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Close cooperation among Texas State Department of Highways and Public Transportation district maintenance operational personnel, central office representatives and the Texas Transportation Institute study team together with a review of the literature provided the necessary information to develop selected maintenance management tools. These management tools consist of maintenance performance standards, cost codes and a maintenance rating system which has been implemented in part by the Texas State Department of Highways and Public Transportation.

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Research Report 151-4F

Maintenance Quality, Methods and Ratings

Research Study No. 2-18-71-151

Sponsored by

Texas State Department of Highways and Public Transportation
In Cooperation with the
U. S. Department of Transportation
Federal Highway Administration

September 1976

Texas Transportation Institute
Texas A&M University
College Station, Texas

PREFACE

This is the final report issued under Research Study 2-18-71-151, "Maintenance Quality, Methods and Ratings". This report presents a review of maintenance management tools developed in this study and suggested for use by the Texas State Department of Highways and Public Transportation. Research efforts sponsored by the Federal Highway Administration and the National Cooperative Highway Research Program contributed information useful in the development of the maintenance rating system.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the Texas State Department of Highways and Public Transportation personnel in all 25 districts as well as representatives from Divisions D-10, D-13, D-18 and D-19 for their time and efforts expended in defining current maintenance methods and activities, review of these methods and guidance in preparing the type of information necessary for the development of an effective maintenance rating system. Special thanks are due personnel in Districts 21 and 7 who generously gave of their time for the development of the maintenance rating system.

ABSTRACT

Close cooperation among Texas State Department of Highways and Public Transportation district maintenance operational personnel, central office representatives and the Texas Transportation Institute study team together with a review of the literature provided the necessary information to develop selected maintenance management tools. These management tools consist of maintenance performance standards, cost codes and a maintenance rating system which has been implemented in part by the Texas State Department of Highways and Public Transportation.

Key Words: Maintenance methods, cost codes, maintenance rating, management, equipment, materials.

SUMMARY

The basic elements of a maintenance management system have been recognized and defined. These elements include maintenance standards, inventory of maintainable facilities, maintenance work load, budgeting, planning and scheduling and management information systems. This report delineates the development of maintenance standards cost codes and a maintenance rating system by establishing panels consisting of Texas State Department of Highways and Public Transportation district maintenance personnel, central office personnel and members of the Texas Transportation Institute.

The literature reviewed as part of this and associated studies has been instrumental in the development of the management tools developed in this study. Flexible management tools capable of satisfying a large number of needs yet capable of accepting anticipated necessary changes have been developed and are offered for general use by Texas as well as other states.

IMPLEMENTATION STATEMENT

The maintenance management tools developed as part of this study and reported herein are either being implemented or scheduled for implementation.

Implementation of the standardized maintenance methods are widespread, as the methods developed are employed in on-going activities. Implementation of these methods and cost codes are expected to improve efficiency and provide for more uniform maintenance activities throughout the state.

The maintenance rating method has been introduced into all 25 districts and has been utilized in its entirety by one district for a three-year period. Other districts have implemented the visual rating portion of the rating system.

The establishment of permanent review panels composed of district maintenance operational personnel and the establishment of a section within the maintenance operations division (D-18) may be necessary to successfully carry out the task of continued review of the methods, codes and rating system.

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INTRODUCTION

Funding for highway maintenance operations in Texas as well as most states comprises a significant and continually increasing portion of the total highway budget. The increasing public demand for high levels of service constantly widens the gap between funds available for maintenance operations and the funds required to provide the desired level of service. The existence of this situation makes it imperative to develop a system that will assist engineers in short and long range maintenance and rehabilitation planning. Such systems, hereafter referred to as maintenance management systems, have been developed or are being developed in thirty-three states (1) and several cities and counties.

Research Study 2-18-71-151, "Maintenance Quality, Methods and Ratings", a cooperative study between the Texas State Department of Highways and Public Transportation and the Texas Transportation Institute responded to this need in Texas by developing selected management tools as outlined by the study objectives given below.

1. Develop a system by which all highway maintenance operations can be coded and placed into functional groups,

2. Develop maintenance quality standards and maintenance methods for various highway classes,

3. Develop a maintenance rating system that can be used as a basis to schedule highway maintenance operations and

4. Implement on a trial basis the maintenance rating system and assess the established quality standards and maintenance methods.

References 2 and 3 describe the development of the maintenance

operation codes, quality standards and maintenance methods. These codes and methods are scheduled for implementation by the Texas State Department of Highways and Public Transportation. Reference 4 describes the maintenance rating system. Implementation of the maintenance rating system together with the establishment of refinements in the system were developed in Research Study 2-18-75-199. This one-year research study was a cooperative study between the Texas State Department of Highways and Public Transportation and the Texas Transportation Institute. The primary work items in this study were as follows:

1. Implement the Maintenance Rating System developed in Research Study 2-18-71-151,

2. Conduct a statewide survey on 250 randomly selected roadway sections,

3. Re-evaluate the assigned weighting factors of the various types of observed distress and roadway conditions and

4. Develop an urban visual rating system.

Statewide survey data were collected on the randomly selected roadway sections. The survey consisted of Mays Ride Meter roughness data and visually obtained maintenance rating scores. These data will furnish background comparisons with data of future reports scheduled for Research Study 2-8-75-207.

Weighting factors assigned to the various types of observed distress and roadway conditions were based primarily on experience gained in Districts 7 and 21 together with information published in the literature. Sufficient data from other districts representing other geographical areas were not available prior to the termination of this project to make rational adjustments in the proposed weighting or deduct factors.

Implementation of the Maintenance Rating System and development of an urban rating system which are items 1 and 4 of Research Study 2-18-75-199 work plan are discussed in detail in reference 5.

Texas Transportation Institute staff participation in other research efforts during the conduct of Research Studies 2-18-71-151 and 2-18-75-199 and a research project titled "Pavement Evaluation" sponsored by the Federal Highway Administration afforded the opportunity for Texas Transportation Institute personnel to review 34 pavement rating systems presently utilized by state, county and city agencies (6). This study also utilized data collected under Research Study 2-18-71-151 in Districts 7 and 21 to determine those types of pavement distress which contribute most heavily to the maintenance urgency rating of pavements.

An evaluation of the Transportation Research Board organized and Federal Highway Administration sponsored Workshop on Pavement Rehabilitation was prepared by B. F. McCullough and J. A. Epps (7). This evaluation summarized the four-day meeting attended by representatives from agencies throughout the United States and Canada. The overall objectives of the workshop were to establish a better understanding of pavement rehabilitation concepts, operations and needs so that the framework for a rational pavement rehabilitation design procedure could be formulated and used as a guide for future research and development studies. This workshop was instrumental in defining the needed interaction between maintenance management pavement information and information required for pavement rehabilitation purposes.

C. V. Wootan and J. A. Epps participated in a three-day workshop to develop national highway maintenance research needs (8). The product of this workshop sponsored by the Federal Highway Administration and

organized by the Transportation Research Board was a priority listing of 28 maintenance research study outlines. This conference was instrumental in identifying national and state needs in the area of maintenance research for Texas Transportation Institute personnel. These research project listings have been considered by the Texas State Department of Highways and Public Transportation Area II research committees.

C. V. Wootan and J. A. Epps participated in the development of a National Cooperative Highway Research Program Synthesis titled "Recording and Reporting Methods for Highway Maintenance Expenditures" (9). This synthesis was developed under NCHRP Project 20-5, Topic 7-04 and afforded Texas Transportation Institute personnel the opportunity to obtain detailed information from 11 states concerning their present maintenance recording and reporting systems.

The close cooperation between the Texas State Department of Highways and Public Transportation and the Texas Transportation Institute, considered necessary for successful completion of the study and referred to above, was obtained by three means of formal contact.

1. A study contact man representing the maintenance operations division of the Texas State Department of Highways and Public Transportation was appointed to devote approximately one-half time to the study. The same person has served in this capacity for the duration of the project. He has maintained contact with both the study supervisors at the Texas Transportation Institute and district personnel of the Texas State Department of Highways and Public Transportation.

2. Study panels were established to identify maintenance activities, develop maintenance methods, and to define the type of

information that would be useful for maintenance management purposes. These panels were comprised of district supervisory maintenance personnel from each of the twenty-five districts.

3. An advisory group was formed consisting of representatives of the Texas State Department of Highways and Public Transportation concerned with design, materials and tests, research and maintenance, representatives of the Federal Highway Administration and representatives of the Texas Transportation Institute. The purpose of this group was to furnish overall guidance to the project.

Formal meetings, together with informal contacts made while traveling and after meetings, established lines of personal communication between the study supervisors, maintenance operations division contact representative and the district maintenance personnel. Understanding and acceptance of the information developed in the project was thus greatly enhanced.

Study panels, as will be discussed below, formed the working element of these research studies. These panels were responsible for identifying the types of maintenance activities currently performed by the Texas State Department of Highways and Public Transportation for preparing the maintenance methods and for guidance in selecting the appropriate approach to the maintenance evaluation portion of the project.

The report that follows is intended to summarize the maintenance management tools developed by the Texas Transportation Institute and the Texas State Department of Highways and Public Transportation personnel during the conduct of Research Studies 2-18-71-151 and 2-18-75-199. The basic structure of a maintenance management system will be introduced and utilized to provide the framework for the report.

COMPONENTS OF A MAINTENANCE MANAGEMENT SYSTEM

As indicated above, more than thirty-three state, county and city agencies have operating or are developing maintenance management systems. As may be anticipated, the needs of these states, counties and cities vary. A review of Table 1 indicates the magnitude of the maintenance budget, lane miles of highway to maintain, population, climates, etc., for eleven states (9) and points out the wide variation in requirements among states. Thus, no two systems are identical; but, most of the systems have key elements or components which can be recognized. In general, the basic components of these maintenance management systems include the following:

1. Maintenance standards,
2. Inventory of maintainable facilities,
3. Maintenance work load,
4. Budgeting,
5. Planning and scheduling and
6. Management information systems (10).

Maintenance standards are developed to formally establish criteria for determining the need for work, the required quality of work and the resources necessary to achieve that quality and expected productivity rate. Maintenance standards are developed for those maintenance activities which consume a large portion of the maintenance budget. Usually at least 95 percent of maintenance expenditures can be defined by maintenance standards (11).

Three types of maintenance standards can be identified; quality standards, quantity standards and performance standards. Quality

TABLE 1. General Information for Eleven States

State	Annual Maintenance Budget (Dollars)	Lane Miles of Highway	Approximate Cost Per Lane Mile	Population	Motor Vehicles	People Per Vehicle	Maintenance Cost Per Vehicle ($/year)	Area of State, Square Miles	Range of Annual Average Moisture, Inches	Temper Extrem Averag and Ho	ture s, Cold Month, °F	Range in Elevation Feet
California	153,000,000	45,000	3,400	20,601,000	13,413,000	1.5	11.40	158,693	4-96	8-	16	-282 to 14,494
Hawaii	10,000,000	2,200	4,550	832,000	477,780	1.7	20.90	6,450	10-450	63-	5	0 to 13,796
Illinois	79,000,000	38,000	2,100	11,236,000	5,952,000	1.8	13.30	56,400	32-48	14-	)	279 to 1,235
Louisiana	86,000,000	36,225	2,400	3,764,000	2,057,000	1.8	41.80	48,523	48-64	36-	)	-5 to 536
Minnesota	53,000,000	29,000	1,800	3,897,000	2,452,616	1.5	21.60	84,068	20-32	-8-	3	602 to 2,301
Nevada	15,500,000	11,794	1,300	548,000	437,000	1.2	35.50	110,540	4-28	4-	.0	470 to 13,143
North Dakota	14,350,000	15,160	950	640,000	490,000	1.3	29.30	70,655	14-20	-10-	3	750 to 3,505
Pennsylvania	201,000,000	75,569	2,650	11,794,000	6,800,000	1.7	29.50	45,333	36-52	14-	3	0 to 3,213
Tennessee	38,485,000	23,500	1,600	4,126,000	2,467,000	1.6	15.40	42,244	40-76	22-	3	182 to 6,643
Washington	40,000,000	17,000	2,400	3,429,000	2,370,000	1.4	16.90	68,192	8-120	8-	3	0 to 14,410
Wyoming	17,000,000	14,620	1,160	353,000	294,000	1.2	51.00	97,914	8-56	-8-		3,100 to 13,804

after reference 9.

standards describe the results to be achieved in terms of the resulting conditions of the highway or in terms of a specific frequency of performance. They may also be expressed in terms of the specific amount of work to be done per unit of highway or the thresholds at which certain maintenance activities should be carried out. Quality standards should represent policy decisions by top management regarding the "level of service" to be provided by the highway system. Quality standards are generally thought of as subjective measures; although many, such as mowing height or shoulder drop off standards, are objective in nature.

Quantity standards, sometimes called frequency standards or work load rates, identify by activity the amount of work set as a standard for a given class of highway or type of pavement in order to sustain the facility at a particular level. Quality standards, when stated in terms of work to be performed, become quantity standards. Quantity standards ususally reflect annual resource requirements needed to attain quality standards. These standards are usually set by policy, judgement based on past experience, historical data or a combination of these factors.

Performance standards usually outline methods of performing maintenance activities and the rate at which work is to be accomplished. These standards describe work methods to be used in performing the activity; the optimum crew configuration in terms of the numbers and classification of labor; the types and numbers of equipment units; the amounts of material required per unit of work accomplishment; the unit of measurement to define accomplishment and a standard average productivity rate for the maintenance activity described.

Highway agencies need information to formulate and evaluate policies,

to plan and design highways and to administer the construction, maintenance and operation of the highway facility. Roadway inventories are part of the basic information that is required to accomplish these tasks. Lane miles of highway pavement by type, bridges, drainage facilities, roadside maintenance features, rest stops, buildings, etc., are types of information that are collected. Inventory data should be collected with the end use of the data in mind. One of these end uses is formulation of the maintenance work load.

Work load is determined by the quantity and criticality of maintenance needs and the desired service level to be maintained. Examples of work load values include quantity of paving material to be placed per lane mile of highway and mowing frequency.

The maintenance budget should accurately reflect the proposed maintenance program. A program-oriented or performance budget is expressed in units of work to be accomplished by the various maintenance activities being programmed. The budget is achieved by developing a program of work units to be accomplished by the desired maintenance administrative sub-division and applying the appropriate unit costs to the work unit. Costs are determined from work units by use of performance standards together with standard labor usage rates, standard equipment rental rates, material unit costs and standard production rates. The budget must also include all items to be performed by outside contract as well as those being performed by the maintenance force itself.

The basic tools used in planning and scheduling include the following:

1. Seasonal-schedule of maintenance activities which provides a general planning framework,

2. A yearly schedule of maintenance activities often prepared during budget preparation and

3. Weekly, biweekly and/or monthly crew scheduling performed by the crew leader or foreman, or a maintenance section supervisor.

The establishment of a maintenance information system which provides the basic information required by operating managers for routine decisions and by top management for program control and improvement is a vital element of the maintenance management system. Accurate information must be recorded and assembled for easy and timely interpretation. The basic information required must be recorded at the field level with the individual workman or crew leader usually performing this function. Reports can be quickly assembled and analyzed through the use of data processing equipment. The types of reports generated should fit the end use of the report at a particular management level.

MAINTENANCE STANDARDS

The major accomplishment in the area of maintenance standards performed as a part of Research Study 2-18-71-151 was the development of maintenance performance standards (2). Initial work on this phase of the study identified methods to classify maintenance activities. A review of the literature resulted in Table 2 being developed and reported in reference 2. Subsequent review of eleven state maintenance management systems documented in Appendix A of this report add to this body of information.

Based on Table 2 and discussions with Texas State Department of Highways and Public Transportation Maintenance Operations Division personnel, five major areas were identified for the purpose of establishing study panels. These panels were formed during the first 6 months of the project and were composed of district personnel, repre-

TABLE 2. Classification of Maintenance Operations

Present THD Method (6)	Proposed THD (7)	AASHO (8)	THD (Proposed) District 2 (9)	NCHRP Report 42 (10)	Arizona (11)	California (12)	Florida (13)	Proposed Idaho (14)	Proposed Iowa (15)
Base & Surface	Subgrade	Routine Roadway	General Section Expense	Routine Roadway Surface Operations	Routine Surface	General Maintenance	Bridges	Traffic Services	Overhead Operations
Shoulders, Side Approaches, Roadside Drainage & Structures	Base	Special Roadway Surface	Regular Roadway	Special Roadway Surface Operations	Shoulders & Sides	Major Slides & Storm Drainage Repair	Tunnels	Traveled Roadway	Routine Surface
Guide Markings, Markers, Signs, Signals, & Lighting	Surface	Shoulders & Side Approaches	Emergency Traffic Services	Shoulders	Roadside & Drainage	Restoration & Traffic Services	Ferries	Shoulders, Side Approaches & Sidewalks	Special Surface
Parks & Plants	Concrete Pavement	Drainage	Traffic Operations Undistributable	Roadside & Drainage	Structures	Maintenance Performed by Cities	Surface & Base	Drainage System	Shoulder & Approach
Row Maintenance (Except Mowing)	Shoulders	Roadside & Landscape	Traffic Directions	Structures	Snow, Ice & Sand Control	Roadside Rests	Roadsides	Bridges & Structures	Roadside & Drainage
Assistance to Traffic, Emergency,, Snow & Ice Removal	Bridges	Structures	Traffic Protection	Snow, Ice and Drift Sand	Traffic Services	Buildings & Grounds	Drainage	Roadside	Snow & Ice
Mowing Row	Culverts	Snow & Ice Control	Beautification & Comfort	Traffic Control & Service Facilities	Emergency Maintenance	Landscaping & Functional Planting	Signs	Buildings & Yards	Traffic Service
Rest Areas with Comfort Stations	Pipe	Traffic Control & Motorists Services	Special Maintenance	Other Services	General Functions		Centerline & Pavement Markings	Disaster Repairs	Other
Channel & Embankment	Row Maintenance	Litter Pick-up		Unusual or Disaster			Traffic Signals	Administrative & Miscellaneous Operations	
Substructure	Signs and Safety	River Crossings					Turnouts, Driveways & Crossovers		
Superstructure (Deck)	Pavement Markings	Other Services					Beautification		
Superstructure (Supporting Members)	Erosion Control	Unusual or Disaster					Recreation Facilities		
Railing	Emergency Services	General Supervision					Plaques & Historical Markers		
Painting Except Railing	Rest Areas & Comfort Stations						Emergencies		
Special Jobs	Miscellaneous								

TABLE 2. Classification of Maintenance Operations (Continued)

Louisiana Study (16) (Jorgensen)	Louisiana (17)	Minnesota (18)	Mississippi (19)	Oklahoma (20)	Oregon (21)	Utah Study (Jorgensen) 5	Virginia Maint. Study (22) (Jorgensen)	Washington (23)
Bituminous Surface	Surface	Roadway Surfaces	Routine Roadway Surface Operations	General Highway Maintenance	Safety & Traffic Control	Hard Surface & Hard Shoulder	Surface	Roadway
Concrete Surface	Shoulders, Approaches, Roadside, Drainage	Shoulders, Approaches, Sidewalks	Shoulders, Side Approaches, & Sidewalks	Emergency Actions	Drainage	Non- Hard Surface	Shoulders	Shoulders & Road Approaches
Gravel or Shell Surface	Structures	Roadsides	Drainage & Beautification	Roadway Surfaces	Roadway	Gravel Shoulder	Drainage	Roadside
Shoulder & Approach	Traffic Services	Drainage Facilities	Traffic Service	P.C.C. Surfaces	Shoulders	Vegetation Control	Roadside	Drainage
Roadside & Drainage	Miscellaneous	Bridges & Tunnels	Snow, Ice & Sand Control	Bituminous Surfaces	Roadsides	Roadside	Traffic Services	Major Structures
Structural		Safety & Traffic Control Devices	Structures	Asphaltic Repairs	Snow & Ice	Drainage & Major Structure	Snow & Ice Control	Snow & Ice Control
Traffic Service		Snow Removal, Ice Control, & Drift Prevention	Extraordinary Maintenance	Earth & Gravel Surfaces	Bridges	Traffic	Structures	Traffic Services
		Structures	General Expenses	Drainage	Highway Structures	Snow & Ice		
			Supervision	Shoulders & Approaches	Traffic Services	Extraordinary		
				Major Structures	Roadside Recreational Areas	General		
				Minor & Miscellaneous Structures		Crusher & Stockpiling		
				Roadside				
				Traffic Service				
				Snow & Ice Control & Removal				
				Special Maintenance				

sentatives of the maintenance division and the Texas Transportation Institute. The panels and their respective areas of responsibility were:

PANEL A - Base and Subgrade,

PANEL B - Bituminous Surfaces and Shoulders and Approaches,

PANEL C - Portland Cement Concrete Surfaces,

PANEL D - Roadside Maintenance and

PANEL E - Structures.

The original members of the panels are shown in Table 3. These panels have remained active during the projects although the composition of the panels have changed due to retirements and promotions.

As noted in Table 3 each district was represented. Meetings were held as required at the various district offices located throughout the state. The first round of panel meetings was held to describe the objectives of the study, to identify existing maintenance operations and to assign responsibility for development of the maintenance methods. Subsequent meetings were held to review the developed methods, assign responsibility for developing additional methods and to initiate action on the development of the maintenance evaluation techniques. A total of 5 rounds of panel meetings have been held to develop in excess of 200 maintenance activities currently performed by Texas Highway Department maintenance forces.

Maintenance Method

A typical example of maintenance method developed by the panel is shown in Figure 1. The major information provided in the method is described below.

TABLE 3. Original Panel Members 1972

PANEL	NAME	MEMBERS
A	BASE AND SUBGRADE	J. M. McDowell, *Chairman, Dist. 1* L. S. Thompson, *Dist. 10* J. N. Dominy, *Dist. 11* J. O'Connel , *Dist. 17* R. P. Hudso , *Dist. 19*
B	BITUMINOUS SURFACES AND SHOULDERS AND APPROACHES	S. G. Cox, r., *Chairman, Dist. 21* J. L. Wilde , Jr., *Dist. 14* W. B. Colli r, *Dist. 15* W. F. Adams *Dist. 22* R. S. Marti , Jr., *Dist. 23*
C	PORTLAND CEMENT CONCRETE SURFACES	V. F. Matus k, *Chairman, Dist. 13* B. E. Davis *Dist. 2* G. G. Cleve and, *Dist. 9* J. H. Doss, *Dist. 12* C. H. Brown *Dist. 20*
D	ROADSIDE MAINTENANCE	A. L. McKee *Chariman, Dist. 8* F. L. Raglan, *Dist. 3* R. C. Liles, *Dist. 4* J. W. King, *Dist. 5* J. H. Swarin gen, *Dist. 25*
E	STRUCTURES	J. R. Evans, *Chairman, Dist. 7* R. S. Neal, *Dist. 6* H. Schneemar , Jr., *Dist. 16* G. Green, *Di t. 18* J. L. Lawrer e, *Dist. 24*

after reference 2.

TABLE 4. Maintenance Quality Standards

Group	Code	Quality Standard
Bit. Surface	Level up ruts	1/2" to 1" allowed before repair
Bit. Surface	Level up waves	1" per 10 ft. section - 50%of roadway
Bit. Surface	Level up corrugations	25% of any 100 foot section
Bit. Surface	Pot holes	1" in depth - 1 ft. in diameter
Bit. Surface	Bleeding	excess of 20 ft. in length
Bit. Surface	Cracks	1/4" in width
P.C.C. Surface	Raveling, pop-outs, scaling	25% of any 100 ft. section
P.C.C. Surface	Spalling	6" in width, 2" in depth
P.C.C. Surface	Blowups	1/2" or greater
P.C.C. Surface	Faulting & Settlement	1/4" or greater
P.C.C. Surface	Cracks	1/4" or greater
Shoulders	Pot Holes	3 inches in depth or greater
Shoulders	Blade	blade once a year
Roadside	Mowing	4" to 6" height allowed
Roadside	Brush Control	no trees larger than 4" diameter within 30 ft.
Structures	Decks	1/2" deep spalling
Structures	Paint Railings stringers	Rust pitting 1/8 inch in depth
Traffic Services	Repair Signs	4 to 5 sq. inches
Traffic Control	Traffic Buttons	50% of buttons missing in any one skip stripe

after reference 12.

TABLE 5. Maintenance Quality Standards

Group	Code	Quality Standard
Bit. Surfaces	Pot Holes	2 inches depth, 24 sq. inches
Bit. Surfaces	Localized	2 inches depth, 6 inches diameter
Bit. Surfaces	Bleeding	One square yard
Traffic Control	Guide Lines	6 lineal ft. missing
Shoulders	Pot Holes	2 inches depth, 12 inches diameter
Shoulders	Localized	2 inch drop off, 6 lineal ft.
Roadside	Mowing	Cut between 6 and 12 inches
Roadside	Litter	10 items of litter in 0.1 mile
Drainage	Reshape	50% of cross section is obstructed
Structures	Culverts	2 inches in depth and 24 sq. inch area
Drainage	Silt Removal	50% of cross section obstructed

after reference 13.

TEXAS HIGHWAY DEPARTMENT ------ MAINTENANCE ACTIVITY

REPAIR OF POT HOLES

Temporary

Cost Code
262

DEFINITION

The temporary repair of bowl-shaped holes of various sizes in an asphalt pavement.

METHOD

Conditions Favoring Use

The temporary method of repair should be used any time that the permanent method cannot be, such as adverse weather conditions, traffic too heavy, etc.

Procedure

1. Provide adequate traffic control.
2. Remove water and loose material from the hole.
3. Backfill the hole with one of the following types of material:
   a. Base material or crushed gravel.
   b. Base material and an asphaltic concrete material.
   c. Asphaltic concrete material.
   d. In case of a submerged hole, asphaltic concrete material in burlap bag.
4. Compact the patch as well as possible by hand operated equipment or truck wheel.

Men

3 Crewmen with capability of operating truck and placing asphaltic concrete material.
Flagmen as needed.

Equipment

Truck
Signs and Barricades as required

Small Tools

Asphalt rake
Broom
Hand Tamp

Materials

Base material
Asphaltic concrete material

Figure 1. Typical Maintenance Method

PERFORMANCE DATA, QUANTITATIVE

Unit of Measure -- Cubic Yard

Unit Cost Labor	Unit Cost Traffic Control
Unit Cost Preparation	Total Unit Cost
Unit Cost Travel	Labor Required Hours/Unit (Net)
Unit Cost Equipment	Labor Required Hours/Unit (Gross)
Unit Cost Materials	Approximate Accomplishment Per Day

PERFORMANCE QUALITY STANDARD

Provide a reasonably smooth and safe riding surface until permanent repairs can be completed.

METHOD OF RATING

1. Test ride the repaired surface at designated speed limit to insure smoothness.
2. Make a visual inspection to insure that a neat appearing surface which adequately prevents surface water from passing into the base or subgrade is produced.

SCHEDULING

Temporary repairs may be performed at any time as needed.

COMMENTS

1. During wet weather cement may be added to the asphalt patching material and around the exposed surfaces of pot holes to add stability to the patch.
2. An infrared heater, butane burner, or other system may be used for drying the hole and patch.
3. An "Ejecto" truck may be useful in this operation.

CROSS REFERENCES

Figure 1. Typical Maintenance Method (Continued)

Activity Code No. _____ Date _____

Method _____ Unit of Measure _____

District _____ Foreman No. _____ County _____

Highway No. _____ Location _____
(Milepost, distance from intersection, etc.)

PERSONNEL DATA

Title	Comp Rate	Hours in Preparation	Hours on Travel	Hours Traffic Control	Hours Performing Activity	
		Indicate number of hours spent in yard preparing equipment, materials, etc. requiring 30 or more minutes, less than 30 show under travel time.	Indicate the number of hours spent on travel from warehouse to work site.	Indicate the number of hours spent on traffic control (setting and removing signs and barricades, flagging, etc.) if 30 minutes or more.	Indicate the number of hours spent doing the method, include time spent on travel or traffic control less than 30 minutes.	

EQUIPMENT DATA

Equip. Number	Rate	Hours or Miles in Preparation	Hours or Miles on Travel	Hours, Miles Traffic Control	Hours, Miles Performing Activity	Description of Equipment
						Indicate type, name, size of equipment used.

Quantity of Material Charged _____

Unit Cost of Material Charged _____

Total Cost of Material Charged _____

Quantity of Work Performed _____ Work Performed per Day _____

Labor Required _____ (Hrs/Unit) Unit Cost _____

Figure 2. Performance Data Gathering Form

Identification. This top portion of the method gives the title and the cost code number.

Definition. This section defines the activity that is described below. The conditions favoring use are stated to provide guidance in terms of traffic, size, extent or other conditions that would favor the use of this method over some other method. The procedure defines a step by step method for accomplishing the maintenance activity together with the necessary men, equipment, materials and small tools necessary for proper performance of the activity.

Performance Data, Quantitative. This section of the method is intended to give the reader an indication of the cost and production that can be expected by use of the method under average conditions. The cost data were obtained from one or more districts by use of a form shown in Figure 2.

Performance Quality Standard and Method of Rating. This item indicates in a very general way the level to which the maintenance activity should be performed and the method to make this evaluation.

Scheduling. This section provides a delineation of the time of year or under what conditions the activity should be performed.

Comments. Alternative types of materials, new equipment and potential problems are often included in the section.

Cross References. The reader is provided with code numbers of other methods that pertain to use of the method being described.

As indicated above the maintenance method or performance standard contained a general quality standard. It is felt that sufficient funds and/or time were not available to quantify the quality standards. Quality standards, however, were obtained from the literature (Tables

4 and 5) (12, 13) and supplied to Texas State Department of Highways and Public Transportation personnel for review and inclusion in the maintenance method where possible.

Definition of quantity standards for particular operations have not been attempted by the Texas State Department of Highways and Public Transportation. In general, it is felt that quantity standards are not required under the present system of budget preparation practiced in Texas.

INVENTORY OF MAINTAINABLE FACILITIES

Selected roadway inventory data are collected and recorded by the Texas State Department of Highways and Public Transportation. These data include miles of highway by pavement type, county, district, highway type; number of bridges; pavement geometric design information; pavement materials and thickness information and certain other selected purposes.

Inventory data in a form and with the degree of detail required for formulation of a maintenance work load presently do not exist within the Texas State Department of Highways and Public Transportation.

MAINTENANCE WORK LOAD

As described above, the maintenance work load is a function of the level of service to be provided and the constraints on the work to be performed. The wide range in climate, traffic and maintenance materials utilized in the state have created difficulties in adopting a system other than that based on historical requirements. Consequently, Texas usually approaches work load and budget from this viewpoint.

BUDGETING

A program-oriented or performance budget is not presently utilized in Texas. The budget is primarily based on historical fiscal requirements of each of the 25 districts in the state. District budget submittals are reviewed by the Maintenance Operations Division and a statewide budget is prepared. The wide range in climate, traffic, maintenance materials and maintenance techniques that exist in the state and the decentralized management system have created difficulties in adopting a system other than that based on historical requirements.

PLANNING AND SCHEDULING

Formalized planning and scheduling tools are being prepared by a number of districts. District 7 (San Angelo) (14) has recently defined a schedule of seasonal maintenance activities which provides a general planning framework (Table 6). In addition, quarterly planning and weekly planning and scheduling forms are utilized in the maintenance sections. Figure 3 shows the Weekly Work Schedule Form utilized by the maintenance foreman to schedule maintenance operation. The job description, job location, men and equipment requirements are listed. In addition, "bad weather" projects are identified for the week. This form has proven to be a valuable tool for field planning purposes.

District 21 was the first district to utilize the maintenance rating system as a planning tool. References 15, 16 and 17 discuss the general use of the visual condition survey, Dynaflect measurements, Mays Ride Meter readings, skid numbers, traffic counts and accident data for planning maintenance activities. Criteria are offered in this paper for determining when and what kind of maintenance actions should be

TABLE 6. Seasonal Maintenance Activities

JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
itter Clean Up rack Pouring inter Asphalt ork runing ainting omplete Center Stripe	Crack Pouring Pruning Complete Litter Pickup Winter Asphalt Complete Painting	Poison Redo Rest Areas for Summer Usage Winter Asphalt Complete Pruning	Seal Shoulders Start Level Work Finish Parks	Level Seal Coats Begin Mowin	Level Mow Asphalt Seals Poison

JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
ow evel eal Coats oison	Mow Level Seal Coats Poison	Chliche Begin Center Stripe Mow Linseed Oil on Bridge Decks Complete Summer Asphalt	Mow Caliche Work Center Stripe Begin Winter Edging Painting of Sign Posts, Guard Rails, Islands etc.	Complete Mo ing Caliche Wor Center Stri e Winter Asph lt Edging Bridge Work Painting	Begin Crack Pouring Center Stripe Winter Asphalt Complete Caliche Work Edging Litter Bridge Work Painting Straighten Sign Delineators after Clean Up Mowing

fter reference 14.

File W.11

WEEKLY WORK SCHEDULE

_____, 19__

MAINTENANCE FOREMAN _____

ITEM	JOB DESCRIPTION & LOCATION	MEN REQ'D.	EQUIPT. REQ'D.	BAD WEATHER PROJECTS
BASE REPAIRS				
PAVEMENT MAINT. 1. LEVEL 2. SQUEGEE 3. SEAL				
R.O.W. MAINT. 1. MOWING 2. PRUNING 3. TRASH				
SHOULDER WORK				NOTES, REMARKS, ETC:
TRAFFIC MAINT. 1. SIGNS 2. STRIPING 3. PAINTING				
PARK MAINT. & UTILITY				
WEED POISON				
VACATION				
MISC.				
WAREHOUSE & OFFICE PERSONNEL				
TOTALS				

Figure 3. Weekly Work Schedule

planned. It should be noted that these criteria are based on field experience and will be improved with additional use of this system.

A yearly schedule of maintenance activities that is prepared during budget preparation is a part of the system developed in District 21. This approach to budgeting should gain acceptance in other areas of the state.

MANAGEMENT INFORMATION SYSTEMS

There appears to be two broad purposes that a maintenance information system could be expected to serve. These are:

1. To improve the internal management of the maintenance function and thereby improve the overall efficiency of the maintenance operation and

2. To provide performance data and cost experience that will guide decision makers in future investment decisions. That is, to provide information needed for objective evaluation of alternative reconstruction, rehabilitation, roadway design and pavement construction options.

The first of these purposes is, of course, totally internal to the maintenance operation. Its basic requirement is to have a data recording and reporting system that will provide the operational detail necessary to answer the question, "How?". How can a given job or function be performed most efficiently, and how can the optimum level of maintenance be performed within a given budget constraint.

The second purpose is geared toward bringing specific activity cost data by specific roadway location to the attention of managers outside the maintenance area. It permits maintenance costs to become one of the

decision elements in a larger decision framework concerning alternative pavement, structural, roadway or geometric design decisions.

Obviously, the detail required for different types of information will vary with the emphasis placed on the purpose of the system. A system designed to serve internal maintenance needs will be more concerned with labor, material and equipment costs, with performance standards and work schedules, and with budgeting, planning and scheduling of maintenance programs. It will be much less concerned with the precise location of these activities within management sub-areas. Precise locational data, on the other hand, are among the basic needs of a system to serve the broader management needs outside the maintenance organization itself.

Since maintenance management systems are relatively new, and since they have been generally developed within the maintenance organization itself, it is perhaps to be expected that they would concentrate on providing data for internal management purposes. As the process matures and experience is gained, it is logical to expect that the maintenance information systems will eventually be broadened to more adequately serve the other purposes. At the present time, however, the maintenance information systems are directed primarily toward providing internal maintenance management information.

Examples of systems utilized in eleven states are outlined in Appendix A. These state summaries were prepared as part of the National Cooperative Research Program Synthesis titled "Recording and Reporting Methods for Highway Maintenance Expenditures" (9) and are included herein to provide background information for the Texas State Department of Highways and Public Transportation committees responsible for revising

the maintenance recording and reporting system currently utilized in Texas. The outline utilized for these "state reports" is as follows:

1. Recording Systems,
2. Collection and Processing of Recorded Data,
3. Reporting Systems,
4. Reliability of Recording and Reporting Systems,
5. Mechanisms for Changing Recording and Reporting Systems and
6. Conclusion, Recommendations, Research Needs.

No two surveyed states had identical recording or identical reporting systems. State maintenance organizational structures differ as do the methods of establishing the location at which the maintenance activity was performed. Two types of recording systems are presently being utilized by states. If a single reporting procedure is utilized for both maintenance management and for payroll and accounting information, a "single recording system" is said to be utilized. If separate reports are filed by field personnel, then the term "parallel recording system" is utilized to describe the reporting system. Of the states surveyed, 5 utilized a single recording system approach while 6 utilized the parallel recording system.

Field data are recorded either by the individual workman or the crew leader for the single reporting system while the crew leader records for the crew as a whole or for the individual workman when parallel reporting systems are utilized. All systems surveyed in the above mentioned study record labor in man-hours and equipment usage in miles or hours. Materials quantities utilized were not recorded for all systems surveyed.

The basic field data reported are normally collected daily. This

information is checked by the immediate supervisor of the individual filing the report and transmitted to the district office or central office for processing and reporting. Delays or lag time between supplying the data and furnishing reports is commonly 20 to 30 days. All reports from the states surveyed except one produced in Tennessee are developed by electronic data processing.

Reports produced by the various states for management purposes are numerous but for convenience can be summarized into eight broad categories as follows:

1. Audit,
2. Inventory,
3. Planning,
4. Equipment Usage,
5. Performance,
6. Budget Control and
7. Special Analytical and Exception Reports.

In the early stages of reporting system development, many states have produced very large numbers of reports utilized by only a few individuals. Upon later evaluation many of these reports have been discontinued. Most states now insist that a real need be defined before a report is prepared as a routine output of the reporting system.

Information system components developed as part of Research Study 2-18-71-151 includes development of codes by which maintenance activities can be identified and placed into functional groups for maintenance recording and reporting purposes. A second major contribution of this research study has been the development of a maintenance rating system. This system has been developed to provide information for both internal

management of maintenance operations and to provide performance data to guide decision makers in future investment decisions. Several reports have been developed which utilize these data for management purposes. The development of cost codes and the maintenance rating system together with reports developed to utilize the results of the maintenance rating system are discussed below.

COST CODES

Coding of the methods for cost accounting purposes was initiated parallel to the development of maintenance methods. Literature such as that summarized in Table 2 was utilized for this development. Results of this study are shown in Appendix B. Seven maintenance categories were established as shown below:

100 Base and Subgrade,

200 Surface,

400 Shoulders and Approaches,

500 Roadside Maintenance,

600 Structures over 20 feet,

700 Traffic Services and

800 Extraordinary Maintenance.

Subgroups were defined in each of the seven categories, and the subgroups were further subdivided, as required. For example, item 521 identifies a roadside maintenance activity - "litter pick-up by hand". The first digit indicates a 500 series activity which is reserved for roadside maintenance. The 520 series represents litter pick-up and the particular item 521 indicates that litter is removed by hand. Items 522 and 523 refer to litter pick-up by a "tow-type" of machine and by

a "self-propelled machine with shredder", respectively.

Field use of these codes can be limited to utilization of only the first of the three digits, two of the three digits or all of the digits can be utilized by the district. This versatility will allow costs and performance information to be kept to the degree of accuracy desired by the individual districts. If all three of the digits are utilized to record field performance information, alternative methods of performing the same basic activity such as litter pick-up can be studied. It is anticipated that this type of information will be helpful in establishing the type of maintenance action most suitable for a given set of environmental and traffic conditions.

From the above discussion, it is apparent that the person recording the maintenance operation must select a three digit number from a list of 304 numbers. This task is not expected to be troublesome because of the structure utilized in developing these codes and because a given individual will usually only be concerned with selection of the proper descriptive code from a relatively short list of meaningful alternatives.

The number of maintenance activities defined by other states in some cases is in excess of 500 (9). The number of maintenance activities that are available to be coded in other states is reported in reference 9 and summarized below:

California - 470,

Hawaii - 36,

Illinois - 49,

Louisiana - 124,

Nevada - 72,

North Dakota - 63,

Pennsylvania - 218,

Tennessee - 71,

Washington - 373 and

Wyoming - 46.

The number of activities available for coding is constantly under change in some states. Some activities are deleted and new and more efficient operations are added.

MAINTENANCE RATING SYSTEM

The maintenance rating system was developed to provide information for the following specific purposes:

1. Define the present condition of the roadway,
2. Compare the present condition with the past condition to predict the future condition of the roadway,
3. Determine maintenance needs in terms of materials, equipment, manpower and dollars,
4. Establish maintenance priorities based upon available resources and
5. Identify those maintenance activities which provide the greatest return for the maintenance investment.

The term "roadway" as utilized above includes all features within the right-of-way; therefore, the maintenance rating system by definition should include an evaluation or rating of the following roadway elements:

1. Pavement,
2. Shoulder,
3. Structures,
4. Roadside including drainage features,
5. Traffic services,
6. Off-highway and
7. Special and emergency.

Special and emergency operations are not predictable and were not of sufficient duration to lend themselves to be evaluated for a useful end result.

Off-highway maintenance operations such as building maintenance were considered adequately covered by preventive maintenance activities already practiced by the Texas State Department of Highways and Public Transportation.

Structures are presently evaluated by a detailed bridge rating system required by the Federal Highway Administration. It was felt that this rating could be utilized to predict bridge maintenance requirements. Thus, a bridge rating system was not developed as part of Research Study 2-18-71-151.

Pavement, shoulder, roadside and traffic service elements were further investigated and a maintenance rating system developed. The resulting rating system was developed based on an extensive literature review conducted by Texas Transportation Institute staff personnel and published in references 6 and 7 and summarized below. Reference 6 contains information collected on condition surveys presently utilized by 34 state, county and city agencies. Of the 34 agencies that reported using a rating system, 20 utilized the rating scores in maintenance decisions. A common characteristic of the reviewed rating systems was their general absence of ratings for roadside, drainage and traffic services elements of the roadway.

Literature Review

Reference (18) contains an excellent literature review of techniques and equipment available to evaluate pavements for maintenance and rehabilitation purposes. Existing techniques available to measure pavement behavior and pavement distress as defined in this report are reviewed below.

Methods of Measuring Behavior. Behavior of a pavement can be defined as its immediate response to load. Methods for measuring behavior of pavements due to loads can be conveniently grouped into the following categories:

1. Bearing tests,
2. Deflection tests,
3. Impact tests,
4. Vibration tests and
5. Other methods.

Many of these test methods measure the response of the pavements in terms of deflection, radius of curvature, and/or elastic modulus under conditions that simulate traffic loads in terms of both magnitude and/or frequency of loading. Little attempt has been made to measure behavior due to non-traffic associated loads.

Although soil classification and soil strength index methods do not directly measure response to load, they can be utilized as an index with a structural model to predict load carrying capacity of the pavement. Advantages, disadvantages, speed of operation and information indicating where the various devices have been implemented are contained in Table 7. A brief discussion is presented below describing the various categories of devices.

Bearing Tests. Bearing tests are distinguished by the application of a static or dynamic load to a pavement or soil through a plate. The static plate bearing tests widely utilized for determining modulus of subgrade reaction and deflection is the most common test of the group. The California Bearing Ratio (CBR) and bearing tests developed by North

TABLE 7. Behavior

CATEGORY	METHOD	BEHAVIOR MEASURED	SPEED OF OPERATION (MEASUREMENTS PER DAY)	ADVANTAGES	DISADVANTAGES	IMPLEMENTATION	RESEARCH NEEDS
Bearing	Static Plate Bearing	*Deflection *Elastic Modulus *Modulus of Subgrade Reaction	1 to 10	*History of Use and Acceptance	*Slow Test to Perform *Massive Equipment Necessary	*U.S. Navy *Corps of Engineers *U.S. Army *U.S. Air Force (3)	*Development of More Portable Equipment *Increase Speed of Data Collection
	Dynamic Plate Load	*Deflection *Elastic Modulus	1 to 10	*Dynamic Loads Which Simulate Traffic	*Slow Test to Perform *Massive Equipment Necessary	*Research Tool Only (1)	*Development of More Portable Equipment *Increase Speed of Data Collection
	California Bearing Ratio	*Soil Strength Index *Deflection *Elastic Modulus	1 to 5	*History of Use and Acceptance	*Slow Test to Perform *Not Suitable for Stabilized Materials	*U.S. Army *U.S. Air Force *Corps of Engineers (3)	*Increase Speed of Data Collection
	North Dakota Florida? Other	*Soil Strength Index	1 to 5	*Acceptance Within State	*Does Not Measure Deflection or Elastic Modulus But Soil Strength Index Only *Not Suitable for Stabilized Materials	—— (1)	*Increase Speed of Data Collection *Determine Relationship Between Measured Data and Behavior
Deflection	Benkleman Beam	*Deflection *Radius of Curvature	300	*History of Use and Acceptance *Realistic Loads *Simple to Perform *Easily Transportable	*Speed of Operation	*Asphalt Institute *U.S.--Oklahoma and Other States *Great Britain R.R.L. *Some South African Provinces *Canada-RTAC (3)	*Reliability of Measurements *Increase Speed of Data Collection
	California Traveling Deflectometer	*Deflection *Radius of Curvature	1800 to 2000	*Speed of Operation *Realistic Loads *Easily Transportable	*Downgrade Measurements Are Not Possible *Measurements on Curves Not Taken Because of Safety	*California (3)	*Determine Reliable Elastic Moduli from Measurements
	Lacroix	*Deflection *Radius of Curvature	5,000	*Speed of Operation *Realistic Loads *Easily Transportable		*France *Great Britain-RRL *Some Canadian Provinces *South African-NIRR (3)	*Determine Reliable Elastic Moduli from Measurements
	State of Washington	*Deflection	——	*Speed and Simplicity of Operation	*Small Load Applied	(1)	*Determine Relationship Between Measured Data and Behavior
Impact	French	*Deflection	500	*Dynamic Load Which Simulates Traffic *Easily Transportable	*Speed of Operation	*Denmark *France (1)	*Determine Relationship Between Measured Data and Behavior *Increase Speed of Data Collection
	Germany Others	*Deflection	——			(1)	*Determine Relationship Between Measured Data and Behavior
	Shell	*Deflection *Elastic Moduli *Radius of Curvature	5 to 50	*Variable Force and Frequency	*Validity of Certain Elastic Moduli *Small Load Applied *Frequency Range *Speed of Operation	*Research Only (1)	*Increase Speed of Data Collection *Determine Reliable Elastic Moduli from Measurements
	Great Britain RRL	*Elastic Moduli *Deflection	5 to 50	*Variable Force and Frequency	*Validity of Certain Elastic Moduli *Frequency Range *Speed of Operation	*Research Only (1)	*Determine Reliable Elastic Moduli for Various Pavement Layers
	French-LCPC	*Elastic Moduli *Deflection		*Variable Force and Frequency	*Validity of Certain Elastic Moduli *Speed of Operation	*Research Only (1)	*Extend Available Load Magnitude and Frequency for Any Single Device

TABLE 7. Behavior (Cont.)

	Road Rater	*Deflection *Radius of Curvature *Elastic Modulus	600-800	*Variable Force *Low Maintenance *Speed of Operation	*Frequency Range *Small Force	*Pennsylvania *California (2)	*Determine Reliable Elastic Moduli from Measurements
	Dynaflect	*Deflection *Radius of Curvature *Elastic Modulus	400-600	*Variable Force *Low Maintenance *Speed of Operation	*Frequency Range *Magnitude of Load Applied	*Texas *Utah *California *Virginia *Pennsylvania (3)	*Determine Reliable Elastic Moduli from Measurements
Vibratory	Cox	*Deflection *Radius of Curvature *Elastic Modulus	1,000	*Speed of Operation		*Under Development for Contra Costa County, California As Well As Other Agencies (2)	*Determine Reliable Elastic Moduli from Measurements
	U.S. Air Force	*Deflection *Radius of Curvature *Elastic Modulus	300	*Variable Force and Frequency *Large Force *Multipurpose *High Frequency	*Size of Equipment *Slow Test to Perform	*Under Development (2)	*Development of More Portable Equipment
	Corps of Engineers	*Deflection *Radius of Curvature *Elastic Modulus	300	*Variable Force and Frequency *Large Force *Multipurpose	*Size of Equipment *Slow Test to Perform	*Under Development (2)	*Development of More Portable Equipment
Other Methods	Soil Classification	Soil Support	1 to 5	*History of Use	*Does Not Measure Behavior of Entire Pavement But Only Subgrade	*FAA *States Using Group Index Method, etc. (3)	*Determine Relationship Between Measured Data and Behavior
	In-Situ Transducers	*Deflection *Deformation *Load		*Capable of Measuring Behavior Under Actual Pavement Loading Conditions *Measure Coupled Loads Due to Traffic and Environment	*Installation *Reliability and Maintenance *Permanent Installation *Limited Number of Measurements Possible	*Research Only (1)	*Develop Method of Measuring Remaining Life of Pavement
	Curvature	*Radius of Curvature	300	*Small *Transportable	*Require a Slow Moving Load	*South Africa *California (3)	*Increase Speed of Measurements

RRL - Road Research Laboratory
LCPC - Laboratoire Central Des Ponts Et Chaussees
RTAC - Road and Transport Association of Canada

after reference 7.

Dakota and Florida, although not widely used to measure pavement behavior, have been included. Dynamic plate load tests have been utilized as a research tool, but have not gained widespread implementation.

Deflection. Benkleman beam, California Traveling Deflectometer and Lacroix Deflectometer are examples of deflection measuring devices. These devices are also capable of obtaining the radius of curvature of the deflection basin. The widespread use of these devices together with their ability to apply realistic loads have resulted in widespread utilization of this category of devices throughout the world.

Impact. Impact devices employ a falling weight to impart a shock-wave into the pavement structure which is measured and converted to deflection. Little if any full scale implementation of this category of devices has taken place in the United States.

Vibratory. Vibratory devices have received widespread use as research tools in the last 10 years; additionally, the Dynaflect and the Road Rater have gained widespread acceptance for pavement rehabilitation forecasting. These devices use either a heavy or light vibrator to excite the pavement. Deflection, radius of curvature and elastic moduli can be determined.

Several sophisticated wave propagation devices have been grouped under this heading and are utilized to evaluate airport pavements. Wide frequencies are used to propagate waves into the pavements under relatively heavy loads. The U. S. Air Force and U. S. Army Corps of Engineers are developing such devices.

Other Methods. Soil classification methods including that utilized by the FAA are part of pavement overlay design models.

In-situ transducers, although utilized for research only at this

stage of development, may become important for certain urban facilities. The development of devices of this nature to measure such items as remaining fatigue life and the behavior of pavements subjected to coupled loads appears reasonable with additional research.

Curvature measuring devices have been used in South Africa, California and Texas.

Methods of Measuring Pavement Distress. Roadway distress manifestations result when some limiting response or damage occurs in the roadway. Distress manifestation associated with the pavement is usually in the form of pavement cracking, distortion and disintegration, vehicle and pavement related noise or skid resistance. Numerous methods have been established to measure pavement distress and attempts have been made to establish limiting values of the various forms of distress. Complications associated with establishment of these limiting responses are due, in part, to the inadequacies of distress measuring methods to identify and accurately measure the significant factors. In addition, it should be realized that distress affects not only occupants of the vehicle but also the operation of the vehicle and the people and goods adjacent to the roadway.

The measurement of pavement distress can be obtained from user oriented evaluations or mechanistic evaluations. The output from the somewhat subjective evaluations and the objective mechanistic evaluation measurements taken at any particular time is usually referred to as the level of service. The history of this level of service, or serviceability, with time is a measure of pavement performance.

Mechanistic evaluations are concerned with measuring in quantitative terms such items as pavement cracking, road roughness, skid resistance,

etc.

User oriented evaluations such as the Present Serviceability Rating are often intended to measure only the riding quality provided by the pavement. A measurement at any particular time is the level of service provided to the user. Variations of this level of service, present serviceability, with time is a measure of pavement performance. The best known definitions and procedures for measuring serviceability in North America are those developed utilizing a panel of highway users at the AASHO Road Test and in Canadian pavement evaluation studies. The AASHO terminology for performance rating is Present Serviceability Rating (PSR) while the Canadian equivalent is presently referred to as the Riding Comfort Index (RCI) to more explicitly denote the evaluation only of pavement riding quality.

It is obviously impractical both in terms of the time and expense to evaluate performance serviceability on anything but a limited basis using the rating panel method. Consequently, considerable effort has gone into correlating various mechanical evaluation methods with panel performance evaluations. This effort has led to the development of a number of road roughness measuring devices, as road roughness is generally considered to be of major importance to the user and is thus reflected in his performance evaluations.

In addition to road roughness measuring devices used to correlate with user oriented evaluations, the engineer has been concerned with pavement distress in terms of pavement cracking, pavement distortion, and pavement disintegration. Pavement evaluation methods attempting to measure these forms of distress are referred to as condition surveys. Another group of methods of pavement evaluation are those associated

with measuring pavement behavior. These test methods along with analysis techniques evaluate the structural load carrying capacity of a pavement among other factors. They do not measure mechanistically the pavement structural distress.

Two other forms of pavement related distress are of concern to the engineer and the driving public: (1) Highway noise created largely by the tire pavement interaction and the vehicle; and (2) skid resistance and other safety related measurements.

Table 8 presents a brief summary of the groups of methods utilized to measure pavement distress. It is the function of pavement evaluation methods to periodically measure the above mentioned distress in order to (19):

1. Provide data for checking design predictions and updating them as necessary,

2. Re-schedule rehabilitation measures as indicated by updated predictions,

3. Provide data for upgrading the design models themselves and

4. Provide information for updating network rehabilitation progress.

Pavement evaluation thus serves the planning and design activities of pavement management and is, therefore, a part of the pavement management system thus providing the means for assessing rehabilitation needs on both a project and a network basis.

Pavement roughness evaluation has received considerable attention from most highway and airport agencies as roughness is generally accepted as the primary component of serviceability as viewed by the user. A number of attempts have been made to correlate different rough-

TABLE 8. Pavement Evaluation Methods

Evaluation Group	Examples of Categories	Comments
Performance	Present Serviceability Index Riding Comfort Index	°User-oriented subjective evaluatio mainly of road roughness
Roughness	Profilometer Mechanical Vibrometer Precise Level	°Developed Primarily to provide fas er and more economical performance evaluatio s
Condition	Visual Photographic	°Measurement of type, degree, magni ude and location of pavement distress
Noise	Sound Recording Equipment	°Measurement of noise associated wi h tire-pavement interaction and vehicle and the ffect of the noise on the driver and adjacent people
Skid Resistance	Indirect - Surface Texture Direct - Locked-wheel Skid Trailer	°Measurement of accident potential f given pavement section
Behavior	Bearing Deflection Impact Vibratory Wave Propagation	°Measurement of the immediate react on or response of a pavement to load
Cost	Maintenance Cost per mile Benefit - Cost Index USER Cost	°Measure of maintenance effectivene s, benefits of certain maintenance activitie , feedback to mechanistic pavement design mode s, etc.
Traffic	Traffic Volume Capacity	°Measurement of pavements ability t adequately handle present and future traffi

After reference (7)

ness measuring devices with panel oriented performance ratings. These results are presented in the literature together with descriptions of the numerous devices utilized to measure roughness.

Table 9 has been prepared based on a literature review and the workshop proceedings (19, 10). For convenience, road roughness measuring devices have been grouped into the following categories:

1. Profilometer,
2. Mechanical Vibrometer,
3. Precise Leveling.

Speed of operation, advantages, disadvantages, research needs and agencies that implemented the individual devices have been identified. A brief discussion is presented below briefly describing the operational features of the various categories of devices.

Profilometer

Rolling straight edge measuring equipment was utilized in the United States as early as 1900. Since that time, numerous profile measuring devices identified by such names as Viagraphs, profilograph and profilometers have been developed and utilized by highway and airport agencies.

Correlation of user-oriented performance evaluation with roughness measurements was formalized at the AASHO Road Test. The Chloe Profilometer was utilized, in part, for this correlation.

Surface dynamic profilometers have received increased use in the last 10 years as research tools and for calibration of other roughness measuring equipment. Surface dynamics profilometer equipment promises to be the most desirable method of this category of equipment to measure road profile characterist Its major

TABLE 9. Pavement Mechanistic Evaluation Roughness Evaluation

CATEGORY	METHOD	QUANTITY MEASURED	SPEED OF OPERATION	ADVANTAGES	DISADVANTAGES	IMPLEMENTATION	RESEARCH NEEDS
Profilometer	Rolling Straight Edge (Calif. U of Michigan, Illinois, French, Others)	Vertical Movement	Slow	*Repeatability	*Operating Speeds *Measurement of Certain Wave Lengths	*California Division of Highways *University of Michigan *Other Agencies (3)	*Increase Speed of Operation and Measurement of Certain Wave Lengths
	CHLOE Profilometer	Slope Variance	Slow	*Repeatability	*Slow Operating Speed *Measurement of Long and Short Wave Lengths *Movement of Towing Vehicle	*AASHO Road Test *General States (3)	*Increase Speed of Operation and Measurement of Certain Wave Lengths
	British - RRL	Vertical Movement (Inches Per Mile)	Slow	*Repeatability *Calibrations of Other Roughness Measuring Devices	*Slow Operating Speed *Measurement of Long Wave Lengths	*Several Canadian Provinces *Canadian Ministry of Transport *British - R.R.L. (3)	*Speed of Operation and Measurement of Long Wave Lengths
	Surface Dynamics Profilometer	Aptitude and Length of all Waves	Moderate	*Repeatability *Calibration of Other Roughness Measuring Devices *Measurement of Long Wave Length	*High Capital and Operating Costs *Highly Skilled Operating Personnel Required for Operation *Data Reduction Costs *Complexity of System *Not a Direct Measure of Vehicle Ride Characteristics	*General Motors *Texas *Michigan (3)	*Transfer Function for Roadway Wave Length and Frequency to User Opinion
Mechanical Vibrometer	VIA-Log	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)	Traffic Speed	----	----	*Developed in 1926 and Utilized in New York State (2)	
	PCA	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)	Traffic Speed or 50 MPH	*Low Cost *Simplicity and Ease of Operation *Speed of Operation *Mass Inventory Possible *Portability of Equipment	*Repeatability *Affected by Environment *Does Not Measure True Amplitude or Length of Waves	*Wisconsin *Washington *California (3)	
	Mays Ride Meter	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)	Traffic Speed or 50 MPH	*Low Cost *Simplicity and Ease of Operation *Speed of Operation *Mass Inventory Possible *Portability of Equipment *Continuous Record	*Repeatability *Affected by Environment *Does Not Measure True Amplitude or Length of Waves	*Texas (3)	*Improve Repeatability of Results *Identify Significant Vehicle and Environmental Factors Affecting Roughness Measurement *Improve Data Handling Technique
	Cox and Son	Relative Vertical Movement Between Rear Axle and Mass (Body of Car)		*Low Cost *Simplicity and Ease of Operation *Speed of Operation *Mass Inventory Possible *Portability of Equipment *Continuous Record	*Repeatability *Affected by Environment *Does Not Measure True Amplitude or Length of Waves	*Research Activities (2)	
	BPR Roughometer	Relative Vertical Movement Between Wheel and Mass (Trailer)	20 MPH	*History of Use	*Low Operating Speed *Attenuation of Wave Lengths in the Ride Frequency Range *Repeatability and Constancy Related to Calibration	*Several States (3)	
Precise Leveling	Rod and Level	Amplitude and Length of All Waves	Slow	*Precise Measurement *History of Use	*Slow Operating Speeds *Safety *"Down Time" of Facility *Not a Direct Measure of Vehicle Ride Characteristics	*Agencies Associated with Airfields (3)	*Increase Speed of Operation *Transfer Function for Roadway Wave Length and Frequency to User Opinion
	Traveling Rod and Laser Beam	Amplitude and Length of All Waves	Slow	*Precise Measurement	*Slow Operating Speed *"Down Time" of Facility *Not a Direct Measure of Vehicle Ride Characteristics	*Under Development (2)	

advantages are summarized below.

1. Determination of actual profiles,
2. Capability of handling large amounts of data by automated means,
3. Operating speeds sufficient to cover reasonable amounts of pavement in a reasonable time,
4. Capability of detecting and analyzing longer wave lengths in the pavement,
5. Excellent repeatability and
6. Capability of use for calibration of car road meters.

Mechanical Vibrometer

This category of equipment measures vertical movement between the axle of an automobile or a wheel in the case of trailer devices and the mass automobile or wheel supports. The State of New York developed a device called a "Via-Log" prior to 1926. This device measured the vertical movement between the front axle and the body of the car. Similar devices commonly referred to as the PCA meter, the Mays Ride Meter and the Cox and Son Road Meter have been developed utilizing many of the same principles. The major advantages offered by this newer equipment are in terms of improved measuring and recording equipment, thus allowing higher speeds of operation.

Limited work has been performed on measuring runway and taxiway roughness with instrumented aircraft. Certainly this is an area which deserves further consideration from both a vehicle operational standpoint as well as a passenger standpoint.

In 1941 the Bureau of Public Roads reported the development of

a trailer unit capable of measuring road roughness. This device known as the BPR Roughometer has been widely used and correlated with performance evaluations. Excellent repeatability and possible use as a calibrator for other roughness measuring devices makes its use attractive.

This category of roughness measuring devices does not give a reliable measure of roughness wave length.

Precise Leveling

The precise leveling method has been utilized for a number of years. A survey rod and level have been widely used on airfields and some highways. Research on the application of laser beams together with a traveling rod have been reported which will offer a faster and perhaps more reliable method.

Equipment to measure road roughness would ideally have the following characteristics:

1. Correlate with performance evaluation,
2. Measure wide spectrum of roadway wave lengths,
3. Measure response of typical vehicular traffic on the facility,
4. High speed of operation,
5. Simple and easy to operate,
6. Capable of mass inventory thus capable of measuring, analyzing, storing and retrieving large amounts of data and
7. Easily transportable.

Such equipment has not been developed in a single unit at this point in time. However, the combination of several existing devices will provide the necessary measurement system.

The combination of equipment to meet the desired requirements would consist of a surface dynamics profilometer or precise leveling device for correlation with performance evaluations and for calibration purposes. Car road meters such as the PCA, Mays or Cox would be utilized for the correlation of mass inventory data. Correlation of these car meters with performance evaluations would be maintained through profilometer equipment such as the surface dynamics profilometer device being developed in Texas or precise leveling methods as described above. An alternate method for calibration of car road meters would be through the use of vibration tables or other suitable devices. Repeatable road profiles would be programmed into the vibration table. The road meter response of the automobile excited by this table would be measured at periodic intervals.

As noted most of the devices noted in Table 9 are considered implementable; however, the areas of applicability of various roughness measuring devices are shown in Table 10. In addition it should be noted that roughness measurements can be utilized for construction monitoring, maintenance programming, inventory and network programming and research. Reference 21 defines the use of the Mays Ride Meter in Texas.

Most highway and airport agencies conduct periodic pavement condition surveys on selected sections, or on a mass basis. These surveys are measurements of pavement distress such as cracking, distortion and disintegration and can be defined as any process of identifying, either

TABLE 10. Areas of Applicability for Various Types of Roughness Measuring Equipment

Type of Facility	Construction Monitoring	Mass Inventory
Expressway or Primary Highway	BPR Roughometer Car Ride Meters Surface Dynamics Profilometer Rolling Straight Edge (British Road Research Laboratory) (CHLOE Profilometer)	Car Ride Meters Surface Dynamics Profilometer) (British Road Research Laboratory) (CHLOE Profilometer)
Secondary (Rural) Highway	BPR Roughometer Car Ride Meter Rolling Straight Edge (Surface Dynamics Profilometer) (British Road Research Laboratory) (CHLOE Profilometer)	Car Ride Meters (Surface Dynamics Profilometer) (British Road Research Laboratory) (CHLOE Profilometer)
Country or Local Rural Highways	BPR Roughometer Car Ride Meters Rolling Straight Edge (Surface Dynamics Profilometer)	Car Ride Meters
Airfields	Car Ride Meters Surface Dynamics Profilometer British Road Research Laboratory (Precise Level)	Car Ride Meters Surface Dynamics Profilometer British Road Research Laboratory (Precise Level)

1. Brackets denote applicability primarily for special purposes or control sections

after reference 7

qualitatively and/or quantitatively, visible manifestations of pavement distress.

Condition surveys are conducted in a variety of fashions and to varying degrees of accuracy, subjectivity, and reliability by the many agencies employing such surveys in the United States and elsewhere. In general, condition surveys are conducted for purposes which are relatively limited in number and which can be briefly summarized as follows:

1. To be used as input to development of a structural rating or index,
2. To aid in projection of budget requirements,
3. To aid in decisions to perform or not to perform maintenance,
4. To act as a diagnostic tool for assessment of design and/or construction procedures,
5. To be used as input to rehabilitation design and
6. To be used as input in determining pavement performance history (22).

As indicated these purposes closely coincide to those given above for the establishment of evaluation methods for pavement distress.

In order to more clearly define the nature of existing conditions surveys a letter was sent to the highway departments in most states, territories and selected Canadian provinces requesting information on their pavement condition rating system currently in use or projections for use in the immediate future.*

*Primarily, this literature review was conducted by the Texas Transportation Institute staff to satisfy research requirements for Federal Highway Administration Contract No. DOT-FH-11-8264. Reference 6 contains details of this survey.

Out of 58 separate agencies contacted, 44 responses were received or had previously been made available. The agencies included not only the states and selected Canadian provinces but also one county in the state of Washington and two city agencies in Texas.

Some of the general items derived from the replies are:

1. Number of agencies using or adopting rating systems - 34,
2. Number of agencies using a composite numerical rating score - 24,
3. Number of agencies using ratings or rating scores in maintenance decisions - 20,
4. Number of agencies using rating systems for flexible pavements - 30 and
5. Number of agencies using rating systems for rigid pavements - 18.

Of the states and agencies for which information was available, a total of sixteen either currently use or plan to use mechanical devices to assist in obtaining pavement ratings. The devices being used and the number of agencies using them are:

1. Roughness measuring devices (PCA Roadmeter, Mays Ride Meter, etc.) - 16,
2. Skid measuring devices - 8,
3. Deflections measured by the Dynaflect - 3 and
4. Deflections measured by the Benkelman Beam - 1.

These mechanical devices are used for rapid surveys and should not be confused with the number of mechanical devices used in design survey procedures. Many agencies use the types of devices shown but do not

necessarily use them in a rating system.

Table 11 is a summary of the 22 agencies for which the salient features of the condition surveys could be determined. There are several important similarities in these rating systems. These are:

1. Over 70 percent of the agencies using numerical rating scores currently or in the near future use their condition rating system in making maintenance decisions,

2. All of the 22 agencies listed have condition rating systems for flexible pavements and approximately 60 percent have systems for rigid pavements,

3. The car ride meter (Mays, Cox, PCA, etc.) is used by more than half the agencies listed in the table for determining roughness. The Dynaflect and various skid devices are used to a lesser extent,

4. Annual inspection frequencies appear to be the most popular and

5. Generally, the overall numerical rating ranges from 100 (best pavements) to 0 (poorest pavements).

The existing pavement condition survey methods can be classified into two broad categories identified as visual and photographic in Table 12. Details of the items measured in condition surveys conducted in Washington, Minnesota, Ohio, Canadian Department of Transport, British Research Laboratory and King County, Washington, are summarized together with advantages and disadvantages of each method in Table 12. All of the visual methods obtain a subjective measure of the type, degree and magnitude of distress in addition to its approximate location.

Nomenclature used by most agencies in describing pavement distress types is somewhat uniform, although the refinement varies among procedures.

TABLE 11.

SUMMARY OF AGENCIES USING NUMERICAL PAVEMENT RATING SCORES

	Does the agency use the rating score in maintenance decisions?	Does the agency use a rating system for flexible pavements?	Does the agency use a rating system for rigid pavements?	Rating Team Composition	Measuring Equipment Used	Rating Frequency	Numerical Rating Range		Is the numerical rating adjusted for traffic?
Arizona	Yes	Yes	Yes	Unk	Unk	Every two years	100	0	Yes
California	Yes	Yes	Yes	5 to 6 Teams, 2 men ea.	Cox Meter	Every two years	0	201	No
Florida	Yes	Yes	No	5 Teams, 2 men ea.	Mays Meter	Annually	100	0	Yes
Georgia	Unk	Yes	No	Unk	Wisc. Roadmeter Dynaflect Skid	Unk	0	100	Yes
Indiana	No	Yes	Yes	2 Teams ea. District, 2 men ea.	None	Annually	100	0	Yes
Kansas	Yes	Yes	Yes	One man	Roughometer	Unk	100	0	No
Louisiana	Yes	Yes	Yes	Unk	Mays Meter Skid	Unk	100	14	Yes
Maine	Unk	Yes	Unk	Unk	None	Unk	5	1	No
Maryland	Unk	Yes	Yes	One man	None	Annually	100	0	No
Minnesota	Yes	Yes	Yes	One team ea. District, 2 men ea.	PCA Meter	Annually	5	0	No
Nebraska	Yes	Yes	Yes	Unk	Neb. Roadmeter Dynaflect Skid	Every two years	100	0	Yes
New Mexico	Yes	Yes	Yes	One man	None	Annually	100	0	Yes
North Dakota	Yes	Yes	No	Unk	None	Unk	0	49	Unk
Tennessee	Yes	Yes	Yes	One team rates entire state	None	Annually	100	0	No
Texas	Yes	Yes	Yes	One team ea. District, 2 men ea.	Mays Meter	Annually	100	0	No
Virginia	Unk	Yes	Yes	Unk	Unk	Unk	Unk		Unk
Washington	Yes	Yes	Yes	Four teams, 2 men ea.	PCA Meter	Every two years	100	0	No
*King County, Washington	Yes	Yes	No	Unk	Cox Meter Benk. Beam Skid	Annually	160	0	No
Oregon	Yes	Yes	Unk	Unk	PCA Meter	Unk	Unk		Yes
Utah	Yes	Yes	Unk	2 Teams, 2 Men ea.	Cox Meter Dynaflect Skid	Annually	NA**		NA
Ontario	Unk	Yes	Unk	Unk	None	Unk	100	0	Unk
Corpus Christi, Texas	Yes	Yes	Unk	Unk	None	Annually	100	60	Unk

* This system is under consideration for adoption.
**Not applicable to date.

After reference (6)

TABLE 12. Pavement Mechanistic Evaluation--Condition Survey (Distress Measurements)

CATEGORY	METHOD	MEASUREMENTS	ITEMS MEASURED	ADVANTAGES	DISADVANTAGES	IMPLEMENTATION	RESEARCH NEEDS
Visual Evaluation	Washington State (Flexible)	Type, Degree, Magnitude and Location of Distress	*Rutting *Waves, Sags, Humps *Corrugations, Potholes, Raveling, Flushing *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Washington *California (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Washington State (Rigid)	Type, Degree, Magnitude and Location of Distress	*Cracking *Raveling, Disintegration, Pop Out Sealing *Joint Spalling *Pumping, Blowing *Blowups *Faulting, Curling, Warping, Settlement *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Washington *California (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Minnesota (Flexible)	Type, Degrees, Magnitude and Location of Distress	*Rutting *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Multiple Cracking *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Minnesota (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Minnesota (Rigid)	Type, Degree, Magnitude and Location of Distress	*Spalled Joints *Faulted Joints *Cracked Panels *Broken Panels *Faulted Panels *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Minnesota (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Minnesota (Bituminous Overland)	Type, Degree, Magnitude and Location of Distress	*Longitudinal Cracking *Transverse Cracking *Multiple Cracking *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Minnesota (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Ohio (Proposed)	Type, Degree, Magnitude and Location of Distress	*Deterioration *Obstruction *Flushing *Stripping	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety *Few Items Measured *Limited Measures of Degree and Magnitude of Distress	*Ohio (Research) (2)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Canadian Dept. of Transport (Flexible)	Type, Degree, Magnitude and Location of Distress	*Hair Cracking *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Chicken Wire *Map Cracking *Reflection Cracking *Stripping *Raveling *Rutting *Deformation *Distortion *Subgrade Settlement *Skin Patches *Deep Patches *Localized Reconstruction *Frost Heave	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Canadian Dept. of Transport (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	British Road Research Laboratory	Type, Degree, Magnitude and Location of Distress	*Disintegration, Flushing *Deformation *Texture *General Variability *Overall Condition	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety *Few Items Measured	*British Road Research Laboratory (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	King County, Washington (Proposed	Type, Degree, Magnitude and Location of Distress	*Corrugation, Shoving, Slippage *Flushing *Raveling *Rutting *Alligator Cracking *Longitudinal Cracking *Transverse Cracking *Waves, Sags, Humps *Patching	*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety *Few Items Measured	*King County (Research) (2)	*Improve Repeatability of Results *Increase Speed of Data Collection
Photographic	British Columbia	*Photographs	*Cracking *Some Distortion *Safety Hazards	*History of Use and Acceptance *Speed of Operation *Safety *Combine Several Measurements in Single Operation *Continuous Record	*Subjectivity of Measurements *Speed *Safety *Detail of Pavement Defects	*British Columbia (3)	*Improve Repeatability of Results *Increase Speed of Data Collection
	Washington State	*Photographs		*History of Use and Acceptance	*Subjectivity of Measurements *Speed *Safety	*Washington (Research) (2)	*Improve Repeatability of Results *Increase Speed of Data Collection

after reference 7.

The following major categories of distress are usually recognized by the various methods:

1. Cracking (alligator, longitudinal, transverse, map, reflection),
2. Disintegration (raveling, stripping, spalling, scaling),
3. Permanent Deformation (rutting, faulting, etc.) and
4. Distortion (settlement, heave, etc.).

Details of individual methods are given in Table 12 and reference 6 to give the reader a better understanding of the differences in condition surveys. In addition to the detail associated with types of distress, some agencies require different forms for flexible, rigid and overlaid pavements while others use a single form.

Length of sections surveyed and weighting factors assigned various types of distress by the different agencies also vary among those conducting condition surveys. For example, Table 13 shows the approximate percent of the condition rating score that is determined by pavement distress factors. The percentage range from 17 percent (Arizona) to 100 percent (Maine). No geographical pattern is evident from the distribution of the percentages. On the average, 49 percent of the rating score for flexible pavements and 43 percent for rigid pavements is accounted for by distress factors. Since the remaining percentages account for such items as roughness, traffic, geometry, etc., it is readily apparent that distress considerations are a significant, though highly variable, part of the individual rating systems.

Table 14 shows the percentage of the pavement rating score represented by each of the forms of distress. The distress factors listed are self-explanatory with the exception of the one listed as "General". This category is used to group those forms of distress listed by the various

TABLE 13. Maximum Percent Distress Factors Influence Overall Rating by Agency*

	Flexible Pavements	Rigid Pavements
1. Arizona	17.0	17.0
2. California	78.3	--
3. Florida	50.0	--
4. Georgia	37.5	--
5. Indiana	22.0	22.0
6. Kansas	44.0	50.0
7. Louisiana	30.0	30.0
8. Maine	100.0	--
9. Maryland	40.0	40.0
10. Minnesota	50.0	50.0
11. Nebraska	40.0	--
12. New Mexico	40.0	40.0
13. North Dakota	75.5	--
14. Tennessee	50.0	50.0
15. Texas	80.4	85.7
16. Virginia	48.0	42.0
17. Washington	50.0	50.0
18. King County, Washington	37.5	--

*In general, the table does not utilize distress measured by ride meters in the computation of percentages.

-- Indicates one of two items: The agency does not use a rating system for rigid pavements or distress factors are not numerically weighted.

after reference 6.

TABLE 14. Maximum Percent Individual Distress Factors Influence Overall Rating by Agency

	Flexible Pavements												Rigid Pavements									
	General	Cracking	Rutting	Raveling	Deflection	Corrugations	Patching	Pitting	Distortion	Shoving	Pot holes	Flushing	General	Cracking	Faulting	Patching	Blow ups	Spalling	Undulations	Scaling	Pumping	
Arizona	17.0												17.0									
California		33.2	9.5	11.9		19.0	4.7															
Florida		30.0	13.3				6.7															
Georgia					37.5																	
Indiana	22.0												22.0									
Kansas	4.0	18.0	12.0				10.0						4.0	24.0	4.0			4.0	10.0	4.0		
Louisiana	30.0												30.0									
Maine	9.0	44.0	14.0			5.0		14.0	14.0													
Maryland	40.0												40.0									
Minnesota		27.5	7.5				15.0							15.0	5.0	15.0		12.5		2.5		
Nebraska	20.0				20.0																	
New Mexico	40.0												40.0									
North Dakota		49.0	10.2	4.1						6.1	6.1											
Tennessee	>50												>50									
Texas		27.4	5.9	7.8		7.8	7.8				15.7	7.8		28.6	7.6	3.8	7.6	11.4		11.4	11.4	
Virginia		35.0	5.0	1.0					2.0			5.0		7.0	10.0			25.0				
Washington		18.1	11.1			2.7	4.2		11.1		2.7			9.8	5.9	2.9	2.9	9.8		9.8	8.8	
King County, Washington		12.5	6.3	6.3		3.1			3.1	3.1		3.1										
Avg. Among Agencies Using the Distress Factor	25.8	29.5	9.5	6.2	28.8	7.5	8.1	14.0	7.6	4.6	8.2	5.3	29.0	16.9	6.5	7.2	5.3	12.5	10.0	6.9	10.1	
Avg. Among Agencies Using Flexible (18) or Rigid (12) Rating Systems	12.9	16.4	5.3	1.7	3.2	2.1	2.7	0.8	1.7	0.5	1.4	0.9	16.9	7.0	2.7	1.8	0.9	5.2	0.8	2.3	1.7	

after reference 6.

agencies under generalized headings like "structural adequacy".

The amount that individual distress factors influence the overall rating can be examined in two ways. First, by determining the average of only those agencies which use the factor and second, by averaging of all agencies. The latter is considered the more informative, because if an agency does not include a given factor, that is an indication that the factor is considered unimportant.

Based on the latter averaging procedure, the "General" category accounts for an average of 13 percent (flexible) and 17 percent (rigid) of the overall pavement rating score. Of all of the specific types of distress, cracking is the most heavily weighted with 16 percent for flexible and 7 percent for rigid pavements. The next most important forms of distress for flexible pavements are rutting (5%) and patching (3%). For rigid pavements, the next most important forms of distress are spalling (5%) and faulting (3%). Deflections average 3 percent for flexible pavements but are not considered as distress in this analysis.

Photographic methods for conducting condition surveys have been developed in British Columbia and Washington. The British Columbia device not only gives an indication of pavement cracking and distortion but also measures road roughness, pavement cross slope, the presence of roadside hazards and signing needs. Detailed pavement distress cannot be recognized from photographic techniques presently used.

Review of Table 12 and the literature indicates that a number of condition survey methods have been implemented by various agencies; however, certain problem areas have been identified and are given below:

1. Undesirable subjectivity in surveys due to present techniques and/or human factors,

2. Absence of valid, workable statistical sampling procedures for highway surveys,

3. Adequate delineation of established survey areas for repetitive survey purposes,

4. Lack of uniformity in severity weighting techniques for distress types,

5. Inability with current data storage and retrieval methods to achieve a valid and workable inventory of pavement condition and

6. Hazardous and disruptive nature of condition surveys, as currently conducted.

In spite of the above mentioned problems with condition surveys, the condition survey approach was considered as a measuring element in the pavement rating system.

Development of Maintenance Rating System

Based on the literature summarized above and discussions with field and central office maintenance personnel of the Texas State Department of Highways and Public Transportation a maintenance rating system has evolved. The key elements of this system have become a subjective visual roadway condition survey and objective mechanistic tools to measure pavement roughness, skid resistance and pavement structural capacity. The objective measuring systems include the Mays Ride Meter to determine pavement roughness (21), the locked-wheel skid trailer to measure the skid number at 40 m.p.h. and the Dynaflect to measure pavement structural capacity. The subjective roadway condition survey consists of a pavement condition survey and

an itemized evaluation of shoulder, roadside, drainage and traffic services features. Separate forms are utilized for flexible and rigid pavements.

Details describing the roadway condition survey as presently utilized in Texas can be found in reference 4. A brief history of the development of this system follows.

Development of Roadway Condition Survey. As discussed above the maintenance rating system should be capable of determining the present condition of highway elements including the pavement, shoulder, roadside, drainage and traffic services features. An extensive list of maintainable features under each of the above categories was prepared and reviewed by Texas Transportation Institute and Texas State Department of Highways and Public Transportation representatives. The items finally selected for shoulder, roadside, drainage and traffic services features are shown in Figure 4 and listed below:

A. Shoulders
    1. Paved Shoulders
        a. Ride
        b. Contrast
        c. Pavement edge
        d. Shoulder edge
        e. Cracks
        f. Raveling or flushing
        g. Vegetation
    2. Unpaved Shoulders
        a. Pavement edge
        b. Rutting, corrugations, loose rock

Figure 4. Maintenance Rating Form for Flexible Pavements

B. Roadside

1. Litter

2. Mowing

3. Vegetation

4. Slope errosion

C. Drainage

1. Culverts

2. Ditches, outfalls, channels

3. Roadside drainage

D. Traffic Services

1. Guardrails

2. Signs

3. Delineators

4. Striping

5. Auxiliary Marking

The items initially considered for evaluation purposes are shown in Table 15. As noted, a considerable number of items were combined or deleted. For example, items finally selected to identify shoulder maintenance needs are in the two categories of paved and unpaved rather than the four categories of asphalt concrete, surface treatment or seal coat, unpaved and sod as originally considered.

The rating techniques selected for use in evaluating the condition of the shoulder, roadside, drainage and traffic services elements are shown in Table 16. This numerical rating is based on the condition of the element being evaluated and not specifically for its need for maintenance. However, numerical ratings can be utilized to suggest the urgency of required maintenance utilizing the guidelines shown below:

TABLE 15. Roadway Items Originally Considered for Evaluation as Part of Maintenance Rating System

SHOULDER FEATURES

A. Asphalt Concrete Shoulders
   1. Appearance
   2. Distress Types Contained on Pavement Condition Survey

B. Surface Treatment on Seal Coat Shoulder
   1. Appearance
   2. Riding Quality
   3. Raveling
   4. Flushing
   5. Cracking
   6. Potholes
   7. Shoulder Build-up

C. Unpaved Shoulders (Granular Materials)
   1. Appearance
   2. Riding Quality
   3. Raveled Pavement Edge
   4. Pavement Drop-off
   5. Potholes
   6. Corrugations or Loose Rock
   7. Erosion

D. Sod Shoulders
   1. Appearance
   2. Riding Quality
   3. Raveled Pavement Edge
   4. Pavement Drop-off
   5. Potholes
   6. Corrugations or Loose Rock
   7. Erosion

ROADSIDE FEATURES

A. Litter
B. Trees
C. Shrubs and Plantings
D. Grass
E. Flowers
F. Roadside Parks
G. Fencing
H. Brush
I. Vegetation Control
J. Encroachments
K. Pest Control

DRAINAGE FEATURES

A. Drainage Ditches
   1. Erosion
   2. Silt Removal
   3. Vegetation Control
   4. Slope Adequency
   5. Vegetation Needs

B. Slopes
   1. Erosion
   2. Vegetation Needs
   3. Retards - Grass
   4. Retards - Concrete

C. Culverts and Drainage Structures
   1. Silting
   2. Structure Condition
   3. Rip Rap

TRAFFIC SERVICES

A. Signs
   1. Cleanness
   2. Supports
   3. Location

B. Delineators
   1. Cleanness
   2. Supports
   3. Location

C. Median Barriers, Guard Rails, Transition Rails
   1. Cleanness
   2. Supports
   3. Location

D. Turnouts
   1. Mailbox
   2. Driveway
   3. Mailbox Condition

E. Intersection Channelization

F. Striping

G. Night Visibility

TABLE 16. Rating Scale for Shoulder, Roadside, Drainage and Traffic Services.

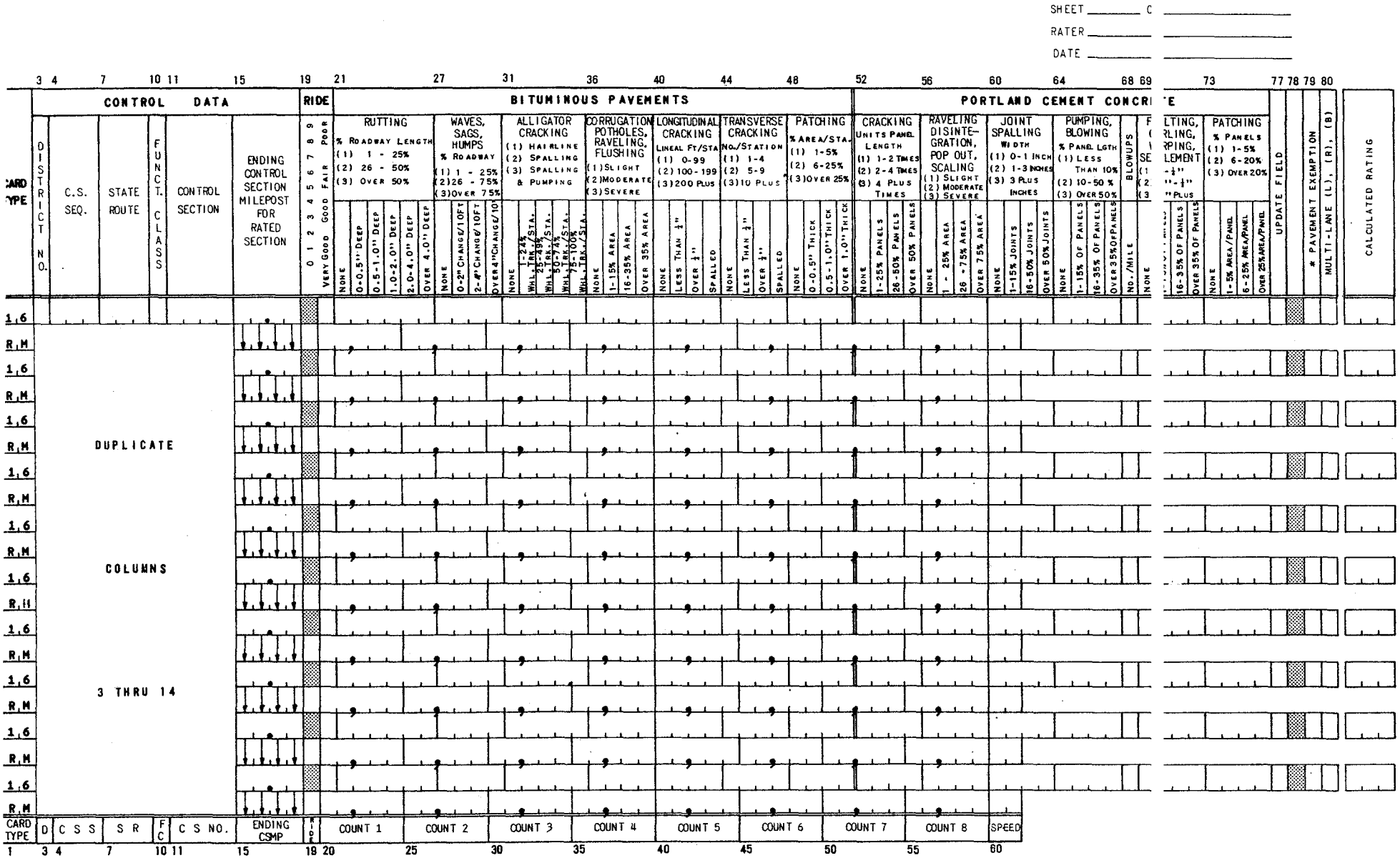
General Description of Condition	Numerical Scale
Very Good	1-2
Good	2-4
Fair	4-6
Poor	6-8
Very Poor	8-9
Item not present on roadway section	0

Evaluation Score	Maintenance Urgency
1 - 2	Maintenance not required in 2 or more years
2 - 4	Maintenance not probable in 2 years but need should be re-evaluated yearly
4 - 6	Possible maintenance in 1 year
6 - 8	Schedule maintenance within 1 year
8 - 9	Schedule maintenance immediately

Development of Flexible Pavement Condition Survey. The pavement condition portion of the maintenance rating system was developed based on the extensive literature review summarized above together with input from personnel from the Texas State Department of Highways and Public Transportation. Two systems for pavement evaluation were seriously considered for adoption by the study staff; the Washington State Method and the method proposed for use in Ohio (13). The Washington Method (Figure 5) appeared to offer more versatility and thus was selected for trial implementation on a maintenance section of District 21. The results of this survey were very encouraging and thus the type of form utilized by Washington was used as a basis for development of the Texas pavement maintenance rating form.

Figure 6 depicts the original maintenance rating form utilized for trial implementation in Districts 7 and 21. All of the roadways in Districts 7 and 21 and approximately 250 pavement sections selected throughout the state were evaluated with this form in 1972-1973. Deduct or negative values assigned to the various degrees and types of pavement distress for the 1973 survey form are shown in Table 17.

A comparison of Figures 5 and 6 illustrates the changes made in the Washington form for use in Texas. These changes are briefly reviewed



*CODE = (1) Unpaved Roadways, (2) Roadways Under Construction (3) Bridge, (4) Road Impassable

REMARKS: _____

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Figure 5. Washington Pavement Condition Survey Form

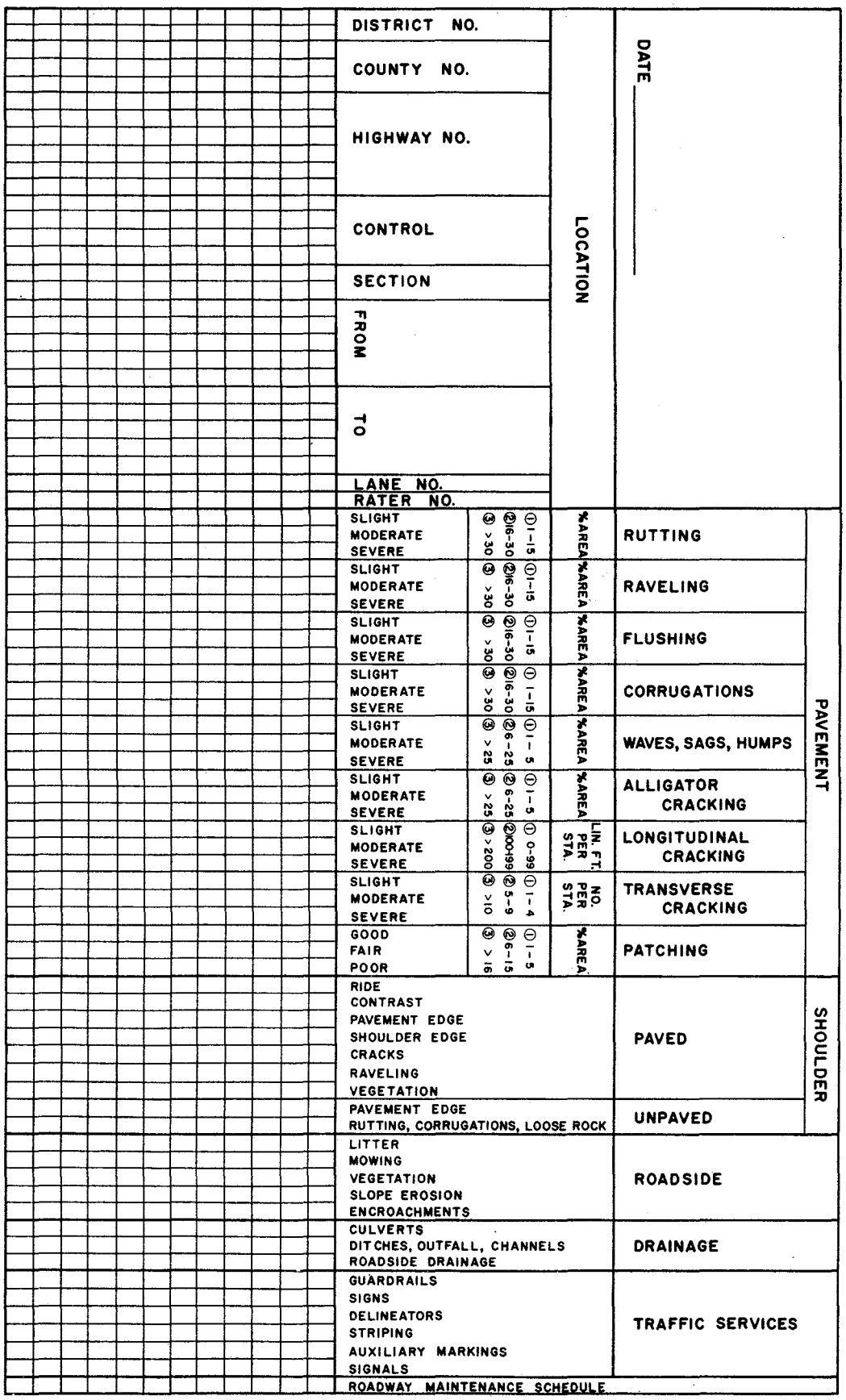

Figure 6. 1973 Maintenance Rating Form for Flexible Pavements

TABLE 17. 1973 Deduct Table
Flexible Pavement Evaluation

Negative Values to be Assigned to the Various Degrees of Pavement Failures

Type of Distress	Degrees of Distress	Extent or Amount of Distress		
Rutting	Slight	0	2	5
	Moderate	5	7	10
	Severe	10	12	15
Raveling	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Flushing	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Corrugations	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Waves Sags Humps	Slight	10	15	20
	Moderate	20	25	30
	Severe	30	35	40
Alligator Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Longtitudinal Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Transverse Cracking	Slight	3	5	10
	Moderate	4	7	12
	Severe	5	10	15
Patching	Good	2	5	7
	Fair	5	7	10
	Poor	7	10	15

below.

1. Shoulder, roadside, drainage and traffic service features were added to the form and bituminous and portland cement concrete pavements were placed on separate forms.

2. The headings of rutting, waves, sags, humps, alligator cracking, longitudinal cracking, transverse cracking and patching were transferred from the Washington to the Texas form although the definition of the amount and severity of distress was changed in many cases.

3. Corrugations, raveling and flushing which appears under one heading on the Washington form was separated into three headings on the Texas form.

4. The pavement distress items for portland cement concrete pavement, as will be discussed below, was altered to include an evaluation method for both continuous and jointed concrete pavements.

A comparison of Figures 4 and 6 illustrates refinements in the rating system which occurred after a trial implementation phase. Six changes which occurred are briefly discussed in the following paragraphs.

1. Additional location data were included. Specifically, the foreman, number and highway class were identified on the new form. In addition, the names of those conducting the rating and the date the ratings were performed was included in a form suitable for data processing.

2. The pavement distress items "Waves, Sags, Humps" was removed and replaced with the Serviceability Index as measured by the Mays Meter.

The field trials demonstrated that considerable variation existed in the estimates of "waves, sags, humps". This variability together with the general availability of the Mays Ride Meter indicated that this was a practical change.

3. From a maintenance scheduling standpoint it is necessary to know if the transverse and longitudinal cracks are sealed, partially sealed or not sealed. A column denoting this condition was inserted.

4. A column denoting the number of failures per mile of roadway was inserted into the form. Due to the reduced frequency of needed maintenance pavement failures were expected and have occurred in Texas at an increasing rate. This category of distress is singled out to emphasize the seriousness of the problem.

5. Under the heading of "roadside" the item "encroachments" has been removed. Encroachments were not considered a major problem in most parts of the state. Encroachment problems can now be entered on the form by use of an appropriate number under the columns "other".

6. A three space column was added and titled "other". This portion of the form is to be utilized by the evaluation team to denote unusual conditions that exist along the roadway. Examples of items to be noted by code numbers are encroachments, signals operating improperly and dangerous geometric features including improper speed signing of curves and striping of no passing zones.

Because of the changes in the pavement rating forms, new deduct values were developed and are shown in Table 18. The deduct points for patching were reduced and deduct points were adjusted for longitudinal and transverse crack condition, i.e., sealed or unsealed.

TABLE 18. Deduct Table Flexible Pavement Evaluation

Negative Values to be Assigned to the Various Degrees of Pavement Failures

Type of Distress	Degrees of Distress	Extent or Amount of Distress (1)	(2)	(3)
Rutting	Slight	0	2	5
	Moderate	5	7	10
	Severe	10	12	15
Raveling	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Flushing	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Corrugations	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Alligator Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Patching	Good	0	2	5
	Fair	5	7	10
	Poor	7	15	20

Deduct Points for Cracking

Longitudinal Cracking

	Sealed			Partially Sealed			Not Sealed		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Slight	2	5	8	3	7	12	5	10	15
Moderate	5	8	10	7	12	15	10	15	20
Severe	8	10	15	12	15	20	15	20	25

Transverse Cracking

Slight	2	5	8	3	7	10	3	7	12
Moderate	5	8	10	7	10	15	7	12	15
Severe	8	10	15	10	15	20	12	15	20

Failures	20	30	40

Deduct points for the Mays Ride Meter were based on Serviceability Index values obtained from the statewide random pavements survey. The distribution of the Serviceability Index values for all pavement sections investigated is shown in Table 19 together with the deduct points presently utilized. Ten deduct points were assigned to the average condition and the other deduct points were arbitrarily assigned as shown. It should be recognized that the vast majority of the pavements surveyed had either asphalt concrete or chip seal surfaces.

Development of Rigid Pavement Condition Survey. The visual rating form for portland cement concrete or rigid pavements is identical to the form for flexible pavements with the exception of the central portion of the form relating to the pavement surface (Figure 7). The development of the form followed a process similar to that utilized for development of the flexible pavement form. The Washington Method was utilized as a general guide and a form for trial implementation developed (Figure 8). This form was utilized to rate pavements in Districts 13 and 17. The results of this trial implementation suggested that certain changes should be made (Figure 7). As will be noted on Figure 7, the pavements portion of the form is divided into three sections. The types of distress observed on both continuously reinforced and jointed pavements are listed first. These distress types include pumping, scaling, raveling, disintegration, pop-outs, spalling, longitudinal cracking, patching and faulting. The other two portions relate to either continuously reinforced concrete or jointed pavements exclusively.

Deduct points utilized with the present rigid pavement form are shown in Table 20.

TABLE 19. Distribution of 1973 Serviceability Index Values as Obtained from Random Pavement Sections

Serviceability Index	Percent of Pavements Less Than Value	Deduct Points
4.70	0	0
3.70	25	3
3.50	35	5
3.30	50	10
3.10	65	20
2.95	75	30
2.75	85	40
2.40	95	50

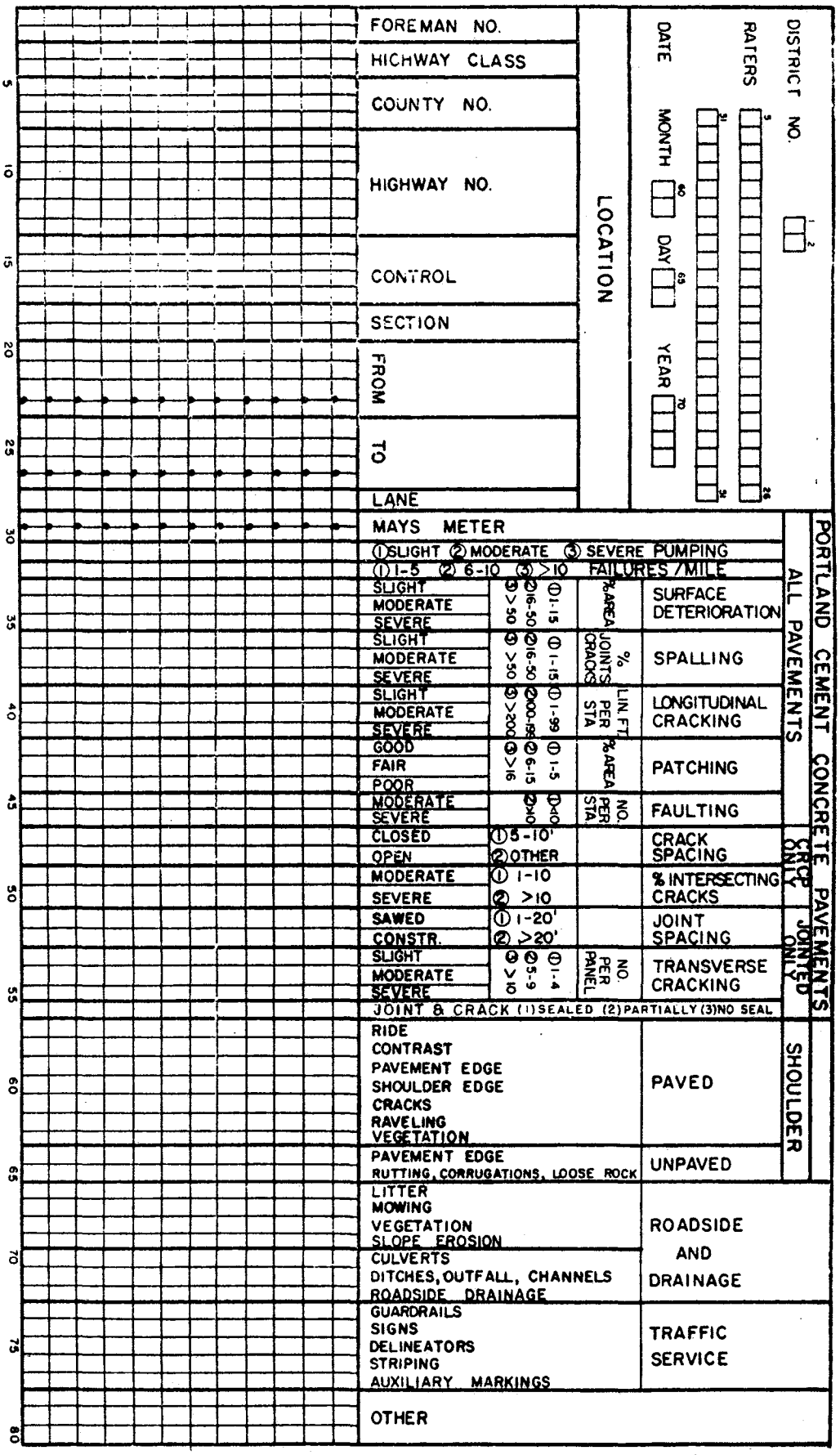

Figure 7. Maintenance Rating Form for Rigid Pavements

DISTRICT NO.		LOCATION	DATE	
COUNTY NO.				
HIGHWAY NO.				
CONTROL				
SECTION				
FROM				
TO				
LANE NO.				
RATER NO.				
1-25% PANELS 25-50% PANELS OVER 50% PANELS	1 1-2 2 3-5 3 5+	CRACKS > 1/8" PER PANEL	CRACKING	JOINTED ONLY — PORTLAND CEMENT CONCRETE PAVEMENT
SAWED CONSTRUCTION	1< 20' 2>20'		JOINT SPACING	JOINTED ONLY — PORTLAND CEMENT CONCRETE PAVEMENT
1-15% JOINTS 16-50% JOINTS OVER 50% JOINTS	1 0-1 2 1-3 3 3+	WIDTH OF SPALL IN INCHES	JOINT SPALLING or TRANSVERSE CRACK SPALLING	ALL PAVEMENTS — PORTLAND CEMENT CONCRETE PAVEMENT
1-25% AREA 26-75% AREA OVER 75% AREA	1 SLIGHT 2 MODERATE 3 SEVERE		RAVELLING DISENTIGRATION POP OUT SCALING	ALL PAVEMENTS — PORTLAND CEMENT CONCRETE PAVEMENT
1-15% SECTIONS 16-35% SECTIONS OVER 35% SECTIONS	1 < 10% 2 10-50% 3 > 50%	% SECTION LENGTH	PUMPING BLOWING	ALL PAVEMENTS — PORTLAND CEMENT CONCRETE PAVEMENT
1-15% SECTIONS 16-35% SECTIONS OVER 35% SECTIONS	1 0-1/4" 2 1/4-1/2" 3 1/2" +		FAULTING CURLING WARPING	ALL PAVEMENTS — PORTLAND CEMENT CONCRETE PAVEMENT
1-5% SECTIONS 6-20% SECTIONS OVER 20% SECTIONS	1 1-5% 2 6-25% 3 25% +	% AREA PER SECTION	PATCHING	ALL PAVEMENTS — PORTLAND CEMENT CONCRETE PAVEMENT
< 1/16" WIDE > 1/16" WIDE	1 5-10' 2 2-5' OR 10-15'	3 <2' OR >15'	TRANSVERSE CRACK SPACING	CRCP ONLY — PORTLAND CEMENT CONCRETE PAVEMENT
< 1/8" WIDE 1/8"-1/4" WIDE SPALLED	1 0-99' 2 100-199' 3 200 +	LINEAL FEET PER STATION	LONGITUDINAL CRACKING	CRCP ONLY — PORTLAND CEMENT CONCRETE PAVEMENT
NO LOOSE PIECES LOOSE PIECES	1<10% 2>10%		% INTERSECTING CRACKS	CRCP ONLY — PORTLAND CEMENT CONCRETE PAVEMENT
RIDE CONTRAST PAVEMENT EDGE SHOULDER EDGE CRACKS RAVELLING VEGETATION			PAVED	SHOULDER
PAVEMENT EDGE RUTTING, CORRUGATIONS, LOOSE ROCK			UNPAVED	SHOULDER
LITTER MOWING VEGETATION SLOPE EROSION ENCROACHMENTS			ROADSIDE	
CULVERTS DITCHES, OUTFALL, CHANNELS ROADSIDE DRAINAGE			DRAINAGE	
GUARDRAILS SIGNS DELINEATORS STRIPING AUXILIARY MARKINGS SIGNALS			TRAFFIC SERVICES	
ROADWAY MAINTENANCE SCHEDULE				

Figure 8. 1973 Maintenance Rating Form for Rigid Pavements

TABLE 20. Deduct Values for Rigid Pavement

Type of Distress	Degrees of Distress	Extent or Amount of Distress (1)	(2)	(3)
Pumping		20	40	60
Failures/Mile		20	30	40
Surface Deterioration	Slight	5	10	20
	Moderate	10	20	30
	Severe	20	40	60
Spalling	Slight	5	10	15
	Moderate	10	15	20
	Severe	20	40	60
Longitudinal Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Patching	Good	0	2	5
	Fair	5	7	10
	Poor	7	15	20
Faulting	Moderate	5	15	
	Severe	15	40	
Crack Spacing	Closed	0	10	
	Open	15	40	
% Intersecting Cracks	Moderate	5	15	
	Severe	15	40	
Joint Spacing	Information Only			
Transverse Cracking				
If Joint Spacing is less than 20 feet.				
	Slight	5	10	20
	Moderate	10	20	30
	Severe	15	30	40
If Joint Spacing is greater than 20 feet.				
	Slight	0	5	10
	Moderate	5	10	20
	Severe	10	15	30
Joints		0	10	20

Use of Maintenance Rating System for Flexible Pavements. The condition survey portion of the maintenance rating system was made available for use by all districts during the conduct of Research Study 2-18-75-199 as described in reference 5. A majority of the 25 districts in Texas have utilized this evaluation tool for a part or all of the pavements in their district. In addition one district, District 21, has made use of the other evaluation tools which are considered a part of the Maintenance Rating System. These tools include the Mays Ride Meter, the skid trailer and the Dynaflect. The use of the information gathered from their survey work is discussed in references 15, 16 and 17. Computer programs developed to assist in the use of these data for maintenance management purposes are described below together with the utilization of the collected data.

