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Wayne State University

COLLEGE OF ENGINEERING

PAVEMENT MARKING MANAGEMENT INFORMATION SYSTEM (PM-MIS)

FINAL REPORT

by

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Prepared in cooperation with

The Michigan Department of Transportation

and

U.S. Department of Transportation

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NOTICE

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 the policies of the Michigan Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

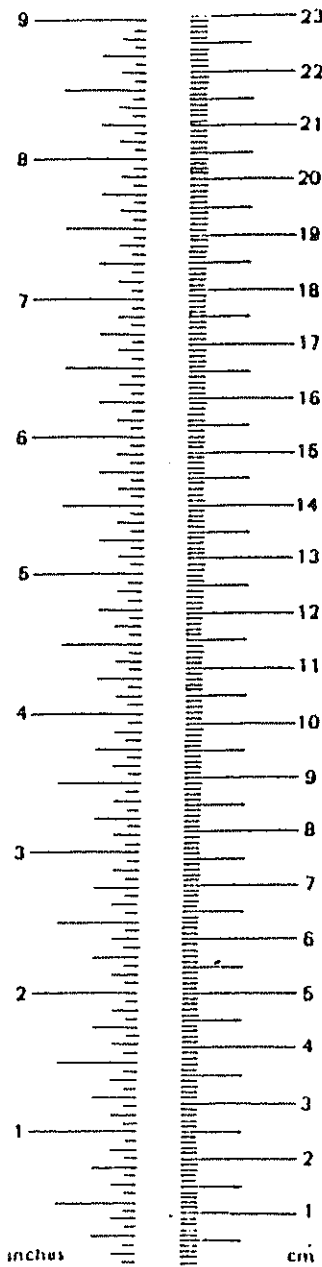
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16. Abstract The objective of this study was to develop a software using DBASE III Plus for pavement marking management information system. Six data bases were developed as a part of this effort to store marking and cost-related information. A software named Pavement Marking Management Information System (PM-MIS) was also designed with the following capabilities: <ul style="list-style-type: none"> ● Data entry ● Editing ● Updating ● Deleting ● Long-term budgeting ● Cost-effectiveness analysis Furthermore, a literature search was conducted and guidelines for various marking material use, as practiced by various agencies, were identified.		13. Type of Report and Period Covered Final Report	
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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in ²	square inches	6.6	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	16	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cup	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.96	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

¹ 1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Min. Publ. 286, Units of Weight and Measures, Price \$2.26 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.6	acres	
MASS (weight)				
g	grams	0.036	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	36	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

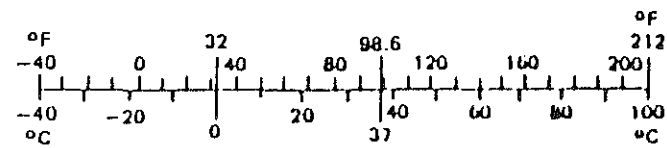


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Introduction

In 1986, the Michigan Department of Transportation (MDOT) retained the services of Wayne State University to develop a software for a pavement marking management information system. The primary activities of this contract consisted of: 1) establishing system requirements, 2) designing system and developing software, 3) providing system training and documentation, and 4) developing guidelines for pavement marking material use.

Establishing System Requirements: A meeting was conducted between the Contractor and Michigan Department of Transportation personnel at Wayne State University, Detroit. The Contractor demonstrated the proposed software and obtained comments from MDOT personnel on the required data elements and report format. This information was later used to design the software.

Designing System and Developing Software: A software called "Pavement Marking Management Information System (PM-MIS)" was designed as a part of this activity. PM-MIS consists of three subsystems to represent three types of marking configurations, namely:

- Lane/Edgeline Subsystem (LES)
- Special Marking Subsystem (SMS)
- Ramp Lane/Edgeline Subsystem (RES)

Each subsystem is equipped with auxiliary programs designed to add, modify and extract data items. It is designed for use on IBM-XT (or compatible) microcomputer and structured with DBASE III Plus file management system.

Each subsystem consists of two data files, totaling six data files for the three subsystems. File number one (PAVMARK.DBF, SPECMARK.DBF, RAMP.DBF) stores marking-related information, i.e., PAVMARK.DBF stores Lane/Edgeline information, SPECMARK.DBF stores Special Marking information, and RAMP.DBF stores Ramp Lane/Edgeline information. File number two stores cost information related to each marking type. Data elements of each subsystem are presented in Tables 1, 2, 3, 4, 5 and 6.

Table 1. Description of the Lane/Edgeline Subsystem Data Item

Column Heading	Data Type	Data Limitation	Description
District	Alpha-Numeric	None	The name of maintenance district.
County	Alpha	None	The name of the county.
Route	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The name of the route (such as US-23).
Alt #1 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The first alternate name of the route, if any.
Alt #2 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The second alternate name of the route, if any.
Control Section	Alpha	None	An unique number assigned to a road segment by MDOT.
Segment Description	Alpha	None	A brief description of the road segment.
Milepoint	Numeric	No Alpha	Digit 1 - begining of section. Digit 8 - end of section.
Traffic Direction	Numeric	No Alpha	Roadway configuration (such as 2-way, 1-way).
Number of Lanes	Numeric	No Alpha	Total number of lanes.
Marking Width	Numeric	No Alpha	Width of the marking in inches.
Center Lane Left Turn Option	Alpha	Y/N	Provision of left turn center lane.

Table 1. Description of the Lane/Edgeline Subsystem Data Item (Continued)

Column Heading	Data Type	Data Limitation	Description
Estimate Quantity in Feet	Numeric	No Alpha	This represents the quantity in LFT of marking by type, such as: Solid white - Broken white - Solid yellow - Broken yellow -
Road Surface	Alpha	(B,C,L,R)	The roadway material (such as bituminous, concrete, etc.).
Material	Alpha	No Numeric	The marking material (such as fast dry, polyester, etc.).
Product Brand	Alpha-numeric	None	Brand of the marking material is divided into two broad categories based on color: White - Yellow - A typical brand could be <u>3M</u> , etc.
Contract Number	Numeric and Alpha	5 Numeric 1 Alpha	The contract number assigned to a particular painting job.
Date	Date	-	Date variable consists of only two segments; month and year of marking.
Cycle	Numeric	No Alpha	When information on a road segment marking is entered into the system, the system sets cycle to 1. However, when the same section of the roadway is repainted, the system sets cycle to (current year - previous year of painting).

Table 2. Description of the Lane/Edgeline Subsystem Contractor Information File

Column Heading	Data Type	Data Limitation	Description
Contractor Name	Alpha-Numeric	None	The name of the contractor.
Federal Project Number	Alpha-Numeric	5 Numeric & 1 Alpha	The federal project number relate to a specific contract.
Unit Cost	Numeric	No Alpha	This variable provides the cost/LFT information regarding the yellow paint and white paint.
Mobilization Cost	Numeric	No Alpha	This represents the cost of mobilization.
Minor Traffic Cost	Numeric	No Alpha	This represents the cost related to temporary traffic barricading, etc. while marking the roadway.

Table 3. Description of the Special Marking Subsystem Data Item

Column Heading	Data Type	Data Limitation	Description
District	Alpha-Numeric	None	The name of maintenance district.
County	Alpha	None	The name of the county.
Route	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The name of the route (such as US-23).
Alt #1 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The first alternate name of the route, if any.
Alt #2 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The second alternate name of the route, if any.
Federal AID System	Alpha	No Numeric	A special code for the federally funded projects.
Control Section	Alpha	None	An unique number assigned to a road segment by MDOT.
City of Township	Alpha	No Numeric	The name of the city or township.
Cross Street or Railroad Crossing	Alpha-Numeric	None	The name of the nearest cross street or railroad crossing.
Surface	Alpha	None	The name of the roadway surface material (such as bituminous, concrete, etc.).
Geometry	Numeric	No Alpha	This represents the roadway configuration (such as 2-way, 1-way).

Table 3. Description of the Special Marking Subsystem Data Item (Continued)

Column Heading	Data Type	Data Limitation	Description
Number of Lanes	Numeric	No Alpha	This represents the number of lanes.
Intersection Leg	Alpha	No Numeric	This represents the compass direction of the intersection leg (such as N for North, S for South, etc.).
Affected Lane	Alpha-Numeric	1 Numeric & 1 Alpha	This represents the number and the type of lane affected by the special marking.
Distance from Cross Street	Numeric	No Alpha	Distance of the special marking from the nearest cross street.
Marking Type	Alpha	No Numeric	This represents the type of special marking (such as S for School, LTO for left turn only, etc.).
Contract Number	Alpha-Numeric	5 Numeric & 1 Alpha	The contract number assigned to a particular job.
Quantity (Each)	Numeric	No Alpha	The number of special markings.
Quantity (Linear Ft)	Numeric	No Alpha	The amount of marking in LFT.
Milepoint	Numeric	No Alpha	This represents the reference point of a marking.
Cycle	Numeric	No Alpha	When information on a road segment marking is entered into the system, the system sets cycle to 1. However, when the same section of the roadway is repainted, the system sets cycle to (current year - previous year of painting).

Table 4. Description of the Special Marking Contractor Information File

Column Heading	Data Type	Data Limitation	Description
Contractor Name	Alpha-Numeric	None	The name of the contractor.
Job Number	Alpha-Numeric	5 Numeric & 1 Alpha	The job number related to a specific contract.
Material	Alpha	No Numeric	The marking material (such as fast dry, polyester, etc.).
Product Brand	Alpha-Numeric	None	Brand of the marking material is divided into two brand categories based on color: White - Yellow -
Unit Cost (Each)	Numeric	No Alpha	Cost of marking by number.
Unit Cost (Linear Ft)	Numeric	No Alpha	Cost of marking by LFT.

Table 5. Description of the Ramp Lane/Edgeline Subsystem Data Item

Column Heading	Data Type	Data Limitation	Description
District	Alpha-Numeric	None	The name of maintenance district.
Date	Date	No Alpha	The date of installation (month/year).
Federal AID System	Alpha	No Numeric	A special code for the federally funded projects.
County	Alpha	None	The name of the county.
Route	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The name of the route (such as US-23).
Alt #1 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The first alternate name of the route, if any.
Alt #2 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The second alternate name of the route, if any.
Control Section	Alpha	None	An unique number assigned to a road segment by MDOT.
Location Description	Alpha	None	A brief description of the road segment.
Name of Exit	Alpha-Numeric	None	The name of the exit (such as 123A, 14A, etc.)
Number of Ramps	Numeric	No Alpha	The number of ramps (entrance and exit) at a particular location.
Interchange Number	Numeric	No Alpha	The number of the nearest interchange.

Table 5. Description of the Ramp Lane/Edgeline Subsystem Data Item (Continued)

Column Heading	Data Type	Data Limitation	Description
Material	Alpha	No Numeric	The marking material (such as fast dry, polyester, etc.).
Estimated Quantity (Ft)	Numeric	No Alpha	This represents the quantity in LFT of marking by type, such as: 4 in white 6 in white 6 in yellow 12 in white 4 in white thermoplastic
Product Brand	Alpha-Numeric	None	Brand of marking material is divided into two brand categories based on color: White Yellow A typical brand could be <u>3M</u> .
Contract Number	Alpha-Numeric	5 Numeric & 1 Alpha	The contract number assigned to a particular job.
Cycle	Numeric	No Alpha	When information on a road segment marking is entered into the system, the system sets cycle to 1. However, when the same section of the roadway is repainted, the system sets cycle to (current year - previous year of painting).

Table 6. Description of the Ramp Lane/Edgeline Subsystem Contractor Information File

Column Heading	Data Type	Data Limitation	Description
Contractor Name	Alpha-Numeric	None	The name of the contractor.
Job Number	Alpha-Numeric	5 Numeric & 1 Alpha	The job number relate to a specific contract.
Unit Cost	Numeric	No Alpha	Unit cost of four marking types are stored in this regard, namely: 4 in white 6 in white 6 in yellow 12 in white 4 in white thermoplastic
Mobilization Cost	Numeric	No Alpha	This represents the cost of mobilization.
Minor Traffic Cost	Numeric	No Alpha	This represents the cost related to temporary traffic barricading, etc. while marking the roadway.

Providing System Training and Documentation: PM-MIS software, along with source code, were delivered to Michigan Department of Transportation and training was conducted in Lansing. The training consisted of providing MDOT personnel with hands-on experience in generating various system output and overall system familiarization. A user's guide was also developed as a part of this project to provide continued guidance to MDOT personnel.

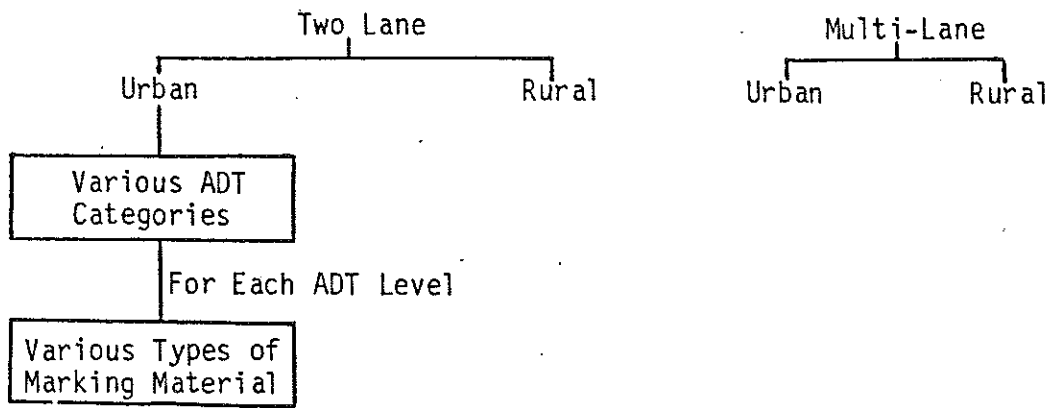
Developing Guidelines for Pavement Marking Material Use:

General Guidelines

Selection of various pavement marking materials should be based on their performance under various traffic and environmental conditions in addition to their relative cost. Determination of the service life of various marking materials should be done either by testing markings under real-life situations or MDOT should attempt to use other research results as a criteria for replacement of pavement markings. The following factors should be used for developing criteria for marking replacement:

- Traffic volume
- Snowfall
- Salting rate
- Type of roadway
- Others

The dependent variable will be the average marking life. So, MDOT needs to develop a set of service life curves for determining the productive life of various types of pavement markings. A typical stratification to be used is presented below.



Figures 1 and 2 represent some examples of service life curves for various materials. Please note that curves presented in figures 1 and 2 should be developed either by extensive research or adopted from the other available sources.

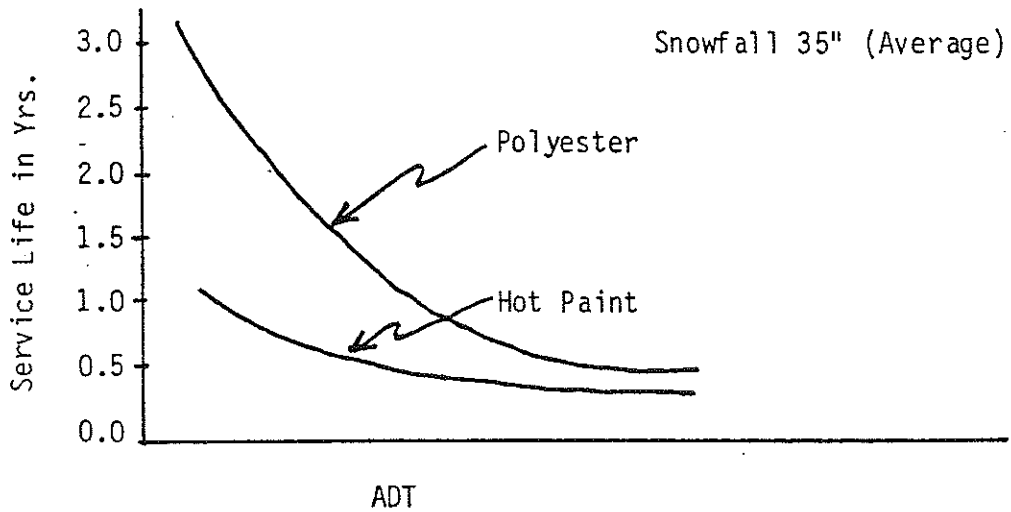


Figure 1. Service life curves for 35" snowfall.

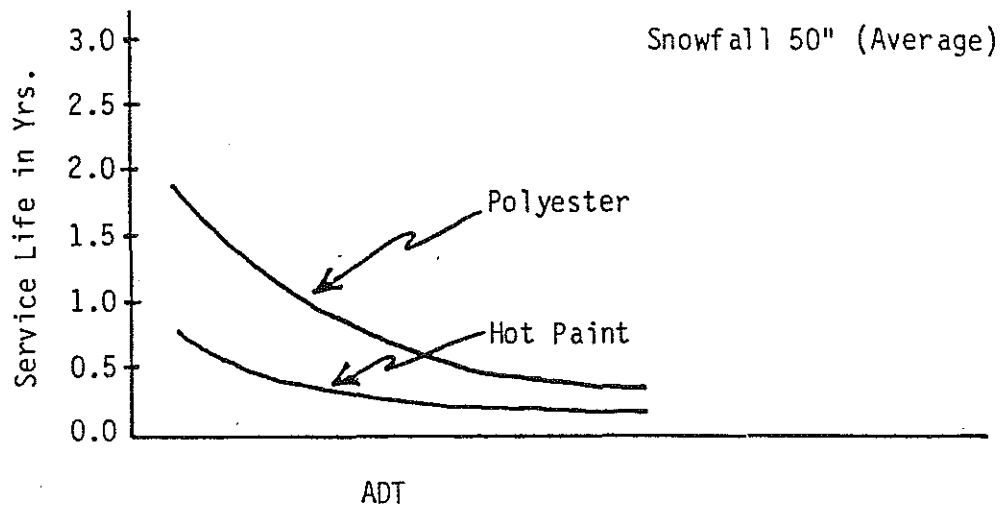


Figure 2. Service life curves for 50" snowfall.

