the maximum rating which approximates 100; m is the slope coefficient (called EQUA COEFF in the printout); and B is the degree of curvature exponent (called EQUA POWER in the printout). Also printed are: R^2, standard error, equation type (explained below), and presence or absence of edge patching.

Three equation types are considered in the program:

1. <u>When the project being considered does not have at least three ratings,</u> a typical equation for the specific pavement type and surfacing depth is assigned. 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. The parameters of the typical equations for different pavement types and surfacing depths are included in the data file containing the interpreting parameters.

2. <u>Regression analysis is applied to all projects that have at least three ratings.</u> This is the primary method of developing performance equations.

3. <u>When regression analysis does not produce a reasonably good fit</u> (R^2 value is less than acceptable), a typical curve is fitted through the first and last values.

The lower half of the printout contains a plot of the performance curve. An examination of this plot provides an understanding of how well the curve fits the ratings, when pavement rehabilitation may be required, and how much variation there is in the ratings (by noting the high and low values for each year).

The final report on the Washington State PMS (2) contains useful guidelines for reviewing the performance curves produced by the INTERP output. These guidelines are repeated below.

In order to be assured that the performance curves and equations for each section are reasonable and represent the best forecast of future pavement condition, each performance curve should be thoroughly reviewed. The performance of most sections should conform to the algorithm utilized in the interpreting program. Pavement sections with rating histories that do not fall in line with this algorithm should be individually analyzed and provided with typical performance curves which are intended only to forecast future ratings and may not fit past ratings at all. Sections that fall into this category are not considered good prospects for the optimizing analysis (described later). Instead, they should be subjected to an engineering analysis to determine a suitable repair action.

Several aspects of the performance curves are considered in the review process. These include:

- the shape and length of curve for the type of pavement it represents,
- the variance in high and low ratings indicated for each year,
- the performance curves for adjacent sections, and
- cycling of pavement ratings that may indicate unrecorded rehabilitation or maintenance

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. This may occur when there is undocumented maintenance or a rehabilitation project has been overlooked and subsequently was not coded. Such a situation may also cause a high degree of variance between the high and low ratings for each year and, again, the solution may be to divide the project into two or more projects.

After the first review, the Master File should be edited to reflect changes in mileposting for specific sections and then reanalyzed with the interpreting program. This process should be reiterated until satisfaction is obtained that all performance sections and the curves representing them are as good as they can be. Ultimately, performance curves for the entire county road network are stored in the Interpreted Data File. It is important to note that although the Master File may be originally based on past surfacing contract limits, these limits may eventually be adjusted to represent the best divisions of pavement performance. However, such changes may be required only on a very small percentage of the network.

In addition to producing plots of performance curves, the program INTERP generates a data file that includes the results of all processing. This file is used as input to the next program in the system, namely, the optimizing program.

Step 7: Obtain Various Outputs from Phase I Programs.

The following outputs can be obtained from Phase I programs:

(i) Use program LINDEX to obtain Master Index Listing, which is a listing obtained from the Project Data File. One page of this listing for the Thurston County road network is shown in Figure 11.

(ii) Use program LISTMSTR to obtain a listing of the Master File that lists the raw distress values and defect ratings for all of the rating segments within the limits of a given project. One page of this listing is shown in Figure 12.

(iii) Use program LISTRATE to obtain a prioritized list of all projects in the order of lowest to highest rating within each functional class. Figure 13 shows an example of such a prioritized list for a selected number of projects in Thurston County.

(iv) Use program RATGRP to obtain summaries of the distribution of pavement ratings for a given generation year. The output of this program consists of the following parts (see Step 3):

a. Defect Rating Summary - This lists the number of miles of pavements within each pavement type and in different ranges of defect rating (0-10, 11-20, ---, 91-100) by functional class (see Figure 14-a for an example of this output for asphalt pavements in Thurston County).

b. Pavement Condition Deficiency Summary - This lists the number of miles in different combinations of severity and extent of a given pavement defect. The miles are sorted by functional class. One summary is produced for each defect within every pavement type. Figure 14-b shows an example of this summary for alligator cracking on asphalt concrete pavements.

c. Exemptions Report - This contains the number of miles in each functional class which are not surveyed for one of the following reasons: unpaved road, under construction, bridge, impassable, or other. Figure 14-C shows an example of this report for asphalt concrete pavements.

(v) Use program RATGEN to obtain a consecutive listing of raw condition ratings with their translated scores for all rated segments within a project. Figure 15 shows an example of this report. This listing can be output in priority of condition rating or road number sequence.

5.2 PHASE II - DETERMINE OPTIMAL REHABILITATION STRATEGY FOR EACH PROJECT

Phase I provides the basic information regarding pavement surface defects of each project in the county-wide network of roads. This information is used to obtain a prioritized list of all projects sorted by functional class.

Phase II provides the additional capability of evaluating alternative rehabilitation strategy for a given project based on life cycle cost comparisons. Since each of Phase II and III builds on the previous phases, the steps are numbered consecutively starting from Phase I.

Step 8: Execute Optimizing Program.

The optimizing Program OPTAL 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.

Input Requirements of OPTAL

The input required for this program comes from two sources:

- The Master File created previously in Step 5.

- A direct access data set that contains optimizing parameters.

The format of the Master file was described previously. It combines the Project Data File and the Pavement Defects Data File for each generation year of a pavement condition survey.

The various optimizing parameters required and the input formats for these are described in Table 3. Figure 16 shows a listing of the optimizing parameters used in Thurston County. It is recommended that initially the same parameters, except for the two noted below, be used by any Washington county. The two exceptions are:

- CONSTC (I) - Construction cost in $ per 12 ft-lane of i^{th} rehabilitation alternative

- AEQ (I) - Equation factor for i^{th} rehabilitation alternative

The construction cost specific to the user agency should be input. The equation factor is defined as:

$$\text{Equation Factor} = \frac{\text{Typical life of altern. for pavement type A}}{\text{Typical life of pavement type A}}$$

Assume, for example, that a bituminous surface treatment (BST) has a typical service life of 10 years. When overlaid with 0.15 feet of asphalt concrete (AC), the pavement, under normal conditions, will last an additional 15 years. The equation factor for the 0.15-foot AC overlay on the existing bituminous surface treatment would be:

$$\text{Equation Factor} = \frac{\text{15 years (for 0.15 ft. AC overlay)}}{\text{10 years (for BST pavement)}} = 1.5.$$

The user agency should specify equation factors that reflect the agency's past experience with the serviceability lives of alternative rehabilitation treatments.

After some experience with the WCPMS programs, a Washington county may revise other optimizing parameters, if appropriate. Guidelines for estimating various optimizing parameters is given in the feasibility study report (pages 55-62 in Reference 1).

Description of OPTAL Output

Figure 17 shows an example of OPTAL output for one project in Thurston County. The output consists of five major parts which are described below.

(i) Project description and performance - This part is identical to the upper half of the output listing generated by the interpreting program (see Figure 10). It identifies the project, gives its performance history, and gives the parameters of the mathematical equation fitted to the past ratings.

(ii) Optimizing parameters - The two top statements list the should and must levels and identify the specific year when these rating levels will be reached on the existing pavement. The next

statement defines the consideration span in terms of period and defines the length of each period. The last line of information in this part indicates the effective interest rate applied in discounting and the equation factors used for the rehabilitation alternatives.

(iii) Rehabilitation alternatives - Each rehabilitation alternative is described, and its performance equation is provided. To the right of the performance equation is the unit construction cost of each rehabilitation alternative. The final columns of data in this part 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 and must levels, respectively, from time of construction.

(iv) Cost summary - This is a summary of costs accumulated in the consideration span for each category of cost for each of the strategies shown.

(v) Summary of strategies - The strategies are summarized 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 are 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 the strategy description indicates the total number of strategies analyzed (possible) and how many strategies were included in each group.

An example of how this block of information would be read is as follows (Figure 17):

- There were 26 rehabilitation strategies analyzed for this specific project.

- Sixteen of these strategies began with an alternative 2 (BST) applied in 1986.

- The least costly strategy in the first group was followed by an alternative 2 in 1994 and again in 2003.

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

5.3 PHASE III - DEVELOP NETWORK-LEVEL MULTI-YEAR REHABILITATION PROGRAM

The function of this last program in WCPMS 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, costs, 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 can be demonstrated for what can be obtained with different budget levels, and most of the "what if" questions faced by administrators are answered.

The basic step involved in Phase III is running the network-level Program NETWORK. This step is described below.

Step 9: Execute the Network-Level Program. (See also Page A-11)

The inputs required for the program NETWORK are as follows:

- Interpreted Data File produced by the program INTERP (Step 6).
- Output of the program OPTAL for each project in the network (Step 8).
- A direct access data set that contains network parameters.
- Job Control Language (JCL) and program modules for applying constraints.

The following network parameters are required:

YEAR - present year

INFL - rate of inflation

EI - effective interest rate (discount rate - rate of inflation)

ENGCOST - engineering cost (as a percentage of construction cost) to cover design and administration costs

SHUD(5) - "should" levels for the five functional classes

MUST(5) - "must" levels for the five functional classes

Figure 18 shows the data set of network parameters used in Thurston County. This data set may be revised by each county to fit its conditions.

The program NETWORK can be run with budget or condition constraints. This will require specific Job Control Language and additional program modules. These have been set up for Thurston County and can be used by any other county with appropriate changes in the available budget or

desired average condition rating for the county-wide network. Instructions for making desired changes are provided in Appendix A.

Description of NETWORK Output

The program NETWORK generates three summaries for each year of a proposed program:

- Action Summary
- Cost Summary
- Rating Distribution Summary

Figure 19 shows an example of the Action Summary generated for one of the years. Since different "should" and "must" levels can be applied for different functional classes, 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 the year specified by functional class, project number, road name, road number, inclusive milepost limits, project length, and rating before the action, with a description of the proposed action and the associated cost -- both in present dollars and dollars inflated to the respective year.

Figure 20 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.

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 21. 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, 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 the "effect of delay", i.e., how much the project condition rating will be changed if the action is delayed.

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:

(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.

The application of these constraints is discussed below.

Budget Constraint

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 the priority order based on the effect of delay. 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. Figures 22-a, -b and -c show the output of NETWORK under a budget constraint.

Condition-Level Constraint

The approach for applying the condition-level constraint is very similar to the budget constraint. The factor 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.

Table 2. INSTRUCTIONS FOR ACCESSING WSDOT MAINFRAME COMPUTER

One will need an IBM-compatible micro, a Logon Identification code, an account name, and WSDOT manual "Remote Access to WSDOT Mainframe Computer (SC5)"* (and if you wish to upload and download data, "RLINK" communications software) to gain access to the WSDOT mainframe computer.

If you are a city or county user of the WSDOT System, contact the WSDOT State Aid Office for assistance.

The RLINK communications software will be provided on floppy disk, and the manual will lead you through the necessary steps to Logon to the WSDOT system.

*SC5 = Service Center Five

Table 3. PARAMETERS FOR OPTAL

Variable	Format	Description
YEAR	I2	Present year
TRAFYR	I2	Year of traffic data
NPRDS	I2	Number of periods used for planning complete strategies (e.g., 20)
NETPRD	I2	Number of periods included in action and cost summaries in program NETWK (e.g., 6)
LPRD	F4.2	Length of the periods
EFFINT	F4.2	Effective interest rate
NOPR	I1	Not used
TFACT(I)	F3.2	Thickness factors for determining equations for alternatives
EXPACT(I)	F4.2	Equation factors for determining equations for alternatives when original pavement has been overlayed before
SHOULD(I)	F2.0	"Should" levels for each functional class
MUST(I)	F2.0	"Must" levels for each functional class
TIR(I)	I3.1	Traffic index ranges to be used for selecting the correct strategy for a given project.
FTMTRX(I,J,K)	5I1	Matrix which gives number of strategy to be used according to functional class, traffic index, and surface type of project
RMATRX(I,J)	3I1	Matrix containing the rehabilitation alternatives for each strategy
DES(I,J)	6A4	Description of rehabilitation strategy I
CONSTC(I)	I8	Construction cost of rehabilitation strategy I per 12 ft. lane
OTHK(I)	F3.2	Traffic interruption cost factor for rehabilitation alternative I.

