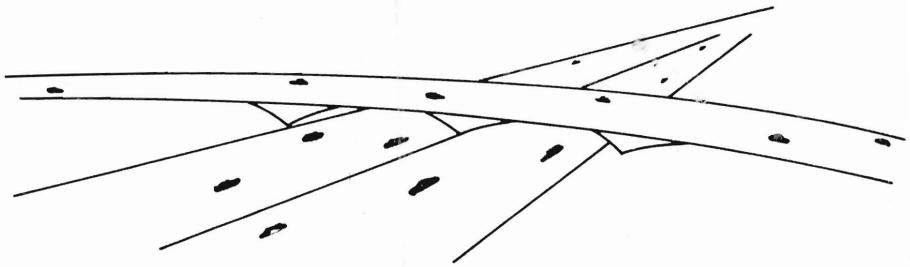


DEPARTMENTAL RESEARCH

Report Number SS-18.1

MAINTENANCE RATING SYSTEM DATA PLOT

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

MAINTENANCE RATING SYSTEM
DATA PLOT

BY

KENNETH D. HANKINS
SUPERVISING RESEARCH ENGINEER

REPORT NO. SS 18.1

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

TRANSPORTATION PLANNING DIVISION
RESEARCH SECTION

APRIL 1976

TABLE OF CONTENTS

LIST OF FIGURES

MAINTENANCE RATING SYSTEM
DATA PLOT

Introduction

The purpose of this report is to make available information concerning a computer program which will be entitled "INFOCOMB" in this report. The program was developed under Research Project 2-18-71-151 "Maintenance Quality, Methods and Ratings" conducted at Texas Transportation Institute by Dr. Jon Epps and Dr. Al Meyer. The program was written by Dr. Harry Jones and Mr. Don Ader. The INFOCOMB program has not been used extensively to date and should not be confused with the "FLEXRATE" or "RIGRATE" program presently in use by D-18 and several Districts. FLEXRATE and RIGRATE are explained in Research Report 151-2 "Roadway Maintenance Evaluation Users Manual."

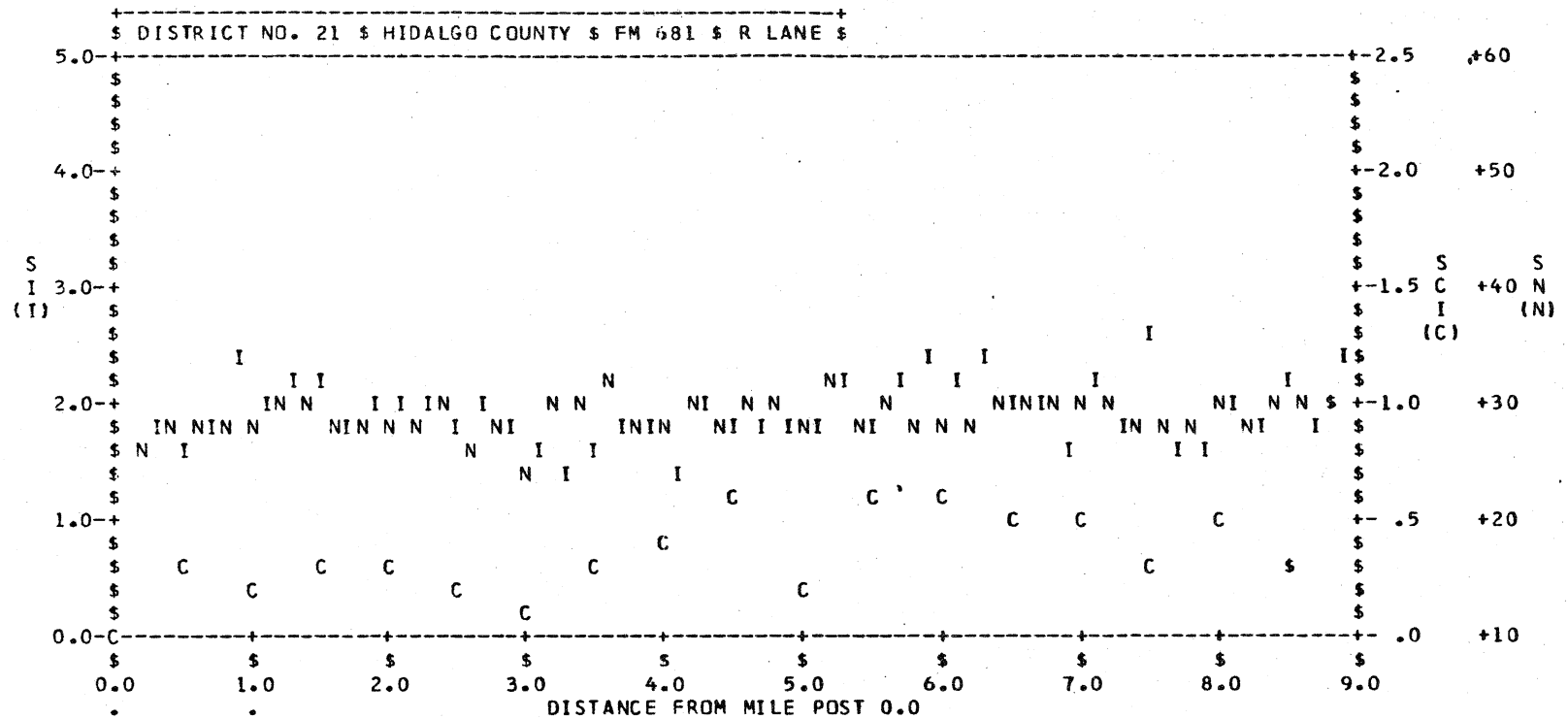
INFOCOMB is different from FLEXRATE and RIGRATE in that INFOCOMB provides a plot of the roadway condition. An example of such a plot may be found in Figure 1. Note each page of the plot contains a nine mile length of a given highway. Roughness (SI Values), Skid Resistance (SN Values) and Deflection (SCI Values) are plotted at the Mile Posts in which they were obtained. Cross Roads are shown at the Mile Posts at which they occur. Average Daily Traffic and 18 Kip Equivalency information are shown at spot locations. The limits of Control-Section, Surface Type, Date of last Surface, Maintenance Costs, Foreman Number, Pavement Rating Score, Shoulder Rating Score, Roadside Rating Score, Drainage Rating Score and Traffic Services Rating Score are shown horizontally. A full plot extends the total length of a given highway within a given county. All highways in a county are plotted and each county in a given District is included.

Background

District 21 personnel under the supervision of Mr. G. G. Garcia (Past supervision of Mr. R. E. Stotzer) and especially Mr. Samuel Cox have pioneered the use and implementation of the INFOCOMB program. However, use of the program is being requested by other Districts, therefore the program was obtained from TTI and prepared for use on the SDH&PT computer by the Automation Division (D-19). The program is presently available for use by requesting Districts.

Use Of The Plots

At this point the reader is referenced to a report entitled "An Approach to Maintenance Management" - SS-18.0 prepared by Mr. Bernabe Contreras. This report describes uses of the plots, but basically the information allows the District Maintenance Engineer, Resident Engineers and Maintenance Foreman to determine the present roadway condition and to make accurate estimates of the type and amount of maintenance activity needed for the next fiscal year. Using this information estimates of number of personnel and work times (man days) can be made along with equipment and material needs. The knowledge of these items allows the preparation of a highly accurate budget; a record of work done versus total work needed; the planning of when the work is to be accomplished; the timely purchase of materials; the timely distribution of equipment within the district and many other items of which we are not aware plus many revisions and additions yet to be developed. Considerable savings have occurred in reductions in manpower for specific jobs and in using the personnel and equipment correctly.



CR$	F
RO$	M
OA$	1
SD$	0
SS$	1
	7

AVERAGE DAILY TRAFFIC 400

18 KIP EQUIV. AXLES 0.093

CONTROL-SECTION	669-1
SURFACE TYPE	SC
DATE OF LAST SURFACE	1/68
DOLLAR COST/MILE	923 I..1477..
COST/BENIFIT RATIO	13.573 II.21.720.
FOREMAN NO.	6
PAVEMENT RATING	76 I...75....
SHOULDER RATING	60 I...60....
ROADSIDE RATING	67 I...70....
DRAINAGE RATING	60 I...60....
TRAFFIC SERV. RATING	80 I...78....

Figure 1 - Example INFOCOMB Plot

Data Types and Data Availability

The program instructions for INFOCOMB as prepared by Dr. Harry Jones are attached in Appendix A. However, the following review may be of aid.

INFOCOMB uses 13 items of data as follows:

1. General Location Information
2. SI Values - Roughness
3. SN Values - Skid Resistance
4. SCI Values - Deflection
5. ADT Information
6. 18 kip Equivalency Information
7. Cross Road Information
8. Maintenance Cost Information
9. Surface Type Information
10. Date of Last Surface Information
11. Control Section Information
12. Maintenance Foreman Number Information
13. Visual Rating Information

The above 13 data items are found for each highway in each county in a given district. For example, District 21 has approximately 220 highway - county combinations and there would be 220 sets of the above 13 data items for the district. The data is input through cards and each data item has its own format.

The following is a description of each data item and how the information is obtained:

1. General Location Information

This data consists of one card for each highway - county data set. The data contains the District number, county name, county number, highway designation and number, and the lane being studied. Probably the best source of information would be the highway listing found with each RI-1 county booklet. A code sheet may be found in Figure 2.

2. SI Values

The Mays Meter roughness information (SI Values) have two card types as indicated on the code sheet found in Figure 3. The first card type or Mays Meter Header Card contains the Data Type, Beginning Mile Post and Data Point Interval. The beginning mile post varies depending on the starting point of the tests but ordinarily the data point interval is set at 0.2 mile. The second card type contains the individual SI Values (see explanation Appendix A). The SI Values are recorded from left to right. The 15th SI Value is recorded on the second line under "1st Data", etc.

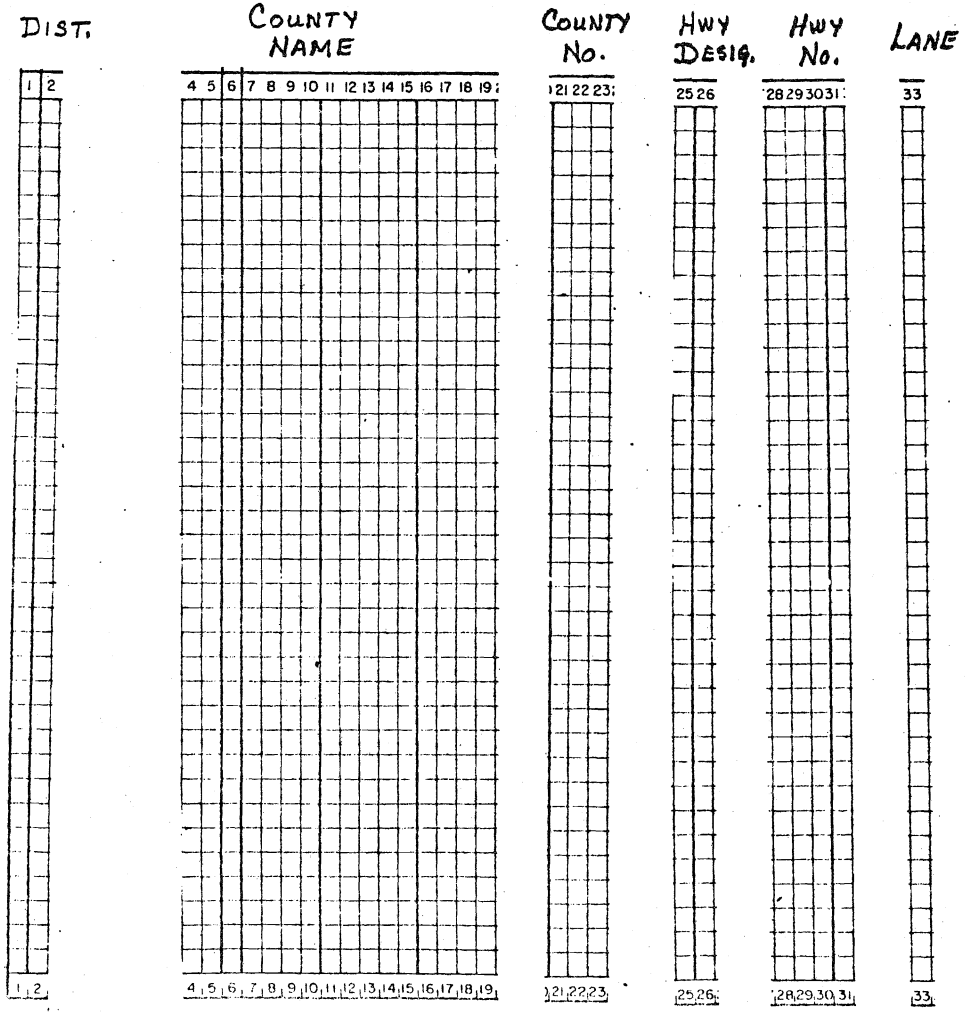
To obtain the data it is necessary to test the MRM equipment over each highway in the District. Since the INFOCOMB program will only accept data in order of increasing mile posts, some consideration may be given to concentrating on the "R" (S or T) Lane(s) during testing. The MRM data obtained in the field

NOTE: The "R" Lane is the outside lane in the direction of increasing mileposts. Alphabetic increases (S, T, etc.) designate lanes ordered toward the centerline or median.

Figure 2 - Code Sheet - General Location Information

ROADWAY HEADER CARD

(1)



FOR HWY DESIG. USE:

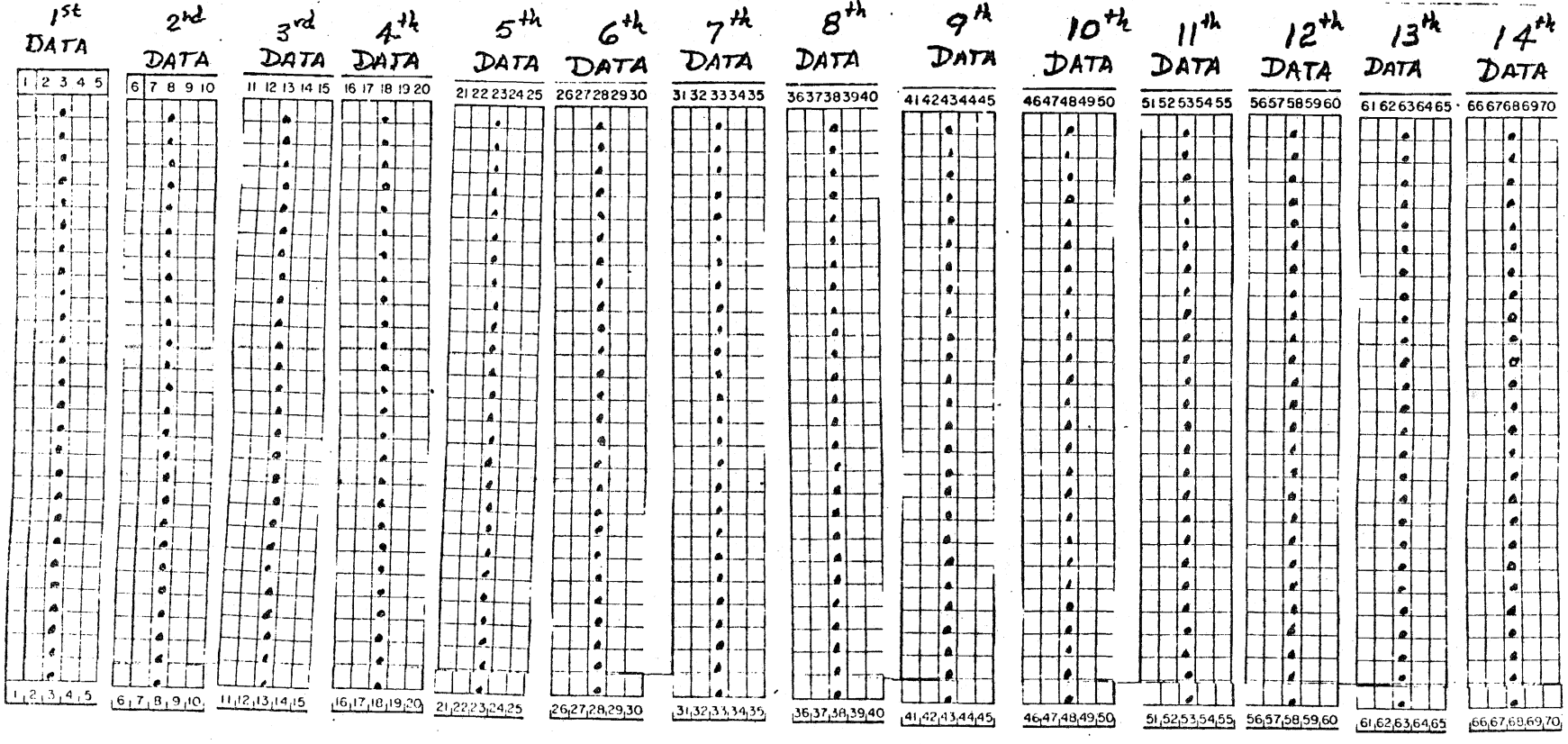
IH - INTERSTATE
US - U.S. HIGHWAY
SH - STATE HIGHWAY
FM - FARM OR RANCH ROAD
SP - SPUR
LP - LOOP
PR - PARK ROAD
RR - RECREATION ROAD

Figure 3 - Code Sheet - SI Values

MAYS METER HEADER CARD

DATA TYPE	BEGINNING MILE POST	DATA POINT INTERVAL (MI)
1 2 3	5 6 7 8 9	11 12 13 14
SI	.	0.2

MAYS METER DATA CARD



is coded directly on code sheets (Form 1392-1 & 2 Revised 9/75). This data is keypunched from the code sheets and processed through the "MRM REP" program (at present available through D-10). The "MRM REP" software program output contains the SI Values and the output generally is returned via the terminal to the District. The beginning Mile Post of the first SI entry should be determined. It is then necessary to again code the information on the INFOCOMB code sheets similar to that shown in Figure 3.

3. SCI Values

The deflection data (SCI Values) also have two card types similar to the SI Values explained above. The explanation of coding may be found in Appendix A but coding is also similar to the SI Values explained above. Code sheets are shown in Figure 4. Ordinarily the "data point interval" will be longer (longer distance between tests) since the tests are more time consuming to perform. District 21 personnel obtained deflection tests every 1/2 mile. It should also be noted that District 21 personnel tested about 1/3 of their highways each year. In three years the deflection tests in the District have been completed on all highways. The reasons for obtaining the data at 1/3 per year amounts were probably the high test costs and the fact the deflection values would not be subject to large yearly changes.

Again "R" (S and T) lanes should be tested in preference to the lanes (L, M and N) where decreasing order of mile posts occur. The data as obtained in the field is coded directly on code sheets (Form 1112-1 & 2 Revised 5/75). The data is keypunched and processed through the "STCOEF" (Stiffness Coefficient) program via the terminal. The output from the STCOEF program is returned over the terminal and contains stiffness coefficients for the pavement structure and subgrade. The output also contains SCI Values and these SCI Values are coded on the INFOCOMB code sheets shown in Figure 4. It is also necessary to determine the beginning Mile Post of the first SCI data point.

4. SN Values

The skid resistance (SN Values) data also have two card types similar to the SI Values explained above. The explanation of coding is found in Appendix A but coding is also similar to the SI Values. The "data point interval" varies from 0.1 to 0.9 mile as the length of the skid test section varies. District 21 personnel selected an interval of 0.2 mile for skid tests because they felt the data would be easier to analyze and provide more representative information. However, West Texas Districts may wish to consider the availability of test water when planning small test intervals.