Computer Programs. Computer programs were developed to fit the needs of different levels of management within the Texas State Department of Highways and Public Transportation as determined from panel meetings and personal visits to several districts. Several of these programs were prepared to provide one-time needs or for illustration purposes and have not been formally prepared for implementation. Those programs anticipated for use on a broad scale have been documented in references 4 and 24.

Condition survey data reduction and sorting programs have been developed and documented in reference 4. Five rating scores have been defined as follows:

1. Pavement Rating Score (PRS),
2. Shoulder Rating Score (SRS),

3. Roadside Rating Score (RRS),

4. Drainage Rating Score (DRS) and

5. Traffic Services Rating Score (TRS).

Ten sort options exist to summarize these data from low to high Pavement Rating Score, by highway class, by county number, by highway type, by foreman and by several combinations of the above basic categories (Table 21). An example of a typical printout is shown in Figure 9.

A program referred to as the plot program has been developed based on a need to summarize a variety of collected data in graphical form (Figure 10) according to location along the roadway. Information collected and displayed includes:

1. Road roughness as measured by the Mays Ride Meter,

2. Skid number as measured by the ASTM E-17 locked wheel skid trailer,

3. Structural adequacy as measured by the Dynaflect,

4. Location of intersecting roads,

5. Average daily traffic,

6. Equivalent 18,000 lb. single axle load applications for a 20-year design life,

7. Control and section number,

8. Type of surfacing material,

9. Date of last surfacing,

10. Cost per mile for pavement and shoulder maintenance,

11. Cost-benefit ratio based on cost per mile and pavement rating score,

12. Pavement Rating Score,

13. Shoulder Rating Score,

TABLE 21. Sort Options

Option	Sort Order
1	Sort by County: county, highway code, highway number, lane, and from mile.
1A	Sort by County: county, highway code, highway number, from mile, and lane.
2	Sort by Foreman Number: foreman, highway code, highway number, lane, and from mile.
3	Sort by PRS-Entire District: pavement rating score.
4	Sort by PRS - by County: county and pavement rating score.
5	Sort by PRS - by Foreman Number: foreman and pavement rating score.
6	Sort by PRS - by Highway Class: highway class and pavement rating score.
7	Sort by Highway Type - Entire District - Ordered by PRS: highway code and pavement rating score.
8	Sort on Foreman - Arranged by Type - Ordered by PRS: foreman, highway code, and pavement rating score.
9	Sort by Highway Type - Entire District - Ordered by PRS - "SH" Highway Codes Converted to "US": highway code and pavement rating score.
10	Sort by Highway Type - Entire District - Ordered by PRS - "US" Highway Codes Converted to "SH": highway code and pavement rating score.

Notes:

A. Sort options 9 and 10 may not be requested in the same run.

B. The conversions of highway codes in options 9 and 10 are internal conversions for the purpose of sorting only. The highway codes will be printed exactly as read from the input cards.

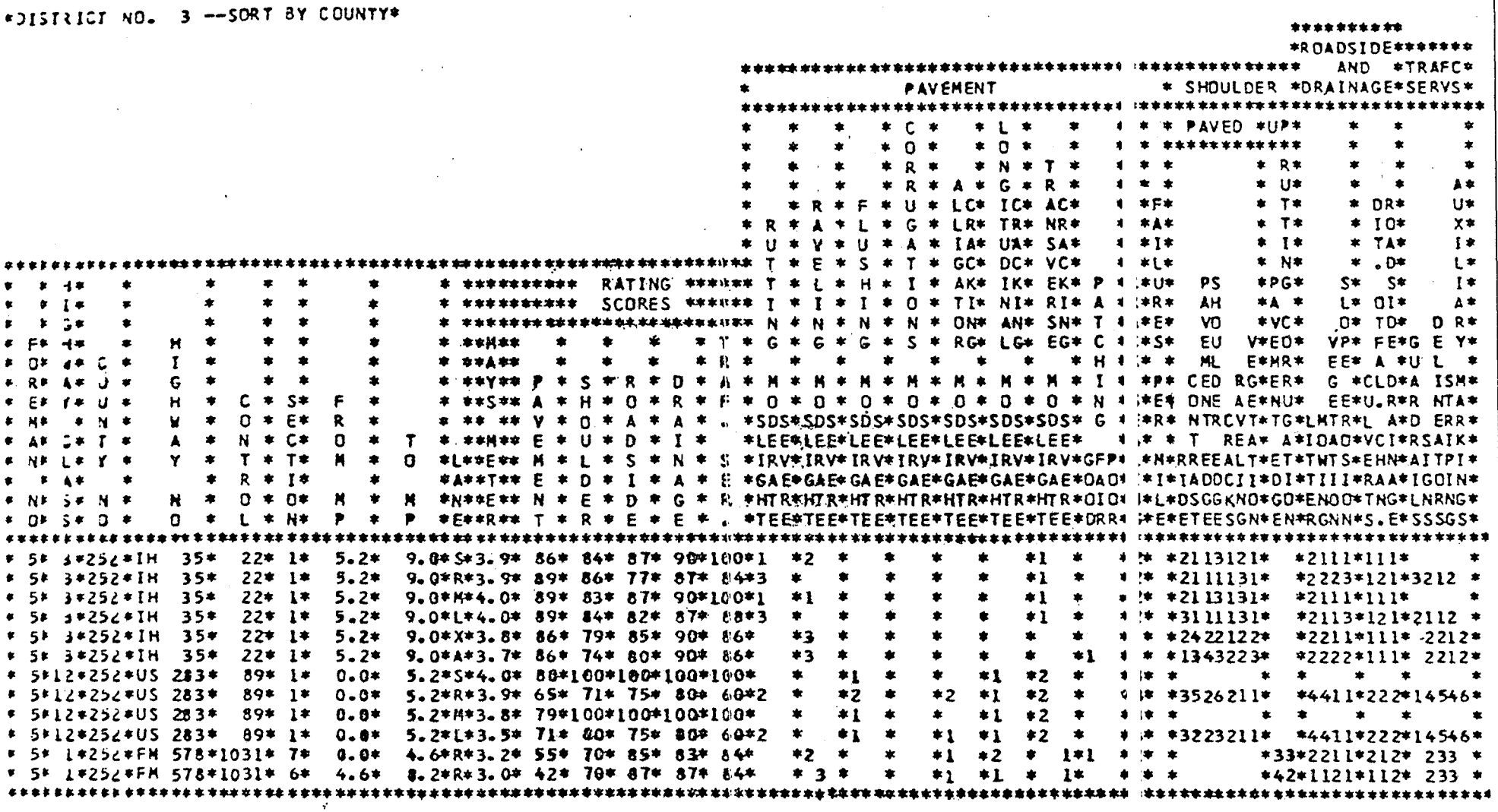

Figure 9. Output from Program MRSFP

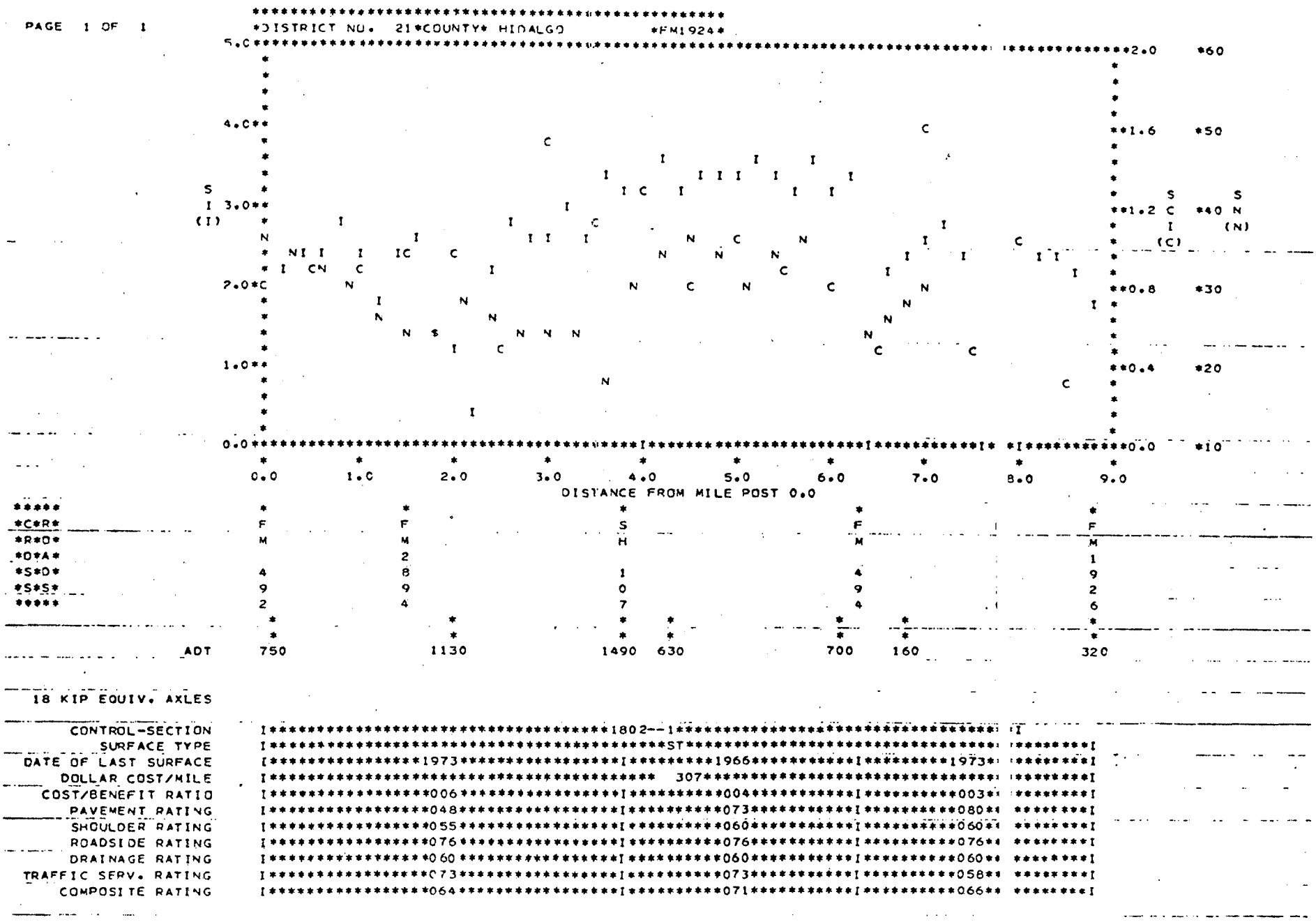

Figure 10. Plot Program Output

14. Roadside Rating Score,

15. Drainage Rating Score,

16. Traffic Services Rating Score and

17. Composite Rating Score obtained by multiplying the PRS, SRS, RRS, DRS and TRS by the percent of the total maintenance budget expended for each category.

The type of output shown in Figure 10 has been utilized by two districts at both the district and section management levels. This plot has been an invaluable reference for district maintenance personnel as well as district planning, design and construction groups.

A summary program has been prepared at the request of district engineers to present a concise review of their roadway conditions. Table 22 illustrates the general format of this output which contains information on the highway location, the rating scores, skid numbers (SN), road roughness (SI), structural capacity (SCI), average daily traffic (ADT), surface type (ST) and date of last surfacing. Because little use of this program has been made, it has not been documented.

A series of three budget programs were developed for District 21 in 1974. These programs were developed to illustrate the usefulness of maintenance rating system information for budget preparation and to satisfy, in part, central office requirements for budget justification. Figures 11 and 12 and Table 23 depict the computer printout format utilized to display the data. Figures 11 and 12 depict actual average and desired rating scores by each foreman by highway class. These data were utilized to adjust past years budgets to consider the present condition of the roadways. Table 23 summarizes cost by foreman for each highway class.

TABLE 22. Data Summary

ROAD	FROM MP	TO MP	LANE	CRS	PRS	SRS	RRS	DRS	TSS	AVG SN	AVG SI	AVG SCI	ADT	ST	AST/UR./ATE
US 281	0.0	3.0		78	53	87	86	77	88	37.	3.6	0.0	3730	AC	969
US 281	3.0	11.0		73	43	83	90	80	83	45.	3.0	0.0	3655	AC	969
US 281	11.0	22.0		87	75	86	92	93	92	42.	3.8	0.0	3580	AC	968
US 281	22.0	30.0		85	77	76	84	93	92	43.	3.8	0.0	3040	AC	968
SH 285	0.0	8.0		80	75	80	72	80	87	49.	3.3	.82	910	ST	961
SH 285	8.0	15.0		78	68	75	68	80	88	52.	3.4	.84	910	ST	961
SH 285	15.0	22.0		79	68	80	70	80	88	40.	3.8	.84	1380	AS	961
FM 430	0.0	3.0		85	70	85	90	90	93	41.	2.6	0.0	115	ST	967
FM 754	0.0	3.0		90	98	85	90	90	88	0.	2.8	0.0	240	ST	969
FM 755	0.0	7.0		88	93	75	86	87	90	39.	3.6	.45	500	ST	970
FM1418	0.0	6.0		87	90	85	90	90	85	38.	2.5	0.0	285	ST	969
FM2191	0.0	6.0		85	77	80	88	90	90	63.	3.1	0.0	760	AC	972
FM2191	6.0	12.0		86	72	83	92	97	92	39.	3.2	0.0	490	ST	966
FM3066	0.0	2.0		84	86	55	92	77	88	70.	3.6	0.0		ST	966

TABLE 23. District 21 -- Budget Data

FOREMAN ACCOUNT NO. 7
LEVEL 2 YEAR 1975
TOTAL FUNDS AVAILABLE TO FOREMAN 630703.

HWY CLASS	TOTAL MILES	EXPENS DISTRB	COST	COST/ MILES MAINTD	
10	33.09	9.2	58025	1754.	
20	126.11	29.3	184796	1465.	
30	26.27	20.7	130556	4970.	
31	0.12	0.1	631	5256.	
40	4.71	6.4	40365	8570.	
50	10.90	2.5	15768	1447.	
60	6.26	2.7	17029	2720.	
70	14.25	12.3	77576	5444.	
71	1.71	0.7	4415	2582.	
80	5.85	16.1	101543	17358.	
		TOTALS	630702	2751.	WEIGHTED AVERAGE

FIGURE 11.

WEIGHTED AVERAGES FOR FOREMAN ACCOUNT NUMBER 4

HWY CLASS	COMPOS SCORE	PAVMNT	SHLDRS	RDSIDE	DRAIN STRCT	TRAF. SERV.	MOWING	COST/MILE	ADJUSTED COST/MILE	COST/ BENFT RATIO	TOTAL COST	ADJ. TOTAL COST
10	75.1	82.6	71.3	74.4	60.0	72.8	3.7	1478.	1402.	18.6	190694.	180929.
20	68.3	65.4	58.8	73.8	60.0	73.0	3.8	839.	862.	12.7	116932.	120076.
30	79.2	88.6	69.6	86.5	65.0	65.7	2.2	4718.	4253.	54.1	4387.	3955.
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
OVERALL WEIGHTED AVG	71.6	73.7	64.8	74.1	60.0	72.9	3.8	1159.	1133.	15.7		
									TOTAL (NON-WEIGHTED)		312013.	304961.

WEIGHTED AVERAGES FOR FOREMAN ACCOUNT NUMBER 5

HWY CLASS	COMPOS SCORE	PAVMNT	SHLDRS	RDSIDE	DRAIN STRCT	TRAF. SERV.	MOWING	COST/MILE	ADJUSTED COST/MILE	COST/ BENFT RATIO	TOTAL COST	ADJ. TOTAL COST
10	73.9	78.0	70.9	72.4	62.3	71.7	4.1	933.	901.	12.2	117654.	113616.
20	69.7	61.9	59.4	73.6	60.0	76.0	4.5	793.	815.	12.4	43002.	44168.
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
40	73.8	73.6	70.4	74.4	60.0	74.0	4.9	2695.	2683.	36.3	90105.	89692.
50	76.6	81.8	75.0	80.6	64.5	64.5	2.6	3456.	3341.	43.4	31138.	30102.
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
80	70.0	68.0	68.0	74.0	60.0	67.0	3.9	16199.	16190.	231.2	65930.	65893.
OVERALL WEIGHTED AVG	72.9	73.5	68.2	73.4	61.5	72.7	4.3	1533.	1514.	21.0		
									TOTAL (NON-WEIGHTED)		347828.	343472.

WEIGHTED AVERAGES FOR FOREMAN ACCOUNT NUMBER 6

HWY CLASS	COMPOS SCORE	PAVMNT	SHLDRS	RDSIDE	DRAIN STRCT	TRAF. SERV.	MOWING	COST/MILE	ADJUSTED COST/MILE	COST/ BENFT RATIO	TOTAL COST	ADJ. TOTAL COST
10	63.7	48.8	54.8	75.6	60.3	69.9	3.8	1685.	1806.	29.6	63339.	67885.
20	68.8	67.1	56.2	75.9	58.9	69.4	3.9	1047.	1027.	15.2	151089.	148156.
30	71.0	73.1	68.6	76.0	60.0	64.6	4.0	6020.	5953.	84.2	44183.	43698.
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
40	70.6	66.0	69.0	76.0	60.0	70.0	3.9	4455.	4580.	64.9	28378.	29175.
50	63.9	48.0	57.1	81.7	70.1	63.0	2.6	2582.	2522.	39.8	38032.	37153.
60	72.6	72.4	61.8	80.5	66.8	70.0	2.9	1773.	1706.	25.4	29914.	28784.
70	72.7	63.4	71.3	87.7	66.9	65.6	1.8	2556.	2558.	36.8	25048.	25070.
71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.	0.
80	70.6	66.0	69.0	76.0	60.0	70.0	3.8	6684.	5940.	84.1	27805.	24710.
OVERALL WEIGHTED AVG	68.2	63.4	58.0	77.0	60.8	68.8	3.7	1691.	1678.	25.2		
									TOTAL (NON-WEIGHTED)		407789.	404631.

FIGURE 12. District 21--Budget Data

Foreman Account No. 4

Level 2 Year 1975

THE COST/MILES MAINTAINED EXPENDITURES ARE DISTRIBUTED BY CATEGORY OF WORK ACCORDING TO THE PERCENTAGES BELOW BASE & SURF 22.30 PCT SHOULDERS 22.10 PCT ROADSIDE 36.20 PCT DRAINAGE 1.00 PCT TRAFFIC SERVICES 18.40

HWY CLS	COST	COST/ MILES MAINTD	**EXPENDITURES BY CATEGORY * SURF COST	SHLD COST	ROAD COST	DRAN COST	TRAF COST	**** COST/BENEFIT RATIOS **** SURF	SHDF	ROAD	DRAN	TRAF	LEVEL OF MAINTENANCE ********* SURF	SHLD	ROAD	DRAN	TRAF
10	231002	1789.	399	395	648	18	329	5.9	5.8	9.5	0.3	4.8	68.0	68.0	68.0	68.0	68.0
20	158616	1138.	254	252	412	11	209	3.7	3.7	6.1	0.2	3.1	68.0	68.0	68.0	68.0	68.0
30	5933	6380.	1423	1410	2310	64	1174	20.3	20.1	33.0	0.9	16.8	70.0	70.0	70.0	70.0	70.0
31	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0
40	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
50	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
60	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
70	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
71	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
80	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	75.0	75.0	75.0	75.0	75.0

Foreman Account No. 5

Level 2 Year 1975

THE COST/MILES MAINTAINED EXPENDITURES ARE DISTRIBUTED BY CATEGORY OF WORK ACCORDING TO THE PERCENTAGES BELOW BASE & SURF 31.30 PCT SHOULDERS 5.60 PCT ROADSIDE 38.30 PCT DRAINAGE 0.30 PCT TRAFFIC SERVICES 24.50

HWY CLS	COST	COST/ MILES MAINTD	**EXPENDITURES BY CATEGORY * SURF COST	SHLD COST	ROAD COST	DRAN COST	TRAF COST	**** COST/BENEFIT RATIOS **** SURF	SHDF	ROAD	DRAN	TRAF	LEVEL OF MAINTENANCE ********* SURF	SHLD	ROAD	DRAN	TRAF
10	154118	1217.	381	68	466	4	298	5.6	1.0	6.9	0.1	4.4	68.0	68.0	68.0	68.0	68.0
20	52096	961.	301	54	368	3	235	4.4	0.8	5.4	0.0	3.5	68.0	68.0	68.0	68.0	68.0
30	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0
31	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0
40	109402	3273.	1024	183	1253	10	802	14.4	2.6	17.7	0.1	11.3	71.0	71.0	71.0	71.0	71.0
50	37770	4356.	1364	244	1668	13	1067	19.2	3.4	23.5	0.2	15.0	71.0	71.0	71.0	71.0	71.0
60	868	1277.	400	72	489	4	313	5.6	1.0	6.9	0.1	4.4	71.0	71.0	71.0	71.0	71.0
70	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
71	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
80	79881	19627.	6143	1099	7517	59	4809	81.9	14.7	100.2	0.8	64.1	75.0	75.0	75.0	75.0	75.0

Foreman Account No. 6

Level 2 Year 1975

THE COST/MILES MAINTAINED EXPENDITURES ARE DISTRIBUTED BY CATEGORY OF WORK ACCORDING TO THE PERCENTAGES BELOW BASE & SURF 26.90 PCT SHOULDERS 15.10 PCT ROADSIDE 30.90 PCT DRAINAGE 0.30 PCT TRAFFIC SERVICES 26.80

HWY CLS	COST	COST/ MILES MAINTD	**EXPENDITURES BY CATEGORY * SURF COST	SHLD COST	ROAD COST	DRAN COST	TRAF COST	**** COST/BENEFIT RATIOS **** SURF	SHDF	ROAD	DRAN	TRAF	**** LEVEL OF MAINTENANCE ******** SURF	SHLD	ROAD	DRAN	TRAF
10	77205	2014.	542	304	622	6	540	7.7	4.3	8.9	0.1	7.7	70.0	70.0	70.0	70.0	70.0
20	176260	1260.	339	190	389	4	338	4.8	2.7	5.6	0.1	4.8	70.0	70.0	70.0	70.0	70.0
30	52926	7211.	1940	1089	2228	22	1932	27.7	15.6	31.8	0.3	27.6	70.0	70.0	70.0	70.0	70.0
31	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0
40	33989	5336.	1435	806	1649	16	1430	19.1	10.7	22.0	0.2	19.1	75.0	75.0	75.0	75.0	75.0
50	44186	2691.	724	406	832	8	721	10.2	5.7	11.7	0.1	10.2	71.0	71.0	71.0	71.0	71.0
60	37874	2124.	571	321	656	6	569	8.0	4.5	9.2	0.1	8.0	71.0	71.0	71.0	71.0	71.0
70	29619	3105.	835	469	959	9	832	11.8	6.6	13.5	0.1	11.7	71.0	71.0	71.0	71.0	71.0
71	0	0.	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0	71.0
80	33504	8054.	2166	1216	2489	24	2158	28.9	16.2	33.2	0.3	28.8	75.0	75.0	75.0	75.0	75.0

Some of the budget programs were utilized for two years by District 21. No other district has expressed an interest in utilizing these programs and therefore refinements have not been made nor has the documentation been prepared.

Additional detail describing the use of the Maintenance Rating System in District 21 can be found in references 15, 16, 17 and 24. Costs of collecting, coding and preparing the information for the "plot program" is given as about 0.5 percent of the maintenance budget.

Use of Maintenance Rating System for Rigid Pavements. The majority of the implementation effort expended in Research Study 2-18-75-199 was devoted to the flexible pavement rating system as there are many more miles of flexible pavements in all classes of highways as opposed to rigid pavements. In addition, the majority of rigid pavements in Texas are located in urban areas which have unique rating problems which are presently under study.

Two interesting observations have been made with the limited data obtained from trial implementation. Figures 13 and 14 illustrate the decrease in Serviceability Index with time for continuously reinforced concrete pavements. In each instance the Serviceability Index showed a significant decline for the first 60 months or five years after construction and then appears to reach a level where little change occurs for the next five to seven years.

A second observation is shown in Figure 15. The annual maintenance costs increased with age as expected; however, a significant increase occurred between the ages of six and ten years, while the Serviceability Index changed very little during this same period. These data support the observed need for a maintenance rating system to consist of more than just a measure of road roughness.

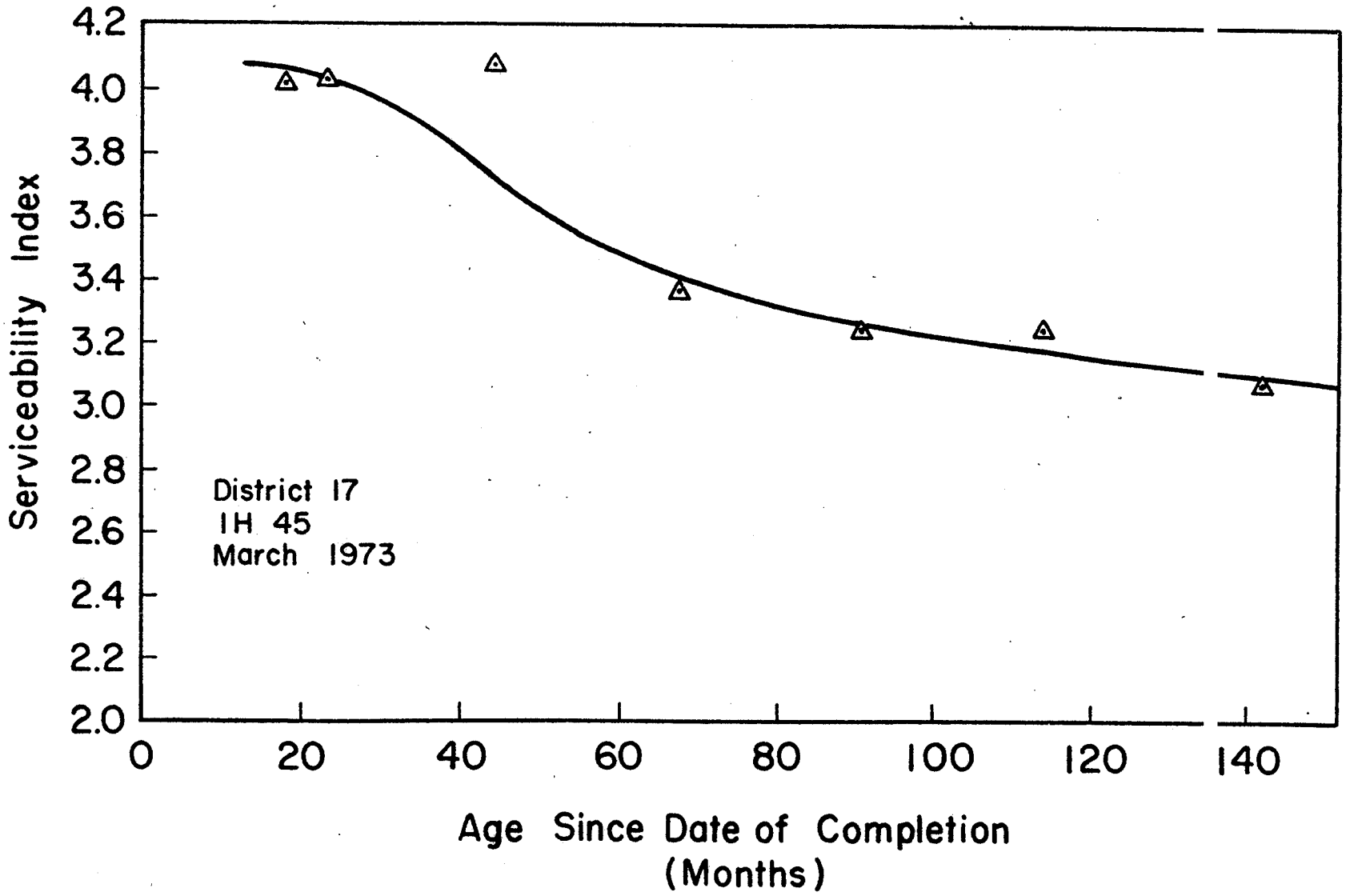

Figure 13. Serviceability Index Versus Age

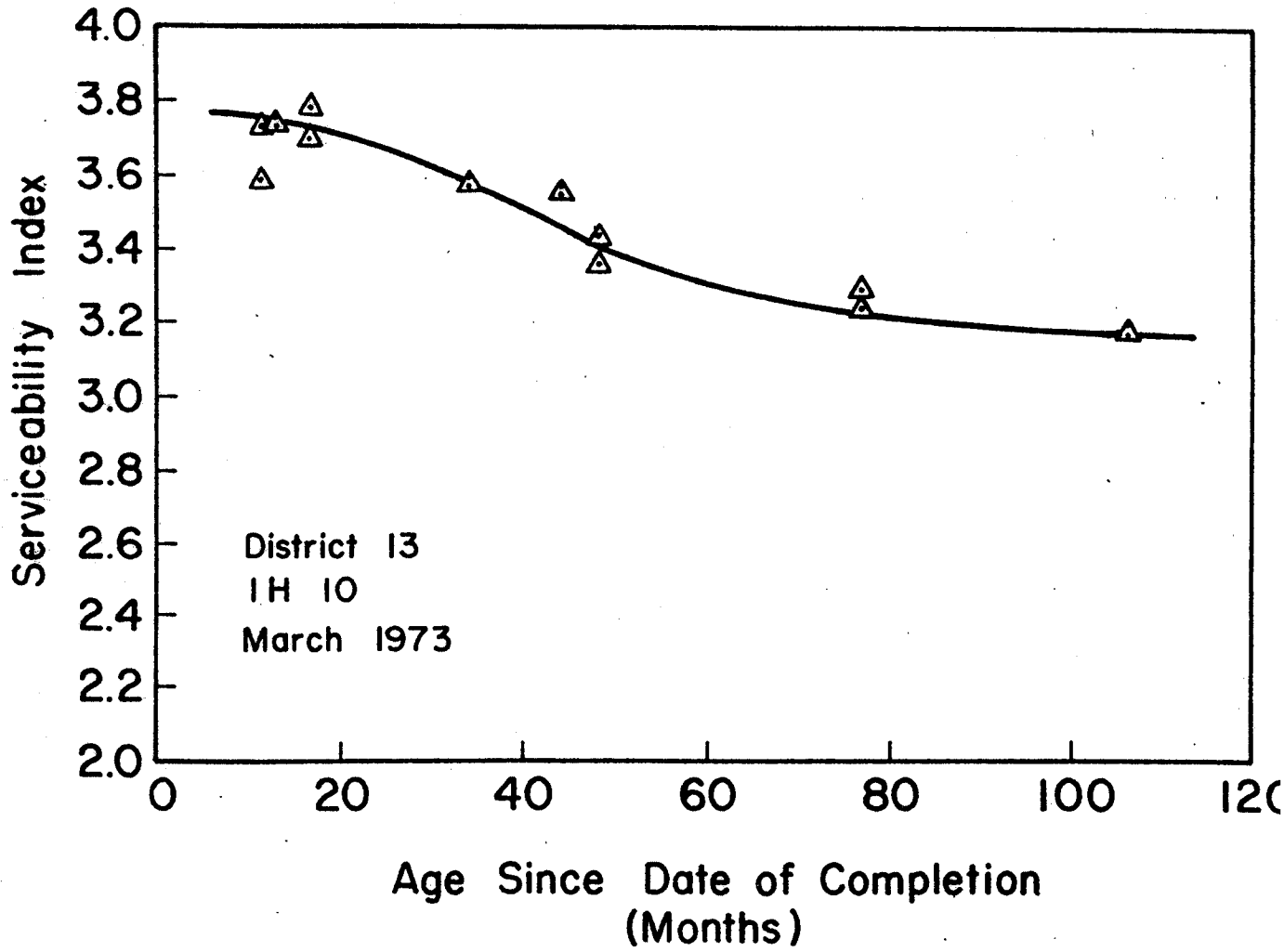

Figure 14. Serviceability Index Versus Age

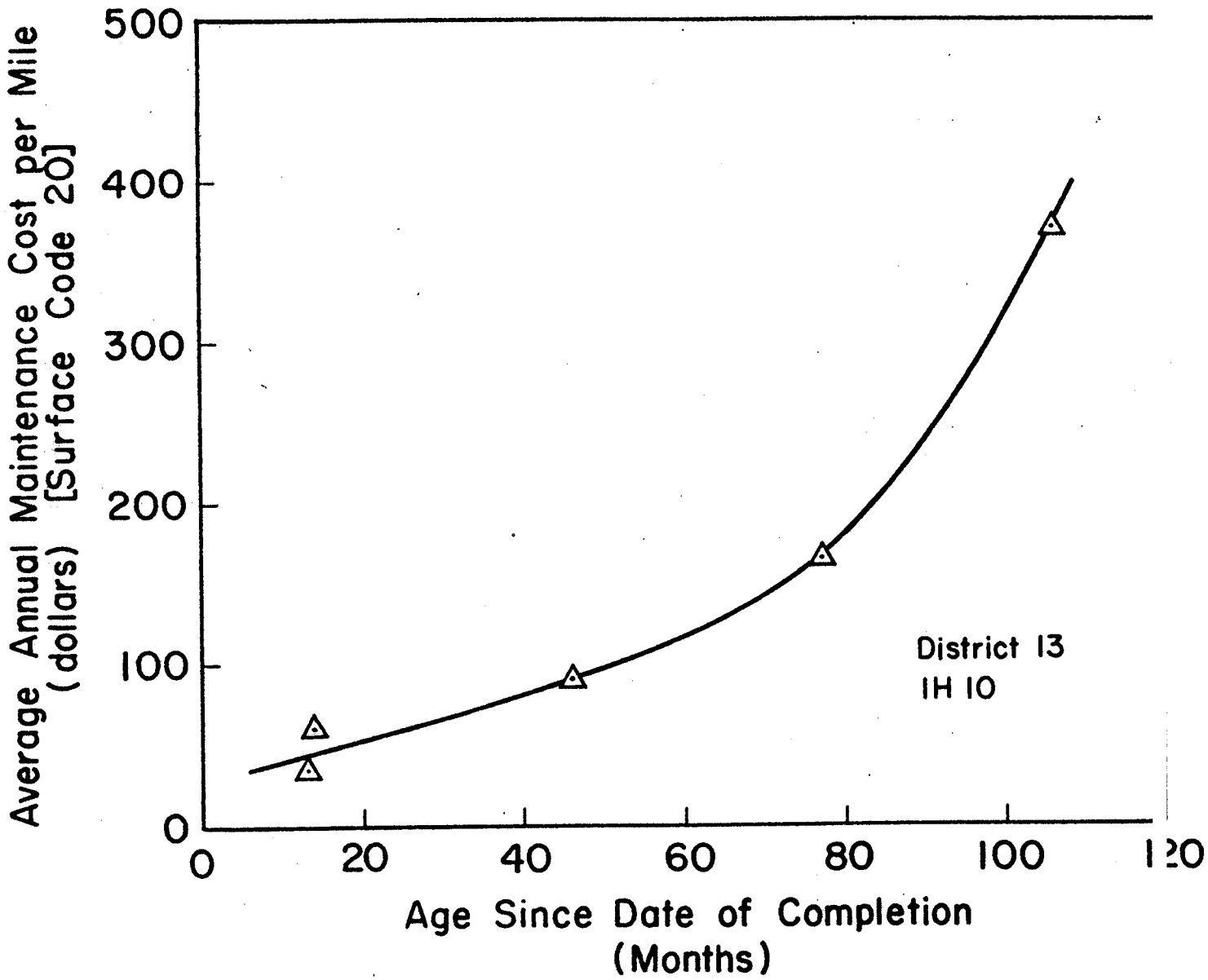

Figure 15. Average Annual Maintenance Cost Versus Age

RANDOM SAMPLE ANALYSIS

The two kinds of flexible pavement survey data presented for treatment are Serviceability Index and the visual rating scores. These data were obtained on approximately 250 randomly selected pavement sections. These sections are located in all 25 State Department of Highways and Public Transportation Districts and were sampled from the three main highway categories: Interstate Highways, U. S. and State Highways and Farm-to-Market Roads.

Each of the randomly sampled pavement sections is approximately two miles in length and collectively represent a one percent sample of the total centerline state maintained rural mileage. These sections were selected by utilizing two-stage cluster sampling theory. This procedure requires the random selection of counties within each highway district followed by a random selection of two-mile pavement sections within the selected counties. The sampling method used allows for efficient gathering of field data on these flexible pavement sections. This sampling method will be treated in more detail in reports being prepared for Research Study 2-8-75-207.

For this report the statistics used to summarize the data are straightforward means and standard deviations. These statistical procedures will allow one to get a "feel" for the kinds of values one might expect for Serviceability Indexes and visual rating scores on pavements around the state of Texas. By utilizing two-stage cluster sampling theory, more sophisticated statistical techniques can be employed to estimate mean and standard error values in any district or for the whole state. Again, a more detailed treatment of the data will be made in later Texas Transportation Institute reports. The formulas

used for the statistical treatment in this report are contained in Appendix C.

The Serviceability Index values and visual rating scores used in this report were obtained primarily in 1974. If 1974 data were missing for a test section, then another year's value was substituted for the missing value. This is a reasonable approximation since the kinds of data being treated for the pavement sections generally change only by small amounts between any two consecutive years.

Referring to Table 24 and considering all of the statewide samples, the Interstate Highways have the highest mean value of Serviceability Index (4.07) and the Farm-to-Market Roads the lowest (2.90) with all "combined" mean Serviceability Index of 3.27. The standard deviations for each highway type tend to increase as the pavements became rougher. This is also shown in Figure 16 which is a plot of Serviceability Index versus standard deviation for the 1974 random section data. The standard deviations in Tables 24 and 25 are weighted values and represent the "average" variation within a given two-mile pavement section for a given highway type. This "within" variation comes about because a Serviceability Index value is obtained every 0.2 mile. Thus, there are about 10 data points within each random section.

The coefficients of variation shown in Table 24 range from 7.3 percent for Interstate Highways to 14.3 percent for Farm-to-Market Roads. These data indicate the amount of variation that can typically be expected in a two-mile pavement section for the different highway types.

Table 25 shows the individual State Department of Highways and Public Transportation Districts listed by alphabetic codes. These

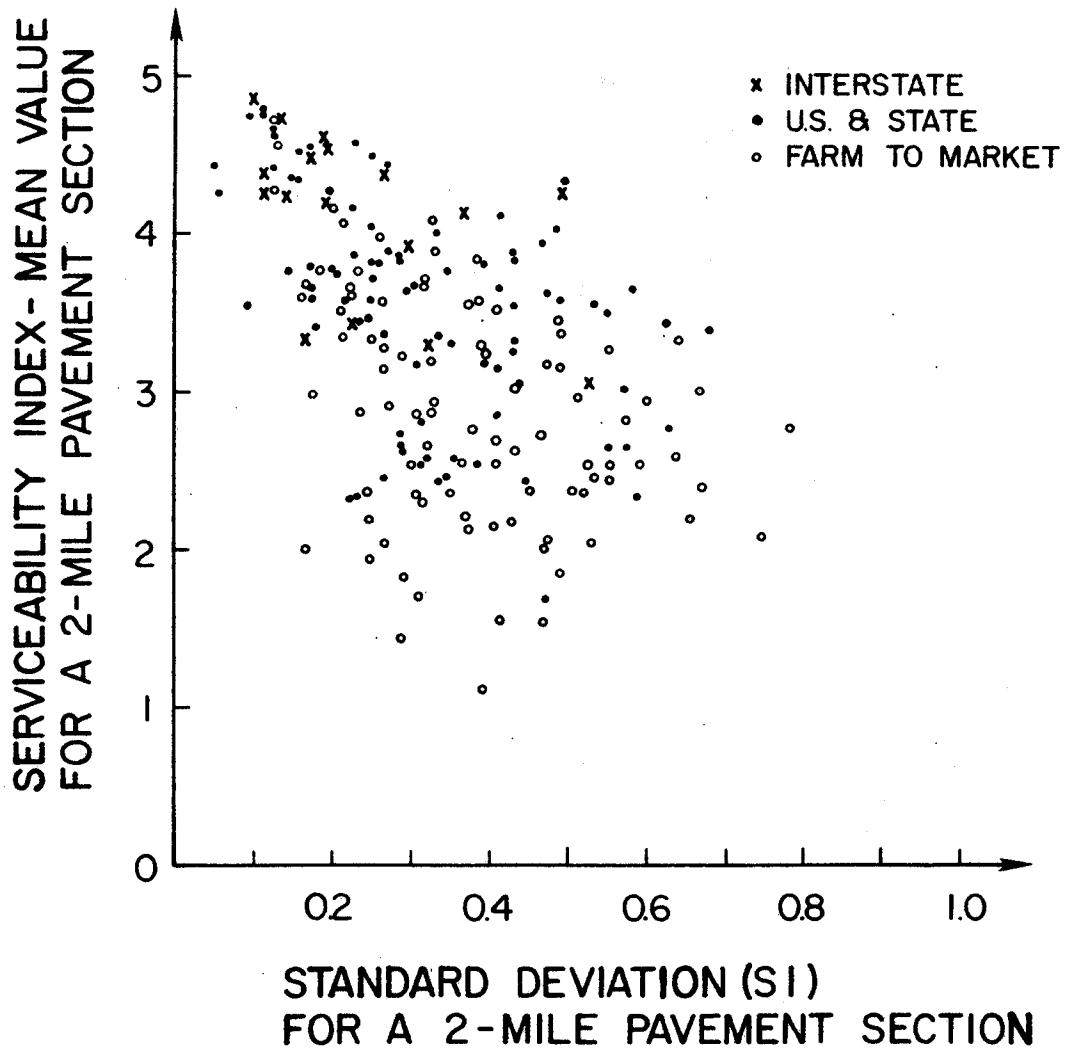

FIGURE 16. SERVICEABILITY INDEX MEAN AND STANDARD DEVIATIONS FOR RANDOMLY SELECTED 2 MILE SECTIONS OF PAVEMEN IN TEXAS - 1974.

TABLE 24. Statewide Serviceability Index Statistics for Randomly Located Pavement Sections (~1974)

	Highway Type			
	IH	US & SH	FM	Combined
Mean	4.07	3.54	2.90	3.27
Standard Deviation	0.296	0.349	0.414	0.379
Coeff. of Variation(%)	7.3	9.9	14.3	11.6

TABLE 25. Serviceability Index Statistics for District Randomly Located Pavement Sections (~1974)

District	Highway Type							
	IH		US & SH		FM		Combined	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
A	3.44	0.230	3.61	0.305	2.36	0.563	2.98	0.444
B	3.06	0.527	3.74	0.274	2.46	0.409	3.02	0.381
C	----	-----	3.42	0.463	3.11	0.568	3.27	0.515
D	4.49	0.149	3.91	0.407	3.20	0.381	3.77	0.360
E	----	-----	3.07	0.396	3.15	0.309	3.11	0.357
F	4.34	0.230	4.21	0.171	3.62	0.279	3.95	0.235
G	----	-----	3.65	0.171	3.21	0.275	3.43	0.229
H	4.58	0.186	2.85	0.417	2.90	0.465	3.13	0.415
I	4.63	0.109	3.84	0.242	2.93	0.388	3.54	0.307
J	----	-----	2.99	0.405	2.72	0.450	2.79	0.438
K	----	-----	2.94	0.506	2.11	0.570	2.42	0.547
L	4.18	0.294	4.11	0.193	3.36	0.478	3.78	0.365
M	----	-----	3.84	0.354	2.53	0.399	3.04	0.382
N	----	-----	4.04	0.269	2.79	0.368	3.41	0.323
O	3.41	0.435	3.11	0.455	2.96	0.386	3.14	0.426
P	3.79	0.297	3.44	0.394	3.10	0.478	3.33	0.423
Q	----	-----	3.16	0.326	2.42	0.471	2.74	0.415
R	3.35	0.165	3.81	0.270	2.83	0.336	3.15	0.306
S	----	-----	3.49	0.442	2.84	0.460	3.12	0.453
T	4.59	0.135	3.64	0.215	3.30	0.506	3.54	0.407
U	----	-----	3.61	0.243	2.85	0.284	3.30	0.262
V	----	-----	3.29	0.527	3.33	0.383	3.31	0.463
W	4.28	0.494	3.96	0.294	2.56	0.446	3.39	0.391
X	4.36	0.200	3.74	0.211	2.33	0.342	3.34	0.261
Y	----	-----	3.08	0.339	3.21	0.241	3.15	0.289

data indicate the kinds of means and standard deviations one may expect within a given district. It has been observed by the Texas Transportation Institute researchers that those Districts which generally have sandy type soils exhibit higher Serviceability Index values than those Districts with expansive clays as subgrade materials.

Figures 17 thru 24 show the Serviceability Index histogram and percentage cumulative distribution plots for the four highway types. The histogram plots reveal how the data are grouped. For example, Figure 17 shows for Interstate Highways in Texas that approximately 36 percent of the 0.2 mile Serviceability Index increments fall between 4.2 and 4.4. Figure 21 for Farm-to-Market Roads indicates that none of the 0.2 mile increments measured falls between 4.2 and 4.4. Figure 18, the percentage cumulative distribution plot for Interstate Highways, reveals that approximately 6 percent of the data points are above a Serviceability Index of 4.8 and 100 percent of the data points are above a Serviceability Index of 2.6. In comparison for Farm-to-Market Roads, Figure 22 shows that approximately 6 percent of the data are above a Serviceability Index of 3.8 and 100 percent of the data are above the value of 1.2.

Collectively, the data presented above indicate that the amount of roughness on Interstate Highway pavement sections is much less than that found on the Farm-to-Market road system. Again, this is as one might expect between the two highway types.

The mean visual rating scores as determined from the randomly selected pavement sections indicate the same basic trends observed for Serviceability Index data. The visual rating scores shown in Table 26 indicate that Interstate Highways are in better "condition" than U. S. and State Highways, and U. S. and State Highways are better than Farm-

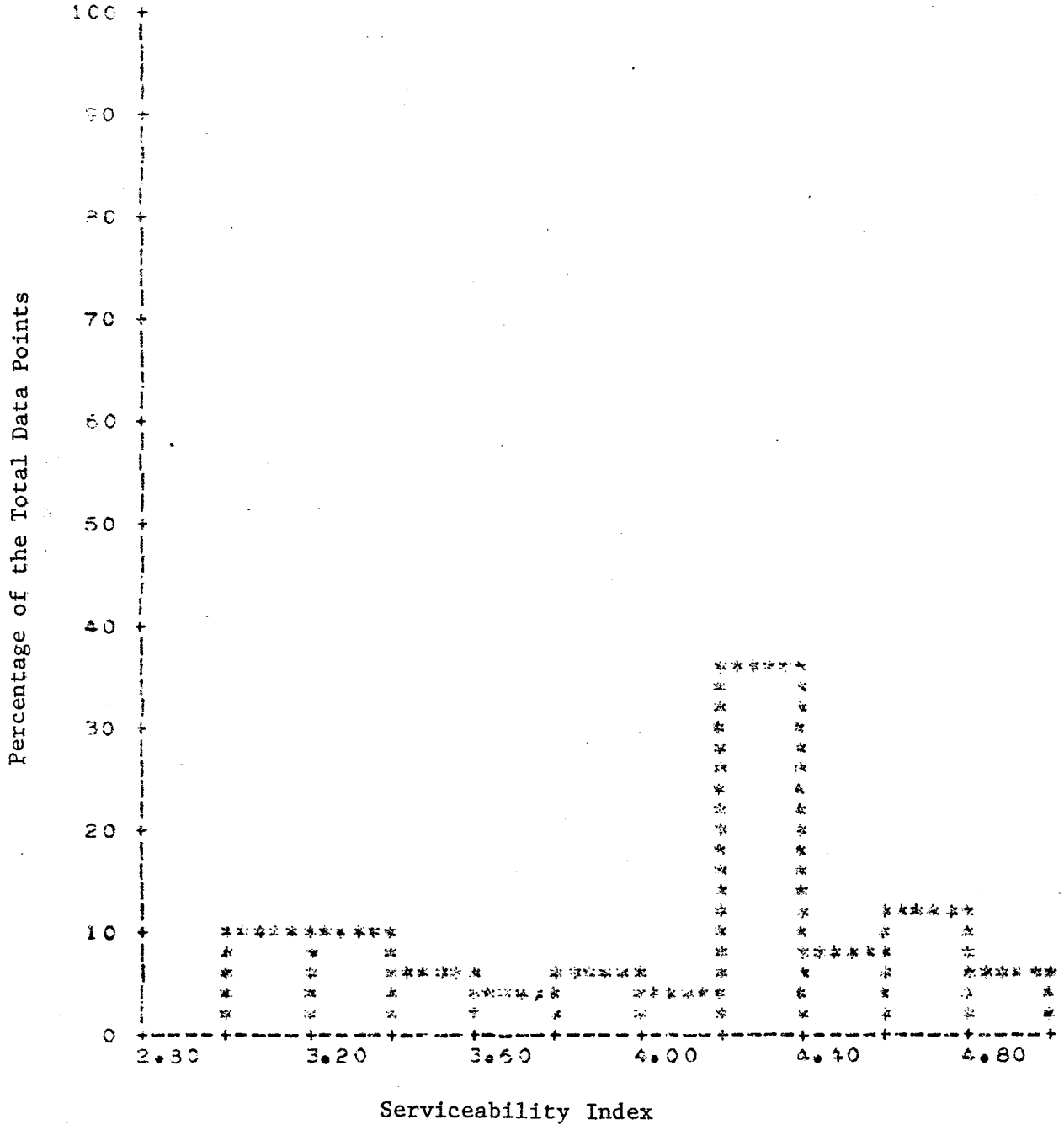

Figure 17. Serviceability Index Histogram for Statewide Random Sections - Interstate Highways (1974).

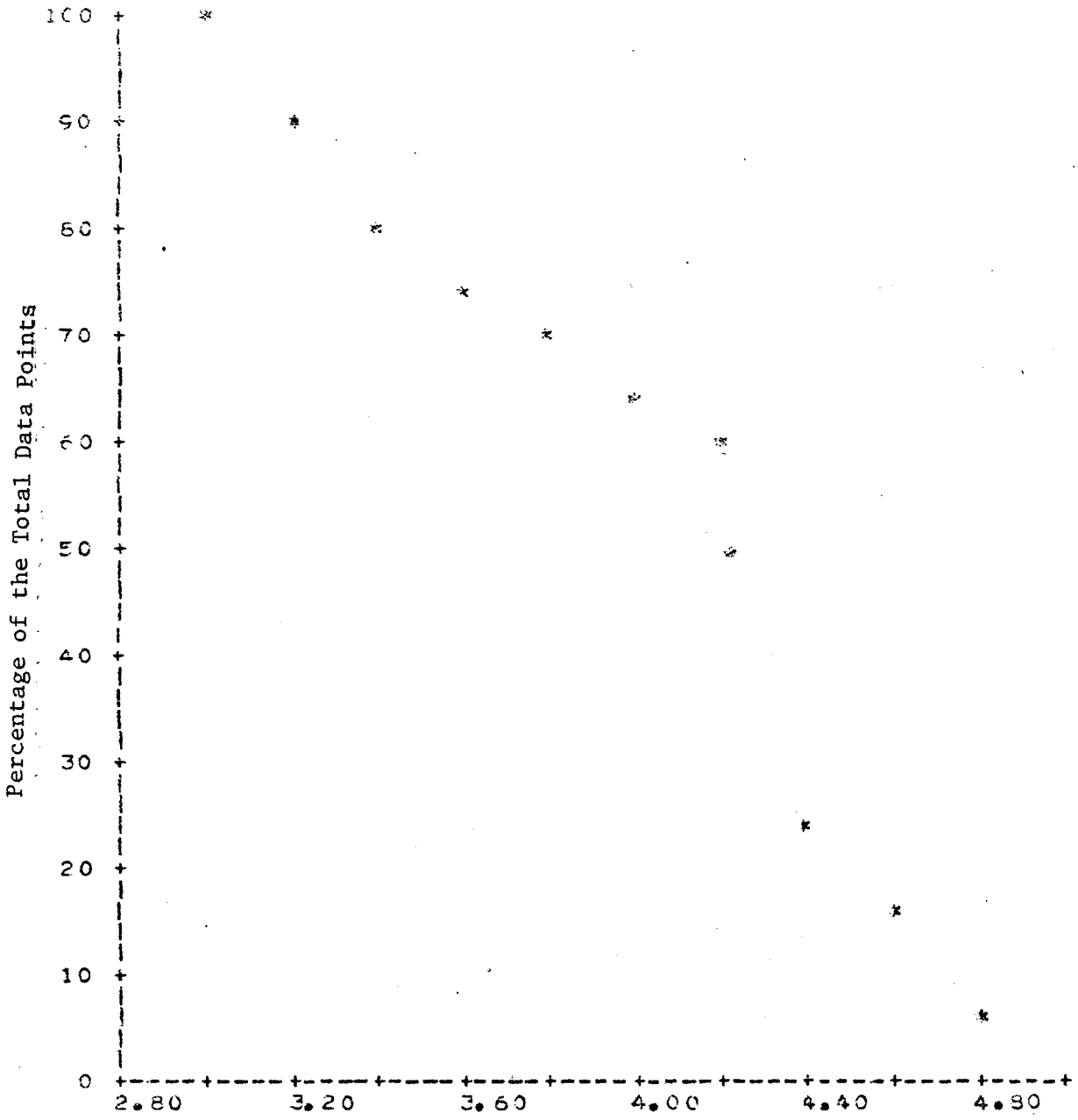

Figure 18. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

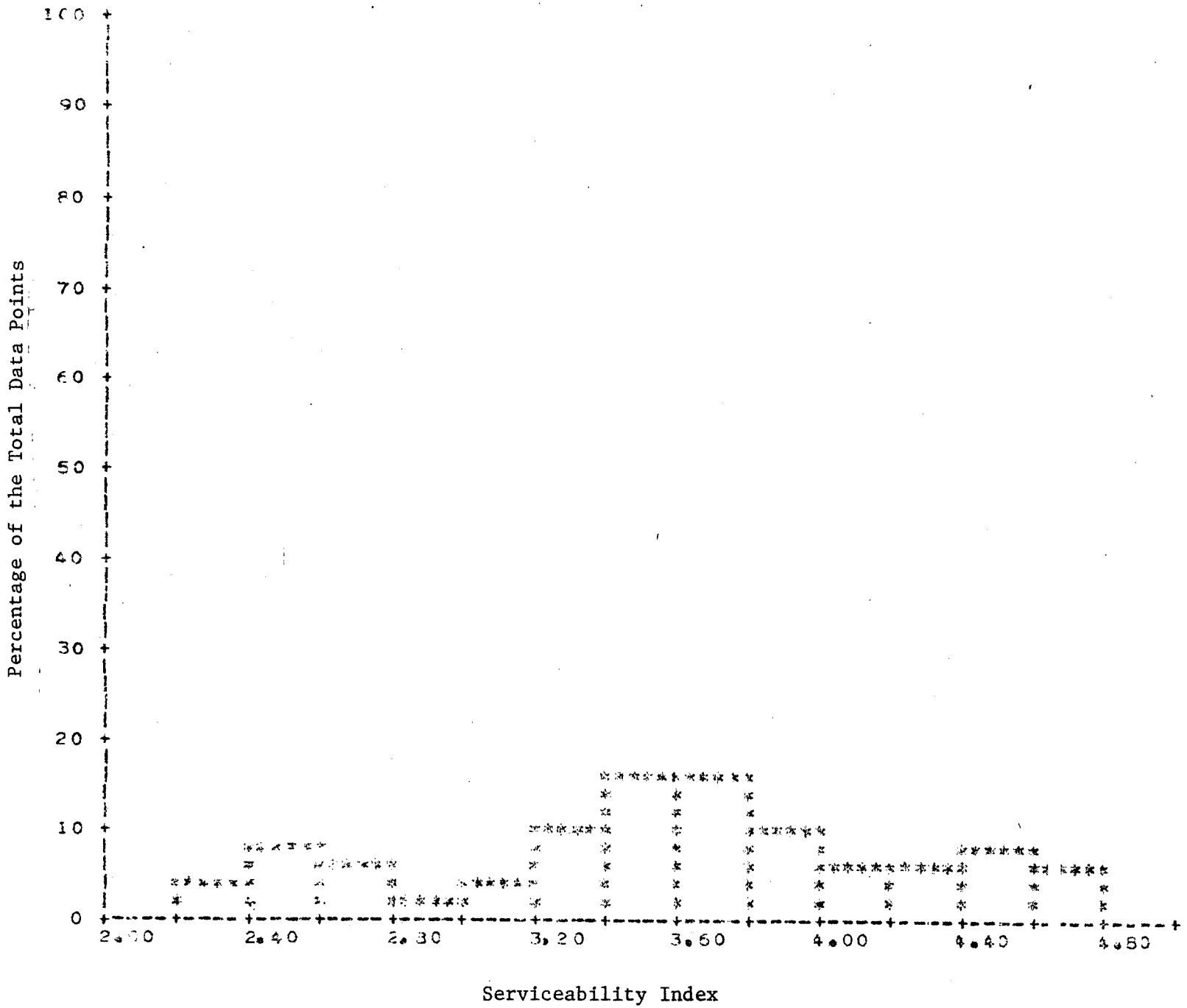

Figure 19. Serviceability Index Histogram for Statewide Random Sections - U.S. & State Highways (1974).

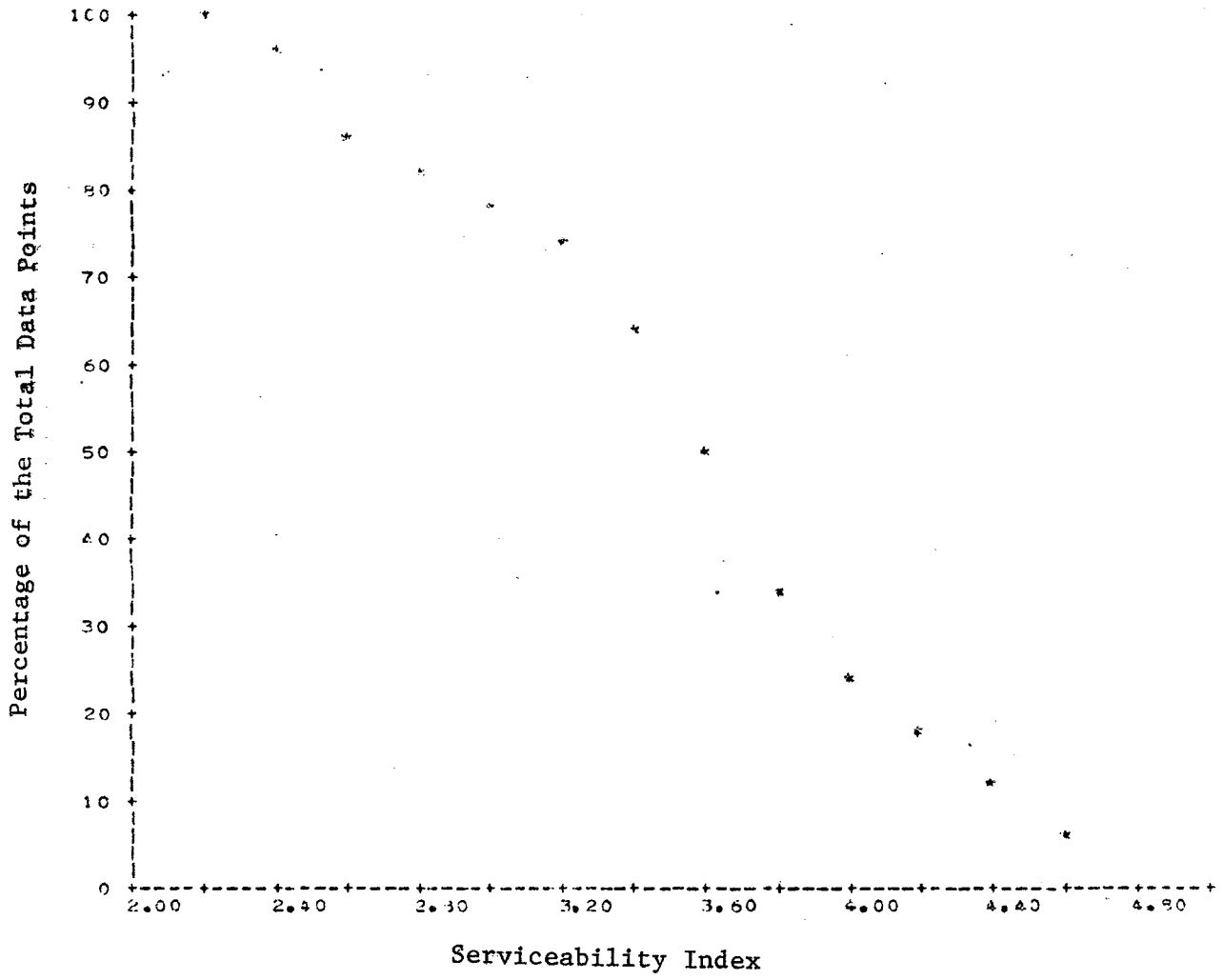

Figure 20. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - U.S. & State Highways (1974).

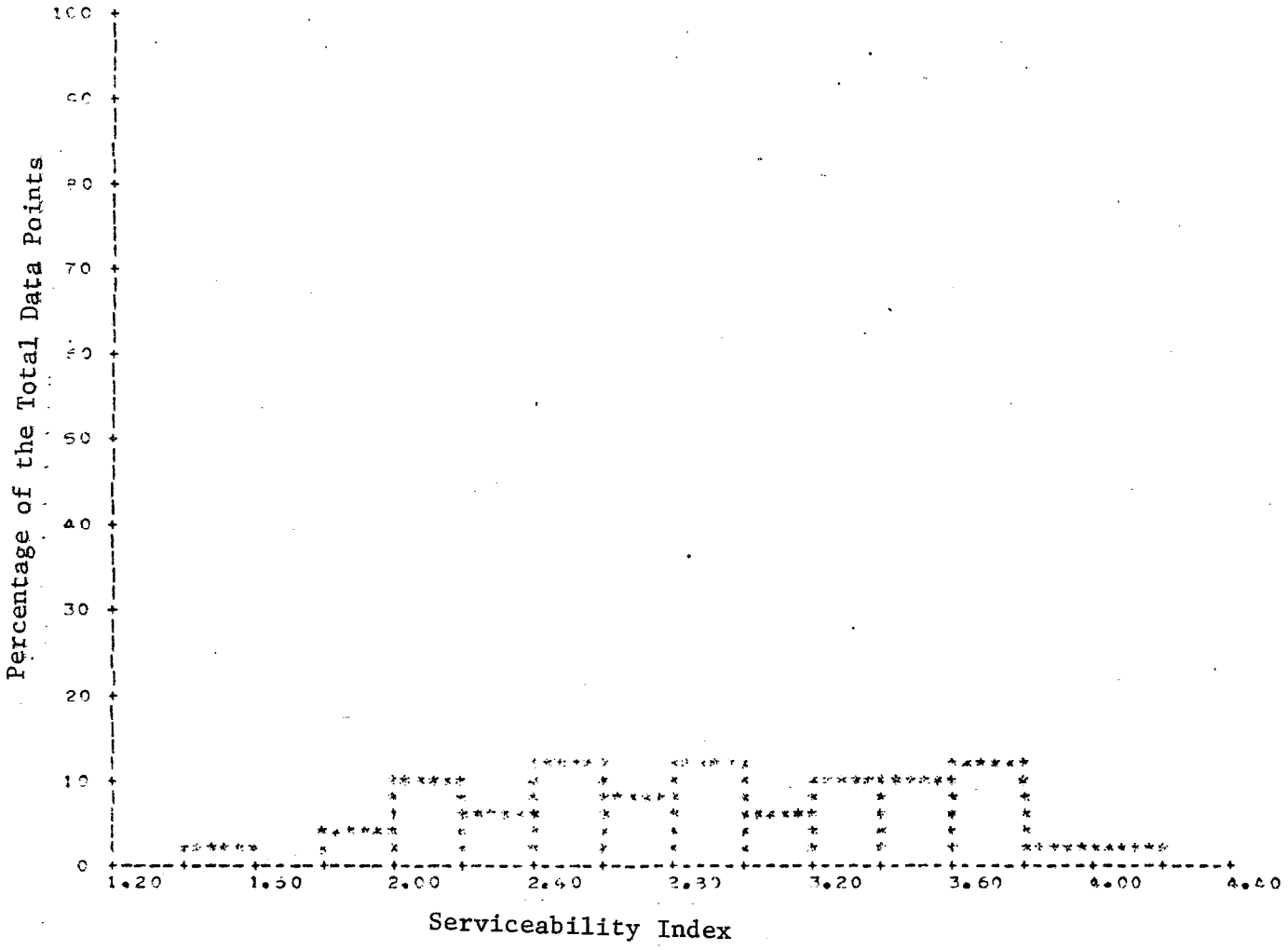

Figure 21. Serviceability Index Histogram for Statewide Random Sections - U.S. & State Highways (1974).

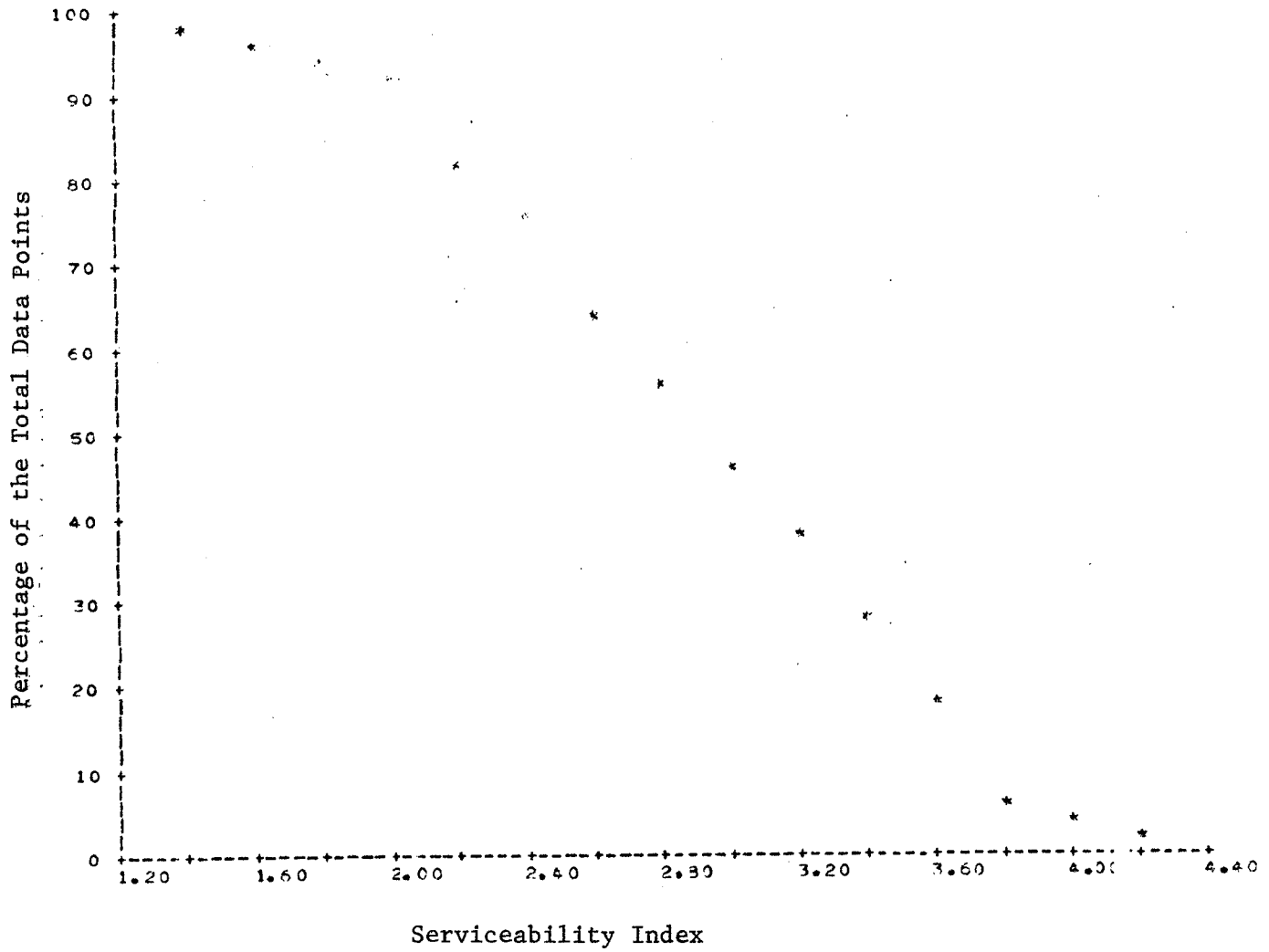

Figure 22. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - U.S. & State Highways (1974).

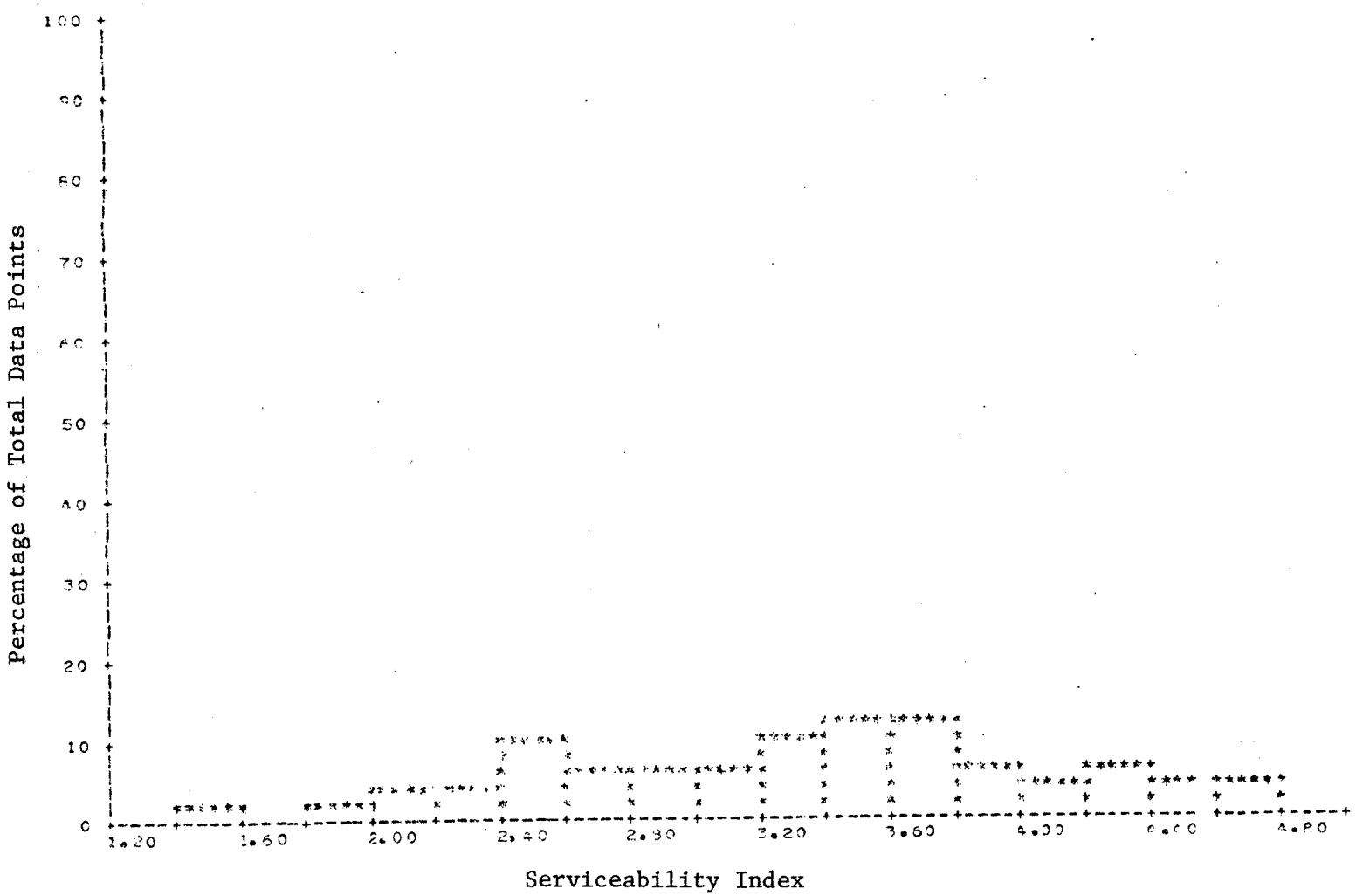

Figure 23. Serviceability Index Histogram for Statewide Random Sections - F.M. Highways (1974).

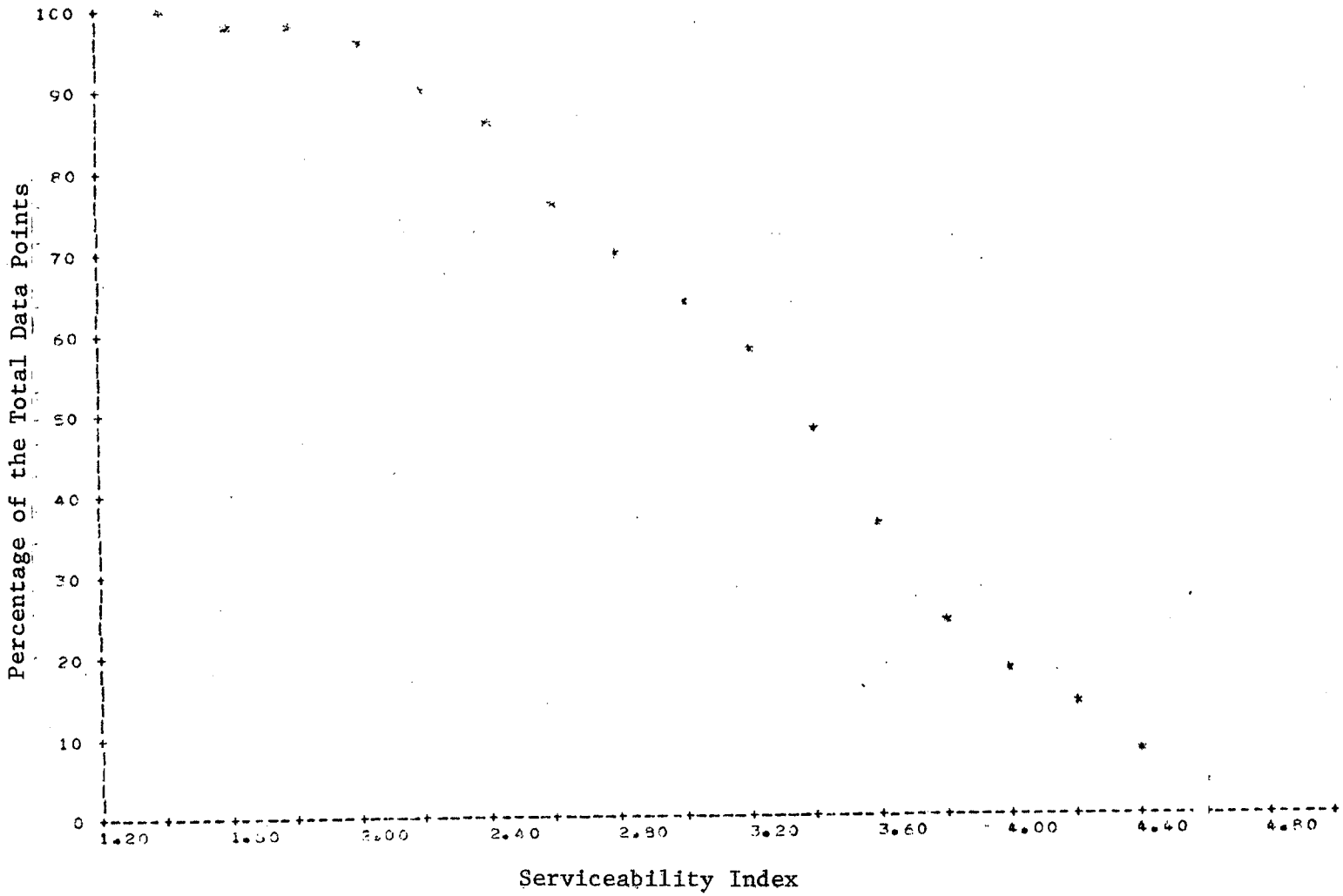

Figure 24. Serviceability Index Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

TABLE 26. Statewide Visual Evaluation Scores for Randomly Located Pavement Sections (~1974)

Type of Rating		Mean for Highway Type			
		IH	US & SH	FM	Combined
1. Pavement Rating Score	(w/o MRM Deduct)	92.4	84.4	80.6	83.3
	(w/MRM Deduct)	87.9	68.5	51.7	61.9
2. Shoulder Rating Score		73.8	69.9	66.2	68.5
3. Roadside Rating Score		78.8	77.4	76.3	77.0
4. Drainage Rating Score		85.0	78.7	76.1	78.0
5. Traffic Services Rating Score		81.6	81.2	81.7	81.5

to-Market Roads. This is a reflection of many factors which affect each highway type such as level of service, age, traffic, maintenance, etc.

The Pavement Rating Scores as shown in Tables 26 through 30 are computed for two cases: one in which the Mays Ride Meter deduction points are not utilized in the calculation of the score and the other in which they are deducted. This is done because some individuals who utilize Pavement Rating Scores prefer to see the score reflect "true" pavement distress, i.e., rutting, flushing, cracking, etc., as opposed to a score which is a composite of both "true" distress and roughness.

In Table 26, the differences between the two computed Pavement Rating Scores for Interstate Highways is small, i.e., 92.4 without Mays Ride Meter deductions versus 87.9 with the deductions. For U. S. and State Highways the two scores are 84.4 and 68.5, respectively. The Farm-to-Market scores are 80.6 and 51.7. It is apparent from these data that the magnitude of roughness deductions is more important for Farm-to-Market Roads than Interstate Highways. As stated in reference 4, a perfect Pavement Rating Score is equal to 100.

It is of interest to note that the Pavement Rating Scores without Mays Ride Meter point deductions are not vastly different between the three highway types. The difference between 92.4 (Interstate) and 80.6 (Farm-to-Market) is not large. Both scores indicate for the sample taken in 1974 that Interstate and Farm-to-Market Roads were in relatively good condition.

The Shoulder, Roadside, and Drainage Rating Scores indicate the same basic trend between highway types as was observed for the Pavement

TABLE 27. District Visual Evaluation Scores for Randomly Located Interstate Highway Pavement Sections (~1974)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
A	1	76.0/68.0	77.0	85.0	80.0	82.0
B	1	85.0/65.0	73.0	82.0	90.0	90.0
C	0	---------	----	----	----	----
D	3	100.0/99.0	76.3	79.7	89.0	87.0
E	0	---------	----	----	----	----
F	2	97.5/96.0	72.5	71.0	90.0	83.0
G	0	---------	----	----	----	----
H	2	98.5/98.0	75.0	73.5	90.0	86.0
I	2	95.0/94.5	80.0	86.0	85.0	86.0
J	0	---------	----	----	----	----
K	0	---------	----	----	----	----
L	2	89.5/87.5	64.5	75.0	83.5	74.0
M	0	---------	----	----	----	----
N	0	---------	----	----	----	----
O	3	85.7/73.0	70.3	89.0	82.0	76.0
P	1	98.0/93.0	81.0	82.0	90.0	78.0
Q	0	---------	----	----	----	----
R	1	82.0/74.0	70.0	85.0	90.0	86.0
S	0	---------	----	----	----	----
T	1	100.0/100.0	69.0	57.0	63.0	72.0
U	0	---------	----	----	----	----
V	0	---------	----	----	----	----
W	1	98.0/96.0	67.0	80.0	73.0	82.0
X	1	83.0/82.0	89.0	67.0	90.0	92.0
Y	0	---------	----	----	----	----

TABLE 28. District Visual Evaluation Scores for Randomly Located State Highway Pavement Sections (~1974)

District No.	No. of Sections	Pavement Rating Score w/oMRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
A	4	82.0/75.0	64.5	79.0	81.8	82.0
B	3	96.3/91.3	77.7	79.0	79.0	81.3
C	4	91.5/74.2	75.2	81.2	85.0	79.0
D	6	80.8/72.3	70.5	80.5	82.8	82.3
E	8	65.5/42.1	67.1	77.0	74.6	80.8
F	5	93.8/91.8	70.0	73.8	86.0	84.4
G	4	89.8/78.2	58.8	72.8	75.0	79.0
H	4	60.5/28.0	65.0	76.0	81.8	82.0
I	4	88.2/74.2	69.2	75.5	77.5	83.5
J	3	87.7/55.0	62.3	77.0	73.3	78.0
K	4	77.2/30.8	65.8	73.5	77.5	79.0
L	4	89.8/87.2	66.2	78.5	74.2	77.5
M	4	91.0/83.0	67.2	79.8	74.0	82.5
N	4	94.5/92.0	74.8	83.0	80.0	84.0
O	4	85.2/59.2	75.0	89.2	89.2	88.5
P	5	95.0/82.6	73.4	74.2	69.2	80.8
Q	3	83.7/62.3	70.0	75.7	71.3	80.0
R	3	84.7/78.0	74.0	78.0	83.3	82.0
S	4	89.2/44.5	70.5	73.5	70.0	71.5
T	3	79.0/71.7	63.7	61.3	66.7	73.3
U	4	86.8/81.5	75.0	77.2	75.0	80.5
V	4	88.0/71.2	72.8	81.8	84.2	86.0
W	4	87.0/82.0	75.0	76.5	82.5	83.0
X	5	85.4/73.6	68.8	76.4	86.0	81.6
Y	4	77.2/47.2	77.2	80.2	82.5	83.5

TABLE 29. District Visual Evaluation Scores for Randomly Located Farm-to-Market Road Pavement Sections (~1974)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
A	6	72.3/29.8	65.0	69.8	75.7	76.7
B	4	85.2/42.4	68.8	67.8	75.0	79.0
C	4	84.2/61.2	78.8	81.0	83.2	86.5
D	5	75.4/56.2	76.0	78.8	75.4	87.6
E	8	79.6/57.2	70.6	76.8	76.1	84.2
F	6	83.2/71.7	65.3	78.8	85.5	87.3
G	4	90.0/75.0	65.0	72.2	73.2	80.0
H	4	68.2/42.8	72.5	73.5	81.5	82.5
I	6	81.2/47.8	56.2	76.3	71.7	82.0
J	7	69.7/37.0	62.9	73.7	74.3	75.1
K	5	61.4/6.0	60.0	77.2	76.0	83.6
L	5	78.2/61.8	62.0	77.8	68.0	79.2
M	6	85.0/50.8	61.7	76.8	74.0	80.0
N	4	90.5/54.8	70.0	81.5	75.8	83.0
O	4	92.2/64.0	75.0	84.2	83.2	86.0

TABLE 29. (Cont.)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
P	4	87.2/67.2	68.8	77.2	70.8	76.5
Q	4	69.8/32.2	53.8	75.5	69.2	79.5
R	7	92.6/64.4	63.4	80.4	81.9	83.7
S	4	81.0/33.8	68.8	70.5	70.8	78.5
T	4	86.2/75.8	57.5	69.0	55.8	76.0
U	3	80.0/44.3	63.3	72.0	70.0	75.3
V	4	84.2/70.0	63.8	77.2	81.8	86.0
W	4	80.2/38.8	68.8	79.8	84.2	84.5
X	3	88.3/50.0	68.3	76.3	87.7	85.3
Y	4	78.5/61.0	78.8	81.2	82.5	83.0

TABLE 30. District Visual Evaluation Scores for Randomly Located Combined Highway Pavement Sections (1974)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Ratin Score	Traffic Services Rating Score
A	11	75.5/49.7	65.9	74.5	78.3	79.1
B	8	89.4/63.5	72.6	73.8	78.4	81.2
C	8	87.9/67.8	77.0	81.1	84.1	82.8
D	14	83.0/72.3	73.7	79.7	81.5	84.1
E	16	72.6/49.7	68.9	76.9	75.4	82.5
F	13	89.5/83.2	68.2	75.7	86.4	85.5
G	8	89.9/76.6	61.9	72.5	74.1	79.5
H	10	71.2/47.9	70.0	74.5	83.3	83.0
I	12	85.8/64.4	64.5	77.7	75.8	83.2
J	10	75.1/42.4	62.7	74.7	74.0	76.0
K	9	68.4/17.0	62.6	75.6	76.7	81.6
L	11	84.5/75.7	64.0	77.5	73.1	77.6
M	10	87.4/63.7	63.9	78.0	74.0	81.0
N	8	92.5/73.4	72.4	82.2	77.9	83.5
O	11	87.9/64.7	73.7	87.4	85.1	84.2

TABLE 30. (Cont.)

District No.	No. of Sections	Pavement Rating Score w/o MRM/w/MRM Deduct/Deduct	Shoulder Rating Score	Roadside Rating Score	Drainage Rating Score	Traffic Services Rating Score
P	10	92.2/77.5	72.3	76.2	71.9	78.8
Q	7	75.7/45.1	60.7	75.6	70.1	79.7
R	11	89.5/69.0	66.9	80.2	83.0	83.5
S	8	85.1/39.1	69.6	72.0	70.4	75.0
T	8	85.2/77.2	61.2	64.6	60.8	74.5
U	7	83.9/65.6	70.0	75.0	72.9	78.3
V	8	86.1/70.6	68.2	79.5	83.0	86.0
W	9	85.2/64.3	71.3	78.3	82.2	83.6
X	9	86.1/66.7	70.9	75.3	87.0	84.0
Y	8	77.9/54.1	78.0	80.8	82.5	83.2

Rating Score. The exception to this is the Traffic Services Rating Score. This score actually increases slightly for Farm-to-Market Roads as compared to the other two highway types. This may be an indicator of the fact that striping, delineators, etc., receive less deterioration on lightly traveled roads as opposed to the heavier traveled highways. It could also be that the Traffic Services Rating items are relatively insensitive to the highway type.

Tables 27 through 30 are averaged summaries of the five different rating scores for all twenty-five State Department of Highways and Public Transportation Districts. Each Table presented treats a different highway type beginning with Interstate Highways in Table 27.

Figures 25 through 72 are histogram and percentage cumulative distribution plots of the five rating scores for each highway type considered. These plots were generated from the scores obtained for all of the statewide randomly selected pavement sections. Although the number of figures containing these data is sizable, it was felt that the information being provided by the figures was particularly worthwhile to the personnel in the field recording and analyzing visual rating data.

An example of the information contained in these plots can be shown by utilizing Figures 25 and 26 which are presentations of Pavement Rating Score data for Interstate Highways. In Figure 25, approximately 48 percent of the data points are shown to lie between the interval of 95 to 100. The percentage cumulative distribution plot, Figure 26, shows that approximately 48 percent of the data points are higher than a Pavement Rating Score of 95. Additionally, this figure indicates that 100 percent of the data points are higher than a Pavement Rating Score of 65.

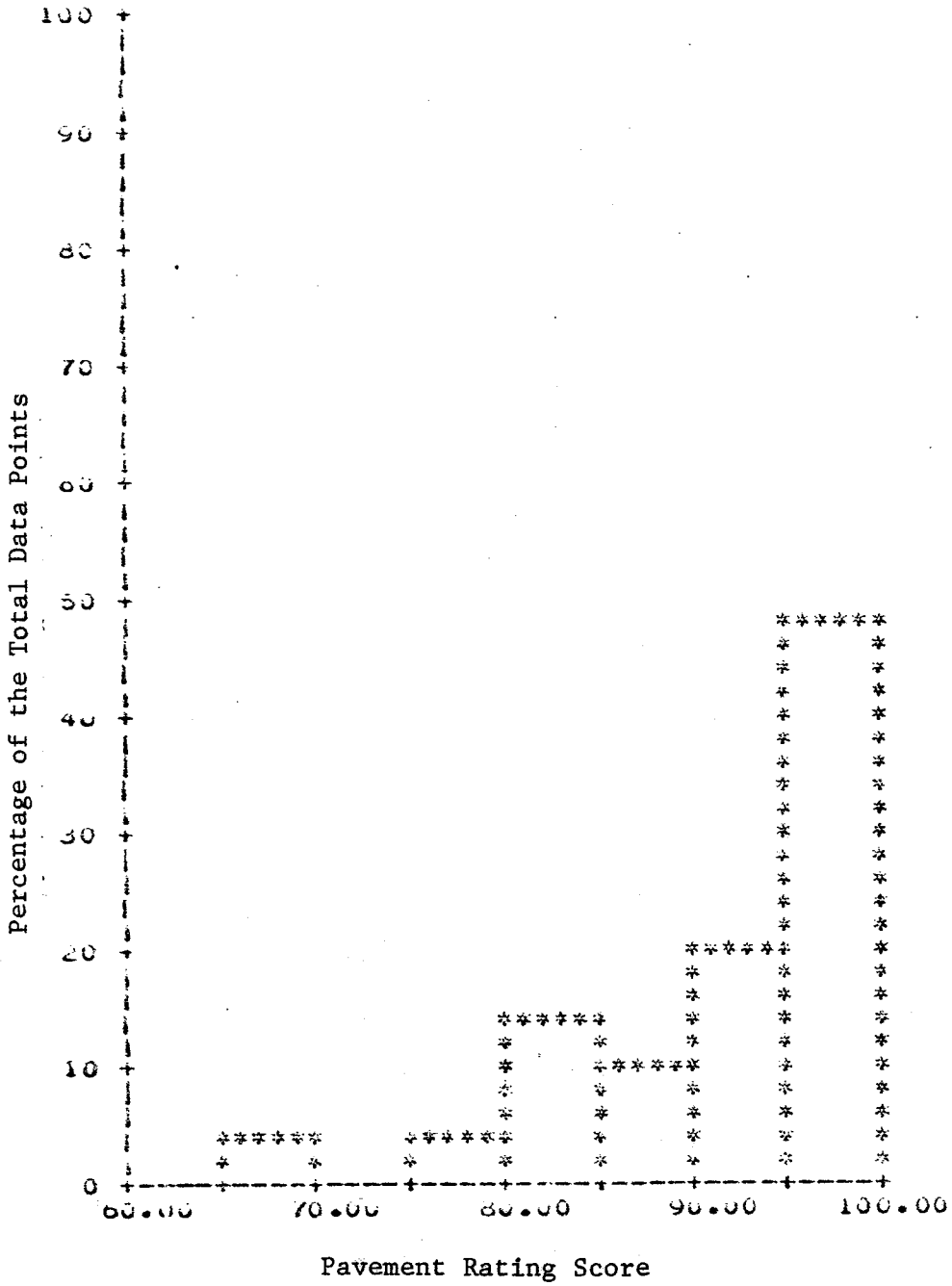

Figure 25. Pavement Rating Score (Without MRM Deductions) Histogram for Statewide Random Sections - Interstate Highways (1974).

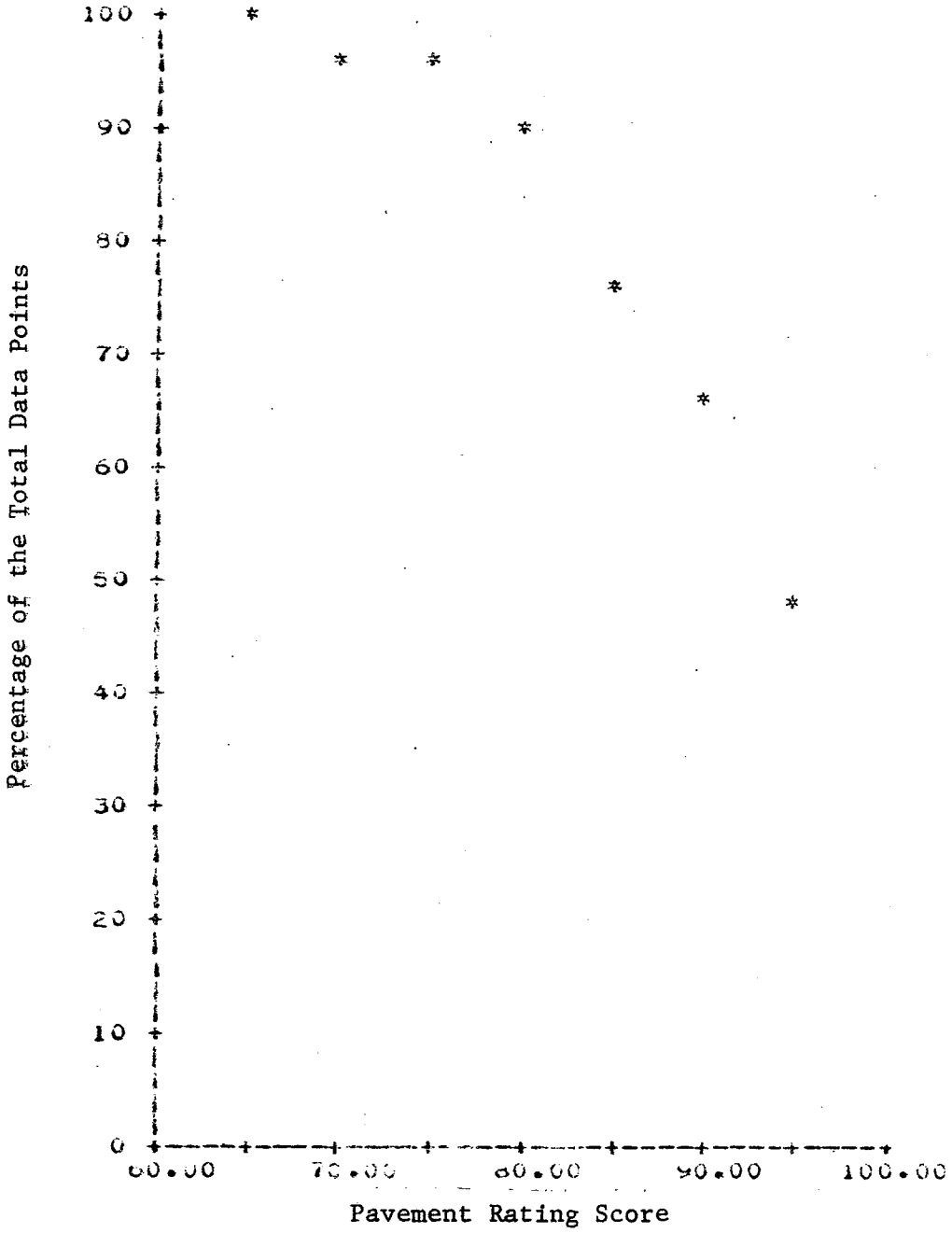

Figure 26. Pavement Rating Score (Without MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

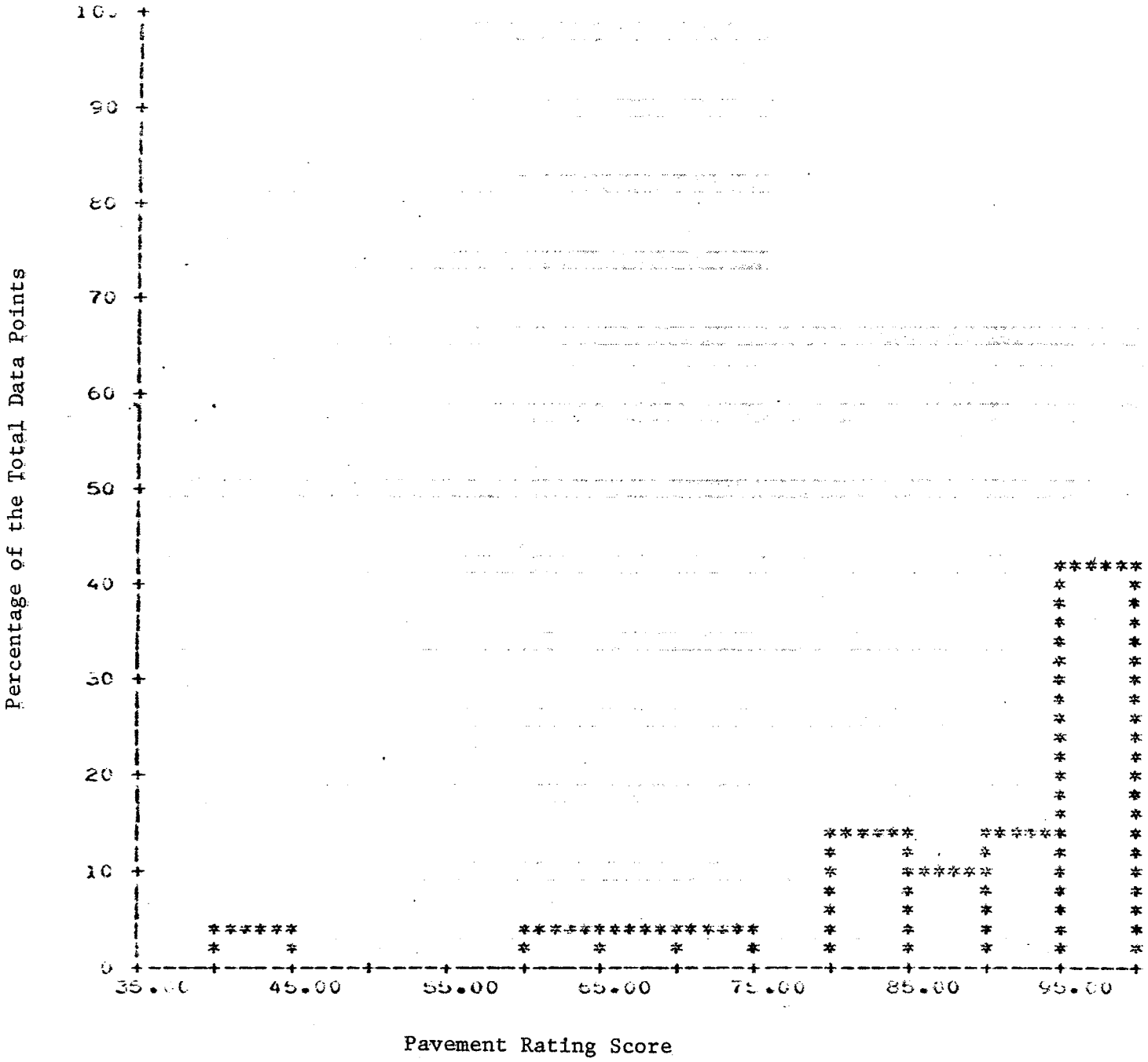

Figure 27. Pavement Rating Score (With MRM Deductions) Histogram for Statewide Random Sections - Interstate Highways (1974).