Table 3. PARAMETERS FOR OPTAL (concluded)

Variable	Format	Description
AEQ(1)	F4.2	Equation factor for estimating life of rehabilitation alternative, used when existing surface has a surface type "A" (asphalt)
BEQ(I)	F4.2	Equation factor for surface type "B" (bituminous surface treatment)
CEQ(I)	F4.2	Equation factor for surface type "C" (portland cement concrete)
MAXRAT(I)	F6.2	Constant to be used in performance equation for rehabilitation alternative I.
MS(I)	F7.2	Slope of performance equation for rehabilitation alternative I.
NOTCOS	I2	A switch. If NOTCOS equals 1, then costs due to traffic interruption are not included in strategy evaluation
NOMC	I2	A switch. If NOMC equals 1, then maintenance costs are not included
NOPC	I2	A switch. If NOPC equals 1, then preparation costs are not included
NOUC	I2	A switch. If NOUC equals 1, then user costs due to pavement condition are not included

PAVEMENT CONDITION RATING

Agency	Date	Rater	Sheet No. ___ of ___

CONTROL DATA								BITUMINOUS PAVEMENTS																						
							RUTTING/ PAV'T. WEAR	CORRUGATION % of Roadway (1) 1-25% (2) 26-75% (3) Over 75%			ALLIGATOR CRACKING Whl. Trk./ Station (1) 1-24% (2) 25-49% (3) 50-74% (4) 75-100%			RAVELING OR FLUSHING (1) Localized (2) Wheel paths (3) Entire lane				LONGITUDINAL CRACKING Lineal Ft/Sta (1) 1-99 (2) 100-199 (3) 200 plus			TRANSVERSE CRACKING No./Sta. (1) 1-4 (2) 5-9 (3) 10 plus			PATCHING % Area/Sta. (1) 1-5% (2) 6-25% (3) Over 25%			EDGE CONDITION Ⓓ			
ROAD NUMBER	BEGINNING MILE POST OF RATED SECTION	ENDING MILE POST OF RATED SECTION	FUNCTIONAL CLASS	PAVEMENT TYPE (A or B) Ⓐ	PAVEMENT EXEMPTION Ⓑ	MULTI-LANE (L), (R), (B)	Ⓒ	1/8-2" CHANGE/10'	2-4" CHANGE/10'	OVER 4" CHANGE/10'	HAIRLINE	SPALLING	SPALLING & PUMPING	SLIGHT	MODERATE	SEVERE	R - Raveling F - Flushing	LESS THAN ¼" WIDE	OVER ¼" WIDE	SPALLED	LESS THAN ¼" WIDE	OVER ¼" WIDE	SPALLED	0.10 - 0.50" THICK	0.50 - 1.0" THICK	OVER 1.0" THICK	RAVELING	PATCHING	LANE<10' *	
1	7	13	19	22	24	26	28	30			34			38				43			47			51			55			
1	7	13	19	22	24	26	28	30			34			38				43			47			51			55			

Ⓐ A Asphalt
B Bituminous

Ⓑ (1) Unpaved roadways
(2) Roadways under construction
(3) Bridge
(4) Impassable road
(5) Other

Ⓒ RUTTING/ PAVEMENT WEAR
(1) 1/4 to 1/2"
(2) 1/2 to 3/4"
(3) Over 3/4"

Remarks ______________________________

Ⓓ (1) 1-5% length/station
(2) 6-25% length/station
(3) Over 25% length/station

* Due to edge raveling

Figure 1. Pavement Condition Rating Form for Bituminous Pavements

PAVEMENT CONDITION RATING

Agency	Date	Rater	Sheet No. of

CONTROL DATA							PORTLAND CEMENT CONCRETE																							
ROAD NUMBER	BEGINNING MILE POST OF RATED SECTION	ENDING MILE POST OF RATED SECTION	FUNCTIONAL CLASS	PAVEMENT TYPE (C)	PAVEMENT EXEMPTION (A)	MULTI-LANE (L), (R), (B)	PAVMNT WEAR (B)	CRACKING % of Panels (1) 1-25 (2) 26-50 (3) Over 50			RAVELING DISINTEGRATION, POP-OUT, SCALING (1) 1-25% Area (2) 26-75 (3) Over 75			JOINT SPALLING % of Joints (1) 1-15 (2) 16-50 (3) Over 50				PUMPING BLOWING % of Panels (1) 1-15 (2) 16-35 (3) Over 35			FAULTING (1) 1-15% (2) 16-35% (3) 35% Plus			PATCHING % of Panels (1) 1-5 (2) 6-20 (3) Over 20			BLOWUPS		
								1-2 UNITS/PANEL	3-4 UNITS/PANEL	>4 UNITS/PANEL	SLIGHT	MODERATE	SEVERE	0-1" WIDE	1-3" WIDE	OVER 3" WIDE		0-5% PANL LGTH	10-50% PANL LGTH	> 50% PANL LGTH	0-1/4"	1/4-1/2"	1/2" PLUS	1-5% AREA/PANEL	6-25% AREA/PANEL	OVER 25% AREA/PANEL	No./MILE		
1	7	13	19	22	24	26	28	30			34			38				43			47			51			55		
1	7	13	19	22	24	26	28	30			34			38				43			47			51			55		

(A) (1) Unpaved roadways
(2) Roadways under construction
(3) Bridge
(4) Impassable road
(5) Other

(B) PAVEMENT WEAR:
(1) 1/4 to 1/2"
(2) 1/2 to 3/4"
(3) Over 3/4"

Remarks: _____

Figure 2. Pavement Condition Rating Form for Portland Cement Concrete Pavements

PAVEMENT CONDITION RATING

Agency	Date	Rater	Sheet No.
Thurston Co.	3-25-85	Stillings Armigo	2 of 3

CONTROL DATA								BITUMINOUS PAVEMENTS																								
ROAD NUMBER	BEGINNING MILE POST OF RATED SECTION	ENDING MILE POST OF RATED SECTION	FUNCTIONAL CLASS	Ⓐ PAVEMENT TYPE (A or B)	Ⓑ PAVEMENT EXEMPTION	MULTI-LANE (L), (R), (B)	Ⓒ RUTTING/ PAVT. WEAR	CORRUGATION % of Roadway (1) 1-25% (2) 26-75% (3) Over 75%			ALLIGATOR CRACKING Whl. Trk./ Station (1) 1-24% (2) 25-49% (3) 50-74% (4) 75-100%			RAVELING OR FLUSHING (1) Localized (2) Wheel paths (3) Entire lane				LONGITUDINAL CRACKING Lineal Ft./Sta. (1) 1-99 (2) 100-199 (3) 200 plus			TRANSVERSE CRACKING No./Sta. (1) 1-4 (2) 5-9 (3) 200 plus			PATCHING ☐ Area/Sta. (1) 1-5% (2) 6-25% (3) Over 25%			EDGE CONDITION Ⓓ			
								1/8-2" CHANGE/10'	2-4" CHANGE/10'	OVER 4" CHANGE/10'	HAIRLINE	SPALLING	SPALLING & PUMPING	SLIGHT	MODERATE*	SEVERE	R = Raveling F = Flushing	LESS THAN ¼" WIDE	OVER ¼" WIDE	SPALLED	LESS THAN ¼" WIDE	OVER ¼" WIDE	SPALLED	0.10 - 0.50" THICK	0.50 - 1.0" THICK	OVER 1.0" THICK	RAVELING	PATCHING	LANE < 10' *	
1	2	13	19	22	24	26	28	30			34			38				43			47			51			55			
Hobson	Rd. SW																													
1 1 2 1 1 9 7	1 0 0 9 0	1 0 9 5 0	0 9	A	N	B	N	N			N			2			R	N			N			N			N	N	N		
1 2 1 1 9 7	1 0 0 5 0	1 0 1 1 0 0	0 9	A	N	B	N	N			N			N				N			N			N			N	N	N		
1 2 1 1 9 7	1 0 1 0 0	1 0 1 5 0	0 9	A	N	B	N	N			N			N				N			N			N			N	N	N		
1 2 1 1 9 7	1 0 1 5 0	1 0 1 6 6	0 9	A	N	B	N	N			N			N				N			N			N			N	N	N		
Oregon	Trail Rd. SW																													
1 3 1 9 0	1 0 9 9 0	1 0 0 4 4	0 9	B	N	B	N	2			1			3			R	1			1			1			1	N	3		
Prather	Rd SW	13	19	22	24	26	28	30			34			38				43			47			51			55			
1 4 0 9 4 0	1 0 0 0 0	1 0 9 5 0	0 8	B	N	B	3	2			2			1			R	N			N			2			N	N	N		
1 4 0 4 1 0	1 0 0 5 0	1 0 1 0 0	0 8	B	N	B	2	3			2			1			R	N			N			1			N	N	N		
1 4 0 4 1 0	1 0 1 0 0	1 0 1 5 0	9 8	B	N	B	3	2			2			2			R	1			N			N			N	N	N		
1 4 0 4 1 0	1 0 1 5 0	1 0 2 9 0	9 8	B	N	B	3		2		1			1			R	N			N			2			N	N	N		
1 4 0 4 1 0	1 0 2 0 0	1 0 2 5 0	0 8	B	N	B	3		2		3			1			R	N			N			2			N	N	N		
1 4 0 9 4 0	1 0 2 5 0	1 0 3 0 0	0 8	B	N	B	3		2		1			1			R	N			N			1			N	N	N		
1 4 0 4 1 0	1 0 3 0 0	1 0 3 5 0	0 6	B	N	B	1	N			N			N				N			N			N			N	N	N		
1 4 0 4 1 0	1 0 3 5 0	1 0 4 0 0	0 6	B	N	B	N	N			N			N				N			N			N			N	N	N		

* Due to edge raveling

Ⓐ A Asphalt
B Bituminous

Ⓑ (1) Unpaved roadways
(2) Roadways under construction
(3) Bridge
(4) Impassable road
(5) Other

Ⓒ RUTTING/ PAVEMENT WEAR:
(1) 1/4 to 1/2"
(2) 1/2 to 3/4"
(3) Over 3/4"

Ⓓ (1) 1-5% length/station
(2) 6-25% length/station
(3) Over 25% length/station

Remarks: * Street Name Sign missing at old 99 & Prather Road

Figure 3. Example of a Completed Pavement Condition Rating Form

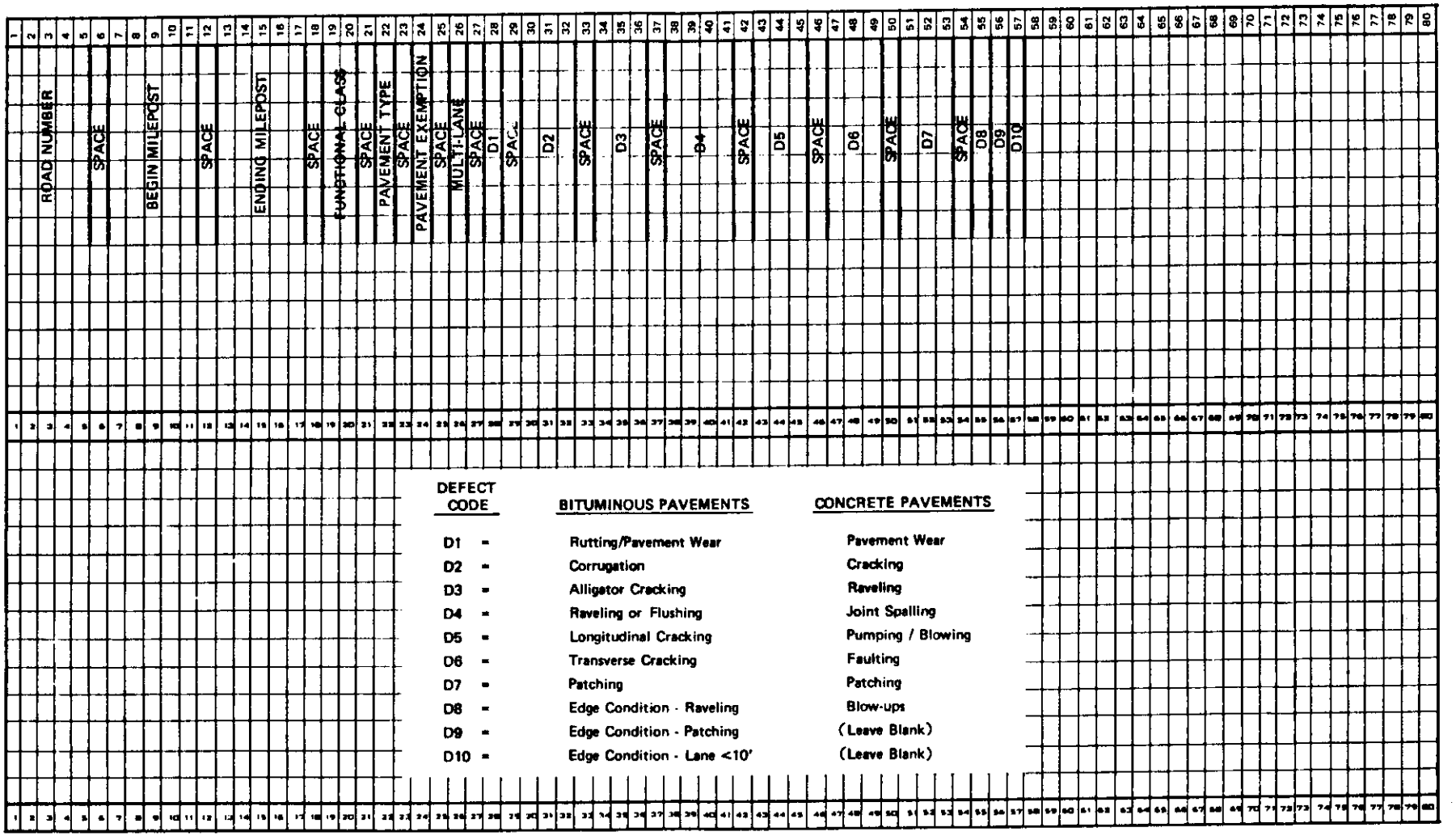
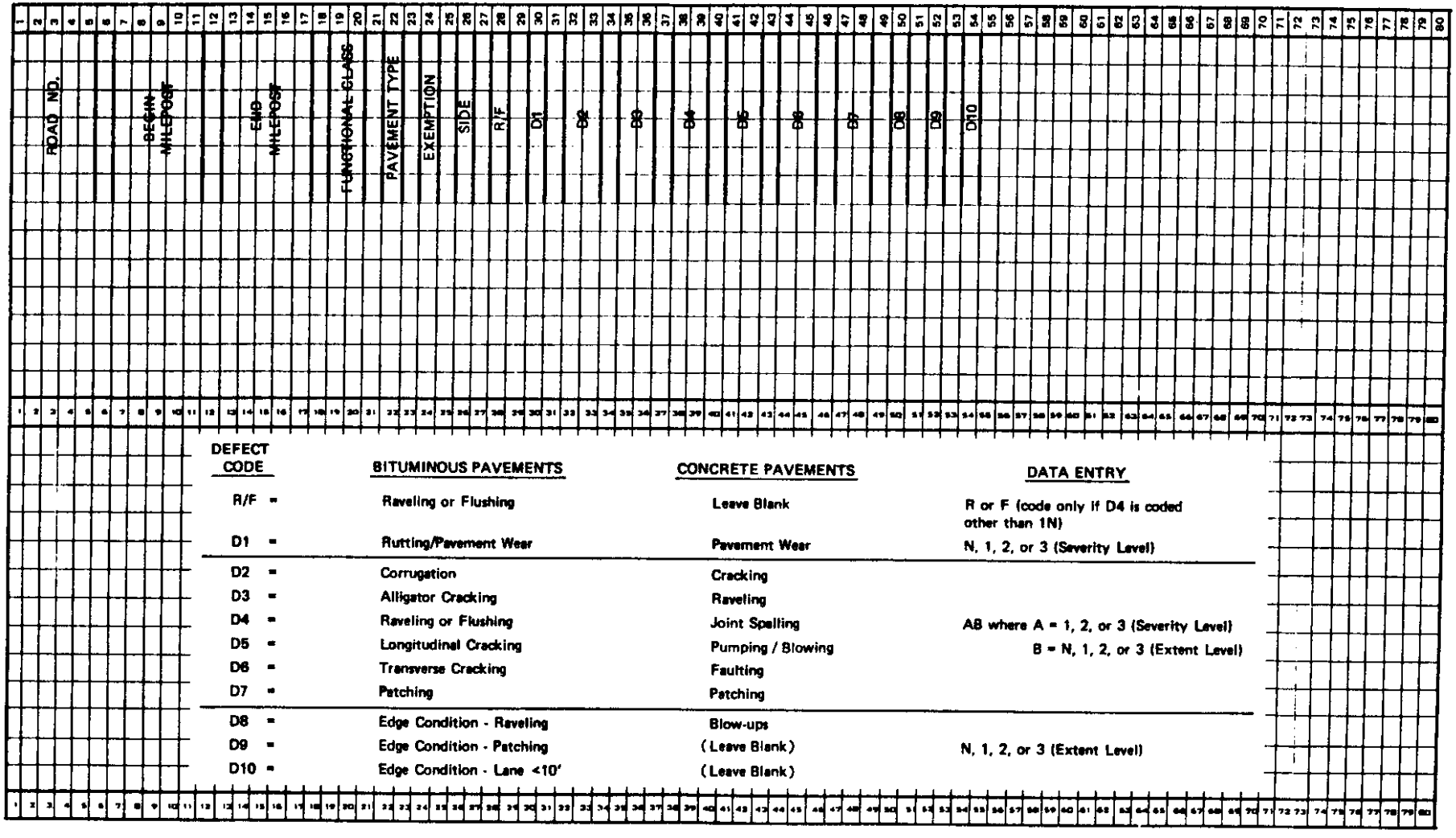
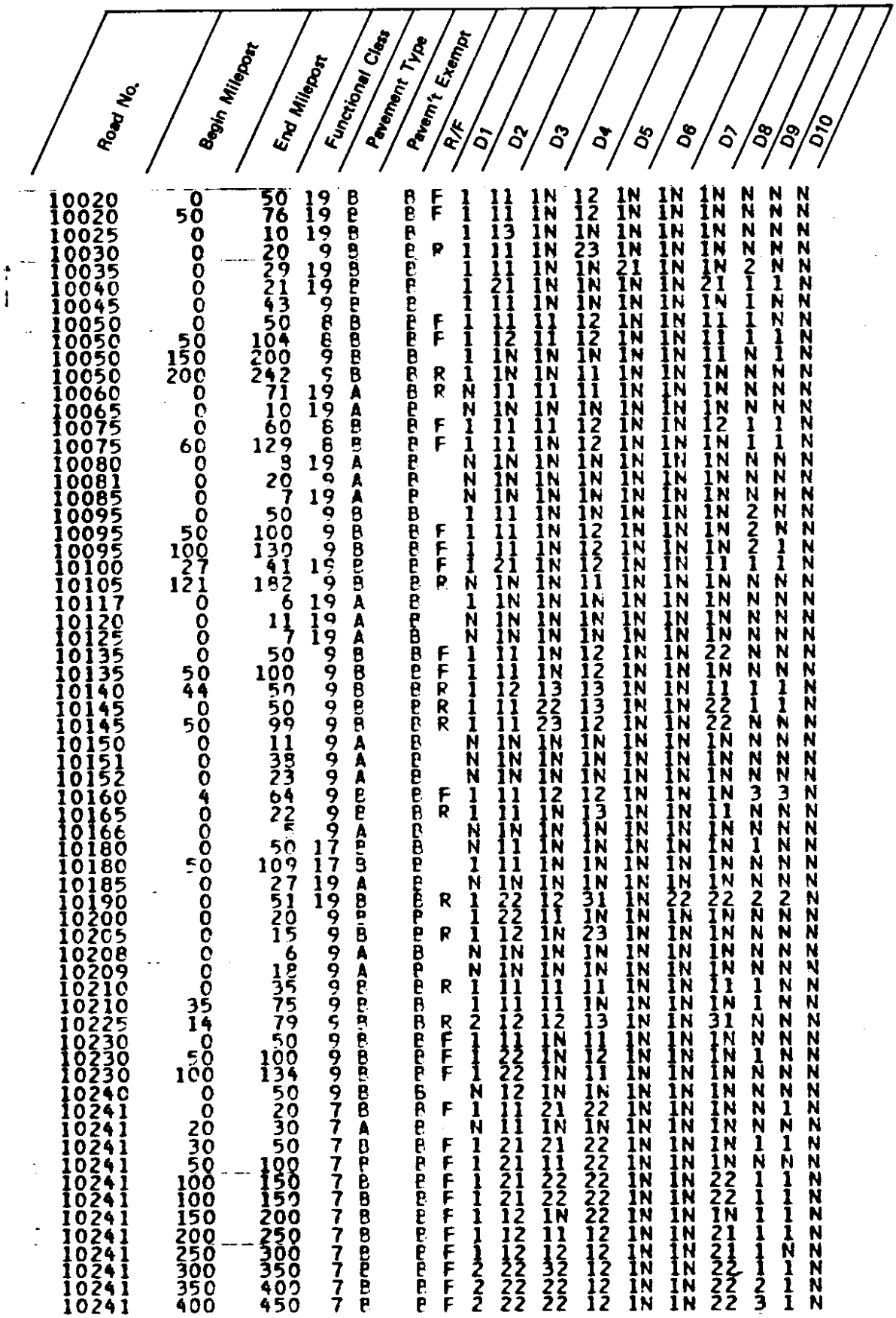