"R" (S & T) Lanes should receive test preference. Each highway is tested as described in the SKIDR manual and the data as it is obtained is punched on a teletype tape. The tape is forwarded to D-10 and processed through the SKIDR program. The output is returned to the District via the terminal. It is necessary to determine mile post of the beginning location of the first SN Value and code the SN Values on the INFOCOMB code sheets similar to those shown in Figure 5.

5. ADT Information

The ADT information is obtained from the latest traffic map. The ADT Values are noted along the highway for which data is being obtained. The lengths to

Figure 4 - Code Sheet - SCI Values

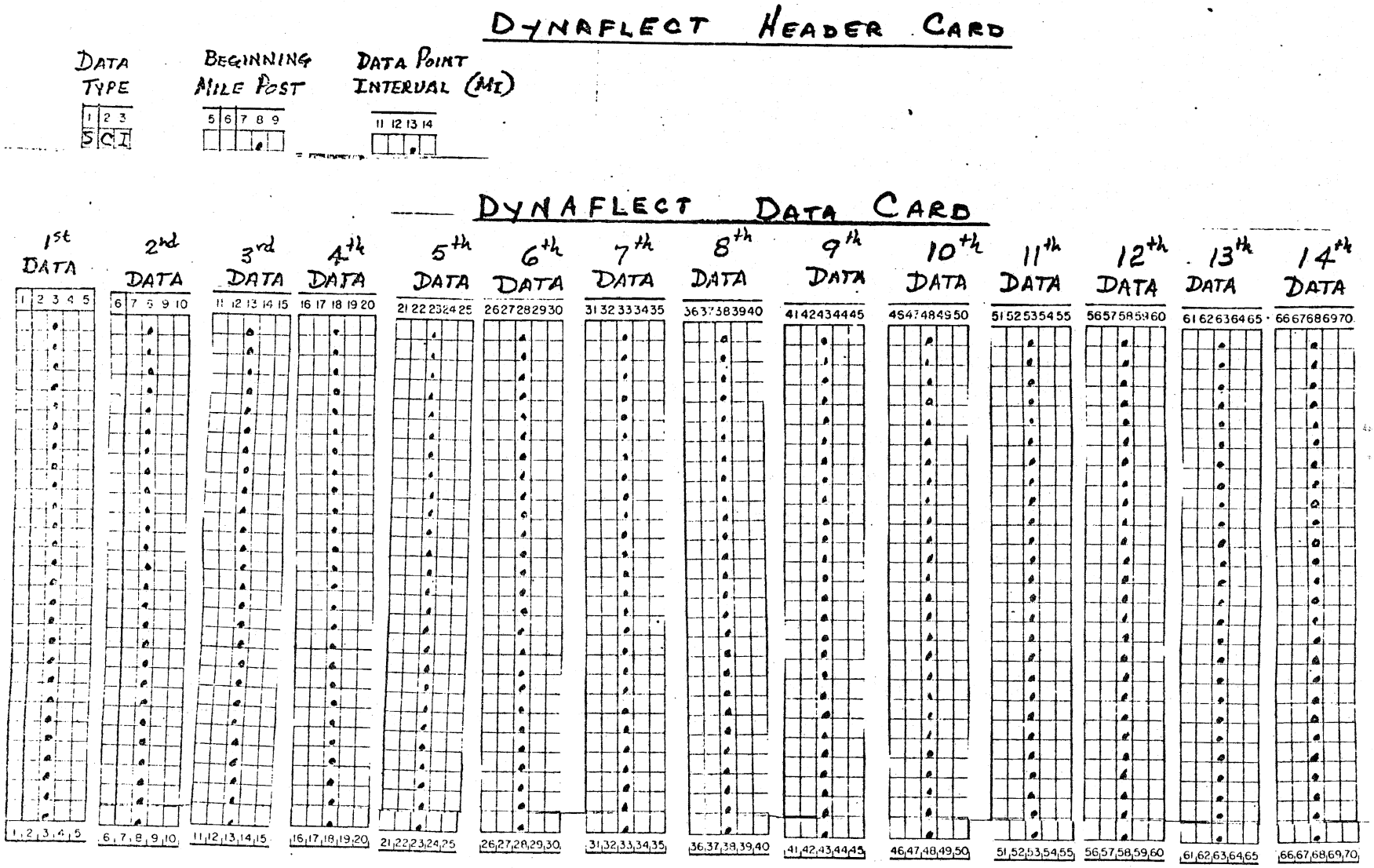
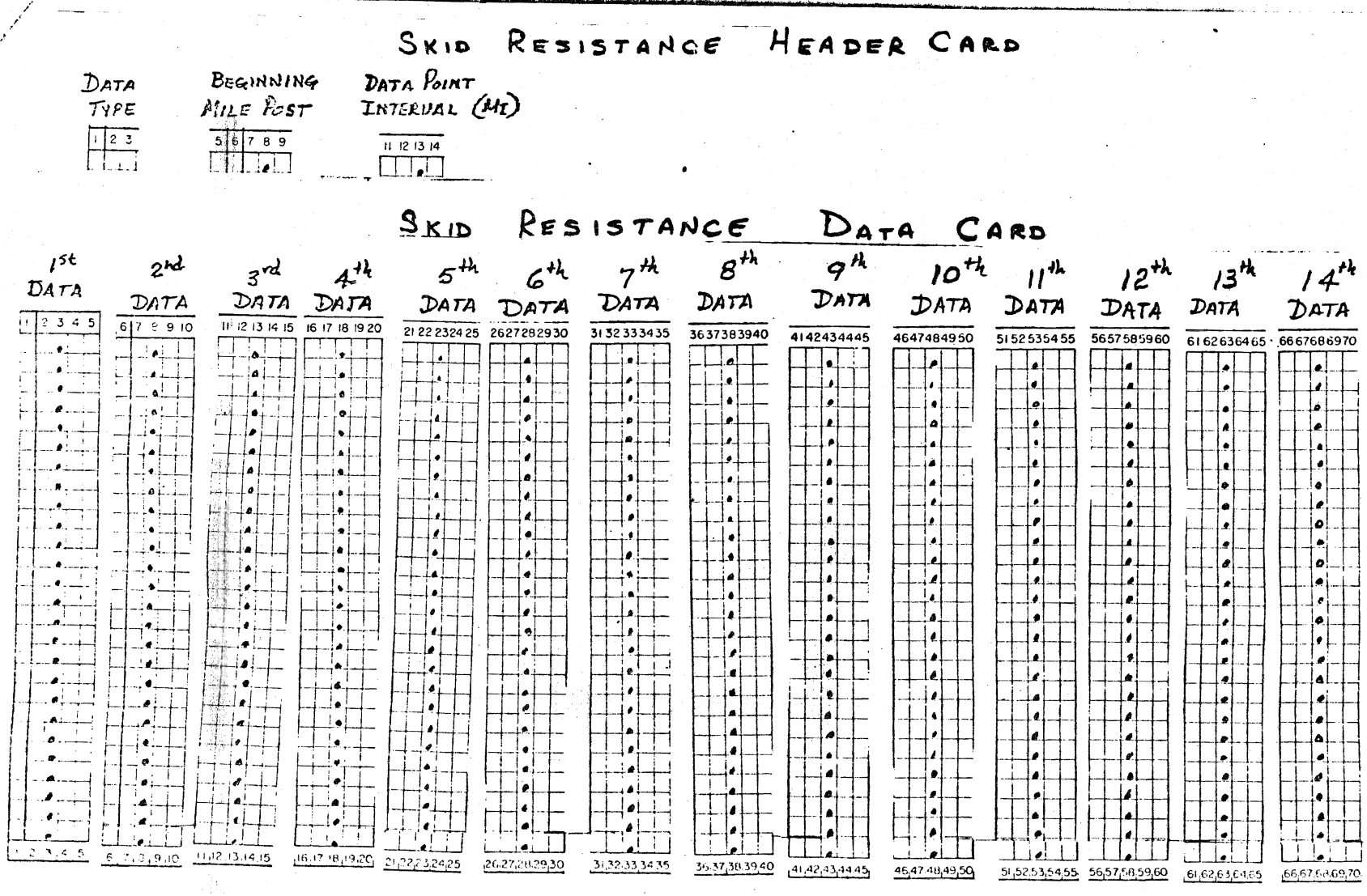


Figure 5 - Code Sheet - SN Values



the values are scaled from the map (generally from county line to the ADT Value), converted to mileage and the mile post determined at the ADT Value. The Mile Posts and ADT Values are coded on INFOCOMB code sheets similar to those shown in Figure 6.

6. 18 Kip Equivalency Information

The 18 Kip Equivalencies can be obtained at the same locations as the ADT information described above. If this is done the Mile Posts are known since they are the same as the ADT locations. However, it is necessary to convert the Mile Posts (actually the total location key is District - County - Highway Designation and Number and Mile Post) to Mile Points (the location key is District-County-Control-Section and Mile Point) in order to access the RIS (Roadway Information System) automated files. The RIS files are maintained by D-9 and D-10 and contain the 18 Kip Equivalency information. A District can obtain this information using the terminal and the MARK IV program prepared for this purpose. In using the MARK IV program it is necessary to input the District, County, and Control-Section of interest. The print out will contain the equivalency information for the whole Control-Section. It will then be necessary to determine the correct 18 Kip Equivalency value using the Mile Point location. The 18 Kip Equivalency and Mile Post values are coded on INFOCOMB code sheets similar to Figure 7.

A refinement in the MARK IV program could be made in order to obtain only the 18 Kip information for the Mile Point in question rather than all values for a Control-Section. This refinement may not be feasible depending on District desires. However, it should be noted that to cover all highways in a District and to obtain equivalency values for every ADT location on a traffic map virtually the whole RIS traffic file for the District will be needed.

Furthermore, it should be noted that the equivalency values are for a 20 year period. At locations where new or revised routes (Loops around a city) are planned for the future, the equivalency values for the present route may be erroneous since the traffic and equivalency information has been estimated for the split between the old and new routes. District 21 personnel used judgement and 18 Kip information before and after the proposed revised routing to estimate the 20 year equivalency information for the present route (as if the new route were not to be constructed).

7. Cross Road Information

The cross road information is obtained by noting the state maintained highways crossing the highway in question on a county map. The lengths to the cross roads are scaled and the lengths converted to mileage and then to Mile Posts, similar to that explained in the ADT information above. The cross road designation - number and the Mile Post value are coded on INFOCOMB code sheets similar to those shown in Figure 8.

It should be noted that this information once obtained can be used from year to year since the cross road locations rarely change. Since this is the case a District may consider obtaining cross road information from the RI-1 log file. The RI-1 file uses District, County - Control - Section Mile Points as the location key but Mile Posts are also shown on the log. It is relatively easy to calculate the Mile Post at cross roads using the information on the log.

Figure 6 - Code Sheet - ADT Information

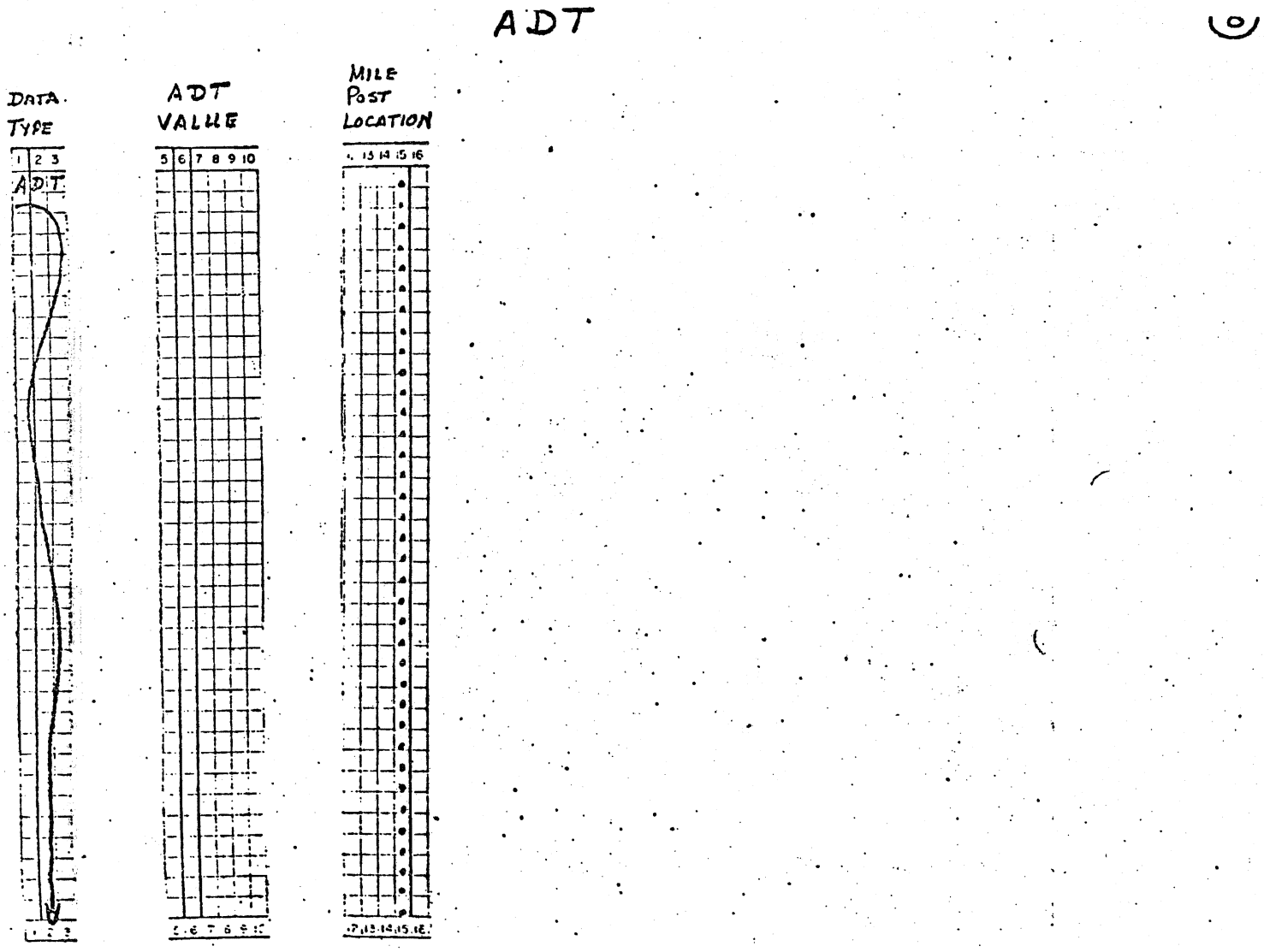


Figure 7 - Code Sheet - 18 Kip Equivalency Information

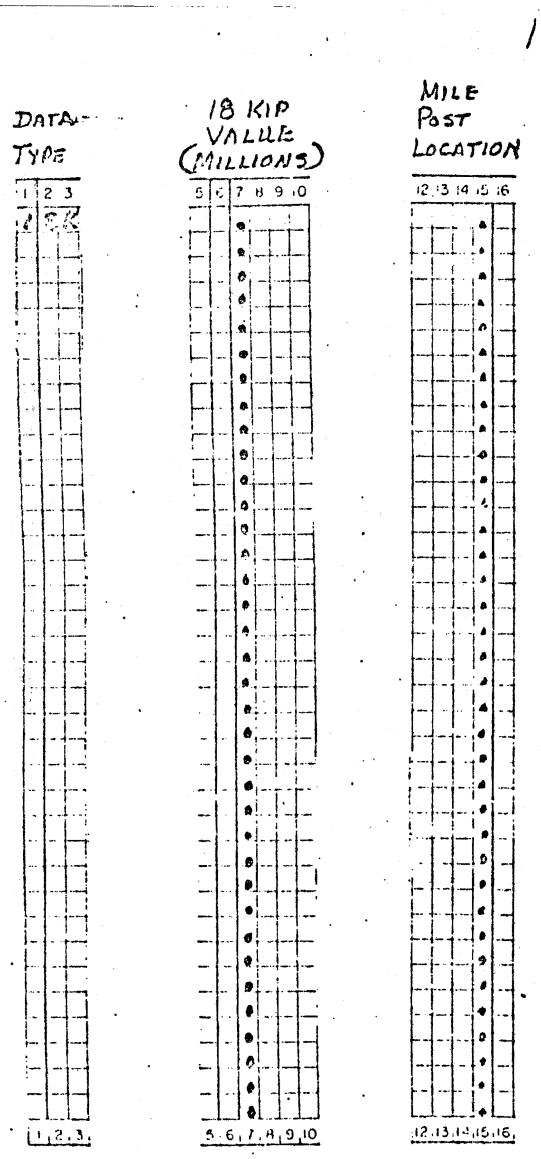
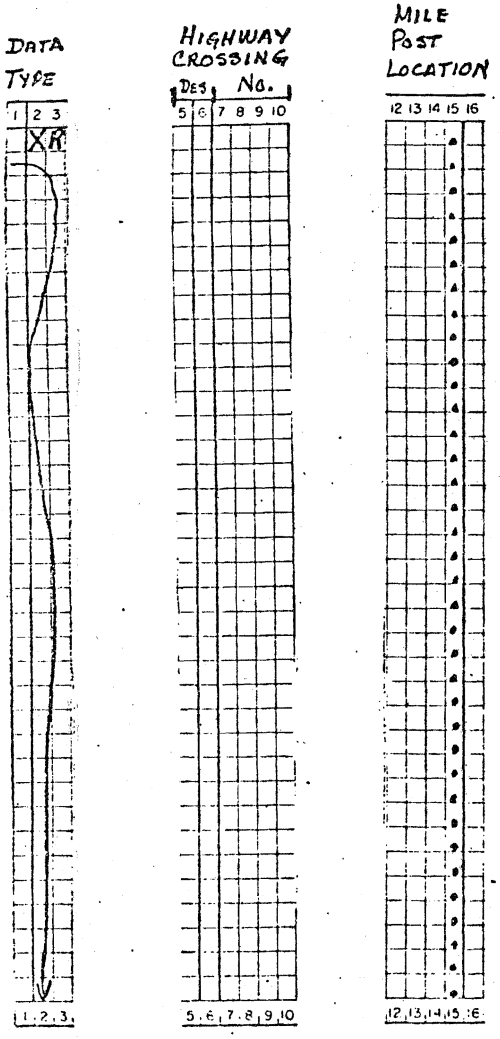


Figure 8 - Code Sheet - Cross Road Information

CROSS ROAD LOCATION

(10)



8. Maintenance Cost Information

Maintenance cost information is generally maintained on a District County and Highway basis. In other words, the smallest break down is a cost each year to maintain a given highway within a given county. This cost is coded on INFOCOMB code sheet similar to that shown in Figure 9. It is also necessary to code the beginning and ending Mile Posts relative to the Maintenance Cost locations for that highway.

9. Surface Type Information

The surface type information is obtained from construction or maintenance files. This information is coded on INFOCOMB code sheets similar to that found in Figure 10. It is also necessary to code the beginning and ending Mile Posts for the limits of that surface type. For those Districts which have developed the SKIDR file, the surface type information along with the location information are available on the SKIDR output. If the SKIDR file is used it will be necessary to convert the location limits from Mile Posts to Mile Points.

It should be noted that the Mile Post limits of the Surface Type information must exactly correspond to the Mile Post limits of each Visual Rating section. (Must have the same beginning and ending Mile Post values.) Considerable difficulty was experienced in the processing of the District 21 data in this area. Two different groups worked up the Surface Type data and the visual rating data and the limit Mile Posts did not match on several occasions. When the Visual Rating beginning or ending Mile Posts caused the Visual Rating section to be longer than the Surface Type section length, the rating scores (pavement rating score, etc.) would not be printed on the INFOCOMB plot.