Life cycle cost comparisons between the various pavement marking materials may be performed by a cost-analysis model, which assumes equal benefits of the pavement markings, but considers cost differences due to varying service lives, material costs, installation costs, etc. The mathematical expression of this model, as reported in the FHWA Roadway Delineation Practices Handbook (Sept. 1981) is as follows:[1]

- Cost-Analysis Model
- Present Worth of Cost = PWC

$$PWC = \sum_{n=0}^N \left[\frac{(TIC)_n}{(1+i)^n} + \frac{(MC)_n}{(1+i)^n} \right] + \frac{TC}{(1+i)^N}$$

Where:

- v = annual percent increase in traffic volume
- i = discount rate (set to zero because MDOT does not use a discount rate)
- N = analysis period
- $(TIC)_n$ = total installed cost in year n
- TC = terminal cost at the end of analysis period
- $(MC)_n$ = maintenance cost in year n

A schematic flow diagram of this economic model is given in figure 3. This involves first identifying the highway situation (i.e., tangent, curve, or intersection with given ADT range) within an area where snowfall and maintenance is distinctly different than other areas. The Present-Worth of Cost Model (Cost-Analysis Model) can be used to compare pavement marking materials, since benefits (accident benefits) are extremely difficult to quantify correctly. Those material types with the smallest Present-Worth of Cost (PWC) are the most economical for the appropriate roadway and traffic volume groups.

Specific Guidelines

As a part of this effort a literature search was conducted, and guidelines for various marking use as practiced by various agencies were identified. Cost information on marking material by years was not available to the Contractor, therefore, no cost-effectiveness analysis was conducted with Michigan data. However, information available from other agencies should be useful to MDOT in determining various material use under different traffic conditions.

Schematic of Cost Analysis Model

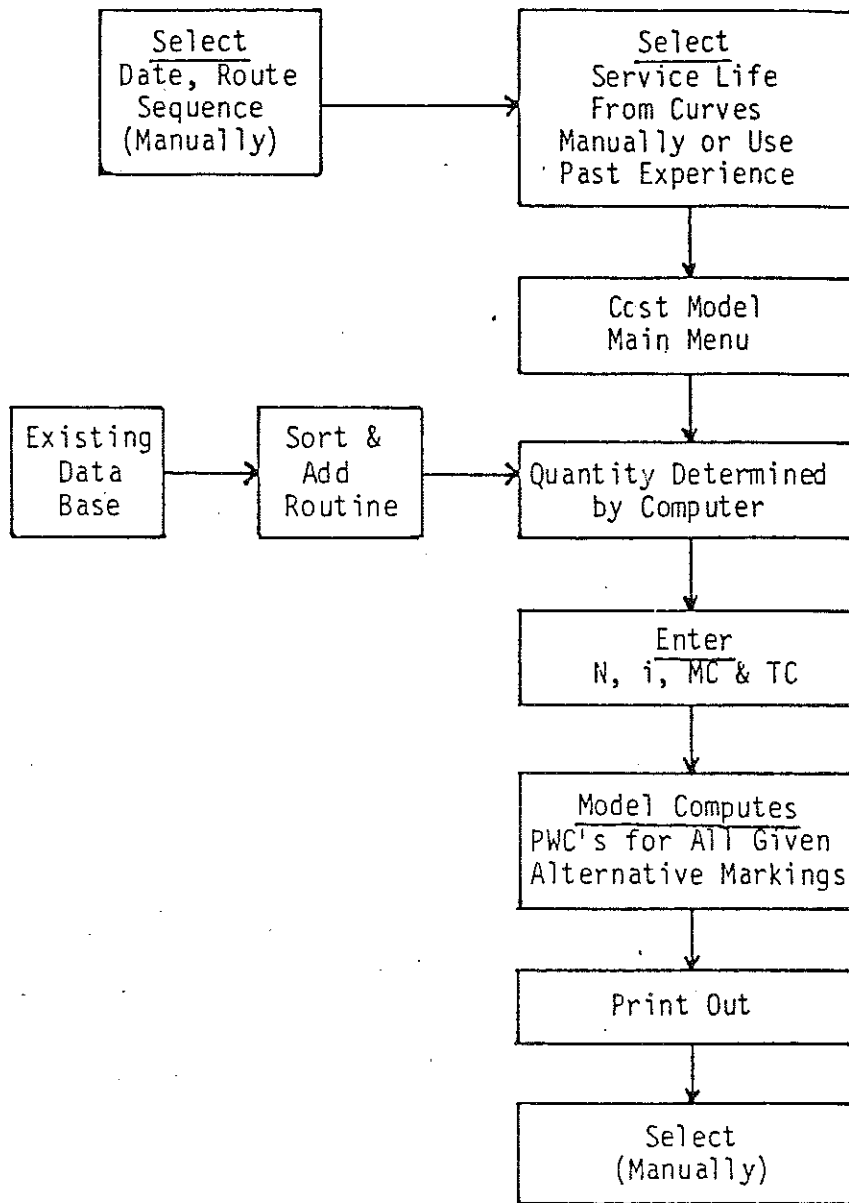


Figure 3. Illustration of economic model.

Thermoplastic stripping

- Thermoplastic stripping performed better on bituminous pavement than concrete pavement.
- Thermoplastic stripping is less desirable on older pavement.
- Volumes required for thermoplastic to be economical are presented in Table 7.

Epoxy

- Epoxy adheres to both bituminous and portland concrete pavements.
- Epoxy withstands high traffic volumes, sanding, salting and plowing more effectively.
- Epoxy has more reflectivity than paint.
- Epoxy is prone to chipping, however, it is not noticeable to drivers until approximately 50 percent of the stripping is removed.

Polyester

- Polyester adheres well to bituminous pavement but not portland cement.
- Application costs for polyester are higher than those of epoxy or paint.
- The reflectivity properties of polyester were better after one year than those of paint.

A typical cost and service life of different types of marking material is presented in Table 8. It is evident from Table 8, that epoxy appears to be the most cost-effective material for higher volume roadways. Cost breakdowns of each material type are also included in Table 9. Readers interested in more information should refer to references [2, 3, 4 and 5].

Table 7. Comparison of costs of thermoplastic and conventional paint striping.

PAVEMENT TYPE	LINE COLOR	VOLUME (ADT) REQUIRED FOR THERMOPLASTIC STRIPING TO BE MORE ECONOMICAL		
		TWO-LANE HIGHWAY	FOUR-LANE HIGHWAY	SIX-LANE HIGHWAY
Bituminous	White and Yellow	15,000	28,000	38,000
	White	26,000	46,000	65,000
Portland Cement Concrete	White	26,000	46,000	65,000
	Yellow	52,000	93,000	120,000

Source: Pigman, J.G. and Agent K.R., "Evaluation of Thermoplastic Pavement - Striping Materials (Louisville and Jefferson County)," Division of Research, Kentucky Bureau of Highways, May 1976.

Table 8. Comparison of service life and costs of pavement-marking materials by ADT level.

ADT	Material	Service Life (days)	Two Years		Four Years	
			Number of Applications	Cost (\$/ft)	Number of Applications	Cost (\$/ft)
<5000	Paint	365	2	9	4	16
	Epoxy	>730				
	10 mils		1	13		
	15 mils		1	18		
5000-15 000	Thermoplastic	<180	4	38	8	76
	Paint	180	4	18	8	36
	Epoxy	>730				
	10 mils		1	13		
70 000	15 mils		1	18		
	Thermoplastic	<180	4	38	8	76
	Polyester	365	2	25	4	50
	Paint	90	12	54	16	72
	Epoxy	365				
	10 mils		4	52		
15 mils		4	72			
	Thermoplastic	<180	8	76		

Source: Gillis, H.J., "Durable Pavement - Marking Materials," TRB Record 762, 1980.

Table 9. Cost comparison of striping materials.

	PAINT	THERMO- PLASTIC	EPOXY (Fast Set)**
Material cost	\$.012	\$.0714	\$.14
Labor and overhead	.017	.0446	.027
Traffic delay	.005	.005	—
Lane marking life	3 mos.	12 mos.	24 mos.
2 year cost	.272	.242	.1670
Cost lineal foot per year	\$.136	\$.121	\$.0885

*cost based on averages of 40 mil applications, 4" wide striping in the states of Minnesota, Wisconsin, and Indiana.

**cost per lineal foot per application based on a 4" wide, 15 mil stripe on PCC in Minnesota, excluding cost of glass beads.

Source: Fullerton, I.J., "Roadway Delineation Practices Handbook," JHK & Associates, September 1981.

References

1. Fullerton, I.J., "Roadway Delineation Practices Handbook," JHK & Associates, September 1981.
2. Scott, J.W., "Interim Performance Report, Experimental Use of Thermoplastic Pavement - Striping Materials," Kentucky Bureau of Highways, Division of Research, Report 243, September 1966.
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4. Arkansas State Highway Department, "Experimental Pavement Markings," Research Report 63-2-65, July 1965.
5. Pigman, J.G. and Agent K.R., "Evaluation of Thermoplastic Pavement - Striping Materials (Louisville and Jefferson County)," Division of Research, Kentucky Bureau of Highways, May 1976.

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USER'S GUIDE

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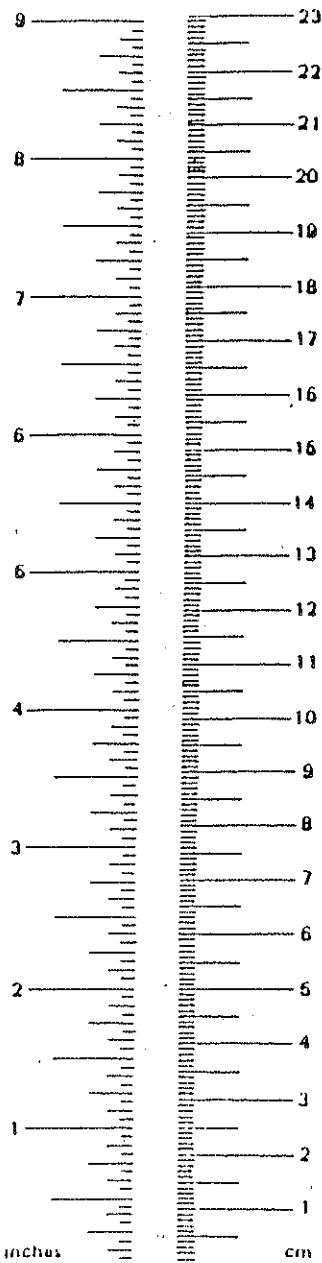
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16. Abstract This document is a guide for users of the Pavement Marking Management Information System (PM-MIS) Software. PM-MIS is designed for use on IBM-XT (or compatible) microcomputer and structured with the DBASE III Plus file management system. PM-MIS provides for the data entry, updating, contract generation, long-term budgeting and cost-effectiveness analysis. PM-MIS consists of three subsystems: <ol style="list-style-type: none"> 1. Lane/Edgeline Subsystem (LES) 2. Special Marking Subsystem (SMS) 3. Ramp Lane/Edgeline Subsystem (RES) 					
17. Key Words Pavement marking, cost-effectiveness analysis, budgeting, updating, contract generation			18. Distribution Statement		
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yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in ²	square inches	6.6	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	16	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.96	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* 1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 208, Units of Weight and Measure, Price \$2.25 SO Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.6	acres	
MASS (weight)				
g	grams	0.036	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	36	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

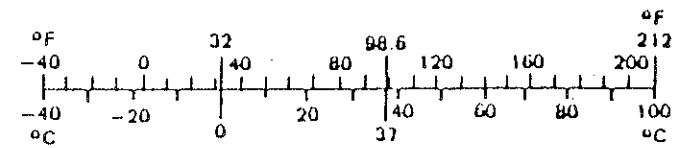


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1.0 INTRODUCTION

This document is intended for use by programmers, managers and users who are responsible for data entry, contract generation, long-term budgeting and cost-effectiveness analysis on the Pavement Marking Management Information Systems (PM-MIS). The system consists of three subsystems to represent three types of marking configurations, namely:

- Lane/Edgeline Subsystem (LES)
- Special Marking Subsystem (SMS)
- Ramp Lane/Edgeline Subsystem (RES)

Each subsystem is equipped with auxiliary programs designed to add, modify and extract data items. It is designed for use on IBM-XT (or compatible) microcomputer and structured with the DBASE III Plus¹ file management system.

The file, associated with each subsystem, is a listing (sorted by district) containing information on specific markings located within, and maintained by, the Michigan Department of Transportation (MDOT). Information on each marking category includes: marking type, location, length, brand name, cost, date of last maintenance, etc. The programs associated with PM-MIS interact with each inventory file to provide a comprehensive and convenient method of managing marking maintenance and contract generation needs. The system, for example, can provide a list of all pavement marking by brand name within a particular maintenance district. This effort permits continued monitoring of highway systems, identification and

1. DBASE III Plus is a registered trade mark of the Ashton-Tate, Corp.

correction of problem areas, development of a systematic maintenance and improvement program, budgeting of capital investments and efficient allocation of manpower.

For the system to achieve its full potential it is necessary to develop a systematic schedule of updating, reviewing and protecting the data files. The individual responsible for maintaining PM-MIS should become thoroughly familiar with the file descriptions, system capabilities and data management recommendations contained in this document. This users guide consists of five major sections and two appendices. Section two provides an overview of PM-MIS structure. Each of the following three sections deal with marking by type; section three addresses Lane/Edgeline Subsystem (LES), section four covers Special Marking Subsystem (SMS) and section five documents Ramp Lane/Edgeline Subsystem (RES). The hardware requirement and software installation procedure of PM-MIS system are included in Appendix A. In Appendix B, information on archive file and detail programming logic are included.

2.0 OVERVIEW OF PM-MIS STRUCTURE

PM-MIS system provides for the entry, updating, and access to data related to roadway markings (which includes lane/edgeline, special and ramp lane/edgeline markings) that are under the jurisdiction of the Michigan Department of Transportation. PM-MIS consists of three subsystems. A description of each subsystem is presented below.

Subsystem 1. Lane/Edgeline Subsystem (LES): This subsystem contains data related to lane/edgeline marking.

Subsystem 2. Special Marking Subsystem (SMS): This subsystem stores special marking information.

Subsystem 3. Ramp Lane/Edgeline Subsystem (RES): The information related to ramp lane/edgeline is inventoried by this subsystem.

Each subsystem consists of eight modules. A description of each module is presented below.

Module 1. Add Information

This module is used to add completely new information to the inventory file.

Module 2. Edit Information

The purpose of this module is to edit any prior data entry error in the existing data base.

Module 3. Update Information

This module is used to update the inventory data base due to repainting activities on the existing marking. The system first will save the existing record into an archive file and then replace existing information with new information.

Module 4. Delete Information

This module is used to delete records from the main data base and contract information data base.

Module 5. Print Main Inventory File

This module enables the hard copy documentation of the data base.

Module 6. Print Contract Information File

This module enables the hard copy documentation of the contract information.

Module 7. Long-Term Budgeting

This module is designed to produce long-term budget and contract documents. A typical budget will provide the following information:

- Quantity of marking type by material.
- Average unit cost.
- Cost by marking type and material.
- Budget year.

The typical contract document produced by module 7 provides a detailed breakdown of marking by road segment, county and district for the base year. Activities involved in this module are:

- Identify the road segments that should be considered for repainting in a particular year, based on the value of cycle variable (consult Table 2 for the definition of cycle variable) and the year of last painting. For example, the user wants to prepare long-term budgets for the years 1988 and 1989. Table 1 represents a hypothetical contract information data base for a subsystem.

Table 1. A Hypothetical Contract Information.

District: Six

County: Clinton

Marking Type: p

Route	Cont. Sect.	Segment Description	Fed. Aid Sys.	Solid White	Unit Cost	Broken White	Unit Cost	Solid Yellow	Unit Cost	Broken Yellow	Unit Cost	Geometry	Year	Cycle
M-21	19061	W. of Morton St.	FU	1260	0.08	100	0.08	2560	0.08	2870	0.08	2WY, 2LN	87	1
I-96 BS	29012	W. of Wright	FU	27826	0.08	3485	0.08	21965	0.08	2798	0.08	2WY, 2LN	86	2
M-44	29016	Lincoln Rd. N.	MU	13570	0.08	1795	0.08	11088	0.08	1109	0.08	2WY, 2LN	87	2

5

Route M-21 will be included in the 1988 budget, since the year of last painting (1987) + cycle (1) \leq budget year (1988). Similarly, Route I-96 BS will also be included in the 1988 budget. However, Route M-44 will not be included in the 1988 budget. The system will also change the year of last painting for routes M-21 and I-96 BS to 1988. Please note that these changes are temporary in nature and do not cause any permanent alteration to the existing data base. For the year 1989, Routes M-21 and M-44 will be included, but not Route I-96 BS.