Figure 4-a. Format for Pavements Defects Data File (Input to the State's Mainframe)



DEFECT CODE		BITUMINOUS PAVEMENTS	CONCRETE PAVEMENTS	DATA ENTRY
R/F	=	Raveling or Flushing	Leave Blank	R or F (code only if D4 is coded other than 1N)
D1	=	Rutting/Pavement Wear	Pavement Wear	N, 1, 2, or 3 (Severity Level)
D2	=	Corrugation	Cracking	
D3	=	Alligator Cracking	Raveling	
D4	=	Raveling or Flushing	Joint Spalling	AB where A = 1, 2, or 3 (Severity Level)
D5	=	Longitudinal Cracking	Pumping / Blowing	B = N, 1, 2, or 3 (Extent Level)
D6	=	Transverse Cracking	Faulting	
D7	=	Patching	Patching	
D8	=	Edge Condition - Raveling	Blow-ups	
D9	=	Edge Condition - Patching	(Leave Blank)	N, 1, 2, or 3 (Extent Level)
D10	=	Edge Condition - Lane <10'	(Leave Blank)	

Figure 4-b. Format for Pavements Defects Data File (Output from State's Mainframe)



Road No.	Begin Milepost	End Milepost	Functional Class	Pavement Type	Pavem't Exempt	R/F	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
10020	0	50	19	B	B	F	1	11	1N	12	1N	1N	1N	N	N	N
10020	50	76	19	B	B	F	1	11	1N	12	1N	1N	1N	N	N	N
10025	0	10	19	B	B		1	13	1N	1N	1N	1N	1N	N	N	N
10030	0	20	9	B	B	P	1	11	1N	23	1N	1N	1N	N	N	N
10035	0	29	19	B	B		1	11	1N	1N	21	1N	1N	2	N	N
10040	0	21	19	B	B		1	21	1N	1N	1N	1N	21	1	N	N
10045	0	43	9	B	B		1	11	1N	1N	1N	1N	1N	1	N	N
10050	0	50	8	B	B		1	11	11	12	1N	1N	11	1	N	N
10050	50	104	8	B	B	F	1	12	11	12	1N	1N	11	1	N	N
10050	150	200	9	B	B		1	1N	1N	1N	1N	1N	11	1	N	N
10050	200	242	9	B	B	R	1	1N	1N	11	1N	1N	1N	N	N	N
10060	0	71	19	A	B	R	N	11	11	11	1N	1N	1N	N	N	N
10065	0	10	19	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10075	0	60	6	B	B	F	1	11	11	12	1N	1N	12	1	N	N
10075	60	129	8	B	B	F	1	11	1N	12	1N	1N	1N	1	N	N
10080	0	9	19	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10081	0	20	9	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10085	0	7	19	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10095	0	50	9	B	B		1	11	1N	1N	1N	1N	1N	2	N	N
10095	50	100	9	B	B	F	1	11	1N	12	1N	1N	1N	2	N	N
10095	100	130	9	B	B	F	1	11	1N	12	1N	1N	1N	2	N	N
10100	27	41	19	B	B	F	1	21	1N	12	1N	1N	11	1	N	N
10105	121	182	9	B	B	P	N	1N	1N	11	1N	1N	1N	N	N	N
10117	0	6	19	A	B		1	1N	1N	1N	1N	1N	1N	N	N	N
10120	0	11	19	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10125	0	7	19	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10135	0	50	9	B	B	F	1	11	1N	12	1N	1N	22	N	N	N
10135	50	100	9	B	B	F	1	11	1N	12	1N	1N	1N	N	N	N
10140	44	50	9	B	B	R	1	12	13	13	1N	1N	11	1	N	N
10145	0	50	9	B	B	R	1	11	22	13	1N	1N	22	1	N	N
10145	50	99	9	B	B	R	1	11	23	12	1N	1N	22	N	N	N
10150	0	11	9	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10151	0	38	9	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10152	0	23	9	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10160	4	64	9	B	B	F	1	11	12	12	1N	1N	1N	3	N	N
10165	0	22	9	B	B	R	1	11	1N	13	1N	1N	11	N	N	N
10166	0	5	9	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10180	0	50	17	B	B		N	11	1N	1N	1N	1N	1N	1	N	N
10180	50	109	17	B	B		1	11	1N	1N	1N	1N	1N	N	N	N
10185	0	27	19	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10190	0	51	19	B	B	R	1	22	12	31	1N	22	22	2	N	N
10200	0	20	9	B	B		1	22	11	1N	1N	1N	1N	N	N	N
10205	0	15	9	B	B	R	1	12	1N	23	1N	1N	1N	N	N	N
10208	0	6	9	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10209	0	18	9	A	B		N	1N	1N	1N	1N	1N	1N	N	N	N
10210	0	35	9	B	B	R	1	11	11	11	1N	1N	11	1	N	N
10210	35	75	9	B	B		1	11	11	1N	1N	1N	1N	1	N	N
10225	14	79	5	B	B	R	2	12	12	13	1N	1N	31	N	N	N
10230	0	50	9	B	B	F	1	11	1N	11	1N	1N	1N	N	N	N
10230	50	100	9	B	B	F	1	22	1N	12	1N	1N	1N	1	N	N
10230	100	134	9	B	B	F	1	22	1N	11	1N	1N	1N	N	N	N
10240	0	50	9	B	B		N	12	1N	1N	1N	1N	1N	N	N	N
10241	0	20	7	B	B	F	1	11	21	22	1N	1N	1N	N	N	N
10241	20	30	7	A	B		N	11	1N	1N	1N	1N	1N	N	N	N
10241	30	50	7	B	B	F	1	21	21	22	1N	1N	1N	1	N	N
10241	50	100	7	B	B	F	1	21	11	22	1N	1N	1N	N	N	N
10241	100	150	7	B	B	F	1	21	22	22	1N	1N	22	1	N	N
10241	100	150	7	B	B	F	1	21	22	22	1N	1N	22	1	N	N
10241	150	200	7	B	B	F	1	12	1N	22	1N	1N	1N	1	N	N
10241	200	250	7	B	B	F	1	12	11	12	1N	1N	21	1	N	N
10241	250	300	7	B	B	F	1	12	12	12	1N	1N	21	1	N	N
10241	300	350	7	B	B	F	2	22	32	12	1N	1N	22	1	N	N
10241	350	400	7	B	B	F	2	22	22	12	1N	1N	22	2	1	N
10241	400	450	7	B	B	F	2	22	22	12	1N	1N	22	3	1	N