Where the surface type is the same for two consecutive construction jobs on the same highway (even though placed on different dates) it is not necessary to form two Surface Type Sections.

10. Date of last Surface Information

The "Date of Last Surface" information is obtained from construction or maintenance files. This information is coded on INFOCOMB code sheets similar to that found on Figure 11. It is also necessary to code the beginning and ending Mile Posts for the limits of the "Date of Last Surface". For those Districts which have developed the SKIDR file, the "Date of Last Surface" information along with the location limits are available on the SKIDR file.

11. Control-Section Information

Probably the best source of information for Control Sections is the RI-1 Log file. However, since the Control Sections for a given highway must be given in order of increasing Mile Post a Control - Section map is useful. The beginning and ending Mile Posts for each Control - Section must be found. The Control Section and beginning and ending Mile Posts are coded on INFOCOMB code sheets similar to that shown on Figure 12. This information will rarely change and could be used from year to year with minor updating.

Figure 9 - Code Sheet - Maintenance Cost Information

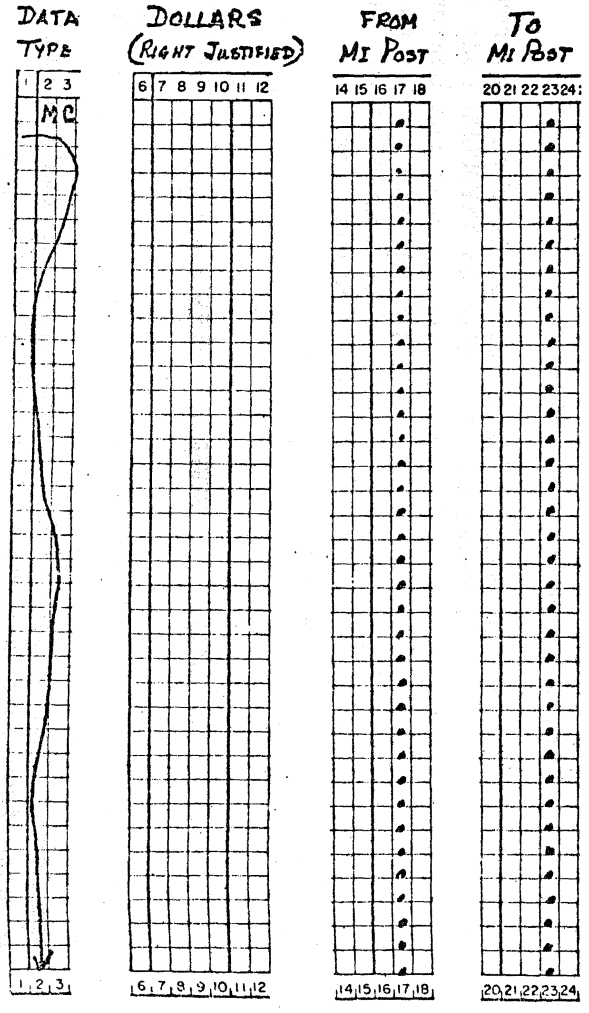
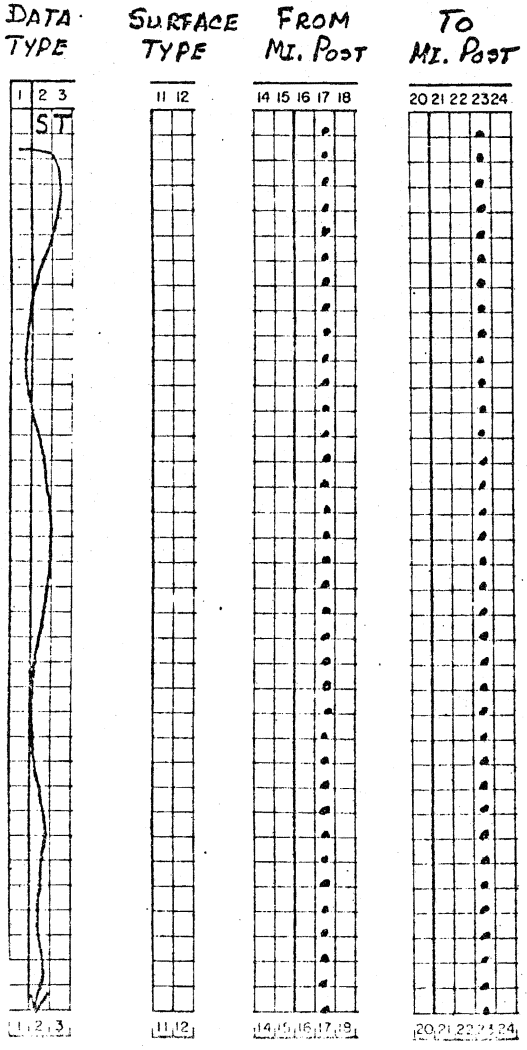


Figure 10 - Code Sheet - Surface Type Information

PAVEMENT SURFACE TYPE

(12)



SURFACE TYPE CODE

SC = SEAL COAT
AC = HOT MIX ASPHALTIC CONC.
ST = SURFACE TREATMENT
PC = PORTLAND CEMENT
CL = HOT MIX - COLD LAID

Figure 11 - Code Sheet - Date of Last Surface Information

DATE OF LAST SURFACING

(13)

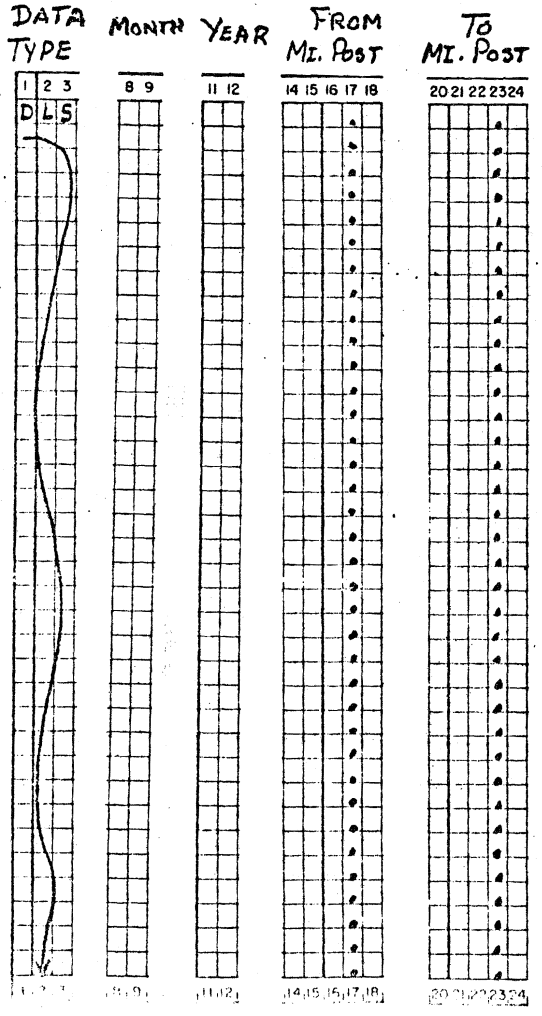
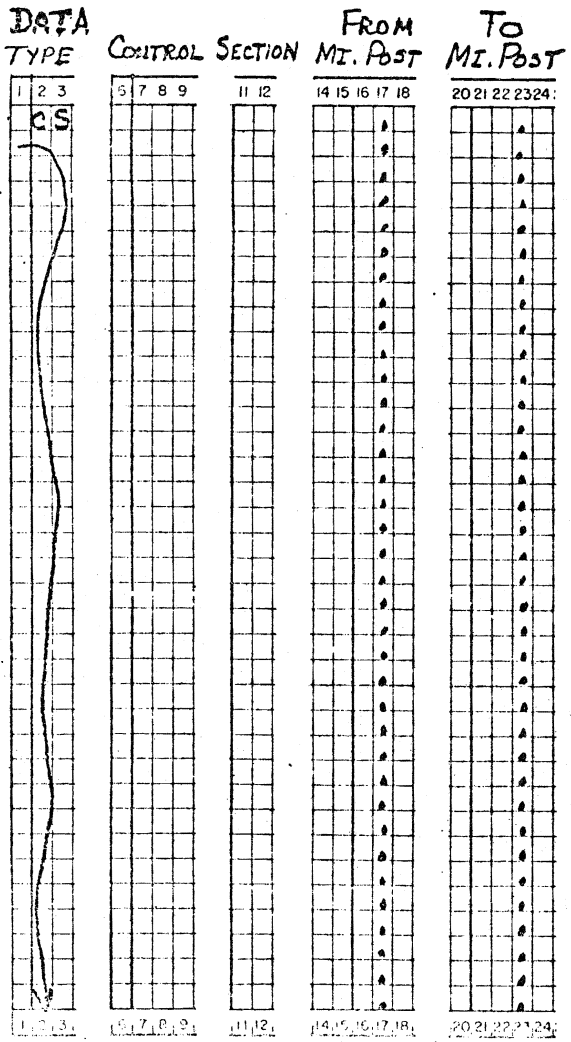


Figure 12 - Code Sheet - Control-Section Information

CONTROL AND SECTION

(14)



12. Maintenance Foreman Number Information

The maintenance foreman number is readily recognized by District maintenance personnel. It is necessary to code the Foreman Number and beginning and ending Mile Posts on INFOCOMB code sheets similar to that shown in Figure 13.

13. Visual Rating Information

Rating schools have been supervised by D-18 and personnel from each District have been trained in visual rating. For further information the reader is referred to Research Report 151-2 "Roadway Maintenance Evaluation Users Manual." It should be noted that the first visual rating card (the header card containing District No., Raters, Month, Day and Year) as explained in the 151-2 manual is not used in the INFOCOMB program. Rather a VIS card (containing a V in column 1, I in column 2 and S in column 3) is placed just prior to the rating information for any given highway in any given county. Other than the above change the visual rating information is used in the same format as explained in the 151-2 manual. A code sheet for flexible pavement is shown in Figure 14.

Additional Aid

It may be noted in the above information that the conversion from Mile Point to Mile Post or conversely from Mile Post to Mile Point occurs repeatedly. In working with the District 21 data straightline plots showing both Mile Posts and the Mile Points was prepared on a large sheet. The plots are similar to a RI-1 log except only Mile Posts and Mile Points are shown. An example of one of the plots is shown in Figure 15 (in reduced scale). Several Divisions have been working for sometime attempting to establish a Mile Post - Mile Point Equivalency File. This file would allow an automated conversion from Post to Point or Point to Post pbssible. The data for such a file has been collected, but the software programming still remains to be accomplished at this time. However, the data for the equivalency file was used to prepare the plots shown in Figure 15 and is available for each District. Should a District desire the data contact should be made with D-10.

Costs

The following are estimated costs in one District to obtain and process the data obtained in INFOCOMB. The estimated costs are based on recent work accomplished in District 21.

1.	General Location Information (5 man - hrs)	$ 59
2.	SI Values - Roughness (600 man - hrs)	7,620
3.	SN Values - Skid Resistance (456 man - hrs)	8,898
4.	SCI Values - Deflection (1/3 per year) (261 man - hrs)	4,992
5.	ADT Information (24 man - hrs)	288
6.	18 Kip Equivalency Information (32 man - hrs)	344

Figure 13 - Code Sheet - Maintenance Foreman Number Information

FOREMAN NUMBER (15)

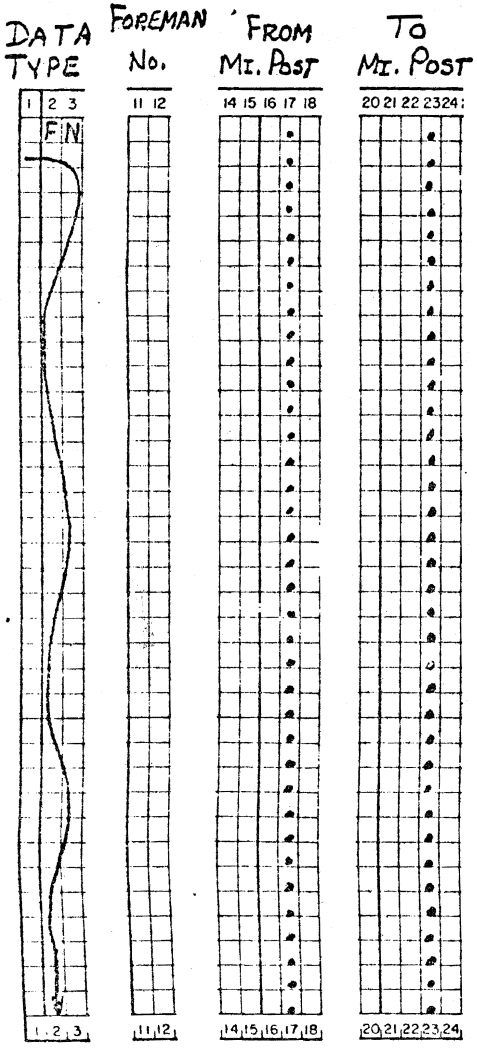


Figure 14 - Code Sheet - Visual Rating for Flexible Pavement

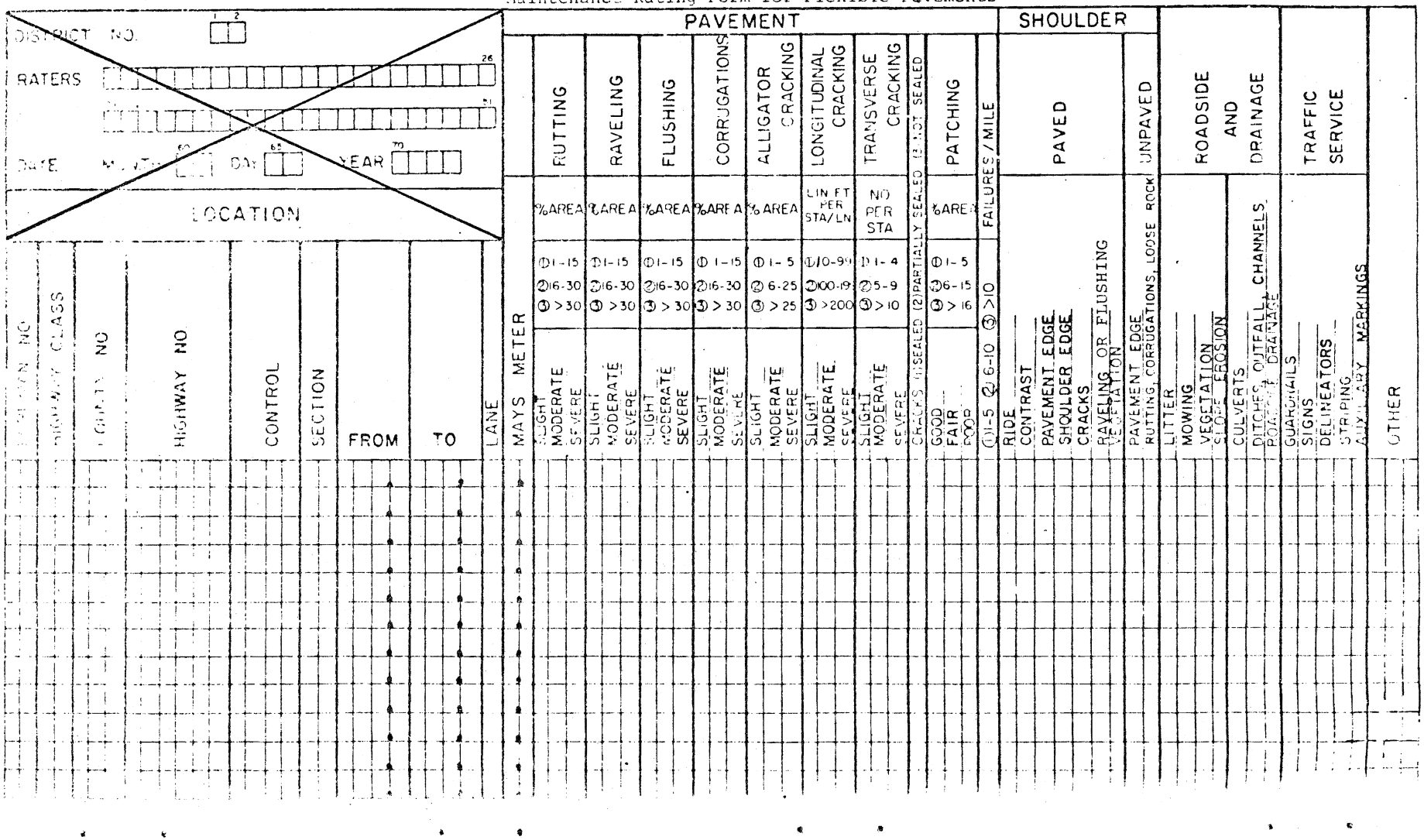
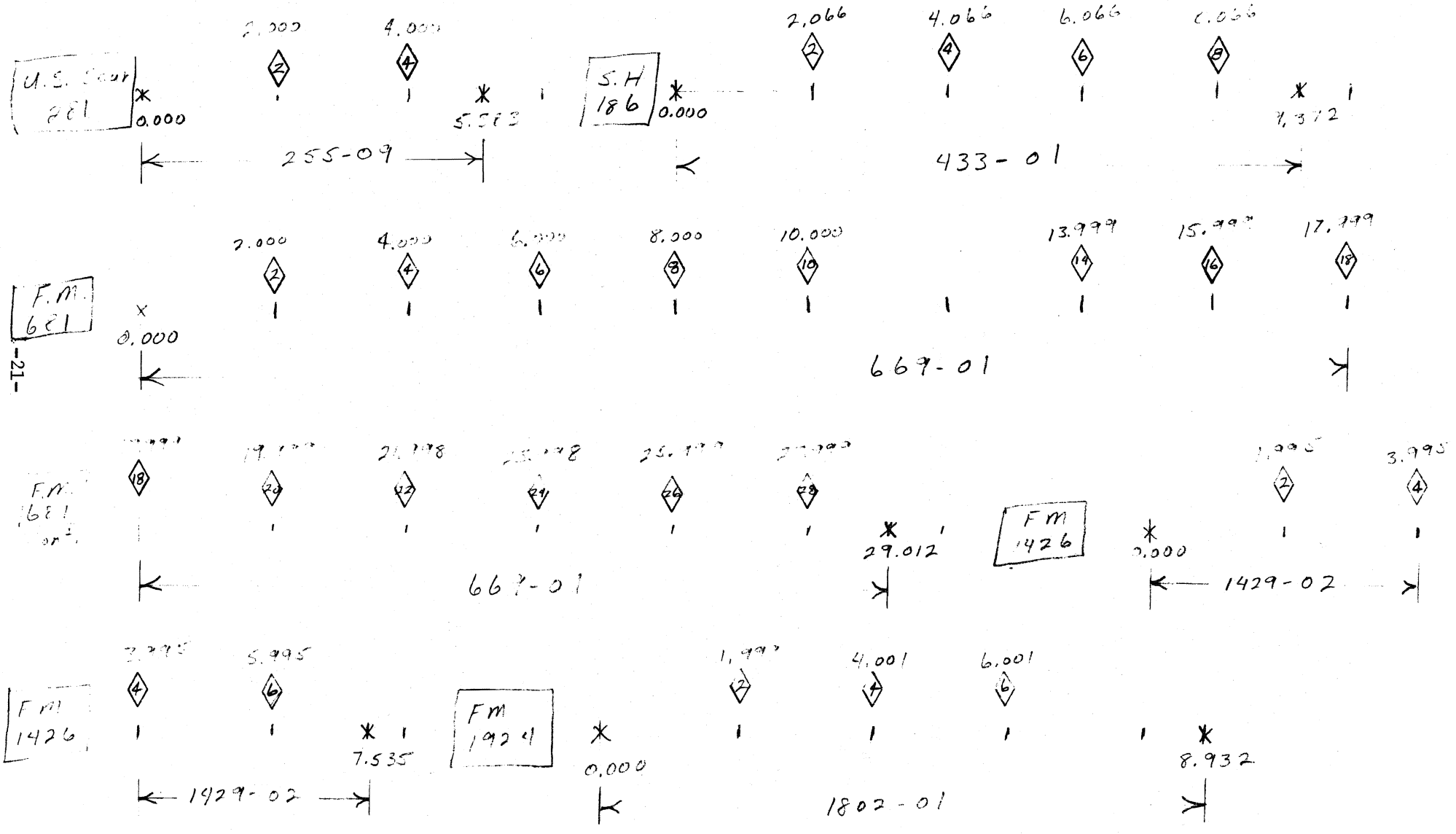


Figure 15 - Example of Mile Post-Mile Point Plot

NOTE: Numbers carried to three decimal places are Mile points. Numbers in diamonds are Mile Post. Numbers between arrow are control-section numbers.