- Adjust unit cost of each selected segment with the inflation factor (i). For example, for the year 1988 and Route M-21, the adjusted unit cost will be actual unit cost * (1+i) ** (88-87).
- Calculate the average unit cost of material by marking type using the following equation for a typical budget year:

$$= \frac{\sum \text{Quantity of material by marking type} * \text{Adjusted unit cost for all identified road segments}}{\sum \text{Quantity of material by marking type for all identified road segments}}$$

- Display the average unit cost by material and marking type on the screen. At this point, the user has the option to specify a different average unit cost.
- Determine:
 - \sum Quantity of material by marking type for all identified road segments.
 - ((\sum Quantity of material by marking type) * Average unit cost) for all identified road segment.
- Display budget on the screen for a particular budget year.

- Generate contract document for base year. This document will provide a detailed breakdown of marking work by road segment for the base year only. A schematic flow diagram of this module is presented in Figure 1.

Module 8. Cost-Effectiveness Analysis

Selection of various pavement marking materials should be based on their performance under various traffic and environmental conditions in addition to their relative cost. The Pavement Marking Management Information System (PM-MIS) provides unit cost information in the form of unit cost by material type. Determination of service life of various marking materials should be determined either by testing markings under real-life situations or MDOT should attempt to use other research results as criteria for replacement of pavement markings. The following factors should be used for developing criteria for marking replacement:

- Traffic volume
- Snowfall
- Salting rate
- Type of roadway
- Others

The dependent variable will be the average marking life. So, MDOT needs to develop a set of curves for determining the productive service life of various markings:

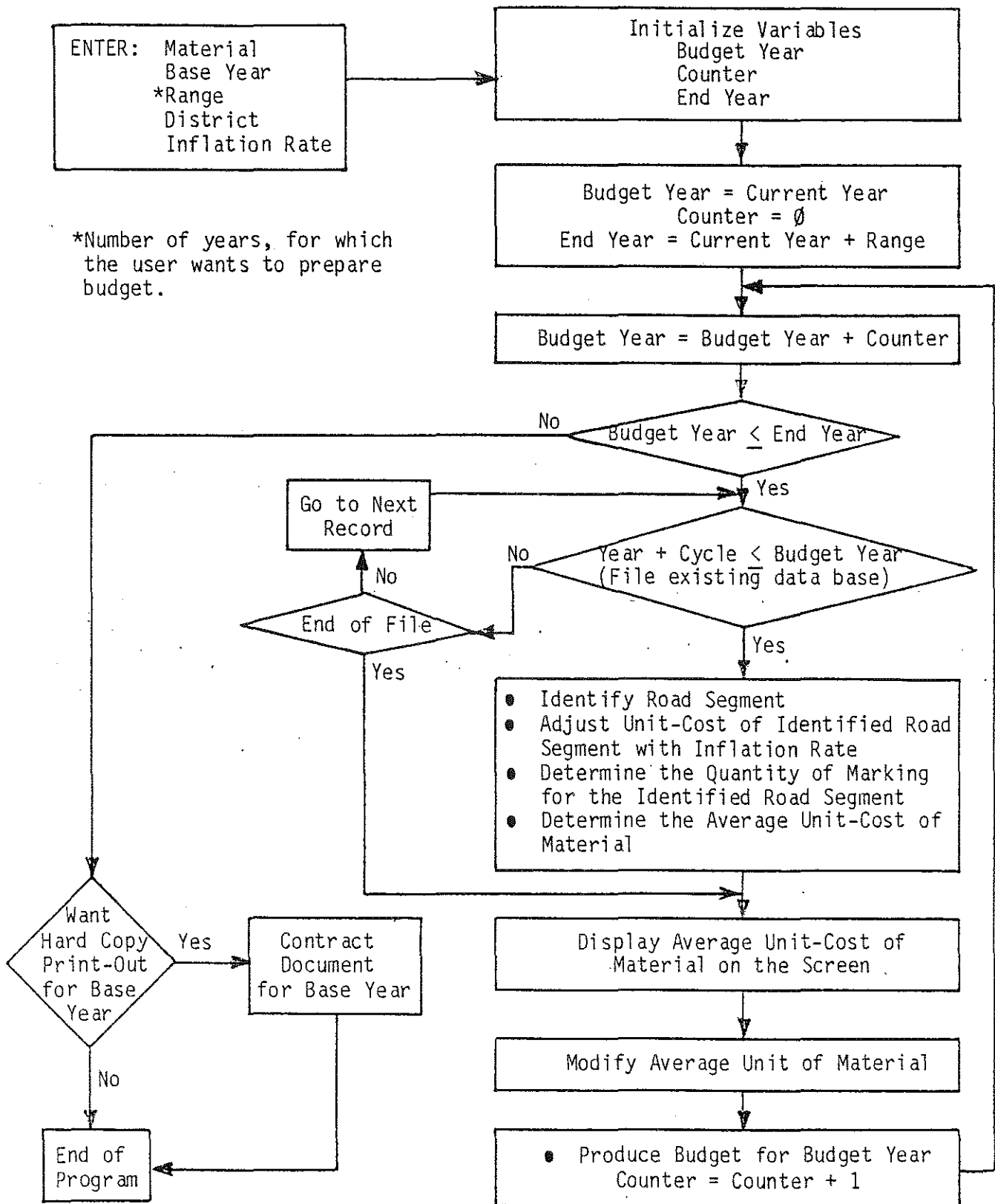
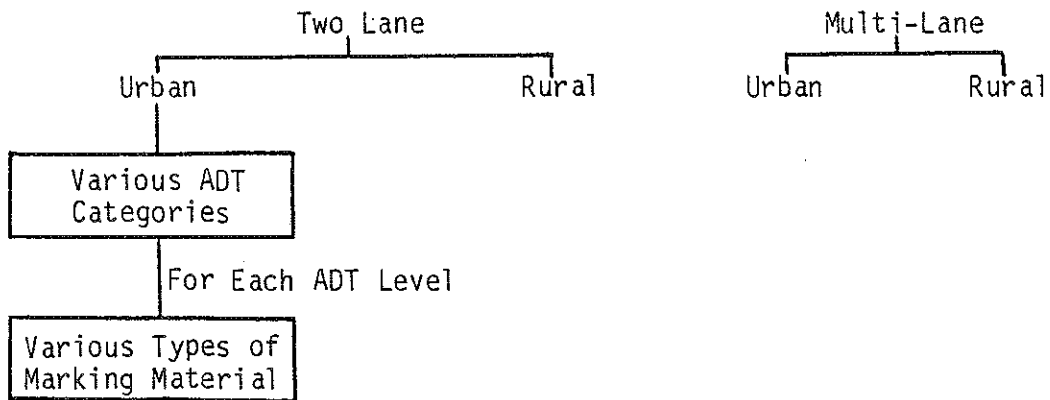


Figure 1. Flow diagram for long-term budgeting module.



Figures 2 and 3 represent typical service life curves for various materials. Please note that the curves presented in Figures 2 and 3 should be developed either by extensive research or adopted from the other available sources.

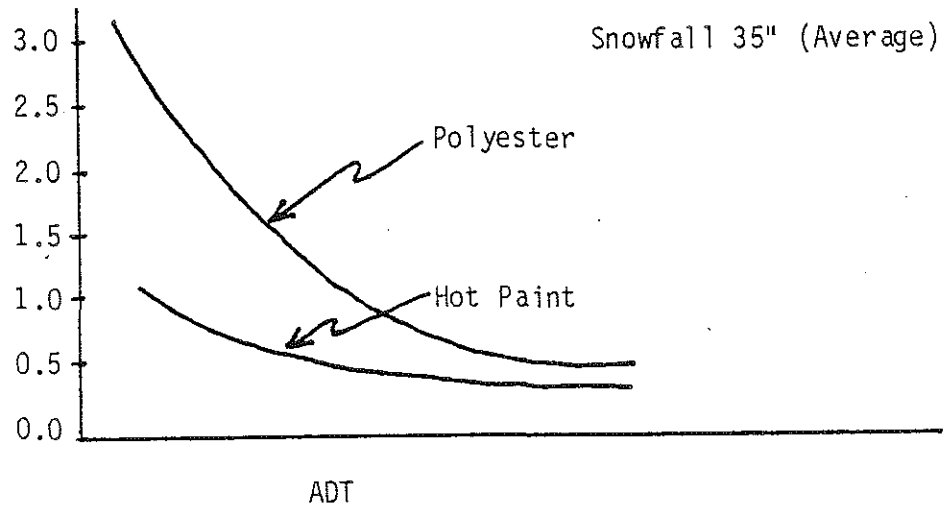


Figure 2. Service life curves for 35" snowfall.

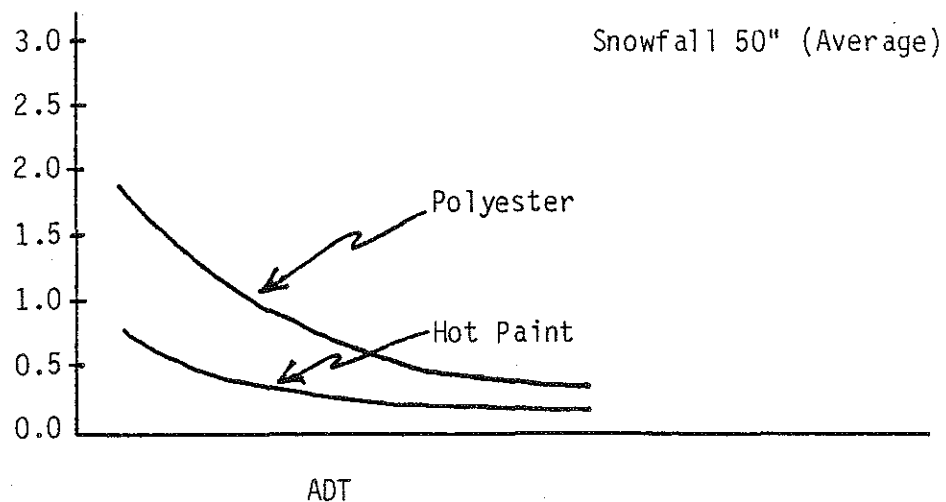


Figure 3. Service life curves for 50" snowfall.

Life cycle cost comparisons between the various pavement marking materials may be performed by a cost-analysis model, which assumes equal benefits of the pavement markings, but considers cost differences due to varying service lives, material costs, installation costs, etc. The mathematical expression of this model, as reported in the FHWA Roadway Delineation Practices Handbook (Sept. 1981) is as follows:

- Cost-Analysis Model
- Present Worth of Cost = PWC

$$PWC = \sum_{n=0}^N \left[\frac{(TIC)_n}{(1+i)^n} + \frac{(MC)_n}{(1+i)^n} \right] * FACT + \frac{TC}{(1+i)^N}$$

where:

- v = annual percent increase in traffic volume
- i = discount rate (set to zero because MDOT does not use a discount rate)
- N = analysis period
- $(TIC)_n$ = total installed cost in year n
- TC = terminal cost at the end of analysis period
- $(MC)_n$ = maintenance cost in year n
- FACT = 1 when cycle = \emptyset ; N/cycle when cycle $> \emptyset$

A schematic flow diagram of this economic model is given in Figure 4. This involves first identifying the highway situation (i.e., tangent, curve, or intersection with given ADT range) within an area where snowfall and maintenance is distinctly different than other areas. The Present-Worth of Cost Model (Cost-Analysis Model) is recommended to compare pavement marking options, since benefits (accident benefits) are extremely difficult to quantify correctly. Those material types with the smallest Present-Worth of Cost (PWC) are the most economical for the appropriate roadway and traffic volume groups.

The following steps should be followed to select the best marking material.

1. Manually determine the service life of the selected marking from the adopted curves. Until appropriate curves are adopted it will be necessary for the user to select the service life. For example, suppose that an analysis is being performed for a particular roadway (for instance, Telegraph Road in the metro district) and past experience indicates that polyester will provide two years service life, whereas, hot paint will only provide one year service. Information of this type is necessary to perform long-term budgeting.

Schematic of Cost Analysis Model

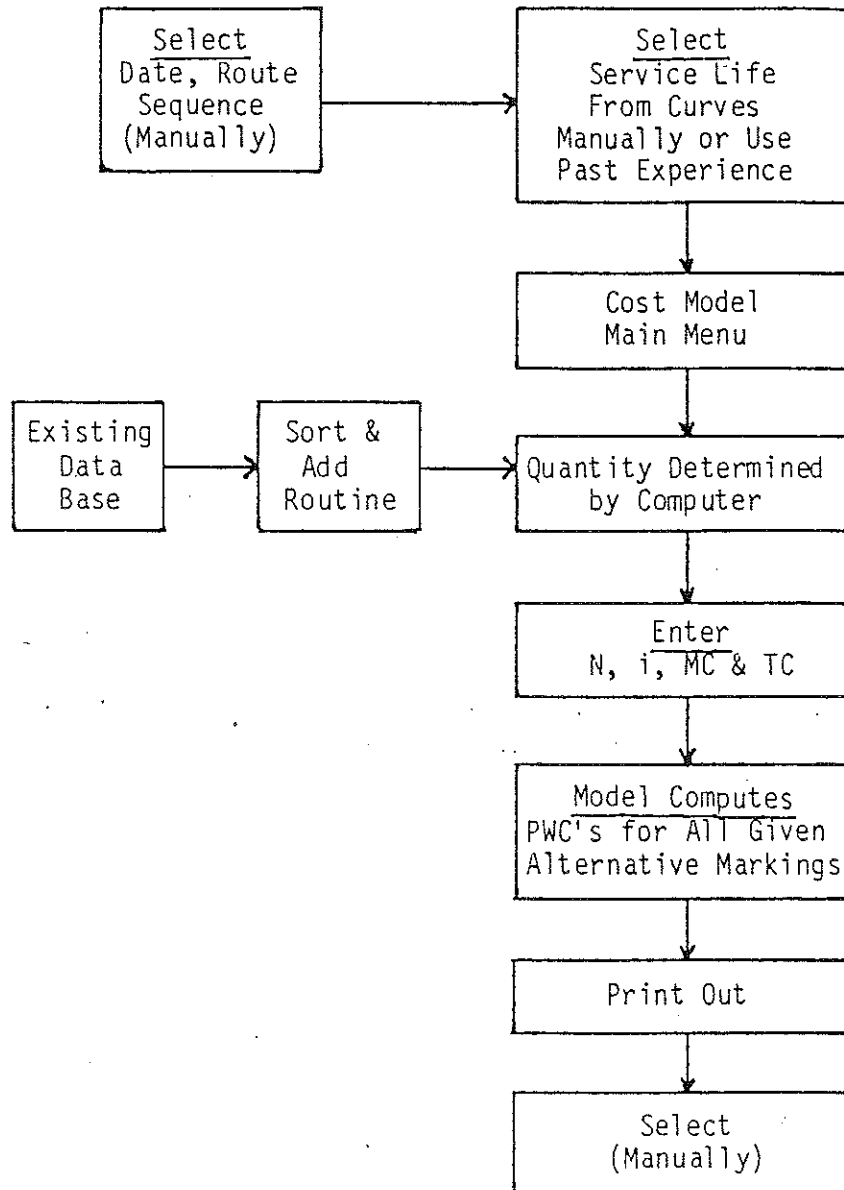


Figure 4. Illustration of economic model.

2. The cost-effectiveness analysis program determines present-worth of cost for any marking material based on the user specified criterion. Total installed cost (TIC) will be determined from the total material quantity presented in the existing data base. This program will only get the total quantity of various markings from the data base. Terminal cost (TC) will be used as a default value, unless the user specifies otherwise. "N" will have to be set by the user as the highest service life of all the various marking materials (i.e., 5 years, 10 years, etc.). Discount rate (i) will have a default value of 5 percent, unless the user specifies otherwise. Maintenance cost $(MC)_n$ will be a user input value.
3. After all of these parameters are entered and program execution, the present-worth cost of material by marking type will be displayed.
4. Manual selection of an alternative material results in a cost-effectiveness analysis between the base and alternative material.

System Operation

This section contains step-by-step instructions and sample screens to enable the user to perform the required functions. A separate section is provided for each subsystem. PM-MIS is designed for IBM-XT compatible systems. Changes to the computer hardware or the operating system may result in changes to the described procedure.

System Initialization

1. Turn the system on.
2. Go to Marking Directory.
3. Type Marking, a screen of Figure 5 will appear prompting the user to select a subsystem.

3.0 LANE/EDGE LINE SUBSYSTEM (LES)

The main inventory data file of LES contains locational and descriptive information on lane/edgeline markings. Data entered into the main inventory data file from the completed workorders prompts the system to initiate the necessary action, as presented in Figure 6. If the workorder pertains to the initiation of a new marking, then a new record containing all related data is created within the inventory file. If the workorder pertains to changes to an existing marking then the new information is updated over the existing data. LES contains the capability of permitting CRT review and scroll of data bases. The auxiliary program enables the deletion of selected records from the data base and the development of the summary print-out.