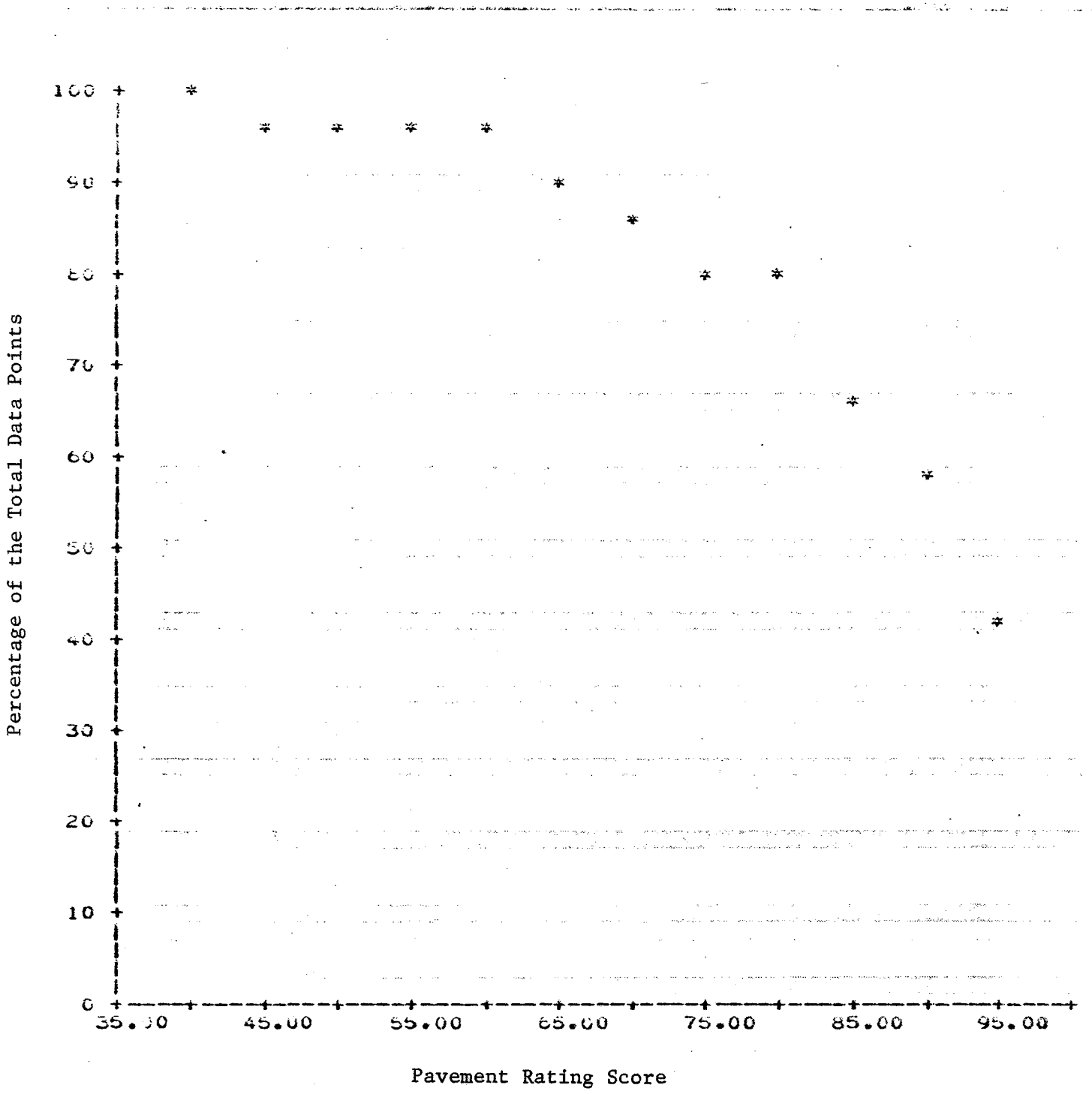

Figure 28. Pavement Rating Score (With MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

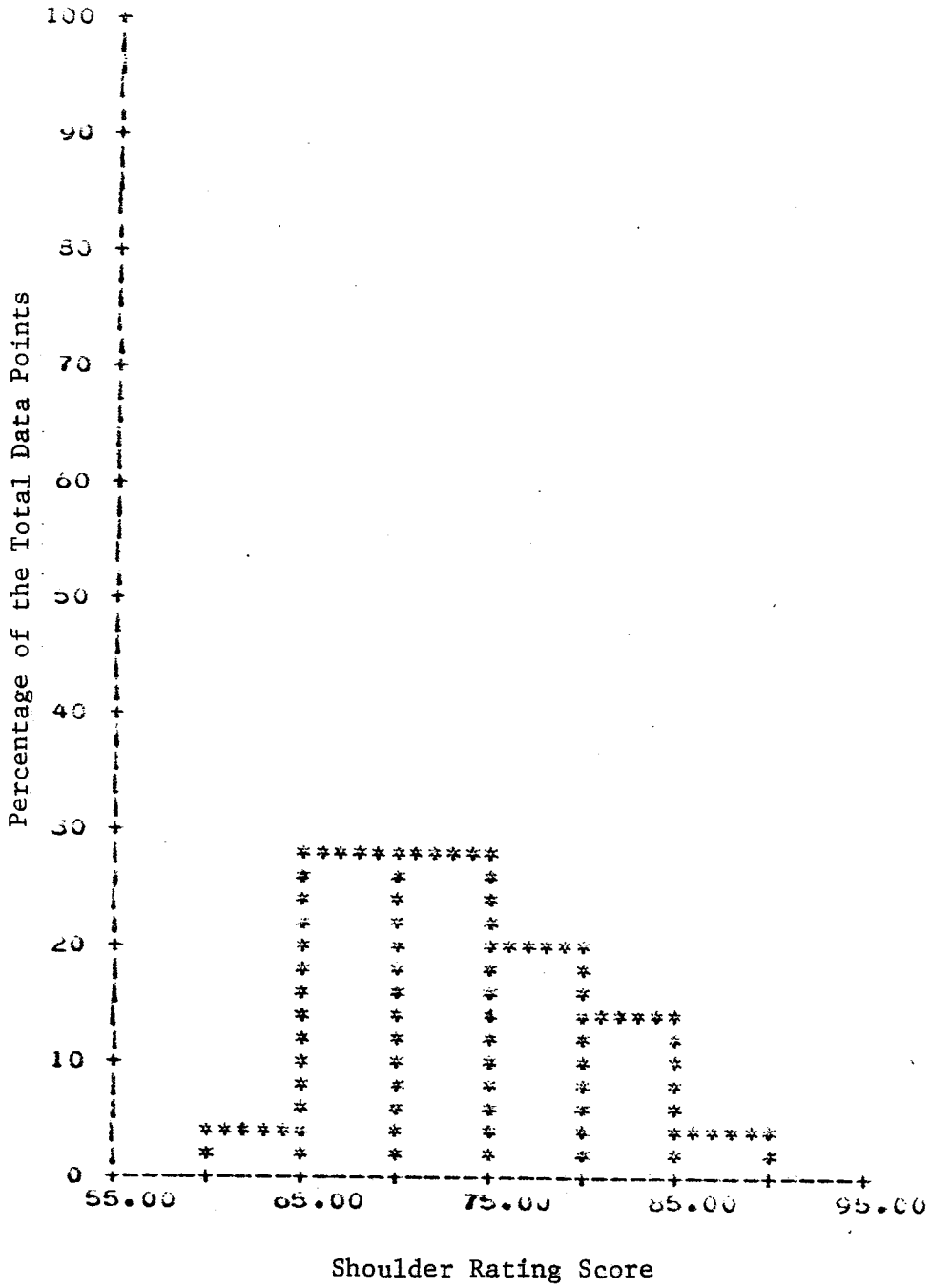

Figure 29. Shoulder Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

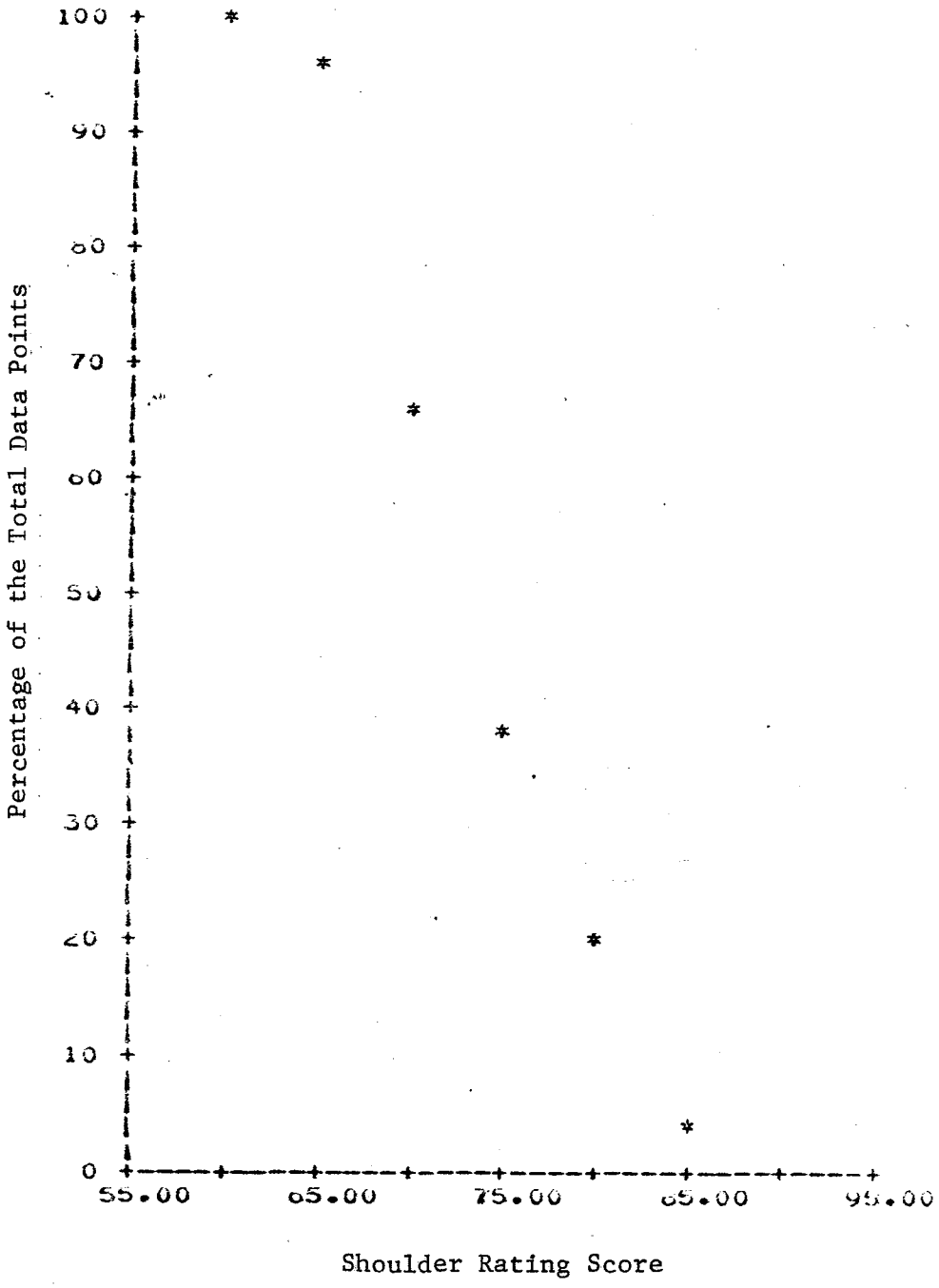

Figure 30. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

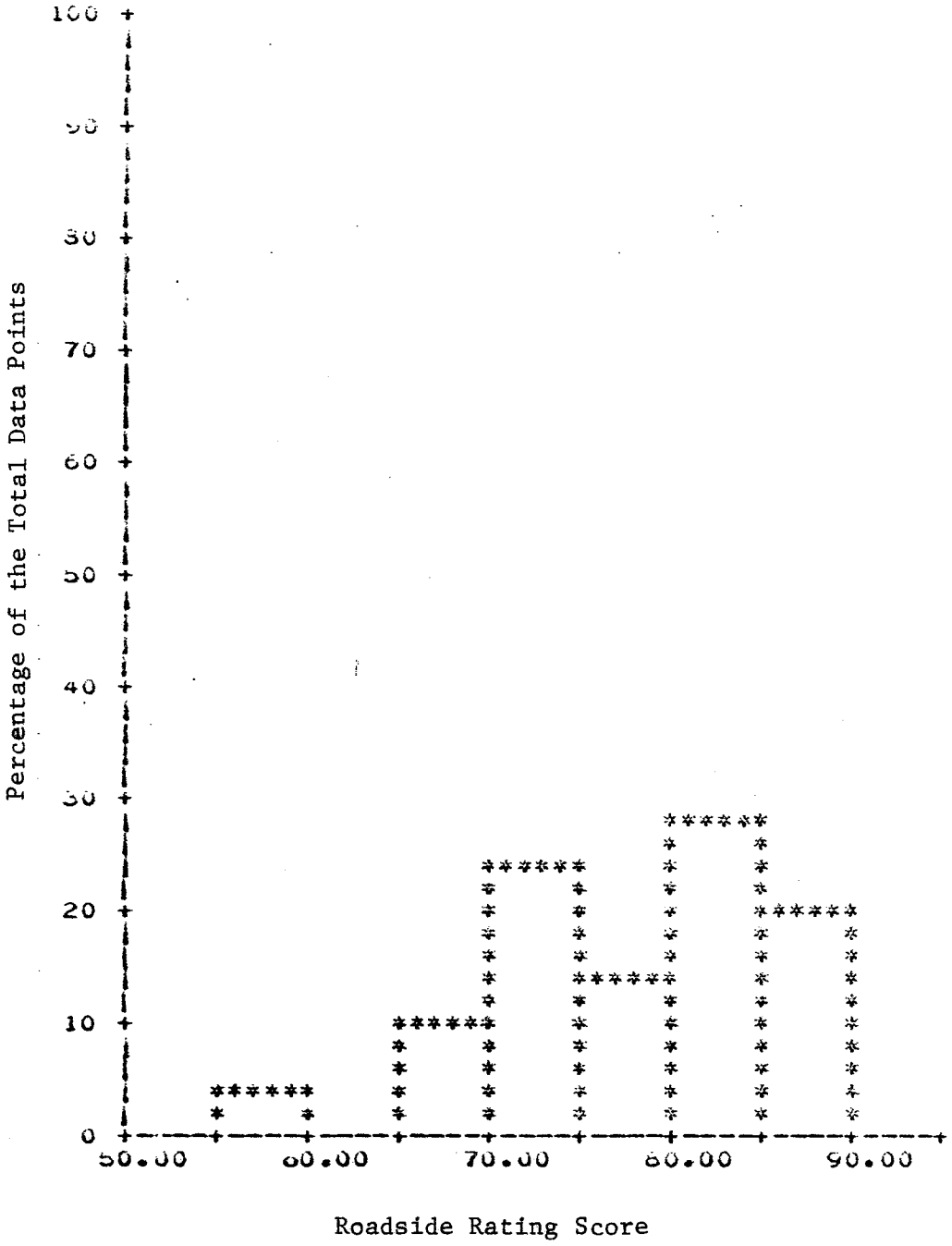

Figure 31. Roadside Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

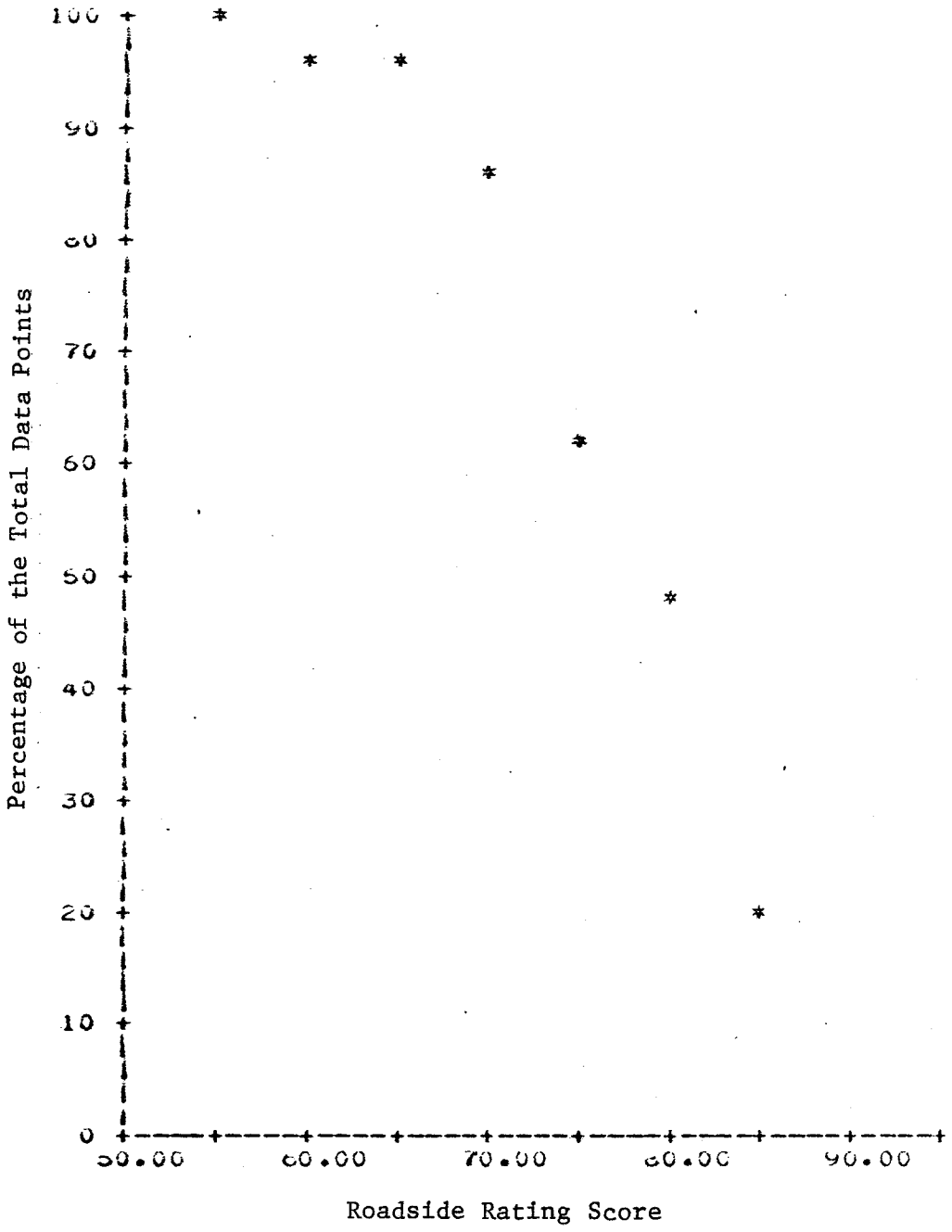

Figure 32. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

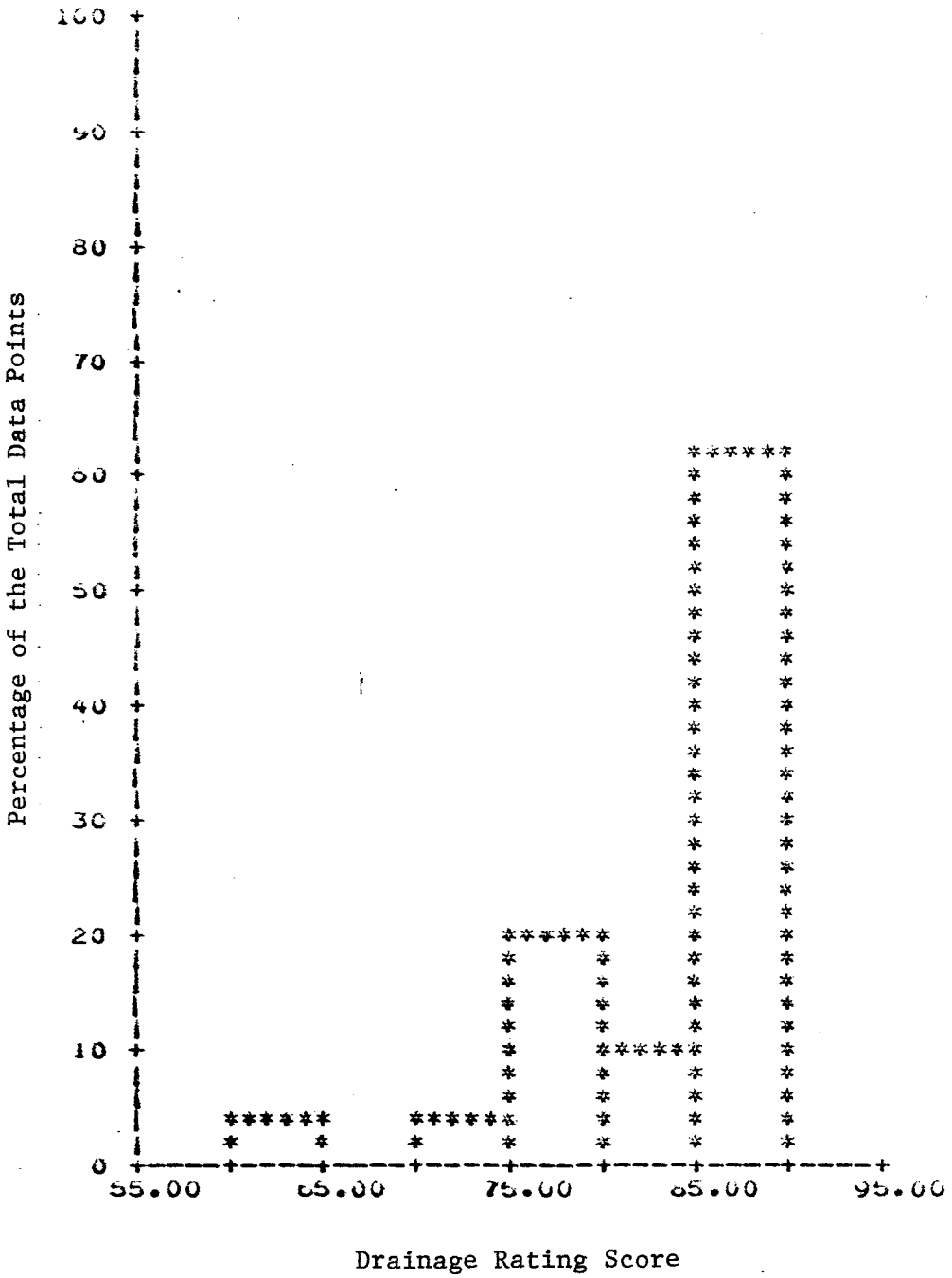

Figure 33. Drainage Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

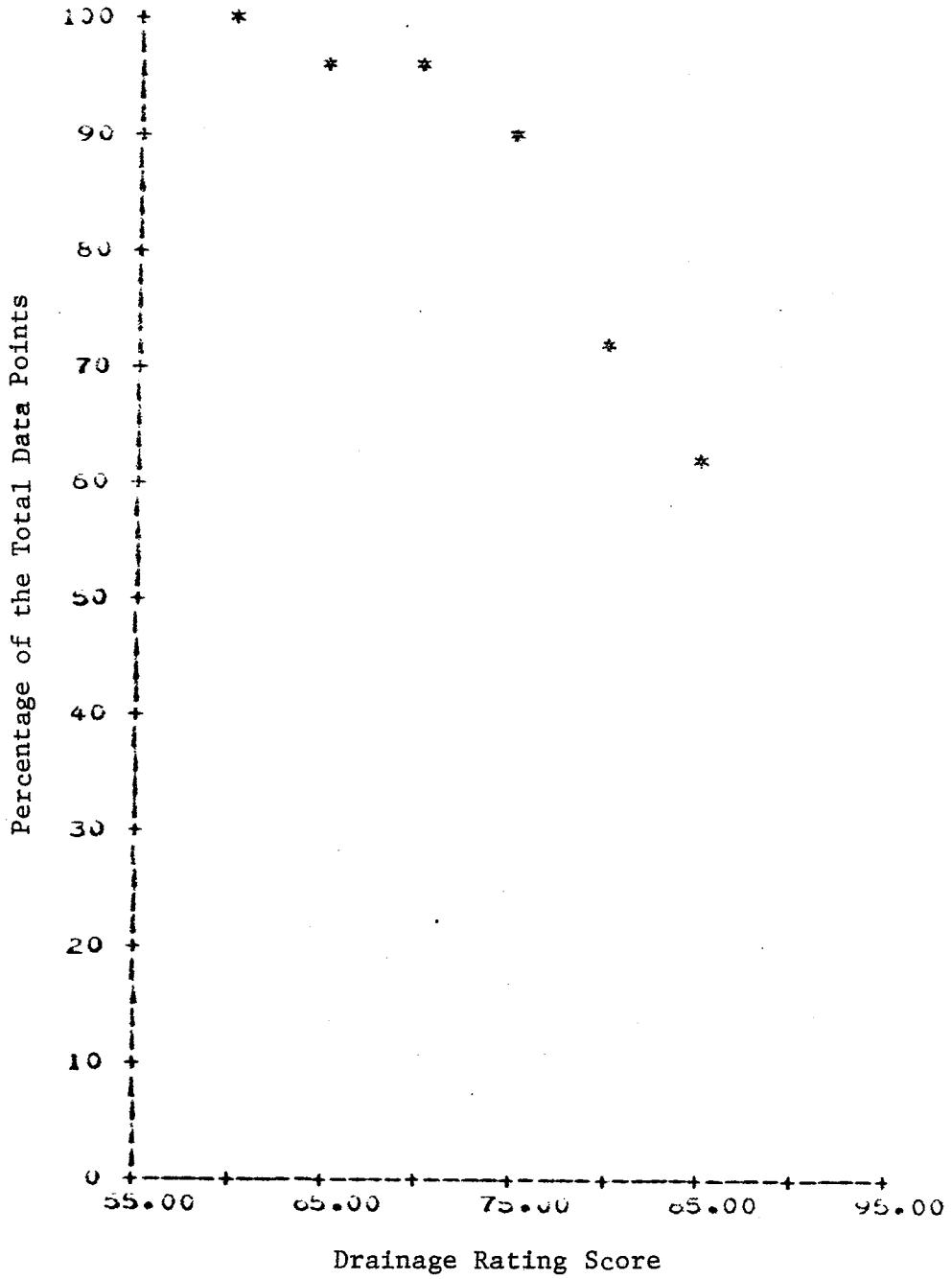

Figure 34. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

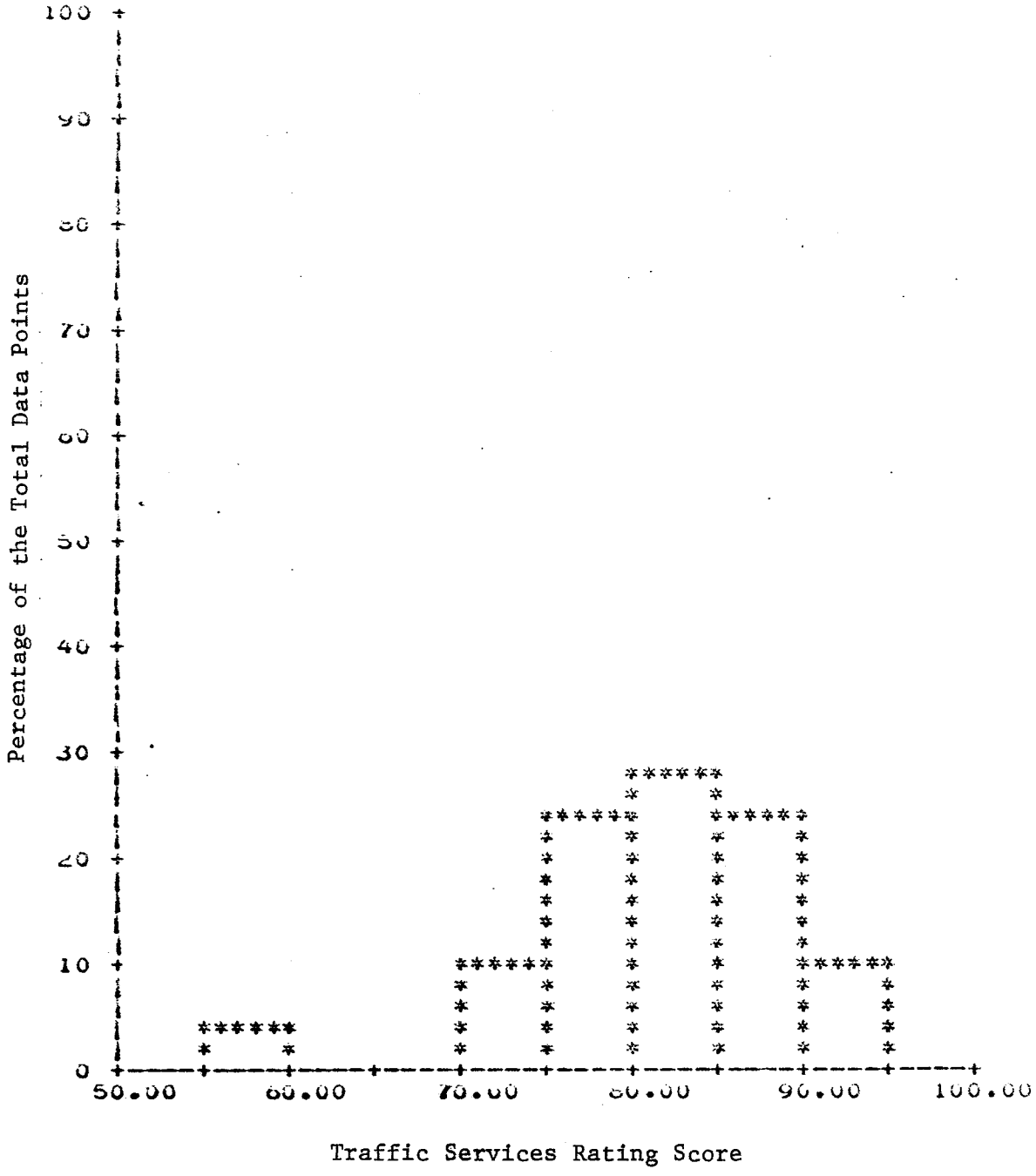

Figure 35. Traffic Services Rating Score Histogram for Statewide Random Sections - Interstate Highways (1974).

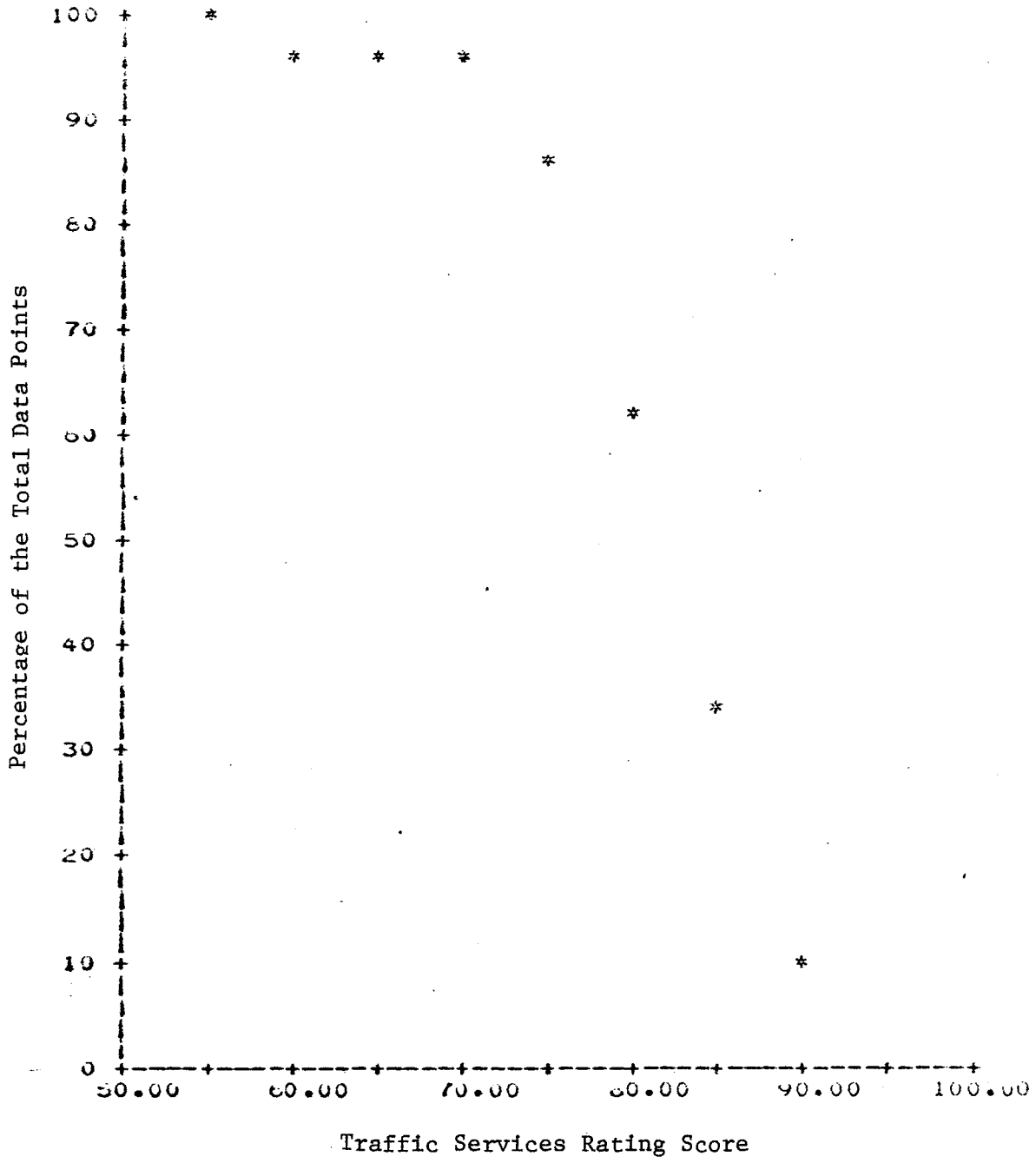

Figure 36. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Interstate Highways (1974).

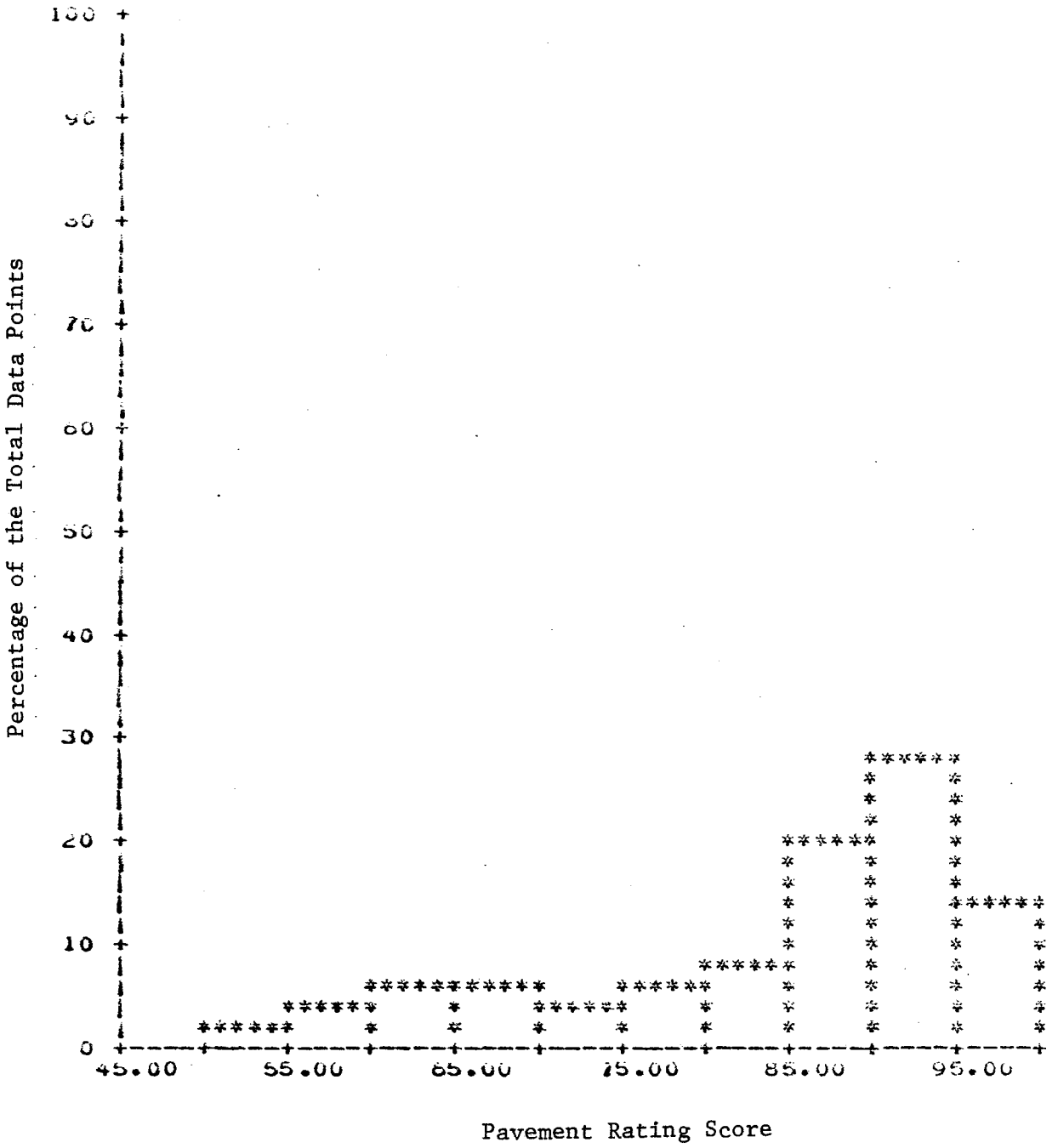

Figure 37. Pavement Rating Score (Without MRM Deductions) Histogram for Statewide Random Sections - U.S. and State Highways (1974).

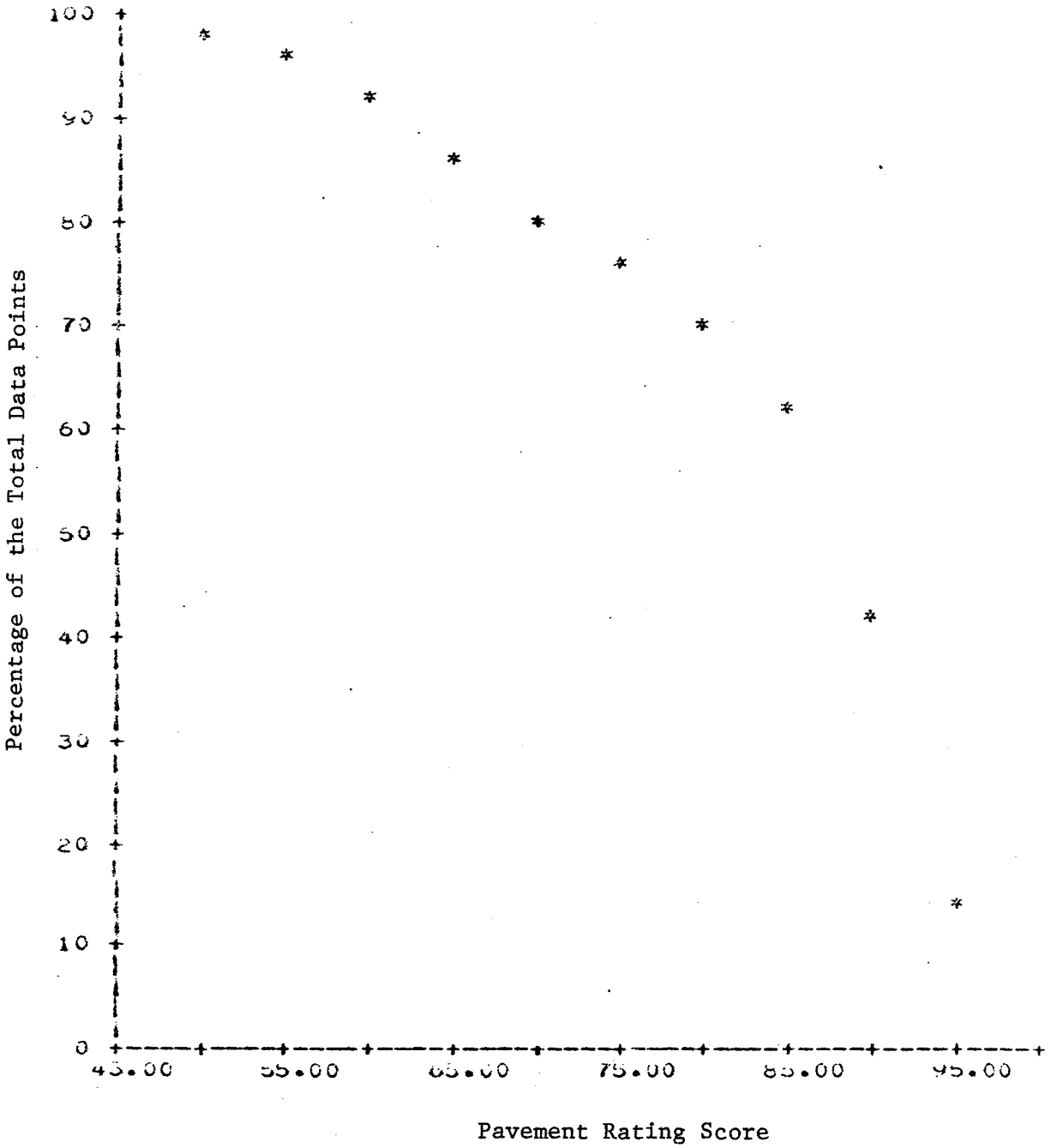

Figure 38. Pavement Rating Score (Without MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

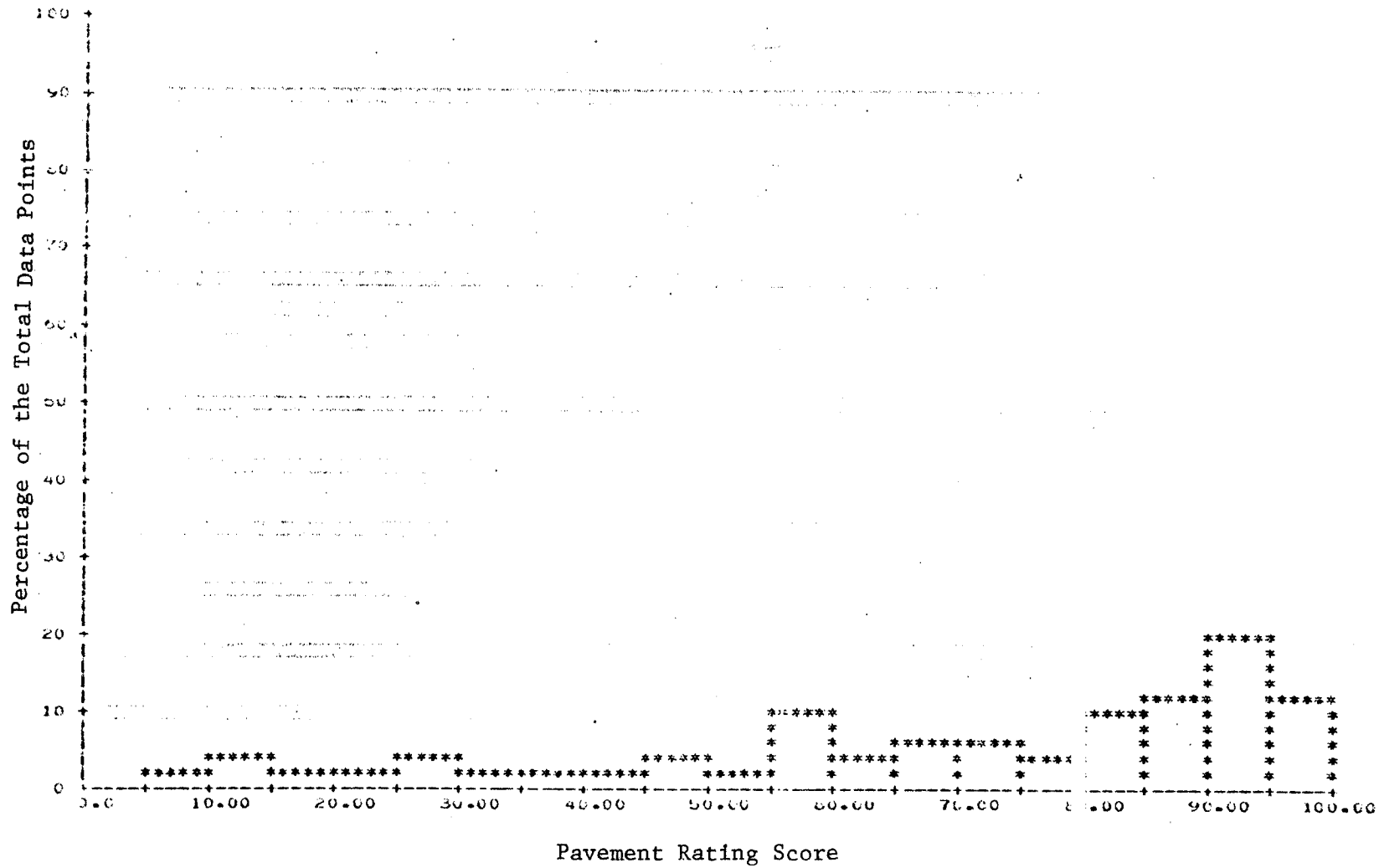

Figure 39. Pavement Rating Score (With MRM Deductions) Histogram for Statewide Random Sections - U.S. and State Highways (1974).

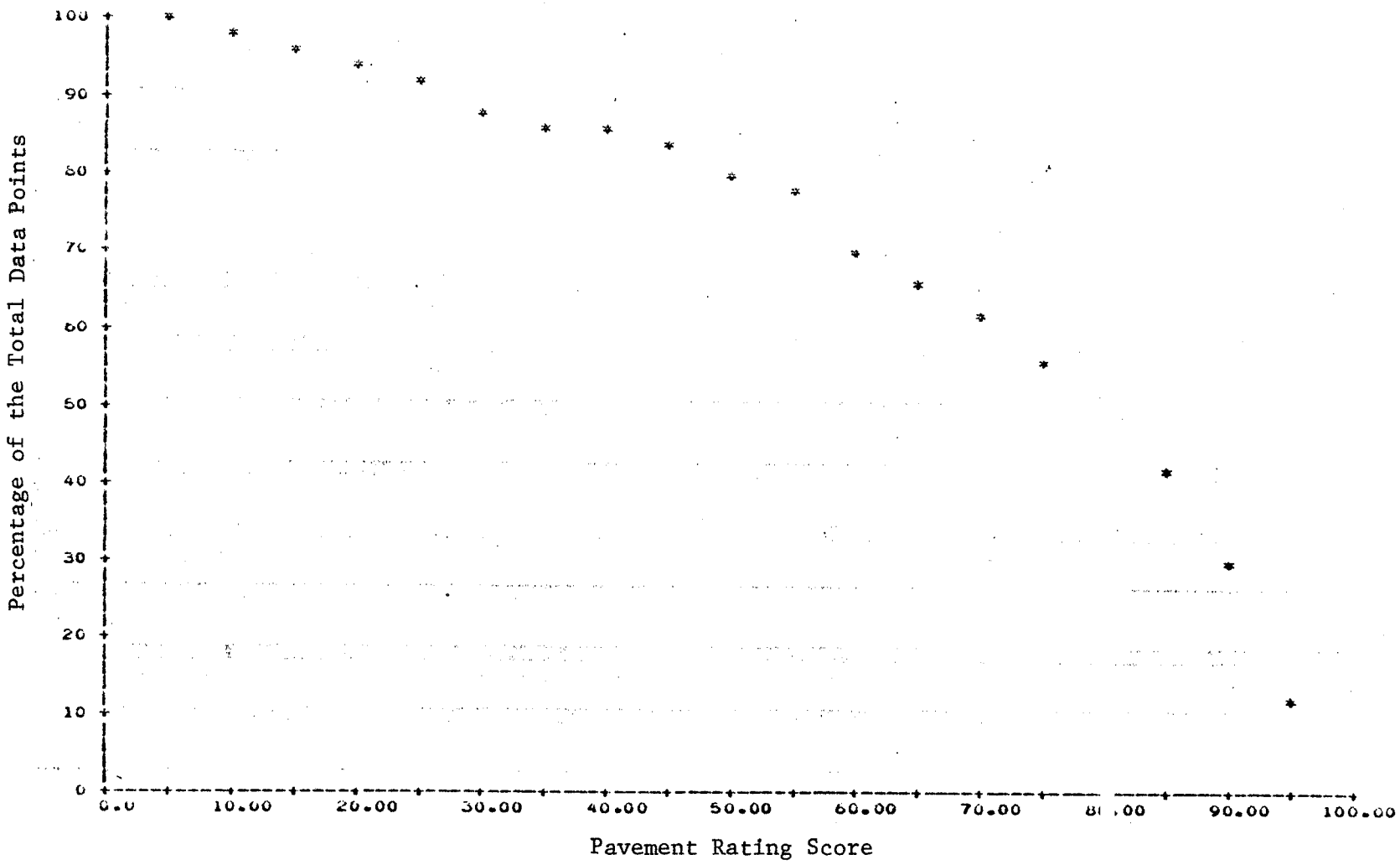

Figure 40. Pavement Rating Score (With MRM Deductions) Percentage Cumulati e Distribution for Statewide Random Sections - U.S. and State Hig ways (1974).

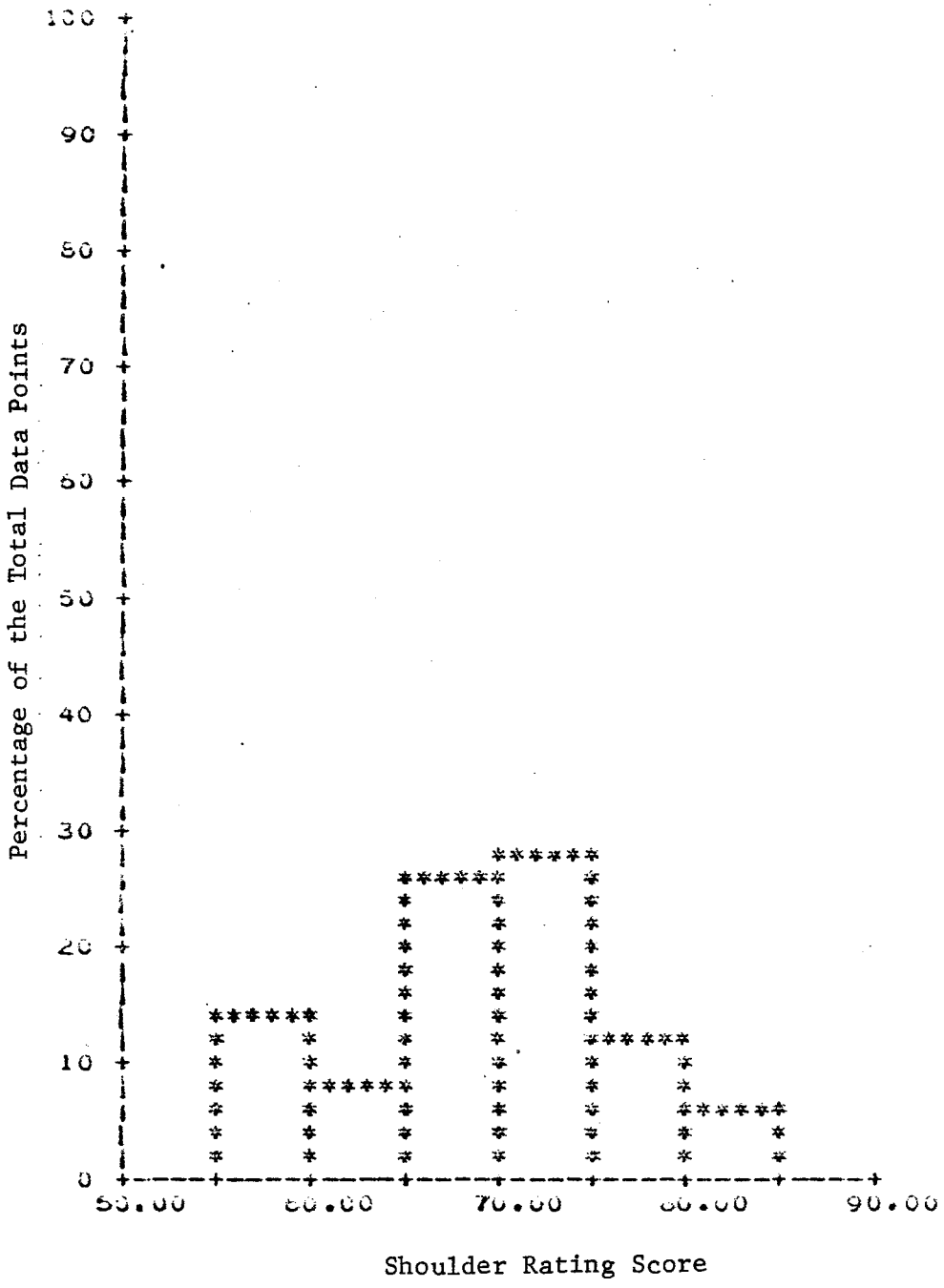

Figure 41. Shoulder Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

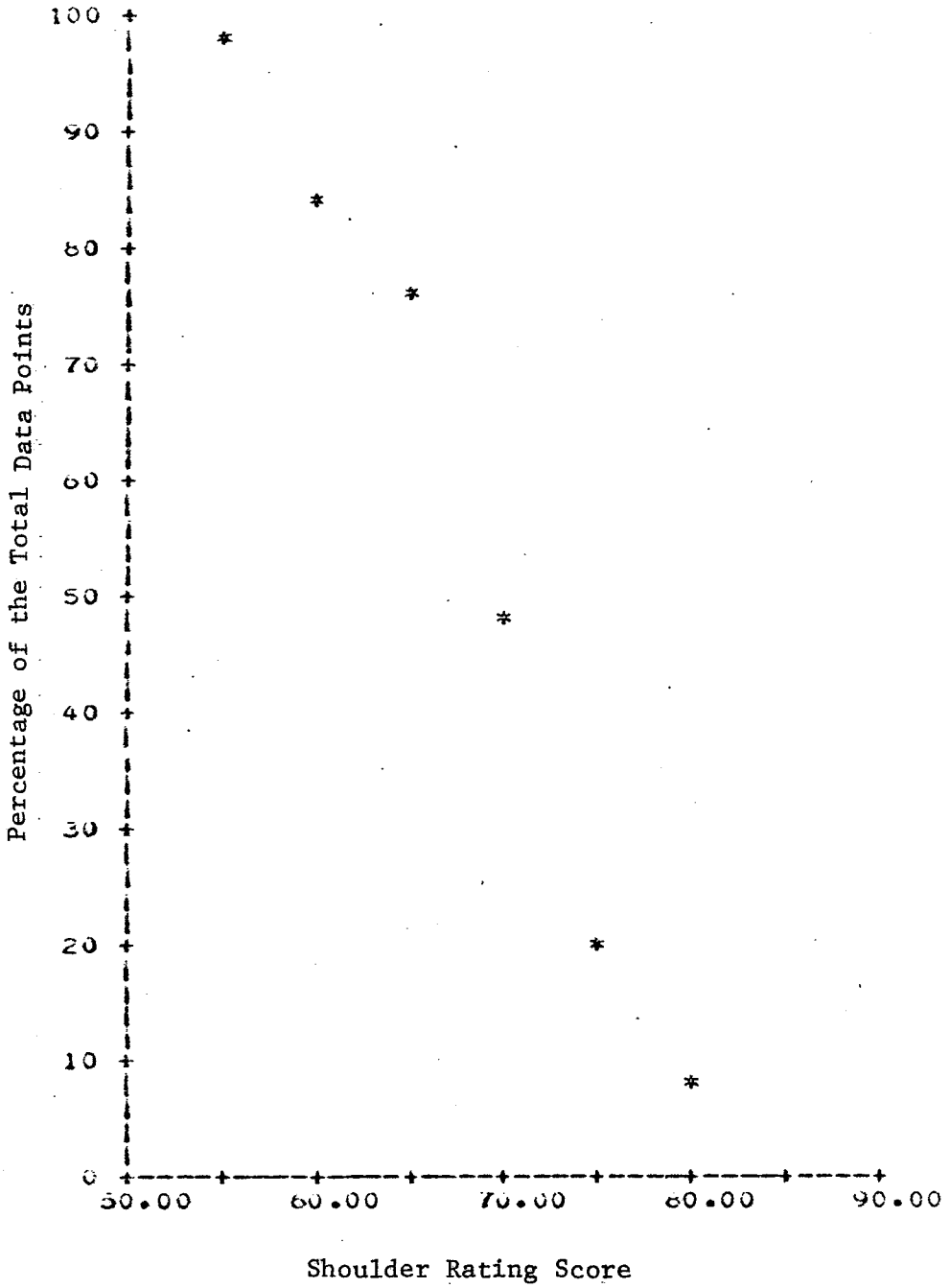

Figure 42. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

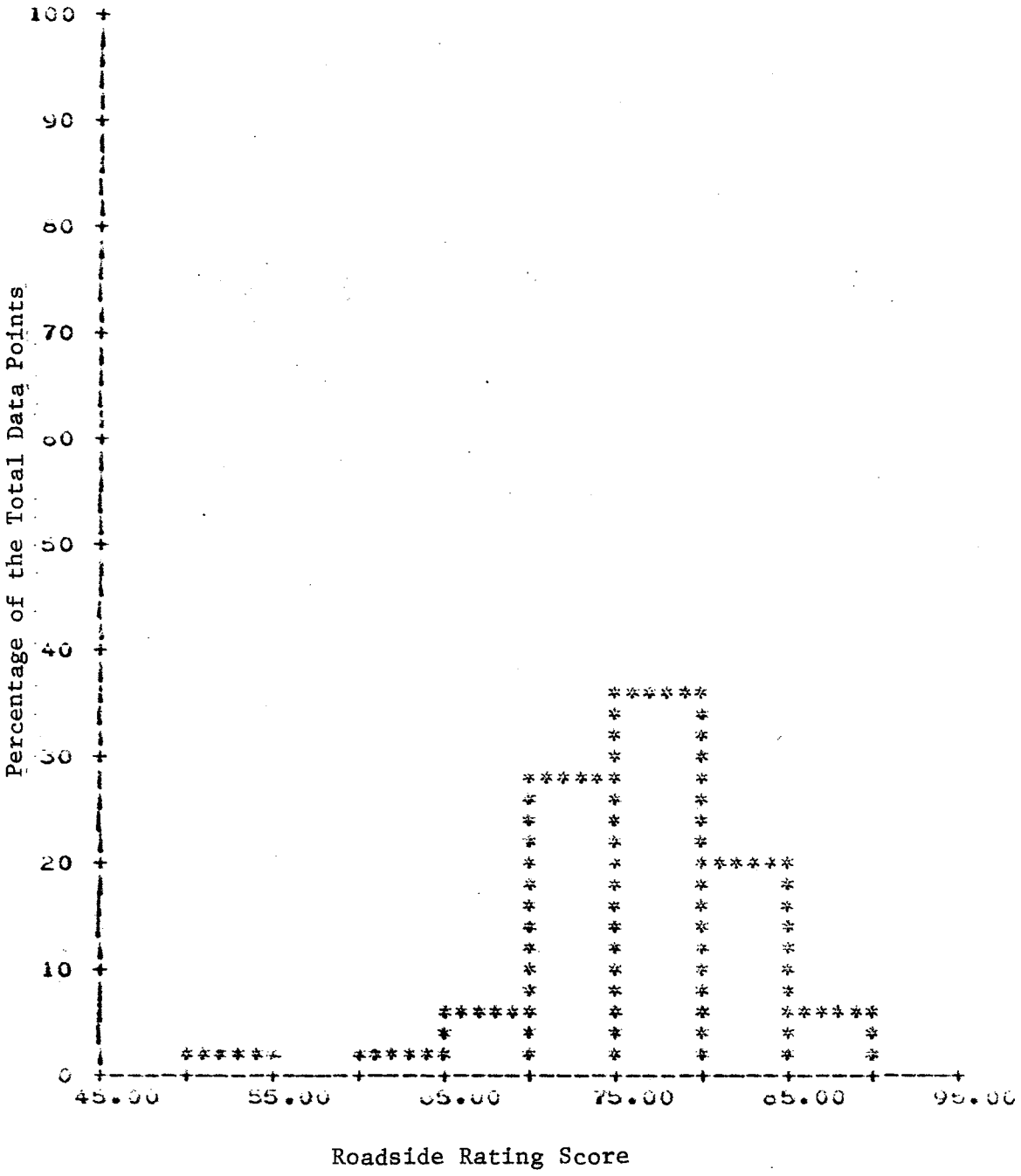

Figure 43. Roadside Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

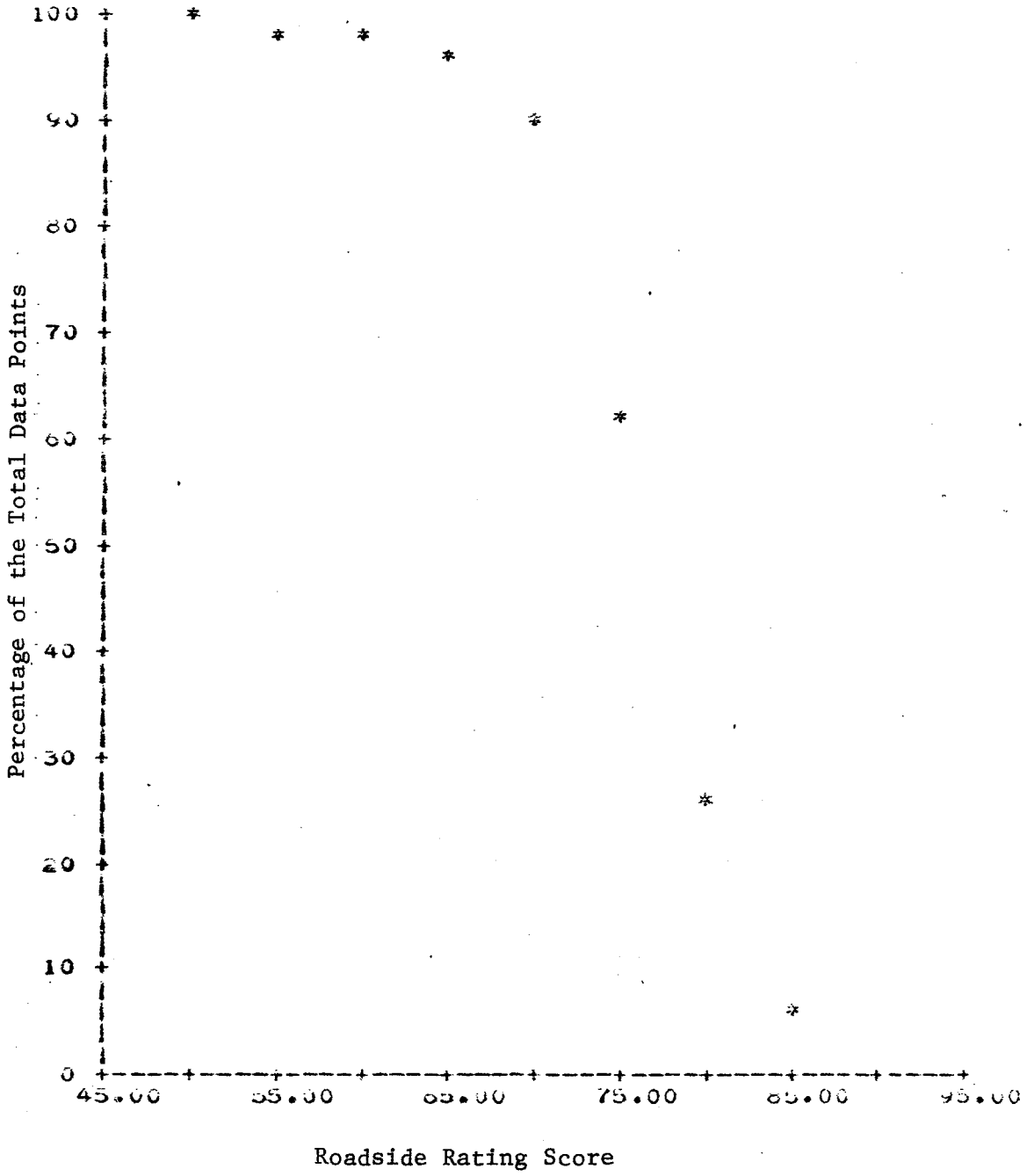

Figure 44. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

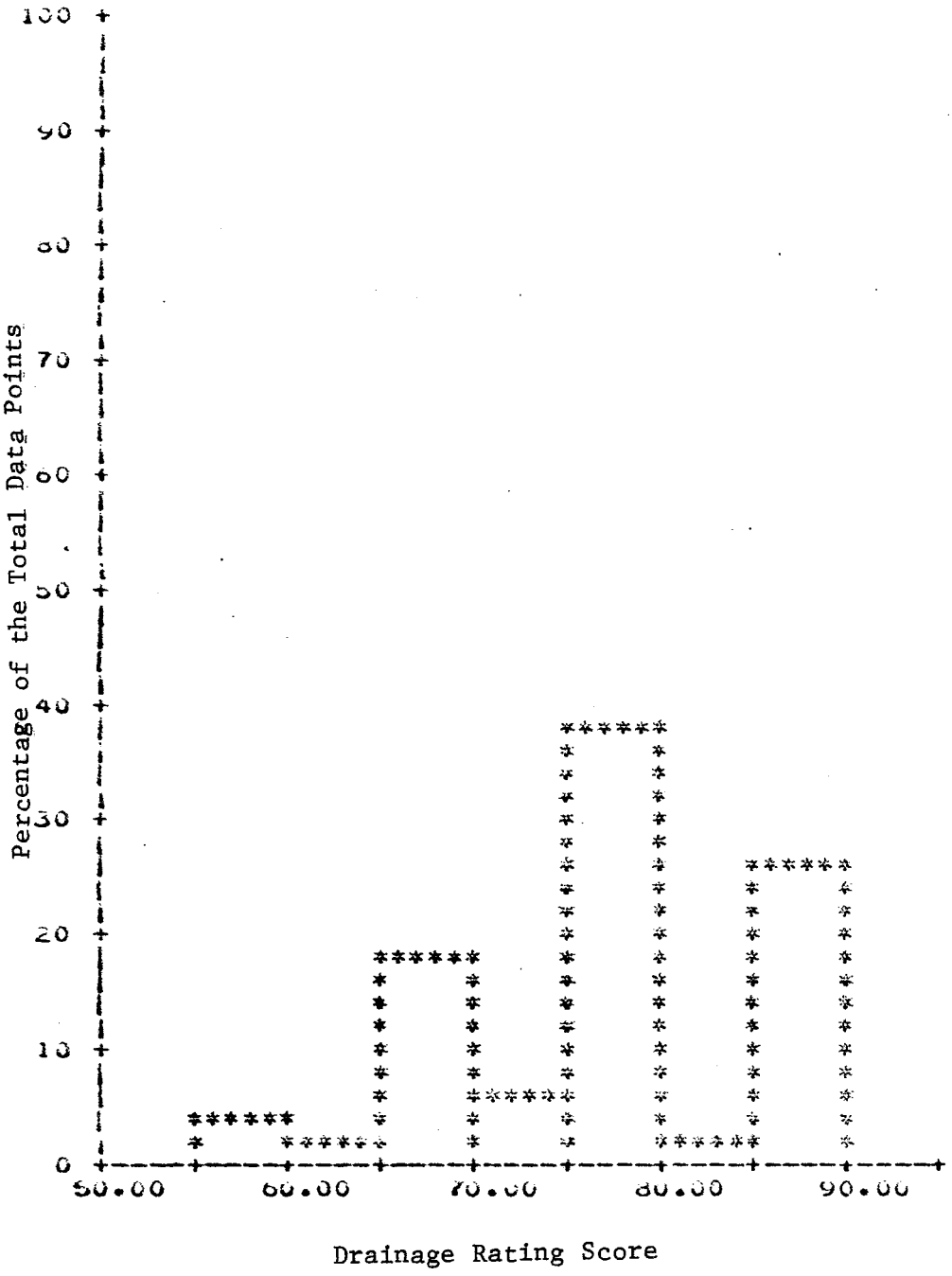

Figure 45. Drainage Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

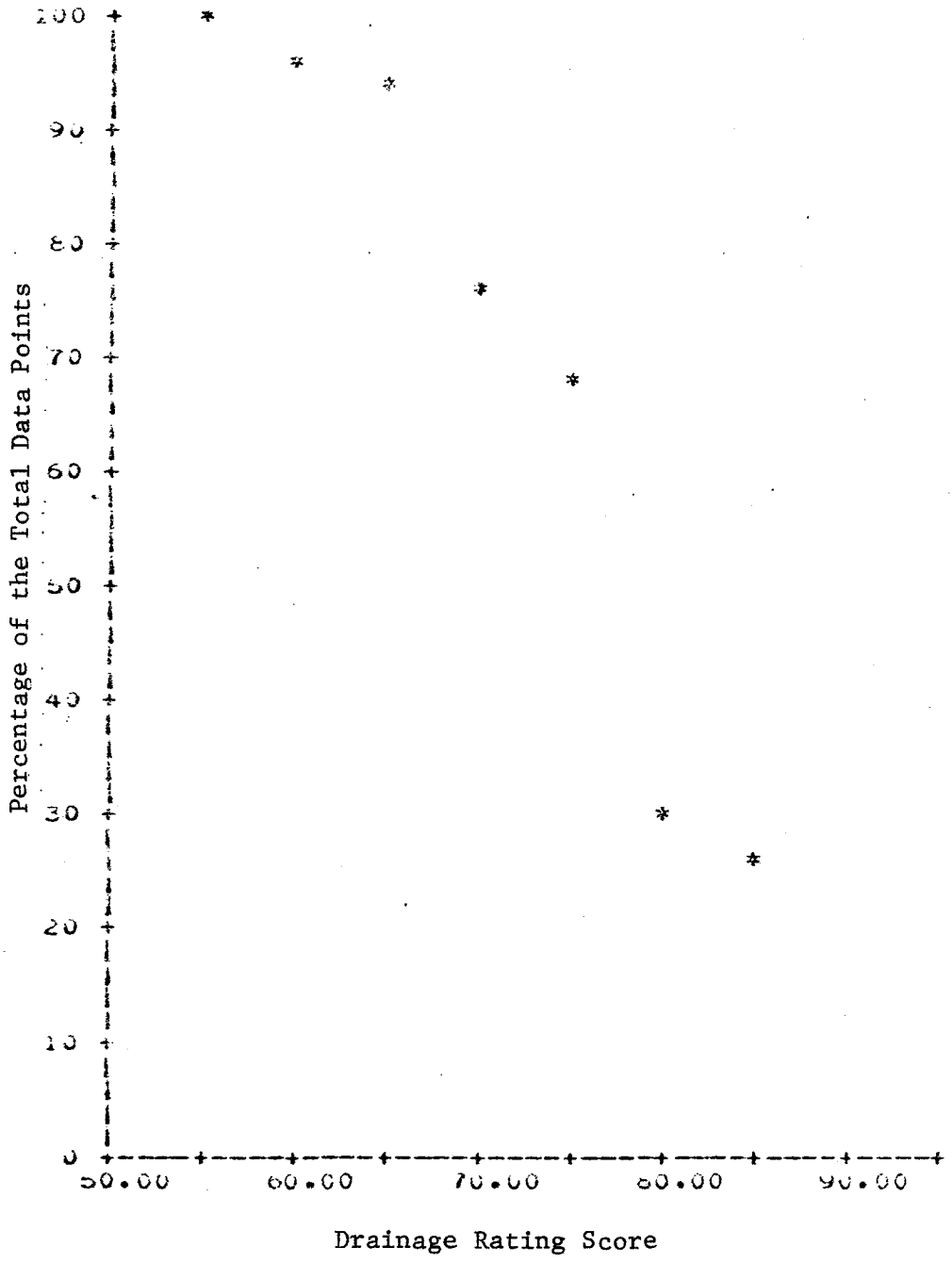

Figure 46. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

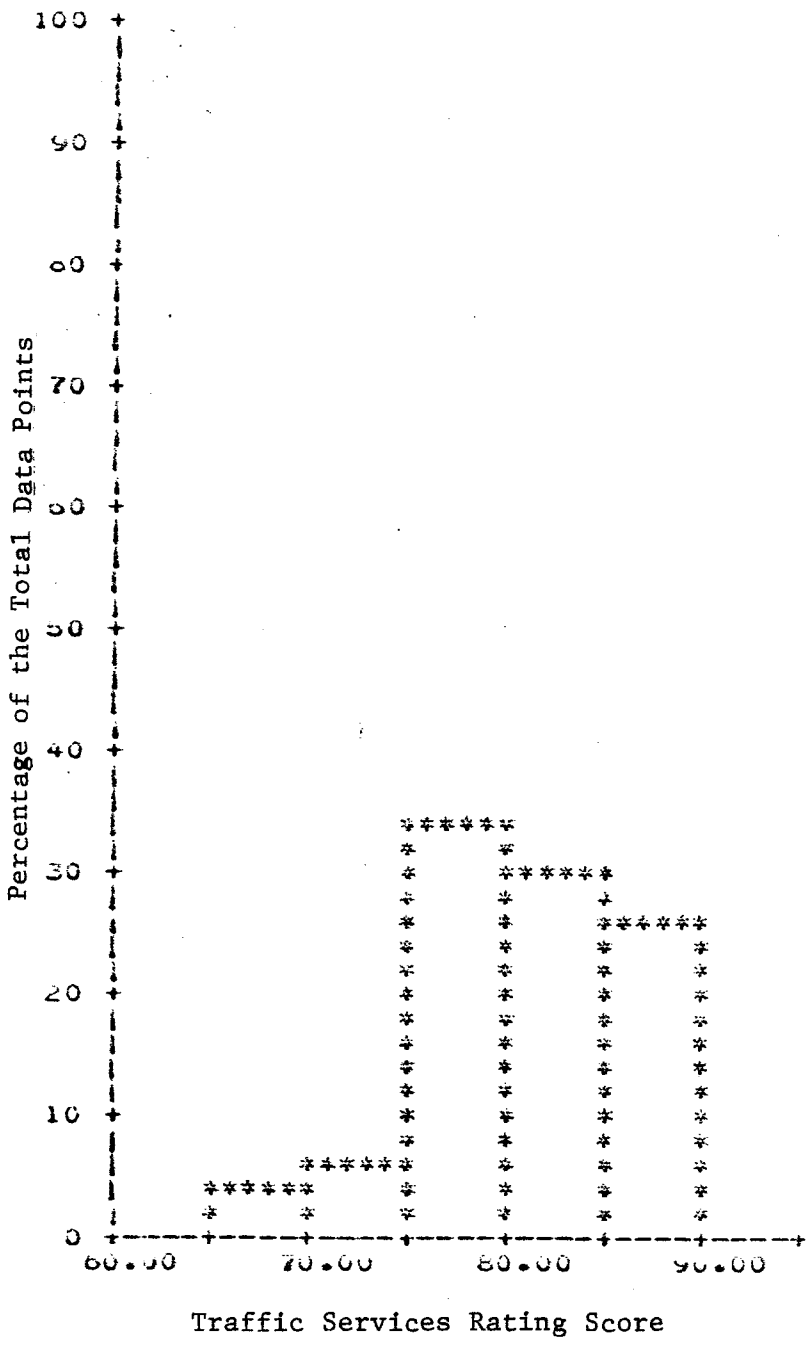

Figure 47. Traffic Services Rating Score Histogram for Statewide Random Sections - U.S. and State Highways (1974).

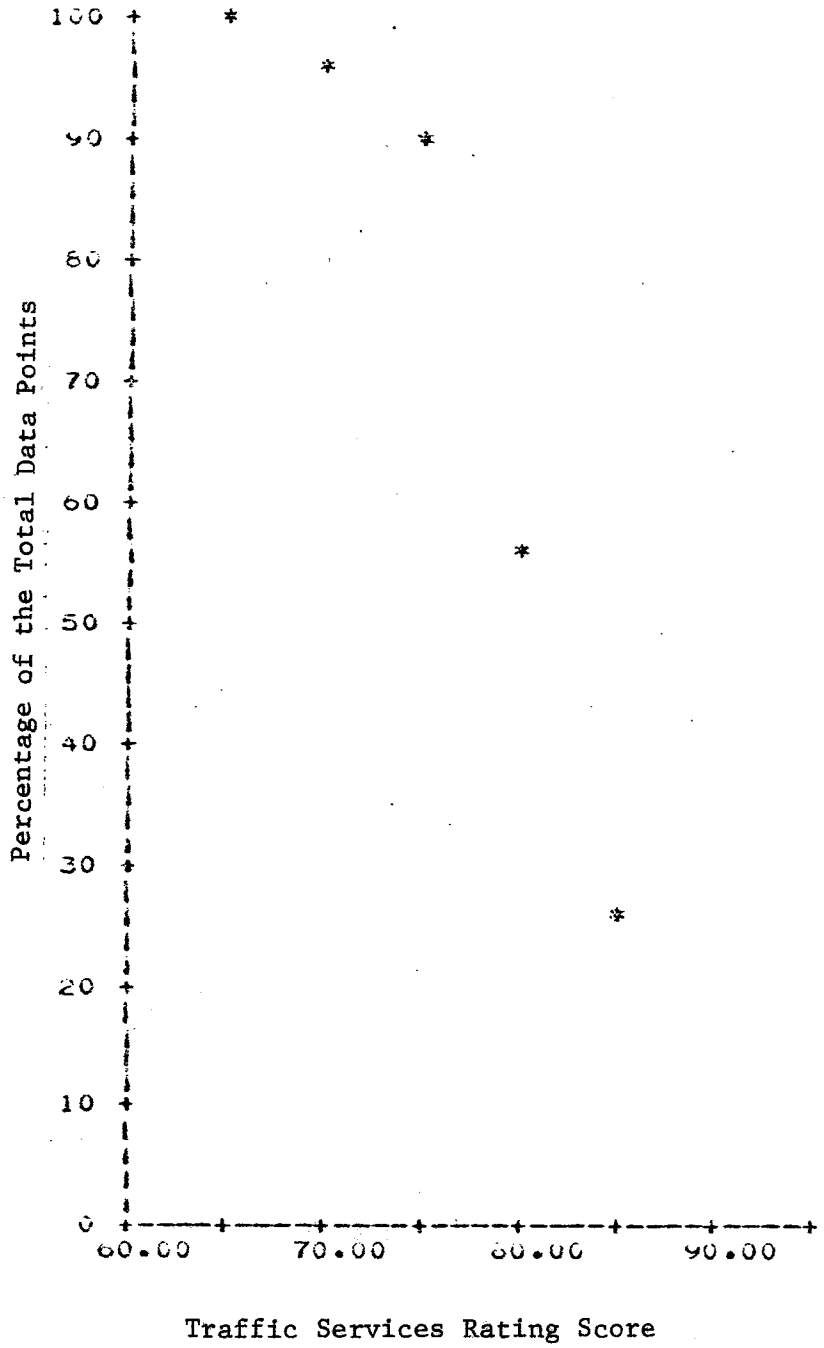

Figure 48. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - U.S. and State Highways (1974).

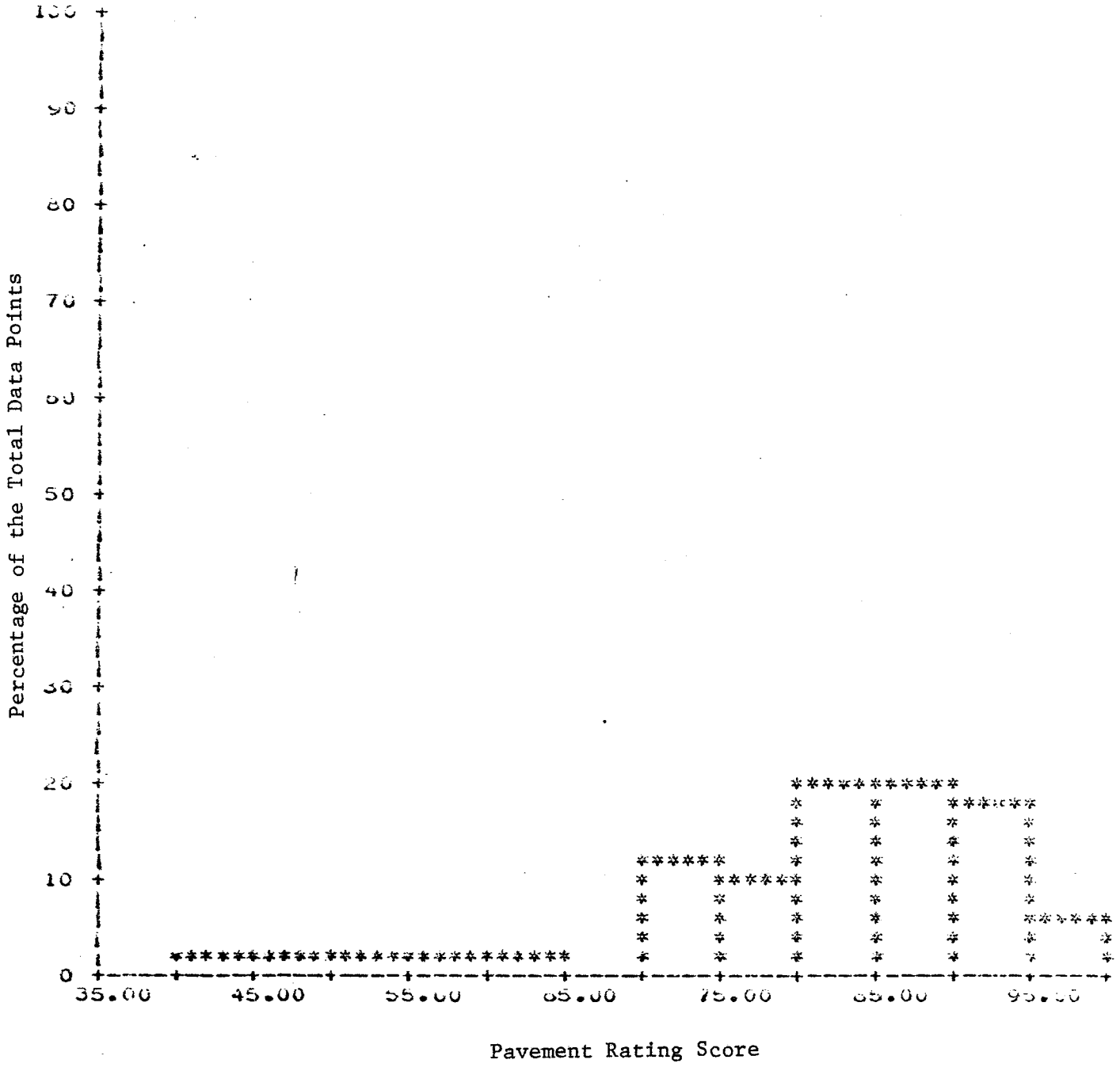

Figure 49. Pavement Rating Score (Without MRM Deductions) Histogram for Statewide Random Sections - F.M. Highways (1974).

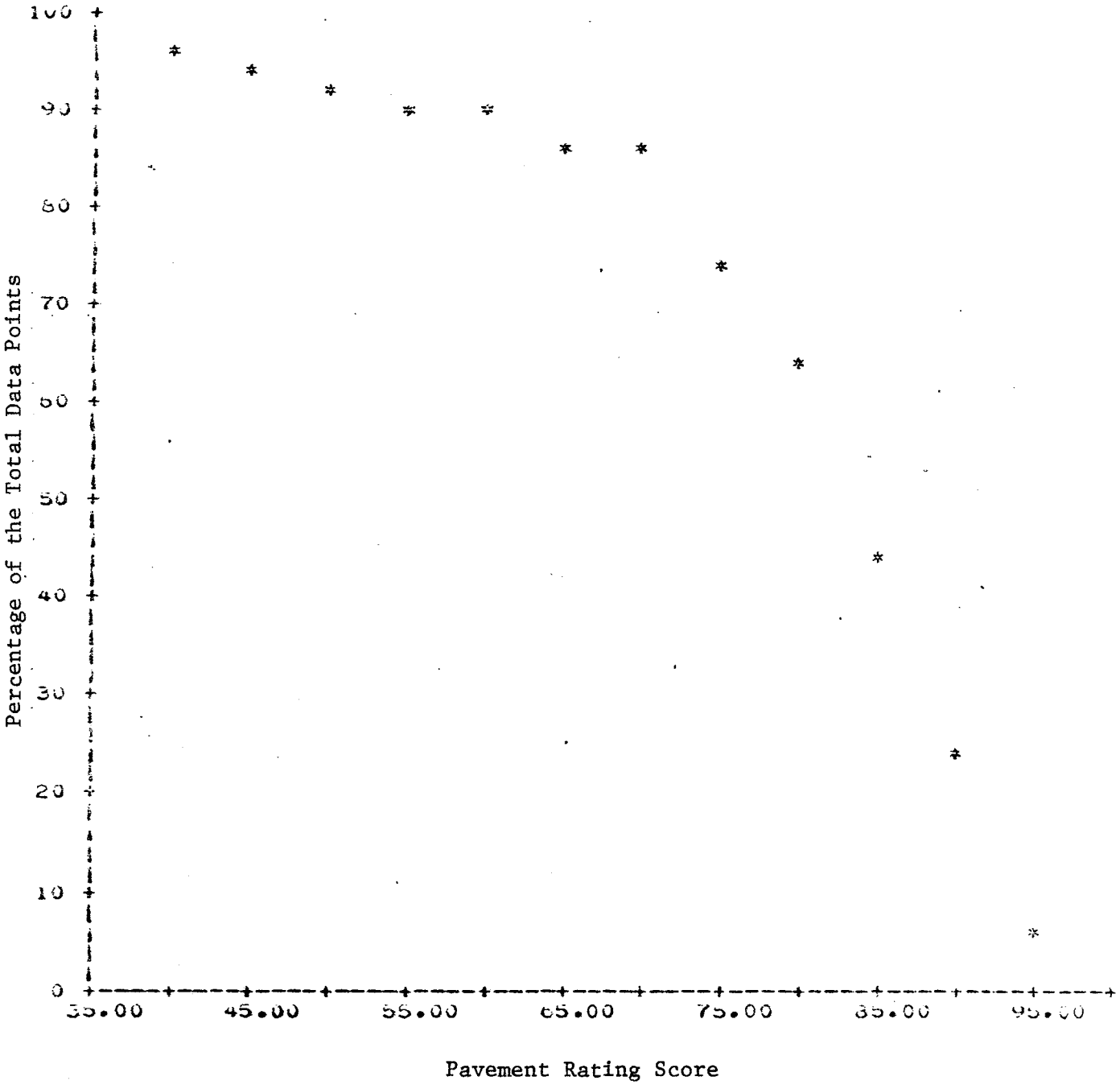

Figure 50. Pavement Rating Score (Without MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

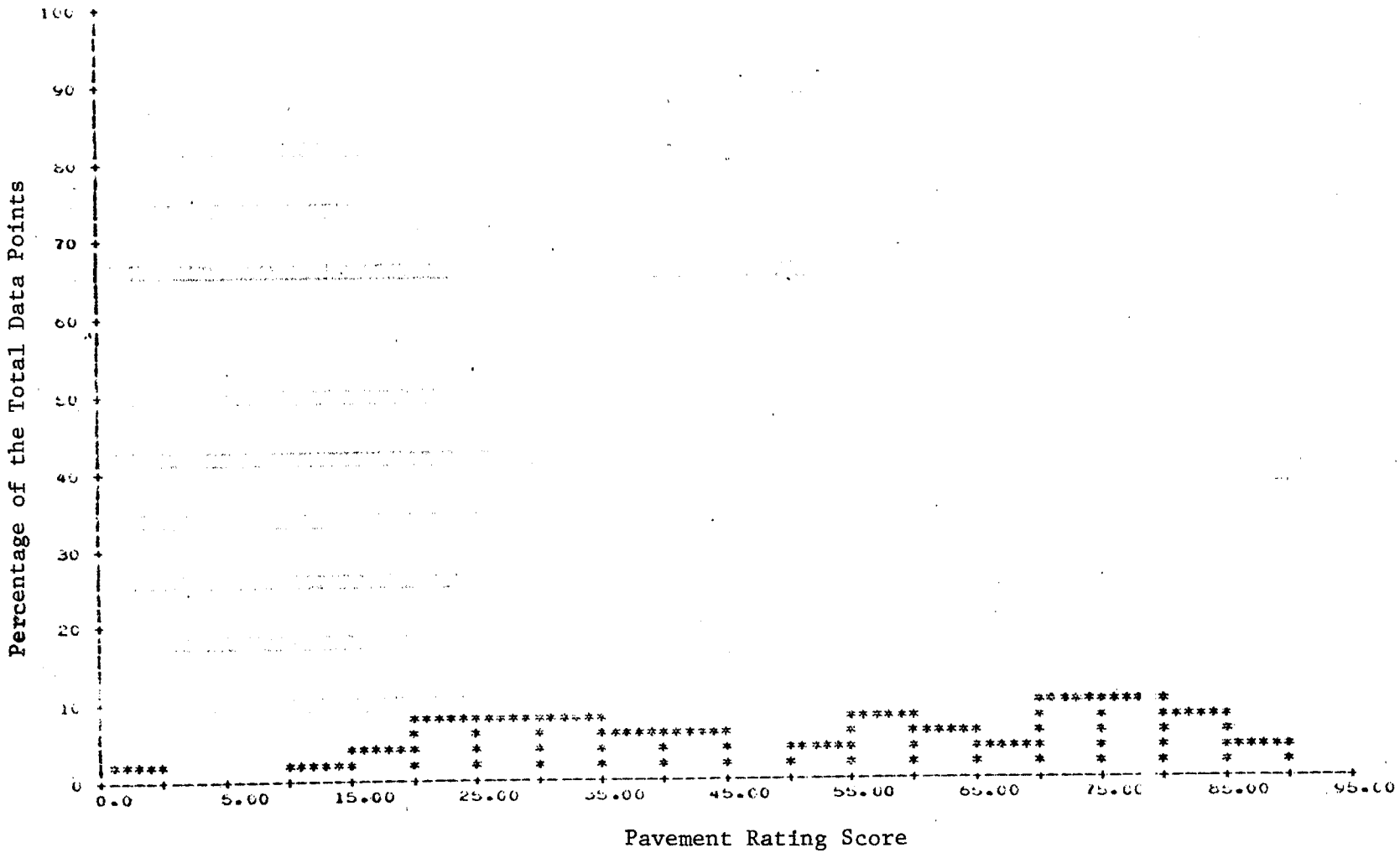

Figure 51. Pavement Rating Score (With MRM Deductions) Histogram for Statewide Random Sections - F.M. Highways (1974).