7.	Cross Road Information (40 man - hrs)	$ 452
8.	Maintenance Cost Information (24 man - hrs)	258
9.	Surface Type Information (24 man - hrs)	292
10.	Date of Last Surface Information (24 man - hrs)	292
11.	Control Section Information (40 man - hrs)	420
12.	Maintenance Foreman Number Information (16 man - hrs)	158
13.	Visual Rating Information (400 man - hrs)	3,372
	Sort and Combine Data	192
	Preparing Mile Point - Mile Post Information (64 man - hrs)	512
	Computer Process Costs	300
	Total (2010 man - hrs)	$28,449

Appendix B contains the method of determining the costs. The costs are based on an average hourly (composite rate) salary of $8. Salaries may be revised to match those expected in a given District.

Note there are a total of 2010 man hours or 251 man days needed to collect and process the data exclusive of equipment and keypunch charges. This seems a large amount of time until the number of men used is noted. The INFOCOMB program is ideally suited to allow several crews to collect and code the data. The collection of the roughness, skid resistance, and deflection data will require about one month for each item. The visual rating will require from 4 to 6 weeks. One man can prepare the data for keypunching on items 1, 5, 6, 7, 8, 9, 10, 11 and 12 in approximately four to six weeks (with some what less time the next year). It will require about one man - month to recode the roughness, skid resistance, and deflection data (3 man months total) after initial processing. In other words five men can collect and process the data in about 2 months. The experience in District 21 is interesting in this respect. Mr. Cox began collecting data in December and obtained the plots in the middle of February. Probably the key data to be collected is the MRM or roughness data since this data is used on the visual rating form and must also be used in the plot. By similar reasoning, the collection times of the roughness, skid resistance and deflection data are critical since the data once processed must be recoded on INFOCOMB code sheets. In order to collect the data in a reasonable time period it will probably be necessary to have more than one data collection crew for these items unless the collection of the data is spaced through out the year. If the collection is spaced through the year it is suggested that all data for one item (for example skid resistance) be collected during one time period.

It may also be noted that District 21 collected 1/3 of the deflection data per year obtaining all information in 3 years. It is easy to collect deflection data in 1/3 increments. One method would be to collect information in the north-

ern 1/3 of the counties in a District the first year, the southern 1/3 the second year, etc. By the same reasoning, skid resistance information could be divided into collection periods. However, a District would probably want to divide the highways into those with new surfaces which could have rapid polish and loss of skid resistance and those with older surfaces which have polished to a terminal level. The problem exists in this method that to get to a new surface the test equipment must travel over a old surface - so why not test as the equipment travels over the old surface.

Comments

1. Any data item or items can be omitted and the remaining information will be plotted. The possible exceptions to this statement are the General Location Information, Visual Rating and the Surface Type Information. The ordering of information should be as shown in Appendix A but the program has run with the data in various ordering schemes. Exceptions are the General Location information should be the first card of any highway - county set and the visual rating information should be the last cards of any highway - county set. The VIS card must come just prior to the visual rating cards.

2. The cost of $28,449 may seem to be a large sum, however, this amount is about 1/2 of one percent (0.5%) of the maintenance budget for a District. It seems well worth this cost to obtain information for budgeting and planning. However as this data is collected a system for total pavement management will emerge. Future uses of this data are tremendous. Many uses readily come to mind but many are just over the horizon.

Future Data Collection Costs

With programming revisions to INFOCOMB and changes in the processing programs for roughness, skid resistance and deflection it will be possible to save about $6000 to $7000 per District in the future. Most of the savings would result in the "recoding" now necessary and mentioned in the Costs chapter. For example when skid resistance data is collected, the data is punched on teletype tape. At present it is necessary to process the teletype tape, receive the SN numbers on printed output sheets from the computer and then recode the SN Values on INFOCOMB code sheets for further processing. In the future it should be possible to eliminate the recoding and use the teletype tape not only in the present SKIDR processing procedure but to input the data directly into INFOCOMB. Roughness and Deflection data are similar. It should also be possible to eliminate the manual coding of such items as Surface Type and Date of Last Surface since these values reside in the SKIDR file and can be processed in an automated manner. (It will be necessary to up date the SKIDR file with surface changes before using INFOCOMB.) The coding of ADT and 18 Kip information could be eliminated by using the automated traffic files.

In order to accomplish the above changes an automated Mile Post - Mile Point Equivalency file will be needed. Work is presently progressing toward an effort to provide the above changes, however, it will probably be some time before they are completed.

References

1. Epps, J.A., Meyer, A.H., Larrimore, I.E., Jones, H.L., "Roadway Maintenance Evaluation User's Manual" Res. Rept. 151-2, Texas Transportation Institute, September, 1974.

2. Contreras, Bernabe, "An Approach to Maintenance Management" Special Report SS-18.0, Texas - State Department of Highways and Public Transportation, January, 1976.

Appendix A

USER'S INSTRUCTIONS FOR MRSDP
(Maintenance Rating System Data Plot)

The computer program MRSDP produces line printer plots of maintenance and roadway condition data by mile post along segments of a roadway. The information displayed consists of Mays Meter data, Dynaflect data, skid number data, cross road locations to assist the user in orienting himself along the roadway, average daily traffic counts, equivalent 18 kip axle counts, control and section location, surface type, date of last surfacing, maintenance cost per mile, a cost/benefit index, and pavement, shoulder, roadside, drainage, traffic services and composite rating scores.

DATA INPUT

Data Card Organization

The roadway header card is the first card in any roadway card set. The information it contains is listed below.

Column Nos.	Item
1-2	District no. (xx) - right justified
4-19	County name
21-23	County number (xxx) - right justified
25-26	Highway designation IH - Interstate SP-Spur US - U.S. highway LP-Loop SH - State highway PR-Park road FM - Farm road RR-Recreation road
28-31	Highway no. (xxxx) - right justified
33	Lane designation - see Figure 3

Card Subsets 1, 2 and 3 (SI, SCI and SN)

These card subsets provide information on roadway roughness (Mays Meter), pavement structural integrity (Dynaflect) and skid resistance (Skid Number). The Mays Meter data is supplied as Serviceability Index (SI) values (1*), the Dynaflect data as Surface Curvature Index (SCI) values (2), and the skid resistance data as skid number (3).

Each of these types of data are to be supplied at uniformly spaced points along a segment of the roadway. A subset header card identifies the data type (SI, SCI or SN), indicates the mile post location where the data begins and the interval at which data was taken. The data values are supplied on one or more cards (14 data values per card) which follow the subset header card. The format for these cards are given below.

*Numerals in parentheses refer to items in the List of References

. . . . . .Subset Header Card. . . . . .

Column Nos.	Item
1-3	Data Type (xxx) - right justified SI - Mays Meter SCI - Dynaflect SN - Skid number
5-9	Mile post at which data begins (xxx.x)
11-14	Data point interval in miles (xx.x)

. . . . . .Subset Data Card. . . . . .

Column Nos.	Item
1-5	First data value (xx.xx)
6-10	Second data value (xx.xx)
11.15	.
.	.
.	.
66-70	Fourteenth data value (xx.xx)

As an example, suppose that a roadway card set is being prepared for a 30.0 mile section of a certain highway which begins at mile post 5.0 and ends at mile post 35.0. Skid data has been recorded for two segments on this section, from mile post 5.0 to mile post 9.5 at 0.5 mile intervals and from mile post 10.0 to mile post 16.3 at 0.3 mile intervals. Card subset 3 would contain 5 cards. The first card would be a subset header indicating SN data, a starting mile post of 5.0 and a data interval of 0.5 miles. The second card would be a data card containing 10 entries. The third card would be another header giving the data type, the starting mile post (10.0) and the interval (0.3 miles). The fourth and fifth cards would contain SN Values; 14 on the fourth card and 8 on the fifth card.

Card Subsets 4, 5 and 6 (ADT, 18K and XR)

Each of these card subsets consists of one or more cards listing average daily traffic count (ADT - Subset 4), equivalent 18 kip axle count (18K - Subset 5) and cross road locations (XR - Subset 6). The format for cards in each of these subsets is identical and is shown below. Within any subset, the cards must be arranged by increasing order of mile post.

Column Nos.	Item
1-3	Data type - right justified ADT - Average daily traffic count 18K - 18 kip axle count XR - Cross road location
5-10	Data value For ADT, (xxxxxx) - right justified

	For 18K, millions of axles (xx.xxx) For XR, highway designation (xx) followed by highway number (xxxx) - right justified

Column Nos.	Item
12-16	Mile post location (xxx.x)

Card Subsets 7 thru 11 (MC, ST, DLS, CS and FN)

Each of these card subsets consists of one or more cards listing maintenance cost (MC), pavement surface type (ST), date of last surfacing (DLS), control and section (CS) and foreman number (FN). The format for these cards is shown below. Within any subset, the cards must be arranged in increasing order of mile post.

Column Nos.	Item
1-3	Data type - right justified MC - Maintenance cost ST - Surface type DLS - Date of last surfacing CS - Control and section numbers FN - Maintenance Foreman numbers
6-12	Data value For MC, $(xxxxxxx) - right justified For ST, (xx) in columns 11 and 12, where SC = seal coat AC = hot mix asphalt concrete ST = surface treatment PC = Portland cement CL = hot mix-cold laid For DLS, month (xx) cols. 8 9 last two digits of year (xx), cols. 11 and 12. For CS, control number (xxxx) - right justified cols. 6-9, and section number (xx) - right justified cols. 11-12 For FN, foreman number (xx) - right justified, cols. 11-12
14-18	From mile post no. (xxx.x)
20-24	To mile post no. (xxx.x)

Card Subset 12 (VIS)

This data subset contains visual condition survey data cards. The format for these cards is described in Reference (4). As noted there, different scoring systems are used for flexible and rigid pavements and the format for the data is

different. The type of pavement (rigid or flexible) is determined by the surface type data entered in card subset 8. The surface types SC, ST, AC and CL are assumed flexible, while PC is taken as rigid. The visual condition survey data cards must be in increasing order of mile post, and their must be entries in the surface type card subset sufficient to cover the limits of the condition survey data.

REFERENCES

1. Walker, R.S. and Hudson, W.R., "A Correlation Study of the Mays Road Meter with the Surface Dynamic Profilometer", Research Report 156-1, Center for Highway Research, University of Texas at Austin, February 1973.

3. "System SKIDR - District Observers Manual", Texas Highway Department, Planning and Research Division, Research and Development Section, January 1, 1974.

4. Epps, J.A., et.al., "Roadway Maintenance Evaluation User's Manual", Texas Transportation Institute, Texas A&M university, Research Report 151-2, September 1974.

Appendix B

COST INFORMATION FOR MAINTENANCE RATING

Mi Post - Mi Point Conversion Sheets

8 man days X 8 hrs/day X $8/hr = $512.00

GENERAL LOCATION INFORMATION

Present

Preparation	60 minutes/60X8 =	$ 8.00
Coding	1 minute per highway per county 1 X 215 = 215 min/60X8 =	29.00
Keypunch	215 cards X $.10/card =	21.50
		$58.50

SI VALUES

Present

Obtain Data

Equipment - $.27/Mi X 2500 Mi =	$ 675.00
Men - 2 men X 200 hrs X $8 =	3200.00
Per Diem one man - 25 days = 5 week	

Initial Process

Keypunch 14,500 cards X $.10 =	1450.00
Computer =	50.00
	$5870.00

MRSDP Process

Coding - 25 man days X 8hrs/day X $8/hr =	1600.00
Keypunch 1500 cards X $.10 =	150.00
	$1750.00
Total	$7620.00

SKID NUMBER

Present

Equipment & Operator =	$5000.00
Observer 200 hrs X $8 =	1600.00

Computer =	100.00
	$6700.00
MRSDP Process	248.00
Coding	
32 days X 8 hrs/day X $8/hr =	2048.00
Keypunch - 1500 X $.10	150.00
	$2198.00
Total	$9146.00

SCI VALUES

	Total	1/3 per Year
Present		
Obtain Data		
Person - 78 days X 8 hrs/day X $8/hr X 2 men =	$ 9984.00	$3328.00
Equipment - $.31/mi X 4500 mi =	1395.00	465.00
Per Diem for one man 78 days		
78 days = 15.6 weeks (15.6) X ($99.00)=	1544.00	515.00
Initial Process		
Keypunch 6000 cards X $.10 =	600.00	200.00
Computer =	50.00	17.00
	$13573.00	$4525.00
MRSDP Process		
Coding - 20 days X 8 hr/day X $8/hr =	$ 1280.00	$ 427.00
Keypunch 1200 X $.10 =	120.00	40.00
	$ 1400.00	$ 467.00
Total	$14973.00	$4992.00

ADT INFORMATION

Present	
Coding - 3 days X 8 hr/day X $8/hr =	$ 192.00
Keypunch - 880 X $.10 =	88.00
Preparation - 1 hour =	8.00
	$ 288.00

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18 KIP

Present	
Coding - 4 day X 8 hr X $8 =	$ 256.00
Keypunch - 880 X $.10 =	88.00
	$ 344.00

X ROADS

Present

Coding - 5 days X 8 hr X $8 =	$ 320.00
Keypunch 1320 cards X $.10 =	132.00
	$ 452.00

MAINTENANCE COST INFORMATION

Present

Coding - 3 days X 8 hr X $8 =	$ 192.00
Keypunch - 660 cards @ $.10 =	66.00
	$ 258.00

SURFACE TYPE INFORMATION

Present

Coding - 3 days X 8 hr X $8 =	$ 192.00
Keypunch - 1000 cards X $.10 =	100.00
	$ 292.00

DATE OF LAST SURFACING

Present

Coding - 3 days X 8 hr X $8 =	$ 192.00
Keypunch - 1000 cards X $.10 =	100.00
	$ 292.00

CONTROL SECTION

Present

Coding - 5 days X 8 hr X $8 =	$ 320.00
Keypunch - 1000 cards X $.10 =	100.00
	$ 420.00

MAINTENANCE FOREMAN NO.

Present	
Coding - 2 days X 8 hr X $8 =	$ 128.00
Keypunch - 300 cards X $.10 =	30.00
	$ 158.00

VISUAL RATING

Present	
Keypunch VIS cards = 220 X $.10 =	$ 22.00
Data Collection	
Personnel - 50 man days X 8 hr/day X $8 =	3200.00
Keypunch - 1500 cards X $.10 =	150.00
	$3372.00

SORT AND COMBINING OF THE VARIOUS DATA CARD TYPES

Present	
Personnel - 3 men X 1 day X 8 hrs X $8 =	$ 192.00

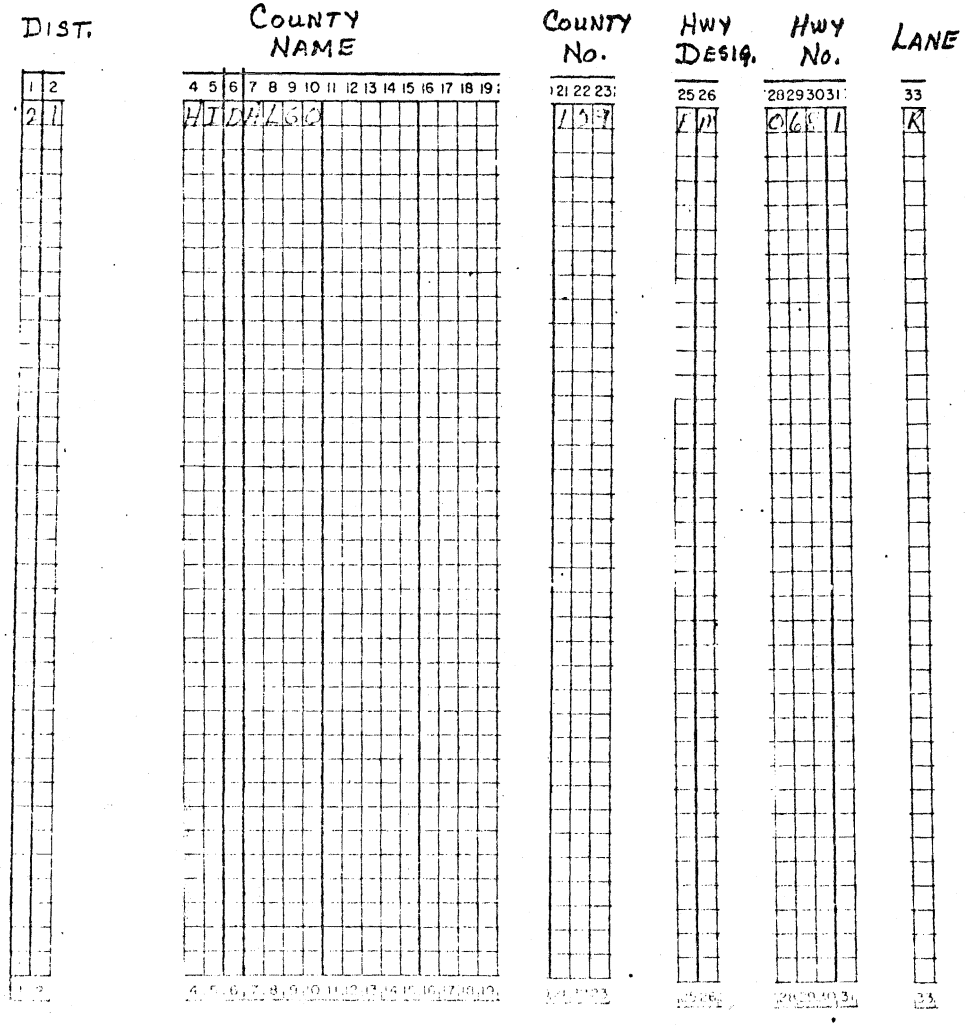
Computer	
D-19 Hardware and Handling	$ 200.00
D-19 Hardware and Handling (Corrections)	50.00
Terminal Charges (500 pages of output including Corrections)	50.00
	$ 300.00

(The data consists of about 9000 cards per District per year)

APPENDIX C

Example Including Code Sheets, Punched Cards, and Final Printout Plot

ROADWAY HEADER CARD



FOR HWY DESIG. USE:

IH - INTERSTATE
US - U.S. HIGHWAY
SH - STATE HIGHWAY
FM - FARM OR RANCH ROAD
SP - SPUR
LP - LOOP
PR - PARK ROAD
RR - RECREATION ROAD