Description of Inventory Files

The main inventory file provides for entry, updating, and access to data related to all of the lane/edgeline markings that are under the jurisdiction of the Michigan Department of Transportation. The inventory file consists of one record per marking workorder describing its location and attributes (width, type, length, amount, brand, etc.) in an expanded, alpha-numeric form. A description of the data contained in each record is presented in Table 2. A specific marking on a particular roadway has a unique contract number and control section. The codes used for the different types of marking are those specified by the MDOT, such as FD for "Fast Dry," LTO for "Left Turn Only," and so on. Contract information related to each marking is stored in the contract information file. A description of data contained in each record of the contractor file is presented in Table 3.

Table 2. Description of the Lane/Edgeline Subsystem Data Item

Column Heading	Data Type	Data Limitation	Description
District	Alpha-Numeric	None	The name of maintenance district.
County	Alpha	None	The name of the county.
Route	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The name of the route (such as US-23).
Alt #1 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The first alternate name of the route, if any.
Alt #2 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The second alternate name of the route, if any.
Control Section	Alpha	None	An unique number assigned to a road segment by MDOT.
Segment Description	Alpha	None	A brief description of the road segment.
Milepoint	Numeric	No Alpha	Digit 1 - begining of section. Digit 8 - end of section.
Traffic Direction	Numeric	No Alpha	Roadway configuration (such as 2-way, 1-way).
Number of Lanes	Numeric	No Alpha	Total number of lanes.
Marking Width	Numeric	No Alpha	Width of the marking in inches.
Center Lane Left Turn Option	Alpha	Y/N	Provision of left turn center lane.

Table 2. Description of the Lane/Edgeline Subsystem Data Item (Continued)

Column Heading	Data Type	Data Limitation	Description
Estimate Quantity in Feet	Numeric	No Alpha	This represents the quantity in LFT of marking by type, such as: Solid white - Broken white - Solid yellow - Broken yellow -
Road Surface	Alpha	:(B,C,L,R)	The roadway material (such as bituminous, concrete, etc.).
Material	Alpha	No Numeric	The marking material (such as fast dry, polyester, etc.).
Product Brand	Alpha-numeric	None	Brand of the marking material is divided into two broad categories based on color: White - Yellow - A typical brand could be <u>3M</u> , etc.
Contract Number	Numeric and Alpha	5 Numeric 1 Alpha	The contract number assigned to a particular painting job.
Date	Date	-	Date variable consists of only two segments; month and year of marking.
Cycle	Numeric	No Alpha	When information on a road segment marking is entered into the system, the system sets cycle to 1. However, when the same section of the roadway is repainted, the system sets cycle to (current year - previous year of painting).

Table 3. Description of the Lane/Edgeline Subsystem Contractor Information File

Column Heading	Data Type	Data Limitation	Description
Contractor Name	Alpha-Numeric	None	The name of the contractor.
Federal Project Number	Alpha-Numeric	5 Numeric & 1 Alpha	The federal project number relate to a specific contract.
Unit Cost	Numeric	No Alpha	This variable provides the cost/LFT information regarding the yellow paint and white paint.
Mobilization Cost	Numeric	No Alpha	This represents the cost of mobilization.
Minor Traffic Cost	Numeric	No Alpha	This represents the cost related to temporary traffic barricading, etc. while marking the roadway.

System Operation

Module 1. Add Information

This module is intended for use when a new marking has been installed. A screen layout of this module is displayed in Figure 7. Description of the type and limitation of each data entry is presented in Table 2. The procedures for performing activities of this module are presented below.

1. Enter "District" information first in the box next to DISTRICT and Return.
2. Followed by COUNTY and ends at DATE.
3. Upon completion of data entry into the main inventory file the system will ask, whether the user wants to enter into the contractor information (Y/N).

Y - will bring the contractor information entry screen as of Figure 8.

N - will take the user to Step 6.

4. Enter "Contractor Name" information in the box next to CONTRACTOR NAME and Return.
5. Followed by FEDERAL PROJECT NUMBER and ends at MINOR COST.
6. Upon completion of data entry into the contractor file or respond "N" to the system's previous inquiry, the system will ask for confirmation (Y/N).

Y - will save the information in the respective data base.

N - will bring the cursor back into the district field.

7. In order to exit from the "Add Information" menu enter "QUIT" in the district field and Return.

Module 2. Edit Information

This module is intended to edit the existing data base. The primary purpose of this module is to correct prior entry errors. A screen layout of module 2 is displayed in Figure 9. The user can get into this module by selecting option 2 of LES subsystem. The procedures for operating this program are:

1. Enter material information in the MATERIAL BOX and return (Figure 10).
2. Enter the control section information.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection (Figure 11).
 - N - will bring the cursor back to the material box.
4. If this is not the record, the user wants to edit, enter:
 - P - for Previous record.
 - N - for Next record.
5. Once the record that needs to be edited appears on the screen, enter:
 - E - for Edit.
6. The system will prompt the user for the required data item. When an acceptable entry has been made, enter "Return" to move to the next data item.
7. Upon completion, the system will ask the user about contract information (Y/N).
 - Y - will bring the related contract information on the screen.
 - N - will ask for confirmation.
8. When all changes are made on the main file and contractor file, the system will ask the user for confirmation (Y/N).
 - Y - will save the information and return to module 2.
 - N - will bring the cursor back to the DISTRICT field.

MDOT
LANE/EDGE LINE SUBSYSTEM

RECORD NUM: 15

«« .
« DISTRICT: FIVE «
« COUNTY: KENT «
« ROUTE: I -196- «
« CONTROL SECTION: 41029 SEGMENT DESCRIPTION: S. OF CHICAGO «
« FEDERAL AID SYSTEM: JOB NUMBER : - «
«««

BEGIN END

MILE POINT: 0.00 - 0.00

TRAFFIC DIRECTION (Enter 2 for 2-way, 1 for 1-way):0

NUMBER OF LANES : 2

MARKING WIDTH: 4 CENTER LANE LEFT TURN (ENTER Y FOR YES, N FOR NO):

	SOLID WHITE	BROKEN WHITE	SOLID YELLOW	BROKEN YELLOW
ESTIMATED QUANTITY	71000	22800	85465	0
IN FEET				

««
EDIT EXISTING INFORMATION

TO GET A DIFFERENT RECORD ENTER
P(REVIOUS),N(EXT), OR E(DIT) TO CHANGE THIS RECORD

27

Figure 11. A Typical Edit Screen (Lane/Edgeline).

Module 3. Update Information

This module is intended to update the existing inventory files due to maintenance work performed on the existing marking. A screen layout of this module is displayed in Figure 12.

Option 1. The user can update an existing record by providing geometry (roadway configuration and number of lanes) and material (material type such as FD for fast dry, etc.) information.

Option 2. The user can update an existing record by providing contract number, material and control section information.

Option 3. The user can update an existing record by providing material and control section information.

Option 1. The user can get into this option by typing 1 from the "Update Information" module. A screen layout of this option is presented in Figure 13. The procedures for operating this program are:

1. Enter material information in the MATERIAL box and Return.
2. Enter roadway configuration information in the TRAFFIC DIRECTION box and Return.
3. Enter number of lane information in the NUMBER OF LANES box and Return.
4. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection (Figure 14).
 - N - will bring the cursor back to MATERIAL box.
5. If this record is not the record the user wants to update enter (Figure 14):
 - P - for Previous record.
 - N - for Next record.

6. After the record that needs to be updated appears on the screen enter:

E - for Edit/Update.

7. The system will prompt the user for the required data item. When an acceptable entry has been made, hit Return to move to the next data item.

8. Upon completion, the system will ask the user about contractor information (Y/N).

Y - will bring the related contract information on the screen.

N - will ask for confirmation.

9. When all changes are made on the main file and contractor file, the system will ask the user for confirmation (Y/N).

Y - will save the information and return to Module 3.

N - will bring the cursor back to DISTRICT field.

Option 2. The user can get into this option by selecting 2 from the "Update Information" module. A screen layout of this option is presented in Figure 15. The procedure for operating this program are:

1. Enter control section information in the CONTROL SECTION box and Return.

2. Enter material information in the MATERIAL box and Return.

3. Enter contract number information in the CONTRACT box and Return.

4. The system will ask for confirmation (Y/N).

Y - will bring the first record on the section.

N - will bring the cursor back to CONTROL SECTION.

5. The rest of the procedures are identical to option 1.

Option 3. The user can enter into this option by selecting 3 from the "Update Information" module. A screen layout of the option is displayed in Figure 16. The user should enter material and control section information to update a related record. The procedures for operating this module are similar to the procedures of option 1.

Module 4. Delete Information Module

The purpose of this module is to delete designated records from the active inventory files (i.e., main file and contractor information). A screen layout of this module is presented in Figure 17. The detailed procedures of this module are:

1. Enter material information into the MATERIAL box and Return.
2. Enter control section information.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection (Figure 18).
 - N - will bring the cursor back to MATERIAL box.
4. If this record is not the record the user wants to delete enter:
 - P - for previous record.
 - N - for next record.
5. After the record that should be deleted from the data base enter:
 - D - for delete.
6. When the user wants to exit from this module, the system will ask for confirmation (Figure 19):
 - Y - will remove the records permanently from the data base and exit from this module.
 - N - will simply exit from the module.

```

««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«                LANE/EDGE LINE SUBSYSTEM                «
«                UPDATE A RECORD                «
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«                «                «                «                «                «                «                «                «                «
«                «                «                «                «                «                «                «                «                «
«MATERIAL (ENTER EF FOR EPOFLEX, E FOR EPOXY                «
«                ET FOR EPOXY THERMOPLASTIC, PT FOR POLY THERMO «
«                P FOR POLYESTER, TPL FOR THERMOPLASTIC «
«                CPL FOR COLD PLASTIC, FD FOR FASTDRY ) : «
«                «                «                «                «                «                «                «                «                «
«CONTROL SECTION : «
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««

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(ENTER QUIT TO EXIT OR MATERIAL TO PROCEED)

Figure 16. Screen for Update Information (Lane/Edgeline) Module (Key Fields Materials and Control Section).

Module 5. Print Lane/Edgeline Information

The purpose of this module is to print a summary report of the Lane/Edgeline inventory file. A typical output is presented in Figure 20.

Module 6. Print Contract Information

The purpose of this module is to print a summary report of the contractor information file. A typical output is presented in Figure 21.

Module 7. Long-Term Budgeting/Contract Generation

This module of LES Subsystem is designed to produce a long-term budget and a contract document. The user can enter into this module by selecting option 7 of LES Subsystem menu. A screen layout of this module is presented in Figure 22.

1. The system will ask for the following information:
 - MATERIAL
 - CURRENT YEAR (base year)
 - RANGE (number of years the user wants to prepare long-term budget)
 - DISTRICT
 - INFLATION RATE

2. The user should enter: material, current year, range, district, and inflation rate information into the system. The system will ask for confirmation (Y/N):
 - Y - will proceed.
 - N - will back to Step 1.

LANE/EDGE LINE SUBSYSTEM
MICHIGAN DEPARTMENT OF TRANSPORTATION

SUMMARY REPORT

COUNTY	Route	Cont. Sect.	Segment Description	Fed Aid Sys	Point Begin	Point End	Solid White	Broken White	Solid Yellow	Broken Yellow	GEO METRY	S U Y		DATE
												R F	C LE	
** District: FIVE MATERIAL :P														
IONIA	M-21	34061	W. OF HAYNOR RD	FU	0.00	0.00	5650	106	14995	1478	2WY 2LN C	2	-	86
IONIA	I-96BS	34042	KENT TO I-96	RS	0.00	0.00	7814	845	11774	0	2WY 2LN C	3	-	85
IONIA	M-44	34081	W. OF M-91	FU	2.24	4.66	16474	1320	10560	0	2WY 2LN C	0	12345-R	85
KENT	US-131BR	41014	S. JCT TO N. JCT		0.00	0.00	2120	4250	17340	250	0WY 2LN C	1	-	86
KENT	I-196	41029	S. OF CHICAGO		0.00	0.00	71000	22600	85465	0	0WY 2LN C	2	-	85
KENT	M-37	41031	S. OF 52ND ST.		0.00	0.00	11680	14165	73125	9125	0WY 2LN C	2	-	86
KENT	M-37	41033	3 MILE RD. N.		0.00	0.00	6850	6600	22525	5075	0WY 5LN C	2	-	87
KENT	M-21	41041	CHICAGO DR.		0.00	0.00	4000	800	4570	125	0WY 5LN C	2	-	86
KENT	I-196BS	41042	E TO US 131 N		0.00	0.00	13825	500	21070	1905	0WY 2LN C	3	-	85
KENT	M-21	41043	FROM M-44		0.00	0.00	55510	17345	78255	6395	0WY 4LN C	3	-	86
KENT	M-11	41061	WILSON AVE		0.00	0.00	24710	32610	141185	29425	0WY 2LN C	2	-	84
KENT	M-45	41081	LAKE MICHL. DR.		0.00	0.00	22870	4750	21040	690	0WY 4LN C	2	-	85
KENT	M-45	41081	LAKE MICHL. DR.		0.00	0.00	600	4140	16625	1140	0WY 2LN C	2	-	86
KENT	US-131	41131	N FROM 28TH ST.		0.00	0.00	88270	18215	44780	0	0WY 2LN C	3	-	84
KENT	US-131	41131	FROM I-96		0.00	0.00	29440	2340	36400	0	0WY 2LN C	2	-	86
KENT	US-131	41132	RAMP TO I-96		0.00	0.00	9245	2470	8715	0	0WY 2LN C	2	-	85
OTTAWA	US-31BR	03051	FROM N JUNCTION		0.00	0.00	6760	55570	42480	15340	0WY 0LN C	4	-	84
OTTAWA	M-40	03072	FROM US-31BR		0.00	0.00	5500	0	8030	0	0WY 0LN C	3	-	85
OTTAWA	M-21	70023	CHICAGO DR		0.00	0.00	18320	4265	16275	0	0WY 4LN C	3	-	85
OTTAWA	I-196BR	70023	W. OF WAVERLY		0.00	0.00	57670	13725	54365	0	0WY 2LN C	3	-	85
MUSKEGON	US-31BR	61073	US-31 S. JUNCT		0.00	0.00	37490	2455	20330	4095	0WY 2LN C	4	-	86
KENT	M-44	41012	FR AIR DR EAST		0.00	0.00	23235	4070	25135	320	2WY 4LN	0	-	87
KENT	US-131BR	41014	FROM US-131 S. JT-N. JT		0.00	0.00	2120	4250	17350	250	3WY 4LN C	0	-	87
KENT	I-196	41027	EB & WB FROM US-131		0.00	0.00	34265	11490	41020	55890	2WY 3LN C	1	12345-R	89
* Subtotal *							555428	229081	833429	131503				
** Subtotal **							555428	229081	833429	131503				

Figure 20. Lane/Edgeline Subsystem Summary Report.

LANE/EDGE LINE CONTRACTOR INFORMATION

MICHIGAN DEPARTMENT OF TRANSPORTATION
SUMMARY REPORT

CONT NUMBER	JOB NUMBER	CONTRACTOR NAME	CONT. SECT.	UNIT COST WHITE (\$\$\$\$)	SOLID WHITE (LFT)	BROKEN WHITE (LFT)	UNIT COST YELLOW (\$\$\$\$)	SOLID YELLOW (LFT)	BROKEN YELLOW (LFT)	TRAFFIC COST (\$\$\$\$)	MOBILIZATION COST (\$\$\$\$\$\$)	YEAR
** DISTRICT : FIVE			MATERIAL :P									
*	-	-		34061	0.0800	5650	106	0.0800	14995	1478	0	86
	-	-		34042	0.0800	7814	845	0.0800	11774	0	0	85
12345-R	-	-		34081	0.0800	16474	1320	0.0800	10560	0	0	85
	-	-		41014	0.0800	2120	4250	0.0800	17340	250	0	86
	-	-		41029	0.0800	71000	22800	0.0800	85465	0	0	85
	-	-		41031	0.0800	11680	14165	0.0800	73125	9125	0	86
	-	-		41033	0.0800	6850	6600	0.0800	22525	5075	0	87
	-	-		41041	0.0800	4000	800	0.0800	4570	125	0	86
	-	-		41042	0.0800	13835	500	0.0800	21070	1905	0	85
	-	-		41043	0.0800	55510	17345	0.0800	78255	6395	0	86
	-	-		41061	0.0800	24710	32610	0.0800	141185	29425	0	84
	-	-		41081	0.0800	22870	4750	0.0800	21040	690	0	85
	-	-		41081	0.0800	600	4140	0.0800	16625	1140	0	86
	-	-		41131	0.0800	88270	18215	0.0800	44780	0	0	84
	-	-		41131	0.0800	29440	2340	0.0800	36400	0	0	86
	-	-		41132	0.0800	9245	2470	0.0800	8715	0	0	85
	-	-		03051	0.0800	6760	55570	0.0800	42480	15340	0	84
	-	-		03072	0.0800	5500	0	0.0800	8030	0	0	85
	-	-		70023	0.0800	18320	4265	0.0800	16275	0	0	85
	-	-		70023	0.0800	57670	13725	0.0800	54385	0	0	85
	-	-		61073	0.0800	37490	2455	0.0800	20330	4095	0	86
	-	-		41012	0.0000	23235	4070	0.0000	25135	320	0	87
	-	-		41014	0.0000	2120	4250	0.0000	17350	250	0	87
12345-R	-	G & G		41027	0.9000	34265	11490	0.8000	41020	55890	99	89
* Subtotal *						555428	229081		833429	131503	99	34
** Subtotal **						555428	229081		833429	131503	99	34

Figure 21. Summary Report Contractor Information (Lane/Edgeline).

3. The system will calculate the average unit cost by material and marking type for base year. Please note that the system will include the user's specified inflation rate while calculating the average unit cost. The system will display the average unit cost by material and marking type on the screen. At this point, the user can specify a new average unit cost. By default, the system will use the calculated average unit cost.
4. The system will generate a budget for base year, as shown in Figure 23.
5. The system will repeat steps 3 and 4 for other years depending on the user's input in step 2.
6. As a final step of this module, the system will produce a print-out of the existing data base, based on the previously furnished user's input. The system will ask "Want hard copy printout for base year? (Y/N)."
7. The system will produce an output for base year marking work, as shown in Figure 24, (contract document for base year) if the answer to the above question is "Yes."
8. The system will go back to the initial input screen.
9. The user can produce a new long-term budget by changing the previously submitted inputs.

Module 8. Cost-Effectiveness Analysis

The purpose of this module is to compare various types of marking materials by type based on the present-worth cost. The user can enter into this module by selecting option 8 of LES Subsystem. A screen layout of this module is presented in Figure 25.

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LANE/EDGELINE SUBSYSTEM

LONG TERM BUDGETING

MATERIAL : P DISTRICT : FIVE

TYPE	QUANTITY(LFT)	UNITCOST	AMOUNT	YEAR
SOLID WHITE	561333	3.15	1768198	88
BROKEN WHITE	230375	4.20	967575	88
SOLID YELLOW	833915	5.25	4378053	88
BROKEN YELLOW	77739	6.30	489755	88
SUM	1703362		7603581	

PRESS ANY KEY TO CONTINUE

Figure 23. A typical computer generated budget for base year (lane/edgeline marking).

LANE/EDGE LINE SUBSYSTEM
MICHIGAN DEPARTMENT OF TRANSPORTATION

SUMMARY REPORT

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Route	Cont. Sect.	Segment Description	Fed Aid Sys	Mile Point Begin	Mile Point End	Geometry	4 in Solid White (1ft)	4 in Broken White (1ft)	4 in Solid Yellow (1ft)	4 in Broken Yellow (1ft)
** District: FIVE			County: IDNIA			MARKING TYPE :P				
M-21	34061	W. OF HAYNOR RD	FU	0.00	0.00	2 WAY 2 LANE	5650	106	14995	1478
I-968S	34042	KENT TO I-96	RS	0.00	0.00	2 WAY 2 LANE	7814	845	11774	0
M-44	34081	W. OF M-91	FU	2.24	4.66	2 WAY 2 LANE	16474	1320	10560	0
* Subsubtotal *							29938	2271	37329	1478
** Subtotal **							29938	2271	37329	1478

Figure 24. Contract generation printout.