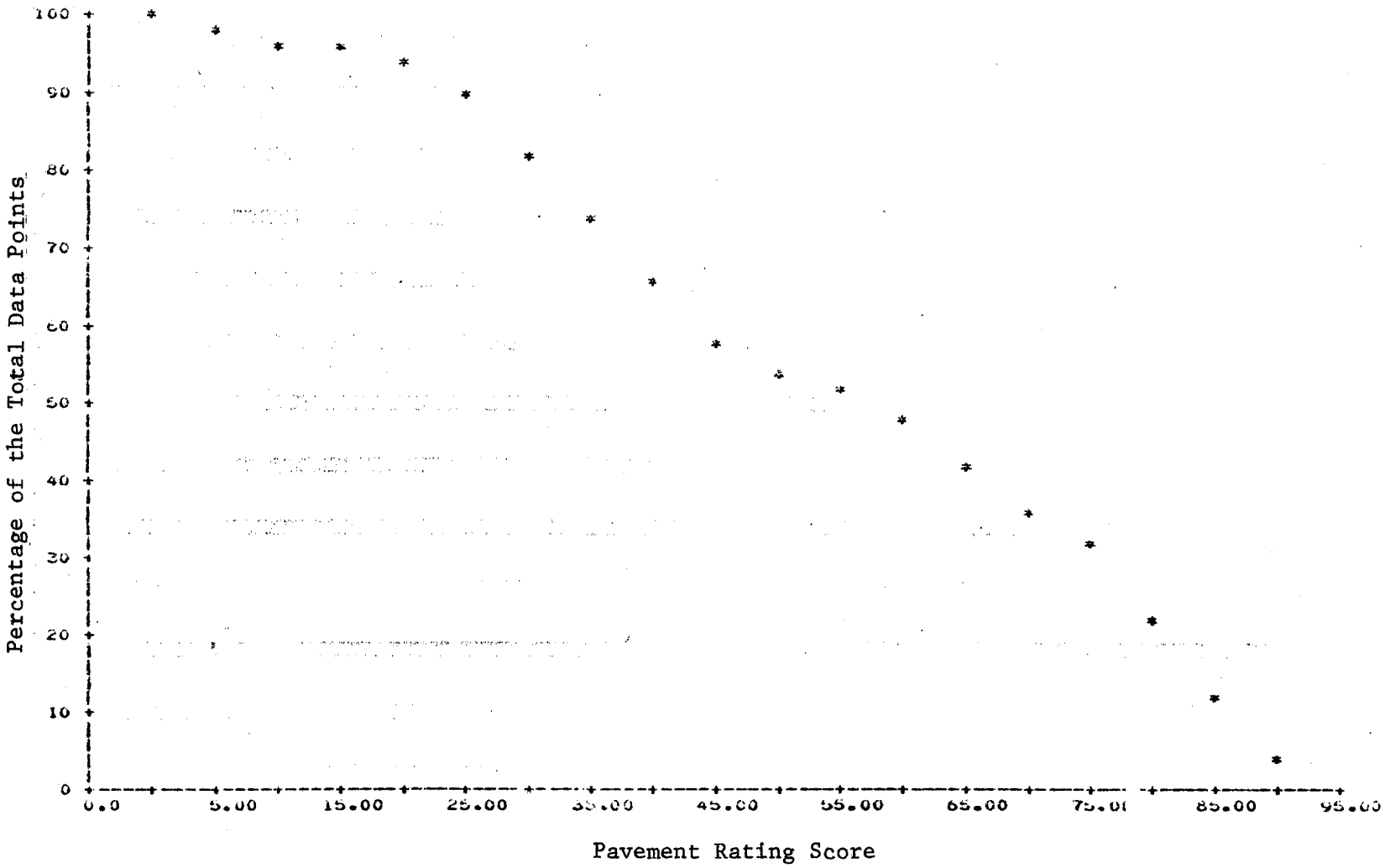

Figure 52. Pavement Rating Score (With MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

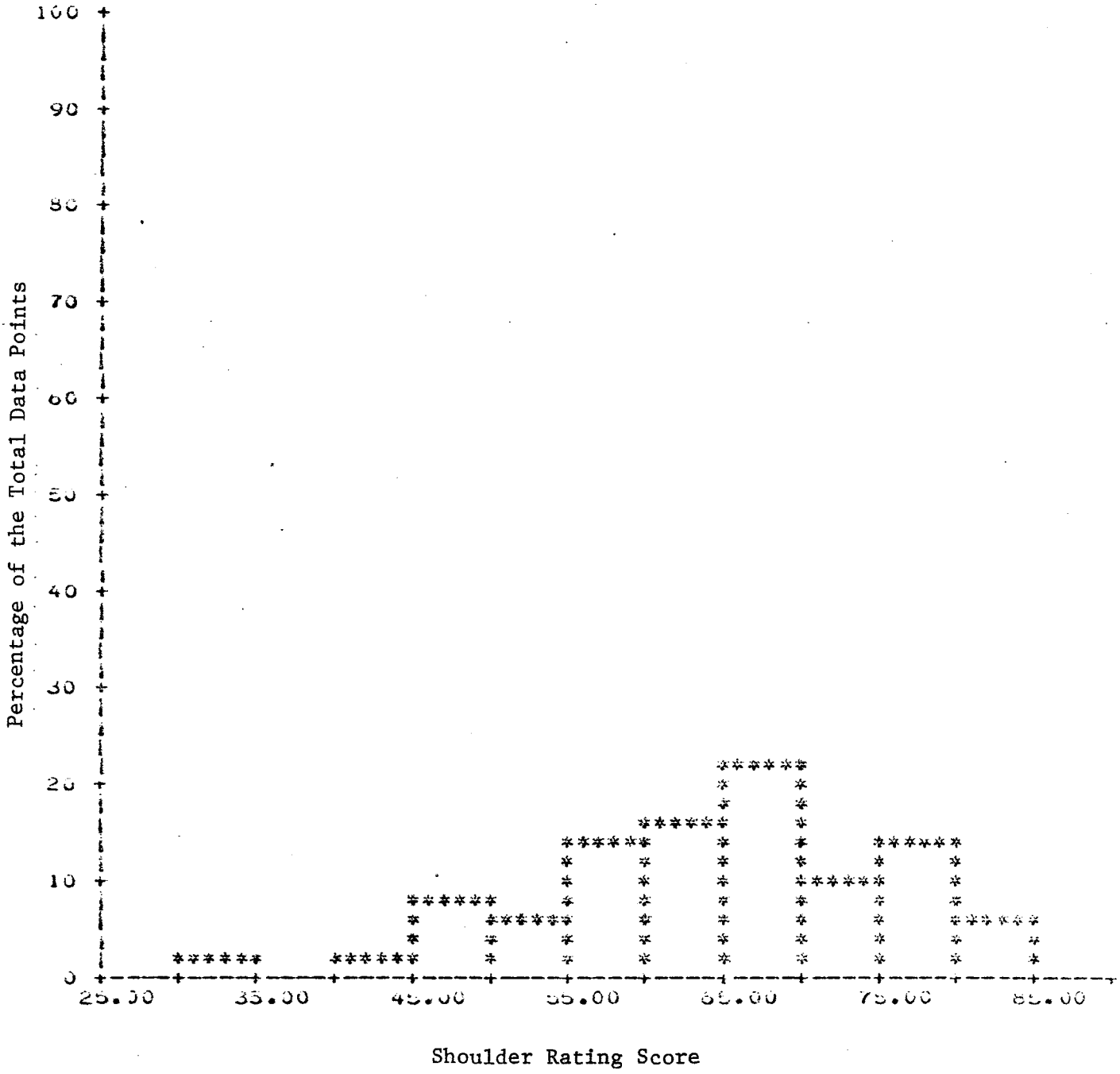

Figure 53. Shoulder Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

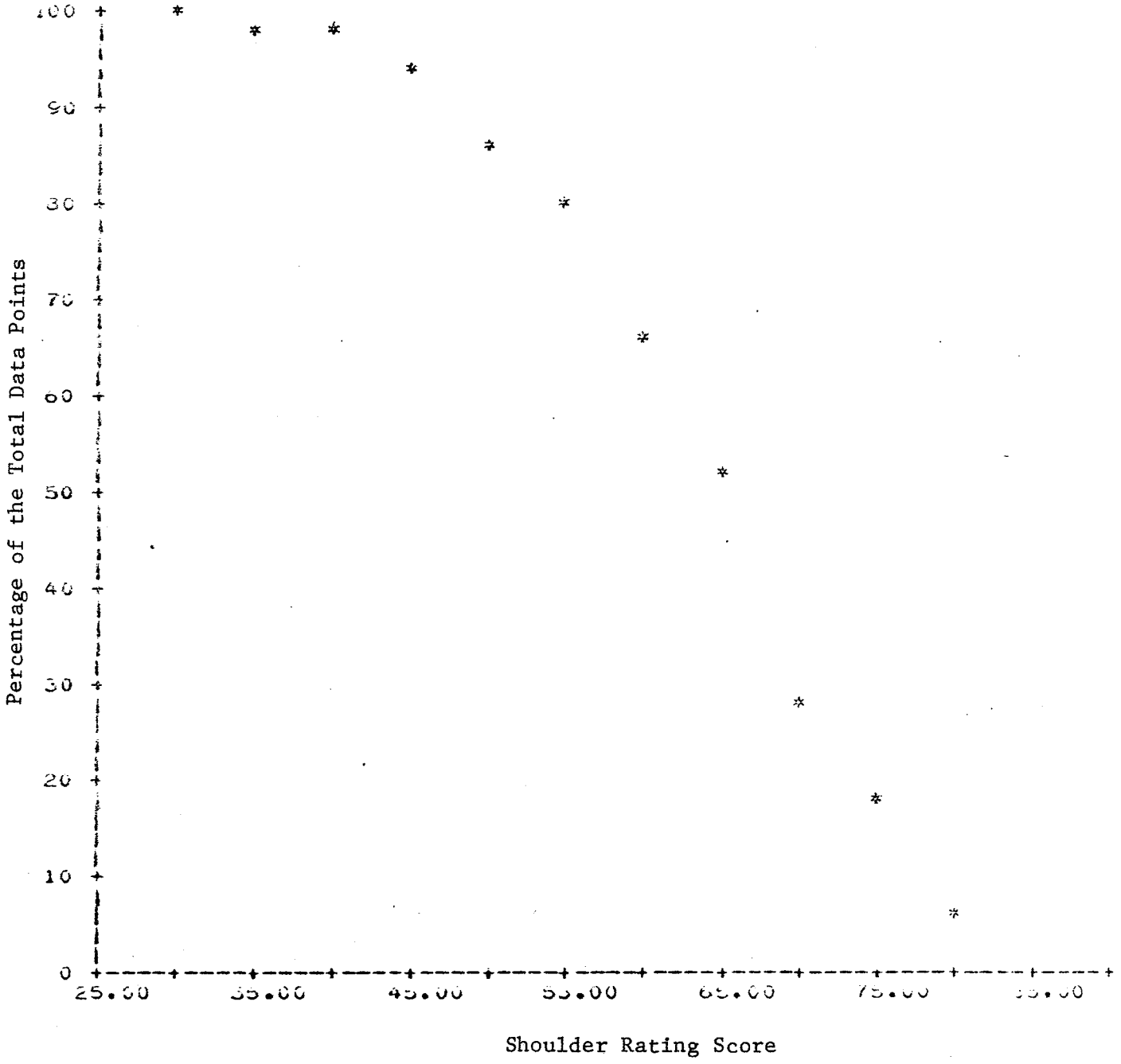

Figure 54. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

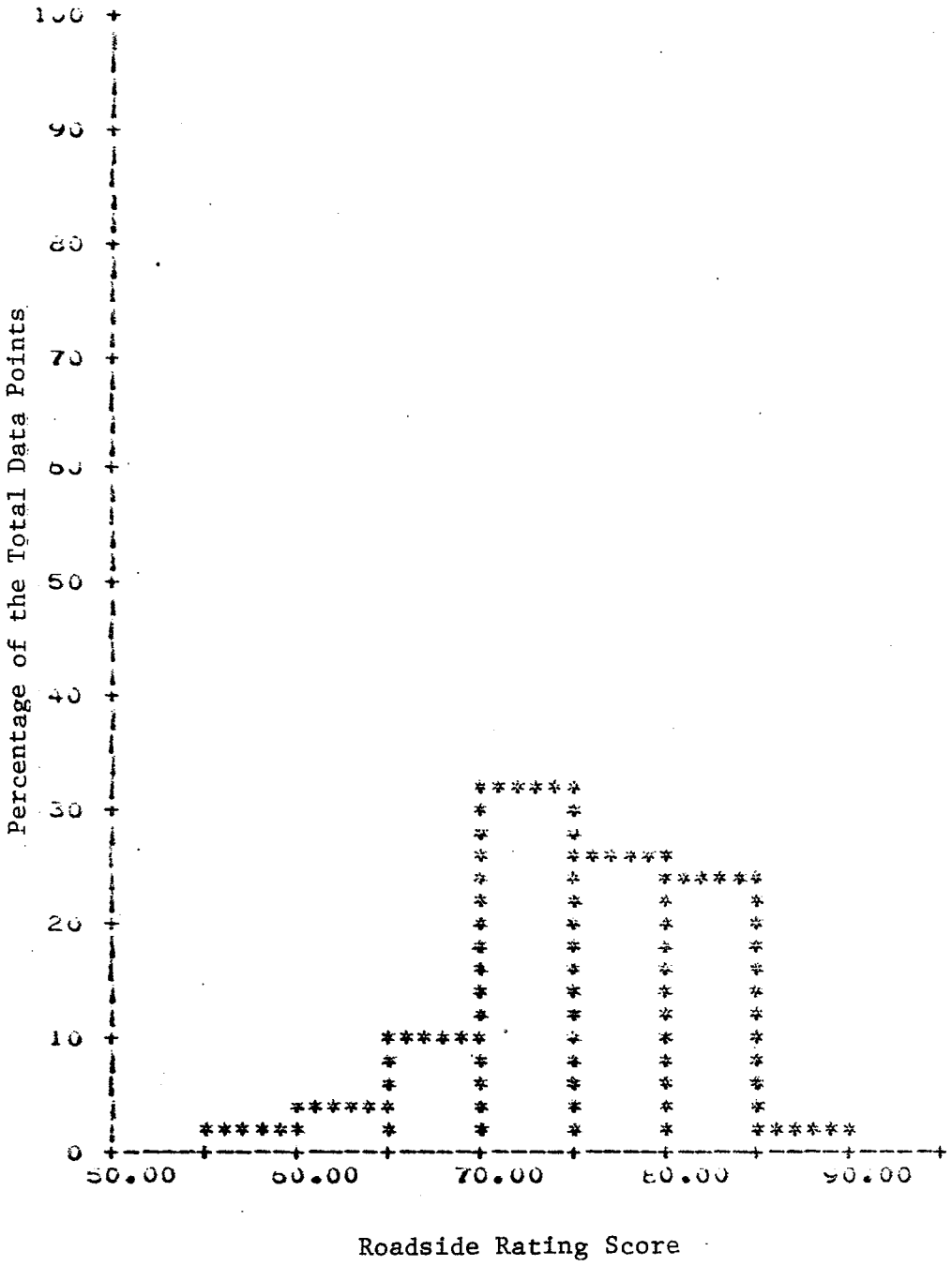

Figure 55. Roadside Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

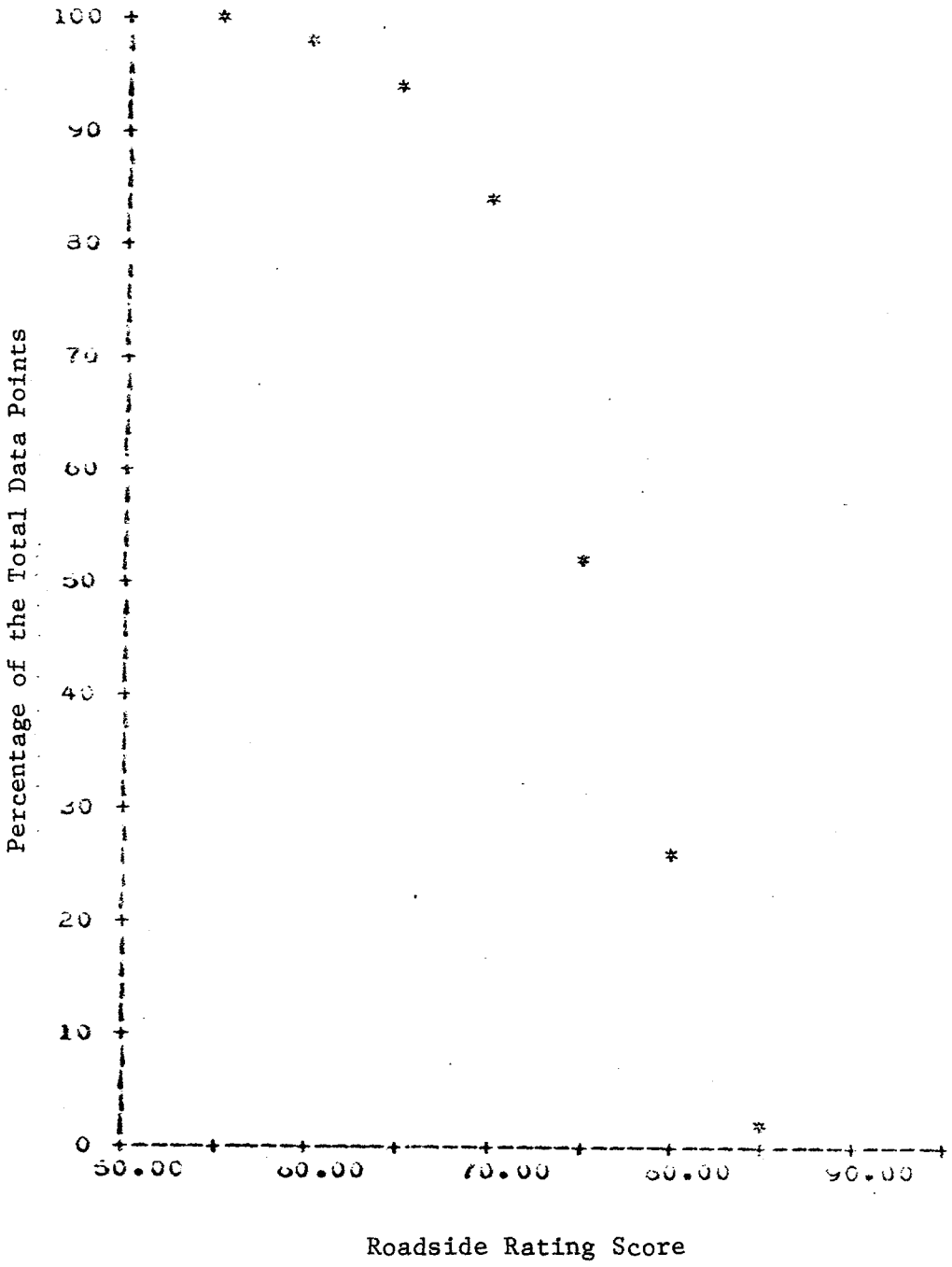

Figure 56. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

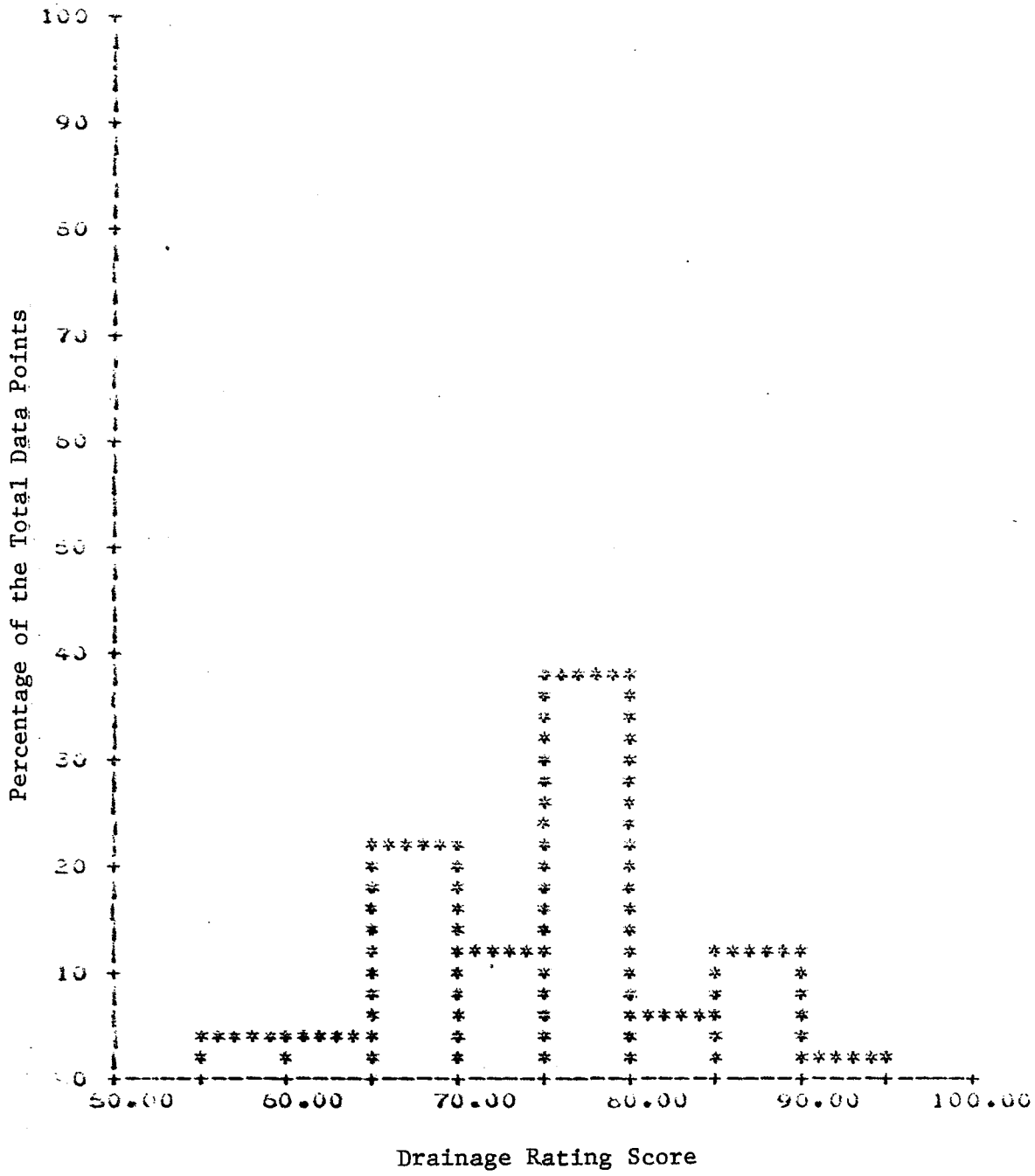

Figure 57. Drainage Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

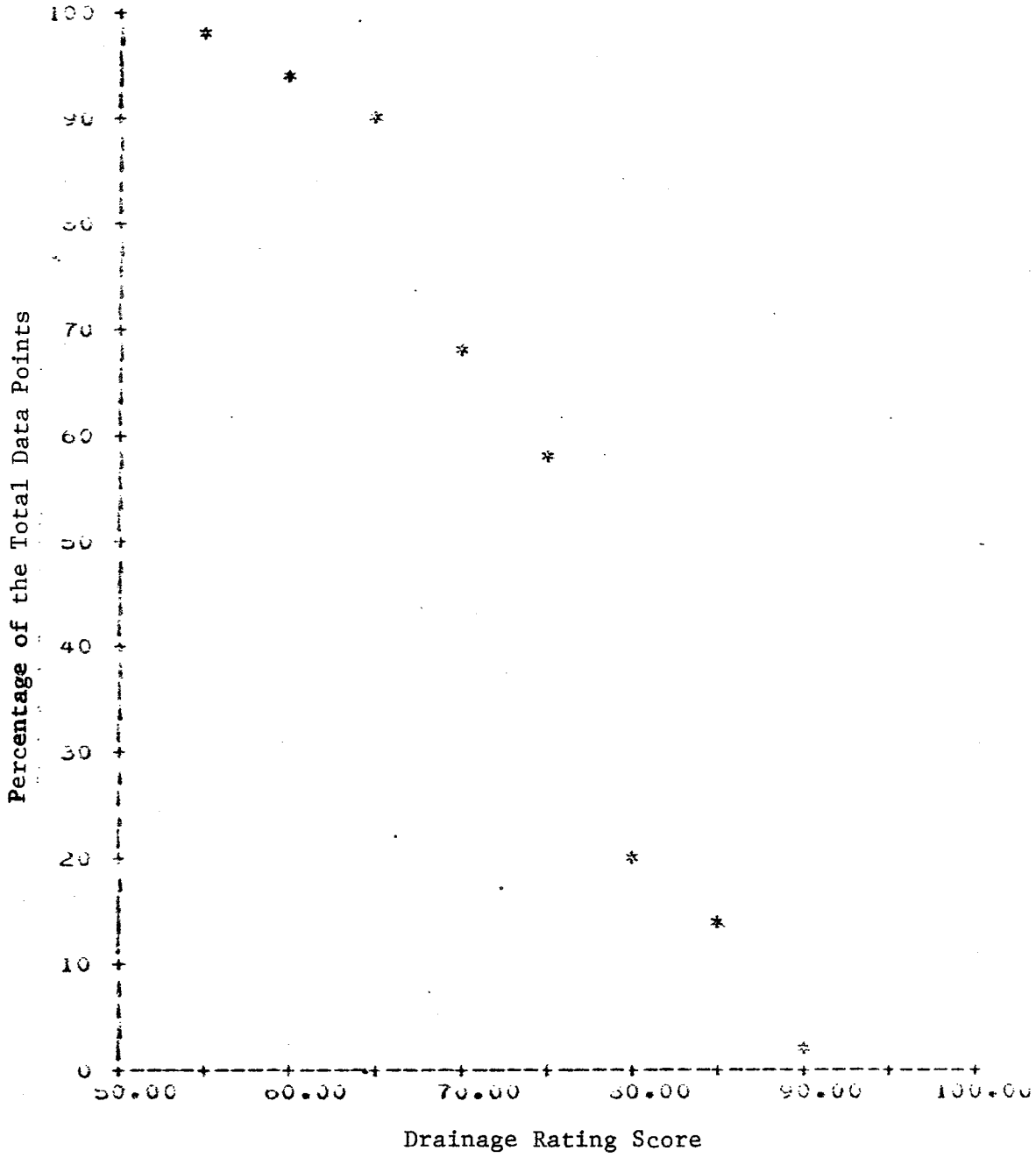

Figure 58. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

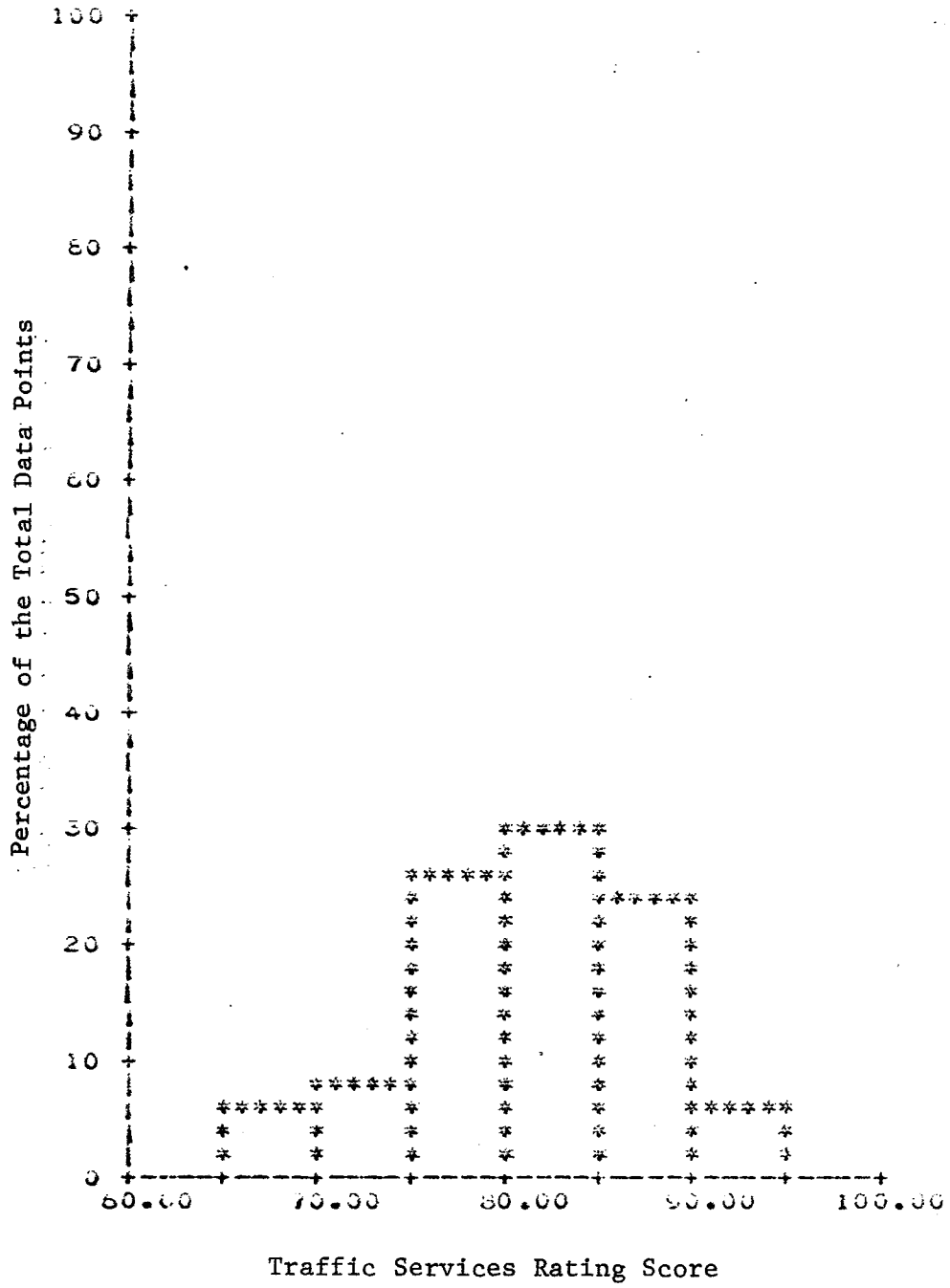

Figure 59. Traffic Services Rating Score Histogram for Statewide Random Sections - F.M. Highways (1974).

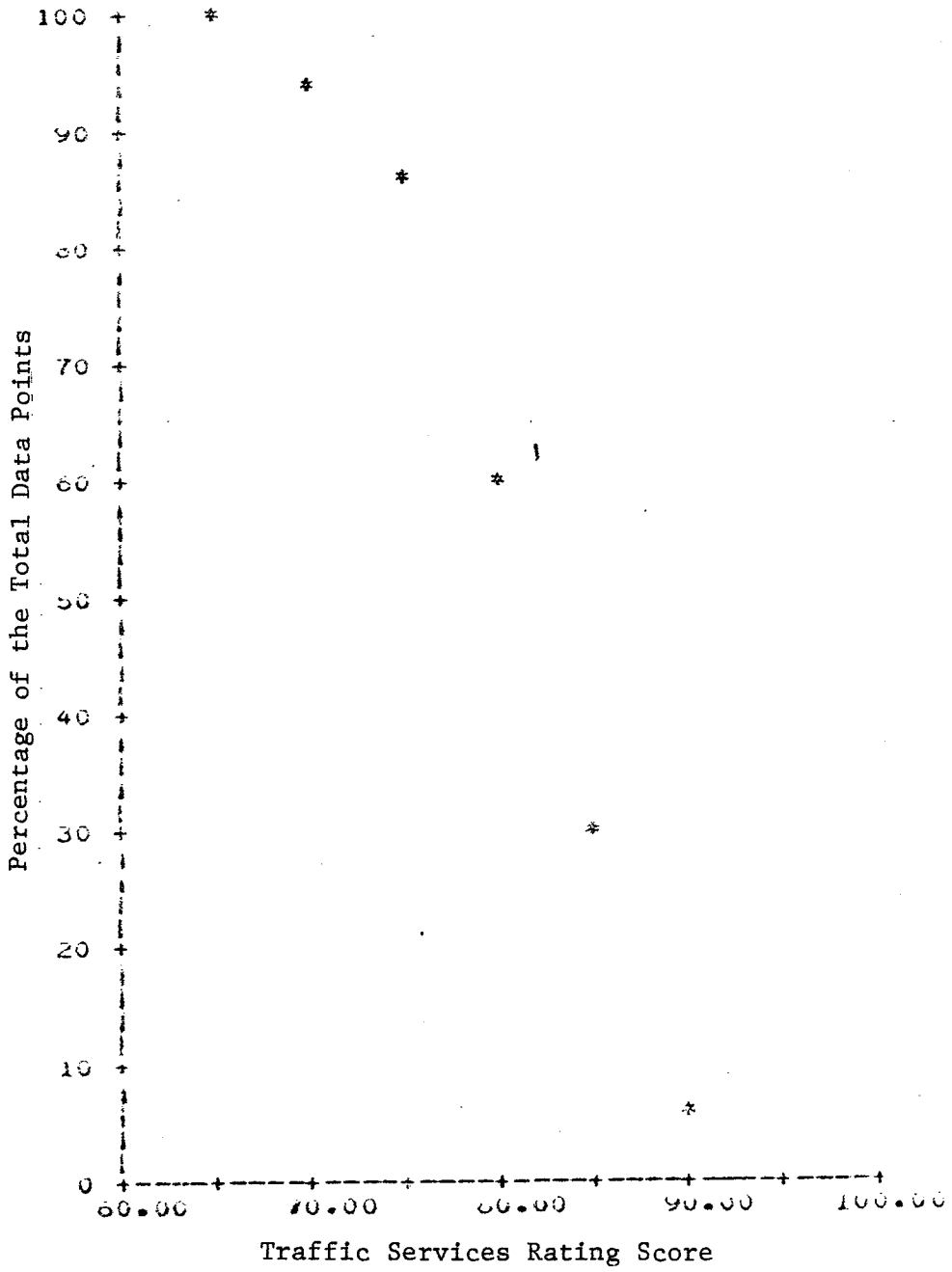

Figure 60. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - F.M. Highways (1974).

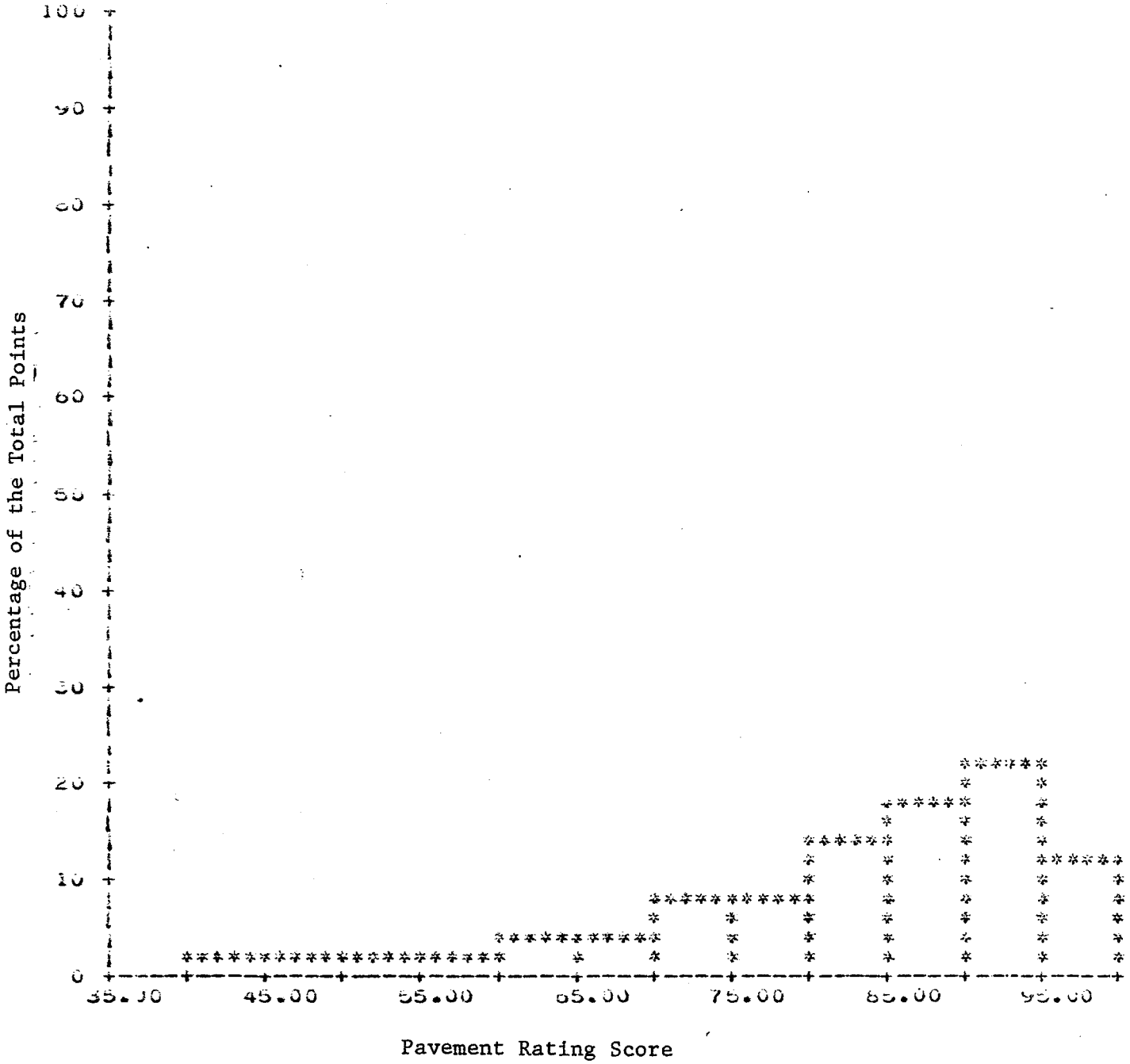

Figure 61. Pavement Rating Score (Without MRM Deductions) Histogram for Statewide Random Sections - Combined Highways (1974).

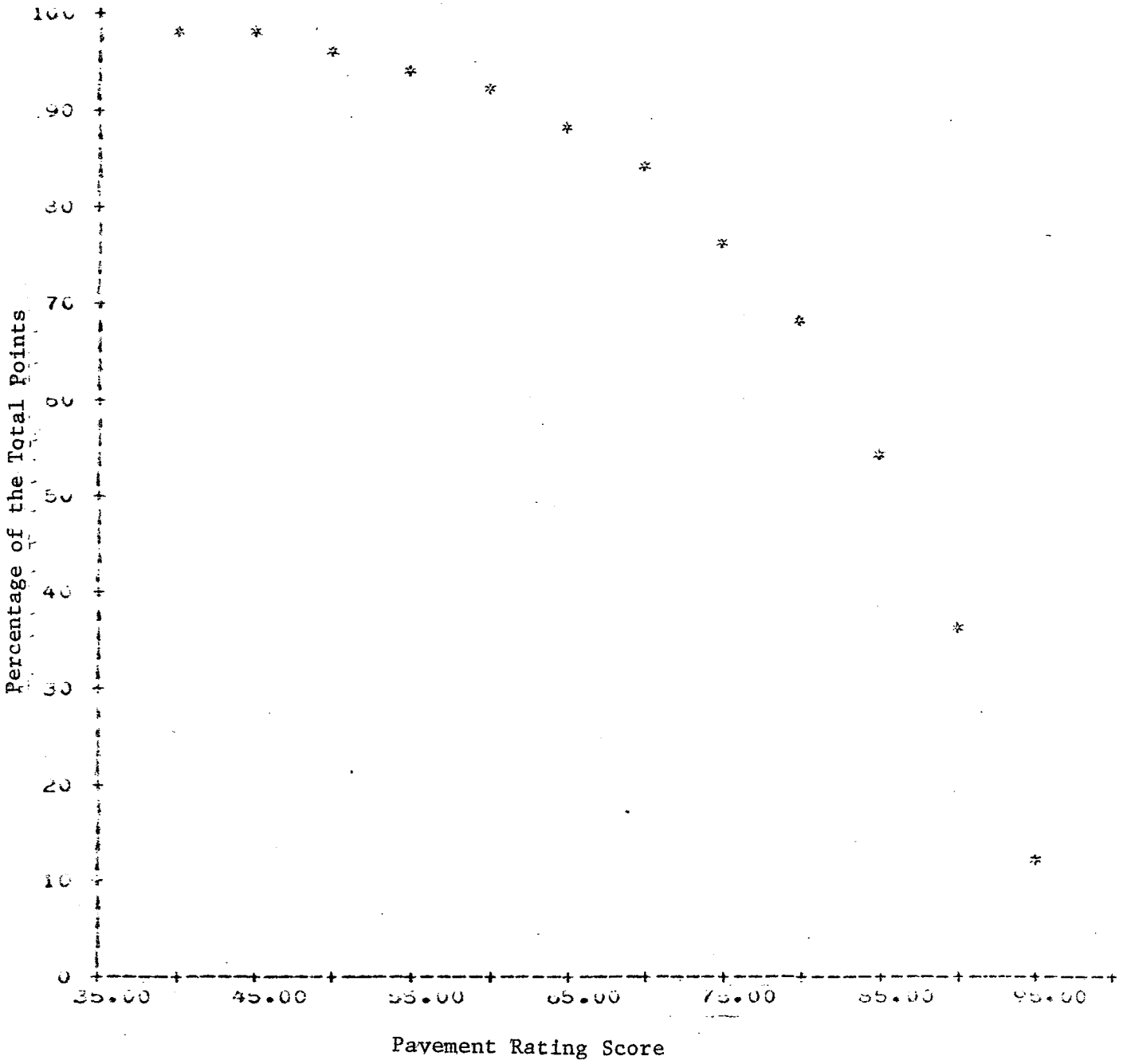

Figure 62. Pavement Rating Score (Without MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

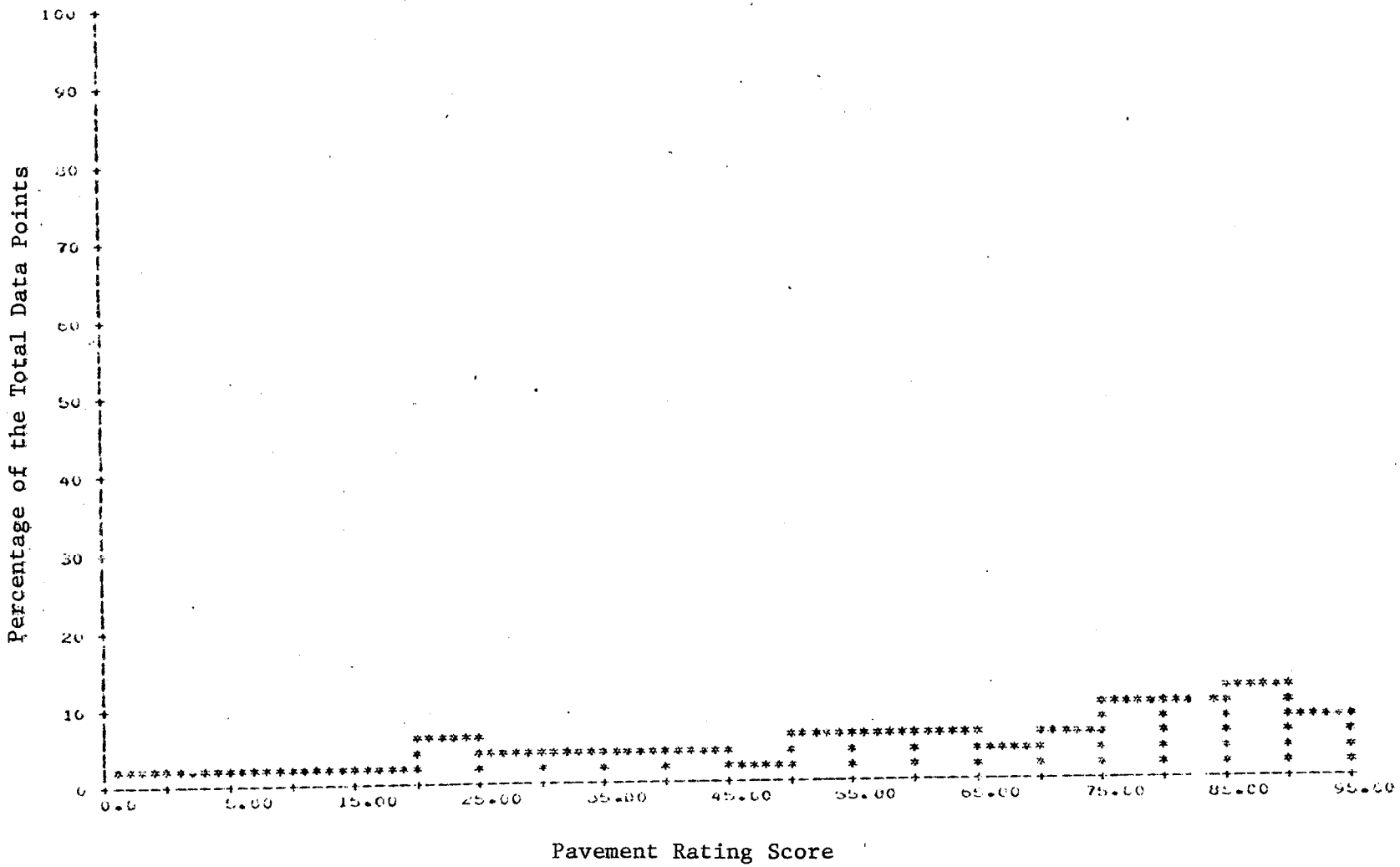

Figure 63. Pavement Rating Score (With MRM Deductions) Histogram for Statewide Random Sections - Combined Highways (1974).

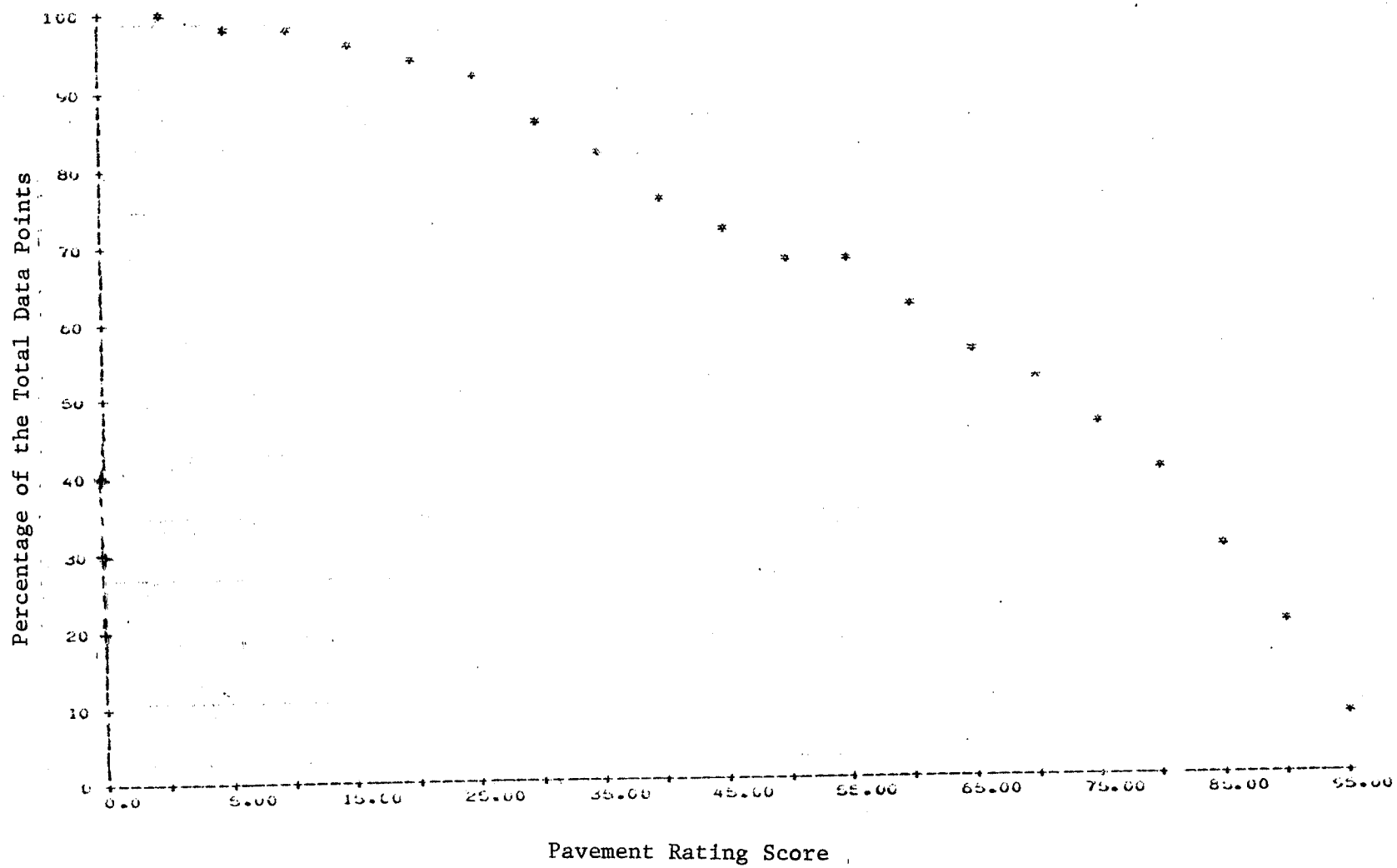

Figure 64. Pavement Rating Score (With MRM Deductions) Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

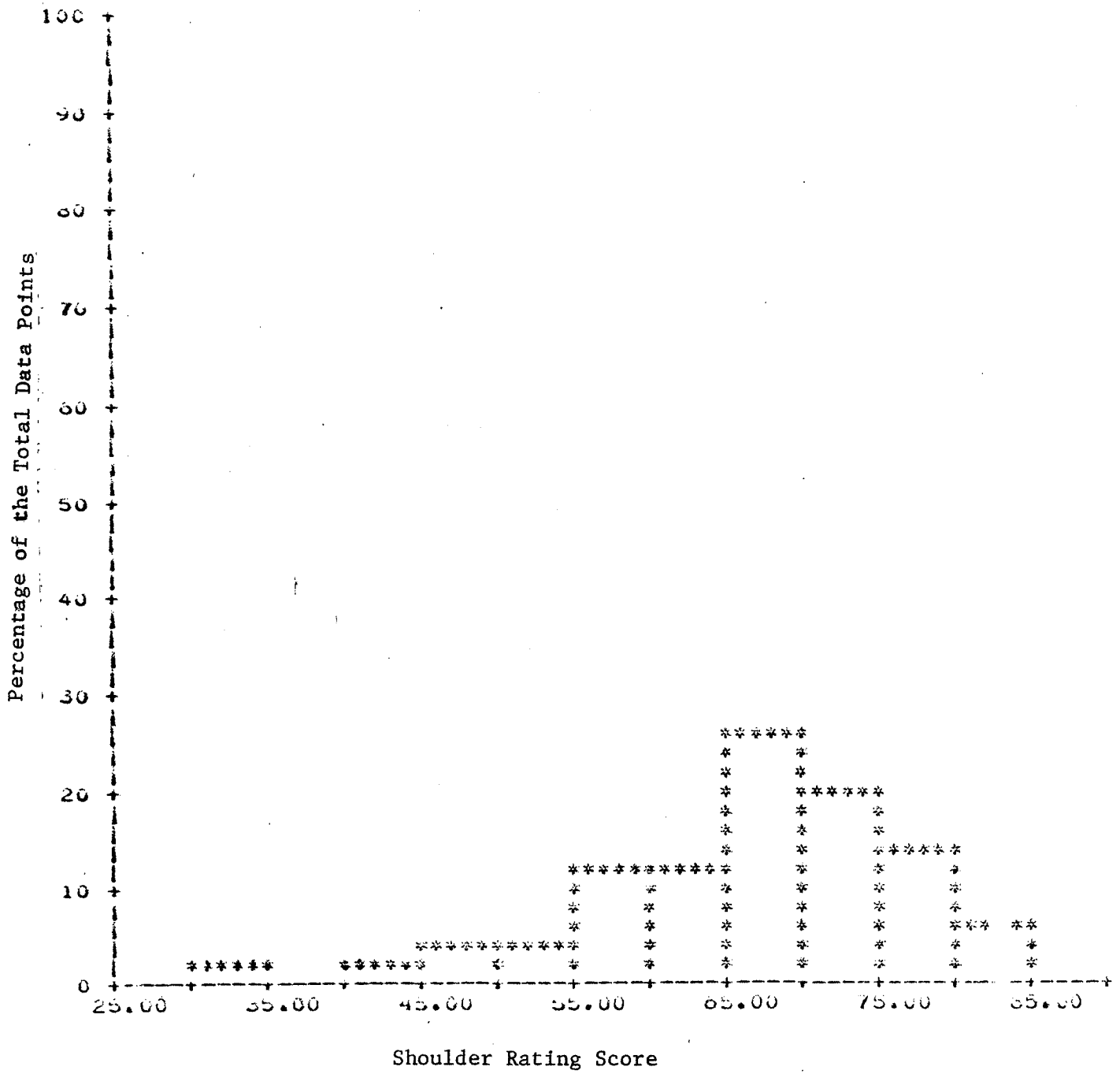

Figure 65. Shoulder Rating Score Histogram for Statewide Random Sections - Combined Highways (1974).

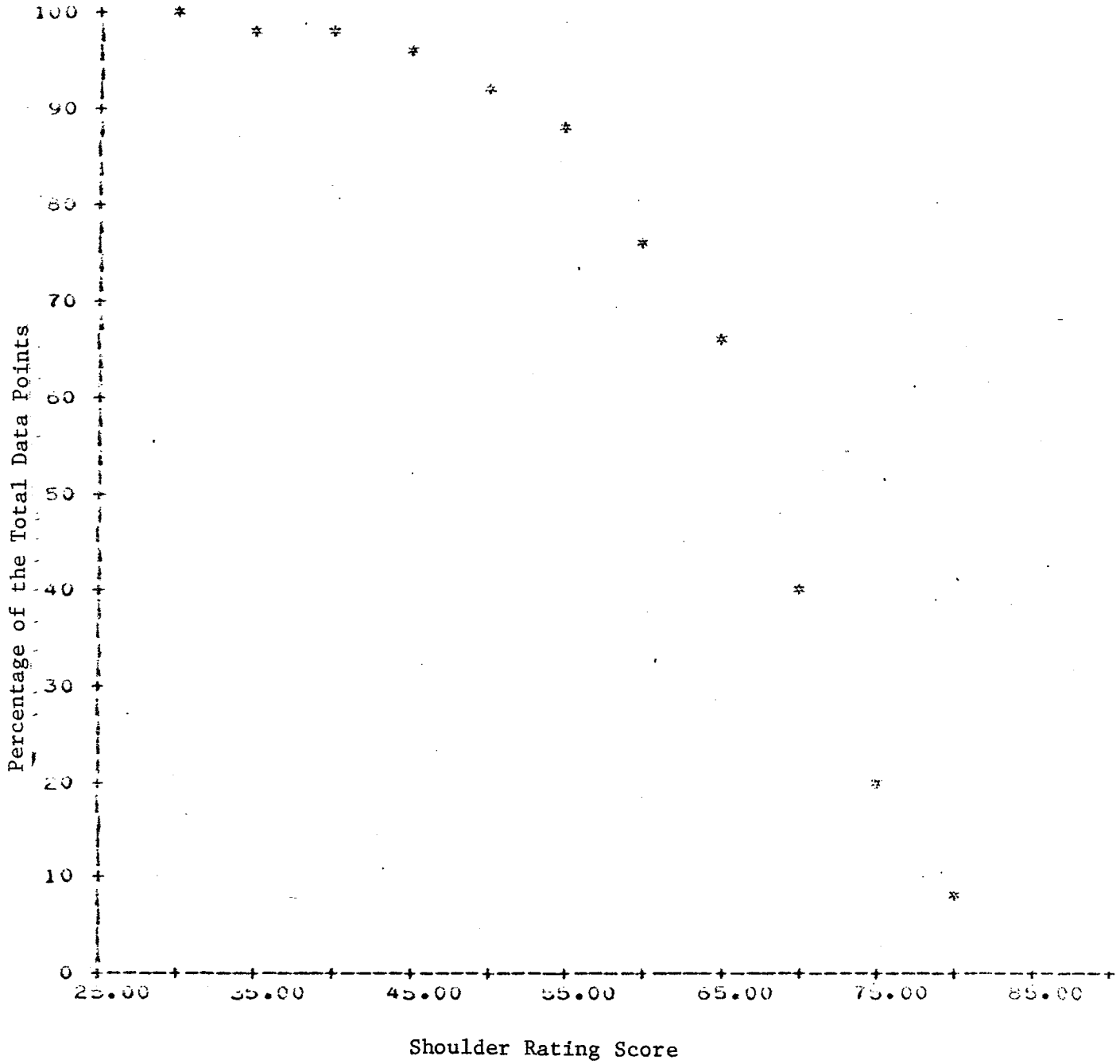

Figure 66. Shoulder Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

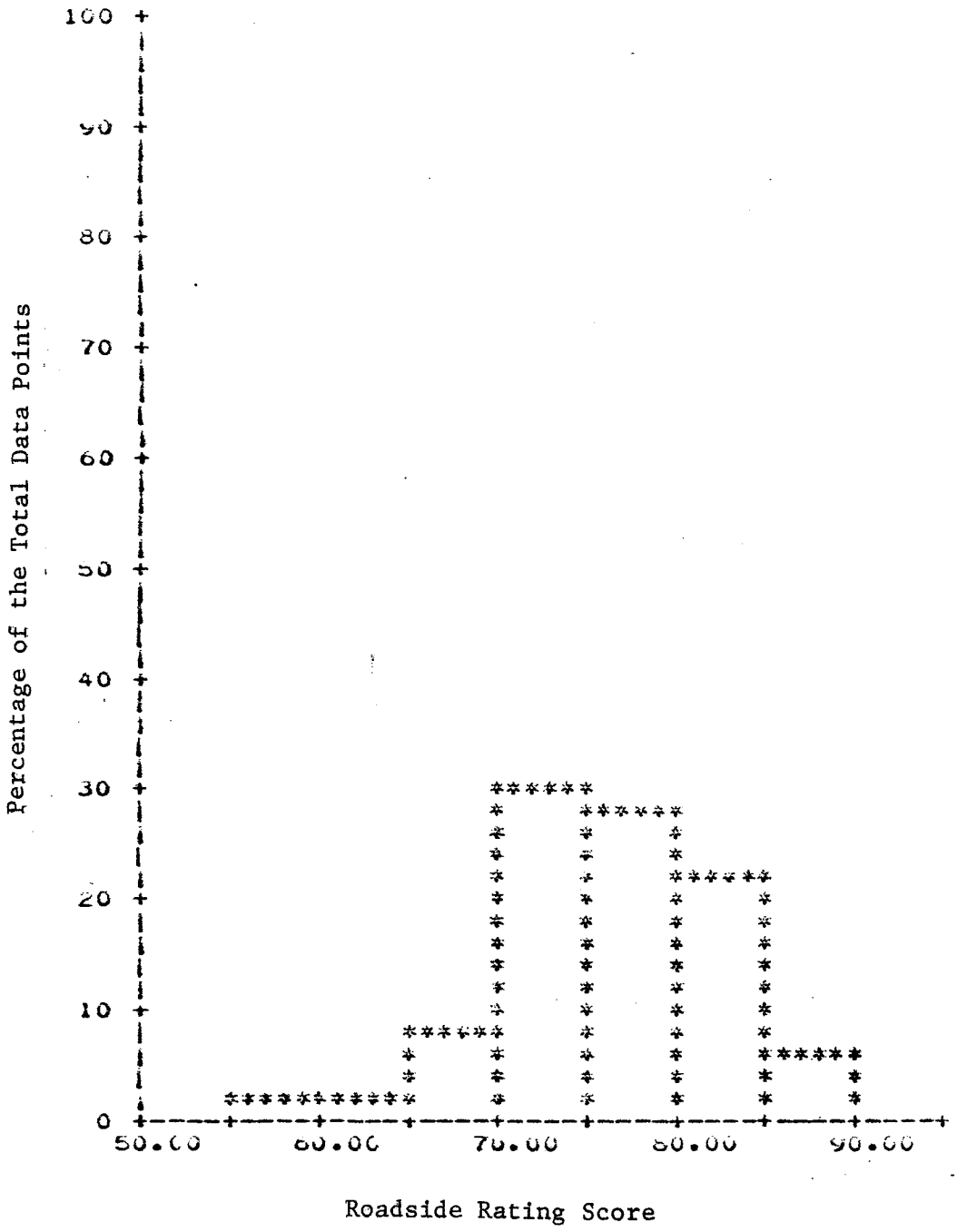

Figure 67. Roadside Rating Score Histogram for Statewide Random Sections - Combined Highways (1974).

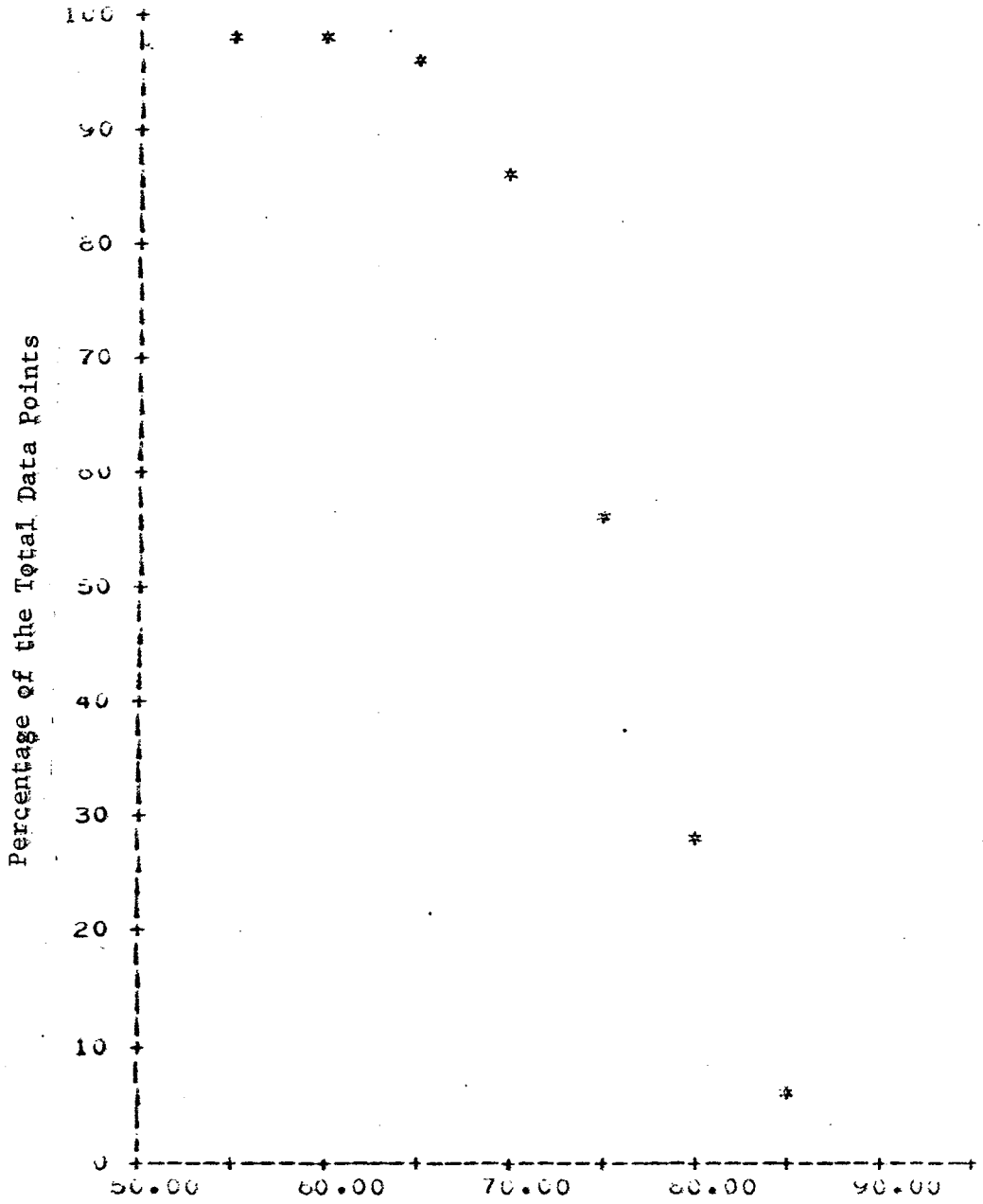

Figure 68. Roadside Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

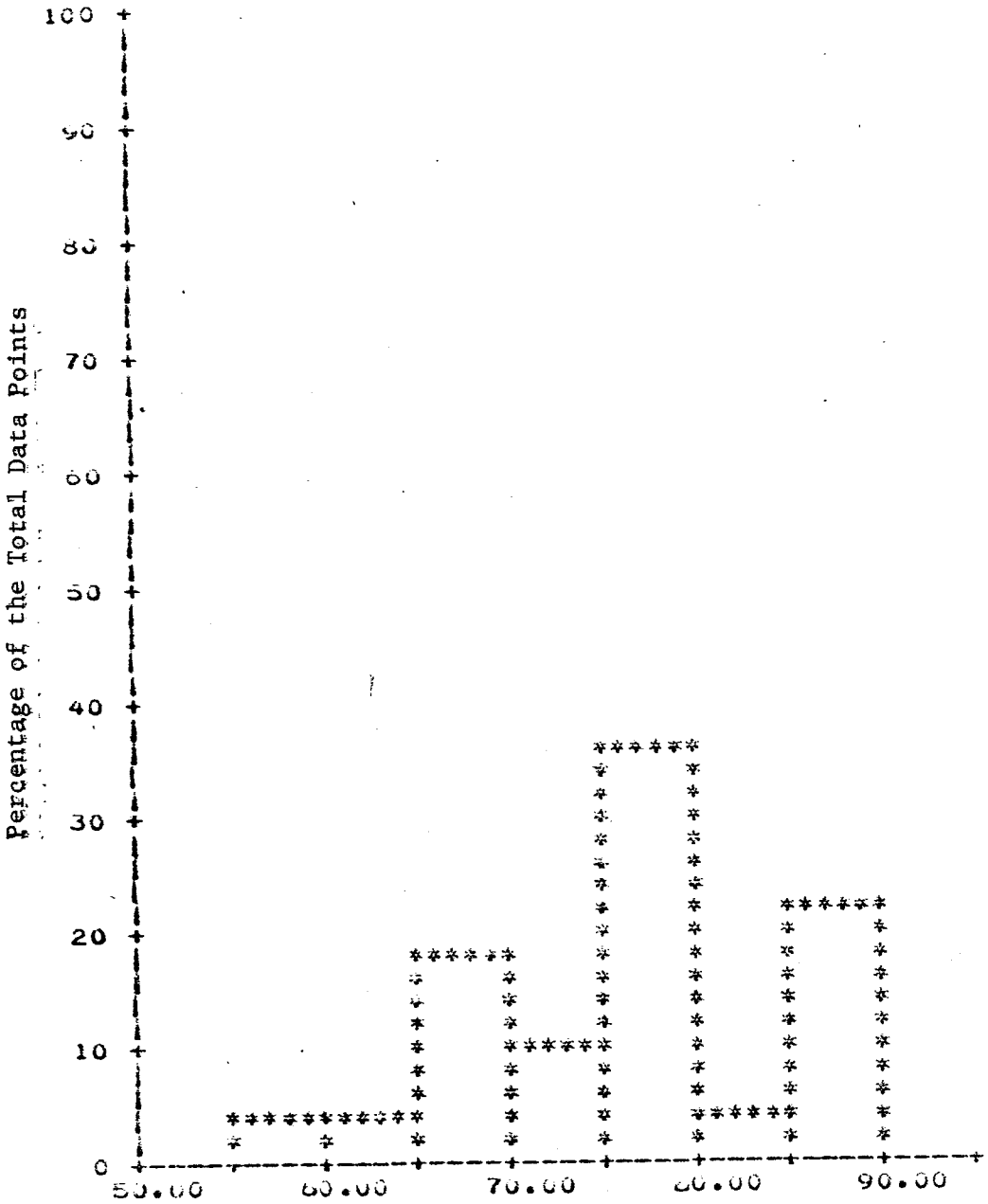

Figure 69. Drainage Rating Score Histogram for Statewide Random Sections - Combined Highways (1974).

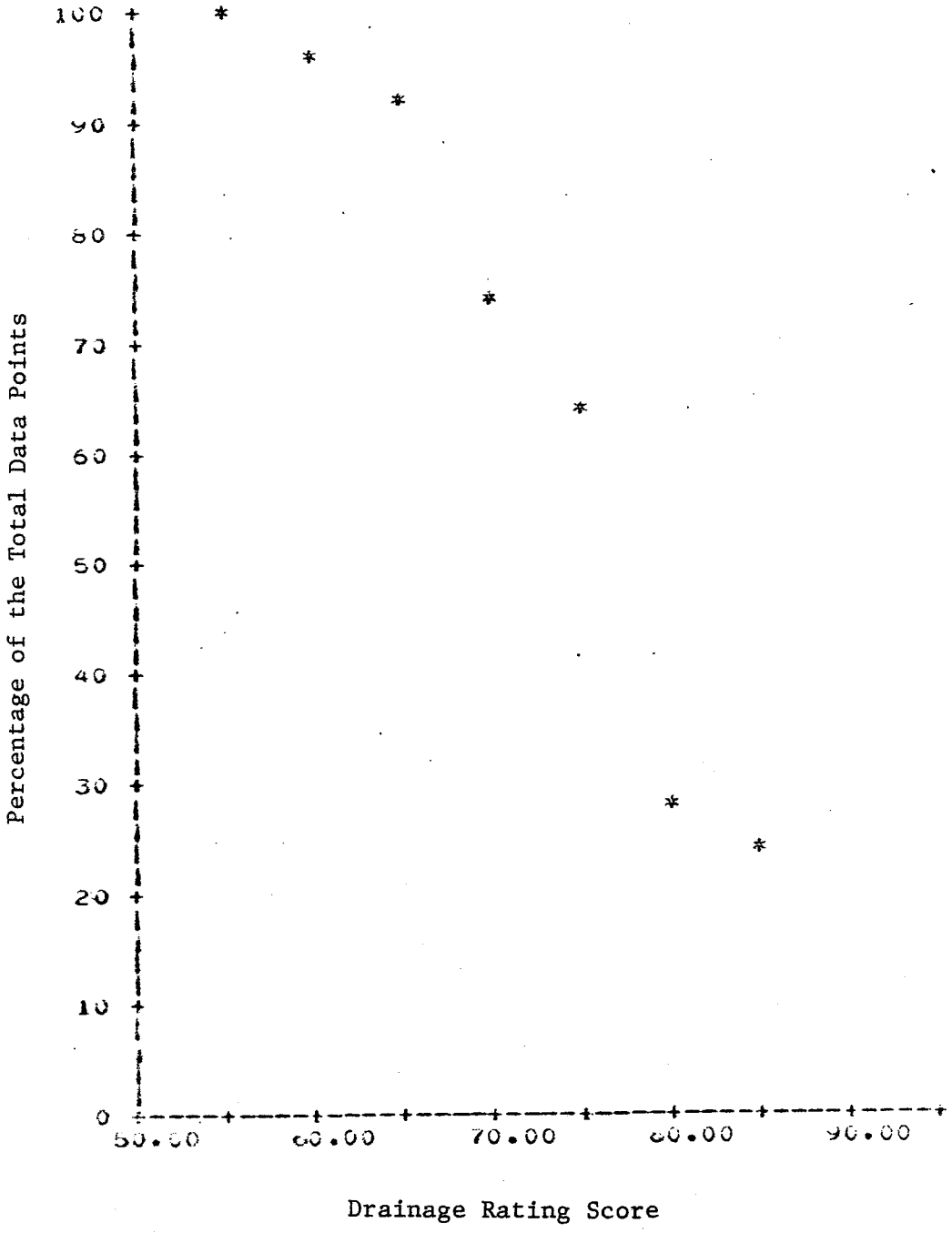

Figure 70. Drainage Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

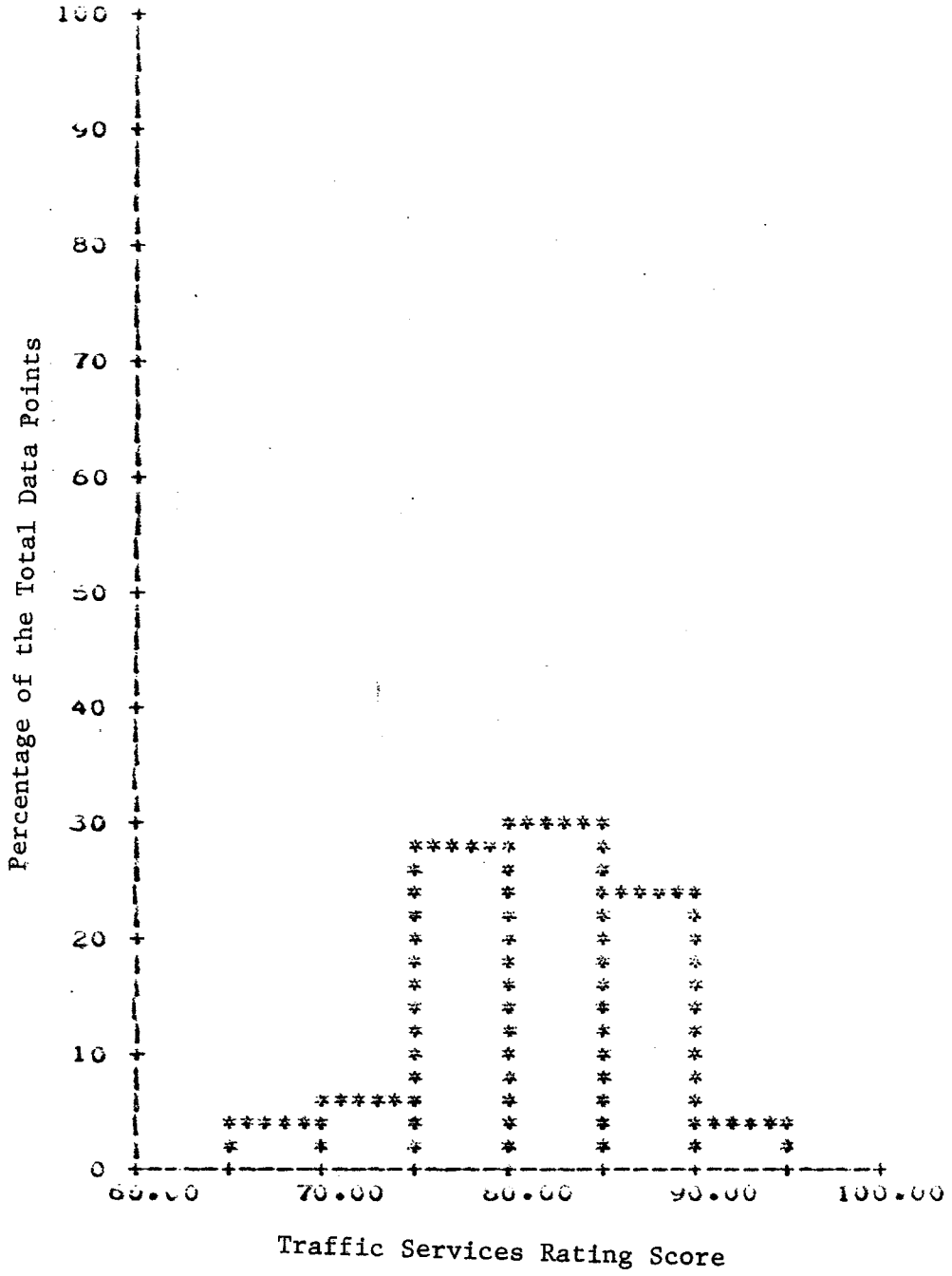

Figure 71. Traffic Services Rating Score Histogram for Statewide Random Sections - Combined Highways (1974).

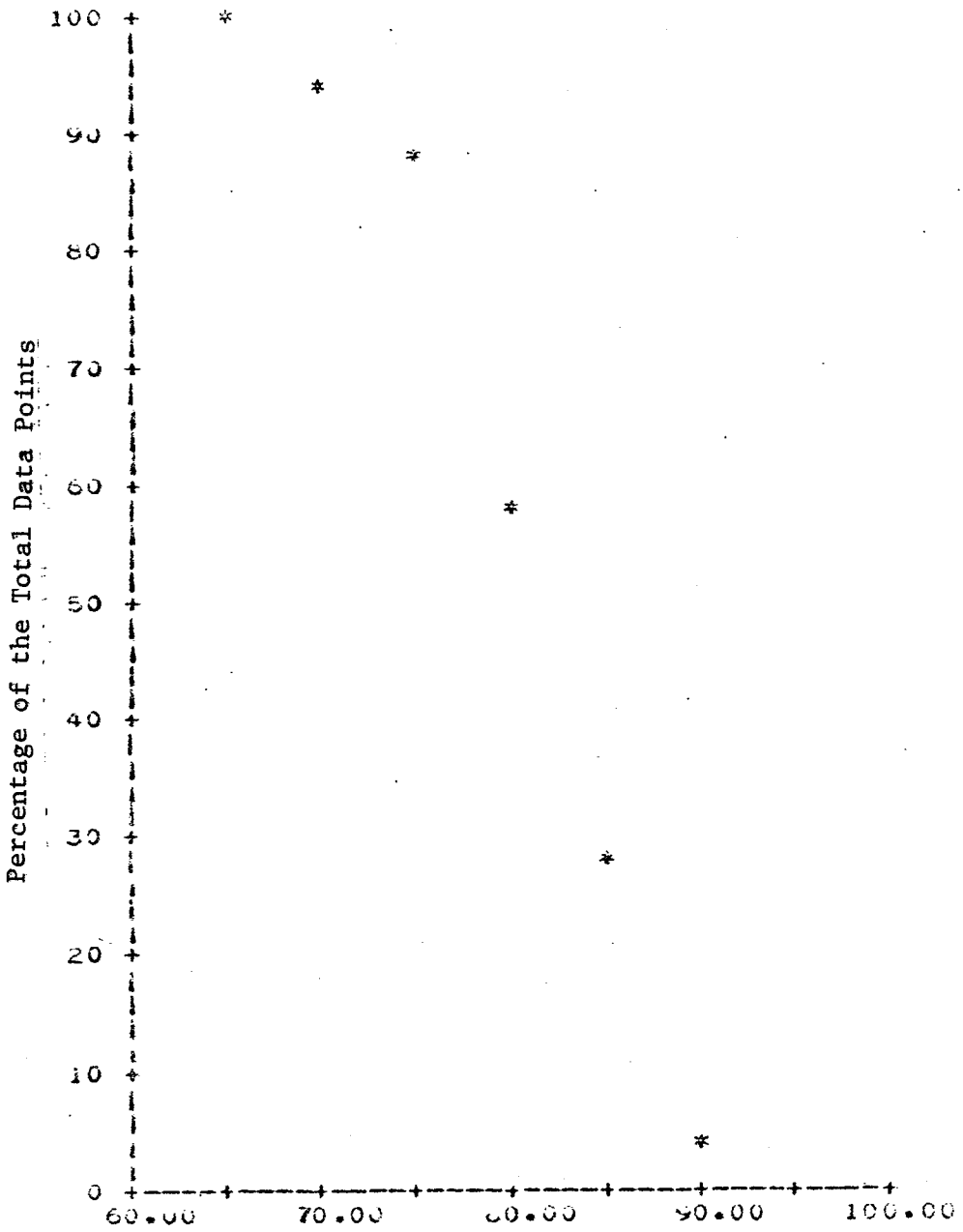

Figure 72. Traffic Services Rating Score Percentage Cumulative Distribution for Statewide Random Sections - Combined Highways (1974).

CONCLUSIONS

By establishing and maintaining close contact among the researchers and central office and operational personnel of the Texas State Department of Highways and Public Transportation, key elements of a maintenance management system have been developed. The specific items developed include the following:

1. Maintenance Performance Standards,
2. Cost Codes and Maintenance Methods,
3. Maintenance Rating System and
4. Data Reduction and Data Summary Programs.

The maintenance performance standards were developed to outline maintenance methods for use by the State Department of Highways and Public Transportation. These methods specifically include the conditions for which a maintenance method should be used along with cost, production, quality and scheduling information.

The cost codes provide for cost accounting of the maintenance performed. These cost codes are separated into seven maintenance categories as follows: base and subgrades, surfaces, shoulders and approaches, roadside maintenance, structures over 20 feet, traffic services and extraordinary maintenance. Additional subgroups are used in each of the seven major groupings as required to define each maintenance operation.

In conjunction with the maintenance methods and cost codes, the maintenance rating system was developed to provide specific information about the roadway. This system can be used to define the present condition of the road, assist in determining maintenance needs, establish main-

tenance priorities and identify maintenance activities which provide the greatest return. The primary benefits of the rating system are rating scores for the pavement, shoulder, roadside, drainage facilities and traffic services.

Computer programs have been written to treat the maintenance rating system information. This information and other types of pavement data such as skid numbers, Dynaflect deflections, etc., can be analyzed and summarized for mass inventory surveys such as those accomplished in District 21. Additionally, three budget programs were developed to illustrate the usefulness of maintenance rating system information for budget preparation purposes.

Literature reviewed as part of studies sponsored by the Texas State Department of Highways and Public Transportation, Federal Highway Administration and the National Cooperative Research Program have been instrumental in the development of the management tools employed in this study. It has been the intent of the research project to furnish flexible management tools capable of satisfying a large number of needs while being capable of accepting change as necessary.

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A P P E N D I C E S

APPENDIX A

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 20,601,000 residents of California operate 13,413,000 motor vehicles on 164,136 miles of highways of which 16,105 miles are under state control. The state occupies 158,693 square miles from an elevation of -282 feet below sea level to 14,494 feet above sea level. Mean minimum and maximum temperatures are 8 and 116°F with average annual moisture ranging from 4 to 96 inches.

The California Department of Transportation has a $153,000,000 maintenance budget for 1975. This budget will be used by its 11 districts to maintain 45,000 lane miles of highways (16,000 center line miles).

Eleven districts comprise the California Department of Transportation. Each district is divided into from 4 to 12 territories which are managed by superintendents. Maintenance supervisors are in responsible charge of individual crew operations and report to the superintendents. Superintendents report to the district maintenance engineers. In the smaller districts, the maintenance engineer will report to the District Director of Transportation while in the larger districts the district maintenance engineer may report to the district Deputy Director of Operations and Maintenance.

The administration of the maintenance program by the Department of Transportation, Division of Maintenance and Operations is performed at the central office level by the Office of Maintenance.

The basic maintenance recording and reporting system was developed in 1971. A parallel recording system (Maintenance and Accounting) is being utilized although an effort is being made to develop a single recording system. A manual recording system is utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

California State Department of Transportation Form DMO-M-83, "Maintenance Daily Report" is utilized to collect maintenance work method information (Figure A-1). The type of information obtained on this form includes;

1. Work method or activity performed
2. Location of work performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization (indirectly) and
6. Accomplishments (Production)

Details are presented below.

Location

Each maintenance work method is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A two digit number is utilized to designate the district.

2. Superintendent Territory. Superintendents are responsible for specific areas of the district. The designation "maintenance

section" is often utilized by other states to identify a similar area of responsibility. Three character numeric codes are utilized to identify the supervisor's section within the Superintendent's Territory.

3. Supervisor Crew. A three character numeric code as described above is utilized to describe this basic cost center. This designation is entered under unit on Form DMO-M-83.

4. County and Route. The county and highway route are designated by a 5 character numeric code. This code consists of a two number county designation and a three number route code.

5. Post Mile. Reporting of post mile or mile posts which is the district's prerogative is utilized to specifically pinpoint where certain maintenance activities were performed on the roadway. The post mile is reported to the nearest 0.1 mile. Approximately one-half of all districts currently report work method performance by the post mile.

Information is not recorded which indicates in what lane the maintenance work method was performed. Designation of the maintenance function or work method indicates if the maintenance action was performed on the pavement, shoulder or side approach, roadside, etc.

Work Method

Maintenance work methods are defined by a maintenance numbering system. The numbering or coding system is a 5 character numeric code used to designate the program, sub-program, and standard method as shown in the example below:

07 - 022

07 - program (signs)

02 - sub-program (sign maintenance)

2 - standard method (clean signs on two posts or poles)

Approximately 470 program - methods have been defined in California. Performance Standards and Scheduling Values for approximately 185 methods have been developed. These work methods have been grouped into 19 programs as shown below:

1. Roadbed, Flexible
2. Roadbed, Rigid
3. Roadside Maintenance
4. Roadway Litter and Debris
5. Vegetation Control
6. Pavement Delineation
7. Signs
8. Electrical
9. Traffic Safety Devices
10. Snow Removal and Ice Control
11. Roadside Rests
12. Landscape Maintenance
13. Bridge and Pump Maintenance
14. Tube, Tunnel, and Public Service Facility Maintenance
15. Permits
16. Operations
17. Administration and Auxiliary Services
18. Major Damage and Disaster Maintenance
19. Work for Others

It should be noted that there are different programs for the maintenance of portland cement concrete pavements and for snow and ice control.

Specific support activities are related to the maintenance work by the addition of a two digit code. Examples of these activities are;

1. travel
2. haul
3. flagging
4. other traffic control
5. delays
6. special equipment preparation
7. additional operated equipment

An example of these codes are shown on Figure A-2 for roadside maintenance activities.

Manpower

Manpower utilization for a particular function is recorded. Labor, equipment and accomplishments are reported by the supervisor for the entire crew.

In recording the labor utilized, three types of entries are made: the total number of man hours actually spent on performing the maintenance activity; the number of work hours spent on support activities such as delays, travel, haul, flagging other traffic control, etc.; and the number of hours required for supervision and administration. Work expended is reported to the nearest 1/2 hour.

Time for vacation, military leave, etc. for the entire crew is obtained from Form HM85 (Figure A-3). A Form HM85 is filled out for the supervisor's crew and is the basic accounting and payroll form. The supervisor is responsible for summerizing vacation time, etc. for his entire crew on Form DMO-M-83.

Form DMO-M-83 is so arranged that five maintenance work methods can be reported on a single form, complete with a designation for manpower and equipment utilization. Total crew hours are summed on this form for a given day.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by a unique equipment number. Equipment use is charged out daily by the hour or by the mile, depending on the type of equipment utilized. Sedans, station wagons and 1/2 ton pickup usage is reported in miles. All other items of equipment are reported in hours of actual usage. For example, if a piece of equipment is at the job site and idle, such as a travel vehicle or a standby vehicle, it is not reported as used for the idle period. Any vehicle with accumulated usage of less than one hour for the day will report one hour of usage. Equipment usage is reported to the nearest one hour.

Downtime either while the equipment is in the shop or field is reported. Downtime is defined as the hours a piece of equipment is unavailable because it is out of service during the working hours of the work day.

Materials

Materials utilized for a particular function are not recorded on the DMO-M-83 but in some cases maybe obtained from the productivity entry. The productivity entry reports the amount of material utilized, in tons, cubic yards, lineal feet, etc. for a particular maintenance work method. Stockpile number, inventory quantities, etc. are a part of a materials management system.

Accomplishments

Accomplishments in terms of productivity units are recorded for certain maintenance work performed. For example, tons or cubic yards of material placed are reported. Productivity for work methods such as inspection of drainage structures, etc., is accounted for in terms of man-hours.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance Daily Report Form DMO-M-83 is filled out daily by the maintenance supervisor for his crew. This information is sent to the superintendent's office generally weekly for approval and checking. The information on the daily forms is key punched monthly at the district office and transmitted through the remote computer terminal to the central office monthly. Reports are returned to the supervisors, superintendents, district maintenance engineers, etc. about 10 to 15 days after the end of the month.

It is estimated that about four-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. The crew supervisors each require about one-half hour per day to complete the Maintenance Daily Report.

REPORTS

Several maintenance management reports are produced from the collected data. A brief discussion is presented below indicating the types of data contained on these reports:

Comparison Reports. The superintendent comparison report (Figure A-4) presents a performance summary of all work performed under the direction of a superintendent in his area of authority. Data is given for the reporting month and the year to date totals.

Data are sorted by the maintenance program, sub-program and method as previously described for each supervisor under the jurisdiction of the superintendent. Comparison information is presented for the state as a whole, for the district within which the superintendent works and for each supervisor. Information reported includes the following:

1. Completed production in terms of a work method unit of measurement (tons, cubic yards, lineal feet).

2. Production in terms of hours of labor worked performing the maintenance work method.

3. Support in terms of hours of labor worked performing support activities such as travel, haul, flagging, etc.

4. Percent support or the work hours devoted to support activities divided by the work hours devoted to production.

5. Realization or the maintenance performance standard (for example man hours per ton of material placed) divided by the actual performance rate for the maintenance activity.

6. Planned production for the maintenance activity to the reporting data.

7. Crew labor cost per productive unit.

The District comparison report (Figure A-5) displays the same information as the superintendent's comparison report except information is presented by maintenance work method to compare state wide totals, district totals and superintendent totals.

State wide comparison reports are also available using the same reporting format.

Expenditure Analysis Report. Expenditures analysis report includes salary and equipment unit cost per production unit of each

work method performed. This report is being utilized to determine the most economical method to perform a work method. Data displayed on these reports by maintenance method include;

1. Man-years of labor expended for the year to date.

2. Dollars expended for the year to date for salaries (labor), equipment, materials and other items together with the total expenditures.

3. Year to date production and the units for measuring production.

4. Cost for salaries and equipment per unit of production, i.e. dollars per ton.

5. Dollar expenditures for the reported month.

Reports are prepared to provide comparison for the superintendent among the supervisors, for the district among the superintendents and for the state among the districts. Thus, the same sequence of Expenditure Analysis reports are available as is the case with the comparison reports. An example of an expenditure analysis report is shown as Figure A-6.

Information to produce this report must come from both the Maintenance Daily Report and accounting input documents.

Budget Status Reports. Budget status reports present both man-year expenditures and dollar expenditures by maintenance programs such as flexible roadbed maintenance, rigid roadbed maintenance, roadside maintenance, etc. Dollar expenditures are reported for three categories - expenditures by state forces, by city forces charged to the state, and contract maintenance charged to the state. Both expended and planned man-years are reported. Dollar expenditures and man-years are reported in the following format:

1. Reporting month
2. Year to date
3. Target year totals
4. Target adjustments
5. Percent expended fiscal year to date
6. Percent expended for the last fiscal year on a year to date basis
7. Percent expended for the last 4 fiscal years on a year to date basis.

This reporting format is utilized for both district summaries and state wide summaries. An example of a district summary is shown in Figure A-7.

Equipment utilization reports have been recently revised and are produced on a monthly basis. An annual program work plan is developed based on information coded by the supervisor and reports are generated to showing yearly planned programs by the month. This data is used to develop monthly scheduling reports. Examples of these are shown as Figures A-8, A-9, A-10, and A-11.

It should be noted that on the DMO-M-83 "Maintenance Daily Report" man hours are reported for the entire working crew. These hours are transferred to dollar values as shown on the Expenditure Analysis Report and Budget Status Report by use of an average cost per hour for the crew. Man-years planned for work methods are prepared by field personnel on a yearly basis after the quality of service level has been determined. These man-years can be altered during the year.

The various reports are produced monthly with year to date totals. Reports as discussed above are utilized by the district maintenance

engineer, the superintendent, the supervisor as well as central office personnal.

Reports are used for fiscal control, by reviewing expenditures and comparing expended and planned man-year totals; for monitoring of program execution by comparing planned and expended man year totals; for allocation of manpower by reviewing the realization figures and cost per unit of productivity; and for budget preparation as a check to determine productivity figures to be utilized in calculating the budget.

Presently maintenance program work that appear to be contrary to planned budgets due to productivity problems and/or prior planning must be located by a review. Exception reports are presently not a part of the reporting system.

OTHER ITEMS

The California Department of Transportation is satisfied with the reliability of the existing system. A manual of instructions has been prepared and are utilized by supervisors to accurately fill out the Maintenance Daily Report. Maintenance management seminars are held annually to discuss the system and improve the reporting accuracy. Spot checks are made on data reported by supervisors.

As pointed out previously data are recorded in the field by the supervisor rather than the individual maintenance employee. It is believed that this approach improves the reliability of the information.

The recording and reporting system can be altered by the direction of the central office maintenance staff as the need arises. Changes usually originate in the field and after field study the needed change can be made. The central office continually works with

the districts through meetings and visitations. Data processing changes do not appear to be a bottleneck as data processing personnel are on the maintenance staff.

Data collected are stored on tape for about a 5-year period. Four year average costs and man-year requirements for maintenance work methods are calculated annually.

References

1. "General Reporting Instructions," California Department of Transportation, Division of Highways.

2. "Maintenance Management System," California Department of Transportation, Office of Maintenance, Planning Section, December, 1975.

Figure A-1. Maintenance Daily Report

California State Department of Transportation

MAINTENANCE DAILY REPORT

PAGE ___ OF ___

SUPERVISOR'S SIGNATURE

1 MO. DAY YR.	2 CREW RATE	3 DIST. UNIT	TRANSFERRED FROM REPORT HM85: 4 CASH OT	5 CTO EARNED	6 VAC	7A SELF	7B FAMILY	8 CTO TAKEN	9A MIL.LEAVE	9B JURY/WIT.	10
											A

	I	II	III	IV	V
PROGRAM – METHOD	11	11	11	11	11
COUNTY – ROUTE	12	12	12	12	12
FROM P.M. TO P.M.	13	13	13	13	13
CHARGE DISTRICT UNIT	14	14	14	14	14
EXPENDITURE AUTH.	15	15	15	15	15
SPECIAL DESIGNATION	16	16	16	16	16
	17B	17B	17B	17B	17B
PRODUCTION UNIT – DESC.	18	18	18	18	18
ACCTG. ACTIVITY–MAN HRS.	19 20	19 20	19 20	19 20	19 20
SUPRV. & ADMIN. (001) HRS	21	21	21	21	21

SUPPORT ACTIVITIES	22	CODE 23	PROD. 24	MAN-HOURS 25
DELAYS (EA. OCC.) *	C	1 1		
TRAVEL (MAN MILES)	C	2 1		
HAUL (MAN MILES)	C	2 2		
FLAGGING (NO. OF MEN)	C	3 1		
OTHER TRAFFIC CONTROL	C	3 2	—	
SPEC. EQUIP. PREP (EA.OCC)	C	7 5		
ADDITIONAL EQUIP. (NO.)	C	8 1		
*(EXPLAIN IN REMARKS)	TOTAL HOURS			

(Columns 22–25 repeated for each of sections I, II, III, IV and V.)

TOTAL CREW HOURS

EQUIPMENT USAGE HRS. 26	ITEM 27	CHC 28	DOWN TIME FIELD 29	DOWN TIME SHOP 30	I USE 31	II USE 31	III USE 31	IV USE 31	V USE 31
D									
D									
D									
D									
D									
D									
D									
D									
D									
D									
D									
D									
D									

REMARKS:

WEATHER:

FORM DMO-M-83 (REV. 7/75)

Figure A-2.

03 PROGRAM (ROADSIDE MAINTENANCE)

		Std or Sch Val.* (Man Hrs.)	/ Unit
03-010	ROADSIDE PATROL Report pumping water off road or storm patrol with graders to this number. Report man miles if appropriate.		Man Miles
-011	RAIN AND WIND PATROL Patrolling of highways during or shortly after storms to check function of drainage facilities, or other potential hazards. Also includes placing and picking up warning devices and cleaning debris from drains or roadway.	.090*	Man Miles
-012	ROCK AND SAND PATROL Patrolling for and blading or removing fallen rock or drifted sand from travel way. Includes warning device control.	.066	Man Miles
03-020	DRAINAGE STRUCTURE CLEANING Cleaning dirt, silt, rock or debris from horizontal drains, underdrains, or slotted drains included in this number. Also report any drainage cleaning with fully operated rented equipment to this number. Also includes flushing down drains.		Each
-021	CULVERT OR OVERSIDE DRAIN OPENINGS - HAND TOOLS Includes cleaning up to 10 Lin. Ft. of adjacent ditch. Count only openings cleaned, do not count openings inspected but not cleaned.	250*	Each Opn
-022	CULVERT OR OVERSIDE DRAIN OPENINGS - MECHANICAL Cleaning ends with loader or backhoe. Includes cleaning up to 30 Lin. Ft. of adjacent ditch. Count only openings cleaned, do not count openings inspected but not cleaned.	750*	Each Opn
03-030	CLEAN DROP INLETS Includes cleaning drop inlets with fully operated rented equipment, or flushing drop inlets.		Cu Yd

Figure A-2. (Continued)

03 PROGRAM (ROADSIDE MAINTENANCE)

		Std. or Sch. Val.* (Man Hrs.)	/	Unit
03-031	CLEAN DROP INLETS - HAND TOOLS Cleaning drop inlets using various types of hand tools.	1.50*		Cu Yd
-032	CLEAN DROP INLETS - MECHANICAL Cleaning drop inlets using mechanical equipment, such as vacuum type.	1.00*		Cu Yd
03-040	SHOULDER GRADING When grading large areas over 20 Ft. wide, which are generally used for parking, report to this number.			Sho Mi
-041	GRADE SHOULDERS Includes shoulder surface grading or shaping and drop-off repair using existing roadside material. Area graded should be less than 20 Ft. wide.	2.00		Sho Mi
03-050	SHOULDER DROP-OFF REPAIR Report shoulder drop-off repair using a shoulder box and imported material to this number. Shoulder should be wide enough for emergency parking otherwise report to applicable 03-11X number.			Tons
-051	MANUAL REPAIR - IMPORT MATERIAL Shoulder drop-off repair (import material) using hand tools to spread the material.	.80*		Tons
-052	MECHANICAL REPAIR - IMPORT MATERIAL Shoulder drop-off repair (import material) using grader, trucks, tractors etc. to spread material.	.02		Tons
03-060	DITCH CLEANING (INVERT LESS THAN 10 FEET) Cleaning dirt, silt, rock or debris from ditches using clam shell, water truck or other methods not listed below. If shoulders are shaped at the same time ditches are cleaned report to the appropriate 03-06X number all time involved in ditch cleaning and shoulder grading.			Lin Ft

Figure A-2. (Continued)

03 PROGRAM (ROADSIDE MAINTENANCE)

		Std. or Sch.Val.* (Man Hrs.)	/	Unit
03-061	DITCH CLEANING - MANUAL Cleaning material from ditches using hand tools.	013*		Lin Ft
-062	DITCH CLEANING - GRADER, LOADER, OR BOTH Includes cleaning ditches with grader, loader or both. Also includes shoulder grading when done in conjunction with ditch cleaning.	002*		Lin Ft
-063	DITCH CLEANING - BACKHOE Cleaning material from ditches using a backhoe	020*		Lin Ft
03-070	CHANNEL CLEANING (INVERT 10 FEET AND OVER) Cleaning dirt, silt, rock or debris from channels using methods not listed below.			Cu Yd
-071	CHANNEL CLEANING - HEAVY EQUIPMENT Above activity using bulldozer, grader, truck shovel, loader etc.	050*		Cu Yd
03-080	DITCH OR CHANNEL REPAIR Do not use the 03-08X sub program for ditch or channel cleaning, use 03-06X or 07X.			Lin Ft
-081	DITCH REPAIR OR RECONSTRUCTION (INVERT LESS THAN 10 FT) Includes reshaping or reconstruction of unpaved ditches, would also include patching of AC or PCC lined ditches.			Lin Ft
-082	CHANNEL REPAIR OR RECONSTRUCTION (INVERT OVER 10 FT) Includes reshaping or reconstruction of unpaved channels, would also include patching of AC or PCC lined channels.			Lin Ft
03-090	DRAINAGE FACILITY OR STRUCTURE REPAIR OR REPLACEMENT Includes removal of graffiti from rocks or various types of walls.			

Figure A-2. (Continued)

03 PROGRAM (ROADSIDE MAINTENANCE)

		Std or Sch Val. (Man Hrs.)	/ Unit
03-091	REPAIR OR REPLACEMENT OF DRAINAGE FACILITIES Repair or replacement of culverts, drop inlets, other type drains, wingwalls, headwalls, debris racks etc. included in this number.		Each
-092	REPAIR OR REPLACEMENT OF OTHER STRUCTURES Includes work on retaining walls, bin walls, crib walls, sound walls, PCC or stone curbs and dikes, sidewalks, cattle guards or other structures not defined elsewhere.		Each Rpr
03-100	REPAIR OF RIGHT OF WAY OR OTHER ROADSIDE FENCE Includes repair to rock fence, or roadside fence used only as glare screen. Also includes repair to gates on right of way fences.		Lin Ft
-101	REPAIR CHAIN LINK FENCE Repair of chain link right of way fence of any height.	.00	Lin Ft
-102	BARBED WIRE FENCE Repair of barbed wire right of way fences.	.26*	Lin Ft
-103	WIRE MESH FENCE, OR MESH AND BARBED WIRE FENCE Repair of wire mesh right of way fence, or combination barbed wire and mesh fence.	.63	Lin Ft
03-110	ROADSIDE SECTION RESTORATION Do not use 03-11X sub program when removing sand from travelway (use 03-012), to improve drainage (use 03-06X or 07X), and for major damage repair (see 18 program).		Cu Yd
-111	REMOVAL OF DRIFT OR STORM DEPOSITED MATERIAL Removal of drift or storm deposited material by any method.	.67*	Cu Yd

Figure A-2. (Continued)

03 PROGRAM (ROADSIDE MAINTENANCE)

		St. or Sc. (Ma	Val.* Hrs.)	/	Unit
03-112	SLIDE REMOVAL Removal of small slides by any method. If estimated expenditure is over $1,000 in one location or $5,000/mile see 18 Program.		034		Cu Yd
-113	MANUAL MATERIAL REPLACEMENT Replacement of roadside material performed with hand tools.		500*		Cu Yd
-114	MECHANICAL MATERIAL REPLACEMENT Replacement of roadside material used graders, loaders, trucks, tractors etc.		040*		Cu Yd
-115	OTHER ROADSIDE SECTION RESTORATION Included in this activity are jobs such as bench cleaning, cut slope grading, removing loose rocks from slopes, and maintaining earth berms. Report cubic yards of material if applicable.				Cu Yd
03-880	SUPV AND ADMIN (ROADSIDE MAINTENANCE PROGRAM) (See Definition 01-880) Do not report support activities to this number.				
03-980	MISCELLANEOUS (ROADSIDE MAINTENANCE PROGRAM)				
-981	CLEANING CULVERT AND OVERSIDE DRAIN INTERIORS Cleaning culvert or overside drain interiors by any method.		2.000*		Cu Yd
-982	SLOPE PROTECTION Such as placement of rock or riprap on slopes for the purpose of slope protection or stabilization. For fertilizing or seeding slopes see 05-984 and 985.				

Figure A-3.

DAILY MAINTENANCE PERSONNEL REPORT

PAGE ____ OF ____

DATE (MO. / DAY / YR.) ____   COST CENTER (DIST. / UNIT) ____   FOREMAN ____

NAME	SOCIAL SECURITY NUMBER	HOURS PRESENT					VAC TAKEN	SICK LEAVE		CTO TAKEN	MILITARY LEAVE	RY TY	ABSENT WITHOUT PAY	TOTAL HOURS PRESENT	BORROW OR LOAN C.C.
		SHIFT RATE			CTO EARNED	CASH OT EARNED		SELF	FAMILY						
		NIGHT	DAY	EVENING											
				TOTALS											

REMARKS:

1. Outlined Totals to be posted on HM-83.
2. Total Hours Present must equal Total Crew Hours on HM-83.

HM 85 (REV 1 72)

Figure A-4.

MMS206-B DIST 02 SUPT 610 YREKA SUPT — MAINTENANCE BRANCH SUPERINTENDENT PERFORMANCE SUMMARY — RUN DATE: 04/19 76 BUS DATE: MARCH 1976 — PAGE 1

PROGRAM METHOD		< CURRENT MONTH > COMPLETED PROD UNIT	PRODUCTION HOURS	SUPPORT HOURS	REAL-IZATION	PCT SUPP	< FISCAL YEAR TO DATE > PLANNED PROD UNIT	COMPLETED PROD UNIT	PRODUCTION HOURS	SUPPO T HOUR	REAL-IZATION	PCT SUPP	CREW RATE BARE $/ PROD
01-880	SUPV & ADMIN						MHRS						
	STATE	16	13,013	4			112,052	32	120,280		4		
	DIST 02		1,353				9,589		10,351				
	SUPT		191				2,133		1,730				
	FORE 612		6				310		104				
	FORE 613		36				294		175				
	FORE 614		10				528		116				
	FORE 615		64				222		396				
	FORE 616		37				285		421				
	FORE 617		38				494		518				
01-031	DIGOUT & REPLACE						MHRS	TON					
	STATE	1,644	718	1,385		193	7,263	7,922	4,272	6,(	11	155	9.37
	DIST 02						109	43	31		28	316	20.88
	SUPT						109						
	FORE 615						109						
01-032	GRADER DIGOUT		(0.410* MHRS PER TON)				TON	TON					
	STATE	734	331	883	91	267	15,698	14,367	5,196	13,(	14	113	262	8.87
	DIST 02	101	36	106	115	294	2,448	809	335		09	99	212	8.99
	SUPT	38	17	60	92	353	200	86	42		46	84	349	15.26
	FORE 615	38	17	60	92	353		39	19		68	84	358	15.53
	FORE 616						113	15	12		42	51	350	25.06
	FORE 617						87	32	11		36	119	332	10.33
01-033	GRDR&RKHO-LDRR DIGOUT		(0.360* MHRS PER TON)				TON	TON					
	STATE	3,003	1,344	3,133	80	233	49,785	31,307	11,931	25,	53	94	210	8.07
	DIST 02	413	158	320	94	203	965	3,403	1,078	2,	52	114	218	7.02
	SUPT	21	9	32	84	356	153	126	70		91	65	273	14.36
	FORE 612						153							
	FORE 614										16			
	FORE 615	21	9	32	84	356		98	57		32	62	232	13.35
	FORE 616							28	13		43	78	331	13.92
01-034	MANUAL DIGOUT		(3.450* MHRS PER TON)				TON	TON					
	STATE	162	309	336	181	109	2,600	1,623	5,447	4,	44	103	74	40.12
	DIST 02		2	2		100	88	146	381		51	132	92	34.90
	SUPT													
	FORE 614													

Figure A-5.

MMS206-C DIST 02 MAINTENANCE BRANCH DISTRICT PERFORMANCE SUMMARY RUN DATE: 04 19/76 BUS DATE: MARCH 1976 PAGE

PROGRAM METHOD		< CURRENT MONTH > COMPLETED PROD UNIT	PRODUCTION HOURS	SUPPORT HOURS	REAL-IZATION	PCT SUPP	< FISCAL YEA TO DATE > PLANNED PROD UNIT	COMPLETED PROD UNIT	PRODUCTION HOURS	SUPPORT HOURS	REAL-IZATION	PCT SUPP	CREW PAT BARE $/ PR
01-880	SUPV & ADMIN						MHRS						
	STATE	16	13,013	4			112,052	32	120,280	54			
	DIST 02		1,353				9,589		10,351				
	SUPT 601		92						280				
	SUPT 610		191				2,133		1,730				
	SUPT 620		216				1,148		2,339				
	SUPT 630		412				1,669		2,261				
	SUPT 650		62				1,704		1,082				
	SUPT 660		208				1,680		1,659				
	SUPT 670		160				1,255		986				
	SUPT 690		12						12				
01-030	BASE & SURFACE REPAIR						MHRS	TON					
	STATE	1	9	5		56	88	13	68	48		71	61
	DIST 02							9	26	41		158	51
	SUPT 620							9	26	41		158	51
01-031	DIGOUT & REPLACE						MHRS	TON					
	STATE	1,644	718	1,385		193	7,263	7,922	4,272	(,611		155	9
	DIST 02						109	43	31	98		316	20
	SUPT 610						109						
	SUPT 660							11	21	73		348	56
	SUPT 670							32	10	25		250	7
01-032	GRADER DIGOUT	(	0.410* MHRS	PER	TON	)	TON	TON					
	STATE	734	331	883	91	267	15,698	14,367	5,196	1 ,614	113	262	8
	DIST 02	101	36	106	115	294	2,448	809	335	709	99	212	8
	SUPT 610	38	17	60	92	353	200	86	42	146	84	349	15
	SUPT 620						81	300	54	129	228	239	4
	SUPT 630							73	40	119	75	299	15
	SUPT 650						177	61	20	42	125	205	7
	SUPT 660						400	92	53	77	71	145	9
	SUPT 670	63	19	46	136	242	1,590	197	126	195	64	155	11
01-033	GRDR&BKHO-LDRR DIGOUT	(	0.360* MHRS	PER	TON	)	TON	TON					
	STATE	3,003	1,344	3,133	80	233	49,785	31,307	11,931	2 053	94	210	8
	DIST 02	413	158	320	94	203	965	3,403	1,078	2 352	114	218	7
	SUPT 610	21	9	32	84	356	153	126	70	191	65	273	14
	SUPT 620						1,062	808	211	367	138	174	4
	SUPT 630						3,384	1,350	369	928	132	251	6
	SUPT 650						30	177	39	108	163	275	5
	SUPT 660	392	149	288	95	193	499	688	269	556	92	207	8
	SUPT 670						675	253	119	201	77	169	8

Figure A-6.

MMS303-EA-D STATEWIDE (DIST 01-11) MAINTENANCE BRANCH EXPENDITURE ANALYSIS RUN DATE: APRIL 1, 1976 FOR FY 1975-76 (JULY THRU MARCH) PAGE 1

PGM-MTHD	MAN YRS @ 1800 HR/YR	DOLLARS EXPENDED YEAR TO DATE SALARIES	EQUIP	MATLS	OTHER	TOTAL	YTD PRODUCTION QUANTITY	UNIT	SAL-EQP UNT-CST	$ THIS MONTH
01-000 ROADBED FLEXIBLE										
DIST 02					4,163	4,163				101
DIST 04		37	6	929		973				
DIST 06					8	8				
DIST 07			57			57				1
TOTAL		37	64	929	4,172	5,202				103
01-880 SUPV & ADMIN										
DIST 01	3.82	62,508	3,775		1	66,284				8,273
DIST 02	5.74	95,963	1,905		94	97,962				13,018
DIST 03	6.62	112,459	4,994		7	117,461				12,310
DIST 04	11.19	183,773	9,205	10		192,988				19,844
DIST 05	4.55	74,152	2,201	8		76,363				10,678
DIST 06	5.72	90,845	1,988		405	93,238				10,828
DIST 07	6.71	108,160	7,815			115,975				13,261
DIST 08	6.79	112,321	4,361		1,558	118,241				11,534
DIST 09	3.01	49,669	2,725			52,394				8,177
DIST 10	6.32	103,011	3,715	85		106,812				5,115
DIST 11	6.35	102,006	8,147	33	170	110,358				12,561
TOTAL	66.82	1,094,873	50,834	137	2,237	1,148,083				125,603
01-981 SPECIAL STUDY										
DIST 04	.01	176	69			246				246
01-030 BASE & SURFACE REPAIR										
DIST 02	.04	623	138	17	160	939	9	TON	84.63	
DIST 04	.01	148	43	442	285	920				
DIST 05	.01	127	29	259		416	1	TON	157.12	157
DIST 06					4,760	4,760				595
DIST 07	.01	171	21			192	3	TON	64.20	
DIST 10					2	2				
TOTAL	.06	1,071	232	719	5,208	7,231	13	TON	100.27	752
01-034 DIGOUT										
DIST 02	.07	1,200	525	47	13	1,786	43	TON	39.68	60
DIST 03	.11	1,785	669	275		2,730	137	TON	17.92	
DIST 04	4.53	73,567	46,444	64,518	2,847	187,377	6,798	TON	17.65	33,967
DIST 05	.21	3,286	2,570	1,184	695	7,838	267	TON	22.31	1,065
DIST 06	.09	1,458	468	177		2,104	107	TON	17.93	962
DIST 07	.86	13,881	4,122	5,649	2	23,656	422	TON	42.59	5,342
DIST 08		18	14	98		131				
DIST 10	.09	1,534	817	473	534	3,360	61	TON	38.24	835
DIST 11	.08	1,325	470	124		1,920	84	TON	21.39	
TOTAL	6.05	98,158	56,104	72,549	4,093	230,905	7,922	TON	19.47	42,234

Figure A-7.

MMS303-BS-D STATEWIDE (DIST 01-11) MAINTENANCE BRANCH BUDGET STATUS RUN DATE: MAY 3, 1976 PAGE 1
FOR FY 1975-76 (JUL THRU APRIL)

PROGRAM	MAN-YEARS EXPND	MAN-YEARS PLANNED	$ BY MAINT	$ BY CITIES	$ BY CONTRACT	$ REIMB	$ TOTAL BUDGET	$ OTHER DEPT-STAFF	$ TOTAL EXPENDED
01 ROADBED FLEXIBLE (GL 93X)									
THIS MONTH	66.47	58.12	3,037,965	24,969		136-	3,062 797	3,318	3,066,115
FISCAL YEAR TO DATE	502.68	525.40	17,398,143	21,789		2,826-	17,417 107	16,190	17,433,297
TARGET FY TOTAL		656.62	28,891,400	261,300		20,000-	29,132 700	8,200	29,140,900
TARGET ADJUSTMENTS		5.63-	32,000				32 000		32,000
PERCENT FYTD	77%	80%	60%	8%		14%	60%	197%	60%
PERCENT LAST FY	80%		79%	69%	100%	97%	79%	82%	79%
PERCENT LAST 4 FY	78%		73%	51%	53%	77%	73%	78%	73%
02 ROADBED RIGID (GL 93X)									
THIS MONTH	14.13	13.13	416,878			560-	416 317	631	416,948
FISCAL YEAR TO DATE	117.91	131.92	3,073,594			3,020-	3,070 574	6,523	3,077,097
TARGET FY TOTAL		158.01	4,218,800		112,800	6,700-	4,324 900	2,700	4,327,600
TARGET ADJUSTMENTS		13.64-	1,326,000-				1,326 000-		1,326,000-
PERCENT FYTD	75%	83%	73%		%	45%	71%	242%	71%
PERCENT LAST FY	83%		83%		47%	97%	81%	67%	81%
PERCENT LAST 4 FY	82%		79%		47%	119%	78%	67%	78%
03 ROADSIDE MAINTENANCE (GL 93X)									
THIS MONTH	49.78	46.60	1,484,140	18,532		23,661-	1,479 011	382	1,479,393
FISCAL YEAR TO DATE	438.50	474.09	10,973,968	52,318	16,053	292,447-	10,749 893	2,718	10,752,611
TARGET FY TOTAL		525.56	13,094,400	82,200	112,800	190,100-	13,099 300	9,300	13,108,600
TARGET ADJUSTMENTS		2.33	577,000-				577 000-		577,000-
PERCENT FYTD	83%	90%	84%	64%	14%	154%	82%	29%	82%
PERCENT LAST FY	89%		89%	60%	97%	82%	89%	98%	89%
PERCENT LAST 4 FY	89%		88%	58%	53%	85%	87%	95%	87%
04 ROADWAY LITTER & DEBRIS (GL 93X)									
THIS MONTH	25.34	24.03	668,457	92,892		10,833-	750 516		750,516
FISCAL YEAR TO DATE	246.07	238.02	5,625,149	521,809		120,988-	6,025 971	357	6,026,328
TARGET FY TOTAL		283.98	6,472,400	1,015,400		116,100-	7,371 700	2,400	7,374,100
TARGET ADJUSTMENTS		5.15-	7,000				7 000		7,000
PERCENT FYTD	87%	84%	87%	51%		104%	82%	15%	82%
PERCENT LAST FY	82%		83%	49%		80%	79%	100%	79%
PERCENT LAST 4 FY	84%		84%	48%		78%	79%	98%	79%
05 VEGETATION CONTROL (GL 93X)									
THIS MONTH	14.53	27.42	429,691	48,241		97	478 030		478,030
FISCAL YEAR TO DATE	205.40	198.93	5,133,072	83,237		1,249-	5,215 061	379	5,215,441
TARGET FY TOTAL		250.42	6,634,400	39,700		5,800-	6,668 300	2,700	6,671,000
TARGET ADJUSTMENTS		23.67	811,300				811 300		811,300
PERCENT FYTD	82%	79%	77%	210%		22%	78%	14%	78%
PERCENT LAST FY	78%		79%	46%		95%	78%	80%	78%
PERCENT LAST 4 FY	79%		78%	63%		78%	78%	61%	78%

Figure A-8.