MAYS METER HEADER CARD

DATA TYPE	BEGINNING MILE POST	DATA POINT INTERVAL (MI)
SI	0.3	0.2

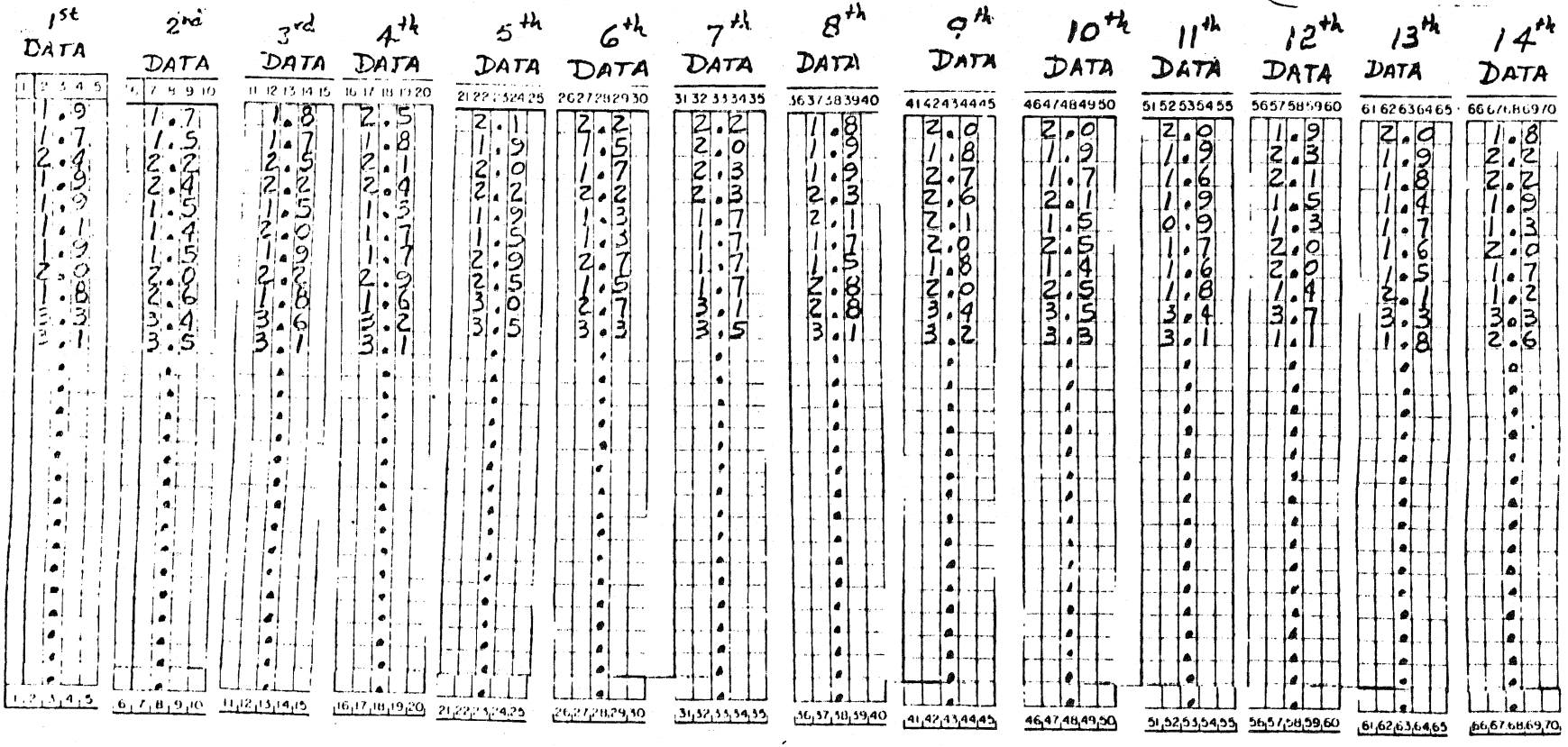
669-1
24.162 – 29.017
5803

HIDALGO (LANE R)
FM 681
669-1 0 – 11.939
5800
669-1 11.939 – 21.797
5801
669-1 21.797 – 24.162
5802

28.9 EMP

MAYS METER DATA CARD

1st DATA
2nd DATA
3rd DATA
4th DATA
5th DATA
6th DATA
7th DATA
8th DATA
9th DATA
10th DATA
11th DATA
12th DATA
13th DATA
14th DATA