```

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«
MDOT LANE/EDGE LINE SUBSYSTEM
«
COST-EFFECTIVENESS ANALYSIS
«
«
«
«
«MATERIAL (ENTER EF FOR EPOFLEX, E FOR EPOXY
«
ET FOR EPOXY PLASTIC, PT FOR POLY THERMO
«
P FOR POLYESTER, TPL FOR THERMOPLASTIC
«
CPL FOR COLD PLASTIC, FD FOR FASTDRY ) :    CPL
«
«DISCOUNT RATE:               1      ANALYSIS PERIOD:               5
«
«TERMINAL COST:                  0      MAINTENANCE COST:               0
«
«DISTRICT :                      SIX
«
««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««

```

(ENTER QUIT TO EXIT OR MATERIAL TO CONTINUE)

Figure 25. Cost-Effective Analysis Input Screen.

1. The system will ask for the following information.
 - MATERIAL
 - DISCOUNT RATE
 - ANALYSIS PERIOD
 - TERMINAL COST (terminal cost at the end of the analysis period)
 - MAINTENANCE COST (most cases it will be 0)
 - DISTRICT
2. The user should enter: material, discount rate, analysis period, terminal cost, maintenance cost and district information into the system. The system will ask for confirmation (Y/N):
 - Y - will proceed.
 - N - back to Step 1.
3. The system will calculate the present-worth cost of the material by marking type, as shown in Figure 26.
4. The user can determine the present-worth cost for any other material by following steps 1-3.
5. The user can get a hard copy by using the SHIFT and PRT.SCR keys at the same time.
6. The user will compare the hard copy printouts of the different materials and determine the cost-effective material.

```
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««»
«          LANE/EDGELINE SUBSYSTEM          «
«
«          COST-EFFECTIVENESS ANALYSIS      «
«
« MATERIAL :      CPL      DISTRICT :      SIX      «
«
« TYPE                PRESENT WORTH COST      «
« SOLID WHITE                9.0189      «
« BROKEN WHITE               9.0189      «
« SOLID YELLOW               9.0189      «
« BROKEN YELLOW              6.5681      «
«
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««»

           PRESS ANY KEY TO CONTINUE
```

Figure 26. A Typical Output of Cost-Effectiveness Analysis Module.

4.0 SPECIAL MARKING SUBSYSTEM (SMS)

The main inventory data file of SMS contains locational and descriptive information on special markings. Data entered into the main inventory data file from the completed workorders prompts the system to initiate the necessary action, as presented in Figure 27. If the workorder pertains to the initiation of a new marking, then a new record containing all related data is created within the inventory file. If the workorder pertains to changes to an existing marking, then the new information is updated over the existing data. SMS contains the capability of permitting CRT review and scroll of data bases. The auxiliary program enables the deletion of selected records from the data base and the development of the summary print-out.

Description of Inventory Files

The main inventory file provides for entry, updating and access to data related to all of the special markings that are under the jurisdiction of the Michigan Department of Transportation. The inventory file consists of one record per marking workorder describing its location and attributes (width, type, length, amount, brand, etc.) in an expanded, alpha-numeric form. A description of data contained in each record is presented in Table 4. Specific marking on a particular roadway has a unique contract number and control section. The codes used for the different type of marking are those specified by the MDOT, such as FD for "Fast Dry," LTO for "Left Turn Only," and so on. Contract information related to each marking is stored in the contract information file. A description of data contained in each record of the contractor file is present in Table 5.