Figure 4-c. Example of Pavement Defects Data Output File from State's Mainframe

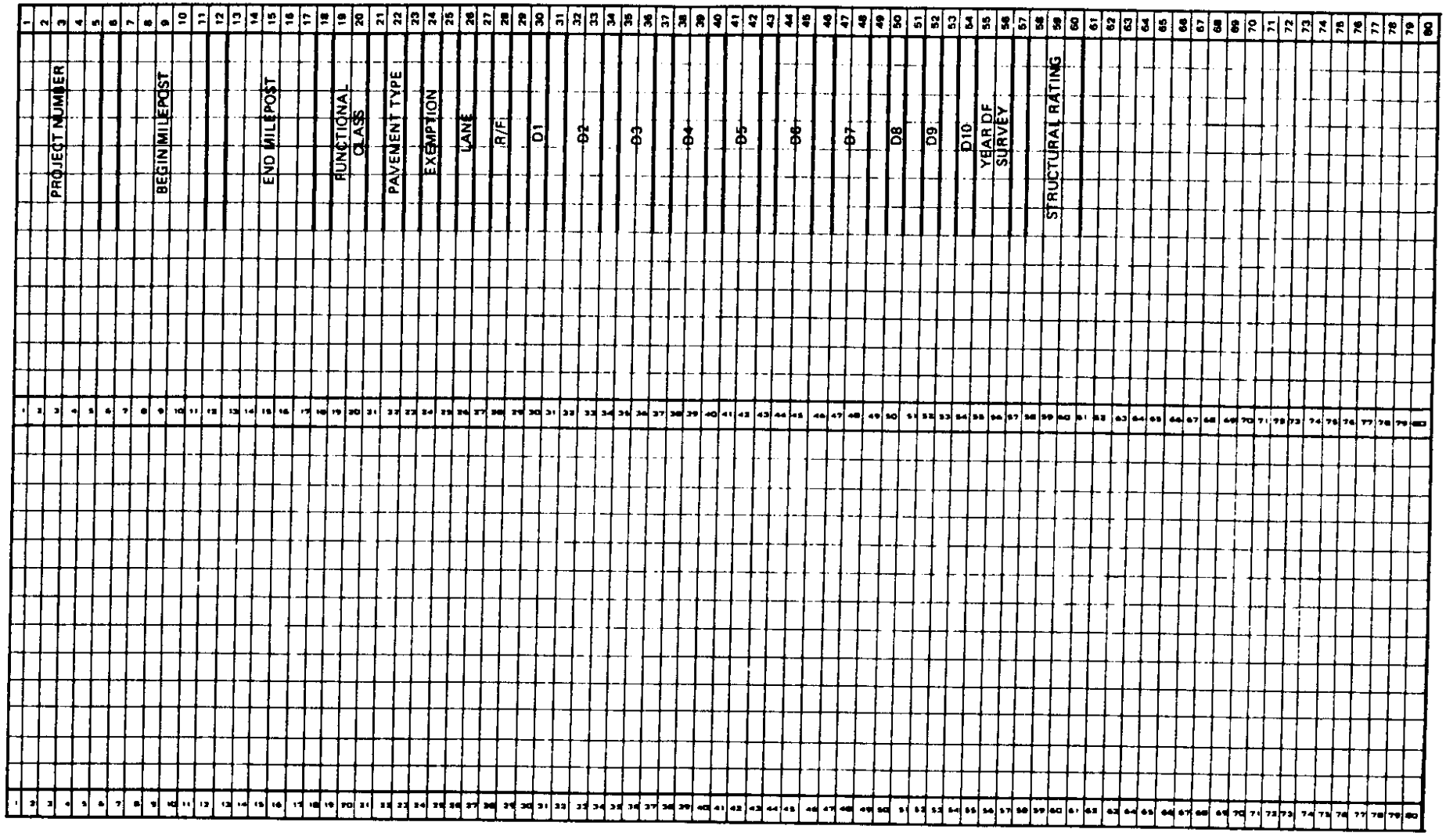


Figure 5. RATGEN Output File Format

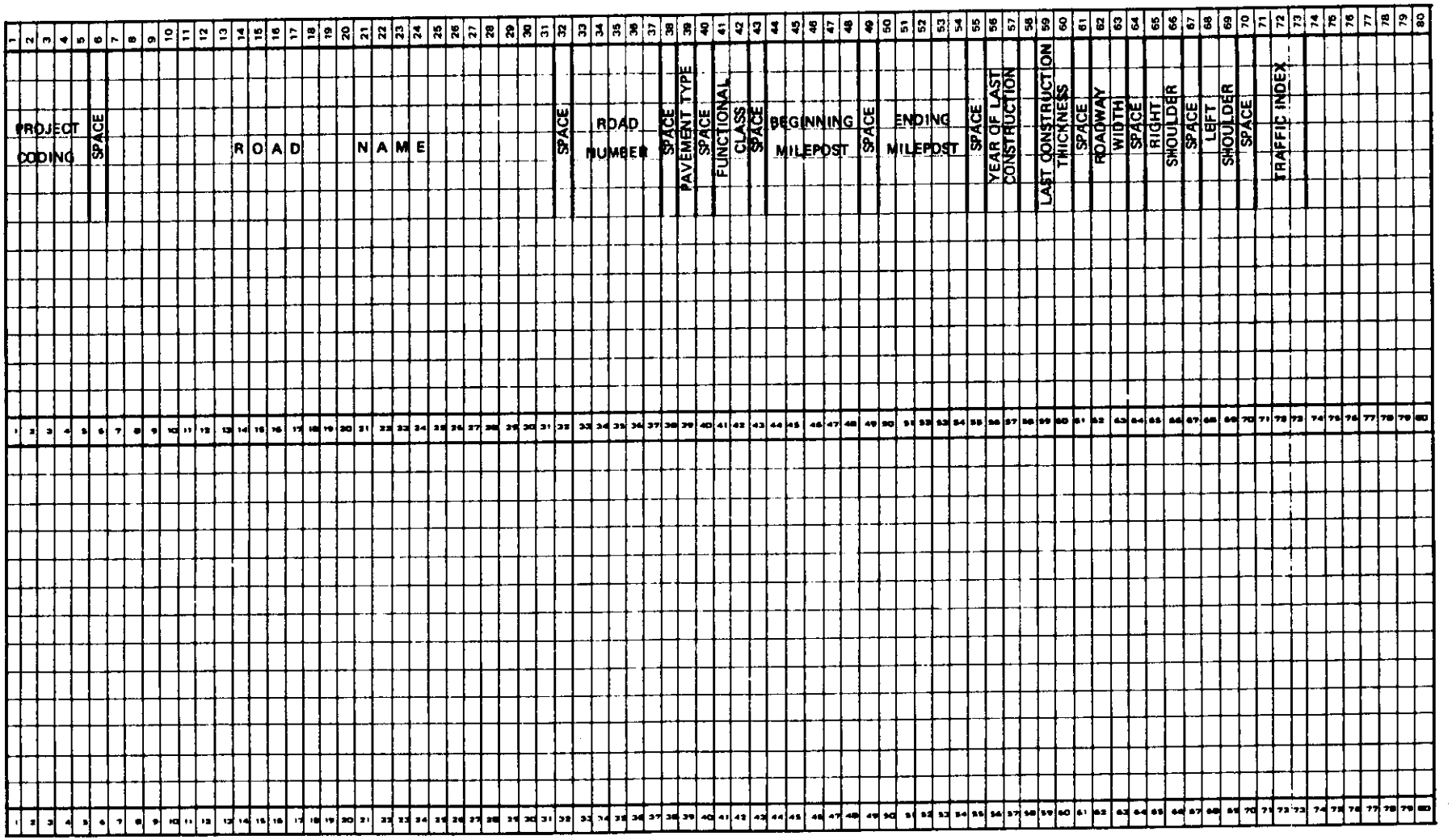


Figure 6. Format for the Project Data File

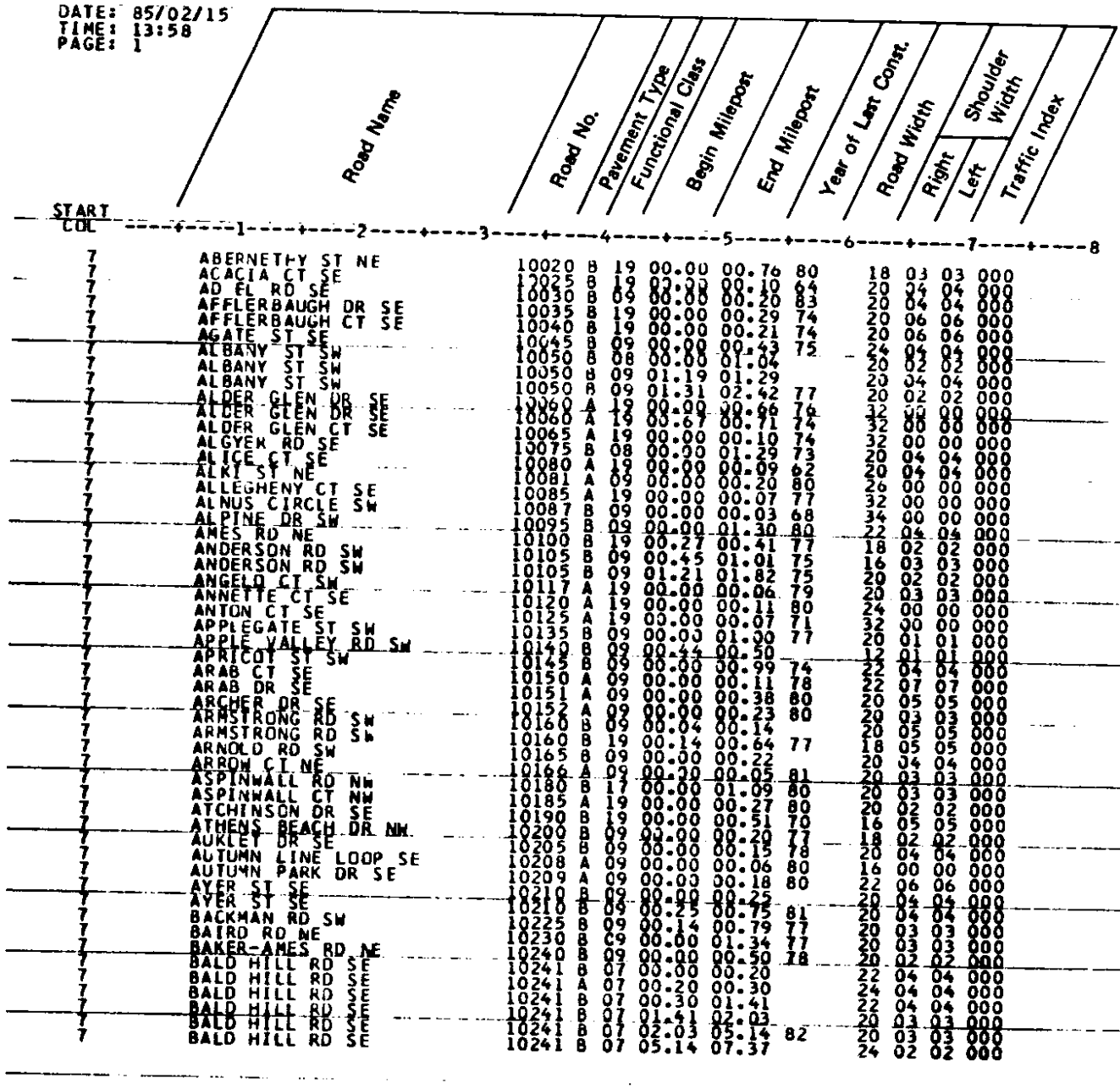


Figure 7. Example of Project Data File

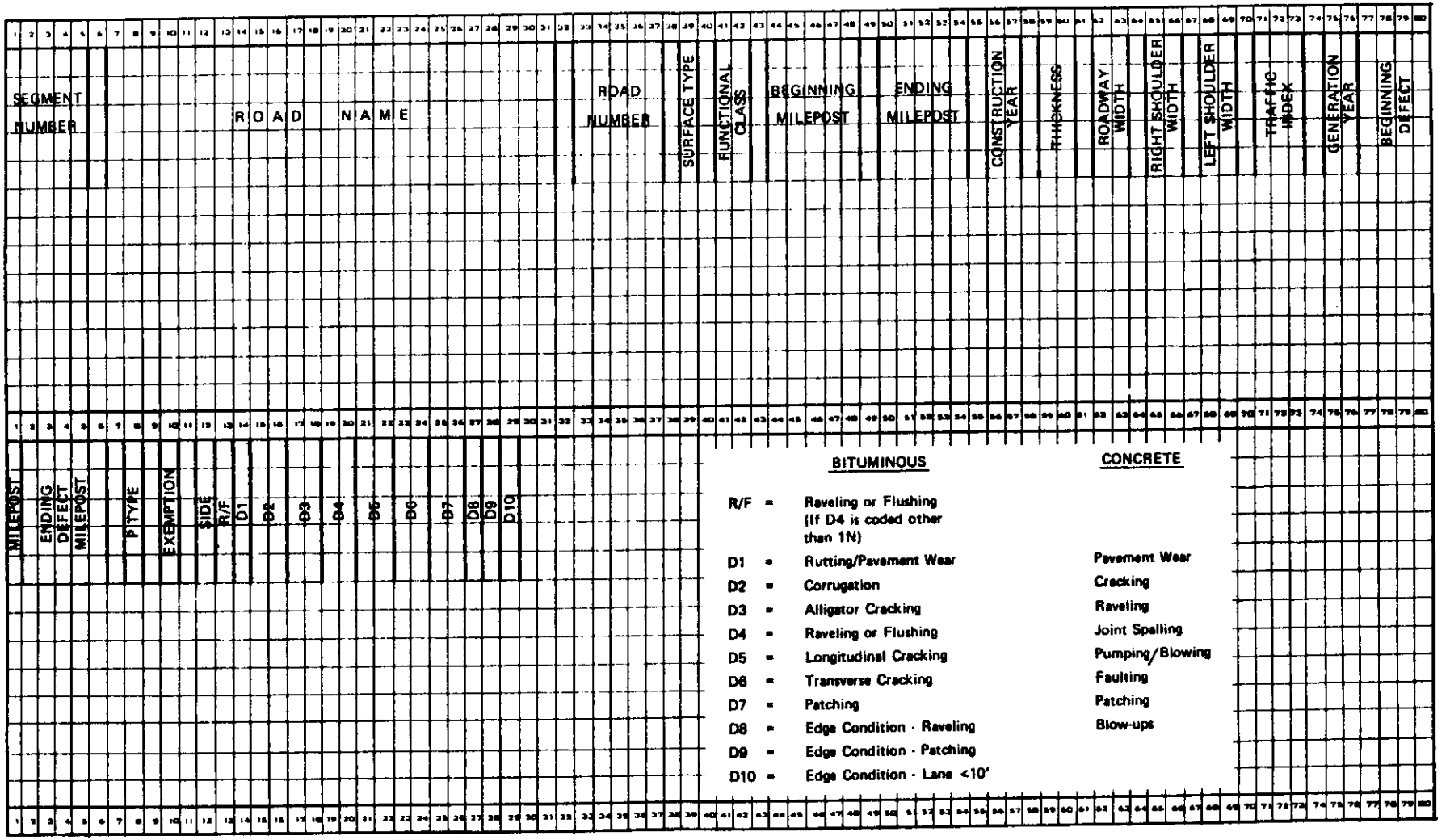


Figure 8. Format of the Master File

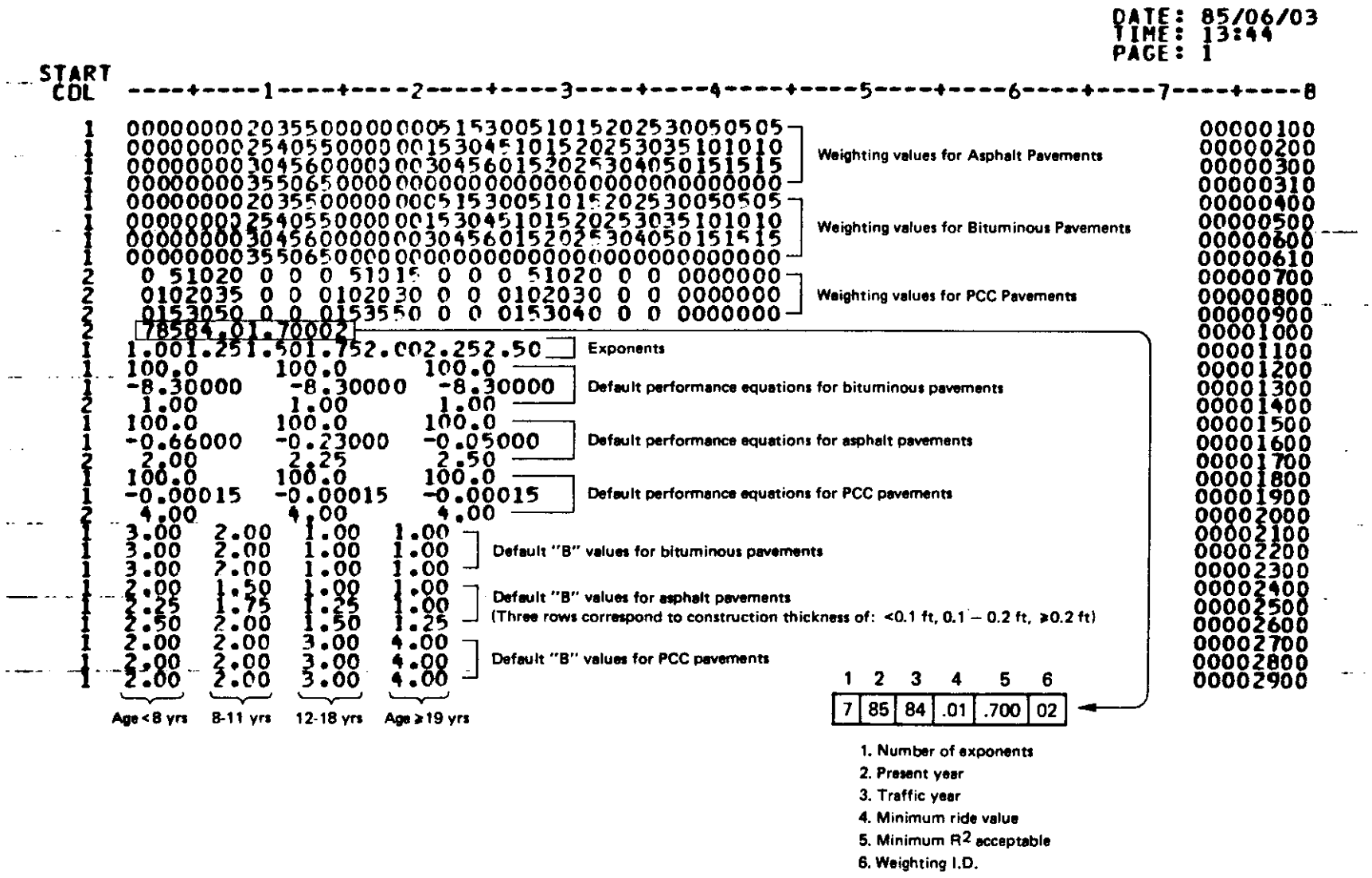


Figure 9. Listing of Interpreting Parameters

R67CO-INT 11/08/84

PROJECT NUMBER	ROAD NUMBER	ROAD NAME	BEGIN MILEPOST	END MILEPOST	PROJECT LENGTH	FUNCT CLASS	SURFACE TYP-THK	CONST YEAR	ROW-RSH-LSH WIDTHS	TRAFFIC INDEX
P0151	10645	CAMELOT DR SW	0.00	0.69	0.69	9	A .00	68	20 4 4	0.0

PERFORMANCE HISTORY

YEAR		68	71	74	77	80	83
AGE		0	3	6	9	12	15
RIDE	RATING	1.00	1.00	1.00	1.00	1.00	1.00
STRUCR	RATING	100.0	100.0	90.0	75.0	70.0	65.0
COMBO	RATING	100.0	100.0	90.0	75.0	70.0	65.0
HIGH	RATING	100.0	100.0	90.0	75.0	70.0	65.0
LOW	RATING	100.0	100.0	90.0	75.0	70.0	65.0

PERFORMANCE EQUATION

EQUA CONST	= 101.31
EQUA COEFF	= -1.33533
EQUA POWER	= 1.25
R SQUARE	= 0.94833
STD ERROR	= 3.91
EQUA TYPE	= 2
EDGE PATCH	= NO

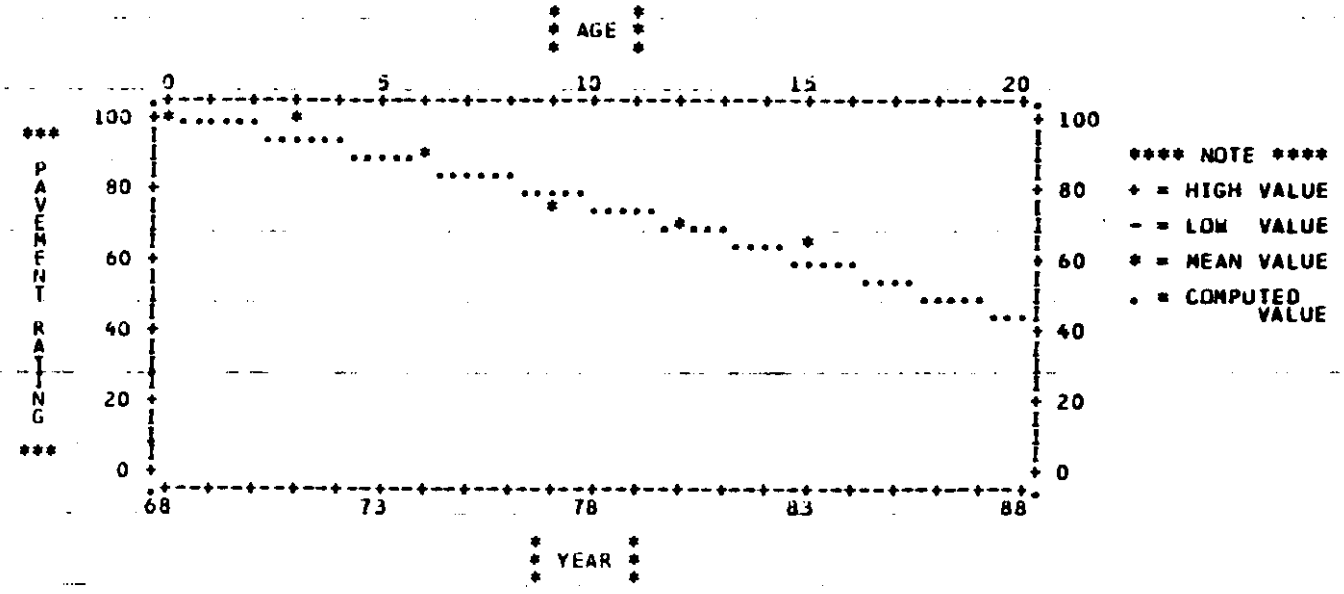


Figure 10. Output of Program INTERP

R67CO-INDX 12/17/85

PROJECT NUMBER	ROAD NUMBER	ROAD NAME	BEGIN MILEPOST	END MILEPOST	PROJECT LENGTH	FUNCT CLASS	SURFACE TYP	SURFACE THK	CONST YEAR	RDW	RSH	LSH	TRAFFIC INDEX
										WIDTHS			
P0001	10020	ABERNETHY ST NE	0.00	0.76	0.76	19	B	6	80	18	3	3	0.0
P0002	10025	ACACIA CT SE	0.00	0.10	0.10	19	B	6	64	20	4	4	0.0
P0003	10030	AD EL RD SE	0.00	0.20	0.20	09	B	6	83	20	4	4	0.0
P0004	10035	AFFLERBAUGH DR SE	0.00	0.29	0.29	19	B	6	74	20	6	6	0.0
P0005	10040	AFFLERBAUGH CT SE	0.00	0.21	0.21	19	B	6	74	20	6	6	0.0
P0006	10045	AGATE ST SE	0.00	0.43	0.43	09	B	6	75	24	4	4	0.0
P0007	10050	ALBANY ST SW	0.00	1.04	1.04	08	B	6	0	20	2	2	0.0
P0008	10050	ALBANY ST SW	1.19	1.29	0.10	09	B	6	0	20	4	4	0.0
P0009	10050	ALBANY ST SW	1.31	2.42	1.11	09	B	6	77	20	2	2	0.0
P0010	10060	ALDER GLEN DR SE	0.00	0.66	0.66	19	A	12	76	32	0	0	0.0
P0011	10060	ALDER GLEN DR SE	0.67	0.71	0.04	19	A	10	74	32	0	0	0.0
P0012	10065	ALDER GLEN CT SE	0.00	0.10	0.10	19	A	10	74	32	0	0	0.0
P0013	10075	ALGYER RD SE	0.00	1.29	1.29	08	B	6	73	20	4	4	0.0
P0014	10080	ALICE CT SE	0.00	0.09	0.09	19	A	10	62	20	4	4	0.0
P0015	10081	ALKI ST NE	0.00	0.20	0.20	09	A	15	80	26	0	0	0.0
P0016	10085	ALLEGHENY CT SE	0.00	0.07	0.07	19	A	12	77	32	0	0	0.0
P0017	10087	ALNUS CIRCLE SW	0.00	0.03	0.03	09	B	6	68	34	0	0	0.0
P0018	10095	ALPINE DR SW	0.00	1.30	1.30	09	B	6	80	22	4	4	0.0
P0019	10100	AMES RD NE	0.27	0.41	0.14	19	B	6	77	18	2	2	0.0