MMS404-A DISTRICT = 01 MAINTENANCE BRANCH RUN DAT = 04/08/76

* VEHICLE NOT ASSIGNED TO USER DISTRICT EQUIPMENT REPORT BUSINES DATE = 12-75 PAGE 99

ITEM-CHC NUMBER	DESCRIPTION	<- THIS MONTH -> DOWN-TIME FIELD	DOWN-TIME SHOP	ACTUAL USE	NON USE	AVER USE	$COST NON-USE	<- FISCAL YEAR TO DATE -> DOWN-TIME FIELD	DOWN-TIME SHOP	ACTUAL USE	NON USE	$COST NON-USE	$COST REPAIRS	$COST OPER	DATE-IN SERVICE
006.00-1561	PICKUP														04-72
	SUPT 01-650	0	0	910				0	30	5223					
	TOTAL FOR CHC-NO.	00	00	910	00	1150	00	00	30	5223	00	00	00	00	
006.00-1563	PICKUP														04-72
	*SUPT 01-620	0	0	211				0	0	211					
	TOTAL FOR CHC-NO.	00	00	211	00	1150	00	00	00	211	00	00	357	231	
006.00-1564	PICKUP														04-72
	*SUPT 01-650	0	0	0				0	0	158					
	TOTAL FOR CHC-NO.	00	00	00	00	1150	00	00	00	158	00	00	00	133	
006.00-1573	PICKUP														04-72
	*SUPT 01-620	0	0	71				0	0	71					
	*SUPT 01-650	0	0	817				0	0	817					
	TOTAL FOR CHC-NO.	00	00	888	00	1150	00	00	00	888	00	00	00	00	
006.00-1830	PICKUP														05-72
	*SUPT 01-650	0	0	0				0	0	446					
	TOTAL FOR CHC-NO.	00	00	00	00	1150	00	00	00	446	00	00	132	58	
006.00-1834	PICKUP														07-72
	*SUPT 01-650	0	0	300				0	0	300					
	TOTAL FOR CHC-NO.	00	00	300	00	1150	00	00	00	300	00	00	449	497	
006.00-1842	PICKUP														05-72
	*SUPT 01-650	0	0	150				0	0	150					
	TOTAL FOR CHC-NO.	00	00	150	00	1150	00	00	00	150	00	00	186	363	
006.07-2488	PICKUP W/AIR COND.														04-73
	SUPT 01-640	0	0	1254				0	8	7299					
	*SUPT 01-650	0	0	0				0	0	310					
	TOTAL FOR CHC-NO.	00	00	1254	00	1150	00	00	08	7609	00	00	00	00	
006.30-0943	UTILITY BODY														08-71
	*SUPT 01-610	0	0	0				0	0	219					
	TOTAL FOR CHC-NO.	00	00	00	00	113	00	00	00	219	00	00	00	00	
006.30-0950	UTILITY BODY														07-71
	SUPT 01-610	0	0	118				0	8	744					
	TOTAL FOR CHC-NO.	00	00	118	05-	113	02-	00	08	744	74-	36-	00	00	

Figure A-9.

MMS018-A

MAINTENANCE BRANCH
FOREMAN (LEVEL I) PROGRAM WORK PLAN - DETAIL
FISCAL YEAR 1974-75

07/01/74 PAGE 1

DISTRICT 03
SUPT 610
FOREMAN 612

PROG-METHOD	DESCRIPTION	CO	RTE	TOTAL PRODUCTION QUANT	*	UNIT	MANHOURS TOTAL	JUL	AUG	SEP	OCT	NOV	DEC	JAN	F	B	MAR	APR	MAY	JUN	M-HR PER PROD. UNIT
01 880	SUPV & ADMIN			731		MAN-HRS	731	61	61	61	61	61	61	61		0	61	61	61	61	1.00
	TOTAL PGM-METHOD						731	61	61	61	61	61	61	61		0	61	61	61	61	
034	MANUAL DIGOUT	YOL	084	19		TON	152		40								72			40	8.04
	TOTAL PGM-METHOD						152		40								72			40	
031	HAND PLACED SURFACING	YOL	016	58		TON	296		26	41	66		20	31		0		51		41	5.10
031	HAND PLACED SURFACING	YOL	084	191		TON	976		92		174	102	77	36	2	4	163	128			5.10
	TOTAL PGM-METHOD						1272		118	41	240	102	97	67	2	4	163	179		41	
025	SERVICE CONTRACT SURF	YOL	016	388		MAN-HRS	388	388													1.00
025	SERVICE CONTRACT SURF	YOL	084	205		MAN-HRS	205	74	131												1.00
	TOTAL PGM-METHOD						593	462	131												
052	ROCK SEAL & SPREAD	YOL	016	112		TON	276			175										101	2.46
052	ROCK SEAL & SPREAD	YOL	084	81		TON	199												27	172	2.46

* MONTHLY PLANNED UNITS DIDNOT EQUAL TOTAL PLANNED UNITS AND WAS NOT CORRECTED. DIFFERENCE LISTED ON ERROR LIST (MMS017-A).

Figure A-10.

DISTRICT 1 [05] (LEVEL III)
SUPERINTENDENT 2 [620] (LEVEL II)
SUPERVISOR 3 [623] (LEVEL I)

DEPARTMENT OF TRANSPORTATION
OFFICE OF MAINTENANCE
PROGRAM WORK PLAN
FISCAL YEAR 1976-77

DATE May 18, 1976
PREPARED BY J. Smith

01 PROGRAM

Program	Method	Location Co	Location Rte	Acc.	Realization	Total Planned Hours		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
01	011	44	101	110	80	150		150											
01	011	44	198	110	80	100		100											
01	023	44	101	95	125	350			350										
01	02[illegible]	44	198	95	125	100			100										
01	031	44	101	85	95	300								100				100	100
01	031	44	198	85	95	200								50				75	75
01	041	44	101	110	115	300				250	50								
01	041	44	198	110	115	100					100								
01	051	44	101	140	75	300					300								
01	880					300		50	50	50	50			50				25	25
REMARKS			TOTAL HRS. →			2200		300	500	300	500			200				200	200

SC 6241

DMO-M-99.

A-26

Figure A-11.

MAINTENANCE MONTHLY WORKLOAD PLAN
BY COST-CENTER
MONTH OF DECEMBER 1976

DISTRICT 02
SUPT. 629 QUINCY
CREW 637 DOYLE CREW

PREPARED BY John Peters DATE 11-21-76

PROGRAM METHOD	DESCRIPTION	CO. RTE.	UNITS OR HRS	UNIT OF MEAS.	PLANNED MAN-HRS.	WORK WEEK NO 1	2	3	4	5	REMARKS MATERIAL &	EQUIPMENT
01-880	SUPV & ADMIN	*	20	MAN-HRS	20	X	X					
01-041	PETROL FILL CORNUCOPIA	LAS 395	40	100#CTN	187	X					Kettle From CC-626	
03-880	SUPV & ADMIN	*	5	MAN-HRS	5		X					
03-063	DITCH CLEAN BACKHOE	LAS 395	876	LIN FT	24		X				Return Hose To Shop	
03-102	BARBED WIRE FENCE	SIE 395	570	LIN FT	20		X				CAT To be delivered 12-4-76	
03-071	Chn Clr. Hvy Equip	LAS 395	200	Cu Yd		X						
04-880	SUPV & ADMIN	*	4	MAN-HRS	4			X				
04-011	LITTER/FREEWAY PATROL	*	390	MAN MI	30	X	X	X	X			
07-880	SUPV & ADMIN	*	3	MAN-HRS	3	X						
10-880	SUPV & ADMIN	*	60	MAN-HRS	60			X	X	X	TRU's on board 12-10-76	
10-030	SNOW SEASON PREP	*	50	MAN-HRS	50		X					
10-011	TRUCK PLOWING	* 395	1,427	VEH MI	140			X	X	X		
10-012	GRADER PLOWING	* 395	167	VEH MI	30			X	X	X		
10-021	SNOW & ICE COVER	LAS 395	2,056	VEH MI	219		X	X	X	X		
		SIE 395	280	VEH MI	30		X					
17-880	SUPV & ADMIN	*	4	MAN-HRS	4	X						
17-054	TRAINING SAFETY	*	5	MAN-HRS	5	X						
17-061	SUPERVISORS MEETING	*	4	MAN-HRS	4					X	Supts office	

APPENDIX B

ILLINOIS DEPARTMENT OF TRANSPORTATION

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 11,236,000 residents of Illinois operate 5,952,000 motor vehicles on 129,942 miles of highway of which 16,780 miles are under state control. The state occupies 56,400 square miles from an elevation of 279 feet to 1,235 feet above sea level. Mean minimum and maximum temperatures are 14 and 90°F with average annual moisture ranging from 32 to 48 inches.

The Illinois Department of Transportation has a $79,000,000 maintenance budget for fiscal year 1976. This budget will be used by its 9 districts to maintain 38,000 lane miles of highways (16,800 center line miles).

Nine districts comprise the Illinois Department of Transportation Maintenance Management System. Each district is divided into "Maintenance Team Sections" resulting in a total of 104 Maintenance Team Sections.

The Highway Maintenance Lead Workers 02 or Section Supervisors are in charge at the Maintenance Team Sections with assistance from Highway Maintenance Lead Workers 01 often referred to as crew leaders. Highway Maintenance Lead Workers 02 report to Maintenance Field Engineers who are in responsible charge of several Maintenance Team Sections. The Maintenance Field Engineers report to the District Maintenance Engineer who reports to the District Engineer.

The administration of the maintenance program by the Director of the Illinois Division of Highways is performed at the central office level by the Engineer of Maintenance.

The basic maintenance recording and reporting system was developed in 1966 and 1967. Significant changes in the system were made in 1970 and 1971. A single reporting system is utilized to satisfy both the accounting and maintenance management function. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Illinois Department of Transportation Form BFM-884, "Maintenance and Traffic Time Card" is utilized to collect maintenance obtained on this form includes:

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Accomplishments
6. Foreman's designation

The forms are prepared for each employee daily and cover a bi-monthly payroll period. In some areas individual workmen fill out the cards while in other areas the Highway Maintenance Lead Worker 01 may fill out the forms for the employee. Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording

the following information:

1. District. A number from 1 to 9 is utilized to designate the district.

2. Maintenance Team Section. One hundred four Maintenance Team Sections are designated by 3 digit numbers. The first number of the code refers to the district, the second number refers to the Maintenance Field Engineer in charge of the Maintenance Team Section and the last digit refers to the particular one of the several Team Sections under his control. Thus, a code of 712 refers to District 7, Maintenance Field Engineer 10 and the second area under Field Engineer 10.

3. Maintenance Sub-Section. Maintenance Sub-Sections are specific segments of highways. A Sub-Section is based on a continuous route through a Maintenance Team Section.

The cost reporting units within a Maintenance Team Section are the "Sub-Sections." A Maintenance Team Section is composed of one or more Sub-Sections. Sub-Sections are assigned 3-digit numbers.

A Sub-Section is based on a continuous route through a Maintenance Team Section and may be modified by pavement width or traffic lanes.

If all the pavement on a route within a Team Section is of uniform width, said route shall constitute one Sub-Section. If a portion of the pavement on a route within a Team Section is under 22 ft. in width and the remainder is 22 ft., or greater in width, a separate Sub-Section shall be established for each portion. A separate Sub-Section shall also be established whenever there is a change in the number of traffic lanes on a route within a Team Section.

Sub-Section numbers are based on the following basic criteria:

1.	Marked Interstate Routes and Primary Routes	010 to 799
2.	Special Bridge Structures	800 to 819
3.	City Street Maintenance	820 to 849
4.	50-50 Financed Roads	850 to 859
5.	River Bridges Maintained with Adjoining States	860 to 869

For example, sub-sections for U. S. Route 30 could be numbered 300, 301, 302.

Little attempt has been made to establish maintenance section limits based on type of pavement and/or time of construction except for some special study sections.

Special job authorizations are filled out by the employee under the direction of the State Maintenance Engineer, the District Maintenance Engineer or the Maintenance Field Engineer. All other times the column on the Maintenance and Traffic Time card is not filled in.

4. Milepost. A milepost or milepoint system is not utilized as a part of the maintenance management system.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder, roadside, etc.

Activity

Maintenance Work Function Codes are utilized to designate the maintenance activity performed (Table B-1). Forty-nine maintenance

codes are presently utilized and are divided into the following major groups:

1. Roadway Surface Operations
2. Shoulder and Side Approaches
3. Roadside and Drainage
4. Bridge Structures
5. Snow and Ice Control
6. Traffic Services and Facilities
7. Maintenance General Functions
8. Equipment Maintenance
9. Traffic Signing
10. Miscellaneous and
11. "Time Off" Codes

It should be noted that a special function code does not exist for maintenance on portland cement concrete pavements. Some special codes exist for snow and ice removal.

Function codes were developed and have been revised based on input from the districts. These function codes can be expected to be altered in the future.

Manpower

Manpower utilization is assigned to a particular study and location on the individual time sheet. The employee's name, position, and social security number are recorded together with the start and stop time for each working day. If the workman performed more than one maintenance activity and/or worked on more than one sub-section for a given day, two or more lines of dates must be filled out for that day indicating the working hours for each

activity and/or sub-section. Regular, over-time and time-off hours are recorded on this form. All time-off hour entries must be accompanied by the appropriate function code as shown in Table B-1.

The report is intended to cover a bi-monthly payroll period ending on the 15th and 31st of the month. The time worked is reported to the nearest one-half hour.

Equipment

Equipment utilized by a particular individual and for a particular maintenance activity and/or sub-section is recorded. Equipment is designated by an equipment code. This code rather than individual equipment numbers are entered on the Maintenance and Traffic Time Card. The equipment usage hours are not just the hours that the equipment was actually in operation, but rather the number of hours that the equipment was assigned to the job and unavailable for other uses. Equipment time is recorded to the nearest half hour.

The Highway Maintenance Lead Worker 01 should be certain that no equipment is omitted or duplicated in reporting. If more than one type of equipment is used, the hours of usage of each type of equipment should be recorded on the time card of the man responsible for its operation that day. For equipment used fully among the entire crew, each type can be recorded on a separate man's time card until all equipment used by the crew is accounted for. If one man must report two or more types of equipment, additional lines should be used, with careful checking that no equipment is omitted or listed twice. It is important that the day's date, work location and work function code be given for each piece of equipment.

Materials

The district collects all materials bills and codes these costs such that the cost of materials is assigned to the Maintenance Team Sections and sub-section as appropriate. The type of material is identified by the work function code shown in Table B-1.

Accomplishments

The accomplishment data entered on the time card are the measure of the amount of work performed at a particular location for a particular work function. If the work is performed by the entire crew, the accomplishments are entered on only one time card which is usually the Lead Worker. The Lead Worker is responsible to insure that a work accomplishment value has been recorded. The units of accomplishment are reported in units assigned to the function code for which the accomplishment is being recorded.

Inventory

A Maintenance Roadway Inventory Record is maintained in each district by Maintenance Team Section and Sub-Section. Information collected and reported on this inventory includes;

1. District designation
2. Maintenance Team Section Number
3. Sub-Section numbers
4. Route numbers
5. Location of road (municipal or rural)
6. County
7. City
8. Average width of R.O.W.
9. Average daily traffic

10. Topography
11. Surface type
12. Width of pavement
13. Lane miles of pavement
14. Lane miles of ramps
15. Access control
16. Feet of curbs and/or gutters
17. Drainage structures
18. Historical markers
19. Frontage roads, lane miles
20. Storm sewers
21. Ditches
22. Shoulders
23. Culverts
24. Entrances and side approaches
25. Bridge structures
26. Acres of mowing
27. Right-of-way fence
28. Field engineers jurisdiction
29. Rest areas
30. Weight stations
31. Pump houses
32. Walls, cribbing, rip-rap, and
33. Highway class

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance and Traffic Time Card is filled out daily by the workman or the Highway Maintenance Lead Worker. At the

end of the bi-monthly pay period the Highway Maintenance Section Lead Worker or Field Engineer checks the card and approves with his signature. The cards are sent to the district for checking and key punching within three days after close of pay period. Processing is completed by the districts in 15 calendar days. These data are then transmitted to the central office for editing, checking and processing which may be 1 to 2 weeks.

It is estimated that about 0.6 percent of the maintenance budget is expended on recording and reporting maintenance activities. Sixty-six thousand dollars for computer charges were expended in 1974. Approximately 5 to 7 minutes per day are required per workman to fill out the time card and approximately one-half per day is required of the lead worker. Key punching in the district office amounts to about 1 to 2 days per pay period and about 1 man day is required at the district office to correct time card entries per pay period.

A one month turn around time is the goal of the reporting system.

REPORTS

Several reports are produced from the collected data. A brief discussion is presented below indicating the types of data contained on these reports.

Roadway Inventories Listings and Summaries. Roadway inventory reports summarize the information obtained on the Maintenance Roadway Inventory Record. These reports are printed upon request and show data by Maintenance Sub-Section, Maintenance Team Sections, Field Engineers areas of responsibility, Districts and State Totals. An example of this report is shown on Figure B-2 for Maintenance Team Section 712 and Sub-Sections 128, 129, 140, 185, 186 and 370.

Work Accomplishment Reports. Work Accomplishment Reports summarize work crew performance and develop labor hours per unit and unit costs from direct labor and equipment usage charged to the various work functions. Only direct labor and equipment usage costs are used in this report. These reports are issued monthly and annually for Lead Workers, Maintenance Team Sections, Field Engineers' areas, Districts and State totals. Special Project Accomplishment Reports are produced monthly. Reports can be printed for each foreman as well as for special projects.

An example of a monthly work accomplishment report for District 7 is shown on Figure B-3. It should be noted that sub totals are given for maintenance function groups such as roadway surface, shoulder and side approach, roadside and drainage, etc. Salaried and hourly labor are separated as are charges for regular and over-time hours.

Direct Cost Summary for Major Work Functions. These reports summarize by District, Maintenance Team Section charges to individual maintenance functions (Figure B-4). Information reported includes; units accomplished, unit costs for labor and equipment, direct costs per lane mile and percent of direct costs. Seventeen of the forty-nine maintenance functions are shown on this report. The 17 functions normally account for about 70 percent of total maintenance expenditures. These reports are issued monthly and annually. A similar report is prepared to compare districts and contains a state wide total.

Equipment Usage Reports. These reports show equipment usage costs which are computed from the usage hours reported multiplied by established hourly rates. Usage hours are not meter hours or hours of actual operations; but as discussed previously, are the work hours

during which the equipment is on a specific job and unavailable for any other use. The reports are issued monthly and annually and are prepared for Field Engineers' Areas, Districts and State totals.

An annual report issued under the cost series reports lists every sub-section in the state by Maintenance Team Section and District and gives the sub-section lane miles or bridge lineal feet and the cost per lane mile for the sub-section or cost per lineal foot if the sub-section is for a special bridge.

Cost Reports. These reports show all costs charged to the maintenance function. They show the costs assigned to the various maintenance functions plus non-production labor, all overhead costs, etc. Material costs are also included in these reports which are printed quarterly and annually. Reports are prepared for each Maintenance Team Section, Field Engineers' area, District and State total. Annual reports are also broken-down for interstate, regular highway and Chicago Expressways.

It should be noted that sub totals are given for maintenance function groups such as roadway surface, shoulder and side approach, roadside and drainage, etc.

Special Sub-Section Reports. As discussed previously each district has been instructed to establish special sub-sections for detailed study. Special reports are issued annually for these roadway and bridge special sub-sections. Costs per lane mile for mainline surface functions are reported for the pavement types within the sub-sections together with costs per lineal foot of bridge length for the various bridge sections under study.

Other reports in the maintenance management system are for error listings and control.

Reports are utilized for fiscal control by reviewing expenditure information. Budget information does not appear in these reports. Comparison of accomplishment units for specific maintenance functions among districts can be utilized to determine access productivity and to allocate manpower. Exception reports are presently not a part of the reporting system. The reports are utilized for budget preparation.

OTHER ITEMS

The Illinois Department of Transportation is not completely satisfied with the accuracy of the reports. Field data collection needs to be improved. Training programs have been utilized in an attempt to improve this accuracy.

The recording and reporting system can be altered by direction of the central office. Field input is normally obtained prior to any changes. Certain changes are contemplated.

A maintenance work standard committee has been formed and is composed of central office staff members, district engineers, field engineers, foremen, and equipment operators.

Recorded data are stored on tape and can be stored for a prolonged period of time.

Reference

1. "Maintenance System," informal report prepared by the State of Illinois, Department of Transportation.

Figure B-1. Field Recording Form

MO.	DAY	YEAR
PAY PERIOD ENDING DATE		

EMP. NAME

POSITION

SOC. SEC. NO.

DISTRICT

CARD OF CARDS

RESP.

PAYROLL NO.

SUBMITTED BY

ILLINOIS DEPT. OF TRANSPORTATION - MAINTENANCE & TRAFFIC TIME CARD

LINE NO.	DAYS DATE	AUTHORIZATION A & B, RP & L OR SPEC. PROJ. NO.	WORK LOCATION MAINT. TEAM SECTION / COUNTY	WORK LOCATION SUB SECTION / ROUTE	WORK FUNCTION CODE	LABOR HOURLY RATE	LABOR START TIME	LABOR STOP TIME	LABOR HOURS REGULAR	LABOR HOURS OVERTIME	LABOR HOURS TIME OFF	EQUIPMENT EQUIPMENT CODE	EQUIPMENT HOURS USED	APPLI...	COM-MENTS ...NTITY	TRAFFIC MATERIAL CODE	TRAFFIC MATERIAL QUANT.	FOREMANS NO.
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
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11																		
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13																		
14																		
15																		
16																		

APPROVED BY _____

OFFICE USE ONLY

BFM-884 (REV. 10-72)

Table 1 on reverse side of card

Table B-1.

PFM 864 (REV. 12-73)

TRAFFIC

WORK FUNCTION CODES

CATEGORY	FUNCTION CODE	WORK ITEMS	ACCOMP. UNITS
SIGN ERECTION	510	New, Interstate	EACH
	511	New, All Others	EACH
	512	Maintenance, Interstate	EACH
	513	Maintenance, All Others	EACH
	514	Temporary, Interstate	EACH
	515	Temporary, All Others	EACH
	516	Sign Erection and Sign Maintenance of Rest Areas and Truck Weigh Stations, Interstate	EACH
	517	Sign Erection and Sign Maintenance of Rest Areas and Truck Weigh Stations, All Others	EACH
DELINEATORS	518	New, Interstate	EACH
	519	New, All Others	EACH
	520	Maintenance, Interstate	EACH
	521	Maintenance All Others	EACH
BARRICADES	522	New and Maintenance	EACH
PAVEMENT STRIPING	525	Laneline, Interstate	MILES
	526	Laneline, Multilane, Non-Interstate	MILES
	527	Centerline, Undivided, Multilane, Non-Interstate	MILES
	528	Centerline, Two Lane	MILES
	529	Edgeline, Interstate	MILES
	530	Edgeline, Divided, Multilane, Non-Interstate	MILES
	531	Edgeline, Undivided, Multilane Non-Interstate	MILES
	532	Edgeline, Two Lane	MILES
	533	Edgeline, Interstate Ramps	MILES
	534	Edgeline, Non-Interstate Ramps	MILES
	535	Yellow, Zone Marking, Two Lane	MILES
SPECIAL PAVEMENT MARKING	545	Gore, Interstate	EACH
	546	Gore, Non-Interstate	EACH
	547	Railroad Crossings	EACH
	548	Rest Areas and Truck Weigh Stations, Interstate	EACH
	549	Rest Areas and Truck Weigh Stations, Non-Interstate	EACH
	550	Stop Lines, Cross Walks	EACH
	551	Channelization Striping	EACH
	552	Messages and Symbols	EACH
	553	Curb Marking	LIN. FT.
	554	Hazard and Other Miscellaneous Marking	EACH
	555	Pavement Marking Removal	LIN. FT.
TRAFFIC CONTROL SIGNALS AND ROADWAY LIGHTING	560	Replacement of Traffic Signals	EACH
	561	Maintenance of Traffic Signals	EACH
	562	Maintenance of Roadway Lighting Units	EACH
	563	Replacement of Roadway Lighting Units	EACH
SIGN SHOP	570	Stripping and Sign Cleaning	EACH
	571	Sign Painting	EACH
	572	Sheeting Applications	EACH
	573	Silk Screening	EACH
	574	Sign Assembly Fabrication	EACH
GENERAL FUNCTIONS	580	General Duties	-----
	581	Lost Time	-----
	582	Low Cost Traffic Improvement	-----
	583	Experimental, Test and Special Projects	-----
	584	Emergency Patrol	NO. ASSISTS
	585	Material Handling	-----
EQUIPMENT MAINTENANCE	590	Trucks	-----
	591	Other Equipment	-----
HIGHWAY MAINTENANCE	594	Disaster Maintenance	-----
	595	Highway Maintenance Activities	-----
SIGN WASHING	596	Interstate	EACH
	597	Non-Interstate	EACH
MISCELLANEOUS	598	Supervisor, Traffic	-----
	599	Office Personnel, Storekeepers, etc.	-----

EQUIP. CODE	EQUIPMENT	MAT'L. CODE	MATERIAL	UNITS
	FIELD			
009	Centerline Striper	210	Paint - Tar or Asphalt	GALS.
011	Edgeline Striper	211	Paint - White	GALS.
012	Curb Marker	214	Paint - Yellow	GALS.
020	Portable Pavement Marker and Traffic Line Grinder	215	Paint - Curb Yellow	GALS.
030	Hydraulic Derrick Truck Mounted Boom (Winch & Auger)	216	Paint-Curb White	GALS.
040	Truck With Mounted Augers	220	Beads - Glass	LBS.
041	Pickup Trucks 1/2 Ton & 3/4 Ton (Panel & Travelall)	221	Beads - Curb	LBS.
042	1½ Ton Trucks (Sign)	230	Reflectors - Delineators	EACH
043	2½ Ton Trucks (Van & Supply)	240	Signs - Special	EACH
044	Sign Cleaner	241	Signs - Less Than 30"	EACH
045	Emergency Patrol Vehicle	242	Signs - 30" to 48"	EACH
050	Air Compressor for Pneumatic Tools	243	Signs - Over 48"	EACH
060	Tractor With Attachments	250	Posts - Metal Delineator	EACH
	SHOP	251	Posts - Telescoping	LIN. FT.
090	Mono-Printer (Silk Screen)	252	Posts - Steel	EACH
110	Paint Sprayer (Spray Booth)	253	Posts - Structural Steel	LBS.
120	Lift Trucks (Fork)	254	Posts - Wood	EACH
130	Vacuum Applicator	260	Tape - Temporary Pvt. Marking	LIN. FT.
		261	Sheeting - Reflective	SQ. FT.

MAINTENANCE

WORK FUNCTION CODES

CATEGORY	FUNCTION CODE	WORK ITEMS	UNITS
ROADWAY SURFACE OPERATIONS	410	Bituminous Surface Patching	TONS
	411	Permanent Patching	SQ. YD.
	412	Crack Filling	GAL
	413	Bump Burning and Joint Cutting	LIN. FT.
	414	Mud Jacking and Undersealing	CU. YD.
	415	Sealing	SQ. YD.
SHOULDERS AND SIDE APPROACHES	430	Sealing	SQ. YD.
	431	Patching (Hand Method)	TON
	432	Patching (Machine Method)	TON
	433	Cutting High Shoulders	CU. YD.
	434	Blading and Dragging	MILES
	435	Filling Edge Joint	MILES
ROADSIDE AND DRAINAGE	440	Repairing Slopes	CU. YD.
	441	Ditches (Hand Method)	-----
	442	Ditches (Machine Method)	CU. YD.
	443	Clean and Repair Sewers, etc.	-----
	444	Walls, Cribbing and Riprap	SQ. YD.
	445	Care and Removal of Trees and Plants	-----
	446	Mowing (Hand Method)	-----
	447	Mowing (Machine Method)	ACRE
	448	Reseeding and Resodding	ACRE
	449	Weed Spraying	ACRE
	450	Cleaning Dirt and Debris (Hand)	LANE MILES
	451	Cleaning Dirt and Debris (Equip.)	MILES
BRIDGE STRUCTURES	460	Repair and Maintain Bridges	-----
	461	Cleaning Bridges	LIN. FT.
	462	Operation of Moveable Span Bridges & Ferries	-----
SNOW AND ICE CONTROL	465	Snow Removal	OPER. HR.
	466	Preparation for Snow Control	-----
TRAFFIC SERVICES AND FACILITIES	470	Guard Rail Maintenance	LIN. FT.
	471	Right of Way Fence Maintenance	LIN. FT.
	472	Maintenance of Rest Areas and Historical Markers	EACH
	473	Weigh Station Maintenance	EACH
	474	Subway Pumping (Includes Cleaning)	EACH
	475	Disaster Maintenance	-----
MAINTENANCE GENERAL FUNCTIONS	480	General Duties	-----
	481	Lost Time	-----
	482	Advertising Sign Removal	EACH
EQUIPMENT MAINTENANCE	*490	Trucks	-----
	*491	Other Equipment	-----
TRAFFIC SIGNING	495	Sign Maintenance	-----
MISCELLANEOUS	*498	Supervisor, Maintenance	-----
	*499	Office Personnel, Storekeeper, etc.	-----

*THIS FUNCTION DOES NOT REQUIRE A SUBSECTION NUMBER

EQUIP. CODE	EQUIPMENT	EQUIP. CODE	EQUIPMENT
010	Asphalt Kettle	420	Sprayers (paint)
070	Air Compressor - up to and including 150 cu. ft.	432	Sprayers (weed)
072	Air Compressor - over 150 cu. ft.	440	Spreaders – rock, asphalt
100	Asphalt Distributor	460	Street Sweeper – self propelled
171	Pull Type Graders	500	Tractor with various attachments
172	Motor Grader - up to 60 h.p.	540	Sewer Cleaners
173	Motor Grader - over 60 h.p.	541	Catch Basin Cleaner
221	End Loader – up to and including 1 cu. yd.	542	Landscaping Equipment, Seeders, etc.
222	End Loader - over 1 cu. yd.	820	Hydro Seeder
223	Crawler Type Loader	900	Brush Chippers
224	Force Feed Loaders	911	Pickup and Carryall Trucks
230	Mixers, concrete and bituminous	912	1-1/2 Ton Trucks
260	Mudjacks	913	2-1/2 Ton Trucks
311	Cranes and Attachments	914	4 Ton Trucks, 2 Wheel Drive
312	Gradall	915	Tandem Axle Truck
340	Rollers, Tandem	916	4 Wheel Drive Trucks
341	Rollers – Patching Type	917	3 Ton Trucks
		920	Rotary Snow Plow

REMARKS

"TIME OFF" CODES

FUNCTION CODE #	REASON FOR TIME OFF
100	Time Off Without Pay
124	Vacation
125	Sick Leave
126	Holidays
127	Personal or Other Leave (Explain)
150	Military Leave

Figure B-2. Roadway Inventory

76.142

HIGHWAY INVENTORY SUMMARY
TEST SECTION REPORT
SECTION 712

DISTRICT 7
PAGE 61

	SUB SECTION 128	SUB SECTION 130	SUB SECTION 140	SUB SECTION 185	SUB SECTION 186	SUB SECTION 370
SPECIAL SUBSECTION CODE			N	N		
ROUTE NUMBER	S12800	S12800	S14000	S18500	S18500	S03700
MUNICIPAL OR RURAL CODE	R	R	R	R	R	R
COUNTY	FAYETTE	FAYETTE	FAYETTE	FAYETTE	FAYETTE	FAYETTE
CITY						
AVERAGE WIDTH OF RIGHT OF WAY-FEET	80	80	60	80	80	80
AVERAGE DAILY TRAFFIC - 100	12	9	10	9	14	6
TOPOLOGY CODE	1	2	2	1	1	1
SURFACE CODE	2	1	2	1	3	2
AVERAGE WIDTH OF PAVEMENT - FEET	24	18	20	18	20	24
LANE MILES - 8 FOOT WIDTH	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES - 9 FOOT WIDTH	0.0	20.5	11.4	37.1	0.0	0.0
LANE MILES - 10 FOOT WIDTH	0.0	0.0	5.4	0.0	17.7	0.0
LANE MILES - 11 FOOT WIDTH	0.0	0.0	0.8	0.8	0.0	0.0
LANE MILES - 12 FOOT WIDTH	5.3	0.0	0.0	1.4	0.0	13.8
LANE MILES-13&14 FOOT WIDTHS	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES-15 FOOT WIDTH	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES - VARIABLE WIDTH	0.0	0.0	0.0	0.0	0.0	0.0
LANE MILES OF RAMPS	0.0	0.0	0.0	0.0	0.0	0.0
CURBS,CURBS/GUTTERS,GUTTERS-100/FT	0	248	117	300	45	55
DRAINAGE STRUCTURES	0	61	4	63	27	39
HISTORICAL MARKERS	0	0	0	0	0	0
FULL ACCESS CONTROL	N	N	N	N	N	N
LANE MILES OF FRONTAGE ROADS	0.0	0.0	0.0	0.0	0.0	0.0
SEWERS - UP TO 36 INCH DIAM.-100/FT	0	0	39	47	0	189
SEWERS - OVER 36 INCH DIAM.-100/FT	0	0	0	0	0	0
DITCHES - PAVED - 100/FT	0	1	1	10	0	4
DITCHES - SOIL - MILES	5	16	16	34	17	12
SHLDRS - SURFACED,HIGH - MILES	0	0	0	1	0	0
SHLDRS-SURFACED,HIGH-AVG WIDTH-FT	0	0	0	10	0	0
SHLDRS - SURFACED,LOW - MILES	0	0	0	0	0	0
SHLDRS - SURFACED,LOW-AVG WIDTH-FT	0	0	0	0	0	0
SHLDRS - AGGREGATE - MILES	0	0	0	0	0	0
SHLDRS - AGGREGATE - AVG WIDTH-FT	0	0	0	0	0	0
SHLDRS - TURF - MILES	5	16	16	36	17	12
SHLDRS - TURF - AVG WIDTH - FEET	5	8	6	11	11	8
CULVERTS - CROSSROADS	8	33	23	53	25	27
CULVERTS - SIDE APPROACHES	20	76	95	244	11	51
ENTRANCES & SIDE APPROACHES	9	67	66	116	36	77

Figure B-2. (Continued)

76.142

HIGHWAY INVENTORY SUMMARY
TEAM SECTION REPORT
SECTION 712

DISTRICT 7
PAGE 01
CONTINUED

	SUB SECTION 128	SUB SECTION 129	SUB SECTION 140	SUB SECTION 155	SUB SECTION 186	SUB SECTION 370
STRUCTURES - LINEAL FEET	3	351	297	326	192	107
NO. OF STRUCTURES - UNDER 100 FEET	0	4	2	6	1	0
NO. OF STRUCTURES - OVER 100 FEET	0	1	1	0	1	1
SPECIAL STRUCTURES - TYPE	0	0	0	0	0	0
SPECIAL STRUCTURES - AGE IN 1	0	0	0	0	0	0
SPECIAL STRUCTURES - LINEAL FEET	0	0	0	0	0	0
GUARD RAIL - STEEL PLATE - LO/FT	0	150	185	165	355	275
GUARD RAIL - CABLE GUARD - LO/FT	0	0	0	0	0	0
GUARD RAIL - WOOD - LO/FT	0	0	0	0	0	0
FIELD ENGINEERS NUMBER	10	10	10	10	10	10
SUPERVISORS NUMBER	12	12	12	12	12	12
LANDSCAPING - INDIVIDUAL PLANTING	0	64	273	83	5	83
LANDSCAPING - MASS PLANTING-SQ YDS	0	37375	0	0	0	49860
LANDSCAPING - ACRES OF TIMBER	0	0	0	0	0	0
TURF ACRES	16	72	37	42	39	41
RIGHT OF WAY FENCE - MILES	0.0	0.0	0.0	0.0	0.0	0.0
REST AREAS - FLUSH	0	0	0	0	0	0
REST AREAS - PIT	0	0	0	0	0	0
REST AREAS - MINOR	0	0	0	0	0	0
WEIGH AND INSPECTION FACILITIES	0	0	0	0	0	0
PUMP HOUSE	0	0	0	0	0	0
WALLS, CRIBBING, AND RIPRAP-LO/FT	0	0	0	0	0	0
EXPRESSWAY/INTERSTATE CODE	0	0	0	0	0	0

Figure B-3. Monthly Accomplishment Reports

DISTRICT 7 MONTHLY WORK ACCOMPLISHMENTS
DISTRICT REPORT
MARCH 1976

WORK FUNCTION	ACCOMPLISHMENT FACTORS: WORK ACCOMPLISHMENT UNITS		LABOR HOURS PER UNIT	UNIT COST LABOR AND EQUIPMENT	LABOR-COST BREAKDOWN: SALARIED LABOR REGULAR HR	REGULAR $	OVERTIME HR	OVERTIME $	HOURLY LABOR REGULAR & OVERTIME HR	HOURLY LABOR REGULAR & OVERTIME $	EQUIPMENT USAGE COST $
BITUMIN PATCH	414.50	TONS	2.58	19.84	1052.0	5935.59	16.0	89.24	.0	.00	2196.85
PERM PATCHING	103.50	SQ YDS	4.66	39.88	452.0	2662.76	.0	.00	32.0	233.60	1230.80
CRACK FILLING	5088.50	GALS	.23	1.78	1182.0	6737.44	.0	.00	.0	.00	2303.00
BUMP BRN&JT CUT	192.00	LIN FT	.65	5.14	124.0	696.76	.0	.00	.0	.00	290.40
MUDJACK&UNDSEAL	.00	CU YDS	.00	.00	.0	.00	.0	.00	.0	.00	.00
SEALING	279.00	SQ YDS	.43	3.46	120.0	674.08	.0	.00	.0	.00	290.40
ROADWAY SURFACE TOTALS					2930.0	16706.63	16.0	89.24	32.0	233.60	6311.45
SEALING	.00	SQ YDS	.00	.00	.0	.00	.0	.00	.0	.00	.0
PATCH-HAND	927.50	TONS	1.30	10.53	1209.0	6621.35	.0	.00	.0	.00	3144.00
PATCH-MACHINE	195.00	TONS	.67	6.74	130.0	736.54	.0	.00	.0	.00	558.20
CUT HIGH SHOULD	30.00	CU YDS	.53	4.70	16.0	84.96	.0	.00	.0	.00	56.00
BLADE AND DRAG	640.00	MILES	1.95	17.43	1248.0	6926.76	.0	.00	.0	.00	4226.80
FILL EDGE JOINT	7.00	MILES	1.14	10.64	8.0	42.48	.0	.00	.0	.00	32.00
SHOULDER AND SIDE APPRC. TOTALS					2611.0	14432.09	.0	.00	.0	.00	8017.00
SLOPES	158.00	CU YDS	.61	5.06	96.0	549.08	.0	.00	.0	.00	250.40
DITCHES-HAND	412.00	LB HRS	.00	.00	412.0	2316.88	.0	.00	.0	.00	747.60
DITCHES-MACHINE	7135.00	CU YDS	.44	3.88	3152.0	17572.83	.0	.00	.0	.00	10115.20
REP SEWERS,ETC.	1306.00	LB HRS	.00	.00	1306.0	7396.67	.0	.00	.0	.00	2740.60
WALLS,CRIB,RIPR	2223.00	SQ YDS	.13	1.03	288.0	1672.68	.0	.00	.0	.00	626.40
TREES&PLANT CARE	2380.30	LB HRS	.00	.00	2380.3	13471.91	.0	.00	.0	.00	4843.00
MOWING-HAND	8.00	LB HRS	.00	.00	8.0	41.24	.0	.00	.0	.00	16.00
MOWING-MACHINE	.00	ACRES	.00	.00	.0	.00	.0	.00	.0	.00	.0
RESEED&RESODDING	.00	ACRES	.00	.00	.0	.00	.0	.00	.0	.00	.00
WEED SPRAYING	64.25	ACRES	7.14	51.74	459.0	2611.29	.0	.00	.0	.00	712.90
DIRT&DEB-MANUAL	2292.70	LN MI	3.94	28.94	9012.0	49672.45	12.0	63.04	.0	.00	16611.90
DIRT&DEB-MACHINE	40.00	MILES	1.80	17.23	72.0	418.08	.0	.00	.0	.00	271.20
ROADSIDE AND DRAINAGE TOTALS					17185.3	95723.31	12.0	63.04	.0	.00	36935.20

Figure B-3. (Continued)

DISTRICT 7 — MONTHLY WORK ACCOMPLISHMENTS DISTRICT REPORT MARCH 1976 — PAGE 2 OF 2

WORK FUNCTION	WORK ACCOMPLISHMENT UNITS		ACCOMPLISHMENT FACTORS: LABOR HOURS PER UNIT	ACCOMPLISHMENT FACTORS: UNIT COST LABOR AND EQUIPMENT	LABOR-COST BREAKDOWN: SALARIED LABOR REGULAR HR	SALARIED LABOR REGULAR $	SALARIED LABOR OVERTIME HR	SALARIED LABOR OVERTIME $	HOURLY LABOR REGULAR & OVERTIME HR	HOURLY LABOR REGULAR & OVERTIME $	EQUIPMENT USAGE COST
BRIDGE REPAIR	1342.50	LB HRS	.00	.00	1341.0	7409.18	1.5	8.21	.0	.00	3705.80
BRIDGE CLEANING	26849.00	LIN FT	.02	.15	520.0	2852.26	.0	.00	.0	.00	1051.20
BRIDGES & FERRIE	.00	S EACH	.0	.00	.0	.00	.0	.00	.0	.00	.00
STRUCTURES TOTALS					1861.0	10261.44	1.5	8.21	.0	.00	4757.00
SNOW REMOVAL	383.50	OPER HR	1.44	16.39	390.0	2069.22	162.5	843.06	.0	.00	3374.00
PREP SNOW CONTRL	.00	LB HRS	.00	.00	22.0	123.30	2.0	13.54	.0	.00	55.60
SNOW AND ICE CONTROL TOTALS					412.0	2192.52	164.5	856.60	.0	.00	3429.60
GUARD RAIL	1661.00	LIN FT	.51	4.30	854.0	4865.24	.0	.00	.0	.00	2282.60
ROW FENCE	1000.00	LIN FT	.05	.36	52.0	276.48	.0	.00	.0	.00	79.20
REST AREAS ETC.	185.00	EACH	7.98	61.46	1476.0	8533.00	.0	.00	.0	.00	2836.20
WEIGH STATIONS	2.00	EACH	8.00	54.48	16.0	84.96	.0	.00	.0	.00	24.00
SUBWAY PUMPING	.00	EACH	.00	.00	.0	.00	.0	.00	.0	.00	.00
DISASTER MAINT	.00	LB HRS	.00	.00	.0	.00	.0	.00	.0	.00	.00
TRAFFIC SERVICES TOTALS					2398.0	13759.68	.0	.00	.0	.00	5222.00
GENERAL DUTIES	1391.00	LB HRS	.00	.00	1383.0	7688.21	8.0	44.32	.0	.00	2719.30
LOST TIME	110.00	LB HRS	.00	.00	110.0	604.98	.0	.00	.0	.00	312.00
BILLBOARD REMOVA	10.00	L EACH	.00	.00	150.0	828.82	.0	.00	.0	.00	238.40
GENERAL FUNCTIONS TOTALS					1643.0	9122.01	8.0	44.32	.0	.00	3269.70
TRUCKS	952.00	LB HRS	.00	.00	940.0	5103.40	12.0	60.00	.0	.00	1011.60
OTHER EQUIPMENT	1472.00	LB HRS	.00	.00	1472.0	8151.10	.0	.00	.0	.00	1154.80
EQUIPMENT MAINTENANCE TOTALS					2412.0	13254.50	12.0	60.00	.0	.00	2166.40
SIGN MAINTENANCE	60.00	LB HRS	.00	.00	60.0	344.40	.0	.00	.0	.00	123.60
TRAFFIC SIGNING TOTALS					60.0	344.40	.0	.00	.0	.00	123.60
SUPERVISOR	.00	LB HRS	.00	.00	.0	.00	.0	.00	.0	.00	.00
OFFC.PERSNL.,ETC	176.00	LB HRS	.00	.00	176.0	869.10	.0	.00	.0	.00	.00
MISCELLANEOUS TOTALS					176.0	869.10	.0	.00	.0	.00	.00
ERRORS	.00	LB HRS	.00	.00	.0	11.48	.0	.00	.0	.00	.00
ERRONEOUS DATA TOTALS					.0	11.48	.0	.00	.0	.00	.00
GRAND TOTALS					31688.3	176677.16	214.0	1121.41	32.0	233.60	70231.95

Figure B-3. (Continued)

EQUIPMENT USAGE REPORT
DISTRICT NO. 7
MARCH 1976

EQUIPMENT	CODE	HOURS USED	RATE PER HOUR	COS
ASPHALT KETTLE	010	436.0	2.20	59.20
AIR COMPRESSORS TO 150 CU FT	070	136.0	3.50	76.00
AIR COMPRESSORS OVER 150 CU FT	072	112.0	5.00	60.00
ASPHALT DISTRIBUTOR	100	.0	3.00	.00
PULL TYPE GRADERS	171	60.0	.50	30.00
MOTOR GRADER TO 60 HORSEPOWER	172	452.0	3.00	1 56.00
MOTOR GRADER OVER 60 H.P.	173	60.0	6.00	60.00
END LOADER TO 1 CUBIC YARD	221	16.0	3.80	60.80
END LOADER OVER 1 CU YD	222	155.0	8.50	1 17.50
CRAWLER TYPE LOADER	223	.0	12.00	.00
FORCE FEED LOADER	224	.0	12.00	.00
MIXERS, CONCRETE AND BITUMINOUS	230	.0	3.50	.00
MUDJACKS	260	.0	8.00	.00
CRANES & ATTACHMENTS	311	184.0	6.80	251.20
GRADALL	312	136.0	8.80	196.80
ROLLERS, TANDEM	340	.0	8.30	.00
ROLLERS-PATCHING TYPE	341	.0	2.70	.00
SPRAYERS-PAINT	420	.0	1.20	.00
SPRAYERS-WEED	432	.0	2.00	.00
SPREADERS-ROCK, ASPHALT	440	.0	2.30	.00
STREET SWEEPER-SELF PROPELLED	460	.0	12.00	.00
TRACTOR WITH ATTACHMENTS	500	908.0	4.00	632.00
SEWER CLEANERS	540	.0	2.00	.00
CATCH BASIN CLEANER	541	.0	10.00	.00
LANDSCAPING EQUIPMENT, ETC.	542	.0	1.20	.00
HYDRO SEEDER	820	.0	5.40	.00
BRUSH CHIPPERS	900	.0	3.00	.00
PICKUP AND CARRYALL TRUCKS	911	4917.5	1.90	343.25
1-1/2 TON TRUCKS	912	1149.5	3.00	448.50
1-1/2 TON TRUCKS, WINTER USAGE	912	8.0	5.00	40.00
2-1/2 TON TRUCKS	913	1861.0	3.00	583.00
2-1/2 TON TRUCKS, WINTER USAGE	913	35.0	5.00	175.00
4 TON TRUCKS	914	.0	4.00	.00
4 TON TRUCKS, WINTER USAGE	914	.0	7.00	.00
TANDEM AXLE TRUCK	915	52.0	8.00	416.00
TANDEM AXLE TRUCK, WINTER USAGE	915	46.5	11.80	548.70
4 WHEEL DRIVE TRUCKS	916	.0	22.00	.00
4 WHEEL DRIVE TRUCKS, WINTER USE	916	.0	27.00	.00
3 TON TRUCK	917	9253.5	4.00	3 014.00
3 TON TRUCK, WINTER USAGE	917	352.0	7.00	464.00
ROTARY SNOW PLOW, TRUCK TYPE	920	.0	40.00	.00
ERRORS	999	.0	.00	.00
TOTAL		20330.0		0231.95

Figure B-3. (Continued)

MONTHLY MAINTENANCE DIRECT COST SUMMARY
FOR MAJOR WORK FUNCTIONS
(DIRECT LABOR & EQUIP. USAGE COSTS ONLY)

DISTRICT NO. 7

MARCH 1976

TEAM SEC. NO.	LANE MILES	BITUMINOUS PATCHING (410) - TONS UNITS ACCOMP.	UNIT COST LBR. & EQ.	DIRECT COST PER LANE MI.	% OF DIRECT COST	PERMANENT PATCHING (411) - SQ. YDS. UNITS ACCOMP.	UNIT COST LBR. & EQ.	DIPECT COST PER LANE MI.	% OF DIRECT COST	UNI S ACCO	CRACK FILLING (412) - GALS. IP.	UNIT COST LBR. & EQ.	DIRECT COST PER LANE MI.	% OF DIREC COST
7XX **********		.00	.00	.00	.00	.00	.00	.00	.00		00	.00	.00	.00
712	374.2	21.00	95.46	5.35	7.52	.00	873.28	2.33	3.27	1355	00	1.38	5.01	7.03
713	517.9	12.00	92.78	2.14	2.48	99.00	24.11	4.60	5.31	3613	50	1.92	13.43	15.49
722	303.5	16.50	61.18	3.32	3.37	.00	.00	.00	.00	120	00	1.74	.68	.70
723	284.3	13.00	31.08	1.42	1.63	.00	.00	.00	.00		00	.00	.00	.00
731	336.8	104.50	21.32	6.61	9.00	.00	70.88	.21	.29		00	.00	.00	.00
732	362.6	54.50	10.63	1.59	1.64	4.50	176.84	2.19	2.25		00	.00	.00	.00
741	412.1	19.50	13.68	.64	.82	.00	.00	.00	.00		00	.00	.00	.00
742	312.9	173.50	3.54	1.96	2.19	.00	.00	.00	.00		00	.00	.00	.00
DIST. 7 TOT.	2904.0	414.50	19.83	2.83	3.31	103.50	39.87	1.42	1.66	5081	50	1.77	3.11	3.64

Figure B-3. (Continued)

NON-PRODUCTIVE LABOR REPORT
DISTRICT NO. 7
MARCH 1976

JOB FUNCTION	CODE	TECHNICAL HOURS	TECHNICAL COST	NON-TECHNICAL HOURS	NON-TECHNICAL COST
NOT PAID					
TIME OFF	100	.0	.00	332.0	.00
SUB-TOTAL		.0	.00	332.0	.00
PAID					
VACATION	124	255.0	2412.54	480.0	26 0.59
SICK LEAVE	125	95.5	698.49	1340.0	74 2.64
HOLIDAYS	126	.0	.00	.0	.00
PERSONAL OR OTHER LEAVE	127	16.0	117.68	464.0	25 2.64
MILITARY LEAVE	150	.0	.00	.0	.00
SUB-TOTAL		366.5	3228.71	2284.0	126 5.87
TOTAL		366.5	3228.71	2616.0	126 5.87

Figure B-3. (Continued)

PAGE 1 OF 1

OVERHEAD LABOR REPORT
DISTRICT NO. 7
MARCH 1976

JOB FUNCTION	* CODE *	HOURS *	COST *
TECH-NON TECH	*		
SUPERVISOR	* 498 *	.0	.00
OFFICE PERSONNEL, ETC	* 499 *	176.0	869.10
SUB-TOTAL		176.0	869.10
TECH-NON TECH	*		
CLERICAL,ENGINEERS-MAINT	* 990 *	2092.0	16527.83
SUB-TOTAL		2092.0	16527.83
TOTAL		2268.0	17396.93

Figure B-3. (Continued)

PAGE 1 OF 1

REPORT ON WORK PERFORMED IN DISTRICT
BY WORKERS FROM OTHER DISTRICTS FOR
DISTRICT NO. 7
MARCH 1976

WORKERS HOME DISTRICT	REGULAR HOURS	COST	OVERTIME HOURS	COST
01	.0	.00	.0	.00
02	.0	.00	.0	.00
03	.0	.00	.0	.00
04	.0	.00	.0	.00
05	.0	.00	.0	.00
06	.0	.00	.0	.00
07	.0	.00	.0	.00
08	.0	.00	.0	.00
09	.0	.00	.0	.00
ERRORS	.0	.00	.0	.00
TOTALS	.0	.00	.0	.00

Figure B-4. Quarterly Cost Reports and Annual Cost Per Mile Reports

DISTRICT 7

STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION
DISTRICT MAINTENANCE COST REPORT
TOTAL COST 1ST QUARTER 1976

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WORK FUNCTIONS		LABOR COSTS REGULAR DIRECTED	LABOR COSTS REGULAR PRORATED	LABOR COSTS OVERTIME	MATERIALS AND SERVICES DIRECTED	MATERIALS AND SERVICES PRORATED	MATERIALS AND SERVICES CONTRACT MAINT.	TOTAL ACCRUED COSTS	PERCENTAGE
BITUMINOUS SURFACE PATCH	410*	32701.51	.00	113.36	2346.64	.00	.00	35161.51	3.07
PERMANENT PATCHING	411*	8523.02	.00	41.83	4.50	69.00	.00	8638.35	.75
CRACK FILLING	412*	38522.37	.00	.00	486.56	14096.24	.00	53107.17	4.63
BUMP BURNING & JOINT CUTTING	413*	8962.00	.00	.00	176.50	.00	.00	9138.50	.80
MUDJACKING & UNDERSEALING	414*	.00	.00	.00	.00	.00	.00	.00	.00
SEALING	415*	7821.74	.00	41.64	211.35	.00	.00	8074.73	.70
ROADWAY SURFACE TOTALS	*	96530.64	.00	196.83	3227.55	14165.24	.00	114120.26	9.95
SEALING	430*	.00	.00	.00	.00	.00	.00	.00	.00
PATCHING - HAND METHOD	431*	20427.26	.00	.00	5044.10	.00	.00	25471.36	2.22
PATCHING - MACHINE METHOD	432*	825.06	.00	.00	63.88	.00	.00	888.94	.08
CUTTING HIGH SHOULDERS	433*	619.36	.00	.00	.00	.00	.00	619.36	.05
BLADING AND DRAGGING	434*	12971.40	.00	.00	105.52	.00	.00	13076.92	1.14
FILLING EDGE JOINTS	435*	337.04	.00	.00	.00	.00	.00	337.04	.03
SHOULDERS & SIDE APPRO. TOTALS	*	35180.12	.00	.00	5213.50	.00	.00	40393.62	3.52
REPAIRING SLOPES	440*	638.24	.00	.00	.00	.00	.00	638.24	.06
DITCHES - HAND METHOD	441*	10105.83	.00	19.86	.00	.00	.00	10125.69	.88
DITCHES - MACHINE METHOD	442*	31233.56	.00	.00	.00	.00	.00	31233.56	2.73
CLEAN. & REPAIR. SEWERS, ETC	443*	14550.85	.00	.00	288.10	850.75	.00	15689.70	1.37
WALLS, CRIBBING, & RIPRAP	444*	4370.00	.00	.00	.00	.00	.00	4370.00	.38
CARE & REM. OF TREES & PLANTS	445*	60330.47	.00	6.73	.00	.00	.00	60337.20	5.27
MOWING - HAND METHOD	446*	41.24	.00	.00	.00	.00	.00	41.24	.00
MOWING - MACHINE METHOD	447*	.00	.00	.00	.00	.00	.00	.00	.00
RESEEDING & RESODDING	448*	140.44	.00	.00	.00	54.00	.00	194.44	.02
WEED SPRAYING	449*	2611.29	.00	.00	.00	3400.80	.00	6012.09	.52
CLEANING DIRT & DEBRIS - HAND	450*	81198.11	.00	188.07	.00	.00	.00	81386.18	7.10
CLEANING DIRT & DEBRIS - EQUIP.	451*	441.80	.00	85.52	.00	.00	.00	527.32	.05
ROADSIDE & DRAINAGE TOTALS	*	205661.83	.00	300.18	288.10	4305.55	.00	210555.66	18.38
REPAIRING & MAINTAINING BRIDGES	460*	17353.86	.00	40.28	339.70	1008.70	.00	18742.54	1.64
CLEANING BRIDGES	461*	5709.04	.00	.00	.00	.00	.00	5709.04	.50
BRIDGES & FERRIES	462*	.00	.00	.00	.00	.00	.00	.00	.00
BRIDGE STRUCTURES TOTALS	*	23062.90	.00	40.28	339.70	1008.70	.00	24451.58	2.14
SNOW REMOVAL	465*	49800.57	.00	27484.59	69.53	91948.04	.00	169302.73	14.78
PREPARATION FOR SNOW CONTROL	466*	8193.18	.00	1428.44	.00	.00	.00	9621.62	.84
SNOW & ICE CONTROL TOTALS	*	57993.75	.00	28913.03	69.53	91948.04	.00	178924.35	15.62
GUARD RAILS MAINTENANCE	470*	6139.71	.00	.00	.00	.00	.00	6139.71	.54
R.O.W. FENCE MAINTENANCE	471*	458.84	.00	.00	.00	107.29	.00	566.13	.05
MAINT. REST AREAS & HIST.MARKERS	472*	28480.53	.00	650.94	306.08	322.69	.00	29760.24	2.60
WEIGH STATION MAINTENANCE	473*	84.96	.00	.00	2242.22	13.54	.00	2340.72	.20
SUBWAY PUMPING	474*	25.76	.00	.00	22.38	.00	.00	48.14	.00
DISASTER MAINTENANCE	475*	51.68	.00	.00	.00	.00	.00	51.68	.00
TRAFFIC SERVICES TOTALS	*	35241.48	.00	650.94	2570.68	443.52	.00	38906.62	3.39

Figure B-4. (Continued)

DISTRICT 7 — STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION — PAGE 2 OF 2

DISTRICT MAINTENANCE COST REPORT

TOTAL COST 1ST QUARTER 1976

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WORK FUNCTIONS		LABOR COSTS REGULAR DIRECTED	LABOR COSTS REGULAR PRORATED	LABOR COSTS OVERTIME	MATERIALS AND SERVICES DIRECTED	MATERIALS AND SERVICES PRORATED	CONTRACT MAINT.	TOTAL ACCRUED COSTS	PERCENTAGE
GENERAL DUTIES	480*	28346.50	93.12	368.47	112.36	.00	.00	28920.45	2.52
LOST TIME	481*	3188.16	27.40	.00	.00	.00	.00	3215.56	.28
BILLBOARD REMOVAL	482*	2244.48	.00	.00	.00	.00	.00	2244.48	.20
MAINTENANCE - GENRL FUNCTION TOTALS	*	33779.14	120.52	368.47	112.36	.00	.00	34380.49	3.00
TRUCKS	490*	26155.24	.00	93.24	10.82	9569.69	.00	35828.99	3.13
OTHER EQUIPMENT	491*	23002.88	49.00	108.56	.00	.00	.00	23160.44	2.02
EQUIPMENT MAINTENANCE TOTALS	*	49158.12	49.00	201.80	10.82	9569.69	.00	58989.43	5.15
SIGN MAINTENANCE	495*	703.24	.00	.00	.00	.00	.00	703.24	.06
SUPERVISOR	498*	.00	.00	.00	.00	.00	.00	.00	.00
OFFICE PERSONNEL,STOREKEEPER ETC.	499*	.00	2425.76	.00	.00	.00	.00	2425.76	.21
MISCELLANEOUS TOTALS	*	.00	2425.76	.00	.00	.00	.00	2425.76	.21
GAS & OIL	*	.00	.00	.00	19.90	71861.39	.00	71881.29	6.27
CITY MAINTENANCE BY AGREEMENT	*	.00	.00	.00	.00	.00	140.64	140.64	.01
TRAVEL	*	.00	.00	.00	.00	1163.19	.00	1163.19	.10
TELECOMMUNICATION	*	.00	.00	.00	.00	18734.97	.00	18734.97	1.64
LABOR CODE ERRORS-MISC MATL-SERV CONT. SERV.	000*	.00	5302.65	.00	160.66	98456.26	593.41	104512.98	9.12
ALL WORK FUNCTIONS TOTALS	*	537311.22	7897.93	30671.53	12012.80	311656.55	734.05	900284.08	78.56
TIME OFF WITH PAY-OTHER 124-127 & 150	*	65615.70	16077.73					81693.43	7.13
DISTRICT/REGION	990*	.00	53916.33					53916.33	4.71
BUREAU	990*	.00	10053.92					10053.92	.88
ADMINISTRATION & SUPERVISION TOTALS	*	.00	63970.25					63970.25	5.59
REGULAR LABOR COSTS TOTALS	*	602926.92	87945.91					.00	.00
EQUIPMENT PURCHASES								25292.60	2.21
MAINTENANCE CONTRIBUTION TO S.E.R. & SOCIAL SECURITY								74614.23	6.51
TOTAL ACCRUED COSTS								1145854.59	100.00
CREDITS ACCRUING TO STATE									
TOTAL ACTUAL COST TO STATE								1145854.59	

R-25

Figure B-4. (Continued)

LCS-R028 STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION PAGE 47
SUBSECTION COST PER LANE MILE REPORT
YEAR OF 1975.

DISTRICT	SECTION	SUBSECTION	ROADWAY CLASS	SUBSECTION CATEGORY	SPECIAL BR & RD SUBSECTION TYPE CODE	LANE MILES-RD LINEAL FEET-BR	COST PER LANE MILE-RD LINEAL FOOT-BR
7	712	128	P	N		5.3	$ 523.22
7	712	129	P	N		20.5	$ 1,115.93
7	712	140	P	N		17.1	$ 1,089.28
7	712	185	P	N		39.3	$ 1,761.12
7	712	186	P	N		17.7	$ 958.18
7	712	370	P	N		13.8	$ 883.33
7	712	400	P	N		52.0	$ 1,801.23
7	712	510	P	N		55.5	$ 1,536.86
7	712	570	I	N		36.1	$ 818.76
7	712	700	I	N		104.3	$ 1,662.50
7	712	800	I	B	0	105.0	$ 0.04
7	712	801	I	B	2	113.0	$ 0.04
7	712	802	I	B	9	1,095.0	$ 0.00
7	712	803	I	B	8	475.0	$ 0.00
7	712	820	P	O		2.3	$ 322.51
7	712	821	P	O		1.7	$ 323.30
7	712	951	P	U		1.8	$ 334.98
7	712	952	P	U		1.9	$ 323.00
7	712	953	P	U		2.8	$ 322.22
7	712	954	P	U		2.1	$ 322.35
7	713	128	P	N		1.9	$ 1,242.75
7	713	130	P	N		41.5	$ 1,678.17
7	713	320	P	N		7.4	$ 963.07
7	713	330	P	N		44.7	$ 1,624.68
7	713	331	P	N		54.6	$ 834.67
7	713	370	P	N		17.4	$ 1,091.07
7	713	371	P	N		9.0	$ 952.60
7	713	400	P	N		36.4	$ 1,176.64
7	713	401	P	N		10.2	$ 1,538.65
7	713	450	P	N		17.0	$ 1,271.67
7	713	451	P	N		25.6	$ 1,104.65
7	713	490	P	N		25.3	$ 1,182.0
7	713	570	I	N		86.9	$ 1,523.1
7	713	700	I	N		78.5	$ 2,570.5
7	713	800	I	B	4	156.0	$ 5.5
7	713	801	I	B	5	422.0	$ 7.8
7	713	802	I	B	6	121.0	$ 6.9
7	713	820	P	O		2.3	$ 313.1
7	713	821	P	O		.1	$ 5,451.0
7	713	822	P	O		2.3	$ 313.0
7	713	823	P	O		3.0	$ 313.9
7	713	824	P	O		1.7	$ 2,710.7
7	713	825	P	O		1.6	$ 314.4
7	713	850	P	O		.2	$ 334.0
7	713	908	P	U		9.9	$ 1,038.9
7	713	909	P	U		15.1	$ 833.5
7	713	922	P	U		1.0	$ 316.4
7	713	923	P	U		1.2	$ 827.0
7	713	925	P	U		2.5	$ 352.0
7	713	926	P	U		20.6	$ 822.7

Figure B-4. (Continued)

LCS-R043 STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION PAGE 01

ANNUAL COST PER LANE MILE REPORT

SPECIAL ROADWAY SUBSECTIONS - MAIN LINE SURFACE COSTS ONLY

YEAR OF 1975

SURFACE TYPE CODE	NO. SUBSECTIONS	TOTAL LANE MILES	TOTAL COST	COST PER LANE MILE
0	4	349.3	$ 23,875.23	$ 6(.35
1	6	390.5	$ 51,519.93	$ 13(.93
				$ (.00
3	5	383.1	$ 69,512.78	$ 18(.44
4	2	92.0	$ 26,069.43	$ 28(.36
5	1	132.0	$ 59,000.98	$ 44(.97
6	3	58.4	$ 3,280.39	$ 5(.17
				$ (.00
8	3	81.7	$ 3,207.21	$ 3(.25
9	1	13.3	$ 389.44	$ 2(.28

Figure B-4. (Continued)

LCS-R044 STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION PAGE 01
ANNUAL COST PER LINEAL FT. REPORT

SPECIAL B-IDGES
YEAR OF 1975

BRIDGE TYPE CODE	NO SUBSECTIONS	TOTAL LINEAL FEET	TOTAL COST	COST PER LINEAL FOOT
INTERSTATE AND EXPRESSWAY				
0	8	850.0	$ 450.79	$).53
1	2	259.0	$ 50.36	$).19
2	10	3,697.0	$ 388.20	$).10
3	9	5,705.0	$ 59,493.68	$ 1).42
4	11	2,881.0	$ 1,359.73	$).47
5	12	3,283.0	$ 7,649.38	$).32
6	10	3,185.0	$ 2,444.36	$).76
7	5	900.0	$ 732.82	$).81
8	9	4,224.0	$ 3,655.73	$).86
9	6	10,504.0	$ 9,901.19	$).94
J	4	23,839.0	$ 12,299.90	$).51
PRIMARY				
0	9	993.0	$ 341.02	$).34
1	8	1,463.0	$ 5,989.31	$ .09
2	7	2,668.0	$ 1,948.63	$).72
3	11	2,696.0	$ 2,559.02	$ .94
4	7	1,757.0	$ 147.33	$).08
5	10	3,250.0	$ 878.00	$).27
6	7	1,661.0	$ 22.10	$ .01
7	1	270.0	$ 12,885.63	$ 4 .72
8	10	4,309.0	$ 7,269.00	$ .68
9	8	13,254.0	$ 21,931.94	$ .65
J	21	25,445.0	$ 1,413,140.21	$ 5 .53

Figure B-4. (Continued)

LCS-R045

STATE OF ILLINOIS - DEPARTMENT OF TRANSPORTATION
ANNUAL COST PER LANE MILE REPORT
BY SYSTEMS
YEAR OF 1975

	DISTRICT	LANE MILES	TOTAL COST	COST PER LANE MILE
REGULAR SYSTEM				
	1	3,060.3	$ 6,730,227.94	$ 2,199.20
	2	3,886.2	$ 6,147,253.09	$ 1,581.81
	3	3,483.6	$ 5,102,779.41	$ 1,464.80
	4	2,620.7	$ 4,327,023.31	$ 1,651.09
	5	3,730.2	$ 5,194,946.10	$ 1,392.67
	6	3,678.3	$ 5,318,415.85	$ 1,446.00
	7	2,240.1	$ 3,344,872.46	$ 1,493.17
	8	3,115.1	$ 5,178,696.70	$ 1,662.44
	9	2,136.3	$ 3,488,799.57	$ 1,633.10
	0	3,698.0	$ 7,902,654.20	$ 2,137.00
	TOTAL	31,648.5	$ 52,735,668.63	$ 1,666.29
INTERSTATE SYSTEM				
	1	401.5	$ 1,288,933.42	$ 3,218.31
	2	471.5	$ 788,698.48	$ 1,672.74
	3	921.9	$ 1,600,478.98	$ 1,736.06
	4	345.2	$ 711,334.98	$ 2,060.64
	5	803.9	$ 1,145,606.66	$ 1,425.06
	6	401.8	$ 657,318.12	$ 1,635.18
	7	681.6	$ 873,355.66	$ 1,281.33
	8	571.7	$ 1,001,857.41	$ 1,752.41
	9	396.5	$ 614,695.04	$ 1,550.30
	TOTAL	4,994.6	$ 8,681,978.75	$ 1,738.27
URBAN EXPRESSWAY SYSTEM				
	1	944.6	$ 9,180,397.50	$ 9,718.82
	TOTAL	944.6	$ 9,180,397.50	$ 9,718.82

ERROR LINE COSTS FROM THE COST REPORT ARE INCLUDED

APPENDIX C

LOUISIANA DEPARTMENT OF HIGHWAYS

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 3,764,000 residents of Louisiana operate 2,057,000 motor vehicles on 52,845 miles of highways of which 16,500 miles are under state control. The state occupies 48,523 square miles from 5 feet below sea level to 535 feet above sea level. Mean minimum and maximum temperatures are 36 and 94°F with average annual moisture from 48 to 64 inches.

The Louisiana Department of Highways has a 86,000,000 dollar maintenance budget for fiscal year 1975-1976. This budget will be used by its 9 districts to maintain 36,225 lane miles (16,554 center line miles) which consist of 515 Interstate highway lane miles, 4,283 primary highway lane miles, 4,275 secondary highway lane miles, 6,988 Farm-to-Market lane miles and 492 frontage road lane miles.

Nine districts comprise the Louisiana Department of Highways. Each district is divided into parish gangs resulting in a total of 62 parish gangs state wide. Sixty-four parishes exist in Louisiana. Two to 3 foremen operate crews within each parish gang. State wide crews for bridge repair and accident damage crews exist. District wide crews are often involved in maintenance betterment activities and activities such as seal coats, placing hot mix, structures repair, mud jacking and certain traffic service activities. Three thousand seven hundred sixteen (3,716) maintenance employees in the state are

distributed as follows: central office - 184, district administrative staff - 324, district wide crews - 894, river crossing staffs - 542, parish gangs - 1,772. Typically parish gangs have about 60 percent of their employees as equipment operators and 40 percent laborers.

Superintendents are in responsible charge of the parish gangs with assistance from the crew leaders or foreman. Superintendents report to maintenance specialists at the district level. Maintenance specialists report to the District Maintenance Engineer and the Assistant District Engineer for Maintenance who in turn report to the District Engineer. The administration of the maintenance program by the Director of the Louisiana Department of Highways is performed at the central office level by the Chief Construction and Maintenance Engineer.

The basic maintenance recording and reporting system was implemented in 1969. A single recording system is being utilized. These data are utilized to produce separate maintenance management and fiscal reports. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Louisiana Department of Highway Form LDH-03-41-4058 "Daily Work Report" and LDH-03-15-4125 "Biweekly Activity Report" are utilized to collect maintenance activity information (Figures C-1 and C-2). The Daily Work Report is filled out daily by the foreman. The Biweekly Activity report is filled out by the parish gang clerk based on information obtained from the Daily Work Reports. The

types of information obtained on this form includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization and
6. Accomplishments

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information.

1. District. A two digit code is utilized to identify the district. The entry can either be for the district or section number of the gang foreman responsible for preparing the daily report.

2. Parish Gang. A three digit code is utilized to identify the gang whose foreman is preparing the daily report.

3. Parish. A two digit numerical code from 01 to 64 is utilized to identify the parish in which the work was performed. If the function is not chargeable to a single parish, the appropriate Districts (90 thru 98) or State-wide (99) Parish Code is used.

4. System. Entries for system codes are utilized to identify and determine the distribution of expenditures into the following categories:

1 - Interstate
2 - Primary
3 - Secondary
4 - Farm-to-Market

5 - Buildings and Grounds

6 - Overhead and Undistributed Expense

7 - Parish Road

8 - City Street and

9 - Parking Lot, Driveway, etc.

5. Structures. A single digit code (1 through 5) identifies the type of structure on which the work is performed. The codes are shown below.

1. Timber
2. Concrete
3. Steel
4. Elevated Roadway
5. Pontoon Bridge

In addition a ten digit numerical code is utilized to designate a particular structure. This code is composed of a 5 digit control section number followed by a five digit structure identifying code.

6. Control Unit. A five digit numeric code is utilized to identify a specific segment of highway on which maintenance was performed. The control unit is utilized only with activities involving surface and shoulder maintenance.

A seven digit project number can be assigned to a specific maintenance project. This unique number which consists of the control unit and a two digit project number is recorded in the space titled "Project Number."

7. Milepost. Milepost designations are not utilized to designate maintenance activity location.

Information is not recorded which indicates the lane in which a maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed

on the pavement shoulder, roadside, traffic services, etc.

Activity

Maintenance function codes are utilized to designate the maintenance activity performed (Figure C-3). One hundred twenty-four function codes are presently utilized and are divided into the following major groups:

1. Bituminous Surface
2. Concrete Surface
3. Gravel or Shell Surface
4. Shoulder Maintenance
5. Roadside and Drainage
6. Structure Maintenance
7. Traffic Services
8. River Crossing Operation
9. Unusual or Disaster Maintenance
10. State Force Construction
11. Maintenance Overhead
12. Service Centers and Clearing Accounts and
13. Administration

A written description of the work is also required for those codes whose last digit is 9. For example, other bituminous maintenance, other concrete surface maintenance, etc.

It should be noted that special function codes exist for bituminous, portland cement concrete and unsurfaced roadways. Designation of the maintenance function on the reporting form is under the heading "Function Number."

Manpower

Manpower utilization for a particular function is recorded by the foreman for each individual. The employee's name is given along with the identifying employee number. The regular hours worked and the over-time worked is recorded to the nearest half-hour. This time is assigned to a specific maintenance function and foreman as described above. Hours taken for annual leave, sick leave, compensatory time off, etc. are recorded on the Daily Work Report and the Biweekly Activity Report.

The recording system allows men borrowed from other gangs to be properly charged. Miscellaneous and overhead labor charges can be properly assigned by the use of function codes.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by an equipment number. A six digit numeric code is utilized. The first three digits refer to an equipment class and the last three digits refer to a particular item of equipment within that class. Equipment usage is reported either in terms of miles or hours. Miles is the reporting unit for smaller pieces of equipment.

All equipment used on a job site must be charged to a function. For example, if a gradall was used only two hours at a job site, but remained there all day, it is charged out as being used 8 hours. Equipment hours or mileage including travel to the job site, materials haul, etc. must be charged to the proper maintenance function.

Materials

Materials utilized for a particular function are recorded daily. A description of each type of material used such as asphalt cement, base material, hot mix, etc. and the location from which the material was obtained is noted on the form. The amount of material and the unit of measure for each material is also recorded. Stockpile and materials eight digit codes are recorded on the Biweekly Activity Report.

Accomplishments

Work performance is reported for most of the maintenance functions involving maintenance activities performed on the roadway. Accomplishments are usually measured in quantities of weight or volume materials, lengths and area of surfaces and in numbers of items. The units of measure used for accomplishments are shown for each function code on Figure C-3.

As mentioned above the Biweekly Activity Report is filled out daily by the parish clerk based on input from the foreman's Daily Work Report. A separate Beweekly Activity Report must be filled out for such maintenance function. Daily labor, equipment and material entries are totaled over a two week period. These biweekly totals are reported for data processing purposes.

COLLECTION AND PROCESSING OF RECORDED DATA

The Daily Work Report is filled out daily by the foreman of the individual crew or gang for each employee in the gang. The parish clerk transfers these data to the Biweekly Activity Report on a daily basis. Totals are obtained biweekly on Biweekly Activity

Reports by the parish clerk. These forms are then transmitted biweekly to the district office for key punching and transmission through a remote terminal to the central office for processing and reporting. Errors recognized by the central computer are referred to the district for correction.

It is estimated that about four-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. Sixty-two parish clerks require approximately two hours per day to prepare the Biweekly Activity Reports at a cost of approximately $115,000 per year. Foreman costs associated with data recording amounts to about $80,000 annually. District lane charges are probably of the order of $20,000 annually for key punching and data transmission. Central office data processing charges are $100,000 annually which includes programming and systems design.

A computerized auditing procedure is utilized to identify certain errors such as employee name and number, equipment numbers, accomplishment units, etc. In addition if certain productivity or accomplishments are reported outside a predetermined range of variance (say $\pm$ 20 % of the work standard) an error message or exception note is returned to the district. This auditing procedure, in addition to that performed at the parish level, improves the accuracy of the reported data.

REPORTS

Several reports are produced for use by management. These reports include a maintenance performance report, a quantity report, a

productivity report and an accounting report. The Performance Report is a quarterly report for each manager which emphasizes amounts of work accomplished. The productivity analysis report is an annual summary organized to help review performance on individual work functions. This report shows the number of organizations which achieve standard productivity and those which do not achieve standard productivity. The quantity analysis report is produced annually for evaluation of the amounts of work performed. This report was designed to verify and update standards and to initiate further research where needed. A brief discussion is presented below indicating the types of data contained on these reports.

Maintenance Performance Report. The Maintenance Performance Report is issued quarterly about one month after the end of the reporting period (Figure C-4). The report list planned and actual accomplishment quantities, planned and actual hours, planned and actual total, planned and actual unit cost and planned and actual man hour rates per quantity of material utilized for each maintenance function. The percent of actual to planned quantities are reported for labor, total cost, etc. This report can be furnished for individual districts as well as for statewide totals.

Productivity Analysis Report. This report is produced annually and displays material quantities, labor hours, total costs, unit costs and productivity rates together with the percent of costs for labor, equipment, and material functions (Figure C-5). The report is prepared such that individual maintenance crews or parish gangs can be compared for a particular maintenance function.

Actual and planned quantities are displayed for parish gangs. Cost distribution of work is also monitored, i.e. labor, equipment, material, and percent.

Quantity Analysis Report. This report is produced annually and illistrates the annual quantity of material placed by maintenance function on interstate, primary, secondary and farm-to-market roads. This report is prepared to assist in the revision of standards.

Maintenance planning reports are prepared. These reports become the basis of the planned quantities reported on the maintenance performance report and productivity analysis report. Planning quantities are based on historical quantities required to perform the various maintenance activities. A preliminary budget report is prepared for the district and parish gang by the central office (Figure C-6). This budget is reviewed by the district staff. A field worksheet can and has been utilized to supply field input to develop the budget information. This form is shown in Figure C-7.

As described above, monthly, quarterly, and annual reports are produced depending on the use of the reports. Reports are returned to the district approximately one month after the end of the reporting period.

Reports are utilized for fiscal control, for monitoring program execution, for allocation of manpower and equipment and for budget preparation and planned work units. The majority of the reports are utilized at the central office and district office level.

Maintenance function activities that appear contrary to planned budgets due to productivity problems or poor planning must be located

by a detailed review of maintenance reports. The auditing procedure described above does, however, identify productivity rates in excess of or below certain standard levels. Other types of exception reports are presently not a part of the reporting system, but are being developed.

OTHER ITEMS

The Louisiana Department of Highways is satisfied with the reliability of the existing system although improvements can be made. It is estimated that data input is 90 percent or more reliable.

The recording and reporting system can be altered by direction of the central office maintenance staff as the need arises. The central office continually works with the districts through district engineering meetings and other meetings to assess the usefulness of the recorded and reported information.

A maintenance standard committee exists which is responsible for revision of the work standards. Meetings are held quarterly.

Changes in the maintenance management system are directed by the central office with changes usually occurring at the beginning of the fiscal year.

Data collected since 1967 have been stored on tapes and therefore can be retained for an extended period of time.

References

Crawford, F. E. and M. Jackson, "Implementing Findings from the Louisiana Maintenance Research Project," Highway Research Board, Special Report 100, 1968.

Figure C-1.

DAILY WORK REPORT

DIST. - SUBDIST. OR SECT. _____ GANG NO. _____ GANG FOREMAN _____ DATE _____

STATE SYSTEM CODE
1-INTERSTATE
2-PRIMARY
3-SECONDARY
4-FARM-TO-MARKET
8-BLDGS. & GROUNDS
9-OVERHEAD & UNDISTRIBUTED EXPENSE

OFF-SYSTEM CODE
7-PARISH ROAD
8-CITY STREET
9-PARKING LOT
DRIVEWAY, ETC.

STRUCTURE CODE
1-TIMBER
2-CONCRETE
3-STEEL
4-ELEVATED ROADWAY
5-PONTOON BRIDGE

LOCATION 1- _____ LOCATION 2- _____ LOCATION 3- _____

WORK DESCRIPTION
1-
2-
3-

BAR NO. 1	BAR NO. 2	BAR NO. 3
AUTH.	AUTH.	AUTH.
PARISH	PARISH	PARISH
FUNCTION NO.	FUNCTION NO.	FUNCTION NO.
SYSTEMS CODE	SYSTEMS CODE	SYSTEMS CODE
STRUCTURE CODE	STRUCTURE CODE	STRUCTURE CODE
STRUCTURE NO.	STRUCTURE NO.	STRUCTURE NO.
CONTROL UNIT	CONTROL UNIT	CONTROL UNIT
PROJECT NUMBER	PROJECT NUMBER	PROJECT NUMBER

EMPLOYEE NAME	MEN BORROWED FROM GANG NO.	HOURS WORKED	OVER TIME	HOURS WORKED	OVER TIME	HOURS WORKED	OVER TIME

EQUIPMENT TYPE	EQUIPMENT NO.	HOURS	MILES	HOURS	MILES	HOURS	MILES

DESCRIPTION OF MATERIALS USED	QUANTITY	MEASURE CODE	QUANTITY	MEASURE CODE	QUANTITY	MEASURE CODE

ACCOMPLISHMENT	QUANTITY	MEASURE CODE	QUANTITY	MEASURE CODE	QUANTITY	MEASURE CODE

Figure C-2. Biweekly Activity Reports

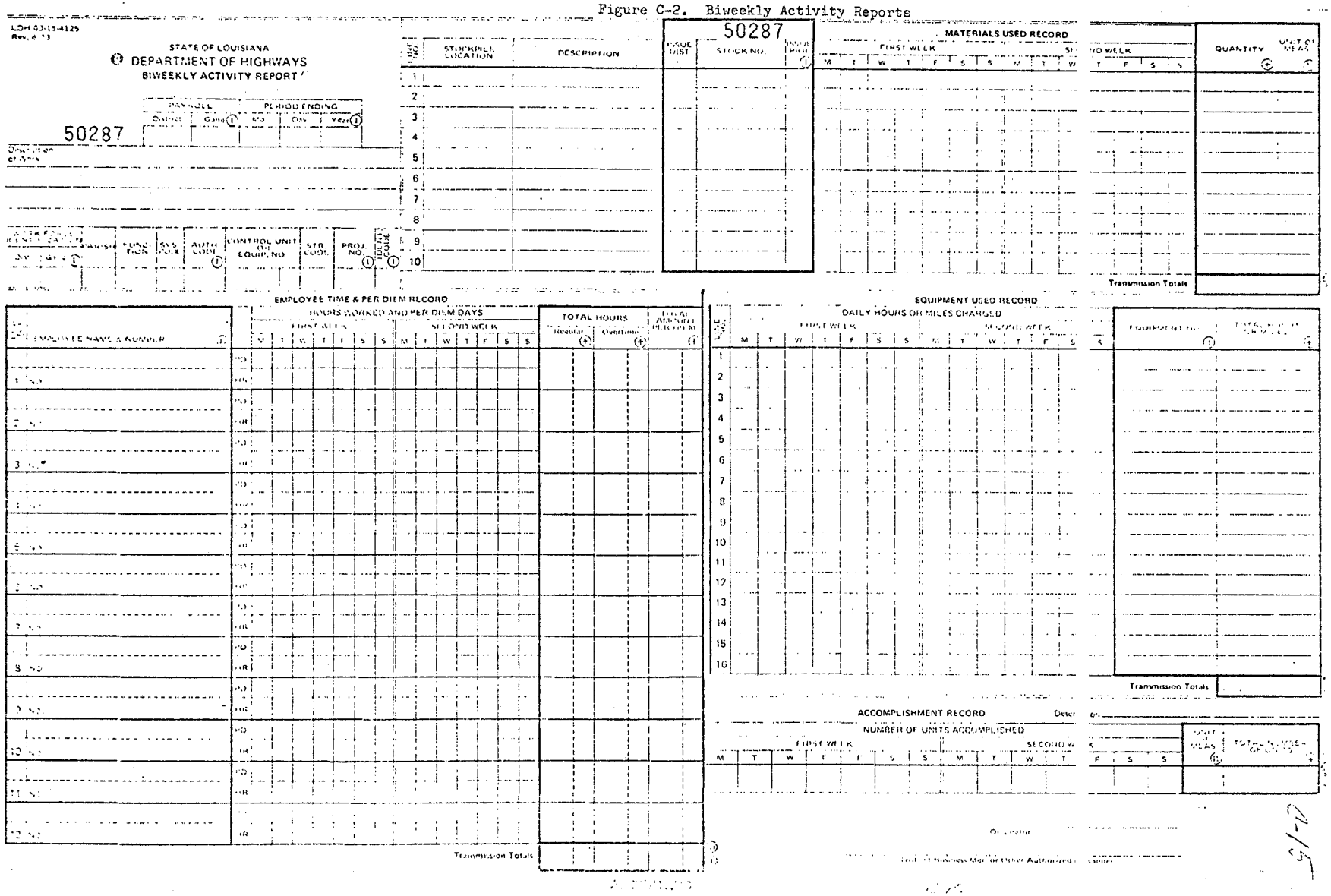

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Figure C-3. Function Codes

Louisiana Department of Highways

FUNCTION CODES FOR MAINTENANCE WORK REPORTING

July 1, 1975

SURFACE MAINTENANCE										
BITUMINOUS SURFACE	CONCRETE SURFACE	GRAVEL OR SHELL SURFACE	SHOULDER MAINTENANCE	ROADSIDE AND DRAINAGE	STRUCTURE MAINTENANCE (OVER 20' SPAN)	TRAFFIC SERVICE	RIVER CROSSING OPERATION	UNUSUAL OR DISASTER MAINTENANCE	STATE FORCE CONSTRUCTION	MISCELLANEOUS
411* Surface Tr. Patching (*C. Y. Aggr.)	421* Patching Surface (*C. Y. Aggr.)	431* Patching Surface (*C. Y. Aggr.)	441* Patching Non-Paved Shoulders (*C. Y. Material)	461 Erosion Control and Repair	481* Painting Structures (*Gal. Paint)	511 Snow & Ice Control	561 Operation of Ferries	601 Storm Damage	621 Earthwork & Grading	MAINTENANCE OVERHEAD
412* Premix Patching (*Tons Premix)	422* Premix Patching (*Tons Premix)	432* Reshaping Surface (*Miles Bladed)	442* Reshaping Non-Paved Shoulders (*Miles Bladed)	462 Clean and Rep. Drain Structures	482 Foundation Repair	531* (Sect. 45 Only) Pavement Striping (*Miles Painted)	563 Operation of Bridges	602 Accident Damage	622 Drainage	651 Field Maintenance Supervision 653 Material Handling & Stockpiling 654 Sales Tax 655 Field Maintenance Standby Time 660 Maintenance Units 661 Small Tools, Minor Equipment & Protective Clothing 662 Testing of Maintenance Materials 665 Radio Communications System 666 Minor Electrical Maintenance 667 Training 668 Travel (Change in Work Location) 680 City Streets & Traffic Signals 690 Severance Tax 698 Detached Services 699 Other Maintenance Overhead Functions
413* Patching Base (*C. Y. Material)	425* Joint Repair (*100 L. F. Joint)	433* Restoring Surface (*C. Y. Material)	443* Restoring Non-Paved Shoulders (*C. Y. Material)	463* Clean and Reshape Ditches (*Miles Cleaned)	483 Structural Repair	532* Electric Signals (*Install. Serv.)	564 Operation Tunnels		623 Base & Surface	
415* Seal Coat (*Miles Sealed)	429 Other Conc. Surface Maintenance	439 Other Gravel or Shell Maintenance	451* Surface Tr. Patching Shoulders (*C. Y. Aggr.)	464* Machining Ditches (*Miles Machined)	484 Deck and Rail Repair	533* Signs, Guide Posts, & Delineators (*Install. Serv.)			624 Shoulder Improvement	
416* Premix Leveling (*Tons Premix)			452* Premix Patching Shoulders (*Tons Premix)	470* Mowing (*Acres Mowed)	485 Repair & Maintain Mechanism for Movable Spans	534 Guard Rails			625 Roadside Development	SERVICE CENTERS & CLEARING ACCOUNTS
417* Spot Surface Replacement (*Tons Premix)			455* Slurry Seal (*Miles Sealed)	471 Cutting Brush	486 Channel Repair and Protection	535 (Sect. 45 Only) Recondition Signal Parts			626 Structures (Over 20' Span)	700 Automotive, Road & Marine Equipment 701 Office Furniture & Equipment 704 Shop Equipment 705 Miscellaneous Equipment 706 Land & Improvements 707 Buildings & Improvements 720 Operating & Maintaining Leased or Rented Auto., Rd. & Marine Equipment 730 Equipment Repair Shop Overhead 731 Fabr. Auto., Rd. & Marine Equipment 732 Repr. or Serv. Auto., Rd. & Mar. Equip. 734 Sales Tax on Purchase of Equipment 737 Service Charges on Parts Contracts for Automotive, Rd. & Marine Equip. 742 Small Tools Rental 744 Equip. Serv. & Insps. (Sect. 45 only) 761 Inventory 762 Inventory - Finished Signs (Sect. 45 only) 771 Fabr. & Recond. Signs (Sect. 45 only) 772 Reclaiming Aluminum (Sect. 45 only) 774 Sign Shop Overhead (Sect. 45 only) 775 Fabr. Signs (Dist. & Sect. other than Sect. 45) 777 Transf. of Fabr. Signs to Inventory (Credit) 778 Transf. to Dist., Sect., Cont. Unit or Proj., etc. (Credit)
418* Slurry Seal (*Miles Sealed)			459 Other Shoulder Maintenance	472 Landscape Maintenance	487 Tunnel Repair	538 Hand Striping			627* Sign Installations (*Install. Serv.)	
419 Other Bit. Surface Maintenance				473* Litter Cleaning Roadside (*C. Y. Hauled)	488 Ferry Ramp Repair	540* Reflectorized Pavement Markers (*Markers Plcd)			628* Signal Installations (*Install. Serv.)	
				474* Servicing Litter Barrels (*Barrels Serv.)	489 Bailey Bridges	541* Hot Plastic Marking (*Lbs. Material)			629 Traffic Service Betterments	
(*) Report Work Accomplishment With These Work Functions				476* Herbicide Application (*Acres Sprayed)	490 Inspection of Structures and Bridges	555 Operation of Pit Scales			630 (Sect. 45 Only) Signal Fabrication	
				479 Other Roadside & Drainage Maintenance	491 Payment to Others for Maintaining Ferries & Bridges	557 Operation of Rest Areas			631 Minor Betterments	ADMINISTRATION
					499 Other Structure Maintenance	559 Other Traffic Services			632* Hot Mix in Place (*Tons Placed)	811 Annual Leave Taken 812 Sick Leave Taken 813 Compensatory Leave Taken 814 Other Leave Taken 820 Admin. & Gen. Office Overhead 823 Compensatory Leave Paid 824 Annual Leave Paid (Terminal Leave Only). 883 Custodial Services 884 Grounds Maintenance 885 Building Maintenance 910 Administrative Engineering
									633* Plant Mix Seal (*Tons Placed)	

Figure C-4. Maintenance performance report.

Fiscal Year 1967 68
Period From 07 01 67 To 09 30 67

District No 08 Parish NATCHITOCHES Parish Supt. Gang No. 085

FUNCTION		ACCOMPLISHMENT UNIT	QUANTITY			LABOR HOURS			TOTAL COST			UNIT COST			RATE—MH O		
NAME	NO		PLAN	ACTUAL	%	PLAN	ACTUAL	%	PLAN	ACTUAL	%	PLAN	ACTUAL	%	%	ACTUAL	%
BITUMINOUS SURFACE																	
SURFACE TREAT PATCH	411	CY AGGR	1212	124	10	2424	1607	66	16968	5792	34	1400	4671334		20	130698	
PREMIX PATCHING	412	TONS MIX	1084	525	48	3252	1847	57	21680	9283	43	2000	1770 88		30	35117	
PATCHING BASE	413	CY MAT	509	434	85	1019	688	68	3565	2159	61	700	497 71		20	15 79	
CRACK REPAIR	414	GAL FILL										180			5		
SEAL COAT	415	SQ YD		54068			344			4792			9				
CONCRETE SURFACE																	
PATCHING SURFACE	421	CY CONC	89			443			2655			3000			50		
PREMIX PATCHING	422	TONS MIX	50			150			1000			2000			30		
PATCHING BASE	423	CY MAT	90			180	7	4	630	20	3	700			20		
CRACK REPAIR	424	GAL FILL										180			5		
JOINT REPAIR	425	100 LN FT										270			9		
GRAVEL-SHELL SURFACE																	
PATCHING SURFACE	431	CY AGGR	18	79	439	12	117	975	105	564	537	600	713119		7	15212	
RESHAPE SURFACE	432	ROAD MI	219	72	33	350	220	63	1313	974	74	600	1353226		16	31191	
SHOULDER + APPROACH																	
PATCH NON-PAV SHLDR	441	CY MAT	175	373	213	175	667	381	628	2246	358	358	602168		10	15179	
RESHAP NON-PV SHLDR	442	SHLDR MI	473	97	21	710	444	63	3607	1946	54	762	2007263		15	46335	
PATCHING BASE	453	CY MAT					6			13							
ROADSIDE + DRAINAGE																	
CLEAN-REP DRAIN STR	462						482			1059							
CLEAN-RESHAPE DITCH	463	DITCH MI	2			360	120	33	1080	297	27	60000			000		
MOWING	470	ACRES	7294	2996	41	7294	3783	52	25529	12670	50	350	424121		10	13126	
LITTER CLEANING	473	LOADS	53	15	28	1066	322	30	2399	715	30	4500	4764106		200	215107	
BERM LITTER BARRELS	474	BARRELS		403			219			569			141			5	
TRAFFIC SERVICE																	
SIGN MAINTENANCE	533						240			464							
DISASTER MAINT																	
ACCIDENT DAMAGE	602						132			375							
MAINT OVERHEAD																	
OTHER GENERAL FUNCT	699						2838			6369							
TOTAL PLANNED MAINT						17435	14083	81	81159	50334	62						
STATE FORCE CONSTR							4286			29891							
LEAVE							4496			8933							
ADMIN AND OVERHEAD							2904			6669							
TOTAL STATE HIGHWAY							25769			95826							
OFF SYSTEM WORK							84			417							
TOTAL							25853			96243							

Figure C-5. Productivity analysis.

Fiscal Year 1967-68
Period From 06-28-67 To 07-25-67

District No 08 Function SURFACE TREAT PATCH Function No 411 Accomplishment CY AGGR

PARISH SUPERINTENDENT LOCATION		GANG NO	QUANTITY	LABOR HOURS	TOTAL COST	PERCENT OF COST LABOR	EQUIP	MAT	CONTR	UNIT COST	RATE MH D
ALEXANDRIA		210	9	54	220	44	22	34		2443	60
ALEXANDRIA		211	78	736	2994	48	26	26		3839	94
	ACTUAL		87	790	3214	48	26	26		3694	91
	PLAN		816	1632	11424	29	15	56		1400	20
FESTER		120	100	800	2893	53	20	27		2893	80
FESTER		220	12	194	403	54	19	27		3356	87
FESTER		221	27	312	915	65	13	22		3388	116
	ACTUAL		139	1216	4211	56	10	26		3029	87
	PLAN		763	1526	10682	29	15	56		1400	20
MARY		130	98	440	2010	45	22	33		2051	45
MARY		230	136	438	2107	38	19	43		1550	30
	ACTUAL		234	878	4108	41	21	38		1760	36
	PLAN		870	1740	12180	29	15	56		1400	20
LEESVILLE		140	137	464	2413	37	21	42		1761	34
LEESVILLE		240	78	416	1940	45	21	34		2358	53
LEESVILLE		241	126	464	2328	36	21	43		1847	37
	ACTUAL		341	1344	6680	39	21	40		1930	39
	PLAN		839	1677	11739	29	15	56		1400	20
NATCHITOCHES		550	412	1215	7062	33	19	48		1714	29
	ACTUAL		412	1215	7062	33	19	48		1714	29
	PLAN		1212	2424	16968	29	15	56		1400	20
NEWFIELD		260	137	520	2537	39	23	38		1852	38
NEWFIELD		261	28	130	690	45	23	32		2463	57
	ACTUAL		165	650	3227	41	23	36		1956	41
	PLAN		1029	2058	14406	29	15	56		1400	20
OAK PROG		170	24	80	385	39	18	43		1605	33
OAK PROG		270	274	548	3816	28	18	54		1393	20
OAK PROG		271	30	160	630	45	22	33		2101	53
	ACTUAL		328	788	4832	31	19	50		1473	24
	PLAN		660	1320	9240	29	15	56		1400	20
DISTRICT	ACTUAL		1706	6881	33242	40	20	40		1949	40
DISTRICT	PLAN		6209	12417	86919	29	15	56		1400	20

Figure C-6. Maintenance planning summary

Fiscal Year 1968 69 | District No. 07 | Parish No | Parish Supt. Gang No. 881

FUNCTION NAME	NO	ACCOMPLISHMENT UNIT	QUANTITY	LABOR HOURS	COST — DOLLARS LABOR	EQUIP	MATERIAL	CONTR	TOTAL	UNIT COST	RATE MH D	SEASONAL DIST %			
BITUMINOUS SURFACE															
SURFACE TREAT PATCH	411	CY AGGR	568	1136	2991	1303	3374		7668	13 50	2 0	30	20	10	40
PREMIX PATCHING	412	TONS MIX	753	2259	5023	1679	6180		12877	17 10	3 0	50	20	15	15
PATCHING BASE	413	CY MAT	893	1786	3497	2953	1320		7770	8 70	2 0	35	5	30	30
CRACK REPAIR	414	GAL FILL	495	248	493	309	42		842	1 70	5		50	50	
PREMIX LEVELING	416	TONS MIX	1420	1846	3590	1391	10973		15904	11 20	1 3	80			50
SPOT SURF REPLACE	417	TONS MIX	403	1352	2561	1193	3649		7921	18 40	2 8	50	20	15	15
CONCRETE SURFACE															
PATCHING SURFACE	421	CY CONC	650	3900	6523	3374	12593		22490	34 60	6 0	30	50	20	
PREMIX PATCHING	422	TONS MIX	84	252	561	187	688		1436	17 10	3 0	30	50	20	
PATCHING BASE	423	CY MAT	835	1670	3270	2770	1235		7285	8 70	2 0	30	50	20	
CRACK REPAIR	424	GAL FILL	835	418	788	556	72		1420	1 70	5		50	50	
JOINT REPAIR	425	100 LN FT	1040	1457	2925	770	153		3848	3 70	1 4		50	50	
GRAVEL-SHELL SURFACE															
PATCHING SURFACE	431	CY AGGR	160	192	362	312	722		1416	8 85	1 2	5	45	30	20
RESHAPE SURFACE	432	ROAD MI	309	614	1284	1521			2765	7 20	1 6	15	25	35	25
RESTORING SURFACE	433	CY AGGR	640	384	749	499	2912		4160	6 50	6	5	45	30	20
SHOULDER & APPROACH															
PATCH NON-PAV SHLDR	441	CY MAT	499	599	1178	883	884		2945	5 90	1 2	5	75	10	10
RESHAPE NON-PAV SHLDR	442	SHLDR MI	550	825	1682	2058			3740	6 80	1 5	30	15	10	45
RESTOR NON-PV SHLDR	443	CY MAT	1007	705	1427	782	1527		3726	3 70	7	5	75	10	10
SURFACE TREAT PATCH	451	CY AGGR	275	963	1974	790	2172		4936	17 95	3 5	30	20	10	40
PREMIX PATCHING	452	TONS MIX	51	153	338	156	373		867	17 00	3 0	50	20	15	15
PATCHING BASE	453	CY MAT	98	56	188	159	71		418	8 71	2 0	35	5	30	30
ROADSIDE & DRAINAGE															
CLEAN-REP DRAIN STR	462		2796	2796	5595	836			6431	2 30	1 0	15	20	15	50
CLEAN-RESHAPE DITCH	463	DITCH MI	9	959	1916	1908			3824	836 00	240 0	20	40	20	20
MACHINING DITCHES	464	DITCH MI	69	552	1113	1395			2508	36 00	8 0	20	40	20	20
MOWING	470	ACRES	10632	10632	35773	23349			59622	5 20	1 0	50	20		30
LITTER CLEANING	473	LOADS	256	5120	10295	1404			11699	45 70	20 0	10	30	40	20
TOTAL PLANNED MAINT				48915	95871	53268	48935		198074			35	27	14	24

APPENDIX D

MINNESOTA DEPARTMENT OF HIGHWAYS

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 3,897,000 residents of Minnesota operate 2,452,616 motor vehicles on 127,742 miles of highway of which 13,472 miles are under state control. The state occupies 84,068 square miles from an elevation of 602 feet to 2,301 feet above sea level. Mean minimum and maximum temperatures are -8 and 88°F with average annual moisture ranging from 20 to 32 inches.

The Minnesota Department of Highways has a $53,000,000 maintenance budget for fiscal year 1975. This budget will be used by its 16 maintenance areas to maintain 29,000 lane miles of highways.

Nine construction districts comprise the Minnesota Department of Highways. Seven of the construction districts are divided into two maintenance areas each. The two metropolitan districts are also the maintenance areas. Hence, a total of 16 maintenance areas exist. Maintenance areas are divided into from 3 to 13 subareas. Seventy-six subareas have been established.

Foremen are in responsible charge of individual subareas. Foremen report to a highway superintendent which is in charge of several subareas. The superintendent reports to the maintenance area engineer who reports to the district engineer.

The existing Maintenance Cost Accounting (MCA) was developed in the late 1950's and data were processed manually. In the 1960's the system was computerized; however, system problems existed because of the detail required to be recorded and the resulting poor accuracy.

A single recording system is being utilized. A manual recording system is being utilized in the field with electronic data processing being utilized to compile and produce the reports.