```

«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«          S P E C I A L   M A R K I N G   S U B S Y S T E M          «
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«
«
«              1. ADD INFORMATION              «
«              2. EDIT INFORMATION            «
«              3. UPDATE INFORMATION          «
«              4. DELETE INFORMATION         «
«              5. PRINT SPECIAL MARKING REPORT «
«              6. PRINT CONTRACT INFORMATION «
«              7. LONG TERM BUDGETING        «
«              8. COST EFFECTIVENESS ANALYSIS «
«              0. EXIT                       «
«
««««««««««««««««««««««««««««««««««««««««««««««««« select 0 ««««««««««««««««««««««««««««««

```

Figure 27. Screen for Special Marking Subsystem Main Menu.

Table 4. Description of the Special Marking Subsystem Data Item

Column Heading	Data Type	Data Limitation	Description
District	Alpha-Numeric	None	The name of maintenance district.
County	Alpha	None	The name of the county.
Route	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The name of the route (such as US-23).
Alt #1 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The first alternate name of the route, if any.
Alt #2 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The second alternate name of the route, if any.
Federal AID System	Alpha	No Numeric	A special code for the federally funded projects.
Control Section	Alpha	None	An unique number assigned to a road segment by MDOT.
City of Township	Alpha	No Numeric	The name of the city or township.
Cross Street or Railroad Crossing	Alpha-Numeric	None	The name of the nearest cross street or railroad crossing.
Surface	Alpha	None	The name of the roadway surface material (such as bituminous, concrete, etc.).
Geometry	Numeric	No Alpha	This represents the roadway configuration (such as 2-way, 1-way).

Table 4. Description of the Special Marking Subsystem Data Item (Continued)

Column Heading	Data Type	Data Limitation	Description
Number of Lanes	Numeric	No Alpha	This represents the number of lanes.
Intersection Leg	Alpha	No Numeric	This represents the compass direction of the intersection leg (such as N for North, S for South, etc.).
Affected Lane	Alpha-Numeric	1 Numeric & 1 Alpha	This represents the number and the type of lane affected by the special marking.
Distance from Cross Street	Numeric	No Alpha	Distance of the special marking from the nearest cross street.
Marking Type	Alpha	No Numeric	This represents the type of special marking (such as S for School, LTO for left turn only, etc.).
Contract Number	Alpha-Numeric	5 Numeric & 1 Alpha	The contract number assigned to a particular job.
Quantity (Each)	Numeric	No Alpha	The number of special markings.
Quantity (Linear Ft)	Numeric	No Alpha	The amount of marking in LFT.
Milepoint	Numeric	No Alpha	This represents the reference point of a marking.
Cycle	Numeric	No Alpha	When information on a road segment marking is entered into the system, the system sets cycle to 1. However, when the same section of the roadway is repainted, the system sets cycle to (current year - previous year of painting).

Table 5. Description of the Special Marking Contractor Information File

Column Heading	Data Type	Data Limitation	Description
Contractor Name	Alpha-Numeric	None	The name of the contractor.
Job Number	Alpha-Numeric	5 Numeric & 1 Alpha	The job number related to a specific contract.
Material	Alpha	No Numeric	The marking material (such as fast dry, polyester, etc.).
Product Brand	Alpha-Numeric	None	Brand of the marking material is divided into two brand categories based on color: White - Yellow -
Unit Cost (Each)	Numeric	No Alpha	Cost of marking by number.
Unit Cost (Linear Ft)	Numeric	No Alpha	Cost of marking by LFT.

System Operation

Module 1. Add Information

This module is intended for use when a new marking has been installed. A screen layout of this module is displayed in Figure 28. Description of the type and limitation of each data entry is presented in Table 4. The procedures for performing activities of this module are presented below.

1. Enter "District" information first in the box next to DISTRICT and Return.
2. Followed by COUNTY and ends at DATE OF INSTALLATION.
3. Upon completion of data entry into the main inventory file the system will ask, whether the user wants to enter into the contractor information (Y/N).

Y - will bring the contractor information entry screen as of Figure 29.

N - will take the user to Step 6.

4. Enter "Contractor Name" information in the box next to CONTRACTOR NAME and Return.
5. Followed by JOB NUMBER and ends at UNIT COST.
6. Upon completion of data entry into the contractor file or respond "N" to the system's previous inquiry, the system will ask for confirmation (Y/N).

Y - will save the information in the respective data base.

N - will bring the cursor back into the district field.

7. In order to exit from the "Add Information" menu enter "QUIT" in the district field and Return.

Module 2. Edit Information

This module is intended to edit the existing data base. The primary purpose of this module is to correct prior entry errors. A screen layout of module 2 is displayed in Figure 30. The user can get into this module by selecting option 2 of SMS Subsystem. The procedures for operating this program are:

1. Enter control section information in the CONTROL SECTION BOX and return (Figure 31).
2. Enter the marking type information.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection.
 - N - will bring the cursor back to the material box.
4. If this is not the record, the user wants to edit, enter:
 - P - for Previous record.
 - N - for Next record.
5. Once the record that needs to be edited appears on the screen, enter:
 - E - for Edit.
6. The system will prompt the user for the required data item. When an acceptable entry has been made, hit return to move to the next data item.
7. Upon completion, the system will ask the user about contract information (Y/N).
 - Y - will bring the related contract information on the screen.
 - N - will ask for confirmation.
8. When all changes are made on the main file and contractor file, the system will ask the user for confirmation (Y/N).
 - Y - will save the information and return to initial screen.
 - N - will bring the cursor back to the DISTRICT field.

Module 3. Update Information

This module is intended to update the existing records due to maintenance work performed on the existing marking. A screen layout of this module is displayed in Figure 32. Three options are available in this module to retrieve an existing record.

Option 1. The user can update an existing record by providing material (material type such as FD for fast dry, etc.) and road surface information.

Option 2. The user can update an existing record by providing contract number and road surface information.

Option 3. The user can update an existing record by providing control section and marking type.

Option 1. The user can get into this option by typing 1 from the "Update Information" module. A screen layout of this option is presented in Figure 33. The procedures for operating this program are:

1. Enter material information in the MATERIAL box and Return.
2. Enter road surface information in the ROAD SURFACE box and Return.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection.
 - N - will bring the cursor back to MATERIAL box.
4. If this record is not the record the user wants to update enter:
 - P - for Previous record.
 - N - for Next record.
5. After the record that needs to be updated appears on the screen enter:
 - E - for Edit/Update.

6. The system will prompt the user for the required data item. When an acceptable entry has been made, hit return to move to the next data item.

7. Upon completion, the system will ask the user about contractor information (Y/N).

Y - will bring the related contract information on the screen.

N - will ask for confirmation.

8. When all changes are made on the main file and contractor file the system will ask the user for confirmation (Y/N).

Y - will save the information and return to change information module.

N - will bring the cursor back to district field.

Option 2. The user can get into this option by selecting 2 from the "Update Information" module. A screen layout of this option is presented in Figure 34. The procedure for operating this program are:

1. Enter contract number information in the CONTRACT NUMBER box and Return.

2. Enter road surface information in the ROAD SURFACE box and Return.

3. The system will ask for confirmation (Y/N).

Y - will bring the first record on the selection.

N - will bring the cursor back to contract number.

4. The rest of the procedures are the same as the previous option.

Option 3. The user can enter into this option by selecting 3 from the "Update Information" module. A screen layout of the option is displayed in Figure 35. The user should enter control section and marking type information to edit a related record. The procedures for operating this program are similar to the procedures of option 1.

Module 4. Delete Information Module

The purpose of this module is to delete designated records from the active inventory files (i.e., main file and contractor information). A screen layout of this module is presented in Figure 36. The detailed procedures of this module are:

1. Enter control section information into the CONTROL SECTION box and Return.
2. Enter marking type information.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection (Figure 37).
 - N - will bring the cursor back to MATERIAL box.
4. If this record is not the record the user wants to delete enter:
 - P - for previous record.
 - N - for next record.
5. After the record that should be deleted from the data base enter:
 - D - for delete.
6. When the user wants to exit from this module, the system will ask for confirmation (Figure 38):
 - Y - will remove the records permanently from the data base and exit from this module.
 - N - will simply exit from the module.

Module 5. Print Special Marking Information

The purpose of this module is to print a summary report of the special marking inventory file. A typical output is presented in Figure 39.

Module 6. Print Contract Information

The purpose of this module is to print a summary report of the contractor information file. A typical output is presented in Figure 40.

Module 7. Long-Term Budgeting/Contract Generation

This module of SMS Subsystem is designed to produce a long-term budget and a contract document. The user can enter into this module by selecting option 7 of SMS Subsystem menu. A screen layout of this module is presented in Figure 41.

1. The system will ask for the following information:
 - MATERIAL
 - CURRENT YEAR (base year)
 - RANGE (number of years the user wants to prepare long-term budget)
 - DISTRICT
 - INFLATION RATE

2. The user should enter: material, current year, range, district, and inflation rate information into the system. The system will ask for confirmation (Y/N):
 - Y - will proceed.
 - N - back to Step 1.

SPECIAL MARKING SUBSYSTEM

MICHIGAN DEPARTMENT OF TRANSPORTATION
SUMMARY REPORT

COUNTY	ROUTE	Cont. Sect.	City or Twp.	CROSS ST. OR RR X-ING	INT	DIST. FROM MILE POINT	S FED U	AID R MARK	QUAN (FT)	QUAN (#)	CONTRACT NUMBER	BRND YELO	BRND WHITE	C LE	Y C YEAR
					L E G										
** District: FIVE															
MATERIAL: CPL															
CLINTON	M-21	19001	FOWLER	MAIN ST	E	0.00	123	FR B 6CW	120	0	12345-Y			0	87
ALLEGAN	M-40	03072	HOLLAND	601	W	0.00		MU B 24B	30	0	-			2	85
ALLEGAN	M-40	03072	HOLLAND	601	E	0.00		MU B RR	0	1	-			3	86
ALLEGAN	M-40	03072	HOLLAND	601	E	0.00		MU B 24B	30	0	-			4	87
CLINTON	US-27	19031	ST JOHNS	WHL. INN MALL	N	0.00		FU B LTA	0	5	12345-Y			5	85
CLINTON	US-27	19031	ST JOHNS	ME1STATE	S	0.00		FU B 24B	30	0	-			1	86
CLINTON	US-31	19031	ST JOHNS	ME1STATE	S	0.00	123	FU B 6CW	120	0	-			2	84
CLINTON	M-21	19061	FOWLER	RAIN ST	E	0.00		FR B 6CW	120	0	12345-Y			3	87
CLINTON	US-27	19031	ST JOHNS	BALDWIN ST	N	0.00		FU B S	0	2	-			4	85
CLINTON	US-27	19031	ST JOHNS	BALDWIN ST	S	0.00		FU B 6CW	160	0	-			3	84
CLINTON	US-27	19031	ST JOHNS	BALDWIN ST	S	0.00		FU B S	0	2	-			0	87
CLINTON	I-96	19022	EAGLE	GRANGE RD#1	W	0.00		IR B DA	0	1	-			3	86
CLINTON	I-96	19022	EAGLE	GRANGE RD#1	W	0.00		IR B 24B	40	0	-			3	87
CLINTON	I-96	19022	EAGLE	W. BD. RAMP#3	E	0.00		IR B DA	0	1	-			2	86
CLINTON	I-96	19022	EAGLE	W BD RAMP#3	E	0.00		IR B 24B	30	0	-			2	85
CLINTON	I-96	19022	EAGLE	M100E. BD. RAMP#1	W	0.00		IR B DA	0	1	-			2	86
CLINTON	I-96	19022	EAGLE	M100E. BD. RAMP#1	W	0.00		IR B 24B	40	0	-			2	85
CLINTON	I-96	19022	EAGLE	W. BD. RAMP#3	E	0.00		IR B DA	0	1	-			2	86
CLINTON	I-96	19022	EAGLE	W. BD. RAMP#3	E	0.00		IR B 24B	40	0	-			2	85
CLINTON	I-96	19022	WATERTOWN	GD. RIVER #1	S	0.00		IR B DA	0	1	-			1	86
CLINTON	I-96	19022	WATERTOWN	W. BD. RAMP#3	S	0.00		IR B DA	0	1	-			1	85
CLINTON	I-96	19022	WATERTOWN	W. BD. RAMP#3	S	0.00		IR B LTA	0	1	-			1	85
CLINTON	I-96	19022	WATERTOWN	W. BD. RAMP#3	S	0.00		IR B RTA	0	1	-			4	86
CLINTON	I-96	19022	WATERTOWN	W. BD. RAMP#3	S	0.00		IR B 24B	50	0	-			3	87
GRATIOT	M-46	29012	ST LOUIS	DAVIS ST	W	0.00		FU B S	0	1	-			3	87
GRATIOT	M-46	29012	ST LOUIS	DAVIS ST	W	0.00		FU B 6CW	100	0	-			3	85
GRATIOT	M-46	29012	ST LOUIS	DAVIS ST	E	0.00		FU B S	0	1	-			2	85
GRATIOT	US-27 BR	29015	ITHACA	ARCADIA ST	N	0.00		FR B S	0	2	-			3	85
GRATIOT	US-27 BR	29015	ITHACA	ARCADIA ST	N	0.00		FR B 6CW	120	0	-			3	86
GRATIOT	US-27 BR	29015	ITHACA	ARCADIA ST	S	0.00		FR B S	0	2	-			3	86
IONIA	M-66	34032	IONIA	601	S	0.00		FU B RR	0	2	-			3	85
IONIA	M-66	34032	IONIA	601	S	0.00		FU B 24B	30	0	-			3	86
IONIA	M-66	34032	IONIA	601	N	0.00		FU B RR	0	2	-			3	86
IONIA	M-66	34032	IONIA	601	N	0.00		FU B 24B	30	0	-			3	86
IONIA	M-50	34021	LK ODESSA	WASH. ST	W	0.00		FR B S	0	1	-			3	86
IONIA	M-50	34021	LK ODESSA	WASH. ST	W	0.00		FR B 6CW	100	0	-			3	84
IONIA	M-50	34021	LK ODESSA	WASH. ST	E	0.00		FR B S	0	1	-			3	84
ISABELLA	M-20	37021	MTPLEASANT	KINNEY ST	W	0.00		FU B S	0	1	-			2	84
ISABELLA	M-20	37021	MTPLEASANT	KINNEY ST	E	0.00		FU B 6CW	80	0	-			2	85
ISABELLA	M-20	37021	MTPLEASANT	KINNEY ST	E	0.00		FU B S	0	1	-			2	86
ISABELLA	US-27 BR	37011	MTPLEASANT	BROOMFIELDST	S	0.00	50	FU B 6CW	150	0	-			2	84

Figure 39. Special Marking Subsystem Summary Report.

SPECIAL MARKING CONTRACTOR INFORMATION

MICHIGAN DEPARTMENT OF TRANSPORTATION
SUMMARY REPORT

CONT. NUMBER	JOB NUMBER	CONT. NAME	CONT. SECT.	QUANTITY (LFT)	UNIT COST (\$#)	MARKING TYPE	QUANTITY (NUMBER)	UNIT COST (\$#)	BRAND YELLOW	BRAND WHITE	BRAND YEAR
** DISTRICT FIVE				MATERIAL	CPL						
*											
12345-Y	-			19061	120	30.0000	6CW	0	0.0000		87
-	-			03072	30	6.0000	24B	0	24.0000		85
-	-			03072	0	33.0000	RR	1	250.0000		86
-	-			03072	30	6.0000	24B	0	23.0000		87
12345-Y	-			19031	0	12.0000	LTA	5	80.0000		85
-	-			19031	30	6.0000	24B	0	23.0000		86
-	-			19031	120	2.0000	6CW	0	34.0000		84
12345-Y	-	NFFFF		19061	120	2.0000	6CW	0	0.0000		87
-	-			19031	0	23.0000	S	2	150.0000		85
-	-			19031	160	2.0000	6CW	0	11.0000		84
-	-			19031	0	12.0000	S	2	150.0000		87
-	-			19022	0	11.0000	DA	1	80.0000		86
-	-			19022	40	6.0000	24B	0	12.0000		87
-	-			19022	0	12.0000	DA	1	80.0000		86
-	-			19022	30	6.0000	24B	0	12.0000		85
-	-			19022	0	33.0000	DA	1	80.0000		86
-	-			19022	40	6.0000	24B	0	12.0000		85
-	-			19022	0	32.0000	DA	1	80.0000		86
-	-			19022	40	6.0000	24B	0	12.0000		85
-	-			19022	0	12.0000	DA	1	80.0000		86
-	-			19022	0	13.0000	DA	1	80.0000		85
-	-			19022	0	14.0000	LTA	1	80.0000		85
-	-			19022	0	15.0000	RTA	1	80.0000		86
-	-			19022	50	6.0000	24B	0	11.0000		87
-	-			29012	0	12.0000	S	1	150.0000		87
-	-			29012	100	2.0000	6CW	0	12.0000		85
-	-			29012	0	12.0000	S	1	150.0000		85
-	-			29015	0	13.0000	S	2	150.0000		85
-	-			29015	120	2.0000	6CW	0	12.0000		86
-	-			29015	0	12.0000	S	2	150.0000		86
-	-			34032	0	11.0000	RR	2	250.0000		85
-	-			34032	30	6.0000	24B	0	11.0000		86
-	-			34032	0	11.0000	RR	2	250.0000		86
-	-			34032	30	6.0000	24B	0	12.0000		86
-	-			34021	0	2.0000	S	1	150.0000		86
-	-			34021	100	2.0000	6CW	0	13.0000		84
-	-			34021	0	11.0000	S	1	150.0000		84
-	-			37021	0	22.0000	S	1	150.0000		84
-	-			37021	80	2.0000	6CW	0	12.0000		85
-	-			37021	0	11.0000	S	1	150.0000		86
-	-			37011	150	2.0000	6CW	0	12.0000		84

Figure 40. Summary Report Contractor Information (Special Marking).

3. The system will calculate the average unit cost by material and marking type for base year. Please note that the system will include the user's specified inflation rate while calculating the average unit cost. The system will display the average unit cost by the material and marking type on the screen. At this point, the user can specify a new average unit cost. By default, the system will use the calculated average unit cost.
4. The system will generate a budget for base year, as shown in Figure 42.
5. The system will repeat steps 3 and 4 for other years depending on the user's input in step 2.
6. As a final step of this module, the system will produce a print-out of the existing data base, based on the previously furnished user's input. The system will ask "Want hard copy printout for base year? (Y/N)."
7. The system will produce an output for base year marking work, as shown in Figure 43, (contract document for base year) if the answer to the above question is "Yes."
8. The system will go back to the initial input screen.
9. The user can produce a new long-term budget by changing the previously submitted inputs.

Module 8. Cost-Effectiveness Analysis

The purpose of this module is to compare various types of marking materials by type based on the present-worth cost. The user can enter into this module by selecting option 8 of SMS Subsystem. A screen layout of this module is presented in Figure 44.

SPECIAL MARKING SUBSYSTEM
MICHIGAN DEPARTMENT OF TRANSPORTATION
SUMMARY REPORT

Route	Cont. Sect.	FED AID SYS	ROAD ROAD SURFACE	City or Twp.	CROSS ST. OR RR X-ING	INT L E G	DIST. FROM X-ST (FT)	AFFECTED LANE(S)	MILE MARKING POINT	QUANTITY (1ft)	QUANTITY (NUM)
** District: FIVE			COUNTY:CLINTON			MATERIAL :CPL					
* US-27	19031	FU	R	ST JOHNS	WHL. INN MALL	N	1		0.00 LTA	0	5
US-27	19031	FU	B	ST JOHNS	M21STATE	S	2A		0.00 24B	30	0
US-31	19031	FU	B	ST JOHNS	M21STATE	S	4A		0.00 6CW	120	0
M-21	19061	FR	B	FOWLER	6AIN ST	E	4A		0.00 6CW	120	0
US-27	19031	FU	B	ST JOHNS	BALDWIN ST	N	2A		0.00 S	0	2
US-27	19031	FU	B	ST JOHNS	BALDWIN ST	S	4A		0.00 6CW	160	0
US-27	19031	FU	B	ST JOHNS	BALDWIN ST	S	2A		0.00 S	0	2
I-96	19022	IR	B	EAGLE	GRANGE RD#1	W	1A		0.00 DA	0	1
I-96	19022	IR	B	EAGLE	GRANGE RD#1	W	4A		0.00 24B	40	0
I-96	19022	IR	B	EAGLE	W. BD. RAMP#3	E	1A		0.00 DA	0	1
I-96	19022	IR	B	EAGLE	W. BD. RAMP#3	E	4A		0.00 24B	30	0
I-96	19022	IR	B	EAGLE	M100E. BD. RAMP#1	W	1A		0.00 DA	0	1
I-96	19022	IR	B	EAGLE	M100E. BD. RAMP#1	W	4A		0.00 24B	40	0
I-96	19022	IR	B	EAGLE	W. BD. RAMP#3	E	1A		0.00 DA	0	1
I-96	19022	IR	B	EAGLE	W. BD. RAMP#3	E	4A		0.00 24B	40	0
I-96	19022	IR	B	WATERTOWN	GD. RIVER #1	S	1A		0.00 DA	0	1
I-96	19022	IR	B	WATERTOWN	W. BD. RAMP#3	S	1A		0.00 DA	0	1
I-96	19022	IR	B	WATERTOWN	W. BD. RAMP#3	S	1A		0.00 LTA	0	1
I-96	19022	IR	B	WATERTOWN	W. BD. RAMP#3	S	1A		0.00 RTA	0	1
I-96	19022	IR	B	WATERTOWN	W. BD. RAMP#3	S	4A		0.00 24B	50	0

Figure 43. A typical computer generated budget for base year (Special Marking).

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«           MDOT SPECIAL MARKING SUBSYSTEM                                 «
«           COST-EFFECTIVENESS ANALYSIS                                  «
«                                                                 «
«                                                                 «
«                                                                 «
«MATERIAL (ENTER EF FOR EPOFLEX, E FOR EPOXY                            «
«           ET FOR EPOXY PLASTIC, PT FOR POLY THERMO                    «
«           P FOR PLASTIC, TPL FOR THERMOPLASTIC                        «
«           CPL FOR COLD PLASTIC, FD FOR FASTDRY ) :                     «
«                                                                 «
«DISCOUNT RATE:                ANALYSIS PERIOD:                         «
«                                                                 «
«TERMINAL COST:                  MAINTENANCE COST:                       «
«                                                                 «
«DISTRICT :                                                                «
«                                                                 «
««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««

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(ENTER QUIT TO EXIT OR MATERIAL TO CONTINUE)

Figure 44. Cost-Effectiveness Analysis Input Screen (Special Marking).

1. The system will ask for the following information.
 - MATERIAL
 - DISCOUNT RATE
 - ANALYSIS PERIOD
 - TERMINAL COST (terminal cost at the end of the analysis period)
 - MAINTENANCE COST (most cases it will be \emptyset)
 - DISTRICT
2. The user should enter: material, discount rate, analysis period, terminal cost, maintenance cost and district information into the system. The system will ask for confirmation (Y/N):
 - Y - will proceed.
 - N - back to Step 1.
3. The system will calculate the present-worth cost of the material by marking type, as shown in Figure 45.
4. The user can determine the present-worth cost for any other material by following steps 1-3.
5. The user can get a hard copy by using the shift and PRT SCR keys at the same time.
6. The user will compare the hard copy printouts of the different materials and determine the cost-effective material.

5.0 RAMP LANE/EDGE LINE SUBSYSTEM (RES)

The main inventory data file of RES contains locational and descriptive information on ramp lane/edgeline markings. Data entered into the main inventory data file from the completed workorders prompts the system to initiate the necessary action, as presented in Figure 46. If the workorder pertains to the initiation of new a marking, then a new record containing all related data is created within the inventory file. If the workorder pertains to changes to an existing marking, then the new information is updated over the existing data. RES contains the capability of permitting CRT review and scroll of data bases. The auxiliary program enables the deletion of selected records from the data base and the development of the summary print-out.

Description of Inventory Files

The main inventory file provides for entry, updating and access to data related to all of the ramp lane/edgeline markings that are under the jurisdiction of the Michigan Department of Transportation. The inventory file consists of one record per marking workorder describing its location and attributes (width, type, length, amount, brand, etc.) in an expanded, alpha-numeric form. A description of data contained in each record is presented in Table 6. Specific marking on a particular ramp has a unique contract number and control section. The codes used for the different type of marking are those specified by the MDOT, such as FD for "Fast Dry," LTO for "Left Turn Only," and so on. Contract information related to each marking is stored in the contract information file. A description of data contained in each record of the contractor file is present in Table 7.

Table 6. Description of the Ramp Lane/Edgeline Subsystem Data Item

Column Heading	Data Type	Data Limitation	Description
District	Alpha-Numeric	None	The name of maintenance district.
Date	Date	No Alpha	The date of installation (month/year).
Federal AID System	Alpha	No Numeric	A special code for the federally funded projects.
County	Alpha	None	The name of the county.
Route	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The name of the route (such as US-23).
Alt #1 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The first alternate name of the route, if any.
Alt #2 (sometimes a road segment has more than one name)	Alpha-Numeric	2 Alpha, 3 Numeric & 2 Alpha	The second alternate name of the route, if any.
Control Section	Alpha	None	An unique number assigned to a road segment by MDOT.
Location Description	Alpha	None	A brief description of the road segment.
Name of Exit	Alpha-Numeric	None	The name of the exit (such as 123A, 14A, etc.)
Number of Ramps	Numeric	No Alpha	The number of ramps (entrance and exit) at a particular location.
Interchange Number	Numeric	No Alpha	The number of the nearest interchange.

Table 6. Description of the Ramp Lane/Edgeline Subsystem Data Item (Continued)

Column Heading	Data Type	Data Limitation	Description
Material	Alpha	No Numeric	The marking material (such as fast dry, polyester, etc.).
Estimated Quantity (Ft)	Numeric	No Alpha	This represents the quantity in LFT of marking by type, such as: 4 in white 6 in white 6 in yellow 12 in white 4 in white thermoplastic
Product Brand	Alpha-Numeric	None	Brand of marking material is divided into two brand categories based on color: White Yellow A typical brand could be <u>3M</u> .
Contract Number	Alpha-Numeric	5 Numeric & 1 Alpha	The contract number assigned to a particular job.
Cycle	Numeric	No Alpha	When information on a road segment marking is entered into the system, the system sets cycle to 1. However, when the same section of the roadway is repainted, the system sets cycle to (current year - previous year of painting).

Table 7. Description of the Ramp Lane/Edgeline Subsystem Contractor Information File

Column Heading	Data Type	Data Limitation	Description
Contractor Name	Alpha-Numeric	None	The name of the contractor.
Job Number	Alpha-Numeric	5 Numeric & 1 Alpha	The job number relate to a specific contract.
Unit Cost	Numeric	No Alpha	Unit cost of four marking types are stored in this regard, namely: 4 in white 6 in white 6 in yellow 12 in white 4 in white thermoplastic
Mobilization Cost	Numeric	No Alpha	This represents the cost of mobilization.
Minor Traffic Cost	Numeric	No Alpha	This represents the cost related to temporary traffic barricading, etc. while marking the roadway.

System Operation

Module 1. Add Information

This module is intended for use when a new marking has been installed. A screen layout of this module is displayed in Figure 47. Description of type and limitation of each data entry are presented in Table 6. The procedures for performing activities of this module are presented below.

1. Enter "District" information first in the box next to DISTRICT and Return.
2. Followed by DATE and ends at CONTRACT NUMBER.
3. Upon completion of data entry into the main inventory file the system will ask, whether the user wants to enter into the contractor information (Y/N).
 - Y - will bring the contractor information entry screen as of Figure 48.
 - N - will take the user to Step 6.
4. Enter "Contractor Name" information in the box next to CONTRACTOR NAME and Return.
5. Followed by JOB NUMBER and ends at MINOR TRAFFIC COST.
6. Upon completion of data entry into the contractor file or respond "N" to the system's previous inquiry, the system will ask for confirmation (Y/N).
 - Y - will save the information in the respective data base.
 - N - will bring the cursor back into the district field.
7. In order to exit from the "Add Information" menu enter "QUIT" in the district field and Return.

MDOT
CONTRACT INFORMATION (RAMP LANE/EDGELINE)

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« CONTRACTOR NAME                                                                              «
«                                                                                              «
«          JOB NUMBER :                               -                                       «
«                                                                                              «
«          4 in WHITE   6 in WHITE   6 in YELLOW   12 in WHITE   TRMPLASTIC       «
« UNIT COST          0.0000        0.0000        0.0000        0.0000        0.0000  «
«                                                                                              «
«                                                                                              «
«                                                                                              «
«                                                                                              «
« MOBLIZATION COST      0              MINOR TRAFFIC COST :      . 0                «
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««

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85

Figure 48. Screen for Add Information (Ramp Lane/Edgeline Contractor File) Module.

Module 2. Edit Information

This module is intended to edit the existing data base. The primary purpose of this module is to correct prior entry errors. A screen layout of module 2 is displayed in Figure 49. The user can get into this module by selecting option 2 of RES Subsystem. The procedures for operating this program are:

1. Enter material information in the MATERIAL BOX and return (Figure 50).
2. Enter the control section information.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection.
 - N - will bring the cursor back to the material box.
4. If this is not the record, the user wants to edit, enter:
 - P - for Previous record.
 - N - for Next record.
5. Once the record that needs to be edited appears on the screen, enter:
 - E - for Edit.
6. The system will prompt the user for the required data item. When an acceptable entry has been made, enter "Return" to move to the next data item.
7. Upon completion, the system will ask the user about contract information (Y/N).
 - Y - will bring the related contract information on the screen.
 - N - will ask for confirmation.
8. When all changes are made on the main file and contractor file, the system will ask the user for confirmation (Y/N).
 - Y - will save the information and return to main screen.
 - N - will bring the cursor back to the DISTRICT field.

Module 3. Update Information

This module is intended to update the existing inventory files due to maintenance work performed on the existing marking. Screen layout of this module is displayed in Figure 51. Two options are available in this module to retrieve an existing record.

Option 1. The user can update an existing record by providing material (material type such as FD for fast dry, etc.) and contract number information.

Option 2. The user can update an existing record by providing material and control section information.

Option 1. The user can get into this option by typing 1 from the "Update Information" module. A screen layout of this option is presented in Figure 52. The procedures for operating this program are:

1. Enter material information in the MATERIAL box and Return.
2. Enter contract number information in the CONTRACT NUMBER box and Return.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection.
 - N - will bring the cursor back to MATERIAL box.
4. If this record is not the record the user wants to update enter:
 - P - for Previous record.
 - N - for Next record.
5. After the record that needs to be updated appears on the screen enter:
 - E - for Edit/Update.

6. The system will prompt the user for the required data item. When an acceptable entry has been made, hit return to move to the next data item.
7. Upon completion, the system will ask the user about contractor information (Y/N).
 - Y - will bring the related contract information on the screen.
 - N - will ask for confirmation.
8. When all changes are made on the main file and contractor file the system will ask the user for confirmation (Y/N).
 - Y - will save the information and return to main screen.
 - N - will bring the cursor back to district field.

Option 2. The user can get into this option by selecting 2 from the "Update Information" module. A screen layout of this option is presented in Figure 53. The procedures for operating this program are:

1. Enter material information in the MATERIAL box and Return.
2. Enter control section information in the control section box and Return.
4. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the section.
 - N - will bring the cursor back to material.
5. The rest of the procedure is the same as the previous option.

Module 4. Delete Information Module

The purpose of this module is to delete designated records from the active inventory files (i.e., main file and contractor information). A screen layout of this module is presented in Figure 54. The detailed procedures of this module are:

```

«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«                                RAMP LANE/EDGE LINE SUBSYSTEM                                «
«                                UPDATE A RECORD                                        «
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«                                                                            «
«                                                                            «
«MATERIAL (ENTER EF FOR EPOFLEX, E FOR EPOXY                                    «
«                                ET FOR EPOXY PLASTIC, PT FOR POLY THERMO          «
«                                P FOR POLYESTER, TPL FOR THERMOPLASTIC          «
«                                CPL FOR COLD PLASTIC, FD FOR FASTDRY ) :       «
«                                                                            «
«                                                                            «
«                                                                            «
«CONTROL SECTION :                                                             «
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
                                  (ENTER QUIT TO EXIT OR MATERIAL TO PROCEED)

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Figure 53. Screen for Update Information (Ramp Lane/Edgeline) Module
 (Search Parameter: Material and Control Section).

1. Enter material information into the MATERIAL box and Return.
2. Enter control section information.
3. The system will ask for confirmation (Y/N).
 - Y - will bring the first record on the selection (Figure 55).
 - N - will bring the cursor back to MATERIAL box.
4. If this record is not the record the user wants to delete enter:
 - P - for previous record.
 - N - for next record.
5. After the record that should be deleted from the data base enter:
 - D - for delete.
6. When the user wants to exit from this module, the system will ask for confirmation (Figure 56):
 - Y - will remove the records permanently from the data base and exit from this module.
 - N - will simply exit from the module.

Module 5. Print Ramp Lane/Edgeline Information

The purpose of this module is to print a summary report of the Ramp Lane/Edgeline inventory file. A typical output is presented in Figure 57.

Module 6. Print Contract Information

The purpose of this module is to print a summary report of the contractor information file. A typical output is presented in Figure 58.

Module 7. Long-Term Budgeting/Contract Generation

This module of RES Subsystem is designed to produce a long-term budget and a contract document. The user can enter into this module by selecting option 7 of RES Subsystem menu. A screen layout of this module is presented in Figure 59.

```

««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«          RAMP LANE/EDGE LINE SUBSYSTEM          «
«          DELETE A RECORD                         «
««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«
«
«MATERIAL (ENTER EF FOR EPOFLEX, E FOR EPOXY      «
«          ET FOR EPOXY PLASTIC, PT FOR POLY THERMO «
«          P FOR POLYESTER, TPL FOR THERMOPLASTIC  «
«          CPL FOR COLD PLASTIC, FD FOR FASTDRY ) : «
«
«
«
«
«
«CONTROL SECTION :                               «
««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««

```

(ENTER QUIT TO EXIT OR MATERIAL TO PROCEED)

Figure 55. A Typical Delete Screen (Ramp Lane/Edgeline) Module.

DO YOU WANT TO DELETE DESIGNATED RECORDS PERMANENTLY (Y/N)

Figure 56. Delete Confirmation Screen.

RAMP LANE/EDGE LINE SUBSYSTEM

MICHIGAN DEPARTMENT OF TRANSPORTATION
SUMMARY REPORT

COUNTY	ROUTE	CONTROL SECTION	Segment Description	Fed. Aid Sys.	NAME OF EXIT	NUM. OF RAMP	BRAND YELLO	BRAND WHITE	4 IN WHITE (LFT)	6 in WHITE (LFT)	6 in YELLOW (LFT)	12 in WHITE (LFT)	4 in WHITE THERMO PLASTIC	CONTRACT NUMBER	C Y C LE YEAR
** District: EIGHT			MATERIAL : P												
CLINTON	I-96	19022	GRANGE RD.		84	4	3M	3M	0	5100	2500	0	0	12345-R	0 87
CLINTON	I-96	19022	M-100		86	4	3M	3M	0	5300	2700	0	0	12345-Y	2 87
CLINTON	I-96	19022	GRANGE RD.	FU	84	4	3M	3M	0	5100	2500	0	0	12345-R	5 87
CLINTON	I-96	19022	GRANGE RD.		84	4	3M	3M	0	5100	2500	0	0	12345-R	0 87
CLINTON	I-96	19022	M-100	FU	86	4	3M	3M	0	5300	2700	0	0	12345-Y	0 87
CLINTON	I-96	19022	M-100		86	4	3M	3M	0	5300	2700	0	0	12345-Y	0 87
CLINTON	I-96	19022	GRANGE RD.	FU	84	4	3M	3M	0	5100	2500	0	0	12345-R	0 87
CLINTON	I-96	19022	GRANGE RD.		84	4	3M	3M	0	5100	2500	0	0	12345-R	0 87
CLINTON	I-96	19022	M-100		86	4	3M	3M	0	5300	2700	0	0	12345-Y	0 87
CLINTON	I-96	19022	GRANGE RD.		84	4	3M	3M	0	5100	2500	0	0	12345-R	0 87
CLINTON	I-96	19022	GRANGE RD.	FU	84	4	3M	3M	0	5100	2500	0	0	12345-R	0 87
INGHAM	I-496	33045	JOLLY-DUNKEL RD		0	4			400	8200	4800	0	0	-	1 87
INGHAM	I-496	33045	KALAMAZOO-TRBR		0	12			0	25400	14800	0	0	-	1 87
INGHAM	I-496	33045	PENN.-CEDAR		0	12			0	8000	15000	0	0	-	2 87
INGHAM	I-496	33044	PINE-WALNUT		0	4			0	5800	2000	0	0	-	2 87
INGHAM	I-496	33044	M-99 LOGAN		0	4			0	6800	3200	0	0	-	2 87
INGHAM	I-496	33044	US-27		0	2			200	4400	2400	0	0	-	2 87
INGHAM	US-127	33031	BELLEVUE RD.		0	4			400	9600	4800	0	0	-	2 87
INGHAM	US-127	33031	BARNES RD.		0	4			400	10800	5800	0	0	-	2 87
INGHAM	US-127	33032	KIPP RD		0	4			400	9800	4800	0	0	-	2 87
INGHAM	US-127	33032	M-36		0	4			400	10600	6000	0	0	-	2 87
INGHAM	US-127	33035	HOLT RD.		0	4			400	10000	6200	0	0	-	2 87
INGHAM	US-127	33035	REST AREA NB		0	2			0	3200	1000	0	0	-	2 87
INGHAM	US-127	33035	I-96 TEMP I-69		0	8			0	24400	10200	0	0	-	2 87
INGHAM	US-127	33171	M-43 TEMP I-69		0	4			0	5600	2200	0	0	-	1 87
INGHAM	US-127	33172	LAKE LANSING RD		0	6			400	16000	7200	0	0	-	1 87
INGHAM	I-96	33083	CEDAR-PENN		104	8			0	15600	10200	0	0	-	1 87
INGHAM	I-96	33084	OKEMOS		110	4			400	7800	4800	0	0	-	1 87
INGHAM	I-96	33084	REST AREA WB		0	2			0	2400	1400	0	0	-	1 87
JACKSON	I-94	38102	M-99		124	4			0	6600	4400	0	0	-	1 87
JACKSON	I-94	38102	CONCORD		127	4			0	7200	4200	0	0	-	2 87
JACKSON	I-94	38101	I-94 BL		144	2			0	3800	2800	0	0	-	2 87
JACKSON	I-94	38103	SARGENT RD.		145	4			200	5600	2400	0	0	-	2 87
JACKSON	I-94	38103	RACE RD.		147	4			0	4500	1800	0	0	-	2 87
JACKSON	I-94	38103	REST AREA WB		0	2			0	2000	300	0	0	-	2 87
JACKSON	I-94	38103	MT. HOPE RD.		150	4			0	5800	2400	0	0	-	2 87
JACKSON	I-94	38103	WEIGH STAT. EB		0	2			0	3200	1200	0	0	-	2 87
JACKSON	I-94	38103	WEIGH STAT. WB		0	2			0	2600	1600	0	0	-	2 87
JACKSON	I-94	38103	CLEAR LAKE RD.		153	4			0	6000	3000	0	0	-	2 87
JACKSON	US-127	38131	REST AREA SB		0	2			0	3000	1200	0	0	-	2 87
JACKSON	US-127	38131	BERRY RD.		0	4			0	9000	5600	0	0	-	2 87
JACKSON	M-60	38081	I-94		0	4			0	12800	8400	0	0	-	1 87
JACKSON	M-60	38081	MICHIGAN AVE		0	4			0	8400	5600	0	0	-	1 87

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Figure 57. Ramp Lane/Edgeline Subsystem Summary Report.

RAMP LANE/EDGE LINE CONTRACTOR INFORMATION

MICHIGAN DEPARTMENT OF TRANSPORTATION
SUMMARY REPORT

CONT. NUMBER	JOB NUMBER	CONT. NAME	CONT. SECT.	4 in WHITE (LFT)	UNIT COST \$\$\$	6 in WHITE (LFT)	UNIT COST \$\$\$	6 in YELLOW (LFT)	UNIT COST \$\$\$	12 in WHITE (LFT)	UNIT COST \$\$\$	4 in WHITE THERMO PLASTIC	UNIT COST \$\$\$	MOB. COST \$\$\$	TRAFFIC COST \$\$\$	YEAR
** DISTRICT EIGHT			MATERIAL P													
12345-R	-	HHHHHHHHHHHH	19022	0	0.100	5100	0.130	2500	0.130	0	0.180	0	0.000	0	6999	87
12345-Y	-		19022	0	0.100	5200	0.130	2700	0.130	0	0.180	0	0.000	0	234	87
-	-		23061	400	0.100	10800	0.130	6400	0.130	0	0.180	0	0.000	0	0	87
-	-		23061	0	0.100	11000	0.130	6500	0.130	0	0.180	0	0.000	0	0	87
-	-		23061	400	0.100	11400	0.130	6800	0.130	0	0.180	0	0.000	0	0	87
-	-		23061	400	0.100	10800	0.130	6000	0.130	0	0.180	0	0.000	0	0	87
-	-		23152	0	0.100	18000	0.130	11000	0.130	0	0.180	0	0.000	0	0	87
-	-		23152	0	0.100	22000	0.130	11400	0.130	0	0.180	0	0.000	0	0	87
-	-		23081	0	0.100	20000	0.130	14400	0.130	0	0.180	0	0.000	0	0	87
-	-		23081	400	0.100	11400	0.130	6800	0.130	0	0.180	0	0.000	0	0	87
-	-		23081	400	0.100	17000	0.130	8400	0.130	0	0.180	0	0.000	0	0	87
-	-		33045	400	0.100	8200	0.130	4800	0.130	0	0.180	0	0.000	0	0	87
-	-		33045	0	0.100	25400	0.130	14800	0.130	0	0.180	0	0.000	0	0	87
-	-		33045	0	0.100	8000	0.130	15000	0.130	0	0.180	0	0.000	0	0	87
-	-		33044	0	0.100	5600	0.130	2900	0.130	0	0.180	0	0.000	0	0	87
-	-		33044	0	0.100	6800	0.130	3200	0.130	0	0.180	0	0.000	0	0	87
-	-		33044	200	0.100	4400	0.130	2400	0.130	0	0.180	0	0.000	0	0	87
-	-		33031	400	0.100	9600	0.130	4800	0.130	0	0.180	0	0.000	0	0	87
-	-		33031	400	0.100	10800	0.130	5800	0.130	0	0.180	0	0.000	0	0	87
-	-		33032	400	0.100	9800	0.130	4800	0.130	0	0.180	0	0.000	0	0	87
-	-		33032	400	0.100	10600	0.130	6000	0.130	0	0.180	0	0.000	0	0	87
-	-		33035	400	0.100	10000	0.130	6200	0.130	0	0.180	0	0.000	0	0	87
-	-		33035	0	0.100	3200	0.130	1000	0.130	0	0.180	0	0.000	0	0	87
-	-		33035	0	0.100	24400	0.130	10200	0.130	0	0.180	0	0.000	0	0	87
-	-		33171	0	0.100	5600	0.130	2200	0.130	0	0.180	0	0.000	0	0	87
-	-		33172	400	0.100	16000	0.130	7200	0.130	0	0.180	0	0.000	0	0	87
-	-		33083	0	0.100	15600	0.130	10200	0.130	0	0.180	0	0.000	0	0	87
-	-		33084	400	0.100	7800	0.130	4800	0.130	0	0.180	0	0.000	0	0	87
-	-		33084	0	0.100	2400	0.130	1400	0.130	0	0.180	0	0.000	0	0	87
-	-		38102	0	0.100	6600	0.130	4400	0.130	0	0.180	0	0.000	0	0	87
-	-		38102	0	0.100	7200	0.130	4200	0.130	0	0.180	0	0.000	0	0	87
-	-		38101	0	0.100	3800	0.130	2800	0.130	0	0.180	0	0.000	0	0	87
-	-		38103	200	0.100	5600	0.130	2400	0.130	0	0.180	0	0.000	0	0	87
-	-		38103	0	0.100	4500	0.130	1800	0.130	0	0.180	0	0.000	0	0	87
-	-		38103	0	0.100	2000	0.130	300	0.130	0	0.180	0	0.000	0	0	87
-	-		38103	0	0.100	5800	0.130	2400	0.130	0	0.180	0	0.000	0	0	87
-	-		38103	0	0.100	3200	0.130	1200	0.130	0	0.180	0	0.000	0	0	87
-	-		38103	0	0.100	2600	0.130	1600	0.130	0	0.180	0	0.000	0	0	87
-	-		38103	0	0.100	6000	0.130	3000	0.130	0	0.180	0	0.000	0	0	87
-	-		38131	0	0.100	3000	0.130	1200	0.130	0	0.180	0	0.000	0	0	87
-	-		38131	0	0.100	9000	0.130	5600	0.130	0	0.180	0	0.000	0	0	87
-	-		38061	0	0.100	12800	0.130	8400	0.130	0	0.180	0	0.000	0	0	87
-	-		38061	0	0.100	8400	0.130	5600	0.130	0	0.180	0	0.000	0	0	87

Figure 58. Summary Report Contractor Information (Ramp Lane/Edge Line).