P0020	10105	ANDERSON RD SW	0.45	1.01	0.56	09	B	6	75	16	3	3	0.0
P0021	10105	ANDERSON RD SW	1.21	1.82	0.61	09	B	6	75	20	2	2	0.0
P0022	10117	ANGELO CT SW	0.00	0.06	0.06	19	A	8	79	20	3	3	0.0
P0023	10120	ANNETTE CT SE	0.00	0.11	0.11	19	A	8	80	24	0	0	0.0
P0024	10125	ANTON CT SE	0.00	0.07	0.07	19	A	10	71	32	0	0	0.0
P0025	10135	APPLEGATE ST SW	0.00	1.00	1.00	09	B	6	77	20	1	1	0.0
P0026	10140	APPLE VALLEY RD SW	0.44	0.50	0.06	09	B	6	0	12	1	1	0.0
P0027	10145	APRICOT ST SW	0.00	0.99	0.99	09	B	6	74	22	4	4	0.0

Figure 11. Example of Master Index Listing

R67CO-LMST 06/05/85

PROJECT NUMBER	ROAD NUMBER	ROAD NAME	BEGIN MILEPOST	END MILEPOST	PROJECT LENGTH	FUNCT CLASS	SURFACE TYP-THK	CONST YEAR	RDW-RSH-LSH WIDTHS	TRAFFIC INDEX
PD242	10960	COUGAR ST SE	0.00	0.54	0.54	19	A .00	63	33 0 0	0.0

GEN	SIDE	RATING MILEPOST	EX	RUTT WEAR	WAVE SAGS	ALG CRK	RAV FLU	LONG CRK	TRNS CRK	PTCH	EDGE RAV	CONDITION PTCH	CONDITION <10	DEFECT RATING
63A	B	0.54	0	N	1N	1N	1N	1N	1N	1N	N	N	N	100.0
67A	B	0.54	0	N	1N	1N	1N	11	1N	1N	N	N	N	95.0
71A	B	0.54	0	N	1N	1N	1N	11	11	1N	N	N	N	90.0
74A	B	0.54	0	N	1N	11	1N	11	11	21	N	N	N	45.0
77A	B	0.54	0	N	1N	11	1N	11	11	21	N	N	N	45.0
80A	B	0.54	0	N	1N	11	1N	21	11	22	N	N	N	30.0
83A	B	0.54	0	N	1N	11	1N	22	11	23	N	N	N	5.0

Figure 12. Example of Master File Listing

R67CO-RATE PROJECT NUMBER	ROAD NUMBER	ROAD NAME	BEGIN MILEPOST	END MILEPOST	PROJECT LENGTH	FUNCT CLASS	SURFACE TYP	SURFACE THK	CNST YEAR	RDW	RSH	LSH	YEAR	11/26/84 DEFECT RATING
P0242	10960	COUGAR ST SE	0.00	0.54	0.54	19	A	12	63	33	0	0	83	5.0
P1460	15575	WILDCAT ST SE	0.00	0.41	0.41	19	A	12	63	33	0	0	83	10.0
P0466	11935	GREGORY WAY SE	0.00	0.34	0.34	09	A	15	69	20	2	2	83	30.0
P0948	13740	OLD MILITARY RD SE	0.01	1.56	1.55	09	B	6	69	20	2	2	83	31.2
P0358	11445	EVERGREEN DR NE	0.00	0.80	0.80	09	A	15	80	20	4	4	83	40.0
P0830	13305	MERKEL WAY NE	0.00	0.14	0.14	19	A	12	61	30	0	0	83	45.0
P0298	11160	DENMARK ST SW	0.00	0.94	0.94	09	B	6	77	20	2	2	83	50.0
P0419	11705	GALLAGHER COVE RD NW	0.00	1.00	1.00	09	B	6	77	20	2	2	83	55.0
P0060	10265	BAYVIEW DR NE	0.00	0.36	0.36	09	B	6	76	14	3	3	83	55.0
P0643	12610	KINWOOD ST SE	0.00	0.72	0.72	19	B	6	72	20	10	10	83	59.2
P0556	12270	HUNTER POINT RD NW	0.00	0.91	0.91	09	B	6	77	20	4	4	83	65.0
P0389	11575	FOOTHILL DR SW	0.00	0.37	0.37	09	A	15	71	22	4	4	83	65.0
P0151	10645	CAMELOT DR SW	0.00	0.69	0.69	09	A	12	68	20	4	4	83	65.0
P0448	11845	GODDARD RD SW	0.00	0.93	0.93	09	B	6	77	18	0	0	83	68.1
P1287	14905	SUNSET BEACH DR NW	0.00	0.17	0.17	09	B	6	73	12	2	2	83	75.0
P0203	10810	CHURCHILL RD SE	0.00	2.11	2.11	09	B	6	78	20	2	2	83	81.0
P0600	12445	JOHNSON PT LOOP NE	0.00	1.05	1.05	09	B	6	73	20	2	2	83	86.9