RECORDING SYSTEM

Minnesota Department of Highways Form 1949, "Uniform Time and Cost Report," Form 1701, "Time Report," and Form 1702, "Requisition and Distribution Sheet," are the main forms utilized to collect maintenance activity information (Figures D-1 to D-3). The Uniform Time and Cost Report (Form 1949) is the official time report used for monthly employees, hourly laborers, intermittent (extra pay) and state equipment. The Time Report (Form 1701) is used to report time charged by hired equipment, both for owner-operated agreements and those under Tabulation of Bids and is filled out usually by the maintenance area engineer or central office. The Requisition and Distribution Sheet (Form 1702) is a multi-use form used primarily for requesting and issuing all stock through the stock room. Form 1702 is also used as a face sheet for schedules, distributing credits and charges, etc. by the area offices. A stockman normally fills the form out. The type of information obtained on the form includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization

The forms are prepared by each employee for every two-week payroll period. The basic information is recorded in columns titled

A, B, C, and D. The entry in each of these columns depends on the type of charges being made, what the charge is to be made to, etc. Column A is utilized to enter the Maintenance Account Number. Two digit Account Numbers are used for all charges not made directly to a control section or a maintenance area code number. Examples of items that have account numbers include;

1. Gravel and Bituminous Stockpiles (69*)
2. Central Office Expenses (70*)
3. Field Expenses (71*)
4. Road Equipment Purchases and Betterments (72*)
5. Accounts Receivable from within Highway Department (98*)
6. Accounts Receivable from outside the Highway Department (99*)
7. Building Construction and Betterments (84*)
8. Equipment Charges, etc. (75*).

A detailed list is shown on Table D-1.

Some accounts are subdivided into commodities to differentiate items included within an account. The most common commodity breakdown is Labor (01), Material (02), and Equipment (03). Examples of Commodities for Account Number 92, "Miscellaneous Field Materials (Inventory)," are seen on Table D-2. Two digit numbers are utilized to distinguish commodities. These numbers are recorded in column D.

It should be reemphasize that all field maintenance operation charges made to Interstate control sections, typical segments or Maintenance Area Code Numbers do not have an Account Number and therefore an X is placed in column A of the reporting form.

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*Refers to account number.

Maintenance operations which fall into this category are routine maintenance operations, special maintenance operations, extra-ordinary maintenance operations, and betterment programs. Detailed discussions of these activities are presented later.

Column B indicates the organization numbers to which the labor, equipment, and/or material is to be charged. For example, if the equipment utilized is to be charged to the organization for which it is assigned, an X is placed in column B. If the equipment is to be charged to a different maintenance area the appropriate maintenance area designation is utilized. Organizational numbers are three digit numerical codes and are shown in Table D-3. The purpose of establishing the organization numbers is to identify transactions between highway department divisions, districts, and areas as well as counties, other state departments and governmental agencies.

Column B is also utilized to indicate the surface type and location code for surface and shoulder repair Maintenance Operations performed on typical segments and interstate control sections. Codes are shown in Table D-4.

Column C is utilized to designate where the field maintenance operation is performed, the equipment number if the work is to be charged to a piece of equipment, a Building Number if the work is to be charged to a building or a Maintenance Job Number if the work is to be charged to a specific job assigned by the area office.

For all field maintenance operations, column C is utilized to record interstate control sections, typical highway segments or Maintenance Area Code Numbers. The state trunk highway system has

been divided into road sections with fixed termini. A four digit number is utilized to identify a road section. The first two digits represent the county number and the last two digits the section within the county. Interstate highways are assigned section numbers in the 80 or 90 series. In establishing the length of the Control Sections consideration was given to the practical limits for survey, for construction projects and maintenance operations. No attempt was made to make the lengths of the Control Sections into lengths to fit the present type of road surface. Detailed maintenance costs are kept for surface repairs and shoulder and approach repairs on typical segments of certain control sections. In addition, maintenance operations involving special roadway maintenance, extra-ordinary maintenance and betterments on all trunk highways are chargeable to control section numbers. Routine maintenance operations on noninterstate and routine surface and shoulder maintenance on nontypical segments are not charged to control sections but rather to maintenance area code numbers.

Column D is utilized to define the activity performed by the field maintenance operation or the Commodity Number if an Account Number is utilized for charges that are not made directly to a control section, or a maintenance area code number. Field maintenance activities are designated by Maintenance Operation Numbers (Table D-5). Six groups of numbers exist. Detailed descriptions of their operations can be found in reference D-1.

Accomplishment Numbers more explicitly defining certain maintenance operations are utilized together with Maintenance

Operation Numbers for special roadway and betterment maintenance activities. Accomplishment numbers are shown on Table D-6. Units of measure are designated for each accomplishment.

From the above discussion it is apparent that a considerable number of codes are utilized to record the various maintenance activities performed. These codes consist of the following:

1. Maintenance Account Numbers are utilized to code activities normally associated with other than field maintenance operations (Table D-1).

2. Commodity Numbers are used to designate subdivisions of Maintenance Account Numbers (Table D-2).

3. Organization Numbers are codes utilized to identify organization for charging purposes (Table D-3).

4. Surface Type and Location Codes are utilized for the types of surfaces on which the repair was performed and the location of the repair (main lanes, service lanes, ramps, surface, shoulder, etc.) (Table D-4).

5. Control Section Numbers are codes which identify specific sections of highways.

6. Typical Segment codes are utilized to identify special study segments of roadways on which detailed maintenance activity information is desired.

7. Maintenance Area Code Numbers are codes used to identify one of the 16 Maintenance Areas within the State.

8. Equipment Numbers are codes used to identify state highway mobile equipment.

9. Building Numbers are codes utilized to identify state owned buildings.

10. Maintenance Job Numbers are codes for special jobs normally associated with Account Numbers 68 (Undistributed Shop Jobs), 98 (Accounts Receivable from within highway department), and 99 (Accounts Receivable from outside the highway department).

11. Maintenance Operation Numbers are codes utilized to designate the type of activity performed (Table D-5).

12. Accomplishment Numbers are codes which more explicitly define certain maintenance operations for special roadway and betterment maintenance activities (Table D-6).

These codes are utilized in columns A, B, C, and D as described above by the individual maintenance employee. A review of the above information is presented below in a format consistent with those utilized to summarize other states recording and reporting systems.

Location

Each field maintenance operation as defined in Table D-5 is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. The district is designated by the use of an Organization Number (Table D-3) to which the maintenance workman is assigned. The district number is the last number of a three digit numeric code. The Organization Number will also appear in the general information part of Form 1949 and may appear in column C.

Another method of identifying the district is by use of the Maintenance Area Code Number found in column C. This four digit

number designates one of the 16 maintenance areas formed in the state. The last digit of this code designates the district.

2. Maintenance Area. The maintenance area is designated by the use of an Organization Number (Table D-3) to which the maintenance workman is assigned or by one of the Maintenance Area Code found in column C as described above.

3. Maintenance Subareas. The maintenance subareas are not directly identified on the recording form. By association with employees, names, Control Section Numbers, Typical Segments, Equipment Numbers, etc., maintenance subarea charges may somewhat be identified.

4. Maintenance Roadway Segments. Segments of roadways are designated by Control Section Numbers. Maintenance activity information is collected by Control Section Numbers for all Interstate Highways. Typical Segments Numbers are utilized to designate special study sections on other parts of the highway system.

5. Milepost. Mileposts or milepoints are not recorded for any maintenance activities.

Maintenance performed on bridges is assigned to a particular bridge by use of a Bridge Number. The bridge number is placed under the remarks column.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance operations number indicates if the maintenance action was performed on the pavement, shoulder and approaches, roadside, etc. Use of the Surface Type and Location Codes identifies service, roads, ramps, loops, etc. for certain maintenance activities.

Activity

Maintenance Operation Numbers, Accomplishment Numbers, Maintenance Account Numbers and Commodity Numbers are utilized to define the type of maintenance activities performed (Table D-1, D-2, D-5, and D-6). Forty-three Maintenance Operation Codes exist, 41 Accomplishment Numbers, 43 Account Numbers and numerous Commodity Numbers associated with the Account Numbers.

Maintenance Operation Numbers are those normally associated with routine maintenance operations and are divided into the following major groups:

1. Roadway Surface,
2. Shoulder and Approaches,
3. Roadside and Drainage,
4. Traffic Service,
5. Snow and Ice Control,
6. Structures,
7. Special Roadway Maintenance,
8. Extra-ordinary Maintenance and
9. Betterments.

It should be noted that roadway surface repair has only two operation numbers; 01-surface repair and 02-crackfilling. However, items in Maintenance Operation Group 6, Special Roadway Maintenance, contain many items which are often under function code groupings for roadway surface.

Maintenance Operation Numbers are presently under review to be reduced in number.

Manpower

Manpower utilization is assigned to a particular activity by the individual. When the employee changes activities such that columns A, B, C, or D are changed he must fill in another line of data. Time is reported to the nearest hour by field crews and to the nearest 0.1 hour by shop personnel daily. Time is summed for a two week period ending on a Tuesday. Form 1949 is turned into central offices on Wednesday and the individual is paid 10 days later. Payrolls are developed by exception reporting as items such as holidays, vacation, sick leave and compensatory time taken are reported.

Equipment

Equipment utilized for a particular Maintenance Operation on Account Number is recorded. Each item of equipment has an assigned Equipment Unit Number. In order to facilitate the assignment of rental rates, equipment units are grouped into classes depending on equipment type, size and relative operating, maintenance, depreciation and initial purchase costs. An Equipment Class Number is assigned to this grouping. A rental rate is computed on a cost per mile, hour, day or year depending on the equipments functions. This rental rate reflects the average operating maintenance, storage, and depreciation cost. The rates are reviewed every year by the Maintenance Division and are adjusted accordingly to reflect fluctuations in the costs of owning and operating the equipment.

Equipment Unit Numbers are recorded on Form 1949 while charges are determined based on Equipment Class Numbers and their associated

Rental Rates. Five character numerical codes designates equipment numbers.

Materials

Materials utilized for a particular maintenance operation are not recorded on Form 1949. Form 1702, Requisition and Distribution Shop is utilized for material and parts items obtained from central warehouses. All material transfers are recorded as such utilizing this form. Average costs for materials are determined by inventory purchase information. Materials stockpiles do not have a unique number assigned to them.

Accomplishments

An accomplishment report is not a part of the Minnesota Department of Highways recording system.

COLLECTION AND PROCESSING OF RECORDED DATA

The forms 1949, 1701, and 1702 are filled out daily and summed every two weeks by the individual maintenance employee. Foremen are responsible for the data accuracy. These forms are then transmitted every two weeks to the central office computer cards and punched and reports prepared monthly in the central office. The monthly reports are presently complete about 6 weeks after the data are transferred to the central office. Secretarial type employees are not utilized at the subarea level to handle these data.

It is estimated that about one-half of one percent of the maintenance budget is expended on recording and reporting maintenance

activities. About $60,000 were required for key punching and computer use in 1974. It is estimated that about 1 hour per individual is required to record the data every two weeks.

REPORTS

Nineteen reports are available from the Minnesota Maintenance Cost Accounting system. Report numbers and a brief description of these reports are seen in Table D-7. A brief discussion of the more important reports from a roadway maintenance management standpoint is presented below indicating the types of data contained on these reports:

MCA-2. Maintenance Cost Accounting report 2 is a presentation of charges to control sections within a particular district. The report is issued monthly and contains a monthly summary of charges as well as a year to date summary. Two different formats are utilized to present these data. Figure D-4 is the reporting format utilized to present a summary for a district by control sections (CS). However, control section has a broad connotation as utilized on this report. The control section may be one of the following;

1. Control Section designating an Interstate Highway segment,
2. Typical Segment designating a special study section on a highway other than Interstate,
3. Maintenance Area Code designating one of the 16 maintenance areas,
4. Control Section numbers of highways where special roadway maintenance, extra-ordinary maintenance and betterment programs are performed.

The column designated OP on the report refers to Maintenance Operation Number (Table D-5). Thus, field maintenance operations including routine maintenance, special roadway maintenance, extra-ordinary maintenance and betterment projects are the only activities reported on this form. Activities defined by Account Numbers and Commodity Numbers are reported on MCA-26.

The column designated ST on the report refers to Surface Type and Location Code (Table D-4). This information is recorded in columns B of Form 1949 and reported for Maintenance Operations in Group 0 (Roadway Surface), Group 6 (Special Roadway) and Group 7 (Extra-ordinary Maintenance) and Group 8 (Betterments). The information gathered in the Surface Type and Location Code column was used to determine maintenance costs for certain types of roadway. Data were collected for a ten-year period ending in 1972. These data are no longer collected.

The column designated ACP on the report refers to the Accomplishment Number which are codes to more explicitly define certain maintenance operations for special roadway and betterment maintenance activities (Table D-6).

The column Labor is the hourly pay rate times 1.38 (38%) for fringe benefits. The column Material is the actual cost of the material taken from Form 1702, "Requisition on Distribution Sheet," and is the average dollar cost from aterial invoices. The column Equipment is the summation of equipment hours using established rental rates. The column Agreement is charges which originate from Form 1701, "Time Report (Hired Equipment)."

The column total, including overhead, is the summation of the columns Labor, Material and Equipment times 1.19 (19% for overhead).

The second format of MCA-2 is shown on Figure D-5. A summary of labor material and equipment costs are presented by Maintenance Operation Numbers for a given District. Monthly and year to date totals are shown on this report.

MCA-4. Maintenance Cost Accounting report 4 compares present year expenditures with past years expenditures both in terms of the reported month and the year to date for specific district totals (Figure D-6). Expenditures are listed by Maintenance Operation Number, summed for Maintenance Operation groups and totaled for the district. For example, expenditures are summed for roadside and drainage maintenance, special roadway, betterments, etc.

MCA-5. Maintenance Cost Accounting report 5 delineates special maintenance and betterment charges for the reporting month and year to date. The report is presented by district, control section as defined in MCA-2 report, and by Maintenance Operation and Accomplishment Number. This report is utilized within the highway department to formulate other internal reports including the "Construction Project Log Record."

MCA-6. Maintenance Cost Accounting report 6 is titled "Maintenance and Betterment Costs for Counties." This is not an accurate description of the report because cost data are not collected by county. Maintenance costs reported is all maintenance except routine maintenance (Table D-5). Routine maintenance typically amounts to the bulk of the money expended on maintenance.

Costs are separated by county. Costs per mile expenditures are reported. This report is generated about twice per year with a summary for the calendar year report.

MCA-7. Maintenance Cost Accounting report 7 details maintenance expenditures for bridges. Labor, material and equipment charges are reported for the report's month and the year to date. The data are presented by district bridge number, control sections and Maintenance Operation Number.

MCA-10. Maintenance Cost Accounting report indicates maintenance expenditures over a number of years for a particular maintenance section in terms of cost per mile. Separate costs are reported for the Maintenance Operation Number groupings.

MCA-26. Maintenance Cost Accounting report 26 contains all charges not assigned to field maintenance activities. These charges as discussed above are made against Maintenance Account Numbers (Table D-1) and Commodity Numbers (Table D-2). Data are grouped by district, Account Number, Organization Number, Special Job Number and Commodity Number. Data are reported for the current month and year to date.

MCA-27. Maintenance Cost Accounting report 27 is an equipment listing and acts as an inventory master file.

MCA-29. Maintenance Cost Accounting report 29 is a listing of overhead charges for the various districts. These charges are reflected on MCA-2 as overhead charges.

MCA-32. Maintenance Cost Accounting reports 32A, 32B, 32C, and 32D are equipment reports indicating fuel, parts, etc. utilized by

various pieces of equipment. These data are utilized to develop rental rates for equipment classes. These are monthly and quarterly reports.

The majority of the reports described above (Table D-7) are prepared monthly with year to date totals. MCA-2 report is the primary maintenance management report. Costs are separated only to the maintenance area level, thus the present reporting system will not be particularly useful at the subareas level. Reports are presently transmitted to the district about 6 weeks after the end of the month.

Reports are utilized for fiscal control and budget preparation. Productivity rates cannot be presently determined from the reported data. The budget is presently budgeted by labor, equipment and materials cost and not by maintenance operation or activity.

OTHER ITEMS

The Minnesota Department of Highways have recently reviewed the Maintenance Cost Accounting program (D-2). The problems with the existing system were defined and given below:

1. The output reports cannot be used by the maintenance people to manage their business.

2. The output reports do not show units of accomplishments and unit costs.

3. The output reports show costs for maintenance activities by maintenance area and not subarea

4. The output reports do not show costs on a trunk highway within a subarea.

5. The output reports do not show budgeted versus actual amounts used per activity in a cost center.

6. The turn around time, recording and reporting the data is too long (six weeks).

7. The input to the MCA system is cumbersome. Some workmen fill out four or more time sheets each day because a separate sheet is required for straight time, shift differential, equipment differentials and equipment used.

8. An accounting manual does not exist.

9. Account and commodity numbers can originate in the districts without central office control.

10. Input to the MCA system from Forms 1949, 1701, and 1702 are presently not transmitted by remote computer terminals.

Reliability of this recording and reporting system is questionable because of the large number of codes that must be utilized, the selective use of the codes in reporting certain types of charges and due to the fact that individual workmen report the data. It is difficult to differentiate between routine and special maintenance.

The concept of the Typical Segment to record maintenance activities for specific types and designs of pavement has merit if properly conducted. This type of data has the potential for use in a pavement data management system.

Committees composed of district representatives make suggestions for altering maintenance operation activities. These recommendations are reviewed and either accepted or rejected by the central office staff. Committees that are formed include the following:

1. Snow and Ice Control,
2. Traffic Services,
3. Equipment,
4. Personnel and
5. Bridge.

These committees normally meet about four times per year. Changes are affected by directive, manual change, or by engineering memorandum.

The Maintenance Cost Accounting system was developed because of legislative pressure and is presently a cost accounting system. Certain changes are contemplated in the system, some of which are being implemented on a trial basis.

Snow removal requires about 27 percent of the annual maintenance budget and hence the distribution of expenses for snow and ice control is of interest to the administration.

References

D-1 "Maintenance Manual," State of Minnesota, Department of Highways, July 1, 1971.

D-2 Glasow, T. A., "Evaluation of the Maintenance Cost Accounting System," an internal report of Minnesota Department of Highways.

D-3 Katz, J. S., "Performance Standards as a Tool in Preparing the Maintenance Program Budget," Highway Research Record No. 347, 1971.

Table D-1

ACCOUNT NUMBERS - MAINTENANCE

ACCOUNT NUMBERS	USED BY			DESCRIPTION	ACCOUNT NUMBERS	USED BY			DESCRIPTION
	M.A.	C.S.	C.O.M.			M.A.	C.S.	C.O.M.	
1-30				Not Assigned					
					73			X	Reserve for Motor Pool
31		X		Maint. Area 1B - Virginia - 321	74	X	X		Field Labor Equip. Maint.
32		X		Maint. Area 1A - Duluth - 301	75	X	X	X	Equipment charges (State Unit)
33		X		Maint. Area 2A - Bemidji - 302	76	X	X	X	Repairs Parts and Supplies (Inventory)
34		X		Maint. Area 3A - Brainerd - 303	77	X	X	X	Shop Overhead
35		X		Maint. Area 2B - Crookston - 322	78	X	X		Shop Tools
36		X		Maint. Area 4A - Detroit Lakes - 304	79	X	X	X	Build. Maint.
37		X		Maint. Area 3B - St. Cloud - 323	80	X		X	Rental Reserve (State Units)
38		X		Maint. Area 4B - Morris - 324	81	X	X	X	Error Correction
39		X		Maint. Area 5A - Golden Valley - 305	82			X	Depreciation Road Equipment
40		X		Maint. Area 8A - Willmar - 308	83				Not Assigned
41		X		Maint. Area 9A - St. Paul Park - 309	84			X	Building Construction and Betterments
42		X		Maint. Area 6A - Rochester - 306	85			X	Miscellaneous Cash Credits
43		X		Maint. Area 6B - Owatonna - 326	86	X			Accounts Payable
44		X		Maint. Area 7A - Mankato - 307	87	X		X	Reserve for Maint. Overhead (District)
45		X		Maint. Area 8B - Marshall - 328	88	X		X	Reserve for Leave with Pay
46		X		Maint. Area 7B - Windom - 327	89				Not Assigned
47-61				Not Assigned	90				Not Assigned
					91			X	Depreciation Building (State Owned)
62				Not Assigned	92	X			Miscellaneous Field Materials (Inventory)
63				Sign Shop (Det. Lakes)	93			X	Asset Account, Road Equipment
64				Not Assigned	94				Not Assigned
65-61				Not Assigned	95				Not Assigned
					96			X	Asset Account, Buildings
					97				Not Assigned
					98	X	X	X	Accounts Receivable from within Highway Dept. (Maintenance Areas Construction Districts, Central Office Stations)
68	X	X		Undistributed Shop Jobs (Betterments or "B" Jobs)					
69	X			Gravel and bituminous Stock Piles (Stock Inventory)	99	X	X	X	Accounts Receivable from outside the Highway Dept. (Governmental Agencies, Firms and Individuals)
70			X	Central Office Expense					
71				Field Expense					
72			X	Road Equipment Purchases and Betterments					

M.A. = Maintenance Areas

C.S. = Central Shop

C.O.M. = Central Office Maintenance Division

Table D-2. Commodity Numbers for Account Number 92, Miscellaneous Field Material (Inventory).

40	Calcium Chloride
41	Salt
42	Crack Filler
43	Bituminous Material (includes tar, road oil, powdered asphalt and bituminous additives)
44	Miscellaneous Field Tools and Supplies
45	Posts, Wood and Steel
46	Culverts, Gutters, Tile, etc.
47	Signs, Flags, Flares and Related Supplies
48	Paint
49	Lumber
50	Bridge and Structural Steel
51	Bridge Supplies

Table D-3

ORGANIZATION NUMBERS

Administration

110	Office of the Commissioner
120	Office of Public Information
132	Office of Personnel (& Training)
133	Office of Data Processing
134	Office of Administrative Management (Management Services)
135	Office of Financial Administration
137	Administrative Services Section (Stores)
138	Electronic Communications Section
139	Audit Section

Safety

201	Office of Safety
202	Office of Highway Patrol
203	Office of Driver License Section
204	Office of Safety Information Section
205	Office of Drivers Training Section
206	Office of Traffic Safety Research
207	Office of Vehicle Safety Inspection

Districts			Maintenance Areas					
311	(1)	Duluth	301	(A)	Duluth	321	(B)	Virginia
312	(2)	Bemidji	302	(A)	Bemidji	322	(B)	Crookston
313	(3)	Brainerd	303	(A)	Brainerd	323	(B)	St. Cloud
314	(4)	Detroit Lakes	304	(A)	Detroit Lakes	324	(B)	Morris
315	(5)	Golden Valley	305	(A)	Golden Valley			
316	(6)	Rochester	306	(A)	Rochester	326	(B)	Owatonna
317	(7)	Mankato	307	(A)	Mankato	327	(B)	Windom
318	(8)	Willmar	308	(A)	Willmar	328	(B)	Marshall
319	(9)	St. Paul	309	(A)	St. Paul Park			

Operations

330	Office of Road Design
340	Office of Bridge Design
350	Office of Materials
360	Office of Right of Way & Utilities
370	Office of Traffic Engineering
380	Office of Contract Administration
381	Central Shop
382	Central Office Maintenance Operations
388	Environmental Services Section

RESEARCH AND STANDARDS

601	Research Coordination
602	Right of Way Standards
604	Design Standards
605	Construction Standards
606	Maintenance Standards
607	Research and Standards Division Headquarters

STATE AID

608	Office of State Aid

TRANSPORTATION AND TRANSIT PLANNING AND PROGRAMMING

701	Office of Programming
702	Office of Transportation Planning

HIGHWAY LEGAL DIVISION

801	Legal Division

Counties

801	Aitkin	830	Istanti	859	Pipestone
802	Anoka	831	Itasca	860	Polk
803	Becker	832	Jackson	861	Pope
804	Beltrami	833	Kanabec	862	Ramsey
805	Benton	834	Kandiyohi	863	Red Lake
806	Big Stone	835	Kittson	864	Redwood
807	Blue Earth	836	Koochiching	865	Renville
808	Brown	837	Lac qui Parle	866	Rice
809	Carlton	838	Lake	867	Rock
810	Carver	839	Lake of the Woods	868	Roseau
811	Cass	840	Le Sueur	869	St. Louis
812	Chippewa	841	Lincoln	870	Scott
813	Chisago	842	Lyon	871	Sherburne
814	Clay	843	Mc Leod	872	Sibley
815	Clearwater	844	Mahnomen	873	Stearns
816	Cook	845	Marchall	874	Steele
817	Cottonwood	846	Martin	875	Stevens
818	Crow Wing	847	Meeker	876	Swift
819	Dakota	848	Mille Lacs	877	Todd
820	Dodge	849	Morrison	878	Traverse
821	Douglas	850	Mower	879	Wabasha
822	Faribault	851	Murray	880	Wadena
823	Fillmore	852	Nicollet	881	Waseca
824	Freeborn	853	Nobles	882	Washington
825	Goodhue	854	Norman	883	Watonwan
826	Grant	855	Olmsted	884	Wilkin
827	Hennepin	856	Otter Tail	885	Winona
828	Houston	857	Pennington	886	Wright
829	Hubbard	858	Pine	887	Yellow Medicine

State of Minnesota Departments

901	Administration	925	Employment & Security
902	Natural Resources	926	State Treasurer
903	Education	927	
904	Adjutant General (A.G.O.)	928	State Auditor
905	Secretary of State (Motor Vehicle)	929	Public Service Department
906	Attorney General	930	Iron Range Recources Comm.
907	Veterans Affairs	931	Department of Corrections
908	Governor's Office	932	Municipal Commission
909	Human Rights Commission	933	Archives Commission
910	State Retirement System (MSRS)	934	State Planning Agency
911	Public Welfare	935	Comm. of Insurance & Banking
912	Civil Defense	936	Upper Great Lakes Regional Comm.
913	Civil Service	937	Pollution Control
914	University of Minnesota	938	Minnesota Geological Surveys
915	Health	939	Junior College Board - Minn.
916	Historical Society	940	State College Board - Minn.
917	Horticultural Society (State Fair)	941	Water Resources Board
918	Agriculture	942	Veterans Home
919	Economic Development	943	Zoological Board
920	Aeronautics	944	Safety Department
921	Legislature - House	945	Arts Council
922	Legislature - Senate	946	Minnesota Resource Commission
923	Taxation	947	Revisor of Statutes
924	Industry and Labor	948	State Soil & Water Conservation Comm.

U.S. Government Departments

951	Transportation (B.P.R.)	955	Interior (Parks)
952	U. S. Engineers	956	Agriculture
953	Postal Services	957	Defense - Air Force, Army, Navy
954	Treasury (Customs)	958	Customs

Table D-4
SURFACE TYPE AND LOCATION CODES

Location		Surface Type	Location and Surface Type Code	Possible Maintenance Operations Chargeable (See Listing Below)
General	Specific			
Main Roadway	Surface	Bituminous	13	List I
		Concrete	14	
	Shoulders and Approaches	Gravel	22	List II
		Bituminous	23	
		Concrete	24	
Service Lane	Surface	Bituminous	53	List I
		Concrete	54	
	Shoulders and Approaches	Gravel	62	List II
		Bituminous	63	
		Concrete	64	
Interchanges Ramps, Legs and Loops	Surface	Bituminous	73	List I
		Concrete	74	
	Shoulders	Gravel	82	List II
		Bituminous	83	
		Concrete	84	

Maintenance Operation List I 01, 02, 61, 63, 64, 65, 66, 71, 82, 85
Maintenance Operation List II 14, 62, 63, 65, 66, 71, 83, 85, 86

Table D-5

MAINTENANCE OPERATION NUMBERS

	OPERATION NO.	OPERATION DESCRIPTION	PROGRAM BUDGET ACTIVITY NUMBER
ROUTINE MAINTENANCE	GROUP 0	ROADWAY SURFACE	
	01	Surface Repair	3212
	02	Crackfilling	3212
	GROUP 1	SHOULDERS AND APPROACHES	
	14	Shoulder and Side Approach Repairs	3220
	GROUP 2	ROADSIDE AND DRAINAGE	
	21	Roadside Repair	3233
	22	Drainage	3232
	23	Vegetation Control	3234
	24	Wayside Rest Areas	3235
	25	Clear Debris	3236
	26	R/W Fence and Marker	3237
	27	Plant Material Maintenance	3249
	GROUP 3	TRAFFIC SERVICE	
	31	Signs and Markers	3340
	32	Pavement Markings	3310
	33	Guard Rail & Traffic Barriers	3338
	34	Dust Control	
		Surface	3212
		Shoulders & Approaches	3220
	35	Lighting	3320
	36	Traffic Signals	3330
	37	Opening Bridges	3260
	38	Detours	3239
	39	Routine Agreements and Contracts	3282
	GROUP 4	SNOW AND ICE CONTROL	
	41	Snow Fence	3250
	44	Snow and Ice Control	3250
	GROUP 5	STRUCTURES	
	52	Bridge Repainting	3260
	53	Bridge Repair	3260
SPECIAL ROADWAY	GROUP 6	SPECIAL ROADWAY MAINTENANCE	
	61	Joint and Crack Sealing	3213
	62	Restore Aggregate to	
		Surface	3212
		Shoulders & Approaches	3220
	63	Bituminous Surface Repairs	3212
	64	Mudjacking and Pavement Repair	3214
	65	Light Reshaping, Grade Lifts & Swamp Fill	3212
	66	Seal Coat with Aggregate	3212
	67	Replacement of Drainage Structure	3232
	68	Special Agreements and Contracts	3282
EXTRA ORDINARY	GROUP 7	EXTRAORDINARY MAINTENANCE	
	71	Damage Prevention and Repairs	*
	72	Signals and Traffic Control	3340
BETTERMENTS	GROUP 8	BETTERMENTS	
	80	Engineering Preliminary, Construction	*
	81	Roadway and Drainage Grading & Earthwork	3212
	82	Drainage Structures & Roadway Earthwork Protective Structures	3232
	83	Base Construction	3212
	84	Untreated Aggregate to Roadway Courses	3212
	85	Bituminous Wearing Courses	3212
	86	Improved Shoulders and Approach Surfacing	3220
	87	Bridges, Viaducts, Grade Separation Structures and Tunnels	3260
	88	Traffic and Pedestrian Service and Miscellaneous Facilities	*
	89	Roadside Development	3239

* use appropriate program budget activity number depending on type of work done within operation.

Table D-6

ACCOMPLISHMENT NUMBERS

ACCOMPLISHMENT NUMBER	WORK ITEM	UNIT OF MEASURE
07	MAINTENANCE REIMBURSEMENT AGREEMENTS	
08	TRAFFIC SERVICE, Includes flagging	LUMP SUM
09	SUPERVISION, Includes checker	LUMP SUM
10	MAINTENANCE AND RESTORATION OF HAUL ROAD (Includes all equipment hours and all regraveling quantities to maintain haul road and restore to original condition)	MILE
16	GRAVEL OR CRUSHED ROCK IN PLACE, Includes regraveling (Includes load, haul, spread, etc.)	TON
19	SALVAGED BITUMINOUS MIXTURE IN PLACE	TON
23	BINDER SOIL IN PLACE	C. Y.
31	PREPARATION OF SUBGRADE (Scarifying, blading, shaping and compacting of the subgrade prior to construction of a base or a surface from existing roadway for use in the new base or surface.)	MILE
42	BASE CONSTRUCTION (Base or Sub-Base; Sand, Gravel, Soil Stabilized Gravel, Crushed Rock or Bituminous Stabilized Base) (All operations on the road of stabilizing, mixing, spreading, shaping and compacting the base) Includes Water. Includes all operation for production of gravel material including cost of material.	TON
51	BITUMINOUS MATERIAL (Including Application)	GALLON
52	BITUMINOUS SURFACE (Includes all operations on the road such as sweeping, windrowing, drying, mixing, spreading and rolling) Includes Aggregate and all operations of gravel production, load, haul, etc.)	TON
54	BITUMINOUS MIXTURE IN PLACE, Includes delivery (Purchased from vendor or const. contract)	TON
57	SPECIAL BITUMINOUS SURFACE REPAIR (Heater, Planer, etc.)	SQUARE YARD
59	SEAL COAT AGGREGATE IN PLACE (All operations) (FA-1, FA-2, FA-3, FA 4 and FA-5)	C. Y.
61	CLEARING AND GRUBBING	ACRE
62	SLOPING	STATION
63	EXCAVATION	C. Y.
66	TOPSOIL IN PLACE	C. Y.
67	EMBANKMENT IN PLACE	C. Y.
68	REMOVE PAVEMENT	SQUARE YARD
69	REMOVE PORTABLE CULVERTS	LIN. FEET

Table D-6 (continued)

ACCOMPLISHMENT NUMBERS (Cont'd.)

ACCOMPLISHMENT NUMBER	WORK ITEM	UNIT OF MEASURE
70	REMOVE MISCELLANEOUS STRUCTURES	C. Y.
71	METAL DAMS, CRIB WALLS, etc. (Area of completed dam)	SQUARE FEET
72	CONCRETE IN PLACE (In culverts, drains and miscellaneous structures. Includes all reinforcement)	C. Y.
73	MASONRY IN PLACE	C. Y.
74	RIPRAP IN PLACE	C. Y.
75	CONCRETE PAVEMENT (OR BASE) REPAIR (REPLACEMENT OR REPAIR OF EXISTING PAVEMENT OR BASE WITH NEW CONCRETE PAVEMENT OR BASE) (Does not include replacement or repair of concrete pavement with bituminous mixture) (Includes all reinforcement)	SQUARE YARD
76	FURNISH AND INSTALL PORTABLE CULVERTS (Size and type must be shown on accomplishment report)	LIN. FEET
77	PREFABRICATED SURFACE DRAINS IN PLACE	LIN. FEET
78	SUB-SURFACE DRAINS IN PLACE (Includes tile drains)	LIN. FEET
79	MANHOLES AND CATCH BASINS IN PLACE (Includes castings) (Adjustments of less than 1 foot in existing manholes and catch basins is considered to be construction of one lineal ft.)	LIN. FEET
80	CURB, CURB AND GUTTER, IN PLACE (Concrete, masonry or bituminous)	LIN. FEET
82	SEEDING	ACRE
83	SODDING	SQUARE YARD
84	GUARD RAIL IN PLACE	LIN. FEET
85	CLEANING AND SEALING JOINTS IN CONCRETE PAVEMENT	MILE
86	MUDJACKING (Use field com. 01, 02 & 03 for oper. no.)	SQUARE YARD
96	TEMP. PILE DRIVING	
97	TIMBER PLACEMENT	
98	STEEL ERECTION	
99	(FIELD COMMODITY 4) To clear from Special Account agreed amount to be billed against report to show full charges by accomplishment numbers - show credit received from Governmental Agency as a separate item. In preparing the accomplishment report, list the reimbursement credit and the overhead credit as a separate item.	

Table D-7. Maintenance Cost Accounting Reports

Report No.	Description
MCA-2*	Changes to Control Sections in District
MCA-4	Comparative Monthly Maintenance Expenditures
MCA-5	Special Maintenance and Betterments
MCA-6	Cost for Counties by Trunk Highway
MCA-7	Bridge Maintenance Costs
MCA-10	Comparative Costs for 10 Year Period
MCA-26	Account Report
MCA-27	Equipment List
MCA-29	Overhead Report
MCA-30	End of Year Account Adjusting and Closing Entries
MCA-32A	Equipment Costs
MCA-32B	Equipment Costs
MCA-32C	Equipment Costs
MCA-32D	Equipment Costs
MCA-33	Area Inventory of Units
MCA-35	Class Inventory of Units
MCA-40A	Control Section Error Listing
MCA-40B	Equipment Error Listing
MCA-52	Control Section Listing

*MCA = Maintenance Cost Accounting

2. Column B

a. Enter "X" for charges to "home" organization.

b. Enter three digit organization number (Ref. 5-791.715) for charges to be interdivision billed.

c. Or make entry as instructed by office or foreman.

3. Column C

a. Enter five digit Equipment Unit Number if work is to be charged to a piece of equipment.

b. Enter five digit Building Number if work is to be charged to a building.

c. Enter assigned Maintenance Job Number if work is to be charged to a job. The Job Numbers are assigned by the area office.

d. If roadway or roadside work is charged to Account 98 (Accounts Receivable from within the Highway Department) in column A, i.e., interdivision billing, and the work is chargeable to a highway, enter the typical segment number, interstate control section number or Maintenance Area Code Number in column C.

e. If none of the above apply, enter an "X" or as instructed by the office.

4. Column D

a. For work chargeable to Account Nos. in column A, enter the appropriate Commodity Number in column D.

b. The most common Commodity Numbers are:

01	Labor
02	Material
03	Equipment
04	Contract and Special Agreements

c. Certain accounts, such as Account 87, Reserve for Overhead (District), and Account 75, Equipment charges (State Units), are subdivided into different commodities. Refer to 5-791.735 or contact the area office manager for complete listings. Commodity listings are given in various manuals such as Stockroom Procedures (5-794), etc. and office memorandums and bulletins.

H. Examples of coding in columns A, B, C and D are shown in Fig. C 5-791.710.

I. Inasmuch as certain information is keypunched for electronic data processing transposed directly from Forms, 1701, 1702 and 1949, it is very important that all entries are legible. This is particularly true for the codes entered in columns A, B, C and D.

J. The general rule is that each line on the forms muse have either a code number or an "X" in each of the columns A, B, C and D. If a column is left blank, the keypunch operator will repeat the code listed on the previous line. In other words, a blank means "repeat". Indiscriminate use of code letters, "X"s or blanks will cause errors in the data processing analysis printouts.

K. Charges on Form 1949 for personal services should be compatible (the same) as charges on Form 1949 equipment usage on any job on a particular day.

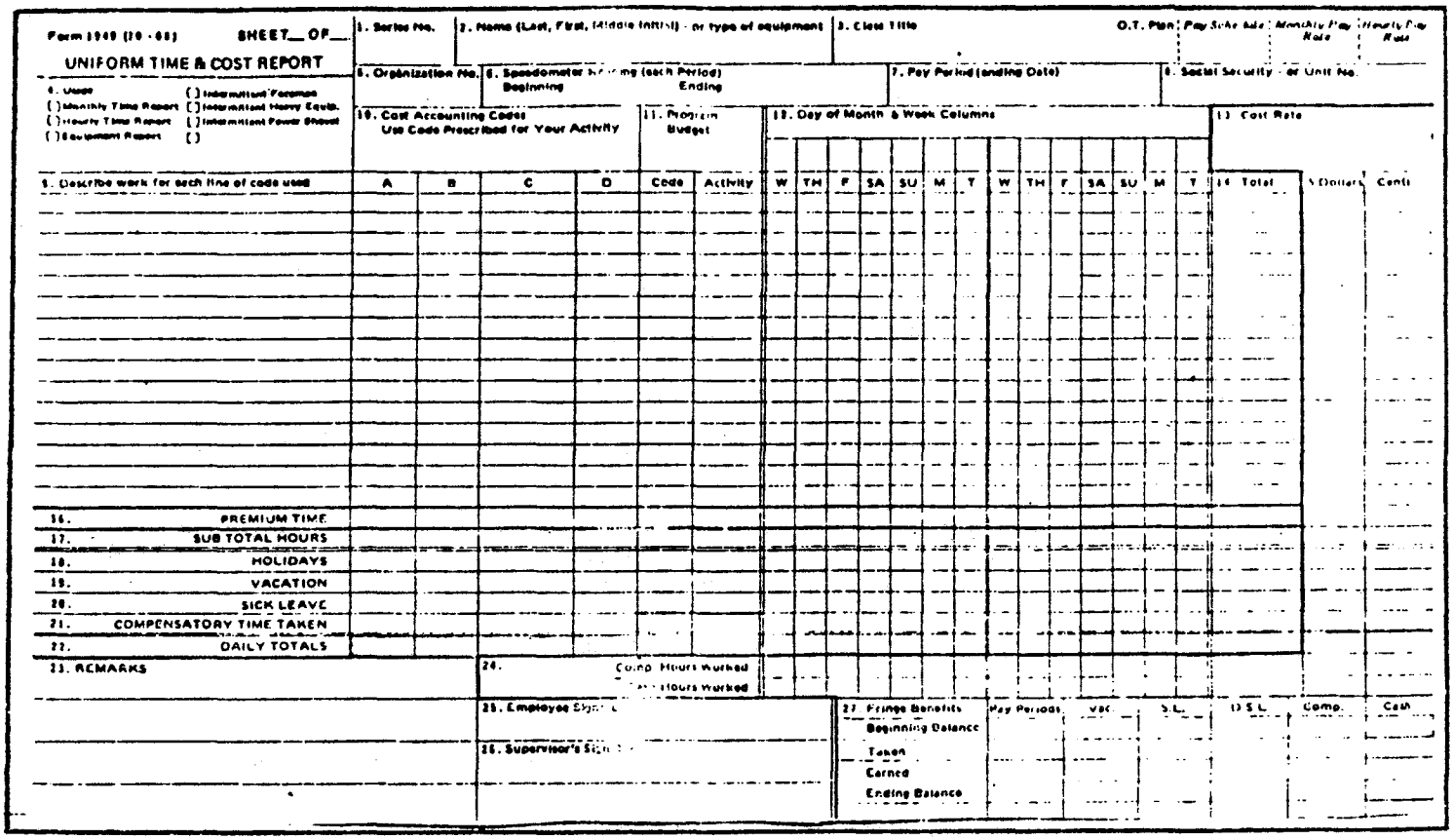

Figure D-1. **FORM 1949 - Uniform Time and Cost Report**

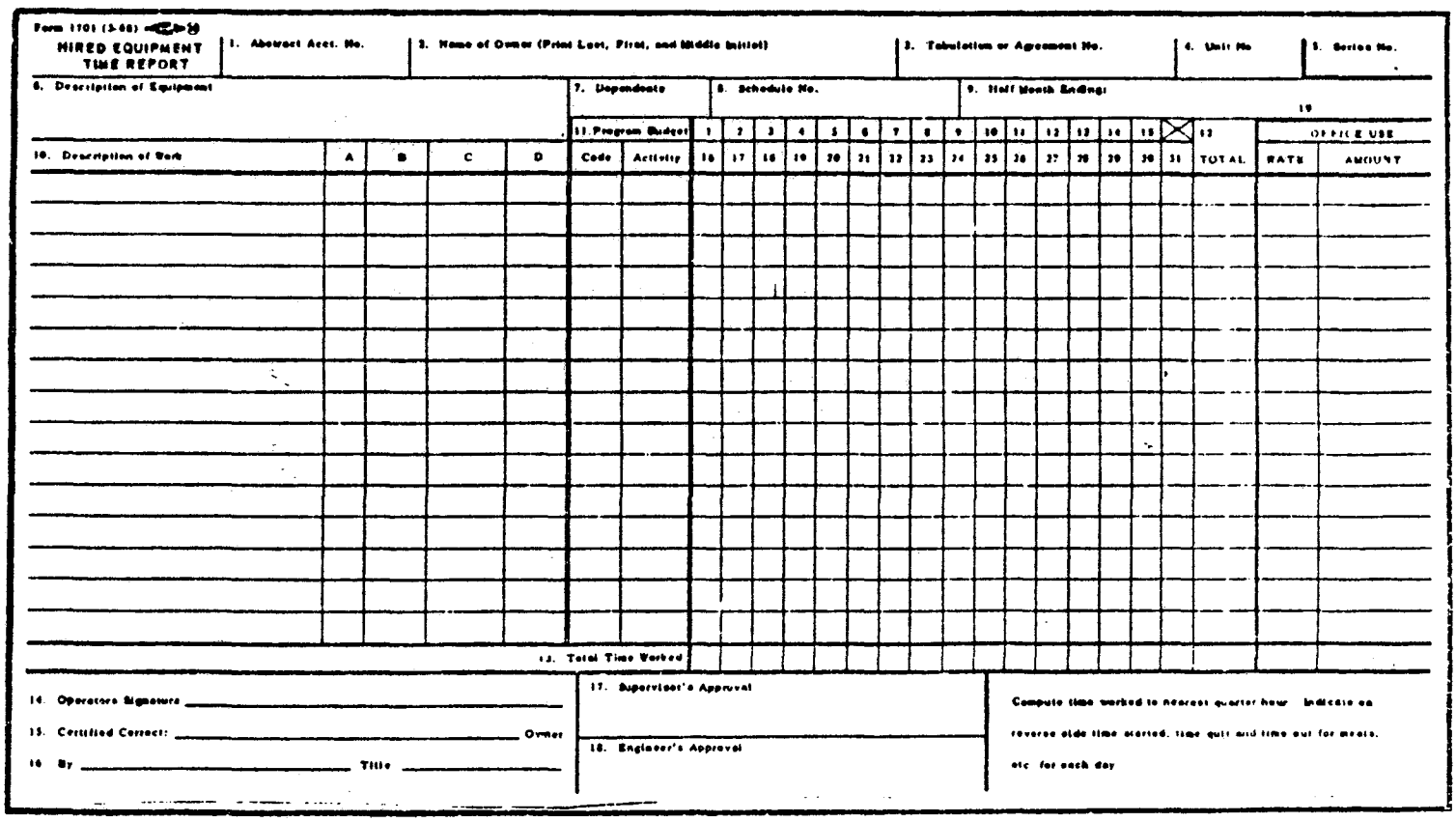

Figure D-2. **FORM 1701 - Time Report (Hired Equipment)**

Form 1702 12-70

REQUISITION AND DISTRIBUTION SHEET

1. Dist./Area	2. Date	3. Stock Location	4. Grav Pit/Stock No.	5. Schedule No	6. Field Command

7. ( ) Warrants ( ) I D Credit ( ) Transportation ( ) I D Exp ( ) Cash Credit ( ) Other – explain in item 9

8. Series No	9. Explain Item 7 (If Necessary)	10. Abstract No	11. Schedule Total

12 Description of Work	13 Code Description				14 Program Budget		15 Quantity	16 Part Number	17 Description	18 Rate	19 Amount
	A	B	C	D	Code	Activity					
									Sheet Total		

20 Date Posted	21 Posted by	22 From Stock Account	23 Commodity	24 Signature of Employee	25 Signature of Supervisor

Figure D-3. FORM 1702 - Requisition and Distribution Sheet

Figure D-4. MCA-2 Report

MCA 2
MINNESOTA HIGHWAY DEPARTMENT

MAINTENANCE COST ACCOUNTING

CHARGES TO CONTROL SECTIONS IN DISTRICT 27

SEPTEMBER 1968

			CURRENT MONTH					CAL YEAR TO DATE				
CS	OP	ST ACP	LABOR	MATERIAL	EQUIP	AGREEMENT	TOT INCL OH	LABOR	MATERIAL	EQUIP	AGREEMENT	TOT INCL OH
0702	61	8						11.55		16.17		30.49
	61	85						26.95		3.50		33.50
								38.50		19.67		63.99
0704	14	14									2007.37	2208.11
	61	8						50.05		4.51		60.07
	61	85						147.73	21.60	176.42		380.33
								197.78	21.60	180.93	2007.37	2640.45
0705	63	8						80.85		12.64		102.84
	63	9						128.75		20.08		163.71
	63	51						207.90		99.00		337.59
	63	52						1035.36		682.00		1889.19
								1452.86		813.72		2493.24
0706	63	8						69.30				76.23
	63	9						79.05		11.84		96.46
	63	51						69.30		45.50		126.28
	63	52		1586.20		1744.82		302.57	1586.20	185.50		2281.70
	64	86	141.35	5.00	35.52	200.06		141.35	17.05	35.52		213.31
			141.35	1591.20	35.52	1944.88		658.37	1603.25	278.36		2793.98
0707	61	85								102.98		113.28
	63	8						15.40		2.88		21.11
	63	9						15.45		5.28		22.90
	63	51						23.10		13.00		39.71
	63	52						109.73		122.00		254.90
								163.68		246.14		450.80

Figure D-5. MCA-2 Report

DISTRICT 27 — OPERATION SUMMARY — SEPTEMBER 1968

1	8210.65	8663.06	4753.69		23790.14	160057.08	73048.11	74574.08		338441.29
2	15.60	34.00			54.56	34872.09	6010.71	7507.73		53229.58
14	26514.56	9979.09	16039.17		58776.10	119192.34	70787.16	78160.17	1469.93	319570.60
21						967.49	22.75	540.30		1692.39
22	7737.74	2595.50	3613.24		15341.13	47153.92	9580.37	24842.60		89739.24
23	16521.16	1759.38	11145.53		32368.68	101379.31	16372.35	52177.02		187471.55
24	1851.66	401.02	712.54		3378.90	11921.31	1410.84	2861.98		17890.54
25	11218.71	22.46	16593.49		30618.13	82674.98	795.46	41634.99		137810.97
26	23.40		5.00		31.24	1840.20	199.77	190.67		2461.70
27	109.20	168.82	7.89		314.47	5316.13	1578.00	728.07		8304.42
31	7568.86	7926.69	1553.04		18753.45	89166.38	32726.54	16258.79		151966.88
32	3209.91	6408.45	1638.31		12376.84	16376.07	42455.99	7966.54		73478.46
33	4059.77	424.74	1153.33		6196.12	17493.69	1715.80	3835.51		25349.50
34	15.60		20.00		39.16	117.46	204.89	61.50		457.04
35		91.40			100.54	188.65	1020.35			1323.99
36		111.09			122.20	522.53	1081.47			1764.40
37							.50			.55
38	51.77		12.50		70.70	226.02	7612.00	55.00	534.87	9269.58
39							4662.00			5128.20
41						13490.67	36.74	3363.87		18580.41
42	19.50	91.67	45.00		171.79	25327.05	1213.51	17396.03		48232.13
43	372.74	4181.71	145.90	7659.59	13598.13	59457.56	109088.41	35116.63	7659.59	232454.41
52	616.50	140.12	76.96		916.94	3054.23	396.16	162.18		3973.83
53	7684.63	672.30	937.62		10224.01	36711.09	2193.84	5208.59		48513.87
61	6407.97	9123.30	3000.00		20472.40	37862.92	18916.04	14968.11		74921.78
62						2161.41		13992.16		16791.13
63		13630.87	13.50CR		14979.11	14100.37	24633.32	7537.02		52091.79
64	1753.98	414.13	200.70		2614.49	2675.31	578.34	266.20		3871.34
66						2333.39	797.45	1720.32	1003.29	73042.10
85							6.75			7.43
86		15.00	13.50		31.35	788.43	897.00	539.34		2446.15
	104000.33	66916.80	62641.88	7659.59	265340.46	887499.12	430534.22	410683.29	10667.69	2007921.54

Figure D-6. MCA-4 Report

MINNESOTA HIGHWAY DEPARTMENT
MAINTENANCE COST ACCOUNTING

MCA 10

COMPARATIVE MONTHLY MAINTENANCE EXPENDITURES DISTRICT 1

SEPTEMBER 1968

EXPENDITURE	SEPTEMBER 1968	SEPTEMBER 1967	1968 TO DATE	1967 TO DATE
ROUTINE MAINTENANCE				
01 PATCH REPAIR BLADE SCARIFY	64,164.60	53,376.35	440,580.73	335,031.90
02 FILL AND SEAL CRACKS JOINTS	4,540.48	[illegible].17	[illegible]	95,614.31
REPORGADWAY SURFACE TOTAL	$ 68,705.08	$ 62,257.52	$ 499,822.[illegible]	$ 430,648.21
14 PATCH BLADE FILLING RUTS ETC	29,043.75	22,307.49	106,234.09	102,432.04
SHOULDERS AND APPROACHES TOTAL	$ 29,043.75	$ 22,307.49	$ 106,234.09	$ 102,432.04
21 REPAIR CUT FILL SLOPES SLIDES	865.46	1,095.42	33,545.74	24,136.25
22 TRAIN DRAINAGE STRUCTURES CULV	16,779.10	16,675.13	109,611.20	89,598.96
23 CUTTING CLEARING VEGETATION	23,014.16	8,725.37	109,908.77	106,291.97
24 WAYSIDE REST AND CAMP AREAS	4,606.21	5,237.58	27,26[illegible].54	33,881.[illegible]
25 CLEAR DEBRIS	4,523.38	4,444.51	74,276.51	59,573.[illegible]
26 RIGHT OF WAY FENCE AND MARKERS	.00	136.27	645.23	5,501.35
27 PLANTING SEEDING AND SODDING	499.04	2,067.86	7,347.69	15,750.59
ROADSIDE AND DRAINAGE TOTAL	$ 50,287.35	$ 38,605.16	$ 421,598.63	$ 335,117.75
31 SIGNS AND MARKERS	20,777.57	24,436.60	113,216.87	145,524.66
32 TRAFFIC AND GUIDE LINES	14,174.83	28,245.60	96,279.47	101,355.87
33 GUARD RAIL MAINTENANCE	4,564.44	2,547.[illegible]	21,706.64	19,290.03
34 APPLICATION DUST PALLIATIVES	26.22	374.44	2,827.33	3,500.54
35 LIGHTING	2,206.17	157.15	7,248.44	3,481.77
36 SIGNALS AND DEVICES	99.66	61.66	747.93	851.67
37 INTERSTATE SIGNS AND MARKERS	.00	202.40	.00	4,342.01
38 DETOUR MAINTENANCE	1,175.01	.00	48,512.97	.00
49 ROUTINE MAINT REIMBURSABLE AGRMT	.00	.00	73,936.07	104,473.34
TRAFFIC SERVICE TOTAL	$ 43,024.90	$ 56,058.96	$ 358,605.74	$ 383,819.70
41 SNOW FENCE HANDLING	83.81	.00	7,542.53	6,095.14
42 REMOVAL OF SNOW AND ICE	7.15	30.59	206,872.16	385,337.53
43 SAND AND CHEMICAL APPLICATION	6,860.96	14,081.42	291,706.31	264,094.03
SNOW AND ICE CONTROL TOTAL	$ 6,951.92	$ 14,112.11	$ 506,523.00	$ 655,526.70
52 REPAINTING	3,834.90	2,279.78	22,400.33	15,536.92
53 REPAIR	8,263.99	8,199.16	63,758.18	57,726.05
STRUCTURES TOTAL	$ 12,098.89	$ 10,478.94	$ 86,158.51	$ 73,262.97

APPENDIX E

NEVADA DEPARTMENT OF HIGHWAY'S

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 548,000 residents of Nevada operate 437,000 motor vehicles on 49,704 miles of highways of which 6,366 miles are under state control. The state occupies 110,540 square miles from an elevation of 470 feet to 13,143 feet above sea level. Mean minimum and maximum temperatures are 4 and 110°F with average annual moisture ranging from 4 to 28 inches.

The Nevada Department of Highways has a $15,500,000 annual maintenance budget. This budget will be used by its 6 districts to maintain 11,794 lane miles of highway (5,486 center line miles of highway are maintained by the state).

Six districts comprise the Nevada Department Highways. Each district is divided into maintenance stations resulting in about 70 maintenance crews state wide.

Foremen are in responsible charge at the maintenance station with assistance from lead men. Foremen report to a supervisor who is often responsible for the activities of several foremen. The supervisor may or may not reside at the location of the district office. Maintenance supervisors report to the superintendent who works out of the district office. The superintendent reports to the Assistant District Engineer for maintenance who in turn reports to the District Engineer. The administration of the maintenance program for the State Highway Engineer of the Nevada Department of Highways is performed at the

central office level by the Maintenance Engineer and his staff.

The basic maintenance recording and reporting system was developed in the 1972 to 1974 period with the assistance of a consultant (Byrd, Tallamy, MacDonald and Lewis). A parallel recording system is being utilized. Manual recording of data is practiced in the field with electronic data processing utilized to compile and produce reports. Two years of reliable maintenance cost data are now available from the recording and reporting system.

RECORDING SYSTEM

Nevada Department of Highways Form NHD-034-012-10-72, "Activity Report" is utilized to collect maintenance activity information (Figure E-1). The type of information obtained on this form includes:

1. Activity performed,
2. Location activity performed,
3. Manpower utilization,
4. Equipment utilization,
5. Material utilization and
6. Accomplishments.

Information is coded daily on the Activity Report by the foreman for the maintenance crew. Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A number from 1 to 6 is utilized to designate the district. This number is the first number of the three character numeric code for "Division Code" as shown on the Activity Report.

2. Maintenance Station. Approximately 70 maintenance stations designate an area of responsibility which is headed by a foreman. Foremen numbers, which are the last two numbers of the Division Code, are used to identify the maintenance stations.

3. County. The county is identified by use of the county designation shown on milepost markers. County abbreviations are utilized. For example, EL designates Elko County.

4. Highway. The highway is designated by five character alphanumeric code. The first two characters designate the highway system (IR-Interstate, SR-State Route). The final three characters designate the highway number. For example, Interstate Route 80 would be recorded as IR 080.

These data are recorded in the columns marked "System and Route or Special Facility." Special Facility Numbers are utilized for such items as rest areas.

5. Milepost. Begin and end mileposts which designate the boundaries within which the maintenance activity was performed are recorded. Items such as structures and inter-change are located by a single milepost entry. Mileposts can be reported to the nearest 0.01 mile.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance activity indicates if the maintenance action was performed on the

pavement or shoulder for portland cement concrete pavements only, however, activities performed on the pavement can be separated from roadside activities, snow and ice control, etc.

Activity

"Maintenance activity codes" are utilized to designate the maintenance activity performed (Table E-1). Seventy-two maintenance activities are presently utilized and are divided into the following programs:

1. Planning and Scheduling
2. Flexible Pavement
3. Rigid Pavement
4. Repairing Miscellaneous Concrete Appurtenances
5. Roadside Maintenance
6. Roadside Cleanups
7. Roadside Facilities
8. Roadside Appurtenances
9. Traffic Service
10. Snow and Ice Control
11. Structure Maintenance
12. Betterments
13. Stockpile

The activities codes are five character numeric codes with the first three numbers indicating the program number and the last two numbers indicating the activity number.

It should be noted that special activity codes are utilized for maintenance on portland cement concrete pavements. Special codes also exist for snow and ice removal.

Manpower

Manpower utilization for a particular function is recorded to the nearest full hour for the entire crew by the foreman. The Division Code identifies the foreman. In recording the labor utilized, three entries are made in the columns headed, N, R, and OVT on the Activity Report as follows:

N Record the number of men working on the job during the day.

R Record the regular hours worked by each employee.

OVT Record the over-time hours worked by each employee.

A typical entry on the Activity Report would be 481 indicating 4 men each worked 8 regular hours and each worked 1 over-time hour. If 4 men worked 8 regular hours and 3 of the men worked 2 over-time hours with I man working 1 over-time hour, a double entry would be made. The first entry would be 382 with the second entry 181.

Sepcial codes are utilized for supervisory personnel.

Equipment

Equipment utilized for a particular function is recorded. Equipment is identified by class and the number of hours or miles operated is recorded depending upon the type of equipment. Fifty-three equipment class codes can be utilized. Examples of some of the class codes are shown on Table E-2.

Total mileage for those items of equipment requiring daily mileage reports is placed in the "mileage" column on the Activity Report. Coupes, sedans, stationwagons, and survey wagons are in this category of equipment.

Reporting Equipment Usage

All equipment which is at the job site must be charged for the entire time it is required at the site regardless of how much it was actually used.

EXAMPLE: A loader is required to be at a job site for 8 hours to load a truck intermittently throughout the day. Only 4 or 5 loads were loaded and the actual usage time was only 30 minutes but the loader would be charged for the full 8 hours it was at the site.

If aggregates or other material hauled is involved in the performance of the maintenance activity, the one way haul distance is recorded in the "haul" column of the Activity Report. Mileage is reported to the nearest mile and hourly usage to the nearest full hour.

Materials

The quantity and material class is reported for all materials utilized to perform a maintenance activity. A partial list of material classes is shown on Table E-3. Quantity is reported to the nearest whole unit as designated on the material class list. If a material is not assigned to a specific material class the code 99 is utilized.

Material stockpiling activities have activity codes. Stockpiles can be assigned a coding number and material purchases can be identified for certain materials by the use of activity codes (Table E-1).

Accomplishments

Accomplishments are reported for all maintenance activities in the units assigned to the specific activity (cubic yards, man hours, square feet, tons, etc.). Accomplishments are recorded to the nearest whole unit.

COLLECTION AND PROCESSING OF RECORDED DATA

The Activity Report is filled out daily by the foreman for the crew for the work week and submitted weekly to the Foreman's Supervisor. The Supervisor edits the Activity Reports and mails them to the Headquarters Maintenance Office where they are subjected to another manual edit then a final machine edit. The computer edit includes date, system, route, county, M.P. location, accomplishment, labor, equipment and material. Headquarters Maintenance Management Coordinators discuss apparent errors with the District Maintenance Superintendent prior to making corrections to the Activity Report. A corrected copy of the Activity Report is then returned to the Foreman thru the district chain of command. Secretarial type employees are not utilized at the station level to record the data.

It is estimated that about two-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. Nine thousand dollars for computer charges was expended in 1975-1976 fiscal year. The foreman requires about 10 minutes per day to record the information. The district superintendent requires about 2 hours per week and the central office staff requires about 8 to 10 hours per week to review and edit the recorded data.

Monthly reports are returned to the district by the 20th of the month following data collection.

REPORTS

A total of 37 maintenance management reports have been prepared. A listing of the programs according to the function they perform is shown below:

1. Eleven programs list inventory information, control files and edit errors.
2. Four budget-related programs
3. Three programs on organization and performance
4. One control program
5. Three informational summary programs
6. One exception report program
7. Two analysis detail programs
8. Five file creation programs
9. Seven support or housekeeping programs

Nineteen management reports are produced which fall into the following six categories:

1. Budget Reports
2. Performance Reports
3. Control Reports
4. Summary Reports
5. Exception Reports
6. Analysis Reports

A brief discussion is presented below which indicates the types of data reported for selected reports.

Productivity and Unit Cost Reports. The District Productivity and Unit Cost Report compares an individual foreman's crew productivity to the district weighted average productivity and the crew's

unit cost to the district weighted average cost for every maintenance activity reported by the foreman (Figure E-2). The district weighted average is the yardstick that enables the foreman to evaluate the crew's productivity and unit cost. Percent productivity is the crew productivity measured in terms of units produced per man-hour divided by the district productivity. The report is produced monthly with monthly and year to date values and is supplied to the foreman.

State Productivity Report. The state productivity report compares productivity among districts. The standard productivity obtained from work standards and the computed state weighted average productivity for the reported year are displayed on the report. Information is presented by maintenance activity. Figure E-3 is an example of the report which is prepared annually and distributed to the central office staff. This report is similar to the State Unit Cost Report.

Productivity/Unit Cost Exception. This report summarizes the productivity and costs which vary widely from district means. This exception report identifies those items which fall outside two standard deviations of the mean productivity value for a given activity. Figure E-4 is an example of such a report. This report is prepared monthly and distributed to the district engineer.

District and State Operations Reports. These reports display district totals from processed activity reports compared to accounting report totals. Administrative, overhead and all other accounting charges against the district budget are presented for the reporting month and the year to date. Totals are presented for the district by foreman's division. Figure E-5 is an example of the District

Operations Report. This report is prepared monthly and distributed to the district engineer. Labor, equipment, and material costs are presented. The State Operations Report is reported in basically the same format.

Man-Hour Utilization Reports. The District Man-Hour Utilization Report displays the district man-hours expended for each month of the year. Figure E-6 is an example of this report which is prepared annually for district office utilization. The State Man-Hour Distribution Report has an identical format and is prepared annually for central office use.

State Unit Cost Report. This report displays the standard unit cost, the state weighted average unit cost and the weighted average unit cost achieved by each district for each maintenance activity on a yearly basis. Figure E-7 is an example of this report which is prepared annually for district office utilization.

Summary of Equipment Hours and Material Quantity. Two reports, one for equipment and one for materials are generated for each district and for the state as a whole. Monthly material quantities coded by material class and equipment usage coded by equipment class are displayed by the month and totaled for the year. Figure E-8 and E-9 are statewide reports for materials and equipment respectively. These reports are issued annually for the central office and district staff.

System - Activity Summary. This report permits information to be requested in total or limited to district, activity division, route, specific location on route or other specific data. Labor, equipment, and material costs are reported together with accomplishment units.

Figure E-10 is an example of this report which is produced upon request.

Location Analysis Report. This report summarizes information on specific units within requested milepost limits for a specified period of time. Maintenance activities, units accomplished, labor costs, equipment costs and material costs are reported. Figure E-11 is an example of this report which is produced upon request.

Activity Analysis Report. This report summarizes information on a specific maintenance activity for a particular section, district or statewide. Items reported include location at which the activity was performed together with labor, equipment, and material costs, net productivity and net unit cost. Figure E-12 is an example of this report which is produced upon request.

District Performance Report. This report ranks district productivity and composite costs for a given month. High and low productivity and unit costs are reported on this report by maintenance activity. This summary is a form of an exception report. Figure E-13 is an example of this report which is produced upon request.

Work Accomplishment Report. The work accomplishment report (Figure E-14) compares the units of work completed and dollars expended to the units of work scheduled and dollar budget. This comparison is made by maintenance activity and maintenance program for the current month and year to date.

Planned quantities and budget amounts shown on this report are obtained from an established planning and scheduling program. Preceding year man-hour efforts and costs are supplied to the districts by the central office in the form of management reports.

District estimates of man-hour requirements by the month by activity (Figure E-15) are based on the data supplied by the district office and by the use of a road evaluation program. Man-hours are adjusted by the month to reflect available man-hours and a tentative budget is formulated. A report is generated delineating this tentative budget by activity. Man-hours, work load and costs are reported (Figure E-16).

A detailed inventory system is also a part of the maintenance management system. Details of the inventory as well as the budget preparation program can be found in the attached references.

It should be noted that man-hours are reported for the entire working crew. These hours are transferred to dollar values by use of an average cost per hour for an individual in the crew. The standard productivity rates are obtained from the maintenance work standard.

Reports are utilized to perform the following function:

1. Establish staffing levels for crews and the district,
2. Fiscal control,
3. Identify economic maintenance activity methods,
4. Compare station and district costs and
5. Budget preparation.

Exception reports are described above as part of the reporting system.

OTHER ITEMS

The Nevada Department of Highways is satisfied with the reliability of the existing system. The recording system utilizes foreman to

record information rather than the individual maintenance employee. It is believed that this approach improves the reliability of the information. Training programs were an integral part of implementing the maintenance management system. Conferences were held with individual foremen as well as follow-up reviews after implementation of the program.

The recording and reporting system is under constant review by central office staff with input from the districts and stations. Changes in the system originate from the central office with input from the field.

A standing maintenance standard committee does not exist although maintenance standard committees were utilized to formulate the maintenance work standards.

Data collected can be stored on tape indefinitely under the present system.

References

Davis, K. J., "Examples of Use of a Maintenance Management System," presented to the Transportation Research Board, Maintenance Management Workshop Las Vegas, Nevada, July, 1975.

"Final Report on the Development and Implementation of a Maintenance Management System," prepared by Byrd, Tallamy, McDonald and Lewis, for the Nevada Department of Highways, July, 1974.

"Maintenance Management System Manual of Instruction," State of Nevada, Department of Highways, July, 1973.

TABLE E-1. MAINTENANCE ACTIVITIES

NEVADA DEPARTMENT OF HIGHWAYS

LIST OF ACTIVITIES

6.1.0 Work Programs

PROGRAM NUMBER	ACTIVITY NUMBER		ACCOMPLISHMENT UNIT
		MAINTENANCE	
100.00		PLANNING & SCHEDULING PROGRAM	
	100.01	Planning & Scheduling	Man Hours
101.00		FLEXIBLE PAVEMENT PROGRAM	
	101.01	Base and Surface Repair	Cu. Yds.
	101.02	Surface Patching - Premix (Hand)	Cu. Yds.
	101.03	Surface Patching - Premix (Machine)	Cu. Yds.
	101.04	Surface Patching - Spot Seal	Sq. Yds.
	101.05	Seal Coat - Sand	Sq. Yds.
	101.06	Seal Coat - Flush	Sq. Yds.
	101.07	Crack Filling	Lbs. Filler Material
	101.08	Heater Planing	Sq. Yds.
	101.09	Seal Coat - Chips	Sq. Yds.
111.00		RIGID PAVEMENT PROGRAM (P.C.C.)	
	111.01	Temporary Patching of P.C.C. Pavements	Cu. Yds.
	111.02	Permanent Patching of P.C.C. Pavements	Cu. Yds.
	111.03	Paved Shoulder Repair (Premix)	Cu. Yds.
	111.04	Paved Shoulder Seal - Sand	Sq. Yds.
	111.05	Joint Sealing	Lbs. Filler Material
	111.06	Expansion Joint Repair	Lin. Ft.
112.00		REPAIRING MISC. CONCRETE APPURTENANCE PROGRAM	
	112.01	Repairing Miscellaneous Concrete Appurtenances	Cu. Ft.
131.00		ROADSIDE MAINTENANCE PROGRAM	
	131.01	Cleaning Culverts	Each
	131.02	Cleaning Culvert Openings & Drop Inlets	Each
	131.03	Dressing and Shaping Ditches	Lin. Ft.
	131.04	Cleaning Ditches	Cu. Yds.
	131.05	Culvert Repair and Replacement	Lin. Ft.
	131.06	Fill Slope Repair	Cu. Yds.
	131.07	Unpaved Shoulder Slope Maintenance (Blading)	Shoulder Miles
	131.08	Vegetation Control (Mowing, Flailing, Burnings, Etc.)	Shoulder Miles
	131.09	Vegntation Control (Chemical Weed Spray)	Shoulder Miles
	131.10	Vegetation Control (Hand Weeding)	Man Hours
133.00		ROADSIDE CLEANUP PROGRAM	
	133.01	Remove Debris, Litter, Trash	Shoulder Miles
	133.02	Empty Litter Barrels	Each
	133.03	Sweeping: Traveled Way, Shoulders & Gutters	Sweeping Miles
	133.04	Remove Roadway Debris	Traveled Miles
134.00		MAINTENANCE OF ROADSIDE FACILITIES PROGRAM	
	134.01	Maintenance of Rest Stops	Man Hours
	134.02	Maintenance of Roadside Parks	Man Hours
	134.03	Maintenance of Landscape Areas, with Turf	Man Hours
	134.04	Maintenance of Landscaped Areas without Turf	Man Hours
135.00		MAINTENANCE OF ROADSIDE APPURTENANCES PROGRAM	
	135.01	Repair of Right-of-Way Fences and Gates	Lin. Ft.
	135.02	Cattle Guards and Wings	Each
	135.03	Removal of Encroachments (Advertising Signs, etc.)	Each
	135.04	Inspection of Right of Way Fences and Gates	Fence Miles

TABLE E-1. (CONTINUED)

NEVADA DEPARTMENT OF HIGHWAYS

LIST OF ACTIVITIES

PROGRAM NUMBER	ACTIVITY NUMBER		ACCOMPLISHMENT UNIT
141.00		TRAFFIC SERVICE PROGRAM	
	141.01	Maintenance of Directional, Route and Warning Signs	Sq. Ft.
	141.02	Guardrail - Repair and Replacement	Lin. Ft.
	141.03	Guardrail - Painting	Lin. Ft.
	141.04	Guardrail - Cleaning	Lin. Ft.
	141.05	Pavement Striping - Dashed and Solid	Striping Miles
	141.06	Raised Pavement Markers	Each
	141.07	Pilot Lining	Pilot Line
	141.08	Pavement Markings and Painted Cattle Guards	Sq. Ft.
	141.09	Roadway Lighting Operations: Highway Lighting, Bridge and Approach Lighting	Man Hours
	141.10	Patrolling for Protection of Public Traffic	Traveled Miles
	141.11	Maintenance of Guideposts, R/W Markers, and Milepost Markers	Each
151.00		SNOW AND ICE CONTROL PROGRAM	
	151.01	Snow Removal, Plowing, Blading, Application of Abrasives, Chemicals	Man Hours
	151.02	Plowing with Rotary Snowplow	Man Hours
	151.03	Patrolling for Snow and Ice Control	Man Hours
	151.04	Installation or Removal of Snow Markers	Each
161.00		STRUCTURE MAINTENANCE PROGRAM	
	161.01	Maintenance and Repair of Structures	Man Hours
	161.02	Inspection of Structures (Bridges and Culverts)	Each
		BETTERMENTS	
254.00		A & B GRADING PROGRAM	
	254.01	Roadway Grade Improvement	Cu. Yds.
	254.02	Flood Control and Drainage Grading	Cu. Yds.
	254.03	Install Drainage Structures	Lin. Ft.
256.00		A & B SURFACE TREATMENT PROGRAM	
	256.01	No Activity Assigned	
	256.02	Bituminous Surface Treatment	Cu. Yds.
261.00		A & B TRAFFIC SERVICE PROGRAM	
	261.01	Erection of Route, Safety and Direction Signs	Sq. Ft.
	261.02	No Activity Assigned	
	261.03	Construct Cattle Guards	Each
	261.04	Construct Guardrail	Lin. Ft.
		STOCKPILE	
270.00		MATERIALS PRODUCTION PROGRAM	
	270.01	Aggregate Production	Cu. Yds.
	270.02	Premix Production	Cu. Yds.
	270.03	Mixing Salt and Sand	Cu. Yds.
	270.04	Hauling Materials	Cu. Yds.
	270.05	Chip Production	Cu. Yds.
280.00		MATERIALS PURCHASE PROGRAM	
	280.01	Purchase Aggregate	Cu. Yds.
	280.02	Purchase Premix	Cu. Yds.
	280.03	Purchase Plantmix	Tons
	280.05	Purchase Chips	Cu. Yds.

TABLE E-2. EQUIPMENT CLASS CODES

NEVADA MAINTENANCE MANAGEMENT SYSTEM

6.3.0 MOBILE EQUIPMENT CLASSIFICATION CODES

CLASS CODE	DESCRIPTION
(Mileage)	Coupes, Sedans and Station Wagons
(Mileage)	Survey Wagons, Units w/spc. Bodies
(Mileage)	Pickups and Scouts
11	9,000 GVW Trucks (Garbage Trucks)
12	Trucks Dump Single Axle
13	Trucks Dump Tandem Axle
14	Trucks; Tractor
15	Trucks; All Wheel Drive
16	Trucks: Flatrack
17	Trucks; Service (Includes Lube, Sign Service, Boom, Mechanic Truck, Concrete Drill, Guardrail Washer, Sterilant, Spray Truck, etc.).
21	Line Striper
23	Traction Broom
24	Street Sweeper (Self-propelled)
25	Street Flusher - Semi-Mount
26	Compressors
27	Cranes and Fork Lifts (does not include truck-mounted cranes)
28	Distributors (truck or semi-mounted)
30	Maintenance Distributors (pot type to 600 gal., usually used for small patch operations (including petrolastic pots).
31	Motor Graders
33	Pulvimixer (Includes self-propelled and towed-type).
34	Chip Spreader Box and Windrow Sizer (towed)
35	Loaders (except Industrial Style Tractors)
37	Conveyors
38	Conveyor w/Screens or Feeder
39	Concrete Mixers
40	Patcheaters (towed)
41	Mowers, Rockpickers, Roto Shreaders, Maintainer (If mower is towed, a class 54 tractor should also be coded.)
42	Rotary Plows
44	Rollers Pulled
45	Rollers, Steel Wheel (includes vibratory)
47	Rollers, Pneumatic Tired
48	Shovel & Backhoe Combination, Truck Mounted
50	Welders, Trailer Mounted
51	Electric Plants
53	Water Tanks, Trailer Mounted
54	Tractors Industrial w/Attachments (Includes Sickle Mower, Loader, Auger, etc.)
55	Tractors; Crawlers
57	Snow Tractor w/Dozer
58	Carryall Scrapers
59	Rippers
60	Trailers, Cargo, Tilt
62	Trailers, Dump
64	Classrooms
65	Trailers, Utility (Arrowboard, LPG Trailers, Small Water Tanks w/pumps, etc.)

TABLE E-3. MATERIAL CLASS CODES

NEVADA MAINTENANCE MANAGEMENT SYSTEM

6.2.0 MATERIALS CLASSIFICATION CODES

CLASS CODE	DESCRIPTION	UNITS
1	AGGREGATE - This class includes gravels, sand, concrete aggregate.	Cu.Yd.
2	CHIPS - This class includes only those that meet gradation requirements of screenings. (See Standard Specifications for Road and Bridge Construction)	Cu.Yd.
5	PREMIX - This class includes premix produced by state or commercial sources. (Produced with a liquid asphalt such as SC 800).	Cu.Yd.
6	CHLORIDES (Salt)	Cu.Yd.
7	SALT AND SAND - This class includes all salt and sand mix used for snow and ice control.	Cu.Yd.
8	PLANTMIX - This class includes all plantmix purchased from a commercial source that is directly applied to the road surface. (Produced with an Asphalt Cement).	Ton
9	EXPANSION JOINT FILLER MATERIAL	Lin.Ft.
10	CEMENT	Sack
11	CONCRETE - This class is limited to ready mixed concrete from a batch plant or commercial source.	Cu.Yd.
12	LIQUID ASPHALT - This class includes liquid asphalts, asphalt cements, emulsions, etc.	Gals.
13	CRACK AND JOINT FILLER	Pounds
14	FERTILIZER	Pounds
15	FERTILIZER	Gallons
16	INSECTICIDES AND HERBICIDES	Pounds
17	INSECTICIDES AND HERBICIDES	Gallons
18	PROPANE CYLINDERS - This class includes only the propane purchased in cylinder containers having 100 lb. capacity.	Each
19	PROPANE - This class includes only the propane purchased for filling trailer-mounted L.P.G. Tra ler Tanks.	Gallons
20	GUIDE POSTS - This class includes ly the physical metal posts and does not include the sig plate or panel.	Each
21	SIGHT PLATES - This class will inc ide snow delineators (1-1/2" x 4"), sight plates (4" x 2" with silver or yellow scotchlite), and guard rail deline ors (3" x 14").	Each
22	MARKER PLATES - This class will in ude milepost panels and hazard marker plates.	Each
23	SNOW POLES - This class includes m ufactured snow poles which are installed on guide posts.	Each
24	SIGNS - All signs will be included n this class.	Sq. Ft.
25	WHITE PAINT - This class includes p int used on traffic lines, pavement markings or guardrail.	Gals.
26	GLASS BEADS	Pounds
27	YELLOW PAINT - This class includes aint used on traffic lines and pavement markings.	Gallons
28	PAINT THINNER	Gallons
29	SIGN POSTS - This class includes on y 1", 2" and 3" pipe used in the replacement or original installation of signs.	Lin.Ft.
30	FENCE POSTS - This class includes m tal and wood fence posts.	Each
31	BARBED WIRE FENCING - This class in ludes only barbed wire.	Lin.Ft.
32	STEEL GUARDRAIL - This class will i clude all panels and hardware necessary for erection of uard rail.	Lin.Ft.
33	STEEL CATTLEGUARD - This class will include only prefabricated portions of cattleguards. Wh portions of cattleguards are constructed, the materia incorporated in the work would be coded (concrete, ceme , aggregate, etc.).	Lin.Ft.
34	CULVERT PIPE - Includes 18" culvert ipe and excludes end sections or headwalls.	Lin.Ft.
35	CULVERT PIPE - Includes 24" culvert ipe and excludes end sections or headwalls.	Lin.Ft.

MAINTENANCE MANAGEMENT SYSTEM

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS
ACTIVITY REPORT

MMS RPT I-1

DIVISION CODE [ ]

WEEK ENDING _____, 19____

DATE	SYSTEM AND ROUTE OR SPECIAL FACILITY	ALTERNATE	COUNTY	INTERCHANGE, STRUCTURE OR BEGINNING MILEPOST	ENDING MILEPOST		ACTIVITY NUMBER	ACCOMP.	LABOR NO.	LABOR R	LABOR OVT.	MATERIAL CLASS	MATERIAL QUANTITY	EQUIPMENT MILEAGE	EQUIPMENT CLASS	EQUIPMENT HOURS	EQUIPMENT CLASS	EQUIPMENT HOURS	EQUIPMENT CLASS	EQUIPMENT HOURS	HAUL
4	8	14	15	16	21	26	27	32	37	38	39	42	44	49	52	54	56	58	60	62	64 65

MMD 034-012 10-72 REVISED 3 73

Figure E-1. Activity report

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS
MAINTENANCE MANAGEMENT SYSTEM

FOREMAN: GARRISON (4511) PRODUCTIVITY AND UNIT COST REPORT FOR DECEMBER MMS RPT O-1 RUN 01/22/75

ACTIVITY	DESCRIPTION	UNIT	MAN HOURS CREW	MAN HOURS DIST	UNIT/MNHRS CREW	UNIT/MNHRS DIST	% PROD.	UNIT COST CREW	UNIT COST DIST	% COST
100.01	PLANNING & SCHEDULING	MN HR	31	69	1.00	1.00	100	9.01	9.35	96
	YTD TOTALS:		73	347	1.00	1.00	100	8.88	8.87	100
101.01	BASE & SURFACE REPAIR	CU YD								
	YTD TOTALS:		114	305	2.36	1.40	169	5.51	10.37	51
101.02	SURF PATCH PREMIX HAND	CU YD	10	10	.13	.13	100	70.11	70.11	100
	YTD TOTALS:		617	1,095	.13	.13	77	110.87	85.46	130
101.03	SURF PATCH PREMIX MACH	CU YD								
	YTD TOTALS:		959	3,779	1.47	1.20	123	19.14	23.21	82
101.04	SURF PATCH SPOT SEAL	SQ YD	164	204	508.30	415.72	122	.06	.07	86
	YTD TOTALS:		164	284	508.30	375.50	135	.06	.07	86
131.02	CLEAN CULVRT OPEN & DI	EACH								
	YTD TOTALS:		34	34	1.21	1.21	100	6.94	6.94	100
131.03	DRESS & SHAPE DITCHES	LN FT	131	147	720.46	661.78	109	.02	.02	100
	YTD TOTALS:		131	147	720.46	661.78	109	.02	.02	100
131.04	CLEANING DITCHES	CU YD	80	242	6.70	3.42	80	2.09	1.41	148
	YTD TOTALS:		192	519	4.63	6.55	71	2.71	1.84	147
131.06	ROAD SECTION RESTORE	CU YD	117	682	3.75	5.20	72	3.44	2.65	130
	YTD TOTALS:		145	1,367	5.34	5.33	100	2.32	2.53	92
131.09	VEGETATION CONTROL MOW SH MI			408		.53			22.50	
	YTD TOTALS:		154	1,900	.96	.61	119	15.69	17.12	92
131.10	VEGETATION CONTROL HND MN HR			98		1.17			7.47	
	YTD TOTALS:		111	665	1.02	1.09	94	8.31	7.86	106

** ACTIVITY 100.01 HAS BEEN PRORATED

Figure E-2. Productivity and unit cost report

STATE OF NEVADA

DEPARTMENT OF HIGHWAYS

MAINTENANCE MANAGEMENT SYSTEM

STATE PRODUCTIVITY REPORT
JULY 1974 THRU OCTOBER 1974

MMS APT 0-0
RUN 12/03/74

ACTIVITY	DESCRIPTION	ACCOMPLISHMENT UNITS	STANDARD UNIT/MH	STATE	DIST. ONE	DIST. TWO	DIST. THREE	DIST. FOUR	DIST. FIVE	DIST. SIX
101.01	B & S REPR	CU YD	1.200	1.219	1.034	1.170	1.126	1.461	2.792	
101.02	SUR PACH H	CU YD	.125	.159	.294	.120	.241	.139	.077	.075
101.03	SUR PACH M	CU YD	1.700	1.293	.650	1.909	1.248	1.267	.828	.934
101.04	SUR PACH S	SQ YD	155.000	113.148	133.333	6.522	112.357		115.518	100.885
101.05	SEAL COT S	SQ YD	480.008	351.513	331.401	575.931	592.325	389.320	216.849	257.556
101.06	SEAL COT F	SQ YD	725.005				136.912		536.933	
101.07	CRACK FILL	LB	45.000	50.337	23.895				107.130	
101.08	HEAT PLAN	SQ YD	55.000	52.892		59.205	32.095			
101.09	SL COT CHP	SQ YD	374.995	288.127					295.648	
111.01	PAT SPAL T	CU YD	.111							
111.02	P & FO PAT	CU YD	.035							
111.03	PV SH MA P	CU YD	1.000							
111.04	PV SH SL S	SQ YD	480.000							
111.05	JOINT SEAL	LB	10.000							
111.06	EXP JNT RP	LN FT	1.600	7.312	7.312					
112.01	RPR CON AP	CU FT	6.000	.857	.100	.200	1.778			
131.01	CLEAN CULV	EACH	.225	.313	.819	.291		.714	.063	.083
131.02	CLN CO DI	EACH	1.000	.929	.990	.935	.797	.939	.135	.756

Figure E-3. State productivity report

DISTRICT NO. 1

FOR DECEMBER

RUN 01/22/75

STATION	ACTIVITY	DESCRIPTION	PRODUCTIVITY EXCEPTIONS	DISTRICT MEAN PROD.	COST EXCEPTIONS	DISTRICT MEAN COST
123	133.04	REMOVE ROADWAY DEBRIS			43.00 TR MI	1.02
126	133.02	EMPTY LITTER BARRELS			6.62 EACH	3.16
128	133.02	EMPTY LITTER BARRELS	6.75 EACH /MAN HR.	3.00		
129	131.02	CLEAN CULVRT OPEN & DI			234.24 EACH	5.69
152	141.11	MAINTAIN POSTS-MARKERS			13.91 EACH	4.87

Figure E-4. Productivity/unit cost exception

DISTRICT: 5 — DISTRICT OPERATIONS REPORT FOR THE PERIOD 3-18 THRU 4-15 — MMS RPT 0-4 RUN 06/03/75

MAINTENANCE, STOCKPILES, BETTERMENT EXPENSES:	LABOR HOURS	LABOR COSTS	EQUIPMENT COSTS	MATERIAL COSTS	TOTAL COSTS	YEAR TO DATE LABOR HOURS	YEAR TO DATE LABOR COSTS	YEAR TO DATE EQUIPMENT COSTS	YEAR TO DATE MATERIAL COSTS	YEAR TO DATE TOTAL COSTS
ACTIVITY REPORT TOTAL	6,270	43,436	41,187	8,012	92,635	61,916	433,329	364,064	288,676	1,086,070
ACCOUNTING TOTALS	6,125	36,256	40,164	7,482	83,902	59,864	396,919	318,671	372,971	1,088,562
CONST SERVICES										
MAINT ACTIVITIES	6,125	36,256	40,164	7,482	83,902	59,864	396,919	318,671	372,971	1,088,562
OPERATIONAL EXPENSES:										
ADMINISTRATION	1,011	8,534	1,057	1,092	10,685	9,749	95,541	12,009	7,962	115,513
MAINTENANCE STATIONS	644	3,935	716	9,086	13,739	6,066	42,043	6,237	61,284	109,565
EQUIPMENT SERVICE	551	3,230	496		3,727	4,857	32,519	5,250	63	37,833
NON RENT EQUIP	16	80		498	578	16	80		498	578
OTHER AGENCIES						234	1,495	182		1,678
MISCELLANEOUS	155	1,196	392	421	2,010	2,704	21,791	4,856	12,450	39,098
PURCHASED STOCK									22,583	22,583
(INVENTORY CREDITS)				2,537	2,537			(	166,509)(	166,509)
ACTUAL DISTRICT TOTALS:	8,502	53,234	42,828	21,117	117,180	83,490	590,392	347,207	311,304	1,248,903
OPERATIONAL EXPENSES CREW ANALYSIS										
STATION: 501										
MAINTENANCE STATION	88	589	120	150	859	856	6,457	1,161	3,795	11,414
EQUIPMENT REPAIR						16	120			120
NON RENT EQUIP										
OTHER AGENCIES						94	660	12		672
MISCELLANEOUS	1,148	9,595	1,308	1,233	12,137	11,280	109,146	14,990	8,834	132,971
STATION: 521										
MAINTENANCE STATION				1,187	1,187				7,898	7,898
EQUIPMENT REPAIR										
NON RENT EQUIP				33	33				33	33
OTHER AGENCIES										
MISCELLANEOUS				88	88				6,958	6,958
STATION: 522										
MAINTENANCE STATION	68	398		1,440	1,838	328	2,120	97	8,587	10,805
EQUIPMENT REPAIR	52	269			269	599	3,802	528		4,330
NON RENT EQUIP	16	90			80	16	80			80
OTHER AGENCIES										
MISCELLANEOUS						57	325		1,027	1,353

Figure E-5. District operations report

DISTRICT: ONE — MAN-HOUR UTILIZATION REPORT FOR 1973 — MMS RPT 0-13 RUN 07/29/74

ACTIVITY DESCRIPTION	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL
135.02 MAINT CATTLE GUARDS	17	20		6	4			42	4	12	6		111
135.03 REMOVE ENCROACHMENTS	5			16					75	3	4	4	107
135.04 INSPECT RW FENCES GATE	24		7	32	33	56	36	42	16	64	32	32	372
141.01 MAINT ROUTE-WARN SIGNS	435	402	395	394	437	387	417	403	206	306	376	473	4,631
141.02 GUARDRAIL REPAIR	240	75	71	54	85	193	76	86	55	56	24	48	1,063
141.03 GUARDRAIL PAINTING	136	26	472	250	146				16				1,046
141.04 GUARDRAIL CLEANING						5							5
141.05 PAVEMENT STRIPE DASHED	203	228	135	21	284	264	144	174	101	180	104	272	2,190
141.06 PAVEMENT STRIPE SOLID	48	164	164			76		237	210	250	32	56	1,237
141.07 PILOT LINING	452			120		96	8		32	24	22	96	850
141.08 PAVEMENT MARKINGS	384	305	274	444	306	165	321	186	155	264	532	324	3,660
141.09 ROWY LIGHTING SYSTEM													
141.10 PATROLLING	18		25	10		47	63	59	101	120	80	32	555
141.11 MAINTAIN POSTS-MARKERS	246	426	366	267	334	425	375	344	169	277	249	266	3,764
151.01 SNOW REMOVAL						123	55	1,027	30	133	10		1,378
151.02 SNOW PLOW ROTARY PLOW													
151.03 SNOW & ICE PATROLLING							9	76	6		14		105
151.04 INST/REM SNOW MARKERS					44	44					30		118

Figure E-6. District man-hour utilization report

STATE UNIT COST REPORT — MMS RPT Q-9
JULY 1974 THRU OCTOBER 1974 — RUN 12/03/74

ACTIVITY	DESCRIPTION	ACCOMPLISHMENT UNITS	STANDARD UNIT COST	STATE	DIST. ONE	DIST. TWO	DIST. THREE	DIST. FOUR	DIST. FIVE	DIST. SIX
100.01	PLAN & SCD	MN HR	6.96	7.49	7.99	7.26	7.49	9.67	7.09	7.06
101.01	B & S REPR	CU YD	18.02	14.09	17.06	14.75	20.73	10.77	8.95	
101.02	SUR PACH H	CU YD	98.12	79.06	40.57	89.88	50.89	83.01	138.00	136.38
101.03	SUR PACH M	CU YD	18.08	20.58	29.80	16.52	20.49	22.73	26.15	26.08
101.04	SUR PACH S	SQ YD	.13	.16	.15	2.09	.18		.16	.21
101.05	SEAL COT S	SQ YD	.08	.11	.15	.09	.07	.10	.12	.16
101.06	SEAL COT F	SQ YD	.05	.05	.06	.04	.16	.04	.06	.03
101.07	CRACK FILL	LB	.30	.29	.52				.19	
101.08	HEAT PLAN	SQ YD	.29	.31		.28	.51			
101.09	SL COT CHP	SQ YD	.22	.22					.22	
111.01	PAT SPAL T	CU YD	89.08							
111.02	P C FO PAT	CU YD	324.98							
111.03	PV SH HA P	CU YD	21.62							
111.04	PV SH SL S	SQ YD	.08							
111.05	JOINT SEAL	LB	1.07							
111.06	EXP JNT RP	LN FT	6.02	3.57	3.57					
112.01	RPR CON AP	CU FT	2.48	13.80	72.27	44.82	9.24			

** ACTIVITY 100.01 HAS BEEN PRORATED

Figure E-7. State unit cost report

SUMMARY OF EQUIPMENT HOURS AND MATERIAL QUANTITIES STATE WIDE — MMS RPT Q-15
QUANTITY — RUN 12/03/74

MATL. CLASS		JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	TOTAL
1	AGGREGATE	39,478	47,719	21,212	9,999	9,295	5,529	5,644	1,447	2,123	3,166	8,645	28,363	182,620
2	SCREENINGS	2,700	1,288	65	3,859	46	257	714	434			533	1,256	11,152
5	PREMIX	34,064	45,765	17,305	4,615	284	274	430	450	586	1,329	1,312	17,000	123,414
6	SALT				574	2,043	1,280	764	134	187	4			4,986
* 7	SALT-SAND				74	5,825	6,193	7,934	3,050	2,172	919	39		26,206
8	PLANTMIX		125	4,851	269						13	1	638	5,897
10	CEMENT	5	15	32	46	56	42	69	60	20	56	44	69	514
11	CONCRETE	6		9		14	3			9	3	8		52
12	LQD ASPH	1,001,497	1,198,535	645,341	271,534	17,622	30,812	20,626	24,232	20,648	65,496	333,413	762,785	4,392,541
13	CRACK FILL		170	400		7,600	52,100	73,900	76,800	60,200	27,500	3,523		302,193
14	FERTILIZER	1,773	1,215	460	80	80			2,293	30	1,470	180	1,340	8,921

Figure E-8. Material quantity summary report

SUMMARY OF EQUIPMENT HOURS AND MATERIAL QUANTITIES STATE WIDE — HOURS — MMS RPT 0-15 RUN 07/30/74

EQUIP. CLASS	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	TOTAL
24 ST SWEEPER	447	443	469	454	334	327	405	426	538	428	615	509	5,395
25 ST FLUSHER	48	114	161	59	43	53	8	37	89	172	218	320	1,322
26 COMPRESSOR	82	75	95	109	96	230	119	131	228	223	98	82	1,568
28 DISTRIB	469	641	689	295	118	96	170	240	225	157	134	307	3,541
30 MAINT DIST	1,248	1,467	996	869	272	918	1,279	1,607	1,307	1,309	421	643	12,036
31 GRADERS	4,990	5,560	3,314	2,588	1,728	1,738	1,201	1,518	2,234	2,975	3,449	4,000	35,275
33 PULVIMIXER	970	837	451	127		8				24	92	680	3,189
34 CHIP SPRD	664	903	385	161	44			6	32	95	94	574	2,960
35 LOADERS	4,798	4,984	3,975	3,697	4,033	3,668	3,616	2,942	4,042	4,352	4,495	5,009	49,611
37 CONVEYORS	1,182	902	909	1,269	1,143	1,040	952	884	636	1,140	854	362	11,273
38 CONVEY W/S	350	238	160	134	296	240	376	360	272	249	206	94	2,975

Figure E-9. Equipment usage summary report

SYSTEM ROUTE-ACTIVITY SUMMARY — MMS RPT 0-14 RUN 12/06/74

SYSTEM ROUTE	FROM DATE	TO DATE	DIST	CTY	FROM MILEPOST	TO MILEPOST	ACTIVITY	ACCOMPL. UNITS	TOTAL LABOR	TOTAL EQUIP.	TOTAL MATL.	TOTAL COSTS
FA 534	7- 1	6-30	1				141.05	35	1,037	503	1,439	2,979
FA 538	7- 1	6-30	1				141.05	26	362	177	3,825	4,364
FA 806	7- 1	6-30	1				141.05	13	295	163	453	911
FA 812	7- 1	6-30	1				141.05	9	108	48	198	354
FA 815	7- 1	6-30	1				141.05		43	25	50	118
FR 403	7- 1	6-30	1				141.05	4	108	49	91	248
FR 406	7- 1	6-30	1				141.05	1	43	23	52	118
FR 407	7- 1	6-30	1				141.05	5	135	71	94	300
FR 416	7- 1	6-30	1				141.05	1	41	23	45	109
FR 419	7- 1	6-30	1				141.05	1	108	44	25	177
FR 420	7- 1	6-30	1				141.05		22	11	440	473
IR 015	7- 1	6-30	1				141.05	232	2,904	1,326	3,797	8,027
RP 808	7- 1	6-30	1				141.05		22	11	6	39
SR 035	7- 1	6-30	1				141.05	22	421	233	478	1,132
SR 007	7- 1	6-30	1				141.05	1	65	53	27	145
SR 012	7- 1	6-30	1				141.05	30	584	391	543	1,518
SR 029	7- 1	6-30	1				141.05	37	756	472	593	1,821
SR 039	7- 1	6-30	1				141.05	4	173	111	102	386
SR 041	7- 1	6-30	1				141.05	19	421	216	384	1,021
SR 060	7- 1	6-30	1				141.05	14	173	123	267	563
SR 068	7- 1	6-30	1				141.05	19	226	135	229	590

Figure E-10. System route activity summary

LOCATION ANALYSIS REPORT — MMS RPT 0-11 RUN 12/11/74

ROUTE: SR 027 WA FROM: 14.00 TO: 24.53 FOR: 7- 1 TO: 10-30

ACTIVITY	UNITS	UNITS ACCOMPLISHED	NET MAN HRS	NET LABOR COSTS	NET EQUIP. COSTS	MATL. COSTS	TRAVEL TIME	AVE. HAUL DISTRICT	NET PROD.	NET UNIT COSTS
101.02 SUR PACH H	CU YD	8	77	535	172	81	2.14		.104	98.65
131.07 SH SCP MNT	SH MI	10	165	1,133	956		6.24		.061	209.00
133.03 SWEEPING	SW MI	48	14	101	107		.77		3.429	4.34
135.03 RMV ENGRMK	EACH	24	4	27	5		1.84		6.000	1.38
141.01 MNT SIGNS	SQ FT	248	13	87	45	93	3.35		19.077	.91
141.11 MNT MARKER	EACH	137	62	434	206	156	5.42		2.210	5.82
151.01 SNOW REMOV	MN HR	28	28	265	231		2.58		1.000	17.74
151.04 SNOW MARK	EACH	520	27	191	74		1.14		19.259	.51

Figure E-11. Location analysis report

ACTIVITY ANALYSIS REPORT

MMS RPT 0-12
RUN 08/22/74

REQUESTED ACTIVITY 141.07 PILOT LINING — REQUESTED DIVISION 127 — REQUESTED MONTH — TO

DATE	LOCATION				UNITS ACCOMPLISHED	NET LABOR HOURS	NET LABOR COSTS	NET EQUIP COSTS	MATERIAL COSTS	TRAVEL TIME	HAUL DISTANCE	NET PRODUCTIVITY	NET UNIT COST
6-17	SR 068	CL	.00	1.50	1	32	216	24		1.12		.03	240.32
6-18	SR 068	CL	1.50	3.00	2	32	216	24		1.02		.06	120.22
6-19	SR 068	CL	3.00	5.60	2	32	216	20		.90		.06	118.54
6-20	SR 068	CL	6.40	10.30	4	32	216	18		.68		.13	58.58
6-21	SR 068	CL	10.30	14.20	4	32	216	18		.46		.13	58.58
6-24	SR 068	CL	14.20	18.60	4	32	216	18		.22		.13	58.58
6-25	SR 068	CL	1.90	5.00	3	32	216	18		.96		.09	78.11
6-26	SR 068	CL	5.10	9.20	4	32	216	18		.74		.13	58.58

Figure E-12. Activity analysis report

DISTRICT PERFORMANCE REPORT
FOR DECEMBER

MMS RPT 0-6
RUN 01/22/75

DISTRICT NO.	COMPOSITE PRODUCTIVITY RATING %	DISTRICT NO.	COMPOSITE UNIT COST RATING %
6	127	6	89
3	124	3	95
2	119	5	97
5	114	2	99
1	97	1	107
4	96	4	114

MAX-MIN PRODUCTIVITY/UNIT COST

ACTIVITY		PRODUCTIVITY HIGH STATION	PRODUCTIVITY HIGH RATE	PRODUCTIVITY LOW STATION	PRODUCTIVITY LOW RATE	UNIT COST HIGH STATION	UNIT COST HIGH RATE	UNIT COST LOW STATION	UNIT COST LOW RATE
101.01	B & S REPR	128	1.56	234	.02	234	398.75	128	6.55
101.02	SUR PACH H	350	.71	234	.05	234	208.39	123	14.68
101.03	SUR PACH M	253	1.07	350	.55	128	29.72	253	25.97
101.04	SUR PACH S	451	508.30	429	30.45	429	1.02	451	.06
101.05	SEAL COT S	623	259.18	623	259.18	623	.14	623	.14
101.06	SEAL COT F								
101.07	CRACK FILL	351	94.87	227	12.42	227	.07	351	.17
101.08	HEAT PLAN	650	65.15	[illegible]	65.15	650	.24	650	.24

Figure E-13. District performance report

DISTRICT: SIX
MONTH: DECEMBER

WORK ACCOMPLISHMENT REPORT

MMS RPT 0-3
RUN 01/22/75

ACTIVITY	MONTHLY UNITS COMPL	MONTHLY UNITS SCHED	MONTHLY DOLLARS EXPENDED	MONTHLY DOLLARS BUDGETED	YEAR TODATE UNITS COMPL	YEAR TODATE UNITS SCHED	YEAR TODATE DOLLARS EXPENDED	YEAR TODATE DOLLARS BUDGETED
100.01 PLANNING & SCHEDULING	33	65	223	485	262	390	1,823	2,910
			223*	485*			1,928*	2,910*
101.01 BASE & SURFACE REPAIR						192		2,908
101.02 SURF PATCH PREMIX HAND	23	38	4,192	3,592	84	238	12,808	19,159
101.03 SURF PATCH PREMIX MACH					1,082	1,360	20,462	22,744
101.04 SURF PATCH SPOT SEAL		15,500		1,779	7,654	31,000	1,801	3,546
101.05 SEAL COAT SAND	2,851		438		341,444	384,006	55,583	26,984
101.06 SEAL COAT FLUSH					351,285	652,505	12,000	32,685
101.07 CRACK FILLING	4,744	27,000	3,325	7,798	11,593	54,000	8,520	15,595
101.08 HEATER PLANING	29,122		7,781		33,194	11,000	8,971	2,874
101.09 SEAL COAT-CHIPS							277	
			15,736*	13,163*			128,422*	126,695*
111.01 PATCH SPALL AREAS TEMP								
111.02 PART & FUL DEPTH PATCH								
111.03 PAVD SHO MAINTENANCE P								
111.04 PAVD SHO SEAL SAND								
111.05 JOINT SEALING								
111.06 EXPANSION JOINT REPAIR								
112.01 REPAIR MISC CONC APURT						150		390
								390*
131.01 CLEANING CULVERTS					5	22	241	1,136
131.02 CLEAN CULVRT OPEN & DI	12	30	176	344	111	160	2,206	2,064
131.03 DRESS & SHAPE DITCHES					2,525	60,000	403	2,576
131.04 CLEANING DITCHES		262		648	14,569	2,361	5,100	5,832
131.05 CULVERT REPAIR REPLACE	2	8	96		2	24	96	
131.06 ROAD SECTION RESTORE	4,387	3,375	7,917	6,241	9,891	15,525	24,797	28,709
131.07 SHLDR SLOPE MAINT BLAD	7		298		26	80	1,973	4,745
131.01 VEGETATION CONTROL MOW	32	165	416	4,260	1,052	880	24,816	22,720
131.03 VEGETATION CONTROL SPR	87	100	1,486	2,352	372	220	6,601	4,704
131.11 VEGETATION CONTROL MND					8	50	94	
			10,309*	13,845*			66,327*	72,486*
131.01 REMOVE DEBRIS LITTER	10		350		85	240	7,127	5,370
132.02 EMPTY LITTER BARRELS	217	150	779	442	4,791	1,500	9,106	4,420
134.01 SWEEPING COVER MV & SH	27	80	344	705	333	480	6,538	4,230
					9,477	6,079	12,794	7,944

Figure E-14. Work accomplishment report

DISTRICT NO. 6 BUDGET INPUT REPORT

MMS RPT B-2
RUN 05/02/74

ACT. NUMBER	ACTIVITY DESCRIPTION	ESTIMATED MAN HOURS BY MONTH JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL EST MN HRS	TOTAL BUDGET MN HRS	CREW DAYS	CREW SIZE	UNITS / MN HRS RATIO	UNIT / RATE
100.01	PLAN & SCD	65	65	65	65	65	65	65	65	65	65	65	65	780	1020	128	1	1.000	7.4
101.01	B & S REPR			80	80					80	80			320	71	1	2	1.099	19.1
101.02	SUR PACH H	100	100	100	500	500	300	300	300	500	500	200	100	3500	5470	171	4	.113	11.9
101.03	SUR PACH M	200	300	200	100							100	100	1000	3215	80	5	1.541	28.4
101.04	SUR PACH S					100	100	100	100	100	100	100		700	320	13	3	141.991	17.7
101.05	SEAL COT S	400	300	100								500	800	2100	3223	40	10	435.765	33.7
101.06	SEAL COT F	400	400	100								200	600	1700	3533	63	7	657.647	36.2
101.07	CRACK FILL				200	400	600	1000	1000	1000	500			4700	2433	71	5	40.326	12.9
101.08	HEAT PLAN				200							200		400	859	21	5	50.066	14.3
101.09	SL COT CHP													0	1207	11	14	342.235	76.7
111.01	PAT SPAL T													0			5		
111.02	P & FD PAT													0			8		
111.03	PV SH MA P													0			7		
111.04	PV SH SL S													0			7		
111.05	JOINT SEAL													0			5		
111.06	EXP JNT RP													0			5		
112.01	RPR CON AP	5	5	5	5	5					5	5	5	40	72	5	2	5.750	15.3
131.01	CLEAN CULV				50	50				50	50			200	325	14	3	.197	11.5

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Figure E-15. Budget input report

DISTRICT 6
FISCAL YEAR 74

PRELIMINARY COMPUTED DISTRICT MAINTENANCE BUDGET

MMS RPT B-1
RUN 05/02/74

ACTIVITY	MAN HOURS	WORK LOAD	COSTS
100.01 PLANNING & SCHEDULING	1,020	1020	7,619
	1,020 *		7,619 *
101.01 BASE & SURFACE REPAIR	71	78	1,290
101.02 SURF PATCH PREMIX HAND	5,470	617	66,506
101.03 SURF PATCH PREMIX MACH	3,215	4954	92,215
101.04 SURF PATCH SPOT SEAL	320	45437	5,676
101.05 SEAL COAT SAND	3,223	1404470	108,714
101.06 SEAL COAT FLUSH	3,528	2326756	128,493
101.07 CRACK FILLING	2,833	115659	36,019
101.08 HEATER PLANING	959	43007	12,343
101.09 SEAL COAT-CHIPS	1,207	413078	92,645
	20,736 *		543,706 *
111.01 PATCH SPALL AREAS TEMP			
111.02 PART & FUL DEPTH PATCH			
111.03 PAVD SHD MAINTENANCE P			
111.04 PAVD SHD SEAL SAND			
111.05 JOINT SEALING			
111.06 EXPANSION JOINT REPAIR			
112.01 REPAIR MISC CONC APURT	72	414	1,135
	72 *		1,135 *
131.01 CLEANING CULVERTS	325	64	3,692
131.02 CLEAN CULVRT OPEN & DI	649	584	7,449
131.03 DRESS & SHAPE DITCHES	3,100	840390	39,936
131.04 CLEANING DITCHES	2,908	13804	37,696
131.05 REMOVE SAND DRIFT			
131.06 ROAD SECTION RESTORE	2,799	17811	34,940
131.07 SHLDR SLOPE MAINT BLAD	769	138	9,129
131.08 VEGETATION CONTROL MOW	7,533	3743	106,973
131.09 VEGETATION CONTROL SPR	516	469	12,136
131.10 CULVERT REPAIR REPLACE			28
	19,599 *		251,984 *
133.01 REMOVE DEBRIS LITTER	3,334	1221	29,856
133.02 EMPTY LITTER BARRELS	1,012	2746	8,052
133.03 SWEEPING TRVLD WY & SH	633	979	8,931
133.04 REMOVE ROADWAY DEBRIS	3,130	21147	27,634
	8,109 *		75,374 *

ACTIVITY	MAN HOURS	WORK LOAD	COSTS
134.01 MAINTENANCE REST STOPS	416	416	3,669
134.02 MAINT OF ROADSIDE PARK	2,496	2496	19,930
134.03 MAINT LNDSCAP AREA WT			
134.04 MAINT LNDSCAP AREA NOT			
	2,912 *		23,599
135.01 REPAIR RR FENCE GATES	200	4012	3,484
135.02 MAINT CATTLE GUARDS	915	52	5,313
135.03 REMOVE ENCROACHMENTS	238	107	2,611
135.04 INSPECT RW FENCES GATE	72	461	654
	825 *		10,463
141.01 MAINT ROUTE-MARK SIGNS	2,052	13270	38,560
141.02 GUARDRAIL REPAIR	478	1272	7,299
141.03 GUARDRAIL PAINTING	670	23401	14,574
141.04 GUARDRAIL CLEANING	321	95647	2,665
141.05 PAVEMENT STRIPE DASHED	1,480	814	41,[illegible]
141.06 PAVEMENT STRIPE SOLID	739	404	37,622
141.07 PILOT LINING	567	67	4,736
141.08 PAVEMENT MARKINGS	1,984	40770	12,[illegible]
141.09 ROAD LIGHTING SYSTEM	107	107	955
141.10 PATROLLING	249	4273	2,719
141.11 MAINTAIN POSTS-MARKERS	4,712	10686	56,174
	12,454 *		219,571
151.01 SNOW REMOVAL	4,182	4182	67,874
151.02 SNOW PLOW ROTARY PLOW			
151.03 SNO & ICE PATROLLING			
151.04 INST/REM SNOW MARKERS			
	4,182 *		67,874
161.01 MAINT REPAIR STRUCTURE	281	263	2,498
161.02 INSPECT STRUCTURES	689	3431	6,104
	970 *		8,602

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Figure E-16. Preliminary maintenance budget

APPENDIX F

NORTH DAKOTA HIGHWAY DEPARTMENT'S

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 640,000 residents of North Dakota operate 490,000 motor vehicles on 106,897 miles of highways of which 6,950 miles are under state control. The state occupies 70,655 square miles from an elevation of 750 feet to 3,506 feet above sea level. Mean minimum and maximum temperatures are -10 and 88°F with average annual moisture ranging from 14 to 20 inches.