1. The system will ask for the following information:
 - MATERIAL
 - CURRENT YEAR (base year)
 - RANGE (number of years the user wants to prepare long-term budget)
 - DISTRICT
 - INFLATION RATE
2. The user should enter: material, current year, range, district, and inflation rate information into the system. The system will ask for confirmation (Y/N):
 - Y - will proceed.
 - N - back to Step 1.
3. The system will calculate the average unit cost by material and marking type for base year. Please note that the system will include the user's specified inflation rate while calculating the average unit cost. The system will display the average unit cost by material and marking type on the screen. At this point, the user can specify a new average unit cost. By default, the system will use the calculated average unit cost.
4. The system will generate a budget for base year, as shown in Figure 60.
5. The system will repeat steps 3 and 4 for other years depending on the user's input in step 2.
6. As a final step of this module, the system will produce a print-out of the existing data base, based on the previously furnished user's input. The system will ask "Want hard copy printout for base year? (Y/N)."

7. The system will produce an output for base year marking work, as shown in Figure 61, (contract document for base year) if the answer to the above question is "Yes."
8. The system will go back to the initial input screen.
9. The user can produce a new long-term budget by changing the previously submitted inputs.

Module 8. Cost-Effectiveness Analysis

The purpose of this module is to compare various types of marking materials by type based on the present-worth cost. The user can enter into this module by selecting option 8 of RES Subsystem. A screen layout of this module is presented in Figure 62.

1. The system will ask for the following information.
 - MATERIAL
 - DISCOUNT RATE
 - ANALYSIS PERIOD
 - TERMINAL COST (terminal cost at the end of the analysis period)
 - MAINTENANCE COST (most cases it will be \emptyset)
 - DISTRICT
2. The user should enter: material, discount rate, analysis period, terminal cost, maintenance cost and district information into the system. The system will ask for confirmation (Y/N):
 - Y - will proceed.
 - N - back to Step 1.

RAMP LANE/EDGE LINE SUBSYSTEM

MICHIGAN DEPARTMENT OF TRANSPORTATION
SUMMARY REPORT

Route	CONTROL SECTION	Segment Description	Fed. Aid Sys.	NAME OF EXIT	NUMBER OF RAMP	4 in WHITE (LFT)	6 in WHITE (LFT)	6 in YELLOW (LFT)	8 in WHITE (LFT)	12 in WHITE (LFT)	4 in WHITE THERMO PLASTIC
** District: EIGHT			COUNTY: CLINTON			MATERIAL : P					
I-96	19022	GRANGE RD.		84	4	0	5100	2500	0	0	0
I-96	19022	M-100		86	4	0	5300	2700	0	0	0
I-96	19022	GRANGE RD.	FU	84	4	0	5100	2500	0	0	0
I-96	19022	GRANGE RD.		84	4	0	5100	2500	0	0	0
I-96	19022	M-100	FU	86	4	0	5300	2700	0	0	0
I-96	19022	M-100		86	4	0	5300	2700	0	0	0
I-96	19022	GRANGE RD.	FU	84	4	0	5100	2500	0	0	0
I-96	19022	GRANGE RD.		84	4	0	5100	2500	0	0	0
I-96	19022	GRANGE RD.	FU	84	4	0	5100	2500	0	0	0
* Subsubtotal *						0	56900	28300	0	0	0
** Subtotal **						0	56900	28300	0	0	0

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Figure 61. A typical computer generated budget for base year (Ramp Lane/Edgeline Marking).

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«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««
«                                MDOT RAMP LANE/EDGE LINE SUBSYSTEM                                «
«                                COST-EFFECTIVENESS ANALYSIS                                «
«                                                                                «
«                                                                                «
«                                                                                «
«MATERIAL (ENTER EF FOR EPOFLEX, E FOR EPOXY                                «
«                                ET FOR EPOXY PLASTIC, PT FOR POLY THERMO          «
«                                P FOR POLYESTER, TPL FOR THERMOPLASTIC           «
«                                CPL FOR COLD PLASTIC, FD FOR FASTDRY ) :   P      «
«                                                                                «
«DISCOUNT RATE:                      5      ANALYSIS PERIOD:                4      «
«                                                                                «
«TERMINAL COST:                         0      MAINTENANCE COST:              0«
«                                                                                «
«DISTRICT :                             EIGHT                                  «
« .                                                                                  «
«««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««««

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(ENTER QUIT TO EXIT OR MATERIAL TO CONTINUE)

Figure 62. Cost-Effectiveness Analysis Input Screen (Ramp Lane/Edgeline).

3. The system will calculate the present-worth cost of the material by marking type, as shown in Figure 63.
4. The user can determine the present-worth cost for any other materials by following steps 1-3.
5. The user can get a hard copy by using the shift and PRT SCR keys at the same time.
6. The user will compare the hard copy printouts of the different materials and determine the most cost-effective material.

APPENDIX A - SYSTEM INFORMATION

File Information

In order to run PM-MIS in your system, the following files should be installed in your Marking directory.

- MARKING.EXE
- PAVMARK.DBF (Lane/edgeline marking main data base file)
 - PAV1.NTX
 - PAV2.NTX Index files of PAVMARK.DBF
 - PAV3.NTX
 - PAV4.NTX
- PAVCONT.DBF (Lane/edgeline marking contract information file)
 - PCONT.NTX (Index file of PAVCONT.DBF)
- SPECMARK.DBF (Special marking main data base file)
 - SPECIN1.NTX
 - SPECIN2.NTX Index files of SPECMARK.DBF
 - SPECIN3.NTX
 - SPECIN4.NTX
- SPECCONT.DBF (Special marking contract information file)
 - SCONT.NTX (Index file of SPECCONT.DBF)
- RAMP.DBF (Ramp lane/edgeline marking data)
 - RAMPI1.NTX
 - RAMPI2.NTX Index files of RAMP.DBF
 - RAMPI3.NTX
- RAMPCONT.DBF (Ramp lane/edgeline contract information file)
 - RCONT.NTX (Index file of RAMPCONT.DBF)
- PAVBAK.DBF (Archive file of PAVMARK.DBF)
- PAVCBAK.DBF (Archive file of PAVCONT.DBF)
- SPECBAK.DBF (Archive file of SPECMARK.DBF)
- SPECCBAK.DBF (Archive file of SPECCONT.DBF)
- RAMPSBAK.DBF (Archive file of RAMP.DBF)
- RAMPCBAK.DBF (Archive file of RAMPCONT.DBF)

- PAVMARK.FRM (Produce figure 20)
- PAVCONT.FRM (Produce figure 24)
- CONTP.FRM (Produce figure 21)
- SPECMAR1.FRM (Produce figure 39)
- SPECCONT.FRM (Produce figure 43)
- CONTS.FRM (Produce figure 40)
- RAMP.FRM (Produce figure 57)
- RAMPCONT.FRM (Produce figure 61)
- CONTR.FRM (Produce figure 58)
- INDEX.EXE (Index program)

Total number of files = 37

How to create Index files:

.NTX file should be created in the following way:

- You are in Marking directory.
- Type: INDEX.
- System will ask for file to be indexed.
- Type E: PAVMARK (Return)
- Name of Index File: PAV1 (Return)
- Index Field: GEOMETRYL (Return)
- Index Field: GEOMETRYN (Return)
- Index Field: MATERIAL (Return)
- Index Field: (Return)

The user has to create a number of .NTX for various data bases.

For PAVMARK.DBF

1. Main File: E:PAVMARK (Return)
 Index File: PAV1 (Return)
 Index Field: GEOMETRYL (Return)
 Index Field: GEOMETRYN (Return)
 Index Field: MATERIAL (Return)
 Index Field: (Return)
2. Main File: E:PAVMARK (Return)
 Index File: PAV2 (Return)
 Index Field: CONTROLSEC (Return)
 Index Field: CONTRACT1 (Return)
 Index Field: CONTRACT2 (Return)
 Index Field: MATERIAL (Return)
 Index Field: (Return)
3. Main File: E:PAVMARK (Return)
 Index File: PAV3 (Return)
 Index Field: CONTROLSEC (Return)
 Index Field: MATERIAL (Return)
 Index Field: (Return)

4. Main File: E:PAVMARK (Return)
Index File: PAV4 (Return)
Index Field: DISTRICT (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)

For PAVCONT.DBF

1. Main File: E:PAVCONT (Return)
Index File: PCONT (Return)
Index Field: DISTRICT (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)

For SPECMARK.DBF

1. Main File: E:SPECMARK (Return)
Index File: SPECIN1 (Return)
Index Field: SURFACE (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)
2. Main File: E:SPECMARK (Return)
Index File: SPECIN2 (Return)
Index Field: CONTRACT1 (Return)
Index Field: CONTRACT2 (Return)
Index Field: SURFACE (Return)
Index Field: (Return)
3. Main File: E:SPECMARK (Return)
Index File: SPECIN3 (Return)
Index Field: CONTROLSEC (Return)
Index Field: MARKTYPE (Return)
Index Field: (Return)
4. Main File: E:SPECMARK (Return)
Index File: SPECIN4 (Return)
Index Field: DISTRICT (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)

For SPECCONT.DBF

1. Main File: E:SPECCONT (Return)
Index File: SCONT (Return)
Index Field: DISTRICT (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)

For RAMP.DBF

1. Main File: E:RAMP (Return)
Index File: RAMPI1 (Return)
Index Field: CONTRACT1 (Return)
Index Field: CONTRACT2 (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)
2. Main File: E:RAMP (Return)
Index File: RAMPI2 (Return)
Index Field: CONTROLSEC (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)
3. Main File: E:RAMP (Return)
Index File: RAMPI3 (Return)
Index Field: DISTRICT (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)

For RAMPCONT.DBF

1. Main File: E:RAMPCONT (Return)
Index File: RCONT (Return)
Index Field: DISTRICT (Return)
Index Field: MATERIAL (Return)
Index Field: (Return)

Additional Software Requirement

- DBASE III Plus in order to produce any other report and clipper compiler.

Hardware Requirement

- 20 Mg. harddrive with 2 floppy drive.
- Speed of the machine should be 12 Hz.
- Color monitor.

Installation Procedure

1. Go to hard drive.
2. Create Marking directory.
3. Copy program diskettes (3 diskettes) into marking directory.
4. In order to create data base file, first time use DBASE III Plus software and do the following:

5. Type A:
6. Insert system diskette 1 in Drive A.
7. Type "DBASE".
8. Insert system diskette 2.
9. Hit "ESC".
10. Type "SET DEFAULT TO DRIVE D OR E" (your harddrive).
11. Type "USE PAVMARK".
12. Type "ZAP".
13. The system will ask for configuration. Type "Y".
14. "Close Data Base".
15. Repeat steps 11 to 14 for other data base files, i.e.:
 - PAVCONT.DBF
 - SPECMARK.DBF
 - SPECCONT.DBF
 - RAMP.DBF
 - RAMPCONT.DBF and other .DBF files.
16. Type "QUIT".
17. Go back to Marking directory.
18. Create Index files (i.e., NTX files).
19. Load program by typing "MARKING".

Important Note:

- Always use uppercase.
- Anytime the user wants to exit, type ALT-C at the same time, a (A/Q/I) symbol will appear on the upper righthand corner of the screen, type Q and it will close all files and return to Marking directory.

APPENDIX B - MISCELLANEOUS INFORMATION

Archive File Information

In order to extract information from the Archive File the following steps should be followed.

1. Go to Marking Directory.
2. Type "A:", the user should in in Drive A.
3. Insert DBASE III Plus System diskette in Drive A and type DBASE.
4. The System will ask for System Diskette 2. Replace previous System diskette with System Diskette 2 and return, a DBASE III setup screen will appear.
5. Hit "ESC" key, a blank screen with a dot prompt on the lower left-hand corner will appear.
6. Insert diskette with Archive information in Drive B.

Type : Set default to Drive B (Return)

 : Use PAVBACK (for Lane/Edgeline Archive File)

(The user can find the name of the data base file by typing DIR and return.)

 : Browse

The user can move the cursor by using various Browse functions.

 : Hit "ESC" in order to exit from Browse menu.

- If the user wants to print the Archive file information for specific district, type:
 - Report form D: PAVMARK to print for district = "Five"
(to print Lane/Edgeline archive file)
 - Report form D: CONTP to print for district = "Six"
(to print Lane/Edgeline contract information)
 - Report form D: SPECMAR1 to print for district = "Five"
(to print Special Marking archive file)

- Report form D: CONTS to print for district = "Five"
(to print Special Marking contractor information)
 - Report form D: RAMP to print for district = "Five"
(to print Ramp Lane/Edgeline archive file)
 - Report form D: CONTR to print for district = "Five"
(to print Ramp Lane/Edgeline archive file)
- Type: - Close data base*
 - Quit (to return to Marking Directory)

Steps to Modify Search Parameters of Update Information Module

Flow diagrams of various subsystems are included in Figure 64, namely:

1. Lane/Edgeline Subsystem
2. Special Marking Subsystem
3. Ramp Lane/Edgeline Subsystem

The following steps should be followed to modify existing search parameters.

- Examine the flow diagrams and identify related program. For example, if the user wants to modify the search parameters of option 1 (Lane/Edgeline Subsystem), he/she will have to deal with only two programs:
 - RET1.PRG and
 - RET4.PRG
- Make a backup copy of the existing programs before the user attempts to make any change.

* Important Note: Always close data base.

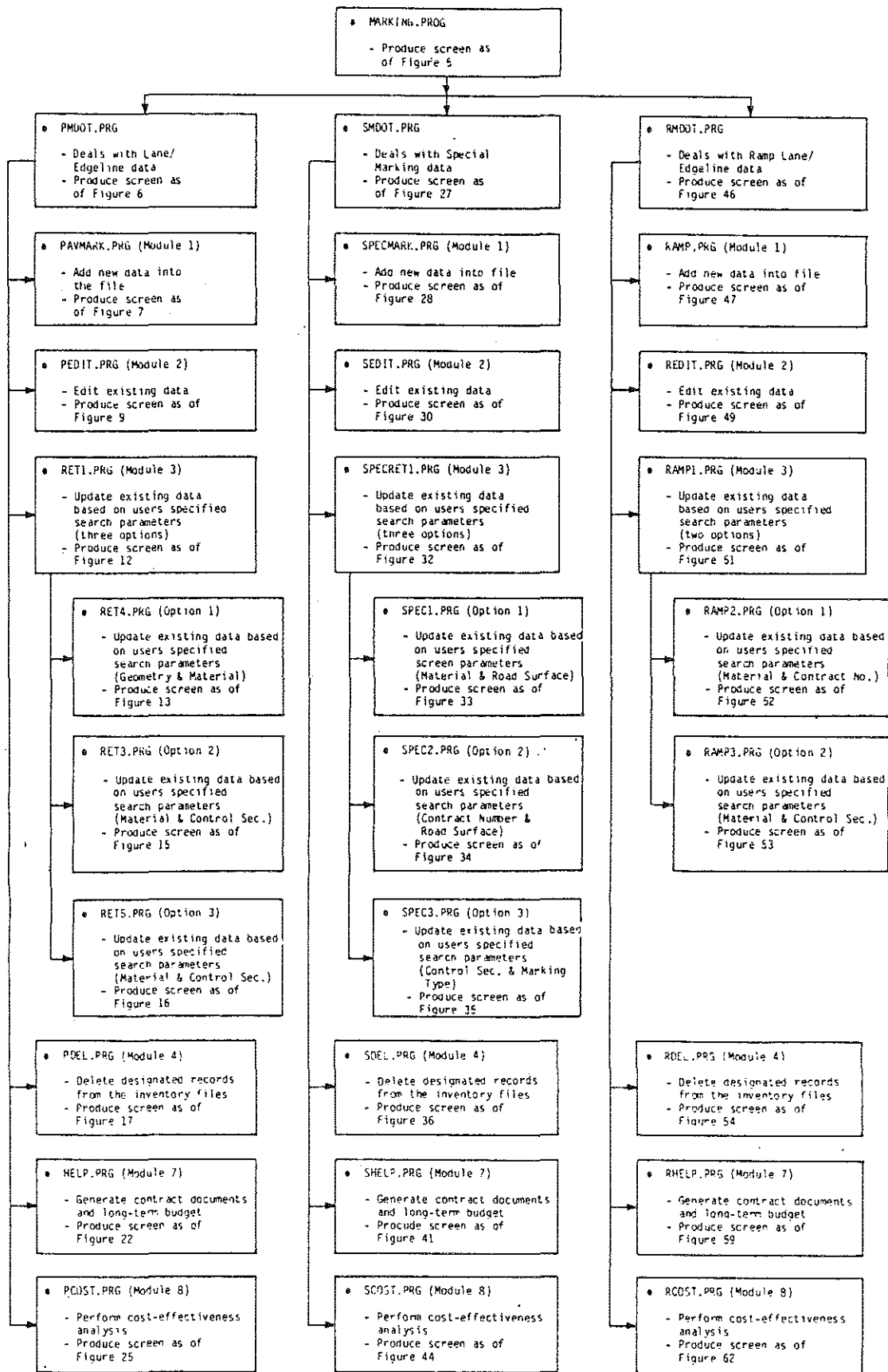


Figure 64. Flow Diagram of PM-MIS Program.

- Replace existing search parameters with the users desired parameters.
- After all necessary modifications have been made, the user should create new index files.