Figure 13. A Prioritized List of Projects

DEFECT RATING SUMMARY FOR ASPHALT PAVEMENTS

FC	100-91	90-81	80-71	71-60	60-51	50-41	40-31	30-21	20-11	10-0	AVG
1	2.6	1.5	0.2	1.0	0.4	0.0	0.4	0.0	0.0	0.0	84.3
2	4.9	0.3	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	93.9
3	36.1	1.6	4.8	2.2	3.2	1.3	2.4	0.0	1.5	0.0	87.0
4	14.2	1.4	1.5	1.4	4.0	0.5	2.1	0.0	0.0	0.0	83.1
5	81.6	2.0	11.9	7.8	3.8	4.2	3.1	2.1	2.5	1.7	86.4
TOTAL	139.3	6.9	19.5	12.9	11.4	6.0	8.0	2.1	4.0	1.7	86.3

DEFECT RATING SUMMARY FOR BITUMINOUS PAVTS

FC	100-91	90-81	80-71	71-60	60-51	50-41	40-31	30-21	20-11	10-0	AVG
1	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	80.0
2	2.7	0.0	2.1	1.1	2.4	1.3	1.0	0.5	0.0	0.0	68.7
3	26.1	0.6	26.0	2.4	14.3	8.5	9.6	4.4	1.3	0.0	71.2
4	38.0	0.0	36.8	2.3	21.6	10.2	8.9	15.3	2.7	4.2	67.4
5	114.1	1.0	108.4	11.9	62.5	42.1	22.8	19.1	8.0	5.8	70.8
TOTAL	181.3	1.6	173.2	17.6	101.3	62.1	42.3	39.3	12.0	9.9	70.1

DEFECT RATING SUMMARY FOR ALL PAVEMENTS

FC	100-91	90-81	80-71	71-60	60-51	50-41	40-31	30-21	20-11	10-0	AVG
1	3.1	1.5	0.2	1.0	0.9	0.0	0.4	0.0	0.0	0.0	83.7
2	7.6	0.3	3.1	1.6	2.4	1.3	1.0	0.5	0.0	0.0	78.2
3	62.2	2.3	30.7	4.6	17.5	9.8	12.0	4.4	2.8	0.0	76.9
4	52.1	1.4	38.3	3.7	25.6	10.7	11.0	15.3	2.7	4.2	69.8
5	195.6	3.0	120.3	19.6	66.4	46.3	25.9	21.2	10.5	7.5	74.4
TOTAL	320.6	8.5	192.7	30.5	112.8	68.1	50.3	41.4	15.9	11.6	74.1

Figure 14(a). Defect Rating Summary from RATGRP Output

PAVEMENT CONDITION DEFICIENCY SUMMARY

BITUMINOUS PAVEMENT

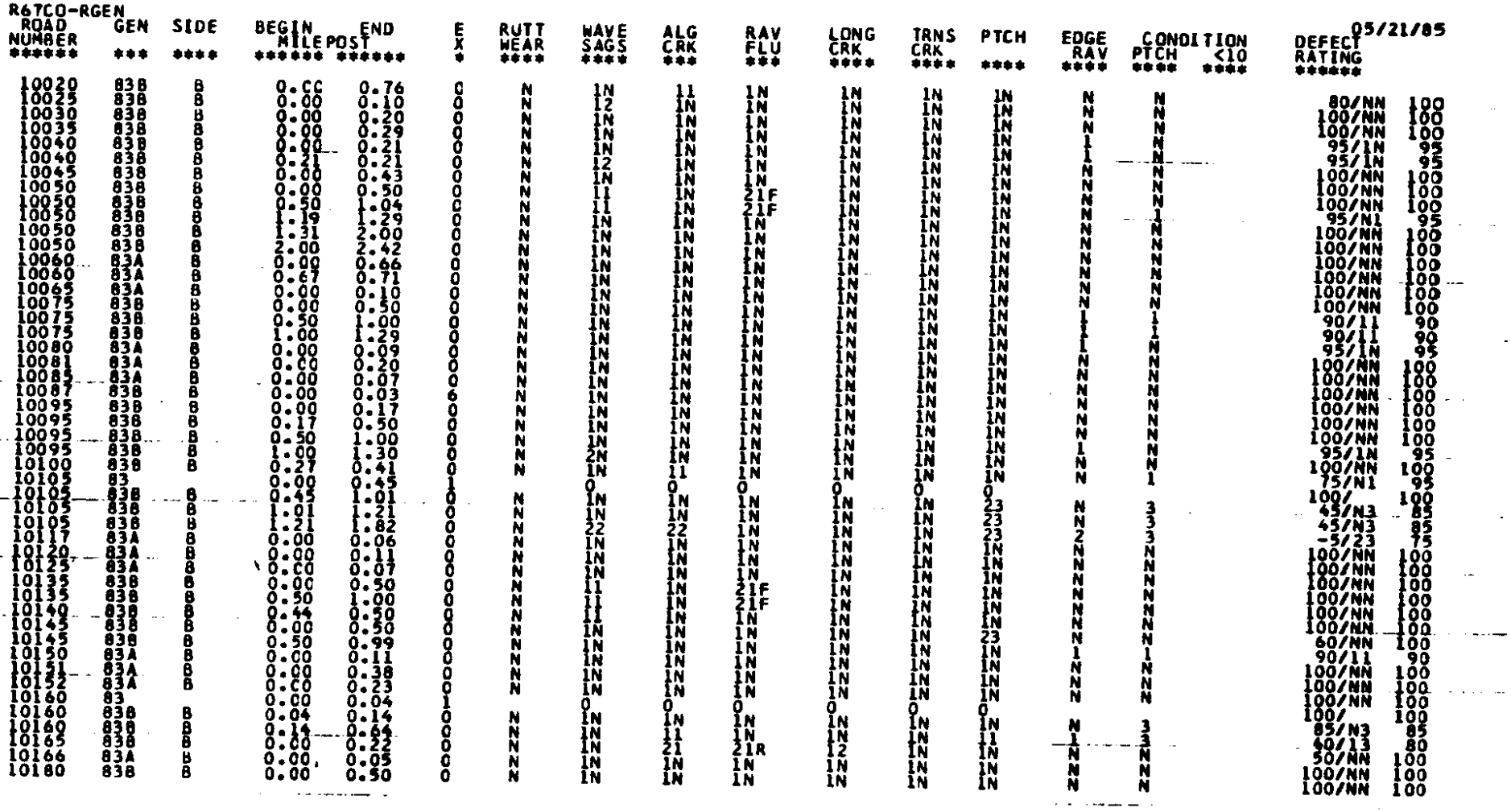
FUNCTIONAL CLASS	NONE	ALLIGATOR CRACKING: HAIRLINE 1-24% WHEEL TRACKS	HAIRLINE 25-49% WHEEL TRACKS	HAIRLINE 50-74% WHEEL TRACKS	HAIRLINE GT75% WHEEL TRACKS	ALLIGATOR CRACKING: SPALLING 1-24% WHEEL TRACKS / STA	SPALLING 25-49% WHEEL TRACKS / STA	SPALLING 50-74% WHEEL TRACKS / STA	SPALLING GT75% WHEEL TRACKS / STA	SPALLING & PUMPING 1-24% WHEEL TRACKS / STA	SPALLING & PUMPING 25-49% WHEEL TRACKS / STA	SPALLING & PUMPING 50-74% WHEEL TRACKS / STA	SPALLING & PUMPING GT75% WHEEL TRACKS / STA	TOTAL
1 MILES	1:	1:	0:	0:	0:	0:	0:	0:	0:	0:	0:	0:	0:	1.
PERCENT	50.	50.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
2 MILES	4:	5:	1:	0:	0:	1:	1:	0:	0:	1:	0:	0:	0:	11.
PERCENT	34.	41.	7.	0.	0.	9.	5.	0.	0.	5.	0.	0.	0.	
3 MILES	33:	30:	8:	0:	0:	10:	8:	3:	0:	0:	1:	0:	0:	93.
PERCENT	36.	33.	9.	0.	0.	11.	8.	3.	0.	0.	1.	0.	0.	
4 MILES	48:	44:	12:	2:	1:	7:	11:	8:	1:	2:	3:	1:	1:	140.
PERCENT	34.	32.	9.	1.	1.	5.	8.	6.	1.	1.	2.	0.	1.	
5 MILES	159:	108:	50:	15:	1:	16:	23:	13:	1:	3:	4:	1:	0:	394.
PERCENT	40.	27.	13.	4.	0.	4.	6.	3.	0.	1.	1.	0.	0.	
TOTAL MILES	244:	187:	71:	17:	2:	34:	43:	24:	2:	5:	7:	2:	1:	640.
PERCENT	38.	29.	11.	3.	0.	5.	7.	4.	0.	1.	1.	0.	0.	

Figure 14–b. Pavement Condition Deficiency Summary from RATGRP Output

PAVEMENT CONDITION DEFICIENCY SUMMARY
BITUMINOUS PAVEMENT

FUNCTIONAL	UNPAVED ROAD	EXEMPTIONS UNDER CONSTRUCTION	BRIDGE	IMPASSABLE	OTHER
MILES[1]	0.00	0.00	0.00	0.00	0.00
MILES[2]	0.00	1.40	0.21	0.00	0.70
MILES[3]	0.00	2.33	0.44	0.00	0.67
MILES[4]	0.00	1.76	1.11	0.00	0.99
MILES[5]	0.00	3.03	2.41	0.00	1.33
TOTAL MILES	0.00	8.52	4.17	0.00	3.69

Figure 14-c. Exemptions Report from RATGRP Output



R6TCO-RGEN 05/21/85

ROAD NUMBER	GEN	SIDE	BEGIN MILEPOST	END MILEPOST	EX	RUTT WEAR	WAVE SAGS	ALG CRK	RAV FLU	LONG CRK	TRNS CRK	PTCH	EDGE RAV	CONDITION PTCH	CONDITION <10	DEFECT RATING
10020	838	B	0.00	0.76	C	N	1N	1I	1N	1N	1N	1N	N	N		80/NN 100
10025	838	B	0.00	0.10	0	N	12	1N	1N	1N	1N	1N	N	N		100/NN 100
10030	838	B	0.00	0.20	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10035	838	B	0.00	0.29	0	N	1N	1N	1N	1N	1N	1N	N	N		95/1N 95
10040	838	B	0.00	0.21	0	N	12	1N	1N	1N	1N	1N	N	N		95/1N 95
10040	838	B	0.21	0.21	0	N	12	1N	1N	1N	1N	1N	N	N		100/NN 100
10045	838	B	0.00	0.43	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10050	838	B	0.00	0.50	0	N	11	1N	21F	1N	1N	1N	N	N		100/NN 100
10050	838	B	0.50	1.04	0	N	11	1N	21F	1N	1N	1N	N	N		95/N1 95
10050	838	B	1.19	1.29	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10050	838	B	1.31	2.00	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10050	838	B	2.00	2.42	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10060	83A	B	0.00	0.66	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10060	83A	B	0.67	0.71	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10065	83A	B	0.00	0.10	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10075	838	B	0.00	0.50	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10075	838	B	0.50	1.00	0	N	1N	1N	1N	1N	1N	1N	N	1		90/11 90
10075	838	B	1.00	1.29	0	N	1N	1N	1N	1N	1N	1N	N	1		90/11 90
10080	83A	B	0.00	0.09	0	N	1N	1N	1N	1N	1N	1N	N	N		95/1N 95
10081	83A	B	0.00	0.20	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10085	83A	B	0.00	0.07	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10087	838	B	0.00	0.03	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10095	838	B	0.00	0.17	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10095	838	B	0.17	0.50	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10095	838	B	0.50	1.00	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10095	838	B	1.00	1.30	0	N	2N	1N	1N	1N	1N	1N	N	N		95/1N 95
10100	838	B	0.27	0.41	0	N	1N	11	1N	1N	1N	1N	N	1		100/NN 100
10105	83		0.00	0.45	0	N	0	0	0	0	0	0	N	N		75/N1 95
10105	838	B	0.45	1.01	1	N	1N	1N	1N	1N	1N	23	N	3		100/ 100
10105	838	B	1.01	1.21	0	N	22	22	1N	1N	1N	23	N	3		45/N3 85
10105	838	B	1.21	1.82	0	N	2N	1N	1N	1N	1N	23	N	3		45/N3 85
10117	83A	B	0.00	0.06	0	N	1N	1N	1N	1N	1N	1N	N	N		-5/23 75
10120	83A	B	0.00	0.11	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10125	83A	B	0.00	0.07	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10135	838	B	0.00	0.50	0	N	11	1N	21F	1N	1N	1N	N	N		100/NN 100
10135	838	B	0.50	1.00	0	N	11	1N	21F	1N	1N	1N	N	N		100/NN 100
10140	838	B	0.44	0.50	0	N	11	1N	1N	1N	1N	1N	N	N		100/NN 100
10145	838	B	0.00	0.50	0	N	1N	1N	1N	1N	1N	23	N	N		100/NN 100
10145	838	B	0.50	0.99	0	N	1N	1N	1N	1N	1N	1N	N	1		60/NN 100
10150	83A	B	0.00	0.11	0	N	1N	1N	1N	1N	1N	1N	N	N		90/11 90
10151	83A	B	0.00	0.38	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10152	83A	B	0.00	0.23	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10160	83		0.00	0.04	0	N	0	0	0	0	0	0	N	N		100/ 100
10160	838	B	0.04	0.14	0	N	1N	1N	1N	1N	1N	1N	N	3		85/N3 85
10160	838	B	0.14	0.64	0	N	1N	11	21	12	1N	1N	N	3		40/13 80
10165	838	B	0.00	0.22	0	N	1N	1N	21R	1N	1N	1N	N	N		50/NN 100
10166	83A	B	0.00	0.05	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100
10180	838	B	0.00	0.50	0	N	1N	1N	1N	1N	1N	1N	N	N		100/NN 100