The North Dakota Highway Department has a $28,743,453 maintenance budget for 1975-1977 biennium. This budget will be used by its 8 districts to maintain 15,160 lane miles of highways.

Eight districts comprise the North Dakota Highway Department. Each district is divided into maintenance sections resulting in a total of 71 maintenance sections state wide. The location of the maintenance sections was originally based upon snow and ice control needs and the amount of unsurfaced roads to be maintained.

Lead men are in responsible charge at the maintenance section with some assistance from crew leaders. Lead men report to the district maintenance engineer who in turn reports to the district engineer. Some of the smaller districts in the state may have one employee acting as the maintenance engineer in addition to certain other duties. The administration of the maintenance program by the Chief Engineer of the North Dakota Highway Department is performed at the central office level by the Maintenance Engineer.

The basic maintenance recording and reporting system was developed in the 1970 to 1971 period. The maintenance management system makes use of information collected for accounting purposes thus a single recording system is utilized. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports. About four years of reliable maintenance cost data are now available from the recording and reporting system.

RECORDING SYSTEM

North Dakota Highway Department, "Maintenance Time Card" (Form 22-3-1) (Figure F-1) is the source document used for posting employees time and expenses to a time sheet and for recording of vehicle usage. The Maintenance Time Card is completed by the employee, reviewed and approved by the immediate supervisor which is often the lead man and mailed daily to the district office. A secretarial type person at the district level fills out an "Employee Time Distribution Sheet" (Form 22-1-1) (Figure F-2) and "Vehicle Use Report" (Form 15-0-1) (Figure F-3) based on information obtained from the "Maintenance Time Card." A fourth form is utilized to transfer inventory. This form called the "Disposal Report" (Form 8-4-1) (Figure F-4) is normally filled out by district warehouse employees. Information recorded on each of these forms is discussed below.

Information recorded on the "Maintenance Time Card" and transferred to the "Employee Time Distribution Sheet" and "Vehicle Use Report" includes the following;

1. Employee's name and Social Security number

2. Activity performed

3. Location activity performed

4. Man-hours, equipment hours, equipment miles

5. Equipment utilization

6. Per Diem charges if eligible

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A number from 1 to 8 is utilized to designate the district. On certain recording forms a 6 must preceed the district number designation.

2. Maintenance Section. The 71 maintenance sections do not have a unique code and thus costs can only be collected indirectly for maintenance sections. Buildings, storage tanks, and certain items of equipment can be recognized as under the control of certain districts. Sections of roadways are designated by district and not by Maintenance Section.

3. Section. Specific highway segments are assigned highway section numbers and designated by a five digit alpha numeric code which includes the district number and the highway number. These codes are recorded in the column "charge-to." An example of such a code is shown below;

H1 - 094

H - indicates that the "charge-to" is a highway section

1 - district number one and

094 - designates the highway number (Interstate Highway 94).

Control and sections set-up by construction contracts were utilized at one time but became a bookkeeping problem and have been discarded. A mile marker system or mile post system is used to designate locations of bridges, signs, stockpiles, rest areas, etc. However, the mile marker system is utilized for inventory control and not to designate the location at which maintenance activities are performed. These data help the lead men manage their sections.

Individual maintenance sections monitor the use of some items such as road ice, blade mix, chips, deicing chemicals, etc. for their own management use. This, however, is not widely done and it must be done without the aid of the computer.

Activity

Maintenance function codes are utilized to designate the maintenance activity performed (Table F-1). Sixty-three maintenance codes are presently utilized and are directed into the following major groups;

1. General Maintenance
2. Additions and Betterments
3. General Maintenance Other Than Roadway
4. Traffic Services
5. Snow and Ice

6. Structures and Extraordinary Maintenance
7. Shop and Building Expense
8. Costs Not Chargeable to Other Maintenance Functions
9. Accounts Receivable
10. Purchase of Equipment, Buildings and Land
11. Other Capitalization Costs
12. Inventory
13. Equipment Expense.

It should be noted that a special function code, "Maintenance of Concrete Surfacing," is utilized for maintenance on portland cement concrete pavements. A special code exists for snow and ice removal.

Manpower

As discussed above, the "Maintenance Time Card" is filled out by the individual workman. It is on this recording form that the hours worked on a particular maintenance activity for a particular highway section or segment are recorded to the nearest hour. Start and quit times are recorded on this form as well as the hours utilized to operate equipment. The total time worked by the individual workman is summed for the day to the nearest hour.

The information supplied by the individual employee on the "Maintenance Time Card" is transferred to the "Employee Time Distribution Sheet" (Figure 2) at the district office daily. The Employee Time Distribution Sheet is a monthly summary record and includes a record of regular time, over-time, vacation, sick leave, jury leave, military leave, etc. All time is assigned to a function and a "charge-to" highway section or segment, building, rest area,

equipment unit, etc. The objective code is also filled out on the Employee Time Distribution Sheet to assign items of expense such as meals, lodging, commercial airfare, taxi, etc. to the proper code. The following is a partial list of objective codes:

123 - Vacation
124 - Sick Leave
125 - Holiday Pay
126 - Jury Leave
127 - Military Leave
128 - Other Leave
241 - In-State Mileage
242 - Out-of-State Mileage
243 - Commercial Airfare
244 - Taxi and Other Transportation
245 - In-State Meals
246 - Out-of-State Meals
247 - In-State Lodging
248 - Out-of-State Lodging
310 - Oil Mix
311 - Gravel Oil Mix
313 - Sand
314 - Chips
332 - Gasoline

Basically the "Objective Code" is a more detailed breakdown of the Function Code.

Employees are paid monthly by two checks as described on page F-8.

Equipment

Equipment utilized by a particular individual is recorded on the "Maintenance Time Card." The equipment unit number is recorded together with the miles driven or motor time depending on the equipment unit. Four digit numbers are utilized for equipment codes. For equipment units designated by 8000 series, the operator reports miles driven. For units designated other than 8000 series, only motor time is recorded. Rental equipment is handled by special function

codes. Equipment use time is recorded to the nearest hour and equipment mileage to the nearest mile. Equipment use is assigned to a particular activity on a particular section of roadway where possible.

The "Vehicle Use Report (Form 15-0-1) shown on Figure F-3 is a monthly summary for a particular vehicle obtained from the Maintenance Time Card. The Vehicle Use Report is filled out at the district level and may contain information from more than one individual's Maintenance Time Card. The Vehicle Use Card can also be utilized to report productivity and the individual operating the vehicle. For example, the number of acres mowed on a daily basis may be recorded for function 450 (mowing) on the form together with the employees name who operated the piece of equipment. Equipment classes have been established to simplify equipment use charges.

Materials

Materials utilized for a particular maintenance activity are recorded daily on the "Disposal Report" (Figure F-4) by employees assigned to material warehouses. This form includes a description of the material by a function and objective code as well as by a word description, the quantity of the material, the unit price of the material and the total cost. Material usage is charged to vehicles for such items as gasoline and to highway section or segment for such items as road oil, sand, chips, oil mix, etc. utilized to perform specific maintenance functions (Debit Column). Inventories are transferred from material stockpile by "crediting" the proper account on this form. The report is prepared for specific districts.

Accomplishments

Accomplishments can be recorded for specific functions on the Maintenance Time Card under the column remarks. This information is then transferred to the Vehicle Use Report.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance Time Card is filled out daily by the maintenance employee and approved by the lead man of the maintenance section. The Maintenance Time Card is mailed daily to the district office where the information is transferred to the Employee Time Distribution Sheet and to a Vehicle Use Report. This data transfer is performed daily. The Disposal Report is filled out daily by the district warehouse employees. Information on these three forms is transmitted by mail to the central office on a monthly basis by the third working day of the month. Key punching is done at a centralized data processing center. The source documents do not leave the district.

Employee checks as described above are issued in two stages. The first check is paid on the first of the month and reflects payment on a monthly basis. A second check is issued about the 10th of the month which includes travel expenses and over-time.

Maintenance management reports obtain their source information from the accounting reports as discussed above. Maintenance management reports are back to the district by the 20th of the month.

It is estimated that about one percent of the maintenance budget is expended on recording and reporting maintenance activities. Annual computer costs are about $10,000 to produce the maintenance

management reports. Individual employees require about 10 minutes per day to fill out the Maintenance Time Card. Three to four hours is required by the district clerical staff daily to transfer the Maintenance Time Card information to the Employee Time Distribution Sheet and Vehicle Use Report. It should be pointed out, however, that these data are required by accounting and a single reporting system is utilized to satisfy both the accounting and maintenance management function.

REPORTS

Two years ago over 28 maintenance reports were given to the districts by the central office. The number of reports has since been reduced to three. A brief discussion is presented below indicating the types of data contained on these reports:

HW1-820-AA. Maintenance Report HW1-820-AA is a report delineating the expected expenditures for maintenance activities by month and a total for the year for all functions the districts expect to perform. The lead men of the section together with the district maintenance engineers are responsible for making these estimates. The estimates are made during March and April or the spring thaw period, by mile marker and highway route. Standard forms are used to record the data collected in the budgetary process. Manpower requirements and availability are primarily responsible for fixing material and equipment quantities for budget preparation.

Two formats are utilized for this report. The report which summarizes district budget amounts by function (Figure F-5) includes

the following information by the month and a yearly total;

1. Planned quantities,
2. Planned hours,
3. Budget amount,
4. Standard unit cost rate and
5. Standard production rates.

The report which summarizes the state budget amounts by function does not include the standard unit cost rate or production rate as it varies by district. It should be noted that costs are not summed for maintenance function or activity groups.

HW1-830-BB. Maintenance Report HW1-830-BB delineates costs for each maintenance function for each district on both a monthly and year to date basis (Figure F-6). All maintenance functions plus overhead costs are shown. The report gives the following information for each function:

1. Function description
2. Function number
3. Unit of measure
4. Planned quantity
5. Actual quantity
6. Planned labor-hours
7. Actual labor-hours
8. Budget
9. Total cost
10. Labor cost
11. Material cost
12. Equipment rental cost
13. Other costs that do not fall in labor, material and equipment rental
14. Standard unit cost
15. Actual unit cost
16. Standard production rate
17. Actual production rate

District total costs are also presented for all functions. Separate print-outs in the same format are provided for monthly and year to

date expenditures. HW1-830-AA Maintenance Report HW1-830-AA summarizes the costs shown on report HW1-830-BB in format to compare district performance. These comparisons are presented on both a monthly and year to date basis for individual maintenance functions. The report includes the following items for each district and each function;

1. Actual quantity
2. Actual hours
3. Total cost
4. Actual unit cost
5. Standard unit cost
6. Actual performance rate
7. Standard performance rate

District total costs are also presented for all functions. Separate print-outs in the same format are provided for monthly and year to date expenditures.

All information with the exception of standard unit costs and standard performance rates are obtained from the information recorded as described above. Standard unit costs and performance rates are based on historical information unique to individual districts.

Reports are utilized at the central office and district level for fiscal control, by reviewing budgeted and actual expenditures; for monitoring of program execution by comparing planned and accomplished man-hours and material quantities; for allocation of manpower by reviewing standard unit costs and productivity rates against actual costs and productivity rates; and for budget pre-

paration to revise productivity rates, etc. based on actual field productivity and unit cost rates.

Presently maintenance functions that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by a detailed review of the reports. Exception reports are presently not a part of the reporting system although their development is under consideration.

OTHER ITEMS

The North Dakota Highway Department is satisfied with the reliability of the existing recording and reporting system although they feel improvements can be made. Basic information is recorded on the Maintenance Time Card and transferred by the district clerical staff to the Employee Time Distribution Sheet and Vehicle Use Report. Material usage is reported by the district warehouse on a Disposal Report. It is believed that this approach improves the reliability of the information in that the workman's time sheet is reviewed by the lead man and district personnel and thus more reliable information is obtained.

The recording and reporting system can be altered by direction of the central office maintenance staff. Prior to any changes in the system operating staff in the districts are consulted. Data processing changes and/or changes involving the accounting system require considerable lead time.

Function codes were developed with the assistance of the district maintenance engineers. A standing standards committee does not exist nor does a format committee exist to review and revise the

recording and reporting system.

The lag time between the reporting of the information by the districts and reporting of the information will probably not be reduced until computer terminals are placed in the district. A new equipment management system is presently being implemented. District productivity standards are being revised as information becomes available.

References

"Maintenance Manual," North Dakota State Highway Department.

"Accounting Manual," North Dakota State Highway Department: July 1, 1975.

Table F-1. Maintenance Function Codes

General Maintenance

410 Routine Roadway Surface Operations
411 Hand Patching
412 Spot Sealing
413 Maintenance of Concrete Surfacing
414 Crack Pouring
415 Maintenance of Expension Joints
416 Blading Gravel Roads and Shoulders
419 Other Surface Maintenance Operations
420 Regraveling
421 Blade Patching and Leveling
422 Resealing - State Forces
423 Slab Jacking
424 Light Reseals
425 Contract Reseals

Additions and Betterments (No mile number needed)

428 Service Roads
429 Other Additions and Betterments

General Maintenance Other Than Roadway

431 Patching and Leveling Shoulders and Side Approaches
433 Shoulder Sealing with Aggregate Cover
435 Shoulder Sealing Without Aggregate Cover
440 Roadside and Drainage
441 Right-of-Way Fences and Markers
445 Maintenance of Special Roadside Development Projects
450 Mowing
451 Control of Vegetation
455 Removal of Debris
461 Guard Rails, Detours and Delineators

Traffic Services

462 Centerline Striping
463 Signal Equipment
464 Signs on Interstate Highways
465 Rest Area Maintenance
466 Highway Lighting
467 Signs on other than Interstate Highways
468 Other Pavement Markings
469 Edgeline Striping

Snow and Ice

480 Snow, Ice and Sand Control and Removal

Table F-1. Continued

Structures and Extraordinary Maintenance

490 Extraordinary Maintenance
510 Structures - Routine Maintenance
511 Structures - Major Maintenance
520 Structures - Special Drainage

Shop and Building Expense

590 Operating Expense of Shop
595 Maintenance of Buildings and Grounds

Costs Not Chargeable to other Maintenance Functions

601 Stores Expense
612 Sign Shop Expense
614 Holiday Pay
615 Radio Rental
616 Overhead Charges
617 Non-Classified Maintenance Costs
619 Maintenance Research

Accounts Receivable

621 Accounts Receivable from Outside Sources

Purchase of Equipment, Buildings and Land

640 Purchase of Major Equipment (licensed)
642 Purchase of Buildings and Land
643 Purchase of Rest Area Sites
645 Purchase of Major Tools and Shop Equipment
646 Purchase of Minor Equipment

Other Capitalization Costs - Equipment, Buildings and Land

647 Major Equipment - Other Capitalized Costs
648 Buildings and Land - Other Capitalized Costs
649 Minor Equipment - Other Capitalized Costs

Inventory

650 Equipment Parts Inventory
655 Petroleum Products Inventory
670 Road Materials Inventory
690 Central Supply Inventory

Equipment Expense

700 Equipment Maintenance Expense
701 Equipment Maintenance Expense (Field Personnel)

DATE: 19 NAME: EMP. NO.

UNIT NO.	MILES					A. M.	P. M.	LODGED AT:
					START			
					QUIT			HOURS WORKED:

NATURE OF WORK	UNIT NO.	SECTION	MILE	FUNCTION	HOURS
MR.	WORKED WITH ME	OPRAT'G UNITS			

REMARKS:

FORM 20 (10M BKS. 2-65) "BUY NORTH DAKOTA PRODUCTS" THE PIERCE CO., FARGO

Figure F-1. Maintenance Time Card.

Form 22-1-1 Rev. 2-15-71

Figure F-2.

North Dakota State Highway Department

EMPLOYEE TIME DISTRIBUTION SHEET

Name (Last) (First) (Initial) | District / Division | Month of 19 | Social Security No. / / | Base Rate

State Vehicle Operated Yes ☐ No ☐ | Page ____ of ____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total Hours Reg.	Total Hours O.T.	Total Hours Comp	Expenses Only Amount	Obj.	Fur	Charge To	Approved :
																																							District Office
																																					Central Office
																																	125		Holiday Pay		
																																	123	3	Vacation		
																																	124	3	Sick Leave		
																																	126	3	Jury Leave	Title	
																																	127	3	Military Leave		
																																	128	3	Other Leave		
																																	120	3	Comp Time Taken		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					TOTALS			

Employee Signature

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4 ton Truck

UNIT NUMBER 9833

DISTRICT TO WHICH UNIT IS ATTACHED 65

NORTH DAKOTA STATE HIGHWAY DEPARTMENT

Figure F-3. **VEHICLE USE REPORT**

CHARGE TO	Function	DAY OF MONTH 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Special Quantity	Total Hours or Miles
[illegible]	[illegible]	1																																1
[illegible]	[illegible]	1																																2
H5 008	4121						5	4																					3					12
H5-200	410	1				1		1	1						2				2				2											10
H5-200	455													3																				3
H5-008	410	1							2			1							2				1											7
H5-009	467																			2														2
H5-200	467																			1														1
65	617																					3												3
H5-008	455																						1											1
H5-008	461																											1						1
Employee's Name		[illegible]				Swanson		"	Swanson			Swanson		Mohl	"				Mohl	"		Swanson	"					Swanson	Mohl					
																																	43	
REMARKS																																	MONTHS TOTALS	

Rev. (9/1/72)
Form 15-0-1

Name of Driver

Year Posted	Month of Operation	Approved
1975	August	Hal

MILEAGE DATA:

MILES THIS MONTH: 972

ENDING LAST MONTH 84,992

MILEAGE TO DATE 85,964

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NORTH DAKOTA STATE HIGHWAY DEPARTMENT

Figure F-4. DISPOSAL REPORT

Central R[illegible]f. No. | District Ref. No. 0 – 0059

DESCRIPTION	DEBIT Dist. Dr.	DEBIT Unit, Hwy., Lot., Bldg., Tank, Project, Inv., Allot., Rest Area, Clm. No.	DEBIT FUNCT.	CREDIT Dist. Cr.	CREDIT Unit, Hwy., Lot., Bldg., Tank, Project, Inv., Allot., Rest Area, Clm. No.	CREDIT FUNCT.	OBJ.	QTY.	UNIT PRICE	TOTAL
Oil Mix	61	I1 J001 06 011	670				310	63	9 15+	5765 31
Gravel O.M.				61	I1 J002 06 011	670	311	(63)	2 57	(1619 10
Road Oil				61	I1 H460 67700	670	302	(12 89)	23 20–	(4146 21
Road Oil	61	H1 041	421	61	I1 H460 67600	670	302	5	30 65	22 9[illegible]
Road Oil	61	H1 200	421	61	I1 H460 67600	670	302	[illegible] 0	30 65	107 2[illegible]
Oil Mix	61	H1 200	421	61	I1 J001 00 226	670	310	5	10 71	696 1[illegible]
Sand	61	H1 049	412	61	I1 J004 94 108	670	313	[illegible]5	5 81	203 3[illegible]
Oil Mix	61	I1 J001 49 102	670				310	[illegible]	[illegible]0 7 32	4398 45
Gravel O.M.				61	I1 J002 49 102	670	311	(6	[illegible]0) 1 99	(1194 00
Road Oil				61	I1 H460 67700	670	302	(10[illegible]	[illegible]7) 31[illegible]3	[illegible]3204 45
Road Oil	61	H1 049	431	61	I1 H460 67600	670	302	1	00 3441	584 9[illegible]
Oil Mix	61	H1 049	431	61	I1 J001 94 108	670	310		40 8 65	346 0[illegible]
Road Oil	61	H1 021	412	61	I1 H460 67600	670	302		75 3649	209 8[illegible]
Chips	61	H1 021	412	61	I1 J005 21 076	670	314		37 6 49	240 1[illegible]
Sand	61	H1 021	412	61	I1 J004 21 076	670	313		48 4 80	230 4[illegible]
Oil Mix	61	H1 021	411	61	I1 J001 21 076	670	310		2 13 60	27 2[illegible]
						PAGE TOTALS		[illegible]157	DEBIT	12,832 0[illegible]
								26 43	CREDIT	TOTAL AMOU

Prepared By Jacob Paul Date Sept 12 197 5

Form 8-4-1 (Rev. 12-6-74)

District 61

Figure F-5. Maintenance Management Report IW1-820-AA.

HW1-820-AA 08/29/74 1

FUNCTION	JULY	AUG									AL
410 RDWY.SUR.OPER.RTN.											
PLAN QTY-											
PLAN HRS-	400	400	300	100	70	50			30	400	400	2,420
BUDGET -	3,716		2,763		650					3,720		22,429
-		3,711		929		464			2.76		3,715	
STANDARD UNIT COST RATE		.60										
STANDARD PRODUCTION RATE		.00										
411 HAND PATCH ON ROAD											
PLAN QTY-	50	100	60	25	25				5	50	38	398
PLAN HRS-	350	700	420	175	175				35	350	266	2,766
BUDGET -	2,000		2,400		1,000					2,000		15,920
-		4,000		1,000					2.00		1,520	
STANDARD UNIT COST RATE		40.00										
STANDARD PRODUCTION RATE		7.00										
412 SPOT SEALING											
PLAN QTY-	33,000	170,000	70,000					9,000	30.00	50,000	40,000	402,000
PLAN HRS-	330	1,700	700					90	30	500	400	4,020
BUDGET -	9,900		21,000					2,700		15,000		120,600
-		51,000							9.00		12,000	
STANDARD UNIT COST RATE		.30										
STANDARD PRODUCTION RATE		.01										
414 TRM.CLN.JTHR.CRACK											
PLAN QTY-						20,000	30,000	40,000				90,000
PLAN HRS-						3,000	4,500	6,000				13,500
BUDGET -						27,000		54,000				121,500
-							40,500					
STANDARD UNIT COST RATE		1.35										
STANDARD PRODUCTION RATE		.15										
416 BLADING GRAVEL RLDG SHLD											
PLAN QTY-	60	60	40	40	40	40	40	40	84	8	60	60	644
PLAN HRS-	18	18	12	12	12	12	12	12	25	2	18	18	193
BUDGET -	240		160		160		160		336		240		2,576
-		240		160		160		160		32		240	
STANDARD UNIT COST RATE		4.00										
STANDARD PRODUCTION RATE		.30										
421 BLADE PATCH & LEVL											
PLAN QTY-	1,200	1,200	500	200					32	500	1,200	5,120
PLAN HRS-	900	900	375	150					24	375	900	3,840
BUDGET -	24,000		10,000							10,000		102,400
-		24,000		4,000					6.40		24,000	
STANDARD UNIT COST RATE		20.00										
STANDARD PRODUCTION RATE		.75										
422 BITUMINOUS RESEAL											
PLAN QTY-	25											25
PLAN HRS-	1,631											1,631
BUDGET -	87,850											87,850
-												
STANDARD UNIT COST RATE		3,500.00										
STANDARD PRODUCTION RATE		65.00										

Figure F-6. Maintenance Management Report HW1-830-BB.

FUNCTION DESC.			QUANTITY	HOURS	*** COST DISTRIBUTION ***						COST	PROD. RATE
OVERTIME TEMPORARY	HRS	PLAN			BUDGET		LAB	333	EQT		STAND.	
		ACTUAL	127		TOT CST	333	MAT		OTH		ACTUAL	2.62	
EMPLOYEE SALARIES	HRS	PLAN			BUDGET		LAB	689,567	EQT		STAND.	
		ACTUAL	142,708		TOT CST	689,567	MAT		OTH		ACTUAL	4.83	
OVERTIME PERMANENT	HRS	PLAN			BUDGET		LAB	18,185	EQT		STAND.	
		ACTUAL	4,208		TOT CST	18,185	MAT		OTH		ACTUAL	4.32	
TEMPORARY SALARIES	HRS	PLAN			BUDGET		LAB	22,897	EQT		STAND.	
		ACTUAL	9,008		TOT CST	22,897	MAT		OTH		ACTUAL	2.54	
COMPENSATORY TIME	HRS	PLAN			BUDGET		LAB	13,402	EQT		STAND.	
		ACTUAL	3,043		TOT CST	13,402	MAT		OTH		ACTUAL	4.40	
RDWY.SUR.OPER.RTN. 410		PLAN		1,390	BUDGET	13,038	LAB	8,637	EQT	6.1 0	STAND.	9.37	
		ACTUAL		1,900	TOT CST	18,695	MAT	3,948	OTH		ACTUAL	9.83	
HAND PATCH ON ROAD 411	CU YD	PLAN	180	1,170	BUDGET	7,740	LAB	9,459	EQT	2.6 3	STAND.	43.00	6.50
		ACTUAL	337	2,143	TOT CST	15,248	MAT	3,096	OTH		ACTUAL	45.24	6.35
SPOT SEALING 412	SQ YD	PLAN	147,500	1,475	BUDGET	30,975	LAB	23,810	EQT	15.8 7	STAND.	.21	.01
		ACTUAL	333,134	5,412	TOT CST	81,228	MAT	41,413	OTH	1 8	ACTUAL	.24	.01
MTCE CONCRETE SURFACE 413		PLAN		610	BUDGET	5,516	LAB	5,806	EQT	1.8 8	STAND.	9.04	
		ACTUAL		1,318	TOT CST	9,565	MAT	1,934	OTH	7	ACTUAL	7.25	
TRM.CLN.OTHR.CRACK 414	GAL	PLAN	150,000	15,000	BUDGET	112,500	LAB	16,414	EQT	6.3 2	STAND.	.75	.10
		ACTUAL	37,580	3,672	TOT CST	29,211	MAT	6,455	OTH		ACTUAL	.77	.09
BLADING GRAVEL RD.& SHLD 416	P/MIL	PLAN	6,000	1,500	BUDGET	24,000	LAB	4,816	EQT	7.9 7	STAND.	4.00	.25
		ACTUAL	3,459	1,011	TOT CST	12,753	MAT		OTH		ACTUAL	3.68	.29
SPC.SURF.MTC.OPER. 419		PLAN			BUDGET		LAB	1,322	EQT	5 5	STAND.		
		ACTUAL		335	TOT CST	2,271	MAT		OTH	4	ACTUAL	6.77	
BLADE PATCH & LEVL 421	CU YD	PLAN	7,640	4,584	BUDGET	114,600	LAB	33,020	EQT	29.3 8	STAND.	15.00	.60
		ACTUAL	11,166	7,393	TOT CST	160,187	MAT	97,789	OTH		ACTUAL	14.34	.66
BITUMINOUS RESEAL 422	MILES	PLAN	90	4,950	BUDGET	270,000	LAB	14,380	EQT	11.4 9	STAND.	3000.00	55.00
		ACTUAL	64	3,378	TOT CST	132,669	MAT	106,043	OTH	7 7	ACTUAL	2069.26	53.19
SLABJACKING 423		PLAN		600	BUDGET	3,780	LAB	4,094	EQT	1.9 3	STAND.	6.30	
		ACTUAL		1,007	TOT CST	6,577	MAT	510	OTH		ACTUAL	6.53	
CONTRACT RESEALS 425		PLAN			BUDGET		LAB		EQT	4	STAND.		
		ACTUAL			TOT CST	4	MAT		OTH		ACTUAL		
ADDTNS.& BETTERMTS 429		PLAN			BUDGET		LAB	2,869	EQT	1.6 2	STAND.		
		ACTUAL		599	TOT CST	4,613	MAT	82	OTH		ACTUAL	7.70	
PTH&LEV.SHDLR&APPR 431	CU YD	PLAN	400	1,000	BUDGET	8,000	LAB	2,303	EQT	1.7 1	STAND.	20.00	2.50
		ACTUAL	500	534	TOT CST	7,606	MAT	3,512	OTH		ACTUAL	15.21	1.06
SHLD.SEALNG W/ AGG COVER 433	SQ YD	PLAN	150,000	1,500	BUDGET	24,000	LAB	1,871	EQT	1.7 9	STAND.	.16	.01
		ACTUAL	110,750	434	TOT CST	13,065	MAT	9,455	OTH	0	ACTUAL	.11	
SHDLR.VEG.CONTROL 434		PLAN		760	BUDGET	6,088	LAB	6,286	EQT	7 5	STAND.	8.01	
		ACTUAL		1,460	TOT CST	7,119	MAT	58	OTH		ACTUAL	4.87	
SHLD.SEALNG W/O AGG COVER 435	SQ YD	PLAN			BUDGET		LAB	90	EQT	8	STAND.		
		ACTUAL	25,107	20	TOT CST	1,489	MAT	1,331	OTH		ACTUAL	.05	
RD.SIDE & DRAINAGE 440		PLAN		5,450	BUDGET	38,913	LAB	51,069	EQT	24.9 9	STAND.	7.14	
		ACTUAL		11,397	TOT CST	80,490	MAT	3,592	OTH	9 0	ACTUAL	7.06	
R/W FENCE & MARKER 441		PLAN		820	BUDGET	3,977	LAB	8,393	EQT	1.2 0	STAND.	4.85	
		ACTUAL		1,862	TOT CST	10,192	MAT	549	OTH		ACTUAL	5.47	
SPEC.ROADSIDE DEVL 445		PLAN		6,100	BUDGET	28,365	LAB	17,996	EQT	4.9 1	STAND.	4.65	
		ACTUAL		5,168	TOT CST	25,915	MAT	3,247	OTH	1 1	ACTUAL	5.01	
MOWING 450	ACRES	PLAN	16,000	6,400	BUDGET	73,280	LAB	25,199	EQT	38.7 5	STAND.	4.58	.40
		ACTUAL	15,638	5,764	TOT CST	63,934	MAT		OTH		ACTUAL	4.08	.36

Figure F-7. Maintenance Management Report HW1-830-AA.

FUNCTION	D[illegible]	[illegible]	[illegible]	DIST-04	[illegible]	[illegible]	DIST-[illegible]	DIST-68	HIGHWAY TOTALS
411 HAND PATCH ON ROAD	CU YD								
ACTUAL QUANTITY	337	611	1.744	624	361	516	3 3	93	4.609
ACTUAL HOURS	2.143	2.796	9.313	3.093	1.535	6.782	1.4 0	1.485	28.577
TOTAL COST	15.248	27.089	81.326	27.614	14.106	46.659	10.8 6	8.712	231.570
UNIT COST-ACTUAL	45.24	44.37	46.64	44.25	39.07	90.42	33. 3	93.38	50.25
-STAND.	43.00	50.00	33.00	50.00	38.00	45.00	40. 0	42.00	4[illegible].62
PROD.RATE-ACTUAL	6.35	4.57	5.34	4.95	4.25	13.14	4. 3	15.91	6.20
-STAND.	6.50	8.00	5.00	6.00	5.00	8.00	5. 0	4.00	5.93
412 SPOT SEALING	SQ YD								
ACTUAL QUANTITY	333.134	273.039	281.164	194.022	591.944	73.119	215.8 8	17.210	1.979.480
ACTUAL HOURS	5.412	5.175	3.518	3.518	4.538	1.649	4.4 7	320	28.537
TOTAL COST	81.227	71.798	51.203	49.154	103.216	19.752	55.9 1	3.990	436.271
UNIT COST-ACTUAL	.24	.26	.18	.25	.17	.27	. 5	.23	.22
-STAND.	.21	.25	.18	.20	.15	.20	. 2	.25	.20
PROD.RATE-ACTUAL	.01	.01	.01	.01		.02	. 2	.01	.01
-STAND.	.01	.01	.01	.01	.01	.01	. 1	.01	.01
414 TRM.CLN.OTHR.CRACK	GAL								
ACTUAL QUANTITY	37.580	19.870	40.400	13.550	25.999	6.050	34.9 0	20.020	198.399
ACTUAL HOURS	3.672	2.949	4.924	2.577	2.858	1.937	4.0 3	2.661	25.611
TOTAL COST	29.211	24.351	36.579	19.127	24.576	13.720	35.3 6	22.268	205.168
UNIT COST-ACTUAL	.77	1.22	.90	1.41	.94	2.26	1. 1	1.11	1.03
-STAND.	.75	1.00	.90	1.10	.85	1.00	. 5	1.30	.96
PROD.RATE-ACTUAL	.09	.14	.12	.19	.10	.32	. 1	.13	.12
-STAND.	.10	.13	.13	.13	.11	.25	. 1	.30	.15
416 BLADING GRAVEL RD.& SHLD P/MIL									
ACTUAL QUANTITY	3.459	2.399	2.334	4.071	1.132	1.342	9 7	1.546	17.230
ACTUAL HOURS	1.011	579	460	1.317	173	394	2 9	506	4.721
TOTAL COST	12.753	7.511	5.296	17.604	1.556	5.048	3.6 9	6.826	60.213
UNIT COST-ACTUAL	3.68	3.13	2.26	4.32	1.37	3.76	3. 2	4.41	3.49
-STAND.	4.00	4.00	3.80	4.20	2.50	4.25	4. 5	4.00	3.87
PROD.RATE-ACTUAL	.29	.24	.19	.32	.15	.29	. 9	.32	.27
-STAND.	.25	.25	.22	.30	.20	.33	. 0	.30	.26
421 BLADE PATCH & LEVL	CU YD								
ACTUAL QUANTITY	11.166	5.565	5.032	4.998	9.048	6.189	8.3 6	7.909 (12,527)	58.263 (62,881)
ACTUAL HOURS	7.393	3.826	3.990	4.937	4.511	6.613	8.1 0	6.443	45.813
TOTAL COST	160.186	92.974	91.003	99.400	151.200	98.814	146.5 0	121.490	961.567
UNIT COST-ACTUAL	14.34	16.70	18.08	19.89	16.71	15.96	17. 3	15.36 (14.63)	~~16.50~~ 16.[illegible]
-STAND.	15.00	20.00	17.00	18.00	17.00	19.00	19. 0	~~15.00~~	17.25
PROD.RATE-ACTUAL	.66	.68	.79	.98	.49	1.06	. 6	.81	.78
-STAND.	.60	.90	.70	.75	.65	.90	. 0	.60	.75
								183,281	1,023,388
422 BITUMINOUS RESEAL	MILES								
ACTUAL QUANTITY	64	1	41	61	44	13	5		289
ACTUAL HOURS	3.378	733	2.714	4.460	2.602	1.521	2.4 0	9	17.967
TOTAL COST	132.668	4.074	94.588	147.835	100.089	21.682	93.5 3	130	594.639
UNIT COST-ACTUAL	2.089.26	3.133.83	2.301.41	2.423.51	2.274.75	1.667.87	1.439. 8		2.058.29
-STAND.	3.000.00	3.000.00	2.500.00	2.575.00	2.000.00	2.500.00	2.500. 0		2.582.14
PROD.RATE-ACTUAL	53.19	563.84	66.03	73.11	59.13	117.00	38. 0		61.98
-STAND.	55.00	70.00	70.00	60.00	55.00	70.00	70. 0		64.28
424 LIGHT RESEAL	MILES								
ACTUAL QUANTITY					3			56	59
ACTUAL HOURS					112			3.323	3.435
TOTAL COST					4.298			68.659	72.957
UNIT COST-ACTUAL					1.432.63			1.232.66	1.242.88
-STAND.								850.00	850.00
PROD.RATE-ACTUAL					37.33			59.65	56.51
-STAND.								33.00	33.00

APPENDIX G

TENNESSEE BUREAU OF HIGHWAYS'

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 4,126,000 residents of Tennessee operate 2,467,000 motor vehicles on 78,666 miles of highways of which 9,832 are under state control. The state occupies 42,244 square miles from an elevation of 182 feet to 6,643 feet above sea level. Mean minimum and maximum temperatures are 22 and 92°F with average annual moisture ranging from 40 to 76 inches.

The Tennessee Bureau of Highways has a $38,485,000 maintenance budget. This budget will be utilized by its 4 Regions and 23 Maintenance Districts to maintain 23,500 lane miles of highway. Each maintenance district is divided into county maintenance units for a total of 95 county units state wide. Maintenance supervisors are in responsible charge of the county maintenance units with assistance from crew leaders. Supervisors report to the District Maintenance Engineer who in turn reports to the Assistant Regional Maintenance Engineer, the Regional Maintenance Engineer and the Regional Engineer. The administration of the maintenance program for the Director of the Bureau of Highways is performed at the central office level by the Maintenance Engineer.

The basic maintenance recording and reporting system was developed in 1971 by Roy Jorgensen and Associates. A parallel recording system is being utilized. The recording system is a

manual system used in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

The Tennessee Bureau of Highways Form MM-1, "Crew Day Card" (Figure G-1) and Form MM-5, "Maintenance Activity Summary" (Figure G-2) are utilized to collect maintenance activity information. The types of information obtained on these forms includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization and
6. Accomplishments

The Crew Day Card is filled out by the crew leader who usually has a title of foreman. These cards are color coded and pre-printed (as possible) based on programmed activity levels with information including crew size, system, region, maintenance activity and equipment and accomplishment units. The color code is briefly described below:

Red. The red Crew Day Card is filled out for routine maintenance activities that normally stay within the planned maintenance program levels. Such items as painting centerline, sign replacement, sign cleaning, grading shoulders, clean culverts, etc. are within this category referred to as Routine Limited Maintenance (RL).

Blue. The blue Crew Day Card is filled out for routine maintenance activities that are often in excess or less than the planned maintenance programs. These items are dependent to a large extent upon environmental conditions such as rainfall. Crack pouring, surface replacement, concrete patching, clean and reshape ditches, etc. are maintenance activities within this general category referred to as Routine Variable maintenance (RV).

Green. The green Crew Day Card is filled out for emergency maintenance such as bridge repair, excessive spot premix patching, accident cleanup, etc. This general category of maintenance is identified as Routine Unlimited (RU).

Orange. The orange Crew Day Card is filled out for overhead items such as bridge inspection, stockpiling, ferry operation, road patrol, etc. This general category of maintenance is identified as Overhead (O).

Yellow. The yellow Crew Day Card is filled out for special maintenance authorizations that are originated by the Regional Maintenance Engineer. Resurfacing and seal coat operations are usually included in this category. This general category of maintenance is identified as Special Authority maintenance (SA).

White. The white Crew Day Card is filled out when the supply of preprinted cards has been depleted.

The Crew Day Cards are filled out daily and sent to the district office where a clerk transfers the data biweekly to the Maintenance Activity Summary.

Details of these reporting forms are presented below:

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording the following information:

1. District. A two digit numeric code from 11 to 16, 21 to 25, 31 to 37, and 41 to 45 is utilized to designate the district by regions. The district numbers can be assigned to regions as required.

2. County. The maintenance unit operating in a county is coded by a two digit numeric code from 1 to 95. The county code can be utilized as assigned to specific districts and regions.

3. System. The highway system is identified by a two digit code. This code is utilized to identify Interstate Highways from other types of highways.

4. Crew. The crew leader's name is recorded on the Crew Day Card but not on the Maintenance Activity Summary. These data cannot be reported for specific crews unless special codes are assigned and recorded.

5. Segments. Particular segments of highways on which the maintenance activity was performed are not presently recorded.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder, roadside, etc.

Activity

Maintenance activity numbers are utilized to designate the

maintenance activity performed (Table G-1). Seventy-one maintenance activity numbers are presently utilized and are divided into district activities and regional activities. Regional activities account for about 30 to 35 percent of the maintenance expenditures and about 25 percent of maintenance activity codes. The codes are further sub-divided into categories for reporting programs on the Crew Day Card as described above. These categories are;

1. Special Authority (SA)
2. Overhead (O)
3. Routine Variable (RV)
4. Routine Limited (RL)
5. Routine Unlimited (RU)

Manpower

Manpower utilization for a particular maintenance activity is recorded. The individual employee is indicated by name and the regular and over-time is recorded to the hour on the Crew Day Card. Manpower is not reported by the individual employee on the Maintenance Activity Summary. Man-hours are reported by the day for standard crew sizes and nonstandard crew sizes by maintenance activity. Man-hour totals are reported for the biweekly report period.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by a 6 digit equipment code. Equipment use is charged out daily by the hour or mile, depending on the type of equipment. A written description of the equipment is also entered.

Materials

Materials utilized for a particular function are recorded daily. A written description of the material is entered together with the units of measurement and the amount of material utilized. Materials utilized are reported to the nearest 0.1 unit. Material codes are utilized to describe materials on the Maintenance Activity Summary. This code is a five digit code.

Accomplishments

Accomplishments are reported in terms of work units as defined by work standards. Tons, man-hours, and lineal feet are commonly used work units. Accomplishments are reported for the entire crew and are recorded to the nearest 0.1 unit. Accomplishments are reported for both standard and nonstandard crew sizes on the Maintenance Activity Summary.

COLLECTION AND PROCESSING OF RECORDED DATA

The Crew Day Card is filled out daily by the crew leader or foreman for his crew. The recorded information is checked by the Foreman II (county supervisor) and sent to the district office where the data are transferred to the Maintenance Activity Summary by a district clerk. Two copies of the Maintenance Activity Summary are sent to the central office, one copy to the Regional Office and one copy is retained in the district. Key punching of data is performed in the central office. Reports are prepared from these data at the district level by a manual process and from the central office by the use of electronic data processing equipment.

An estimate of the recording and reporting expenses was not obtained. However, it was estimated that the crew leader requires about 10 minutes per day to report the daily work activities.

REPORTS

Five reports are produced from the collected data. The Work Performance Report is prepared manually. All other reports are prepared at the central office by electronic data processing equipment. A brief discussion is presented below indicating the types of data contained on these reports.

Work Performance Report. This report is compiled by hand every two weeks by the district clerk at the end of the reporting period (Figure G-3). A copy of the district reports are sent to the regional office where the region report is completed by hand to include regional statistics. The regional compilation takes about 1 week. The 4 regional reports are compiled into a state summary manually requiring about an additional 7 to 10 days. This report is primarily utilized at the District level or Regional level.

For each maintenance activity the work quantities, man-hours and man-hours per unit of accomplishment are recorded for each county maintenance unit together with district totals for the activity. Work quantities and man-hours are reported for the current reporting period, year-to-date totals and the annual programmed quantities. Man-hours per unit of accomplishment are reported for year-to-date together with the work standard for the activity.

Cost Distribution Report. This report summarizes labor, equipment and material costs together with total costs by activity (Figure G-4). These reports are calculated for the county maintenance units, districts, regions and for state wide totals. Interstate costs are separated from other "types of highways" costs. The reports are prepared monthly and reflect year-to-date costs. These reports are utilized mainly at the state level.

Materials are costed at the time of use on the roadway. Inventory accounts are utilized for stockpiles.

Evaluation of Work Load Plan. This report is the basic management report and it is compiled to reflect County, District, Region and State quantities (Figure G-5). The report is printed quarterly and prepared by the highway system (Interstate and other) and by Maintenance Activity Group (Routine Variable RV), Routine Limited (RL), Routine Unlimited (RU), etc. Annual planned and year-to-date quantities are reported for crew days, man-hours, and accomplishments. Man-hour per unit of accomplishment and daily productivity quantities are reported on a year-to-date basis together with the standard quantities. The percent standard achieved is the actual accomplishment divided by the standard accomplishment. This report is distributed to the Districts and Regions for evaluation.

Crew Usage and Performance Report. This report is prepared quarterly and distributed to the District and Region to evaluate crew size and performance against standards (Figure G-6). The report is prepared for a specific district with county unit totals displayed by maintenance activity. Standard crew size performance

is compared to nonstandard crew and both are compared to the work standard. The report is prepared by District and Maintenance Activity Group.

Annual Work Quantity and Planning Value Analyses. This report is prepared annually to evaluate this year's planned activities and to adjust planning values for next year (Figure G-7). Districts are regions receive copies of these reports.

The reports are prepared by regions, by highway system, and by Maintenance Activity Group. The report is printed by maintenance activities for each District within the Region.

The following information is displayed:

1. Planned and Accomplished work units together with the percent or ratio of accomplished to planned units,

2. Inventory units for each District,

3. Standard and actual work units accomplished for each work unit,

4. Planned and actual man-hours together with the percent or ratio of actual to accomplished man-hours, and

5. Standard versus actual man-hours per accomplishment unit.

Reports are utilized for fiscal control, by reviewing expenditures to date on the Cost Distribution Report; for monitoring program execution by comparing annual planned and accomplished work units to date on the Evaluation of Workload Plan Report; for allocation of manpower by reviewing the standard and actual productivity measurements; and for budget preparation by reviewing data contained on the Annual Work Quantity and Planning Value Analysis Report.

Presently maintenance activities that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by a detailed review of the reports. Exception reports are presently not a part of the reporting system.

OTHER ITEM

The Tennessee Bureau of Highways is satisfied with the reliability of the existing system although improvements can be made. The recording system utilizes crew leaders to record information rather than the individual maintenance employee. These data are then transferred to the Maintenance Activity Summary by a district clerk which should improve data accuracy. It is believed that this approach to recording data improves the reliability of the information.

The recording and reporting system can be altered by direction of the central office staff as the need arises. An annual meeting is held by the central office staff with district and county maintenance personnel to obtain feedback on the performance of the system. Changes in the management system are directed by the central office.

Data collected are stored for about an 18-month period within the central office; then it is stored on film for an indefinite period of time.

Figure G-1. Crew Day Card.

FORM MM-1 (REV. 10-72)

DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS
DIVISION OF MAINTENANCE

CREW DAY CARD

CARD NO.

ASSIGNED TO:

DATE / /

ACTIVITY:

ACT. NO.

SYSTEM | DISTRICT | COUNTY

LOCATION AND SPECIAL INSTRUCTIONS

LABOR			EQUIPMENT		
HRS. REG.	HRS. O.T.	EMPLOYEE	TDH NO.	DESCRIPTION	HRS / MI
		TOTAL			

MATERIAL

DESCRIPTION	UNIT	AMOUNT

ACCOMPLISHMENT _____

Form No. MM-5 (REV. 10-72)

Figure G-2.

DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS
DIVISION OF MAINTENANCE

MAINTENANCE ACTIVITY SUMMARY

REG.	DIST.	COUNTY NAME	COUNTY CODE	SYSTEM NAME	SYSTEM CODE	ACT. NO.	MAINTENANCE ACTIVITY DESCRIPTION	PERIOD ENDING
								/ /

	DAY OF MONTH																TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
STANDARD CREW SIZE																	
Number of Crew Cards																	
Man-hours																	
Work Accomplishment																	
Accompl. Unit _____																	
NON-STANDARD CREW SIZE																	
Number of Crew Cards																	
Man-hours																	
Work Accomplishment																	
Accompl. Unit _____																	

EQUIPMENT USED		HOURS / MILES USED																TOTAL
Code	Description																	

MATERIALS USED			QUANTITY USED															TOTAL
Code	Description	Unit																

NASHVILLE BUSINESS FORMS CO.
NASHVILLE, TENNESSEE 37202

FORM NO. MM-6 (10-72)

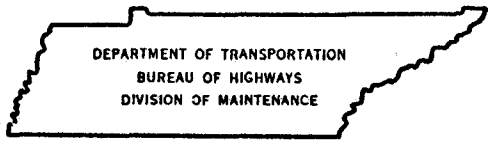


Figure G-3.

WORK PERFORMANCE REPORT

District _____ Period From _____ To _____

CODE	ACTIVITY	WORK QUANTITIES				MAN-HOURS			MH/ACCOM. UNIT	
		MEASUREMENT UNIT	CURRENT PERIOD	TOTAL TO DATE	ANNUAL PROGRAM	CURRENT PERIOD	TOTAL TO DATE	ANNUAL PROGR.	TO DATE	STANDARD
	Total									
	Total									
	Total									
	Total									

Figure G-4. Cost Distribution Report.

EEAD 279

STATE OF TENNESSEE
DEPARTMENT OF HIGHWAYS
COST DISTRIBUTION BY WORK ACTIVITY
PERIOD FROM 03-01-74 TO 03-31-74

SYSTEM INTERSTATE REGION NASHVILLE 7 DISTRICT 37

ACTIVITY NO.	ACTIVITY DESCRIPTION	TOTAL WORK QUANTITY	WORK UNIT	EXPENDITURES -- DOLLARS LABOR	EQUIPMENT	MATERIAL	TOTAL
420	SPOT PREMIX PATCHING	3.4	TONS-MIX	104.64	9.03	27.20	140.87
429	OTHER SHOULDER	120.0	MAN HRS.	392.40	260.48	.00	652.88
430	CLEAN/RESHAPE DITCH	825.0	LF CLEAN	183.12	212.87	.00	395.99
431	CLEAN CULVERTS/PIPES	14.0	NO CLEAN	52.32	6.42	.00	58.74
434	OTHER DRAINAGE	264.0	MAN HRS.	863.28	264.79	.00	1,128.07
435	MACHINE MOWING	398.2	ACRES	1,373.40	748.35	.00	2,121.75
436	SLOPE MOWING	80.0	MAN HRS.	261.60	39.14	.00	300.74
437	CHEMICAL CONTROL-VEG	2,650.0	GAL CHEM	627.84	143.33	2,199.50	2,970.67
438	BRUSH CUTTING	88.0	MAN HRS.	287.76	21.73	.00	309.49
439	MAINT-LANDSCAPED ARS	512.0	MAN HRS.	1,674.24	165.43	.00	1,839.67
441	ROADSIDE CLEANUP	178.5	R/W P-MI	2,158.20	101.68	.00	2,259.88
442	SERV. LITTER BARRELS	617.0	NO SERV.	2,145.12	766.66	.00	2,911.78
443	CLEANUP ROSIDE PARKS	14.0	NO CLEAN	366.24	32.41	.00	398.65
445	FENCE REPAIR	1,230.0	LF-FEN.	497.04	20.80	87.65	605.49
447	MAN. RDWAY SWEEPING	56.0	MAN HRS.	183.12	3.91	.00	187.03
449	OTHER ROADSIDE	56.0	MAN HRS.	183.12	12.49	.00	195.61
450	CLEANING BRIDGE	21.0	NO CLEAN	235.44	11.54	.00	246.98
461	SPREAD CHEMICALS	160.0	MAN HRS.	523.20	100.38	560.00	1,183.58
469	OTHER SNOW AND ICE	502.0	MAN HRS.	1,641.54	161.72	.00	1,803.26
472	MINOR SIGN REPAIR	20.0	NO SIGNS	52.32	6.95	10.11	69.38
473	SIGN REPLACEMENT	6.0	NO SIGNS	206.01	99.94	4,080.00	4,385.95
475	REPAIR SB-GUARDRAIL	62.5	NO FEET	104.64	1.76	.00	106.40
476	REPAIR GUIDE POSTS	252.0	NO REPRD	444.72	33.96	57.06	535.74
479	OTH TRAFFIC SERVICES	68.0	MAN HRS.	222.36	54.44	.00	276.80
480	SLIDE REMOVAL	80.0	MAN HRS.	261.60	226.64	.00	488.24
491	INTERST EMERG PATROL	6,368.0	MAN HRS.	20,823.36	9,515.23	.00	30,338.59
497	BRIDGE INSPECTION	362.0	MAN HRS.	1,781.04	326.24	.00	2,107.28
498	INCLEMENT WEATHER	543.0	MAN HRS.	1,775.61	39.88	.00	1,815.49
	TOTAL ALL ACTIVITIES			39,425.28	13,388.20	7,021.52	59,835.00

Figure G-5. Evaluation of Work Load Plan.

4285

TENNESSEE ... NTENANCE MANAGEMENT
EVALUATIO... OF WORKLOAD PLAN
PERIOD FROM 07-01-73 TO 12-31-73

ACTIVITY GROUP- VARIABLE SYSTEM- STATE REGION 1 KNOXVILLE DISTRIC 15 PAGE 149

ACTIVITY NO.	DESCRIPTION		CREW DAYS ANNUAL PLAN	CREW DAYS TO DATE	CREW DAYS PCT	MAN-HOURS ANNUAL PLAN	MAN-HOURS TO DATE	MAN-HOURS PCT	ACCOMPLISHMENT ANNUAL PLAN	UNITS	ACCOMPLISHMENT TO DATE	ACCOMPLISHMENT PCT	U/ACCOMP TO DATE	U/ACCOMP STD	U/ACCOMP PCT STD	DAILY PROD STD	DAILY PROD TO DATE	DAILY PROD PCT STD
402	CRACK POURING																	
	BLOUNT	05	9	1	11	504	56	11	906	GAL-SEAL	200	22	.2	.56	50	100	200	200
	KNOX	47	22	10	45	1232	646	52	2129	GAL-SEAL	1050	49	.2	.56	111	100	105	105
	MONROE	62	7	0	00	392	0	00	716	GAL-SEAL	0	00	.0	.56	00	100	0	00
	DISTRICT TOTAL		38	11	29	2128	702	33	3751	GAL-SEAL	1250	33	.3	.56	100	100	114	114
* 403	CONT PREMIX PATCHING																	
	BLOUNT	05	5	5	100	600	442	74	680	TONS-MIX	435	64	1.2	.80	128	150	87	58
	KNOX	47	11	8	73	1320	777	59	1597	TONS-MIX	972	61	.8	.80	100	150	122	81
	MONROE	62	4	4	100	480	450	94	537	TONS-MIX	2017	376	.2	.80	28	150	504	336
	DISTRICT TOTAL		20	17	85	2400	1669	70	2814	TONS-MIX	3424	122	.9	.80	61	150	201	134
** 406	SURFACE REPLACEMENT																	
	BLOUNT	05	12	0	00	672	0	00	227	TONS-MAT	0	00	.0	2.80	00	20	0	00
	KNOX	47	27	4	15	1512	208	14	532	TONS-MAT	65	12	3.2	2.80	115	20	16	80
	MONROE	62	9	5	56	504	264	52	179	TONS-MAT	88	49	3.2	2.80	108	20	18	90
	DISTRICT TOTAL		48	9	19	2688	472	18	938	TONS-MAT	152	16	3.0	2.80	111	20	17	85
411	CONCRETE PATCHING																	
	KNOX	47	2	0	00	128	0	00	18	CY-PCC	0	00	.0	7.11	00	9	0	00
	DISTRICT TOTAL		2	0	00	128	0	00	18	CY-PCC	0	00	.0	7.11	00	9	0	00
412	JOINT REPAIR																	
	KNOX	47	1	0	00	48	0	00	120	GAL-SEAL	0	00	.0	.38	00	125	0	00
	DISTRICT TOTAL		1	0	00	48	0	00	120	GAL-SEAL	0	00	.0	.38	00	125	0	00
* 419	OTHER SURFACE																	
	BLOUNT	05	19	0	00	456	0	00	449	MAN HRS.	0	00	.0	1.00	00	0	0	00
	KNOX	47	46	19	41	1104	920	83	1093	MAN HRS.	920	84	1.0	1.00	100	0	48	00
	MONROE	62	15	3	20	360	96	27	358	MAN HRS.	96	27	1.0	1.00	100	0	32	00
	DISTRICT TOTAL		80	22	28	1920	1016	53	1900	MAN HRS.	1016	53	1.0	1.00	100	0	46	00
421	CONT PREMIX PATCHING																	
	BLOUNT	05	0	0	00	0	0	00	16	TONS-MIX	0	00	.0	.77	00	125	0	00
	KNOX	47	1	0	00	96	0	00	82	TONS-MIX	0	00	.0	.77	00	125	0	00
	MONROE	62	0	0	00	0	0	00	10	TONS-MIX	0	00	.0	.77	00	125	0	00
	DISTRICT TOTAL		1	0	00	96	0	00	108	TONS-MIX	0	00	.0	.77	00	125	0	00
* 426	RESHAPE SHLD/DITCH																	
	BLOUNT	05	20	20	100	1440	1816	126	39	SHLD MIS	49	126	37.6	36.00	103	2	2	100
	KNOX	47	25	15	60	1800	1016	56	49	SHLD MIS	59	120	17.2	36.00	48	2	4	200
	MONROE	62	19	11	58	1368	984	72	38	SHLD MIS	52	137	18.2	36.00	53	2	5	250
	DISTRICT TOTAL		64	46	72	4608	3816	83	126	SHLD MIS	160	127	23.5	36.00	66	2	3	150
* 427	PATCH GRAVEL SHLDRS.																	
	BLOUNT	05	13	6	46	728	320	44	1947	TONS-AGG	167	09	1.2	.37	519	150	28	19
	KNOX	47	16	0	00	896	0	00	2310	TONS-AGG	0	00	.0	.37	00	150	0	00
	MONROE	62	15	0	00	840	0	00	2153	TONS-AGG	0	00	.0	.37	00	150	0	00
	[illegible]		44	6	14	2464	320	13	6410	TONS-AGG	167	03	1.2	.37	519	150	28	19

Figure G-6. Crew Usage and Performance Report.

STATE OF TENNESSEE - DEPARTMENT OF HIGHWAYS
MAINTENANCE MANAGEMENT SYSTEM
CREW USAGE AND PERFORMANCE REPORT
PERIOD FROM 07-01-71 TO 07-31-71

EGAD4287 SAMPLE

ACTIVITY GROUP- UNLIMITED DISTRICT 11 REGION 1 KNOXVILLE PAGE 1

ACTIVITY NO.	ACTIVITY DESCRIPTION	STANDARD CREW SIZE NO. DAYS	STANDARD CREW SIZE MAN HOURS	STANDARD CREW SIZE ACCOMPL.	STANDARD CREW SIZE MH/ACC	NON-STANDARD CREW SIZE NO. DAYS	NON-STANDARD CREW SIZE MAN HOURS	NON-STANDARD CREW SIZE ACCOMPL.	NON-STANDARD CREW SIZE MH/ACC	COMBINED MH/ACC TO DATE	STANDARD	PCT
** 401	SPOT PREMIX PATCHING											
	CARTER	4	184	26	7.08	2	64	8	8.00	7.29	1.00	729
	JOHNSON	0	0	0	.00	1	40	6	6.67	6.67	1.00	667
	SULLIVAN	1	48	6	8.73	4	224	22	10.32	10.00	1.00	00
	UNICOI	4	168	32	5.25	2	80	12	6.67	5.64	1.00	564
	DISTRICT TOTAL	9	400	64	6.30	9	408	48	8.55	7.27	1.00	727
420	SPOT PREMIX PATCHING											
	JOHNSON	0	0	0	.00	2	136	16	8.50	8.50	1.00	850
	DISTRICT TOTAL	0	0	0	.00	2	136	16	8.50	8.50	1.00	850
* 475	REPAIR SB-GUARDRAIL											
	SULLIVAN	1	40	107	.37	0	0	0	.00	.37	1.00	37
	DISTRICT TOTAL	1	40	107	.37	0	0	0	.00	.37	1.00	37
476	REPAIR GUIDE POSTS											
	CARTER	0	0	0	.00	2	64	55	1.16	1.16	1.00	116
	DISTRICT TOTAL	0	0	0	.00	2	64	55	1.16	1.16	1.00	116

Figure G-7. Work Quantity and Planning Value Analysis

STATE OF TENNESSEE - DEPARTMENT OF HIGHWAYS
ANNUAL WORK QUANTITY AND PLANNING VALUE ANALYSIS
PERIOD FROM 07-01-72 TO 06-30-73

EGAD 4286

ACTIVITY GROUP- UNLIMITED SYSTEM- INTERSTATE REGION- CHATTANOOGA

ACTIVITY NO.	DESCRIPTION	MEASURE	WORK UNITS PLANNED	WORK UNITS ACCOMP.	PCT	INVENT. UNIT NO.	INVENT. UNITS	WORK UNITS PER INVENT. UNIT STD.	WORK UNITS PER INVENT. UNIT ACTUAL	PLAN ED	MAN HOURS ACTUAL	MAN HOURS PCT	MAN HOURS PER ACCOMP. UNIT STD.	MAN HOURS PER ACCOMP. UNIT ACTUAL
** 401	SPOT PREMIX PATCHING													
	DISTRICT 21	TONS-MIX	61	139	228	104.16	BIT LANE MILE	.50	1.33	24	672	108	9.60	4.83
	DISTRICT 22	TONS-MIX	62	72	115	123.20	BIT LANE MILE	.50	.58	24	668	107	9.60	9.33
	DISTRICT 23	TONS-MIX	68	75	110	136.80	BIT LANE MILE	.50	.54	72	560	83	9.60	7.52
	DISTRICT 24	TONS-MIX	75	34	45	149.16	BIT LANE MILE	.50	.22	20	412	57	9.60	12.30
	DISTRICT 25	TONS-MIX	55	94	158	117.20	BIT LANE MILE	.50	.80	76	432	75	9.60	4.62
	REGION TOTAL	TONS-MIX	325	412	127	630.52	BIT LANE MILE	.50	.65	3 16	2744	85	9.60	6.66
410	SPOT PREMIX PATCHING													
	DISTRICT 21	TONS-MIX	50	0	00	78.84	PCC LANE MILE	.50	.00	80	0	00	9.60	.00
	REGION TOTAL	TONS-MIX	50	0	00	78.84	PCC LANE MILE	.50	.00	80	0	00	9.60	.00
415	SURF TREATMENT PATCH													
	DISTRICT 24	TONS-AGG	0	7	00	.00	BST LANE MILE	.00	.00	0	76	00	4.00	10.86
	REGION TOTAL	TONS-AGG	0	7	00	.00	BST LANE MILE	.00	.00	0	76	00	4.00	10.86
420	SPOT PREMIX PATCHING													
	DISTRICT 21	TONS-MIX	83	12	14	139.30	PAVED SHLD MI	.50	.09	40	56	07	10.00	4.67
	DISTRICT 22	TONS-MIX	63	0	00	125.40	PAVED SHLD MI	.50	.00	40	0	00	10.00	.00
	DISTRICT 23	TONS-MIX	68	0	00	136.80	PAVED SHLD MI	.50	.00	80	0	00	10.00	.00
	DISTRICT 24	TONS-MIX	72	0	00	144.86	PAVED SHLD MI	.50	.00	20	0	00	10.00	.00
	DISTRICT 25	TONS-MIX	57	0	00	114.60	PAVED SHLD MI	.50	.00	00	0	00	10.00	.00
	REGION TOTAL	TONS-MIX	343	12	03	660.96	PAVED SHLD MI	.50	.02	3 80	56	02	10.00	4.67
445	FENCE REPAIR													
	DISTRICT 21	LF-FEN.	5120	2780	55	84.40	R/W FEN-MILES	50.00	32.94	72	688	102	.13	.25
	DISTRICT 22	LF-FEN.	3225	785	24	64.50	R/W FEN-MILES	50.00	12.17	16	132	32	.13	.17
	DISTRICT 23	LF-FEN.	3420	1280	37	68.40	R/W FEN-MILES	50.00	18.71	48	200	45	.13	.16
	DISTRICT 24	LF-FEN.	3729	358	10	74.58	R/W FEN-MILES	50.00	4.80	80	128	27	.13	.36
	DISTRICT 25	LF-FEN.	2930	1050	36	58.60	R/W FEN-MILES	50.00	17.92	84	311	81	.13	.30
	REGION TOTAL	LF-FEN.	18240	6253	34	350.48	R/W FEN-MILES	50.00	17.84	2 00	1459	61	.13	.23
* 451	MINOR BRIDGE REPAIR													
	DISTRICT 21	MAN HRS.	2868	448	16	22828.00	LF OF BRIDGE	.10	.02	2 80	448	16	1.00	1.00
	DISTRICT 22	MAN HRS.	892	592	66	8931.00	LF OF BRIDGE	.10	.07	12	592	65	1.00	1.00
	DISTRICT 23	MAN HRS.	814	192	24	8137.00	LF OF BRIDGE	.10	.02	16	192	24	1.00	1.00
	DISTRICT 24	MAN HRS.	622	0	00	6217.00	LF OF BRIDGE	.10	.00	24	0	00	1.00	.00
	DISTRICT 25	MAN HRS.	908	288	32	9078.00	LF OF BRIDGE	.10	.03	12	288	32	1.00	1.00
	REGION TOTAL	MAN HRS.	6105	1520	25	55191.00	LF OF BRIDGE	.10	.03	6 44	1520	25	1.00	1.00
460	PLOW SNOW													
	DISTRICT 21	MAN HRS.	147	100	68	183.00	TOTAL LANE MI	.00	.55	47	100	68	1.00	1.00
	DISTRICT 22	MAN HRS.	103	53	51	123.20	TOTAL LANE MI	.00	.43	03	53	51	1.00	1.00
	DISTRICT 23	MAN HRS.	405	159	39	136.80	TOTAL LANE MI	.00	1.16	05	159	39	1.00	1.00
	DISTRICT 24	MAN HRS.	304	294	97	149.16	TOTAL LANE MI	.00	1.97	04	294	97	1.00	1.00

Table G-1. Maintenance Activity Numbers

DISTRICT ACTIVITIES

401 Spot Premix Patching (RU)
402 Crack Pouring (RV)
406 Surface Replacement (RV)
410 Spot Premix Patching (RU)
411 Concrete Patching (RV)
412 Joint Repair (RV)
415 Surface Treatment Patching(RU)
419 Other Surface Maintenance (RV)
420 Spot Premix Patching (RU)
425 Grade Shoulders (RL)
426 Reshaping Shoulders and Pulling Ditches (RV)
427 Patch Gravel Shoulders (RV)
429 Other Shoulder Maintenance(RV)
430 Clean and Reshape Ditches (RV)
431 Clean Culverts & Pipes (RL)
432 Repair Minor Drainage (RV)
433 Clean Catch Basins (RL)
434 Other Drainage Maintenance (RV)
435 Machine Mowing (RL)
436 Slope Mowing (RL)
438 Brush Cutting (RV)
441 Roadside Cleanup (RL)
442 Service Litter Barrels (RL)
443 Clean Up Roadside Parks (RL)
444 Rest Area and Weigh Station Maintenance (RL)
445 Fence Repair (RU)
446 Mechanical Roadway Sweeping (RL)
447 Manual Roadway Sweeping (RL)
449 Other Roadside Maintenance(RV)
450 Clean Bridges (RL)

DISTRICT ACTIVITIES

451 Minor Repair of Bridge (RU)
452 Replace Expansion Seal (RV)
459 Other Bridge Maintenance (RV)
460 Plow Snow (RU)
461 Spread Chemicals (RU)
462 Stockpile and Load Snow Removal Materials (RU)
469 Other Snow and Ice (RU)
472 Minor Sign Repair (RU)
474 Clean Traffic Signs (RL)
475 Repair Steel Beam Guardrail (RU)
476 Repair Guideposts (RU)
477 Paint Guardrails and Posts (RL)
479 Other Traffic Services (RV)
482 Accident Cleanup (RU)
489 Other Extraordinary Maintenance (RU)
492 Ferry Operation (0)
493 Stockpiling Material (0)
494 Building and Grounds Maintenance (0)
495 Road Patrol (0)
496 Field Maintenance Supervision (0)
498 Inclement Weather and Standby (0)

REG ON ACTIVITIES

400 Maintenan e Improvement (0)
403 Continuou Premix Patching (RV)
404 Resurfaci g (SA)
416 Seal Coat ng (SA)
421 Continuou Premix Patching (RV)
422 Seal Coat ng (SA)
437 Chemical (ontrol of Vegetatio (RL)
439 Maintenan e of Landscaped Areas (RL
440 Reseeding and Mulching (RV)
453 Paint Bri ge (RL)
454 Major Repa ir of Bridge (SA)
470 Paint Cent erlines (RL)
471 Paint Edge lines (RL)
473 Sign Repla cement (RL)
480 Slide Remo val (RU)
481 Major Sett ements (RU)
483 Emergency Bridge Repair (RU)
490 Rest Area Attendants (Q)
491 Interstate Emergency Patrol (0)
497 Bridge Ins pection (0)

Figure G-8.

STATE OF TENNESSEE - DEPARTMENT OF HIGHWAYS
MAINTENANCE MANAGEMENT SYSTEM
CREW USAGE AND PERFORMANCE REPORT
PERIOD FROM 07-01-75 TO 12-31-75

ACTIVITY GROUP- LIMITED DISTRICT 15 REGION 1 KNOXVILLE

ACTIVITY NO.	DESCRIPTION	STANDARD CREW SIZE NO. DAYS	MAN HOURS	ACCOMPL.	MH/ACC	NON-STANDARD CREW SIZE NO. DAYS	MAN HOURS	ACCOMPL.	COMBINED MH/ACC MH/ACC	TO DATE	STANDARD	PCT
* 425	GRADE SHOULDERS											
	BLOUNT	13	208	81	2.57	2	48	18	2.67	2.59	2.14	121
	KNOX	5	80	33	2.42	0	0	0	.00	2.42	2.14	113
	MONROE	21	336	109	3.08	0	0	0	.00	3.08	2.14	144
	DISTRICT TOTAL	39	624	223	2.80	2	48	18	2.67	2.79	2.14	130
* 431	CLEAN CULVERTS/PIPES											
	BLOUNT	4	64	41	1.56	3	80	51	1.57	1.57	1.11	141
	KNOX	75	1,200	1,612	.74	39	608	766	.79	.76	1.11	68
	MONROE	34	392	304	1.29	6	72	66	1.09	1.25	1.11	113
	DISTRICT TOTAL	113	1,656	1,957	.85	48	760	883	.86	.85	1.11	77
433	CLEAN CATCH BASINS											
	BLOUNT	1	16	12	1.33	1	24	5	4.80	2.35	.90	261
	KNOX	27	432	570	.76	15	264	368	.72	.74	.90	82
	MONROE	2	24	17	1.41	0	0	0	.00	1.41	.90	157
	DISTRICT TOTAL	30	472	599	.79	16	288	373	.77	.78	.90	87
** 435	MACHINE MOWING											
	BLOUNT	79	1,896	1,159	1.64	42	1,208	788	1.53	1.59	1.60	99
	KNOX	168	4,000	1,766	2.26	120	3,178	1,381	2.30	2.28	1.60	143
	MONROE	66	1,772	541	3.28	43	1,344	373	3.60	3.41	1.60	213
	DISTRICT TOTAL	313	7,668	3,466	2.21	205	5,730	2,542	2.25	2.23	1.60	139
437	CHEMICAL CONTROL-VEG											
	BLOUNT	3	72	441	.16	0	0	0	.00	.16	.08	200
	KNOX	3	88	275	.32	2	40	185	.22	.28	.08	350
	DISTRICT TOTAL	6	160	716	.22	2	40	185	.22	.22	.08	275
** 441	ROADSIDE CLEANUP											
	BLOUNT	57	1,364	357	3.82	9	144	44	3.27	3.76	4.12	91
	KNOX	162	3,848	1,014	3.79	101	1,388	522	2.66	3.41	4.12	83
	MONROE	38	900	116	7.76	56	812	182	4.46	5.74	4.12	139
	DISTRICT TOTAL	257	6,112	1,487	4.11	166	2,344	748	3.13	3.78	4.12	92
* 442	SERV. LITTER BARRELS											
	BLOUNT	25	416	397	1.05	41	984	611	1.61	1.39	.55	253
	KNOX	48	368	407	.90	4	40	46	.87	.90	.55	164
	MONROE	45	712	1,087	.66	14	112	350	.32	.57	.55	104
	DISTRICT TOTAL	118	1,496	1,891	.79	59	1,136	1,007	1.13	.91	.55	165
* 443	CLEANUP RDSIDE PARKS											
	BLOUNT	2	32	20	1.60	6	152	26	5.85	4.00	4.27	94
	KNOX	35	552	114	4.84	0	0	0	.00	4.84	4.27	113
	MONROE	4	64	9	7.11	0	0	0	.00	7.11	4.27	167
	DISTRICT TOTAL	41	648	143	4.53	6	152	26	5.85	4.73	4.27	111
446	MECH. RDWAY SWEEPING											
	BLOUNT	1	16	8	2.00	0	0	0				

Figure G-9.

STATE OF TENNESSEE
DEPARTMENT OF HIGHWAYS
COST DISTRIBUTION BY WORK ACTIVITY
PERIOD FROM 07-01-75 TO 03-31-76

SYSTEM INTERSTATE REGION NASHVILLE DISTRICT 34

ACTIVITY NO.	DESCRIPTION	TOTAL WORK QUANTITY	WORK UNIT	EXPENDITURES -- DOLLARS LABOR	EQUIPMENT	MATERIAL	TOTAL
401	SPOT PREMIX PATCHING	41.9	TONS-MIX	1,455.12	419.31	502.80	2,377.23
419	OTHER SURFACE	56.0	MAN HRS.	216.72	20.41	.00	237.13
420	SPOT PREMIX PATCHING	29.7	TONS-MIX	681.12	105.76	356.40	1,143.28
429	OTHER SHOULDER	506.0	MAN HRS.	1,958.22	860.97	167.40	2,986.59
430	CLEAN/RESHAPE DITCH	2,500.0	LF CLEAN	185.76	113.78	.00	299.54
431	CLEAN CULVERTS/PIPES	89.0	NO CLEAN	340.56	44.98	.00	385.54
433	CLEAN CATCH BASINS	250.0	NO CLEAN	464.40	122.80	.00	587.20
434	OTHER DRAINAGE	472.0	MAN HRS.	1,826.64	400.94	.00	2,227.58
435	MACHINE MOWING	2,213.6	ACRES	8,599.14	7,425.80	.00	16,024.94
437	CHEMICAL CONTROL-VEG	31,059.0	GAL CHEM	832.05	755.09	6,522.39	8,109.53
438	BRUSH CUTTING	1,026.0	MAN HRS.	3,970.62	471.21	.00	4,441.83
439	MAINT-LANDSCAPED ARS	376.0	MAN HRS.	1,455.12	180.67	.00	1,635.79
441	ROADSIDE CLEANUP	146.7	R/W P-MI	3,722.94	567.65	.00	4,290.59
442	SERV. LITTER BARRELS	886.0	NO SERV.	1,718.28	588.63	.00	2,306.91
443	CLEANUP RDSIDE PARKS	19.0	NO CLEAN	750.78	164.13	.00	914.91
445	FENCE REPAIR	1,097.0	LF-FEN.	1,068.12	185.39	.00	1,253.51
446	MECH. RDWAY SWEEPING	32.0	MI-SWEPT	61.92	125.96	.00	187.88
447	MAN. RDWAY SWEEPING	72.0	MAN HRS.	278.64	32.03	.00	310.67
449	OTHER ROADSIDE	308.0	MAN HRS.	1,191.96	286.59	24.00	1,502.55
451	MINOR BRIDGE REPAIR	2,251.0	MAN HRS.	8,711.37	6,270.40	32,995.71	47,877.48
461	SPREAD CHEMICALS	446.0	MAN HRS.	1,726.02	562.26	5,352.75	7,641.03
462	STKPILING SNOW CHEM.	13.0	MAN HRS.	50.31	123.54	.00	173.85
469	OTHER SNOW AND ICE	95.0	MAN HRS.	367.65	26.18	.00	393.83
470	PAINT CENTERLINES	130.9	MI PAINT	1,501.56	1,332.07	5,953.05	8,786.68
471	PAINT EDGELINE	217.8	MI PAINT	2,027.88	1,910.47	20,213.75	24,152.10
472	MINOR SIGN REPAIR	112.0	NO SIGNS	402.48	73.37	.00	475.85
473	SIGN REPLACEMENT	28.0	NO SIGNS	437.31	86.76	972.10	1,496.17
475	REPAIR SB-GUARDRAIL	618.5	NO FEET	1,609.92	785.23	328.18	2,723.33
476	REPAIR GUIDE POSTS	681.0	NO REPRD	1,486.08	249.79	.00	1,735.87
479	OTH TRAFFIC SERVICES	115.0	MAN HRS.	445.05	143.13	.00	588.18
482	ACCIDENT CLEANUP	8.0	MAN HRS.	30.96	9.15	.00	40.11
489	OTHER EXTRAORD MAINT	56.0	MAN HRS.	216.72	86.75	.00	303.47
496	FIELD MTC SUPRVISION	8.0	MAN HRS.	37.68	11.06	.00	48.74
497	BRIDGE INSPECTION	1,014.0	MAN HRS.	5,881.20	419.82	.00	6,301.02
498	INCLEMENT WEATHER	16.0	MAN HRS.	61.92	62.07	.00	123.99
499	NON-SYSTEM MAINT.	16.0	MAN HRS.	61.92	26.74	.00	88.66
	TOTAL ALL ACTIVITIES			55,834.14	25,050.89	73,288.53	154,173.56

APPENDIX H

WASHINGTON DEPARTMENT OF HIGHWAY'S

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 3,429,000 residents of Washington operate 2,370,000 motor vehicles on 75,098 miles of highway of which 11,800 are under state control. The state occupies 68,192 square miles from an elevation of 14,410 feet above sea level to sea level. Mean minimum and maximum temperatures are 8 and 92°F with average annual moisture ranging from 8 to 120 inches.

The Washington Department of Highways has a $40,000,000 yearly maintenance budget. This budget will be used by its 6 districts to maintain 17,000 lane miles of highways (7,000 center line miles are under state maintenance).

Six districts comprise the Washington Department of Highways. Each district is divided into Maintenance Divisions resulting in a total of 31 Maintenance Divisions state wide. Maintenance Divisions are further divided into Maintenance Sections resulting in a total of 134 Maintenance Sections, in the state.

Supervisors are in responsible charge at the Maintenance Section with assistance from Maintenance Lead Technicians. Supervisors report to the Maintenance Division Superintendent who in turn reports to the District Maintenance and Operations Engineer who is responsible to the District Engineer. The overall administration of the maintenance program in the Washington Department of Highways

has been delegated by the Director of Highways to the Assistant Director of Maintenance.

Development of a management information system was initiated in 1964 with the assistance of a consultant. In the 1967 period the highway department developed a Maintenance Control System, a subsystem to the management information system with the consultant acting as a member of the research and development team. The developed system was tried on a trial basis in 4 divisions with the majority of the system implemented in 1968. A performance budget was first prepared for the 1969-1970 biennium based on data collected as part of the maintenance management system. The management system has remained under development with further changes anticipated in the future.

A combination of manual field data input is coupled with electronic data processing to compile and produce the reports. The compilation of field data is duplicated for independent use for payroll and accounting purposes. The duplicated data are being utilized for the Maintenance Control System. Each basic recording document is filled out by the individual maintenance employee. Eight years of reliable performance data have been collected. Performance data for the last three years of record are supplied to the district to aid in plan and budget preparation.

RECORDING SYSTEM

Washington Department of Highways Form 174-036, "Maintenance and Shop Labor Reporting Form" is utilized to collect maintenance

activity information (Figure H-1). The type of information recorded on this form includes;

1. Activity performed,
2. Location activity performed,
3. Manpower utilization,
4. Equipment utilization,
5. Material utilization indirectly, and
6. Accomplishments.

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated on the Maintenance and Shop Labor Reporting Record by designating the highway control section number together with the district, division and crew designation. The organization code is a six digit number denoting the Department's organizational element within which the employee is assigned to work. This code can be utilized to determine the district, and division in which the workman was assigned. Specific information is recorded to denote the location of the work as follows:

1. District. A number from 1 to 6 is utilized to designate district.

2. Maintenance Division. A one digit number is utilized to designate the Maintenance Division. District and Maintenance Division designation is coded in the column identified as Job Number. For example the code M51 would indicate the following:

M - Maintenance Operation (C utilized for Construction and P utilized for general supervision and planning)

5 - District 5

1 - Maintenance Division 1.

If the labor reported on this form is for a nonmaintenance job, the proper engineering, administrative, etc. job number should be entered under Job Number.

3. Maintenance Section. The maintenance section can be identified by the crew designation. The crew designation is a letter code normally entered after the Maintenance Operation Code. For example, 2113B entered under "function" would designate crew B.

4. Control Section. Control sections identify a specifc highway segment. Six digit numeric codes are utilized to identify control sections. If the workmen performed a maintenance activity on the highway a control section is identified in the column titled "Control Section or Equipment Worked on." In the case of shop personnel, the equipment number worked on is indicated in this column. Flexibility in the coding format exists to allow for an increase in the number of maintenance sections as required in the future.

5. Milepost. The state has a milepost system, however, it is not utilized to report the location of maintenance activities. Attempts are presently being made to make use of the milepost system to report the location of the maintenance activity.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder or side approach, roadside, etc.

Activity

Highway Maintenance Operation Codes are utilized to designate the maintenance activity performed. A four digit numeric code is utilized to identify the Highway Maintenance Operation. The first two digits of the code reveal the specific accounting functions as shown below:

1. Physical Maintenance
2. Traffic Control and Service Facilities
3. Snow and Ice Control
4. Repair of Damages Caused by Traveling Public
5. Suspense Accounts
6. General Functions

The first two digits as a unit also identify the functional class. A list of the 37 functional classes are shown on Table H-1.

The last two digits of the Highway Maintenance Operation Code as a unit are utilized to identify specific activity codes. Table H-2 shows an example of the codes and units utilized for activities associated with maintenance of drainage facilities. Engineering and flagging activities associated with specific functional classes are among the 373 Highway Maintenance Operations. It should be noted that special operation codes do not exist for portland cement concrete pavement as opposed to asphalt concrete surfaced pavements. Special codes exist for snow and ice removal. Maintenance standards exist for many of the operation codes. Usually about 40 to 60 of the maintenance operation codes are widely used.

Manpower

The individual filling out the Maintenance and Shop Labor Reporting Record supplies his name, social security number, organization code, the starting and ending time of his shift, the hours worked, the type of activity performed, the location of the activity and the equipment utilized. Both regular and overtime are reported. Working time is reported to the nearest 0.1 hour. Separate Highway Maintenance Operation codes are utilized for supervision personnel and for delay time due to equipment breakdown. These codes are in the 6,000 series.

As discussed above the entry under Job Number and maintenance crew identify the working unit to which the employee is assigned.

Equipment

Equipment utilized for a particular maintenance operation is recorded by the individuals operating the equipment. Equipment usage is reported by the mile or hour, depending upon the type of equipment. Time is reported to the nearest half-hour and mileage to the nearest mile.

Each item of equipment is designated by an equipment alpha-numeric code. An example of such a designation is shown below:

6A5 - 27

6 - indicates the equipment class

A - indicates the district (District 1)

5 - indicates the equipment sub-class and

27 - indicates the sequential number of the vehicle in the sub-class within the district.

The vehicle described above is a diesel powered dump truck in the 19,000 to 24,000 gross vehicle weight category. For each vehicle sub-class a rental category and depreciation schedule are assigned. Costs per mile or hour operated and cost per hour assigned are also calculated for each vehicle sub-class. Twenty-four vehicle classes have been identified.

Materials

Materials utilized for a particular maintenance operation are not recorded. Individual measurements of materials can be obtained by utilization of the reported "work units" and the work standards. The inclusion of material usage on the Maintenance and Shop Labor Reporting Record is under study. A special maintenance operation code does exist for material haul.

Accomplishments

Accomplishments are reported by the individual under the heading "Work Units." The units reported are those designated on the maintenance operation code summaries (Table H-2). For example, accomplishments reported for maintenance operation 1135 (patch pot holes - hand spread and compact with truck) are in units of tons. For those operations requiring a crew to perform, only one time card would report accomplishments in the column work units.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance and Shop Labor Reporting Record is filled out daily by the maintenance employee. The section leader will audit the entries for correct coding, total numbers of hours, and the breakdown of the over-time hours. Secretaries are not responsible for individual time reports. These daily records are transmitted

to the division office weekly. The district office will key punch the daily time sheets and combine the data monthly for transmission through the remote computer terminal in the district to the HQ office. The HQ office computer and staff are responsible for the reports. Monthly reports are returned to the district by the 15th of the following month. Yearly reports are returned within 6 weeks after the close of the fiscal year.

It is estimated that about three-tenths of one percent of the maintenance budget is expended on recording and reporting maintenance activities. About 80,000 dollars of computer charges are utilized annually.

REPORTS

Several reports are produced from the collected data. A brief discussion of the more important reports from a maintenance management standpoint are presented below.

Accomplishment Reports. Accomplishment reports are prepared for the state as a whole, the District, Maintenance Divisions, Maintenance Sections and maintenance crews. Year to date totals and current month work units accomplished and costs are reported by Maintenance Operation Number. A District Accomplishment Report is shown on Figure H-2. Information displayed on this report is summarized below.

1. Accomplishments for the year to date reported in terms of the standard unit (tons, lineal feet, etc.) for the maintenance operation.

2. Percent of scheduled work units complete for the year to date.

3. Remaining amount of work units to be completed during the remainder of the year.

4. Hours of labor expended for the year to date.

5. Actual cost and standard cost of the labor for the year to date. The standard cost of labor, equipment and material is obtained from the work standards, man-hour per unit of accomplishment standard, and an estimate of the average cost of labor to perform the given maintenance operation.

6. Labor performance percent or ratio of the standard labor cost to the actual labor cost.

7. Equipment standard and actual cost.

8. Equipment performance percent or the ratio of the standard equipment cost to the actual equipment cost.

9. Material standard and actual cost both of which are obtained by use of the work standard.

10. Total actual and standard cost.

11. Total unit cost or the ratio of the actual costs to the number of work units accomplished.

12. Cost ratio or the ratio of the actual costs to the standard cost.

13. Work units and costs are given for the reported month.

Planning Reports. Several planning reports are prepared from information collected on the Maintenance Yearly Planning Sheet (Figure H-3) and the work standards information. These sheets are developed from input from the crew leadman and section supervisor. Distribution of the work units is made on a monthly basis in

accordance with the direction given in reference H-1. The following reports are obtained from this information;

1. Monthly Man-hour Distribution for:
    a. Sections (Report No. 8031)
    b. Divisions (Report No. 8032)
    c. Districts (Report No. 8033)
    d. State-wide (Report No. 8034) (Figure H-4)
2. Budget-Aging reports showing monthly cost distributions for:
    a. Divisions (Report No. 8035)
    b. Districts (Report No. 8036)
    c. State-wide (Report No. 8037) (Figure H-5)
3. Workman skill requirement reports for:
    a. Divisions (Report No. 8039)
    b. District (Report No. 8040)
    c. State-wide (Report No. 8041) (Figure H-6)
4. Fund Requirement Reports

The reports described above are prepared before the beginning of each fiscal year. The yearly work plans in some cases are prepared 2 to 3 years in advance. Thus, it is not desirable to compare scheduled or planned activities with performed activities on the Accomplishment reports.

Reports are utilized for fiscal control, by reviewing cost to date in the Accomplished Report; for monitoring of program execution by reviewing the percent completion column of the Accomplishment Report; for allocation of manpower and equipment, by review of the performance percent for labor and equipment costs and by utilizing the Planning Reports; and for budget preparation

as a check to determine productivity figures to be utilized in calculating the budget. The reports are also utilized to justify budget to state legislation and have been utilized to relocate section boundaries.

Presently maintenance operations that appear to be contrary to planned productivity and budgets must be located by a detailed review. Exception reports are presently not a part of the reporting system.

OTHER ITEMS

The Washington Department of Highways is very happy with the reliability of the reported data. HQ office checking is performed selectively.

The recording and reporting system can be altered by direction of the HQ office maintenance staff as the need arises. The HQ office continually works with the districts to assess the usefulness of the recorded and reported information.

A standing maintenance standards committee does not exist. Standards are revised as necessary.

Changes have been made in the reporting format since 1968. These changes are made from the HQ office usually after consultation with field personnel. The maintenance management system has been developed and altered by the Department of Highways with assistance from consultants.

Data can be stored for an extended period of time. The last three years of data are routinely supplied to the districts.

References

H-1 "Maintenance Control System, Maintenance Yearly Planning Procedures Manual," Washington Department of Highways, September, 1971.

H-2 "Equipment Information and Reporting System User Manual," State of Washington, Department of Highways, Accounting Division Manual.

H-3 Dorsey, V. L., "State of Washington Reporting System," Highway Research Record No. 347, 1971.

H-4 "Quality Standards for Highway Maintenance," Washington Department of Highways, May, 1968.

H-5 "Highway Maintenance Operations," Washington Department of Highways, July 1, 1975.

H-6 "Uniform Equipment Rental Rates," Washington Department of Highways, September 1, 1975.

H-7 "Maintenance Work Control System, Time Standard Manual," Washington Department of Highways, March, 1973.

H-8 Anderson, D. R., "Maintenance Work Control System, Highway Signal and Lighting Preventive Maintenance and Repair Manual," Washington Department of Highways, December, 1971.

Table H-1. Functional Classes of Highway Maintenance Operation.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

HIGHWAY MAINTENANCE OPERATIONS

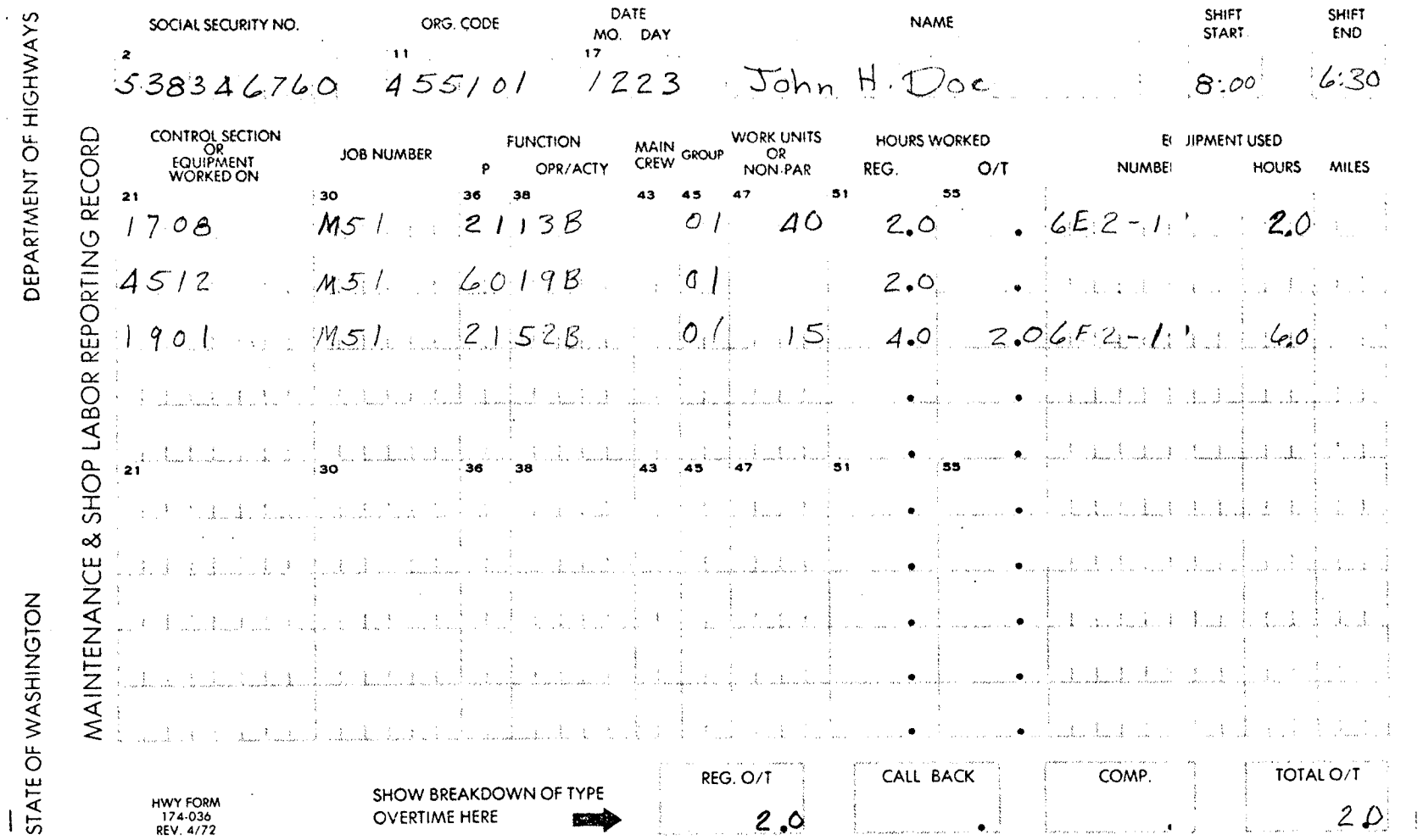
OPERATION NUMBER FROM	TO	CHART OF ACCOUNTS		PAGE
1100	1199	M2110	ROADWAY SURFACE	1
1200	1299	M2121	ROADSIDE REPAIRS	2
1300	1399	M2122	CLEANING - DRAINAGE FACILITIES	4
1400	1499	M2123	MOWING AND BURNING GRASS - WEEDS (Excluding rest and landscape areas)	6
1500	1599	M2124	MAINTENANCE OF LANDSCAPED AREAS (Other than roadside rest areas)	7
1600	1699	M2125	BRUSH AND TREE GROWTH ALONG RIGHT OF WAY (Excluding rest or landscape areas)	9
1700	1799	M2126	WEED CONTROL (Excluding rest and landscape areas)	10
1800	1899	M2130	SHOULDERS AND SIDE APPROACHES	11
1900	1999	M2140	STRUCTURES	13
2000	2099	M2210	PATHS AND TRAILS	15
2100	2199	M2510	SNOW AND ICE CONTROL	16
2200	2299	M2221	TRAFFIC SIGNS, DIRECTION MARKERS, AND OTHER TRAFFIC DEVICES	18
2300	2399	M2222	PAINTING OF STRIPES AND PAVEMENT MARKINGS	20
2400	2499	M2223	REPAIRING AND MAINTAINING GUARDRAILS	22
2500	2599	M2224	REPAIRING, MAINTAINING, AND OPERATING ELECTRICAL SIGNAL EQUIPMENT	23
2600	2699	M2224	ELECTRONIC MAINTENANCE AND REPAIR	25
2700	2799	M2225	REPAIRING, MAINTAINING, AND OPERATING HIGHWAY LIGHTING SYSTEM	26
2800	2879	M2226	REPAIR AND MAINTENANCE OF ROADSIDE REST AREAS	27
2880	2889	M2240	OPERATION OF DRAWBRIDGES AND FERRIES	29
2890	2899	M2250	OTHER SERVICES	29
2900	2999	M2260	ROADSIDE CLEANING	30
3000	3999	M2310	REPAIR OF DAMAGES CAUSED BY TRAVELING PUBLIC	31
4000	4099	M2400	DISASTER MAINTENANCE	32
5012	5012	M2800	DORMITORY AND DINING ROOM - SUSPENSE	32
5013	5013	M2900	SIGN MANUFACTURE - SUSPENSE	32
5311	5319	M2700	TRAFFIC STRIPING - SUSPENSE	32
6011	6016	M2600	MAINTENANCE - GENERAL FUNCTIONS	33
6017	6017	M2690	MAINTENANCE - TRAINING	33
6018	6023	M2600	MAINTENANCE - GENERAL FUNCTIONS	33
6024	6025	M2610	MAINTENANCE - GENERAL FUNCTIONS - RADIO OPERATIONS	33
6026	6027	M2620	MAINTENANCE - GENERAL FUNCTIONS - ADMINISTRATION	33
6028	6099	M2600	MAINTENANCE - GENERAL FUNCTIONS	33
6500	6530	M2630	MAINTENANCE - PERMIT FUNCTIONS	34
6610	6610	M2150	MAINTENANCE - CETA - SUPERVISION/PHYSICAL MAINTENANCE	35
* 6620	6620	M2150	MAINTENANCE - CETA - PHYSICAL MAINTENANCE	35
6630	6630	M2270	MAINTENANCE - CETA - SUPERVISION/TRAFFIC SERVICES	35
* 6640	6640	M2270	MAINTENANCE - CETA - TRAFFIC SERVICES	35

*CETA employees only

Table H-2. Highway Maintenance Operation Codes - Example.

NUMBER	UNIT	OPERATION DESCRIPTION
		FUNCTION 1300 MAINTENANCE OF DRAINAGE FACILITIES
		MAJOR JOB 1310 CLEANING DITCHES AND CHANNELS
1311	100 Linear Ft.	Motor grader and front-end loader (may include use of trucks)
1312	100 Linear Ft.	Front-end loader only
1313	100 Linear Ft.	Front-end loader with trucks
1314	100 Linear Ft.	Motor grader(s) -(includes distributing material on shoulder if suitable)
1315	100 Linear Ft.	Motor grader with belt loader with trucks
1316	100 Linear Ft.	Power shovel or clam/dragline (with or without trucks)
1318	100 Linear Ft.	Hydraulic shovel with trucks (includes backhoe type attachments on other equipment)
1329	None	Channel cleanup and other methods of ditch or channel cleaning
		MAJOR JOB 1330 CLEANING CULVERTS AND CROSS DRAINS
		(Run out ditches cleaned mechanically to be included under 1310 series)
1331	Each	Manual shovel - (brushing & inspection included)
1333	Each	Painting culvert marks
1339	None	Other - includes mechanical cleaning methods
		MAJOR JOB 1340 CLEANING MANHOLES AND CATCH BASIN
1341	Each	Manual shovel
1342	Each	Mechanical cleaning - (Vac-All, Eductor, etc.)
1349	None	Other methods

Figure H-1. Maintenance and Shop Labor Reporting Record.