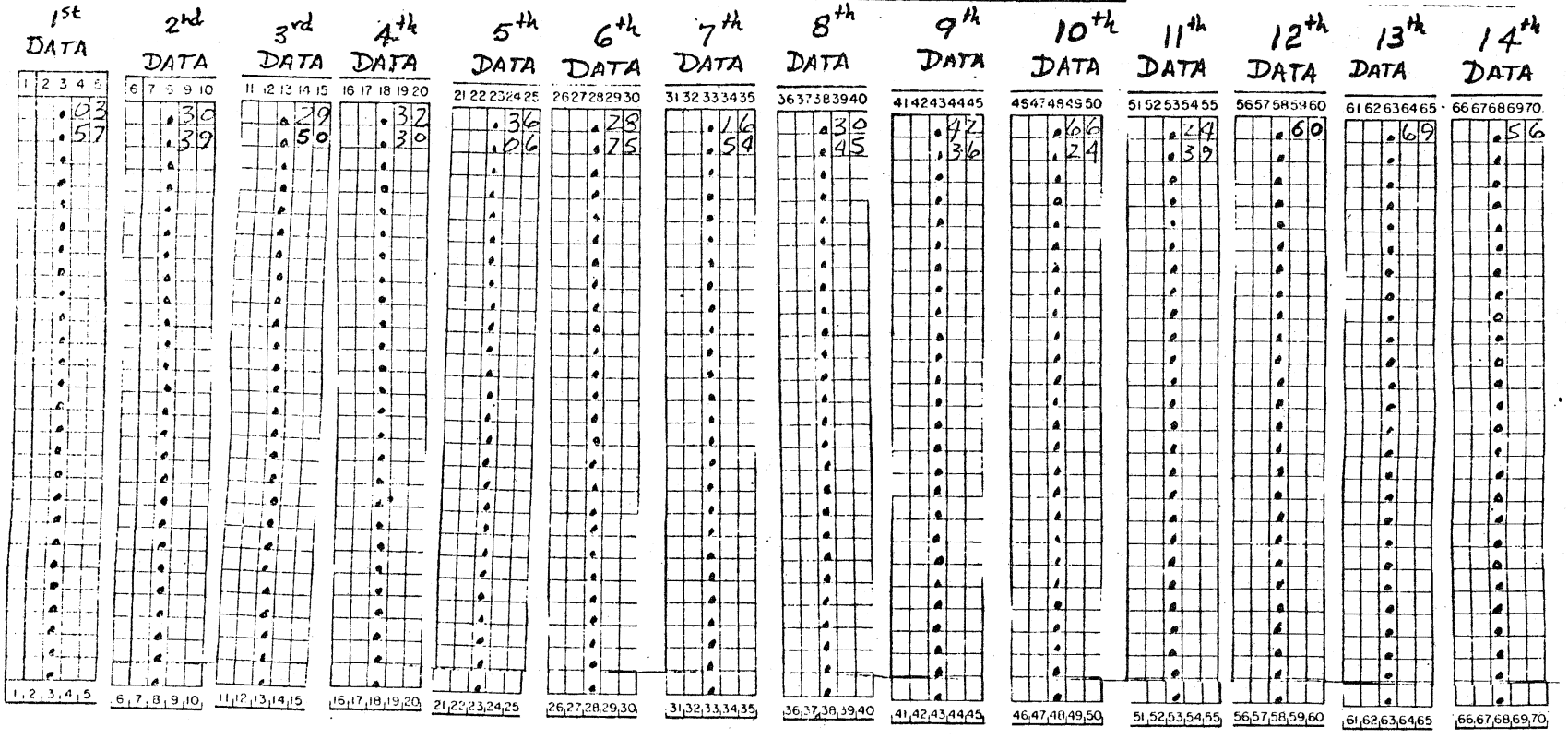
144
2
28.8

DYNAFLECT HEADER CARD

DATA TYPE	BEGINNING MILE POST	DATA POINT INTERVAL (MI)
5	0.0	0.5

HIDALGO #109
FM 631

DYNAFLECT DATA CARD

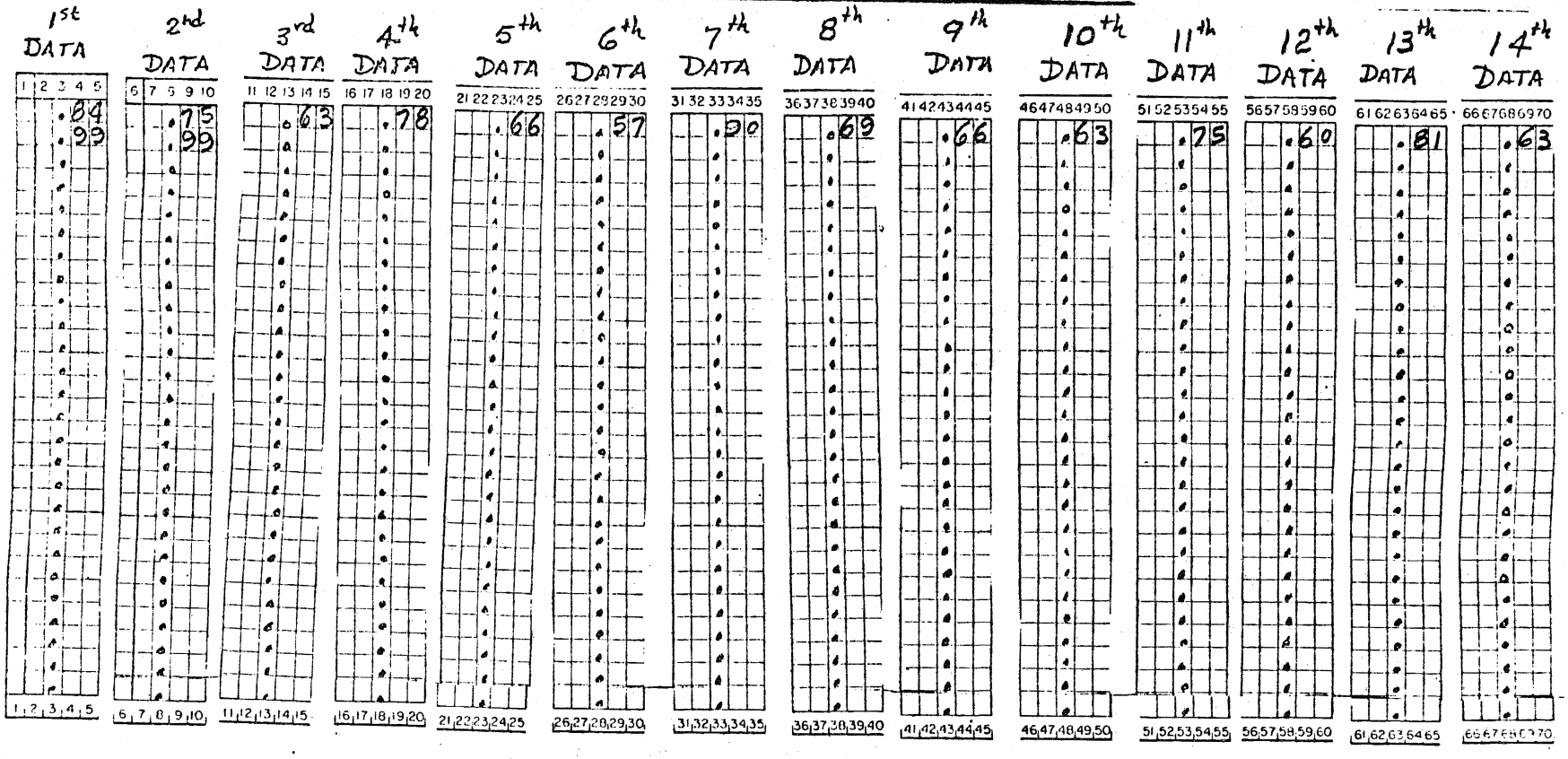


FM-681

DYNAFLECT HEADER CARD

DATA TYPE	BEGINNING MILE POST	DATA POINT INTERVAL (FT)
1 2 3	5 6 7 8 9	11 12 13 14
S C T	1 4 . 0	0 . 5

DYNAFLECT DATA CARD

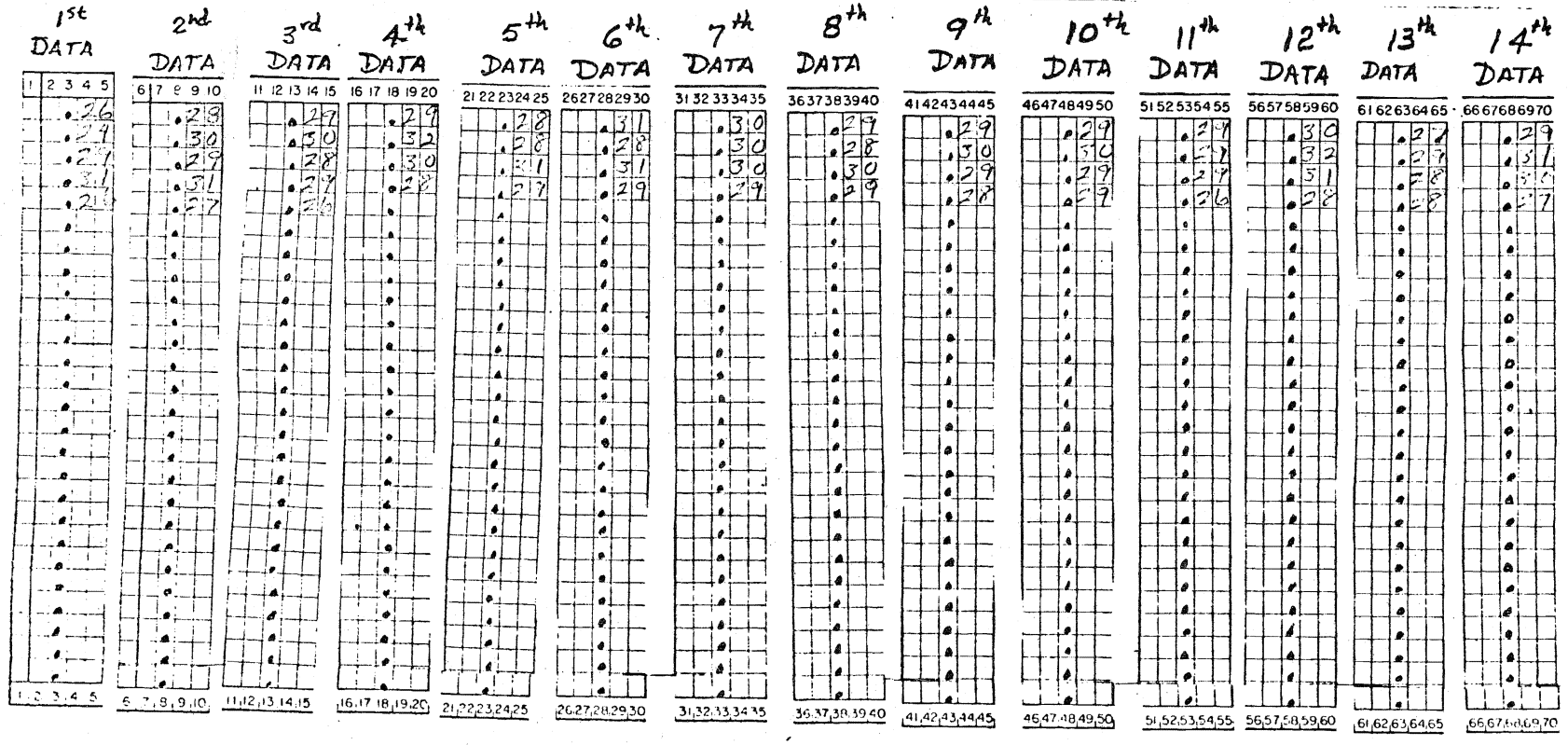


SKID RESISTANCE HEADER CARD

Hidalgo #109
FM 681
669-01 0.0 to 11.731
5800

DATA TYPE	BEGINNING MILE POST	DATA POINT INTERVAL (MI)
1 2 3	5 6 7 8 9	11 12 13 14
S M	0 . 2	0 . 2

SKID RESISTANCE DATA CARD



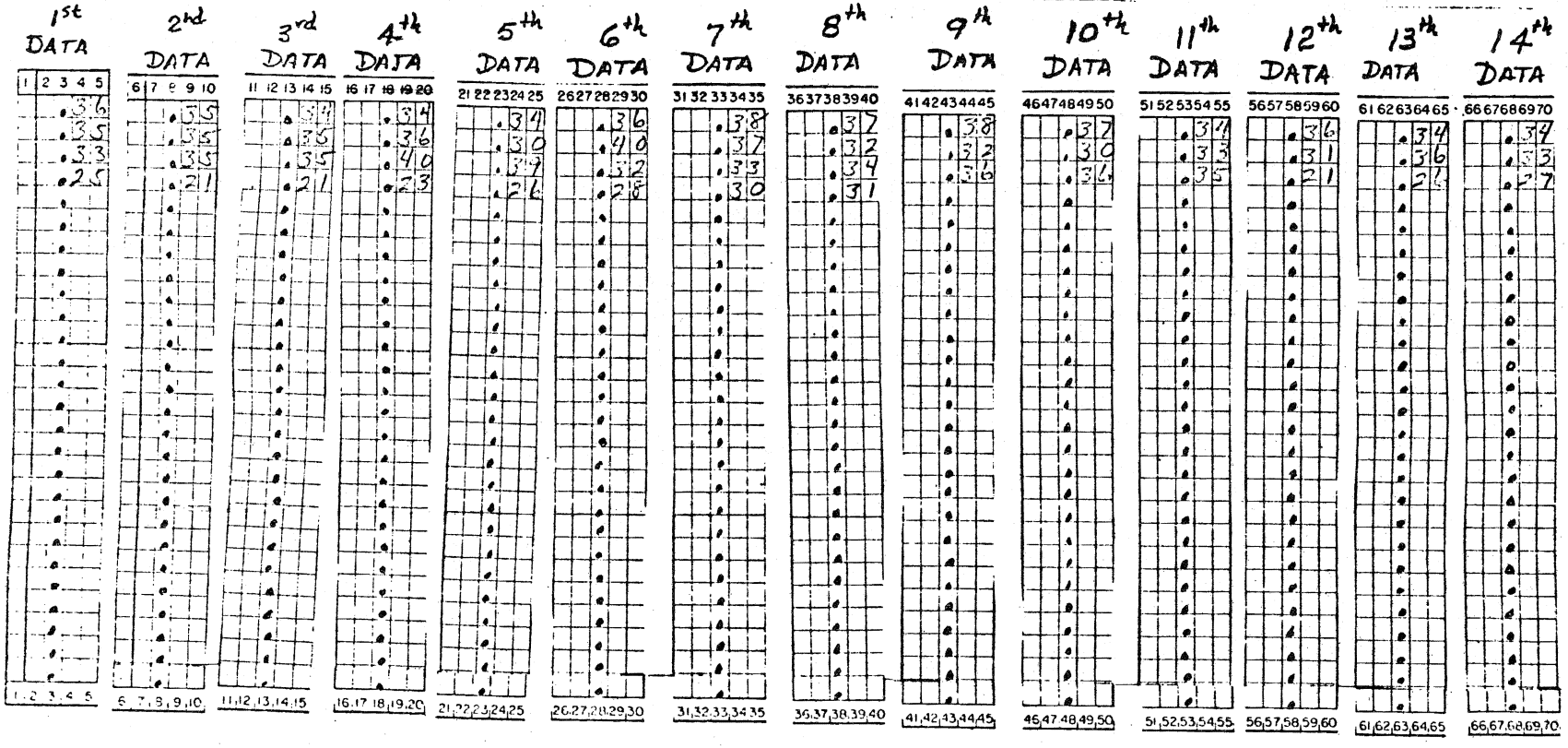
SKID RESISTANCE HEADER CARD

Hidalgo #109
Fm 681
669-01 11.939 to 21.797
5801

DATA TYPE	BEGINNING MILE POST	DATA POINT INTERVAL (MI)
1 2 3	5 6 7 8 9	11 12 13 14
S N	1 1 . 9	0 . 2

50
10.0
9.8
11.9
21.7

SKID RESISTANCE DATA CARD

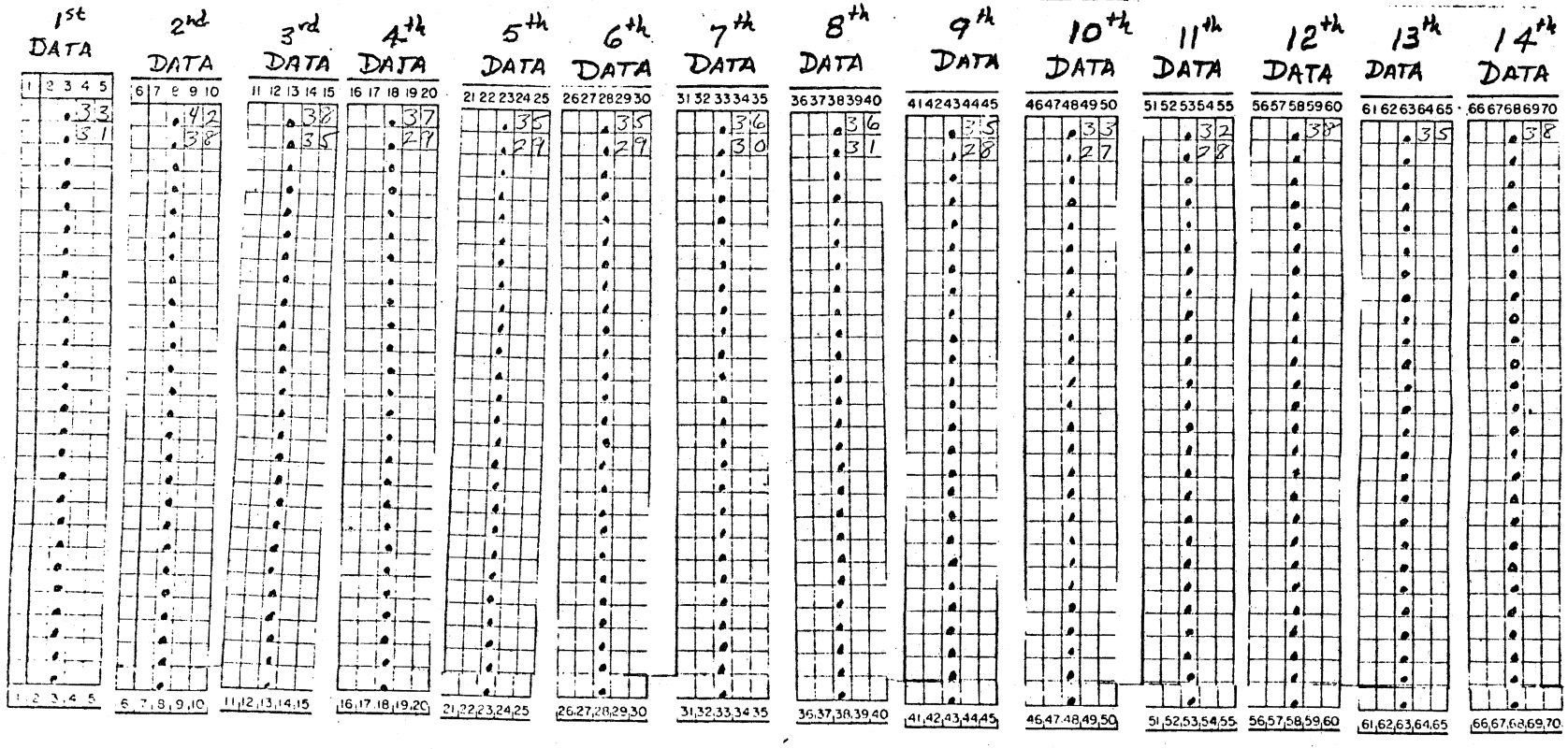


SKID RESISTANCE HEADER CARD

Hidalgo # 109
FM 681 669-01
24.162 to 29.017
5803

DATA TYPE	BEGINNING MILE POST	DATA POINT INTERVAL (MI)
1 2 3	5 6 7 8 9	11 12 13 14
SN	24.12	0.2

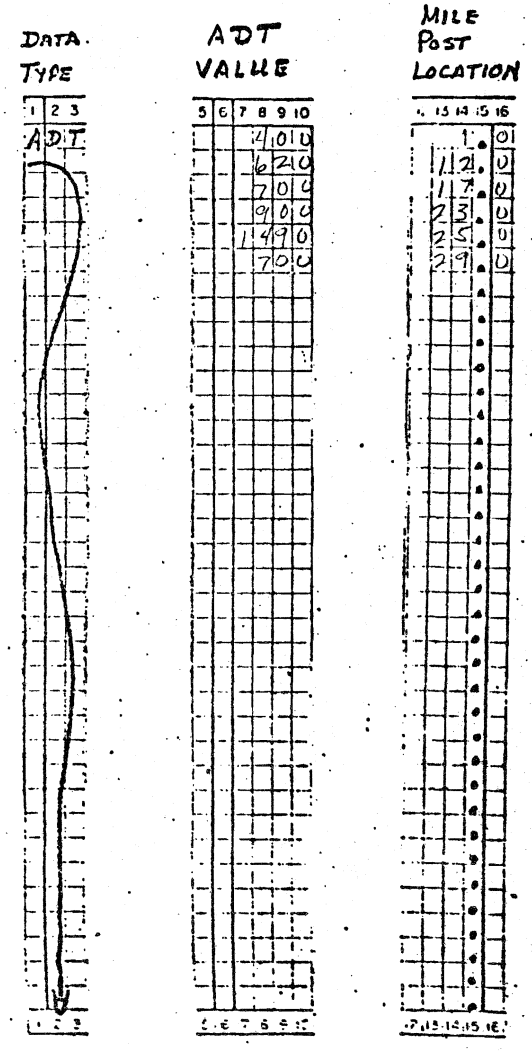
SKID RESISTANCE DATA CARD



ADT

Hidalgo Co., # 109.

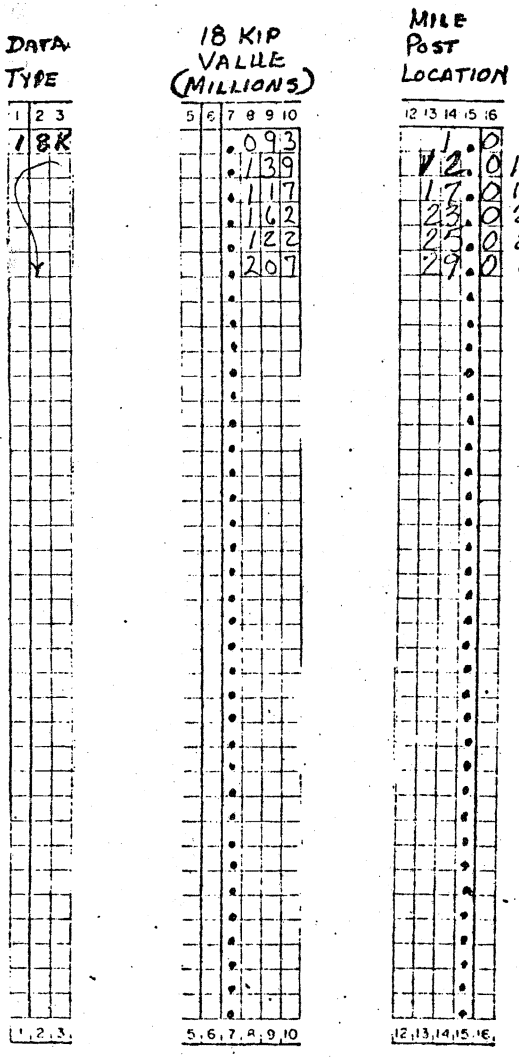
FM 681



18 KIP EQUIVALENCY

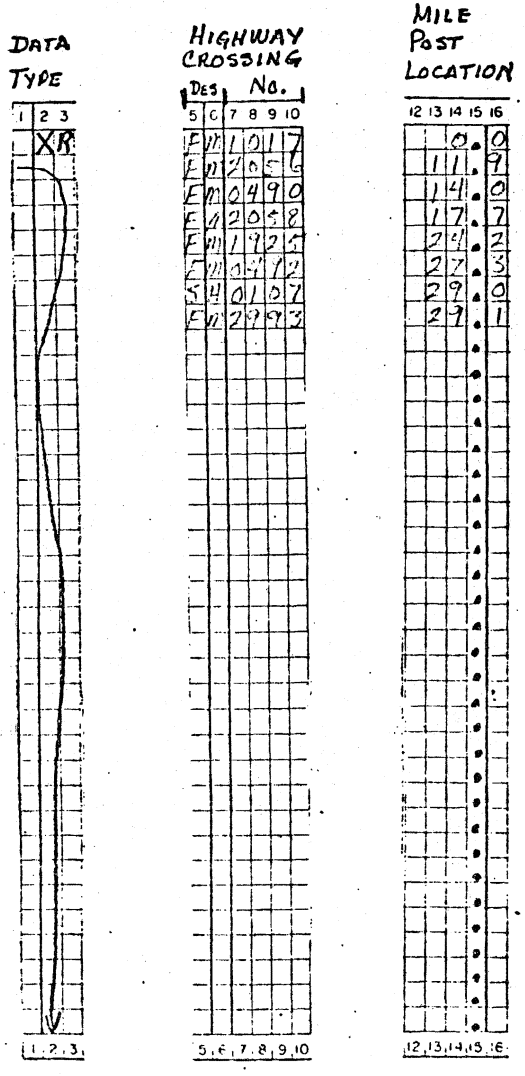
(-1)

Hidalgo #107
FM 681



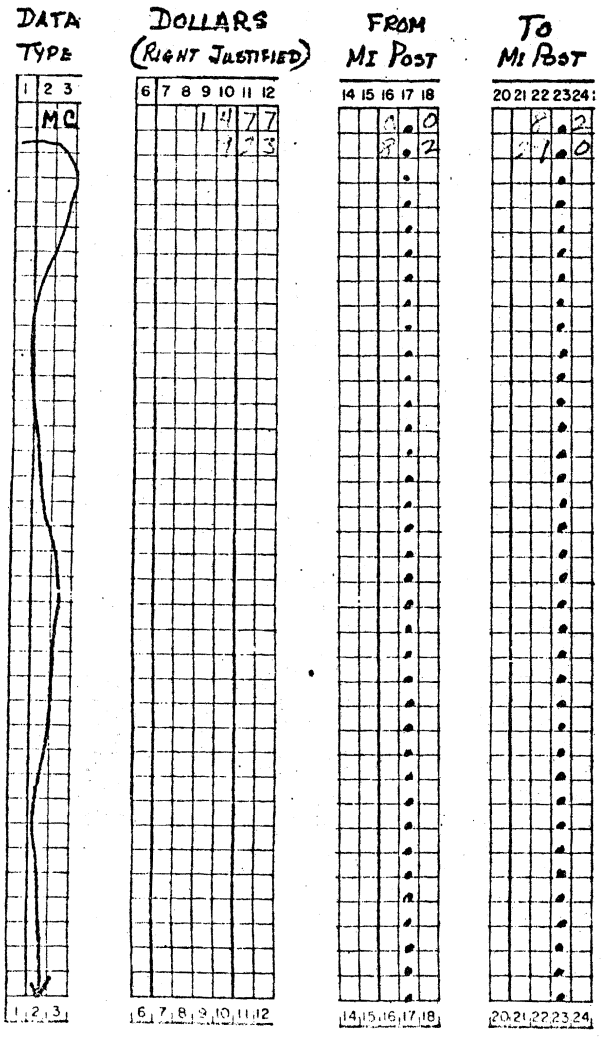
CROSS ROAD LOCATION

(10)

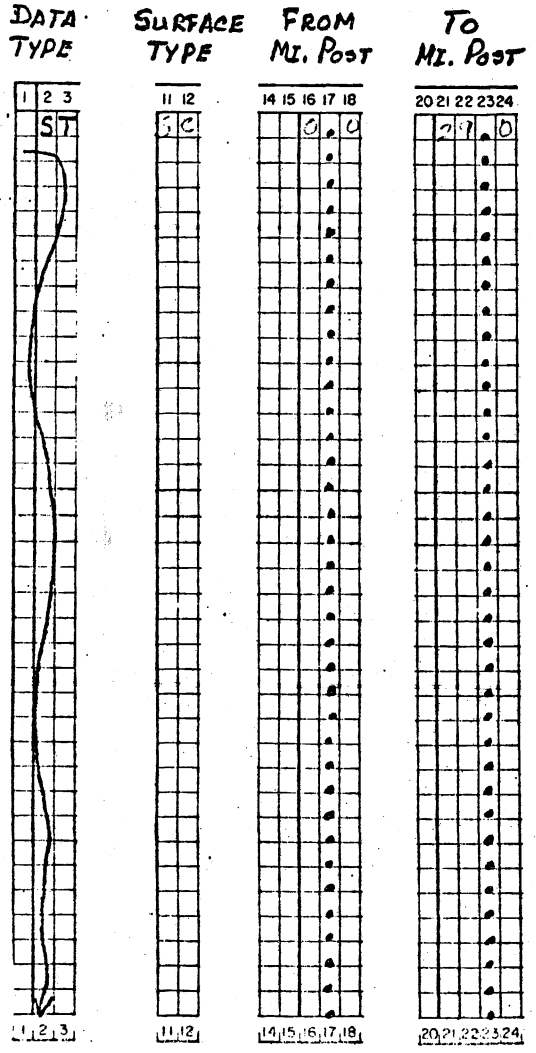


MAINTENANCE COST

(11)



PAVEMENT SURFACE TYPE (12)

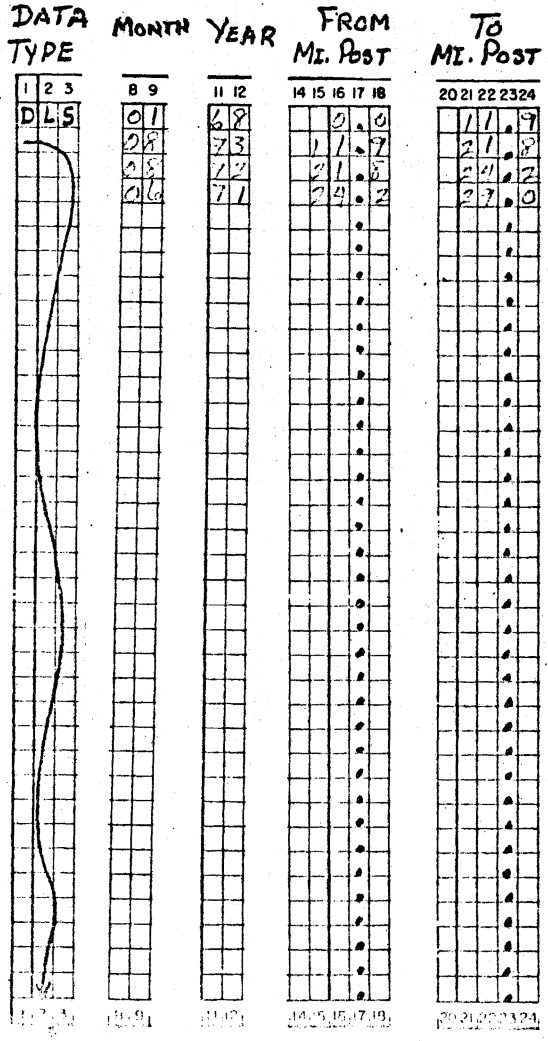


SURFACE TYPE CODE

SC = SEAL COAT
AC = HOT MIX ASPHALTIC CONC.
ST = SURFACE TREATMENT
PC = PORTLAND CEMENT
CL = HOT MIX - COLD LAID

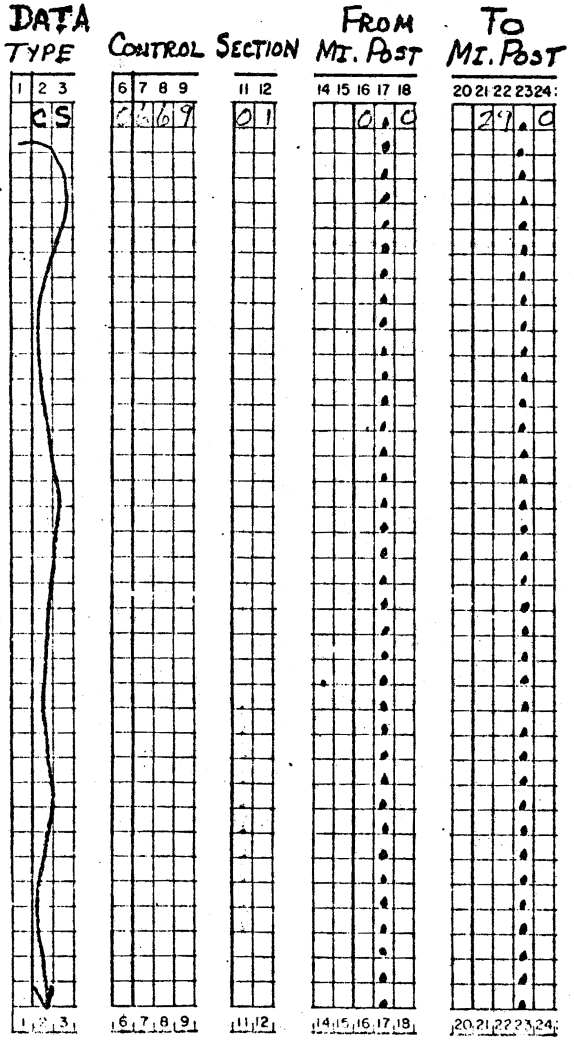
DATE OF LAST SURFACING

(13)



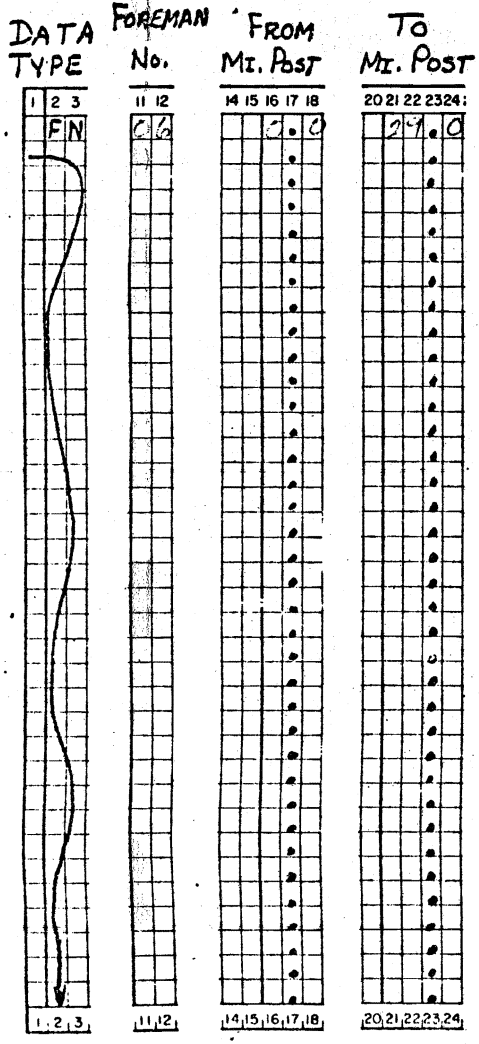
CONTROL AND SECTION

(14)