Figure 15. Example of RATGEN Output

```
START
COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

```
1  852020 1.00.041 ---------- Control Parameters                                00000100
2    .08    .15    .25 ------ Thickness Factors                                00000200
1  0.63   0.82   0.96   1.25 - Equation Factors                                  00000300
1  5050404040 ---------------- Should Levels                                     00000400
1  4040302030 ---------------- Must Levels                                       00000500
1  6.06.57.07.4 ------------- Traffic Index Ranges                              00000600
1  77777 ┐                                                                      00000700
1  77777 │                                                                      00000800-
1  77777 │ Selection Matrix for PCC Pavements                                   00000900
1  77777 │                                                                      00001000
1  77777 ┘                                                                      00001100
1  44444 ┐                                                                      00001200
1  44444 │                                                                      00001300
1  44444 │ Selection Matrix for Bituminous Pavements                            00001400
1  44444 │                                                                      00001500
1  44444 ┘                                                                      00001600
1  88886 ┐                                                                      00001700
1  88886 │                                                                      00001800
1  88886 │ Selection Matrix for Asphalt Pavements                               00001900
1  88886 │                                                                      00002000
1  66666 ┘                                                                      00002100
1  234 ┐                                                                        00002200
1  245 │                                                                        00002300
1  248 │                                                                        00002400
1  145 │                                                                        00002500
1  247 │ Alternative Combinations Array                                         00002600
1  456 │                                                                        00002700
1  345 │                                                                        00002800
1  459 │                                                                        00002900
1  457 ┘                                                                        00003000
```

	Rehab. Alt.	Const. Cost	Thickness	Equation Factors			Equation Constants	
1	BITUMINOUS SURF TREATMNT	14300	06	063	100		100008.27404	00003100
1	OVERLAY 0.06 CLASS C	20700	06	083		030	100000.66181	00003200
1	OVERLAY 0.08 CLASS G	21400	08	050			95000.66181	00003300
1	OVERLAY 0.15 CLASS B	32500	15	083	150	032	100000.22686	00003400
1	OVERLAY 0.25 CLASS B	52500	25	100	200	040	100000.05231	00003500
1	OVERLAY 0.35 CLASS B	62300	35	140	283	048	100000.13558	00003600
1	RECYCLE 0.15	32500	15	090			100000.66181	00003700
1	RECYCLE + 0.06 CLASS D	40100	21	100			100000.13558	00003800
1	0.35 CSTC + 0.25 AC	62300	60			079	100000.13558	00003900
1	ROUTINE MAINTENANCE							00004000
2	1 2 2 1 ---------- Cost Model Delimiters							00004100

Figure 16. List of Optimizing Parameters

R67CO-OPT

11/06/84

PROJECT NUMBER	ROAD NUMBER	ROAD NAME	BEGIN MILEPOST	END MILEPOST	PROJECT LENGTH	FUNCT CLASS	SURFACE TYP-THK	CONST YEAR	RDWY-RSH-LSH WIDTHS	TRAFFIC INDEX
P0060	10265	BAYVIEW DR NE	0.00	0.36	0.36	09	B .00	76	14 3 3	0.0

PERFORMANCE HISTORY

YEAR		76	77	79	81	83
AGE		0	1	3	5	7
RIDE	RATING	1.00	1.00	1.00	1.00	1.00
STRUCR	RATING	100.0	95.0	70.0	60.0	55.0
CUMBO	RATING	100.0	95.0	70.0	60.0	55.0
HIGH	RATING	100.0	95.0	70.0	60.0	55.0
LOW	RATING	100.0	95.0	70.0	60.0	55.0

PERFORMANCE EQUATION

EQUA CONST	= 98.05
EQUA COEFF	= -6.89020
EQUA POWER	= 1.00
R SQUARE	= 0.00000
STD ERROR	= 0.00
EQUA TYPE	= 2
EDGE PATCH	= NO

SHOULD REHABILITATE AT 40.0 WHICH WILL OCCUR IN 1984
MUST REHABILITATE AT 30.0 WHICH WILL OCCUR IN 1986
CONSIDERATION SPAN = 20 PERIODS, EACH PERIOD = 1.0 YEARS
EFFECTIVE INTEREST RATE = 4.0% FACTORS = 100.0% 150.0% 200.0%

DESCRIPTION OF THE ALTERNATIVES	PERFORMANCE EQUATIONS	CONSTRCT COST 12' LANE MILE	MIN LIFE AT SHLD	MAX LIFE AT MUST
ALTERNATE 1 ROUTINE MAINTENANCE	R = 98.05 - 6.89020 P ** 1.00	0	8.43	9.88
ALTERNATE 2 BITUMINOUS SURF TREATMNT	R = 100.00 - 8.27404 P ** 0.93	14300	8.37	9.88
ALTERNATE 3 OVERLAY 0.15 CLASS B	R = 100.00 - 0.22686 P ** 2.13	32500	13.78	14.61
ALTERNATE 4 OVERLAY 0.25 CLASS B	R = 100.00 - 0.05231 P ** 2.41	52500	16.53	19.75

ITEMIZED COSTS

ROUT MAINT COST	+ COST OF CONSTR INCL PR	+ COST OF TRAFFIC INTERPT	+ USER COST	- SALVAGE VALUE	= EXPECTED TOTAL COST	NUMB POSS	STRATEGY DESCRIPTION (ALTERNATIVE - PRD APPLIED) 1ST REHAB	2ND REHAB	3RD REHAB	4TH REHAB
						26				
6084	24787	0	0	4032	26839	16	2-86	2-94	2- 3	
3492	28325	0	0	2261	29556	6	3-86	2- 0		
2329	38707	0	0	4303	36733	4	4-86	2- 4		

Figure 17. Example of OPTAL Output

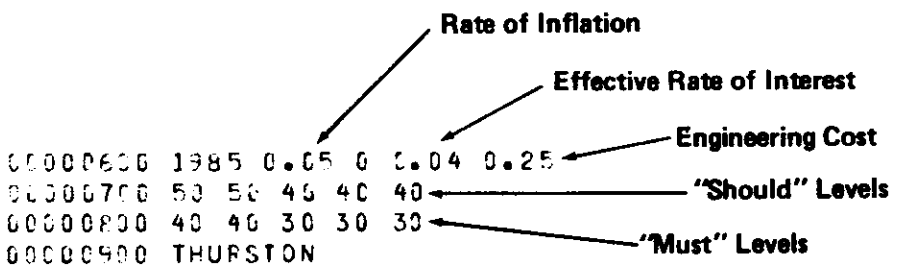


Figure 18. List of NETWORK Parameters

R67CO-NTWK

THURSTON COUNTY
1986 ACTION SUMMARY

11/27/84

	FC 1 ****	FC 2 ****	FC 3 ****	FC 4 ****	FC 5 ****
SHUD	50	50	40	40	40
MUST	40	40	30	30	30

FC	PROJ NUMBER	ROAD NAME	ROAD NUMBER	BEGIN MILEPOST	END MILEPOST	PROJ LENGTH	BEF RTNG	PROPOSED ACTION	PRESENT COST	INFLATED COST
09	P0060	BAYVIEW DR NE	10265	0.00	0.36	0.36	29.1	BITUMINOUS SURF TREATMNT	15124	15880
19	P0242	COUGAR ST SE	10960	0.00	0.54	0.54	0.0	OVERLAY 0.15 CLASS B	95346	100113
09	P0298	DENMARK ST SW	11160	0.00	0.94	0.94	19.1	BITUMINOUS SURF TREATMNT	56447	59269
09	P0358	EVERGREEN DR NE	11445	0.00	0.80	0.80	0.0	OVERLAY 0.08 CLASS G	81375	85443
09	P0419	GALLAGHER COVE RD NW	11705	0.00	1.00	1.00	32.4	BITUMINOUS SURF TREATMNT	51347	53914
09	P0466	GREGORY WAY SE	11935	0.00	0.34	0.34	6.0	OVERLAY 0.15 CLASS B	39558	41535
09	P0949	OLD MILITARY RD SE	13740	0.01	1.56	1.55	4.6	BITUMINOUS SURF TREATMNT	111650	117232
19	P1460	WILDCAT ST SE	15575	0.00	0.41	0.41	0.0	OVERLAY 0.15 CLASS B	72392	76011

Figure 19. Action Summary from NETWORK Output

R67CO-NT THURSTON COUNTY 11/27/84
1986 COST SUMMARY

	FC 1 ****	FC 2 ****	FC 3 ****	FC 4 ****	FC 5 ****
SHUD	50	50	40	40	40
MUST	40	40	30	30	30

FC 1 = PRINCIPAL ARTERIAL FC 2 = MINOR ARTERIAL FC 3 = MAJOR COLLECTOR FC 4 = MINOR COLLECTOR FC 5 = LOCAL ACCESS

FC	RTNG AVG BEF ACTN	RTNG AVG AFT ACTN	NUMB PROJ	MILES ACTED ON	TOTAL MILES	% ACTED ON	PRESENT COST	INFLATED COST	DISCOUNTED COST
1	0	0	0	0	0	0 %	0	0	0
2	0	0	0	0	0	0 %	0	0	0
3	71	71	0	0	1	0 %	0	0	0
4	0	0	0	0	0	0 %	0	0	0
5	34	76	8	5	12	45 %	523239	549397	503113
ALL	36	76	8	5	14	35 %	523239	549397	503113

Figure 20. Cost Summary from NETWORK Output

R67CO-NT

THURSTON COUNTY
1986 RATING DISTRIBUTION SUMMARY

11/27/84

	FC 1 ****	FC 2 ****	FC 3 ****	FC 4 ****	FC 5 ****
SHUD	50	50	40	40	40
MUST	40	40	30	30	30

FC 1 = PRINCIPAL ARTERIAL FC 2 = MINOR ARTERIAL FC 3 = MAJOR COLLECTOR FC 4 = MINOR COLLECTOR FC 5 = LOCAL ACCESS

LANE MILES IN RATING GROUP BEFORE ACTION

FC	100-91	90-81	80-71	70-61	60-51	50-41	40-31 *****	30-21	20-11	10 -0	AVG RTNG	TOTAL MILES
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.2	1.1
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	0.0	0.0	3.2	0.0	1.2	1.8	1.9	0.4	0.9	3.6	34.0	13.0
ALL	0.0	0.0	4.2	0.0	1.2	1.8	1.9	0.4	0.9	3.6	36.8	14.1

LANE MILES IN RATING GROUP AFTER ACTION

FC	100-91	90-81	80-71	70-61	60-51	50-41	40-31 *****	30-21	20-11	10 -0	AVG RTNG	TOTAL MILES
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.2	1.1
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	5.9	0.0	3.2	0.0	1.2	1.8	0.9	0.0	0.0	0.0	76.8	13.0
ALL	5.9	0.0	4.2	0.0	1.2	1.8	0.9	0.0	0.0	0.0	76.3	14.1

Figure 21. Rating Distribution Summary from NETWORK Output

R67CO-NTWK

THURSTON COUNTY
1986 ACTION SUMMARY

06/08/85

	FC 1 ****	FC 2 ****	FC 3 ****	FC 4 ****	FC 5 ****
SHUD	50	50	40	40	40
MUST	40	40	30	30	30

FC	PROJ NUMBER	ROAD NAME	ROAD NUMBER	BEGIN MILEPOST	END MILEPOST	PROJ LENGTH	REF RTNG	PROPOSED ACTION	PRESENT COST	INFLATED COST
19	P0242	COUGAR ST SE	10960	0.00	0.54	0.54	0.0	OVERLAY 0.15 CLASS B	95346	100113
09	P0358	EVERGREEN DR NE	11445	0.00	0.80	0.80	0.0	OVERLAY 0.08 CLASS C	81375	85443

Figure 22(a). NETWORK Action Summary Under a Budget Constraint

R67CO-NT

THURSTON COUNTY
1986 COST SUMMARY

06/08/85

	FC 1 ****	FC 2 ****	FC 3 ****	FC 4 ****	FC 5 ****
SHUD	50	50	40	40	40
MUST	40	40	30	30	30

FC 1 = PRINCIPAL ARTERIAL FC 2 = MINOR ARTERIAL FC 3 = MAJOR COLLECTOR FC 4 = MINOR COLLECTOR FC 5 = LOCAL ACCESS

FC	RTNG AVG BEF ACTN	RTNG AVG AFT ACTN	NUMB PROJ	MILES ACTED ON	TOTAL MILES	% ACTED ON	PRESENT COST	INFLATED COST	DISCOUNTED COST
1	0	0	0	0	0	0 %	0	0	0
2	0	0	0	0	0	0 %	0	0	0
3	71	71	0	0	1	0 %	0	0	0
4	0	0	0	0	0	0 %	0	0	0
5	34	46	2	1	12	10 %	176721	185556	169924
ALL	36	48	2	1	14	7 %	176721	185556	169924

Figure 22(b). NETWORK Cost Summary Under a Budget Constraint

R67CO-NT

THURSTON COUNTY
1986 RATING DISTRIBUTION SUMMARY

06/08/85

	FC 1 ****	FC 2 ****	FC 3 ****	FC 4 ****	FC 5 ****
SHUD	50	50	40	40	40
MUST	40	40	30	30	30

FC 1 = PRINCIPAL ARTERIAL FC 2 = MINOR ARTERIAL FC 3 = MAJOR COLLECTOR FC 4 = MINOR COLLECTOR FC 5 = LOCAL ACCESS

LANE MILES IN RATING GROUP BEFORE ACTION ******

FC	100-91	90-81	80-71	70-61	60-51	50-41	40-31	30-21	20-11	10 -0	AVG RTNG	TOTAL MILES
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.2	1.1
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	0.0	0.0	3.2	0.0	1.2	1.8	1.9	0.4	0.9	3.6	34.0	13.0
ALL	0.0	0.0	4.2	0.0	1.2	1.8	1.9	0.4	0.9	3.6	36.8	14.1

LANE MILES IN RATING GROUP AFTER ACTION *****

FC	100-91	90-81	80-71	70-61	60-51	50-41	40-31	30-21	20-11	10 -0	AVG RTNG	TOTAL MILES
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.2	1.1
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	1.3	0.0	3.2	0.0	1.2	1.8	1.9	0.4	0.9	2.3	46.3	13.0
ALL	1.3	0.0	4.2	0.0	1.2	1.8	1.9	0.4	0.9	2.3	48.2	14.1

Figure 22(c). NETWORK Rating Distribution Summary Under a Budget Constraint

REFERENCES

1. Kulkarni, R., Finn, F., and Lamont, A. (1984), "Feasibility Study of a Pavement Management System for Washington Counties", Final Report submitted to Thurston County, Washington.

APPENDIX A
USERS GUIDE

The Programs used in the Pavement Management System are: REFORM, RATGEN, RATGRP, MASTINDX, BUILDGEN, SORTGEN, MASTLIST, INTERP, OPTIM, NETWORK, and MASTRAT. This is a brief description of the JCL (Job Control Language) which one would use to run or execute these programs on the Washington State Department of Transportation computer system.

To run each of the JCL Datasets, one uses the SPF (System Productivity Facility) package of the WSDOT computer system. At the ready prompt on the terminal, type "SPF 2" (with a space between the "F" and "2"), then hit Enter or Return to gain access to the SPF Edit mode. In this mode, one may make the modifications necessary to use the agency's data. When the SPF Edit Menu screen appears, enter the appropriate JCL dataset name on the line asking for "other partitioned or sequential data set:

DATA SET NAME =".

After typing in the name and pushing Enter, the dataset appears on the screen as in the examples. Make the changes to run the data, move the cursor to the "COMMAND" line of the screen, and type in "SUB" and hit Enter. This will submit the JCL dataset to the run mode screen, which will show:

"ENTER ADDITIONAL RUN PARAMETERS
RUN * "

Hit Enter at this time to run the job at premium cost rate or type in "CLA(7)" to run at discount rate overnight. After hitting Enter, one receives a Job Number. Hit Enter again to return to the Edit Mode screen. Type in "CANCEL" on the COMMAND line and hit Enter to exit from the SPF Edit Mode.

REFORM

REFORM reformats survey data from its raw format (as it was coded) into a format useable to the Pavement Management System. It is run by the dataset CRABPMS.JCLLIB.DATA(REFORM)". To edit this dataset: change line 300 to the name of the raw survey dataset and line 1700 to the name of the reformatted dataset. (Recommended names are "UID.RAW.SURVEYyr.DATA" and "UID.SURVEYyr.DATA", where UID stands for the LOGON USER IDENTIFICATION, and yr is the year in which the survey was conducted.)