STATE OF WASHINGTON — DEPARTMENT OF HIGHWAYS

MAINTENANCE & SHOP LABOR REPORTING RECORD

SOCIAL SECURITY NO.	ORG. CODE	DATE MO. DAY	NAME	SHIFT START	SHIFT END
538346760	455101	1223	John H. Doe	8:00	6:30

CONTROL SECTION OR EQUIPMENT WORKED ON	JOB NUMBER	FUNCTION P	FUNCTION OPR/ACTY	MAIN CREW	GROUP	WORK UNITS OR NON-PAR	HOURS WORKED REG.	HOURS WORKED O/T	EQUIPMENT USED NUMBER	EQUIPMENT USED HOURS	EQUIPMENT USED MILES
1708	M51	2	13B		01	40	2.0		6E2-1	2.0	
4512	M51	6	019B		01		2.0				
1901	M51	2	152B		01	15	4.0	2.0	6F2-1	6.0	

HWY FORM 174-036 REV. 4/72

SHOW BREAKDOWN OF TYPE OVERTIME HERE ➡

REG. O/T	CALL BACK	COMP.	TOTAL O/T
2.0			2.0

Figure H-2. District Maintenance Accomplishment Report.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

REPORT NO R8067

MAINTENANCE ACCOMPLISHMENT REPORT FOR MONTH OF NOVEMBER 75

MAINTENANCE DISTRICT 01

DATE OF RUN 12/11/75

OPER. NO.	WORK UNIT ACCUMP TO-DATE	PCT COMP	REMAIN	UNITS	LABOR HOURS TO-DAT	PER. PCT.	LABOR ACTUAL COST	LABOR STD. COST	EQUIPMENT PER. PCT.	EQUIPMENT ACTUAL COST	EQUIPMENT STD. COST	MATERIAL ACTUAL COST	MATERIAL STD. COST	TOTAL ACTUAL COST	TOTAL STD. COST	CURR. MO. UNIT COST	CURR. MO. PAT.	CURR. MO. WORK UNITS	CURR. MO. COST
11111	MECH MIX PATCH	31	11415	TON	1567	65	12907	8400	136	5739	7640	60356	60356	79004	7 404	15.45	1.03		
	5114																		
11121	HAUL FOR PATCH	65	48073	SQ MI	6316	79	49296	39073	90	31256	28291			80592	6 364	.69	1.20	1289	950
	90683																		
11221	MANUAL MIX SPOT	38	904	TON	1370	104	11044	11505	135	5491	7416	6650	6650	23185	2 571	42.54	.91	4	331
	545																		
11261	MACH MIX CONT	>	5209-	TON	5937	174	47641	82954	182	18906	34561	228122	228122	294669	34 637	15.50	.85	224	3563
	19012																		
11331	PATCH PCCw/PCC*		4	SQ FT	38		154			36				190		1.57		37	141
	121	97																	
11341	PATCH APH W/APH	16	7870	SQ FT	157	36	1332	1141	95	644	614	360	360	2336	115	1.56	1.10		
	1500																		
11351	PATCH POT HOLES	20	1076	TON	1426	106	11101	11716	141	3105	4367	4807	4807	19013	2 910	45.16	.91	145	6076
	421																		
11361	PREP FD MIX	*	200	CU YD															
11411	MAINT GRAVEL RD	>	3-	LN MI	46	58	400	232	56	505	295			905	527	32.32	1.72		
	28																		
11471	SEAL COAT BC&D	>	472-	100CL	357	77	7417	5741	111	2771	3062	29471	29471	39659	3 274	72.90	1.04		78
	544																		
11481	HAUL FOR 1147	>	7422-	SQ MI	922	125	4439	5505	196	2012	3985			6418	488	.76	.68		
	8472																		
11531	FOG SEALS	>	16-	100CL	21		319			319				638		35.44			
	13																		
11541	PATCH-SURF-APP*	5	1163	SQ YD	67	31	593	182	34	414	142	85	85	1090	409	18.79	2.67		
	54																		
11551	SLURRY PATCHING	3	8503	GAL	60	57	540	202	120	107	128	163	163	810	493	2.75	1.64		
	295																		

WASHINGTON STATE HIGHWAY COMMISSON
DEPARTMENT OF HIGHWAYS

Figure H-3. **MAINTENANCE YEARLY PLANNING SHEET**

CARD TYPE [1] 8,0 FISCAL YEAR [3] ORGANIZATION CODE [5]

Prepared By ________ Date ________
Checked By ________ Date ________
Sheet ___ Of ___

FUNCTIONAL CLASS CODE

- Principal –1
- Major –2
- Collector –3
- Other –4
- Interstate –5

ACTIVITY CODE

- Add – 1
- Delete – 2
- Replace – 3

DESCRIPTION	ACTIVITY →			LOCATION ←					QUANTITY ←		COST DISTRIBUTION ←				PERCEN				MONTHLY DISTRIBUTION ←								Acty Code
	Major Work Category 11 Code	Operation Number 15	Unit 20	State Route 25	Area 29	Code 30	31	32	Work Units 33	Man Hours 40	Std. Cost Per Man Hour 45	% Lbr 50	% Eqp 52	% Mat 54	July 56	Aug 58	Sept 60	Oct 62	ov	Dec 66	Jan 68	Feb 70	Mar 72	Apr 74	May 76	June 78	80

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

MAINTENANCE YEARLY WORK PLAN — FISCAL YEAR 1 — REPORT NO 8034

STATEWIDE — PAGE NO 2 — DATE RUN 03/03/71

MONTHLY MANHOUR DISTRIBUTION

DIST	WORK UNITS	MAN HOURS	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL COSTS	% LBR	% EQP	% MAT
1170 SPCL MNT & RPR																		
1	4	242	151					45		45				1	1977	65.5	15.8	18.7
3	10	784	66	44	49	76	55	37	40	37	37	178	67	78	8379	48.9	21.1	30.0
4		192	14	12									166		2442	42.3	10.1	47.6
5	289	939	33	52	259	436	32						104	23	10827	44.7	26.9	28.4
6		710	177	226	129							26	19	133	6695	56.6	10.9	32.5
7		250			48	101							101		1625	82.0	18.0	
TOTAL	303	3117	401	334	485	613	87	82	40	82	37	204	457	235	31945	51.3	19.6	29.1
1180 CLN RDWY SURFCE																		
1	2000	1517	22	103	123	142	81	29	5	91	77	445	313	86	20723	38.0	62.0	
2	1655	4267	127	212	2						1221	1233	616	856	40801	54.1	45.9	
3	4173	4024	273	288	309	265	226	212	218	235	766	563	400	269	47576	43.8	56.2	
4	651	593	15	3	58	114	18	1	9		142	154	78	1	7713	39.6	60.4	
5	2905	2247	196	423	249	90	18				355	559	257	98	29824	38.9	61.1	
6	2569	2677			222	635					556	441	562	461	33019	44.8	55.2	
7	176	856	3	1	353	4	3	4	3	4	120	354	3	4	8818	49.4	50.6	
TOTAL	14151	16381	636	1030	1316	1250	346	245	235	330	3237	3749	2229	1775	188274	44.9	55.1	
1195 FLAGGING																		
1		6873	1110	984	596	466	172	64	30	166	166	639	449	2031	41360	91.3	8.7	
2	208	2102	661	963	420						1072	935	2359	1732	45131	99.3	.7	
3		11767	1199	1269	1636	953	565	513	510	535	958	1089	1448	1092	62356	97.6	2.4	
4		7432	1055	1243	661	698	248	156	119	226	255	903	1031	697	40216	96.8	3.2	
5		7775	1145	1300	515	879	306	50	46	138	566	993	883	956	41516	97.3	2.7	
6		7391	772	1055	1492	198	111		22	89	301	1411	832	808	38385	98.4	1.6	
7		1058	79	131	174	123	80	31	11	71	69	91	69	109	7431	75.8	24.2	
TOTAL	208	45596	6041	6945	5432	3317	1482	814	738	1225	3387	6061	7091	7425	276398	96.3	3.7	

Figure H-4. Monthly Man-Hour Distribution Report.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

PROGRAM 4 BUDGET-AGING — FISCAL YEAR 71 — REPORT NO 8037

STATEWIDE — PAGE NO 2 — DATE RUN 03/03/71

ACTIVITY DIST	QUANTITY WORK UNITS	MAN HOURS	*	COST DISTRIBUTION JUL JAN	AUG FEB	SEP MAR	OCT APR	NOV MAY	DEC JUN	TOTAL	LABOR	EQUIPMEN	MATERIAL
1150 CRACK&JNT SEAL													
2	24	326				1106	1539			2645	1666	635	344
3	243	4662		1578	70	7594	11494	4399	2201				
			*	2271	2252	2952	88	2051	70	37020	23699	8200	5121
4	23	322					919	1266					
			*				265			2450	1617	514	319
5	452	5396		1121		4263	31756	12775					
			*							49909	32077	11392	6440
6	116	1624				278	10448	54					
			*					1582		12362	8159	2595	1608
7	70	980		1456	3704	1414							
			*					548	548	7672	4913	1764	995
TOTAL	1056	16105		4157	2207	20306	58959	18494	2201				
			*	2271	2252	2961	353	4131	1545	125887	80978	28288	16621
1170 SPCL MNT & RPR													
1	4	242		1156					407				
			*		407				7	1979	1295	314	370
3	1?	784		754	520	573	706	624	426				
			*	469	426	426	1971	765	727	8378	4097	1766	2515
4		192		176	155								
			*					2111		2442	1031	248	1163
5	289	939		236	354	2968	5538	232					
			*					1345	155	10828	4848	2908	3072
6		710		1372	2373	1381							
			*				186	139	1244	6695	3791	730	2174

Figure H-5. Statewide Budget-Aging Report.

WASHINGTON STATE HIGHWAY COMMISSION

DEPARTMENT OF HIGHWAYS

YEARLY WORK PLAN - SKILL REQUIREMENTS

DISTRICT 10000

MONTHLY SKILL REQUIREMENTS (MANHOURS)

SKILL TITLE	SALARY RANGE	ACTIVITY	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	AY	JUN	TOTAL
HWY MT.MAN I	19A	041	9099	8187	12413	15467	11550	5921	3795	9146	12238	10698	11 16	11255	121335
HWY MT.MAN II	20A	041	1145	1154	1156	1580	835	197	44	437	516	1495	1 16	1481	11456
HWY MT.LEADMAN	22A	041	628	613	807	447	300	378	209	607	835	607	1 25	1093	7549
BRIDGE MT.MAN	20A	041	441	404	988	591	906	275	285	574	1470	1489	1 62	5057	14352
BRIDGE MT.SPEC	24A	041	121	114	276	139	240	72	74	150	410	368	02	1345	3731
HWY EQP OPR II	22A	041	643	548	906	2053	1186	878	396	896	1519	1018	64	870	11796
HWY EQP OPR III	24A	041			86	466	426	71	2	42	163	151	13	13	1533
	ACT TOTAL		12077	11020	16632	20743	15443	7792	4805	11852	17201	15826	17 98	21153	171742
ELECTRICIAN	21A	042	226	216	186	146	217	218	206	219	169	150	72	138	2316
HWY MT.MAN I	19A	042	6069	6328	8389	8356	10550	10982	12501	9713	7219	8607	10 12	7768	106788
HWY MT.MAN II	20A	042	8	9	20	27				3	42	60	51	29	249
HWY MT.SPEC	21A	042	433	556	624	810	282	182	195	222	302	447	69	706	5123
HWY MT.LEADMAN	22A	042	41	77	24						6	13	82	25	268
HWY MT.FOREMAN	24	042	1	2	1						1	1	1	4	11
BRIDGE TENDER	16A	042	1696	1696	1696	1696	1696	1696	1696	1696	1908	1908	1 08	1908	21200
TRAF SIG TECH I	19A	042	388	261	290	263	251	198	212	292	229	311	11	345	3251
TRF SIG TECH II	25A	042	435	300	331	283	302	248	215	335	265	337	26	369	3645
ELECT TECH I	19A	042	14	14	13	12	15	13	12	14	13	12	14	13	159
ELECT TECH II	24A	042	14	14	13	12	15	13	12	14	13	12	14	13	159
ELECT TECH III	25A	043	567	406	479	461	459	419	555	465	504	454	24	387	5664
HWY EQP OPR II	22A	042	151				360	781	1483	1004	512	522	56		4953
COOKS HELPER	17	042	81	80	80	80	80	201	201	201	221	100	80	80	1485
COOK	19	042	81	80	80	80	80	201	201	201	221	100	80	80	1485
CARETAKER	14	042	155	160	160	160	160	403	403	403	443	200	60	160	2970
	ACT TOTAL		10324	10299	12389	11892	14462	15555	17892	14782	12068	13234	14 60	12075	159631
ELECTRICIAN	21A	043	39	19	19	61	17	27	49	27	17	59	17	32	383

Figure H-6. District Skill Requirement Report.

APPENDIX I

WYOMING STATE HIGHWAY DEPARTMENT'S

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 353,000 residents of Wyoming operate 294,000 motor vehicles on 40,636 miles of highways of which 6,000 miles are under state control. The state occupies 97,914 square miles from an elevation of 3,100 feet to 13,804 feet above sea level. Mean minimum and maximum temperatures are -8 and 92°F with average annual moisture ranging from 8 to 56 inches.

The Wyoming State Highway Department has a $15,000,000 maintenance budget for fiscal year 1975-1976. This budget will be used by its 5 districts to maintain 14,620 lane miles of highways (6,000 center line miles) which consist of 3,820 Interstate highway lane miles, 6,160 primary highway lane miles and 4,640 secondary highway lane miles.

Five districts comprise the Wyoming State Highway Department. Each district is divided into maintenance stations resulting in a total of 55 maintenance stations state wide.

Foremen are in responsible charge at the maintenance station with assistance from crew leaders or lead men at certain larger stations. Foremen report to the district maintenance engineer who in turn reports to the district engineer. The administration of the maintenance program by the Superintendent and Chief Engineer of the Wyoming State Highway Department is performed at the central

office level by the Construction and Maintenance Branch through the Operations Division.

The basic maintenance recording and reporting system was developed in the 1970 to 1971 period at the same time the accounting system was being revised. A parallel recording system is being utilized although an effort is being made to develop a single recording system. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports. About one year of reliable maintenance cost data is now available from the recording and reporting system.

RECORDING SYSTEM

Wyoming State Highway Department Form M-17, "Maintenance Activity Record" is utilized to collect maintenance activity information (Figure I-1). The type of information obtained on this form includes;

1. Activity performed,
2. Location activity performed,
3. Manpower utilization
4. Equipment utilization,
5. Material utilization,
6. Accomplishments and,
7. Planned accomplishments.

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. This location is designated by recording

the following information:

1. District. A number from 1 to 5 is utilized to designate the district.

2. Maintenance Station. Fifty-five maintenance stations designate an area of responsibility which is headed by a foreman. Maintenance stations are designated by 4-letter codes designating the town nearest the maintenance station.

3. Maintenance Section. Maintenance sections identify a specific highway segment. A total of 409 maintenance sections are identified by a 5 character alpha-numeric code. This code consists of a two-letter county designation, a two number route number code and a letter code indicating if the section is in a rural or urban location. Subsections are designated with A, B, or C, depending on the number of sections in rural areas and X, Y, or Z for urban sections. Limits of the sections are established primarily based on snow removal considerations. Little attempt has been made to establish maintenance section limits based on type of pavement and/or time of construction. Flexibility in the coding format exists to allow for an increase in the number of maintenance sections as required in the future.

The space assigned to designate the maintenance section may also be utilized to designate special maintenance projects with unique job numbers and work performed on stockpiles such as an oil mix process, stockpile transfer, or addition of salt performed under function 920. Thus either a maintenance section or job number may be utilized depending on the type of work.

4. Milepost. Begin and end milepost which designate the boundaries within which a maintenance activity was performed must be recorded for the following maintenance functions:

412 - Equipment Leveling,

422 - Black Seal,

423 - Sand - Gravel Seal,

424 - Plant Mix Seal and,

441 - Shoulder Seal.

461 - Slides (at Geology's request)

481 - Structures

Mileposts which are recorded to the nearest 0.01 miles may be designated for other maintenance functions. However, it is the usual practice to designate only maintenance sections. In some cases only the begin milepost need be designated. For example, maintenance performed at a bridge can be adequately located by designating the begin milepost location.

Information is not recorded which indicates in what lane the maintenance activity was performed. Designation of the maintenance function or activity indicates if the maintenance action was performed on the pavement, shoulder or side approach, roadside, etc.

Activity

Maintenance function codes are utilized to designate the maintenance activity performed (Table I-1). Forty-six maintenance codes are presently utilized and are divided into the following major groups:

1. Surface maintenance,
2. Shoulder and side approaches,
3. Roadside and landscape,
4. Drainage,
5. Structures,
6. Snow, ice, and sand control and removal,
7. Traffic services,
8. Rest areas and parks,
9. Maintenance houses and
10. General (Function 920, work in process)

It should be noted that a special function code, concrete paving repair, is utilized for maintenance on portland cement concrete pavements. Some special codes exist for snow and ice removal.

Function codes were developed with reference to the AASHO guides and expanded to include those activities that were a significant portion of the maintenance budget. These maintenance function accounts have been altered and can be expected to be further revised in the future.

Manpower

Manpower utilization for a particular function is recorded. Each crew has a three digit designation. Crews which work under the supervision of a maintenance station are designated as regular (R) while district special crews such as those associated with chip sealing, equipment overlays are designated as district (D).

In recording the labor utilized, two types of entries are made; the total number of men used and the number of hours worked

for monthly and hourly employees. The report is designed to be a weekly report except for those months that end on any day other than Friday. The total time worked is reported to the nearest hour daily and summed for the weekly reporting period.

Separate codes are utilized in the crew designation for administrative personnel such as district maintenance engineers and central office personnel. These data are not transmitted on Form M-17, but through accounting using function 401-405. (Administrative budgets are not reported by activity.)

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by an equipment number which is either the Wyoming license plate number or an assigned equipment number. This number is unique to the piece of equipment for its life. A 6-character alpha-numeric code is utilized for the equipment number always beginning with "H" if the equipment has a Wyoming license plate. Equipment use is charged out daily by the hour or mile, depending on the type of equipment utilized. For example, pick-ups are charged by the mile while graders and other items of equipment are charged by the hour of actual use. If a piece of equipment was on the job for 8 hours but was actually used 3 1/2 hours, 4 hours would be recorded. The total hours or miles each piece of equipment was utilized during the week is summed from the daily record.

Rental equipment utilized for a particular maintenance function can be recorded by designating that the equipment is rented by placing "RENTAL" in the equipment number entry, and by indicating its

rental rate by the hour or mile and by recording the hours or miles of use daily.

Materials

Materials utilized for a particular function are recorded daily and totaled weekly. Material stockpiles have a unique number assigned to them. If the material in a stockpile is improved by the addition of oil, salt, etc., it is assigned a new stockpile number. All stockpiles are tied to a specific maintenance station. The site of the stockpile is recorded by the 4-letter code used to designate the maintenance station. The inventory number of the material is a 6-character alpha-numeric code which can be obtained from accounting code manuals together with the unit of measure. For example, Inventory number 10-2910 designates salt and the unit of measure is tons. SP4011 refers to a stockpile number 4011 in District 4.

Items recorded under materials designate the source of the material. The location of the use of the material is designated by the location information as discussed above and is charged against the maintenance function only as it is utilized.

Accomplishments

All maintenance functions do not require the reporting of accomplishments. Those functions requiring a report on Accomplishments designate the units such as tons per day, man-hours per day, etc. These units are recorded on the form together with the daily accomplishments. Daily accomplishments are summed weekly.

It is common practice to move materials from one stockpile to another with or without an improvement in the specific material,

The stockpile from which the material was removed is designated by codes in the material used section of the Maintenance Activity Record. The site of the new stockpile is recorded under accomplishments together with the new stockpile identification number and the unit of measurement.

For all maintenance functions that require a measurement of accomplishments, the planned accomplishments part of the form must be filled out. Utilization of this part of the form forces preplanning. The unit of measure is recorded as obtained from the function code together with the anticipated daily and weekly planned accomplishments.

COLLECTION AND PROCESSING OF RECORDED DATA

The Maintenance Activity Record is filled out daily by the lead man for his crew and summed weekly. The foreman is responsible for checking the work of the lead man.

These forms are then transported to the district and checked at the district level prior to electronic transmission to the central office for processing and reporting. Secretarial type employees are not utilized at the station level to handle these data. Data are transmitted weekly to the central office and reported monthly to the districts.

It is estimated that about one-half of one percent of the maintenance budget is expended on recording and reporting maintenance activities. Twenty-four thousand dollars for computer charges was expended in 1974. The lead men and station foremen each require

about 1 hour per week to complete the Maintenance Activity Record with an additional 2 man-hours required at the district level for checking input data. Thus, the average district expends approximately 25 man-hours per week or 100 man-hours per month to collect maintenance activity information.

REPORTS

Seven reports are being produced from the collected data. A brief discussion is presented below indicating the types of data contained on these reports:

MR-1. Maintenance Report 1 is a copy of the data transmitted from the Maintenance Activity Record by the district.

MR-2. Maintenance Report 2 indicates the errors that occur on the transmitted Maintenance Activity Record. It is utilized to locate and correct errors associated with the field report and thus may be considered a type of audit or exception report.

MR-3. Maintenance Report 3 has a format similar to MR-5 shown in Figure I-2 except it is prepared for special maintenance projects and other activities associated with stockpile beneficiation or moving. Selected function accounts can also be displayed on this report.

MR-4. Maintenance Report 4 summarizes holding accounts, district overhead accounts, supervising accounts, special work items, function activity 920 and other items not budgeted as regular maintenance.

MR-5. Maintenance Report 5 is a popular reprot and is shown on Figure I-2. The report is organized by district, maintenance

station and crew number, maintenance section, and maintenance function account. For each function account number the following information is displayed:

1. man-hours for the year to date
2. man-hours per unit of work
    a. actually performed for the year.
    b. expected standard obtained from maintenance function standard
3. work units
    a. accomplished for the year to date
    b. planned for the year
4. cost per unit of work
    a. actual for the year to date
    b. planned for the year based on the maintenance function standard
5. Expenditures
    a. for the month reported
    b. for the fiscal year to date
6. budgeted amount for the year
7. balance remaining for the year.

Year to date totals for man-hours, expenditures for the month, year to date expenditures, budget amounts and balance amounts are summed for groups of maintenance activities such as surface maintenance, shoulder and side approach maintenance, roadside and landscape maintenance, etc. The same information is summed by highway section and maintenance crews.

MR-6A. Maintenance Report 6A is a summary report organized by district, maintenance station and crew number. For each crew number the annual budget is displayed together with expenditures for the reporting month, expenditures for the year to date, remaining balance for the year to date and the percent expended to date. In addition the report presents separate summaries on a district-wide basis for interstate, primary and secondary highway snow removal. This report is shown on Figure I-3.

MR-6B. Maintenance Report 6B is a summary report for the entire state organized into four categories, namely; expenditures other than snow and ice control, interstate highway snow and ice control, primary highway snow and ice control and secondary highway snow and ice control. For each district the annual budget is displayed together with expenditures for the reporting month, expenditures for the year to date, remaining balance for the year to date and the percent expended to date.

Snow removal requires about 23 percent of the annual maintenance budget and hence the distribution of expenses for snow and ice control is of interest to the administration. Other types of reports are being considered by the Wyoming State Highway Department.

Inventory control reports are prepared by the accounting branch. These reports contain inventory amounts, the location of the items and the dollar amounts. Equipment reports are also produced. Equipment use rates are determined in the central office by the equipment engineer based on depreciation, operating and repair costs together with historical information.

It should be noted that man-hours are reported for the entire working crew. These hours are transferred to dollar values by use of an average cost per hour for an individual in the crew which is calculated by the central office. The standard man-hour per unit of accomplishment is obtained from the maintenance function standard. Work units planned are prepared by field personnel on a yearly basis at budget preparation time. Planned costs per unit are determined by use of the standard man-hour per unit of productivity and the average labor cost per man for the crew. Budget amounts are obtained by multiplying units planned by costs per unit planned.

The various reports are prepared monthly with year to data totals. The MR-5 report is utilized by the district maintenance engineer and the maintenance station foreman. The MR-6A and MR-6B reports are prepared monthly with year to date totals and are utilized mainly by the central office and the district maintenance engineer. The Maintenance Activity Record is utilized by the foreman and district maintenance engineer to monitor weekly progress and productivity. Reports are transmitted to the district 2 weeks after the end of the month.

Reports are utilized for fiscal control, by reviewing the budget, expenditures and balance columns of the report; for monitoring of program execution by comparing planned and accomplished work units; for allocation of manpower by reviewing productivity quantities such as man-hours per unit of work and cost per unit of production; and for budget preparation as a check to determine productivity figures to be utilized in calculating the budget.

Presently maintenance function activities that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by a detailed review of MR-5. Exception reports are presently not a part of the reporting system although their development is under consideration.

OTHER ITEMS

The Wyoming State Highway Department is satisfied with the reliability of the existing system although improvements can be made. The recording system utilized lead men and foremen to record information rather than the individual maintenance employee. It is believed that this approach improves the reliability of the information. It is generally believed that more reliable data must be obtained if the information is to be utilized as feedback information to design.

The recording and reporting system can be altered by direction of the central office maintenance staff as the need arises. The central office continually works with the districts through district engineers meetings and other meetings to access the usefulness of the recorded and reported information.

A maintenance standard committee exists which is responsible for revision of the standards. Meetings are held as necessary. Productivity rates which were originally based on time and motion studies plus a review of the literature have not been changed as sufficient information has not been collected to warrant a change.

Equipment use charges are reviewed quarterly and revised as necessary.

Changes in the maintenance management system are directed by the state construction and maintenance engineer. Changes usually occur at the beginning of the fiscal year or at the beginning of the month. Few changes have been made to date as it will be necessary to firmly establish the system prior to making refinements. Data processing changes often require considerable lead time to change.

Data collected are stored in the MR-5 format presently for a fiscal year period. A Mark IV data system is used and allows access to data for a prolonged period of time.

References:

1. "Instructions for Maintenance Reporting System, M-17," Wyoming State Highway Department, Revised March 1, 1973.

2. "Maintenance Standards (Guide for Uniform Service)," Wyoming Highway Department, April 1, 1974.

Table I-1.

WYOMING HIGHWAY DEPARTMENT

MAINTENANCE FUNCTION ACCOUNTS

January 1, 1974

SURFACE MAINTENANCE

411 Hand Patching

All charges including labor, equipment and materials used in repairing asphalt roadway surfaces. Includes patching pot-holes, raveled edges, etc., when done by hand.

412 Equipment Patching

All charges including labor, equipment and materials used in repairing asphaltic roadway surfaces. To include all patching utilizing laydown machine, motor grader or other approved equipment to patch small isolated failures up to one-quarter in length

413 Equipment Leveling

All charges including labor, equipment and materials used in leveling and resurfacing asphaltic roadway surfaces. To include all work utilizing laydown machine, motor grader or other approved equipment to level or resurface continuous areas of one-quarter mile length or greater.

417 Concrete Paving Repair

All charges including labor, equipment and materials used in repair of concrete paving. To include mudjacking, undersealing and repair of concrete median and concrete curb and gutter.

418 Crack Sealing

All charges including labor, equipment and materials used in filling or sealing roadway surface cracks.

421 Oil Surface Modification

All charges including labor, equipment and materials used in reconditioning asphaltic surfaces. to include repaver operations, deslicking, discing, scarifying, tear-up, reprocessing and relaying.

422 Black Seal

All charges including labor, equipment and materials used in applying a black seal to the roadway surface. The term "black seal" refers to work in which a cover aggregate is not used. Any approved asphaltic or speciality product may be used.

423 Aggregate Seal

All charges including labor, equipment and materials used in applying an aggregate seal. To include cover aggregates such as sand-gravel, chips, sand and scoria.

424 Plant Mix Seal

All charges including labor, equipment and materials used in applying a plant mix seal.

425 Base Repair

All charges including labor, equipment and materials used in repairing the base. To include stabilizing bases by additives, rebasing or grade raising and realignment, digging out and replacing large areas of base or subbase failures using equipment.

429 Other

All charges including labor, equipment, and materials used in cleaning railroad crossings, reshaping gravel surfaces, sidewalk repair and any other work that pertains to the roadway surface not chargeable to another function..

SHOULDERS & SIDE APPROACHES

441 Shoulder Seal

All charges including labor, equipment and materials used in applying a seal to the edge of the mat or the roadway shoulder.

442 Shoulders

All charges including labor, equipment and materials used in maintaining and widening shoulders. To include blading, shaping and widening new or existing shoulders.

443 Approaches

All charges including labor, equipment and materials used in removing, repairing and constructing approaches, mail box turnouts, median crossovers and other specialized widening. (i.e. scenic turnouts, snowmobile widening).

ROADSIDE AND LANDSCAPE

451 Mechanical Vegetation Control

All charges including labor and equipment used in mechanical mowing. Does not include cutting of trees and brush or the removal of tree stumps.

453 Chemical Vegetation Control

All charges including labor, equipment and materials used in the chemical control of vegetation.

455 Litter Control

All charges including labor, equipment and materials used in gathering litter and trash from the R/W and road surface to include: removing dead stock, removing and clearing wrecks, removing weeds from R/W fence, cutting brush or trees, removal of tree stumps or brush from the R/W and cleaning curbs and gutters on urban roadway sections (outside corporate limits, towns over 1,500 population).

457 Fences

All charges including labor, equipment and materials used in removal, replacement and repair of fences.

DRAINAGE

461 Slides

All charges including labor, equipment and materials used in slide removal and correction. Removal of loose rock from the roadway.

462 Irrigation and Drainage

All charges including labor, equipment and materials used in constructing, cleaning and maintaining roadside ditches, drainage and irrigation channels. The maintenance of all structures not considered a bridge, excluding stock structures. To include cleaning, repairing, replacing, thawing, and new installations of underdrains, siphons, pipe and box culverts.

464 Miscellaneous Structures

All charges including labor, equipment and materials used in maintaining miscellaneous structures, to include stockpasses, cattleguards, headgates, diversion boxes, cribbing, binwalls and other structures of similar nature.

468 Erosion Repair and Control

All charges including labor, equipment and materials used in erosion repair or control. To include repair, replacing or constructing dikes, rundowns, embankment protectors, rip-rap. jute mesh and other erosion controlling devices.

STRUCTURES

481 Structures

All charges including labor, equipment and materials used in the repair, maintenance and operation of structures. To include bridges, overhead sign structures, pedestrian crossing, overhead grade separations and other structures that are considered a bridge and do not fall under "Miscellaneous Structures".

482 Tunnels

All charges including labor, equipment and materials incurred in the physical maintenance of tunnels portal to portal, excluding lighting, signals or electric warning systems.

SNOW, ICE, SAND CONTROL AND REMOVAL

512 Snow, ice and Sand Control

All charges including labor, equipment and materials used in snow, ice and sand removal. To include removal of snow and ice, snow and ice removal to open waterways and snow and ice sanding.

513 Snow Fence Maintenance

All charges including labor, equipment and materials used in the erection, removal and replacement of snow fence, or facilities for the prevention of the accumulation of snow,ice or sand on the roadway.

514 Avalanche Control

All charges including labor, equipment and materials used to induce controlled snow slides. Includes firing of the howitzer and reporting. Does not include snow removal or clearing operations created by firing operations.

515 Road Closure

All charges including labor, equipment and materials used in setting up, manning and removing roadblocks.

TRAFFIC SERVICES

531 Traffic Lane and Guide Line Holding Account

All charges including labor, equipment and materials, to report striping costs which are not readily charged to a maintenance section, a construction project, a work order, an APE, an ARS or an SMP. In addition, this account will be used to report ALL PERSONAL EXPENSES incurred in the maintenance striping work under account 533. No personal expenses that are incurred when striping work is done on a construction project, ARS, etc., will be charged to account 531. (When reporting time, equipment,materials and personal expense charges to account 531, county-route and mileposts do not need to be shown.)

533 Traffic Lane and Guide Line Painting

All charges including labor, equipment and materials to report all maintenance striping costs, except personal expenses, that can readily be charged to county-route and mileposts. Striping work done on construction projects, work orders, APE's ARS's and SMP's are not to be charged to account 533. (When reporting time, equipment and material charges to account 533, county-route and mileposts are to be shown.)

541 New Signs

All charges including labor, equipment and materials used for placing any new signs and posts. This account is to be used for original installation and not replacement.

542 Sign Replacement

All charges including labor, equipment and materials used for replacing signs due to normal wear and tear, vandalism, damage by motor vehicles, snow plows, etc.

545 Delineators

All charges including labor, equipment and materials used for setting, removing, replacing old or new posts and placing, removing or rejuvenating old or new delineator tabs or buttons. This also includes snow pole maintenance.

546 Guardrail

All charges including labor, equipment and materials used for removing, resetting, repairing guardrails and posts or installing new guardrail. To include repairing or replacing barrier fence.

547 Lighting

All charges including labor, equipment, materials and power used for highway and tunnel lighting. To include electric warning systems.

548 Traffic Signals and Flashing Beacons

All charges including labor, equipment, materials and power used for traffic signals and flashing beacons.

549 Special Signing and Delineating Materials

All charges for the following materials ONLY at the time of purchase to include: posts, delineators, sign bolts, nuts and washers, thermoplastic tape.

REST AREAS AND PARKS

557 Lighting

TO BE USED BY TRAFFIC OPERATIONS PERSONNEL ONLY. All charges including labor, equipment and materials. To include electric warning systems.

558 Traffic Signals and Flashing Beacons

TO BE USED BY TRAFFIC OPERATIONS PERSONNEL ONLY. All charges including labor, equipment and materials.

571 Roadside Parks

All charges including labor, equipment and materials for the cleaning, repair and general maintenance of the grounds and structures of roadside parks, rest areas and other landscaped areas.

572 Rest Areas and Parks

TO BE USED BY TRAFFIC OPERATIONS PERSONNEL ONLY. All charges including labor, equipment and materials for the cleaning, repair and general maintenance of the grounds and structures of roadside parks, rest areas and other landscaped areas.

MAINTENANCE HOUSES

591 Operation and Repair to Maintenance Houses

All charges including labor, equipment and materials used in the operation or repair of houses owned by the Department at various maintenance stations. (Charges are to be divided between the Road Sections maintained by the Crew occupying the houses at the station.)

GENERAL

920 Oil Mix Processing

The processing and mixing of aggregates and bituminous materials by any method.

920 Screening Aggregate

All charges including labor, equipment and royalty when screening materials.

920 Material Stockpile Transfer

All labor and equipment charges incurred when hauling material with equipment to include: moving material from one stockpile to another, laying material and stockpiling at new locations, etc.

920 Salt, Chloride and Aggregate Mixing

The processing and mixing of aggregates and salt and/or chlorides by any method.

FORM M-17
REV. OCT 72

Figure I-1. WYOMING STATE HIGHWAY DEPARTMENT
MAINTENANCE ACTIVITY RECORD

DISTRICT _____ MAINTENANCE STATION _____

1,0	CREW	D (DISTRICT) R (REGULAR)	FUNCTION	JOB NO. MAINT. SECTION	BEGIN MILEPOST	END MILEPOST	LAST DATE REPORTED THIS SHEET MO. DY. YR.

LABOR USED

	SAT.	SUN.	MON.	TUE.	WED.	THU.	FRI.		REMARKS
TOTAL NUMBER OF MEN USED ON THIS FUNCTION								TOTAL	
TOTAL HOURS OF MONTHLY EMPLOYEES									
TOTAL HOURS OF HOURLY EMPLOYEES									
TOTAL									

2,0 EQUIPMENT USED

EQUIP. NO.	SAT.	SUN.	MON.	TUE.	WED.	THU.	FRI.	TOTAL	EQUIP. NO.	RATE	SAT.	SUN.	MON.	TUE.	WED.	HU.	FRI.	TOTAL
	HOURS (OR MILES)										HOURS (OR MILES)							

3,0 MATERIAL USED

SITE	INVENTORY NO.	UNIT	SAT.	SUN.	MON.	TUE.	WED.	THU.	FRI.	TOTAL	REMARKS
			QUANTITY								

PREPARED BY:

4,0 RECORD OF ACCOMPLISHMENT

UNIT OF MEASUREMENT	QUANTITY							TOTAL	SITE	RECEIVING S.P.	UNIT
										S,P	T,N
										S,P	T,N

CERTIFIED CORRECT BY

5,0 PLANNED ACCOMPLISHMENT

Figure I-2. Maintenance Report MR-5.

WYOMING HIGHWAY DEPARTMENT * * * CONSTRUCTION AND MAINTENANCE DIVISION * * * REPORT NO. MR- 5 DATE 03/25/75
DISTRICT 5 MAINTENANCE EXPENDITURES PAGE 5-256

CREW = 532 LOC = DUBC PERIOD JUL 1,1974 THRU FEB 28,1975

SECT. FCT	DESCRIPTION	MAN HRS	MAN-HR/UNIT ACT.	MAN-HR/UNIT STD.	WORK UNITS ACCOMP	WORK UNITS PLAN	COST PER UNIT ACTUAL	COST PER UNIT PLANNED	EXPENDITURES 02/01/75 02/28/75	EXPENDITURES 07/01/7[illegible] 02/28/7[illegible]	BUDGET	BALAN[illegible]
* * * * * COUNTY ROUTE = FR03 FROM MILEPOST 26.75 TO MILEPOST 98.86 = 72.10 CL-MILES * * * * *												
FR03A 411	HAND PATCHING	24	2.40	4.00	10.0	280	$35.60	$55.000	$0	$[illegible]6	$15,400	$15,044
412	EQUIPMENT PATCHING	286	0.46	0.62	620.0	1300	$15.97	$18.750	$0	$9,[illegible]4	$24,375	$14.471
413	EQUIPMENT LEVELING	996	0.33	0.25	3012.9	900	$14.80	$13.126	$0	$44,[illegible]0	$11,813	$32,777-
423	AGGREGATE SEAL	1486	3.36	2.00	442.6	227	$143.40	$116.115	$0	$63,[illegible]1	$26,358	$37,113-
429	OTHER	0	0.00	1.00	0.0	110	$0.00	$10.000	$0	[illegible]0	$1,100	$1,100
	TOTAL SURFACE MAINTENANCE	2,792<- - -						- - ->	$0	$118,[illegible]1	$79,046	$39,275-
FR03A 441	SHOULDER SEAL	72	4.09	2.24	17.6	0	$134.72	$0.000	$0	$2,[illegible]1	$0	$2,371-
442	SHOULDERS	484	1.01	1.00	480.0	350	$10.26	$15.000	$0	$4,[illegible]3	$5,250	$327
	TOTAL SHOULDER & SIDE APPROACH	556<- - -						- - ->	$0	$7,[illegible]4	$5,250	$2,044-
FR03A 451	MECH. VEG. CONTROL	144	1.06	0.55	136.3	400	$12.85	$7.500	$0	$1,[illegible]2	$3,000	$1,248
453	CHEM. VEG. CONTROL	0	0.00	0.45	0.0	32	$0.00	$42.000	$0	$[illegible]2	$1,344	$812
455	LITTER CONTROL	488	1.00	1.00	488.0	265	$7.63	$8.498	$0	$3,[illegible]2	$2,252	$1,470-
457	FENCES	226	0.92	1.00	246.0	17	$8.54	$47.118	$833	$2,[illegible]1	$801	$1,300-
	TOTAL ROADSIDE AND LANDSCAPE	858<- - -						- - ->	$833	$8,[illegible]7	$7,397	$710-
FR03A 461	SLIDES	8	1.00	1.00	8.0	800	$18.00	$9.500	$0	$1[illegible]4	$7,600	$7,456
462	IRRIGATION AND DRAINAGE	296	1.00	1.00	296.0	516	$13.71	$10.500	$0	$4,[illegible]7	$5,418	$1,361
464	MISCELLANEOUS STRUCTURES	0	0.00	1.00	0.0	71	$0.00	$10.507	$0	0	$746	$746
468	EROSION REPAIR & CONTROL	0	0.00	1.00	0.0	47	$0.00	$11.511	$0	0	$541	$541
	TOTAL DRAINAGE	304<- - -						- - ->	$0	$4,[illegible]1	$14,305	$10,104
FR03A 481	STRUCTURES	16	1.00	1.00	16.0	140	$9.69	$11.500	$0	$1[illegible]5	$1,610	$1,455
	TOTAL STRUCTURES	16<- - -						- - ->	$0	$1[illegible]5	$1,610	$1,455
FR03A 533	LANE & GUIDE PAINTING	356	1.00	1.00	356.0	72	$13.78	$72.931	$0	$4,[illegible]6	$5,251	$345
541	NEW SIGNS	0	0.00	0.00	0.0	6	$0.00	$100.000	$0	$3[illegible]0	$600	$300
542	SIGN REPLACEMENT	16	16.00	0.00	1.0	28	$137.00	$50.000	$98	$1[illegible]7	$1,400	$1,263
545	DELINEATORS	48	0.41	0.15	116.0	800	$3.92	$1.500	$0	$4[illegible]5	$1,200	$745
546	GUARDRAIL	0	0.00	0.24	0.0	100	$0.00	$2.500	$0	0	$250	$250
	TOTAL TRAFFIC SERVICES	420<- - -						- - ->	$98	$5,[illegible]8	$6,701	$2,903
FR03A 571	ROADSIDE PARKS	0	0.00	1.00	0.0	40	$0.00	$47.000	$0	$1,[illegible]0	$1,880	$880

Figure I-2. Continued

WYOMING HIGHWAY DEPARTMENT — * * * CONSTRUCTION AND MAINTENANCE DIVISION * * * — REPORT NO MR- 5 — DATE 03/25/75
DISTRICT 5 — MAINTENANCE EXPENDITURES — PAGE 5-297

CREW = 532 LOC = DUBO — PERIOD JUL 1,1974 THRU FEB 28,1975

SECT. FCT	DESCRIPTION	MAN HRS	MAN-HR/UNIT ACT.	MAN-HR/UNIT STD.	WORK UNITS ACCOMP	WORK UNITS PLAN	COST PER UNIT ACTUAL	COST PER UNIT PLANNED	EXPENDITURES 02/01/75 02/28/75	EXPENDITURES C7/01/7 C2/28/7	BUDGET	BALANCE
TOTAL REST AREAS AND PARKS		0							$0	$1, CO	$1,88C	$88C
FR03A	SECTION TOTALS	4,946							$931	$144, 76	$118,185	$26,687-
* * * * * COUNTY ROUTE = TE03 FROM MILEPOST 2.2C TO MILEPOST 26.75 = 24.55 CL-MILES * * * * *												
TE03	411 HAND PATCHING	24	3.00	4.CC	8.0	145	$42.50	$55.000	$0	$ 40	$7,575	$7,635
	412 EQUIPMENT PATCHING	224	0.72	0.62	310.0	350	$16.80	$18.751	$0	$5, 28	$6,563	$1,355
	429 CTHER	0	C.00	1.CC	C.0	40	$0.00	$10.000	$0	$0	$4CC	$400
TOTAL SURFACE MAINTENANCE		248							$0	$5, 48	$14,538	$9,390
TE03	441 SHOULDER SEAL	20	C.71	2.24	28.2	0	$91.03	$0.000	$0	$2, 57	$C	$2,567-
TOTAL SHOULDER & SIDE APPROACH		20							$0	$2, 57	$C	$2,567-
TE03	453 CHEM. VEG. CONTROL	0	C.00	0.45	0.0	8	$0.00	$42.000	$0	$ 17	$336	$199
	455 LITTER CONTROL	0	0.00	1.00	0.0	28	$0.00	$8.500	$0	10	$238	$238
	457 FENCES	371	1.01	1.CC	368.0	5	$7.26	$5C.400	$0	$2, 13	$252	$2,421-
TOTAL ROADSIDE AND LANDSCAPE		371							$0	$2, 0	$826	$1,584-
TE03	461 SLIDES	90	C.94	1.00	96.0	1000	$12.36	$9.500	$0	$1, 17	$9,500	$8,313
	462 IRRIGATION AND DRAINAGE	380	1.01	1.00	376.0	70	$10.83	$10.500	$0	$4, 1	$735	$3,336-
	468 EROSION REPAIR & CONTROL	16	1.00	1.CC	16.0	16	$16.63	$11.500	$0	$ 6	$184	$82-
TOTAL DRAINAGE		486							$0	$5, 4	$10,419	$4,895
TE03	533 LANE & GUIDE PAINTING	60	1.00	1.CC	60.0	24	$31.65	$74.708	$0	$1, 9	$1,793	$106-
	541 NEW SIGNS	16	4.00	0.00	4.0	2	$61.50	$100.000	$0	$ 6	$200	$46-
	542 SIGN REPLACEMENT	48	16.CC	C.CC	3.0	12	$159.33	$50.000	$0	$ 8	$60C	$122
	545 DELINEATORS	0	C.00	0.15	0.0	160	$0.00	$1.500	$0	0	$240	$24C
TOTAL TRAFFIC SERVICES		124							$0	$2, 3	$2,833	$21C
TE03	SECTION TOTALS	1,249							$0	$19,C 2	$29,016	$9,544
DUBO CREW NO. 532 TOTALS		6,195							$931	$163,9 8	$147,205	$16,743-

Figure I-3. Maintenance Report MR-6A.

WYOMING HIGHWAY DEPARTMENT — * * * CONSTRUCTION AND MAINTENANCE DIVISION * * * — REPORT NO MR-6A — DATE 03/25/75
DISTRICT 5 — MAINTENANCE EXPENDITURES — PAGE 5

PERIOD JUL 1,1974 THRU FEB 28,1975

MAINT.STA.	BUDGET	EXPENDITURES 02/01/75 02/28/75	EXPENDITURES 07/01/74 02/28/75	BALANCE	% EXPEND
BASI CREW NO. 530	$146,978	$3,053	$67,979	$78,999	46.2%
CODY CREW NO. 531	$171,182	$2,151	$108,223	$62,959	63.2%
DUBO CREW NO. 532	$147,205	$931	$163,948	$16,743-	111.3%
LAND CREW NO. 533	$211,626	$7,832	$167,306	$44,320	79.0%
LOVE CREW NO. 534	$205,863	$5,305	$98,041	$107,822	47.6%
MEET CREW NO. 535	$44,909	$4,493	$46,966	$2,057-	104.5%
SHOS CREW NO. 536	$166,160	$5,410	$85,053	$81,107	51.1%
SOPA CREW NO. 537	$64,442	$400	$74,292	$9,850-	115.2%
TENS CREW NO. 538	$70,326	$1,453	$41,178	$29,148	58.5%
THER CREW NO. 539	$128,574	$3,582	$51,535	$87,039	37.1%
WORL CREW NO. 540	$117,834	$4,667	$111,645	$6,189	94.7%
SUB TOTAL	$1,465,099	$39,477	$1,016,166	$468,933	68.4%
INTL	$0	$0	$0	$0	0.0%
PRI2	$0	$30,810	$150,564	$150,564-	0.0%
SEC2	$0	$25,192	$84,686	$84,686-	0.0%
SUB TOTAL	$0	$56,002	$235,250	$235,250-	0.0%
TOTAL	$1,465,099	$95,479	$1,251,416	$233,683	84.2%

Figure I-4. Maintenance Report MR-6B.

WYOMING HIGHWAY DEPARTMENT — * * * CONSTRUCTION AND MAINTENANCE DIVISION * * * — REPORT NO MR-6B — DATE 03/25/75

STATE — MAINTENANCE EXPENDITURES — PAGE - 1

PERIOD JUL 1,1974 THRU FEB 28,1975

DIST	BUDGET	EXPENDITURES 02/01/75 02/28/75	EXPENDITURES 07/01/74 02/28/75	BALANCE	% EXPEND
1	$2,026,300	$94,749	$1,299,686	$726,614	64.1%
2	$2,166,057	$48,903	$1,107,943	$1,058,114	51.1%
3	$1,991,530	$26,162	$1,212,125	$779,405	60.8%
4	$1,585,135	$37,198	$1,098,132	$487,007	69.2%
5	$1,485,099	$39,477	$1,016,166	$468,933	68.4%
SUB TOTAL	$9,254,125	$246,489	$5,734,052	$3,520,073	61.9%
INT1 SNOW REMOVAL AND CONTROL					
1	$0	$33,545	$151,367	$151,367-	0.0%
2	$0	$15,250	$71,565	$71,565-	0.0%
3	$0	$51,217	$167,144	$167,144-	0.0%
4	$0	$15,128	$64,700	$64,700-	0.0%
SUB TOTAL	$0	$115,144	$455,176	$455,176-	0.0%
PRI2 SNOW REMOVAL AND CONTROL					
1	$0	$14,262	$48,991	$48,991-	0.0%
2	$0	$25,581	$117,256	$117,256-	0.0%
3	$0	$48,979	$205,544	$205,544-	0.0%
4	$0	$19,124	$81,254	$81,254-	0.0%
5	$0	$30,810	$150,564	$150,564-	0.0%
SUB TOTAL	$0	$138,756	$603,609	$603,609-	0.0%
SEC2 SNOW REMOVAL AND CONTROL					
1	$0	$42,212	$121,487	$121,487-	0.0%
2	$0	$8,125	$25,410	$25,410-	0.0%
3	$0	$19,458	$92,519	$92,519-	0.0%
4	$0	$15,688	$68,601	$68,601-	0.0%
5	$0	$25,192	$84,686	$84,686-	0.0%
SUB TOTAL	$0	$110,675	$392,703	$392,703-	0.0%
TOTAL	$9,254,125	$611,064	$7,185,540	$2,068,585	77.6%

Figure I-4. Continued

WYOMING HIGHWAY DEPARTMENT * * * CONSTRUCTION AND MAINTENANCE DIVISION * * * REPORT NO. MR-6B DATE 03/2:/75
STATE MAINTENANCE EXPENDITURES PAGE 2

PERIOD JUL 1,1974 THRU FEB 28,1975

DIST	BUDGET	EXPENDITURES 02/01/75 02/28/75	EXPENDITURES 07/01/74 02/28/75	BALANCE	% EXPEND
SNOW AND ICE CONTROL CHARGED TO MAINTENANCE SECTIONS					
TOTAL 1	$627,935	$121,196	$353,781	$274,154	56.3%
TOTAL 2	$61,890	$31,277	$85,881	$23,991-	138.7%
TOTAL 3	$94,160	$4,526	$51,422	$42,738	54.6%
TOTAL 4	$54,400	$17,502	$76,433	$22,033-	140.5%
TOTAL 5	$2,640	$17	$889	$1,751	33.6%
TOTAL	$841,025	$174,518	$568,406	$272,619	67.5%

APPENDIX J

HAWAII HIGHWAYS DIVISION

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 832,000 residents of Hawaii operate 477,780 motor vehicles on 3,530 miles of highways of which 880 miles are under state control. The state occupies 6,450 square miles from sea level to an elevation of 13,796 feet above sea level. Mean minimum and maximum temperatures are 63 and 86°F with average annual moisture from 10 to 450 inches.

The Hawaii Highways Division has a $10,000,000 maintenance budget. This budget will be used by its 4 districts to maintain 883 center line miles. The Oahu District, which is the largest district, has a district maintenance engineer and a maintenance superintendent at the district level. Foremen act as crew supervisors. In the remaining three districts a maintenance superintendent is in responsible charge of maintenance. In general foremen report to the district maintenance engineer or the superintendent who in turn reports to the district engineer. The administration of the maintenance program by the Chief of the Hawaii Highways Division is performed at the central office level by the Assistant Chief for Construction and Maintenance.

The basic maintenance recording and reporting system was implemented in 1969. A parallel recording system is being utilized although plans have been made to extensively revise the maintenance

management system. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Hawaii Highways Division Form DOT.4-127, "Daily Maintenance Report" is utilized to collect maintenance activity information (Figure J-1). The type of information obtained on this form includes;

1. Activity performed
2. Location activity performed
3. Manpower utilization
4. Equipment utilization
5. Material utilization and
6. Accomplishments

Details are presented below.

Location

Each maintenance activity is performed at a specific location on the highway system. The location is identified by a charge code assigned to the road maintenance section. The charge code also can be utilized to indicate a particular project, piece of equipment, or administrative activity. The charge code is recorded on the Daily Maintenance Report.

Activity

Maintenance function codes are utilized to designate the activity performed. These 36 cost codes were obtained from the AASHO Maintenance Guide. Groups of these function codes include roadway, roadside, structures, traffic services, landscaping and others (storm damage, vehicle damage, trench repairs and engineering services).

To amplify function codes, object codes are utilized. Examples of these object codes are shown below;

2975 - Redistributed Labor Cost

3252 - Gas or Vehicle Fuel

4111 - Private Car Mileage

4209 - Freight and Delivery Charges

4530 - Rental - Motor Vehicles, etc.

Maintenance function codes and object codes are utilized to assign costs for labor, equipment and materials.

Basically the functional code indicates the purpose for which the expenditure is made and the specific activity or type of work performed to accomplish this purpose, while the object code refers to the commodity or service obtained from a specific expenditure. It indicates what kind of expense is being incurred (i.e., salaries, materials, contractual services, etc.). The object codes are grouped by character of expenditure.

It should be noted that a special function code exists for portland cement concrete repair as opposed to bituminous surfaced roadways.

Manpower

Manpower utilized for a particular function is recorded by the crew foreman for the entire crew. The employee's name is recorded together with the hours worked on a particular function. Employees on temporary assignment, employees on leave and overtime work is recorded on the Daily Maintenance Report. The total time worked is reported to the nearest hour daily.

Equipment

Equipment utilized for a particular function is recorded. Each item of equipment is designated by an equipment charge code. The operator's name is recorded together with the mileage or hours utilized depending upon the type of equipment. Each piece of equipment has a unique number. Mileage of hours of equipment usage are reported to the nearest mile or hour.

Rental equipment is designated by the charge code.

Materials

Materials utilized for a particular function and charge code are recorded. The material utilized is designated by name and not code. Established standard material usage quantities are designated and quantities are recorded in these units.

Accomplishments

Accomplishments are reported indirectly by recording the materials utilized.

COLLECTION AND PROCESSING OF RECORDED DATA

The Daily Maintenance Report is filled out daily by the foreman of the crew and submitted by the foreman daily to the maintenance superintendent. Every two weeks these forms are submitted to the central office. Monthly reports are prepared and are returned to the district about 2 months after the end of the reporting period.

REPORTS

Several reports are produced from the collected data.

Expense Summary. The expense summary report is a basic management report. Expenses for the reporting month and year-to-date

expenses are reported by district for each charge, function, and object code. An example of this report is shown on Figure J-2.

Another expense summary report is produced for each road maintenance section identified by charge code and listing expenditure by functions.

Both reports show the expenses for the reporting month and year-to-date expenses.

Planned and accomplished programs are compared on this report by control and section and function code. The planned program is developed by the foremen with assistance from the superintendent.

Reports are utilized for fiscal control, for monitoring program execution by comparing planned and accomplished work units and for budget preparation.

Presently maintenance function activities that appear to be contrary to planned budgets due to productivity problems or poor planning must be located by detailed review of the reports. Exception reports are presently not a part of the reporting system.

OTHER ITEMS

The Hawaii Highways Division is satisfied with the accuracy of the reporting system with the exception of equipment data. The recording system utilizes foreman to record information rather than the individiual maintenance employee. It is believed that this approach improves the reliability of the information.

The recording and reporting system can be altered by direction of the central office maintenance staff as the need arises.

The central office staff meets with the district superintendent every 4 months to review problems with the management system. The state is presently considering extensive revision in their maintenance management program. Maintenance crews remain together to perform all types of maintenance activities.

DOT 4-127
(HWY-LM 3/66)

Figure J-1: Daily Maintenance Report

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

DAILY MAINTENANCE REPORT

District ____________ Date [illegible] 10, 197[illegible]

LABOR	C/C	5170				
NAME OF EMPLOYEE	Func. V / S	HOURS 3413	HOURS	HOURS	HOURS	HOURS
C Bajal[illegible]		8				
M Bustillo		8				
J Yama[illegible]		8				
D Wilson		8				
K Sakai		8				
K Cummings		8				
D Alores		8				

EQUIPMENT USED

EQUIPMENT CHARGE CODE	OPERATOR	BEGIN MILEAGE	END MILEAGE	M/D (Charge Code 5170, Function 3413)	M/D	M/D	M/D	M/D
7438	Bajal[illegible]	12[illegible]	12[illegible]5	20				
7242	Sakai	78465	[illegible]87[illegible]	8				
7453	Yama[illegible]	7456	77[illegible]	8				
7212	Cummings	50[illegible]	50.581	6				
7238	Bustillo	[illegible]		6				

MATERIALS

LIST OF ITEMS	UNIT PRICE	QTY (Charge Code 5170, Function 3413)	AMT	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
3.99 Tons of [illegible] 5 mil		3.99									
10 gal S/S1 [illegible]		10									

Attach outside purchase and warehouse issue tags to time sheets.

TEMPORARY ASSIGNMENT

EMPLOYEE ON TEMPORARY ASSIGNMENT	EMPLOYEE ON LEAVE	EQUIP. USED (IF ANY)	HOURS	REASON FOR TEMPORARY ASSIGNMENT
	None			

USE BACK OF SHEET FOR REMARKS

C Bajal[illegible] (signature)
Foreman

[illegible] (signature)
Mtnce. Supt.

Figure J-2.

REPORT NO. HWY-250 PREP. 09/16/74 EXPENSE SUMMARY - FUNCTION BY OBJECT JUNE 1974 P. 17

FUNC CODE	OBJ CODE	DESCRIPTION	THIS MONTH	YEAR TO-DATE	
2 410					
	2875	REDISTRIBUTED LABOR COST-DR	.00	4.79	
		FUNCTION TOTAL	.00	4.79	*
411		BITUMINOUS SURFACE TREATMENT			
	2875	REDISTRIBUTED LABOR COST-DR	.00	6,891.14	
	3340	HWY CON & MAINT MATRLS & SUPP	.00	1,511.92	
	5505	EQUIPMENT USE CHARGE-DEBIT	.00	2,420.32	
		FUNCTION TOTAL	.00	10,823.38	*
412		ASPHALT MACADAM			
	2875	REDISTRIBUTED LABOR COST-DR	2,690.62	59,261.93	
	3340	HWY CON & MAINT MATRLS & SUPP	3,208.53	19,482.21	
	5505	EQUIPMENT USE CHARGE-DEBIT	440.90	14,773.15	
		FUNCTION TOTAL	6,340.05	93,517.29	*
413		ASPHALT CONCRETE			
	2875	REDISTRIBUTED LABOR COST-DR	7,493.96	113,992.77	
	3252	GASOR VEHICLE FUEL	.00	1.94	
	3270	FUEL, OIL & LUBS (EXCEPT M/V)	.00	1.24	
	3340	HWY CON & MAINT MATRLS & SUPP	6,012.37	89,020.05	
	4111	PRIVATE CAR MILEAGE	.00	3.12	
	4209	FREIGHT & DELIVERY CHARGES	.00	3.15	
	4530	RENTAL-MOTORTVEHICLESM&NEUPT	.00	3,726.24	
	5505	EQUIPMENT USE CHARGE-DEBIT	1,831.54	27,828.55	
		FUNCTION TOTAL	15,337.87	234,577.06	*
414		PORTLAND CEMENT CONCRETE			
	2875	REDISTRIBUTED LABOR COST-DR	.00	25.52	
		FUNCTION TOTAL	.00	25.52	*
415					
	2875	REDISTRIBUTED LABOR COST-DR	.00	49.47	
	3340	HWY CON & MAINT MATRLS & SUPP	.00	298.80	
		FUNCTION TOTAL	.00	348.27	*
418					
	2875	REDISTRIBUTED LABOR COST-DR	.00	48.1	
		FUNCTION TOTAL	.00	48.1	*
419		OTHERS			
	2875	REDISTRIBUTED LABOR COST-DR	.00	346.6	

APPENDIX K

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION'S

Recording and Reporting Methods for Highway Maintenance Expenditures

INTRODUCTION

The 11,793,909 residents of Pennsylvania operate 6,800,000 motor vehicles on 115,167 miles of highways of which 44,700 miles (75,559 lane miles) are under state control. The state occupies 45,333 square miles from sea level to an elevation of 3,213 feet above sea level. Mean minimum and maximum temperatures are 14 and 88°F with average annual moisture ranging from 36 to 52 inches.

The Pennsylvania Department of Transportation has a 201,000,000 maintenance budget for 1976-1977. This budget will be utilized by its 67 maintenance districts to maintain 75,559 lane miles of highway. These maintenance districts are located within counties. (The state utilizes a system of 11 engineering districts to administer its construction program.)

Superintendents are in responsible charge of the maintenance district. Assistant superintendents, foreman and laborers comprise the remaining members of the district personnel. The eleven engineering district's maintenance staff review operations and provide direction to the 67 maintenance districts. The engineering districts play an important role in implementing management policies.

The present recording and reporting system was developed in-house with the assistance of an outside consultant. The present system was described in a prepared manual in 1972. Presently this

system is about 50 percent implemented. The maintenance management system makes use of information collected for accounting purposes, thus a single recording system is utilized. A manual recording system is being utilized in the field with electronic data processing utilized to compile and produce the reports.

RECORDING SYSTEM

Pennsylvania's "Crew Daily Project Time Record for Direct Labor Production and Equipment Distribution" (Form C-65C) and "Individual Daily Project Time Record for Direct Labor Production and Equipment Distribution" are the major source documents for posting employees time and expenses to a time sheet and for recording of vehicle usage (Figures K-1 and K-2). The foreman completes the "Crew Daily Project Time Record" for all members of his crew that are not specifically assigned to a piece of equipment. Individual equipment operators fill out the "Individual Daily Project Time Record." All recording forms are reviewed by the foreman and the superintendent or assistant superintendent. The information recorded on these forms is coded onto a tape cassette the day following the recording of the information and transmitted to the central office (i.e., work performed Monday is coded onto tape Tuesday and transmitted Tuesday night). Error messages, if any, will be received by the maintenance district office on the morning after transmission.

Information recorded on the Individual and Crew Daily Project Time Record includes the following:

1. Employee's name and Social Security number
2. Activity performed
3. District, County and Foreman number
4. Man-hours, equipment hours and/or equipment miles
5. Equipment designation and
6. Productivity

The report on work and equipment does not indicate the highway route or segment of roadway where the work was performed. Man-hours are recorded by activity to the nearest 0.5 hours. Two hundred eighteen maintenance activities are identified by a 8 digit numeric code. Special codes exist for portland cement concrete pavement repair.

Productivity is reported in untis such as tons, feet, man-hours, etc. depending on the activity. When reporting production the production hours (referred to as Produciton Activity Hours by Penn DOT) are equal to the Project Hours minus the Support Hours. Support Hours include time devoted to items such as travel, safety, equipment breakdown, hauling of material, etc.

Equipment usage is recorded by individual piece of equipment and assigned to a specific activity. Entries for shop and field repair can be made directly on the Crew and Individual Daily Project Time Record.

Materials reports are handled through a separate reporting system. A teletype terminal transmits data from the district to the central office. Materials are not accounted for by route or other identification point on the output reports.

REPORTS

Reports that are produced contain information desired by the districts. This system does not provide specific maintenance cost information for a particular segment or section of roadway. Reports produced include the following:

1. Highway Feature Inventory
2. Production Planning Worksheet
3. Budget Generation Worksheet
4. Annual Work Plan Worksheet
5. Department Force Program
6. Maintenance Program Summary
7. Specialized Crews Work Program
8. District Efficiency Report
9. Performance Exception Report
10. Detailed Performance Report
11. Production Performance Report - Activity
12. Expenditure Analysis Report

The reports identified by the number 1 to 7 above are basically planning and scheduling reports. The remaining reports are utilized to monitor program execution.

District Efficiency Report. This report presents information delineating the percent of plan completed, the man-hour productivity and the average unit costs for each maintenance activity by maintenance district. The current month and year-to-date totals are presented (Figure K-3).

Performance Exception Report. This report delineates the ten major productivity deviations for a given month for the 10 major activities

performed by the district maintenance crews (Figure K-4).

Detailed Performance Report. Productivity and support units for each maintenance activity are reported on a current month and fiscal year-to-date basis. These units are compared with maintenance standards (Figure K-5).

Production Performance Report. Planned and completed production units for each activity are reported for the current month and the year-to-date. Year-to-date totals are also reported for production hours, support hours and performance hours for each maintenance activity (Figure K-6).

Expenditure Analysis Report. Dollars expended are reported for manpower, materials and equipment by maintenance district and maintenance activity. Production units and unit costs for the county and the state average are also presented for each activity. Both current month and fiscal year-to-date expenditures are reported (Figure K-7).

Reports are utilized at the central office and district level for fiscal control, by reviewing budgeted and actual expenditures; for monitoring of program execution by comparing planned and accomplished production, man-hours and material quantities; for allocation of manpower by reviewing standard unit costs and productivity rates against actual costs and productivity rates; and for budget preparation to revise productivity rates, etc. based on more extensive field productivity and unit cost rates. As noted above exception reports are an integral part of the reporting system.

References

"Foremans Manual," Pennsylvania Department of Transportation, Bureau of Maintenance, Publication No. 113, January, 1975.

C-65C (10-73)

Figure K-1

CREW

DAILY PROJECT TIME RECORD

DIRECT LABOR PRODUCTION AND EQUIPMENT DISTRIBUTION

ID 65 TC | ORGN | MO. | DAY | YR | Foreman Number | PAGE | OF | PAGES

NO	NAME	SOC. SECURITY NUMBER	PAY CODE	HOURS WORKED: PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	HOURS WORKED	LEAVE TAKEN: ANN. LV	SICK LV	HOLI-DAY	Other LV	LW OP	Comp. Time Taken	Total Hours
1																
2																
3																
4																
5																
6																
7																
			TOTAL ▶							TOTAL ▶						

PROJ. NO.	STATE PROJECT NUMBER: Sys	WO or LR	Sp	Ph	Sec.	Orgn	Work Prog: Allot	Func	Pt Cd	Method	Chgd Foreman No.	MFC	PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5
1																	
2																	
3																	
4																	
5																	
											TOTAL ▶						

PRODUCTION: Activity Hours	UNITS	DESCRIPTION	Cd.	TRAVEL: Hrs	Miles	Safety Hrs	Other: Hrs	DESCRIPTION

EQUIP. NO.	DEPT. EQUIP. SERV. OR REP. (EQUIP. NO.)	SHOP REP.	FIELD REP.	ID-72 Dept. Equip. Operated (Equip. No.)	ID-67 Outside Equip. Rented (Agree. No.)	PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	TOTAL UNITS
1											
2											
3											
4											
5											
6											
7											
					TOTAL ▶						

REMARKS:

I hereby certify that the data on this report is a true and correct record of time, equipment, and service incurred or furnished for the Department of Transportation in accordance with the agreement entered into by the parties. Any overtime is hereby approved.

Foreman: Supt. Asst. Supt:

Figure K-2

C-65-I (11-74)

INDIVIDUAL
DAILY PROJECT TIME RECORD
DIRECT LABOR PRODUCTION AND EQUIPMENT DISTRIBUTION

ID 65 TI | ORGN | MO. | DAY | YR. | Foreman Number | PAGE | OF | PAGES

NO.	NAME	SOC. SECURITY NUMBER	PAY CODE	HOURS WORKED: PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	HOURS WORKED	LEAVE TAKEN: ANN. LV	SICK LV	HOLI-DAY	OTHER LV	LW OP	COMP. TIME TAKEN	TOTAL HOURS	REMARKS:
1																	

PROJ. NO.	STATE PROJECT NUMBER: SYS	WO or LR	SP	Ph	SEC.	ORGN	WORK PROG.: ALLOT	FUNC	PT. CD.	METHOD	Chgd. Foreman No.	M T C	HOURS WORKED: PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	PRODUCTION: Activity Hours	UNITS	DESCRIPTION	Cd.	TRAVEL: Hrs.	Miles	Safety Hrs.	Hrs.	OTHER DESCRIPTION	Hauling Hours	Field Approval
1																												
2																												
3																												
4																												
5																												
													TOTAL ►															

EQUIP. NO.	DEPT. EQUIP. SERV. OR REP. (EQUIP. NO.)	SHOP REP.	FIELD REP.	ID 72 DEPT. EQUIP. OPERATED (EQUIP. NO.)	ID 67 OUTSIDE EQUIP. RENTED (AGREEMENT NO.)	PROJ. NO. 1	PROJ. NO. 2	PROJ. NO. 3	PROJ. NO. 4	PROJ. NO. 5	TOTAL UNITS	CROSS OUT AM or PM NOT APPLICABLE: START	STOP	HRS.	PERSONAL STATEMENT OF WORK PERFORMED
1												AM PM	AM PM		
2												AM PM	AM PM		
3												AM PM	AM PM		
4												AM PM	AM PM		
5												AM PM	AM PM		
6												AM PM	AM PM		
7												AM PM	AM PM		
					TOTAL ►										

I hereby certify that the data on this report is a true and correct record of time, equipment, and service incurred or furnished for the Department of Transportation in accordance with the agreement entered into by the parties. Any overtime is hereby approved.

EMPLOYE SIGNATURE: | FOREMAN: | SUPT. OR ASST. SUPT.

Figure K-3

PROGRAM GEN/C670360 — H.M.M.S DISTRICT EFFICIENCY REPORT — MONTH MARCH — PAGE 41

ACTIVITY	UNIT	DESCRIPTION		PCT OF PLAN COMPLETION DISTRICT 05	COUNTY 05-1	COUNTY 05-2	COUNTY 05-3	COUNTY 05-4	COUNTY 05-5	COUNTY 05-6	COUNTY	COUNTY	COUNTY
711-125	TONS	ROADS-FLEX BASE SURF TREAT-PL MIX	CUR	------	------	------	------	------	------	------			
			YTD	124.1%	87.4%	27.0%	102.4%	100.0%	132.7%	124.5%			
711-126	TONS	ROADS-FLEX BASE BASE REPAIR	CUR	307.2%	.0%	------	141.8%	999.9%	.0%	.0%			
			YTD	162.2%	3.3%	999.9%	96.4%	999.9%	3.8%	2.8%			
711-129	MAN PRS	ROADS-FLEX BASE OTHER	CUR	.0%	------	------	------	.0%	------	------			
			YTD	364.3%	.0%	.0%	.0%	76.0%	.0%	------			
711-131	TONS	ROADS-RIG BASE PATCHING-MANUAL	CUR	46.0%	67.1%	172.1%	5.1%	25.0%	24.9%	90.3%			
			YTD	63.5%	16.0%	101.3%	39.8%	42.5%	52.1%	202.4%			
711-132	TONS	ROADS-RIG BASE PATCHING-MECH	CUR	------	------	------	------	------	------	------			
			YTD	42.4%	.0%	365.9%	.0%	6.5%	17.1%	19.1%			
711-134	GALS	ROADS-RIG BASE SURF TREAT-LIQ BIT	CUR	.0%	------	------	------	.0%	------	------			
			YTD	16.3%	------	25.3%	.0%	.0%	------	.4%			
711-135	TONS	ROADS-RIG BASE SURF TREAT-PL MIX	CUR	------	------	------	------	------	------	------			
			YTD	38.3%	------	.0%	.0%	------	.0%	36.1%			
711-136	TONS	ROADS-RIG BASE BASE/SUBBASE REP	CUR	11.9%	.0%	------	.0%	------	.0%	66.7%			
			YTD	116.5%	7.1%	999.9%	30.3%	202.6%	8.3%	251.1%			
711-137	GALS	ROADS-RIG BASE CRACK SEALING	CUR	.0%	------	------	------	------	.0%	.0%			
			YTD	118.6%	4.4%	127.9%	.0%	93.8%	182.5%	205.5%			
711-139	MAN PRS	ROADS-RIG BASE OTHER	CUR	371.4%	------	------	------	371.4%	------	------			
			YTD	999.9%	.0%	.0%	.0%	511.1%	.0%	.0%			
711-141	TONS	ROADS-RIG PAVEMENT PATCHING-MANUAL	CUR	42.6%	7.5%	560.0%	27.8%	80.0%	62.5%	.0%			
			YTD	109.2%	92.1%	131.3%	131.1%	80.9%	295.8%	13.6%			
711-142	TONS	ROADS-RIG PAVEMENT PATCHING-MECH	CUR	.0%	.0%	------	------	.0%	------	------			
			YTD	449.8%	59.1%	999.9%	361.4%	52.0%	999.9%	.0%			
711-143	SQ YDS	ROADS-RIG PAVEMENT CONCRETE PATCH	CUR	------	------	------	------	------	------	------			
			YTD	87.1%	130.1%	.0%	6.5%	.0%	.0%	123.0%			

------ MEANS THERE IS NO PLANNED PRODUCTION OR ACTUAL PRODUCTION RECORDED.
0% MEANS EITHER PLANNED PRODUCTION OR ACTUAL PRODUCTION IS NOT RECORDED.

Figure K-3 (continued)

PROGRAM GEN/CB70350 M.Y.M.S DISTRICT EFFICIENCY REPORT MONTH MARCH PAGE 42

MAN HR PRODUCTIVITY

ACTIVITY	UNIT	DESCRIPTION		DISTRICT 05	COUNTY 05-1	COUNTY 05-2	COUNTY 05-3	COUNTY 05-4	COUNTY 05-5	COUNTY 05-6	COUNTY	COUNTY	COUNTY
711-122	TONS	ROADS-FLEX BASE	CUR	5.00	.000	.000	.000	.000	5.000	.000			
		PATCHING-MECH	YTD	.68	.667	.000	.000	.258	.693	1.280			
711-12-	GALS	ROADS-FLEX BASE	CUR	.11	.000	.000	.106	.137	.168	.180			
		SURF TREAT-LIQ BI	YTD	.03	.031	.014	.040	.024	.016	.045			
711-125	TONS	ROADS-FLEX BASE	CUR	.00	.000	.000	.000	.000	.000	.000			
		SURF TREAT-PL MIX	YTD	.25	.151	.307	.352	.246	.135	.319			
711-12-	TONS	ROADS-FLEX BASE	CUR	.53	.000	.000	1.397	.467	.000	.000			
		BASE REPAIR	YTD	.61	2.750	.467	1.408	.464	6.000	3.583			
711-129	MAN HRS	ROADS-FLEX BASE	CUR	1.00	.000	.000	.000	1.000	.000	.000			
		OT-EP	YTD	1.01	1.017	1.000	1.000	1.015	1.065	.000			
711-131	TONS	ROADS-RIG BASE	CUR	4.99	3.021	3.824	4.666	6.600	3.893	6.492			
		PATCHING-MANUAL	YTD	7.13	3.695	6.045	7.345	6.934	3.722	9.226			
711-132	TONS	ROADS-RIG BASE	CUR	.00	.000	.000	.000	.000	.000	.000			
		PATCHING-MECH	YTD	.96	.000	.965	.000	1.399	.751	1.007			
711-134	GALS	ROADS-RIG BASE	CUR	.12	.000	.000	.000	.120	.000	.000			
		SURF TREAT-LIQ BI	YTD	.10	.000	.017	.405	.094	.000	.299			
711-135	TONS	ROADS-RIG BASE	CUR	.00	.000	.000	.000	.000	.000	.000			
		SURF TREAT-PL MIX	YTD	.33	.000	.335	.000	.000	.000	.334			
711-136	TONS	ROADS-RIG BASE	CUR	5.50	.000	.000	.000	.000	.000	5.500			
		BASE/SUBBASE REP	YTD	5.82	6.900	4.375	5.800	4.280	13.062	8.584			
711-137	GALS	ROADS-RIG BASE	CUR	.24	.000	.000	.000	.000	.218	.260			
		CRACK SEALING	YTD	.25	.480	.280	.000	.183	.204	.281			
711-139	MAN HRS	ROADS-RIG BASE	CUR	1.00	.000	.000	.000	1.000	.000	.000			
		OTHER	YTD	1.00	1.000	1.000	1.000	1.000	1.000	1.000			
711-141	TONS	ROADS-RIG PAVEMENT	CUR	6.09	8.333	3.607	4.400	10.500	3.933	.000			
		PATCH MANUAL	YTD	5.46	4.520	5.031	9.161	7.150	2.919	11.818			

Figure K-3 (continued)

PROGRAM GEN/C670370 — H.M.M.S. DISTRICT EFFICIENCY REPORT — MONTH MARCH — PAGE 41

ACTIVITY	UNIT	DESCRIPTION		AVERAGE UNIT COST DISTRICT 05	COUNTY 05-1	COUNTY 05-2	COUNTY 05-3	COUNTY 05-4	COUNTY 05-5	COUNTY 05-	COUNTY	COUNTY	COUNTY
711-111	TONS	ROADS-UNPAVED PATCHING	CUR	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
			YTD	$2323.00	$.00	$.00	$86.00	$.00	$.00	$. 0			
711-112	MILES	ROADS-UNPAVED SHAPING	CUR	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
			YTD	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
711-113	SQ YDS	ROADS-UNPAVED RESTABILIZATION	CUR	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
			YTD	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
711-114	SQ YDS	ROADS-UNPAVED DUST PALLIATIVE	CUR	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
			YTD	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
711-119	MAN HRS	ROADS-UNPAVED OTHER	CUR	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
			YTD	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
711-121	TONS	ROADS-FLEX BASE PATCHING-MANUAL	CUR	$79.70	$59.10	$104.58	$54.35	$66.90	$49.43	$679. 2			
			YTD	$48.65	$44.01	$37.16	$44.42	$34.62	$43.60	$91. 5			
711-122	TONS	ROADS-FLEX BASE PATCHING-MECH	CUR	$45.50	$.00	$.00	$.00	$.00	$.25	$. 0			
			YTD	$17.79	$20.46	$.00	$.00	$11.48	$24.14	$9. 0			
711-124	GALS	ROADS-FLEX BASE SURF TREAT-LIQ BI	CUR	$1.01	$.00	$.00	$.91	$.58	$1.14	$9. 0			
			YTD	$.81	$.79	$.93	$.77	$.92	$.57	$. 0			
711-125	TONS	ROADS-FLEX BASE SURF TREAT-PL MIX	CUR	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
			YTD	$16.83	$18.15	$152.83	$18.06	$14.64	$13.03	$10. 9			
711-126	TONS	ROADS-FLEX BASE BASE REPAIR	CUR	$16.09	$.00	$.00	$65.37	$11.32	$.00	$. 0			
			YTD	$7.82	$34.21	$.00	$16.03	$12.46	$113.75	$208. 9			
711-129	MAN HRS	ROADS-FLEX BASE OTHER	CUR	$8.40	$.00	$.00	$.00	$6.48	$.00	$. 0			
			YTD	$12.59	$15.93	$.51	$11.05	$10.32	$15.87	$. 0			
711-131	TONS	ROADS-RIG BASE PATCHING-MANUAL	CUR	$143.18	$51.19	$65.89	$351.00	$343.60	$84.15	$196. 0			
			YTD	$79.47	$33.13	$32.74	$89.92	$84.84	$46.25	$110. 7			
711-132	TONS	ROADS-RIG BASE PATCHING-MECH	CUR	$.00	$.00	$.00	$.00	$.00	$.00	$. 0			
			YTD	$9.01	$.00	$6.64	$.00	$45.45	$16.37	$12. 3			

REPORT R87343 — HIGHWAY MAINTENANCE MANAGEMENT SYSTEM — CUT-OFF DATE 3/31/76 — PAGE 1

Figure K-4. PERFORMANCE EXCEPTION REPORT

COUNTY LEHIGH — DISTRICT 053

TEN MAJOR ACTIVITIES YEAR - TO - DATE						TEN MAJOR DEVIATION			THIS MONTH			
			CURRENT MO		YEAR-TO-DATE				PRODUCTION		PERFORMANCE	
ACTIVITY	DESCRIPTION	UNITS	HOURS	%	HOURS	%	ACTIVITY	DESCRIPTION	UNITS	HOURS	HOURS	%
711-121	ROADS-FLEX BASE PATCHING-MANUAL	TONS	3035	94	8398	80	711-415	BRIDGE MAINT/REPR SUBSTRUCTURE	1 SITES	28	28	928
711-124	ROADS-FLEX BASE SURF TREAT-L1O BI	GALS	1853	39	5868	42	714-716	VEG MGT-TREE REM GINGUP	5 EACH	10	10	389
712-522	SNOW/ICE CONTROL APPLY ASKID/CHEM	MILES	444	107	5640	79	711-321	DRAIN REP/REPL INLET/ENDWALL	5 EACH	59	59	305
719-119	MAINT ADM-OTHER	MAN HRS	682		5595		712-523	SNOW ICE CONTROL SIMUL PLOW-SPREAD	14.9 MILES	144	144	259
711-215	SHOULDERS-UNPAVED CUTTING	MILES	676	84	4756	64	711-126	ROADS-FLEX BASE BASE REPAIR	3 TONS	113	113	201
712-519	SNOW SEASON PREP OTHER	MAN HRS	141		4383		713-621	SIGNS-CONST, DETOUR/TEMP	2 SITES	188	188	17
711-312	DRAIN CLEAN-DITCH/ DRAIN CHAN	FEET	81	53	3605	28	712-524	SNOW ICE CONTROL CLEAN UP/WIDEN	54 MILES	184	60	180
713-624	SIGNS-INSTALL/REPL ALL OTHER	SITES	390	82	3542	67	713-632	GUARDRAIL-PAINT	60 FEET	35	35	28
714-715	VEG MGMT-BRUSH& SELECT TRM/TRN	ACRES			3532	214	711-322	DRAIN REP/REPL DITCH/DRAIN CHAN	7 FEET	35	35	34
711-311	DRAIN CLEAN-INLET /ENDWALL	EACH	113	78	2823	50	711-323	DRAIN REP/REPL PIPE UNDER 36"	30 FEET	395	395	37

REPORT R87341 HIGHWAY MAINTENANCE MANAGEMENT SYSTEM CUT-OFF DATE 1/31/76 PAGE 10

Figure K-5. DETAILED PERFORMANCE REPORT

COUNTY LEHIGH ORG: 053

COST CENTER	ACTIVITY	DESCRIPTION	CURRENT MONTH (PROD OR SUPPORT	ACT-HRS	STD-HRS)	FISCAL YEAR TO DATE (PROD OR SUPPORT	ACT-HRS	STD-HRS	%)
31	711-121-01	ROADS-FLEX BASE PATCHING-HANUAL COLD MIX	194 TONS	660	720	289 TONS	1225	1072	88
		SAFETY		9			28		
		TRAVEL	502 MILES	23		952 MILES	42		
	711-124-02	ROADS-FLEX BASE SURF TREAT-LIQ BIT MECHANIZED				108220 GALS	1398	1039	74
		HAULING					555		
		OTHER					149		
		SAFETY					13		
		TRAVEL				3272 MILES	117		
	711-126-01	ROADS-FLEX BASE BASE REPAIR MECHANIZED				34 TONS	95	99	104
		HAULING					5		
		OTHER					4		
		SAFETY					1		
		TRAVEL				64 MILES	3		
	711-212-01	SHOULDERS-UNPAVED GRADING MECHANIZED	1 MILES	3	9	8 MILES	100	72	72
		SAFETY					24		
		TRAVEL	13 MILES	1		153 MILES	10		

Figure K-6. PRODUCTION PERFORMANCE REPORT - ACTIVITY

NORTHAMPTON DISTRICT 055

ACTIVITY	DESCRIPTION	UNITS	CURRENT PERIOD PRODUCTION UNITS PLANNED	CURRENT PERIOD PRODUCTION UNITS COMPLETED	CURRENT PERIOD %	TOTAL UNITS PLANNED	YEAR-TO-DATE PRODUCTION UNITS PLANNED	YEAR-TO-DATE PRODUCTION UNITS COMPLETED	YEAR-TO-DATE %	TOT PROD HOUR	YEAR-TO-DATE SUPPORT HOURS	YEAR-TO-DATE SUPPORT %	YEAR-TO-DATE PERFORMANCE HOURS	YEAR-TO-DATE PERFORMANCE %
711-121	ROADS-FLEX BASE PATCHING-MANUAL	TONS	660	481	73	4125	2640	2121	80	8 62	2939	35	8362	93
711-122	ROADS-FLEX BASE PATCHING-MECH	TONS		12		4644	3714	515	14	58	236	66	358	63
711-124	ROADS-FLEX BASE SURF TREAT-LIQ BI	GALS		1950		55932	55932	51060	91	59	517	60	859	69
711-125	ROADS-FLEX BASE SURF TREAT-PL MIX	TONS				6059	5456	7240	133	79	168	17	979	185
711-126	ROADS-FLEX BASE BASE REPAIR	TONS	35			322	210	8	4	48	37	77	48	48
711-129	ROADS-FLEX BASE OTHER	MAN HRS	UNAVAIL			UNAVAIL	UNAVAIL	46		49	49	100		
711-120	**TOTAL SUBPROGRAM									10 55	3946	37	10606	98
711-131	ROADS-RIG BASE PATCHING-MANUAL	TONS	189	47	25	1180	754	393	52	-1 63	655	45	1463	98
711-132	ROADS-RIG BASE PATCHING-MECH	TONS				1180	944	161	17	21	79	65	121	60
711-136	ROADS-RIG BASE BASE/SUBBASE REP	TONS	32			295	192	16	8	09	107	51	209	25
711-137	ROADS-RIG BASE CRACK SEALING	GALS		972		1180	1160	2132	183	37	251	57	437	122
711-139	ROADS-RIG BASE OTHER	MAN HRS	UNAVAIL			UNAVAIL	UNAVAIL	18		18	5	28		

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Figure K-7. EXPENDITURE ANALYSIS REPORT

COUNTY CARBON ORG 052

PROGRAMS AND ACTIVITIES	DESCRIPTION		DOLLARS EXPENDED PERSONNEL	CONTRACTS & SERVICES	MATERIAL	EQUIPMENT RENTED	EQUIPMENT DEPT.	TOTAL	PRODUCTION UNITS	UNIT COSTS COUNTY	UNIT COSTS STATE AVERAGE
711-111	ROADS-UNPAVED PATCHING	MONTH	21	-	-	-	-	21	0 TONS	.00	
		FYTD	21	-	2038	-	-	2059	0 TONS	.00	15.29
711-119	ROADS-UNPAVED OTHER	MONTH	-	52	-	-	-	52	0 MAN HRS	.00	
		FYTD	315	52	1897	-	59	2323	0 MAN HRS	.00	16.59
711-121	ROADS-FLEX BASE PATCHING-MANUAL	MONTH	13602	53	-	-	3108	16837	161 TONS	104.58	
		FYTD	28994	53	-	-	7069	36116	972 TONS	37.16	45.61
711-122	ROADS-FLEX BASE PATCHING-MECH	MONTH	90	-	-	-	-	90	0 TONS	.00	
		FYTD	87	-	44	-	80	211	0 TONS	.00	19.81
711-124	ROADS-FLEX BASE SURF TREAT-LIQ BI	MONTH	-	-	-	-	-	-	0 GALS	.00	
		FYTD	8000	-	38304	-	6023	52327	56146 GALS	.93	1.05
711-125	ROADS-FLEX BASE SURF TREAT-PL MIX	MONTH	-	-	2812	-	-	2812	0 TONS	.00	
		FYTD	3028	-	68726	-	996	72747	476 TONS	152.83	16.35
711-126	ROADS-FLEX BASE BASE REPAIR	MONTH	-	-	-	-	-	-	0 TONS	.00	
		FYTD	-	-	-	-	-	-	1511 TONS	.00	10.05
711-129	ROADS-FLEX BASE OTHER	MONTH	-	-	-	-	-	-	0 MAN HRS	.00	
		FYTD	15	-	50	-	-	65	128 MAN HRS	.51	10.64
711-131	ROADS-RIG BASE PATCHING-MANUAL	MONTH	4135	-	-	-	741	4876	74 TONS	65.89	
		FYTD	10121	-	-	-	3079	12899	394 TONS	32.74	58.91
711-132	ROADS-RIG BASE PATCHING-MECH	MONTH	-	-	-	-	-	-	0 TONS	.00	
		FYTD	4633	-	-	-	3145	7778	1171 TONS	6.64	21.68
711-134	ROADS-RIG BASE SURF TREAT-LIQ BI	MONTH	-	-	-	-	-	-	0 GALS	.00	
		FYTD	1068	-	-	-	468	1536	4651 GALS	.35	1.35
711-135	ROADS-RIG BASE SURF TREAT-PL MIX	MONTH	-	-	-	-	-	-	0 TONS	.00	
		FYTD	4103	-	22869	-	3736	30708	1295 TONS	23.71	17.52

APPENDIX L

MAINTENANCE ACTIVITY COST CODES

100 Base and Subgrade

110 Removal of Base and/or Subgrade

120 In Place Repair - No Stabilizer

130 In Place Repair - Stabilizers (Maintainer)

131 In Place Repair Existing Base and/or Subgrade - Add Lime
132 In Place Repair Existing Base and/or Subgrade - Add Cement
133 In Place Repair Existing Base and/or Subgrade - Add Asphalt
134 In Place Repair Existing Base and/or Subgrade - Add Sand
135 In Place Repair Existing Asphalt Stabilized Base - Add Sand

140 In Place Repair - Stabilizers (Maintainer and Mixing Machine)

141 In Place Repair Existing Base and/or Subgrade - Add Lime
142 In Place Repair Existing Base and/or Subgrade - Add Cement
143 In Place Repair Existing Base and/or Subgrade - Add Asphalt
144 In Place Repair Existing Base and/or Subgrade - Add Sand
145 In Place Repair Existing Asphalt Stabilized Base - Add Sand

150 Repair Existing Base and/or Subgrade Other Than In Place

160 Install and/or Maintain Sub-drains - All Types

200 Surfaces

210 Seal Coat

211 Aggregate Seal Coat
212 Strip or Spot Seal Coat - Major
213 Strip or Spot Seal Coat - Minor
214 Fog or Sheet Sealing

220 Leveling or Overlay

221 Spot Leveling - Blade Spread
222 Spot Leveling - Hand
223 Spot Leveling - Hot Box
224 Level-up Blade - Sections
225 Level-up Blade - Continuous
226 Overlay - Major
227 Overlay - Minor
228 Underseal

230 Improve Texture

231 Treat Bleeding Pavement - Add Aggregate
232 Treat Bleeding Pavement - Heating Aggregate
233 Treat Bleeding Pavement - Heating Pavement
234 Heater Planer Work
235 Grooving (ACP)
236 Grooving (Concrete Pavement)
237 Improve Pavement Texture - Basic (CRCP)
238 Improve Pavement Texture - Basic (RCP)

240 Rutting and Shoving

241 Repair Rutting and Shoving - Basic
242 Repair Rutting and Shoving - Trim and Overlay

250 Cracks and Joints

251 Seal Cracks and/or Joints - Major
252 Seal Cracks and/or Joints - Minor
253 Seal Cracks - Squeegee
254 Seal Cracks - Major Operation (CRCP)
255 Seal Cracks - Minor Operation (CRCP)
256 Seal Cracks - Hot Rubber (CRCP)
257 Seal Cracks - Major Operation (RCP)
258 Seal Cracks - Minor Operation (RCP)
259 Seal Cracks - Hot Rubber (RCP)

260 Potholes and Spalling

- 261 Repair Potholes - Permanent
- 262 Repair Potholes - Temporary
- 263 Repair Potholes - Hot Box
- 264 Repair Spalling - Basic (Epoxy-CRCP)
- 265 Repair Spalling - Asphaltic Concrete (CRCP)
- 266 Repair Spalling - Basic (Epoxy-RCP)
- 267 Repair Spalling - Asphaltic Concrete (RCP)

270 Edge Repairs

- 271 Edge Repairs - Basic
- 272 Edge Repairs - Box
- 273 Seal Joint Between Pavement and Shoulder - Basic (Cat Blown-CRCP)
- 274 Seal Joint Between Pavement and Shoulder - Cutback (CRCP)
- 275 Seal Joint Between Pavement and Shoulder - Basic (Cat Blown-RCP)
- 276 Seal Joint Between Pavement and Shoulder - Cutback (RCP)

280 Remove and Replace Concrete Pavement

- 281 Removing and Replacing - Basic (CRCP)
- 282 Removing and Replacing - Fast Set Cement (CRCP)
- 283 Removing and Replacing - Stabilized Base (CRCP)
- 284 Removing and Replacing - Normal Portland Cement (Minor Repairs-CRCP)
- 285 Removing and Replacing - Basic (RCP)
- 286 Removing and Replacing - Fast Set Cement (RCP)
- 287 Removing and Replacing - Stabilized Base (RCP)
- 288 Removing and Replacing - Normal Portland Cement (Minor Repairs-RCP)

290 Blow-ups, Joint and Stress Relief

- 291 Repair Blow-up - Permanent (RCP)
- 292 Repair Blow-up - Temporary (RCP)
- 293 Seal Contraction and Expansion Joints - Basic (RCP)
- 294 Seal Contraction and Expansion Joints - Emulsion with Latex (RCP)
- 295 Seal Contraction and Expansion Joints - Hot Rubber (RCP)
- 296 Stress Relief - CRCP
- 297 Stress Relief - RCP

400 Shoulders and Approaches

410 Seal Coat Shoulders

411 Aggregate Seal Coat Shoulders
412 Strip or Spot Seal Coat Shoulders - Major
413 Strip or Spot Seal Coat Shoulders - Minor
414 Fog or Sheet Sealing Shoulders

420 Leveling or Overlay Shoulders

421 Spot Leveling Shoulders - Blade Spread
422 Spot Leveling Shoulders - Hand
423 Spot Leveling Shoulders - Hot Box
424 Level-up Shoulders - Blade, Sections
425 Level-up Shoulders - Blade, Continuous
426 Overlay Shoulders - Major
427 Overlay Shoulders - Minor

430 Treat Bleeding, Rutting and Shoving Shoulders

431 Treat Bleeding Shoulders - Add Aggregate
432 Treat Bleeding Shoulders - Heating Aggregate
433 Treat Bleeding Shoulders - Heating Paved Shoulder
434 Heater Planer Work Shoulders
435 Repair Rutting and Shoving Shoulders - Basic
436 Repair Rutting and Shoving Shoulders - Trim and Overlay

440 Cracks and Joints, Shoulders

441 Seal Cracks and/or Joints, Shoulders - Major
442 Seal Cracks and/or Joints, Shoulders - Minor
443 Seal Cracks, Shoulders - Squeegee

450 Potholes and Edge Repairs, Shoulders

451 Repair Potholes, Shoulders - Permanent
452 Repair Potholes, Shoulders - Temporary
453 Repair Potholes, Shoulders - Hot Box
454 Edge Repairs, Shoulder - Basic
455 Edge Repairs, Shoulder - Box

460 Repair Existing Base and/or Subgrade Other Than In Place, Shoulders

461 Removal of Base and/or Subgrade, Shoulders
462 Replacement of Removed Base and/or Subgrade, Shoulders - Stabilized Material
463 Replacement of Removed Base and/or Subgrade, Shoulders - Non-Stabilized Material

470 In Place Repair Existing Base and/or Subgrade, Shoulders

- 471 In Place Repair Shoulders - No Stabilizer
- 472 In Place Repair Shoulders - Add Lime (Maintainer)
- 473 In Place Repair Shoulders - Add Cement (Maintainer)
- 474 In Place Repair Shoulders - Add Asphalt
- 475 In Place Repair Shoulders - Add Sand (Maintainer)
- 476 In Place Repair Shoulders - Add Lime (Maintainer and Mixing Machine)
- 477 In Place Repair Shoulders - Add Cement (Maintainer and Mixing Machine)
- 478 In Place Repair Shoulders - Add Asphalt (Maintainer and Mixing Machine)
- 479 In Place Repair Shoulders - Add Sand (Maintainer and Mixing Machine)

480 Unpaved Shoulders

- 481 Recondition Sod Shoulders
- 482 Blade Flexible Shoulders - Maintainer and Pneumatic Roller
- 483 Blade Flexible Shoulders - Two Machines
- 484 Blade Flexible Shoulders - One Machine Kickoff Blade
- 485 Blade Flexible Shoulders - Maintainer

490 Approaches, Driveways, Turnouts

- 491 Public Side Road Approaches
- 492 Driveways - Valley and Pipe Type
- 493 Driveways - Safety Island

500 Roadside Maintenance

510 Mowing

511 State Owned Mowers
512 Leased Mowers
513 Full Width Mowing - State Owned Mowers
514 Full Width Mowing - Leased Mowers
515 Specialized Mowers
516 Hand Clean-up

520 Litter

521 Litter Pick-up - Hand
522 Litter Pick-up - Machine (Tow Type)
523 Litter Pick-up - Machine (Self-propelled with Shredder)
524 Street Sweeping
525 Maintain Litter Barrel

530 Rest Area Maintenance

531 Maintain Rest Areas - Comfort Stations
532 Maintain Rest Areas

540 Chemical Vegetation Control

541 Chemical Vegetation Control - Basic
542 Chemical Vegetation Control - Shoulder Edges
543 Chemical Vegetation Control - Spray Mesquite
544 Chemical Vegetation Control - Channels

550 Establish and Maintain Vegetation

551 Establish Vegetation - Basic
552 Establish Vegetation - Mulch Sodding
553 Establish Vegetation - Asphalt Mulch
554 Establish Vegetation - Small Hand Operation
555 Establish Vegetation - Disk or Drill
556 Maintain Sprinkler System Urban Areas

560 Pruning and Planting

561 Pruning and Brush Control - Minor
562 Pruning and Brush Control - Major
563 Pruning and Brush Control - Chipper
564 Planting - Large
565 Planting - Small

570 Silt and Erosion

571 Silt Removal - Basic
572 Silt Removal - Hydraulic Telescopic Boom Type Excavating Machine
573 Reshape Ditch and Slope - Basic
574 Ditch Retards - Grass
575 Ditch Retards - Concrete
576 Ditch Retards - Other
577 Ditch Liners - Jute
578 Ditch Liners - Concrete

580 Remove Silt From Culverts

581 Up to 36"
582 36" to 6' x 6'
583 6' x 6' to Bridge Class

600 Structures Over 20 Feet

601 Inspection Cost

610 Bridge Decks

611 Repair of Bridge Deck Spalling and Delamination - Portland Cement
612 Repair of Bridge Deck Spalling and Delamination - Epoxy
613 Repair of Bridge Deck Spalling and Delamination - Quick Setting Cements
614 Armor Joint Repair
615 Clean Bridge Deck - Mechanical
616 Clean Bridge Deck - Hand

620 Substructure - Concrete

621 Substructure Crack Repair
622 Substructure Crack Repair - Pressure Grouting
623 Repair of Badly Cracked or Spalled Substructure
624 Repair of Badly Cracked or Spalled Substructure - Collar
625 Repair of Badly Cracked or Spalled Substructure - Gunite
626 Repair Bearing Plates - Replace Lead Sheeting (Concrete Beams)
627 Substructure Waterproofing
628 Substructure Waterproofing - Epoxy Coating

630 Substructure Steel

631 Repair of Steel Substructure
632 Repair of Steel Substructure - Asphalt

640 Substructure - Timber

641 Repair of Timber Substructures
642 Removal of Timber Substructures

650 Railing

651 Paint Railing - Spray (Hand Cleaning)
652 Paint Railing - Hand
653 Paint Railing - Spray (Sandblast Cleaning)
654 Paint Railing - Touch-up
655 Metal Bridge Railing Repair
656 Concrete Bridge Railing Repair

660 Paint Bridges

661 Brush-off Blast
662 Near White
663 Touch-up

670 Channels and Riprap

671 Maintain Channels
672 Maintain Channels - Remove Drift
673 Repair and/or Replace Concrete Riprap
674 Remove Silt From Culverts

680 Linseed Oil

681 Linseed Oil Treatment of Bridge Decks

691 Biennial Safety Inspection
692 Damage Inspection

700 Traffic Services

710 Guide Markings

711 Center Stripe
712 Edgelining
713 Painting Traffic Medians and Islands
714 Zone and Pavement Markings
715 Install Traffic Buttons
716 Maintain Traffic Buttons

720 Delineation and Railing

721 Erect and Maintain Guard Fence and Railing
722 Maintain Concrete Median Barrier
723 Erect Delineators
724 Replace Damaged Delineators
725 Clean Delineators

730 Signs

731 Special Sign Studies
732 Install New Signs
733 Replace Signs
734 Repair Signs
735 Replace or Repair Traffic Damaged Signs
736 Replace or Repair Vandalized Signs
737 Wash Signs
738 Wash Vandalized Signs
739 Sign Clear Coating

740 Signals and Illumination

741 Install Signals
742 Install Illumination
743 Maintain Signals
744 Maintain Illumination
745 Replace or Repair Traffic Damaged or Vandalized Signals
746 Replace or Repair Traffic Damaged or Vandalized Illumination
747 Sign Illumination
748 Safety Lighting

750 Reimbursement to Railroad Companies (D-18 Use Only)

800 Extraordinary Maintenance

801 Emergency Repairs Due to Flooding

802 Emergency Repairs Due to Hurricanes

803 Emergency Repairs Due to Tornadoes

804 Emergency Repairs Due to Other Causes

810 Assistance to Traffic Other Than Caused by Snow and Ice

- 811 Assistance Needed Due to Floods or Flooding
- 812 Assistance Needed Due to Hurricanes
- 813 Assistance Needed Due to Tornadoes
- 814 Assistance Needed Due to Accident
- 815 Operation of Nail Picker
- 816 Removal of Sand Drifts

820 Assistance to Traffic - Snow and Ice

- 821 Assistance Needed Due to Snow and Ice
- 822 Plow Snow or Ice
- 823 Sand Bridges
- 824 Sand Roadway
- 825 Deicing Agents
- 826 Remove Sand, etc., - Mechanical
- 827 Remove Sand, etc., - Hand

APPENDIX M

APPENDIX M

The means and standard deviations presented in Tables A and B are weighted values. This was done because the number of 0.2 mile Serviceability Index values obtained for the various randomly selected pavement sections were not necessarily a constant value. This occurred because the length of some of the pavement sections had to be decreased to achieve a uniform construction section.

The equation for calculation of means is as follows:

$$\bar{\bar{x}} = \frac{n_1 \bar{x}_1 + n_2 \bar{x}_2 + \ldots + n_k \bar{x}_k}{n_1 + n_2 + \ldots + n_k} \qquad (1)$$

where $\bar{\bar{x}}$ = mean for a district for a particular highway type

$\bar{x}_1$ = mean for the first pavement section in a particular State Department of Highways and Public Transportation District and highway type

$\bar{x}_k$ = mean for the last pavement section in a particular State Department of Highways and Public Transportation District and highway type

n = number of 0.2 mile Serviceability Indexes for a pavement section.

The variances and resulting standard deviations for Serviceability Indexes were also obtained by a weighting process. The equation is:

$$s^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2 + \ldots + (n_k - 1)S_k^2}{(n_1 - 1) + (n_2 - 1) + \ldots + (n_k - 1)} \qquad (2)$$

where s^2 = weighted variance for each State Department of Highways and Public Transportation District and highway type

s_1^2 = variance for the first pavement section in a particular State Department of Highways and Public Transportation District and highway type

s_k^2 = variance for the last pavement section in a particular State Department of Highways and Public Transportation District and highway type

n = same as for Equation 1

$n - 1$ = degrees of freedom

The standard deviation was obtained by taking the square root of the weighted variance.

Means for the visual rating scores were unweighted averages. This was done because only one rating score was obtained for each pavement section.