FOREMAN NUMBER

(15)



Maintenance Rating Form for Flexible Pavements

DISTRICT NO. ☐☐

RATERS ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

DATE MONTH ☐☐ DAY ☐☐ YEAR ☐☐☐☐

LOCATION

PAVEMENT: Rutting (%Area: ① 1-15, ② 16-30, ③ >30); Raveling (%Area: ① 1-15, ② 16-30, ③ >30); Flushing (%Area: ① 1-15, ② 16-30, ③ >30); Corrugations (%Area: ① 1-15, ② 16-30, ③ >30); Alligator Cracking (%Area: ① 1-5, ② 6-25, ③ >25); Longitudinal Cracking (Lin Ft per Sta/Ln: ① 10-99, ② 100-199, ③ >200); Transverse Cracking (No. per Sta: ① 1-4, ② 5-9, ③ >10); Cracks (1) Sealed (2) Partially Sealed (3) Not Sealed; Patching (%Area: ① 1-5, ② 6-15, ③ >16; Good, Fair, Poor); Failures / Mile (① 1-5, ② 6-10, ③ >10)

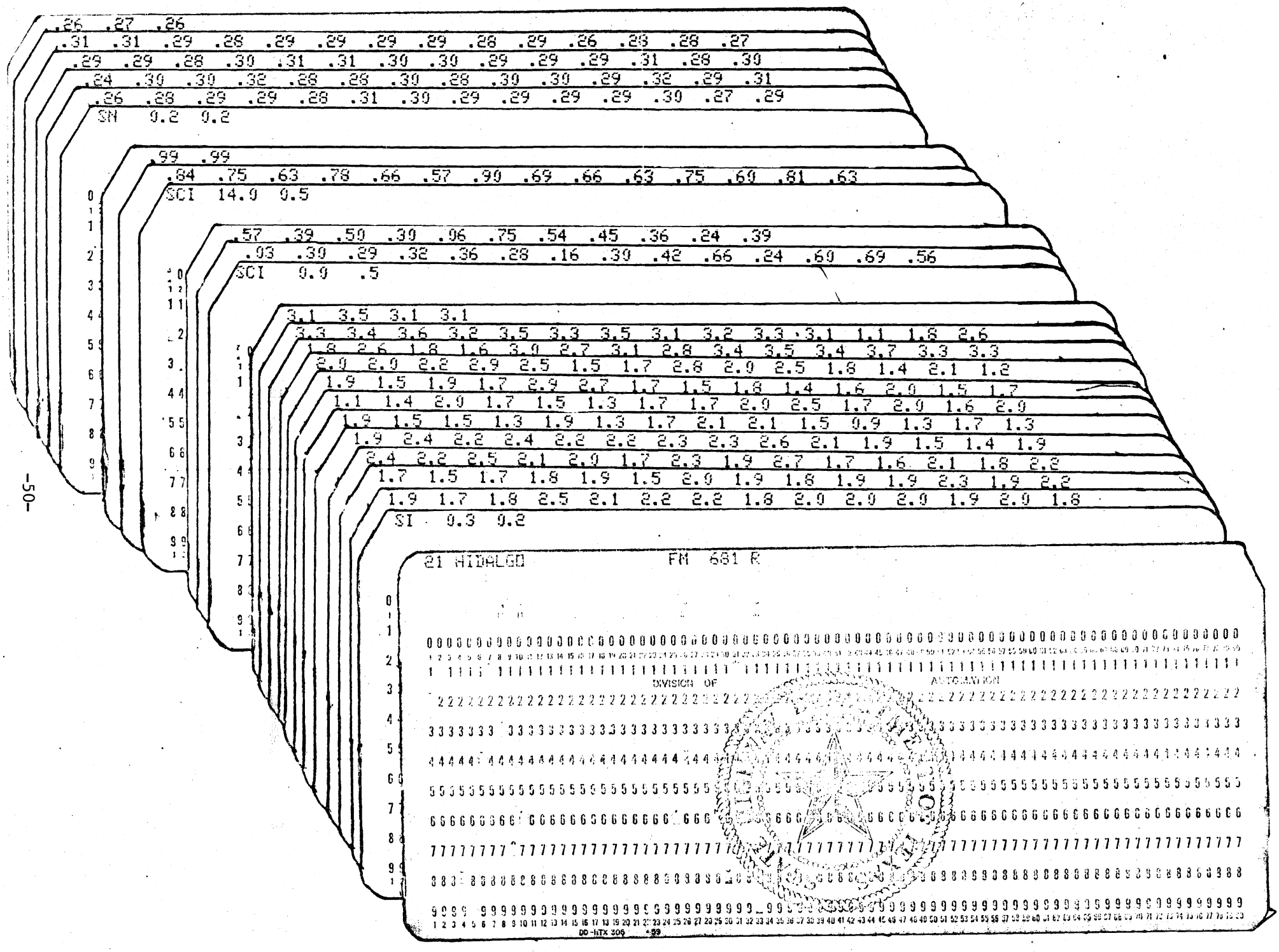
SHOULDER: Paved (Ride, Contrast, Pavement Edge, Shoulder Edge, Cracks, Raveling or Flushing, Vegetation); Unpaved (Pavement Edge, Rutting, Corrugations, Loose Rock)

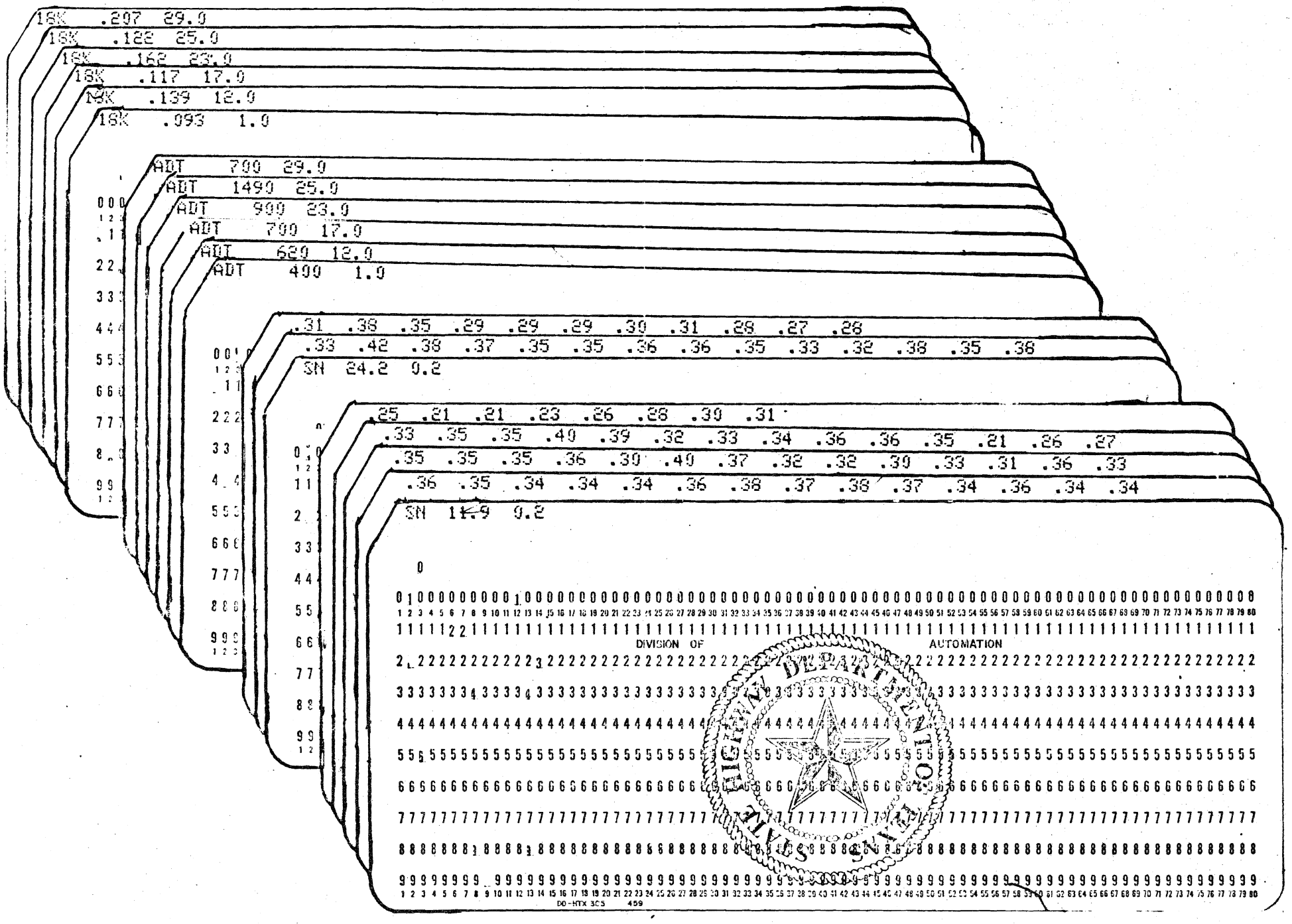
ROADSIDE AND DRAINAGE: Litter, Mowing, Vegetation, Slope Erosion, Culverts, Ditches, Outfall Channels, Roadside Drainage

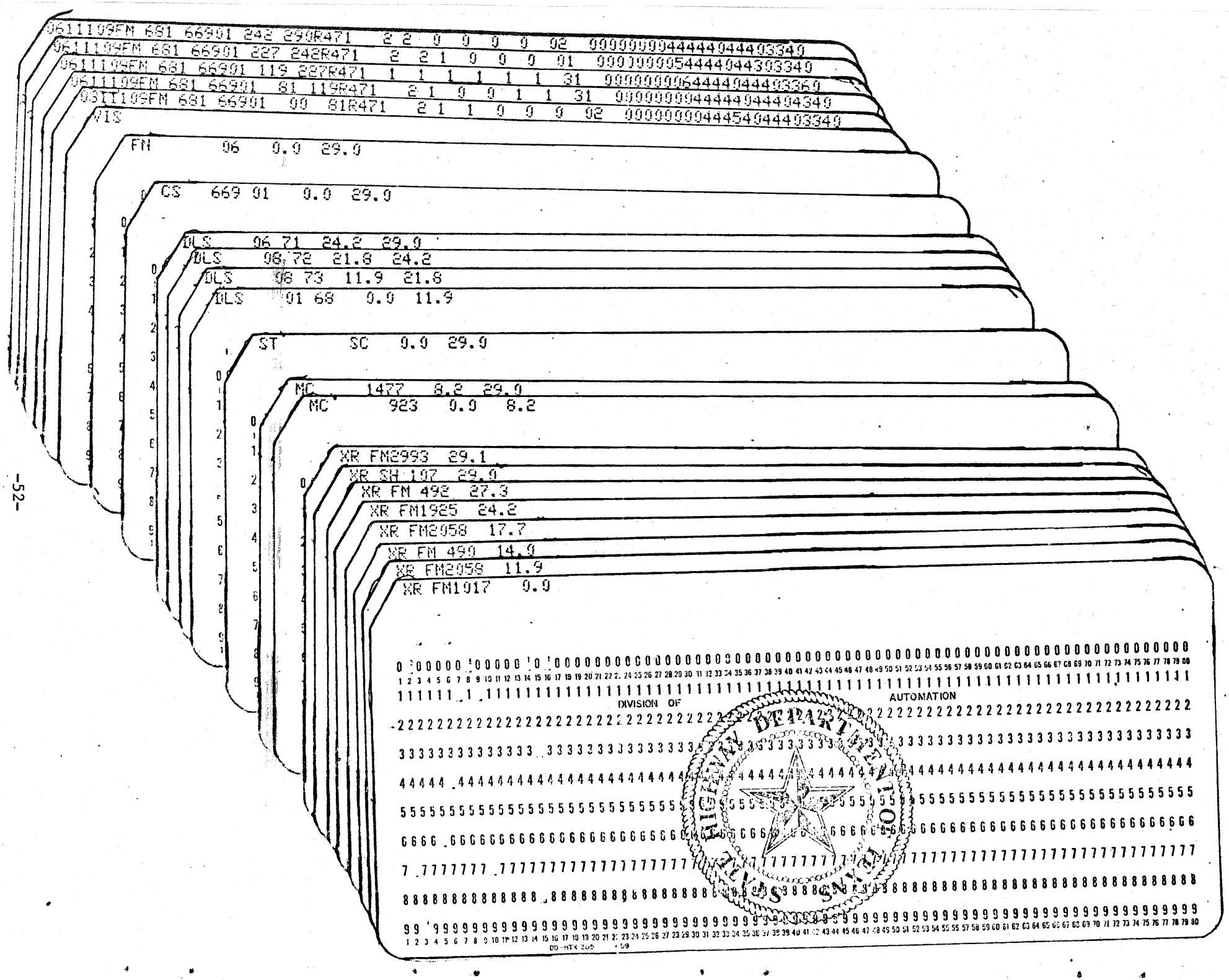
TRAFFIC SERVICE: Guardrails, Signs, Delineators, Striping, Auxiliary Markings

OTHER

Foreman No.	Highway Class	County No.	Highway No.	Control	Section	From	To	Lane	Mays Meter	Rutting Slight	Raveling Slight	Raveling Moderate	Flushing Slight	Flushing Moderate	Corrugations Slight	Alligator Cracking Slight	Longitudinal Cracking Slight	Transverse Cracking Slight	Cracks	Patching Good	Failures / Shoulder / Roadside and Drainage / Traffic Service (as written)	Other
03	11	109	FM 681	669	01	0.0	8.1	R	47	1		2	1		1	0	0	0	0	2	0000000044454044433340	
06	11	109	FM 681	669	01	8.1	11.9	R	47	1		2	1		0	0	1	1	3	1	0000000044444044404340	
06	11	109	FM 681	669	01	11.9	22.7	R	47	1	1		1		1	1	1	1	3	1	0000000064444044403360	
06	11	109	FM 681	669	01	22.7	24.2	R	47	1		2		2	1	0	0	0	0	1	0000000054444044303340	
06	11	109	FM 681	669	01	24.2	29.0	R	47	1		2	2		0	0	0	0	0	2	0000000044444044403340	


.26 .27 .26
.31 .31 .29 .28 .29 .29 .29 .29 .28 .29 .26 .28 .28 .27
.29 .29 .28 .30 .31 .31 .30 .30 .29 .29 .29 .31 .28 .30
.24 .30 .30 .32 .28 .28 .30 .28 .30 .30 .29 .32 .29 .31
.26 .28 .29 .29 .28 .31 .30 .29 .29 .29 .29 .30 .27 .29
SN 0.2 0.2
.99 .99
.84 .75 .63 .78 .66 .57 .90 .69 .66 .63 .75 .69 .81 .63
SCI 14.9 0.5
.57 .39 .50 .30 .96 .75 .54 .45 .36 .24 .39
.03 .30 .29 .32 .36 .28 .16 .30 .42 .66 .24 .60 .69 .56
SCI 0.9 .5
3.1 3.5 3.1 3.1
3.3 3.4 3.6 3.2 3.5 3.3 3.5 3.1 3.2 3.3 3.1 1.1 1.8 2.6
1.8 2.6 1.8 1.6 3.0 2.7 3.1 2.8 3.4 3.5 3.4 3.7 3.3 3.3
2.0 2.0 2.2 2.9 2.5 1.5 1.7 2.8 2.0 2.5 1.8 1.4 2.1 1.2
1.9 1.5 1.9 1.7 2.9 2.7 1.7 1.5 1.8 1.4 1.6 2.0 1.5 1.7
1.1 1.4 2.9 1.7 1.5 1.3 1.7 1.7 2.9 2.5 1.7 2.0 1.6 2.9
1.9 1.5 1.5 1.3 1.9 1.3 1.7 2.1 2.1 1.5 0.9 1.3 1.7 1.3
1.9 2.4 2.2 2.4 2.2 2.2 2.3 2.3 2.6 2.1 1.9 1.5 1.4 1.9
2.4 2.2 2.5 2.1 2.9 1.7 2.3 1.9 2.7 1.7 1.6 2.1 1.8 2.2
1.7 1.5 1.7 1.8 1.9 1.5 2.0 1.9 1.8 1.9 1.9 2.3 1.9 2.2
1.9 1.7 1.8 2.5 2.1 2.2 2.2 1.8 2.0 2.0 2.0 1.9 2.0 1.8
SI 0.3 0.2
21 HIDALGO FM 681 R
DIVISION OF AUTOMATION
DD-HTX 306 .99


18K .207 29.0
18K .122 25.0
18K .162 23.0
18K .117 17.0
18K .139 12.0
18K .093 1.0
ADT 700 29.0
ADT 1490 25.0
ADT 900 23.0
ADT 700 17.0
ADT 620 12.0
ADT 400 1.0
.31 .38 .35 .29 .29 .29 .30 .31 .28 .27 .28
.33 .42 .38 .37 .35 .35 .36 .36 .35 .33 .32 .38 .35 .38
SN 24.2 0.2
.25 .21 .21 .23 .26 .28 .30 .31
.33 .35 .35 .40 .39 .32 .33 .34 .36 .36 .35 .21 .26 .27
.35 .35 .35 .36 .30 .40 .37 .32 .32 .30 .33 .31 .36 .33
.36 .35 .34 .34 .34 .36 .38 .37 .38 .37 .34 .36 .34 .34
SN 11.9 0.2
DIVISION OF AUTOMATION
DO-HTX 305 459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VIS
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CS 669 01 0.0 29.9
DLS 06 71 24.2 29.9
DLS 06 72 21.8 24.2
DLS 06 73 11.9 21.8
DLS 01 68 0.0 11.9
ST SC 0.0 29.9
MC 1477 8.2 29.9
MC 923 0.0 8.2
XR FM2993 29.1
XR SH 107 29.9
XR FM 492 27.3
XR FM1925 24.2
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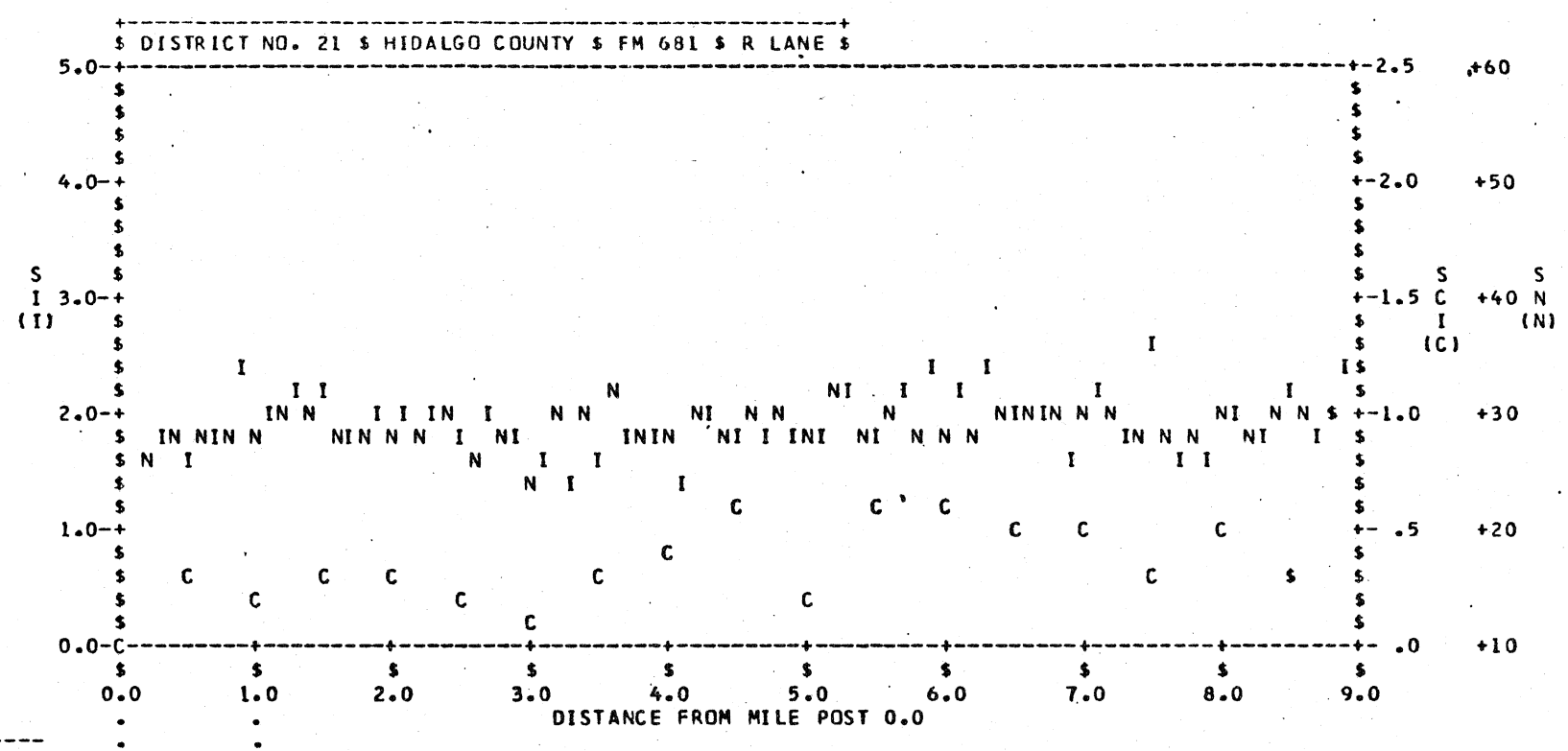
DIVISION OF
AUTOMATION
DEPARTMENT OF TRANSPORTATION
TEXAS