```
START
COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
  1  //SORT     EXEC PGM=SORT
  1  //SYSOUT   DD SYSOUT=A                                                    00000100
  1  //SORTIN   DD DISP=SHR,DSN=UID.RAW.SURVEY85.DATA                          00000200
  1  //SORTOUT  DD DSN=&&TEMP2A,UNIT=WORK,                                     00000300
  1  //              DISP=(,PASS),SPACE=(6160,(20,20),RLSE),                  00000400
  1  //              DCB=(RECFM=FB,LRECL=80,BLKSIZE=6160)                     00000500
  1  //SORTWK01 DD UNIT=WORK,SPACE=(CYL,(2,2))                               00000600
  1  //SORTWK02 DD UNIT=WORK,SPACE=(CYL,(2,2))                               00000700
  1  //SORTWK03 DD UNIT=WORK,SPACE=(CYL,(2,2))                               00000800
  1  //SORTWK04 DD UNIT=WORK,SPACE=(CYL,(2,2))                               00000900
  1  //SYSIN DD *                                                            00001000
  3    SORT FIELDS=(1,5,A,7,5,A,26,1,A),FORMAT=CH                            00001100
  1  /*                                                                      00001200
  1  //STEP1 EXEC PGM=REFORM                                                 00001300
  1  //STEPLIB DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                              00001400
  1  //FT05F001 DD DSN=*.SORT.SORTOUT,UNIT=WORK,DISP=(OLD,DELETE)            00001500
  1  //FT09F001 DD DSN=UID.SURVEY85.DATA,DISP=(,CATLG),UNIT=USER,            00001600
  1  //              DCB=(RLCFM=FB,LRECL=80,BLKSIZE=6160),SPACE=(6160,(20,10),RLSE)  00001700
  1  //FT06F001 DD SYSOUT=A                                                  00001800
  1  /*                                                                      00001900
                                                                            00002000
```

RATGEN and RATGRP

RATGEN and RATGRP both use the reformatted dataset from REFORM as input. While output is paper or hardcopy, no computer file is created. They are run by using their respective JCL Datasets, "CRABPMS.JCLLIB.DATA(XRATGEN)" and "CRABPMS.JCLLIB.DATA(XRATGRP)", and changing line 400 to the name of the dataset and changing line 700 to the year of the survey.

```
START
 COL    ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8

   1  //RATGEN EXEC PGM=RATGEN                                                  00000100
   1  //STEPLIB DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                                00000200
   1  //FT04F001  DD DSN=XXX.PMS.LIB.DATA(PARMINTP),DISP=SHR                    00000300
   1  //FT05F001 DD DSN=UID.SURVEY85.DATA,DISP=SHR                              00000400
   1  //FT06F001  DD SYSOUT=A                                                   00000500
   1  //FT10F001  DD *                                                          00000600
   1  85                                                                        00000700
   1  /*                                                                        00000800
```

```
START
 COL    ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8

   1  //RATGRP EXEC PGM=RATGRP                                                  00000100
   1  //STEPLIB DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                                00000200
   1  //FT04F001  DD DSN=XXX.PMS.LIB.DATA(PARMINTP),DISP=SHR                    00000300
   1  //FT05F001 DD DSN=UID.SURVEY85.DATA,DISP=SHR                              00000400
   1  //FT06F001  DD SYSOUT=A                                                   00000500
   1  //FT10F001  DD *                                                          00000600
   1  85                                                                        00000700
   1  /*                                                                        00000800
```

MASTER INDEX FILE

To build the Master Index File of project segments from the County Road Log, use the COMMAND LIST (CLIST) created for the State Aid Section. To print this file, use "CRABPMS.JCLLIB.DATA(MASTINDX)"--change line 300 to match the Master Index File dataset name.

```
START
COL ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
  1  //MASTINDX EXEC PGM=MASTINDX
  1  //STEPLIB  DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                          00000100
  1  //FT05F001 DD DSN=UIC.PMS00.DATA,DISP=SHR                            00000200
  1  //FT06F001  DD SYSOUT=A                                              00000300
  1  /*                                                                  00000400
                                                                         00000500
```

BUILDGEN - COMBINE MASTER INDEX FILE AND SURVEY DATA

To combine the Master Index File with the Survey data, edit "CRABPMS.JCLLIB.DATA(BUILDGEN)"--change line 400 to match the Master Index File name, line 300 to match the Survey data file name, line 600 to match the output dataset name, and line 900 to match the respective year of survey data being combined or built.

```
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8

   1  //BUILDGEN EXEC PGM=BUILDGEN                                                00000100
   1  //STEPLIB  DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                                 00000200
   1  //FT04F001  DD DSN=UID.SURVEY85.DATA,DISP=SHR                               00000300
   1  //FT05F001 DD DSN=UID.PMS00.DATA,DISP=SHR                                   00000400
   1  //FT06F001  DD SYSOUT=A                                                     00000500
   1  //FT09F001  DD DSN=UID.GENERYR.DATA,DISP=(,CATLG),UNIT=USER,                00000600
   1  //         DCB=(RECFM=FB,LRECL=120,BLKSIZE=6120),SPACE=(6120,(10,10),RLSE)  00000700
   1  //FT10F001  DD *                                                            00000800
   1  85                                                                         00000900
   1  /*                                                                         00001000
```

SORTGEN - COMBINE ALL YEARS OF SURVEY

To combine all years of survey, use "CRABPMS.JCLLIB.DATA(SORTGEN)"--change lines 300 through 500 to match the names of the datasets built previously in BUILDGEN, add as many other input lines as necessary to add all generations of data together, and change line 600 to the output dataset name. This utility will sort all years of generation together by project and within each project by year of survey from oldest to most recent and within each year by lowest milepost to highest milepost.

```
START
 COL ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
   1 //SORT     EXEC PGM=SORT
   1 //SYSOUT   DD SYSOUT=A                                                    00000100
   1 //SORTIN   DD DISP=SHR,DSN=UID.GENER84.DATA                              00000200
   1 //         DD DISP=SHR,DSN=UID.GENER85.DATA                              00000300
   1 //         DD DISP=SHR,DSN=UID.GENER86.DATA                              00000400
   1 //SORTOUT DD DSN=UID.ALLGENYR,UNIT=USER,                                 00000500
   1 //            DISP=(,CATLG),SPACE=(6120,(20,20),RLSE),                   00000600
   1 //            DCB=(RECFM=FB,LRECL=120,BLKSIZE=6120)                      00000700
   1 //SORTWK01 DD UNIT=WORK,SPACE=(CYL,(2,2))                                00000800
   1 //SORTWK02 DD UNIT=WORK,SPACE=(CYL,(2,2))                                00000900
   1 //SORTWK03 DD UNIT=WORK,SPACE=(CYL,(2,2))                                00001000
   1 //SYSIN DD *                                                            00001100
   3   SORT FIELDS=(33,5,A,44,5,A,75,2,A,77,5,A),FORMAT=CH                   00001200
   1 /*                                                                      00001300
                                                                             00001400
```

MASTLIST

To run MASTLIST, which is a listing of all survey data for each project, use "CRABPMS.JCLLIB.DATA(MASTLIST)"--change line 400 to match the Master File Dataset, which was the output from the latest attempt at SORTGEN.

```
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
   1  //MASTLIST EXEC PGM=MASTLIST                                          00000100
   1  //STEPLIB DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                            00000200
   1  //FT04F001 DD DSN=XXX.PMS.LIB.DATA(PARMINTP),DISP=SHR                 00000300
   1  //FT05F001 DD DSN=UID.ALLGENYR.DATA,DISP=SHR                          00000400
   1  //FT06F001  DD SYSOUT=A                                               00000500
   1  /*                                                                    00000600
```

INTERP

To run INTERP, use "CRABPMS.JCLLIB.DATA(INTERP)"--change line 400 to the Master File Dataset name as input and line 600 to the interpreting file output name.

```
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
   1  //STEP1 EXEC PGM=INTERP
   1  //STEPLIB DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                                  00000100
   1  //FT04F001 DD DSN=XXX.PMS.LIB.DATA(PARMINTP),DISP=SHR                       00000200
   1  //FT05F001 DD DSN=UID.ALLGEN85.DATA,DISP=SHR                                00000300
   1  //FT06F001 DD SYSOUT=A                                                      00000400
   1  //FT09F001 DD DSN=UID.INTERP85.DATA,DISP=(,CATLG),UNIT=USER,                00000500
   1  //    SPACE=(6015,(10,10),RLSE),DCB=(RECFM=FB,LRECL=401,BLKSIZE=6015)      00000600
   1  /*                                                                          00000700
                                                                                  00000800
```

OPTIMIZING

To run OPTIMIZE, use "CRABPMS.JCLLIB.DATA(OPTIM)"--change line 400 to the input file which would be the output from an interpreting run and line 600 to the name of the optimization run filename.

```
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
   1  //OPTIM  EXEC PGM=OPTIM                                                  00000100
   1  //STEPLIB  DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                              00000200
   1  //FT04F001 DD DSN=XXX.PRS.LIB.DATA(PARMOPT),DISP=SHR                     00000300
   1  //FT05F001 DD DSN=UID.INTERP85.DATA,DISP=SHR                             00000400
   1  //FT06F001 DD SYSOUT=A                                                   00000500
   1  //FT09F001 DD DSN=UID.OPTIM85.DATA,UNIT=USER,                            00000600
   1  //             DISP=(,CATLG),SPACE=(6000,(10,10),RLSE),                  00000700
   1  //             DCB=(RECFM=FB,LRECL=250,BLKSIZE=6000)                     00000800
   1  /*                                                                       00000900
```

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NETWORK

To run NETWORK, use "CRABPMS.JCLLIB.DATA(NETWORK)"--change line 300 to the optimized output dataset name, line 600 to the start year, and line 900 to the county name.

```
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
   1  //STEP1  EXEC PGM=NETWRK                                                  00000100
   1  //STEPLIB  DD DSN=XXX.PMS.LOAD.LIB,DISP=SHR                               00000200
   1  //FT05F001   DD DSN=UID.OPTIM85.DATA,DISP=SHR                             00000300
   1  //FT06F001  DD SYSOUT=A                                                   00000400
   1  //FT04F001  DD *                                                          00000500
   1  1985  0.05  0  0.04  0.25                                                 00000600
   1  50  50  40  40  40                                                        00000700
   1  40  40  30  30  30                                                        00000800
   1  THURSTON                                                                  00000900
   1  /*                                                                        00001000
```

NETWORK CONSTRAINTS (See also Page 5-16)

There are two types of constraints which may be used for network analysis. One may use a budget constraint, that is, one decides how much funding will exist for each year of a six (6) year budget cycle and put those values in the JCL to arrive at how many and which projects will be rehabilitated each year. At the conclusion of this run, one would know what effect those budget constraints would have on the serviceability of the highway system.

The other type of constraint is service level. One selects the minimum level of service at which the system must be performing at the end of each year. At the conclusion of this run, one would know how much it would cost the agency each year to achieve these levels of service.

Both of these JCL statements are quite large, however, the actual number of lines which must be changed are not so large. To run Budget Constraints, use "CRABPMS.JCLLIB.DATA(BUDGNET)"--change line 800 to the optimized output dataset name; lines 1800, 4000, 5500, 7700, 9200, 11400, 12900, 15100, 16600, 18800, 20300, and 22500 to the year and budget level for each respective year of the six-year program; line 24400 to the start year; and line 24700 to the county name. To run Service Level Constraint, use "CRABPMS.JCLLIB.DATA(SERVNET)"--change the line numbers as for BUDGNET, only this time use a level of service in place of budget.