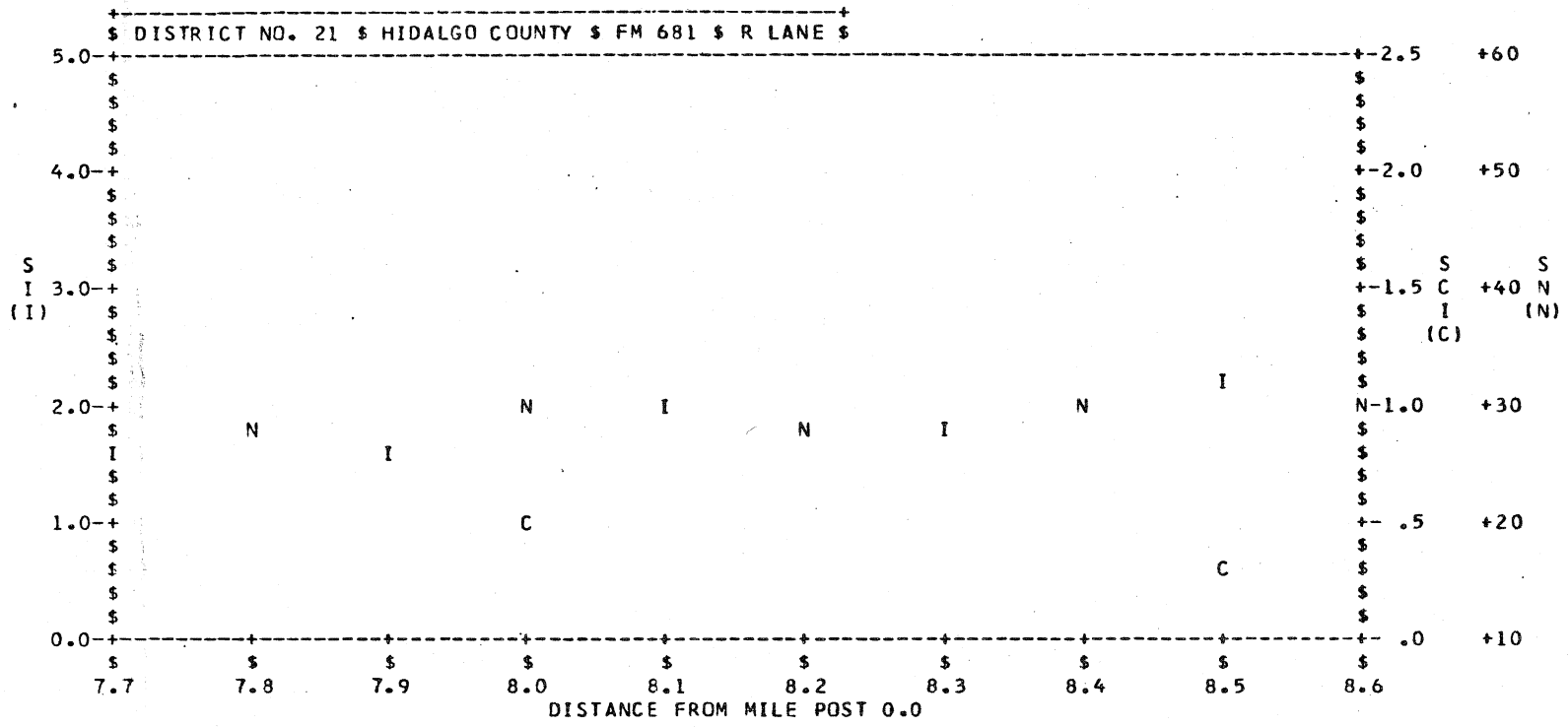


CR$	F
RO$	M
OA$	1
SD$	0
SS$	1
	7

AVERAGE DAILY TRAFFIC 400

18 KIP EQUIV. AXLES 0.093

CONTROL-SECTION	669-1
SURFACE TYPE	SC
DATE OF LAST SURFACE	1/68
DOLLAR COST/MILE	923
COST/BENIFIT RATIO	13.573
FOREMAN NO.	6
PAVEMENT RATING	76
SHOULDER RATING	60
ROADSIDE RATING	67
DRAINAGE RATING	60
TRAFFIC SERV. RATING	80



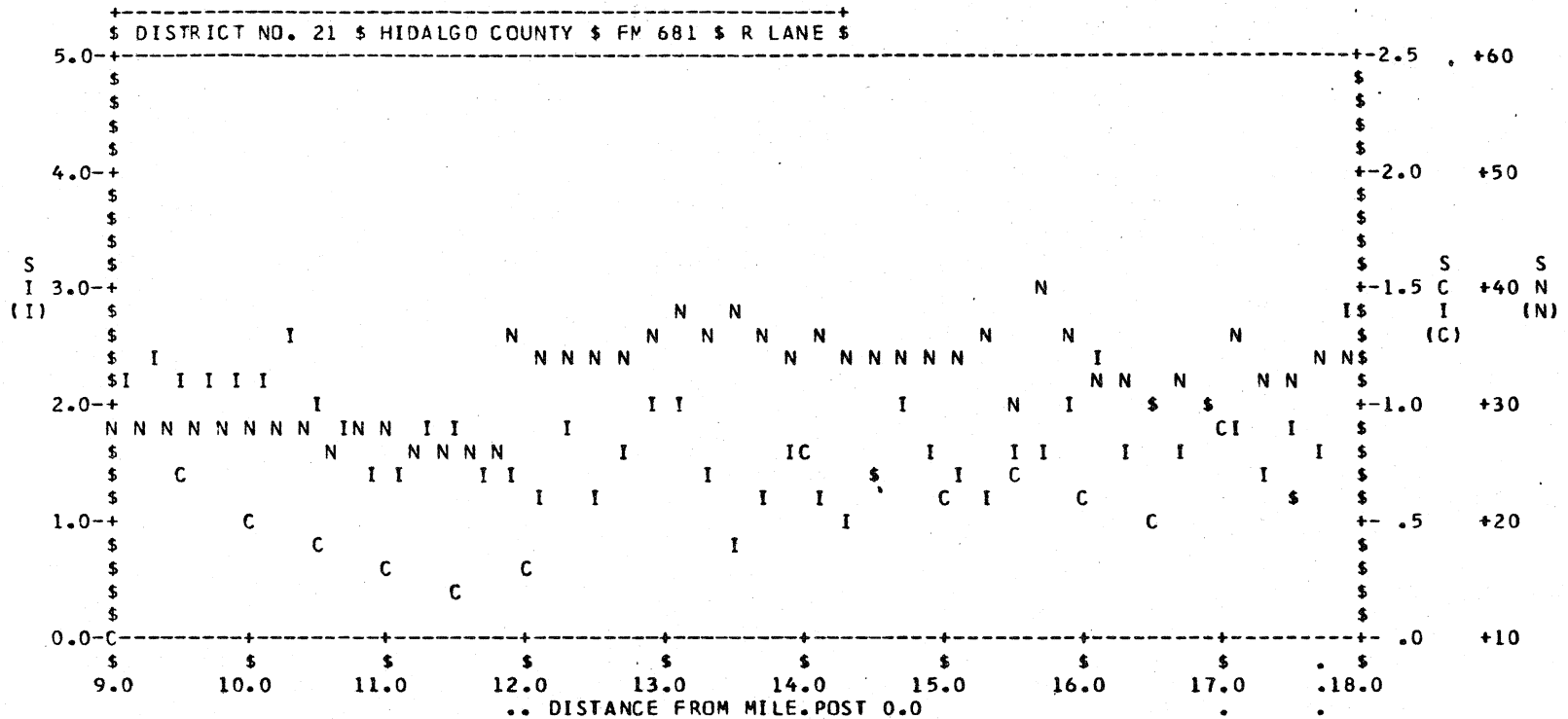
-54-

CR$
RO$
OA$
SD$
SS$

AVERAGE DAILY TRAFFIC

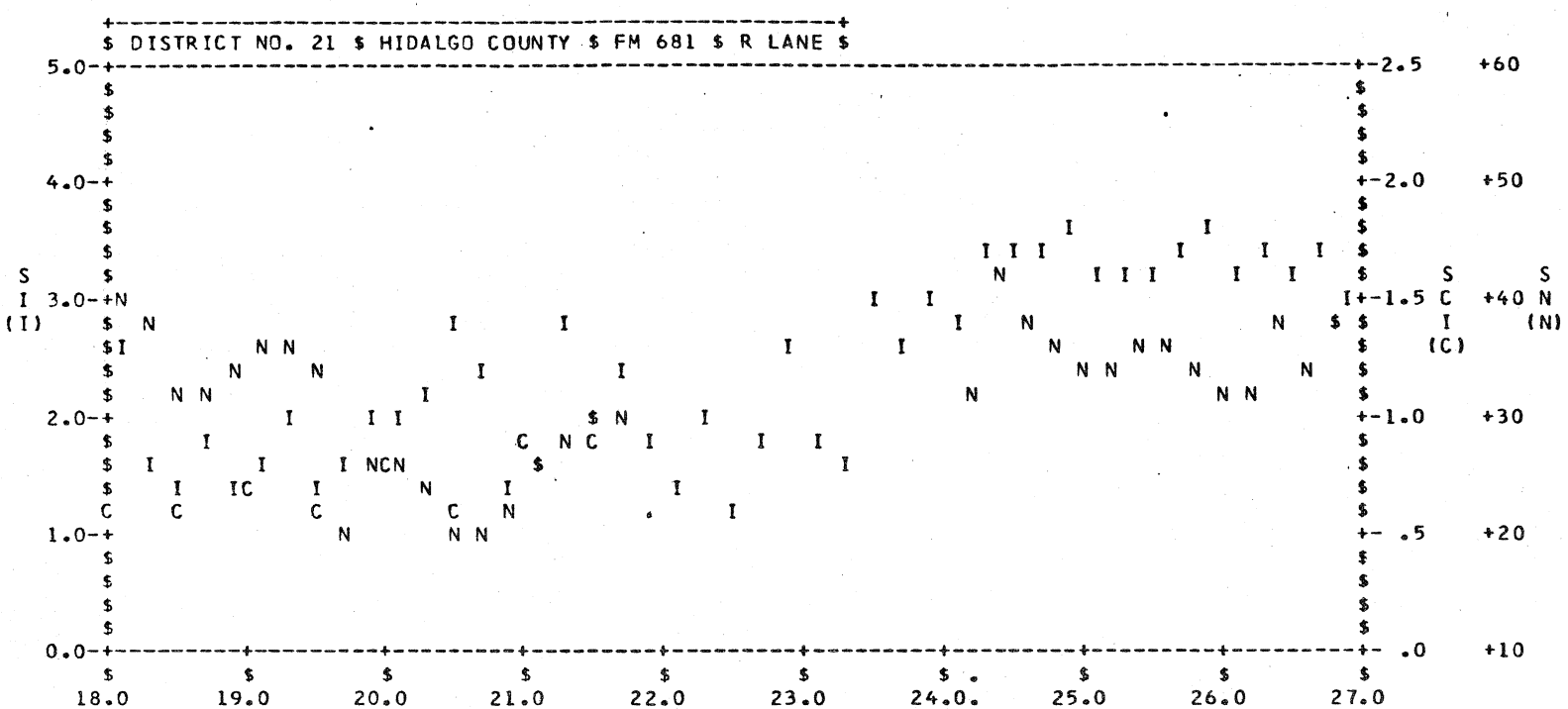
18 KIP EQUIV. AXLES

CONTROL-SECTION	669-1		
SURFACE TYPE	SC		
DATE OF LAST SURFACE	1/68		
DOLLAR COST/MILE	923	I	1477
COST/BENIFIT RATIO	13.573	I 13.573	I 21.720
FOREMAN NO.	6		
PAVEMENT RATING	76	I	75
SHOULDER RATING	60	I	60
ROADSIDE RATING	67	I	70
DRAINAGE RATING	60	I	60
TRAFFIC SERV. RATING	80	I	78



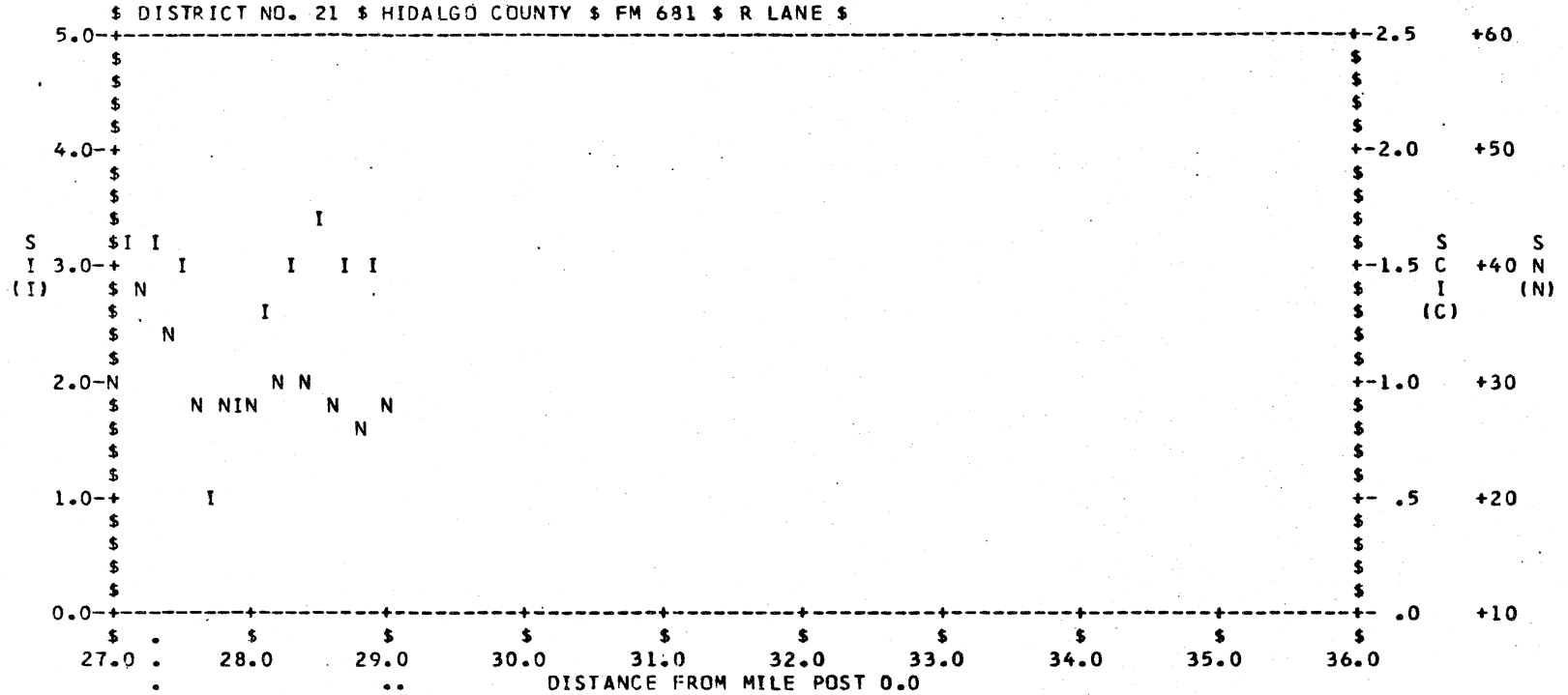
CR$	F.	F	F
RO$	M.	M	M
OA$	2.		2
SD$	0.	4	0
SS$	5.	9	5
	8.	0	8
AVERAGE DAILY TRAFFIC	620		700
18 KIP EQUIV. AXLES	0.139		0.117

CONTROL-SECTION		669-1	
SURFACE TYPE		SC	
DATE OF LAST SURFACE	1/68	I	8/73
DOLLAR COST/MILE		1477	
COST/BENIFIT RATIO	21.720	I	22.723
FOREMAN NO.		6	
PAVEMENT RATING	75	I	72
SHOULDER RATING	60	I	50
ROADSIDE RATING	70	I	70
DRAINAGE RATING	60	I	60
TRAFFIC SERV. RATING	78	I	76



-56-

CR$			
RO$			
OA$			
SD$			
SS$			
		FM 1925	
AVERAGE DAILY TRAFFIC		900	1490
18 KIP EQUIV. AXLES		0.162	0.122
CONTROL-SECTION		669-1	
SURFACE TYPE		SC	
DATE OF LAST SURFACE	8/73	8/72	6/71
DOLLAR COST/MILE		1477	
COST/BENIFIT RATIO	22.723	22.44	21.405
FOREMAN NO.		6	
PAVEMENT RATING	72	71	78
SHOULDER RATING	50	55	60
ROADSIDE RATING	70	70	70
DRAINAGE RATING	60	63	60
TRAFFIC SERV. RATING	76	80	80



CR$	F SF
RO$	M HM
OA$	2
SD$	4 19
SS$	9 09
	2 73

AVERAGE DAILY TRAFFIC 700

18 KIP EQUIV. AXLES 0.207

CONTROL-SECTION	669-1
SURFACE TYPE	SC
DATE OF LAST SURFACE	6/71
DOLLAR COST/MILE	1477
COST/BENIFIT RATIO	21.405
FOREMAN NO.	6
PAVEMENT RATING	78
SHOULDER RATING	60
ROADSIDE RATING	70
DRAINAGE RATING	60
TRAFFIC SERV. RATING	80